EAST BATON ROUGE PARISH

Professional Engineering Services

Stormwater Master Plan Implementation Framework

SUBMITTED BY
HNTB Corporation

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STATE OF LOUISIANA
MELISSA A. KENNEDY
License No. 39175
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

Melissa A. Kennedy
6/21/2018

HNTB

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1 Executive Summary

The City of Baton Rouge and Parish of East Baton Rouge experienced widespread flooding in August 2016. The floods brought to light the current challenges regarding existing stormwater conveyance systems, development and drainage ordinances, and their impact on overall stormwater management in the Parish. The preparation of the Stormwater Master Plan (SMP) addresses these and other issues. The purpose of the SMP is to:

- Understand how the Parish's natural and man-made stormwater systems perform,
- Develop a plan that addresses the risks and impacts of local and regional flooding,
- Communicate the plan and engage the public

The program has been broken down into three phases:

SMP Phase 1

Phase 1 included a number of activities with the end result this Implementation Framework document which provides the summary of what has been completed to date and the path forward to complete Phases 2 and 3. Phase 1 included:

- existing data collection
- preliminary regional model
- visioning workshop with key Parish staff
- preliminary risk analyses
- development of applications for Hazard Mitigation Grant Program
- SMP Implementation Framework document

SMP Phase 2

Phase 2 includes the continuation of work performed in Phase 1 to evaluate each of 11 watersheds to determine flood risks and mitigation, public engagement program, ordinance revisions and draft SMP. The analyses for Phase 2 watersheds will be based on the preliminary risk assessment performed in Phase 1 with priority given to those watersheds subject to the highest risk. Phase 2 will consist of the following:

- Data collection & organization to understand the current stormwater systems: Performing channel and subsurface drainage system surveys, and obtaining the LiDAR data necessary for refining hydraulic models
- Public outreach and agency coordination: Develop a Public Engagement Plan for communications with stakeholders and partners
- Assessing the hazards: Development of hydraulic models for existing and future conditions to determine the extents and causes of flooding
- Assessing the problems that result from the hazards: Identification of buildings and infrastructure impacted by flooding and their relative risk from existing and future conditions
- Coordination with the Parish and key stakeholders to establish criteria, guidance, and ordinances for addressing and reducing existing and potential future levels of flooding risk
- Development of activities to mitigate the hazards: Concept level engineering to determine projects for flood risk reduction in areas with significant numbers of homes, businesses and infrastructure as well as update ordinances/regulations for future development
- Draft SMP.

It is anticipated that Phase 2 will begin in September 2018 and be completed in August 2020.

SMP Phase 3

Phase 3 will take all of the information developed during Phase 2 and combine into one comprehensive SMP document. In addition, the proposed projects will be developed into a 20-Year Stormwater Capital Improvement Plan (CIP). Phase 3 includes the following:

- Development and adoption of final SMP action plan: Specific informed recommendations for ordinance and regulation changes, a prioritized list of projects to address current and/or anticipated future flooding risks, and a maintenance plan strategy.
- 20-Year Stormwater CIP will be developed that will take the list of projects determined during the development of the stormwater master plan and prioritize them based on pre-determined criteria, including a funding and financing plan.

Table 1-1 shows the proposed overall schedule. This preliminary schedule assumes financing the full program as one project to increase efficiency and reduce cost. Should the project be budgeted in phases, the schedule will be adjusted accordingly.

In addition, a 20-Year Stormwater CIP will be developed that will take the list of projects determined during the development of the stormwater master plan and prioritize them based on pre-determined criteria, including a funding and financing plan.

Table 1-1: Preliminary SMP Schedule

REQUIRED ACTIVITIES	DETAILED TASKS SUMMARY	SUGGESTED TIMELINE
	Phase 2	
Asset Inventory	Obtain Parish-Wide LiDAR	9/18
	Enclosed System Survey	9/18 - 9/19
	Open Channel Bridges/Culverts Survey	9/18 - 9/19
	Data Asset Management Database	12/18 - 12/19
Public Involvement and Agency Coordination	Stakeholder/Public/Partners Meetings	10/18 - 3/21
	Website Communication	
	Media Relations	
	Social Media	
Design Criteria & Methodology Development	Regional Analysis Reference Documentation	9/18 - 4/19
	Watershed Criteria Development	
	Project Prioritization Schemes Development	
Hazard/Problems Assessment	Regional Hazard Assessment	1/19 - 7/19
	Watershed Hazard Assessments (11 watersheds)	4/19 - 10/20
	Problem Identification	5/19 - 11/20
Mitigation Activities	Determine Potential Risk Reduction Projects	5/19 - 11/20
	Model Potential Projects	6/19 - 12/20
	Screen Initial Projects for Further Analysis	8/19 - 12/20
	Concept Level Engineering and Design	8/19 - 1/21
	Cost and Benefit Estimates for B/C Ratios	8/19 - 1/21
	Hydraulic modeling for floodplain development guidance	4/19 - 7/19
	Ordinance and code revision recommendations based on model results and floodplain development guidance	9/18 - 11/19
DRAFT Stormwater Master Plan Document	Preliminary (30%) Report and Appendices	4/19 - 8/19
	60% Report and Appendices	8/19 - 8/20

Phase 3		
FINAL Stormwater Master Plan Document	Final Report & Appendices	8/20 - 4/21
20-Year Stormwater CIP Document	Projects Prioritization Funding/Financing Plan 20-Year CIP	8/20 - 4/21
	TOTAL	**9/18 - 4/21**

2 Introduction and Purpose

The City of Baton Rouge and unincorporated areas of the East Baton Rouge Parish (hereafter collectively referred to as the Parish) are in southeast Louisiana along the eastern bank of the Mississippi River. The Parish covers an area of approximately 470 square miles and is shown in Figure 2-1. Other than the City of Baton Rouge, there are three incorporated communities within East Baton Rouge Parish: the City of Baker, the City of Zachary, and the City of Central.

Figure 2-1: East Baton Rouge Parish

The cities of Baker, Zachary, and Central are, with few exceptions, each responsible for the design, construction, and maintenance of the streets and storm drainage facilities located within their corporate limits. The City of Baton Rouge and the unincorporated areas of East Baton Rouge Parish operate as a consolidated government with responsibility for streets and drainage systems located within the remainder of the Parish. An underlying part of that responsibility is some level of monitoring and maintenance of the storm drainage systems. A periodic comprehensive investigation and review can help to develop recommendations for drainage projects that will improve the performance of the storm drainage systems within the City of Baton Rouge and the unincorporated areas of the Parish. It will also help to understand and account for watershed interactions with the other cities in the Parish.

While the Mississippi River forms the western boundary of the Parish, less than 20 percent of the Parish drains to it. The Amite River forms the eastern boundary of the Parish and serves as the primary drainage outfall for the region. The Comite River, which is the primary tributary to the Amite, flows through the central portion of the Parish. Approximately 42 percent of the land area in East Baton Rouge Parish has a potential of being flooded by a 1% annual exceedance probability (AEP event (100-Year. The principal cause of the inundation risk is backwater from the larger regional floods along the Amite and Comite Rivers and their tributaries. The Parish should consider these regional impacts with respect to its storm drainage systems and impacts to public safety and property damages.

The August 2016 widespread flooding in southeast Louisiana further exposed the need to address stormwater issues on a regional basis. It is imperative that representatives from Ascension, Iberville, and Livingston Parishes work in conjunction with the Parish to review causes and potential solutions to flooding along the lower reaches of the Amite River and Bayou Manchac. Collaboration will lead to better stormwater management outcomes for all the parishes in the region.

The Parish contracted with HNTB Corporation and its sub-consultants (the HNTB team) to assist in the development of a Parish Stormwater Master Plan (SMP). The purpose of this SMP Implementation Framework document is to summarize the purpose and goals of the SMP and how it will be developed and implemented. The SMP will help guide the Parish into the future with improved data, stormwater system planning, and flood risk reduction. The overall goal is
a comprehensive plan for stormwater system improvements that will address both local and regional issues. A 20-Year Capital Improvement Plan (CIP) for stormwater will be produced in support of that goal.

In addition to the development of the SMP Implementation Framework document, the Parish requested assistance with finding and developing projects that would secure available funding through Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP). In order to accomplish this, preliminary risk assessments, regional hydrology and hydraulic modeling, and engineering assessments were performed. Portions of these assessments and modeling will serve as a foundation for the analysis in the next phase of the SMP. Further development of the HMGP projects is not considered a component of the SMP, and as such is not discussed further within this SMP Implementation Framework document. However, the HMGP projects will be reviewed and accounted for, along with other ongoing projects and initiatives throughout the Parish, as the SMP is developed.

3 Approach

The Parish has adopted a phased approach to the development of the SMP. Phase 1 laid the foundation for the SMP through outreach to key stakeholders, partners, and community organizations, collection/acquisition of critical data, an assessment of current flood related risks, and formulation of an approach for development of a comprehensive SMP and CIP. Through these efforts, remaining tasks necessary to complete the Parish SMP were better identified. The resulting SMP Implementation Framework is exhibited through the descriptions, the phases graphic, and the master plan work flow exhibit in this document. The framework will be used to take the project to successful completion. The fundamental pieces of the framework include development of goals/objectives, data collection, data analysis, planning and development and development of the action and maintenance plan. This will all be performed while engaging and coordinating with the public throughout the process.

Phase 2 will assess and recommend updates to development guidance and stormwater ordinances. It will also continue stakeholder and partner communications and meetings initiated in Phase 1, and conclude with the preparation of the formal Stormwater Master Plan Report and the 20-Year CIP In Phase 3. An overview of the phases is outlined in Figure 3-1.

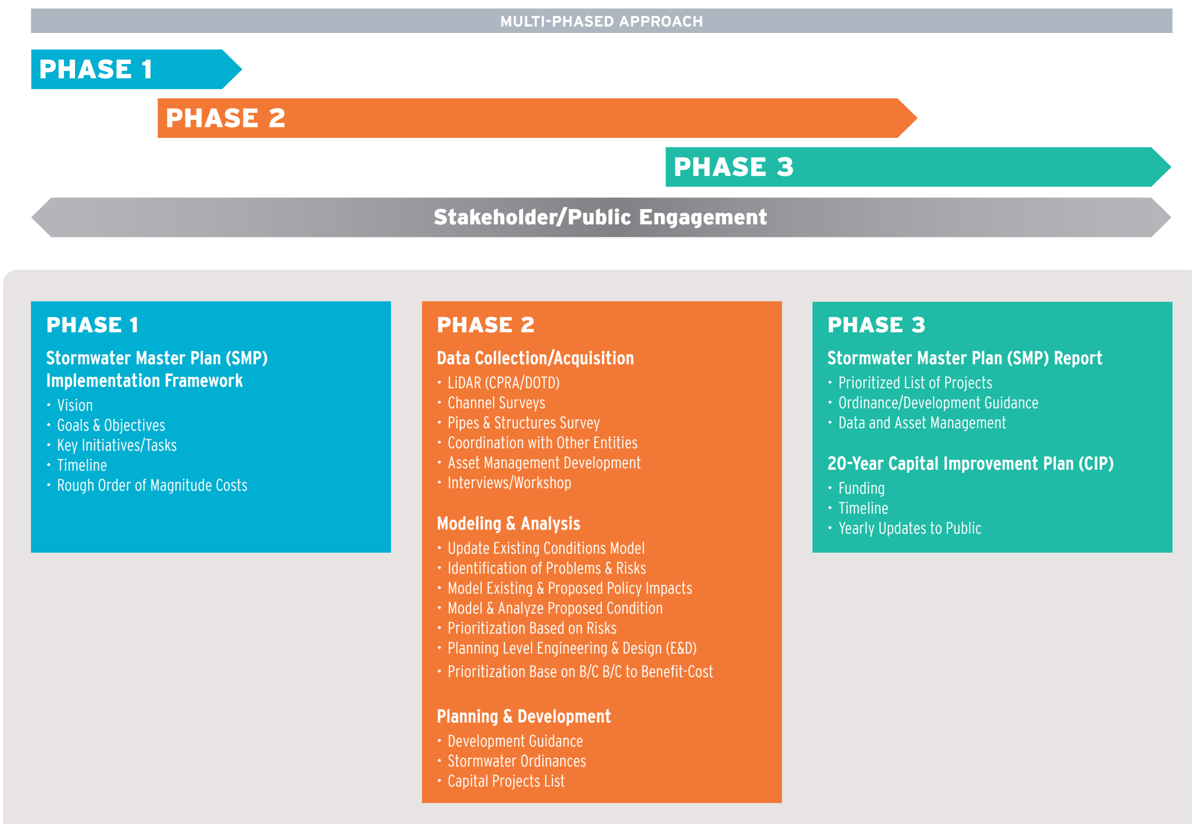


Figure 3-1: Stormwater Master Plan Phases

4 Phase 1 Summary

The following sections summarizes the work completed as part of Phase 1. This includes the Visioning Workshop that was completed to help identify overall project goals and objectives; the initial data collection and data needs assessment; preliminary risk assessment; preliminary regional model development; and this SMP Implementation Framework document.

4.1 Visioning Workshop

To develop a strong implementation framework for successful execution, it is critical to ensure a common understanding of the SMP between the project stakeholders and HNTB project team. This implementation framework lays out a path based on the ultimate goals of the stakeholders and the required elements to achieve those goals. The HNTB Team conducted a SMP Visioning Workshop on December 11, 2017. The workshop was attended by representatives from the Parish and HNTB Team members. The intent of the workshop was to obtain input from the Parish stakeholders that would provide insight and convey their knowledge of the problems, solutions, and expectations for the project, as well as to include them in the development of this implementation framework. The results of the workshop discussions form the foundation of this framework, and are included in the following sections.

4.1.1 Stakeholder Expectations

One of the first activities in the Visioning Workshop was to elicit and define Parish expectations regarding what the SMP should include and involve. Drainage issues are the primary concern in the community, so stakeholders have correspondingly high expectations for drainage improvements. It was expressed the comprehensive plan to address needs for reduced flood risk should include the following items:

- Innovative and cost-effective ideas to change drainage in the Parish and the region
- Incorporation of a resiliency initiative
- Modification of the out-of-date stormwater regulations
- Technical information to serve as the basis for change
- Parish watershed flood risk reduction with consideration of downstream impacts
- Technical data collection on all streams for Parish-wide updates
- Ordinance updates
- Migration to GIS-based data management
- Updates to outdated rainfall data for development and public projects

4.1.2 Vision for Success

One of the key objectives of the Visioning Workshop was to understand how the Parish defines a successful SMP. A *headline* exercise was conducted to elicit what each representative hoped the local newspapers would publish once the HNTB Team delivers this plan. As shown on the next page in Figure 4-1, each of these headlines reflect individual vision for the SMP – some long-term and others focused on near-term solutions. The consensus was to resolve flooding and drainage issues, help the residents of the Parish while remaining respectful of their neighbors, and provide technical information and planning that will allow success long into the future. Based on the headlines and the discussions that followed during the workshop, a Vision Statement for the Parish SMP was developed:

A Comprehensive SMP approved by the Metro Council that will resolve/improve major drainage issues, mitigate future flooding challenges, and facilitate project implementation through appropriate financing mechanisms.

Figure 4-1: Visioning Workshop Headlines

4.1.3 Goals and Objectives

The workshop included group discussions that led to development of common goals for the SMP. Some basic themes emerged and are summarized below.

- Data is critical. Data is needed to identify problems and should be used to perform technical analysis for quantitative results. An asset management system should be developed using the data collected. There are currently areas of decent data coverage as well as areas of very limited data within the Parish.
- Up-to-date technology and criteria is important. Tools for analyses should be state of the art. Updates to criteria, guidelines, and ordinances are needed. They should consider climate change and reflect today's commonly accepted design practices and rationale.
- Funding is a concern, especially related to data needs. Data could be a large part of the cost, so decisions as to how much is needed and where it will come from are critical. There are multiple potential data sources.
- Schedule is a concern. Requirements for data acquisition and the potential need to wait on others could cause schedules to become lengthy or unknown. Decisions to move ahead instead of waiting on others, for instance, may be needed. Tracking results and keeping stakeholders informed will be required so that appropriate and timely decisions can be made.
- Public involvement is important. The public needs to be engaged and informed. Citizens need to know something is being done and have confidence in their leaders. The public deserves improvements to their stormwater systems and management.

The following goals were developed based on the described themes.

GOAL 1	GOAL 2	GOAL 3	GOAL 4
Plan for a stormwater system that accounts for a warming climate	Identify hazards, develop a comprehensive technical plan that reduces flood risk in the watershed and no downstream impacts	Develop and build a stormwater plan that has minimal local/regulatory impact	Develop/maintain stormwater infrastructure

4.1.4 Problem Identification

In order to help with the development of more specific items for consideration during the SMP effort, participants in the Visioning Workshop were asked to provide and discuss known problems in the Parish watershed. The focus was on locations of areas of concern that were considered local flooding, regional flooding, aging stormwater infrastructure, and development impacts. The general themes that emerged from the problem identification exercise are summarized below.

- Often local flooding was associated with areas of aging infrastructure. This included areas in older central areas of Baton Rouge, LSU and Southern University. Other local flooding near tributaries included areas along Hurricane Creek to the Comite River junction, Monte Sano Bayou, Claycut Bayou, Highland/Perkins area near Bayou Duplantier, in Baker near Brushy and White Bayous, and in Zachary near Cypress Bayou. Local flooding included flooding of roads.
- Regional flooding concerns are near development along the major streams including Amite River and Comite River, as well as some of the major tributaries including Bayou Manchac.

- The line between local and regional flooding is somewhat blurred at times. The stakeholders often identified the same locations during the workshop, but some indicated local flooding and some indicated regional flooding.
- Development impacts were mostly noted in areas further away from downtown Baton Rouge. These included near the Mall of Louisiana; between Burbank and Hwy 30 near Gardere; S. Harrells Ferry Road near Jones Creek and Amite River; along Mt. Pleasant Road between Hwy 964 and US 61; near Doyle Bayou near Zachary; in the City of Central near Hooper Road and Beaver Bayou, development south of Claycut Bayou in Tiger Bend Rd. area; and the area just south of LSU.

4.1.5 Solution Considerations

The project stakeholders were able to provide a better understanding of issues, objectives, and goals for the SMP through the Visioning Workshop. The HNTB Team used it as a listening session to learn the expectations and needs of those closely tied to the outcome of the project. The stakeholders have their constituents' best interests in mind and conveyed several key considerations with respect to the solutions ultimately provided by the SMP.

- The initial expectation from most was to have something produced by end of 2018. As the group discussed it further, it was considered more realistic to have the path defined for implementation of the SMP and submitting applications for approval funding for the HMGP projects within that timeframe. The overall schedules for both will be dependent on funding.
- There should be proactive communication and outreach with the stakeholders and in the community. The team should have an initial assessment to present and ask for input from communities at public meetings. There is a need to understand what the public is willing to pay for the improvements. Coordination should be done with the Federation of Greater Baton Rouge Civic Association. Media should be kept in the loop and there should be proactive communication with the Metro Council to provide updates once progress on the project starts.
- Unified Development Code (UDC) updates should be part of the SMP. The UDC changes are currently being proposed to clarify and simplify without data. Updates should be evaluated as part of Phase 2. The Metro Council expects substantial revisions to the UDC quickly.
- The SMP must consider water quality.
- The recommendations in the SMP need to consider climate change impacts. LSU has a grant to evaluate climate change and impact on rainfall. Collaboration with the university should be used to benefit the SMP outcomes.
- The Visioning Workshop brought out many valuable ideas and considerations though thoughtful discussions with the project stakeholders. The HNTB team will utilize the feedback and knowledge gained when considering the components, steps, and challenges presented through this important process for the Parish. Early communication is a key contributor to success.

4.2 Data Collection and Data Needs Assessment

The purpose of the data collection task was to:

1. Collect currently available information that will be used in support of planning, modeling, design, cost estimation, and prioritization for the SMP and development of the HMGP projects.
2. Coordinate with other agencies to avoid duplication of future data collection efforts.
3. Develop a list of additional data and information that will need to be collected to complete subsequent phases of the SMP.

4.2.1 Data Needs

A significant amount of data is required to develop a comprehensive SMP. The following list summarizes the general information necessary for completing a SMP.

- Historic records of flooding, especially ones that indicate where or how past flooding may have occurred, including property owner complaint reports, high water marks, and stream gage data.
- Physical and geometric data related to the hydrologic and hydraulic properties of the watersheds and drainage systems. This information will be used to develop hydraulic models of the existing systems and provide the resulting water levels in channels and pipe systems for various frequency storm events.
- Geospatial and temporal hydrologic data, such as data from rainfall gages, stream gages, and high-water marks. This information will be used to develop inputs to the hydraulic models, as well as calibrate and validate them.
- Geospatial data related to population, economics, planimetrics, critical infrastructure, zoning, planning, and other information related to flood impacts.
- Current ordinances, codes, laws, design criteria, and guidance that govern stormwater planning and design within the Parish (parish, state, and national).
- Public and stakeholder input related to stormwater challenges and solutions.

4.2.2 Data Collection Process

More than 160,000 files were obtained for review. Given the large amount of information that was collected, the project team set up a screening process to go through each file to determine its relevancy to the SMP.

The result of this screening process was a table that listed the most relevant information obtained, and is provided in the Data Record in Appendix A. The Data Record table lists the source of the information, as well as a description.

4.2.3 Existing Data

Data was collected from various Parish departments including Engineering, Maintenance, Information Services, and MOHSEP. Meetings with the staff from Central, Zachary, and Baker were conducted to identify data these jurisdictions have that could be utilized during the development of the SMP. Information was obtained from other parish, state, and federal agencies including US Army corps of Engineers (USACE), FEMA, Louisiana Department of Transportation and Development (DOTD), US Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Amite River Basin Commission (ARBC), Coastal Protection and Restoration Authority (CPRA), and Ascension Parish. Coordination with USACE and DOTD for survey data that is currently being collected is ongoing.

A summary of the most valuable information found from each source is below. For more detailed information regarding the relevant data collected from each source, see the Data Record in Appendix A.

East Baton Rouge Parish
The project team received a hard drive of drainage related information from the Parish dated September 2017. The hard drive contained more than 160,000 files in over 16,000 folders. Given the large number of files and folders, a pre-screening of the file folders was performed in order to determine their relevance. Below is a list of most relevant information received from the Parish.

- As-built plans of subdivision, roadway, bridge/culvert, and drainage projects.
- Hydrologic and Hydraulic models of streams within the Parish
- Maps of the drainage system for the Parish
- Historic flood information

United States Army Corps of Engineers (USACE)
The project team coordinated with USACE to obtain the following information.

- HEC hydrologic and hydraulic models of the Amite-Comite River basin and tributaries
- Design memorandums, reports, and plans for various USACE flood control projects
- Stream and precipitation gage information
- Survey data associated with various USACE flood control projects
- New survey data (stream profiles and cross-sections) of the Amite River and Comite River

Federal Emergency Management Agency (FEMA)
Hydrology and hydraulic information and models related to the current Flood Insurance Study (FIS) for the Parish. A FEMA data request was made in September 2017. A list of the effective FIS models is provided in Appendix A.

- FIS reports and maps
- Hydrologic and hydraulic models for most of the Zone AE streams in the Parish
- Letter of Map Revision (LOMR) requests
- 2016 flooded structure data

4.2.4 Data Gaps

Although the data collection process was extensive, gaps still exist in the data that will be required for completion of future phases of the SMP. Based on this review, most of the data needed is related to the layout and size of the existing drainage systems. Below is a summary of the major data gaps that must be filled for future phases of the SMP.

Enclosed Drainage System - Based on preliminary estimates, there are more than 25,000 enclosed drainage system structures within the Parish. These structures and associated pipe systems must be surveyed to develop a comprehensive stormwater system map and stormwater models that will be used to analyze existing conditions and potential projects.

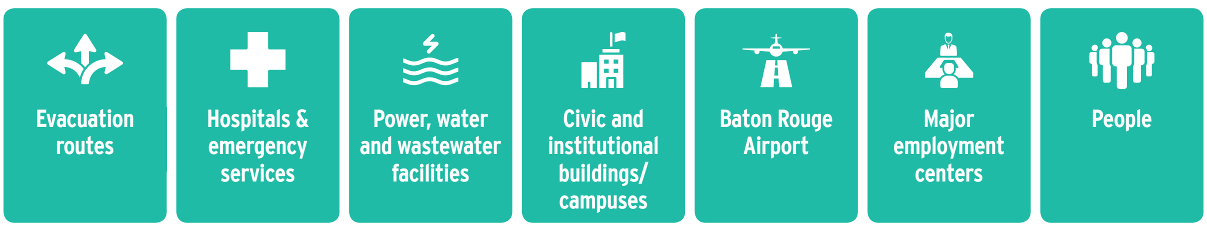
Open Channel Drainage System - Based on preliminary estimates, there are more than 550 miles of major tributary streams that drain to the Amite and Comite Rivers within the Parish. Channel surveys, including bridges and culverts, must be performed on these channels. These channels and bridges must be surveyed to develop comprehensive stream system maps and detailed models that will be used to analyze existing conditions and potential flood protection projects. This data collection effort will supplement surveys that have been completed or are currently being conducted by USACE and DOTD.

LiDAR Elevation Data - The DOTD is in the process of obtaining new LiDAR for the Amite River basin and the Coastal Protection Restoration Authority is in the process of obtaining new LiDAR for the coastal areas of southeast Louisiana. The elevation information provided by these two sources will be utilized to develop the digital elevation dataset and land use for the hydrology and hydraulic modeling. The areas have already been flown and both entities are processing the data with the intent to distribute the data in Summer 2018.

4.3 Preliminary Risk Assessment

Development of stormwater master plans typically require a significant amount of time and resources to complete. Surveying, modeling, and analyzing all the watersheds in the entire parish at the same time is not an efficient or cost-effective way of developing a SMP. It is necessary to prioritize and stagger the required data collection and analysis for each watershed to effectively manage resources and costs. To assist with prioritization of watersheds for the SMP data collection and analyses, a preliminary asset-based risk assessment was performed of the Parish. As a result of the assessment, the Parish was delineated into three "risk typologies": Low, Medium, and High, with the intent to analyze and develop solutions for the watersheds with higher risk first.

Risk typologies were determined by calculating risk scores for each watershed, based on assigning numerical values for probability and impact of flooding on critical assets. The critical assets included:



The inputs that contributed to each asset's probability score included whether it was located within a FEMA 100-Year floodplain, and whether it flooded in the August 2016 event. The inputs that contributed to each assets impact score include whether it impacted FEMA's defined critical facilities or infrastructure, and the areas Social Vulnerability rating.

Risk scores for each asset were the result of multiplying the probability score by the impact score. Assets were aggregated by watershed, and the risk scores were summed, resulting in preliminary risk scores by watershed.

An additional score for each watershed was determined based on the number of flooded structures and the percentage of total structures flooded. Watersheds with the highest number of structures and the highest percentage of total structures flooded received the highest "flood score." The flood score was added to the preliminary risk score for each watershed, creating the final risk score. Watersheds with a final risk score below 30 were identified as "Low Risk," those with a score between 30 and 60 were denoted as "Medium Risk" and watersheds with a score above 60 were deemed "High Risk."

The net result was that high-risk watersheds were generally those within the more urbanized areas with most buildings and infrastructure subject to flooding. This generally covers the central and lower (downstream-most) portions of the Parish. A large portion of the Parish, bounded roughly by the Mississippi River and I-110 to the west, the airport and Greenwell Springs to the north, the Amite River to the east and Dawson Creek to the south, represents the area at greatest risk. Figure 4-2 shows the Parish risk zones and Appendix B contains a more detailed discussion of the preliminary risk assessment.

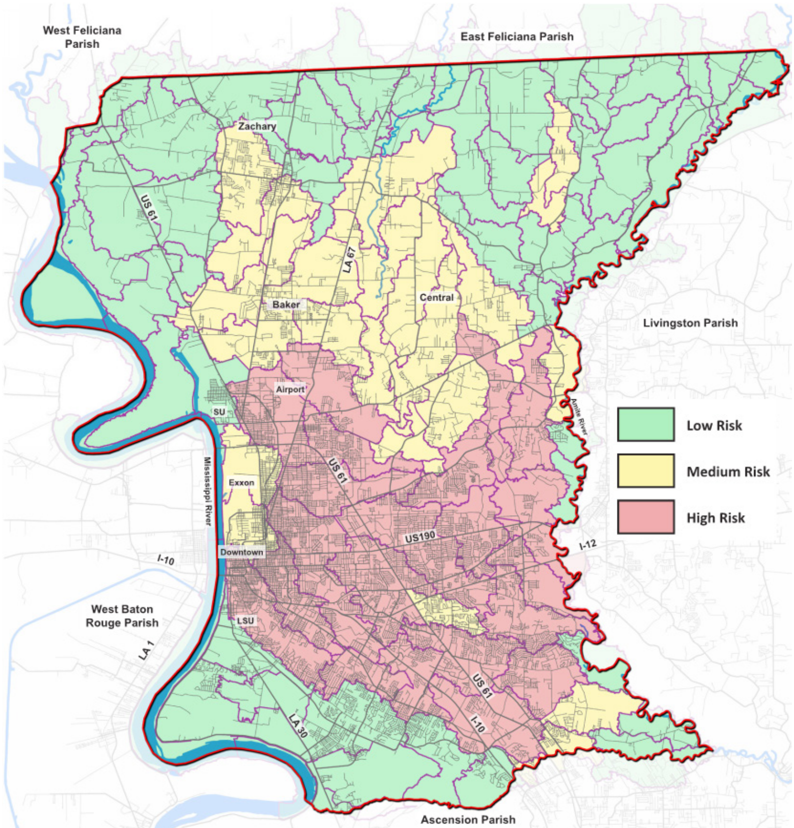


Figure 4-2: Map of EBR Risk Zones

4.4 Hydrologic and Hydraulic Model Development

As discussed in the Phase 2 Hazard Assessment section of this report (Section 6.3), the hydrology and hydraulic modeling approach for the future phases of the SMP is to develop a regional, parish-wide model (lower resolution) and individual watershed models (higher resolution). Due to the urgency of the request to develop projects to secure HMGP funding, preliminary development of the regional model was pushed forward to identify and analyze potential HMGP projects.

The USACE HEC-RAS software was used to develop a parish-wide 2-dimensional (2D) hydraulic model. The USACE HEC-HMS software was used to develop a hydrologic model of the upstream reaches of the Amite River, Comite River, Darling Creek, Sandy Creek, Redwood Bayou, Doyle Bayou, Copper Mill Bayou, and White Bayou.

Existing available data from multiple sources was used to develop the preliminary model quickly. This data included existing models developed by Ascension Parish, effective FEMA models, and models from various USACE projects within the Parish. The Northern Gulf of Mexico (NGOM) Topobathymetric Digital Elevation Model (TBDEM) was obtained from the USGS and consisted of LiDAR flown in 1999 combined with recent bathymetric information for major rivers and water bodies. Hydrologic parameters were developed using current NRCS land cover, soil type, and stream gage data, as well as historic NOAA precipitation data and Atlas 14 precipitation frequency estimates. The models were calibrated using stream gage and high-water mark (HWM) data from the August 2016 flood and validated using March 2016 flood data. In addition to the August and March events, the 10%, 2%, 1%, and 0.2% AEP frequency events were also generated.

The preliminary model will serve as a foundation for the modeling performed in the next phase of the SMP. A more detailed discussion of the preliminary hydrology and hydraulic model development can be found in Appendix C of this report.

5 Implementation Framework for Phases 2 & 3

The Parish has adopted a phased approach for developing the SMP. The intent of Phase I was to develop the foundation for the SMP through outreach to key stakeholders, partners, and community organizations to develop partnerships, collection/acquisition of existing critical data, preparation of a risk analysis to determine areas of various risk within the Parish, and development of preliminary regional hydrology and hydraulic models for use in development of initial projects.

Phase 2 will include developing a comprehensive public engagement plan, assessing and recommending updates to development guidance and stormwater ordinances, acquiring information identified by the Phase 1 data needs assessment, collecting storm drainage system data, developing regional and watershed-based hydrology and hydraulic models to evaluate flood hazards and mitigation of such, developing and prioritizing planning level projects to address flooding problems, and an action plan to communicate the path forward towards implementation and funding of projects.

Because developing a plan for all of the watersheds in the parish concurrently is not an efficient or cost-effective way of developing a SMP, it is necessary to prioritize and stagger the required data collection and analysis by watershed to effectively manage resources and costs. Given this, the parish was separated into 11 major watersheds, some of which include groupings of smaller watersheds that become interconnected during large flood events. As discussed in Section 4.3, a preliminary risk assessment was performed to assist with prioritization of watersheds for the SMP data collection and analyses. The Parish was delineated into low, medium, and high risk topologies with the intent to analyze and develop solutions for the watersheds with higher risk first. The 11 watersheds in order by their risk topologies are and shown in Figure 5-1:

1. Ward Creek
2. Jones Creek/Honey Cut Bayou and Tributaries near Amite/Comite River Confluence
3. Claycut Bayou
4. Hurricane Creek/Engineer Depot Canal
5. Monte Sano Bayou
6. Lower & Upper Cypress Bayou/Baker Canal/Bayou Baton Rouge and White Bayou
7. Bayou Fountain/Bayou Manchac
8. Cooper Bayou/Lilly Bayou
9. Redwood Creek/Upstream Comite River and Tributaries
10. Sandy Creek/Little Sandy Creek/Mill Creek
11. Upstream Amite River and Tributaries

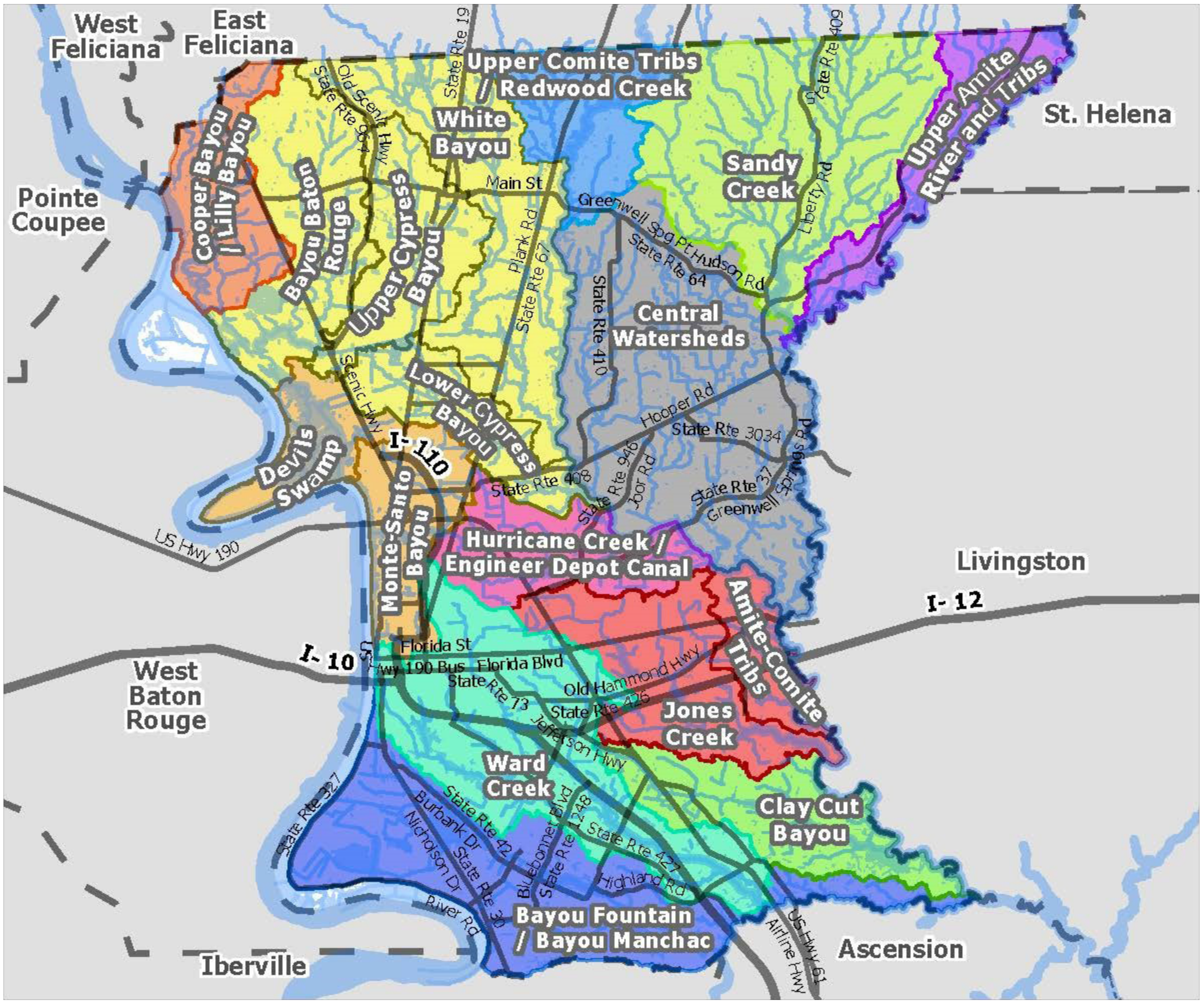
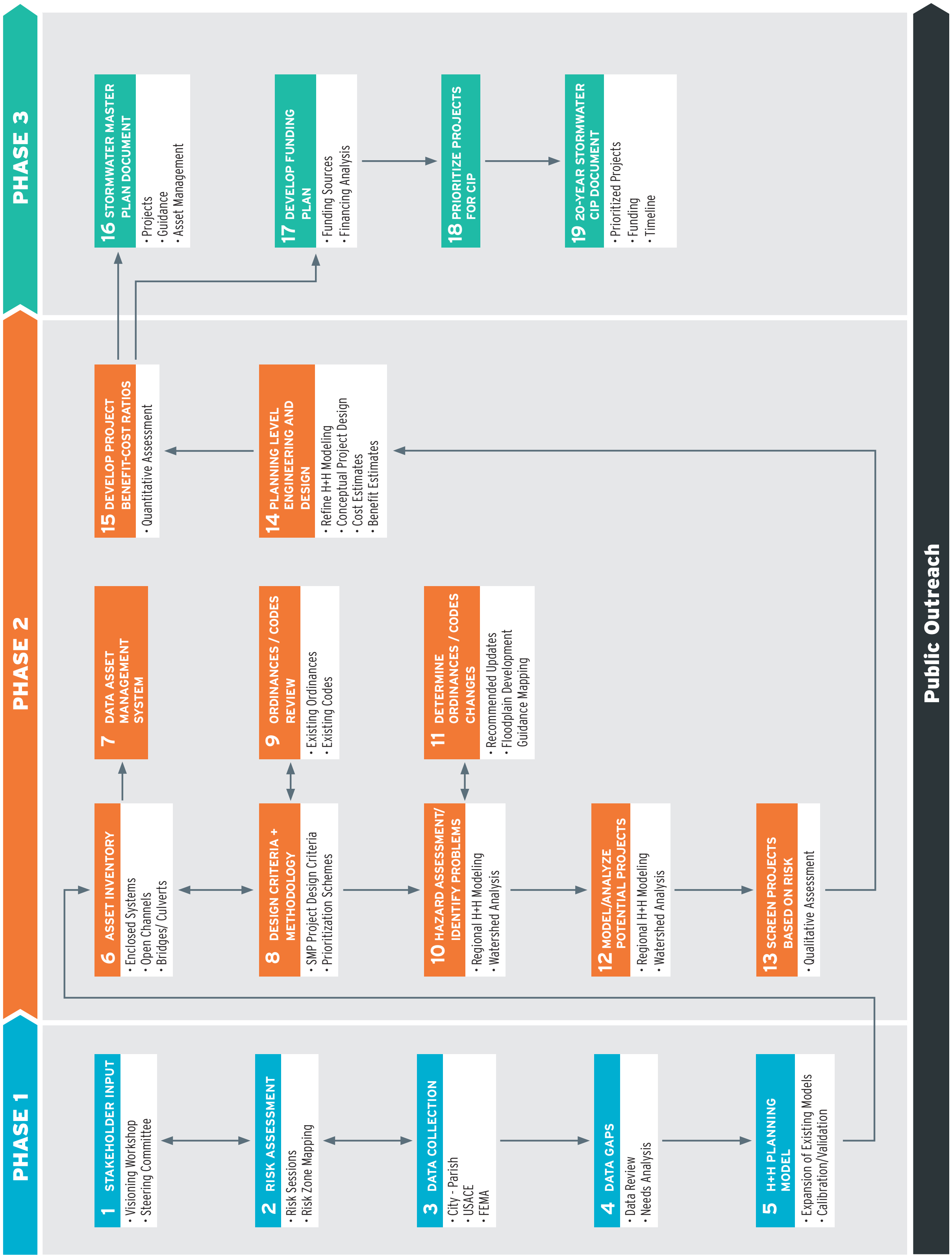


Figure 5-1: SMP Watersheds

Phase 3 concludes with the preparation of the formal Stormwater Master Plan (SMP) Report, development of a project funding plan, prioritization of projects for the CIP, and the 20-Year CIP. Refer to the SMP work flow in Figure 5-2 for further details.


