Loss Avoidance Study

St. Tammany Parish, Louisiana

Hurricane Isaac, 2012

DR-4080-LA

Joint Field Office, Hazard Mitigation Branch, Baton Rouge, LA

January 2013

FEMA

Hurricane Isaac, August 2012

Losses Avoided Through Hazard Mitigation

St. Tammany Parish, Louisiana

January 2013

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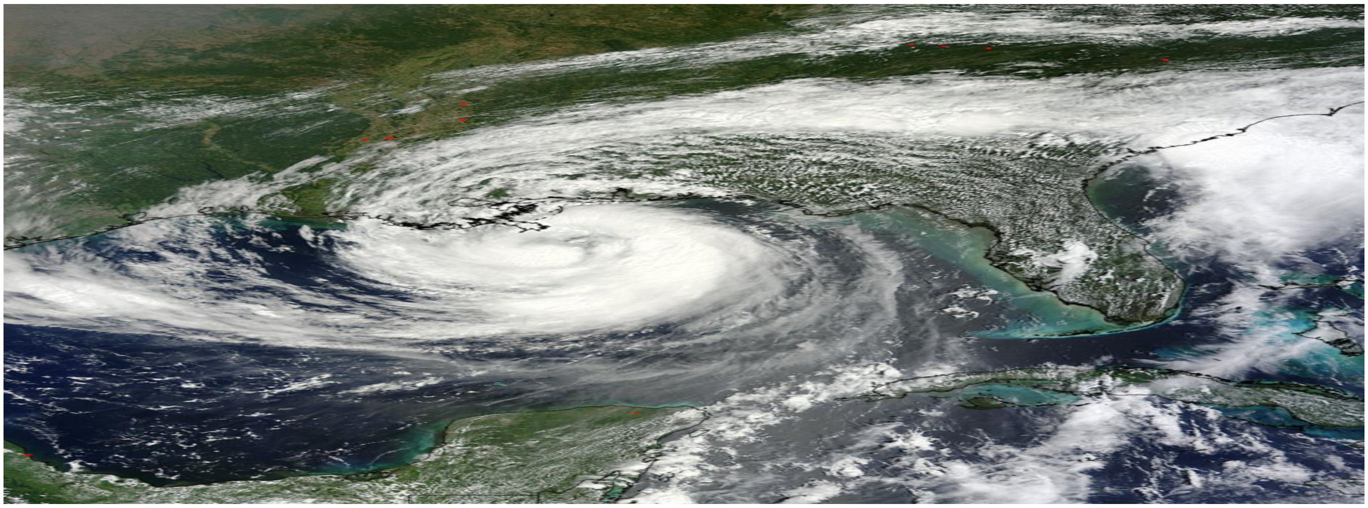
This study was completed entirely by Hazard Mitigation Region 6 staff and reservists deployed to the Joint Field Office in Baton Rouge, LA during the response and recovery from Hurricane Isaac.

(DR-4080-LA)



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Executive Summary

In the early hours of August 29, 2012, southeast Louisiana was bracing for Hurricane Isaac. As the storm moved through southeast Louisiana, flood levels and storm surge from Isaac were exceptionally high for a Category 1 storm. The persistent storm-force winds, very slow forward motion and the broadness of the wind field were the main contributing factors producing much higher than normal storm surge values for a typical Category 1 hurricane.

The north shore of Lake Pontchartrain was inundated by both storm surge and prolonged precipitation. The flood damage to this area was severe, with flooding four feet or higher above the ground elevation and causing millions in damages. Many were displaced as their homes became inhabitable.

The regional landscape responds in a very complex way to an approaching hurricane. The shallow off-shore depths and the mouth-like shape of the shoreline contribute to the buildup of storm surge levels. Along the shores of Lake Pontchartrain, it is difficult to predict the effects of the shallow, open water of the lake and large expansive wetlands. These varying complex factors bring concern that any approaching storm system should be considered both deadly and dangerous to life and property. Hurricane Isaac created flood hazards very similar to Hurricane Katrina, though it was rated significantly lower on the Saffir-Simpson Hurricane Wind Scale.

Over the past seven (7) years following the extensive damage and loss of life from Hurricane Katrina, the Federal Emergency Management Agency (FEMA), other Federal agencies, the State of Louisiana and its citizens, have invested millions of dollars in Hazard Mitigation measures to protect individuals and property from the effects of future hazards and disasters. This Loss Avoidance Study (LAS) provides hard data validating the effectiveness of elevating a structure above the base flood elevation (BFE) or otherwise known as the one-percent annual chance flood.

Along the north shore of Lake Pontchartrain, in St. Tammany Parish, 62 elevated properties were examined and none of them sustained flood damage above the finish floor elevation. All had been flooded severely during Hurricane Katrina. These 62 homes, located in the communities of Mandeville, Lacombe and Slidell, were selected for extensive analysis of actual losses avoided.

Approximately 7.2 million dollars were spent to elevate these 62 homes, most of the cost being funded by FEMA's Hazard Mitigation Grant Program (HMGP). In contrast, had the homes *not been elevated* during Hurricane Isaac, nearly all of the homes would have been flooded above the finish floor (main floor level); many a foot or higher with an average flood depth of 1.58 feet. Had these damages actually occurred, it would have cost approximately 4.9 million dollars in repairs. These are the ***losses avoided*** and represent 68 percent of the total cost to elevate these homes.

A Losses Avoided Ratio with any number *greater-than-one* indicates that the project benefits have exceeded project costs and the mitigation activity is determined to be cost effective and performing successfully. The Losses Avoided Ratio for this study, including all 62 properties, was determined to be 0.68.

This ratio, being *less-than-one*, indicates that the mitigation benefits have not *yet* exceeded project costs. However, this study represents only one flood event over a 7 year period, and this value is expected to increase as storms continue to test the projects' effectiveness over their life-cycle. An elevation project has an expected useful life of 30 years or more, and given the storm history of southeast Louisiana (see Figure ES.1), the cost of mitigation should pay for itself many times over.

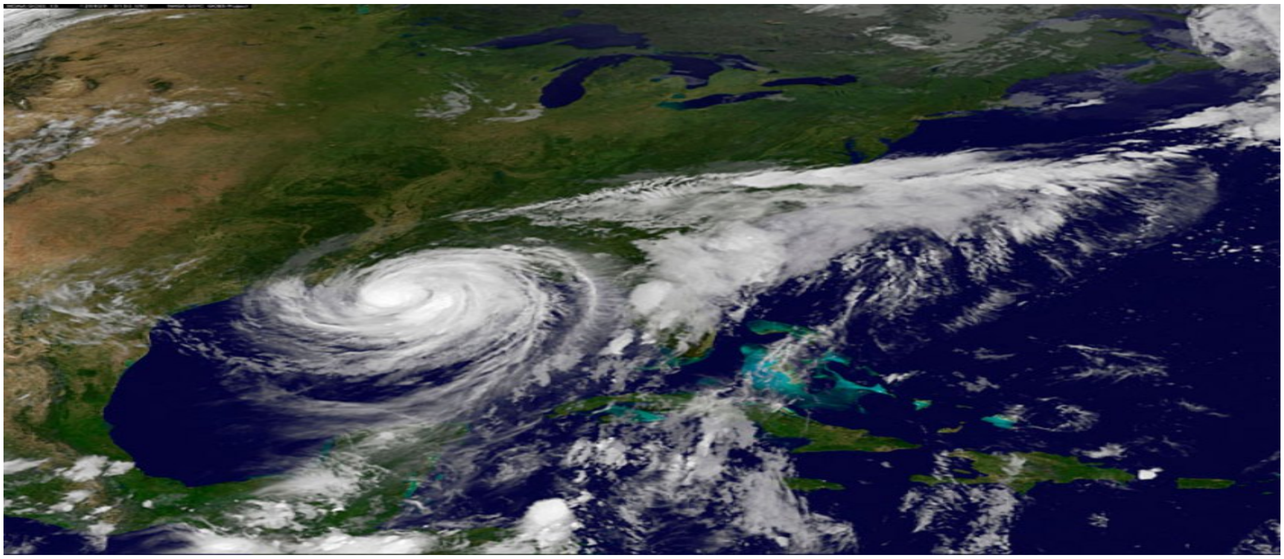
In addition to the protection of life and property provided by an elevated home, the home also adds value to the community. The property itself will increase in value as a result of being elevated. Many of the homes in our study were elevated high enough to provide parking, storage and access below. Neighborhood values increase and economic stability is maintained when homes are not damaged or abandoned from flood events. For the community, this means a stronger tax base and a more resilient, sustainable environment for its residents.

Louisiana Hurricane History

Figure ES.1 **Past 30 years (1982-2012)**

#	Year	Month	Name	Category	Max Wind
1	1985	August	Danny	1	90
2	1985	September	Elena	3	115
3	1985	October	Juan	1	85
4	1986	June	Bonnie	1	85
5	1988	September	Florence	1	75
6	1992	August	Andrew	3	115
7	1995	October	Opal	3	115
8	1997	July	Danny	1	85
9	1998	September	Georges	2	110
10	2002	October	Lili	1	75
11	2005	August	Katrina	3	125
12	2005	September	Rita	3	115
13	2008	August	Gustav	2	100
14	2012	August	Isaac	1	85

***Data from *Louisiana Hurricane History*, David Roth, National Weather Service, Camp Springs, MD**



1. Introduction

On September 3, 2012, the Region 6 Mitigation Division of the Federal Emergency Management Agency (FEMA) deployed a Hazard and Performance Analysis (HPA) Team to the State of Louisiana to assess damage caused by Hurricane Isaac (2012). This study presents evidence that mitigation measures made following Hurricane Katrina in 2005 are cost effective investments in protecting lives and property. Hurricane Isaac put many of these post-Katrina mitigated properties to the test as storm surge flooded many areas of southeastern Louisiana.

1.1 Storm History of Southeast Louisiana

Southeast Louisiana, no stranger to destructive hurricanes, has been hammered repeatedly over the years. In 1969 Hurricane Camille pounded the southern coast as a Category 5, Katrina (Category 3) in August 2005, then Rita (Category 3) the next month in September 2005, Gustav (Category 2) in August 2008, and finally, Isaac in August 2012 (see Figure 1.1).

The people of southeast Louisiana along the north shore of Lake Pontchartrain, have shown to be resilient, however, many seem to agree that the severity and frequency of hurricanes, storm surge and resultant damage, is increasing. Various factors may account for this including climate change, rising sea levels, subsidence (ground levels sinking) due to underground collapse or compaction, coastal erosion, increased development and changes in land use.

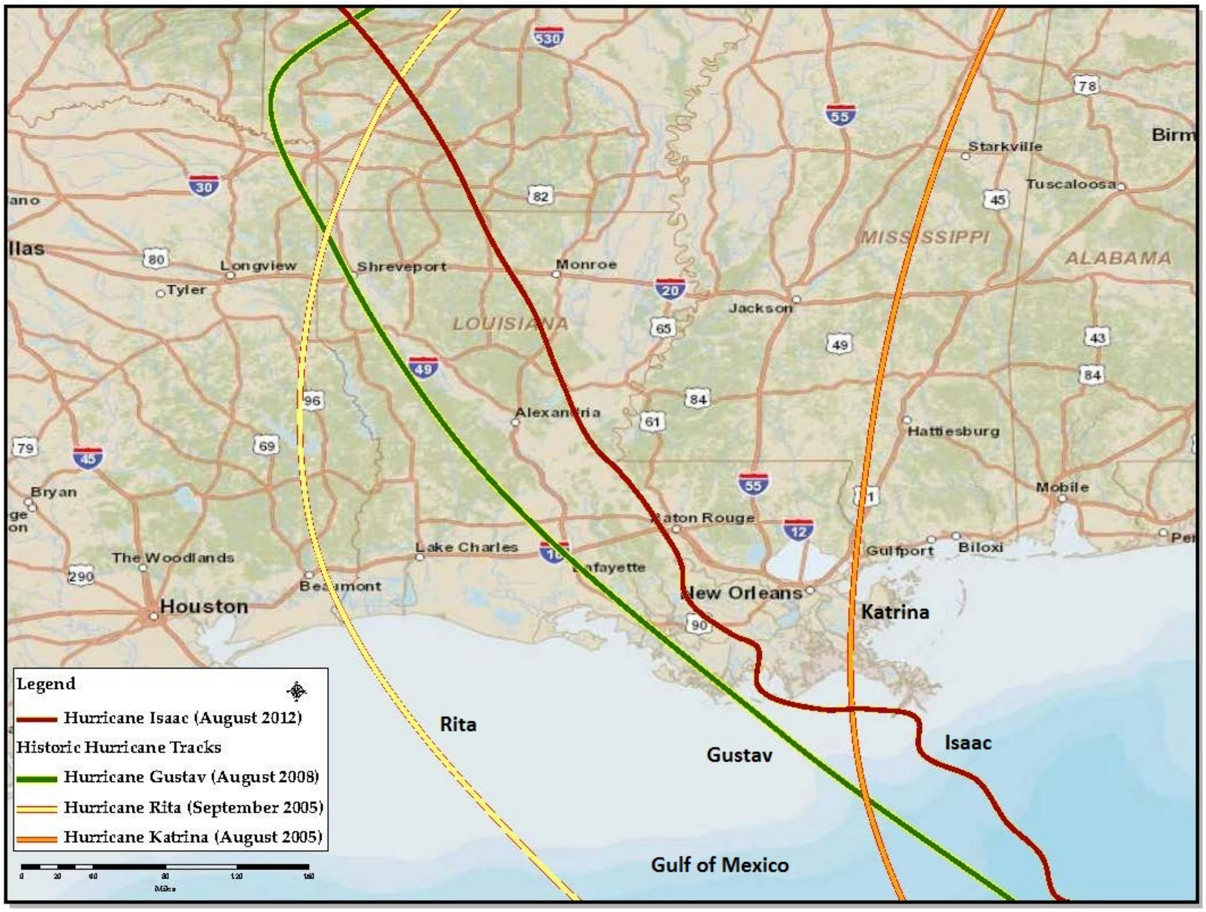


Figure 1.1 Historic Hurricane Storm Tracks

1.2 Hurricane Isaac- The Event

In the early hours of August 29, 2012, southeast Louisiana and the Greater New Orleans area were bracing for Hurricane Isaac- exactly seven years after Hurricane Katrina (2005) brought death and devastation to this area. Isaac had attained Category 1 hurricane status the previous day as it made landfall near Grand Isle, Louisiana, southwest of the mouth of the Mississippi River. The large storm brought high winds across southeast Louisiana, with sustained winds of 67 mph and gusts to 85 mph on Grand Isle, according to the National Hurricane Center. The powerful winds caused downed trees and power lines, roof damage, and a brutal assortment of wreckage in its trail. However, the deadliest weapon in Isaac's arsenal was its storm surge – the wall of water that the storm's very low air pressure and high winds pushed ashore.

