# Rainfall Analysis of the June 27th, 2020, Flash Flood in the Vicinity of Kentland, IN

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## Summary

Very heavy rainfall from two waves of thunderstorms occurred in the vicinity of Kentland, IN, from late June 26th, 2020, through late June 27th, 2020. The first wave of rainfall moved into the general area (Kankakee and Iroquois Counties in Illinois, Newton, Jasper, and Benton Counties in Indiana) just after 10PM on June 26th (0300UTC June 27th) and dissipated around 2AM on June 27th (0700UTC). A second wave of rainfall formed about 3AM on June 27th (0800UTC) and moved out of the area around 7AM (1200UTC). About 1PM June 27th (1800UTC) a third wave of rainfall formed which was the heaviest of the three for the Kentland area. This rainfall ending just before 10PM June 27th (0300UTC June 28th).

Gridded rainfall estimates indicated that areas of Kankakee, Iroquois, Newton, Jasper, and Benton Counties received heavy rainfall, with the heaviest rainfall near the Newton/Benton County boundary and Kentland, IN. Data from 63 rain gauges was collected and analyzed with the gridded rainfall estimates. Rainfall was also compared to NOAA Atlas 14 to determine how common or rare a given location's storm total rainfall was. And isolated area near Kentland, IN, likely received 8-9 inches of rainfall over a two (2) day period ending at 1200UTC (7AM CDT) on June 28th, with about 8 inches of that occurring in about 24-hours. Observed rainfall ranged from unusual to extreme across the general area, with maximum rainfall amounts having less than a 1% chance of occurring in a given year. Rainfall of the analyzed magnitude is usually associated with significant flood impacts.





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## Data Sources and Data Collection

The official rainfall estimates created by the National Weather Service (NWS) come from the River Forecast Centers (RFCs). Gridded rainfall estimates come from radar estimates adjusted (bias-corrected) to better match observed rainfall at rain gauge locations. Gridded rainfall data is then manually quality controlled each hour. Data becomes available 30-60 minutes after the top of the hour, but may still be reviewed and adjusted by NWS forecasters for a few days after the rainfall occurred due to the availability of additional data. It should be noted that during real-time operations, local NWS Weather Forecast Offices (WFOs) have access to the unadjusted rainfall estimates from radar which are available every few minutes.

The three waves of rainfall (hereafter referred to as the "storm total") that occurred during this event began about 10PM on June 26th (0300UTC June 27th) and ended about 10PM June 27th (0300UTC June 28th). This rainfall event spanned two calendar days (midnight to midnight, including June 26$^{th}$ and June 27$^{th}$) and also two meteorological observation days (1200UTC (7AM CDT) to 1200 UTC, including the periods ending on June 27$^{th}$ and June 28$^{th}$). This presented a challenge for analysis due to the different periods of time covered by the individual waves of rainfall, the storm total, and the multiple definitions of "day" (Figure 1). Most of the rainfall occurred over a 24-hour period, but this didn't line up with either of the other definitions of "day." Although some very light amounts of rainfall occurred outside of this storm total period, it was not considered significant enough to analyze. This caused the "storm total" amounts to be slightly less than the accumulated totals over the two meteorological observation days; this difference will be elaborated on further in subsequent discussion.

A substantial amount of additional rainfall information was collected to perform analysis on rainfall that occurred on June 26$^{th}$ and 27$^{th}$, 2020. For the areas hardest-hit by rainfall, 6 gauges would be available to NWS forecasters in real-time operations. Real-time gauges include those operated by the FAA (ASOS and AWOS) and the US Geological Survey (USGS). No real-time FAA or USGS rain gauge information is available in the immediate Kentland area. Once per day, additional rainfall information is available from manual observations which can be used to further improve gridded rainfall estimates. This rainfall data comes from the NWS cooperative observer program (COOP) and the Community Collaborative Rain Hail and Snow (CoCoRaHS) network and cover a meteorological observation day (24-hour period ending at 1200 UTC or 7AM CDT). Data was available from 29 of these stations across the area, of which two (2) CoCoRaHS locations are near Kentland. There are also numerous additional

private weather stations located throughout the larger area of interest that have varying quality and usefulness. Private weather station data is available from the Citizen Weather Observing Program (CWOP) and also from Weather Underground Private Weather Station (WUPWS) network. Data was collected from 27 such private weather stations including two (2) near Kentland, although one of the Kentland stations had erroneous data and had to be discarded. In total, hourly and daily rainfall data was collected for 63 locations (Figure 2).

## Rainfall Amounts

Portions of Kankakee and Iroquois Counties in Illinois and Newton, Jasper, Benton, and White Counties in Indiana received several inches of rainfall between 10PM on June 26th and 10PM on June 27th, 2020. According to the bias-corrected gridded rainfall from the NWS RFCs, each of the indicated counties had at least some areas receiving greater than 1.0 inch of rainfall over the 2-day period ending at 1200UTC (7AM) June 28th. The heaviest rainfall amounts were estimated to have occurred just southeast of Kentland, IN, near the Newton County and Benton County boundary, where at least 6.0 inches of rainfall was estimated. A steep gradient from lighter rainfall amounts to higher rainfall amounts was evident close to the hardest-hit area. Although small amounts of rainfall occurred at other times within the 2-day period, the overwhelming majority of the rainfall appeared to occur over the "storm total" period.