PHASE 1
1 STAKEHOLDER INPUT
• Visioning Workshop
• Steering Committee
2 RISK ASSESSMENT
• Risk Sessions
• Risk Zone Mapping
3 DATA COLLECTION
• City - Parish
• USACE
• FEMA
4 DATA GAPS
• Data Review
• Needs Analysis
5 H+H PLANNING MODEL
• Expansion of Existing Models
• Calibration/Validation
PHASE 2
6 ASSET INVENTORY
• Enclosed Systems
• Open Channels
• Bridges/ Culverts
7 DATA ASSET MANAGEMENT SYSTEM
8 DESIGN CRITERIA + METHODOLOGY
• SMP Project Design Criteria
• Prioritization Schemes
9 ORDINANCES / CODES REVIEW
• Existing Ordinances
• Existing Codes
10 HAZARD ASSESSMENT/ IDENTIFY PROBLEMS
• Regional H+H Modeling
• Watershed Analysis
11 DETERMINE ORDINANCES / CODES CHANGES
• Recommended Updates
• Floodplain Development Guidance Mapping
12 MODEL/ANALYZE POTENTIAL PROJECTS
• Regional H+H Modeling
• Watershed Analysis
13 SCREEN PROJECTS BASED ON RISK
• Qualitative Assessment
14 PLANNING LEVEL ENGINEERING AND DESIGN
• Refine H+H Modeling
• Conceptual Project Design
• Cost Estimates
• Benefit Estimates
15 DEVELOP PROJECT BENEFIT-COST RATIOS
• Quantitative Assessment
PHASE 3
16 STORMWATER MASTER PLAN DOCUMENT
• Projects
• Guidance
• Asset Management
17 DEVELOP FUNDING PLAN
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18 PRIORITIZE PROJECTS FOR CIP
19 20-YEAR STORMWATER CIP DOCUMENT
• Prioritized Projects
• Funding
• Timeline
Public Outreach

5.1 Data Collection

New data will be collected to supplement what was obtained during Phase I of the SMP. The data will be used to prepare hydrology and hydraulic models to identify flood hazards and problems and develop proposed improvements within the 11 identified watersheds. The data collection will be prioritized by watersheds based on the watershed risk factors that were determined during the risk assessment that was performed in Phase I. The data collection will be conducted in stages as necessary for modeling and planning efforts to progress smoothly and seamlessly. Most of the data collection will focus on collection of physical information related to stormwater infrastructure. This includes obtaining new LiDAR information and surveys of open channels/streams, enclosed systems, bridges, and culverts.

Prior to deployment of survey crews to collect the necessary data, a GIS asset inventory database and GIS data collection forms will be developed for data input by the surveyors. The asset inventory database will include fields to collect all of the necessary drainage feature information required for the SMP modeling and analysis, as well as a cursory condition assessment for use in future maintenance operations by the Parish. Once the initial asset inventory is complete, the data will be migrated into a GIS asset management system to be maintained by the Parish and used for their ongoing operations and maintenance.

5.2 Public Engagement

The stormwater master plan process will identify flood hazards, problems and recommend improvements. It will also serve as a vehicle to educate the general public and specific stakeholders about the process, about trade-offs, and to collect ideas and concerns for inclusion in the planning process and implementation. It is vitally important that the public be engaged in all phases of the SMP project as public input is valuable to assist in identifying location-specific problem areas and providing feedback on potential capital improvements and proposed parish ordinances and legislation. It is also advantageous to gauge the public's tolerance for risk and willingness to fund any necessary capital and operating costs.

A draft comprehensive public engagement plan will be written and presented to the Parish at the beginning of the SMP project. This plan will detail the tasks, staffing, schedule and deliverables necessary to successfully engage the public for this parish-wide project.

5.2.1 Project Branding

It is recommended to establish a unique and concise identity for the effort and the program's sustained life. This project brand, name, and logo would become the public-facing and easily recognizable identifier of this work, helping to distinguish it from other ongoing projects and studies.

In addition to a graphic mark and project name, an internet domain name and potentially a project slogan would be developed and reserved. Once produced, the logos, fonts, and slogan can be incorporated into MS Office template documents for project letterhead, memos, sign-in sheets, on-screen presentations, flyers and FAQ sheets, and similar documents.

A brief Project Impact Video may be produced to provide a multi-media promotion tool. This professionally produced video would be distributed to TV media outlets for community notices, posted on the project website, utilized at public meetings and distributed via social media channels such as Facebook, Twitter and Instagram.

5.2.2 Project Coordination

Project Stakeholders

Project stakeholders will be identified including representatives of constituency groups such as industries, real estate developers, local governments, and neighborhoods to ensure representation of key user groups and of traditionally disenfranchised populations. Stakeholders groups will be used to inform the stakeholders of project status and goals, provide an opportunity to solicit feedback from them, and set/manage expectations of project outcomes. An important goal of stakeholder group discussions will be to determine their response to proposed adjustments to public policy and land use/ development regulations as well as project prioritization and funding scenarios. Such proposals will be presented to project stakeholders seeking feedback, recommended refinements, or alternative solutions.

Project Partners

Project partners consist of agency representatives will be organized for the project. This will be an extension of the coordination efforts initiated under Phase 1. These could include representatives such as the Parish, LDEQ, US EPA, FEMA, HUD, USACE, DOTD, the Office of Community Development, and similar organizations. These additional organizations could be the Amite River Basin Commission (ARBC), Ascension Parish, Iberville Parish, and Livingston Parish, who have an influence on decisions within the Parish. This group will influence aspects of the plan including: regulatory reviews, flooding assessments, water quality assessment, funding governance and maintenance reviews. Sub-committees may be needed depending upon the size of the group, and agency participants such as regional leaders may need to have differing levels of involvement.

General Public

Open house style public meetings should also be conducted within the Parish for the SMP. These meetings will be geographically distributed to maximize contact with the public. There will also be conclusion or "wrap-up" public meeting(s) at or near the end of the project period. In addition, engagements should be targeted to specific neighborhoods and locations within the parish based on the watersheds and risk assessment. Civic associations, HOAs, or neighborhood leaders should be selected for with whom to coordinate outreach events. The purpose of these meetings will be twofold, establishing bi-directional communication to: 1 ensure the HNTB team receives specific and ground-truthed information about stormwater conditions in that locale, and 2) educate the population of the capacity of the planning effort to address their needs.

Elected Officials

Coordination with elected officials will include attendance at Metro Council meetings as related to the SMP and will be done to provide status updates quarterly. Meetings with Metro Council members will be conducted on a watershed basis to include an anticipated two meetings per watershed. Council members will also be invited to stakeholder meetings within their districts. Quarterly and annual legislative and congressional briefings will be conducted.

5.2.3 Media Efforts

A project website would be developed, tested and launched on its unique domain name for the SMP project. This website would serve as a 24/7 portal of information about the project and will be regularly updated throughout the duration of the project. Updates would include news articles, dates and descriptions of events and project milestones, copies of draft and final documents, descriptions of individual drainage improvements, and contact information for additional information. It is recommended that the website hosting be obtained directly by the Parish. This is to ensure that the website can live on beyond the preparation of the SMP. Low-cost basic hosting from a reliable hosting company is adequate. Alternately, it could be hosted in conjunction with the City-Parish's existing web presence.

Another role of public engagement will be to distribute Public Service Announcements (PSAs) to local broadcast and print media outlets. These will aid in informing the public of available meeting opportunities, key project milestones, and opportunities to provide their input. City-Parish communications staff and local news media should also be informed to: 1) make sure they are aware of the event and, 2) assist the news reporters and camera operators with any needs they have at the event.

5.3 Design Criteria and Methodology

A SMP design criteria and guidance document will be developed at the beginning of Phase 2 to generate consistency between the Parish and the SMP design team. This document will help to provide all SMP team members and reviewers with standard design criteria and guidance that will be used to identify and develop solutions to stormwater challenges throughout the development of the SMP.

In addition to development of the SMP design criteria and guidance document, a qualitative screening process will be developed for the initial list of projects along with a quantitative analysis process for developing benefit/cost (B/C) information for the screened projects. These processes will help the design team by providing a consistent methodology for analysis and an efficient process to determine project benefits.

5.4 Hazard Assessment

For the purposes of the SMP, a hazard is defined as a flood or storm event that has the potential to cause harm or loss. Risk is defined as the probability of exposure to that hazard, and an identified problem is defined as an unacceptable level of risk of exposure to that hazard.

A hazard assessment is necessary to define the hazards so that problem areas can be identified and mitigated. In order to define the stormwater hazards, a hydrology and hydraulics analysis must be performed to determine the extent and severity of the hazards and risks associated with flooding. Once the stormwater hazards are determined, an analysis will be performed to identify where and to what extent they will impact public safety, structures, and infrastructure.

The first step in the hydrology and hydraulics analysis is development of models that will be used to represent the stormwater systems throughout the parish. When developing hydrology and hydraulic models, a certain level of detail is necessary to adequately represent existing conditions, determine problem areas, and develop proposed solutions. Given the large nature of the project area to be modeled (over 470 square miles) and the relatively high level of detail that will be needed in order to analyze the problems and solutions, it was decided that multiple watershed models should be created. This will allow watershed analyses to be performed concurrently. The watershed-specific modeling includes the development of HEC-RAS 1D/2D models for open channels and floodplains for all watersheds, and EPA SWMM models for watersheds with extensive enclosed drainage systems. New LiDAR data, selective channel surveys, and bridge/culvert crossings will be used to improve the accuracy and detail of the models. Models will be calibrated to stream gage data and the numerous highwater marks that exist for prior events, particularly for the August 2016 flood.

In addition to individual watershed models, a regional model will also be developed to determine downstream boundary conditions for each of the watersheds. The regional model will also be used to determine downstream impacts and analyze larger regional multi-watershed projects. The model developed during Phase 1 will be used as a basis for development of the regional model in Phase 2.

5.5 Mitigation Activities

Hazards and risks can be mitigated by both infrastructure improvements and policy updates. The following sections describe how projects will be identified and developed, as well as discuss development of updates to the Parish stormwater ordinances and codes.

5.5.1 Flood Risk Reduction Projects Identification/Evaluation

As the models are completed (both regional and watershed-specific and the hazards have been defined, an analysis will be performed to identify problem areas and develop a preliminary list of projects. These preliminary projects will go through a qualitative screening process to determine if they should be further analyzed and developed. The screened projects will be further analyzed through a qualitative process for formulation of benefit/cost (B/C) information. The projects could be very specific, such as culvert or structure replacements, but they could also be more regionally based, such as detention ponds or channel improvements. The appropriate models will be used to simulate events at each of the project sites to determine the potential benefits and costs. Once the projects and B/C information has been developed, they will be incorporated into the CIP and prioritized based on funding opportunities and public input.

5.5.2 Ordinance Reviews and Recommendations

During the initial stages of Phase 2, recommendations for changes to development standards and stormwater guidance and ordinances will be developed. This will include evaluations of design events and possible variations based on location and magnitude of risk throughout the Parish. To provide backup and justification for the changes being recommended, an analysis will be performed to determine how floodplain development impacts flood risk and what the potential benefits and impacts are regarding limiting development in flood prone areas.

5.5.3 Flood Zone Mapping

Mapping is an effective tool that can and has been used to clearly communicate flood risk to the public. Once the hazards have been defined and ordinances have been updated to define the level of risk that the communities in the Parish are willing to accept, flood zone maps will be developed. The intent of the flood zone maps is that they will become part of the stormwater policy and ordinances to help define and direct how development occurs within the floodplains. This effort will also help to emphasize to the public how floodplains are a community asset and natural resource that should be protected, and can be used in coordination with community education and outreach efforts.

5.6 Stormwater Master Plan

As the various components of the SMP are completed, documentation will be developed to summarize the findings and recommendations. The relevant information from the modeling, investigations and detailed analyses will be included in applicable appendices. A summary for each watershed will be developed. Stakeholder involvement meetings will be conducted to present the SMP findings and results to interested/affected organizations and stakeholders. It is the intent that the SMP becomes a living set of documents that should be reviewed and updated on a 5-Year basis as projects are continually being designed and constructed. One of the goals for development of the SMP is to meet the requirements of the National Flood Insurance Program (NFIP) Community Rating System (CRS) credit requirements for stormwater master planning.

6 20-Year Stormwater Capital Improvement Plan

The purpose of the Stormwater CIP is to take the technical information and results from the SMP and prioritize the projects based on public input and funding opportunities.

6.1 Prioritization

Based on results of the results of the studies performed for the SMP, a prioritized list of projects for the 20-Year Stormwater Capital Improvement Plan (CIP) will be developed and prioritized based on funding opportunities and public input. Investigations of methods to fund the 20-Year CIP will be performed and will include recommendations for some projects to be "shovel ready" in anticipation of near-term funding opportunities. Stakeholder involvement meetings will be used to present the 20-Year CIP to interested/affected organizations and stakeholders and gather input regarding priority projects.

6.2 Funding Plan

The Parish recognizes that municipal stormwater management for local governments has evolved over time from an urban flood control function, to a water and resource management function, to an environmental protection and regulatory function. All three functions now co-exist as responsibilities of the Parish. As such, the stormwater function has evolved from a basic capital construction and maintenance program supported primarily by local taxes, to a program of integrated water resource management, environmental enhancement, and recreational services requiring a multi-faceted benefit based finance system.

The focus of the funding plan for the SMP project is to develop a resource that will address stormwater program financing for the 20-Year CIP projects and potentially beyond. It will include researching and documenting procedural, legal, and financial considerations in developing viable funding approaches. The project will examine a range of possible approaches to paying for stormwater management and address various sources of funding. Legal considerations and implementation of stormwater funding programs will also be outlined.

7 Schedule

Development of a comprehensive stormwater master plan should begin as quickly as practical with the additional asset inventory efforts that are required. Other tasks such as design criteria and methodology development, along with existing ordinance and codes review, can begin in earnest coincident with the asset inventory tasks. The HNTB team has outlined a suggested workflow that optimizes the timeframes for data collection and H&H modeling through the use of multiple teams. These two overarching tasks cover the greatest extent of the overall schedule for the SMP project. The main project activities are highlighted in Table 7-1 with corresponding suggested timelines. If the project begins by the fall of 2018, the HNTB team projects a potential completion by the spring of 2021. The 20-Year Stormwater CIP would, therefore, provide a plan for the Parish through 2041.

REQUIRED ACTIVITIES	DETAILED TASKS SUMMARY	SUGGESTED TIMELINE	ORDER OF MAGNITUDE COST
Asset Inventory	Obtain Parish-Wide LiDAR	9/18	$4.5 - $5.0 M
	Enclosed System Survey	9/18 - 9/19	
	Open Channel Bridges/Culverts Survey	9/18 - 9/19	
	Data Asset Management Database	12/18 - 12/19	
Public Involvement and Agency Coordination	Stakeholder/Public/Partners Meetings	10/18 - 3/21	$0.5 - $1.0M
	Website Communication		
	Media Relations		
	Social Media		
Design Criteria & Methodology Development	Regional Analysis Reference Documentation	9/18 - 4/19	$0.05 - 0.1M
	Watershed Criteria Development		
	Project Prioritization Schemes Development		
Hazard /Problems Assessment	Regional Hazard Assessment	1/19 - 7/19	$2.5 - $3.5M
	Watershed Hazard Assessments (11 watersheds)	4/19 - 10/20	
	Problem Identification	5/19 - 11/20	
Mitigation Activities	Determine Potential Risk Reduction Projects	5/19 - 11/20	$3.5 - $4.5M
	Model Potential Projects	6/19 - 12/20	
	Screen Initial Projects for Further Analysis	8/19 - 12/20	
	Concept Level Engineering and Design	8/19 - 1/21	
	Cost and Benefit Estimates for B/C Ratios	8/19 - 1/21	
	Hydraulic modeling for floodplain development guidance	4/19 - 7/19	
	Ordinance and code revision recommendations based on model results and floodplain development guidance	9/18 - 11/19	
Stormwater Master Plan Document	Preliminary (30%) Report and Appendices	4/19 - 8/19	$0.3 - $0.5M
	60% Report and Appendices	8/19 - 8/20	
	Final Report & Appendices	8/20 - 4/21	
20-Year Stormwater CIP Document	Projects Prioritization	8/20 - 4/21	$0.2 - $0.4M
	Funding/Financing Plan		
	20-Year CIP		
	TOTAL	**9/18 – 4/21**	**$11.5 - $15M**

Table 7-1: Preliminary SMP Schedule and Cost

Appendix A – Data Summary Table
Appendix B – Risk Assessment
Appendix C – Preliminary Modeling

Appendix A – Data Summary Table

Description	Source	Date	File Type	Have? (Y/N)	Additional Description
From FEMA, MOHSEP, and GOHSEP					
Old Hydraulic Models of EBR Streams	FEMA	Various	HEC-2, WSPRO, USGS SBP	Y	Models are only scans of HEC-2, WSPRO, or USGS SBP output for the following streams: Amite River (HEC-2), Baker Canal (HEC-2), Beaver Bayou (HEC-2), Blackwater Bayou (HEC-2 and WSPRO), Draughan Creek (HEC-2), Engineer Depot Canal (HEC-2), Honey Cut Bayou (HEC-2), Hub Bayou (HEC-2), Indian Bayou (HEC-2), Robert Canal (HEC-2), Shoe Creek (HEC-2), and Upper Cypress Bayou (USGS SBP)
Old Hydrologic Models of EBR Streams	FEMA	Various	HEC-2	Y	Models are only scans of hand calculations and HEC-1 output for the following streams: Draughan Creek (hand calcs), Amite River (hand calcs), Blackwater Bayou (hand calcs), and Honeycut Bayou (HEC-1)
Letter of Map Revision for Various Locations in EBR	FEMA	1987-2015	PDF	Y	LOMR documentation for various locations in EBRP, including hydraulic models for Sandy Creek and Beaver Bayou
Plans for White Bayou - Baker Canal Diversion and East Lateral of Cypress Bayou Projects	FEMA	1970-1977	PDF	Y	Plans for widening and deepening of Baker Canal from Hwy 61 eastward to Wilson Street, also channelization project plans for East Lateral Cypress Bayou in vicinity of zoo, both plans include channel size/material and size/material of laterals
Documentation for 2008 FIS/FIRM update	FEMA	2004-2007	PDF, HEC-RAS, HEC-HMS	Y	Documentation for 2007 FIS update including map data, calculations, TSDNs, and HEC-RAS hydraulic models for the following Phase I streams: Bayou Duplantier, Bayou Fountain, Clay Cut Bayou, Corporation Canal, Dawson Creek, Elbow Bayou, Jacks Bayou, and Wards Creek; and including HEC-RAS hydraulic models for the following Phase II streams: Bayou Baton Rouge, Beaver Creek, Duff Bayou, Flanagan Bayou, Hanna Creek, Hub Bayou, Little Sandy Creek, Mill Creek, Sandy Creek, Scalous Creek, Taber Creek, Cypress Bayou, White Bayou, Weiner Creek, and Wind Bayou; and including HEC-HMS hydrologic models for the following streams: Cypress Bayou, White Bayou, and Weiner Creek
Historic Studies and Reports for Various EBR Streams	FEMA	1976-1995	PDF	Y	Historic studies and reports for the following streams: Amite River, Bayou Fountain, Clay Cut Bayou, Cypress Bayou, Hurricane Creek - Monte Santo Bayou, Ward Creek, and USACE Tributaries Feasibility (Blackwater Bayou, Beaver Bayou, Jones Creek, Ward Creek, and Bayou Fountain)
Historic Flood Information from USGS	FEMA	1975	PDF	Y	Flood frequency study by the USGS, includes pictures of flood innundation and high water marks from historic floods
Documentation for 2012 FIS/FIRM update	FEMA	2010	HEC-RAS	Y	HEC-RAS models related to a FIRM update for the following streams: North Branch Ward Creek, Redwood Creek, Shoe Creek, and Upper White Bayou
FEMA FIS and FIRM Maps	FEMA	2007-2012	PDF, SHP	Y	FEMA FIS reports, maps, and GIS data for EBRP and surrounding Parishes
FEMA Hazard Mitigation Grant Program Policy and Guidance	FEMA/GOHSEP	2015-2017	PDF	Y	HMGP Guidance and Policy
Louisiana Watershed Resilency Study	GOHSEP	2016-2017	GIS Database	Y	Geospatial information including, watershed information, land cover, watershed demographics, GDP, SoVI, transportation, critical facilities, emergency facilities, and energy infrastructure
LaWRS Flood Data	GOHSEP/MOHSEP	2018	GIS Database	Y	Severe Repetitive Loss properties, Repetitive Loss properties, Structures Flooded in August 2016 (flood claims), Jobs Data, GDP data, flood extent rasters (Aug and Mar 2016), LaWRS watersheds
National Flood Hazard Layer	FEMA	2018	GIS Database	Y	GIS database containing geospatial information from FEMA FIS flood insurance maps (flood hazard zones, BFEs, etc.)
From USACE					
2017-2018 Channel Surveys					
Amite River and Tributaries, Louisiana East Baton Rouge Parish Flood Control Projects February 1995 Environmental Impact Statement	USACE	1995	PDF	Y	Ward Creek, Jones Creek, and Bayou Fountain Channel Improvement Study
Flood Control, Amite River and Tributaries, LA Comite River Basin Design Memorandum No. 1 Comite River Diversion Project	USACE	1995	PDF	Y	Comite River Diversion design information, including plans
2009 Degredation Study Hydrologic Model	USACE	2009	HMS	Y	HEC-HMS hydrology model from USACE 2009 streambed degredation and sedimentation study of the Comite River and how the Comite River Diversion would impact it.
2016 Comite Flood Hydrologic Model	USACE	2016	HMS	Y	HEC-HMS hydrology for the low resolution hindcast model created by the USACE to represent the August 2016 flood event for the entire Amite/Blind River Basin and other tributaries on the northern side of Lake Ponchitrain.
2016 Economic III Evaluation Hydrologic Model	USACE	2016	HMS	Y	HEC-HMS hydrology model from USACE 2016 economic evaluation study to determine the cost benefit of the Comite River Diversion
2009 Comite Diversion Hydrologic Model	USACE	2009	HMS	Y	HEC-HMS hydrology model from USACE 2009 study of the Comite River Diversion
2009 Degradation Study 1-d RAS Model	USACE	2009	RAS	Y	HEC-RAS hydraulic model from USACE 2009 streambed degredation and sedimentation study of the Comite River and how the Comite River Diversion would impact it.
2016 Comite Flood 2-d Model	USACE	2016	RAS	Y	HEC-RAS hydraulic for the low resolution hindcast model created by the USACE to represent the August 2016 flood event for the entire Amite/Blind River Basin and other tributaries on the northern side of Lake Ponchitrain.
Diversion Channel 1-d RAS Model	USACE	2012-2014	RAS	Y	HEC-RAS hydraulic model from USACE 2009 study of the Comite River Diversion
Econ Level III Evaluation Model	USACE	2016	RAS	Y	HEC-RAS hydraulic model from USACE 2016 economic evaluation study to determine the cost benefit of the Comite River Diversion
Lilly Bayou 1-d RAS Model	USACE	2013	RAS	Y	HEC-RAS hydraulic model for the Lilly Bayou drop structure.
Misc Comite Diversion RAS Models	USACE	2004-2012	RAS	Y	Comite River Diversion guide levees and other models
Survey Data from Misc Corps Projects	USACE	1999-2017	Various Survey Formats	Y	Survey for various projects related to the Comite River Diversion Project
Amite River and Comite River Surveys	USACE	2018	SHP	Y	2018 survey of the Amite and Comite River channels (profile and cross sections), performed by Forte and Tablada for USACE.

Description	Source	Date	File Type	Have? (Y/N)	Additional Description
From USGS, NRCS, and NOAA					
Northern Gulf of Mexico Topobathy	USGS	1999-2016	DEM	Y	A compilation of the latest and greatest elevation data, including bathymetry for larger streams and lakes and LiDAR from the Louisiana Statewide LiDAR project.
USGS Stream Gage Data	USGS	2017	XLS	Y	USGS stream level data for stream gages
Land Cover	NRCS	2011	DEM	Y	Land cover raster for the state of Louisiana
HUC 8 Watershed Boundaries	NRCS	2012	SHP	Y	8 digit HUC watershed boundaries (Subbasin Level, >250,000 acres)
HUC 10 Watershed Boundaries	NRCS	2012	SHP	Y	10 digit HUC watershed boundaries (Watershed Level, 40,000 to 250,000 acres)
HUC 12 Watershed Boundaries	NRCS	2013	SHP	Y	12 digit HUC watershed boundaries (Subwatershed Level, 10,000 to 40,000 acres)
NHD 24k Hydrography	NRCS	2016	SHP	Y	Shapefile of the streams and waterbodies withing East Baton Rouge Parish
2016 Flood Aerial Photography	NOAA	2016	GIS JPG Tiles	Y	Aerial photography flown during the August 2016 flood event, Aerial photograph for 3 different flights, two on August 15th and one on August 18th.
NEXRAD Rainfall Data	NOAA	2016	MDB	Y	NEXRAD rainfall database for August and March Storm Events
From DOTD					
2018 LiDAR of Amite River Watershed	DOTD	2018	LAZ	N	Will be used to develop updated terrain for 2D HEC-RAS model of EBR
DOT Bridge Plans	DOTD	2017	PDF	N	Will be used to develop structure geometry for future hydraulic models.
Proposals for Amite River Basin LiDAR Acquisition and Hydrology and Hydraulics Study	DOTD	2017	PDF, GIS Database	Y	Dewberry's proposal to DOTD to develop comprehensive planning model for the Amite River basin, including acquisition of new LiDAR information for the entire watershed. Also, provided shapefile of HWM points that will be used for model calibration and a shapefile of the streams that will be modeled (with indicator of the detail of the modeling for each).
National Bridge Inventory	DOTD	2017	GIS Database	Y	GIS database of NHI/DOTD bridges within the state of Louisiana
August 2016 Flood High Water Marks and Gage Data	DOTD	2018	SHP, XLS	Y	Calibration dataset used by Dewberry to calibrate the DOTD hydrology and hydraulic models.
From ARBC					
August 2016 Flood Preliminary Report, Amite River Basin	ARBC	2017	PDF	Y	Report of the August 2016 flood from ARBC perspective, folder also contains information from the October 2017 ARBC workshop at LSU
From CPRA					
2017 LiDAR of Southeast Louisiana	CPRA	2017	LAZ	N	LiDAR for southeast Louisiana with ground return information
From EBR					
Survey and GIS database of the enclosed storm sewer system for pipes/boxes 36" or larger	EBR	2018-2019	GIS Database	N	To be collected in the next phase of the SMP.
Survey information for specifically defined HMGP projects	EBR	2018	Survey Data	N	To be collected in the next phase of the SMP.
GIS Data	EBR	2017-2018	SHP	Y	Shapefiles include 2016 Flooded Homes, Adjudicated Parcels, Base Flood Elevation, Bridges, Buildings, City Limits, Conservation Areas, Drainage Problem Locations, Estimated Flood Innundation Areas, Existing Land Use, FEMA Lots, Flood Depth Model, Flood Hazard Area, Future Land Use, Hydrography, Lot Profile, Mobile Home Parks, Pavement Edges, Stormwater Drainage, Stream Segments, Street Addresses, Subdivisions, Swamps, Tax Parcel IDs, Watersheds, Watershed Sinks, and Zoning
Parish Hazard Mitigation Plan	EBR	2016	PDF	Y	Parish Hazard Mitigation Plan
Parish Stormwater and Flood Ordinances	EBR	2017	PDF, DOC	Y	Compilation of Parish Ordinances and Codes related to stormwater and flood protection
FUTUREBR Reports	EBR	2017	PDF	Y	FUTUREBR planning study documents

Description	Source	Date	File Type	Have ? (Y/N)	Additional Description
From EBR Hard Drive (most relevant of 156,507 files)					
Roadway and Drainage As-Built Plans for Various Projects within EBR	EBR	Various	PDF	Y	Roadway and Drainage As-Built Plans for Various Projects within EBR
Drainage and Bridge Design Documents for Various projects within EBR	EBR	2004-2016	Various	Y	96 Project Folders with plans, photos, drainage calculations (including models), and GIS files
Multiple Bridge Replacement Plans	EBR	2015	PDF	Y	Cost Estimate information also found
Denham Street Bridge Improvement	EBR	2010	TIFF	Y	Denham Street Bridge Improvement
2013 LRA Brdiges Replacement Locations	EBR	2013	PDF	Y	See PDFs "2013 Updated Bridge Budget 12Sept2013.pdf" and "2013 LRA Bridges Replacement 11X17.pdf"
Off-System Bridge Replacements	EBR	2011-2013	Various	Y	2013 LRA Brdiges Replacement Locations
Minor Bridge Replacement on Roberts Canal	EBR	1960's	PDF	Y	Minor bridge install for one resident to access back property, plans show channel and bridge dimensions. Correspondence is from 2014.
East Brookstown Bridge	EBR	2014	Various	Y	Bridge over Hurricaine Creek
Woodlake Bridge	EBR	2011	PDF	Y	Bridge over Jones Creek
Bridges for 2009 Bond Issue	EBR	2009	PDF	Y	Map showing bridge projects, unknown if projects were completed
Drainage Files (Parent Folder)	EBR	Various	Various	Y	Many files and folders related to drainage studies and design, parent folder contains a useful stream map
Various Drainage Project Files	EBR	1995-2002	DWG, XLS, HEC-RAS	Y	Contains CAD drawings, cost estimates, and a few H&H model files for 59 drainage/development projects.
EBR Base Map	EBR	1998	DWG	Y	Base map CAD files from 1998.
DEM data from 1999 LiDAR	EBR	2001	DEM	Y	Appears to be DEM tiles for EBR based on the 1999 LiDAR
Parish Benchmark Information	EBR	2001-2013	Various	Y	Misc Parish Survey BM files
Capitol Lake Pumping Station Pump Curve	EBR	1982-1984	PDF	Y	See PDF "Capitol Lake Pumping Station 2"
Misc. H&H Models	EBR	1990-2003	HEC-1, HEC-2, HEC-RAS	Y	Primarily HEC-2 files of most EBR major streams, some HEC-1 and HEC-RAS files (all loose files in main COE directory), many are duplicates in sub folders
USACE Amite River Inspection Documentation	EBR	2005-2010	JPG, DOC, PDF	Y	Aerial Inspections of the Amite River as documented by USACE
USACE Amite and Comite River HEC-1 Models	EBR	1994-1996	HEC-1	Y	USACE HEC-1 files for Amite and Comite Rivers, including 1993 flood
Bayou Manchac and Spanish Lake Study Documents	EBR	2002-2107	DOC, Emails, PDF, JPG		Various communications and reports for Bayou Manchac and Spanish Lake
H&H Analysis of the Bayou Manchac Watershed	EBR	2002	HEC-RAS, DOC, PDF	Y	Bayou Manchac HEC-RAS model files, supporting geospatial data, reports, and maps prepared by URS and CSRS
Bayou Manchac Flood Risk Reduction Study H&H	EBR	2009	HEC-RAS, DOC, PDF	Y	Amite River models and report prepared by Taylor Engineering (George Hudson), steady and unsteady HEC-RAS files included
Beaver Bayou H&H Models	EBR	2006	HEC-RAS, HEC-HMS	Y	Beaver Bayou H&H models, appears to be from CSRS
USACE Comite River Diversion H&H Models	EBR	2003	HEC-1, HEC-RAS	Y	USACE Comite River Diversion H&H Models
Bridge Replacement at Firewood Dr and N Flannery	EBR	2016	PDF	Y	Permit for bridge replacements of Firewood Dr @ Drainage Canal and N Flannery @ Lively Bayou, includes plans
Elbow Bayou at Nicholson Dr Hydraulic Models	EBR	2004	HEC-RAS	Y	Elbow Bayou at Nicholson Dr Hydraulic Models, for propsed apartments, appears to be from E&G
Hydraulic Models for Various EBR Streams	EBR	1990-1998	HEC-2	Y	HEC-2 files for EBR: Clay Cut Bayou, Amite River (Maurepas to Comite), Beaver Bayou, Bayou Duplantier, Bayou Fountain, Blackwater Bayou, Comite River, Dawson Creek, Hurricane Creek, Jones Creek, Ward Creek (including July 1992 Flood), Lively Bayou, Lower White Bayou, North Branch Ward Creek, Upper Amite River (Denham Springs to State Line), Upper Cypress Bayou, White Bayou East Diversion Canal, Weiner Creek. May be the files that USACE created for FEMA.
Ward Creek H&H Models	EBR	1990-2000	HEC-1, HEC-2, HEC-RAS	Y	H&H models of Ward Creek, HEC-RAS model is a HEC-2 conversion for Mall of LA
Jones Creek Hydraulic Models	EBR	1990-2007	HEC-2, HEC-RAS	Y	Hydraulic models for Jones Creek, mostly from the 2000's, includes one model for Lively Bayou
Jones Creek Lateral Hydrologic Model	EBR	2003	HEC-1	Y	Jones Creek Lateral HEC-1 files for input into SWMM
Knox Branch Hydrologic Model	EBR	2004	HEC-HMS	Y	HEC-HMS model of Knox Branch upstream of S Harrells Ferry Road
Hydraulic Models for Various EBR Streams	EBR	1990-1998	HEC-2	Y	HEC-2 files for EBR: Clay Cut Bayou, Amite River (Maurepas to Comite), Beaver Bayou, Bayou Duplantier, Bayou Fountain, Blackwater Bayou, Comite River, Dawson Creek, Hurricane Creek, Jones Creek, Ward Creek (including July 1992 Flood), Lively Bayou, Lower White Bayou, North Branch Ward Creek, Upper Amite River (Denham Springs to State Line), Upper Cypress Bayou, White Bayou East Diversion Canal, Weiner Creek. Appears to be duplicate files, USACE/FEMA models.
Ward Creek H&H Models for the Mall of LA	EBR	2000	HEC-1, HEC-RAS	Y	H&H models of Ward Creek, HEC-RAS model is a HEC-2 conversion for Mall of LA. May be duplicates
Mississippi River Levee Documents	EBR	2009-2015	Various	Y	Includes top of levee profiles (including PLD MS River Levees from BR to NOLA), daily stage data, 2004 MS River hydrographic survey, emergency action plans, permits, and projects impacting the levees.
North Branch Wards Creek H&H Models	EBR	1993-1995	HEC-1, HEC-2	Y	HEC-1 and HEC-2 files for EBR: Country Club Lateral and North Branch Ward Creek
Section 14 streambank stabilization project for Comite River at Pride Port Hudson Road and Tucker Road	EBR	2003-2015	Various	Y	Project files for Section 14 streambank stabilization project for Comite River at Pride Port Hudson Road and Tucker Road, includes survey, plans, and other project documentation (pre and post construction)
Robert Canal Hydraulic Model	EBR	2006	HEC-RAS	Y	HEC-RAS model files for Robert Canal
Section 14 streambank stabilization project for Unnamed Tributary to the MS River at Southern University (F Street)	EBR	2009	PDF	Y	FONSI for Section 14 streambank stabilization project for unnamed tributary to the MS River at Southern University (F Street), communications only
Jones Creek Channel Surveys and Drainage Analyses	EBR	2001-2004	Various	Y	Documentation for Jones Creek project, including survey files and GIS files, includes some drainage calculations in spreadsheets
Weiner Creek Drainage Improvements	EBR	1997	PDF	Y	Plan set for Weiner Creek Drainage Improvements, including channel geometry information
LSU Lakes Section 206 Project Documentation	EBR	2008-2009	PDF, Email, JPG	Y	See PDF Cost Estimate Report for Section 206 project "LSU_Cost_Estimate_20080730", also other misc. correspondence and documentation, no H&H

