Final Coastal and Riverine High Water Mark Collection for Hurricane Katrina in Mississippi

FEMA-1604-DR-MS, Task Orders 413 and 420

March 14, 2006 (Final)

FEMA

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Mississippi Coastal & Riverine High Water Mark Collection
FEMA-1604-DR-MS

Final Report

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Abbreviations and Acronyms

Acronym	Definition
cfs	Cubic feet per second
FEMA	Federal Emergency Management Agency
FIRM	FEMA Flood Insurance Rate Map
GPS	Global Positioning System
HMGP	Hazard Mitigation Grant Program
HMTAP	Hazard Mitigation Technical Assistance Program
HWM	High Water Mark
HWM ID	High Water Mark Identification Number
IA	Individual Assistance
LAT	Latitude
LON	Longitude
mb	Millibar
mph	Miles Per Hour
MS	State of Mississippi
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NGS	National Geodetic Survey
NGVD 29	National Geodetic Vertical Datum of 1929
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
PA	Public Assistance
QA	Quality Assurance
RV	Recreational Vehicle
SLOSH	Sea, Lake and Overland Surges from Hurricanes
TBM	Temporary Bench Mark
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

Glossary of Terms

Term	Definition
Astronomical Tide	The periodic rising and falling of the earth's ocean waters resulting from the gravitational attraction of the Moon, Sun and other astronomical bodies acting upon the rotating earth.
Building Performance Assessment	The structural assessments of how buildings hold up during a storm event.
Coastal Flooding	Onshore rush of water piled higher than normal as a result of high winds on an open water body's surface.
Debris Line	Defines the extent of flooding where debris such as parts of houses, docks, cars, or other non-natural materials are carried by flood waters with some velocity and then dropped as the flood waters lose velocity and begin to recede.
Disaster declaration	The formal action by the President that makes a State eligible for major disaster or emergency assistance under the Stafford Act.
Flagging	Marking or otherwise documenting the horizontal and vertical location of a high water mark so that the high water mark data is preserved for future surveying. This data will then be available even if the homeowner cleans the property or it rains and therefore eliminates the visible high water mark.
Flood recovery map	High-resolution maps that show flood impacts, including high water mark flood elevations, flood inundation limits, the inland limit of waterborne debris (trash lines), and storm surge elevation contours based on the high water marks. The maps also show existing FEMA Flood Insurance Rate Map (FIRM) flood elevations for comparison to hurricane data.
Hazard Mitigation Grant Program	A FEMA program that provides grants to States and local government to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster.

Term	Definition
High Water	The maximum elevation that flood waters reach as a result of a storm event.
High Water Mark	A physical mark, such as a mud line, that designates the location and elevation of flood waters from a storm event.
Individual Assistance	Federal assistance provided to families or individuals following a major disaster or emergency declaration. Under a major disaster declaration, assistance to individuals and families is available through grants, loans, and other services offered by various Federal, State, local, and voluntary agencies.
Inundation Maps	Maps that delineate the areas flooded during a storm.
Millibar	A unit of atmospheric pressure equal to one thousandth of a bar. Standard atmospheric pressure at sea level is about 1,013 millibars.
Mitigation	Any measure that reduces or eliminates the long-term risk to life and property from a disaster event.
National Flood Insurance Program	The Federal program created by an Act of Congress in 1968 that makes flood insurance available in communities that enact and enforce satisfactory floodplain management regulations.
National Geodetic Vertical Datum of 1929	Vertical control datum that was widely used in the U.S. prior to the establishment of NAVD 88.
North American Datum of 1983	Used as the standard map horizontal coordinate system default by the majority of GPS devices.
North American Vertical Datum of 1988	The most widely used vertical control datum in the U.S. today. It was established by the minimum-constraint adjustment of the Canadian-Mexican-U.S. leveling observations. The general adjustment of NAVD 88 was completed in June 1991.
Point	A point associated with a discrete geographic location where data pertaining to the study were taken.
Public Assistance	Federal assistance provided to State and local governments, Native American Tribes, and certain non-profit organizations after a disaster declaration. The assistance is for the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain Private Non-Profit organizations. The Federal share of assistance is not less than 75 percent of the eligible cost for emergency measures and permanent restoration. The State determines how the non-Federal

Term	Definition
	share (up to 25 percent) is split with the applicants.
Riverine Flooding	Flooding that is a result of elevated levels of a river due to heavy rainfall.
SLOSH	Stands for "Sea, Lake and Overland Surges from Hurricanes," a computer model used by coastal scientists and engineers to predict the level of coastal flooding during a hurricane.
Stage	A term used by water resource professionals to indicate the elevation of the water.
Surge-only	A rise in the normal water level of a coastal body, also referred to as Stillwater flooding.
Temporary Bench Mark	A point (often a nail or stake) set near a high water mark. The vertical distance between the high water mark and temporary bench mark is measured by the personnel setting the temporary bench mark. Surveyors then survey the location and elevation of the temporary bench mark. The measured vertical distance between the high water mark and temporary bench mark is added to the temporary bench mark elevation to compute the elevation of the high water mark.
Water mark	A mark, usually on structures, left by flood waters.
Wave Height	Represents the coastal high water mark elevation due to more direct wave action.
Wave Runup	Represents the height of water rise above the surge-only level due to water rush up from a breaking wave.
Wind Water Line	An approximate boundary to delineate the inland extent of the area where structures were damaged as a result of flooding from storm surge from a particular event. Landward of the line, most of the damage is attributable to winds and/or wind-driven rain. Sometimes, the wind water line is located along the debris line, but in some cases, inundation and flood damage extends beyond the area where major debris was deposited.
Wrack line	Defines the extent of flooding where organic type debris such as grass and weeds are carried by flood waters and left behind as the flood waters recede.

Executive Summary

Introduction and Purpose of the Study

The Federal Emergency Management Agency (FEMA) contracted URS Group, Inc. (URS) under Rapid Response Task Orders 413 and 420 of the Hazard Mitigation Technical Assistance Program (HMTAP) contract to assist in the disaster recovery in Mississippi following Hurricane Katrina by collecting high water marks (HWMs). HWMs collected were classified as either a result of coastal flooding (caused by storm surge) or riverine flooding (caused by rainfall). This study documents the HWM survey conducted along the Mississippi coast and streams following Hurricane Katrina which began affecting the area on August 29, 2005.

The purpose of this study was to document maximum flooding elevations that occurred as a result of Hurricane Katrina by collecting HWMs in affected areas. HWM data collection helps accurately document a flooding event and assists in response, recovery, and mitigation, for future disasters. These HWM data help place the event within a historical context, improve estimates of current flood risk, and enable governments to make cost-effective decisions about mitigation efforts.

Methodology

HWMs are perishable, and it was important to quickly capture HWM information before the HWMs disappeared. Consequently field work first involved locating and flagging representative HWMs. Flagging captured information regarding the location and description of the HWM so that it could be surveyed, even if the markings had been cleaned.

URS flagged over 300 HWMs during the rapid response field assignment, which began on August 30, 2005 with a Notice to Proceed from FEMA. URS initiated data collection to determine the HWM study area on August 31, 2005. An orientation meeting was held for field staff on September 1, 2005, but due to the ongoing recovery efforts in the impacted areas, the lack of lodging, and the concern for obtaining gasoline and other essential supplies, the field work in Mississippi did not begin until September 12, 2005.

After receiving the Notice to Proceed, URS placed calls to Federal, State, and county emergency managers in Mississippi; reviewed available gage information; and obtained preliminary coastal storm surge elevation modeling prepared by the National Hurricane Center. The data indicated that the coastal counties of Hancock, Harrison, and Jackson received the most significant flooding; therefore, these counties became the study area.

Two-person flagging teams were assigned a geographic area in which to identify and flag HWMs, as indicated by mud lines, water lines, debris lines (i.e., man-made materials), or wrack lines (i.e., plant materials). In coastal areas, multiple HWMs were flagged in the same area to document different coastal flood types (i.e., surge-only, wave height, or wave runup) or to better determine flood elevation. The height of flood waters can be affected by outside forces such as wind and shielding by other structures. Therefore, in significantly damaged areas, and if available, multiple HWMs were obtained in the same area to provide better flood elevation data. In many areas, Hurricane Katrina caused extensive damage, leaving few structures standing, and in these areas it was difficult to find HWMs.

In addition, the U.S. Geological Survey (USGS) flagged approximately 100 HWMs. The URS team surveyed the HWMs flagged by both URS and USGS. The survey crews used static Global Positioning System (GPS) methods and conventional leveling to determine the horizontal coordinates (latitude and longitude) and elevation for each HWM. HWMs were surveyed horizontally in the North American Datum of 1983 (NAD 83), Mississippi East State Plane Coordinates, and vertically in the North American Vertical Datum of 1988 (NAVD 88). The HWMs were surveyed to an accuracy of 0.25 foot vertically and 10 feet horizontally with a 95% accuracy level.

Coastal and Riverine HWM Observations

The coastal flooding from Hurricane Katrina was significant and brought widespread devastation along the Mississippi coast. The HWM elevations were noticeably highest in western Mississippi, near the border between Hancock County and Harrison County. Overall the pattern of the surge was clear: this massive event extended along the entire Mississippi coast, often more than 5 miles inland.

The riverine flooding was not as significant as coastal flooding during Hurricane Katrina. HWMs from riverine flooding were found in some areas north of I-10 in Mississippi. Most of the HWMs from riverine flooding were found near the stream channel. It appears that riverine flooding from Hurricane Katrina was typically low and therefore had limited impact on buildings. The following observations pertain to elevations that are referenced in NAVD 88.

Hancock County

Coastal HWM data from points approximately 3 miles inland show fairly consistent elevations on the order of 19 to 20 feet. Lower elevations, on the order of 8 to 14 feet, were found north of Pearlington; these are 8 to 10 miles inland from the sound.

In Waveland and Bay St. Louis, the coastal flooding elevations ranged from 24 to 28 feet. Farther inland in Diamondhead, coastal HWM elevations of 25 feet were measured at several places along I-10. Coastal HWMs with elevations on the order of 20 feet extended north of I-10, 8 to 10 miles inland from the coastline.

Most of the riverine flooding in Hancock County appears limited to the stream channel. The areas where riverine flooding had some impact on buildings are located near the interface of the coastal and riverine flooding. Therefore, these riverine HWMs may have been influenced by the high coastal surge levels, such as along the Jourdan River.

Harrison County

The highest coastal HWM elevation of 34.9 feet was found in Pass Christian and represented flooding including wave height. Coastal surge elevations ranged between 25 and 27 feet along the coast in the western portion of the county. In this area the flooding extended to I-10 with elevations between 20 and 24 feet in the inland portions of the town of Pass Christian. The flooding along the coast due to surge was 1 to 2 feet lower in the eastern portion of the county toward Gulfport. In the nearby communities of Gulfport, Biloxi, and D'Iberville, the surge traveled up through the bay instead of directly across the peninsula; significant coastal flooding extended 1 to 2 miles north of I-10.

Most of the riverine flooding appears to have been confined to the stream banks. However, there were some buildings along the Biloxi River and along Tuxachanie Creek that were impacted by riverine flooding.

Jackson County

There were coastal flooding elevations on the order of 20 feet in the vicinity of I-10 in Jackson County. Along the open coast, the surge levels in western Jackson County were lower than farther west, but they were still in the devastating range of 18 to 21 feet. To the east, coastal flooding elevations were marginally lower, in the 16 to 18 feet range, along the Gulf shoreline at Mosspoint in eastern Jackson County. In addition, inland flooding along I-10 in Jackson County was noticeably lower than it had been in areas farther west. Nevertheless, flooding extended to and beyond I-10 because waters were able to propagate through the extensive low wetland north of the community of Pascagoula. The wetlands also appeared to have diminished the extent of the inland surge from Katrina.

There was a significant depth of riverine flooding near the Pascagoula River. However, the buildings where the HWMs were collected were typically elevated, so there was minimal impact to buildings from the flooding at that location. In most of the other areas in Jackson County, riverine flooding was confined to the stream banks.

1. Introduction

1.1 General

The Federal Emergency Management Agency (FEMA) contracted URS Group, Inc. (URS) under Task Orders 413 and 420 of the Hazard Mitigation Technical Assistance Program (HMTAP) contract to assist in the disaster recovery in Mississippi following Hurricane Katrina by collecting high water marks (HWMs). Consequently, this study documents the HWM survey conducted along the Mississippi coast and streams following Hurricane Katrina. The effects of Hurricane Katrina were first observed on August 29, 2005, as the storm made landfall along the Gulf Coast of the United States.

This study was performed as rapid response Task Orders to help FEMA assess storm conditions for its Mitigation Program. The study was conducted in three of Mississippi's counties: Hancock, Harrison, and Jackson (Figure 1). The URS team for these Task Orders includes URS and its subconsultants PBS&J, ESP Associates, Michael Baker Jr., Inc., and Watershed Concepts.

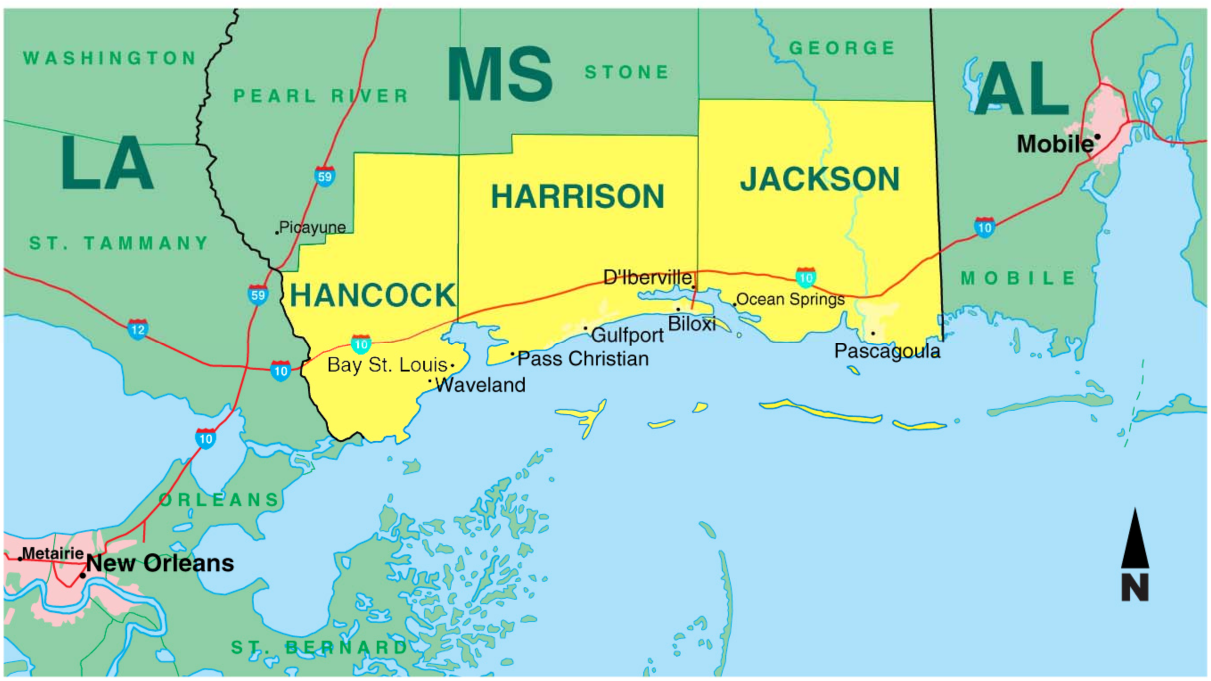

Figure 1 – Mississippi Coastal Counties

This report provides information on both coastal flooding and riverine flooding. Although FEMA provided separate Task Orders for these two types of flooding, URS combined the data into one report because all of the significant riverine flooding during Hurricane Katrina occurred in the coastal counties. As such, it was often difficult to distinguish HWMs resulting from the two flooding types.

Section 1 of this report summarizes the purpose of the Task Order and provides overviews of related projects and of Hurricane Katrina. The remaining sections of the report discuss the methodology used to collect the HWMs, explain the types of flooding, summarize the FEMA Rapid Response Task Orders, and condense the results from the HWM collection efforts. The appendices include the detailed results from the HWM survey.

1.2 Purpose

After significant flooding from a hurricane, it is imperative to collect data rapidly to: document the event; assist in response, recovery, and mitigation; and improve disaster preparedness and prevention for future disasters. HWM data collection is an initial step in accurately documenting an event. These data help place the event within a historical context, improve estimates of current flood risk, and enable governments to make predictions about potential future flooding to assist with mitigation efforts.

Collection of site-specific high water data along rivers, bays, and coasts has numerous applications. The purpose of this study was to document the maximum flooding elevations that occurred as a result of Hurricane Katrina. There are a number of uses of the HWM elevation data, including:

- Estimate storm frequency and severity
- Assess accuracy of the Flood Insurance Rate Maps (FIRMs)
- Assist in preparation of Wind Water Line Maps
- Prepare Inundation Maps
- Share information for Building Performance Assessments
- Share information for calibrating models that simulate the storm
- Assist in prioritizing mitigation projects and preparing their benefit/cost analysis
- Determine depth of flooding of structures

Specific FEMA programs that directly benefit from post-disaster flood data collection include:

- Individual Assistance – advises individuals on how to use Federal grants to increase their homes' wind and flood resistance. Federal grants are available for purchase or relocation of residential properties in Special Flood Hazard Areas;
- Public Assistance – identifies appropriate flood mitigation measures to pursue when providing Federal grants to repair publicly owned infrastructure;
- Hazard Mitigation Grant Program – ensures that accurate benefit/cost analysis is performed; and
- National Flood Insurance Program – provides insurance claim information, floodplain management and repetitive loss classification, and flood hazard identification.

This report supersedes the "Hurricane Katrina Coastal High Water Survey Preliminary Field Summary Report (Task Order 413)," dated September 23, 2005, in its entirety and subsequent submissions of preliminary HWM data. URS prepared the Preliminary Field Summary Report to provide FEMA with initial field-observed visual estimates of HWM elevations with respect to either the level of the adjacent water body at the time or their estimate of the mean tide level in this water body. These estimates are useful indicators of the overall pattern of the surge inundation. However, these estimates can be inaccurate because they are based on visual observations and were not from survey information. The HWM survey data provided in this report include actual surveyed locations and elevations. Consequently, the information in this report supersedes the visual surge estimates provided in the cited Preliminary Field Summary Report. These data also supersede the preliminary HWM elevations provided on the Hurricane Katrina Surge Inundation and Advisory Base Flood Elevation maps, dated November 2005, prepared by URS (see Section 1.3).

1.3 Overview of Related Projects

After Hurricane Katrina, FEMA issued several Task Orders under the HMTAP contract called Rapid Response Task Orders. The purpose of these Task Orders was to allow FEMA contractors to move quickly into disaster-stricken areas to collect perishable data for use in defining the parameters of the event; these parameters can be used for future studies and flood mitigation activities. In addition to the HWM Task Orders, there were several other Rapid Response Task Orders, including Aerial Imagery Data Collection and Wind Water Line Data Collection Task Orders. HWM survey findings are used to define the extent of flooding and therefore can be used in conjunction with field findings from Wind Water Line Task Orders to determine the extent of the wind water line. Aerial imagery is also used to estimate the wind water line; post-event imagery can be used to identify areas affected by flood damages, as well as the approximate inland extent of storm-surge flooding. Topographic data collected with the aerial imagery was also used to evaluate the HWM elevations.

In response to Katrina, FEMA issued several Rapid Response Task Orders: HMTAP Task Order 413, Rapid Response, Hurricane Katrina Coastal High Water Mark Survey – MS; HMTAP Task Order 420, Rapid Response, Hurricane Katrina Riverine High Water Mark Survey – MS; HMTAP Task Order 411, Rapid Response, Aerial Radar – Louisiana, Mississippi and Alabama; and HMTAP Task Order 416, Wind Water Debris Line – MS. Task Orders 413 and 420 are the focus of this report. HMTAP Task Order 437, Flood Data Analysis – MS, was also issued in mid-September. An overview of the related Task Orders is provided below:

- Under Task Order 411, *Rapid Response, Aerial Radar – Louisiana, Mississippi and Alabama*, cartographic analysts were tasked with using post-event aerial imagery to delineate areas affected by flooding along the Mississippi Coast.
- Under Task Order 416, *Rapid Response, Hurricane Katrina, Wind Water Debris Line - Mississippi*, visual surveys and data collection were used to determine the location of the debris line and extent of flooding to identify the wind water line.
- Under Task Order 437, *Flood Data Analysis – Mississippi*, maps showing the extent and magnitude of Hurricane Katrina's surge, as well as information on advisory flood data, were created for the areas of Harrison, Hancock, and Jackson Counties. These maps show preliminary high water marks surveyed after the storm, an inundation limit developed from these surveyed points, FEMA's Advisory Base Flood Elevations, and the estimated zone of wave impacts. These maps and data are published at

http://www.fema.gov/hazards/floods/recoverydata/katrina_ms_index.shtm. Note that the data on these maps were published on November 15, 2005, prior to the final quality review of the HWM data (see Section 2.9). Consequently, there were some minor differences between the website and this report; the website is being updated.

1.4 Overview of Hurricane Katrina

Hurricane Katrina became the eleventh named tropical storm and the fourth hurricane in the 2005 Atlantic hurricane season and was one of the strongest storms to impact the coast of the United States during the last 100 years. According to the National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center (NHC), the storm began as Tropical Depression 12 over the southeastern Bahamas on August 23, 2005. On August 24, 2005 the cyclone became Tropical Storm Katrina. The storm strengthened, and Katrina is estimated to have reached hurricane status on August 25, 2005. Katrina made its first landfall in the United States as a Category 1 hurricane on the Saffir-Simpson Hurricane Scale, with maximum sustained winds of 70 knots (80 mph). Katrina continued west-southwestward, spent only 6 hours over land, and weakened to a tropical storm with maximum sustained winds of 60 knots (70 mph) as it emerged into the Gulf of Mexico.

Katrina continued northward over the Gulf of Mexico, quickly regaining hurricane status and strengthening to a Category 5 hurricane on the morning of August 28, 2005. Katrina attained its peak intensity of 150 knots (173 mph) about 170 miles southeast of the mouth of the Mississippi River. Katrina remained a significantly large, sustained storm and impacted a broad area of the Gulf Coast. By the morning of August 29, Katrina weakened to a Category 3 storm, making landfall near Buras, Louisiana, with estimated maximum sustained winds of 110 knots (126 mph).[1] Heading northward, Katrina downgraded to a tropical depression near Clarksville, Tennessee, and dissipated on August 31 in southeastern Canada. The Hurricane Katrina storm track is shown in Figure 2.[2]

[1] "Tropical Cyclone Report, Hurricane Katrina, 23-30 August 2005, Richard D. Knabb, Jamie R. Rhome, and Daniel P. Brown, National Hurricane Center, 20 December 2005."
[2] http://cimss.ssec.wisc.edu/tropic/archive/2005/storms/katrina/katrina.html

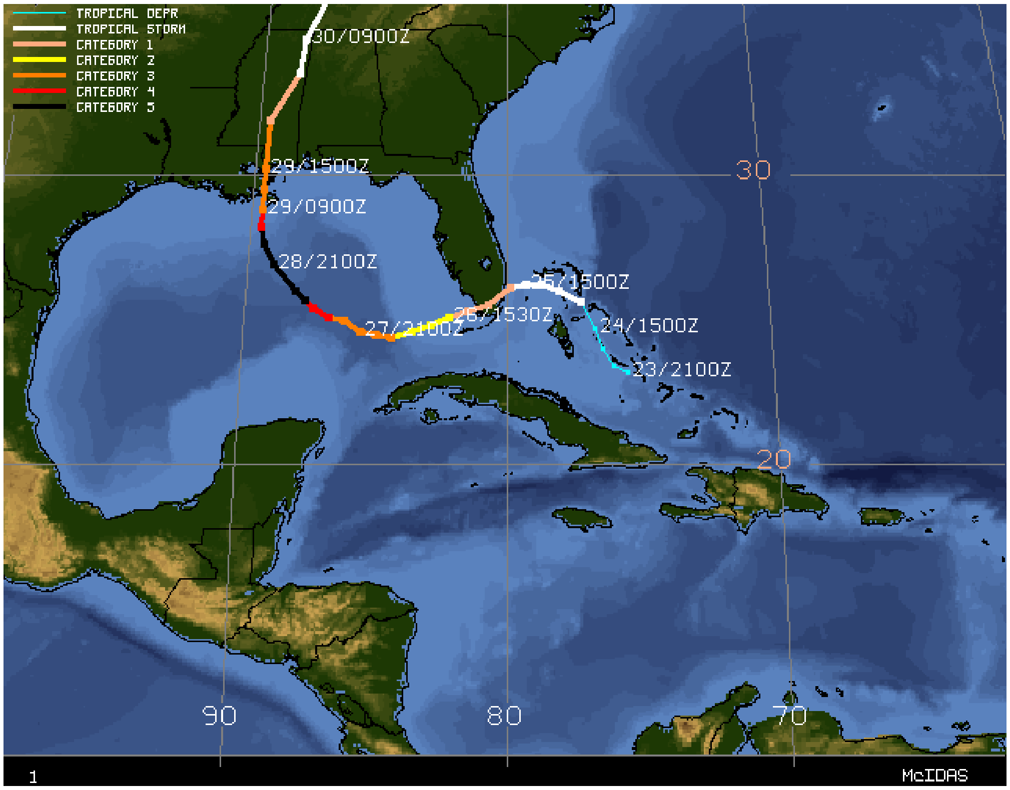

Figure 2 – Hurricane Katrina Storm-Track

Figure 3 shows a composite image of Hurricane Katrina. This image is Advanced Very High Resolution Radiometer/Multi-Channel Visible and Infrared Radiometer composite imagery provided by the Cooperative Institute for Meteorological Satellite Studies as provided by NOAA and the Joint Typhoon Warning Center.[3]

[3] http://cimss.ssec.wisc.edu/tropic/archive/2005/storms/katrina/avhrr/avhrr.katrina.html

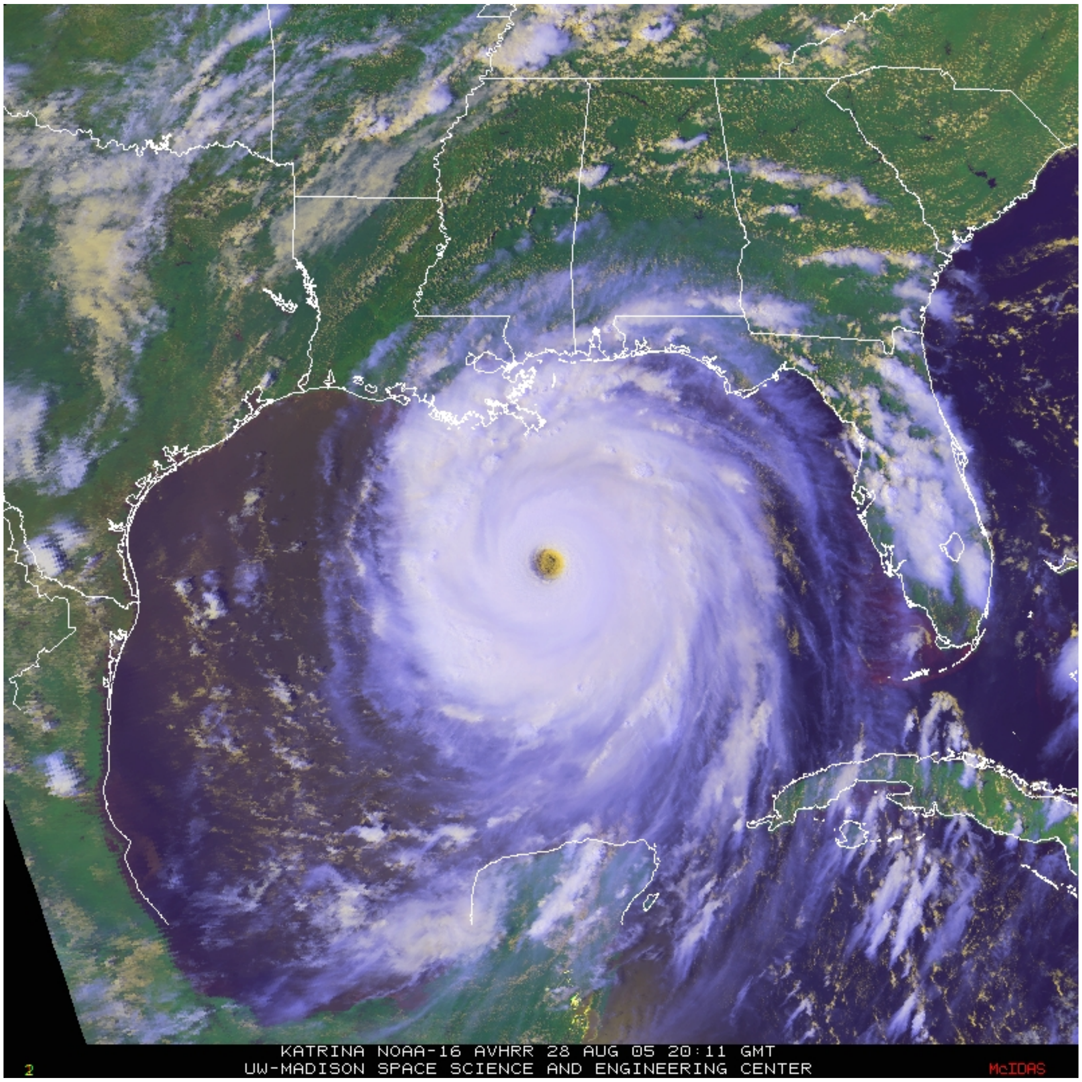

Figure 3 – Hurricane Katrina Composite Imagery

President George W. Bush issued a major disaster declaration on August 29, 2005, under the authority of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), for damage in certain areas of Mississippi resulting from Hurricane Katrina (FEMA-1604-DR-Mississippi).[4] Katrina caused widespread devastation along the central Gulf Coast states with major damage to the coastal regions of Louisiana, Mississippi, and Alabama. Katrina was the most destructive and costliest natural disaster in the history of the United States because of the extent of damage caused by the storm. According to NOAA, the storm surge along the Mississippi coast was the highest storm surge ever recorded in the United States.[5]

[4] http://www.fema.gov/news/dfrn.fema?id=4505
[5] "Tropical Cyclone Report, Hurricane Katrina, 23-30 August 2005, Richard D. Knabb, Jamie R. Rhome, and Daniel P. Brown, National Hurricane Center, 20 December 2005."