Despite being a Category 1 storm, Isaac was an unusually broad storm, had low central pressure, and moved ashore at a snail's pace; ensuring that flooding would occur during multiple high tides and producing long duration rainfall events (see Figure 1.2).

1.3 Hurricane Katrina and Isaac Compared

The most devastating hurricane in recent years was Hurricane Katrina, the third strongest hurricane to make landfall in the history of the United States. Though crossing Florida as only a moderate Category 1 hurricane, it moved into the Gulf of Mexico where it rapidly increased to a Category 5 hurricane. After weakening just 24 hours prior to landfall, Katrina came ashore as a Category 3 storm in Louisiana and Mississippi. Hurricane Katrina went on to cause over 1,800 deaths and $81.2 billion in insured losses, making it one of the largest natural disasters in U.S. history.

Hurricane Katrina provided Emergency Managers, Community Officials, First Responders, Flood Plain Managers and Levee Design Engineers many "*lessons learned*" in the hazards of a major hurricane in southeastern Louisiana. The storm surge was enormous and the levees were overwhelmed, flooding most of the city of New Orleans, taking lives and homes in its wake.

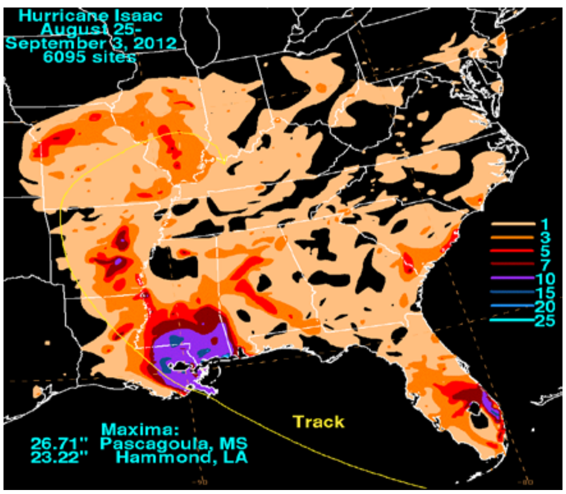


Figure 1.2 Average Rainfall 10"-15" in SE Louisiana from August 25- September 3, 2012 (NWS)

Katrina had major coastal flooding and inland flooding exceeding effective Base Flood Elevations (BFE's) by as much as 15 feet along the coast and at least half that inland. During Katrina, critical and essential facilities including fire departments, Emergency Operations Centers (EOCs), hospitals, police departments, and other critical structures failed due to flooding, high winds, or both. Katrina exposed the weaknesses of the emergency preparedness systems at the Federal, State and local levels. Following Katrina, mitigation actions were taken to protect lives and property from future hazards.

1.3.1 Storm Path Compared

The storm path also has a significant effect on the location and severity of storm surge. Hurricane Isaac's path went west of Jefferson Parish and Lake Pontchartrain which resulted in the highest storm surge being in the areas east of the storm track (see Figure 1.1 and 1.3). This is the result of the counter-clockwise rotation of hurricanes in the northern hemisphere where the upper right quadrant of the circulation produces the highest winds. During Isaac, these high winds were blowing off the Gulf of Mexico in a northerly direction and pushing the water toward land until the topography of the land began to restrict the flow. This created a piling up of water along the north shore of Lake Pontchartrain and along the marshes of southeastern Louisiana – especially in the areas of southern Jefferson Parish and Plaquemines Parish. Hurricane Katrina's path in 2005 was east of Lake Pontchartrain (and New Orleans) resulting in the highest storm surges from Katrina being actually along the Mississippi coast (see Figure 1.3) rather than the Louisiana coast – though they were severe even in Louisiana.

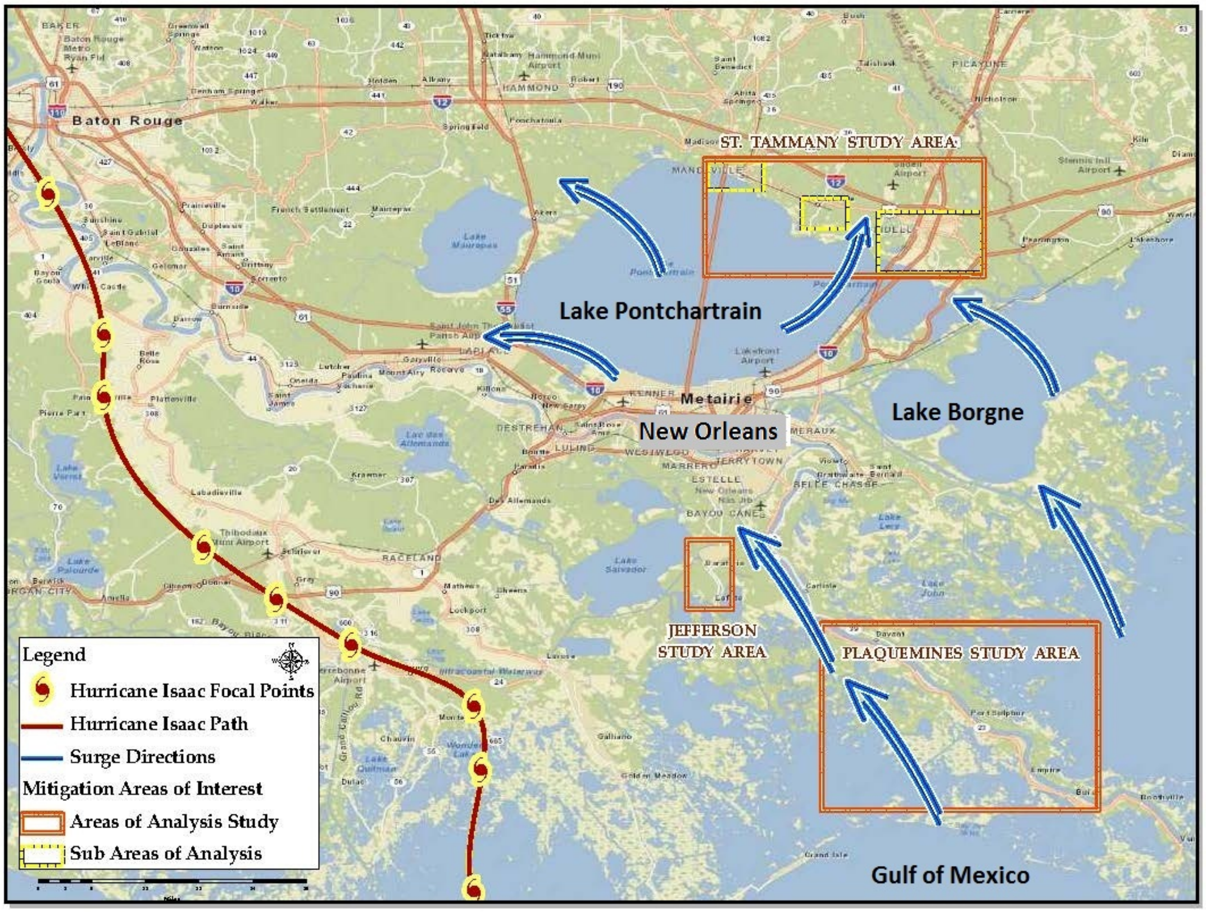


Figure 1.3 Hurricane Isaac Path and Storm Surge- St. Tammany Study Area in Upper Box

The storm path as pictured above should be understood to represent the general path but not the scope of the storm. As a very broad storm, all of the areas around it and especially in the upper right quadrant such as Jefferson Parish, Plaquemines Parish and the north and west shore of Lake Pontchartrain all suffered extreme storm surge (see arrows in Figure 1.3).

One of the great success stories of Hurricane Isaac was how well the Greater New Orleans area weathered the storm surge – especially compared to the extensive flooding experienced during Hurricane Katrina. The recently completed massive Civil Works project, known as the Hurricane and Storm Damage Risk Reduction System (HSDRRS), provided a modified levee and reinforced barrier perimeter defense systems around the city. Constructed by the U.S. Army Corps of Engineers and its contractors, the HSDRRS includes a system of levees, floodgates, canals and pump stations which performed as designed. Isaac's storm surge reached 13.6 feet at the Inner Harbor Navigational Canal Surge Barrier (see Figure 1.4). That was only two feet lower than Katrina's 15.5 feet storm surge, which was a Category 3 storm.

Regardless of the storm category or internal wind speed, each storm has its own unique fingerprint. Based on a complex matrix of factors including speed over water (or ground), storm path, internal pressure, humidity, bathymetry (ocean floor topography), solar and lunar tides, and rain potential – even a Category 1 hurricane can create extreme surge. The United States' Northeast coast recently experienced similar record storm surge and extensive damage from Hurricane Sandy (October, 2012), another Category 1 storm with record breaking low internal pressures.

Figure 1.4 Inner Harbor Surge Barrier Closed During Hurricane Isaac

The initial Hurricane Isaac storm surge that swept across Grand Isle, LA, was a moderate 3 foot plus surge, but as it moved into Lake Pontchartrain and the bayous along the lake's north shore, levels were 7 feet or greater.

The major areas in St. Tammany Parish affected by the high storm surge levels were the towns of Mandeville, Lacombe, and Slidell.

These communities experienced similar flooding during Hurricane Katrina and many property owners decided to elevate their homes post-Katrina. Elevated homes along Lake Pontchartrain's north shore were not flooded during Hurricane Isaac; but most non-elevated homes were inundated and many severely damaged. Most of the homes that had been elevated post-Katrina used funds from FEMA's Hazard Mitigation Grant Program (HMGP). This report will document the performance of these properties during a major storm surge flooding event.

Properties were selected from three communities along the north shore of Lake Pontchartrain. Elevated properties in each community were evaluated for their *performance* during the storm surge flooding that resulted from Hurricane Isaac.

Figure 1.3, shows the St. Tammany study area; the upper left corner of this area shows the location of the community of Mandeville; the center box shows Lacombe, and the lower right box locates the community of Slidell. The LAS team analyzed elevated properties in each of these communities and the results will be further expanded upon in sections 3 and 4.

Note: All elevation references are based on the NAVD88 Datum, a fixed primary tidal bench mark referenced to the International Great Lakes Datum of 1985 mean sea level height.

1.3.2 Storm Surge

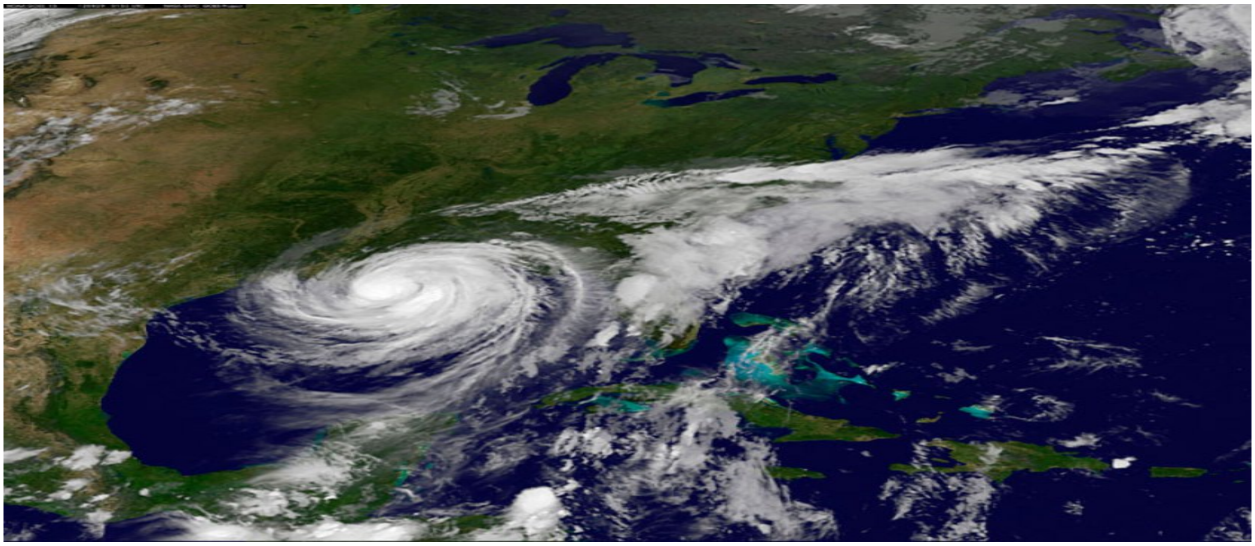
Hurricane storm surge has always been a major factor impacting lives and properties in this area. Two primary factors that amplify Louisiana's storm surge are the shallow offshore depths and the shape of the shoreline. As the storm surge advances toward the shoreline it tries to escape via the return bottom water column. The shallow depths along the Louisiana coastline restrict this return movement and the surge piles up into the marshes and onto the low-lying shorelines. The shape of the shoreline, which is almost like a mouth at the Lake Borgne connection to Lake Pontchartrain, also traps storm surge (see figure 1.3). On a straight shoreline, the surge can partially escape at each end of the shoreline, reducing peak storm surge elevations. The Mississippi River Delta along the Louisiana and Mississippi shoreline forms a mouth-like feature that effectively confines the surge and amplifies the elevation as a hurricane moves ashore. This study provides one of the first analyses of losses avoided due to a storm surge event. Most previous loss avoidance studies were focused upon flooding from a river source (riverine flooding).