Description	Source	Date	File Type	Have ? (Y/N)	Additional Description
Project Documentation for Comite River Diversion	EBR	2000-2015	Various	Y	Misc. project documentation for the Comite River Diversion, correspondence, maps, plans, permits, but no H&H models
Comite River Diversion Map, CBR Analysis, and Downstream Water Surface Impacts	EBR	2008	PDF	Y	Map of the Comite River Diversion, map of downstream water surface elevation impacts due to Comite River Diversion project, as well as a cost to benefit ratio summary/justification for the Comite River Diversion project
2008 Comite River Diversion H&H Report by Taylor Engineering	EBR	2008	PDF	Y	2008 Comite River Diversion H&H Report by Taylor Engineering
Community Rating System (CRS) Documentation	EBR	1992-2015	Various	Y	Various documentation for the EBR CRS, including repetitive loss information (also PDF titled "Repetitive Loss lot & block Map", old maps), finished floor elevation information, insurance policy information, 2006 EBR Hazard Mitigation Plan, community Program for Public Information (PPI)
EBR Drainage Design Studies and Drainage Issues	EBR		Various	Y	Documentation of drainage studies and drainage issues, including folders for each project or problem area with plans, maps, and/or correspondence
USACE Amite River Basin & Tributary Studies	EBR	1964-1998	PDF	Y	Scans of past USACE studies that have been performed on the Amite River and Tribs, including the FRMP projects.
EBR Drainage Criteria and Manuals	EBR	1994-2014	Various	Y	EBR Drainage Criteria and Manuals
EBR Drainage Design Files	EBR	1993-2014	Various	Y	Documentation for drainage projects, primarily CAD files, but some H&H models, survevys, reports, and communications
Azalea Lakes Study Files	EBR	1998-2001	CAD, DOC, HEC-RAS	Y	5 folders containing CAD files, HECRAS files, HYDRAWIN files, and photos
Bluebonnet Realignment Project Files	EBR	1998-2001	CAD, DOC, HEC-RAS, HEC-HMS	Y	Bluebonnet Realignment Phase I: Letters, HECRAS files, HECHMS files, and unknown file types
Core Lane Bridge H&H Model Files	EBR	2000	HEC-1	Y	Core Lane Bridge Project H&H files
Various Data for Flood Control Projects	EBR	1998-2014	CAD, PDF	Y	CAD and survey files for various flood control projects, including channels and pipes
E. Mckinley Bridge Replacement	EBR	2008	CAD, PDF	Y	PDF and tif file of the plans, cross sections and profiles
EBR FEMA Documents	EBR	Various	Various	Y	Various files related to FEMA floodplain delineation, flood modeling, flood recovery, flood profiles, repetitive loss information, and flood recovery documentation
Previous EBR HMGP Funding Requests	EBR	1999-2014		Y	Past HMGP application and funding information
FEMA Flood Profiles	EBR	2004 2005 2008	DWG	Y	FEMA flood profiles for EBR FEMA streams
2012 FEMA Model Updates	EBR	2012	HEC-RAS, HEC-2	Y	2012 FEMA Model Updates
Drainage Issue Studies	EBR	2004-2015	PDF, GMW, CAD, JPG	Y	Contains over 350 folders of areas that were studied for drainage issues, primarily just contour maps and survey/GPS files of these areas in each folder, some have additional drainage, plan sheets, and ROW information, no information regarding what the drainage issue was though
Historic Hurricaine Information	EBR	2008-2015	DOC, PDF	Y	Various documents regarding past hurricaine events, including repair work done for Gustav in 2008
Mill Creek and Ward Creek Hydrology Files	EBR	2003	HEC-HMS	Y	HEC-HMS files of Mill Creek and Ward Creek basins, purpose unknown
Bayou Manchac Scenic River Management Plan	EBR	2012	PDF	Y	LDEQ plan showing the requirements for development in and around Bayou Manchac due to it's scenic river designation
Navigable Streams Map	EBR	2009	PDF	Y	Information regarding which streams in the Parish are considered navigable
Stream System Map for NPDES Permit	EBR	2002-2004	XLS, CAD	Y	Stream system (open and closed) documentation for the Parish's NPDES permit, including CAD files with stream numbering, basins, and streets
Pipe Location and Size Requests	EBR	2011-2013	PDF	Y	Property owner requests to the Parish to provide pipe size and material for ditch crossings throughout the Parish. Indicates location, size, and material type.
Stream Profiles	EBR	1993-1996	CAD	Y	Stream profiles for various streams in EBR, all CAD files, 47 files
Development and Codes for Drainage and Floodplain Management	EBR	2002-2008	Various	Y	Various files related to development and codes for drainage and floodplain management
Stream Index and Stream Maps for EBR	EBR	2007-2015	PDF, TIF, CAD	Y	Stream index maps, stream project numbering system maps, watershed maps, and USACE Amite River and Tributaries reports, including CAD files with stream numbers
Road, Stream, Bridge and Drainage Maps for EBR	EBR	1993-2008	CAD, PDF	Y	Overall EBR road, stream, and bridge maps and CAD files, includes a map of drainage projects for EBR for FY 1993-2002 (it's unclear if they were constructed, or are still needed), also there is a drainage area map for the larger basins in the Parish
EBR Subdivision Plans/Plats	EBR	2000-2003	PDF, TIF	Y	1,987 folders of layout, grading, and drainage plans, one folder for each subdivision or phase
University Club Plantation Drainage Impact Study	EBR	1997-1999	PDF	Y	Drainage impact study from 1997 as prepared by CSRS, review copy with comments from EBR
Repetitive Loss Grant for Greenwell Springs	EBR	2009	PDF, TIF	Y	Documentation for Greenwell Springs repetive loss grant from FEMA, report generated by University of New Orleans Center for Hazards Assessment, Response and Technology
USGS Stream Gage Program Information	EBR	2006-2017	PDF	Y	Information regarding stream gage program procurement and other gage information
College Drive from Perkins Road to S. Foster Drive, Drainage Improvements	EBR	1967 (2010 scan)	PDF	Y	Enclosed drainage system, roadway improvments, and bridge over Ward's Creek at College Drive
ArcGIS Shapefiles of Parish Features	EBR	2017	SHP	Y	Shapefiles including: ALLUVIAL_TERRACE, BENCHMARK, BRIDGE_LOCATION, DISTRICT_FLOOD_PROTECT, DRAINAGE_OUTFALL, EXISTING_LAND_USE, FLOOD_BASE_ELEVATION, FLOOD_HAZARD_AREA, FLOOD_PANEL, HYDROGRAPHY, LOT_ADDRESS_AREA, PAVEMENT_EDGE, PIPELINE, PUBLIC_LAND_SURVEY_SYSTEM, RAILROAD, RAILROAD_CROSSING, SEWER_MANHOLE, SEWER_PIPE, SEWER_PUMP_STATION, STORMWATER_CONVEYANCE, STORMWATER_STRUCTURE, SUBDIVISION, WATERSHED_MICRO, WATERSHED_MICRO_SINK
Historic Drainage Project Information Organized by EBR Stream Index	EBR	60's through the 00's	PDF	Y	Project information for various drainage projects around the Parish, organized by the Parish's stream index, including calculations, cost estiamtes, and plan/profile sheets of drainage features, also found original stream index map
Capitol Lake Pumping Station Information	EBR	1982-1983	PDF	Y	Information regarding the Capitol Lake Pumping Station
Terrace Street Pumping Station Information	EBR	1974 and 2015	PDF	Y	Information regarding the Terrace Street Pumping Station
Subdivision Grading and Drainage Plans	EBR	2000-2008	PDF	Y	24 grading and drainage plans, some are for phases of a larger subdivision

Description	Source	Date	File Type	Have ? (Y/N)	Additional Description
From Ascension Parish					
Hydraulic Model of the Amite River and Blind River	Ascension Parish / HNTB	2017	HEC-RAS	Y	Used to help generate combined HEC-RAS model of EBR
Hydraulic Model of Bayou Manchac	Ascension Parish / NRP	2017	HEC-RAS	Y	Used to help generate combined HEC-RAS model of EBR
From Baker					
Groom Road Improvement Project Plans	Baker	1967	PDF		As-built plans for the construction of Groom road through Baker. Includes drainage area map and drainage pipe plans and profiles.
Baker Bridge Replacement Locations	Baker	2018	KMZ	Y	Document from City of Zachary indicating potential bridge replacement locations for HMGP funding.
From Zachary					
Zachary Bridge Replacement Locations	Zachary	2018	KMZ	Y	Document from City of Zachary indicating potential bridge replacement locations for HMGP funding.
From Central					
HMGP Bridge Replacement Locations	Central	2018	XLS	Y	List of bridges that are proposed to be replaced througe HMGP funding, CSRS was coordinating these and the list came from them.

LIST OF FEMA FIS MODELS FOR EAST BATON ROUGE PARISH

FLOODING SOURCE	COMMUNITY NAME	CASE NUMBER	EFFECTIVE DATE	STUDY TYPE	LOMR STATUS	REACH DESCRIPTION	MODEL	XS AFFECTED	FLOODWAY	BFE RANGE (D/S)	BFE RANGE (U/S)
Clay Cut Bayou	EAST BATON ROUGE PARISH	08-06-2505P	8/15/2008	LOMR	EFFECTIVE	From approximately 1600 feet downstream of Elliot Road to approximately 6000 feet upstream of Antioch Road.	OTHER (SEE NOTES)		-	0	0
Bayou Duplantier	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Dawson Creek to confluence of Bayou Duplantier and Corporation Canal	HEC-RAS	A-N	NO	26	26
Bayou Fountain North Branch	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Bayou Fountain to approx. 7,300 feet above	HEC-RAS	A-J	NO	15	22
Bayou Fountain South Branch	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Bayou Fountain to approx. 7,900 feet above	HEC-RAS	A-I	NO	22	24
Bayou Fountain Tributary 1	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Bayou Fountain to approx. 11,800 feet above	HEC-RAS	A-J	NO	8	19
Corporation Canal	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From approx. 14,700 feet above confluence with Dawson Creek to approx. 29,100 feet above	HEC-RAS	O-AE	NO	26	30
Dawson Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Wards Creek to 43,700 feet above	HEC-RAS	A-AJ	NO	24	37
Elbow Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Bayou Fountain to approx. 31,200 feet above	HEC-RAS	A-W	NO	20	24
North Branch Wards Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Wards Creek to approx. 20,400 feet above	HEC-RAS	A-O	NO	17	45
Unnamed Tributary to Bayou Fountain	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Bayou Fountain to approx. 8,450 feet above	HEC-RAS	A-G	NO	7	14
Unnamed Tributary to North Branch Wards Creek (Harelson Lateral)	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with North Branch Wards Creek to approx. 5,900 feet above	HEC-RAS	A-G	NO	35	44
Wards Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Bayou Manchac to approx. 76,150 feet above	HEC-RAS	A-BR	NO	19	53
Clay Cut Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Amite River to approx. 3.4 miles above	HEC-RAS	A-AA	NO	21	33
Jacks Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Clay Cut Bayou to approx. 9,800 feet above	HEC-RAS	A-I	NO	23	37
Upper White Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with South Canal to approx. 52,500 feet above	HEC-RAS	A-AV	NO	73	120
Upper Cypress Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Baker Canal to approx. 26,700 feet above	HEC-RAS	A-Y	NO	75	95
Weiner Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Jones Creek to approx. 14,050 feet above	HEC-RAS	A-N	NO	23	43
Bayou Fountain	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY		From confluence with Bayou Manchac to approx. 69,650 feet above	HEC-RAS	A-BF	NO	11	24
Beaver Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	72	116
Duff Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	88	122
Flanagan Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	104	113
Hanna Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	111	121
Little Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	66	117
Mill Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	92	110
Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	66	118
Scalous Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	103	116
Taber Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	97	109
UNT 1 to Mill Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	96	112
UNT 1 to Little Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	77	99
UNT 2 to Little Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	72	104
UNT 1 to Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	102	116
UNT 2 to Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	91	112
UNT 3 to Little Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	75	98
UNT 3 to Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	72	95
UNT 4 to Little Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	65	79
UNT 4 to Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	65	77
UNT 5 to Little Sandy Creek	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	58	76
UNT to Duff Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	89	122
Wind Bayou	EAST BATON ROUGE PARISH	MICS 30156	5/2/2008	RESTUDY			HEC-RAS	N/A	N/A	66	109
Cypress Bayou	ZACHARY, CITY OF	03-06-827P	9/30/2003	LOMR	EFFECTIVE	From approximately 250 feet upstream of Rollins Road to approximately 500 feet downstream of Rollins Road.	HEC-RAS	W	YES	95	97
Tributary of Jones Creek	EAST BATON ROUGE PARISH	93-06-340P	10/28/1993	LOMR	EFFECTIVE	Just downstream of Mollyea Drive to approximately 600 feet upstream.	OTHER (SEE NOTES)		-	0	0
Blackwater Bayou Tributary 1	EAST BATON ROUGE PARISH	93-06-296P	9/16/1993	LOMR	EFFECTIVE		OTHER (SEE NOTES)		-	0	0
Blackwater Bayou Tributary 2	EAST BATON ROUGE PARISH	93-06-296P	9/16/1993	LOMR	EFFECTIVE		OTHER (SEE NOTES)		-	0	0
Blackwater Bayou	EAST BATON ROUGE PARISH		5/17/1993	RESTUDY		From confluence with Comite River to approx. 41,575 feet above	WSPRO	F-J	NO	75	79
Blackwater Bayou Tributary No. 1	EAST BATON ROUGE PARISH		5/17/1993	RESTUDY		From the confluence with Blackwater Bayou to 30,625 feet above	WSPRO	H-K	NO	77	80
Blackwater Bayou Tributary No. 3	EAST BATON ROUGE PARISH		5/17/1993	RESTUDY		From the confluence with Blackwater Bayou to approx. 3,350 feet above	WSPRO	N/A	NO	76	78
Amite River	EAST BATON ROUGE PARISH		5/17/1993	RESTUDY		From 35 miles above mouth to approx. 82.6 miles (Parish Boundary)	HEC-2	A-AS	YES	19	110
Draughans Creek	EAST BATON ROUGE PARISH		5/17/1993	RESTUDY		From the confluence with Comite River to approx. 23,600 feet above	HEC-2	F-L	NO	47	59
Blackwater Bayou Tributary 1	EAST BATON ROUGE PARISH		2/10/1987	LOMR	EFFECTIVE	In the vicinity of Core Lane and Blackwater Road.	HEC-2		YES	58	75
Blackwater Bayou Tributary 2	EAST BATON ROUGE PARISH		2/10/1987	LOMR	EFFECTIVE	In the vicinity of Core Lane and Blackwater Road.	HEC-2		YES	58	75
Wards Creek	EAST BATON ROUGE PARISH		10/8/1986	LOMR	INCORPORATED	Along the South Acadian Thruway.	OTHER (SEE NOTES)		-	0	0
North Branch Wards Creek	EAST BATON ROUGE PARISH		10/8/1986	LOMR	INCORPORATED	Along the South Acadian Thruway.	OTHER (SEE NOTES)		-	0	0
Blackwater Bayou Tributary No. 2	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Blackwater Bayou to 10,675 feet above	HEC-2	A-G	NO	66	77
Baker Canal	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From approx. 4,000 feet above confluence with Bayou Baton Rouge to confluence with Upper Cypress Bayou	HEC-2	A-G	NO	64	85
Beaver Bayou	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Comite River to approx. 46,250 feet above	HEC-2	A-N	NO	35	76
Engineer Depot Canal	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From the confluence with Comite River to approx. 13,050 feet above	HEC-2	A-I	NO	30	53
Honey Cut Bayou	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Amite River to approx. 23,250 feet above	HEC-2	A-I	NO	15	42
Hub Bayou	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Amite River to approx. 19,000 feet above	HEC-2	A-H	NO	45	78
Indian Bayou	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Upper White Bayou to approx. 14,200 feet above	HEC-2	A-H	NO	92	105
Robert Canal Tributary No. 1	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Robert Canal to approx. 2,400 feet above	HEC-2	A-D	NO	53	58
Shoe Creek	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Comite River to approx. 21,000 feet above	HEC-2	A-I	NO	42	59
Shoe Creek Tributary No. 1	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Shoe Creek to approx. 6,275 feet above	HEC-2	A-D	NO	47	60
Blackwater Bayou Tributary No. 1	EAST BATON ROUGE PARISH		11/15/1985	RESTUDY		From confluence with Blackwater Bayou to McCullough Road	HEC-2	A-G	NO	57	78
Weiner Creek	EAST BATON ROUGE PARISH		10/28/1985	LOMR	EFFECTIVE	At the Interstate I-12 crossing.	HEC-2		NO	45	51
Comite River	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Amite River to approx. 18.5 miles above	REPORT	A-U	NO	0	0
East Lateral Cypress Bayou	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Lower Cypress Bayou to approx. 0.38 miles above	REPORT	N/A	NO	0	0
Gibbens Lateral North	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with lower Cypress Bayou to approx. 0.57 miles above	REPORT	N/A	NO	0	0
Hollywood Lateral	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Monte Sano Bayou to confluence of Wildwood Lateral	REPORT	N/A	NO	0	0
Hurricane Creek	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Comite River to confluence of Wildwood Lateral	REPORT	A-J	NO	0	0
Jones Creek	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Amite River to Airline Highway	REPORT	N/A	NO	0	0
Knox Branch	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Jones Creek to approx. 1.425 miles above	REPORT	N/A	NO	0	0
Lively Bayou	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Jones Creek to approx. 3.55 miles above	REPORT	A-H	NO	0	0
Lively Bayou Tributary	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Lively Bayou to approx. 2.475 miles above	REPORT	N/A	NO	0	0
Lower Cypress Bayou	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Comite River to approx. 7.1 miles above	REPORT	A-G	NO	0	0
Lower White Bayou	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Comite River to confluence with Upper White Bayou	UNKNOWN	A-I	NO	0	0
Monte Sano Bayou	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From approx. 3,000 feet above confluence with Mississippi River to approx. 5.5 miles above	REPORT	A-J	NO	0	0
North Airport Lateral	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Gibbens Lateral North to approx. 0.78 miles above	REPORT	N/A	NO	0	0
Scotlandville Lateral	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Monte Sano Bayou to approx. 1.63 miles above	REPORT	N/A	NO	0	0

LIST OF FEMA FIS MODELS FOR EAST BATON ROUGE PARISH

FLOODING SOURCE	COMMUNITY NAME	CASE NUMBER	EFFECTIVE DATE	STUDY TYPE	LOMR STATUS	REACH DESCRIPTION	MODEL	XS AFFECTED	FLOODWAY	BFE RANGE (D/S)	BFE RANGE (U/S)
South Airport Lateral	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Monte Sano Bayou to approx. 0.78 miles above	REPORT	N/A	NO	0	0
South Canal	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Upper Cypress Bayou to confluence with Upper White Bayou	UNKNOWN	H-L	NO	0	0
South Canal Diversion	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Comite River to confluence with Upper White Bayou	UNKNOWN	A-F	NO	0	0
South Lateral	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Lower Cypress Bayou to approx. 1.1 miles above	REPORT	N/A	NO	0	0
West Lateral Cypress Bayou	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Lower Cypress Bayou to approx. 1.1 miles above	REPORT	N/A	NO	0	0
Wildwood Lateral	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Hollywood Lateral to confluence with Hurricane Creek	REPORT	N/A	NO	0	0
Robert Canal	EAST BATON ROUGE PARISH		7/2/1979	STUDY		From confluence with Hurricane Creek to approx. 5 miles above	REPORT	A-C	NO	0	0
Upper Cypress Bayou Tributary No. 1	ZACHARY, CITY OF		9/15/1977	STUDY		From approx. 9,200 feet above confluence with Upper Cypress Bayou to approx. 12,975 feet above	USGS STEPBACKWATER MODEL	A-H	YES	88	99
Upper Cypress Bayou Tributary No. 2	ZACHARY, CITY OF		9/15/1977	STUDY		From approx. 7,650 feet above confluence with Upper Cypress Bayou to approx. 10,925 feet above	USGS STEPBACKWATER MODEL	A-K	YES	84	86

Appendix B – Risk Assessment

1. BASE MAP

RISK ASSESSMENT METHODOLOGY

To assist with the identification and privatization of projects, CSRS performed a high-level, asset-based, risk assessment of East Baton Rouge Parish. The preliminary outcome of the assessment is the delineation of the Parish into three "risk typologies": Low, Medium and High.

The methodology to determine the risk typologies and apply them across the Parish included calculating a risk score for each watershed. This was done by assigning a numeric value to inputs that indicate the probability and impact of flooding for a specific set of critical assets. Those critical assets included:

- Evacuation routes
- Hospitals & Emergency Services
- Power, water & wastewater treatment facilities
- Civic & institutional buildings/campuses
- Baton Rouge Airport
- Major employment centers
- People (as indicated by social vulnerability)

The inputs that contributed to each asset's probability score included:

- Is the asset located in a FEMA 100-year Flood Zone? If so, the asset received a score of "2".
- Did the asset experience any flooding during the August 2016 event? If so, the asset received an additional score of "1".

The inputs that contributed to each asset's impact score included:

- Does the asset fall within FEMA's defined critical facilities or critical infrastructure sectors? If yes, the asset received a score of "3". If no, the asset received a score of "2".
- Social Vulnerability Index ("SoVI") rating. Those watersheds rated "High" the index received a score of "3". Those rated "Low" got a score of "1". Watersheds that were found to have "Low-Medium", "Medium", or "Medium-High" vulnerability on the index received a score of "2".

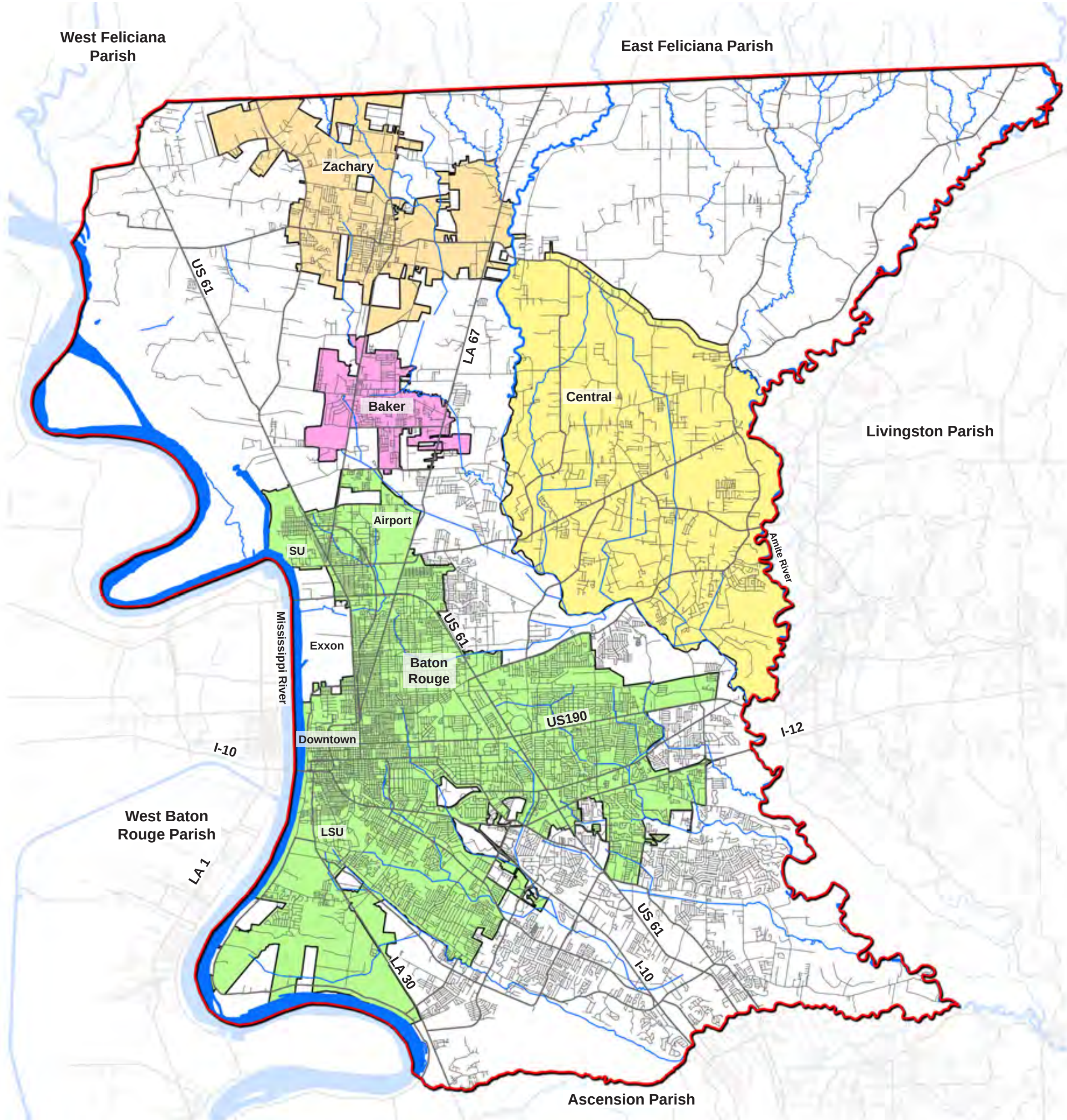
Risk scores for each asset were then calculated by multiplying the probability score by the impact score. Assets were then aggregated by watershed, and the risk scores were added together to produce a preliminary risk score by watershed. No risk value was given greater weight than another.

CSRS also looked at flooded structures by watershed, creating an additional score for each, based on:

- Number of flooded structures
- Percentage of total structures flooded.

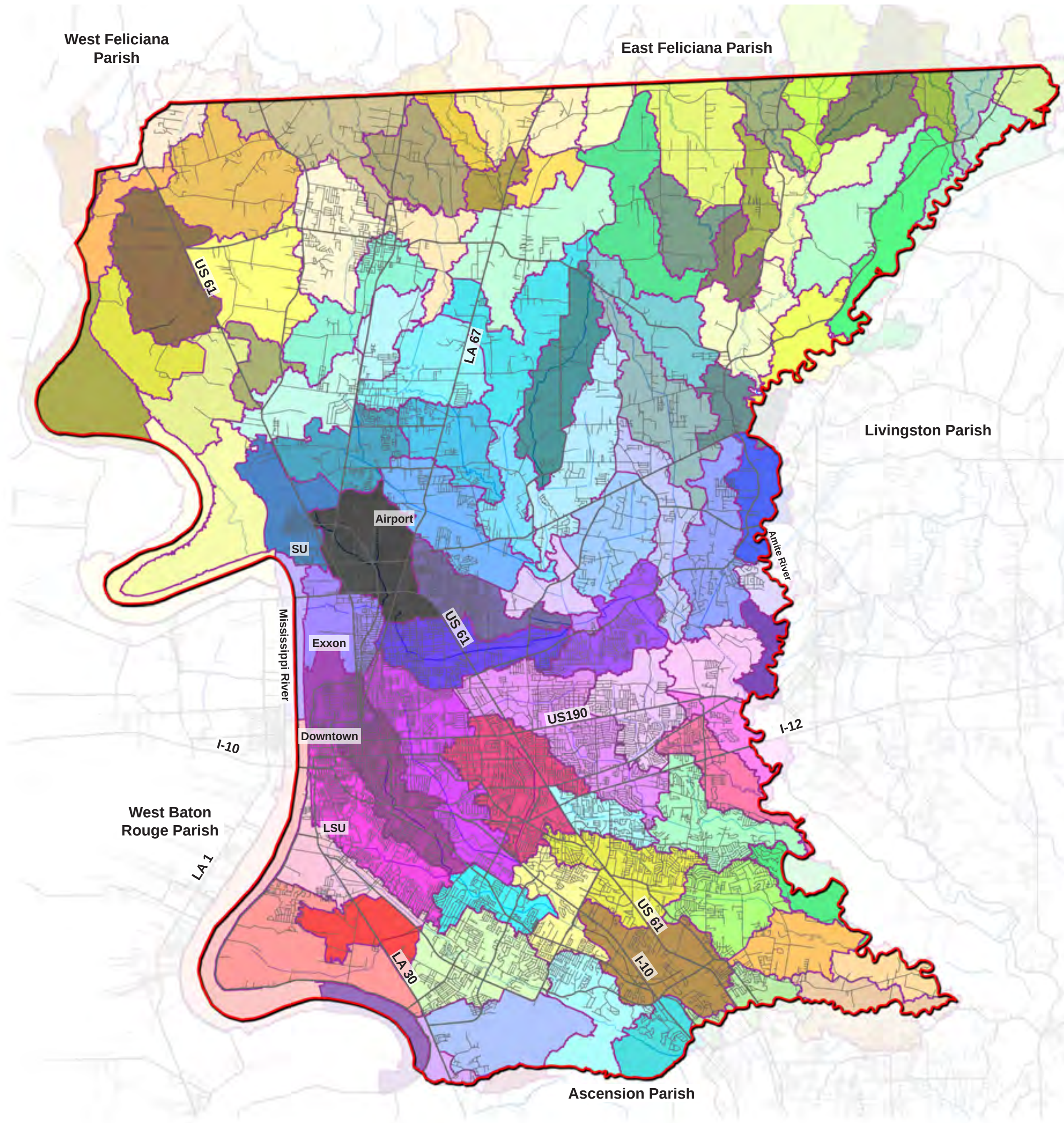
Those watersheds with the highest number of flooded structures and highest percentage of total structures flooded (structures flooded divided by total structures) received the highest "flood score", which was added to the preliminary risk score for each watershed, to create the final risk score.

Watersheds with a final risk score below 30 were identified as "Low Risk", those with a score between 30 and 60 were identified as "Medium Risk". Watersheds with a score above 60 were denoted as "High Risk".



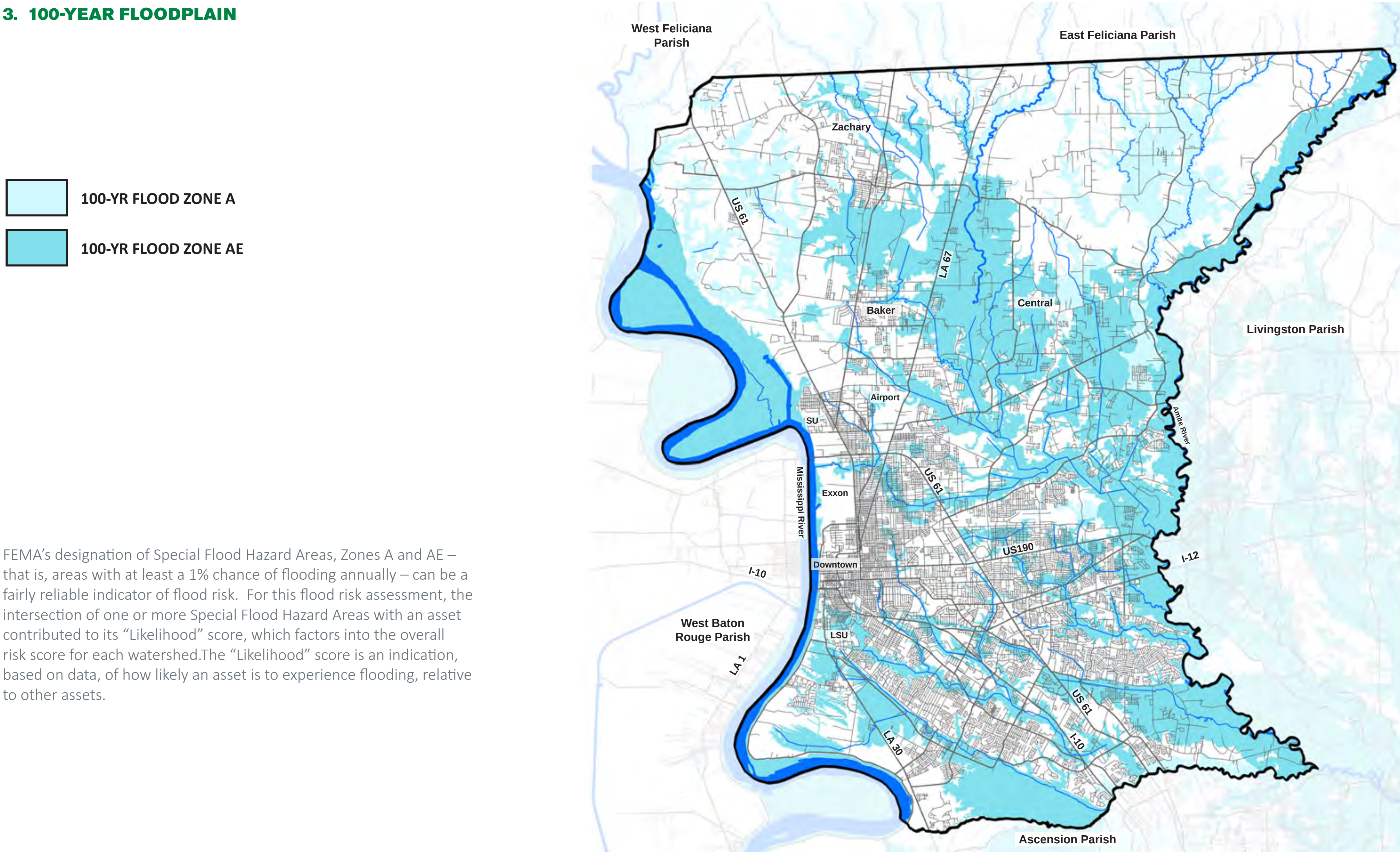
2. NATURAL WATERSHEDS

- Profit Island Chute
- Thomas Point
- Mississippi River-Monte Sano Bayou
- Duncan Point
- Upper Manchac Point
- Foster Creek
- Lower Sandy Creek
- Faulkner Lake
- Lilly Bayou-Cooper Bayou
- Cooper Bayou
- Upper Baton Rouge Bayou
- Alsen Oil Field-Bayou Baton Rouge
- Middle Bayou Baton Rouge
- Upper Cypress Bayou
- Middle Cypress Bayou
- South Canal
- Baker Canal
- Cow Lake-Bayou Baton Rouge
- Lower Bayou Baton Rouge
- Baton Rouge Harbor
- Upper Monte Sano Bayou
- Lower Monte Sano Bayou
- Capitol Lake
- Kidds Creek
- Whitten Creek
- Baywood-Amite River
- Mill Creek-Amite River
- Stonypoint-Amite River
- Lower Sandy Creek-Amite River
- Taber Creek
- Mill Creek
- Duff Bayou-Little Sandy Creek
- Upper Little Sandy Creek
- Beaver Creek
- Wind Bayou
- Lower Little Sandy Creek
- Flanagan Bayou-Sandy Creek
- East Fork of Sandy Creek
- Middle Sandy Creek
- Beaver Pond Bayou
- Lower Sandy Creek
- Philadelphia Church-Comite River
- Green Hughes-Comite River
- Lower Redwood Creek-Comite River
- Upper Redwood Creek
- Doyle Bayou
- Lower Redwood Creek
- Upper White Bayou
- Copper Mill Bayou-Indian Bayou
- White Bayou-South Canal
- Brushy Bayou-White Bayou
- Lower White Bayou
- Deer Park-Comite River
- Saunders Bayou-Comite River
- Upper Blackwater Bayou
- Lower Blackwater Bayou
- Lower White Bayou-Comite River
- Ash Slough-Cypress Bayou
- Lower Cypress Bayou
- Jones Bayou-Comite River
- Roberts Canal
- Hurricane Creek
- Shoe Creek
- Engineer Depot Canal-Comite River
- Upper Beaver Bayou
- Lower Beaver Bayou
- Draughan Creek
- Lower Comite River
- Bayou Braud
- Bayou Duplantier
- Upper Dawson Creek
- Lower Dawson Creek
- North Branch Ward Creek
- Upper Ward Creek
- Middle Ward Creek
- Lower Ward Creek
- Upper Bayou Fountain
- Elbow Bayou
- Bayou Fountain-Elbow Bayou
- Middle Bayou Fountain
- Selene Bayou
- Lower Bayou Fountain
- Lower Bayou Fountain-Bayou Manchac
- Middle Bayou Manchac
- Lower Bayou Manchac
- Lively Bayou
- Weiner Creek
- Upper Jones Creek
- Lower Jones Creek
- Hub Bayou
- Hub Bayou-Amite River
- Magnolia-Amite River
- Bellingrath-Amite River
- Frenchtown-Amite River
- Riverview-Amite River
- Honey Cut Bayou-Amite River
- Jacks Bayou-Clay Cut Bayou
- Middle Clay Cut Bayou
- Boggy Cut Bayou-Clay Cut Bayou
- Shenandoah-Amite River
- Kendalwood-Amite River



For East Baton Rouge Parish, CSRS used the USGS HUC-14 watershed map to define community-scale boundaries for the delineation of flood risk, which includes 101 different watersheds.

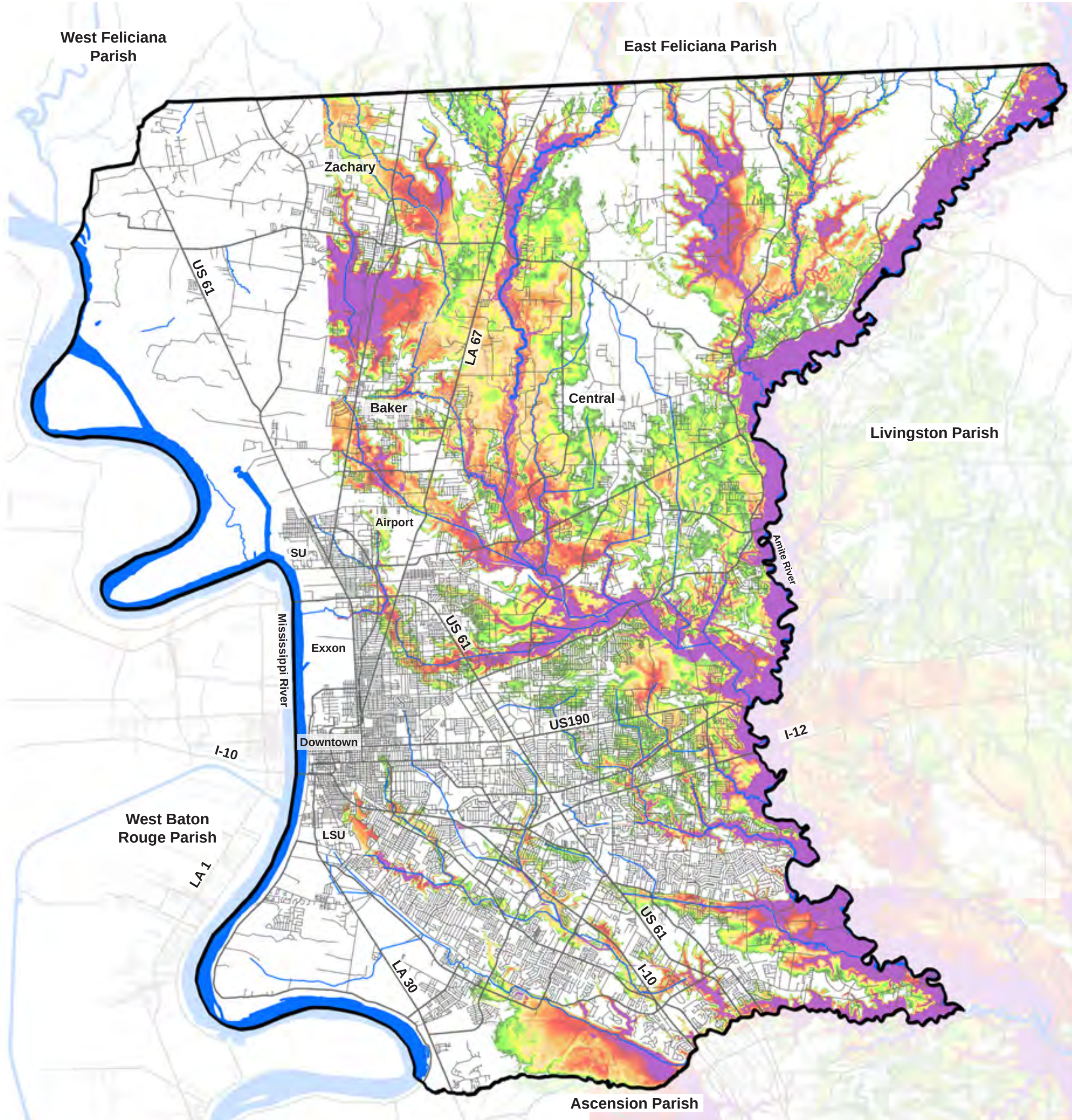
3. 100-YEAR FLOODPLAIN



FEMA's designation of Special Flood Hazard Areas, Zones A and AE – that is, areas with at least a 1% chance of flooding annually – can be a fairly reliable indicator of flood risk. For this flood risk assessment, the intersection of one or more Special Flood Hazard Areas with an asset contributed to its "Likelihood" score, which factors into the overall risk score for each watershed.The "Likelihood" score is an indication, based on data, of how likely an asset is to experience flooding, relative to other assets.