As the storm moved inland and weakened to a tropical storm on August 29, rainfall became the primary impact. Rainfall amounts exceeded 2 to 4 inches across a large area from the Gulf Coast to the Ohio Valley. As a result, flood watches and warnings were common across these regions.

2. Methodology

2.1 General

This section summarizes the methodology used to flag and survey the HWMs. It should be noted that it is important to quickly mark or flag HWMs after a disaster so that the HWMs are captured before residents clean up or it rains, thereby potentially eliminating the HWM. Therefore, HWMs are considered perishable, and every effort to quickly flag the HWM is employed so that the HWM can later be surveyed to determine the HWM elevation.

URS received a notice to proceed for this HWM Task Order on August 30, 2005. On that same day, notices to proceed were also received for HWM collection in Alabama and Louisiana, which were also significantly impacted by Hurricane Katrina. At that time, there were reports of significant riverine flooding, and therefore HWM Task Orders were obtained for both coastal and riverine HWM collection.

During the 2005 hurricanes, it was determined that there was a large overlap in the field work between the HWM Task Orders and the Wind Water Line Task Order. To increase efficiency and address the lack of available lodging in the affected area, it was decided to combine the field collection for the HWM Task Orders and the Wind Water Line Task Order. Additional information regarding the Wind Water Line Task Order can be found in the "Hurricane Katrina Rapid Response Wind Water Line Report – Mississippi, Task Order 416."

2.2 Pre-Field Deployment

On August 31, 2005, URS arranged travel and lodging for field staff, modified the HWM database and forms (based on comments from FEMA regarding previous Task Orders), finalized training/orientation material, obtained equipment (e.g., hand-held Global Positioning System [GPS] units, cameras, and health and safety equipment), obtained vaccinations and blood work for field staff (due to concerns about standing water), and obtained FEMA badges for field staff.

A training/organization meeting was held for approximately 30 staff in Tallahassee, Florida on September 1, 2005. Flaggers, data collectors, quality assurance staff, and managers attended this meeting. The training was held for staff who would conduct field work in both Mississippi and Alabama. The meeting was held at URS' office in Tallahassee because it was near the affected areas and had electricity and access to available gasoline and hotel rooms. The training/orientation included discussions on selecting HWM locations, collecting wind water line data, review of field processes (including data capture, documentation, and information transfer), distribution of equipment, and a health and safety briefing.

After the training/organization meeting on September 1, 2005, FEMA agreed that mobilization of staff to the field should be postponed due to the ongoing recovery efforts in the impacted areas, the lack of lodging, and the concern for obtaining gasoline and other essential supplies. Therefore, the flagger teams were placed on standby for later deployment.

On September 5, 2005, URS began to deploy field staff to Alabama where most of the recovery efforts had been completed. At that time recovery efforts in Mississippi were ongoing. Since lodging was still not available in the area, URS rented recreational vehicles (RVs) for the field staff and parked the RVs at a site in Mobile, Alabama. Since no available RV site with electricity could be found along the Mississippi coast, this location was also used during the Mississippi field collection. By September 11, 2005, some field teams were finishing flagging HWMs in Alabama and HWM flagging started in Mississippi on September 12, 2005.

2.3 Data Sources

On August 31, 2005, URS began to collect available information on the extent of flooding to assist in identifying locations for the HWM collection. This included contacting each of the county emergency managers to determine the extent of flooding in their county as well as their priority locations for collecting high water marks. By September 2, 2005, URS placed calls to all county emergency managers in Mississippi. Thirty-six counties indicated there was no significant flooding in their county, and 43 counties did not answer their phone or no one knowledgeable was available.

Over the next several days, URS contacted several other agencies to determine available data sources and information that could be used to determine the best HWM locations. URS contacted the Mobile District of the U.S. Army Corps of Engineers (USACE), which indicated no preference for HWM collection locations. The Mississippi Department of Community Affairs said the hardest hit counties were Hancock, Harrison, and Jackson (along the coast) and Pearl River, Stone, and George Counties (just north of the coastal counties). The NHC provided URS with 15 locations along the coast as their preferred HWMs collection locations. URS also coordinated with the U.S. Geological Survey (USGS), which is discussed in Section 2.7.

URS downloaded forecasted coastal storm surge levels from Crownweather.com (Figure 4) and obtained a preliminary Sea, Lake and Overland Surges from Hurricanes (SLOSH) model prepared by the NOAA NHC. Through the USGS, the NHC provided output from the SLOSH model[6] dated September 9, 2005, and shown in Figure 5. This figure includes graphical, color-designated maximum surge-only levels that occurred during the modeled storm. According to NHC, the SLOSH model is generally accurate within plus or minus 20 percent. The model accounts for astronomical tides (which can add significantly to the water height) by specifying an initial tide level, but does not include rainfall amounts, river flow, or wind-driven waves.

[6] http://marine.usgs.gov/response/katrina/stormsurge/

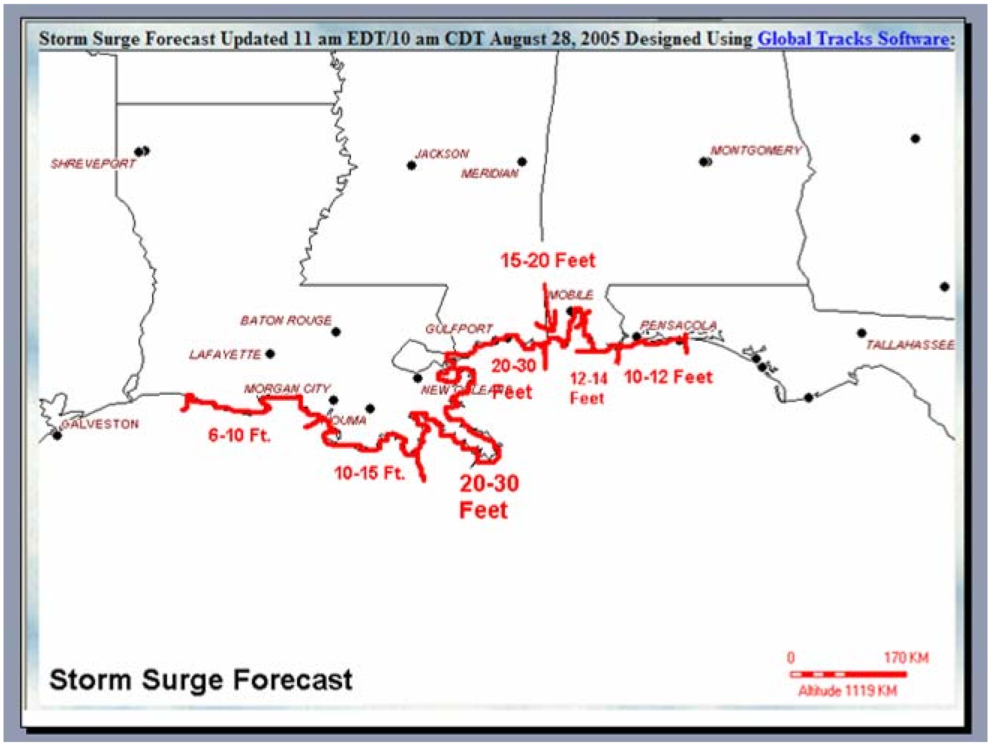

Figure 4 – Forecast Katrina Storm Surge from www.Crownweather.com

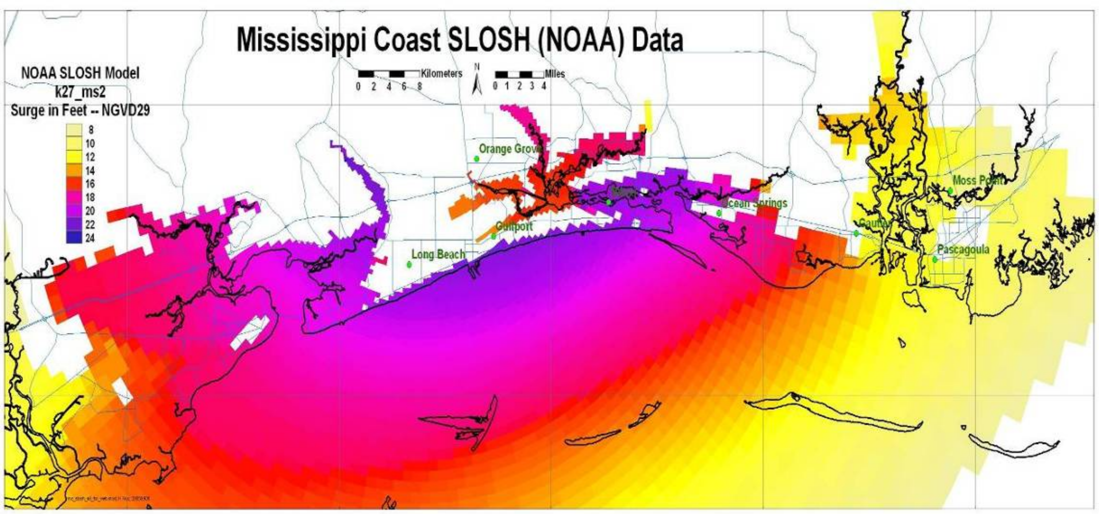

Figure 5 – NOAA Katrina Mississippi Coast SLOSH Data

USGS stream gages in Mississippi were also reviewed. As of September 7, 2005, 15 USGS gages recorded elevations higher than the National Weather Service (NWS) flood stage. A summary of these gages and their elevation in relation to flood stage is shown in Table 1. This table shows that major flooding occurred at two streams. These two gages are located in Harrison County and on the border of Pearl River County and Hancock County. Moderate riverine flooding was also identified in Harrison County, Pearl River County, and Neshoba County (Burnside).

Table 1. USGS Hurricane Katrina Stream Gage Flood Stage and Discharges

USGS Station ID	USGS Station Name	Peak Stage (ft)	NWS Flood Stage (ft)	Peak Discharge (cfs)	Highest Historic Peak Discharge (cfs)	Feet above Flood Stage	Rank of current peak	Flooding Level	County
02481000	BILOXI RIVER AT WORTHAM, MS	25.61	16	9,440	13,500	9.6	3/49	Major	Harrison
02492343	EAST HOBOLOCHITTO CREEK NR CAESAR, MS	20	15	9,800	8,350	5.0	1/4	Major	Pearl River
0248018020	ESCATAWPA RIVER AT I-10 NR ORANGE GROVE, MS	10.24	8	---	---	2.2	---	Moderate	Harrison
02492360	WEST HOBOLOCHITTO CREEK NR MCNEILL, MS	20.95	15	12,600	27,800	6.0	5/35	Moderate	Pearl River
02481880	PEARL RIVER AT BURNSIDE, MS	17.49	13	16,300	76,600	4.5	8/23	Moderate	Neshoba
02475000	LEAF RIVER NR MCLAIN, MS	19.46	18	27,200	131,000	1.5	47/62	Minor	Greene
02478500	CHICKASAWHAY RIVER AT LEAKESVILLE, MS	20.33	20	11,700	125,000	0.3	63/65	Minor	Greene
02481510	WOLF RIVER NR LANDON, MS	26.33	27	16,500	24,500	-0.7	4/30	Minor	Harrison
07289350	BIG BLACK RIVER AT WEST, MS	16.98	15	3,830	71,200	2.0	66/66	Minor	Holmes
02482000	PEARL RIVER AT EDINBURG, MS	23.83	20	11,600	77,900	3.8	41/92	Minor	Leake
02482550	PEARL RIVER NR CARTHAGE, MS	20.03	17	10,900	102,000	3.0	31/41	Minor	Leake
02483000	TUSCOLAMETA CREEK AT WALNUT GROVE, MS	25.08	25	3,140	34,600	0.1	59/62	Minor	Leake
02437000	TOMBIGBEE RIVER NR AMORY, MS	23.46	20	29,000	162,000	3.5	45/65	Minor	Monroe
02433500	TOMBIGBEE RIVER AT BIGBEE, MS	14.82	14	9,130	112,000	0.8	46/48	Minor	Monroe
02439400	BUTTAHATCHEE RIVER NR ABERDEEN, MS	13.69	13	5,060	80,000	0.7	33/34	Minor	Monroe
02448000	NOXUBEE RIVER AT MACON, MS	28.13	26	11,200	125,000	2.1	44/68	Minor	Noxubee
02479155	CYPRESS CREEK NR JANICE, MS	24.99	---	5,800	16,700	---	7/35	---	Perry

2.4 Identification of the Study Area

URS prepared a Work Plan for Hurricane Katrina Mississippi HWMs, which was submitted to FEMA on September 11, 2005. The purpose of the Work Plan was to outline URS' general locations where HWMs would be collected. This plan was based on discussions with other agencies and data collected (refer to Section 2.3), as well as discussions with FEMA.

Based on the discussions and collected information (see Section 2.3), URS focused the HWM collection in the coastal counties where significant flooding occurred: Hancock, Harrison, and Jackson. In addition, URS assigned field visits for the approximately 30 rivers identified in the Task Order Work Plan with predicted flooding based on the SLOSH modeling and USGS stream gages. These rivers were also mostly located in the three coastal counties.

2.5 Flagging Field Data Collection Procedures

The field work for the Mississippi HWM flagging began on September 12, 2005 and ended on September 23, 2005. Two-person teams were used to flag the HWMs. The number of two-person flagging teams in Mississippi varied daily during the project, ranging from 6 teams to 9 teams. By September 19, 2005, most of the flagging was completed and many of the flagging teams had been demobilized. However, a couple of flagging teams remained in the field to complete flagging in some areas.

In addition to the flagging teams, data collectors and field coordinators were in the field. The data collectors collected the data from the flagging teams and delivered it to a URS office where the data was entered into a database. Use of the data collectors was required because electricity and working phone lines in the impacted areas were intermittent. Field coordinators met daily with the flaggers to review the HWMs collected that day and to discuss the next day's assignments. A field manager, located in the URS Tallahassee office, reviewed and mapped the compiled data daily and directed the field coordinators to the general areas of HWMs collection locations.

Each day the two-person flagging teams were given a general geographic area in which to identify and flag HWMs. The flagging teams visited these areas and searched for structures with mud or water lines and areas with debris lines (i.e., man-made materials) or wrack lines (i.e., plant materials). Upon visiting the assigned geographic area, the flaggers would first determine whether the area appeared impacted by flooding. If the area did not appear to be impacted by flooding, then the flaggers noted this for their daily briefing with the field coordinator and proceeded to the next area. If the area appeared to have been impacted by flooding, then the flagger searched for a visible HWM to be flagged.

A building is the preferred location for a HWM to be flagged. However, there were few remaining buildings in those areas severely impacted by Hurricane Katrina's flooding and high winds. When impacted buildings were still standing, the flagger searched for visible HWMs. The preferred HWM location is inside the building; therefore, the flaggers searched inside for a visible HWM when access was available. If no inside HWM could be obtained, an exterior

HWM was flagged. In areas where there were no visible HWMs on buildings, the flaggers searched for other signs of high water, such as debris lines or wrack lines on the ground, vegetation, bridge embankments, or fences. Visible HWMs are often difficult to find because coastal flooding typically enters and exits a site quickly, receding before a water mark is left. Examples of various types of HWMs are shown in Figures 6 through 9.

Figure 6 – Interior Mud Line HWM

Figure 7 – Exterior Mud Line HWM

Figure 8 – Debris Line HWM

Figure 9 – Wrack Line HWM

The spacing of the flagged HWMs was irregular. More HWMs were flagged in areas that were significantly impacted by flooding than in areas of minor flooding. Consequently, more HWMs were flagged along the coast. However, inland coastal HWMs were also flagged to determine the inland extent of flooding. In the coastal areas, multiple HWMs were flagged in the same area to document different coastal flood types (e.g., surge-only, wave height, wave runup) or to better determine the flood elevation. Evaluation of site conditions where HWMs were flagged is based on the flaggers' best judgment of the height of flood waters. In addition, the height of flood waters can be affected by outside forces such as wind and shielding by other structures. Therefore, in significantly damaged areas, multiple HWMs were obtained in the same area to provide better flood elevation data. Fewer HWMs were flagged in areas that received less flooding or where there were fewer buildings.

For riverine flooding, the flaggers visited hydraulic structures, such as bridges and culverts, inland of the coastal flooding. URS visited each of the 30 rivers identified in the Work Plan. The field coordinator directed the flaggers to collect riverine HWMs both upstream and downstream of the bridge or culvert. However, significant flooding at the bridge or culvert often did not occur, and conditions resulted in flagging of only one HWM at the bridge or culvert. The flaggers also visited flooded inland buildings. Depending on the location and elevation of the building, the HWMs may have been classified as riverine flooding.

On a daily basis, URS reviewed the areas where HWMs were flagged and sent flaggers to fill in apparent data gaps. However, often there was no access to these areas (typically near the coast) or there was no evidence of flooding (typically along the rivers).

It should be noted that FEMA initially identified a large number of counties to be investigated for riverine HWM collection. However, based on URS' field investigations, HWMs for significant riverine flooding were not present in the non-coastal counties. Therefore, URS collected HWMs in only the three Mississippi coastal counties.

URS flagged over 300 HWMs. For each identified HWM, the flaggers completed a standardized form including detailed data about the HWM (Figure A.1 in Appendix A). The flaggers documented the HWM's approximate latitude and longitude coordinates using hand-held GPS units to help surveyors find the HWM. The flaggers used their judgment regarding the source of the flood water (coastal flooding or riverine flooding). In some instances, flaggers obtained anecdotal information from residents as to the timing of the flood. Since riverine flooding is typically delayed one or several days from the actual coastal event, this timing helped determine whether a particular HWM was classified as coastal or riverine. The flaggers used the location of the HWM in relation to other land features to estimate of the type of coastal flooding (e.g., surge-only, wave height, and wave runup). For example, a debris or wrack line on a stretch of open coast is the result of wave run-up. However, when significant amounts of vegetation block or dampen the wave effect, these marks are identified as surge-only instead.

URS submitted the Preliminary Mississippi Field Summary Report, dated September 23, 2005. This report showed the location of flagged HWMs available at that time. In addition, preliminary visually estimated HWM elevations for some points were provided to assist FEMA in its recovery efforts.

2.6 Survey Procedures

Due to the necessity to quickly obtain surveyed HWM information, the URS team surveyors began the survey field work shortly after the HWMs were flagged. URS' surveyor, PBS&J, began to establish the benchmark/control network on September 17, 2005. Due to the disturbance of existing benchmarks as a result of Hurricane Katrina, two additional days were required to set up the network. Seven survey crews began their work in Mississippi during the week of September 19, 2005. However, due to heavy rain from Hurricane Rita, they had to demobilize from Mississippi on September 23, 2005, and then remobilized the following week. The surveyors completed the initial surveying of approximately 400 points at the end of October 2005.

URS survey crews surveyed the HWMs identified and flagged by URS flagger teams and the HWMs identified separately by the USGS, as discussed in Section 2.7. The survey crews used static GPS methods and conventional leveling to determine the horizontal coordinates (latitude and longitude) and elevation for each HWM. HWMs were surveyed horizontally in the North American Datum of 1983 (NAD 83), Mississippi East State Plane Coordinates, and vertically in the North American Vertical Datum of 1988 (NAVD 88); both surveys were conducted in U.S. survey feet. The HWMs were surveyed to the accuracy of 0.25 foot vertically and 10 feet horizontally with a 95% accuracy level. Inclement weather that would have adversely affected the GPS surveys was avoided to ensure this level of accuracy.

Data were recorded on standardized forms as shown in the example, Surveyor High Water Mark Data Collection Report Form (Figure A.2 in Appendix A). Static GPS was performed directly at the HWM whenever possible. The survey crews used conventional leveling techniques from a static GPS reference point when the HWM location would not support direct GPS observations. Wherever possible, a building floor elevation was surveyed on structures. These floor elevations were taken adjacent to the HWM where available and may or may not represent the first floor of the structure. This information was obtained for later use in damage assessments or HMGP applications.

2.7 USGS-Flagged HWMs

During URS' discussions with the USGS in early September, the USGS indicated that they were flagging HWMs in Mississippi, assisted by the USACE, and requested that FEMA survey the HWMs that they flagged. FEMA agreed and tasked URS with surveying USGS/USACE-flagged HWMs. On September 15, 2005, the USGS provided URS with longitude, latitude, HWM description, and temporary bench mark (TBM) descriptions for approximately 100 HWMs in Mississippi. URS provided the longitude, latitude, and HWM description to the surveyor.

On October 19, 2005, URS sent the HWM survey results to the USGS. However, on October 28, 2005, USGS stated that they intended for URS to survey the TBMs and not the HWMs. On January 20, 2006, the USGS provided the following summary of their work:

The USGS initiated HWM flagging in Mississippi on September 1, 2005. USGS flaggers did not leave physical flags at several locations situated on private property or where HWMs varied extensively, such as at bridge sections subject to drawdown. Instead they established and flagged TBMs and did “line-of-sight” or conventional leveling from these TBMs to each of various HWMs at the time of the leveling to establish the relative elevations of the HWMs. The intent was for the follow-on URS surveyors to level-in the TBMs to a controlled datum using GPS so that all of the elevations could be determined for multiple HWMs more efficiently and with less danger of mark destruction or disturbance. This expectation was not uniformly communicated to URS surveyors who often omitted leveling of the TBMs and directly shot some USGS HWMs, based on USGS HWM descriptions and photographs, or leveled-in HWMs of their own selection. This miscommunication hampered use of many USGS HWMs in subsequent analysis.

In follow-on quality assurance surveying, the USGS resurveyed 35 USGS-flagged, URS-surveyed HWM locations in Mississippi (Table 2). The USGS used National Geodetic Survey benchmarks (usually 1st order benchmarks) where available and line-of-site survey techniques with closure errors of 0.03 foot or less (usually 0.015 foot or less). Of the 35 HWM elevations, 19 matched URS estimates within 0.25 foot. Most of the remaining errors are thought to have arisen from differences in identification of HWMs elevations (owing to communications difficulties described above), and not surveying technique.

Table 2. Summary of Comparisons of USGS and URS Mississippi HWM Elevations

Comparison Error (in feet)	Less than or equal to 0.25	Greater than 0.25 and less than or equal to 0.50	Greater than 0.50 and less than or equal to 0.75	Greater than 0.75 and less than or equal to 1.0	Greater than 1.0 and less than or equal to 2.5
Number of High Water Marks	19	6	2	3	5

It should be noted that URS flaggers did not visit the USGS-flagged HWMs. Since USGS did not use the same flagger collection form as URS, several data fields were not collected (such as flooding source, flooding type, etc.), and therefore those data are not included.

2.8 Elevation Conversion from NAVD 88 to NGVD 29 Using Corpscon

As indicated, the surveyor computed the HWM elevations in the vertical datum of NAVD 88. However, since many of the FEMA FIRMs are in National Geodetic Vertical Datum of 1929 (NGVD 29), each elevation was converted and also reported in NGVD 29. This conversion was completed using the Corpscon program version 5.11.08.[7] The Corpscon program uses the VERTCON software internally. The VERTCON software was developed by the National

[7] http://www.cae.wisc.edu/site/software/?title=app199

Geodetic Survey (NGS) office to convert data between different vertical data scales. VERTCON is available as an element of the NGS Geodetic Toolkit and can be downloaded from the NGS website.[8]

The VERTCON software allows the user to compute the modeled difference, or datum shift, in orthometric height for a given location specified by its latitude and longitude. Applying the computed datum difference value to a specific elevation converts from one datum to another.

For converting elevations in the NAVD 88 datum to the NGVD 29 datum, the datum shift has to be subtracted from the NAVD 88 elevation. This can be demonstrated by two examples, one with a positive shift and one with a negative shift:

	Case 1	Case 2
NAVD 88 Elevation	5.33	5.33
Datum shift	+0.50 feet	-1.17 feet (negative shift)
NGVD 29 Elevation	5.33 – (0.50 feet) = 4.83	5.33 – (-1.17) = 6.50

2.9 Quality Assurance Review

Upon receipt of the data from the surveyor, URS began the quality assurance (QA) process. The QA process involved checking each data field in the database, including HWM elevation and flood type. As requested by FEMA, URS provided FEMA, USGS, and the USACE partially QA reviewed data sets on October 27 and October 31, 2005. URS provided FEMA a more fully QA reviewed data set on November 19, 2005.

