DelDOT

BRIDGE INSPECTION MANUAL

Bridge Inspection Manual

2016

BRIDGE SECTION

Bridge Management Section

BRIDGE INSPECTION MANUAL
2016 Edition

Adopted as policy for all DelDOT Bridge Inspection Projects and Activities as of May 1, 2016

Recommended By:

4/18/16

Bridge Management Engineer

Recommended By:

4/18/16

State Bridge Engineer

Approved By:

Robert B. McCleary 4/18/16

Chief Engineer

Approved By:

Jordan 4/19/16

Cabinet Secretary

Approved For Use on All Federal Aid Projects By:

Mary Ridgeway

Division Administrator, Federal Highway Administration

Preface

Every effort has been made to develop a complete and comprehensive manual which covers the most common situations faced by the DelDOT Bridge Inspection Program; however, this manual cannot supplant proper bridge inspection training or the exercise of good engineering judgement by inspectors and Professional Engineers, especially in cases involving public safety.

Techniques, standards, policies, and technology for bridge inspection and condition reporting constantly evolve. In order to remain current, this document will be updated over time to reflect the industry's changing practices. Updates will be distributed by the Bridge Inspection Engineer when appropriate.

Comments and suggestions for improvement of this Manual should be forwarded to the Bridge Inspection Engineer.

Table of Contents

1. Introduction

1.1 Purpose

The inspection of bridges has historically played, and will continue to play, an important role in assuring a safe transportation system for citizens, commercial and industrial businesses, government agencies, military forces, and emergency agencies nationwide. As bridges continue to age and deteriorate, an accurate and thorough condition assessment of each bridge structure is critical in maintaining a safe, functional, and reliable highway network.

Delaware currently has over 1,600 bridges in its State Bridge Inventory. The Delaware Department of Transportation (DelDOT) is charged with inspecting and reporting the condition of those structures to help maintain the highway network. This manual, in concert with the *Bridge Element Inspection Manual* (BEIM), has been prepared to assist DelDOT, its inspectors, and its consultants in the inventory, inspection, and appraisal of highway bridges on public roadways in the State of Delaware.

The objectives of this Manual are to:

1. Maintain a current inventory of Delaware’s bridges and their condition.
2. Define proper inspection procedures and techniques.
3. Outline uniform, appropriate, and accurate reporting practices.
4. Ensure the safety of the traveling public on Delaware’s bridges.

1.2 Applicability

The majority of bridge structures in Delaware are owned and operated by DelDOT, but can be owned by cities, railroads, Delaware River and Bay Authority (DRBA), Delaware Department of Natural Resources and Environmental Control (DNREC), U.S. Army Corps of Engineers (USACE), or other private owners. This manual applies to the inspection of all bridges located on or over public roads in the State of Delaware as defined in Sections 1.2.3 and 1.2.4, however, portions of this manual may not be applicable to private owners, and these exceptions will be identified throughout the manual.

1.2.1 National Bridge Inspection Standards

The National Bridge Inspection Standards (NBIS), 23 C.F.R. §650 Subpart C, set the criteria for the proper safety inspection and evaluation of all highway bridges in the United States in accordance with 23 U.S.C. §151. This document requires the bridge owners to have a bridge inspection program in place and, as part of that program, maintain a bridge inventory and establish inspection policies and procedures. The NBIS also sets minimum requirements for qualifications of personnel, inspection frequency and inspection procedures on those bridges with federal reporting requirements.

The NBIS also establishes the National Bridge Inventory (NBI), the aggregation of structure inventory and appraisal data collected by each state to fulfill the requirements of the NBIS. The data elements to be recorded in the NBI are published in the Federal Highway Administration's (FHWA) *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (NBI Coding Guide). Section 3.4.2 covers entry of this data required by the NBIS, and the NBI Coding Guide is included in Appendix C.

As referenced in the NBIS, the American Association of State Highway Transportation Officials (AASHTO) Manual for Bridge Evaluation (MBE) provides general inspection standards to create uniformity in the procedures and policies for determining the condition, maintenance needs, and load capacity of the nation's highway bridges.

1.2.2 Delaware Code

Delaware Code Title 17 §529 defines the inspection requirements for bridge owners within the State as related to the NBIS and authorizes DelDOT to oversee the inspection scheduling and reporting for bridges owned by entities other than the Department that lie within the State's boundaries. The full text of Title 17 §529 is included in Appendix C.

1.2.3 NBI Bridges

Bridges required as part of the NBI include:

- Highway bridges located on public roads, regardless of ownership
- Structures, including supports, erected over a depression or an obstruction such as water
- Highway or railway with tracks or passageways for carrying traffic or other moving loads on a public roadway and with openings measured along the center of the roadway of more than 20 feet

between undercopings of abutments, spring lines of arches, or the extreme ends of openings for multiple boxes

- Multiple pipe structures where the clear distance between pipe openings is less than half of the smaller pipe diameter(s), and the combined structure exceeds 20 feet in total span length

1.2.4 Non-NBI Bridges

DelDOT policy also applies to non-NBI bridges including:

- State-owned bridge and culvert structures having an opening of greater than 20 square feet, and a minimum vertical opening of 48 inches
- Pedestrian structures over State maintained public roadways, regardless of ownership
- DelDOT owned pedestrian structures over waterways
- Railroad bridge structures over public roadways

While there are no federal NBI reporting requirements for State-owned bridge and culvert structures or DelDOT-owned pedestrian structures over waterways, they are still included in DelDOT's bridge inventory. The NBIS does not require under record reporting for railroad and pedestrian bridges over highways.

Specific requirements and differences for non-NBI bridges are noted where appropriate in this manual.

1.3 Definitions and Abbreviations

AASHTO – American Association of State Highway and Transportation Officials

ASNT – American Society for Nondestructive Testing

Base Highway Network - The Base Highway Network includes the through lane (mainline) portions of the NHS, rural/urban principal arterial system and rural minor arterial system. Ramps, frontage roads and other roadways are not included in the Base Network.

BDM – Bridge Design Manual, DelDOT

BEIM – Bridge Element Inspection Manual, DelDOT

BIE – Bridge Inspection Engineer

BIRM – Bridge Inspector's Reference Manual, FHWA

BME – Bridge Management Engineer

Bridge (Federal) – Structures, including supports, erected over a depression or an obstruction such as water, a highway or a railway with tracks or passageways for carrying traffic or other moving loads on a public roadway and with openings measured along the center of the roadway of more than 20 feet between undercopings of abutments, spring lines of arches, or the extreme ends of openings for multiple boxes. The term "bridge" shall also include multiple pipe structures where the clear distance between pipe openings is less than half of the smaller pipe diameter(s), and the combined structure exceeds 20 feet in total span length.

Bridge (Private) – Any structure not owned by the State or municipality carrying vehicular or pedestrian traffic on or over a State maintained or public roadway regardless of length of bridge.

Bridge (State) – All structures meeting the federal definition of a bridge, all State-owned bridge and culvert structures having an opening of greater than 20 square feet, and a minimum vertical opening of 48 inches, State-maintained pedestrian structures over roadways, and DelDOT owned pedestrian bridges over waterways.

Bridge Management System (BMS) – A system designed to optimize the use of available resources for the inspection, maintenance, rehabilitation, and replacement of bridges. DelDOT utilizes AASHTO BrM.

C.F.R. – Code of Federal Regulations

Critical Bridge Action Form (CBAF) – Form that documents critical bridge inspection findings and any associated follow-up actions.

Condition State (CS) – Used to describe the condition severity during an element level bridge inspection.

Culvert – A structure designed hydraulically to take advantage of submergence to increase hydraulic capacity. Culverts, as distinguished from bridges, are usually covered with embankment and are composed of structural material around the entire perimeter. Depending on the length, culverts may be classified as NBI or State-owned structures and included in the bridge inventory.

DelDOT – Delaware Department of Transportation

DNREC – Delaware Department of Natural Resources and Environmental Control

DRBA – Delaware River and Bay Authority

FHWA – Federal Highway Administration

Fracture Critical Bridge – A bridge that contains one or more fracture critical members.

Fracture Critical Member (FCM) – Any steel member in tension, or with a tension element, whose failure would cause a portion of or the entire bridge to collapse.

GPR – Ground-Penetrating Radar

IE – Impact Echo Testing

IFRC – Inspection Field Review Checklist

IP – Improvement Plan

IR – Infrared Imaging

IRIB – Indian River Inlet Bridge (Charles W. Cullen Bridge)

LRE – Load Rating Engineer

MBE – *Manual for Bridge Evaluation*, AASHTO

MPT – Magnetic Particle Testing

MUTCD – Manual on Uniform Traffic Control Devices, FHWA

National Bridge Inspection Standards (NBIS) – Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a State bridge inventory. The NBIS apply to all structures defined as bridges located on all public roads.

National Bridge Inventory (NBI) – The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Bridge Inspection Standards. DelDOT shall prepare and maintain an inventory of all bridges subject to the NBIS.

NBI Coding Guide – *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, FHWA

NBIP – National Bridge Inspection Program

NDE – Non-Destructive Evaluation

OSHA – Occupational Safety & Health Administration

PCA – Plan of Corrective Action

PE – Professional Engineer

POA – Plan of Action

PPE – Personal Protective Equipment

Public Road – Any road under the jurisdiction of and maintained by a public authority and open to public travel.

QA/QC – Quality Assurance / Quality Control

QARR – QA Inspection Review Report

QCRR – QC Inspection Report Review Form

SDR – Structural Data Report

SI&A – Structural Inventory and Appraisal

SPRAT – Society of Professional Rope Access Technicians

SR – Sufficiency Rating

Thalweg – A line connecting the lowest points of a waterway.

TL – Team Leader

TM – Team Member

TMC – DelDOT Transportation Management Center

TTC – Temporary Traffic Control

UBIV – Under Bridge Inspection Vehicle

USACE – United States Army Corps of Engineers

UT – Ultrasonic Testing

1.4 References

Annual Book of ASTM Standards
American Society for Testing and Materials International
2016 Publication

Bridge Inspection – Typical Rope Access Techniques, Version 1.02
Society of Professional Rope Access Technicians
May 2015 Publication

Bridge Inspectors Reference Manual (BIRM), Volume 1
Federal Highway Administration
2012 Publication

Bridge Inspector Traffic Safety Features Rating Manual
Maryland State Highway Administration
2007 Publication

DelDOT Bridge Design Manual, 2015 Edition
Delaware Department of Transportation
2015 Publication

DelDOT Bridge Element Inspection Manual
Delaware Department of Transportation
2014 Publication, 2015 Interim Revisions

DelDOT Policy for Inspection and Load Posting of Corrugated Metal Culverts
Delaware Department of Transportation
January 2008 Publication

Manual for Bridge Evaluation, 2nd Edition
American Association of State Highway and Transportation Officials (AASHTO)
2011 Publication, 2015 Interim Revisions

Manual for Inspection and Maintenance: Indian River Inlet "Charles W. Cullen" Bridge
Delaware Department of Transportation
June 2013 Publication

Manual on Uniform Traffic Control Devices (MUTCD)
Federal Highway Administration
2009 Publication, 2012 Interim Revisions

Movable Bridge Inspection, Evaluation, and Maintenance Manual, 1st Edition
American Association of State Highway and Transportation Officials
1998 Publication

Recommended Practice No. SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing
American Society of Nondestructive Testing
2011 Publication

Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges
Federal Highway Administration
1995 Publication

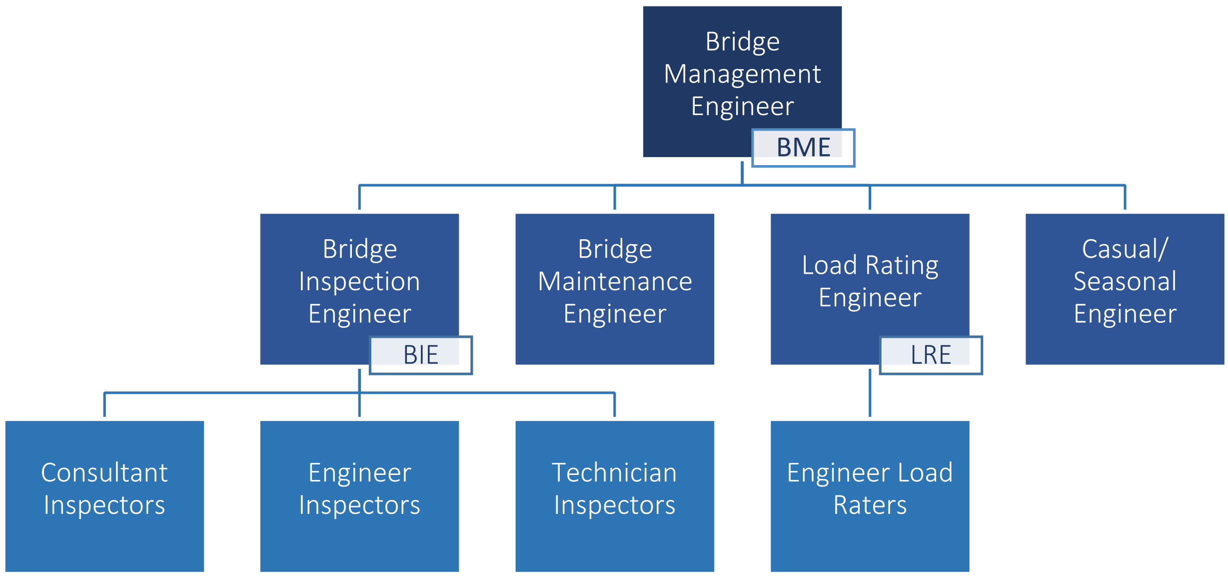
Roadside Design Guide, 4th Edition
American Association of State Highway and Transportation Officials (AASHTO)
2011 Publication, 2014 Interim Revisions

Safe Practices for Rope Access Work
Society of Professional Rope Access Technicians
August 2012 Publication, November 2014 Revisions

2. Bridge Inspection Organization

2.1 Organization Chart

Below is DelDOT's Bridge Management Section organization chart.



2.2 Roles and Responsibilities of Inspection Personnel

DelDOT's Bridge Inspection Program is comprised of many individuals in various roles. The following sections define the responsibilities of those individuals as they relate to the bridge inspection.

2.2.1 Bridge Management Engineer

The Bridge Management Engineer (BME) reports directly to the Assistant Director of the Bridge Department and is responsible for overseeing DelDOT's Bridge Management Section which includes the Bridge Inspection, Load Rating, and Bridge Maintenance Programs. The BME's role in the Bridge Inspection Program is to assure that the goals of the Bridge Management Section are being accounted for and procedures for the Load Rating and Maintenance Programs are being implemented properly in the inspection and inspection reporting processes.

Quality Assurance responsibilities for the BME can be found in Section 4.3.5.2.

2.2.2 Bridge Inspection Engineer

The Bridge Inspection Engineer (BIE) is responsible for overseeing DelDOT's Bridge Inspection Program which includes the Department's inspectors and consultant inspectors. The BIE serves as the point of contact for most in-house and consultant inspection activities involving coordination, critical conditions, and reporting and is ultimately responsible for the successful and timely completion of inspections, maintaining the bridge inventory and records, and administering the Quality Control and Quality Assurance programs.

Quality Control, Quality Assurance, and safety responsibilities for the BIE can be found in Sections 4.2.2.3, 4.3.5.1, and 5.2.2, respectively.

2.2.3 Bridge Inspection Team Leader

The Bridge Inspection Team Leader (TL) is responsible for planning and performing a bridge inspection and preparing the inspection report. This may include coordinating traffic control, arranging for appropriate access equipment, obtaining right of entry to property below and around the structure, and other duties related to performing the bridge inspection. The TL may assign inspection tasks but is responsible for their completion as well as reviewing and signing off on the final report upon submission to and subsequent approval of the BIE.

Quality Control and safety responsibilities for the TL can be found in Sections 4.2.2.2 and 5.2.1, respectively.

2.2.4 Bridge Inspection Team Member

The Bridge Inspection Team Member (TM) is responsible for assisting the TL in their duties planning and performing the inspection and preparing the inspection report. This may include gathering, preparing, and reviewing documents prior to the bridge inspection, any duties involved in performing the inspection, preparation of the inspection report or completing other inspection-related tasks assigned by the TL.

Quality Control responsibilities for the TM can be found in Section 4.2.2.1

2.3 Qualifications of Inspection Personnel

The NBIS establishes minimum qualifications for personnel performing bridge inspections. DelDOT has adopted those requirements and augmented the qualifications for individuals performing routine, underwater, fracture critical, and complex bridge inspections as well as non-destructive evaluation.

Qualifications of inspection personnel have been defined as part of the bridge inspection Quality Control program and can be found in Section 4.2.3.

3. Inspection Policies & Procedures

3.1 Inspection Types

The type of inspection a bridge receives may vary over its useful life to reflect the intensity of evaluation required at a particular time. In the *Bridge Inspector's Reference Manual* (BIRM) FHWA recognizes several basic types of bridge inspection. DelDOT augments those types to cover all situations in the State. The requirements for each inspection type, including levels of access, detail, and testing, are included below.

As part of any type of inspection, some pre-inspection activities may be required and include, but are not limited to:

- Approximately two to four weeks prior to the scheduled inspection date, the TL should visit the bridge to check for the presence or extent of vegetation, debris, or water that may present a safety concern or access issue for the inspection team. The TL should inform the BIE to address any concerns.
- Assess the bridge and adjacent area for current or future construction activities.
- Evaluate equipment, personnel, and access needs.
- Assess water levels or tide charts.

3.1.1 Inventory Inspections

An inventory, or initial, inspection should be performed and finalized in the database within 90 days after completion of work for a new structure or bridge project in which the configuration, material, or design type has changed or been modified in order to document its permanent characteristics and to provide an initial appraisal and baseline of the structure's condition. Completion of work typically corresponds to when the bridge is opened or reopened to traffic. Inspectors should identify any members or details that have been repaired, retrofitted, replaced, or require special attention in future inspections, such as those that are fracture critical.

Per the NBIS, DelDOT is mandated to update and report Structure Inventory and Appraisal (SI&A) information for each NBI length bridge within the state, regardless of ownership. SI&A data items are defined in FHWA's NBI Coding Guide. DelDOT collects and updates SI&A data for non-NBI length bridges as well as state-maintained railroad bridges, but does not report this data to the FHWA. Section 3.5.2 covers NBI coding in BrM. All applicable SI&A items will be populated during this inspection and/or during the BIE's review. The BIE is responsible for assigning bridge numbers.

Items that are generally specific to an inventory inspection include:

- Identification – Bridge ID, feature carried, feature crossed, and location information
- Structure Type and Material – Bridge design and materials, including wearing surface
- Navigation Data – Clearances for vessels on the waterway below, if applicable
- Age and Service – Year built, traffic information, travel lanes, and detour length
- Classification – Classifications of the bridge and feature carried

- Geometric Data – Dimensions of the bridge, roadway, and underclearances (typically taken from the plans and field verified as-needed)
- Load Capacity – HS20 and HL93 Inventory and Operating Ratings and DE Legal Load Restrictions

Refer to the NBI Coding Guide for proper SI&A data selection. Additional SI&A data clarification and resource information can be found in Appendix C.3, which is a modified version of the NBI Coding Guide with DelDOT commentary. Various agency data fields exist within BrM and shall be properly coded during the inventory inspection per the figures in Appendix B.3. Any NBI or agency data field coding questions shall be brought to the attention of the BIE.

DelDOT utilizes element level assessment and reporting for bridges in its inventory. The initial element level assessment is accomplished visually with hand-on inspection techniques used at important locations of the structure such as bearings, along the length of all fracture critical members, fatigue prone details of Category D, E or E', and complex or unusual connections and details. The inspector may also find it necessary to use hands-on techniques to inspect additional areas as a result of observed construction defects or issues noted during the inventory inspection. Elements and coding are defined in DelDOT's *Bridge Element Inspection Manual* (BEIM). During or prior to an inventory inspection, inspectors should select appropriate elements for the structure and define their quantities and scale factors. Any bridge element selection questions shall be brought to the attention of the BIE. Section 3.3 defines visual and hands-on inspection techniques, and Section 3.5.1 covers element level coding in DelDOT's *Bridge Management Software* (AASHTO BrM).

In addition to the inventory items reported, DelDOT requires specific photographs from the inventory inspection to fully document the new structure. Section 3.5.4 specifies the photographs required for each inspection type.

3.1.2 Routine Inspections

A routine inspection is performed during the regular inspection cycle for all State-owned bridges. All exposed elements of the structure should be inspected to determine the physical and functional condition of the bridge. Conditions that may warrant a structural evaluation, affect the traffic safety features of the bridge, affect the rideability of the bridge, or present an immediate concern for the structural stability or safety of the bridge should be noted and immediately communicated to DelDOT. Any critical bridge finding shall follow the protocol as described in Section 3.5.7.

Routine inspections are performed visually with hands-on techniques used at, but not limited to, important locations of the structure such as high moment or shear regions, changes in cross section, previously identified deficiencies, along the length of all fracture critical members, fatigue prone details of Category D, E or E', and those members governing load posting restrictions. The inspector may also find it necessary to use hands-on techniques to inspect additional areas as a result of defects or deficiencies noted during the current inspection. Section 3.3 covers inspection procedures and defines visual and hands-on inspection techniques.

Inspection of underwater elements is usually limited to observations during low-flow and probing for signs of undermining of pier or abutment footings. In wadable water an inspection of underwater elements can be accomplished from above the water surface visually, tactilely, or with a probing rod and should be done during all routine inspections. Soundings should be taken to monitor the condition of the channel bottom along substructure units, center of channel, and at previously identified scour locations. If water depth and flow prevents access with chest waders to structural elements (generally 3-4 feet of water depth depending on flow velocity), inspection of underwater elements may be accomplished through the use of a boat when sufficient clearance is available. If neither waders nor a boat provides sufficient access, an underwater inspection may be necessary (see Section 3.1.4).

Routine inspection frequency is typically 24 months for NBI structures and 48 months for non-NBI structures but can vary based on condition and configuration with an increase in frequency for lower condition ratings. For bridges with NBI condition ratings of 6 or greater, the bridge may be visually inspected in every other routine inspection when deemed appropriate by the BIE; this typically pertains to bridges requiring UBIV or bucket truck/lift access, bridges that span over railroads or roadways, and low clearance structures, where access restrictions are a concern. Ladders may be used during a visual inspection to access pier or abutment bearings for simple span configurations. The following routine inspection will typically utilize lift-type access equipment to perform a more hands-on inspection of the bridge superstructure and substructure units. Similarly, underwater inspectors are used for the following routine inspection of low clearance bridges. Section 3.1.9 defines DelDOT’s inspection frequencies.

3.1.2.1 Low Clearance Inspections

A low clearance bridge refers to those structures that require diving and/or confined space techniques to access the bridge in and outside the water for inspection because of a limited vertical clearance between the waterline and the bottom of the superstructure or deck. The frequency of low clearance inspection follows that of a routine inspection for portions of the bridge outside the water or confined space, while the inspection frequency for the underwater portions of the bridge follows that of an underwater bridge inspection. Inspections should occur at the appropriate frequency based on the bridge classification and condition per Section 3.1.9. Underwater inspectors are required for a hands-on inspection of a low clearance bridge inspection due to the restricted means of access, so inspector qualifications mirror those of an underwater inspection. Low Clearance Inspection Procedures have been established for each low clearance bridge and include inspector qualifications, specified inspection procedures, and guidance for assigning inspection frequency. These procedures can be found in the bridge file. Section 4.2.3.1 states the qualifications of underwater bridge inspectors. Selecting the Underwater inspection type within DelDOT’s BMS for a low clearance inspection signifies that the respective Low Clearance Inspection Procedures were followed during the inspection.

3.1.3 Fracture Critical Inspections

A fracture critical inspection focuses on fracture critical elements and their associated fatigue prone details of a Fatigue Category D, E or E’ of the bridge structure. These elements and details are identified in the Fracture Critical Detail Sheet(s), and inspection procedures are provided in the Fracture Critical Inspection

Procedure document for each corresponding fracture critical bridge. Inspection of fracture critical members must be hands-on and may require additional cleaning, clearing, or access methods prior to or during the inspection to maintain inspector safety and ensure that all elements are inspected at an arm's length. Non-destructive evaluation (NDE) may be used where defects have been identified in the past or when inspectors identify potential defects in the field. Previously identified crack locations shall be checked, measured, and marked on the member with permanent marker noting the end of the crack and date of inspection. All defects shall be documented in the inspection report.

A fracture critical inspection occurs as part of the routine inspection, but may require an increased frequency due to the condition of the fracture critical members. Section 3.1.9 defines DelDOT's inspection frequencies. Additional personnel requirements for fracture critical inspections are identified in the Fracture Critical Inspection Procedures for each fracture critical bridge. These procedures can be found in the bridge file. Section 4.2.3.2 also covers the qualifications of fracture critical bridge inspectors. Selecting the Fracture Critical inspection type within DelDOT's BMS signifies that the respective Fracture Critical Inspection Procedures were followed during the inspection.

3.1.4 Underwater Inspections

An underwater inspection is intended to capture the condition and depths of the channel bottom, scour locations, and condition of bridge components below the high waterline. In water greater than 4 feet in depth, an underwater inspection may require diving or other appropriate techniques. Underwater inspections are typically completed on a 48 month basis but may require an increased frequency as a result of the substructure rating based upon the underwater portions of the substructure element. Additional qualifications and requirements for underwater inspection personnel have been established. This is documented in the Underwater Inspection Procedures that have been established for each bridge requiring an underwater inspection and can be found in the bridge file. These procedures also identify which specific substructure components are to be assessed during the underwater inspection along with specified inspection procedures and guidance for assignment of the underwater inspection frequency. Section 3.1.9 defines DelDOT's underwater inspection frequencies, and Section 4.2.3.1 covers the qualifications of underwater bridge inspectors.

3.1.5 Special Inspections

A special inspection is scheduled at the discretion of the BIE and is typically used to monitor known or suspected defects. An NBI condition rating of 3 or lower will typically trigger a special inspection; however, there may be instances where a special inspection is required for a NBI rating of 4 or higher. This may include inspection of a single member, connection, or areas of scour. Deterioration or damage that affects load carrying capacity, results in bridge closure, or results in lane closure on or under the bridge may be grounds for a special inspection.

The BIE will select appropriate personnel qualifications, frequency, and reporting guidelines of special inspections based on bridge type, elements to be inspected, and nature of the deficiency. Special inspections are performed independent of the routine inspection since they are generally focused on particular elements.

3.1.6 Complex Bridges

Complex bridges include movable, suspension, cable stayed, and may include other bridges with unusual characteristics. DelDOT currently has a total of nine (9) bridges that meet this classification. This list includes seven (7) movable bridges with fracture critical members, one movable bridge without fracture critical members, and the IRIB, which is cable stayed. Section 4.2.3.3 covers the inspector qualifications for each complex bridge type. All complex bridge inspections will follow the requirements of inventory, routine, fracture critical, and underwater inspections as appropriate. Specific Complex Bridge Inspection Procedures have been created for each of the nine (9) bridges and include inspector qualifications, access requirements, specialized testing procedures, and inspection frequency requirements. In addition, Interaction of Structural and Mechanical Systems Inspection Procedures have been created for the eight (8) movable bridges and focus on the locations of the bridge where the structural and mechanical systems interact with each other.

In order to confirm that the complex bridge inspection procedures and Interaction of Structural and Mechanical Systems Inspection Procedures were followed, the TL shall make the following note in the Inspections Notes tab in DelDOT's BMS: "The inspection adhered to the protocol identified in the complex bridge inspection procedures." This will be displayed on the SDR sheets of the finalized inspection report and initialed by the TL.

3.1.6.1 Movable Bridges

Movable bridges require inspections of structural, mechanical, and electrical elements. In addition to the requirements set forth in this manual, movable bridge inspections should comply with the specifications of AASHTO's *Movable Bridge Inspection, Evaluation, and Maintenance Manual*.

The structural portion of the inspection shall follow the requirements of the inventory, routine, fracture critical, and underwater inspections as appropriate. Specific inspection procedures have been created for each of the eight (8) movable bridges and include inspector qualifications, access requirements, specialized testing procedures, and inspection frequency guidance. Additional inspection guidance regarding the structural and mechanical interaction for all movable bridges has been established, is in the inspection file, and can be made available by the BIE to consultant inspection teams for use in the structural inspection.

The electrical and mechanical inspections are typically carried out by a consultant specializing in the inspection, design, and maintenance of such structures. There are two types of inspections pertaining to the electrical and mechanical components, routine and in-depth. The inspection procedures for both types should adhere to the specifications of AASHTO's *Movable Bridge Inspection, Evaluation, and Maintenance Manual*.

Inspectors should coordinate with the BIE and the corresponding Maintenance District to ensure an operator will be available when test openings are required or to obtain access to locked areas of the structure. Approximately 2-4 weeks prior to the scheduled inspection date of a movable bridge, the TL should visit the bridge to check for the presence or extent of debris in the pits. If debris, water, or bird droppings present a safety concern or access issue for the inspection team, the TL should inform the BIE that the pits need to be cleaned. When on site the inspection team should utilize appropriate safety techniques such as maintaining constant contact with the bridge operator and following lock-out/tag-out procedures when necessary. Lock-out/tag-out procedures have been identified for each movable bridge in its *Operation and Maintenance Manual*, available through the BIE.

3.1.6.2 Cable Stayed Bridges

IRIB is currently the only cable stayed bridge in DelDOT's inventory. In addition to the requirements set forth in this manual, IRIB inspections should comply with the specifications of the specific Complex Bridge Inspection Procedures for this bridge and the IRIB *Manual for Inspection and Maintenance*.

3.1.7 Closed Bridges

Public bridges closed to vehicular and pedestrian travel as a result of deterioration or damage and not currently under construction are not required to be inspected while closed unless the BIE determines that special circumstances exist that warrant otherwise, such as a closed bridge in poor condition that spans over a roadway. In such cases, the BIE will identify and document in BrM, the appropriate frequency, procedures, and documentation requirements on a case-by-case basis.

Public bridges that have been closed to vehicular traffic but are still used for pedestrian traffic shall receive a special inspection as part of the DelDOT inspection program. In such cases, the BIE will identify the appropriate frequency, procedures, and documentation requirements on a case-by-case basis.

3.1.8 Bridges under Construction

When any portion of a bridge is open to public travel while under construction, that portion of the bridge is still subject to the bridge's inspection and reporting frequency. Extra coordination efforts may be required to avoid interfering with or interference from construction activities. Due to possible safety concerns, access restrictions, and temporarily modified bridge components resulting from construction activities, modified inspection procedures may be incorporated as specified by the BIE.

Portions of a bridge under construction and not open to public travel shall receive a visual assessment to identify obvious defects or deterioration, as long as it is safe to do so. In addition, the Inspection Team may work with the corresponding Construction Inspector to identify any bridge related issues until travel lanes have reopened. Once reopened, the bridge may be subject to an inventory inspection if the configuration of the structure has changed and requires updated inventory item coding. Inspectors should verify all SI&A information using plans and field observations and update or note changes in the inspection report. The BIE will review the SI&A data prior to finalizing the inspection report in the database.

3.2 Inspection Frequencies

Inspection frequencies will vary based on the configuration of the bridge and its condition. The following tables list the inspection frequencies for both NBI and non-NBI bridges for routine, fracture critical, underwater, and special inspections.

Pedestrian bridges and state-maintained substructures of specific railroad bridges will follow the same policy as a non-NBI bridge.

Inspection Frequency Guidance for NBI Bridges

<table>
<tr><td colspan="2">Routine Inspection Frequency
(NBI Item # 91)</td><td colspan="2">Fracture Critical Inspection Frequency
(NBI Item # 92A)</td><td colspan="2">Underwater Inspection Frequency
(NBI Item # 92B)</td><td colspan="2">Special Inspection Frequency
(NBI Item # 92C)</td></tr>
<tr><td>Condition Ratings
(NBI Items 58, 59, 60, or 62)</td><td>Inspection Frequency
(months)</td><td>Super-structure Rating
(NBI Item 59)</td><td>Inspection Frequency
(months)</td><td>Sub-structure or Culvert Rating
(NBI Items 60 or 62)</td><td>Inspection Frequency
(months)</td><td>Structural Evaluation
(NBI Item 67)</td><td>Inspection Frequency
(months)</td></tr>
<tr><td>≥ 5</td><td>24</td><td>≥ 6</td><td>24</td><td>≥ 6</td><td>48</td><td>≤ 4</td><td>12</td></tr>
<tr><td>≤ 4</td><td>12</td><td>≤ 5</td><td>12</td><td>= 5</td><td>24</td><td colspan="2" rowspan="3">Notes 2 and 3</td></tr>
<tr><td colspan="2" rowspan="2">Notes 1 and 2</td><td colspan="2" rowspan="2">Note 1</td><td>≤ 4</td><td>12</td></tr>
<tr><td colspan="2">Note 1</td></tr>
</table>

Inspection Frequency Guidance for Non-NBI Bridges

<table>
<tr><td colspan="2">Routine Inspection Frequency
(NBI Item # 91)</td><td colspan="2">Fracture Critical Inspection Frequency
(NBI Item # 92A)</td><td colspan="2">Underwater Inspection Frequency
(NBI Item # 92B)</td><td colspan="2">Special Inspection Frequency
(NBI Item # 92C)</td></tr>
<tr><td>Condition Ratings
(NBI Items 58, 59, 60, or 62)</td><td>Inspection Frequency
(months)</td><td>Super-structure Rating
(NBI Item 59)</td><td>Inspection Frequency
(months)</td><td>Sub-structure or Culvert Rating
(NBI Items 60 or 62)</td><td>Inspection Frequency
(months)</td><td>Structural Evaluation
(NBI Item 67)</td><td>Inspection Frequency
(months)</td></tr>
<tr><td>≥ 6</td><td>48</td><td>≥ 6</td><td>24</td><td>≥ 6</td><td>48</td><td colspan="2" rowspan="4">Note 5</td></tr>
<tr><td>= 5</td><td>24</td><td>= 5</td><td>12</td><td>= 5</td><td>24</td></tr>
<tr><td>= 4</td><td>12</td><td>≤ 4</td><td>6</td><td>≤ 4</td><td>12</td></tr>
<tr><td>3 or 2</td><td>6</td><td colspan="2">Note 4</td><td colspan="2">Notes 1 and 10</td></tr>
</table>

Inspection Frequency Guidance Notes:

1. In general the tables above are used for inspection frequency selection. However, for some situations the BIE may select differing inspection frequencies and will provide justification within the structure notes.
2. If the structure is not a culvert and the NBI Item # 67 is a 2 or a 3, then a Special Inspection of specific elements may be implemented at the reduced inspection frequency. Special Inspections include inspection of a single member or connection that is cracked or severely deteriorated. It may also include inspection of extensive scour affecting the substructure. In general, a Special Inspection would be required for any deficiency causing an NBI condition rating of a 3 or less, but may be used for an NBI condition rating of a 4 if the defect/deterioration is localized, and inspecting the entire bridge at an increased routine inspection frequency is not cost effective or feasible. It may be possible that a special inspection is required by the BIE to monitor a specific location, element, or detail that is causing the bridge to be posted, but the condition may be in a fair or good condition due to non-structural repairs that were made. If the structure is a culvert and the NBI Item # 67 is a 2 or a 3, then the bridge will be placed on a 6 month routine inspection frequency.
3. A special inspection may be created if significant damage caused by traffic impact has affected load capacity or has caused closure of the bridge or reduction in the number of lanes on or under the bridge. Determination of whether or not a special inspection is required will be made on a case-by-case basis by the BIE.
4. The inspection frequency for a non-NBI bridge can be increased to 6 months, because the structure is small enough and does not have a big effect on manpower and/or inspection schedules. In the case of a non-NBI bridge that is fracture critical with a superstructure rating of a 3 or less, the routine inspection frequency can remain at 12 months per the discretion of the BIE.
5. Typically non-NBI bridges do not receive special inspections due to their small size and a lack of need; however, a special inspection may be scheduled at the discretion of the BIE.
6. Pin and hanger ultrasonic testing is performed in the same year as the routine inspection, unless the BIE determines that an increased frequency is needed.
7. DelDOT-owned pedestrian bridges are to follow the policy as non-NBI bridges. Privately-owned pedestrian bridges are allowed to have a 60 month inspection frequency as long as NBI Items # 59, 60, and 62 condition ratings are 6 or higher; otherwise, inspection frequency is to follow the policy of a non-NBI (State-length) bridge.
8. Inspection frequencies for state-maintained substructure portions of railroad bridges will follow the policy as a non-NBI (State length) bridge.
9. Ultrasonic testing of bolts for bolted on/through parapets will be considered as part of the routine inspection, and 25% of the bolts will be tested during the routine inspection. If defective bolts are found, the BIE may require testing of additional bolts.
10. Underwater inspections for non-NBI bridges are identified as Low Clearance Bridges.

3.3 Inspection Procedures

This section is intended to serve as an overview of visual and hands-on inspection of typical material types and elements for DelDOT inspections. It follows the layout of elements in the BEIM and highlights Department-specific resources, forms, maintenance reporting, and notification procedures where necessary. Inspectors shall record defects as described in the BEIM for the appropriate elements, including location, orientation, and corresponding dimensions.

When reporting section loss, inspection personnel shall ensure that the information collected is of sufficient detail to accurately document the deterioration. Measurements shall always be taken in a manner which is repeatable for future inspection teams. If feasible, mark where the controlling measurements were taken on the member in the field, so that future inspections teams can track any progressions in deterioration. Information collected shall include, but not be limited to:

- Field verified original cross section
- Member identification (example: *Span 1, Girder 4, Bottom Flange*)
- Location of section loss (relative to a fixed point, example: centerline bearing, diaphragm, etc…)
- Size of section loss including 3 dimensions (example: *4" H x 10' L x 1/4" D section loss*)

If a load rating analysis is warranted (CS4), then pertinent information shall be reported in detail on the Beam or Girder sketch sheets found in Appendix A of this manual. When sketches are used to identify section losses, refer to the sketch in the element condition notes and document losses as a calculated percentage of either section loss or section remaining based on the original cross section. In situations where section loss may not warrant analysis or is general in nature, record the pertinent deterioration information within the condition notes for the appropriate element. Refer to the BIRM and the MBE for a complete discussion of inspection techniques.

Visual inspection is defined by proximity greater than an arm's length from a bridge component, but a distance sufficient enough to permit clear visual identification of defects. Inspection can be performed from the deck surface, ground, or access equipment and could require traffic control and/or specialized equipment to obtain access. Visual techniques are used to identify obvious defects and determine if problem areas warrant additional investigation. Defects including advanced deterioration, distortion, impact damage, and areas of previous repairs/rehabilitations warrant additional investigation and should be inspected utilizing hands-on techniques. Inspectors should always keep in mind that deficiencies and distortions could affect the remainder of the bridge components or indicate larger issues with the structure.

Hands-on inspection is defined by proximity within an arm's length from a bridge component. Inspection can be performed from the deck surface, ground, or access equipment and could require traffic control and/or specialized equipment to obtain access at arm's length. Sketches may be useful or required in describing deteriorations or deficiencies such as section loss requiring structural analysis. Hands-on techniques are often used to further investigate elements identified using visual inspection and can be supplemented with NDE when necessary. Refer to Sections 3.3.11-13 for more information regarding NDE techniques.

Dirt, debris, vegetation, and defects such as rust laminations and delaminated/spalled concrete should be removed to the extent practical to allow for accurate inspector evaluation, but bearing grease should remain untouched. Contact the BIE if the inspector determines more extensive cleaning or bearing grease removal is necessary for proper evaluation based on the observed or previous condition of the bearings.

When removing debris, rust laminations, and delaminated/spalled concrete, inspectors should consider potential impacts to pedestrians, live traffic, parked vehicles, buildings, private property, and the environment. If significant amounts of material are removed from the bridge, it should be collected in a discrete location as a consideration to property owners and to avoid alarming the public. Notify the BIE of materials removed from the bridge that could prompt public reports of damage to the structure.

3.3.1 Bridge Rail

The functions of bridge railings are to contain and redirect errant vehicles on the bridge and separate vehicles from pedestrians. This section only pertains to bridge railing carried by and attached to the bridge. This does not include transitions of adjacent roadway guardrail that is attached to the ends of the bridge railing. Guardrail components not attached to the bridge are not to be included with the bridge railing element as part of the inspection.

Inspect for impact damage, distortion, and missing elements or sections, noting conditions that may prevent the railing from properly redirecting errant vehicles or present blunt ends or protrusions to traffic. Specify in the element inspection notes whether defects are due to deterioration or impact damage. Investigate areas of collision damage for tearing, crushing, spalling, cracking, loss of reinforcing bond, or broken members or connections. Check connections and anchorages to determine if the rail and its components are securely fastened to the bridge. Use a hammer to verify bolted connections are secure. Note any misalignment at transitions and joints. Sight along the lengths of members to identify distortion or misalignment. Distortion, misalignment, or settlement noted during the inspection may be an indicator that other issues associated with the superstructure or substructure may exist and shall be considered and investigated by the TL.

For reporting purposes, note bridge rail conditions under the appropriate element.

<u>Guardrail Considerations</u>

Per the NBI Coding Guide, inspectors must evaluate bridge rail, approach rail, transitions, and end treatments based on conformance to current DelDOT and FHWA standards. Verify rail height, post spacing, materials used, and design of railing systems to aid in assessing acceptability, and crash worthiness. See the Bridge Inspector Traffic Safety Features Rating Manual in Appendix C.6 for a discussion of current bridge rail and guardrail standards (not all safety features will apply in Delaware).

Bridge inspection does not typically include a detailed inspection of the approach guardrail system, however, a brief evaluation of the guardrail system shall be made to identify any obvious safety hazards or deficiencies resulting from prior damage to the rail system. Any significant findings or concerns to the approach roadway guardrail, transitions, and end treatments shall be documented in the Inspection Notes in AASHTO BrM and brought to the attention of the BIE.

Maintenance and Notification

Any condition that jeopardizes the effectiveness of the guardrail system to safely redirect errant vehicles shall be communicated to the BIE and immediately brought to the attention of the Traffic Section and corresponding Maintenance District to have the issue addressed.

3.3.1.1 Metal Bridge Railing

This element refers to all types and shapes of metal bridge railing, including steel, aluminum, metal beam, and rolled shapes. This element also includes metal bridge rail attached to concrete parapet, timber posts, or masonry railing.

Inspect all components of the railing system with an emphasis on corrosion, cracking, and section loss. Inspect welds for cracking. Use a chipping hammer or wire brush to clean areas of corrosion to determine section loss and remaining section as required. If possible, check for water infiltration and interior defects in tubular members.

3.3.1.2 Reinforced Concrete Bridge Railing

This element refers to all types and shapes of reinforced concrete bridge railing, including reinforced concrete with stone facing.

Inspect all components of the railing system with an emphasis on delaminations, spalls, patched areas, exposed reinforcement, efflorescence, rust staining, and cracking. For stone facing, check that all blocks or stones are secure. Sound concrete surfaces and stone facing for delaminations and loose or deteriorated blocks or stones. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required.

Connections for bolted-on or through parapets are to be tested utilizing NDE at a rate of 25% or higher per routine inspection cycle per BIE direction. If defective bolts are found in the sample, the BIE may increase the testing requirement or frequency. See Section 3.3.11 for a discussion of these techniques.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

A recommendation to apply a protective coating to seal cracks in parapets is a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Deterioration of stone facing shall be noted in the inspection report and brought to the attention of the BIE.

3.3.1.3 Timber Bridge Railing

This element refers to all timber bridge railing, including timber posts for metal rails.

Inspect all components of the railing system with an emphasis on decay, checks, cracks, splits, crushing, and abrasion. All bolted connections shall be checked for tightness, corrosion, and cracking. Interior timber defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of decay and insect or fire damage to determine the extent of the defect.

3.3.1.4 Masonry Bridge Railing

This element refers to all types and shapes of masonry bridge railing, excluding stamped concrete and reinforced concrete with stone facing.

Inspect all components of the railing system with an emphasis on delaminations, spalls, efflorescence, rust staining, mortar deterioration, and split, spalled, loose, or displaced/missing masonry; sound masonry for delaminations and loose or deteriorated blocks or stones. Check mortar for deterioration, loss, cracks, vegetation growth, and water seepage. Quantify mortar deterioration in the report as a percentage per linear foot of railing. At exposed ends, note cracks and deterioration that could indicate loss of interlocking and potential for failure.

3.3.2 Curbs, Medians, Sidewalks, and Drains

The function of curbs and medians is to separate vehicles from each other in adjacent travel lanes, and from pedestrians on the bridge. Sidewalks serve to provide pedestrians with a safe means of crossing the bridge. Curbs and drains direct and remove water and debris from the structure.

Observe the curb, topside of sidewalk, all faces of median, drains, and scuppers from the deck. The underside of sidewalk, median connections, outboard sides of drains and scuppers, and drain pipes require inspection from below. Note median rail height, post spacing, materials used, and design of railing systems to aid in assessing acceptability and crash worthiness. Inspect for impact damage, misalignment, and distortion, noting conditions that may prevent the median from properly redirecting errant vehicles. Inspect sidewalks for structural defects as well as their ability to allow easy and safe movement of pedestrians across the bridge. Structural defects, debris, and vegetation growth on or near the sidewalk can all affect pedestrian use of the structure. Check that curbs and drains are sufficiently clear and free of defects to redirect water from the bridge deck and away from the bridge components below. Check for damage, misalignment, distortion, and any conditions that present blunt ends or protrusions to traffic or present tripping or other hazards to pedestrians.

For all elements, check connections and anchorages to determine if the elements are securely fastened. Use a hammer to verify that bolted connections are secure. Note any misalignment at transitions and joints. Sight along the lengths of members to identify distortion.

Maintenance and Notification

Notify the BIE of significant damage or deterioration of sidewalks that may affect the safety of pedestrians.

3.3.2.1 Reinforced Concrete Curb, Median, and Sidewalk

This element refers to all types and shapes of reinforced concrete curbs, mountable and non-mountable raised medians, and sidewalks, including only those elements that are placed directly on top of the bridge deck, slab, or culvert.

Inspect all components with an emphasis on delaminations, spalls, patched areas, exposed reinforcement, efflorescence, rust staining, and cracking. Sound concrete surfaces for delaminations. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

A recommendation to apply a protective coating to seal cracks in sidewalks is a Maximo Priority 1 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Deterioration of stone facing shall be noted in the inspection report and brought to the attention of the BIE.

3.3.2.2 Steel Curb, Median, and Sidewalk

This element refers to all types and shapes of steel curbs, mountable and non-mountable raised medians, and sidewalks, including open and filled steel grid sidewalk.

Inspect all components with an emphasis on corrosion, cracking, and section loss. Use a chipping hammer or wire brush to clean areas of corrosion to determine section loss and remaining section as required. Note deteriorated, spalled, and flaking concrete in filled steel grid sidewalks.

3.3.2.3 Timber Curb and Sidewalk

This element refers to all types and shapes of timber curbs and sidewalks.

Inspect all components with an emphasis on decay, checks, cracks, splits, crushing, and abrasion. Interior timber defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of decay and insect or fire damage to determine the extent of the defect.

3.3.2.4 Masonry Curb, Median, and Sidewalk

This element refers to all types and shapes of masonry curbs, mountable and non-mountable raised medians, and sidewalks, excluding stamped concrete and reinforced concrete with stone facing.

Inspect all components with an emphasis on delaminations, spalls, efflorescence, rust staining, mortar deterioration, and split, spalled, loose, or displaced/missing masonry; sound masonry for delaminations and loose or deteriorated blocks or stones. Check mortar for deterioration, loss, cracks, vegetation growth, and water seepage. Quantify mortar deterioration in the report as a percentage per linear foot of the element. At exposed ends, note cracks and deterioration that could indicate loss of interlocking and potential for failure.

3.3.2.5 Bridge Drains

This element refers to all types, shapes, and materials of bridge drains and drain systems, including scuppers, catch basins, downspouts, and clean-outs that are on or attached to the bridge structure.

Inspect all components with an emphasis on corrosion, cracking, alignment, and effectiveness. Note debris and vegetation inside the drainage system as well as signs of clogging or leakage on the surrounding elements. Indicate if drainage water is not being directed away from the structure, and identify ponding water on the deck and beneath the structure. Inspect couplers and attachments to the bridge. Note misaligned or disconnected basins or downspouts.

Maintenance and Notification

A recommendation to clean out scuppers and/or drains requires a Maximo Priority 2 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.3 Approach Slab

Approach slabs provide the transition between the approach roadway and bridge structure. This element refers to all reinforced concrete and prestressed concrete structural slabs that exist between the bridge abutment and approach roadway pavement.

Inspect the approach slab with an emphasis on delaminations, spalls, exposed reinforcement or prestressing, cracking, wear, and settlement. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required.

Observe live traffic and/or drive across the approach slab to determine the severity of any vertical offsets and the rideability of the surface. Note erosion below or adjacent to the slab and investigate its extent. When the approach slab is not visible due to a wearing surface, assess the condition based on the available visible surface such as cracking or settlement of the wearing surface. For rating purposes, treat bituminous patches as unsound patched areas.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

A recommendation to repair approach slab spalls requires a Maximo Priority 2 Maintenance Request. A recommendation to apply a protective coating to seal cracks in an approach slab is a Maximo Priority 1 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of potholes large enough to receive a spall defect rated in CS3 per the BEIM.

3.3.4 Deck/Slab

The functions of a bridge deck are to provide a smooth riding surface across the bridge and transfer vehicle loads to the superstructure. Slabs serve as both the deck and superstructure, directly transferring vehicle loads to the substructure. Decks and slabs must be evaluated for structural condition, effectiveness in transferring loads to the superstructure or substructure, and ability to provide a smooth riding surface.

Deck and slab evaluation is largely dependent on its configuration and interaction with the superstructure. Problem areas for decks and slabs are generally at joints and high stress regions such as midspan and over piers and at supports for continuous spans; however, all elements should be inspected for defects.

Observe traffic or drive across the bridge deck to determine vertical offsets and rideability. Look for excessive or non-uniform deflections in the deck. For surfaces of the deck not visible due to a wearing surface and/or stay in place forms, assess the condition based on the available visible surface for cracking or settlement of the wearing surface or corrosion to stay in place forms. For condition rating purposes, treat any bituminous patch as though it is an unsound patched area.

Additional Resources

Further deck evaluation techniques may be necessary based on inspection findings or per BIE direction. See Section 3.3.12 for a discussion of these techniques.

Maintenance and Notification

Notify the BIE of significant damage or deterioration of the deck or slab that may affect the riding surface, or if there are signs of a pending punch-thru in a concrete deck or slab.

3.3.4.1 Reinforced Concrete Deck/Slab

This element refers to all reinforced concrete bridge decks and slabs but does not include concrete or asphaltic wearing surfaces. This element also includes precast reinforced concrete deck/slab panels that are posttensioned together. Refer to Section 3.3.10 for a discussion of wearing surfaces and protective coatings.

Inspect the deck with an emphasis on delaminations, spalls, exposed reinforcement, efflorescence, rust staining, cracking, and wear. Sound concrete surfaces for delaminations. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required. For precast decks, check connections and anchorages to determine if the deck panels are securely fastened together and to the superstructure.

Further deck evaluation techniques such as chain drag, impact echo, coring, and infrared (among others) may be necessary based on inspection findings or per BIE direction. See Section 3.3.12 for a discussion of these techniques.

Precast Deck Panels Inspection Considerations

Bridges with precast reinforced concrete deck panels shall be inspected for the defects and distress using the techniques described in Section 3.3.4.1 with additional considerations. Adjacent concrete along longitudinal and transverse deck panel seams and joints shall be checked for delaminations, cracking, and rust staining. Connections shall be checked to confirm that deck panels are securely fastened to beams.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

A recommendation to repair deck spalls requires a Maximo Priority 2 Maintenance Request. A recommendation to apply a protective coating to seal cracks in the deck is a Maximo Priority 1 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of potholes or other areas of deterioration in the riding surface large enough to receive a spall defect rated in CS3 per the BEIM.

3.3.4.2 Prestressed Concrete Deck

This element refers to all prestressed concrete bridge decks and precast prestressed deck panels with or without posttensioning. This does not include concrete or asphaltic wearing surfaces; refer to section 3.3.10 Wearing Surfaces and Protective Coatings for guidance.

Inspect the deck with an emphasis on delaminations, spalls, exposed reinforcement, exposed prestressing, efflorescence, rust staining, cracking, wear, and settlement. Sound concrete surfaces for delaminations. Clean exposed reinforcement or prestressing with a chipping hammer or wire brush to determine section loss and remaining section as required. For precast decks, check connections and anchorages to determine if the deck panels are securely fastened to each other, the superstructure, and/or the substructure.

Further deck evaluation techniques such as chain drag, impact echo, coring, and infrared (among others) may be necessary based on inspection findings or per BIE direction. See Section 3.3.12 for a discussion of these techniques.

Precast Deck Panels Inspection Considerations

Bridges with precast reinforced concrete deck panels shall be inspected for the defects and distress using the techniques described in Section 3.3.4.1 with additional considerations. Adjacent concrete along longitudinal and transverse deck panel seams and joints shall be checked for delaminations, cracking, and rust staining. Connections shall be checked to confirm that deck panels are securely fastened to beams.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

A recommendation to repair deck spalls requires a Maximo Priority 2 Maintenance Request. A recommendation to apply a protective coating to seal cracks in the deck is a Maximo Priority 1 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of potholes or other areas of deterioration in the travel lanes large enough to receive a spall defect rated in CS3 per the BEIM.

3.3.4.3 Timber Deck/Slab

This element refers to all timber bridge decks and slabs created using solid, glue-laminated, and nail-laminated timbers. This does not include timber running plank wearing surfaces; refer to Section 3.3.10.1 Wearing Surfaces and Protective Coatings for inspection guidance.

Inspect the deck with an emphasis on decay, checks, cracks, splits, crushing, and abrasion. Note delamination of laminated timber members. Check connections and anchorages to determine if the deck and individual members are securely fastened to each other, the superstructure, and/or the substructure. Use a hammer to verify that bolted connections are secure. Interior timber defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of decay and insect or fire damage to determine the extent of the defect.

NDE techniques such as sonic stress wave may be necessary based on inspection findings per BIE direction. See Section 3.3.13 for a discussion of these techniques.

3.3.4.4 Steel Deck

This element refers to all steel bridge decks, including open grid, concrete filled grid, and corrugated decks.

Inspect the deck with an emphasis on corrosion and cracking. Inspect for damaged, distorted, bent, or torn bars in a grid deck. Check connections and anchorages to determine if the deck and its components are securely fastened to adjacent panels, the superstructure, and/or the substructure. Use a hammer to verify that bolted connections are secure. Inspect welds for cracking. Use a wire brush to clean areas of corrosion to determine section loss and remaining section as required. Note deteriorated concrete in filled steel grid decks. Observe and listen to live traffic, listening for popping or banging which may indicate a broken grid or loose connections.

NDE techniques such as dye-penetrant and ultrasonic testing (among others) may be necessary based on inspection findings. See Section 3.3.11 for a discussion of these techniques.

Maintenance and Notification

A recommendation to repair connections or replace damaged areas of an open grid deck is a Maximo Priority 3 Maintenance Request. A recommendation to clean and paint deteriorated primary load carrying steel members requires a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.4.5 Other Deck/Slab

This element refers to all composite and plastic bridge decks and slabs. This does not include concrete or asphaltic wearing surfaces; refer to Section 3.3.10 Wearing Surfaces and Protective Coatings for inspection guidance.

Inspect the deck with an emphasis on cracking, delaminations, spalls, and deterioration. Check connections and anchorages to determine if the deck and its components are securely fastened to adjacent panels, the superstructure, and/or the substructure. Use a hammer to verify that bolted connections are secure. Inspect welds for cracking. Interior defects not visible to the inspector may be located using a hammer to sound. Clean and inspect areas of deterioration to determine the extent of the defect, section loss, and remaining section.

3.3.4.6 Asphaltic Concrete Overlay

This element refers to the asphaltic concrete surface of reinforced concrete frames or box culverts with overlays placed directly on top. This does not include concrete or asphaltic wearing surfaces; refer to Section 3.3.10 Wearing Surfaces and Protective Coatings for inspection guidance.

Inspect the overlay with an emphasis on delaminations, spalls, cracking, and wear, especially noting conditions that may signify deterioration in the underlying structural element. Inspectors should also note any bulging or settlement of the overlay or if drains, joints, or other elements have been unintentionally paved over.

Maintenance and Notification

A recommendation to repair overlay requires a Maximo Priority 2 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.5 Joints

The function of joints is to allow for the movement of the deck and superstructure in expansion and contraction while minimizing the ability of water, dirt, road salt, and other debris from impacting the superstructure, bearings, and substructure. Joints should provide a smooth roadway transition from the approach to the bridge and between bridge spans.

Inspect joints from above and below for damage and distortion due to traffic and snow plows, especially noting conditions that present blunt ends or protrusions to traffic or hazards to pedestrians or prevent bridge movement. Observe and listen to traffic or drive across the joint to determine vertical offsets, rideability, and loose components.

Note vertical displacement in the deck at the joint, recording which side of the joint is higher. This is especially important when the second half of the joint (in the direction of traffic) is higher causing an impact loading on the bridge as traffic passes. Measure the opening of every joint at the right shoulder stripe when moving up station. When safe to do so measure the joint opening at the left stripe as well. Check for a uniform horizontal opening across the length of the joint. Document joint opening measurements in the inspection report along with ambient temperature in degrees Fahrenheit.

Check connections and anchorages to determine if the joint is securely fastened. Watch for movement under live load to detect if anchorages are loose or damaged. Use a hammer to verify that bolted connections are secure. Inspect welds for cracking.

Sound the adjacent concrete header for delaminations. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required. Remove deteriorated and soft concrete near joints to determine if anchorages are securely embedded.

Additional Resources
Refer to Section 5.5 of the BEIM for joint type descriptions and schematics.

Maintenance and Notification
A recommendation to repair header spalls requires a Maximo Priority 2 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of significant damage or deterioration of joint armoring that may present a safety hazard for motorists or pedestrians.

3.3.5.1 Joints with Glands

This element refers to expansion joint devices which utilize a neoprene type of waterproof gland with some type of metal extrusion or other system to anchor the gland, including strip seals, compression joints, and modular assembly joints.

Inspect the seal with an emphasis on leakage, adhesion, damage, and cracking. Check for signs of water leakage or debris on the elements below. If debris accumulations are present, carefully clean out or probe debris to determine the condition of the gland. Inspect the remainder of the joint and adjacent header with an emphasis on debris, delaminations, spalling, corrosion, and cracking.

Maintenance and Notification
A recommendation to repair header spalls requires a Maximo Priority 2 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of significant damage or deterioration of joint armoring that may present a safety hazard for motorists or pedestrians.

3.3.5.2 Joints without Glands

This element refers to expansion joint devices which are open and not sealed, including finger, sliding plate, and open joints.

Inspect the joint and adjacent header with an emphasis on debris, delaminations, spalling, corrosion, and cracking. Note lateral and vertical misalignment of finger joints and check if the condition prevents bridge movement.

Also note joint trough defects under this element. Inspect for leakage, damage, tearing/cracking, corrosion, and debris. Check connections to the deck or joint. Note leakage and debris on elements below and the trough's ability to drain water away from the bridge.

Maintenance and Notification
A recommendation to repair header spalls requires a Maximo Priority 2 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of significant damage or deterioration of joint armoring that may present a safety hazard for motorists or pedestrians.

3.3.5.3 Joints with Pourable or Asphaltic Seal

This element refers to joints with a pourable or asphaltic type of seal with or without a backer rod.

Inspect the seal with an emphasis on leakage, adhesion, damage, and cracking. Note deteriorated or missing material as well as debris and vegetation growth. If debris accumulations are present, carefully clean out or probe debris to determine the condition of the seal.

Inspect the remainder of the joint and adjacent header with an emphasis on debris, delaminations, spalling, and cracking. Check for signs of water or debris infiltration through the joint and under adjacent elements.

Maintenance and Notification
A recommendation to repair header spalls or re-seal pourable deck joints requires a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.6 Superstructure

The function of the superstructure is to safely transfer loads from the deck to the substructure. The superstructure must be evaluated for structural condition and ability to transfer loads.

Superstructure inspection is largely dependent on its configuration and interaction with the deck. Use design plans to identify primary and secondary load carrying members. Problem areas often include locations of maximum moment, maximum shear, bearing, section change, and connections; however, all elements should be inspected for defects. Elements such as cables, truss members, gusset plates, non-redundant beam elements, and pin and hanger assemblies are especially sensitive to abrasion and minor defects that lead to section loss such as surface corrosion and decay. These elements should be inspected closely for defects.

Inspect for impact damage and distortion, especially noting conditions that may weaken the structure. Note water draining or leaking onto, and debris buildup on and around elements along with associated defects.

Note any misalignment at transitions and joints. Sight along the lengths of members and along the entire structure to identify distortion and misalignment. Look for excessive or non-uniform deflections in the superstructure under both dead and live loading. Ensure that superstructure elements do not have excessive negative camber which could indicate loss of composite action with the deck or other problems. Check that weepholes in box beams and other enclosed members are open and functional.

Sketches shall be required in documenting advanced deterioration and section loss in critical areas of primary members or if the inspector is recommending a load rating of the structure due to its condition.

Additional Resources

Refer to Section 6.5 for inspection guidance on impact damage.

Beam sketch sheets can be found in Appendix A to document advanced deterioration of superstructure members.

Maintenance and Notification

Notify the BIE of significant damage or deterioration of superstructure elements warranting an NBI Condition Rating of 4 or less or presenting a safety hazard for motorists or pedestrians.

3.3.6.1 Steel Superstructure

This element refers to all types and shapes of steel superstructure elements, including girders, floorbeams, stringers, trusses, arches, cables, pin and hanger assemblies, and diaphragms.

Inspect all components of the superstructure with an emphasis on corrosion, cracking, and section loss. Check connections to determine if the elements are securely fastened. Use a hammer to verify that bolted connections are secure. Inspect welds and surrounding areas for cracks. Use a chipping hammer or wire brush to clean areas of corrosion to determine section loss and remaining section as required. Fracture critical members and fatigue-prone details with Fatigue Category D or worse should be inspected hands-on. Clean areas around a suspected crack to visually confirm and identify its limits. NDE techniques may be utilized for cracks or suspected cracks of steel primary load carrying members to confirm existence and length. After identifying the limits and recording dimensions, mark and date crack lengths on the element for future monitoring. Refer to section 3.3.11 for more discussion and guidance.

Gusset plates and their connections should be inspected for distortion and out-of-plane bending. Cables should specifically be checked for fraying strands, slipping at connections, and moisture buildup. Inspect pin and hanger assemblies for proper movement and alignment. Check for signs of a frozen assembly such as unbroken paint film. Hangers should be inspected closely for cracks, especially at the thinnest portion of its eye. Pins may be hidden for inspection, but are to be tested utilizing NDE at a rate of 100% per routine inspection cycle or at a frequency determined by the BIE. Inspectors shall coordinate with the BIE and District maintenance personnel prior to commencing the inspection for removal of pin covers. If defective assemblies are found in the sample, the BIE may increase the testing frequency.

Maintenance and Notification

A recommendation to clean and paint deteriorated primary load carrying steel members requires a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.6.2 Reinforced Concrete Superstructure

This element refers to all types and shapes of reinforced concrete superstructure elements, including girders, floorbeams, stringers, arches, and diaphragms.

Inspect all components of the superstructure with an emphasis on delaminations, spalls, exposed reinforcement, efflorescence, rust staining, and cracking. High positive and negative moment regions shall be checked for flexural cracking, and beam ends shall be inspected for shear cracking. Check for indications of lost fill material from filled arches. Sound concrete surfaces for delaminations. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required.

Further concrete evaluation techniques such as impact echo, coring, and infrared (among others) may be necessary based on inspection findings or per BIE direction. See Section 3.3.12 for a discussion of these techniques.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

3.3.6.3 Prestressed Concrete Superstructure

This element refers to all types and shapes of prestressed concrete superstructure elements, including girders, floorbeams, and stringers.

Inspect all components of the superstructure with an emphasis on delamination, spalls, exposed reinforcement, exposed prestressing, efflorescence, rust staining, and cracking. High positive and negative moment regions shall be checked for flexural cracking, and beam ends shall be inspected for shear cracking. Check for indications of lost fill material from filled arches. Sound concrete surfaces for delaminations. Clean exposed reinforcement or prestressing with a chipping hammer or wire brush to determine section loss and remaining section as required.

Further concrete evaluation techniques such as impact echo, coring, and infrared may be necessary based on inspection findings or per BIE direction. See Section 3.3.12 for a discussion of these techniques.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

A recommendation to clean or clear weepholes in prestressed concrete box beams requires a Maximo Priority 1 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.6.4 Timber Superstructure

This element refers to all types and shapes of timber superstructure elements, including girders, floorbeams, stringers, trusses, arches, and diaphragms created using solid, glue-laminated, and nail-laminated timbers.

Inspect all components of the superstructure with an emphasis on decay, checks, cracks, splits, crushing, and abrasion. Note delamination of laminated timber members. Check connections and anchorages to determine if the superstructure elements are securely fastened. Use a hammer to verify that bolted connections are secure. Note any misalignment at transitions and joints. Interior timber defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of decay and insect or fire damage to determine the extent of the defect.

NDE techniques such as sonic stress wave may be necessary based on inspection findings per BIE direction. See Section 3.3.13 for a discussion of these techniques.

3.3.6.5 Masonry Superstructure

This element refers to all types and shapes of masonry or stacked stone arches.

Inspect all components of the superstructure with an emphasis on efflorescence, rust staining, mortar deterioration, spalled masonry, patched masonry, and displacement of stones. Check for indications of lost fill material for filled arches. Sound masonry for delaminations and loose or deteriorated blocks or stones. Check mortar for deterioration, loss, cracks, vegetation growth, and water seepage. Quantify mortar deterioration in the report as a percentage per linear foot of the element. Note cracks, deterioration, misalignment, and displacement that could indicate loss of interlocking and potential for failure at exposed ends, spandrel walls, along the springlines, and along the arch centerline.

3.3.6.6 Other Superstructure

This element refers to all types and shapes of composite, plastic, and other material girders, floorbeams, stringers, trusses, arches, and cables.

Inspect all components of the superstructure with an emphasis on corrosion, cracking, delaminations, spalls, efflorescence, rust staining, and deterioration. Check connections and anchorages to determine if the superstructure elements are securely fastened. Use a hammer to verify that bolted connections are secure. Interior defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of deterioration to determine the extent of the defect. Use a wire brush to clean areas of corrosion and decay to determine section loss and remaining section as required.

3.3.7 Bearings

The functions of bearings are to transfer loads from the superstructure to the substructure and to accommodate normal bridge movement due to vehicle and thermal loads, in the longitudinal and transverse directions and in rotation. Bearings must be evaluated for condition, ability to transfer loads, and ability to allow for bridge movement.

Bearing evaluation is dependent on the design of the structure and bearing types. Use field observations and, if necessary, design plans to determine the locations of fixed and movable bearings and the overall design of the structure.

Note water leakage from above, ponding water, and debris on or around the bearing, especially noting conditions that may prevent normal bridge movement. Loss of bearing area, over-expansion or contraction, and signs of frozen or locked bearings should be inspected hands-on. Check connections and anchorages to determine if the bearing is securely fastened to both the bearing seat and superstructure. Use a hammer to verify that bolted connections are secure. Inspect welds within the bearing assembly and between the bearing and surrounding structure for cracking. Use a chipping hammer or wire brush to clean areas of corrosion to determine section loss and remaining section as required.

For visual inspections, record the general bearing expansion or contraction condition along with the ambient temperature in degrees Fahrenheit. For hands-on inspections, measure and report the expansion or contraction of movable bearings along with the steel or concrete temperature in degrees Fahrenheit (ambient temperature is acceptable). Check for signs of a frozen bearing such as pack rust, unbroken paint film, or undisturbed debris in the normal path of movement. Report lateral or vertical misalignment as well as expansion/contraction causing bearing overhang and effects on bearing contact and bearing area.

Sound the adjacent concrete of the bearing seat for delaminations. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required. Measure loss of bearing and the original bearing dimensions in order to report bearing loss as a percent of overall bearing area. A photo and sketch is required for bearing loss greater than 10%.

Additional Resources

Refer to Section 5.4 of the BEIM for bearing type descriptions and schematics. The Rocker Bearing Measurement Sheet can be found in Appendix A to document advanced deterioration of superstructure members.

Maintenance and Notification

A recommendation to clean or flush bearings or bearing seats requires a Maximo Priority 1 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of significant damage or deterioration of bearing elements warranting an element CS4.

3.3.7.1 Bearings with Elastomers

This element refers to elastomeric and pot-type bearings with or without fabric or metal reinforcement.

Inspect the elastomer with an emphasis on bulging, splitting, and tearing. Inspect the remainder of the bearing with an emphasis on corrosion, movement, alignment, and loss of bearing area. Measure and report gaps, bulging, deformation, curling, sliding, walking, or crushing in elastomeric material. Inspect for variable elastomer thickness that could indicate uneven bearing pressure.

3.3.7.2 Bearings without Elastomers

This element refers to movable, rocker, enclosed/concealed, fixed, and disk bearings without an elastomeric component.

Inspect the bearing with an emphasis on corrosion, movement, alignment, and loss of bearing area. The DelDOT Rocker Bearing Measurement Sheet in Appendix A shall be used to document defects in CS3 or 4 for any defect category per the BEIM.

3.3.7.3 Other Bearings

This element refers to other bearings regardless of translation or rotation constraints.

Inspect the bearing with an emphasis on corrosion, movement, alignment, and loss of bearing area.

3.3.8 Substructure

The function of the substructure is to transfer loads from the superstructure to the foundation. Substructure elements must be inspected for structural condition, ability to carry loads, and adequacy of foundation. Even though they are not critical in transfer of live loads, this section is also applicable to retaining walls and headwall elements.

Check for signs of differential and uniform settlement, sliding, and rotation of the substructure unit. Sight along the lengths of substructure elements to identify distortion and misalignment, and sight along the entire structure to identify uneven settlement or abnormal rotations. Use non-uniform or excessive bearing movements, deck joint openings, substructure joint openings, and new substructure cracks as an indicator that substructure elements may be experiencing undesired settlement, sliding, or rotation. When measuring rotations, use a well-defined and repeatable method so that the condition can be monitored during future inspections. Document the method and measurements in the corresponding substructure element in the inspection report. When feasible, provide permanent markings on the substructure unit where measurements will be repeated.

Look or probe around the base of substructure elements to check for erosion, scour, and undermining. Check if the footing has been exposed or if material has been washed from beneath the foundation and record the dimensions of exposure.

Note leakage on substructure elements from the joint above and debris buildup on and around the element. Inspect for impact damage and distortion, especially noting conditions that may weaken the structure. Inspect weep holes and the areas surrounding them in substructure units for blockage, loss of fill, or excessive standing water. Note excessive vegetation growth adjacent to substructure units. Special attention shall be given to areas around MSE walls and slope paving as these areas are more susceptible to damage from vegetation growth.

Additional Resources
Refer to Section 6.5 for inspection guidance on impact damage.

Maintenance and Notification
A recommendation to seal joint concrete slope paving or between the abutment and wingwall requires a Maximo Priority 3 Maintenance Request. A recommendation to repair erosion, place erosion control measures, or remove vegetation and debris affecting the substructure requires a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of significant damage or deterioration of substructure elements warranting an element CS4 or presents a safety hazard for motorists or pedestrians.

3.3.8.1 Steel Substructure

This element refers to all types and shapes of steel substructure elements, including columns, towers, abutments, monotube and H piles, pier caps, sheeting, and fender/dolphin systems.

Inspect all components of the steel substructure with an emphasis on corrosion, cracking, settlement, and section loss. Check connections to determine if the elements are securely fastened. Use a hammer to verify that bolted connections are secure. Inspect welds and surrounding areas for cracks. Use a chipping hammer or wire brush to clean areas of corrosion to determine section loss and remaining section as required. Mark and date existing crack lengths for future monitoring. NDE techniques may be utilized for cracks or suspected cracks of steel primary load carrying members. After finding the limits and recording dimensions, mark and date crack lengths for future monitoring. Refer to Section 3.3.11 Metal NDE Techniques for more discussion and guidance

Maintenance and Notification
A recommendation to clean and paint deteriorated primary load carrying steel members requires a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.8.2 Reinforced Concrete Substructure

This element refers to all types and shapes of reinforced concrete substructure elements, including columns, walls, abutments, piles, pier caps, sheeting, fender/dolphin systems, wingwalls, and headwalls.

Inspect all components of the substructure with an emphasis on delaminations, spalls, exposed reinforcement, efflorescence, rust staining, and cracking. Sound concrete surfaces for delaminations. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required.

Further concrete evaluation techniques such as impact echo, coring, and infrared may be necessary based on inspection findings or per BIE direction. See Section 3.3.12 for a discussion of these techniques.

Additional Resources
Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

Deterioration of stone facing shall be noted in the inspection report and brought to the attention of the BIE.

3.3.8.3 Prestressed Concrete Substructure

This element refers to all types and shapes of prestressed concrete substructure elements, including columns, piles, pier caps, and sheeting.

Inspect all components of the substructure with an emphasis on delaminations, spalls, exposed reinforcement, exposed prestressing, efflorescence, rust staining, and cracking. Sound concrete surfaces for delaminations. Clean exposed reinforcement or prestressing with a chipping hammer or wire brush to determine section loss and remaining section as required.

Further concrete evaluation techniques such as impact echo, coring, and infrared may be necessary based on inspection findings or per BIE direction. See Section 3.3.12 for a discussion of these techniques.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

3.3.8.4 Timber Substructure

This element refers to all types and shapes of timber substructure elements, including columns, towers, walls, abutments, piles, pier caps, sheeting, and fender/dolphin systems created using solid, glue-laminated, and nail-laminated timbers.

Inspect all components of the substructure with an emphasis on decay, checks, cracks, splits, crushing, and abrasion. Note delamination of laminated timber members. Check connections and anchorages to determine if the elements are securely fastened. Use a hammer to verify that bolted connections are secure. Interior timber defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of decay and insect or fire damage to determine the extent of the defect. Check for indications of lost fill material from behind walls.

NDE techniques such as sonic stress wave may be necessary based on inspection findings per BIE direction. See Section 3.3.13 for a discussion of these techniques.

3.3.8.5 Masonry Substructure

This element refers to all types and shapes of masonry substructure elements, including wingwalls, piers, and abutments.

Inspect all components of the substructure with an emphasis on efflorescence, rust staining, mortar deterioration, spalled masonry, patched masonry, and displacement of stones. Sound masonry for delaminations and loose or deteriorated blocks or stones. Check mortar for deterioration, loss, cracks, vegetation growth, and water seepage. Quantify mortar deterioration in the report and recommendations as a percentage per linear foot of mortar. At exposed ends and spandrel walls note cracks, deterioration, misalignment, and displacement that could indicate loss of interlocking and potential for failure. Check for indications of lost fill material from behind walls.

3.3.8.6 Mechanically Stabilized Earth Wall Substructure

This element refers to all types of soil-retaining wall systems that consist of a concrete or stone facing with steel or geosynthetic reinforcing fabric.

Inspect all components of the substructure with an emphasis on delaminations, spalls, exposed reinforcement, efflorescence, rust staining, cracking, displacement, settlement, and loss of fill. Sound concrete and masonry for delaminations and loose or deteriorated panels. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required. Check joints between panels for deterioration, vegetation growth, and signs of water seepage, loss of fill, and misalignment.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

Deterioration of stone facing shall be noted in the inspection report and brought to the attention of the BIE.

3.3.8.7 Other Substructure

This element refers to all types and shapes of composite, plastic, and other material columns, walls, abutments, piles, and pier caps.

Inspect all components of the substructure with an emphasis on corrosion, cracking, delaminations, spalls, efflorescence, rust staining, and deterioration. Check connections and anchorages to determine if the deck and its components are securely fastened. Use a hammer to verify that bolted connections are secure. Inspect welds for cracking. Interior defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of deterioration to determine the extent of the defect. Use a wire brush to clean areas of corrosion and decay to determine section loss and remaining section as required. Check for indications of lost fill material from behind walls.

3.3.9 Culvert

The function of culverts is to transfer vehicle and earth loads directly into the foundation while allowing water to flow freely beneath. Culverts must be evaluated for structural condition, the ability to carry loads, and adequacy of foundation.

Inspect for damage and distortion. Check for signs of settlement and misalignment of the culvert. Check along the waterline for deterioration. Check for indications of lost fill material in the form of erosion holes above the culvert, areas of depressed roadway, and backfill infiltration inside the culvert. Look for signs of water exfiltration through culvert walls into the backfill or supporting material. Note misalignment at seams or joints and other deformations when sighting along the length of the culvert. Note locations of debris buildup within or immediately up/downstream of the culvert which could restrict the hydraulic opening. Inspect weep holes and the areas surrounding them in culvert walls for blockage, loss of fill, or excessive standing water.

Look or probe around the base of the culvert to check for erosion, scour, and undermining. Check if the footing has been exposed or if material has been washed from beneath the foundation and record the dimensions of exposure. For elements in water check portions of the element along the waterline for deterioration. If an apron or the bottom of a pipe is present, probe below the waterline checking that the apron or bottom of pipe is intact.

Low clearance culverts will require wading or diving performed by underwater inspectors (See Sections 3.1.2.1 and 3.1.4). For culverts too small for an inspector to enter or if a hazard is present that prevents safe entry, even when using proper confined space entry procedures, a borescope or other remote controlled video inspection may be utilized after approval from the BIE.

Additional Resources
Refer to Section 5.3.4 for safety guidance related to confined space issues.

Maintenance and Notification
A recommendation to repair erosion, place erosion control measures, or remove vegetation and debris affecting the substructure requires a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

Notify the BIE of significant damage or deterioration of culvert elements warranting an element CS4 or presents a safety hazard for motorists or pedestrians.

3.3.9.1 Steel Culvert

This element refers to all types and shapes of steel culverts, including arch, round, or elliptical pipes.

Inspect all components of the culvert with an emphasis on corrosion, cracking, settlement, and section loss. Emphasis should be placed along the waterline of the culvert when looking for corrosion. Check connections to determine if the elements are securely fastened. Use a hammer to verify that bolted connections are secure. Inspect welds for cracking. Note bulging, non-uniform, or widened internal seam joints. Use a hammer to check areas of section loss and corrosion for perforations, especially around the waterline. Measure and record distortions in pipe shape along the length.

Additional Resources
See the DelDOT *Policy for Inspection and Load Posting of Corrugated Metal Culverts* in Appendix C for a discussion of corrugated metal pipe inspection.

3.3.9.2 Aluminum Culvert

This element refers to all types and shapes of aluminum culverts, including arch, round, or elliptical pipes.

Inspect all components of the culvert with an emphasis on corrosion, cracking, settlement, and section loss. Emphasis should be placed along the waterline and top half of the culvert when looking for corrosion. Check connections to determine if the elements are securely fastened. Use a hammer to verify that bolted connections are secure. Inspect welds for cracking. Note any bulging, non-uniform, or widened internal seam joints. Measure and record distortions in pipe shape along the length. Inspectors shall not use a hammer on corrosion areas instead use visual inspection techniques.

Additional Resources

See the DelDOT *Policy for Inspection and Load Posting of Corrugated Metal Culverts* in Appendix C for a discussion of corrugated metal pipe inspection.

3.3.9.3 Reinforced Concrete Culvert

This element refers to all types and shapes of reinforced concrete culverts, including arch, round, or elliptical pipes, boxes, and frames.

Inspect all components of the culvert with an emphasis on delaminations, spalls, exposed reinforcement, efflorescence, rust staining, cracking, and settlement. Sound concrete surfaces for delaminations. Clean exposed reinforcement with a chipping hammer or wire brush to determine section loss and remaining section as required. Check for non-uniform or widened internal joint openings which could indicate movement, settlement, or distortion.

Additional Resources

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

3.3.9.4 Masonry Culvert

This element refers to all types and shapes of masonry culvert elements, including culvert headwalls.

Inspect all components of the culvert with an emphasis on efflorescence, rust staining, mortar deterioration, spalled masonry, patched masonry, and displacement of stones. Sound masonry for delaminations and loose or deteriorated blocks or stones. Check mortar for deterioration, loss, cracks, vegetation growth, and water seepage. Quantify mortar deterioration in the report and recommendations as a percentage per linear foot of mortar. At exposed ends and headwalls, note cracks, deterioration, misalignment, and displacement that could indicate loss of interlocking and potential for failure.

3.3.9.5 Other Culvert

This element refers to all types and shapes of composite, plastic, and other material culverts, including arch, round, or elliptical pipes.

Inspect all components of the substructure with an emphasis on corrosion, cracking, delaminations, spalls, efflorescence, rust staining, and deterioration. Check connections and anchorages to determine if the elements are securely fastened. Use a hammer to verify that bolted connections are secure. Inspect welds for cracking. Interior defects not visible to the inspector may be located using a hammer to sound and an awl/pick for a penetration test. Clean and inspect areas of deterioration to determine the extent of the defect. Note any bulging, non-uniform, or widened internal seam joints. Use a wire brush to clean areas of corrosion and decay to determine section loss and remaining section as required. Measure and record distortions in pipe shape along the length.

3.3.9.6 Sacked Concrete Wall

This element refers to walls constructed of sacked concrete bags belonging to pipe culvert structures.

Inspect all components of the wall with an emphasis on splitting, spalling, and displacement of bags. Sound for delaminations and loose bags. Check joints between bags for deterioration, cracks, vegetation growth, and water seepage. Especially at exposed ends note cracks, deterioration, misalignment, and displacement that could indicate possible loss of interlocking and potential for future failure.

3.3.10 Wearing Surfaces and Protective Coatings

Wearing surfaces act as a sacrificial layer to protect the structural deck from vehicle wear and serve to provide a smooth riding surface across the bridge. Protective coatings of steel, concrete, and steel reinforcement protect the underlying component from harmful environments. Both element types should be inspected for their ability to protect the underlying element. Wearing surfaces should also be evaluated for their ability to provide a smooth riding surface.

3.3.10.1 Wearing Surface

This element refers to non-structural deck overlays made with flexible, semi-rigid, and rigid materials and timber running planks.

Inspect for cracking, delaminations, spalls, potholes, damage, settlement, wear, and overall effectiveness of the overlay; especially noting conditions that may signify deterioration in the underlying structural element. Observe live traffic and/or drive across the bridge deck to determine the severity of any vertical offsets and rideability. Note any bulging or settlement of the overlay or if drains, joints, or other elements have been unintentionally paved over. Sound patched surfaces for delaminations.

For rating purposes, treat any bituminous patch as though it is an unsound patched area.

Additional Resources

Techniques used for deck evaluation such as chain drag, impact echo, and infrared (among others) may be useful in evaluating wearing surface condition. See Section 3.3.12 for a discussion of these techniques.

Classify crack widths according to the BEIM Concrete Crack Size Definitions.

Maintenance and Notification

Notify the BIE of potholes or other areas of deterioration in the roadway large enough to receive a spall defect rated in CS3 per the BEIM.

3.3.10.2 Steel Protective Coating

This element refers to protective coatings used to protect steel elements present on the bridge, including paint, galvanization, weathering steel patina, or non-structural concrete encasement.

Inspect paint coatings with an emphasis on chalking, peeling, bubbling, and cracking. Inspect weathering steel patina with an emphasis on oxide film development, color, texture, and flaking. Inspect concrete encasements with an emphasis on delaminations, spalls, efflorescence, rust staining, and cracking. Inspect all steel protective coatings with an emphasis on effectiveness and wear, especially noting conditions that expose bare steel to the elements.

Additional Resources

Refer to Section 5.2.4 of the BEIM for steel protective coating quantity calculation.

Maintenance and Notification

A recommendation to clean and paint deteriorated primary load carrying steel members requires a Maximo Priority 3 Maintenance Request. See Section 3.5.6.1 for a discussion of Maximo Work Orders.

3.3.10.3 Concrete Protective Coating

This element refers to protective coatings used to protect concrete elements present on the bridge, including waterproofing, crack sealant, or top coat barrier. This element does not include other coatings expressly placed to prevent graffiti.

Inspect concrete protective coatings with an emphasis on effectiveness and wear, especially noting conditions that expose bare concrete, reinforcing steel, or cracks.

3.3.11 Metal Non-Destructive Evaluation Techniques

Frequently visual inspection alone is not enough to appropriately evaluate the condition of steel or aluminum elements. When defects are difficult to detect visually, either because the defects are internal or because of their size, there are many NDE methods available to assist the inspector. The following sections outline the most common of these methods.

3.3.11.1 Liquid-Penetrant Testing

Liquid-penetrant (also referred to as dye-penetrant) is a form of NDE used to highlight discontinuities, including cracks, in the surface of nonporous, metallic materials. The procedure for its use is relatively simple:

1. Clean and prepare the surface with appropriate cleaner

   a. Emery cloths and/or blasting should not be used to clean surfaces as these may partially obstruct penetrant from entering the discontinuity in the metal.
   b. Wire brushes may be used as a last resort if proper cleaners are not available to remove the paint and other foreign objects.
   c. Ensure the area is dry prior to proceeding to Step 2.
2. Apply the penetrant and let it dwell
   a. Do not use water washable penetrants for suspected fatigue cracks in steel.
   b. Required dwell times may vary depending on the penetrant type, the temperature of the specimen and the penetrant, relative humidity, type and size of discontinuity, etc.
   c. Consult penetrant manufacturer recommendations for required dwell times.
3. Remove the excess penetrant from the surface
   a. Perform each cleaning pass in only one direction.
   b. Dry Pass - Perform dry pass to remove all excess penetrant. Perform only one pass so as to not remove penetrant from discontinuities.
   c. Wet Pass – Use enough solvent on a clean rag that one pass in one direction will remove any remaining excess penetrant left after the Dry Pass is completed.
   d. Solvent should never be applied directly to the specimen as this might wash out or dilute the penetrant in the discontinuity.
4. Apply developer
   a. Apply developer from a distance of approximately 9” – 12” minimizing overlap and runs of developer.
   b. Apply the developer as to form a thin white coating on the specimen without soaking the test surface. A thick coating of developer may mask indications from being properly identified.
5. Observe and document the length, width, and direction of the crack
6. Remove penetrant/developer and protect surface
   a. Use solvent directly on surface to remove all remaining penetrant and developer and allow area to dry completely.
   b. Apply galvanizing spray paint or similar to protect test area from corrosion and deterioration.

This method has the advantage of being portable, as well as easy to use and interpret. It is best used as a tool during a visual or hands-on inspection, aiding the inspector in determining if the area should be evaluated further. Although no specific qualifications are needed, the user should be familiar with specific directions from the penetrant manufacturer.

For more information on liquid-penetrant see:

- ASTM E1417 – 05e1 Standard Practice for Liquid Penetrant Testing
- ASTM E165 – 02 Standard Test Method for Liquid Penetrant Examination

3.3.11.2 Ultrasonic Testing

Ultrasonic testing (UT) is a form of NDE used to detect internal flaws in metal elements. This typically includes hanger pins, bearing pins, and anchor bolts where cracks, grooving, and other flaws would be difficult or impossible to identify visually.

UT introduces high frequency sound energy into the element of interest via transducer. The energy propagates in the form of a wave through the material until the wave path reaches a discontinuity in the material, where some of the energy is reflected back to the transducer and the wave energy is recorded. Based on the travel time of this wave to and from the discontinuity and an estimated wave speed, the location of the reflecting discontinuity can be approximated. When this location varies from the known or assumed length or thickness of the element, an internal flaw may be indicated.

To perform this test, the transducer must be coupled to the element of interest. This requires a flat, smooth surface. Preparation of the surface by grinding may be required to remove loose paint, surface corrosion, scale, and other foreign matter before testing. Care should be taken by the inspector to remove only paint without gouging the base metal. Tight paint or scale need not be removed. The tested area should be repainted after the test has been concluded to protect the base metal.

The equipment is relatively portable, however it requires skill and training to operate and interpret. As such, operators of this equipment are required to maintain an American Society of Nondestructive Testing (ASNT), SNT-TC-1A Supplement C, Level II certification or higher to perform UT during DelDOT bridge and sign inspections.

After the UT has been completed the technician shall provide a summary of the results to the bridge inspector for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

A common form of UT not requiring additional certification is the digital ultrasonic thickness meter, generally referred to as a D-meter. D-meters provide instant, digital thickness measurements of metal elements, are very small in size, and are inexpensive, making them ideal for measuring section losses in the field without specialized NDE personnel.

3.3.11.3 Magnetic Particle Testing

Magnetic particle testing (MPT) is a form of NDE used to detect near-surface flaws (typically up to 1/8" below the surface, or less) of ferromagnetic materials such as steel. This includes cracks, even those filled with paint or debris, and weld discontinuities. MPT has a high sensitivity in the detection of tight surface cracks and other small discontinuities which may not be observed by liquid penetrant testing.

The most common form of MPT introduces a magnetic field to the element of interest using externally applied alternating or direct current. This current creates magnetic lines of force (flux) that are distorted by near-surface discontinuities. Other forms simply use magnets to create this flux. A powder of fine iron filings is applied to the magnetized element. These iron particles will be influenced by the flux, highlighting any distortion. The pattern created by iron particles is then interpreted by the operator to determine an indication of a flaw.

Surface preparation is not as rigorous as in other methods. The surface needs to be clean, dry, and free of oil, grease, and loose corrosion. It is recommended that the testing be performed on bare, clean, unpainted surfaces to detect very small discontinuities however this method can be conducted on surfaces that are painted with non-conductive coatings up to 2 mils thick in accordance with ASTM E-709. Discontinuities are best detected when their orientation is perpendicular to that of the test, meaning the test should be conducted twice, each test oriented 90 degrees from the other.

This method is effective in indicating surface defects and will typically be more precise in the identification of very small defects than liquid penetrant. The equipment is relatively portable, however it requires skill and training to operate and interpret. As such, operators of this equipment are required to maintain an ASNT SNT-TC-1A Supplement C, Level II certification or higher to perform MPT during DelDOT bridge inspections.

After the MPT has been completed the technician shall provide a summary of the results to the bridge inspector for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.11.4 Eddy Current Testing

Eddy current testing is a form of NDE used to detect near-surface defects in conductive materials. This includes small cracks, even those filled with paint or debris.

Eddy current testing places an energized probe coil near the surface of the element of interest. When the AC current flows through the coil a magnetic field is created, which will introduce circulating “eddy” currents into the nearby surface. Any surface discontinuities will affect the magnitude and phase of these eddy currents, which will affect the loading on the coil, and in turn affect the measured impedance across the coil. When a crack is immediately below the coil, the eddy currents will be interrupted and reduced, decreasing the loading, and increasing the measured impedance. This change in effective impedance will indicate the presence of a defect.

Similar to MPT, this method is an effective method to indicate surface defects even on elements coated in non-conductive material. The equipment is relatively portable, however it requires skill and training to operate and interpret. As such, operators of this equipment are required to maintain an ASNT SNT-TC-1A Supplement C, Level II certification or higher to perform eddy current testing during DelDOT bridge inspections.

After the eddy current testing has been completed the technician shall provide a summary of the results to the bridge inspector for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.12 Concrete Non-Destructive Evaluation Techniques

Concrete bridge elements may be subject to internal deterioration that visual inspection alone cannot detect. NDE techniques can help inspectors identify these defects. It should be noted that no one method of concrete evaluation tells a complete story; the more methods used, the more accurate the evaluation will be.

Bridge decks in particular are exposed to harsher conditions than other bridge elements. Traffic and snow plow impact, deicing chemicals, poor drainage, and freeze-thaw cycles can lead to deterioration of the deck that directly affects the serviceability of the bridge. As such, non-destructive and destructive evaluation of concrete bridge decks are important to manage these components and prioritize bridge preservation. Where applicable, concrete deck evaluation techniques are highlighted. Deck evaluation is performed as-needed per BIE instruction.

There are different forms of concrete deck evaluation, most of which test isolated points and interpolate between them to come to conclusions about the condition of the entire deck. To assist in determining these test locations as well as correlating the data to these locations, it is common practice to lay out a grid on the deck surface. Simply using a water based paint to mark a dot on the deck on a 2-foot x 2-foot grid is sufficient enough for most forms of NDE. The use of a pre-made 'jig' can be the most efficient method of laying out the grid.

3.3.12.1 Sounding/Chain-drag

Sounding is the most common method of determining the location of delaminations. This method is performed by striking the concrete surface with a hammer. If the area struck by the hammer exhibits a shallow delamination, then the area will sound "hollow". This is an effective way of determining if the near-surface area is in the later stages of delamination, however it is not capable of identifying deep delaminations or delaminations in the early stages of cracking before the delamination has completely debonded. This method also will not provide information about the depth of the defect. When sounding a concrete deck, an overlay can make it very difficult to differentiate between a delamination and a debonded overlay.

Although the use of a hammer is portable and easy to perform, it is limited to specific areas and is not practical in evaluating larger areas such as an entire bridge deck. To assist with this it is common to use the chain-drag method. Chain-drag is performed by dragging a set of chains across the deck. As the chain is pulled, each chain-link impacts the deck. Similar to sounding, a delamination is indicated by a hollow sound. Using this method the tester can evaluate large areas of the bridge deck at a time. When the tester locates a delamination, a hammer can be used to sound the area and more accurately define the extent of the delamination. The delamination is then marked on the bridge deck. The size and location of that area is then recorded, typically using measurements along spans and within lanes to help locate and report the delamination globally on the bridge as opposed to the placement of a grid.

After the sounding has been completed a report mapping the location and size of each delamination identified shall be provided by the bridge inspection team to be included in the inspection report or submitted as a stand-alone report to the BIE.

3.3.12.2 Impact Echo

Impact echo (IE) is a method of NDE used to detect delaminations and can identify them in the early stages of cracking. It can be used on any concrete surface, but is most typically and effectively used on concrete bridge decks.

This method is performed by placing a receiver at the point of interest, then impacting the surface of the concrete near the receiver with a small impactor (frequently a steel ball, between 5mm - 15mm in diameter, at the end of a thin steel rod). The impact sends compression stress waves through the concrete. These waves will propagate through the concrete until it reaches an interface of two materials with different acoustic impedances (e.g. concrete and air).

In a solid section of concrete, the compression waves will propagate the full-depth of the member and reflect off the opposite side where the concrete and air interface. It will then propagate back to the surface where it will be recorded by the receiver and reflect back downward. The wave continues back and forth, with the receiver set to record long enough to catch multiple passes. The receiver's signal is then processed determining the "peak frequency", which indicates the frequency of these passes. The peak frequency is dependent solely on the depth of the section and wave velocity, which is constant for each concrete section. Ultimately a lower frequency indicates a deeper the section, and a higher frequency indicates a shallower section.

In a section of concrete that is in the early stages of delamination, where a subsurface crack is present but has not debonded from the base material, part of the energy of the compression wave is reflected at the crack interface. Part of the energy will reflect back and forth between the surface and the crack with the remaining energy reflecting back and forth between the surface and the underside. When the receiver's signal is processed, two peak frequencies are identified: One low frequency from the opposite side of the member and one higher frequency from the crack. If the wave speed is known or assumed, the depth of the crack can be approximated.

If the delamination is fully debonded, then another phenomenon controls. The upper debonded section of the concrete acts independently, similar to a drum. In this case the peak frequency will become much lower than those recorded in the solid section.

On concrete decks, data is commonly taken at each point on a 2-foot x 2-foot grid. Although the basic system requires placing the receiver and making the impact by hand, many manufacturers and consultants have developed systems that allow inspectors to perform the test while standing as well as automated machines that collect data and advance automatically. Once this data is collected and processed it can be presented in many different ways. For deck evaluations it is most commonly presented as a contour map, with the each grid point associated with a condition value and those values plotted on a color scale over the plan view of the deck.

Although this method works well to detect delaminations, even in the early stages of development, it is relatively slow and requires the closure of at least one travel lane at a time to evaluate a deck. It should also be noted that defects below a delamination or debonded overlay will not be detected with this method; it will only detect the shallowest defect.

After IE has been completed at each grid location a report showing the results in a contour map shall be generated for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.12.3 Ground-Penetrating Radar

Ground-penetrating radar (GPR) is a method of NDE used on concrete to determine the presence and pattern of steel reinforcement as well as to indicate the presence of a corrosive environment within. The following description identifies techniques for its use on concrete decks as it is most effective for that purpose, however it can be used for all reinforced concrete members with similar, handheld devices.

This method is performed by moving the GPR equipment across the deck along a line of interest. Although there are a number of types of GPR systems, including multi-channel GPR array, dual polarization antennas, and air-coupled antennas, the most common system is the ground coupled system, normally mounted to a cart for ease of movement. At each point of interest, the transmitter in the equipment near the surface of the concrete deck sends out an electromagnetic wave into the section of deck. This wave propagates through the material until it reaches an interface with differing relative dielectric permittivity (e.g. concrete and steel). At this interface, a portion of the wave energy is reflected back to the surface of the deck.

The portion of energy reflected is proportional to the difference in the dielectric permittivity at the interface. For example the interface between concrete and steel reinforcement will reflect much more energy than the interface between concrete and air.

After the electromagnetic wave is reflected back towards the surface, it is recorded by the receiver in the equipment. Based on the time of travel and the assumed velocity of the wave, the depth of the reflector can accurately be indicated. The signal is typically recorded for 10-20 nanoseconds. This quick test time allows many tests to be taken in quick secession. Typical ground coupled units will record a signal along a test line every 60th of a foot, as fast as the cart can be pushed across the deck.

The results of these lines of tests are shown in what is called a B-Scan. A B-Scan is a 2-D plot in which the X-axis represents the distance along the line, the y-axis represents the depth into the deck, and the amplitude of the signal is shown in in greyscale. This plot depicts a type of cross-section of the deck along the test line, with long reflectors (underside of deck, steel reinforcement run parallel to the test) shown as lines, and point reflectors (steel reinforcement run perpendicular to the test) shown as parabolas.

Because the concrete/steel interface reflects so strongly, GPR is a great tool for locating steel reinforcement. However, it reflects most of the energy, leaving it “blind” to any reflectors behind it. As such, it is common practice to run tests perpendicular to the top layer of reinforcing steel.

The concrete/air interface does not reflect as much energy, making directly identifying delaminations difficult with GPR. Even though it cannot directly indicate a delamination, it can identify a corrosive environment, which would be prone to delaminations. Concrete with higher concentrations of chlorides and other corrosive particles will increase the attenuation of electromagnetic waves compared to that of sound concrete. After all the signals have been recorded the data is processed to identify each perpendicular steel reinforcing bar. The magnitude of the reflection caused by each bar is compared. Areas where the reflection magnitude is comparatively lower than other parts of the deck indicate a higher presence of chlorides and a more corrosive environment.

After GPR has been completed at each grid line a report showing the results in a contour map shall be generated for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.12.4 Electrical Resistivity

Electrical resistivity is a method of NDE used to assess the ability of the concrete to protect its steel reinforcement from corrosion. This method does not directly indicate defects or corrosion, merely quantifies the potential for advanced corrosion rates.

This method measures the electrical resistivity of the concrete. The higher the resistivity of the concrete, the greater the resistance the concrete provides to the corrosion current passing between the anodic and cathodic areas of the steel reinforcement, reducing corrosion rates. Resistivity values greater than 7.88 kΩ-inch are associated with very low corrosion rates. Low resistivity values (less than 1.97 kΩ-inch) allow ions to flow more freely and can support very rapid corrosion of the steel reinforcement.

The most common device to measure electrical resistivity is the Wenner array. This device uses four probes, spaced equally along a line. The ends of these probes typically have a wetted sponge to allow the probes to couple to the concrete element. Pre-wetting the test location is typically performed to assist with this coupling. Once the four probes are placed on the element, an electrical current is applied to the two exterior probes. The resulting potential is measured between the two interior probes. Based on this measurement the device then calculates and displays the resistivity of the concrete.

For evaluation of decks, electrical resistivity is commonly tested on the same grid as the Impact Echo tests and can be performed simultaneously.

After electrical resistivity testing has been completed at each grid location a report showing the results in a contour map shall be generated for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.12.5 Half-Cell Potential

Half-cell potential is a method used to assess the probability of active corrosion of uncoated steel reinforcement in concrete members.

This method is performed by first connecting the positive end of a high-impedance voltmeter directly to the steel reinforcement mesh. As the reinforcement mesh is not typically exposed, this test may require a core hole be drilled for this connection to be made, so it may be advantageous to simultaneously schedule additional coring tests as discussed later in this Manual (see Section 3.3.12.7). Once the connection is made the test can be performed from the deck surface anywhere above the connected steel mesh. The other terminal of the voltmeter is connected to a reference electrode, typically a copper electrode in a copper sulfate solution. The reference electrode is coupled to the pre-wetted concrete at each test point, where the potential difference is measured in volts. Values greater than -200 mV indicate there is a low probability of active corrosion and values less than -350 mV indicate a high probability of active corrosion, with values in between being inconclusive.

It should be noted that epoxy coated steel cannot be tested with this method, and concrete coatings (asphalt overlays) may influence or nullify the results. Most bridges in Delaware include epoxy coated steel, so this method may only be suitable for older structures in DelDOT's inventory.

After half-cell potential testing has been completed at each grid location a report showing the results in a contour map shall be generated for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.12.6 Infrared Imaging

Infrared (IR) imaging, also known as thermal imaging, is a method of testing concrete members for delaminations.

This method uses natural temperature gradients of the concrete to indicate the presence of delaminations. As the ambient temperature warms the member in the morning or cools the member in the afternoon an infrared image is taken. The infrared image depicts the temperature of the surface of the member. Because the sub-surface crack of a delamination acts to impede the transfer of heat from the delaminated surface to the remaining depth, these surfaces warm quicker than a fully-intact section. Like-wise, the delaminated sections also cool faster in the evening. This difference in surface temperature can be picked up by the infrared image and indicate a delamination.

The surface temperature can be affected by different factors other than the presence of delaminations. Surface material/color, shadows, orientation of the surface to the sun, and ponding water can all affect temperature readings. An infrared image is often paired with a normal picture, which allows the inspector to reference the indications to a location on the member and identify possible false indications.

This method allows a large area, such as the deck, to be scanned at once. However, IR must be performed during a time in which the ambient temperature is different than that of the concrete, making this method more dependent on environmental conditions than other methods.

After IR testing has been completed a report showing the results shall be generated for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.13 Timber Non-Destructive Evaluation Techniques

Timber bridge elements can potentially be subject to deteriorations where visual inspection techniques are unable to appropriately evaluate their condition. Physical and NDE inspection techniques can assist the inspector in identifying the location, severity, and extent of timber defects. Certain methods can also be utilized in the field to identify properties necessary for performing a load rating such as moisture content.

3.3.13.1 Sounding

Similar to concrete, timber can be sounded by striking it with a hammer. A dull or hollow sound may indicate the presence of an interior void or area of deterioration or decay, and nearby loose hardware will vibrate. This is an effective way of determining large and near-surface defects, however it is not capable of identifying deep or small internal deterioration and will not provide information about the depth of the defect.

3.3.13.2 Probing

Timber deterioration located near the surface can be indicated through probing. A moderately pointed tool such as a knife, awl, or pick is used to locate areas that are excessively soft and lack resistance to penetration. The breakage pattern by probing can also indicate decay. When inserting a probe across the grain of timber, an abrupt break at the location of insertion indicates decay, whereas splintering indicates sound wood.

3.3.13.3 Stress Wave Velocity

Stress wave velocity method, also known as spectral analysis, can identify areas of internal deterioration by measuring the velocity that an induced stress wave propagates through the material. Stress wave velocity is dependent on the material properties of the timber. The wave will propagate slower through deteriorated timber than through solid/sound timber. Other material properties can affect the velocity as well, including direction of cell structure (ring orientation), moisture content, and preservative treatment, so it is important to consider these conditions when analyzing the results.

There are many methods to measure the stress wave velocity. It should be noted that the only difference between sonic and ultrasonic stress wave methods is the frequency of the stress waves induced by the impact. This difference does not affect the velocity of the stress wave or results.

Typically, stress wave velocity is measured with a “time of flight type” technique. In this method, two sensors (either accelerometers or piezoelectric) are coupled to the timber at a known distance. A stress wave is introduced into the timber by either mechanical means (hammer) or a pulse generating transducer. As the stress wave passes the first sensor a timer is started. When it passes the second sensor the timer is stopped. With this time of flight and known distance, the velocity can be calculated then compared to other areas of known deterioration as well as theoretical values.

Stress wave velocity can also be measured with a “pulse echo” technique. In this method one sensor is placed near the stress wave inducing impact. When the impact is made, a timer starts. The stress wave propagates through the material to the opposite surface of the member where it is reflected back towards the sensor. When the wave arrives back at the sensor, the timer is stopped. Knowing the depth of the member, the velocity can be calculated. This method is especially useful if access is unavailable to both faces of the timber member being investigated.

3.3.13.4 Moisture Content

Moisture content can strongly influence the rate of deterioration of the member and is necessary for performing a load rating. The two most common techniques for determining moisture content include using a resistance type meter or the electromagnetic wave technique. A resistance meter measures the resistance of an electrical current through the timber. The less resistance measured in the material, the higher the moisture content. In this method two pins are driven into the timber member of interest, and the electrical resistance is measured between these pins.

Using the electromagnetic wave technique, a probe is place against the timber member of interest, and an electromagnetic field is emitted into the member. The behavior of the field is dependent on the moisture content and measured by the probe. This method only requires a flat surface to couple the probe to and does not require driving pins into the member.

3.3.14 Destructive Evaluation Techniques

3.3.14.1 Concrete Coring

Evaluation of concrete often requires physical sampling of the material. The most convenient method of sampling is by coring. This is performed per ASTM C 42, typically using diamond impregnated coring bits with diameters of 2-4 inches. The extracted cores can then be used for an assortment of material properties tests such as compression tests, dynamic elastic moduli tests, chloride profiling, and petrographic analysis as well as simple visual inspection. The core results can also be used as benchmarks by which other forms of NDE can be verified or calibrated.

Coring location(s) shall be specified by the BIE or Bridge Maintenance Engineer. Typically before the coring takes place, a pachometer or GPR unit is used to locate steel reinforcement so damage to the reinforcement from coring activities can be avoided. The required depth of the core is typically marked on the drill bit itself. The depth of the core can vary from a few inches to nearly the full-depth of the member, depending on the desired test. Once the drill has reached the desired depth, the core is cracked off at the bottom. This crack may not be completely flat and should be accounted for when determining the core depth before drilling. Once the core is removed it should be marked and wrapped for storage before being tested. The void from the removed hole should be patched with a quick setting concrete (type to be submitted and approved by the BIE prior to commencing work) and given the required time to cure before the bridge is reopened to traffic.

After the cores are completed, a report showing an image of the core, as well as the results of the test shall be generated for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.3.14.2 Timber Coring

Evaluation of timber often requires physical sampling of the material. The most convenient method of sampling is by coring, sometimes called pencil coring. This is performed typically using an increment borer with diameters of 0.169-0.200 inches. The extracted cores can then be used for visual inspection and an assortment of material properties tests to determine moisture content, strength, and the presence of rot or fungus. The core results can also be used as benchmarks by which other forms of NDE can be verified or calibrated.