4. AUGUST 2016 FLOOD INUNDATION

- 0' - 1' INUNDATION
- 1' - 2' INUNDATION
- 2' - 3' INUNDATION
- 3' - 4' INUNDATION
- 4' - 5' INUNDATION
- 5' - 6' INUNDATION
- 6' - 7' INUNDATION
- 7' - 8' INUNDATION
- 8' + INUNDATION

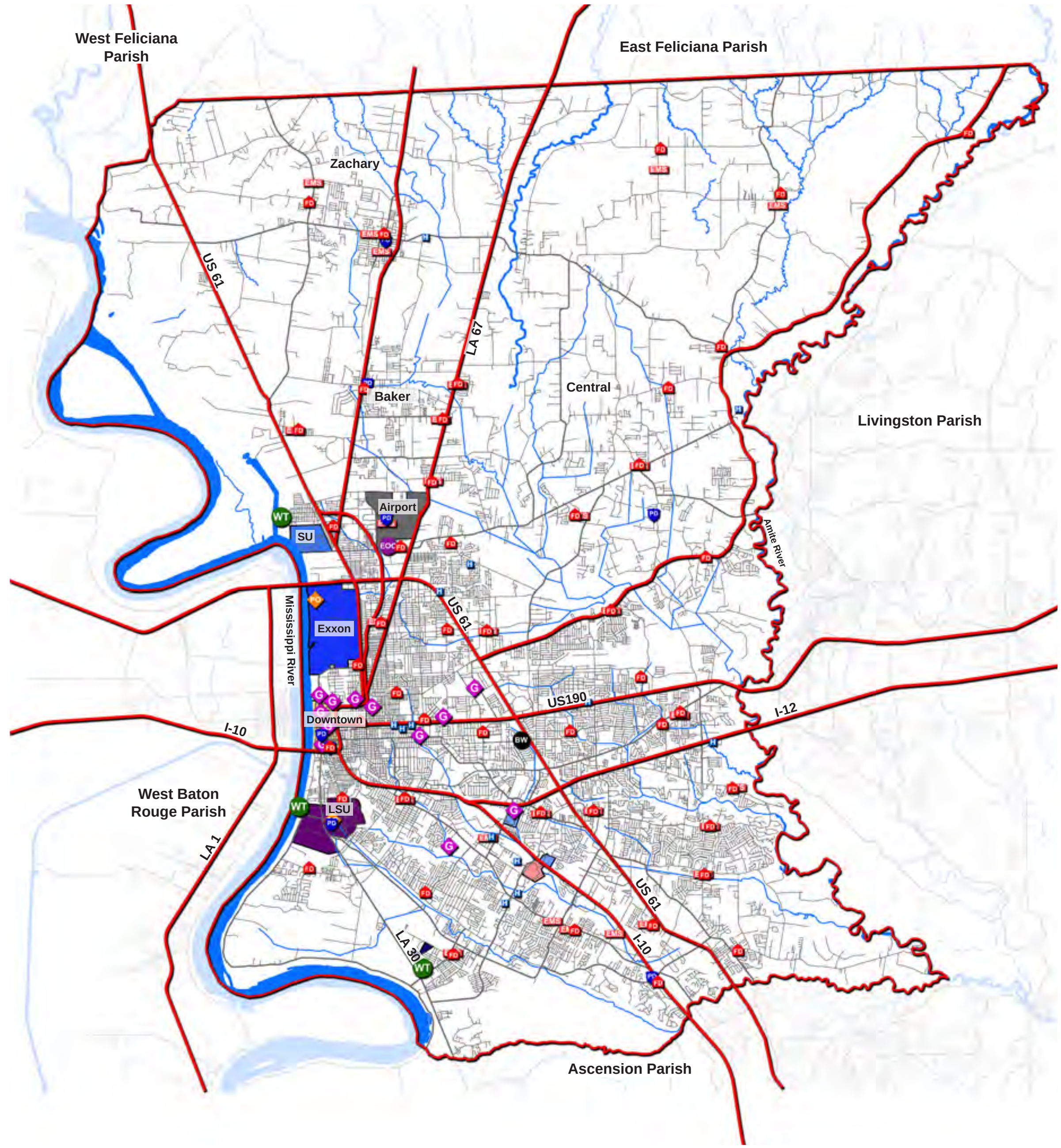


The floods of August 2016 had a significant impact on East Baton Rouge Parish and, in some ways, changed our understanding of stormwater flood risk. The August 2016 serves as a fresh benchmark for catastrophic flooding, and recent data from those floods was included in this risk assessment. As part of its work in support of the Parish's flood recovery, CSRS developed flood inundation data, based on damage assessments, high water marks, and surveys, and was able to map the extent of the flooding, as well as approximate flood depth for most of the Parish. Any asset that experienced any level of flood inundation, according to CSRS' data, received a higher "Likelihood" score than assets that did not flood in August 2016.

Note: Data was not available for the extreme western portion of the Parish, which is why the map shows no shading on its western edge. This is not necessarily an indication that the extreme western portion of the parish experienced no flooding in August 2016.

5. CRITICAL INFRASTRUCTURE

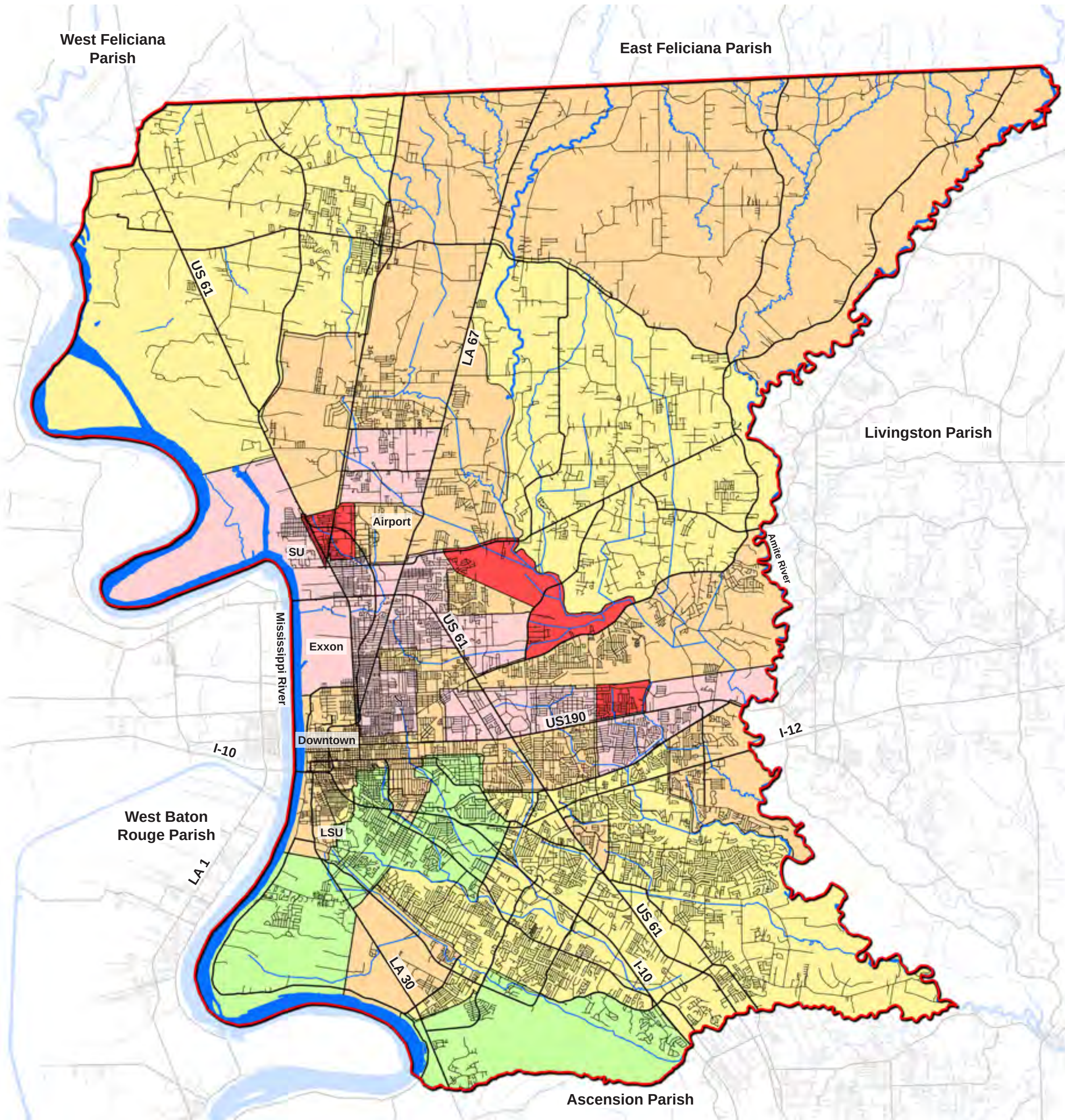
- FD — FIRE STATION LOCATIONS
- H — HOSPITAL LOCATIONS
- EMS — EMERGENCY MEDICAL STATIONS
- EOC — EMERGENCY OPERATIONS CENTER
- PD — POLICE STATION LOCATIONS
- G — STATE GOVERNMENT BUILDING LOCATIONS
- PO — POWER PLANT LOCATIONS
- WT — WASTEWATER TREATMENT LOCATIONS
- BW — BATON ROUGE WATER COMPANY
- DESIGNATED EVACUATION ROUTES



For any risk assessment, it is important to determine the vulnerability of critical infrastructure that could play an important role in the response and/or recovery to disasters. CSRS used the U.S. Department of Homeland Security's Critical Infrastructure Sectors to guide its identification of infrastructure assets for this assessment, and tailored those assets to East Baton Rouge Parish using the Parish's Hazard Mitigation Plan and Open Data BR. Each of the critical infrastructure assets were evaluated for flood risk, in every watershed in which the assets were located. Specifically, infrastructure assets were evaluated based on their likelihood of flooding (Was it located in a 100-year floodplain and/or flooded in August 2016?), and their impact (Is it defined as a "critical" facility or infrastructure by FEMA).

6. SOCIAL VULNERABILITY (2006 - 2010)

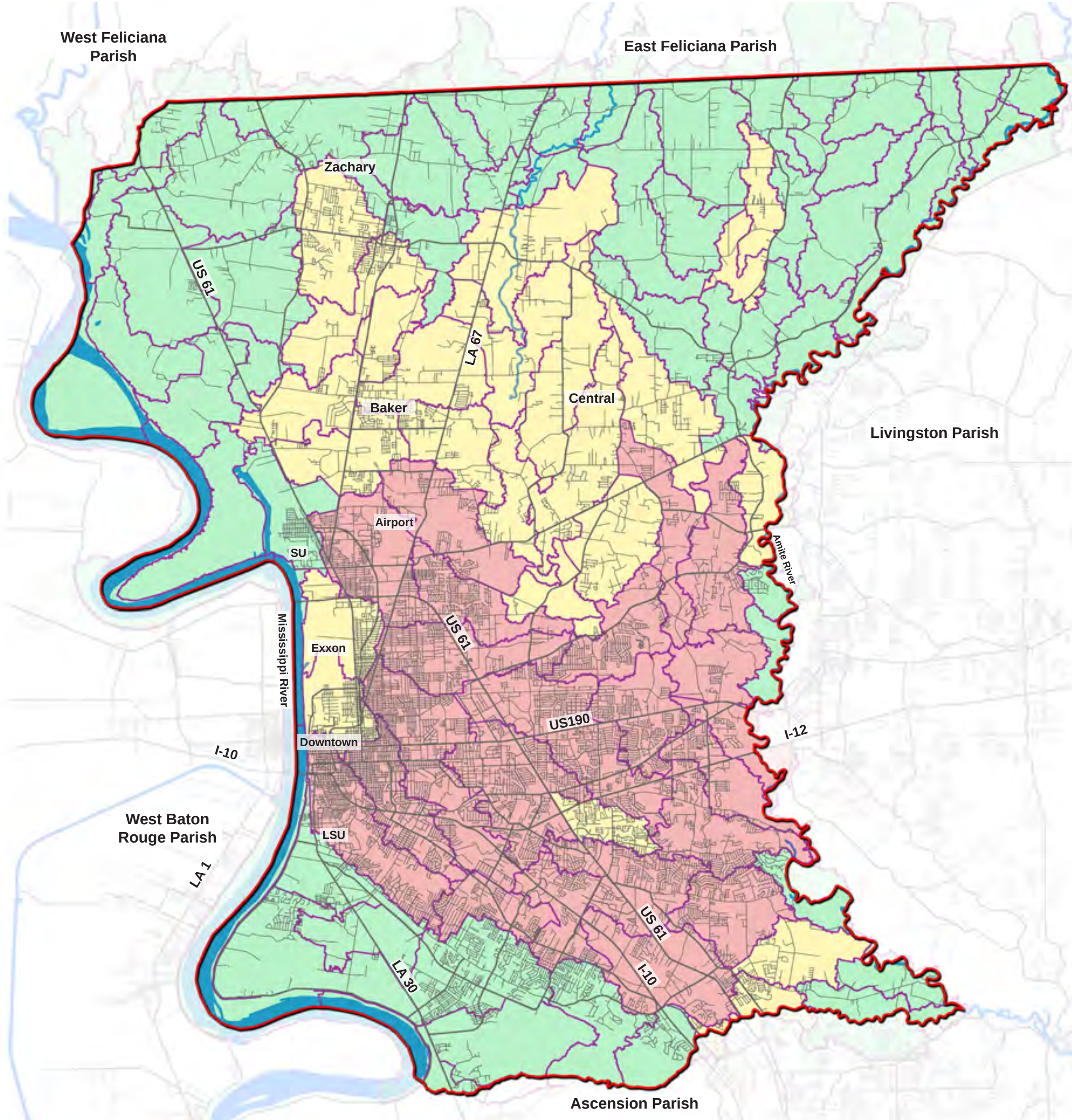
- Low Vulnerability
- Low-Medium Vulnerability
- Medium Vulnerability
- Medium-High Vulnerability
- High Vulnerability



Social vulnerability refers to the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-cased disasters. Reducing social vulnerability can decrease both human suffering and economic loss. For this risk assessment, CSRS used the U.S. Center for Disease Control's Social Vulnerability Index (SoVI), which uses U.S. census variables at tract level to help local officials identify communities that may need support in preparing for hazards, or recovery from disasters.

SVI data was aggregated by HUC-14 watershed, and a social vulnerability score was calculated for each watershed, based on the SoVI's determination of "Low", "Medium" (which includes Low-Medium, Medium, and Medium-High) or "High" vulnerability. The social vulnerability score was then added to other asset risk scores, so that the presence of vulnerable populations in a watershed would contribute to a higher overall risk score.

7. RISK ASSESSMENT SUMMARY



Low Risk

Medium Risk

High Risk

Based on the location and vulnerability of critical assets, as well as the presence and concentration of structures that flooded in August 2016, each of the 101 HUC-14 watersheds in East Baton Rouge Parish were assigned a risk score. Knowing the vulnerability of the watersheds relative to flooding can help guide disaster planning and investments in flood risk reduction in the Parish.

A large portion of the Parish, bounded roughly by the Mississippi River and Interstate 110 to the west, the airport and Greenwell Springs Road to the north, the Amite River to the east, and Dawson Creek to the south, represents the "core" of the Parish at greatest risk. The area just north of downtown Baton Rouge, and those surrounding the communities of Baker, Central and Zachary, make up the "medium risk" zones. The northern and southwestern edges of the Parish largely represent the "low risk" zones.

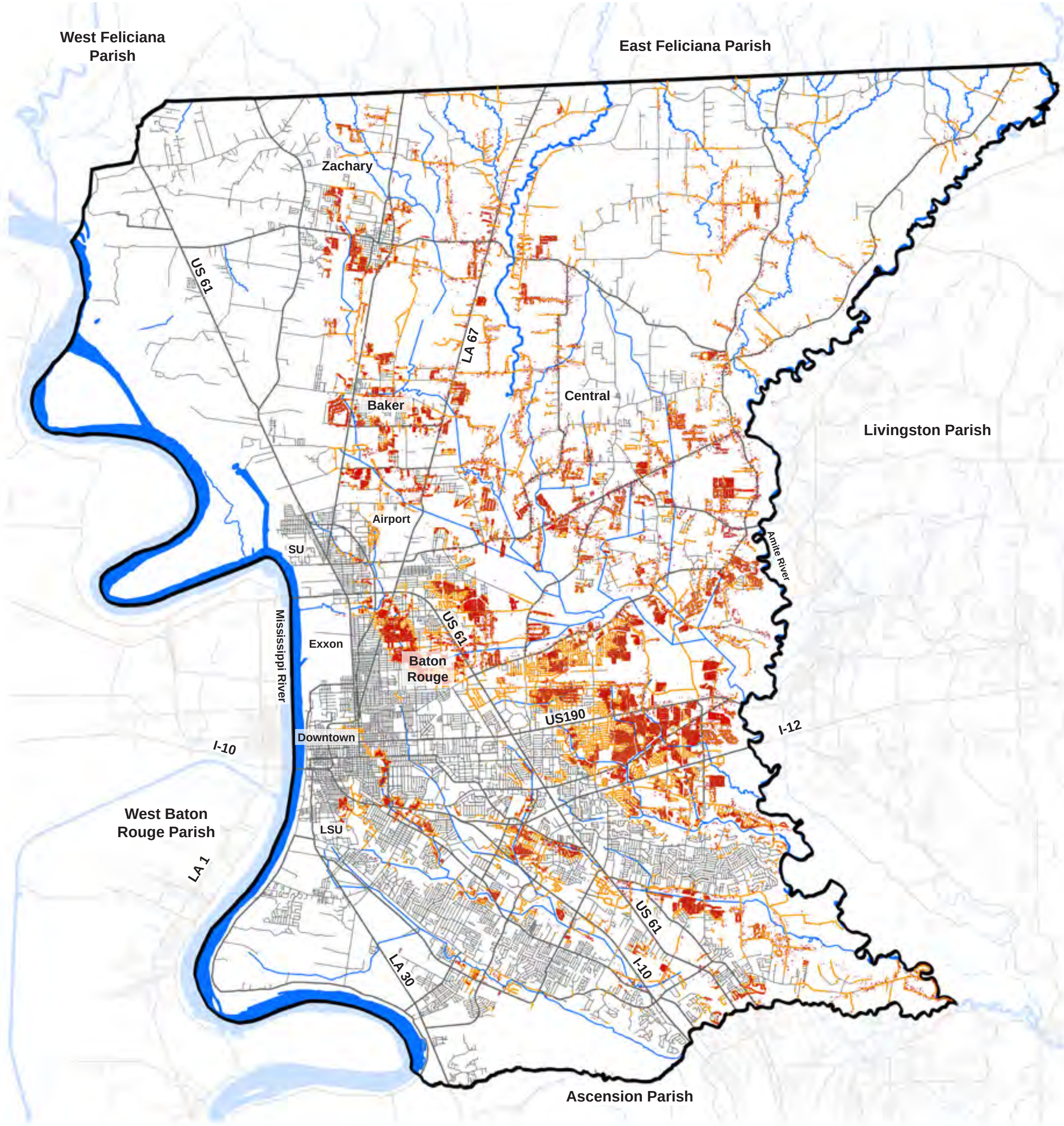
Generally, those watersheds within East Baton Rouge Parish that are more urbanized and house a higher density of assets present a higher level of risk due to flooding than outlying areas that are less developed.

8. AUGUST 2016 FLOOD - FLOODED STRUCTURES

● FLOODED STRUCTURES

FLOODED ROADWAYS

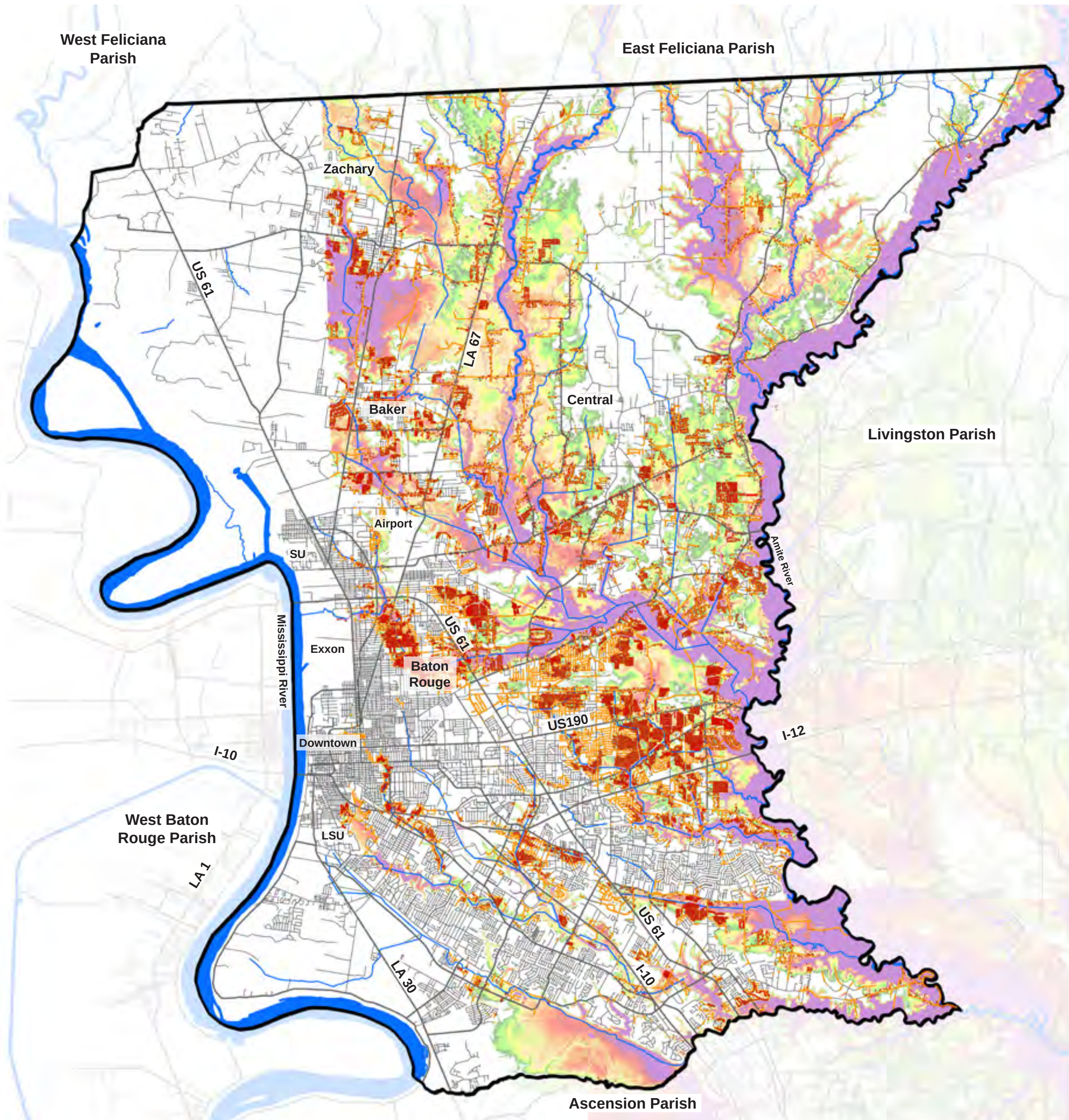
Structures and roadways that experienced any level of flooding in August 2016 were also aggregated by watershed. Those watersheds with the highest numbers of flooded structures and the highest concentration (by percentage) of flooded structures received the highest "flood scores" in this assessment. The process helps indicate those watersheds in which the greatest number of structures are at risk.



9. AUGUST 2016 FLOOD - FLOODED STRUCTURES WITH INUNDATION

- 0' - 1' INUNDATION
- 1' - 2' INUNDATION
- 2' - 3' INUNDATION
- 3' - 4' INUNDATION
- 4' - 5' INUNDATION
- 5' - 6' INUNDATION
- 6' - 7' INUNDATION
- 7' - 8' INUNDATION
- 8' + INUNDATION

- FLOODED STRUCTURES
- FLOODED ROADWAYS



Understanding the extent and depths of the flooding in August 2016, as well as the locations of structures that flooded during that event, helps to understand where the greatest impacts of the flooding were felt, relative to the built environment. Those watersheds that had housed critical assets and experienced flooding in 2016, including a high concentration of flooded structures, scored highest, in terms of flood risk in this assessment, especially if social vulnerability in those watersheds was higher.

10. SOCIAL VULNERABILITY (2006 - 2010) AND AUGUST 2016 FLOODED STRUCTURES & ROADWAYS

Low Vulnerability

Low-Medium Vulnerability

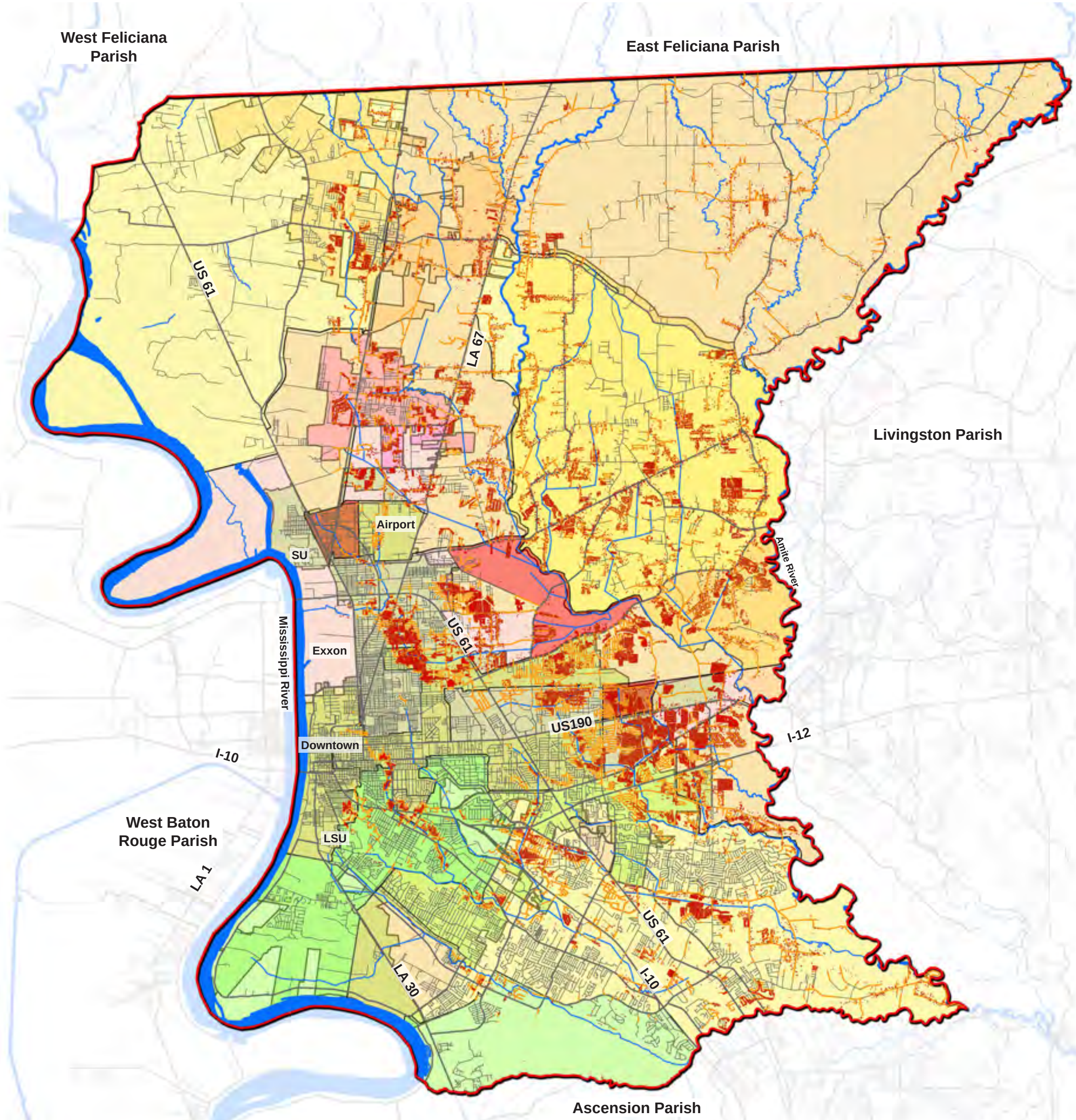
Medium Vulnerability

Medium-High Vulnerability

High Vulnerability

FLOODED STRUCTURES

FLOODED ROADWAYS

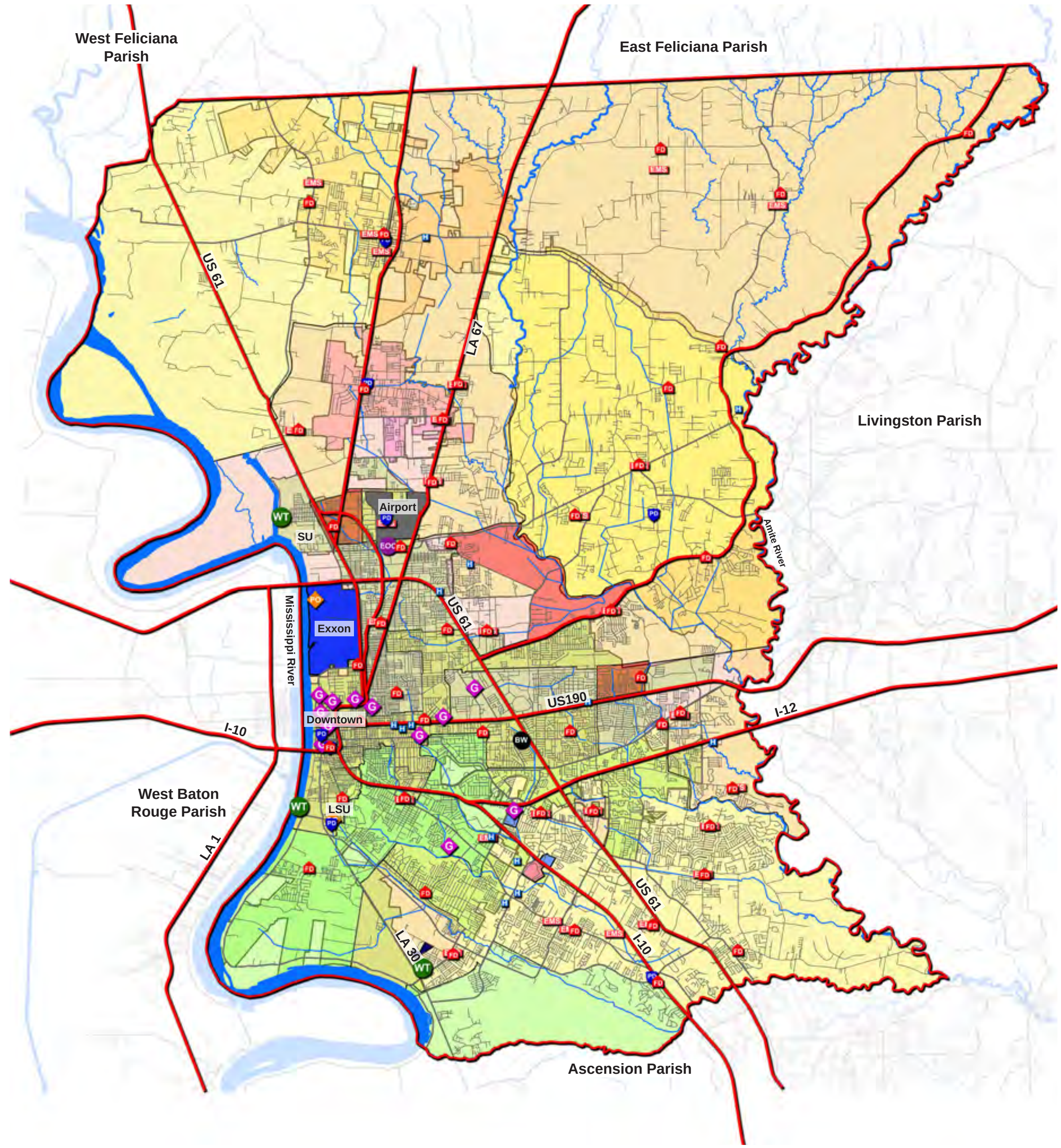


Because vulnerable populations take longer to recover from disaster, those watersheds that have higher social vulnerability and possess higher concentrations of flooded structures present a higher overall risk to East Baton Rouge Parish.

11. SOCIAL VULNERABILITY (2006 - 2010) AND CRITICAL INFRASTRUCTURE

- Low Vulnerability
- Low-Medium Vulnerability
- Medium Vulnerability
- Medium-High Vulnerability
- High Vulnerability

- FD FIRE STATION LOCATIONS
- H HOSPITAL LOCATIONS
- EMS EMERGENCY MEDICAL STATIONS
- EOC EMERGENCY OPERATIONS CENTER
- PD POLICE STATION LOCATIONS
- G STATE GOVERNMENT BUILDING LOCATIONS
- PO POWER PLANT LOCATIONS
- WT WASTEWATER TREATMENT LOCATIONS
- BW BATON ROUGE WATER COMPANY
- DESIGNATED EVACUATION ROUTES



Vulnerable populations tend to rely on critical infrastructure for assistance during and after disasters. Watersheds that had higher social vulnerability and housed critical infrastructure that is at risk of flooding received some of the highest risk scores in this assessment.

12. AUGUST 2016 FLOOD - FLOODED STRUCTURES WITH RISK SUMMARY

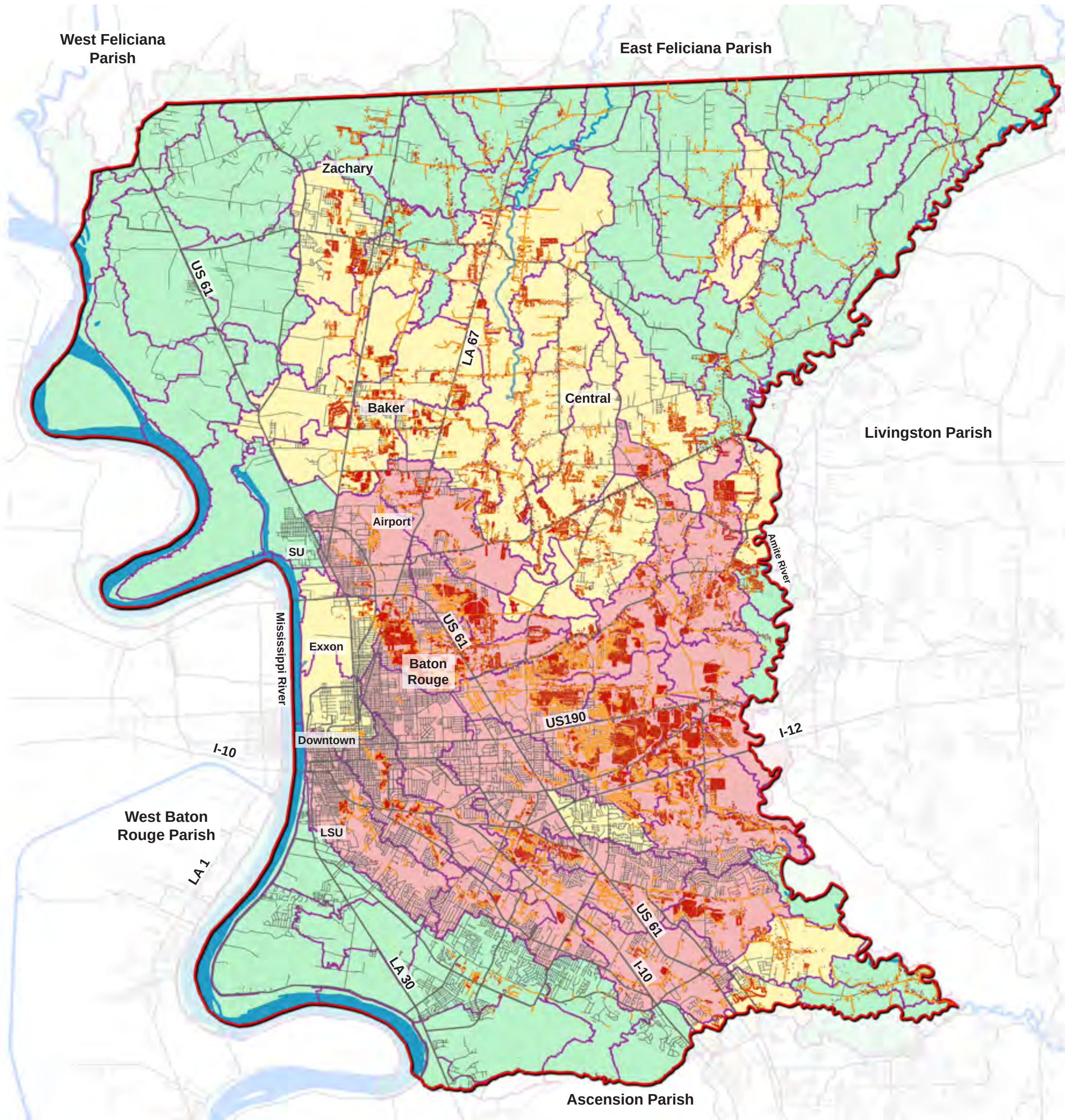
Low Risk

Medium Risk

High Risk

FLOODED STRUCTURES

FLOODED ROADWAYS



Most of the structures that flooded in August 2016 are captured in the "high risk" or "medium risk" zones, as identified through this assessment. Those watersheds in the high risk zones have both the highest concentrations of flooded structures and the highest concentrations of critical assets at risk of flooding.

Appendix C – Preliminary Modeling

East Baton Rouge City-Parish Stormwater Master Plan

Phase I Regional, Conceptual-Level Model Development

Prepared for:

East Baton Rouge City-Parish

Department of Public Works

Prepared by:

NRP

STATE OF LOUISIANA
TORGER S. BROWN
License No. 38148
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

April 17, 2018

TABLE OF CONTENTS

1 INTRODUCTION

Widespread flooding during the August 2016 Flood Event exposed the need to address flooding on a local and regional basis working with Ascension, Iberville, St. James, and Livingston Parishes to review flooding along the Comite River, lower Amite River and Bayou Manchac. The City of Baton Rouge and Parish of East Baton Rouge (EBR) selected the HNTB Corporation (HNTB) team to assist in the development of a Parish Stormwater Master Plan (SMP). To develop this SMP, the Parish adopted a phased approach. Phase 1 of the project was focused on developing critical capital projects within the Parish that qualify for the FEMA Hazard Mitigation Grant Program (HMGP) allocations the Parish will receive for the August 2016 Flood Event. A regional, conceptual-level model was developed to:

- help the team better understand the hydraulic system of rivers, bayous and canals;
- help identify (from a macro level) problem areas and potential projects;
- simulate and develop proposed solutions to the macro problems; and
- provide a foundation for the development of the future, more detailed models for the next phase of the Stormwater Master Plan.

HNTB requested Natural Resource Professionals, LLC (NRP) to assist in developing the conceptual-level model. NRP developed the hydrology and 2-Dimensional (2-D) hydraulic models using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) and River Analysis System (HEC-RAS), respectively. HNTB utilized this 2-D hydraulic model to determine potential project locations and simulate proposed solutions for HMGP projects.

The following sections describe the models' development.

2 REGIONAL, CONCEPTUAL-LEVEL MODEL

NRP and HNTB previously developed 2-D hydraulic models of the Bayou Manchac Basin and Lower Amite River for Ascension Parish, respectively. NRP utilized both models as the starting point for the Phase I Reginal, Conceptual-Level Model (Phase I Model). The Phase I Model was developed using a hydrology model for translating rainfall runoff into flow from areas upstream of East Baton Rouge Parish (Parish) and a hydraulic model to simulate hydrodynamics within the Parish. These models were developed using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) for hydrology and River Analysis System (HEC-RAS) for hydraulics. Figure 2-1 shows the extent of the Amite River Basin (outlined in black), HEC-RAS model (outlined in yellow with hatching), and HEC-HMS model (shaded in various colors). The HEC-HMS and HEC-RAS models were preliminarily calibrated to the March and August 2016 Flood Events.