URS' QA review of the data included checking the surveyed elevation for reasonableness based on other nearby HWMs and available topography. If a discrepancy was found, it was sent back to the surveyor for his/her review. If the point continued to be inconsistent, then URS made a judgment regarding continued use of the point. Based on the flaggers' information, if it appeared the surveyed point may not actually represent a valid HWM, then the point was removed from the database. An example of this is when debris in a tree was flagged as a HWM. Based on comparing the surveyed elevation of this point and other nearby points, it appeared that the debris in the tree may be wind-blown debris and not flooding debris; therefore the point was deleted from the database. Approximately 10 HWMs flagged and surveyed by URS were removed from the database due to concerns regarding reasonableness.

URS QA review also included examination of the flooding type. While the flaggers made their best estimate of the flooding type based on observed field conditions, sometimes the flooding type can be better identified after the HWM locations and elevations are mapped. Therefore, the flooding type for each HWM was reviewed based on mapped locations and elevations of the surveyed HWMs.

8 http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html

The determination of whether a point was from coastal flooding or riverine flooding was based on review of all of the HWMs in the area and the estimated wind-water line. The wind-water line is the estimated boundary that delineates the inland extent of the area where structures were damaged as a result of flooding from coastal surge. Landward of the line, most of the damage is attributable to winds and/or wind-driven rain, and HWMs in this area were typically designated as riverine. On the ocean-side of the line, HWMs were typically designated as coastal flooding. The analysis of flooding type was conducted based on the approximate location of the wind water-line because it is difficult to determine the exact location of the wind-water line. URS also considered the coastal HWM elevation at the inland extent of coastal flooding. The elevation of the coastal flooding at the inland extent should be relatively consistent in an area. Therefore, if a HWM elevation near the wind-water line was higher than the estimated coastal surge elevation in the area, then the HWM was identified as riverine flooding.

The HWMs designated as coastal flooding were further identified as representing surge-only, wave height, and wave runup (see Section 3 for discussions of these flooding types). The QA review included evaluation of the coastal flooding types that the flaggers identified. HWMs collected inside a building or within other protected areas were designated as surge-only HWMs. URS evaluated the HWM’s associated photograph, the location of the HWM relative to other land features, and other nearby HWM elevations to confirm the coastal flooding type.

Other QA checks included reviewing the flooding source, nearest municipality, county, photographs, consistency of data, and similar factors. After the QA review of the data was completed, URS prepared the Draft Report. However, since the QA review showed inconsistency in the USGS-flagged data, URS worked with USGS to resolve these issues. The Draft Report was submitted to FEMA on January 16, 2006. FEMA provided comments on February 3, 2006.

3. Flood Types

3.1 General

HWMs were collected for two types of flooding: coastal and riverine. Consequently, each HWM was classified as either a result of coastal flooding (caused by storm surge) or riverine flooding (caused by rainfall). The conditions that compose these flood types are described in the following section. It should be noted that while Hurricane Katrina was a significant coastal flooding event, a much smaller number of properties were affected by riverine flooding.

3.2 Coastal Flooding

Coastal flooding is caused when coastal waters are driven inland by waves and wind. Coastal flooding conditions are more varied in their origin than those associated with riverine flooding and can be further classified as either surge-only, wave height, or wave runup. The coastal flooding types are discussed below and presented graphically in Figures 10 through 16. These figures illustrate ideal situations of coastal flooding, which will not necessarily occur in any one location or one particular storm event. Each of the three basic types of coastal HWMs—surge only, wave height, and wave runup—are often found close to each other. These HWM types can differ in elevation, and each provides information that describes the nature and behavior of the coastal flooding.

Since this project was a Rapid Response Task Order that required that the HWMs be quickly flagged, surveyed, and reported, the assignment of the flooding type was based on observations made during the flagging field work and later reviewed based on mapping the data. A detailed analysis of land conditions, such as topography, bathymetry, locations of dunes, sloped water surface, overwash, or breaching, was not performed; this level of analysis was not part of the scope of work or even possible due to the time limitations. Therefore, all classifications are estimates based on the best available data at the time.

It is beneficial to collect HWM for the different types of coastal flooding because different uses of the HWM data require different coastal flooding types. Table 3 shows the typical coastal flooding type needed for each of the uses of the HWM data.

Table 3. Coastal Flooding Type Required For Various Uses of HWM Data

HWM Data Use	Coastal Flooding Type Required
Quickly estimate event frequency and severity for different areas	Surge-Only and Wave Height
Assess Flood Insurance Rate Maps	Surge-Only and Wave Height
Assist in preparation of wind-water line maps	Any type
Prepare inundation maps	Surge-Only (typical), Wave Height and Wave Runup
Share information for building performance assessment	Wave Height
Share information for modeling	Surge-Only
Provide public and agencies with elevations for prioritizing mitigation and benefit/cost analysis	Wave Height
Determine depth of flooding of structures	Surge-Only

3.2.1 Surge-Only

Figure 10 shows the simplest form of coastal flooding (surge-only). In this type of flooding, as the water level during the storm rises to a maximum level, it can leave marks on both the interior and exterior walls of a structure that are of equal elevation. Both of these water marks indicate a coastal flooding level that is not complicated by other factors, such as waves. However, these situations occur only where the structure is at a location sheltered from waves.

Ideally, surge-only flooding has maximum elevations that are either level or have a slight slope that is not easily detected visually. This is shown schematically in Figure 11. However, this is not always the case in the coastal zone. As shown in Figure 12, coastal surges can also have sloped water surfaces. High water caused by a hurricane storm surge is brought about by the combination of rapidly changing factors such as wind speed, wind direction, lowered barometric pressure and the storm track. Surge represents the rise in the water level where the location was shielded from waves. In some cases the surge develops in open water areas and spreads inland over large distances because the coastal lands have minimal topographic change. The overland flow can be retarded by inland marsh areas and other obstructions so that the flood water surface slopes downward towards the inland shore, as shown as Case A, Figure 12. Under other circumstances, a strong onshore wind can force the overland coastal flood waters further inland, forming an upward slope towards the inland shore, as shown in Case B in Figure 12.

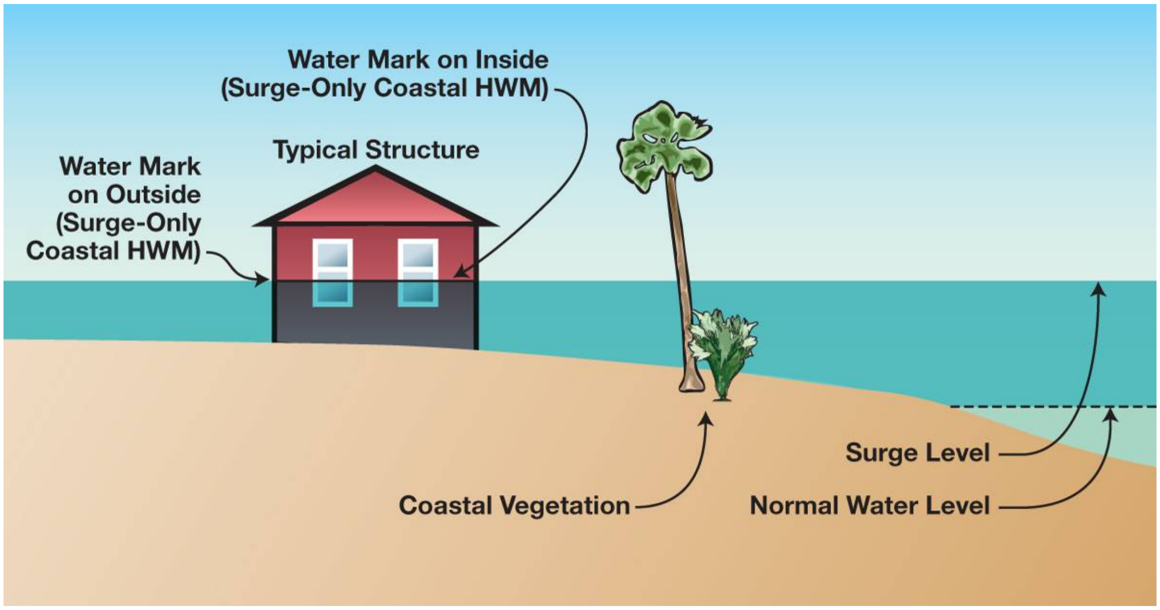

Figure 10 – Coastal HWM Resulting from Surge-Only

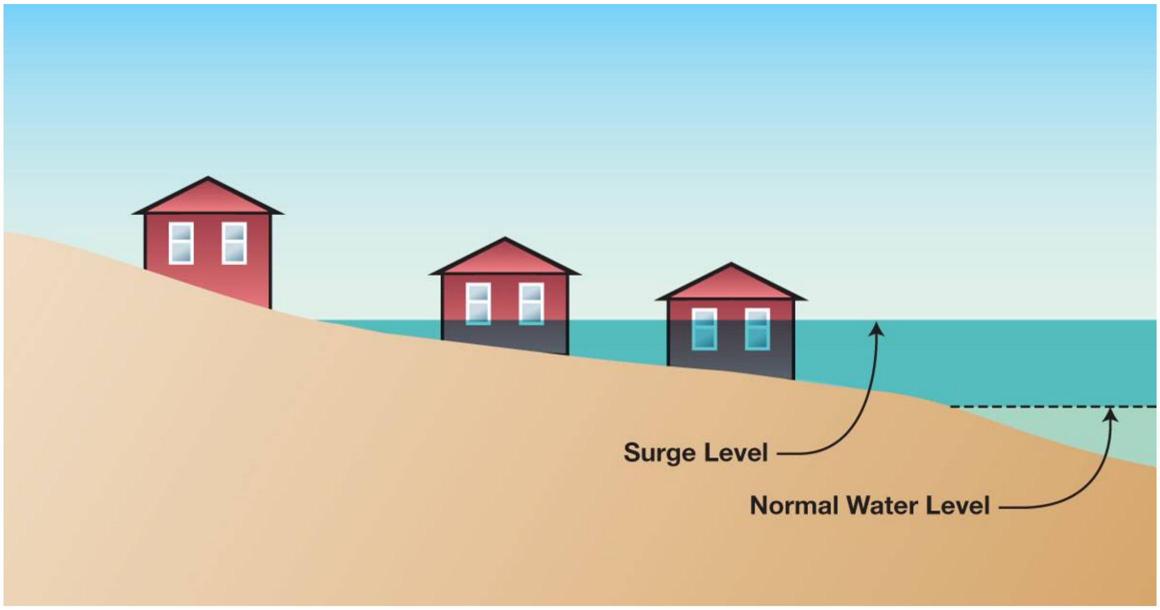

Figure 11 – A Coastal Storm Surge With a Level Water Surface

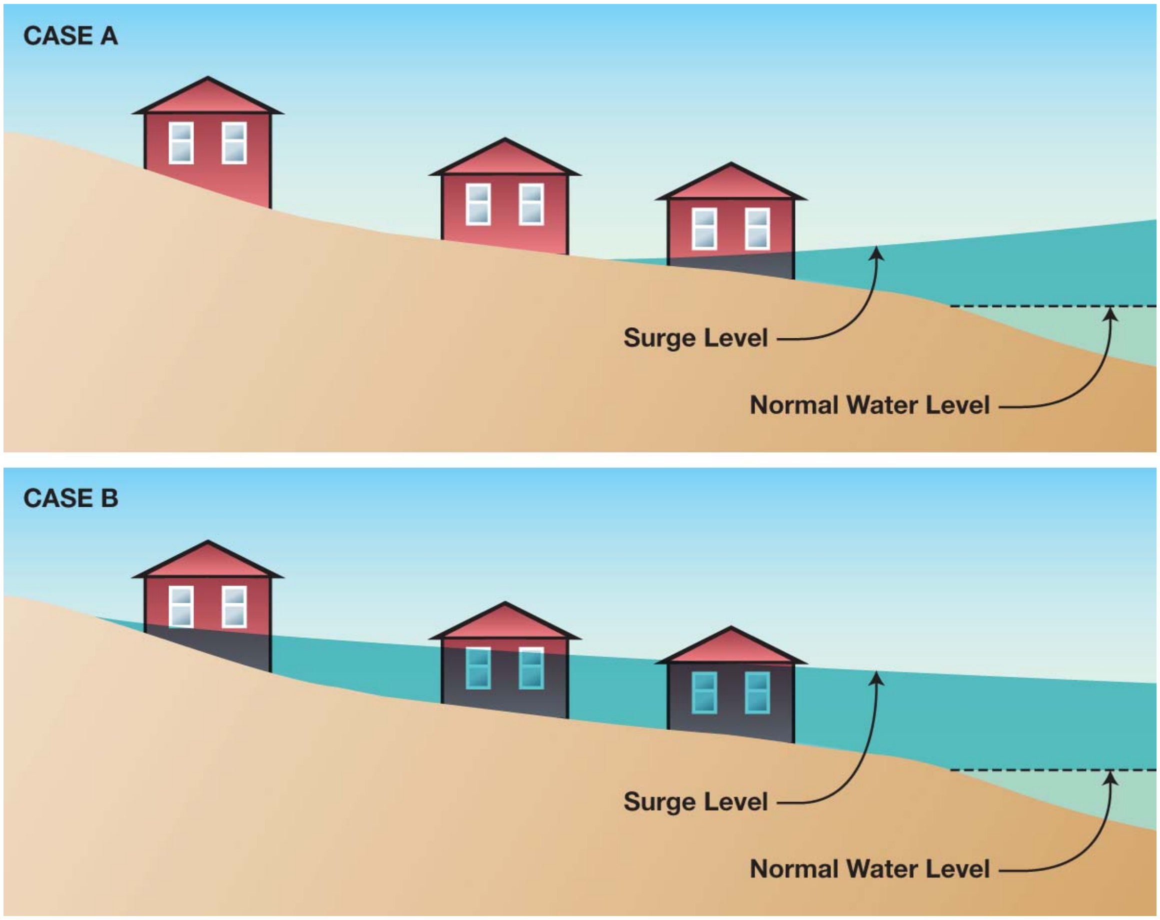

Figure 12 – Two Cases of Storm Surges With Sloped Water Surfaces

3.2.2 Wave Height

The second type of coastal flooding includes action due to waves, or coastal wave height flooding. As coastal flood waves propagate, high water conditions on structures and land vary. Coastal wave height flooding is created by the crest of the wave riding on the surge. Figure 13 shows how HWMs found inside and outside of a structure can differ considerably if they are impacted by waves. HWMs corresponding to the conditions shown on the exterior wall in Figure 13 are designated as wave height flooding because the crests of the waves that are riding on the surge leave the highest mark. HWMs corresponding to the situation shown on the interior wall in Figure 13 are designated as surge-only flooding because the whole structure acts as a stilling-well, and the HWM corresponds to a water level unaffected by the waves.

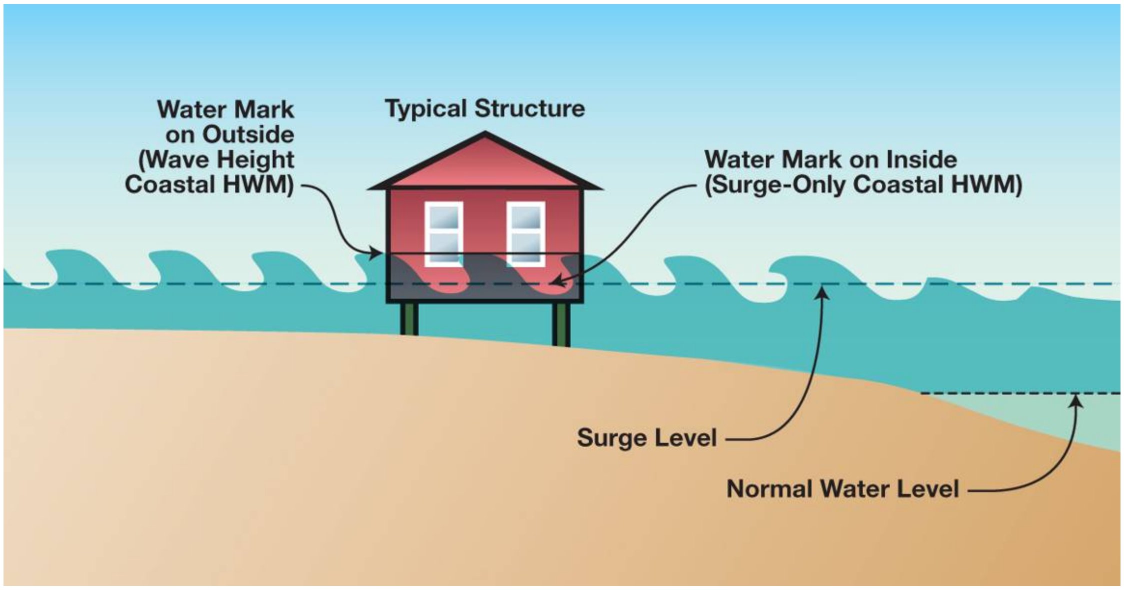

Figure 13 – Coastal HWM Resulting from Wave Height

3.2.3 Wave Runup

The third type of coastal flooding includes wave action runup, or coastal wave runup, as illustrated in Figure 14. With coastal wave runup, the situation is complicated by the presence of a surf zone, which is the broad zone of spilling and breaking waves between the open water body and the beach. At the very top of the surf zone, the remaining energy of the wave causes the waves to wash up the beach slope. The result is referred to as wave runup. Wave runup often pushes debris to its maximum limit where it is left as a wrack line. HWMs of this type are designated as wave runup flooding.

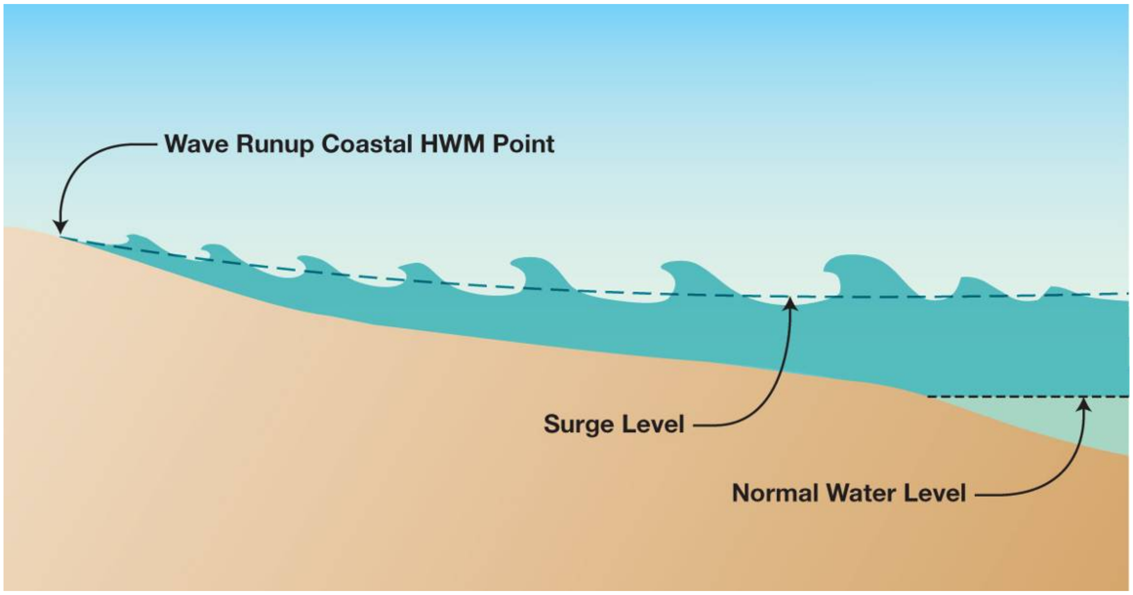

Figure 14 – Coastal HWM Resulting from Wave Runup

3.2.4 Impact of Dunes

Figure 15 shows more variable conditions of coastal flooding caused by land conditions, such as sand dunes. It is not uncommon for the wave runup in a storm to be so large that it completely crosses the beach and flows through gaps in the coastal dunes. These are called "washover channels," and they convey the water over the dunes to low areas behind the dunes. Figure 15 shows three structures at different locations along the dune, each impacted differently by coastal flood waters during the storm. When the corresponding HWMs are found, marked, and surveyed, the elevations can differ up to several feet over a relatively short distance (e.g., 1,000 feet).

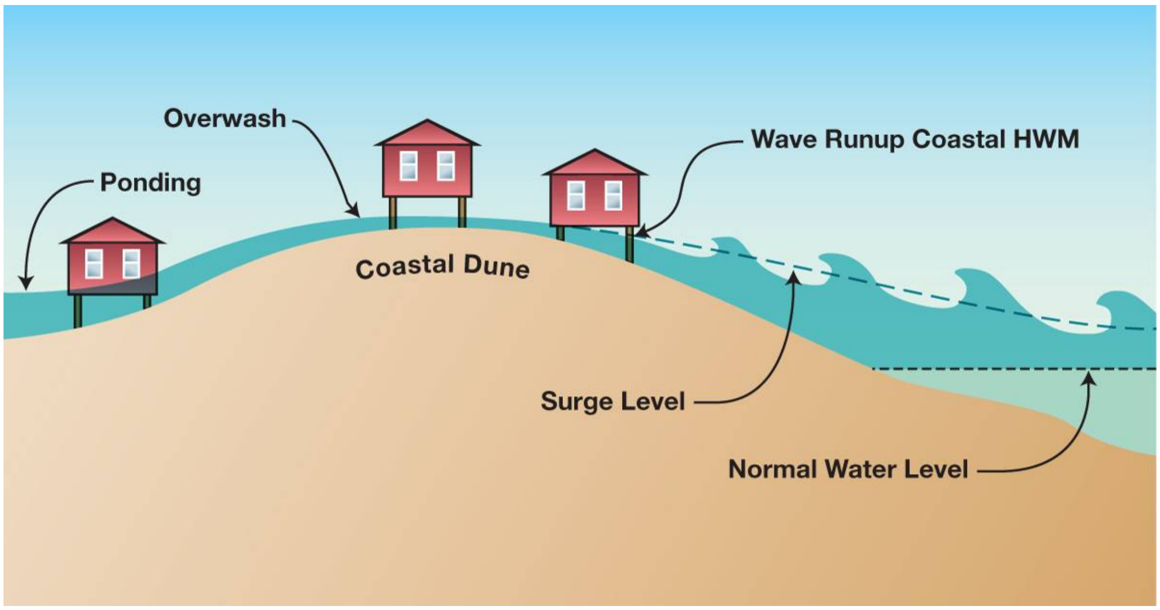

Figure 15 – Variations in Coastal Flooding Levels Due to Washover of Coastal Dunes

During some hurricanes, changes in the shape of the beach and dunes can substantially affect the elevation and extent of the coastal flood waters. Typically, storm conditions cause erosion of beaches and dunes. The combined effects of this erosion and the rise of the water levels can substantially reduce the level of coastal protection. This will inevitably result in inland inundation and flooding that would not have occurred if the coastal dunes had not eroded. These conditions are illustrated in Figure 16. Coastal flooding elevations in these areas can depend on how long the dune line held the ocean back compared to the rate at which the storm moved inland. If the dunes held back the ocean long enough, then the backshore flooding may have occurred after the maximum surge height.

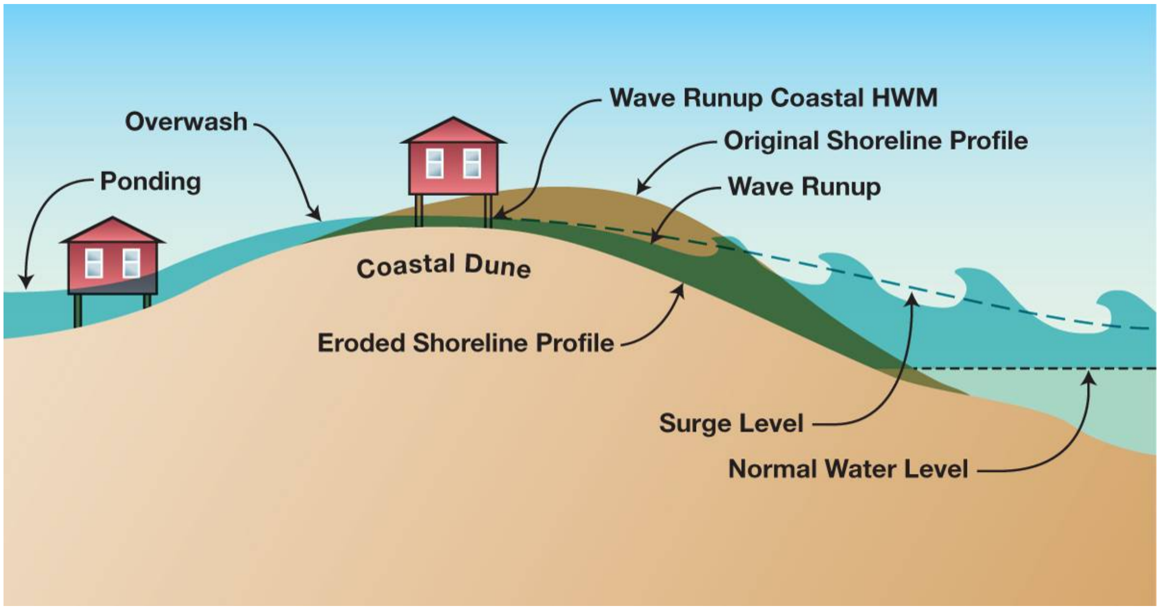

Figure 16 – Interaction of Profile Erosion and Coastal Flooding

There are other factors in coastal flooding to consider related to local conditions. On barrier islands, coastal flooding on the seaward side may differ in elevation from those on the bay side because the maximum surge levels formed at different times during the storm. Within bays, the surge may be amplified by the effect of wind acting on broad, shallow areas. In other cases, the tidal inlet may retard the flow of water into the bay so that its level cannot rise to the level of the ocean. Conversely, it is common to find a funneling action that amplifies the surge level where the shorelines of the bay converge toward the head of the bay.

3.3 Riverine Flooding

Riverine flooding occurs when heavy rainfall causes river levels to rise. The origin of riverine flood conditions vary less than coastal flooding, as riverine conditions do not undergo the coastal forces of wind and waves. High water levels from riverine flooding are mainly driven by the amount of rainfall based on the intensity, speed, and progression of a hurricane as it moves inland. Often the peak water elevations from riverine flooding along major rivers occurs one or more days after the hurricane has made landfall. Flooding occurs as the rainfall from the hurricane impacts the watershed and makes its way through downstream rivers. Riverine high water levels near coastal water bodies could also be affected by backwater, which occurs when the river cannot discharge into elevated coastal waters.

4. Observations and Conclusions

The HWM data collected for this study demonstrate that the Hurricane Katrina coastal storm surge and wave-related high water conditions reached historical proportions and affected a significant portion of the Mississippi study area. This section discusses the data that was collected as well as characteristics of the coastal and riverine HWM elevations in Hancock, Harrison, and Jackson Counties. The following observations pertain to the data and figures in this report and are referenced in NAVD 88.

