METRIC 18
INSPECTION PROCEDURES – SCOUR

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Bridge Inspection Program Manager

March 19, 2019
National Bridge Inspection Program Review

- 23 Metrics
  - (1) Bridge Inspection Organization
  - (2-5) Qualifications
  - (6-11) Inspection Frequency
  - (12-21) Inspection Procedures
  - (22-23) Inventory and Data

- 3 Assessment Levels
  - Minimum Assessment – FHWA's knowledge of current practice
  - Intermediate Assessment – Random samples and site visits
  - In-Depth Assessment – Increased sample size and site visits

- 4 Levels of Compliance
  - Compliant
  - Substantially Compliant
  - Noncompliant
  - Conditionally Compliant

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**Metric #18: Inspection procedures – Scour**

*NBIS Reference: 23 CFR 650.313 (e), (e3) Bridges that are scour critical*

**Criteria**
- Bridges over water have a documented evaluation of scour vulnerability.
- Bridges that are scour critical have a scour plan of action (POA) prepared to monitor known and potential deficiencies and to address scour critical findings.
- Bridges that are scour critical are monitored in accordance with the POA.

**Population:** Bridges for the entire State that are over water and open to traffic.
### NBIP Review – Results

- **Substantial Compliance**
  - Metric 03
  - Metric 06
  - Metric 07
  - Metric 12

- **Conditional Compliance**
  - Metric 13
  - Metric 14
  - **Metric 18**

- **Non-Compliance**
  - Metric 15

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#### National Bridge Inspection Program Status and Summary

**National Bridge Inspection Program (NBIP) review Final Summary of Metrics (FSM) Assessment (AL) and Compliance (CL) Levels and review status:**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Prev CL</th>
<th>AL</th>
<th>CL</th>
<th>Dec 31 Complete</th>
<th>Mar 31 Complete</th>
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</thead>
<tbody>
<tr>
<td>01 - Bridge Inspection Organization</td>
<td>C</td>
<td>Min</td>
<td>C</td>
<td></td>
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<tr>
<td>02 - Qualifications of Personnel - Program Manager</td>
<td>C</td>
<td>Int</td>
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<tr>
<td>03 - Qualifications of Personnel - Team Leader(s)</td>
<td>C</td>
<td>Min</td>
<td>SC</td>
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<td>04 - Qualifications of Personnel - Load Rating Engineer</td>
<td>C</td>
<td>Min</td>
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<td>05 - Qualifications of Personnel - UW Bridge Inspection Diver</td>
<td>C</td>
<td>Min</td>
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<tr>
<td>06 - Inspection Frequency - Routine - Lower Risk Bridges</td>
<td>SC</td>
<td>Min</td>
<td>SC</td>
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<td>07 - Inspection Frequency - Routine - Higher Risk Bridges</td>
<td>SC</td>
<td>Min</td>
<td>SC</td>
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<td>08 - Inspection Frequency - Underwater - Lower Risk Bridges</td>
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<td>09 - Inspection Frequency - Underwater - Higher Risk Bridges</td>
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<td>10 - Inspection Frequency - Fracture Critical Member</td>
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<td>Min</td>
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<td>11 - Inspection Frequency - Frequency Criteria</td>
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<td>12 - Inspection Procedures - Quality Inspections</td>
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<td>C</td>
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<td>13 - Inspection Procedures - Load Rating</td>
<td>CC</td>
<td>Min</td>
<td>CC</td>
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<td>14 - Inspection Procedures - Post or Restrict</td>
<td>CC</td>
<td>Int</td>
<td>NC</td>
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<td>15 - Inspection Procedures - Bridge Files</td>
<td>CC</td>
<td>Int</td>
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<td>16 - Inspection Procedures - Fracture Critical Members</td>
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<td>17 - Inspection Procedures - Underwater</td>
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<td>18 - Inspection Procedures - Scour Critical Bridges</td>
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<td>20 - Inspection Procedures - QC/QA</td>
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<tr>
<td>21 - Inspection Procedures - Critical Findings</td>
<td>C</td>
<td>Min</td>
<td>C</td>
<td></td>
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<tr>
<td>22 - Inventory - Prepare and Maintain</td>
<td>C</td>
<td>Min</td>
<td>C</td>
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<tr>
<td>23 - Inventory - Timely Updating of Data</td>
<td>C</td>
<td>Min</td>
<td>C</td>
<td></td>
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</tr>
</tbody>
</table>
Metric 18: Inspection Procedures – Scour

