National Weather Service Central Region
Service Assessment

July 2022 Significant River/Flash Flood in Southeastern Kentucky

U.S. DEPARTMENT OF COMMERCE
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Preface

Flash flooding in Eastern Kentucky from July 25-29, 2022 claimed the lives of 43 people, making it the deadliest non-tropical flood event in the United States since the late 1970s. During this five-day span, total estimated rainfall of 14" to 16" occurred, including official observed rainfall amounts of 13.21" in 48 hours and 8" in 24 hours. Record flooding of the North Fork of the Kentucky River occurred at Jackson and Whitesburg.

The flash flooding primarily affected populations that are quite vulnerable to significant events with complexities that run deep and span generations. The impacts were great, with entire homes wiped clean from their foundations, significant loss of life, and an impact that will be long remembered in southeastern Kentucky. These impacts took a toll not only on the community, but also the National Weather Service (NWS) in Jackson and the personnel that support and work there.

This regional Service Assessment was commissioned to examine the watch/warning services provided by the NWS, the response to those services, and the overarching experiences and mental toll this event had on the NWS Jackson and its supporting personnel.

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Executive Summary

Flash flooding in Eastern Kentucky from July 25-29, 2022 claimed the lives of 43 people, making it the deadliest non-tropical flood event in the United States since the late 1970s. During this five-day span, total estimated rainfall of 14” to 16” occurred, including official observed rainfall amounts of 13.21” in 48 hours and 8.00” in 24 hours. Record flooding of the North Fork of the Kentucky River occurred at Jackson and Whitesburg.

The flash flooding primarily affected populations that are quite vulnerable to significant events with complexities that run deep and span generations. These complexities include no available cellular coverage, few areas to live that are not in flood prone valleys (hollows), complacency from previous floods, and lack of overall resources and/or ability/desire to alter the generational problems of societal/economic strains in the region. Serving these areas remains a challenge for the NWS. While some barriers toward better education, technology, and relationships to improve weather safety and response have been broken, many remain.

The impact of such an event is wide ranging, with several in the Weather Forecast Office (WFO) being affected either directly or indirectly. Challenges with staffing shortages, recent COVID policies, impact on their family and/or personal property, and the magnitude of the event had a significant impact on employee mental wellness, one that the NWS should address more urgently.

Extreme impact events highlight the importance of a consistent and repeatable approach to WFO operations. This report points out several best practices, findings and recommendations based on information provided to the Service Assessment team. While some recommendations are highlighted in this report, the assessment team found many instances of an exceptional job being performed in a highly stressful situation. The team found that Critical Incident Stress Management (CISM) and recognition of symptoms became very important after this event. Finding and maintaining a positive environment for employees' mental health and wellbeing is also highlighted within this report.

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1. Event Overview

Flash flooding in Eastern Kentucky from July 25-29, 2022 claimed the lives of 43 people, making it the deadliest non-tropical flood event in the United States since the late 1970s. Reports also indicate that more than 1,300 people were rescued over the course of the event. During this five-day span, total estimated rainfall of 14" to 16" occurred, including official observed rainfall amounts of 13.21" in 48 hours and 8.00" in 24 hours. This magnitude of rainfall exceeded the 0.1% annual recurrence amounts (i.e., 1,000-year), and fell over wet soils and a high-relief landscape contributing to rapid runoff. Record flooding of the North Fork of the Kentucky River occurred at Jackson and Whitesburg while other rivers around the region also surpassed major flood stage levels. The most intense rainfall and quickest flash flood water rises occurred under cover of darkness in many locations, and some of the greatest losses occurred in areas of poor phone coverage.

The NWS WFO in Jackson Kentucky was cut off from vehicle access for an extended period of time, with eight NWS employees sheltering in place until the water receded. Some employees experienced personal losses due to the flooding, even while continuing to fulfill the NWS mission. Despite the historic nature of the event and the serious personal and professional impacts, NWS WFO Jackson staff overcame these factors, and was awarded the 2022 NWS Director's award "For exceptional life-saving Flash Flood warning and community support for the historic July 2022 Eastern Kentucky flooding, which personally impacted the office staff."

2. Facts, Findings, Recommendations, and Best Practices

2.1 Forecast Process

Fact: Forecaster expertise played a significant role in the accuracy, messaging, timeliness, and staffing of this event**.**

Weather Prediction Center (WPC), Ohio River Forecast Center (OHRFC), and WFO forecasters all identified model guidance as a significant challenge for this event. Forecaster application of pattern recognition and an ingredients-based approach to heavy rain forecasting led to a well-advertised message favoring potential flash flooding despite model guidance that was unsupportive. Some noted examples were:

1. Model guidance:
    a. Quantitative Precipitation Forecast (QPF) - location and amounts were very inconsistent, and well short of actual total precipitation amounts.

   b. Mesoscale models, High Resolution Ensemble Forecast (HREF), and even Storm Prediction Center (SPC) objective analysis had difficulty assessing the near storm environment.
   c. The Warn-on-Forecast System (WoFS) provided little to no signal for excessive rainfall, likely due to a substantial underestimate of available instability and forcing magnitude that would contribute to eventual backbuilding convection.
2. Forecaster intervention:
   a. Forecasters noted they employed learned pattern recognition and an ingredients-based approach to identify the threat of heavy rainfall and used training and experience to identify and message the significant event. Forecasters knew something was going to happen, but location and amplitude were hard to pin down.
   b. Forecasters were able to use the Extreme Forecast Index (EFI) and shift of tails which did focus on heavy rainfall potential days in advance
   c. WPC forecasters noted their desire to stay the course with the Excessive Rainfall Outlook (ERO) over the eventual flood area because soil conditions supported runoff and expected to get rain somewhere in the region. Their consistency was spot on.
   d. Forecasts from WPC of the ERO made a difference in messaging and consistency of products from WPC and WFO Jackson.

Best Practice: A rigorous training program that includes pattern recognition, an ingredients-based methodology, and a thorough statistical understanding "beyond the models" gave the forecasters the tools needed to succeed in challenging forecast scenarios. For example, anecdotes such as during the warm season, the Shift of Tails does not capture the 5-95% tails (as was mentioned during the interviews), and gave the forecaster a heightened awareness during events such as these.

Best Practice: Attending the Model Evaluation Group (MEG) presentations, especially after significant events, shared valuable findings on model performance, improved local forecasting expertise, and provided critical information to model developers.

Finding 1: National Center products, at times, were too static for use in effective Impact-Based Decision Support Services (IDSS) at the WFO level.