4.1 High Water Mark Data Collected

High water marks were collected in coastal and riverine areas of the three Mississippi counties that lie between the Mississippi/Alabama border and the Mississippi/Louisiana border: Hancock, Harrison, and Jackson. As shown in Tables 4 and 5, a total of 402 HWMs were surveyed in these three counties; 312 HWMs were flagged and surveyed by URS, and 90 HWMs were flagged by USGS and surveyed by URS.

Table 4. URS Team HWMs Surveyed by County

County	Number of HWMs Surveyed
Jackson	117
Harrison	145
Hancock	50
Total	312

Table 5. USGS-Located HWMs Surveyed by County

County	Number of HWMs Surveyed
Jackson	12
Harrison	46
Hancock	32
Total	90

HWMs are based on the flagger teams' best judgment of the flood waters' height. Many structures were severely damaged during Katrina, which often made locating HWMs difficult. In addition, the height of flood waters can be impacted by outside forces such as wind and shielding by other structures. Therefore, HWMs should be used to identify trends and not to extrapolate exact height of water throughout the area. In addition, severe damage to structures, trees, and other features made it difficult to find good indicators of the combined surge and wave height maximum water level.

HWMs flagged and surveyed by the URS team and USGS are shown graphically in Figure 17.

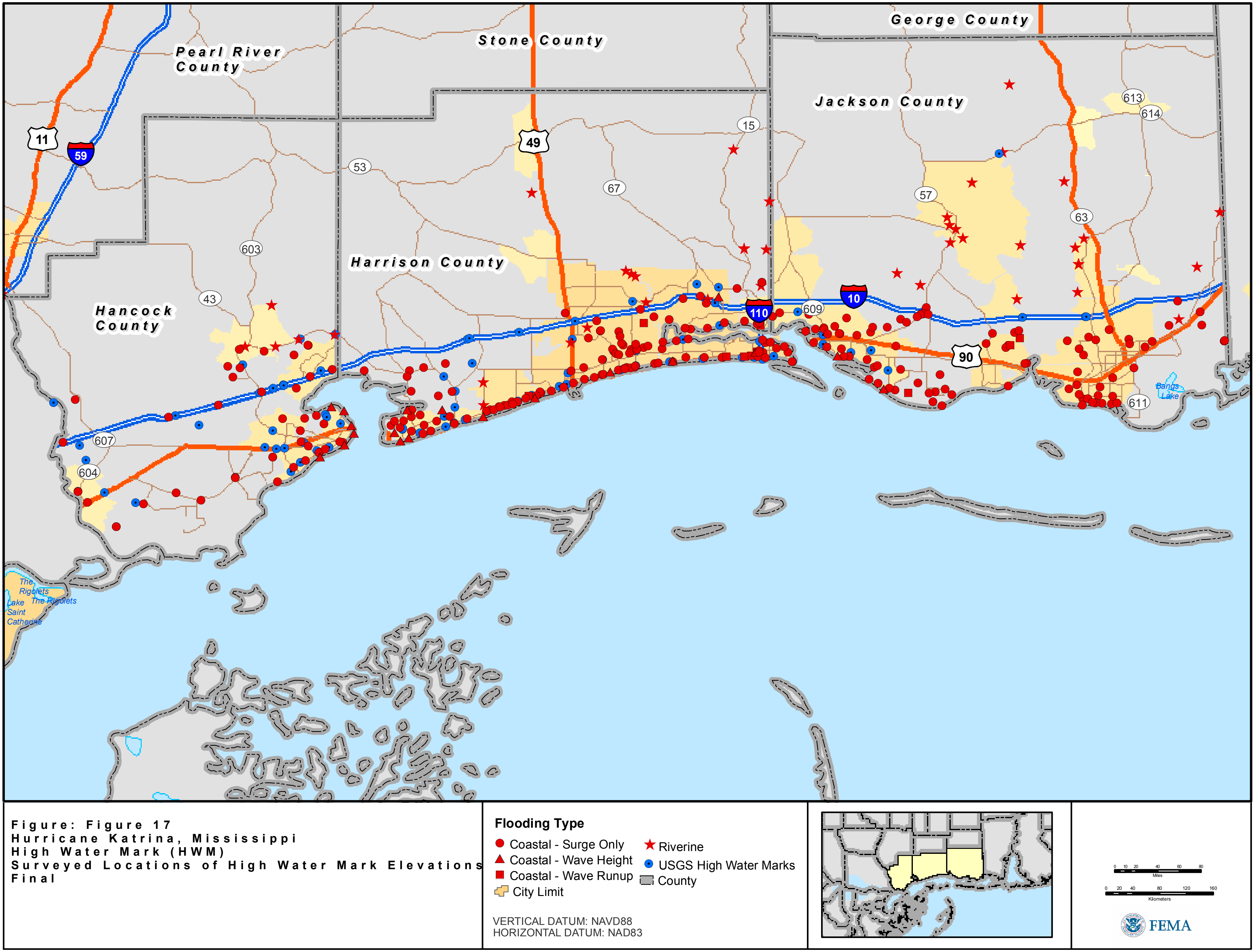

Figure: Figure 17
Hurricane Katrina, Mississippi
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final

Data collected for the HWMs are stored in a digital database and presented on one-page forms that are sorted by county in the appendices of this report. Forms for HWMs that were flagged and surveyed by URS are included as Appendices C through E. Points investigated and located by USGS are shown on forms in Appendix F. The HWMs are identified with a unique point number, the High Water Mark Identifier (HWM ID), as shown on the one-page HWM form. The one-page HWM forms include data for the storm event, flood type, location, point description, surveyed point coordinates (LAT/LON and state plane), and elevations. A summary of basic data for all HWMs collected are sorted by county and HWM sheet number and presented in Table 6. A second summary table with HWM data sorted by HWM ID is provided in Appendix B as Table B-2.

HWM location maps and a second summary table of HWM data are provided in Appendix B. HWMs collected for Hurricane Katrina Mississippi, including URS Team and USGS flagged points, are shown spatially on HWM location maps, Figures B.1 through B.8. These figures present the location, HWM ID, and the field-surveyed HWM elevation in feet referenced in NAVD 88. The symbol representing the HWM point on the map is graphically coded and designates whether the HWM is a URS Team or USGS point, and whether it is riverine or coastal (i.e., surge, wave height, or wave runup). Table B-1 lists Counties in which the data were collected and the corresponding figures on which they are shown. Table B-2 provides the HWM summary data provided in Table 6, however, the data is sorted by the HWM ID value for referencing convenience.

Table 6. Hurricane Katrina Mississippi HWM Data Summary

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
URS Team Surveyed Points						
KMSC-02-35	Hancock	Coastal - Surge Only	20.4	30.330756	-89.376202	Hanc-1
KMSC-02-36	Hancock	Coastal - Surge Only	20.6	30.333419	-89.363736	Hanc-2
KMSC-02-37	Hancock	Coastal - Surge Only	26.9	30.317860	-89.380749	Hanc-3
KMSC-02-38	Hancock	Coastal - Surge Only	21.1	30.330132	-89.399373	Hanc-4
KMSC-02-39	Hancock	Coastal - Surge Only	23.8	30.362593	-89.385026	Hanc-5
KMSC-04-01	Hancock	Coastal - Surge Only	20.1	30.241955	-89.605661	Hanc-6
KMSC-04-02	Hancock	Coastal - Surge Only	19.5	30.216038	-89.575426	Hanc-7
KMSC-04-03	Hancock	Coastal - Surge Only	16.6	30.243894	-89.485826	Hanc-8
KMSC-04-04	Hancock	Coastal - Surge Only	23.7	30.267713	-89.449307	Hanc-9
KMSC-04-05	Hancock	Coastal - Surge Only	20.4	30.251886	-89.511768	Hanc-10
KMSC-04-06	Hancock	Coastal - Surge Only	20.1	30.240107	-89.546675	Hanc-11
KMSC-04-07	Hancock	Coastal - Surge Only	22.2	30.358643	-89.421384	Hanc-12
KMSC-05-01	Hancock	Coastal - Surge Only	19.8	30.263517	-89.404830	Hanc-13
KMSC-05-02	Hancock	Coastal - Surge Only	24.4	30.285967	-89.375132	Hanc-14
KMSC-05-03	Hancock	Coastal - Surge Only	25.5	30.294469	-89.361203	Hanc-15
KMSC-05-04	Hancock	Coastal - Surge Only	25.9	30.305190	-89.335591	Hanc-16
KMSC-05-05	Hancock	Coastal - Wave Height	25.8	30.314997	-89.323922	Hanc-17
KMSC-05-06	Hancock	Coastal - Wave Height	25.8	30.322952	-89.326554	Hanc-18
KMSC-05-07	Hancock	Coastal - Wave Height	22.8	30.338542	-89.334562	Hanc-19

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-05-08	Hancock	Coastal - Wave Height	22.3	30.342769	-89.347578	Hanc-20
KMSC-05-09	Hancock	Coastal - Surge Only	16.3	30.324812	-89.355554	Hanc-21
KMSC-06-01	Hancock	Coastal - Surge Only	19.5	30.374266	-89.451833	Hanc-22
KMSC-06-02	Hancock	Coastal - Surge Only	18.3	30.253223	-89.615515	Hanc-23
KMSC-06-03	Hancock	Riverine - Hurricane	20.6	30.407104	-89.439158	Hanc-24
KMSC-06-04	Hancock	Coastal - Wave Runup	9.7	30.305489	-89.631494	Hanc-25
KMSC-06-05	Hancock	Coastal - Surge Only	13.1	30.331792	-89.519915	Hanc-26
KMSC-06-06	Hancock	Coastal - Surge Only	15.4	30.344935	-89.467345	Hanc-27
KMSC-06-07	Hancock	Coastal - Surge Only	25.3	30.375087	-89.370138	Hanc-28
KMSC-09-01	Hancock	Coastal - Surge Only	26.7	30.306162	-89.339176	Hanc-29
KMSC-09-02	Hancock	Coastal - Surge Only	22.7	30.298032	-89.354450	Hanc-30
KMSC-09-03	Hancock	Coastal - Surge Only	25.2	30.295002	-89.360329	Hanc-31
KMSC-09-04	Hancock	Coastal - Surge Only	19.6	30.279233	-89.387849	Hanc-32
KMSC-09-05	Hancock	Coastal - Surge Only	22.6	30.289700	-89.409855	Hanc-33
KMSC-09-06	Hancock	Coastal - Surge Only	22.5	30.301714	-89.372239	Hanc-34
KMSC-10-55	Hancock	Coastal - Surge Only	11.6	30.401727	-89.419029	Hanc-35
KMSC-10-56	Hancock	Coastal - Surge Only	20.0	30.403666	-89.445279	Hanc-36
KMSC-10-57	Hancock	Coastal - Surge Only	11.0	30.350832	-89.618469	Hanc-37
KMSC-10-58	Hancock	Coastal - Surge Only	13.6	30.385748	-89.457349	Hanc-38
KMSC-10-59	Hancock	Coastal - Surge Only	19.5	30.384251	-89.444322	Hanc-39
KMSC-10-60	Hancock	Coastal - Surge Only	21.7	30.397865	-89.387362	Hanc-40
KMSC-10-61	Hancock	Coastal - Surge Only	16.0	30.408311	-89.372585	Hanc-41
KMSC-10-74	Hancock	Coastal - Surge Only	25.3	30.382284	-89.346810	Hanc-42
KMSC-10-75	Hancock	Coastal - Surge Only	20.5	30.407720	-89.372474	Hanc-43
KMSC-20-02	Hancock	Coastal - Surge Only	24.5	30.305938	-89.380006	Hanc-44
KMSC-20-03	Hancock	Coastal - Wave Height	28.1	30.289894	-89.359639	Hanc-45
KMSC-20-04	Hancock	Coastal - Wave Height	22.2	30.302206	-89.334182	Hanc-46
KMSR-10-15	Hancock	Riverine - Hurricane	35.5	30.450605	-89.411189	Hanc-47
KMSR-10-16	Hancock	Riverine - Hurricane	14.9	30.419306	-89.344273	Hanc-48
KMSR-10-17	Hancock	Riverine - Hurricane	13.4	30.414342	-89.382161	Hanc-49
KMSR-10-18	Hancock	Riverine - Hurricane	21.6	30.407034	-89.407003	Hanc-50
KMSC-02-17	Harrison	Coastal - Surge Only	8.7	30.459883	-88.957634	Harr-1
KMSC-02-18	Harrison	Coastal - Surge Only	15.5	30.457448	-88.976079	Harr-2
KMSC-02-19	Harrison	Coastal - Surge Only	18.7	30.438356	-89.006944	Harr-3
KMSC-02-20	Harrison	Coastal - Surge Only	19.0	30.426213	-88.973735	Harr-4
KMSC-02-21	Harrison	Coastal - Surge Only	18.6	30.435235	-88.990528	Harr-5
KMSC-02-22	Harrison	Coastal - Surge Only	20.4	30.425472	-88.968203	Harr-6
KMSC-02-23	Harrison	Coastal - Surge Only	18.9	30.425943	-88.950021	Harr-7
KMSC-02-24	Harrison	Coastal - Surge Only	12.1	30.452505	-88.951516	Harr-8
KMSC-02-25	Harrison	Coastal - Surge Only	24.6	30.374895	-89.267862	Harr-9
KMSC-02-26	Harrison	Coastal - Surge Only	17.1	30.359542	-89.263453	Harr-10
KMSC-02-27	Harrison	Coastal - Surge Only	24.1	30.354434	-89.234960	Harr-11
KMSC-02-28	Harrison	Coastal - Surge Only	24.7	30.380947	-89.265402	Harr-12
KMSC-02-29	Harrison	Coastal - Surge Only	23.0	30.388699	-89.227453	Harr-13
KMSC-03-01	Harrison	Coastal - Surge Only	20.8	30.410779	-88.888898	Harr-14
KMSC-03-02	Harrison	Coastal - Surge Only	25.8	30.394681	-88.888884	Harr-15
KMSC-03-04	Harrison	Coastal - Wave Height	27.8	30.306564	-89.274642	Harr-16
KMSC-03-07	Harrison	Coastal - Wave Runup	26.2	30.431597	-89.017808	Harr-17

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-03-08	Harrison	Riverine - Hurricane	16.7	30.481287	-89.026392	Harr-18
KMSC-03-09	Harrison	Riverine - Hurricane	17.4	30.453713	-89.015174	Harr-19
KMSC-04-08	Harrison	Coastal - Surge Only	26.7	30.317467	-89.242560	Harr-20
KMSC-04-09	Harrison	Coastal - Surge Only	25.0	30.314344	-89.251147	Harr-21
KMSC-04-10	Harrison	Coastal - Surge Only	25.0	30.317068	-89.262998	Harr-22
KMSC-04-11	Harrison	Coastal - Surge Only	22.6	30.321175	-89.275085	Harr-23
KMSC-04-12	Harrison	Coastal - Wave Height	25.8	30.315313	-89.281200	Harr-24
KMSC-04-13	Harrison	Coastal - Surge Only	22.7	30.323215	-89.284641	Harr-25
KMSC-04-14	Harrison	Coastal - Surge Only	20.9	30.327600	-89.281183	Harr-26
KMSC-04-15	Harrison	Coastal - Surge Only	22.2	30.328362	-89.271412	Harr-27
KMSC-04-16	Harrison	Coastal - Surge Only	24.1	30.332277	-89.263053	Harr-28
KMSC-04-17	Harrison	Coastal - Surge Only	24.9	30.339453	-89.262803	Harr-29
KMSC-04-18	Harrison	Coastal - Surge Only	24.0	30.334645	-89.254108	Harr-30
KMSC-04-19	Harrison	Coastal - Surge Only	22.7	30.323809	-89.249680	Harr-31
KMSC-04-20	Harrison	Coastal - Surge Only	25.5	30.327945	-89.236589	Harr-32
KMSC-04-21	Harrison	Coastal - Surge Only	23.9	30.332889	-89.222535	Harr-33
KMSC-04-22	Harrison	Coastal - Surge Only	27.2	30.325196	-89.217849	Harr-34
KMSC-04-23	Harrison	Coastal - Surge Only	26.3	30.330242	-89.204382	Harr-35
KMSC-04-24	Harrison	Coastal - Surge Only	23.5	30.359015	-89.220216	Harr-36
KMSC-04-25	Harrison	Coastal - Wave Height	23.3	30.339269	-89.230796	Harr-37
KMSC-04-26	Harrison	Coastal - Surge Only	23.7	30.390785	-88.860629	Harr-38
KMSC-04-27	Harrison	Coastal - Surge Only	19.7	30.406527	-88.868908	Harr-39
KMSC-04-28	Harrison	Coastal - Surge Only	21.1	30.400540	-88.865196	Harr-40
KMSC-04-29	Harrison	Coastal - Surge Only	20.8	30.404794	-88.877048	Harr-41
KMSC-04-30	Harrison	Coastal - Surge Only	20.6	30.411305	-88.883392	Harr-42
KMSC-04-31	Harrison	Coastal - Surge Only	20.9	30.413606	-88.891999	Harr-43
KMSC-04-32	Harrison	Coastal - Surge Only	20.0	30.400439	-88.891575	Harr-44
KMSC-04-33	Harrison	Coastal - Surge Only	20.6	30.429057	-88.894540	Harr-45
KMSC-05-11	Harrison	Coastal - Wave Height	27.7	30.332489	-89.187385	Harr-46
KMSC-05-12	Harrison	Coastal - Wave Height	33.0	30.352230	-89.132638	Harr-47
KMSC-05-13	Harrison	Coastal - Surge Only	25.3	30.348299	-89.150941	Harr-48
KMSC-05-14	Harrison	Coastal - Surge Only	25.7	30.345597	-89.156121	Harr-49
KMSC-05-15	Harrison	Coastal - Surge Only	25.9	30.342788	-89.169327	Harr-50
KMSC-05-16	Harrison	Coastal - Surge Only	25.4	30.339689	-89.176119	Harr-51
KMSC-05-17	Harrison	Coastal - Surge Only	25.0	30.354494	-89.131380	Harr-52
KMSC-05-18	Harrison	Coastal - Surge Only	25.2	30.344886	-89.161267	Harr-53
KMSC-05-22	Harrison	Coastal - Surge Only	22.9	30.344268	-89.165344	Harr-54
KMSC-05-23	Harrison	Coastal - Surge Only	25.5	30.343306	-89.170571	Harr-55
KMSC-05-24	Harrison	Coastal - Surge Only	23.9	30.339768	-89.180145	Harr-56
KMSC-05-25	Harrison	Coastal - Surge Only	24.4	30.338198	-89.183905	Harr-57
KMSC-05-26	Harrison	Coastal - Surge Only	23.5	30.348035	-89.157015	Harr-58
KMSC-05-27	Harrison	Coastal - Surge Only	25.5	30.352166	-89.142421	Harr-59
KMSC-05-28	Harrison	Coastal - Wave Runup	24.8	30.354481	-89.139451	Harr-60
KMSC-05-29	Harrison	Coastal - Surge Only	24.3	30.358583	-89.127227	Harr-61
KMSC-06-08	Harrison	Coastal - Surge Only	23.0	30.384570	-89.250214	Harr-62
KMSC-06-09	Harrison	Coastal - Surge Only	11.7	30.446200	-89.021123	Harr-63
KMSC-06-10	Harrison	Riverine - Hurricane	11.7	30.456960	-88.949795	Harr-64
KMSC-07-12	Harrison	Coastal - Surge Only	24.9	30.371872	-89.080163	Harr-65

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-07-13	Harrison	Coastal - Surge Only	23.5	30.368309	-89.092044	Harr-66
KMSC-07-14	Harrison	Coastal - Surge Only	24.5	30.363494	-89.102105	Harr-67
KMSC-07-15	Harrison	Coastal - Surge Only	24.9	30.357343	-89.126410	Harr-68
KMSC-07-16	Harrison	Coastal - Surge Only	24.6	30.359986	-89.115093	Harr-69
KMSC-07-17	Harrison	Coastal - Surge Only	24.8	30.374018	-89.069978	Harr-70
KMSC-07-18	Harrison	Coastal - Surge Only	23.4	30.376927	-89.062022	Harr-71
KMSC-07-19	Harrison	Coastal - Surge Only	23.4	30.395198	-88.934961	Harr-72
KMSC-07-20	Harrison	Coastal - Surge Only	22.2	30.395456	-88.953322	Harr-73
KMSC-07-21	Harrison	Coastal - Surge Only	22.8	30.395507	-88.972947	Harr-74
KMSC-07-22	Harrison	Coastal - Wave Height	22.7	30.391077	-88.986872	Harr-75
KMSC-07-23	Harrison	Coastal - Surge Only	23.4	30.389461	-89.002289	Harr-76
KMSC-07-24	Harrison	Coastal - Surge Only	19.3	30.414902	-88.970629	Harr-77
KMSC-07-25	Harrison	Coastal - Surge Only	18.8	30.412844	-88.982968	Harr-78
KMSC-07-26	Harrison	Coastal - Surge Only	19.1	30.411470	-88.997465	Harr-79
KMSC-08-14	Harrison	Coastal - Wave Height	19.4	30.400523	-88.899403	Harr-80
KMSC-08-15	Harrison	Coastal - Wave Runup	21.7	30.397110	-88.904450	Harr-81
KMSC-08-16	Harrison	Coastal - Wave Runup	19.0	30.401243	-88.898283	Harr-82
KMSC-08-17	Harrison	Coastal - Wave Runup	22.2	30.396138	-88.930329	Harr-83
KMSC-09-07	Harrison	Coastal - Wave Height	23.7	30.379573	-89.053292	Harr-84
KMSC-09-08	Harrison	Coastal - Surge Only	24.2	30.381806	-89.044250	Harr-85
KMSC-09-09	Harrison	Coastal - Surge Only	25.0	30.383408	-89.037766	Harr-86
KMSC-09-10	Harrison	Coastal - Surge Only	23.3	30.384319	-89.035435	Harr-87
KMSC-09-11	Harrison	Coastal - Surge Only	24.7	30.386005	-89.026399	Harr-88
KMSC-09-12	Harrison	Coastal - Surge Only	23.6	30.388514	-89.005981	Harr-89
KMSC-09-13	Harrison	Coastal - Surge Only	23.9	30.377558	-89.060239	Harr-90
KMSC-09-14	Harrison	Coastal - Surge Only	23.2	30.383617	-89.038244	Harr-91
KMSC-09-15	Harrison	Coastal - Surge Only	23.5	30.384165	-89.031595	Harr-92
KMSC-09-16	Harrison	Coastal - Surge Only	23.8	30.384909	-89.027344	Harr-93
KMSC-09-17	Harrison	Coastal - Surge Only	15.5	30.403442	-89.024611	Harr-94
KMSC-09-18	Harrison	Coastal - Surge Only	18.2	30.407452	-89.013243	Harr-95
KMSC-09-19	Harrison	Coastal - Surge Only	18.0	30.409190	-89.026071	Harr-96
KMSC-09-20	Harrison	Coastal - Surge Only	16.6	30.402447	-89.028585	Harr-97
KMSC-09-21	Harrison	Coastal - Surge Only	15.9	30.403709	-89.030955	Harr-98
KMSC-09-22	Harrison	Coastal - Surge Only	15.4	30.400001	-89.032548	Harr-99
KMSC-09-23	Harrison	Coastal - Surge Only	16.6	30.410279	-89.041090	Harr-100
KMSC-09-24	Harrison	Coastal - Surge Only	18.1	30.417959	-89.042810	Harr-101
KMSC-09-25	Harrison	Coastal - Surge Only	16.8	30.401469	-89.049282	Harr-102
KMSC-09-26	Harrison	Coastal - Surge Only	15.1	30.403899	-89.050454	Harr-103
KMSC-09-27	Harrison	Coastal - Surge Only	17.1	30.399264	-89.046899	Harr-104
KMSC-09-28	Harrison	Coastal - Surge Only	18.2	30.405752	-89.017492	Harr-105
KMSC-09-29	Harrison	Coastal - Surge Only	18.6	30.404346	-88.998069	Harr-106
KMSC-10-37	Harrison	Coastal - Wave Height	17.9	30.459194	-88.938671	Harr-107
KMSC-10-38	Harrison	Coastal - Surge Only	17.1	30.468109	-88.918718	Harr-108
KMSC-10-39	Harrison	Coastal - Surge Only	15.9	30.474382	-88.892584	Harr-109
KMSC-10-40	Harrison	Riverine - Hurricane	20.9	30.510306	-88.911355	Harr-110
KMSC-10-41	Harrison	Riverine - Hurricane	22.0	30.510640	-88.911488	Harr-111
KMSC-10-42	Harrison	Coastal - Surge Only	21.1	30.431854	-88.932225	Harr-112
KMSC-10-43	Harrison	Coastal - Surge Only	20.1	30.433443	-88.910972	Harr-113