Over the past seven years following the extensive damage and loss of life from Hurricane Katrina, the Federal government, State of Louisiana and local communities have invested millions of dollars in Hazard Mitigation measures. The recent high winds and flooding that resulted from Hurricane Isaac provided an opportunity to evaluate and analyze the performance of many of these measures and provide hard data to validate losses avoided.

With the landfall of Hurricane Isaac in late August 2012, many areas along the shores of Lake Pontchartrain were again flooded. These were areas outside the newly completed complex levee system around New Orleans known as the (HSDRRS). The area inside this formidable defense system held its ground and there was only minor flooding – mostly due to heavy rain. This study focused on the areas outside of the HSDRRS. This included many homes and businesses along the shores of Lake Pontchartrain. The storm surge elevations during Isaac were not as high as those of Katrina; however, the inundation period was longer. During Katrina, the water rose and then receded in a 24 hour period. During Isaac, the inundation period was nearly 72 hours and in some areas even longer. A longer inundation period typically causes more damage as building materials become no longer salvageable.

Figure 1.5 Historic Home, Lakeshore Blvd. in Mandeville, LA

This report documents the results of Hazard Performance Analysis (HPA) of properties along the north shore of Lake Pontchartrain in St. Tammany Parish.



2. Hazards and Performance Analysis

Hazards and Performance Analysis (HPA) is a technical group within the FEMA Hazard Mitigation Branch that provides engineering, architectural, economic and scientific assistance to Federal, State and local partners in support of disaster response and recovery.

The HPA group developed a Loss Avoidance Study (LAS) team that was composed of specialists from FEMA Region 6 including Civil Engineers, building construction expert/code specialists, a Geospatial Risk specialist and Hazards and Performance Analysis (HPA) Specialists. The Loss Avoidance Study (LAS) took approximately three months from initiation to completion. This LAS is significant in that the project was completed entirely within the Hurricane Isaac Joint Field Office by FEMA staff without outside support.

2.1 Purpose of a Loss Avoidance Study

A LAS provides the justification for existing and future mitigation projects and measures. The ability to assess the economic performance of mitigation projects over a period of time is important to encourage additional funding and continued support of mitigation activities. A LAS requires the mitigation project be completed prior to the event being analyzed. Losses avoided by the mitigation measure are determined by comparing damage that ***would have been caused*** by the same event, had the project not been in place.

In this study the LAS team examined properties that were elevated and determined the extent of damage the properties would have had, had they not been elevated. The LAS team used a depth damage calculation that determined the dollar value of losses avoided based on depth of inundation in the home had it not been mitigated (elevated). This dollar value will be compared with the actual cost to elevate the home to determine cost-effectiveness of the measure. Technical aspects of this process are explained in the LAS methodology section 2.2 and Appendix B and C.

2.2 LAS Methodology

This study is focused on a series of properties along the north shore of Lake Pontchartrain, all of which were elevated post-Katrina using Federal, State and local funding. These projects were funded under FEMA's *Hazard Mitigation Grant Program* (HMGP) following Hurricane Katrina and Hurricane Rita, both in 2005. The *Hazard Mitigation Grant Program* is a part of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (The Stafford Act) and provides grants for states and communities to implement hazard mitigation measures after Presidentially-declared disasters. Hazard Mitigation is defined as a *sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects.*

FEMA completed nine Loss Avoidance Studies for *riverine* flood hazard from 2001 to 2009. Mitigation projects for river flooding involve acquisition or elevation of flood prone properties. Homes may be purchased and removed from a flood prone area and replaced with buffer areas such as walking trails installed along the rivers' edge. Properties usually are elevated 2 feet to 6 feet or more in order to raise the property above the base flood elevation. In this way, the property will no longer be at risk for future riverine flooding providing a losses avoided situation.

Mitigation efforts for a storm surge event are more problematic as the flood waters may come from a variety of sources (wind, rain, waves, rivers, high tides) and from a variety of directions; whereas a riverine flood is more specifically defined. Determining the extent, frequency and height of storm surge for any given area or event is quite a challenge in itself and beyond the scope of this document.

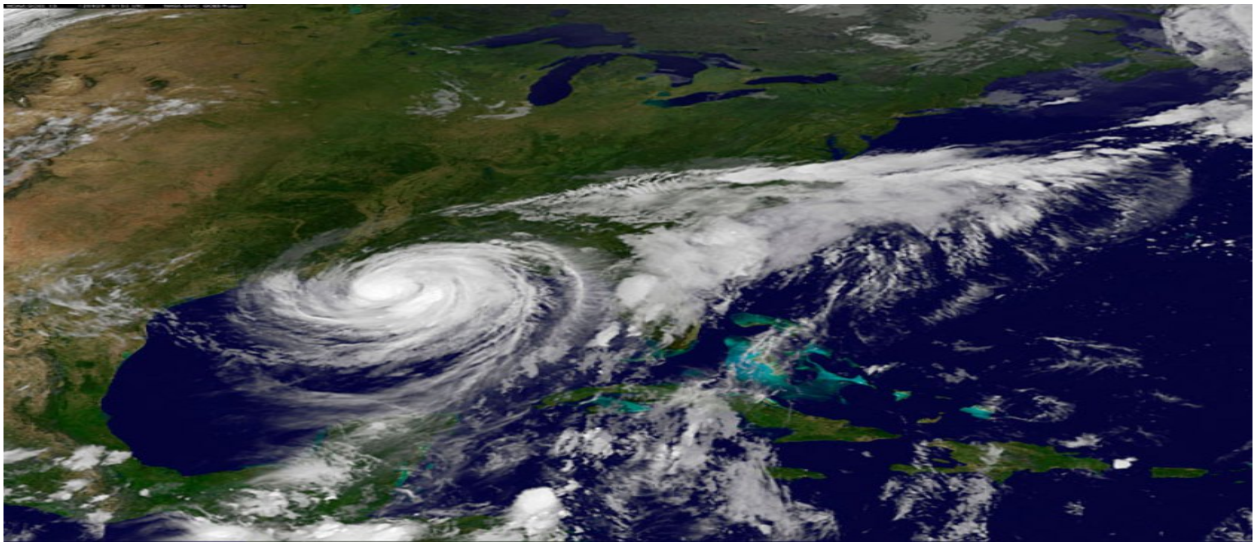
The losses avoided by the elevation of a property (mitigation project) are determined by comparing damage (from inundation) that would likely have been caused by the same event without the project in place (Mitigation Project Absent [MP_A]) with damage that actually occurred with the project in place (Mitigation Project Complete [MPc]). For example:

MP_A= Damages and expenses that would have occurred had the property not been elevated. A dollarized value is placed on this Mitigation Project Absent (MP_A) scenario.

MP_C= Damages (if any) that actually occurred during the event. Was there damage to the property? What was the cost of the elevation project? A dollarized value is then placed on this Mitigation Project Complete (MP_C) scenario.

The difference between the two scenarios is calculated to determine losses avoided in dollars as shown in the following equation:

L(A)= \$ [MP_A] – \$ [MPc] where L(A)= Losses Avoided in Dollars



3. Phase 1: Initial Project Selection

Phase 1 of the LAS methodology requires initial project selection. The LAS Team had to select which properties were to be included in the study. Primarily, properties were selected along the north shore of Lake Pontchartrain where the most significant storm surge occurred. However, a number of properties were selected further inland, that were located near Liberty, Bonfouca, and Lacombe Bayous. Storm surge pushed into these waterways overtopping the banks and flooding hundreds of homes. Several properties were selected in the Slidell area along the West Pearl River which flooded from both storm surge and, several days later, from the extensive precipitation during Hurricane Isaac.

Figure 3.1 High Water Mark (HWM) on Residence in Mandeville, LA

The storm surge swept into Lake Pontchartrain from the connection with Lake Borne to the east, and piled up on the north and west shores creating high surge elevations in the range of 7 feet (NAVD88) or more. In addition to the storm surge, Hurricane Isaac produced rainfall totals between 10 and 15 inches between August 25 and September 3, 2012. As a result of both storm surge and rainfall, significant flooding took place along the bayous and the West Pearl River. In this broad area of inundation we selected 62 properties for extensive LAS analysis.

3.1 Data Requirements for Initial Project Selection

Phase 1 of our LAS required collecting the following data:

- HPA teams were deployed to the affected area within several days following the event.
- Approximately 2,000 properties were located across the region that had been flooded during Katrina and then elevated (mitigated) post-Katrina using Hazard Mitigation Grant Program (HMGP) funding.
- Storm damage reports and assessments from Isaac were analyzed to determine which of these 2000 properties were in areas of repeat flooding from Isaac.
- Two teams of two HPA specialists were established and site visits were conducted.
- HPA teams determined high water marks (HWMs) by observation of local debris lines or by interviewing homeowners or neighbors.
- Structures were evaluated to determine performance during the storm event including: structure elevation; foundation piers and column strength and support during the flooding and storm surge; utility elevation height to provide continued service during the flooding event; and wind effects on the performance of the exterior surfaces (windows, siding and roof).
- Photographs were taken and data records were collected for each of the properties.
- Finally a project effectiveness evaluation was conducted to determine if the projects met the established criteria for Phases II of the LAS.

Additional data sets were necessary to complete this study including: census data, field measurements, tax assessments, U.S. Geological Survey data, U.S. Army Corps of Engineer data, and other primary sources as listed in Appendix B, C, and E.

Figure 3.2 HWM Data Collection

3.2 Typical Elevated Structures and Best Practices

The style and systems used to mitigate homes along Lake Pontchartrain are varied. Some homes represent a “Best Practices” approach to hazard mitigation providing many elements that reduce the risk of loss of life and property damage. The following provides an example of the homes, styles and systems that were encountered during this study.

3.2.1 Freeboard

The home in Figure 3.3 represents a FEMA “Best Practices” approach to hazard mitigation. The critical consideration is to get the home above the base flood elevation (BFE), and preferably one foot or more higher than the BFE- this additional elevation above the BFE is known as “freeboard”. The home has 2.7’ of freeboard which represents an excellent “best practices” scenario.

3.2.2 Storm Shutters

In addition to this extra freeboard, the homeowners installed high wind rated storm shutters on all windows. Hurricane Isaac did not exceed design wind speed levels (which are 100 mph or more in coastal areas). However, storm shutters also provide excellent protection from wind-borne debris during high wind events. Broken windows expose the home to wind-driven rain and debris potentially causing additional damages.

3.2.3 Elevation of Utilities

It’s also important to secure (mitigate) all of the utility systems against high winds and storm surge. A large HVAC exterior unit is vulnerable to high winds and must be secured with metal strapping, or in this case, surrounded by the deck handrails. The electrical service entrance, meter base and meter (as allowed by the service provider) should also be raised above the BFE – or higher if possible. The service entrance and meter on this home are located next to the HVAC unit – well above the BFE (see Appendix E, FEMA Recovery Advisory RA2, 2012).

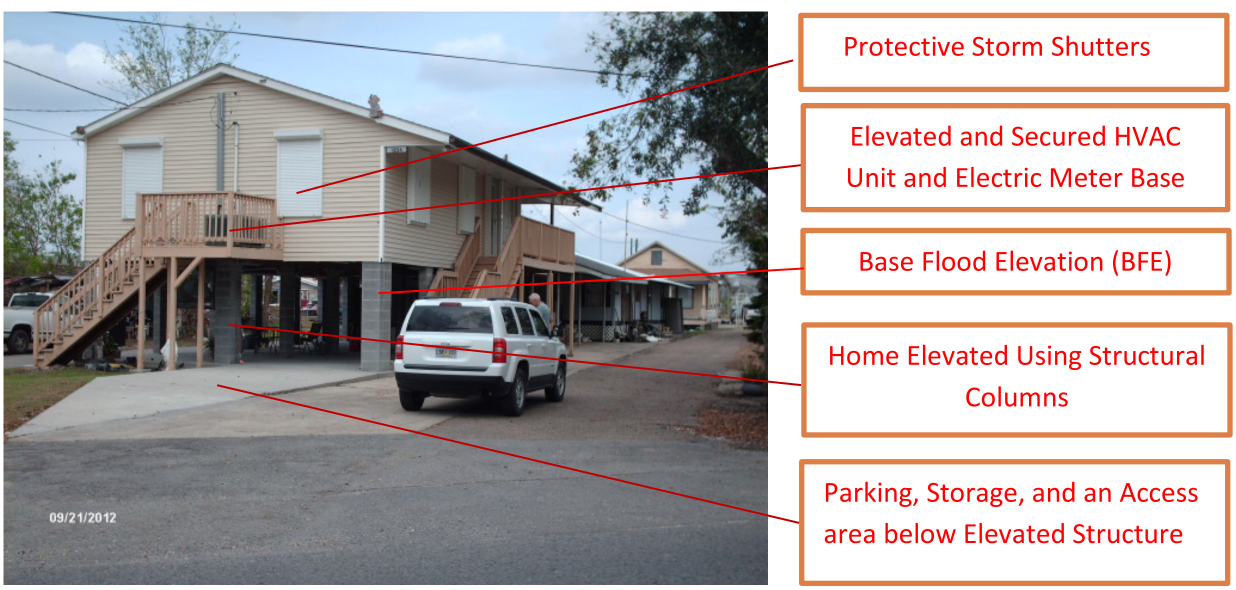


Figure 3.3 Typical Elevated Structure

3.3 Types of Elevated Foundation Systems

There are various types of structural systems to elevate a home. The two most common are structural concrete CMU filled blocks with grade beams, and pressure treated driven piles either braced or with a grade beam (see guidance documents in Appendix E). Elevated foundation systems should be engineered and designed according to the International Building Code (IBC) as adopted by the State of Louisiana. These systems should also meet the additional IBC requirements for building in a Special Flood Hazard Area (SFHA).