It was recognized that National Center products can become "outdated" and not representative of the ongoing or expected situation over the short term (defined here as the next 6 hours). Workflow at National Centers does not lend itself to short fused updates to forecasts or outlooks that may change the narrative of expectations to end users. Moreover WFOs, who are more dynamically update driven, rely on these products and are expected to remain consistent with these as "one message" from the National Weather Service.

In this case, the ERO Day 1 forecast is updated at 0100Z, 0830Z, 1600Z. Issues of communication arose where the forecast "snapshot" made by the WPC presented a forecast threat of excessive rainfall in the ongoing recovery/damage area. The local WFO and mutual aid office determined the threat had passed not soon after issuance and tried to convey that to partners. This caused a great deal of confusion and discord with partners. In the process, WPC was asked if they could update their forecast and they stated they would not be able to do that until the next update time.

Recommendation 1a: NWS should resolve differences in workflow dynamics between National Centers and WFOs to bring product consistency, update frequency and times, and scales into congruence.

Recommendation 1b: NWS should better coordinate messaging internally across each layer (local, regional, national offices) to ensure consistency which will promote confidence regarding the forecast outcome and impact.

Finding 2: Partners were well informed about the nature of the impending event.

Partners stated that they knew some portion of the multi-day flood potential was going to be historic. Area Forecast Discussions (AFDs) mentioning the flood potential began 6 days prior to the event. NWS wording 3 days out through briefing packets, graphics, and conference calls, gave partners the understanding that something significant was coming. Graphics and/or words in the briefing packets which garnered the partner's attention:

- QPF maps with county overlays
- "Stalled"
- "Localized Heavy Rain"

Weekly partner conference calls are held at 9 am each Monday. Partners mentioned that these routine calls are typically "optional". But when special conference calls are held at times that are different, they know it is a significant event that needs their attention.

Probabilistic data was relayed from the WFO in a limited fashion. The model forecast QPF was extremely poor for this event, which made it difficult to convey the Probabilistic QPF (PQPF) well if at all. But most partners still agreed that they would like more probabilistic forecast data if available.

Recommendation 2: WFOs should Include probabilistic forecast data as much as possible in partner briefings to better convey worse case scenarios and expectations.

Best Practice: Conference calls made "only when it matters" helped partners differentiate between serious and non-serious days.

Best Practice: Adjusting minimum advisory and warning criteria based on societal impacts immediately after a significant event (in this case power outages from the flood), improved safety of residents and first responders and gives a more accurate representation of near-term high impact events. For example, local WFOs issued heat-related headlines based upon the potential impacts, not pre-defined criteria. The widespread loss of power and other services in and near the flooded area significantly impacted local residents. Anticipating the potential impacts of the heat, local WFOs opted to issue heat-related headlines based upon the expected community impacts, not just pre-defined criteria. Guided by the NWS heat-related headlines, partner agencies were able to implement plans to counteract the expected heat and provide services to the impacted population.

2.2. Warning Process

Fact: Wireless Emergency Alerts (WEAs) sent by the NWS had mixed responses by those receiving them**.**

People received the WEAs. The verbiage used by the NWS of historic and catastrophic flooding was shocking to partners, but conveying that message to the local residents before and during the event proved difficult.

Most respondents interviewed by partners were said to have had one of three responses to WEAs:

1. Took action to protect themselves.
2. Did nothing (didn't know what the WEAs meant and/or what to do)
3. Saw it (including the flash flood emergency) but intentionally took no action, with the common remark that "it floods here all the time"

Finding 3a: Failure to respond to a WEA was typically tied to a lack of understanding of how to respond and/or the history of frequent flooding in southeast Kentucky.

Finding 3b: WFO staff were not completely aware of what type of flash flood warnings initiated WEA alerts.

Partners asserted that lack of knowledge regarding WEAs played a role. They tried to convey via many means (radio, social media) the seriousness of the event. A significant part of the education/response challenge is the history of flooding in southeast Kentucky ("It always floods here") similar to areas hit by hurricanes. Surveys from Kentucky Public Health (approx 400 households) showed that most people knew what was coming but the predicted magnitude and impacts were hard to believe.

Partners noted the best way to educate people was by two means:

1. In schools. “Mom and dad will listen to the kids” was a repeated theme.
2. Church organizations. “Everyone reads the bulletin” was remarked and agreed on by the partners. The suggestion here was to pursue large church organizations that would include weather safety and education information in churches and church bulletins which serve a significant number of people in this region of the country.

Recommendation 3a: WFOs should continue/direct education efforts on WEA to both traditional and non-traditional groups, some of which is driven by local cultural norms of the most vulnerable.

Recommendation 3b: WFO staff should be aware of the criteria for which a WEA message will be sent and not be hesitant to reissue or upgrade warnings which will initiate WEA messages, especially for situations in which people may be in heightened danger (i.e., historic events) or particularly vulnerable (after dark, underserved population, etc.)

Best Practice: Initiating multiple WEA messages during the event as the flooding worsened gave those receiving the messages the impression the situation was life threatening and needed immediate attention.

Fact: Repeated reception of WEAs originating from the NWS moved many to action, especially those susceptible to complacency.

Multiple WEAs were sent because of either polygon overlapping, cellular company differences in how towers (and therefore WEAs) were activated, and/or upgraded from base to considerable, to catastrophic or some combination of these. Feedback from social media and public response indicated that when they “kept getting them” they realized “it must be bad”.

Fact: The inclusion of detailed locations in the warning/messaging moved additional residents into protective action**.**

Partners documented and discussed that providing an intersection or neighborhood in their communication or in an NWS warning resulted in more effective action than just using generic locations over larger areas. Several public officials noted that smaller warnings were better.

Best Practice: Configuring warning software to include local intersections of known areas in smaller warnings, when appropriate, resulted in a higher percentage of residents taking protective action.

Finding 4: A number of residents do not have cell service and therefore, did not receive the WEAs when issued**.**

A number of residents in this region do not have cell service. Partners noted that it requires them to rely on NOAA Weather Radio (NWR), and private sector capabilities such as Rave Mobile Safety™, and Code Red™ programs, to alert residents. Cell service in the hollows (as referred to locally, are valleys in the steep relief areas in southeast Kentucky) is very sporadic, which makes it hard to reach them through "reverse 911" systems unless it is a landline phone. Most of the deaths from this event occurred in areas with poor cell service. Free phone programs have helped, with the exception of areas with poor cell phone service,

Recommendation 4a: WFOs and Central Region Headquarters (CRH) should work with partners and NWR providers to pursue grants and partner related programs, especially in areas where cell service is a challenge and/or vulnerable populations exist, to place NWR receivers in homes.