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-10-44	Harrison	Coastal - Surge Only	20.2	30.430612	-88.897587	Harr-114
KMSC-10-50	Harrison	Riverine - Hurricane	16.6	30.483580	-89.030712	Harr-115
KMSC-10-51	Harrison	Coastal - Surge Only	14.6	30.471084	-88.893491	Harr-116
KMSC-10-52	Harrison	Riverine - Hurricane	21.0	30.509600	-88.888082	Harr-117
KMSC-10-53	Harrison	Coastal - Surge Only	20.1	30.432133	-88.895175	Harr-118
KMSC-10-54	Harrison	Riverine - Hurricane	18.7	30.442056	-89.100800	Harr-119
KMSC-10-62	Harrison	Coastal - Surge Only	19.9	30.408340	-89.039396	Harr-120
KMSC-10-63	Harrison	Coastal - Surge Only	24.6	30.422411	-89.043788	Harr-121
KMSC-10-64	Harrison	Coastal - Surge Only	17.9	30.423237	-89.063370	Harr-122
KMSC-10-65	Harrison	Coastal - Surge Only	19.1	30.423824	-89.063187	Harr-123
KMSC-10-66	Harrison	Coastal - Surge Only	19.3	30.426774	-89.077247	Harr-124
KMSC-10-67	Harrison	Coastal - Surge Only	18.7	30.415800	-89.075940	Harr-125
KMSC-10-68	Harrison	Coastal - Surge Only	18.0	30.392668	-89.061564	Harr-126
KMSC-10-69	Harrison	Coastal - Surge Only	20.0	30.398423	-89.043963	Harr-127
KMSC-10-70	Harrison	Coastal - Surge Only	18.6	30.384362	-89.080974	Harr-128
KMSC-10-71	Harrison	Coastal - Surge Only	18.6	30.380575	-89.094237	Harr-129
KMSC-10-72	Harrison	Coastal - Surge Only	18.0	30.411308	-89.094667	Harr-130
KMSC-10-73	Harrison	Coastal - Surge Only	25.1	30.381059	-89.312983	Harr-131
KMSC-15-01	Harrison	Coastal - Surge Only	20.6	30.402285	-88.895595	Harr-132
KMSC-15-02	Harrison	Coastal - Surge Only	20.5	30.400767	-88.895594	Harr-133
KMSC-15-04	Harrison	Coastal - Surge Only	21.0	30.396211	-88.896945	Harr-134
KMSC-15-05	Harrison	Coastal - Wave Runup	22.5	30.396159	-88.911582	Harr-135
KMSC-15-06	Harrison	Coastal - Surge Only	25.7	30.390733	-88.986947	Harr-136
KMSC-20-05	Harrison	Coastal - Wave Height	29.8	30.339524	-89.267820	Harr-137
KMSC-20-06	Harrison	Coastal - Wave Height	34.9	30.309676	-89.266203	Harr-138
KMSR-02-01	Harrison	Riverine - Hurricane	19.0	30.368997	-89.187179	Harr-139
KMSR-02-02	Harrison	Riverine - Hurricane	19.0	30.344732	-89.186839	Harr-140
KMSR-02-03	Harrison	Riverine - Hurricane	16.1	30.486882	-89.036506	Harr-141
KMSR-10-09	Harrison	Riverine - Hurricane	32.5	30.560358	-88.884801	Harr-142
KMSR-10-10	Harrison	Riverine - Hurricane	57.4	30.615243	-88.922486	Harr-143
KMSR-10-19	Harrison	Coastal - Surge Only	18.2	30.433976	-89.067206	Harr-144
KMSR-10-21	Harrison	Riverine - Hurricane	48.0	30.569672	-89.135979	Harr-145
KMSC-02-01	Jackson	Coastal - Surge Only	13.6	30.416640	-88.547106	Jack-1
KMSC-02-02	Jackson	Coastal - Surge Only	14.6	30.412611	-88.569817	Jack-2
KMSC-02-03	Jackson	Coastal - Surge Only	13.0	30.414593	-88.504551	Jack-3
KMSC-02-04	Jackson	Coastal - Surge Only	12.2	30.413608	-88.539624	Jack-4
KMSC-02-05	Jackson	Coastal - Surge Only	12.8	30.404349	-88.557125	Jack-5
KMSC-02-06	Jackson	Coastal - Surge Only	14.7	30.397906	-88.552399	Jack-6
KMSC-02-07	Jackson	Coastal - Surge Only	12.1	30.409681	-88.503953	Jack-7
KMSC-02-08	Jackson	Coastal - Surge Only	11.5	30.411946	-88.479896	Jack-8
KMSC-02-09	Jackson	Coastal - Surge Only	11.7	30.405950	-88.487574	Jack-9
KMSC-02-10	Jackson	Coastal - Surge Only	20.5	30.344181	-88.702300	Jack-10
KMSC-02-11	Jackson	Coastal - Surge Only	16.9	30.355796	-88.691939	Jack-11
KMSC-02-12	Jackson	Coastal - Surge Only	18.4	30.361346	-88.699072	Jack-12
KMSC-02-13	Jackson	Coastal - Surge Only	19.0	30.358731	-88.709244	Jack-13
KMSC-02-14	Jackson	Coastal - Surge Only	19.9	30.348318	-88.711937	Jack-14
KMSC-02-15	Jackson	Coastal - Surge Only	19.2	30.368061	-88.727840	Jack-15
KMSC-02-16	Jackson	Coastal - Surge Only	19.4	30.376919	-88.704322	Jack-16

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-02-30	Jackson	Coastal - Surge Only	10.6	30.428885	-88.462346	Jack-17
KMSC-02-31	Jackson	Coastal - Surge Only	14.2	30.443423	-88.429145	Jack-18
KMSC-02-32	Jackson	Coastal - Surge Only	16.0	30.364139	-88.535258	Jack-19
KMSC-02-33	Jackson	Coastal - Surge Only	14.4	30.373731	-88.521614	Jack-20
KMSC-02-34	Jackson	Coastal - Surge Only	16.7	30.346879	-88.540243	Jack-21
KMSC-02-40	Jackson	Coastal - Surge Only	15.2	30.388538	-88.614552	Jack-22
KMSC-02-41	Jackson	Coastal - Surge Only	14.4	30.384084	-88.499126	Jack-23
KMSC-03-03	Jackson	Coastal - Wave Height	12.7	30.424656	-88.525667	Jack-24
KMSC-03-05	Jackson	Coastal - Surge Only	21.1	30.364817	-88.631998	Jack-25
KMSC-03-06	Jackson	Coastal - Surge Only	21.1	30.396205	-88.800120	Jack-26
KMSC-03-10	Jackson	Coastal - Wave Runup	18.2	30.357944	-88.737995	Jack-27
KMSC-03-11	Jackson	Coastal - Surge Only	18.6	30.362780	-88.758148	Jack-28
KMSC-03-12	Jackson	Coastal - Surge Only	18.8	30.386721	-88.770639	Jack-29
KMSC-03-13	Jackson	Coastal - Surge Only	20.4	30.372130	-88.779294	Jack-30
KMSC-03-14	Jackson	Coastal - Surge Only	17.1	30.362080	-88.567977	Jack-31
KMSC-06-11	Jackson	Coastal - Surge Only	15.3	30.440817	-88.716966	Jack-32
KMSC-06-13	Jackson	Coastal - Wave Height	22.0	30.396746	-88.812518	Jack-33
KMSC-06-14	Jackson	Coastal - Surge Only	21.4	30.410861	-88.838051	Jack-34
KMSC-06-15	Jackson	Coastal - Surge Only	20.5	30.406209	-88.823959	Jack-35
KMSC-06-16	Jackson	Coastal - Surge Only	20.7	30.422880	-88.846252	Jack-36
KMSC-06-17	Jackson	Coastal - Surge Only	20.1	30.392846	-88.781316	Jack-37
KMSC-06-18	Jackson	Coastal - Surge Only	21.3	30.396271	-88.805888	Jack-38
KMSC-06-19	Jackson	Coastal - Surge Only	22.4	30.404665	-88.808660	Jack-39
KMSC-06-21	Jackson	Coastal - Surge Only	18.3	30.357484	-88.715830	Jack-40
KMSC-06-22	Jackson	Coastal - Surge Only	16.4	30.441074	-88.722781	Jack-41
KMSC-06-23	Jackson	Coastal - Surge Only	16.4	30.441074	-88.722781	Jack-42
KMSC-06-24	Jackson	Coastal - Surge Only	16.1	30.441596	-88.723237	Jack-43
KMSC-06-25	Jackson	Coastal - Surge Only	18.1	30.440145	-88.724984	Jack-44
KMSC-07-01	Jackson	Coastal - Surge Only	16.9	30.351753	-88.553321	Jack-45
KMSC-07-02	Jackson	Coastal - Surge Only	16.8	30.351592	-88.548077	Jack-46
KMSC-07-03	Jackson	Coastal - Surge Only	18.0	30.344992	-88.553775	Jack-47
KMSC-07-04	Jackson	Coastal - Surge Only	17.2	30.347724	-88.542869	Jack-48
KMSC-07-05	Jackson	Coastal - Surge Only	17.3	30.346347	-88.533150	Jack-49
KMSC-07-06	Jackson	Coastal - Surge Only	16.6	30.354695	-88.537086	Jack-50
KMSC-07-07	Jackson	Coastal - Surge Only	16.8	30.346849	-88.517255	Jack-51
KMSC-07-08	Jackson	Coastal - Surge Only	16.2	30.353997	-88.521867	Jack-52
KMSC-07-09	Jackson	Coastal - Surge Only	20.0	30.356234	-88.557388	Jack-53
KMSC-07-10	Jackson	Coastal - Surge Only	16.7	30.366045	-88.559767	Jack-54
KMSC-07-11	Jackson	Coastal - Surge Only	14.9	30.379839	-88.558912	Jack-55
KMSC-07-27	Jackson	Coastal - Surge Only	14.4	30.389150	-88.612768	Jack-56
KMSC-07-28	Jackson	Coastal - Wave Runup	19.5	30.415704	-88.620100	Jack-57
KMSC-07-29	Jackson	Coastal - Surge Only	15.2	30.423799	-88.621120	Jack-58
KMSC-08-02	Jackson	Coastal - Surge Only	18.7	30.413096	-88.403277	Jack-59
KMSC-08-03	Jackson	Coastal - Surge Only	19.1	30.412257	-88.403847	Jack-60
KMSC-08-04	Jackson	Coastal - Surge Only	15.0	30.429428	-88.427646	Jack-61
KMSC-08-05	Jackson	Coastal - Wave Runup	14.5	30.408232	-88.629978	Jack-62
KMSC-08-06	Jackson	Coastal - Surge Only	14.3	30.405895	-88.634502	Jack-63
KMSC-08-07	Jackson	Coastal - Surge Only	15.8	30.438124	-88.728277	Jack-64

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-08-08	Jackson	Coastal - Surge Only	18.9	30.407308	-88.751182	Jack-65
KMSC-08-09	Jackson	Coastal - Surge Only	19.3	30.384860	-88.773938	Jack-66
KMSC-08-10	Jackson	Coastal - Surge Only	19.4	30.382220	-88.745983	Jack-67
KMSC-08-11	Jackson	Coastal - Surge Only	19.7	30.367995	-88.769664	Jack-68
KMSC-08-12	Jackson	Coastal - Wave Height	21.2	30.361605	-88.764105	Jack-69
KMSC-08-13	Jackson	Coastal - Surge Only	17.6	30.360801	-88.751799	Jack-70
KMSC-10-01	Jackson	Riverine - Hurricane	9.3	30.490950	-88.432509	Jack-71
KMSC-10-02	Jackson	Riverine - Hurricane	10.0	30.435842	-88.451796	Jack-72
KMSC-10-03	Jackson	Riverine - Hurricane	12.3	30.464325	-88.559037	Jack-73
KMSC-10-04	Jackson	Riverine - Hurricane	10.0	30.581433	-88.572824	Jack-74
KMSC-10-06	Jackson	Riverine - Hurricane	13.4	30.612380	-88.638130	Jack-75
KMSC-10-07	Jackson	Riverine - Hurricane	13.3	30.457152	-88.622953	Jack-76
KMSC-10-08	Jackson	Coastal - Surge Only	14.0	30.421645	-88.625543	Jack-77
KMSC-10-09	Jackson	Coastal - Surge Only	14.4	30.407641	-88.632187	Jack-78
KMSC-10-10	Jackson	Coastal - Surge Only	14.3	30.407954	-88.631995	Jack-79
KMSC-10-11	Jackson	Coastal - Surge Only	7.2	30.454792	-88.453156	Jack-80
KMSC-10-12	Jackson	Riverine - Hurricane	11.2	30.511378	-88.561312	Jack-81
KMSC-10-14	Jackson	Riverine - Hurricane	10.6	30.521243	-88.552277	Jack-82
KMSC-10-15	Jackson	Riverine - Hurricane	11.7	30.494219	-88.558110	Jack-83
KMSC-10-16	Jackson	Riverine - Hurricane	10.4	30.493899	-88.557756	Jack-84
KMSC-10-17	Jackson	Riverine - Hurricane	9.4	30.521638	-88.680228	Jack-85
KMSC-10-19	Jackson	Riverine - Hurricane	10.7	30.513890	-88.619482	Jack-86
KMSC-10-20	Jackson	Coastal - Surge Only	20.1	30.425247	-88.826933	Jack-87
KMSC-10-21	Jackson	Coastal - Surge Only	18.8	30.426559	-88.827426	Jack-88
KMSC-10-22	Jackson	Coastal - Surge Only	19.7	30.428138	-88.815710	Jack-89
KMSC-10-23	Jackson	Coastal - Surge Only	18.4	30.437009	-88.802931	Jack-90
KMSC-10-24	Jackson	Coastal - Surge Only	18.9	30.426840	-88.775559	Jack-91
KMSC-10-25	Jackson	Coastal - Surge Only	21.0	30.435790	-88.745898	Jack-92
KMSC-10-26	Jackson	Riverine - Hurricane	21.0	30.484382	-88.749729	Jack-93
KMSC-10-27	Jackson	Riverine - Hurricane	11.4	30.471948	-88.725270	Jack-94
KMSC-10-28	Jackson	Coastal - Surge Only	18.9	30.447630	-88.719054	Jack-95
KMSC-10-29	Jackson	Coastal - Surge Only	15.6	30.441676	-88.721789	Jack-96
KMSC-10-30	Jackson	Coastal - Surge Only	17.2	30.432358	-88.739901	Jack-97
KMSC-10-31	Jackson	Coastal - Surge Only	16.5	30.426916	-88.760328	Jack-98
KMSC-10-32	Jackson	Coastal - Surge Only	22.0	30.421831	-88.777497	Jack-99
KMSC-10-33	Jackson	Coastal - Surge Only	22.5	30.418683	-88.792240	Jack-100
KMSC-10-34	Jackson	Coastal - Surge Only	19.5	30.420366	-88.810102	Jack-101
KMSC-10-35	Jackson	Coastal - Surge Only	18.6	30.420718	-88.810786	Jack-102
KMSC-10-36	Jackson	Coastal - Surge Only	20.1	30.419881	-88.823268	Jack-103
KMSC-10-45	Jackson	Coastal - Surge Only	20.9	30.438715	-88.881604	Jack-104
KMSC-10-46	Jackson	Coastal - Surge Only	20.2	30.425368	-88.835994	Jack-105
KMSC-10-47	Jackson	Coastal - Surge Only	21.0	30.440847	-88.843046	Jack-106
KMSC-10-48	Jackson	Coastal - Surge Only	21.4	30.442512	-88.874078	Jack-107
KMSC-20-01	Jackson	Coastal - Surge Only	16.5	30.346330	-88.523089	Jack-108
KMSR-10-01	Jackson	Coastal - Surge Only	14.5	30.409774	-88.655584	Jack-109
KMSR-10-02	Jackson	Coastal - Surge Only	14.5	30.420734	-88.649082	Jack-110
KMSR-10-03	Jackson	Riverine - Hurricane	11.7	30.517036	-88.693557	Jack-111
KMSR-10-04	Jackson	Riverine - Hurricane	11.0	30.531292	-88.687444	Jack-112

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSR-10-05	Jackson	Riverine - Hurricane	19.6	30.543463	-88.696683	Jack-113
KMSR-10-06	Jackson	Riverine - Hurricane	29.7	30.580304	-88.670738	Jack-114
KMSR-10-07	Jackson	Riverine - Hurricane	17.5	30.683960	-88.630859	Jack-115
KMSR-10-08	Jackson	Riverine - Hurricane	7.1	30.535368	-88.694373	Jack-116
KMSR-10-11	Jackson	Riverine - Hurricane	18.4	30.548947	-88.408561	Jack-117
USGS Surveyed Points						
KMS_USGS_16	Jackson	N/A	14.4	30.443072	-88.722138	U-Jack-1
KMS_USGS_17	Jackson	N/A	17.3	30.437456	-88.617352	U-Jack-2
KMS_USGS_18	Jackson	N/A	16.8	30.437437	-88.617277	U-Jack-3
KMS_USGS_21	Jackson	N/A	15.5	30.610569	-88.641692	U-Jack-4
KMS_USGS_88	Jackson	N/A	21.4	30.443412	-88.854921	U-Jack-5
KMS_USGS_89	Jackson	N/A	21.3	30.409017	-88.828083	U-Jack-6
KMS_USGS_90	Jackson	N/A	21.6	30.400250	-88.798574	U-Jack-7
KMS_USGS_91	Jackson	N/A	17.3	30.402947	-88.777143	U-Jack-8
KMS_USGS_92	Jackson	N/A	19.1	30.381598	-88.759280	U-Jack-9
KMS_USGS_94	Jackson	N/A	20.4	30.419230	-88.828067	U-Jack-10
KMS_USGS_99	Jackson	N/A	11.9	30.438244	-88.550535	U-Jack-11
KMS_USGS_100	Jackson	N/A	11.6	30.438190	-88.549876	U-Jack-12
KMS_USGS_10	Harrison	N/A	18.7	30.414611	-89.203792	U-Harr-1
KMS_USGS_11	Harrison	N/A	19.0	30.415209	-89.201955	U-Harr-2
KMS_USGS_12	Harrison	N/A	27.4	30.422148	-89.149442	U-Harr-3
KMS_USGS_13	Harrison	N/A	19.1	30.433739	-89.090122	U-Harr-4
KMS_USGS_14	Harrison	N/A	18.8	30.454475	-89.029222	U-Harr-5
KMS_USGS_15	Harrison	N/A	16.1	30.452726	-88.942322	U-Harr-6
KMS_USGS_27	Harrison	N/A	24.6	30.315378	-89.254257	U-Harr-7
KMS_USGS_28	Harrison	N/A	23.4	30.319090	-89.272844	U-Harr-8
KMS_USGS_29	Harrison	N/A	23.7	30.319874	-89.272514	U-Harr-9
KMS_USGS_33	Harrison	N/A	19.7	30.412087	-88.895005	U-Harr-10
KMS_USGS_35	Harrison	N/A	21.0	30.396655	-88.879966	U-Harr-11
KMS_USGS_36	Harrison	N/A	22.0	30.393051	-88.891660	U-Harr-12
KMS_USGS_37	Harrison	N/A	22.5	30.395270	-88.900746	U-Harr-13
KMS_USGS_38	Harrison	N/A	22.5	30.395296	-88.913372	U-Harr-14
KMS_USGS_39	Harrison	N/A	22.5	30.395277	-88.933990	U-Harr-15
KMS_USGS_40	Harrison	N/A	23.1	30.393989	-88.954996	U-Harr-16
KMS_USGS_41	Harrison	N/A	23.2	30.390655	-88.990218	U-Harr-17
KMS_USGS_42	Harrison	N/A	18.7	30.429030	-88.937468	U-Harr-18
KMS_USGS_43	Harrison	N/A	23.6	30.390603	-88.860153	U-Harr-19
KMS_USGS_62	Harrison	N/A	14.4	30.378714	-89.097645	U-Harr-20
KMS_USGS_63	Harrison	N/A	19.2	30.414176	-88.975886	U-Harr-21
KMS_USGS_66	Harrison	N/A	24.8	30.357692	-89.126634	U-Harr-22
KMS_USGS_67	Harrison	N/A	25.0	30.355107	-89.136133	U-Harr-23
KMS_USGS_68	Harrison	N/A	25.0	30.348861	-89.150485	U-Harr-24
KMS_USGS_69	Harrison	N/A	25.0	30.342341	-89.170287	U-Harr-25
KMS_USGS_70	Harrison	N/A	24.9	30.337721	-89.183724	U-Harr-26
KMS_USGS_71	Harrison	N/A	25.3	30.329367	-89.206552	U-Harr-27
KMS_USGS_72	Harrison	N/A	24.5	30.325762	-89.218221	U-Harr-28
KMS_USGS_73	Harrison	N/A	23.3	30.342266	-89.217165	U-Harr-29
KMS_USGS_74	Harrison	N/A	23.5	30.332737	-89.228390	U-Harr-30
KMS_USGS_75	Harrison	N/A	24.3	30.364593	-89.106948	U-Harr-31

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMS_USGS_76	Harrison	N/A	24.3	30.366902	-89.098761	U-Harr-32
KMS_USGS_78	Harrison	N/A	24.2	30.381973	-89.042370	U-Harr-33
KMS_USGS_79	Harrison	N/A	23.9	30.384316	-89.035429	U-Harr-34
KMS_USGS_80	Harrison	N/A	23.5	30.375070	-89.228936	U-Harr-35
KMS_USGS_81	Harrison	N/A	22.5	30.359642	-89.216953	U-Harr-36
KMS_USGS_82	Harrison	N/A	13.4	30.388879	-89.199066	U-Harr-37
KMS_USGS_83	Harrison	N/A	16.9	30.414277	-89.093248	U-Harr-38
KMS_USGS_84	Harrison	N/A	17.4	30.392619	-89.061104	U-Harr-39
KMS_USGS_85	Harrison	N/A	18.8	30.402593	-89.025650	U-Harr-40
KMS_USGS_86	Harrison	N/A	23.8	30.386454	-89.026023	U-Harr-41
KMS_USGS_96	Harrison	N/A	26.0	30.321616	-89.227311	U-Harr-42
KMS_USGS_98	Harrison	N/A	26.1	30.321834	-89.226728	U-Harr-43
KMS_USGS_102	Harrison	N/A	18.9	30.472782	-88.961565	U-Harr-44
KMS_USGS_103	Harrison	N/A	18.2	30.469321	-88.938352	U-Harr-45
KMS_USGS_104	Harrison	N/A	15.9	30.474511	-88.892558	U-Harr-46
KMS_USGS_03	Hancock	N/A	13.8	30.333581	-89.512738	U-Hanc-1
KMS_USGS_04	Hancock	N/A	22.1	30.358406	-89.422965	U-Hanc-2
KMS_USGS_05	Hancock	N/A	24.7	30.357979	-89.423555	U-Hanc-3
KMS_USGS_06	Hancock	N/A	20.1	30.362802	-89.409301	U-Hanc-4
KMS_USGS_07	Hancock	N/A	23.9	30.366287	-89.398455	U-Hanc-5
KMS_USGS_08	Hancock	N/A	25.4	30.365773	-89.398188	U-Hanc-6
KMS_USGS_09	Hancock	N/A	19.7	30.387349	-89.441456	U-Hanc-7
KMS_USGS_23	Hancock	N/A	27.0	30.300155	-89.350082	U-Hanc-8
KMS_USGS_24	Hancock	N/A	26.2	30.296350	-89.363198	U-Hanc-9
KMS_USGS_25	Hancock	N/A	23.6	30.325251	-89.338034	U-Hanc-10
KMS_USGS_26	Hancock	N/A	24.8	30.419556	-89.343535	U-Hanc-11
KMS_USGS_31	Hancock	N/A	25.0	30.331851	-89.352818	U-Hanc-12
KMS_USGS_32	Hancock	N/A	24.2	30.335029	-89.353838	U-Hanc-13
KMS_USGS_45	Hancock	N/A	23.0	30.305017	-89.377069	U-Hanc-14
KMS_USGS_47	Hancock	N/A	24.2	30.414876	-89.380745	U-Hanc-15
KMS_USGS_48	Hancock	N/A	22.3	30.317932	-89.409849	U-Hanc-16
KMS_USGS_49	Hancock	N/A	22.2	30.298498	-89.406062	U-Hanc-17
KMS_USGS_50	Hancock	N/A	21.6	30.300180	-89.418186	U-Hanc-18
KMS_USGS_51	Hancock	N/A	22.4	30.299231	-89.397249	U-Hanc-19
KMS_USGS_52	Hancock	N/A	18.6	30.252471	-89.587925	U-Hanc-20
KMS_USGS_53	Hancock	N/A	18.3	30.253469	-89.615650	U-Hanc-21
KMS_USGS_54	Hancock	N/A	10.9	30.286629	-89.607501	U-Hanc-22
KMS_USGS_55	Hancock	N/A	8.2	30.302099	-89.613893	U-Hanc-23
KMS_USGS_56	Hancock	N/A	7.7	30.323469	-89.487969	U-Hanc-24
KMS_USGS_57	Hancock	N/A	23.6	30.268385	-89.449417	U-Hanc-25
KMS_USGS_58	Hancock	N/A	23.0	30.289711	-89.409754	U-Hanc-26
KMS_USGS_59	Hancock	N/A	25.1	30.274281	-89.390503	U-Hanc-27
KMS_USGS_60	Hancock	N/A	25.3	30.284237	-89.380531	U-Hanc-28
KMS_USGS_61	Hancock	N/A	25.3	30.381227	-89.359029	U-Hanc-29
KMS_USGS_64	Hancock	N/A	19.0	30.241663	-89.554751	U-Hanc-30
KMS_USGS_65	Hancock	N/A	20.1	30.215991	-89.575246	U-Hanc-31
KMS_USGS_105	Hancock	N/A	14.8	30.347524	-89.641672	U-Hanc-32

4.2 Coastal HWM Observations

The coastal flooding for Hurricane Katrina was significant and brought widespread devastation along the Mississippi coast. As discussed in the following sections, the HWM elevations were noticeably highest in western Mississippi, near the border between Hancock County and Harrison County. Overall the pattern of the surge is clear: this massive event extended along the entire Mississippi coast, often more than 5 miles inland.

Interstate Highway 10 (I-10) runs west to east about 4 or more miles inland of the shoreline along most of the Mississippi coast. Coastal storm surge flooding was noted up to and north of this highway in many places. However, the inland extent appeared to be farther behind Bay St. Louis and other places where there are extensive coastal marshes. Local topography also caused considerable variations in the extent of the inland propagation of the coastal storm surge. For example, a railroad running parallel to the coast approximately 0.5 to 1 mile inland extends from Biloxi to Pass Christian and affected flooding levels. This railroad rests atop an embankment that blocked coastal flooding during Hurricane Katrina by dampening or eliminating wave set-up as the flooding propagated inland.

4.2.1 Hancock County

Much of the western half of Hancock County (Figure B.2) is a wetland that extends well inland along the eastern side of the Pearl River. Aside from the town of Pearlington, this area is thinly populated with a sparse road network, and therefore the shoreline of Mississippi Sound is essentially inaccessible. Coastal HWM data from points approximately 3 miles inland show fairly consistent values on the order of 19 to 20 feet. Lower values, on the order of 8 to 14 feet, were found north of Pearlington; these are 8 to 10 miles inland from the sound. Overall, the pattern indicates some inland attenuation of the surge as it propagated through the extensive wetland vegetation. However, the magnitude of this event was so great that even inland areas were affected by substantial coastal flooding.

The coastal communities of Waveland, Bay St. Louis, and Diamondhead are located in eastern Hancock County (Figure B.3). The land rises behind the beaches to form a low, gently sloping coastal bluff, which previously provided flood protection to many of the homes along the shore during numerous lesser storms. However, the Katrina surge completely overtopped this bluff and propagated far inland. In Waveland and Bay St. Louis the coastal flooding levels were measured at 24 to 28 feet. Farther inland in Diamondhead, coastal HWM values of 25 feet were measured at several places along I-10. Coastal HWMs at elevations on the order of 20 feet extended north of I-10, 8 to 10 miles inland from the coastline. Although this surge was massive, there are no indications of an amplification of the surge toward the head of Bay St. Louis. On the other hand, variations in the maximum surge level on the order of 4 to 5 feet are noted, especially closer to the shoreline. These probably demonstrate the effects of local variations in the topography and possibly spatial variability in the storm winds.

4.2.2 Harrison County

The coastal HWM elevations found all along the Gulf shoreline in Harrison County were consistently high (Figures B.4 through B.6). The highest coastal HWM elevation of 34.9 feet was found in Pass Christian (Figure B.4) and represented flooding including wave height. The coastal surge elevations ranged between 25 and 27 feet along the coast in the western portion of the county (Figure B.4). In this area the flooding extended to I-10 with values between 20 and 24 feet in the inland portions of the town of Pass Christian. The flooding along the coast was 1 to 2 feet lower in the eastern portion of the county toward Gulfport (Figure B.6). The nearby communities of Gulf, Biloxi, and D'Iberville were strongly impacted by the surge, which traveled up through the bay instead of directly across the peninsula. In this area, significant coastal flooding also extended 1 to 2 miles north of I-10 (Figure B.6).

4.2.3 Jackson County

Jackson County, which is the easternmost coastal county in Mississippi, had flooding in Gulf Hills (Figure B.7) similar to Biloxi. There were surge levels on the order of 20 feet in the vicinity of I-10. Along the open coast the surge levels in western Jackson County were lower than farther west, but they were still in the devastating range of 18 to 21 feet (Figure B.7). To the east, surge levels were marginally lower, in the 16- to 18-foot range, along the Gulf shoreline at Moss in eastern Jackson County (Figure B.8). In addition, inland flooding along I-10 in Jackson County was noticeably lower than it had been in areas farther west. Nevertheless, flooding extended to and beyond I-10 because waters were able to propagate through the extensive low wetland north of the community of Pascagoula. It should be noted that wetlands along the eastern shoreline of Jackson County make the coast inaccessible, and therefore limited HWM data was collected in this region. However, the wetlands also appeared to have diminished the extent of the inland surge from Katrina.

