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2012 Southeast Louisiana and Southern Mississippi Flooding Due to Hurricane Isaac

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33 **ABSTRACT**

34

35 Slow-moving Hurricane Isaac affected the northern gulf coast between August 28<sup>th</sup> and

36 August 31<sup>st</sup>, 2012. The most severe flooding impacts from storm surge and heavy rainfall

37 occurred in southeast Louisiana and southern Mississippi. The slow movement of Isaac was a

38 major contributor to this flooding. The National Weather Service (NWS) Lower Mississippi

39 River Forecast Center (LMRFC) coordinated the creation of flood survey teams to document the

40 impacts and discuss forecast services with our customers and partners. Survey team members

41 obtained anecdotes from persons living in impacted areas, high water marks, and in some cases,

42 established river crests at forecast locations. Notes from the survey teams were compiled and

43 summarized by river system. Post survey action items included establishing crests for non-

44 automated gauge locations and investigating anecdotes provided by members of the public.

45 Multiple methods for estimating storm total precipitation were compared and contrasted, leading

46 to discovery of an isolated extreme rainfall maximum across portions of New Orleans.

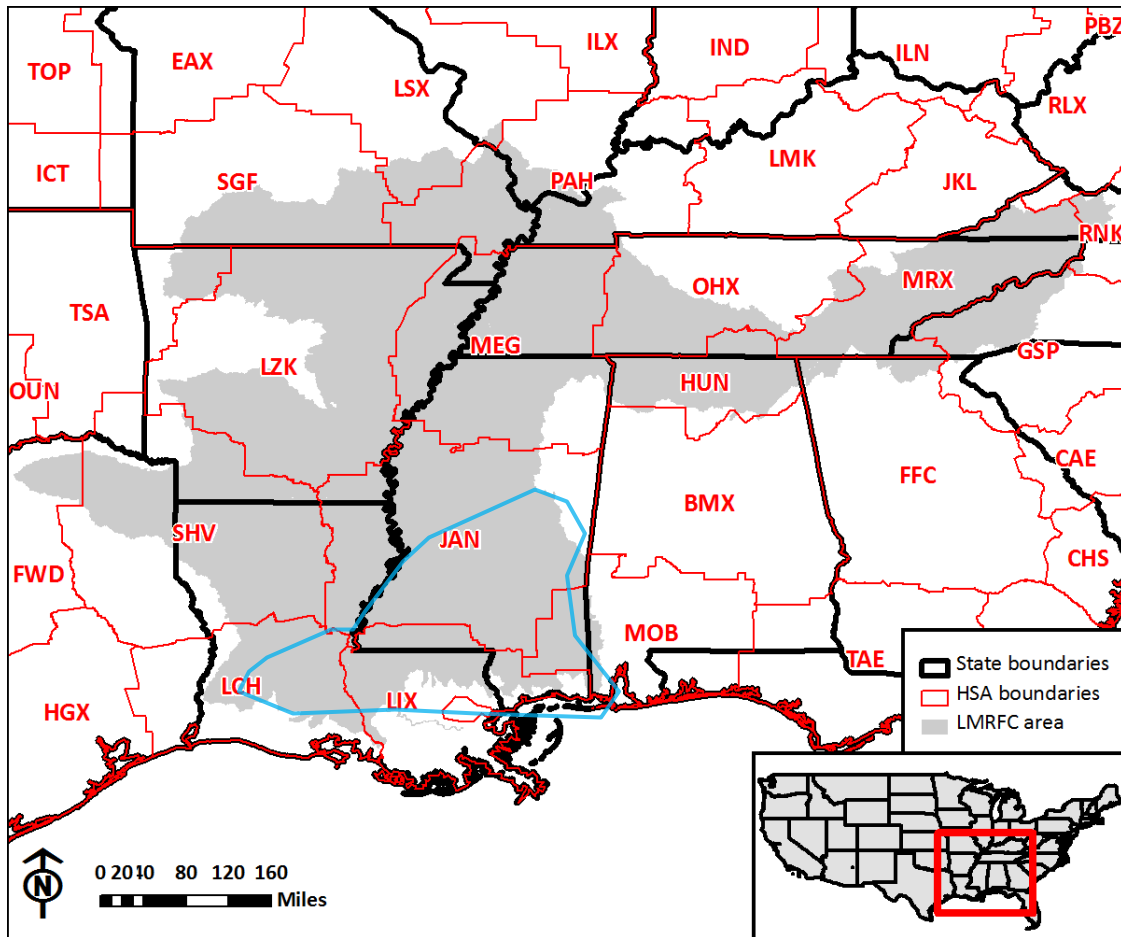
47 Recommendations for service improvement were provided to the relevant NWS Weather

48 Forecast Offices (WFOs).

49

50 **1. Introduction**

51  
52 Hurricane Isaac was a very slow moving tropical system that affected the central Gulf  
53 Coast over several days, starting with outer rain bands arriving on August 28<sup>th</sup>, 2012. By August  
54 31<sup>st</sup>, 2012, the very heavy rainfall in conjunction with storm surge had caused numerous forecast  
55 locations to exceed flood stage. The region most impacted by flooding associated with  
56 Hurricane Isaac included the forecast areas of National Weather Service (NWS) Weather  
57 Forecast Office (WFO) Lake Charles, NWS WFO New Orleans/Baton Rouge, NWS WFO  
58 Jackson, and NWS WFO Mobile, and was almost entirely within the hydrologic service area  
59 (HSA) of the Lower Mississippi River Forecast Center (LMRFC) (Figure 1). By mid-September,  
60 flooding associated with Isaac had subsided, leaving behind 16 minor flood stage crests, 5  
61 moderate flood stage crests, and 12 major flood stage crests; out of these, 3 were new record  
62 crests. Recognizing the widespread, significant nature of the flood event, the NWS LMRFC  
63 coordinated the creation of flood survey teams to document the impacts and discuss forecast  
64 services with our customers and partners. This document provides the results of the survey  
65 teams' activities and some suggestions for improving service in the future.



66  
 67 Figure 1. Map of central Gulf Coast region, with the LMRFC forecast area shaded in gray and  
 68 individual NWS WFO hydrologic service areas (HSAs) delineated in red. The area of significant  
 69 flooding from Hurricane Isaac - determined by locations climbing above the 90th percentile of  
 70 streamflow by the USGS – is circled in blue.

71 *a. Post-flood Survey Methodology*

72 Surveys of areas impacted by Hurricane Isaac's flood-producing rainfall were  
73 conducted from Wednesday, September 5<sup>th</sup>, 2012, through Saturday, September 8<sup>th</sup>, 2012.  
74 National Weather Service staff members from several different offices were involved in the  
75 survey team, which was composed of:

- 76 1. Dr. Suzanne Van Cooten, Hydrologist-in-Charge, NWS Lower Mississippi River  
77 Forecast Center
- 78 2. Jeffrey Grascel, Service Coordination Hydrologist, NWS Lower Mississippi River  
79 Forecast Center
- 80 3. Katelyn Costanza, Senior Hydrologist, NWS Lower Mississippi River Forecast Center
- 81 4. W. Scott Lincoln, Hydrologist, NWS Lower Mississippi River Forecast Center
- 82 5. David Schlotzhauer, Hydrologist, NWS Lower Mississippi River Forecast Center
- 83 6. Jonathan Brazzell, Service Hydrologist, NWS Lake Charles
- 84 7. Roger McNeil, Service Hydrologist, NWS Birmingham
- 85 8. Marty Pope, Service Hydrologist, NWS Jackson

86 During each day of surveys, individuals were split into different teams (typically 2-4  
87 persons) and sent to the affected areas in Louisiana and Mississippi. The survey team members  
88 sought to document evidence of flooding and speak with our partner agencies such as the local  
89 emergency management officials. The survey teams also spoke with local residents impacted by  
90 the flooding to get a feel for how our forecasts were received and note potential issues that  
91 should be resolved to improve our services.

92 *b. Flood Category Descriptions*

93 Most official forecast points and even some non-forecast gauging data points have a  
94 stretch of river reach associated with the point location. Flood categories – action/bankfull,  
95 minor, moderate, major – are determined for river reaches based upon the impacts typically  
96 observed for particular stages. It is typically the responsibility of the service hydrologist or  
97 hydrology focal point of a NWS WFO to create and maintain these categories. Although flood  
98 categories can be adjusted based upon the needs of the local community and criteria may differ  
99 between NWS WFOs, NWS Manual 10-950 (OCWWS, 2012) defines the flood categories as  
100 follows:

- 101 • Minor Flood Stage: Minimal or no property damage, but possibly some public threat.
- 102 • Moderate Flood Stage: Some inundation of structures and roads near stream. Some  
103 evacuations or people and/or transfer of property to higher elevations.
- 104 • Major Flood Stage: Extensive inundation of structures and roads. Significant evacuations  
105 of people and/or transfer of property to higher elevations.
- 106 • Record Flood Stage: Flooding which equals or exceeds the highest stage or discharge  
107 observed at a given site during the record-keeping period. The highest stage on record is  
108 not necessarily above the other three categories. It may be within any of them or even  
109 less than the lowest, particularly if the period of record is short.

110 In the following sections, the flood category listed is determined first by categories  
111 already in place (as provided by the responsible NWS WFO), but if the surveyed location is not a  
112 gauged location or has not been surveyed, the flood category is estimated as objectively as  
113 possible using the criteria from NWS Manual 10-950, but partially expanded:

- 114 • Minor flooding: River/stream is above flood stage, but the expected impacts are of minor  
115 severity. Typically water inundates floodplain areas and/or agricultural areas, but causes  
116 minimal property damage. Rural roads that are prone to water may flood.
- 117 • Moderate flooding: River/stream is above flood stage with impacts of moderate severity.  
118 Water begins to inundate roads and may also flood a few structures, especially those  
119 prone to flooding in the 1%-chance FEMA floodplain.
- 120 • Major flooding: River/stream is above flood stage with impacts of major severity. Water  
121 starts to inundate numerous residents and businesses. Water may also severely disrupt  
122 travel on major roads. Inundation extent may extend beyond that of the 1%-chance  
123 FEMA floodplain and may also near the flood of record.

124 **2. Meteorological Synopsis**

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127 *a. Track and Forecast Overview*

128           Hurricane Isaac became the ninth tropical depression of the 2012 hurricane season  
129 about 715 miles east of the Leeward Islands around daybreak on Tuesday, August 21. By early  
130 evening, Depression 9 had strengthened to a tropical storm located about 500 miles east of  
131 Guadeloupe. Isaac was expected to strengthen slowly, reaching hurricane intensity prior to  
132 landfall in Hispaniola late Friday night on August 24.

133           The morning of Saturday, August 25, tropical storm Isaac moved off the coast of Haiti.  
134 At daybreak Sunday, August 26, satellite imagery showed Isaac was poorly organized. The  
135 National Hurricane Center (NHC) noted that the SFS, HWRF, and GFS ensemble showed Isaac  
136 turning northward toward the eastern Gulf Coast but later that day the forecast track was shifted  
137 westward significantly, with forecasters noting a “Large spread among the more reliable track  
138 models” in the midday discussion. The European Center for Medium Range Weather Forecasting  
139 (ECMWF) forecast model was about 300 nautical miles east of the Global Forecast System  
140 (GFS) model solution for Day 3. As result, a Hurricane Watch was issued for the Louisiana coast  
141 and did include metropolitan New Orleans and Lake Pontchartrain. On Sunday evening, the  
142 center of Isaac was just south of Key West, Florida. NHC highlighted two critical elements: 1)  
143 the abnormally large extent of the wind field and 2) the decrease in the forward speed of the  
144 storm. The public was advised that over the next 48 hours, tropical storm conditions were  
145 expected to reach the northern Gulf by late Monday and Hurricane conditions would arrive  
146 Tuesday. With its Sunday evening product suite, NHC added wording highlighting storm surge  
147 and rainfall threats. Initial predictions were 6-12ft of storm surge for areas from Morgan City,



148 LA, to Destin, FL, and total rainfall amounts of 5-10 in with maximum amounts up to 15 in  
149 possible along the central and eastern Gulf Coast.

150           At daybreak Monday, August 27, the minimum pressure of Isaac had fallen to 990 mb,  
151 but the inner core structure remained disorganized. The center of Isaac was located 405 miles  
152 southeast of the mouth of Mississippi River. Numerical weather models were now locking into a  
153 landfall along the central portion of the Gulf of Mexico. NHC products continued to highlight the  
154 fact that Isaac had an abnormally large wind field and significant storm hazards extended well  
155 away from the storm's center. Aircraft, buoy, ship, and oil platform observations indicated that  
156 although Isaac's maximum sustained winds were below Hurricane strength (65 mph) tropical  
157 storm force winds extended outward up to 240 miles from the center. It was also noted that Isaac  
158 would slow in its forward speed and take a turn to the northwest on Tuesday. By Monday  
159 evening, forward movement slowed to northwest at 12 mph and the center of Isaac was located  
160 255 miles southeast of the mouth of the Mississippi River. Total rainfall amounts up to a  
161 maximum of 18 in were forecast for southeastern Louisiana, southern Mississippi, southern  
162 Alabama, and the extreme western portions of the Florida Panhandle. Overnight Monday  
163 (August 27) into Tuesday (August 28), NHC reported a drop in Isaac's minimum pressure, but  
164 observations indicated maximum sustained winds remained just below hurricane strength. The  
165 NHC's discussion stated "The threat of heavy rainfall and flooding is also expected to spread  
166 inland over the lower Mississippi valley region during the next few days" with rainfall amounts  
167 of 7 to 14 inches total and isolated maximum amounts of 20 inches. Enhanced wording was  
168 added, "In southeastern Louisiana...southern Mississippi...southern Alabama...and the extreme  
169 western Florida Panhandle these rains could result in significant lowland flooding." NHC  
170 maintained its forecast of 6 to 12 feet of storm surge for southeast Louisiana and Mississippi.

171           Hurricane Isaac remained relatively unchanged until midday Tuesday, August 28, when  
172 aircraft reported maximum winds with Isaac near 75 mph and Isaac was upgraded to hurricane  
173 strength about 75 miles south-southeast of the mouth of the Mississippi River. By afternoon, data  
174 from numerical weather models showed atmospheric wind speeds decreasing in the upcoming 36  
175 to 48 hours. This decrease in the mid and upper level steering flow would slow the forward speed  
176 of Isaac and normally result in intensification as wind shear diminishes and the storm remains  
177 over warm ocean water longer. By evening, the center of Isaac was 20 miles SSW of the mouth  
178 of the Mississippi River with maximum sustained winds of 80 mph and movement northwest at 8  
179 mph. Hurricane force winds extended outward up to 60 miles mainly to northeast and east of the  
180 center with tropical storm force winds extending outward up to 185 miles. At 6:45 PM CDT,  
181 Hurricane Isaac brushed the Mississippi River Delta. The center jogged westward and re-entered  
182 the Gulf of Mexico around 10PM CDT. The minimum central pressure continued to fall to 968  
183 mb yet observations indicated no significant increase in maximum sustained wind speeds. NHC  
184 stated that “National Ocean Service tide gauges indicate that storm surge heights of 6 to 10 feet  
185 are occurring along portions of the coast of southeastern Louisiana and Mississippi. Given the  
186 long duration of onshore flow in these areas...water levels are expected to remain high for the  
187 next 12 to 24 hours.” Hurricane Isaac became nearly stationary just off the coast of Louisiana for  
188 several hours before wobbling westward and making a second landfall near Port Fourchon, LA.  
189 By Tuesday morning, radar indicated areas of intensifying convection in the northern and eastern  
190 quadrants of the storm.

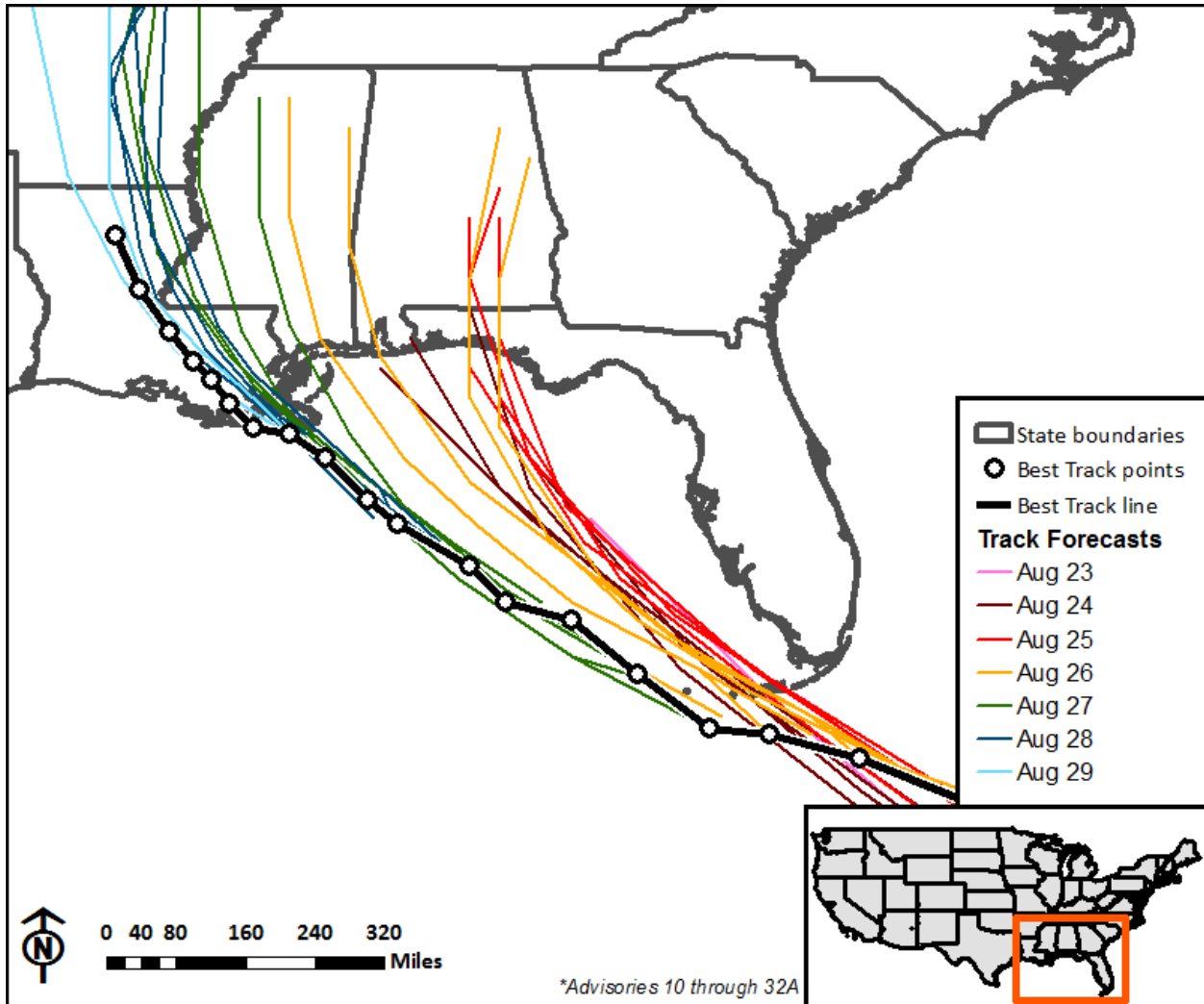
191           On the morning of Wednesday, August 29th, Isaac was moving west northwest at 8  
192 mph centered 30 miles south southeast of Houma, LA. Convective rain bands continued to  
193 intensify and increase in coverage in the eastern quadrant of the circulation. Hurricane Isaac

194 continued to slow, and by Wednesday afternoon Isaac was creeping northwest at only 6 mph. At  
195 2PM CDT, NHC downgraded Hurricane Isaac to a tropical storm with maximum sustained  
196 winds of 70 mph with a center located 55 miles south southeast of Baton Rouge. By late evening  
197 Wednesday, the NHC noted that “Isaac is expected to produce total rainfall amounts of 7 to 14  
198 inches...with possible isolated maximum amounts of 25 inches...over much of Louisiana,  
199 southern and central Mississippi, southwest Alabama, and southern and central Arkansas through  
200 Friday.” Isaac maintained its abnormally large wind field after landfall with tropical storm force  
201 winds extending outward up to 175 miles primarily in the southeast quadrant of the storm.

202           On the morning of Thursday, August 30th, mid and upper level wind speeds began to  
203 increase. With the center located 55 miles southeast of Alexandria, Louisiana, the forward  
204 motion of Isaac increased to 8 mph. The forward motion continued to increase into Friday,  
205 August 31<sup>st</sup>, with only a few lingering bands of showers affecting southeast Louisiana and  
206 southern Mississippi.

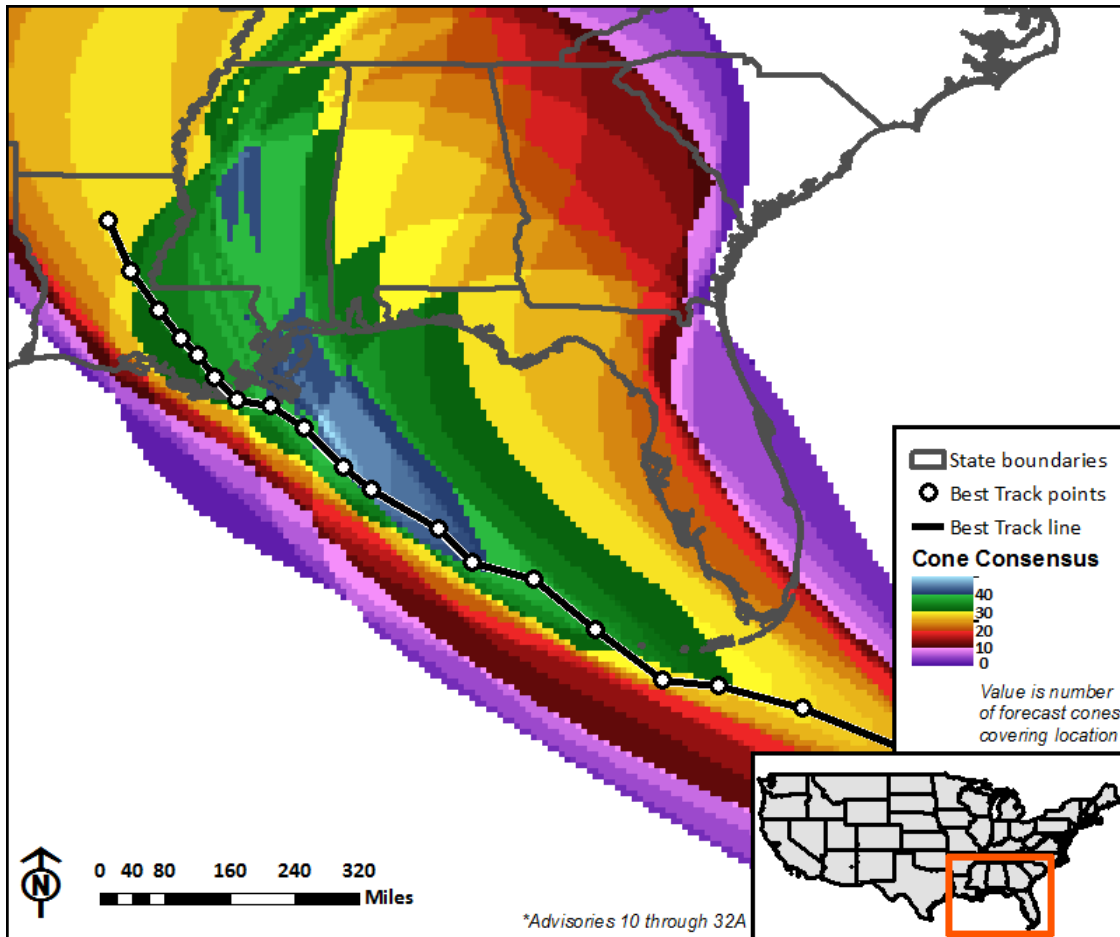
207           Climatologically, heaviest rainfall totals with coastal storms are closely tied to the  
208 landfall location and forward speed. The uncertainty with Isaac’s forecast track, forward speed,  
209 and ultimate point of landfall was problematic for quantitative precipitation forecasts, the  
210 primary forcing for medium-term river forecasting. Between August 24th and August 29th,  
211 forecast landfall locations ranged from near Panama City, FL, in the east to near Grand Isle, LA,  
212 in the west, a distance of about 270 miles (Figure 2 and Figure 3). Final landfall was just to the  
213 west of this range. The final landfall location was within the forecast cone of uncertainty for the  
214 advisories issued on August 24th between 03 GMT and 18 GMT, and again from August 26th at  
215 09 GMT through landfall.

