Bridge Scour Policy and Updates

Trenton Ellis, P.E. TxDOT Bridge Division
<table>
<thead>
<tr>
<th></th>
<th>Table of contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TxDOT Bridge Scour Resources</td>
</tr>
<tr>
<td>2</td>
<td>NBIS Metric #18: Scour</td>
</tr>
<tr>
<td>3</td>
<td>Making Bridge Scour a Higher Priority</td>
</tr>
<tr>
<td>4</td>
<td>Scour Coding</td>
</tr>
<tr>
<td>5</td>
<td>Scour Coding for Abutments</td>
</tr>
<tr>
<td>6</td>
<td>Scour Evaluation Requirements</td>
</tr>
</tbody>
</table>
TxDOT Bridge Scour Resources

TxDOT Bridge Scour Policy

- **Geotechnical Manual**
  - Chapter 5, Section 6

- **Bridge Inspection Manual**
  - Chapter 4, Sections 2, 3, and 8
  - Chapter 8, Sections 5 and 6

- **Bridge Project Development Manual**
  - Chapter 4, Section 2
  - Chapter 5, Sections 1, 2, and 6

- **Bridge Design Manual - LRFD**
  - Chapter 4, Sections 2 and 3

- **TxDOT Coding Guide**
  - Items 60, 113, 113.1, and 113.2

- **Hydraulic Design Manual**
  - Chapter 3
  - Chapter 4, Section 6
  - Chapter 9, Sections 3 and 6
  - Chapter 13, Section 2
  - Chapter 15, Section 6

- **PS&E Manual**
  - Chapter 2, Section 1

- **Project Dev. Process Manual**
  - Chapter 5, Sections 2, 6, and 7

- **Local Gov. Projects Policy Manual**
  - Chapter 7, Section 6
TxDOT Bridge Scour Resources

TSEAS Has Been Retired

- No longer allowed for new scour evaluations
- Remains acceptable where it was used prior to July 2020
  - Previous scour evaluations remain valid for as long as the assumed conditions remain accurate.
### TSEAS → Scour Evaluation Guide Crosswalk

<table>
<thead>
<tr>
<th>TSEAS</th>
<th>Scour Evaluation Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable Scour Depth</td>
<td>Chapter 2 – Max Allowable Scour Depth</td>
</tr>
<tr>
<td>Concise Analysis</td>
<td>Chapter 8 – Detailed Scour Evaluations</td>
</tr>
<tr>
<td>Worksheet for Concise Analysis</td>
<td></td>
</tr>
<tr>
<td>Secondary Screening</td>
<td>Chapter 6 – Scour Vulnerability Screening (SVS)</td>
</tr>
<tr>
<td>Worksheet for Secondary Screening</td>
<td>Form 538</td>
</tr>
<tr>
<td>Reporting Procedures</td>
<td>Chapter 4, Appendix A – Scour Coding</td>
</tr>
</tbody>
</table>
New in the Scour Evaluation Guide

- **Scour Vulnerability Assessment (Ch. 7)**
  - Scour evaluation based on current and historical performance
  - Ideal for older and off-system structures
  - Form 537

- **Instructions for Using SRICOS (Appendix B)**
  - Scour analysis for clay and soft rock

- **Scour Summary Sheet Instructions**
  - Scour Summary Sheet for Span Bridges (Form 2605) *(Appendix C)*
  - Scour Summary Sheet for Bridge-Class Culverts (Form 2606) *(Appendix D)*

- **Guidance for Trigger Elevations (Ch. 9)**
Bridge Webinar Presentations

- **July 2, 2020**
  - **Presenter**: Trenton Ellis
  - **Presentation**: Bridge Scour: Evaluation, Documentation, and Coding

- **History of Scour Evaluations**
- **Max Allowable Scour Depth**
- **Scour Coding**
- **Scour Documentation**
- **Scour Evaluation Methods + Examples**
- **Consultant Requirements**

熟知“TxDOT Bridge Webinars”
NBIS Metric #18: Scour

National Bridge Inspection Standards

- **23 CFR Part 650, Subpart C**
  - Legally Binding Federal Regulation

- **FHWA Oversight**
  - 23 Metrics: Data-Driven, Risk-Based
  - Metric #18 – Scour

- **Metric #18 Criteria**
  - Bridges over water have a documented scour evaluation
  - Scour critical structures have a POA for monitoring and countermeasures
  - Scour POAs are being implemented
DOCUMENTED EVALUATION OF SCOUR VULNERABILITY

- A *documented scour evaluation* should be:
  - a report with calculations,
  - a documented assessment, or
  - documented screening process explaining how the Item 113 value was determined.

This evaluation should be available for every bridge over water.