4.3 Riverine HWM Observations

The HWMs from riverine flooding were found in some areas north of I-10 in Mississippi. However, most of these HWMs were found near the stream channel and did not impact buildings. It appears that riverine flooding from Hurricane Katrina was typically low and therefore had limited impact on buildings.

Although there were some riverine flooding HWMs in eastern Hancock County (Figure B.3), most of the riverine flooding in Hancock County appears limited to the stream channel. The areas where riverine flooding had some impact on buildings are located near the interface of the coastal and riverine flooding. Therefore, these riverine HWMs may have been influenced by the high coastal surge levels, such as along the Jourdan River.

Similarly, in Harrison County most of the riverine flooding appears to have been confined to the stream banks. However, there were some buildings along the Biloxi River (Figure B.5) and along Tuxachanie Creek (Figure B.6) where riverine flooding caused minor flooding at the buildings.

In Jackson County, there was a significant depth of riverine flooding near the Pascagoula River (Figure B.8). However, the buildings where the HWMs were collected were typically elevated, so there was minimal impact to the buildings from the flooding at that location. In most of the other areas in Jackson County, the riverine flooding was confined to the stream banks.

Appendix A. Field Data Collection Forms

Figure A.1

FLAGGER HIGH WATER MARK – COASTAL and RIVERINE
DATA COLLECTION REPORT FORM
(For Use By Flaggers) **HMTAP TO No.____________________**

HWM ID (e.g. DFLC-07-01) (Repeat in case forms are separated)		
HWM Street Address		
Rep Loss Number		
Multiple HWM	**(Circle One)**: Yes No	
HWM Area Identifier		
Subdivision / Industrial Park		
Date of Flagging/Interview		
Date of Flood Event		
Type/Name of Storm Event	**(Circle One)**: Hurricane, Tropical Storm, Tropical Depression, Other:	Name of storm event (e.g., Dennis)
Disaster Number (e.g.: DR-1539-FL)		
Date of Peak		
Source for Date of Peak		
Stream Name/Flood Source (Closest/responsible water body)		
Municipality, City or Town (Circle One: Known, closest)		
County		
State		
Type of HWM – **(Circle One)** **If Personal Account or Other, you MUST provide comment**	Mud Line Wrack Line Debris Line Water Line Personal Account Other Comment	
Wind Water Debris Line	**(Circle One)**: Yes No	
HWM Object, Surface (What object, surface is the HWM on? An interior/exterior wall, tree, fence, etc…)		

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Storm: ______________________
FLAGGER FORM Page 1 of 4

Figure A.1 (continued)

FLAGGER HIGH WATER MARK – COASTAL and RIVERINE
DATA COLLECTION REPORT FORM
(For Use By Flaggers) **HMTAP TO No.____________________**

HWM ID (e.g. DFLC-07-01) (Repeat in case forms are separated)		
Location/Directions to HWM Object		
Was a Vertical Offset Measurement used for HWM **(Circle Yes, No. If Yes, enter data)**	Yes No	If Yes: Measurement: Description of offset point:
Vertical Distance HWM to existing ground (feet) (Required		
HWM Quality – **(Circle One)**	GOOD FAIR POOR	
Description of Marker Used To Flag HWM **(e.g. red paint, tape. NOTE: HWM IS LINE AT BOTTOM OF TAPE OR PAINT. UNLESS the Flagger indicates that there is a vertical offset from the marked point)**		
Survey of HWM Needed	YES NO	
Flagger HWM Latitude (Decimal Degrees ex: 29.12345 (5 places))	N DECIMAL DEGREES	
Flagger HWM Longitude (Decimal Degrees ex: 84.12345 (5 places))	W DECIMAL DEGREES	
Flooding Type – **(Circle One)**	**Riverine Choices are**: - Riverine - Heavy Rain - Riverine - Hurricane	**Coastal Choices are:** - Coastal - surge only - Coastal - wave height - Coastal - wave runup **Breached Levee**
Estimated HWM Surge Level and what is this based on (Coastal HWM Only)	Elevation (Feet) Based On:	
Timestamp of Surge Estimate (Coastal HWM Only)	____ : ____ AM / PM CENTRAL / EASTERN	
Photo ID (HWM ID)-(Photo file name from camera)	Photo 1 (HWM mark from 20 feet away)	Photo 2 (Structure / Area from 50 feet away)
Photos Location/Orientation		
Photos Description/Subject		
Unit Number (2-digit number)		

URS Storm: ____________________
Flagger Form Rev September 1, 2005.doc **FLAGGER FORM Page 2 of 4**

Figure A.1 (continued)

FLAGGER HIGH WATER MARK – COASTAL and RIVERINE
DATA COLLECTION REPORT FORM
(For Use By Flaggers) HMTAP TO No.____________________

HWM ID (e.g. DFLC-07-01) (Repeat in case forms are separated)		
Name of Flagger 1/Flagger 2	1	2
Flagger 1 Company/Flagger 2 Company	1	2
Flagger's Comments		
Resident/Eyewitness Information		
Name		
Address		
Obtained Permission to Survey	Yes	No
Phone		
Length of residence or familiarity with area		
Relevant witness Information (Document only if witness is willing to have personal information included in record)		
Wind Damage Data		
Structure Damage **(Circle as applicable)**	1) No Damage; 2) Structure type (use): residential, commercial, agricultural, mobile home; 3) Cause: wind, fallen objects, blown debris; 4) Severity (subjective): light, moderate, severe	
Tree Damage **(Circle as applicable)**	1) No Damage; 2) Tree Species: oak, pine, palm, other; 3) Damage: uprooted, snapped, twisted; 4) Severity (subjective): light (single tree), moderate, severe	
Overhead Utility Damage **(Circle as applicable)**	1) No Damage; 2) Materials: wood, metal, concrete; 3) Utility Type: power, telephone, cable; 4) Cause: wind, fallen objects, blown debris; 5) Severity (subjective): light, moderate, sever	

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Storm: ____________________
FLAGGER FORM Page 3 of 4

Figure A.1 (continued)

FLAGGER HIGH WATER MARK – COASTAL and RIVERINE
DATA COLLECTION REPORT FORM
(For Use By Flaggers) **HMTAP TO No.**____________________

HWM ID (e.g. DFLC-07-01) (Repeat in case forms are separated)	
Other Damage/Comments	

Required Plan/ Elevation View Sketches (use back if needed)

Required: 1) Sketch/Plan of nearest cross roads, directions to get to the HWM
2) Plan and Elevation views of the HWM

Example Measurements

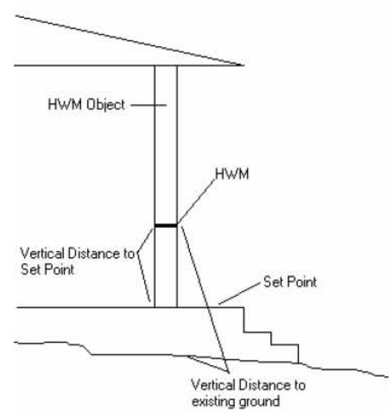

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Figure A.2

SURVEYOR'S
HIGH WATER MARK (HWM) – COASTAL AND RIVERINE
DATA COLLECTION REPORT FORM HMTAP TO No._______________

HWM ID (Repeat in case forms are separated)		
HWM Street Address		
Municipality, City or Town (Known, closest)		
County		
State		
Exact Mark To Survey		
HWM Flood Elevation (NAVD 88 Datum) (1)		
HWM Flood Elevation (NGVD 29) (1)		
Was Flagger's Vertical Offset Measurement used to survey HWM Elevation (1)		No Yes
If Yes, then:	Flagger Vertical Offset Distance	
	Surveyed Elevation of Reference Point (NAVD 88)	
Survey Latitude Must Use Decimal Degrees (6 Decimal places)		N
Survey Longitude Must Use Decimal Degrees (6 Decimal places)		W
Northing (feet)		
Easting (feet)		
Approx. First Floor Elevation (NAVD 88)		
Map Projection Used During Survey		
Vertical Datum		NAVD 88 NGVD 29 OTHER:
Horizontal Datum		NAD 83 OTHER:
Survey Crew		
Responsible Licensed Professional Land Surveyor Name and Number		PLS Name:
Survey Company / Office Location		

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Storm________________
SURVEY FORM Page 1 of 2

Figure A.2 (continued)

SURVEYOR'S
HIGH WATER MARK (HWM) – COASTAL AND RIVERINE
DATA COLLECTION REPORT FORM HMTAP TO No._______________

HWM ID (Repeat in case forms are separated)	
Survey Date (e.g. 07/15/2005)	
Surveyor's Comments	

(1) note that the HWM is the line at the bottom of the tape or paint **UNLESS the Flagger indicates that there is a vertical offset from the marked point**

Surveyor Plan/ Elevation View Sketches (if needed)

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Storm________________
SURVEY FORM Page 2 of 2

APPENDICES

Appendix B. HWM Location Maps and Summary Table

Table B.1 Appendix B Figures

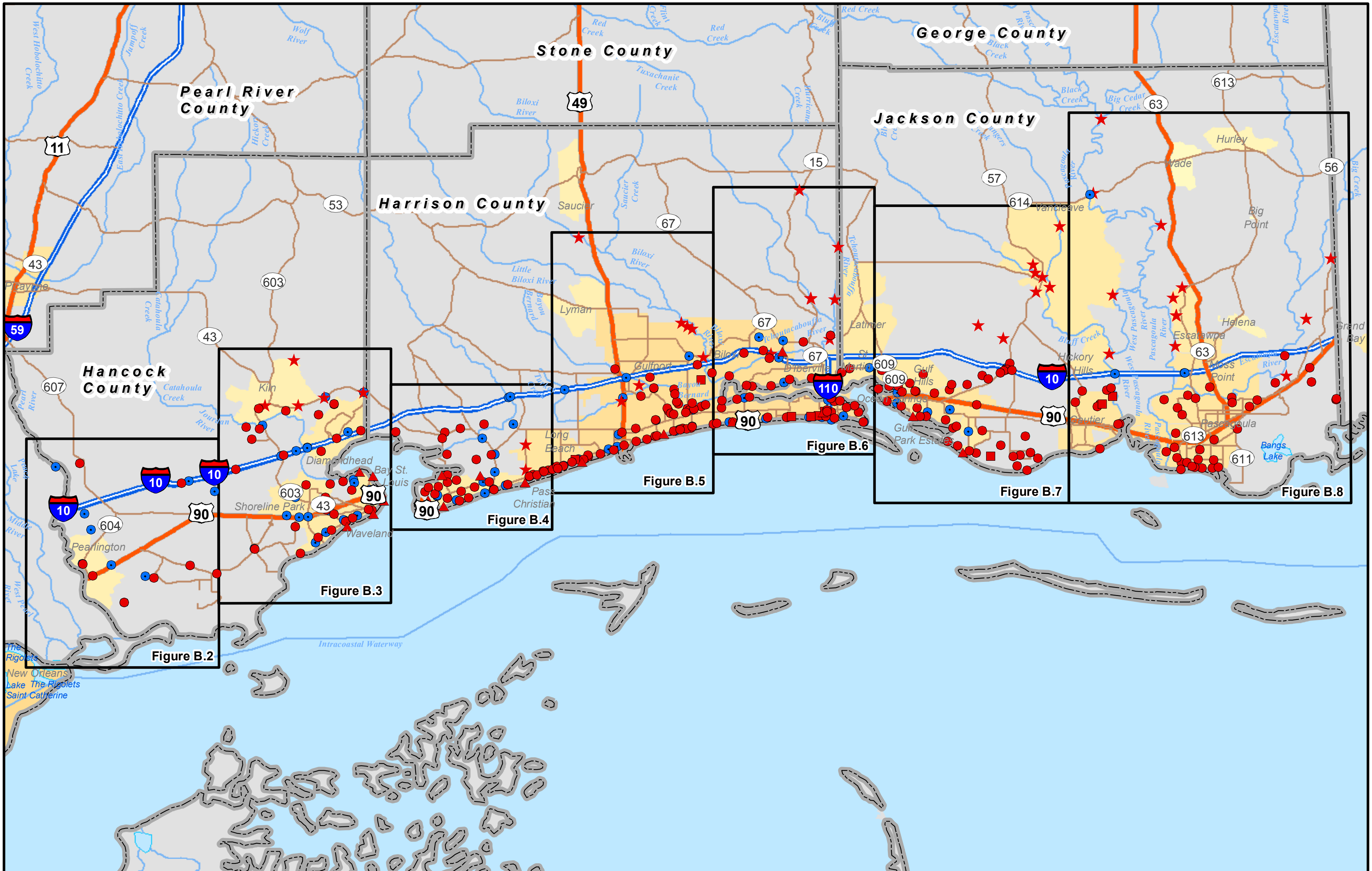
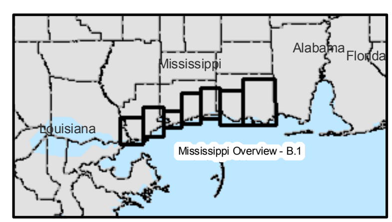


Figure B.1: Mississippi Overview
Hurricane Katrina, Mississippi
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final

Flooding Type

- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- City Limit
- Riverine
- USGS High Water Marks
- County

VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83



N

Miles 0 10 20 40 60 80

Kilometers 0 20 40 80 120 160

FEMA

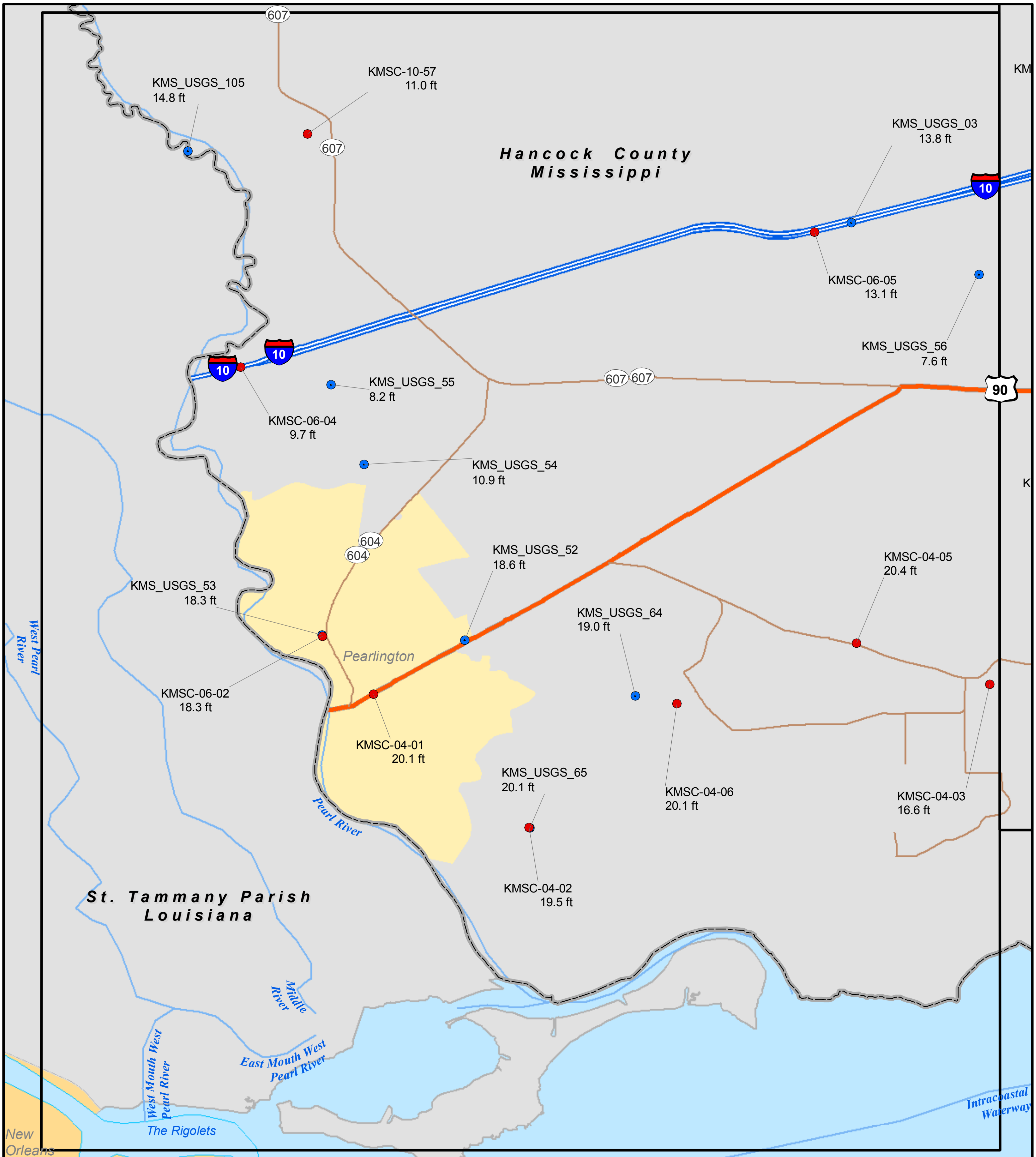
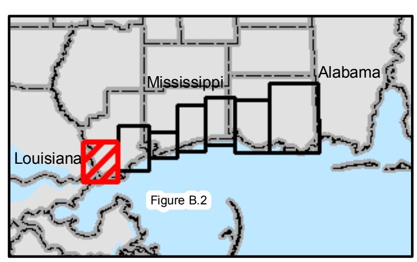
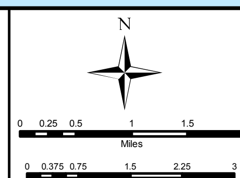


Figure: B.2
Hancock County, Mississippi
Hurricane Katrina
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final





Flooding Type

- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- Riverine
- USGS High Water Marks
- City Limit
- County

VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83

FEMA

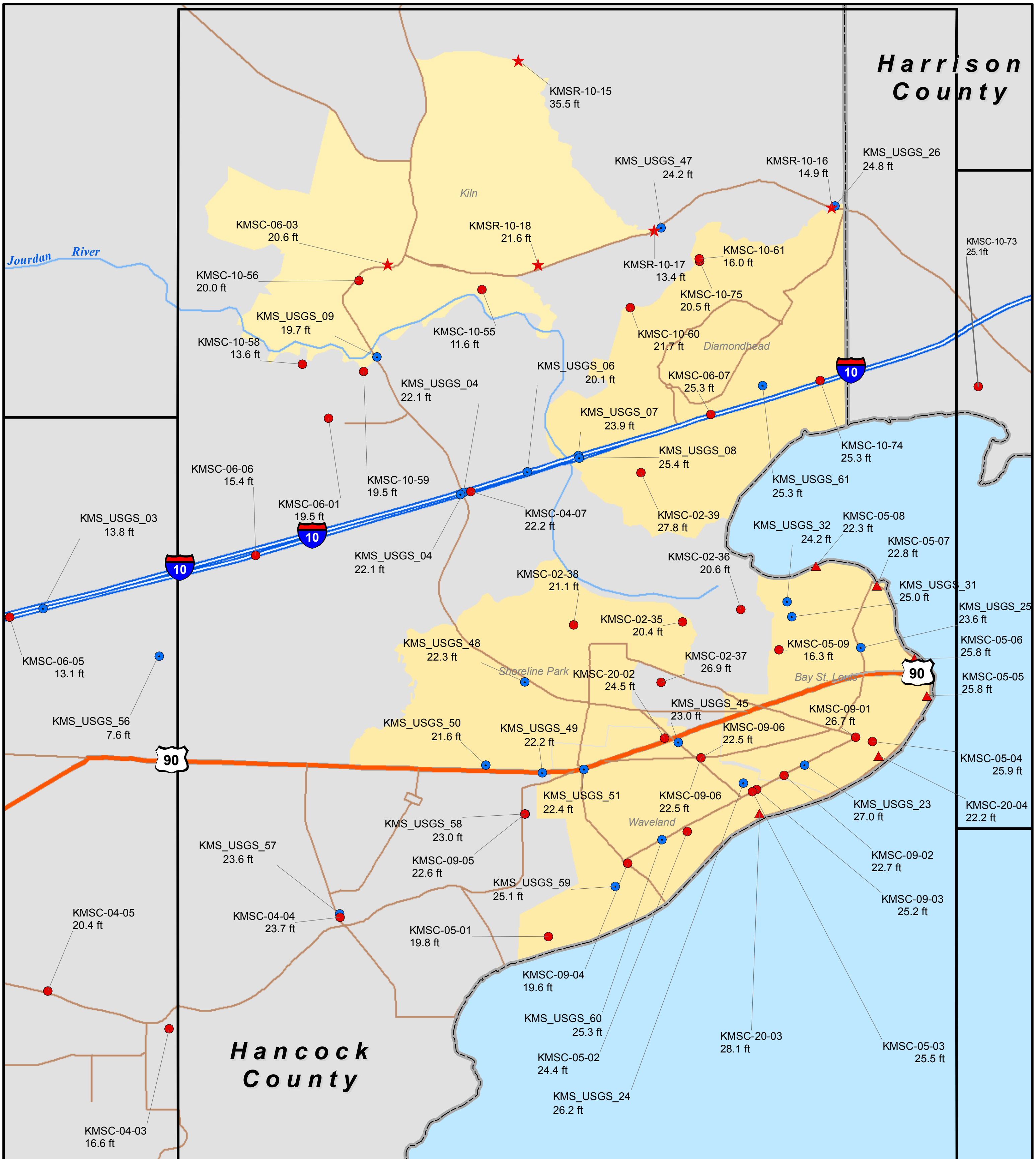
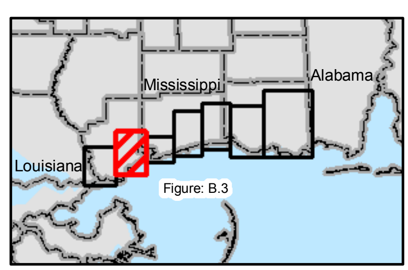
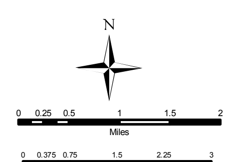


Figure: B.3
Hancock County, Mississippi
Hurricane Katrina
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final

Flooding Type
- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- Riverine
- USGS High Water Marks
- City Limit
- County

VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83





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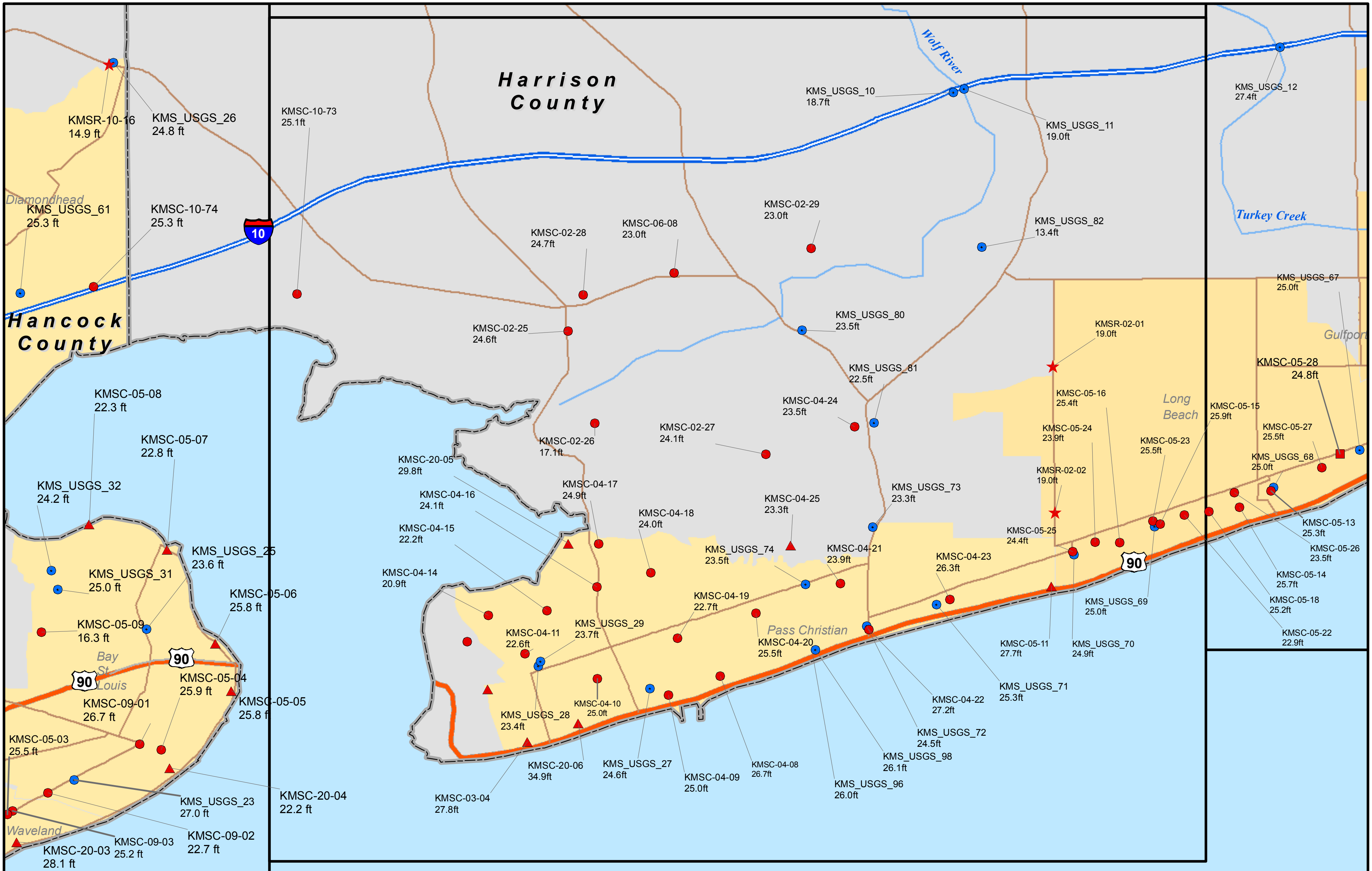
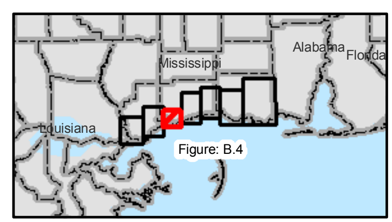


Figure: B.4
Harrison County, Mississippi
Hurricane Katrina
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final

Flooding Type

- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- City Limit
- Riverine
- USGS High Water Marks
- County

VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83

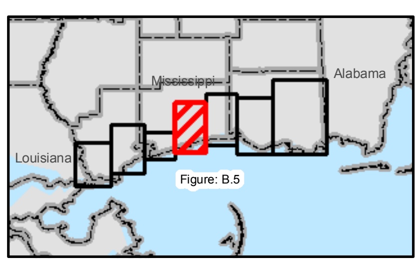


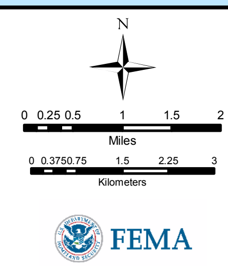
N

0 0.25 0.5 1 1.5 2
Miles
0 0.375 0.75 1.5 2.25 3
Kilometers

FEMA

Figure: B.5
Harrison County, Mississippi
Hurricane Katrina
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final