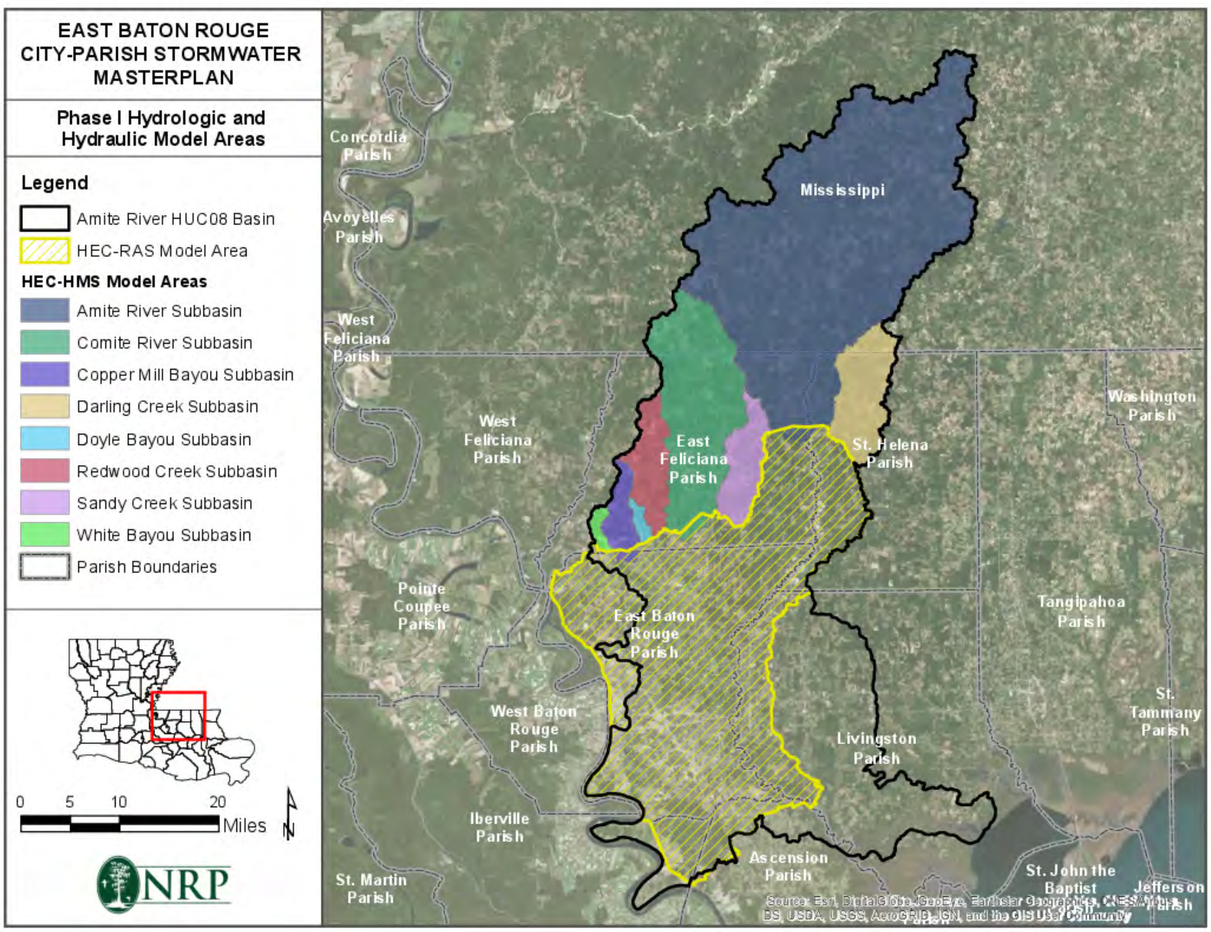


Figure 2-1. Amite River Basin and Phase I Hydrologic and Hydraulic Model.

2.1 Spatial Input Datasets

The following sections identify data collected and used to develop the HMS and RAS models.

2.1.1 Topography

Topographic elevation data were obtained from the Coastal National Elevation Database (CoNED) Project (Figure 2-2) and the Louisiana Oil Spill Coordinator's Office (LOSCO) Digital Elevation Model (DEM) (Figure 2-3). The CoNED Project data was selected where available due to its inclusion of bathymetry data in certain locations. It, however, did not cover the northern portions of the Amite River Basin which extends into Mississippi. To cover this area, the LOSCO DEM was collected. Light Detection and Ranging (Lidar) data in both data sets were collected in 1999 for the model area, and the resolution of the resulting DEMs ranged from 1 to 5 meters. All elevations were converted to North American Vertical Datum of 1988 (NAVD88) Geoid12A.

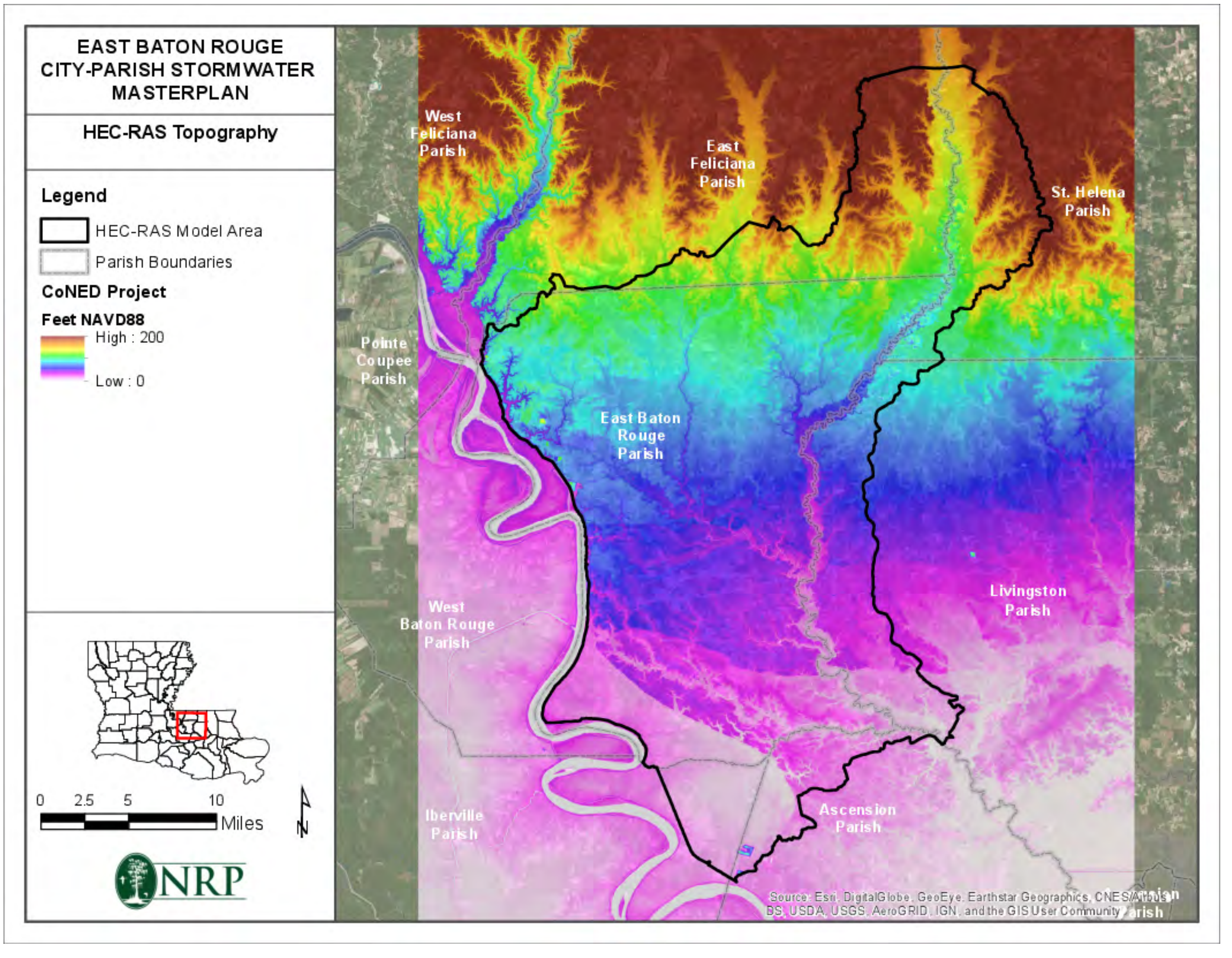


Figure 2-2. HEC-RAS Model topographic and bathymetric data.

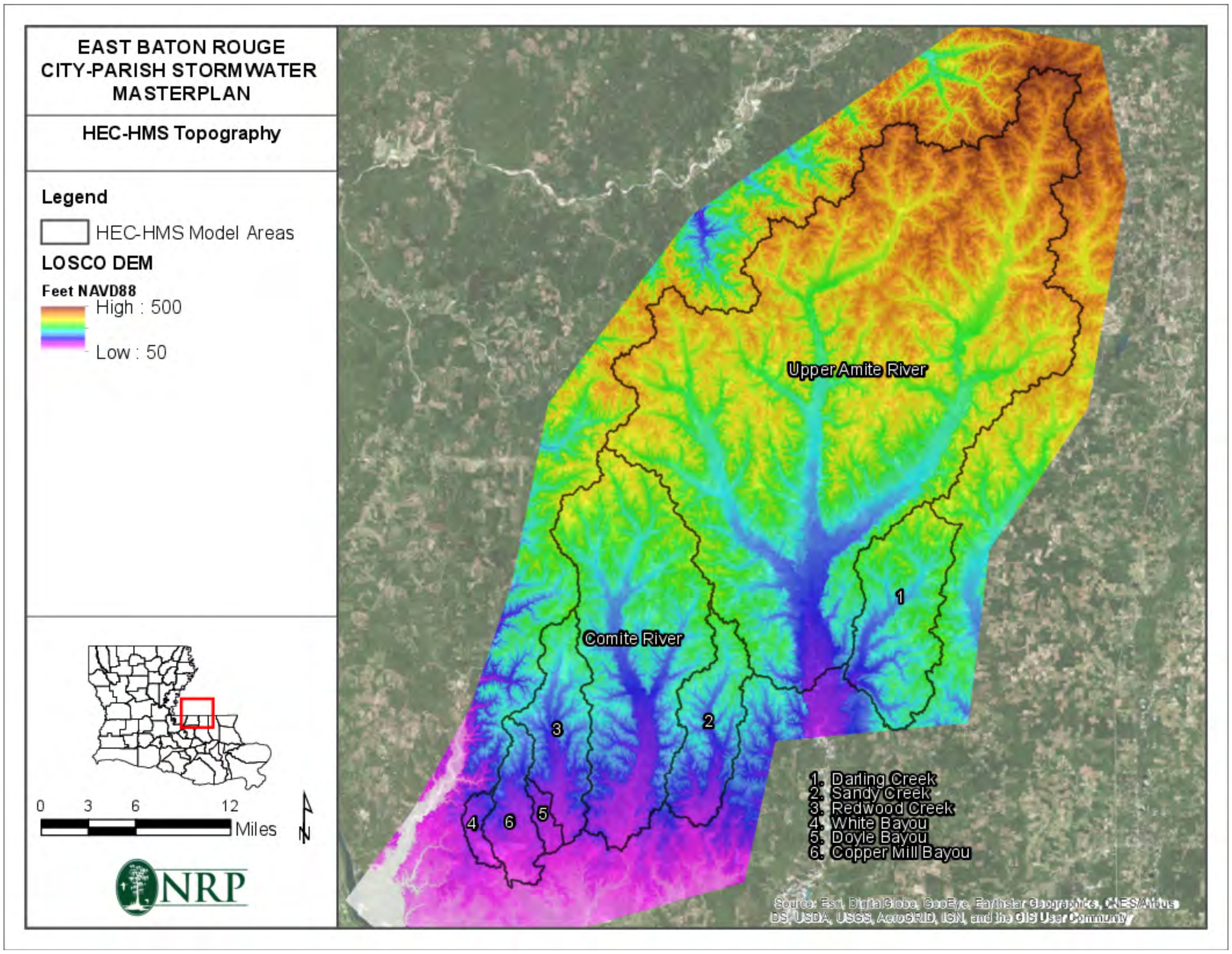


Figure 2-3. HEC-HMS Model topographic data.

2.1.2 Channel Bed Elevations

Lidar data do not provide elevations below the water surface. Therefore, additional data were obtained to define the bed elevations of channels and lakes. Bed elevations for the majority of the channels within the model area were obtained from the United States Army Corps of Engineering's (USACE) Econ Level III Evaluation Model (USACE Econ III) developed in HEC-RAS for the Comite River Diversion Project and the 2005 East Baton Rouge Parish Phase I Flood Insurance Study (2005 EBR FIS) hydraulic models. Figure 2-2 displays the channel bed elevations obtained from both sources. From the USACE Econ III model, only the Amite and Comite Rivers and Bayou Manchac and tributaries were based on survey data. The dates for the survey data were not provided. All of the other channel data were estimated by USACE. Channel bed elevation from the 2005 EBR FIS for Bayou Fountain were based on survey data collected in 2004.

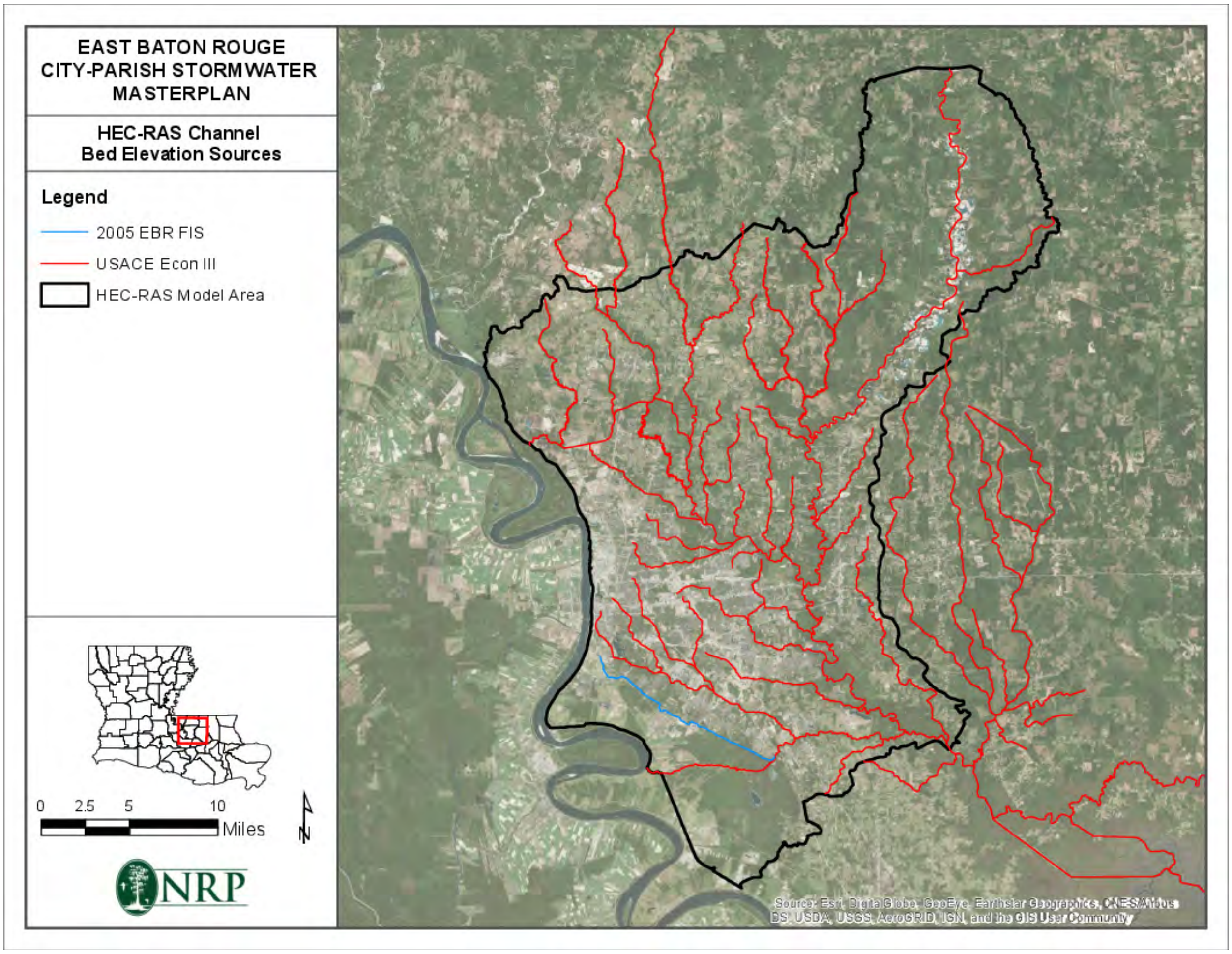


Figure 2-4. HEC-RAS Model channel bed elevation data sources.

2.1.3 Precipitation

March and August 2016 rainfall radar data covering the basin were obtained from the National Severe Storms Laboratory (NSSL) Multi-Radar/Multi-Sensor (MRMS) system1. The MRMS system provides 1-hour accumulation radar precipitation estimates corrected based on local gauge bias as the 'GaugeCorrQPE01H' output. Values were converted from millimeters per hour to inches per hour. An example of the radar data after processing is shown in Figure 2-5 displays the cumulative rainfall depth across the HEC-HMS and HEC-RAS model areas from August 11, 2016 through August 13, 2016.

[1] https://www.nssl.noaa.gov/projects/mrms/

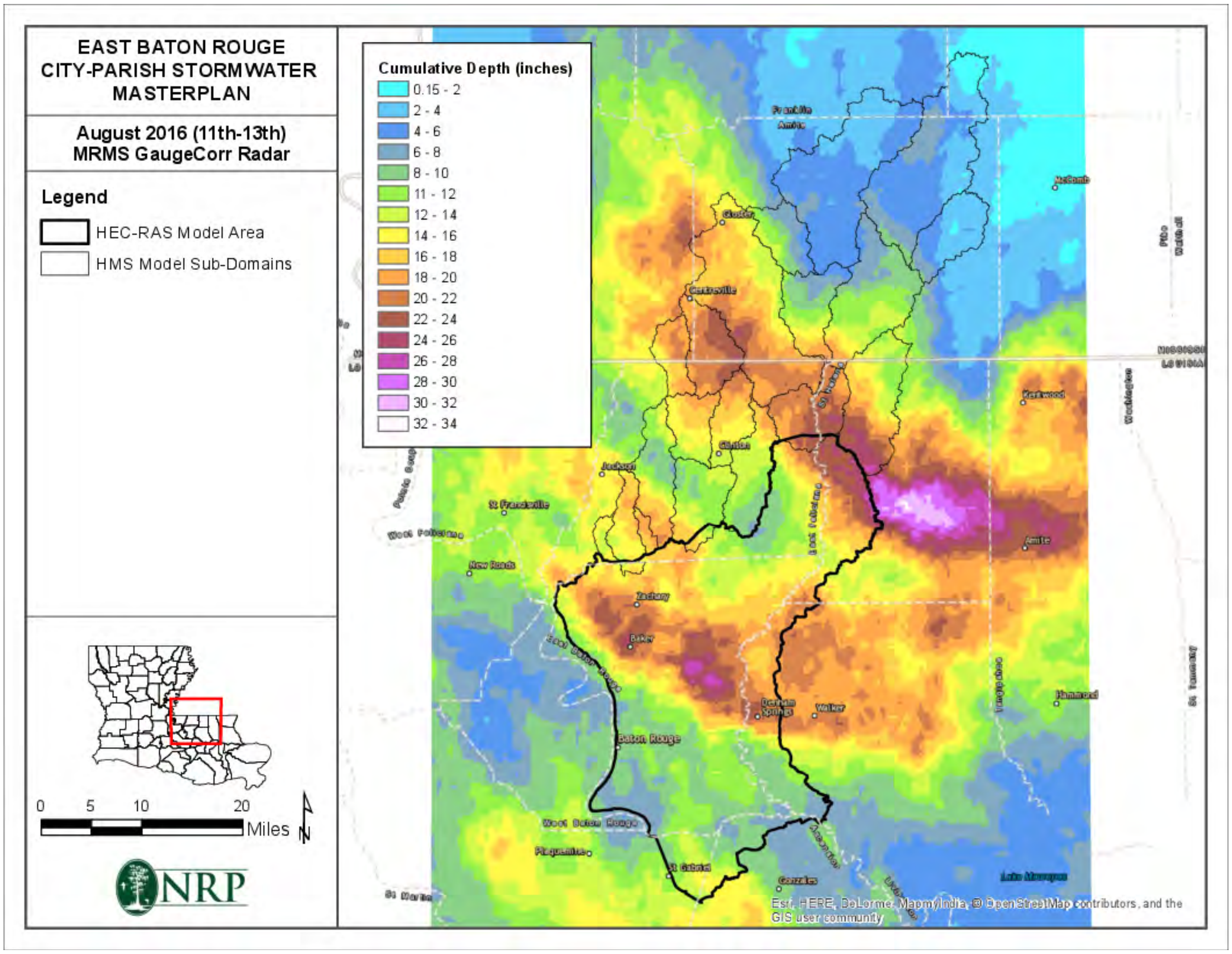


Figure 2-5. August 2016 Cumulative Rainfall Depths from NSSL Gauge Corrected MRMS data

2.1.3.1 Hydrology Model

Figure 2-6 shows the resultant time series for the HMS sub-domains from March 6, 2016 – March 21, 2016. Average accumulation during the heavy rains from March 10^{th} – 12^{th} ranged from 4.5 to 6.5 inches with the average accumulation throughout the time period ranged from 6 to 8 inches.

Figure 2-7 shows the resultant time series for the HMS sub-domains from August 8, 2016 – August 23, 2016. Average accumulation during the heavy rains from August 11^{th} –13^{th} ranged from 4 to 24 inches with the average accumulation throughout the time period ranged from 7 to 30 inches.

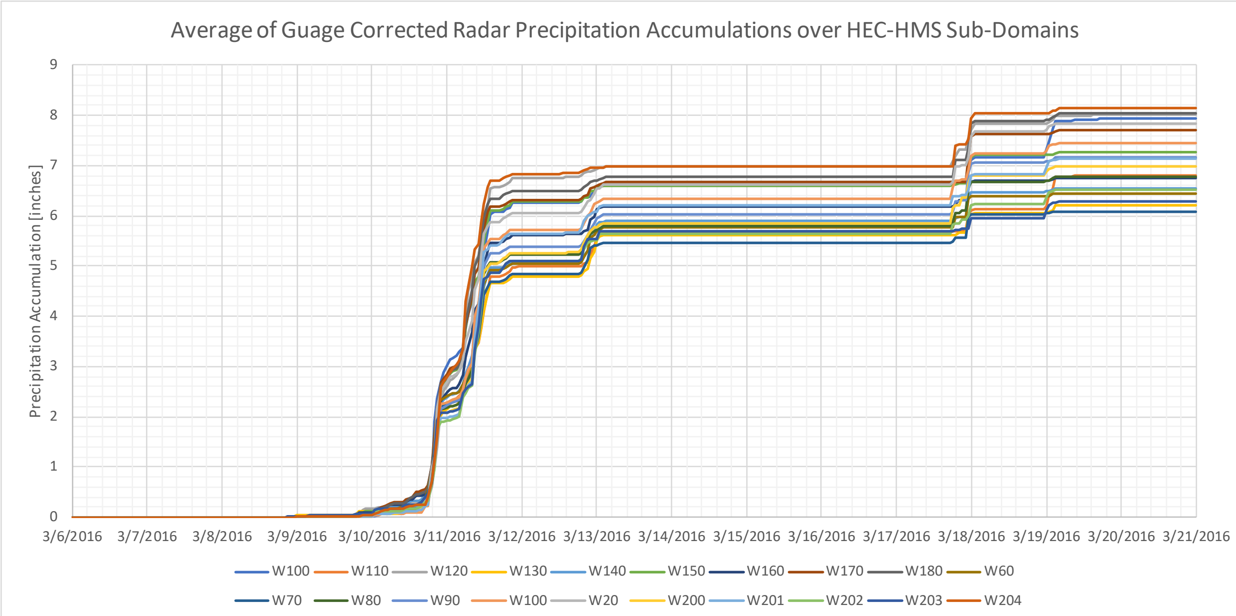


Figure 2-6. March 2016 Rainfall Accumulation Time Series.

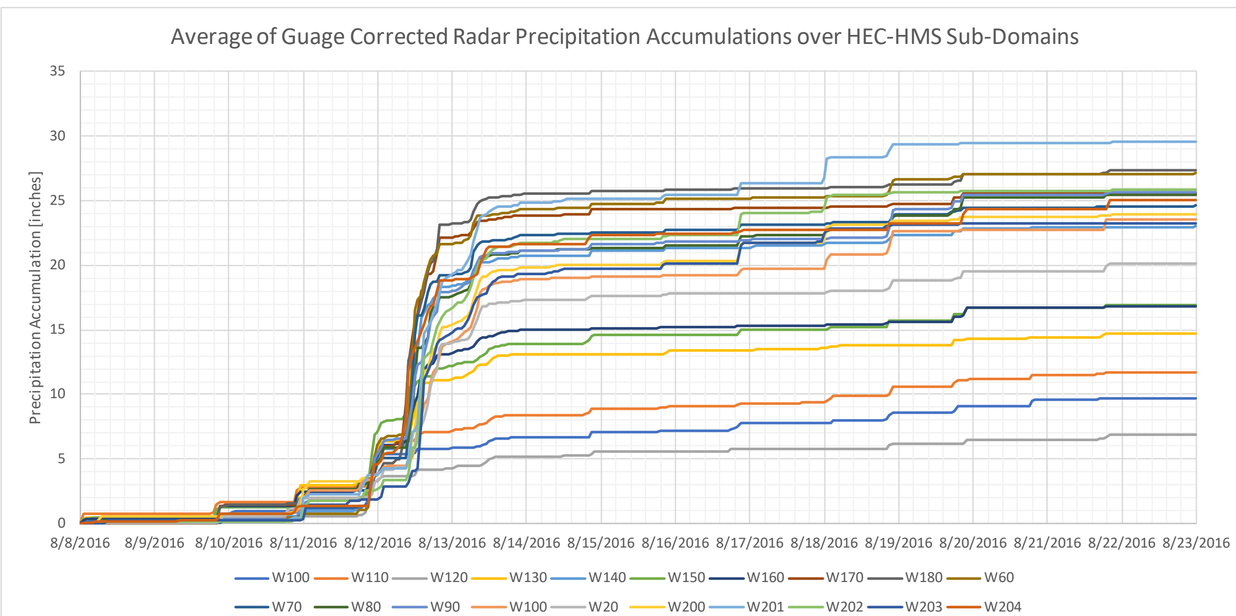


Figure 2-7. August 2016 Rainfall Accumulation Time Series.

2.1.3.2 Hydraulic Model

Figure 2-8 shows the comparison of the cumulative average rainfall for the full domain versus each sub domain from March 6, 2016 – March 18, 2016. As shown in the graph, average cumulative depths in the sub domains varied from a total of 6.8 to 8 inches while the average cumulative depth over the full domain totaled approximately 7.4 inches.

Figure 2-5 shows high spatial variability of the cumulative rainfall depths within the full model domain during the August 2016 Flood Event. The HEC-RAS software does not currently allow spatially variable input for precipitation within one 2-D domain. Therefore, the full domain was separated into sub-domains to account for this variability. Due to instabilities at the sub-domain boundaries, the full domain was used for the Phase I Model. In order to compare the difference between the average rainfall depth over the full domain to the spatially varying rainfall depth, the average of the rainfall depths within the full model domain and sub-domains were calculated and hourly rainfall time series produced.

Figure 2-9 shows the time series from August 8, 2016 – August 23, 2016. The average cumulative depths in the sub-domains varied from totals of 19 to 29 inches while the average cumulative depth over the full domain totaled 24.5 inches.

As a result of using the full domain, the southern portions of the model area receive an excess rainfall of 5.5 inches while the northern portions receive a deficit. This variability was taken into consideration during the preliminary model calibration.

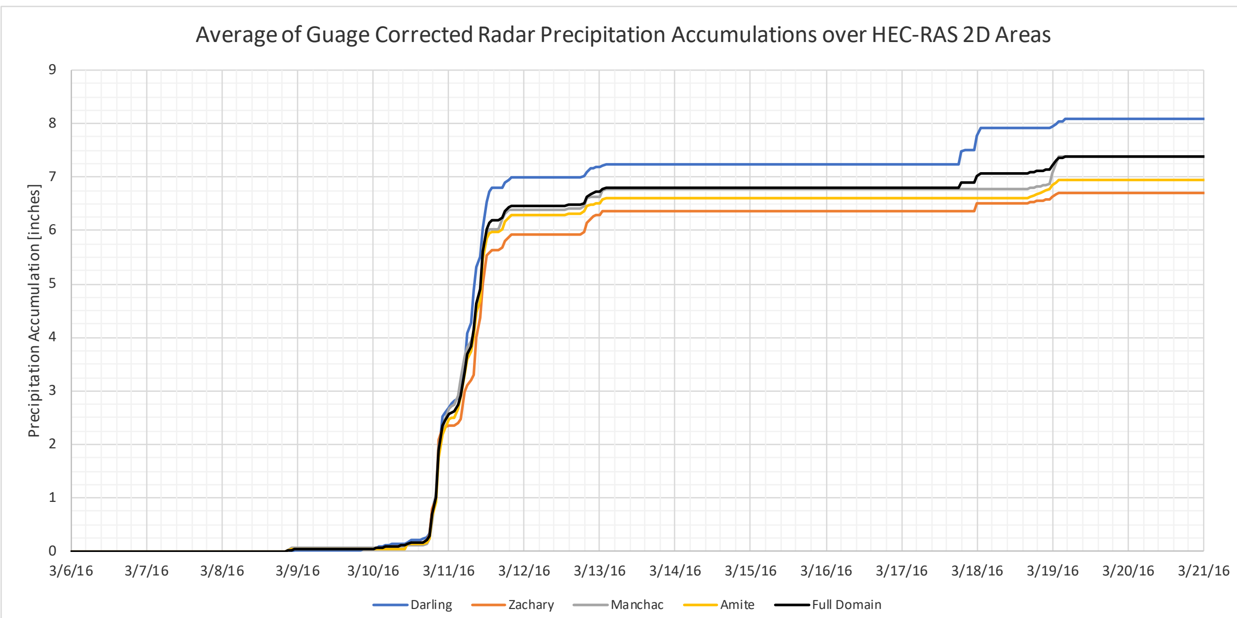


Figure 2-8. March 2016 Rainfall Accumulation Time Series.

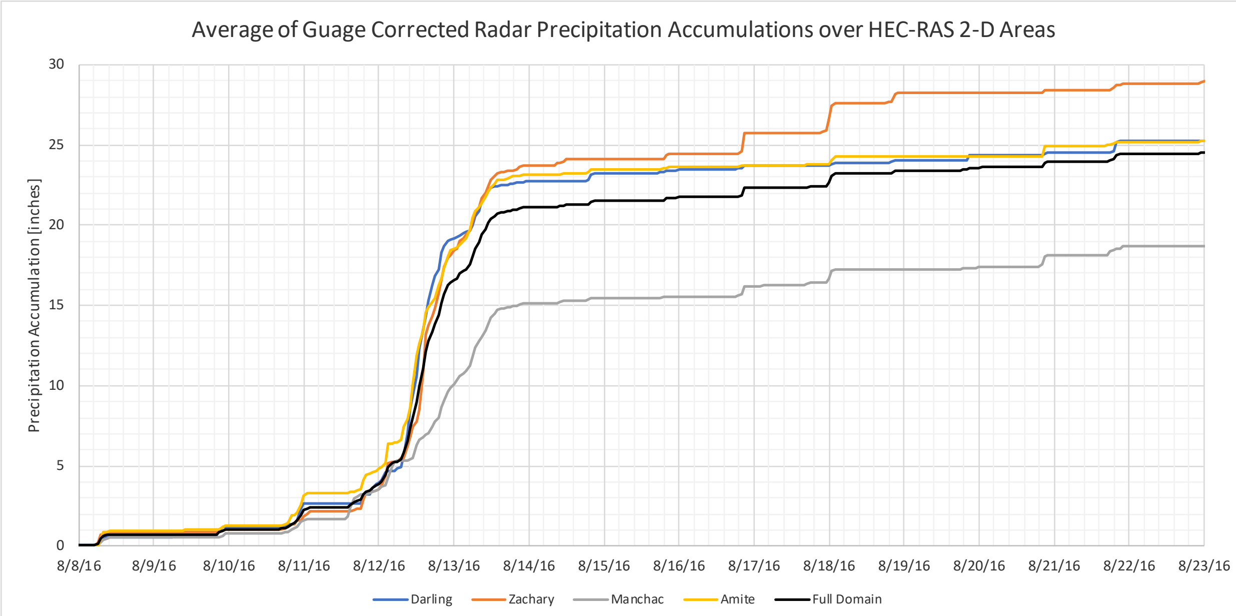


Figure 2-9. April 2016 Rainfall Accumulation Time Series.

2.1.4 Rainfall Runoff Parameters

The Soil Conservation Service (SCS) runoff curve number (CN) and percent impervious were used in the hydrology model to estimate the amount of rainfall runoff from the flood events.

The CN grid was generated from land use and soil data (see Figure 2-10). Land use data was obtained from the Multi-Resolution Land Characteristics (MRLC) Consortium's National Land Cover Database 2011 (NLCD 2011)[2] (see Figure 2-11), and soil data was obtained from the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database[3] (see Figure 2-12).

Percent impervious is the percentage of surface area which is impervious and does not allow water to seep through. Percent impervious data were obtained from the Multi-Resolution Land Characteristics (MRLC) Consortium's National Land Cover Database 2011 (NLCD 2011)[2] (see Figure 2-13).

[2] https://www.mrlc.gov/nlcd2011.php
[3] https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/

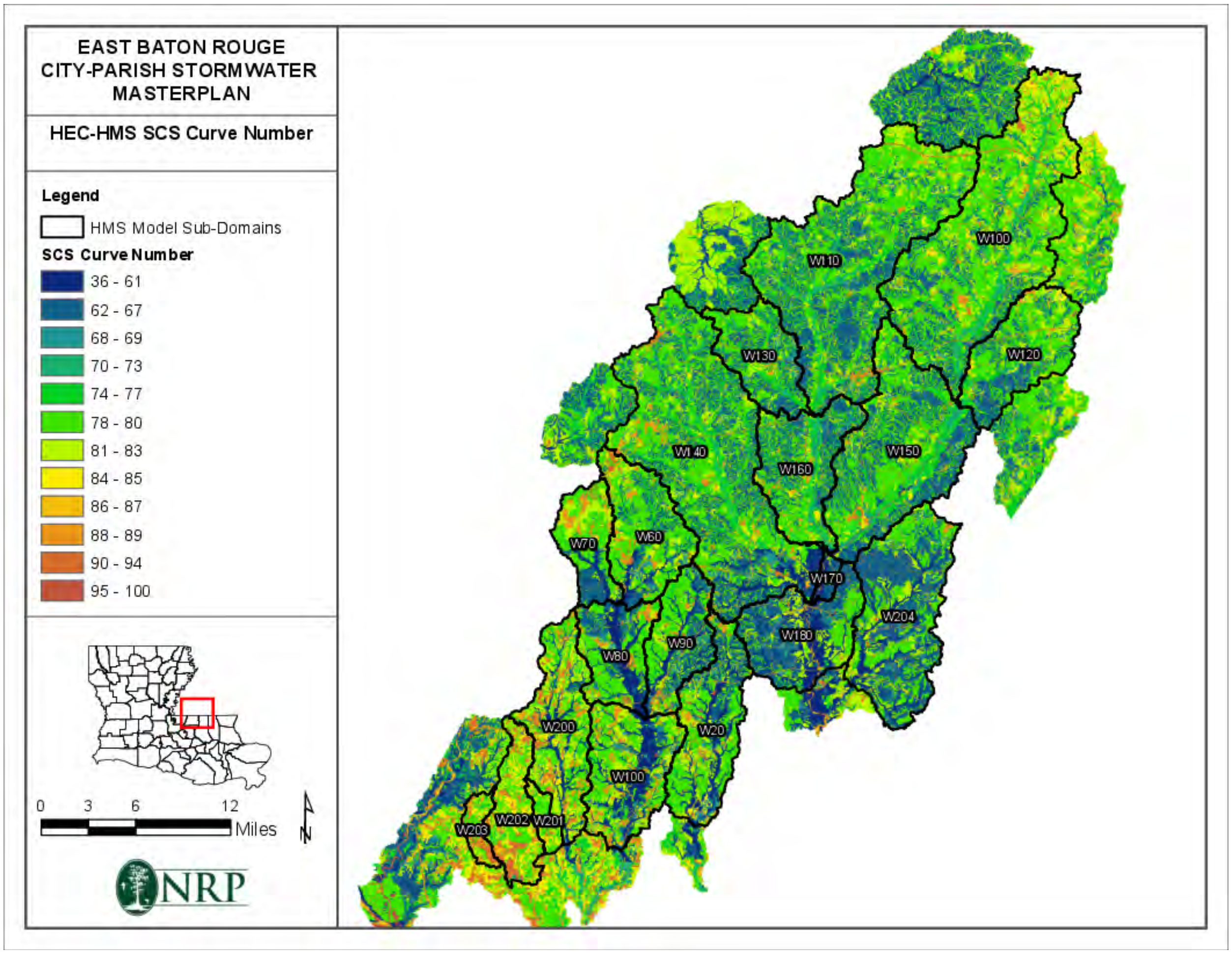


Figure 2-10. HEC-HMS Model curve number grid.

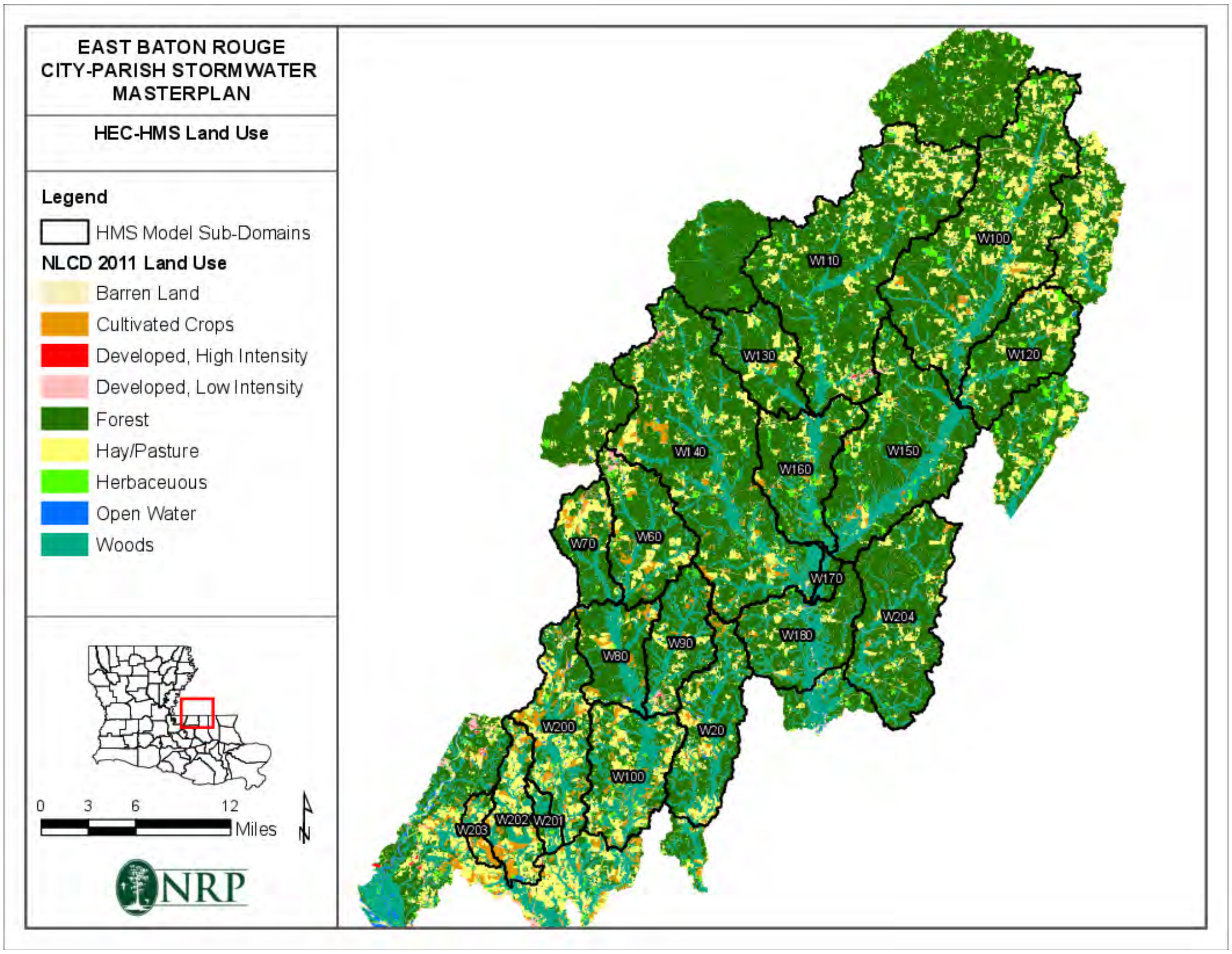


Figure 2-11. HEC-HMS Model Land Use.