- Scour evaluation can be based on **analysis, assessment, or screening**
- Documentation must be available (in AssetWise)
NBIS Metric #18: Scour

Scour Plan of Action (POA)

- **Develop a Plan**
  - Required if Item 113 < 4

<table>
<thead>
<tr>
<th>Item 113 Coding</th>
<th>POA Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Form 2609</td>
</tr>
<tr>
<td>2</td>
<td>Form 2624</td>
</tr>
<tr>
<td>3</td>
<td>Form 2604</td>
</tr>
</tbody>
</table>

- **Implement the Plan**

<table>
<thead>
<tr>
<th>Item 113 Coding</th>
<th>POA Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, or 3</td>
<td>Form 2607 (POA Follow-Up)</td>
</tr>
</tbody>
</table>
Identifying Scour Deficiencies

- Item 113 = 6
  - Scour documentation missing in AssetWise

- Missing Scour POA
  - Scour POA and Form 2607 required if Item 113 < 4
    • Span Bridges, Bridge-Class Culverts, On-System, and Off-System

- Verification of Existing Scour Documentation
  - Routine Inspections:
    • Is the required scour documentation uploaded to AssetWise?
    • Have conditions changed since the last inspection?
    • This information is documented in the Lists of Structures
# NBIS Metric #18: Scour

## Lists of Structures

<table>
<thead>
<tr>
<th>Current Item 113</th>
<th>Scour Evaluation (*)</th>
<th>Scour Summary Sheet (SSS)</th>
<th>Scour Plan of Action (POA)</th>
<th>Changes to Site Conditions Since Last SSS Completion (Y/N)</th>
<th>Scour Summary Sheet Re-Evaluate (Y/N)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>*</td>
<td>N/A</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td>*TSEAS Sec. Scr. Documentation assumes channel is non-erodible, but scour has occurred at Abut #2. New scour eval. &amp; Form 2605 needed.</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
<td>B</td>
<td>N/A</td>
<td>N</td>
<td>N</td>
<td>Documented scour evaluation and Form 2605 are missing.</td>
</tr>
<tr>
<td>6</td>
<td>N/A</td>
<td>B</td>
<td>N/A</td>
<td>N</td>
<td>N</td>
<td>Form 2606 is missing.</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>B</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Countermeasures installed. Recommend Item 113 = 7. Documented scour evaluation and Form 2605 are missing.</td>
</tr>
<tr>
<td>8</td>
<td>*</td>
<td>N/A</td>
<td>Y</td>
<td>N</td>
<td></td>
<td>*Traditional HEC-18. Additional 2 ft. observed scour at Bent #3, but trigger elev. not exceeded.</td>
</tr>
</tbody>
</table>
Lists of Structures

- Routine Inspection Contract
  - Section 32

Submit to the following people at the end of each Work Authorization:

- TxDOT District Bridge Inspection Coordinator
- TxDOT Bridge Inspection Program Manager
  - Mark.Wallace@txdot.gov
- TxDOT Bridge Division Scour Engineer
  - Trenton.Ellis@txdot.gov
Making Bridge Scour a Higher Priority

- **District Responsibilities**
  - Obtain scour documentation for new bridges
    - *Should already be required in PS&E Contract or AFA*
  - Upload scour documentation to AssetWise
  - Revise scour documentation as conditions change
    - *Must monitor Lists of Structures*
  - Notify Bridge Division when scour documentation is uploaded to AssetWise

- **Bridge Division Responsibilities**
  - Check scour evaluations during PBLR
  - Ensure compliance with National Bridge Inspection Standards
  - Support districts in implementation of statewide scour policy
Making Bridge Scour a Higher Priority

When to Upload Scour Documentation

- **New Structures**
  - As soon as the structure is added to AssetWise
    - Scour evaluation is required with PBLR
    - Scour Summary Sheet is required by the end of PS&E
      - SSS can be completed after foundations are designed.
      - Observed scour may be assumed = 0 for as-built condition.

- **Existing Structures**
  - If conditions change, upload a revised Scour Summary Sheet and notify Bridge Division within 90 days of the inspection or evaluation
Scour Vocabulary: Part 1 – Scour Depths

- **Max Allowable Scour Depth**
  - Largest scour depth that can occur before the foundation becomes unstable

- **Max Possible Scour Depth**
  - Depth to non-erodible channel material

- **Calculated Scour Depth**
  - Predicted depth of scour for Scour Design Flood
    - What does this represent?