Flooding Type

- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- Riverine
- USGS High Water Marks
- City Limit
- County

VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83

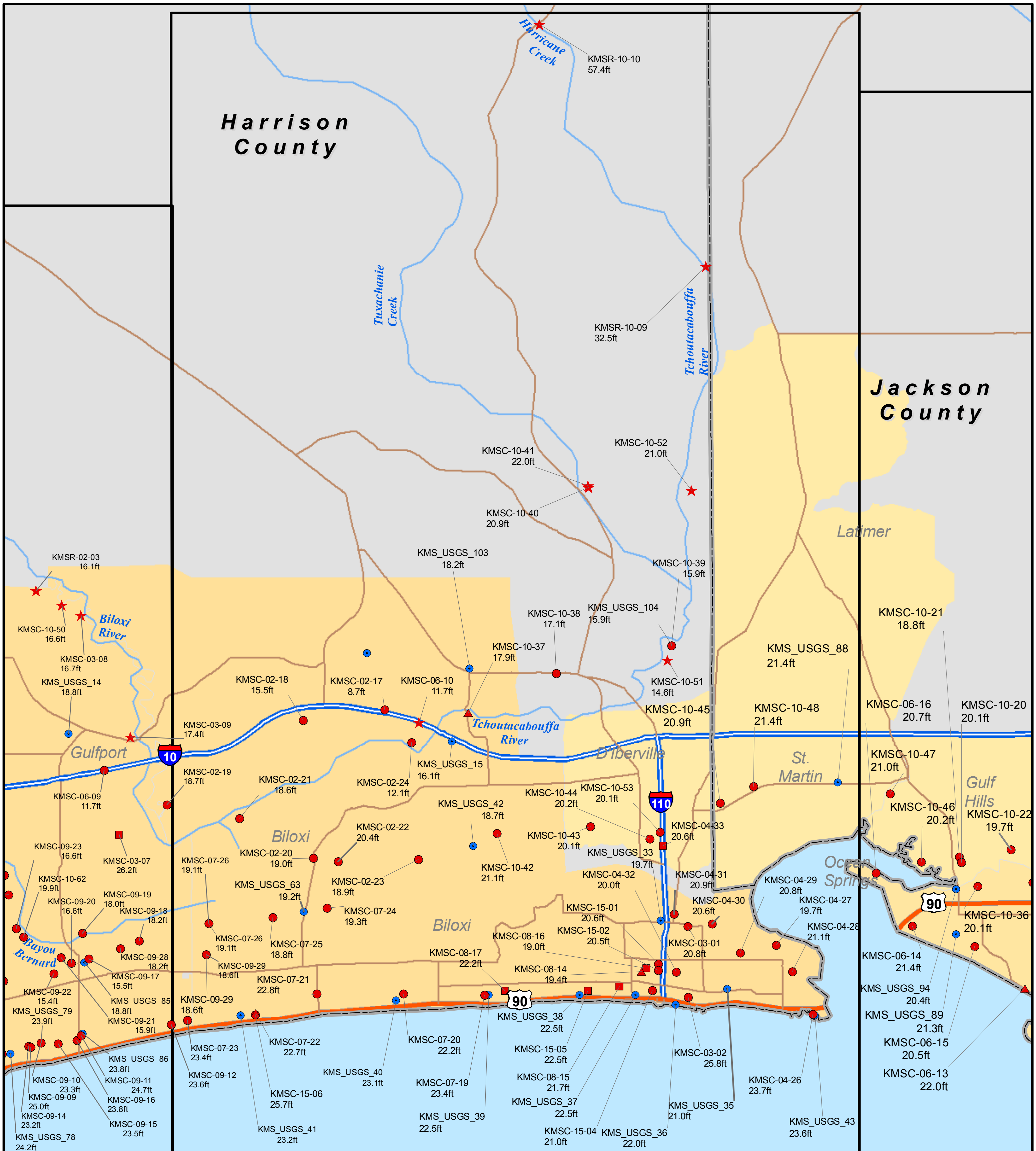
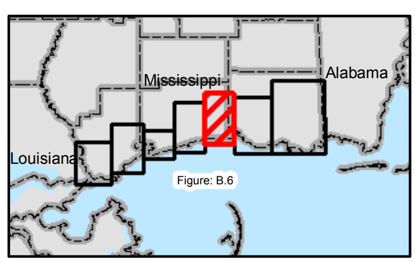


Figure: B.6
Harrison County, Mississippi
Hurricane Katrina
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final



Flooding Type

- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- Riverine
- USGS High Water Marks
- City Limit
- County

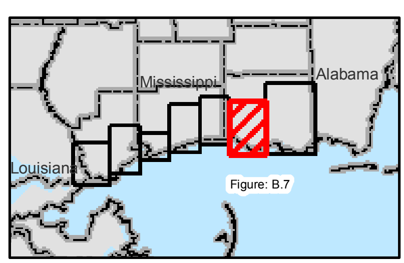
VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83

N

0 0.25 0.5 1 1.5 2
Miles
0 0.375 0.75 1.5 2.25 3
Kilometers

FEMA

Figure: B.7
Jackson County, Mississippi
Hurricane Katrina
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final



Flooding Type

- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- Riverine
- USGS High Water Marks
- City Limit
- County

VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83

N
0 0.25 0.5 1 1.5 2 Miles
0 0.375 0.75 1.5 2.25 3 Kilometers

FEMA

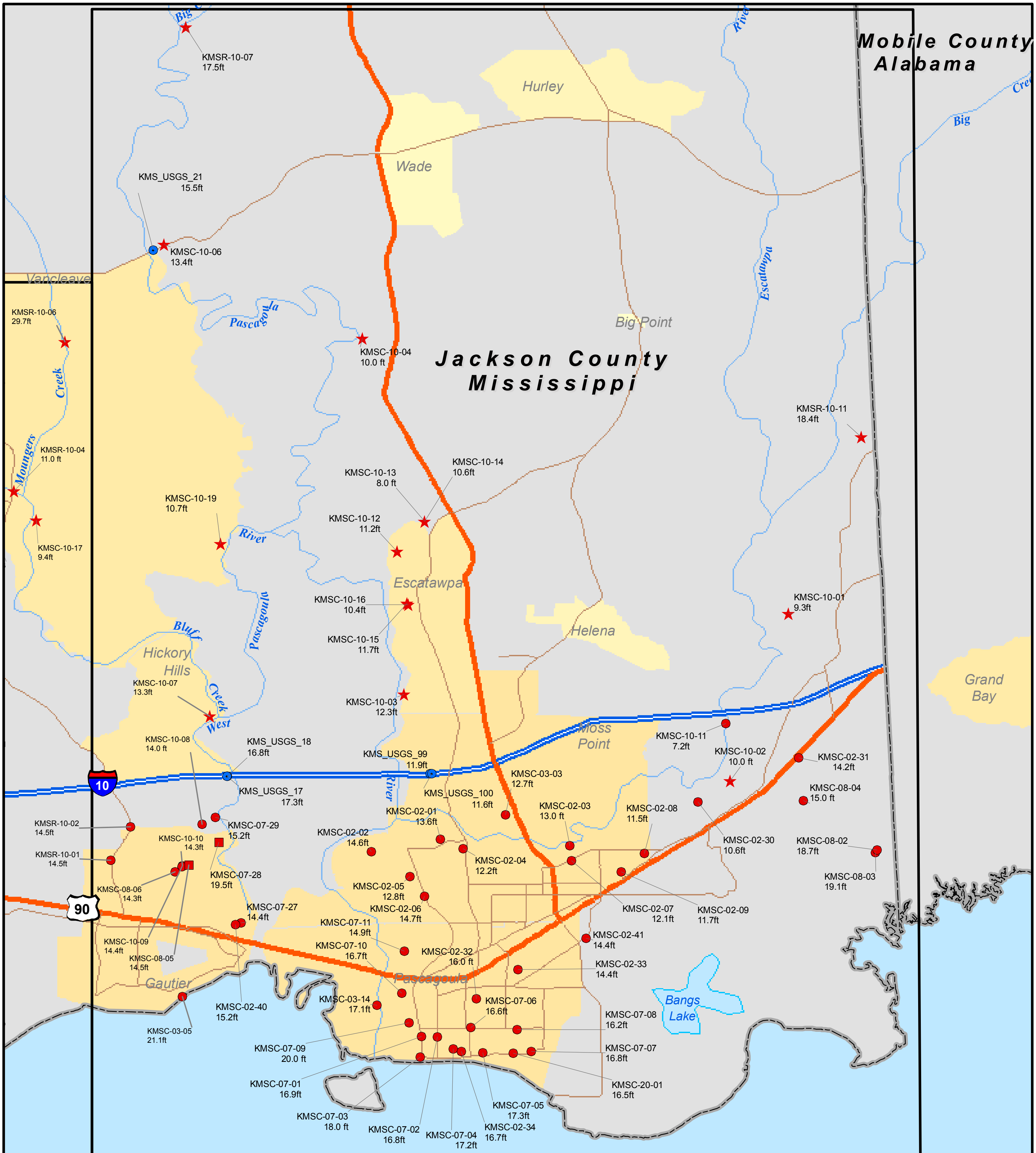
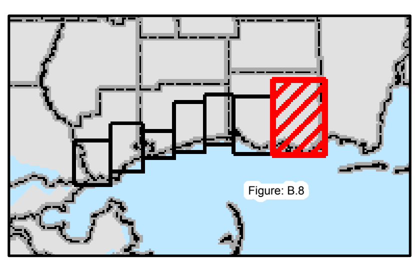


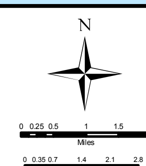
Figure: B.8
Jackson County, Mississippi
Hurricane Katrina
High Water Mark (HWM)
Surveyed Locations of High Water Mark Elevations
Final

Flooding Type

- Coastal - Surge Only
- Coastal - Wave Height
- Coastal - Wave Runup
- Riverine
- USGS High Water Marks
- City Limit
- County

VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83





FEMA

Table B.2 Hurricane Katrina Mississippi HWM Data Summary (same as Table 6, sorted by HWM-ID)[9]

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
URS Team Surveyed Points						
KMSC-02-01	Jackson	Coastal - Surge Only	13.6	30.416640	-88.547106	Jack-1
KMSC-02-02	Jackson	Coastal - Surge Only	14.6	30.412611	-88.569817	Jack-2
KMSC-02-03	Jackson	Coastal - Surge Only	13.0	30.414593	-88.504551	Jack-3
KMSC-02-04	Jackson	Coastal - Surge Only	12.2	30.413608	-88.539624	Jack-4
KMSC-02-05	Jackson	Coastal - Surge Only	12.8	30.404349	-88.557125	Jack-5
KMSC-02-06	Jackson	Coastal - Surge Only	14.7	30.397906	-88.552399	Jack-6
KMSC-02-07	Jackson	Coastal - Surge Only	12.1	30.409681	-88.503953	Jack-7
KMSC-02-08	Jackson	Coastal - Surge Only	11.5	30.411946	-88.479896	Jack-8
KMSC-02-09	Jackson	Coastal - Surge Only	11.7	30.405950	-88.487574	Jack-9
KMSC-02-10	Jackson	Coastal - Surge Only	20.5	30.344181	-88.702300	Jack-10
KMSC-02-11	Jackson	Coastal - Surge Only	16.9	30.355796	-88.691939	Jack-11
KMSC-02-12	Jackson	Coastal - Surge Only	18.4	30.361346	-88.699072	Jack-12
KMSC-02-13	Jackson	Coastal - Surge Only	19.0	30.358731	-88.709244	Jack-13
KMSC-02-14	Jackson	Coastal - Surge Only	19.9	30.348318	-88.711937	Jack-14
KMSC-02-15	Jackson	Coastal - Surge Only	19.2	30.368061	-88.727840	Jack-15
KMSC-02-16	Jackson	Coastal - Surge Only	19.4	30.376919	-88.704322	Jack-16
KMSC-02-17	Harrison	Coastal - Surge Only	8.7	30.459883	-88.957634	Harr-1
KMSC-02-18	Harrison	Coastal - Surge Only	15.5	30.457448	-88.976079	Harr-2
KMSC-02-19	Harrison	Coastal - Surge Only	18.7	30.438356	-89.006944	Harr-3
KMSC-02-20	Harrison	Coastal - Surge Only	19.0	30.426213	-88.973735	Harr-4
KMSC-02-21	Harrison	Coastal - Surge Only	18.6	30.435235	-88.990528	Harr-5
KMSC-02-22	Harrison	Coastal - Surge Only	20.4	30.425472	-88.968203	Harr-6
KMSC-02-23	Harrison	Coastal - Surge Only	18.9	30.425943	-88.950021	Harr-7
KMSC-02-24	Harrison	Coastal - Surge Only	12.1	30.452505	-88.951516	Harr-8
KMSC-02-25	Harrison	Coastal - Surge Only	24.6	30.374895	-89.267862	Harr-9
KMSC-02-26	Harrison	Coastal - Surge Only	17.1	30.359542	-89.263453	Harr-10
KMSC-02-27	Harrison	Coastal - Surge Only	24.1	30.354434	-89.234960	Harr-11
KMSC-02-28	Harrison	Coastal - Surge Only	24.7	30.380947	-89.265402	Harr-12
KMSC-02-29	Harrison	Coastal - Surge Only	23.0	30.388699	-89.227453	Harr-13
KMSC-02-30	Jackson	Coastal - Surge Only	10.6	30.428885	-88.462346	Jack-17
KMSC-02-31	Jackson	Coastal - Surge Only	14.2	30.443423	-88.429145	Jack-18
KMSC-02-32	Jackson	Coastal - Surge Only	16.0	30.364139	-88.535258	Jack-19
KMSC-02-33	Jackson	Coastal - Surge Only	14.4	30.373731	-88.521614	Jack-20
KMSC-02-34	Jackson	Coastal - Surge Only	16.7	30.346879	-88.540243	Jack-21
KMSC-02-35	Hancock	Coastal - Surge Only	20.4	30.330756	-89.376202	Hanc-1
KMSC-02-36	Hancock	Coastal - Surge Only	20.6	30.333419	-89.363736	Hanc-2
KMSC-02-37	Hancock	Coastal - Surge Only	26.9	30.317860	-89.380749	Hanc-3
KMSC-02-38	Hancock	Coastal - Surge Only	21.1	30.330132	-89.399373	Hanc-4
KMSC-02-39	Hancock	Coastal - Surge Only	23.8	30.362593	-89.385026	Hanc-5
KMSC-02-40	Jackson	Coastal - Surge Only	15.2	30.388538	-88.614552	Jack-22
KMSC-02-41	Jackson	Coastal - Surge Only	14.4	30.384084	-88.499126	Jack-23

[9] Note – For HWM data summary listing sorted by County and HWM sheet number, refer to Table 6

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-03-01	Harrison	Coastal - Surge Only	20.8	30.410779	-88.888898	Harr-14
KMSC-03-02	Harrison	Coastal - Surge Only	25.8	30.394681	-88.888884	Harr-15
KMSC-03-03	Jackson	Coastal - Wave Height	12.7	30.424656	-88.525667	Jack-24
KMSC-03-04	Harrison	Coastal - Wave Height	27.8	30.306564	-89.274642	Harr-16
KMSC-03-05	Jackson	Coastal - Surge Only	21.1	30.364817	-88.631998	Jack-25
KMSC-03-06	Jackson	Coastal - Surge Only	21.1	30.396205	-88.800120	Jack-26
KMSC-03-07	Harrison	Coastal - Wave Runup	26.2	30.431597	-89.017808	Harr-17
KMSC-03-08	Harrison	Riverine - Hurricane	16.7	30.481287	-89.026392	Harr-18
KMSC-03-09	Harrison	Riverine - Hurricane	17.4	30.453713	-89.015174	Harr-19
KMSC-03-10	Jackson	Coastal - Wave Runup	18.2	30.357944	-88.737995	Jack-27
KMSC-03-11	Jackson	Coastal - Surge Only	18.6	30.362780	-88.758148	Jack-28
KMSC-03-12	Jackson	Coastal - Surge Only	18.8	30.386721	-88.770639	Jack-29
KMSC-03-13	Jackson	Coastal - Surge Only	20.4	30.372130	-88.779294	Jack-30
KMSC-03-14	Jackson	Coastal - Surge Only	17.1	30.362080	-88.567977	Jack-31
KMSC-04-01	Hancock	Coastal - Surge Only	20.1	30.241955	-89.605661	Hanc-6
KMSC-04-02	Hancock	Coastal - Surge Only	19.5	30.216038	-89.575426	Hanc-7
KMSC-04-03	Hancock	Coastal - Surge Only	16.6	30.243894	-89.485826	Hanc-8
KMSC-04-04	Hancock	Coastal - Surge Only	23.7	30.267713	-89.449307	Hanc-9
KMSC-04-05	Hancock	Coastal - Surge Only	20.4	30.251886	-89.511768	Hanc-10
KMSC-04-06	Hancock	Coastal - Surge Only	20.1	30.240107	-89.546675	Hanc-11
KMSC-04-07	Hancock	Coastal - Surge Only	22.2	30.358643	-89.421384	Hanc-12
KMSC-04-08	Harrison	Coastal - Surge Only	26.7	30.317467	-89.242560	Harr-20
KMSC-04-09	Harrison	Coastal - Surge Only	25.0	30.314344	-89.251147	Harr-21
KMSC-04-10	Harrison	Coastal - Surge Only	25.0	30.317068	-89.262998	Harr-22
KMSC-04-11	Harrison	Coastal - Surge Only	22.6	30.321175	-89.275085	Harr-23
KMSC-04-12	Harrison	Coastal - Wave Height	25.8	30.315313	-89.281200	Harr-24
KMSC-04-13	Harrison	Coastal - Surge Only	22.7	30.323215	-89.284641	Harr-25
KMSC-04-14	Harrison	Coastal - Surge Only	20.9	30.327600	-89.281183	Harr-26
KMSC-04-15	Harrison	Coastal - Surge Only	22.2	30.328362	-89.271412	Harr-27
KMSC-04-16	Harrison	Coastal - Surge Only	24.1	30.332277	-89.263053	Harr-28
KMSC-04-17	Harrison	Coastal - Surge Only	24.9	30.339453	-89.262803	Harr-29
KMSC-04-18	Harrison	Coastal - Surge Only	24.0	30.334645	-89.254108	Harr-30
KMSC-04-19	Harrison	Coastal - Surge Only	22.7	30.323809	-89.249680	Harr-31
KMSC-04-20	Harrison	Coastal - Surge Only	25.5	30.327945	-89.236589	Harr-32
KMSC-04-21	Harrison	Coastal - Surge Only	23.9	30.332889	-89.222535	Harr-33
KMSC-04-22	Harrison	Coastal - Surge Only	27.2	30.325196	-89.217849	Harr-34
KMSC-04-23	Harrison	Coastal - Surge Only	26.3	30.330242	-89.204382	Harr-35
KMSC-04-24	Harrison	Coastal - Surge Only	23.5	30.359015	-89.220216	Harr-36
KMSC-04-25	Harrison	Coastal - Wave Height	23.3	30.339269	-89.230796	Harr-37
KMSC-04-26	Harrison	Coastal - Surge Only	23.7	30.390785	-88.860629	Harr-38
KMSC-04-27	Harrison	Coastal - Surge Only	19.7	30.406527	-88.868908	Harr-39
KMSC-04-28	Harrison	Coastal - Surge Only	21.1	30.400540	-88.865196	Harr-40
KMSC-04-29	Harrison	Coastal - Surge Only	20.8	30.404794	-88.877048	Harr-41
KMSC-04-30	Harrison	Coastal - Surge Only	20.6	30.411305	-88.883392	Harr-42
KMSC-04-31	Harrison	Coastal - Surge Only	20.9	30.413606	-88.891999	Harr-43
KMSC-04-32	Harrison	Coastal - Surge Only	20.0	30.400439	-88.891575	Harr-44
KMSC-04-33	Harrison	Coastal - Surge Only	20.6	30.429057	-88.894540	Harr-45

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-05-01	Hancock	Coastal - Surge Only	19.8	30.263517	-89.404830	Hanc-13
KMSC-05-02	Hancock	Coastal - Surge Only	24.4	30.285967	-89.375132	Hanc-14
KMSC-05-03	Hancock	Coastal - Surge Only	25.5	30.294469	-89.361203	Hanc-15
KMSC-05-04	Hancock	Coastal - Surge Only	25.9	30.305190	-89.335591	Hanc-16
KMSC-05-05	Hancock	Coastal - Wave Height	25.8	30.314997	-89.323922	Hanc-17
KMSC-05-06	Hancock	Coastal - Wave Height	25.8	30.322952	-89.326554	Hanc-18
KMSC-05-07	Hancock	Coastal - Wave Height	22.8	30.338542	-89.334562	Hanc-19
KMSC-05-08	Hancock	Coastal - Wave Height	22.3	30.342769	-89.347578	Hanc-20
KMSC-05-09	Hancock	Coastal - Surge Only	16.3	30.324812	-89.355554	Hanc-21
KMSC-05-11	Harrison	Coastal - Wave Height	27.7	30.332489	-89.187385	Harr-46
KMSC-05-12	Harrison	Coastal - Wave Height	33.0	30.352230	-89.132638	Harr-47
KMSC-05-13	Harrison	Coastal - Surge Only	25.3	30.348299	-89.150941	Harr-48
KMSC-05-14	Harrison	Coastal - Surge Only	25.7	30.345597	-89.156121	Harr-49
KMSC-05-15	Harrison	Coastal - Surge Only	25.9	30.342788	-89.169327	Harr-50
KMSC-05-16	Harrison	Coastal - Surge Only	25.4	30.339689	-89.176119	Harr-51
KMSC-05-17	Harrison	Coastal - Surge Only	25.0	30.354494	-89.131380	Harr-52
KMSC-05-18	Harrison	Coastal - Surge Only	25.2	30.344886	-89.161267	Harr-53
KMSC-05-22	Harrison	Coastal - Surge Only	22.9	30.344268	-89.165344	Harr-54
KMSC-05-23	Harrison	Coastal - Surge Only	25.5	30.343306	-89.170571	Harr-55
KMSC-05-24	Harrison	Coastal - Surge Only	23.9	30.339768	-89.180145	Harr-56
KMSC-05-25	Harrison	Coastal - Surge Only	24.4	30.338198	-89.183905	Harr-57
KMSC-05-26	Harrison	Coastal - Surge Only	23.5	30.348035	-89.157015	Harr-58
KMSC-05-27	Harrison	Coastal - Surge Only	25.5	30.352166	-89.142421	Harr-59
KMSC-05-28	Harrison	Coastal - Wave Runup	24.8	30.354481	-89.139451	Harr-60
KMSC-05-29	Harrison	Coastal - Surge Only	24.3	30.358583	-89.127227	Harr-61
KMSC-06-01	Hancock	Coastal - Surge Only	19.5	30.374266	-89.451833	Hanc-22
KMSC-06-02	Hancock	Coastal - Surge Only	18.3	30.253223	-89.615515	Hanc-23
KMSC-06-03	Hancock	Riverine - Hurricane	20.6	30.407104	-89.439158	Hanc-24
KMSC-06-04	Hancock	Coastal - Wave Runup	9.7	30.305489	-89.631494	Hanc-25
KMSC-06-05	Hancock	Coastal - Surge Only	13.1	30.331792	-89.519915	Hanc-26
KMSC-06-06	Hancock	Coastal - Surge Only	15.4	30.344935	-89.467345	Hanc-27
KMSC-06-07	Hancock	Coastal - Surge Only	25.3	30.375087	-89.370138	Hanc-28
KMSC-06-08	Harrison	Coastal - Surge Only	23.0	30.384570	-89.250214	Harr-62
KMSC-06-09	Harrison	Coastal - Surge Only	11.7	30.446200	-89.021123	Harr-63
KMSC-06-10	Harrison	Riverine - Hurricane	11.7	30.456960	-88.949795	Harr-64
KMSC-06-11	Jackson	Coastal - Surge Only	15.3	30.440817	-88.716966	Jack-32
KMSC-06-13	Jackson	Coastal - Wave Height	22.0	30.396746	-88.812518	Jack-33
KMSC-06-14	Jackson	Coastal - Surge Only	21.4	30.410861	-88.838051	Jack-34
KMSC-06-15	Jackson	Coastal - Surge Only	20.5	30.406209	-88.823959	Jack-35
KMSC-06-16	Jackson	Coastal - Surge Only	20.7	30.422880	-88.846252	Jack-36
KMSC-06-17	Jackson	Coastal - Surge Only	20.1	30.392846	-88.781316	Jack-37
KMSC-06-18	Jackson	Coastal - Surge Only	21.3	30.396271	-88.805888	Jack-38
KMSC-06-19	Jackson	Coastal - Surge Only	22.4	30.404665	-88.808660	Jack-39
KMSC-06-21	Jackson	Coastal - Surge Only	18.3	30.357484	-88.715830	Jack-40
KMSC-06-22	Jackson	Coastal - Surge Only	16.4	30.441074	-88.722781	Jack-41
KMSC-06-23	Jackson	Coastal - Surge Only	16.4	30.441074	-88.722781	Jack-42
KMSC-06-24	Jackson	Coastal - Surge Only	16.1	30.441596	-88.723237	Jack-43

