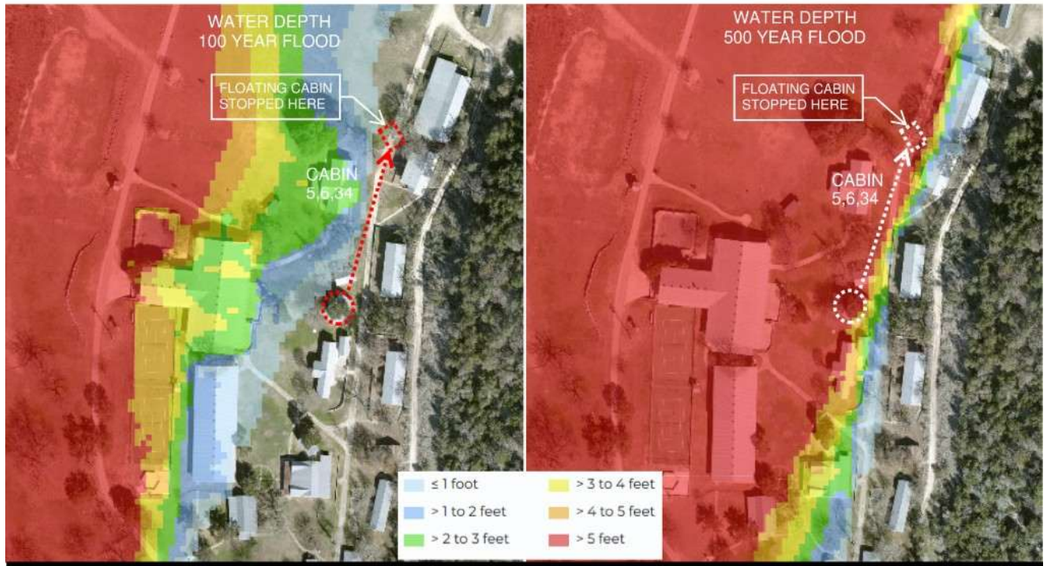
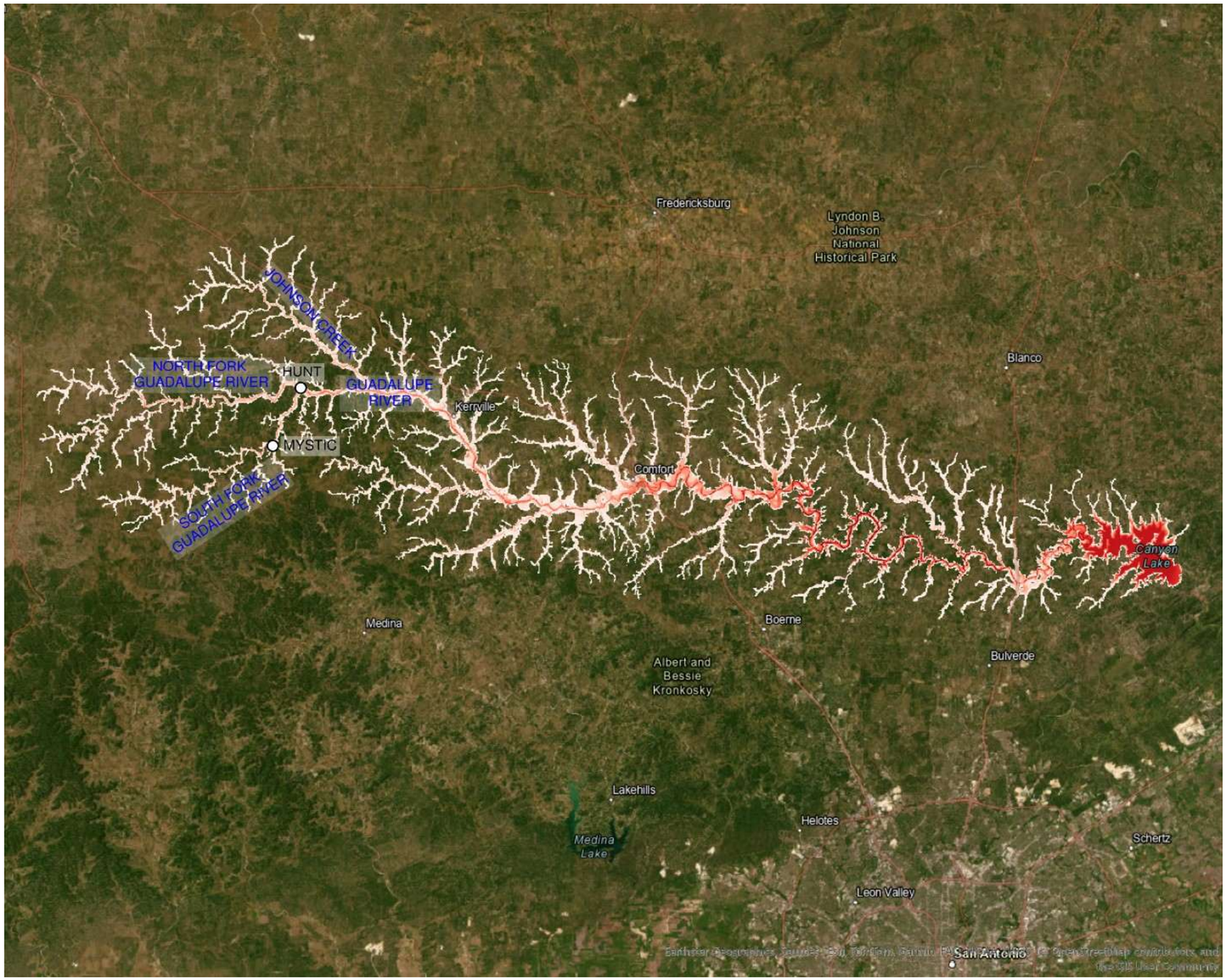
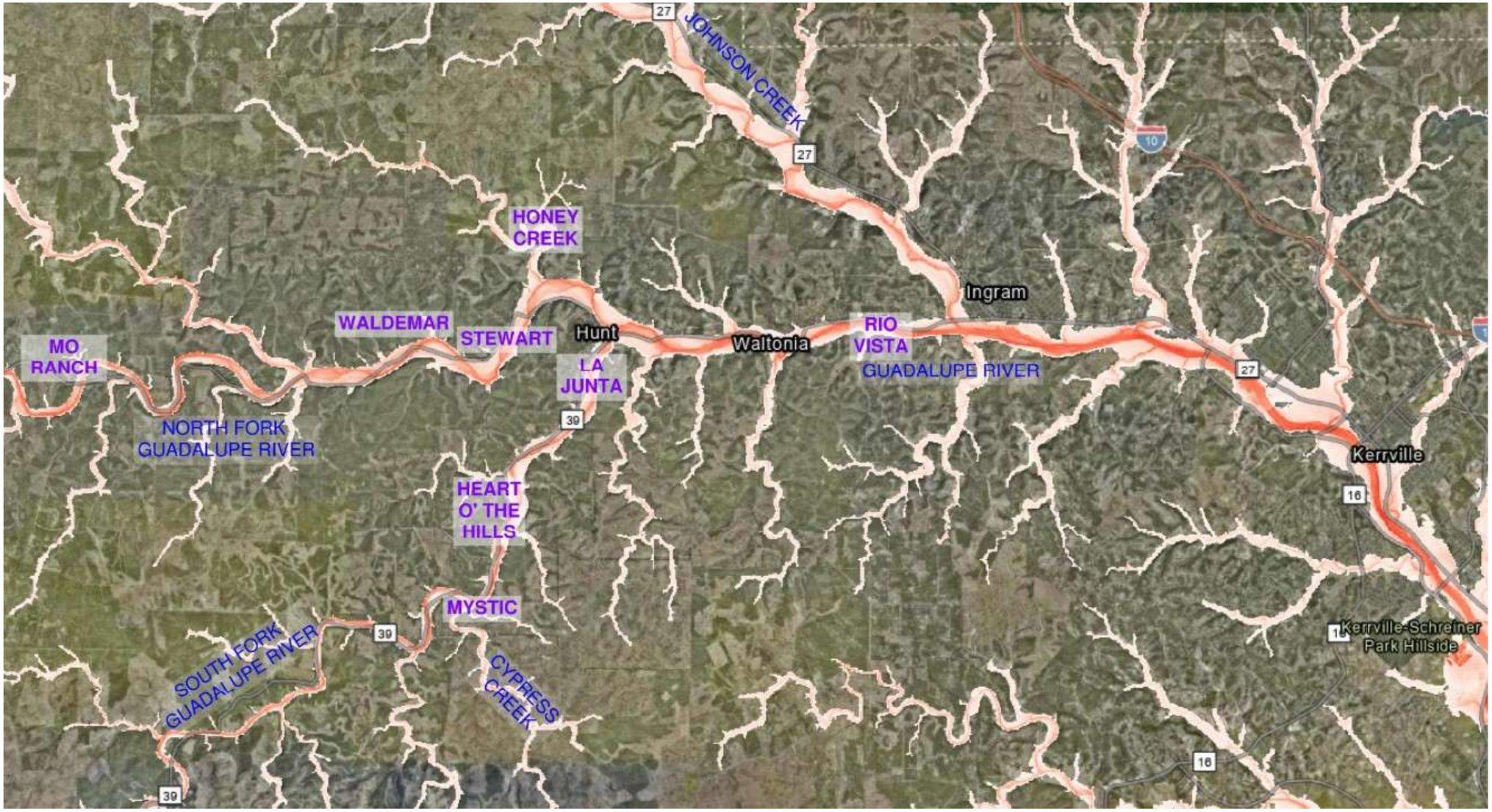
Most everything is designed and constructed based on what FEMA considers a 100-year flood event (i.e. 1/100 probability of happening in any given year). FEMA also publishes the approximate extents of a 500-year flood event for informational purposes, but I don't believe there are any restrictions for buildings within the 500-year floodplain. When looking at the predicted water depths for a 100-year vs 500-year flood event at Camp La Junta, the observed water levels appear to more closely match a 500-year flood event. From the video of the floating cabin, you can see Cabin 5,6,34 in the background with the large roof and exposed wood truss. It appears that the water is a couple feet below the windows/door which is consistent with news reports of campers treading water and climbing into the roof rafters. Also, the floating cabin would not have been in water for a 100-year flood event. Therefore, I believe this was close to a 500-year type flood event (as defined by FEMA).