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Figure 2. Five day track forecasts issued by the National Hurricane Center with the preliminary best track for Hurricane Isaac.



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Figure 3. A “forecast cone consensus” for Hurricane Isaac forecasts issued by the National Hurricane Center. Value is the number of overlapping uncertainty cones for a given location.

224 *b. Estimated Rainfall*

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226 1) OFFICIAL SOURCES

227 The slow movement speed of Hurricane Isaac prior to and during landfall contributed  
228 to very significant rainfall amounts across southeast Louisiana and southern Mississippi. Heavy  
229 rainfall associated with the core of Isaac occurred for almost three days, starting on August 29th  
230 and ending on August 31st. The remnant low pressure area of Isaac continued to pull bands of  
231 rainfall from the Gulf of Mexico on September 1st and 2nd, although amounts were substantially  
232 less.

233 Gauge reports from United States Geological Survey (USGS), United States Army  
234 Corps of Engineers (USACE), and NOAA stations in Louisiana and Mississippi were collected  
235 for August 28th – August 30th when the heaviest rain rates occurred. These point values were  
236 interpolated to a grid (Figure 4) using the kriging geo-statistical interpolation method to enable  
237 comparisons to the other gridded estimates. The kriging technique also produces an estimate of  
238 the standard error due to the interpolation (Figure 5). This data set showed the highest rainfall  
239 totals (12-16" range) near New Orleans. Unfortunately, several rain gauges in the impacted area  
240 produced erroneous data and had to be removed from the analysis.

241 Data from the National Severe Storms Laboratory (NSSL) National Mosaic &  
242 Multisensor QPE (NMQ) project were also retrieved. The NMQ project creates a national radar  
243 mosaic every 5 minutes across the continental U.S. and applies the Z-R relationship equations on  
244 a gridded basis based upon vertical profile reflectivity and atmospheric conditions. This is in  
245 contrast to the operational gridded rainfall data sent to NWS RFCs where the Z-R relationship is  
246 chosen by the WFO and then applied to the entire radar field. The highest rainfall totals in the

247 NMQ data were about 16” near New Orleans, LA, and about 20” near Columbia, MS (Figure  
248 10). Also of note were bands of heavier rainfall showing up in the NMQ data that were not  
249 evident in data-sparse regions of the gauge-only data, as well as areas of apparent radar over-  
250 estimation, apparently in central Mississippi (Figure 11 & Figure 12).

251 The operational quantitative rainfall estimate (QPE) used by the NWS RFCs is the  
252 multi-sensor best-estimate rainfall product, also referred to as Stage IV. This product is created  
253 by mosaicing individual gridded radar estimates, bias correcting the radar rainfall grids with  
254 automated rain gauges, then subsequently quality controlling the grids every hour. QPE created  
255 by the LMRFC indicated rainfall totals exceeding 10” over large portions of southeast Louisiana  
256 and southern Mississippi, with a few areas of 12-16” (Figure 9). Rainfall totals and spatial  
257 characteristics of the LMRFC MPE rainfall product were similar to the NMQ data in most areas  
258 (within a few inches), although the NMQ data appeared to overestimate rainfall overall which  
259 was particularly significant in south central Mississippi (Figure 11).

260 Rainfall data from the NWS Cooperative Observer (COOP) sites was not available in  
261 realtime during Hurricane Isaac but was obtained by the NWS New Orleans-Baton Rouge WFO  
262 staff in the subsequent weeks. WFO New Orleans maintains 11 of these sites within their  
263 County Warning Area (CWA) (WFO New Orleans staff, personal communication, Dec 2012).  
264 Of these 11 sites, it appeared that 8 did not fully capture the storm total rainfall from Isaac.  
265 Because of these issues, the COOP sites were only of limited use in this this report, but a few  
266 sites in metropolitan New Orleans and the Mississippi gulf coast were used. It was not made  
267 clear which particular sites recorded accurate data.

268

269 2) UN-OFFICIAL SOURCES

270           When available, rainfall data from private weather station networks were retrieved and  
271 compared to the realtime gauges and radar estimates typically available in realtime to RFC  
272 forecasters. The most extensive set of data was made available by Weather Underground, and  
273 came from their Personal Weather Station (PWS) network. Personal Weather Station data comes  
274 from volunteer observers who purchase weather observing hardware of varying cost and quality,  
275 and then choose to share their information with Weather Underground servers. Weather  
276 Underground has archived this data for a number of years for thousands of weather stations  
277 across the United States (<http://www.wunderground.com/weatherstation/index.asp>, Dec 2012).  
278 Weather Underground staff indicated that there was no mechanism in place to batch  
279 download/retrieve numerous stations over a several day time frame, but data could be exported  
280 for a single site at a time in comma-delimited CSV format (Jeff Masters & Shaun Tanner,  
281 personal communication, Dec 2012). A PHP-based web application was written to speed up the  
282 retrieval of this data from their database; ultimately over 150 stations were manually retrieved  
283 and entered into a data format that could be read into and analyzed using GIS software. After the  
284 original analysis of Hurricane Isaac was completed for this report, a more extensive process for  
285 data retrieval was developed which automates most steps (Appendix D: Data mining of the  
286 Weather Underground Raingauge Network). Unfortunately, due to the lower reliability of  
287 private stations compared to official USGS/USACE/NWS stations, there were some locations  
288 that could not be used for the event. There were also a number of time frames for some stations  
289 when data was not available; these time periods typically corresponded to the landfall of  
290 Hurricane Isaac and may be due to power outages in the area. Gridded rainfall interpolated from  
291 unofficial data sources (Figure 6) produced generally similar results to official gauges. We also



292 created a combined data set of both official and private weather stations (Figure 8), which  
293 yielded a slightly lower kriging standard error in some areas (Figure 7).

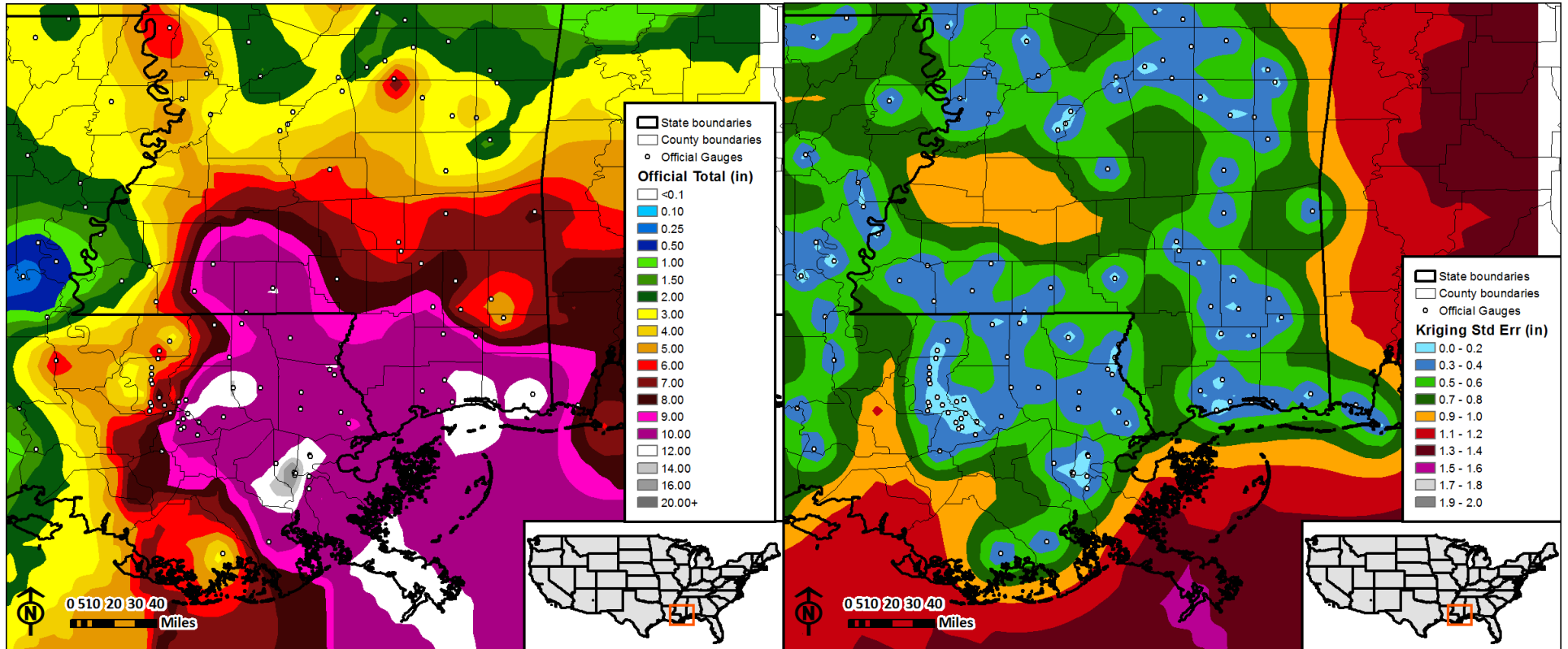


Figure 4. Storm total rainfall as observed by official precipitation gauges. Observations were interpolated by the Kriging method, which also estimates standard error due to interpolation (Figure 5). Gauge data in this plot ends at 12 GMT on 08/30/12.

Figure 5. Standard error due to kriging interpolation of data in Figure 4. Interpolation uncertainty is closely related to the density of the gauge network and observed variability between neighboring gauges.

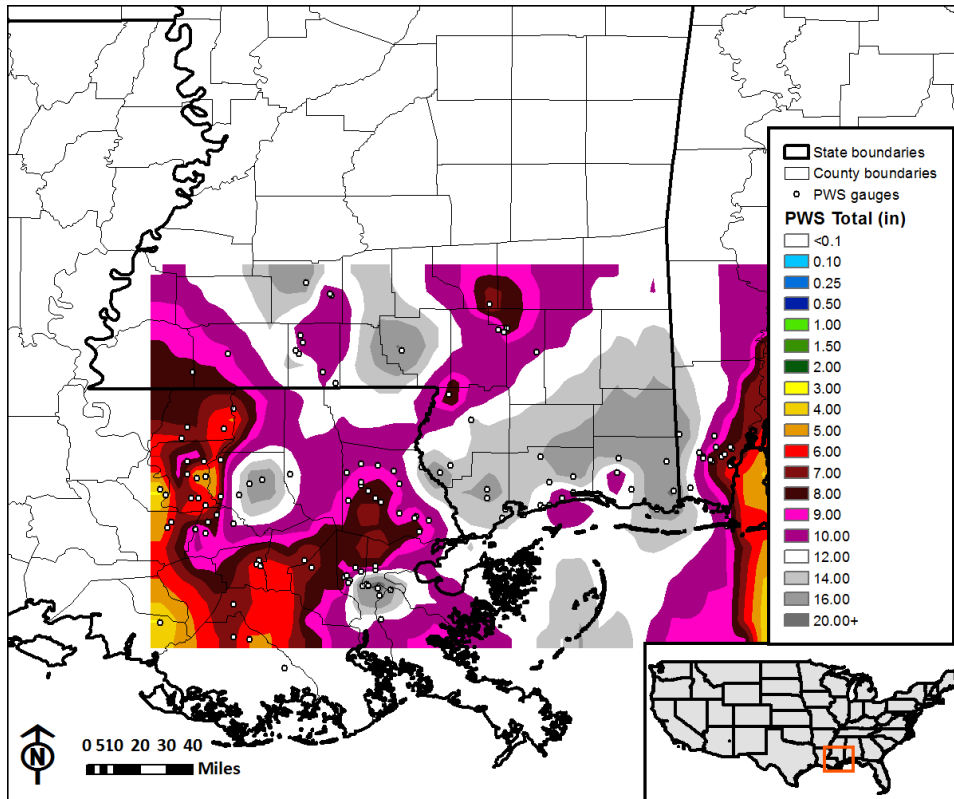


Figure 6. Storm total rainfall as estimated from QCed private weather station data. Data was mostly obtained through Weather Underground PWS sites with a few from AWS/WeatherBug and other individuals contacted by the survey team. Observations were interpolated by the Kriging method as with the official gauges, and heavily extrapolated areas were removed. Gauge data in this plot ends at 5 GMT on 09/02/12.

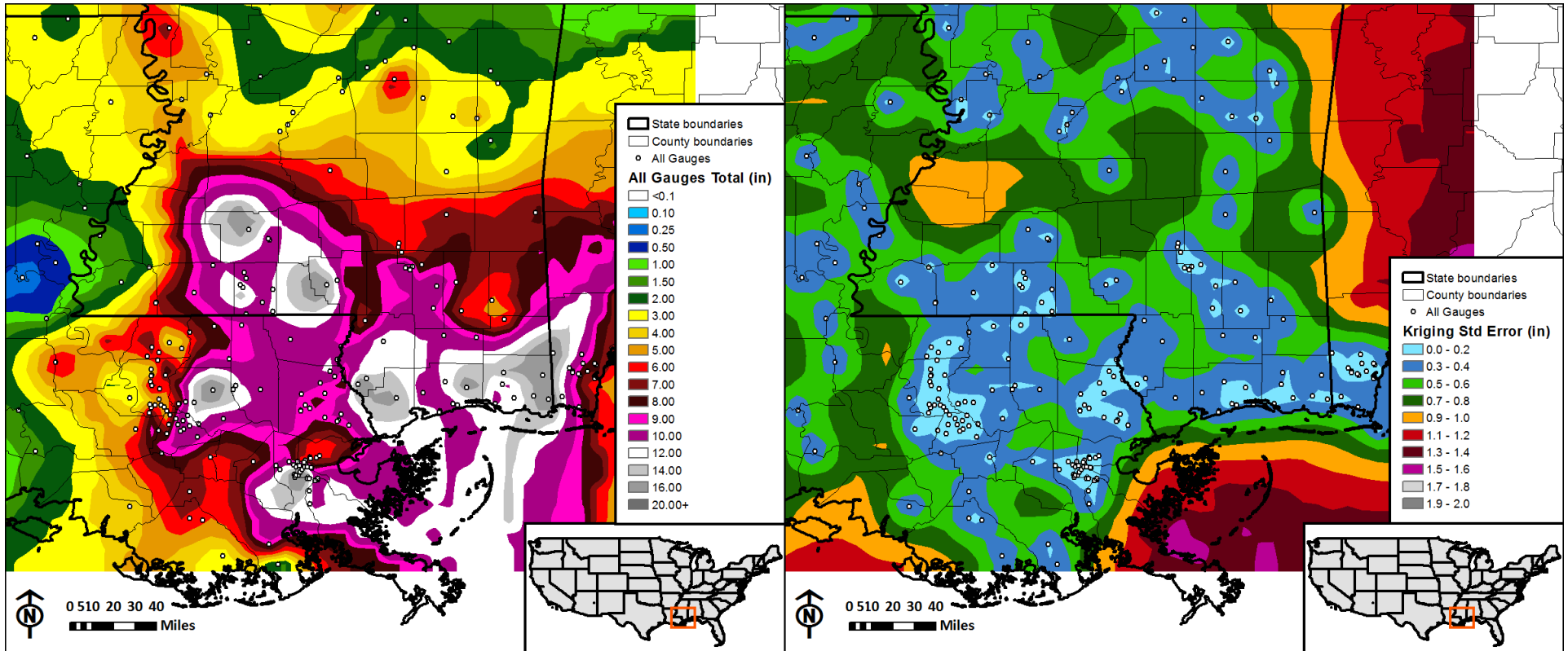


Figure 8. Storm total rainfall as estimated from a combination of official and QCed private weather stations. Observations were interpolated by the Kriging method, which also estimates standard error due to interpolation (Figure 7). Precipitation data from official stations ends at 12 GMT on 09/03/12, and data from private stations ends at 5z on 09/03/12. This small discrepancy should cause minimal issues with the data, as most rainfall had ended by 09/02/12.

Figure 7. Standard error due to kriging interpolation of data in **Error!** **Reference source not found.** Interpolation uncertainty is closely related to the density of the gauge network and observed variability between neighboring gauges.

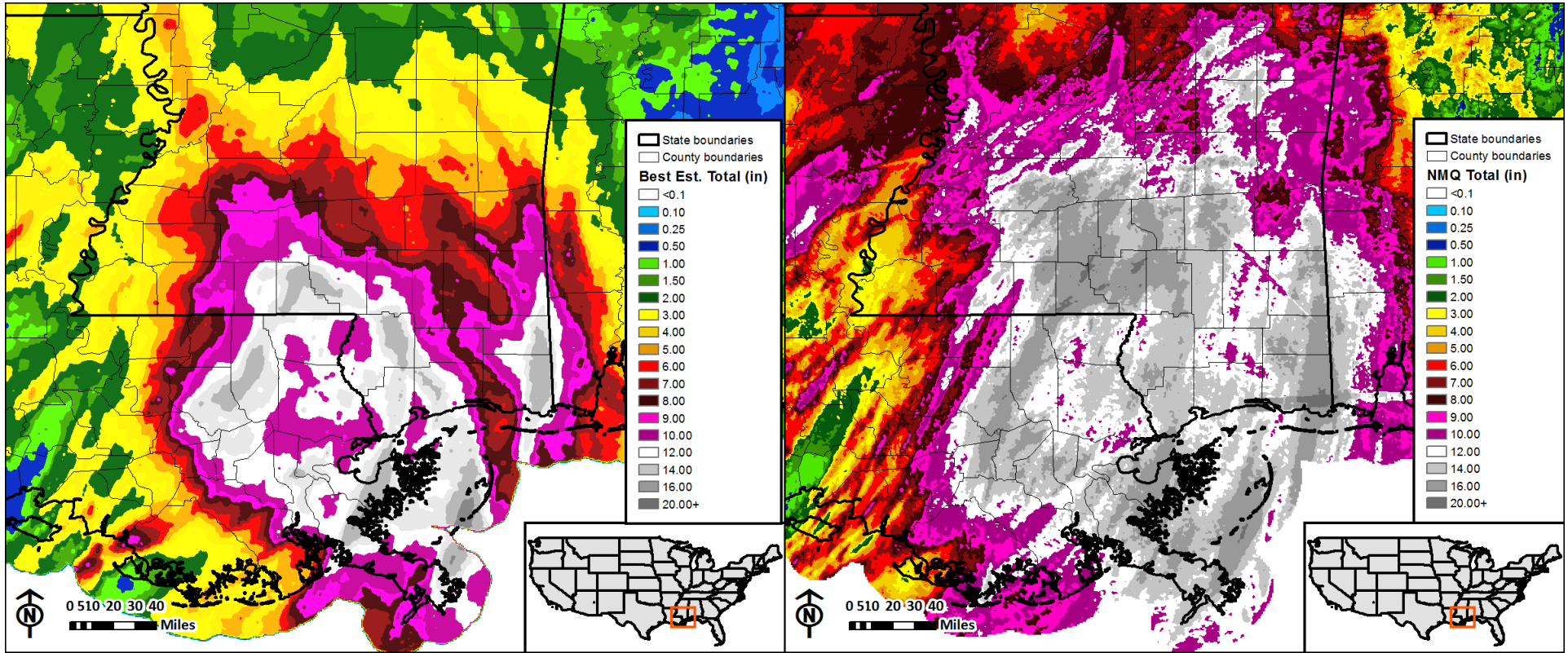


Figure 9. Storm total rainfall as estimated by a combination of official gauges, radar data, and forecaster experience in the NWS RFC MPE product. Precipitation data in this plot ends at 12 GMT on 09/03/12.

Figure 10. Storm total rainfall as estimated from radar data by the National Severe Storms Laboratory's NMQ/Q2 product. Precipitation data in this plot ends a day later than the gauge data, at 12 GMT on 09/03/12.

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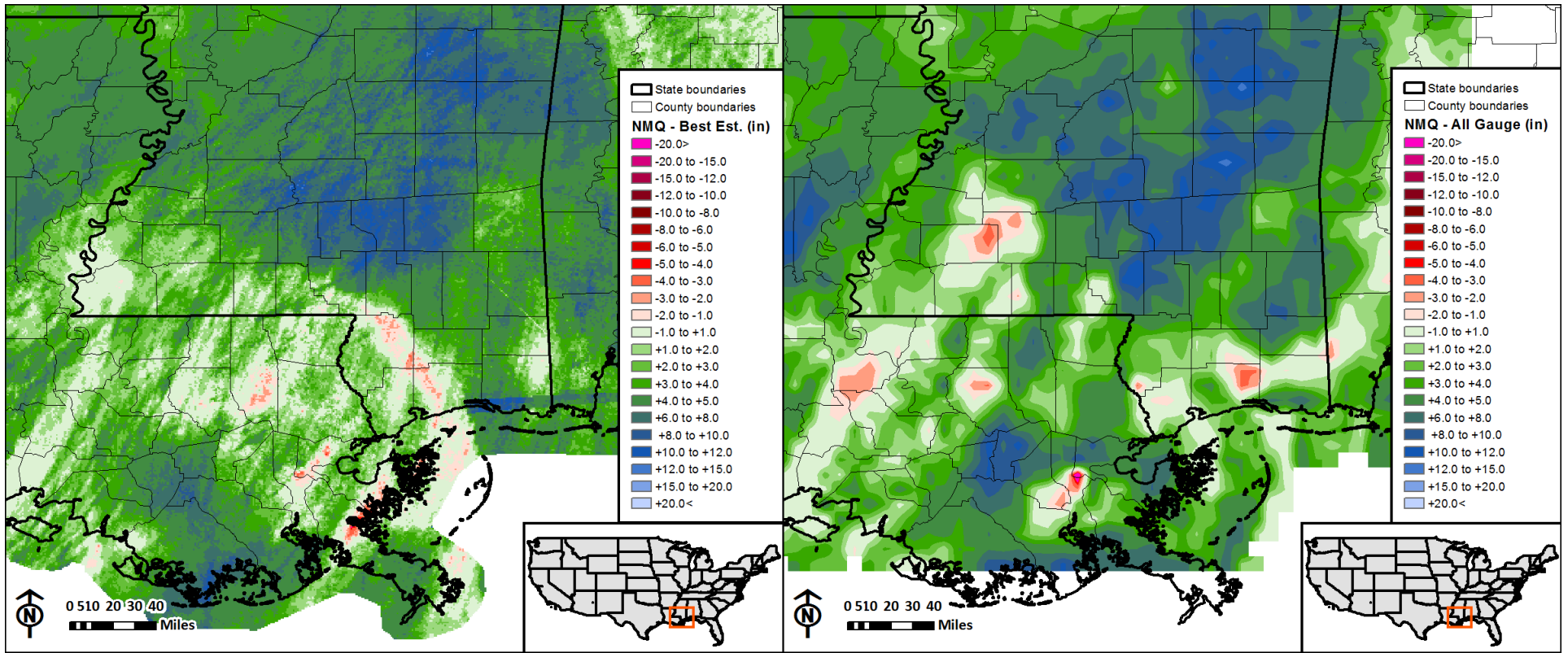


Figure 11. Difference between the NSSL NMQ rainfall product (Figure 10) and the LMRFCs best-estimate rainfall product (Figure 9).