- **Plan of Corrective Action**
- Local Bridge Owners guide, QA Program, MDOT Policy change, Bridge Advisory
Metric 18: Inspection Procedures – Scour

- MDOT Policy Change – All waterway data must be uploaded to MiBRIDGE
  - Scour Evaluation showing Item 113 coding
    - Level I Scour Assessment
    - Level II Scour Assessment
    - Scour Depth Calculations
  - Stream Bed Cross-Sections
    - MDOT Frequency Guidelines
MDOT Frequency Guidelines

- [www.michigan.gov/bridgeoperations](http://www.michigan.gov/bridgeoperations)
- Scour Critical Bridges
  - Active Erosion or Observed Scour
  - No Active Erosion/Observed Scour

<table>
<thead>
<tr>
<th>COMPONENT OR BRIDGE TYPE</th>
<th>FREQUENCY (1) (Months)</th>
<th>COMMENTS (2)/(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STREAM BED CROSS-SECTIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scour critical bridges with active erosion or observed scour</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Scour critical bridges with no active erosion or observed scour</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Structures with minor observed scour or erosion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structures over water with no substructures in the water and no channel erosion</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

(1) Frequency is expressed in terms of months.
(2) Minimum every two years or after flood event where the scour POA was reviewed and monitoring occurred (Item 113 = U, 0-3).
(3) Minimum every four years or after flood event where the scour POA was reviewed and monitoring occurred (Item 113 = U, 0-3).
(4) Minimum of one cross section must be in the bridge file. Record additional cross-sections as changes in the channel are observed and every 60 months for locations requiring underwater diving.
(5) Minimum of one cross section must be in the bridge file for each structure over water. Record additional cross-sections as changes in the channel are observed.
Stream Cross-Section Report

- [www.michigan.gov/bridgeoperations](http://www.michigan.gov/bridgeoperations)
- All structures over water
  - Compare to previous data
  - Upstream and downstream
STR 1702

Facility
US-127 NB

Feature
8 BR TOBACCO RIVER

Location
N LTS OF CLARE

Region / County
Bay(4) / Clare(10)

Material / Design
3 Presressed Concrete

Load Ratings

Outstanding Work

Work History

Document / Photo Data

Waterway Under Bridge

Waterway Name

Navigation Vertical Clearance (ft)

Navigation Horizontal Clearance (ft)

List Bridge Navigation Clearance (ft)

Pier Protection (ft)

Scour Evaluation

Item 113

Scour Criticality
3 SC - Unstable

Source of Item 113

Level 1 Assessment
Yes

Level II Analysis
Yes

Document Date

Document Name

Document Type

06/05/2018

06/05/2018

Level I SA.pdf

Level II SA.pdf

Level I

Level II

Calculated Values

Scour Analysis Frequency

25 Year

50 Year

100 Year

600 Year

Anticipated Surface Elevation (ft)

Distance Below Bottom Chord (ft)

Anticipated Flow (cubic ft/sec)

Anticipated Pressure Flow (YN)

Comments

25 Year

50 Year

100 Year

600 Year

0.0

0.0

816.0

0.0

0.0

2370.0

0.0

0.0
Waterway Data Compliance
**Waterway Data Compliance**

### STR-1702

**Facility**
- US-127 NB

**Feature**
- S BR TOBACCO RIVER

**Location**
- N LITS OF CLARE
- Bay (4) / Clare (15)

**Material / Design**
- Prestressed Concrete / Multi Str Comp

**Latitude / Longitude**
- 43°31'2" / 84°7'61"

**Length / Width / Span**
- 49.8 / 59.7 / 102 / 2001

**Built / Recon / Paint / Only**
- 1962 / 2001

**Owner**
- Region: Bay (4)

**MDOT Structure ID**
- 101180390008010

**Operational Status**
- 3 SC - Unstable

**Last NDI Inspection**
- 10/02/2018 / NUEB

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### Other Features Under Inspection Data

#### Waterway Under Bridge

<table>
<thead>
<tr>
<th>Waterway Name</th>
<th>Traffic Control (Ft)</th>
<th>Navigation Vertical Clearance (Ft)</th>
<th>Navigation Horizontal Clearance (Ft)</th>
<th>Gill Under Bridge Navigation Clearance (Ft)</th>
<th>Pier Protection (Ft)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
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</table>