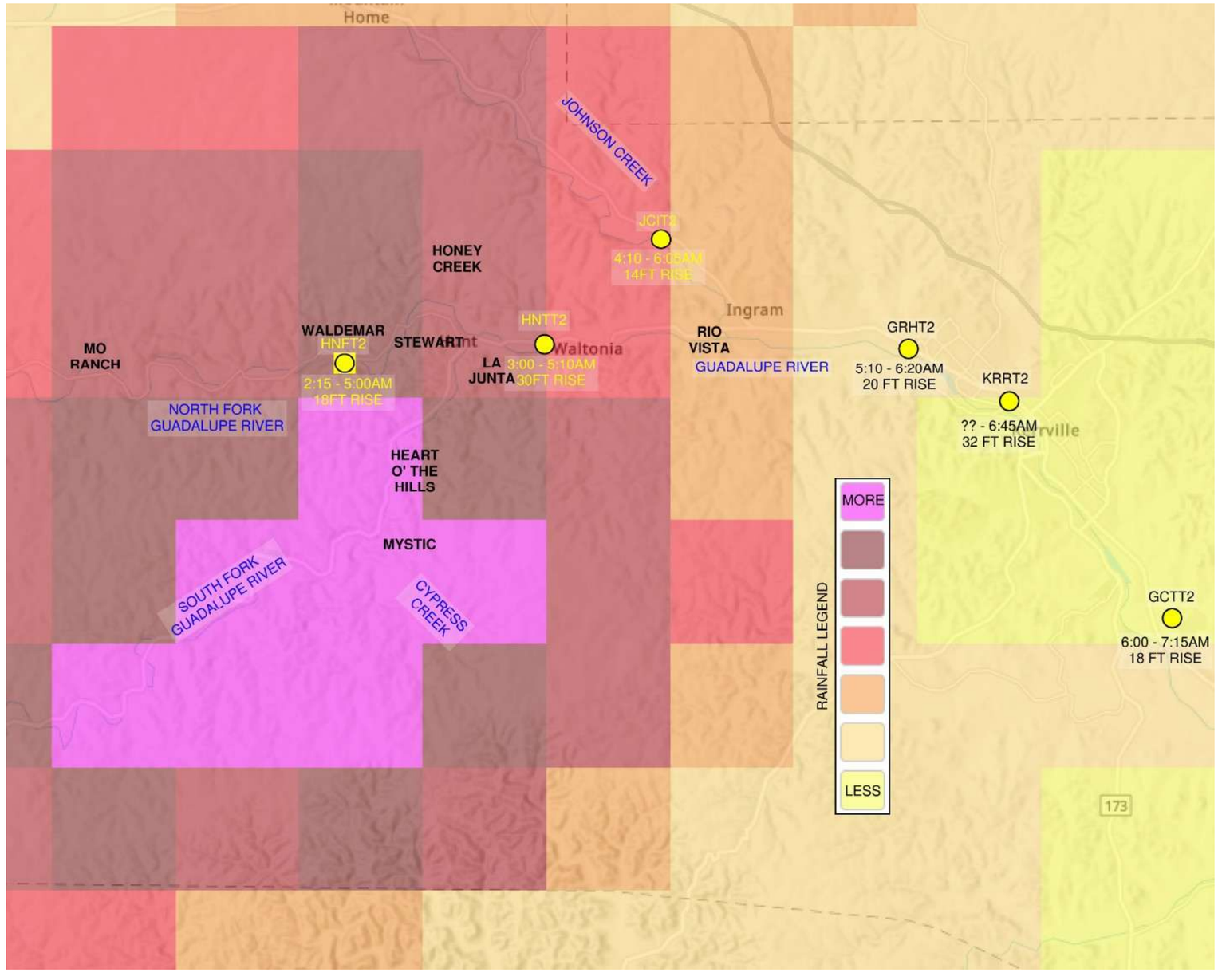
Next, I wanted to understand overall geography and why some camps might have fared better than others. From a big picture standpoint, the Guadalupe starts as a north and south fork which converge in Hunt, TX and then eventually makes its way into Canyon Lake.



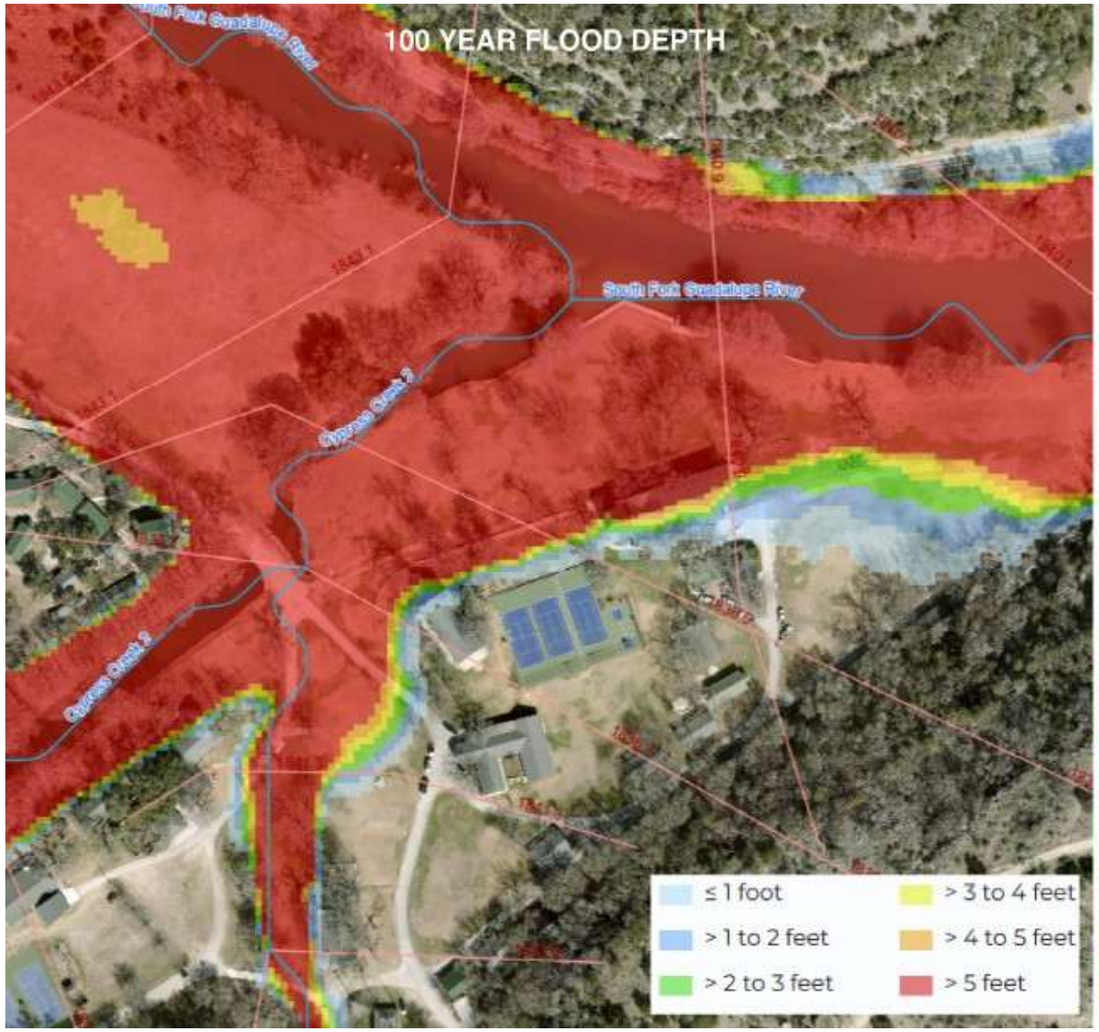
There are a lot of summer camps in the area, but it seems the most affected by the flood were located along the south fork of the Guadalupe.