Location(s) of coring shall be selected to avoid bolts and pins. Typical coring locations are at or near the waterline, at ends of caps, and at uniform spacing between. The depth of the core can vary from a couple inches to nearly the full-depth of the member, depending on the desired test; however, cores should stop approximately 2 inches from the backside of the member. Once the drill has reached a location of rot, the depth of the core should be measured prior to continued coring. Additional cores are usually taken around a confirmed location of rot to determine its approximate extents.

Once the core is removed it should be marked and wrapped for storage before being tested. The void from the removed hole should be filled with a small amount of creosote then sealed with a plug. The drill bit should then be disinfected to prevent transfer of rot.

After the cores are completed, a report showing an image of the core, as well as the results of the test shall be generated for inclusion in the bridge inspection report or submitted as a stand-alone report to the BIE.

3.4 Inspection Activity Related Timeline

The following table represents the typical and desired timeline for a DelDOT bridge inspection including reporting, load rating, and load posting. If these timelines cannot be met due to weather related events, inspector personal leave, state holidays, equipment / traffic control limitations, or larger bridge structures requiring additional report, inspection, or analysis efforts, notify and coordinate with the BIE prior to the milestone date. Not all items will be required for every bridge inspection.

Activity	Time Constraint (Taken from the Inspection Start Date)		Notes
	In-House Staff	Consultant Staff	
Inspect Bridge (Inspection Start Date)	+/- 2 Weeks of the Next Inspection Date listed in the previous Inspection Report		1,2
BIE Field Verification of NBI Condition Ratings ≤ 2	24 hours		
BME to Submit Critical Bridge Action Form	3 calendar days		5
BIE Field Verification of NBI Condition Ratings 3 or 4	7 calendar days		
Submit Maximo Work Order(s)	14 calendar days	N/A	5
Prepare and Submit Draft Inspection Report to BIE	14 calendar days	45 calendar days	
Submit Draft Load Rating Analysis to BME	21 calendar days	45 calendar days	3,5
BIE to Review Draft Inspection Report and Provide Comments to Team Leader	28 calendar days	60 calendar days	4
BME to Review and Finalize Load Rating Analysis	28 calendar days	60 calendar days	5
BME to Update Load Posting Resolution and Distribute to Chief Engineer for Signature	35 calendar days	67 calendar days	5
Team Leader to Revise Report and Submit Final Inspection Report to BIE	35 calendar days	75 calendar days	5
BME to Distribute Load Posting Resolution	45 calendar days	75 calendar days	5
BIE to Finalize Inspection Report in Database and Distribute Report to Team Leader for Signature	45 calendar days	82 calendar days	
Team Leader to Sign Inspection Report	60 calendar days	90 calendar days	
BME Verification of Load Posting Signs	75 calendar days	115 calendar days	

Timeline Notes:

1. Section 3.1.9 defines DelDOT's inspection frequencies.
2. Privately-owned and DRBA bridges must be inspected with the inspection report and NBI ratings submitted prior to the previous inspection date plus 180 days.
3. Load ratings should be updated within this time frame of the inspection date when damage or deterioration affecting the integrity of the structure is found during the inspection.
4. BIE shall use the Quality Control Inspection Report Review form included in Appendix A.
5. If applicable.

3.5 Inspection Guidelines

3.5.1 Element Level Data

Element level data shall be collected during each inspection and recorded into the AASHTO BrM software, which will be uploaded to the live bridge database, by the BIE, on a routine basis. Guidance on element selection, condition rating, quantities, scale factors, bridge orientation, and span numbering can be found in the DelDOT BEIM.

3.5.2 NBI Coding and Condition Rating Data

3.5.2.1 Inventory Data

Inventory data is stored and updated in the BrM software. The NBI Inventory Forms, included in Appendix A, shall be completed and submitted to the BIE upon completion of the inventory inspection. These forms include the inventory and appraisal data along with the condition ratings. The inspection team shall refer to the NBI Deck Items Reference Table for assistance with the proper selection and data coding for various NBI items related to the bridge deck and structure type. The NBI Deck Items can be found in Appendix B. The BIE will be responsible for transferring the data from the form into the BrM program.

For guidance on coding each inventory item, reference the NBI Coding Guide with DelDOT comments located in Appendix C of this Manual. Information regarding the Recent ADT, Recent ADT Year, and Truck Percentage (Items 029, 030, and 109) can be found in the most current Delaware Vehicle Volume Summary (Traffic Counts) available on the Publications page of the DelDOT website at www.deldot.gov/information/pubs_forms. When the inspector must interpolate the ADT due to entrance or exit ramps or insufficient available data, the TL shall include a brief explanation of the calculation in the Inspection Notes. ADT values for ramps can be obtained from the BIE.

Items 29, 30, and 109 pertaining to ADT and truck traffic are the only codings to be updated by the inspection team in inspections subsequent to an inventory inspection. All other coding changes deemed necessary by the TL should be communicated to the BIE for further direction and approval.

3.5.2.2 Appraisal Data

Appraisal data is stored and updated in the BrM software. Items 36A, 36B, 36C, and 36D pertaining to guardrail and railings are the only ratings to be confirmed or updated by the inspection team after an inventory inspection has occurred for a replacement or modification of the rail system. Items 67-69 are calculated automatically be DelDOT's BMS when the Sufficiency Rating (SR) is calculated. After the inventory inspection, Items 71, 72, and 113 are updated only when a change has been made to the bridge, approach roadway, or waterway. Appraisal rating changes deemed necessary by the TL should be communicated to the BIE for further direction and approval.

For guidance on coding each appraisal data item, reference the NBI Coding Guide with DelDOT comments located in Appendix C of this Manual. The SR is automatically calculated within BrM upon BIE review and require no inspector action. Even though use of federal funds for bridge preservation activities is no longer associated with the SR, it is still calculated and displayed within the inspection report. Further information regarding the coding of traffic safety features can be found in the *Bridge Inspector Traffic Safety Features Rating Manual* located in Appendix C (not all safety features will apply in Delaware) and/or in the AASHTO Roadside Design Guide .

3.5.2.3 Condition Ratings

Condition rating data is stored and updated in the BrM software. Items 58, 59, 60, 61, and 62 pertaining to the overall condition of the structure and channel are to be confirmed or updated by the inspection team.

For guidance in coding condition ratings for concrete decks, superstructures, substructures, and corrugated metal pipe culverts, reference Appendix G of the BEIM. Further guidance in rating corrugated metal culverts can be found in the DelDOT *Policy for Inspection and Load Posting of Corrugated Metal Culverts* located in Appendix C. For all other condition ratings reference the NBI Coding Guide with DelDOT comments located in Appendix C.

New NBI Condition Ratings of 4 or lower must be brought to the attention of the BIE within 24 hours of the inspection. Any reduction to NBI Condition Ratings already rated 4 or lower must also be brought to the attention of the BIE in a similar timeframe.

3.5.2.4 Agency Data Fields

In addition to the standard NBI data and condition ratings, DelDOT utilizes agency-specific data fields. A number of the data fields are to be identified during the inventory inspection by the inspection team. These items are included in the NBI Inventory Forms and follow the same protocol as the NBI items. The Agency Data Field Reference Tables in Appendix B provide a description for inspector use during the inventory inspection.

There are three other agency field tabs within the BrM program: detailed vertical clearance, load rating and posting, and preventative maintenance data. These fields are not to be populated or modified by the inspection team. The detailed vertical clearance tabs are to be updated by the BIE. The load rating and posting and preventative maintenance tabs are to be populated and updated by the BME.

3.5.3 Inspection Documentation Requirements

Inspection notes can be documented in a variety of ways. Element comment fields within BrM are always to be used to record inspection findings, however forms and sketch sheets may be required in order to thoroughly depict the condition of the bridge and its surroundings at the time of the inspection. Standard forms and sketch sheets are provided in Appendix A of this manual. All additional notes, forms, and sketches are to be uploaded through the Inspect program.

The names of all personnel that participated in the inspection shall be noted in the Inspection Notes in BrM. Identify which personnel performed the following roles using the abbreviation in parenthesis:

- Team Leader (TL)
- Fracture Critical Team Leader (FC)
- Inspection (I)
- Scour Sketch Sheet and Scour Sounding Sheet (S)
- Photos (P)
- Under Record Sketch Sheet (U)
- Review of Report (R)

Once the inspection report is finalized and printed, the TL shall sign and date the SDR where this information is displayed.

3.5.3.1 BrM Element Comment Fields

Element comment fields shall be used to explain defects and condition states for each respective element. If no defects are found, the inspector shall add a comment stating this such as “no defects noted” (NDN).

If the comments for a particular element exceed the character limit in BrM, notes for that element should be transcribed to a word document and included in the report through the Inspect program. The inspector shall label the sheet with the appropriate span and element numbers and add a note to the element comment field to see additional pages for element notes.

3.5.3.2 Waterway Sketch Sheet

Waterway sketch sheets are broken into plan and elevation views. The plan view shows the adjacent features of the bridge along the channel, flow arrow, north arrow, areas of bank erosion, and limits of scour. The elevation view shall capture a typical cross section of the bridge indicating underclearance, water level, high water level, substructure and footing dimensions, pile and sheet pile dimensions, and detailed scour dimensions.

Refer to Appendix A for template and sample forms/sketches.

3.5.3.3 Sounding Sheet

Sounding sheets are used to monitor streambed elevation at specified points around a particular bridge’s substructure and the thalweg of the stream. Reference the general notes and guidelines on the back of the sounding sheet to properly fill out this form. Complete the spillway information if one is located within 50 feet of the bridge.

Refer to Appendix A for template and sample sounding sheets.

3.5.3.4 Underclearance / Overclearance Sketch Sheet

The underclearance sketch is used for bridges over railroads or roadways to document the vertical and lateral clearance measurements. Vertical measurements shall be taken at all solid lines and skip lines of the under record roads and all railroad tracks of the under record railroads along both fascia beams. The overall minimum vertical clearance shall be recorded as well. Minimum left and right lateral clearances shall be documented.

An overclearance sketch will show an elevation view of the overclearance obstruction; i.e. bridge, roof, sign structure, etc. The minimum vertical clearance shall be documented.

Refer to Appendix A for templates and sample forms/sketches.

3.5.3.5 Beam Sheets

Beam sheets shall be used to identify general areas of deterioration observed during inspection that correlate to an element condition state rating of a 3 or 4. For areas assigned an element rating of CS4, inspectors shall also prepare a separate sketch providing a more detailed view of the deterioration that accurately notes measureable section loss, spalling, or cracking of stringers, floorbeams, and beams/girders. Inspectors shall clearly identify the span, beam number, and orientation of each sketch.

Refer to Appendix A for template and sample forms/sketches.

3.5.3.6 Rocker Bearing Sheets

Rocker bearing sheets shall be used at all rocker bearing locations with CS3 or 4 defects to document the bearing expansion or contraction, ambient temperature, and the tilt angle. Confirm that bearing angle measurements are being taken parallel to the centerline of the bearing. The angle may need to be taken independent of a bearing element if the bearing has tapered sides.

Refer to Appendix A for template and sample forms.

3.5.3.7 Joint Measurements and Tracking

Joint measurements shall be taken and documented in the respective BrM joint element notes for all armored joints. The joint gap, location the measurement was taken, and ambient temperature shall be noted during all routine inspections.

Refer to Appendix A for template and sample forms.

3.5.3.8 Other Sketches and Miscellaneous Documentation

Additional defects requiring a sketch include loss of bearing greater than 10%, when the NBI Deck item is rated 5 or lower, significant impact damage and deformations, and cracks in steel elements.

Inspectors may create additional sketches or sheets not covered in this section as needed in order to accurately and fully document the current condition of the bridge. In all cases, inspectors shall create a sketch thoroughly documenting the defects, their dimensions, and their severity. Define any shorthand that may not be readily understood. Tabulation sheets may be necessary for easier documentation of severe defects occurring at multiple locations on a bridge, such as steel cracking.

When first preparing deck sketch sheets for a bridge, a full sounding may be necessary to confirm the NBI Deck rating. Subsequently the BIE will determine if an increased frequency of special inspections is required to complete further sounding or NDE.

Refer to Appendix A for sample sketches.

3.5.4 Photograph Requirements

Photographs are an invaluable part of any bridge inspection. Along with appropriate captions and associated condition notes, photographs help to document bridge configuration and conditions in more detail than words alone and are often essential to understanding a condition as it exists in the field.

For inventory, routine, fracture critical, and underwater inspections, DelDOT utilizes the Inspect program to store photographs, their associated captions, and generate the photo log to be included in the report.

DelDOT requires two types of photographs, standard and condition, but guidelines for all photographs included in an inspection report are generally the same:

- Photographs must be digital and at an appropriate size and quality to clearly present the subject while maintaining reasonable file sizes. Photographs should be no smaller than 640 x 480 pixels (0.3 MP) to preserve quality and no larger than 2048 x 1536 pixels (3 MP) to control file size.
- Inspectors should provide appropriate lighting so the subject and adjacent elements are clearly visible in the photograph.
- Inspectors should ensure that the photograph conveys both the significance of the defect and how it relates to the element and the overall structure. This may require one photograph showing the general area and a second photograph to show the defect in detail.
- Inspectors should include a ruler or tape measure for scale when photographing specific elements or defects. Pens, pencils, hammers, and other objects without a graduated scale should not be used for this purpose.
- Photographs must be presented in landscape orientation.
- Captions should identify the element(s) shown, indicate the location on the bridge, and include a brief description of the defect, if applicable. Due to limitations of the Inspect program, abbreviations may be necessary. When space permits, the direction the photo is “looking” may also be helpful in orienting the reader.

3.5.4.1 Standard Photographs

Standard photographs depict the general configuration of the bridge. They are required for inventory, routine, fracture critical, and underwater inspections and should appear first in the report photo log.

The inspector may decide that additional photographs are necessary to adequately convey the configuration of the structure, such as for complex bridges with unusual configurations, and may include these following the standard photographs. The following table lists the required standard photographs and the order in which they should appear in the report (fracture critical and low clearance inspections should follow the routine inspection requirements):

Photograph	Description	Inventory Inspection	Routine Inspection	Underwater Inspection
1. Approach Roadway	The bridge deck and roadway including approach guardrail, looking onto the bridge. Taken from the approach roadway.	Both approaches	One approach (in direction of traffic for bridges with one direction of traffic, preferred)	One approach (in direction of traffic for bridges with one direction of traffic, preferred)
2. Elevation View	An elevation showing the general configuration of the bridge and including its entire length when practical.	Both elevations	One elevation	One elevation
3. General View	General views of the underside of the structure showing typical examples of each of the bridge's superstructure types.	Required	Required	Elevation of each substructure unit in waterway
4. Upstream/ Under Record	Looking upstream at the waterway beneath or looking north/west at the roadway beneath. Taken from the bridge deck and including a small portion of the barrier at the bottom of the photograph as a reference point.	Each feature crossed	Each feature crossed	Each waterway crossed (may be taken from waterway)

Photograph	Description	Inventory Inspection	Routine Inspection	Underwater Inspection
5. Downstream/ Under Record	Looking downstream at the waterway beneath or looking south/east at the roadway beneath. Taken from the bridge deck and including a small portion of the barrier at the bottom of the photograph as a reference point.	Each feature crossed	Each feature crossed	Each waterway crossed (may be taken from waterway)
6. Deck View	Overall view of top deck surface.	Each deck / wearing surface type	Each deck / wearing surface type	-
7. Bridge Plaque	View of one typical plaque on the bridge.	If applicable	If applicable	-
8. Vertical Clearance Signs	View of one typical advance vertical underclearance sign leading to the bridge.	If applicable	If applicable	-
9. Load Posting Signs	View of one typical load posting sign leading to the bridge.	If applicable	If applicable	-
10. Fender System	General view of each fender system on the bridge.	If applicable	If applicable	If applicable

3.5.4.2 Condition Photographs

Following the standard photographs in the report, inspection teams should include photographs documenting the bridge's condition and defects. The report should reference photographs in the element notes. Photos not pertaining to specific bridge elements shall be referenced in the Inspection Notes field within BrM.

All instances of deficiencies on structural members receiving a rating of CS4 per the BEIM or requiring a Maximo maintenance request should be photographed and included in the report.

For structural elements receiving a rating of CS3 or requiring a maintenance recommendation, inspectors must minimally include a photograph representing the worst case of each type of deficiency of a specific element. If multiple CS3 defects of different types exist for a certain element, include a photograph of each defect type. For example, if a number of reinforced concrete columns exhibit wide cracks and spalls greater than 6-inches in diameter (both CS3 defects), inspectors should include at least one photograph of a wide crack and one photograph of a 6-inch diameter spall to represent the entirety of similar defects on columns throughout the bridge. An area of wide cracks receiving a CS3 rating on another element such as a pier cap would require at least one additional photograph.

Inspectors may include any additional photographs they deem necessary, regardless of element rating, to accurately and clearly represent the condition of the bridge.

3.5.5 Load Ratings

This section provides guidance in the development of bridge load ratings. Additional information on load rating policies can be found in Section 108 of the DelDOT *Bridge Design Manual* (BDM) and the current version of the MBE.

Typically bridges are not load rated as a part of their routine inspection. However, discovery of significant loss of section, continued deterioration, or suspected loss of capacity during the inspection may prompt a load rating analysis per the BIE/BME. These areas of deterioration should be given special attention during the field inspection and the inspection team shall produce detailed sketches documenting the deficiencies. The field measurements that differ from the plans shall be used to update the load rating to determine if the load carrying capacity has been compromised.

Any structural element that has a condition rating that contains the phrase "warrants analysis" shall have the load ratings evaluated. The evaluation could involve engineering judgement from the BIE, BME, or LRE based on past experience and knowledge. DelDOT policy also requires load ratings be reviewed and updated at least every ten (10) years over the life of the bridge.

Consultant teams shall receive direction from the BIE/BME prior to performing a load rating analysis.

3.5.5.1 Load Rating Data Verification

Prior to performing a load rating analysis, the previous load rating and member section property assumptions should be compared to the documented section properties from the most recent inspection to determine if a new analysis is justified. If existing section properties have not deteriorated since the completion of the previous load rating, a new rating may not be warranted. If existing section properties have deteriorated, re-evaluation of the capacity of the bridge may be required. Consult the BME if there are questions as to whether a load rating must be performed based on findings from the inspection.

In any case, inspectors shall cross-reference and confirm that the current load rating in the bridge inspection file matches the load rating data within BrM.

3.5.5.2 Posting Sign Placement Verification

If NBI Item 41 is coded as "P", check that a posting sign is present, visible and in good condition. Refer to Section 2B.59 of the Delaware MUTCD for guidance on signage and placement. Verify the restriction posted on the sign at the bridge matches that of the most recent load rating and the values found in BrM. Notify the BIE/BME if incorrect signage or no sign is present, signage is not visible due to obstructions, or signage requires repair/replacement.

3.5.5.3 Inspector Generated Load Ratings

If after verification of the existing load rating data an updated analysis is deemed necessary, an inspector generated load rating shall be performed. Load ratings are to be performed by the engineer team member or the engineer team leader. A Professional Engineer registered in the State of Delaware is required to review the load rating analysis. If there is no engineer team member or engineer team leader on the inspection team for a specific bridge, then consult the DelDOT Load Rating Engineer and provide necessary beam sketches and section details so an analysis can be performed.

Consultants will be assigned structures for which they are to load rate by the DelDOT BIE. The load rater shall possess a Bachelor's Degree or higher in Civil Engineering and have knowledge of structural analysis methods and/or structural design. A Professional Engineer registered in the State of Delaware is required to review the load rating analysis prior to submission of the load rating results to DelDOT's LRE or BME.

All load ratings and submissions must follow the guidelines set forth in this Manual, the BDM, and the MBE.

3.5.6 Bridge Maintenance Requests

Inspectors shall prepare a list of recommended maintenance requests that are outside of the work actions identified in DelDOT's BMS or BEIM and should be performed to ensure the continued safety of the public and to extend the life of the structure.

DelDOT utilizes the Maximo program to log and track bridge maintenance requests. Instructions on its use and appropriate coding of work orders can be found in Appendix F of the BEIM.

3.5.6.1 Required Maximo Maintenance Requests

For each bridge inspected, Maximo maintenance items shall be requested by both consultant and DelDOT bridge inspectors where applicable. Maximo maintenance requests found in the BEIM shall be included in the Inspection Notes field in BrM. DelDOT staff will then input the appropriate Maximo work order. For inspections performed by DelDOT inspection teams, work orders shall be input directly into Maximo with the appropriate priority. For inspections performed by consultant inspection teams, work orders will be input by the BIE.

3.5.6.2 Other Maintenance Requests

Other maintenance requests not falling under a Maximo category listed in the BEIM shall also be included in the inspection report. Inspectors shall list the additional recommended maintenance in the Inspection Notes field in BrM. DelDOT staff will then input the appropriate work orders where necessary. DelDOT inspectors shall discuss additional recommended maintenance with the Bridge Maintenance Engineer and input the appropriate work orders where necessary.

3.5.7 Critical Findings

3.5.7.1 Criteria

Federal regulations (23 CFR 650, Subpart C) define a critical finding as "A structural or safety related deficiency that requires immediate follow-up inspection or action." Critical findings are deficiencies that, if left unattended, will create a hazard to the traveling public or severely limit the use of the bridge structure. The discovery of a critical finding would warrant a CS4 rating for the associated element and an NBI Condition Rating of 2 or less. Federal regulations require critical findings to be reported to FHWA for NBI length bridges. This shall be accomplished through positive contact via phone or email as soon as it is reasonably possible.

Examples of such critical findings may include, but are not limited to the following:

1. Distress in primary members where the members may not be capable of safely carrying the imposed loads, and partial or total failure of the bridge is a possibility.
2. Scour at or under a substructure unit which is extensive enough that significant movement of the substructure unit is possible, and partial or total failure of the bridge is a possibility.
3. Substructure movement or distress that is so excessive that the substructure unit may not be capable of supporting the superstructure, and partial or total failure of the bridge is a possibility.
4. Confirmed cracks in fracture critical members.
5. Any situation where the structural integrity of the bridge has been compromised.
6. Any situation that poses an immediate safety hazard to traffic on or under the bridge including severely deteriorated or damaged bridge railing, falling concrete from the bridge deck, or an unsafe riding surface due to extensive deck deterioration.

3.5.7.2 Critical Bridge Action Form and Documentation

Proper documentation of a critical finding is necessary in order to:

1. Document the current condition of the finding in the inspection file.
2. Effectively and thoroughly convey the condition to the FHWA, Chief Engineer, and other pertinent DelDOT personnel.
3. Provide information to be utilized in decision making and to initiate a plan of action.
4. Ensure proper repairs.
5. Use as a reference for comparison to future damage and repairs.

This is documented through the Critical Bridge Action Form (CBAF). The CBAF is to be used when a critical finding is observed and confirmed during the inspection of a bridge structure. This form provides a plan of action and ensures:

1. All necessary parties are informed of the bridge condition.

2. Proper measures are put in place to protect the immediate safety of the public.
3. Timely and proper repairs to the damaged or deteriorated areas are performed.

The Bridge Management Engineer is to fill out the CBAF, sign and submit the form to the Assistant Director-Bridge within 72 hours of confirming the critical finding.

Conditions that require a CBAF shall include, but are not limited to one of the following:

1. A partial or complete bridge collapse.
2. Structural or other defects posing a definite and immediate public safety hazard.
3. A condition rating of 3 or less for any of the following bridge items:
    a. Item 58, Deck,
    b. Item 59, Superstructure,
    c. Item 60, Substructure,
    d. Item 61, Channel/Channel Protection,
    e. Item 62, Culverts, or
    f. Item 113, Scour Critical.

Refer to Appendix A for an example of a CBAF.

The following information regarding the critical finding should be noted in the corresponding incident or inspection report:

1. Structure Number
2. City, Town, or General Location of Bridge
3. Route Number/Road Name
4. Features Intersected
5. Type of Bridge
6. Type of Defect Encountered
7. Location of Defect
    a. Span
    b. Girder/Floorbeam/Stringer No.
8. Field Sketches
    a. Deterioration details
    b. Dimensions to fixed points
    c. Details and dimensions of original/undamaged section
9. Photos (in accordance with Section 3.5.4)
10. Other Pertinent Information.

The CBAF shall make reference to the incident report. The incident report shall be included when distributing the CBAF to the FHWA and DelDOT entities.

3.5.7.3 Notification

When a critical finding affecting the safety of the bridge structure or the safety of the traveling public is found during an inspection, it is imperative that the BIE and/or BME be informed immediately. Inspectors shall provide all possible documentation discussed in Section 3.5.7.2 by telephone. Condition photographs and a brief description should be sent electronically from the field to the BIE and/or BME to allow them to make informed decisions about a path forward. A written report accompanied by field sketches and photos shall be submitted to the BIE and/or BME within 24 hours of discovering the critical finding.

Consultant teams that discover critical findings shall immediately contact the Consultant's Project Manager who will have the responsibility of assessing the problem and notifying the BIE and/or BME if deemed necessary.

Critical findings identified outside of normal working hours shall be reported to the BIE or BME via cell phone, which will be made available to in-house and consultant Project Managers. When the BIE and BME are not available, high priority conditions shall be reported to the DelDOT Traffic Management Center (TMC) in Smyrna at 302-659-4600. TMC will then initiate a High Priority Request which will follow standard DelDOT protocols.

3.5.7.4 Additional Testing and Analysis

If deemed necessary by the BIE/BME, additional testing and/or analysis of a critical finding shall be performed in order to determine the extent, existence, or severity of the critical finding. For additional testing methods and procedures refer to Section 3.2 of this Manual. Consultant teams shall receive direction from the BIE/BME prior to performing additional testing that requires specialized equipment, personnel, or analysis as a result of a critical finding.

3.5.7.5 Structural Analysis

If deemed necessary by the BIE/BME, structural analysis of a critical finding shall be performed in order to determine the load carrying capacity of the member/structure in question. For guidance on load ratings refer to Section 3.5.5 of this Manual, Section 108 of the BDM and the MBE. Consultant teams shall receive direction from BIE/BME prior to performing structural analysis as a result of a critical finding.

3.5.8 Inspection Files

Inspection files include the complete history of a bridge and are maintained by DelDOT's Bridge Management Section in accordance with the MBE. The inspection files include electronic and hard copies of inspection reports, load ratings, posting resolutions, plans, maintenance history, and correspondence for each bridge. They are available to inspectors upon request to assist in the successful continuation of the inspection program. DelDOT separates hard copies of these files into two categories, active and inactive, to allow for more efficient file management. Sample folders are located on top of the DelDOT Bridge Inspection file cabinets and specify the correct arrangement for the various inspection related documents. Starting with the 2015 inspection cycle, hard copies of inspection reports, with the exception of the last three routine inspection reports, will be purged and digitized to reduce the need for additional file cabinet space. Moving forward, all files will be kept electronically, thus making the distinction between Active and Inactive folders unnecessary.

3.5.8.1 Active Folders

Active files contain the most recent and relevant information to a bridge inspection. This will include the following, if applicable:

- The last three routine inspection reports and any other type of inspection report within the three routine inspection timeframe
- The most recent underwater inspection report
- The most recent load rating calculations and load posting resolution
- Complex, Fracture Critical, and Underwater Inspection Procedures
- Fracture Critical Detail Sheets
- Correspondence related to the bridge that occurred within the last three inspection cycles, including memorandums of agreement, critical bridge findings, and results of special and emergency inspections
- Bridge design and/or as-built drawings and rehabilitation plans

3.5.8.2 Inactive Folders

In addition to older inspection reports, the inactive files contain older information not regularly needed for inspection but kept in order to provide a history of the structure. As inspection reports, ratings, postings, and correspondence are replaced with more recent versions in the Active Folder, those documents are transferred to the Inactive Folder. Incident reports, and maintenance summaries, are typically stored directly in the Inactive Folder. All items shall be arranged with the most recent documents on top.

3.5.8.3 Additional Folders

Additional folders are maintained for other documentation related to bridges as necessary. This documentation will include the following, if applicable:

- Electrical and Mechanical Inspection Reports for movable bridges
- Hydraulic and Hydrologic Analyses
- Scour Plans of Action (POA)
- More complex load rating analyses or design/hydraulic calculations
- Additional or older correspondence relating to the bridge

3.6 Inspection Equipment

Proper field inspection requires the appropriate tools and equipment. These decisions should be made during the planning and preparation stages of the inspection process. Most often, the time spent reviewing the bridge file can save lost or wasted inspection time in the field. Numerous factors play a role in determining the equipment needed for an inspection.

The safety of the bridge inspector and the traveling public should be the first consideration in selecting bridge inspection equipment. When working near active roadways, precautions should be taken to avoid fouling any active travel lane with dropped tools or access equipment. Specific considerations for different access equipment can be found below.

Bridge type and location are significant factors in selecting appropriate inspection equipment. For instance, a steel bridge is likely to require different tools for cleaning and inspection than those required for a concrete bridge. Similarly, a bridge over water or a railroad may require different access equipment than a bridge over a roadway.

The type of inspection or level of inspection detail is another factor that can influence equipment decisions. Fracture critical members and fatigue prone details will require hands-on access and additional scrutiny that may require cleaning or use of different access equipment than what is required for inspection of the non-fracture critical portion of the bridge structure.

3.6.1 Inspection Tools

It is the responsibility of the TL to select and arrange for the appropriate tools based on the specific bridge that is to be inspected.

Each inspector should have, or have access to, the equipment required to perform his or her job. A bridge inspection team's equipment inventory can be varied and based on personal preference but generally includes tools for cleaning, inspection, visual aid, measuring, and documentation. In addition, all inspectors should have proper safety equipment, or personal protective equipment (PPE), such as a hardhat, safety vest, boots, gloves, harness and lanyard, life jacket, and safety glasses. For more information on safety, see Section 5.

The following list includes some of the more common tools that should be readily available to the inspection team:

- Paint Scraper
- Wire Brush
- Hammer
- Pick/Awl
- Flashlight
- Inspection Mirror
- Binoculars
- 6' Folding Rule
- Measuring Tape
- Calipers
- Crack Thickness Gauge
- Plumb Bob
- Level
- Vertical Clearance Rod

- Scour Probing Rod
- Laser Distance Measuring Tool
- Tilt Meter
- Thermometer (ambient and surface)
- Digital Camera
- Keel/Lumber Crayon
- Pencil/Pen
- Permanent Marker
- Spray Paint
- Cell Phone
- Clipboard
- Liquid-Penetrant Kit
- First Aid Kit
- Broom/Shovel
- Ladder
- Waders
- Inspection References/Manuals

3.6.2 Specialty Inspection Tools

It is impractical for every bridge inspector to have every piece of equipment. Whether for financial reasons or because of the frequency of need, inspection teams often share bridge inspection equipment or rent supplies when necessary. These items can vary greatly but generally include specialized/expensive inspection tools, safety supplies, and basic tools for access.

The following list includes some of the specialty tools or equipment that may be needed and shared amongst multiple inspection teams:

- Borescope
- NDE Testing (various types)
- Survey Level
- Ultrasonic Thickness Gauge (D-Meter)
- Pachometer
- IR Camera
- Moisture Meter
- Fathometer

3.6.3 Bridge Inspection Access Methods

Bridge inspection access can be as varied as bridges themselves. Numerous considerations for choosing a particular access method are touched upon here, along with several of the most prominent methods of access.

Safety of the bridge inspector and the travelling public is always a primary concern at every inspection. The current industry standard is that bridge inspection falls under the General Industry OSHA regulation category for fall protection. Since bridge inspection work is seldom static, personal fall arrest systems (harness and lanyard) are most often used for the duration of the inspection when appropriate. See Section 5 for safety considerations and standards related to various access methods.

In addition to safety, TLs must also weigh other considerations when selecting the appropriate access equipment. Questions the TL needs to consider in the planning process include but are not limited to:

- What is the anticipated level of inspection detail? Are there fracture critical members, fatigue prone details, or problematic details that require hands-on access? Is there a pre-existing condition where the inspector anticipates needing additional access in order to make a proper evaluation?

- How much inspection time can be saved by using a particular method of access?
- What types of access method are available at a given location or at a particular time of year?
- Is specially trained personnel required to use a particular method of access?
- Are all portions of the bridge accessible by utilizing a single access method? Is a combination of methods more appropriate?
- Are multiple traffic control setups or equipment deployments required? What are the time considerations associated with changing set-ups?
- Does the access equipment require special training or a specialized operator?
- Is traffic control required for a particular method of access?
- Do traffic conditions either restrict or prohibit any access methods (rush hour, night work, seasonal traffic)?
- Is the inspection team comfortable or familiar with the access equipment?
- Are physical restrictions like electrical lines or railroad tracks a concern?
- Do Confined Space considerations affect the evaluation?

3.6.3.1 Under Bridge Inspection Vehicle

An under bridge inspection vehicle (UBIV) may be considered for inspections when access from below is difficult or prohibitive. UBIVs are highly maneuverable and typically hold two to three people. Most units are able to move vertically, rotate, and telescope, making them highly maneuverable but complex to operate, requiring additional training or a skilled operator. UBIVs typically require traffic control both on and below the structure. Inspectors may operate over unprotected, low-ADT, local roads when sufficient vertical clearance is available and extra precautions are taken such as care to tie-off all equipment. UBIVs are generally heavy and may not be a viable option for load-restricted bridges. A structural analysis may be completed to confirm whether or not the bridge is safe for using a UBIV if deemed necessary per BIE or BME direction. On structures subject to high velocity sustained winds, use of UBIVs is generally limited to wind speeds less than 35 mph. Consideration and proper safety protocol shall be taken when utilizing a UBIV adjacent to power lines. A pre-inspection field visit shall be made during the planning process to access the bridge site for tree and vegetation restrictions. If vegetation removal or tree trimming is deemed necessary, the BIE shall be notified and will coordinate requests with the corresponding Maintenance District.

3.6.3.2 Bucket Truck

Bucket trucks are one of the most common access vehicles used for bridge inspection today. Bucket trucks are typically driven by the inspection team and do not require a commercial driver’s license. Bucket trucks can be used to reach heights up to 50-feet, depending on the model. They require a relatively level area to deploy from and require a skilled operator. Some units may be equipped with outriggers, for additional stability. Most units are able to lift, rotate, and telescope but are generally only capable of accommodating a single inspector. Consideration and proper safety protocol shall be taken when utilizing a bucket truck adjacent to power lines.

3.6.3.3 Non-Motorized Boats

Smaller, non-motorized boats may be considered for inspections in water that is too deep for chest waders and has limited underclearance for the use of larger motorized boats or other types of access equipment. Use of boats for inspection may require additional inspection team members dedicated to safely maneuvering the boat for bridges with stronger flows/currents or in and around areas of debris accumulation. Tying the boat to a fixed bridge component or structure on land should be considered for stronger flows/currents. Proper boater safety protocol shall be followed when using boats to assist with bridge inspection operations.

3.6.3.4 Motorized Boats and Barges

Larger, motorized boats or barges may be considered for inspections over water and are often used for conducting underwater inspections or when restricting traffic is undesirable. These options typically require additional inspection team members or operators dedicated to safely maneuvering the vessel. Barges and larger boats can be used in combination with other access equipment like ladders, manlifts, or scaffolding. Proper boater safety protocol shall be followed when using boats to assist with bridge inspection operations.

3.6.3.5 Ladders

Ladders are commonly used during bridge inspection activities to access areas up to 30-feet above the ground. They are dependent upon the comfort of the inspector and can prohibit the use of both hands at the same time. Ladders must be transported to the bridge with an adequately equipped vehicle and an inspection team that is capable of safely loading the ladder on and off the vehicle and carrying it to the appropriate inspection location.

Ladders must be set on firm, level, non-slippery surfaces and should not be set in deep or flowing water that presents a safety concern for inspection personnel. Proper use requires enough horizontal space at the base of the ladder, which is generally accepted as one-quarter the working length of the ladder. An assistant is generally required to steady or hold the bottom of the ladder while inspectors climb or inspect from the ladder. In some situations such as when working near electrified rail, fiberglass ladders are required to minimize conduction of electricity.

3.6.3.6 Manlifts

A manlift is a vehicle that has a platform or bucket attached to a hydraulic boom that can reach up to 200-feet and accommodate two to three inspectors. Use is limited to fairly level terrain and requires a skilled operator. Manlifts can often be maneuvered on-site but in most cases must be delivered to and from the bridge location with a flatbed truck or trailer. When site conditions allow, manlifts are often a more cost effective alternative to UBIVs when considering a lower traffic control cost.

3.6.3.7 Rigging

Rigging on a structure typically consists of parallel cables and a transverse platform or safety cables allowing access to members via walking or climbing. Rigging is most commonly used to obtain access to floor systems and/or the bottom of main load carrying members. Rigging systems can be complicated and should only be installed and maintained by those properly qualified and experienced to do so. When using a rigging system, an independent safety line should always be supplied. Rigging requires additional lead time for set up and tear down. Rigging using platforms can be considered when inspectors must remain in one location for an extended period of time. Rigging is also light-weight and can be ideal for load posted bridges that may not be able to safely carry the weight of other inspection vehicles.

3.6.3.8 Climbers

Climbers are mobile inspection platforms or cages that “climb” steel cables. Climbers are most often used to inspect long vertical faces of bridge members, like piers or cables and is typically required for use during the inspection of IRIB cable stays. Similar to rigging, these systems can be complicated and should only be installed and maintained by those properly qualified and experienced to do so, and an independent safety line should always be supplied.

3.6.4 DelDOT In-House Inspector Policies

Inspectors are encouraged to take care of all inspection equipment, especially electronic devices. If a TL has missing, lost, or damaged inspection tools or equipment, notify the BIE for replacement approval.

TLs shall report any concerns with their assigned work truck to the vehicle maintenance shop. Any concerns with the UBIV, bucket truck, and/or boats shall be brought to the attention of the BIE immediately so that the problem can be rectified and the safety of future inspection personnel using the equipment is not jeopardized.

3.7 Traffic Control

Temporary Traffic Control (TTC) is often necessary when inspecting above-deck and superstructure portions of the bridge with access equipment from the roadway.

TTC setups for bridge inspection should follow the following principles:

- Accommodate all road users and inspection activities
- Minimize impact on traffic and pedestrians
- Provide clear guidance to traffic and pedestrians
- Use TTC devices in good working order that are routinely inspected
- Maintain roadside safety
- Train individuals involved in TTC operations
- Disseminate information to the public

Traffic control teams shall meet the qualifications and follow proper traffic control standards and procedures as defined in the most current version of the Delaware MUTCD.

3.7.1 Notification Protocol

Inspectors should coordinate TTC with the BIE, District Safety Officer, DelDOT TMC, and DelDOT Public Relations, minimally providing two weeks of notice for approval of the traffic control concept and plan. Public Relations will generate press releases to be distributed to the public and posted on DelDOT's website. The TL should communicate with the District Safety Officer to determine road closure restrictions such as rush hour, nighttime, holiday, and seasonal considerations.

3.7.1.1 Consultant Inspections

Consultant inspection teams shall obtain the final approval of the appropriate District Safety Officer at least one week prior to the desired lane closure start date. This ensures that there are no conflicting closures planned for the area and allows the District Safety Officer to evaluate if additional measures (beyond the signage and requirements of the Delaware MUTCD) need to be taken to ensure the safety of the traveling public.

On the day of the inspection, TMC shall be notified prior to TTC setup and again after the TTC setup has been removed and traffic restored to normal conditions. Inspection teams will be expected to provide an on-site point of contact, roadway name, nearest intersections, type of closure, and estimated length of closure. TMC shall be notified again after TTC is cleared and traffic is no longer restricted.

It is vital that the on-site point of contact be accessible to TMC throughout the closure time period. Changing traffic and weather conditions may necessitate a shortened period for road closure or an immediate end to TTC operations. TMC will communicate these changes as needed. Consider the individual activities of the inspection team members in order to select a point of contact that can respond to TMC in a timely manner.

If consultant inspectors and the BIE determine that use of a DelDOT traffic control team is the best means of providing TTC, inspectors shall submit a Maintenance of Traffic Request and Notification Form (See Appendix A). Coordinate with the BIE for appropriate contact information to be entered on the form. When the form has been submitted for closure, TMC shall be notified of TTC cancelations as they are determined.

3.7.1.2 DelDOT In-House Inspections

In-house inspection teams must submit a Maintenance of Traffic Request and Notification Form (See Appendix A) to the District and all individuals currently on the respective contact list at least two weeks prior to the scheduled inspection date. Approval from the appropriate District Safety Officer should be received at least one week prior to the desired lane closure start date. This ensures that there are no conflicting closures planned for the area and allows the District Safety Officer to evaluate if additional measures (beyond the signage and requirements of Delaware MUTCD) need to be taken to ensure the safety of the traveling public.

The Team Leader must coordinate with the BIE for any additional inspection personnel needed to operate equipment.

On the day of the inspection, District personnel providing the TTC will conduct all communication with TMC prior, during, and after TTC setup. District personnel shall also notify TMC of TTC cancelations as they are determined.

Public Relations and TMC must also be notified of bucket truck inspections not requiring maintenance of traffic. The in-house bucket truck has traffic warning signs for the inspection team’s use if inspectors deem them necessary based on site conditions.

4. Quality Control & Quality Assurance Bridge Inspection Procedures

4.1 Introduction

To maintain an accurate and thorough condition assessment of each bridge structure, the NBIS require bridge owners to establish a Quality Control and Assurance Program as part of their Bridge Inspection Program to assist in carrying out the following responsibilities:

1. Maintain public safety and confidence
2. Protect public investment
3. Maintain a desired level of service
4. Provide Bridge Inspection Program support
5. Provide accurate bridge records
6. Fulfill legal responsibilities as defined in the Code of Federal Regulations

This section presents the Quality Control and Quality Assurance (QC/QA) procedures and policies related to the Bridge Inspection Program and is a subsection to the Department's Bridge Inspection Manual. It is applicable to DelDOT and DelDOT consultant bridge inspection staff. DRBA's inspection program is not required to comply with DelDOT's QC/QA procedures. However, they are required to have a QC/QA program as required by the NBIS, and their bridges are evaluated as part of the State's inspection program. DelDOT has oversight responsibility for the DRBA Bridge Inspection Program and are subject to periodic inspection program compliance reviews as discussed in Section 4.3.2.

4.1.1 Purpose and Benefits of the QC/QA Program

DelDOT has established a Bridge Inspection Program to meet the NBIS requirements. Bridge inspectors collect inventory and condition data for each bridge, and the information is updated in the Department's database. The accuracy and consistency of the inspection and associated documentation are vital to public safety and also impact prioritization, work recommendations, programming, and funding appropriations. In recognition of the importance of this information, DelDOT has established QC and QA procedures to ensure a high quality and consistent inspection program.

The QC/QA procedures are integrated into all aspects of the bridge inspection. The procedures include the essential requirements which demonstrate and emphasize that adequate care, skill and diligence be utilized during the inspection and in the preparation of bridge inspection reports. The Bridge Management Section will put in place those management tools needed to define, implement and evaluate the effectiveness of the Bridge Inspection Program. The Bridge Inspection Program needs to allow feedback to occur for enhancing performance and institute actions to address areas where inspectors or the inspection program are deficient and to prevent errors from reoccurring in the future. One tool for accomplishing this is through the use of a successful QC/QA program. The QC/QA program, along with other initiatives presented throughout this Manual, ensures the following:

1. Inspection personnel have the appropriate tools, information, and resources available to adequately perform bridge inspections.

2. Inspection personnel have clearly defined programs, processes, and procedures as a basis for performing bridge inspections.
3. Inspection personnel are sufficiently trained to ensure acceptable work performance.
4. Appropriate management oversight is allocated for work performance and to identify, and correct problems as they are encountered.

In order to be effective, the QC/QA procedures must be followed by all personnel, and the procedures must be evaluated and updated on a regular basis or as needed. The program shall be flexible and updated routinely by memos and directives from the BIE or the BME.

4.1.2 Definitions

The terms Quality Control and Quality Assurance are not interchangeable. The following definitions describe the distinction between the two terms as they are used in this manual. Also provided are nomenclature and descriptions of the various personnel associated with the Bridge Inspection Program.

Quality Control (QC) – QC is defined as the enforcement of procedures that are intended to maintain the quality and consistency of bridge inspection procedures and documentation in accordance with the NBIS. The responsibility of QC is shared among different personnel within DelDOT's Bridge Management and Inspection programs. The duties and responsibilities for each member of these programs will be presented within this document.

Quality Assurance (QA) – QA is defined as a measurement of the level of consistency of the overall program in achieving and ensuring that a certain level of quality has been met. QA involves the use of random sampling and other measures to assure the adequacy of QC procedures in order to verify or measure the level of quality for the entire Bridge Inspection Program.

Inspection Team Member (TM) – The TM is an inspector assisting the TL with the inspection. It is possible for an individual to serve as a TM and be a qualified TL as per the NBIS. However, they would not be designated as the TL for that inspection. Refer to Section 4.2.2.1 for qualification requirements.

Inspection Team Leader (TL) – The TL is the individual in charge of the actual inspection, assigning inspection tasks to other members of the inspection team, must be on-site at all times during the inspection, and is responsible for signing off on the finalized inspection report. Refer to Section 4.2.2.2 for qualification requirements.

Bridge Inspection Engineer (BIE) – The BIE is the individual in charge of overseeing DelDOT's bridge Inspection program and serves as the Bridge Inspection Program Manager as defined in the NBIS. Refer to Section 4.2. 3 for qualification requirements.

Bridge Management Engineer (BME) – The BME is the individual responsible for overseeing and managing DelDOT's Bridge Management Section. This includes the Department's Bridge Inspection, Maintenance, Load Rating, and Overweight Permitting Programs.

Bridge Maintenance Engineer – The Bridge Maintenance Engineer is the individual in charge of assisting with QA field inspections with a focus on maintenance aspects of the reports.

4.2 Quality Control Plan

DelDOT's QC Plan consists of four key components that are necessary for successful implementation and compliance with the NBIS. The four components are as follows:

1. QC Inspection Review Procedures
2. QC Roles and Responsibilities
3. Qualification of Inspection Personnel
4. Resolution of Data Errors

4.2.1 QC Inspection Review Procedures

The first component of the QC Plan pertains to Quality Control Inspection Review Procedures. This has been separated into four areas where proper review procedures are necessary to implement an effective QC Plan. The QC review procedures are as follows:

1. QC of Inspection Operations
2. QC of Documentation
3. QC of the Inspection Report
4. Quarterly Inspection Staff Meetings

These procedures ensure that bridge inspectors are submitting and reporting inspection data correctly and to a consistent standard. All four QC review procedures are performed throughout different phases of the inspection and reporting process.

4.2.1.1 QC of Inspection Operations

QC of inspection operations includes tasks during the inspection and pre-inspection stages.

The pre-inspection activities primarily involve the inspection planning and reconnaissance aspects and may involve both office and field work to properly prepare for the inspection. The pre-inspection activities include the following:

1. Perform general reconnaissance prior to the date of inspection to properly prepare for the upcoming inspection including the following:
    - Assess access requirements and equipment needs
    - Assess traffic control needs
    - Assess any special inspection equipment or evaluation needs
    - Check tide charts (if bridge is over tidal waterway)
    - Verify the status of any on-going construction or repair work
    - Perform brief site visit if deemed necessary
2. Assure that the inspection vehicle includes all required inspection tools and equipment, and all applicable inspection coding/reference manuals.
3. Coordinate necessary traffic control in accordance with this Manual.

4. Assign various inspection duties amongst the inspection team.
5. Review prior inspection report(s), available plans, and maintenance history.

During the inspection, the inspection team shall comply with the established protocol, as outlined in this Manual, including the following items:

1. Proper safety apparel is worn by all inspection personnel.
2. Proper selection and use of access equipment (UBIV, Bucket Truck, ladders, boats, and hip/chest waders) are being utilized.
3. Confirm appropriate measuring devices and inspection tools are being utilized.
4. Ensure that any identified defect or deterioration locations are given adequate attention and that sufficient measurements are obtained.
5. If applicable, assure that proper fracture critical bridge inspection procedures are followed as per the bridge inspection file and in accordance with this Manual.
6. If applicable, assure that proper complex bridge inspection procedures are followed as per the bridge inspection file and in accordance with this Manual.

Further discussion regarding each of the items listed, has been provided throughout this Manual. All the items listed should be addressed by the inspection team during the inspection.

Included with the QC process are periodic field reviews during the actual inspection. Each in-house and consultant inspection TL will be field reviewed at least twice a year. In some situations, more frequent review may be needed to appropriately address areas of special concern. The field review shall be conducted in sufficient detail and duration to enable the reviewer to determine whether the field inspections are being conducted and documented in full accordance with applicable DelDOT policies/procedures and this Manual. See Appendix A of this Manual for a sample form of the Inspection Field Review Checklist (IFRC). It shall be completed during the field review effort. The checklist is meant to assist the reviewer with the field review.

A Quality Control Inspection Field Review (QCFR) report will be prepared for each TL summarizing the field reviews for that year. The report shall specify the time, date, bridge number, and location of each field review visit. The report shall state the TL's name, title, and duties assigned of all inspection team members at the inspection site. The QCFR report will include the IFRCs and a brief summary of the findings. Positive attributes of the reviewed inspections will also be documented. See Appendix A of this manual for a sample form of the QCFR.

Any major finding during the field review shall be discussed immediately with the TL and corrected in the inspection report. The IFRC for each field visit will be sent to the TL within one week of the actual field visit. All findings will be presented and discussed during the next Quarterly Bridge Inspection Staff Meeting. Refer to Section 4.2.1.4 for more details pertaining to the Quarterly Bridge Inspection Staff Meetings. The QCFR reports will be submitted to each TL and each consultant towards the end of the inspection season along with the Quality Assurance Inspection Review Reports (QARR).

4.2.1.2 QC of Documentation

The QC of Documentation includes the review of each individual component of the inspection report in accordance with this Manual. The quality of the documentation review is accomplished with efforts from members of the inspection team and the BIE and is performed in two phases. The first phase pertains to review procedures carried out by the inspection team, while the second phase occurs once the inspection team submits the inspection report to be downloaded into the database.

In regards to the first phase, the QC review process includes the review of all inspection documentation by other inspection member(s) participating on a particular inspection. If the individual performing the review is not the TL, then the TL should review all documentation as well. The second phase of the review is performed by the BIE once the TL submits the report and all documentation to be downloaded into the database. The QC review of the inspection documentation is the same for both phases and the items that are to be reviewed include the following:

1. Proper recording of field conditions with clear, clean, and complete field notes.
2. Ensure that standard photographs along with photos of deficient areas have been obtained in accordance with this Manual.
3. Review applicable inspection forms such as Waterway Sketch Sheet, Under Record Sketch Sheet, Scour Sounding Sheet, and Beam Sketch Sheet for compliance with this Manual. Complex bridges may have some additional forms or documentation that are required and identified in the Complex Bridge Inspection Procedures for that particular bridge.
4. Review sketches or marked-up drawings to confirm that sufficient detail has been provided to properly illustrate defects or deterioration observed during the inspection. If applicable, confirm that adequate documentation for inspection findings warranting analysis has been obtained in accordance with this Manual.
5. Ensure that documentation of access required for inspection has been provided, if applicable.
6. Review and confirm NBI data updates based upon observed inspection findings, recent rehabilitation, or modifications to the bridge (ex. bridge widening).
7. Review and confirm that appropriate Maximo maintenance needs have been identified and called out within the inspection notes as per Appendix F of the BEIM.
8. Review and confirm that assigned element and NBI condition ratings match conditions observed during the inspection.
9. Confirm that appropriate NBI inventory data have been successfully updated such as year of ADT, ADT and the truck percentage. Verify that all NBI data is collected during an inventory or initial inspection of a bridge.
10. If applicable, confirm that documentation for further investigation/evaluation needs, such as NDE, in order to identify, clarify and/or resolve observed deficiencies found during the inspection has been identified.
11. Identify critical findings.

4.2.1.3 QC of Reports

QC of reports involves reviewing the inspection report to ensure that all documentation has been cross-referenced successfully and that the report is checked for overall completeness. This is accomplished in two phases. The first phase pertains to review procedures carried out by the inspection team, while the second phase occurs once the inspection team submits the inspection report to be downloaded into the database.

In the first phase, the process includes QC review of the inspection report by other inspection member(s) serving on a particular inspection. In addition, the TL shall review the final inspection report. The second phase of the QC review is performed by the BIE once the TL submits the final report and all documentation to be downloaded into the database. The QC review of the inspection report includes the following:

1. Check for overall completeness of the report.
2. Compliance of inspection reporting procedures in accordance with this Manual.
3. Cross-reference of element quantities to that of the inspection comments.
4. Cross-reference inspection documentation in order to confirm assigned element condition-state ratings and comments. This includes the photo report, Waterway Sketch & Scour Sounding Forms, Beam Sketch Sheet, and any other pertinent sketches.
5. Confirm that the inspection team members and the designated TL have been identified within the report.
6. Cross-reference and confirm that the current load rating in the bridge inspection file matches the load rating data within the BrM and that of any posting signs at bridge. If posting signs exist, confirm that all posting signs are in place as per DelDOT policy.
7. Confirm that the report has been signed and dated by the TL.
8. Confirm that Critical Findings have been documented and communicated properly.

4.2.1.4 Quarterly Bridge Inspection Staff Meetings

In an effort to communicate with inspection staff, Quarterly Bridge Inspection Staff Meetings will be held throughout the year. The meetings will be held, at a minimum, once every three (3) months and will include the BIE, BME, and all in-house inspection staff. The Bridge Maintenance Engineer may be included if needed. Communication with consultant inspection staff for matters directly related to bridge inspection is typically accomplished through emails, periodic consultant status meetings, or memorandums, but they may be included in with the quarterly meetings if deemed necessary. The meetings cover topics including re-occurring errors found during the QC process, clarifications to element or NBI condition ratings, Maximo Work Order changes, and modifications to existing procedures or new procedures. A memorandum summarizing items that were discussed during the meeting will be distributed to inspection personnel within two days of the meeting.

4.2.1.5 QC of Inspection Frequencies and Schedules

The BIE will run queries in January, July, and October every year to confirm condition ratings coordinate with the proper inspection frequency. These queries will also be used to verify that bridges inspected in the first half of the year with inspection frequencies reduced to 6 months are scheduled for inspections later in the year.

The BIE will run the Inspection Priority spreadsheet on a monthly basis to check for delinquent or soon to be delinquent routine, fracture critical, underwater, and special bridge inspections.

The BIE is responsible for populating the inspection schedule spreadsheets with the inspection finalized date. This date is uploaded to BrM by selecting the “Update Upload Date” toggle in the upper right hand corner of the respective inspection schedule. Once this is complete, the SDR report can be run and returned to the TL to sign off on the inspection. The inspection finalized date is shown in the upper right hand corner of the SDR sheet.

4.2.2 QC Roles and Responsibilities

The primary responsibility of enforcing the QC Plan for in-house and consultant bridge inspections is the responsibility of the BIE; however, all inspection personnel share some part of implementing, enforcing, and/or performing the duties of the QC Plan. Consultants performing inspections shall designate a Project Engineer that meets the requirements in the NBIS for that of a Bridge Inspection Program Manager and has primary responsibility for overseeing the QC/QA program for assigned inspection tasks. The roles and responsibilities for all inspection personnel have been broken out for each QC Inspection Review Procedure.

4.2.2.1 Bridge Inspection Team Member

TM Duties for the QC of Inspection Operations

The main responsibility of the TM, in regards to the pre-inspection activities, is to assist the TL with evaluating access issues and equipment and safety needs for the upcoming inspection. The TM shall review the portions of the inspection report related to assigned activities prior to performing those tasks.

The role of the TM in regards to the actual inspection operation is determined by which responsibilities are assigned by the TL. The roles and duties assigned to the TM could include any of the following and should be performed in accordance to the policies and procedures established in this Manual:

- Performing the actual inspection
- Taking photograph documentation during the inspection
- Taking under clearance and/or scour measurements
- Completing various inspection forms including the Under Record Sketch Sheet, Waterway Sketch Sheet, Scour Sounding Sheet, Beam Sheet and any other sketch deemed necessary during the inspection to adequately document deterioration and inspection findings

In regards to safety, it is the TM’s responsibility to make sure they are wearing the appropriate safety gear and follow proper safety procedures in accordance to this Manual and/or Department protocol. The TM should be familiar with their surroundings during the inspection and constantly evaluate and update their approach to the inspection as needed in order to accommodate changes in traffic, weather and other factors.

TM Duties for the QC of Documentation

In regards to tasks assigned to the TM during the inspection, the main responsibility will consist of performing those tasks in accordance with this Manual.

The TM may be assigned the task of reviewing various inspection documentation generated by the TL or another inspection member. Activities associated with this are presented in Section 4.2.1.2. This review is performed prior to the TL reviewing the report and finalizing everything prior to submitting the report to the BIE.

TM Duties for the QC of Reports

If the TM is assigned the task of creating the inspection report, then their main responsibility will consist of writing the inspection report and verifying that the photos and associated forms and sketches are properly cross-referenced within the report in accordance with this Manual.

The TM may be assigned the task of reviewing reports for inspections that were performed by the TL or another inspection member. Activities associated with this are presented in Section 4.2.1.3. This review is performed prior to the TL reviewing the report and finalizing everything prior to submitting the report to the BIE.

Quarterly Bridge Inspection Staff Meetings

The TM will attend and participate in all Quarterly Staff Meetings.

4.2.2.2 Bridge Inspection Team Leader

TL Duties for the QC of Inspection Operations

The TL holds the majority of the responsibility when it comes to performing and assuring that activities during the pre-inspection stage and the actual inspection stage are completed in accordance with this Manual. It is the TL's responsibility to verify assigned tasks, as identified in Section 4.2.1.1, have been completed successfully.

TL Duties for the QC of Documentation

The TL is ultimately responsible for all the inspection documentation regardless of which team member performs the inspection. As a result, the TL is required to review all inspection documentation for completeness, clarity, accuracy, and compliance with established protocol presented throughout this Manual. Specific items to be reviewed during the QC of documentation are presented in Section 4.2.1.2. Regarding fracture critical and/or complex bridge inspections, emphasis shall be placed on following the procedures identified within the bridge inspection file for those bridges and throughout this Manual.

TL Duties for the QC of Reports

The TL is ultimately responsible for the inspection report regardless of which TM actually performed the inspection. As a result, the TL is required to review the report in its entirety for completeness, clarity, accuracy, and compliance with established protocol presented throughout this Manual. In addition to the tasks presented in Section 4.2.1.3, additional tasks for the TL include the following:

1. Ensure that any Work Orders for identified Maximo maintenance needs have been submitted and that the Work Order number has been identified in the inspection report.
2. Coordinate and schedule any additional inspection or evaluation needs as identified during the inspection.
3. If posting signs were found to have been missing or are incorrect, bring to the BIE's attention.

The final duty of the TL during the QC report process is to sign and date the inspection report once everything has been reviewed, all issues have been resolved, and the report has been printed out by the BIE. In addition, the TL is to assemble the finalized report and place into the bridge inspection file in accordance with the protocols established in this Manual.

Quarterly Bridge Inspection Staff Meetings

The TL will attend and participate in all Quarterly Bridge Inspection Staff Meetings. Any questions, clarifications, or suggestions for improvements to the inspection program shall be brought to the attention of the BIE during the meetings.

4.2.2.3 Bridge Inspection Engineer (BIE)

The BIE serves an important role in the QC Plan. Responsibilities extend into all four QC review procedures. The BIE is the individual in charge of updating and enforcing the QC Plan. Tasks associated with this include the following:

1. Coordinate and implement basic training programs for bridge inspectors and specialized instruction on aspects of the work requiring special attention, e.g. fatigue and/or fracture critical details, complex bridges, scour evaluation, etc.
2. Provide bridge inspectors with access to the latest applicable standards and training of proper use of inspection tools and equipment.
3. Coordinate and communicate the Department's QC Plan with in-house and consultant bridge inspection personnel.
4. Periodically review inspection team schedules and resource assignments to aid inspection teams in meeting inspection deadlines.

BIE Duties for the QC of Inspection Operations

The BIE is responsible for performing periodic field review of the inspection TLs including the tasks described in Section 4.2.1.1.

BIE Duties for the QC of Documentation

The BIE is responsible for performing a secondary review of all inspection documentation. This involves a cursory review of all inspection documentation for completeness, clarity, accuracy, and compliance with established protocol presented throughout this Manual and listed in Section 4.2.1.2. Regarding fracture critical and complex bridge inspections, the BIE shall verify that procedures identified within the bridge inspection file for those bridges and throughout this Manual were followed.

BIE Duties for the QC of Reports

The duties of the BIE, in regards to QC of reports for both in-house and consultant bridge inspections, have been broken down into three general areas: report review, resolution of data errors and verification of follow-up actions.

1. Report review
    - The BIE is to review each inspection report for the items discussed in Section 4.2.1.3. In performing QC report reviews, the BIE is required to fill out the Quality Control Inspection Report Review Form (QCRR) for each bridge upon completion of the review. More discussion about the form can be found in Section 4.2.4 and a copy of the template can be found in Appendix A**.**
2. Resolution of data errors
    - Upon the review of the inspection report, the BIE is responsible for correcting or working with the TL to clarify any data or condition rating errors or discrepancies. This includes errors or clarifications that need to be addressed for the various inspection forms, photo report, and sketches. A more comprehensive discussion of the types of data and errors and procedures for addressing them are presented in Section 4.2.4.
3. Verification of any follow-up inspection related action
    - Any additional inspection, evaluation or testing that was recommended by the inspection team shall be verified and approved by the BIE. Once approved, the BIE shall take the necessary steps in coordinating the work. This could include working with DelDOT's M&R section for performing a deck survey or taking concrete core samples, utilizing Bridge Management Section's inspection consultant(s) to provide NDE services or underwater inspection services, and reaching out to the FHWA, University of Delaware, or specialty contractors/vendors on an as needed basis. Also, if any posting signs were found to be missing or incorrect, then necessary measures are to be taken to have the situation corrected.
    - During the download process and once all documentation has been reviewed, the BIE will scan, save, and attach all documentation electronically to the inspection report. Finally, the inspection report and all associated documentation will be printed, assembled, and distributed to the TL along with the Quality Control Inspection Report Review summary.

Quarterly Bridge Inspection Meetings

The BIE has primary role for scheduling, determining the agenda, and soliciting participation from the inspection staff. The BIE is also responsible for sending out the follow-up memorandum summarizing the items discussed during the meeting.

4.2.3 Qualifications of Inspection Personnel

This section provides the qualifications of all inspection personnel including the BIE, TL, and TM. These qualifications apply to in-house and consultant inspection personnel. The qualifications follow the guidelines from the NBIS; however, DelDOT has additional requirements for underwater, fracture critical, complex bridge, and NDE inspection personnel. These are addressed in Sections 4.2.3.1-4.

Bridge Inspection Program Manager (Bridge Inspection Engineer - BIE)

A program manager must, at a minimum:

1. Be a registered professional engineer (PE) in the State of Delaware, and;
2. Successfully complete the two-week NHI Comprehensive Bridge Safety Inspection Course.

Bridge Inspection Team Leader (TL)

There are five (5) ways to qualify as a TL. A TL must, at a minimum:

1. Have the qualifications that of a Bridge Inspection Program Manager; or
2. Have five (5) years of bridge inspection experience and have successfully completed the two-week NHI Comprehensive Bridge Safety Inspection Course; or
3. Be certified as Level III or IV Bridge Safety Inspector under the National Society of Professional Engineers Program for National Certification in Engineering Technologies (NICET) and have successfully completed the two-week NHI Comprehensive Bridge Safety Inspection Course; or
4. Have all of the following:
    - A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;
    - Successfully pass the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering Examination;
    - Two (2) years of bridge inspection experience; and
    - Successfully completed the two-week NHI Comprehensive Bridge Safety Inspection Course, or
5. Have all of the following:
    - An associate's degree in engineering or engineering technology from a college or university accredited by the Accreditation Board for Engineering and Technology;
    - Four (4) years of bridge inspection experience; and
    - Successfully complete the two-week NHI Comprehensive Bridge Safety Inspection Course.

For in-house inspection staff, DelDOT considers a full year of inspection experience as assisting with or performing inspections for at least 150 bridges within one calendar year. The requirement for consultant inspection staff is 50 bridges per year due to the recognition that consultants typically inspect larger, more complex structures.

Bridge Inspection Team Member (TM)

DelDOT takes the qualifications one step further than the NBIS to address inspection TMs that have not obtained TL status as per the requirements above. This requirement applies to engineer and technician inspectors alike.

- Less than 12 months of inspection experience – no requirement, the individual will be assisting with inspection activities and under direct supervision of the TL
- 12 months or greater of inspection experience – the individual must successfully complete the two-week NHI Comprehensive Bridge Safety Inspection Course

Refresher Training

In addition to the requirements just listed, all inspection personnel, regardless of TL status, are required to have taken and successfully passed the three-day NHI Bridge Safety Inspection Refresher Course every five (5) years from the date of taking and successfully passing the two-week course.

4.2.3.1 Underwater Inspector Qualifications

The qualifications of underwater inspection personnel are broken down into two categories: the diving operation and the inspection operation. The underwater consultant and all inspection personnel assigned to the project must meet these requirements in order to be approved to perform the inspection of any State-owned bridge.

Diving Operations

In regards to the diving operation, each diver assigned to the project shall have received certification from a commercial diving school or organization. All divers must satisfy requirements for training and medical examinations in accordance with the Occupational Safety & Health Administration's (OSHA) Commercial Diving Standards. In addition, the consultant is to maintain a Safe Dive Practices Manual as per OSHA.

Inspection Operations

Essentially, the qualifications are the same as for inspection personnel as outlined in Section 4.2.3. However, there are additional requirements that are specific to DelDOT's Bridge Inspection Program and are as follows:

1. All diver inspection personnel are to have taken and successfully passed the four-day NHI Underwater Bridge Inspection Course.
2. The underwater inspection team shall have a PE diver registered in the State of Delaware that also qualifies as a TL on site during each underwater bridge inspection. This individual does not necessarily have to be the diving inspector, but should be available to assess, evaluate, and confirm inspection findings, if necessary.
3. As noted in Section 4.2.3, all inspection personnel with 12 months or greater of inspection experience are required to have taken and successfully passed the two-week NHI Comprehensive Bridge Safety Inspection Course. As a result of this requirement, an underwater inspector with the four-day NHI Underwater Bridge Inspection Course and 12 months or greater of bridge inspection

experience is not qualified to inspect or assist with an inspection of a DelDOT-owned bridge without the two-week NHI Comprehensive Bridge Safety Inspection Course and will not be approved to do so.

4.2.3.2 Fracture Critical Bridge Inspector Qualifications

In addition to the qualifications outlined in Section 4.2.3, inspection personnel for the fracture critical elements of a bridge must meet the following additional requirements:

1. The TL and TM personnel participating in a fracture critical bridge inspection are required to have taken and successfully passed the NHI Fracture Critical Inspection Techniques for Steel Bridges Course.
2. All inspection personnel participating in a fracture critical bridge inspection are required to have taken and successfully passed the NHI Fracture Critical Inspection Techniques for Steel Bridges Course once every ten (10) years from the date of originally taking the course.
3. All fracture critical bridge inspections shall have a certified TL that has a PE license in the State of Delaware present during the inspection due to the complexity of fracture critical bridges and the vulnerability to fatigue cracking. The PE shall serve as a technical resource for the inspection team and ensure a thorough investigation. They shall provide careful consideration of all critical fatigue prone details, fracture critical members, and problematic areas. Having the PE present will aid the inspection team in better identifying critical findings and locations warranting analysis or requiring follow-up actions.

4.2.3.3 Complex Bridge Inspector Qualifications

To match DelDOT's current bridge inventory, inspection staff qualifications for complex bridges have been broken into three groupings: non-fracture critical movable bridges, fracture critical movable bridges, and cable stayed bridges.

Non-Fracture Critical Movable Bridges

The requirements for all inspection personnel follow that of a routine bridge inspection and therefore utilize the same qualifications found in Section 4.2.3 with one additional requirement: the TL and TM that perform the inspection are required to have taken a movable bridge inspection course or have inspection experience with similar types of bridges.

Fracture Critical Movable Bridges

The requirements for all inspection personnel follow that of a fracture critical bridge inspection and therefore utilize the same qualifications found in Section 4.2.3.2 with the one additional requirement: the TL and TM that participate in the inspection are required to have taken a movable bridge inspection course or have inspection experience with similar types of bridges.

Cable Stayed Bridges

The qualifications of inspection personnel for the IRIB shall comply with the specifications of the IRIB *Manual for Inspection and Maintenance*. In general, the requirements for all inspection personnel follow that of a routine bridge inspection and therefore utilize the same qualifications found in Section 4.2.3 with the one additional requirement. The TL and TM that participate in the inspection are required to have received specialized training pertaining to the features commonly found with that of a cable stayed bridge or have inspection experience with similar types of bridges.

4.2.3.4 NDE Inspector Qualifications

The governing association for training and certifying inspectors for use in NDE is the American Society for Nondestructive Testing (ASNT). Likewise, the Certification for Welding Inspection (CWI) is issued through the American Welding Society (AWS). There are different requirements and certification levels within ASNT for identifying the qualifications of a NDE technician or inspector.

The first requirement is that the NDE Technician must have CWI certification. Additional requirements, specific to each type of NDE method, are listed below. For radiography testing, the Industrial Radiography and Radiation Safety Personnel (IRRSP) certification is offered through the ASNT program.

- Dye-Penetrant Testing - ASNT Level II Certification or have been trained by a ASNT Level II Certified Technician or have attended and successfully passed a training course involving Dye-Penetrant Testing
- Ultrasonic Testing - ASNT Level II Certification for straight beam and shear wave
- Magnetic Particle Testing - ASNT Level II Certification or have been trained by a ASNT Level II Certified Technician
- Eddy Current Testing - ASNT Level II Certification
- Radiography Testing - IRRSP certification as an ASNT Level II

4.2.3.5 QC of Inspection Personnel

QC of inspection personnel consists of ensuring that all inspection staff meet the qualifications as defined in Section 4.2.3. The responsibility of ensuring that qualified personnel are inspecting DelDOT’s bridges belongs to the BIE. The BIE will verify that the TL and all TM’s for each inspection have been approved by the Department and are on DelDOT’s Bridge Inspection Certified Inspector List. This task is accomplished while reviewing and performing QC on the inspection report.

Inspector qualifications will be documented and tracked by the BIE to maintain a master list of all approved inspection personnel for participating on State-owned bridge inspections. As part of this, the BIE is responsible for coordinating refresher training for in-house personnel. This includes budgeting, scheduling the training and accounting time into the yearly inspection schedules to allow for the necessary inspection staff to attend training. The BIE is also required to verify and update information for all previously approved inspection personnel on a yearly basis. Copies of certifications and registrations are stored in electronic format for each inspector along with a spreadsheet. Items that are to be updated and/or verified include the following:

- Years of Experience
- Certifications and Registrations
- Training and Refresher Training

This information, as well as the addition of new inspection personnel, may be updated during the course of the inspection year as information is submitted to the BIE.

4.2.4 Resolution of Data Errors

Throughout the QC process, data errors may be encountered that will need to be addressed. These errors can stem from the quality of the documentation or from that of the report itself. The errors may be detected during any phase of the inspection or review process. Errors will generally fall under one of the following categories:

- NBI Inventory Data
- Element Selection and Condition Rating Data
- NBI Condition Rating Data
- Inspection Forms and Sketches
- Photographic Documentation

The process to resolve any data error found should follow these general guidelines:

1. Any obvious error that is observed and that does not affect the condition ratings can be corrected in the inspection report, particular form or sketch by the individual finding the error.
2. Any missing or indiscernible data or information from the report, form, or sketch should be brought to the attention of the TL if the error is found by the BIE through the use of the QCRR (refer to Appendix A). It will then ultimately be the responsibility of the TL to acquire the missing data or clarify the data as necessary before the BIE finalizes the report in the database. This includes any out of focus, mislabeled or missing photographs as well.
3. Discrepancies in inventory data or assigned element and/or NBI condition rating data in regards to established procedures and protocol presented within this Manual should be brought to the attention of the TL. The discrepancy should be discussed and, if determined necessary, additional measurements, sketches or photos will be obtained to resolve the issue. This could also result in either the original inspection team revisiting the bridge and/or the BIE making a visit to confirm the inspection team’s findings.
4. Ultimately, the BIE has final say and has the authority to supersede the NBI condition assignments made by the TL and/or inspection team that performed the inspection. In the case of such an event, adequate documentation shall be provided in the inspection report by the BIE.

All data errors found by the BIE should be included in the QCRR that is filled out as inspection reports are downloaded in the database. The form includes the date that the BIE performed the review as well as the initials of the inspection team members. The first initials are that of the designated TL for that particular inspection. Once the error has been corrected or the discrepancy resolved, the BIE shall update the form to identify that the error(s) have been resolved and the final report shall be printed.

4.3 Quality Assurance Procedures

In order to comply with the NBIS, bridge owners are required to have a Bridge Inspection Program that includes QA procedures. QA procedures are important to maintain a high degree of accuracy and consistency in the inspection program. Accuracy and consistency of the bridge inspection data are the foundation of the bridge management systems and operations. The accuracy and consistency of the inspection and documentation is vital because it impacts programming and funding appropriations, and public safety.

The next few pages present DelDOT's QA Procedures which have been broken down into five separate areas:

1. Bridge Inspection Review Processes
2. Inspection Program Review Process
3. Sampling Protocol
4. Inspector Disqualification Procedures
5. Roles and Responsibilities of the QA Team

4.3.1 QA Bridge Inspection Review Procedures

This section provides guidelines and procedures for administering QA reviews for the field inspection, documentation, reports, and bridge inspection files in regards to the inspection process. The QA review has been organized into three separate components to address all areas listed above. The QA Inspection Review process proceeds through all three components sequentially. First, the inspection file review is completed, then the office review, and finally the field reviews are conducted.

All three procedures are performed for the same group of selected bridges and include an equal percentage of in-house and consultant inspections. However, it does not involve underwater inspections that only assess the substructure, channel, and waterway conditions. This is due to the inability of the QA Team to access the bridge and confirm inspection findings. However, the documentation provided within the underwater inspection report is reviewed to verify that the underwater inspection findings justify the NBI condition ratings.

The bridges are randomly selected during the beginning of the calendar year by the BIE as inspection schedules are being established and assigned. The random selection encompasses various types of bridges including the following: fracture critical, complex, and posted bridges. Prescriptive sampling protocol details can be found in Section 4.3.3. The QA Team can modify their selection requirements as to the type of bridges that the quality review will incorporate and emphasis may change from year to year depending on general inspection results, observed problems, or inconsistencies in reporting, or the desire to monitor new or critical evaluation items. Since the bridges being randomly selected can have inspection dates ranging from February to November, the QA Inspection Review process usually takes place during the months of November and December. As part of the QA Inspection Review process, the QARR reporting template has been established. A sample QARR can be found in Appendix A.

The goals of the QA Inspection Review procedures are two-fold. The first goal is to identify deviations or discrepancies that are associated with a particular TL or inspection staff and to bring it to their attention so the issue(s) can be resolved. The second goal is to highlight improvements that may need to be made to the Bridge Inspection Program to address and resolve issues found throughout the QA review process. This may include setting up special training on specific items, issuance of clarifying memorandums or directives, or meetings with staff and/or consultant inspection teams.

4.3.1.1 QA Bridge Inspection File Review Procedures

The first step in the QA Inspection Review process is reviewing the bridge inspection files. As part of DelDOT's Bridge Inspection Program, each bridge has its own bridge inspection file. Refer to Section 3.5.8 for further discussion of the bridge files.

The steps for QA review of the bridge inspection files include the following tasks:

1. Confirm that the most recent inspection report was placed on top on the left hand side in the Active inspection file.
2. Confirm that all documentation, forms, sketches, photo report, Structural Data Report (SDR) sheets have been assembled and placed in the inspection file correctly as per this Manual.
3. Confirm that the designated TL has signed and dated the inspection report.
4. Confirm that the latest three routine inspection reports are included in with the Active inspection file and any other report beyond that have been placed in the Inactive file(s).
5. In general, confirm that all plans, load ratings, and other necessary documentation exist in the bridge inspection files.

Anything found during the QA Office Review process shall be identified on the QARR for that particular bridge.

4.3.1.2 QA Office Review Procedures

The QA Office Review Procedures involve reviewing all documentation and the entire inspection report for accuracy and conformance to procedures and protocol presented throughout this Manual. Essentially, this portion of the QA Inspection Review is similar to the review performed during the QC Inspection Review process for the documentation and reports. Tasks associated with this portion of the QA process can be found in Sections 4.2.1.2 and 4.2.1.3. The one additional task involved with the QA procedure involves confirming that all items identified on the QCRR (see Appendix A) have been addressed and that there is a corresponding sign-off date for each item. Anything found during the QA Office Review process shall be identified on the QARR for that particular bridge.

4.3.1.3 QA Field Review Procedures

All three members of the QA Team (see Section 4.3.5) will participate in field visiting each bridge that was randomly selected. The purpose of the visit is to perform a cursory inspection to confirm the inspection team's findings and their documentation. The cursory inspection will consist of a visual inspection only, unless a critical defect or deterioration is observed, and that was not found or reported during the original inspection. In this case, the necessary steps shall be taken by the QA Team to obtain traffic control and/or equipment access to gain hands-on access of the area in question. In regards to a critical defect or deterioration that was noted during the inspection, if feasible those areas shall be accessed by the QA Team to confirm the severity and that adequate documentation of the defect was obtained. The tasks of the QA Team that are associated with QA Field Review include the following:

1. Verify NBI inventory data
2. Verify the element selection for the bridge
3. Verify element and NBI condition ratings through performing an independent, cursory inspection of the bridge
4. Verify measurements of section loss, bearing loss and/or sketches denoting significant deterioration
5. Verify load posting and signage
6. Verify any identified maintenance recommendation selections
7. Verify/spot check scour soundings and/or under clearance measurements

All findings from the QA Team's field visit will be presented in the QAAR. It is possible that some of the findings will require additional action from that of the TL, such as placing additional Maximo Work Orders or sketching additional or missed deterioration. Likewise, some findings may not require action, but will need to be discussed or clarified with the TL. Once the QA Team has completed all field reviews and the BIE finishes the QAAR for each bridge, the BIE and BME will meet with each TL to discuss the QAAR for each bridge that was randomly selected as part of the QA process.

4.3.2 Inspection Program Review Procedures

A QA program would be incomplete without procedures for assessing and reviewing the Bridge Inspection Program to assure that the NBIS requirements are being met. In order to get an unbiased, independent review of the inspection program and how it complies with the NBIS, inspection program review procedures have been incorporated into the QA process. The inspection program review procedures are separated for State-owned, DRBA, municipality, and privately-owned bridges.

4.3.2.1 State-Owned Bridges

The inspection program review procedure for DelDOT's Bridge Inspection Program consists entirely of the FHWA's National Bridge Inspection Program (NBIP) Compliance Review procedures. Activities associated with the NBIP Compliance review are performed by the FHWA Division Engineer and therefore, serves as an independent review of the inspection program. The NBIP Compliance Review process has been broken into 23 metrics that address all significant areas of an inspection program. The 23 metrics relate directly to the wording and subsections in the Code of Federal Regulations, 23 CFR 650 Subpart C. Each metric has multiple requirements and is evaluated on a yearly basis. Further details and discussion regarding the FHWA compliance review process can be viewed in the NBIP Compliance Review document accessible from the FHWA's website.

The NBIP Compliance Review process involves all state-owned bridges (DelDOT and DNREC-owned), DRBA bridges, and any city or town-owned NBI bridges. In accordance with the compliance review process, if the FHWA finds DelDOT's Bridge Inspection Program to be "Substantially Compliant" for a particular metric, then an Improvement Plan would be initiated requiring for the deficiency pertaining to that metric to be addressed. Likewise, a Plan of Corrective Action (PCA) would be initiated for a particular metric that was found to be "Non-Compliant". For metric(s) originally receiving a "Non-Compliant" rating, a "Conditional Compliant" classification will be assigned upon the FHWA approval of the PCA. It is the responsibility of the Bridge Management Section to address any deficiency found during the NBIP Compliance Review and to ensure that all PCA(s) and Improvement Plan(s) be adequately addressed and in the time frame agreed upon with the FHWA. The BIE serves in the primary role for accomplishing this, however, the BME will provide guidance, support and, if needed, allocation of additional resources in order to improve the inspection program and to implement new processes to correct any identified deficiencies.

In addition to evaluating the Bridge Inspection Program, the NBIP Compliance Review process involves a random sampling of DelDOT's NBI bridge inventory. Different random selections are made to evaluate the bridge inspection files, inspection reports, and to perform a field review consisting of a cursory inspection. This is similar to, and in addition to, that of the QA Inspection Review Procedures that DelDOT's QA Team performs on a yearly basis. For details as to how the random selection generation is made, refer to the FHWA NBIP Compliance Review document.

4.3.2.2 City-Owned Bridges

In 2009, DelDOT decided to assume responsibility for inspection and performing load rating analyses for NBI bridges that are owned by a municipality upon request. Maintenance, load posting, and replacement are still the responsibility of the individual municipality, but DelDOT will assist with obtaining federal funding, if applicable. Therefore, a city-owned bridge follows the same inspection program review process as a state-owned bridge, since those bridges now fall under the responsibility of DelDOT's Bridge Inspection Program. Additional discussion in regards to load posting of city-owned bridges can be found in DelDOT's Bridge Design Manual.

4.3.2.3 DRBA-Owned Bridges

DRBA's bridges are included in the random sampling of the NBIP Compliance Review process. DelDOT is required to submit DRBA's NBI data to the FHWA each year and DelDOT maintains a separate bridge inspection file for each of DRBA's 15 bridges. This includes SDR reports, field notes, photo reports, plans, load ratings, maintenance history, and any correspondence.

DRBA's inspection program is not evaluated or reviewed during the FHWA compliance review process, although their bridge data is included in the review of DelDOT's Bridge Inspection Program. As per the NBIS, it is the State's responsibility to review another agency's Bridge Inspection Program to ensure that it complies with the requirements of the NBIS. Therefore, DelDOT's Bridge Management Section has established a Bridge Inspection Program Compliance Review Process specific to the DRBA. This process is completed every four (4) years and is similar to the previous NBIP Compliance Review process. The compliance review process addresses and evaluates all the fundamental requirements identified in the NBIS. As part of the process, DRBA staff and DelDOT's BIE and BME will meet to go over the compliance review form and discuss DRBA's Bridge Inspection Program. The FHWA Division Engineer will be invited to participate.

The form will typically be sent prior to the meeting to provide DRBA additional time to review the prior compliance review document and prepare for the upcoming compliance review. As part of the process, a random selection of DRBA's bridge will be made and DelDOT's QA Team will perform a QA review of the documentation, inspection report and will field visit each selected bridge to verify inspection findings similar to DelDOT's internal QA Inspection Review process. Refer to Section 4.3.3 for sampling protocol details. The compliance review form will identify deficiency where DRBA needs improvement as well as provide "Good Practices" relating to DRBA's Bridge Inspection Program. Any deficiencies found during the compliance review process of DRBA's Bridge Inspection Program or DelDOT's NBIP Compliance Review process that affect DelDOT's Bridge Inspection compliance with the NBIS, will require a Plan of Corrective Action to address each deficiency. The PCA(s) shall be completed within 12 months of DelDOT notifying DRBA of the deficiencies. Upon completion of the QA inspection review and the compliance review form, the BIE will send the finalized form to DRBA, the FHWA Division Engineer, and the BME for signatures.

4.3.2.4 Other Bridge Owners

Within the State, there are privately-owned bridges that do not meet the definition of a bridge per the NBIS but do span over a public road or highway. Per Delaware Law, these bridge owners are required to have their bridges inspected every five (5) years and submit inspection reports to DelDOT. The private bridge inventory primarily consists of pedestrian bridges that are typically inspected by consultants. The bridge owner is not required to have an official Bridge Inspection Program; therefore, these bridges do not require a comprehensive compliance review to be performed. DelDOT's BIE will confirm the qualifications of the consultant's inspection staff to confirm they meet the requirements of the NBIS. The BIE will also confirm that any private bridge inspection has been completed on time. In the event that a consultant assigns a NBI condition rating of a privately-owned bridge as being Structurally Deficient, the BIE and BME may choose to field visit the bridge to assess the severity of the condition and work with the bridge owner in addressing the deficiencies. Documentation of the correspondence between DelDOT and the bridge owner will be updated in the bridge inspection file.

4.3.3 QA Sampling Protocol

This section presents the sampling protocol that is incorporated into the random bridge selection as part of the QA Process for a particular inspection year. These criteria will apply to consultant and in-house inspections. The bridges are randomly selected during the beginning of the inspection year to filter out bridges that may be under construction or bridges that have complex access restrictions. The random selection percentages are carried out for all NBI bridges due for inspection in a given inspection year. The same percentages are applied when selecting bridges for TL review. TLs shall not be aware of bridge selection prior to their inspection.

4.3.3.1 Routine Inspections

The sampling parameter for all NBI bridge inspections for a given inspection year is 5%, regardless of the design or material type. This is applied to assigned bridge inspections for all TLs.

4.3.3.2 Fracture Critical Inspections

The sampling parameter for all NBI Fracture Critical bridge inspections for a given inspection year is 25%. This is applied to assigned bridge inspections for each individual in-house inspection TL and each consultant. In the case that a particular team has less than four (4) fracture critical bridge inspections assigned to them, a minimum of one (1) bridge shall be selected. The selected fracture critical bridges may be included with the 5% of the routine inspection random selection. This means, that it is possible that a fracture critical bridge may be randomly selected for the routine inspection portion and selected for the fracture critical inspection as well.

4.3.3.3 Complex Bridge Inspections

The sampling parameter for all NBI Complex bridge inspections for a given inspection year is 25%. This is applied to assigned bridge inspections for each individual in-house inspection TL and each consultant. The selected complex bridges will be included with the 5% of the routine inspection random selection. In the case that a particular team has less than four (4) complex bridge inspections assigned to them, a minimum of one (1) bridge shall be selected.

4.3.3.4 Posted Bridges

The sampling parameter for all NBI load posted bridges for a given inspection year is 25%. This is applied to assigned bridge inspections for each individual in-house inspection TL and each consultant. The selected load posted bridges will be included in with the 5% of the routine inspection random selection. In the case that a particular team has less than four (4) posted bridges assigned to them, a minimum of one (1) bridge shall be selected.

4.3.4 Disqualification Process of Inspection Staff

The last component of the inspection QA program involves the disqualification and the requalification requirements for inspection staff that lose their TL status. This process is applicable for any in-house or consultant inspection personnel participating in the inspection of a state-owned bridge. There are two ways that a TL can be disqualified: delinquency of training certification or unsatisfactory performance. The disqualification process only addresses inspection related deficiencies. Other issues associated with in-house inspection personnel behavior including, but not limited to, drug and alcohol use, violence, and any other violation stated in the State of Delaware Merit Rules do not fall within the limits of this process.

4.3.4.1 Refresher Training

Disqualification Trigger

The first way for disqualifying a TL involves becoming delinquent in training requirements. Per the qualification requirements presented in Section 4.2.3, all inspection personnel are required to take and successfully pass the three-day NHI Bridge Inspection Refresher Training Course every five years upon completion of the two-week NHI Comprehensive Bridge Safety Inspection Course. In the event that an inspector does not successfully pass the three day refresher course or the inspector does not take the refresher course within the five year time frame, that inspector will be considered disqualified and will lose their TL status. A score of less than 70% constitutes unsuccessful completion of the course.

Re-qualification Requirement

In the event that a TL is disqualified as a result of unsuccessful completion of the three day refresher course, the protocol for reinstating their TL status is as follows. The inspector will be required to wait 6 months in order to retake the course.

If an inspector is disqualified as a result of not taking the course within the five year time frame, then they will lose their TL status until they take and successfully pass the refresher training course. A consultant TL that is disqualified due to training requirements will be replaced with another qualified consultant TL approved by the DelDOT's BIE until the disqualified consultant TL obtains requalification.

4.3.4.2 Unsatisfactory Performance Review

Disqualification Trigger

The other way for disqualifying an inspection TL involves the annual Performance Review for an in-house inspector or the Consultant Performance Review for consultant inspection staff. In the event that an inspector receives an overall rating of an "Unsatisfactory" for a given Performance Review, that inspector will be considered disqualified and will lose their TL status. If this occurs, the BIE must have sufficient documentation in order to justify the unsatisfactory review. This will include results from the QA Inspection Review Procedures or not meeting scheduled inspection deadlines in accordance with the parameters identified in that individual's signed work plan. The Consultant Performance Review will follow the protocol established for the in-house Performance Reviews. The signed work plan provides criteria for each Performance Review Rating level.

In addition, if an individual receives an overall rating of a "Needs Improvement" for a given Performance Review, then the individual is placed on probation. This means that the individual can still serve as TL, however if they do not receive an overall rating on their next Performance Review of a "Meets Expectations" or higher, then they will be disqualified and lose their TL status.

Re-qualification Requirement

In the event that a TL is disqualified as a result of receiving an "Unsatisfactory" rating during the Performance Review, the protocol for reinstating their TL status requires that the inspector will be required to wait a minimum of 6 months and up to 12 months until their next Performance Review has been completed. This serves to provide the inspector ample time for obtaining additional experience, training and allow the individual a chance to improve upon their inspection skills. A consultant TL that is disqualified due to unsatisfactory performance will not be allowed to serve as TL for a DelDOT bridge inspection for the remaining length of the inspection agreement. If the same consultant is selected for a subsequent inspection agreement, consideration will be given to reinstating the TL by DelDOT.

4.3.5 QA Roles & Responsibilities

The roles and responsibilities involved with the QA Procedures for DelDOT's Bridge Inspection Program are spread among various staff from within the Bridge Management Section. The Department's Bridge Management Section has established a QA Team in order to handle the tasks associated with the QA Procedures. The QA Team's function is to monitor the inspection program by independently field visiting and inspecting a representative sample of bridges previously inspected by in-house and consultant inspection teams, and preparing a report comparing findings for consistency and accuracy. The QA Team consists of the BIE, BME, and the Bridge Maintenance Engineer.

As a result of their extensive experience and broad spectrum of background in the bridge related field, the QA Team is able to provide the technical expertise necessary for assuring that the Bridge Inspection Program is efficient, consistent and is maintaining a high level of quality. The QA Team will perform an annual review in order to measure the quality and uniformity of the inspection and documentation, and to identify specific items or procedures in the Bridge Inspection Program where clarification, revision, or additional training is needed. The members of the QA Team have different roles in accomplishing goals of the QA Procedures.

4.3.5.1 Bridge Inspection Engineer

The BIE has a majority of the responsibility for QA and has oversight of the QA initiative. There are two separate areas of the QA review process: the QA Inspection Review and QA Inspection Program Review.

QA Inspection Review Process

The tasks associated with the QA Inspection Review process are as follows:

1. Randomly select bridges to be reviewed
2. Perform QA review of the inspection files for those selected bridges
3. Perform QA review of the inspection report and documentation in the office for those selected bridges
4. Start completing the first two sections of the QARR based upon the findings of the previous two items
5. Schedule dates with the rest of the QA team to field visit and perform a cursory inspection for each of the bridges selected
6. Perform the cursory QA inspections
7. Complete the last portion of the QARR based upon the findings of the cursory inspection for each bridge

8. Schedule dates to meet with each in-house TL or consultant Project Manager and the BME to discuss the QARRs
9. Finalize each QARR by collecting the required signatures and dates, save documents electronically, and submit to each TL by email for them to include with their records
10. Incorporate discussions of any significant QA review findings during the next Quarterly Inspection Staff Meeting

More detailed discussion of these processes can be found in Section 4.3.1.

<u>QA Inspection Program Review Process</u>
The QA Inspection Program Review involves bridges that are State-owned as well as bridges owned by DRBA, DNREC, city/towns within the State, and private owners. Roles of the BIE for participating in this review process include the following tasks:

1. Coordinating with FHWA during the NBIP Compliance Review Process
2. Conducting a separate Bridge Inspection Program Compliance Review for DRBA
3. Conducting QA reviews for “Other” (Private) bridge owners

More detailed discussion of these processes can be found in Section 4.3.2.

4.3.5.2 Bridge Management Engineer

Roles of the BME can be broken out between the QA Inspection Review & QA Inspection Program Review processes.

<u>QA Inspection Review Process</u>
There are three tasks that involve the BME during the QA Inspection Review process. The first involves attending the cursory inspection for each of the randomly selected bridges with the rest of the QA Team. The role of the BME is slightly different than that of the BIE. The BME is evaluating how the load ratings, maintenance recommendations, and/or Maximo Work Orders all get incorporated into the inspection report. The BME assures that goals of the Bridge Management Program are being accounted for and procedures for each primary function of the program are being implemented properly during the inspections. The three main functions of the Bridge Management Program are the Bridge Inspection, Load Rating, and Bridge Maintenance Programs.

The second role of the BME during the QA review process involves participating in meetings with the BIE and each TL upon completion of the QARRs. This allows for the BME to reinforce the value of the QC/QA process and assist with communicating among the inspection staff any concerns or additional needs that could improve the inspection program.

The final role of the BME is to follow-up on any process or program issues that surface as a result of the QA review process. This could involve an issue that needs clarification for the inspectors and how to accomplish a certain task or an additional process that needs to be incorporated into an existing procedure to resolve the issue. The issue could be something affecting either the Bridge Inspection, Bridge Maintenance, or Load Rating programs.

QA Inspection Program Review Process

The BME will participate in meetings with the FHWA and/or DRBA. The BME is ultimately responsible for overseeing the BIE and the Bridge Inspection Program, but the role served during the compliance review process is geared more towards providing management support to the BIE and the process as a whole, and assisting with discussions. The BME provides more insight and takes the lead on load rating and maintenance issues involved with the compliance review processes.

4.3.5.3 Bridge Maintenance Engineer

The Bridge Maintenance Engineer participates in the cursory field inspection but has no other involvement in the QA Inspection Review process.

The Bridge Maintenance Engineer assists with comparing bridge condition findings during the cursory inspection to what was reported by the inspection team, but focuses more on the maintenance aspects including both preventative and corrective maintenance items. This includes assuring that existing policies were followed by the inspection team, determining if modifications are required for existing policies, and evaluating different element condition state and corresponding work action description assignments within the BEIM. Further discussion is presented in Section 4.3.1.2.

5. Safety

5.1 Introduction

Bridge inspection is inherently dangerous and requires continual awareness on the part of each member of the inspection team. This section provides individuals and organizations involved with bridge inspections information aimed at ensuring the safe completion of inspection activities on DelDOT bridges. Additional information provided in this section includes relevant regulations, requirements, and procedures for personal equipment, access equipment, site conditions, and responses to on-site emergencies.

5.2 Safety Roles & Responsibilities

Safety for oneself and others is the responsibility of all involved in the inspection process. All participants should have the appropriate training for their assigned tasks and the equipment they will use. The following is a list of key personnel involved in bridge inspections and their roles and responsibilities regarding safety.

5.2.1 Team Member

Bridge Inspection Team Members (TM) are responsible for the condition of their own equipment, removing unsuitable equipment from service, and reporting unsafe conditions. Inspectors should recognize their own limitations and comfort level and communicate them with their supervisor and team members.

5.2.2 Team Leader

The Bridge Inspection Team Leader (TL) shall be familiar with applicable safety laws, able to recognize potential health concerns, ensure compliance when performing inspection tasks, and include safety in the planning process including an analysis of conditions at the bridge site such as potential confined spaces and environmental hazards. The TL is responsible for ensuring that the appropriate equipment is available and enforcing its proper use. TLs shall conduct safety meetings when starting a new inspection task, site conditions change, new team members are present, and before unfamiliar work is performed in order to:

- Review new or different tasks to be performed
- Identify potential hazards and discuss solutions
- Identify unusual conditions associated with the bridge site
- Discuss traffic control procedures
- Verify equipment condition and use

5.2.3 Bridge Inspection Engineer/Consultant Project Manager

The BIE and consultant project managers shall be familiar with applicable safety and health laws, enforce safety policies, and ensure that inspectors have the appropriate training and equipment necessary to safely perform their jobs. Project managers shall ensure that training certificates are kept on file and current, review incidents as they occur, and facilitate discussion to periodically review safety practices. Refer to Section 5.5 for incident reporting requirements.

The BIE is additionally responsible for distribution of this manual and communication of updated DelDOT policies to in-house staff and consultant project managers. All consultant project managers are responsible for disseminating new or updated information to their inspectors.

5.2.4 DelDOT Safety Officer

The DelDOT Safety Officer will review incident reports and maintain documentation pertinent to on-site accidents. The Safety Officer is responsible for periodically reviewing safety practices and altering current standards or augmenting training to foster a safe working environment. Refer to Section 5.5 for incident reporting requirements.

5.3 Safety Regulations & Guidance

When inspecting DelDOT bridges, consultant workers shall be bound to the safety standards set forth in OSHA Safety & Health Regulations for the Construction Industry (29 CFR 1926) and the Delaware MUTCD. In-house inspectors shall follow the DelDOT Safety Manual and the Delaware MUTCD. The following sections refer to specific subparts and articles of those documents and provide guidance where necessary, but inspectors should be familiar with and follow pertinent standards.

5.3.1 Personal Protective and Life Saving Equipment

29 CFR 1926 Subpart E governs the use and minimum requirements for most PPE. Foot, head, hearing, eye, and respiratory protection standards are covered here. Remaining PPE such as high visibility apparel is governed by the MUTCD in Section 6D.03 and as amended in the Delaware Revisions to the MUTCD. While in many cases it is the employer's responsibility to supply PPE to the inspector, it is the individual's responsibility to maintain and inspect the equipment. Expired, damaged, and defective PPE should be reported and replaced immediately.

Most inspection activities involving access equipment will present the danger of head injury due to accidental impact with bridge components, therefore hardhats or other approved head protection should at a minimum be worn during these activities. Eye protection becomes necessary when particles become airborne such as sounding concrete or brushing or scraping an element.

Respiratory protection may be necessary at any time based on the surrounding environment and conditions at the bridge site. Many types are available for various atmospheric hazards. Inspectors should carefully assess potential hazards and select the appropriate protection. Respiratory protection should especially be considered when cleaning, working in areas of significant animal debris, entering enclosed box members, disturbing lead-based paint, and working near construction. Evaluation for use of respiratory protection shall be considered for inspection operations to be conducted in machinery pits of moveable bridges as a result of pigeon dropping debris.

Subpart E also governs work over or near water and the use of approved flotation devices, life buoys, and safety boats. All three are considerations when working over or near water where there is a drowning hazard present. Safety boats may be used when conditions warrant and will be determined on a case-by-case basis. Clarifications to the OSHA standards state that life jackets may not be necessary when fall protection systems are suitable to alleviate the drowning hazard, however life buoys and a safety boat should still be available.

5.3.2 Access Methods

This subpart covers safe practices for the use of most means of access required for bridge inspection.

5.3.2.1 Lift Vehicle Access Equipment

29 CFR 1926 Subpart L governs the use, maintenance, and condition of aerial lifts. Subpart O governs motor vehicle and mechanized equipment usage on jobsites.

All access equipment, including bucket trucks, aerial lifts, and UBIVs, must be erected, deployed, and maintained by trained and, if applicable, certified personnel. Inspectors shall ensure that all access equipment has been correctly maintained and is in good working condition prior to its use by running basic checks of mechanical equipment to verify that the system is working properly. Equipment requiring maintenance shall be put out of service immediately and reported to the appropriate individual for repair or replacement.

Inspectors shall refrain from using or operating equipment with which they are not familiar. Inspectors shall understand and follow the limitations and usage cases defined by the manufacturer. Bucket trucks, aerial lifts, and UBIVs should have documentation available on the vehicle stating the safe working envelope and appropriate environmental conditions. High winds, soft or wet soils, and steep slopes may preclude the safe operation of certain access equipment. Modern equipment may include safety checks (limit switches) that prevent the operator from maneuvering the equipment outside of the safe working envelope, however inspectors should not rely on these to prevent unsafe situations. Such equipment may also include system overrides allowing potentially unsafe positions, but only trained personnel should utilize this feature.

5.3.2.2 Ladder & Scaffolding

29 CFR 1926 Subpart L governs the use, maintenance, and condition of work platforms. Subpart X governs stairways and ladders.

All access equipment, including ladders and scaffolding must be erected, deployed, and maintained by trained and, if applicable, certified personnel. Inspectors shall ensure that all access equipment has been correctly maintained and is in good working condition prior to its use by performing a visual check. Equipment requiring maintenance shall be put out of service immediately and reported to the appropriate individual for repair or replacement.

Care should be taken when loading and unloading ladders from vehicles and transporting them on-site, especially up and down slopes. When leaving the job site, inspectors should verify that all equipment is stowed and secure for transportation.

5.3.2.3 Working Adjacent to Traffic

When working either on foot or in inspection access equipment adjacent to live traffic, inspectors must wear the appropriate high visibility apparel as governed by the MUTCD in Section 6D.03 and as amended in the Delaware Revisions to the MUTCD. Inspectors shall refrain from entering live traffic lanes for any reason.

5.3.2.4 Working over or Near Water

29 CFR 1926 Subparts E and O govern work performed over or near water. Typical inspector activities over or near water include when walking or climbing on catwalks or bridge elements, when using a UBIV or manlift, and when working from boats or barges. When walking or working near unguarded edges, a U.S.

Coast Guard-approved work vest or buoyant vest shall be worn. A lifesaving skiff or safety boat shall be immediately available.

5.3.2.5 Boat Safety

The Delaware Division of Fish & Wildlife and Delaware State law govern the education and certification requirements for operation of a motorized waterborne vessel on Delaware waterways. Each person working from a boat shall be provided with a U.S. Coast Guard-approved life jacket or buoyant work vest.

Care should be taken when loading and unloading boats and equipment from vehicles and trailers. When leaving the job site, inspectors should verify that the boat and equipment are properly stowed and secure for transportation.

5.3.2.6 Climbing & Rope Access

Assisted free climbing and industrial rope access to towers, cables, and other bridge elements are governed by the Society of Professional Rope Access Technicians (SPRAT). SPRAT provides standards through their *Safe Practices for Rope Access Work* and *Bridge Inspection-Typical Rope Access Techniques* documents. These access methods shall be erected, maintained, and utilized by personnel properly trained and certified in SPRAT techniques.

5.3.3 Fall Protection

29 CFR 1926 Subpart M governs the design, use, and maintenance of various fall protection systems. In general, fall protection shall be used when working at heights of 6-feet and higher and with lifts, bucket trucks, UBIVs, and other similar access equipment. The most frequently used fall protection for inspections is a personal fall arrest system made up of a harness, lanyard, and anchor point. While potentially acceptable for some purposes, inspectors should be aware that belt systems are no longer acceptable for most inspection activities. Instead a full body harness shall be used. Refer to Subpart M and the OSHA Standard Interpretations for guidance.

5.3.3.1 Indian River Inlet Bridge Pylon Towers

The IRIB pylon towers have been equipped with a ladder system and rigging anchors for a proprietary fall arrest system. Inspectors shall familiarize themselves with this unique system and its use and coordinate with the BIE for the additional training and equipment that may be necessary.

More information is available in Section 5 of the IRIB *Manual for Inspection and Maintenance*.

5.3.4 Confined Spaces

29 CFR 1926 Subpart AA governs confined space entry, permitting, training, and equipment. OSHA defines a permit-required confined space as a confined space that has one or more of the following characteristics:

1. Contains or has a potential to contain a hazardous atmosphere;
2. Contains a material that has the potential for engulfing an entrant;

3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
4. Contains any other recognized serious safety or health hazard.

Confined spaces in DelDOT bridge inspections can include the interiors of steel box girders, long or full culverts, and pylon towers. In the case of culverts not deemed to be a confined space where access or maneuverability is not restricted, use of an air meter shall still be used to confirm that adequate air conditions exist for inspection personnel.

All participants in a confined space entry shall be properly trained in OSHA permit-required confined space entry procedures; however the TL will determine the appropriate permit requirements, equipment, and controls for a safe entry per OSHA standards.

5.3.5 Diving Operations

29 CFR 1910 Subpart T provides the regulations for commercial diving operations. Divers shall be properly trained in best industry practices, practice good judgement, and utilize well-maintained equipment in good working order which must include a diver communication system, regardless of diving method.

In accordance with OSHA regulations, all diving operations must have a safe practices manual available at the dive location outlining the OSHA standards and the employer's policies for implementing the requirements of the standards. The manual must include:

- Safety procedures and checklists for diving operations
- Assignments and responsibilities of the dive team members
- Equipment procedures and checklists
- Emergency procedures

Divers should also have a site-specific dive plan available at the dive location with an activity hazard analysis and locations of the closest hospital and hyperbaric chamber.

5.3.6 Bridges over Railroad

When inspecting within the right-of-way of railroads or other agencies, inspectors shall follow the appropriate agency standards. This may include additional permitting procedures, training for agency-specific regulations, and safety programs not included in this manual. Contact the applicable agency for details and lead times on the appropriate measures. AMTRAK, in particular, requires additional safety training through their annual Contractor Orientation Course available at www.AmtrakContractor.com.

5.4 Personal Safety

5.4.1 Clothing

In addition to PPE, proper clothing should be worn that is appropriate for the weather and anticipated activities. Inspectors should be aware of the signs of heat and cold stress in themselves and others and cease work activities when symptoms present themselves.

Long pants and sleeves as well as gloves can help to prevent many hazards inherent in bridge inspection such as cuts, poisonous plants, sunburn, and insect bites. Clothing and equipment should not be loose-fitting or hanging from the body in a manner that presents a snagging or tripping hazard when performing inspection activities.

5.4.2 Waders

When waders are worn for inspection purposes, inspectors must be aware to avoid conditions that could cause the waders to fill with water and drag the inspector under. Slipping, stepping in a scour hole or other deep area, and quick moving currents can cause waders to overtop and fill. Even in calm weather conditions, storms upstream of the inspection site may generate high flows or flash flooding in culverts and streams. Inspectors shall use caution when in the waterway, utilizing a scour pole or rod to probe the channel bottom, confirm water depth, help identify hazards, and provide stability while moving about the waterway. Inspectors may wear a personal flotation device depending on his or her comfort level and the presence of a drowning hazard. Never use waders without another qualified person present.

5.5 Injury, Accident, and Equipment Damage

5.5.1 Personal Injury

In the event of a serious accident or injury, contact emergency medical personnel immediately by calling 911. When reporting, be clear and accurate, providing exact location for emergency responders. Do not move the injured person while waiting for medical assistance unless it is essential to prevent further injury.

Assist the injured person and stay with them while waiting for medical assistance, but first aid should not be administered by non-medical personnel except in the case of severe bleeding or cessation of breathing. In this case, any attempt to render first aid is performed under the State of Delaware's Good Samaritan Law. DelDOT offers first aid training to in-house staff. This training is not required but recommended for bridge inspection staff.

As soon as time permits, notify the BIE and, if applicable, consultant project manager of the incident. The BIE shall contact DelDOT's TMC Section to make them aware of the situation and to coordinate assistance from the District or Traffic Section if needed. A full account will be issued to the DelDOT Safety Officer for investigation and analysis.

