



# 2015 SPRING FLOODING OUTLOOK AND POTENTIAL IMPACTS TO CRITICAL INFRASTRUCTURE

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## SCOPE

The Department of Homeland Security's Office of Cyber and Infrastructure Analysis (DHS/OCIA)<sup>1</sup> produces Critical Infrastructure Security and Resilience Notes in response to changes in the infrastructure protection community's risk environment from terrorist attacks, natural hazards, and other events. This product provides an overview of the National Oceanic and Atmospheric Administration (NOAA) 2015 Spring Flooding Outlook, and examines the potential impacts to U.S. critical infrastructure. This product is an update to the May 16, 2014 OCIA Spring Flooding and Critical Infrastructure Note.<sup>2</sup> This updated Critical Infrastructure Security and Resilience Note supports DHS leadership, the DHS Protective Security Advisors, and other Federal, State, and local agencies.

This product was developed in coordination with the DHS National Protection and Programs' (NPPD) Office of Infrastructure Protection's Sector Outreach and Programs Division (SOPD), DHS' Federal Emergency Management Agency (FEMA), NOAA, and the US Army Corps of Engineers (USACE).

OCIA will continue to monitor conditions and produce additional analysis if significant flooding occurs.

## KEY FINDINGS

- **Spring flooding occurs annually in many regions in the United States and is often the result of late summer and fall precipitation, frost depth, soil saturation levels, stream flow levels, snowpack, temperatures and rate of snowmelt. NOAA predicts that there are no widespread areas at risk of exceeding major flood levels for 2015.**
- **The NOAA 2014 Spring Flooding Outlook stated rivers in half the continental United States were at minor to moderate risk of exceeding flood levels; heavy rains produced major flooding in Missouri, Illinois, Iowa, Minnesota, South Dakota, Nebraska, Georgia, Alabama, and Mississippi.**
- **OCIA assesses that the critical infrastructure sectors most likely to be degraded or disrupted during a flood event are the Transportation Systems, Energy, Dams, Water and Wastewater Systems, Food and Agriculture, and Chemical Sectors.**
- **OCIA assesses that after a flooding event and the water subsides, restoration should focus on lifeline sectors. Priority for restoration should be given to the following Sectors and Subsectors: Water and Wastewater Systems, Healthcare and Public Health, Electric Power, Telecommunications, and Oil and Natural Gas.**

<sup>1</sup> In February 2014, NPPD created the Office of Cyber and Infrastructure Analysis by integrating analytic resources from across NPPD including the Homeland Infrastructure Threat and Risk Analysis Center (HITRAC) and the National Infrastructure Simulation and Analysis Center (NISAC).

<sup>2</sup> For more information on flooding impacts to critical infrastructure, please see the May 16, 2014 Critical Infrastructure Security and Resilience Note, "Spring Flooding and Critical Infrastructure" available on HSIN-CI or by request at OCIA@hq.dhs.gov.

## OVERVIEW

Flooding events during the spring are an annual occurrence in many areas of the United States and several conditions contribute to these events:

- **Precipitation:** Additional precipitation could lead to minor-to-moderate flooding in some areas.
- **Permafrost and Ice:** The extreme cold of winter often freezes the ground along with bodies of water. During the spring, frozen land prevents melting snow or rainfall from seeping into the ground.<sup>3</sup> The heavy snowpack and frozen lakes, rivers, and streams can bring a high risk of flooding if a fast melt were to occur. Melting can cause runoff and ice jams that result in flooding to surrounding areas.
- **Snowpack:** The seasonal accumulation of slow-melting packed snow.<sup>4</sup> In many areas, snowpack replenishes groundwater, lakes, rivers, and streams. Flooding can occur from a rapidly melting snowpack. Heavy precipitation can also cause rivers and streams to overtop in areas where there is large accumulation of snowpack.

## 2015 SPRING FLOOD OUTLOOK

The 2015 NOAA Spring Flooding Outlook quantifies river flood risk based on the river location having a 50 percent or more likelihood of exceeding minor, moderate, or major flood levels. Analysis of flood risk and water supply integrates late summer and fall precipitation, frost depth, soil saturation levels, stream flow levels, snowpack, temperatures and rate of snowmelt.<sup>5</sup> The National Weather Service (NWS), in coordination with local officials nationwide, defines flood categories as:

- **Minor Flooding** – Minimal or no property damage, but possibly some public threat (e.g., inundation of roads).
- **Moderate Flooding** – Some inundation of structures and roads near the stream. Some evacuations of people or transfer of property to higher elevations.
- **Major Flooding** – Extensive inundation of structures and roads. Significant evacuations of people or transfer of property to higher elevations.