Figure 12. Difference between the NSSL NMQ rainfall product (Figure 10) and the interpolation of all gauges (**Error! Reference source not found.**).

300 4) NOTABLE HEAVY RAINFALL AREAS

301           A few areas of rainfall stood out as particularly anomalous or notable when looking at  
302 the gauge and radar rainfall estimates. One such swath of heavy rainfall occurred near the  
303 Mississippi/Alabama Border, near Pascagoula. This heavy rainfall mostly drained into the  
304 Escatawpa River watershed. This rainfall maximum likely ranged from 14-18 inches of storm  
305 total accumulation, as estimated by the various products discussed in the preceding section.  
306 Another swath of heavy rainfall occurred in coastal Mississippi stretching from roughly Gulfport  
307 to Poplarville. The swath mostly followed the path of the Wolf River and drained into its  
308 watershed. This rainfall maximum likely ranged from 14-20 inches of storm total accumulation,  
309 as estimated by the various precipitation products.

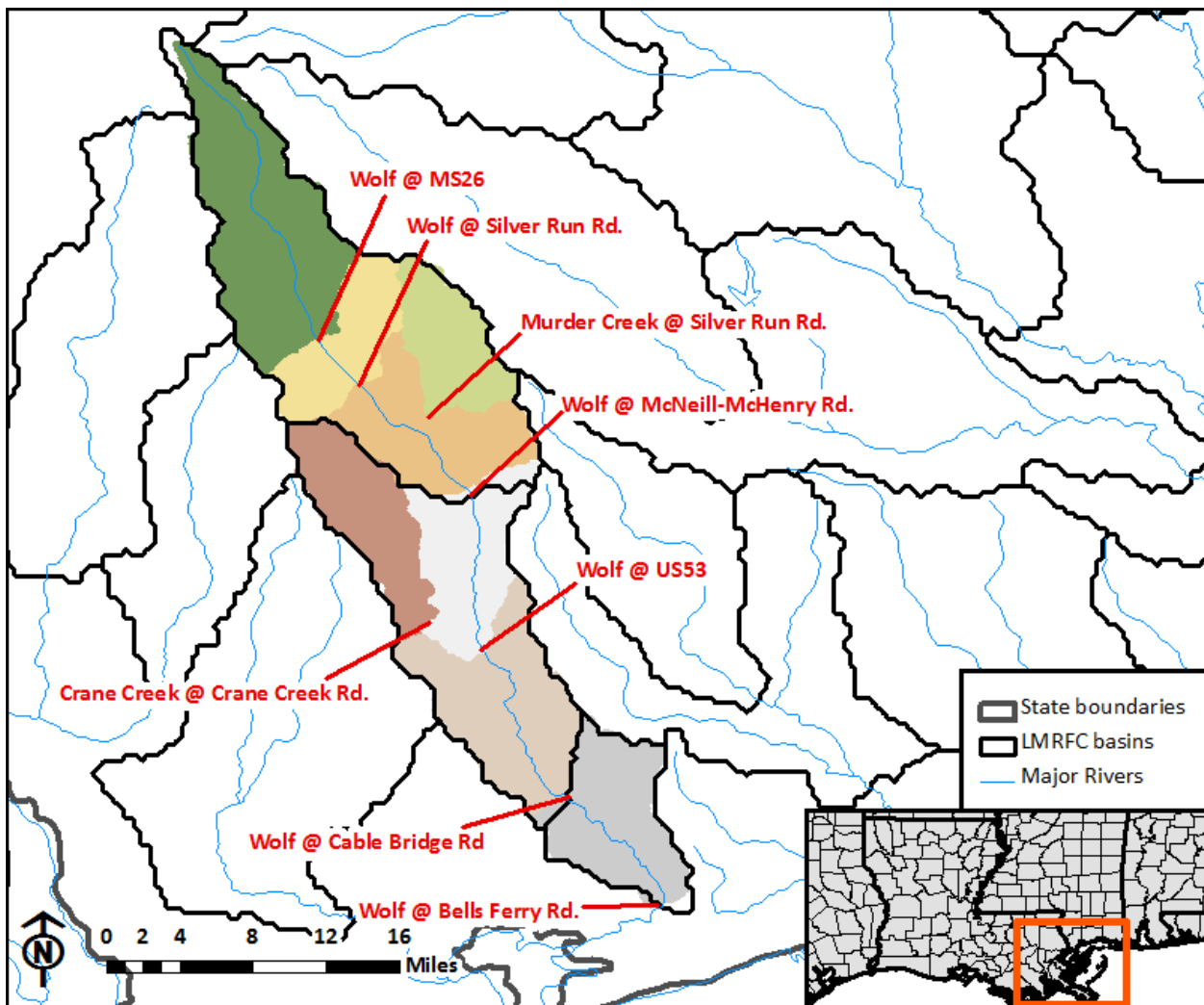
310           A particularly notable swath of heavy rainfall occurred over an isolated portion of the  
311 New Orleans metropolitan area in southeast Louisiana. Water in this area mostly drains into  
312 Lake Pontchartrain through the city's storm sewer system. Several official and private rain  
313 gauges indicated 20-24 inches of rainfall in a small area, with a sharp gradient down to roughly  
314 10-15 inches a few miles away (Appendix C: Isolated Rainfall Maximum in Uptown New  
315 Orleans).

316 **3. Wolf River**

317

318 *a) NWS Post-Event Flood Survey*

319 Flood surveys for the Wolf River watershed were conducted by the NWS teams over a  
320 several day period from September 5th to 7th, 2012. Findings from the survey are summarized  
321 by river reach in the subsequent sections. A map of the Wolf River watershed and subbasins  
322 defined by surveyed locations is shown in Figure 13 below.



323 Figure 13. Wolf River subbasins as defined by locations surveyed by the post-storm survey  
324 teams. Subbasins defined by the current model configuration of LMRFC are also indicated for  
325 comparison.  
326  
327



328 1) WOLF HEADWATERS TO MS26  
329  
330 **Flood Category:** Major Flooding, \*NEW RECORD\*  
331 **River Gauge:** USGS crest stage gauge on MS26 bridge  
332 **Period of Record:** 1952-1971, 1998-Present  
333 **Crest:** 34.5 ft sometime before 12:05 PM CDT 08/30/2012  
334

335 Widespread bent and snapped trees/brush were observed in the floodplain near the  
336 MS26 bridge. A fence on the southeast side of the bridge appeared to have been washed out,  
337 with a metal gate separated from the fence and washed up against a tree.

338 The Pearl River County Emergency Manager (EM) indicated to the flood survey team that water  
339 was over the southbound lanes of I-59 during the peak of the event. The EM office believed that  
340 this was at the Wolf River bridge, but indicated that it was the first bridge north of I-59 exit 29.  
341 Based upon this information, it appeared likely that this flooding was from Beaverdam Creek.  
342 Further investigation yielded an article by the *Picayune Item*, which stated the southbound lanes  
343 of Interstate 59 were closed at mile marker 32 near Poplarville by the Wolf River, with the  
344 northbound lanes threatened as of 6:00 AM August 30<sup>th</sup> (Farrell, 2012). Mile marker 32 on I-59  
345 is two miles north of the Beaverdam Creek bridge, very close to the bridge over Wolf River.

346 A Twitter update from the Mississippi Department of Transportation Handle “MDOT  
347 I-59” indicated that MS26 was flooded – but not closed - 3 miles east of I-59  
348 ([https://twitter.com/mdot\\_i59/status/241167172318134272](https://twitter.com/mdot_i59/status/241167172318134272)). This is likely not referring to the  
349 Wolf River bridge (located ~1.3mi east of I-59), but instead the Alligator Creek (located ~3.4 mi  
350 east of I-59). The survey team did not survey this location.

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353 2) MS26 TO SILVER RUN RD  
354  
355 **Flood Category:** Major Flooding  
356 **River Gauge:** None  
357 **Crest:** Possibly highest since 1934  
358

359 Widespread bent and snapped trees/brush were observed in the floodplain near the  
360 Silver Run Rd bridge. Evidence of damage was up to about 1.0 ft higher than the bridge deck.  
361 Scouring was noted on downstream side of bridge approach guardrails (Figure 14). Anecdotal  
362 evidence from an individual residing at the corner of Silver Run Rd and Oscar Lee Rd suggests  
363 that the flood elevation may have exceeded that of any flood since at least 1934.



364  
365 Figure 14. Guardrails on downstream side of the Silver Run Rd. bridge showing evidence of  
366 scouring.  
367

368 3) Silver Run Rd to McNeill-McHenry Rd

369

370 **Flood Category:** Major Flooding

371 **River Gauge:** None, RFC modeled location at McNeill-McHenry Rd bridge (SVRM6)

372

373 Water elevation in small camp near the river off of Go Go Rd appeared to reach 8.0-

374 10.0 ft above the ground level in many places. A camper appeared to have been moved about

375 100 yds downstream from its original site (identified by what appeared to be a light pole and

376 power hook-ups). The camper was dropped against trees and a pile of damaged brush.

377 Some bent trees and brush were noted along the edges of Murder Creek near the Silver

378 Run Rd bridge. Evidence suggested a flash flood that remained below the elevation of the bridge

379 deck.

380 Widespread bent and snapped trees/brush were observed in the floodplain near the

381 McNeill-McHenry Rd bridge. Water appeared to have reached an elevation about 1.0 ft higher

382 than the road at the bridge approaches. The bridge itself was an arch design, thus the higher

383 middle portion of the bridge did not flood. Large branches and other tree debris were noted on

384 top of the bridge support pilings of the upstream side.

385

386 4) MCNEILL-MCHENRY RD TO CONFLUENCE CRANE CREEK

387

388 **Flood Category:** Major Flash Flooding

389 River Gauge: None

390

391 Widespread bent and snapped trees/brush were observed in the small floodplain near

392 the Crane Creek bridge on Crane Creek Rd. Mud marks and debris suggested that flash flooding

393 reached an elevation 1.0-3.0 ft over the bridge deck.

394

395 5) CONFLUENCE CRANE CREEK TO CONFLUENCE SANDY CREEK

396

397 **Flood Category:** Moderate Flooding

398 **River Gauge:** None

399

400 Widespread bent trees/brush were observed in the floodplain near the US53 bridge.

401 Evidence suggested that water reached within 1.0-3.0 ft of the bridge deck and did not inundate

402 the road.

403 6) CONFLUENCE SANDY CREEK TO I-10

404

405 **Flood Category:** Major Flooding (perhaps Moderate), \*NEW RECORD\*

406 **River Gauge:** USGS automated gauge on Cable Bridge Rd bridge (LNDM6)

407 **Period of Record:** 1971-Present

408 **Crest:** 31.4 ft about 3:00 PM CDT 08/31/2012

409

410 Widespread bent trees/brush were observed in the floodplain near the Cable Bridge Rd

411 bridge (Figure 15). Evidence suggested that water reached within 1.0-3.0 ft of the bridge deck

412 and did not inundate the road. Although official flood category for this stage was “major,”

413 damage for this river reach appeared to be closer to that expected for the moderate category.

414 Information from Harrison County Emergency Management Office indicated that the

415 water elevation was very near the elevation of I-10 near the bridge. Evidence from the survey

416 suggested that water may have reached the shoulder of the bridge approaches, but did not

417 inundate the road or bridge deck (Figure 16).

418



419  
420 Figure 15. Downstream view from Cable Bridge Rd. Widespread damage to trees and brush  
421 were noted.  
422



423  
424 Figure 16. Wolf River floodplain between the eastbound and westbound bridges of I-10.  
425 Widespread tree/brush damage was noted along with scouring of the overbank areas.  
426  
427

428 7) I-10 TO ST. LOUIS BAY

429

430 **Flood Category:** Major Flooding, \*NEW RECORD\*

431 **River Gauge:** Manual staff gauge on Bells Ferry Rd bridge (GLFM6)

432 Period of Record: 1981-Present

433 **Crest:** 16.0 ft about 12:00 PM CDT 09/01/2012

434

435 Widespread bent brush and trees in the floodplain, covering a width roughly 0.5-1.0

436 miles along Bells Ferry Rd. Mud marks were noted several feet above the road level throughout

437 this stretch, reaching heights of 3.0-4.0 ft in places. Numerous properties were affected near the

438 gauge location, especially along Magnolia Dr and Tucker Rd where some homes received water

439 damage. Magnolia Rd appeared to have been under several feet of moving water, especially

440 away from intersection with Bells Ferry Rd, and drifts of sand 1.0-2.0 ft high lined the road in

441 places.

442 Flood damage also occurred downstream of the staff gauge location toward Menge

443 Ave. USGS personnel obtained high water marks for tidal locations that also received surge

444 flooding, so the NWS survey teams mostly stayed upstream to avoid duplication of efforts. The

445 survey team did visit the Wolf River Campground, where a guest stated that the water nearly

446 reached the top of the steps of the laundry building and was just a few feet from flooding most of

447 the property.

448 Numerous residents were interviewed by the survey team along this river reach, along

449 both Magnolia Dr. and Tucker Rd. A resident with a clear high water mark in a garage at the

450 corner of Magnolia and Bells Ferry gave permission for the team to use her property to survey

451 the mark to the staff gauge. Resident directly across the street indicated location of high water

452 on his home, which was used for QC. Other residents provided comparisons of this event to the

453 crest from the 1995 event.

454 Home #1: 3rd house in on west side of Magnolia Rd. This house took ~1” of water  
455 during 1995 even, as relayed by previous owners to current owner. Current resident estimated  
456 ~9” of water inside his home during this event. Resident also indicated that he believed the staff  
457 gauge was reading several inches too high.

458 Home #3: The Montgomery home, the first house in on east side of Magnolia Dr.  
459 House had clearly visible high water mark in garage and in trees near river (**Error! Reference**  
460 **source not found.**). The crest stage of 16.0 ft was surveyed to the Harrison County staff gauge  
461 by using this high water mark. This crest estimate was consistent - within 1-3” - of another high  
462 water mark across the street, as well as anecdotal evidence provided by interviewed residents.

463 Home #4: First house in on west side of Magnolia Dr. Occupant indicated that water  
464 reached several bricks up from foundation to bottom of brick that was outside window sill. This  
465 elevation was compared with high water mark from home #3 using surveying equipment.  
466 Elevation was estimated to be about 2” different at this location.

467 Home #5: The Russell home, on the east side of Magnolia Dr. Owner, Garner Russell,  
468 indicated that he was an engineer. The residents indicated that they believed the river was falling  
469 at the time of 16.5ft observation, although they were not home during crest of flood. Residents  
470 also indicated believe that staff gauge is reading 1.0-1.5 ft too high. Occupants stated that their  
471 slab was surveyed at 8.0 ft which typically floods at 9.5 ft on the staff gauge. The elevated first  
472 floor of their home was surveyed to ~16.1ft elevation, which was several inches above  
473 floodwater. Residents also made mention that the forecast crest of 19.0 ft briefly appeared on  
474 NWS/AHPS page, but no evidence of this was found in the LMRFC database. Forecasters  
475 working this forecast point could not recall such a forecast being issued.

476 Home #6: The Erby home, 3rd house in on the east side of Magnolia Dr. Occupant  
477 indicated that he was an engineer. The resident also indicated that he believed the staff gauge to  
478 be ~1.0 ft too high. The resident stated that his elevated slab was surveyed at ~15.1 ft with  
479 floodwater cresting about 4" lower. This resident had printed AHPS page for GLFM6 several  
480 times a day during height of event, which he showed to the survey team. The survey team could  
481 find no evidence of a 19.0 ft crest forecast. The resident made mention of differences between  
482 "latest stage" values that show up on AHPS vs. those in text products.

483 Home #8: The Feil home, at the end of Tucker Rd. Joe Feil owns the canoe rental  
484 business in the area. Occupant lived in area about 30 yrs, purchased home after previous owners  
485 left just after 1995 flood event. Occupant indicated that elevated slab was surveyed at ~13.0 ft  
486 with measured ~4.0 ft of water in home based upon a high water mark. The resulting 17.0 ft  
487 elevation estimate for this location seems somewhat inconsistent with other observations.

488 Home #9: Home of Joanne, at the end of Tucker Rd and next to Joe Feil. Occupant  
489 indicated that elevated floor of home was surveyed at 18.6 ft with water reaching elevation "just  
490 under." Water was measured as covering concrete slab with ~87" of water, but concrete slab  
491 elevation unknown. Occupant indicated that crest likely occurred before issuance of the 17.0 ft  
492 forecast crest... probably before 1400 GMT 09/01/2012.

493 Home #10: The Larson home, at the end of Tucker Rd next to Joanne, back away from  
494 the road. The resident, Jennifer Larson, indicated that she remained during the crest and closely  
495 monitored the river stage under her elevated home. Resident indicated that the elevated slab was  
496 surveyed at ~16.8 ft, and water crested about 6" below. Resident estimated the crest time as  
497 1630-1800 GMT on 09/01/2012.





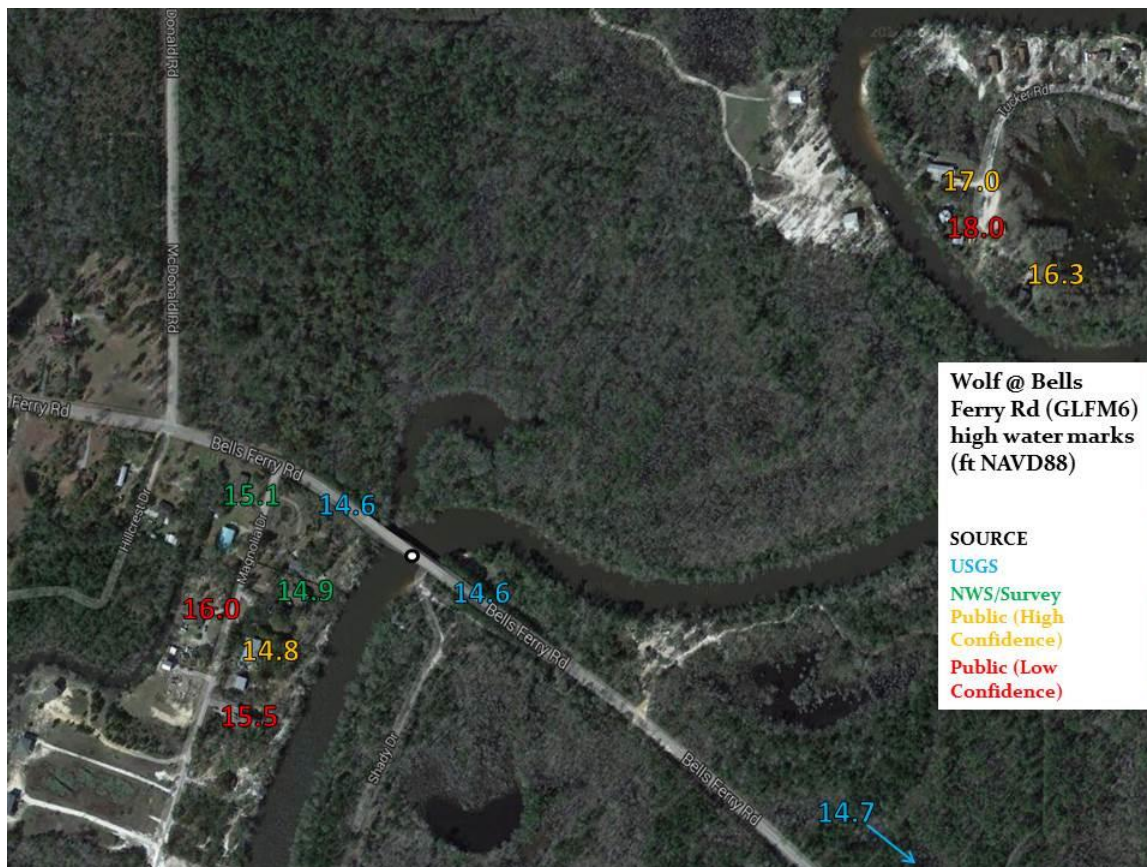
498  
499 Figure 17. The Montgomery home on Magnolia Dr. had a clear high water mark inside of the  
500 attached garage. Flood survey team members Marty Pope (pictured) and W. Scott Lincoln used  
501 this high water mark to help estimate the crest for the Wolf River at Bells Ferry Rd. (GLFM6)  
502 forecast point.  
503

504 *b) Discussion*

505           Based upon all of the anecdotal information gathered for the Wolf River at Bells Ferry  
506 Rd location and river reach, questions existed as to the actual datum of the staff gauge. In the  
507 months following the original survey, more information from the USGS office in Jackson, MS,  
508 was made available. USGS staff collected high water marks in the area of Bells Ferry Rd during  
509 the post-storm flooding associated with Hurricane Isaac (K. Van Wilson, personal  
510 communication, Sep 2012 and June 2013). Of these high water marks, two were on the Bells  
511 Ferry Rd bridge over the Wolf River (14.6 ft NAVD88), and another was east of the river at a  
512 campground (14.7 ft NAVD88). These numbers are about 1.3ft lower than the estimated high  
513 water mark determined by the survey team (16.0 ft), and this strongly suggests that the datum for  
514 GLFM6 is not 0.0 ft NAVD88 (as set during Hurricane Isaac). Based upon all available  
515 information, we find that the datum for GLFM6 should be set to -1.0 ft NAVD88. This number  
516 is roughly the same as suggested, and is rounded off to take into account measurement  
517 uncertainty. Although an offset of -1.0 ft would make our estimated crest of 16.0 ft (15.0 ft

518 NAVD88) much closer to USGS high water marks, a discrepancy of 0.2-0.3 ft will remain that is  
519 likely due to measurement uncertainty.

520 In response to the concerns raised by the Russell's (Home #5), LMRFC and WFO LIX  
521 staff checked the southern region NWS and local WFO archives in January, 2013, for evidence  
522 of the 19.0 ft crest at GLFM6. It was hypothesized that one way such a crest could make it to  
523 AHPS was via the HMLLIX product instead of the RVFLIX product from LMRFC.  
524 Unfortunately, the archives did not extend back into September of 2012. Neither a verification  
525 of crest issuance, nor a mechanism of crest issuance without LMRFC as the source has been  
526 found.