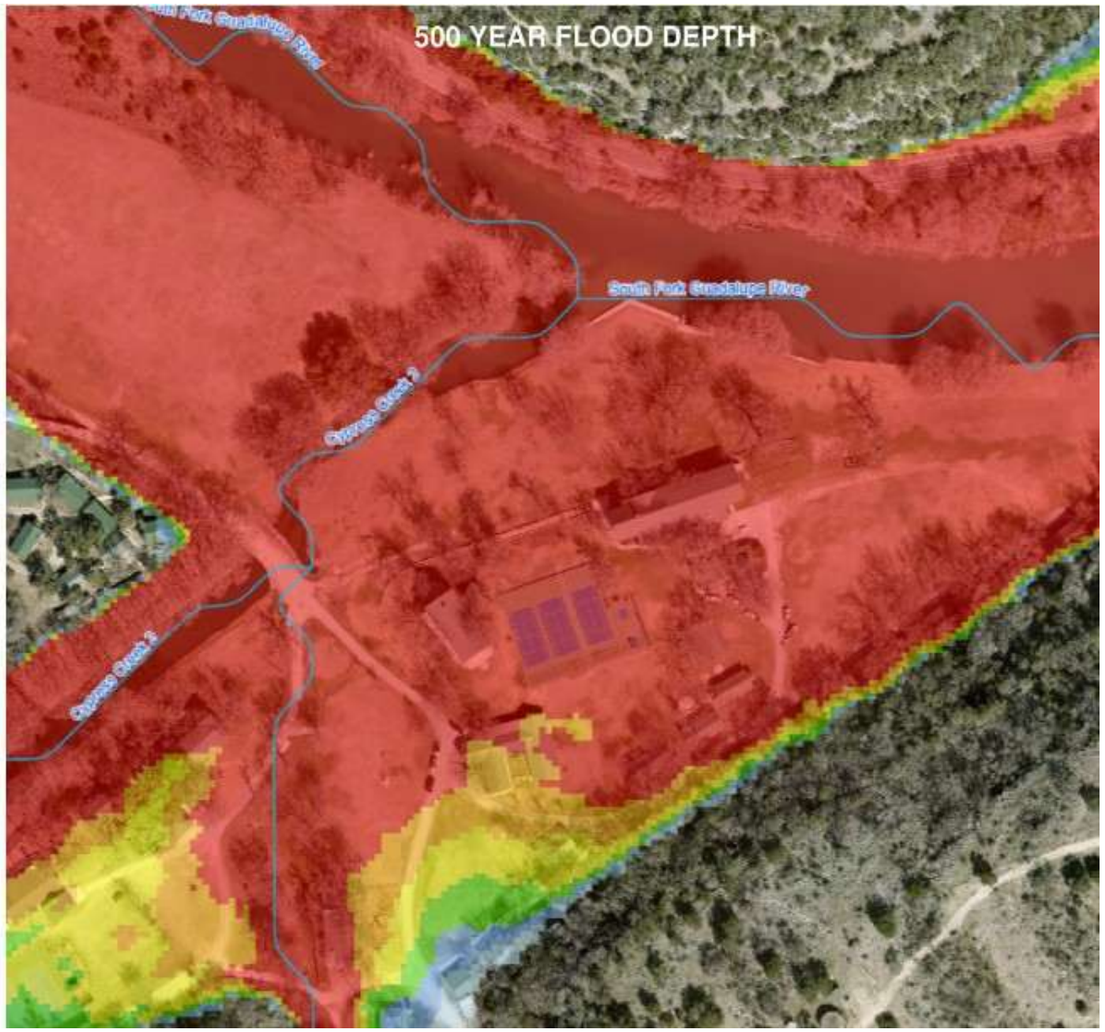


The south fork also received the highest rain totals. There are no flow gauges on the south fork but based on the nearest flow gauges, I'd imagine the south fork was rapidly rising during the 3 and 4 o'clock hours, possibly rising 30 or more feet within those couple of hours.