Rainfall observations collected from the various rain gauge networks was found to be in general agreement with the gridded rainfall estimates (Figure 3). No clear pattern of overestimation or underestimation was noted when additional rainfall gauges were used, suggesting the gridded rainfall product was a reasonable depiction of the rainfall that occurred. One exception was near the hardest-hit area in the Kentland vicinity, where two (2) rain gauges indicated greater than 8 inches of rainfall where the gridded estimate indicated 4-6 inches.

Based upon all of the available information, it appears likely that a small area of Newton and Benton Counties between Kentland and Earl Park received 8-9 inches of rainfall between 10PM June 26th and 10PM June 27th. The heaviest rainfall impacted the Bowtan Ditch, Morrison Ditch, Kent Ditch, Talley Ditch, Montgomery Ditch, and Sugar Creek basins (Figure 4). Kent Ditch, in particular, flows northward from near the middle of the hardest-hit area, through Kentland, and then merges with Montgomery Ditch before flowing into the Iroquois River. It is plausible that an overwhelmed Kent Ditch was responsible for some of the flood impacts reported in Kentland during this event.

## Climatological Context of Rainfall Amounts

The gridded rainfall estimates were compared to NOAA Atlas 14 which provides estimates of how rare a given amount of rainfall is. Although the storm total rainfall spanned two calendar days and also two meteorological observation days, the overwhelming majority of rainfall in all locations occurred within a 24-hour period. Thus, the 2-day rainfall totals were compared to rainfall statistics for a 24-hour/1-day rain event. From NOAA Atlas 14, the annual exceedance probability (AEP), was calculated for a given rain amount. AEP is related to the more widely (and often inaccurately) used term "average recurrence interval" (ARI). For example, a so-called "100-year event" has about a 1% chance of occurring in a given year (AEP).

Although each of the individual waves of rainfall during the event were heavy, none by themselves were particularly rare or extreme. The multiple waves of heavy rainfall within short duration, however, were key to making this event significant. Storm total rainfall which occurred between 10PM June 26th and 10PM June 27th ranged from unusual to extreme. Portions of each of the counties of Kankakee, Iroquois, Newton, Jasper, and Benton received rainfall with less than a 50% chance of occurring in a given year (Figure 5). Rainfall amounts rapidly became rarer closer to the Kentland area, with very rare rainfall (<10% AEP) occurring in far southern Newton County, far southern Jasper County, and the northern half of Benton County. Extreme rainfall amounts (<1% AEP) were recorded between Kentland and Earl Park, near the Newton County and Benton County boundary (Figure 6), with an isolated maximum of 0.5% AEP. Rainfall of this magnitude is usually associated with significant flood impacts.

Due to the extreme rainfall observed by multiple gauges in the area, rain gauges near Kentland were analyzed more closely. The rain gauges with the highest 2-day totals (ending June 28th at 1200UTC) included CoCoRaHS site IN-NW-6 with 8.5 inches, WUPWS site KINKENTL7 with 8.1 inches, and WUPWS site KINKENTL3 with 6.0 inches. Of those sites, hourly data was only available from the privately-operated WUPWS sites. Hourly data from KINKENTL7 and KINKENTL3 confirmed that the overwhelming majority of the 2-day rainfall total occurred within an approximately 24-hour long period from about 10PM June 26th to 10PM June 27th. Sites KINKENTL7 and KINKENTL3 recorded 7.8 and 5.8 inches, respectively, over the "storm total" period (Figure 7), which was about 96% of the 2-day total (meteorological observation days). For the heaviest third wave of rainfall, about 4.5 inches was recorded by KINKENTL7 in just a single 3-hour period ending at 6PM June 27th (2300UTC; Figure 8).

## Flood Impacts

According to records from the Small Business Administration, flood damages to homes and businesses in Kentland were estimated at $1.56 million (https://data.sba.gov/dataset/disaster-loan-data). An additional $200,000 in damage was reported elsewhere from this rain event in areas including Gary, Merrillville, and Crown Point. According to records from FEMA's National Flood Insurance Program, flood damage claims totaled $137,000 in the Kentland area (https://www.fema.gov/openfema-data-page/fima-nfip-redacted-claims-v2). It is estimated that total damages from this flash flood event are likely at least $2 million.

## Conclusions

Very heavy rainfall from two waves of thunderstorms occurred in the vicinity of Kentland, IN, from late June 26th, 2020, through late June 27th, 2020. Gridded rainfall estimates and rain gauges indicated that areas of Kankakee, Iroquois, Newton, Jasper, and Benton Counties received heavy rainfall, with an isolated area between Kentland and Earl Park receiving 8-9 inches over a two (2) day period ending at 1200UTC (7AM CDT) on June 28th, with about 8 inches of that occurring in about 24-hours. The amount of rainfall observed over a 24-hour period ranged from unusual to extreme, with AEP values of approximately 0.5% analyzed near the Newton County and Benton County boundary. The most extreme rainfall impacted the Bowtan Ditch, Morrison Ditch, Kent Ditch, Talley Ditch, Montgomery Ditch, and Sugar Creek basins. Rainfall of the analyzed magnitude is usually associated with significant flood impacts.