- **Observed Scour Depth**
  - Measured scour depth from latest inspection
    - Channel profile measurements
Reference Elevation for Scour Depths

- Always Report Scour Depths from the Same Reference Elevation
  - Original / As-Built / Proposed Channel Profile (Preferred)
  - Reference Point (e.g., bottom of cap)
  - Measured channel profile (year)
### Reference Elevation for Scour Depths

- **Always Report Scour Depths from the Same Reference Elevation**

<table>
<thead>
<tr>
<th>SCOUR DEPTHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scour depths are measured from the as-built channel profile.</td>
</tr>
<tr>
<td>Scour depths are measured from:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abutment or Bent #</th>
</tr>
</thead>
<tbody>
<tr>
<td>y_{ab}</td>
</tr>
<tr>
<td>y_{al}</td>
</tr>
<tr>
<td>Max Allowable Scour Depth^{1}</td>
</tr>
<tr>
<td>Max Possible Scour Depth^{2}</td>
</tr>
<tr>
<td>Calculated Contraction Scour</td>
</tr>
<tr>
<td>Calculated Pier Scour</td>
</tr>
<tr>
<td>Total Calculated Scour Depth</td>
</tr>
<tr>
<td>Observed Scour Depth</td>
</tr>
</tbody>
</table>
Scour Coding

Foundation Exposure Category

1. Minimal Foundation Exposure
2. Moderate Foundation Exposure
3. Major Foundation Exposure
4. Max Allowable Scour Depth ($y_a$)
## Scour Coding

### Item 113 Coding for Span Bridges

<table>
<thead>
<tr>
<th>Category</th>
<th>Calculated Scour</th>
<th>Observed Scour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal Foundation Exposure</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Previous Scour Problem Corrected with Countermeasures</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Missing Scour Documentation</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Moderate Foundation Exposure</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Major Foundation Exposure</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Exposure / Undermining of Abutment Toewalls

- **Spill-Through Abutments**
  - Partial exposure does not impact foundation stability.
  - Toewall undermining can usually be corrected before the foundation (or the embankment) is impacted.

> Do not code Item 113 based on scour at the toewall (observed or calculated). Item 113 should reflect scour at the foundation.
Exposure / Undermining of Abutment Toewalls

- **Vertical Wall Abutments** (Cantilever Wall)
  - Drilled Shafts, Sheet Piling, etc.
  - Trigger Elevation = 5 ft. (from original ground line)
Scour Coding for Abutments

Exposure / Undermining of Abutment Toewalls

- **Vertical Wall Abutments** *(Gravity Cantilever Wall)*
  - CIP, Spread Footing Retaining Walls
  - Scour coding works like any other spread footing

![Diagram showing minimal and moderate scour with As-Built Channel Profile and ya = Max Allowable Scour Depth.](image)
Scour Coding for Abutments

Exposure / Undermining of Abutment Toewalls

- **Hybrid Abutments** (Sheet Pile Wall in front of Abutment)
  - Scour coding is based on primary piles or drilled shafts.
  - Trigger elevation is 5 ft. below original ground line.
Scour Coding for Abutments

Exposure / Undermining of Abutment Toewalls

- **Hybrid Abutments** *(MSE Wall in front of Abutment)*
  - Undermining the leveling pad can quickly lead to Major Foundation Exposure along the piles or drilled shafts.
  - This *does* impact stability, and should be considered in Item 113 coding.

- Scour coding should be based on foundation exposure at the piles or drilled shafts.
- If the top of the leveling pad is exposed, assume the scour depth at the facing extends back to the piles or drilled shafts.
Scour Vocabulary: Part 2 – Scour Evaluation Methods

- **Screening** (Identify Non-Erodible Channel Material)
  - Identify bridges clearly not vulnerable to scour
  - Scour Vulnerability Screening (SVS) (Form 538)
  - Scour Evaluation Guide, Ch. 6

- **Assessment** (Consider Present and Past Performance)
  - Must have historical data (channel profiles)
    - Not applicable for new bridges
  - Scour Vulnerability Assessment (SVA) (Form 537)
  - Scour Evaluation Guide, Ch. 7

- **Analysis** (H&H with Calculated Scour Depths)
  - Calculated Scour Depths
  - Appropriate Method (e.g., HEC-18, SRICOS) Depends on Channel Material
  - Scour Evaluation Guide, Ch. 8
Scour Evaluation Requirements

- Does the structure cross a waterway (or a floodplain)?
  - Check plans, inspection photos, Item 42.2, and Item 71

- Is the structure a culvert?
  - Treat bottomless culverts like span bridges

- Is this a new or recently constructed structure?

- Are the foundations protected by non-erodible channel material?
  - Refer to Scour Evaluation Guide, Chapter 6

- Is this a high-priority structure?
  - The following structures are high-priority:
    • Span bridges on Interstate Highways or Principal Arterials
    • Span bridges on evacuation or emergency routes
Scour Evaluation Requirements

Does it cross a waterway?
- Yes
  - Is it a culvert?
    - Yes: Form 2606 (SSS)
    - No
      - Non-erodible channel?
        - Yes: Form 538 (SVS)
        - No
          - Is it a new structure?
            - Yes: Detailed Analysis Form 2605 (SSS)
            - No
              - Is it high-priority?
                - Yes: Form 537 (SVA)
                - No: Form 2605 (SSS)

Item 113 = N

SSS = Scour Summary Sheet
SVA = Scour Vulnerability Assessment
SVS = Scour Vulnerability Screening

Scour Critical Bridges Also Require Bridge Scour POA.
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TxDOT Bridge Division

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