HURRICANE
ISAAC
IN LOUISIANA

1 Introduction

On October 8, 2012, the Department of Homeland Security's Federal Emergency Management Agency (FEMA) Region VI Joint Field Office (JFO), in conjunction with the Mitigation Division of FEMA, deployed a Mitigation Assessment Team (MAT) to Louisiana to assess damage caused by Hurricane Isaac and document the successes of Post-Katrina reconstruction. This report presents the MAT's observations, conclusions, and recommendations as a result of those field investigations.

This chapter includes an introduction, a discussion of the event, historical information, and a description of the MAT process. Chapter 2 discusses the floodplain management regulations and the building codes and standards that affect construction in Louisiana. Chapter 3 contains a basic assessment and characterization of the observed flood and wind effects on residential construction. Chapter 4 details the performance of nonresidential structures and infrastructure. Chapter 5 presents an evaluation of elevation projects the MAT assessed. Chapter 6 presents the conclusions and recommendations, which are intended to help guide the reconstruction of hurricane-resistant

communities in Louisiana and other hurricane-prone regions affected by future hurricanes. In addition, the following appendices are presented herein:

Appendix A: Acknowledgements
Appendix B: References
Appendix C: Acronyms and Glossary of Terms
Appendix D: FEMA Recovery Advisories for Hurricane Isaac
Appendix E: High Water Marks

1.1 Hurricane Isaac – The Event

Hurricane Isaac made landfall twice along the Louisiana coast as a Category 1 hurricane. The storm's first landfall was at the mouth of the Mississippi River in the southeastern portion of the State on August 28, 2012, at which point it moved west, making its second landfall near Port Fourchon, LA, the following day. The track of the storm in southeastern Louisiana is shown in Figure 1-1.

