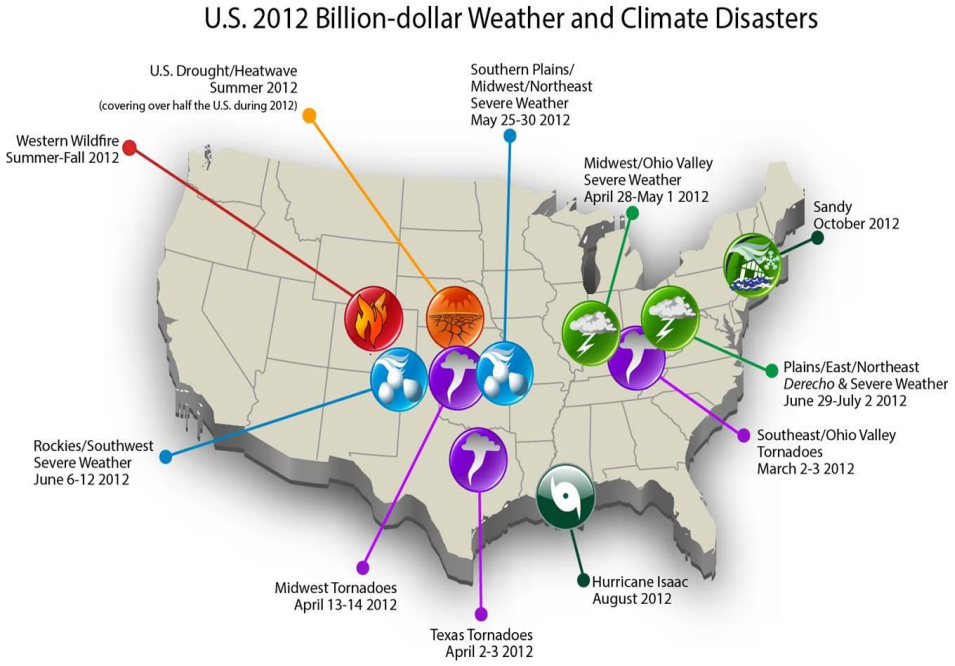
AASHTO
EXTREME WEATHER & THE TRANSPORTATION SYSTEM

Extreme Weather Events and Potential Impacts on Maintenance

Extreme weather events affect nearly every state in the U.S. In 2012, a total of 133 disaster events[i] occurred resulting in about $881 billion in damages[ii] (see NOAA NCDC graphic[iii] at right). Events ranged from hurricanes, droughts, heat waves, severe local storms, non-tropical floods, and winter storms, to wildfires and freezes. There is strong evidence that events related to heat, heavy precipitation, and coastal flooding will grow in frequency and severity in coming decades and we will likely continue to experience droughts and tropical storms. Changes in the frequency or intensity of extreme weather events could require changes in maintenance procedures. For example, how does one plan for the maintenance of assets differently provided changes in weather-related stressors like increased temperatures, precipitation, freeze-thaw cycles, wind or storm exposure?



How Can Maintenance Managers and Staff Prepare for Extreme Weather Events?

Although DOT experience will vary by state, below is a "Top 10" list of maintenance suggestions to better prepare for extreme weather.

1. **Culverts and Drainage Structures:** Keep culverts and drainage structures debris free and maintained to handle flows.
2. **Materials & Equipment:** Develop strategies for responding to transportation system disruptions due to weather-related events, including pre-positioning of replacement materials (e.g., culvert pipe, temporary bridge components, fuel, stone armor) and equipment (e.g., generators, chain saws, traffic control devices) for easy deployment in vulnerable areas.
3. **Debris Removal:** Develop agency strategies for identifying potential debris sources (i.e., survey upstream unstable bank vegetation) and for handling debris removal subsequent to an extreme weather event. Strategies could include potential stand-by contracts to increase response capacity and shorten reaction time, and coordination with environmental agencies to expedite debris removal and disposal.
4. **Contingency Plans:** Have contingency plans for bridge and road closures, power outages, detours, debris clearance, and routing for overweight or disabled trucks. Include pre-approved contractors and funds.
5. **Backup Power:** Put in place power back up for electrical devices in areas prone to extreme weather events.
6. **Back up Communications:** Prepare backup communications such as satellite phones, portable highway advisory radios, truck radios, and alternative networks.
7. **Early Warning Systems:** Incorporate "early warning indicators" such as the use of Roadway Weather Information Stations (RWIS) to plan for extreme weather-related risks. Over the longer term, incorporate indicators into maintenance management systems.
8. **Harden the System:** Avoid significant disruptions and maintenance demands by "hardening" such items as sign structures and traffic signal wires.
9. **Workforce Training:** Provide greater cross-training of staff, across the agency, to enhance the ability to adapt and mobilize for emergency situations.
10. **Future Protection:** Consult with designers about more durable materials and designs (e.g., paints, paving materials, drainage features), including those that can easily be modified as climate conditions change. Further, map and track maintenance costs associated with extreme weather events to inform future maintenance budgetary needs.

