Next Generation Bridge Management Tools and Inspection

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The objectives of this research were twofold. The first objective was to identify the needs for the inspection methodology, manuals, training, and the timetable needed for all bridge owners to start collecting element-level bridge inspection data. The second objective was to identify how to incorporate this new inspection methodology into the rich reporting tools and performance measures that the Minnesota Department of Transportation (MnDOT) uses for determining the bridge projects in the annual program.

Working with the MnDOT Bridge Office, the research team identified the necessary changes to the bridge inspection elements that would both ensure MnDOT conforms to the new American Association of State Highway and Transportation Officials (AASHTO) Guide Manual for Bridge Element Inspection and provide the necessary data for the agency’s bridge management process. The changes needed for MnDOT’s Bridge Replacement and Improvement Management (BRIM) were also identified working with the MnDOT Bridge Office.</td></tr>
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Executive Summary

The latest transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21), focuses on performance-based management for bridge structures. The Federal Highway Administration (FHWA) is currently updating the *Recording and Coding Guide* and incorporating element-level bridge inspection data into the National Bridge Inventory (NBI). The element-level bridge inspection data are referred to as the National Bridge Elements (NBEs) in the American Association of State Highway and Transportation Officials (AASHTO) *Guide Manual for Bridge Element Inspection*.

These changes affect all bridge owners in the states. The Minnesota Department of Transportation (MnDOT) needs to build on the existing tools and methodology to incorporate element-level bridge inspection data and bridge management system (BMS) programming tools to conform to the current legislation and advance current bridge management efforts.

The objectives of the research were twofold. The first objective was to identify the needs for the inspection methodology, manuals, training, and the timetable needed for all bridge owners to start collecting element-level bridge inspection data. The second objective was to identify how to incorporate this new inspection methodology into the rich reporting tools and performance measures that MnDOT uses for determining the bridge projects in the annual program.

Working with the MnDOT Bridge Office, the research team identified the necessary changes to the bridge inspection elements that would both ensure MnDOT conforms to the new *AASHTO Guide Manual for Bridge Element Inspection* and provide the necessary data for the agency's bridge management process.

The changes needed for MnDOT's Bridge Replacement and Improvement Management (BRIM) tool were also identified working with the MnDOT Bridge Office. The recommendations for the BRIM tool make it compatible with the AASHTO 2014 Elements and reflect MnDOT's current approach in project prioritization.

The mapping of current MnDOT elements to the AASHTO 2014 Elements helped MnDOT with the migration of the last set of element inspections that were done with the AASHTO CoRe (Commonly Recognized) Elements. The migrated dataset will provide the bridge inspectors with a starting point as they start using the AASHTO 2014 Elements and provide consistency in the data.

The project also gave MnDOT the chance to thoroughly review its element inspection framework and streamline the list of bridge elements as it sees fit for an improved methodology.

The implementation of the findings will ensure that MnDOT's bridge management data and tools are ready for the MAP-21 requirements regarding bridge management and compatible with the next generation AASHTOWare Bridge Management System.

Chapter 1: Introduction

The Moving Ahead for Progress in the 21st Century Act (MAP-21), signed into law on July 6, 2012, requires State and Federal agencies to begin collecting element-level data. For agencies such as the Minnesota Department of Transportation (MnDOT) that have been collecting element-level data for their bridges, the major change is adapting the new American Association of State Highway and Transportation Officials (AASHTO) Guide Manual for Bridge Element Inspection. This new manual replaces AASHTO's CoRe elements, introduces a new, defect-based inspection methodology with four condition states for all elements, and separates wearing surfaces and protection systems from structural elements.

The first edition of the manual was published in 2011 (AASHTO 2011). A set of revisions were approved by the AASHTO Subcommittee on Bridges and Structures (SCOBS) in June 2013. The revised manual was published as the Manual for Bridge Element Inspection in late 2013 (AASHTO 2013) and any necessary changes were incorporated during this project. In 2014, a set of final revisions were provided by AASHTO (AASHTO 2014). The project team incorporated the changes as they were published. The new AASHTO elements in this report will be identified as "AASHTO 2014" elements while the previous elements will be identified as "AASHTO CoRe" elements.

The purpose of this project was to ensure a seamless transition of the MnDOT bridge inspection program and decision making framework as they implement the new AASHTO Guide Manual for Bridge Element Inspection. The project team worked with the MnDOT Bridges and Structures Office staff on identifying the needs for the agency's bridge inspection program and changes to the performance measures and decision-making tools for their bridge program. This report presents project findings by task, as follows.

Task 1: Review of MnDOT inspection methodology and bridge management tools. The research team reviewed the current MnDOT inspection methodology, manuals, and tools, including the Bridge and Structure Information Management System (SIMS) and Bridge Replacement and Improvement Management (BRIM), for the necessary background and insight to address the remaining project tasks regarding agency practices. Chapter 2 of this report presents findings from this task.

Task 2: Identification of the necessary changes to the MnDOT inspection methodology to adapt the new AASHTO bridge elements and development of a strategic plan to complete the transition. The research team reviewed the latest guidance from the Federal Highway Administration (FHWA) and the AASHTO Guide Manual for Bridge Element Inspection. The requirements and guidance were compared with MnDOT's inspection practices and guidelines. The research team then identified and documented the necessary changes to the inspection manual to adapt the new National Bridge Elements (NBEs), Bridge Management Elements (BMEs), and Agency Developed Elements (ADEs) in Minnesota. A meeting with the technical advisory panel (TAP) solicited their input and feedback. A final list of changes needed by MnDOT to incorporate the new AASHTO bridge elements into their bridge inspections was then provided to the TAP. Chapter 3 presents findings from Tasks 2 and 3.

Task 3: Identification of the impact of the new inspection methodology on the current MnDOT bridge management practice and development of a plan for how to incorporate the new inspection methodology to MnDOT bridge management. The MnDOT Bridge Office has a rich set of reporting tools and performance measures that are used for developing the annual bridge program. During this task, the research team reviewed current tools and performance measures to identify how the new inspection methodology will affect these reporting tools and performance measures. The research team developed a document that covers the impact and anticipated changes for the reporting tools and performance measures. After another meeting with the TAP, the research team finalized the recommendations based on the input and discussions from the meeting. Chapter 3 presents findings from Tasks 2 and 3.

Task 4: Establish guidelines for all bridge owners to adopt the new inspection methodology. The research team developed a set of recommendations for both state and local agencies for MnDOT to implement the new AASHTO Bridge Elements. The recommendations are presented in Chapter 4.

Chapter 2: Review of MnDOT Inspection Methodology and Bridge Management Tools

Important dates and notes from the FHWA on the new element inspection submittal are presented in Figure 1.