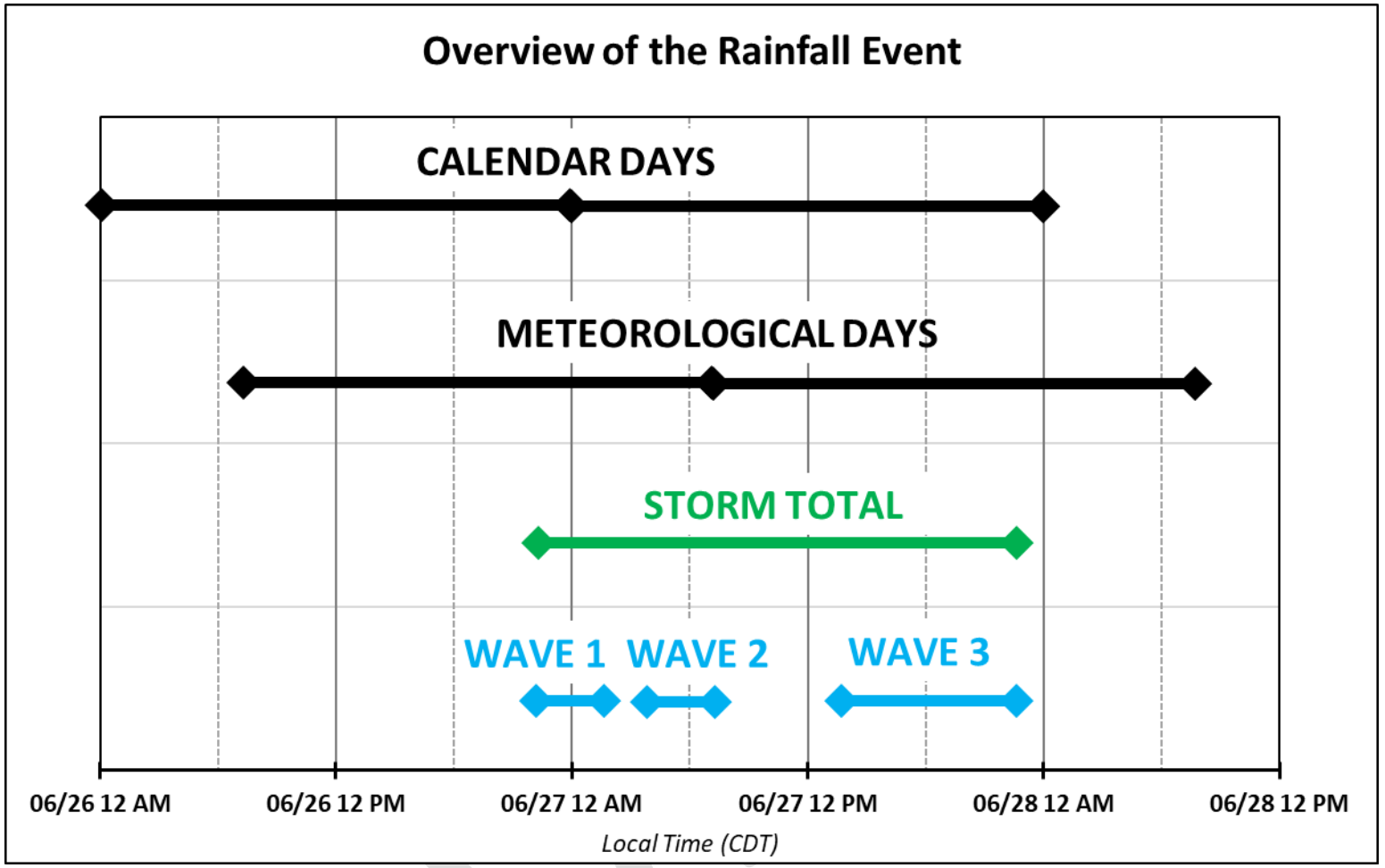


Figure 1. The three waves of rainfall making up the "storm total" analyzed for this report span two meteorological observation days and two calendar days.

