Updated 3/22/2019

Bridge Office
Trunk Highway Bridge Flood Response Plan

Purpose

Bridges are vulnerable to damage and failure during flooding. Scour may undermine the bridge foundations or remove the protection from the abutment slopes. To protect the public and the bridges, the bridges should be monitored during flooding. Monitoring generally requires measuring the river bed elevation at the bridge. Monitoring may indicate that the bridge should be closed, corrective action should be taken immediately (such as removing debris), or that protection should be installed as soon as practical.

Each district is responsible for monitoring their bridges. This Flood Response Plan contains recommendations to the Districts on monitoring bridges and the support available from the Bridge Office.

Priority

Monitoring is recommended for all bridges during significant flooding. However, the extent, frequency, and the flood stage to begin monitoring will vary. The District is responsible to determine which bridges will be monitored; the Bridge Office recommendations are as follows:

Bridge Monitoring Recommendation

Priority	Bridge Description	Scour Code	Recommended Action
High	Scour critical with action plan	R, U	Follow action plan
High	Limited Risk, Monitor in lieu of eval.	K	Follow action plan
High	Known scour problems with no POA	Any Code	Follow general guidelines
Medium	Others with action plans	O, P, G	Follow action plan
Secondary	Scour susceptible bridges	F, J	Follow general guidelines
Secondary	Stable and low risk bridges	H, I, L, M, N	Follow general guidelines

Action Plans (POA) have been prepared for scour critical bridges and contain details on monitoring a specific bridge site. The Action Plan is on file in the District and at the Bridge Office. Bridges that do not have an action plan should be monitored using the general guidelines listed in this plan.

Monitoring Tools

Sounding weights and/or sonar are normally used to monitor the river bed elevations at the bridge. Both methods are usually used from the bridge deck. However, the measurements taken along the bridge fascia may not be located at the site of maximum scour which is usually close to the pier or abutment. Ice and debris may limit the locations and can cause inaccurate readings.

Each District should have at least one sonar unit. If no sonar units are available within the District contact the Bridge Office to borrow a unit or request they respond to the flooding. Most District's utilize truck-mounted winches for deploying sounding weights. However, two portable winches with 35 and 100 pound weights are available; they are located in District 1 - Duluth and District 6 - Rochester. If one of these units is needed, the scour coordinator from that District should be contacted.

If Mn/DOT is unable to monitor a certain bridge, the United States Geological Survey may be able to assist in monitoring that bridge with their equipment. Contact the Bridge Office Flood Coordinator if this is necessary.

A boat may be required to monitor pier scour at bridges over major rivers. Since safety of the operating personnel is a prime consideration, the boat must be of sufficient size and equipped properly to navigate around piers during flood stage.

Pre-flood Preparation

The District must be prepared to monitor when flooding occurs. Personnel who will monitor the bridges must have access to the necessary equipment and have adequate training. The District should have a plan for checking water surface elevations after rainfall or snowmelt, and notification procedures must be defined.

The District should conduct a pre-flood site investigation on all bridges with a high monitoring priority. The purpose of the pre-flood investigation is to prepare the bridge for monitoring and would include:

- Mark the locations at which measurements will be taken and measure baseline river bed elevations.
- Mark and survey a reference point elevation to measure the water surface elevation.
- Mark the water surface elevation at which monitoring should begin. May use Bridge Scour Monitoring Sign symbol.

Monitoring Frequency

Flooding that warrants monitoring of trunk highway bridges may occur any year. The District is responsible for determining if bridges are undergoing flooding conditions that require monitoring. The Bridge Office Flood Coordinator can be contacted by the District to assist in determining when monitoring shall commence and be suspended.