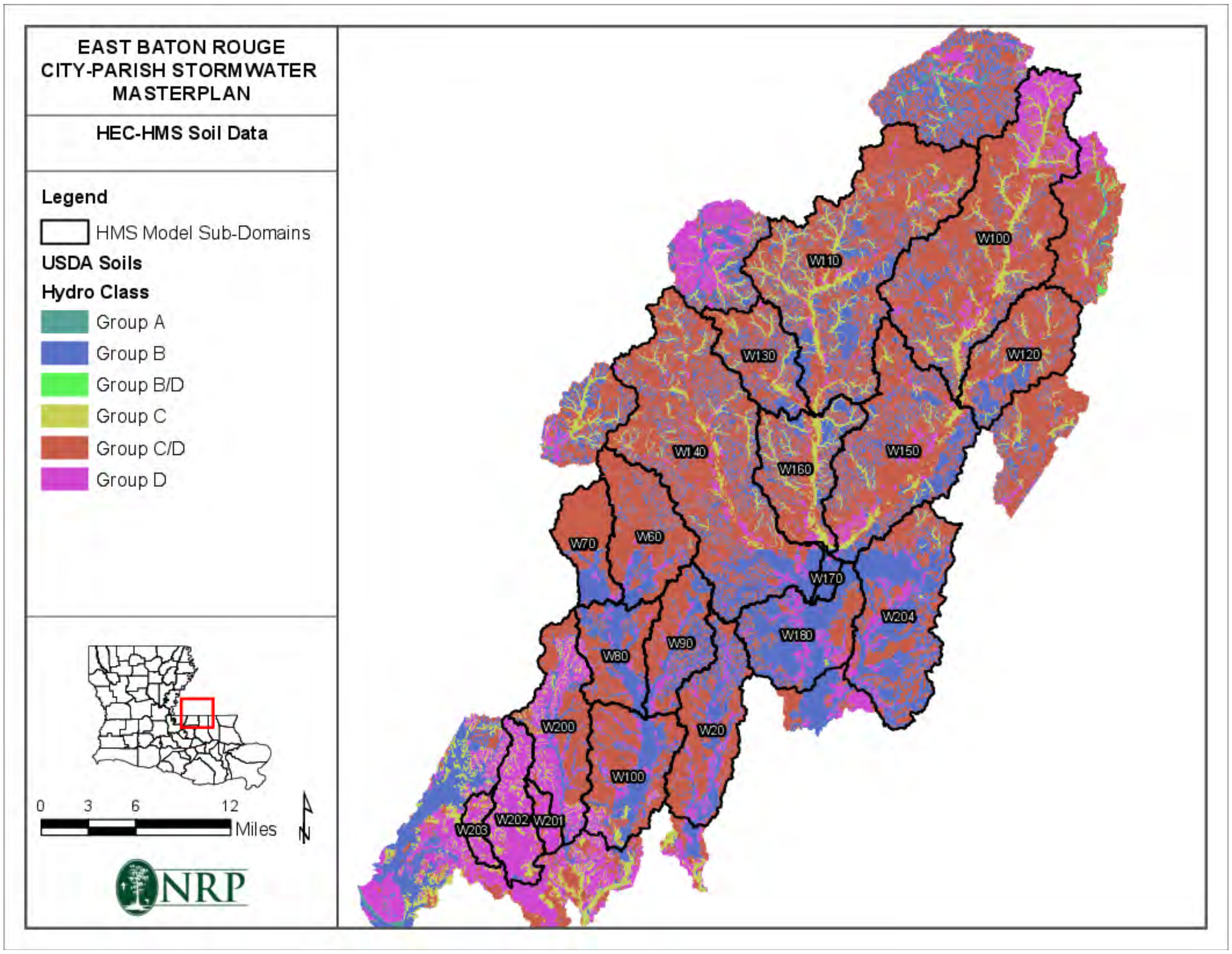


Figure 2-12. HEC-HMS Model soil data.

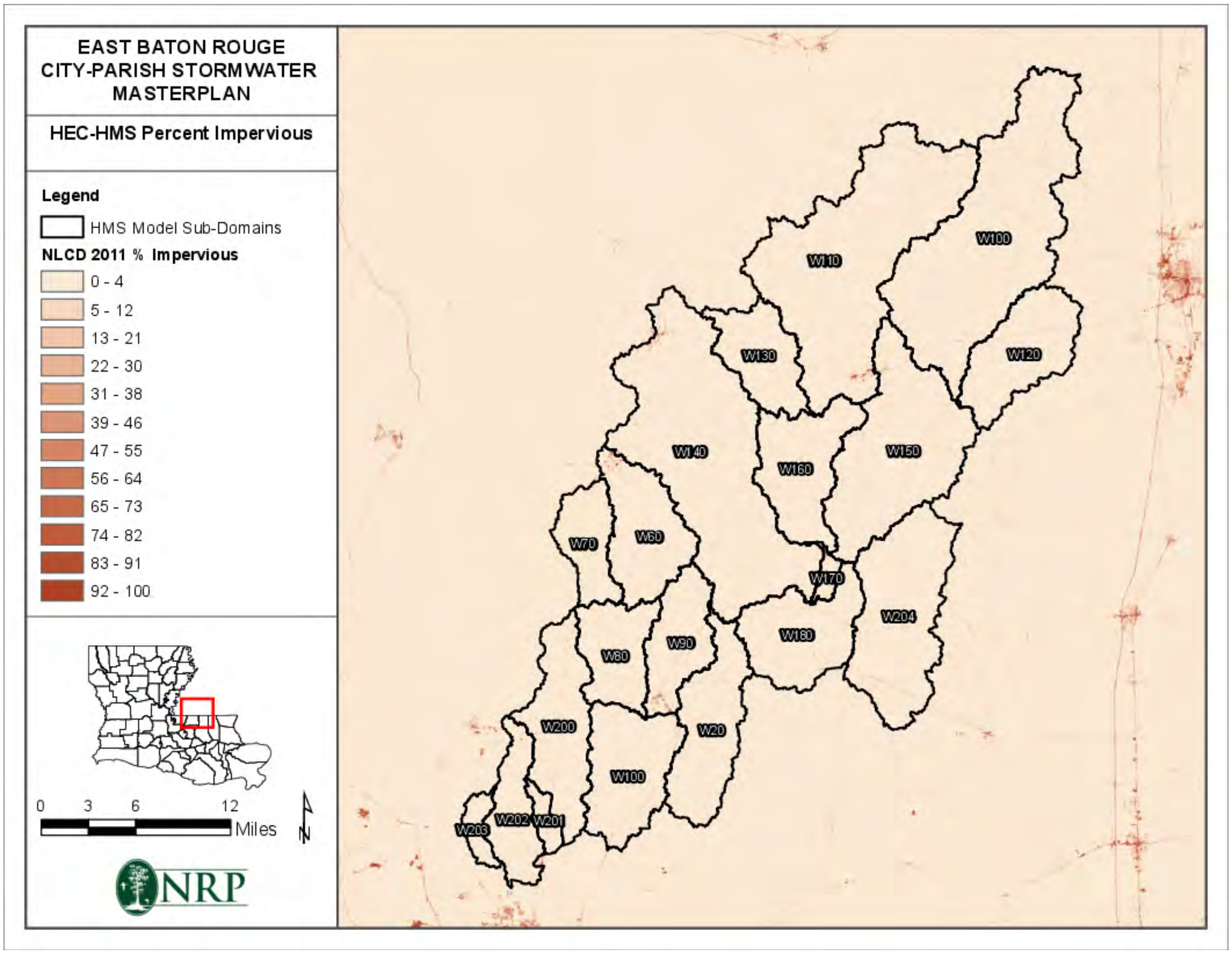


Figure 2-13. HEC-HMS Model percent impervious data.

2.1.5 Roughness

Roughness determines how fast or slow water moves over the surface. Initial roughness values, represented as Manning n values, were determined based on land use/land cover and channel roughness values used in the 2012 East Baton Rouge Parish Flood Insurance Study. Figure 2-14 displays the land use/land cover manning n values for the hydraulic model. Table 2-1 presents the initial and final range of n values for various land use/land cover types.

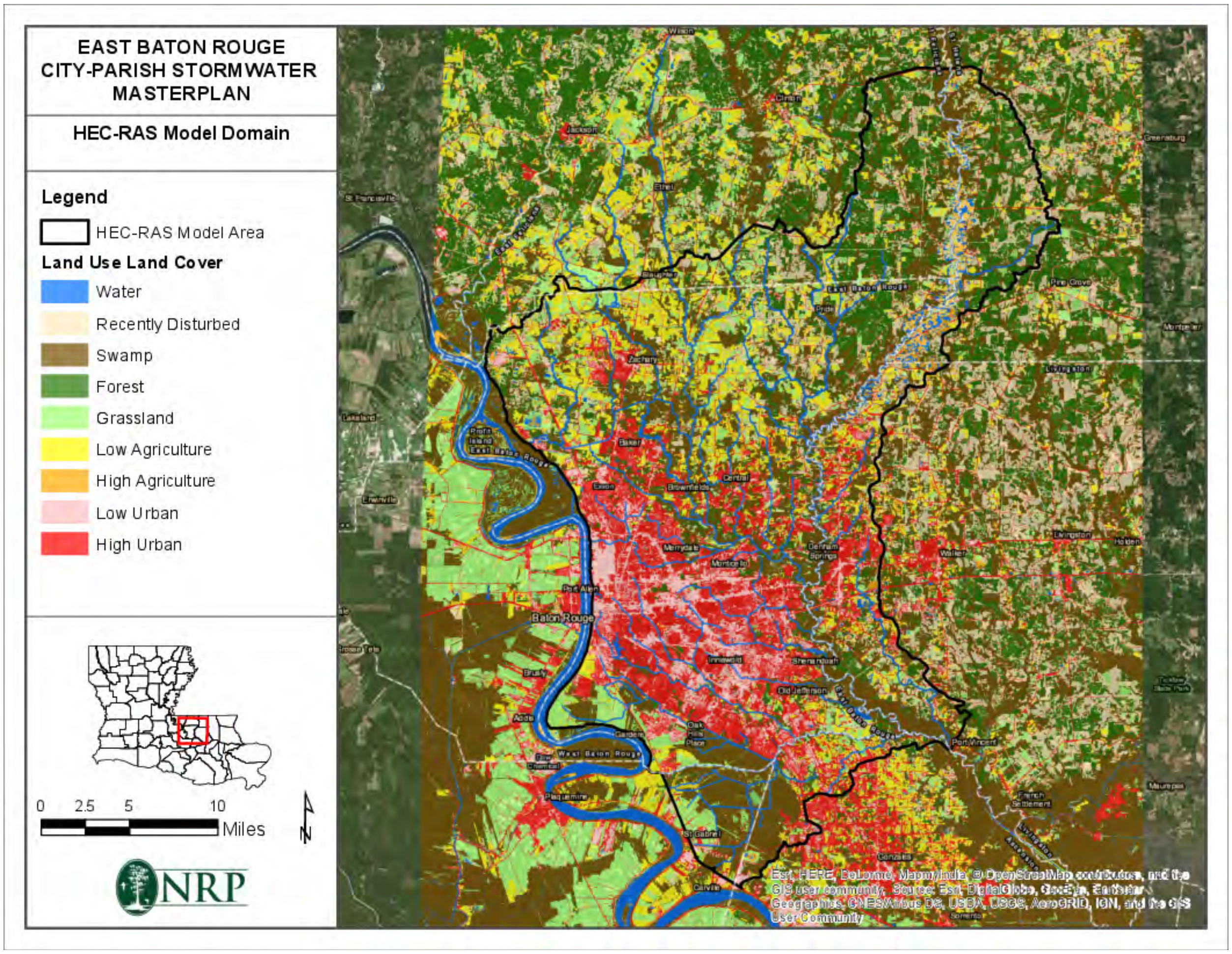


Figure 2-14. HEC-RAS Model Land Cover.

Table 2-1. Initial and Preliminary Calibrated Manning's n values

Land Use Land Cover	Initial n Value	Preliminary Calibrated n Value Ranges		
Open Water	0.022	0.022	-	0.022
Bayous, Creeks, Rivers	0.022	0.012	-	0.050
Recently Disturbed	0.070	0.070	-	0.070
Swamp	0.140	0.140	-	0.140
Grassland	0.035	0.035	-	0.035
Low Agriculture	0.033	0.050	-	0.070
High Agriculture	0.040	0.040	-	0.040
Low Urban	0.050	0.050	-	0.050
High Urban	0.120	0.120	-	0.120

3 HYDROLOGY MODEL DEVELOPMENT

Excess rainfall runoff from areas upstream of the 2-D Hydraulic Model were estimated using the HEC-HMS hydrology software. Areas modeled include the Upper Amite River, Darling Creek, Sandy Creek, Comite River, Redwood Creek, Doyle Bayou, Copper Mill Bayou, and White Bayou. Figure 3-1 identifies these model domains and resultant outflow locations input into the 2-D HEC-RAS Model.

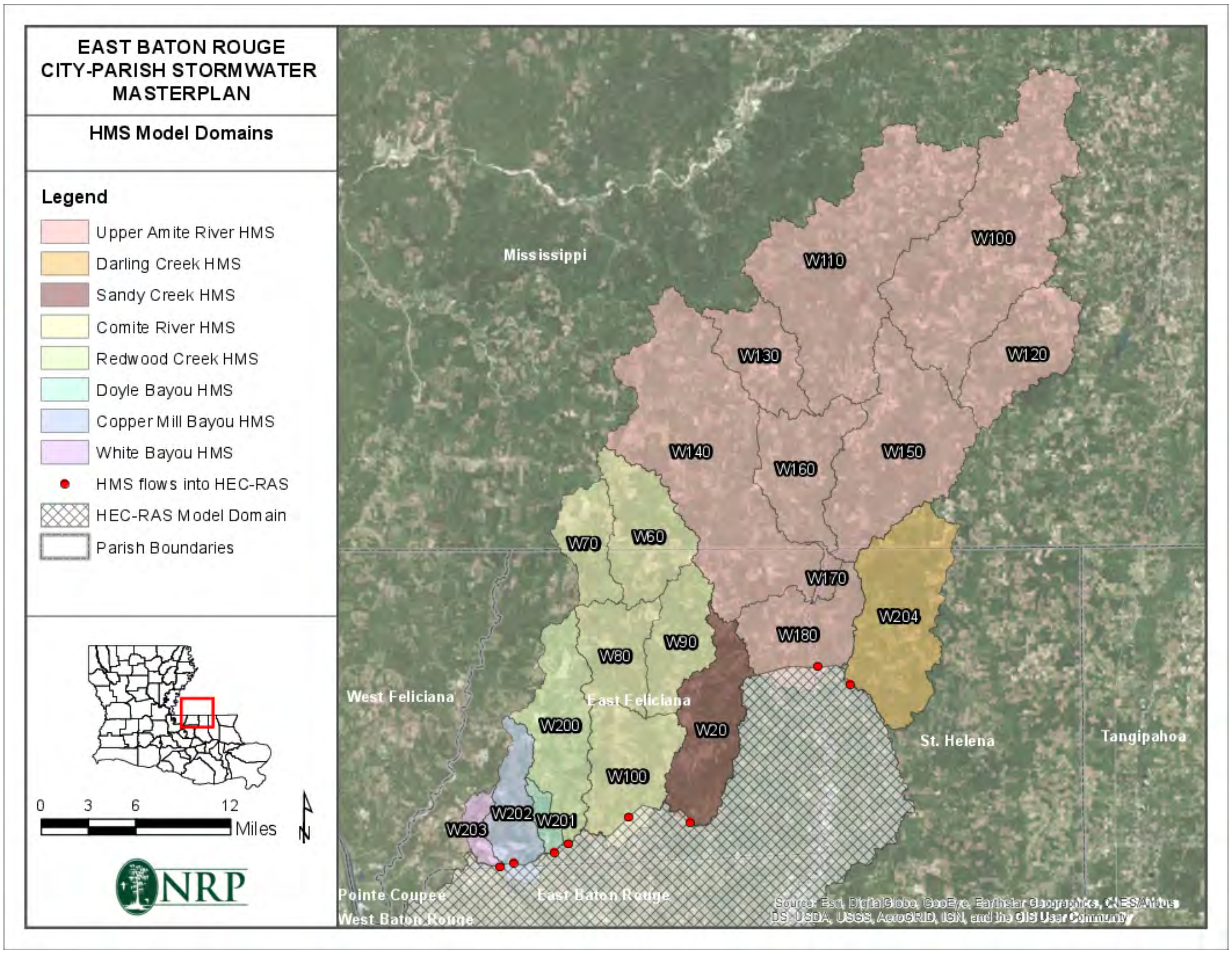


Figure 3-1. HEC-HMS Model Domains

3.1 MODEL SETUP

Model subbasin delineations and parameters were generated using the HEC-GeoHMS. Initially the Soil Conservation Service (SCS) Curve Number Loss Method and Kinematic Wave Transform Method and Muskingum-Cunge Routing Method were used.

3.1.1 Upper Amite River

The Upper Amite River HMS model covers the Amite River Basin north of Highway 10 near Darlington, LA. Figure 3-2 shows the delineated subbasins and respective channel reaches.

Table 3-1, Table 3-2, and Table 3-3 identify subbasins' area, loss, flow plane, main channel, collector channel, and sub-collector channel parameters.

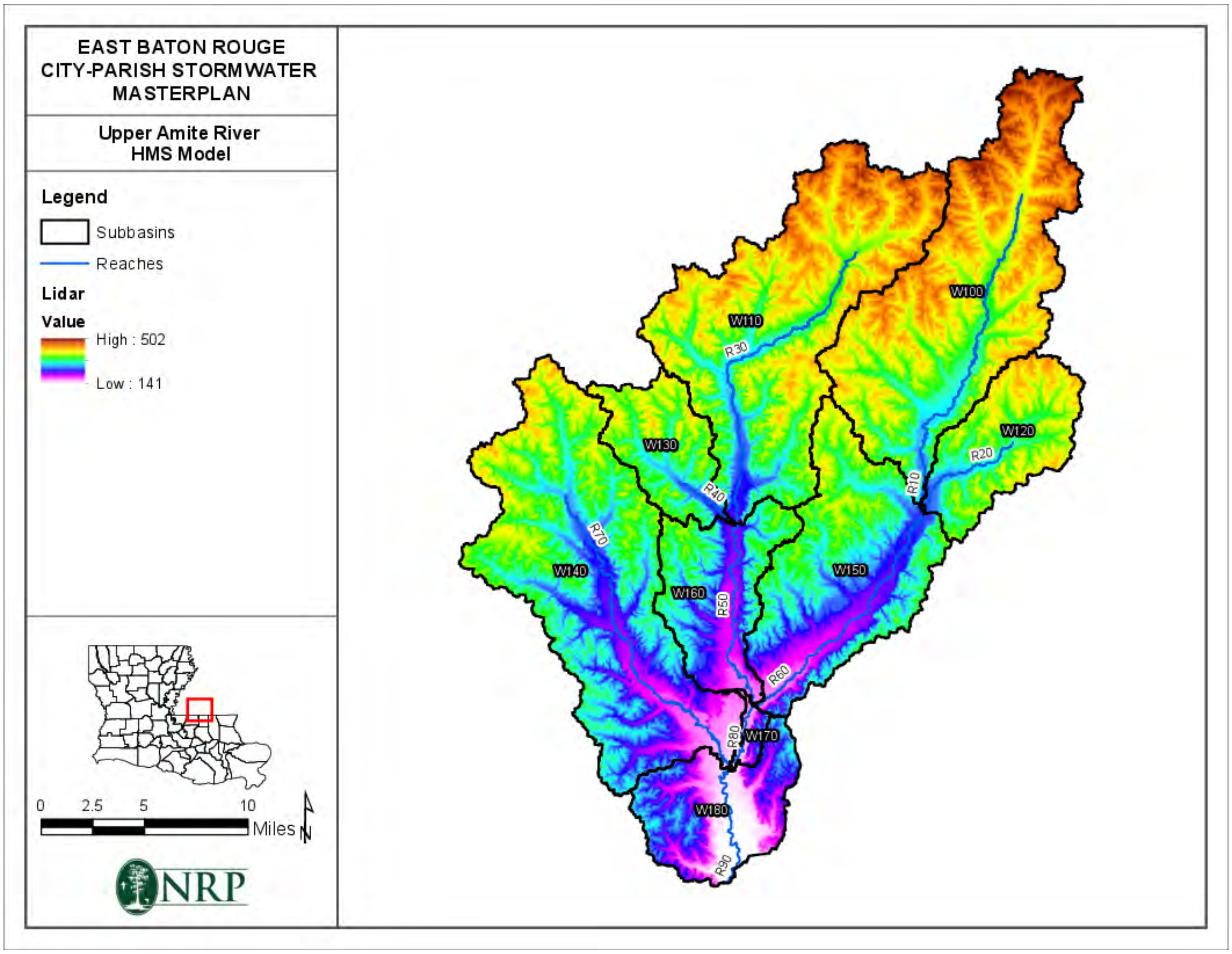


Figure 3-2. Upper Amite River HMS Model

Table 3-1. Upper Amite River HMS Area, Loss, and Flow Plane Parameters

Subbasin	Basin				Flow Plane		
	Area (Sq mi)	Initial Abstraction (in)	Curve Number	Impervious (%)	Length (ft)	Slope (ft/ft)	n
W180	39.3	0.85	77.3	34%	100	0.037	0.15
W170	3.6	0.99	73.5	13%	100	0.005	0.15
W160	39.8	0.69	81.9	33%	100	0.003	0.15
W150	77.1	0.68	82.0	35%	100	0.004	0.15
W140	128.4	0.68	82.2	43%	100	0.002	0.15
W130	28.8	0.69	81.9	28%	100	0.002	0.15
W120	38.7	0.64	83.2	36%	100	0.003	0.15
W110	122.5	0.66	82.6	54%	100	0.008	0.15
W100	120.0	0.58	85.4	45%	100	0.002	0.15

Table 3-2. Upper Amite River HMS Main Channel and Reach Parameters

Subbasin / Reach	Route Method	Length (ft)	Slope (ft/ft)	Shape	n	LB n / Width (ft)	RB n / Side Slope (xH:1V)	X-Sec
W180	Musk-Cunge	27,906	0.001	Eight Point	0.08	0.1	0.1	Amite_R90
W170	Musk-Cunge	21,116	0.001	Eight Point	0.08	0.1	0.1	Amite_R80
W160	Musk-Cunge	69,067	0.001	Eight Point	0.08	0.1	0.1	Amite_R50
W150	Musk-Cunge	96,034	0.001	Eight Point	0.08	0.1	0.1	Amite_R60
W140	Musk-Cunge	140,625	0.001	Eight Point	0.08	0.1	0.1	Amite_W140
W130	Musk-Cunge	27,629	0.001	Trapezoid	0.06	1000	36	--
W120	Musk-Cunge	45,823	0.001	Trapezoid	0.06	1000	200	--
W110	Musk-Cunge	133,301	0.001	Trapezoid	0.06	2000	42	--
W100	Musk-Cunge	135,547	0.001	Trapezoid	0.06	2500	200	--
R50	Musk-Cunge	81,310	0.0008	Eight Point	0.06	0.08	0.08	Amite_R50
R60	Musk-Cunge	99,027	0.0008	Eight Point	0.06	0.08	0.08	Amite_R60
R80	Musk-Cunge	24,534	0.0007	Eight Point	0.06	0.08	0.08	Amite_R80
R90	Musk-Cunge	45,710	0.0007	Eight Point	0.06	0.08	0.08	Amite_R90

Table 3-3. Upper Amite River HMS SubCollector and Collector Channel Parameters

Subbasin	Collector	Length (ft)	Slope (ft/ft)	n	Area (Sqmi)	Shape	Width (ft)	Side Slope (xH:1V)
W180	Sub	3,000	0.004	0.08	0.1	Trapezoid	50	1
W180	Collector	39,189	0.004	0.08	4.8	Trapezoid	800	10
W170	Sub	3,000	0.002	0.08	0.1	Trapezoid	50	1
W170	Collector	13,437	0.002	0.08	0.4	Trapezoid	100	10
W160	Sub	3,000	0.005	0.08	0.7	Triangle	--	20
W160	Collector	29,839	0.005	0.08	4.6	Triangle	--	20
W150	Sub	3,000	0.003	0.08	1.0	Trapezoid	250	1
W150	Collector	66,477	0.003	0.08	7.5	Trapezoid	500	30
W140	Sub	3,000	0.003	0.08	0.7	Triangle	--	20
W140	Collector	50,342	0.003	0.08	7.1	Trapezoid	500	20
W130	Sub	3,000	0.003	0.08	0.2	Triangle	--	20
W130	Collector	46,960	0.003	0.08	2.5	Triangle	--	20
W120	Sub	3,000	0.004	0.08	0.2	Triangle	--	20
W120	Collector	32,929	0.004	0.08	3.0	Triangle	--	20
W110	Sub	3,000	0.002	0.08	1.5	Triangle	--	20
W110	Collector	46,972	0.002	0.08	10.0	Triangle	--	20
W100	Sub	3,000	0.002	0.08	1.8	Triangle	--	1000
W100	Collector	53,019	0.002	0.08	7.5	Triangle	--	1000

3.1.2 Comite River

The Comite River HMS model covers the Comite River Basin north of Highway 67 near Olive Branch, LA. Figure 3-3 shows the delineated subbasins and respective channel reaches. Table 3-4,

Table 3-5, and Table 3-6 identify subbasins' area, loss, flow plane, main channel, collector channel, and sub-collector channel parameters.

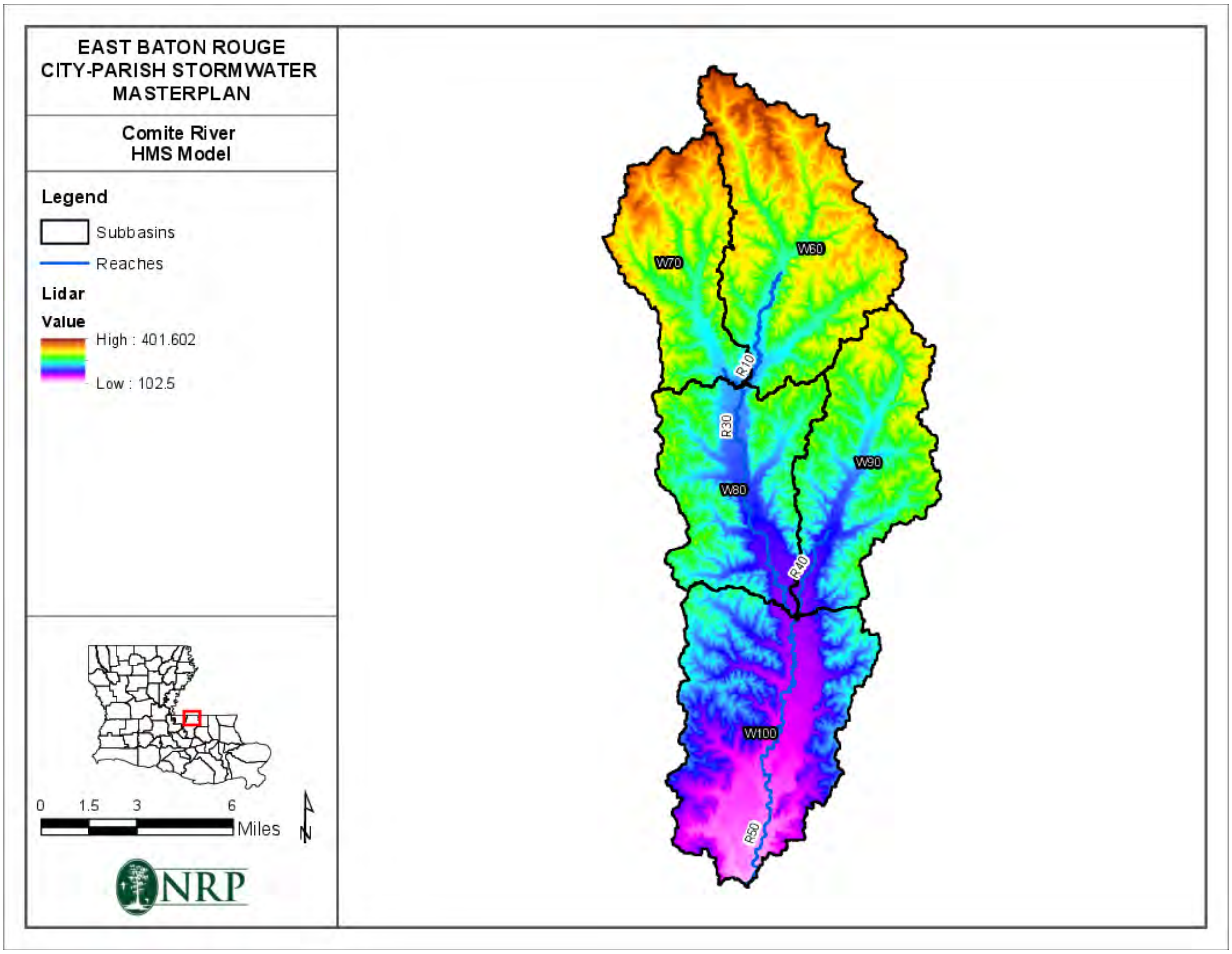


Figure 3-3. Comite River HMS Model

Table 3-4. Comite River HMS Area, Loss, and Flow Plane Parameters

Subbasin	Basin				Flow Plane		
	Area (Sq mi)	Initial Abstraction (in)	Curve Number	Impervious (%)	Length (ft)	Slope (ft/ft)	n
W100	41.3	0.66	82.7	37%	100	0.019	0.10
W90	28.5	0.71	81.1	87%	100	0.009	0.10
W80	27.7	0.74	80.2	14%	100	0.018	0.10
W70	21.8	0.60	84.6	38%	100	0.001	0.10
W60	38.0	0.61	84.2	57%	100	0.002	0.10

Table 3-5. Comite River HMS Main Channel and Reach Parameters

Sub-basin	Route Method	Length (ft)	Slope (ft/ft)	Shape	n	LB n / Width (ft)	RB n / Side Slope (xH:1V)	X-Sec
W100	Musk-Cunge	72,782	0.001	Eight Point	0.11	0.1	0.11	Comite_R50_2
W90	Musk-Cunge	52,497	0.001	Eight Point	0.08	0.08	0.08	Comite_W90
W80	Musk-Cunge	63,553	0.001	Eight Point	0.08	0.1	0.1	Comite_R30_2
W70	Musk-Cunge	53,557	0.002	Eight Point	0.08	0.08	0.08	Comite_W70
W60	Musk-Cunge	68,188	0.002	Eight Point	0.08	0.08	0.08	Comite_W60
R30	Musk-Cunge	67,777	0.0012	Eight Point	0.08	0.10	0.10	Comite_R30_2
R50	Musk-Cunge	69,338	0.0012	Eight Point	0.10	0.11	0.11	Comite_R50_2

Table 3-6. Comite River HMS SubCollector and Collector Channel Parameters

Subbasin	Collector	Length (ft)	Slope (ft/ft)	n	Area (Sqmi)	Shape	Width (ft)	Side Slope (xH:1V)
W100	Sub	3,000	0.005	0.06	0.3	Triangle	--	15
W100	Collector	12,683	0.005	0.06	3.0	Trapezoid	700	15
W90	Sub	3,000	0.005	0.06	0.3	Triangle	--	20
W90	Collector	20,932	0.005	0.06	2.3	Trapezoid	600	20
W80	Sub	3,000	0.009	0.06	0.5	Triangle	--	40
W80	Collector	7,355	0.009	0.06	2.3	Trapezoid	1000	40
W70	Sub	3,000	0.007	0.06	0.5	Triangle	--	50
W70	Collector	10,143	0.007	0.06	2.7	Triangle	--	50
W60	Sub	3,000	0.007	0.06	0.5	Triangle	--	20
W60	Collector	9,079	0.007	0.06	5.6	Trapezoid	500	20

3.1.3 Other Creeks and Bayous

The Darling Creek and Sandy Creek models neighbor and are more similar in composition to the Upper Amite River model (see Figure 3-4). Since no data was available for preliminary calibration of these creeks, similar processes used in and changes in parameters during preliminary calibration of the Upper Amite River were used.

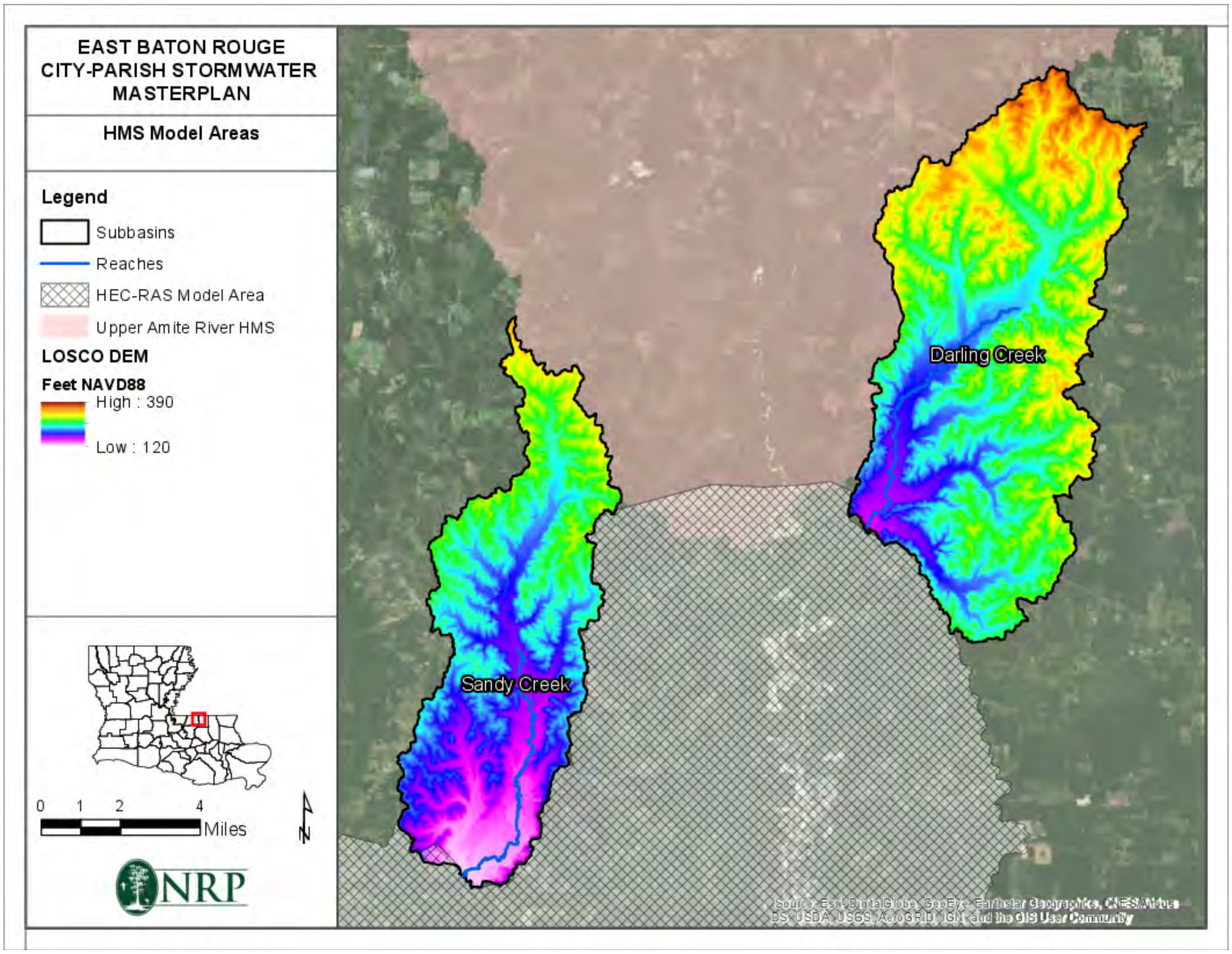


Figure 3-4. Darling and Sandy Creek HMS Models

The Redwood Creek, Doyle Bayou, Copper Mill Bayou, and White Bayous are in closer proximity and more similar in composition to the Comite River model (see Figure 3-5). Since no data was available for preliminary calibration of these bayous, similar processes used in and changes in parameters during preliminary calibration of the Comite River model were used.

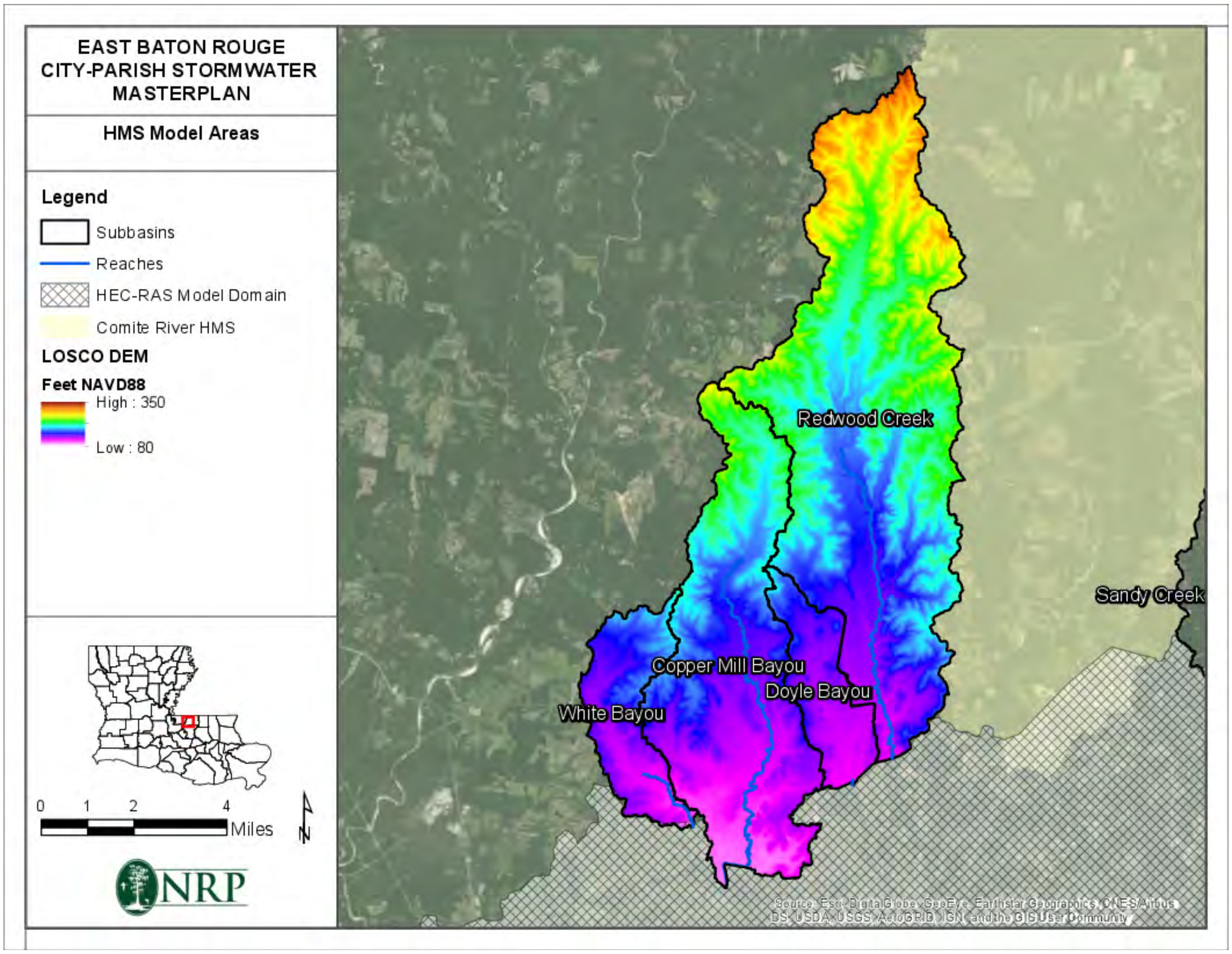


Figure 3-5. Redwood Creek and, Doyle, Copper Mill, and White Bayous HMS Models

3.2 Preliminary Calibration

The Upper Amite River and Comite River HMS models were preliminarily calibrated to measured discharge data collected by the United States Geological Survey (USGS) at the Amite River near Darlington, LA station (07377000) and Comite River near Olive Branch, LA station (07377500), respectively.