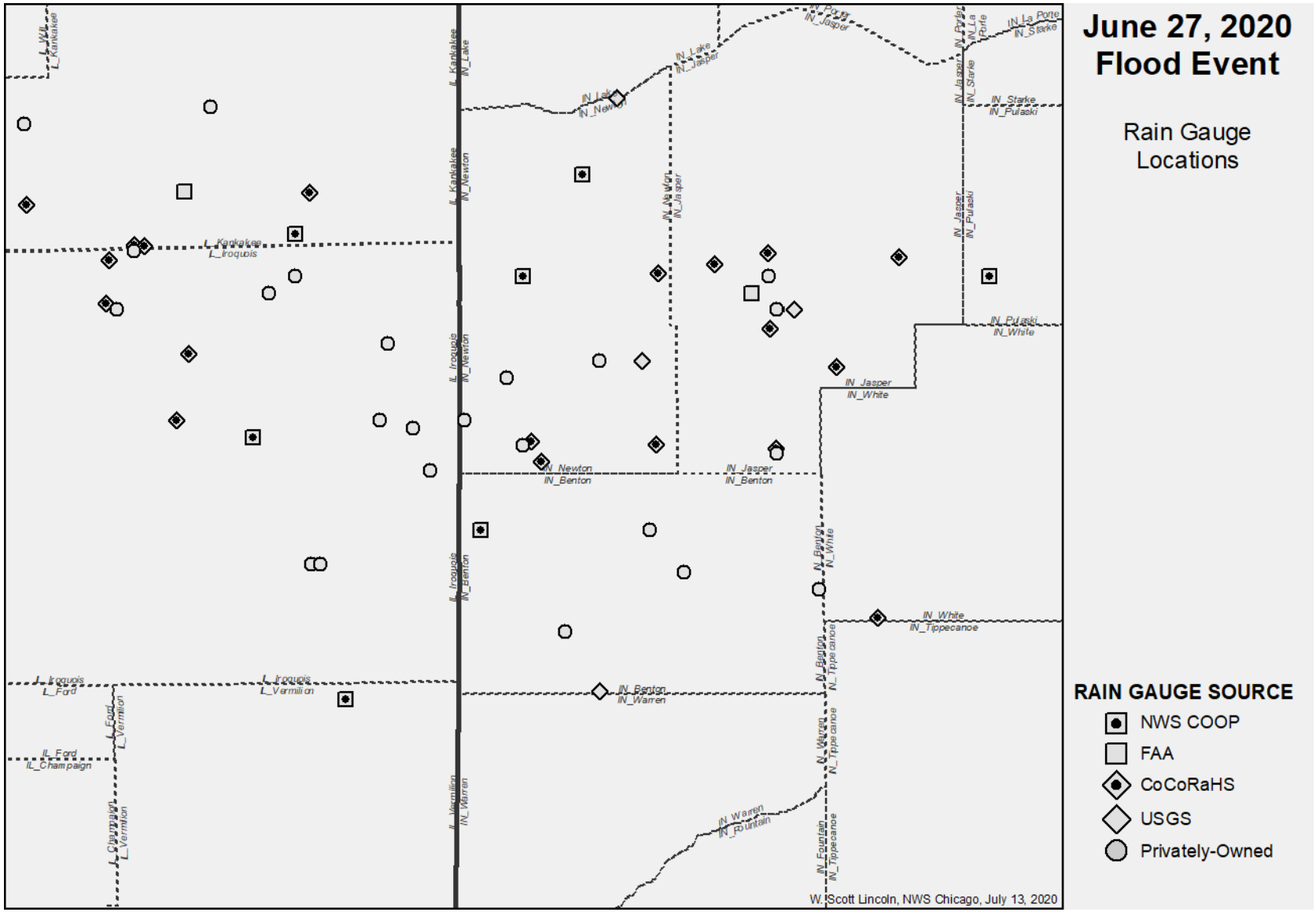


Figure 2. Locations of rain gauge data collected for this analysis. Rain gauges are organized by the source network (COOP, FAA, CoCoRaHS, USGS, or private) and also whether they are daily, manual observations only (black dot).