Recommendation 4b: WFOs should educate users of NWRs how to reduce warning fatigue and when a "turn on the NWR day" exists.

Best Practice: Providing local residents with opportunities to program radios and promotional activities to increase awareness of NWR and its capabilities resulted in more residents being warned and taking action

Fact: Local cultural issues and high-relief terrain exacerbated the threat to life and property, likely resulting an increase in deaths

A number of regional/cultural challenges that affected the outcome of this event. For example, most residents live in hollows, about the only place that is flat in the area. These are found along creeks, streams, and rivers. Additionally, the Assessment Team found a common scenario where several families live in small quarters and/or old structures, including a significant amount in mobile homes or similar structures. This challenged the ability or desire for these residents to take precautions.

During Search and Rescue (SAR), a number of occurrences were documented where a water rescue crew would approach a family in a flooded home only to be waived off by the family, who would later need to be rescued from their rooftop. When questioned why they would initially decline rescue, the reasons given were commonly in the following themes:

1. They were on family land and did not want to leave. For example, there are a number of homesteads that have their deceased family members buried on that plot of land. Leaving that would be emotionally traumatic.

2. Fear of people stealing what was not lost in the flood, because that is all they have.
3. They have nowhere else to go. This problem is significantly misunderstood and/or overlooked in this region of the country. It was repeated a number of times that residents will not leave because of this. It was further noted that this is the same reason residents will refuse Federal Emergency Management Association (FEMA) buyouts.

Fact: Flash flood warning decisions (including important upgrades to "Considerable" and "Catastrophic" warnings) benefited from anecdotal evidence and local training on valuable tools, especially given the lack of real time reports overnight with an overwhelmed regional communication infrastructure.

Multi-Sensor Multi-Radar (MRMS), Flooded Locations And Simulated Hydrographs (FLASH), and Couple Routing and Excess Storage (CREST) guidance, as well as the radar estimates of storm total precipitation and instantaneous precipitation rate, helped guide the areal extent of warning decisions, and the extreme magnitude of that guidance helped support the decisions for warning tag upgrades. Even with this useful guidance, the decisions to upgrade warning tags were supported by several subtle anecdotal observations that were deftly noted by the operational staff during the heart of the flash flood event. Some of these included:

- There were very few meaningful real-time flooding reports to the office. This on its own became a meaningful observation for warning forecasters. They were unable to contact 911 dispatch centers due to busy or disconnected lines. There was little to no local interaction on social media. Several of the WFO Jackson meteorologists noted that this lack of communication was observed as likely due to a failure of infrastructure and viewed as a contributing factor along with other signals to upgrade warnings to considerable and catastrophic.
- Received observations from "lighter" rain areas which helped them calibrate to the magnitude of what was happening within the heaviest rain areas, even in the absence of direct reports.
- Saturated soil conditions and night time flooding contributed to the elevated risk assessment in this scenario, helping lean toward emergency issuance.

Best Practice: Developing local understanding of FLASH, CREST, the valuable thresholds of these products, and other tools improved warning performance.

Best Practice: Use of anecdotal, non-traditional evidence helped to calibrate and make decisions during this catastrophic event, especially when traditional datasets and reports were not productive.

Fact: Loss of communications made situational awareness, information gathering and sharing, and event coordination very difficult

Communications in the Jackson area went down around Midnight, and continued for hours. The WFO lost cell service around 6 am on July 28th. A number of partners mentioned they were "flying blind", or had a "feeling of hopelessness". Some of the communications outside of the Jackson area still worked but were limited because of cell service challenges.

Primary communications in this area are cell, VHF/UHF radio, and internet. Other systems widely available to dispatch centers across the U.S. are very difficult to deploy in this region because of the number of radio towers that would be required to properly support such a network.

First responders noted the primary communication mechanism for rescue was by word of mouth, not by phone. This caused up to 10 repeat visits for rescue in certain locations. Several were begging to be picked up in the flash flood zone.

Finding 5: Loss of the Integrated Flood Warning System (IFLOWS) data program and national support over the years had a significant negative impact on partner Situational Awareness and warning response**.**

This was a significant point of contention in all of the impacted areas. A number of officials at multiple locations lamented this program no longer being supported. They said that they would have been able to evacuate earlier and save lives with it. They said that this data would have allowed broadcast media to show a "play by play" of the data to get people to act, similar to the time of arrival with storms. It was said that if they had these data like they used to, they would have been evacuating people on pavement rather than by boat.

In response to this disaster, local Emergency Management is trying to acquire 48 IFLOWS gauges to manage and support locally.

Recommendation 5: NOAA, NWS, and local WFOs should work with government partners at the local, state, and national level to develop programs that improve situational awareness and data availability for high impact events.

Finding 6: Using the Site Specific Headwater Model at the WFO proved to be very difficult.

WFO Jackson, while well versed in flood operations and having recently completed training with these tools, found it challenging to effectively run the Site Specific software and confidently disseminate the predictions. These challenges were magnified by the stress and time sensitive nature of the situation. In this case, the rainfall put the flow off of the rating curve, so most of the forecasting done was beyond precedent. The initial forecast was two feet above the previous

record, which proved to be five feet too low. The River Forecast Center (RFC) was in constant contact with WFO Jackson to assist in producing forecasts for these headwaters points using the Site Specific software, but comments from the RFC and WFOs were that Site Specific has outlived its usefulness and a new solution should be examined. There are also some RFCs that are actively bringing the headwater points back to the RFC for better support and forecasts.

Recommendation 6: NWS should develop a path forward to provide effective headwater point forecasts.

2.3 Impact-Based Decision Support Services (IDSS)

Finding 7: The on-site support provided by WFO Jackson at the Incident Command Post (ICP) was crucial to local officials**.**

Great services start with great relationships. Emails and other remote IDSS are important, but do not replace nor match the services provided by on-site, deployment trained NWS personnel. Extreme and/or historic events impact local partners and communities particularly hard, often on a very short timescale, and may include the need for unique IDSS requests. NWS partner agencies may be stretched beyond normal capacity and struggle to reach out to the NWS. Local officials stated a need to have the NWS deployed sooner and said, ***"The NWS is always needed. Don't wait for us to call you."***

Recommendation 7a: CRH should broaden a training program for IDSS by offering regional in-person "Boot Camp" training classes and "Train-the-Trainer" concepts.

Recommendation 7b: NWS deployment-ready personnel should be trained and prepared to offer IDSS for a variety of situations, including SAR, air support or other unique requests.