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-06-25	Jackson	Coastal - Surge Only	18.1	30.440145	-88.724984	Jack-44
KMSC-07-01	Jackson	Coastal - Surge Only	16.9	30.351753	-88.553321	Jack-45
KMSC-07-02	Jackson	Coastal - Surge Only	16.8	30.351592	-88.548077	Jack-46
KMSC-07-03	Jackson	Coastal - Surge Only	18.0	30.344992	-88.553775	Jack-47
KMSC-07-04	Jackson	Coastal - Surge Only	17.2	30.347724	-88.542869	Jack-48
KMSC-07-05	Jackson	Coastal - Surge Only	17.3	30.346347	-88.533150	Jack-49
KMSC-07-06	Jackson	Coastal - Surge Only	16.6	30.354695	-88.537086	Jack-50
KMSC-07-07	Jackson	Coastal - Surge Only	16.8	30.346849	-88.517255	Jack-51
KMSC-07-08	Jackson	Coastal - Surge Only	16.2	30.353997	-88.521867	Jack-52
KMSC-07-09	Jackson	Coastal - Surge Only	20.0	30.356234	-88.557388	Jack-53
KMSC-07-10	Jackson	Coastal - Surge Only	16.7	30.366045	-88.559767	Jack-54
KMSC-07-11	Jackson	Coastal - Surge Only	14.9	30.379839	-88.558912	Jack-55
KMSC-07-12	Harrison	Coastal - Surge Only	24.9	30.371872	-89.080163	Harr-65
KMSC-07-13	Harrison	Coastal - Surge Only	23.5	30.368309	-89.092044	Harr-66
KMSC-07-14	Harrison	Coastal - Surge Only	24.5	30.363494	-89.102105	Harr-67
KMSC-07-15	Harrison	Coastal - Surge Only	24.9	30.357343	-89.126410	Harr-68
KMSC-07-16	Harrison	Coastal - Surge Only	24.6	30.359986	-89.115093	Harr-69
KMSC-07-17	Harrison	Coastal - Surge Only	24.8	30.374018	-89.069978	Harr-70
KMSC-07-18	Harrison	Coastal - Surge Only	23.4	30.376927	-89.062022	Harr-71
KMSC-07-19	Harrison	Coastal - Surge Only	23.4	30.395198	-88.934961	Harr-72
KMSC-07-20	Harrison	Coastal - Surge Only	22.2	30.395456	-88.953322	Harr-73
KMSC-07-21	Harrison	Coastal - Surge Only	22.8	30.395507	-88.972947	Harr-74
KMSC-07-22	Harrison	Coastal - Wave Height	22.7	30.391077	-88.986872	Harr-75
KMSC-07-23	Harrison	Coastal - Surge Only	23.4	30.389461	-89.002289	Harr-76
KMSC-07-24	Harrison	Coastal - Surge Only	19.3	30.414902	-88.970629	Harr-77
KMSC-07-25	Harrison	Coastal - Surge Only	18.8	30.412844	-88.982968	Harr-78
KMSC-07-26	Harrison	Coastal - Surge Only	19.1	30.411470	-88.997465	Harr-79
KMSC-07-27	Jackson	Coastal - Surge Only	14.4	30.389150	-88.612768	Jack-56
KMSC-07-28	Jackson	Coastal - Wave Runup	19.5	30.415704	-88.620100	Jack-57
KMSC-07-29	Jackson	Coastal - Surge Only	15.2	30.423799	-88.621120	Jack-58
KMSC-08-02	Jackson	Coastal - Surge Only	18.7	30.413096	-88.403277	Jack-59
KMSC-08-03	Jackson	Coastal - Surge Only	19.1	30.412257	-88.403847	Jack-60
KMSC-08-04	Jackson	Coastal - Surge Only	15.0	30.429428	-88.427646	Jack-61
KMSC-08-05	Jackson	Coastal - Wave Runup	14.5	30.408232	-88.629978	Jack-62
KMSC-08-06	Jackson	Coastal - Surge Only	14.3	30.405895	-88.634502	Jack-63
KMSC-08-07	Jackson	Coastal - Surge Only	15.8	30.438124	-88.728277	Jack-64
KMSC-08-08	Jackson	Coastal - Surge Only	18.9	30.407308	-88.751182	Jack-65
KMSC-08-09	Jackson	Coastal - Surge Only	19.3	30.384860	-88.773938	Jack-66
KMSC-08-10	Jackson	Coastal - Surge Only	19.4	30.382220	-88.745983	Jack-67
KMSC-08-11	Jackson	Coastal - Surge Only	19.7	30.367995	-88.769664	Jack-68
KMSC-08-12	Jackson	Coastal - Wave Height	21.2	30.361605	-88.764105	Jack-69
KMSC-08-13	Jackson	Coastal - Surge Only	17.6	30.360801	-88.751799	Jack-70
KMSC-08-14	Harrison	Coastal - Wave Height	19.4	30.400523	-88.899403	Harr-80
KMSC-08-15	Harrison	Coastal - Wave Runup	21.7	30.397110	-88.904450	Harr-81
KMSC-08-16	Harrison	Coastal - Wave Runup	19.0	30.401243	-88.898283	Harr-82
KMSC-08-17	Harrison	Coastal - Wave Runup	22.2	30.396138	-88.930329	Harr-83
KMSC-09-01	Hancock	Coastal - Surge Only	26.7	30.306162	-89.339176	Hanc-29

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-09-02	Hancock	Coastal - Surge Only	22.7	30.298032	-89.354450	Hanc-30
KMSC-09-03	Hancock	Coastal - Surge Only	25.2	30.295002	-89.360329	Hanc-31
KMSC-09-04	Hancock	Coastal - Surge Only	19.6	30.279233	-89.387849	Hanc-32
KMSC-09-05	Hancock	Coastal - Surge Only	22.6	30.289700	-89.409855	Hanc-33
KMSC-09-06	Hancock	Coastal - Surge Only	22.5	30.301714	-89.372239	Hanc-34
KMSC-09-07	Harrison	Coastal - Wave Height	23.7	30.379573	-89.053292	Harr-84
KMSC-09-08	Harrison	Coastal - Surge Only	24.2	30.381806	-89.044250	Harr-85
KMSC-09-09	Harrison	Coastal - Surge Only	25.0	30.383408	-89.037766	Harr-86
KMSC-09-10	Harrison	Coastal - Surge Only	23.3	30.384319	-89.035435	Harr-87
KMSC-09-11	Harrison	Coastal - Surge Only	24.7	30.386005	-89.026399	Harr-88
KMSC-09-12	Harrison	Coastal - Surge Only	23.6	30.388514	-89.005981	Harr-89
KMSC-09-13	Harrison	Coastal - Surge Only	23.9	30.377558	-89.060239	Harr-90
KMSC-09-14	Harrison	Coastal - Surge Only	23.2	30.383617	-89.038244	Harr-91
KMSC-09-15	Harrison	Coastal - Surge Only	23.5	30.384165	-89.031595	Harr-92
KMSC-09-16	Harrison	Coastal - Surge Only	23.8	30.384909	-89.027344	Harr-93
KMSC-09-17	Harrison	Coastal - Surge Only	15.5	30.403442	-89.024611	Harr-94
KMSC-09-18	Harrison	Coastal - Surge Only	18.2	30.407452	-89.013243	Harr-95
KMSC-09-19	Harrison	Coastal - Surge Only	18.0	30.409190	-89.026071	Harr-96
KMSC-09-20	Harrison	Coastal - Surge Only	16.6	30.402447	-89.028585	Harr-97
KMSC-09-21	Harrison	Coastal - Surge Only	15.9	30.403709	-89.030955	Harr-98
KMSC-09-22	Harrison	Coastal - Surge Only	15.4	30.400001	-89.032548	Harr-99
KMSC-09-23	Harrison	Coastal - Surge Only	16.6	30.410279	-89.041090	Harr-100
KMSC-09-24	Harrison	Coastal - Surge Only	18.1	30.417959	-89.042810	Harr-101
KMSC-09-25	Harrison	Coastal - Surge Only	16.8	30.401469	-89.049282	Harr-102
KMSC-09-26	Harrison	Coastal - Surge Only	15.1	30.403899	-89.050454	Harr-103
KMSC-09-27	Harrison	Coastal - Surge Only	17.1	30.399264	-89.046899	Harr-104
KMSC-09-28	Harrison	Coastal - Surge Only	18.2	30.405752	-89.017492	Harr-105
KMSC-09-29	Harrison	Coastal - Surge Only	18.6	30.404346	-88.998069	Harr-106
KMSC-10-01	Jackson	Riverine - Hurricane	9.3	30.490950	-88.432509	Jack-71
KMSC-10-02	Jackson	Riverine - Hurricane	10.0	30.435842	-88.451796	Jack-72
KMSC-10-03	Jackson	Riverine - Hurricane	12.3	30.464325	-88.559037	Jack-73
KMSC-10-04	Jackson	Riverine - Hurricane	10.0	30.581433	-88.572824	Jack-74
KMSC-10-06	Jackson	Riverine - Hurricane	13.4	30.612380	-88.638130	Jack-75
KMSC-10-07	Jackson	Riverine - Hurricane	13.3	30.457152	-88.622953	Jack-76
KMSC-10-08	Jackson	Coastal - Surge Only	14.0	30.421645	-88.625543	Jack-77
KMSC-10-09	Jackson	Coastal - Surge Only	14.4	30.407641	-88.632187	Jack-78
KMSC-10-10	Jackson	Coastal - Surge Only	14.3	30.407954	-88.631995	Jack-79
KMSC-10-11	Jackson	Coastal - Surge Only	7.2	30.454792	-88.453156	Jack-80
KMSC-10-12	Jackson	Riverine - Hurricane	11.2	30.511378	-88.561312	Jack-81
KMSC-10-14	Jackson	Riverine - Hurricane	10.6	30.521243	-88.552277	Jack-82
KMSC-10-15	Jackson	Riverine - Hurricane	11.7	30.494219	-88.558110	Jack-83
KMSC-10-16	Jackson	Riverine - Hurricane	10.4	30.493899	-88.557756	Jack-84
KMSC-10-17	Jackson	Riverine - Hurricane	9.4	30.521638	-88.680228	Jack-85
KMSC-10-19	Jackson	Riverine - Hurricane	10.7	30.513890	-88.619482	Jack-86
KMSC-10-20	Jackson	Coastal - Surge Only	20.1	30.425247	-88.826933	Jack-87
KMSC-10-21	Jackson	Coastal - Surge Only	18.8	30.426559	-88.827426	Jack-88
KMSC-10-22	Jackson	Coastal - Surge Only	19.7	30.428138	-88.815710	Jack-89

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-10-23	Jackson	Coastal - Surge Only	18.4	30.437009	-88.802931	Jack-90
KMSC-10-24	Jackson	Coastal - Surge Only	18.9	30.426840	-88.775559	Jack-91
KMSC-10-25	Jackson	Coastal - Surge Only	21.0	30.435790	-88.745898	Jack-92
KMSC-10-26	Jackson	Riverine - Hurricane	21.0	30.484382	-88.749729	Jack-93
KMSC-10-27	Jackson	Riverine - Hurricane	11.4	30.471948	-88.725270	Jack-94
KMSC-10-28	Jackson	Coastal - Surge Only	18.9	30.447630	-88.719054	Jack-95
KMSC-10-29	Jackson	Coastal - Surge Only	15.6	30.441676	-88.721789	Jack-96
KMSC-10-30	Jackson	Coastal - Surge Only	17.2	30.432358	-88.739901	Jack-97
KMSC-10-31	Jackson	Coastal - Surge Only	16.5	30.426916	-88.760328	Jack-98
KMSC-10-32	Jackson	Coastal - Surge Only	22.0	30.421831	-88.777497	Jack-99
KMSC-10-33	Jackson	Coastal - Surge Only	22.5	30.418683	-88.792240	Jack-100
KMSC-10-34	Jackson	Coastal - Surge Only	19.5	30.420366	-88.810102	Jack-101
KMSC-10-35	Jackson	Coastal - Surge Only	18.6	30.420718	-88.810786	Jack-102
KMSC-10-36	Jackson	Coastal - Surge Only	20.1	30.419881	-88.823268	Jack-103
KMSC-10-37	Harrison	Coastal - Wave Height	17.9	30.459194	-88.938671	Harr-107
KMSC-10-38	Harrison	Coastal - Surge Only	17.1	30.468109	-88.918718	Harr-108
KMSC-10-39	Harrison	Coastal - Surge Only	15.9	30.474382	-88.892584	Harr-109
KMSC-10-40	Harrison	Riverine - Hurricane	20.9	30.510306	-88.911355	Harr-110
KMSC-10-41	Harrison	Riverine - Hurricane	22.0	30.510640	-88.911488	Harr-111
KMSC-10-42	Harrison	Coastal - Surge Only	21.1	30.431854	-88.932225	Harr-112
KMSC-10-43	Harrison	Coastal - Surge Only	20.1	30.433443	-88.910972	Harr-113
KMSC-10-44	Harrison	Coastal - Surge Only	20.2	30.430612	-88.897587	Harr-114
KMSC-10-45	Jackson	Coastal - Surge Only	20.9	30.438715	-88.881604	Jack-104
KMSC-10-46	Jackson	Coastal - Surge Only	20.2	30.425368	-88.835994	Jack-105
KMSC-10-47	Jackson	Coastal - Surge Only	21.0	30.440847	-88.843046	Jack-106
KMSC-10-48	Jackson	Coastal - Surge Only	21.4	30.442512	-88.874078	Jack-107
KMSC-10-50	Harrison	Riverine - Hurricane	16.6	30.483580	-89.030712	Harr-115
KMSC-10-51	Harrison	Coastal - Surge Only	14.6	30.471084	-88.893491	Harr-116
KMSC-10-52	Harrison	Riverine - Hurricane	21.0	30.509600	-88.888082	Harr-117
KMSC-10-53	Harrison	Coastal - Surge Only	20.1	30.432133	-88.895175	Harr-118
KMSC-10-54	Harrison	Riverine - Hurricane	18.7	30.442056	-89.100800	Harr-119
KMSC-10-55	Hancock	Coastal - Surge Only	11.6	30.401727	-89.419029	Hanc-35
KMSC-10-56	Hancock	Coastal - Surge Only	20.0	30.403666	-89.445279	Hanc-36
KMSC-10-57	Hancock	Coastal - Surge Only	11.0	30.350832	-89.618469	Hanc-37
KMSC-10-58	Hancock	Coastal - Surge Only	13.6	30.385748	-89.457349	Hanc-38
KMSC-10-59	Hancock	Coastal - Surge Only	19.5	30.384251	-89.444322	Hanc-39
KMSC-10-60	Hancock	Coastal - Surge Only	21.7	30.397865	-89.387362	Hanc-40
KMSC-10-61	Hancock	Coastal - Surge Only	16.0	30.408311	-89.372585	Hanc-41
KMSC-10-62	Harrison	Coastal - Surge Only	19.9	30.408340	-89.039396	Harr-120
KMSC-10-63	Harrison	Coastal - Surge Only	24.6	30.422411	-89.043788	Harr-121
KMSC-10-64	Harrison	Coastal - Surge Only	17.9	30.423237	-89.063370	Harr-122
KMSC-10-65	Harrison	Coastal - Surge Only	19.1	30.423824	-89.063187	Harr-123
KMSC-10-66	Harrison	Coastal - Surge Only	19.3	30.426774	-89.077247	Harr-124
KMSC-10-67	Harrison	Coastal - Surge Only	18.7	30.415800	-89.075940	Harr-125
KMSC-10-68	Harrison	Coastal - Surge Only	18.0	30.392668	-89.061564	Harr-126
KMSC-10-69	Harrison	Coastal - Surge Only	20.0	30.398423	-89.043963	Harr-127
KMSC-10-70	Harrison	Coastal - Surge Only	18.6	30.384362	-89.080974	Harr-128

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMSC-10-71	Harrison	Coastal - Surge Only	18.6	30.380575	-89.094237	Harr-129
KMSC-10-72	Harrison	Coastal - Surge Only	18.0	30.411308	-89.094667	Harr-130
KMSC-10-73	Harrison	Coastal - Surge Only	25.1	30.381059	-89.312983	Harr-131
KMSC-10-74	Hancock	Coastal - Surge Only	25.3	30.382284	-89.346810	Hanc-42
KMSC-10-75	Hancock	Coastal - Surge Only	20.5	30.407720	-89.372474	Hanc-43
KMSC-15-01	Harrison	Coastal - Surge Only	20.6	30.402285	-88.895595	Harr-132
KMSC-15-02	Harrison	Coastal - Surge Only	20.5	30.400767	-88.895594	Harr-133
KMSC-15-04	Harrison	Coastal - Surge Only	21.0	30.396211	-88.896945	Harr-134
KMSC-15-05	Harrison	Coastal - Wave Runup	22.5	30.396159	-88.911582	Harr-135
KMSC-15-06	Harrison	Coastal - Surge Only	25.7	30.390733	-88.986947	Harr-136
KMSC-20-01	Jackson	Coastal - Surge Only	16.5	30.346330	-88.523089	Jack-108
KMSC-20-02	Hancock	Coastal - Surge Only	24.5	30.305938	-89.380006	Hanc-44
KMSC-20-03	Hancock	Coastal - Wave Height	28.1	30.289894	-89.359639	Hanc-45
KMSC-20-04	Hancock	Coastal - Wave Height	22.2	30.302206	-89.334182	Hanc-46
KMSC-20-05	Harrison	Coastal - Wave Height	29.8	30.339524	-89.267820	Harr-137
KMSC-20-06	Harrison	Coastal - Wave Height	34.9	30.309676	-89.266203	Harr-138
KMSR-02-01	Harrison	Riverine - Hurricane	19.0	30.368997	-89.187179	Harr-139
KMSR-02-02	Harrison	Riverine - Hurricane	19.0	30.344732	-89.186839	Harr-140
KMSR-02-03	Harrison	Riverine - Hurricane	16.1	30.486882	-89.036506	Harr-141
KMSR-10-01	Jackson	Coastal - Surge Only	14.5	30.409774	-88.655584	Jack-109
KMSR-10-02	Jackson	Coastal - Surge Only	14.5	30.420734	-88.649082	Jack-110
KMSR-10-03	Jackson	Riverine - Hurricane	11.7	30.517036	-88.693557	Jack-111
KMSR-10-04	Jackson	Riverine - Hurricane	11.0	30.531292	-88.687444	Jack-112
KMSR-10-05	Jackson	Riverine - Hurricane	19.6	30.543463	-88.696683	Jack-113
KMSR-10-06	Jackson	Riverine - Hurricane	29.7	30.580304	-88.670738	Jack-114
KMSR-10-07	Jackson	Riverine - Hurricane	17.5	30.683960	-88.630859	Jack-115
KMSR-10-08	Jackson	Riverine - Hurricane	7.1	30.535368	-88.694373	Jack-116
KMSR-10-09	Harrison	Riverine - Hurricane	32.5	30.560358	-88.884801	Harr-142
KMSR-10-10	Harrison	Riverine - Hurricane	57.4	30.615243	-88.922486	Harr-143
KMSR-10-11	Jackson	Riverine - Hurricane	18.4	30.548947	-88.408561	Jack-117
KMSR-10-15	Hancock	Riverine - Hurricane	35.5	30.450605	-89.411189	Hanc-47
KMSR-10-16	Hancock	Riverine - Hurricane	14.9	30.419306	-89.344273	Hanc-48
KMSR-10-17	Hancock	Riverine - Hurricane	13.4	30.414342	-89.382161	Hanc-49
KMSR-10-18	Hancock	Riverine - Hurricane	21.6	30.407034	-89.407003	Hanc-50
KMSR-10-19	Harrison	Coastal - Surge Only	18.2	30.433976	-89.067206	Harr-144
KMSR-10-21	Harrison	Riverine - Hurricane	48.0	30.569672	-89.135979	Harr-145
USGS Surveyed Points						
KMS_USGS_03	Hancock	N/A	13.8	30.333581	-89.512738	U-Hanc-1
KMS_USGS_04	Hancock	N/A	22.1	30.358406	-89.422965	U-Hanc-2
KMS_USGS_05	Hancock	N/A	24.7	30.357979	-89.423555	U-Hanc-3
KMS_USGS_06	Hancock	N/A	20.1	30.362802	-89.409301	U-Hanc-4
KMS_USGS_07	Hancock	N/A	23.9	30.366287	-89.398455	U-Hanc-5
KMS_USGS_08	Hancock	N/A	25.4	30.365773	-89.398188	U-Hanc-6
KMS_USGS_09	Hancock	N/A	19.7	30.387349	-89.441456	U-Hanc-7
KMS_USGS_10	Harrison	N/A	18.7	30.414611	-89.203792	U-Harr-1
KMS_USGS_11	Harrison	N/A	19.0	30.415209	-89.201955	U-Harr-2
KMS_USGS_12	Harrison	N/A	27.4	30.422148	-89.149442	U-Harr-3
KMS_USGS_13	Harrison	N/A	19.1	30.433739	-89.090122	U-Harr-4

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMS_USGS_14	Harrison	N/A	18.8	30.454475	-89.029222	U-Harr-5
KMS_USGS_15	Harrison	N/A	16.1	30.452726	-88.942322	U-Harr-6
KMS_USGS_16	Jackson	N/A	14.4	30.443072	-88.722138	U-Jack-1
KMS_USGS_17	Jackson	N/A	17.3	30.437456	-88.617352	U-Jack-2
KMS_USGS_18	Jackson	N/A	16.8	30.437437	-88.617277	U-Jack-3
KMS_USGS_21	Jackson	N/A	15.5	30.610569	-88.641692	U-Jack-4
KMS_USGS_23	Hancock	N/A	27.0	30.300155	-89.350082	U-Hanc-8
KMS_USGS_24	Hancock	N/A	26.2	30.296350	-89.363198	U-Hanc-9
KMS_USGS_25	Hancock	N/A	23.6	30.325251	-89.338034	U-Hanc-10
KMS_USGS_26	Hancock	N/A	24.8	30.419556	-89.343535	U-Hanc-11
KMS_USGS_27	Harrison	N/A	24.6	30.315378	-89.254257	U-Harr-7
KMS_USGS_28	Harrison	N/A	23.4	30.319090	-89.272844	U-Harr-8
KMS_USGS_29	Harrison	N/A	23.7	30.319874	-89.272514	U-Harr-9
KMS_USGS_31	Hancock	N/A	25.0	30.331851	-89.352818	U-Hanc-12
KMS_USGS_32	Hancock	N/A	24.2	30.335029	-89.353838	U-Hanc-13
KMS_USGS_33	Harrison	N/A	19.7	30.412087	-88.895005	U-Harr-10
KMS_USGS_35	Harrison	N/A	21.0	30.396655	-88.879966	U-Harr-11
KMS_USGS_36	Harrison	N/A	22.0	30.393051	-88.891660	U-Harr-12
KMS_USGS_37	Harrison	N/A	22.5	30.395270	-88.900746	U-Harr-13
KMS_USGS_38	Harrison	N/A	22.5	30.395296	-88.913372	U-Harr-14
KMS_USGS_39	Harrison	N/A	22.5	30.395277	-88.933990	U-Harr-15
KMS_USGS_40	Harrison	N/A	23.1	30.393989	-88.954996	U-Harr-16
KMS_USGS_41	Harrison	N/A	23.2	30.390655	-88.990218	U-Harr-17
KMS_USGS_42	Harrison	N/A	18.7	30.429030	-88.937468	U-Harr-18
KMS_USGS_43	Harrison	N/A	23.6	30.390603	-88.860153	U-Harr-19
KMS_USGS_45	Hancock	N/A	23.0	30.305017	-89.377069	U-Hanc-14
KMS_USGS_47	Hancock	N/A	24.2	30.414876	-89.380745	U-Hanc-15
KMS_USGS_48	Hancock	N/A	22.3	30.317932	-89.409849	U-Hanc-16
KMS_USGS_49	Hancock	N/A	22.2	30.298498	-89.406062	U-Hanc-17
KMS_USGS_50	Hancock	N/A	21.6	30.300180	-89.418186	U-Hanc-18
KMS_USGS_51	Hancock	N/A	22.4	30.299231	-89.397249	U-Hanc-19
KMS_USGS_52	Hancock	N/A	18.6	30.252471	-89.587925	U-Hanc-20
KMS_USGS_53	Hancock	N/A	18.3	30.253469	-89.615650	U-Hanc-21
KMS_USGS_54	Hancock	N/A	10.9	30.286629	-89.607501	U-Hanc-22
KMS_USGS_55	Hancock	N/A	8.2	30.302099	-89.613893	U-Hanc-23
KMS_USGS_56	Hancock	N/A	7.7	30.323469	-89.487969	U-Hanc-24
KMS_USGS_57	Hancock	N/A	23.6	30.268385	-89.449417	U-Hanc-25
KMS_USGS_58	Hancock	N/A	23.0	30.289711	-89.409754	U-Hanc-26
KMS_USGS_59	Hancock	N/A	25.1	30.274281	-89.390503	U-Hanc-27
KMS_USGS_60	Hancock	N/A	25.3	30.284237	-89.380531	U-Hanc-28
KMS_USGS_61	Hancock	N/A	25.3	30.381227	-89.359029	U-Hanc-29
KMS_USGS_62	Harrison	N/A	14.4	30.378714	-89.097645	U-Harr-20
KMS_USGS_63	Harrison	N/A	19.2	30.414176	-88.975886	U-Harr-21
KMS_USGS_64	Hancock	N/A	19.0	30.241663	-89.554751	U-Hanc-30
KMS_USGS_65	Hancock	N/A	20.1	30.215991	-89.575246	U-Hanc-31
KMS_USGS_66	Harrison	N/A	24.8	30.357692	-89.126634	U-Harr-22
KMS_USGS_67	Harrison	N/A	25.0	30.355107	-89.136133	U-Harr-23
KMS_USGS_68	Harrison	N/A	25.0	30.348861	-89.150485	U-Harr-24
KMS_USGS_69	Harrison	N/A	25.0	30.342341	-89.170287	U-Harr-25
KMS_USGS_70	Harrison	N/A	24.9	30.337721	-89.183724	U-Harr-26

HWM ID	County	Flooding Type	HWM Flood Elevation - NAVD 88	Survey Latitude	Survey Longitude	HWM Report Sheet No.
KMS_USGS_71	Harrison	N/A	25.3	30.329367	-89.206552	U-Harr-27
KMS_USGS_72	Harrison	N/A	24.5	30.325762	-89.218221	U-Harr-28
KMS_USGS_73	Harrison	N/A	23.3	30.342266	-89.217165	U-Harr-29
KMS_USGS_74	Harrison	N/A	23.5	30.332737	-89.228390	U-Harr-30
KMS_USGS_75	Harrison	N/A	24.3	30.364593	-89.106948	U-Harr-31
KMS_USGS_76	Harrison	N/A	24.3	30.366902	-89.098761	U-Harr-32
KMS_USGS_78	Harrison	N/A	24.2	30.381973	-89.042370	U-Harr-33
KMS_USGS_79	Harrison	N/A	23.9	30.384316	-89.035429	U-Harr-34
KMS_USGS_80	Harrison	N/A	23.5	30.375070	-89.228936	U-Harr-35
KMS_USGS_81	Harrison	N/A	22.5	30.359642	-89.216953	U-Harr-36
KMS_USGS_82	Harrison	N/A	13.4	30.388879	-89.199066	U-Harr-37
KMS_USGS_83	Harrison	N/A	16.9	30.414277	-89.093248	U-Harr-38
KMS_USGS_84	Harrison	N/A	17.4	30.392619	-89.061104	U-Harr-39
KMS_USGS_85	Harrison	N/A	18.8	30.402593	-89.025650	U-Harr-40
KMS_USGS_86	Harrison	N/A	23.8	30.386454	-89.026023	U-Harr-41
KMS_USGS_88	Jackson	N/A	21.4	30.443412	-88.854921	U-Jack-5
KMS_USGS_89	Jackson	N/A	21.3	30.409017	-88.828083	U-Jack-6
KMS_USGS_90	Jackson	N/A	21.6	30.400250	-88.798574	U-Jack-7
KMS_USGS_91	Jackson	N/A	17.3	30.402947	-88.777143	U-Jack-8
KMS_USGS_92	Jackson	N/A	19.1	30.381598	-88.759280	U-Jack-9
KMS_USGS_94	Jackson	N/A	20.4	30.419230	-88.828067	U-Jack-10
KMS_USGS_96	Harrison	N/A	26.0	30.321616	-89.227311	U-Harr-42
KMS_USGS_98	Harrison	N/A	26.1	30.321834	-89.226728	U-Harr-43
KMS_USGS_99	Jackson	N/A	11.9	30.438244	-88.550535	U-Jack-11
KMS_USGS_100	Jackson	N/A	11.6	30.438190	-88.549876	U-Jack-12
KMS_USGS_102	Harrison	N/A	18.9	30.472782	-88.961565	U-Harr-44
KMS_USGS_103	Harrison	N/A	18.2	30.469321	-88.938352	U-Harr-45
KMS_USGS_104	Harrison	N/A	15.9	30.474511	-88.892558	U-Harr-46
KMS_USGS_105	Hancock	N/A	14.8	30.347524	-89.641672	U-Hanc-32

Note – For HWM data summary listing sorted by County and HWM sheet number, refer to Table 6.

Appendices

Appendices C through F are not included due to privacy issues.