3.3.1 Concrete Filled CMU Blocks

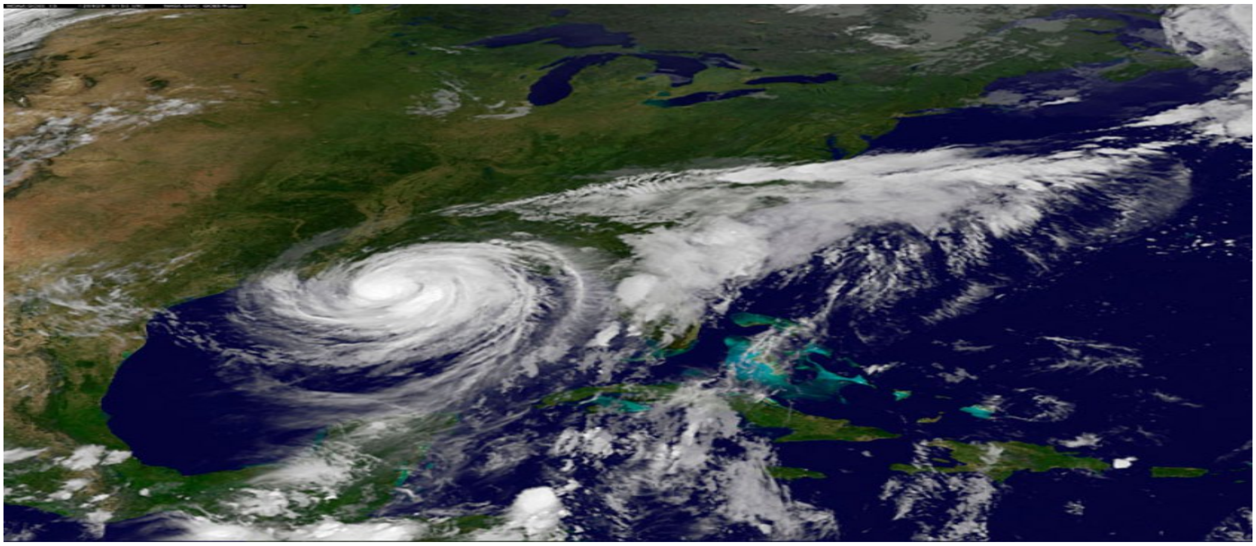
The home in Figure 3.3 (previous page) has concrete filled CMU block columns. The concrete block columns must be tied together with concrete foundation beams below elevation grade, and a 4 inch slab. The entire system is connected with steel 5/8" reinforcing bars in the beams below the grade and turned up into the block columns. The columns usually have 4 steel vertical bars and the entire block column poured with concrete and tie connects to the main structure. Again, the system must be properly engineered and built to code specifications as adopted by the local jurisdiction. One advantage of the concrete block system is that the columns can be "faced" with decorative brick for a very attractive appearance (see Figure 3.4).

Figure 3.4 Elevated Home with CMU Columns faced with Brick

3.3.2 Pressure Treated Driven Piles

The home in Figure 3.5 was elevated using pressure treated wooden piles driven into the earth and tied together with grade beams. If the driven piles do not have cross bracing they must be connected together below grade using a concrete and steel reinforced grade beam. This is required to prevent lateral forces upon the piles from high winds, fast moving storm surge waters or wave action upon the pilings. Properly engineered and installed, the pile driven foundation meets IBC code requirements for Coastal Areas (*see FEMA 550 Recommended Residential Construction for Coastal Areas).*

Figure 3.5 Elevated Home with Pressure Treated Driven Piles



4. Phase II: Project Effectiveness Analysis

To calculate project effectiveness for the 62 elevated properties from our initial project selection the following data was collected:

- High Water Marks (HWMs) or storm surge elevation at each specific property location
- Original Finish Floor Elevation (FFE) of property before it was elevated or what is also called the pre-mitigation FFE (FFE-BM)
- Completed project finish floor elevation or post-mitigation FFE (FFE-AM)
- Base Flood Elevation (BFE)
- Existing Grade Elevation (average elevation of ground surrounding the residence)
- Square footage of the residence
- Building Replacement Value (BRV) of the Improved Property (residence only)
- Average number of people living in the residence
- Structure type (single or multi-story, slab on grade, or pier and beam foundation)
- Cost in dollars of the mitigation measure (elevation)
- Date of mitigation project completion

Additional data sets were necessary to complete this study including: census data, field measurements, tax assessments, U.S. Geological Survey data, U.S. Army Corps of Engineer data, and other primary sources as listed in Appendix B and E.

Tables 4.1-3 that follow, record the data collected during our Phase II Project Effectiveness Analysis. Data was collected in the communities of Mandeville, Lacombe and Slidell.

4.1 Base Flood Elevation

Utilizing Table 4.3 for the following example shown in Sections 4.1-5, see the Slidell property identified as ID 1837. The Base Flood Elevation (BFE) is located in an AE Zone – meaning there is a one-percent chance of the property flooding in any given year. AE11 means the BFE is at 11 feet (NAVD88) or 11 feet above the mean sea level bench mark used as a datum. This property flooded during Katrina; however, the elevated residence did not flood during Isaac.

4.2 Finish Floor Elevation

The Finish Floor Elevation (FFE) before the property was elevated was 6.2 feet and after mitigation (AM) the FFE was 13.2 feet. The residence was raised 2.2 feet above the BFE (13.2 – 11 = 2.2). Elevating a building higher than the required BFE is a construction practice known as freeboard that can eliminate or minimize damage to buildings when flood levels exceed the BFE.

4.3 Grade Elevation and High Water Mark

The Grade Elevation is 5.20; compared with the before mitigation FFE of 6.20, it can be determined that the residence was originally only elevated 1 foot above grade (6.20 – 5.20 = 1). The High Water Mark (HWM) at this property location was 6.5 feet (NAVD88) which means that the property actually flooded 1.3 feet above the grade or ground elevation (6.50 – 5.20 = 1.30).

4.4 Depth of Flooding in the Residence

It can further be determined that if the original elevation of the property was at 6.2 feet and the flood elevation was 6.5’, then the original residence ***had it not been elevated*** would have been inundated by 0.3 feet of water (6.5 – 6.2 = 0.3) above the finish floor (see Table 5.3, ID 1837).

4.5 Square Footage and Completion Date

The residence had 964 square feet of elevated area and was a single story, wood frame home with a porch. The total cost to elevate this residence was $81,713 and the elevation was completed on August 25, 2010. The completion date is required for the calculations to be in 2012 dollars.

Figure 4.1 Subject Properties in Mandeville, St. Tammany Parish (note green triangle)

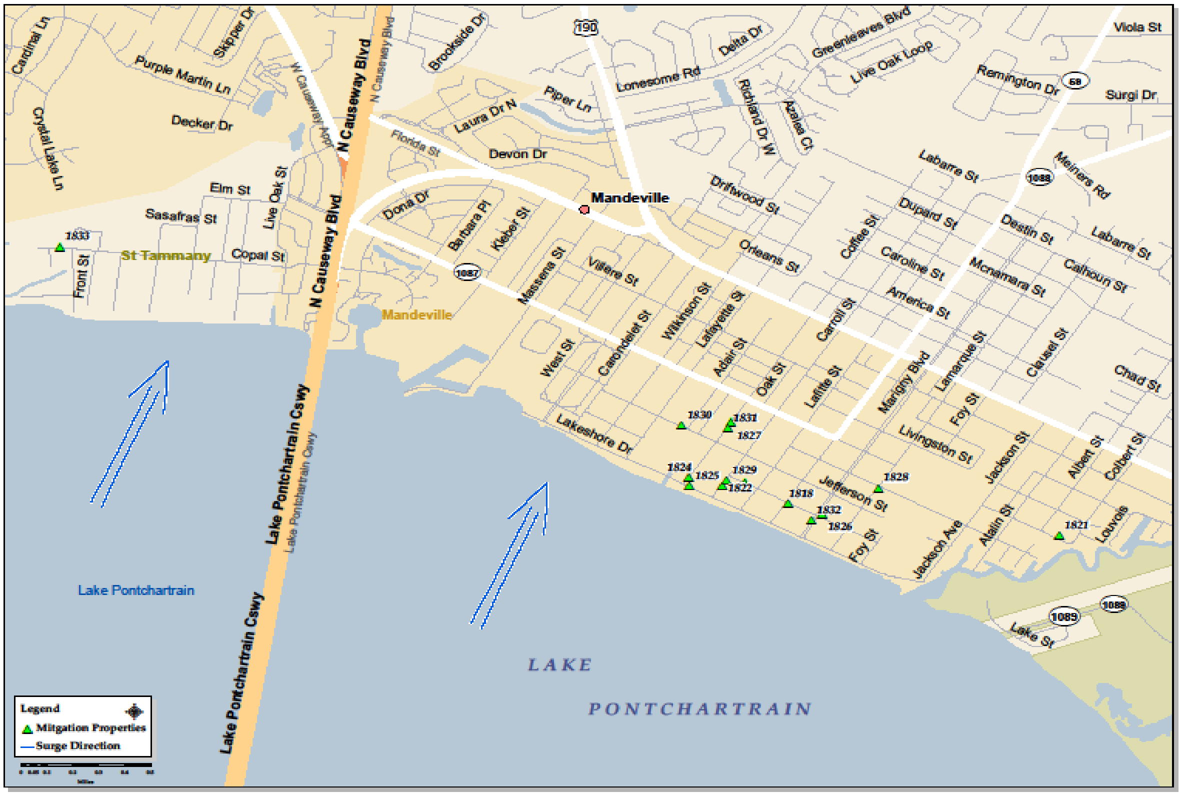


Table 4.1 LAS Subject Data on Properties in Mandeville, St. Tammany Parish

Prop ID	BFE	FFE BM	FFE AM	EABF	GRA	HWM	Sq. Ft.	Structure Type	Mitigation Cost	Date
1818	AE10	7.35	15.3	5.3	4.86	8.25	1090	1.WF.P.C	$131,141.69	2/7/2008
1819	VE12	7.35	15.2	3.2	4.86	8.25	2004	1.WF.P	$85,011.47	5/2/2006
1821	VE12	8.4	16.7	4.7	6.46	8.25	1104	1.MH.C	$44,446.65	12/28/2010
1822	VE12	5.7	18.9	6.9	3.24	8.25	3623	2.WF.P.C	$165,000.00	10/3/2006
1824	AE11	4.4	17.1	6.1	1.92	8.25	2814	1.WF.P	$90,122.95	3/26/2007
1825	AE10	6.0	15.4	5.4	3.50	8.25	1651	1.5.WF.P	$136,555.00	7/22/2008
1826	AE10	5.94	15.7	5.7	3.44	8.25	1026	1.WF.P	$74,652.48	6/21/2007
1827	AE12	6.4	15.63	3.63	5.49	8.25	1040	1.BV.P	$83,670.00	8/19/2011
1828	AE11	7.6	15.56	4.56	6.11	8.25	1798	1.WF.G.P	$130,000.00	5/5/2010
1829	AE10	5.5	15.4	5.4	3.03	8.25	1204	1.WF	$106,374.79	7/11/2008
1830	AE12	7.9	13.94	1.94	5.36	8.25	1601	1.5.WF.P	$106,977.37	6/21/2007
1831	AE11	8.3	15.3	4.3	5.81	8.25	1224	1.WF.P	$127,445.00	11/30/2010
1832	AE10	5.6	15.1	5.1	3.16	8.25	2094	1.WF.P	$87,941.29	9/27/2006
1833	VE12	6.1	15	3.0	3.66	8.25	2450	2.WF.P	$129,900.00	8/20/2011

Note: High Water Marks (HWMs) based on USACE data at Mandeville Harbor Entrance

BFE= Base Flood Elevation; FFE BM= Finish Floor Elevation before Mitigation;
FFE AM= Finish Floor Elevation after Mitigation; EABF= Elevation Property was Raised Above Base Flood Elevation
GRA= Grade of Ground at Base of Property; HWM= High Water Mark; Sq. Ft.= Square Footage of Residence
Structure Type= Number of Stories; WF= Wood Frame; MH= Modular Home; BV= Brick Veneer; C= Carport; G= Garage; P= Porch
Mitigation Cost= Total Cost of Elevation of Residence; Date= Date the Mitigation Measure (Elevation) was Completed

Figure 4.2 Subject Properties in Lacombe, St. Tammany Parish (note green triangle)