Finding 8: While early messaging tactics were noticed by the partner agencies and the public, consistent messaging within the framework of the Integrated Warning Team (IWT) was a challenge.

Messaging for the event initiated at least six days prior and continued throughout. Early messaging allowed local officials to know "something was up" prior to the event. However, NWS relationships with Emergency Management and Broadcast Media within the IWT were critical to the success of public messaging and derivative public safety. It was noted that a particular broadcast media partner presented information to viewers that contradicts the NWS message, which led to division, confusion, and lower trust in the information by the end user.

Recommendation 8a: NWS should work with local partner agencies to identify extreme and historic events well ahead of time. Recognizing partner agencies may not have the time to reach out to the NWS for IDSS, NWS should develop guidelines which allow local WFOs to engage partners prior to or at the onset of such events to provide IDSS even without a formal request from local officials.

Recommendation 8b: WFOs should develop a set of best practices focused on solutions that work with challenging partner relationships along with their supporting success stories.

2.4 Mutual Aid/Service Backup

Finding 9: Mutual Aid/Service Backup (SBU) could not initially be performed from the servicing Senior Service Hydrologist (SSH) office.

WFO Jackson's servicing Service Hydrologist was located in Louisville, KY. Louisville is neither a primary nor a secondary backup site for WFO Jackson. As a result, the Senior Service Hydrologist was initially unable to provide mutual aid (e.g. hydrology products) for the WFO Jackson office. This was later corrected, and since the time of the flood, CRH has recruited and hired a Service Hydrologist specifically for WFO Jackson.

Recommendation 9: CRH should ensure that all Service Hydrologists that serve two offices have the ability to provide on demand hydrology mutual aid to their second WFO.

Finding 10: The Mutual Aid/Service Backup process remains fragmented and under-developed in some cases.

Several factors contributed to this finding. They are as follows:

1. There was some confusion as to the support levels that could/should be provided by the Central Region - Regional Operations Center (CR-ROC) and supporting WFOs given different circumstances, which evolved during the event. Confusion was compounded given that the SBU office was in a different region.
2. There was a lack of autonomy given to the field WFOs involved. Eastern Region - Regional Operations Center (ER-ROC) mentioned their end of shift time as a means for WFO Wilmington to take action on SBU which had already been decided with WFO Jackson.
3. The notice given by WFO Jackson for service backup was an off-then-on proposition. WFO Wilmington mentioned that WFO Jackson said they "had it" and they were reluctant to ask for help. Then later the same shift, they called WFO Wilmington and asked for SBU.

4. WFO Jackson being in SBU was difficult as the timeliness of products and services are at the mercy of the office providing the SBU/Mutual Aid. This was especially difficult then to provide partner briefings, especially when deployed.

Recommendation 10a: In the age of expanding mutual aid, the CR-ROC should develop a catalog of best practices for WFOs and ROCs to refer to, cross-regionally, that would enable those offices to examine and take cues from real world scenarios that would enable better and advancing mutual aid concepts and execution in the future.

Recommendation 10b: CRH should work to improve communication/collaboration between the WFO and the CR-ROC, especially during situations of cross-regional SBU, to ensure efficient, seamless mission execution.

Recommendation 10c: WFOs should communicate clear timeline expectations to their backup office for partner needs appropriately, when SBU/Mutual Aid is being provided during an active deployment.

Best Practice: Continue using a minimum number of SBU/Mutual aid events between SBU WFOs per year. If this cannot be performed, then an adequate, active tabletop exercise shall be performed for each one in substitution.

Finding 11: An open Google Meet™ between internal/external partners resulted in a better, more coordinated service

Initially, WFO Jackson and OHRFC had an open Meet during the height of the flash flood. Both offices acknowledged that this was the best way to communicate and brought them together as one team. It enabled them to communicate through the many challenges of using Site Specific Hydrologic Predictor (SSHP) and a rapidly changing flood situation. The SSH in LMK also joined, as did others as the event unfolded. Several commented that having the Meet with the RFC brought calm to a very difficult situation. “The open Google Meet™ with OHRFC was fantastic. It felt like the OHRFC was here sitting with us”.

Recommendation 11: Each WFO should develop, as part of their Hazardous Weather Operations, a plan to dynamically incorporate open virtual meetings (via Google Meet™, GoToMeeting™, or other resources), both internally and externally during high impact events, to maximize inter-office collaboration and partner/stakeholder engagement.

2.5 Damage Assessment

Finding 12: The post-event damage survey was completed, but not without technical delays and limitations when using the Damage Assessment Toolkit (DAT) and Survey123™.

While the use of the DAT and Survey123™ has improved NWS damage survey documentation and coordination in general, the DAT and Survey123™ still lack capabilities in rural areas and for flood surveys, both of which made conducting the flood survey and compiling data more difficult and time consuming.

Recommendation 12a: NWS should look to Improve the DAT Flood Layer by adding the ability to add multiple geotagged photos at once (currently only one geotagged photo can be added) along with improved polygon and line functionality to allow for better representation of flood damage extent and impacts. Additional layers such as E-19s and NWS FIMs (Flood Inundation Mapping) could be added for comparison to flood survey data.

Recommendation 12b: Survey123™ requires the user to be logged into an account for use. Each NWS storm survey team should log into Survey123™ at a location with good connectivity on at least one survey divide (phone or tablet) before beginning the survey

Recommendation 12c: Should Survey123™ become inaccessible (i.e. logged out) during a survey in an area with limited cellular service, reestablishing connectivity can be frustrating, if not impossible at times. NWS should consider developing an alternative program which permits survey data acquisition in the event of lost connectivity with Survey123™, while allowing for a simple, quick transfer of data collected once connectivity can be reestablished.

Finding 13: Visual data from a drone provided excellent video and imagery, which enhanced the ability of WFO Jackson and WFO Louisville to complete the damage survey.

The use of a drone to capture aerial photos and video of flood damage was extremely valuable to provide a birds eye view of the historic flood damage, including high water marks and damage to vegetation and structures. However, there were some issues regarding on-scene flight restrictions which delayed drone deployment.

Damage assessment using drones not only provides a unique view of the damage, but allows damage surveyors the opportunity to survey a larger area or inaccessible areas in a timely manner, thus providing a more accurate representation of the damage and impacts. Drones could also be used beyond damage assessment, such as building, tower and radome assessments and even possibly limited meteorological measurements, if equipped.

Recommendation 13: WFOs should collaborate with Emergency Management and other partner groups to leverage the use of drones.