527  
528 Figure 18. High water marks near the Wolf River at Bells Ferry Rd (GLFM6) gauge color-coded  
529 by confidence level. High water marks were adjusted to NAVD88 based upon the assumed staff  
530 gauge datum of -1.0 ft NAVD88.  
531

532 **4. Tchoutacabouffa River**

533

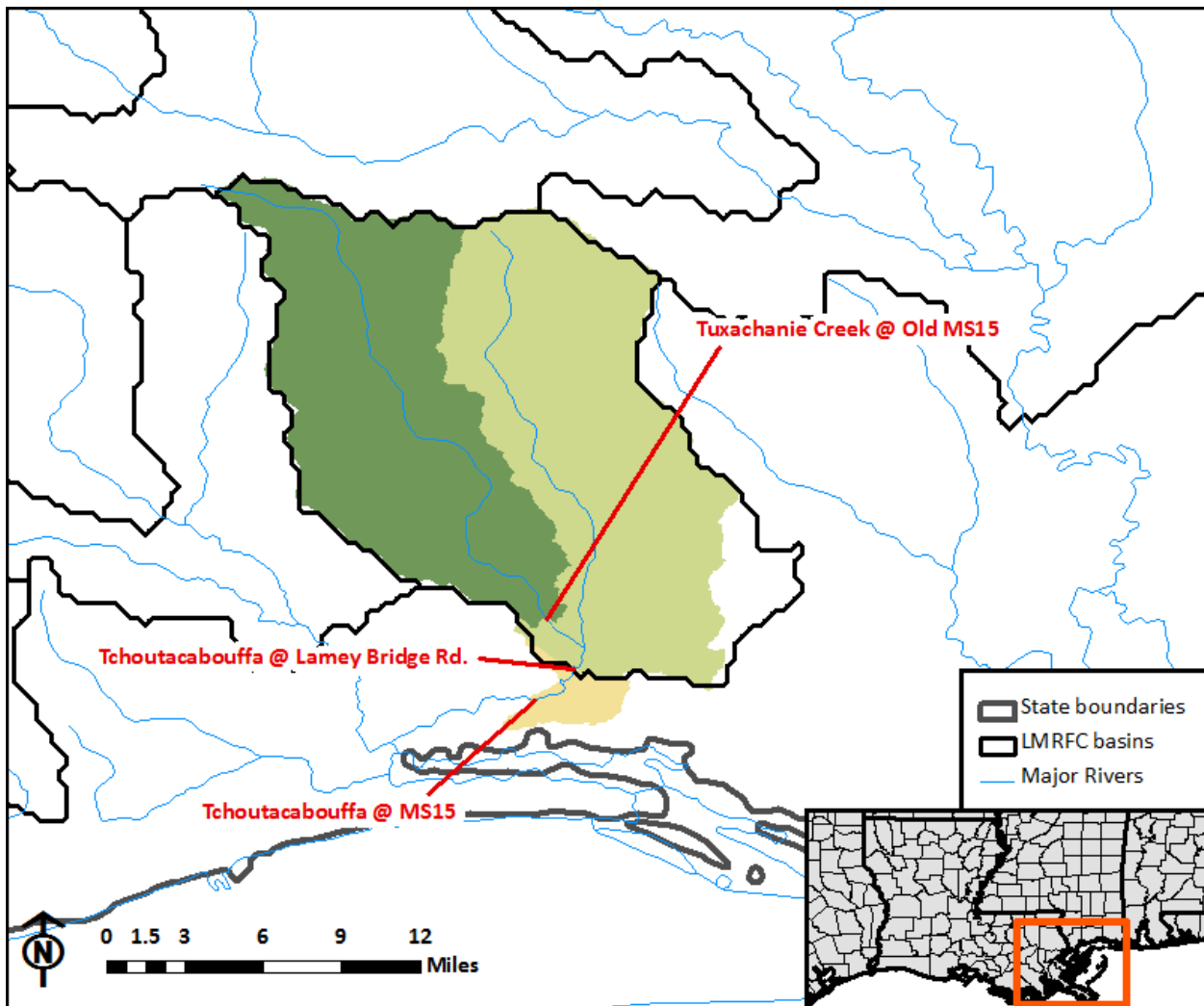
534 *a) NWS Post-Event Flood Survey*

535

536 A flood survey for the lower Tchoutacabouffa River watershed area was conducted by

537 the NWS teams on September 6th, 2012. The survey was focused on the area around the

538 Harrison County manual staff gauge on Lamey Bridge.



539

540 Figure 19. Biloxi River subbasins as defined by locations surveyed by the post-storm survey  
541 teams. Subbasins defined by the current model configuration of LMRFC are also indicated for  
542 comparison.

543

544 1) TWO MILES UPSTREAM/DOWNSTREAM OF LAMEY BRIDGE RD

545

546 **Flood Category:** Minor Flooding (possibly Moderate)

547 **River Gauge:** Manual staff gauge on Lamey Bridge Rd bridge (DIBM6)

548 **Period of Record:** 1973-Present

549 **Crest:** 14.5 ft about 9:00 AM CDT 08/31/2012

550

551 Some bent brush and trees were observed on the point bar of a large meander bend at

552 Lamey Bridge Rd crossing of Tchoutacabouffa. New apartments and condos built very near the

553 cut bank of the meander bend experienced small slides from scouring in their back yards, which

554 workers were attempting to fill with dirt during the time of the surveys. Based upon road closure

555 information provided by Harrison County Emergency management, it is possible that water

556 neared or inundated Lamey Bridge Rd. somewhere between Mallet Rd. and Longwood Dr.

557 Another area was surveyed just off of Lamey Bridge Rd. along Tuxachanie Creek just upstream

558 of the confluence with the Tchoutacabouffa. No damage or evidence of water was noted along

559 Longwood Circle. Just upstream, some evidence of water was noted along the lower portions of

560 H Street, with evidence that some homes may have taken water damage.

561 The survey team interviewed one resident of the Riverbend Cove Apartment complex,

562 Wendell Green, who stayed during most of the event. Mr. Green indicated to the survey team

563 that water had crested right at the line of the highest patch of sod, and marked the location

564 (Figure 20). He also indicated that at the crest, water was just below the crest of a light pole on

565 the dock the opposite bank, as well as being almost level with the bottom of the horizontal beams

566 placed upon the Lamey Bridge Rd crossing's support pilings. Mr. Green provided some

567 photographs of the river several hours before the crest. The survey team surveyed the staff

568 gauge level of the light pole and the estimated high water mark on the riverbank. A substantial

569 difference in elevations was noted between the elevation of the light pole (14.4 ft) and that of the  
570 riverbank behind the apartments (16.5 ft).



571  
572 Figure 20. Flooding from the Tchoutacabouffa River caused substantial scouring to the cut bank  
573 behind the Riverbend Cove Apartments just off Lamey Bridge Rd. Resident Wendell Green  
574 (pictured), who stayed during most of the flood event, indicated the high water level to the NWS  
575 flood survey team which they used to help estimate the crest for Tchoutacabouffa River at  
576 Lamey Bridge Rd (DIBM6).  
577

578 *b. Discussion*

579 After the survey for the Tchoutacabouffa River at Lamey Bridge Rd. was conducted,  
580 NWS survey team members looked for additional information to aid in determining the exact  
581 crest at the staff gauge. It was hypothesized that the substantial meander bend in the river right  
582 at the location of the bridge and the apartments could explain most of the discrepancy in crest  
583 elevations between each side of the river. Historical crests for Tuxachanie Creek at Old Hwy 15  
584 and Tchoutacabouffa River at MS67 were retrieved and compared to historical crests at Lamey  
585 Bridge Rd. The shape of the hydrograph for the the Lamey Bridge Rd. location was also

586 analyzed using the data available before/after the time of crest. Based upon the shape of the  
587 hydrograph, a crest of about 14.0-15.0 ft seemed most likely. Previous similar events on the  
588 Tuxachanie and Tchoutacabouffa in 2002 and 2003 also produced crests at DIBM6 of about 14.5  
589 ft. It was determined that the crest most consistent with our surveyed elevations, anecdotes, and  
590 post-survey analysis was about 14.5 ft on the morning of 8/31.

591           The survey team did not talk with any residents that had known survey elevations of  
592 their property or structures. Because of this, the current datum for Tchoutacabouffa River at  
593 Lamey Bridge Rd. (DIBM6) was not able to be evaluated.

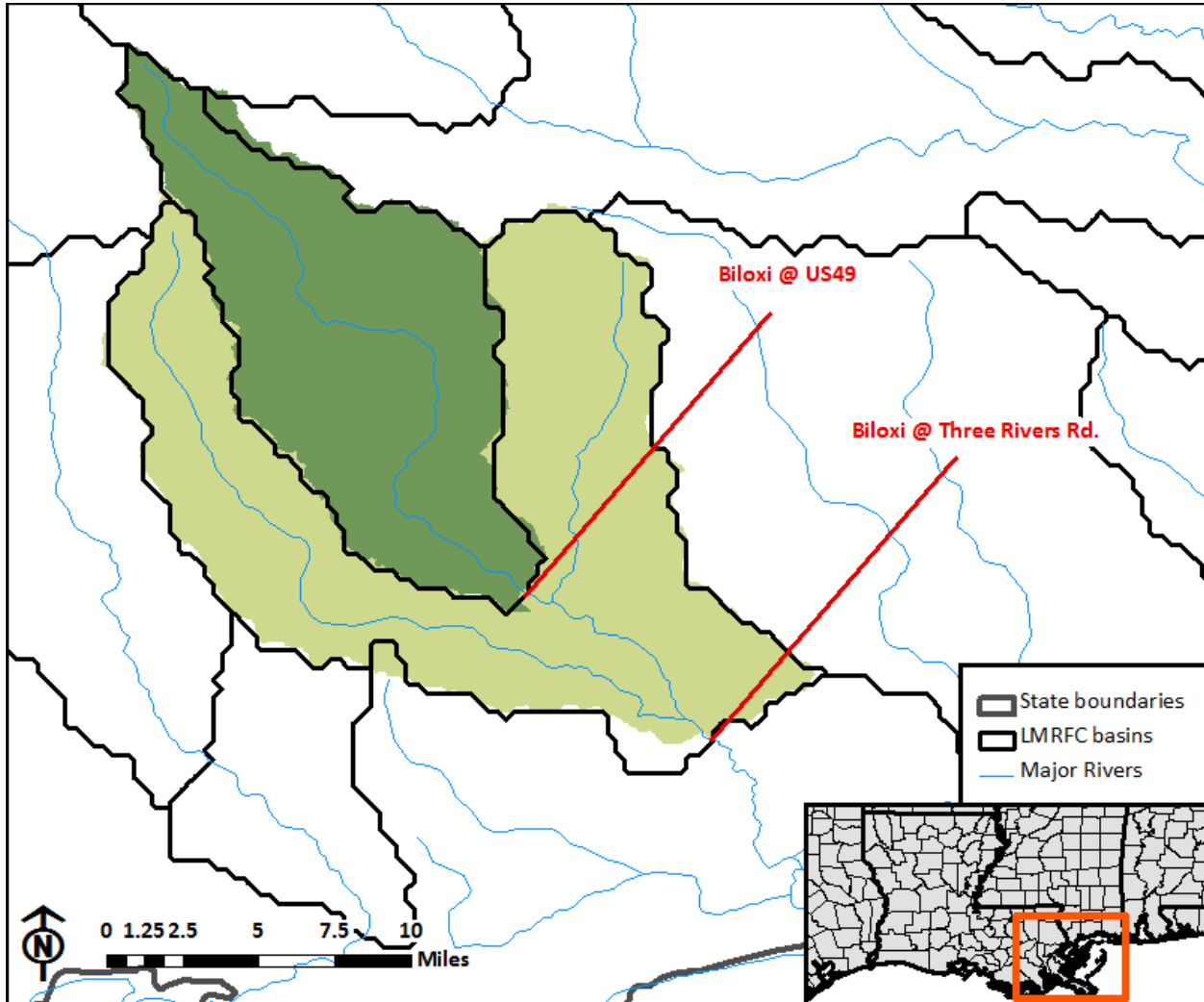
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595

596 **5. Biloxi River**

597 *a. NWS Post-Event Flood Survey*

598 A flood survey for the lower Biloxi River watershed area was conducted by the NWS  
599 teams on September 6th, 2012. The survey was focused on the area around the Biloxi River at  
600 Three Rivers Rd bridge, including areas downstream along Lorraine Rd.



601 Figure 21. Biloxi River subbasins as defined by locations surveyed by the post-storm survey  
602 teams. Subbasins defined by the current model configuration of LMRFC are also indicated for  
603 comparison.  
604  
605

606

607

608 1) STONE/HARRISON CO. LINE TO THREE RIVERS RD. BRIDGE

609

610 **Flood Category:** Major Flooding

611 **River Gauge:** USGS automated gauge on US49 bridge (BLWM6)

612 **Period of Record:** 1953-Present

613 **Crest:** 26.4 ft about 1:00 PM CDT 08/30/2012

614

615 NWS survey teams did not visit the gauge location or vicinity. Although the crest  
616 reached a level set as the major flood stage, current information on the E-19s does not indicate  
617 any major impacts from flooding of this magnitude. Information from Harrison County  
618 Emergency Management suggests that at least minor flood impacts may have occurred to at least  
619 one residence. Analysis of aerial imagery indicates some development in the area.

620

621 2) CONFLUENCE WITH LITTLE BILOXI RIVER TO I-10

622

623 **Flood Category:** Major Flooding

624 **River Gauges:** USGS crest stage gauge on Three Rivers Rd bridge;

625 Estimates of stage via improvised wire-weight dropped from bridge

626 **Period of Record:** 1964-Present

627 **Crest:** 19.2 ft about 1:00 AM CDT 08/31/2012

628

629 Some bent brush and trees were noted in the floodplain near the gauge location.  
630 Scouring, debris marks, and sand deposition was noted in the small park near the Three Rivers  
631 Rd. bridge. Mud marks were evident in the trees lining the floodplain several feet above the  
632 ground in places. Information from Harrison County Emergency Management indicated that the  
633 MS605 bridge, an official evacuation route, was inundated by floodwaters during the event. It  
634 appeared as if some homes may have taken water damage along River Rd. near and just  
635 downstream of the MS605 bridge.



636 Flooding was also surveyed downstream along Lorraine Rd. Numerous residences and  
637 businesses east of the Lorraine Rd. bridge along the river appeared to have sustained water  
638 damage.

639

640 *b. Discussion*

641

642 The USGS maintains a crest staff gauge on the Three Rivers Rd. bridge. For realtime  
643 observations, Harrison County measures the distance to the surface of the water from the center  
644 of the Three Rivers Rd. bridge deck. The USGS gauge datum is set to 3.0 ft lower than the  
645 datum referenced by both Harrison County and the NWS historical flood crests. This presented  
646 some initial confusion when trying to compare observations before and after the crest with the  
647 data provided by the USGS.

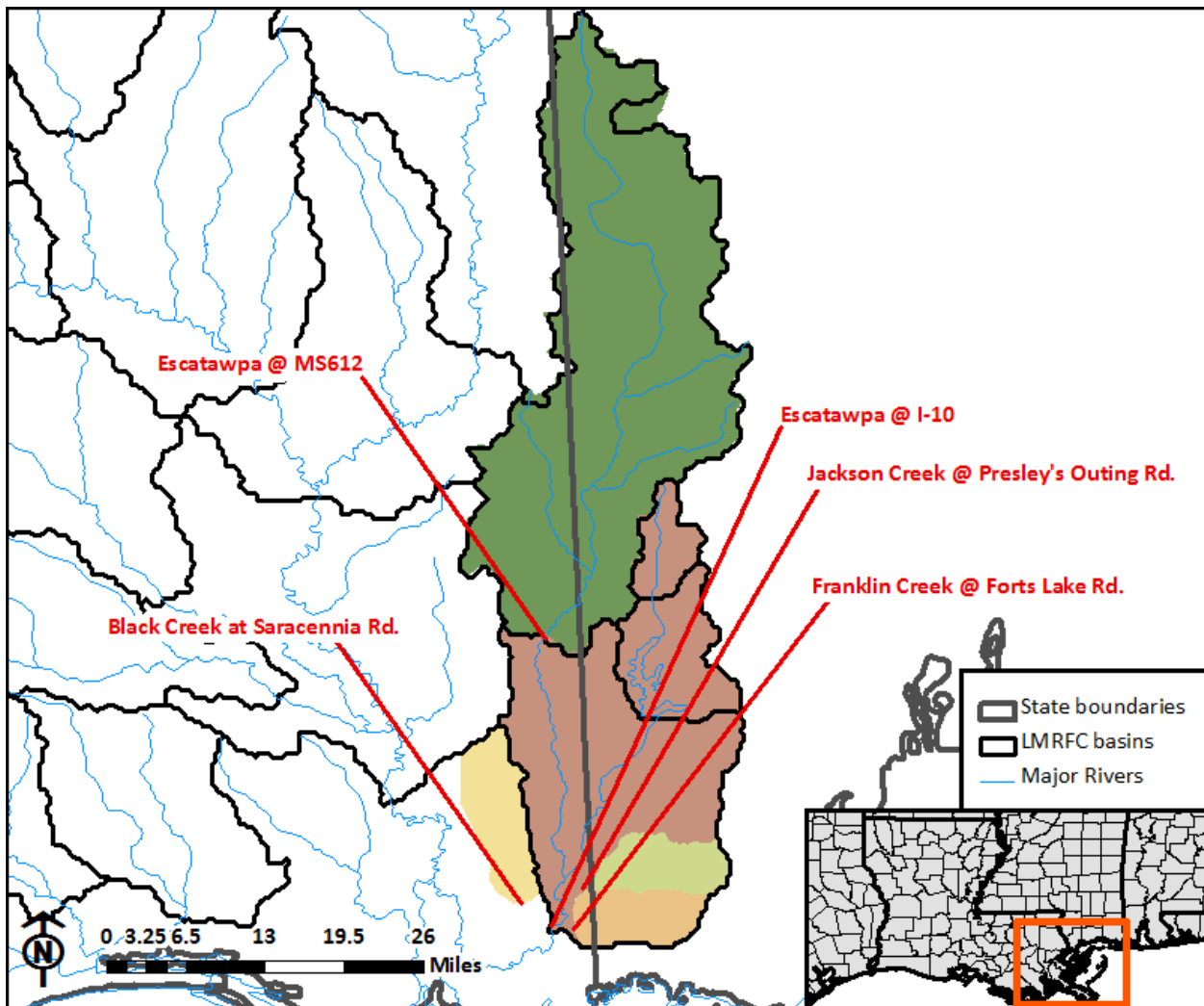
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649

650 **6. Escatawpa River**

651 *a. NWS Post-Event Flood Survey*

652 The flood survey for the lower Escatawpa River watershed area was conducted by the  
653 NWS teams on September 6th, 2012. The survey was focused on the area around the Escatawpa  
654 River at I-10 USGS automated gauge, including areas of Helena affected by flooding from Black  
655 Creek.



656  
657 Figure 22. Escatawpa River subbasins as defined by locations surveyed by the post-storm survey  
658 teams. Subbasins defined by the current model configuration of LMRFC are also indicated for  
659 comparison.  
660

661 1) VICINITY OF MS612 BRIDGE

662 **Flood Category:** Minor Flooding

663 **River Gauge:** USGS automated gauge on MS612 bridge (AGRM6)

664 **Period of Record:** 1974-Present

665 **Crest:** 20.8 ft about 9:00 AM CDT 08/31/2012

666

667 NWS survey teams did not visit the gauge location or vicinity. The crest reached flood

668 stage, but current information on the E-19s and NWS AHPS page does not indicate any impacts

669 from flooding. Information from USGS suggests that flows of this magnitude have only been

670 exceeded 3-4 times since 1946.

671

672 2) I-10 TO MOSS POINT

673

674 **Flood Category:** Minor Flooding (possibly Moderate)

675 **River Gauge:** USGS automated gauge on I-10 bridge (ORAM6)

676 **Period of Record:** 2001-Present

677 **Crest:** 10.9 ft about 10:00 AM CDT 08/31/2012

678

679 NWS survey teams did not survey most of this reach of river, as most impacts appeared

680 to be near the gauge or upstream of the gauge. Few, if any, areas of bent trees or brush were

681 noted by the survey team. Widespread mud marks on trees and houses were observed, however,

682 and evidence suggested that numerous homes and a church were impacted near the gauge,

683 especially along Franklin Creek Rd., where it appeared likely that some homes took 1.0-2.0 ft of

684 water.

685 Presley's Outing Campground: The campground was surveyed by NWS teams and

686 staff members were interviewed. Water was still elevated during the time of the survey. Staff

687 indicated that water was within 1.0 ft of flooding the clubhouse at the campground. Staff also

688 indicated that crest was about 1.0 ft lower than crest during Hurricane Georges in 1998, which  
689 corresponds exactly with the crest difference at the USGS gauge.

690 Home #1: Thomas Marthaler residence at the corner of Marthaler Rd. and  
691 Independence Rd. was visited by a survey team. Mr. Marthaler kept a personal record of water  
692 levels moving up the road toward his house and shed during the event (Figure 23). This notes  
693 suggested that the water crested between 10:00 AM and 12:00 AM on 8/31, which is consistent  
694 with the gauge readings just downstream. Mr. Marthaler indicated that the crest was about 1.0 ft  
695 below what he experienced after Hurricane Georges in 1998, which corresponds exactly with the  
696 crest difference at the USGS gauge.

697



698  
699 Figure 23. Flooding from the Escatawpa River nearly affected the property of Thomas  
700 Marthaler. Mr. Marthaler made frequent note of the water elevation near his home and shared  
701 his observations with the survey team.

702

703 3) BLACK CREEK AT SARACENIA RD IN HELENA

704

705 **Flood Category:** Moderate Flash Flooding (possibly Major)

706 **River Gauge:** None

707 **Crest:** Thursday morning; Early Saturday morning

708

709 NWS survey team noted numerous homes in the Helena area appeared to be impacted  
710 by high water. Some evidence of high water was noted on Coda Rd. east of Helena. Evidence of  
711 more substantial flooding was noted along Hans Rd. on the north side of Helena near Black  
712 Creek.

713 Home #1: Resident of red brick home, 2<sup>nd</sup> in on southwest side of road, indicated that  
714 water crested about “6 bricks up,” or an estimated 1.0-1.5 ft above floor elevation. Resident  
715 indicated that water began rising in his area around 8:30 AM on 8/29, with a first crest occurring  
716 Thursday morning. A second crest occurred early Saturday morning, which was lower than the  
717 Thursday crest. Resident indicated that he decided to evacuate his home after receiving an  
718 emergency alert on his phone indicating that floodgates had been opened upstream at the power  
719 plant (see discussion in *b. Discussion*). Using the timing information provided by the resident  
720 and the hydrograph for the downstream gauge on the Escatawpa River, it appeared likely that the  
721 first crest was due to flash flooding and the second crest was due to backwater from the  
722 Escatawpa.