Action plans give the beginning flood stage at which monitoring is recommended. General guidelines are:

Begin monitoring:

- Scour Critical Bridges: As recommended in action plan
- Limited Risk and Scour Susceptible Bridges:
    - During significant flooding (water nears design high water elevation)
    - River nears elevation that has caused problems in past
    - Unusual conditions (such as large amount of debris)
- Stable or low risk Bridges:
    - River nears historic high water or design high water elevation
    - Unusual conditions (such as large amount of debris)

Initial Monitoring:

- Compare the measured bed elevation to the base line elevation. Determine if the bed has lowered significantly, a significant bed change is defined as:
    - 5 ft: Large rivers (river channel over 100' wide)
    - 2 ft: Medium/small rivers (river channel less than 100' wide)

Continued Monitoring:

- Significant bed changes are not detected: monitor once per day until flood crest begins to recede.
- Significant bed changes are detected: monitor a minimum of twice per day and contact the District Scour Coordinator or Bridge Office Flood Coordinator.
- Monitor continuously if river bed nears the critical scour elevation.

Monitoring Procedure

Monitor all critical piers and abutments to determine if the channel bottom elevation is changing.

- Maximum pier scour is expected to occur near the front face of the pier. If flood water is attacking the pier at a skew angle, the deepest scour is expected on the front or side that the flow impacts.
- Maximum abutment scour typically occurs at the toe of the abutment slope or the upstream corner of a vertical abutment.
- Bridges with abutment slopes should be monitored both at the toe of the abutment slope and next to the abutment foundation. If the foundation is undermined, the approach fill may be endangered.
- Foundations protected by countermeasures should be monitored. Riprap is not typically designed to withstand a 100 year or 500 year flood event. Monitor to verify that the riprap remains in place.

Measure for scour from the upstream face of the bridge if possible. However, if this is not possible due to ice or debris, measure from the downstream face. The notes should state where monitoring was taken and if ice or debris were present (since they can increase the amount of scour).

To measure river bed elevations:

- Measure the water surface elevation by measuring down from the bridge
- Determine bed elevation from water depth and known water surface elevation
- Record data. Include a water surface elevation, reference locations from a pier or the end of bridge. Elevations should be tied to MSL datum.

Action

For bridges with monitoring action plans (scour code R, U, K, O, P or G), follow the action plan recommendation to close the bridge if the riverbed lowers to the critical scour elevation. For bridges without an action plan, close the bridge if scour threatens the bridge stability.

- Notify the proper authorities
- Detour traffic (use Trunk Highways where practical)
- Review bridges on detour route for scour code and monitor if necessary.
- Check bridge after flood recedes/make recommendations for repair/protection

If large amounts of debris are at bridge, remove the debris if possible. If scour occurs at the bridge, consult with Bridge Office to see if protection should be installed.

Reporting
Report results of monitoring to the District Scour Coordinator daily. If scour reaches the critical river bed elevation, the monitoring personnel should take appropriate action and contact the District Scour Coordinator.

The District Scour Coordinator and Bridge Office personnel should regularly contact the Bridge Office Flood Coordinator to notify him/her of the flood monitoring results. The Flood Coordinator is responsible for coordinating all Bridge Office responses. In the event of wide spread flooding, the Bridge Office Flood Coordinator will provide the State Bridge Engineer with daily status reports.

After flooding has subsided, the District Scour Coordinator should summarize the bridges that were monitored and the results for the Bridge Office Flood Coordinator. The District may request that the Bridge Office review a specific bridge(s).

Bridge Office Services to the Districts

- The Bridge Office Flood Coordinator will monitor the following data sources to detect flooding which may affect Mn/DOT bridges.
    - River Flood Forecasts issued by the River Forecast Center.
    - Weekly Precipitation Maps issued by the Minnesota DNR.
    - Contact with other State and Federal agencies, including: National Weather Service; River Forecast Center; Corps of Engineers; Minnesota DNR; State Climatologist; United States Geological Survey.
- Contact District as soon as flooding is probable to alert them of flooding potential, offer our services and set up a line of communication.
- Act in an advisory capacity to provide technical expertise on flood monitoring techniques, identify bridges that should be monitored, and analyze flood monitoring results.
- Provide additional flood monitoring resources when available, including: staff, equipment and use of consultants through contracts.

BRIDGE OFFICE CONTACTS

See the Bridge Scour Contacts sheet at: http://ihub/bridge/hydraulics/scour/pdf/scour-contact-list-2019.pdf