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Center for Environmental Excellence

U.S. Department of Transportation
Federal Highway Administration

Maintenance Resources for Extreme Weather Preparedness

PUBLICATIONS

- **Climate Change, Extreme Weather Events and the Highway System** (NCHRP Report 750, Volume 2, 2014). This report presents guidance for practitioners on adaptation strategies to likely impacts of climate change in the planning, design, construction, operation, and maintenance of infrastructure assets in the U.S.
- **Expedited Procurement Procedures for Emergency Construction Services** (NCHRP Synthesis 438, Nov. 2012). This report explores procurement procedures being utilized by State DOTs in coordination with Federal agencies to repair and reopen roadways in emergency situations.
- **Research Results Digest 378: Evaluation of Bridge Scour Research** (NCHRP Project 24-27(01/02/03), Sept. 2012). Through three research projects related to bridge scour, key findings are summarized covering evaluation of processes and predictions related to pier scour, abutment and contraction scour, and geomorphic scour.
- **Transportation Research Record Journal No. 2292: Maintenance and Preservation** (Dec. 2012). This journal is a compilation of 20 research papers on roadway maintenance and preservation-related topics including maintenance costs of extreme weather events, climate impact on asphalt pavement preservation, and carbon emissions of road maintenance.
- **Western Iowa Missouri River Flooding – Geo-Infrastructure Damage Assessment, Repair, and Mitigation Strategies** (Aug. 2013). The Center for Earthworks Engineering Research report addresses the effects of the 2011 Missouri River flooding on Iowa's geo-infrastructure systems (e.g., levees, bridge abutments and foundations, paved and unpaved roadways, culverts and embankment slopes) and offers 20 potential repair and mitigation solutions related to damage type.

GUIDANCE AND RULES

- **Eligibility of Activities To Adapt To Climate Change and Extreme Weather Events Under the Federal-Aid and Federal Lands Highway Program** (Sept. 24, 2012). Memo clarifies activities eligible for FHWA funding, including vulnerability assessments, design and construction of projects or features to protect assets from damage associated with climate change.
- **Hydraulic Engineering Circular No. 9, Debris Control Structures, Evaluation and Countermeasures** (Oct. 2005). Circular provides information on debris accumulation and various debris control countermeasures available for culvert and bridge structures.
- **MAP-21, Section 1315 – USDOT Final Rule on Categorical Exclusions (CE) for Emergency Repair Projects** (Feb. 19, 2013). Rule revises the existing CE for emergency repair projects under Moving Ahead for Progress in the 21st Century Act (MAP-21).
- **MAP-21, Section 1511 – Special Permits During Periods of National Emergency Implementation Guidance, Revised** (June 2013). Section provides policy direction on special permits for divisible loads and guidance describing the program's purpose, permit requirements, and ineligible activities.

WEBSITES

- **AASHTO Transportation and Climate Change Resource Center:** Extreme Weather Symposium, 2013. Materials on recent extreme weather events, costs, and how DOTs can manage them. climatechange.transportation.org/symposium/
- **FHWA Climate Change Adaptation Website:** www.fhwa.dot.gov/environment/climate_change/adaptation/
- **Emergency Management Assistance Compact (EMAC):** http://www.emacweb.org/
- **Center for Climate and Energy Solutions:** Interactive map depicting extreme weather events, 1990-2012. www.c2es.org/science-impacts/maps/extreme-weather

OTHER RESOURCES

AASHTO's Sustainable Transportation: Energy, Infrastructure, and Climate Solutions (STEICS) Technical Assistance Program provides timely information, tools, and technical assistance to State DOTs to manage challenging issues associated with extreme weather events. (http://climatechange.transportation.org/about/steering_committee.aspx)

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[i] "Disaster events" in this context have been defined as tropical cyclones (e.g., hurricanes), droughts/heatwaves, severe local storms, non-tropical floods, winter storms, wildfires, and freezes.

[ii] Smith and Katz, Natural Hazards, June 2013, Volume 67, Issue 2, pp. 387-410.

[iii] Source: NOAA NCDC at www.ncdc.noaa.gov/billions/summary-stats