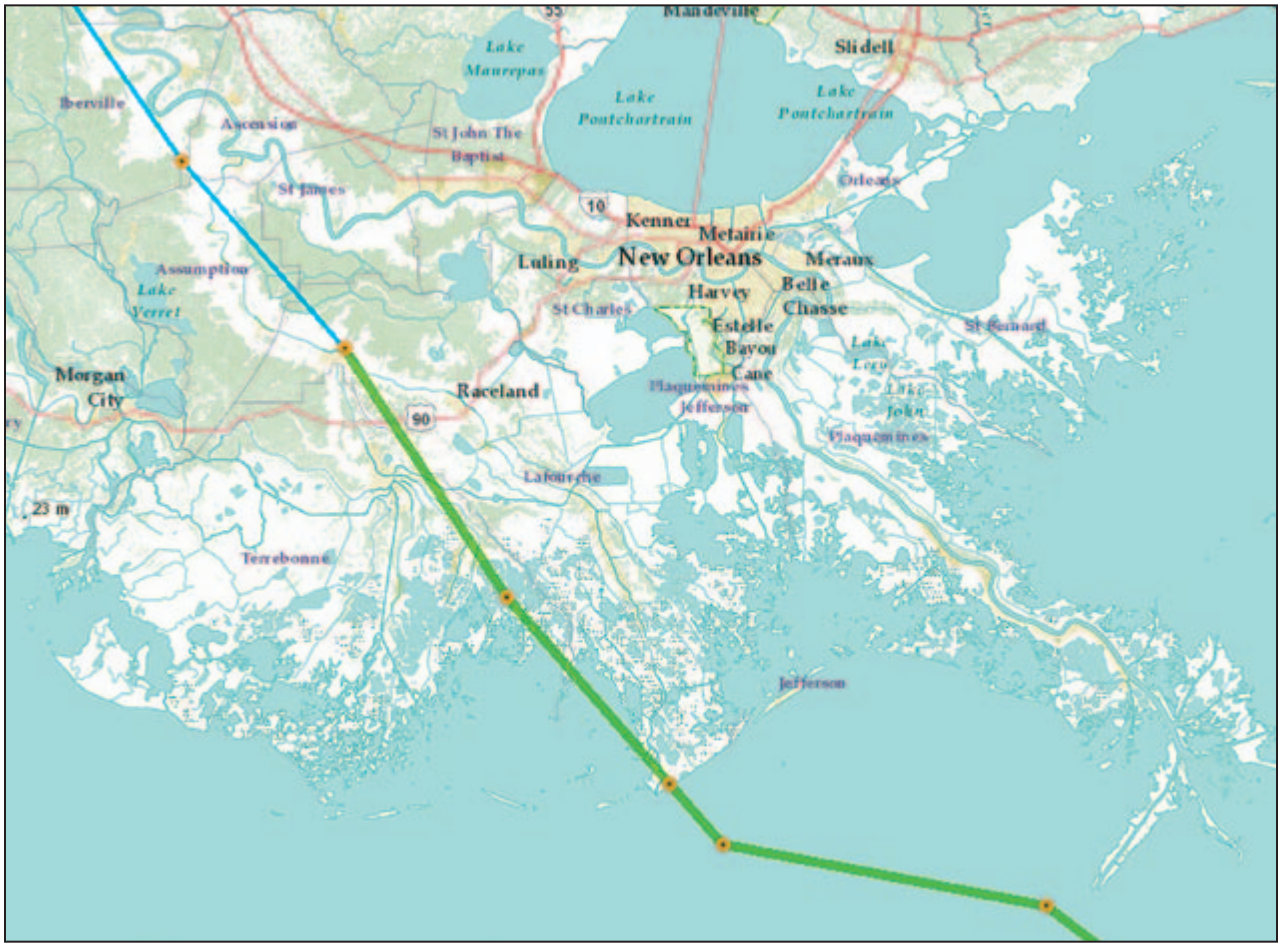

Figure 1-1: Hurricane Isaac's path through southeastern Louisiana

SOURCE: USGS ISAAC STORM TIDE MAPPER HTTP://WIM.USGS.GOV/ISAACSTORMTIDEMAPPER/STORMTIDEMAPPER.HTML

Hurricane Isaac was the ninth named storm during the 2012 hurricane season and the third to make landfall on the continental United States. It was significant not only for its impact on the Louisiana coast but also because it made landfall almost exactly 7 years after Hurricane Katrina and affected many of the same locations. This provided the MAT with a unique opportunity to evaluate post-Katrina mitigation measures in the New Orleans area for their performance in this storm.

1.1.1 Timeline

According to the National Hurricane Center, Hurricane Isaac originated as Tropical Depression 9, east of the Lesser Antilles on August 21, 2012, and was upgraded to Tropical Storm Isaac later that day. On August 28, the storm was upgraded to a Category 1 hurricane before making its first landfall over the Mississippi River Delta in extreme southeast Louisiana at 6 p.m. (Central Daylight Saving Time) (NOAA 2012b). Wind speeds at this time were 80 miles per hour (mph), and the wind field was broad, 200 miles at times. This breadth is significant because a broad wind field may produce higher levels of surge than a higher category storm with a smaller wind field. After the initial landfall in Louisiana, the eye of the hurricane moved west along the coast, making a second landfall on August 29 at 1:15 a.m. west of Port Fourchon, LA. The storm then turned to the north and weakened, though still producing large amounts of rain throughout the region. Hurricane Isaac was downgraded to a tropical storm by 1 p.m. on August 29 and then further downgraded to a tropical depression on August 30 at 3 p.m. Despite weakening upon landfall, Isaac's slow movement resulted in prolonged exposure to storm conditions for affected areas. Isaac produced more than 19 inches of rain in New Orleans and more than 12 inches in areas around the Gulf Coast. The peak storm surge was estimated at 12 to 14 feet in the Braithwaite, LA, area (USACE 2012). After its initial landfall and movement north, the storm traveled slowly north-northwest through Louisiana and then over Arkansas and southern Missouri.

Once Isaac made landfall, many areas that had ordered mandatory evacuations, as well as some that had not, experienced extreme flooding as a result of Isaac's storm surge and large volume of rain. In particular, the East Bank of the Mississippi River in Plaquemines Parish experienced high flood levels, and those who had ignored the mandatory evacuation orders had to be rescued from attics and rooftops.

1.1.2 Damage and Economic Loss

The damage from Hurricane Isaac primarily resulted from flooding. The levees constructed in the greater New Orleans area after Hurricane Katrina, the 2012 greater New Orleans area 100-year Hurricane and Storm Damage Risk Reduction System (HSDRRS), succeeded in holding back Isaac's floodwaters. However, flooding did occur in areas not protected by the Federal levee system. The storm surge pushed floodwaters over a non-Federal levee in Plaquemines Parish, flooding a large area on the East Bank of the Mississippi River from Braithwaite south, including White Ditch. This flooding forced many citizens in Plaquemines Parish to evacuate. To alleviate some of this flooding, a section of levee was removed in a low-lying area near the Braithwaite Park neighborhood.

In addition to Plaquemines Parish, other communities in the greater New Orleans area sustained damage, including Slidell, Mandeville, Madisonville, LaPlace, and Lafitte, among others. Based on FEMA damage assessments conducted after the storm, Hurricane Isaac damaged nearly 59,000 homes in southeast Louisiana (Associated Press 2012). This estimate includes nearly 47,000

owner-occupied houses and just over 12,000 rental units. Hurricane Isaac caused damage across 21 parishes, with Jefferson, Orleans, and St. John the Baptist Parishes having the highest numbers of damaged properties. Table 1-1 summarizes the number of owner-occupied housing and rental units damaged by Hurricane Isaac in Louisiana.