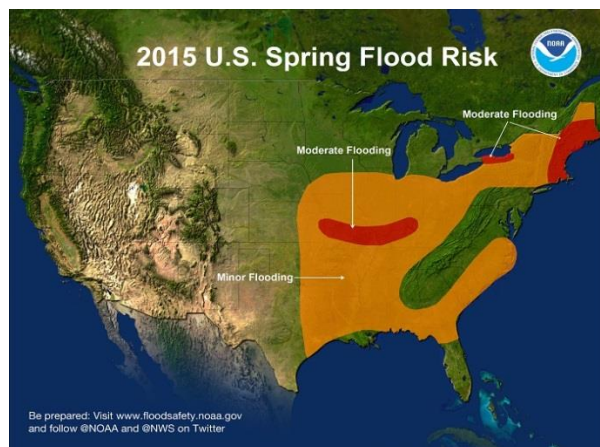


FIGURE 1—2015 SPRING FLOOD OUTLOOK<sup>6</sup>

As illustrated in Figure 1, NOAA predicts that there are no widespread areas at risk of exceeding major flood levels for 2015. Significant river ice across the interior northeastern United States increases the possibility of localized major flooding. Below normal seasonal soil moisture, limited frost depths, and below normal ground

<sup>3</sup> Ready.gov, "Floods," [www.ready.gov/floods](http://www.ready.gov/floods), accessed March 30, 2015.

<sup>4</sup> Merriam-Webster Dictionary, "Snowpack," [www.merriam-webster.com/dictionary/snowpack](http://www.merriam-webster.com/dictionary/snowpack), accessed March 30, 2015.

<sup>5</sup> NOAA "2015 Spring Flood Outlook," [www.nws.noaa.gov/hic/nho/](http://www.nws.noaa.gov/hic/nho/), accessed March 24, 2015.

<sup>6</sup> NOAA "2015 Spring Flood Outlook," [www.nws.noaa.gov/hic/nho/](http://www.nws.noaa.gov/hic/nho/), accessed March 24, 2015.

water levels will allow snowmelt to infiltrate into the ground alleviating flood risk. There is a 50 percent chance of exceeding moderate flood levels in small streams and rivers in the lower Missouri River basin in Missouri and eastern Kansas. Moderate flooding is expected in the Ohio River basin including portions of southern Illinois, southwestern Indiana, and western Kentucky. Minor flooding is possible from the Gulf Coast through the Ohio River Valley and into the Southeast, including east Texas, Louisiana, Arkansas, Missouri, southern Iowa, Illinois, Indiana, Ohio, Kentucky, Mississippi, southern and western Alabama, southern Georgia, northern Florida, the coastal Carolinas and coastal Virginia. The flood potential in Alaska is below normal due to low levels of snowmelt and ice jams this spring.

## NEW ENGLAND AND WESTERN NEW YORK

Due to the record cold and snowy period during the second half of the winter in 2014-2015, deep snowpack and significant river ice remain (Figure 2). Snow water contents of 3 to 7 inches cover southern New England, with up to 10 inches in the higher terrain of northern New York State, down east Maine, and the mountains of northern New England. River ice thicknesses are running 1 to 2 feet across interior and northern New York State and northern New England. Heavy rains and warm temperatures could cause localized major flooding.