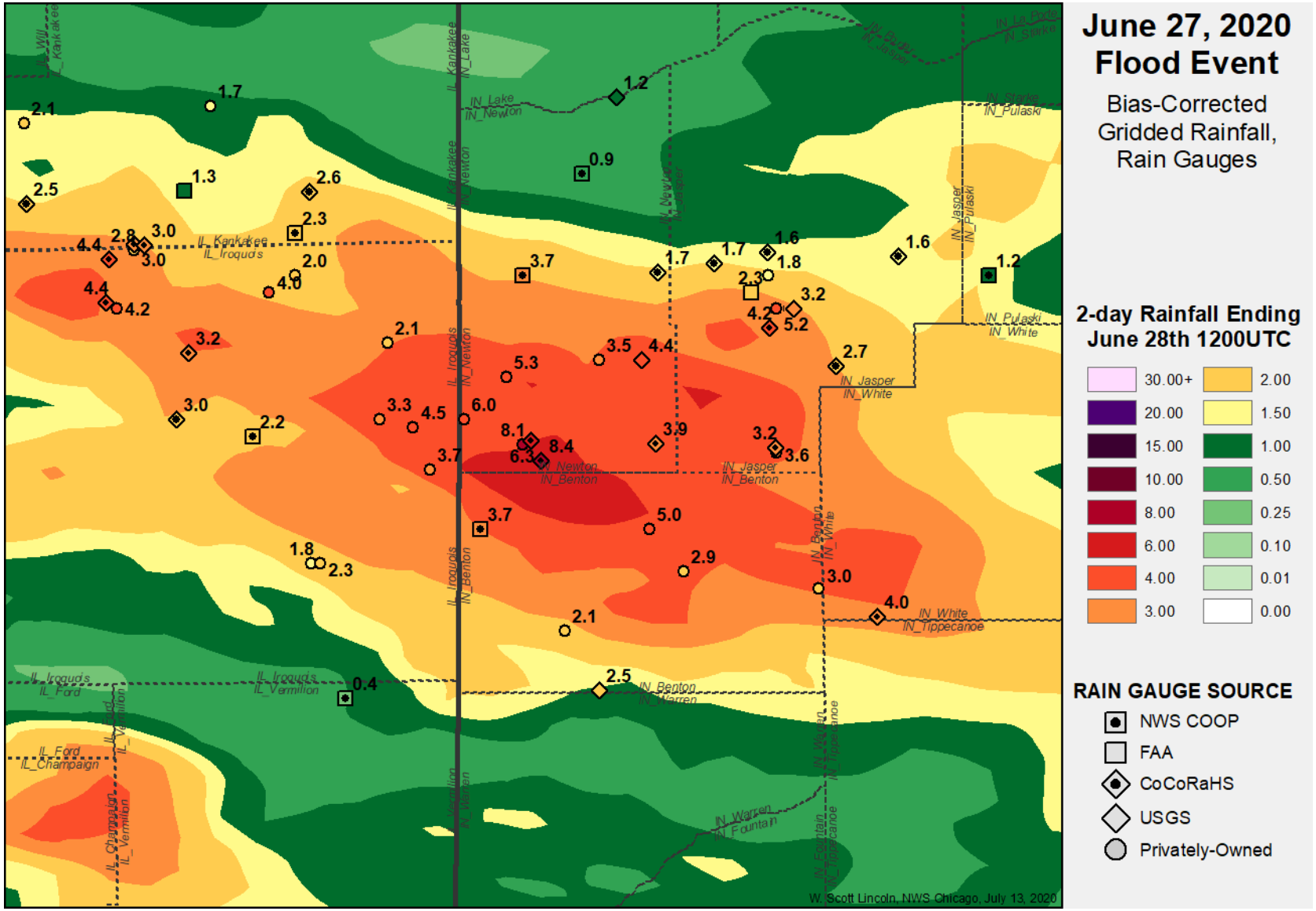


Figure 3. Gridded rainfall estimate covering the 2-day period ending June 28th, 2020, at 1200UTC with gauge observations as an overlay. Rain gauges symbolized by source network.

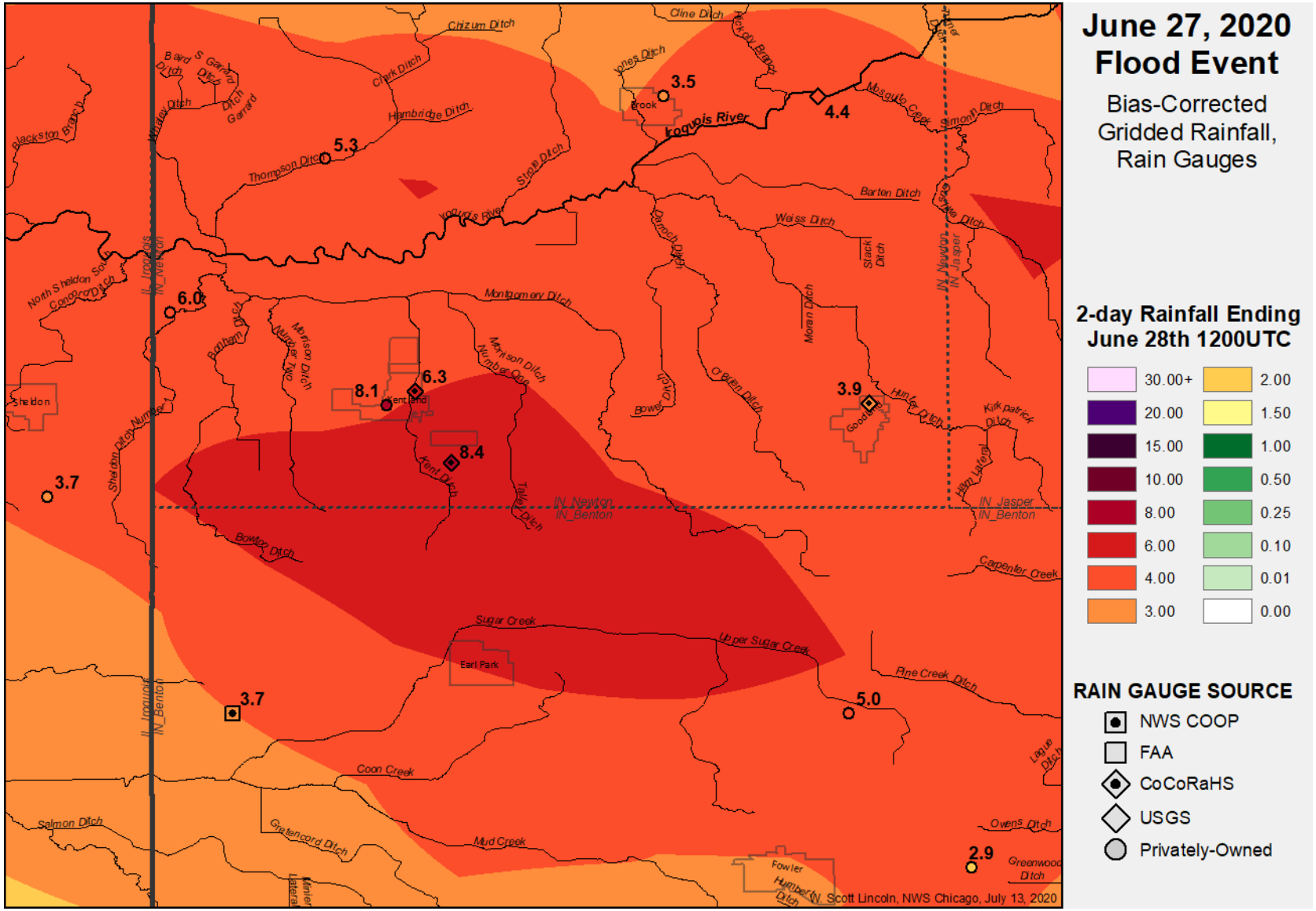


Figure 4. Gridded rainfall estimate covering the 2-day period ending June 28th, 2020, at 1200UTC with gauge observations as an overlay. Same as Figure 3 but zoomed in to the area of heaviest rainfall near Kentland, IN, with cities and streams added as overlays.