In addition to housing damage, power loss contributed to the widespread impact of the storm. At least 903,000 residences lost power, mainly in the New Orleans metropolitan area. This represents nearly 43 percent of the State's energy users (Louisiana Public Service Commission, media update August 31, 2012).

Total economic losses from Hurricane Isaac, as of September 4, 2012, are estimated by claims forecasting company EQECAT to be in excess of $2 billion, with insured losses on land estimated at between $500 million and $1.5 billion (Sanburn 2012, Vanacore 2012). This includes residential and commercial property, onshore energy production, and business interruption. Losses of offshore assets are estimated at over $1 billion.

Table 1-1: Housing Damage in Louisiana

Parish	Housing Damage (number of homes)
Ascension	1,112
Assumption	562
East Baton Rouge	1,114
East Feliciana	165
Iberville	515
Jefferson	12,912
Lafourche	2,103
Livingston	2,453
Orleans	9,777
Plaquemines	2,983
St. Bernard	2,257
St. Charles	1,368
St. Helena	482
St. James	953
St. John the Baptist	6,871
St. Mary	1,127
St. Tammany	4,572
Tangipahoa	4,584
Terrebonne	1,695
Washington	1,293
West Feliciana	54
TOTAL	58,952

1.2 Historic Hurricanes

The Louisiana coastline has experienced 59 hurricane strikes since 1851 (including Isaac), with Hurricane Katrina the most notable. Hurricane Katrina, which struck the U.S. coast on August 25, 2005, ranks as one of the most destructive hurricanes in U.S. history in terms of cost (No. 1), deaths (No. 3), and intensity (No. 3). Hurricane Isaac affected many of the same areas as Katrina (Figure 1-2), which provided an opportunity to study the performance of structures that were elevated after Hurricane Katrina.

Table 1-2 shows a comparison of Hurricanes Katrina and Isaac. All 55 of the parishes included in Isaac's Federal disaster declaration (and therefore eligible for either Individual or Public Assistance) were also included in Katrina's Federal disaster declaration (Table 1-2). Hurricane Isaac was a weaker wind event than Hurricane Katrina, with a maximum sustained wind speed of 65 mph, compared to Katrina's 127 mph maximum wind speed. Isaac's wind speeds did not equal or exceed the design level wind speeds for the affected areas. However, because Isaac was a slower moving storm and took a different path through Louisiana than Katrina, it produced higher and longer lasting storm surge conditions in areas not affected as severely by Katrina. Isaac's longer duration storm surge pushed more water into Lake Pontchartrain and Lake Maurepas (USACE 2012). In addition, some areas, including Braithwaite, LaPlace, and Lafitte, experienced higher storm surges during Isaac than during Katrina because of the slow movement and direction of the storm (USACE 2012).