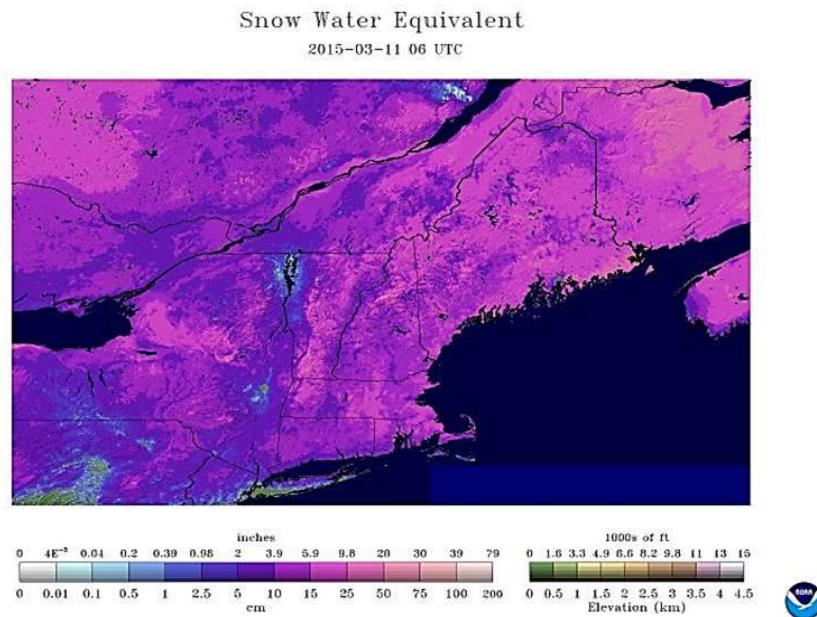


FIGURE 2—SNOW WATER EQUIVALENT<sup>7</sup>

## LOWER MISSOURI AND LOWER OHIO BASINS

The lower Missouri River basin in Missouri and eastern Kansas has a threat of moderate flooding due to rain storms typical during the spring. Recent winter storms brought rain and snow to the lower Ohio River Valley that has primed soils and streams for the typical heavy spring rains, which impact these areas with flooding every year.

## OHIO VALLEY, TENNESSEE, AND CUMBERLAND VALLEYS

Experiencing prolonged periods of significant cold and stormy weather this winter, locations in Illinois, Indiana, Ohio, Kentucky, Tennessee and West Virginia are likely to experience minor flooding, due to river ice breakup in

<sup>7</sup> NOAA, "Snow Water Equivalent," [www.noahsc.noaa.gov/snow\\_model/images/full/Northeast/nsm\\_swe/201503/nsm\\_swe\\_2015031105\\_Northeast.jpg](http://www.noahsc.noaa.gov/snow_model/images/full/Northeast/nsm_swe/201503/nsm_swe_2015031105_Northeast.jpg), accessed March 24, 2015.

northern regions and potential spring rains. Due to the abnormally cold and snowy winter in these areas, snowmelt has already contributed to flooding; spring rains may quickly change river levels and increase flood risk in these areas.

## SOUTHERN PLAINS AND SOUTHEASTERN UNITED STATES

Minor flooding is possible across the Southeast, including Missouri, Arkansas, Louisiana, Mississippi, Alabama, Georgia and northern Florida. Minor to moderate flooding has already begun in eastern Texas. The flood potential is driven by spring rainstorms where near to above-average soil moisture conditions exist.

## 2014 SPRING OUTLOOK AND ACTUAL RESULTS

In March 2014, NOAA published the 2014 Spring Flooding Outlook, which stated rivers in half the continental United States were at minor to moderate risk of exceeding flood levels.<sup>8</sup> Predictions called for delayed flooding due to winter weather, above average snowpack, frozen ground and thick ice coverage on streams and rivers. The intensity of the flooding was dependent on the rate of snow and ice melt and future rainfall. In general, the spring and summer months saw massive amounts of rainfall over several days which resulted in major flooding across many states. Below are the predictions and observations (see Table 1).

TABLE 1—2014 FLOODING PREDICTIONS AND OUTCOMES

| 2014 PREDICTIONS   | 2014 OBSERVATIONS   |
|--|---|
| Southern Great Lakes region at highest risk of flooding due to above-average snowpack and a deep layer of frozen ground.   | <p>April 2014, Michigan saw heavy rainfall coupled with snow melt causing severe flooding of the Muskegon River.<sup>9</sup></p> <p>June 2014, Lake Superior's ice had finally melted making it the latest ice-out date in 40 years of recordkeeping.<sup>10</sup> The Great Lakes basin received 120 percent of its average summer precipitation. Thirty-five of Minnesota's 87 counties declared a State of Emergency due to flooding.<sup>11</sup></p> |
| Moderate flooding in parts of southern Wisconsin, southern Michigan and portions of Illinois, Indiana, and Iowa due to snowpack and deep layer of frozen ground. | July and August 2014, heavy rainfall caused severe flooding in Missouri, Illinois, Iowa, Michigan and Minnesota. <sup>12,13</sup>   |
| Moderate flooding along the Red River between eastern North Dakota and northwest Minnesota and western South Dakota due to saturated soils.                      | June 2014, South Dakota, Iowa, and Nebraska saw massive amounts of rain resulting in severe flooding. <sup>14</sup>   |
| Minor flooding for the southern states depending on rainfall.  | <p>April 2014, Georgia, Alabama, and Mississippi faced severe river flooding due to heavy rainfall.<sup>15</sup></p> <p>May 2014, Texas, Louisiana, and Florida saw heavy amounts of rainfall resulting in widespread flooding.<sup>16,17</sup></p>   |

<sup>8</sup> NOAA, "2014 Spring Flood Outlook," [www.noaa.gov/stories/2014/20140320\\_springoutlook.html](http://www.noaa.gov/stories/2014/20140320_springoutlook.html), accessed March 25, 2015.