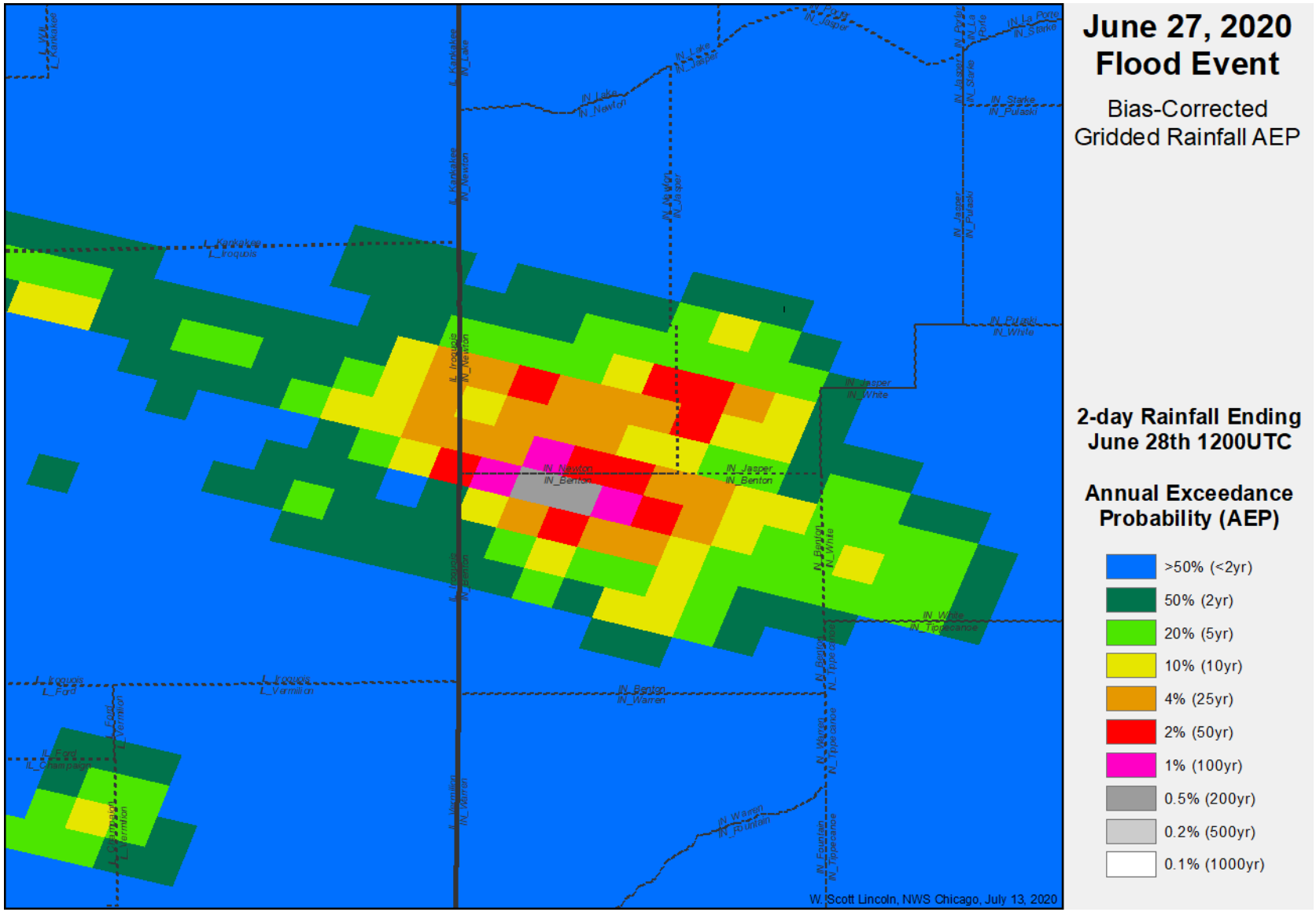


Figure 5. Annual Exceedance Probability (AEP) of the gridded rainfall estimate covering the 2-day period ending June 28th, 2020, at 1200UTC.