Non-serious accidents or injuries not requiring immediate medical assistance shall also be reported to the BIE and, if applicable, consultant project manager. The BIE or acting manager must complete a DelDOT Employee Incident Report within 24 hours of any incident/injury involving DelDOT personnel. DelDOT Occupational Safety must also be contacted immediately after an incident has occurred at 302-760-2088. This form can be found on the DelDOT intranet at the link below.

http://mydot-stage/divisions/hr/policies_procedures/work_comp_info/index.shtml

5.5.2 Traffic Accident

When a DelDOT work or access vehicle is involved in a traffic accident, general information must be obtained and reported to the BIE and DelDOT Safety Officer:

- The make and license number of each vehicle involved in the accident
- Photographs of damage and location of the accident
- The name, telephone number, and insurance information for all drivers involved in the accident
- The names and phone numbers of any witnesses to the accident, including inspection team members
- If the assistance of police is necessary, request a copy of the official police report
- Complete a DelDOT Automobile Accident Report within 24 hours for all state vehicles involved

When a traffic accident occurs in or around TTC, the TL shall immediately contact the DelDOT Safety Officer, the BIE, and document the same information along with information pertaining to the TTC setup and the contact information for the traffic control team.

5.5.3 Equipment Damage

DelDOT-owned equipment such as the UBIV, bucket truck, work trucks, ladders, or boats damaged when in use shall be reported immediately to the BIE and appropriate maintenance personnel so the problem can be rectified and the safety of future inspection personnel is not in jeopardy. Document the cause and known extent of the damage with photographs to accompany the description.

6. Incident Response

6.1 Introduction

Events that result in bridge damage will often require the immediate assessment of the structure by qualified inspectors. The BIE and/or BME will assess the situation and determine the level of inspection required. Inspections could be triggered by storms, fires, earthquakes, vehicle and marine vessel impacts, or other extreme events affecting the structural integrity of a bridge. Inspections for such events will generally focus on the areas of damage, the immediate surrounding area, and any members directly or indirectly affected by the transfer of the damaging loads through the structure and/or the new load path caused by weakened or distorted members. Inspectors should assess the structural integrity of the bridge and fully document areas of damage and members affected by impact or movement with photographs, notes, measurements, and sketches. Inspectors shall also provide recommendations for necessary repairs, including full or partial bridge closure. The BIE or BME will direct inspectors on the appropriate reporting procedures on a case-by-case basis.

Many events that result in bridge damage cannot be anticipated and require quick response from inspection teams. Individuals at all levels of DelDOT and consultant inspection teams should ensure that their contact information is up to date and understand who is to contact them and who they are to contact in the case of an incident response.

A description of the incident event and Bridge Management's response effort summary is to be documented in the Incident Response Summary Form. A sample form as been included in Appendix A. Any additional forms, sketches, photographs, or reports shall be included electronically with the Incident Response Summary Form in the Inspect program and in the inspection file as a hard copy. The BIE or BME shall update the Incident Response Log for tracking purposes.

Regardless of the type of response, the BIE and/or BME shall remain in constant communication with DelDOT's TMC staff to identify or confirm incident details and locations, provide Bridge Management response effort updates and findings, identify plans moving forward, and coordinate bridge closure or reopening recommendations. Communication with other DelDOT entities and outside agencies shall occur through TMC staff per established protocols.

6.2 High Priority Road Condition Report

Bridge conditions may be reported to the Department from a variety of sources including in-house and consultant inspectors as well as the general public and may be reported at any time of day. Any report that involves the structural integrity of a bridge, sign structure, high mast light, dam, or dike will be considered a High Priority Road Condition. Once a report is received by DelDOT, DelDOT District representatives and a representative of Bridge Management must receive immediate positive contact. All conditions must be reviewed by the representatives or a designee. Should further review or an immediate special inspection be required, DelDOT may contact either in-house or consultant inspectors.

Work orders resulting from High Priority Road Conditions will be designated as High Priority and distributed to the appropriate DelDOT personnel. Closure of any High Priority Work Order will require approval by both Bridge Management and the respective District Superintendent. Bridge Management shall update and respond to TMC and other DelDOT staff using TMC's High Priority Road Condition email notification.

6.3 Weather Related Event

When weather such as forecasted high wind, heavy rain, or hurricanes may result in potential on-call inspection assignments, the BIE and/or BME will receive updates on the upcoming weather event from TMC, the University of Delaware's DEOS, and other sources and participate in in-house meetings and conference calls to assess the likelihood of the event and the necessary actions to be taken. The BIE will assemble packets for the structures and waterways that are anticipated to be affected and make contact with in-house and consultant inspection teams to coordinate availability and confirm lines of communication. Packets will identify bridge locations, include a copy of the most recent waterway sketch, and provide forms and sketch sheets to document water levels, response findings, and maintenance needs. Upon completion of Bridge Management's response efforts, the BIE will compile the forms, photographs, and other documentation to include and save with the Incident Response Summary Form. The BIE and/or BME will keep TMC updated as to the status of Bridge Management Section's response, findings, and path forward for addressing potential issues if needed.

6.3.1 Rain Event

Heavy rains may affect bridges over non-tidal waterways. When flow velocity increases, scour and substructure stability may become a concern. The BIE will determine the appropriate type and intensity of inspection which may include visual, wading, or diving operations. Inspectors should probe the waterway for areas of scour and undermining, including the waterway embankments. Inspectors in or near the waterway should be aware and especially careful due to increased flow as water velocity may be too high for safe operations, bank stability may have been compromised, and debris may have accumulated in the waterway.

The inspection team shall check previous inspection reports to verify whether conditions were existing or potentially caused by the event. Inspectors shall document any scour or damage caused to the bridge as a result of the event with photographs, notes, measurements, soundings, and sketches. Inspectors shall also provide recommendations for necessary repairs, including full or partial bridge closure. The BIE or BME will direct inspectors on the appropriate reporting procedures on a case-by-case basis.

6.3.1.1 Scour Plan of Action

Bridges with known scour concerns will have a Scour Plan of Action (POA) in place per FHWA guidelines directing DelDOT on the appropriate actions to take during flood and high water events. Inspection or monitoring during and/or after a weather event will be required if the triggers specified in the POA occur. The BIE will direct personnel accordingly. Required inspection levels will be outlined in the POA document and may include a visual inspection of substructure units, wading and probing, and/or underwater inspection. Inspectors should fully document areas of damage, scour, substructure movement, overtopping, and waterway movement with photographs, notes, measurements, and sketches as outlined in the POA. Inspectors shall also provide recommendations for necessary repairs. The BIE or BME will direct inspectors on the appropriate reporting procedures on a case-by-case basis.

Upon completion of the storm event and bridge inspection response efforts, the BIE will compile the photos, inspection notes, maintenance requests, and sketches to create an Incident Report documenting the weather event, waterways affected, inspection teams, hours worked, and specific structures. A summary of any damage to specific bridges and anticipated follow-up actions will be included in the Incident Report.

6.3.2 Flood Event

Flooding can be caused by heavy rains, sustained periods of rain, unusually high tidal fluctuations, or damage to a dam or dike. Flooding and high water can result in a variety of adverse conditions for bridges. Inspectors should check for debris affecting the movement of the structure, damage due to debris, and misalignment of roadway elements. If higher than normal flow velocities are a concern, probe the waterway for areas of scour and undermining. Check that bearings are in an appropriate state of expansion for the ambient temperature and upright, if applicable.

Any bridge closed due to a flood event shall remain closed until DelDOT's Bridge Management Section inspects and confirms that the bridge is safe for reopening to normal traffic.

Movable bridges with pits may flood and will first require the removal of flood waters. In addition to structural concerns, electrical and mechanical systems submerged in flood waters should receive a full inspection to determine damage due to water infiltration prior to conducting test openings.

The inspection team shall check previous inspection reports to verify whether conditions were existing or potentially caused by the event. Inspectors shall document any scour or damage caused to the bridge as a result of the event with photographs, notes, measurements, soundings, and sketches. Inspectors shall also provide recommendations for necessary repairs, including full or partial bridge closure. The BIE or BME will direct inspectors on the appropriate reporting procedures on a case-by-case basis.

6.3.3 Wind Event

High wind will affect tall structures, especially in open areas. IRIB is the only DelDOT-owned bridge that is particularly susceptible to wind and will be limited or closed to traffic during certain wind events per DelDOT's TMC Bridge Closure Plan. The University of Delaware's DEOS website may be used to assist in identifying or confirming actual wind speeds through the State for planning and response needs. If damage is suspected due to wind, the BIE will determine the type of inspection, equipment, and access that are required.

If necessary, inspectors should check for debris affecting the movement of the structure, damage due to debris, and misalignment of roadway elements. The direction of wind or aerodynamic characteristics of the structure may cause the bridge to experience uplift, unintended stress reversals, or vibrations. Bridge components such as the cables of IRIB, tall substructure units, bearings, and attachments to the structure should all be checked for signs of damage or misalignment. Fracture critical members and fatigue prone details identified in the Fracture Critical Inspection procedures shall be inspected once the storm event has subsided and it is safe for inspection personnel to access the bridge.

Any bridge closed due to a wind storm event shall remain closed until DelDOT's Bridge Management Section inspects and confirms that the bridge is safe for resuming normal traffic conditions.

The inspection team shall check previous inspection reports to verify whether conditions were existing or potentially caused by the event. Inspectors shall document any scour or damage caused to the bridge as a result of the event with photographs, notes, measurements, and sketches. Inspectors shall also provide recommendations for necessary repairs, including full or partial bridge closure. The BIE or BME will direct inspectors on the appropriate reporting procedures on a case-by-case basis.

6.4 Earthquake Event

Although rare, Delaware has experienced small seismic occurrences in the past. The lateral ground forces of an earthquake could affect bridges in a way that most structures in Delaware were not designed to withstand. Bridges with tall and exposed substructure units, masonry foundations, rocker bearings, fracture critical elements, and movable spans are particularly susceptible to these forces and should be inspected following a seismic event. The BIE will collect a list of bridges with these characteristics and disperse inspection responsibilities among in-house and consultant inspection teams per the BIE's discretion. Inspectors should pay particular attention to the alignment of roadway elements, movement of the overall bridge, and the condition of the previously mentioned elements. Rocker bearings should be upright and in an appropriate state of expansion for the ambient temperature. Check previous inspection reports to verify whether conditions were existing or potentially caused by the event.

The inspection team shall check previous inspection reports to verify whether conditions were existing or potentially caused by the event. Inspectors shall document any scour or damage caused to the bridge as a result of the event with photographs, notes, measurements, and sketches. Inspectors shall also provide recommendations for necessary repairs, including full or partial bridge closure. The BIE or BME will direct inspectors on the appropriate reporting procedures on a case-by-case basis.

6.5 Traffic Impact Event

6.5.1 Vehicular Impact

Inspections following a vehicular impact event should focus on the areas of damage, the immediate surrounding area, and any members directly or indirectly affected by the transfer of the impact loads through the structure and/or the new load path caused by weakened or distorted members. Inspectors should check for misalignment of roadway elements as well as movement of bearings and the overall bridge and inspect connections and surrounding areas for distortion and cracking.

Inspectors shall review prior Incident Response Summaries and inspection reports to assist in distinguishing prior damage from new damage, if applicable. Inspectors should document members affected by impact or movement with photographs, notes, measurements, and sketches. Any impact causing cracking, distortion, or failure shall be immediately communicated to the BIE or BME.

6.5.2 Marine Impact

Similar to a vehicular impact event, inspection following a marine impact event should focus on areas of damage, the immediate surrounding area, members affected by transfer of loads or a new load path, and connections. Marine impact can occur from boats, vessels, or debris striking or becoming lodged under or against the bridge structure. Often marine impact inspections will also require a special underwater inspection to check the condition of substructure units and foundations below the waterline. Divers should check for deterioration, distortion, and signs of movement due to the impact.

Inspectors shall review prior Incident Response Summaries and inspection reports to assist in distinguishing prior damage from new damage, if applicable. Inspectors shall document members affected by impact or movement with photographs, notes, measurements, and sketches. Any impact causing cracking, distortion, or failure shall be immediately communicated to the BIE or BME.

6.6 Bomb/Terroristic Threat

In the event of a bomb or terroristic threat or executed event to a DelDOT bridge, the BIE or BME will make contact with the appropriate in-house or consultant inspection teams. If damage occurs due to such an event, emergency and law enforcement personnel will first assess the safety of the area. Inspectors may be necessary to assess the structural integrity of the bridge and fully document areas of damage once approved to do so. Inspectors should work with public safety authorities and law enforcement to assure the safety of the area prior to and during inspection activities.

Inspectors shall assess and document members affected by impact or movement with photographs, notes, measurements, and sketches. Inspectors shall also provide recommendations for necessary repairs, including full or partial bridge closure. The BIE or BME will direct inspectors on the appropriate reporting procedures on a case-by-case basis.

Appendix A. Forms and Sketch Sheets

Appendix A.1

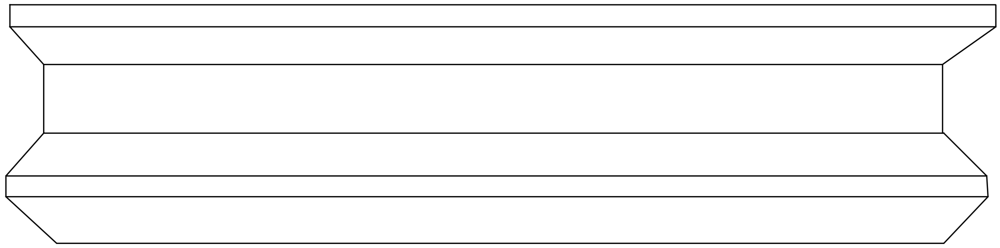
Concrete Beam Sketch Sheet

A-3

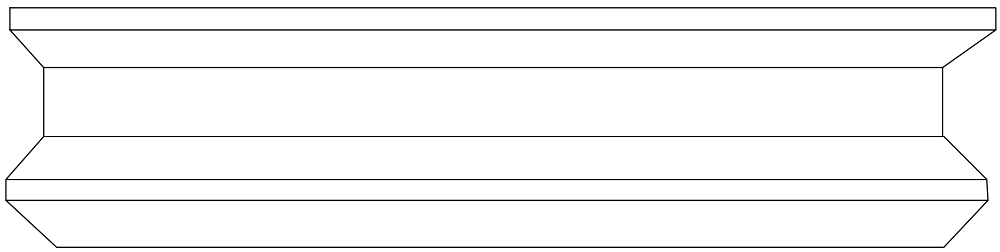
DELAWARE
DEPARTMENT OF TRANSPORTATION

CONCRETE BEAM
SKETCH SHEET

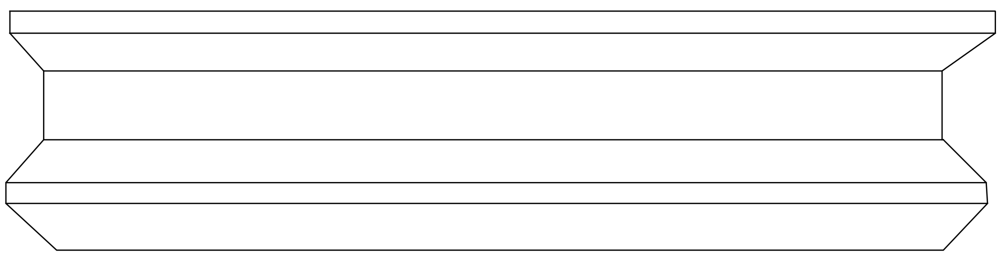
BRIDGE:



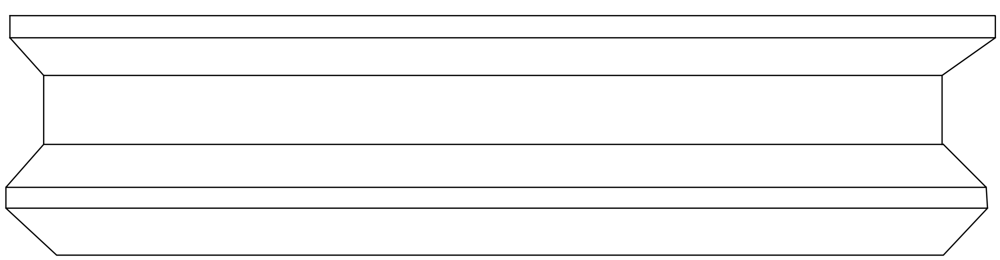
SPAN ____ , BEAM ____ , ____ FACE



SPAN ____ , BEAM ____ , ____ FACE



SPAN ____ , BEAM ____ , ____ FACE



SPAN ____ , BEAM ____ , ____ FACE

INSPECTED BY:

DATE:

A-4

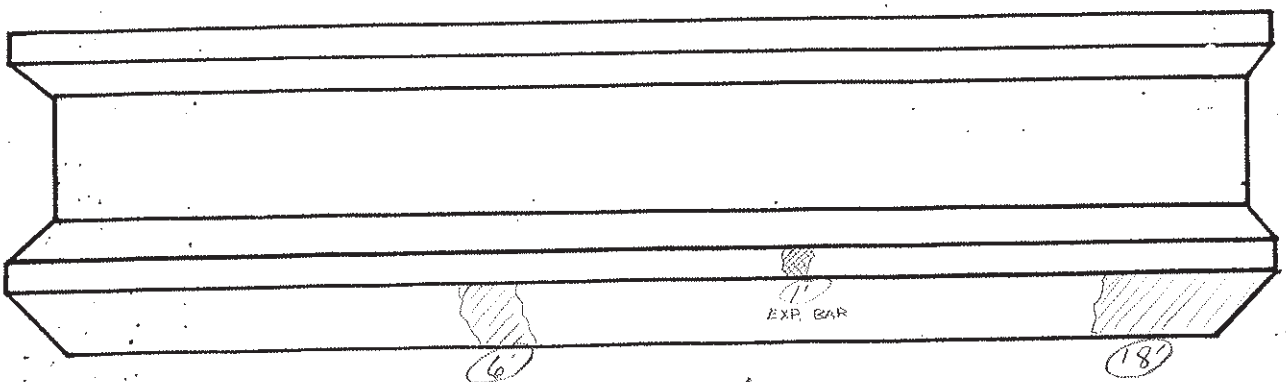
WEST

INSP. BY: ND/JM

INSP. DATE: 4/1/14

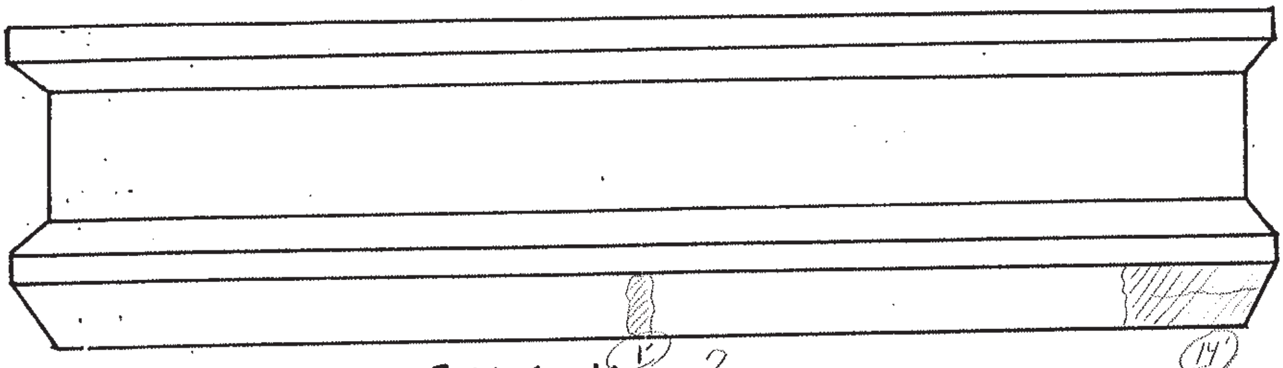
SPAN 1

MAIN

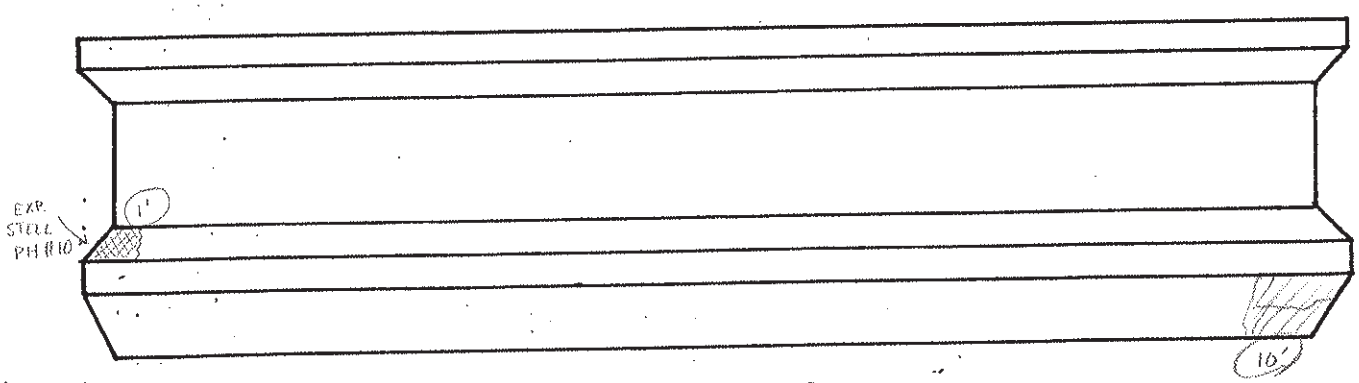


EAST

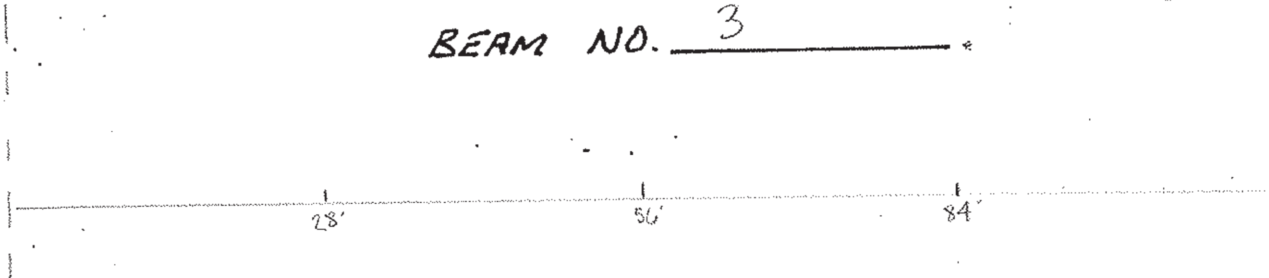
BEAM NO. 1 NORTH



BEAM NO. 2



BEAM NO. 3



BR: 1-002-232

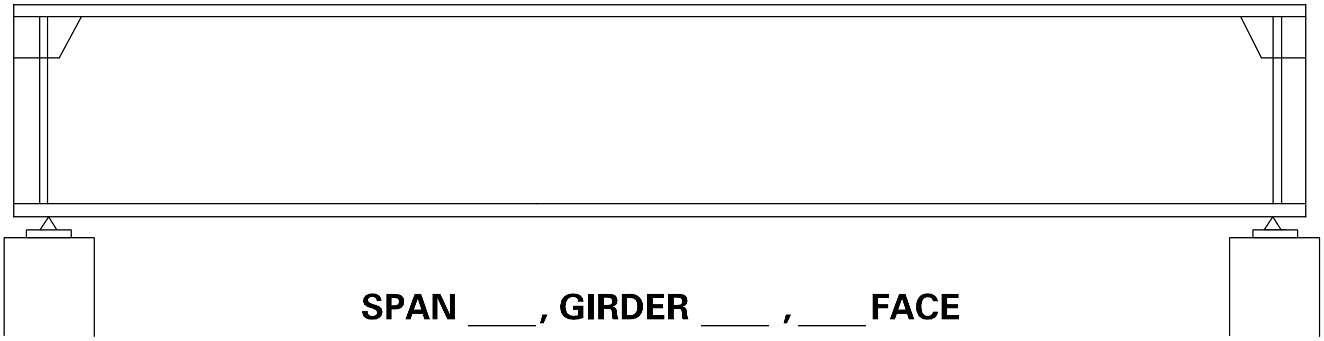
Appendix A.2

Steel Girder Sketch Sheet

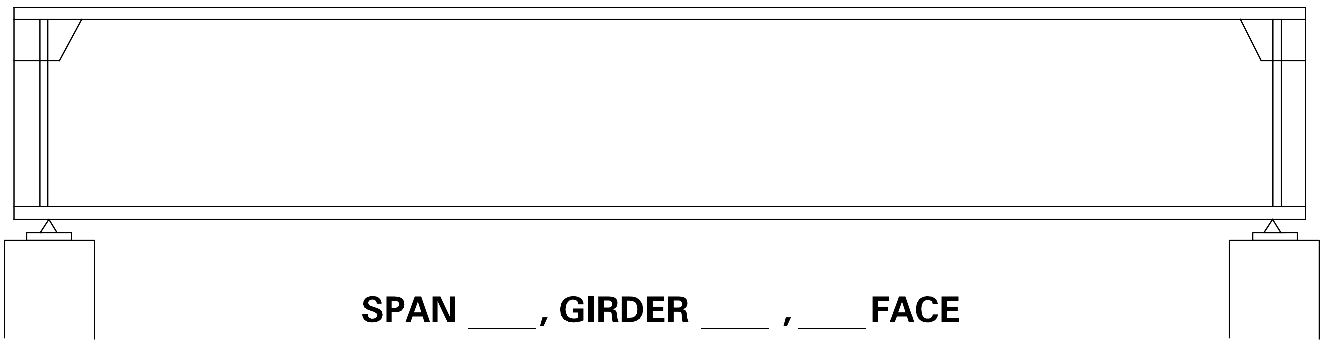
DELAWARE DEPARTMENT OF TRANSPORTATION

STEEL GIRDER SKETCH SHEET

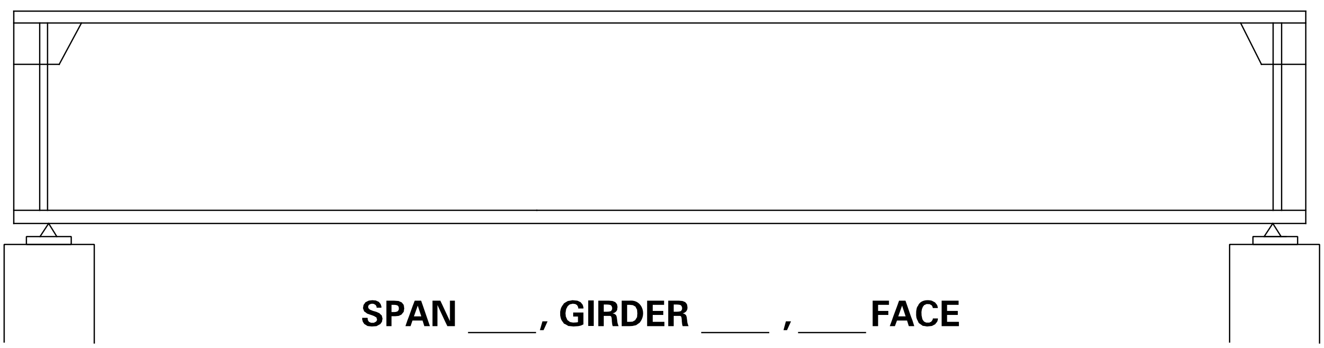
BRIDGE:



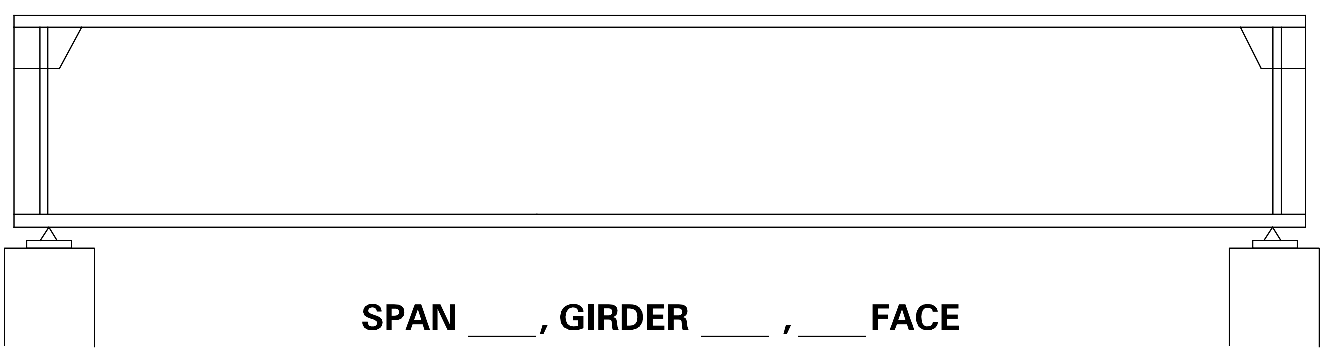
SPAN ____, GIRDER ____ , ____FACE



SPAN ____, GIRDER ____ , ____FACE



SPAN ____, GIRDER ____ , ____FACE

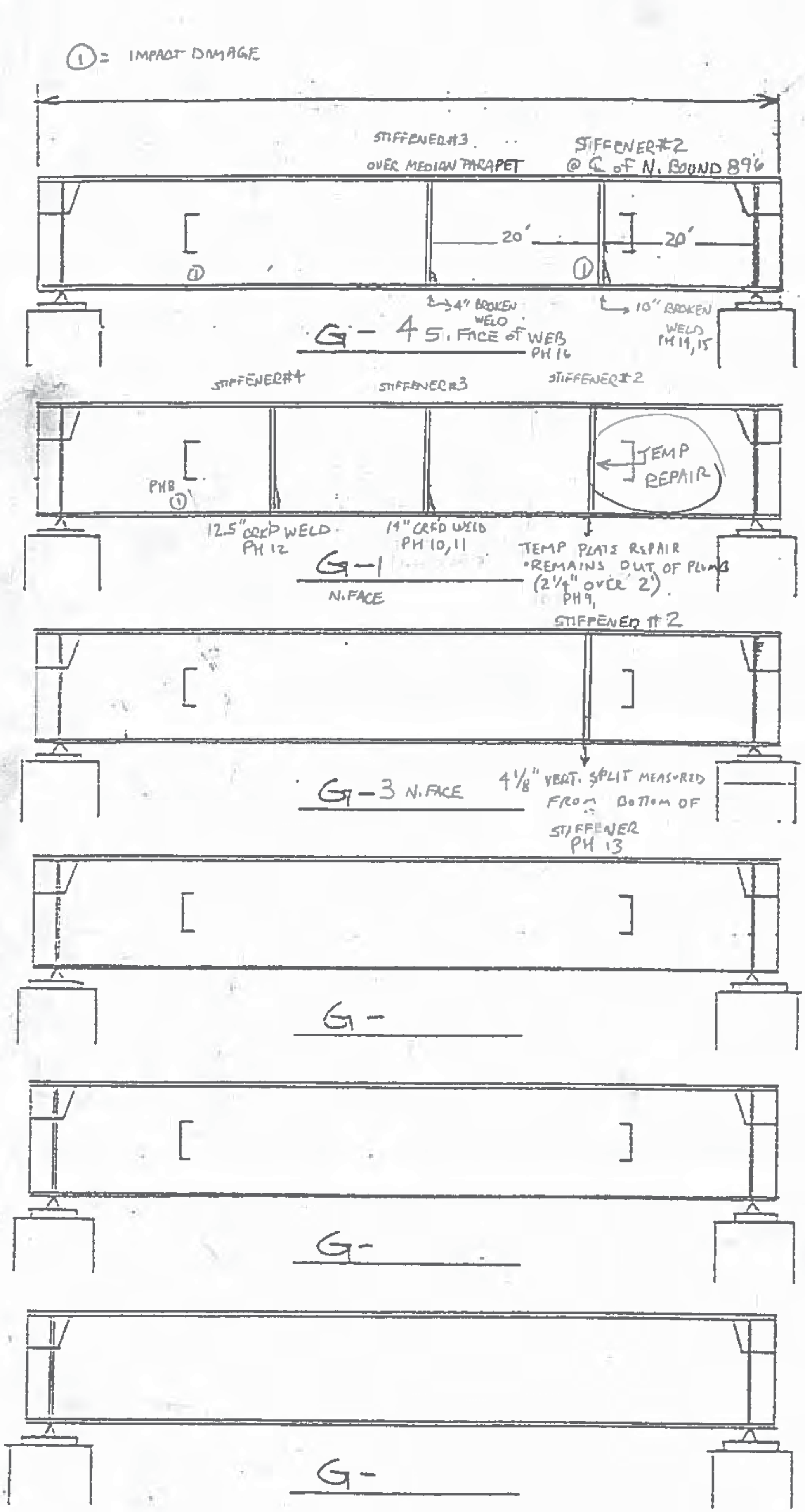


SPAN ____, GIRDER ____ , ____FACE

INSPECTED BY:	DATE:

A-8

ND/GM 08-12-15



BY ND/GM DATE 08-14-12 10-07-14

CHKD. BY .... DATE ....

SUBJECT B.R.#

SHEET NO. 1 OF 1

JOB NO. SPAN # 2

Appendix A.3

Prestressed Box Beam Sketch Sheet

DELAWARE DEPARTMENT OF TRANSPORTATION	PRESTRESSED BOX BEAM SKETCH SHEET	BRIDGE:

✱ SHOW NORTH

SPAN ____

(INSERT PIERS WHERE NEEDED)
(OMIT ANY BEAMS IF NECESSARY)

INSPECTED BY:	DATE:

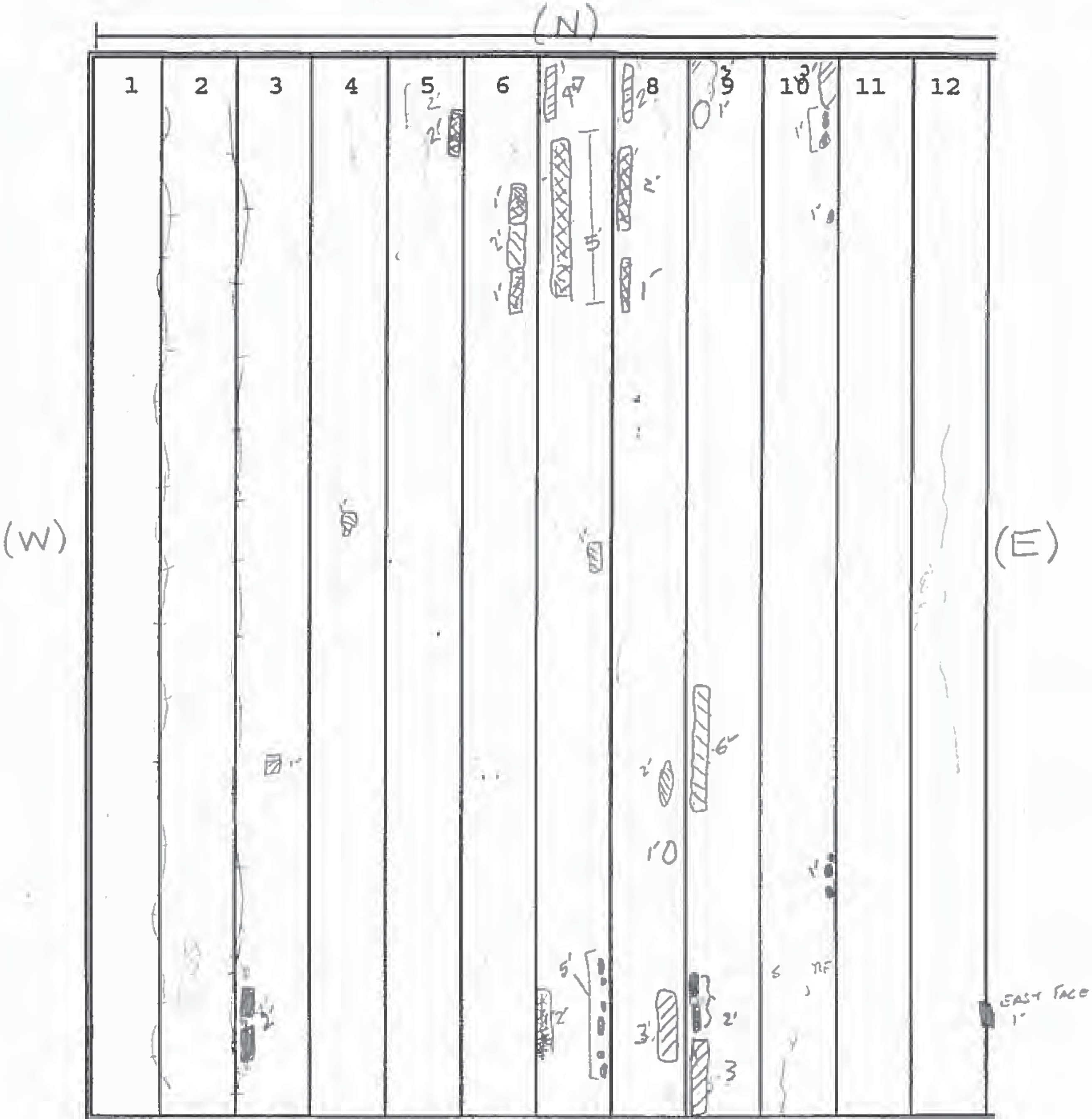
PRESTRESSED BOX BEAM SKETCH REPORT

(INSERT PIERS WHERE NEEDED)

SHOW NORTH (OMIT ANY BEAMS IF NECESSARY)

BRIDGE I.D. 1 -308 -378 SPAN NO. 1

INSPECTED BY : JM / DS / SC / ___ DATE : 7 / 8 / 15



DO ALL BEAMS HAVE VENT HOLES - (YES) - NO

IF YES, ARE VENT HOLES OPEN - (YES) - NO - SOME

1= DELAMINATION

2= SPALL w/ EXPO BAR TIPS

3= MOD. SIZED CRK (UNLESS NOTED)

4= RUST STAINS

5= EFFLO.

6= O – Shallow spall

(BXBM12/96)

Appendix A.4

Waterway Sketch Sheet

A-15

DELAWARE
DEPARTMENT OF TRANSPORTATION

WATERWAY SKETCH SHEET

BRIDGE:

✱ SHOW NORTH

PLAN

ELEVATION

WATERWAY:

INSPECTED BY:

DATE:

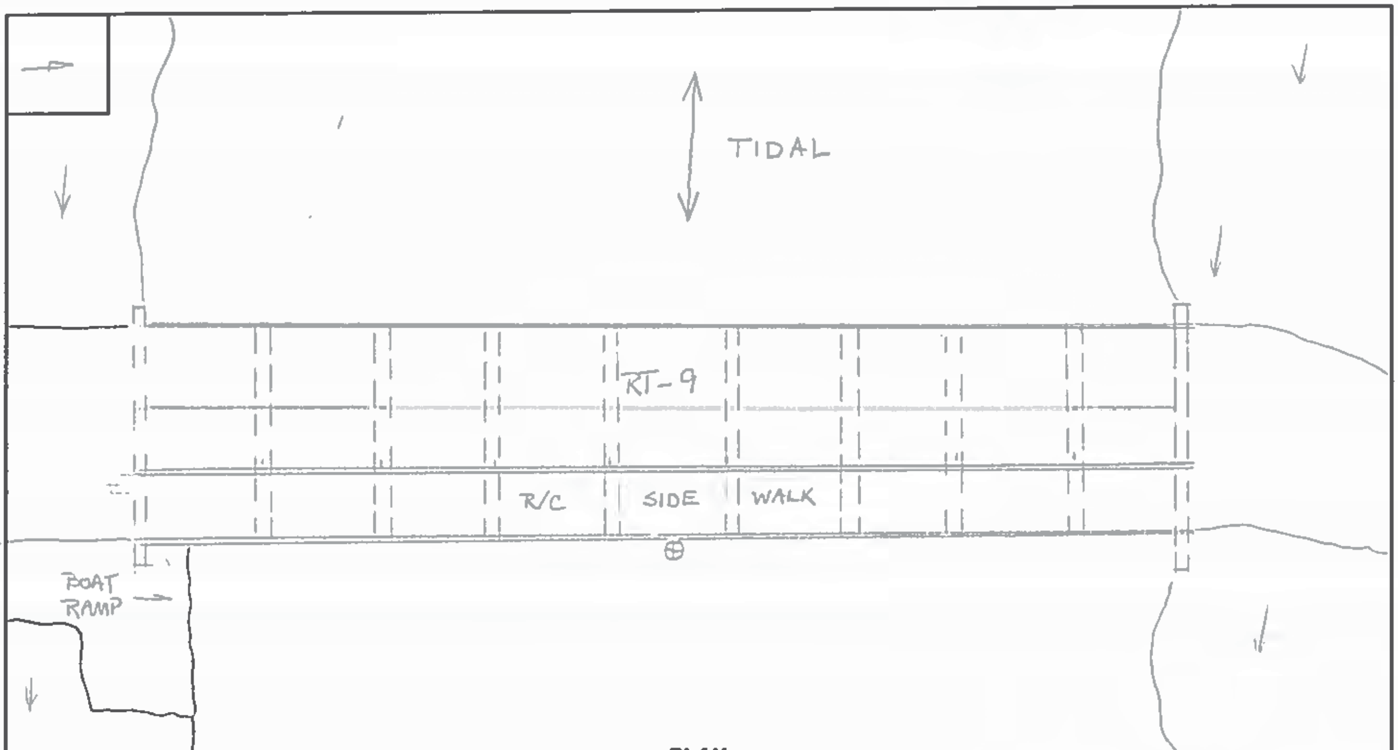
WATERWAY SKETCH SHEET

BR. I.D.: 1 - 390 - 424

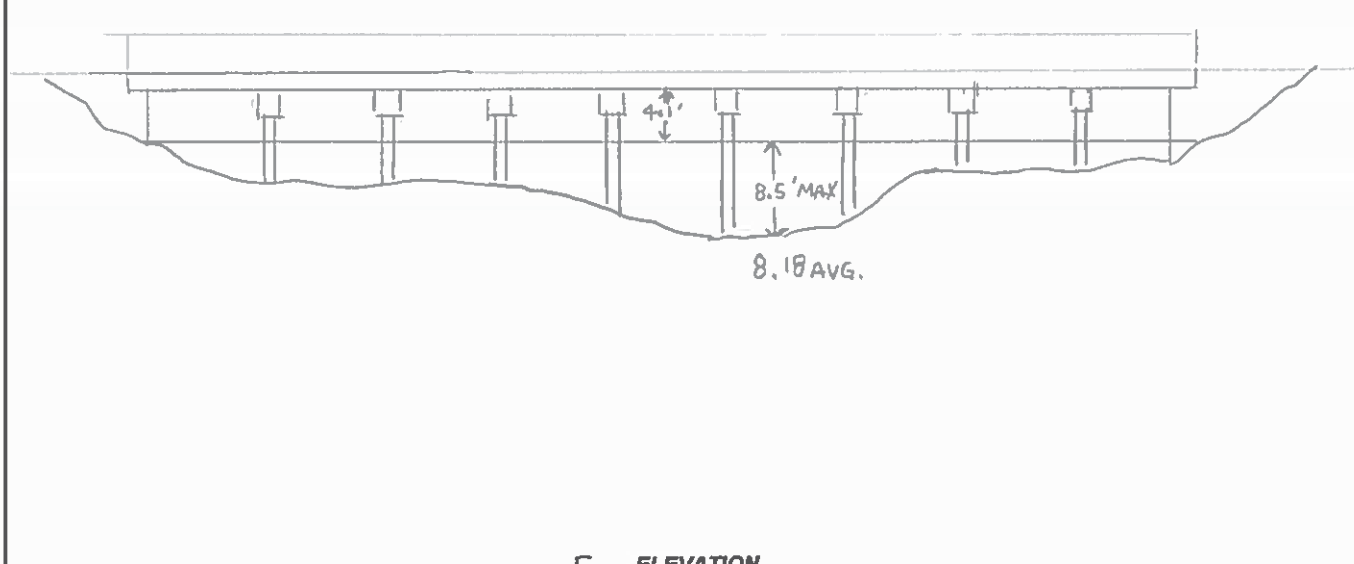
WATERWAY NAME: SILVER RUN

DATE: 03 / 30 / 15

INSPECTED BY: RM / JM / /



PLAN



ELEVATION

Appendix A.5

Under Record Sketch Sheet

DELAWARE DEPARTMENT OF TRANSPORTATION	UNDER RECORD SKETCH SHEET	BRIDGE:	INSPECTED BY:	DATE:

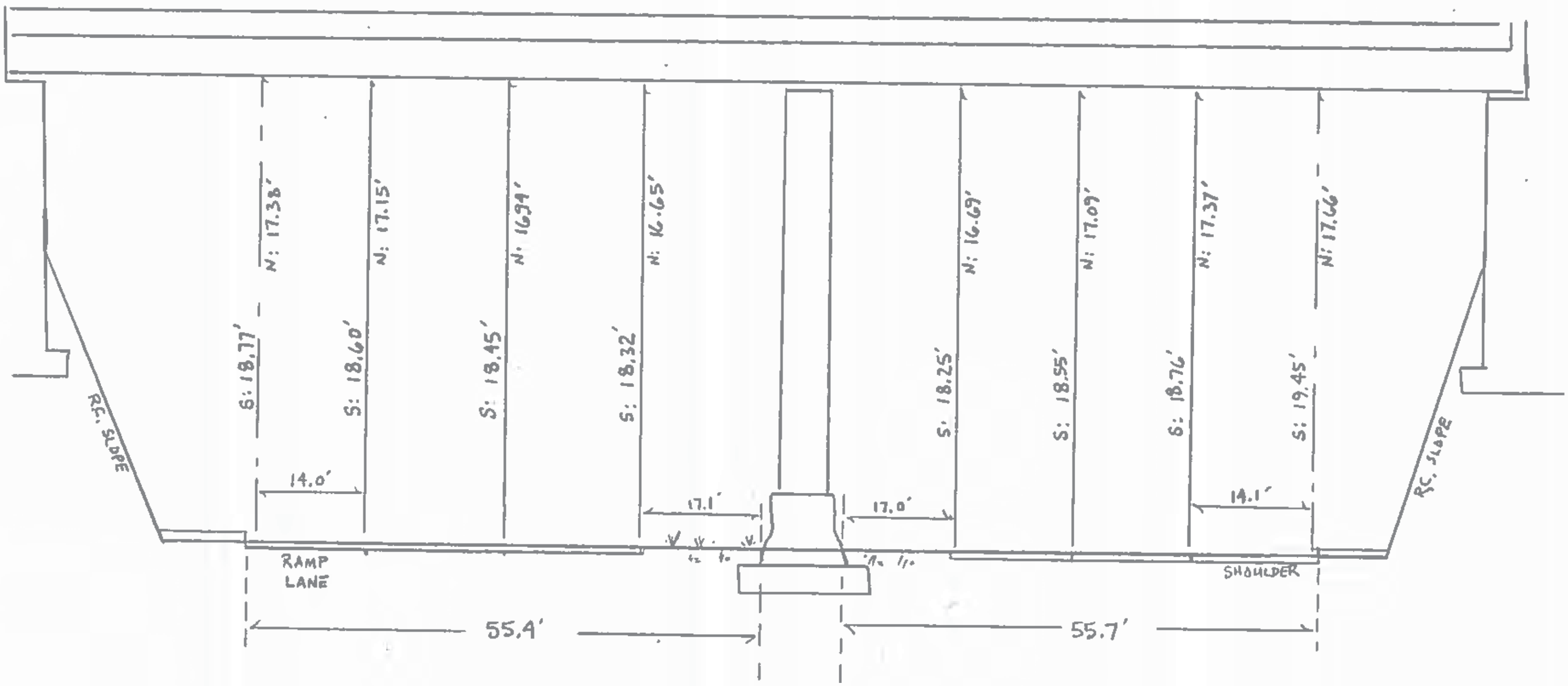
A-20

Under Record Sketch Sheet

Bridge: 1 . 286 E . 018

Inspected By: GM , GG , DT

Date: 4 , 8 , 2015

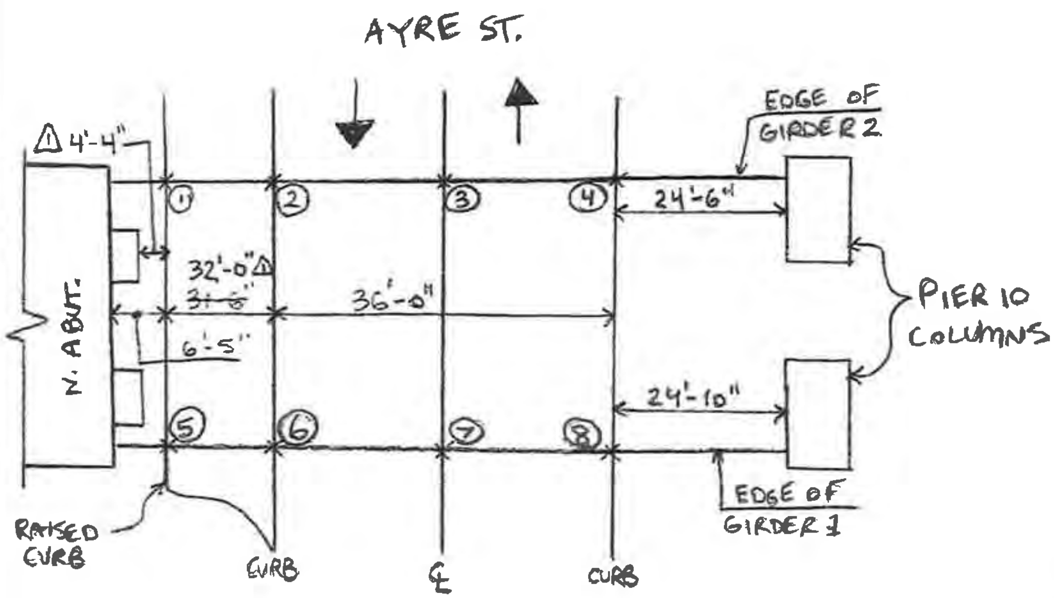


SOUTH ELEVATION

Under Record Sketch Sheet

△1 PA1 - 3/21/14 - MDR/DJC
△2 PA1 - 3/10/15 - JLC/QD

Bridge: 1-501B 6263
Inspected By: MDR, JRQ, BJM
Date: 3 , 15 , 13



VERTICAL CLEARANCES	
1	14'-9"
2	18'-3"
3	18'-6"
4	19'-9"
5	~~14'-6"~~ △2 14'-7"
6	17'-8" *
7	17'-10"
8	19'-1"

* MIN. VERT. UNDER CLEARANCE

ITEM 54 = 17'-8"
ITEM 55 = 24'-6"
ITEM 56 = 0.00'

Appendix A.6

Sounding Field Report Sheet

DelDOT Bridge Sounding Field Report Sheet

Bridge Number: ____________ **Inspection Date:** ____________ **Inspected by:** ____________

Distance Out From Face Of Bridge					Points Along Substructure Unit					Distance Out From Face Of Bridge				
50'	40'	30'	20'	10'	END	1/4	C/L	3/4	END	10'	20'	30'	40'	50'
Thawleg (deepest points along the channel)														

Substructure Unit #4 =

B							
	Substructure Unit #3 =						
A							

B							
	Substructure Unit #2 =						
A							

Substructure Unit #1 =

[blue box] = Refer to 'General Notes' about blue blank boxes

Data Measurements Input

Underclearance (Note #1) =		**Abutment width (Note #7) =**	
Bottom of Abutment Footer (Note #2) =		**Thawleg is in span# =**	
Bottom of Abutment Piles (Note #3) =		**Pier width (Note #8) =**	
Bottom of Pier Footer (Note #4) =		**Number of Spans of Bridge =**	
Bottom of Pier Piles (Note #5) =			
Abutment sheeting bottom (Note #6) =		**Direction looking from Sub. Unit #1 to #4 =**	

Scour Sounding Sheet Notes & Guidelines

General Notes & Guidelines

Note A:	If bridge has more than three spans, then only take soundings along the three main waterway spans. If only one main waterway span exists, then take the approach span on either side of the main span. This might result in Substructure Units #1 and/or 2 (as denoted on Sounding Sheet) being a Pier rather than an abutment. The Substructure Units shall be numbered in the same order as the spans are for each bridge.
Note B:	If the bridge is only one span, then use the boxes along Substructure Units #1 & 4. If the bridge is two spans, then use the the boxes along Substructure Units #1, 2 & 4. Inspector shall insert '0.00' In all the boxes for the Substructure units that are not being used.
Note C:	In the blue blank boxes, insert the word 'Abutment' if that particular substructure unit is an abutment or insert 'Pier' if it is a pier. If one of the substructure units is not being used, then insert "N/A'.
Note D:	All water depths are to be entered as a positive number and all depths at locations of sediment buildup are to be entered as a negative number.
Note E:	

Data Measurements Notes

Note #1:	Measurement location shall be marked above w/ a '**X**' and subsequent inspections shall obtain measurement from same location. Underclearance is to be measured from bottom of superstructure to actual water surface at time of inspection.
Note #2:	Input '999' if substructure unit is a Pier or if abutment doesn't have a footer and input '990' if footer location is unknown. Measurement shall be taken referenced from the same point as the underclearance location.
Note #3:	Input a value of '999' if abutment doesn't have piles or if substructure unit is a pier and input '990' if pile tip elevation is unknown. Measurement shall be taken referenced from the same point as the underclearance location.
Note #4:	Input a value of '999' if bridge is one span or if pier does not have footer and input '990' if pier footer location is unknown. Measurement shall be taken referenced from the same point as the underclearance location.
Note #5:	Input a value of '999' if bridge is one span or if pier does not have piles and input '990' if pier pile tip elevation is unknown. Measurement shall be taken referenced from the same point as the underclearance location.
Note #6:	If none of the substructure units are abutments, then input '999'. This may be sheeting along the footer of an abutment or the timber sheeting for a timber bridge.
Note #7:	If none of the substructure units are abutments, then input '0.00'
Note #8:	If none of the substructure units are piers, then input '0.00'

A-27

DelDOT Bridge Sounding Field Report Sheet

Bridge Number: 1-390-424 **Inspection Date:** 03-30-15 **Inspected by:** RM/JM

Distance Out From Face Of Bridge					Points Along Substructure Unit					Distance Out From Face Of Bridge				
50'	40'	30'	20'	10'	END	1/4	C/L	3/4	END	10'	20'	30'	40'	50'
Thalweg (deepest points along the channel)														
7.1	7.7	7.6	7.5	7.6	8.0	8.2	8.5	8.2	8.0	7.7	7.1	7.2	7.0	7.1

Spillway Location from "END" of Substructure Unit = ∅

Spillway height (underclearance measurement - distance from water surface to top of spillway) = ∅

N ↑

Substructure Unit #4 = P-6

	10'	END	1/4	C/L	3/4	END	10'	
	7.6	8.6	8.2	8.5	7.7	7.4	6.8	THALWEG
B	7.5	8.0	7.8	8.3	7.8	8.0	7.7	

Substructure Unit #3 = P-5

	10'	END	1/4	C/L	3/4	END	10'
A	7.6	8.4	8.3	8.2	8.2	6.6	7.3
B	6.8	7.5	7.4	7.6	7.3	7.1	6.9

Substructure Unit #2 = P-4

	10'	END	1/4	C/L	3/4	END	10'
A	5.9	7.5	6.9	6.4	6.8	7.0	6.3
	6.3	6.7	7.0	5.9	5.6	5.1	5.0

Substructure Unit #1 = P-3

= Refer to 'General Notes' about blue blank boxes

Data Measurements Input

Underclearance (Note #1) =	4.1 (7.4)	Abutment width (Note #7) =	41'
Bottom of Abutment Footer (Note #2) =	2.75'	Thalweg is in span# =	6
Length of Abutment Piles (Note #3) =	75'	Pier width (Note #8) =	37'
Bottom of Pier Footer (Note #4) =	3.0	Number of Spans of Bridge =	8
Length of Pier Piles (Note #5) =	75'		
Abutment sheeting bottom (Note #6) =	20'	Direction looking from Sub. Unit #1 to #4 =	N

Datum (Note # E) SPAN #5 E. FACE

Appendix A.7

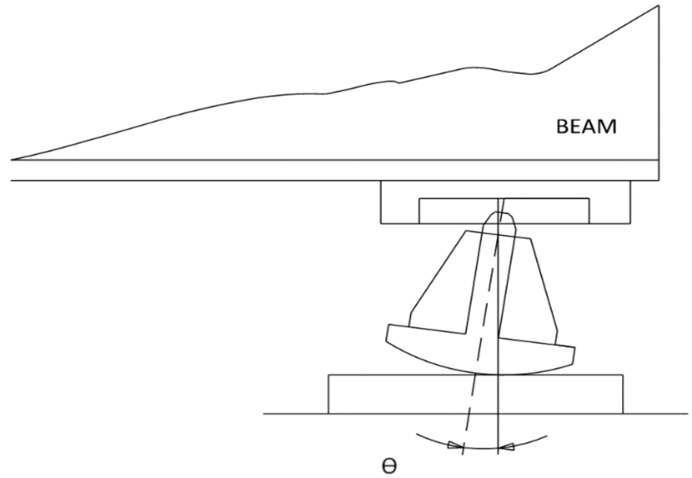
Rocker Bearing Measurement Sheet

A-31

DELAWARE DEPARTMENT OF TRANSPORTATION	ROCKER BEARING MEASUREMENT SHEET	BRIDGE:

NOTES:

- ENSURE ANGLE IS MEASURED PARALLEL TO CENTERLINE OF ROCKER
- ANGLE MAY NEED TO BE TAKEN INDEPENDENT OF A BEARING ELEMENT IF BEARING HAS TAPERED SIDES (EX. TAPERED FLANGE)
- ANGLE MUST BE MEASURED FROM VERTICAL (0° = NEUTRAL)
- MEASURE IN DEGRESS



Span	Pier	Beam	Angle	Temp	Exp/ Cont	Comments

INSPECTED BY:	DATE:

Appendix A.8

Critical Bridge Action Form

DELAWARE DEPARTMENT OF TRANSPORTATION
BRIDGE MANAGEMENT SECTION

CRITICAL BRIDGE ACTION FORM

(Original copy to be filed in Bridge Folder)

BRIDGE NO. on ROAD NO. in County

The Critical Bridge Action Form is intended to document critical deficiencies found on a bridge, which requires immediate action.

Description of Deficiency:

Proposed Actions:

1. An immediate Load Posting ☐
2. An immediate Closure of one or more traffic lanes ☐
3. An immediate Closure of the Bridge to all traffic ☐
4. Other Action: ☐

If Bridge is of NBI Length, FHWA shall be notified (✔) ☐

The Bridge Managment Engineer shall send a copy of this form to the appropriate District Engineer. If the structure meets the minimum length requirement of NBIS, then the Division office of FHWA shall also receive copies.

Bridge Management Engineer Signature: ______________________________ Date: ___ / ___ / ____

Assistant Director, Bridge Signature:__________________________________ Date: ___ /___ / _____

Cbaf : 5/16/14

DELAWARE DEPARTMENT OF TRANSPORTATION
BRIDGE MANAGEMENT SECTION

CRITICAL BRIDGE ACTION FORM

(Original copy to be filed in Bridge Folder)

BRIDGE NO. 680 on ROAD NO. 006 in New Castle County

The Critical Bridge Action Form is intended to document critical deficiencies found on a bridge, which requires immediate action.

Description of Deficiency:

A TMC High Priority Road Condition Report was issued on Tuesday, March 24th around 10:30 am for bridge 1-680. A 1.5' diameter area of the concrete bridge deck in the right-hand southbound lane in the center span had failed/punched-through. Bridge Management met with Canal District personnel, Wayne Hamilton and North District's Structure Maintenance Contractor (EHS) to discuss repair & lane closure options. It was decided that both southbound lanes on the bridge as well as the ramp lane from SR141 southbound to US13 northbound will be closed until repairs can be made. EHS will be placing shielding underneath the punch-thru area during the evening of the 24th and then will start first thing in the morning of the 25th in making deck repairs. It is expected to have the lane closure in place for two weeks. Once the deck repairs are completed, shielding will be placed underneath the southbound lanes over the US13 north & southbound and ramp lanes to prevent future punch-thru debris from falling on traffic underneath the bridge.

Proposed Actions:

1. An immediate Load Posting ☐
2. An immediate Closure of one or more traffic lanes ☒
3. An immediate Closure of the Bridge to all traffic ☐
4. Other Action: ☒

Once repairs have been completed, the bridge will be opened back up to full traffic. The bridge is currently Structurally Deficient and will remain so once the repairs are completed. Bridge Design currently has a project to replace the entire bridge and it is currently programmed for FY18-19.

If Bridge is of NBI Length, FHWA shall be notified (✓) ☒

The Bridge Managment Engineer shall send a copy of this form to the appropriate District Engineer. If the structure meets the minimum length requirement of NBIS, then the Division office of FHWA shall also receive copies.

Bridge Management Engineer Signature: [signature] Date: 3 / 25 / 15

Assistant Director, Bridge Signature: [signature] Date: 3 / 25 / 15

Cbaf: 5/16/14

Appendix A.9

DelDOT MOT Request and Notification Form

Bridge Management Section
Maintenance of Traffic Request & Notification Form

DISTRICT

North ○ | Canal ○ | Central ● | South ○

CONTACT INFORMATION

Bridge Mgmt. Contact: Nate Draper
Cell Phone #: 562-8196
Team Leader 800MHz call sign: BR-8
Office Phone #: 760-2314

REQUESTED DATE & TIME for MOT

Number of Days of MOT Being Requested: 1

Date Requested: 10 / 13 to 10 / 13 / 2015

Rain Date Requested: 10 / 14 to 10 / 14 / 2015

Inspection Start Time: 9:00 AM
Inspection Finish Time: 3:00 PM

Location for MOT

Bridge #: 2-024A **Road #:** 24 **Road Name:** Dupont Hwy / US13

Feature Intersected: St. Jones River

Road that traffic control will be utilized for: Dupont Hwy / US13 Southbound & Northbound

Nearest Roadway Intersection Before Bridge: Public Safety Blvd
(along the road that the traffic control is required)

Nearest Roadway Intersection After Bridge: South State St
(along the road that the traffic control is required)

ADC Map & Coordinates (county, map# & coordinates): **KC 17-H7**
Ex. (NC 18-K6 for the C&D Canal Bridge)

Description of MOT Being Requested

Type of Inspection: **UBIV** ☑ **Bucket Truck** ☐

Lane Closure Required: Right Lane
Shoulder Closure Required: Right Shoulder

TMA to be SUPPLIED BY THE DISTRICT and set up directly behind the UBIV or Bucket Truck at all times. Portable Arrow Board required at taper. Sufficient number and placement of cones is required to maintain safe work zone. Advanced warning signs are required.

Special Instructions:

Setup will be US13 SB first, then procedd to to US13NB.

Appendix A.10

NBI Inventory Forms

Bridge Number: ___________________ Date of NBI Assessment: ___________ NBI Assessment Performed BY: _____________

NBI Item #	Coding or Data Determined in the Office	Coding or Data Determined or Verified Out In the Field	Inspector Notes
1 - State Code			
2 - Highway Agency District			
3 - County (Parish) Code			
4 - Place Code			
5A - Record Type			
5B - Route Signing Prefix			
5C - Designated Level of Service			
5D - Route Number			
5E - Directional Suffix			
6A - Features Intersected			
6B - Critical Facility			
7 - Facility Carried by Structure			
8 - Structure Number			
9 - Location			
10 - Inventory Route, Minimum Vertical Clearance			
11 - Milepoint (kilometer point)			
12 - Base Highway Network			
13A - LRS Inventory Route Number			
13B - Subroute Number			
19 - Bypass, Detour Length			
20 - Toll			
21 - Maintenance responsibility			
22 - Owner			
26 - Functional Class			
27 - Year Built			
28A - Lanes on Structure			
28B - Under the Structure			
29 - Average Daily Traffic			
30 - Year Of ADT			
32 - Approach Roadway width			
33 - Bridge Median			
34 - Skew			
35 - Structure flared			
36A - Bridge railings			
36B - Transitions			
36C - Approach Guardrail			
36D - Approach guardrail Ends			
37 - Historical Significance			
38 - Navigation Control			
39 - Navigation Vertical Clearance			
40 - Navigation Horizontal Clearance			
42A - Type of Service on Bridge			
42B - Type of Service under bridge			
43A - Main Span Material Type			
43B - Main Span Design Type			

NBI Item #	Coding or Data Determined in the Office	Coding or Data Determined or Verified Out In the Field	Inspector Notes
44A - Approach Span Material Type			
44B - Approach Span Design Type			
45 - Number of Main Spans			
46 - Number of Approach spans			
47 - Horizontal Clearance for Inventory route			
48 - Max Span Length			
49 - Structure length			
50A - Left Curb/Sidewalk Width			
50B - Right Curb/Sidewalk Width			
51 - Bridge Roadway Width (Curb-to-Curb)			
52 - Deck Width, Out-to-Out			
53 - Minimum Vertical Clearance Over Bridge			
54A - Reference Feature			
54B - Minimum Vertical Underclearance			
55A - Reference feature			
55B - Minimum Lateral Underclearance, on right			
56 - Minimum Lateral Underclearance, on left			
58 - Deck Condition rating			
59 - Superstructure Condition Rating			
60 - Substructure Condition Rating			
61 - Channel Condition rating			
62 - Culvert Condition rating			
71 - Waterway Adequacy			
72 - Approach roadway Alignment			
90 - Inspection date			
91 - Inspection Frequency			
98A - Border bridge, State			
98B - Border Bridge region			
98C - Border Bridge, % Responsibility			
99 - Border bridge Structure Number			
100 - STRAHNET Highway			
101 - Parallel Structure Designation			
102 - Direction of Traffic			
103 - Temporary Structure Designation			
104 - NHS Highway System			
105 - Federal Lands Highways			
106 - Year Reconstructed			
107 - Deck Structure Type			
108A - Wearing Surface Type			
108B - Type of membrane			
108C - Deck Protection			
109 - Truck Traffic %			
110 - Designated National TruckNetwork			
111 - Pier or Abutment Protection For Navigation			
112 - NBIS Length bridge			
116 - Minimum Vertical Clearance for Lift Bridges			

Bridge Number: ____________________ **Date of NBI Assessment:** ___________ **NBI Assessment Performed BY:** _______________

NBI Item #	Coding or Data Determined in the Office	Coding or Data Determined or Verified Out In the Field	Inspector Notes
Name of Structure (Inventory-ID/Admin)			
On/Off Agency System (Inventory-ID/Admin)			
Agency Admin Area (Inventory-ID/Admin)			
Deck Area (inventory-Design)			
Total Length (Inventory-Design)			
Roadway/Route Name (Inventory-Roads)			
# of Medians (Inventory-Roads)			
Roadway Speed Limit(Inventory-Roads)			
ADT Class (Inventory-Roads)			
Detour Speed Limit(Inventory-Roads)			
Fracture Critical Details (Inventory-Classification)			
UBIV Inspection Date (Agency-Bridge)			
UBIV Days (Agency-Bridge)			
Pier 1(Agency-Bridge)			
Pier 2 (Agency-Bridge)			
Pier Ftg 1 (Agency-Bridge)			
Pier Ftg 2 (Agency-Bridge)			
Abut 1(Agency-Bridge)			
Abut Ftg 1 (Agency-Bridge)			
Abut 2 (Agency-Bridge)			
Abut Ftg 2 (Agency-Bridge)			
Contract 1 (Agency-Bridge)			
Contract 2 (Agency-Bridge)			
Contract 3 (Agency-Bridge)			
Contract 4 (Agency-Bridge)			
Contract 5 (Agency-Bridge)			
Contract 6 (Agency-Bridge)			

Bridge Number: ___________________ **Date of NBI Assessment:** ___________ **NBI Assessment Performed BY:** _______________

Under Record #: _____ **Under Record Maintenance Rd. #:** _________ **Under Record Roadway Name:** _______________________________

NBI Item #	Coding or Data Determined in the Office	Coding or Data Determined or Verified Out In the Field	Inspector Notes
Roadway/Route Name (Inventory-Roads)			
# of Medians (Inventory-Roads)			
ADT Class (Inventory-Roads)			
Detour Speed Limit(Inventory-Roads)			
Speed (mph)			
5A - Record Type			
5B - Route Signing Prefix			
5C - Designated Level of Service			
5D - Route Number			
5E - Directional Suffix			
6B - Critical Facility			
10 - Inventory Route, Minimum Vertical Clearance			
11 - Milepoint (kilometer point)			
12 - Base Highway Network			
13A - LRS Inventory Route Number			
13B - Subroute Number			
19 - Bypass, Detour Length			
20 - Toll			
26 - Functional Class			
# of Lanes			
29 - Average Daily Traffic			
30 - Year Of ADT			
32 - Approach Roadway width			
47 - Horizontal Clearance for Inventory route			
100 - STRAHNET Highway			
102 - Direction of Traffic			
104 - NHS Highway System			
105 - Federal Lands Highways			
109 - Truck Traffic %			
110 - Designated National Truck Network			

Appendix A.11

Incident Response Summary Form (example)

Bridge 1-680
Incident Response Log

Date: September 2, 2015

Description of Incident: Bridge 1-680 carries traffic on SR141 over US13 in the New Castle area. The incident occurred as a roll back hauling a small crane had struck the bridge while traveling in the center northbound through lane.

Personnel Log

Date: September 2, 2015
Personnel/Hours: Calvin Weber = 3.5 hours

Activities: Calvin Weber responded after being contacted by TMC at ~4pm on September 2, 2015. Calvin drove up in his personal vehicle from home and inspected the damaged area. A small area of loose concrete in the sidewalk overhang soffit above the beam impacted was removed for safety concerns for motorists. Only minor scrapes were found and the structural capacity had not been affected. Therefore, US13 was reopened to full traffic.

The following pages include photos with their descriptions taken by the inspector after the accident:

South Fascia Beam in Northbound direction along US13

South Fascia Beam in Northbound direction along US13

Appendix A.12

Quality Control Inspection Report Review Form

QUALITY CONTROL INSPECTION REPORT REVIEW

DATE OF BRIDGE INSPECTION ENGINEER REVIEW =		IN-HOUSE OR CONSULTANT INSPECTION TEAM:	

BRIDGE NUMBER:		INSPECTION DATE:		INSPECTION TEAM:	

ITEM	DESCRIPTION	RESOLUTION DATE
PONTIS ELEMENTS		
PONTIS CONDITION STATES		
NBI ITEMS #58, 59, 60, 61 & 62		
NBI RATING OF A '4'		
NBI DATA		
WRITTEN REPORT PORTION OF UNDERWATER REPORT		
UNDERWATER REPORT SOUNDING PLAN		
SCOUR SKETCH SHEET		
SCOUR SOUNDING SHEET		
UNDER RECORD SKETCH		
BEAM SKETCH SHEET(S)		
PHOTOS		
MAXIMO WORK ORDERS		
MISC.		
FOLLOW-UP ACTIONS IDENTIFIED		

(red)	= SIGNIFIES THAT ACTION IS STILL NEEDED AS A RESULT OF MISSING DATA OR ERRORS THAT NEED TO BE ADDRESSED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER
(blue)	= SIGNIFIES THAT AN ERROR WAS FOUND DURING THE QC REPORT REVIEW AND WAS CORRECTED DURING THE REVIEW
(green)	= SIGNIFIES THAT SOME CLARIFICATION OR DISCUSSION NEEDS TO TAKE PLACE TO CONFIRM THE ISSUE (NOT NECESSARILY A NEGATIVE THING)
(purple)	= SIGNIFIES THAT ACTION IS NEEDED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER, BUT IS NOT THE RESULT OF AN ERROR OR MISSING DATA

QUALITY CONTROL INSPECTION REPORT REVIEW

DATE OF BRIDGE INSPECTION ENGINEER REVIEW =	4/11/2012	IN-HOUSE OR CONSULTANT INSPECTION TEAM:	IN-HOUSE
BRIDGE NUMBER:	1-052	INSPECTION DATE:	3/12/12
INSPECTION TEAM:	GM & JM		

ITEM	DESCRIPTION	RESOLUTION DATE
PONTIS ELEMENTS	Element #330 should have been a #334 as per Pontis Manual	4/11/12
PONTIS CONDITION STATES	Good - no problems noted	
NBI ITEMS #58, 59, 60, 61 & 62	Not sure that a rating of a "6" is appropriate - need to discuss	4/19/12
NBI RATING OF A '4'	N/A	
NBI DATA	Good - no problems noted	
WRITTEN REPORT PORTION OF UNDERWATER REPORT	N/A - This was not an underwater inspection	
UNDERWATER REPORT SOUNDING PLAN	N/A - This was not an underwater inspection	
SCOUR SKETCH SHEET	Missing underclearance measurement - need to get	4/21/12
SCOUR SOUNDING SHEET	N/A	
UNDER RECORD SKETCH	N/A	
BEAM SKETCH SHEET(S)	N/A	
PHOTOS	Good - no problems noted	
MAXIMO WORK ORDERS	Go ahead and place a work order in Maximo to have the guardrail repaired roughly 30' from the N/E corner of the bridge	4/19/12
MISC.	N/A	
FOLLOW-UP ACTIONS IDENTIFIED	N/A	

(red)	= SIGNIFIES THAT ACTION IS STILL NEEDED AS A RESULT OF MISSING DATA OR ERRORS THAT NEED TO BE ADDRESSED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER
(blue)	= SIGNIFIES THAT AN ERROR WAS FOUND DURING THE QC REPORT REVIEW AND WAS CORRECTED DURING THE REVIEW
(green)	= SIGNIFIES THAT SOME CLARIFICATION OR DISCUSSION NEEDS TO TAKE PLACE TO CONFIRM THE ISSUE (NOT NECESSARILY A NEGATIVE THING)
(purple)	= SIGNIFIES THAT ACTION IS NEEDED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER, BUT IS NOT THE RESULT OF AN ERROR OR MISSING DATA

Appendix A.13

Quality Assurance Inspection Review Report

A-57 QUALITY ASSURANCE INSPECTION REVIEW REPORT: OFFICE REVIEW

DATE OF BRIDGE INSPECTION ENGINEER REVIEW =		IN-HOUSE OR CONSULTANT INSPECTION TEAM:	

BRIDGE NUMBER:		INSPECTION DATE:		INSPECTION TEAM:	

Inspection File Review Checklist

INSPECTION REPORT		INSPECTION FILE	
ITEM	INCLUDED	ITEM	INCLUDED
FINALIZED SDR:		PLANS:	
PONTIS MSPE SHEETS:		LOAD RATING:	
BEAM SKETCH SHEETS:		LOAD POSTING RESOLUTION:	
OTHER SKETCHES OR TABLES:		VERT. CLEARANCE POSTING RESOLUTION:	
NDT INSPECTION REPORT:		INSPECTION REPORTS:	
UNDER RECORD SUMMARY & SKETCH:		SCOUR PLAN OF ACTION:	
SCOUR INFO & WATERWAY SKETCH:		HYDROLOGIC & HYDRAULIC ANALYSIS:	
SCOUR SOUNDING PROFILES:		LATEST UNDERWATER INSP. REPORT:	
PHOTO REPORT:		UNDERWATER INSPECTION PROCEDURES:	
MAXIMO MAINTENANCE HISTORY:		FRACTURE CRITICAL INSP. PROCEDURES:	
BRIDGE REHAB PROJECT SUMMARY:		FRACTURE CRITICAL DETAIL SHEET(S):	
TEAM LEADER SIGNATURE & DATE:		COMPLEX BRIDGE INSP. PROCEDURES:	
REPORT ASSEMBLED CORRECTLY:		FILE ASSEMBLED CORRECTLY:	
INSPECTION REPORT & FILE COMMENTS:			

Inspection Report Review

ITEM	DESCRIPTION OF DESCREPENCY	RESOLUTION DATE
PONTIS ELEMENTS		
PONTIS CONDITION STATES		
NBI ITEMS #58, 59, 60, 61 & 62		
NBI RATING OF A '4'		
NBI DATA		
WRITTEN REPORT PORTION OF UNDERWATER REPORT		
UNDERWATER REPORT SOUNDING PLAN		
SCOUR SKETCH SHEET		
SCOUR SOUNDING SHEET		
UNDER RECORD SKETCH		
BEAM SKETCH SHEET(S)		
PHOTOS		
MAXIMO WORK ORDERS		
MISC.		
FOLLOW-UP ACTIONS IDENTIFIED		

QUALITY ASSURANCE INSPECTION REVIEW REPORT: FIELD REVIEW

DATE OF QA TEAM FIELD REVIEW =		IN-HOUSE OR CONSULTANT INSPECTION TEAM:	

BRIDGE NUMBER:		INSPECTION DATE:		INSPECTION TEAM:	

ITEM	DESCRIPTION	RESOLUTION DATE
PONTIS ELEMENTS		
PONTIS CONDITION STATES		
NBI ITEMS #58, 59, 60, 61 & 62		
NBI RATING OF A '4'		
NBI DATA		
WRITTEN REPORT PORTION OF UNDERWATER REPORT		
UNDERWATER REPORT SOUNDING PLAN		
SCOUR SKETCH SHEET		
SCOUR SOUNDING SHEET		
UNDER RECORD SKETCH		
BEAM SKETCH SHEET(S)		
PHOTOS		
MAXIMO WORK ORDERS		
MISC.		
FOLLOW-UP ACTIONS IDENTIFIED		

Color	Meaning
(Red)	= SIGNIFIES THAT ACTION IS STILL NEEDED AS A RESULT OF MISSING DATA OR ERRORS THAT NEED TO BE ADDRESSED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER
(Blue)	= SIGNIFIES THAT AN ERROR WAS FOUND DURING THE QA FIELD REVIEW AND WAS CORRECTED DURING THE REVIEW
(Green)	= SIGNIFIES THAT SOME CLARIFICATION OR DISCUSSION NEEDS TO TAKE PLACE TO CONFIRM THE ISSUE (NOT NECESSARILY A NEGATIVE THING)
(Purple)	= SIGNIFIES THAT ACTION IS NEEDED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER, BUT IS NOT THE RESULT OF AN ERROR OR MISSING DATA

QUALITY ASSURANCE INSPECTION REVIEW REPORT: OFFICE REVIEW

DATE OF BRIDGE INSPECTION ENGINEER REVIEW =	12/11/2012	IN-HOUSE OR CONSULTANT INSPECTION TEAM:	IN-HOUSE
BRIDGE NUMBER:	1-052	INSPECTION DATE:	3/12/12
INSPECTION TEAM:	GM & JM		

Inspection File Review Checklist

INSPECTION REPORT		INSPECTION FILE	
ITEM	INCLUDED	ITEM	INCLUDED
FINALIZED SDR:	YES	PLANS:	YES
PONTIS MSPE SHEETS:	YES	LOAD RATING:	YES
BEAM SKETCH SHEETS:	YES	LOAD POSTING RESOLUTION:	N/A
OTHER SKETCHES OR TABLES:	N/A	VERT. CLEARANCE POSTING RESOLUTION:	N/A
NDT INSPECTION REPORT:	N/A	INSPECTION REPORTS:	YES
UNDER RECORD SUMMARY & SKETCH:	N/A	SCOUR PLAN OF ACTION:	N/A
SCOUR INFO & WATERWAY SKETCH:	YES	HYDROLOGIC & HYDRAULIC ANALYSIS:	N/A
SCOUR SOUNDING PROFILES:	YES	LATEST UNDERWATER INSP. REPORT:	N/A
PHOTO REPORT:	YES	UNDERWATER INSPECTION PROCEDURES:	N/A
MAXIMO MAINTENANCE HISTORY:	YES	FRACTURE CRITICAL INSP. PROCEDURES:	N/A
BRIDGE REHAB PROJECT SUMMARY:	N/A	FRACTURE CRITICAL DETAIL SHEET(S):	N/A
TEAM LEADER SIGNATURE & DATE:	NO	COMPLEX BRIDGE INSP. PROCEDURES:	N/A
REPORT ASSEMBLED CORRECTLY:	YES	FILE ASSEMBLED CORRECTLY:	YES
INSPECTION REPORT & FILE COMMENTS:	TEAM LEADER SIGNED THE REPORT ON 12/12/12		

Inspection Report Review

ITEM	DESCRIPTION OF DESCREPENCY	RESOLUTION DATE
PONTIS ELEMENTS	Element #330 should have been a #334 as per Pontis Manual	12/11/12
PONTIS CONDITION STATES	Good - no problems noted	
NBI ITEMS #58, 59, 60, 61 & 62	Good - no problems noted	
NBI RATING OF A '4'	N/A	
NBI DATA	Good - no problems noted	
WRITTEN REPORT PORTION OF UNDERWATER REPORT	N/A - This was not an underwater inspection	
UNDERWATER REPORT SOUNDING PLAN	N/A - This was not an underwater inspection	
SCOUR SKETCH SHEET	Missing underclearance measurement - need to get	12/13/12
SCOUR SOUNDING SHEET	N/A	
UNDER RECORD SKETCH	N/A	
BEAM SKETCH SHEET(S)	N/A	
PHOTOS	Good - no problems noted	
MAXIMO WORK ORDERS	Go ahead and place a work order in Maximo to have the guardrail repaired roughly 30' from the N/E corner of the bridge	12/12/12
MISC.	N/A	
FOLLOW-UP ACTIONS IDENTIFIED	N/A	

QUALITY ASSURANCE INSPECTION REVIEW REPORT: FIELD REVIEW

DATE OF QA TEAM FIELD REVIEW =	12/12/2012	IN-HOUSE OR CONSULTANT INSPECTION TEAM:	IN-HOUSE
BRIDGE NUMBER: 1-052	INSPECTION DATE: 3/12/12	INSPECTION TEAM:	GM & JM

ITEM	DESCRIPTION	RESOLUTION DATE
PONTIS ELEMENTS	Good - no problems noted	
PONTIS CONDITION STATES	Good - no problems noted	
NBI ITEMS #58, 59, 60, 61 & 62	Not sure that a rating of a "6" is appropriate - need to discuss	12/13/12
NBI RATING OF A '4'	N/A	
NBI DATA	Good - no problems noted	
WRITTEN REPORT PORTION OF UNDERWATER REPORT	N/A - This was not an underwater inspection	
UNDERWATER REPORT SOUNDING PLAN	N/A - This was not an underwater inspection	
SCOUR SKETCH SHEET	Good - no problems noted	
SCOUR SOUNDING SHEET	N/A	
UNDER RECORD SKETCH	N/A	
BEAM SKETCH SHEET(S)	N/A	
PHOTOS	Good - no problems noted	
MAXIMO WORK ORDERS	Good - no problems noted	
MISC.	N/A	
FOLLOW-UP ACTIONS IDENTIFIED	N/A	

= SIGNIFIES THAT ACTION IS STILL NEEDED AS A RESULT OF MISSING DATA OR ERRORS THAT NEED TO BE ADDRESSED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER

= SIGNIFIES THAT AN ERROR WAS FOUND DURING THE QA FIELD REVIEW AND WAS CORRECTED DURING THE REVIEW

= SIGNIFIES THAT SOME CLARIFICATION OR DISCUSSION NEEDS TO TAKE PLACE TO CONFIRM THE ISSUE (NOT NECESSARILY A NEGATIVE THING)

= SIGNIFIES THAT ACTION IS NEEDED BY THE BRIDGE INSPECTION TEAM AND/OR TEAM LEADER, BUT IS NOT THE RESULT OF AN ERROR OR MISSING DATA

Appendix A.14

Joint Measurement Sheet

DELAWARE
DEPARTMENT OF TRANSPORTATION

JOINT MEASUREMENT SHEET

BRIDGE:

Date:									
Inspectors:									
Location:									
Temp (°F):									
Left Gap ("):									
Right Gap ("):									
Comments:									
Location:									
Temp (°F):									
Left Gap ("):									
Right Gap ("):									
Comments:									
Location:									
Temp (°F):									
Left Gap ("):									
Right Gap ("):									
Comments:									
Location:									
Temp (°F):									
Left Gap ("):									
Right Gap ("):									
Comments:									
Location:									
Temp (°F):									
Left Gap ("):									
Right Gap ("):									
Comments:									

Note: Joints are measured at solid lines unless a comment states otherwise. Left and right is determined by looking from span 1 and towards increasing roadway stationing.

Appendix A.15

Other Sketches and Miscellaneous Documentation Examples

A-67

BRIDGE 1-251-355

SPAN 1 S.

DECK SURF

(C+O C)

6/16/2014 GM/TW

1408 SF TOT. DELAM
8464 SF TOT DECK AREA
} AS A WHOLE 16.6 % TOTAL AFFECTED AREA.

2' × 2' = (4 SF)

TOT. SF = 412 /SPAN DELAM

TOT SF OF SPAN = 2622

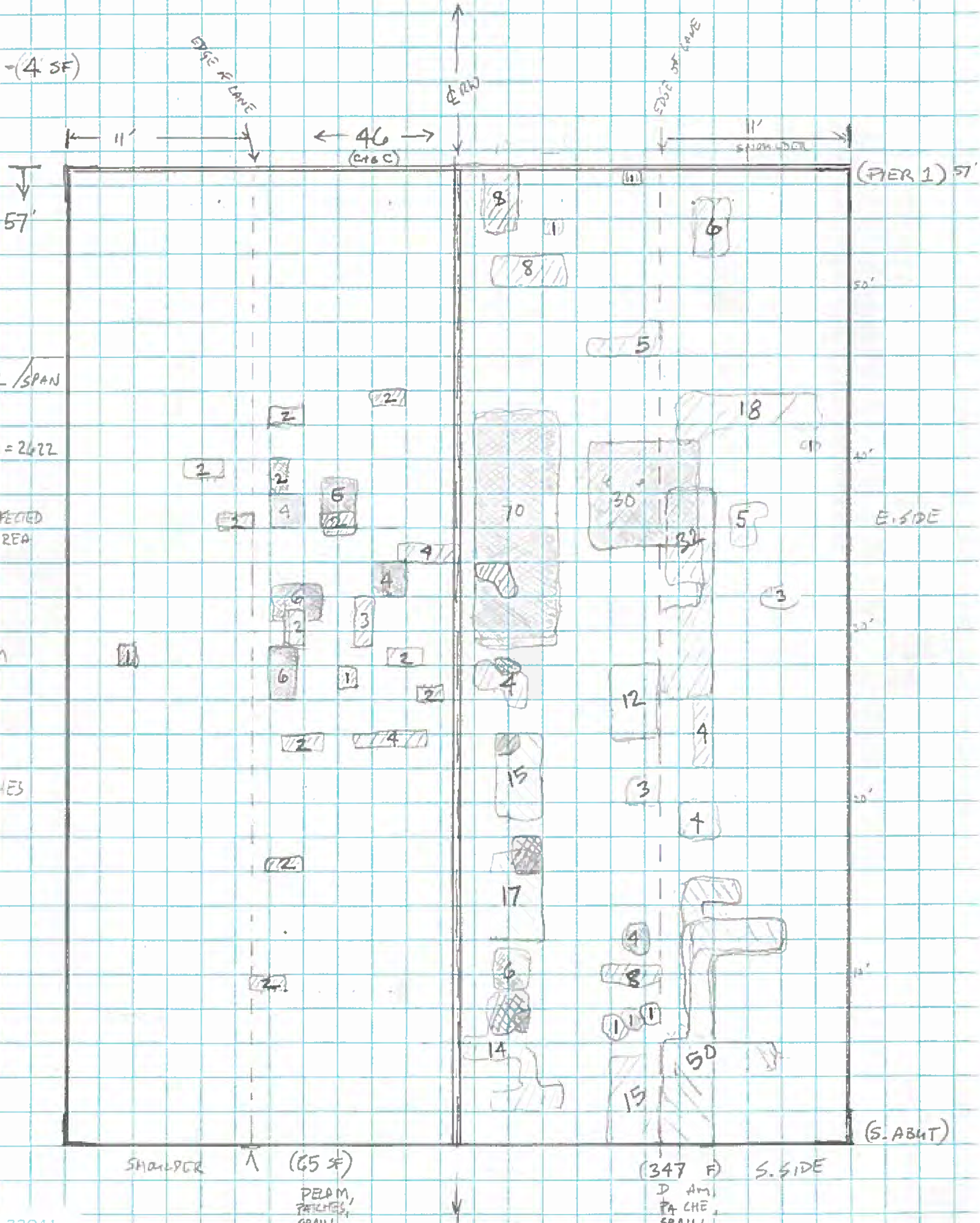
15.7 % AFFECTED AREA

LEGEND

= DELAM

= SPALL

= PATCHES



Pennoni Associates Inc.
Consulting Engineers

A-68

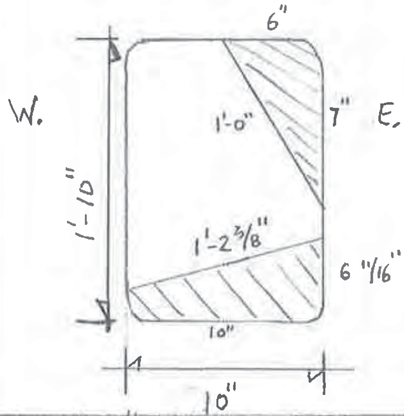
PROJECT: DDOT : BR. 1-814-009	JOB NO. DDOT 1501	
SUBJECT: SPAN 1 LOSS OF BEARING	SHEET 1 OF 1	DATE
	BY: PAS	11/30/15
	CHK'D JRG	12/1/15

ORIGINAL BRG AREA = 220 in^2

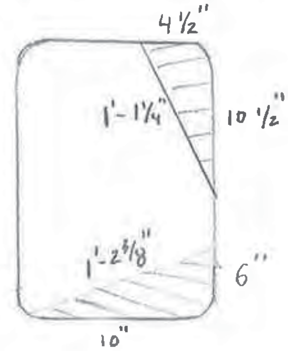
WEST PIER SPAN 1 BEARING PEDISTALS

★ N.T.S

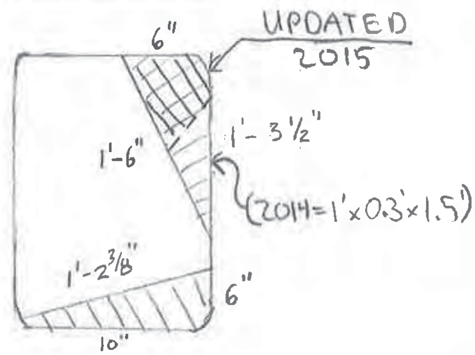
PAD. #2



PAD. #3

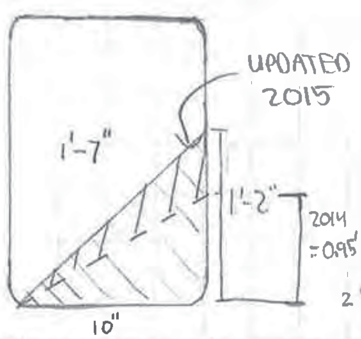


PAD #4

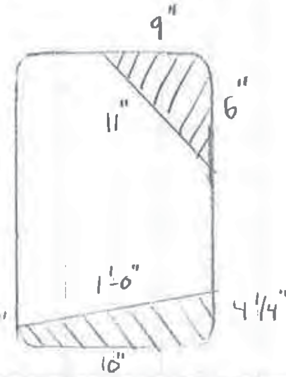


LOSS OF BRG		PAD #2	PAD #3	PAD #4
	in^2	44.6 in^2 (NC-15)	45.1 in^2 (NC-15)	69.3 in^2
	%	20.1 %	20.3 %	31.2 %

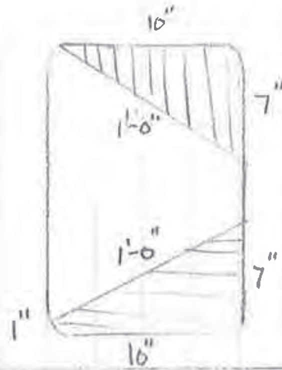
PAD #5



PAD # 6

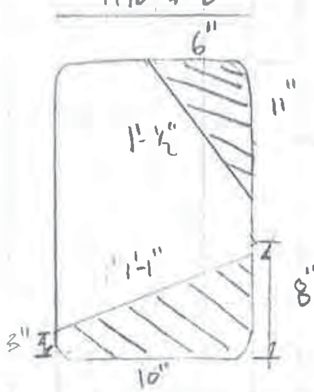


PAD # 7



LOSS OF BRG		PAD #5	PAD #6	PAD #7
	in^2	68.2 in^2	60.8 in^2 (NC-15)	74.6 in^2 (NC-15)
	%	30.7 %	27.4 %	33.62 %

PAD #8



LOSS OF BRG		PAD #8
	in^2	85.5 in^2 (NC-15)
	%	38.9 %

LEGEND

= AREA WITHOUT BEARING

ADT. NOTES

- EXPOSED NORTH AND SOUTH ANCHOR BOLTS, TYPICAL AT LOCATIONS THAT EXHIBIT LOSS OF BRG.

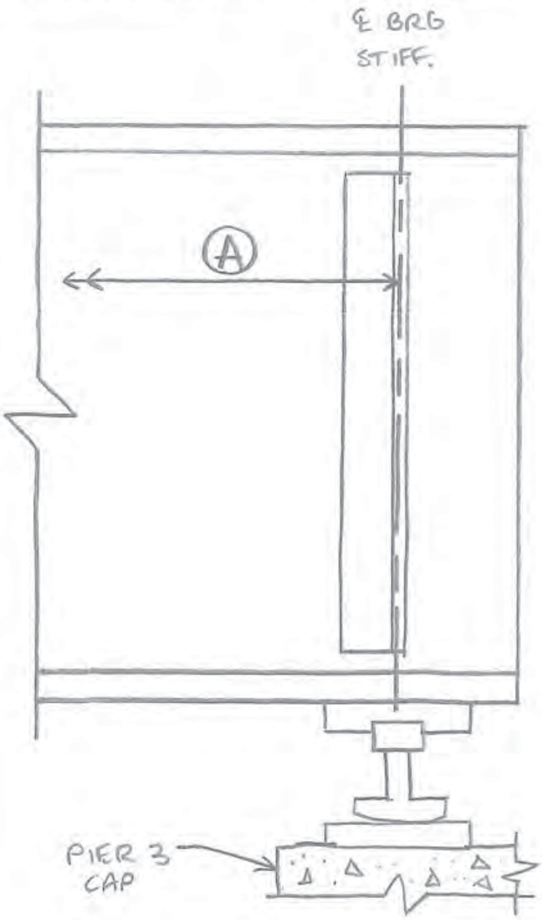
FORM NO. 42

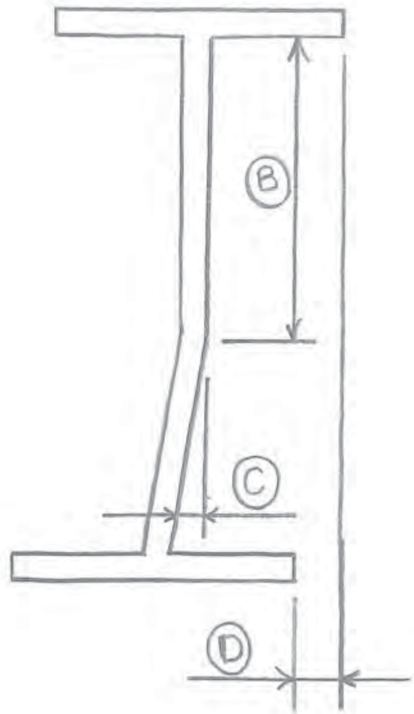
Pennoni Associates Inc.
Consulting Engineers

JOB NO.	
SHEET OF	DATE
BY: BJM	5/30/14
CHK'D	

PROJECT: BRIDGE 1680 - IMPACT DAMAGE MEASUREMENTS

SUBJECT: SPAN 4, BEAM 1 WEST ELEVATION





*TAKEN @ REPAIR PLATE

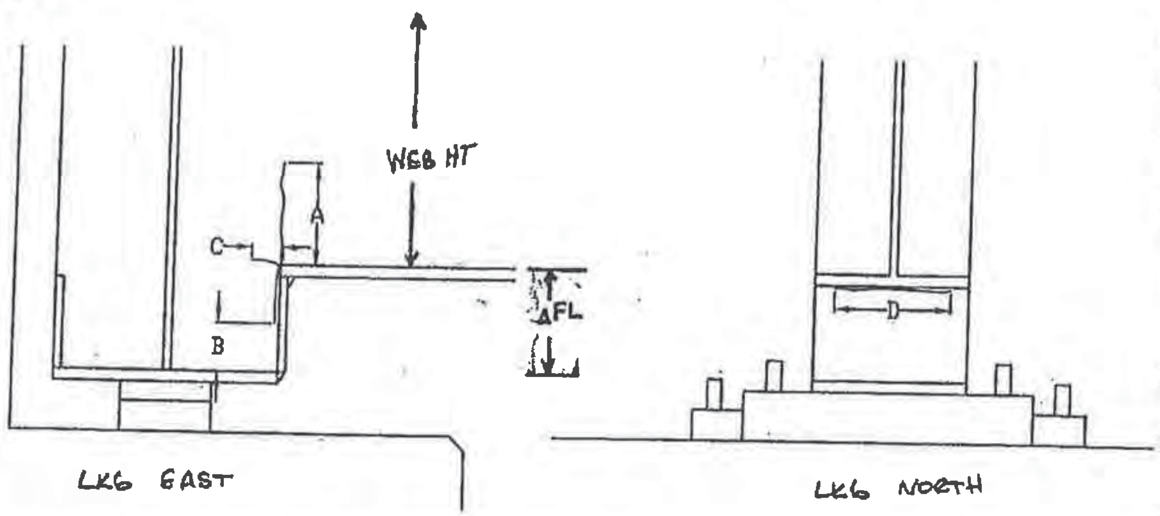
(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)
1.0'	N/A	0"	–	17.0'	10 7/8"	11/16"	–	33.0'	0"	–	1 9/16"
2.0'	N/A	0"	–	18.0'	10 3/8"	7/8"	–	34.0'	0"	–	1 1/2"
3.0'	12"	1/8"	–	19.0'	10 1/2"	1 1/16"	–	35.0'	0"	–	1 7/16"
4.0'	12 1/2"	3/16"	–	20.0'	17 1/2"	1 1/4"	–	36.0'	0"	–	1 1/8"
5.0'	11 1/2"	1/4"	–	21.0'	10 1/2"	1 3/16"	–	37.0'	0"	–	1 9/16"
6.0'	N/A	0"	–	22.0'	9 1/2"	15/16"	–	38.0'	0"	–	1 11/16"
7.0'	12 1/2"	1/8"	–	23.0'	8 1/4"	3/4"	–	39.0'	0"	–	1 5/8"
8.0'	10"	1/4"	–	24.0'	0"	–	1 9/16"	40.0'	0"	–	1 3/4"
9.0'	11 1/4"	1/2"	–	25.0'	0"	–	1 1/2"	41.0'	0"	–	1 3/4"
10.0'	SPLICE	PLATE	–	26.0'	0"	–	1 3/8"	42.0'	0"	–	1 3/4"
11.0'	15"	7/16"	–	27.0'	0"	–	1 7/16"	43.0'	0"	–	1 7/8"
12.0'	15"	3/8"	–	28.0'	0"	–	1 5/8"	*44.0'	0"	–	1 13/16"
13.0'	14 3/4"	7/16"	–	29.0'	0"	–	1 1/4"	*45.0'	0"	–	1 5/8"
14.0'	13 1/2"	1/2"	–	30.0'	0"	–	1 3/8"	*46.0'	0"	–	1 5/8"
15.0'	13 1/2"	1/2"	–	31.0'	0"	–	1 3/8"	*47.0'	0"	–	1 3/4"
16.0'	11 5/8"	1/2"	–	32.0'	0"	–	1 1/2"	*48.0'	0"	–	1 7/8"

AECOM

SUBJECT SR 141 NB OVER I-95 & 295 NB

SHEET NO. 1 OF 1
JOB NO.
BY: GM/MS DATE: 5/14/12
BY: MM SON/DSC DATE: 6/24/13

Bridge No. 1678 006 AECOM No. 2011-07 OWNER: DelDOT



SPAN #	BEAM #	FACE	(A)	(B)	(C)	(D)	AFL	WEB HT.	
5	3	E W	4 3/4" 3 5/8"	3 1/2" 3 5/8"	15/16" N/A	8 1/4"	6.25"	29"	(S) N. ABUT *
5	3	E	5 1/4" PHOTOS (1,2 & 3)						(S) N. ABUT ⊗ ⊛

* 6/17/11 DELDOT CREW DRILLED (2) HOLES TO ARREST CRK & PLACED TIMBER BLOCK UNDER BEAM.

⊗ 5/14/12 DELDOT INSPECTION TEAM DISCOVERED 1 VERTICAL CRACK PROPAGATING THROUGH A HOLE DRILLED TO ARREST THE CRACKS FURTHER PROGRESS.