2.6 Flood Inundation Mapping (FIM)

Finding 14: Prototype National Water Model (NWM) and Prototype RFC FIM was provided by the National Water Center (NWC) to a limited number of FEMA HQ and FEMA Region IV employees. However, there were challenges in internal NWS collaboration due to lack of FIM collaboration procedures, training, and understanding how to incorporate the information into operations.

This was the first time that the FEMA Liaison Officer (LNO) from FEMA HQ requested NWM and/or RFC FIM for a Flash Flood Warning event. Given the rapid timing of a flash flood event requiring fast action, several discussion/learning points are noted. These are focused on collaboration on FIM releases to FEMA HQ being more transparent.

1. A conference call was held between the NWC, CR, and ER offices (ROCs, RFC, WFOs) where a brief overview of the FIM proposed to be shared, with a select number of FEMA employees, was shown and discussed. All offices were concerned that due to lack of training and familiarity of FIM they could not provide concurrence whether to share FIM with FEMA. Although the NWC was available to assist with any questions, an established procedure for reachback was not in place. Ultimately, FIM was shared to a select number of FEMA employees at FEMA HQ and Region IV via the FEMA liaison to the NWC.
2. At the time of the event the FEMA recipients of the FIM had agreed to non-disclosure. However, due to the initial lack of aerial impact information, FEMA did share the FIM with county and local partners to aid with search and rescue efforts. Additionally, FEMA Region IV wanted the FIM for response and recovery, execution of flood mitigation, and other functions of oversight by FEMA.

Recommendation 14a: NWS should expand training of FIM for NWS field offices. Familiarization and understanding of NWS FIM is needed for all offices.

Recommendation 14b: The National Water Center should inform, educate and update the NWS field offices on the NWS Flood Inundation Mapping (FM) Concept of Operations (CONOPS) (November 2022). The NWC Google Site for Flood Inundation Mapping Services provides access to all NWC FIM plans and information.

Recommendation 14c: Education of field offices by NWC is needed to ensure understanding of the process for collaboration and distribution of FIM where the phased rollout has not yet occurred. As explained in the NWS FIM CONOPS, a phased rollout of publicly available FIM will occur through FY2026.

2.7 Mental Wellness/Health

Finding 15: Significant events have both short and longer term impacts on employees' well-being. Impacts were noted by the Assessment Team within the WFO Jackson staff.

A number of employees recognized the emotional, mental, and physical toll on them during the event. This toll led to productivity losses over time that would otherwise not have happened. Employees noted the strain to focus on the mission and to try and ignore the ongoing devastation.

Long term impacts, such as those that have been mentioned in the Critical Incident Stress Management (CISM) materials, were observed during interviews.

Recommendation 15: NWS should develop a team of NWS employee peers and emotional recovery experts that will be referred to and available for individual or group discussion sessions with those employees involved in the significant event. These should be done right after the event and at some interval (6 months to 1 year) later.

Finding 16: The emotional strain of a significant event came from a multitude of sources**.**

Forecasters observed a number of stressors during the event that should be taken into account in crisis management. These include the following:

1. Inability to talk to someone that resonates with what forecasters encountered in this type of event. Many mentioned they could not discuss this with friends, their spouse, etc. because they could not relate.
2. Social media. Forecasters noted, with significant emphasis, that it was very hard seeing a number of Twitter posts that were actively celebrating and rooting for the demise of the people that they were trying to save. On a number of occasions, they had to look away from it just to function. Also, the specific stories of survivors were particularly impactful and memorable. Forecasters said that seeing the devastation, then needing to tell people that more was coming was really difficult. They mentioned the need to take time away from social media, which sometimes helped to focus on science and operations.
3. Reaction from political officials. The Governor was noticeably saddened by the event and its devastation. The feeling of helplessness was noted.

4. Fear that because an "outside the box" decision was made during their shift (e.g the Flash Flood Emergency with no reports) that somehow the wrong decision was made, even when it was clearly the correct decision.
5. Calling people into work during the night not knowing if they were being led into harm's way.
6. Leaving the office shortly after the significant event.
7. Knowing the devastation and not being able to avoid seeing it
8. Guilt for not being present or able to contribute due to circumstances outside of their control. A number of employees mentioned a survivor's type of guilt where they could not make it to the office and watching everything unfold while not being able to help was very difficult. *"[I was} not at the office and stuck at home […I] knew what coworkers were going through and wanted more than anything to be able to help them out. From an emotional standpoint, previous events did not compare to this…it was very difficult". "Worst helpless feeling being stuck at home and knowing people are being impacted and not being able to help. Feeling of guilt not being there was something I don't want to experience again." "I was told at around 8 am to go home or I would be stuck. Shortly after leaving, they closed the road to the office. I wished I would have stayed and felt guilty for leaving - should have stayed with those stuck at the office."*
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    a. Blackhawk helicopters were making frequent flights, bringing people to the office for rescue. *"The humanitarian part of having to say no to them being dropped off was extremely difficult (had no resources available to support them…cut off from the world with no food or water). Those kinds of things stick with you, it took an emotional toll. We were able to provide snacks and drinks, access to restrooms, but we were unable to provide any resources and were totally cut off, which was hard to describe to the military personnel who were trying to find them a place."*
    b. Un-announced, secret service personnel just showed up at the office seeing if the president could land there. *"The weirdness of things that happened afterward was very strange (people in the parking lot as the secret service trying to figure out if they could use the airport - ended up being legit)."*
    c. Other families at the bottom of the hill and cabins nearby. WFO Jackson staff said that they were helping them in whatever ways we could, especially with the water. The staff shared with them and they shared with the staff. A church group was able to land a plane and help out. The staff stated that it was very encouraging to see people coming together

Recommendation 16: NWS should make annual CISM training mandatory for all employees, especially management, to help improve mental health awareness.

Finding 17: The chronic staffing shortage at WFO Jackson helped lead to burnout

Several employees admitted that burnout can be a problem when offices are regularly short staffed. Having management working a high percentage of shifts also amplifies the problem. It is unreasonable to expect local management to be able to successfully tend to the administrative needs of the entire office, recovery from a significant event, *and* high-impact daily operations, particularly for an extended period. Staff mentioned that they cannot recover or run things appropriately after these events when this is the case.

NOTE: These stressors affect each employee differently and each resource for each employee should be different.

Recommendation 17: WFOs, through the support of regional headquarters, should utilize temporary duty assignments and other support mechanisms to mitigate significant staffing shortages.