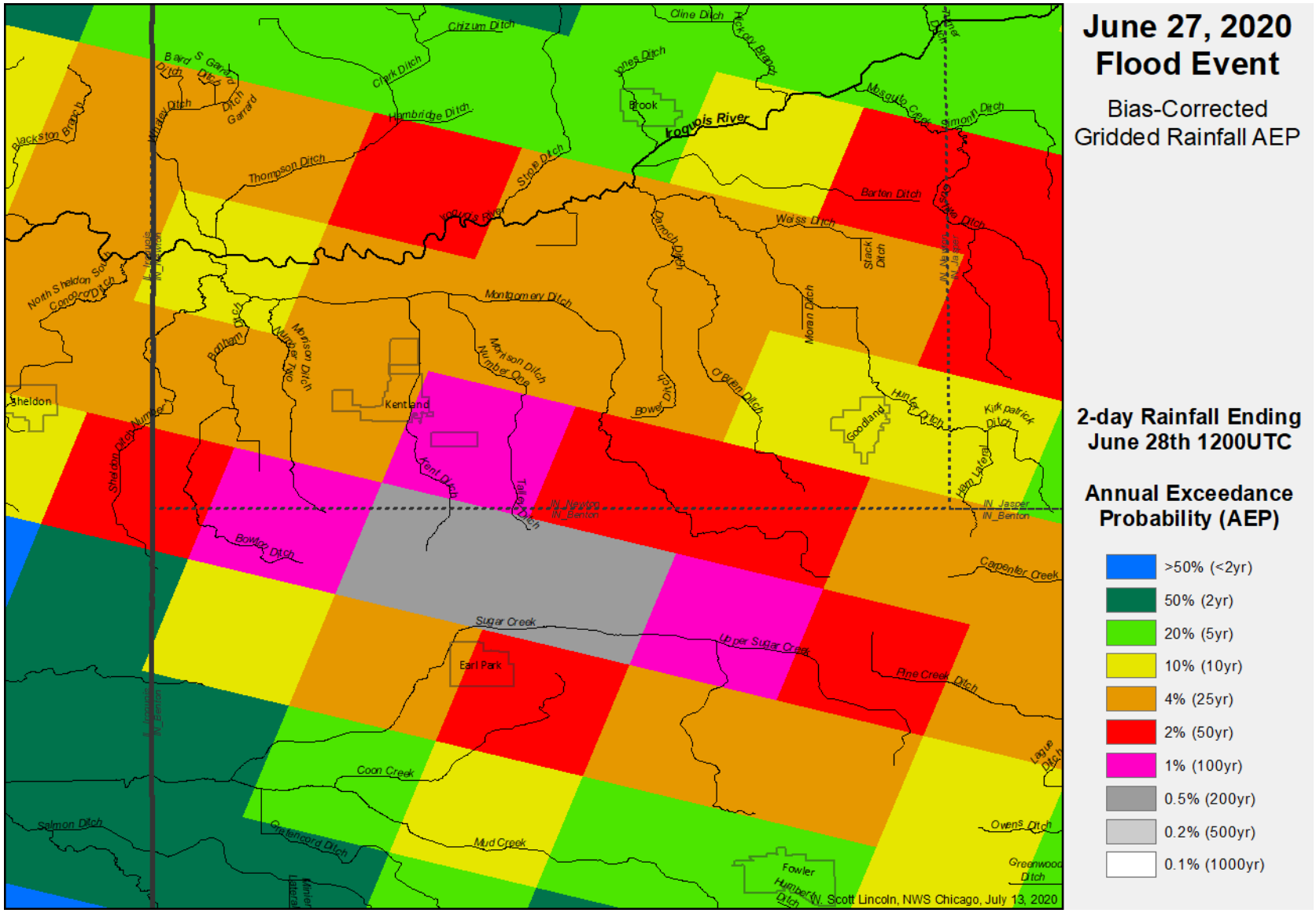


Figure 6. Annual Exceedance Probability (AEP) of the gridded rainfall estimate covering the 2-day period ending June 28th, 2020, at 1200UTC. Same as Figure 5 but zoomed in to the area of heaviest rainfall near Kentland, IN, with cities and streams added as overlays.