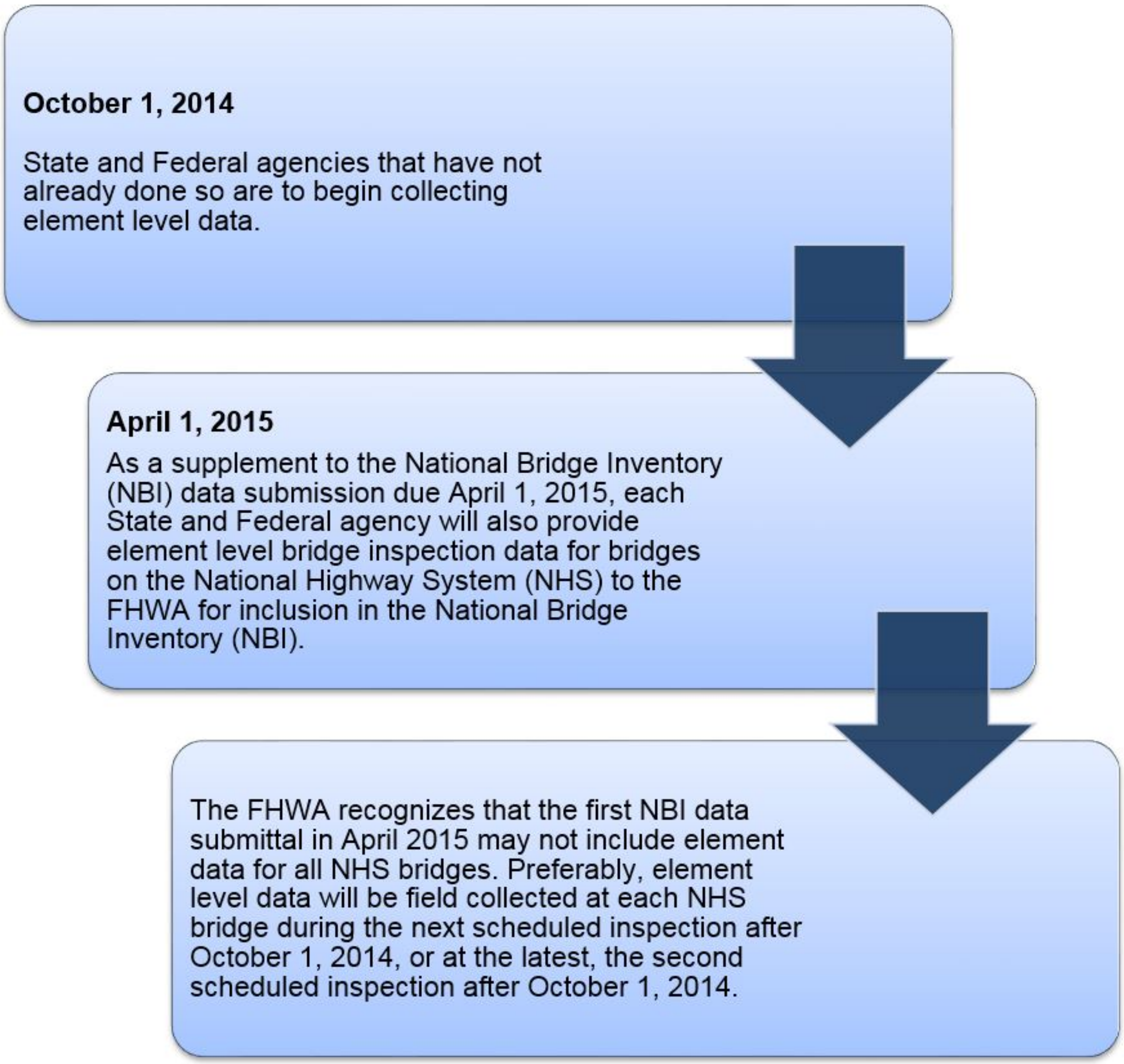

Figure 1: Important Dates for the New Element Inspection Submittal

The FHWA is also working on a new Recording and Coding Guide that incorporates the element inspection methodology of the AASHTO Guide Manual for Bridge Element Inspection. There is yet no set date on when this guide will be available.

For Task1, the project team reviewed a set of documents provided by MnDOT to become acquainted with MnDOT bridge inspection and management practices. This report includes general notes on these documents, which we believed were critical for the tasks that followed and completion of the project. The intent behind this task was to both familiarize the project team with MnDOT bridge inspection and management practices and start the internal dialogue among MnDOT Bridge Office staff on our notes and suggestions. We emphasize major changes in element-level inspection as related to each document.

2.1 Documents Reviewed

For Task 1, the MnDOT Bridge Data Management supervisor, Thomas Martin, provided the project team with relevant documents for review. Each document is briefly discussed below with information pertaining to the project.

2.1.1 Bridge Inspection Field Manual

This document will be the focus point of this work and the recommendations that the project team provides. The changes necessary for MnDOT performance measures and reporting tools will be majorly due to the changes in element-level inspections.

For Task 1, a general review of the document was done and the findings are presented in this chapter. The manual covers all in-service bridges in Minnesota. Task 2 of this project included a thorough review of the field manual and identification of necessary changes to the manual to adopt the AASHTO 2014 elements. The project team reviewed how individual bridge elements in the field manual compare to the new elements. The findings from Task 2 are provided in Chapter 3 of this report.

2.1.1.1 Section 2: NBI Condition Ratings

Section 2 of this manual covers mostly National Bridge Inventory (NBI) data items and some related MnDOT-specific data items, such as unsound wearing surface percentage and unsound paint percentage.

The AASHTO Manual separates wearing surfaces from structural deck elements and paint (as steel protective coating, #515) from steel elements. Historical records of “unsound wearing surface percentage” can be used to set the total of condition states 2 and 3 for the AASHTO #510 wearing surfaces element. However, details of severity and type of defect are needed for a complete inspection record with AASHTO elements. “Unsound paint percentage,” as defined in the MnDOT inspection manual, applies to condition state 4 of the AASHTO #515 steel protective coating. However, #510 is an element-level data item while the MnDOT unsound paint percentage is a bridge-level data item.

Once AASHTO wearing surface and steel protective system elements are implemented by MnDOT, unsound wearing surface and paint percentage data items will become redundant. These may be removed from the next version of the manual. There may be additional changes to this section based on the expected FHWA Recording and Coding Guide.

2.1.2 MnDOT Inspection Report

This is the inspection form that MnDOT inspectors use during field inspection. This form will need to lose the CONDITION STATE 5 column unless there will be ADEs that must have 5 condition states (not recommended). Also, wearing surfaces, protective systems, and defects are sub-elements to major elements. The new inspection methodology supports a hierarchical framework and there are parent, child, and grandchild relationships. The form design should accommodate this new framework.

2.1.3 MnDOT Bridge Inspection Best Practices

This document contains guidance on inspector certification, training, inspection equipment, frequency, and quality. In general, few changes would be needed for this document because it is more related to NBI data items. However, this is, again, a document that will need review once the FHWA guidance is available.

Part of this document includes training. The FHWA Resource Center has developed training titled Introduction to Element-level Bridge Inspection (ELBI) based on material in the AASHTO Guide Manual for Bridge Element Inspection. The target audience is Federal, State, and local highway agency employees and consultants involved in inspecting bridges or in charge of a bridge inspection unit. The FHWA Resource Center can tailor the training to specific agency needs for one- to two-day training sessions. This course may be added to the list of courses needed for inspection certification levels. We also suggest the key bridge inspection staff at MnDOT take this training soon before finishing the changes to the inspection manual and identifying training needs.

The NBI/Element Ratings section may change pending guidance from the FHWA. The references to inspection manuals and policies will also need to be updated once those documents are updated.

2.1.4 Deficient Status Decoder

This document needs to be reviewed once FHWA guidance is available.

2.1.5 Scour CODE FHWA & MNDOT

No change is necessary.

2.1.6 Pontis User Manual and Data Dictionary

AASHTO 2014 elements will be fully supported for AASHTOWare Bridge Management Software 5.2.2. As the documentation for 5.2.2 becomes available, MnDOT may prefer to develop a similar data dictionary. The technical manual for the software should cover data items aside from the agency tables. Major agency tables MnDOT has within the Pontis (previous name of AASHTOWare BrM) database are MNDOT_RDWY, MNDOT_BRDGE, and MNDOT_INSP. These tables support agency analysis and reporting and will be carried over to the 5.2.2 schema. When the 5.2.2 schema is available, MnDOT would do a comparison of agency fields versus new data fields in 5.2.2 to avoid any data redundancy.

2.1.6.1 Section 3: Structural Element Condition Ratings

Section 3 of the manual covers structural element condition ratings, which includes CoRe elements as well as elements added by MnDOT.

The MnDOT Bridge Inspection Manual divides structural elements into five groups by structural function:

- Deck Elements (decks, slabs, railings, and expansion joints)
- Superstructure Elements (girders, beams, arches, trusses, and bearings)
- Substructure Elements (abutments, wingwalls, pilings, columns, pier caps, and pier walls)
- Culvert Elements (culverts and culvert headwalls/wingwalls)
- Miscellaneous Elements ("smart flags" and miscellaneous bridge elements)

These elements fit under three general AASHTO 2014 element categories: National Bridge Elements (NBEs), Bridge Management Elements (BMEs), and Agency Developed Elements (ADEs). Structural elements such as decks/slabs, girders, abutments, and pier walls are NBEs. Bridge railings and bearings are also NBEs. Approach slabs, joints, and protective systems are major BME categories for AASHTO elements. BMEs are not mandatory for NBI data submittal; however, the FHWA is planning to also collect element-level data for joints, wearing surfaces, and protective systems in the future. AASHTO protective systems elements, such as paint or overlays, are not separate elements for MnDOT, but they are elements uniquely identified based on their protective systems. An example would be deck elements with varying overlays and additional protection systems.

One effort in future tasks (especially Task 2) was to group these CoRe/MnDOT elements into AASHTO 2014 elements as they fit into MnDOT bridge inspection and management policies. For example, AASHTO element #510 covers all deck/slab overlays. MnDOT may prefer to have several BMEs for wearing surfaces to differentiate between low slump, epoxy, or bituminous overlays.

Wingwalls are not separate AASHTO elements and are included in AASHTO abutments (as NBEs). MnDOT may prefer to have a separate wingwall element that rolls into abutments. The decision should be based on what MnDOT would like to track for wingwalls (e.g., separate deterioration/cost models or maintenance needs). Also, the MnDOT wingwall element is in each unit; whereas, AASHTO abutments include wingwall width in lineal feet. This is discussed further in Chapter 3.