Curve numbers were uniformly increased by 10% to generate the lag time decrease and volume of runoff increase needed to replicate the measured data. Manning's roughness values were adjusted to further bring the model results to replicate the measured flows.

3.2.1 Upper Amite River

Figure 3-6 and Figure 3-7 show the preliminary calibration results for the Upper Amite River model during the March and August 2016 Flood Events, respectively. The measured peak flows from the March was approximately 30,000 cubic feet per second (cfs) while the August event was nearly 120,000 cfs. The model replicates the general shape and peak flow for the August event better than the March event. The Upper Amite River model is, therefore, more accurate simulating higher flows and less accurate simulating lower flows. This is acceptable for the application of the Phase I scope of modeling higher flow events.

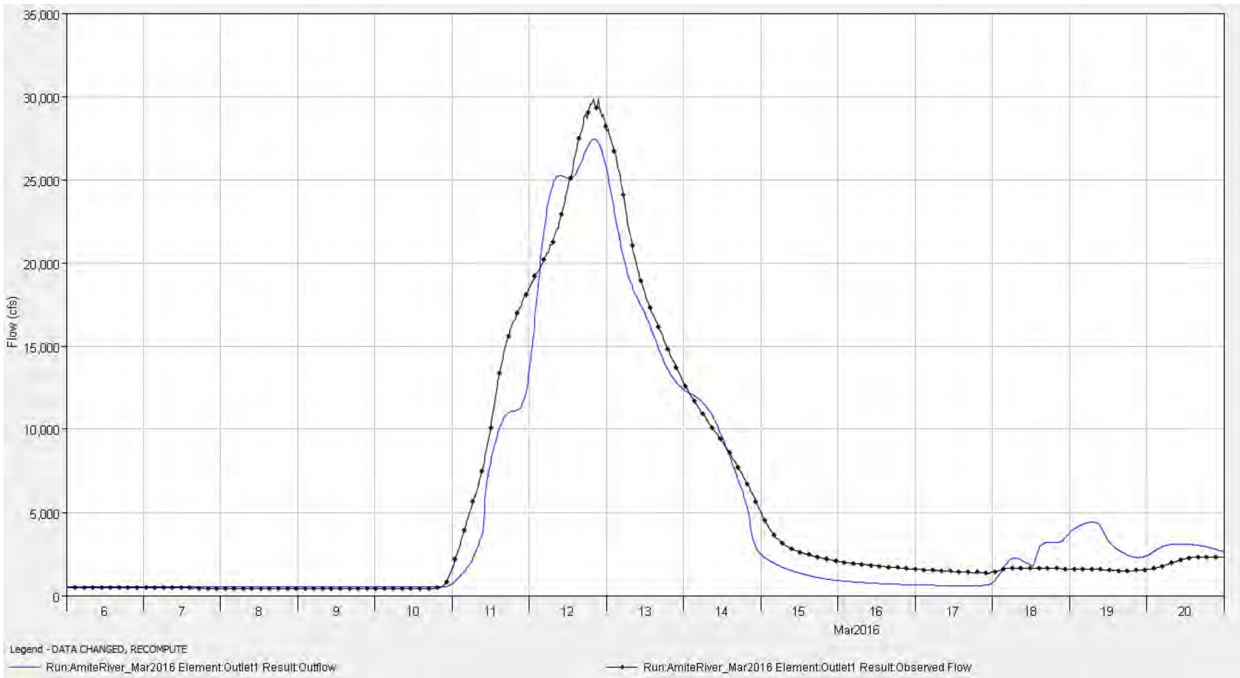


Figure 3-6. March 2016 Discharge Preliminary Calibration result at USGS 07377000 Amite River near Darlington, LA.

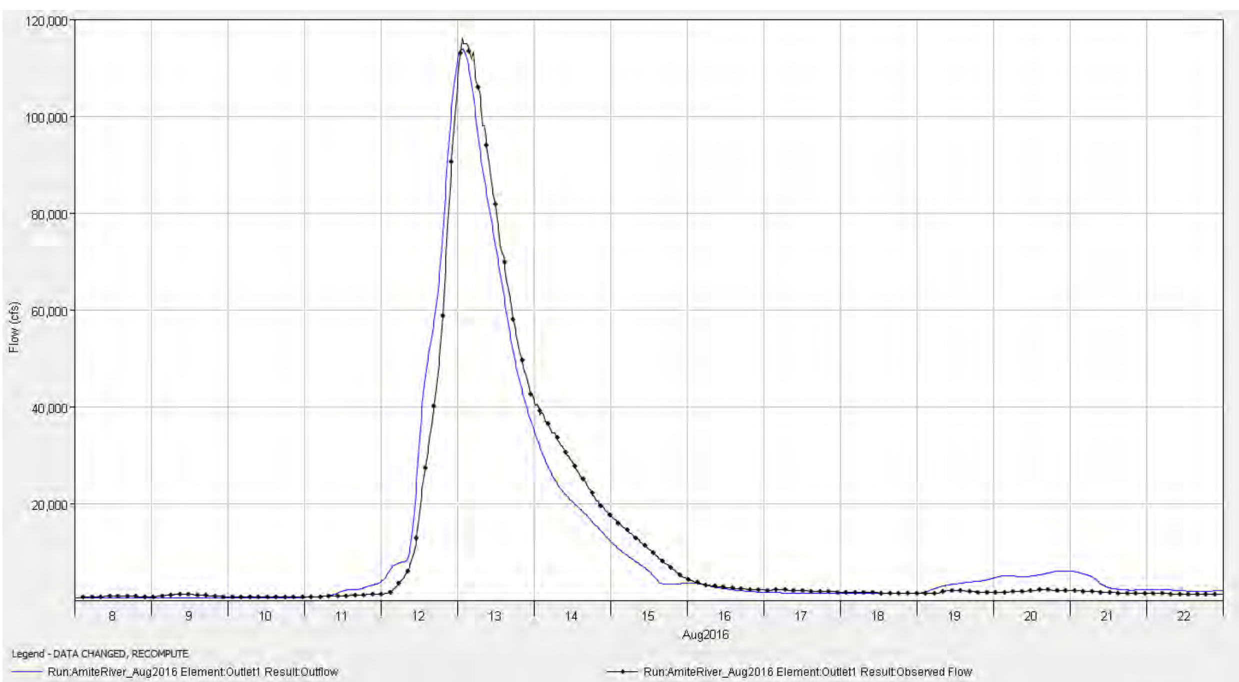


Figure 3-7. August 2016 Discharge Preliminary Calibration result at USGS 07377000 Amite River near Darlington, LA.

3.2.2 Comite River

Figure 3-8 and Figure 3-9 show the preliminary calibration results for the Comite River model during the March and August 2016 events, respectively. The measured peak flows from the March was approximately 11,000 cfs while the August event was approximately 80,000 cfs. The model replicates the rising limb of the hydrograph well, however, it underestimates flows in the falling limb for both the March and August events. The timing of the peak flow for the March event is early while the timing of the peak flow for the August event is accurate. Just as with the Upper Amite River, the Comite River model is more accurate at simulating higher flows and less accurate simulating lower flows. This is acceptable for the application of the Phase I scope of modeling higher flow events.

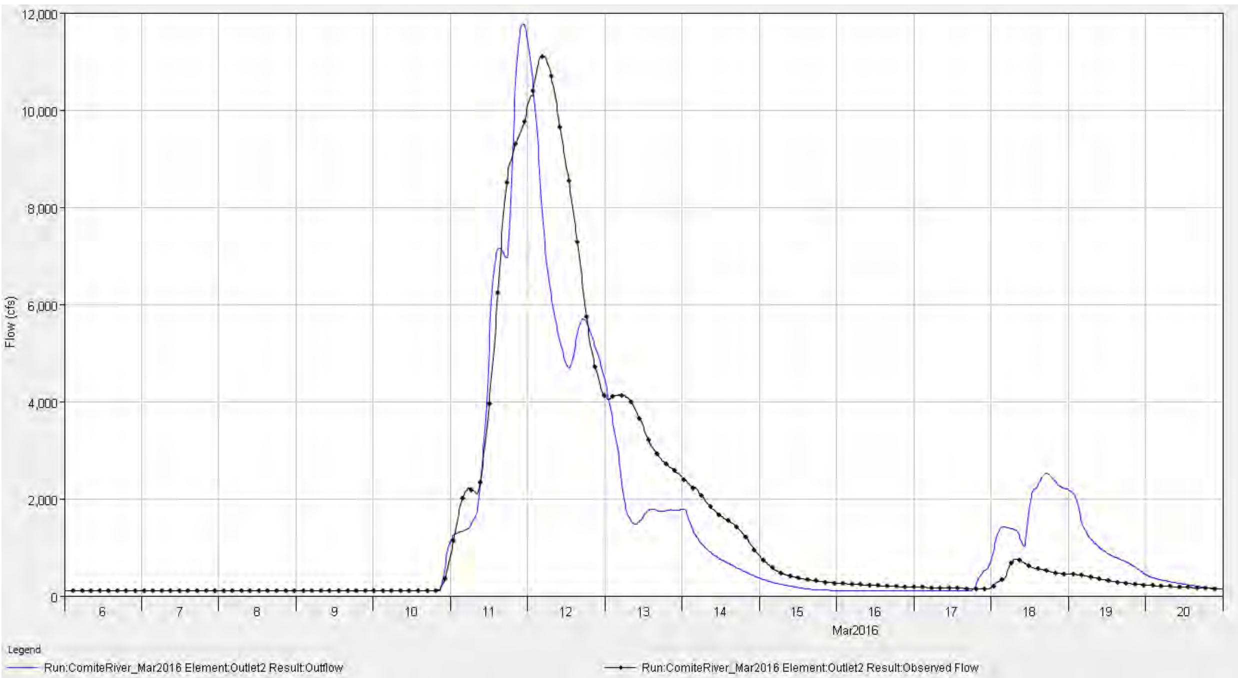


Figure 3-8. March 2016 Discharge Preliminary Calibration result at USGS 07377500 Comite River near Olive Branch, LA.

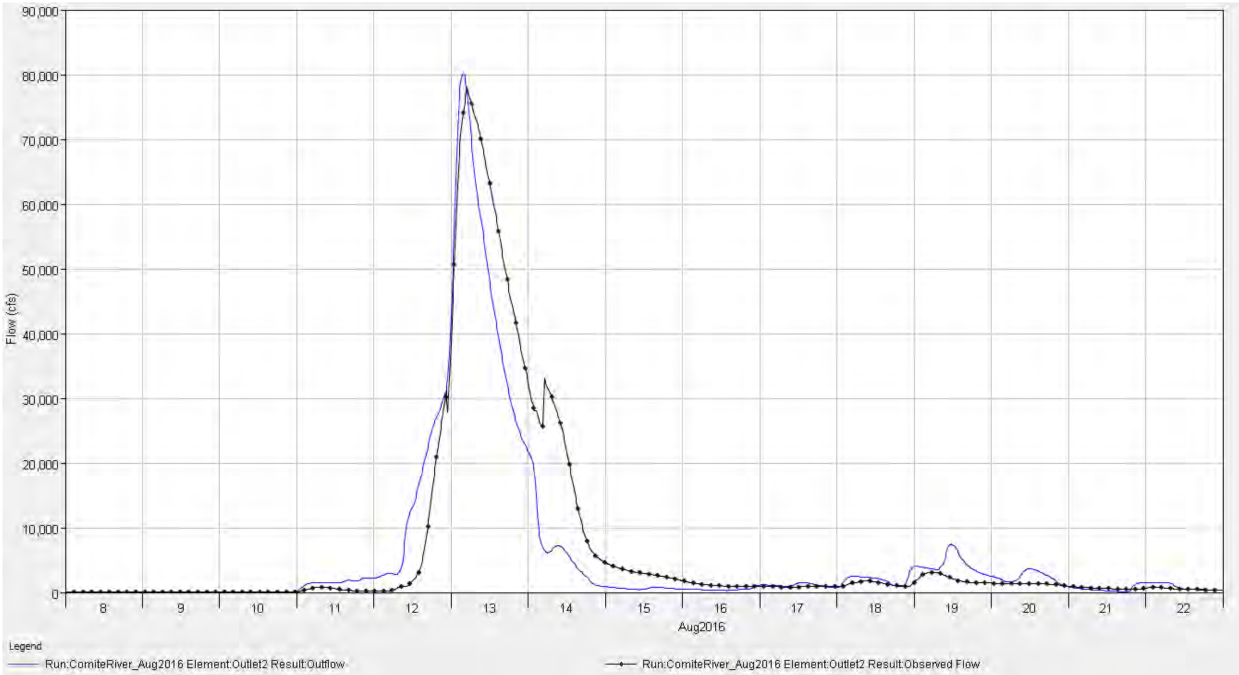


Figure 3-9. August 2016 Discharge Preliminary Calibration result at USGS 07377500 Comite River near Olive Branch, LA.

4 HYDRAULIC MODEL DEVELOPMENT

The hydraulic model was developed using the USACE's HEC-RAS software and encompasses the entirety of East Baton Rouge Parish extending south to the Amite River at Port Vincent and the Spanish Lake and Bluff Swamp basins, east to the ridge separating the Amite and Colyell Creek basins, west to the Mississippi River Levee and north to the outflow boundaries of the HEC-HMS models. Figure 4-1 shows the extent of the HEC-RAS model domain.

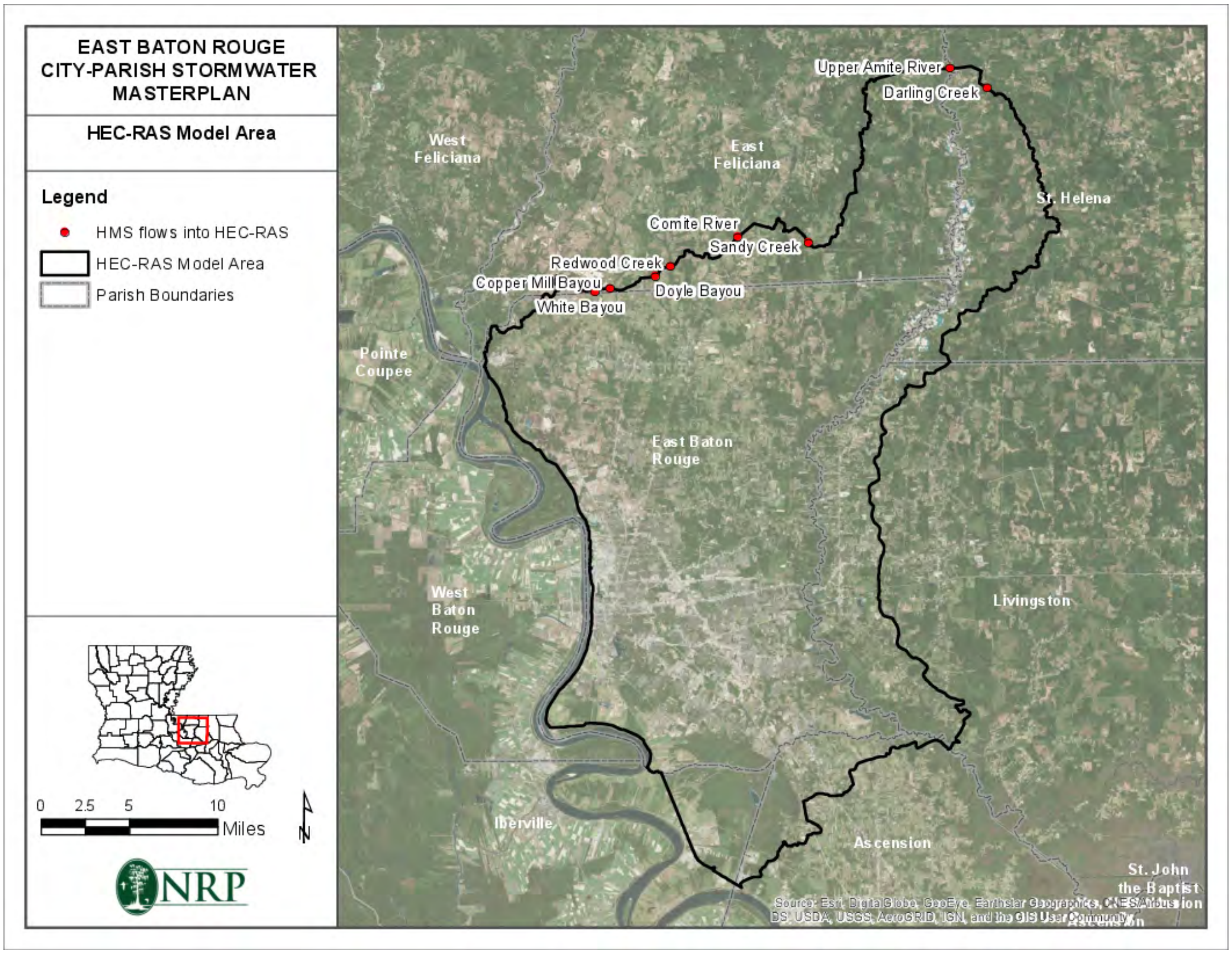


Figure 4-1. HEC-RAS Model Area.

4.1 MODEL GEOMETRY

The 2-D model mesh was generated using HEC-RAS version 5.0.3. The mesh was generated with a resolution of 500 feet by 500 feet with breakline cell spacing ranging from 150 feet to 300 feet. The final mesh contained just over 105,000 computational mesh cells.

4.1.1 Features and Structures

Major features such as natural ridges, highways, railways and roads were included in the model as "breaklines". Breaklines force the model to account for these features and, as a result, calculates flow over them. Structures were added for Interstate-12 and Alligator Bayou Road/Manchac Road to more accurately simulate flow over and through those features. Figure 4-2 displays the location of breaklines and structures in the model area.

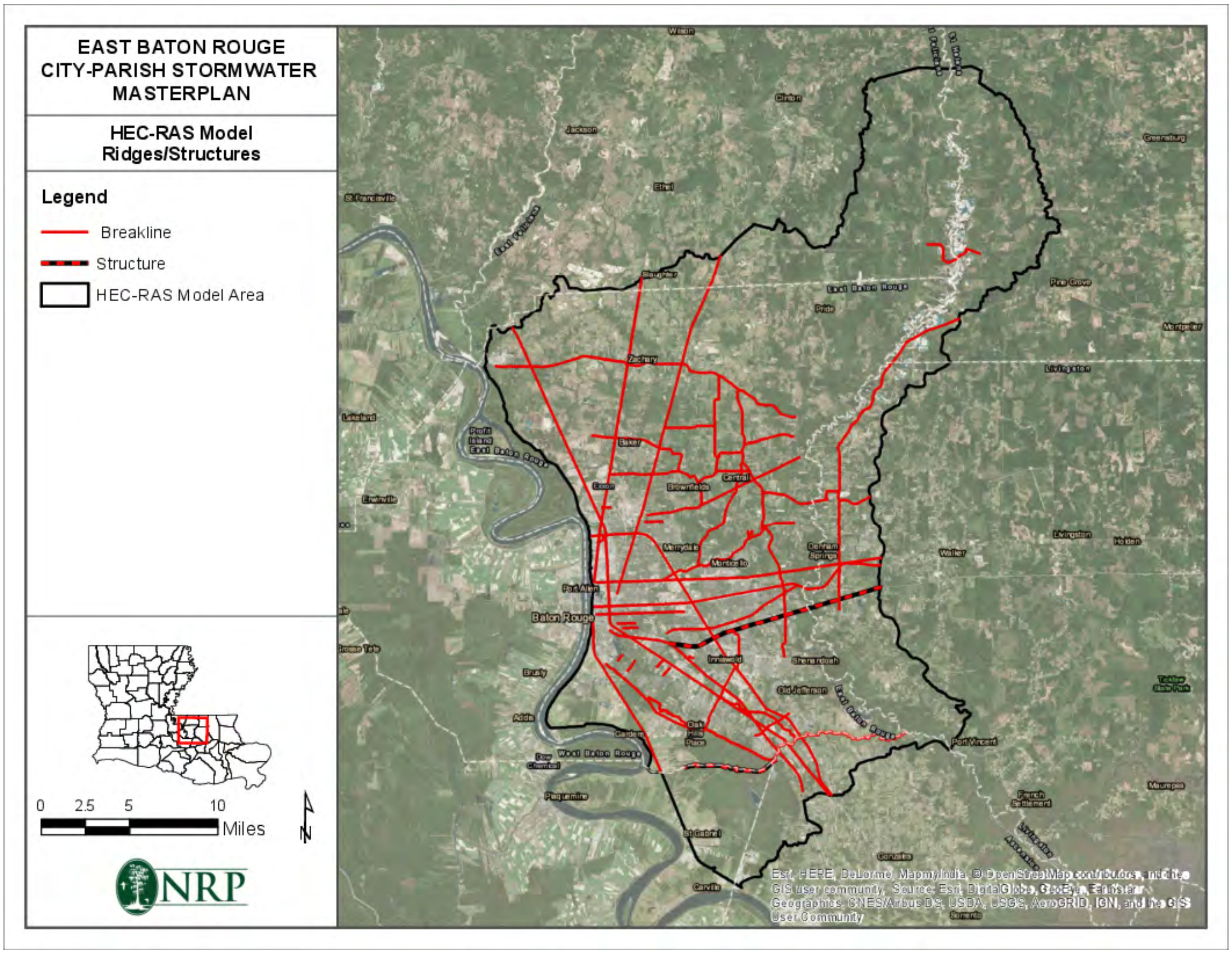


Figure 4-2. HEC-RAS Breaklines and Structures.

4.2 Boundary Conditions

4.2.1 Upland Discharge

Rainfall runoff flows calculated from the HEC-HMS models were included as inflow discharges into the HEC-RAS model as discussed in Section 3. Figure 4-3 and Figure 4-4 show the resultant discharges from the upland areas during the March and August 2016 Flood Events, respectively.

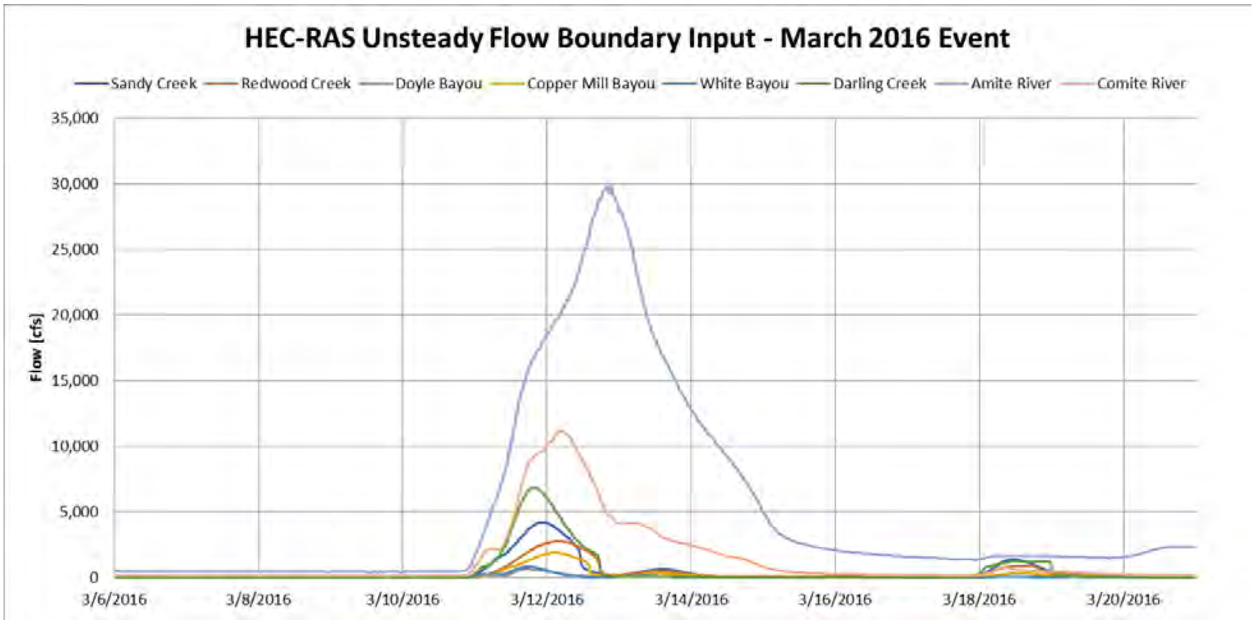


Figure 4-3. March 2016 HEC-RAS Unsteady Flow Boundary Input Time Series.

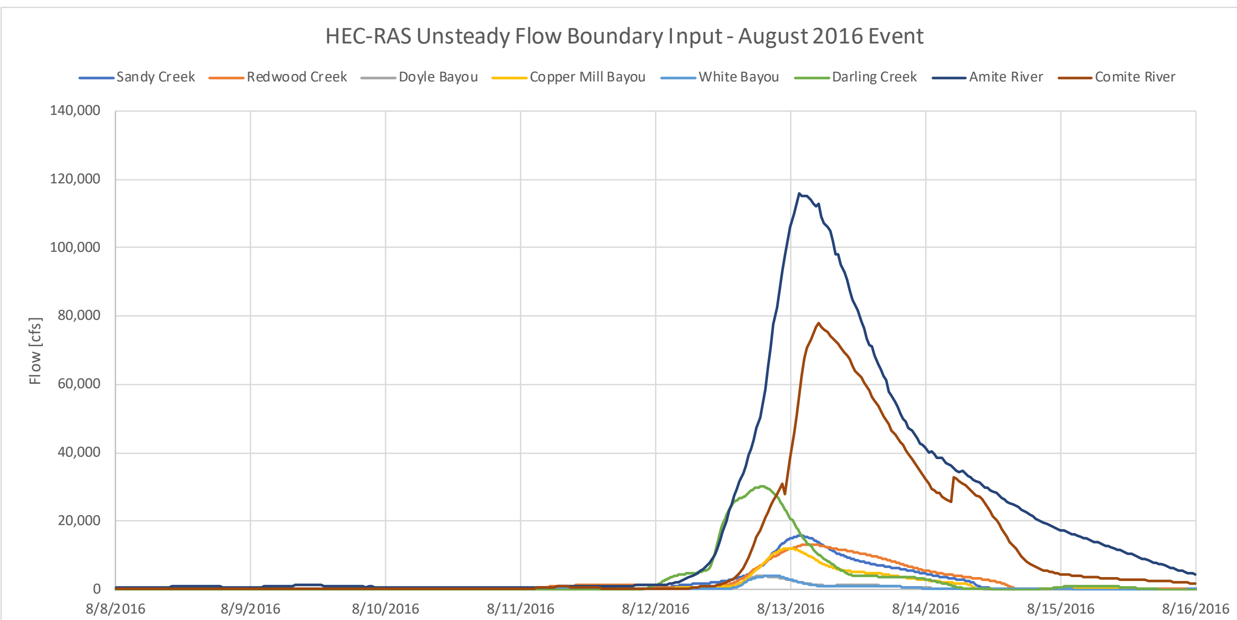


Figure 4-4. August 2016 HEC-RAS Unsteady Flow Boundary Input Time Series.

4.2.2 Water Level

A downstream water level boundary was created for the Amite River at Port Vincent. Measured water levels from the USGS Amite River at Port Vincent, LA station (07380120) were input at this location of the model for the March and August 2016 Flood Events. Figure 4-5 and Figure 4-6 show these water level time series, respectively. Water levels at Port Vincent peaked at nearly 10 feet during the March event and nearly 16.5 feet during the August event.

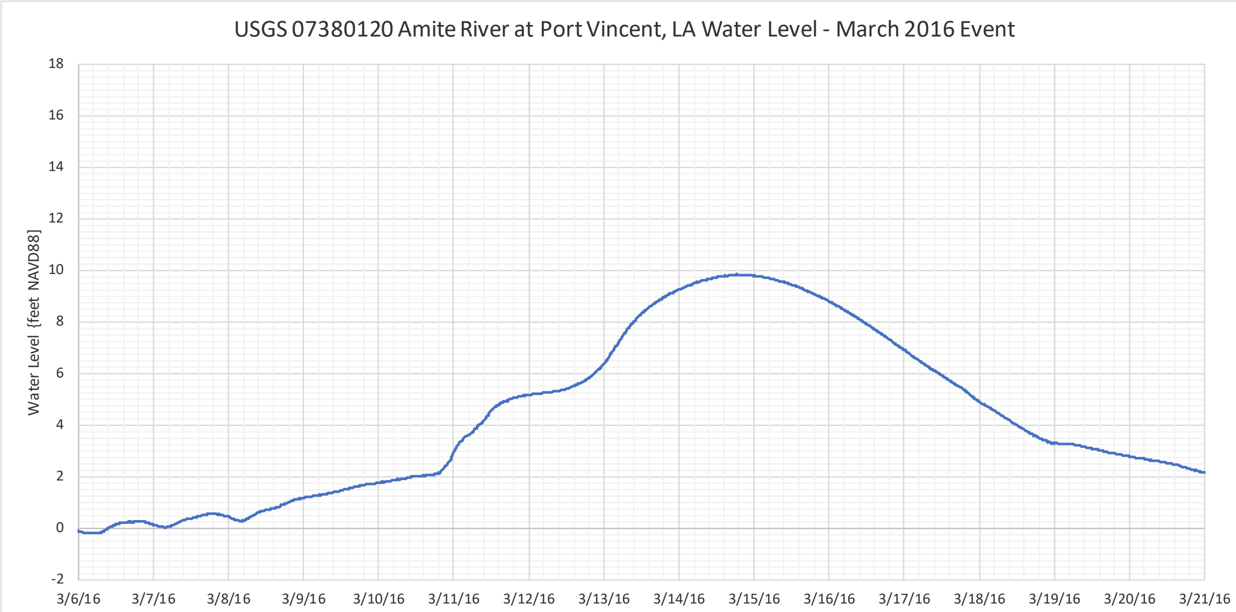


Figure 4-5. March 2016 measured water level at USGS 07380120 Amite River at Port Vincent, LA.

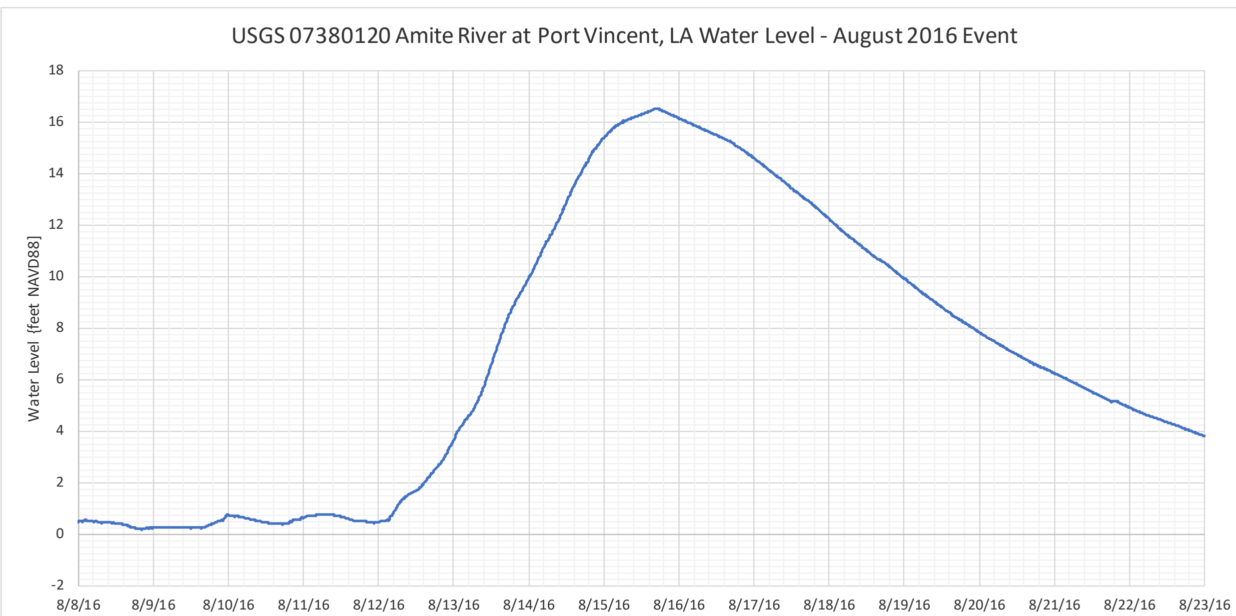


Figure 4-6. August 2016 measured water level at USGS 07380120 Amite River at Port Vincent, LA.

4.2.3 Open Boundaries

Open boundaries were placed along the model east, west and southern boundaries. The open boundaries all exhibited flow across them during large flood events, such as the August 2016 Flood Event. In these events, water levels can reach heights which overtop the ground level at the model boundaries. The open boundary allows water to flow as it would into adjacent basin. To the east, a normal depth with slope of 0.01 boundary was placed to allow overflow from the Amite River into Colyell Creek. To the south, a normal depth with slope of 0.01

boundary was placed to allow overflow from Bayou Manchac into Henderson, Sides and Black Bayous. To the west, a normal depth with slope of 0.01 boundary was placed to allow flow into the Mississippi River.

4.3 PRELIMINARY CALIBRATION

The hydraulic model was preliminary calibrated to the March and August 2016 Flood Events. Measured water levels collected by the USGS at locations throughout the model area were compared to modeled water levels during the calibration periods. Figure 4-7 shows the location of measured USGS stations used for the model calibration.

USGS and Amite River Basin Commission High Water Marks (HWMs) from the August 2016 Flood Event were also compared to modeled peak water levels from the August 2016 model simulation. Figure 4-8 shows the location of surveyed HWMs used for model calibration. No HWMs were surveyed following the March 2016 Flood Event. Therefore, no comparisons to modeled peak water levels from the March 2016 model simulation were performed.

Mesh edits, structures, and channel and overland roughness values were adjusted for this preliminary model calibration.

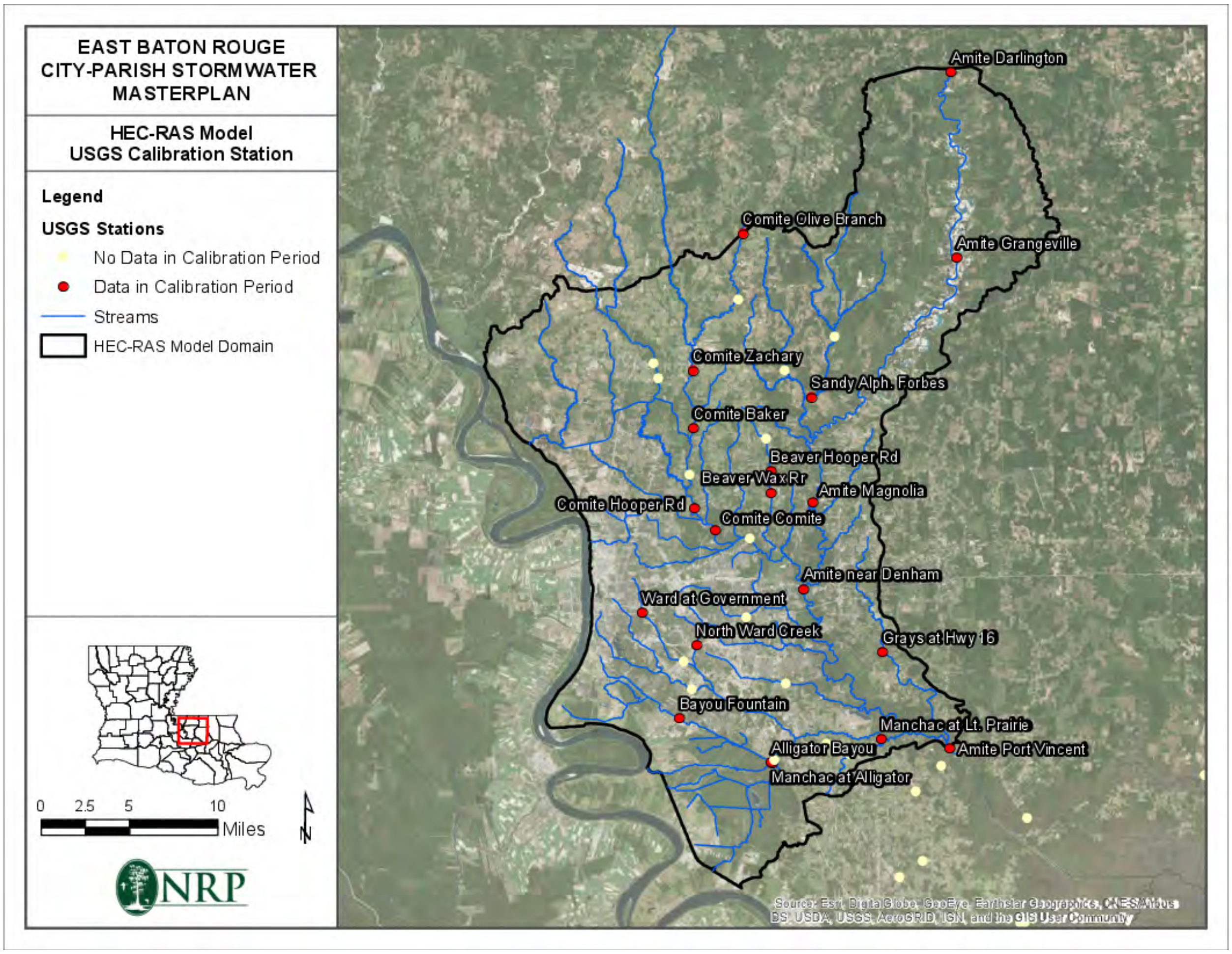


Figure 4-7. Measured USGS stations used for preliminary model calibration.

