WTRC
Western Transportation
Research Consortium

JUNE 2026

RESEARCH POINTS

Practices for Estimating Bridge Scour During Extreme Hydrological Events

Bridge scour, the erosion of soil around bridge foundations caused by the removal of bed material and streambed sediments due to water flows, is a leading cause of bridge failure. Debris, woody material, and other material can become snagged on piers and abutments, increasing the scour potential. Assessing scour during extreme flood events presents challenges and dangers for state departments of transportation (DOTs), which are responsible for monitoring large bridge inventories. To better understand current practice and inform possible next steps for research, the Western Transportation Research Consortium pooled fund study conducted a synthesis of national practice to examine current and promising technologies used to estimate bridge scour in both normal and high-flow conditions.

(Source: U.S. Geological Survey.)

Taking measurements of the streambed and gathering hydrometric data during typical base flow conditions can help determine scour severity during more extreme flow events.

Need

State transportation agencies rely on a variety of established methods to evaluate scour under normal flow conditions, including field inspections, manual data collection, and hydraulic modeling. During high water flow and flooding events, however, safety risks from deep, fast-moving and opaque waters often prevent direct measurements. This leaves agencies to depend on predictive tools and alternative technologies to make time-sensitive decisions about bridge closures, load restrictions, and emergency response.

There is growing interest in ways to collect data during hazardous conditions and support reliable scour estimates. This study was conducted to document current scour monitoring practices and their effectiveness, understand current needs for improving scour monitoring, examine new techniques in use or being developed, and identify opportunities for next steps.

Research

Thirty state DOTs responded to a nationwide survey about current

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> "Exploring technologies that provide key measurements while protecting staff during high flow, extreme events is of utmost importance to the DOT."
>
> — **Michael Tanner,**
> **State Hydraulic Engineer, Colorado DOT**

practices, challenges, and areas of interest related to scour monitoring. Responses were grouped into four primary categories: modeling, field inspections and manual tools, sonar technologies, and remote or real-time monitoring systems. A literature review complements the survey findings and includes state manuals, agency guidance, and research produced by responding DOTs, grounding the findings in real-world practice.

Results

Findings show that agencies rely on a combination of traditional methods and newer technologies to monitor scour.

During normal flow conditions, states use analytic guidance and hydraulic modeling tools such as HEC-18, HEC-RAS, SRH-2D, and the FHWA Hydraulic Toolbox. Field inspections and manual measuring tools are also widely used. Fewer agencies employ sonar technologies or real-time or remote visual monitoring systems during normal conditions.

About half of the states responding to the survey reported that safety concerns prevent them from taking direct measurements during extreme flooding events. In these situations, states rely primarily on modeling supported by inputs such as USGS stream gage, weather, and precipitation data.

States also use visual inspections and manual tools such as weighted tapes, scour placards, and handheld velocity meters when conditions allow. Less frequently reported technologies include sonar deployed during or shortly after flood events, Doppler current profilers, and depth finders.

Several states also use or have piloted remote and real-time monitoring tools during extreme events. These include LiDAR, drones, stream cameras, tilt sensors, and online monitoring platforms. While such tools offer the potential for safer, continuous data collection, their use is typically limited to high-risk sites due to cost, maintenance requirements, and concerns about durability in extreme conditions.

Agencies consistently combine modeling, field observations, and monitoring technologies to improve confidence in scour estimates. Some of the most effective approaches pair modeling with streamgage, sonar, and sensor-based data. Common challenges include limited gage coverage, resource constraints, equipment vulnerability, and restricted site access during extreme events.

Next Steps

The study findings highlighted several opportunities to strengthen scour monitoring practice:

- Expand monitoring coverage, particularly at scour-critical bridges, to provide more data for emergency response decision-making.
- Employ technologies that can withstand turbulent conditions, such as drones, radar-based systems, and embedded sensors.
- Invest in training to support deployment and interpretation of advanced monitoring tools.
- Evaluate cost-benefit tradeoffs for technologies with higher upfront costs but potential long-term safety and efficiency gains.
- Strengthen collaboration across agencies to expand access to data and track pilot projects to identify promising tools.

About This Pooled Fund

Western Transportation Research Consortium (WTRC)

Study Detail: TPF-5(526)
Study website

Participating Agencies
Alaska DOT&PF
Caltrans
Colorado DOT
Idaho TD
Montana DOT
Nebraska DOT
Nevada DOT
New Mexico DOT
North Dakota DOT
Oklahoma DOT
South Dakota DOT
Texas DOT
Utah DOT
Washington State DOT
Wyoming DOT

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About This Research Project

Title: Estimating Bridge Scour During Hydrological Disaster and Extreme Weather Events: Synthesis of Practice

Report No. WTRC-003
Project web page

Report Date:
March 2026