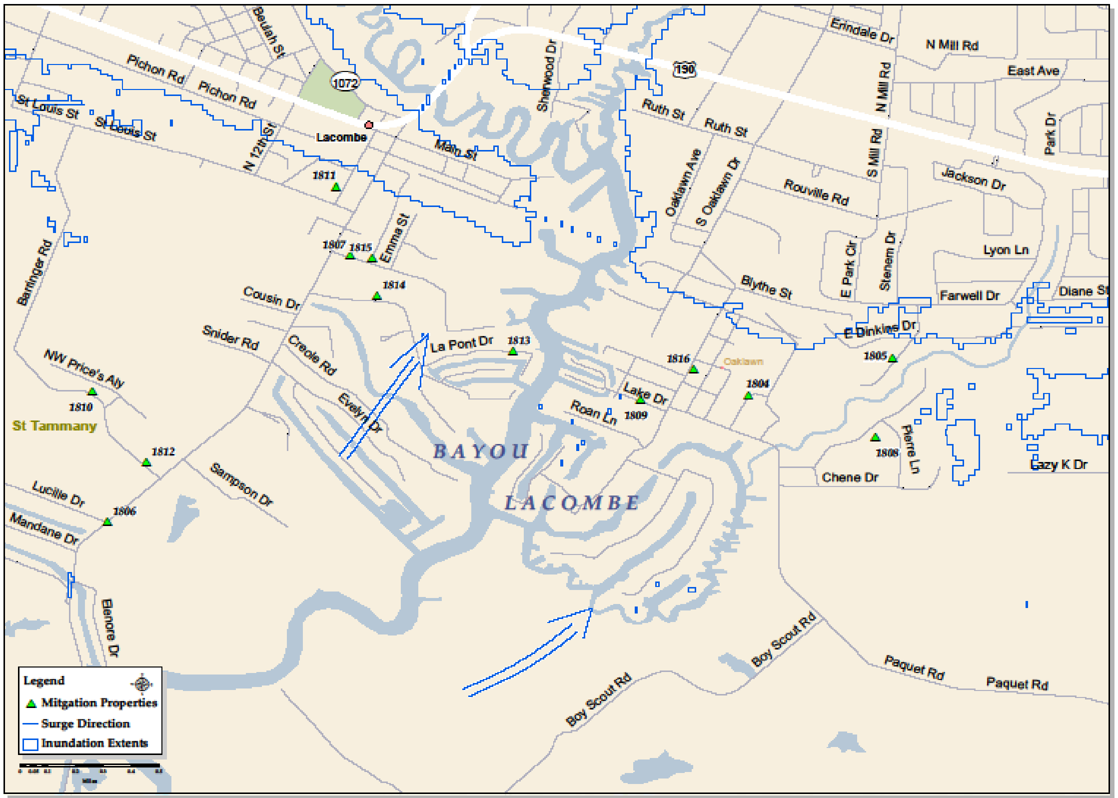


Table 4.2 LAS Subject Data on Properties in Lacombe, St. Tammany Parish

Prop ID	BFE	FFE BM	FFE AM	EABF	GRA	HW M	Sq. Ft.	Structure Type	Mitigation Cost	Date
1804	AE 11	5.5	11.80	0.80	3.00	7.0	1400	1.WF.P.C	$119,900.00	7/28/2009
1805	AE 10	7.6	10.90	0.90	5.17	7.4	1220	1.WF.P.C	$89,174.59	8/25/2010
1806	AE 11	4.62	13.60	2.6	2.13	6.6	2469	1.WF	$76,135.00	1/25/2011
1807	AE 10	4.9	15.60	5.6	3.92	7.4	2812	1.BV.G	$222,171.90	2/18/2011
1808	AE 10	6.2	12.20	2.2	3.76	7.26	1450	1.WF	$64,565.23	12/7/2010
1809	AE 11	6.7	15.00	4.0	4.20	7.7	1947	1.5.WF.P	$122,620.00	11/16/2007
1810	AE 11	4.28	13.50	2.5	3.28	7.4	686	1.WF.P.G	$99,900.00	12/2/2010
1811	AE 10	6.1	12.97	2.97	3.64	7.4	1897	1.WF.P.G	$145,000.00	9/27/2010
1812	AE 11	5.8	12.70	1.70	3.32	7.5	1310	1.WF.P.C	$124,414.28	9/14/2007
1813	AE 10	4.4	14.00	4.0	1.96	7.0	1191	1.WF.P.C	$159,950.00	1/11/2011
1814	AE 10	6.3	12.48	2.48	3.81	8.3	1076	1.WF.P	$98,600.00	10/20/2009
1815	AE 10	5.64	12.83	2.83	3.14	7.3	1076	1.WF.P	$54,457.00	8/10/2010
1816	AE 11	6.1	13.27	2.27	3.67	7.34	1597	1.WF	$107,540.00	9/17/2010

BFE= Base Flood Elevation; FFE BM= Finish Floor Elevation before Mitigation;
FFE AM= Finish Floor Elevation after Mitigation; EABF= Elevation Property was Raised Above Base Flood Elevation
GRA= Grade of Ground at Base of Property; HWM= High Water Mark; Sq. Ft.= Square Footage of Residence
Structure Type= Number of Stories; WF= Wood Frame; MH= Modular Home; BV= Brick Veneer; C= Carport; G= Garage; P= Porch
Mitigation Cost= Total Cost of Elevation of Residence; Date= Date the Mitigation Measure (Elevation) was Completed

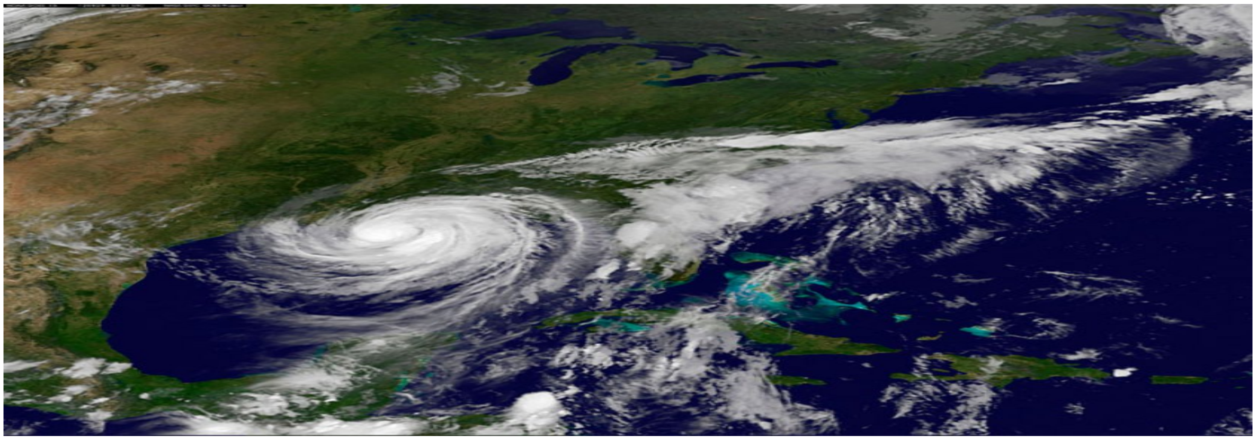
Figure 4.3 Subject Properties in Slidell, St. Tammany Parish (note green triangle)

Figure 4.3 provides the geographic location of the subject properties in Slidell, LA. West of Interstate 10, the majority of the properties are located on or near Bayou Bonfouca, and further west, on Liberty Bayou. These properties were primarily impacted by storm surge from Lake Pontchartrain. The properties to the east of Interstate 10, and further inland, were inundated by both storm surge from the lake, and riverine flooding from the West Pearl River. The West Pearl River can be seen in the upper right corner next to White Stork Drive.

Table 4.3 LAS Subject Data on Properties in Slidell, St. Tammany Parish

Prop ID	BFE	FFE BM	FFE AM	EABF	GRA	HWM	Sq. Ft.	Structure Type	Mitigation Cost	Date
1836	AE11	4.2	11.20	0.2	3.18	4.75	1025	1.WF.P	$55,042.00	7/28/2009
1837	AE11	6.2	13.20	2.2	5.20	6.5	964	1.WF.P	$81,713.00	8/25/2010
1838	AE12	5.71	14.49	2.49	4.71	6.7	1782	1.S.G.P	$104,571.00	1/25/2011
1839	AE11	3.34	12.87	1.87	2.34	3.83	1893	1.BV.G.P	$155,650.00	2/18/2011
1844	AE11	1.67	11.29	0.29	2.36	4.03	1904	1.WF.G.P	$130,000.00	12/7/2010
1854	AE11	3.7	16.30	5.3	1.70	5.7	1550	1.5.WF.P	$130,000.00	9/27/2010
1860	AE12	6.16	19.50	7.5	3.66	8.16	2500	1.5.WF.P	$207,031.53	9/14/2007
1861	AE11	5.2	13.50	2.5	4.20	6.25	2068	1.WF.G.P	$100,000.00	1/11/2011
1863	AE10	7.0	14.10	4.1	5.00	8.25	1421	1.WF.G	$172,003.09	10/20/2009
1872	AE11	5.9	19.33	8.33	3.49	6.5	3416	1.5.WF.P	$245,563.74	9/17/2010
1873	AE11	3.33	14.30	3.3	2.34	5.42	3430	1.5.WF.G.	$117,159.67	9/21/2007
1874	AE13	9.42	17.80	4.8	8.42	11	2472	1.WF.P	$152,551.22	9/21/2006
1877	AE14	9.22	13.55	-0.45	8.22	11	2450	2.WF.P.G	$160,000.00	7/15/2009
1879	AE11	3.44	11.60	0.6	2.44	4.439	1234	1.WF.P	$71,138.00	6/7/2010
1880	AE10	5.55	11.35	1.35	4.56	6.5	1403	1.WF.C	$105,225.00	9/30/2010
1881	AE10	5.88	15.20	5.2	4.52	6.5	984	1.WF.P	$77,574.00	2/15/2011
1883	AE11	6.34	12.01	1.01	5.34	8.25	1968	1.BV.S.P	$130,000.00	11/16/2010
1884	AE11	3.66	14.40	3.4	2.66	5.42	2200	1.WF.P	$173,580.00	11/16/2010
1887	VE13	3.76	12.84	-0.16	2.76	6.25	2376	2.BV.G.P	$106,079.60	12/21/2009
1889	AE11	2.62	14.10	3.1	1.62	6.12	2232	1.WF.P	$160,000.00	3/22/2011
1890	VE13	2.88	15.10	2.1	1.88	6.25	2600	1.WF.G	$143,153.88	9/27/2007
1893	AE14	4.34	17.70	3.7	3.34	5.3	2232	1.WF	$120,780.00	7/11/2011
1903	AE12	7.6	13.46	1.46	6.59	8.09	1727	1.BV.G	$96,705.00	5/20/2010
1906	AE14	7.84	14.20	0.2	6.84	8.8	2608	1.BV	$129,590.50	12/27/2010
1907	VE18	6.3	18.40	0.4	3.80	8.8	1822	1.WF.C	$129,100.00	11/29/2010
1910	AE11	4.85	16.10	5.1	3.85	6.25	2500	1.WF.C.P	$122,480.00	4/25/2011
1911	AE14	8.53	14.50	0.5	7.53	9.53	2700	2.BV.G.P	$150,268.72	3/19/2010
1914	VE16	6.8	19.70	3.7	4.83	8.8	1492	1.MH.P	$88,000.00	10/1/2010
1916	AE11	8.5	14.79	3.79	7.51	9	1500	1.BV.C	$115,220.00	5/19/2011
1918	AE11	5.53	13.00	2	3.03	6.5	1980	1.MH.P	$26,346.21	9/1/2009
1919	AE10	5.0	15.00	5	4.00	5.5	1177	1.WF	$116,500.00	1/25/2011
1922	AE11	5.52	12.30	1.3	3.52	6.25	1450	1.WF	$30,590.92	5/20/2011
1923	AE11	3.5	15.10	4.1	2.51	6.25	1876	1.BV.G.P	$124,497.20	9/20/2010
1925	AE11	5.36	11.79	0.79	4.36	6.25	1302	1.BV.P	$100,000.00	5/11/2011
1926	AE14	7.34	16.70	2.7	6.34	9.34	1765	1.WF	$130,000.00	1/25/2012

BFE= Base Flood Elevation; FFE BM= Finish Floor Elevation before Mitigation;
FFE AM= Finish Floor Elevation after Mitigation; EABF= Elevation Property was Raised Above Base Flood Elevation
GRA= Grade of Ground at Base of Property; HWM= High Water Mark; Sq. Ft.= Square Footage of Residence
Structure Type= Number of Stories; WF= Wood Frame; MH= Modular Home; BV= Brick Veneer; C= Carport; G= Garage; P= Porch
Mitigation Cost= Total Cost of Elevation of Residence; Date= Date the Mitigation Measure (Elevation) was Completed



5. Phase III: Loss Estimation Analysis

To complete Phase III of the LAS, the following data and calculations had to be performed.

- Building Repair Costs Based on Flood Depth
- Content Losses
- Displacement costs (food and lodging expenses while displaced)
- Losses Avoided

5.1 Building Repair Costs Based on Flood Depth

With the required data the LAS can determine the actual cost of the damages *had the property not been elevated*. This calculation becomes our "losses avoided" in dollars because this mitigation project was in place at the time of the flood event (Hurricane Isaac). Calculating 964 square feet of this residential property (ID 1837) would have been flooded 0.3 feet above the finish floor (approximately 3.5 inches) determines the building repair costs based on flood depth (see Table 5.3).