723

724 *b. Discussion*

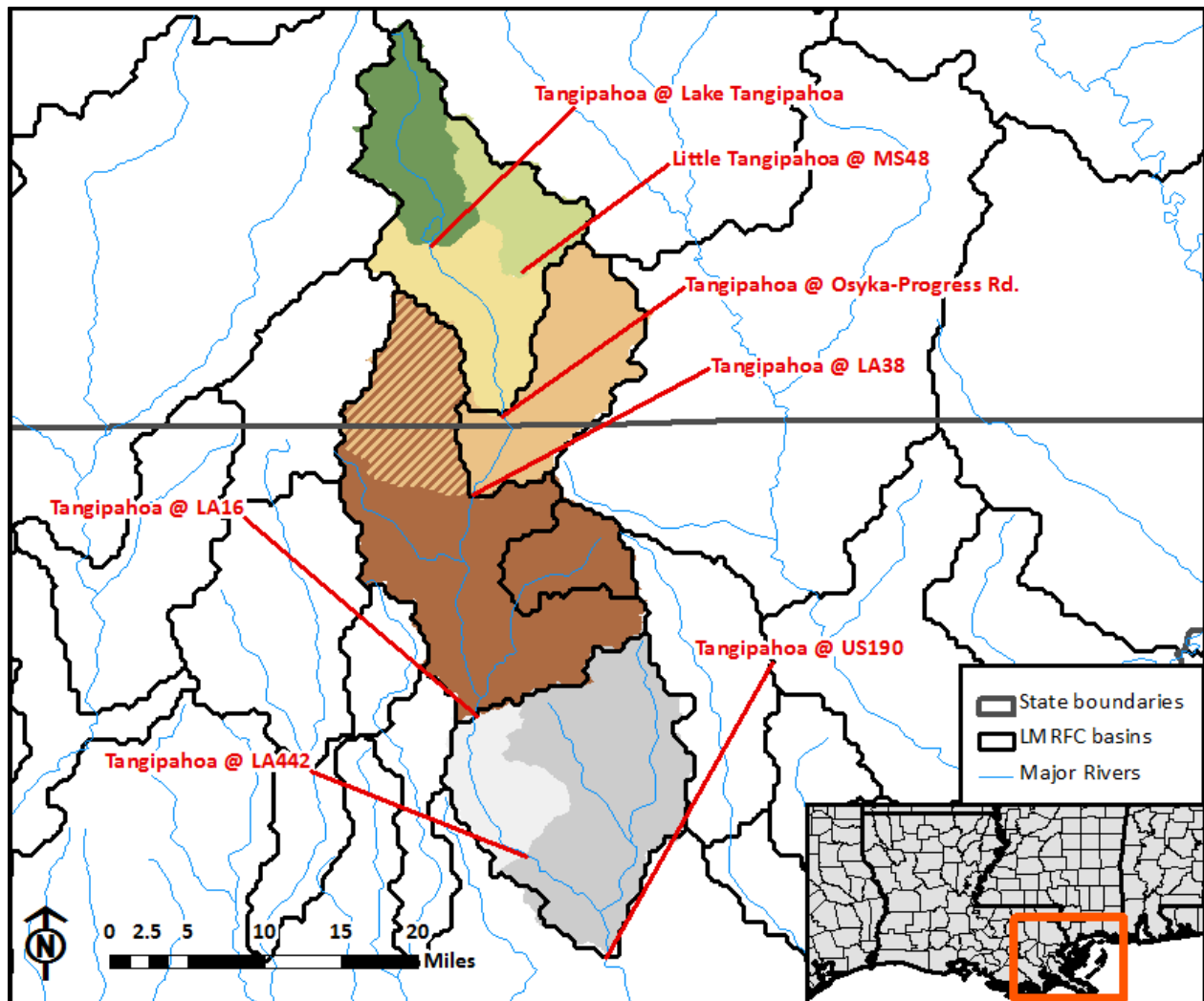
725 The anecdote made by the resident near Black Creek in Helena about the floodgates  
726 being opened up at the power plant was investigated further by the survey team. Maps and aerial  
727 imagery indicate a power plant, owned by Mississippi Power, has a cooling reservoir on Black

728 Creek just upstream of Helena. This reservoir appeared to have a spillway but specifics are  
729 unknown. A search for news articles about a potential release of water from this reservoir did  
730 not turn up any additional information. The main mechanism by which an emergency alert  
731 would be sent to a phone would be from an NWS Flash Flood Warning, but no NWS warning  
732 text was found that indicated floodgates opening at this power plant.  
733

734 **7. Tangipahoa River**

735 *a. NWS Post-Event Flood Survey*

736 A flood survey for the Tangipahoa River watershed area was conducted by the NWS  
737 teams from September 6<sup>th</sup>-8<sup>th</sup>, 2012. The survey covered areas from Lake Tangipahoa dam in the  
738 headwaters downstream to just south of Robert, LA, where river flooding impacts became mixed  
739 with storm surge flooding impacts.



740  
 741 Figure 24. Tangipahoa River subbasins as defined by locations surveyed by the post-storm  
 742 survey teams. Subbasins defined by the current model configuration of LMRFC are also  
 743 indicated for comparison. The subbasins upstream of LA16 (AMIL1) and LA38 (KENL1) have  
 744 an “overlapping” section indicated with hatching; during normal, within-bank flow conditions  
 745 the Terrys Creek tributary parallels the Tangipahoa River under the LA38 bridge and merges  
 746 with it just below the gauge, but during high flow conditions Terrys Creek likely combines with  
 747 the Tangipahoa upstream of the bridge.



748 1) LAKE TANGIPAHOA TO LA38

749 **Flood Category:** Minor Flooding

750 **River Gauge:** USGS automated gauge on Osyka-Progress Rd bridge (OSYM6)

751 **Period of Record:** 1998-Present

752 **Crest:** 17.8 ft about 8:00 PM CDT 08/30/2012

753

754 During the flood event, the Lake Tangipahoa Dam was damaged, briefly causing fears

755 of an imminent dam failure. Thousands of persons were put into an evacuation area in Louisiana

756 near the River, from the MS/LA state line to the mouth of the river at Lake Pontchartrain. The

757 emergency spillway was also utilized during the event, which seems to be the source of reports

758 that the dam had already failed with a 100 ft breach. Actual damage to the dam consisted of two

759 slides - one on the tailwater side at the main spillway outflow, and another minor slump between

760 the emergency spillway and the main spillway. The emergency spillway of Lake Tangipahoa

761 was still being utilized during the time of the surveys and water was also being pumped across

762 the spillway to help drop the pool elevation more quickly. Interviews with representatives from

763 the U. S. Army Corp of Engineers Vicksburg District office and Mississippi Department of

764 Environmental Quality at the site indicated that an estimated 130,000 gal/min was being pumped

765 over the spillway. It was also indicated that at crest, water of about 3 ft depth was moving over

766 the spillway. It was also indicated during survey of this location that the current spillway crest is

767 333 ft; a new spillway was with a crest of 331 ft.

768 Downstream at Muddy Springs Rd, a high water mark was estimated at about 5.0 ft

769 below the bridge deck. Information from Pike County EM indicated that water came over the

770 roadway near the bridge during the event. Further downstream at Hamp Lea Rd, a high water

771 mark was also estimated at about 5.0 ft below the bridge deck, but no evidence of water over the

772 roadway was noted.

773 2) LITTLE TANGIPAHOA AT MS48

774 **Flood Category:** N/A

775 **River Gauge:** None

776

777 Flooding was also surveyed in the Magnolia, MS, area from the Little Tangipahoa  
778 River. The Little Tangipahoa River is a significant contributor to the Tangipahoa upstream of  
779 Osyka. The Pike County EM indicated that water flooded some Entergy power trucks just east  
780 of the MS48 bridge, on Union Church Rd. The NWS survey team found a high water mark in  
781 the area on the south side of the building (and the building interior) located at 31.14243, -  
782 90.45377. A water depth about 4.6 ft above ground was estimated, with the elevation estimated  
783 at 300.0 ft via USGS topo maps, yielding a water surface elevation of about 304.6 ft. The Pike  
784 County EM also indicated that flooding was reported on the Little Minnehaha Creek which runs  
785 through Magnolia and has a confluence with the Little Tangipahoa just downstream of MS48,  
786 but no further information was available.

787

788 3) MS/LA STATE LINE TO CONFLUENCE BIG CREEK

789

790 **Flood Category:** Major Flooding

791 **River Gauge:** USGS automated gauge on LA38 bridge (KENL1)

792 **Period of Record:** 1951-Present

793 **Crest:** 16.9 ft about 1:00 AM CDT 08/31/2012

794

795 NWS survey teams visited the area near the LA1054 bridge. The floodplain was very  
796 wide and flat with several channels & sloughs noted. No impacts from high water were noted.

797 Farther downstream at the LA38 bridge near Kentwood, survey teams estimated that  
798 water crested near the bottom of the horizontal supports. The floodplain was also noted as very  
799 broad in this location. It was also noted that water was close to impacting an electrical substation  
800 on the west side of the floodplain near the LA38 and Ave F intersection.

801           At the LA440 bridge just east of Tangipahoa, the survey team noted that the roadway  
802 appeared to be about 15.0 ft higher than the estimated crest elevation. A high water mark was  
803 noted along LA440 west of the bridge near the intersection with Easley Rd (30.87517 -90.49884)  
804 with a water depth of 0.0 ft above ground elevation on the center line of the roadway estimated at  
805 168.6ft NAVD88 via LiDAR elevation data. The survey team also interviewed Sharon & Mike  
806 Broussard, who indicated that water was halfway up the banked curve of LA440 west of the  
807 river, near the high water mark.

808           Off LA440, a high water mark was taken near the end of Easley Rd (30.86843  
809 90.49368) with a water depth of 0.0 ft above ground elevation estimated to be 162.0-163.0 ft  
810 NAVD88 via LiDAR elevation data and about 162.0ft via USGS topo maps. Down at the end of  
811 the road, the water depth was estimated to be about 3.6 ft via surveying a nearby high water  
812 mark. The high water mark was estimated to be a depth of 0.9 ft above ground elevation  
813 estimated to be 162.0-163.0 ft NAVD88 and 162.0ft via USGS topo maps. These two nearby  
814 high water marks yielded water surface elevations of about 162.0 ft and about 163.0 ft,  
815 respectively.

816           The NWS survey team also visited the Tangipahoa River at the LA10 bridge, where no  
817 flood damage was noted.

818

819 4) CONFLUENCE BIG CREEK TO LA40

820

821 **Flood Category:** Minor Flooding

822 **River Gauge:** USGS automated gauge on LA16 bridge (AMIL1)

823 **Period of Record:** 1949-Present

824 **Crest:** 23.3 ft about 9:00 PM CDT 08/31/2012

825

826 Mud marks were noted by the survey team near the gauge site on the LA16 bridge.

827 Water elevation was estimated to be just under the elevation of the highway road surface, and

828 likely exceeding the elevation of some nearby driveways and side roads.

829 The survey team interviewed staff at the nearby veterinary clinic just east of the bridge.

830 Staff indicated that water covered the driveway of the clinic for the first time in 18 years, and

831 neared the structure. The staff also indicated that water was 1.0-2.0 ft deep over Thomas Rd,

832 cutting off residents behind the clinic.

833 Just east of the clinic, the survey team discussed the flood event with a resident in his

834 shop. Water reached right up to the edge of his shop. The ground elevation at this location was

835 estimated at 102.0-103.0 ft via LiDAR elevation data and 103 ft via USGS topo maps.

836 Downstream at LA40, a large section of roadway appeared to be overtopped based

837 upon the elevation of mud marks. The overtopped area was estimated to be from a structure at

838 the speed zone sign east of Amite to just west of the DOTD building, or a stretch of highway

839 about 0.5-1.0 mi long.

840

841 5) LA40 TO CONFLUENCE CHAPPAPEELA CREEK

842

843 **Flood Category:** N/A

844 **River Gauge:** Staff gauge on LA442 bridge no longer in service (TIKL1)

845 **Period of Record:** 1985-?

846

847           At the LA442 bridge, a dead tree was wedged into a bridge piling and left high and dry.  
848 Light debris was also noted in trees & brush in the floodplain, as well as about halfway up the  
849 abutments of the bridge. The staff gauge indicated by the E-19 could not be found on the bridge.  
850 Based upon information in the E-19, the roadway elevation was assumed to be 67.3 ft. The high  
851 water mark of light debris was estimated to be about 7.2 ft below the top of road surface,  
852 yielding a water elevation of about 60.1 ft. The missing staff gauge's datum was given as 34.5  
853 ft, which means the estimated high water elevation would be a stage of about 25.6 ft.

854           Further downstream at LA443, water inundated a substantial section of the roadway  
855 and caused damage to the downstream slope of the embankment. Louisiana DOTD crews were  
856 working on the damage during the time of the survey. The survey team spoke with DOTD  
857 workers in the area, who indicated that water was estimated to be 1.0-3.0 ft deep over the  
858 roadway, and water covered an almost 1 mile long stretch. It was also indicated by the workers  
859 that water overtopped the bridge by about 0.5 ft.

860  
861 5) CONFLUENCE CHAPPAPEELA CREEK TO LAKE PONTCHARTRAIN

862 **Flood Category:** Major Flooding  
863 **River Gauges:** USGS automated gauge on US190 bridge (ROBL1)  
864 **Period of Record:** 1939-Present  
865 **Crest:** 24.0 ft about 8:00 PM CDT 09/01/2012

866  
867           Flooding from roughly US190 downstream toward Lake Pontchartrain is assumed to be  
868 from a combination of both river flooding and surge flooding, tending more toward surge  
869 impacts closer to the lake. High water marks from surge flooding have been taken by other  
870 agencies and were not the main focus on the NWS surveys.

871           Along US190, the survey team noted that mud marks in the trees and brush were about  
872 at road level for a section roughly 1.0 mi long.

873 Flooding of a few sections of Thibedeaux Rd were noted. A brown house on the road  
874 near Big Branch appeared to have taken water. Just to the east, along Eli Joiner Rd. and River  
875 Rd., the NWS survey team interviewed a resident. It was indicated that water reached the edge  
876 of his property and flooded a portion of the road where it switches from parish to private  
877 maintenance. Elevation at the high water mark indicated by the resident was estimated to be  
878 about 21.0-22.0 ft via LiDAR and 21.0 ft via USGS topo maps. It was also noted from mud  
879 marks that water was over the road where River Rd marks a sharp right turn to the south near the  
880 river. The roadway elevation was estimated to be at 18.0-19.0 ft via both LiDAR and USGS  
881 topo maps.

882 The area along Will Richards Rd. was also surveyed. Heavy accumulation of sand was  
883 noted across the roadway and under elevated homes.

884 Farther downstream, at Lees Landing near the end of LA445, several structures  
885 appeared to have taken water. Mud marks were also noted several feet above the ground level.  
886 East of Lees Landing, several sections of Traino Rd. appeared to have flooded, with numerous  
887 more homes appearing to have taken water.

888

## 889 6) CHAPPAPEELA CREEK

890 **Flood Category:** N/A

891 **River Gauges:** None

892

893 Although not surveyed by the NWS survey team, Chappapeela Creek is a significant  
894 contributor to the Tangipahoa River just upstream of the US190 bridge. It has been noted in past  
895 floods that local runoff from between the gauging station at LA16 and the gauging station at  
896 US190 can cause flooding in this reach. It is hypothesized that Chappapeela Creek, the largest  
897 tributary through this reach, is responsible for a large portion of this.

898           Unfortunately, in addition to the lack of survey information, no automated or manual  
899 gauge information is available anywhere along this creek.

900  
901 *b. Discussion*

902           LiDAR elevation data was analyzed in the area just east of the Tangipahoa River at  
903 LA40 bridge, where high water elevations were estimated. It was estimated by the elevation data  
904 that floodwaters were about 2.0 ft from overtopping LA40 in the lowest spot just east of the  
905 bridge. Elevation data also suggested that the roadway west of the bridge would not be  
906 overtopped until a crest about 4.0 ft higher than observed during this event.

907           LiDAR elevation data was analyzed in the area along LA40 east of Independence,  
908 where water was noted to have inundated the roadway for a substantial section. Elevation data  
909 from LiDAR and notes from the survey suggest that the water elevation reached at least 72.0-  
910 74.0 ft in this area.

911           LiDAR elevation data was analyzed in the area along LA442 east of Tickfaw, where a  
912 high water mark was estimated against a benchmark on the bridge. Elevation data from LiDAR  
913 suggested that the roadway would be threatened both east and west of the bridge at about 62.0-  
914 63.0 ft elevation, or about 2.0-3.0 ft higher than the estimated crest at this location.

915           LiDAR elevation data was analyzed in the area along LA443 southeast of Tickfaw  
916 where water was noted to have inundated the roadway for a substantial section and damaged the  
917 embankment. Elevation data from LiDAR indicated that the roadway on both the east and west  
918 approaches to the bridge were about 47.0-48.0 ft in elevation, suggesting a crest in the 48.0-51.0  
919 ft range at this location based upon survey notes.

920

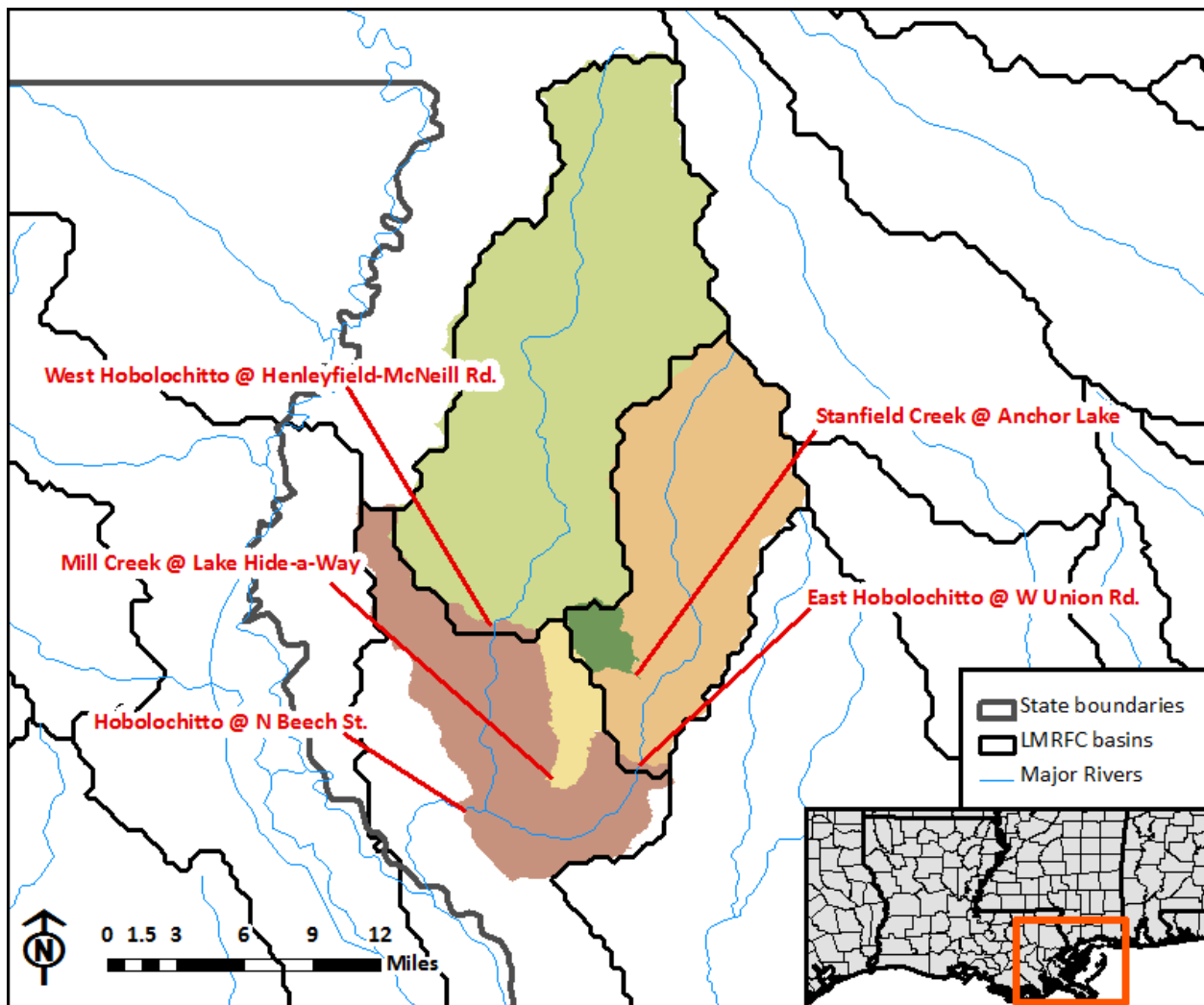
921

922 **8. East/West Hobolochitto Creeks**

923

924 *a. NWS Post-Event Flood Survey*

925 A flood survey for the East/West Hobolochitto Creek watershed area was conducted by  
926 the NWS teams from September 6<sup>th</sup>-7<sup>th</sup>, 2012. The survey covered areas from the gauges on East  
927 and West Hobolochitto Creeks as well as the Lake Hide-a-Way and Anchor Lake dams upstream  
928 of Picayune, MS.



929

930 Figure 25. Hobolochitto Creek subbasins as defined by locations surveyed by the post-storm  
931 survey teams. Subbasins defined by the current model configuration of LMRFC are also  
932 indicated for comparison.  
933



934 1) E. HOBOLOCHITTO FROM W. UNION RD. TO CONFLUENCE WITH W.  
935 HOBOLOCHITTO

936

937 **Flood Category:** Major Flooding, \*NEW RECORD\*

938 **River Gauge:** USGS automated gauge on W. Union Rd. bridge (CREM6)

939 **Period of Record:** 1997-Present

940 **Crest:** 21.5 ft about 3:00 AM CDT 08/31/2012

941

942 The survey team visited Anchor Lake, which is an impoundment of Stanfield Creek

943 and also considered a high hazard dam. During the survey on 09/06/2012, water was still going

944 over the emergency spillway to a depth of a few inches. A few high water marks were noted,

945 and brush was flattened in the floodplain of the creek at the toe of the dam (Figure 26). A survey

946 of the high water marks yielded +3.1 ft on the left face (SW), +4.5 ft in a fence at the right face

947 (NE), and +3.2 ft on the right bank under trees (NE), all with respect to the center of the

948 spillway.



949

950 Figure 26. Downstream side of Anchor Lake Dam. Trees and brush in the floodplain below the

951 emergency spillway were bent and patches of soil showed signs of scouring.

952 2) W. HOBOLOCHITTO FROM HENLEYFIELD-MCNEILL RD. TO CONFLUENCE WITH  
953 PEARL RIVER

954

955 **Flood Category:** Major Flooding , \*NEW RECORD\*

956 **River Gauges:** USGS automated gauge on Henleyfield-McNeill Rd. bridge (MNLM6)

957 **Period of Record:** 1966-Present

958 **Crest:** 24.6 ft about 6:00 AM CDT 08/31/2012

959

960 The survey team visited the MS43 bridge crossing of W. Hobolochitto Creek just north

961 of Picayune, MS. It was noted that the high water mark on the bridge was just to the base of the

962 bridge. Water appeared to encroach upon the highway and perhaps overtop it. The survey team

963 made note of a surveyed elevation marker on the bridge of 25.5 ft.

964

965 3) E. & W. HOBOLOCHITTO CREEKS BELOW GAUGED LOCATIONS

966 **Flood Category:** N/A

967 **River Gauges:** None

968 **Period of Record:** N/A

969 **Crest:** N/A

970

971 The survey team visited Lake Hide-a-Way, which is an impoundment of Mill Creek

972 and also considered a high hazard dam. The team spoke with the lake superintendent, who

973 indicated that the valves were opened on the dam embankment Friday evening (August 24<sup>th</sup>)

974 prior to the arrival of Hurricane Isaac. It was indicated that although the lake level was lowered

975 2 ft prior to Isaac's arrival, water began to overtop the spillway beginning Tuesday night (August

976 28<sup>th</sup>).