⊛ 2"Ø ARREST HOLE DRILLED @ TOP OF CRACK DATED 2/12/13

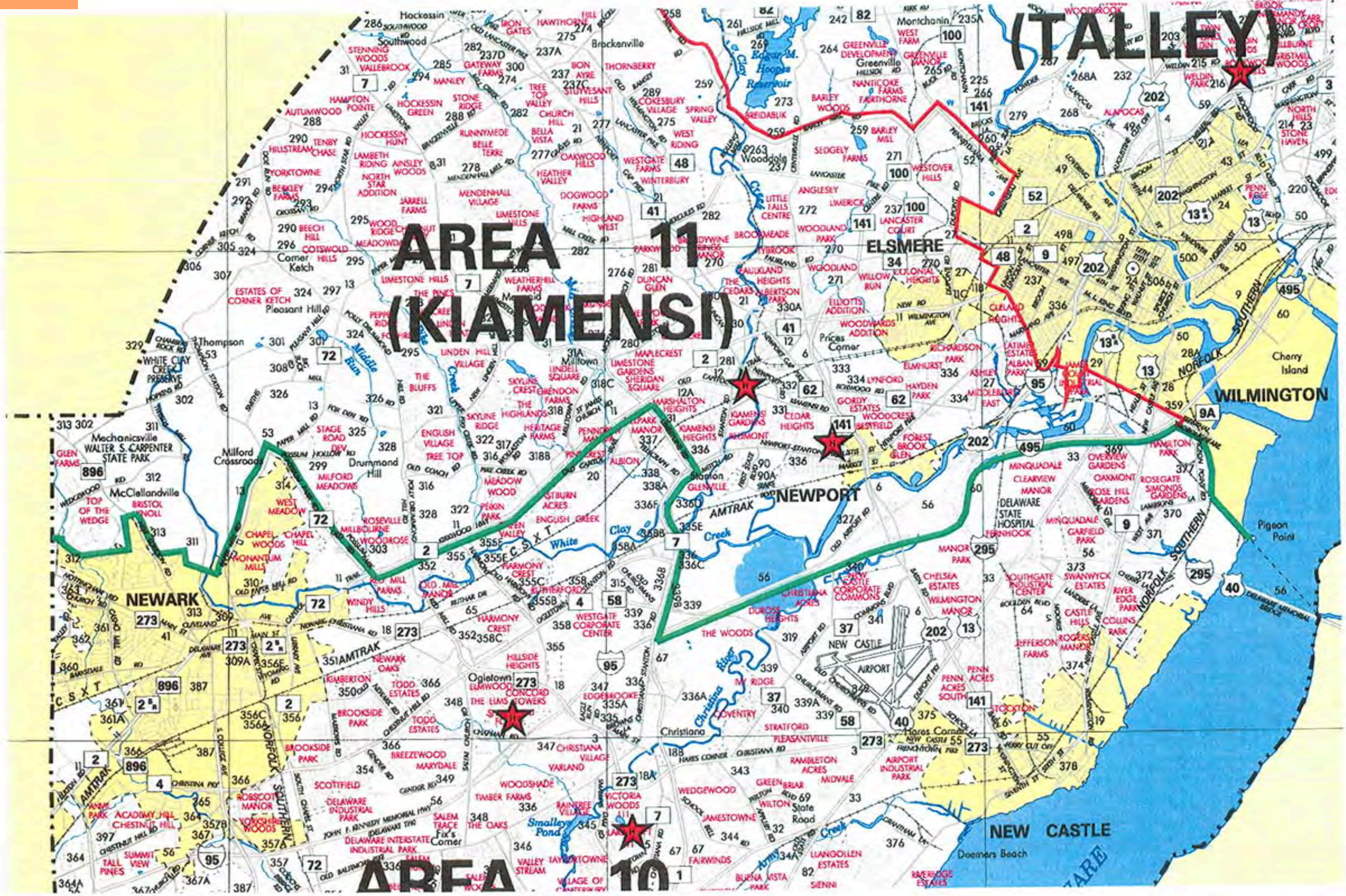
△1 6/12/15 DC/BJM - NO CHANGE

Appendix B. Figures

Appendix B.1

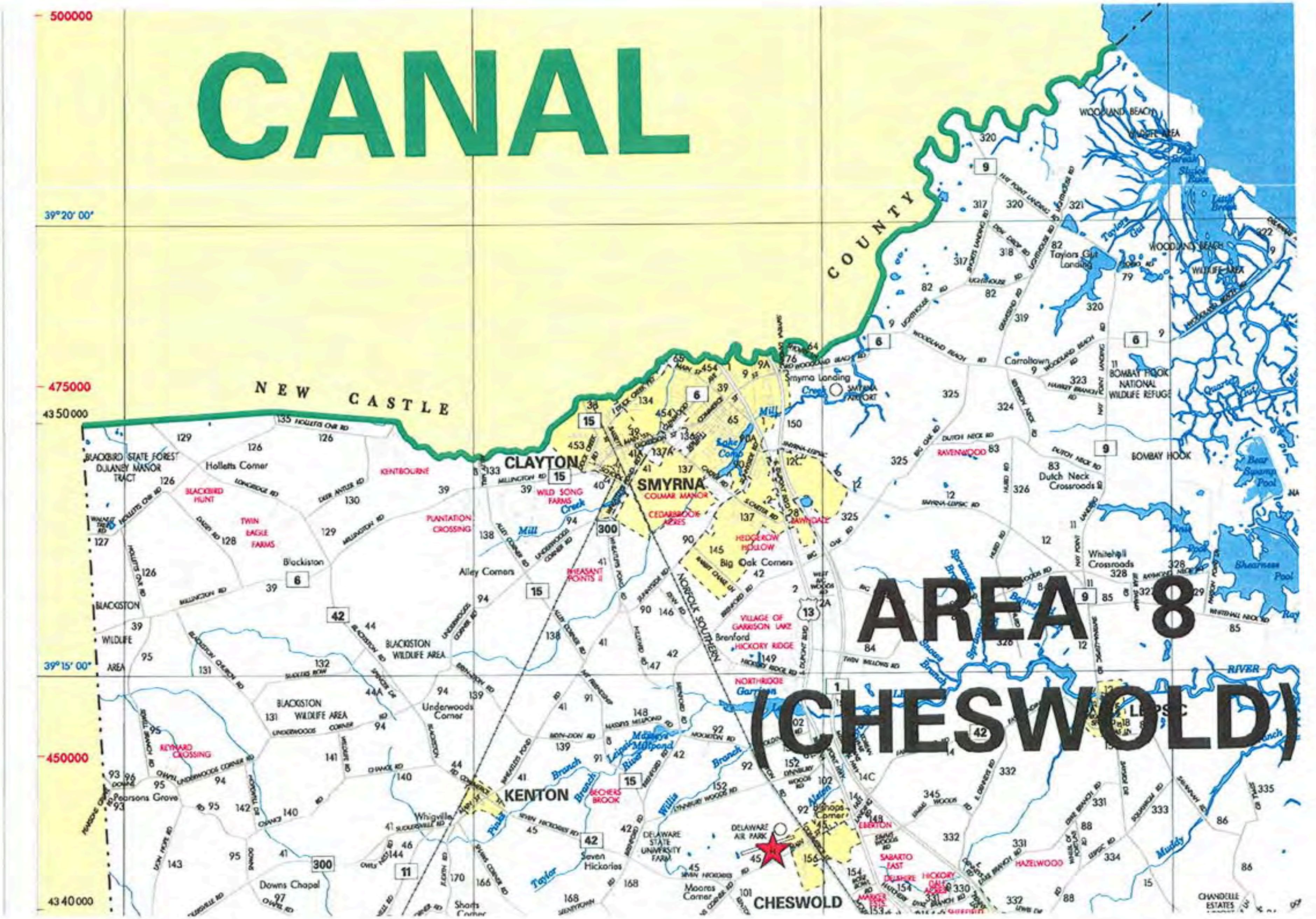
District Boundary Maps

B-3

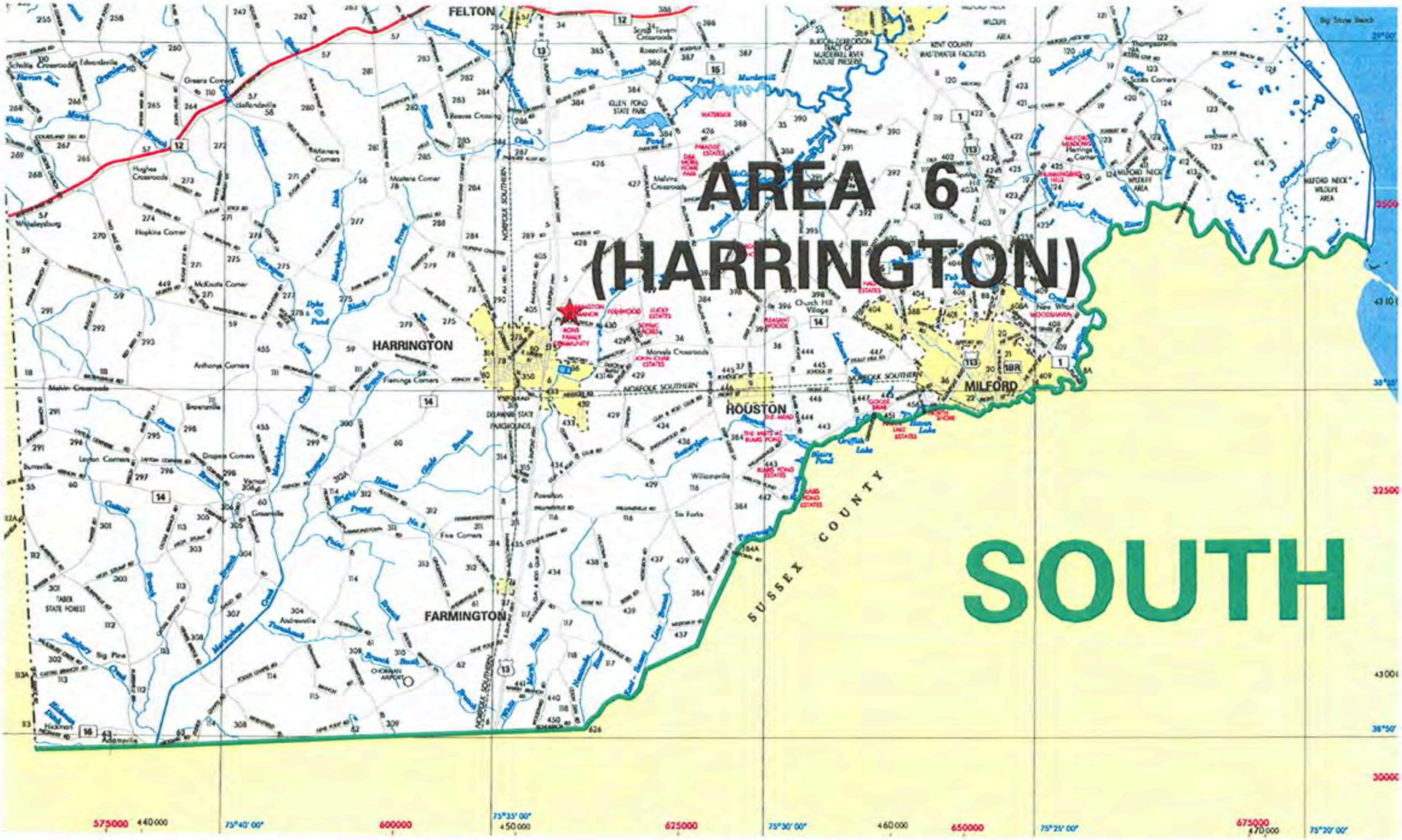


AREA 11
(KIAMENSI)
(TALLEY)
WILMINGTON
NEWARK
NEWPORT
ELSMERE
NEW CASTLE
10

B-4



CANAL
NEW CASTLE COUNTY
AREA 8 (CHESWOLD)
CLAYTON
SMYRNA
KENTON
CHESWOLD
BOMBAY HOOK NATIONAL WILDLIFE REFUGE
BLACKISTON WILDLIFE AREA
DELAWARE AIR PARK
DELAWARE STATE UNIVERSITY FARM
39°20' 00"
39°15' 00"
500000
475000
450000
4350000
4340000


AREA 6
(HARRINGTON)
SOUTH
HARRINGTON
FELTON
HOUSTON
MILFORD
FARMINGTON
SUSSEX COUNTY
NORFOLK SOUTHERN
575000
600000
625000
650000
675000
450000
460000
470000
75°40' 00"
75°35' 00"
75°30' 00"
75°25' 00"
75°20' 00"
38°50'

Appendix B.2

FIPS Place Codes

Place Code	FIPS55 Feature Name	County Code	County Name	Place Code	FIPS55 Feature Name	County Code	County Name
00130	Addick Estates	3	New Castle	04780	Bellemoor	3	New Castle
00230	Afton	3	New Castle	04910	Bellevue	3	New Castle
00360	Airport Villa	3	New Castle	05040	Bellevue Manor	3	New Castle
00490	Alapocas	3	New Castle	05200	Belmoor	3	New Castle
00600	Alban Park	3	New Castle	05300	Belvedere	3	New Castle
00610	Albertson	3	New Castle	05320	Belvidere	3	New Castle
00620	Albertson Park	3	New Castle	05560	Bestfield	3	New Castle
00630	Albion	3	New Castle	06080	Binns Village	3	New Castle
00750	Analine Village	3	New Castle	06210	Birchwood Park	3	New Castle
01010	Anglesey	3	New Castle	06470	Blackbird	3	New Castle
01350	Arbour Park	3	New Castle	06960	Blue Ball	3	New Castle
01400	Arden	3	New Castle	07120	Blue Rock Manor	3	New Castle
01530	Ardencroft	3	New Castle	07380	Boxwood	3	New Castle
01660	Ardentown	3	New Castle	07450	Brackenville	3	New Castle
01825	Armstrong	3	New Castle	07480	Brackenville Woods	3	New Castle
02050	Arundel	3	New Castle	07510	Brack-Ex	3	New Castle
02180	Ashbourne Hills	3	New Castle	07610	Brandon	3	New Castle
02310	Ashland	3	New Castle	07640	Brandywine	3	New Castle
02440	Ashley	3	New Castle	07770	Brandywine Estates	3	New Castle
02830	Atlas Point	3	New Castle	07900	Brandywine Hills	3	New Castle
02900	Auburn Hills	3	New Castle	08000	Brandywine Springs	3	New Castle
02930	Augustine	3	New Castle	08030	Brandywine Springs Manor	3	New Castle
02960	Augustine Beach	3	New Castle	08160	Brandywood	3	New Castle
03090	Avalon	3	New Castle	08650	Brick Store	3	New Castle
03480	Baldton	3	New Castle	09330	Brookbend	3	New Castle
03675	Barkley	3	New Castle	09590	Brookhaven	3	New Castle
03840	Bayview Manor	3	New Castle	09620	Brookhill Farms	3	New Castle
04130	Bear	3	New Castle	09720	Brookland Terrace	3	New Castle
04260	Beaver Brook	3	New Castle	09850	Brookside (census name for Brookside Park)	3	New Castle
04450	Beaver Valley	3	New Castle	09980	Brookside Park (census name Brookside)	3	New Castle

04650	Bellefonte	3	New Castle	10110	Brookview Apartments	3	New Castle
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
10310	Buckingham Heights	3	New Castle	15080	Church Hill	3	New Castle
10630	Buttonwood	3	New Castle	15310	Claymont	3	New Castle
11020	Canby Park	3	New Castle	15340	Claymont Addition	3	New Castle
11050	Canby Park Estates	3	New Castle	15370	Claymont Heights	3	New Castle
11440	Canterbury Hills	3	New Castle	15440	Clayton	3	New Castle
11770	Caravel Farms	3	New Castle	15570	Clearfield	3	New Castle
11800	Cardiff	3	New Castle	15700	Clearview Manor	3	New Castle
12060	Carpenter	3	New Castle	15830	Cleland Heights	3	New Castle
12320	Carrcroft	3	New Castle	15960	Clifton Park Manor	3	New Castle
12450	Carrcroft Crest	3	New Castle	16220	College Park	3	New Castle
12710	Castle Hills	3	New Castle	16320	Collins Beach	3	New Castle
12970	Catalina Gardens	3	New Castle	16350	Collins Park	3	New Castle
13100	Cedar Heights	3	New Castle	16480	Colonial Heights	3	New Castle
13130	Cedars	3	New Castle	16610	Colonial Park	3	New Castle
13200	Centennial Village	3	New Castle	16640	Colony Hills	3	New Castle
13230	Center Green	3	New Castle	16930	Concord Hills	3	New Castle
13360	Centerville	3	New Castle	17130	Concord Manor	3	New Castle
13490	Centreville (Centerville)	3	New Castle	17260	Cooch	3	New Castle
13620	Chalfonte	3	New Castle	17520	Cooper Farm	3	New Castle
13660	Chambersville	3	New Castle	17540	Corbit	3	New Castle
13750	Channin	3	New Castle	17570	Corner Ketch	3	New Castle
13880	Chapel Hill	3	New Castle	17600	Cornish Hills	3	New Castle
14010	Chatham	3	New Castle	17625	Cottage Mill	3	New Castle
14140	Chelsea Estates	3	New Castle	17780	Coventry	3	New Castle
14270	Cherokee Woods	3	New Castle	18040	Covered Bridge Farms	3	New Castle
14300	Cherry Hill	3	New Castle	18300	Cragmere	3	New Castle
14400	Chestnut Hill Estates	3	New Castle	18430	Cragmere Woods	3	New Castle
14730	Choate	3	New Castle	18690	Cranston Heights	3	New Castle
14790	Christiana	3	New Castle	18720	Cristine Manor	3	New Castle

Place Code	FIPS55 Feature Name	County Code	County Name	Place Code	FIPS55 Feature Name	County Code	County Name
14920	Christiana Acres	3	New Castle	19080	Darley Woods	3	New Castle
15050	Christine Manor	3	New Castle	19210	Dartmouth Woods	3	New Castle
19440	Deakyneville	3	New Castle	23760	Edgewood Hills	3	New Castle
19470	Deerhurst	3	New Castle	24150	Elliott Heights	3	New Castle
19570	Delaire	3	New Castle	24410	Elmhurst	3	New Castle
19590	Delaney Corner	3	New Castle	24540	Elsmere	3	New Castle
19600	Delaplane Manor	3	New Castle	24670	Elsmere Junction	3	New Castle
19730	Delaware City	3	New Castle	24800	English Village	3	New Castle
19860	Delaware Heights	3	New Castle	25060	Fairfax	3	New Castle
19890	Delaware Junction	3	New Castle	25190	Fairfield	3	New Castle
19990	Delaware River Pier	3	New Castle	25320	Fairfield Crest	3	New Castle
20120	Delaware State Hospital	3	New Castle	25710	Fairwinds	3	New Castle
20510	Delpark Manor	3	New Castle	25970	Farnhurst (Delaware State Hospital)	3	New Castle
20640	Devon	3	New Castle	26100	Faulkland	3	New Castle
20770	Devonshire	3	New Castle	26230	Faulkland Heights	3	New Castle
20910	Dexter Corners	3	New Castle	26360	Faulkwoods	3	New Castle
21030	Dobbinsville	3	New Castle	26490	Federal	3	New Castle
21680	Drummond North	3	New Castle	26910	Fern Hook	3	New Castle
21810	Dunleith	3	New Castle	27140	Fieldsboro	3	New Castle
21940	Dunlinden Acres	3	New Castle	27270	Fireside Park	3	New Castle
22200	Duross Heights	3	New Castle	27530	Flemings Landings	3	New Castle
22270	Eastburn Acres	3	New Castle	27630	Forest	3	New Castle
22300	Eastburn Heights	3	New Castle	27660	Forest Brook Glen	3	New Castle
22330	East Lake	3	New Castle	27790	Forest Hills Park	3	New Castle
22430	East Minquadale	3	New Castle	27920	Forest Park	3	New Castle
22720	Eden Park	3	New Castle	27950	Fort Delaware	3	New Castle
22750	Eden Park Gardens	3	New Castle	28150	Foulk Woods	3	New Castle
22780	Edenridge	3	New Castle	28180	Four Seasons	3	New Castle
22830	Edgebrooke	3	New Castle	28200	Fox Chase Park	3	New Castle
23110	Edge Moor (sta.)	3	New Castle	28220	Foxfield	3	New Castle

23240	Edgemoor	3	New Castle	28280	Fox Meadow Farm	3	New Castle
23370	Edgemoor Gardens	3	New Castle	28570	Galewood	3	New Castle
23500	Edgemoor Terrace	3	New Castle	28600	Gams Crest	3	New Castle
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
28700	Garfield Park	3	New Castle	32550	Hanbys Corner	3	New Castle
28830	Gateway Farms	3	New Castle	32860	Harmony	3	New Castle
28960	George Read Village	3	New Castle	32990	Harmony Hills	3	New Castle
29220	Ginns Corner	3	New Castle	33400	Haverford	3	New Castle
29350	Glasgow	3	New Castle	33510	Hayden Park	3	New Castle
29380	Glasgow Pines	3	New Castle	33610	Hazeldell	3	New Castle
29480	Glen Berne Estates	3	New Castle	33800	Heather Valley	3	New Castle
29610	Glendale	3	New Castle	34030	Henry Clay	3	New Castle
29740	Glenville	3	New Castle	34160	Hercules	3	New Castle
29850	Goose Point	3	New Castle	34190	Heritage	3	New Castle
29870	Gordon Heights	3	New Castle	34400	Hickory Hill	3	New Castle
30000	Gordy Estates	3	New Castle	34420	Hickory Hill	3	New Castle
30130	Granogue	3	New Castle	35100	Highland Meadows	3	New Castle
30390	Graylyn Crest	3	New Castle	35200	Highland West	3	New Castle
30520	Green Acres	3	New Castle	35230	Highland Woods	3	New Castle
30650	Green Bank	3	New Castle	35260	High Point	3	New Castle
30770	Greenbank	3	New Castle	35330	Hillcrest	3	New Castle
30860	Greenbridge	3	New Castle	35490	Hillendale	3	New Castle
30940	Greenleaf Manor	3	New Castle	35590	Hillside Heights	3	New Castle
30980	Green Meadow	3	New Castle	35720	Hilltop Manor	3	New Castle
31020	Green Spring	3	New Castle	35850	Hockessin	3	New Castle
31170	Greentree	3	New Castle	35920	Holiday Hills	3	New Castle
31430	Greenville	3	New Castle	36110	Holloway Terrace	3	New Castle
31460	Greenville Manor	3	New Castle	36180	Holly Knoll	3	New Castle
31590	Grendon Farms	3	New Castle	36240	Holly Oak	3	New Castle
31620	Greylag	3	New Castle	36500	Holly Oak Terrace	3	New Castle
31820	Gumwood	3	New Castle	36860	Hunting Hills	3	New Castle

31950	Guyencourt	3	New Castle	37020	Hyde Park	3	New Castle
32080	Gwinhurst	3	New Castle	37150	Idela	3	New Castle
32340	Hambys Corner	3	New Castle	37410	Indian Field	3	New Castle
32470	Hamilton Park	3	New Castle	37700	Iron Hill	3	New Castle
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
37800	Ivy Ridge	3	New Castle	43260	Longview Farms	3	New Castle
37930	Jefferson Farms	3	New Castle	43285	Longwood	3	New Castle
38290	Keeney	3	New Castle	43310	Lorewood Grove	3	New Castle
38450	Kenilworth	3	New Castle	43340	Loveville	3	New Castle
38970	Kentmere	3	New Castle	43520	Lumbrook	3	New Castle
39130	Keystone	3	New Castle	43780	Lyndalia	3	New Castle
39230	Kiamensi	3	New Castle	43910	Lynnfield	3	New Castle
39360	Kiamensi Gardens	3	New Castle	44040	McClellandville	3	New Castle
39620	Kirkwood	3	New Castle	44170	McDaniel Heights	3	New Castle
39680	Kirkwood Gardens	3	New Castle	44230	McDonough	3	New Castle
40010	Klair Estate	3	New Castle	44530	Manette Heights	3	New Castle
40140	Kynlyn Apartments	3	New Castle	44560	Manor	3	New Castle
40400	Lamatan	3	New Castle	44690	Manor Park	3	New Castle
40530	Lancashire	3	New Castle	44820	Manor Park Apartments	3	New Castle
40660	Lancaster Court	3	New Castle	44950	Maplecrest	3	New Castle
40790	Lancaster Village	3	New Castle	45080	Maplewood	3	New Castle
40920	Landenberg Junction	3	New Castle	45150	Marabou Meadows	3	New Castle
40950	Landers Park	3	New Castle	45210	Marshallton	3	New Castle
40980	Landlith	3	New Castle	45700	Masonicville	3	New Castle
41280	Latimer Estates	3	New Castle	45990	Mayfield	3	New Castle
41360	Lauren Farms	3	New Castle	46120	Mayview Manor	3	New Castle
41570	Leedon Estates	3	New Castle	46250	Meadowbrook	3	New Castle
42060	Liberty	3	New Castle	46380	Meadowood	3	New Castle
42090	Liftwood	3	New Castle	46510	Mechanicsville	3	New Castle
42220	Limestone Acres	3	New Castle	46640	Meeting House Hill	3	New Castle
42320	Limestone Gap	3	New Castle	46720	Mermaid	3	New Castle

42350	Limestone Gardens	3	New Castle	46750	Middleboro Manor	3	New Castle
42740	Lindamere	3	New Castle	47030	Middletown	3	New Castle
42750	Linden Hill	3	New Castle	47160	Midvale	3	New Castle
43000	Llangollen	3	New Castle	47550	Milford Crossroads	3	New Castle
43130	Llangollen Estates (Llangollen)	3	New Castle	47610	Milford Meadows	3	New Castle
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
47780	Mill Creek	3	New Castle	53140	Oak Grove	3	New Castle
47990	Millside	3	New Castle	53400	Oak Hill	3	New Castle
48040	Milltown	3	New Castle	53500	Oakland	3	New Castle
48590	Minquadale	3	New Castle	53530	Oak Lane Manor	3	New Castle
48950	Mockingbird Hills	3	New Castle	53660	Oakmont	3	New Castle
48980	Monroe Park	3	New Castle	53820	Oakwood Hills	3	New Castle
49110	Montchanin	3	New Castle	54050	Odessa	3	New Castle
49240	Monterey Farms	3	New Castle	54080	Odessa Heights	3	New Castle
49500	Mount Cuba	3	New Castle	54310	Ogletown	3	New Castle
49630	Mount Pleasant	3	New Castle	54370	Old Mill Manor	3	New Castle
49890	Naaman	3	New Castle	54570	Overlook	3	New Castle
50020	Naamans Gardens	3	New Castle	54600	Overlook Colony	3	New Castle
50150	Naamans Manor	3	New Castle	54700	Overview Gardens	3	New Castle
50280	Naamans Trailer Park	3	New Castle	54830	Owls Nest Estates	3	New Castle
50670	Newark	3	New Castle	54960	Palm Spring Manor	3	New Castle
50800	New Castle	3	New Castle	55120	Parkside	3	New Castle
50930	New Castle Manor	3	New Castle	55220	Pembrey	3	New Castle
51060	Newkirk Estates	3	New Castle	55350	Penarth	3	New Castle
51190	Newport	3	New Castle	55380	Pencader	3	New Castle
51220	Newport Heights	3	New Castle	55440	Pendrew Manor	3	New Castle
51290	Nonatum Mills	3	New Castle	55480	Penn Acres	3	New Castle
51320	North Claymont	3	New Castle	55610	Pennock	3	New Castle
51450	Northcrest	3	New Castle	55640	Pennrock	3	New Castle
51580	North Hills	3	New Castle	55670	Penn Rose	3	New Castle
51710	North Ridge	3	New Castle	55740	Pennyhill	3	New Castle

Place Code	FIPS55 Feature Name	County Code	County Name	Place Code	FIPS55 Feature Name	County Code	County Name
51970	Northshire	3	New Castle	55765	Pennyhill Terrace	3	New Castle
52490	North Star	3	New Castle	55790	Penrock	3	New Castle
52750	Northwood	3	New Castle	55870	Perry Park	3	New Castle
52880	Nottingham Green	3	New Castle	56000	Perth	3	New Castle
52910	Nottingham Manor	3	New Castle	56230	Phillips Heights	3	New Castle
53000	Oakdale	3	New Castle	56450	Piermont Woods	3	New Castle
56490	Pike Creek	3	New Castle	62110	Rogers Manor	3	New Castle
56520	Pilgrim Gardens	3	New Castle	62240	Rolling Hills	3	New Castle
56720	Pinecrest	3	New Castle	62370	Rolling Park	3	New Castle
56750	Pine Swamp Corner	3	New Castle	62630	Rosegate	3	New Castle
56910	Pine Tree Corners	3	New Castle	62760	Rose Hill	3	New Castle
57170	Pleasant Hill	3	New Castle	62890	Rose Hill Gardens	3	New Castle
57175	Pleasant Hills	3	New Castle	63020	Roselle	3	New Castle
57560	Pleasantville	3	New Castle	63050	Roselle Terrace	3	New Castle
57820	Point Breeze	3	New Castle	63150	Roseville Park	3	New Castle
57950	Polly Drummond	3	New Castle	63410	Rosscott Manor	3	New Castle
58080	Polly Drummond Hill	3	New Castle	63600	Runnymeade	3	New Castle
58340	Porter	3	New Castle	63640	Ruthby	3	New Castle
58600	Port Penn	3	New Castle	63670	Rutherford	3	New Castle
58830	Prices Corner	3	New Castle	63800	Saint Georges	3	New Castle
59090	Quaker Hill	3	New Castle	63830	Saint Georges Heights	3	New Castle
59150	Quarryville	3	New Castle	64060	Scottfield	3	New Castle
59250	Radnor Green	3	New Castle	64580	Sedgley Farms	3	New Castle
59380	Radnor Woods	3	New Castle	65100	Sharpley	3	New Castle
59510	Rambleton Acres	3	New Castle	65230	Shawtown	3	New Castle
59640	Ramblewood	3	New Castle	65330	Sheffield Manor	3	New Castle
59900	Red Lion	3	New Castle	65360	Shellburne	3	New Castle
60680	Reybold	3	New Castle	65590	Sherwood Forest	3	New Castle
61070	Richardson Park	3	New Castle	65620	Sherwood Park	3	New Castle
61100	Ridgewood	3	New Castle	65750	Sherwood Park	3	New Castle

61430	Riverside	3	New Castle	65780	Shipley Heights	3	New Castle
61460	Riverside Gardens	3	New Castle	66140	Silver Brook	3	New Castle
61560	Robscott Manor	3	New Castle	66270	Silverbrook	3	New Castle
61590	Rockland	3	New Castle	66300	Silverbrook Gardens	3	New Castle
61620	Rock Manor	3	New Castle	66530	Silverside	3	New Castle
61650	Rodney Square	3	New Castle	66660	Silverside Heights	3	New Castle
61950	Rogers Corners	3	New Castle	66790	Silview	3	New Castle
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
66920	Simonds Gardens	3	New Castle	71560	The Highlands	3	New Castle
66985	Skyline Crest	3	New Castle	71730	The Timbers	3	New Castle
67310	Smyrna	3	New Castle	71890	Thorntown	3	New Castle
67975	South Wilmington	3	New Castle	72120	Todd Estates	3	New Castle
67990	Southwood	3	New Castle	72250	Tower Trailer Park	3	New Castle
68035	Spring Valley	3	New Castle	72510	Townsend	3	New Castle
68090	Stanton (sta.)	3	New Castle	72610	Trepagnier	3	New Castle
68220	Stanton	3	New Castle	72900	Tuxedo Park	3	New Castle
68250	Stanton Estates	3	New Castle	72990	Twin Oaks	3	New Castle
68610	Stockdale	3	New Castle	73030	Tybrook	3	New Castle
68870	Stockton	3	New Castle	73160	Union Street	3	New Castle
68900	Stonehaven	3	New Castle	73420	Vagabond Trailer Park	3	New Castle
69000	Stratford	3	New Castle	73550	Valley Run	3	New Castle
69230	Summit Bridge	3	New Castle	73650	Vandyke	3	New Castle
69260	Surrey Park	3	New Castle	73680	Van Dyke Village	3	New Castle
69490	Swallow Hill	3	New Castle	73810	Varlano	3	New Castle
69650	Swanwyck	3	New Castle	74070	Village of Drummond Hill	3	New Castle
69780	Swanwyck Estates	3	New Castle	74200	Villa Monterey	3	New Castle
69910	Swanwyck Gardens	3	New Castle	74490	Walker	3	New Castle
70170	Sycamore Gardens	3	New Castle	74500	Walnut Ridge	3	New Castle
70530	Talleys Corner	3	New Castle	74580	Washington Heights	3	New Castle
70560	Talleyville	3	New Castle	74590	Washington Heights	3	New Castle
70690	Tanglewood (Pilgrim Gardens)	3	New Castle	74720	Washington Park	3	New Castle

70820	Tarleton	3	New Castle
70950	Tasker	3	New Castle
71050	Tavistock	3	New Castle
71210	Taylors Bridge	3	New Castle
71240	Taylors Corner	3	New Castle
71270	Taylortown	3	New Castle
71310	Tent	3	New Castle
71470	The Cedars	3	New Castle
74780	Wawaset Park	3	New Castle
74810	Waynes Corner	3	New Castle
74825	Ways Corner	3	New Castle
74980	Webster Farm	3	New Castle
75080	Wedgewood	3	New Castle
75110	Wedgewood Acres	3	New Castle
75340	Wellington Hills	3	New Castle
75370	Welshire	3	New Castle

Place Code	FIPS55 Feature Name	County Code	County Name
75730	West Farm	3	New Castle
75760	Westfield	3	New Castle
75860	Westgate Farms	3	New Castle
75890	West Haven	3	New Castle
76020	West Meadow	3	New Castle
76030	West Minquadale	3	New Castle
76050	West Minquadale	3	New Castle
76080	Westminster	3	New Castle
76150	Westover Hills	3	New Castle
76280	West Park	3	New Castle
76410	Westview	3	New Castle
76540	Westwood Manor	3	New Castle
76615	White Briar	3	New Castle
77000	Wiggins Mill	3	New Castle
77030	Williamsburg	3	New Castle
77450	Willow Run	3	New Castle
77580	Wilmington	3	New Castle
77710	Wilmington College	3	New Castle
77840	Wilmington Manor	3	New Castle
77970	Wilmington Manor-Chelsea-Leedom	3	New Castle
78100	Wilmington Manor Gardens	3	New Castle
78360	Wilmont	3	New Castle
79400	Woodbrook	3	New Castle
79660	Woodcrest	3	New Castle
79790	Wooddale	3	New Castle
79920	Wooddale (sta.)	3	New Castle
80440	Woodland Homes	3	New Castle
80570	Woodshade	3	New Castle
80960	Woodside Hills	3	New Castle
80990	Woodside Manor	3	New Castle
81220	Worthland	3	New Castle
81250	Wrange Hill Estates	3	New Castle
81280	Wrangle Hill	3	New Castle
81610	Yorklyn	3	New Castle

78490	Wilsmere	3	New Castle
78500	Wilson	3	New Castle
78620	Windermer	3	New Castle
78720	Windsor Hills	3	New Castle
78750	Windy Bush	3	New Castle
78880	Windy Hills	3	New Castle
78980	Winterbury	3	New Castle
79010	Winterthur	3	New Castle
79140	Woodbine	3	New Castle

Place Code	FIPS55 Feature Name	County Code	County Name	Place Code	FIPS55 Feature Name	County Code	County Name
00100	Adamsville	1	Kent	11410	Canterbury	1	Kent
00865	Andrew's Lake	1	Kent	11540	Capitol Green	1	Kent
00880	Andrewsville	1	Kent	11670	Capitol Park	1	Kent
01300	Anneville	1	Kent	11930	Carlisle Village	1	Kent
03610	Barkers Landing	1	Kent	12580	Carter	1	Kent
04500	Beech Haven	1	Kent	12610	Carter Development	1	Kent
05530	Berrytown	1	Kent	13070	Cedarbrook Acres	1	Kent
05760	Bethel	1	Kent	13910	Chapeltown	1	Kent
05850	Bethesda	1	Kent	13940	Chaplecroft	1	Kent
05880	Bicentennial Village	1	Kent	14370	Chestnut Grove	1	Kent
05910	Big Oak Corners	1	Kent	14660	Cheswold	1	Kent
05940	Big Pine	1	Kent	14760	Choptank Mills	1	Kent
05950	Big Stone Beach	1	Kent	15100	Church Hill Village	1	Kent
06240	Bishops Corner	1	Kent	15440	Clayton	1	Kent
06600	Blackiston	1	Kent	16410	Colmar Manor	1	Kent
07250	Bowers	1	Kent	18150	Cowgills Corner	1	Kent
07270	Bowers Beach	1	Kent	18820	Crossgates	1	Kent
08290	Breezewood	1	Kent	20250	Del Haven Estates	1	Kent
08420	Brenford	1	Kent	20540	Del Shire	1	Kent
08550	Briar Park	1	Kent	20575	Delshire-Hickory Dale	1	Kent
09460	Brookdale Heights	1	Kent	20610	Derby Shores	1	Kent
09490	Brookfield	1	Kent	21200	Dover	1	Kent
10210	Browns Corner	1	Kent	21290	Dover Air Force Base	1	Kent
10240	Brownsville	1	Kent	21355	Dover Base Hospital	1	Kent
10460	Burwood	1	Kent	21387	Dover Base Housing	1	Kent
10500	Bush Manor	1	Kent	21420	Doverbrook Gardens	1	Kent
10760	Camden	1	Kent	21550	Downs Chapel	1	Kent
10890	Camden-Wyoming (P.O. Name for Wyoming)	1	Kent	22040	Dupont	1	Kent

11150	Cannery	1	Kent	22070	Dupont Manor	1	Kent
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	***Place Code***	**FIPS55 Feature Name**	**County Code**	**County Name**
22230	Dutch Neck Crossroads	1	Kent	32500	Hammville	1	Kent
22360	East Lake Gardens	1	Kent	33120	Harrington	1	Kent
22460	Eastover Hills	1	Kent	33250	Hartly	1	Kent
22590	Eberton	1	Kent	33640	Hazlettville	1	Kent
22810	Eden Roc	1	Kent	34290	Hickman	1	Kent
22850	Edge Hill	1	Kent	34390	Hickory Dale Acres	1	Kent
22980	Edgehill Acres	1	Kent	34550	Hickory Ridge	1	Kent
23890	Edwardsville	1	Kent	34580	Hideaway Acres	1	Kent
24900	Everetts Corner	1	Kent	34810	Highland Acres	1	Kent
25450	Fairfield Farms	1	Kent	34940	Highland Acres	1	Kent
25680	Fairview	1	Kent	35460	Hilldale	1	Kent
25840	Farmington	1	Kent	35820	Hoars Addition	1	Kent
26620	Felton	1	Kent	35980	Hollandsville	1	Kent
26750	Felton Manor	1	Kent	36010	Holletts Corners	1	Kent
26780	Felton Station	1	Kent	36660	Hopkins Corners	1	Kent
27400	Fleming Corners	1	Kent	36730	Hourglass	1	Kent
27560	Florence	1	Kent	36760	Houston	1	Kent
27600	Fords Corner	1	Kent	36830	Hughes Crossroads	1	Kent
28240	Fox Hall	1	Kent	36890	Huntley	1	Kent
28260	Foxhall Courtside	1	Kent	38710	Kent Acres	1	Kent
28440	Frederica	1	Kent	38840	Kent Acres-south Dover Manor	1	Kent
28715	Garrisons Lake	1	Kent	39100	Kenton	1	Kent
28730	Garton Development	1	Kent	39880	Kitts Hummock	1	Kent
28930	Generals Greene	1	Kent	41335	Laurel Bend	1	Kent
30780	Green Briar	1	Kent	41385	Lawndale	1	Kent
31300	Greenview	1	Kent	41410	Layton Corners	1	Kent
31420	Greenville	1	Kent	41440	Lebanon	1	Kent

31425	Greenville	1	Kent	41700	Leipsic	1	Kent
32210	Hall Estates	1	Kent	42040	Lexington Mill	1	Kent
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
42870	Little Creek	1	Kent	56130	Petersburg	1	Kent
42900	Little Heaven	1	Kent	56390	Pickering Beach	1	Kent
42920	Little Heaven-High Point	1	Kent	56970	Pinewood	1	Kent
43200	Locustville	1	Kent	57300	Pleasanton Acres	1	Kent
43230	London Village	1	Kent	57690	Plymouth	1	Kent
43650	Lynch Heights	1	Kent	58470	Port Mahon	1	Kent
44260	McKnatt Corners	1	Kent	58760	Postles Corner	1	Kent
44430	Magnolia	1	Kent	58790	Powelton	1	Kent
44460	Mahan	1	Kent	60030	Reeves Crossing	1	Kent
45180	Marker Estates	1	Kent	60810	Richardson Circle	1	Kent
45340	Marvels Crossroads	1	Kent	60840	Richardson Estates	1	Kent
45470	Marydel	1	Kent	61200	Rising Sun	1	Kent
45730	Masten's Corner	1	Kent	61265	Rising Sun-Lebanon	1	Kent
45860	Mayfair	1	Kent	61480	Riverview	1	Kent
46280	Meadowbrook Acres	1	Kent	61720	Rodney Village	1	Kent
46660	Melvin Crossroads	1	Kent	61850	Rodric Village	1	Kent
46680	Melvins	1	Kent	61880	Roesville	1	Kent
46700	Melvins Crossroads	1	Kent	63570	Royal Grant	1	Kent
47420	Milford	1	Kent	63740	Sabarto East	1	Kent
48560	Minners Corners	1	Kent	63930	Sandtown	1	Kent
49310	Moores Corner	1	Kent	64010	Schoolview	1	Kent
49370	Morris Estates	1	Kent	64030	Schultie Crossroads	1	Kent
52620	Northwest Dover Heights	1	Kent	64090	Scrap Tavern Crossroads	1	Kent
53010	Oak Grove	1	Kent	64710	Seeneytown	1	Kent
54890	Paden Corner	1	Kent	64870	Seven Hickories	1	Kent
54930	Palmer Park	1	Kent	64970	Shady Lane	1	Kent

Place Code	FIPS55 Feature Name	County Code	County Name
55090	Paris Villa	1	Kent
55190	Pearson Grove	1	Kent
55700	Pennwood	1	Kent
65490	Sherwood	1	Kent
66950	Six Forks	1	Kent
67020	Slaughter	1	Kent
67250	Smith Crossroads	1	Kent
67310	Smyrna	1	Kent
67440	Smyrna Landing	1	Kent
67610	Somers Center	1	Kent
67830	South Bowers	1	Kent
67960	South Dover Acres	1	Kent
68020	Spring Hill	1	Kent
68050	Spruance City	1	Kent
68350	Star Hill	1	Kent
68415	Star Hill-Briar Park	1	Kent
68445	Star Hill Village	1	Kent
71080	Taylor Estates	1	Kent
71340	The Beeches	1	Kent
71370	The Blades	1	Kent
71500	The Hamlet	1	Kent
71860	Thompsonville	1	Kent
71990	Tidbury Manor	1	Kent
72380	Towne Point	1	Kent
72870	Turnkey	1	Kent
72960	Twin Eagle Farms	1	Kent
73940	Vernon	1	Kent
74330	Viola	1	Kent
74460	Voshell Cove	1	Kent
74480	Voshell Mill	1	Kent
75050	Wedgewood	1	Kent
76800	White Oak Farms	1	Kent
77060	Williamsville	1	Kent
77320	Willow Grove	1	Kent
79270	Woodbrook	1	Kent
79530	Woodcrest	1	Kent
80310	Woodland Beach	1	Kent
80700	Woods Haven	1	Kent
80830	Woodside	1	Kent
80895	Woodside East	1	Kent
81090	Woods Manor	1	Kent
81120	Woods Manor East	1	Kent
81310	Wrights Crossroads	1	Kent
81350	Wyoming (P.O. name Camden-Wyoming)	1	Kent

76600	Whigville	1	Kent
76630	White Hall	1	Kent
76645	Whitehall Crossroads	1	Kent
76670	Whiteleysburg	1	Kent

Place Code	FIPS55 Feature Name	County Code	County Name	Place Code	FIPS55 Feature Name	County Code	County Name
00095	Adams Crossroads	5	Sussex	09070	Broadkill	5	Sussex
00850	Anderson Crossroads	5	Sussex	09200	Broadkill Beach	5	Sussex
01140	Angola Beach	5	Sussex	10265	Bryan Park	5	Sussex
01170	Angola by the Bay	5	Sussex	10290	Bryans Store	5	Sussex
01270	Anna Acres	5	Sussex	10340	Bullseye	5	Sussex
01790	Argo Corners	5	Sussex	10370	Bunting	5	Sussex
02570	Atlanta	5	Sussex	11280	Cannon	5	Sussex
02700	Atlanta Estates	5	Sussex	13000	Cave Colony	5	Sussex
03220	Bacon	5	Sussex	14530	Chestnut Knoll	5	Sussex
03350	Bacons	5	Sussex	15150	Clarksons Crossroads	5	Sussex
03740	Bayard	5	Sussex	15180	Clarksville	5	Sussex
03870	Bay View Park	5	Sussex	16090	Cocked Hat	5	Sussex
04000	Bayville	5	Sussex	16380	Collins Pond Acres	5	Sussex
04030	Bay Vista	5	Sussex	16740	Columbia	5	Sussex
04390	Beaver Dam Heights	5	Sussex	16870	Concord	5	Sussex
05170	Belltown	5	Sussex	17390	Cool Spring	5	Sussex
05430	Bennum	5	Sussex	17420	Cool Spring Farms	5	Sussex
05690	Bethany Beach	5	Sussex	17650	Cottonpatch Hill	5	Sussex
05820	Bethel	5	Sussex	17750	Country Club Estates	5	Sussex
06630	Blackwater	5	Sussex	17910	Coverdale Crossroads	5	Sussex
06660	Blackwater Beach	5	Sussex	18560	Craigs Mill	5	Sussex
06730	Blades	5	Sussex	18850	Cross Keys	5	Sussex
06760	Blanchard	5	Sussex	18950	Dagsboro	5	Sussex
07190	Bottom Hills	5	Sussex	20380	Delmar	5	Sussex
07580	Branchview	5	Sussex	20900	Dewey Beach	5	Sussex
08680	Bridgeville	5	Sussex	21170	Douglas Forge	5	Sussex
08710	Bridgeville Manor	5	Sussex	21650	Drawbridge	5	Sussex
08810	Broad Acres	5	Sussex	21780	Dublin Hill	5	Sussex

08940	Broad Creek	5	Sussex	22400	Eastman Heights	5	Sussex
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
22490	East Side Village	5	Sussex	35750	Hitchens Crossroads	5	Sussex
23630	Edgewater Acres	5	Sussex	35890	Holiday Acres	5	Sussex
24020	Ellendale	5	Sussex	35950	Holiday Pines	5	Sussex
24930	Evergreen Acres	5	Sussex	36210	Hollymount	5	Sussex
25580	Fairmount	5	Sussex	36370	Holly Oak	5	Sussex
26520	Federalsburg	5	Sussex	36630	Hollyville	5	Sussex
26880	Fenwick Island	5	Sussex	36800	Hudson Pond Acres	5	Sussex
26940	Fernwood	5	Sussex	37280	Indian Beach	5	Sussex
27300	Five Points	5	Sussex	37500	Indian Mission	5	Sussex
27370	Flea Hill	5	Sussex	37540	Indian River	5	Sussex
27980	Fort Saulsbury	5	Sussex	37670	Indian River Acres	5	Sussex
28310	Frankford	5	Sussex	37730	Israel Haul	5	Sussex
29090	Georgetown	5	Sussex	37830	Jacobs Crossroads	5	Sussex
30060	Goslee Mill	5	Sussex	37900	Jefferson Crossroads	5	Sussex
30260	Gravel Hill	5	Sussex	38060	Jimtown	5	Sussex
30900	Green Hill	5	Sussex	38160	Johnson	5	Sussex
31040	Greentop	5	Sussex	38190	Johnson Corner	5	Sussex
31560	Greenwood	5	Sussex	38220	Johnstown	5	Sussex
31690	Gumboro	5	Sussex	38250	Jones Crossroads	5	Sussex
31700	Gum Crossroads	5	Sussex	38320	Keen-Wik	5	Sussex
32600	Harbeson (Broadkill)	5	Sussex	38580	Kenmore Park	5	Sussex
32730	Hardscrabble	5	Sussex	39490	Killens Addition	5	Sussex
33380	Haven Lake Acres	5	Sussex	39520	Kings Crossroads	5	Sussex
33740	Hearns Crossroads	5	Sussex	40040	Knowles Crossroads	5	Sussex
33770	Hearns Mill	5	Sussex	40270	Lake Pines	5	Sussex
33900	Henlopen Acres	5	Sussex	40295	Lake Shores	5	Sussex
34230	Heritage Village	5	Sussex	40320	Lakeside Manor	5	Sussex

34260	Herring Landing	5	Sussex	40345	Lakewood	5	Sussex
35070	Highland Acres	5	Sussex	40370	Lakewood	5	Sussex
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
41310	Laurel	5	Sussex	50470	Nanticoke Indian Tribe (SDAISA)	5	Sussex
41830	Lewes	5	Sussex	50540	Nassau	5	Sussex
41960	Lewes Beach	5	Sussex	51090	New Market	5	Sussex
42010	Lewes Naval Facility	5	Sussex	51840	North Seaford Heights	5	Sussex
42120	Lightfoots Furnace	5	Sussex	52100	North Shores	5	Sussex
42480	Lincoln (Lincoln City)	5	Sussex	52230	North Shores	5	Sussex
42610	Lincoln City (Lincoln)	5	Sussex	53270	Oak Grove	5	Sussex
43245	Long Neck	5	Sussex	53560	Oakley	5	Sussex
43365	Lowe	5	Sussex	53790	Oak Orchard	5	Sussex
43390	Lowes Crossroads	5	Sussex	53920	Ocean View	5	Sussex
44200	McDonalds Crossroads	5	Sussex	53950	Ocean Village	5	Sussex
45240	Marshtown	5	Sussex	54340	Old Furnace	5	Sussex
46220	Meadow Acres	5	Sussex	54400	Old Shawnee	5	Sussex
46770	Middleford	5	Sussex	54440	Omar	5	Sussex
46900	Middlesex Beach	5	Sussex	54540	Overbrook	5	Sussex
47090	Midnight Thicket	5	Sussex	54800	Owens	5	Sussex
47290	Midway	5	Sussex	54860	Oyster Rocks	5	Sussex
47320	Midway Park	5	Sussex	55815	Pepper	5	Sussex
47420	Milford	5	Sussex	55840	Pepperbox	5	Sussex
47810	Millpond Acres	5	Sussex	56260	Phillips Hill	5	Sussex
47940	Millsboro	5	Sussex	56650	Pilottown	5	Sussex
48200	Millville	5	Sussex	56780	Pinetown	5	Sussex
48330	Milton	5	Sussex	57040	Piney Grove	5	Sussex
48720	Mispillion Light	5	Sussex	57070	Piney Grove Manor	5	Sussex
48850	Mission	5	Sussex	58210	Ponders Siding	5	Sussex
49390	Morris Mill	5	Sussex	58730	Portsville	5	Sussex

49570	Mount Joy	5	Sussex	58990	Primehook Beach	5	Sussex
50410	Nanticoke Acres	5	Sussex	59020	Pusey Crossroads	5	Sussex
50440	Nanticoke Estates	5	Sussex	59120	Quakertown	5	Sussex
Place Code	**FIPS55 Feature Name**	**County Code**	**County Name**	**Place Code**	**FIPS55 Feature Name**	**County Code**	**County Name**
59480	Ralphs	5	Sussex	65540	Sherwood Acres	5	Sussex
59770	Redden	5	Sussex	65850	Shockley Manor	5	Sussex
59800	Redden Crossroads	5	Sussex	65880	Shortly	5	Sussex
60290	Rehoboth Beach	5	Sussex	66010	Shorts Beach	5	Sussex
60420	Rehoboth Manor	5	Sussex	66400	Silver Lake Shores	5	Sussex
60550	Reliance	5	Sussex	67050	Slaughter Beach	5	Sussex
60710	Reynolds Mill	5	Sussex	67180	Slaytonville	5	Sussex
60780	Richard Heights	5	Sussex	67280	Smith Hill	5	Sussex
61330	Riverdale	5	Sussex	67570	Snug Harbor	5	Sussex
61485	Riverview	5	Sussex	67700	South Bethany	5	Sussex
61510	Robbins	5	Sussex	68005	Springfield Crossroads	5	Sussex
61535	Robinsonville	5	Sussex	68070	Stanley Manor	5	Sussex
61980	Rogers Haven	5	Sussex	68480	Staytonville	5	Sussex
62500	Rosedale Beach	5	Sussex	68710	Stockley	5	Sussex
63280	Ross	5	Sussex	68740	Stockly	5	Sussex
63540	Roxana	5	Sussex	69390	Sussex Shores	5	Sussex
63770	Saint George	5	Sussex	69460	Swain Acres	5	Sussex
63850	Saint Johnstown	5	Sussex	69520	Swann Keys (Trailer Park)	5	Sussex
63900	Sand Hill	5	Sussex	70040	Sycamore	5	Sussex
63945	Sandy Brae	5	Sussex	71530	The Heath	5	Sussex
63960	Sandy Fork	5	Sussex	71600	The Island	5	Sussex
63975	Sandy Landing	5	Sussex	71700	The Oaks	5	Sussex
63990	Saulsbury Switch	5	Sussex	72740	Trinity	5	Sussex
64190	Seabreeze	5	Sussex	72800	Truitts Park	5	Sussex
64320	Seaford	5	Sussex	74520	Waples	5	Sussex

Place Code	FIPS55 Feature Name	County Code	County Name
64450	Seaford Heights	5	Sussex
64840	Selbyville	5	Sussex
65170	Shawnee	5	Sussex
65200	Shawnee Acres	5	Sussex
74540	Ward	5	Sussex
74560	Warwick	5	Sussex
74750	Waterview Acres	5	Sussex
74850	Webb Manor	5	Sussex
75240	Weisman Acres	5	Sussex
75450	Wescoats Corner	5	Sussex
75500	West Beach	5	Sussex
76555	Westwoods	5	Sussex
76570	Whaleys Corners	5	Sussex
76585	Whaleys Crossroads	5	Sussex
76900	White River Estates	5	Sussex
76915	Whites Creek	5	Sussex
76930	Whitesville	5	Sussex
77190	Williamsville	5	Sussex
79040	Wisseman Acres	5	Sussex
79240	Wood Branch	5	Sussex
80050	Woodenhawk	5	Sussex
80180	Woodland	5	Sussex
80430	Woodland Heights	5	Sussex
81480	York Beach	5	Sussex
81640	Zoar	5	Sussex

Appendix B.3

Agency Data Field Reference Tables

Agency Data Field Reference

BrM Fracture Critical Detail List

- Exposed Pre-Stressed Tendons
- Steel Bent Caps – tensile stress areas and connections
- One or Two Steel Girder Systems
- Single and Multi-Cell Steel Box Beams/Girders
- High-Strength Steel Girders
- Detail Prone Out-of-Plane Bending
- Hinges with Pin and Hanger Assembly
- Steel Tension Elements – with ≤ 3 multi I-bar trussing
- Tied Arches
- Super/Substructure Integral Frame Detail
- Electroslag Weld Fabrication Process
- Horizontally Curved Girders
- High Fatigue-Prone Weld Details
- Suspension or cable structures
- Steel trusses
- Partial in-weld cover plate
- Missing or broken off members
- No fracture critical details

<u>BrM Substructure Type List</u>

Pier 1 and Pier 2

<u>Material</u>

1. Timber
2. Steel
3. Reinforced Concrete (RC)
4. Concrete (C)
5. Pre-Stressed Concrete (PS)
6. Stone Masonry (SM)
9. Other

<u>Configuration</u>

1. Single Column
2. Hammerhead
3. Bent
4. Solid
5. Hollow

Abutment 1 and Abutment 2

1. Stub
2. Cantilever
3. Gravity Concrete
4. Gravity Stone Masonry
5. Counterfort
6. Integral
7. Cellular
8. Bulkhead

Pier 1 Footing, Pier 2 Footing, Abutment 1 Footing, and Abutment 2 Footing

A. Spread Footing
B. Cast-in-Place Concrete Piles (CIP P)
C. Pre-Cast Concrete Piles (PC P)
D. Pre-Stressed Concrete Piles (PS P)
E. Steel H-Piles
F. Steel Pipe (Monotubes)
G. Timber Piles
H. Caisson
J. Pedestals

Appendix B.4

NBI Deck Items Reference Table

TYPE OF STRUCTURE	Headwalls, Rails, or curbs that are attached to the structure and affect the flow of traffic	NBI Deck-Related Item to be Recorded or Coded										
		#51: Curb-to-Curb	#52: Deck Width: Out-to-Out	#58: Deck	#59: Super-structure	#60: Sub-structure	#62: Culvert	#107: Deck Type	#108a: Deck Wearing Surface type	#108b: Deck Membrane Type	#108c: Deck Protection Type	DECK AREA
Steel Beam Bridge (Includes Box Beam)	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Any Type of Thru-Truss	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Any Type of Deck-Truss	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Any Type of Thru-Arch	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Any Type of Deck-Arch (excluding filled arch)	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Filled Arch (R/C & Stone Masonry) (excluding "Arch-culverts")	N/A	Y	Y	N	Y	Y	N	N	N	N	N	Y
Covered Bridge	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Prestressed-Concrete MultipleBox Beams w/ A/C Overlay (assume deck is pre-cast concrete)	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Prestressed-Concrete MultipleBox Beams with R/C Deck	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Prestressed-Concrete I-Beams	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
R/C Concrete T-Beams	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Timber Slab	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Timber Beams or Stringer-Floor Beam Configuration	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
*Pipe Culvert: Steel, Plastic or Concrete	Y N	Y N	Y N	N N	N N	N N	Y Y	N N	N N	N N	N N	N N
*R/C Slab (without fill)	Y N	Y N	Y N	Y Y	Y Y	Y Y	N N	Y N	Y N	Y N	Y N	Y Y
*R/C Slab (with fill)	Y N	Y N	Y N	Y Y	Y Y	Y Y	N N	N N	N N	N N	N N	Y Y
*R/C Frame Culvert w/ No Fill	Y N	Y N	Y N	Y Y	Y Y	Y Y	N N	Y N	Y N	Y N	Y N	Y Y
*R/C Frame Culverts (Under Fill)	Y N	Y N	Y N	N N	N N	N N	Y Y	N N	N N	N N	N N	Y Y
*R/C Box Culvert with or without Fill	Y N	Y N	Y N	N N	N N	N N	Y Y	Y N	Y N	Y N	Y N	Y Y
Any kind of Movable bridge	N/A	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y

*** Note: For slabs, pipes, box culverts or frame culverts where the headwalls, rails or curbs are attached to the structure, but are separated from the shoulder or roadway on the bridge with grass, the coding for NBI Items #51 & 52 are subject to the inspectors' determination of whether or not they affect the flow of traffic. If the inspector is not sure, consult either the BIE.**

Appendix C. Reference Documents

Appendix C.1

National Bridge Inspection Standards

(23 CFR 650 C)

Code of Federal Regulations

Title 23: Highways

Chapter I: Federal Highway Administration, Department of Transportation

Subpart G: Engineering and Traffic Operations

Part 650: Bridges, Structures, and Hydraulics

Subpart C: National Bridge Inspection Standards

69 FR 74436, Dec. 14, 2004, unless otherwise noted.

§650.301 Purpose.

This subpart sets the national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151.

§650.303 Applicability.

The National Bridge Inspection Standards (NBIS) in this subpart apply to all structures defined as highway bridges located on all public roads.

§650.305 Definitions.

Terms used in this subpart are defined as follows:

American Association of State Highway and Transportation Officials (AASHTO) Manual. "The Manual for Bridge Evaluation," First Edition, 2008, published by the American Association of State Highway and Transportation Officials (incorporated by reference, *see* §650.317).

Bridge. A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge inspection experience. Active participation in bridge inspections in accordance with the NBIS, in either a field inspection, supervisory, or management role. A combination of bridge design, bridge maintenance, bridge construction and bridge inspection experience, with the predominant amount in bridge inspection, is acceptable.

Bridge inspection refresher training. The National Highway Institute "Bridge Inspection Refresher Training Course"[1] or other State, local, or federally developed instruction aimed to improve quality of inspections, introduce new techniques, and maintain the consistency of the inspection program.

[1]The National Highway Institute training may be found at the following URL: *http://www.nhi.fhwa.dot.gov./*

Bridge Inspector's Reference Manual (BIRM). A comprehensive FHWA manual on programs, procedures and techniques for inspecting and evaluating a variety of in-service highway bridges. This manual may be purchased from the U.S. Government Printing Office, Washington, DC 20402 and from National Technical Information Service, Springfield, Virginia 22161, and is available at the following URL: *http://www.fhwa.dot.gov/bridge/bripub.htm.*

Complex bridge. Movable, suspension, cable stayed, and other bridges with unusual characteristics.

Comprehensive bridge inspection training. Training that covers all aspects of bridge inspection and enables inspectors to relate conditions observed on a bridge to established criteria (see the Bridge Inspector's Reference Manual for the recommended material to be covered in a comprehensive training course).

Critical finding. A structural or safety related deficiency that requires immediate follow-up inspection or action.

Damage inspection. This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.

Fracture critical member (FCM). A steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.

Fracture critical member inspection. A hands-on inspection of a fracture critical member or member components that may include visual and other nondestructive evaluation.

Hands-on. Inspection within arms length of the component. Inspection uses visual techniques that may be supplemented by nondestructive testing.

Highway. The term "highway" is defined in 23 U.S.C. 101(a)(11).

In-depth inspection. A close-up, inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations.

Initial inspection. The first inspection of a bridge as it becomes a part of the bridge file to provide all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions.

Legal load. The maximum legal load for each vehicle configuration permitted by law for the State in which the bridge is located.

Load rating. The determination of the live load carrying capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection.

National Institute for Certification in Engineering Technologies (NICET). The NICET provides nationally applicable voluntary certification programs covering several broad engineering technology fields and a number of specialized subfields. For information on the NICET program certification contact: National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314-2794.

Operating rating. The maximum permissible live load to which the structure may be subjected for the load configuration used in the rating.

Professional engineer (PE). An individual, who has fulfilled education and experience requirements and passed rigorous exams that, under State licensure laws, permits them to offer engineering services directly to the public. Engineering licensure laws vary from State to State, but, in general, to become a PE an individual must be a graduate of an engineering program accredited by the Accreditation Board for Engineering and Technology, pass the Fundamentals of Engineering exam, gain four years of experience working under a PE, and pass the Principles of Practice of Engineering exam.

Program manager. The individual in charge of the program, that has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance.

Public road. The term “public road” is defined in 23 U.S.C. 101(a)(27).

Quality assurance (QA). The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program.

Quality control (QC). Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level.

Routine inspection. Regularly scheduled inspection consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge, to identify any changes from initial or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.

Routine permit load. A live load, which has a gross weight, axle weight or distance between axles not conforming with State statutes for legally configured vehicles, authorized for unlimited trips over an extended period of time to move alongside other heavy vehicles on a regular basis.

Scour. Erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges.

Scour critical bridge. A bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

Special inspection. An inspection scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency.

State transportation department. The term “State transportation department” is defined in 23 U.S.C. 101(a)(34).

Team leader. Individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge.

Underwater diver bridge inspection training. Training that covers all aspects of underwater bridge inspection and enables inspectors to relate the conditions of underwater bridge elements to established criteria (see the Bridge Inspector's Reference Manual section on underwater inspection for the recommended material to be covered in an underwater diver bridge inspection training course).

Underwater inspection. Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.

[69 FR 74436, Dec. 14, 2004, as amended at 74 FR 68379, Dec. 24, 2009]

§650.307 Bridge inspection organization.

(a) Each State transportation department must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the State's boundaries, except for bridges that are owned by Federal agencies.

(b) Federal agencies must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the respective agency responsibility or jurisdiction.

(c) Each State transportation department or Federal agency must include a bridge inspection organization that is responsible for the following:

(1) Statewide or Federal agencywide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory.

(2) Bridge inspections, reports, load ratings and other requirements of these standards.

(d) Functions identified in paragraphs (c)(1) and (2) of this section may be delegated, but such delegation does not relieve the State transportation department or Federal agency of any of its responsibilities under this subpart.

(e) The State transportation department or Federal agency bridge inspection organization must have a program manager with the qualifications defined in §650.309(a), who has been delegated responsibility for paragraphs (c)(1) and (2) of this section.

§650.309 Qualifications of personnel.

(a) A program manager must, at a minimum:

(1) Be a registered professional engineer, or have ten years bridge inspection experience; and

(2) Successfully complete a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course.

(b) There are five ways to qualify as a team leader. A team leader must, at a minimum:

(1) Have the qualifications specified in paragraph (a) of this section; or

(2) Have five years bridge inspection experience and have successfully completed an FHWA approved comprehensive bridge inspection training course; or

(3) Be certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET) and have successfully completed an FHWA approved comprehensive bridge inspection training course, or

(4) Have all of the following:

(i) A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;

(ii) Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;

(iii) Two years of bridge inspection experience; and

(iv) Successfully completed an FHWA approved comprehensive bridge inspection training course, or

(5) Have all of the following:

(i) An associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;

(ii) Four years of bridge inspection experience; and

(iii) Successfully completed an FHWA approved comprehensive bridge inspection training course.

(c) The individual charged with the overall responsibility for load rating bridges must be a registered professional engineer.

(d) An underwater bridge inspection diver must complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course.

§650.311 Inspection frequency.

(a) *Routine inspections.* (1) Inspect each bridge at regular intervals not to exceed twenty-four months.

(2) Certain bridges require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these bridges are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(3) Certain bridges may be inspected at greater than twenty-four month intervals, not to exceed forty-eight-months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(b) *Underwater inspections.* (1) Inspect underwater structural elements at regular intervals not to exceed sixty months.

(2) Certain underwater structural elements require inspection at less than sixty-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as construction material, environment, age, scour characteristics, condition rating from past inspections and known deficiencies.

(3) Certain underwater structural elements may be inspected at greater than sixty-month intervals, not to exceed seventy-two months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(c) *Fracture critical member (FCM) inspections.* (1) Inspect FCMs at intervals not to exceed twenty-four months.

(2) Certain FCMs require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(d) Damage, in-depth, and special inspections. Establish criteria to determine the level and frequency of these inspections.

§650.313 Inspection procedures.

(a) Inspect each bridge in accordance with the inspection procedures in the AASHTO Manual (incorporated by reference, *see* §650.317).

(b) Provide at least one team leader, who meets the minimum qualifications stated in §650.309, at the bridge at all times during each initial, routine, in-depth, fracture critical member and underwater inspection.

(c) Rate each bridge as to its safe load-carrying capacity in accordance with the AASHTO Manual (incorporated by reference, *see* §650.317). Post or restrict the bridge in accordance with the AASHTO Manual or in accordance with State law, when the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating or equivalent rating factor.

(d) Prepare bridge files as described in the AASHTO Manual (incorporated by reference, *see* §650.317). Maintain reports on the results of bridge inspections together with notations of any action taken to address the findings of such inspections. Maintain relevant maintenance and inspection data to allow assessment of current bridge condition. Record the findings and results of bridge inspections on standard State or Federal agency forms.

(e) Identify bridges with FCMs, bridges requiring underwater inspection, and bridges that are scour critical.

(1) Bridges with fracture critical members. In the inspection records, identify the location of FCMs and describe the FCM inspection frequency and procedures. Inspect FCMs according to these procedures.

(2) Bridges requiring underwater inspections. Identify the location of underwater elements and include a description of the underwater elements, the inspection frequency and the procedures in the inspection records for each bridge requiring underwater inspection. Inspect those elements requiring underwater inspections according to these procedures.

(3) Bridges that are scour critical. Prepare a plan of action to monitor known and potential deficiencies and to address critical findings. Monitor bridges that are scour critical in accordance with the plan.

(f) *Complex bridges.* Identify specialized inspection procedures, and additional inspector training and experience required to inspect complex bridges. Inspect complex bridges according to those procedures.

(g) *Quality control and quality assurance.* Assure systematic quality control (QC) and quality assurance (QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program. Include periodic field review of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations.

(h) *Follow-up on critical findings.* Establish a statewide or Federal agency wide procedure to assure that critical findings are addressed in a timely manner. Periodically notify the FHWA of the actions taken to resolve or monitor critical findings.

§650.315 Inventory.

(a) Each State or Federal agency must prepare and maintain an inventory of all bridges subject to the NBIS. Certain Structure Inventory and Appraisal (SI&A) data must be collected and retained by the State or Federal agency for collection by the FHWA as requested. A tabulation of this data is contained in the SI&A sheet distributed by the FHWA as part of the “Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges,” (December 1995) together with subsequent interim changes or the most recent version. Report the data using FHWA established procedures as outlined in the “Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.”

(b) For routine, in-depth, fracture critical member, underwater, damage and special inspections enter the SI&A data into the State or Federal agency inventory within 90 days of the date of inspection for State or Federal agency bridges and within 180 days of the date of inspection for all other bridges.

(c) For existing bridge modifications that alter previously recorded data and for new bridges, enter the SI&A data into the State or Federal agency inventory within 90 days after the completion of the work for State or Federal agency bridges and within 180 days after the completion of the work for all other bridges.

(d) For changes in load restriction or closure status, enter the SI&A data into the State or Federal agency inventory within 90 days after the change in status of the structure for State or Federal agency bridges and within 180 days after the change in status of the structure for all other bridges.

§650.317 Reference manuals.

(a) The materials listed in this subpart are incorporated by reference in the corresponding sections noted. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval, and notice of any change in these documents will be published in the FEDERAL REGISTER. The materials are available for purchase at the address listed below, and are available for inspection at the National Archives and Records Administration (NARA). These materials may also be reviewed at the Department of Transportation Library, 1200 New Jersey Avenue, SE., Washington, DC 20590, (202) 366-0761. For information on the availability of these materials at NARA call (202) 741-6030, or go to the following URL: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* In the event there is a conflict between the standards in this subpart and any of these materials, the standards in this subpart will apply.

(b) The following materials are available for purchase from the American Association of State Highway and Transportation Officials, Suite 249, 444 N. Capitol Street, NW., Washington, DC 20001, (202) 624-5800. The materials may also be ordered via the AASHTO bookstore located at the following URL: *http://www.transportation.org.*

(1) The Manual for Bridge Evaluation, First Edition, 2008, AASHTO, incorporation by reference approved for §§650.305 and 650.313.

(2) [Reserved]

[74 FR 68379, Dec. 24, 2009]

Appendix C.2

Inspection Requirements for Bridge Owners

(DE Code Title 17, Section 529)

Delaware Code

Title 17: Highways

Chapter 5: Highways, Roads, and Bridges Generally

July 20, 1999

§ 529 Inspection requirements for bridge owners.

(a) As used herein, the terms "bridge" and "bridge with approaches" are defined as structures, including supports, erected over a depression or an obstruction such as water, a highway or a railway, with tracks or passageways for carrying traffic or other moving loads, and with openings measured along the center of the roadway of more than 20 feet (6.1 meters) between undercopings of abutments or spring lines of arches, or the extreme ends of openings for multiple boxes. The term "bridge" shall also include multiple pipe structures where the clear distance between pipe openings is less than half of the smaller pipe diameter(s), and the combined structure exceeds 20 feet (6.1 meters) in total span length.

(b) All bridges and bridges with approaches located on or over public roads must be inspected in accordance with The National Bridge Inspection Standards, as codified in 23 C.F.R. Part 650, Subpart C, as amended, and in accordance with the following provisions:

(1) Such inspections shall be the responsibility of the bridge owner.

(2) The inspections shall be performed by qualified personnel not less frequently than every 2 years, based on the bridge condition and on the schedule set by the Department of Transportation.

(3) Inspection information must be collected, maintained and be available for review as required by the Federal Highway Administration's Recording and Coding Guide for Structure Inventory and Appraisal of the Nation's Bridge.

(4) If the bridge owner does not perform the required inspection on the schedule approved by the Department of Transportation, the Department shall notify the bridge owner and give the bridge owner 60 days to produce the required inspection report.

(5) If the bridge owner fails to produce the required inspection report after notice pursuant to subsection (b)(4) of this section, the Department shall be empowered to take the following enforcement actions:

a. Perform the inspection, the costs of which shall be borne by the bridge owner. The Department shall have the right to enter the property to perform such inspections, regardless of the ownership of the property; or

b. Close the bridge.

Appendix C.3

FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges with DelDOT Commentary

C-17

U.S. Department
of Transportation
Federal Highway Administration

Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges

Report No. FHWA-PD-96-001

Office of Engineering
Bridge Division

December 1995

FOREWORD

The Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Guide) has been revised several times in the past. This latest edition revises the Guide to convert all of the units of measurement to the International System of Units. This revised Guide represents several years of effort by the Federal Highway Administration with the States' cooperation and comments, both individually and through the AASHTO Subcommittee on Bridges and Structures.

Initial distribution of the Guide is being made directly to each FHWA field office for distribution to the States. Additional copies are available from the Bridge Management Branch (HNG-33) of the FHWA Bridge Division.

William A. Weseman, Director
Office of Engineering

Under the Paper Work Reduction Act and CFR 1320 the Structure Inventory and Appraisal Sheet reporting requirements have been cleared by OMB under 2125-0501.

RECORDING AND CODING GUIDE FOR THE STRUCTURE INVENTORY AND APPRAISAL OF THE NATION'S BRIDGES

Report No. FHWA-PD-96-001

U.S. Department of Transportation

Federal Highway Administration

Prepared by

Office of Engineering
Bridge Division
Bridge Management Branch
Washington, D.C. 20590

December 1995

TABLE OF CONTENTS

INTRODUCTION

The Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, hereafter referred to as the Guide, has been revised several times in the past. This latest edition revises the Guide to convert all of the units of measurement to the International System of Units (SI). It also provides more thorough and detailed guidance in evaluating and coding specific bridge data. New items have been added to include the reporting of Federal Lands Highway Systems, each State's existing linear referencing system (LRS), and the method used to determine the load ratings. Some items in the Guide have also been expanded to provide more definitive and explicit explanations and instructions for coding. Further, more basic definitions applicable to the instructions in the Guide are provided. The changes are based on comments received on the previous Guide and the metric version (January 1994) draft Guide. This revised Guide should be thoroughly reviewed by each individual involved with the National Bridge Inspection Program.

This Guide has been prepared for use by the States, Federal and other agencies in recording and coding the data elements that will comprise the National Bridge Inventory data base. By having a complete and thorough inventory, an accurate report can be made to the Congress on the number and state of the Nation's bridges. The Guide also provides the data necessary for the Federal Highway Administration (FHWA) and the Military Traffic Management Command to identify and classify the Strategic Highway Corridor Network and it's connectors for defense purposes.

The coded items in this Guide are considered to be an integral part of the data base that can be used to meet several Federal reporting requirements, as well as part of the States' needs. These requirements are set forth in the National Bridge Inspection Standards (23 CFR 650.3) which are included as Appendix C. A complete, thorough, accurate, and compatible data base is the foundation of an effective bridge management system. Reports submitted in connection with the Highway Bridge Replacement and Rehabilitation Program and the National Bridge Inspection Program also are related to this Guide.

The AASHTO Manual for Condition Evaluation of Bridges discusses the various items of information that are to be recorded as part of original bridge reports. That manual and the Bridge Inspector's Training Manual/90, with supplements, discuss inspection procedures and the preparation of detailed reports about the structure components. These reports will be the basis for recording values for many of the data elements shown in the Guide, particularly those having to do with the condition or the appraisal ratings.

Some bridge owners are collecting bridge condition ratings for items included in this Guide (Items 58-Deck, 59-Superstructure, 60-Substructure, and 62-Culvere) using the American Association of

Highway and Transportation Officials' (AASHTO) Guide for Commonly Recognized (CoRe) Structural Elements. CoRe element inspection ratings provide detailed condition assessments that can serve as input into a comprehensive bridge management system (BMS). The FHWA has provided bridge owners with a computer program for translating bridge condition data in the CoRe element format to National Bridge Inventory (NBI) condition ratings for the purpose of NBI data submittal to FHWA. The purpose of the program is to permit bridge inspectors to record condition information in a format that satisfies both BMS and NBI data collection requirements.

The Structure Inventory and Appraisal (SI&A) Sheet and the sufficiency rating formula, with examples, are included as Appendices A and B, respectively. The SI&A sheet is intended to be a tabulation of the pertinent elements of information about an individual structure. Its use is optional, subject to the statements in the preceding paragraph of this Introduction. It is important to note that the SI&A Sheet is not an inspection form but merely a summary sheet of bridge data required by the FHWA to effectively monitor and manage a National bridge program.

States, Federal and other agencies are encouraged to use the codes and instructions in this Guide. However, its direct use is optional; each agency may use its own code scheme provided that the data are directly translatable into the Guide format. When data are requested by FHWA, the format will be based on the codes and instructions in this Guide. An agency choosing to use its own codes shall provide for translation or conversion of its own codes into those used in the Guide. In other words, agencies are responsible for having the capability to obtain, store, and report certain information about bridges whether or not this Guide or the SI&A Sheet is used. Any requests by the FHWA for submittals of these data will be based on the definitions, explanations, and codes supplied in the Guide, the AASHTO Manual for Condition Evaluation of Bridges and the Bridge Inspector's Training Manual/90 plus supplements.

The values provided in the tables or otherwise listed in this Guide are for rating purposes only. Current design standards must be used for structure design or rehabilitation. All possible combinations of actual site characteristics are not provided in this Guide. If a special situation not listed in the Guide is encountered, the evaluation criteria closest to the actual site situation should be used.

The implementation of this Guide may require some restructuring of an agency's data base and support software. If so, it is suggested that the agency consider the additional enhancements that would be necessary to support a bridge management system.

Appendix D is a Commentary that compares, item by item, the 1988 Guide to this Guide. The Commentary will provide a ready reference for item changes.

DEFINITION OF TERMS

The definitions of terms used in the Guide are provided below.

(1) Bridge. The National Bridge Inspection Standards published in the Code of Federal Regulations (23 CFR 650.3) give the following definition:

A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet* between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

* (6.1 meters)

(b) Culvert. A structure designed hydraulically to take advantage of submergence to increase hydraulic capacity. Culverts, as distinguished from bridges, are usually covered with embankment and are composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert. Culverts may qualify to be considered "bridge" length.

(c) Inventory Route. The route for which the applicable inventory data is to be recorded. The inventory route may be on the structure or under the structure. Generally inventories along a route are made from west to east and south to north.

(d) National Bridge Inventory (NBI). The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Bridge Inspection Standards. Each State shall prepare and maintain an inventory of all bridges subject to the NBIS.

(e) National Bridge Inventory (NBI) Record. Data which has been coded according to the Guide for each structure carrying highway traffic or each inventory route which goes under a structure. These data are furnished and stored in a compact alphanumeric format on magnetic tapes or disks suitable for electronic data processing.

(f) National Bridge Inspection Standards (NBIS). Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a State bridge inventory. The NBIS apply to all structures defined as bridges located on all public roads.

(g) Public Road. Any road under the jurisdiction of and maintained by a public authority and open to public travel.

(h) Structure Inventory and Appraisal (SI&A) Sheet. The graphic representation of the data recorded and stored for each NBI record in accordance with this Guide.

(i) Strategic Highway Corridor Network (STRAHNET). A system of highways which are strategically important to the defense of the United States. It includes the Interstate Highways and 25,215 kilometers of other non-interstate highways. The Military Traffic Management Command Report SE 89-4b-27, Strategic Highway Corridor Network, January 1991, contains additional information on STRAHNET.

(j) STRAHNET Connectors are roads that connect military installations and ports of embarkation to the STRAHNET. The connector routes represent about 3,042 kilometers of roads that complement STRAHNET.

(k) Indian Reservation Road (IRR). A public road that is located within or provides access to an Indian reservation as described in Title 23, U.S.C., Sect.101. The terminus of a road providing access to an Indian reservation or other Indian land is defined as the point at which the road intersects with a road functionally classified as a collector or higher classification (outside the reservation boundary) in both urban and rural areas. In the case of access from an Interstate Highway, the terminus is the first interchange outside the reservation.

(l) Land Management Highway System (LMHS). Consists of adjoining state and local public roads that provide major public access to Bureau of Land Management administered public lands, resources, and facilities.

(m) Forest Highway (FH). A road, under the jurisdiction of, and maintained by, a public authority and open to public travel; wholly or partly within, or adjacent to, and serving the National Forest System (NFS) and which is necessary for the protection, administration, and utilization of the NFS and the use and development of its resources. (23 CFR 660).

(n) Forest Service Development Road. A forest road wholly under the jurisdiction of the Forest Service, which may be "open to public travel". Bridges on Forest Service Development Roads which are "open to public travel" are subject to the NBIS.

(o) Base Highway Network. The Base Highway Network includes the through lane (mainline) portions of the NHS, rural/urban principal arterial system and rural minor arterial system. Ramps, frontage roads and other roadways are not included in the Base Network.

(p) Highway Performance Monitoring System. The Highway Performance Monitoring System (HPMS) is a database of universe and sample data that describes the nation's public road mileage. The data are annually updated and submitted to FHWA by the State Highway Agencies, Puerto Rico and the District of Columbia. The universe data provides some basic characteristics of all public road mileage while the sample of the arterial and collector systems allows for assessment of the condition, performance, usage and additional characteristics of the nation's major highway systems.

(q) Conversion of Numerical Data. Throughout this Guide the following conversion factors are used:

Convert - foot to meter multiply by 0.3048
- mile to kilometer multiply by 1.609
- english ton to metric ton multiply by .9

(r) Rounding and Truncating of Numerical Data. All numeral values in this Guide, except as specifically noted, will follow standard rounding criteria, that is, 5 and above will be rounded up to the next higher unit and 4 and below will be rounded down to the next lower unit. This is applicable to all decimal roundings. In certain items where rounding may cause a safety hazard for clearance, the numeric measurements will be truncated at the appropriate decimal place. This means that a fractional portion less than a whole unit will be dropped to the lower whole number, for example 2.88 would be truncated to 2.8 when using tenth of a meter accuracy. All decimal points are assumed in the locations as specified in the Guide.

(s) Commonly Recognized (CoRe) Structural Elements). A group of structural elements endorsed by AASHTO as a means of providing a uniform basis for data collection for any bridge management system, to enable the sharing of data between States, and to allow for a uniform translation of data to NBI Items 58, 59, 60 and 62.

(t) Bridge management System (BMS). A system designed to optimize the use of available resources for the inspection, maintenance, rehabilitation and replacement of bridges.

General Notes

DelDOT-specific comments have been included in red and bold throughout this guide to aid Delaware inspectors. No content published by FHWA was intended to be altered in the inclusion of these comments. In the event of a discrepancy between this manual's NBI coding and FHWA's original document, the FHWA Coding Guide shall govern.

This edition of the FHWA Recording and Coding Guide is presented in metric units; however, DelDOT utilizes US customary units. Where applicable notes have been provided to aid in coding NBI items involving units of measure.

If an Inspection Team Leader or Team Member is unsure of the coding of an NBI item, please direct questions to the Bridge Inspection Engineer (BIE). The BIE will investigate the request and respond in a reasonable time frame.

DelDOT utilizes RIMS, Geomedia, Inform, and video logging for collecting and logging various Inventory NBI information. DelDOT staff generally performs the Inventory inspection and populates the related NBI data in-house; therefore, information and work pertaining to these programs will be completed in-house.

DATA ITEMS

Item 1 - State Code 3 digits

The first 2 digits are the Federal Information Processing Standards (FIPS) code for States, and the third digit is the FHWA region code. (New Jersey and New York will retain an FHWA region code of 2.)

Code	State	Code	State
014	Alabama	308	Montana
020	Alaska	317	Nebraska
049	Arizona	329	Nevada
056	Arkansas	331	New Hampshire
069	California	342	New Jersey
088	Colorado	356	New Mexico
091	Connecticut	362	New York
103	Delaware	374	North Carolina
113	District of Columbia	388	North Dakota
124	Florida	395	Ohio
134	Georgia	406	Oklahoma
159	Hawaii	410	Oregon
160	Idaho	423	Pennsylvania
175	Illinois	441	Rhode Island
185	Indiana	454	South Carolina
197	Iowa	468	South Dakota
207	Kansas	474	Tennessee
214	Kentucky	486	Texas
226	Louisiana	498	Utah
231	Maine	501	Vermont
243	Maryland	513	Virginia
251	Massachusetts	530	Washington
265	Michigan	543	West Virginia
275	Minnesota	555	Wisconsin
284	Mississippi	568	Wyoming
297	Missouri	721	Puerto Rico

Item 2 - Highway Agency District 2 digits

The highway agency district (State or Federal) in which the bridge is located shall be represented by a 2-digit code. Existing district numbers shall be used where districts are identified by number. Where districts are identified by name, a code number shall be assigned based on an alphabetical or organizational listing of the districts.

Resource Location: Appendix XX of the DelDOT Bridge Inspection Manual: District Boundary Maps

Code	District
01	North
02	Central
03	South
04	Canal

Item 3 - County (Parish) Code 3 digits

Counties shall be identified using the Federal Information Processing Standards (FIPS) codes given in the current version of the Census of Population and Housing - Geographic Identification Code Scheme.

Resource Location: ADC Map (Contact BIE for bridges located on boarders)

Code	District
001	Kent
002	New Castle
003	Sussex

Item 4 - Place Code 5 digits

Cities, towns, townships, villages, and other census-designated places shall be identified using the Federal Information Processing Standards (FIPS) codes given in the current version of the Census of Population and Housing - Geographic Identification Code Scheme. If there is no FIPS place code, then code all zeros.

Resource Location: Appendix XX of the DelDOT Bridge Inspection Manual: FIPS Place Codes in conjunction with ADC Map.

Start with the nearest neighborhood or land feature and work away from the structure until landing on the proper place code. If a structure is located within a town or city limits, the place code for the structure is the corresponding code for that town or city.

Item 5 - Inventory Route 9 digits

The inventory route is a 9-digit code composed of 5 segments.

Segment	Description	Length
5A	Record Type	1 digit
5B	Route Signing Prefix	1 digit
5C	Designated Level of Service	1 digit
5D	Route Number	5 digits
5E	Directional Suffix	1 digit

Item 5A - Record Type 1 digit

There are two types of National Bridge Inventory records: "on" and "under". Code the first digit (leftmost) using one of the following codes:

Code	Description
1	Route carried "on" the structure
2	Single route goes "under" the structure
A through Z	Multiple routes go "under" the structure

A signifies the first of multiple routes under the structure.
B signifies the second of multiple routes under the structure.
Z signifies 26 routes under the structure.

Item 5A - Record Type (cont'd)

"On" signifies that the inventory route is carried "on" the structure. Each bridge structure carrying highway traffic must have a record identified with a type code = 1 (numeric). All of the NBI data items must be coded, unless specifically excepted, with respect to the structure and the inventory route "on" it.

"Under" signifies that the inventory route goes "under" the structure. If an inventory route beneath the structure is a Federal-aid highway, is a STRAHNET route or connector or is otherwise important, a record must be coded to identify it. The type code must be 2 or an alphabetic letter A through Z. Code 2 for a single route under the structure. If 2 or more routes go under a structure on separate roadways, the code of 2 shall not be used. Code A, B, C, D, etc. consecutively for multiple routes on separate roadways under the same structure. STRAHNET routes shall be listed first. When this item is coded 2 or A through Z, only the following items must be coded: Items 1, 3-13, 16, 17, 19, 20, 26-30, 42, 43, 47-49, 100-104, 109 and 110. All other items may remain blank.

It cannot be overemphasized that all route-oriented data must agree with the coding as to whether the inventory route is "on" or "under" the structure.

Tunnels shall be coded only as an "under" record; that is, they shall not be coded as a structure carrying highway traffic.

There are situations of a route "under" a structure, where the structure does not carry a highway, but may carry a railroad, pedestrian traffic, or even a building. These are coded the same as any other "under" record and no "on" record shall be coded.

Resource Location: Field inspection or RIMS (Response Information management System) in conjunction with past inspection photos and ADC Map

If the under record is a dual highway (I-95N/S or US-13N/S) and the functional class is the same for each direction, that is considered a single route (Item 5A = 2). If the functional class is different for the two directions, that is considered multiple routes (Item 5A = A-Z)

Item 5B - Route Signing Prefix 1 digit

In the second position, identify the route signing prefix for the inventory route using one of the following codes:

Code	Description
1	Interstate highway
2	U.S. numbered highway
3	State highway
4	County highway
5	City street
6	Federal lands road
7	State lands road
8	Other (include toll roads not otherwise indicated or identified above)

Item 5B - Route Signing Prefix (cont'd)

When 2 or more routes are concurrent, the highest class of route will be used. The hierarchy is in the order listed above.

Resource Location: RIMS

Subdivisions: code 5
Park roads with a maintenance road number: code 4
Park roads without a maintenance road number: code 7
On/Under records for bridges in a service plaza: code 8
Unclassified frontage road or shopping plaza: code 8

Item 5C - Designated Level of Service 1 digit

In the third position, identify the designated level of service for the inventory route using one of the following codes:

Code	Description
0	None of the below
1	Mainline
2	Alternate
3	Bypass
4	Spur
6	Business
7	Ramp, Wye, Connector, etc.
8	Service and/or unclassified frontage road

Resource Location: ADC Map

City streets, subdivisions, and park roads: code 1
Service plaza, unclassified frontage road, and shopping plaza: code 8

Item 5D - Route Number 5 digits

Code the route number of the inventory route in the next 5 positions. This value shall be right justified in the field with leading zeros filled in. (See examples below.)

If concurrent routes are of the same hierarchy level, denoted by the route signing prefix, the lowest numbered route shall be coded. Code 00000 for bridges on roads without route numbers.

Resource Location: RIMS

Item 5E - Directional Suffix 1 digit

In the last position, code the directional suffix to the route number of the inventory route when it is part of the route number, using one of the following codes:

Code	Description
0	Not applicable
1	North
2	East
3	South
4	West

In some cases, letters may be used with route numbers and as part of the route numbers and not to indicate direction. In such cases, the letter should be included in the 5-position route number field.

EXAMPLES:	Record	Code
Interstate 95, on	1 1 1 00095 0	111000950
Interstate 70S, under	2 1 1 00070 3	211000703
State Highway 104, Spur, under	2 3 4 00104 0	234001040
U.S. 30E Bypass, on	1 2 3 00030 2	123000302
City street, on	1 5 0 00000 0	150000000
Ramp from I-81, under	2 1 7 00081 0	217000810
County Highway 173 on	1 4 1 00173 0	141001730
Interstate 84 under	2 1 1 00084 0	211000840
Interstate 495 on	1 1 1 00495 0	111004950
State Hwy 120 (STRAHNET Rte) under	A 3 1 00120 0	A31001200
Alternate State Hwy 130 under	B 3 2 00130 0	B32001300
Tunnel on Interstate 70	2 1 1 00070 0	211000700

Item 6 - Features Intersected 25 digits

This item contains a description of the features intersected by the structure and a critical facility indicator. When Item 5A indicates an "under" record, this item describes the inventory route and/or features under the structure. There are 25 digits divided into 2 segments.

Segment	Description	Length
6A	Features Intersected	24 digits
6B	No Longer Coded (Blank)	1 digit

Item 6 - Features Intersected (cont'd)

The information to be recorded for this item in the first 24 digits shall be the name or names of the features intersected by the structure. When one of the features intersected is another highway, the signed number or name of the highway shall appear first (leftmost) in the field. The names of any other features shall follow, separated by a semicolon or a comma. Parentheses shall be used to provide a second identification of the same feature (see third example). Abbreviations may be used where necessary, but an effort shall be made to keep them meaningful. The data in this segment shall be left justified in the first 24 positions without trailing zeros.

EXAMPLES:

I 81, US 51, MILL ROAD
MISSISSIPPI RIVER
SR 42 (POND ROAD)

Resource Location: ADC Map or RIMS

Item 7 - Facility Carried by Structure 18 digits

The facility being carried by the structure shall be recorded and coded. In all situations this item describes the use "on" the structure. This item shall be left justified without trailing zeros.

EXAMPLES:

US 66
MAIN STREET
COUNTY ROAD 450
C & O RAILROAD (appropriate for "under" record only)
PEDESTRIAN BRIDGE (appropriate for "under" record only)

Resource Location: ADC Map or RIMS

Item 8 - Structure Number 15 digits

It is required that the official structure number be recorded. It is not necessary to code this number according to an arbitrary national standard. Each agency should code the structure number according to its own internal processing procedures. When recording and coding for this item and following items, any structure or structures with a closed median should be considered as one structure, not two. Closed medians may have either mountable or non-mountable curbs or barriers.

The structure number must be unique for each bridge within the State, and once established should preferably never change for the life of the bridge. If it is essential that structure number(s) must be changed, all 15 digits are to be filled. For any structure number changes, a complete cross reference of corresponding "old" and "new" numbers must be provided to the FHWA Bridge Division. The cross reference shall include both a computer tape or diskette and a printed listing in the FHWA required format.

The identical structure number must appear on the "on" and all "under" records associated with a particular structure. (Refer to Item 5 - Inventory Route).

Item 9 - Location 25 digits

This item contains a narrative description of the bridge location. It is recommended that the location be keyed to a distinguishable feature on an official highway department map such as road junctions and topographical features. This item shall be left justified without trailing zeros.

EXAMPLES:

6 km SW. OF RICHMOND
3.5 km S. OF JCT. SR 69

Resource Location: ADC Map

Item 10 - Inventory Route, Minimum Vertical Clearance (XX.XX meters) 4 digits

Code the minimum vertical clearance over the inventory route identified in Item 5, whether the route is "on" the structure or "under" the structure. The minimum clearance for a 3-meter width of the pavement or traveled part of the roadway where the clearance is the greatest shall be recorded and coded as a 4-digit number truncated to the hundredth of a meter (with an assumed decimal point). For structures having multiple openings, clearance for each opening shall be recorded, but only the greatest of the "minimum clearances" for the two or more openings shall be coded regardless of the direction of travel. This would be the practical maximum clearance. When no restriction exists or when the restriction is 30 meters or greater, code 9999. Coding of actual clearances between 30.0 and 99.99 meters to an exact measurement is optional.

Resource Location: Field measurement

Units: XX.XXX feet

Measurement is to be taken from the edge of each lane at both faces of the bridge. All measurements will appear in the Underclearance Sketch Sheet. The minimum measurement will be coded here.

Item 11 - Kilometerpoint (XXXX.XXX) 7 digits

The linear referencing system (LRS) kilometerpoint is used to establish the location of the bridge on the Base Highway Network (see Item 12). It must be from the same LRS Inventory Route and kilometerpoint system as reported in the Highway Performance Monitoring System (HPMS). The kilometerpoint coded in this item directly relates to Item 13 - LRS Inventory Route, Subroute Number.

This item must be coded for all structures located on or overpassing the Base Highway Network. Code a 7-digit number to represent the LRS kilometer-point distance in kilometers to the nearest thousandth (with an assumed decimal point). For structures carrying the LRS Inventory Route, code the kilometerpoint at the beginning of the structure (i.e. the lowest kilometer-point on the bridge). When the LRS Inventory Route goes under the structure (Item 5A coded 2 or A-Z), then code the kilometerpoint on the underpassing route where the structure is first encountered.

Item 11 – Kilometerpoint (cont'd)

Code all zeros in this field for all records where kilometerpoints are not provided. Kilometerpoints may be coded for bridges that are not located on the Base Highway Network, however Item 12 - Base Highway Network shall be coded 0 for these records.

The kilometerpoint is coded aligned to the assumed decimal point and zero filled where needed to fill the 7 digits.

EXAMPLES:	Code
Kilometerpoint is 130.34	0130340
Kilometerpoint is 9.60	0009600

Resource Location: RIMS for state-maintained roads. Geomedia and Inform for non-state-owned roads. DelDOT video logging may also be utilized.

Units: miles

Item 12 - Base Highway Network   1 digit

This item is to be coded for all records in the inventory. The Base Highway Network includes the through lane (mainline) portions of the NHS, rural/urban principal arterial system and rural minor arterial system. Ramps, frontage roads and other roadways are not included in the Base Network. For the inventory route identified in Item 5 - Inventory Route, indicate whether the inventory route is on the Base Highway Network or not on that network. Use one of the following codes:

Code	Description
0	Inventory Route is not on the Base Network
1	Inventory Route is on the Base Network

Item 26 – Functional Classification of Inventory Route coded as 1, 2, 6, 11, 12, or 14: code 1
Otherwise: code 0

Item 13 - LRS Inventory Route, Subroute Number   12 digits

If Item 12 - Base Highway Network has been coded 1, the information to be recorded for this item is inventory route for the State's linear referencing system (LRS). If Item 12 has been coded 0, this entire item should be left blank. This item is a 12-digit code composed of 2 segments.

Segment	Description	Length
13A	LRS Inventory Route	10 digits
13B	Subroute Number	2 digits

Item 13 - LRS Inventory Route, Subroute Number (cont'd)

The LRS inventory route and subroute numbers to be reported in this item must correspond to the LRS inventory route and subroute numbers reported by the State for the HPMS. The LRS inventory route number is coded in the ten positions of segment 13A, right justified and zero filled. The subroute number, if it exists, is coded in the two positions of segment 13B, right justified and zero filled.

The LRS inventory route number can be alphanumeric, but must not contain blanks. The LRS inventory route number is not necessarily the same as that posted along the roadway, but is a number used to uniquely identify a route within at least a county and perhaps throughout the State.

The subroute number is a number that uniquely identifies portions of an inventory route sections where duplicate kilometerpoints occur. These subroute numbers, if they exist, are identified in the State's HPMS-LRS records. If there is no subroute number, code 00 in this segment.

EXAMPLES:	Code
Inventory Route 2775, Subroute Number 0	000000277500
Inventory Route 2775, Subroute Number 3	000000277503

Resource Location: RIMS

Item 14 and Item 15

(Reserved)

Item 16 - Latitude (XX degrees XX minutes XX.XX seconds) 8 digits

For bridges on STRAHNET and STRAHNET Connector highways and on the NHS, record and code the latitude of each in degrees, minutes and seconds to the nearest hundredth of a second (with an assumed decimal point). The point of the coordinate may be the beginning of the bridge in the direction of the inventory or any other consistent point of reference on the bridge which is compatible with the LRS. If the bridge is not on a STRAHNET highway or the NHS, a code of all zeros is acceptable, but it is preferable to code the latitude if available.

The reason for the increased precision is to facilitate the use of Global Positioning System (GPS) data directly into this item. The increased precision is not currently mandatory and, if GPS readings are not available, the current measuring methods and level of precision may continue to be used. The minimum precision should be to the nearest minute, but the preferred precision is to the nearest hundredth of a second using GPS methods.

EXAMPLE:		Code
Latitude is 35°27.3'	(current precision)	35271800
	(acceptable coding)	35270000
35°27'18.55"	(GPS reading)	35271855

Resource Location: Geomedia or Inform.

Do not recode for bridges already in the inventory.

<u>Item 17 - Longitude</u> (XXX degrees XX minutes XX.XX seconds)   9 digits

For bridges on STRAHNET and STRAHNET Connector highways and on the NHS, record and code the longitude of each in degrees, minutes and seconds to the nearest hundredth of a second (with an assumed decimal point). A leading zero shall be coded where needed. The point of the coordinate may be the beginning of the bridge in the direction of the inventory or any other consistent point of reference on the bridge which is compatible with the LRS. If the bridge is not on a STRAHNET highway or the NHS, a code of all zeros is acceptable, but it is preferable to code the longitude if available.

The reason for the increased precision is to facilitate the use of Global Positioning System (GPS) data directly into this item. The increased precision is not currently mandatory and, if GPS readings are not available, the current measuring methods and level of precision may continue to be used. The minimum precision should be to the nearest minute, but the preferred precision is to the nearest hundredth of a second using GPS methods.

EXAMPLE:

		Code
Longitude is 81°5.8'	(current precision)	081054800
	(acceptable coding)	081060000
81°5'50.65"	(GPS reading)	081055065

Resource Location: Geomedia or Inform

Do not recode for bridges already in the inventory.

<u>Item 18</u>

(reserved)

<u>Item 19 - Bypass, Detour Length</u> (XXX kilometers)   3 digits

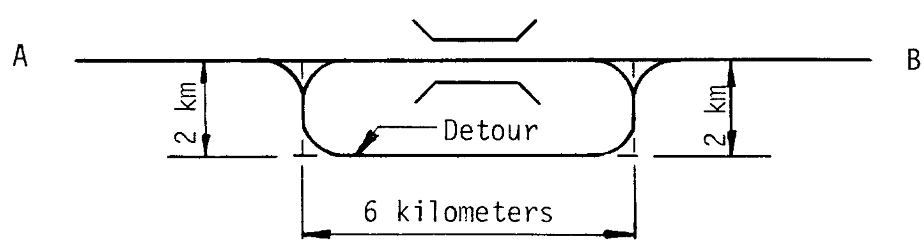
Indicate the actual length to the nearest kilometer of the detour length. The detour length should represent the total additional travel for a vehicle which would result from closing of the bridge. The factor to consider when determining if a bypass is available at the site is the potential for moving vehicles, including military vehicles, around the structure. This is particularly true when the structure is in an interchange. For instance, a bypass likely would be available in the case of diamond interchanges, interchanges where there are service roads available, or other interchanges where the positioning and layout of the ramps is such that they could be used without difficulty to get around the structure. If a ground level bypass is available at the structure site for the inventory route, record and code the detour length as 000.

Item 19 - Bypass, Detour Length (cont'd)

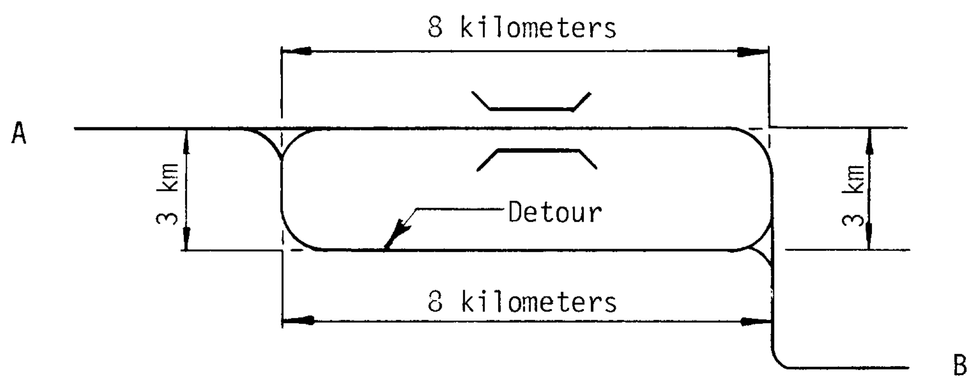
If the bridge is one of twin bridges and is not at an interchange, code 001 where the other twin bridge can be used as a temporary bypass with a reasonable amount of crossover grading. The detour route will be established following allowable criteria determined by the governing authority. (Some authorities will not allow a designated detour over a road or bridge of lesser "quality.") Code 199 for 199 kilometers or more.

EXAMPLES:	Code
Diamond interchange, structure bypassable	000
Cloverleaf, not bypassable; 18-kilometer detour	018
Structure over river; 121-kilometer detour	121
Structure over highway, no interchange, Bypassable at ground level	000
Structure on dead end road	199

Bypass, Detour Length A to B = 4 kilometers



Bypass, Detour Length A to B = 0 kilometers



Resource Location: Inform or scaled from ADC Map

Item 20 - Toll 1 digit

The toll status of the structure is indicated by this item. Interstate toll segments under Secretarial Agreement (Title 23 - United States Code - Highways Section 129 as amended by 1991 ISTEA and prior legislation) shall be identified separately. Use one of the following codes:

Code	Description
1	Toll bridge. Tolls are paid specifically to use the structure.
2	On toll road. The structure carries a toll road, that is, tolls are paid to use the facility, which includes both the highway and the structure.
3	On free road. The structure is toll-free and carries a toll-free highway.
4	On Interstate toll segment under Secretarial Agreement. Structure functions as a part of the toll segment.
5	Toll bridge is a segment under Secretarial Agreement. Structure is separate agreement from highway segment.

Toll facility locations in Delaware include:

- **I-95 from Maryland state line to SR-141 (Exit 5)**
- **SR-1 from SR-72/Wrangle Hill Rd (Exit 152) to Dover AFB North Gate (Exit 93)**

Item 21 - Maintenance Responsibility 2 digits

The actual name(s) of the agency(s) responsible for the maintenance of the structure shall be recorded on the inspection form. The codes below shall be used to represent the type of agency that has primary responsibility for maintaining the structure. If more than one agency has equal maintenance responsibility, code one agency in the hierarchy of State, Federal, county, city, railroad, and other private.

Code	Description
01	State Highway Agency
02	County Highway Agency
03	Town or Township Highway Agency
04	City or Municipal Highway Agency
11	State Park, Forest, or Reservation Agency
12	Local Park, Forest, or Reservation Agency
21	Other State Agencies
25	Other Local Agencies
26	Private (other than railroad)
27	Railroad
31	State Toll Authority
32	Local Toll Authority
60	Other Federal Agencies (not listed below)
61	Indian Tribal Government
62	Bureau of Indian Affairs

Item 21 - Maintenance Responsibility (cont'd)

63	Bureau of Fish and Wildlife
64	U.S. Forest Service
66	National Park Service
67	Tennessee Valley Authority
68	Bureau of Land Management
69	Bureau of Reclamation
70	Corps of Engineers (Civil)
71	Corps of Engineers (Military)
72	Air Force
73	Navy/Marines
74	Army
75	NASA
76	Metropolitan Washington Airports Service
80	Unknown

Item 22 - Owner 2 digits

The actual name(s) of the owner(s) of the bridge shall be recorded on the inspection form. The codes used in Item 21 - Maintenance Responsibility shall be used to represent the type of agency that is the primary owner of the structure. If more than one agency has equal ownership, code one agency in the hierarchy of State, Federal, county, city, railroad, and other private.

Item 22 is coded using the same set of codes as Item 21. The two values do not need to match if the party responsible for maintenance differs from the owner.

Item 23 through Item 25

(Reserved)

Item 26 - Functional Classification of Inventory Route 2 digits

For the inventory route, code the functional classification using one of the following codes:

Code		Description
	Rural	
01		Principal Arterial - Interstate
02		Principal Arterial - Other
06		Minor Arterial
07		Major Collector
08		Minor Collector
09		Local
	Urban	
11		Principal Arterial - Interstate
12		Principal Arterial - Other Freeways or Expressways
14		Other Principal Arterial
16		Minor Arterial
17		Collector
19		Local

The bridge shall be coded rural if not inside a designated urban area. The urban or rural designation shall be determined by the bridge location and not the character of the roadway.

Resource Location: RIMS the HPMS Delaware Functional Classification Maps available at www.deldot.gov/information/projects/hpms

Item 27 - Year Built 4 digits

Record and code the year of construction of the structure. Code all 4 digits of the year in which construction of the structure was completed. If the year built is unknown, provide a best estimate. See also Item 106 - Year Reconstructed.

EXAMPLES:

		Code
Construction completed	1956	1956
	1892	1892

Resource Location: Bridge Plans and Appendix C of the DelDOT Bridge Inspection Manual: Historic Bridge Inventory

Item 28 - Lanes On and Under the Structure 4 digits

Record and code the number of lanes being carried by the structure and being crossed over by the structure as a 4-digit number composed of 2 segments. The number of lanes should be right justified in each segment with leading zero(s) coded as required.

Segment	Description	Length
28A	Lanes on the structure	2 digits
28B	Lanes under the structure	2 digits

Include all lanes carrying highway traffic (i.e., cars, trucks, buses) which are striped or otherwise operated as a full width traffic lane for the entire length of the structure or under the structure by the owning/maintaining authority. This shall include any full width merge lanes and ramp lanes, and shall be independent of directionality of usage (i.e., a 1-lane bridge carrying 2-directional traffic is still considered to carry only one lane on the structure). It should be noted here that for the purpose of evaluating the Deck Geometry - Item 68, any "1-lane" bridge, not coded as a ramp (Item 5C = 7), which has a Bridge Roadway Width, Curb-to-Curb - Item 51 coded 4.9 meters or greater shall be evaluated as 2 lanes.

When the inventory route is "on" the bridge (the first digit of Item 5 - Inventory Route is coded 1), the sum of the total number of lanes on all inventoried routes under the bridge shall be coded. When the inventory route is "under" the bridge (the first digit of Item 5 - Inventory Route is coded 2 or A through Z), only the number of lanes being identified by that "under" record shall be coded in Item 28B.

When the inventory route is "under" the structure, the obstruction over the inventory route may be other than a highway bridge (railroad, pedestrian, pipeline, etc.). Code 00 for these cases if there are no highway lanes on the obstructing structure.

Double deck bridges may be coded as 1 or 2 structures as noted in the examples on the next page. Either method is acceptable, however, all related data must be compatible with the method selected.

Item 28 - Lanes On and Under the Structure (cont'd)

EXAMPLES*:

	Code
1 lane on, 0 lanes under	0100
3 lanes on, 1 lane under	0301
8 lanes on 2-way, 12 lanes under **	0812
5 lanes on double deck each direction, 2 lanes under	1002***
5 lanes on double deck each direction, 2 lanes under	0502****
Railroad and pedestrian on, 4 lanes under	0004

* For the inventory route on the bridge, the first digit of Item 5 - Inventory Route is coded 1.

** This example has 3 inventory routes under the bridge of 6, 4, and 2 lanes of 2-way traffic respectively. When coding an "under" record for each of these inventory routes, the first digit of Item 5 - Inventory Route is coded A, B, and C, and Item 28 is coded 0806, 0804, and 0802 respectively for the 3 required records.

***Acceptable if coded as 1 bridge. However, other data such as ADT, curb- to-curb width, etc., must be for both decks (preferred method).

****Acceptable if coded as 2 separate bridges. However, other data such as ADT, curb-to-curb width, etc., must be for a single deck.

Item 29 - Average Daily Traffic — 6 digits

Code a 6-digit number that shows the average daily traffic volume for the inventory route identified in Item 5. Make certain the unit's position is coded even if estimates of ADT are determined to tens or hundreds of vehicles; that is, appropriate trailing zeros shall be coded. The ADT coded should be the most recent ADT counts available. Included in this item are the trucks referred to in Item 109 - Average Daily Truck Traffic. If the bridge is closed, code the actual ADT from before the closure occurred.

The ADT must be compatible with the other items coded for the bridge. For example, parallel bridges with an open median are coded as follows: if Item 28 - Lanes On and Under the Structure and Item 51 - Bridge Roadway Width, Curb-to-Curb are coded for each bridge separately, then the ADT must be coded for each bridge separately (not the total ADT for the route).

EXAMPLES:

		Code
Average Daily Traffic	540	000540
	15,600	015600
	24,000	024000

Resource Location: The latest Delaware Vehicle Volume Summary (Traffic Summary) available at www.deldot.gov/information/pubs_forms/manuals/traffic_count

Item 30 - Year of Average Daily Traffic 4 digits

Record the year represented by the ADT in Item 29. Code all four digits of the year so recorded.

EXAMPLE:	Code
Year of ADT is 1994	1994

Resource Location: The latest Delaware Vehicle Volume Summary (Traffic Summary) available at www.deldot.gov/information/pubs_forms/manuals/traffic_counts

Item 31 - Design Load 1 digit

Use the codes below to indicate the live load for which the structure was designed. The numerical value of the railroad loading should be recorded on the form. Classify any other loading, when feasible, using the nearest equivalent of the loadings given below.

Code	Metric Description		English Description
1	M 9	or	H 10
2	M 13.5		H 15
3	MS 13.5		HS 15
4	M 18		H 20
5	MS 18		HS 20
6	MS 18+Mod		HS 20+Mod
7	Pedestrian		Pedestrian
8	Railroad		Railroad
9	MS 22.5		HS 25
0	Other or Unknown (describe on inspection reporting form)		

Inspectors are not to update this Item

Item 32 - Approach Roadway Width (XXX.X meters) 4 digits

Code a 4-digit number to represent the normal width of usable roadway approaching the structure measured to the nearest tenth of a meter (with an assumed decimal point). Usable roadway width will include the width of traffic lanes and the widths of shoulders where shoulders are defined as follows:

> Shoulders must be constructed and normally maintained flush with the adjacent traffic lane, and must be structurally adequate for all weather and traffic conditions consistent with the facility carried.

Unstabilized grass or dirt, with no base course, flush with and beside the traffic lane is not to be considered a shoulder for this item.

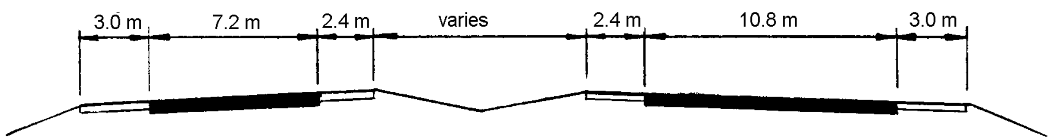
For structures with medians of any type and double-decked structures, this item should be coded as the sum of the usable roadway widths for the approach roadways (i.e., all median widths which do not qualify as shoulders should not be included in this dimension). When there is a variation between the approaches at either end of the structure, record and code the most restrictive of the approach conditions.