A depth damage calculation function is used (see Appendix C.1) to determine the dollar value of this level of flooding in a residence. The calculation takes into account the structural members supporting the property below the finish floor level, as well as the finish flooring, cabinets, appliances, drywall, insulation, electrical outlets and wiring or any item that is damaged by the inundation. Many of the items just mentioned would have been damaged with 3.5 inches of flooding in the home. Flooding below the finish floor elevation can still cause damages to the sub-floor structural members, HVAC and electrical systems if located in the crawl space. In Table 5.1, property ID 1821 has a –0.15 flood depth, but damages are still sustained.

5.2 Content Losses

Contents that are damaged are also calculated including appliances, electronic equipment, furniture; clothing and other standard residential contents (see Appendix C.2).

Table 5.1 Losses Avoided in Mandeville, St. Tammany Parish

Property ID	Water Depth Above FFE Pre-Mitigation	Building Repair Costs	Contents Losses	Displacement Costs	Total Losses Avoided
1818	0.9	$29,003.37	$4,966.67	$9,760.05	$43,730.10
1819	0.9	$53,323.63	$9,131.39	$9,760.05	$72,215.07
1821	-0.15	$3,151.92	$907.75	0	$4,059.67
1822	2.55	$108,815.36	$19,239.22	$29,280.15	$157,334.72
1824	3.85	$151,359.99	$24,776.76	$39,040.20	$215,176.96
1825	2.25	$39,405.74	$6,900.72	$19,520.10	$65,826.56
1826	2.31	$37,611.31	$6,291.99	$19,520.10	$63,423.40
1827	1.85	$38,124.53	$6,377.84	$19,520.10	$64,022.47
1828	0.65	$47,842.26	$8,192.73	$9,760.05	$65,795.04
1829	2.75	$55,136.22	$9,074.79	$19,520.10	$83,731.11
1830	0.35	$17,003.58	$2,742.51	0	$19,746.09
1831	-0.05	$18,730.63	$3,396.67	0	$22,127.30
1832	2.65	$95,893.05	$15,782.90	$29,280.15	$140,956.10
1833	2.15	$58,476.11	$10,240.31	$19,520.10	$88,236.52
Totals	**1.64 Average**	**$753,877.71**	**$128,022.25**	**$224,481.15**	**$1,106,381.11**

Table 5.2 Losses Avoided in Lacombe, St. Tammany Parish

Property ID	Water Depth Above FFE Pre-Mitigation	Building Repair Costs	Contents Losses	Displacement Costs	Total Losses Avoided
1804	1.5	$51,321.48	$8,585.56	19,520.10	$79,427.14
1805	-0.2	$18,669.42	$3,385.57	0	$22,054.99
1806	1.98	$90,509.10	$15,141.24	19,520.10	$125,170.44
1807	2.5	$128,773.29	$21,194.61	29,280.15	$179,248.05
1808	1.06	$38,582.47	$6,607.04	9,760.05	$54,949.56
1809	1.0	$33,796.80	$5,803.27	9,760.05	$49,360.12
1810	3.12	$31,414.82	$5,170.52	29,280.15	$65,865.49
1811	1.3	$50,476.51	$8,643.83	9,760.05	$68,880.40
1812	1.7	$48,022.24	$8,033.63	19,520.10	$75,575.97
1813	2.6	$54,540.89	$8,976.81	29,280.15	$92,797.85
1814	2.0	$39,444.22	$6,598.61	19,520.10	$65,562.94
1815	1.66	$39,444.22	$6,598.61	19,520.10	$65,562.94
1816	1.24	$42,493.93	$7,276.86	9,760.05	$59,530.84
Totals	**1.65’ Average**	**$667,489.41**	**$112,016.15**	**$224,481.15**	**$1,003,986.71**

Table 5.3 Losses Avoided in Slidell, St. Tammany Parish

Property ID	Water Depth Above FFE Pre-Mitigation	Building Repair Costs	Content Losses	Displacement Costs	Total Losses Avoided
1836	0.55	$27,273.82	$4,670.49	$9,760.05	$41,704.36
1837	0.3	$14,751.90	$2,675.16	0	$17,427.06
1838	0.99	$47,416.53	$8,119.83	$9,760.05	$65,296.40
1839	0.49	$28,968.20	$5,253.19	0	$34,221.39
1844	2.36	$69,797.21	$11,676.36	$19,520.10	$100,993.67
1854	2.0	$36,995.09	$6,478.57	$19,520.10	$62,993.76
1860	2.0	$59,669.50	$10,449.30	$19,520.10	$89,638.90
1861	1.05	$55,026.58	$9,423.01	$9,760.05	$74,209.64
1863	1.25	$37,810.82	$6,474.90	$9,760.05	$54,045.77
1872	0.6	$59,296.29	$10,181.80	$9,760.05	$79,238.14
1873	2.09	$81,866.55	$14,336.44	$19,520.10	$115,723.09
1874	1.58	$90,619.07	$15,159.64	$19,520.10	$125,298.81
1877	1.78	$58,476.11	$10,240.31	$19,520.10	$88,236.52
1879	1.0	$32,835.01	$5,622.82	$9,760.05	$48,217.88
1880	0.95	$37,331.87	$6,392.88	$9,760.05	$53,484.80
1881	0.62	$26,182.86	$4,483.67	$9,760.05	$40,426.59
1883	1.91	$72,143.34	$12,068.84	$19,520.10	$103,732.28
1884	1.76	$80,648.04	$13,491.59	$19,520.10	$113,659.73
1887	2.49	$56,709.89	$9,931.01	$19,520.10	$86,161.01
1889	3.5	$120,055.26	$19,652.36	$39,040.20	$178,747.82
1890	3.37	$119,064.92	$19,596.72	$29,280.15	$167,941.79
1893	0.96	$59,390.40	$10,170.29	$9,760.05	$79,320.73
1903	0.49	$26,427.94	$4,792.53	0	$31,220.46
1906	0.96	$69,395.23	$11,883.56	$9,760.05	$91,038.84
1907	2.5	$83,437.03	$13,732.78	$29,280.15	$126,449.96
1910	1.4	$66,521.50	$11,391.45	$9,760.05	$87,673.00
1911	1.0	$46,867.68	$8,047.67	$9,760.05	$64,675.40
1914	2.0	$54,694.03	$9,149.75	$19,520.10	$83,363.88
1916	0.5	$39,912.90	$6,834.87	$9,760.05	$56,507.82
1918	0.97	$52,685.03	$9,022.03	$9,760.05	$71,467.11
1919	0.5	$31,318.32	$5,363.09	$9,760.05	$46,441.47
1922	0.73	$38,582.47	$6,607.04	$9,760.05	$54,949.56
1923	2.75	$85,909.92	$14,139.79	$29,280.15	$129,329.86
1925	0.89	$34,644.40	$5,932.67	$9,760.05	$50,337.11
1926	2.0	$64,701.72	$10,823.93	$19,520.10	$95,045.76
Totals	**1.44’ Average**	**$1,967,427.44**	**$334,270.33**	**$507,522.60**	**$2,809,220.37**

5.3 Displacement Costs

Along with the property damage calculation, a displacement calculation is made that provides a dollar value for the time that the property owners would have been displaced had the property been flooded. This calculation is based on the percentage of damage to the residence which means that the greater the damage (or flood level in the home) the longer the family members would be displaced while repairs are being made. Displacement costs include lodging and the cost of purchasing meals while displaced. The displacement costs are determined in *number of days* before the family members can return to their home. Displacement costs do not include loss of wages or the emotional cost of the loss (see Appendix B10 for calculations).

5.4 Losses Avoided

The 35 properties listed in Table 5.3 represent a total of over 2.8 million dollars in total losses avoided in the community of Slidell. These losses include structural damage repairs, replacement of various contents that were destroyed or damaged, and displacement costs.

The second column in Table 5.3, provides the depth of inundation had the home still been at its former pre-mitigation elevation. All the homes would have flooded, some as much as 2 feet or more. Property ID 1837 suggests that even the smallest amount of flooding, in this case, 0.3 feet (3.5 inches) above the finish floor elevation, causes quite a bit of damage – over $17,000. The next question to consider is the actual cost of the mitigation measure compared with the losses avoided.

Table 5.4 Mandeville Losses Avoided Compared with Total Mitigation Costs

Property ID	Water Depth in feet above FFE Pre-Mitigation	Total Losses Avoided	Total Cost of Mitigation	Difference (+ or -)	Loss Avoidance Ratio
1818	0.9	$43,730.10	$131,141.69	$(87,411.59)	0.33
1819	0.9	$72,215.07	$85,011.47	$(12,796.40)	0.85
1821	-0.15	$4,059.67	$44,446.65	$(40,386.98)	0.09
1822	2.55	$157,334.72	$165,000.00	$(7,665.28)	0.95
1824	3.85	$215,176.96	$90,122.95	$125,054.01	2.39
1825	2.25	$65,826.56	$136,555.00	$(70,728.44)	0.48
1826	2.31	$63,423.40	$74,652.48	$(11,229.08)	0.85
1827	1.85	$64,022.47	$83,670.00	$(19,647.53)	0.77
1828	0.65	$65,795.04	$130,000.00	$(64,204.96)	0.51
1829	2.75	$83,731.11	$106,374.79	$(22,643.68)	0.79
1830	0.35	$19,746.09	$106,977.37	$(87,231.28)	0.18
1831	-0.05	$22,127.30	$127,445.00	$(105,317.70)	0.17
1832	2.65	$140,956.10	$87,941.29	$53,014.81	1.60
1833	2.15	$88,236.52	$129,900.00	$(41,663.48)	0.68
Totals	**1.64’ Average**	**$1,106,381.11**	**$1,499,238.69**	**$(392,857.58)**	**0.74**

Table 5.5 Lacombe Losses Avoided Compared with Total Mitigation Costs

Property ID	Water Depth above FFE Pre-Mitigation	Total Losses Avoided	Total Cost of Mitigation	Difference (+ or -)	Loss Avoidance Ratio
1804	1.5	$79,427.14	$119,900.00	$(40,472.86)	0.66
1805	-0.2	$22,054.99	$89,174.59	$(67,119.60)	0.25
1806	1.98	$125,170.44	$76,135.00	$49,035.44	1.64
1807	2.5	$179,248.05	$222,171.90	$(42,923.85)	0.81
1808	1.06	$54,949.56	$64,565.23	$(9,615.67)	0.85
1809	1.0	$49,360.12	$122,620.00	$(73,259.88)	0.40
1810	3.12	$65,865.49	$99,900.00	$(34,034.51)	0.66
1811	1.3	$68,880.40	$145,000.00	$(76,119.60)	0.48
1812	1.7	$75,575.97	$124,414.28	$(48,838.31)	0.61
1813	2.6	$92,797.85	$159,950.00	$(67,152.15)	0.58
1814	2.0	$65,562.94	$98,600.00	$(33,037.06)	0.66
1815	1.66	$65,562.94	$54,457.00	$11,105.94	1.20
1816	1.24	$59,530.84	$107,540.00	$(48,009.16)	0.55
Totals	**1.65' Average**	**$1,003,986.71**	**$1,484,428.00**	**$(480,441.29)**	**0.68**

Figure 5.1 Elevated Property in Slidell, LA

Table 5.6 Slidell Losses Avoided Compared with Total Mitigation Costs

Property ID	Water Depth above FFE Pre-Mitigation	Total Losses Avoided	Total Cost of Mitigation	Difference (+ or -)	Loss Avoidance Ratio
1836	0.55	$41,704.36	$55,042.00	$(13,337.64)	0.76
1837	0.3	$17,427.06	$81,713.00	$(64,285.94)	0.21
1838	1.0	$65,296.40	$104,571.00	$(39,274.60)	0.62
1839	0.49	$34,221.39	$155,650.00	$(121,428.61)	0.22
1844	2.36	$100,993.67	$130,000.00	$(29,006.33)	0.78
1854	2.0	$62,993.76	$130,000.00	$(67,006.24)	0.48
1860	2.0	$89,638.90	$207,031.53	$(117,392.63)	0.43
1861	1.05	$74,209.64	$100,000.00	$(25,790.36)	0.74
1863	1.25	$54,045.77	$172,003.09	$(117,957.32)	0.31
1872	0.6	$79,238.14	$245,563.74	$(166,325.60)	0.32
1873	2.09	$115,723.09	$117,159.67	$(1,436.58)	0.99
1874	1.58	$125,298.81	$152,551.22	$(27,252.41)	0.82
1877	1.78	$88,236.52	$160,000.00	$(71,763.48)	0.55
1879	0.999	$48,217.88	$71,138.00	$(22,920.12)	0.68
1880	0.95	$53,484.80	$105,225.00	$(51,740.20)	0.51
1881	0.62	$40,426.59	$77,574.00	$(37,147.41)	0.52
1883	1.91	$103,732.28	$130,000.00	$(26,267.72)	0.80
1884	1.76	$113,659.73	$173,580.00	$(59,920.27)	0.65
1887	2.49	$86,161.01	$106,079.60	$(19,918.59)	0.81
1889	3.5	$178,747.82	$160,000.00	$18,747.82	1.12
1890	3.37	$167,941.79	$143,153.88	$24,787.91	1.17
1893	0.96	$79,320.73	$120,780.00	$(41,459.27)	0.66
1903	0.49	$31,220.46	$96,705.00	$(65,484.54)	0.32
1906	0.96	$91,038.84	$129,590.50	$(38,551.66)	0.70
1907	2.5	$126,449.96	$129,100.00	$(2,650.04)	0.98
1910	1.4	$87,673.00	$122,480.00	$(34,807.00)	0.72
1911	1.0	$64,675.40	$150,268.72	$(85,593.32)	0.43
1914	2.0	$83,363.88	$88,000.00	$(4,636.12)	0.95
1916	0.5	$56,507.82	$115,220.00	$(58,712.18)	0.49
1918	0.97	$71,467.11	$26,346.21	$45,120.90	2.71
1919	0.5	$46,441.47	$116,500.00	$(70,058.53)	0.40
1922	0.73	$54,949.56	$30,590.92	$24,358.64	1.80
1923	2.75	$129,329.86	$124,497.20	$4,832.66	1.04
1925	0.89	$50,337.11	$100,000.00	$(49,662.89)	0.50
1926	2.0	$95,045.76	$130,000.00	$(34,954.24)	0.73
Totals	**1.44' Average**	**$2,809,220.37**	**$4,258,114.28**	**$(1,448,893.91)**	**0.66**

5.4.1 Losses Avoided Compared with Total Mitigation Costs

Table 5.6 compares the total losses avoided from Table 5.3 (Slidell) with the actual cost to elevate the property (mitigation measure). The difference between these two numbers will be either positive or negative.