CoRe smart flags no longer exist in the AASHTO elements. AASHTO defect flags replace smart flags and expand flags to all possible defects that can be attributed to elements. This framework will support multi-path deterioration models proposed for the AASHTOWare Bridge Management Software (BMS) versions 5.2.x (formerly Pontis BMS) used by MnDOT.

One major change that will need to be addressed is the separation of paint (or other protective systems) from steel elements. AASHTO element #515 is steel protective coating, which covers all "protective coatings for steel elements such as paint, galvanization, weathering steel patina, or other top coat steel corrosion inhibitor" (AASHTO 2011). Again, MnDOT may prefer to have several BMEs to track/model different materials. Also, #515 is measured in surface units (sq ft). MnDOT may leave it to the inspectors to calculate paint quantities in the field or go with an approach to enter quantities from bridge plans beforehand. Regardless, a methodology is needed. This issue will need to be included in the training as well.

CoRe elements are rated on a scale of three, four, or five condition states. AASHTO NBEs and BMEs are both four- condition states only. Some CoRe elements with four condition states transition smoothly to new AASHTO elements. For remaining elements, mapping CoRe condition states to AASHTO condition states perfectly is not quite possible due to the changes in the methodology. However, AASHTO has a stand-alone migrator for this purpose. Additional migrator rules will be needed for MnDOT-specific elements (additional BMEs and ADEs).

The project team provided recommendations on additional migrator rules for MnDOT as part of Task 3, in order to transfer historic condition data to the new inspection methodology as sufficiently as possible.

2.1.7 Bridge Maintenance Manual

The bridge maintenance manual includes information and details for preventive and reactive bridge maintenance activities performed by MnDOT bridge maintenance crews. The manual also includes general information on inspection, data recording and asset management. Since the Districts have the responsibility for both bridge inspection and maintenance, the data needs for the maintenance and inspection framework are interconnected. Maintenance tasks are assigned within SIMS to bridge elements based on conditions documented during safety inspections and maintenance assessments. The input provided by MnDOT's maintenance engineer was critical for Task 2 since the bridge elements should tally with the data items that are used by the maintenance crews. References to Pontis, the AASHTO Manual, and Pontis reports within this manual will need to be updated following the conversion process.

2.1.8 Bridge Maintenance Source Code Guide for BI

This document lists maintenance activities that are performed by MnDOT bridge maintenance crews with references to the associated element numbers when applicable. The element numbers listed in this document will need to be updated once the MnDOT AASHTO element numbers are finalized.

2.1.9 BRIM v1.13 and Bridge Improvement Cost Report

MnDOT's BRIM is an agency tool that provides bridge-level replacement and rehabilitation recommendations. The tool makes use of both NBI condition ratings and some element condition data together with other bridge characteristics (e.g., year of construction, average daily traffic/ADT).

The project team was provided with an Excel file with District 7 data for this task, along with a demonstration of the tool for one bridge. The tool calculates a Bridge Planning Index (BPI) that represents the probability of a service interruption based on eight resilience factors: deck, superstructure, and substructure condition; scour; fracture critical; fatigue; load rating; and vertical clearance. BPI also includes the consequence of the service interruption with the importance factor portion of the calculation. Resilience factors have different weights. Each resilience factor is calculated based on an individual scale (see Figure 2), which is reduced by smart flags when applicable. Resilience factors are then combined into the overall BPI.

		DECK CONDITION					
		Smart flag reduction					
NBI Condition		None	1	2	3	4	5
N	Not applicable	100	100	100	100	100	100
9	Excellent	100	100	95	95	85	85
8	Very good	95	95	90	90	80	80
7	Good	90	90	85	85	75	75
6	Satisfactory	75	75	70	70	55	55
5	Fair	55	55	50	50	35	35
4	Poor	35	35	30	30	20	20
3	Serious	20	20	15	15	10	10
2	Critical	10	10	5	5	0	0
1	Imminent fail	5	5	5	5	0	0
0	Failed	0	0	0	0	0	0

Smart flag reduction:
Use worst condition state of smart flags:
358: Concrete deck cracking
359: Deck soffit

Figure 2: Scale for Deck Condition Resilience Factor

Major changes that affect the tool are separation of wearing surfaces, separation of protection systems, and replacement of smart flags with defects. Some MnDOT elements, such as painted and unpainted gusset plate, will also be updated. Steel gusset plates are now NBEs with a separate paint element. Instead of having one scale for deck condition, MnDOT may prefer to have a scale for wearing surfaces and a scale for the structural deck element, with updated valid actions per element.

The bridge replacement and rehabilitation grid will also need an update since the categorization of valid actions depend heavily on traffic and deck condition. Since element-level paint areas will be available with AASHTO 2014 elements, the paint quantity and cost calculations within BRIM can be adjusted accordingly, if preferred. CoRe smart flags used in BRIM are now replaced with AASHTO defects. The final listing of MnDOT defect elements and how they compare to smart flags are included in Appendix A.

Chapter 3: Changes to the MnDOT Inspection Methodology

3.1 Introduction

The previous chapter included an introduction to the changes to the bridge elements that were to be implemented by MnDOT to adopt the new AASHTO Manual for Bridge Element Inspection (AASHTO 2013). In this chapter, the descriptions of the changes for the element categories are completed. A final list of MnDOT Bridge Elements that are currently in the inspection manual are matched to future adopted elements, as included in the current draft inspection manual and compatible with AASHTO 2014 elements, is included as Appendix A.

The migration effort, which is transferring the last inspection data in the old system to the AASHTO 2014 elements in the new system, is being carried out by MnDOT staff. Discussions on migration of elements have been a continuous effort within this project. Appendix A also includes notes on matching AASHTO 2014 elements for each MnDOT (CoRe) element. The condition state assignments for migration have been developed by MnDOT staff and the notes on migration are included in Appendix B.

MnDOT's BRIM tool contains a variety of performance measures and related scales that are part of the agency's project prioritization. These scales contain MnDOT's bridge elements; therefore, the research team reviewed their performance measures. The findings were discussed with the TAP during a one-day meeting November 12, 2014 and final recommendations are included in this report.

3.2 Changes to Bridge Elements

The previous chapter included an introduction to the general changes to the inspection methodology with AASHTO's Guide Manual for Bridge Element Inspection. During the TAP meeting the remaining categories of elements were discussed. The general changes to these elements are presented herein.

The listing in Appendix A is based on the old MnDOT element list and presents the matching AASHTO 2014 element numbers for migration efforts. (In this report, "old" is used to refer to the bridge elements in the current bridge inspection manual that are based on CoRe elements prior to the 2013 AASHTO manual. We use "new" to identify MnDOT's elements that are in accordance with the AAASHTO 2014 elements.)

3.2.1 Decks and Slabs

As mentioned before, one major change in the new AASHTO manual is the separation of wearing surfaces from deck and slab elements. The old MnDOT deck elements actually present the condition of the wearing surfaces as described in the new AASHTO manual while the old underside of the deck smart flag (359) describes the condition of the deck or slab element. The element matches in Appendix A and migration set up in Appendix B were developed accordingly. MnDOT will use a wearing surface element (510) for overlays. At this point, the agency did not prefer to separate wearing surfaces by type of material.

3.2.2 Deck Joints

The changes to deck joints are minimal. The old 411 Finger Deck Joint will be categorized under the new 305 Assembly Deck Joint. The agency-developed Approach Relief Joint (412) will be kept with a change in numbering (now 816).

3.2.3 Roadway Approaches

The old 320 Concrete Approach Slab with Bituminous Overlay and 407 Bituminous Approach Roadway will be categorized under the new 822 Bituminous Approach Roadway. MnDOT will keep Gravel Approach Roadway with a new number (823).

3.2.4 Bridge Railings

All metal railings, which were previously in three categories, will be categorized under 330 Metal Bridge Railing. Element #515 (Steel Protective Coating) will be added as needed.

3.2.5 Painted/Weathering Steel Elements

The major change in this category is the separation of paint and other protective coatings as Element #515 (Steel Protective Coating). Some agency-developed elements, such as truss bottom chord and upper members, were combined. The details are listed in Appendix A.

3.2.6 Reinforced Concrete Elements

For most reinforced concrete elements, the transition will be straightforward with a change in numbering. The major change in this category is the separation of #16 Reinforced Concrete Top Flange from girders, beams, stringers, and precast concrete channels.