Item 32 - Approach Roadway Width (cont'd)

EXAMPLES:

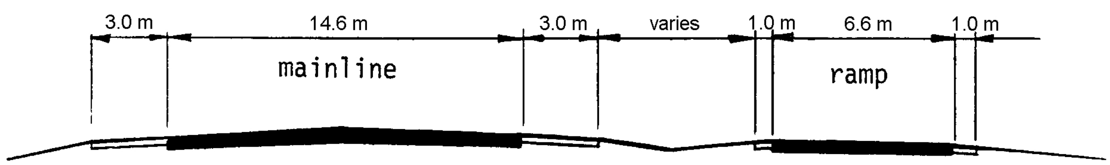
Left Shoulder	Left Roadway	Median Shoulders	Right Roadway	Right Shoulder	Code
1.2	-	-	4.8	1.8	0078
1.8	-	-	10.8	3.6	0162
3.6	14.4	9.0	14.4	3.6	0450
3.0	7.2	4.8	10.8	3.0	0288

The last example above represents the coding method for a structure in which the most restrictive approach has the cross-section shown below:



Regardless of whether the median is open or closed, the data coded must be compatible with the other related route and bridge data (i.e., if Item 51 - Bridge Roadway Width, Curb-to-Curb is for traffic in one direction only, then Items 28, 29, 32, etc. must be for traffic in one direction only).

If a ramp is adjacent to the through lanes approaching the structure, it shall be included in the approach roadway width. The total approach roadway width for the example below is 29.2 meters (a code of

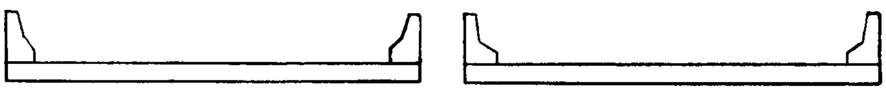


292).

Item 33 - Bridge Median 1 digit

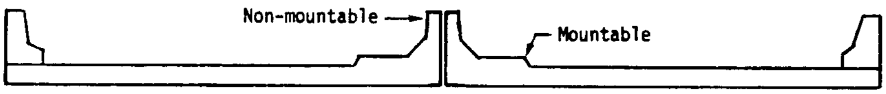
Indicate with a 1-digit code if the median is non-existent, open or closed. The median is closed when the area between the 2 roadways at the structure is bridged over and is capable of supporting traffic. All bridges that carry either 1-way traffic or 2-way traffic separated only by a centerline will be coded 0 for no median.

Code	Description
0	No median
1	Open median
2	Closed median (no barrier)
3	Closed median with non-mountable barriers



Open Median

Closed Median



Closed Median with Non-mountable Barrier

Item 34 - Skew (XX degrees) 2 digits

The skew angle is the angle between the centerline of a pier and a line normal to the roadway centerline. When plans are available, the skew angle can be taken directly from the plans. If no plans are available, the angle is to be field measured if possible. Record the skew angle to the nearest degree. If the skew angle is 0E, it should be so coded. When the structure is on a curve or if the skew varies for some other reason, the average skew should be recorded, if reasonable. Otherwise, record 99 to indicate a major variation in skews of substructure units. A 2-digit number should be coded.

EXAMPLES:

		Code
Skew angle	0°	00
	10°	10
	8°	08
	29°	29

Reference: Bridge Plans and Appendix C of the DelDOT Bridge Inspection Manual: Historic Bridge Inventory

Item 35 - Structure Flared 1 digit

Code this item to indicate if the structure is flared (i.e., the width of the structure varies). Generally, such variance will result from ramps converging with or diverging from the through lanes on the structure, but there may be other causes. Minor flares at ends of structures should be ignored.

Code	Description
0	No flare
1	Yes, flared

Flared pipe ends: code 0

Item 36 - Traffic Safety Features 4 digits

Bridge inspection shall include the recording of information on the following traffic safety features so that the evaluation of their adequacy can be made.

(A) Bridge railings: Some factors that affect the proper functioning of bridge railing are height, material, strength, and geometric features. Railings must be capable of smoothly redirecting an impacting vehicle. Bridge railings should be evaluated using the current AASHTO Standard Specifications for Highway Bridges, which calls for railings to meet specific geometric criteria and to resist specified static loads without exceeding the allowable stresses in their elements. Bridge railing should be crash tested per FHWA policy. Railings that meet these criteria and loading conditions are considered acceptable. Other railings that have been successfully crash tested are considered acceptable even though they may not meet the static loading analysis and geometric requirements. Acceptable guidelines for bridge railing design and testing are also found in the AASHTO Guide Specifications for Bridge Railings 1989. Additional guidance for testing is found in National Cooperative Highway Research Program - Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features 1993.

Item 36 - Traffic Safety Features (cont'd)

(B) Transitions: The transition from approach guardrail to bridge railing requires that the approach guardrail be firmly attached to the bridge railing. It also requires that the approach guardrail be gradually stiffened as it comes closer to the bridge railing. The ends of curbs and safety walks need to be gradually tapered out or shielded.

(C) Approach guardrail: The structural adequacy and compatibility of approach guardrail with transition designs should be determined. Rarely does the need for a barrier stop at the end of a bridge. Thus, an approach guardrail with adequate length and structural qualities to shield motorists from the hazards at the bridge site needs to be installed. In addition to being capable of safely redirecting an impacting vehicle, the approach guardrail must also facilitate a transition to the bridge railing that will not cause snagging or pocketing of an impacting vehicle. Acceptable guardrail design suggestions are contained in the AASHTO Roadside Design Guide and subsequent FHWA or AASHTO guidelines.

(D) Approach guardrail ends: As with guardrail ends in general, the ends of approach guardrails to bridges should be flared, buried, made breakaway, or shielded. Design treatment of guardrail ends is given in the AASHTO Roadside Design Guide.

The data collected shall apply only to the route on the bridge. Collision damage or deterioration of the elements are not considered when coding this item. Traffic safety features is a 4-digit code composed of 4 segments.

Segment	Description	Length
36A	Bridge railings	1 digit
36B	Transitions	1 digit
36C	Approach guardrail	1 digit
36D	Approach guardrail ends	1 digit

The reporting of these features shall be as follows:

Code	Description
0	Inspected feature does not meet currently acceptable standards or a safety feature is required and none is provided.*
1	Inspected feature meets currently acceptable standards.*
N	Not applicable or a safety feature is not required.*

* For structures on the NHS, national standards are set by regulation. For those not on the NHS, it shall be the responsibility of the highway agency (state, county, local or federal) to set standards.

Item 36 - Traffic Safety Features (cont'd)

EXAMPLE:	Code
All features meet currently acceptable standards except transition	1011

Resource Location: Appendix C of the DelDOT Bridge Inspection Manual: Bridge Inspector Traffic Safety Features Rating Manual

Item 37 - Historical Significance — 1 digit

The historical significance of a bridge involves a variety of characteristics: the bridge may be a particularly unique example of the history of engineering; the crossing itself might be significant; the bridge might be associated with a historical property or area; or historical significance could be derived from the fact the bridge was associated with significant events or circumstances. Use one of the following codes:

Code	Description
1	Bridge is on the National Register of Historic Places.
2	Bridge is eligible for the National Register of Historic Places.
3	Bridge is possibly eligible for the National Register of Historic Places (requires further investigation before determination can be made) or bridge is on a State or local historic register.
4	Historical significance is not determinable at this time.
5	Bridge is not eligible for the National Register of Historic Places.

Resource Location: Appendix C of the DelDOT Bridge Inspection Manual: Historic Bridge Inventory

Item 38 - Navigation Control — 1 digit

Indicate for this item whether or not navigation control (a bridge permit for navigation) is required. Use one of the following codes:

Code	Description
N	Not applicable, no waterway.
0	No navigation control on waterway (bridge permit not required).
1	Navigation control on waterway (bridge permit required).

For purposes of NBI coding, 33 CFR §2.36 defines a navigable waterway

<u>Item 39 - Navigation Vertical Clearance</u> (XXX.X meters) 4 digits

If Item 38 - Navigation Control has been coded 1, record the minimum vertical clearance imposed at the site as measured above a datum that is specified on a navigation permit issued by a control agency. The measurement shall be coded as a 4-digit number truncated to the tenth of a meter (with an assumed decimal point). This measurement will show the clearance that is allowable for navigational purposes. In the case of a swing or bascule bridge, the vertical clearance shall be measured with the bridge in the closed position (i.e., open to vehicular traffic). The vertical clearance of a vertical lift bridge shall be measured with the bridge in the raised or open position. Also, Item 116 - Minimum Navigation Vertical Clearance Vertical Lift Bridge shall be coded to provide clearance in a closed position. If Item 38 - Navigation Control has been coded 0 or N, code 000 to indicate not applicable.

EXAMPLES:

		Code
Measured Vertical Clearance	50.00 meters	0500
	20.65 meters	0206
	24.28 meters	0242

Resource Location: Field measurement

Units: XX.XXX feet

<u>Item 40 - Navigation Horizontal Clearance</u> (XXXX.X meters) 5 digits

If Item 38 - Navigation Control has been coded 1, record the horizontal clearance measurement imposed at the site that is shown on the navigation permit. This may be less than the structure geometry allows. If a navigation permit is required but not available, use the minimum horizontal clearance between fenders, if any, or the clear distance between piers or bents. Code the clearance as a 5-digit number truncated to the tenth of a meter (with an assumed decimal point). If Item 38 - Navigation Control has been coded 0 or N, code 0000 to indicate not applicable.

EXAMPLES:

		Code
Horizontal Clearance	53.57 meters	00535
	95.00 meters	00950
	202.09 meters	02020

Resource Location: Field measurement

Units: XX.XXX feet

<u>Item 41 - Structure Open, Posted, or Closed to Traffic</u> 1 digit

This item provides information about the actual operational status of a structure. The field review could show that a structure is posted, but Item 70 - Bridge Posting may indicate that posting is not required. This is possible and acceptable coding since Item 70 is based on the operating stress level and the governing agency's posting procedures may specify posting at some stress level less than the operating rating. One of the following codes shall be used:

Item 41 - Structure Open, Posted, or Closed to Traffic (cont'd)

Code	Description
A	Open, no restriction
B	Open, posting recommended but not legally implemented (all signs not in place or not correctly implemented)
D	Open, would be posted or closed except for temporary shoring, etc. to allow for unrestricted traffic
E	Open, temporary structure in place to carry legal loads while original structure is closed and awaiting replacement or rehabilitation
G	New structure not yet open to traffic
K	Bridge closed to all traffic
P	Posted for load (may include other restrictions such as temporary bridges which are load posted)
R	Posted for other load-capacity restriction (speed, number of vehicles on bridge, etc.)

Inspectors are not to update this Item.

Item 42 - Type of Service 2 digits

The type of service on the bridge and under the bridge is indicated by a 2-digit code composed of 2 segments.

Segment	Description	Length
42A	Type of service on bridge	1 digit
42B	Type of service under bridge	1 digit

The first digit indicates the type of service "on" the bridge and shall be coded using one of the following codes:

Code	Description
1	Highway
2	Railroad
3	Pedestrian-bicycle
4	Highway-railroad
5	Highway-pedestrian
6	Overpass structure at an interchange or second level of a multilevel interchange
7	Third level (Interchange)
8	Fourth level (Interchange)
9	Building or plaza
0	Other

Item 42 - Type of Service (cont'd)

The second digit indicates the type of service "under" the bridge and shall be coded using one of the following codes:

Code	Description
1	Highway, with or without pedestrian
2	Railroad
3	Pedestrian-bicycle
4	Highway-railroad
5	Waterway
6	Highway-waterway
7	Railroad-waterway
8	Highway-waterway-railroad
9	Relief for waterway
0	Other

Resource Location: Field inspection, RIMS, or past inspection photos

Subdivisions, park roads, service plaza, unclassified frontage roads, or shopping plaza: code 1
Overpass structures at an interchange with a sidewalk: code 6

Item 43 - Structure Type, Main 3 digits

Record the description on the inspection form and indicate the type of structure for the main span(s) with a 3-digit code composed of 2 segments.

Segment	Description	Length
43A	Kind of material and/or design	1 digit
43B	Type of design and/or construction	2 digits

The first digit indicates the kind of material and/or design and shall be coded using one of the following codes:

Code	Description
1	Concrete
2	Concrete continuous
3	Steel
4	Steel continuous
5	Prestressed concrete *
6	Prestressed concrete continuous *
7	Wood or Timber
8	Masonry
9	Aluminum, Wrought Iron, or Cast Iron
0	Other

* Post-tensioned concrete should be coded as prestressed concrete.

Item 43 - Structure Type, Main (cont'd)

The second and third digits indicate the predominant type of design and/or type of construction and shall be coded using one of the following codes:

Code	Description
01	Slab
02	Stringer/Multi-beam or Girder
03	Girder and Floorbeam System
04	Tee Beam
05	Box Beam or Girders - Multiple
06	Box Beam or Girders - Single or Spread
07	Frame (except frame culverts)
08	Orthotropic
09	Truss - Deck
10	Truss - Thru
11	Arch - Deck
12	Arch - Thru
13	Suspension
14	Stayed Girder
15	Movable - Lift
16	Movable - Bascule
17	Movable - Swing
18	Tunnel
19	Culvert (includes frame culverts)
20 *	Mixed types
21	Segmental Box Girder
22	Channel Beam
00	Other

* Applicable only to approach spans - Item 44

EXAMPLES:	Code
Wood or Timber Through Truss	710
Masonry Culvert	819
Steel Suspension	313
Continuous Concrete Multiple Box Girders	205
Simple Span Concrete Slab	101
Tunnel in Rock	018

Adjacent box beams: code 05

Multiple box beams (Newport Viaduct): code 06

Item 44 - Structure Type, Approach Spans 3 digits

Indicate with a 3-digit code composed of 2 segments, the type of structure for the approach spans to a major bridge or for the spans where the structural material or design is different. The codes are the same as for Item 43 preceding. However, code 000 if this item is not applicable. Use code 20 (Item 44B) when no one type of design and/or construction is predominate for the approach units. If the kind of material (Item 44A) is varied, code the most predominant.

Item 44 - Structure Type, Approach Spans (cont'd)

Segment	Description	Length
44A	Kind of material and/or design	1 digit
44B	Type of design and/or construction	2 digits

EXAMPLES:

	Code
Simple prestressed concrete I-beam	502
Continuous concrete T-beam	204
Continuous steel deck truss	409

Use a 3-digit code composed of 2 segments, the type of structure for the approach spans to a major bridge or for the spans where the structural material *or design* is different.

Item 45 - Number of Spans in Main Unit 3 digits

Record the number and indicate with a 3-digit number the number of spans in the main or major unit. This item will include all spans of most bridges, the major unit only of a sizable structure, or a unit of material or design different from that of the approach spans.

Item 46 - Number of Approach Spans 4 digits

Record the number and indicate with a 4-digit number the number of spans in the approach spans to the major bridge, or the number of spans of material different from that of the major bridge.

Item 47 - Inventory Route, Total Horizontal Clearance (XX.X meters) 3 digits

The total horizontal clearance for the inventory route identified in Item 5 should be measured and recorded. The clearance should be the available clearance measured between the restrictive features -- curbs, rails, walls, piers or other structural features limiting the roadway (surface and shoulders). The measurement should be recorded and coded as a 3-digit number truncated to the nearest tenth of a meter (with an assumed decimal point). When the restriction is 100 meters or greater, code 999.

The purpose of this item is to give the largest available clearance for the movement of wide loads. Flush and mountable medians are not considered to be restrictions. This clearance is defined in 2 ways; use the most applicable:

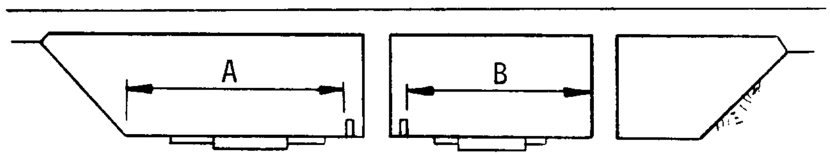
1. Clear distance between restrictions of the inventory route either "on" or "under" the structure.

2. Roadway surface and shoulders - when there are no restrictions.

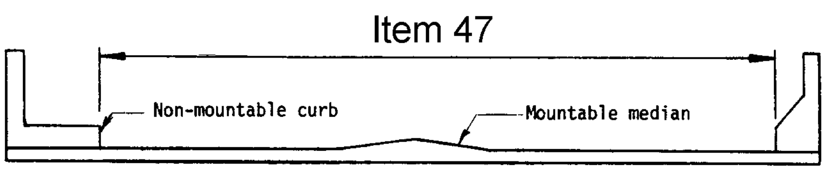
For a divided facility with a raised or non-mountable median, or an "under" route divided by piers, record the greater of the restricted widths in either direction, not both directions.

Item 47 - Inventory Route, Total Horizontal Clearance (cont'd)

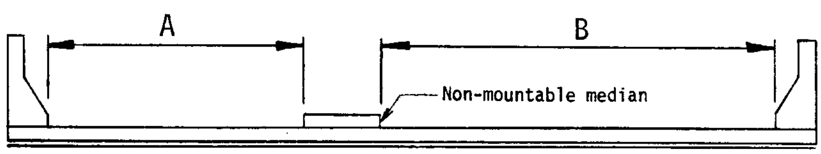
EXAMPLES:



Clearance A > B   Item 47 = A



No Median or Flush or Mountable Median



Raised Median or Non-mountable Median

B > A   Item 47 = B

Item 48 - Length of Maximum Span (XXXX.X meters)   5 digits

The length of the maximum span shall be recorded. It shall be noted whether the measurement is center to center of bearing points or clear open distance between piers, bents, or abutments. The measurement shall be along the centerline of the bridge. For this item, code a 5-digit number to represent the measurement to the nearest tenth of a meter (with an assumed decimal point).

EXAMPLES:

		Code
Length of Maximum Span	35.5 meters	00355
	117.0 meters	01170
	1219.2 meters	12192

Length of maximum span shall be measured as the clear span for arches and culverts, and center-to-center of bearings for all other structure types.

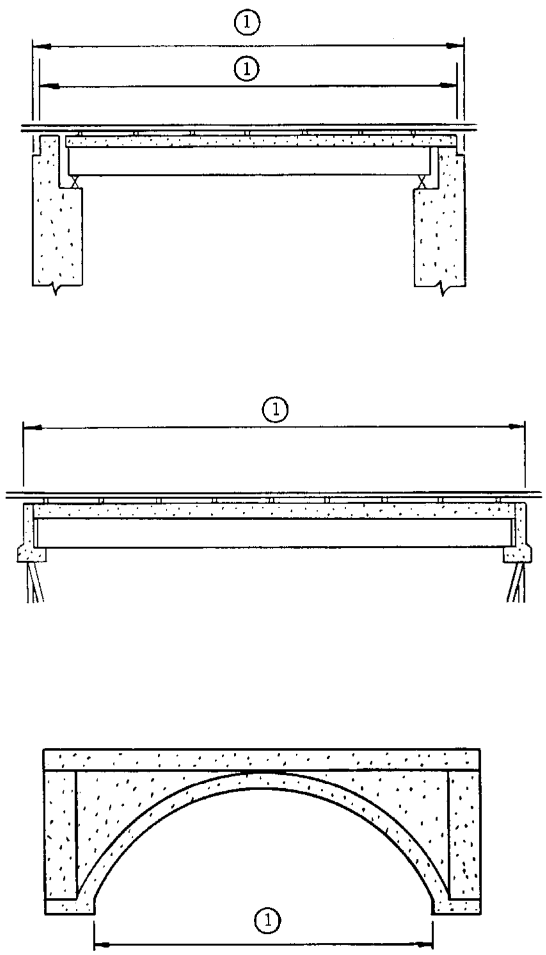
<u>Item 49 - Structure Length</u> (XXXXX.X meters) 6 digits

Record and code a 6-digit number to represent the length of the structure to the nearest tenth of a meter (with an assumed decimal point). This shall be the length of roadway which is supported on the bridge structure. The length should be measured back to back of backwalls of abutments or from paving notch to paving notch.

Culvert lengths should be measured along the center line of roadway regardless of their depth below grade. Measurement should be made between inside faces of exterior walls. Tunnel length should be measured along the centerline of the roadway. Be sure to code Item 5A = 2 for all tunnels.

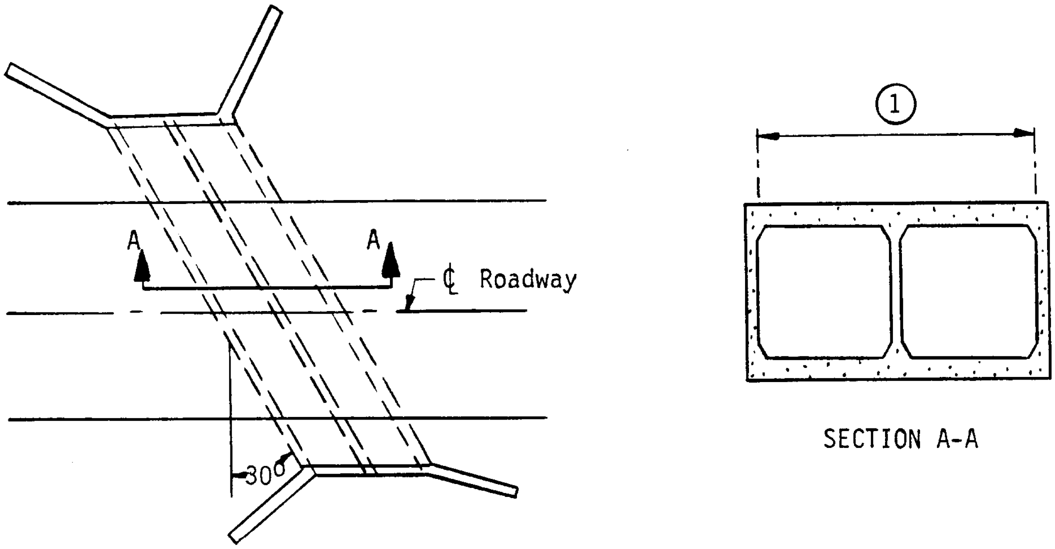
EXAMPLES:

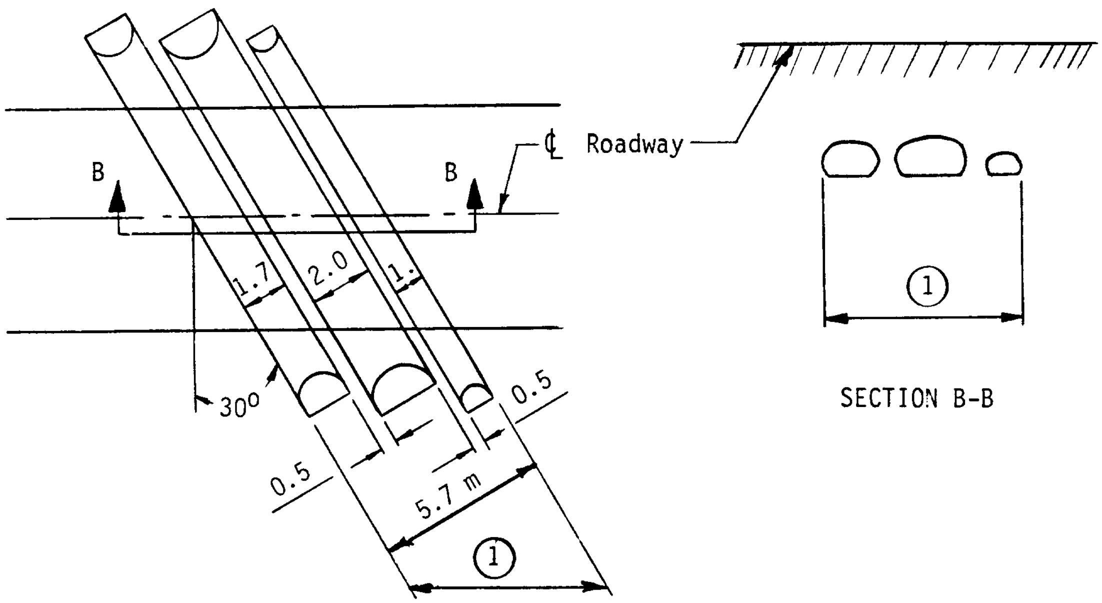
		Code
Structure Length	35.5 meters	000355
	542.1 meters	005421
	333.0 meters	003330
	10 123.5 meters	101235



(1) Item 49 - Structure Length

Item 49 - Structure Length (cont'd)





(1)	Item 49 - Structure Length = $\frac{5.7\text{ m}}{\cos 30^\circ}$ = 6.58 m	Code 000066

Structure length shall be measured as the clear span for arches and culverts, and back-to-back of abutment backwalls for all other structure types. If the back of the backwall locations are unknown, the measurement shall be from paving notch to paving notch.

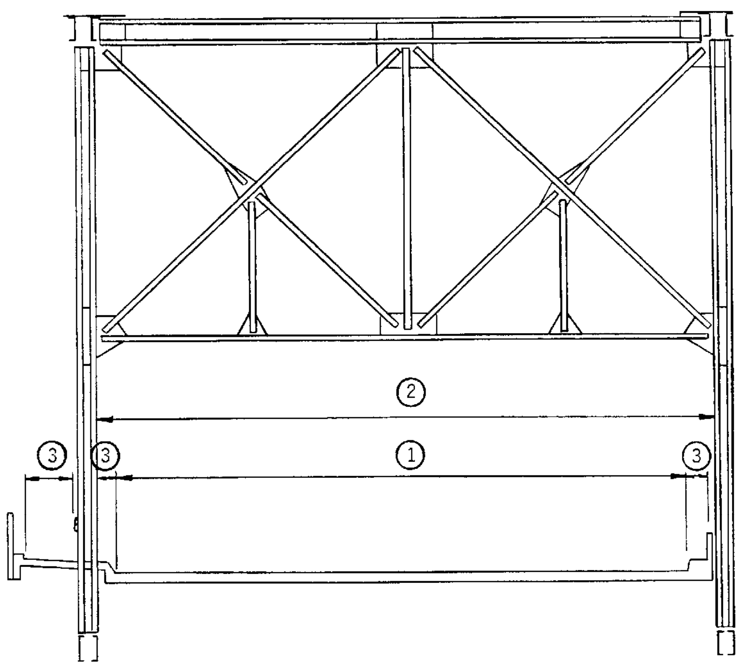
Item 50 - Curb or Sidewalk Widths (XX.X meters, XX.X meters) 6 digits

Record and code two contiguous 3-digit numbers to represent the widths of the left and right curbs or sidewalks to nearest tenth of a meter (with assumed decimal points). This is a 6-digit number composed of 2 segments, with the leftmost 3 digits representing the left curb or sidewalk and the rightmost 3 digits representing the right curb or sidewalk. "Left" and "Right" should be determined on the basis of direction of the inventory.

Segment	Description	Length
50A	Left curb or sidewalk width	3 digits
50B	Right curb or sidewalk width	3 digits

EXAMPLES:

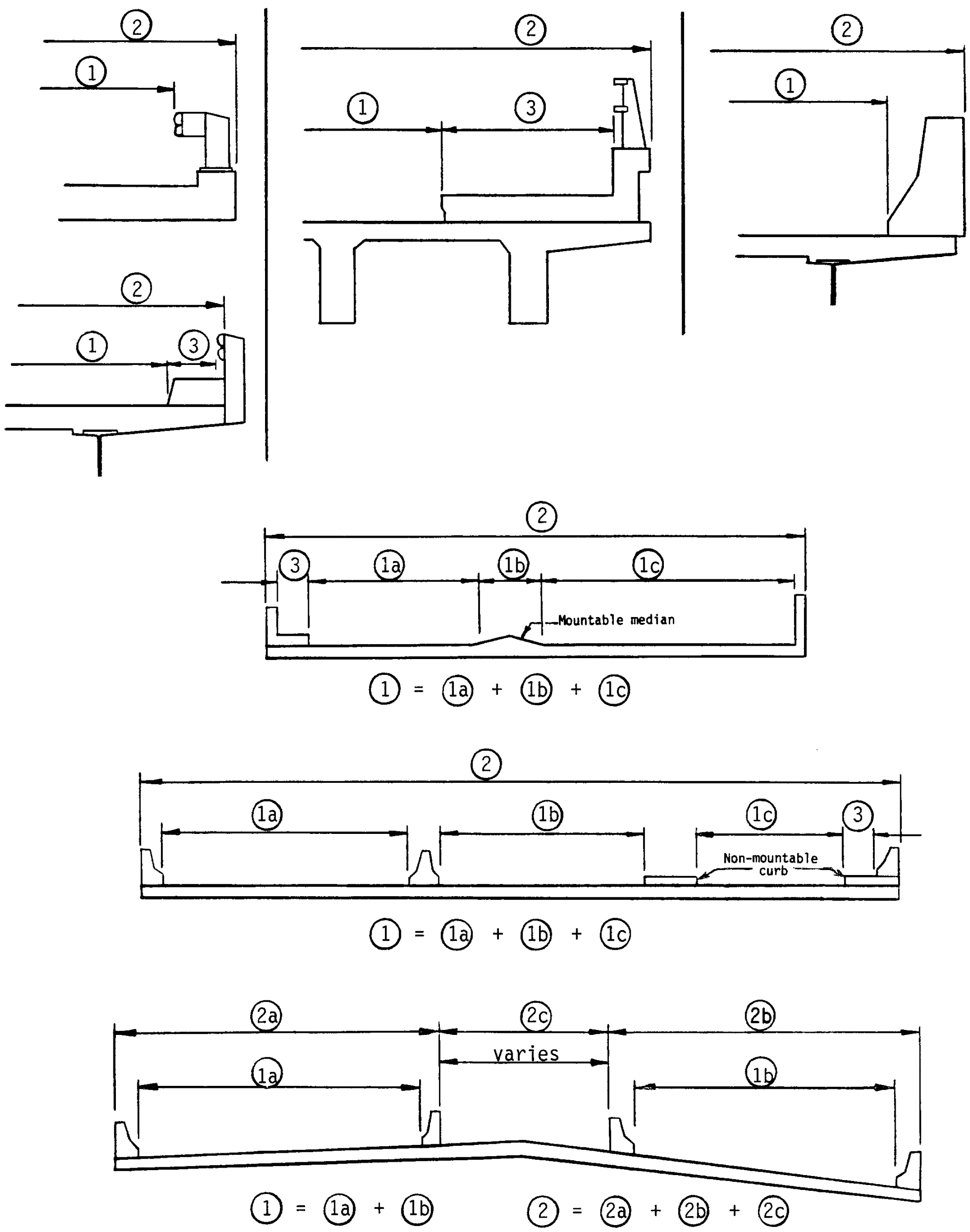
	Left Side	Right Side	Code
Curb or sidewalk	None	2.3 meters	000023
	3.0 meters	4.1 meters	030041
	3.3 meters	None	033000
	12.1 meters	11.5 meters	121115
	None	None	000000
	0.6 meters	1.5 meters	006015



(1) Item 51 - Bridge Roadway Width, Curb-to-Curb
(2) Item 52 - Deck Width, Out-to-Out
(3) Item 50 - Curb or Sidewalk Width

Item 50 - Curb or Sidewalk Widths (cont'd)

EXAMPLES:



(1) Item 51 - Bridge Roadway Width, Curb-to-Curb
(2) Item 52 - Deck Width, Out-to-Out
(3) Item 50 - Curb or Sidewalk Width

Code the actual sidewalk width no matter if the sidewalk is on fill or directly attached to the structure. If the sidewalk is on fill, there will be no sidewalk bridge element.

<u>Item 51 - Bridge Roadway Width, Curb-to-Curb</u> (XXX.X meters) 4 digits

The information to be recorded is the most restrictive minimum distance between curbs or rails on the structure roadway. For structures with closed medians and usually for double decked structures, coded data will be the sum of the most restrictive minimum distances for all roadways carried by the structure*. The data recorded for this item must be compatible with other related route and bridge data (i.e., Items 28, 29, 32, etc.). The measurement should be exclusive of flared areas for ramps. A 4-digit number should be used to represent the distance to the nearest tenth of a meter (with an assumed decimal point). See examples on pages 30 and 31.

Where traffic runs directly on the top slab (or wearing surface) of a culvert- type structure, e.g. an R/C box without fill, code the actual roadway width (curb-to-curb or rail-to-rail). This will also apply where the fill is minimal and headwalls or parapets affect the flow of traffic.

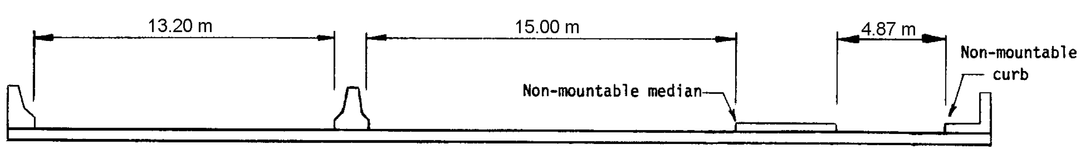
Where the roadway is on fill carried across a structure and the headwalls or parapets do not affect the flow of traffic, code 0000. This is considered proper inasmuch as a filled section simply maintains the roadway cross-section. However, for sidehill viaduct structures code the actual full curb-to-curb roadway width. See figure in the Commentary Appendix D.

* Raised or non-mountable medians, open medians, and barrier widths are to be excluded from the summation along with barrier-protected bicycle and equestrian lanes.

EXAMPLES:

		Code
Bridge Roadway Width	16.00 meters wide	0160
	21.43 meters wide	0214
	33.07 meters wide	0331

The last example above would be the coded value for the deck section shown below.



Item 52 - Deck Width, Out-to-Out (XXX.X meters) 4 digits

Record and code a 4-digit number to show the out-to-out width to the nearest tenth of a meter (with an assumed decimal point). If the structure is a through structure, the number to be coded will represent the lateral clearance between superstructure members. The measurement should be exclusive of flared areas for ramps. See examples on pages 30 and 31.

Where traffic runs directly on the top slab (or wearing surface) of the culvert (e.g., an R/C box without fill) code the actual width (out-to-out). This will also apply where the fill is minimal and the culvert headwalls affect the flow of traffic. However, for sidehill viaduct structures code the actual out-to-out structure width. See figure in the Commentary Appendix D.

Where the roadway is on a fill carried across a pipe or box culvert and the culvert headwalls do not affect the flow of traffic, code 0000. This is considered proper inasmuch as a filled section over a culvert simply maintains the roadway cross-section.

Item 53 - Minimum Vertical Clearance Over Bridge Roadway 4 digits
(XX.XX meters)

The information to be recorded for this item is the actual minimum vertical clearance over the bridge roadway, including shoulders, to any superstructure restriction, rounded down to the nearest hundredth of a meter. For double decked structures code the minimum, regardless whether it is pertaining to the top or bottom deck. When no superstructure restriction exists above the bridge roadway, or when a restriction is 30 meters or greater, code 9999. Coding of actual clearances between 30 meters and 99.99 meters to an exact measurement is optional. A 4-digit number should be coded to represent the clearance to the nearest hundredth of a meter (with an assumed decimal point).

EXAMPLES:

Minimum Vertical Clearance	Code
No restriction	9999
5.25 meters	0525
23.00 meters	2300
38.50 meters	9999

Resource Location: Field measurement during every routine inspection.

Item 54 - Minimum Vertical Underclearance 5 digits
(X code, XX.XX meters)

Using a 1-digit code and a 4-digit number, record and code the minimum vertical clearance from the roadway (travel lanes only) or railroad track beneath the structure to the underside of the superstructure. (When both a railroad and highway are under the structure, code the most critical dimension.)

Segment	Description	Length
54A	Reference feature	1 digit
54B	Minimum Vertical Underclearance	4 digits

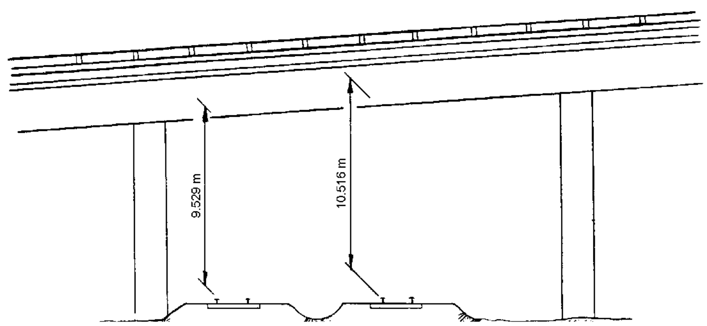
Item 54 - Minimum Vertical Underclearance (cont'd)

Using one of the codes below, code in the first position, the reference feature from which the clearance measurement is taken:

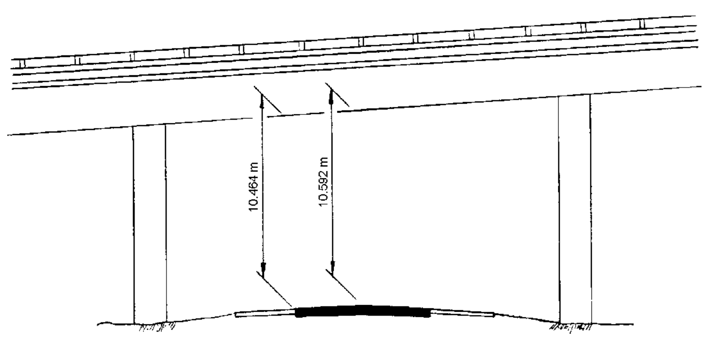
Code	Description
H	Highway beneath structure
R	Railroad beneath structure
N	Feature not a highway or railroad

In the next 4 positions, code a 4-digit number to represent the minimum vertical clearance from that feature to the structure, truncated to the hundredth of a meter (with an assumed decimal point). When a restriction is 30 meters or greater, code 9999. Coding of actual clearances between 30 meters and 99.99 meters to an exact measurement is optional. If the feature is not a highway or railroad, code the minimum vertical clearance 0000.

EXAMPLES:	CODE
River beneath structure	N0000



Railroad 9.529 meters beneath structure	R0952



Highway 10.464 meters beneath structure	H1046

Resource Location: Field measurement during every routine inspection

Measurements shall be recorded on the Under Record Sketch Sheet at the time of inspection.

Item 55 - Minimum Lateral Underclearance on Right (X code, XX.X meters) 4 digits

Using a 1-digit code and a 3-digit number, record and code the minimum lateral underclearance on the right to the nearest tenth of a meter (with an assumed decimal point). When both a railroad and highway are under the structure, code the most critical dimension (Refer to Item 69 - Underclearances, Horizontal - Table 3B).

Segment	Description	Length
55A	Reference feature	1 digit
55B	Minimum Lateral Underclearance	3 digits

Using one of the codes below, code in the first position the reference feature from which the clearance measurement is taken:

Code	Description
H	Highway beneath structure
R	Railroad beneath structure
N	Feature not a highway or railroad

In the next 3 positions, code a 3-digit number to represent the minimum lateral underclearance on the right. The lateral clearance should be measured from the right edge of the roadway (excluding shoulders) or from the centerline (between rails) of the right-hand track of a railroad to the nearest substructure unit (pier, abutment, etc.), to a rigid barrier (concrete bridge rail, etc.), or to the toe of slope steeper than 1 to 3, e.g. 1 to 1 or 2 to 1. The clearance measurements to be recorded will be the minimum after measuring the clearance in both directions of travel. In the case of a dual highway this would mean the outside clearances of both roadways should be measured and the smaller distance recorded and coded.

If two related features are below the bridge, measure both and record the lesser of the 2. An explanation should be written on the inspection form as to what was recorded. When the clearance is 30 meters or greater, code 999. Coding of actual clearances between 30 meters and 99.9 meters to an exact measurement is optional.

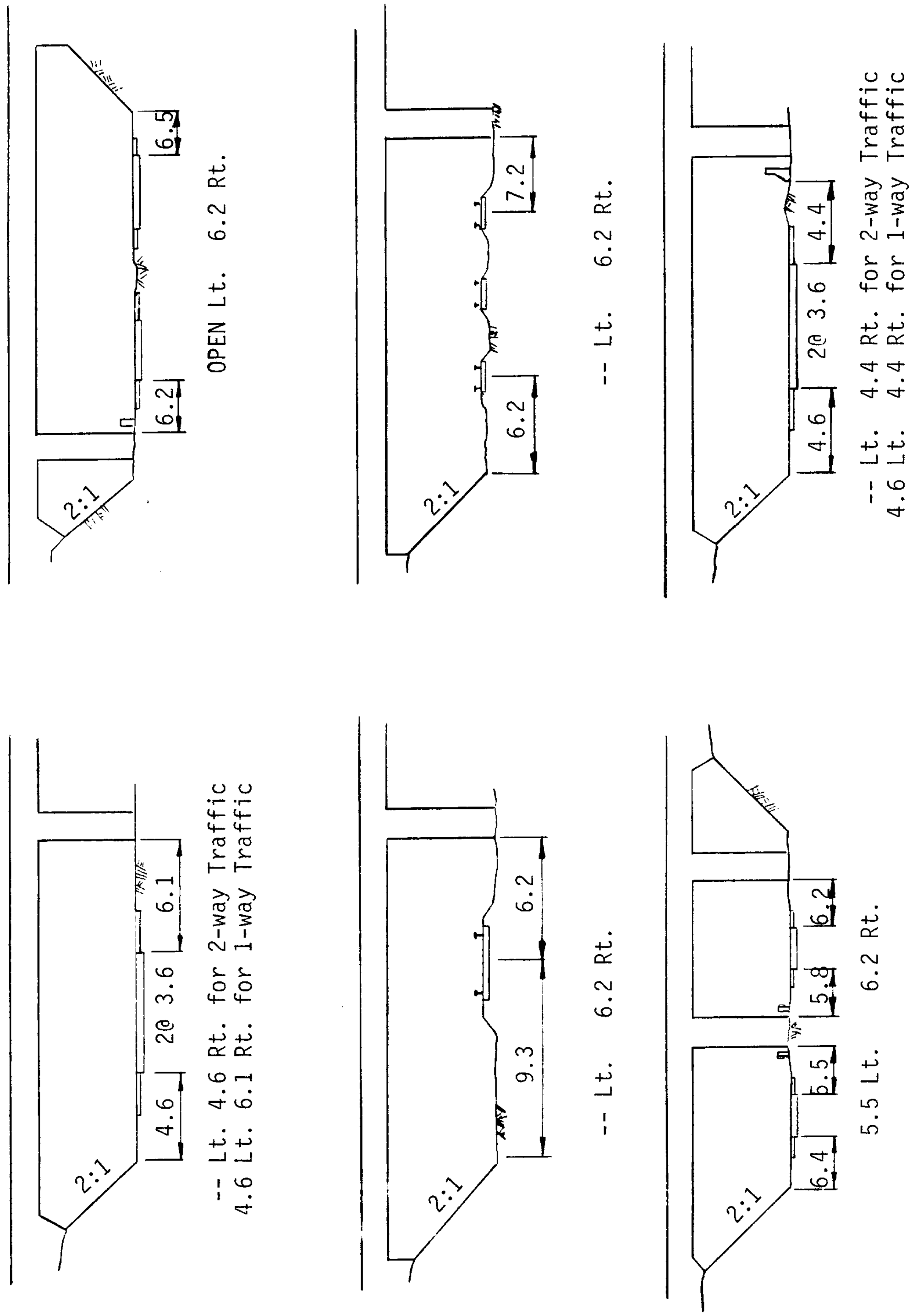
If the feature beneath the structure is not a railroad or highway, code N000 to indicate not applicable.

The presence of ramps and acceleration or turning lanes is not considered in this item; therefore, the minimum lateral clearance on the right should be measured from the right edge of the through roadway.

EXAMPLES:	Code
Railroad 6.22 meters centerline to pier	R062
Highway 6.16 meters edge of pavement to pier	H062
Creek beneath structure	N000

Item 55 – Minimum Lateral Underclearance on Right (cont'd)

EXAMPLES:



Resource Location: Field measurement during every routine inspection

Measurements shall be recorded on the Under Record Sketch Sheet at the time of inspection.

Item 56 - Minimum Lateral Underclearance on Left 3 digits
(XX.X meters) (code only for divided highways, 1-way streets, and ramps; not applicable to railroads)

Using a 3-digit number, record and code the minimum lateral underclearance on the left (median side for divided highways) to the nearest tenth of a meter (with an assumed decimal point). The lateral clearance should be measured from the left edge of the roadway (excluding shoulders) to the nearest substructure unit, to a rigid barrier, or to the toe of slope steeper than 1 to 3. Refer to examples on page 34 under Item 55 - Minimum Lateral Underclearance on Right.

In the case of a dual highway, the median side clearances of both roadways should be measured and the smaller distance recorded and coded. If there is no obstruction in the median area, a notation of "open" should be recorded and 999 should be coded. For clearances greater than 30 meters, code 998. Coding of actual clearances greater than 30 meters to an exact measurement is optional. Code 000 to indicate not applicable.

Resource Location: Field measurement during every routine inspection

Measurements shall be recorded on the Under Record Sketch Sheet at the time of inspection.

Item 57

(Reserved)

Items 58 through 62 - Indicate the Condition Ratings

In order to promote uniformity between bridge inspectors, these guidelines will be used to rate and code Items 58, 59, 60, 61, and 62. The use of the AASHTO Guide for Commonly Recognized (CoRe) Structural Elements is an acceptable alternative to using these rating guidelines for Items 58, 59, 60, and 62, provided the FHWA translator computer program is used to convert the inspection data to NBI condition ratings for NBI data submittal.

Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition. Evaluation is for the materials related, physical condition of the deck, superstructure, and substructure components of a bridge. The condition evaluation of channels and channel protection and culverts is also included. Condition codes are properly used when they provide an overall characterization of the general condition of the entire component being rated. Conversely, they are improperly used if they attempt to describe localized or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread throughout the component being rated.

The load-carrying capacity will not be used in evaluating condition items. The fact that a bridge was designed for less than current legal loads and may be posted shall have no influence upon condition ratings.

Portions of bridges that are being supported or strengthened by temporary members will be rated based on their actual condition; that is, the temporary members are not considered in the rating of the item. (See Item 103 - Temporary Structure Designation for the definition of a temporary bridge.)

Completed bridges not yet opened to traffic, if rated, shall be coded as if open to traffic

Condition Ratings (cont'd)

The following general condition ratings shall be used as a guide in evaluating Items 58, 59, and 60:

Code	Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION - no problems noted.
7	GOOD CONDITION - some minor problems.
6	SATISFACTORY CONDITION - structural elements show some minor deterioration.
5	FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
4	POOR CONDITION - advanced section loss, deterioration, spalling or scour.
3	SERIOUS CONDITION - loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION - 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 CONDITION - major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.
0	FAILED CONDITION - out of service - beyond corrective action.

Item 58 - Deck — 1 digit

This item describes the overall condition rating of the deck. Rate and code the condition in accordance with the above general condition ratings. Code N for culverts and other structures without decks e.g., filled arch bridge.

Concrete decks should be inspected for cracking, scaling, spalling, leaching, chloride contamination, potholing, delamination, and full or partial depth failures. Steel grid decks should be inspected for broken welds, broken grids, section loss, and growth of filled grids from corrosion. Timber decks should be inspected for splitting, crushing, fastener failure, and deterioration from rot.

The condition of the wearing surface/protective system, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rail, and scuppers shall not be considered in the overall deck evaluation. However, their condition should be noted on the inspection form.

Item 58 - Deck (cont'd)

Decks integral with the superstructure will be rated as a deck only and not how they may influence the superstructure rating (for example, rigid frame, slab, deckgirder or T-beam, voided slab, box girder, etc.). Similarly, the superstructure of an integral deck-type bridge will not influence the deck rating.

Bare Concrete Deck and Concrete Deck with overlay: Refer to Appendix G of the BEIM

Item 59 - Superstructure 1 digit

This item describes the physical condition of all structural members. Rate and code the condition in accordance with the previously described general condition ratings. Code N for all culverts.

The structural members should be inspected for signs of distress which may include cracking, deterioration, section loss, and malfunction and misalignment of bearings.

The condition of bearings, joints, paint system, etc. shall not be included in this rating, except in extreme situations, but should be noted on the inspection form.

On bridges where the deck is integral with the superstructure, the superstructure condition rating may be affected by the deck condition. The resultant superstructure condition rating may be lower than the deck condition rating where the girders have deteriorated or been damaged.

Fracture critical components should receive careful attention because failure could lead to collapse of a span or the bridge.

Resource Location: Refer to the NBI Deck Related Items in Appendix G of the BEIM

Item 60 - Substructure 1 digit

This item describes the physical condition of piers, abutments, piles, fenders, footings, or other components. Rate and code the condition in accordance with the previously described general condition ratings. Code N for all culverts.

All substructure elements should be inspected for visible signs of distress including evidence of cracking, section loss, settlement, misalignment, scour, collision damage, and corrosion. The rating given by Item 113 - Scour Critical Bridges, may have a significant effect on Item 60 if scour has substantially affected the overall condition of the substructure.

The substructure condition rating shall be made independent of the deck and superstructure.

Integral-abutment wingwalls to the first construction or expansion joint shall be included in the evaluation. For non-integral superstructure and substructure units, the substructure shall be considered as the portion below the bearings. For structures where the substructure and superstructure are integral, the substructure shall be considered as the portion below the superstructure.

Resource Location: Refer to the NBI Deck Related Items in Appendix G of the BEIM

Item 61 - Channel and Channel Protection 1 digit

This item describes the physical conditions associated with the flow of water through the bridge such as stream stability and the condition of the channel, riprap, slope protection, or stream control devices including spur dikes. The inspector should be particularly concerned with visible signs of excessive water velocity which may affect undermining of slope protection, erosion of banks, and realignment of the stream which may result in immediate or potential problems. Accumulation of drift and debris on the superstructure and substructure should be noted on the inspection form but not included in the condition rating.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

Code	Description
N	Not applicable. Use when bridge is not over a waterway (channel).
9	There are no noticeable or noteworthy deficiencies which affect the condition of the channel.
8	Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.
7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
6	Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor stream bed movement evident. Debris is restricting the channel slightly.
5	Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.
4	Bank and embankment protection is severely undermined. River control devices have severe damage. Large deposits of debris are in the channel.
3	Bank protection has failed. River control devices have been destroyed. Stream bed aggradation, degradation or lateral movement has changed the channel to now threaten the bridge and/or approach roadway.
2	The channel has changed to the extent the bridge is near a state of collapse.
1	Bridge closed because of channel failure. Corrective action may put back in light service.
0	Bridge closed because of channel failure. Replacement necessary.

Inspectors to evaluate the portion of the channel directly affecting the substructure only.

Item 62 - Culverts 1 digit

This item evaluates the alignment, settlement, joints, structural condition, scour, and other items associated with culverts. The rating code is intended to be an overall condition evaluation of the culvert. Integral wingwalls to the first construction or expansion joint shall be included in the evaluation. For a detailed discussion regarding the inspection and rating of culverts, consult Report No. FHWA-IP-86-2, Culvert Inspection Manual, July 1986.

Item 58 - Deck, Item 59 - Superstructure, and Item 60 - Substructure shall be coded N for all culverts.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

Code	Description
N	Not applicable. Use if structure is not a culvert.
9	No deficiencies.
8	No noticeable or noteworthy deficiencies which affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting.
6	Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion or moderate pitting.
5	Moderate to major deterioration or disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion or deep pitting.
4	Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion or deep pitting.

(codes continued on the next page)

Item 62 - Culverts (cont'd)

3 Any condition described in Code 4 but which is excessive in scope. Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.

2 Integral wingwalls collapsed, severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.

1 Bridge closed. Corrective action may put back in light service.

0 Bridge closed. Replacement necessary.

Corrugated Metal Pipe: Refer to Appendix C of the BEIM and the Corrugated Metal Pipe Inspection Policy in Appendix C.

Item 63 - Method Used to Determine Operating Rating 1 digit

Use one of the codes below to indicate which load rating method was used to determine the Operating Rating coded in Item 64 for this structure.

Code	Description
1	Load Factor (LF)
2	Allowable Stress (AS)
3	Load and Resistance Factor (LRFR)
4	Load Testing
5	No rating analysis performed

Inspectors are not to update this Item.

Item 64 - Operating Rating (XX.X metric tons) 3 digits

This capacity rating, referred to as the operating rating, will result in the absolute maximum permissible load level to which the structure may be subjected for the vehicle type used in the rating. Code the operating rating as a 3-digit number to represent the total mass in metric tons of the entire vehicle measured to the nearest tenth of a metric ton (with an assumed decimal point).

It should be emphasized that only MS loading shall be used to determine the operating rating. This is the metric equivalent of an HS loading. The total mass in tons of the entire vehicle should be coded; that is, MS18 which has a mass of 32.4 metric tons shall be coded '324', and likewise, a MS13.5 shall be coded '243'.

The AASHTO Manual for Condition Evaluation of Bridges provides a choice of load rating methods, such as the new load and resistance factor (LRFR) rating method, in addition to the traditional allowable stress (AS) and load factor (LF) methods. Of the three rating methods, the LF method is the most suitable for use as a national standard, therefore the FHWA has chosen the LF method as the standard for computing inventory and operating ratings reported to the NBI. The highway agencies may, however, elect to use LF, AS or LRFD to establish load limits for purposes of load posting.

If the bridge will not carry a minimum of 2.7 metric tons of live load, the operating rating shall be coded '000'; and consistent with the direction of the AASHTO Manual, it shall be closed.

The use or presence of a temporary bridge requires special consideration in coding. In such cases, since there is no permanent bridge, Items 64 and 66 should be coded as 000 even though the temporary structure is rated for as much as full legal load.

A bridge shored up or repaired on a temporary basis is considered a temporary bridge and the inventory and operating rating shall be coded as if the temporary shoring were not in place. See Item 103 - Temporary Structure Designation for definition of a temporary bridge.

Code 999 for a structure under sufficient fill such that, according to AASHTO design, the live load is insignificant in the structure load capacity.

EXAMPLES:	Code
MS27	486
Temporary bridge	000
Shored-up bridge	030*
Structure under fill (not affected by live load)	999

* load capacity without shoring.

Inspectors are not to update this Item.

Item 65 - Method Used to Determine Inventory Rating 1 digit

Use one of the codes below to indicate which load rating method was used to determine the Inventory Rating coded in Item 66 for this structure.

Code	Description
1	Load Factor (LF)
2	Allowable Stress (AS)
3	Load and Resistance Factor (LRFR)
4	Load Testing
5	No rating analysis performed

Inspectors are not to update this Item.

Item 66 - Inventory Rating (XX.X metric tons) 3 digits

This capacity rating, referred to as the inventory rating, will result in a load level which can safely utilize an existing structure for an indefinite period of time. Only the MS loading shall be used to determine the inventory rating. Code the Inventory Rating as a 3-digit number to represent the total mass in metric tons of the entire vehicle measured to the nearest tenth of a metric ton (with an assumed decimal point). The statements in Item 64 - Operating Rating apply to this item also.

Code 999 for a structure under sufficient fill such that, according to AASHTO design, the live load is insignificant in the structure load capacity.

Inspectors are not to update this Item.

Items 67, 68, 69, 71, and 72 - Indicate the Appraisal Ratings

The items in the Appraisal Section are used to evaluate a bridge in relation to the level of service which it provides on the highway system of which it is a part. The structure will be compared to a new one which is built to current standards for that particular type of road as further defined in this section except for Item 72 - Approach Roadway Alignment. See Item 72 for special criteria for rating that item.

Items 67, 68, 69, 71, and 72 will be coded with a 1-digit code that indicates the appraisal rating for the item. The ratings and codes are as follows:

Code	Description
N	Not applicable
9	Superior to present desirable criteria
8	Equal to present desirable criteria
7	Better than present minimum criteria
6	Equal to present minimum criteria
5	Somewhat better than minimum adequacy to tolerate being left in place as is
4	Meets minimum tolerable limits to be left in place as is
3	Basically intolerable requiring high priority of corrective action
2	Basically intolerable requiring high priority of replacement
1	This value of rating code not used
0	Bridge closed

The FHWA Edit/Update computer program calculates values for Items 67, 68 and 69 according to the tables provided in this manual. These tables and the table for Item 71 shall be used by all evaluators to rate these items. They have been developed to closely match the descriptions for the appraisal evaluation codes of 0 to 9. The tables shall be used in all instances to evaluate the item based on the designated data in the inventory, even if a table value does not appear to match the descriptive codes. For unusual cases where the site data does not exactly agree with the table criteria, use the most appropriate table to evaluate the item. The code of N is not valid for use with Items 67 and 72.

Completed bridges not yet opened to traffic, if rated, shall be appraised as if open to traffic. Design values, for example ADT, shall be used for the evaluation. The data provided will include a code of G for Item 41 - Structure Open, Posted, or Closed to Traffic.

Item 67 - Structural Evaluation 1 digit

This item is calculated by the Edit/Update Program based on Table 1, and need not be coded by the bridge inspector. The following specifications are used by the Edit/Update Program:

- For structures other than culverts, the lowest of the codes obtained from Item 59 - Superstructure, Item 60 - Substructure, or Table 1 is used.

- For culverts, the lowest of the codes obtained from Item 62 - Culverts, or Table 1 is used.

- If Item 59, Item 60 or Item 62 is coded 1, then Item 67 is equal to zero (0), regardless of whether the structure is actually closed. However, if the structure is closed, it does not mean that this value is zero (0) unless the overall condition and appraisal ratings indicate that a code of 0 is appropriate.

Table 1 Notes:

1. Use the lower rating code for values between those listed in the table.

2. Inventory Ratings are shown in metric tons with decimal point.

3. To use Table 1, the Inventory Rating must be the coded MS rating or its equivalent. If the comparable MS equivalent is not calculated for the controlling rating, using a factor to determine the MS equivalent is acceptable even though converting other rating loads to an MS equivalent is not a constant.

4. All bridges with Item 26 - Functional Class coded Interstate, Freeway or Expressway shall be evaluated using the ADT column of >5000 regardless of the actual ADT on the bridge.

Item 67 - Structural Evaluation (cont'd)

Table 1. Rating by Comparison of ADT - Item 29 and Inventory Rating - Item 66

Structural Evaluation Rating Code	Inventory Rating		
	Average Daily Traffic (ADT)		
	0-500	501-5000	>5000
9	>32.4 (MS18)*	>32.4 (MS18)	>32.4 (MS18)
8	32.4 (MS18)	32.4 (MS18)	32.4 (MS18)
7	27.9 (MS15.5)	27.9 (MS15.5)	27.9 (MS15.5)
6	20.7 (MS11.5)	22.5 (MS12.5)	24.3 (MS13.5)
5	16.2 (MS9)	18.0 (MS10)	19.8 (MS11)
4	10.8 (MS6)	12.6 (MS7)	16.2 (MS9)
3	Inventory rating less than value in rating code of 4 and requiring corrective action.		
2	Inventory rating less than value in rating code of 4 and requiring replacement.		
0	Bridge closed due to structural condition.		

*MS Designation (typical)

Item 67 is automatically computed by BrM, if an error in the computation is believed to have occurred, contact the Bridge Inspection Engineer.

Item 68 - Deck Geometry 1 digit

This item is calculated by the Edit/Update Program and need not be coded by the bridge inspector.

The overall rating for deck geometry includes two evaluations: (a) the
curb-to-curb or face-to-face of rail bridge width using Table 2A, B, C or D and (b) the minimum vertical clearance over the bridge roadway using Table 2E. The lower of the codes obtained from these tables is used by the Edit/Update Program. When an individual table lists several deck geometry rating codes for the same roadway width under a specific ADT, the lower code is used. (For example, Table 2A lists deck geometry rating codes of 6, 7 and 8 for a 13.4 meter roadway width and an ADT of >5000. Use the code of 6.) For values between those listed in the tables, the lower code is used.

The curb-to-curb or face-to-face of rail dimension shall be taken from Item 51 - Bridge Roadway Width, Curb-to-curb. Item 53 - Minimum Vertical Clearance Over Bridge Roadway is used to evaluate the vertical clearance.

For culverts which have Item 51 - Bridge Roadway Width coded 0000, the Deck Geometry code will be equal to N.

The values provided in the tables are for rating purposes only. Current design standards must be used for structure design or rehabilitation.

Item 68 - Deck Geometry (cont'd)

Table 2A & 2B. Rating by Comparison of ADT - Item 29 and Bridge Roadway Width, Curb-to-Curb - Item 51

	TABLE 2A						TABLE 2B	
Deck Geometry Rating Code	Bridge Roadway Width 2 Lanes; 2 Way Traffic						Bridge Roadway Width 1 Lane; 2-Way Traffic	
	ADT (Both Directions)						ADT (Both Directions)	
	0-100	101-400	401-1000	1001-2000	2001-5000	>5000	0-100	>100
9	>9.8	>11.0	>12.2	>13.4	>13.4	>13.4	-	-
8	9.8	11.0	12.2	13.4	13.4	13.4	<4.9	-
7	8.5	9.8	11.0	12.2	13.4	13.4	4.6	-
6	7.3	8.5	9.1	10.4	12.2	13.4	4.3	-
5	6.1	7.3	7.9	8.5	10.4	11.6	4.0	-
4	5.5	6.1	6.7	7.3	8.5	9.8 (8.5)*	3.7	-
3	4.9	5.5	6.1	6.7	7.9	9.1 (7.9)*	3.4	<4.9
2	Any width less than required for a rating code of 3 and structure is open.							
0	Bridge Closed							

* Use value in parentheses for bridges longer than 60 meters.

Notes:

1. Use the lower rating code for values between those listed in the table.
2. Dimensions are in meters.
3. For 1 lane of one-way traffic Table 2A is used.
4. For 3 or more undivided lanes of 2-way traffic, use Table 2C, Other Multilane Divided Facilities.
5. Do not use Table 2B for code 9 and for codes 8 through 4 inclusive when the ADT >100. Single lane bridges less than 4.9 meters wide carrying 2-way traffic are always appraised at 3 or below if they carry more than an ADT of 100.
6. One-lane bridges 4.90 meters and greater in roadway width, which are not ramps, are evaluated as a 2-lane bridge using Table 2A.

Item 68 - Deck Geometry (cont'd)

Table 2C & 2D. Rating by Comparison of Number of Lanes - Item 28 and Bridge Roadway Width, Curb-to-Curb - Item 51

TABLE 2C					TABLE 2D	
Deck Geometry Rating Code	Bridge Roadway Width 2 or More Lanes				Bridge Roadway Width 1-Way Traffic	
	Interstate and Other Divided Freeways		Other Multilane Divided Facilities		Ramps Only (Item 5C = 7)	
	2 Lanes 1-way	3 or more Lanes	2 Lanes 1-way	3 or more Lanes	1 Lane	2 or more Lanes
9	>12.8	>3.7N+7.3	>12.8	>3.7N+5.5	>7.9	>3.7N+3.7
8	12.8	3.7N+7.3	12.8	3.7N+5.5	7.9	3.7N+3.7
7	12.2	3.7N+6.1	11.6	3.7N+4.6	7.3	3.7N+3.0
6	11.6	3.7N+4.9	11.0	3.7N+3.7	6.7	3.7N+2.4
5	11.0	3.7N+4.3	10.1	3.4N+3.0	6.1	3.7N+1.8
4 4	10.4 (8.8)*	3.4N+3.7 (3.4N+2.1)*	9.1 9.1	3.4N+1.8 3.4N+1.8	5.5 5.5	3.7N+1.2 3.7N+1.2
3 3	10.1 (8.5)*	3.4N+3.4 (3.4N+1.8)*	8.2 8.2	3.4N+1.5 3.4N+1.5	4.9 4.9	3.7N+0.6 3.7N+0.6
2	Any width less than required for a rating code of 3 and structure is open.					
0	Bridge Closed					

* Use value in parentheses for bridges longer than 60 meters.
N = Total number of lanes of traffic on the structure.

Notes

1. Use the lower rating code for values between those listed in the tables.
2. Dimensions are in meters.
3. Use Table 2C, Other Multilane Divided Facilities, for 3 or more undivided lanes of 2-way traffic.

Item 68 - Deck Geometry (cont'd)

Table 2E. Rating by Comparison of Minimum Vertical Clearance over Bridge Roadway - Item 53 and Functional Classification - Item 26

Deck Geometry Rating Code	Minimum Vertical Clearance		
	Functional Class		
	Interstate and Other Freeway	Other Principal and Minor Arterial	Major and Minor Collectors and Locals
9	>5.18	>5.02	>5.02
8	5.18	5.02	5.02
7	5.10	4.72	4.72
6	5.02	4.41	4.41
5	4.80	4.34	4.34
4	4.57	4.26	4.26
3	Vertical clearance less than value in rating code of 4 and requiring corrective action.		
2	Vertical clearance less than value in rating code of 4 and requiring replacement.		
0	Bridge Closed.		

Notes

1. Use the lower rating code for values between those listed in the table.
2. Dimensions are in meters.

Item 68 is automatically computed by BrM, if an error in the computation is believed to have occurred, contact the Bridge Inspection Engineer.

Note: The values provided in Tables 2A, 2B, 2C, 2D and 2E are in meters and need to be converted to feet.

Units: XX.XXX feet

Item 69 - Underclearances, Vertical and Horizontal 1 digit

This item is calculated by the Edit/Update Program and need not be coded by the bridge inspector.

Vertical and horizontal underclearances are measured from the through roadway to the superstructure or substructure units, respectively. Code "N" is used unless the bridge is over a highway or railroad.

The vertical underclearance is evaluated using Table 3A. The horizontal underclearance is evaluated using Table 3B. The lower of the codes obtained from Table 3A and Table 3B is used by the Edit/Update Program.

Bridges seldom are closed due to deficient underclearances, however, these bridges may be good candidates for rehabilitation or replacement.

Item 54 - Minimum Vertical Underclearance, Item 55 - Minimum Lateral Underclearance on Right, and Item 56 - Minimum Lateral Underclearance on Left are used to evaluate this item.

The functional classification used in the table is for the underpassing route. Therefore, the functional classification is obtained from the record for the route "under" the bridge (see Item 5 - Inventory Route).

If the underpassing route is not on a Federal-aid system, is not a defense route, or is not otherwise important, an "under" record may not be available. If no "under" record exits, it is assumed that the route under the bridge is a major or minor collector or a local road for the purpose of using Tables 3A and 3B.

Item 69 - Underclearances, Vertical and Horizontal (cont'd)

Table 3A. Rating by Comparison of Minimum Vertical Underclearance - Item 54 and Functional Classification of Underpassing Route - Item 26

Under-clear-ance Rating Code	Minimum Vertical Underclearance			
	Functional Class			Railroad
	Interstate and Other Freeway	Other Principal and Minor Arterial	Major and minor Collectors and Locals	
9	>5.18	>5.02	>5.02	>7.01
8	5.18	5.02	5.02	7.01
7	5.10	4.72	4.72	6.85
6	5.02	4.41	4.41	6.70
5	4.80	4.34	4.34	6.40
4	4.57	4.26	4.26	6.09
3	Underclearance less than value in rating code of 4 and requiring corrective action.			
2	Underclearance less than value in rating code of 4 and requiring replacement.			
0	Bridge closed.			

Notes

1. Use the lower rating code for values between those listed in the tables.
2. Dimensions are in meters.
3. The functional classification of the underpassing route shall be used in the evaluation. If an "under" record is not coded, the underpassing route shall be considered a major or minor collector or a local road.

Item 69 - Underclearances, Vertical and Horizontal (cont'd)

Table 3B. Rating by Comparison of Minimum Lateral Underclearances Right & Left - Items 55 & 56 and Functional Classification of Underpassing Route - Item 26

<table>
<tr><th rowspan="5">Under-clearance Rating Code</th><th colspan="7">Minimum Lateral Underclearance</th></tr>
<tr><th colspan="6">Functional Class</th><th rowspan="4">Railroad</th></tr>
<tr><th colspan="4">1-Way Traffic</th><th colspan="2">2-Way Traffic</th></tr>
<tr><th colspan="4">Principal Arterial-Interstate, Freeways or Expressways</th><th rowspan="3">Other Principal and Minor Arterial</th><th rowspan="3">Major and Minor Collectors and Locals</th></tr>
<tr><th colspan="2">Main Line</th><th colspan="2">Ramp</th></tr>
<tr><th></th><th>Left</th><th>Right</th><th>Left</th><th>Right</th><th></th></tr>
<tr><td>9</td><td>>9.1</td><td>>9.1</td><td>>1.2</td><td>>3.0</td><td>>9.1</td><td>>3.7</td><td>>6.1</td></tr>
<tr><td>8</td><td>9.1</td><td>9.1</td><td>1.2</td><td>3.0</td><td>9.1</td><td>3.7</td><td>6.1</td></tr>
<tr><td>7</td><td>5.5</td><td>6.4</td><td>0.9</td><td>2.7</td><td>6.4</td><td>3.4</td><td>5.2</td></tr>
<tr><td>6</td><td>1.8</td><td>3.7</td><td>0.6</td><td>2.4</td><td>3.7</td><td>3.0</td><td>4.3</td></tr>
<tr><td>5</td><td>1.5</td><td>3.4</td><td>0.6</td><td>1.8</td><td>3.0</td><td>2.4</td><td>3.4</td></tr>
<tr><td>4</td><td>1.2</td><td>3.0</td><td>0.6</td><td>1.2</td><td>1.8</td><td>1.2</td><td>2.4</td></tr>
<tr><td>3</td><td colspan="7">Underclearance less than value in rating code of 4 and requiring corrective action.</td></tr>
<tr><td>2</td><td colspan="7">Underclearance less than value in rating code of 4 and requiring replacement.</td></tr>
<tr><td>0</td><td colspan="7">Bridge closed.</td></tr>
</table>

Notes:

1. Use the lower rating code for values between those listed in the tables.
2. Dimensions are in meters.
3. When acceleration or deceleration lanes or ramps are provided under 2-way traffic, use the value from the right ramp column to determine code.
4. The functional classification of the underpassing route shall be used in the evaluation. If an "under" record is not coded, the underpassing route shall be considered a major or minor collector or a local road.

Item 69 is automatically computed by BrM, if an error in the computation is believed to have occurred, contact the Bridge Inspection Engineer.

Note: The values provided in Tables 3A and 3B are in meters and need to be converted to feet.
Units: XX.XXX feet

Item 70 - Bridge Posting 1 digit

The National Bridge Inspection Standards require the posting of load limits only if the maximum legal load configurations in the State exceeds the load permitted under the operating rating. If the load capacity at the operating rating is such that posting is required, this item shall be coded 4 or less. If no posting is required at the operating rating, this item shall be coded 5.

This item evaluates the load capacity of a bridge in comparison to the State legal load. It differs from Item 67 - Structural Evaluation in that Item 67 uses Item 66 - Inventory Rating, while the bridge posting requirement is based on Item 64 - Operating Rating.

Although posting a bridge for load-carrying capacity is required only when the maximum legal load exceeds the operating rating, highway agencies may choose to post at a lower level. This posting practice may appear to produce conflicting coding when Item 41 - Structure Open, Posted or Closed to Traffic is coded to show the bridge as actually posted at the site and Item 70 - Bridge Posting is coded as bridge posting is not required. Since different criteria are used for coding these 2 items, this coding is acceptable and correct when the highway agency elects to post at less than the operating rating. Item 70 shall be coded 4 or less only if the legal load of the State exceeds that permitted under the operating rating.

The use or presence of a temporary bridge affects the coding. The actual operating rating of the temporary bridge should be used to determine this item. However the highway agency may choose to post at a lower level. This also applies to bridges shored up or repaired on a temporary basis.

Code	Description
4 or less	Posting required
5	No posting required

The degree that the operating rating is less than the maximum legal load level may be used to differentiate between codes. As a guide and for coding purposes only, the following values may be used to code this item:

Code	Relationship of Operating Rating to Maximum Legal Load
5	Equal to or above legal loads
4	0.1 - 9.9% below
3	10.0 - 19.9% below
2	20.0 - 29.9% below
1	30.0 - 39.9% below
0	> 39.9% below

Inspectors are not to update this Item.

Item 71 - Waterway Adequacy 1 digit

This item appraises the waterway opening with respect to passage of flow through the bridge. The following codes shall be used in evaluating waterway adequacy (interpolate where appropriate). Site conditions may warrant somewhat higher or lower ratings than indicated by the table (e.g., flooding of an urban area due to a restricted bridge opening).

Where overtopping frequency information is available, the descriptions given in the table for chance of overtopping mean the following:

Remote	-	greater than 100 years
Slight	-	11 to 100 years
Occasional	-	3 to 10 years
Frequent	-	less than 3 years

Adjectives describing traffic delays mean the following:

Insignificant	-	Minor inconvenience. Highway passable in a matter of hours.
Significant	-	Traffic delays of up to several days.
Severe	-	Long term delays to traffic with resulting hardship.

Functional Classification

Principal Arterials - Interstates, Freeways, or Expressways	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Locals	Description Code
N	N	N	Bridge not over a waterway.
9	9	9	Bridge deck and roadway approaches above flood water elevations (high water). Chance of overtopping is remote.
8	8	8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches.
6	6	7	Slight chance of overtopping bridge deck and roadway approaches.
4	5	6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with insignificant traffic delays.

(codes continued on the next page)

Item 71 - Waterway Adequacy (cont'd)

Functional Classification: Principal Arterials - Interstates, Freeways, or Expressways	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Locals	Description Code
3	4	5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with significant traffic delays.
2	3	4	Occasional overtopping of bridge deck and roadway approaches with significant traffic delays.
2	2	3	Frequent overtopping of bridge deck and roadway approaches with significant traffic delays.
2	2	2	Occasional or frequent overtopping of bridge deck and roadway approaches with severe traffic delays.
0	0	0	Bridge closed.

Resource Location: Item 26 is required to assist with proper coding, RIMS

Item 72 - Approach Roadway Alignment 1 digit

Code the rating based on the adequacy of the approach roadway alignment. This item identifies those bridges which do not function properly or adequately due to the alignment of the approaches. It is not intended that the approach roadway alignment be compared to current standards but rather to the existing highway alignment. This concept differs from other appraisal evaluations. The establishment of set criteria to be used at all bridge sites is not appropriate for this item. The basic criteria is how the alignment of the roadway approaches to the bridge relate to the general highway alignment for the section of highway the bridge is on.

The individual structure shall be rated in accordance with the general appraisal rating guide described on page 453 in lieu of specific design values. The approach roadway alignment will be rated intolerable (a code of 3 or less) only if the horizontal or vertical curvature requires a substantial reduction in the vehicle operating speed from that on the highway section. A very minor speed reduction will be rated a 6, and when a speed reduction is not required, the appraisal code will be an 8. Additional codes may be selected between these general values.

Item 72 - Approach Roadway Alignment (cont'd)

For example, if the highway section requires a substantial speed reduction due to vertical or horizontal alignment, and the roadway approach to the bridge requires only a very minor additional speed reduction at the bridge, the appropriate code would be a 6. This concept shall be used at each bridge site.

Speed reductions necessary because of structure width and not alignment shall not be considered in evaluating this item.

Item 73 and Item 74

(Reserved)

Item 75 - Type of Work 3 digits

The information to be recorded for this item will be the type of work proposed to be accomplished on the structure to improve it to the point that it will provide the type of service needed and whether the proposed work is to be done by contract or force account. Code a 3-digit number composed of 2 segments.

Segment	Description	Length
75A	Type of Work Proposed	2 digits
75B	Work Done by	1 digit

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. To be eligible, a bridge must carry highway traffic, be deficient and have a sufficiency rating of 80.0 or less. This item may be coded for other bridges at the option of the highway agency. Use one of the following codes to represent the proposed work type, otherwise leave blank:

Code	Description
31	Replacement of bridge or other structure because of substandard load carrying capacity or substandard bridge roadway geometry.
32	Replacement of bridge or other structure because of relocation of road.
33	Widening of existing bridge or other major structure without deck rehabilitation or replacement; includes culvert lengthening.
34	Widening of existing bridge with deck rehabilitation or replacement.

(codes continued on the next page)

Item 75 - Type of Work (cont'd)

35	Bridge rehabilitation because of general structure deterioration or inadequate strength.
36	Bridge deck rehabilitation with only incidental widening.
37	Bridge deck replacement with only incidental widening.
38	Other structural work, including hydraulic replacements.

If segment A is blank, leave segment B blank. Otherwise, the third digit shall be coded using one of the following codes to indicate whether the proposed work is to be done by contract or by force account:

Code	Description
1	Work to be done by contract
2	Work to be done by owner's forces

EXAMPLES:	Code
A bridge is to be replaced by contract because it has deteriorated to the point that it can no longer carry legal loads. The same code should be used if the bridge is replaced because it is now too narrow or the original design was too light to accommodate today's legal loads.	311
A bridge is to be replaced because the roadway must be straightened to eliminate a dangerous curve. The work will be done by contract.	321
A bridge is to be widened to increase shoulder width or the number of traffic lanes. The existing deck is in good condition and will be incorporated as is into the new structure. The work is to be done by contract.	331
A culvert is to be extended by contract to accommodate additional roadway width as part of a reconstruction contract to improve the safety of the adjacent slopes.	331
A deck is to be rehabilitated and the bridge widened to provide a full 3.6 meter shoulder. The existing shoulder is only .2 meters wide and an extra line of girders with appropriate substructure widening must be added. The work will be done by contract.	341
A bridge superstructure and substructure are to be rehabilitated by State forces to increase the bridge's load capacity.	352

Item 75 - Type of Work (cont'd)

EXAMPLES:	Code
A bridge deck is to be rehabilitated by contract and a safety curb to be removed which results in incidental widening of 0.6 meters.	361
A bridge deck is to be replaced by contract and the deck cantilever overhang extended 0.6 meters, which is the maximum that can be done without adding another line of stringers or girders to the superstructure.	371
A bridge which is no longer needed is to be demolished and an at-grade crossing built by State forces. (This code could also be used to designate incidental safety work on a bridge such as bridge-rail upgrading or replacement.)	382

Inspectors are not to update this Item.

Item 76 - Length of Structure Improvement (XXXXX.X meters) 6 digits

Code a 6-digit number that represents the length of the proposed bridge improvement to the nearest tenth of a meter (with an assumed decimal point). For replacement or rehabilitation of the entire bridge, the length should be back to back of backwalls of abutments or from pavement notch to pavement notch. For replacement or rehabilitation of only part of the structure, use the length of the portion to be improved.

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. It may be coded for other bridges at the option of the highway agency.

For culvert improvements, use the proposed length measured along the centerline of the barrel regardless of the depth below grade. The measurement should be made between the inside faces of the top parapet or edge-stiffening beam of the top slab.

EXAMPLES:		Code
Length of Structure Improvement	76.2 meters	000762
	1200 meters	012000
	12,345 meters	123450

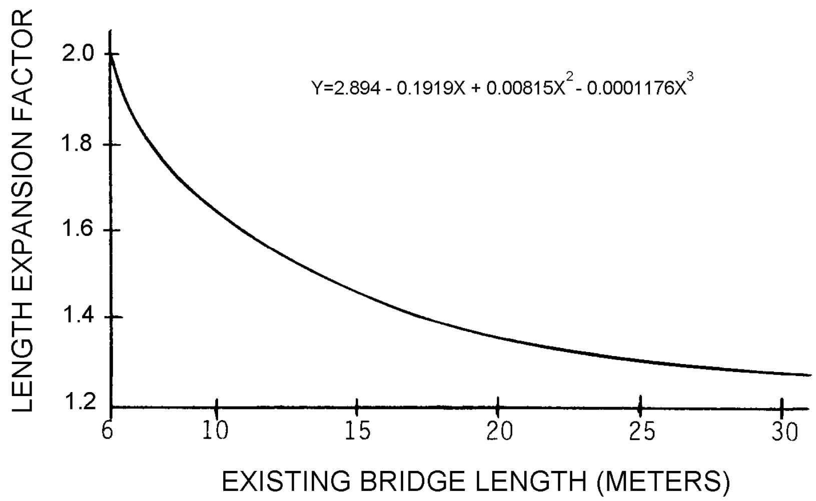
For substructure or channel work only, code the length of superstructure over, or supported by, the substructure or channel.

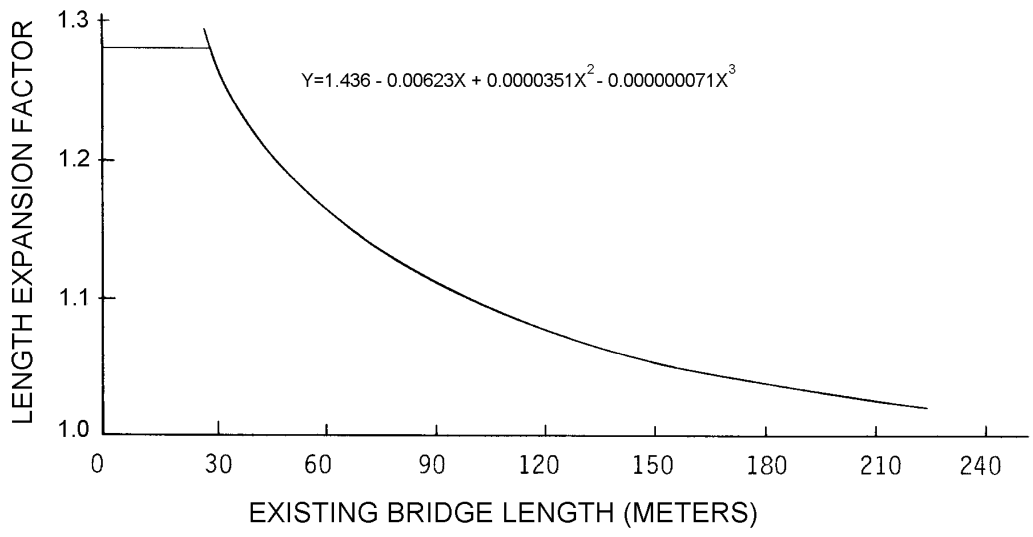
Typically, a replacement bridge is longer than the existing bridge. Nationwide averages for the increase in bridge length with replacement as a function of the existing length are given in the following figures. The length-expansion factors represent data for the years 1981 to 1985. Where site-specific data is lacking, these factors are suggested for estimating the length of replacement bridges. For exceedingly long bridges (i.e., 300 meters or more) the length-expansion factor approaches 1.0.

Item 76 - Length of Structure Improvement (cont'd)

INCREASED LENGTH OF REPLACEMENT BRIDGES

X = EXISTING BRIDGE LENGTH
Y = LENGTH EXPANSION FACTOR





REPLACEMENT BRIDGE LENGTH = EXISTING BRIDGE LENGTH x LENGTH EXPANSION FACTOR

Inspectors are not to update this Item.

Item 77 through Item 89

(Reserved)

Item 90 - Inspection Date 4 digits

Record the month and year that the last routine inspection of the structure was performed. This inspection date may be different from those recorded in Item 93 - Critical Feature Inspection Date. Code a 4-digit number to represent the month and year. The number of the month should be coded in the first 2 digits with a leading zero as required and the last 2 digits of the year coded as the third and fourth digits of the field.

EXAMPLES:	Code
Inspection date November 1992	1192
March 1994	0394

Item 90 is automatically generated with the date the inspector creates a "New" inspection in BrM, however the inspector shall confirm the date matches the first day of inspection.

Item 91 - Designated Inspection Frequency 2 digits

Code 2 digits to represent the number of months between designated inspections of the structure. A leading zero shall be coded as required. This interval is usually determined by the individual in charge of the inspection program. For posted, understrength bridges, this interval should be substantially less than the 24-month standard. The designated inspection interval could vary from inspection to inspection depending on the condition of the bridge at the time of inspection.

EXAMPLES:	Code
Posted bridge with heavy truck traffic and questionable structural details which is designated to be inspected each month	01
Bridge is scheduled to be inspected every 24 months	24

It should be noted that bridges will also require special non-scheduled inspections after unusual physical traumas such as floods, earthquakes, fires or collisions. These special inspections may range from a very brief visual examination to a detailed in-depth evaluation depending upon the nature of the trauma. For example, when a substructure pier or abutment is struck by an errant vehicle, in most cases only a visual examination of the bridge is necessary. After major collisions or earthquakes, in-depth inspections may be warranted as directed by the engineer in overall charge of the program. After and during severe floods, the stability of the substructure of bridges may have to be determined by probing, underwater sensors or other appropriate measures. Underwater inspection by divers may be required for some scour critical bridges immediately after floods. See Item 113 - Scour Critical Bridges.

Resource Location: Refer to the chart in Section 3.1.9 of the DelDOT Bridge Inspection Manual for guidance.

Item 92 - Critical Feature Inspection 9 digits

Using a series of 3-digit code segments, denote critical features that need special inspections or special emphasis during inspections and the designated inspection interval in months as determined by the individual in charge of the inspection program. The designated inspection interval could vary from inspection to inspection depending on the condition of the bridge at the time of inspection.

Segment	Description	Length
92A	Fracture Critical Details	3 digits
92B	Underwater Inspection	3 digits
92C	Other Special Inspection	3 digits

For each segment of Item 92A, B, and C, code the first digit Y for special inspection or emphasis needed and code N for not needed. The first digit of Item 92A, B, and C must be coded for all structures to designate either a yes or no answer. Those bridges coded with a Y in Item 92A or B should be the same bridges contained in the Master Lists of fracture critical and special underwater inspection bridges. In the second and third digits of each segment, code a 2-digit number to indicate the number of months between inspections only if the first digit is coded Y. If the first digit is coded N, the second and third digits are left blank.

Current guidelines for the maximum allowable interval between inspections can be summarized as follows:

Fracture Critical Details	24 months
Underwater Inspection	60 months
Other Special Inspections	60 months

EXAMPLES:

	Item	Code
A 2-girder system structure which is being inspected yearly and no other special inspections are required.	92A 92B 92C	Y12 N__ N__
A structure where both fracture critical and underwater inspection are being performed on a 1-year interval. Other special inspections are not required.	92A 92B 92C	Y12 Y12 N__
A structure has been temporarily shored and is being inspected on a 6-month interval. Other special inspections are not required.	92A 92B 92C	N__ N__ Y06

Item 93 - Critical Feature Inspection Date — 12 digits

Code only if the first digit of Item 92A, B, or C is coded Y for yes. Record as a series of 4-digit code segments, the month and year that the last inspection of the denoted critical feature was performed.

Segment	Description	Length
93A	Fracture Critical Details	4 digits
93B	Underwater Inspection	4 digits
93C	Other Special Inspection	4 digits

For each segment of this item, when applicable, code a 4-digit number to represent the month and year. The number of the month should be coded in the first 2 digits with a leading zero as required and the last 2 digits of the year coded as the third and fourth digits of the field. If the first digit of any part of Item 92 is coded N, then the corresponding part of this item shall be blank.

EXAMPLES:	Item	Code
A structure has fracture critical members which were last inspected in March 1986. It does not require underwater or other special feature inspections.	93A 93B 93C	0386 (blank) (blank)
A structure has no fracture critical details, but requires underwater inspection and has other special features (for example, a temporary support) for which the State requires special inspection. The last underwater inspection was done in April 1986 and the last special feature inspection was done in November 1985.	93A 93B 93C	(blank) 0486 1185

Item 94 - Bridge Improvement Cost — 6 digits

Code a 6-digit number to represent the estimated cost of the proposed bridge or major structure improvements in thousands of dollars. This cost shall include only bridge construction costs, excluding roadway, right of way, detour, demolition, preliminary engineering, etc. Code the base year for the cost in Item 97 - Year of Improvement Cost Estimate. Do not use this item for estimating maintenance costs.

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. It may be coded for other bridges at the option of the highway agency.

EXAMPLES:

		Code
Bridge Improvement Cost	$ 55,850	000056
	250,000	000250
	7,451,233	007451

Item 94 - Bridge Improvement Cost (cont'd)

Nationally, the deck area of replaced bridges is averaging 2.2 times the deck area before replacement. The deck area of rehabilitated bridges is averaging 1.5 times the deck area before rehabilitation. Widening square meter costs are typically 1.8 times the square meter cost of new bridges with similar spans. For example, if the average cost of a new bridge is $500 per square meter, the average cost of the widened area would be $900 per square meter.

Each highway agency is encouraged to use its best available information and established procedures to determine bridge improvement costs. In the absence of these procedures, the highway agency may wish to use the following procedure as a guide in preparing bridge improvement cost estimates.

Apply a construction unit cost to the proposed bridge area developed by using (1) current State deck geometry design standards and (2) proposed bridge length from Item 76 - Length of Structure Improvement.

Inspectors are not to update this Item.

Item 95 - Roadway Improvement Cost 6 digits

Code a 6-digit number to represent the cost of the proposed roadway improvement in thousands of dollars. This shall include only roadway construction costs, excluding bridge, right-of-way, detour, extensive roadway realignment costs, preliminary engineering, etc. Code the base year for the cost in Item 97 - Year of Improvement Cost Estimate. Do not use this item for estimating maintenance costs.

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. It may be coded for other bridges at the option of the highway agency.

In the absence of a procedure for estimating roadway improvement costs, a guide of 10 percent of the bridge costs is suggested.

Inspectors are not to update this Item.

Item 96 - Total Project Cost 6 digits

Code a 6-digit number to represent the total project cost in thousands of dollars, including incidental costs not included in Items 94 and 95. This item should include all costs normally associated with the proposed bridge improvement project. The Total Project Cost will therefore usually be greater than the sum of Items 94 and 95. Code the base year for the cost in Item 97 - Year of Improvement Cost Estimate. Do not use this item for coding maintenance costs.

This item must be coded for bridges eligible for the Highway Bridge Replacement and Rehabilitation Program. It may be coded for other bridges at the option of the highway agency.

In the absence of a procedure for estimating the total project cost, a guide of 150 percent of the bridge cost is suggested.

Inspectors are not to update this Item.

Item 97 - Year of Improvement Cost Estimate 4 digits

Record and code the year that the costs of work estimated in Item 94 - Bridge Improvement Cost, Item 95 - Roadway Improvement Cost, and Item 96 - Total Project Cost were based upon. This date and the data provided for Item 94 through Item 96 must be current; that is, Item 97 shall be no more than 8 years old.

EXAMPLES:

		Code
Year of Cost Estimate	1994 costs	1994
	2000 costs	2000

Inspectors are not to update this Item.

Item 98 - Border Bridge 5 digits

Use this item to indicate structures crossing borders of States. Code a 5-digit number composed of 2 segments specifying the percent responsibility for improvements to the existing structure when it is on a border with a neighboring State. Code the first 3 digits with the neighboring State code using State codes listed in Item 1 - State Code. Code the fourth and fifth digits with the percentage of total deck area of the existing bridge that the neighboring State is responsible for funding.

Segment	Description	Length
98A	Neighboring State Code	3 digits
98B	Percent Responsibility	2 digits

If a neighboring State codes the structure and accepts 100% of the responsibility, but your State still codes a record for the structure, then Item 98B in your State's record should be coded 99 to represent that your State has no responsibility for the structure.

For the special case of a structure on the border with Canada or Mexico, code the State code value = CAN or MEX respectively. If structure is not on a border, leave blank.

EXAMPLES:

	Code
A structure connects your State with New Jersey and New Jersey is responsible for funding 45 percent of future improvement costs.	34245
A structure connects your State with Mexico and Mexico is not responsible for any funding of future improvement costs.	MEX00

Item 99 - Border Bridge Structure Number 15 digits

Code the neighboring State's 15-digit National Bridge Inventory structure number for any structure noted in Item 98 - Border Bridge. This number must match exactly the neighboring State's submitted NBI structure number. The entire 15-digit field must be accounted for including zeros and blank spaces whether they are leading, trailing, or embedded in the 15-digit field. If Item 98 is blank, this item is blank.

In the above example where Mexico (or a neighboring State) has 00% responsibility, and, if there is no NBI Structure Number in that State's inventory file, then the entire 15-digit field shall be coded zeroes.

Item 100 - STRAHNET Highway Designation 1 digit

This item shall be coded for all records in the inventory. For the purposes of this item, the STRAHNET Connectors are considered included in the term STRAHNET. For the inventory route identified in Item 5, indicate STRAHNET highway conditions using one of the following codes:

Code	Description
0	The inventory route is not a STRAHNET route.
1	The inventory route is on a Interstate STRAHNET route.
2	The inventory route is on a Non-Interstate STRAHNET route.
3	The inventory route is on a STRAHNET connector route.

Resource Location: RIMS

Item 101 - Parallel Structure Designation 1 digit

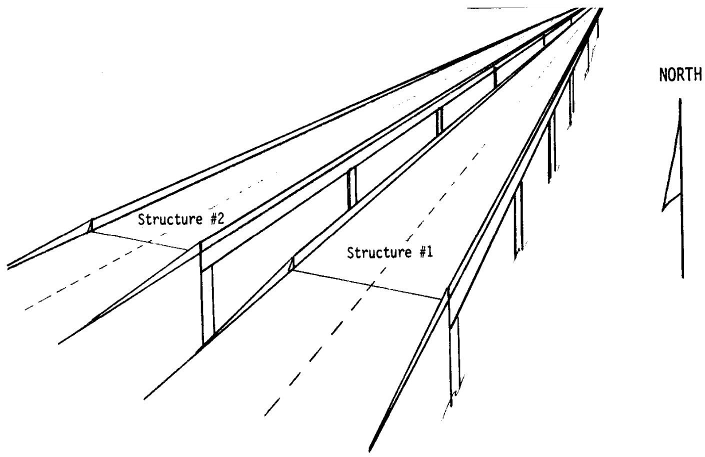
Code this item to indicate situations where separate structures carry the inventory route in opposite directions of travel over the same feature. The lateral distance between structures has no bearing on the coding of this item. One of the following codes shall be used:

Code	Description
R	The right structure of parallel bridges carrying the roadway in the direction of the inventory. (For a STRAHNET highway, this is west to east and south to north.)
L	The left structure of parallel bridges. This structure carries traffic in the opposite direction.
N	No parallel structure exists.

Item 101 - Parallel Structure Designation(cont'd)

EXAMPLE: Code

Structure #1	R
Structure #2	L



Resource Location: RIMS or Bridge Plans

Determine the "forward" direction of the roadway. Then looking along the "forward" (or upstation) direction of the road, the bridge on the right will be coded "R".

Item 102 - Direction of Traffic 1 digit

Code the direction of traffic of the inventory route identified in Item 5 as a 1-digit number using one of the codes below. This item must be compatible with other traffic-related items such as Item 28A Lanes on the Structure, Item 29 - Average Daily Traffic, Item 47 - Total Horizontal Clearance and Item 51 - Bridge Roadway Width, Curb-to-Curb.

Code	Description
0	Highway traffic not carried
1	1-way traffic
2	2-way traffic
3	One lane bridge for 2-way traffic

Item 103 - Temporary Structure Designation 1 digit

Code this item to indicate situations where temporary structures or conditions exist. This item should be blank if not applicable.

Code	Description
T	Temporary structure(s) or conditions exist.

Temporary structure(s) or conditions are those which are required to facilitate traffic flow. This may occur either before or during the modification or replacement of a structure found to be deficient. Such conditions include the following:

! Bridges shored up, including additional temporary supports.
! Temporary repairs made to keep a bridge open.
! Temporary structures, temporary runarounds or bypasses.
! Other temporary measures, such as barricaded traffic lanes to keep the bridge open.

Any repaired structure or replacement structure which is expected to remain in place without further project activity, other than maintenance, for a significant period of time shall not be considered temporary. Under such conditions, that structure, regardless of its type, shall be considered the minimum adequate to remain in place and evaluated accordingly.

If this item is coded T, then all data recorded for the structure shall be for the condition of the structure without temporary measures, except for the following items which shall be for the temporary structure:

Item 10 - Inventory Route, Minimum Vertical Clearance
41 - Structure Open, Posted, or Closed to Traffic
47 - Inventory Route, Total Horizontal Clearance
53 - Minimum Vertical Clearance Over Bridge Roadway
54 - Minimum Vertical Underclearance
55 - Minimum Lateral Underclearance on Right
56 - Minimum Lateral Underclearance on Left
70 - Bridge Posting

Item 104 - Highway System of the Inventory Route 1 digit

This item is to be coded for all records in the inventory. For the inventory route identified in Item 5, indicate whether the inventory route is on the National Highway System (NHS) or not on that system. Initially, this code shall reflect an inventory route on the NHS "Interim System" description in Section 1006(a) of the 1991 ISTEA. Upon approval of the NHS by Congress, the coding is to reflect the approved NHS. Use one of the following codes:

Code	Description
0	Inventory Route is not on the NHS
1	Inventory Route is on the NHS

Resource Location: RIMS

Item 105 - Federal Lands Highways — 1 digit

Structures owned by State and local jurisdictions on roads which lead to and traverse through federal lands sometimes require special coded unique identification because they are eligible to receive funding from the Federal Lands Highway Program. One of the following codes shall be used:

Code	Description
0	Not applicable
1	Indian Reservation Road (IRR)
2	Forest Highway (FH)
3	Land Management Highway System (LMHS)
4	Both IRR and FH
5	Both IRR and LMHS
6	Both FH and LMHS
9	Combined IRR, FH and LMHS

Item 106 - Year Reconstructed — 4 digits

Record and code the year of most recent reconstruction of the structure. Code all 4 digits of the latest year in which reconstruction of the structure was completed. If there has been no reconstruction code 0000.

For a bridge to be defined as reconstructed, the type of work performed, whether or not it meets current minimum standards, must have been eligible for funding under any of the Federal-aid funding categories. The eligibility criteria would apply to the work performed regardless of whether all State or local funds or Federal-aid funds were used.

Some types of eligible work not to be considered as reconstruction are listed:

- Safety feature replacement or upgrading (for example, bridge rail, approach guardrail or impact attenuators).
- Painting of structural steel.
- Overlay of bridge deck as part of a larger highway surfacing project (for example, overlay carried across bridge deck for surface uniformity without additional bridge work).
- Utility work.
- Emergency repair to restore structural integrity to the previous status following an accident.
- Retrofitting to correct a deficiency which does not substantially alter physical geometry or increase the load-carrying capacity.
- Work performed to keep a bridge operational while plans for complete rehabilitation or replacement are under preparation (for example, adding a substructure element or extra girder).

EXAMPLE:	Code
Reconstruction completed 1970	1970

Resource Location: Bridge Plans, documentation or correspondence in the inspection file

Item 107 - Deck Structure Type 1 digit

Record the type of deck system on the bridge. If more than one type of deck system is on the bridge, code the most predominant. Code N for a filled culvert or arch with the approach roadway section carried across the structure. Use one of the following codes:

Code	Description
1	Concrete Cast-in-Place
2	Concrete Precast Panels
3	Open Grating
4	Closed Grating
5	Steel plate (includes orthotropic)
6	Corrugated Steel
7	Aluminum
8	Wood or Timber
9	Other
N	Not applicable

Resource Location: Bridge Plans, or field verification

Item 108 - Wearing Surface/Protective System 3 digits

Information on the wearing surface and protective system of the bridge deck shall be coded using a 3-digit code composed of 3 segments.

Segment	Description	Length
108A	Type of Wearing Surface	1 digit
108B	Type of Membrane	1 digit
108C	Deck Protection	1 digit

1st Digit - Type of Wearing Surface (Item 108A):

Code	Description
1	Monolithic Concrete (concurrently placed with structural deck)
2	Integral Concrete (separate non-modified layer of concrete added to structural deck)
3	Latex Concrete or similar additive
4	Low Slump Concrete
5	Epoxy Overlay
6	Bituminous
7	Wood or Timber
8	Gravel
9	Other
0	None (no additional concrete thickness or wearing surface is included in the bridge deck)
N	Not Applicable (applies only to structures with no deck)

Item 108 - Wearing Surface/Protective System (cont'd)

2nd Digit - Type of Membrane (Item 108B):

Code	Description
1	Built-up
2	Preformed Fabric
3	Epoxy
8	Unknown
9	Other
0	None
N	Not Applicable (applies only to structures with no deck)

3rd Digit - Deck Protection (Item 108C):

Code	Description
1	Epoxy Coated Reinforcing
2	Galvanized Reinforcing
3	Other Coated Reinforcing
4	Cathodic Protection
6	Polymer Impregnated
7	Internally Sealed
8	Unknown
9	Other
0	None
N	Not Applicable (applies only to structures with no deck)

Resource Location: Bridge Plans, or field verification

Item 108B: If plans specify a membrane was used, then code accordingly. If inspector is unsure of which code to use, contact the Bridge Inspection Engineer.

Item 109 - Average Daily Truck Traffic (XX percent) 2 digits

Code a 2-digit percentage that shows the percentage of Item 29 - Average Daily Traffic that is truck traffic. Do not include vans, pickup trucks and other light delivery trucks in this percentage.

If this information is not available, an estimate which represents the average percentage for the category of road carried by the bridge may be used. May be left blank if Item 29 - Average Daily Traffic is not greater than 100.

EXAMPLES:

		Code
Average Daily Traffic	7% trucks	07
	12% trucks	12

Resource Location: The latest Delaware Vehicle Volume Summary (Traffic Summary) available at www.deldot.gov/information/pubs_forms/manuals/traffic_counts or the latest google earth .kmz file available at the same web address.

Item 110 - Designated National Network 1 digit

The national network for trucks includes most of the Interstate System and those portions of Federal-Aid highways identified in the Code of Federal Regulations (23 CFR 658). The national network for trucks is available for use by commercial motor vehicles of the dimensions and configurations described in these regulations. For the inventory route identified in Item 5, indicate conditions using one of the following codes:

Code	Description
0	The inventory route is not part of the national network for trucks.
1	The inventory route is part of the national network for trucks.

The following routes are Designated Truck Routes:
US 13 from MD state line to I-495 southbound (Wilmington)
US 40 from MD state line to I-295/US 13 (Wilmington)
US 113 from MD state line to US 13 (Dover)
US 301 from MD state line I-295/US 13 (Wilmington)

Item 111 - Pier or Abutment Protection (for Navigation) 1 digit

If Item 38 - Navigation Control has been coded 1, use the codes below to indicate the presence and adequacy of pier or abutment protection features such as fenders, dolphins, etc. The condition of the protection devices may be a factor in the overall evaluation of Item 60 - Substructure. If Item 38 - Navigation Control has been coded 0 or N, leave blank to indicate not applicable.

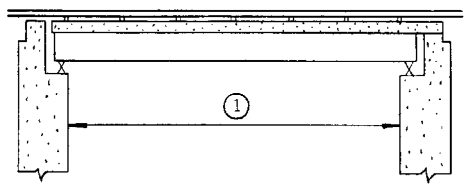
Code	Description
1	Navigation protection not required
2	In place and functioning
3	In place but in a deteriorated condition
4	In place but reevaluation of design suggested
5	None present but reevaluation suggested

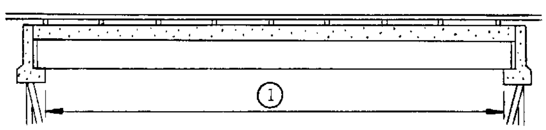
Item 112 - NBIS Bridge Length 1 digit

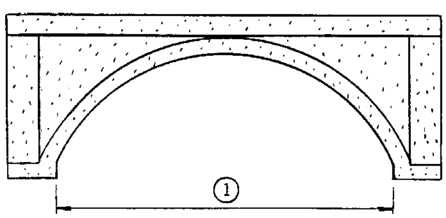
Does this structure meet or exceed the minimum length specified to be designated as a bridge for National Bridge Inspection Standards purposes? The following definition of a bridge is to be used:

> A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than
> 20 feet* between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.
> * (6.1 meters).

Code	Description
Y	Yes
N	No



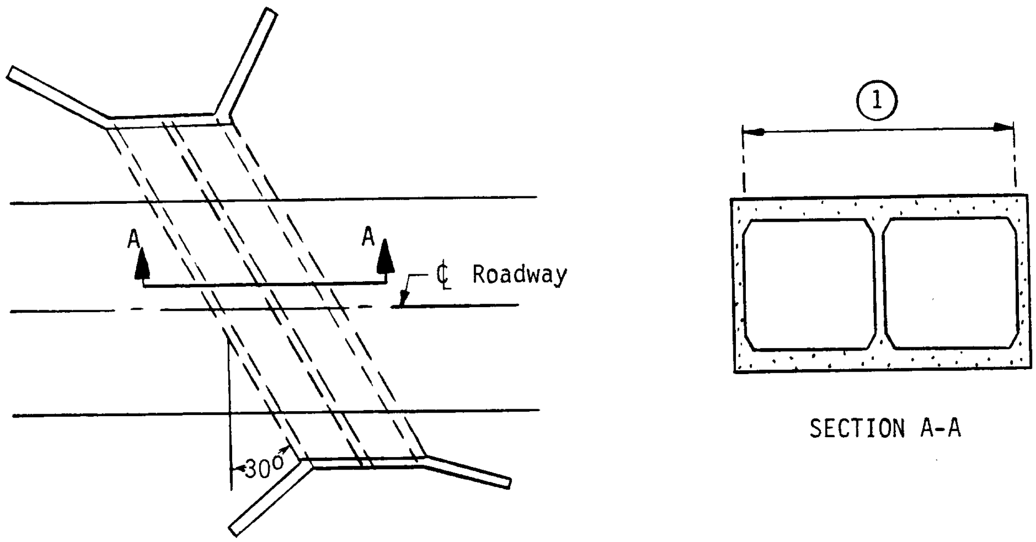


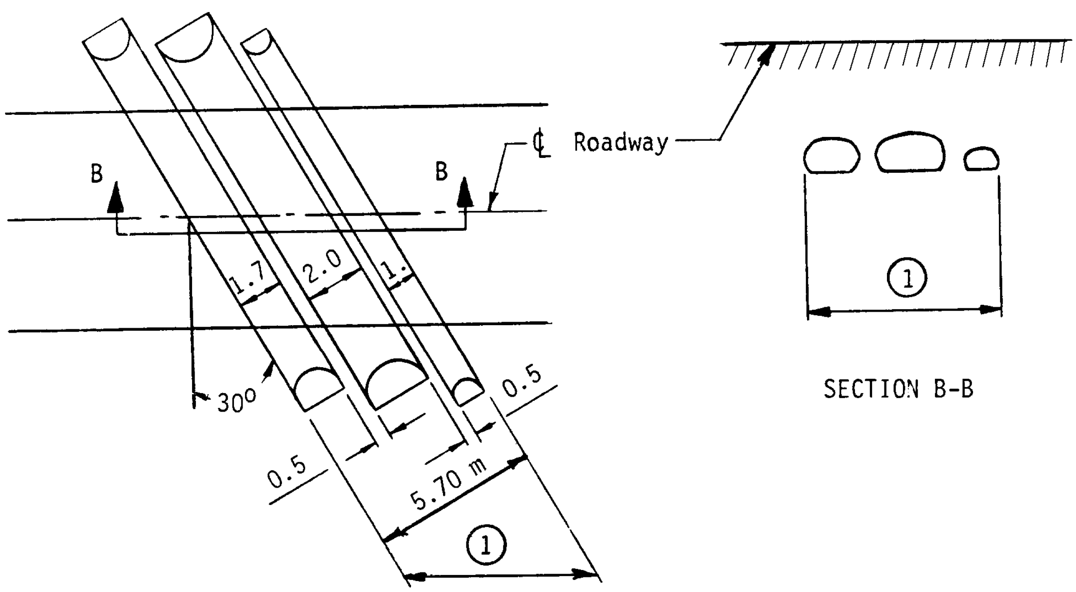


EXAMPLES:

(1) Item 112 - NBIS Bridge Length

Item 112 – NBIS Bridge Length (cont'd)





EXAMPLES:

(1) Item 112 - NBIS Bridge Length

Item 113 - Scour Critical Bridges 1 digit

Use a single-digit code as indicated below to identify the current status of the bridge regarding its vulnerability to scour. Scour analyses shall be made by hydraulic/geotechnical/structural engineers. Details on conducting a scour analysis are included in the FHWA Technical Advisory 5140.23 titled, "Evaluating Scour at Bridges." Whenever a rating factor of 4 or below is determined for this item, the rating factor for Item 60 - Substructure may need to be revised to reflect the severity of actual scour and resultant damage to the bridge. A scour critical bridge is one with abutment or pier foundations which are rated as unstable due to (1) observed scour at the bridge site or (2) a scour potential as determined from a scour evaluation study.