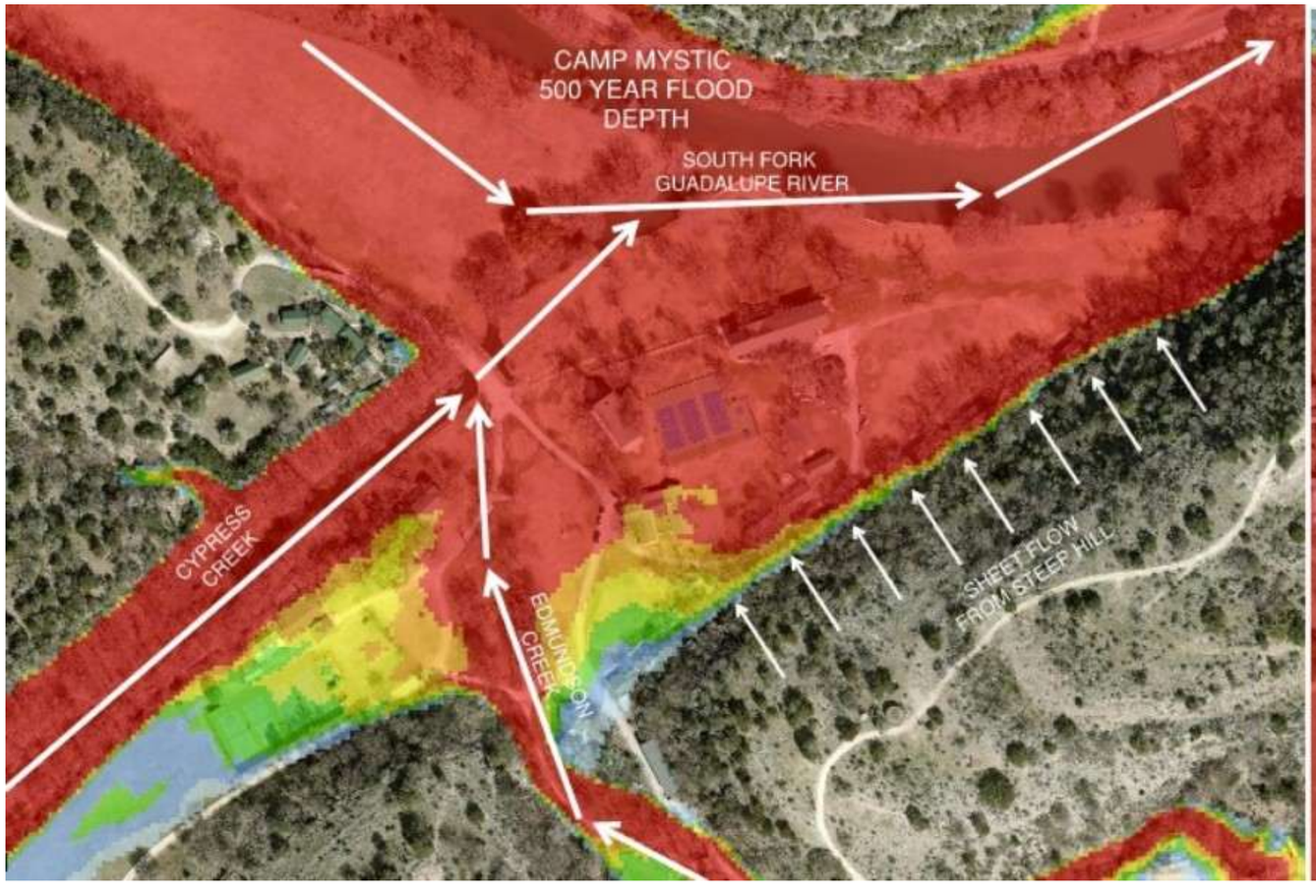


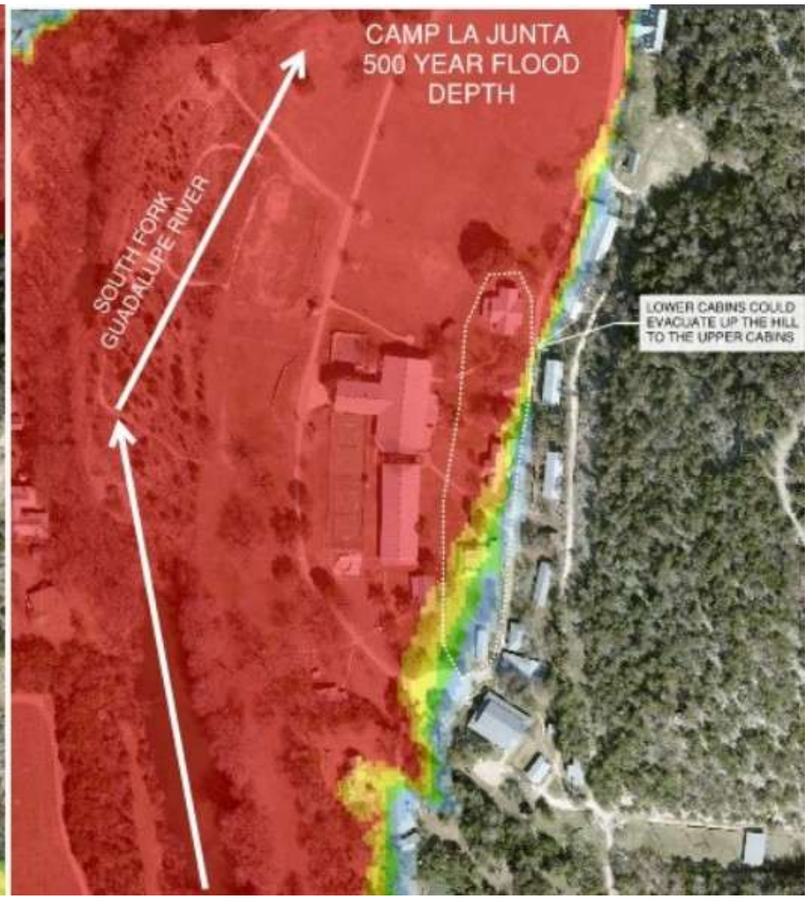
Mystic is the furthest camp upstream on the south fork and other than the NWS flash flood warning issued at 1:14am, Mystic likely did not know that there was an extreme flood headed at them. From news reports of firsthand accounts, it sounds like the cabins with the lowest elevations were evacuated first. Then when the water kept rising higher, they started evacuating the cabins at higher elevations which housed the youngest campers. At some point during that evacuation, the water may have risen too high or been flowing too fast. That evacuation plan may have been sufficient for a 100-year flood, but they likely need more time to safely evacuate for a 500-year flood.





