

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

Purpose

The purpose of this policy is to identify MDOT and local agencies' responsibilities for the management of bridges vulnerable to scour. MDOT's goals for management of scour susceptible bridges are:

- Ensure the safety of individual bridges and bridge approaches crossing waterways.
 - Perform Scour Evaluations following procedures listed in HEC-18.
 - Develop and implement Plan of Actions (POA).
 - Address critical findings by initiating follow up actions such as scour monitoring, mitigation, or replacement.
- Reduce the network wide risk of bridge scour and minimize future flood damage to bridges.
 - Utilize data driven, risk-based asset management. See MDOT Scour Risk Assessment, or Local Agency Scour Risk Assessment documents
 - Prioritize scour mitigation and countermeasures given fiscal resources and constraints.
 - Design and place countermeasures to reduce the risk of bridges that are scour critical.
 - Consider bridge replacement as an option for mitigation if one of the following conditions are met:
 - The structure is a replacement candidate due to condition.
 - The structure is ranked both highly critical and highly vulnerable during the risk assessment and countermeasures will not reduce the risk to acceptable levels.
 - Countermeasures are not feasible due to cost, constructability, environmental constraints or backwater concerns.

Information

MDOT seeks to enhance bridge safety and make effective use of resources in managing bridges on a network level while ensuring safety at a bridge level. In order to accomplish these goals, MDOT uses a risk and data driven procedure to classify and manage bridges. In 1988, FHWA initiated the National Scour Evaluation Program. The National Bridge Inspection Standards (NBIS) specifies that all bridges over waterways must be evaluated to assess susceptibility to scour and to determine if protection in the form of countermeasures is required to ensure the stability of the structure. NBIS further specifies that the responsible agencies for all bridges determined to be scour critical must prepare and implement a Plan of Action (POA) to monitor known and potential deficiencies in accordance with the POA and to address Critical Findings.

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

The following definitions are provided within the NBIS and the Bridge Inspectors Reference Manual (BIRM):

Scour: Erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges.

Scour Critical Bridge: A bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

Critical Finding: A structural or safety related deficiency that requires immediate follow-up inspection or action.

Bridge: A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge Abutment: The bridge abutment is a substructure unit that transfers load from the superstructure to the foundation soil or rock. Bridge abutments provide support for the ends of the superstructure and retain the roadway approach embankment.

Bridge Pier: The bridge pier is a substructure unit that transfers load from the superstructure to the foundation soil or rock. Piers provide support for the superstructure at intermediate points along the bridge spans.

The following definitions are provided from the glossary within Hydraulic Engineering Circular No. 23 (HEC-23) 'Bridge Scour and Stream Countermeasures: Experience, Selection and Design Guidance-Third Edition:

Countermeasure: Measure intended to prevent, delay or reduce the severity of hydraulic problems.

Monitoring: Activities used to facilitate early identification of potential scour problems. Monitoring could also serve as a continuous survey of the scour progress around the bridge foundations.

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

The following definition is provided from the glossary within Hydraulic Engineering Circular No. 11 (HEC-11) ‘Design of Riprap Revetment’:

Header: The lowest terminus of the scour mitigation material; the base or foundation of mitigation material

All structures in the National Bridge Inventory have been assigned a Scour Critical Evaluation Rating, Item 113. A POA has been developed for all bridges determined to be scour critical or have unknown foundations and a copy of the POA is maintained in the Michigan Bridge Inventory. As conditions on a bridge change or a bridge is added to the inventory the ratings and POA’s are updated. These items address maintaining safety at a bridge level.

Coding Scour Critical Evaluations

Structure Inventory and Appraisal Item 113, Scour Critical Bridges is the key data item that indicates the general scour risk ranging from not applicable, stable, mitigated, moderate risk, scour critical and failure. The definitions were last updated on 6/28/12, and are included below with MDOT comments.

Bridges with multiple substructure units shall be coded based on the highest risk substructure unit.

N – *Bridge not over a waterway*

Coding Requirements:

- Structure is not over water or located in a floodplain.

Management Plan:

- No management plan is required.

U – *Bridge with “unknown foundation that has not been evaluated for scour. Until risk can be determined, a plan of action should be developed and implemented to reduce the risk to users from a bridge failure during and immediately after a flood event (see HEC 23).*

Coding Requirements:

- Structure either not evaluated for scour or has unknown foundation depths or types.