Appendix A: Definition of Terms

AFD	Area Forecast Discussion
CISM	Critical Incident Stress Management
CR-ROC	Central Region - Regional Operations Center
CREST	Couple Routing and Excess Storage
CRH	Central Region Headquarters
DAT	Damage Assessment Tool-kit
EFI	Extreme Forecast Index
ER-ROC	Eastern Region - Regional Operations Center
ERO	Excessive Rainfall Outlook
FEMA	Federal Emergency Management Association
FLASH	Flooded Locations And Simulated Hydrographs
FIM	Flood Inundation Mapping
HREF	High Resolution Ensemble Forecast
ICP	Incident Command Post
IDSS	Impact-Based Decision Support Services
IFLOWS	Integrated Flood Warning System
IWT	Integrated Warning Team
LNO	Liaison Officer
MEG	Medel Evaluation Group
MRMS	Multi-Sensor Multi-Radar
NWR	NOAA Weather Radio
NWS	National Weather Service
NWM	National Water Model
OHRFC	Ohio River Forecast Center
PQPF	Probabilistic Quantitative Precipitation Forecast
QPF	Quantitative Precipitation Forecast
RFC	River Forecast Center
SAR	Search and Rescue
SBU	Service Backup
SPC	Storm Prediction Center
SSHP	Site Specific Hydrologic Predictor
WEA	Wireless Emergency Alerts
WFO	Weather Forecast Office
WoFS	Warn-on-Forecast System
WPC	Weather Prediction Center

Appendix B: Summary of Findings and Recommendations

Finding 1: National Center products, at times, were too static for use in effective Impact-Based Decision Support Services (IDSS) at the WFO level.

It was recognized that National Center products can become "outdated" and not representative of the ongoing or expected situation over the short term (defined here as the next 6 hours). Workflow at National Centers does not lend itself to short fused updates to forecasts or outlooks that may change the narrative of expectations to end users. Moreover WFOs, who are more dynamically update driven, rely on these products and are expected to remain consistent with these as "one message" from the National Weather Service.

In this case, the ERO Day 1 forecast is updated at 0100Z, 0830Z, 1600Z. Issues of communication arose where the forecast "snapshot" made by the WPC presented a forecast threat of excessive rainfall in the ongoing recovery/damage area. The local WFO and mutual aid office determined the threat had passed not soon after issuance and tried to convey that to partners. This caused a great deal of confusion and discord with partners. In the process, WPC was asked if they could update their forecast and they stated they would not be able to do that until the next update time.

Recommendation 1a: NWS should resolve differences in workflow dynamics between National Centers and WFOs to bring product consistency, update frequency and times, and scales into congruence.

Recommendation 1b: NWS should better coordinate messaging internally across each layer (local, regional, national offices) to ensure consistency which will promote confidence regarding the forecast outcome and impact.

Finding 2: Partners were well informed about the nature of the impending event.

Partners stated that they knew some portion of the multi-day flood potential was going to be historic. Area Forecast Discussions (AFDs) mentioning the flood potential began 6 days prior to the event. NWS wording 3 days out through briefing packets, graphics, and conference calls, gave partners the understanding that something significant was coming. Graphics and/or words in the briefing packets which garnered the partner's attention:

- QPF maps with county overlays
- "Stalled"
- "Localized Heavy Rain"

Weekly partner conference calls are held at 9 am each Monday. Partners mentioned that these routine calls are typically "optional". But when special conference calls are held at times that are different, they know it is a significant event that needs their attention.

Probabilistic data was relayed from the WFO in a limited fashion. The model forecast QPF was extremely poor for this event, which made it difficult to convey the Probabilistic QPF (PQPF) well if at all. But most partners still agreed that they would like more probabilistic forecast data if available.

Recommendation 2: WFOs should Include probabilistic forecast data as much as possible in partner briefings to better convey worse case scenarios and expectations.

Finding 3a: Failure to respond to a WEA was typically tied to a lack of understanding of how to respond and/or the history of frequent flooding in southeast Kentucky.

Finding 3b: WFO staff were not completely aware of what type of flash flood warnings initiated WEA alerts.

Partners asserted that lack of knowledge regarding WEAs played a role. They tried to convey via many means (radio, social media) the seriousness of the event. A significant part of the education/response challenge is the history of flooding in southeast Kentucky ("It always floods here") similar to areas hit by hurricanes. Surveys from Kentucky Public Health (approx 400 households) showed that most people knew what was coming but the predicted magnitude and impacts were hard to believe.

Partners noted the best way to educate people was by two means:

1. In schools. "Mom and dad will listen to the kids" was a repeated theme.
2. Church organizations. "Everyone reads the bulletin" was remarked and agreed on by the partners. The suggestion here was to pursue large church organizations that would include weather safety and education information in churches and church bulletins which serve a significant number of people in this region of the country.

Recommendation 3a: WFOs should continue/direct education efforts on WEA to both traditional and non-traditional groups, some of which is driven by local cultural norms of the most vulnerable.

Recommendation 3b: WFO staff should be aware of the criteria for which a WEA message will be sent and not be hesitant to reissue or upgrade warnings which will initiate WEA messages, especially for situations in which people may be in heightened danger (i.e., historic events) or particularly vulnerable (after dark, underserved population, etc.)

Finding 4: A number of residents do not have cell service and therefore, did not receive the WEAs when issued**.**

A number of residents in this region do not have cell service. Partners noted that it requires them to rely on NOAA Weather Radio (NWR), and private sector capabilities such as Rave Mobile Safety™, and Code Red™ programs, to alert residents. Cell service in the hollows (as referred to locally, are valleys in the steep relief areas in southeast Kentucky) is very sporadic, which makes it hard to reach them through "reverse 911" systems unless it is a landline phone. Most of the deaths from this event occurred in areas with poor cell service. Free phone programs have helped, with the exception of areas with poor cell phone service,

Recommendation 4a: WFOs and Central Region Headquarters (CRH) should work with partners and NWR providers to pursue grants and partner related programs, especially in areas where cell service is a challenge and/or vulnerable populations exist, to place NWR receivers in homes.

Recommendation 4b: WFOs should educate users of NWRs how to reduce warning fatigue and when a "turn on the NWR day" exists.

Finding 5: Loss of the Integrated Flood Warning System (IFLOWS) data program and national support over the years had a significant negative impact on partner Situational Awareness and warning response**.**

This was a significant point of contention in ALL of the impacted areas. A number of officials at multiple locations lamented this program no longer being supported. They said that they would have been able to evacuate earlier and save lives with it. They said that this data would have allowed broadcast media to show a "play by play" of the data to get people to act, similar to the time of arrival with storms. It was said that if they had these data like they used to, they would have been evacuating people on pavement rather than by boat.