3.2.7 Prestressed or Post-Tensioned Concrete Elements

The transitions in this category are also straightforward with the exception of Prestressed Concrete Double, Quad, Bulb, or Inverted Tees. The new #15 Prestressed Concrete Top Flange will be separated from this element.

3.2.8 Timber Elements

The old Timber Arch or Truss element will be separated to two new elements: timber arch and timber truss. The old Timber Wingwall will be eliminated but the notes from this element will be added to timber abutment element.

3.2.9 Masonry, Other, or Combination Material Elements

The Wingwall and spandrel wall elements in this category will be eliminated.

3.2.10 Other Structural Elements

In this category, some old agency elements will have new numbers and some elements will be adopted as new agency elements (ADEs) as presented in Table 1.

Table 1: Agency elements for other structural elements.

New Element #	Migration?	Old Element #	Element
850	yes	373	Steel Hinge Assembly
851	yes	379	Concrete Hinge Assembly
855	nothing to migrate	380	Secondary Structural Elements
856	nothing to migrate	856	Secondary Members (Substructure)
860	nothing to migrate	381	Tunnel
861	nothing to migrate	–	Non-Integral Retaining Wall

The old painted Pin & Hanger Assembly (161) will have the same number but paint (515 Steel Protective Coating) quantities will need to be added for migration. MnDOT 382 Cast-In-Place Piling will be eliminated. This element will be migrated to 225 steel piling. MnDOT 146 Steel Cable (Bare) will become 147 Steel Main Cable and MnDOT Steel Cable (Coated or Encased) will become 148 Secondary Steel Cable and paint (515).

3.2.11 Culverts

Major culvert elements remain the same in this category such as steel, reinforced concrete, and timber culverts. MnDOT 243 Masonry, Other, or Combination Material Culvert is divided into two new NBE elements: 243 Other Culvert and 244 Masonry Culvert. Inventory items that help identify different materials will be used for migration. MnDOT 421 Culvert Footing will be eliminated. The old 870 Culvert Wingwall, Headwall, or Other End Treatment will be adopted as 870 Culvert End Treatment (ADE). The old ADE 987 Roadway over Culvert will be renumbered as 871.

3.2.12 Defect Elements

MnDOT has decided to adopt the defect-based inspection approach recommended in the new AASHTO manual but chose not to adopt the defect elements as sub-elements. Optional to the agencies, defect elements may be defined as sub-elements of the main elements to have a parent-child relationship. This type of inspection, however, increases inspector's work in the field significantly. During the TAP discussion the options were compared and going with defect elements was not preferred at this time. A list of old smart flags and new defect elements are presented in Table 2.

Table 2: Defect elements.

New Element #	Migration?	Old Element #	Element
800	Possibly	964	Critical Structural Deficiency/Serious Safety Hazard
810	Possibly	358	Concrete Decks - Cracking & Sealing
880	Possibly	362	Impact Damage
881	Possibly	363	Section Loss
882	Possibly	356	Steel Cracking
883	Possibly	965	Concrete Shear Cracking
884	Possibly	360	Substructure Settlement and Movement
885	Possibly	361	Scour
	Eliminated	357	Pack Rust Smart Flag
	Eliminated	359	Underside of Conc. Deck Smart Flag
	Eliminated	966	Fracture Critical Smart Flag
	Eliminated	967	Gusset Plate Distortion Smart Flag

Four of the old MnDOT smart flags were eliminated since they either became redundant with the new inspection approach or were no longer assessed as necessary for MnDOT's practice. Eight of the old MnDOT smart flags have comparable or matching defect elements in the new list. These are presented in Table 2 with their old numbers and the new defect element names. The names, number of condition states, and description of condition states have differences between the old smart flags and the new defect elements. These details are provided in Appendix A.

3.3 Migration

The guidelines for the migration effort are being developed by MnDOT staff. Discussions on elements and migration have been a part of TAP meetings and communication between the research team and MnDOT staff during the project. In Appendix A, corresponding old (MnDOT and AASHTO CoRe) and new (AASHTO 2014) elements for migration are presented. This final report will include any changes with the guidelines that are being developed. In Appendix B, guidelines on quantity and condition state migration are included as developed by MnDOT.

A major change with the AASHTO 2014 elements was separation of wearing surfaces and steel protective systems from CoRe elements. In MnDOT's current inspection methodology, deck elements actually present the wearing surfaces and the underside deck smart flag presents the structural deck condition. The migration recommendations were developed accordingly.

Steel protective system and wearing surface elements will be added for the latest inspection during the migration effort. The quantities for wearing surfaces will be entered as the roadway area while steel protective system (e.g., paint) quantities will be coded values that will need to be updated by the inspectors in the field.

The old 374 Prestressed Concrete Double, Quad, Bulb, or Inverted Tees and 375 Precast Concrete Channels will be migrated to a combination of top flange and a girder/beam element. MnDOT will have AASHTO 120 (steel truss) for the current MNDOT combination of 121 Painted Steel through Truss - Bottom Chord and 126 Painted Steel through Truss - Upper Members, and go with the worst condition for 120. They will continue doing their detailed structural reviews for these elements. The same approach will be used for 120 Weathering Steel through Truss - Bottom Chord and 125 Weathering Steel through Truss - Upper Members.

3.4 Changes to BRIM Performance Measures

MnDOT's BRIM is a spreadsheet-based, project prioritization tool that identifies candidate actions for bridges based on many NBI and element data fields. "Scales" in the tool consist of a variety of resilience factors that are used to calculate the BPI. During the project meetings, possible changes to the resilience factors were presented to the TAP. The recommendations in this section are presented based on TAP suggestions.

The changes to the resilience factors were necessary due to the changes in element numbering, condition state numbers and definitions, and smart flags (now defect elements). For each resilience factor, we present an image of the current scale and follow with the suggested scale.

3.4.1 Deck Condition

Deck soffit (old 359) is no longer a defect element and no longer applies to this scale. Concrete deck cracking has a new number and four condition states, instead of five. Figure 3 shows the old scale and the new recommended scale.

NBI Condition		DECK CONDITION – Smart flag reduction: None	1	2	3	4	5
N	Not applicable	100	100	100	100	100	100
9	Excellent	100	100	95	95	85	85
8	Very good	95	95	90	90	80	80
7	Good	90	90	85	85	75	75
6	Satisfactory	75	75	70	70	55	55
5	Fair	55	55	50	50	35	35
4	Poor	35	35	30	30	20	20
3	Serious	20	20	15	15	10	10
2	Critical	10	10	5	5	0	0
1	Imminent fail	5	5	5	5	0	0
0	Failed	0	0	0	0	0	0

Smart flag reduction:
Use worst condition state of smart flags:
358: Concrete deck cracking
359: Deck soffit

NBI Condition		DECK CONDITION – Deflect element reduction: None	1	2	3	4
N	Not applicable	100	100	100	100	100
9	Excellent	100	95	95	85	85
8	Very good	95	90	90	80	80
7	Good	90	85	85	75	75
6	Satisfactory	75	70	70	55	55
5	Fair	55	50	50	35	35
4	Poor	35	30	30	20	20
3	Serious	20	15	15	10	10
2	Critical	10	5	5	0	0
1	Imminent fail	5	5	5	0	0
0	Failed	0	0	0	0	0

Defect element reduction:
Use worst condition state of Defect elements:
810: Concrete deck cracking

Figure 3: Deck Condition Resilience Factor Scale Old (top) versus New (bottom)

3.4.2 Superstructure Condition

For this scale, since the pack rust smart flag is eliminated, it no longer applies. Steel protective coating condition is added to the considerations. The number changes and element changes are reflected in Figure 4.