Management Plan:



GUIDANCE DOCUMENT

IDENTIFIER

EFFECTIVE DATE

10231

10/10/14

SUPERSEDES

DATED

10231

10/10/14

RESPONSIBLE ORGANIZATION: Bureau of Highway Development – Design – Bridge Development

SUBJECT: Coding and Managing Bridges for Scour Vulnerability

- Bridge owner initiates records review to see if foundation information can be determined. If foundation information is determined, analyze structure for new scour rating.
- If foundation information cannot be determined, evaluate structure risk, scour depths, and develop a POA. Monitoring requirements contained in the POA will be based on structure risk.
- Add to mitigation or replacement programs based on risk comparisons, constructability and environmental requirements.
- Consider Non Destructive Testing to confirm type, length and depth on the foundation.

T – Bridge over “tidal” waters that have not been evaluated for scour, but considered low risk. Bridge will be monitored with regular inspection cycle and with appropriate underwater inspections until an evaluation is performed.

Coding Requirements:

- Rating not used in Michigan since tidal impacts are minimal.

Management Plan:

- No management plan is required.
- If structure is currently coded “T” a scour evaluation is required and item 113 updated.
See Bridge Advisories for guidance.

9 – Bridge foundations (including piles) on dry land well above flood water elevations.

Coding Requirements:

- Foundations outside of 100 year floodplain.

Management Plan:

- No management plan is required. If floodwater elevations or locations change, routine bridge inspections would trigger re-evaluation.

8 – Bridge foundations determined to be stable for the assessed or calculated scour condition. Scour is determined to be above top of footing (Example A) by assessment (i.e., bridge foundations are on rock

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

formations that have been determined to resist scour within the service life of the bridge), by calculation or by installation of properly designed countermeasures (see HEC 23).

Coding Requirements for Abutments:

- The top of spread footings at abutments must either be below the total calculated scour or have properly designed and constructed countermeasure installed with the bottom of the countermeasure header placed below the contraction and long term scour depth.
- Rip rap used at abutments to achieve this rating must meet material specifications for durability and gradation as listed in the special provision for rip rap.
- Countermeasures shall be designed and constructed to the horizontal plan requirements according to HEC-23 and MDOT Design.

Coding Requirements for Piers:

- The top of pier footings must be below the total scour depth (combined local, contraction and long term scour depth) without accounting for the benefit of scour countermeasures in order to be eligible for a coding of 8. Piers cannot rely on countermeasures to be coded 8.

Management Plan:

- No management plan is required. If floodwater elevations or locations change, or the countermeasure has been compromised, routine bridge inspections would trigger re-evaluation. If a structure relied on a countermeasure to achieve this rating, the structure shall be coded 7 or less until the countermeasure is repaired or replaced. For MDOT owned structures, any changes of scour countermeasures must be reported to the Hydraulics Unit and the Region Bridge Engineer.

7 – Countermeasures have been installed to mitigate an existing problem with scour and to reduce the risk of bridge failure during a flood event. Instructions contained in a plan of action have been implemented to reduce the risk to users from a bridge failure during or immediately after a flood event.

Coding Requirements:

- Countermeasures installed at abutments may be coded “7” for designed countermeasures where “As Built” plans or construction records cannot be reviewed to verify proper placement.

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

- Countermeasures installed at existing piers may be coded “7” if designed and where “As Built” plans or construction records verify proper placement. This includes specifications on the size and type of material, placement methods, pad dimensions and header installation.

Management Plan:

- For MDOT owned structures, a POA must be developed and implemented for all structures coded “7” rating to verify that the countermeasures are in place and functioning as designed.
- For Local Agency owned structures, a POA is recommended, but not required.
- If environmental conditions change or the countermeasures are significantly compromised, the structure must be recoded to scour critical until countermeasures can be repaired or replaced. For MDOT structures, any changes of scour countermeasures must be reported immediately to the Hydraulic Unit and the Region Bridge Engineer.

6 – Scour calculation/evaluation has not been made.

Coding Requirements:

- Scour evaluation/calculation has not been completed. Foundation information is known.