#### Scour Evaluation

<table>
<thead>
<tr>
<th>Item 113</th>
<th>Scour Criticality</th>
<th>Source of Item 113</th>
<th>Calculated</th>
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<tbody>
<tr>
<td>113</td>
<td>3 SC - Unstable</td>
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<table>
<thead>
<tr>
<th>Item 71</th>
<th>Waterway Adequacy</th>
<th>Equal Desirable</th>
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<tbody>
<tr>
<td>71</td>
<td></td>
<td>Yes</td>
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</table>

<table>
<thead>
<tr>
<th>Level I Assessment</th>
<th>Level II Analysis</th>
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</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Document Data

<table>
<thead>
<tr>
<th>Date</th>
<th>Document Name</th>
<th>Document Type</th>
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<tbody>
<tr>
<td>06/05/2018</td>
<td>Level1 SA.pdf</td>
<td>Level I</td>
</tr>
<tr>
<td>06/05/2018</td>
<td>Level2 SA.pdf</td>
<td>Level II</td>
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</table>

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### Score Analysis Frequency

<table>
<thead>
<tr>
<th>Year</th>
<th>25 Year</th>
<th>50 Year</th>
<th>100 Year</th>
<th>500 Year</th>
<th>Comments</th>
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<tbody>
<tr>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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</table>

### Anticipated Surface Elevation (ft)

<table>
<thead>
<tr>
<th>Surface Elevation</th>
<th>0.0</th>
<th>0.0</th>
<th>0.0</th>
<th>0.0</th>
<th>0.0</th>
</tr>
</thead>
</table>

### Anticipated Runoff Volume (cubic ft/second)

<table>
<thead>
<tr>
<th>Runoff Volume</th>
<th>0.0</th>
<th>0.0</th>
<th>2370.0</th>
</tr>
</thead>
</table>
Waterway Data Compliance

- **Timeline: Bridge Advisory**
  - After 4/30/2018
    - 180 days from notification
  - Before 4/30/2018
    - With next Routine Inspection
Scour Plan of Action

- Monitor known and potential deficiencies
- Item 113 Coded ≤ 3 or U (Unknown Foundation)
- Item 113 = 7 (Countermeasures have been installed)
  - MDOT vs. Local Agency
Scour Plan of Action

- Information Summary
- Plan of Action authors
- Scour Vulnerability
- Countermeasures
- Monitoring Program
- Bridge Closure Plan
### Monitoring Program

**Recommended Monitoring Requirements**

Top of Pier (SW): 554.0 South Abutment: Top of Footing 565.0, Bottom of Footing 560.0, Bottom of Thrust 547.0 North Abutment: Top of Footing 565.0, Bottom of Footing 560.0, Bottom of Thrust 547.0

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency/Amount</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular Inspection</td>
<td>15.0</td>
<td>Perform depth soundings during annual routine inspection.</td>
</tr>
<tr>
<td>Other Special Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underwater Inspection</td>
<td>60.0</td>
<td>Contracted underwater diving inspections.</td>
</tr>
<tr>
<td>Stream Bed Cross Sections</td>
<td>48.0</td>
<td></td>
</tr>
</tbody>
</table>

**Flow Information**

- NOAA Flood Warning (This includes both Flash Flood and Flood Warnings)
  - Discharge: cfs
  - Rainfall: in/hr
  - WS Elevation: ft measured from

**Items to Watch During Monitoring**

Perform depth soundings along piers. Monitor structure for signs of settlement.

<table>
<thead>
<tr>
<th>Foundation</th>
<th>Items to Watch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abutment A</td>
<td>Perform depth soundings; South Abutment: Top of Footing 565.0, Bottom of Thrust 547.0</td>
</tr>
<tr>
<td>Abutment B</td>
<td>Perform depth soundings; North Abutment: Top of Footing 565.0, Bottom of Thrust 547.0</td>
</tr>
<tr>
<td>Pier 1</td>
<td></td>
</tr>
<tr>
<td>Pier 2</td>
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</table>

**Inspection Summary**

<table>
<thead>
<tr>
<th>Type</th>
<th>Latest Date Completed</th>
<th>Current Frequency</th>
<th>Inspector</th>
<th>Agency</th>
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<tbody>
<tr>
<td>Routine</td>
<td>04/23/2018</td>
<td>15</td>
<td>Andrew Enovy</td>
<td>MOOT Bridge Field Services</td>
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<tr>
<td>Underwater</td>
<td>08/09/2015</td>
<td>60</td>
<td>Amy Travey</td>
<td>Great Lakes Engineering Group, LLC</td>
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<tr>
<td>Cross Section</td>
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<tr>
<td>Scour Inspection</td>
<td></td>
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<tr>
<td>High Flow</td>
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</tr>
</tbody>
</table>
Scour Action Plan – High Flow