The total cost of mitigation for each project was derived from Hazard Mitigation Grant Program (HMGP) data records and represent actual costs. This amount includes all of the costs for a home elevation contractor to set up and lift the home based on vertical increments of 6". All utilities have to be disconnected prior to elevation and then reconnected when the home is at the new elevation, including water and sewer. HVAC units and electrical meter bases (as directed by the Public Utility Owner) have to be elevated with appropriate stands and equipment. A slab foundation home will usually require the entire slab to be lifted with the home and then columns installed to support it.

5.4.2 Loss Avoidance Ratio

Table 5.6 represents 4 projects out of the 35 that were better than break-even (loss avoidance ratio 1 or greater) and another 3 that were in the 90^{th} percentile. The final column from table 5.6 provides a ratio that better explains this relationship.

The losses avoided ratio (L_R) is calculated by comparing the Losses Avoided (L_A) to the net present value of the cost of the project to date. A L_R of greater than one indicates that project benefits have exceeded project costs and the mitigation activity is determined to be cost effective and performing successfully. A ratio below one indicates that mitigation benefits have not *yet* exceeded project costs, however, this study represents only one flood event. An elevation project has a useful life of 30 years or more. Given the useful life of an elevation project it can be assumed that every project with a .5 or greater ratio will break even if there is another similar event to Isaac in the next 30 years – a realistic assumption based upon the storm history of southeast Louisiana.

The Losses Avoided Ratio (L_R) is calculated as follows: $L_R = L_A \div P_C$

Where L_A = Losses Avoided in Dollars and P_C = Project Costs

Using the totals at the bottom of Table 5.6, we derive the following losses avoided ratio:

2,809,220.37 ÷ 4,258,144 = 0.66 (Losses Avoided Ratio for Slidell properties)

This ratio describes the fact that 66% of the costs expended to elevate these 35 homes in Slidell were recovered during one flood event. A second flood event of even less severity than Isaac could bring this ratio to one or better.

In St. Tammany Parish, all 62 properties examined sustained no flooding above the finish floor elevation. All had been flooded severely during Hurricane Katrina. It cost approximately 7.2 million dollars to elevate these 62 homes (see Table 5.7), most of the cost being funded by FEMA Hazard Mitigation Assistance (HMA). In contrast, had the homes ***not been elevated*** during Hurricane Isaac, nearly all of the homes would have been flooded above the finish floor, many a foot or higher with an average flood depth of 1.58 feet. Had these damages occurred, it would have cost approximately 4.9 million dollars to repair them – these are the losses avoided and represent 68 percent of the total cost to elevate these homes. Again, considering an elevation project has a useful life of 30 years or more and, given the storm history of southeast Louisiana, the cost of mitigation should pay for itself many times over.

The Table below summarizes the analysis of all three communities in our study and provides the loss avoidance data for St. Tammany Parish, a total of 62 elevation projects.

Table 5.7 St. Tammany Parish Losses Avoided Compared with Total Mitigation Costs

Community	Average Water Depth (FFE Pre-Mitigation)	Total Losses Avoided	Total Cost of Mitigation	Difference (+ or -)	Loss Avoidance Ratio
Mandeville	1.64	$1,106,381.11	$1,499,238.69	$(392,857,58)	0.74
Lacombe	1.65	$1,003,986.71	$1,484,428.00	$(408,441.29)	0.68
Slidell	1.44	$2,809,220.37	$4,258,114.28	$(1,448,893.91)	0.66
Totals For St. Tammany	**1.58' Average**	**$4,919,588.19**	**$7,241,780.97**	**$(2,322,192.78)**	**0.68**

5.5 Hazard Mitigation Grant Funding

Many of the hazards of living in a Special Flood Hazard Area (SFHA) can be mitigated using FEMA Hazard Mitigation Assistance (HMA). These funds are administered through the State and information concerning FEMA HMA funding can be obtained by contacting the State Hazard Mitigation Officer (SHMO) or a local Flood Plain Administrator (FPA). Additional information can be found at FEMA website: http://www.fema.gov/hazard-mitigation-assistance.

Homeowners with flood insurance may also qualify for Increased Cost of Compliance (ICC), a flood policy benefit that assists policy holders bring their home into compliance with local flood plain ordinances, such as elevating a home above the BFE. The ICC benefit can also be used to offset cost share requirements for HMA grant programs – which could effectively fund an elevation project at no cost to the homeowner. Information describing ICC can be found at: http://www.fema.gov/national-flood-insurance-program-2/increased-cost-compliance-coverage.

5.6 Summary of Losses Avoided

In summary, this Loss Avoidance Study demonstrates that Federal, State and local funds used to elevate properties provides a cost-effective long-term mitigation measure that helps reduce or prevent future costs and damages to both life and property that result from a storm event.

There are also significant non-monetary benefits when a home is elevated. It protects the homeowner and family from loss of priceless, irreplaceable items such as photo albums and keep-sakes and prevents the inconvenience and personal trauma that results from having your home and belongings damaged or destroyed.

Hazard Mitigation provides a community with the ability to minimize losses; recover quickly and be resilient in response to a natural disaster event. This strengthens the economic base and provides the residents with confidence and hope for the future.

Figure 5.1 Historic Home in Mandeville- Elevated above the BFE

Appendix A

Value Added Benefits of Hazard Mitigation

A. Value Added Benefits of Mitigation

A.1 Property Value Increase

In addition to protection of life and property, an elevated home above the Base Flood Elevation (BFE) will increase in market value. Depending on terms of the grant program, the homeowner will be required to share no more than 25% of the cost to elevate, and in some cases even less. When a home is elevated above the BFE the flood insurance premium is significantly reduced. All of these benefits increase the value and marketability of the home.

A.2 Neighborhood Values Sustained

A significant community challenge in southeast Louisiana is the abandonment of homes that were severely damaged during a natural disaster. An unsightly abandoned structure with broken windows, surrounded by tall grass and weeds will immediately devalue a neighborhood. The elevation of a home above the BFE not only adds value to the home itself, but also improves the neighborhood in which it is located.

A.3 Increased Tax Base

Community leaders and public officials recognize that increased home values strengthen the tax base, providing sustainability and the opportunity for continued community investment.

A.4 Building a Resilient Community

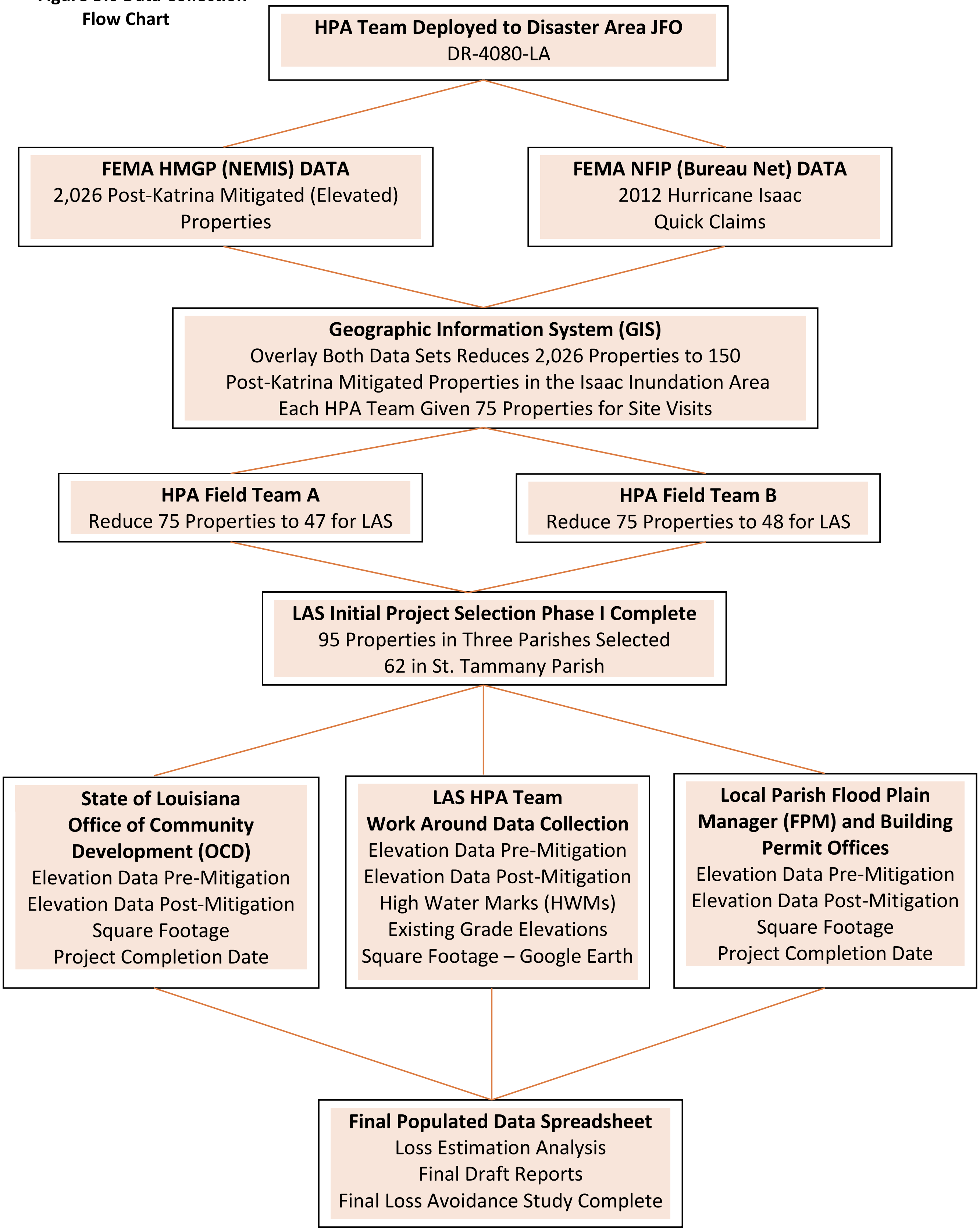
Hazard Mitigation provides a community with the ability to minimize losses, recover quickly and be resilient in response to a natural disaster event. This strengthens the economic base and provides the residents with confidence and hope for the future.

Figure A.1 Elevated Home. Fence Covered in Flood Debris from Isaac.

Appendix B

Data Sources and Collection Methods

Figure B.0 Data Collection Flow Chart



B. Data Sources and Collection Methods

The data sources required for LAS are critical elements for its accuracy and success. The following sources were used for the data collection requirements based upon the following categories.

B.1 Locating Previously Mitigated Properties in the Inundation Area

The LAS team worked with the Region 6 Hazard Mitigation Grant Program (HMGP) specialist to locate all properties in southeastern Louisiana that had been elevated post-Katrina using HMGP funding. A data search was conducted using the ***National Emergency Management Information System*** (NEMIS) and 2,026 properties were identified in this category.

However, many of these properties were not in the Hurricane Isaac inundation area and it was critical to overlay the inundation area with the selected properties. This was accomplished by working with the National Flood Insurance Program (NFIP) specialist and running a search using their data program known as ***Bureau Net*** and locating all of the Quick Claims that had been filed immediately following Hurricane Isaac. This list provided the flood damage "hot spots".

Both data sets (Bureau Net/NEMIS) were collected by a ***Geographic Information System*** (GIS) analyst and a series of maps were generated locating the post-Katrina mitigated properties that were in the areas flooded by Isaac – or that were in the "hot spots." This reduced the list of 2,026 properties to a more manageable 150. These maps were then used for navigating our HPA teams as they travelled to the project sites. The maps were also helpful as some of the properties could not be located by GPS systems.

B.2 High Water Marks

Three data sources were used to collect high water marks (HWMs). The HPA team collected ***field data,*** wherever possible using debris lines and water stain lines. This requires early deployment to the field as HWMs are perishable data often lost after several rains or as a result of community cleanup efforts or even homeowner pressure washing of the debris and stain lines.

Figure B.1 Typical Sensor Used by USGS Hydrologists

Where accurate field data was lacking the HPA team utilized ***U.S. Army Corp of Engineers*** (USACE) HWM data when available. The USACE provides surge gauge readings along major harbor entrances and waterways. Coordination with the GIS Mapping Group in the JFO and the USACE assisted in this data collection.

Finally, the ***U.S. Geological Survey*** (USGS) partnered with FEMA and deployed dozens of additional storm surge sensors (see Figure 6.1) prior to the landfall of Hurricane Isaac. For quality control, the LAS team used the USGS data as a cross check reference to the other HWM data.