Management Plan:

- This code should only be used as an interim measure for NBI bridges. The Bridge Management Unit will check, on a quarterly basis, for structures coded “6”. Structures must be recoded within 90 days for MDOT owned bridges, and within 180 days of opening the bridge to traffic for local agencies.
- For MDOT owned bridges, the Bridge Management Unit will notify Region Bridge Engineer and Hydraulics Unit Supervisor of any structures found with this rating.

5 – Bridge foundations determined to be stable for assessed or calculated scour condition. Scour is determined to be within the limits of footing or piles (Example B) by assessment (i.e., bridge foundations

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

are on rock formations that have been determined to resist scour within the service life of the bridge), by calculations or by installation of properly designed countermeasures (see HEC 23).

Coding Requirements:

- Scour may be below the footing for pile supported structures but the structure is still stable under anticipated scour conditions.

Management Plan:

- No management plan is required. If conditions change, routine bridge inspections would trigger re-evaluation.

4 – Bridge foundations determined to be stable for assessed or calculated scour condition; field review indicates action is required to protect exposed foundations (see HEC 23).

Coding Requirements:

- Structure is stable under anticipated scour conditions, but scour has occurred at the site (For example, debris on a pier has caused a local scour hole).

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

Management Plan:

- Increased inspection frequencies may be necessary to verify the stability of the channel. For MDOT owned bridges, contact Hydraulics Unit Supervisor to ensure rating is correct and review the site to determine if a site correction is warranted. Local Agencies should consult with their engineer.

3 – Bridge is scour critical; bridge foundations determined to be unstable for assessed or calculated scour conditions:

- Scour within limits of footing or piles. (Example B)
- Scour below spread-footing base or pile tips. (Example C)

Coding Requirements:

- Calculated or assessed scour shows total scour depth below spread footings or exposing significant pile lengths where piles are no longer stable either due to loss of bearing or lateral instability. Countermeasures, if previously installed, are compromised and are no longer providing required protection.

Management Plan:

- Develop and implement a POA.
- Evaluate structures for risk, accounting for the structure's performance on past flood events.
- Add to mitigation, replacement or monitoring programs based on risk comparisons, constructability and environmental requirements.
- If a structure had a countermeasure installed, examine the cause of failure to determine if certain countermeasures are not applicable at the site.

2 – Bridge is scour critical; field review indicates that extensive scour has occurred at bridge foundations; which are determined to be unstable by:

- A comparison of calculated scour and observed scour during the bridge inspection, or
- An engineering evaluation of the observed scour condition reported by the bridge inspector in Item 60.

Coding Requirements:

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

- Calculated or assessed scour shows total scour depth below spread footings or exposing significant pile lengths where piles are no longer stable either due to loss of bearing or lateral instability.

DRAFT

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

Management Plan:

- Evaluate criticality and extent of active scour and perform emergency maintenance or program project to address need. All MDOT projects must be submitted to the Hydraulics Unit Supervisor to review the site and provide appropriate recommendations.
- Implement the POA. Increase inspection frequency until emergency maintenance is performed or the structure is replaced.
- Evaluate structures for risk, accounting for the structure’s performance on past flood events.
- Add to mitigation or replacement programs based on risk comparisons, constructability and environmental requirements.
- If a structure had a countermeasure installed, examine the cause of failure to determine if certain countermeasures are not applicable at the site.
- If a structure is closed due to scour conditions causing unstable foundations it must be reported as a “Critical Finding” per FHWA and MDOT policies.

1 – *Bridge is scour critical; field review indicates that failure of piers/abutments is imminent. Bridge is closed to traffic. Failure is imminent based on:*

A comparison of calculated scour and observed scour during the bridge inspection, or an engineering evaluation of the observed scour condition reported by the bridge inspector in Item 60 Management Plan:

Coding Requirements:

- Observed scour below the bottom of spread footings or exposing significant pile lengths where piles are not stable under anticipated scour conditions.

Management Plan:

- Add to mitigation or replacement programs based on risk comparisons, constructability and environmental requirements.
- If a structure had a countermeasure installed, examine the cause of failure to determine if certain countermeasures are not applicable at the site.
- If a structure is closed due to scour conditions causing unstable foundations it must be reported as a “Critical Finding” per FHWA and MDOT policies.

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

0 – Bridge is scour critical. Bridge has failed and is closed to traffic.

Coding Requirements:

- Bridge has partially or completely failed and has been closed to traffic.

Management Plan:

- Evaluate cause of failure. Determine if site issues dictate a different location or bridge type for replacement.