In response to this disaster, local Emergency Management is trying to acquire 48 IFLOWS gauges to manage and support locally.

Recommendation 5: NOAA, NWS, and local WFOs should work with government partners at the local, state, and national level to develop programs that improve situational awareness and data availability for high impact events.

Finding 6: Using the Site Specific Headwater Model at the WFO proved to be very difficult.

WFO Jackson, while well versed in flood operations and having recently completed training with these tools, found it challenging to effectively run the Site Specific software and confidently disseminate the predictions. These challenges were magnified by the stress and time sensitive nature of the situation. In this case, the rainfall put the flow off of the rating curve, so most of the forecasting done was beyond precedent. The initial forecast was two feet above the previous record, which proved to be five feet too low. The River Forecast Center (RFC) was in constant contact with WFO Jackson to assist in producing forecasts for these headwaters points using the Site Specific software, but comments from the RFC and WFOs were that Site Specific has outlived its usefulness and a new solution should be examined. There are also some RFCs that are actively bringing the headwater points back to the RFC for better support and forecasts.

Recommendation 6: NWS should develop a path forward to provide effective headwater point forecasts.

Finding 7: The on-site support provided by WFO Jackson at the Incident Command Post (ICP) was crucial to local officials**.**

Great services start with great relationships. Emails and other remote IDSS are important, but do not replace nor match the services provided by on-site, deployment trained NWS personnel. Extreme and/or historic events impact local partners and communities particularly hard, often on a very short timescale, and may include the need for unique IDSS requests. NWS partner agencies may be stretched beyond normal capacity and struggle to reach out to the NWS. Local officials stated a need to have the NWS deployed sooner and said, ***"The NWS is always needed. Don't wait for us to call you."***

Recommendation 7a: CRH should broaden a training program for IDSS by offering regional in-person "Boot Camp" training classes and "Train-the-Trainer" concepts.

Recommendation 7b: NWS deployment-ready personnel should be trained and prepared to offer IDSS for a variety of situations, including SAR, air support or other unique requests.

Finding 8: While early messaging tactics were noticed by the partner agencies and the public, consistent messaging within the framework of the Integrated Warning Team (IWT) was a challenge.

Messaging for the event initiated at least six days prior and continued throughout. Early messaging allowed local officials to know "something was up" prior to the event. However, NWS relationships with Emergency Management and Broadcast Media within the IWT were

critical to the success of public messaging and derivative public safety. It was noted that a particular broadcast media partner presented information to viewers that contradicts the NWS message, which led to division, confusion, and lower trust in the information by the end user.

Recommendation 8a: NWS should work with local partner agencies to identify extreme and historic events well ahead of time. Recognizing partner agencies may not have the time to reach out to the NWS for IDSS, NWS should develop guidelines which allow local WFOs to engage partners prior to or at the onset of such events to provide IDSS even without a formal request from local officials.

Recommendation 8b: WFOs should develop a set of best practices focused on solutions that work with challenging partner relationships along with their supporting success stories.

Finding 9: Mutual Aid/Service Backup (SBU) could not initially be performed from the servicing Senior Service Hydrologist (SSH) office.

WFO Jackson's servicing Service Hydrologist was located in Louisville, KY. Louisville is neither a primary nor a secondary backup site for WFO Jackson. As a result, the Senior Service Hydrologist was initially unable to provide mutual aid (e.g. hydrology products) for the WFO Jackson office. This was later corrected, and since the time of the flood, CRH has recruited and hired a Service Hydrologist specifically for WFO Jackson.

Recommendation 9: CRH should ensure that all Service Hydrologists that serve two offices have the ability to provide on demand hydrology mutual aid to their second WFO.

Finding 10: The Mutual Aid/Service Backup process remains fragmented and under-developed in some cases.

Several factors contributed to this finding. They are as follows:

1. There was some confusion as to the support levels that could/should be provided by the Central Region - Regional Operations Center (CR-ROC) and supporting WFOs given different circumstances, which evolved during the event. Confusion was compounded given that the SBU office was in a different region.
2. There was a lack of autonomy given to the field WFOs involved. Eastern Region - Regional Operations Center (ER-ROC) mentioned their end of shift time as a means for WFO Wilmington to take action on SBU which had already been decided with WFO Jackson.
3. The notice given by WFO Jackson for service backup was an off-then-on proposition. WFO Wilmington mentioned that WFO Jackson said they "had it" and they were

reluctant to ask for help. Then later the same shift, they called WFO Wilmington and asked for SBU.

4. WFO Jackson being in SBU was difficult as the timeliness of products and services are at the mercy of the office providing the SBU/Mutual Aid. This was especially difficult then to provide partner briefings, especially when deployed.

Recommendation 10a: In the age of expanding mutual aid, the CR-ROC should develop a catalog of best practices for WFOs and ROCs to refer to, cross-regionally, that would enable those offices to examine and take cues from real world scenarios that would enable better and advancing mutual aid concepts and execution in the future.

Recommendation 10b: CRH should work to improve communication/collaboration between the WFO and the CR-ROC, especially during situations of cross-regional SBU, to ensure efficient, seamless mission execution.

Recommendation 10c: WFOs should communicate clear timeline expectations to their backup office for partner needs appropriately, when SBU/Mutual Aid is being provided during an active deployment.

Finding 11: An open Google Meet™ between internal/external partners resulted in a better, more coordinated service

Initially, WFO Jackson and OHRFC had an open Meet during the height of the flash flood. Both offices acknowledged that this was the best way to communicate and brought them together as one team. It enabled them to communicate through the many challenges of using Site Specific Hydrologic Prediction (SSHP) and a rapidly changing flood situation. The SSH in LMK also joined, as did others as the event unfolded. Several commented that having the Meet with the RFC brought calm to a very difficult situation. “The open Google Meet™ with OHRFC was fantastic. It felt like the OHRFC was here sitting with us”.

Recommendation 11: Each WFO should develop, as part of their Hazardous Weather Operations, a plan to dynamically incorporate open virtual meetings (via Google Meet™, GoToMeeting™, or other resources), both internally and externally during high impact events, to maximize inter-office collaboration and partner/stakeholder engagement.

Finding 12: The post-event damage survey was completed, but not without technical delays and limitations when using the Damage Assessment Toolkit (DAT) and Survey123™.