977  
978 Figure 27. Spillway at Lake Hide-a-Way after heavy rainfall from Hurricane Isaac. Image is a  
979 capture from video taken by Bruce Devillier. Lake elevation appears to have reached the top of  
980 the concrete lining the guide channel at the time of the video.  
981

982           The survey team also visited the confluence of East and West Hobolochitto Creeks near  
983 Picayune, MS. Along N. Beech St and Inside Rd., flooding of residential areas was noted to  
984 have occurred one to two blocks from the creek. It was noted by the survey team that water  
985 depths likely exceeded 2-3 ft in places.  
986

987 **9. Lower Pearl River**

988 *a. NWS Post-Event Flood Survey*

989 A flood survey for the Lower Pearl River watershed area was conducted by the NWS  
990 teams on September 7<sup>th</sup>, 2012.

991 1) US98 TO CONFLUENCE WITH BOGUE CHITTO RIVER

992 **Flood Category:** Major Flooding

993 **River Gauge:** USGS automated gauge on LA10 bridge (BXAL1)

994 **Period of Record:** 1938-Present

995 **Crest:** 21.0 ft about 5:00 AM CDT 09/03/2012

996

997 2) I-59 TO LAKE BORGNE

998 **Flood Category:** Major Flooding

999 **River Gauges:** USGS automated gauge on I-59 bridge (PERL1)

1000 Period of Record: 1900-Present

1001 **Crest:** 18.5 ft about 12:00 AM CDT 09/04/2012

1002

1003 3) E. PEARL AT WALKIAH BLUFF

1004 **Flood Category:** Likely Minor to Moderate

1005 **River Gauges:** USGS automated gauge along Parkside Dr (WSWM6)

1006 **Period of Record:** 2007-Present

1007 **Crest:** 43.4 ft about 1:00 AM CDT 09/03/2012

1008

1009 The survey team noted that water was likely around 1 ft deep throughout the area along

1010 Parkside Dr., just upstream of the Walkiah Bluff gauge. It was also noted that water likely

1011 inundated the one road into and out of the residential area.

1012

1013 4) PEARL RIVER NAVIGATION CANAL

1014

1015 **Flood Category:** Not determined.

1016 **River Gauges:** USGS automated gauges at L&D1 (PRUL1), L&D2 (PRDL1), and L&D3  
1017 (PRTL1)

1018 **Period of Record:** 2007-Present

1019 **Crest:** 43.4 ft (L&D2) about 1:00 AM CDT 09/03/2012

1020

1021           Near the time of crest of the Pearl and Bogue Chitto Rivers in this area, it was reported

1022 by St. Tammany Parish officials that failure of the small dam at Lock and Dam 2 (L&D2) was

1023 imminent. Through an as of yet unknown combination of forecasting difficulties, confusion, and

1024 misunderstanding of maximum potential threat in regards to L&D2, a substantial portion of St.

1025 Tammany Parish near the canal was evacuated and some citizens in the Slidell area became

1026 concerned. Most of these individuals were never in any danger from a failure of L&D2. More

1027 discussion on this situation can be found in

1028 *Appendix A: Potential Dam Failures During Hurricane Isaac.*

1029

1030 **10. Bogue Chitto River**

1031

1032 *a. NWS Post-Event Flood Survey*

1033 1) US98 TO THE LA/MS BORDER

1034

1035 **Flood Category:** Major Flooding

1036 **River Gauge:** USGS automated gauge on US98 bridge (TYTM6)

1037 **Period of Record:** 1953-Present

1038 **Crest:** 26.4 ft about 1:00 PM CDT 08/30/2012

1039

1040 The survey team also visited the Bogue Chitto Water Park. High water marks

1041 suggested that the river level almost reached the circle drive at the top of the boat ramp. The

1042 survey team spoke with a staff member, Scott, at the water park, who indicated that backwater

1043 flooding up Bars Branch floods Dogwood Trail (cutting off the entrance road) before water

1044 reaches the main sections of the water park. He also indicated that MS27 was the only road he

1045 knew of that flooded from the storm. He also indicated that Nola Rd. bridge over Little Fair

1046 River could be used as a proxy for flooding at the water park; when the bridge flooded, the water

1047 park would flood within 24 hrs (see further discussion in section *b. Discussion*). Scott also

1048 provided a contact (Elmore Riles of Wright Rd.) for further information about the Bogue Chitto

1049 River and past floods.

1050 Scott from the Bogue Chitto Water Park also indicated that a section of Mesa Walkers

1051 Bridge Rd west of Tylertown may have flooded to a depth of over 1 ft. The location may be the

1052 crossing of Sweetwater Creek, but this was not made clear to the survey team.

1053 At the US98 bridge, high water marks were noted in the trees about 14-15 ft above

1054 bank level, but this was below the bridge elevation.

1055

1056 2) TWO MILES DOWNSTREAM OF TYLERTOWN TO LA437

1057

1058 **Flood Category:** Major Flooding

1059 **River Gauges:** USGS automated gauge on LA10/16 bridge (FRNL1)

1060 **Period of Record:** 1964-Present

1061 **Crest:** 19.2 ft about 1:00 AM CDT 08/31/2012

1062

1063 The survey team discussed flooding impacts with the Washington Parish emergency

1064 manager. It was mentioned that areas west of the MS10/16 bridge flooded. Upon visiting the

1065 area, the survey team noted that the area may have flooded up to several feet in depth, especially

1066 along VFW Rd. which was nearest to the river.

1067 A few homes appeared to have flooded along LA437.

1068 Flooding was noted in the area of True Light Church Rd.

1069 Flooding was also noted in the Isabel, LA, area just west of Bogalusa, especially near

1070 the Bogue Chitto Canoeing & Tubing Park along Choctaw Rd. Staff members at the Bogue

1071 Chitto Canoeing & Tubing Park indicated to the survey team that the crest at Choctaw Rd.

1072 occurs about 24-36 hrs after FRNL1 and about 12hrs before BSHL1.

1073

1074 3) LA437 TO CONF. WEST PEARL RIVER

1075

1076 **Flood Category:** Major Flooding

1077 **River Gauges:** USGS automated gauge on LA21 bridge (BSHL1)

1078 **Period of Record:** 1964-Present

1079 **Crest:** 19.2 ft about 1:00 AM CDT 08/31/2012

1080

1081 The survey team did not record any notes of flood impacts through this river reach.

1082 River flood category was determined through impact statements.



1083 *b. Discussion*

1084           The anecdote regarding Little Fair River being a predictor of flooding for Bogue Chitto  
1085 Water Park was investigated further. Little Fair River flows into Fair River between  
1086 Brookhaven, MS, and Monticello, MS, which is a tributary of the Pearl River just upstream of  
1087 Monticello. Although the headwaters of the Fair River are near the headwaters of the Bogue  
1088 Chitto River and may see similar rainfall amounts during events, flooding at Nola Rd. cannot  
1089 impact any location on the Bogue Chitto.

1090

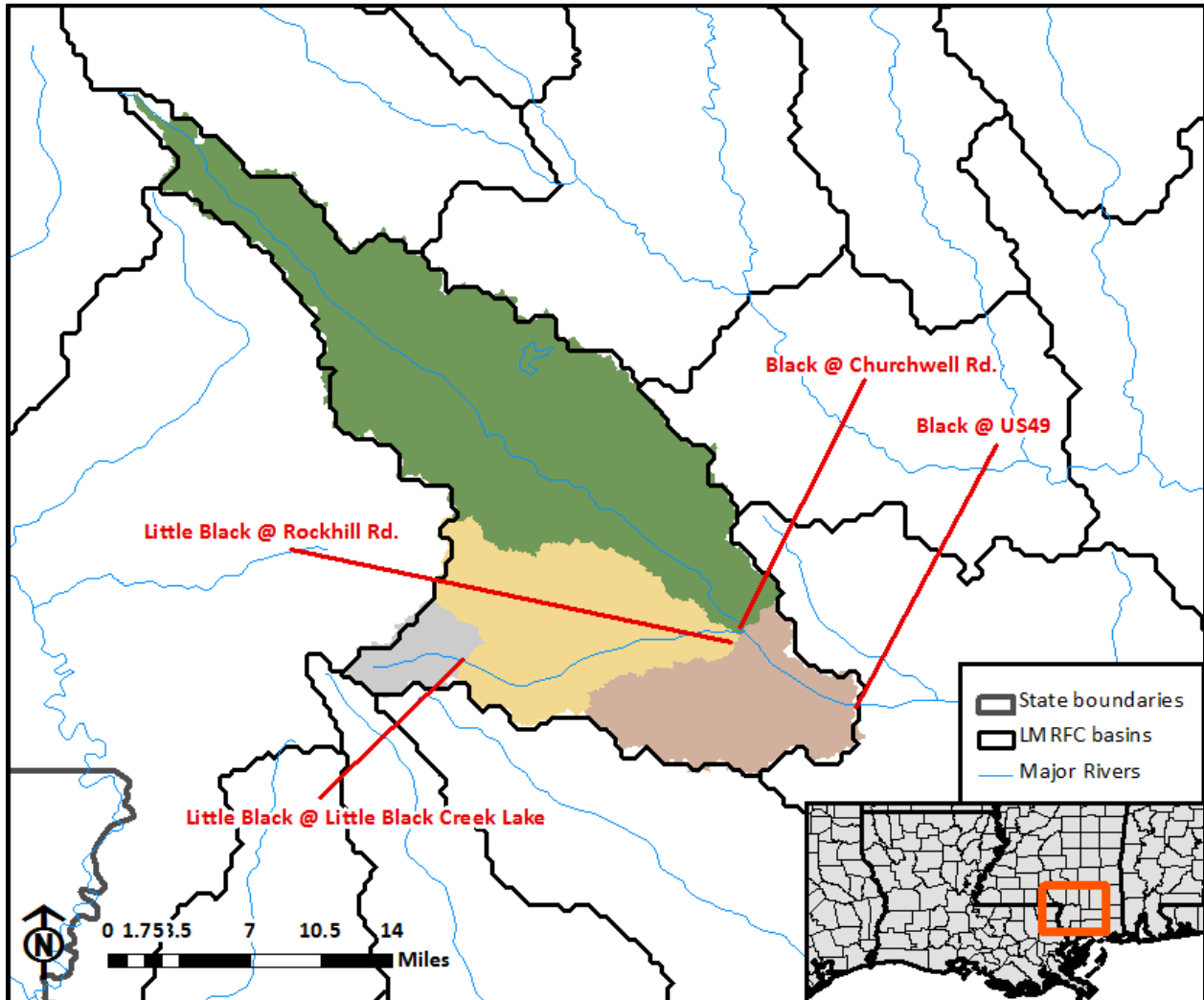
1091

1092 **11. Black Creek**

1093

1094 *a. NWS Post-Event Flood Survey*

1095 A survey of the Black Creek watershed area was conducted by hydrologists from the  
1096 LMRFC in September of 2012 separately from the main Isaac flood survey. The survey covered  
1097 areas from the Black Creek gauge on the US49 bridge as well as the Little Black Creek dam.



1098

1099 Figure 28. Black Creek subbasins as defined by locations surveyed by LMRFC/WFO Jackson  
1100 staff. Subbasins defined by the current model configuration of LMRFC are also indicated for  
1101 comparison.

1102 1) LAKE SERENE

1103

1104 **Flood Category:** Unknown

1105 **River Gauges:** None

1106

1107 Lake Serene is actually a complex of multiple smaller lakes separated by small

1108 embankments and connected by small spillways or conduits. An embankment on one of the

1109 smaller lakes received damage during the heavy rainfall and there was concern over a possible

1110 failure. The lake was drained successfully and no dam failure occurred (Marty Pope, personal

1111 communication). This location was not visited by the survey team.

1112

1113 2) LITTLE BLACK CREEK LAKE

1114

1115 **Flood Category:** Most likely moderate or major

1116 **River Gauges:** None

1117 **Period of Record:** ???-Present

1118 **Crest:** Estimated to be 2<sup>nd</sup> highest since constructed

1119

1120 Although staff drained the lake almost 3.0 ft prior to the onset of heavy rainfall, the

1121 elevation of Little Black Creek Lake reached an elevation high enough for water to move around

1122 the side of the dam into the emergency spillway channel (Little Black Creek Water Park staff,

1123 personal communication, September 2012). It was indicated to the survey team that the lake

1124 level's crest was lower after Isaac than during the flooding of 1983.

1125

1126 3) 5MI UPSTREAM OF US49 TO 5MI DOWNSTREAM OF US49

1127 **Flood Category:** Major Flooding

1128 **River Gauge:** USGS automated gauge on US49 bridge (BKNM6)

1129 **Period of Record:** 1971-Present

1130 **Crest:** 26.7 ft about 4:00 PM CDT 08/31/2012

1131

1132 Staff members from the Forrest County Emergency Mangement office guided NWS  
1133 hydrologists to a few flooded areas along Black Creek in the Brooklyn area. Although flooding  
1134 impacts to the town of Brooklyn itself were minimal, a few elevated structures near the river  
1135 west of town did experience flooding. One known flood prone area, referred to as Camp  
1136 Dantzler, again received flooding near the river from this event. Most structures are elevated,  
1137 but road access was flooded.

1138 NWS hydrologists also visited Beaver Lake which impounds Little Beaver Creek  
1139 upstream of Camp Dantzler and the gauging location on Black Creek. Mud marks and debris  
1140 appeared to indicate flooding of a few structures just downstream of the dam. The dam is  
1141 privately owned and was inaccessible by the surveyors during the visit. Previous surveys of the  
1142 location have noted trees and brush growing out of the earthen dam structure as well as evidence  
1143 of possible dam overtopping.

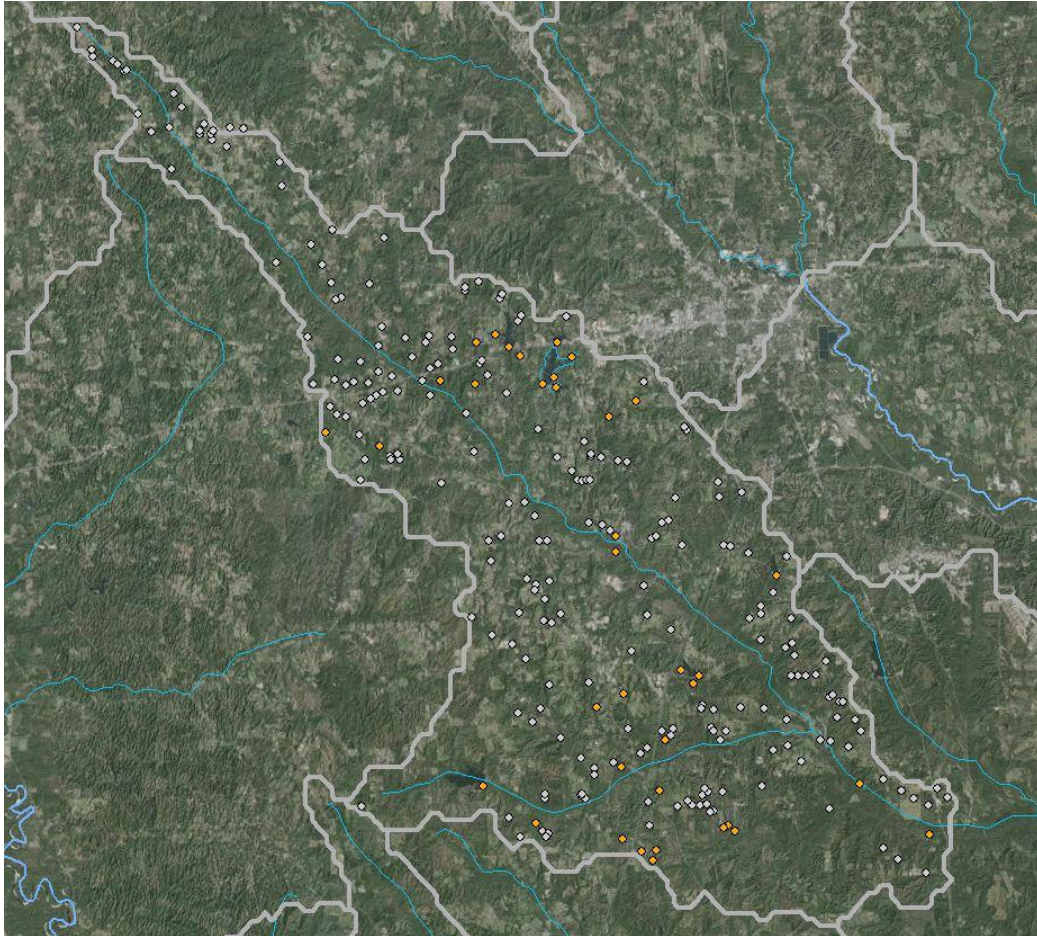
1144

1145 *b. Discussion*

1146 The Black Creek at Brooklyn basin is complex to model and forecasting challenges  
1147 include complex land use changes. Although a trend of increasing heavy precipitation events  
1148 appears likely based upon rainfall data available to LMRFC staff, streamflow response for the  
1149 automated gauging location on the US49 bridge suggests stable or reduced flood activity. A  
1150 substantial number of retention ponds and small lakes were evident in satellite imagery (Figure  
1151 29) analyzed by LMRFC staff in late 2012.

1152 Due to the close proximity of this basin to the LMRFC office, the forecast point and  
1153 upstream areas have been visited numerous times in recent years. Hydrologists have noted a  
1154 fairly incised channel for the downstream half of the basin, including a gravelly or rocky channel

1155 bottom in some locations with unusually clear water for the area. It has been hypothesized that  
1156 land use changes, particularly the slow addition of multiple private retention ponds and small  
1157 lakes, may have changed the response characteristics of the basin enough to mitigate flood risk.  
1158 This remains an area of active research and study, and as such, the hypothesis should be  
1159 considered preliminary at this time.



1160  
1161 Figure 29. Map of the Black Creek at Brooklyn (BKNM6) subbasin with structures showing  
1162 both known dams and unlisted ponds/lakes identified from satellite imagery. Known dams are  
1163 indicated as yellow (37), and manually-added dams are indicated as white (230).  
1164

1165 **12. Post-Survey Discussion**

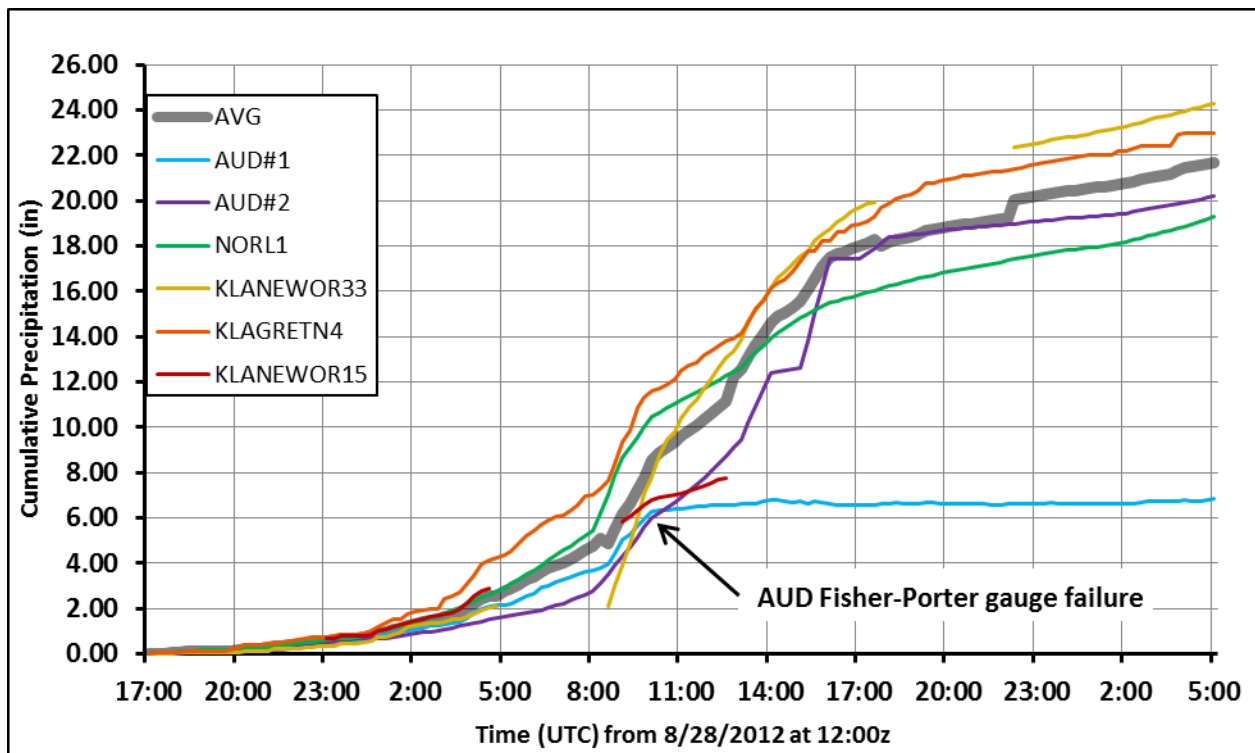
1166  
1167           Some differences between actual impacts and the forecasted impacts based upon E19s  
1168 and AHPS information was noted by the various survey teams. A break-down of these  
1169 differences was provided to the responsible NWS WFOs. It was also noted that both flash  
1170 flooding and longer-term river flooding occurred due to heavy rainfall from Hurricane Isaac.  
1171 This highlights the necessity of a multi-pronged forecasting approach including FFG/FFMP,  
1172 RFC forecasts, and new experimental techniques such as DHM-TF for the transitional events.

1173           The Audubon Park COOP station (AUD) started at a notably high accumulation before  
1174 the storm, and then during the period of highest intensity rainfall, the reported accumulation  
1175 remained relatively constant once it exceeded the design capacity of the gauging equipment  
1176 (Figure 30). This highlights the need for NWS staff to make sure gauging equipment is in  
1177 working order and properly emptied prior to high-impact events with a substantial lead time such  
1178 that important mission-critical data is not lost. Because of the loss of some official data, private  
1179 data was acquired to help fill in the gaps.

1180           During Hurricane Isaac, the number of watches, warnings, and statements in effect for  
1181 some areas made it particularly difficult to use a warning map such as the one provided by the  
1182 NWS. This is likely to only get worse with the additional of new hurricane products. Flood  
1183 warnings would be issued for entire counties, even when flooding was only to impact areas near  
1184 the river, and this would overlap other warning products that were probably more relevant to  
1185 other portions of the county. Multiple NWS service assessments have recommended the usage  
1186 of polygon warnings tied to river forecast locations (NWS, 2011b) (NWS, 2012). Methodology  
1187 already exists to work around default WFO system configuration and issue polygon-based river

1188 flood warnings. Isaac highlights the type of situations where polygon-based river flood warnings  
1189 can greatly improve our warning dissemination.

1190 Forecasters could also greatly improve our decision support services by using severity-  
1191 based product wording (NWS, 2010) (NWS, 2011a) (NWS, 1999). Even when observations  
1192 were beginning to indicate that some areas were experiencing an extreme event, rarely was  
1193 heightened wording used to make it clear that this was not just an ordinary flood event. Some  
1194 areas flooded by Hurricane Isaac experienced record and/or life-threatening stages. Severity-based  
1195 product wording helps our customers and partners put an event such as that in context.