Responsibility for Coding of Item 113

Local Agency Owned Structures

Coding of Item 113 is the responsibility of the designated bridge owner for local agencies.

MDOT Owned Structures

For MDOT owned structures, the coding of Item 113 is shared by a multi-disciplinary team of hydraulic, structural, and geotechnical engineers. The Bureau of Development, Hydraulics Unit will determine the initial coding based on the design of new construction, bridge replacements or scour countermeasures with input from the multi-disciplinary team specialty areas as needed. The Region Bridge Engineer will notify the Hydraulics unit when countermeasure projects are complete and update the relevant portions of the POA as necessary. The Hydraulics unit will modify their relevant portions of the POA and contact the Bureau of Development, Bridge Management Unit to update the scour rating, if necessary.

In cases where a need to change an existing rating is identified by the Region Bridge Engineer or Bridge Inspector, the Hydraulics Unit shall be notified for concurrence that the structure is properly coded.

In the event that the multi-disciplinary team cannot reach consensus on the coding for a structure, the issue will be moderated by the Bureau of Field Services-Bridge Field Services Engineer, Bureau of Development-Bridge Development Engineer, Bureau of Development-Environmental Services Section Manager, and the Bureau of Field Services-Geotechnical Services Foundation Analysis Engineer.

	GUIDANCE DOCUMENT	IDENTIFIER	EFFECTIVE DATE
		10231	10/10/14
		SUPERSEDES	DATED
		10231	10/10/14
RESPONSIBLE ORGANIZATION:		Bureau of Highway Development – Design – Bridge Development	
SUBJECT:	Coding and Managing Bridges for Scour Vulnerability		

It is the responsibility of the Statewide Scour Committee to recommend to the Statewide Bridge Alignment Team, policy and guidance for bridge scour issues including clarification of coding Item 113. The Statewide Scour Committee is a subcommittee of the Statewide Bridge Alignment Team.

DRAFT



GUIDANCE DOCUMENT

IDENTIFIER

EFFECTIVE DATE

10231

10/10/14

SUPERSEDES

DATED

10231

10/10/14

RESPONSIBLE ORGANIZATION: Bureau of Highway Development – Design – Bridge Development

SUBJECT: Coding and Managing Bridges for Scour Vulnerability

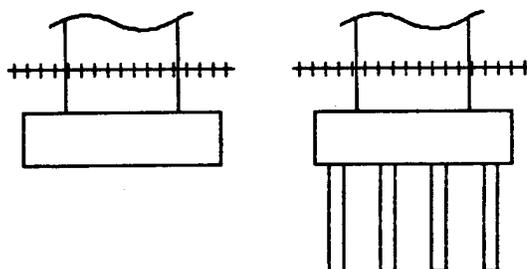
Examples A, B, and C from *Item 113, Structure Inventory and Appraisal Coding Guide*.

EXAMPLES:

CALCULATED SCOUR DEPTH

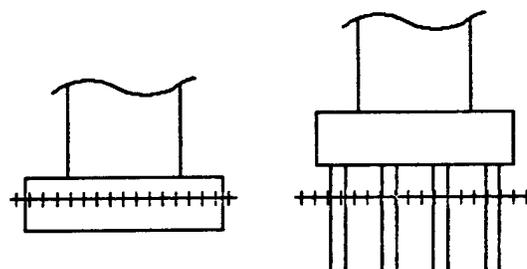
ACTION NEEDED

A. Above top of footing



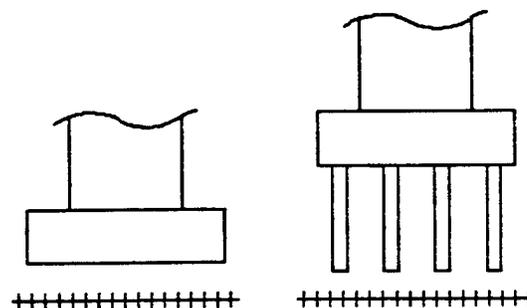
None - indicate rating of 8 for this item

B. Within limits of footing or piles



Conduct foundation structural analysis

C. Below pile tips or spread-footing base



Provide for monitoring and scour countermeasures as necessary

SPREAD FOOTING
(NOT FOUNDED
IN ROCK)

PILE FOOTING

+++++ = Calculated scour depth