- High Flow Event Field Review
  - As-Needed until Scour Inspection
- High Flow Event Report
  - Storm Duration
  - High Water Distance from Chord
  - Estimated Total Rainfall
  - Estimated Flow Discharge
  - Whirlpools
  - Debris
  - Actions Taken/Closure
Scour Action Plan – Scour Inspection

- Scour Inspection Field Review
  - Probe substructure units
- Scour Inspection Report
  - Observed Scour
  - Inspection Methods/Location
  - Recommendations
  - Supporting Documents and Photos
MDOT Scour Program

Erik Carlson, PE
MDOT Hydraulic Unit
Beginnings of the Scour Program

- On April 5, 1987, the New York State Thruway Bridge over Schoharie Creek collapsed due to scour killing ten people.
- The bridge was built in 1953 on piers with spread footings and no piles.
- National scour evaluation program was established in 1988 by Technical Advisory T 5140.20, which was superseded in 1991 by T 5140.23, “Evaluating Scour at Bridges.”

Source: https://water.usgs.gov/wid/images/NY.figure.id.3.gif
Beginnings of the Scour Program

- In the early 1990’s, MDOT formed a multi-disciplinary team for scour.
- Recommendations from the committee led to the development of the Level I, Level II, and Level III evaluations.
MDOT Scour Program

- Outline of procedures in the MDOT Drainage Manual in Appendix 6-D
- Level I and Level II forms can also be found in Appendix 6-D.

https://www.michigan.gov/stormwatermgt/0,4672,7-205--93193--,00.html
Scour Program -
Level I Review

• Level I forms originally developed with guidance from FHWA’s HEC-18 and HEC-20 manuals.

• Approved through the MDOT Scour committee in the 1990’s.

• Overall scour and stream stability through site visit, aerial photographs, construction records, etc.

• Many single span structures rated 8 off original Level I analysis through engineering judgement, which we often re-review at project level.

• Construction records often required to verify pile length or if piles were even constructed.
Stream morphology rating using Figure 2.6 from FHWA’s HEC-20 manual.

MDOT existing structures typically were rated 8 or 6 for Item 113 off a Level I evaluation with the initial screening (some 7 and U’s).
Scour Program - Level I Review

Stable or Unstable?
Scour Program - Level I Review

Stable or Unstable?
Scour Program - Level I Review

- Substructure elements on deep foundations or bedrock?
- Sufficient Riprap?
- Low risk for scour?
Scour Program - Level II Analysis

- Calculations following guidelines in FHWA’s HEC-18 Manual.
- Estimating any future stream degradation.
- Calculating contraction and local scour for the substructure elements.
- Requires a hydraulic survey and analysis.
- All new structures require Level II analysis.
- Soil borings and sieve analysis required.
Scour Program - Level II Analysis

- Scour computed for the design scour event (100 year, 1% chance, for MDOT structures) and evaluated for the check flood (500 year, 0.2% chance, for MDOT structures)
- Recommended minimum frequencies found in Table 2.1 in FHWA’s HEC-18 manual:

| Table 2.1. Hydraulic Design, Scour Design, and Scour Design Check Flood Frequencies. |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Hydraulic Design Flood Frequency, \( Q_D \) | Scour Design Flood Frequency, \( Q_S \) | Scour Design Check Flood Frequency, \( Q_C \) |
| \( Q_{10} \)                            | \( Q_{25} \)                             | \( Q_{50} \)                                |
| \( Q_{25} \)                             | \( Q_{50} \)                             | \( Q_{100} \)                               |
| \( Q_{50} \)                             | \( Q_{100} \)                            | \( Q_{200} \)                               |
| \( Q_{100} \)                            | \( Q_{200} \)                            | \( Q_{500} \)                               |
Scour Program - Level II Analysis
Scour Program -
Level II Analysis

Item 113 coding based on MDOT Guidance Document “Coding and Managing Bridges for Scour Vulnerability.”

Scour Program - Level III Analysis

- Physical modeling in a lab environment.
- Has not been done on any MDOT structures.
- FHWA’s J. Sterling Jones Hydraulics Research Lab at Turner-Fairbanks

Source: https://highways.dot.gov/laboratories/hydraulics-research-laboratory/hydraulics-research-laboratory-overview