Code	Description
N	Bridge not over waterway.
U	Bridge with "unknown" foundation that has not been evaluated for scour. Since risk cannot be determined, flag for monitoring during flood events and, if appropriate, closure.
T	Bridge over "tidal" waters that has not been evaluated for scour, but considered low risk. Bridge will be monitored with regular inspection cycle and with appropriate underwater inspections. ("Unknown" foundations in "tidal" waters should be coded U.)
9	Bridge foundations (including piles) on dry land well above flood water elevations.
8	Bridge foundations determined to be stable for assessed or calculated scour conditions; calculated scour is above top of footing. (Example A)
7	Countermeasures have been installed to correct a previously existing problem with scour. Bridge is no longer scour critical.
6	Scour calculation/evaluation has not been made. (Use only to describe case where bridge has not yet been evaluated for scour potential.)
5	Bridge foundations determined to be stable for calculated scour conditions; scour within limits of footing or piles. (Example B)
4	Bridge foundations determined to be stable for calculated scour conditions; field review indicates action is required to protect exposed foundations from effects of additional erosion and corrosion.
3	Bridge is scour critical; bridge foundations determined to be unstable for calculated scour conditions: - Scour within limits of footing or piles. (Example B) - Scour below spread-footing base or pile tips. (Example C)

(codes continued on the next page)

Item 113 - Scour Critical Bridges (cont'd)

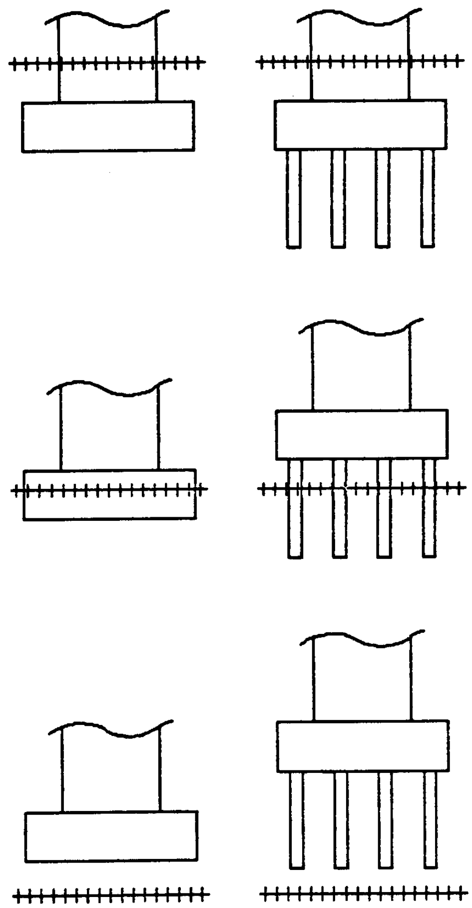
Code Description

2 Bridge is scour critical; field review indicates that extensive scour has occurred at bridge foundations. Immediate action is required to provide scour countermeasures.

1 Bridge is scour critical; field review indicates that failure of piers/abutments is imminent. Bridge is closed to traffic.

0 Bridge is scour critical. Bridge has failed and is closed to traffic.

EXAMPLES:	CALCULATED SCOUR DEPTH	ACTION NEEDED
A. Above top of footing		None - indicate rating of 8 for this item
B. Within limits of footing or piles		Conduct foundation structural analysis
C. Below pile tips or spread-footing base		Provide for monitoring and scour countermeasures as necessary



SPREAD FOOTING (NOT FOUNDED IN ROCK) PILE FOOTING

++++++++++++++++ = Calculated scour depth

Contact the Bridge Inspection Engineer if inspector believes a rating change is necessary.

Item 114 - Future Average Daily Traffic 6 digits

Code for all bridges the forecasted average daily traffic (ADT) for the inventory route identified in Item 5. This shall be projected at least 17 years but no more than 22 years from the year of inspection. The intent is to provide a basis for a 20-year forecast. This item may be updated anytime, but must be updated when the forecast falls below the 17-year limit. If planning data is not available, use the best estimate based on site familiarity.

The future ADT must be compatible with the other items coded for the bridge. For example, parallel bridges with an open median are coded as follows: if Item 28 -Lanes On and Under the Structure and Item 51 - Bridge Roadway Width, Curb-to-Curb are coded for each bridge separately, then the future ADT must be coded for each bridge separately (not the total for the route).

EXAMPLES:

		Code
Future ADT	540	000540
	15,600	015600
	240,000	240000

Inspectors are not to update this Item.

Item 115 - Year of Future Average Daily Traffic 4 digits

Record and code the year represented by the future ADT in Item 114. The projected year of future ADT shall be at least 17 years but no more than 22 years from the year of inspection.

EXAMPLE:

		Code
Year of Future ADT is	2014	2014

Inspectors are not to update this Item.

Item 116 - Minimum Navigation Vertical Clearance, Vertical Lift Bridge (XXX.X meters) 4 digits

Record and code as a 4-digit number truncated to the tenth of a meter (with an assumed decimal point), the minimum vertical clearance imposed at the site as measured above a datum that is specified on a navigation permit issued by a control agency. Code this item only for vertical lift bridges in the dropped or closed position, otherwise leave blank.

EXAMPLES:

		Code
Vertical Clearance	10.67 meters	0106
	24.22 meters	0242

Resource Location: Field measurement during every routine inspection

Measurements shall be recorded on the Waterway Sketch Sheet at the time of inspection.

GENERAL

Inspection reports should generally include the following:

1. A statement of action taken, if any, pursuant to findings of inspection.
2. Any special findings stemming from the inspection and evaluation of fracture critical members, underwater inspections, and special feature inspection.
3. Any features which should be monitored closely during subsequent inspections as should any specific descriptions, instructions, or concerns.

Measurements, sketches, diagrams, test results, or calculations should generally be included on separate sheets.

APPENDIX A

Structure Inventory and Appraisal Sheet

Appendix A

OMB No. 2125-0501

Structure Inventory and Appraisal Sheet

NATIONAL BRIDGE INVENTORY - - - - - - - STRUCTURE INVENTORY AND APPRAISAL 10/15/94

********** IDENTIFICATION **********************
(1) STATE NAME - ____________ CODE __
(8) STRUCTURE NUMBER #______________
(5) INVENTORY ROUTE (ON/UNDER) - ____ = ________
(2) HIGHWAY AGENCY DISTRICT __
(3) COUNTY CODE ___ (4) PLACE CODE _____
(6) FEATURES INTERSECTED - ____________________
(7) FACILITY CARRIED - _______________
(9) LOCATION - ____________________
(11) MILEPOINT/KILOMETERPOINT ___.__
(12) BASE HIGHWAY NETWORK - _________ CODE _
(13) LRS INVENTORY ROUTE & SUBROUTE #__________
(16) LATITUDE __ DEG __ MIN __.__ SEC
(17) LONGITUDE ___ DEG __ MIN __.__ SEC
(98) BORDER BRIDGE STATE CODE ___ % SHARE __ %
(99) BORDER BRIDGE STRUCTURE NO. #____________

********** STRUCTURE TYPE AND MATERIAL *********
(43) STRUCTURE TYPE MAIN: MATERIAL - ____________
TYPE - ____________________ CODE ___
(44) STRUCTURE TYPE APPR: MATERIAL - ____________
TYPE - ____________________ CODE ___
(45) NUMBER OF SPANS IN MAIN UNIT ___
(46) NUMBER OF APPROACH SPANS ____
(107) DECK STRUCTURE TYPE - _______________ CODE _
(108) WEARING SURFACE / PROTECTIVE SYSTEM:
A) TYPE OF WEARING SURFACE - ____________ CODE _
B) TYPE OF MEMBRANE - ____________ CODE _
C) TYPE OF DECK PROTECTION - ____________ CODE _

********** AGE AND SERVICE *********************
(27) YEAR BUILT ____
(106) YEAR RECONSTRUCTED ____
(42) TYPE OF SERVICE: ON - __________________
UNDER - ____________________ CODE __
(28) LANES: ON STRUCTURE __ UNDER STRUCTURE __
(29) AVERAGE DAILY TRAFFIC ______
(30) YEAR OF ADT ____ (109) TRUCK ADT __ %
(19) BYPASS, DETOUR LENGTH ___ KM

********** GEOMETRIC DATA **********************
(48) LENGTH OF MAXIMUM SPAN ____.__ M
(49) STRUCTURE LENGTH ______.__ M
(50) CURB OR SIDEWALK: LEFT __.__ M RIGHT __.__ M
(51) BRIDGE ROADWAY WIDTH CURB TO CURB ___.__ M
(52) DECK WIDTH OUT TO OUT ___.__ M
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) ___.__ M
(33) BRIDGE MEDIAN - ____________________ CODE _
(34) SKEW __ DEG (35) STRUCTURE FLARED _
(10) INVENTORY ROUTE MIN VERT CLEAR __.__ M
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR __.__ M
(53) MIN VERT CLEAR OVER BRIDGE RDWY __.__ M
(54) MIN VERT UNDERCLEAR REF - ______ __.__ M
(55) MIN LAT UNDERCLEAR RT REF - ______ __.__ M
(56) MIN LAT UNDERCLEAR LT __.__ M

********** NAVIGATION DATA *********************
(38) NAVIGATION CONTROL - _______________ CODE _
(111) PIER PROTECTION - _______________ CODE _
(39) NAVIGATION VERTICAL CLEARANCE __.__ M
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR __.__ M
(40) NAVIGATION HORIZONTAL CLEARANCE ___.__ M

****

SUFFICIENCY RATING = ___._
STATUS = ____________________

********** CLASSIFICATION ***************** CODE
(112) NBIS BRIDGE LENGTH - __
(104) HIGHWAY SYSTEM - __
(26) FUNCTIONAL CLASS - ________________ _
(100) DEFENSE HIGHWAY - ________________ _
(101) PARALLEL STRUCTURE - ________________ _
(102) DIRECTION OF TRAFFIC - ________________ _
(103) TEMPORARY STRUCTURE - ________________ _
(105) FEDERAL LANDS HIGHWAYS - ________________ _
(110) DESIGNATED NATIONAL NETWORK - ____________ _
(20) TOLL - ____________________ _
(21) MAINTAIN - ____________________ _
(22) OWNER - ____________________ _
(37) HISTORICAL SIGNIFICANCE - ______________ _

********** CONDITION ********************** CODE
(58) DECK _
(59) SUPERSTRUCTURE _
(60) SUBSTRUCTURE _
(61) CHANNEL & CHANNEL PROTECTION _
(62) CULVERTS _

********** LOAD RATING AND POSTING ******** CODE
(31) DESIGN LOAD - ________ OR ________ _
(63) OPERATING RATING METHOD - ____________ _
(64) OPERATING RATING - ________ __._
(65) INVENTORY RATING METHOD - ____________ _
(66) INVENTORY RATING - ________ __._
(70) BRIDGE POSTING - ____________________ _
(41) STRUCTURE OPEN, POSTED OR CLOSED - _
DESCRIPTION - ____________________

********** APPRAISAL ********************** CODE
(67) STRUCTURAL EVALUATION _
(68) DECK GEOMETRY _
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL _
(71) WATERWAY ADEQUACY _
(72) APPROACH ROADWAY ALIGNMENT _
(36) TRAFFIC SAFETY FEATURES ____
(113) SCOUR CRITICAL BRIDGES _

********** PROPOSED IMPROVEMENTS ***************
(75) TYPE OF WORK - ____________________ CODE ___
(76) LENGTH OF STRUCTURE IMPROVEMENT _____._ M
(94) BRIDGE IMPROVEMENT COST $___,___,000
(95) ROADWAY IMPROVEMENT COST $___,___,000
(96) TOTAL PROJECT COST $___,___,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE ____
(114) FUTURE ADT ______
(115) YEAR OF FUTURE ADT ____

********** INSPECTIONS *************************
(90) INSPECTION DATE __/__ (91) FREQUENCY __ MO
(92) CRITICAL FEATURE INSPECTION: (93) CFI DATE
A) FRACTURE CRIT DETAIL - ___ - __ MO A) __/__
B) UNDERWATER INSP - ___ - __ MO B) __/__
C) OTHER SPECIAL INSP - ___ - __ MO C) __/__

APPENDIX B

Sufficiency Rating Formula and Example

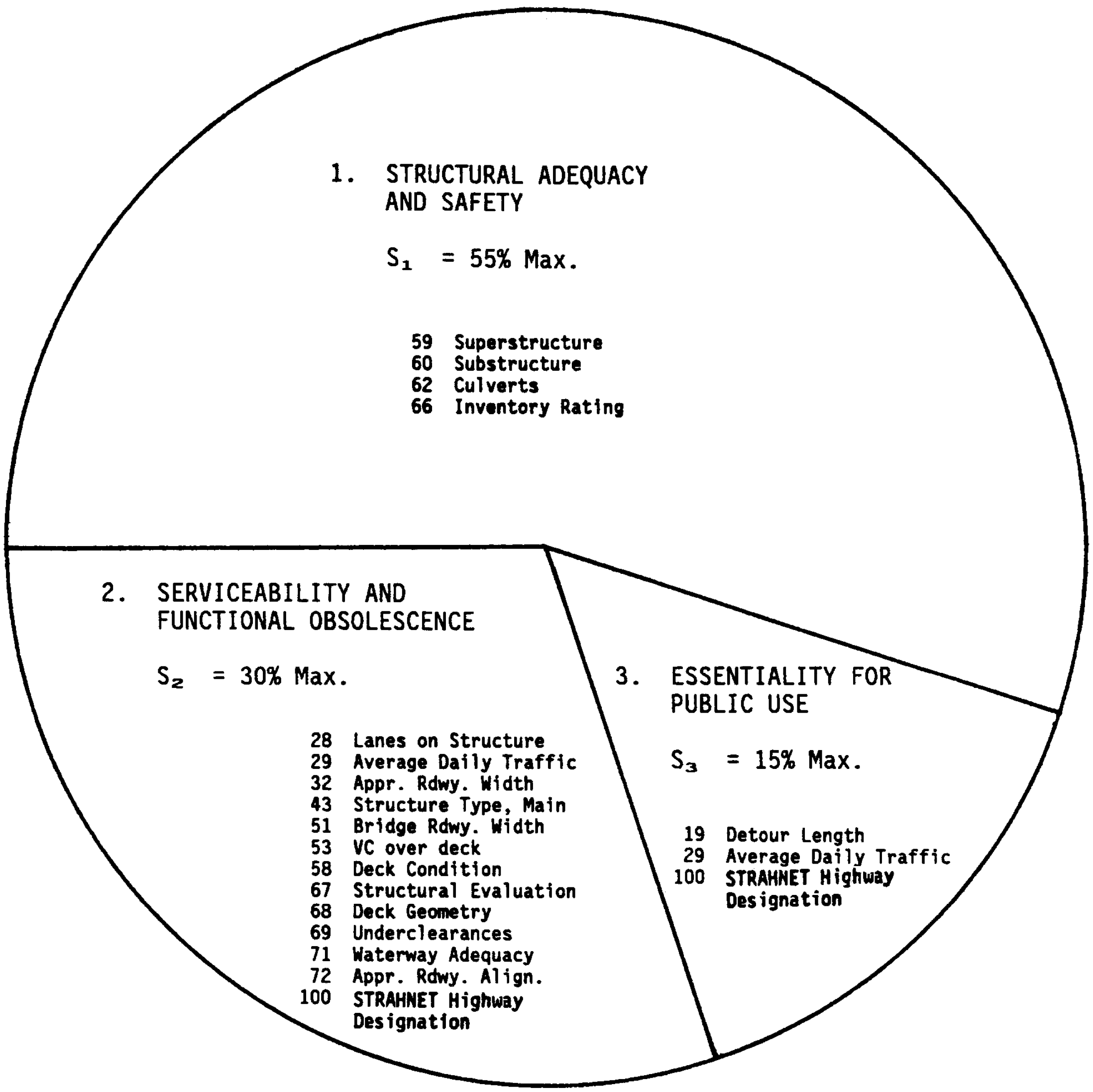
Appendix B

Sufficiency Rating Formula and Example

The sufficiency rating formula described herein is a method of evaluating highway bridge data by calculating four separate factors to obtain a numeric value which is indicative of bridge sufficiency to remain in service. The result of this method is a percentage in which 100 percent would represent an entirely sufficient bridge and zero percent would represent an entirely insufficient or deficient bridge.

An asterisk prefix is used to identify a sufficiency rating that was calculated even though some essential data was missing or coded incorrectly. The Edit/Update Program will substitute a value for the unusable data (which will not lower the rating) and calculate the sufficiency rating. The asterisk is dropped when the unusable data is corrected. It is normal that all culverts with Bridge Roadway Width, Curb-to-Curb - Item 51 coded '0000' will have an asterisk prefixed sufficiency.

Figure 1. Summary of Sufficiency Rating Factors



4. SPECIAL REDUCTIONS

S_4 = 13% Max.

19 Detour Length
36 Traffic Safety Features
43 Structure Type, Main

SUFFICIENCY RATING $= S_1 + S_2 + S_3 - S_4$

Sufficiency Rating shall not be less than 0% nor greater than 100%

Sufficiency Rating Formula

1. Structural Adequacy and Safety (55% maximum)

   a. Only the lowest rating code of Item 59, 60, or 62 applies.

If Item 59 (Superstructure Rating) or Item 60 (Substructure Rating) is	≤ 2	then	A = 55%
	= 3		A = 40%
	= 4		A = 25%
	= 5		A = 10%

If Item 59 and Item 60 = N and Item 62 (Culvert Rating) is	≤ 2	then	A = 55%
	= 3		A = 40%
	= 4		A = 25%
	= 5		A = 10%

   b. Reduction for Load Capacity:

   Calculate using the following formulas where IR is the Inventory Rating (MS Loading) in tons or use Figure 2:

   $$B = (32.4 - IR)^{1.5} \times 0.3254$$

   or

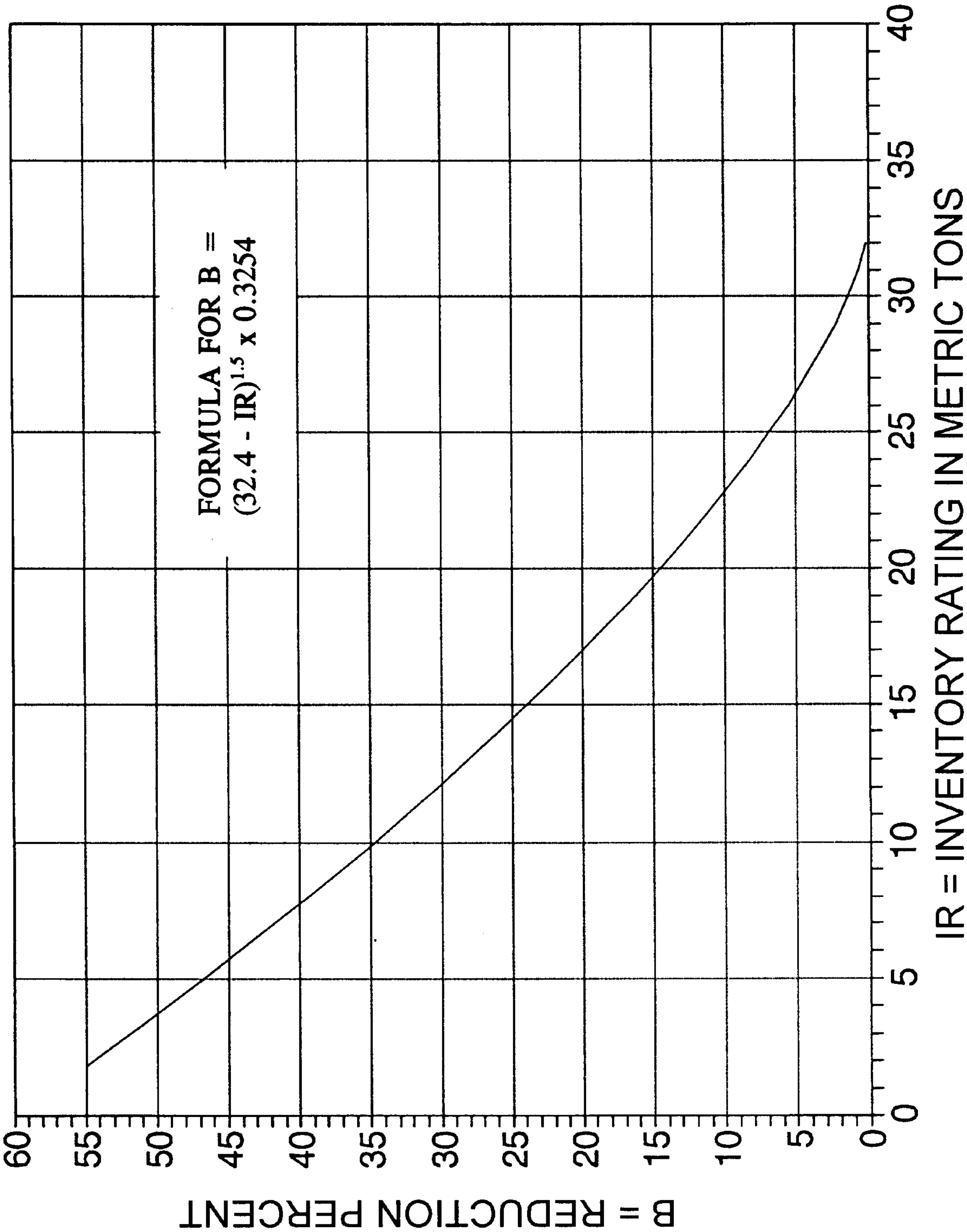
   If $(32.4 - IR) \leq 0$, then $B = 0$

   "B" shall not be less than 0% nor greater than 55%.

$S_1 = 55 - (A + B)$

S_1 shall not be less than 0% nor greater than 55%.

FIGURE 2. Reduction for Load Capacity



2. Serviceability and Functional Obsolescence (30% maximum)

a. Rating Reductions (13% maximum)

If #58 (Deck Condition) is	$\leq$ 3	then	A = 5%
	= 4		A = 3%
	= 5		A = 1%
If #67 (Structural Evaluation) is	$\leq$ 3	then	B = 4%
	= 4		B = 2%
	= 5		B = 1%
If #68 (Deck Geometry) is	$\leq$ 3	then	C = 4%
	= 4		C = 2%
	= 5		C = 1%
If #69 (Underclearances) is	$\leq$ 3	then	D = 4%
	= 4		D = 2%
	= 5		D = 1%
If #71 (Waterway Adequacy) is	$\leq$ 3	then	E = 4%
	= 4		E = 2%
	= 5		E = 1%
If #72 (Approach Road Alignment) is	$\leq$ 3	then	F = 4%
	= 4		F = 2%
	= 5		F = 1%

J = (A + B + C + D + E + F)

J shall not be less than 0% nor greater than 13%.

b. Width of Roadway Insufficiency (15% maximum)

Use the sections that apply:

(1) applies to all bridges;
(2) applies to 1-lane bridges only;
(3) applies to 2 or more lane bridges;
(4) applies to all <u>except</u> 1-lane bridges.

Also determine X and Y:

$$X \text{ (ADT/Lane)} = \frac{\text{Item 29 (ADT)}}{\text{first 2 digits of \#28 (Lanes)}}$$

$$Y \text{ (Width/Lane)*} = \frac{\text{Item 51 (Bridge Rdwy. Width)}}{\text{first 2 digits of \#28 (Lanes)}}$$

*A value of 10.9 Meters will be substituted when item 51 is coded 0000 or not numeric.

(1) Use when the last 2 digits of #43 (Structure Type) are not equal to 19 (Culvert):

If(#51 + 0.6 meters) < #32 (Approach Roadway Width) G = 5%

(2) For 1-lane bridges only, use Figure 3 or the following:

If the first 2 digits of #28 (Lanes) are equal to 01 and

Y < 4.3 then H = 15%

Y ≥ 4.3 < 5.5 H = $15\left[\frac{5.5-Y}{1.2}\right]\%$

Y ≥ 5.5 H = 0%

(3) For 2 or more lane bridges. If these limits apply, do not continue on to (4) as no lane width reductions are allowed.

If the first 2 digits of #28 = 02 and Y ≥ 4.9, H = 0%

If the first 2 digits of #28 = 03 and Y ≥ 4.6, H = 0%

If the first 2 digits of #28 = 04 and Y ≥ 4.3, H = 0%

If the first 2 digits of #28 ≥ 05 and Y ≥ 3.7 H = 0%

(4) For all <u>except</u> 1-lane bridges,use Figure 3 or the following:

If Y < 2.7 and X > 50 then H = 15%

Y < 2.7 and X ≤ 50 H = 7.5%

Y ≥ 2.7 and X ≤ 50 H = 0%

If X > 50 but ≤ 125 and

Y < 3.0 then H = 15%

Y ≥ 3.0 < 4.0 H = 15(4-Y)%

Y ≥ 4.0 H = 0%

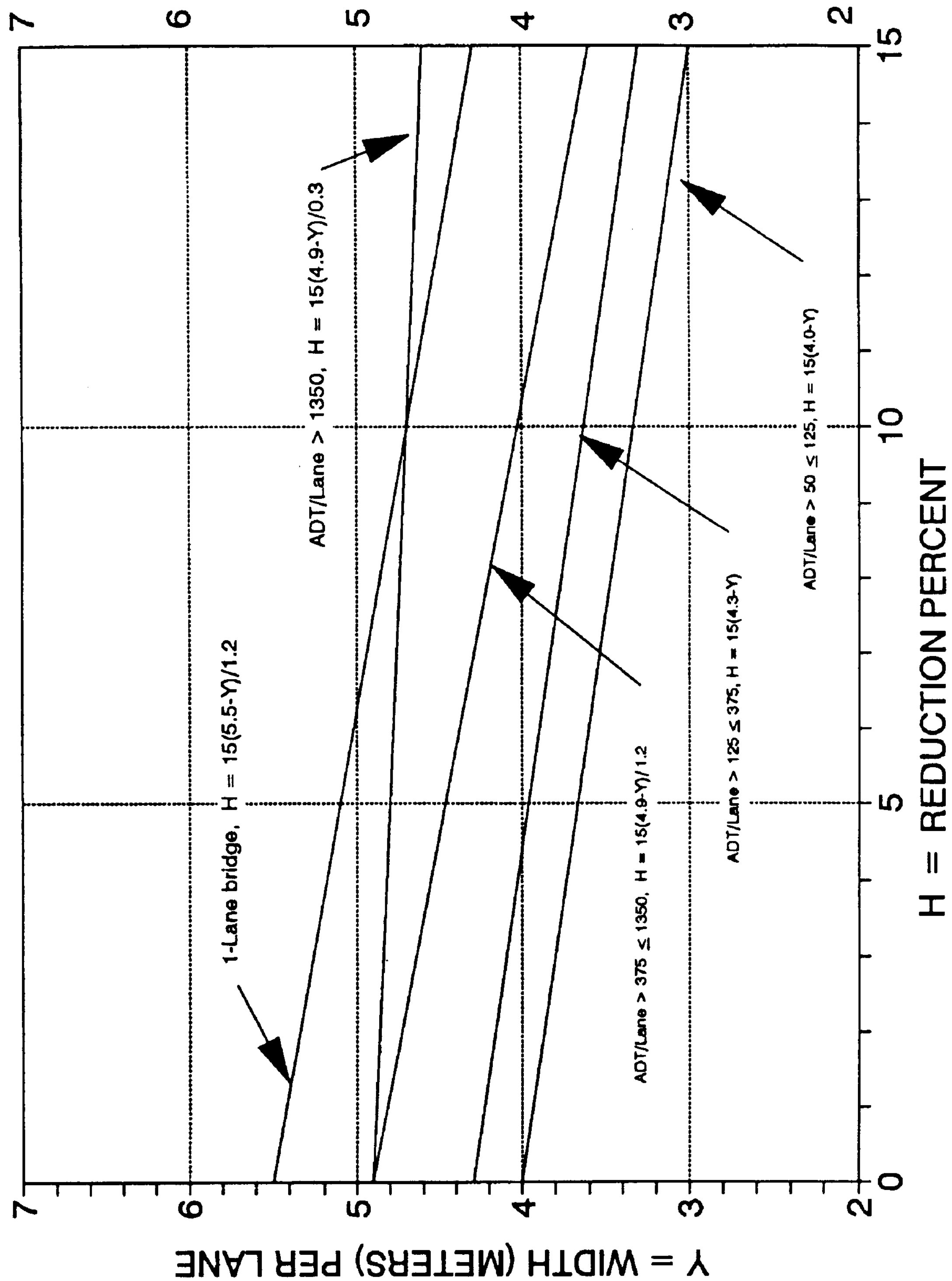
If X > 125 but ≤ 375 and

Y < 3.4 then H = 15%

Y ≥ 3.4 < 4.3 H = 15(4.3-Y)%

Y ≥ 4.3 H = 0%

Figure 3. Width of Roadway Insufficiency



If X > 375 but ≤ 1350 and

Y < 3.7 then H = 15%

Y ≥ 3.7 < 4.9 H = $15\left[\frac{4.9-Y}{1.2}\right]\%$

Y ≥ 4.9 H = 0%

If X > 1350 and

Y < 4.6 then H = 15%

Y ≥ 4.6 < 4.9 H = $15\left[\frac{4.9-Y}{1.2}\right]\%$

Y ≥ 4.9 H = 0%

G + H shall not be less than 0% nor greater than 15%.

c. Vertical Clearance Insufficiency - (2% maximum)

If #100 (STRAHNET Highway Designation) > 0 and

#53 (VC over Deck) ≥ 4.87 then I = 0%

#53 < 4.87 I = 2%

If #100 = 0 and

#53 ≥ 4.26 then I = 0%

#53 < 4.26 I = 2%

S_2 = 30 - [J + (G + H) + I]

S_2 shall not be less than 0% nor greater than 30%.

3. Essentiality for Public Use (15% maximum)

a. Determine:

$$K = \frac{S_1 + S_2}{85}$$

b. Calculate:

$$A = 15\left[\frac{\#29(ADT)x\#19(DetourLength}{320{,}000xK}\right]$$

"A" shall not be less than 0% nor greater than 15%.

c. STRAHNET Highway Designation:

If #100 is > 0	then	B = 2%
If #100 = 0	then	B = 0%

S_3 = 15 - (A + B)

S_3 shall not be less than 0% nor greater than 15%.

4. Special Reductions (Use only when $S_1 + S_2 + S_3 \geq 50$)

a. Detour Length Reduction, use Figure 4 or the following:

$A = (\#19)^4 \times (7.9 \times 10^{-9})$

"A" shall not be less than 0% nor greater than 5%.

b. If the 2nd and 3rd digits of #43 (Structure Type, Main) are equal to 10, 12, 13, 14, 15, 16, or 17; then

B = 5%

c.

If 2 digits of #36 (Traffic Safety Features)	= 0	C = 1%
If 3 digits of #36	= 0	C = 2%
If 4 digits of #36	= 0	C = 3%

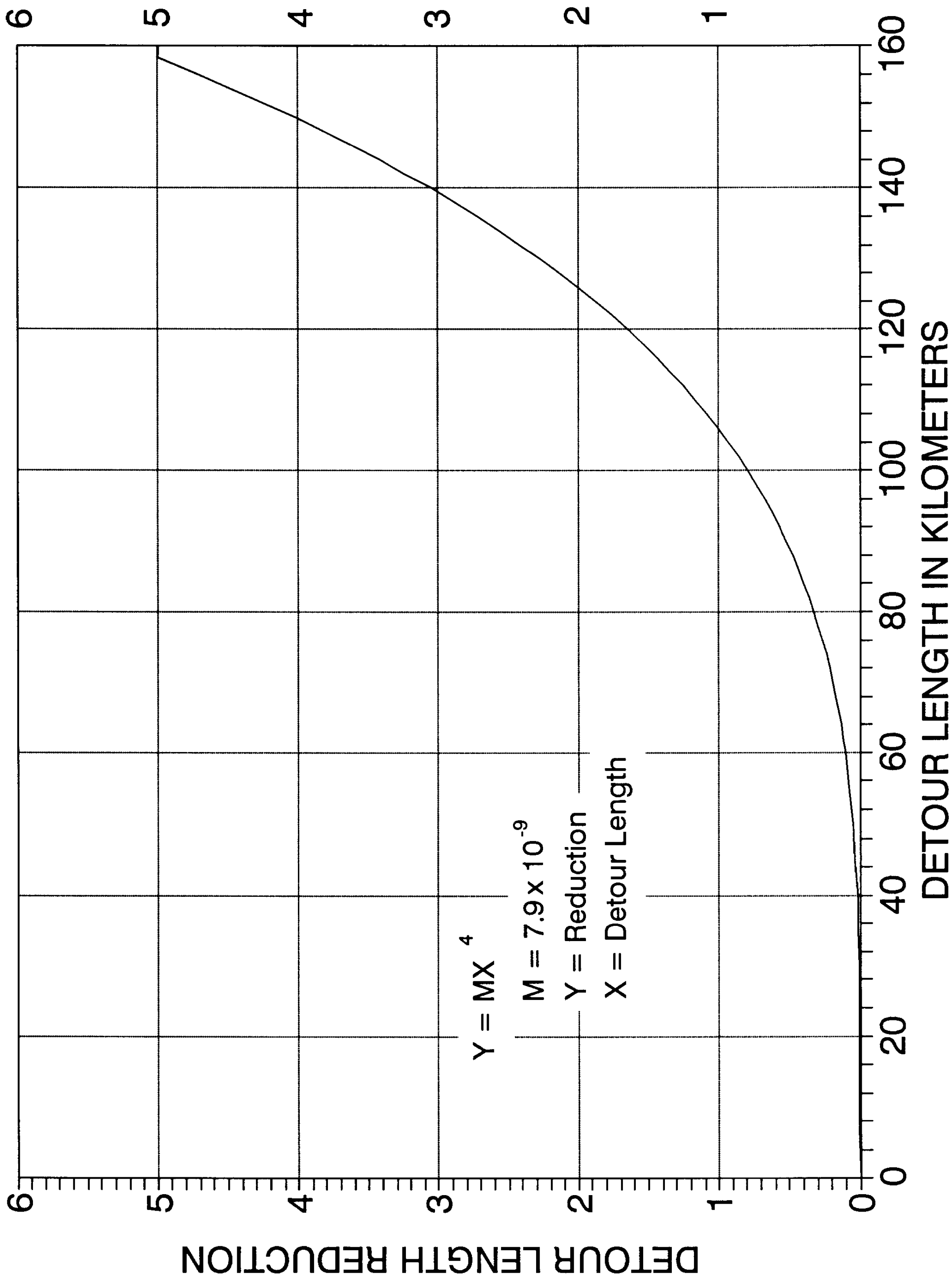
S_4 = A + B + C

S_4 shall not be less than 0% nor greater than 13%.

Sufficiency Rating = $S_1 + S_2 + S_3 - S_4$

The Rating shall not be less than 0% nor greater than 100%.

Figure 4. Special Reduction for Detour Length



EXAMPLE

Calculation of Sufficiency Rating

1. Structural Adequacy and Safety

   A = 10%

   B = $[32.4 - (19.8 \text{ metric tons})]^{1.5} \times 0.3254 = 14.6$

   S_1 = 55 - (10 + 14.6) = 30.4

2. Serviceability and Functional Obsolescence

   A = 3%, B = 1%, C = 4%, D = NA, E = NA, F = NA

   J = (3 + 1 + 4) = 8%

   $X = \frac{18500}{2} = 9250 \quad Y = \frac{7.9\ m}{2} = 3.95$

   (1) If (7.9 + 0.6) < 12.2 then G = 5

   (2) Not Applicable

   (3) Not Applicable

   (4) If X = 9250 and Y = 3.95 then H = 15

   G + H = 5 + 15 = 20 (however, maximum allowable = 15)

   I = 0

   S_2 = 30 - [8 + (15) + 0] = 7.0

3. Essentiality For Public Use

   $K = \frac{30.4 + 7.0}{85} = 0.44$

   $$A = 15\left[\frac{18{,}500 x 12.8 Km}{320{,}000 x 0.44}\right] = 25.2(however, \max .allowable = 15)$$

   B = 0

   S_3 = 15 - (15 + 0) = 0

4. Special Reductions

$S_1 + S_2 + S_3 = (30.4 + 7.0 + 0.0) = 37.4 < 50$

S_4 = NA

SUFFICIENCY RATING = 30.4 + 7.0 + 0.0 = 37.4

EXAMPLE DATA

OMB No. 2125-0501
NATIONAL BRIDGE INVENTORY - - - - - - - STRUCTURE INVENTORY AND APPRAISAL 10/15/94

********** IDENTIFICATION **********************
(1) STATE NAME - YOUR STATE NAME CODE 999
(8) STRUCTURE NUMBER
(5) INVENTORY ROUTE (ON/UNDER) - ON = 131000440
(2) HIGHWAY AGENCY DISTRICT 03
(3) COUNTY CODE 075 (4) PLACE CODE 59767
(6) FEATURES INTERSECTED - SR 772, ROARING LION R. *
(7) FACILITY CARRIED - STATE ROUTE 44
(9) LOCATION - 9.7 KM SW. OF RICHMOND
(11) MILEPOINT/KILOMETERPOINT 0036.008
(12) BASE HIGHWAY NETWORK - PART OF NET CODE 1
(13) LRS INVENTORY ROUTE & SUBROUTE #000000277503
(16) LATITUDE 35 DEG 27 MIN 18.55 SEC
(17) LONGITUDE 081 DEG 05 MIN 50.65 SEC
(98) BORDER BRIDGE STATE CODE 888 % SHARE 40 %
(99) BORDER BRIDGE STRUCTURE NO. #ABC003790243009

********** STRUCTURE TYPE AND MATERIAL *********
(43) STRUCTURE TYPE MAIN: MATERIAL - STEEL
TYPE - DECK TRUSS CODE 309
(44) STRUCTURE TYPE APPR: MATERIAL - STEEL
TYPE - GIRDER & FLOORBEAM SYSTEM CODE 303
(45) NUMBER OF SPANS IN MAIN UNIT 002
(46) NUMBER OF APPROACH SPANS 0004
(107) DECK STRUCTURE TYPE - CONCRETE C-I-P CODE 1
(108) WEARING SURFACE / PROTECTIVE SYSTEM:
A) TYPE OF WEARING SURFACE - CONCRETE CODE 1
B) TYPE OF MEMBRANE - NONE CODE 0
C) TYPE OF DECK PROTECTION - UNKNOWN CODE 8

********** AGE AND SERVICE *********************
(27) YEAR BUILT 1948
(106) YEAR RECONSTRUCTED 0000
(42) TYPE OF SERVICE: ON - HIGHWAY-PEDESTRIAN
UNDER - HIGHWAY-WATERWAY CODE 56
(28) LANES: ON STRUCTURE 02 UNDER STRUCTURE 02
(29) AVERAGE DAILY TRAFFIC 019500
(30) YEAR OF ADT 1993 (109) TRUCK ADT 05 %
(19) BYPASS, DETOUR LENGTH 013 KM

********** GEOMETRIC DATA **********************
(48) LENGTH OF MAXIMUM SPAN 0097.5 M
(49) STRUCTURE LENGTH 00312.0 M
(50) CURB OR SIDEWALK: LEFT 00.0 M RIGHT 02.5 M
(51) BRIDGE ROADWAY WIDTH CURB TO CURB 007.9 M
(52) DECK WIDTH OUT TO OUT 011.8 M
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) 12.2 M
(33) BRIDGE MEDIAN - NO MEDIAN CODE 0
(34) SKEW 00 DEG (35) STRUCTURE FLARED NO
(10) INVENTORY ROUTE MIN VERT CLEAR 99.99 M
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR 07.9 M
(53) MIN VERT CLEAR OVER BRIDGE RDWY 99.99 M
(54) MIN VERT UNDERCLEAR REF - HIGHWAY 10.46 M
(55) MIN LAT UNDERCLEAR RT REF - HIGHWAY 06.2 M
(56) MIN LAT UNDERCLEAR LT 00.0 M

********** NAVIGATION DATA *********************
(38) NAVIGATION CONTROL - BR PERMIT REQ CODE 1
(111) PIER PROTECTION - FUNCTIONING CODE 2
(39) NAVIGATION VERTICAL CLEARANCE 18.3 M
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR __._ M
(40) NAVIGATION HORIZONTAL CLEARANCE 047.2 M

****

SUFFICIENCY RATING = 37.4
STATUS = STRUCTURALLY DEFICIENT

********** CLASSIFICATION *******************CODE
(112) NBIS BRIDGE LENGTH - YES
(104) HIGHWAY SYSTEM - ROUTE ON NHS 1
(26) FUNCTIONAL CLASS - OTHER PRIN ART URBAN 14
(100) DEFENSE HIGHWAY - NOT DEFENSE 0
(101) PARALLEL STRUCTURE - NONE EXISTS N
(102) DIRECTION OF TRAFFIC - 2 WAY 2
(103) TEMPORARY STRUCTURE - NOT TEMPORARY _
(105) FEDERAL LANDS HIGHWAYS - NOT APPLICABLE 0
(110) DESIGNATED NATIONAL NETWORK - PART OF NET 1
(20) TOLL - ON FREE ROAD 3
(21) MAINTAIN - STATE HIGHWAY AGENCY 01
(22) OWNER - STATE HIGHWAY AGENCY 01
(37) HISTORICAL SIGNIFICANCE - NOT ELIGIBLE 5

********** CONDITION ********************** CODE
(58) DECK 4
(59) SUPERSTRUCTURE 5
(60) SUBSTRUCTURE 6
(61) CHANNEL & CHANNEL PROTECTION 8
(62) CULVERTS N

********** LOAD RATING AND POSTING ******** CODE
(31) DESIGN LOAD - H-15 OR M-13.5 2
(63) OPERATING RATING METHOD - LOAD FACTOR 1
(64) OPERATING RATING - MS-14 25.2
(65) INVENTORY RATING METHOD - LOAD FACTOR 1
(66) INVENTORY RATING - MS-11 19.8
(70) BRIDGE POSTING - POSTING REQUIRED 2
(41) STRUCTURE OPEN, POSTED OR CLOSED - P
DESCRIPTION - POSTED FOR LOAD

********** APPRAISAL ********************** CODE
(67) STRUCTURAL EVALUATION 5
(68) DECK GEOMETRY 3
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL 6
(71) WATERWAY ADEQUACY 8
(72) APPROACH ROADWAY ALIGNMENT 8
(36) TRAFFIC SAFETY FEATURES 1100
(113) SCOUR CRITICAL BRIDGES 8

********** PROPOSED IMPROVEMENTS ***************
(75) TYPE OF WORK - REPLACE FOR DEFICIENCY CODE 311
(76) LENGTH OF STRUCTURE IMPROVEMENT 00317.0 M
(94) BRIDGE IMPROVEMENT COST $ 4,200,000
(95) ROADWAY IMPROVEMENT COST $ 300,000
(96) TOTAL PROJECT COST $ 5,000,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE 1995
(114) FUTURE ADT 025600
(115) YEAR OF FUTURE ADT 2014

********** INSPECTIONS *************************
(90) INSPECTION DATE 03/94 (91) FREQUENCY 12 MO
(92) CRITICAL FEATURE INSPECTION: (93) CFI DATE
A) FRACTURE CRIT DETAIL - YES - 06 MO A) 09/94
B) UNDERWATER INSP - NO - __ MO B) __/__
C) OTHER SPECIAL INSP - NO - __ MO C) __/__

APPENDIX C

National Bridge Inspection Standards

Section 650.311 - The January 1979 Coding Guide has been superseded by a December 1988 Guide, which is superseded by this metric version of the Coding Guide.

Appendix C

National Bridge Inspection Standards

CODE OF FEDERAL REGULATIONS

23 HIGHWAYS - PART 650

Subpart C - National Bridge Inspection Standards

'650.301 Application of standards.

The National Bridge Inspection Standards in this part apply to all structures defined as bridges located on all public roads. In accordance with the AASHTO (American Association of State Highway and Transportation Officials) Transportation Glossary, a "bridge" is defined as a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

'650.303 Inspection procedures.

(a) Each highway department shall include a bridge inspection organization capable of performing inspections, preparing reports, and determining ratings in accordance with the provisions of the AASHTO Manual[1] and the Standards contained herein.

(b) Bridge inspectors shall meet the minimum qualifications stated in '650.307.

(c) Each structure required to be inspected under the Standards shall be rated as to its safe load carrying capacity in accordance with Section 4 of the AASHTO Manual. If it is determined under this rating procedure that the maximum legal load under State law exceeds the load permitted under the Operating Rating, the bridge must be posted in conformity with the AASHTO Manual or in accordance with State law.

(d) Inspection records and bridge inventories shall be prepared and maintained in accordance with the Standards.

(e) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting and inventory shall determine and designate on the individual inspection and inventory records and maintain a master list of the following:

(1) Those bridges which contain fracture critical members, the location and description of such members on the bridge and the inspection frequency and procedures for inspection of such members. (Fracture critical members are tension members of a bridge whose failure will probably cause a portion of or the entire bridge to collapse.)

(2) Those bridges with underwater members which cannot be visually evaluated during periods of low flow or examined by feel for condition, integrity and safe load capacity due to excessive water depth or turbidity. These members shall be described, the inspection frequency stated not to exceed five years, and the inspection procedure specified.

(3) Those bridges which contain unique or special features requiring additional attention during inspection to ensure the safety of such bridges and the inspection frequency and procedure for inspection of each such feature.

(4) The date of last inspection of the features designated in paragraphs (e)(1) through (e)(3) of this section and a description of the findings and follow-up actions, if necessary, resulting from the most recent inspection of fracture critical details, underwater members or special features of each so designated bridge.

'650.305 Frequency of inspections.

(a) Each bridge is to be inspected at regular intervals not to exceed 2 years in accordance with Sect. 2.3 of the AASHTO Manual.

[1] The "AASHTO Manual" referred to in this part is the 'Manual for Maintenance Inspection of Bridges 1983" together with subsequent interim changes or the most recent version of the AASHTO manual published by the American Association of State Highway and Transportation Officials. A copy of the Manual may be examined during normal business hours at the office of each Division Administrator of the Federal Highway Administration, at the office of each Regional Federal Highway Administrator, and at the Washington Headquarters of the Federal Highway Administration. The addresses of those document inspection facilities are set forth in Appendix D to Part 7 of the regulations of the Office of the Secretary (40 CFR Part 7). In addition, a copy of the Manual may be secured upon payment in advance by writing to the American Association of State

Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 225, Washington, D.C. 20001.

(b) Certain types or groups of bridges will require inspection at less than 2-year intervals. The depth and frequency to which bridges are to be inspected will depend on such factors as age, traffic characteristics, state of maintenance, and known deficiencies. The evaluation of these factors will be the responsibility of the individual in charge of the inspection program.

(c) The maximum inspection interval may be increased for certain types or groups of bridges where past inspection reports and favorable experience and analysis justifies the increased interval of inspection. If a State proposes to inspect some bridges at greater than the specified 2-year interval, the State shall submit a detailed proposal and supporting data to the Federal Highway Administrator for approval.

'650.307 Qualifications of personnel.

(a) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and inventory shall possess the following minimum qualifications:

(1) Be a registered professional engineer; or

(2) Be qualified for registration as a professional engineer under the laws of the State; or

(3) Have a minimum of 10 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the, "Bridge Inspector's Training Manual"[2], which has been developed by a joint Federal-State task force, and subsequent additions to the manual.[3]

(b) An individual in charge of a bridge inspection team shall possess the following minimum qualifications:

(1) Have the qualifications specified in paragraph (a) of this section; or

(2) Have a minimum of 5 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the "Bridge Inspector's Training Manual", which has been developed by a joint Federal-State task force.

(3) Current certification as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET)[4] is an alternative acceptable means for establishing that a bridge inspection team leader is qualified.

'650.309 Inspection report.

The findings and results of bridge inspections shall be recorded on standard forms. The data required to complete the forms and the functions which must be performed to compile the data are contained in Section 3 of the AASHTO Manual

[2]The "Bridge Inspector's Training Manual" may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[3]The following publications are supplements to the "Bridge Inspector's Training Manual": "Bridge Inspector's Manual for Movable Bridges," 1977, GPO Stock No. 050-00200103-5; "Culvert Inspector's Training Manual," July 1986, GPO Stock No. 050-001-0030-7; and "Inspection of Fracture Critical Bridge Members," 1986, GPO Stock No. 050-00100302-3.

'650.311 Inventory.

(a) Each State shall prepare and maintain an inventory of all bridge structures subject to the Standards. Under these Standards, certain structure inventory and appraisal data must be collected and retained within the various departments of the State organization for collection by the Federal Highway Administration as needed. A tabulation of this data is contained in the structure inventory and appraisal sheet distributed by the Federal Highway Administration as part of the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Coding Guide) in January of 1979. Reporting procedures have been developed by the Federal Highway Administration.

(b) Newly completed structures, modification of existing structures which would alter previously recorded data on the inventory forms or placement of load restriction signs on the approaches to or at the structure itself shall be entered in the State's inspection reports and the computer inventory file as promptly as practical, but no later than 90 days after the change in the status of the structure for bridges directly under the State's jurisdiction and no later than 180 days after the change in status of the structure for all other bridges on public roads within the State.

[4]For information on NICET program certification contact: National Institute for Certification in Engineering Technologies 1420 King Street, Alexandria, Virginia 22314. Attention: John D. Antrim, P.E., Phone (703) 684-2835.

Effective date October 25. 1988.

APPENDIX D

Commentary

The 22 page commentary contained in the 1988 Coding Guide has not been included in this document. The following pages of commentary, however, show item by item changes caused by this revision.

Appendix D

December 1994 Commentary

This commentary provides a ready reference for item by item changes between the 1988 Coding Guide and this proposed revision. Items not specifically mentioned here are essentially unchanged except for SI metric conversion.

Introduction

! Mentions new items and their use.

! References to Defense Bridges removed and STRAHNET added.

! Federal agencies specifically included in this Guide.

! Minor editorial changes and reference revisions have been made to bring the text up to date.

Definition of Terms

! The order of the definitions has changed and the following added or modified:

(a) Bridge length has been converted to metric.
The length of 20 feet has been changed to 6.1 meters.
(b) Culvert.
(i) Strategic Highway Corridor Network (STRAHNET). Replaces Defense Items, which were dropped.
(j) STRAHNET Connectors.
(k) Indian Reservation Road definition has been added.
(l) Land Management Highway System (LMHS)
(m) Forest Highway (FH)
(n) Forest Service Development Road.
(o) Base Highway Network.
(p) Highway Performance Monitoring System.
(q) Conversion of Numerical Data
(r) Rounding and Truncating of Numerical Data.

Item 2 - Highway Agency District

! Name of item changed to reflect inclusion of federal bridges.

Item 5A - Record Type

! Clarification has been made for the case of 2 or more routes passing under a structure.

! Items 30, and 109 have been added to the list of items required to be coded for "under" records.

Item 6 - Features Intersected

! Item coding requirements have been clarified for "under" records.

! References to defense highway and FHPM 6-10-2 have been eliminated.

! Critical facilities are now STRAHNET and STRAHNET Connectors.

Item 7 - Facility Carried by Structure

! Item coding requirements have been clarified for "under" records.

! Temporary use of this item for coding IRR has been changed to Item 105.

Item 8 - Structure Number

! Closed median has been described.

! Additional emphasis has been given to the need to have all 15 digits filled.

Item 10 - Inventory Route, Minimum Vertical Clearance

! Units of measurement have been converted to metric, using a 3-meter width of pavement.

! Vertical restrictions 30 meters or greater may now be coded 9999, with exact actual clearances in this range optional.

Item 11 - Kilometer Point

! Units of measurement and the description of the item have been converted to metric.

! Seven digits will be coded instead of six.

Item 12 - Base Highway Network

! New item added for use in identifying Linear Referencing System (LRS).

Item 13 - LRS Inventory Route, Subroute Number

! New item added for identifying LRS.

Item 16 - Latitude and Item 17 - Longitude

! Number of digits have been expanded to 8 and 9 digits, respectively.

! The format of the item allows an increased precision of measurement (not mandatory) to accommodate the use of the Global Positioning System (GPS). Current measuring methods and level of precision may continue to be used.

References to defense highways changed to STRAHNET.

! Location where measurement is taken must be compatible with the LRS.

Item 19 - Bypass, Detour Length

! Number of digits has been expanded to three to accommodate metric.

Item 20 - Toll

! Reference to Secretarial Agreement updated.

Item 21 - Maintenance Responsibility and Item 22 - Owner

! Several federal agencies have been added.

Item 26 - Functional Classification of Inventory Route

! This item is no longer compatible with Item 104 and appropriate revisions have been made.

Item 28 - Lanes On and Under the Structure

! Text clarified for "under" records.

! Text has been added advising that any "1-lane" bridge 4.9 meters or greater in curb-to curb width is evaluated as 2 lanes or more in Item 68 -Deck Geometry.

Item 29 - Average Daily Traffic

! Text has been added explaining that if the bridge is closed, the coding is to be the actual ADT from the period before the closure occurred.

Item 30 - Year of Average Daily Traffic

! Field expanded to four digits to allow coding of complete year.

Item 31 - Design Load

! Codes have been converted from the H and HS loadings to metric M and MS loadings.

Item 32 - Approach Roadway Width

! A hard conversion of the units of measure has been used to match the metric standards of AASHTO.

Item 36 - Traffic Safety Features

! Add and update reference publications.

! Segment A has been updated to include the latest FHWA policy on crash testing and other recommended barrier specifications.

! Note on national set of standards updated.

Item 38 - Navigation Control

Term bridge permit clarified.

Item 41 - Structure Open, Posted or Closed to Traffic

Code B has been clarified concerning signs not correctly implemented. An example of "not correctly implemented" is existing posting signs not changed to indicate a lower load posting calculated for more recent inspection conditions.

Code P expanded to include temporary bridges which are load posted.

Item 43 - Structure Type, Main

Segment A codes 5 and 6 have been noted to include post-tensioned concrete.

Segment B code 07 has been noted that frame culverts are excluded. Code 19 has been noted that frame culverts are included.

Item 47 - Inventory Route, Total Horizontal Clearance

FHPM reference has been eliminated.

In addition to the metric changes and editorial clarifications, the definition for clearance has been modified.

Item 48 - Length of Maximum Span

The units of measurement have been converted to metric and the number of digits expanded to 5 digits to accommodate the metric values.

Center to center measurements specified to be center of bearing points.

Item 49 - Structure Length

In addition to the metric changes, an explanation has been added concerning the measuring and coding of tunnels.

Item 50 - Curb or Sidewalk Widths

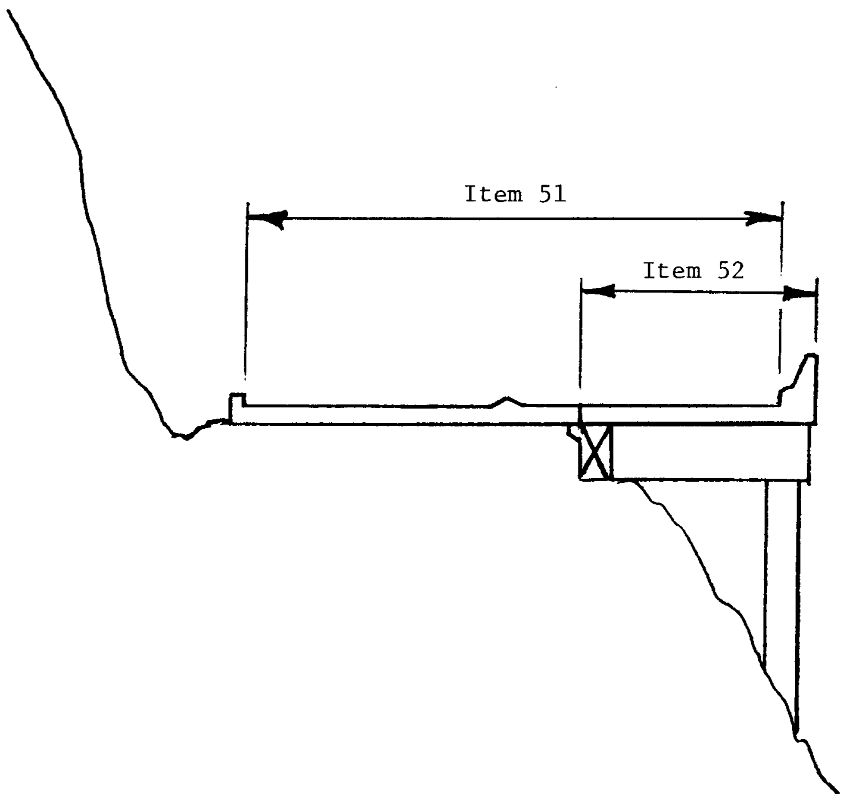
Example figure modified to accentuate the mountable median.

Item 51 - Bridge Roadway Width, Curb-to-Curb

In addition to the metric changes, a reference has been added for the case of sidehill viaducts. A sidehill viaduct has a portion of its width on embankment and a portion on structure. The problem arises in calculating Item 68, the sufficiency rating and the deck area of the bridge. Commentary Figure 1 illustrates the coding of sidehill viaducts.

Commentary Figure 1

FIGURE ILLUSTRATING CODING
OF SIDEHILL VIADUCTS



Associated Items:

Item 28A - Lanes On Structure
Item 29 - ADT = Total for entire structure
Item 32 - Approach Roadway Width
Item 102 - Direction of Traffic = 2 for 2-way

Item 53 - Minimum Vertical Clearance Over Bridge Roadway

! Units of measurement have been converted to metric.

! Clarification has been added for recording the minimum vertical clearance for double decked structures.

! Restrictions of 30 meters or greater or no superstructure restriction are now both to be coded 9999. However coding of actual clearances between 30 and 99.99 meters to an exact measurement is optional.

Item 54 - Minimum Vertical Underclearance

! In addition to metric changes, instructions have been given to code restrictions of 30 meters or greater as code 9999. However coding of actual clearances between 30 and 99.99 meters to an exact measurement is optional.

Item 55 - Minimum Lateral Underclearance on Right

! In addition to metric changes, instructions have been given for the coding of restrictions 30 meters or greater. The numeric value in segment B is to be coded 999 for restrictions of 30 meters or greater. However coding of actual clearances between 30 and 99.9 meters to an exact measurement is optional.

! If the feature beneath the structure is not a railroad or highway, the code 000 in the numeric value for segment B is to indicate that the item is not applicable. This replaces the previous code of 999 to indicate that the item is not applicable.

Item 56 - Minimum Lateral Underclearance on Left.

! Care should be used in coding bridges with "open" medians, they should be coded 999. Those with clearances greater than 30 meters may be coded 998. However coding of actual clearances between 30 and 99.8 meters to an exact measurement is optional. When indicating that the item is not applicable code 000.

Item 58 - Deck

! Clarification has been added for "structures without decks".

Item 61 - Channel and Channel Protection

! The word channel is now consistently used in this item.

Item 63 - Method Used to Determine Operating Rating.

! New item added for use with Operating Rating.

Item 64 - Operating Rating

! The entire item has been redefined using the MS rating system instead of the previous HS vehicle ratings. Instructions have been given to code a 3 digit number representing the total weight in metric tons of the entire vehicle (maximum load).

! A description has been added indicating that the load factor (LF) method is to be used for determining operating ratings and inventory ratings.

! A change has been made to advise that with the coding for metric tonnage, the codes 200 or 900 are not appropriate for temporary bridges. Code 000 is to be used.

! Instructions have been given to use code 999 for a structure under a fill where live load is insignificant in the structure load capacity.

Item 65 - Method Used to Determine Inventory Rating

! New item added for use with Inventory Rating.

Item 66 - Inventory Rating

! See commentary for Item 64 - Operating Rating.

Items 67, 68, 69, 71, and 72 - Indicate the Appraisal Ratings

! Information has been provided advising that the Edit/Update computer calculates the codes for Items 67, 68 and 69, based on the Coding Guide tables for these items. Values entered by bridge owners or inspectors are not used.

! Because the level of service concept is no longer being considered, all reference to level of service has been eliminated.

Item 67 - Structural Evaluation

! This item is calculated by the Edit/Update program and need not be coded in the field. The reference to how the item was to be coded by bridge inspectors has been eliminated. Editorial changes have also been made to indicate the specifications on which the Edit/Update program is based.

! The load rating vehicle conversion factors have been eliminated as only MS (previously HS) ratings are to be coded into the inventory rating item.

! Table 1 has been converted to metric values for the MS inventory ratings. Note that the inventory ratings have been shown in total metric tons with the decimal point included instead of assumed. The MS equivalent values have been included in the table.

Item 68 - Deck Geometry

! This item is calculated by the Edit/Update program and need not be coded in the field. Editorial changes have also been made to indicate the specifications on which the Edit/Update program is based.

! A statement has been added to advise that culverts coded 0000 for roadway width will be given the coding of N for this item.

! All tables have been converted to metric units of measurement. Where appropriate, a hard conversion has been used to match the metric standards of AASHTO.

! A note has been added to advise that one-lane bridges 4.90 meters and greater in deck width are evaluated as a 2-lane bridge using Table 2A.

Item 69 - Underclearances, Vertical Horizontal

! This item is calculated by the Edit/Update program and need not be coded in the field. Editorial changes have also been made to indicate the specifications on which the Edit/Update program is based.

! All tables have been converted to metric units of measurement. Where appropriate, a hard conversion has been used to match the metric standards of AASHTO.

Item 75 - Type of Work

! Segment A code "38" has been expanded to include hydraulic replacements.

! In addition to metric changes, editorial additions have been made, such as that this item may be left blank if not required.

Item 76 - Length of Structure Improvement

! Formulae for graphs have been added.

Item 92 - Critical Feature Inspection

! Text has been added to give the current guidelines on maximum allowable inspection intervals.

Item 94 - Bridge Improvement Cost.

! The examples showing average cost per unit of area have been changed to reflect in metric units. The value used is for example only.

Item 97 - Year of Improvement Cost Estimate

!Field expanded to four digits to allow coding of complete year.

Item 99 - Border Bridge Structure Number

! Text has been added to clarify the coding.

Item 101 - Parallel Structure Designation

! Clarification of distance between structures coding.

Item 102 - Direction of Traffic

! Text has been added to clarify the coding.

Item 104 - Highway System of the Inventory Route

! With the passage of the 1991 ISTEA, the previous designation of highway systems has been eliminated. This item has been changed to identify structures that are on inventory routes that are on the National Highway System.

Item 105 - Federal Lands Highways

! New item used to indicate special federal lands highways.

Item 108 - Wearing Surface/Protective System

! Wearing surface type code 3 or latex concrete has been modified to include "similar" types of additive enhanced concrete, i.e. silica fume.
! A note has been added to the code 0 description of Segment A to make it clear that code 0 is to be used if no additional concrete thickness or thickness of a wearing surface is included in the bridge deck.

Item 110 - Designated National Network

! Consistent with the changes caused by the 1991 ISTEA, the reference to the Primary System has been changed to Federal-aid highways.

Item 112 - NBIS Bridge Length

! Bridge length has been defined in metric terms to be structures greater than 6.1 meters.

Item 113 - Scour Critical Bridges

- Two new codes have been added. These are for bridges over "tidal" waters and bridges with unknown foundations.

- Text has been added to update guidance and instructions on the scour critical coding of bridges over waterways to be in line with an October 6, 1993 memorandum on the coding of this item. The subject of the memorandum is "NBIS Clarification of Recording and Coding Guide - Item 113." The memorandum advises that structures such as culverts which have a low risk of scour damage and accordingly assessed as stable, are exempt from a scour analysis. Culverts which are assessed as low risk may be coded 8, and this includes open bottom culverts on competent rock or piles. Open bottom culverts with footings on soil should be coded 6 until they have been analyzed. The memorandum further states that in considering if a bridge is eligible for a code 8, the State shall have completed an analysis of a similar bridge with comparable conditions. It is recommended that the memorandum be reviewed for more detail.

Item 115 - Year of Future Average Daily Traffic

- Field expanded to four digits to allow coding of complete year.

- Editorial change made to clarify the coding instructions.

APPENDIX E

National Bridge Inventory Record Layout

Appendix E

National Bridge Inventory Record Format

With the conversion to metric and the addition of new items it is required to expand the size of the NBI record to 432 characters. The following format will be use to submit data to the FHWA.

ITEM NO	ITEM NAME	ITEM POSITION	ITEM LENGTH/TYPE
1	State Code	1 - 3	3/N
8	Structure Number	4 - 18	15/AN
5	Inventory Route	19 - 27	9/AN
5A	Record Type	19	1/AN
5B	Route Signing Prefix	20	1/N
5C	Designated Level of Service	21	1/N
5D	Route Number	22 - 26	5/AN
5E	Directional Suffix	27	1/N
2	Highway Agency District	28 - 29	2/AN
3	County (Parish) Code	30 - 32	3/N
4	Place Code	33 - 37	5/N
6	Features Intersected	38 - 62	25/AN
6A	Features Intersected	38 - 61	24/AN
6B	Critical Facility Indicator	62	1/AN
7	Facility Carried By Structure	63 - 80	18/AN
9	Location	81 - 105	25/AN
10	Inventory Rte, Min Vert Clearance	106 - 109	4/N
11	Kilometerpoint	110 - 116	7/N
12	Base Highway Network	117	1/N
13	Inventory Route, Subroute Number	118 - 129	12/AN
13A	LRS Inventory Route	118 - 127	10/AN
13B	Subroute Number	128 - 129	2/N
16	Latitude	130 - 137	8/N
17	Longitude	138 - 146	9/N
19	Bypass/Detour Length	147 - 149	3/N
20	Toll	150	1/N
21	Maintenance Responsibility	151 - 152	2/N
22	Owner	153 - 154	2/N
26	Functional Class Of Inventory Rte.	155 - 156	2/N
27	Year Built	157 - 160	4/N
28	Lanes On/Under Structure	161 - 164	4/N
28A	Lanes On Structure	161 - 162	2/N
28B	Lanes Under Structure	163 - 164	2/N
29	Average Daily Traffic	165 - 170	6/N
30	Year Of Average Daily Traffic	171 - 174	4/N
31	Design Load	175	1/N
32	Approach Roadway Width	176 - 179	4/N
33	Bridge Median	180	1/N
34	Skew	181 - 182	2/N
35	Structure Flared	183	1/N

ITEM NO	ITEM NAME	ITEM POSITION	ITEM LENGTH/TYPE
36	Traffic Safety Features	184 - 187	4/AN
36A	Bridge Railings	184	1/AN
36B	Transitions	185	1/AN
36C	Approach Guardrail	186	1/AN
36D	Approach Guardrail Ends	187	1/AN
37	Historical significance	188	1/N
38	Navigation Control	189	1/AN
39	Navigation Vertical Clearance	190 - 193	4/N
40	Navigation Horizontal Clearance	194 - 198	5/N
41	Structure Open/Posted/Closed	199	1/AN
42	Type Of Service	200 - 201	2/N
42A	Type of Service On Bridge	200	1/N
42B	Type of Service Under Bridge	201	1/N
43	Structure Type, Main	202 - 204	3/N
43A	Kind of Material/Design	202	1/N
43B	Type of Design/Construction	203 - 204	2/N
44	Structure Type, Approach Spans	205 - 207	3/N
44A	Kind of Material/Design	205	1/N
44B	Type of Design/Construction	206 - 207	2/N
45	Number Of Spans In Main Unit	208 - 210	3/N
46	Number Of Approach Spans	211 - 214	4/N
47	Inventory Rte Total Horz Clearance	215 - 217	3/N
48	Length Of Maximum Span	218 - 222	5/N
49	Structure Length	223 - 228	6/N
50	Curb/Sidewalk Widths	229 - 234	6/N
50A	Left Curb/Sidewalk Width	229 - 231	3/N
50B	Right Curb/Sidewalk Width	232 - 234	3/N
51	Bridge Roadway Width Curb-To-Curb	235 - 238	4/N
52	Deck Width, Out-To-Out	239 - 242	4/N
53	Min Vert Clear Over Bridge Roadway	243 - 246	4/N
54	Minimum Vertical Underclearance	247 - 251	5/AN
54A	Reference Feature	247	1/AN
54B	Minimum Vertical Underclearance	248 - 251	4/N
55	Min Lateral Underclear On Right	252 - 255	4/AN
55A	Reference Feature	252	1/AN
55B	Minimum Lateral Underclearance	253 - 255	3/N
56	Min Lateral Underclear On Left	256 - 258	3/N
58	Deck	259	1/AN
59	Superstructure	260	1/AN
60	Substructure	261	1/AN
61	Channel/Channel Protection	262	1/AN
62	Culverts	263	1/AN

ITEM NO	ITEM NAME	ITEM POSITION	ITEM LENGTH/TYPE
63	Method Used To Determine Operating Rating	264	1/N
64	Operating Rating	265 - 267	3/N
65	Method Used To Determine Inventory Rating	268	1/N
66	Inventory Rating	269 - 271	3/N
67	Structural Evaluation	272	1/AN
68	Deck Geometry	273	1/AN
69	Underclear, Vertical & Horizontal	274	1/AN
70	Bridge Posting	275	1/N
71	Waterway Adequacy	276	1/AN
72	Approach Roadway Alignment	277	1/AN
75	Type of Work	278 - 280	3/N
75A	Type of Work Proposed	278 - 279	2/N
75B	Work Done By	280	1/AN
76	Length Of Structure Improvement	281 - 286	6/N
90	Inspection Date	287 - 290	4/N
91	Designated Inspection Frequency	291 - 292	2/N
92	Critical Feature Inspection	293 - 301	9/AN
92A	Fracture Critical Details	293 - 295	3/AN
92B	Underwater Inspection	296 - 298	3/AN
92C	Other Special Inspection	299 - 301	3/AN
93	Critical Feature Inspection Dates	302 - 313	12/AN
93A	Fracture Critical Details Date	302 - 305	4/AN
93B	Underwater Inspection Date	306 - 309	4/AN
93C	Other Special Inspection Date	310 - 313	4/AN
94	Bridge Improvement Cost	314 - 319	6/N
95	Roadway Improvement Cost	320 - 325	6/N
96	Total Project Cost	326 - 331	6/N
97	Year Of Improvement Cost Estimate	332 - 335	4/N
98	Border Bridge	336 - 340	5/AN
98A	Neighboring State Code	336 - 338	3/AN
98B	Percent Responsibility	339 - 340	2/N
99	Border Bridge Structure Number	341 - 355	15/AN
100	STRAHNET Highway Designation	356	1/N
101	Parallel Structure Designation	357	1/AN
102	Direction Of Traffic	358	1/N
103	Temporary Structure Designation	359	1/AN
104	Highway System Of Inventory Route	360	1/N
105	Federal Lands Highways	361	1/N
106	Year Reconstructed	362 - 365	4/N
107	Deck Structure Type	366	1/AN
108	Wearing Surface/Protective System	367 - 369	3/AN
108A	Type of Wearing Surface	367	1/AN
108B	Type of Membrane	368	1/AN
108C	Deck Protection	369	1/AN

ITEM NO	ITEM NAME	ITEM POSITION	ITEM LENGTH/TYPE
109	AVERAGE DAILY TRUCK TRAFFIC	370 - 371	2/N
110	DESIGNATED NATIONAL NETWORK	372	1/N
111	PIER/ABUTMENT PROTECTION	373	1/N
112	NBIS BRIDGE LENGTH	374	1/AN
113	SCOUR CRITICAL BRIDGES	375	1/AN
114	FUTURE AVERAGE DAILY TRAFFIC	376 - 381	6/N
115	YEAR OF FUTURE AVG DAILY TRAFFIC	382 - 385	4/N
116	MINIMUM NAVIGATION VERTICAL CLEARANCE VERTICAL LIFT BRIDGE	386 - 389	4/N
---	Washington Headquarters Use	392 - 426	
	STATUS	427	
n/a	Asterisk Field in SR	428	1/AN
SR	SUFFICIENCY RATING (select from last 4 positions only)	429 - 432	4/N

Status field: 1=Structurally Deficient; 2=Functionally Obsolete; 0=Not Deficient; N=Not Applicable

Appendix C.4

Inventoried Delaware Highway Bridges

APPENDIX

Inventoried Delaware Highway Bridges

Following is a complete inventory of bridges surveyed as part of the 1988 survey and the 1995-98 update survey. Black & white photographs of surveyed bridges are available and indexed. Photos, negatives, and indexes are stored in DelDOT's archives.

New Castle County Bridges

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-1/1A	1833/1928	Rising Sun Lane, Brandywine Crk.	Pratt thru truss and stone arch approach span (NC-1A)	Yes	The only thru truss surveyed, a representative example of a 20th-century riveted truss bridge. The stone arch approach span dates from 1833, and is one of four stone arches surveyed.	BNC-89, 70-30-02, 78-061-05	N-1072	1988, 1997
NC-1B	1919/1939	Pennsylvania Ave., Waterway	A 21'-6" encased steel girder	No	Altered, poor example.	239A, 644	N-12568	1988
NC-2	1933	Rockland Rd., Brandywine Crk.	112' encased, cantilevered, steel multi girder and 10' rigid frame	Yes	Unique example of a cantilevered multi girder bridge.	Levy Court, 92-074-02	N-12533	1988,1997
NC-3	1934	Thompson Br., Brandywine Crk.		No	Replaced in late 1980s	BNC-87	N-12509	1988
NC-9	1962	Smiths Bridge Rd., Brandywine Crk.	3 span steel girder	No	Not of historic age. Replaced a covered bridge.	1374,2057, 87-570-15	N-438	1988
NC-12	n.d.	Woodlawn Rd., Hurricane Run	Small, single span steel girder bridge	No	Altered, poor example.	None	N-2539	1988
NC-16	n.d.	BeaverValley Rd., Beaver Valley Crk.		No	Replaced in mid 1980s.	None		1988
NC-17	n.d.	BeaverValley Rd., Beaver Valley Crk.		No	Replaced in mid 1980s.	83-071-11		1988
NC-18	1914	BeaverValley Rd., Beaver Valley Crk.		No	Replaced in mid 1980s.	83-071-11		1988
NC-19	n.d.	Rockland Rd., Waterway	Single span, 7'-7"reinforced concrete slab bridge	No	Poor example.	Levy Court	N-12559	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-20	1932	Rockland Rd., Husband Run		No	Historic encased steel multi girder bridge from 1932 replaced in 1993 with slab superstructure and stone parapets mimicking original appearance.	92-071-06	N-12532	1988,1997
NC-23A	1918/1982	Guyencourt Rd., Reading RR	3 span, 66' timber girder bridge	No	Compromised by original fabic replacement.	82-071-01	N-4316	1988
NC-38	1931	Grubb Rd., S.Br. Naamans Crk.	Single span, encased steel girder bridge	No	Deteriorated.	BNC-82	N-12538	1988
NC-43	n.d.	Weldin Rd., Mastens Run	Single span, 16' reinforced concrete deck arch	No	Poor example.	None	N-12560	1988
NC-44	1919/1934	Shipley Rd., Shellpot Crk.	2-span reinforced concrete slab bridge widened with encased steel girder addition	No	Deteriorated.	BNC-81	N-4312	1988
NC-48	1955	Wilson Rd., Shellpot Crk.	Single span, 41'-long rigid frame	No	Late, undistinguished example.	1235	N-13575	1997
NC-49	1955	Wilson Rd., Shellpot Crk. Trib.	Single-span, 14'-long reinforced concrete slab bridge	No	Late, undistinguished example.	1235	N-13576	1997
NC-50	1955	Veale Rd., Stony Crk.	One-cell, 9' box culvert	No	Late, undistinguished example.	1385	N-13577	1997
NC-51	1956	Veale Road, Trib. to Brandywine Ck.	A concrete slab spanning 18'	No/Arden Village H.D.	Poor example.	727,1385	N-12544	1988
NC-51A	1954/1966	Harvey Road, CSXT RR	A 3 span,149'-long, continuous steel multi girder	No	Undistinguished example, widened in 1966.	1197 65-020-04 84-074-05	N-13578	1997
NC-52	1926/1947/ 1988	SR3, Marsh Road, W. Branch Naamans Ck.	A double span concrete slab bridge spanning 16'	No	Historic structure obscured by alterations.	CN-24, 936	N-12536	1988
NC-52A	1920/1947	Naamans Road, Branch of Naamans Ck.	Double span concrete slab bridge spanning 28'-0"	No	Altered; poor example.	CN-2, 910	N-12537	1988
NC-53	1926/1947/ 1988	SR 3, Marsh Road, Arden Ck.	r. c. slab bridge spanning 19'	No	Altered; undistinguished.	24, 936	N-12536	1997
NC-54A	1920/1947	Naamans Road, Naamans Ck.	A closed spandrel elliptical arch bridge	No	Altered; poor example.	CN-2, 910	N-4279	1988
NC-56A Amtrak Br.#18.51	1902	U.S. 13 Overpass (Amtrak)	A double span steel girder bridge	NA/RR owned	Not evaluated.	No	N-4322	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-56B	1919	U.S. 13 Overpass (Amtrak)	A 22' span steel girder bridge	NA/RR owned	Not evaluated.	No	N-12530	1988
NC-56D	1919/1955	Philadelphia Pike, Phoenix Steel Road	A solid spandrel,filled arch concrete bridge with a span length of 50'-0"	No	Compromised by widening.	BNC-80,4, 1315(3)	N-4280	1988
NC-57A	1919/1955	Philadelphia Pike, Naamans Ck.	A 32' double span concrete slab bridge	No	Altered; poor condition.	4,1315(3)	N-3654	1988
NC-66	ca.1890	Brecks Lane, Waterway	A Warren pony truss	Yes	A rare surviving example of its type and design in the state. Fabricated by Edge Moor Bridge Works.	No	N-4301	1988,1997
NC-68	1925	Rockland Road, Waterway	A 19'-0" concrete encased steel girder span	Yes/Rock-land H. D.	A concrete encased steel multi girder with stone parapets and abutments. A good example of its type, contributing to a NR-listed historic district.	BNC-72 192	N-12535	1988, 1997
NC-69	1934	Adams Dam Road, Waterway	A concrete beam bridge with a single span of 28'-0"	Yes/Rock-land H.D.	An uncommon r. c. deck girder bridge; also contributing to the Rockland H.D.	BNC-73 1933	N-12534	1988, 1997
NC-70	n.d.	Thompson Bridge Rd., Wilson Run		No	Replaced prior to 1988.	Levy Court	N-12552	1988
NC-71	n.d.	Thompson Bridge Road, Winter Run	A single span concrete encased steel girder bridge	No	Deteriorated.	County	N-12553	1988
NC-73A W&N Br.#8.73	1945	Montchanin Road Overpass (W&N), Guyen Court	A single span through steel girder bridge	NAIRR owned	Not evaluated.	No	N-12551	1988
NC-74C	1959	Darley Road, CSX RR	A 3 span,159'-long, continuous steel multi girder bridge	No	Undistinguished example. Not of historic age.	1237	N-13603	1997
NC-76	ca. 1915 /1932	Montchanin Road, Waterway, Granogue	A single span r. c. slab bridge spanning 9'-0"	Yes	A good representative example of its type with stone facing.	Levy Court	N-12529	1988, 1997
NC-78	n.d.	Montchanin Road, Waterway, Guyen Court	A single span concrete frame bridge	No	Altered; poor example.	No	N-12661	1988
NC-81	1919	Montchanin Road, Waterway	A 14'-0" concrete encased steel girder span	No	Deteriorated.	County, BNC-77	N-12569	1988
NC-83	1932	Twaddell Mill Road, Waterway	A 13'-3" concrete encased steel girder span	No	Poor example.	BNC-78	N-12546	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-84	1932	Twaddell Mill Road, Waterway, Granogue	A single span concrete slab bridge with a clear span of 5'-4"	No	Poor, not fully articulated example.	No	N-12545	1988
NC-88	1939	Snuff Mill Road, Trib. of Red Clay Ck.	A 32'-9" encased steel multi girder span	Yes	A good, complete, and representative example of its type with stone facing, typical of New Castle County bridges of the period.	680, 87-570-15	N-12531	1988, 1997
NC-89	n.d.	Snuff Mill Road, Waterway, Delaware Heights	A single span concrete slab bridge with a clear span of 8'-9"	No	Deteriorated example.	No	N-12547	1988
NC-90	n.d.	Snuff Mill Road, Waterway, Delaware Heights	A single span concrete slab bridge with a clear span of 8'-0"	No	Poor example.	No	N-12548	1988
NC-91	n.d.	Snuff Mill Road, Waterway	A 8'-0" filled spandrel semicircular concrete arch.	No	Deteriorated; poor example.	No	N-12549	1988
NC-96	n.d.	No	A reinforced concrete slab bridge replaced prior to 1988	No				1988
NC-97	n.d.	No	A reinforced concrete slab bridge replaced prior to 1988	No				1988
NC-99	n.d.	Old Kennett Road Waterway	A steel girder bridge replaced prior to 1988	No		No		1988
NC-112	1929/1990	Yorklyn Road, Red Clay Ck.	A Warren pony truss	Yes	A rare surviving example of the truss type and design in Delaware. Fabricated by Edge Moor Bridge Works.	BNC-70, 72-120-03, 72- 090-11 1929	N-4054	1988,1997
NC-114	n.d.	Creek Mill Road, Waterway, Hockessin	A single span concrete slab bridge spanning 4'-0"	No	Altered; poor condition.	615	N-12555	1988
NC-118	ca.1860/ 1982	Wooddale Drive, Red Clay Ck.	A covered timber Town lattice truss bridge measuring 51'-0"	NR listed	One of two remaining covered bridges in the state. The structures were jointly listed in the National Register of Historic Places in 1973.	76-020-04	N-331	1988,1997
NC-119	1938	Mt. Cuba Road, Red Clay Ck.	A 107'-2"steel thru girder bridge	Yes	Thru girder with decorative concrete parapets; an exceptional example of a common type.	664, 83-570-01	N-1069	1988,1997
NC-120	1922	Mt. Cuba Road, Red Clay Ck.	An 81'-0" long closed spandrel r. c. arch	Yes	A significant example of a Luten arch bridge.	No	N-4277	1988, 1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-121	1930	Mt. Cuba Road, Trib. to Red Clay Ck.	A 20'-2" concrete encased girder	No	Deteriorated.	BNC-60	N-12558	1988
NC-124	n.d.	Campbell Road, Waterway	A 6'-3" filled spandrel segmental concrete arch bridge	No	Altered; poor example.	No	N-12571	1988
NC-126	1932	Nine Gates Road, Waterway, Hockessin	A single span concrete slab bridge spanning 12'-0"	No	Deteriorated.	Levy Court	N-12556	1988
NC-134	n.d.	Barley Mill Road, Mt. Cuba	A single span concrete slab bridge spanning 12'-6"	No	Deteriorated.	No	N-12572	1988
NC-135	1996	Barley Mill Road, Red Clay Ck.	A 2 span, 104'-long, prestressed concrete box beam bridge. Replaced a 1949 steel multi girder bridge in 1996.	No	Modern bridge.		N-13604	1997
NC-136	1931	Barley Mill Road, Trib. to Red Clay Ck.	An 18'-4" concrete arch	No	Fair condition; poor example.	BNC-64	N-12573	1988
NC-137	ca. 1860 /1969	Road 263A, Red Clay Ck.	A covered timber Town lattice bridge measuring 54'-0" long	NR listed	One of two remaining covered bridges in the state. The structures were jointly listed in the National Register of Historic Places in 1973.	BNC-63, 69-040-01, 77- 080-50 1939, 1981	N-296	1988, 1997
NC-138	1941	Lancaster Pike, Red Clay Ck.	Comprises three steel girder spans	No	Deteriorated.	673, 75 - 020-02	N-12081	1988
NC-139	1939	Lancaster Pike, Wooddale	A single span concrete slab bridge spanning 8'-0"	No	Poor condition.	673	N-12574	1988
NC-140	1929	Lancaster Pike, Little Mill Ck.	An 18'-0"concrete slab span	No	Obscured by widening.	BNC-65, 673	N-12575	1988
NC-143	1955	SR141, Center Rd., Little Mill Ck.	A 2 span, 45'-long, continuous r. c. slab	No	Undistinguished example.	1300	N-13579	1997
NC-149	1930	Newport Gap Pike, Red Clay Ck.	A concrete arch bridge with a span length of 64'-2"	No	Deteriorated; poor example.	BCN-58	N-12590	1988
NC-150	1917/1934	New Road, Waterway	A concrete encased steel girder bridge with a span length of 17'-6"	No	Widened; poor example.	BCN-59, 386	N-12598	1988
NC-151	1917/1934	New Road, Little Mill Ck.	A small single-span steel girder bridge	No	Widened; poor example.	386, 79-099-10	N-12597	1988
NC-152	1939	New Road, Waterway	A single 22'-0" concrete slab span	No	Poor example.	597	N-12594	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-153	1938	Kirkwood Hwy., Little Mill Ck.	A 33'-8"-long two span reinforced concrete slab bridge	Yes	A good example of this common type.	597	N-12595	1988,1997
NC-155	1931	Old Capital Trail, Red Clay Ck.	A 121'-2"long, one span, steel thru girder bridge	Yes	A good example of a common type with custom decorative pylons, light standards, and railings.	144, 144A, 87-570-15, 81-099-23	N-12663	1988, 1997
NC-156	1925	Kiamensi Road, Red Clay Ck.	A solid spandrel, ribbed concrete arch bridge with a span length of 91'-0"	No	Poor example.	No	N-4289	1988
NC-159	1929/1967/ 1986	James Street, Christina River	A non-operable single leaf bascule bridge with thru girder approach spans built in 1929. Fixed in place in 1967, and operating machinery and operators house removed in 1985.	No	Integrity of original design and materials has been lost.	103A 103B, 85 -074-01, 66-060-03 962A	N-4294	1988,1997
NC-160	1931	Maryland Avenue, Little Mill Ck.	A r.c. deck arch bridge with a span length of 50'-2"	Yes	A good example of its type built in association with Richardson Park development.	BNC-46, 83-074-04 1931	N-12624	1988,1997
NC-161	1926/1969	Old Dupont Road, Mill Ck.	A single span conclete encased steel girder bridge with a span length of 34'-0"	No	Poor example.	CN-30,295	N-12599	1988
NC-162	1936	Newport Gap Pike, Hyde Run	A 22'-0" concrete slab span	No	Late; fair condition; poor example.	CN-298A	N-12591	1988
NC-163	1931/1936	Newport Gap Pike, Hyde Run	Comprises a 20'-3"concrete encased steel girder span which has been widened on both elevations by the addition of a concrete slab	No	Deteriorated.	BNC-47, 298A	N-12592	1988
NC-169	1930	Old Lancaster Pike, Mill Ck.	A 16'-9" concrete encased steel girder span	No	Fair condition; poor example.	BCN-48	N-12662	1988
NC-170	1954/1958	SR 41, Lancaster Pike, Mill Ck.	A 2 cell, 21'-long, r. c. box culvert	No	Undistinguished example, widened in 1958.	755, 1236	N-13580	1997
NC-172	1929/1948	Yorklyn Rd., Red Clay Ck. Trib.	A 1 cell, 8'-long, r. c. box culvert	No	Undistinguished example, widened in 1948.	677	N-13581	1997
NC-172A	1925	Old Wilmington Rd., Wilmington Northern RR		No	A timber multi girder bridge from 1925 replaced prior to 1988.	86-071-02		1988
NC-177	1846/1965/ 1996	Brackenville Road, Mill Ck.	A single-span stone arch bridge with a clear-span of approximately 17'-0"	Yes	It is considered significant as one of four remaining historic stone arch bridges in Delaware.	BNC-51, 64-040-14 1925	N-278	1988,1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-178	n.d.	Mill Creek Road, Mill Creek Tributary	A concrete encased steel girder bridge with a span length of 8'	No	Deteriorated; altered.	No	N-12577	1988
NC-179	ca.l890/ 1995	Ashland Cut-off, Mill Ck.	A Warren pony truss	Yes	A rare surviving example of its type and design in the state.	BNC-52, 70-040-01, 1926	N-12578	1988,1997
NC-181	n.d.	Mill Creek Road, Waterway	A concrete encased steel girder bridge with a span length of 8'	No	Deteriorated; altered.	No	N-12578	1988
NC-182	1922	Faulkland Road, Hyde Run	A 24'-9"concrete encased steel multi girder bridge	Yes	A good representative example of a common type.	BNC-53 1922	N-12593	1988,1997
NC-192	1913	Road 318C, Mill Ck.	A single span steel girder bridge, with a span length of 38'-10"	No	Poor condition.	BNC-54	N-12587	1988
NC-193	1954	Newport Road, Red Clay Ck.	A 2-span, 74'-long, continuous rigid fame bridge	No	A late and undistinguished example in the state.	1253	N-13520	1997
NC-196	1930	Henderson Road, Pike Ck.	A single span girder bridge, with a span length of 30'-6"	No	Altered; historic integrity compromised.	No	N-4300	1988
NC-203	1926/1971	SR 72, Pike Ck.	A 20'-6" concrete slab span	No	Historic structure obscured by widening.	CN-29, 65-100-03	N-12583	1988
NC-211	1958	Kirkwood Highway, Waterway	A single span concrete arch bridge which has been altered by the addition of a plain concrete slab extension on its south elevation	No	Altered; poor example.	907,1497	N-12610	1988
NC-211A	1948/1958	Kirkwood Highway, Pike Ck.	A 1 span, 56'-long, steel multi girder	No	Undistinguished example, widened in 1958.	907, 1497	N-13582	1997
NC-216	1928/1995	Chambers Rock Road, White Clay Ck.	A Warren pony truss bridge	Yes	A rare surviving example of its type and design in the state.	BNC43, 87-570-15 1928	N-4296	1988,1997
NC-221	1979	Pleasant Hill Road, Muddy Run	A 20'-6"concrete slab span	No	Altered; integrity comprised.	70-100-18 83-071-02	N-12584	1988
NC-224	n.d.	Fox Den Road, Muddy Run	A 29'-6"steel girder span	No	Altered; poor condition.	No	N-12585	1988
NC-225	1922	Smiths Mill Road, Middle Run	A 14'-2" concrete encased steel girder span	No	Deteriorated.	County	N-12586	1988
NC-229A	1958	Kirkwood Highway, Muddy Run	A single span concrete arch bridge that has been widened on each elevation with concrete encased steel girder additions	No	Altered; compromised, poor example.	907, 1497, 79-099-10, 68-040-01	N-12607	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-229B	1954/1979	Kirkwood Hwy., White Clay Ck.	A 7 span, 496'-long, steel multi girder bridge with drop in and cantilever sections with pin-and-hanger connections	No	Late, undistinguished example with alterations.	1208 78-011-02	N-13583	1997
NC-231	1948	Curtis Mill Rd., White Clay Ck.	A 3 span, 160'-long, ribbed, reinforced concrete rigid frame bridge with cantilever spans. Moderne-style balustrades	Yes	Early application of continuous reinforcing and ribbing to the rigid frame bridge type, in order to achieve longer spans and economy of material. Earliest example in the state.	665, 78-021-01	N-13584	1997
NC-233	n.d	Old Capitol Trail, Waterway	A 16'-2" long concrete arch bridge.	No	Poor example.	No	N-12664	1988
NC-234	1949/1958	Kirkwood Hwy., Mill Ck.	A 1 span,72'-long, steel multi girder bridge	No	Late, undistinguished example. widened in 1958.	1000, 1497	N-13585	1997
NC-235	1918/1937	Old Capitol Trail, Mill Ck.	A 52'-2" concrete arch bridge that has been widened on the south elevation by a four span timber addition	No	Deteriorated; altered.	BNC-41, 1965-1	N-4278	1988
NC-243	n.d		A r. c. slab bridge replaced prior to 1988	No		No		1988
NC-244	1920	Telegraph Road Overpass (CSX)	A single span concrete slab bridge spanning 19'-6"	NA/RR owned	Not evaluated	No	N-4328	1988
NC-246	1942	Pedestrian, White Clay Ck.	A reinforced concrete tied thru arch bridge	Yes	The only example surveyed in Delaware.	750	N-12611	1988,1997
NC-255	1925	SR273, Trib. to White Clay Ck.	A double span concrete slab bridge spanning 22'-6"	No	Altered; poor condition.	CN27	N-12608	1988
NC-257	1937/1996	SR7,Christina River	A single-span steel multi girder bridge with a span length of 99'-0"	Yes/Christ-iana H.D.	A good example of its type with stone facing and parapets. Rehabilitation in 1996 was sensitive to original materials and design. Contrbutes to Christiana H. D.	401, 78-099-12	N-12617	1988,1997
NC-259		Smalley's Dam Rd., Christina Ck.		No	A metal truss bridge replaced prior to 1988.	84-071-01		1988
NC-269	1930	Tweeds Mill Road, Waterway	A timber beam span measuring 9'-6" long	No	Compromised by super-structure replacement.	No	N-12581	1988
NC-270	1930	Road 312, Appleton Road, Waterway	A 6'-10"timber beam span	No	Compromised by super-structure replacement.	No	N-12582	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-276	1930	Nottingham Road, Christina Ck.	A single span concrete arch bridge with a clear span of 42'-0"	No	Deteriorated.	147	N-12604	1988
NC-298	1927	SR7, Red Lion Ck.	A 20'-6"concrete rigid frame bridge	No	Poor example.	97	N-12665	1988
NC-299	1923	SR71, Red Lion Ck.	A 22'-0"concrete slab span	No	Deteriorated.	CN-13	N-12628	1988
NC-300	1934	Porter Station Road Red Lion Ck.	A 10'-10" r. concrete rigid frame bridge	Yes	An early and complete example of its type.	CN 43	N-12629	1988, 1997
NC-303	1927/1973	SR 9, Army Creek	A single span concrete encased steel girder bridge with a span length of 39'-6"	No	Poor example.	BNC-38, 68-040-30	N-12620	1988
NC-305A	1922	U.S. 13 SB, Red Lion Ck.	A single span concrete arch bridge with a clear span of 35'-0"	No	Poor example.	33	N-4275.1	1988
NC-305B	1929	U.S. 13 NB, Red Lion Ck.	A single span concrete arch bridge with a clear span of 35'-0"	No	Poor example.	114	N-4275.2	1988
NC-307	1955	SR 9, pipe lines	A 2 span, 43'-long, continuous r. c. slab bridge	No	Undistinguished example.	Plans in DELDOT Insp. File	N-13586	1997
NC-311	n.d.	SR72, Waterway	A single span 17'-6" long concrete arch bridge	No	Altered; compromised.	143	N-12635	1988
NC-312	n.d.	Road 405, Waterway	A single span concrete arch bridge with a clear span of 6'-0"	No	Altered; compromised.	No	N-12630	1988
NC-317A	n.d.	Road 384 Overpass (Conrail) Porter	A single span steel plate girder with a clear span of 59'-0"	NA/RR owned	Not evaluated.	No	N-12627	1988
NC-321A	n.d.	Road 35A Overpass (Conrail)	A single span concrete slab bridge with a clear span of 14'-9"	NA/RR owned	Not evaluated.	No	N-12631	1988
NC-330	ca. 1946	Marrow's Road, Cool Run	A l3'-0" long, corrugated steel pipe arch with stone headwalls	No	An undistinguished example of a common technology.	No	N-12606	1988,1997
NC-333	n.d.	Coochs Bridge Road, Mill Pond Flume	A single span concrete slab bridge spanning 25'-0"	No	Poor example.	No	N-12614	1988
NC-334	n.d.	Coochs Bridge Road, Mill Race	A single span concrete arch bridge with a clear span of 12'-0"	No	Poor example.	No	N-12615	1988
NC-336	1922	Road 336, Old Baltimore Road, Christina Ck.	A single span r.c. arch bridge with a clear span of 63'-0"	Yes/Cooch's Br. H D.	An unaltered and good representative example of this common type; also contributing to the Cooch's Bridge Historic District.	Levy Court 1922	N-4288	1988, 1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-337	1912/1932	Road 408, Waterway	A single span r. c. arch bridge with a clear span of 8'-6". Widened to one side in 1932 with a slab addition.	Yes/Cooch's Br. H.D.	A small arch bridge built by the Luten Bridge Co. of York; Contributing to the Cooch's Bridge Historic District.	BNC-11 1932	N-4290	1988, 1997
NC-342	1934	Welsh Tract Road, Waterway	A 10'-0" concrete rigid frame bridge	No	Poor example.	CN 44	N-12612	1988
NC-346	1932	Road 408, Waterway	A 16'-8" concrete encased steel girder span	No	Altered; poor example.	BNC-12	N-12616	1988
NC-348	1932	Road 408, Waterway	A single span concrete arch bridge	No	Poor example.	BNC-14	N-12622	1988
NC-349	1932	Road 408, Waterway	A single span concrete arch bridge with a clear span of 8'-0"	No	Poor example.	BNC-15	N-12623	1988
NC-351	1926/1936	SR 896, Muddy Run	A 30'-0" steel girder span	No	Altered; good but not outstanding example.	BNC-16, 503, 78 -099-12	N-12625	1988
NC-363	1922/1951	U.S. 40 Belltown Run Road 399, Waterway	An 18'-0" concrete slab span	No	Altered; compromised.	CN6, 261, 848, 1073	N-12626	1988
NC-366	1935	Road 399, Waterway	A 25'-0" concrete encased steel girder span	No	Poor example.	No	N-12634	1988
NC-368	1948	Frazer Rd., Guthrie Run	A 1 span, 12'-long, r. c. slab bridge	No	Late, undistinguished example.	1002	N-13587	1997
NC-377	1964	Choptank Road Back Creek	A concrete beam bridge with a single span length of 28'-0"	No	Altered; earlier superstructure replaced.	2154	N-12659	1988
NC-382	1933	Road 413, Scotts Run	A 19'-4"timber girder span	No	Compromised by superstructure replacement.	BNC-18	N-12637	1988
NC-383	1910	Road 413, Scotts Run	A single span r. c. arch bridge with a clear span of 12'-0"	Yes	The earliest known example of a Luten arch in Delaware.	No	N-12636	1988, 1997
NC-386	1952	SR 9, St. Georges Ck.	A 3 cell, 26'-long, r. c. box culvert with sluiceway	No	Undistinguished example.	1099	N-13588	1997
NC-388	1930	SR 9 over marsh, Port Penn.	A single span concrete frame bridge 10'-6" long	No	Poor example.	Levy Court	N-12639	1988
NC-393	1993	SR 299, Appoquinimink River	A 2 span, steel multi girder bridge	No/Odessa H D.	Steel multi girder bridge replaced swing span bridge in 1993.	County, 79-099-10, 83-570-01, 28A 1928	N-12643	1988, 1997
NC-394A	1933/1967	U.S. 13 NB, Drawyers Ck.	A concrete slab structure comprising six spans	No	Deteriorated; poor example.	182D, 182B, 67-060-12, 2019	N-12641	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-399N	1930/1980	U.S. 13 NB, Scott Run	A single span concrete slab bridge spanning 18'-0"	No	Altered; historic structure obscured.	169, 79-012-02	N-12638.1	1988
NC-399S	1923/1944	U.S. 13 SB, Scott Run	A single span concrete slab bridge spanning 18'-0"	No	Altered; historic structure obscured.	32, 79-012-02	N-12638.2	1988
NC-400	1921/1948	Road 428, Shellcross Lake	A single span concrete frame bridge	No	Poor example.	971	N-12640	1988
NC-405	1920	Road 429, Drawyers Ck.	A 16'-0" concrete encased steel girder span	No	Altered; poor condition.	BNC-34	N-12642	1988
NC-407	1935	Road 442, Silver Lake Spillway	A 19'-0"concrete encased steel multi girder bridge built in association with a dam/spillway	Yes	A good, complete example of its type with historic association to a water control dam and spillway.	672, BNC-35	N-12644	1988,1997
NC-407A	1950	Road 442, Silver Lake, Mill Race	A 8'-0" steel girder span	No	Altered; poor example.	BNC-35, 1079	N-12645	1988
NC-409	1934/1948	SR 896, Deep Creek	A 18'-6"steel girder span	No	Altered; poor example.	458,903, 79-099-10	N-12647	1988
NC-417	1919/1928	Road 25, Waterway	A 16'-0"concrete encased steel girder span	No	Altered; poor example.	CN-11	N-12651	1988
NC-419	1928	Road 461, Waterway	A 10'-0"concrete rigid frame bridge	No	Poor example.	BNC-24	N-12649	1988
NC-423	1919	Road 446, Waterway	A 12'-0" concrete encased steel girder span	No	Poor example.	365	N-12650	1988
NC-424	1884	Road 446, Wiggins Mill Pond	A Warren pony truss bridge	Yes	A rare surviving example of its type in the state. Fabricated by Delaware's Edge Moor Bridge Works.	87-570-15	N-4303	1988,1997
NC-427	1935	Road 459, Barlow Branch	A 20'-0" cambered concrete slab span	No	Poor example.	No	N-12655	1988
NC-430	1928	Road 460, Barlow Branch	A single cell box culvert	Yes	A good representative, complete example of this type.	Levy Court	N-12652 1928	1988, 1997
NC-435	1956	Road 477, Cypress Branch	A 18'-0" concrete slab span	No	Deteriorated, hybrid structure.	1506	N-12656	1988
NC-440	1936/1948	Road 14, Cattail Branch	A 34'-0" steel girder span	No	Altered; poor example.	458, 903, 78-099-12, 87-570-15	N-12648	1988
NC-452		SR 9, Smyrna River		No	A swing span bridge (1934) replaced prior to 1988.	87-570-15, 81-071-05, 81-071-04, 81-071-07		1988
NC-456	1980	Road 45, Saw Mill	A 2 span, 15'-6"-long timber	No	Bridge superstructure replaced	274A	N-12653	1988, 1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
		Branch	multi girder bridge		in 1980.			
NC-474	1927/1965	Delaney's Road, Paw Branch	A 20'-0"long concrete encased steel girder span.	No	Altered; poor example.	BNC-31, 64-010-29	N-12658	1988
NC-476	1933	Road 483, Paw Branch	A 20'-3"-long, reinforced concrete slab bridge	Yes	A good, complete representative example of this common type.	No	N-12657	1988, 1997
NC-487S	1920/1980	U.S. 13 SB, Blackbird Ck. Trib.	A 18'-0" concrete slab span	No	Altered; poor example.	27, 930, 79-012-01	N-12654	1988
NC-488N	1931	U.S. 13 NB, Blackbird Ck.	A single span rigid frame concrete bridge	Yes	A good early example of this common type.	220	N-12660.1	1988, 1997
NC-488S	1920	U.S. 13 NB, Blackbird Ck.	A single span concrete arch bridge with a clear span of 41'-3"	No	Poor example.	27	N-12660.2	1988
NC-495	1942/1972	U.S. 13,C&D Canal	A multiple span bridge comprising a 540' steel arch and 41 plate girder approach spans.	NA	Not evaluated; Owned by U.S. Army Corps of Engineers.	Corps	N-12632	1988
NC-497	1933/1971	SR 9,C&D Branch Channel	A 89'-0"double leaf bascule bridge of built-up plate girder construction.	NA	Not evaluated; Owned by U.S. Army Corps of Engineers.	Corps	N-12633	1988
NC-499	n.d	Forrest Avenue, Little Mill Ck.	Consists of two timber beam spans measuring 12'-3" and 14'-7"	No	Altered; compromised.	No	N-12596	1988
NC-503	n.d	Road 447, Conrail	A triple span steel plate girder bridge	NA/RR owned	Not evaluated.	No	N-4309	1988
NC-504	1939	Road 442, Silver Lake Spillway	A 2 span r. c. slab bridge spanning 25'-0" and incorporating a water control structure	Yes	A good, complete example of its type with structural association with a dam/spillway.	672,672A	N-12646	1988, 1997
NC-513	1952	SR9, Augustine Ck.	A 2 cell, 18'-long, r.c. box culvert with sluiceway	No	Undistinguished example.	1171	N-13602	1997
NC-515A	1920/1941	U.S. 13 SB, Dragon Ck.	A single span concrete arch bridge with a clear span of 19'-9"	No	Poor example.	33, 675	N-4291.1	1988
NC-515B	1928-1929	U.S. 13 NB, Dragon Ck.	A single span concrete arch bridge with a clear span of 19'-9"	No	Poor example.	114	N-4291.2	1988
NC-523	n.d	Lebanon Road, Waterway, Rockland	A single span concrete slab bridge with a clear span of 4'-11"	No/Rock-land H D.	Poor example.	No	N-12554	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-526 W&N Br.# 8.44	1926	Adams Dam Road Overpass, Winterthur	A single span concrete slab bridge spanning 30'-0"	No	Poor example.	No	N-12550	1988
NC-528	n.d	Pyles Ford Road, Wilson Run	A 2'-9" stone arch culvert	No	Compromised, deteriorated.	No		1988
NC-543	1936	Carr Road, Shellpot Ck.	A single span steel multi girder bridge with a span length of 34'-6"	Yes	Features rock-face ashlar veneer and good craftsmanship, and it is an excellent example of this type.	495, 87-570-1	N-12613	1988, 1997
NC-550	1919	Philadelphia Pike, Shellpot Ck.	A double span concrete arch bridge	No	Poor example.	3,81,880, 71-100-06	N-4281	1988
NC-552	1919/1927/ 1956	Philadelphia Pike, Stoney Run	A single span concrete arch bridge with a clear span of 16'-0"	No	Altered; poor example.	4, 92,1377	N-12543	1988
NC-554	1919/1927/ 1956	Philadelphia Pike, Hollyoak Ck.	A single span concrete arch bridge with a clear span of 16'-6"	No	Altered; poor example.	4,92,1377	N-12540	1988
NC-558	1934/1939	Gov. Printz Blvd., Hollyoak Ck.	A single span steel girder bridge with a span length of 28'-6"	No	Altered; poor example.	394,729, 70-040-01	N-12541	1988
NC-559	1935/1939	Gov. Printz Blvd., Quarry Ck.	A single span steel girder bridge with a span length of 41'-9"	No	Poor example.	728, 70-040-01	N-12542	1988
NC-562	1956	Bellevue Rd., Del. River Trib.	A 1 cell, 8'-long, r. c. box culvert	No	Undistinguished example.	1398	N-13589	1997
NC-566		Hay Rd., US 13, Gov. Printz Blvd		No	A 1934 steel girder bridge replaced prior to 1988.	367		1988
NC-567		Edgemoor Rd., Conrail		No	A 1924 steel girder bridge replaced prior to 1988.	No		1988
NC-567A	1951	Hay Rd., Shellpot Ck.	A 5 span, 130'-long, continuous, r. c. T beam bridge	No	Undistinguished example.	City	N-13590	1997
NC-568	1930	Tweeds Mill Road, Trib. White Clay Ck.	An 11'-2" timber beam span	No	Altered; poor example.	No	N-12694	1988
NC-569	1930	Road 311, Trib. White Clay Ck.	A single span timber stringer bridge with a clear-span of 9'-0"	No	Compromised by superstructure replacement.	No	N-12580	1988
NC-575	1928	North Market Street, Brandywine Ck.	A 3 span, 213'-long steel multi girder bridge with cantilevered end spans	Yes/Brandy-wine Village H D.	The bridge is an uncommon cantilevered design by a nationally recognized consulting engineer firm. The bridge is located in the Brandywine Village Historic District.	BNC-6, 82-099-01, 82-099-02, 70-040-09, 80-050-13	N-1439	1988,1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-576	1922/1966	Washington Street, Brandywine Ck., Conrail	A monumental open spandrel r.c. arch bridge	NR listed/Brandy-wine Park H.D.	The only example of an open spandrel arch bridge surveyed in Delaware. Designed by a leading engineer.	83-071-05, 64-040-15	N-1427	1988,1997
NC-577	1932	North Church Street, Brandywine River	A non-operable, single leaf simple trunnion bascule bridge with five T beam approach spans.	Yes	Although non-operable, it retains its integrity of original design. Handsome architectural details.	BNC-4, 1080, 2142, 84-074-02, 68-060-01, 74-040-01	N-12600	1988, 1997
NC-579	1940	Lea Blvd., Shellpot Ck.	A three span bridge comprising 14'-0" corrugated metal pipes and stone faced headwalls	No	Poor example.	No	N-12566	1988
NC-580	1934	Lea Blvd., Matson's Run	A single span concrete frame bridge, altered with a new culvert	No	Altered; compromised integrity.	183	N-12564	1988
NC-585		Augustine Cutoff, Brandywine Ck., Conrail		No	Replaced prior to 1988.		79-071-02	1988
NC-586	1920	Pennsylvania Avenue Overpass (CSX) Wilmington	A single span steel plate girder bridge spanning 66'-0"	NA/RR owned	Not evaluated.	No	N-4326	1988
NC-587	1951	SR141, Brandywine Ck. (Tyler McConnell Bridge)	A 12 span, 816'-long bridge consists of a 3-span, continuous haunched built up deck girder main span, and steel multi girder approach spans.	Yes	Reflects mid 20th century advances in the use of continuous designs. An early use of hammer head pier.	1082, 78-011-07	N-13591	1997
NC-588	1923	Rising Sun Road Overpass, Wilmington	A single span steel plate girder bridge with a clear span of 39'-4"	NA/RR owned	Not evaluated.	No	N-12567	1988
NC-593 CSX Br.# 11B	n.d	Wooddale Drive, Wilmington Northern RR	A single span timber stringer bridge with a clear-span of 34'-0"	No	A poor example of simple timber beam bridge due to deterioration.	No	N-12557	1988
NC-607	1955	North Star Rd. ,Pike Ck.	A 1 span, 17'-long, r.c. slab bridge	No	Undistinguished example.	1336	N-13592	1997
NC-608	1925	Kennett Pike, Waterway	A single span concrete arch bridge with a clear span of 24'-6"	No	Poor example.	No	N-12570	1988
NC-609 CSX, Br.#65C		Lancaster Ave., CSX RR		No	Bridge replaced prior to 1988.		78-021-08, 78010	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-609A CSX Br.#65D		Fourth St., CSX RR		No	Bridge replaced prior to 1988.		78-021-08,	1988
NC-609B CSX Br.#65E	1901	6th Street, CSX RR	A single span, through steel plate girder bridge with a clear span of 62'-0"	NA/RR owned	Not evaluated.	No	N-4306	1988
NC-609C CSX Br.#65 1/2E	1909/1941	7th Street, CSX RR	A five span steel girder bridge, with an overall length of 129'	No	Altered; poor example.	No	N-4307	1988
NC-609D CSXBr.#6 5G	1912/1941	9th Street, CSX RR	A three span steel girder bridge with an overall length of 105'	No	Altered; poor example.	No	N-4308	1988
NC-611	1953	SR 41, Lancaster Pike, Mill Ck. Trib.	A 1 cell, 8'-long, r.c. box culvert	No	Undistinguished example.	755	N-13593	1997
NC-617	ca. 1808	Old Lancaster Pike, Waterway	A 10'-3"-long stone arch bridge	Yes	The oldest bridge in the survey and 1 of 4 stone arch bridges identified. Historically associated with the development of the Newport Gap Turnpike.	No	N-12576	1988, 1997
NC-622	1953/1995	SR 72, Muddy Run	A 1 span, 56'-long, r. c. frame bridge, widened in kind in 1995	No	Altered, undistinguished example.	1181 89-116-01	N-13594	1997
NC-623		Paper Mill Rd., Cattle Crossing		No	A timber bridge replaced prior to 1988.	No		1988
NC-624	1922	North Chapel Street Overpass (CSX) Newark	A five span steel girder bridge with an overall length of 219'	NA/RR owned	Not evaluated.	No	N-435	1988
NC-628	1920	Casho Mill Road Overpass	A single span concrete slab bridge with a clear span of 16'	NA/RR owned	Not evaluated.	No	N-4327	1988
NC-630	1953	Jefferson Ave., Chestnut Run	A 1 span, 18'-long, reinforced concrete slab bridge with concrete parapets	Yes. Contribut-ing to Potential Willow Run Section 2 H.D.	A representative and individually undistinguished example of a standard design bridge, it is significant only in association with its setting in a potential historic district of post-WW II houses.	1226	N-13595	1997
NC-631	1949	Kirkwood Hwy., Little Mill Ck. Trib.	A single span, 26'-long, r.c. slab bridge	No	Undistinguished example.	791	N-13596	1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-632	1948/1985	SR 2 over CSX RR, Delaware Valley RR, Silver Run	A 13 span,1,049'-long, continuous steel multi girder bridge built in 1948, strengthened and widened in 1985.	No	Alterations have resulted in loss of integrity of original design.	765, 80-011-01	N-13597	1997
NC-635	1940/1988	Kirkwood Highway, Red Clay Ck. & RR	An 11 span steel girder bridge with an overall length of 732'.	No	Altered; historic structure obscured.	649A, 64-010-04, 78-099-12, 78-011-01	N-12589	1988
NC-636	1938/1968	Kirkwood Highway, Trib. Red Clay Ck.	A single span concrete slab	No	Altered; historic structure obscured.	649, 64-120-04	N-12588	1988
NC-639	1949/1958	Kirkwood Hwy., Mill Ck. Trib.	A 1 span, 23'-long, r. c. slab bridge.	No	Altered; undistinguished example.	1000	N-13598	1997
NC-641		SR896, Amtrak & Conrail		No	Bridge replaced prior to 1988.	78-011-01, 462, 80-071-01		1988
NC-646 Amtrak Br.#36.42	1885	Route 273 Overpass (Amtrak) Newark	Single span brick-lined arch with a clear span of 35'-3"	NA/RR owned	Not evaluated.	No	N-12609	1988
NC-651	1951	Newport Ave., CSX RR	A 5 span,144'-long bridge with 43'-long steel multi girder span and 4 timber multi girder spans.	No	Altered; undistinguished example.	RR Plans	N-13599	1997
NC-652 CSX Br. #66B	1906	Gilpin Avenue Overpass (CSX) WIlmington	A triple span through steel plate girder bridge with an overall length of 69'-6"	NA/RR owned	Not evaluated.	No	N-12562	1988
NC-657 CSX Br.#66A	n.d	Delaware Avenue Overpass (CSX) Wilmington	A triple span steel plate girder bridge with an overall length of 74'-0"	NA/RR owned	Not evaluated.	No	N-12563	1988
NC-659 CSX Br. #66C	n.d	Lovering Avenue Overpass (CSX) Wilmington	Single span, steel plate girder bridge with a length of 87'-0"	NA/RR owned	Not evaluated.	No	N-12561	1988
NC-660	1922/1975	U.S.13, Mill Ck.	A concrete slab bridge spanning 20'-6"	No	Altered; historic structure obscured.	14,114, 72-080-01	N-12618	1988
NC-661A	1884	Road 34A, Army Creek	A 18'-10"span comprising a riveted steel pony truss and a concrete slab	No	Two-type hybrid; poor example of either.		N-4296	1988
NC-663	1922	Conrail over U.S. 13, Llangoller	A double span through deck steel plate girder bridge with an overall length of 169'-8"	No	Altered; poor example.	No	N-12619	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-668 Amtrak Br.#30.67	1930	James Street Overpass (Amtrak) New Fort	A triple span steel girder bridge with an overall length of 46'-1"	NA/RR owned	Not evaluated	No	N-12603	1988
NC-680	1954	SR141, Basin Rd., over US 13, US 40	A 7 span, 602'-long, steel multi girder bridge	No	Undistinguished example of common technology	1318(2), 2028, 67-08-005	N-13600	1997
NC-681	1936	Chestnut Street, Conrail	A 113'-0" triple span concrete encased steel girder bridge	No	Altered; deteriorated.	381	N-12621	1988
NC-684	1942/1994	South Heald Street, Conrail	A 21 span bridge with a steel multi girder span over the tracks (1994) and r. c. continuous slab approach spans with mushroom column piers.	Yes	Unusual mushroom column piers and early use of continuous slab design. Handsome parapets in Moderne-style. Rehabilitation in 1994 was sensitive to the original design and materials.	700, 2028, 70-040-09	N-12601	1988, 1997
NC-685	1925/1960	16th Street, Brandywine River	A multiple span plate girder bridge with an overall length of 232'-10"	No	Altered; historic structure compromised.	N-11749, 1849, 79-099-10, 87-570-15, 70-040-09, 73-080-09	N-4293	1988
NC-686 Conrail Br.#0.55, Del River Ext.	1938/1994	U.S. 13 Business, Conrail	A 30 span bridge with a prestressed concrete box beam span over the track (1994) and r. c. continuous slab approach spans with mushroom columnn piers	Yes	Unusual mushroom column piers and early use of continuous slab design. Handsome parapets in Moderne-style. Rehabilitation in 1994 was sensitive to the original design and materials.	474,2028, 70-100-21	N-12602	1988,1997
NC-687	1954	Walnut St., Christina River	A double leaf bascule bridge with 276'-long main span flanked by steel multi girder approach spans	Yes	Historically significant example of its type with mid 20th century refinements such as enclosed reducing gears and automated controls. Designed to relieve traffic congestion in Wilmington. One of largest of state highway department bridge division's 1950s projects.	1224, 89-074-05	N-13601	1997
NC-688	1927/1982	South Market Street, Christina River	A 208'-0"double leaf bascule bridge with girder superstructure.	Yes	The most complete simple trunnion bascule highway bridge in Delaware. Designed by nationally known movable bridge consulting engineer firm.	72ABD, 927A, 2049, 81-071-02, 64-020-18, 73-080-02	N-1434	1988, 1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
NC-689 Amtrak Br.# 26.92	1905/1916	Route 13 overpass (Amtrak) Wilmington	A triple span steel plate girder bridge with an overall length of 70'-0"	NA/RR owned	Not evaluated.	No	N-5281.16	1988
NC-690 Amtrak Br.# 26.85	1905	King Street Overpass (Amtrak) WIlmington	A triple span steel plate girder bridge	NA/RR owned	Not evaluated.	No	N-5281.15	1988
NC-694 Amtrak Br.#26.33	1905	7th and Church Street Overpass (Amtrak) Wilmington	A steel plate girder bridge built on a 45 degree skew with an overall length of 200'-10"	NA/RR owned	Not evaluated.	No	N-5281.07	1988
NC-695	1918	12th Street Overpass (Amtrak) Wilmington	A triple span steel plate girder bridge built on a 25 degree skew with an overall length of 48'-0"	NA/RR owned	Not evaluated.	No	N-5281.03	1988
NC-697 CSX Br.# 67A	1918	18th Street Overpass (CSX) WIlmington	A double span concrete slab bridge spanning 44'-0"	NA/RR owned	Not evaluated.	No	N-4329	1988
NC-698	1906	Van Buren Street, Brandywine Ck.& Flume	An 8-span, 286'-10" long Melan arch in Brandywine Park	NR listed	The only example of a Melan arch in Delaware. Designed by nationally known engineering firm. Excellent example of the influence of the City Beautiful Movement.	BNC-7, 70-05-02, 80-071-02	N-4285	1988, 1997
NC-698B	1920	Lovering Avenue, Bridle Path	A single span concrete arch bridge with a clear span of 35'-6"	NA	Owned by City of Wilmington; stone-faced, horseshoe arch bridge, an integral element of the park.	No	N-4286	1988
NC-700	n.d	North Park Drive, Waterway at I-95 Wilmington	A single span concrete encased steel girder bridge with a span length of 10'-5"	NA	Owned by City of Wilmington; also located within the Brandywine Park Historic District.		N-12695	1988
NC-701	n.d.	North Park Drive (Pedestrian Walk), Waterway at I-95, Wilmington	A single-span stone arch bridge with a clear span of 14'-4"	NA	Owned by City of Wilmington; also located within the Brandywine Park Historic District.	72ABC, 927A, 2049, 81-071-02, 64-020-18, 73-080-02	N-12696	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed

Kent County Bridges

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
K-1A	1940	Route 1, Mill Creek	A single span concrete rigid frame bridge	No	Undistinguished example.	281 A&B BK-3	K-6458	1988
K-1C	1921/1933	Route 1, Smyma River	A four span 78'-0"concrete slab bridge	No	Deteriorated; altered and compromised.	281,25A	K-5643	1988
K-2C	1929/1986	U.S. 13 SB, Little Duck Creek	A triple span 52'-6" long concrete slab blidge	No	Deteriorated; altered and compromised.	2D, 716, 87-075-01	K-5644	1988
K-2D	1934/1986	U.S. 13 NB, Little Duck Creek	A triple span 88'-0" long concrete slab bridge	No	Deteriorated; altered and compromised.	287,1810, 87-075-01	K-5645	1988
K-3A	1952	US 13, Isaacs Br.	A 3 cell, 34'-long, r. c. box culvert	No	Undistinguished example.	843	K-6833	1997
K-3B	1929/1962	S. Governors Ave., Puncheon Run	A two span concrete slab bridge	No	Altered; compromised (span enlargements).	138,2038	K-6464	1988
K-3C	1937	North State Street, Silver Lake	An architectonic three span reinforced concrete deck arch bridge with brick veneer	Yes	Significant for the high artistic value of its design.	155, 86-098-06	K-6463	1988,1997
K-4A	1922	S.R 13A, Tidbury Creek	A single span concrete slab	No	Fair condition; better examples found.	No	K-5646	1988
K-5A	1913	U.S. 13 SB, Stream	A single span concrete slab	No	Altered; original structure obscured.	No	K-5647	1988
K-5B	1956	US 13 NB, Browns Br.	A 2 cell, 14'-long, r. c. box culvert	No	Undistinguished example.	916	K-6834	1997
K-5C	1920	U.S. 13 SB, Murderkill River	Single span concrete beam bridge	No	Fair-to-deteriorated.	20	K-5648	1988
K-5D	1955	U.S. 13 NB, Murderkill River	A single span r. c. T beam bridge	No	Undistinguished example.	915	K-5649	1988, 1997
K-5E	1954	US 13, Hudson Br.	A 2 cell, 19'-long, r. c. box culvert	No	Undistinguished example.	915	K-6835	1997
K-6A	1956/1985	US 13, White Marsh Br. Trib.	A 1 span, 12'-long, r. c. slab bridge, widened to one side with prestressed concrete box culvert.	No	Altered, undistinguished example.	925, 2065, 84-62-08	K-6847	1997
K-6D	1956	US 13 NB, Browns Br. Trib.	A 1 cell, 10'-long, r. c. box culvert	No	Undistinguished example.	916	K-6836	1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
K-6E	1919/1956	US 13 NB, Browns Br. Trib.	A 1 span, 10'-long, r. c. slab bridge, widened in 1956.	No	Altered, undistinguished example.	916	K-6837	1997
K-8F	1920	Road 10, Murderkill River	A 4 span concrete encased steel multi girder bridge	Yes	One of the earliest and longest examples of the standard type built by the state highway department after its establishment in 1917.	24A	K-5651	1988, 1997
K-8G	1920	Route 12, Spring Creek	A double span concrete encased steel girder bridge	No	Poor condition; poor example.	24A	K-5652	1988
K-9A	1996	Route 6, Mill Creek	Prestressed concrete box beam bridge	No	A modern structure built to replace a composite wood and concrete slab bridge built in 1936.	412, 70-05-001	K-6457	1988,1997
K-12B	1952	SR 9, Denny St., Leipsic R.	A 13 span, 547'-long, steel multi girder bridge	No	Undistinguished example.	425	K-6841	1997
K-15A	1939	Route 9, Muddy Branch	A single span concrete slab bridge	No	Poor example.	676, 87-075-02 (repairs)	K-6461	1988
K-16A	1885/1958	Route 8, St. Jones River	A composite structure comprising a late nineteenth century brick lined stone arch bridge with twentieth century additions on both elevations.	No	Altered; compromised.	400 (sidewalks), 1094	K-5653	1988
K-17A	1995	SR 9, Little River	A 2 span, prestressed concrete box beam bridge	No	Modern bridge, replaced a 1952 slab bridge.		K-6849	1997
K-21A	1929	Rehoboth Road, Mispillion River	A single leaf Scherzer bascule bridge with two thru girder approach spans	Yes	One of two Scherzer bascule bridges in Delaware.	104A&B, 1049, 1573	K-5654	1988,1997
K-22A	1939	Route 14 and Truitt Lane, Mullet Run	A 16’-0”concrete rigid frame bridge	No	Undistinguished example.	No	K-6481	1988
K-23A	1934	Loockerman Street, St. Jones River	An architectonic single span reinforced concrete arch bridge with brick veneer	Yes	One of two bridges in Dover featuring Colonial Revival detailing designed by Wilmington architect E. William Martin. It is considered eligible for the high artistic value of its design.	227A, 80-098-03 (repairs), 81-098-04 (repairs)	K-5655	1988, 1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
K-24A	1951	US 13, St. Jones River	A 3 span, 200'-long continuous, r. c. T beam bridge finished with concrete balustrades and fluted pylons	Yes	Bridge reflects important post-1940 advances in the application of the T beam technology to longer span continuous structures. It is only example of a haunched, continuous T beam bridge in the state.	993,1562	K-6842	1997
K-24B	1951/1991	US 13, Puncheon Run	A 2 cell, 15'-long, box culvert lengthened to 4 cells in 1991	No	Altered. Undistinguished example.	913, 81-022-02	K-6843	1997
K-24C	1952	US 13, Tidbury Ck.	A 1 cell, 10'-long, r. c. box culvert	No	Undistinguished example.	843	K-6838	1997
K-27A	1919/1958	U.S.113A, Tidbury Branch	A 62'-0" concrete arch bridge	No	Altered; compromised.	16,1551	K-6469	1988
K-27B	1919/1958	U.S. 113A, Isaac Branch-Moores Lake	A 84'-0" concrete arch bridge	No	Remodeled; compromised.	16, 1551	K-6466	1988
K-36A	1922/1938	Route 14, Browns Branch	A 31'-0"concrete slab bridge	No	Altered; compromised.	CK-2,654	K-5656	1988
K-39C	ca. 1860	Route 6, Duck Creek	A single span stone arch bridge combining vehicular and railroad use	Yes	One of four DelDOT stone arch highway bridges and the only stone arch highway bridge in Kent County.	No	K-5657	1988,1997
K-40A		Road 40, Clayton		No	A 1932 steel girder bridge replaced prior to 1988.	No	K-5658	1988
K-40B	1931	Bassett Street, Clayton	A single span concrete encased steel girder bridge	No	Better examples found.	No	K-5659	1988
K-42A	1933	Road 42, Little Duck Creek	2 cell, 32'-long, r.c. box culvert	Yes	A good complete example of its type.	278	K-5660	1988,1997
K-45A	1923/1959	Route 42, Pinks Branch	A 23'-6" single span concrete slab bridge	No	Altered; compromised.	CK-14, 1695	K-5661	1988
K-50A	1922/1952	Route 8, Tappahanna Branch	A 46'-6" single span concrete encased steel girder bridge	No	Altered; poor example.	CK-9, 1037	K-5662	1988
K-53C	1925/1959	Route 10, Iron Mine Prong	A 18'-6" single span concrete slab	No	Altered; compromised.	CK-28, 1775	K-6471	1988
K-59D	1931/1957	Road 59, Black Arm Prong	A 19'-4" single span concrete encased girder bridge	No	Altered; compromised.	175, 1503	K-6477	1988
K-59E	1931/1957	Road 59, Black Arm Prong	A 46'-0" single span concrete slab bridge	No	Altered; deteriorated.	175, 1503	K-5663	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
K-60A	1923/1937/ 1987	SR 14, Marshyhope Creek	A 17'-9" single span concrete slab	No	Altered; compromised.	CK-10, 524	K-6480	1988
K-64A		Smyrna Landing, Smyrna River		No	Bridge replaced prior to 1988.	No		1988
K-67A	1956	Court St., St. Jones River	A 1 span, 68'-long, reinforced concrete tied deck arch bridge with brick veneer spandrel walls, ornamental steel railings, and pilasters.	Yes	Handsome architectural treatment in keeping with the state capitol complex and uncommon design of reinforced concrete deck arch with reinforced concrete ties between the abutments.	1169	K-6844	1997
K-81B	1929/1965	Road 81, Brown Branch	A 16'-0" single span concrete encased steel girder bridge	No	Altered; compromised.	113, 64-010-06	K-6478	1988
K-84A	1996	Road 84, Snows Br.	A 14' prestressed concrete slab	No	Modem structure. Replaced a timber multi girder bridge from 1955.		K-6848	1997
K-84B	1955	Road 84, Spraunces Neck Br.	A 18'-long,timber multi girder bridge	No	Undistinguished example.	1264	K-6845	1997
K-86A	1955	Road 86, Muddy Br.	A 2 span, 64'-long, steel multi girder bridge	No	Undistinguished example.	1382, 69-120-01, 88-075-01	K-6846	1997
K-88A	1935	Road 88, Muddy Branch	A 7'-6" single span timber girder bridge	No	Better examples found.	No	K-6462	1988
K-89A	1935/1980	Road 89, Taylors Gut	A single span timber girder bridge 19'-4"in length	No	Altered; compromised.	308A, 81-098-04	K-5664	1988
K-1OOA		Denneys Rd., Fork Branch		No	A 1928 steel girder bridge replaced prior to 1988.	86-072-03		1988
K-101B	1931	Road 101, Fork Branch	A 17'-9"single span concrete slab	No	Better examples found.	156	K-6460	1988
K-104A	1934	Road 104, Cahoon Brook	A 22'-0" single span concrete slab bridge	No	Unexceptional example.	157	K-5665	1988
K-104B	1920/1984	Road 104, Mudstone Branch	A 23'-8" concrete arch bridge which has been encased on both elevations by a concrete slab	No	Altered; fair condition.	157	K-5666	1988
K-104C	1934	Road 104, Fork Branch	A single span concrete slab 22'-0" long	No	Unexceptional example.	157	K-5667	1988
K-123A	1997	Road 123, Kings Causeway Branch	A single span timber multi girder bridge	No	Modern bridge replaced a timber multi girder bridge from 1933.	297	K-5668	1988, 1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
K-124B	1935	Road 124, Trib. to Mispillion River	A single span timber girder bridge	No	Deteriorated.	348	K-5669	1988
K-124D	1935	Road 124, Grecos Canal	A 15'-2"single span timber girder bridge	No	Compromised by repairs, replacements.	No	K-5670	1988
K-137A	1936/1993	Road 137, Duck Creek	A 15'-2" single span timber multi girder blidge	No	Bridge superstructure replaced in 1993. Only timber piles of previous timber multi girder bridge from 1936 remain.	493	K-5671	1988, 1997
K-156C		Saulsbury Rd., Mudstone Br.		No	A timber bridge replaced prior to 1988.	606		1988
K-160A	1945	Road 160, Mudstone Branch	A 22'-0" single span timber bridge	No	Undistinguished example.	877	K-6465	1988
K-162A	n.d	Route 162, Mudstone Branch	A 32'-0" single span steel girder bridge	No	Deteriorated.	No	K-6467	1988
K-167A	1937	Road 167, Fork Branch	A single span timber girder bridge, 20'-0"	No	Deterioration.	545	K-6459	1988
K-19OB	1919/1940	Layton Avenue, Isaac Branch	A single span 25'-0" steel girder bridge	No	Altered; poor example.	681, 69-120-01	K-5684	1988
K-210A	n.d	Road 210, Shades Branch	A 31'-0" single span steel girder bridge	No	Repaired; compromised integrity.	69-120-01	K-5672	1988
K-211A	ca. 1909/1936	Road 211, Choptank River	A five span steel multi girder bridge 132'-0" in length,with riveted steel caisson bents.	Yes	An early example of its type in a rural county. The only identified examples of riveted caisson bents.	494, 69-120-01	K-6470	1988,1997
K-265B	1937	Road 265, White Marsh Branch	A single span timber girder bridge	No	Better examples found.	520	K-6473	1988
K-266A		Road 266, Whitemarsh Br.		No	A 1935 timber bridge replaced prior to 1988.	84-072-04		1988
K-270A	1930	Road 270, Price Prong	A 12'-0" single span timber girder bridge	No	Better examples found.	No	K-6474	1988
K-275A	1939	Road 275, Horse Pen Arm Ditch	A 21'-0" single span timber girder bridge	No	Widened; altered.	607	K-6475	1988
K-275C	1939/1985	Road 275, Black Arm Ditch	A double span timber girder bridge 34'-0" long	No	Better examples found.	607	K-6476	1988
K-284C	1949/1967	Road 284, Murderkill River Trib.	A single span, 16' long, r.c. slab bridge, widened in kind in 1967.	No	Altered; undistinguished example.	1005, 67-080-15	K-6839	1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
K-285A	1949/1969	Road 285, Black Swamp Ck.	A single span, 26'-long, r.c. slab bridge, widened in kind in 1969.	No	Altered; undistinguished example.	1005, 67-080-15	K-6840	1997
K-291A		Road 291, Engle Ditch		No	A 1938 timber bridge replaced prior to 1988.	631		1988
K-299B	1928/1969	Hemping Road, Black Arm Prong Ditch	A single span steel girder bridge measuring 30'-0" in length	No	Altered; undistinguished example.	No	K-5674	1988
K-348B	1949	Road 348, Pipe Elm Branch	A 36'-0" double span timber girder bridge	No	Undistinguished.	834	K-6468	1988
K-356A	1925	Road 356, Tib. St. Jones River	A 32'-0" double span steel girder bridge	No	Deteriorated.	No	K-5676	1988
K-384C		Road 384, Browns Br.		No	A 1935 timber bridge replaced prior to 1988.	453, 86-072-01	K-5677	1988
K-389A	1996	Market St., Murderkill River	A 2 span, 90' long, prestressed concrete box beam bridge	No	Modem replacement. Replaced a previous prestressed concrete. box beam bridge (1954) believed to be Delaware's first example.		K-6850	1997
K-418A	1936	Road 418,Trib. Murderkill River	A 19'-3"single span timber girder bridge.	No	Altered; compromised.	510	K-6472	1988
K-431A	n.d.	Road 431,Browns Branch	A 18'-6"steel girder bridge	No	Deteriorated.	No	K-6479	1988
K-501	1933	Washington Street, Mispillion River	A 40'-0"steel multi girder bridge	Yes	A good representative example of its type.	No	K-5679	1988,1997
K-502		Walnut Street, Mispillion River		No	A 1913 steel girder bridge replaced prior to 1988.	85-075-01	K-5680	1988
K-504	n.d	S.W. Front Street, Mispillion River	A double span concrete slab bridge	No	Deteriorated.	No	K-5681	1988
K-505	1995	Church Street, Mispillion River	A prestressed concrete box beam bridge	No	Modern structure replaced a steel multi girder bridge built in 1903. Stone substructure elements were reused.	No	K-5682	1988,1997

Sussex County Bridges

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-105	1955	Governors Ave., Cart Branch	A 1 span, 14'-long, r. c. slab bridge	No	Undistinguished example.	1361	S-9087	1997
S-108	1937	Route 16, Nanticoke River, N.W. Fork	A single span steel girder bridge	No	Altered; compromised.	516, 1429	S-8332	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-131	1930	Route 600, N.W. Fork Nanticoke River	A single span concrete encased steel girder with a span length of 31'-0"	No	Undistinguished example.	160,1877	S-3992	1988
S-132		Road 565, West Br.		No	A timber bridge replaced prior to 1988.		S-3993	1988
S-143	1930	Route 583A, Cart Branch	Single span timber bridge	No	Undistinguished example.		S-8335	1988
S-144S	1919	Route 4, Gravelly Branch Trib.	A small concrete rigid frame spanning 12'-6"	No	Altered; compromised.	10	S-8336	1988
S-145N	1919	Route 4, Waterway	A concrete rigid frame bridge	No	Altered; compromised.	10	S-8337	1988
S-146	1934	Route 5, Bridgeville Branch	A concrete slab bridge comprising a single 18'-4" span	No	Altered; historical integrity compromised.	314,211	S-8341	1988
S-146A	1951	US 13, Bridgeville Br.	A 1 span, 25'-long, r. c. slab bridge	No	Undistinguished example.	1007	S-9088	1997
S-147A	1951	US13,Turkey Br.	A 1 cell, 8'-long, r.c. box culvert	No	Undistinguished example.	1007	S-9089	1997
S-151	1925,1992	Route 13, Nanticoke River	A single leaf bascule bridge (1925) with prestressed concrete box beam approach spans (1992).	Yes	A distinguished bascule bridge by Chicago Bascule Bridge Co.	42B&C, 1043A, 6710005, 8209912	S-3994	1988,1997
S-152	1923	Route 13, Broad Creek	A non-operable single leaf Scherzer bascule bridge	NR listed/ Laurel H.D.	One of two Scherzer bascule bridges and contributing to the Laurel Historic District.	41A,802, 965, 6812001, 7306012, 8209912	S-3995	1988,1997
S-161	1915	Route 28A, Broad Creek	A non-operable center-bearing swing span bridge with Warren truss superstructure	NR listed/ Laurel H.D.	The oldest surviving swing span highway bridge in Delaware and contributing to the Laurel Historic District.		S-3997	1988, 1997
S-164	1997	SR 36, Cedar Creek	Center-bearing swing span with steel multi girder superstructure	No	Modern bridge not of historic age. Superstructure was placed in 1997. Portions of the previous swing span's center pier were reused.		S-9093	1997
S-200H-1	1912	Entry lane to Hearn's Mill Pond/Dam Spillway	2-cell,11'-6"-long r.c. box culvert	Yes	An early complete example of its type/design historically associated with the waterpower development of the NR-listed Hearn's Mill.	No	S-4045	1988,1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-202	1919	Route 13, Clear Brook	A 26'-8" long reinforced concrete arch bridge	Yes	A typical example of a concrete arch bridge constructed during the period following the enactment of the State Aid Road Law in 1919.	7	S-3998	1988,1997
S-205		Route 13, Gum Branch		No	A r.c. slab bridge replaced prior to 1988.			1988
S-207		Road 485, Gum Branch		No	A timber bridge replaced prior to 1988.		S-3999	1988
S-214	1956	Road 536, Turtle Br.	A 1 cell, 12'-long, r. c. box culvert	No	Undistinguished example.	1438	S-9094	1997
S-226	1948	Road 561, Freidel Prong	A 1 span, 15'-long, r. c. slab bridge	No	Undistinguished example.	753	S-9090	1997
S-227	1914/1948	Road 561, Gilbert Trivits Ditch	A 1 span, 8'-long, r. c. slab bridge built in 1914 and widened in 1948	No	Altered.	753	S-9091	1997
S-231	1941	Route 18, Clear Brook	A 50'-0"concrete slab bridge	No	Unexceptional example.	767	S-8347	1988
S-232	1920	Route 18, Gravelly Branch	Comprises two 33'-0" concrete girder spans for a total length of 66'-0"	No	Widened; compromised.	CS6,603, 1795	S-8348	1988
S-237	1919	Route 46, Gravelly Branch	A 62'-long reinforced concrete arch	Yes	A significant example of a Luten arch bridge.	No	S-4000	1988, 1997
S-238	1936	Route 46, Gravelly Fork	A timber stringer span measuring 20'-0" long	No	Compromised; original fabric replaced.	517	S-8352	1988
S-239	1932	Route 46, Deer Creek	A 36'-0"concrete encased steel multi girder span	Yes	A good complete, representative example of standardized bridge type.	229	S-4001	1988,1997
S-241	n.d	Route 534, Nanticoke River	A small single span timber bridge	No	Compromised; original fabric replaced.		S-4002	1988
S-242	1955	High St., Nanticoke R. Tributary	A 3 span, 134'-long, steel multi girder bridge	No	Undistinguished example.	1319, 72-090-14	5-9095	1997
S-253N	1952	US 13 NB, No. Fork Nanticoke R.	A 2 span,108'-long, steel multi girder bridge	No	Undistinguished example.	1103, 93-076-01	S-9096	1997
S-253S	1952	US13 SB, No. Fork Nanticoke R.	A 2 span,108'-long, steel multi girder bridge	No	Undistinguished example.	1103, 93-076-01	S-9096	1997
S-254N	1951	US 13 NB, Nanticoke R.	9 span, 325'-long, steel multi girder bridge	No	Undistinguished example.	1103, 93-076-01	S-9097	1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-254S	1951	US 13 SB, Nanticoke R.	9 span, 325'-long, steel multi girder bridge	No	Undistinguished example.	1103, 93-076-01	S-9097	1997
S-255	1952	US 13, Clear Brook	3 cell, 34'-long r.c. box culvert	No	Undistinguished example.	1148	S-9092	1997
S-256	1954	Road 535B, WIlliams Pond	2 span, 76'-long steel multi girder bridge	No	Undistinguished example.	1312	S-9098	1997
S-257E	1940	Route 21, Conrail	A 566'-long bridge with steel multi girder main span and continuous, variable depth r. c. slab approach spans.	Yes	A handsome, architectonic example with Moderne-style parapets. An early use of variable depth, continuous slab design.	690	S-8353	1988, 1997
S-258	1941	Route 536, Conrail	A three-span, 97'-long, continuous, variable depth, r.c. slab bridge	Yes	A handsome and aesthetically pleasing example of its type with Modeme-style details. An early use of a variable depth slab design.	699	S-6971	1988,1997
S-305	1949	Road 492, Holly Branch	A 1 span, 14'-long, timber multi girder bridge	No	Undistinguished example.	878	S-9099	1997
S-306	1951	Road 493, Collins & Culver Ditch	A 2 span, 32'-long, timber multi girder bridge	No	Altered; Undistinguished example.	1067	S-9100	1997
S-312	1925	Route 24, Horseys Ponds	A 19'-0" double span reinforced concrete box culvert	No	Altered; compromised.	CS45	S-4003	1988
S-314	1920	Route 24, James Branch	A 79'-0" reinforced concrete arch bridge	No	Undistinguished example.	CS8	S-4004	1988
S-319		Road 436, Saunders Branch		No	A 1930 timber bridge replaced prior to 1988.			1988
S-329	ca. 1910	Records Pond	A 4 cell concrete box culvert	Yes	An early, complete example of its type. Structural association with a dam/spillway.	No	S-4005	1988, 1997
S-335	1933	Route 515, Meadow	A timber bridge measuring 16'-0"	No	Undistinguished example.	301	S-8366	1988
S-337	1933	Route 64, James Branch	A single concrete slab span 20' long	No	Widened; historical integrity compromised.	341, 1633	S-8372	1988
S-346	n.d	Route 422A, Trib. James Branch	A timber girder span measuring 12'-0" long	No	Compromised by replacements.		S-8367	1988
S-347	1952	Road 449, Trap Pond Spillway	A 1 span, 42'-long steel multi girder bridge	No	Undistinguished example.	No	S-4007	1997
S-350	1947	Road 72, Racoon Branch	A 1 span, 21'-long, timber multi girder bridge	No	Undistinguished example.	942	S-9102	1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-353		Route 66, Wards Branch		No	A 1934 timber bridge replaced prior to 1988.			1988
S-354	1934	Route 66, James Branch	A timber bridge measuring 12'-6" long	No	Compromised by replacements.	356	S-8373	1988
S-358	n.d	Route 451, Racoon Ditch	A 12'-3" long timber girder span	No	Compromised by replacement.		S-8374	1988
S-365N	1951	US 13 NB, Records Pond	A 5 span, 178' long, steel multi girder bridge	No	Undistinguished example.	1103, 80-099-04	S-9101	1997
S-365S	1951	US 13 SB, Records Pond	A 5 span, 178' long, steel multi girder bridge	No	Undistinguished example.	1103, 80-099-04	S-9101	1997
S-402	1915	Route 113, Polly Branch	A concrete rigid frame bridge with a 15'-0" span	No	Compromised by repairs or replacements.	DuPont 145, 6503003	S-8383	1988
S-404S	1915/1930/ 1965	Route 113, Polly Prong	An encased steel multi girder bridge (1915) widened with r.c. slab extensions in 1930 and 1965.	No	Widening has compromised integrity of original design.	DuPont 145	S-8375	1988,1997
S-410	1948/1967	US 113, Vines Ck.	A 4 cell, 49'-long, precast concrete pipe culvert, widened in kind in 1967	No	Altered late, undistinguished example of common technology.	844, 65-03-003	S-9103	1997
S-418	1947/1967	US 113, Pepper Ck.	A 1 span, 23'-long r.c. slab bridge built in 1947, and widened in kind in 1967	No	Altered, undistinguished example.	844, 65-030-03, 89-002-01	S-9104	1997
S-425	1935	Route 26, Vines Creek	A 102'-6" triple span steel girder bridge	No	Undistinguished example.	409	S-4008	1988
S-429		Route 26, Assawoman Canal		No	A 1928 steel girder bridge replaced prior to 1988.		S-4009	1988
S-442	1935	Route 92, Vines Creek	A two span timber bridge measuring 32'-6" long	No	Compromised by repairs, replacements.		S-4011	1988
S-445	1937	Route 54, Vines Creek	A three span, composite timber and concrete slab bridge	Yes	A rare composite structure is an early and unusual example that has considerable technological significance.	543	S-8371	1988,1997
S-453		Road 361, Assawoman Canal		No	A 1930 timber bridge replaced prior to 1988.		S-4013	1988
S-491	1930	Route 394B, Perch Creek Ditch	A 12'-0" timber girder span	No	Undistinguished example.		S-8376	1988
S-504S	1911/1946/ 1967	Route 113, Wattons Branch	Two span concrete slab bridge was widened in 1946 and 1967	No	Widening has compromised integrity of original design.	DuPont 844, 8207306	S-8361	1988,1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-507S	1916/1946	Route 113, Iron Branch	A 20'-6"single span bridge comprising steel girders encased in concrete	No	Altered, compromised.	DuPont 845	S-8362	1988
S-508S	1912/1930/ 1946/1967	Route 113, Betts Pond	A reinforced concrete slab bridge widened at 3 different times	No	Widening has compromised integrity of original design.	DuPont 145, DuPont 845	S-4018	1988,1997
S-511	1950	SR 24, Cowhouse Branch	A 1 span, 17'-long, r.c. slab bridge	No	Undistinguished example.	1001	S-9105	1997
S-517	1930	Route 297, Swan Branch	A 14'-6" single span timber bridge	No	Undistinguished example.		S-8359	1988
S-519		Road 312, Waterway		No	A 1930 timber bridge replaced prior to 1988.			1988
S-521	n.d	Route 338, Pepper Creek	A metal lined concrete culvert	No	Date undocumented; poor example.		S-8365	1988
S-522	1940	Route 334, Pepper Creek	A 46'-0" long reinforced concrete slab bridge	No	Unexceptional example.	733	S-8364	1988
S-523	1940	Route 334, Hickory Br.	A 28'-0" reinforced concrete slab bridge	No	Unexceptional example.	733	S-8363	1988
S-534		Road 421, Phillips Ditch		No	A timber girder bridge replaced ca. 1988.			1988
S-545	1935	Route 407, Houston Thoroughgood D.	A timber bridge measuring 10'	No	Undistinguished example.	35.1	S-8368	1988
S-550	1936	Route 403, Whattons Br.	A 20'-0" timber bridge	No	Undistinguished example.	467	S-8369	1988
S-557	1936	Route 82, Whattons Br.	A 18'-0" long timber bridge	No	Undistinguished example.	398	S-8370	1988
S-564		Road 413, Gum Branch Ditch		No	A 1930 timber bridge replaced prior to 1988.			1988
S-583		Route 26, Gum Branch		No	A 1926 r. c. slab bridge replaced prior to 1988.	CS49, 655, 1446	S-4019	1988
S-586	1924	Route 26, Pocomoke River	A 20'-0" concrete slab bridge	No	Altered; poor example.	CS33, 655, 1446	S-4020	1988
S-591	1936	Route 472, Sunset Branch	A 20'-0" timber bridge	No	Compromised by replacements.	423	S-8360	1988
S-615	1912/1946	Route 113, Mifflin Ditch	A 12'-0" single span bridge	No	Altered; compromised.	DuPont 857	S-8344	1988
S-617	1932	Route 113, Gravelly Br.	A 24'-0" concrete slab bridge	No	Widened; historical integrity compromised	DuPont 857	S-4021	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-619	1912/1946	Route 113, Gravelly Br.	A single span bridge measuring 10'-0" long	No	Altered, compromised.	DuPont 857	S-8338	1988
S-634	1930	Route 40, Gravelly Br.	A 38'-0" long concrete encased steel girder bridge	No	Undistinguished example.	179	S-4022	1988
S-636	1935	Route 565, Gravelly Br.	A double span timber bridge	No	Undistinguished example.	465	S-8343	1988
S-642	1922	Route 18,Gravelly Br.	Comprises two 12'-3"concrete box culvert cells, for an overall length of 25'-6"	No	Compromised by rehabilitation.	CS17,1493, 65405020	S-8342	1988
S-644	1922	Route 18, Deep Creek	A 30'-0"concrete encased steel girder span	No	Compromised by reconstruction.	CS17, 6401035	S-4023	1988
S-659	1920	Route 28, Tyndall Br.	A 28'-0" concrete arch span	No	Undistinguished example.	CS13	S-4023	1988
S-661	1996	US 9, McColley Br.	Pipe culvert	No	Modern replacement.	No	S-9106	1997
S-670		Road 432, Sheep Pen Ditch		No	A timber bridge replaced prior to 1988.		S-8358	1988
S-673	1932	Route 48, Morris Mill Pond	A 22'-0" single span r. concrete slab bridge	Yes	A good representative example of a common type.	232	S-4025	1988, 1997
S-674	1934	Route 315, Deep Branch	A 15'-8"single span timber bridge	No	Compromised by replacements.		S-8354	1988
S-677		Route 47, Sockrockets Ditch		No	A 1930 timber bridge replaced prior to 1988.			1988
S-680	1984	Route 617, Walls Ditch	A 20'-0" single span timber multi girder bridge	No	A modern structure.	535	S-8355	1988, 1997
S-707	1938	Route 50, Silver Lake	A thirteen span composite timber and concrete slab bridge 260'-0" long	Yes	A rare composite structure has considerable technological significance.	53	S-8351	1988,1997
S-708	1993	Route 24, Love Creek		No	A timber multi girder bridge was replaced in 1993.	643A, 6904004	S-8350	1988, 1997
S-709	1938	Route 24, Herring Creek	A 28'-0" two cell, r. concrete box culvert	Yes	A good example of its type with structural association to a dam/spillway.	643	S-8349	1988, 1997
S-712	1930	Route 285A, Goslec Creek	A single span timber bridge 8'-0"in length	No	Compromised by replacements.		S-8345	1988
S-713	1993	Route 277, Love Creek		No	A modern structure was built to replace the previous timber multi girder bridge.	535	S-8346	1988, 1997

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-714	1930	Route 266, Canary Creek	A 16'-0"single span timber bridge	No	Compromised by replacements.		S-8340	1988
S-716	n.d	Route 260, Beaverdam Creek	A 20'-0" long single span timber bridge	No	Undistinguished example.		S-8339	1988
S-722	1930	Route 302A, Simpler Br.	A 10'-6" single span timber bridge	No	Undistinguished example.		S-8356	1988
S-723	1930	Route 298, Guinea Ck.	A 14'-6" single span timber bridge	No	Undistinguished example.		S-8357	1988
S-724		Road 281, Martin Branch		No	A timber bridge replaced prior to 1988.			1988
S-805		Road 319, Savannah Ditch		No	A 1933 timber bridge replaced prior to 1988.			1988
S-808	1992	Route 197, Broadkill Ck.		No	A modern structure was built to replace the previous r. c. slab bridge.	No	S-4027	1988, 1997
S-809	1993	Route 22, Broadkill River		No/Milton H D.	A modem structure was built to replace the previous steel multi girder bridge.	769	S-4028	1988, 1997
S-811	1924	Route 16, Trib. of Broadkill River	A two span steel girder bridge measuring 26'-0" long	No	Undistinguished example.π	352	S-4029	1988
S-813	1930	Route 284, Deep Branch	A small single span timber bridge	No	Undistinguished example.		S-8334	1988
S-815N	1925	Route 14, Waples Pond	A two span concrete slab bridge.	No	Widened; historical integrity compromised.	CS39,1151	S-8333	1988
S-818	1931	Route 38,Slaughter Creek	A 36'-0"concrete encased steel girder bridge	No	Undistinguished example.	193	S-4030	1988
S-823	1913	Route 88, Beaver Dam Ck.	A small single span concrete bridge 7'-10" in length.	No	Altered; compromised.	1016	S-8378	1988
S-901	1919/1946	Route 113, School House Ditch	A single span concrete encased steel girder bridge	No	Altered; compromised.	8, 173, 935	S-8331	1988
S-902	1919	Route 113, Hudson Pond	A 20'-0" long, single span concrete encased steel girder bridge that was widened with the addition of a concrete box culvert to each elevation.	No	Altered; compromised.	8, 173, 935	S-4032	1988
S-903	1919/1946	Route 113, Herring Br.	A single span concrete-encased steel girder bridge that has been widened by the addition of a concrete box culvert to each elevation.	No	Altered; compromised.	8, 173, 935	S-8330	1988

Bridge No.	Date of Construction	Feature Carried, Crossed	Description	National Register Eligible	Evaluation/Comments	Plans or DelDOT Contract #	CRS#	Year Surveyed
S-906		Road 618, Bowman Br.		No	A 1930 timber bridge replaced prior to 1988.			1988
S-907	1930	Route 614, Johnson Br.	A 16'-0" single span timber bridge	No	Undistinguished example.		S-8329	1988
S-908		Road 633, Griffith Pond		No	A 1941 timber bridge replaced prior to 1988.	87-073-03	S-4033	1988
S-911	1947	Route 36, Johnson's Br.	A 20'-4" long reinforced concrete slab bridge	No	Poor example.	939	S-4034	1988, 1997
S-917D		Road 226, Church Branch Ditch		No	A 1930 timber bridge replaced prior to 1988.			1988
S-920		Road 212, Cedar Ck.		No	A 1941 timber bridge replaced prior to 1988.	85-073-05		1988
S-925		Road 203, Ditch		No	A 1930 timber bridge replaced. prior to 1988.			1988
S-926		Road 200, Beaver Dam Ditch		No	A 1935 timber bridge replaced prior to 1988.			1988
S-927	1929	Route 36, Herring Branch	A 19'-0" reinforced concrete slab bridge	No	Undistinguished example.	115	S-4035	1988
S-930		Road 225, Herring Br.		No	A 1933 timber bridge replaced prior to 1988.			1988
S-933N	1925	Route 14, Cedar Ck.	A 65'-0" long triple span reinforced concrete slab bridge	No	Widened; historical integrity compromised.	CS39, 1150	S-4036	1988
S-934		Road 216A, Cedar Cr. (Abandoned)		No	A timber bridge replaced prior to 1988.		S-4037	1988
S-937	1935	Route 214, Cubbage Pond Spillway	A timber bridge on concrete substructure	No	Undistinguished example.	68-09-006	S-8382	1988
S-938		Road 214, Church Br.		No	A 1934 timber bridge replaced prior to 1988.	39		1988
S-940	1932	Route 38, Clendaniel Pond	A 22'-0" long concrete slab bridge	No	Deteriorated.	231	S-4038	1988

Appendix C.5

Policy for Inspection and Load Posting of Corrugated Metal Culverts

Delaware Department of Transportation
Bridge Management Section

DelDOT

Policy for Inspection and Load Posting of Corrugated Metal Culverts

Introduction

As of January 2008, there were 270 Corrugated Metal Culverts, which represents 18.4% of the inventory of 1,469 bridges that are maintained by DelDOT. The total number includes steel and aluminum pipes and arches. There are 113 National Bridge Inventory (NBI) length structures included in the list. An NBI length structure is a structure that is greater than 20' in length. These structures are potentially eligible for federal funding through the FHWA Highway Bridge Program. Bridges eligible for this funding must be structurally deficient or functionally obsolete, and have a sufficiency rating of 80 or less.

DelDOT has utilized the Pontis Bridge Management System to store element level bridge inspection data since 1994. The preservation modeling capabilities of Pontis were implemented in 2005. These preservation models are updated annually based on cost changes and experience gained through the use of the Pontis program. In March 2006, Bridge Management Section created a Deficiency Formula for use in managing bridge preservation activities. The Deficiency Formula assigns points to each bridge based on several factors, such as health index, Pontis benefit to cost ratio, structural deficiency, load capacity, roadway functional class, truck traffic volume, detour length, and historic significance. The points are added for each bridge and the bridges are ranked in order of the Deficiency Points. This ranking is used to prioritize work for the Bridge Design Program and the District Structure Maintenance Program.

The Deficiency Formula was created in such a way that a structurally deficient pipe culvert would rise to the top of the priority list, regardless of the roadway characteristics. However, it became evident that the culverts that were identified as structurally deficient were in very poor condition and near the end of their service life. Given the three-year timeline to initiate, design, obtain environmental permits, and construct a project, these culverts need to remain in service for at least three years after being identified as a priority. Also, DelDOT does not have a policy for restricting truck traffic on pipe culverts in poor condition. The soil around these culverts is distributing the traffic loads in a way that cannot be determined with simple analytical methods. In order to assure public safety, several of these culverts were placed on a monthly watch list to closely monitor their condition and close the road as necessary. As of January 2008, there were four metal culverts on the monthly watch list.

Bridge Management Section identified two areas of improvement in our policies and procedures. First, the Pontis and NBI inspection rating criteria need to be modified such that deficiencies are identified earlier and replacement projects are programmed before these culverts reach critical condition. Second, a load posting policy needs to be created in order to restrict heavy vehicles on pipe culverts that are in poor condition. Representatives from DelDOT Bridge Management and Bridge Design Sections, and FHWA met to create a policy regarding these two areas.

Inspection Criteria

All pipe culverts are inspected using Pontis and NBI criteria. Pontis utilizes an element level approach, dividing each linear foot of the culvert into its appropriate condition state, whereas the NBI rating provides an overall characterization of the general condition of the entire culvert.

Pontis Ratings

There is some overlap in the current condition state language for Condition States 3 and 4. Holes in the barrel were listed in both states, and there was no clear definition of significant corrosion. The new rating criteria removes “holes” from Condition State 3. The new rating criteria identify significant corrosion in Condition State 3 as that which allows easy perforation with a hammer. The Pontis condition states were defined as follows (with revisions in 2011):

240 Steel Culvert (<7’ Span length) (L.F.)

Condition State — Description

1. The element shows little or no deterioration. Some discoloration or surface corrosion may exist but there is no metal pitting. There is little or no deterioration or separation of seams. ~*Surface Corrosion*
   - Do nothing
2. There may be minor to moderate corrosion and pitting. Cannot easily perforate steel culverts with pick hammer. Little or no distortion exists. There may be minor deterioration and/or separation of seams. ~*Minor corrosion*
   - Do nothing
3. Significant corrosion, deep pitting, or flaking exists. Can easily perforate steel culverts with pick hammer. Aluminum culverts exhibit corrosion (White spots). Minor to moderate distortion and deflection may exist. Minor cracking or abrasion of the metal may exist. There may be considerable deterioration and/or separation of seams. ~*Moderate corrosion*
   - Do nothing
4. Major corrosion, perforations and/or holes exist. Major distortion, deflection, or settlement may be evident. Major cracking or abrasion of the metal may exist. Major separation of seams may have occurred. ~*Major corrosion*
   - Do nothing
   - Replace

Note: **Inspector should not attempt to perforate or remove corrosion on Aluminum Culverts**. Concrete footings are not part of this element, any necessary repair actions should be noted in the inspection report. See Corrugated Metal Culvert Inspection Guide for NBI culvert rating guidance.

NBI Ratings

The NBI rating criteria was not modified. However, the following procedure will be use to "translate" Pontis condition states into NBI ratings. Photos are included as general illustrative examples.

Item 62 - Culverts

Code	Description
N	Not applicable. Use if structure is not a culvert.
9	No deficiencies.

Pontis Equivalent: 100% of the quantity is in Condition State 1. This coding shall only be used for a newly inventoried culvert.

8	No noticeable or noteworthy deficiencies which affect the condition of the culvert. Insignificant scrape marks caused by drift.

Pontis Equivalent: 100% of the quantity is in Condition State 1. This coding shall only be used for a culvert that has been previously inspected, and exhibits no corrosion.

7 Shrinkage cracks, light scaling, and insignificant spalling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting.

Pontis Equivalent: 100% of the quantity is in Condition State 1. Portions of the culvert exhibit surface corrosion with no pitting.

6 Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion or moderate pitting.

Pontis Equivalent: There is some quantity in Condition State 2, but none in Condition States 3 or 4.

5 Moderate to major deterioration or disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion or deep pitting.

Pontis Equivalent: The combined quantity in Condition States 3 and 4 is less than 75%, and the quantity in Condition State 4 is less than 30%.

4 Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion or deep pitting.

Pontis Equivalent: The combined quantity in Condition States 3 and 4 is greater than 75%. The quantity in Condition State 4 is less than 30%

3 Any condition described in Code 4 but which is excessive in scope. Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.

Pontis Equivalent: The quantity in Condition States 4 is greater than 30%. There is no deflection, settlement, loss of backfill, kinking, or separation of the culvert.

2 Integral wingwalls collapsed, severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.

Pontis Equivalent: The quantity in Condition States 4 is greater than 30%. There is loss of backfill, or kinking, but no separation with displacement of the culvert.

1 Bridge closed. Corrective action may put back in light service.

Pontis Equivalent: The quantity in Condition States 4 is greater than 30%. There is separation with displacement of the culvert.

0 Bridge closed. Replacement necessary. (This code is normally not used)

Load Posting and Road Closure

Corrugated metal culverts develop their strength through the interaction of the soil backfill with the metal structure. As metal culverts deteriorate to serious and critical condition, there is no analytical method to determine the remaining strength of the system. It is desirable to reduce or eliminate heavy vehicle loads when metal culverts reach this deteriorated state. The NBI ratings will be utilized to define the level of load posting or the need for closure of the road. The following chart summarizes the criteria:

NBI Rating	Load Posting
9 - 4	None
3	15 Tons
2	3 Tons
1	Road Closure
0	Road Closure

Impact on the Bridge Inventory

A comparison was made between current NBI ratings and the new "translated" NBI ratings. Existing Pontis ratings were used for the new NBI ratings. The following chart summarizes the comparison:

NBI Rating	Existing # of Bridges	New # of Bridges
9 - 7	105	64
6	86	97
5	64	33
4	14	62
3	1	9
2	0	3
1	0	2
0	0	0

The comparison reveals that 61 additional bridges would be classified as structurally deficient, and would rise to the top of the priority list for work. Twelve of the bridge would require load posting and two of the bridges would be closed. It should be noted that the two bridges that would require closure are on the monthly watch list.

Implementation
The new inspection and load posting criteria for metal culverts will be implemented with the 2008 Bridge Inspection season. Training will be provided for inspection staff prior to the inspection season. The following guide will be used by the inspectors in the field:

Corrugated Metal Culvert Inspection Guide					
	Pontis Condition State				
NBI Rating	CS1	CS2	CS3	CS4	Load Posting
9	100% (new)				N/A
8	100% (w/ no corrosion)				N/A
7	100% (w/ surface corrosion)				N/A
6		> 0%	0%		N/A
5			> 0%		N/A
4			> 75%		N/A
3				> 30%	15 Tons
2				> 30% (w/ minor loss of fill, or kinking)	3 Tons
1				> 30% (w/ loss of fill or separation)	Road Closure
0					Road Closure

For multiple barrel CMP locations, the above chart is applied to each CMP barrel and the lowest rating is used for the NBI culvert rating.

Large-Span CMP Policy Proposed Changes

Similar to the improvements that were made in 2008, the proposed changes in this portion of the document looks to alter the current CMP inspection policy so that large-span metal pipe culverts will be closed or replaced before the deterioration reaches the same state that bridges 3-240 & 2-143A were found to be at failure. In order to accomplish this, the policy also needs to be adjusted so that advanced deterioration and deficiencies could be identified even earlier than that of smaller CMP culvert structures. This will result in a large-span CMP to be identified as structurally deficient sooner than smaller culverts for similar deterioration. This is important because the three year timeline constraint requires the structure to remain in service to allow for the initiation, design, environmental permit process and the actual project construction to occur. The proposed changes will directly affect the inspection policies and procedures and will be presented later. As part of these proposed changes, there will be more emphasis placed on the QA/QC Inspection procedures.

Currently, any bridge that is brought back by an inspection team with a NBI rating of 1-4, the Bridge Inspection Engineer and the Bridge Management Engineer will make a field visit within the same week to verify the pipe conditions. Based on their visit, they may make the bridge structurally deficient, load post or decide to close the bridge. With this new policy, more importance will be given to loss of fill and other indicators that are applicable to large-span CMP culverts. Also, for large-span CMP's that have span lengths of 7-10', the determination of load posting or closing a road will be more dependant upon the QA/QC review team. Whereas, the criteria for load posting or closing a road for large-span CMP's with a span length greater than 10' will be more defined by the percentages of Pontis Condition States 3 & 4. However, the criteria for making a large-span CMP structurally deficient will be the same for all pipes with a span length of 7' or greater. The load posting and closure criteria that was created in 2008 will still be utilized and is presented next.

Load Posting and Road Closure

Corrugated metal culverts develop their strength through the interaction of the soil backfill with the metal structure. As metal culverts deteriorate to serious and critical condition, there is no analytical method to determine the remaining strength of the system. It is desirable to reduce or eliminate heavy vehicle loads when metal culverts reach this deteriorated state. The NBI ratings will be utilized to define the level of load posting or the need for closure of the road. The following chart summarizes the criteria:

NBI Rating	Load Posting
9 - 4	None
3	15 Tons
2	3 Tons
1	Road Closure
0	Road Closure

Inspection Criteria

All pipe culverts are inspected using Pontis and NBI criteria. Pontis utilizes an element level approach, dividing each linear foot of the culvert into its appropriate condition state, whereas the NBI rating provides an overall characterization of the general condition of the entire culvert. The specific criteria tying the Pontis element level inspection data to the assigned NBI Rating will be described in the NBI Inspection & Rating Policy section of this document. The Pontis Inspection & Rating Policy is to remain as is for the most part and has been included next in this document to illustrate the different condition states that are applicable to corrugated metal pipe culverts.

Pontis Inspection & Rating Policy

In 2008, Bridge Management Section realized that there was some overlap in the original condition state language for Condition States 3 and 4. Holes in the barrel were listed in both states, and there was no clear definition of significant corrosion. The revised rating criteria established back in 2008 removed "holes" from Condition State 3. The revised rating criteria identified significant corrosion in Condition State 3 as that which allows easy perforation with a pick hammer. The only change being proposed for the large-span CMP policy involves assigning the current Pontis element #244 to that of the large-span metal pipe culverts and element #240 will pertain only to CMP's less than 7' in length. This change will aid inspectors in determining which policy to utilize for a specific structure and it will help the Bridge Management Section to manage either type of structure. The Pontis condition states that were revised in 2008 and updated in 2011 will be applied to large-span CMP's and they are defined as follows:

244 Steel Culvert – Major ($\geq$ 7' Span) (L.F.)

Condition State	Description

1. The element shows little or no deterioration. Some discoloration or surface corrosion may exist but there is no metal pitting. There is little or no deterioration or separation of seams. *~Surface Corrosion*
   - Do nothing
2. There may be minor to moderate corrosion and pitting. Cannot easily perforate steel culverts with pick hammer. Little or no distortion exists. There may be minor deterioration and/or separation of seams. *~Minor corrosion*
   - Do nothing
3. Significant corrosion, deep pitting, or flaking exists. . Aluminum culverts exhibit corrosion (White spots). Can easily perforate steel culverts with pick hammer. Minor to moderate distortion and deflection may exist. Minor cracking or abrasion of the metal may exist. There may be considerable deterioration and/or separation of seams. *~Moderate corrosion*
   - Do nothing
4. Major corrosion, perforations and/or holes exist. Major distortion, deflection, or settlement may be evident. Major cracking or abrasion of the metal may exist. Major separation of seams may have occurred. *~Major corrosion*
   - Do nothing
   - Replace

Note: **Inspector should not attempt to perforate or remove corrosion on Aluminum Culverts**. Concrete footings are not part of this element, any necessary repair actions should be noted in the inspection report. See Large-Span Corrugated Metal Culvert Inspection Guide for further guidance.

NBI Inspection & Rating Policy

As discussed earlier, the modifications that we are proposing concentrates most of its focus on the NBI inspection and rating policy. In a nutshell, these changes will allow for large-span CMP culverts to be brought to the structurally deficient status earlier and to close a metal pipe culvert bridge before failing. The following guide will be used by the inspectors in the field:

Large-Span Corrugated Metal Pipe Culvert Inspection Guide					
	Pontis Condition State				
NBI Rating	**CS1**	**CS2**	**CS3**	**CS4**	**Load Posting**
9	100% (new)				N/A
8	100% (w/ no corrosion)				N/A
7	100% (w/ surface corrosion)				N/A
6		> 0%	0%		N/A
5			>0-30% CS3 or >0-5% CS4		N/A
4			>30% CS3 or >5-10% CS4 No loss of fill present		N/A
3			>10-20% CS4 No loss of fill present		15 Tons
2				>20-30% CS4 No Loss of fill present	3 Tons
1				>30% CS4 Or Loss of fill exists (See Note Below)	Road Closure
0				Pipe(s) have failed	Road Closure

Note: If any large-span CMP (>10’) is found to have loss of fill, then the structure will be closed unless a temporary repair can be made. Temporary repairs may include (but not limited to) sand bagging along areas where loss of fill is determined to be occurring or installing steel plates along the roadway to span the bad pipe(s). If a structure with a span length of 7-10’ is found to have greater than 30% CS4 or minor loss of fill, the decision to close the road will be determined upon the QA/QC review. Factors that may or may not affect the decision to close a road could include the following:

- severity of perforations or holes that exist in pipe(s)
- location of perforations or holes that exist in the pipe(s)
- deflection or distortion of the pipe(s) that may be present
- type of backfill that is present
- age of the structure
- the quantity of pipe(s) in a CS4 that exists
- kinking or separation along the pipe invert that may exist
- separation of pipe seams that may exist
- the quantity of pipe(s) in a CS3 that exists
- where (vertically) along the invert the deteriorated areas are present
- Rate of deterioration (comparison of previous inspections)
- Shape of pipe (round or arched)

Impact on the Bridge Inventory

A comparison was made between current NBI ratings and the new "translated" NBI ratings. Existing Pontis ratings along with field verification were used for the new NBI ratings. It is important to note that the field verification for some CMP culvert locations only included the inspection for settlement, erosion or other signs for loss of fill due to high water as a result of recent snow and rain. The following chart summarizes the comparison:

NBI Rating	Existing # of Bridges	New # of Bridges
9 - 7	93	93
6	78	78
5	78	71
4	40	41
3	14	11
2	2	8
1	5	9
0	2	2

<u>*Comparison Results*</u>

- 4 of the bridges that are currently posted for load restriction would be closed
- 2 bridges that currently have a 15 ton posting, will be required to have a 3 ton posting
- 2 bridges that are currently NBI = 4, will be required to have a 3 ton posting
- 1 bridge that is currently a NBI = 5, will be required to have a 3 ton posting
- 3 bridges that are currently assigned a NBI Rating of a 4 would require a 15 ton load posting
- 6 additional bridges that were NBI = 5 ,will be classified as structurally deficient (NBI = 4)
- 1 recently found bridge will also be classified as structurally deficient (NBI = 4)

Appendix A of this document gives a table of all the large-span metal culverts that will be affected by this policy change.

Implementation

The new inspection, load posting and closure criteria for large-span metal culverts will be implemented with the 2010 Bridge Inspection season. Training will be provided for inspection staff prior to the inspection season. As part of implementing this new policy, all 24 bridges that are given in Appendix A will have an impromptu inspection done and created in the database immediately so that proper closing and load posting procedures can be initiated. This will also allow for the ten bridges that will now be structurally deficient to be included in with the 2010 Bridge Deficiency List.

As stated earlier, the QA/QC Inspection procedures will place more emphasis on key indicators for large-span CMP's that fall within the 7-10' span length range. The inspection frequency will be based on the new NBI Ratings and the current Bridge Inspection Frequency Policy. In addition, maintenance personnel within Central & South District have been notified and asked to notify Bridge Management Section if they should observe additional settlement or erosion at metal pipe culvert locations that they may encounter through the course of their workday or while on their routes to and from work. We feel that with all three mechanisms implemented, the department can better recognize, program and most importantly – minimize the risk of failure for in-service large-span corrugated metal pipe culverts.

Appendix A

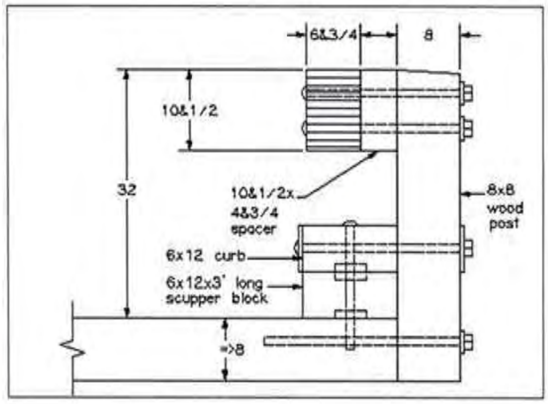
DelDOT Large-Span Corrugated Metal Culvert Changes

Bridge Number	Facility Carried	Feature Intersected	NBI Length	Current NBI Culvert Rating	Proposed NBI Culvert Rating	Span length	Program Status
2254A254	MT OLIVE CEMETERY	WILDCAT BRANCH	Y	3	1	7.45	BD FY-2011
3103 612A	GREENHURST FARM RD	N FORK OF NANTICOKE	Y	2	1	8.17	BD FY-2011
2381A381	FOX CHASE RD	HUDSON BRANCH	Y	3	1	10.69	BD FY-2011
3462 390A	BEAR HOLE RD	BEARHOLE DITCH	Y	3	1	11.40	BD - Const.
2040A040	SCHOOL LN / RD 40	DUCK CREEK	Y	3	2	7.92	BD FY-2012
2429A429	JACKSON DITCH RD.	BROWNS BRANCH	Y	4	2	8.00	BD FY-2012
1325 397	OTTS CHAPEL RD	PERSIMMON RUN	N	3	2	8.20	BD FY-2010
1404 427	CEDAR LANE RD.	WATERWAY	N	3	2	9.30	BD FY-2012
3368 466	SYCAMORE RD	ELLIOT POND BRANCH	Y	4	2	8.00	Unassigned
3930 225	MARSHALL STREET	HERRING BRANCH	N	5	2	8.50	Unassigned
3367 475	SYCAMORE RD.	DUKES & JOBS DITCH	N	4	3	7.30	IHM CY-2010
2266A266	EDWARDSVILLE RD	WHITE MARSH BRANCH	N	4	3	7.90	Not in Program Yet
2204A204	APPLE GROVE SCHOOL Rd.	ISAAC BRANCH	N	4	3	8.00	IHM CY-2011
2158A158	CHESTNUT GROVE RD	MUDSTONE BRANCH	Y	5	4	10.30	Unassigned
3587 026	SR 26/NINE FOOT RD	WHARTON BRANCH DITCH	Y	5	4	7.23	Unassigned
3224 546	CONRAIL RD.	BUCKS BRANCH	Y	5	4	7.92	Unassigned
3583 026	MILLSBORO HWY/SR26	GUM BRANCH	Y	5	4	9.58	Unassigned
2371A371	BARRETT'S CHAPEL RD.	DOUBLE RUN CREEK	Y	5	4	10.63	Unassigned
1246 347	CHAPMAN RD.	UNKNOWN WATERWAY	Y	N/A	4	10.70	Unassigned
1248 355	OLD HARMONY RD	TRIB. TO WHITE CLAY CREEK	N	5	4	11.00	Unassigned

BD = Bridge Design
IHM = In-House Maintenance
FY = Fiscal Year
CY = Calendar Year

Appendix C.6

Bridge Inspector Traffic Safety Features Rating Manual



BRIDGE INSPECTOR TRAFFIC SAFETY FEATURES RATING MANUAL

Item 36 of the Structure Inventory & Appraisal Form

Last updated 2007

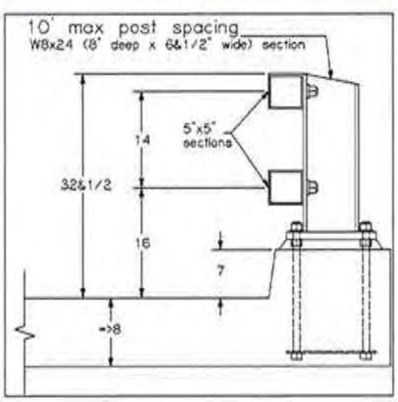


TABLE OF CONTENTS

3) Rating Approach Rail

   i) Rating Procedure

4) Rating End Treatments

   i) Rating Procedure
   ii) Crash Tested End Treatment Diagrams

5) Determining Clear Zone Requirements

   i) Rating Procedure
   ii) Clear Zone Chart

INTRODUCTION

Bridge traffic safety features include the rail/parapet, transitions, approach rail/barrier and end treatments. Bridge inspectors must determine whether these features meet current standard in order to code item 36 of the Structure Inventory and Appraisal Form. This manual provides guidance on rating these features.

This manual is presented in two parts. Part One describes the evolution of safety feature performance standards and describes the current AASHTO LRFD Specification standard which is based on the dynamic crash testing and performance requirements presented in NCHRP Research Report 350. This part also outlines the policies of the responsible government agencies. Part Two provides a procedure for inspectors to follow when rating features.

It is important to recognize that when a feature does not meet current standard, it does not mean replacement will be a priority. There will be lower priority for features that have performed functional to date, have low likelihood of being hit or there is limited public risk if the feature is hit or penetrated. However, this determination shall be made by an engineer and shall not influence the inspector's rating.

This manual shall be used for rating in-service features only. It is not intended for design or construction because the manual's methodology and included diagrams have been simplified. This simplification is necessary to provide an efficient field rating approach based on readily available roadway information and visual evaluation of only the exposed components. As well, design shall follow the current policy of owners with respect to required feature type and test level for different roadways. Such policies are intended for replacement and new design and are not directly incorporated into this manual's rating methodology. For instance, if an owner's policy is to use 42 inch F safety shape rail (meets test level 5) on all National Highway System roads, however the national policy is to use any rail that meets test level 3 or higher, by this manual's rating methodology any rail tested to level 3 or higher will be rated as meets standard.

PERFORMANCE STANDARDS FOR TRAFFIC SAFETY FEATURES

Performance standards are established to ensure safety features have sufficient strength and geometry to protect the public. Properly designed features will prevent vehicles from leaving the bridge or roadway by penetration, climbing or rollover. They also safely redirect vehicles without excessive damage to the occupant compartment, without snagging or dramatic deceleration and without redirection into the travel lane or opposing traffic.

For years the AASHTO Standard Specification static force and geometric design criteria have been used in bridge railing design. This specification calls for the application of a 10,000 lb static force and includes some dimensional requirements for the opening between rail components and other geometry. Designs by this outdated criteria sometimes have insufficient strength and geometry. Modern design criteria require full-scale simulated crash testing otherwise termed dynamic crash testing. Dynamic performance standards have evolved over time in response to an improved understanding of safety performance, a changing vehicle fleet, a broader range of feature types and increased interest in matching safety performance to levels of roadway use. The history of standards has included the following;

- 1962 Highway Research Correlation Services Circular 482: Proposed Full-Scale Testing Procedures for Guardrails
- 1974 NCHRP Report 153: Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances
- 1978 Transportation Research Board's Transportation Research Circular 191
- 1980 NCHRP Report 230: Recommended Procedures for the Safety Performance Evaluation of Highway Safety Appurtenances
- 1981 NCHRP Report 239: Multiple-Service-Level Highway Bridge Railing Selection Procedures
- 1989 AASHTO Guide Specifications for Bridge Railings
- 1993 NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features
- 1994 AASHTO LRFD Bridge Design Specifications, 1st Edition
- 1998 AASHTO LRFD Bridge Design Specifications, 2nd Edition
- 2003 Interims to 1998 AASHTO LRFD Bridge Design Specifications, 2nd Edition

Each of these standards specifies different dynamic crash test criteria. The criteria include parameters such as simulation vehicle types, weight, impact speed and impact angle. The criteria also include the acceptable response to the simulated impact as it relates to structural adequacy, occupant risk and vehicle post-impact trajectory. Typical response criteria are provided in Table 1.

Table 1: Typical Crash Test Response Criteria
Structural Adequacy ⇒ Contain and redirect vehicle, i.e. vehicle cannot penetrate, override or underride the feature. ⇒ Feature shall have a controlled failure mechanism including breakaway or yielding that presents minimal risk to the public.
Occupant Risk ⇒ Detached fragments, elements or debris should not show potential for penetrating occupant compartment or present an undue hazard to other traffic and pedestrians. ⇒ Vehicle should remain upright although moderate roll, pitch and yaw are acceptable. ⇒ Occupant impact velocity limits are prescribed. ⇒ Occupant deceleration limits are prescribed.
Vehicle Trajectory ⇒ After impact the vehicle should not intrude into adjacent traffic lanes. ⇒ Following impact the exit angle should be less than 60 percent of the impact angle.

The 1962 Highway Research Correlation Services Circular 482 was the first widely recognized set of recommendations for performing full-scale crash tests of guardrails. The 1974 NCHRP Report 153 expanded on Circular 482 by including recommendations for crash cushions, breakaway and yielding supports, guardrail transitions and end treatments. The 1978 Transportation Research Board's Circular 191 was an interim modification to NCHRP Report 153. The 1980 NCHRP Report 230 introduced many now-standard test and performance criteria. Like the prior documents it addressed crash cushions, breakaway and yielding supports, end treatments, median barriers and guardrails. The 1989 AASHTO Guide Specifications presented test and performance criteria specifically for bridge railings. It was the first AASHTO specification that adopted crash testing. It included a multiple service level concept for bridge railings which provided variable test levels that could be applied to different roadway types, roadway geometry, traffic types and traffic volumes. The 1993 NCHRP Report 350 expanded on Report 230 by modifying the test and performance requirements and including truck mounted attenuators and work zone traffic control devices.

The 1989 AASHTO Guide Specification has three test levels (PL-1, PL-2 and PL-3) as described in Table 2. It includes tests for cars, pickups, single unit trucks and light tractor trailers. The 1994 AASHTO LRFD Specification adopted the 1989 AASHTO Guide Specification's three test levels and hence was the first AASHTO standard specification to adopt dynamic crash test criteria. The 1998 AASHTO LRFD Specification adopted the six test levels of NCHRP 350 plus one additional for light tractor trailers as described in Table 3. The 2003 interim revisions to the 1998 AASHTO LRFD Specification then adopted the NCHRP 350 tests levels without modification. The 1993 NCHRP Report 350 has six test levels (TL-1 through 6) as described in Table 4. It includes tests for cars, pickups, single unit trucks, heavy tractor trailers and tankers. The NCHRP 350 test levels were developed to provide a broader range of tests which could be applied to different roadway types, roadway geometry, traffic types and traffic volumes. This is the current standard adopted by FHWA and AASHTO.

The 1997 FHWA memo, Crash Testing of Bridge Railings, established correlations between each performance standard as described in Table 5. Therefore, features tested to prior standards do not necessarily have to be tested to NCHRP 350 standard. However, the equivalencies are regarded as conservative and testing could be conducted if particular features are expected to pass a higher NCHRP 350 test level.

Although NCHRP 350 established six test levels, amazingly there is little guidance on selecting the appropriate test level for different roadway types, roadway geometry, traffic types and traffic volumes. The 1989 AASHTO Guide Specification provides a matrix for selecting bridge rail test level as a function of roadway type, travel speed, ADT, ADTT and travel lane offset. The matrix was generated using a cost benefit analysis program. However, the matrix is outdated as it includes just three test levels whereas today's standards include six test levels.

Lastly, it is important to recognize that when a feature does not meet current standard, it does not mean replacement will be a priority. There will be lower priority for features that have performed functional to date, have low likelihood of being hit or there is limited public risk if the feature is hit or penetrated. However, this determination shall be made by an engineer and shall not influence the inspector's rating.

Table 2: AASHTO Guide Specification Test Criteria 1989

Performance Level	Vehicle	Impact Angle	Speed
1	compact (1,800lb)	20	50
	pickup (5,400lb)	20	45
2	compact (1,800lb)	20	60
	pickup (5,400lb)	20	60
	single unit truck (18,000lb)	15	50
3	compact (1,800lb)	20	60
	pickup (5,400lb)	20	60
	light tractor trailer (50,000lb)	15	50

Table 3: AASHTO LRFD Specification Test Criteria 1998			
Test Level	Vehicle	Impact Angle	Speed
1	mini-compact (1,550lb)	20	30
	compact (1,800lb)	20	30
	pickup (4,500lb)	25	30
2	mini-compact (1,550lb)	20	45
	compact (1,800lb)	20	45
	pickup (4,500lb)	25	45
3	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
4	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
	single unit truck (18,000lb)	15	50
5A	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
	light tractor trailer (50,000lb)	15	50
5	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
	tractor trailer (80,000lb)	15	50
6	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
	tanker (80,000lb)	15	50

Table 4: NCHRP Report 350 Test Criteria & AASHTO LRFD Specification 2003			
Test Level	Vehicle	Impact Angle	Speed
1	mini-compact (1,550lb)	20	30
	compact (1,800lb)	20	30
	pickup (4,500lb)	25	30
2	mini-compact (1,550lb)	20	45
	compact (1,800lb)	20	45
	pickup (4,500lb)	25	45
3	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
4	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
	single unit truck (18,000lb)	15	50
5	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
	tractor trailer (80,000lb)	15	50
6	mini-compact (1,550lb)	20	60
	compact (1,800lb)	20	60
	pickup (4,500lb)	25	60
	tanker (80,000lb)	15	50

Table 5: Test Criteria Equivalencies						
Rail Test Criteria	Equivalencies					
NCHRP Report 350 & AASHTO LRFD specification 2003	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6
AASHTO Guide Specification 1989 & AASHTO LRFD Specification 1994		PL-1		PL-2	PL-3	
NCHRP Report 230		MSL-1 MSL-2		MSL-3		
TL = test level, PL = performance level, MSL = multiple service level						

POLICY

Owners' policies apply to replacement and new design. Therefore, regardless of the feature type and test level specified by an owner's policy, for rating purposes it is appropriate to rate as meets standard if it has been crash tested to a level appropriate for the roadway type, roadway geometry, traffic type and traffic volume. The following policies are provided for information purposes, not for rating purposes.

i) Federal Highway Administration

Bridge Rail

National Highway System roads, regardless of funding source, shall meet NCHRP 350 test level 3 or higher unless a rational selection procedure is used to select an appropriate test level based on roadway type, roadway geometry, traffic type and traffic volume. On roads other than National Highway System it is strongly encouraged to utilize crash tested features that meet NCHRP 350.

Other Traffic Safety Features

National Highway System roads, regardless of funding source, shall meet NCHRP 350. Minimum test levels are not specified. On roads other than National Highway System it is strongly encouraged to utilize crash tested features that meet NCHRP 350.

ii) Maryland State Highway Administration

Bridge Rail

A policy is under development that requires utilization of crash tested rail on all roads on all MSHA projects regardless of funding source. The rails to be utilized include;

- Divided/Dual Highways
  ⇒ 42" F safety shape (meets NCHRP 350 test level 5)
- Undivided Highways with Future Projected ADT ≥ 2,500
  ⇒ 32" F safety shape (meets NCHRP 350 test level 4)
- Undivided Highways with Future Projected ADT < 2,500
  ⇒ 32" Two Tube Curb Mounted Rail Oregon Type (meets NCHRP 350 test level 4)

- Rails adjacent to Sidewalk
  - ⇒ 42" vertical parapet composed of 27" vertical shape with 14" tall elliptical tube rail (has not been crash tested)

MSHA current standard drawings include;

- 34" and 42" F safety shape
- 27" vertical face 12" wide with 14" tall elliptical tube rail (note 15" elliptical tube rail is required for 42" height despite the standard), 5' wide sidewalk, 8" curb (note 6" curb is preferred despite the standard)

Transitions

A policy is under development that requires utilization of crash tested transitions on all roads on all MSHA projects regardless of funding source.

MSHA current standard drawings include;

- w-beam (steel posts) and rub rail anchored to Jersey or F safety shape
- thrie-beam (wood posts) anchored to Jersey or F safety shape tapered face

Approach Rail

MSHA utilizes crash tested rails that meet NCHRP 350 standard.

MSHA current standard drawings include;

- w-beam with "strong" posts
- 34" and 42" F safety shapes

End Treatments

MSHA utilizes crash tested end treatments that meet NCHRP 350 standard.

MSHA current standard drawings include;

- Type A (Buried-in-Backslope) Single Rail & Double Rail
- Type B (Modified Flared Breakaway)
- Type C (Parallel Breakaway Extruder)
- Type D (Two-Sided Breakaway Attenuating)
- Type E (Two-Sided Non-Breakaway G.R.E.A.T.)
- Type F (Two-Sided Semi-Breakaway Brakemaster)
- Type G (Turn-Down)
- Type J (Two-Side Non-Breakaway)
- Type K (Downstream Anchorage)
- Type L (Radius Section Anchorage)

- Sand Barrel Crash Cushions

iii) Maryland Local Governments

In the absence of a prescribed policy approved by MSHA, AASHTO specifications apply. The AASHTO LRFD Specification says all bridge rail shall be crashworthy regardless of roadway type, geometry and traffic. AASHTO defines crashworthy as successfully crash tested to a currently acceptable performance standard and test level or can be geometrically and structurally evaluated as equal to a crash tested system.

BASIS OF RATING PROCEDURE

This manual's rating procedure is based on the premise a safety feature meets current standard only if it has been crash tested to an appropriate test level. Selection of test levels for different roadways is problematic given a lack of available guidance.

For bridge rail, the 1989 AASHTO Guide Specification offers a selection matrix however it is based on three crash test levels rather than the six test levels of NCHRP 350 and the AASHTO LRFD Specification. There is need for updated selection guidance that takes advantage of the broader six test levels. Regardless, the AASHTO matrix is used in this manual. For simplification ADTT is assumed equal to 10% whereas AASHTO allows selection from 0 to 40%.

After selecting the appropriate test level the inspector then refers to the included diagrams of crash tested bridge rail. The rails selected for inclusion in this manual are those likely to be found in Maryland. All crash tested rails are not included. If a rail is encountered that is believed to have been tested, the FHWA Bridge Rail Guide may be consulted. This manual's diagrams are simplified design/construction drawings. The following simplifications were made;

- The bridge rail diagrams do not show all structural details. Primary member sizes are shown however unexposed connections and reinforcement are not shown given they are not visible in the field. The diagrams show all significant geometry such as height, shape, openings and post setback.
- The bridge rail heights shown have zero tolerance unless a range is noted. Per the AASHTO LRFD Specification 4th Edition, for safety shapes with a bottom lip for future overlays, an encroachment of 2" leaving a 1" lip has been satisfactorily tested. MSHA's standard for 34" F safety shape is 2" higher that the crash tested 32" safety shape to allow future overlays while retaining a height of 32".
- Deck overhang width is not shown. Crash testing is conducted on a representative deck section to evaluate whether the rail anchorage is adequate, whether the deck reinforcement steel is adequate to distribute post anchorage loads without deck localized failures and whether the deck is structurally sufficient. The tested overhang width is not readily available for all rails therefore maximum allowed overhang width is not shown.
- Minimum deck thickness is provided from rules of thumb when not readily available for specific rail. Sufficient deck thickness is required for anchorage.
- Pedestrian and bicycle rail attachments are not shown. Current standard requires 42" height if there is an adjacent sidewalk or bicycle lane. The lack of a pedestrian/bicycle rail should not enter into the rating, however should be noted in the inspection report recommendations.

For informational purposes the following are some general rules of thumb based on observations of bridge rail crash tests;

- Minimum deck overhang mount thickness regardless of test level
  - ⇒ Concrete parapet – 8"
  - ⇒ Top mounted post system – 8"
  - ⇒ Side mounted post system – 12"
- Minimum height to top of structural rail (excludes height of pedestrian rail attachments)
  - ⇒ TL-3 ≥ 27"
  - ⇒ TL-4 ≥ 32"
  - ⇒ TL-5 ≥ 42"
  - ⇒ TL-6 ≥ 90"
  - ⇒ Pedestrian and bicycle traffic (if sidewalk or bicycle lane present) – 42"
- Transverse load capacity (note these far exceed the 1989 AASHTO Guide Specification 10,000 lb static force criteria)
  - ⇒ TL-1 ≥14,000 lb
  - ⇒ TL-2 ≥ 27,000 lb
  - ⇒ TL-3 ≥ 54,000 lb
  - ⇒ TL-4 ≥ 54,000 lb
  - ⇒ TL-5 ≥ 124,000 lb
  - ⇒ TL-6 ≥ 175,000 lb

CRASH TESTED BRIDGE RAIL LIST

The following is a list of crash tested bridge rails included in the FHWA Bridge Rail Guide. The most current version of the Guide can be found at internet address http://www.fhwa.dot.gov/bridge/bridgerail/. The Guide includes geometric and structural details of crash tested rail. The rail diagrams selected for inclusion in Part 2 of this manual are those likely to be found in Maryland. The diagrams are simplified versions of design/construction drawings.

Type	FHWA Bridge Rail Guide Section	NCHRP 350 Test Level	Agency That Crash Tested & Rail Name	Diagram Source Used In This Manual	Included In This Manual?
Safety Shape Rail					
Single Slope 32"	4.62	TL-4	California Type 732	FHWA Bridge Rail Guide	YES
Jersey Shape 32"	4.1	TL-4	California Type	FHWA Bridge Rail Guide	YES
F Shape 32"	5.21	TL-4	Florida Type	FHWA Bridge Rail Guide	YES
Jersey Shape & One Tube 39"	4.76	TL-4	Nevada Type	FHWA Bridge Rail Guide (not on NVDOT website)	YES
Single Slope 42"	4.66	TL-5	California Type 742	CALTRANS website	YES
F Shape 42"	5.43	TL-5	Florida Type	FHWA Bridge Rail Guide	YES
Jersey Shape & One Tube 50"	4.78	TL-5	Texas Type HT	TXDOT website	YES
Jersey Shape 32"	4.15	TL-4	Georgia type	(not on GDOT website)	
Single Slope 42"	4.33	TL-5	Missouri Type		
Jersey Shape 72"	4.45	TL-4	Texas Type T501SW		
Jersey Shape 90"	4.54	TL-6	Texas Type TT		
Jersey Shape 32"	4.56	TL-4	Missouri Type		
Single Slope 36"	4.64	TL-4	California Type 736		
Jersey Shape & One Tube 39"	4.70	TL-3	California Type 20		
Vertical Shape Rail					
Vertical Face Balustrade 32" to 42"	4.47 & 4.52	TL-2	Texas Type T411 & C411	TXDOT website	YES
Vertical Face & One Tube 32"	3.4	TL-2	North Carolina Type	FHWA Bridge Rail Guide	YES
Vertical Face & Two Tube with Sidewalk 41"	4.19	TL-2	Georgia Type	FHWA Bridge Rail Guide (not on GDOT website)	YES
Vertical Face & One Tube with Sidewalk 42"	4.17	TL-4	Georgia Type	FHWA Bridge Rail Guide (not on GDOT website)	YES
Vertical Face with Sidewalk 34"	4.21	TL-4	Georgia Type	FHWA Bridge Rail Guide (not on GDOT website)	YES
Vertical Face & One Tube with &	4.41	TL-4	Oregon Flush Mounted Type	ORDOT website	YES

without Sidewalk 42"			(w/o 54" pedestrian rail)		
Vertical Face & One Tube 27"	3.26	TL-2	California Type 9		
Vertical Face & Two Tube 42"	3.31	TL-4	Michigan Type BR27D		
Vertical Face & One Tube 36"	3.33	TL-4	Minnesota Type		
Vertical Face & One Tube 54"	3.35	TL-5	Texas Type C202		
Vertical Face Modern Pilaster 32"	4.3	TL-4	California Type 80		
Vertical Face Masonry 32"	4.9	TL-3	Federal Lands Type		
Vertical Face Modern Pilaster 32.5"	4.13	TL-2	Federal Lands Type		
Vertical Face Modern Pilaster 29"	4.24	TL-2	Iowa Type		
Vertical Face Modern Pilaster 27"	4.28	TL-2	Kansas Type Modified Corral		
Vertical Face Modern Pilaster 32"	4.31	TL-4	Kansas Type Corral		
Vertical Face Modern Pilaster 29"	4.35	TL-2	Nebraska Type		
Vertical Face Modern Pilaster 29"	4.37	TL-4	Nebraska Type		
Vertical Face Modern Pilaster 29"	4.39	TL-2	Oklahoma Type TR1 Modified		
Vertical Face Modern Pilaster 27"	4.49	TL-3	Texas Type T203		
Vertical Face & One Tube with Sidewalk 36"	4.60	TL-2	California Type 26		
Metal Tube Rail					
Two Tube Curb Mounted 32"	3.57	TL-4	Oregon Type	ORDOT website (although FHWA Bridge Rail Guide lists as TL-2 ORDOT "Office Practice Manual" contains an updated rail that meets TL-4)	YES
Three Tube Curb Mounted 42"	3.58	TL-4	Oregon Type	ORDOT website	YES
Two Tube Curb Mounted 32"	3.39	TL-4	Illinois Type 2399	FHWA Bridge Rail Guide	
Two Tube Curb Mounted 33" (aluminum)	3.1	TL-2	Federal Lands Type		
Two Tube Bottom	3.5	TL-3	Texas Type		

Mounted 27"					
Two Tube Side Mounted 36"	3.7	TL-2	California Type 18		
Two Tube Side Mounted 30"	3.10	TL-2	California Type 115		
Two Tube Side Mounted 42"	3.12	TL-2	California Type 116		
Two Tube Side Mounted 54"	3.14	TL-2	California Type 117		
Two Tube Side Mounted 32"	3.18	TL-4	Oregon type		
Two Tube Top Mounted 32"	3.20	TL-2	Texas Type 421		
Two Tube Curb Mounted 32"	3.24	TL-4	Alaska Type		
Two Tube Curb Mounted 32"	3.28	TL-4	California Type ST-10		
Three Tube Curb Mounted 42"	3.37	TL-3	Federal Lands Type		
Three Tube Top Mounted 42"	3.42	TL-4	Michigan Type		
Two Tube Curb Mounted 32.5"	3.44	TL-4	Michigan Type		
Two Tube Curb Mounted 34"	3.46	TL-4	New England Type		
Two Tube Curb Mounted 32"	3.48	TL-4	New York Type		
Three Tube Top Mounted 32"	3.50	TL-4	New York Type		
Four Tube Top Mounted 42"	3.52	TL-4	New York Type		
Five Tube Top Mounted 56"	3.54	TL-4	New York Type		
Two Tube Curb Mounted 32"	3.61	TL-4	Wyoming Type		
Two Tube Curb Mounted 29"	3.64	TL-3	Wyoming Type		
Thrie-Beam Rail					
Thrie-Beam Side Mounted 27"	2.9	TL-2	Oregon Type	ORDOT website	YES
Thrie-Beam Top Mounted 34"	N/A	TL-2	New York Type	NYSDOT website	YES
Thrie-Beam Top Mounted 32"	2.1	TL-4	Delaware Type		
Thrie-Beam Top Mounted 30.5"	2.5	TL-3	Missouri Type		
Tubular Thrie-Beam Top Mounted 32"	2.7	TL-3	Nebraska Type		
Thrie-Beam Side Mounted 32"	6.15	TL-2	US Forest Service Type	FHWA Bridge Rail Guide (rail guide insufficient, no drawings on internet)	
Thrie-Beam with Upper Channel Side Mounted 33"	6.17	TL-4	US Forest Service Type TCB8000		

W-Beam Rail					
W-Beam Top & Side Mounted 28"	6.19	TL-1	US Forest Service Type	University of Nebraska-Lincoln published drawings	YES
W-Beam Backed with Box Beam Side Mounted 27"	1.5	TL-2	Ohio Type	OHDOT website	YES
W-Beam Backed with Box Beam Top Mounted 27"	1.1	TL-3	Texas Type T101	TXDOT website (although FHWA Bridge Rail Guide lists as TL-2 TXDOT drawing lists as TL-3)	YES
W-Beam Side Mounted 28"	1.3	TL-2	Michigan Type	MDOT procured drawings (although FHWA Bridge Rail Guide lists as TL-3 MDOT procured drawings are same as Ohio Type TL-2 which is correct)	
Tubular W-Beam Top Mounted 27"	1.7	TL-2	Texas Type T6		
Timber Rail					
Curb Type Glulam Rail 18"	6.5	TL-1	US Forest Service Type	University of Nebraska-Lincoln published drawings	YES
W-Beam with Timber Breakaway Post Side Mounted 28"	6.13	TL-1	US Forest Service Type	University of Nebraska-Lincoln published drawings	YES
Glulam Rail with Shoe Attachment Side Mounted 32"	6.7	TL-2	US Forest Service Type	University of Nebraska-Lincoln published drawing	YES
Glulam Rail with Curb Top & Side Mounted 32"	N/A	TL-2	US Forest Service Type	University of Nebraska-Lincoln published drawings	YES
Glulam Rail with Curb Top & Side Mounted 33"	6.9	TL-4	US Forest Service Type GC8000	University of Nebraska-Lincoln published drawings	YES
Glulam Rail Top & Bottom Mounted 27"	6.1	TL-3	Oklahoma Type Timber Rail 3	FHWA Bridge Rail Guide (not on OKDOT website)	

REFERENCES

1. Bridge Deck Design for Railing Impacts Texas Department of Highways Report FHWA/TX-85/17+295-1F, 1985, Arnold & Hirsch

2. Bridge Rail Guide, 2005, FHWA and CALTRANS

3. Crash Testing of Bridge Railings (Memo), 05/30/97, FHWA

4. Guidelines for Traffic Barrier Placement and End Treatment Design, 2006, MSHA

5. Guide Specifications for Bridge Railings, 1989, AASHTO

6. Guide to Standardized Highway Bridge Hardware, 1995, AASHTO-AGC-ARTBA

7. LRFD Bridge Design Specifications 2nd Edition, 1998, AASHTO

8. LRFD Bridge Design Specifications 2nd Edition 2003 Interims, 2003, AASHTO

9. LRFD Bridge Design Specifications 4th Edition, 2007, AASHTO

10. National Cooperative Highway Research Program Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features, 1993, Transportation Research Board

11. National Cooperative Highway Research Program Report 554: Aesthetic Concrete Barrier Design, 2006, Transportation Research Board

12. Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, 1995, FHWA

13. Roadside Design Guide, 2002, AASHTO

14. Specifications for the National Bridge Inventory (Draft), 2006, FHWA

15. Standard Specifications for Highway Bridges 17th Edition, 2003, AASHTO

RATING BRIDGE RAIL

Bridge rail must be adequate to prevent vehicles from leaving the bridge by penetration, climbing or rollover. It should also redirect vehicles without excessive damage to the occupant compartment, without snagging or dramatic deceleration and without detached fragments, elements or debris penetrating the occupant compartment. The rail geometry and structural capacity are essential to its proper function. Modern design criteria require full-scale simulated crash testing. There are six different crash test levels a rail may be tested to (TL-1 through TL-6). Each test level includes different vehicle types, weights, impact speed and impact angle. TL-1 includes the lowest vehicle weight (1,550 lb car) and impact speed (30 mph). TL-6 includes the highest vehicle weight (80,000 lb tanker) and impact speed (60 mph). Part 1 of this manual may be referred to for further explanation.

i) Rating Procedure

The rating of rail includes three steps;

STEP 1
select crash test level for roadway using included procedure

↓

STEP 2
compare in-service rail to included diagrams to determine if meets selected crash test level

↓

STEP 3
assign rating to SI&A Form item 36 using Recording and Coding Guide definition

STEP 1:

A) National Highway System Roads

Determine if road is a National Highway System (NHS) route by referring to Structure Inventory and Appraisal Form item 104 "Highway System of the Inventory Route". Per the 1995 Recording and Coding Guide if item 104 is coded "1" it is a NHS route. NHS generally includes interstates, other principle arterials and Strategic Highway Network Routes (STRAHNET).

If is National Highway System the test level shall be greater than or equal to 3

B) Roads other than National Highway System

If not NHS the test level shall be selected from Table 1. The following information is needed to use the table;

Travel Speed: Can be estimated from field observation.

Rail Offset: Offset from travel lane can be taken as the distance from painted edge line to the rail's closest component. Typically this is considered the shoulder width.

ADT: Can be taken from Structure Inventory and Appraisal Form item 29 "Average Daily Traffic". Is the combined traffic in both directions unless are parallel structures in which case the ADT is only for the direction carried.

Enter this information in the table to determine the required crash test level.

STEP 2:

Compare in-service rail to included diagrams of crash tested rails. If the in-service rail matches any of the diagrams, compare the selected test level to that on the diagram. If the selected test level is less than or equal to the diagram then the rail may be rated as meets standard.

The rail heights shown have zero tolerance unless a range is noted. For safety shapes with a bottom lip for future overlays, an encroachment of 2" leaving a 1" lip has been satisfactorily tested.

Rail with sidewalk only meets standard if crash testing included the sidewalk. Diagrams with sidewalk were tested with the sidewalk. Sidewalk is generally not recommended for speeds greater than 40 mph. Bridge curb height shall not exceed 6" unless it ties into approach curb that is higher than 6" for a significant length beyond the bridge and is also higher elsewhere on the roadway in nearby vicinities. *How may sidewalk width dimensions vary?*

If the rail has aesthetic surface treatments (reliefs or depressions) the treatments must be evaluated according to the criteria given in this manual's section "Aesthetic Surface Treatments".

Pedestrian and bicycle rail attachments are not shown. Current standard requires 42" height if there is an adjacent sidewalk or bicycle lane. The lack of a pedestrian/bicycle rail should not enter into the rating, however should be noted in the inspection report recommendations.

The rails selected for inclusion in this manual are those likely to be found in Maryland. All crash tested rails are not included. If a rail is encountered that is believed to have been tested, the FHWA Bridge Rail Guide may be consulted to check if has been tested.

STEP 3:

1995 Recording and Coding Guide definition

Code item 36A of the Structure Inventory and Appraisal Form.

0	=	does not meet currently acceptable standard
1	=	meets currently acceptable standard
N	=	safety feature not required

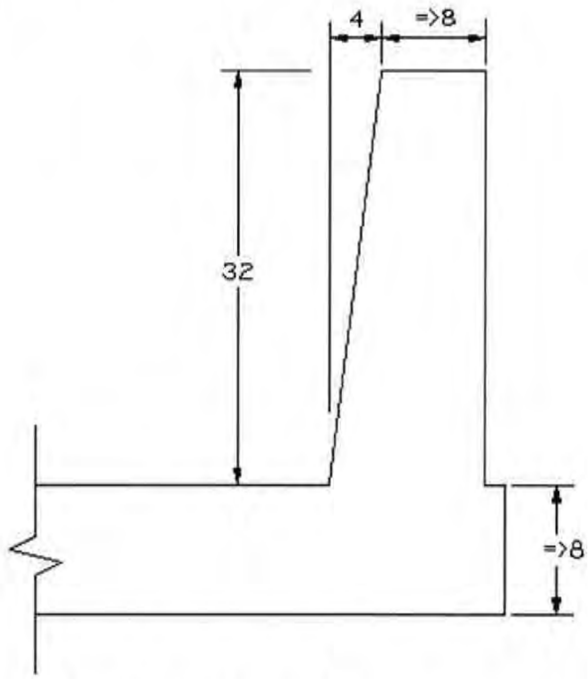
Code N shall seldom be used. An example where N may be used is for box and pipe culverts with side slopes and headwalls far from travel lane such that rail is not required.

Collision damage or deterioration of elements is not considered when coding.

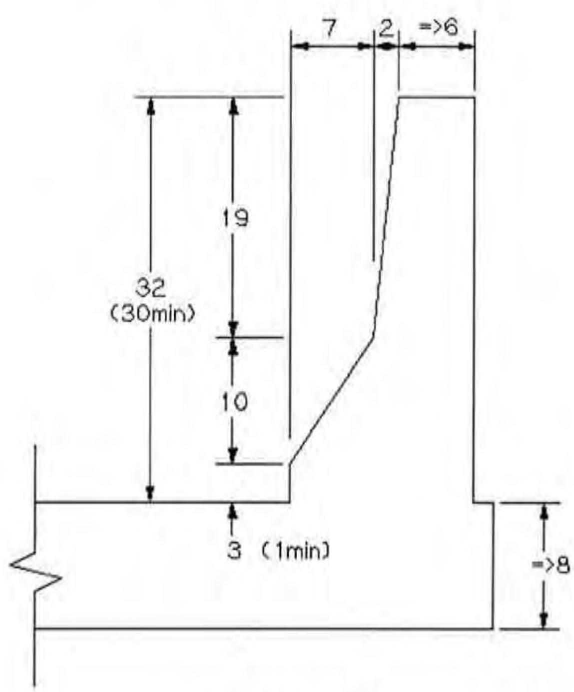
Table 1: Test Level Selection Non-NHS										
Site Characteristics		ADT (1000 vehicles per day both directions combined total)								
Travel Speed (mph)	Rail Offset (ft)	All Divided Roadways & Undivided Roadways ≥ 5 Lanes Combined			Undivided Roadways ≤ 4 Lanes Combined			One Direction Roadways (Ramps, One Way Streets, Etc.)		
		TL-2	TL-4	TL-5	TL-2	TL-4	TL-5	TL-2	TL-4	TL-5
30	0-3	0 to 23.9	to 179.8	to ∞	0 to 19.3	to 147.9	to ∞	0 to 12.0	to 89.9	to ∞
	>3-7	0 to 36.5	to 258.3	to ∞	0 to 28.8	to 228.7	to ∞	0 to 18.3	to 129.2	to ∞
	>7-12	0 to 55.9	to 404.4	to ∞	0 to 46.5	to 364.6	to ∞	0 to 28.0	to 202.2	to ∞
	>12	0 to 100.7	to ∞		0 to 84.6	to ∞		0 to 50.4	to 417.1	to ∞
40	0-3	0 to 9.8	to 79.7	to ∞	0 to 7.1	to 55.6	to ∞	0 to 4.9	to 39.9	to ∞
	>3-7	0 to 12.7	to 89.8	to ∞	0 to 9.2	to 68.6	to ∞	0 to 6.4	to 44.9	to ∞
	>7-12	0 to 16.9	to 132.4	to ∞	0 to 12.8	to 102.3	to ∞	0 to 8.5	to 66.2	to ∞
	>12	0 to 25.8	to 183.6	to ∞	0 to 20.1	to 157.2	to ∞	0 to 12.9	to 91.8	to ∞
50	0-3	0 to 4.7	to 50.0	to ∞	0 to 3.2	to 32.0	to ∞	0 to 2.4	to 25.0	to ∞
	>3-7	0 to 5.4	to 61.4	to ∞	0 to 3.7	to 41.8	to ∞	0 to 2.7	to 30.7	to ∞
	>7-12	0 to 7.2	to 70.6	to ∞	0 to 5.1	to 49.3	to ∞	0 to 3.6	to 35.3	to ∞
	>12	0 to 9.6	to 88.5	to ∞	0 to 6.9	to 67.8	to ∞	0 to 4.8	to 44.3	to ∞
60	0-3	0 to 2.8	to 39.6	to ∞	0 to 1.8	to 25.0	to ∞	0 to 1.4	to 19.8	to ∞
	>3-7	0 to 3.1	to 47.5	to ∞	0 to 2.0	to 29.3	to ∞	0 to 1.6	to 23.8	to ∞
	>7-12	0 to 3.9	to 53.1	to ∞	0 to 2.5	to 33.7	to ∞	0 to 2.0	to 26.6	to ∞
	>12	0 to 4.7	to 67.6	to ∞	0 to 3.1	to 44.1	to ∞	0 to 2.4	to 33.8	to ∞
70	0-3	0 to 2.0	to 32.1	to ∞	0 to 1.2	to 20.0	to ∞	0 to 1.0	to 16.1	to ∞
	>3-7	0 to 2.3	to 38.5	to ∞	0 to 1.4	to 22.9	to ∞	0 to 1.2	to 19.3	to ∞
	>7-12	0 to 2.6	to 42.2	to ∞	0 to 1.6	to 26.7	to ∞	0 to 1.3	to 21.1	to ∞
	>12	0 to 3.0	to 53.0	to ∞	0 to 1.8	to 33.1	to ∞	0 to 1.5	to 26.5	to ∞

NOTES:
This table is a simplification of 1989 AASHTO Guide Specification, 10% ADTT assumed.
A limitation of this matrix is only three of NCHRP 350's six test levels are represented. This is because the matrix is based on the 1989 AASHTO Guide Specification's three performance levels. As a result high speeds will almost always require TL-4 or greater given TL-2 only satisfies for very low ADTs.