B.3 Finish Floor Elevation (Pre-Mitigation)

In order to obtain Finish Floor Elevations (FFE) for the pre-mitigated structure, several data sources were used. The first source was to find this data in the FEMA HMGP (NEMIS) files; however, these records only maintain the most basic of data. The second source was the State of Louisiana, which is required to maintain hard copy files. Contact was made with the *Louisiana Office of Community Development (OCD)* the host of those files. The OCD was provided a spreadsheet of the 150 properties and the data gaps needed for each property. This was a manual search process and the OCD needed four weeks to collect this data.

Therefore, the LAS team began a work-around third source strategy. The team contacted the local Flood plain Administrator and building inspection departments to obtain *Elevation Certificates* that may have been on file for the pre-mitigation elevation. It required all three data sources to address the gaps required for the completion of the LAS effort.

For the remaining data gaps the team utilized one final data source; ***FEMA LAS Methodology for Riverine Flooding*** (Version 2) p 2-7 which provides an estimate for how high a structure will be above grade based on foundation type. The following estimates were used:

Table B.1

Foundation Type	FFE (feet above grade)
Basement	4
Crawl Space (Pier and Beam)	2.5
Slab	1

There are no basements in southeast Louisiana as a result of a very high water table. Also, crawl space (pier and beam) structures were typically about 2.5’ or 30” above grade. Using this approach required property grade (ground) elevation data to which the estimates were added. For example, if the grade elevation was 3.22’ and the property was a crawl space foundation, the FFE (pre-mitigation) elevation would be 5.72’ (3.22 + 2.5 = 5.72). A critical element in this last step is finding the grade elevation – which is discussed next.

B.4 Property Ground Elevation

This data was available through the ***Louisiana State University Ag Center*** web site (www.lsuagcenter.com) under the Flood Map section. To obtain this data the parish is located; then the property address is provided, a search function is operated and the data is accessed – including the preliminary Flood Zone and the Ground Elevation. The LSU Ag Center obtained the ground elevation data using LiDAR (Light Detection and Ranging Data) which provides topographic data collected by aerial fly-overs using lasers and digital processing to capture ground elevations. Field surveys have proven this method to be adequate to meet the needs of the LAS. Where available, this data was cross checked with *Elevation Certificates*.

B.5 Completed Project Finish Floor Elevation (Post-Mitigation FFE)

Many data gaps with all systems and processes administrating the HMGP created major hurdles for the LAS study. Other HPA specialists who had attempted LASs in different regions encountered similar challenges and were not able to complete their study.

The LAS team utilized the combination of data sources mentioned above, -FEMA Region 6 data management sources, *State of Louisiana Office of Community Development (OCD*), local Parish Flood plain Administrators and building inspection departments for *Elevation Certificate*s on file for the post-mitigation elevation. With the combination of these data sources most data was available and provided to the LAS team within three to four weeks.

In some cases, the LAS team actually measured the height of the finish floor elevation and then added this to the LiDAR ground elevation for the post-mitigation FFE.

B.6 Square Footage of the Residence

The square footage of the residence was another critical piece of data needed. For determined data gaps a work-around strategy was developed by calculating square footages using ***Google Earth Pro***. This was accomplished by locating the property with lat/long coordinates, securing a view directly overhead, using the Google Earth ruler/polygon tool and outlining the roof. Once the outline is complete, Google Earth provides the perimeter measurements and the area measurements. Subtract the roof overhang by subtracting the perimeter measurement from the area measurement to estimate square footage measurements. The limitations of this method are accuracy and availability when trees blocked the overhead view.

In some cases, field measurements were required to get actual perimeter measurements of the property. This was the most accurate method, but also the most time consuming. When documented data was available, the official square footage numbers were utilized. Team observations indicated that the Google Earth calculations had an approximate 20% error factor.

Figure B.2 Google Earth Aerial Measurements

B.7 Structure Type

During the LAS field visits, the teams were able to collect structural data. If the property was a full two-story structure, a different "percent damaged" amount was used to take into account that only the first floor would have been inundated (see Appendix C).

It was also important to know if the home had a crawl space or slab foundation as this would often determine how high the home had been elevated pre-mitigation. If, for any reason, the field notes failed to mention this data, team members had field photographs for reference to complete the structural data requirements.

B.8 Cost of the Mitigation Measure

This data was available in the FEMA HMGP (NEMIS) database. The total cost numbers were used rather than the Federal share (which is normally less) as this provides a more accurate analysis of losses avoided.

B.9 Building Replacement Costs (BRC) of the Improved Property

The depth-damage calculation is a function of the square footage of the residence and the Building Replacement Cost (BRC) of the property in 2012 dollars. The cost data for each property was obtained using the ***2012 RSMeans Square Foot Costs*** manual. The RSMeans 1800 square foot average 1 Story template (p.28) was used as follows:

Table B.2 RSMeans Cost Data

Page Number	Feature	Cost	Total Cost
28	1800 Average 1 Story	$112.50/SF	$202,500
28	Add Second Bath	$6,823	$6,823
28	Central Air (1800 SF)	$4.31/SF	$7,758
28	1 Car Garage	$13,197	$13,197
60	Porch (240 SF)	$24.76/SF	$5,942
	Total		**$236,220**
454	**Geographic Multiplier**	For New Orleans=.87	**$205,511**
	Cost per Square Foot	205,511÷1800	**$114.20**

Table B.2 provides the cost data required to calculate the 2012 BRC of the properties in our subject group. The total of $236,220 (for an 1800SF home) is a national average and must be multiplied by .87 for the New Orleans geographic area. The square footage numbers of our subject properties were multiplied by $114.20 to arrive at the 2012 BRC. Property 1836 in Table 4.3 has 1025 Square Feet- this is multiplied by 114.20 to arrive at a BRC of $117,055.

B.10 Displacement Costs

The displacement costs are based on the Government Services Administration (GSA) per diem rates for Slidell, Louisiana. This includes both lodging and meals.
(*See http://www.gsa.gov/portal/category/100120*)

The 2012 lodging rate for St. Tammany Parish (Slidell) is $89.00 and the rate for meals and incidentals was $56. LAS methodology recommends subtracting $7 to reflect more accuracy in this rate which provides an average rate for meals of $49.

This rate is multiplied by the average number of people living in the residence which was determined to be 2.61 (see section B.11). This brings the total meal cost per day per household to $127.89 ($49 X 2.61 = $127.89).

The total for daily meals per household ($167.04) is added to the total daily lodging rate ($89.00) for a ***Total Daily Displacement Cost of $216.89.***

The **Number of Days Displaced** is based on the flood depth (percent of damage) caused by the flood event.

Table B.3

Flood Depth in Feet	Displacement in Days
0.5 ≤ > 1.5	45
1.5 ≤ > 2.5	90
2.5 ≤ > 3.5	135
3.5 ≤ > 4.5	180
4.5 ≤ > 5.5	225

For example, using ID 1836 in Table 5.6, we see that the pre-mitigation water depth would have been 0.55 feet above the finish floor had the property not been elevated. This would have displaced the family for 45 days at an average daily displacement cost of $216.89 or a ***Total Displacement Cost of $ 9,760.05 ($216.89 X 45).*** This number is found in column 5, Table 5.3.

B.11 Average Number of People Living in the Residence

The Louisiana average household size according to the 2010 ***U.S. Census Bureau*** is 2.61. (*See www.factfinder2.census.gov*)

B.12 Date of Mitigation Project Completion

The project completion date was provided by the Louisiana Office of Community Development (OCD) as part of the broader data request form.

In conclusion, the LAS data collection effort required multiple sources and a work-around strategy to fill in our data gaps. In many cases, the same data was collected from different sources providing a crosscheck for most of the data points and allowing the team to work with the best available data.

Appendix C

LAS Calculations

C.1 Residential Building Depth Damage Function

The residential building depth damage function is a critical calculation for the Loss Avoidance Study. It is a percent of damage curve based on the building value. For a more complete curve with greater than 5.5 feet of flood depth, see *Appendix D of: Loss Avoidance Study: Riverine Flood Methodology Report.*

Table C.1 Residential Building Depth Damage Data

Building Type	1 Story without Basement	2 Story Without Basement	Mobile Home
Flood Depth in Feet	**Percent Damage**	**Percent Damaged**	**Percent Damaged**
-1.5 ≤ > -0.5	2.5	3	0
- 0.5 ≤ > 0.5	13.4	9.3	8
0.5 ≤ > 1.5	23.3	15.2	9.4
1.5 ≤ > 2.5	32.1	20.9	63
2.5 ≤ > 3.5	40.1	26.3	73
3.5 ≤ > 4.5	47.1	31.4	78
4.5 ≤ > 5.5	53.2	36.2	80

Source: USACE Generic

For example, using ID 1836 from Table 4.3, the structure type is a single story, wood frame with a porch and contains 1025 square feet. From Table 5.6, the water depth above the finish floor elevation (pre-mitigation) is 0.55 feet which provides a 23.3 percent of damage function.

The total building replacement cost (BRC) of the 1025 square foot residence is $114.20 (see Table B.2) multiplied by 1025 square feet for a BRC of $117,055 (1025 X 114.20 = $117,055).

To arrive at the Depth Damage Data for this property requires multiplying the BRC of the home by the percent damaged (see chart above) which is 23.3% or **$27,273.82** (117,055 X .233 = $27,273.82). This number can be found in Table 5.3 under the third column “Building Repair Costs.”

A similar process is required to determine the Residential Building ***Contents*** Depth-Damage Data on the following page.

C.2 Residential Building Contents Depth Damage Data

The residential building contents depth-damage function is another critical calculation for the Loss Avoidance Study. It is a percent of damage curve based on the contents value. The contents are valued at 30% of the total Building Replacement Cost (BRC).

ID 1836 has a BRC of $117,055 X .30 = **$35,116.50** (Total Contents Value)

Again, using ID 1836 from Table 4.3, the residence is a single story, 1025 square foot structure. From Table 5.6, the water depth above the finish floor elevation (pre-mitigation) is 0.55 feet which provides a 13.3% of contents damage function (see Table C.2).

The Total Contents Value is then multiplied by the percent of damage as follows:
$35,116.50 X .133= $ 4,670.49. This number can be found in Table 5.3 under the fourth column "Contents Losses."

For a more complete curve with greater than 5.5 feet of flood depth see *Appendix D Loss Avoidance Study: Riverine Flood Methodology Report.*

Table C.2 Residential Building Contents Depth Damage Data

Building Type	1 Story without Basement	2 Story Without Basement	Mobile Home
Flood Depth in Feet	**Percent Damage**	**Percent Damaged**	**Percent Damaged**
-1.5 ≤ > -0.5	2.4	1	0
- 0.5 ≤ > 0.5	8.1	5	12
0.5 ≤ > 1.5	13.3	8.7	66
1.5 ≤ > 2.5	17.9	12.2	90
2.5 ≤ > 3.5	22	15.5	90
3.5 ≤ > 4.5	25.7	18.5	90
4.5 ≤ > 5.5	28.8	21.3	90

Source: USACE Generic

Appendix D

Sample Field Worksheet

Hazard Mitigation HPA Data Collection

Project Number		
Mitigation Area		
Address		
Mitigation Measure (Narrative)		
Success or Failure (Explain)		
Type of Damage		
Base Flood Elevation		
Elevated How Much Above BFE		
FFE Before Mitigation		
FFE After Mitigation		
High Water Mark + or – Finish Floor		
Structure Sq. Footage		
Structure Type		
Total Mitigation Cost		
Fed. Award Amount		
Photos of Property		

Figure D.1 This Document Used for HPA Field Site Visits

Appendix E

Resource and Guidance Documents

Resource and Guidance Documents

Federal Emergency Management Agency (FEMA). 2011. *Loss Avoidance Study: Riverine Flood Methodology Report* (*with Appendices*). Version 2.

FEMA. 2006. *Mitigation Assessment Team Report: Hurricane Katrina in the Gulf Coast*,
FEMA Publication 549.

FEMA. 2006. *Recommended Residential Construction for the Gulf Coast: Building on Strong and Safe Foundations,* FEMA Publication 550.

FEMA. 2012. *Hazard Mitigation Field Operations Guide, HM FOG (Version 3.0)*

FEMA. Hazard Mitigation Grant Program (HMGP) *Website*
http://www.fema.gov/hazard-mitigation-grant-program

FEMA. Hazard Mitigation Assistance (HMA) *Website*
http://www.fema.gov/hazard-mitigation-assistance

FEMA. National Flood Insurance Program (NFIP) Website on Increased Cost of Compliance (ICC)
http://www.fema.gov/national-flood-insurance-program-2/increased-cost-compliance-coverage.

FEMA. 2012. *Minimizing Flood Damage to Electrical Service Components*
Recovery Advisory RA2, December 2012 (see FEMA Library online)

Government Services Administration (GSA). 2012 Per Diem Rates
http://www.gsa.gov/portal/category/100120

Louisiana State University Agricultural Center (LSUAgCenter)
http://www.lsuagcenter.com/

National Weather Service (NWS) 2012. *Hurricane Isaac - August 25-September 3, 2012*
http://www.hpc.ncep.noaa.gov/tropical/rain/isaac2012.html

U.S. Army Corp of Engineers (USACE). 2012. *Hurricane Katrina: August 29, 2005/ Hurricane Isaac: August 29, 2012*. Task Force Hope Status Newsletter, September 7, 2012.

USACE. 2012. *Hurricane Isaac With and Without 2012 100-Year HSDRRS Evaluation,* Preliminary Report November 2012

RS Means Square Foot Costs, 33rd Annual Edition, as published by RSMeans, 2011.

U.S. Census Bureau American Factfinder
http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml
Louisiana, Selected Social Characteristics, Average Household Size