		SUPERSTRUCTURE CONDITION		
		Smart flag reduction		
NBI Condition		None	Case 1	Case 2
N	Not applicable	100	100	100
9	Excellent	100	90	80
8	Very good	95	85	80
7	Good	90	80	60
6	Satisfactory	75	60	40
5	Fair	55	40	25
4	Poor	35	25	10
3	Serious	15	10	0
2	Critical	5	5	0
1	Imminent fail	0	0	0
0	Failed	0	0	0

Smart flag reduction:

Case 1:
If Case 2 does not apply
and any of the following are true:
If any smart flag worse than state 2:
357: Pack rust
363: Section loss
Or any element has >=10% worse than state 2:
379: Concrete hinge
146: Steel Cable - Uncoated
147: Steel Cable - Coated or Encased
Or older segmental bridge:
main_span_mat_id='P' and yearbuilt<2000

Case 2:
If smart flag worse than state 3:
965: Conc shear crack
Or any element has >=10% worse than state 3:
373: Steel Hinge Assembly
379: Concrete hinge
146: Steel Cable - Uncoated
147: Steel Cble - Coated or Encased

		SUPERSTRUCTURE CONDITION		
		Defect element reduction		
NBI Condition		None	Case 1	Case 2
N	Not applicable	100	100	100
9	Excellent	100	90	80
8	Very good	95	85	80
7	Good	90	80	60
6	Satisfactory	75	60	40
5	Fair	55	40	25
4	Poor	35	25	10
3	Serious	15	10	0
2	Critical	5	5	0
1	Imminent fail	0	0	0
0	Failed	0	0	0

Defect element reduction:

Case 1:
If Case 2 does not apply
and any of the following are true:
If any Deflect element worse than state 2:
881: Section loss
Or any element has >=10% worse than state 2:
851: Concrete hinge
147: Steel Main Cable
148: Steel Secondary Cable
515 (for 147): Steel Protective Coating
Or older segmental bridge:
main_span_mat_id='P' and yearbuilt<2000

Case 2:
If Deflect element worse than state 3:
883: Conc shear crack
Or any element has >=10% worse than state 3:
850: Steel Hinge Assembly
851: Concrete hinge
147: Steel Main Cable
148: Steel Secondary Cable

Figure 4: Superstructure Condition Resilience Factor Scale Old (left) versus New (right)

3.4.3 Substructure Condition

For substructure condition, the number of condition states for the substructure settlement defect goes up to four instead of three. The new scale is arranged accordingly in Figure 5.

NBI Condition		SUBSTRUCTURE CONDITION – Smart flag reduction: None	1	2	3
N	Not applicable	100	100	100	100
9	Excellent	100	100	90	80
8	Very good	95	90	85	85
7	Good	90	85	80	80
6	Satisfactory	75	70	60	40
5	Fair	55	50	40	20
4	Poor	35	35	25	5
3	Serious	15	15	10	5
2	Critical	5	5	5	5
1	Imminent fail	0	0	0	0
0	Failed	0	0	0	0

Smart flag reduction:
Use worst condition state of smart flag
360: Settlement

NBI Condition		SUBSTRUCTURE CONDITION – Defect element reduction: None/1	2	3	4
N	Not applicable	100	100	100	100
9	Excellent	100	100	90	80
8	Very good	95	90	85	85
7	Good	90	85	80	80
6	Satisfactory	75	70	60	40
5	Fair	55	50	40	20
4	Poor	35	35	25	5
3	Serious	15	15	10	5
2	Critical	5	5	5	5
1	Imminent fail	0	0	0	0
0	Failed	0	0	0	0

Defect element reduction:
Use worst condition state of Defect element:
884: Substructure Settlement & Movement

Figure 5: Substructure Condition Resilience Factor Scale Old (top) versus New (bottom)

3.4.4 Scour

For scour, the number of condition states for the scour defect element goes up to four instead of three. The new scale is arranged accordingly in Figure 6.

		SCOUR			
		Smart flag reduction			
Code	Description	None	1	2	3
A	Not a waterway	100	100	100	100
E	Culvert	100	100	100	100
M	Stable; scour above footing	90	90	70	40
H	Foundation above water	90	90	70	40
N	Stable; scour in footing/pile	80	80	60	30
I	Screened; low risk	70	70	50	30
L	Evaluated; stable	70	70	50	30
P	Stable due to protection	60	60	40	20
K	Screened; limited risk	60	60	30	20
F	No eval; foundation known	50	50	40	20
C	Closed; no scour	50	50	25	20
J	Screened; susceptible	40	40	30	10
O	Stable; action required	40	40	20	10
G	No eval; foundation unknown	20	20	15	10
R	Critical; monitor	10	10	5	0
B	Closed; scour	0	0	0	0
D	Imminent protection reqd	0	0	0	0
U	Critical; protection required	0	0	0	0

Smart flag reduction:

Use worst condition state of smart flag:

361: Scour

		SCOUR			
		Defect element reduction			
Code	Description	None/1	2	3	4
A	Not a waterway	100	100	100	100
E	Culvert	100	100	100	100
M	Stable; scour above footing	90	90	70	40
H	Foundation above water	90	90	70	40
N	Stable; scour in footing/pile	80	80	60	30
I	Screened; low risk	70	70	50	30
L	Evaluated; stable	70	70	50	30
P	Stable due to protection	60	60	40	20
K	Screened; limited risk	60	60	30	20
F	No eval; foundation known	50	50	40	20
C	Closed; no scour	50	50	25	20
J	Screened; susceptible	40	40	30	10
O	Stable; action required	40	40	20	10
G	No eval; foundation unknown	20	20	15	10
R	Critical; monitor	10	10	5	0
B	Closed; scour	0	0	0	0
D	Imminent protection reqd	0	0	0	0
U	Critical; protection required	0	0	0	0

Defect element reduction:

Use worst condition state of Defect element:

885: Scour

Figure 6: Scour Condition Resilience Factor Scale Old (top) versus New (bottom)

3.4.5 Fracture Critical

Two old smart flags, 967 Gusset plate distortion and 966 fracture critical, are no longer used. Since paint is now a separate element, there is only one pin and hanger element (161). A case for gusset plate is now added to the scale since the fracture critical smart flag is no longer used and also to avoid any overlook. The Fracture Critical changes are presented in Figure 7.

	FRACTURE CRITICAL							
		Fracture critical superstructure						
		No reduction			Smart flag reduction			
					Case 1			Case 2
Year built up to	Not fracture critical	Cumulative truck traffic Low	Medium	High	Cumulative truck traffic Low	Medium	High	Gusset pl conditions
9999	100	100	95	90	90	80	70	0
1980	100	100	90	80	80	70	60	0
1959	100	80	70	50	60	50	40	0
1929	100	50	30	20	40	20	10	0

Smart flag reduction:

Case 1:
If Case 2 does not apply and any of the following are true:
If any smart flag worse than condition state 1:
967: Gusset plate distortion
If smart flag worse than condition state 2:
966: Fracture critical
If any element has >=10% worse than state 1:
160: Unpainted steel pin & hanger
161: Painted steel pin & hanger

Case 2:
If smart flag worse than condition state 2:
967: Gusset plate distortion
If element has >=10% worse than state 2:
424: Unpainted gusset plate
If element has >=10% worse than state 3:
423: Painted gusset plate

Cumulative truck traffic:
Low: <1 M trucks
Medium: 1-5 M trucks
High: >5 M trucks

	FRACTURE CRITICAL							
		Fracture critical superstructure						
		No reduction			Defect element reduction			
					Case 1			Case 2
Year built up to	Not fracture critical	Cumulative truck traffic Low	Medium	High	Cumulative truck traffic Low	Medium	High	Gusset pl conditions
9999	100	100	95	90	90	80	70	0
1980	100	100	90	80	80	70	60	0
1959	100	80	70	50	60	50	40	0
1929	100	50	30	20	40	20	10	0

Deflect element reduction:

Case 1:
If Case 2 does not apply and any of the following are true:
If any element has >=10% worse than state 1:
161: Pin & hanger
162: Gusset Plate

Case 2:
If element has >=10% worse than state 2:
162: Gusset Plate

Cumulative truck traffic:
Low: <1 M trucks
Medium: 1-5 M trucks
High: >5 M trucks

Figure 7: Fracture Critical Resilience Factor Scale Old (top) versus New (bottom)

3.4.6 Fatigue

In earlier discussions, MnDOT staff decided to eliminate the fatigue cracking smart flag. After the discussion on the fatigue scale, MnDOT staff decided to include the steel cracking defect element. The changes to the scale are presented in Figure 8. The numbers for reduction categories are revised to reflect the change in the defect element condition states.

	FATIGUE		
Maximum Classification	Smart flag reduction		
U of M Fatigue Detail	None	1	>=2
0	100	80	0
1	80	60	0
2	60	40	0
3	20	0	0
4	0	0	0

Smart flag reduction:
Use worst condition state of smart flag:
356: Fatigue cracking

	FATIGUE		
Maximum Classification	Defect element reduction		
U of M Fatigue Detail	None/1	2	>=3
0	100	80	0
1	80	60	0
2	60	40	0
3	20	0	0
4	0	0	0

Deflect element reduction:
Use worst condition state of Deflect element
882: Steel cracking

Figure 8: Fatigue Resilience Factor Scale Old (top) versus New (bottom)

3.4.7 Overweight Trucks

No change was necessary for this scale.

3.4.8 Over-Height Trucks on/under a Bridge

The old traffic impact smart flag (362) is now replaced by the 880 impact damage defect flag. The scale was updated with this defect flag and a threshold of condition state 2 instead of 1 to reflect the change in the defect element condition states is reflected in Figure 9.