<sup>9</sup> Floodlist, "Floods Damage 403 Homes in Newaygo County, Michigan," [floodlist.com/america/usa/floods-damage-403-homes-newaygo-county-michigan](http://floodlist.com/america/usa/floods-damage-403-homes-newaygo-county-michigan), accessed March 27, 2015.

<sup>10</sup> NOAA Great Lakes Region, "Quarterly Climate Impacts and Outlook," [mrcc.isws.illinois.edu/pubs/docs/GL-201409Summer\\_Final.pdf](http://mrcc.isws.illinois.edu/pubs/docs/GL-201409Summer_Final.pdf), accessed April 1, 2015.

<sup>11</sup> Floodlist, "Cost of the June 2014 Minnesota Floods," [floodlist.com/america/usa/cost-minnesota-floods-june-2014](http://floodlist.com/america/usa/cost-minnesota-floods-june-2014), accessed March 27, 2015.

<sup>12</sup> Floodlist, "Storms Hit Central USA – Floods in Missouri, Illinois and Iowa," [floodlist.com/america/usa/storms-hit-central-usa-floods-missouri-illinois-iowa](http://floodlist.com/america/usa/storms-hit-central-usa-floods-missouri-illinois-iowa), accessed March 27, 2015.

<sup>13</sup> NOAA Great Lakes Region, "Quarterly Climate Impacts and Outlook," [mrcc.isws.illinois.edu/pubs/docs/GL-201409Summer\\_Final.pdf](http://mrcc.isws.illinois.edu/pubs/docs/GL-201409Summer_Final.pdf), accessed April 1, 2015.

<sup>14</sup> Floodlist, "Floods Across South Dakota, Iowa, and Minnesota," [floodlist.com/america/usa/floods-south-dakota-iowa-minnesota](http://floodlist.com/america/usa/floods-south-dakota-iowa-minnesota), accessed March 27, 2015.

<sup>15</sup> Floodlist, "Floods in Southern USA – 2 Killed, 100s Evacuated," [floodlist.com/america/usa/floods-southern-states-kill-2](http://floodlist.com/america/usa/floods-southern-states-kill-2), accessed March 27, 2015.

<sup>16</sup> Floodlist, "Louisiana Floods – Floating Caskets and Stray Alligators," [floodlist.com/america/usa/louisiana-floods-floating-caskets-stray-alligators](http://floodlist.com/america/usa/louisiana-floods-floating-caskets-stray-alligators), accessed April 1, 2015.

# FLOODING SEVERITY AND INFRASTRUCTURE IMPACTS

Although a flood event could affect all critical infrastructure sectors, the Transportation Systems, Energy, Dams, Water and Wastewater Systems, Food and Agriculture, and Chemical Sectors are likely to experience the greatest infrastructure impacts. The NWS defines flood levels based on the impact over a given area; the impact to infrastructure depends on the severity of flooding (see Table 2).<sup>18</sup>

TABLE 2—FLOODING SEVERITY AND INFRASTRUCTURE IMPACTS

| Flooding Severity and Infrastructure Impacts |  |   |
|--|--|---|
| Type   | Severity   | Likely Sector Impacts   |
| Minor  | Minimal or no property damage, but possibly some public threat (e.g., inundation of roads).  | <b>Transportation Systems:</b> The inundation and under-cutting of sections of roadways is likely and could impact public safety.   |
| Moderate                                     | Some inundation of structures and roads near streams. Some evacuations of people or the transfer of property to higher elevations. | <p><b>Transportation Systems:</b> Some threat to public safety due to inundation of structures and roads. Increased water levels could impact river traffic and disrupt lock systems.</p> <p><b>Dams:</b> Levees could be impacted; earthen dams in the inundation zone could be damaged.</p> <p><b>Water and Wastewater Systems:</b> Contamination by flood water or compromise or loss of water delivery systems could occur.</p>   |
| Major  | Extensive inundation of structures and roads. Significant evacuations of people or transfer of property to higher elevations.      | <p><b>Transportation Systems:</b> Roads, rails, and ports could be damaged or destroyed.</p> <p><b>Water and Wastewater Systems:</b> Wastewater for overload of water; water for contamination or intake issues.</p> <p><b>Dams:</b> Levees could become inoperable; earthen dams could be damaged or destroyed; other types of dams could become strained or compromised, overtopping could occur.</p> <p><b>Energy:</b> Production and distribution impacts could occur.</p> <p><b>Food and Agriculture:</b> Depending on the timing of flooding, planting seasons could be impacted as well as transportation and distribution.</p> <p><b>Chemical:</b> The supply chain of key chemicals could be interrupted.</p> <p><b>Emergency Services and Healthcare and Public Health:</b> May be impacted if involved with evacuations.</p> |

<sup>17</sup> Floodlist, "Florida Requests Federal Help After Floods," <http://floodlist.com/america/usa/florida-requests-federal-help-floods>, accessed April 1, 2015.