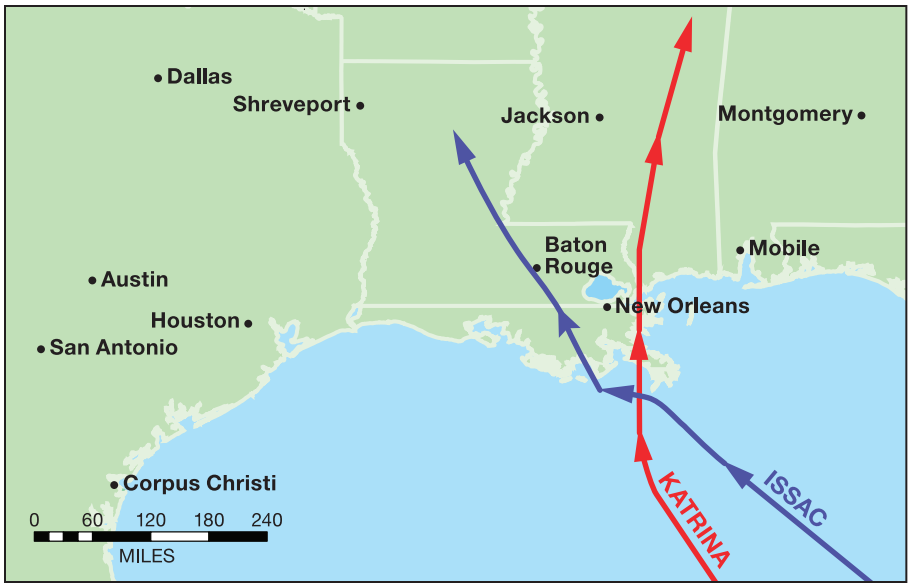

Figure 1-2: Storm tracks of Hurricanes Isaac and Katrina

Table 1-2: Comparison of Hurricanes Katrina and Isaac in Louisiana

Storm Feature	Katrina[1]	Isaac
Category at Landfall	3	1
Minimum Pressure at Landfall (millibars)	920	925
Maximum Sustained Wind Speed (mph)	127	65
Peak Storm Surge	10 to 20 feet above normal tide levels	10 to 15 feet above normal tide levels
Affected Parishes[2]	64	55
Number of Residential Buildings Damaged	283,838	59,000 (estimated)
Cost	$108 billion	$2 billion

mph = miles per hour

1 Source: FEMA 549, Hurricane Katrina in the Gulf Coast Mitigation Assessment Team Report, July 2006 (FEMA 2006a)

2 Includes parishes receiving Individual Assistance and/or Public Assistance (source: Katrina, http://www.fema.gov/disaster/1603/designated-areas; Isaac, http://www.fema.gov/disaster/4080/designated-areas)

1.3 Riverine and Coastal Flooding

The areas affected by Hurricane Isaac were primarily low-lying regions that are susceptible to flooding. Although the storm was only rated a Category 1 on the Saffir-Simpson scale, far lower than Hurricane Katrina, some areas still experienced significant flooding. Storm surge was exacerbated by intense and prolonged rainfall, affecting the coastline and traveling up the Mississippi River. These factors combined to produce higher flooding than Hurricane Katrina in some areas.

1.3.1 Storm Surge

The implementation of the HSDRRS system after Hurricane Katrina played a key role in protecting low-lying areas from storm surge in Hurricane Isaac. However, some areas experienced flood levels

greater than those experienced during Hurricane Katrina. According to the U.S. Army Corps of Engineers (USACE), surge elevations generally ranged from 5 to 7 feet on the West Bank of the Mississippi River near Ama, LA, and from 12 to 14 feet on the East Bank of the Mississippi River near Braithwaite, LA. During Hurricane Isaac, southeastern Louisiana experienced sustained tropical-storm-force winds for as long as 45 hours from August 28 through August 30. These strong winds generated offshore waves of 5 to 15 feet. This storm surge, combined with the heavy rainfall, produced high water marks (HWMs) that, in some locations, exceeded levels for Hurricane Katrina.

1.3.2 High Water Marks

HWM data for Hurricane Isaac was provided to the MAT by the U.S. Geological Survey (USGS). Appendix E provides more detail of HWM data compared to the effective base flood elevation (BFE), the post-Katrina Advisory Base Flood Elevation (ABFE), and the preliminary BFE (as applicable) in the areas affected by Hurricane Isaac.

1.4 FEMA Mitigation Assessment Team

In response to a request for technical support from the FEMA JFO in Baton Rouge, LA, FEMA's Mitigation Division deployed a MAT composed of national and regional experts to affected areas in Louisiana on October 8, 2012. The MAT was charged with evaluating damage from Hurricane Isaac as well as post-Hurricane Katrina construction and reconstruction efforts, assessing the performance of critical facilities affected by the storm, evaluating the performance of electrical distribution and communication facilities, and investigating claims of wind damage in newer buildings.

Hurricane Isaac was below a design level wind event, which enabled the team to examine building elements that failed when they would not have been expected to fail. In addition, the MAT deployment provided a unique opportunity to visit a location that was previously studied by a MAT (Hurricane Katrina MAT) and to evaluate building performance of structures built since Hurricane Katrina.

Preliminary field investigations to assess damage in New Orleans and the surrounding areas were conducted between October 1 and October 4, 2012. These investigations involved identifying damaged areas for further observation. The data collected in the preliminary field investigations determined the area of focus for the full MAT. The full complement of MAT experts was deployed from October 8 through October 12 and conducted ground observations in Jefferson Parish, Orleans Parish, Plaquemines Parish, and St. Tammany Parish, observing sites in the City of New Orleans, as well as in the nearby communities of LaPlace, Port Sulphur, Mandeville, and Slidell. The team also visited affected rural areas in Plaquemines Parish.

Damage was observed to single- and multi-family buildings, manufactured housing, commercial properties, communications towers, and electrical substations. In addition, critical and essential facilities, such as fire stations, were evaluated to document building performance as well as loss of function from Hurricane Isaac. The MAT's observations are presented in this report. Photographs and figures are included to illustrate building performance in the wind field and surge areas produced by Hurricane Isaac. The conclusions and recommendations of the MAT as presented in this report are intended to assist in minimizing damage from future hurricanes.