Vert clr (feet) up to	OVER-HEIGHT TRUCKS ON BRIDGE MnDOT network (roadway on)				OVER-HEIGHT TRUCKS UNDER BRIDGE MnDOT network (roadway under)			
	A	B	C	D	A	B	C	D
9999.0	100	100	100	100	100	100	100	100
17.0	95	95	100	100	95	95	100	100
16.0	80	80	90	100	80	80	90	100
15.5	60	60	70	100	60	60	70	100
15.0	40	40	60	100	40	40	60	100
14.5	20	20	40	80	20	20	40	80
14.0	10	10	30	50	10	10	30	50
13.5	5	5	20	30	5	5	20	30
13.0	0	0	5	5	0	0	5	5

Use the lesser of the values from the roadway-on or roadway-under.
Smart flag reduction:
Reduce the scaled value by 5 points (but not less than zero) if:
If smart flag worse than condition state 1:
362: Traffic impact

Vert clr (feet) up to	OVER-HEIGHT TRUCKS ON BRIDGE MnDOT network (roadway on)				OVER-HEIGHT TRUCKS UNDER BRIDGE MnDOT network (roadway under)			
	A	B	C	D	A	B	C	D
9999.0	100	100	100	100	100	100	100	100
17.0	95	95	100	100	95	95	100	100
16.0	80	80	90	100	80	80	90	100
15.5	60	60	70	100	60	60	70	100
15.0	40	40	60	100	40	40	60	100
14.5	20	20	40	80	20	20	40	80
14.0	10	10	30	50	10	10	30	50
13.5	5	5	20	30	5	5	20	30
13.0	0	0	5	5	0	0	5	5

Use the lesser of the values from the roadway-on or roadway-under.
Defect element reduction:
Reduce the scaled value by 5 points (but not less than zero) if:
If Defect element worse than condition state 2:
880: Impact damage

Figure 9: Over-Height Trucks on/under a Bridge Scale Old (top) versus New (bottom)

3.4.9 Flood Over-Topping Bridge Roadway

No change was necessary for this scale.

3.5 Changes to the Maintenance Guide

The MnDOT Bridge Maintenance Support Unit revised the element numbers listed in the *Bridge Maintenance Source Code Guide* to correspond to the new AASHTO element list. A copy of the guide was provided to the research team for review. The following two changes were noted by the research team. These changes have been incorporated into the guide.

- Source Type Code 2829, Superstructure repair or replacement
    - Steel gusset plate is now coded 162, not 164
- Source Type Code 2830, Bearing assembly cleaning, greasing, repair, reset or replacement
    - Other bearing, 316, is now excluded

Chapter 4: Guidelines for Bridge Owners to Adopt the New Inspection Methodology

4.1 Introduction

The 2013 AASHTO Manual for Bridge Element Inspection made fundamental changes to the way element inspections are done in the US. As documented in the previous chapters, major changes were the standardization of all condition states to four, separation of wearing surfaces and protective systems from structural elements, and a defect-based inspection methodology.

With the expansion of the National Highway System (NHS) with MAP-21, there are now bridges on the NHS for which element inspections were not required before. NBEs, as required by the FHWA will need to be inspected now on these structures. The consistency among the element inspections by MnDOT inspectors and other bridge owners will provide quality input for Minnesota bridge condition assessment, performance measures, and decision making. Notes on training and quality control and assurance that would aid successful adoption of the new elements by all bridge owners are included below.

4.2 Training

MnDOT planned to complete the development of the new inspection manual and element migration before fall 2015 and start inspections in early 2016. The defect-based inspection approach will be new to the inspectors and a major objective during the training should be communicating the importance of consistency among condition state assignments.

Examples on defect levels and team exercises on how to assign matching condition states should be incorporated into the training as much as possible. Having mixed teams (MnDOT state inspectors with local inspectors) would help in consistency since inspectors can realize if they have different practices in condition assignments. This approach of mixed teams would also help in annual refresher training seminars.

4.3 Quality Control and Quality Assurance

As all bridge inspectors gain experience in doing NBE inspections, especially due to the fundamental changes to element inspections in general, questions and differences among practices may arise. Identifying these issues as early as possible in the process would both increase data quality and reduce the difficulties inspectors experience in field inspections.

Comparative quality assurance checks of the earliest submitted NBE data several months into the process may help MnDOT staff to identify common problems and differences among inspection practices. Ultimately, the issues identified may lead to guidelines to be adopted by all inspectors, as part of quality control procedures, and may be incorporated into annual refresher training seminars.

Chapter 5: Conclusions

The research team, working with the MnDOT Bridge Office, identified the necessary changes to the MnDOT bridge element inspection methodology and decision making framework as they implement the new AASHTO *Guide Manual for Bridge Element Inspection* (2011). The findings will enable MnDOT to start the new element inspections with a refined set of bridge elements that are compatible with the new AASHTO Bridge Elements and the FHWA guidelines.

The mapping of current MnDOT elements to the new elements helped MnDOT with the migration of the last set of element inspections that were done with the old elements to the new elements. The migrated dataset will provide the bridge inspectors with a starting point as they start using the new elements and provide consistency in the data.

The project also gave MnDOT the chance to thoroughly review its element inspection framework and streamline the list of bridge elements as it sees fit for an improved methodology.

The MnDOT Bridge Replacement and Improvement Management (BRIM) tool, which includes variety of performance measures and related scales that are part of the agency's project prioritization, was also reviewed during this project. The recommendations for the BRIM tool make it compatible with the new AASHTO Bridge Elements and reflect MnDOT's current approach in project prioritization.

The implementation of the findings will ensure that MnDOT's bridge management data and tools are ready for the MAP-21 requirements regarding bridge management and compatible with the next generation AASHTOWare Bridge Management System.

References

AASHTO, 2013. *Manual for Bridge Element Inspection*, American Association of State Highway and Transportation Officials, Washington DC.

AASHTO, 2014. 2015 Interim Revisions to the *AASHTO Guide Manual for Bridge Element Inspection*, First Edition, American Association of State Highway and Transportation Officials, Washington DC.

Appendix A
Changes to Bridge Elements

Old Element #	Old Element Name	Migration Notes
Concrete Decks		
12	Top of Concrete Deck with Uncoated Rebar (No Overlay)	old 359 to new 12+510 (Overlays will be assumed for all concrete decks)
13	Bituminous Overlay (Concrete Deck)	Old 13 to new 510, old 359 to new 12
14	Bituminous Overlay with Membrane (Concrete Deck)	Old 13 to new 510, old 359 to new 12
18	Latex, Epoxy, or Thin Overlay (Concrete Deck)	Old 18 to new 510, old 359 to new 12 + 521
22	Low Slump Overlay (Concrete Deck with Uncoated Rebar)	Old 22 to new 510, old 359 to new 12
26	Top of Concrete Deck with Epoxy Reinforcement (No Overlay)	old 359 to new 12+510
27	Top of Concrete Deck with Cathodic Protection System	old 359 to new 12 , old 29 to new 29
377	Low Slump Overlay (Concrete Deck with Epoxy Rebar)	old 377 to new 510, old 359 to new 12
429	Top of Conc. Deck w/Epoxy Rebar top mat only (No Overlay)	old 359 to new 12+510
430	Low Slump Overlay (Conc. Deck w/Epoxy Rebar top mat only)	old 430 to new 510, old 359 to new 12
Concrete Slabs		
38	Top of Concrete Slab with Uncoated Rebar (No Overlay)	old 359 to new 38+510
39	Bituminous Overlay (Concrete Slab)	old 39 to new 510, old 359 to new 38
40	Bituminous Overlay with Membrane (Concrete Slab)	old 40 to new 510, old 359 to new 38+521
44	Latex, Epoxy, or Thin Overlay (Concrete Slab)	old 44 to new 510, old 359 to new 38
48	Low Slump Overlay (Concrete Slab with Uncoated Rebar)	old 48 to new 510, old 359 to new 38
52	Top of Concrete Slab with Epoxy Reinforcement (No Overlay)	old 359 to new 38+510
53	Top of Concrete Slab with Cathodic Protection System	old 359 to new 38+510
378	Low Slump Overlay (Concrete Slab with Epoxy Rebar)	old 378 to new 510, old 359 to new 38
405	Top of CIP Concrete Voided Slab (No Overlay)	old 359 to new 38+510
406	Low Slump Overlay (CIP Concrete Voided Slab)	old 406 to new 510, old 359 to new 38
431	Top of Conc. Slab w/Epoxy Rebar top mat only (No Overlay)	old 359 to new 38+510
432	Low Slump Overlay (Conc. Slab w/Epoxy Rebar top mat only)	old 432 to new 510, old 359 to new 38
Timber Decks & Slabs		
31	Timber Deck (No Overlay)	old 31 to new 31
32	Timber Deck with Bituminous (AC) Overlay	old 32 to new 31+ 510
54	Timber Slab (No Overlay)	old 54 to new 54
55	Timber Slab with Bituminous (AC) Overlay	old 55 to new 54 +510
Other Deck Types		
28	Steel Grid Deck - Open	old 28 to new 28
29	Steel Grid Deck - Concrete Filled	old 29 to new 29
30	Corrugated, Orthotropic, Exodermic, or Other Deck	old 30 to new 30
401	Steel Ballast Plate Deck(Railroad Bridges)	old 401 to new 30