1196 Figure 30. Accumulated precipitation plots for gauges near the Audubon Park cooperative  
1197 observer site. The Fisher-Porter rain gauge (AUD#1) failed after exceeding about 6.0 inches of  
1198 accumulation during the period of heaviest rainfall.  
1199  
1200

1201 **13. Summary and Final Remarks**

1202  
1203           Hurricane Isaac’s slow movement at landfall during late August of 2012 set the stage  
1204 for substantial storm surge and river flooding impacts. Moderate and major flooding was  
1205 observed along numerous river reaches in Louisiana and Mississippi. This widespread,  
1206 significant flooding lead to the creation of survey teams tasked with documenting the flood’s  
1207 impacts and discussing our hydrologic forecast service with our customers and partners.

1208           From the summaries of post-flood survey notes, it was determined that numerous roads  
1209 were inundated, several residential and business structures were flooded, and impacts for a few  
1210 areas were of a historic nature. The Wolf River floodplain was one of those areas, but flood  
1211 impacts were limited due to most of the floodplain being undeveloped. In contrast, some areas  
1212 experienced significant flooding but not of a record magnitude, and numerous structures were  
1213 affected. New development was noted in areas that were just outside of the limit of inundation,  
1214 in areas that have flooded in the past and will flood again. These contrasting anecdotes suggest  
1215 that we must continue to work with our partner agencies to educate the public on past floods and  
1216 likely future floods to mitigate risk.

1217           It was also found that many individuals kept a close watch on river forecasts as they  
1218 were updated using the NWS Advanced Hydrologic Prediction Service. Many of these  
1219 individuals also were knowledgeable in their surveyed elevation, the base flood elevation  
1220 determined for their area, and how to correlate a nearby river gauge to impacts in their area.  
1221 From this event we have further evidence of the diverse range of hydrology knowledge found  
1222 amongst our public customers, and can also see our methods of product dissemination in action.

1223           The survey team also found areas where the National Weather Service offices in the  
1224 affected area could improve the service provided to our customers and partners. Flood



1225 categories may need adjustment in some areas, and flood impacts need updating to reflect recent  
1226 development. It has been indicated through numerous NWS service assessments that the  
1227 frequent updating of impact statements is very important to our customers and partners; the best  
1228 way to keep them useful and relevant is to visit a flooded area during or soon after the event  
1229 (NWS Eastern Region Headquarters, 2012) (NWS, 2011b) (NWS, 2012).  
1230

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~~1284~~

1286 **Appendix A: Potential Dam Failures During Hurricane Isaac**

1287 *This report, authored by Katelyn Costanza, summarizes the potential dam failures encountered*  
1288 *during Hurricane Isaac and ways to improve our forecast methodology for those situations.*  
1289

1290           Three potential dam break situations occurred due to flooding from Hurricane Isaac’s  
1291 heavy rainfall – Lake Tangipahoa, Lock & Dam #2 of the Pearl River Navigation Canal and  
1292 Lake Serene. Lake Tangipahoa is in the headwaters of the Tangipahoa River and is in the  
1293 National Weather Service (NWS) Weather Forecast Office (WFO) New Orleans/Baton Rouge  
1294 (LIX) HSA . Lock & Dam #2 is one of three locks on the Pearl River Navigation Canal that  
1295 parallels the Pearl River in southeast Louisiana, and is also within the NWS WFO LIX HSA.  
1296 Lake Serene is a combination of small suburban lakes in the headwaters of Black Creek and is in  
1297 the NWS WFO Jackson HSA. Lake Tangipahoa and Lock & Dam #2 presented several  
1298 challenges to forecasters at the NWS Lower Mississippi River Forecast Center (LMRFC) and  
1299 NWS WFO LIX. This appendix summarizes the dam break response of both offices as  
1300 determined by personal communications and review of shift logs, and also offers  
1301 recommendations for improvement.

1302

1303 *A.1 Lake Tangipahoa*

1304 A.1.1 EVENT TIMELINE

1305           NWS WFO LIX received notification by email on the morning of August 30th that a  
1306 dam failure at Lake Tangipahoa, located in the headwaters of the Tangipahoa River at Percy  
1307 Quin State Park, could occur. Percy Quin personnel notified the Amite County EM who  
1308 contacted the Mississippi Emergency Management Agency (MEMA). In response to the  
1309 notification, the duty forecasters at LIX issued a Flash Flood Warning for southwestern Pike

1310 County, which included the low lying areas along the Tangipahoa River downstream to Osyka,  
1311 MS. LIX coordinated with the LMRFC to run a dam break analysis for the dam. Once  
1312 completed, the LMRFC coordinated the dam break analysis with LIX and updated the river  
1313 forecast guidance products (RVFs) for Osyka and further downstream at Kentwood, LA, to  
1314 reflect the potential flood wave caused by a failure at the Lake Tangipahoa Dam. At 11:07 AM a  
1315 Civil Emergency Message (CEM) was composed for Lake Tangipahoa Dam area. WFO LIX  
1316 coordinated wording with MEMA and the Louisiana Governor's Office of Homeland Security  
1317 and Emergency Preparedness (GOHSEP). At 11:11 AM, LIX issued another Flash Flood  
1318 Warning for Pike County and Northern Tangipahoa Parish to now include the Kentwood area.  
1319 Dam safety officials from Mississippi Department of Environmental Quality (MDEQ) arrived on  
1320 site and determined that although two slumps in the earthen dam had occurred, they were not  
1321 indicative of imminent failure. At 2:00 PM, the LIX WFO issued a Flash Flood Statement,  
1322 updating the warning in effect, which indicated that the warning would expire for Pike County  
1323 and Tangipahoa Parish, but would be monitored and a warning reissued if conditions  
1324 deteriorated. On the evening of August 30th, LMRFC staff members coordinated with United  
1325 States Army Corps of Engineers (USACE) Vicksburg District (MVK) personnel on floodwave  
1326 timing and inundation extents should failure occur. LMRFC forwarded the inundation map  
1327 provided by MVK which included the areas downstream of the dam.

1328 Mid-morning, September 1st, WFO-LIX contacted the Pike County EM to discuss the  
1329 status of the dam. The EM indicated that the lake draw down was still occurring, and provided an  
1330 estimate of the lake at normal pool (331.0 ft NGVD29). WFO LIX staff used this estimate of  
1331 pool elevation in conjunction with lake surface area and lake storage values from DAMCAT to  
1332 determine a lake depth. WFO LIX staff assumed that the average lake depth (determined by

1333 dividing the lake's pool storage by the surface area) would be applicable to the lake depth right  
1334 at the dam.

1335           The Lake Tangipahoa Dam is known to have structural issues due primarily to steep  
1336 side slopes. During significant rainfall, the earthen dam can become saturated compromising  
1337 slope stability.

1338

#### 1339 A.1.2 DISCUSSION

1340           The average depth is not typically representative of the height of water right at the dam,  
1341 which is the height of water that could potentially spill from the dam should failure occur. A  
1342 better estimate would be to use the difference between the dam top elevation and the lowest  
1343 floodplain elevation just downstream, or to use the given value for hydraulic head in the National  
1344 Inventory of Dams (NID) as well as DAMCAT. During potential dam break situations, these  
1345 calculations are typically done by hydrologists at an NWS River Forecast Center (RFC), not by  
1346 staff at a WFO.

1347

#### 1348 *B.2 Lock & Dam #2 on the Pearl River Navigation Canal*

##### 1349 A.1.1 EVENT TIMELINE

1350           The WFO LIX was notified at 2:44 PM, September 1st, via a twitter message by St.  
1351 Tammany Parish that failure of Lock and Dam #2 was imminent and would affect properties  
1352 along the Pearl River Navigation Canal. A Flash Flood Warning was issued – originally for  
1353 portions of Washington Parish by mistake, then subsequently for eastern St. Tammany Parish.  
1354 The NWS Southern Region's Regional Operations Center (ROC) and LMRFC were notified of  
1355 the situation. The LMRFC subsequently began working on a quantitative dam break analysis,

1356 although Lock & Dam #2 was not a typical dam break situation trained for by LMRFC staff. A  
1357 Flash Flood Warning was issued at 3:04 PM for St. Tammany Parish downstream of Lock and  
1358 Dam #2 to Highway 36 including the heightened “Flash Flood Emergency” wording. The  
1359 LMRFC provided LIX with a quantitative dam break analysis based on preliminary data to  
1360 provide the potential impacts should the lock fail. The WFO LIX conveyed this information in a  
1361 subsequent Flash Flood Statement issued at 4:37 PM. LMRFC staff visited the site of the lock  
1362 and dam to discuss the impacts with emergency management officials and the USACE. The  
1363 USACE conveyed that they were able to stop the overtopping of the lock chamber and prevent  
1364 further scour to the downstream wing wall of the structure which had received the most damage.  
1365 The USACE was monitoring the situation and would continue to do so until structural engineers  
1366 were able to arrive at the site the next day to assess the structural damage, but indicated that the  
1367 situation had stabilized. The USACE also conveyed that if conditions should worsen or failure  
1368 occurs, the floodwave would be captured in the pool of Lock and Dam #1 just downstream on  
1369 the Pearl River Navigation Canal. Unless Lock & Dam #1 were also to fail (which was  
1370 considered very unlikely), this floodwave would have been contained within the navigation canal  
1371 and would not continue to the main channel of the Pearl River. LMRFC called WFO LIX after  
1372 leaving the site (approximately 7 PM) to communicate this updated information so that it could  
1373 be conveyed in the warnings. The WFO re-issued a Flash Flood Statement at 9:03 PM with the  
1374 preliminary information from early evening; this warning included areas east of Hwy 41 and  
1375 north of Hwy 36. The Flash Flood Warning was continued at 2:51 AM, again using preliminary  
1376 information. These issuances did not include an updated assessment or qualitative analysis and  
1377 were not coordinated with the LMRFC. At 3:44 AM, LMRFC staff re-coordinated updated  
1378 information provided earlier on the situation which was acquired at the dam site to WFO LIX.



1379 The WFO reissued the Flash Flood Warning indicating that pressure had been relieved and was  
1380 being monitored by USACE officials. This verbiage was maintained in the 9:00 AM issuance of  
1381 the Flash Flood Warning.

1382

### 1383 B.2.2 DISCUSSION

1384 A contact list of appropriate state personnel should be developed for Louisiana and  
1385 Mississippi to discuss dam emergency situations with the appropriate personnel. All information  
1386 should be communicated with the RFC before providing any quantitative information related to a  
1387 potential dambreak. The RFC staff is trained in evaluating a dam break scenario and providing  
1388 quantitative forecasts of downstream impacts.

1389 The first flash flood watch/warning issued for a potential dam failure should extend  
1390 downstream just enough to cover the time needed by the RFC to do the dambreak calculations.  
1391 Empirical data from past dam break flood waves indicates that the waves travel at 10 mph or  
1392 less, even in the steepest of mountain terrain. A Flash Flood Warning length of roughly 10 miles  
1393 for every 1hr of required calculation time by the RFC would be a reasonable assumption. In  
1394 accordance with National Weather Service Policy Directive NWS 10-921 and Supplement 02-  
1395 2006, a quantitative analysis is the responsibility of the RFC and all flood warnings should be  
1396 coordinated with the responsible RFC.

1397 **Appendix B: Private Weather Station Data**

1398

1399 A large amount of private weather station data was obtained to help the analysis in this  
1400 post-flood report. Over 160 sites were originally hand-entered into a spreadsheet program for  
1401 later comparison in ArcGIS with official gauging location data and radar derived precipitation  
1402 estimates. Most of these sites came from the Weather Underground Personal Weather Station  
1403 (PWS) project. In addition to the PWS data, estimates from a wastewater treatment plant and a  
1404 few functioning stations from the AWS/WeatherBug network were used. This section discusses  
1405 the data acquisition and quality control process further than the main body of the report.

1406 As discussed in the main report (*Section 2 Un-Official Sources*), a PHP script was created to  
1407 speed up this process of retrieving data from the PWS and AWS stations

1408 (<http://www.meteor.iastate.edu/~slincoln/stationdata/>). Even with this script, data still had to be  
1409 hand-entered one gauge at a time. After obtaining this data, a limited amount of quality control  
1410 was applied by to eliminate obvious erroneous gauges. To obtain as much useful data as  
1411 possible, the gauges were evaluated independently for each day using the following criteria:

- 1412 1. Any gauge that did not have more than a few hours of data available was automatically  
1413 eliminated.
- 1414 2. Many gauges had periods of time where no data was reported. This was likely due to  
1415 intermittent power outages. If the gauge data returned before 12:00 AM and a reasonable  
1416 daily rainfall value was reported, the site was kept for that day (this is due to the private  
1417 stations reporting daily totals to Weather Underground instead of rates).
- 1418 3. If gauge data stopped and did not return before 12:00 AM, the station was only kept for  
1419 that day if the lost data period was shorter than 1 hr in duration.

1420 4. Some gauges reported rainfall rates that were unrealistic or did not follow a shape that  
1421 appeared to be natural. These sites were typically removed for that day, especially if  
1422 other problems were noticed.

1423 5. As is typical even for official sites during heavy rainfall coincident with high winds,  
1424 many rainfall gauges appeared to underestimate when compared to nearby sites.  
1425 Typically this did not cause a gauge to be excluded for that day unless the discrepancy  
1426 was substantial (for example, 5” or more) and aerial imagery suggested poor siting of the  
1427 gauge.

1428 Although an attempt was made to reduce errors in the private station data and improve the data  
1429 quality, it cannot be guaranteed that all data are accurate or that a particular site is located in an  
1430 adequate location to properly measure rainfall. A table of daily and storm total rainfall values,  
1431 ordered from highest to lowest, is shown by Table 1.

1432  
1433  
1434

Table 1. Summary of QCed rainfall totals from private weather stations (mostly Weather Underground PWS sites) in southeast Louisiana and south Mississippi during Hurricane Isaac. Questionable values highlighted yellow. Site PWWTP measured at 7 AM rather than 12 AM.

PWS_ID	Lat	Lon	Location	State	Source	08_28_12	08_29_12	08_30_12	08_31_12	09_01_12	Total
KLANEWOR33	29.93	-90.11	New Orleans (Uptown)	LA	WU	2.10	24.34	0.94	0.00	0.00	27.38
KLAGRETN4	29.91	-90.05	Gretna	LA	WU	4.37	18.66	0.87	0.06	0.00	23.96
PWWTP*	30.54	-89.71	Picayune Treatment Plant*	MS	Other	1.00	13.00	5.50	1.20	0.00	20.70
KMSBROOK3	31.58	-90.44	Brookhaven	MS	WU	0.08	8.10	9.08	1.22	0.14	18.70
KMSMOSSP1	30.60	-88.47	Moss Point	MS	WU	1.52	9.08	7.65	0.19	0.00	18.44
MCKWM6	30.52	-88.98	Woolmarket	MS	WU	1.54	9.30	7.22	0.33	0.00	18.39
KLABELLE5	29.90	-89.98	Belle Chasse	LA	WU	1.33	14.46	1.77	0.00	0.00	17.56
KLANEWOR26	30.01	-90.06	New Orleans	LA	WU	3.21	9.64	1.65	0.00	0.00	14.50
KMSMCCOM2	31.21	-90.50	McComb	MS	WU	0.14	8.39	5.02	0.48	0.21	14.24
IMSPOPLA2	30.83	-89.54	Poplarville	MS	WU	0.23	7.69	6.23	0.04	0.00	14.20
KMSHATTI12	31.32	-89.39	Hattiesburg	MS	WU	2.97	6.10	3.64	0.40	0.01	13.12
KMSLONGB5	30.36	-89.16	Long Beach	MS	WU	1.57	9.60	1.93	0.00	0.00	13.10
KMSCARRI3	30.58	-89.65	Carriere	MS	WU	0.73	9.18	3.05	0.03	0.00	13.07
KMSOSYKA2	31.03	-90.28	Osyka	MS	WU	0.15	4.99	5.12	0.80	1.27	12.55
KALMOBIL52	30.65	-88.29	Mobile	AL	WU	3.16	4.50	4.62	0.25	0.01	12.54
KALMOBIL40	30.68	-88.20	Mobile	AL	WU	4.53	5.59	2.03	0.23	0.01	12.52
KLHAMMO3	30.53	-90.53	Hammond	LA	WU	0.06	8.11	2.74	1.37	0.12	12.42
MTT090	31.20	-89.18	Hattiesburg	MS	WU	1.12	5.78	4.48	0.64	0.06	12.18
KLASTAMA2	30.26	-90.84	Gonzales	LA	WU	0.08	8.57	2.94	0.58	0.00	12.17
KALGRAND3	30.46	-88.34	Grand Bay	AL	WU	1.32	7.42	2.72	0.21	0.00	11.67
KLABELLE4	29.74	-90.03	Belle Chasse	LA	WU	2.91	6.89	1.85	0.00	0.00	11.65
KLAMETAI14	30.02	-90.17	Metairie	LA	WU	3.38	6.88	0.64	0.01	0.01	10.92
KLACARVI2	30.23	-91.05	Gonzales	LA	WU	0.00	9.53	0.71	0.63	0.04	10.91
KMSSUMMI2	31.29	-90.47	Summit	MS	WU	0.75	6.24	3.27	0.00	0.16	10.43
KMSMAGNO2	31.09	-90.35	Magnolia	MS	WU	0.15	5.21	4.33	0.54	0.01	10.24
KLAPRAIR4	30.31	-90.93	Prairieville	LA	WU	0.02	7.11	2.53	0.42	0.05	10.14
KLAABITA1	30.55	-89.96	Abita Springs	LA	WU	0.24	6.85	2.68	0.00	0.00	10.12
KALMOBIL7	30.74	-88.21	Mobile	AL	WU	2.98	4.90	1.90	0.22	0.01	10.10
KMSVANCL4	30.54	-88.74	Van Cleave	MS	WU	1.29	5.49	2.45	0.08	0.31	9.66
KLARIVER3	29.97	-90.23	River Ridge	LA	WU	1.00	7.75	0.80	0.01	0.01	9.57
KLABATON23	30.40	-91.07	Westminster	LA	WU	0.00	5.70	3.11	0.62	0.05	9.48
KALMOBIL44	30.63	-88.27	Mobile	AL	WU	3.07	3.04	3.20	0.16	0.00	9.47
KLAABITA2	30.48	-89.93	Abita Springs	LA	WU	0.49	4.61	4.24	0.04	0.00	9.41
KLAGEISM2	30.21	-90.99	Gonzales	LA	WU	0.05	5.97	2.03	0.62	0.62	9.29
KLACENTR2	30.60	-91.00	Greenwell Springs	LA	WU	0.00	5.92	1.85	0.97	0.44	9.19
KALMOBIL27	30.62	-88.27	Mobile	AL	WU	3.28	4.25	1.49	0.14	0.00	9.16

PWS_ID	Lat	Lon	Location	State	Source	08_28_12	08_29_12	08_30_12	08_31_12	09_01_12	Total
KMSBROOK4	31.52	-90.31	Brookhaven	MS	WU	0.32	2.37	5.58	0.51	0.01	8.79
KLASLIDE10	30.30	-89.84	Slidell	LA	WU	0.72	4.79	2.88	0.00	0.00	8.39
KMSHATTI10	31.31	-89.36	Hattiesburg	MS	WU	0.92	4.28	2.81	0.30	0.00	8.31
KMSGULFP20	30.40	-89.04	Gulfport	MS	WU	0.85	6.22	1.23	0.00	0.01	8.31
KMSHATTI7	31.33	-89.34	Hattiesburg	MS	WU	1.07	4.95	2.07	0.18	0.01	8.28
KALMOBIL17	30.60	-88.22	Tillmans Corner	AL	WU	2.98	3.56	1.36	0.28	0.00	8.19
KMSMCCOM4	31.25	-90.46	McComb	MS	WU	0.19	5.73	1.39	0.38	0.19	7.89
KLATHIBO3	29.82	-90.84	Thibodaux	LA	WU	0.28	4.52	2.26	0.82	0.00	7.89
KLASLIDE7	30.29	-89.85	Slidell	LA	WU	0.98	4.62	2.27	0.00	0.00	7.88
KLAMANDE14	30.40	-90.06	Mandeville	LA	WU	0.77	6.06	0.84	0.00	0.00	7.67
KLAMANDE15	30.38	-90.03	Mandeville	LA	WU	0.66	5.16	1.80	0.00	0.00	7.62
KLASCHRI3	29.64	-90.84	Bayou Cane	LA	WU	0.66	3.53	2.99	0.24	0.00	7.42
KLABATON3	30.40	-91.03	Shenandoah	LA	WU	0.00	5.75	0.87	0.75	0.04	7.41
KLANORCO2	30.02	-90.41	Norco	LA	WU	0.72	4.54	1.50	0.48	0.08	7.32
KALMOBIL32	30.61	-88.23	Tillmans Corner	AL	WU	2.91	2.66	1.26	0.29	0.00	7.12
KALMOBIL49	30.68	-88.12	Mobile	AL	WU	2.39	3.45	0.72	0.52	0.00	7.08
KALMOBIL42	30.63	-88.17	Mobile	AL	WU	2.54	3.19	0.90	0.37	0.00	7.00
KLAMETA13	30.00	-90.14	Metairie	LA	WU	1.63	3.10	1.80	0.01	0.01	6.55
KLASLAUG1	30.73	-91.12	Slaughter	LA	WU	0.00	3.21	1.78	0.46	0.11	6.29
KALTHEOD3	30.58	-88.12	Tillmans Corner	AL	WU	2.66	2.77	0.47	0.39	0.00	6.29
KMSSEMIN2	31.46	-89.44	Seminary	MS	WU	0.90	2.88	1.81	0.63	0.03	6.25
KMSPOPLA1	30.97	-89.66	Poplarville	MS	WU	0.16	5.25	0.65	0.01	0.00	6.07
KLALUTCH2	30.05	-90.70	Lutcher	LA	WU	0.66	1.07	2.77	1.54	0.00	6.04
KALFAIRH16	30.51	-87.84	Fairhope	AL	WU	3.24	2.21	0.06	0.32	0.00	5.83
KLAHOUMA4	29.63	-90.75	Bayou Cane	LA	WU	0.83	4.07	0.66	0.24	0.00	5.80
KLANEWOR13	30.03	-90.06	New Orleans	LA	WU	2.87	0.98	1.86	0.00	0.01	5.72
KALFAIRH6	30.52	-87.82	Fairhope	AL	WU	3.64	1.49	0.16	0.28	0.00	5.57
KMSHATTI2	31.31	-89.36	Hattiesburg	MS	WU	1.29	2.20	1.70	0.34	0.00	5.53
KALFAIRH13	30.54	-87.90	Fairhope	AL	WU	3.83	1.50	0.02	0.15	0.00	5.50
KLAPLAQU3	30.24	-91.20	Plaquemine	LA	WU	0.00	3.82	0.95	0.68	0.00	5.45
KALROBER2	30.53	-87.73	Robertsdale	AL	WU	4.21	0.94	0.00	0.16	0.00	5.31
KALFAIRH9	30.45	-87.83	Fairhope	AL	WU	3.13	1.47	0.07	0.24	0.00	4.91
KLACLINT2	30.78	-90.89	Clinton	LA	WU	0.00	2.16	1.82	0.31	0.03	4.32
KALDAPHN2	30.60	-87.91	Daphne	AL	WU	2.17	1.65	0.10	0.24	0.00	4.16
KALGULFS7	30.25	-87.72	Gulf Shores	AL	WU	3.35	0.48	0.03	0.00	0.00	3.86
KLABERW12	29.72	-91.24	Morgan City	LA	WU	0.03	1.94	1.78	0.06	0.00	3.82
KLAPORTA4	30.45	-91.24	Port Allen	LA	WU	0.00	1.59	0.55	1.31	0.01	3.46
KALDAPHN3	30.59	-87.91	Daphne	AL	WU	1.42	1.42	0.07	0.17	0.00	3.08
KLAPRIA12	30.27	-90.98	Prairieville	LA	WU	0.03	2.17	0.68	0.04	0.01	2.99