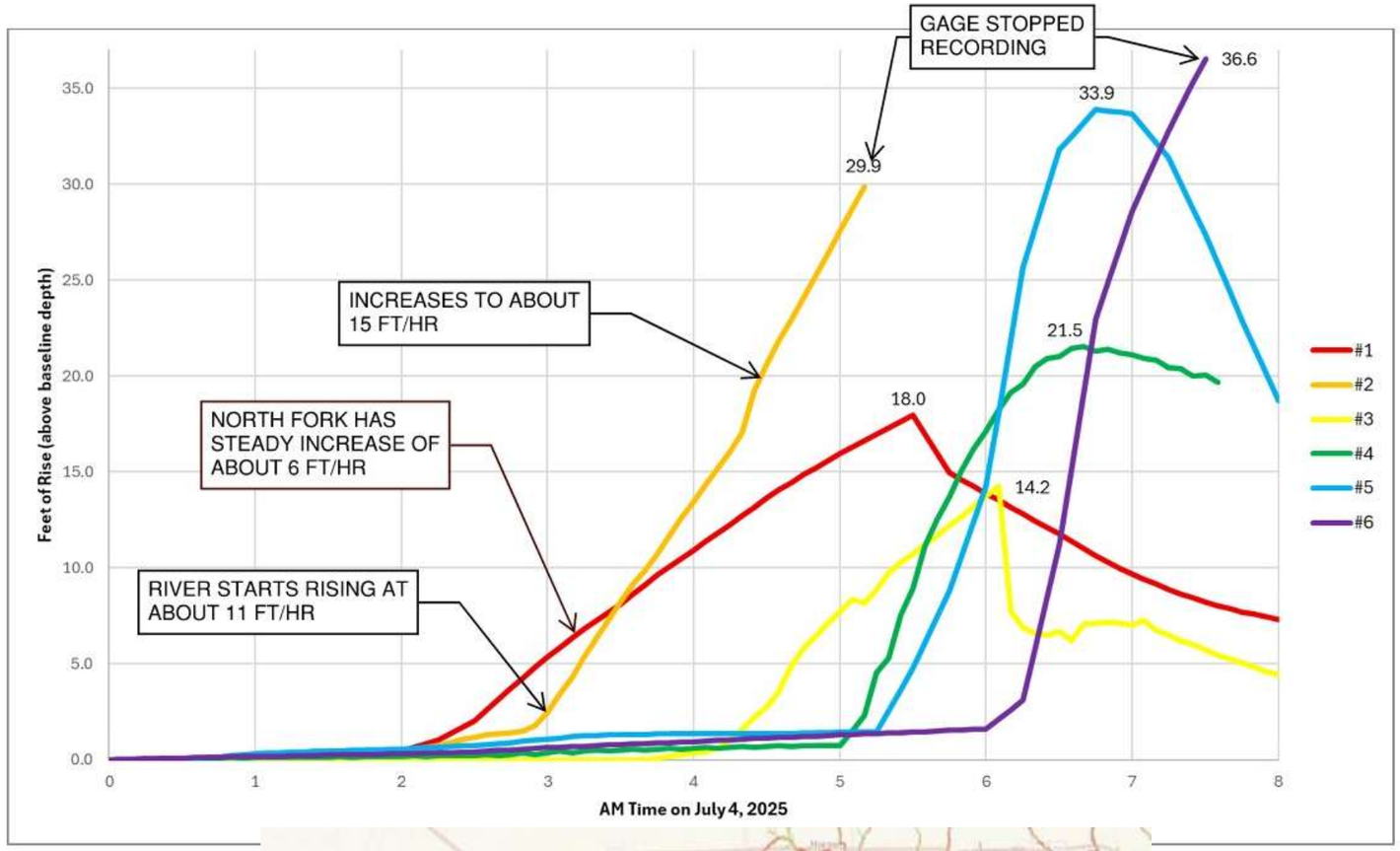
Lastly, I wanted to understand if there were any differences between Camp Mystic and Camp La Junta that contributed to their survival/peril since both are on the lower fork of the Guadalupe. La Junta is further downstream and has a simple layout and water flow. The cabins are built between the river and the hill at different elevations. If needed, the campers in the lower cabins could evacuate to the upper cabins. There is also a road above the upper cabins that could be an additional evacuation location if the water kept rising. The layout and water flow at Mystic is more complicated. The oldest campers are located on senior hill and are cut off from the rest of the camp by Cypress Creek and Edmundson Creek. The middle-aged campers are in cabins along the hill. There were reports that some of these cabins were evacuated to the rec hall and some climbed the hill behind the cabins. The youngest campers were near the office between the hill and the river. Edward Eastland said that the water around these cabins was swirling which seems likely based on the multiple directions of water flow.