Old Element #	Old Element Name	Migration Notes
Deck Joints		
300	Strip Seal Deck Joint	old 300 to new 300
301	Poured Deck Joint	old 301 to new 301
302	Compression Seal Deck Joint	old 302 to new 302
303	Assembly Deck Joint (with or without seal)	old 303 to new 305
304	Open Deck Joint	old 304 to new 304
410	Modular Deck Joint	old 410 to new 303
411	Finger Deck Joint	old 411 goes to new 305
412	Approach Relief Joint	old 412 goes to new 816
Roadway Approaches		
320	Concrete Approach Slab with Bituminous Overlay	old 320 goes to new 822
321	Reinforced Concrete Approach Slab	old 321 goes to new 321
407	Bituminous Approach Roadway	old 407 goes to 822
408	Gravel Approach Roadway	old 408 goes to 823
Bridge Railings		
330	Metal Bridge Railing (Uncoated or Unpainted)	old 330 goes to new 330+515 for painted
331	Reinforced Concrete Bridge Railing	old 331 goes to new 331
332	Timber Bridge Railing	old 332 goes to new 332
333	Masonry, Other, or Combination Material Bridge Railing	old 333 goes to new 330+331+515, if superstructure is timber 332
334	Metal Bridge Railing (Coated or Painted)	old 334 goes to 330+ 515
409	Chain Link Fence	old 409 goes to 330+ 515
Painted Steel Elements		
102	Painted Steel Box Girder	old 102 goes to new 102 + 515
107	Painted Steel Girder or Beam	old 107 goes to new 107+ 515
113	Painted Steel Stringer	old 113 goes to new 113+ 515
121	Painted Steel Through Truss - Bottom Chord	old 121 goes to new 120
126	Painted Steel Through Truss - Upper Members	old 126 quantity no migration
131	Painted Steel Deck Truss	old 131 goes to new 120 + 515
141 + 384	Painted Steel Arch	old 141 goes to new 141 + 515 (no migration for 384, notes of old 384 go to 141)
152	Painted Steel Floorbeam	old 152 goes to new 152 + 515
202	Painted Steel Column	old 202 goes to new 202+515
231	Painted Steel Pier Cap/Bearing Cap	old 231 goes to new 231 + 515
419	Painted Steel Piling	old 419 goes to new 225 + 515
422	Painted Steel Beam Ends	eliminate, no quantity migration, notes to new 107
423	Painted Steel Gusset Plate Truss Connection	old 423 goes to new 162 + 515
425	Painted Steel Pinned Truss Connection	old 425 goes to new 161 + 515
427	Painted Steel Pier Cap (Superstructure)	old 427 goes to new 102 + 515

Old Element #	Old Element Name	Migration Notes
Weathering Steel Elements		
101	Weathering Steel Box Girder	old 101 goes to new 102 + 515
106	Weathering Steel Girder or Beam	old 106 goes to new 107+ 515
112	Weathering Steel Stringer	old 112 goes to new 113+ 515
120	Weathering Steel Through Truss - Bottom Chord	old 120 goes to new 120
125	Weathering Steel Through Truss - Upper Members	old 125 quantity no migration
130	Weathering Steel Deck Truss	old 130 goes to new 120 + 515
140	Weathering Steel Arch	old 140 goes to new 141 + 515
151	Weathering Steel Floorbeam	old 151 goes to new 152 + 515
201	Weathering Steel Column	old 201 goes to new 202+515
225	Weathering Steel Piling	old 225 goes to new 225 + 515
230	Weathering Steel Pier Cap/Bearing Cap	old 230 goes to new 231 + 515
413	Weathering Steel Arch Spandrel Column	eliminate, no quantity migration, notes to new 141
424	Weathering Steel Gusset Plate Truss Connection	old 424 goes to new 162 + 515
426	Weathering Steel Pinned Truss Connection	old 426 goes to new 161 + 515
428	Weathering Steel Pier Cap (Superstructure)	old 428 goes to new 102 + 515
Reinforced Concrete Elements		
105	Reinforced Concrete Box Girder	old 105 goes to new 105
110	Reinforced Concrete Girder or Beam	old 110 goes to new 110+new 16 reinforced concrete top flange (quantity from deck area, assessment from 359)
116	Reinforced Concrete Stringer	old 116 goes to new 116+new 16 reinforced concrete top flange (quantity from deck area, assessment from 359)
144	Reinforced Concrete Arch	old 144 goes to new 144
155	Reinforced Concrete Floorbeam	old 155 goes to new 155
205	Reinforced Concrete Column	old 205 goes to new 205
210	Reinforced Concrete Pier Wall	old 210 goes to new 210
215	Reinforced Concrete Abutment	old 215 goes to new 215, 217, add 10 lineal feet per wingwall
220	Reinforced Concrete Footing	old 220 goes to new 220
227	Reinforced Concrete Piling	old 227 goes to new 227
234	Reinforced Concrete Pier Cap/Bearing Cap	old 234 goes to new 234
375	Precast Concrete Channels	Old 375 quantity * 2 goes to quantity for new 110. + new 16 reinforced concrete top flange (quantity structure area unless approach spans are present, if approach spans code 999) +510 quantity roadway area
385	Reinforced Concrete Arch Spandrel Column	nothing to migrate, notes to new 144
387	Reinforced Concrete Wingwall	nothing to migrate, notes to new 215
414	Reinforced Concrete Arch Spandrel Wall	nothing to migrate, notes to new 215

Old Element #	Old Element Name	Migration Notes
Prestressed or Post-Tensioned Concrete Elements		
104	Prestressed Concrete Box Girder	104+15(quantity from deck area, assessment from 359)
109	Prestressed Concrete Girder or Beam	109
115	Prestressed Concrete Stringer	115
143	Prestressed Concrete Arch	143
154	Prestressed Concrete Floorbeam	154
204	Prestressed Concrete Column	204
226	Prestressed Concrete Piling	226
233	Prestressed Concrete Pier Cap/Bearing Cap	233
374	Prestressed Concrete Double, Quad, Bulb, or Inverted Tees	Old 374 quantity * 2 goes to quantity for new 109. + new 15 prestressed concrete top flange (quantity structure area unless approach spans are present, if approach spans code 999) + 510 quantity roadway area
402	Prestressed Concrete Voided Slab Panels	402 goes to 805
Timber Elements		
111	Timber Girder or Beam	111
117	Timber Stringer	117
135	Timber Arch or Truss	Old 135 goes to new 135 or 146. If truss to 135, if arch to 146
156	Timber Floorbeam	156
206	Timber Column	228
216	Timber Abutment	216, add 10 lineal feet per wingwall
228	Timber Piling	228
235	Timber Pier Cap/Bearing Cap	235
386	Timber Wingwall	Delete quantity notes go to 216 timber abutment
415	Timber Transverse Stiffener Beam (Timber Slabs)	415 goes to 156
Masonry, Other, or Combination Material Elements		
145	Masonry, Other, or Combination Material Arch	145
211	Masonry, Other, or Combination Material Pier Wall	213
217	Masonry, Other, or Combination Material Abutment	217, add 10 lineal feet per wingwall
416	Masonry, Other, or Combination Material Pier Cap/Bearing Cap	234
417	Masonry, Other, or Combination Material Column	205
418	Masonry, Other, or Combination Material Wingwall	Delete quantity, notes to 217
420	Masonry, Other, or Combination Material Arch Spandrel Wall	Delete quantity, notes to 145