PWS_ID	Lat	Lon	Location	State	Source	08_28_12	08_29_12	08_30_12	08_31_12	09_01_12	Total
KALGULFS5	30.25	-87.79	Gulf Shores	AL	WU	1.96	0.75	0.08	0.09	0.00	2.88
KALORANG4	30.28	-87.58	Orange Beach	AL	WU	2.50	0.15	0.10	0.02	0.00	2.77
KALORANG6	30.29	-87.51	Orange Beach	AL	WU	1.64	0.09	0.03	0.15	0.00	1.91
KALDAUPH3	30.25	-88.14	Dauphin Island	AL	WU	-999.00	2.41	0.09	0.40	0.00	
KALMOBIL45	30.64	-88.15	Mobile	AL	WU	3.71	4.05	0.62	-999.00	-999.00	
KLAMONTE2	29.47	-90.56	Chauvin	LA	WU	1.59	3.44	0.57	0.00	-999.00	
KLAPLAQU4	30.27	-91.18	Plaquemine	LA	WU	0.00	4.65	0.45	-999.00	0.00	
KLAPORTA8	30.42	-91.21	Port Allen	LA	WU	0.00	3.70	0.69	0.86	0.00	
KLAWATSO2	30.61	-90.91	Edmonds	LA	WU	0.00	8.67	1.67	0.92	0.17	
KMSLIBER2	31.19	-90.87	Liberty	MS	WU	0.06	4.99	2.91	0.05	0.04	
KMSLONGB8	30.35	-89.14	Long Beach	MS	WU	1.23	10.64	1.78	-999.00	-999.00	
KMSPASSC14	30.31	-89.25	Pass Christian	MS	WU	1.24	4.12	0.11	-999.00	-999.00	
KMSWAVEL6	30.29	-89.37	Waveland	MS	WU	1.51	3.60	2.35	0.00	-999.00	

1435

1436 **Appendix C: Isolated Rainfall Maximum in Uptown New Orleans**  
1437

1438           Although several locations recorded rainfall accumulation near 20 inches for the  
1439 duration of Isaac’s slow landfall, one rainfall maximum is particularly notable due to its isolated  
1440 nature, the validation with several sites in the close vicinity, and the apparent lack of significant  
1441 flood impacts. Two official gauges near Audubon Park in New Orleans reported notably high  
1442 totals for the event, defined as August 28<sup>th</sup>, 2012, 17 GMT through August 30<sup>th</sup>, 2012, 17 GMT.  
1443 NORL1, which is operated by the USACE, reported 21.1 in, and one of the two gauges at AUD,  
1444 which is operated by NWS LIX, reported 21.0 in. One hourly report at the AUD site appeared to  
1445 be so much higher than neighboring gauges that WFO LIX staff suspected the gauge data of  
1446 being faulty for that day, and replaced the raw values with estimated values before they were  
1447 used in the Hurricane Isaac Tropical Cyclone Report and the official climate data reported to  
1448 NCDC (LIX staff, personal communication). When compared to other rainfall data available at  
1449 the time for New Orleans, these values appeared significantly higher than any other location.  
1450 For example, data from rain gauges at pump stations operated by the New Orleans Sewerage and  
1451 Water Board ranged from 4.6 inches to 12.4 inches.

1452           To validate the NORL1 and AUD gauges, additional data from private weather stations  
1453 (see *Appendix B: Private Weather Station Data*) was obtained. Rainfall accumulations and  
1454 rainfall rates for stations closest to Audubon Park were compared to the official sites in question.  
1455 The locations and storm total rainfall of all quality-controlled gauges available in the New  
1456 Orleans area (official and private) is illustrated by Figure 33. The storm total rainfall amount for  
1457 the other AUD gauge was not plotted due to the gauge failure in the middle of the heaviest  
1458 rainfall band.

1459           Staff members from WFO LIX and LMRFC – Suzanne Van Cooten, W. Scott Lincoln,  
1460 and Tim Erickson – also visited some of these gauges on January 9<sup>th</sup>, 2013, in particular the

1461 Weather Underground PWS site KLANEWOR33, which reported the highest storm total of 27.4  
1462 inches. Station KLANEWOR33 was located on the roof of a three floor residential structure,  
1463 roughly 30 ft above ground level (Figure 35). The rain gauge was a tipping bucket sensor  
1464 attached to the side of a pole used for the anemometer. The rain gauge and anemometer were  
1465 estimated to be roughly 3 ft and 5 ft above roof level, respectively. The residential structure was  
1466 the tallest building in the neighborhood, greatly limiting the impact of trees and buildings on the  
1467 rainfall measurement. Although the station was sited such that rainfall should not be blocked by  
1468 taller objects, two sources of potential over-estimation were identified. The rain gauge was  
1469 attached to, and within just a few inches of, the pole holding the anemometer. The pole was  
1470 located to the northeast of the rain gauge, which we hypothesize may have provided a  
1471 mechanism for dripping water to enter the gauge during specific wind conditions. It was also  
1472 hypothesized that the strong winds observed at the station (during the time of heaviest rainfall  
1473 rates, frequent gusts in the 55-70 mph range were recorded) may have caused false tips in the  
1474 rain gauge. Neither of these hypotheses were thoroughly tested.

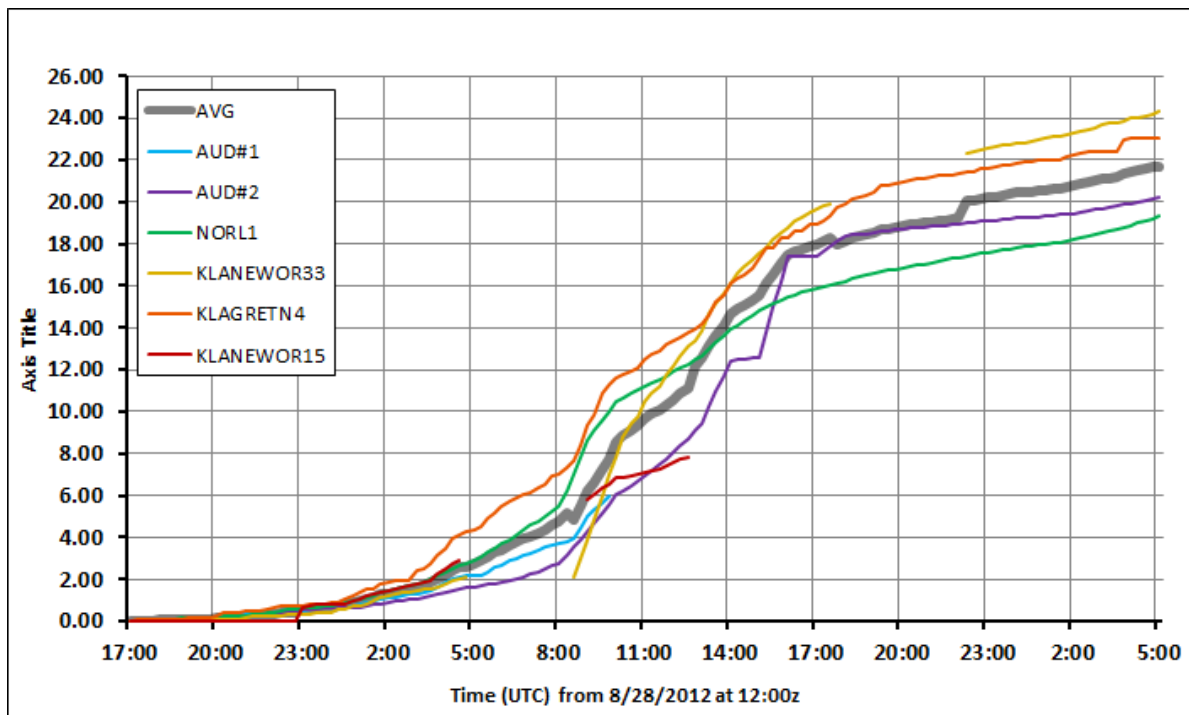
1475           Another way to validate the data reported by the NORL1 and AUD gauges is to look at  
1476 running accumulation (Figure 31) and hourly rainfall rates (Figure 32). NORL1 and AUD  
1477 appear to be consistent, both in timing and magnitude, with nearby private gauges. One private  
1478 gauge in the area, Weather Underground PWS site KLANEWOR15, was in disagreement with  
1479 rainfall rates reported by the other stations, especially between roughly 9GMT and 1230GMT on  
1480 August 29<sup>th</sup>, 2012 (a brief time period when the station reported between power interruptions).  
1481 Because this site is located just 3 blocks from site AUD, the discrepancy was investigated. The  
1482 rainfall gauge was located in a small backyard area within just a few feet of nearby structures  
1483 and trees (Figure 34). The anemometer for the site, located on an out building near the rain



1484 gauge, reported lower wind speeds than other stations in the area. It seems likely that this station  
1485 under-reported rainfall due to these issues.

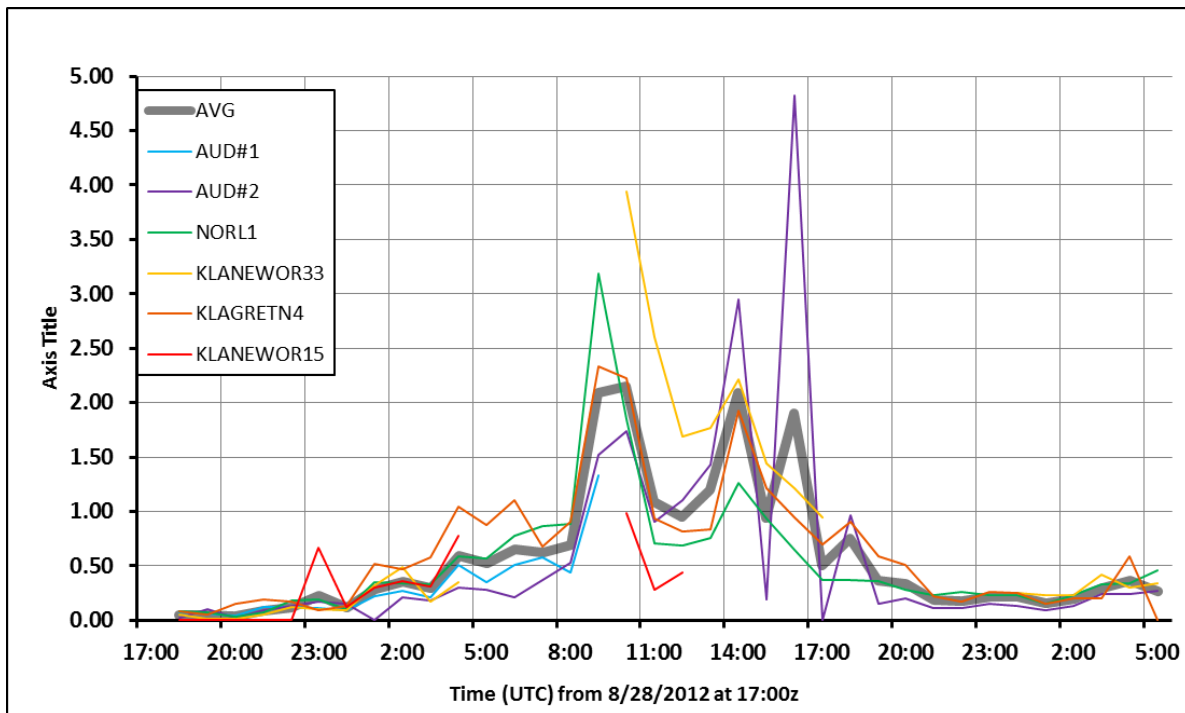
1486           The number of gauges consistently reporting very high values of rainfall in the uptown  
1487 New Orleans area strongly suggests that the two gauges in question were not reporting incorrect  
1488 values. Typically, gauges are biased toward under reporting rainfall during the landfall of  
1489 tropical systems. The chance of four rainfall gauges operated by different entities all failing in  
1490 the same atypical direction is considered remote. Questions still remain, however, including  
1491 reasons why no major flooding was reported during and after these extreme rainfall amounts  
1492 were observed. To further corroborate data summarized in this section, pumping records from  
1493 the Sewerage and Water Board of New Orleans (SWBNO) should be compared to rainfall  
1494 estimates.

1495



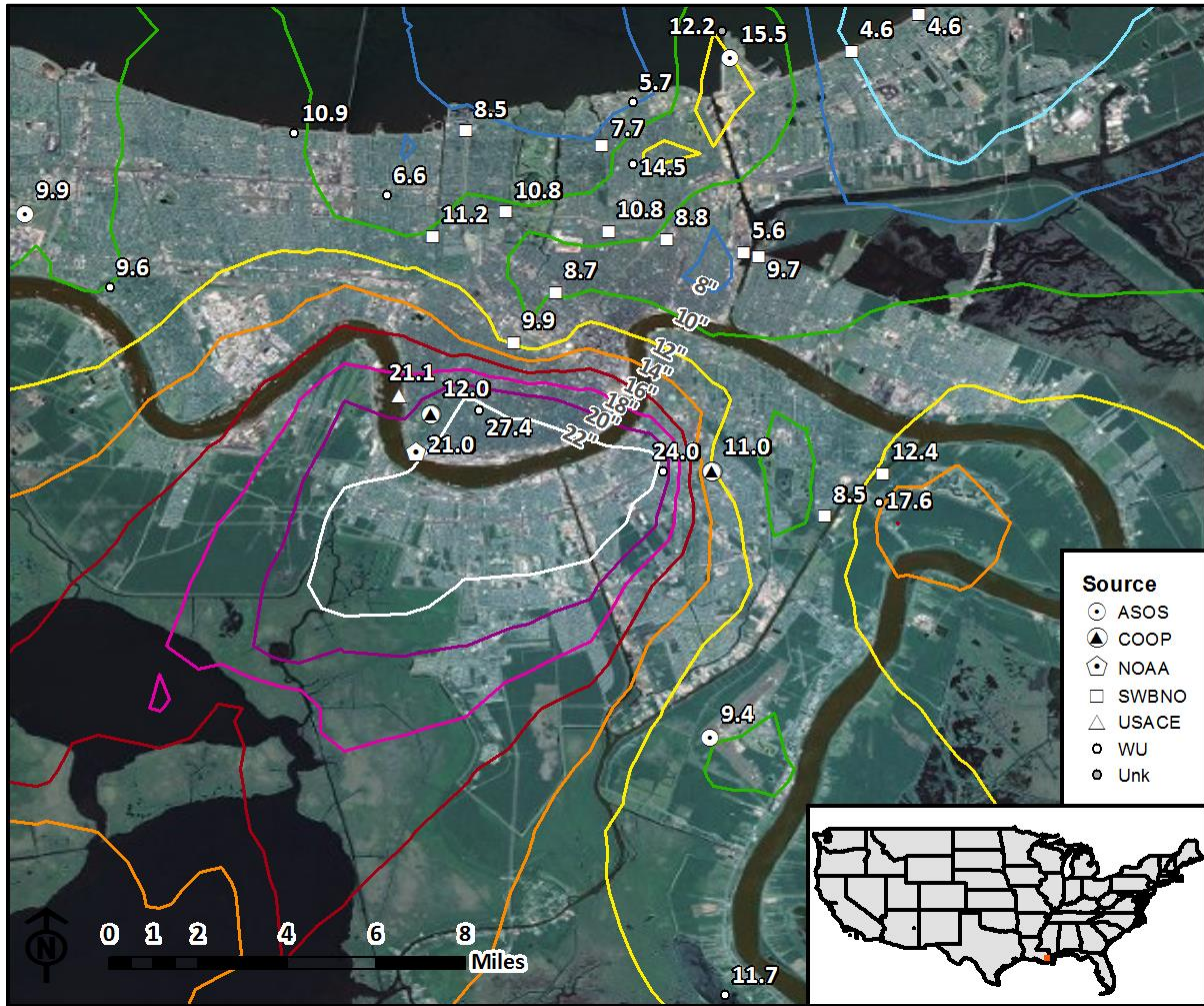
1496

1497 Figure 31. Cumulative rainfall for several official and private gauging sites near Audubon Park  
 1498 in New Orleans. Note the large hourly jump by AUD#2; this hourly value was originally  
 1499 discounted, but in the context of running accumulation seems to have been related to a gauge  
 1500 clog. Also note the substantially lower rainfall rates reported by KLANEWOR15, located 3  
 1501 blocks from AUD – this rain gauge was likely impacted significantly by nearby structures and  
 1502 trees, based upon information from the owner and a site visit by NWS staff.  
 1503



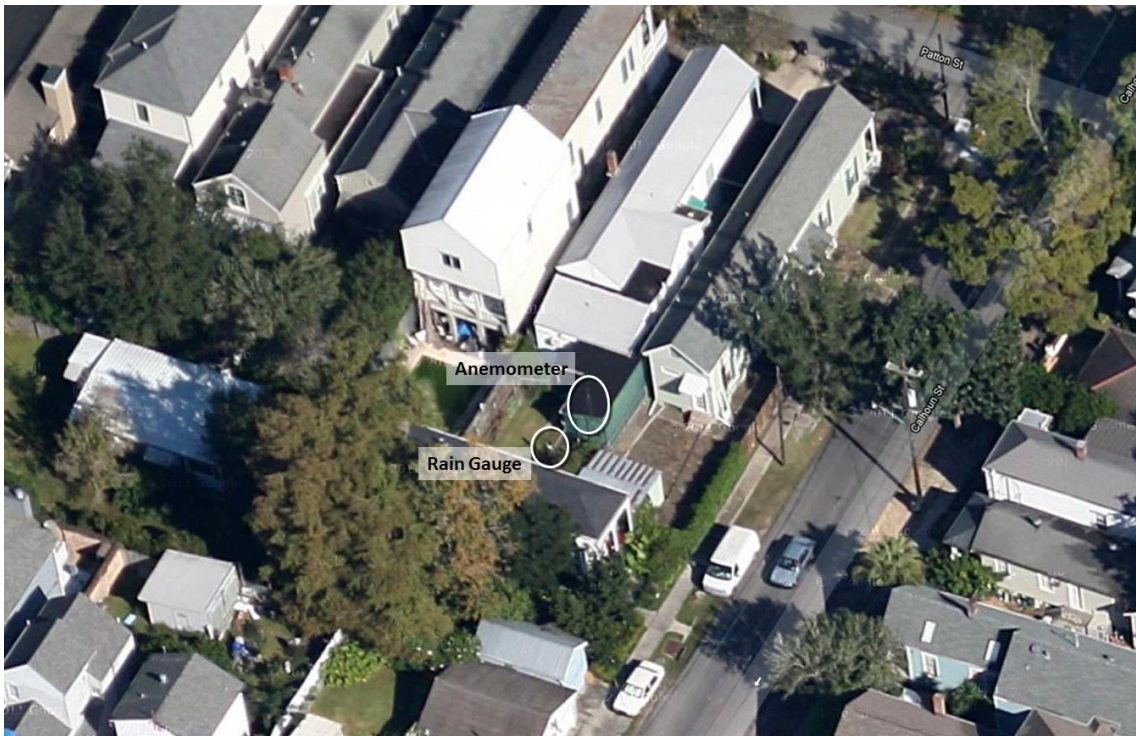
1504  
 1505 Figure 32. Hourly rainfall rates for several official and private gauging sites near Audubon Park  
 1506 in New Orleans. Note the large hourly jump by AUD#2; this hourly value was originally  
 1507 discounted, but in the context of running accumulation seems to have been related to a gauge  
 1508 clog. Also note the substantially lower rainfall rates reported by KLANEWOR15, located 3  
 1509 blocks from AUD – this rain gauge was likely impacted significantly by nearby structures and  
 1510 trees, based upon information from the owner and a site visit by NWS staff.  
 1511

1512



1513

1514 Figure 33. Storm total rainfall reported from all official and private gauges in the New Orleans  
1515 area during Hurricane Isaac. Contours were produced from a Kriging interpolation of all official  
1516 and private gauges. Note the particularly high values evident along the Mississippi River from  
1517 roughly Gretna to Audubon Park.  
1518



1519



1520

1521 Figure 34. Aerial imagery showing location of Weather Underground PWS site KLANEWOR15  
 1522 in relation to nearby trees and buildings. The predominant wind direction during the heaviest  
 1523 period of rainfall, roughly 3 AM-2PM on August 29<sup>th</sup>, 2012, was from the east, which likely  
 1524 caused an under-estimate.  
 1525



1526

1527 Figure 35. NWS personnel W. Scott Lincoln (pictured, middle), Tim Erickson (pictured, right)  
1528 and Suzanne Van Cooten visited Weather Underground PWS site KLANEWOR33 owned by  
1529 Andy Brott (pictured, left) in January, 2013. The station is located on top of Brott's residence in  
1530 the Uptown Neighborhood of New Orleans. Rain gauge is the box located halfway up the pole  
1531 with the anemometer on top. The station is high above almost all trees and structures in the area.  
1532 Photo credit: Uptown Messenger.

1533 **Appendix D: Data mining of the Weather Underground Raingauge Network**  
1534

1535 As discussed in Appendix C, private weather station data can be very valuable in  
1536 responding to and analyzing extreme events such as Hurricane Isaac. However, the collection of  
1537 the data can be very manpower intensive and time consuming even though it is readily available  
1538 via the internet.

1539 In the summer of 2013, the process of collecting rain gauge data one station at a time  
1540 was automated using a Python scripting language routine. The method is described below.  
1541 Thanks are due to Weather Underground for providing access to their internal data listing the  
1542 location of each PWS in their network.

- 1543 - Via the Weather Underground website, collect the names/identifiers of each PWS on a  
1544 “state-scale” basis.
- 1545 - Using the accessibility to the internal data, collect the latitude and longitude  
1546 coordinates for each station. This enables the data to be georeferenced using  
1547 Geographic Information System (GIS) software.
- 1548 - Define the area of interest (AOI) for the given storm event and, using the GIS  
1549 functionality, collect the names of the PWSs within that area.
- 1550 - Using the list of PWSs in the AOI, collect the corresponding daily rainfall amount from  
1551 the internet for the time-frame of interest (the script must be re-run for each day).

1552 The “day” is defined as 12Z to 12Z; if data is missing an error code is generated.  
1553 This script can save significant amounts time in the data collection process. As a test of the  
1554 script, data was collected for all 30,000+ stations across the continental United States -- the  
1555 process took over 15 hours. While this seems like a significant amount of time, the labor  
1556 involved in doing the data collection by hand would take many, many, many times as long. In  
1557 general, an AOI for a given event will probably involve a County Warning Area, or at most a

1558 River Forecast Office area of responsibility. For the 160 stations referenced in Appendix C, the  
1559 data collection process takes a matter of minutes. Additionally, the data is recorded  
1560 electronically and can be readily merged back into the GIS processing framework.