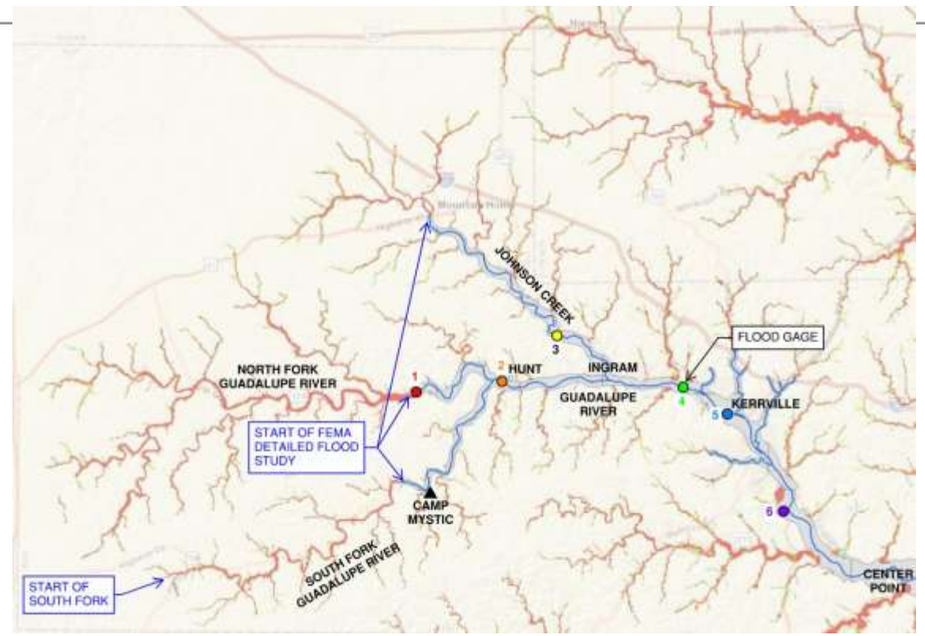




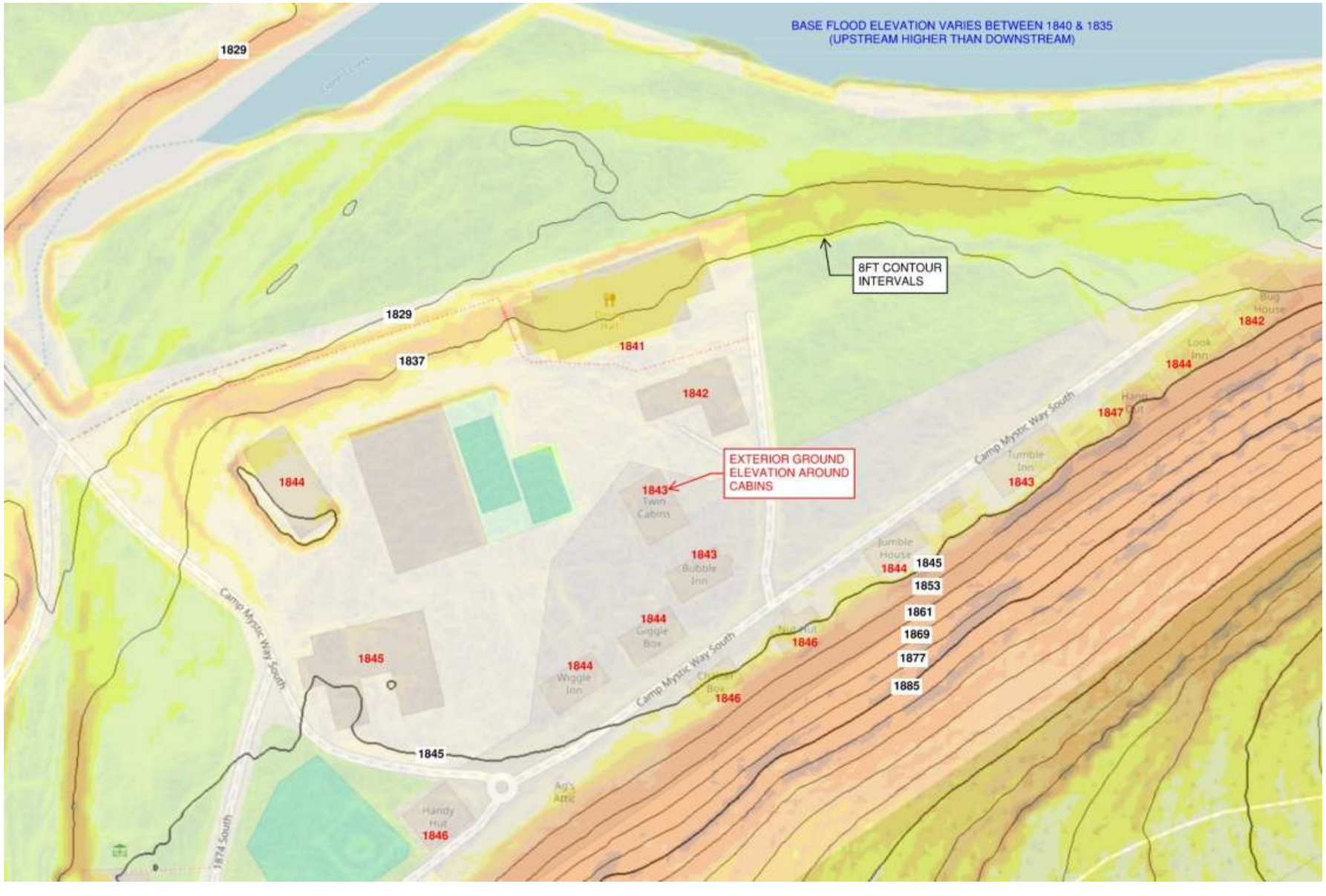
Here are some additional thoughts after studying the flood gage data:

- At 2am, the north fork began rising steadily at 6ft/hr. This is probably slow enough for a typical evacuation plan.
- At 3am in Hunt, the river began rapidly rising at a rate of about 11 ft/hr. At 4:30am, the rate of rise increased to about 15 ft/hr. The flood gage reading doesn't predict how high the river will rise, but it does indicate the intensity of the flooding and the urgency for evacuations downstream.
- It sounds like Mystic had already started evacuations at 3am for the cabins at the lowest elevations. If Mystic had known the water was rising at an unsafe rate of 11-15 ft/hr, they could have evacuated all cabins at the same time rather than in phases.