<sup>18</sup> NOAA, "Spring Flooding Outlook," [www.nws.noaa.gov/hic/nho](http://www.nws.noaa.gov/hic/nho), accessed March 24, 2015.

## INFRASTRUCTURE IMPORTANT TO RESPONSE AND RECOVERY

After flooding subsides, restoration should focus on lifeline sectors and services, and then to other critical infrastructure sectors. Lifeline sectors and subsectors include Water and Wastewater Systems, Healthcare and Public Health, Electric Power, Telecommunications, and Oil and Natural Gas (see Table 3).

**TABLE 3—RESTORATION PRIORITY SECTORS FOLLOWING A FLOOD EVENT**

| Infrastructure  | In Preparation   | Restoration and Decision Maker Awareness   |
|---|--|--|
| <b>Drinking Water and Wastewater Facilities</b>                   | <p>Announce a drinking water alert for areas serviced by facilities that are in the flood zone (impacted area vs. flooded area may not be the same).</p> <p>Have water trailers on standby to deliver water to impacted areas.</p>   | <p>Drinking water and wastewater service should be restored as quickly as possible after flooding subsides.</p> <p>Drinking water service in flooded areas and areas serviced by facilities within the flooded areas are likely to be contaminated.</p> <p>Generally, 5 or more feet of flooding for water and wastewater facilities may render the facilities inoperable or contaminated.</p> |
| <b>Hospitals and Public Health</b>                                | <p>Evacuate hospitals that are projected to be in the flood zone.</p> <p>Ensure hospitals near the flood zone have sufficient fuel (3-day minimum) and electrical power backups.</p> <p>Onset of illness due to water contamination is possible; alert public as to the potential health hazards associated with flooding.</p> | <p>Restoration of hospitals in the flooded area is important, but should be secondary to basic services (water and wastewater, electric power, telecommunications), since hospitals cannot function for extended periods without these services.</p>   |
| <b>Nursing Homes, Assisted Living, and Vulnerable Populations</b> | <p>Ensure that any of these facilities in the flooded area are evacuated.</p>  | <p>People from these facilities could be temporarily deferred to other facilities; therefore, restoration of these facilities is not a high priority.</p>  |
| <b>Electric Power</b>   | <p>Survey areas serviced by any electric power substations that are projected to be flooded. Some of the areas that lose power may be outside the flooded area.</p> <p>If possible, inform critical infrastructure facilities in the electric power substation service areas that there may be a disruption.</p>               | <p>Once flooding subsides, electric power should be restored as quickly as possible to enable restoration and recovery.</p> <p>Electric power outages would be expected to be fairly localized. Electric power should be restored in a matter of days to weeks.</p> <p>Rising water can render electric power facilities inoperable; low-laying equipment would be of most concern.</p>        |



| Infrastructure   | In Preparation  | Restoration and Decision Maker Awareness   |
|--|---|--|
| <b>Telecommunications</b>                                    | <p>Survey areas serviced by telecommunication facilities that are projected to be flooded. Some of the areas that lose power may be outside the flooded area.</p> <p>If possible, inform critical infrastructure facilities in the telecommunication facilities' service areas that there will be a disruption.</p> | <p>Once flooding subsides telecommunications should be restored as quickly as possible to enable restoration and recovery.</p> <p>Telecommunications outages should be fairly localized. Electric power should be restored in a matter of days to weeks.</p> <p>Rising water can render telecommunications facilities inoperable; low-laying equipment would be of most concern.</p> |
| <b>Oil, Natural Gas, Chemical, and Industrial Facilities</b> | <p>Shut down facilities in the projected flooding area.</p> <p>Advise facilities in the region that disruption of electric power may interrupt operations.</p> <p>Ensure hazardous materials have been secured.</p>   | <p>Facilities that have not been flooded but have experienced electrical outages could be restored in days to weeks.</p> <p>If a facility's components have been flooded, operations may take weeks to restore.</p>  |
| <b>Police, Fire, and Ambulance</b>                           | <p>Evacuate essential equipment (e.g., fire trucks, and communication equipment), outside of the flooded area.</p> <p>Establish temporary stations for equipment and resources outside the flood zone.</p>  |  |

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