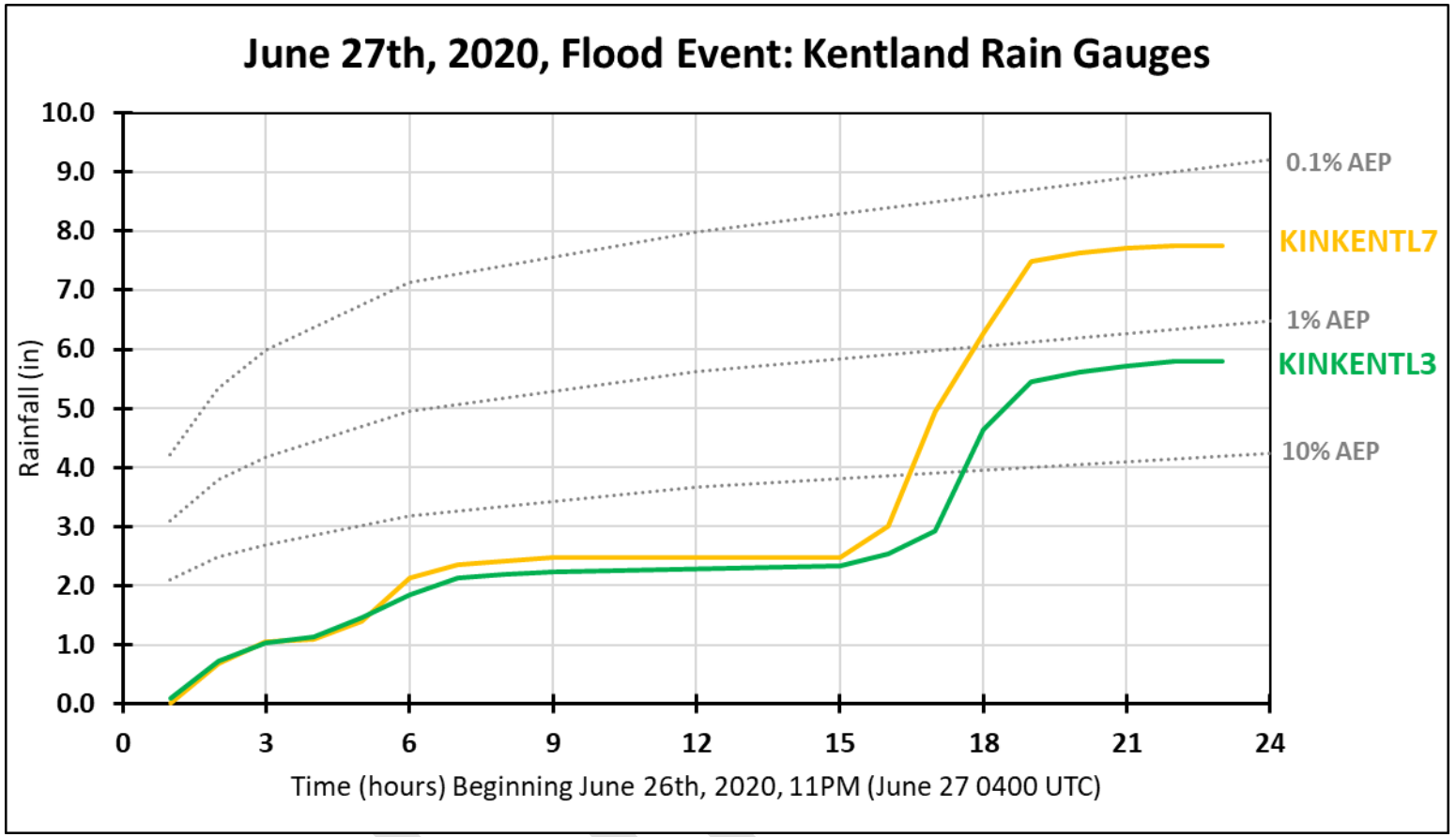


Figure 7. Total accumulated rainfall for two WUPWS sites in the Kentland area beginning at 11PM June 26th (0400UTC June 27th). NOAA Atlas 14 data added as an overlay.

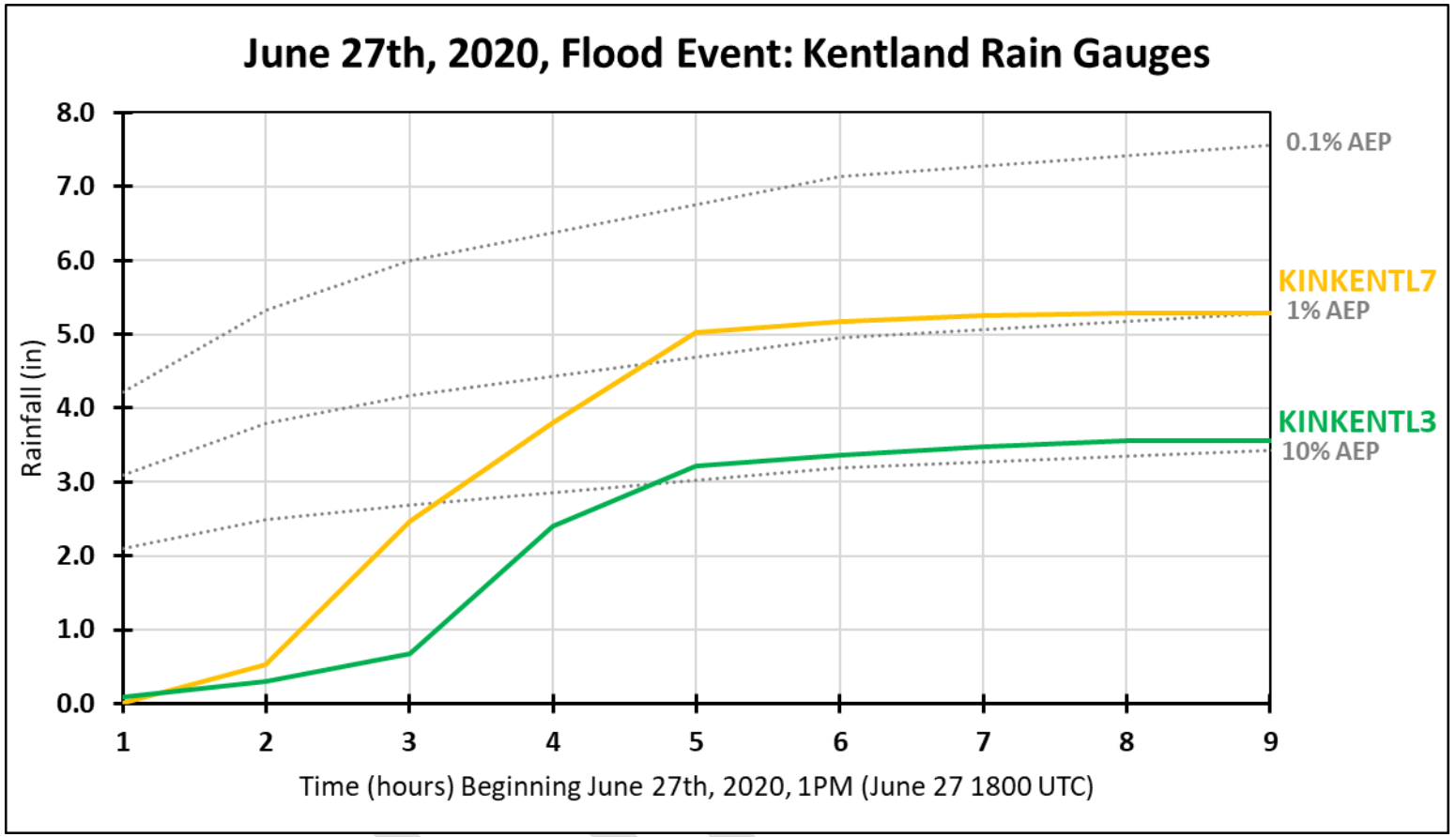


Figure 8. Total accumulated rainfall for two WUPWS sites in the Kentland area beginning at 1PM June 27th (1800UTC). NOAA Atlas 14 data added as an overlay.