While the use of the DAT and Survey123™ has improved NWS damage survey documentation and coordination in general, the DAT and Survey123™ still lack capabilities in rural areas and for flood surveys, both of which made conducting the flood survey and compiling data more difficult and time consuming.

Recommendation 12a: NWS should look to Improve the DAT Flood Layer by adding the ability to add multiple geotagged photos at once (currently only one geotagged photo can be added) along with improved polygon and line functionality to allow for better representation of flood damage extent and impacts. Additional layers such as E-19s and NWS FIMs (Flood Inundation Mapping) could be added for comparison to flood survey data.

Recommendation 12b: Survey123™ requires the user to be logged into an account for use. Each NWS storm survey team should log into Survey123™ at a location with good connectivity on at least one survey divide (phone or tablet) before beginning the survey

Recommendation 12c: Should Survey123™ become inaccessible (i.e. logged out) during a survey in an area with limited cellular service, reestablishing connectivity can be frustrating, if not impossible at times. NWS should consider developing an alternative program which permits survey data acquisition in the event of lost connectivity with Survey123™, while allowing for a simple, quick transfer of data collected once connectivity can be reestablished.

Finding 13: Visual data from a drone provided excellent video and imagery, which enhanced the ability of WFO Jackson and WFO Louisville to complete the damage survey.

The use of a drone to capture aerial photos and video of flood damage was extremely valuable to provide a birds eye view of the historic flood damage, including high water marks and damage to vegetation and structures. However, there were some issues regarding on-scene flight restrictions which delayed drone deployment.

Damage assessment using drones not only provides a unique view of the damage, but allows damage surveyors the opportunity to survey a larger area or inaccessible areas in a timely manner, thus providing a more accurate representation of the damage and impacts. Drones could also be used beyond damage assessment, such as building, tower and radome assessments and even possibly limited meteorological measurements, if equipped.

Recommendation 13: WFOs should collaborate with Emergency Management and other partner groups to leverage the use of drones.

Finding 14: Prototype National Water Model (NWM) and Prototype RFC FIM was provided by the National Water Center (NWC) to a limited number of FEMA HQ and FEMA Region IV employees. However, there were challenges in internal NWS collaboration due to lack of FIM collaboration procedures, training, and understanding how to incorporate the information into operations.

This was the first time that the FEMA Liaison Officer (LNO) from FEMA HQ requested NWM and/or RFC FIM for a Flash Flood Warning event. Given the rapid timing of a flash flood event requiring fast action, several discussion/learning points are noted. These are focused on collaboration on FIM releases to FEMA HQ being more transparent.

1. A conference call was held between the NWC, CR, and ER offices (ROCs, RFC, WFOs) where a brief overview of the FIM proposed to be shared, with a select number of FEMA employees, was shown and discussed. All offices were concerned that due to lack of training and familiarity of FIM they could not provide concurrence whether to share FIM with FEMA. Although the NWC was available to assist with any questions, an established procedure for reachback was not in place. Ultimately, FIM was shared to a select number of FEMA employees at FEMA HQ and Region IV via the FEMA liaison to the NWC.
2. At the time of the event the FEMA recipients of the FIM had agreed to non-disclosure. However, due to the initial lack of aerial impact information, FEMA did share the FIM with county and local partners to aid with search and rescue efforts. Additionally, FEMA Region IV wanted the FIM for response and recovery, execution of flood mitigation, and other functions of oversight by FEMA.

Recommendation 14a: NWS should expand training of FIM for NWS field offices. Familiarization and understanding of NWS FIM is needed for all offices.

Recommendation 14b: The National Water Center should inform, educate and update the NWS field offices on the NWS Flood Inundation Mapping (FM) Concept of Operations (CONOPS) (November 2022). The NWC Google Site for Flood Inundation Mapping Services provides access to all NWC FIM plans and information.

Recommendation 14c: Education of field offices by NWC is needed to ensure understanding of the process for collaboration and distribution of FIM where the phased rollout has not yet occurred. As explained in the NWS FIM CONOPS, a phased rollout of publicly available FIM will occur through FY2026.

Finding 15: Significant events have both short and longer term impacts on employees' well-being. Impacts were noted by the Assessment Team within the WFO Jackson staff.

A number of employees recognized the emotional, mental, and physical toll on them during the event. This toll led to productivity losses over time that would otherwise not have happened. Employees noted the strain to focus on the mission and to try and ignore the ongoing devastation.

Long term impacts, such as those that have been mentioned in the Critical Incident Stress Management materials, were observed during interviews.

Recommendation 15: NWS should develop a team of NWS employee peers and emotional recovery experts that will be referred to and available for individual or group discussion sessions with those employees involved in the significant event. These should be done right after the event and at some interval (6 months to 1 year) later.

Finding 16: The emotional strain of a significant event came from a multitude of sources**.**

Forecasters observed a number of stressors during the event that should be taken into account in crisis management. These include the following:

A. Inability to talk to someone that resonates with what forecasters encountered in this type of event. Many mentioned they could not discuss this with friends, their spouse, etc. because they could not relate.
B. Social media. Forecasters noted, with significant emphasis, that it was very hard seeing a number of Twitter posts that were actively celebrating and rooting for the demise of the people that they were trying to save. On a number of occasions, they had to look away from it just to function. Also, the specific stories of survivors were particularly impactful and memorable. Forecasters said that seeing the devastation, then needing to tell people that more was coming was really difficult. They mentioned the need to take time away from social media, which sometimes helped to focus on science and operations.
C. Reaction from political officials. The Governor was noticeably saddened by the event and its devastation. The feeling of helplessness was noted.
D. Fear that because an "outside the box" decision was made during their shift (e.g the Flash Flood Emergency with no reports) that somehow the wrong decision was made, even when it was clearly the correct decision.
E. Calling people into work during the night not knowing if they were being led into harm's way.
F. Leaving the office shortly after the significant event.
G. Knowing the devastation and not being able to avoid seeing it

H. Guilt for not being present or able to contribute due to circumstances outside of their control. A number of employees mentioned a survivor's type of guilt where they could not make it to the office and watching everything unfold while not being able to help was very difficult. *"[I was} not at the office and stuck at home […I] knew what coworkers were going through and wanted more than anything to be able to help them out. From an emotional standpoint, previous events did not compare to this…it was very difficult". "Worst helpless feeling being stuck at home and knowing people are being impacted and not being able to help. Feeling guilty for not being there was something I don't want to experience again." "I was told at around 8 am to go home or I would be stuck. Shortly after leaving, they closed the road to the office. I wished I would have stayed and felt guilty for leaving - should have stayed with those stuck at the office."*

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