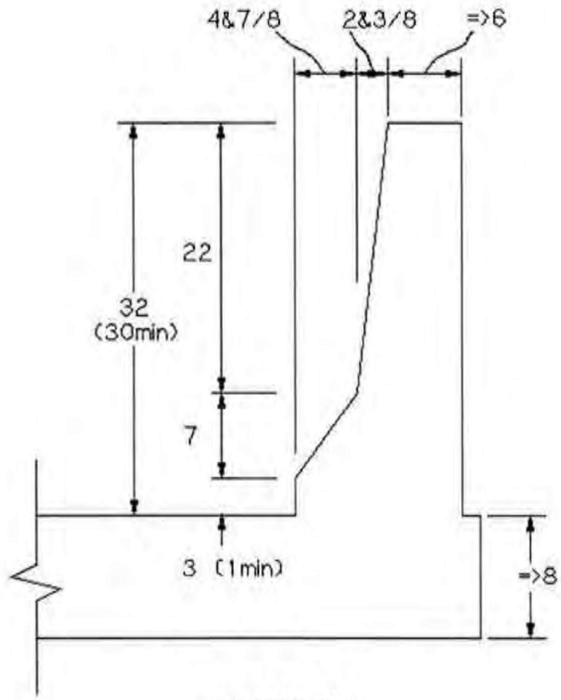
ii) Crash Tested Rail Diagrams



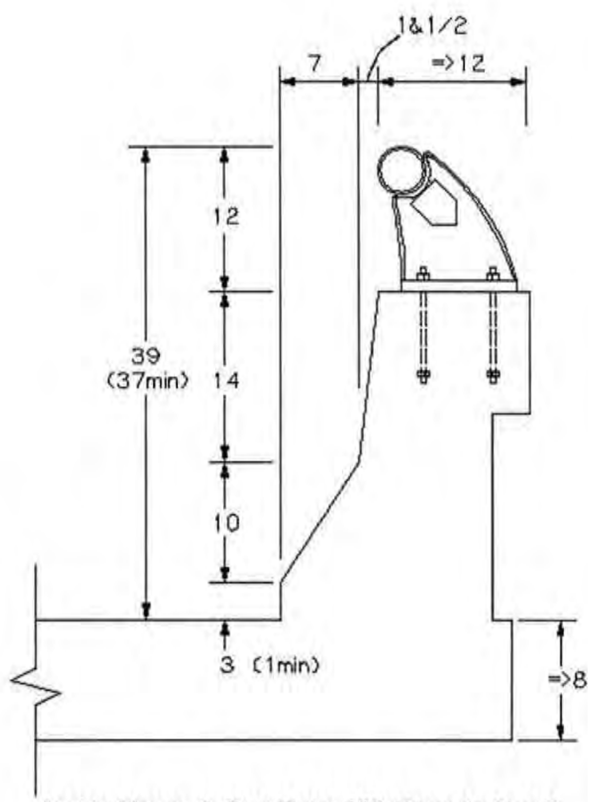
Single Slope 32" (California Type 732)
TL-4



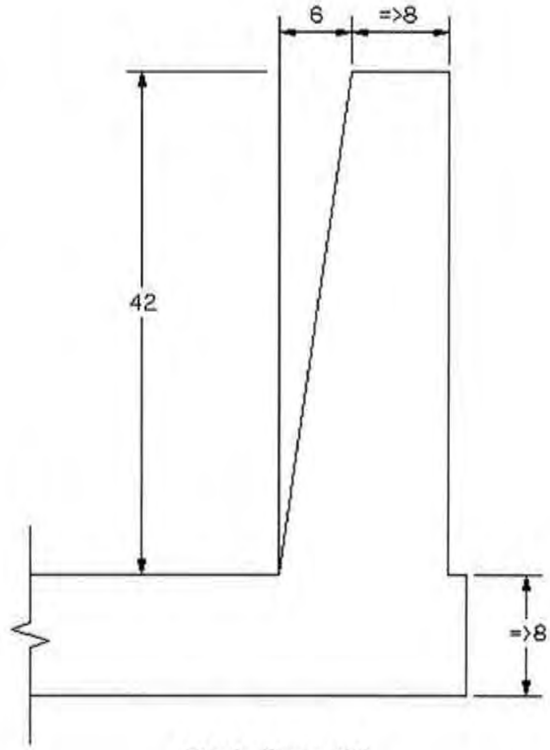
Jersey Shape 32"
TL-4



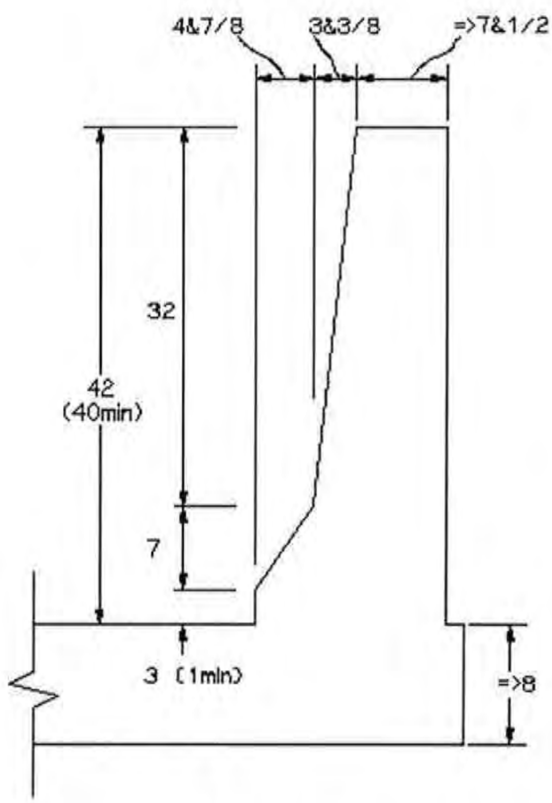
F Shape 32"
TL-4



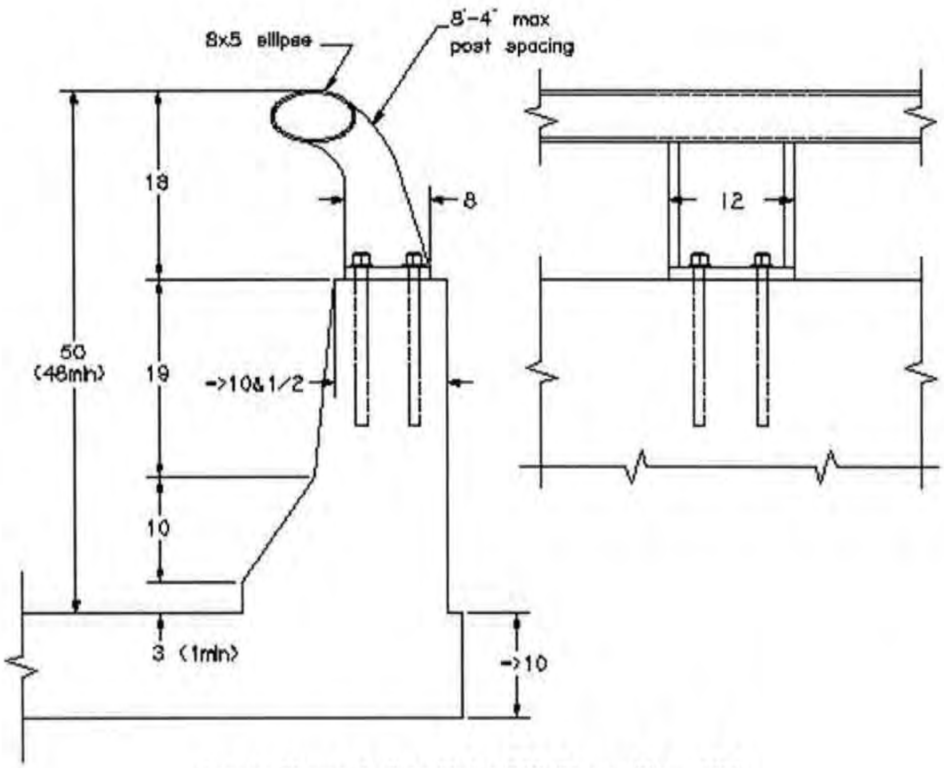
Jersey Shape & One Tube 39" (Nevada Type)
TL-4



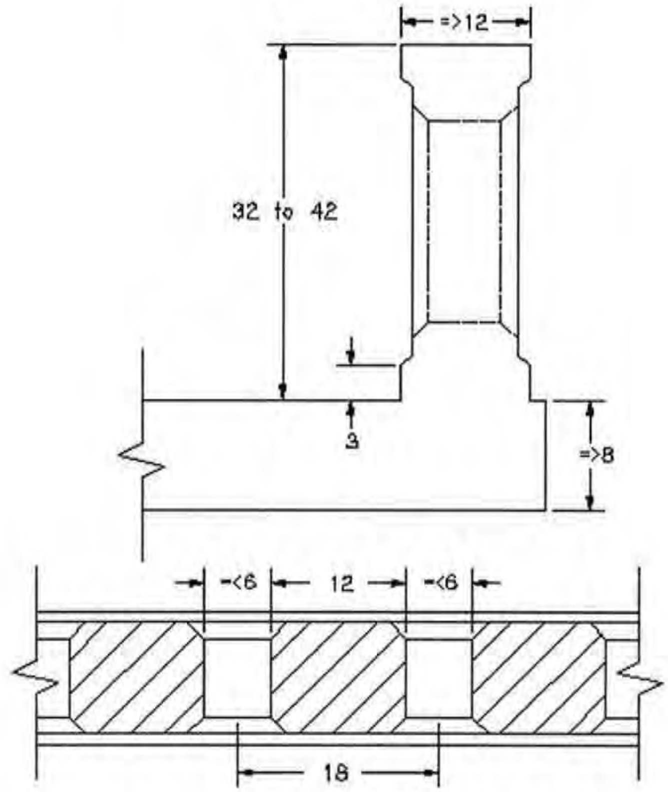
Single Slope 42"
TL-5



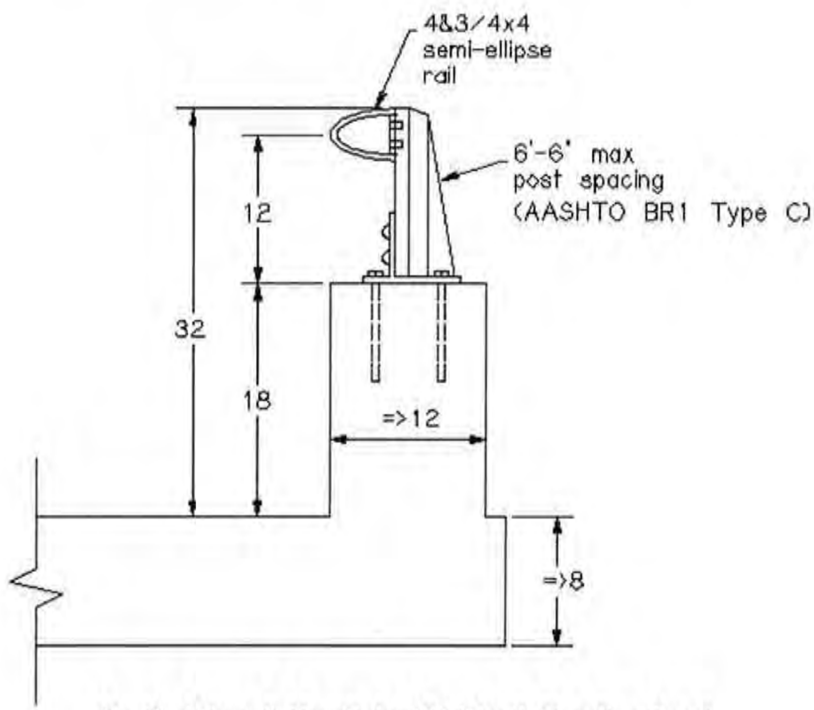
F Shape 42"
TL-5



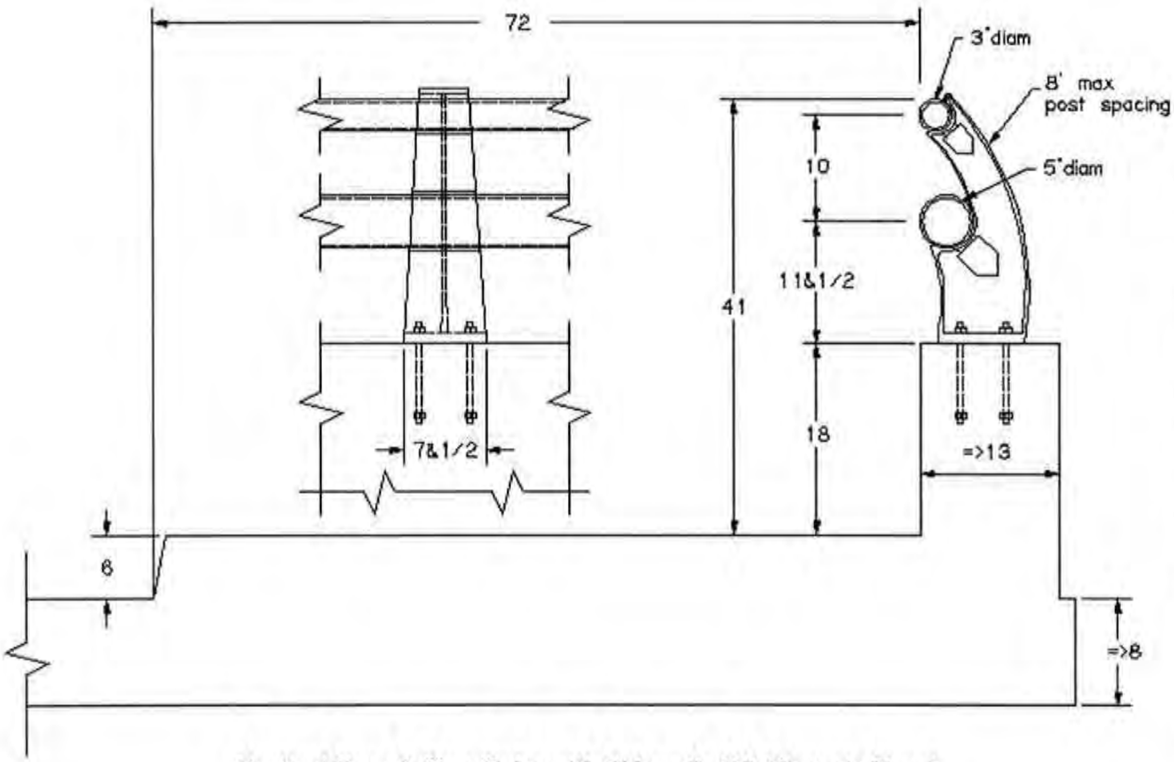
Jersey Shape & One Tube 50" (Texas Type HT)
TL-5



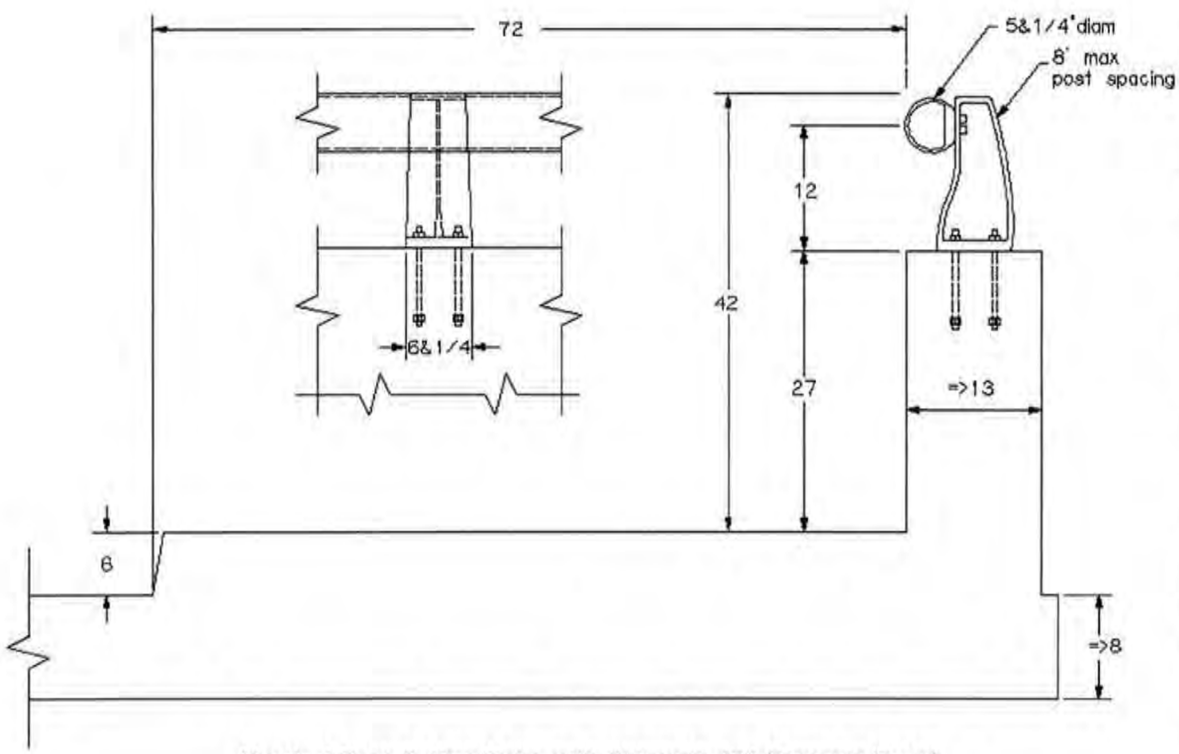
Vertical Face Balustrade 32" to 42" (Texas Type T411 & C411)
TL-2



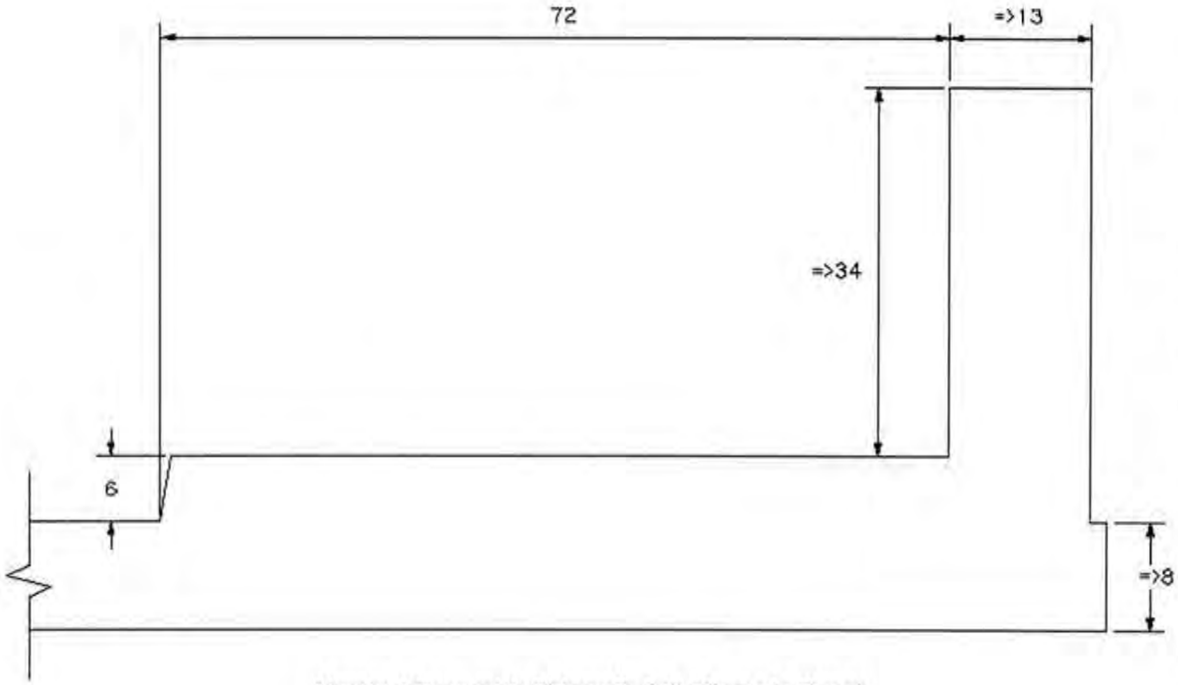
Vertical Face & One Tube 32" (North Carolina Type)
TL-2



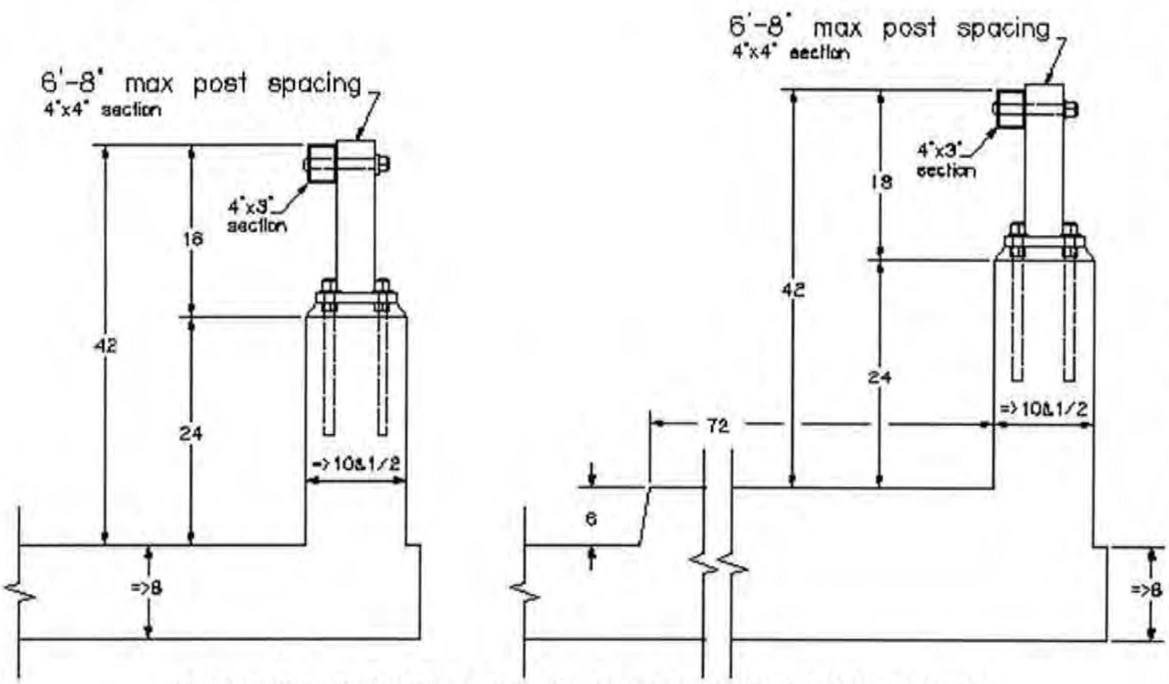
Vertical Face & Two Tube with Sidewalk 41" (Georgia Type)
TL-2



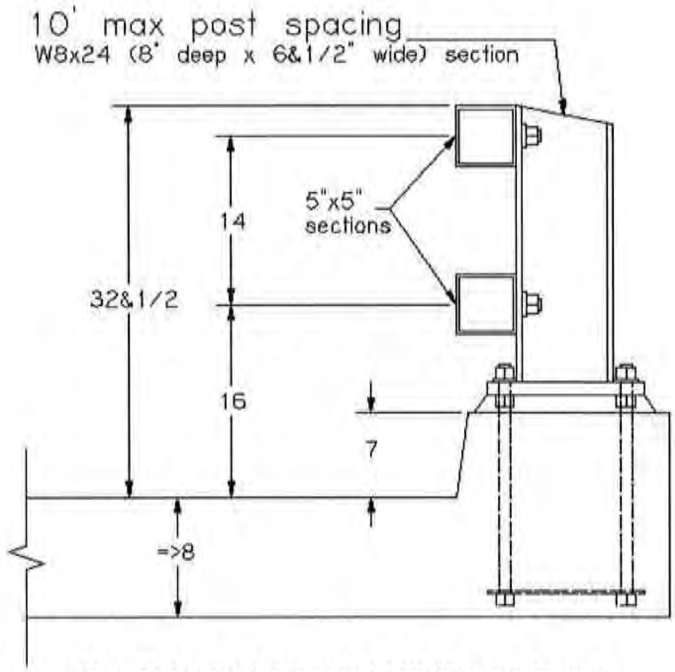
Vertical Face & One Tube with Sidewalk 42" (Georgia Type)
TL-4



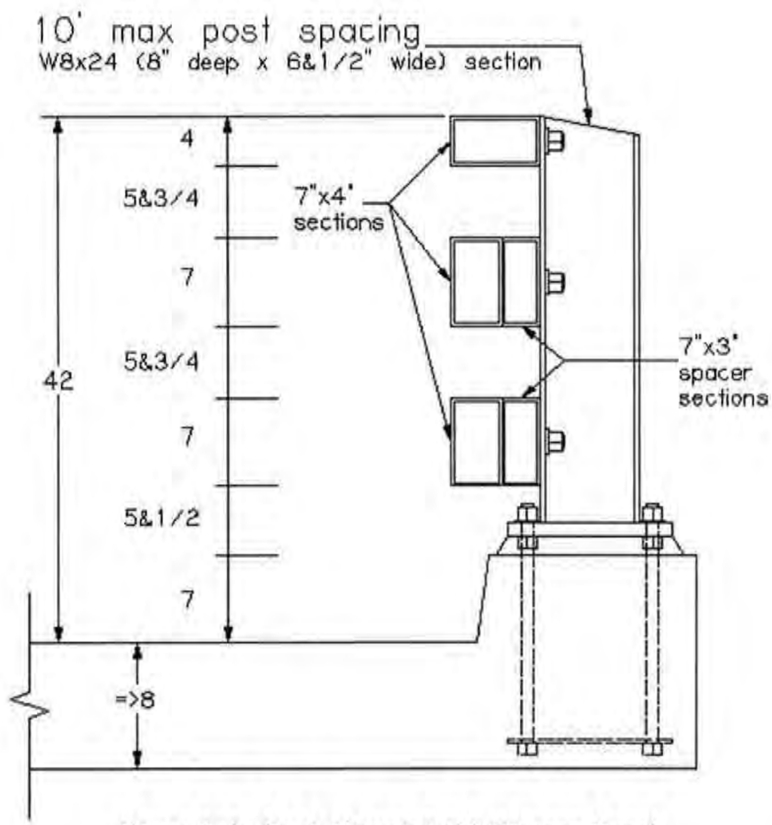
Vertical Face with Sidewalk 34" (Georgia Type)
TL-4



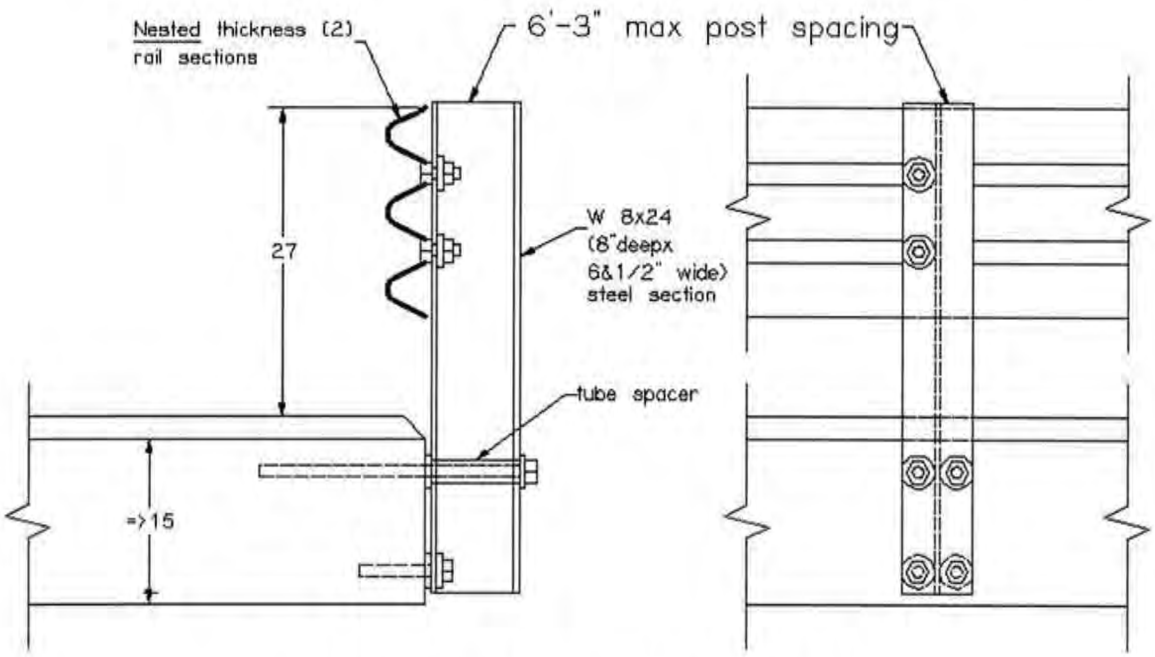
Vertical Face & One Tube 42" with & without Sidewalk (Oregon Type)
TL-4



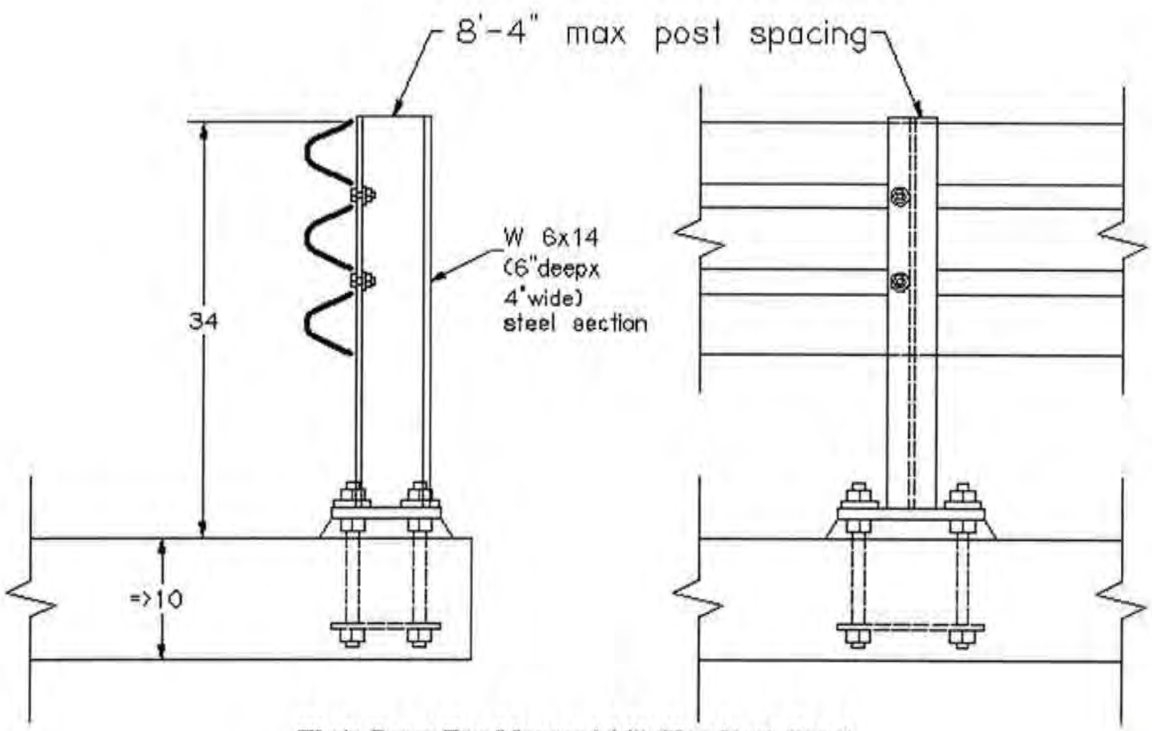
Two Tube Curb Mounted 32" (Oregon Type)
TL-4



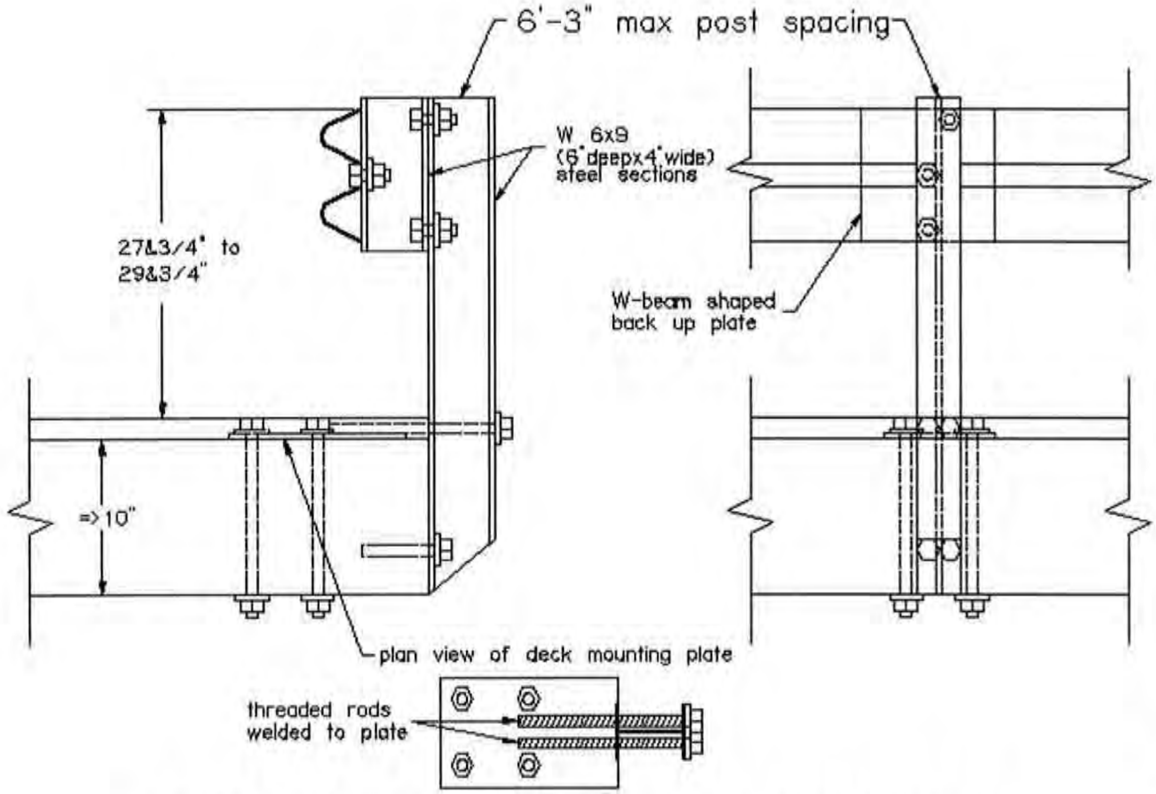
Three Tube Curb Mounted 42" (Oregon Type)
TL-4



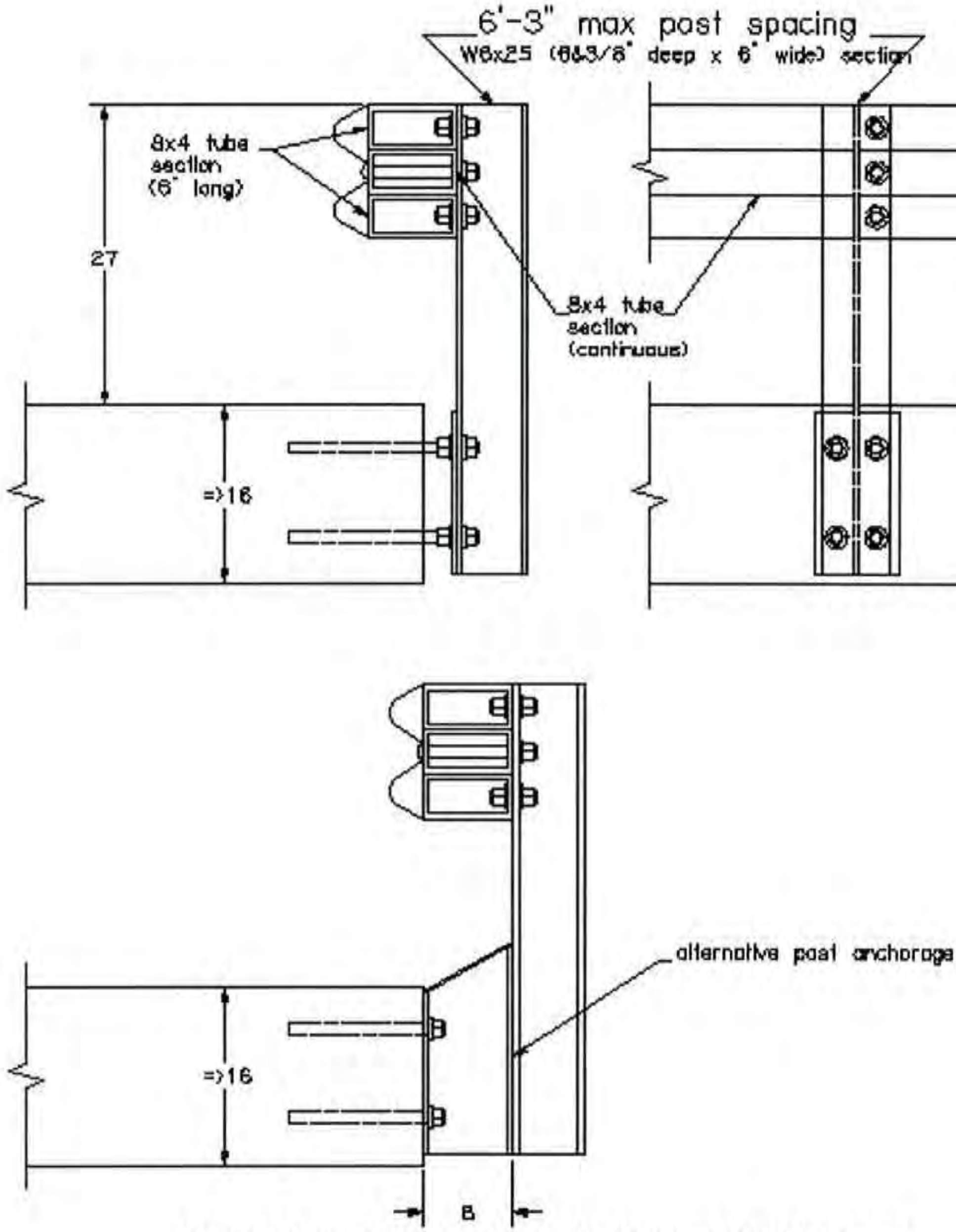
Thrie-Beam Side Mounted 27" (Oregon Type)
TL-2



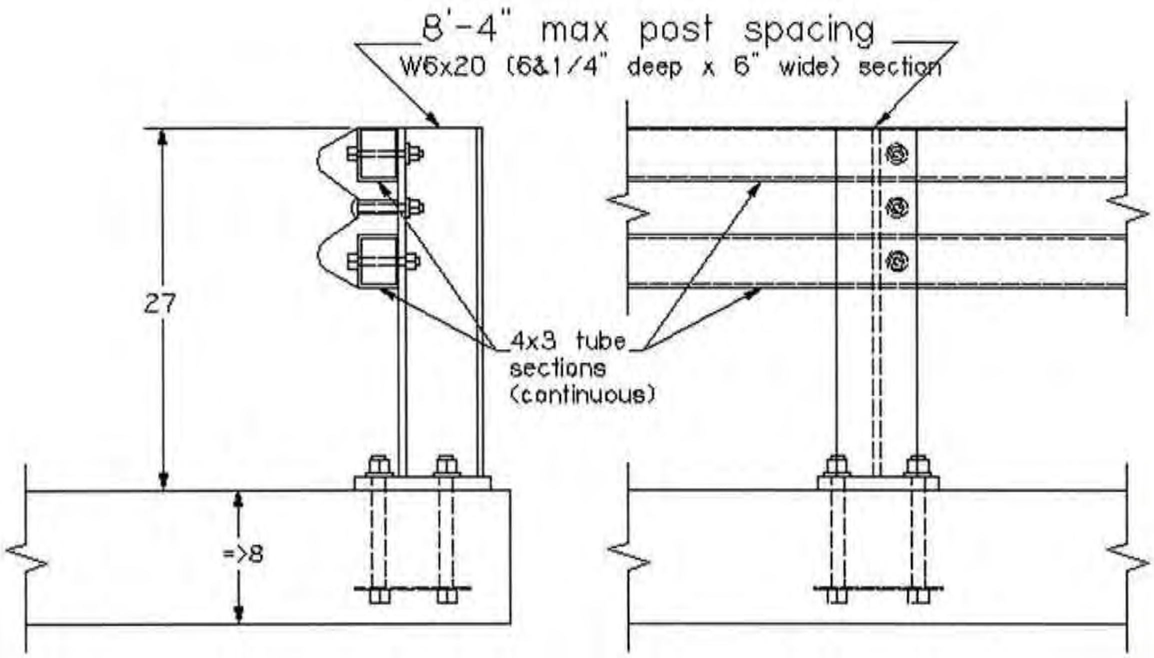
Thrie-Beam Top Mounted 34" (New York Type)
TL-2



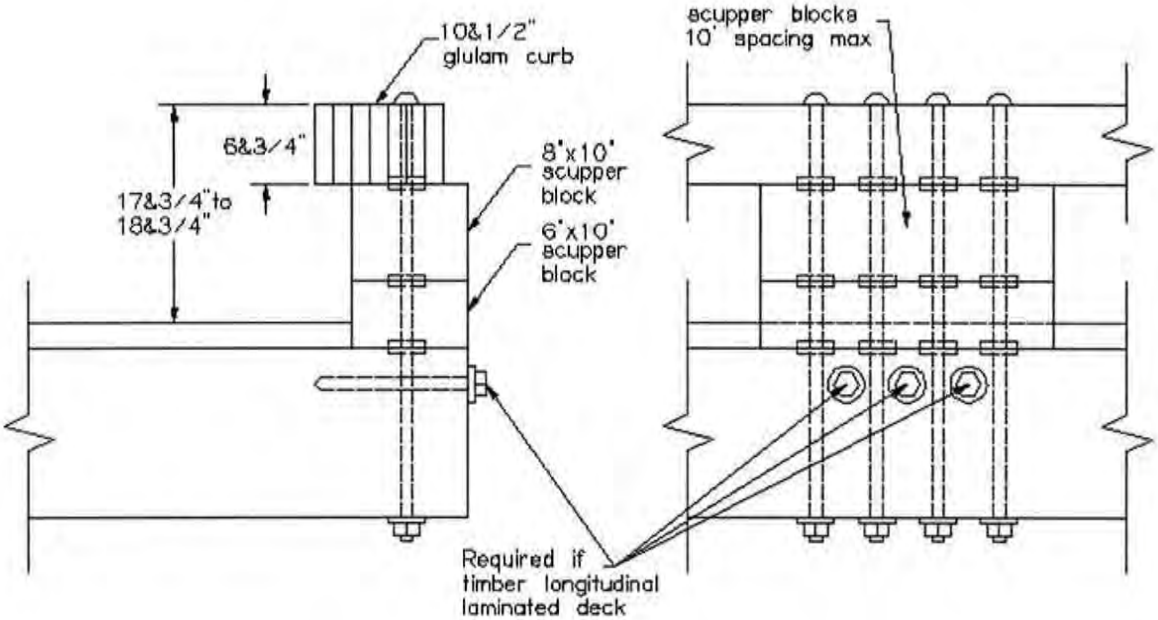
W-Beam Top & Side Mounted 28" (University of Nebraska-Lincoln Type)
TL-1



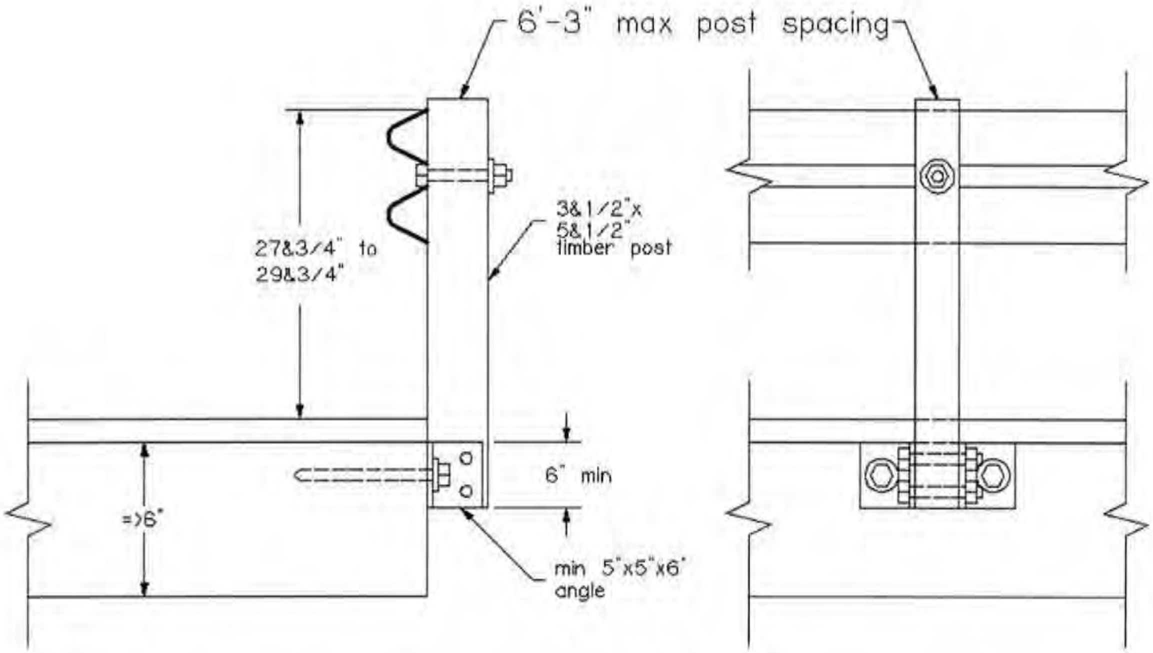
W-Beam Backed with Box Beam Side Mounted 27" (Ohio Type)
TL-2



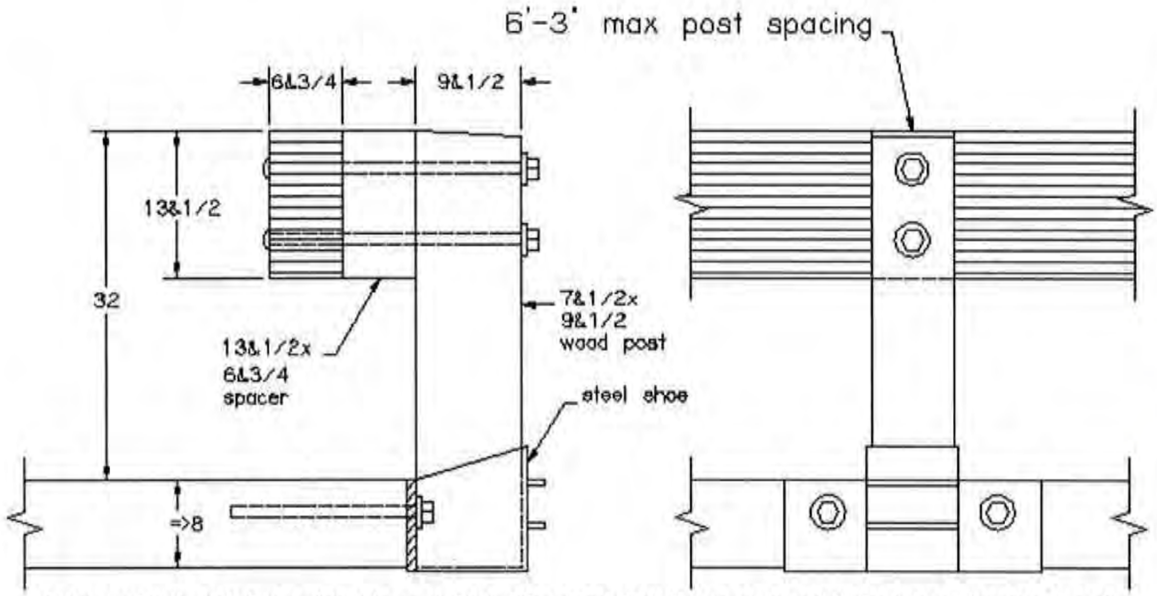
W-Beam Backed with Box Beam Top Mounted 27" (Texas Type T101)
TL-3



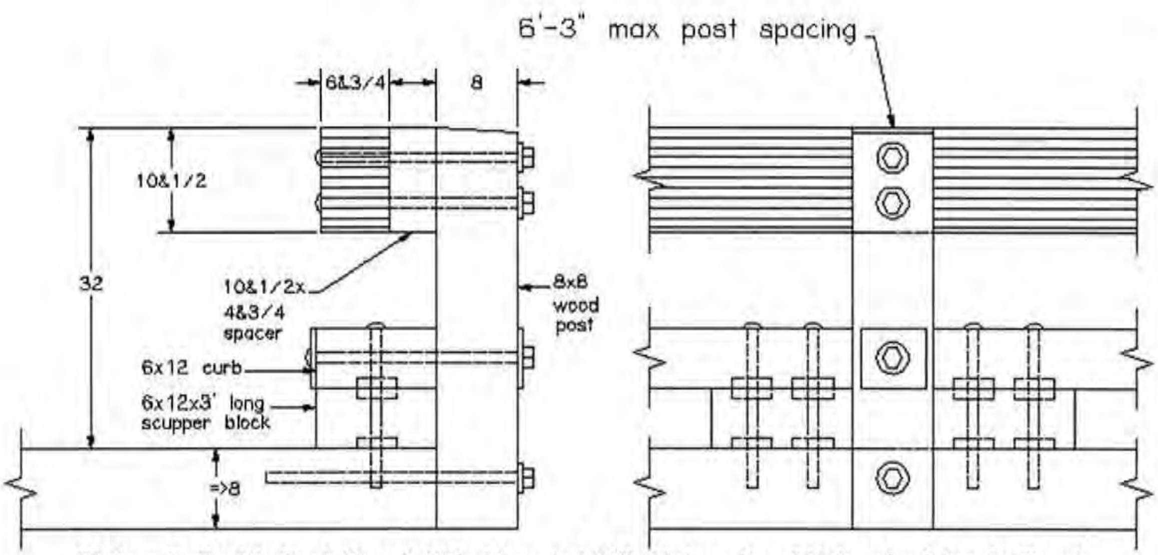
Curb Type Glulam Rail 18"
TL-1



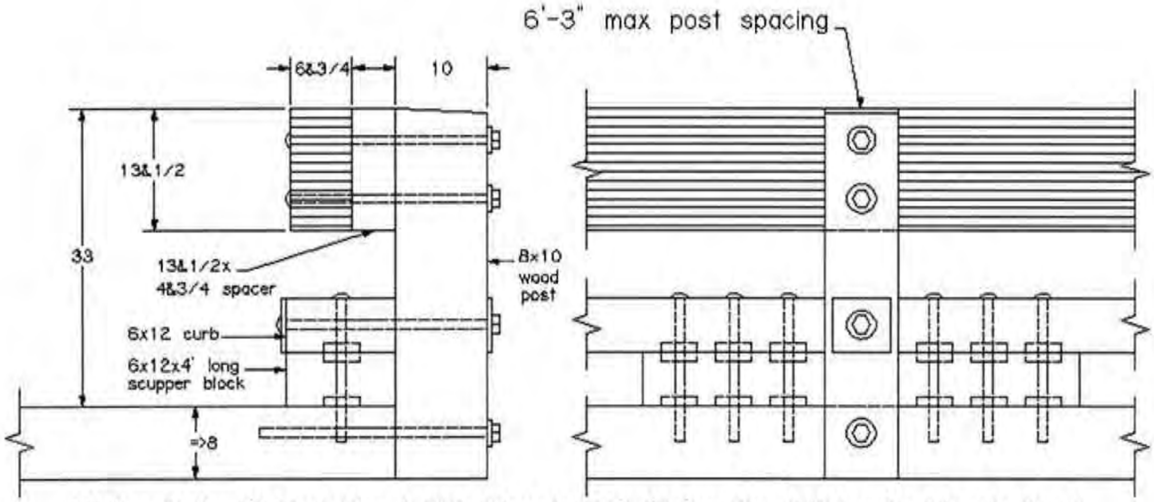
W-Beam with Timber Breakaway Post Side Mounted 28" (University of Nebraska-Lincoln Type)
TL-1



Glulam Rail with Shoe Attachment Side Mounted 32" (University of Nebraska-Lincoln Type) TL-2



Glulam Rail with Curb Top & Side Mounted 32" (University of Nebraska-Lincoln Type) TL-2



Glulam Rail with Curb Top & Side Mounted 33" (University of Nebraska-Lincoln Type)
TL-4

iii) Aesthetic Surface Treatments

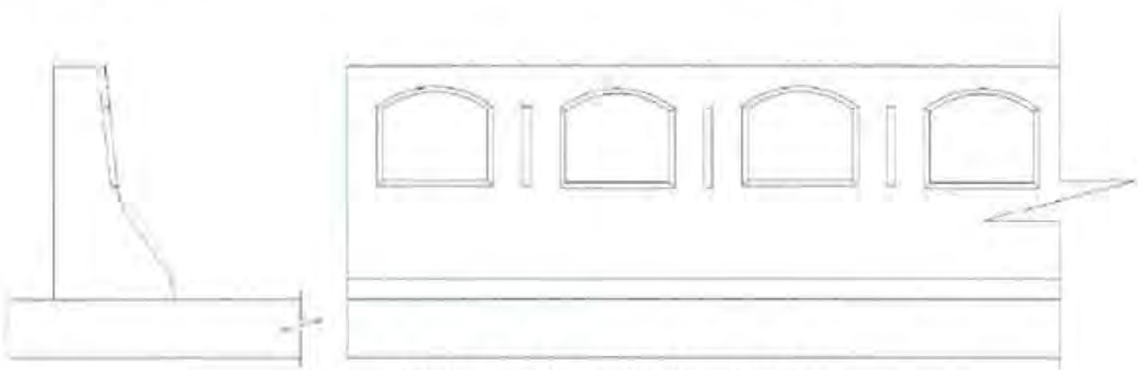
The following criteria are taken from NCHRP Report 554 Aesthetic Concrete Barrier Design.

(a) Jersey and F Safety Shape Rails

Surface treatments that comply with the following criteria satisfy for all crash test levels (TL-1 through TL-6).

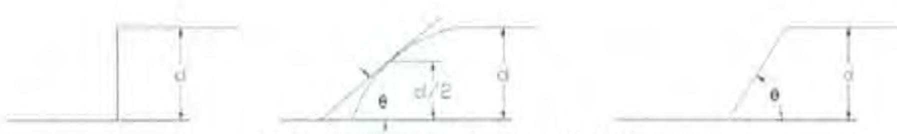
Criteria:

- Only depressions (not relieves) shall be used.
- Depressions shall only be used in the upper flat portion of the rail face (above the break point).
- Depression pattern shall not have repeating upward sloping edges as this can cause vehicle instability and high roll angles on impact that may result in vehicle rollover (see below illustration "Example Surface Depression Repeating Upward Edges").
- The below figures shall be used to determine if the depression depth, edge chamfer angle (90°, 45°or 30°) and pattern width (longitudinal dimension along rail face) meets standard.

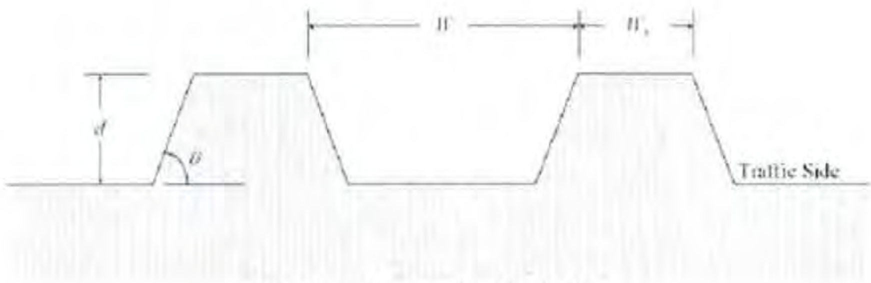


Example Surface Depression Treatment

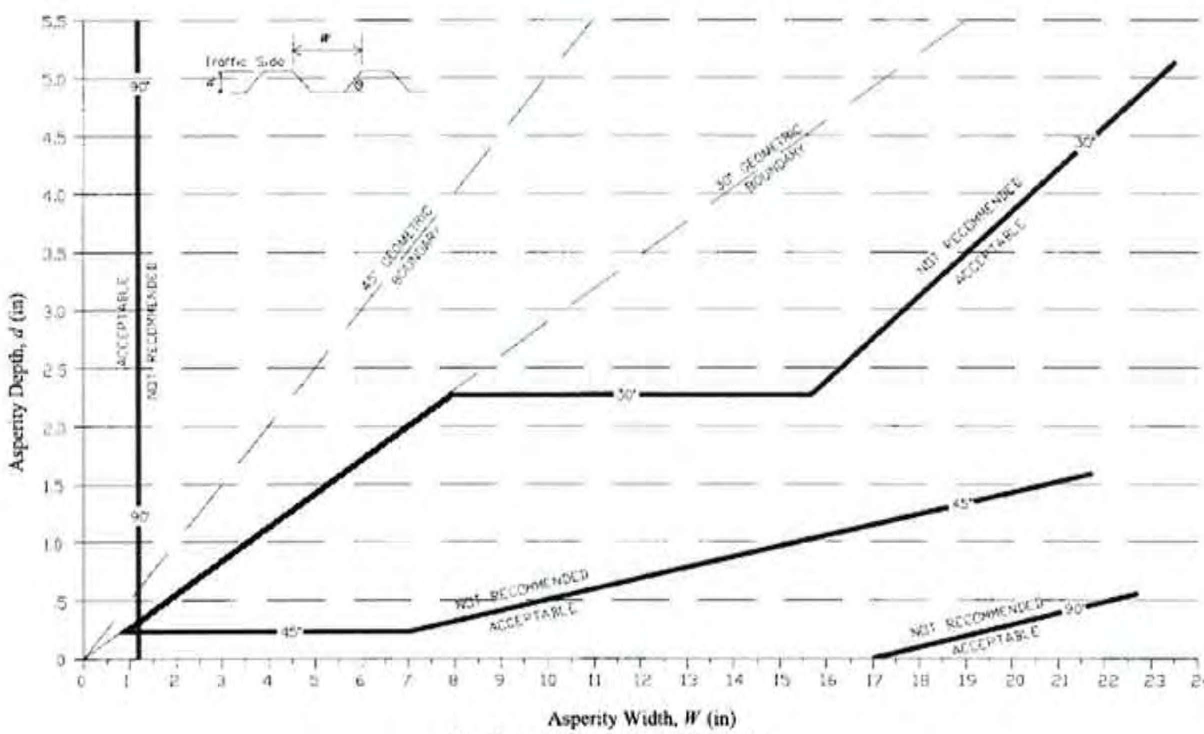
Example Surface Depression Repeating Upward Edges



Types of Depression Chamfer Edges



Surface Depression Variables



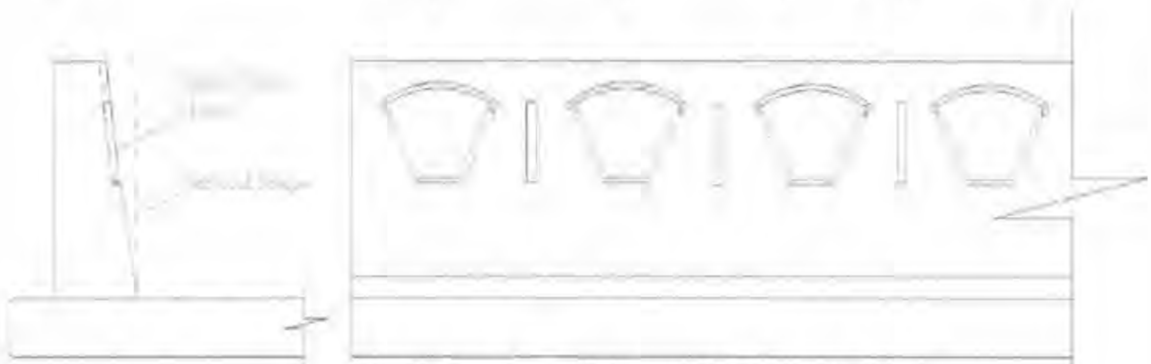
Surface Depression Criteria

(b) Single Slope Safety Shape and Vertical Shape Rails

Surface treatments that comply with the following criteria satisfy for crash test levels TL-1, TL-2 and TL-3.

Criteria:

- Sandblasted and exposed aggregate textures with relieves ≤ 3/8".
- Depression patterns with depths ≤ 1" and chamfer edges 45° or flatter.
- Depression patterns with depths ≤ 1/2", widths ≤ 1" and chamfer edges ≤ 90°.
- Slots, grooves and joints of any depth, width ≤ 3/4", and maximum surface differential of 3/16".
- Patterns with gradual undulations and a maximum relief of 3/4" over 12".
- Patterns with a maximum relief of 2&1/2" if located 24" or higher from the rail bottom and with all chamfer edges rounded or sloped.
- Depression or relief patterns shall not have repeating upward sloping edges as this can cause vehicle instability and high roll angles on impact that may result in vehicle rollover (see below illustration "Example Surface Depression Repeating Upward Edges").



Example Surface Depression Repeating Upward Edges

(c) Masonry Rails

Surface treatments that comply with the following criteria satisfy for crash test levels TL-1, TL-2 and TL-3.

Criteria:

- Stone projections shall be shaped/dressed so are no jagged surfaces or square edges.
- Ends, exposed angles and corners of rail shall have smooth shaped stones.
- No stone shall project more than 1&1/2" from neat line.
- Large projections shall be oriented downstream to prevent vehicle snagging.
- Mortar joint width shall be ≤ 2&1/2".
- Mortar joint depth shall be ≤ 2".

RATING TRANSITIONS

Transitions connect rail of lesser stiffness to rail of greater stiffness. Most transitions consist of;

1. strong rail elements composed of w-beam or thrie-beam nested sections (two rails nested inside each other) strongly anchored to the rigid bridge rail to maintain tension to prevent pocketing and poor redirection
2. reduced post spacing and sometimes stronger posts approaching the rigid rail to maintain tension to prevent pocketing and poor redirection
3. a component such as thrie-beam, rub rail or flared back curb to prevent vehicle snagging on the end of the rigid bridge rail

i) Rating Procedure

<u>1995 Recording and Coding Guide definition</u>

Code item 36B of the Structure Inventory and Appraisal Form.

0	=	does not meet currently acceptable standard
1	=	meets currently acceptable standard
N	=	safety feature not required

Code N shall seldom be used. An example where N may be used is for box and pipe culverts with side slopes and headwalls far from travel lane such that rail is not required.

Collision damage or deterioration of elements is not considered when coding.

When rating approach rail the following should be checked;

<u>Approach versus Trail End</u>: Transitions are required only on the approach ends unless there is two-directional traffic with two lanes or less combined.

<u>Type</u>:
- W-beam nested and rub rail
- Thrie-beam nested
- Other

<u>Height</u>:
- W-beam – 25" min, 30" max, 27" desired
- Thrie-beam – can be higher than maximum allowed for w-beam

Post Spacing: Less than approach rail standard spacing which is typically 6'-3" maxiumum. For travel speeds ≥ 45 mph posts should gradually transition from standard spacing (6'-3") to half spacing (3'-1&1/2") to quarter spacing (1'-6&3/4"). For travel speeds < 45 mph half spacing is adequate.

Post Setback: Timber or plastic offset blocks are required to distance w-beam or thrie-beam from the posts to prevent vehicle snagging on the posts. Steel is not an acceptable offset block.

Post Embedment: 4'-6" nominal embedment required. 5'-6" nominal embedment required in slopes steeper than 4:1 or within 2' from the top of a slope steeper than 4:1. If erosion is affecting the embedment depth it should not enter into the rating, however it should be noted in the inspection report recommendations.

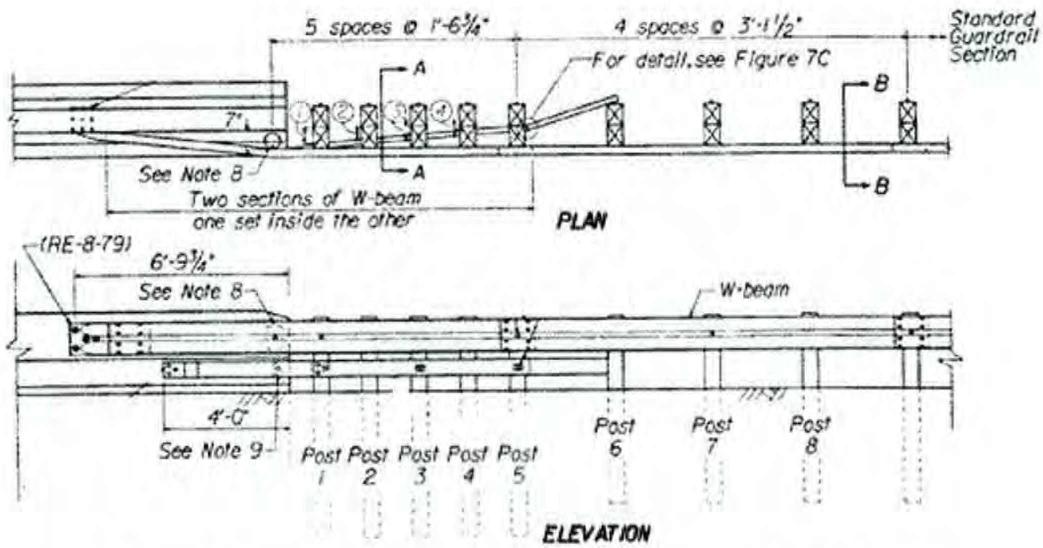
Curb Sections: Ends of bridge curbs should be flared behind transition rail, tapered or made continuous with approach roadway curb.

Horizontal Projection of Bridge Rail: Rigid bridge rail should not have any horizontal projection in front of the transition rail face to prevent vehicle snagging on the end of the rigid bridge rail. Normally the bridge rail safety shape face is gradually tapered to a vertical face.

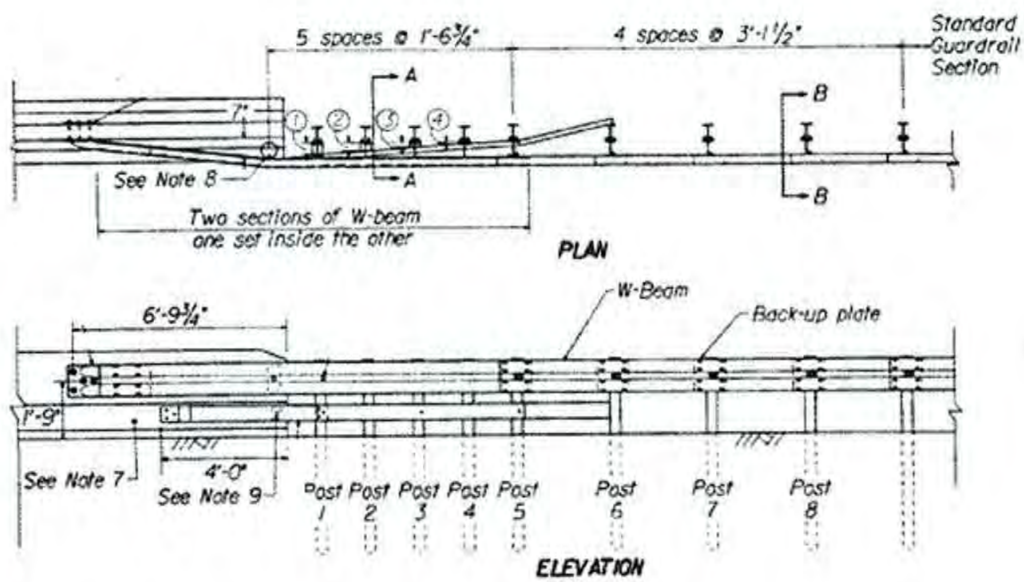
Vertical Projection of Bridge Rail: Top of rigid bridge rail should not be higher than transition rail. When impacted the more flexible transition rail will rotate slightly allowing the vehicle to lean over it. Any vertical projection of the rigid rail will snag the vehicle. Normally the top of rigid rail is gradually tapered down to match the transition height.

ii) Crash Tested Transition Diagrams

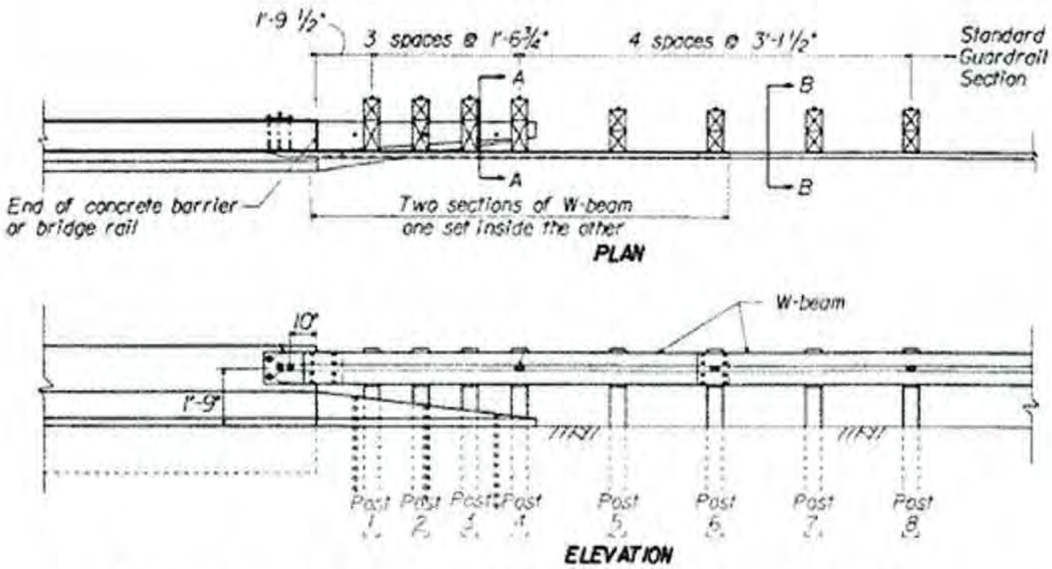
The following diagrams do not include all crash tested transitions. If the in-service transition is not included in the following diagrams evaluate it according to the criteria in part (i).



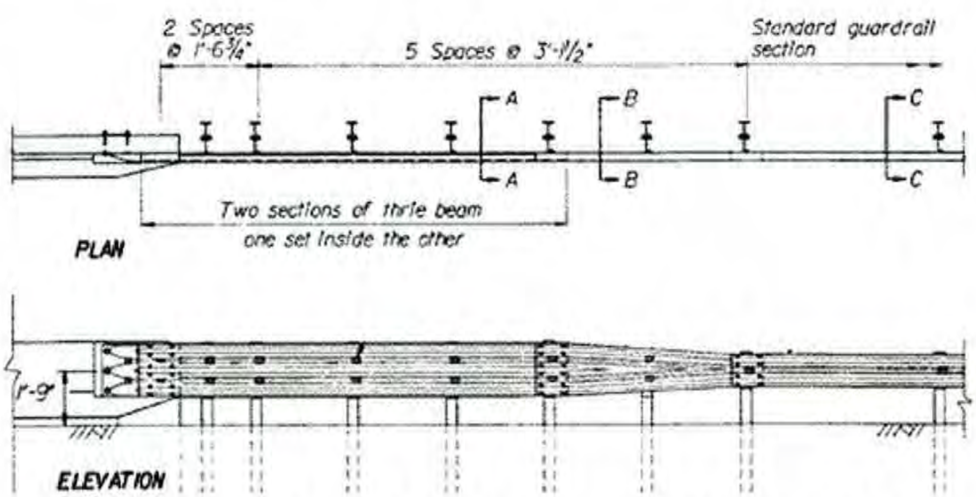
W-Beam Nested and Wood Post with Rub Rail Anchored to Safety Shape



W-Beam Nested and Steel Post with Rub Rail Anchored to Safety Shape



W-Beam Nested and Wood Post Anchored to Flared Back Safety Shape



Thrie-Beam Nested and Steel or Wood Post Anchored to Tapered Safety Shape

RATING APPROACH RAIL

Approach rail/barrier shields vehicles from roadside hazards. Rail may be classified among the three types, flexible, semi-rigid and rigid, based on how much deflection or rotation occurs when impacted. Examples of flexible rail are w-beam and thrie-beam with "weak" posts. Examples of semi-rigid rail are w-beam and thrie-beam with "strong" posts and offset blocks and timber rail that is steel backed. "Strong" posts may be composed of wood or steel. Offset blocks prevent vehicle snagging and climbing and may be composed of timber or plastic blocks – steel I-shapes are not acceptable. Examples of rigid rail are concrete vertical shapes, concrete safety shapes and masonry. Flexible rail is not preferred. W-beam with "strong" posts (semi-rigid system) is the most commonly used.

i) Rating Procedure

1995 Recording and Coding Guide definition

Code item 36C of the Structure Inventory and Appraisal Form.

0	=	does not meet currently acceptable standard
1	=	meets currently acceptable standard
N	=	safety feature not required

Code N shall seldom be used. An example where N may be used is for box and pipe culverts with side slopes and headwalls far from travel lane such that rail is not required.

Collision damage or deterioration of elements is not considered when coding.

When rating approach rail the following should be checked;

Type: Should be semi-rigid or rigid.

- Flexible - w-beam with "weak" posts, thrie-beam with "weak" posts
- Semi-rigid - w-beam with "strong" posts and offset blocks, thrie-beam with "strong" posts and offset blocks, timber rail that is steel backed
- Rigid - concrete vertical shapes, concrete safety shapes, masonry

Height:

- W-beam - 25" min, 30" max, 27" desired
- Thrie-beam - can be higher than maximum allowed for w-beam
- Concrete and masonry vertical faces - 27" min
- Concrete safety shapes - 29" min

Post Spacing: 6'-3" maximum. If a post is missing because of obstructions (drop inlets, storm pipes, etc.) the rail must be stiffened. Up to two posts may be left out if an additional w-beam or thrie-beam rail is nested inside the normal rail. The additional rail must extend to at least the second post on each side of the gap. Stiffening may also be needed when rigid objects (pole, tree, etc.) are located directly behind the rail. Semi-rigid rails have deflections of about 3' when impacted by heavy cars or pickups at 60 mph. For travel speeds ≥ 45 mph, 3' clearance is required. For travel speeds < 45 mph, 2' clearance is required. The rail can be stiffened by decreasing the post spacing or nesting the rail. A single stiffening system will reduce deflection by 1', two systems will reduce deflection by 1'-6" and three systems will reduce deflection by 2'. An example of three systems is half post spacing and three rails nested.

Post Setback: Timber or plastic offset blocks are required to distance w-beam and thrie-beam from the posts to prevent vehicle snagging on the posts. Steel blocking is not acceptable.

Post Embedment: 4'-6" nominal embedment required. 5'-6" nominal embedment required when in slopes steeper than 4:1 or within 2' of the top of a slope steeper than 4:1. If erosion is affecting the embedment depth it should not enter into the rating, however it should be noted in the inspection report recommendations.

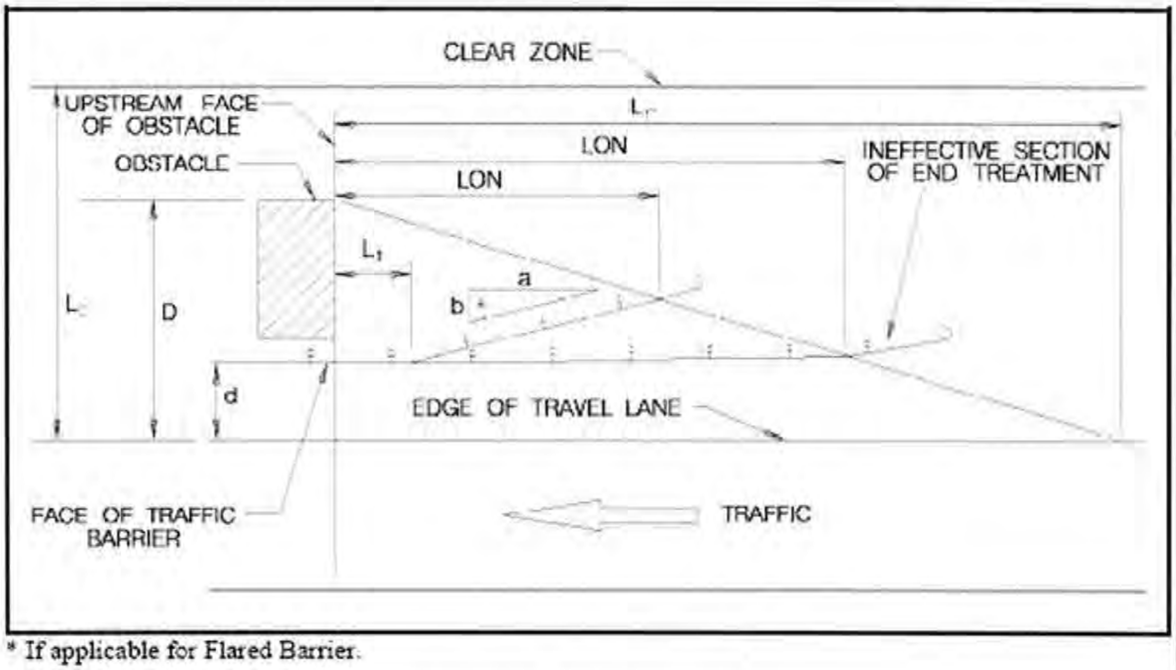
Flare Rate: This is the rate at which a rail is moved away from the roadway. Since rail is crash tested at a specific impact angle, to keep the angle from being more severe than tested, flare rates are limited to the below values.

Maximum Flare Rate		
Travel Speed (mph)	Rigid Rail (concrete)	Semi-Rigid & Flexible Rail (w-beam, thrie-beam, timber)
70	20:1	15:1
60	18:1	14:1
50	14:1	11:1
40	10:1	8:1
30	8:1	7:1

Curb Sections: When curb is used in combination with flexible or semi-rigid rail, if the travel speed is ≥ 35 mph and curb height is > 4" stiffer rail shall be used such as thrie-beam or nested w-beam with rub rail. The face of rail must align with or be in front of the flow line.

Length-of-Need: This is the length of rail needed from the location of the hazard to a required distance upstream. Length is needed in advance of a hazard to develop the full rail strength so a vehicle does not pass through the rail and so vehicles leaving the roadway in advance of the rail which can get behind the rail have adequate distance to stop before the hazard.

The inspector can make a rough determination if the length-of-need does not meet standard by visually checking if it is likely a vehicle can get behind the rail and not come to a stop before reaching the hazard.. For more exact determinations the following guidance can be used.



* If applicable for Flared Barrier.

$$LON = \{L_r * (D - d)\} / D$$

L_r ≡ runout length (refer to below values)
D ≡ distance from edge of travel lane to back of hazard or design clear zone width whichever is less (clear zone values given below)
d ≡ distance from edge of travel lane to face of rail

Runout Length (L_r) in Feet				
Travel Speed (mph)	ADT			
	> 6,000	6,000 – 2,000	2,000 - 800	< 800
70	475	445	395	360
60	425	400	345	330
50	330	300	260	245
40	230	200	180	165
30	165	165	150	130

Travel Speed (mph)	Clear Zone (ft)
≥55	30
54-41	24
≤40	16

RATING END TREATMENTS

End treatments serve two purposes, (1) if hit end-on they minimize injury to vehicle occupants by preventing sudden deceleration and preventing rail/barrier elements from penetrating the occupant compartment and (2) if hit side-on some systems are capable of redirecting a vehicle by developing tension. Systems without sufficient strength (along entire length including the end) to redirect a vehicle are termed breakaway systems. Those with sufficient strength are termed non-breakaway. A breakaway system allows a vehicle to pass through therefore there must be traversable ground behind the treatment and approach rail.

i) Rating Procedure

1995 Recording and Coding Guide definition

Code item 36D of the Structure Inventory and Appraisal Form.

0	=	does not meet currently acceptable standard
1	=	meets currently acceptable standard
N	=	safety feature not required

Code N shall seldom be used. Examples where N may be used include;

- When the approach rail is terminated beyond the required clear zone. Clear zone values measured as distance from edge of travel lane may be taken as;
  - -30' for travel speed ≥ 55 mph,
  - -24' for travel speed between 54 and 41 mph
  - -16' for travel speed ≤ 40 mph
- When the length of approach rail exceeds 400' (any additional rail length is normally not required because of the feature that is bridged over).

Collision damage or deterioration of elements is not considered when coding.

The in-service end treatment should be compared to the included diagrams of crash tested treatments. Each diagram includes requirements regarding the features and roadway types for which it meets standard. Length-of-need requirements may be checked according to the criteria given in this manual's section on approach rail. If the in-service treatment closely matches an included diagram and complies with the stated requirements and appropriate roadway types noted on the diagram, it may be rated as meets standard.

ii) Crash Tested End Treatment Diagrams

Type A (Buried-in-Backslope) Single Rail & Double Rail

How Works: For side-on impacts tensile strength developed by end anchor composed of either a post and plate, concrete block or rock bolts.

Requirements: Rail height shall be constant relative to shoulder until exceeds 45" and then can gradually lower. If grading is steeper than 10:1 utilize double rail or when height exceeds 30" utilize rub rail or double rail. The length-of-need must be provided in advance of the toe of back slope if more gradual than 1:1 because vehicles may climb over the back slope and get behind the rail.

MEETS STANDARD: ALL ROADS

Type B (Modified Flared Breakaway)

How Works: For end-on impacts first two posts fracture allowing rail to bend away (if flare not provided rail too stiff to bend). For side-on impacts tensile strength developed by anchored cable.

Requirements: Grading 10:1 or more gradual in front. 6:1 maximum allowed when located 12 feet or more from outside edge of shoulder. Flared 4 feet from front face of approach rail. Eight wooden breakaway posts. Length-of-need must be provided in advance of the third post from the end. Must be traversable behind rail.

MEETS STANDARD: ALL ROADS

Type C (Parallel Breakaway Extruder)

How Works: For end-on impacts end extruder passes over rail flattening it and bending it into a roll. For side-on impacts tensile strength developed by anchored cable.

Requirements: Grading 10:1 or more gradual in front. 6:1 maximum allowed when located 12 feet or more from outside edge of shoulder. Eight wooden breakaway posts. Length-of-need must be provided in advance of the third post from the end. Must be traversable behind rail.

MEETS STANDARD: ALL ROADS

Type D (Two-Sided Breakaway Attenuating)

How Works: For end-on impacts rail telescopes and posts break away. For side-on impacts tensile strength developed by anchored cable.

Requirements: Grading 10:1 or less in front. 6:1 maximum allowed when located 12 feet or more from outside edge of shoulder. Length-of-need must be provided in advance of the fourth post from the end. Must be traversable behind rail.

MEETS STANDARD: ALL ROADS (PARTICULARLY USED AT MEDIANS AND GORES)

Type E (Two-Sided Non-Breakaway G.R.E.A.T.)

How Works: For end-on impacts rail telescopes, foam cartridges compress and posts temporarily collapse. For side-on impacts tensile strength developed by post leg pins and anchored cable.

Requirements: Grading 10:1 or less in front. Length varies between 5'-9" and 32'-9" depending on travel speed. Full length of end treatment can be included in the length-of-need because is non-breakaway.

MEETS STANDARD: ALL ROADS (PARTICULARLY USED AT MEDIANS, MEDIAN OPENINGS AND GORES)

Type F (Two-Sided Semi-Breakaway Brakemaster)

How Works: For end-on impacts rail telescopes and friction brake cable assembly dissipates energy. For side-on impacts tensile strength developed by an anchor assembly.

Requirements: Grading 10:1 or less in front. 6:1 maximum allowed when located 12 feet or more from outside edge of shoulder. Length-of-need must be provided in advance of the midpoint of the end treatment.

MEETS STANDARD: ALL ROADS (PARTICULARLY USED AT MEDIANS AND GORES)

Type G (Turn-Down)

How Works: For end-on impacts vehicle collapses rail and is slowed down as strikes posts.

Requirements: Flared 6 feet from front face of approach rail. Twist from vertical to horizontal occurs within 39' length. Length-of-need must be provided before begins to turn down. Must be traversable behind rail.

MEETS STANDARD: NON-NHS ROADS WITH TRAVEL SPEED < 40 MPH AND < 10,000 ADT

Type J (Two-Side Non-Breakaway)

Requirements: Grading 10:1 or less in front or 8:1 if paved. Number of cylinders vary between 4 and 9 depending on travel speed. Full length of end treatment can be included in the length-of-need because is non-breakaway.

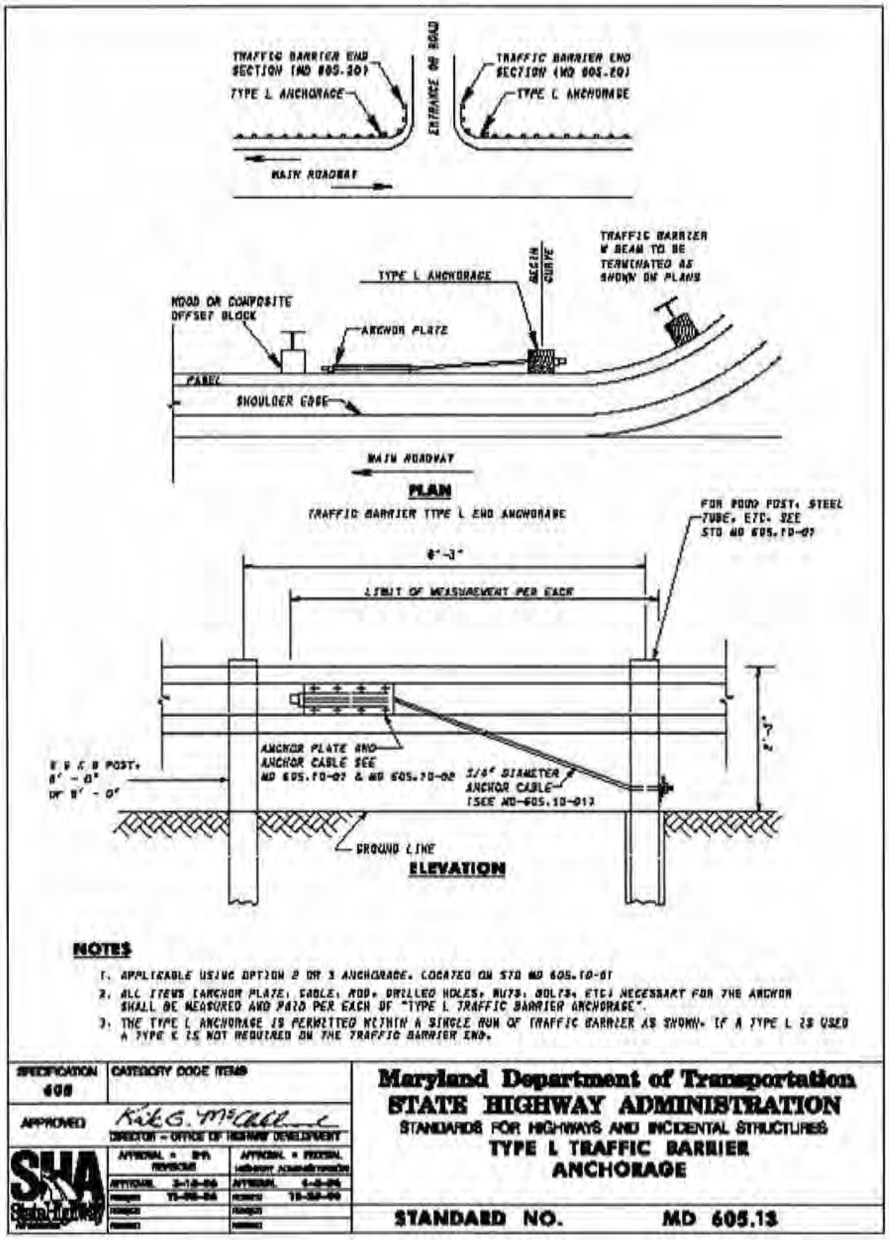
MEETS STANDARD: ALL ROADS (PARTICULARLY USED AT MEDIANS AND GORES)

Type K (Downstream Anchorage)

How Works: Not intended for end-on impacts. For side-on impacts tensile strength developed by anchored cable.

Requirements: Not to be used when opposing traffic within clear zone distance (30' for travel speeds ≥ 55 mph, 24' for 54 to 41 mph and 16' for ≤ 40 mph) to prevent end-on impacts.

MEETS STANDARD: ALL ROADS DOWNSTREAM END ONLY



Type L (Radius Section Anchorage)

How Works: Improves rail strength at radius section of access breaks. Develops tension immediately down stream of the cable attachment.

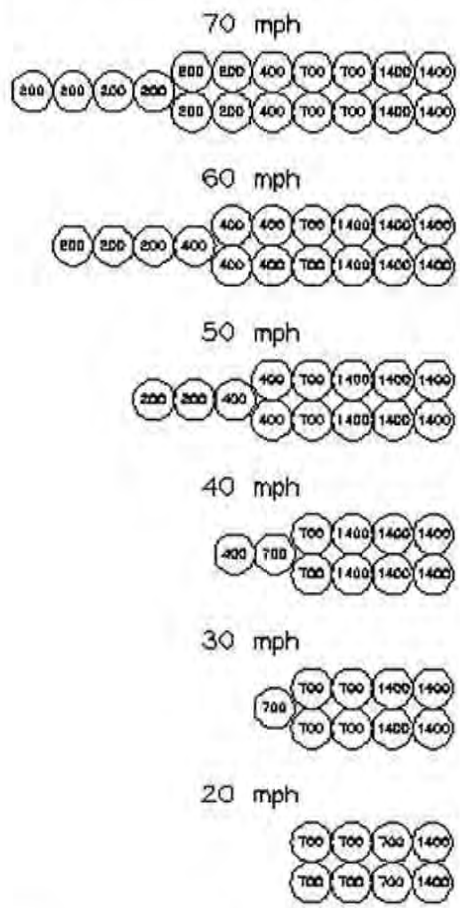
Requirements: Rail should be utilized on main road on both sides of access break to minimize opportunity for perpendicular impacts on radius section. When this anchorage is used at radius sections and the rail is terminated at the end of the radius, a Type K end treatment is not required at the very end. When opposing traffic is within 16' (clear zone value for travel speeds < 40 mph) a Type L should be provided on both radius sections. Length-of-need must be provided in advance of the anchored cable.

MEETS STANDARD: ALL ROADS WITH TRAVEL SPEEDS < 40 MPH

SAND BARREL CRASH CUSHIONS

Typical Configurations
(minor variations acceptable)

Barrel standard sizes are 200, 400, 700, 1,400 and 2,100 lbs however 2,100 seldom used. Combination barrels may be substituted for single barrels if have equal combined weight, for instance one 1,440 lb barrel may be substituted for two 700 lb barrels.



<u>How Works</u>: For end-on impacts transfers momentum to sand. No side-on impact redirection capability.

<u>Requirements</u>: Must be traversable on both sides of cushions. No side-on impact redirection capability. When opposing traffic is within the required clear zone distance (30' for travel speeds ≥ 55 mph, 24' for 54 to 41 mph and 16' for ≤ 40 mph) the rearmost "heavy" cushions shall not be exposed such that an end-on impact can occur.

<u>MEETS STANDARD</u>: ALL ROADS (PARTICULARLY USED AT MEDIANS AND GORES)

DETERMINING IF ADEQUATE CLEAR ZONE EXISTS

There are bridges that currently do not have any type of traffic safety feature present. The majority of these structures are located on backroads and see a relatively small amount of vehicular traffic. It is important for the inspection team to evaluate whether or not traffic safety features are required at such a location during the inspection. In order to determine this, the amount of clear zone present needs to be measured and compared to the chart below. In addition, the NBI Items #36A-D shall be coded according to the procedure below.

i) Rating Procedure

1995 Recording and Coding Guide definition

Code item 36A, B, C & D of the Structure Inventory and Appraisal Form.

0	=	approved traffic safety features do not exist, but are needed
N	=	traffic safety feature not required

ii) Clear Zone Chart

Roadside Design Guide

TABLE 3.1 (Cont'd)

[U.S. Customary Units]

DESIGN SPEED	DESIGN ADT	FORESLOPES			BACKSLOPES		
		1V:6H or flatter	1V:5H TO 1V:4H	1V:3H	1V:3H	1V:5H TO 1V:4H	1V:6H or flatter
40 mph or less	UNDER 750	7 – 10	7 – 10	**	7 – 10	7 – 10	7 – 10
	750 – 1500	10 – 12	12 – 14	**	10 – 12	10 – 12	10 – 12
	1500 – 6000	12 – 14	14 – 16	**	12 – 14	12 – 14	12 – 14
	OVER 6000	14 – 16	16 – 18	**	14 – 16	14 – 16	14 – 16
45–50 mph	UNDER 750	10 – 12	12 – 14	**	8 – 10	8 – 10	10 – 12
	750 – 1500	14 – 16	16 – 20	**	10 – 12	12 – 14	14 – 16
	1500 – 6000	16 – 18	20 – 26	**	12 – 14	14 – 16	16 – 18
	OVER 6000	20 – 22	24 – 28	**	14 – 16	18 – 20	20 – 22
55 mph	UNDER 750	12 – 14	14 – 18	**	8 – 10	10 – 12	10 – 12
	750 – 1500	16 – 18	20 – 24	**	10 – 12	14 – 16	16 – 18
	1500 – 6000	20 – 22	24 – 30	**	14 – 16	16 – 18	20 – 22
	OVER 6000	22 – 24	26 – 32 *	**	16 – 18	20 – 22	22 – 24
60 mph	UNDER 750	16 – 18	20 – 24	**	10 – 12	12 – 14	14 – 16
	750 – 1500	20 – 24	26 – 32 *	**	12 – 14	16 – 18	20 – 22
	1500 – 6000	26 – 30	32 – 40 *	**	14 – 18	18 – 22	24 – 26
	OVER 6000	30 – 32 *	36 – 44 *	**	20 – 22	24 – 26	26 – 28
65–70 mph	UNDER 750	18 – 20	20 – 26	**	10 – 12	14 – 16	14 – 16
	750 – 1500	24 – 26	28 – 36 *	**	12 – 16	18 – 20	20 – 22
	1500 – 6000	28 – 32 *	34 – 42 *	**	16 – 20	22 – 24	26 – 28
	OVER 6000	30 – 34 *	38 – 46 *	**	22 – 24	26 – 30	28 – 30

* Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by cras history, the designer may provide clear-zone distances greater than the clear-zone shown in Table 3.1. Clear zones may be limited t 30 ft for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicate satisfactory performance.

** Since recovery is less likely on the unshielded, traversable 1V:3H slopes, fixed objects should not be present in the vicinity of the to of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond th toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-wa availability, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of th through traveled lane and the beginning of the 1V:3H slope should influence the recovery area provided at the toe of slope. While th application may be limited by several factors, the foreslope parameters which may enter into determining a maximum desirabl recovery area are illustrated in Figure 3.2.

C-256

Appendix C.7

Crash Testing of Bridge Railings

Subject: ACTION: Crash Testing of Bridge Railings May 30, 1997

From: Chief, Federal-Aid and Design Division

To: Regional Administrators
Federal Lands Highway Program Administrator

On August 28, 1986 and on August 13, 1990, the Office of Engineering sent you listings of bridge railing designs that were considered acceptable for use on Federal-aid projects by virtue of their crash test performance. As noted in the transmittal memoranda, some of these railings had been tested under the National Cooperative Highway Research Program (NCHRP) Report 230 and some under the 1989 "AASHTO Guide Specifications for Bridge Railings". Since the FHWA has now adopted NCHRP Report 350 as the guideline for testing all roadside hardware, including bridge railings, we reviewed these listings and assigned each railing on the lists a rating that we consider approximately equivalent to one of the six test levels suggested in NCHRP Report 350. These "equivalency" listings, along with a third listing which identified additional bridge railings tested after the 1990 memorandum, were included in a paper we presented to the AASHTO Highway Subcommittee on Bridges and Structures on May 14, 1996. A copy of this position paper, without the originally accompanying lists, is attached for your reference.

Also attached are revised copies of the three lists with sketches for each cited design. We have added several additional railings to the third list. Please note that those railings which were specifically tested to NCHRP Report 350 criteria are now identified in bold type, whereas those assigned an equivalent test level based on earlier testing guidelines are shown in regular type. The equivalent test levels are conservative and may be subject to further evaluation in some cases as additional NCHRP Report 350 tests are run on these railings or on similar systems.

Recognizing that these lists are not rationally organized and that the quality of many of the accompanying sketches is poor, we wish to consolidate and reorganize the three lists into a single list and provide a drawing of each bridge rail that is similar in detail to the drawings in the AASHTO-AGC-ARTBA "Guide for Standardized Highway Barrier Hardware" (SB-series drawings). To aid us in this effort we would appreciate your doing the following:

- Tell us which States within your region are currently using which of the railing designs identified on the three lists.

- Provide us with a set of drawings of each of the railings on the lists that are used in your Region. Where there are duplications or slight variations of nominally the same railing used by different agencies, only one drawing for that type of railing need be sent. However, we would appreciate a brief verbal description of any differences and an assessment of their significance.

- Tell us of any railings <u>not</u> on one of the lists that any State within your Region plans to use on the NHS after September 30, 1998. We would also appreciate receiving drawings of these railings and information on any crash tests that have been run on these designs.

Information on railings developed and tested for use on Federal Lands Highways will be requested from that office.

Responses by July 15 would be appreciated. When we have received the requested information, a consolidated listing with drawings will be sent to each field office, and we will keep this listing current as additional designs are tested. Please address any questions regarding this effort to Mr. Richard Powers at (202) 366-1320.

(original signed by Dwight A. Horne)

Dwight A. Horne

4 Attachments

BRIDGE RAILING DESIGN AND TESTING

A Discussion with the
AASHTO Highway Subcommittee on Bridges and Structures
Technical Committee (T-7) for Guardrail and Bridge Rail

May 14, 1996

Until the late 1980's, designers relied on precedent, the information contained in the most recent edition of the AASHTO "Standard Specifications for Highway Bridges", and their judgement to design a bridge railing appropriate for a given site. The Standard Specifications, as they still do, called for the application of a 10-Kip static load at key locations on the railing as well as some dimensional requirements for the openings between rail elements and other cross section geometry. Full-scale crash testing was not required, although a design that "passed" crash testing could be used even if it did not meet the static loading and/or geometric design criteria. The test requirements generally accepted by highway agencies at the time were contained in the National Cooperative Highway Research Program (NCHRP) Report 230, "Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances," 1981. (Two earlier publications with this title, NCHRP Report 153,1974, and Transportation Research Circular Number 191, 1978, and the Highway Research Board publication, Highway Research Correlation Service Circular 482, "Proposed Full-Scale Testing Procedures for Guardrails," 1962, also provided testing guidance.)

In the late 1970's and early 1980's, actual tests were run on several commonly-used railings that had been designed under the static loading procedures. The results were unexpected: several of the railings failed quite dramatically and it was shown that static design loadings were not sufficient to ensure adequate railing performance. As a result of these findings, Mr. R.D. Morgan , FHWA's Executive Director , issued a policy memorandum on August 28, 1986, that stated that railings on bridges on Federal-aid projects must be (or have been) crash tested and meet the acceptance criteria in NCHRP Report 230 or equivalent acceptance procedures. Included with that memorandum was a list of 22 railings that were considered crashworthy based on previous testing.

In 1989 AASHTO published its "Guide Specifications for Bridge Railings", a document that not only specified tests to be run, but categorized them into three separate performance levels. This publication also included a selection procedure for determining an appropriate performance level for a given site. The crash test matrix included in the Guide Specifications differed in several areas from the NCHRP Report 230 test matrices, and its use by State highway agencies was (and remains) optional.

On August 13, 1990, the FHWA issued a second memorandum listing 25 additional railings that had met the requirements in NCHRP Report 230 or one of the performance levels in the AASHTO Guide Specifications. This memorandum also stated that the FHWA considered any railing that was acceptable based on NCHRP Report 230 testing could also be considered acceptable at least as a PL-1

railing as described in the Guide Specifications. In addition, it indicated that any SL-1 railing (as developed by Southwest Research Institute and reported in NCHRP Report 239, "Multiple-Service-Level Highway Bridge Railing Selection Procedures", November 1981) could also be considered equivalent to a PL-1 railing.

NCHRP Report 230 was superseded by NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features", in 1993. This document includes six different Test Levels, all of which differ in some ways from the previous Report 230 basic test matrix as well as from the Performance Levels contained in the Guide Specifications. No selection procedures for the use of a specific test level are included in Report 350. And finally, to add to the conflicting guidance for selecting an appropriate bridge railing, AASHTO issued its 1994 "LRFD [Load and Resistance Factor Design] Bridge Design Specifications"as an alternate to the long-standing "Standard Specifications for Highway Bridges". Section 13 of the new publication contains recommendations on railing designs and a crash test matrix that differs from NCHRP Report 350 and the AASHTO Guide Specifications.

FHWA's current position can be summarized as follows:

- All bridge railings installed on NHS projects let to contract after August 16, 1998, shall meet the acceptance criteria contained in NCHRP Report 350 or an FHWA recognized successor to those criteria. The minimum acceptable bridge railing will be a TL-3 (MSL-2 until August 1998) unless supported by a rational selection procedure. Acceptability under NCHRP Report 350 and a rational selection procedure are defined below.

- Railings that have been found acceptable under the crash testing and acceptance criteria in NCHRP Report 230, the AASHTO Guide Specifications for Bridge Railings, or the AASHTO LRFD Bridge Design Specifications will be considered as meeting the requirements of NCHRP Report 350 without further testing as indicated in the following table.

RAILING LEVEL EQUIVALENCY TABLE

BRIDGE RAILING TESTING CRITERIA	ACCEPTANCE EQUIVALENCIES					
NCHRP Report 350	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6
NCHRP Report 230		MSL-1 MSL-2*		MSL-3		
AASHTO Guide Specifications		PL-1		PL-2	PL-3	

AASHTO LRFD Bridge Specifications		PL-1		PL-2	PL-3	

* This is the performance level usually cited when describing a barrier as tested under NCHRP Report 230. It is close to a TL-3 but adequate TL-3 performance cannot be assured without a pickup truck test.

- o The FHWA strongly suggests that the AASHTO adopt the test level definitions in NCHRP Report 350.
- o The FHWA strongly recommends that all future testing of bridge railings be conducted in accordance with the recommendations in Report 350 or an FHWA-recognized successor to Report 350.
- o The FHWA strongly encourages the AASHTO to support the ongoing NCHRP efforts to develop railing level selection procedures and, after appropriate review and, if needed, adjustment, adopt railing level selection procedures.
- o Until the AASHTO adopts a new railing level selection procedure the FHWA will accept the procedures in the "Guide Specifications for Bridge Railings" or a rational, experience-based, cost-beneficial, consistently-applied procedure proposed by a State.
- o Exceptions to the items in this position, which are expected to be rare, will be considered on their merits on a case-by-case basis.

Attached is a list of the railings that are considered acceptable under the guidelines in NCHRP Report 350 or the presumed equivalent guidelines indicated in the Railing Level Equivalency Table. This list will be supplemented with sketches of each railing soon. Omission of a railing from this list may be the result of an oversight or a judgement that a particular railing is unlikely to be used. Therefore, the list should not be considered all-inclusive. As is currently the case, any railing that is essentially the same as one that was successfully tested, even though not identical, may often be considered acceptable as well.

J. H. Hatton
FHWA HNG-10
7 May 96

EQUIVALENT TEST LEVELS FOR CRASH-TESTED BRIDGE RAILINGS - PART 1

1-1	NCHRP 239 SL-1 Thrie beam, wood posts	TL-2
1-2	NCHRP 239 SL-1 Thrie beam, steel posts	TL-2
1-3	Texas Type 6 (tubular w-beam)	TL-2
1-4	Aluminum Tru-beam (modified AASHTO BR5)	TL-2
1-5	AASHTO BR2 (California Type 9)	TL-2
1-6	Ohio Box Beam Rail (w-beam backed with box beam)	TL-2
1-7	Modified Kansas Corral (open concrete beam and post)	TL-2
1-8	Oklahoma Modified TR-1 (open concrete beam and post)	TL-2
1-9	Oregon 2-Tube Curb-Mounted Rail	TL-2
1-10	North Carolina Standard 1 Bar Metal Rail	TL-2
1-11	Texas T101 Bridge Rail	TL-3
1-12	Nebraska Tubular Thrie Beam	TL-3
1-13	California Type 20 (NJ Safety Shape with Rail)	TL-3
1-14	Nevada Safety Shape Parapet (NJ Shape with Rail)	TL-3
1-15	New Jersey Concrete Safety Shape	TL-4
1-16	F Profile Concrete Safety Shape	TL-4
1-17	NJ Turnpike Heavy Vehicle Barrier	TL-5
1-18	Texas T5 Modified	TL-6

EQUIVALENT TEST LEVELS FOR CRASH-TESTED BRIDGE RAILINGS - PART 2

2-1	Oregon Side-Mounted Thrie Beam	TL-2
2-2	Texas T202 Concrete Beam and Post	TL-2
2-3	Federal Lands Modified Kansas Corral	TL-2
2-4	Nebraska Concrete Beam and Post	TL-2
2-5	Iowa Concrete Beam and Post	TL-2
2-6	California Type 115	TL-2
2-7	Washington 10 gage Thrie Beam Retrofit	TL-2
2-8	California Thrie Beam	TL-2
2-9	Glu-Lam Wood Rail on Timber Deck	TL-2
2-10	Texas 411 Aesthetic Concrete Baluster	TL-2
2-11	Texas T421 Aesthetic Steel Pipe Bridge Rail	TL-2
2-12	Aesthetic Stone Masonry-Faced Concrete	TL-3
2-13	Missouri Thrie Beam and Channel	TL-3
2-14	Wyoming Curb-Mounted 2-Tube (Two Designs)	**TL-3**
	(see Acceptance letter B-37)	**TL-4**
2-15	Michigan 10 gage Retrofit on curb/sidewalk	TL-4
2-16	Iowa Concrete Block Retrofit	TL-4
2-17	32-in Vertical Concrete Parapet	TL-4
2-18	Pre-cast NJ or F-Shape bolted to deck (see Acceptance letters B-5 and B-5A)	TL-4
2-19	Illinois 2399 2-Rail on Curb	TL-4
2-20	42-in Vertical Concrete Parapet	TL-5
2-21	42-in F Shape Concrete Barrier	TL-5
2-22	Texas Type HT (Modified T5)	TL-5
2-23	Modified Texas C202 Bridge Rail	TL-5

Attachment 3

EQUIVALENT TEST LEVELS FOR CRASH-TESTED BRIDGE RAILINGS - PART 3

Railings for Timber Bridges:

3-1	Timber rail-System 1	TL-2
3-2	Timber rail-System 2	TL-2
3-3	Timber rail-System 3	TL-2
3-4	Steel System-Thrie beam on steel posts	TL-2
3-5	Curb System- Glu-Lam timber rail w/ curb	TL-2
3-6	Shoe Box System-Glu-Lam rail w/out curb	TL-2
3-7	TBC-8000-Thrie-beam w/ stiffened steel posts	TL-4
3-8	**GC-8000 Glu-Lam timber rail w/ curb** **TL-4** (see Acceptance letter B-31 for 3-4 through 3-8 designs)	

Railings for Concrete Bridges:

3-9	Texas C411 42" Concrete Baluster Rail	TL-2
3-10	BW Parkway Smooth Stone Bridge Rail	TL-2
3-11	West Virginia W-beam Retrofit Railing for Concrete Baluster designs	TL-2
3-12	Foothills Parkway Aluminum Bridge Rail	TL-2
3-13	GW Parkway Steel Tri-Rail on curb	TL-2
3-14	Natchez Trace Concrete Bridgerail (post and beam)	TL-2
3-15	Washington, D. C. Historic Bridgerail (curb-mounted retrofit)	TL-2
3-16	BR27D-two steel rails on 18" concrete parapet w/ curb and sidewalk	TL-2
3-17	BR27D-flush-mounted	TL-2
3-18	BR27C-single steel rail on 24" concrete parapet w/ curb and sidewalk	TL-4
3-19	BR27C-flush-mounted	TL-4
3-20	Nebraska Open Concrete Bridgerail (modified from earlier TL-2 design)	TL-4
3-21	Missouri 30" NJ Concrete Barrier (to test effect of 3" overlay on standard height)	TL-4
3-22	Illinois Side-mounted railing	TL-4
3-23	New England Transportation Consortium (NETC) 2-rail curb-mounted railing (see Acceptance letter B-50)	TL-4
3-24	Delaware Thrie-beam Retrofit Railing (curb-mounted)	TL-4
3-25	**Wyoming 2-tube steel railing on curb** (see Acceptance letter B-37)	**TL-4**
3-26	**Minnesota Combination Bridge Rail**	**TL-4**
3-27	Single Slope Concrete Bridge Rail (see Acceptance letter B-45A)	TL-4