- The NWS issued a flash flood warning at 1:14am and a flash flood emergency at 4:03am. There was sufficient data from the Hunt flood gage at 3am indicating an emergency. A warning system using river flow data rather than rain gages and weather forecasts would have triggered the emergency status 1 hour earlier. (that's not a knock against the NWS since that type of warning system would probably need to be implemented at the local or state level)
- Downstream areas along portions of a major river would probably see the biggest benefit from a warning system because of the all the data from upstream and the time it takes for the flood head wall to travel downstream.

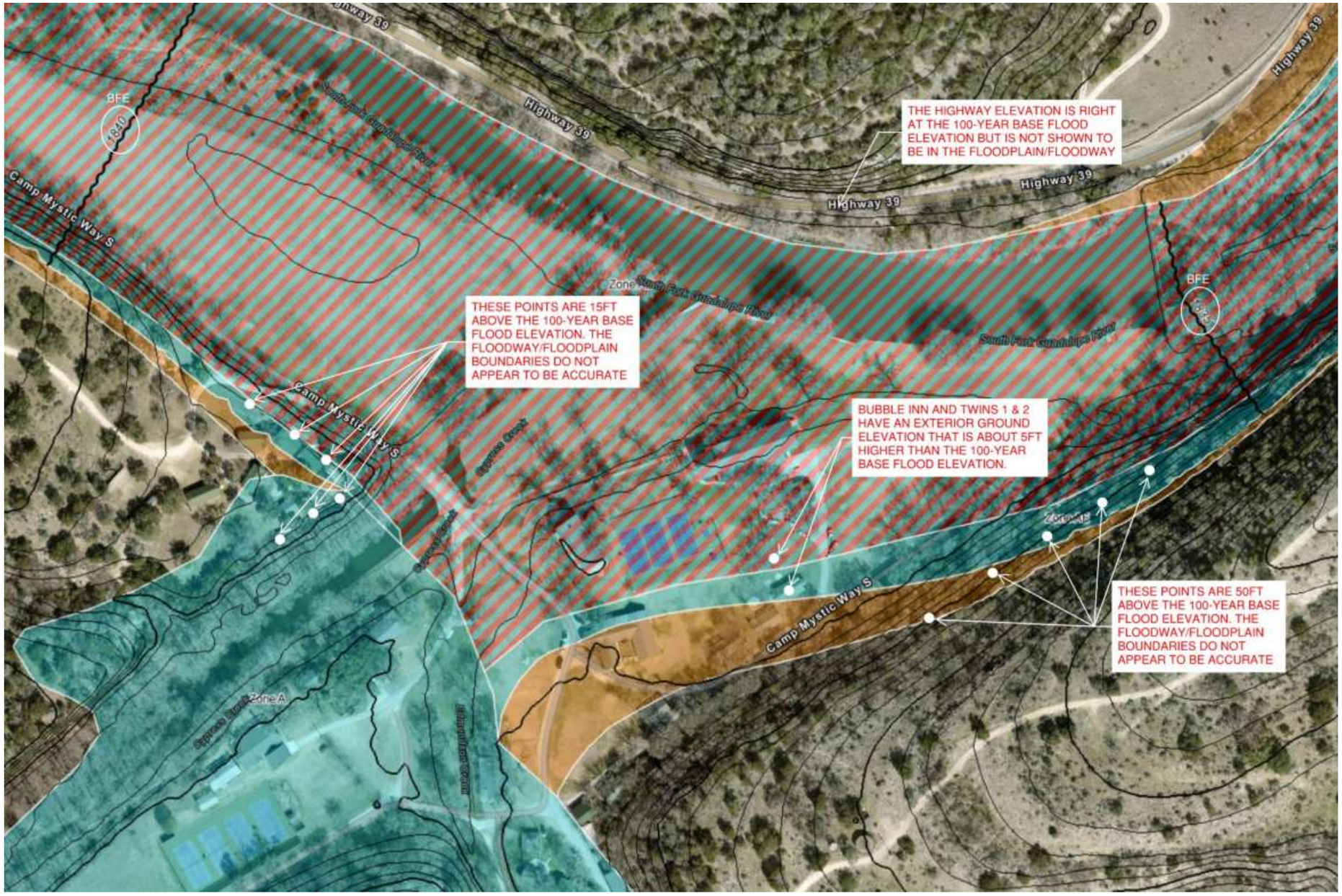




It seems that many news outlets have simply looked at the 2 dimensional FEMA FIRM map, saw that some cabins are located within the floodplain/floodway boundary, and have been quick to criticize the camp for putting the kids in harms way. Most of the articles I read do not mention anything about vertical elevation. The ground outside most of the cabins are at least 5ft above the 100-year base flood elevation. In addition, some cabins are built up further above the ground. This graphic shows the ground elevations outside the cabins based on USGS LIDAR data. You can find the interactive map here: https://apps.nationalmap.gov/viewer/



When overlaying the FEMA floodplain/floodway boundaries with the ground contours, I noticed that the FEMA FIRM map seems off. For example, FEMA shows the floodplain to extend into the hill behind the cabins which is significantly higher than the BFE and it also shows most of the cabins on senior hill to be in the floodplain. Also, the FEMA map does not show Hwy 39 to be in the floodplain even though it is near the BFE. It seems that the FEMA FIRM maps are using less accurate elevation data to generate the boundaries.



The online FEMA estBFE Viewer seems to show a more accurate depiction of the flood extents for a 100-year flood. As I have mentioned before, this was clearly an extreme flood event and probably closer to what FEMA currently considers a 500-year flood event. You can find the interactive map here: https://webapps.usgs.gov/infrm/estbfe/