Old Element #	Old Element Name	Migration Notes
Other Structural Elements		
310	Elastomeric (Expansion) Bearing	310
311	Expansion Bearing	311
312	Enclosed/Concealed Bearing	312
313	Fixed Bearing	313
314	Pot Bearing	314
315	Disk Bearing	315
161	Pin & Hanger (or Hinge Pin) Assembly - Painted	161+paint?
373	Steel Hinge Assembly	850
379	Concrete Hinge Assembly	851
146	Steel Cable (Bare)	148
147	Steel Cable (Coated or Encased)	148+515
380	Secondary Structural Elements	855
382	Cast-In-Place (CIP) Piling	225+515 (paint quantity 99)
381	Tunnel	860
Culverts		
240	Steel Culvert	240
241	Reinforced Concrete Culvert	241
242	Timber Culvert	242
243	Masonry, Other, or Combination Material Culvert	Old 243 to new 243 and 244. If aluminum to 243, if not to 244
388	Culvert Wingwall, Headwall, or Other End Treatment	870 Culvert End Treatment
421	Culvert Footing	220
Smart Flags		
356	Fatigue Cracking Smart Flag	882 Steel Cracking
357	Pack Rust Smart Flag	Delete, add to general notes or steel beam
358	Deck Cracking Smart Flag	810 Concrete Decks - Cracking & Sealing
359	Underside of Conc. Deck Smart Flag	Added in the language for 12,38,805,13
360	Substructure Settlement Smart Flag	884 Substructure Settlement & Movement
361	Scour Smart Flag	885 Scour
362	Traffic Impact Smart Flag	880 Impact Damage
363	Section Loss Smart Flag	881 Steel Section Loss
964	Critical Finding Smart Flag	800 Critical Deficiencies or Safety Hazards
965	Shear Cracking Smart Flag	883 Concrete Shear Cracking
966	Fracture Critical Smart Flag	Delete, add to general notes, or steel truss 120, 102, 107
967	Gusset Plate Distortion Smart Flag	Delete, notes add to 162

Old Element #	Old Element Name	Migration Notes
Miscellaneous		
981	Signing	890 Load Posting or Vertical Clearance Signing, 891 Other Bridge Signing
982	Guardrail	893 Guardrail
983	Plowstraps	old 983 to new 815
984	Deck & Approach Drainage	894 Deck & Approach Drainage
985	Slopes & Slope Protection	892 Slopes & Slope Protection
986	Curb & Sidewalk	895 Sidewalk, Curb, & Median
987	Roadway Over Culvert	871 Roadway Over Culvert
988	Miscellaneous Items	899 Miscellaneous Items

Appendix B
Element Data Migration

Concrete Decks

Overlays (510) will be assumed for all concrete decks

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If 12 then

If CS1	100% CS1	510	
CS2	2% CS3		510
CS3	10% CS3	510	
CS4	25% CS3	510	
CS5	30% CS3	510	

Quantity for 510 = Roadway Area

12 = Structure Area (out-to-out)

If 359 then

CS1	100% CS1	12	
CS2	2% CS3		12

Else no 359

100% quantity CS1 12

521 will not be added for element 14, however will be used for element 12 when converting from existing 18.

Steel Decks

28, 29, 30

If 28 then

If CS1	then	100%	CS1	28
CS2	then	2%	CS3	28
CS3	then	10%	CS3	28
CS4	then	25%	CS3	28
CS5	then	30%	CS3	28

Quantities → 28 out-to-out

28 → 28, 29 → 29, 30/401 → 30

Timber Decks

510 will not be added for Timber Decks that were previously coded with no overlay

If 32, 55 (no 510 for 31 or 54)

If CS1 → 100%	CS1	510	
CS2 → 2%	CS2	510	
CS3 → 10%	CS3	510	
CS4 → 25%	CS3	510	

Quantity for 510 = Roadway Area

31 = out-to-out

100% CS1 for 31, 32, 54, 55

Deck Joints
- Notes and quantities direct transfer 304, 300, 301, 302 → direct

Old	New	411, 303 → 305
CS1 →	CS1	410 → 303
CS2 →	CS2	412 → 816
CS3 →	CS4	983 → 815

Roadway Approaches
Page 41
320→ 822 321 → 321
407 → 822 408 → 823

If 320, 321, 407, 408

If CS1	100%	CS1	320
CS2	2%	CS3	320
CS3	10%	CS3	320
CS4	25%	CS3	320

Quantity is each x (roadway app width)

Weathering Painted Steel

102/101 → 102 + 515 (need to determine quantity)
106/107 → 107 + 515 (need to determine quantity)
112/113 → 113 + 515
120/121/125/126 → 120 + 515
Use bottom chord quantity + ratings
130/131 → 120 + 515
140/141 → 141 + 515
151/152 → 152 + 515
201/202 → 202 + 515 (quantity needs to be field determined)
231/230 → 231 + 515
225/419 → 225 + 515
384/413 → Discard quantities, notes go to 141
422 → discard, notes go to 107
423/424 → 162 + 515
967 → Discard, notes go into 162
425/426 → 161 + 515
427/428 → 102+ 515 (no concrete flange)

Most quantities for 515 will be RAGs, so instead **assign quantity of 999 SF in CS1**
Reinforced Concrete

105 → 105
110 → 110 + 16 → quantity deck area
116 → 116 + 16 → assessment areas from 359
144 → 144

155 → 155
205 → 205
210 → 210
215 → 215 truncate quantity to convert to 9?
220 → 220 multiply each quantity by 10 and subtract one?
227 → 227
234 → 234
375 → 110 quantity ratings times 2
→ +15 quantity = structure area, CS1 unless approach spans are present 999
414/385 → discard, move notes to 144
387 → discard, move notes to 215

Prestressed Concrete Double, Quad, Bulb, Inverted Tee– 374

If 374 = true
374 CS ➔ directly 109
15(concrete beams) CS ➔ 100% CSI
510 ➔ deck CS rules

Quantity for 510 = Roadway area
15 = Structure area out-to-out
109 = quantity from 374

Channel Spans – 375

375 CS ➔ directly 110
16 CS ➔ 100% CSI
510 ➔ deck area rules (for any deck present) else 100% CS1

Quantity for 510 = Roadway area
16 = Structure area out-to-out
110 = quantity from 375

Special Notes
- Concrete top flange need to be used instead of deck for boxes. Look into querying manually and adding post operation.
- Arches may be treated as culverts and measured perpendicular to traveled way. No way to really tell from data, as later will be examined on case by case.
-Concrete abutment will be truncated at and converted last digit to 9

Roadway Approaches

320 → 822
321 → 321
407 → 822
408 → 823

Quantity and elements is direct transfer except:

Quantity 321 = existing each count x 20’ x roadway approach width

Bridge Railings

330/334 → 330 DC 331,332 If 344, then also add 515, 3’ of height
409 → 330 and add 515, 6’ of height

CS1 → CS1	CS1 → CS1
CS2 → CS2	CS2 → CS2
CS3 → CS2	CS3 → CS4
CS4 → CS3	
CS5 → CS4	

333 assume combination thus add 100% quantity into 330 and 331

Masonry

145 → 145 DC

211 → 213 DC

217 → 217 truncate, add 9

416 → 234

418→ delete, notes go into 217

420 → delete notes go into 145

Culverts

240 → 240 DC

241 → 241 DC

242 → 242 DC

243 → if aluminum then 243, if not then 244

388 → 870 DC

421 → 220

Bearings / Other structural elements

310 → 310

CS1 → CS1

CS2 → CS2

CS3 → CS4

311 → 311

312 → 312

313 → 313

314 → 314

315 → 315

160/161 → 161

373 → 850

379 → 851

146 → 148

147 → 148+515

380 → 855 DC

382 → 225 DC

381 → 860 DC

Smart Flags

356 → 882

Correct quantity to 1

CS1 → CS2

CS2 → CS3

CS3 → CS4

357 → delete add to general notes or steel beam

358 → 810 99 quantity in CS existing

359 → added in language for 12, 38, 805, 13

360 → 884 correct quantity to 1, CS1 → 1, 2 → 3, 3 → 4

361 → 885 correct quantity to 1, CS1 → 1, 2 → 3, 3 → 4, add to bridges that have scour code D, G, K , O, P, R, U

362 → 880, correct quantity to 1, CS1 → 1, 2 → 3, 3 → 4

363 → 881, DC, correct quantity to 1

964 → 800, correct quantity to 1, CS1 → 1, 2 → 4

965 → 883, correct quantity to 1, add to beams, boxes slabs

966 → delete, add to general notes? Or steel truss 120, 102, 107

967 → delete add to 162

Rule for breaking painted steel element into paint/steel elements

	Paint				**Steel**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
1	**X**				**X**			
2			**X**		**X**			
3				**X**		**X**		
4				**X**			**X**	
5				**X**				**X**