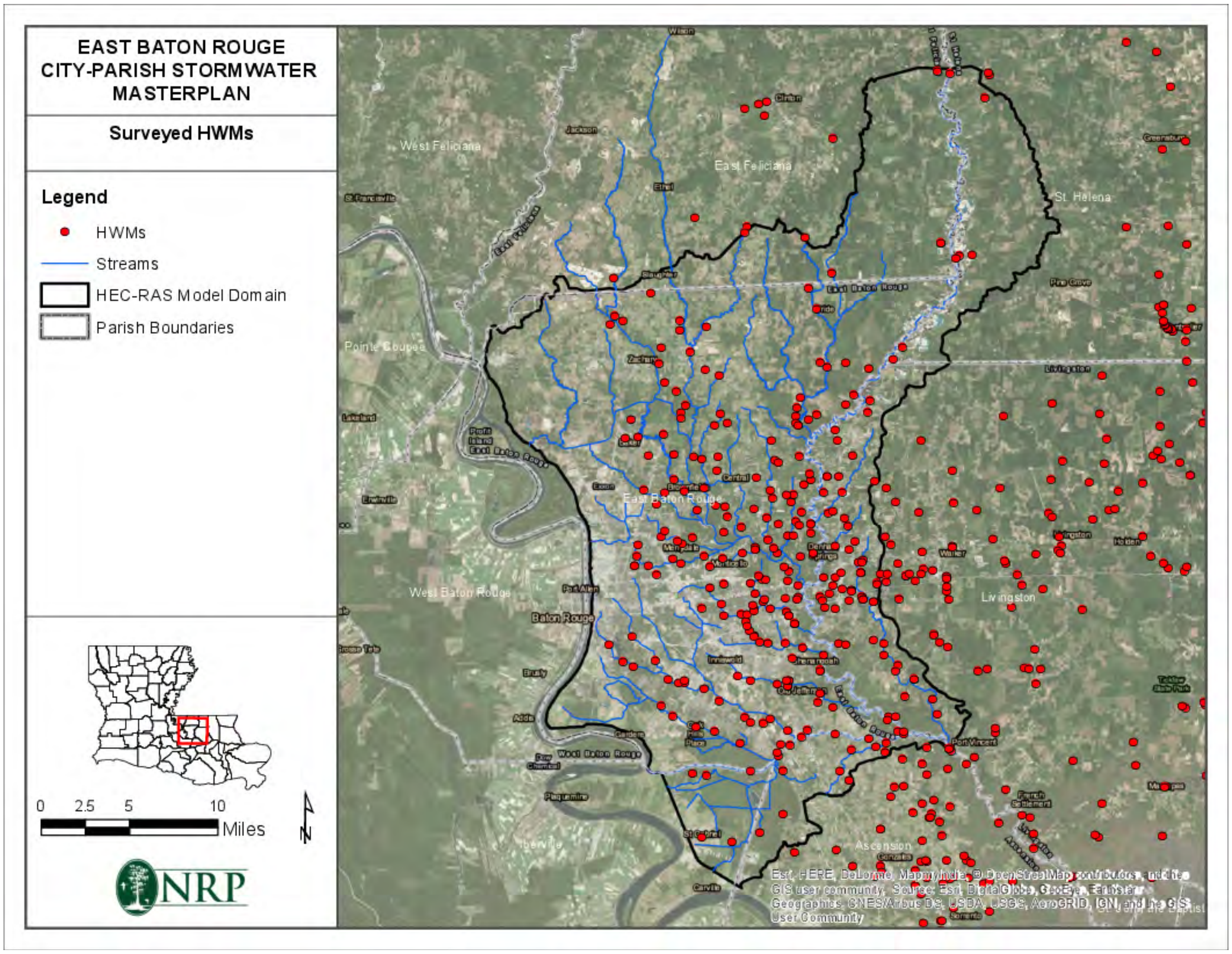


Figure 4-8. August 2016 Surveyed HWMs.

4.3.1 March 2016 Flood Event Water Level Comparisons

4.3.1.1 Amite River

Figure 4-9 shows the individual time series comparison of water level at USGS stations on or near the Amite River. Figure 4-10 shows these time series on the same graph revealing how the measured and modeled water level gradient down the Amite River compared from the March 2016 Flood Event. The model performed generally well in translating the shape, timing, and peak height of the flood hydrograph down the Amite River. The model under estimated the peak water level at Darlington, Grangeville, and Magnolia and overestimated the peak water levels at Denham Springs and near the confluence of Bayou Manchac.

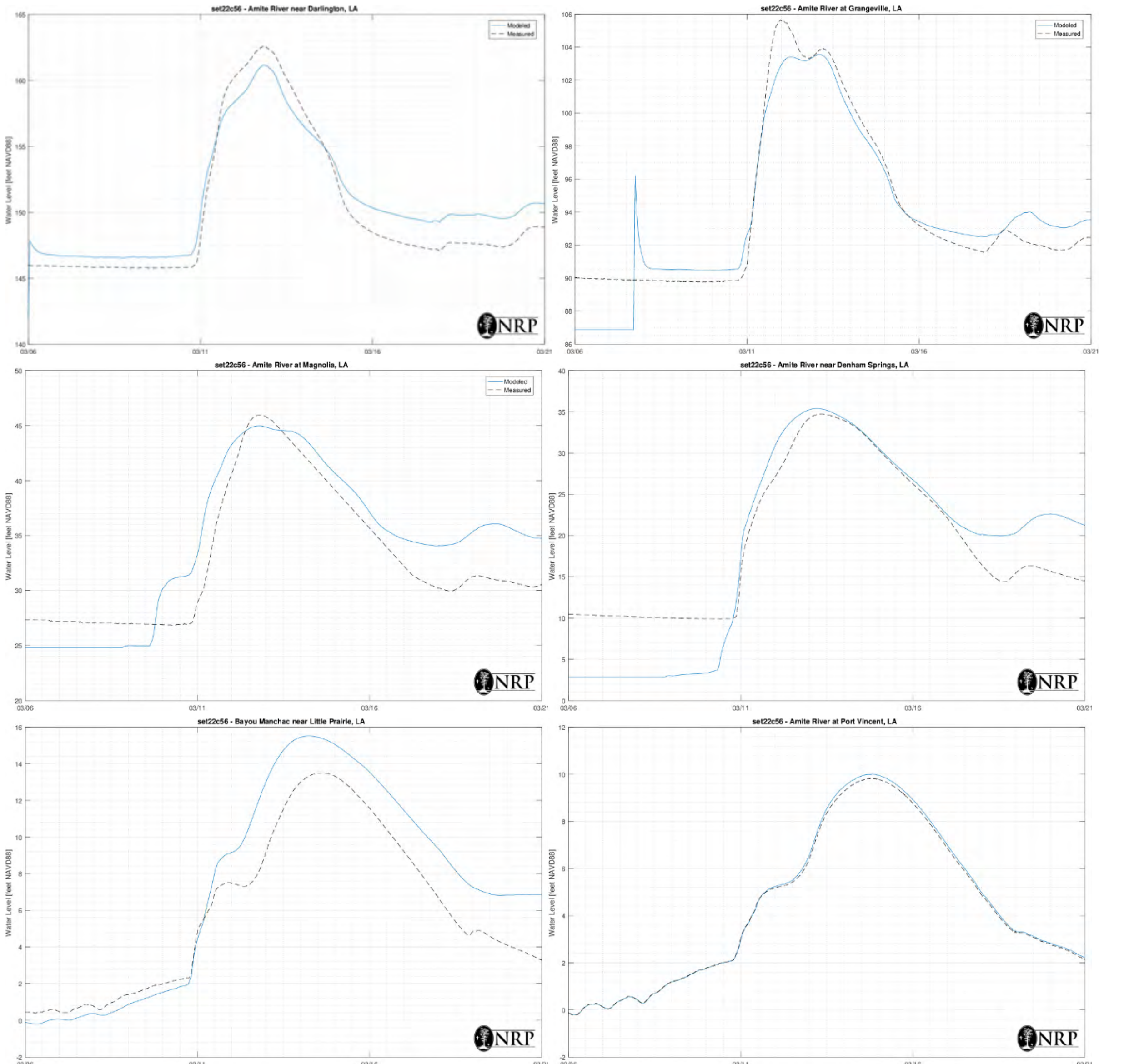


Figure 4-9. March 2016 water level preliminary calibration results at USGS Station on the Amite River (Upstream to Downstream is Left to Right/Up to Down).

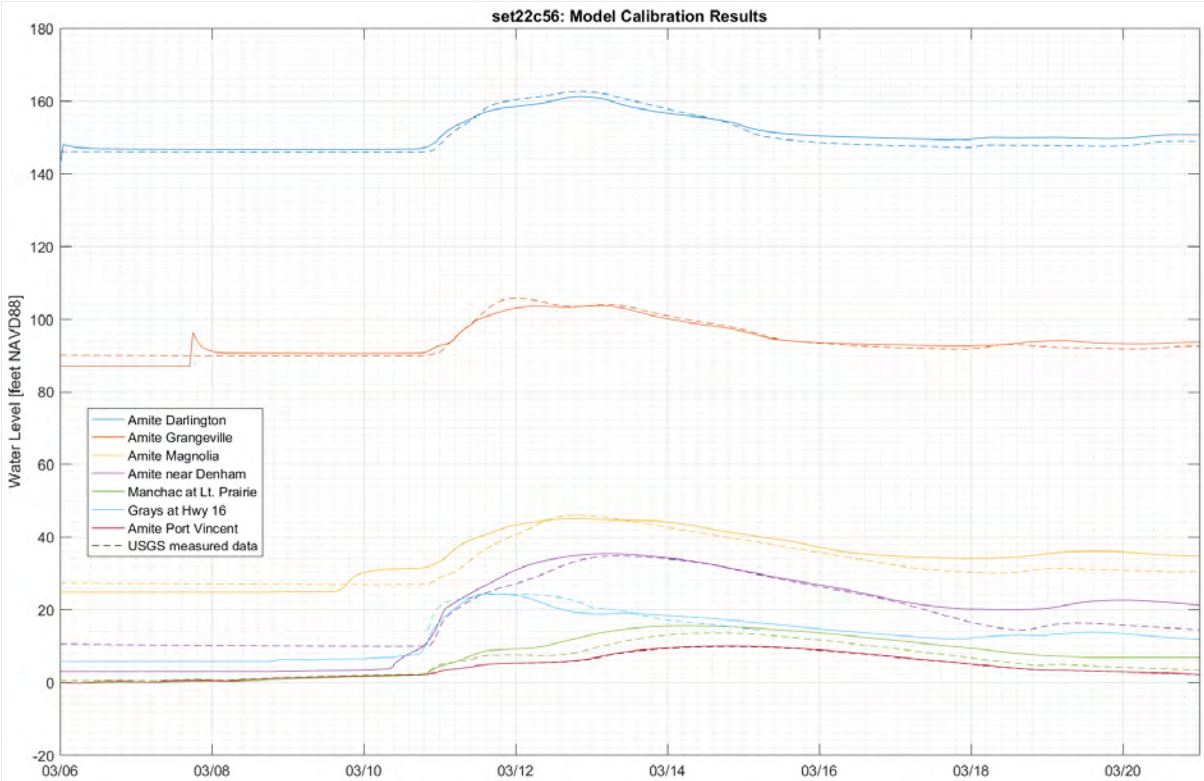


Figure 4-10. March 2016 water level preliminary calibration results at USGS Station on the Amite River.

4.3.1.2 Comite River

Figure 4-11 shows the individual time series comparison of water level at USGS stations down the Comite River. Figure 4-12 shows these time series on the same graph revealing how the measured and modeled water level gradient down the Comite River to its confluence with the Amite River near Denham Springs, LA compared from the March 2016 Flood Event. The model was less accurate in translating the general shape, timing, and peak height of the flood hydrograph down the Comite River compared to the Amite River. At the upstream flow boundary near Olive Branch, the model appears to consistently overestimate water level approximately 5 feet indicating the possibility of a datum shift error. This will be investigated in the next phase of the project. Moving downstream from the boundary, the model overestimates the peak water level near Baker, LA while under estimating it at Hooper Road and Comite, LA.

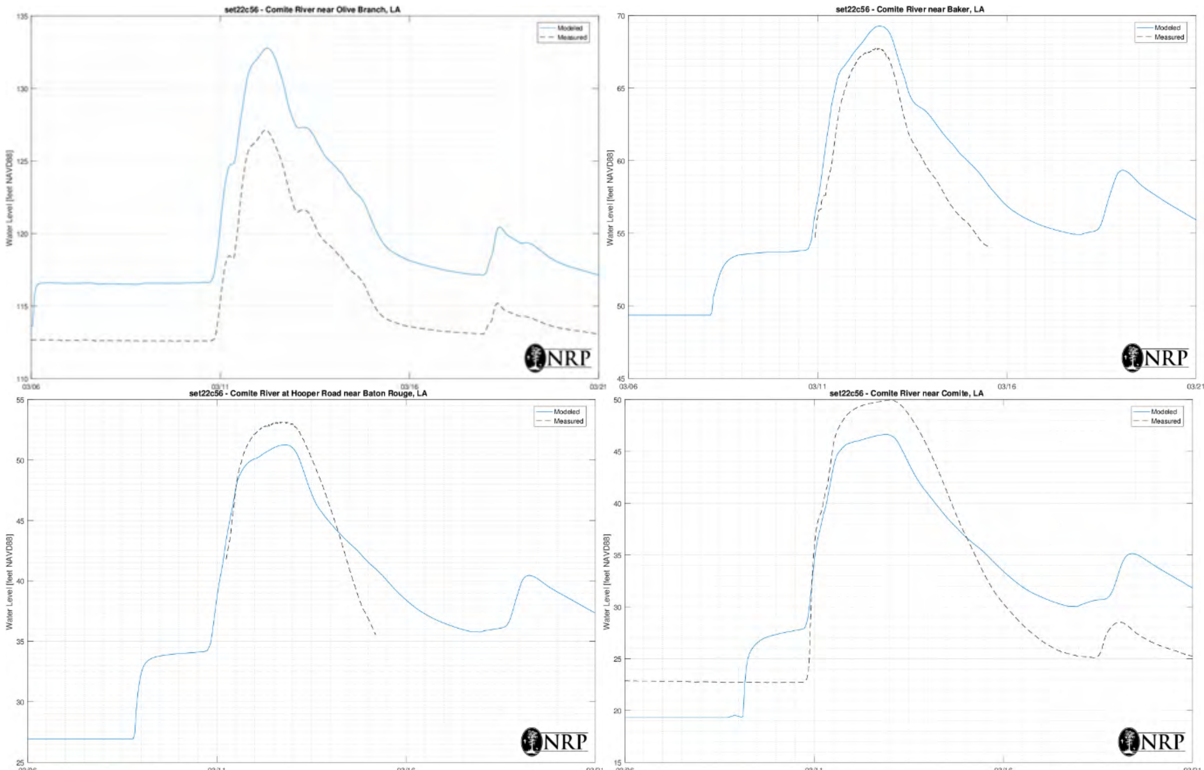


Figure 4-11. March 2016 water level preliminary calibration results at USGS Station on the Comite River (Upstream to Downstream is Left to Right/Up to Down).

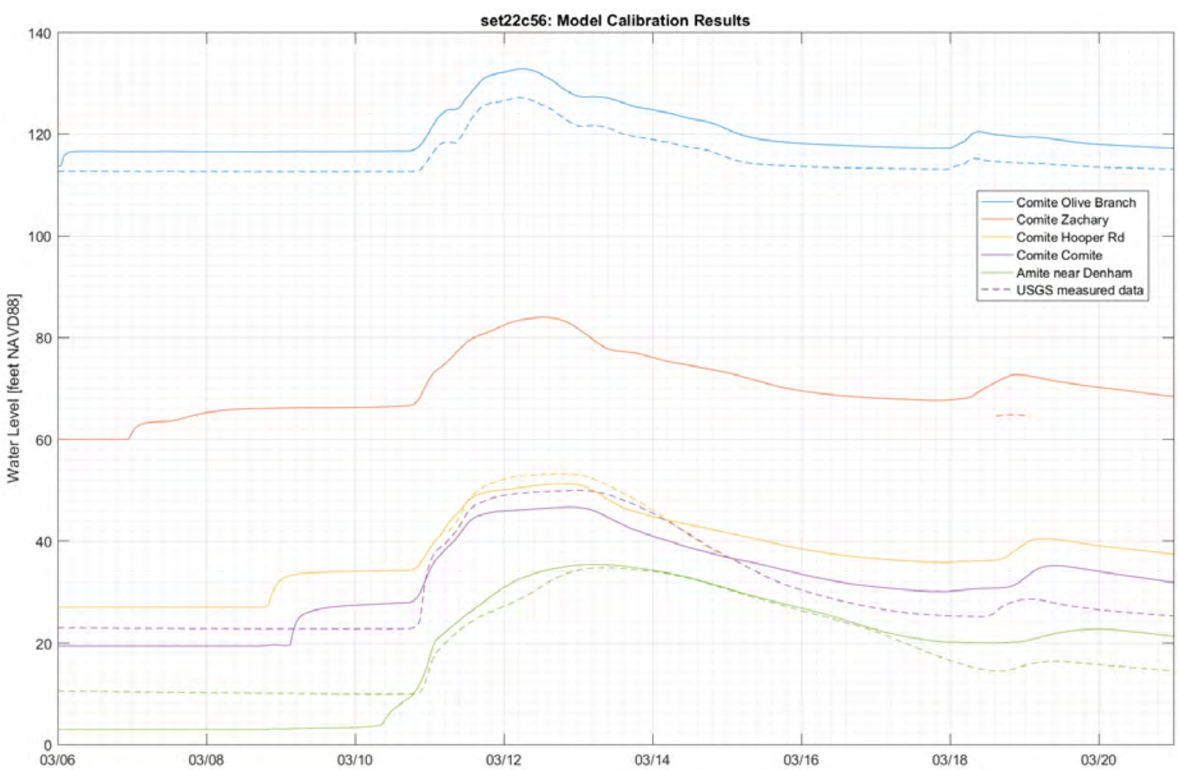


Figure 4-12. March 2016 water level preliminary calibration results at USGS Station on the Comite River.

4.3.1.3 Bayou Manchac

Figure 4-13 shows the individual time series comparison of water level at USGS stations with the Bayou Manchac basin including Ward Creek, Bayou Fountain, and Bayou Manchac. Figure 4-14 shows Bayou Fountain and Bayou Manchac time series on the same graph revealing how the measured and modeled water level gradient down these stream to its confluence with the Amite River near Little Prairie compared from the March 2016 Flood Event. The model does not currently have the resolution nor channel bathymetry to replicate the steep and short duration hydrographs from urban areas such as Ward Creek. The model was able to accurately estimate the peak water level from rainfall within the Bayou Fountain and upper Bayou Manchac basin (upstream of the I-10 crossing). This peak was just on August 11th. Backwater flow from the Amite River started reaching upper Bayou Manchac and Bayou Fountain around August 12th. The model overestimated the peak water level from backwater flooding as a result of higher modeled water levels producing the backwater compared to measured. However, relative to the backwater water level source, the model simulated backwater flooding well.

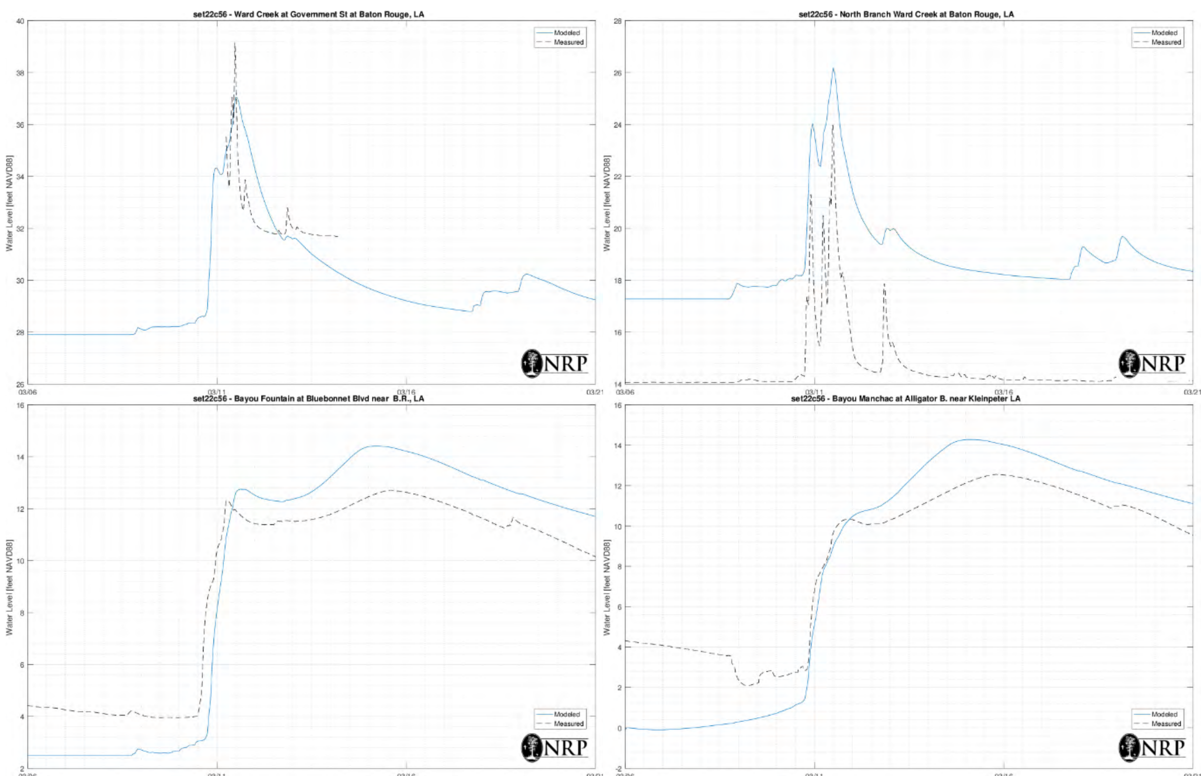


Figure 4-13. March 2016 water level preliminary calibration results at USGS Station on the Bayou Manchac Basin.

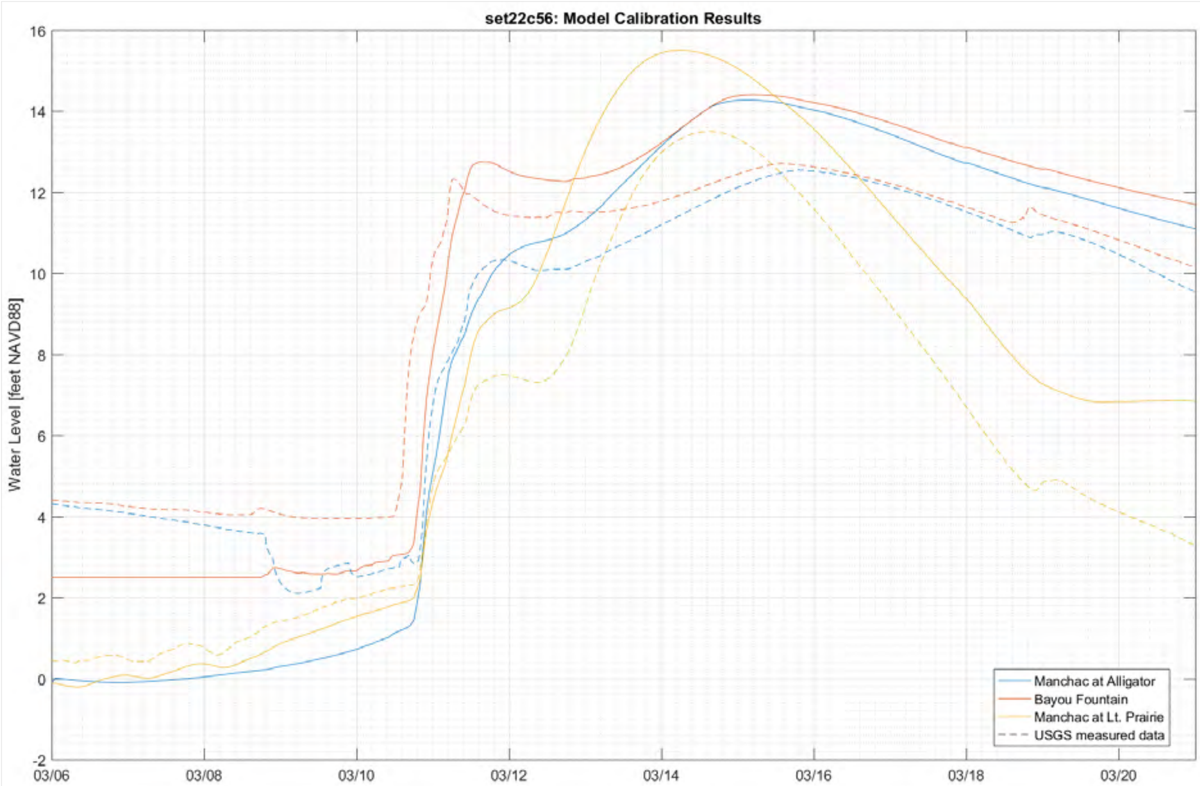


Figure 4-14. March 2016 water level preliminary calibration results at USGS Station on the Bayou Manchac Basin.

4.3.2 August 2016 Flood Event Water Level Comparisons

4.3.2.1 Amite River

Figure 4-15 and Figure 4-16 show the individual and combined time series similar as above but for the August 2016 Flood Event. In review, the model performed well in translating the general shape, timing, and peak height of the flood hydrograph down the Amite River. The model overestimated the peak water level at the upstream flow input near Darlington, LA. The model under estimated the peak at Grangeville, LA and overestimated the peak at Magnolia, Denham Springs, and near Bayou Manchac.

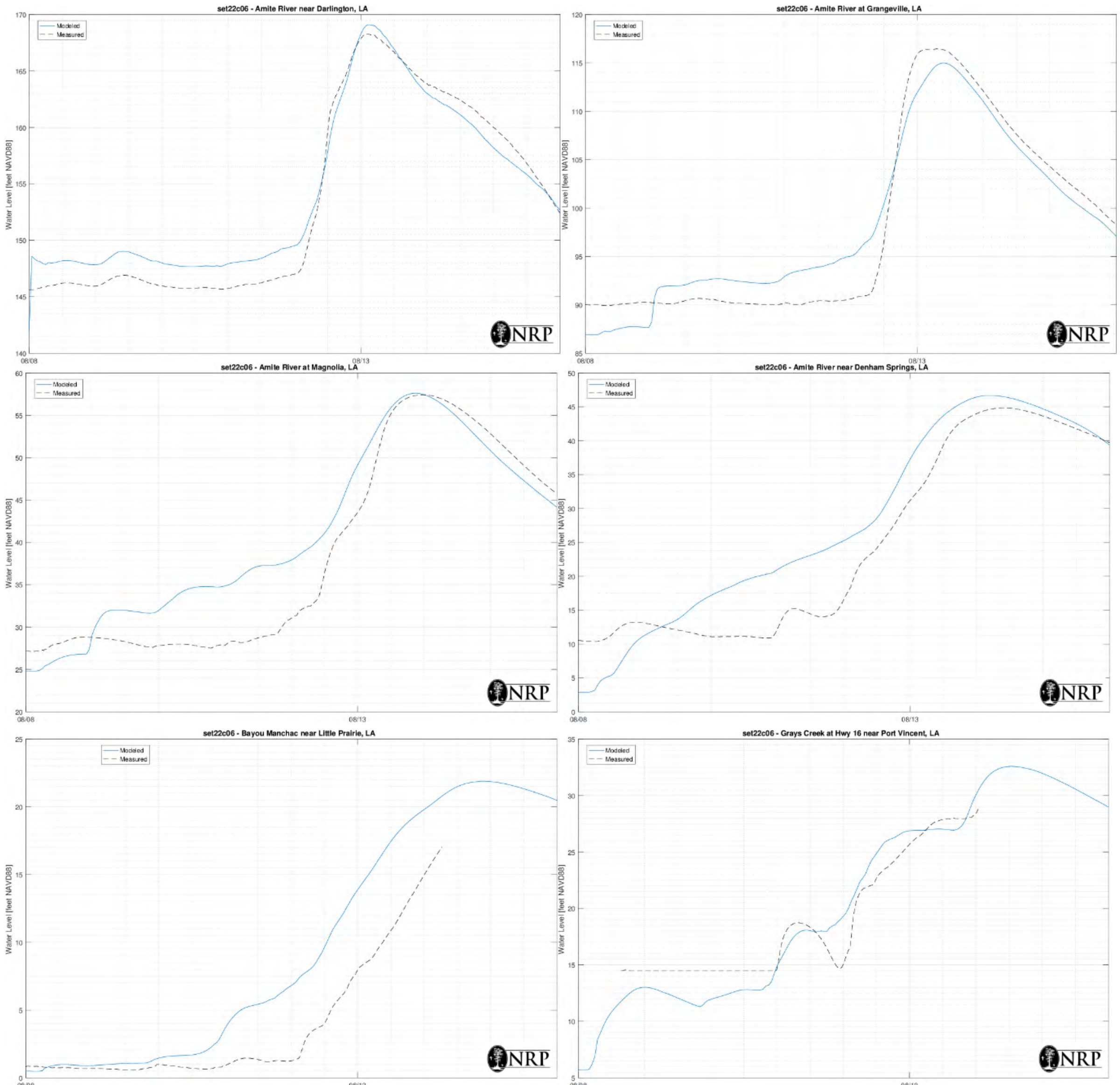


Figure 4-15. August 2016 water level preliminary calibration results at USGS Stations on the Amite River (Upstream to Downstream is Left to Right/Up to Down).

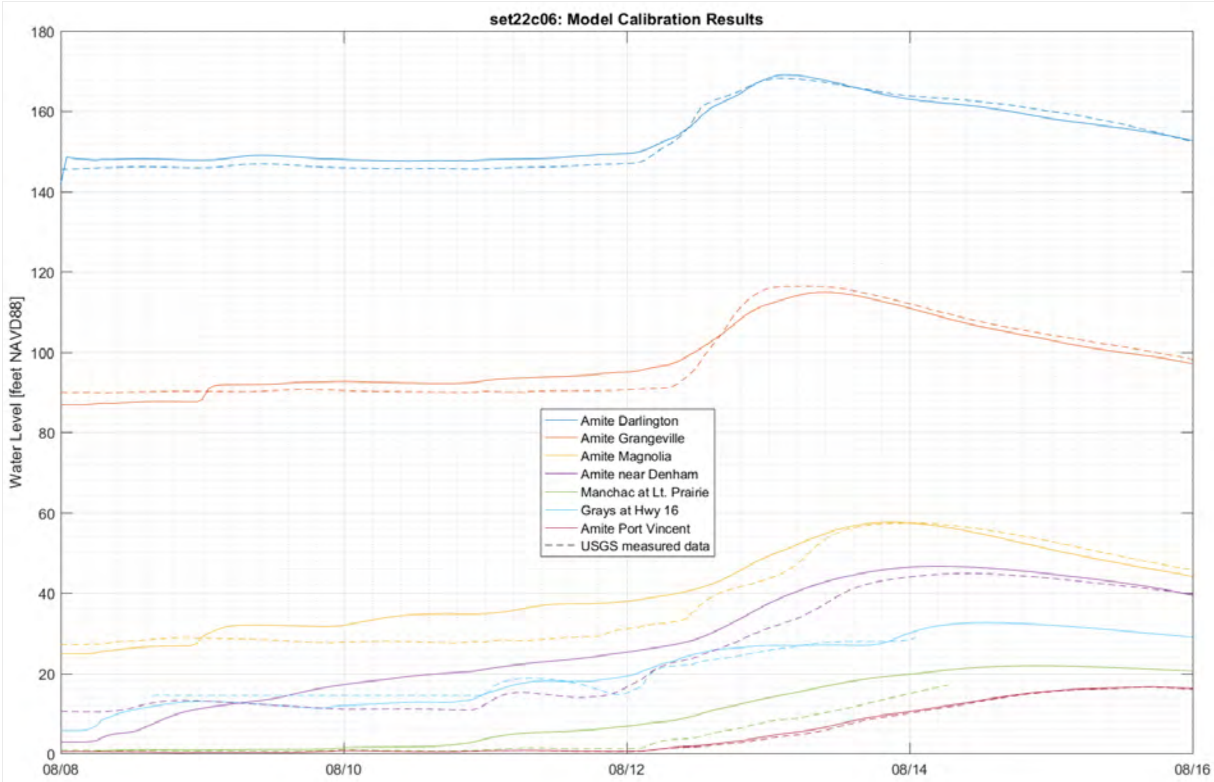


Figure 4-16. August 2016 water level preliminary calibration results at USGS Stations on the Amite River.

4.3.2.2 Comite River

Figure 4-17 and Figure 4-18 show the individual and combined time series similar as above but for the August 2016 Flood Event. In review, the model performed well in translating the general shape, timing, and peak height of the flood hydrograph down the Comite River. At the upstream flow boundary near Olive Branch, the model again appears to consistently overestimate water level approximately 5 feet indicating the potential datum shift error. Moving downstream from the boundary, the model overestimates the peak water level near Zachary, LA while under estimating it at Hooper Road and Comite, LA.

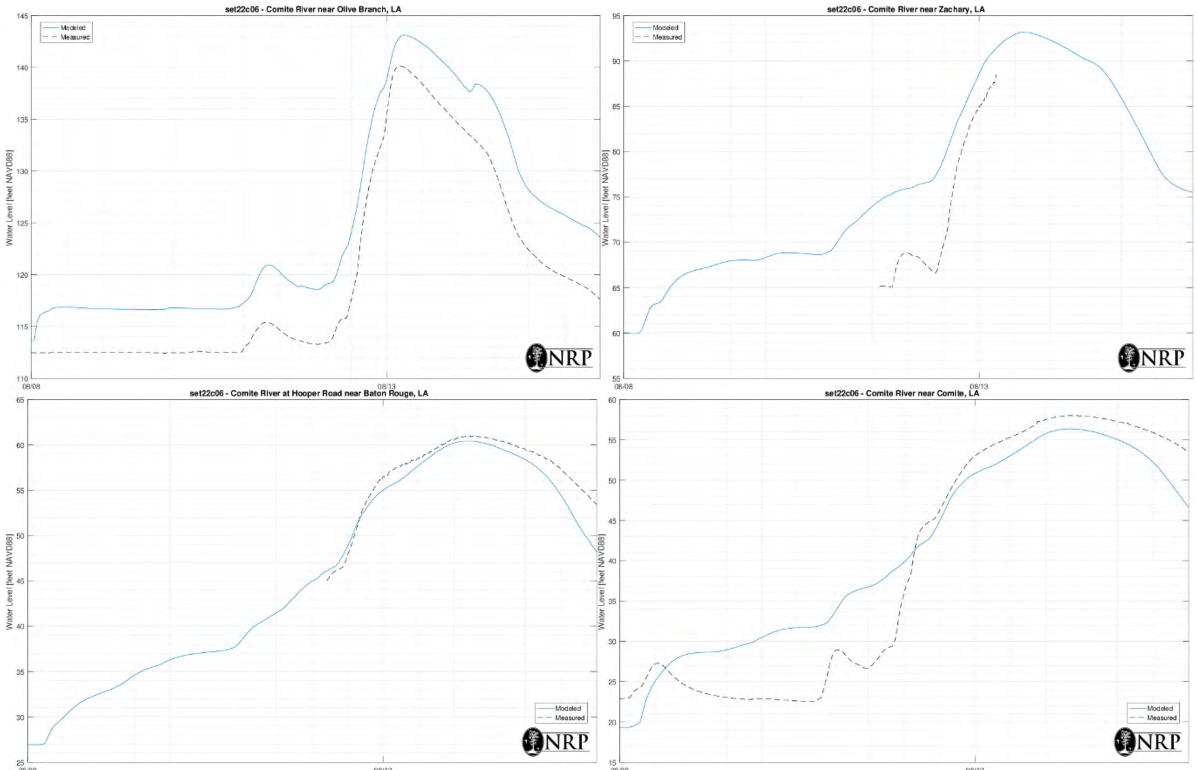


Figure 4-17. August 2016 water level preliminary calibration results at USGS Stations on the Comite River (Upstream to Downstream is Left to Right/Up to Down).

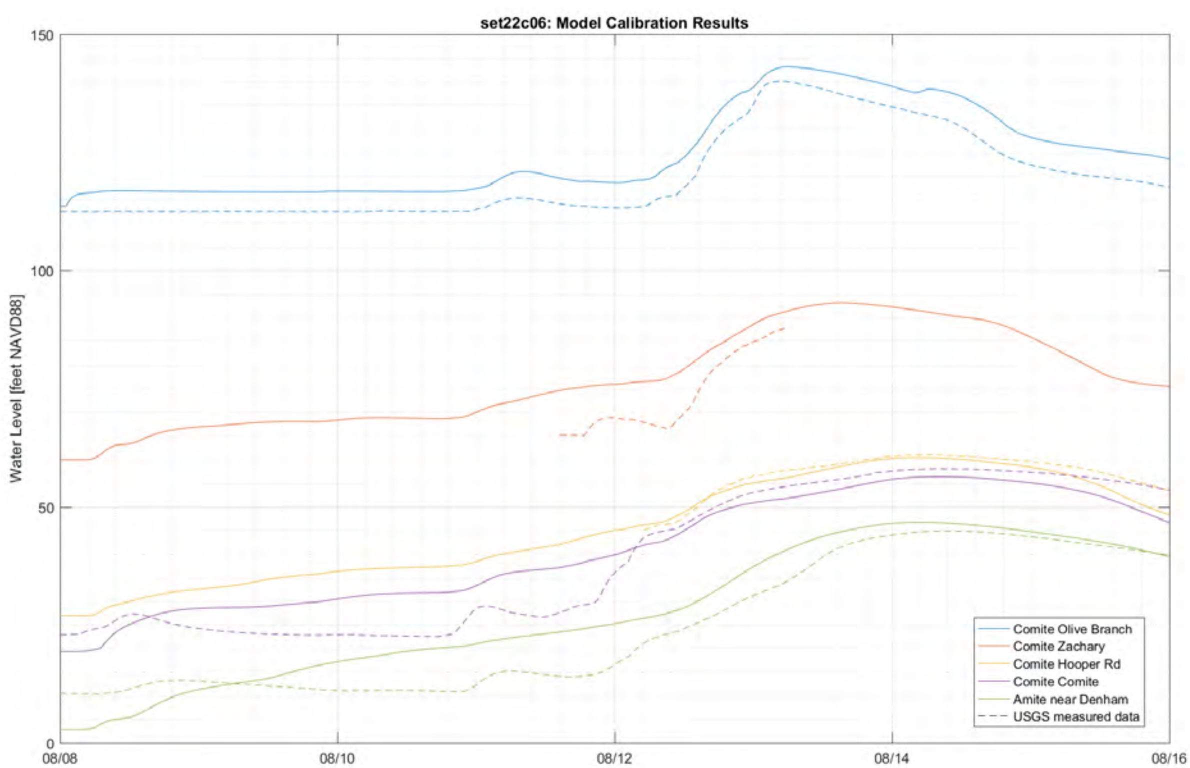


Figure 4-18. August 2016 water level preliminary calibration results at USGS Stations on the Comite River.

4.3.2.3 Bayou Manchac

Figure 4-19 and Figure 4-20 show the individual and combined time series similar as above but for the August 2016 Flood Event. The model does not currently have the resolution nor channel bathymetry to replicate the steep and short duration hydrographs from urban areas such as Ward Creek. In contrast with the March 2016 Flood Event, the model did not reasonably estimate the peak water level from precipitation within the Bayou Fountain and upper Bayou Manchac basin due to having 5.5 inches more of rainfall than was measured as a result of the model setup limitations (see Section 2.1.3). Additionally, the model overestimated the peak water levels from backwater flooding from the Amite River. This is again, the result of the higher modeled water levels compared to measured in the Amite River at the confluence with Bayou Manchac. Relative to the backwater water level source, the model simulated backwater flooding well.

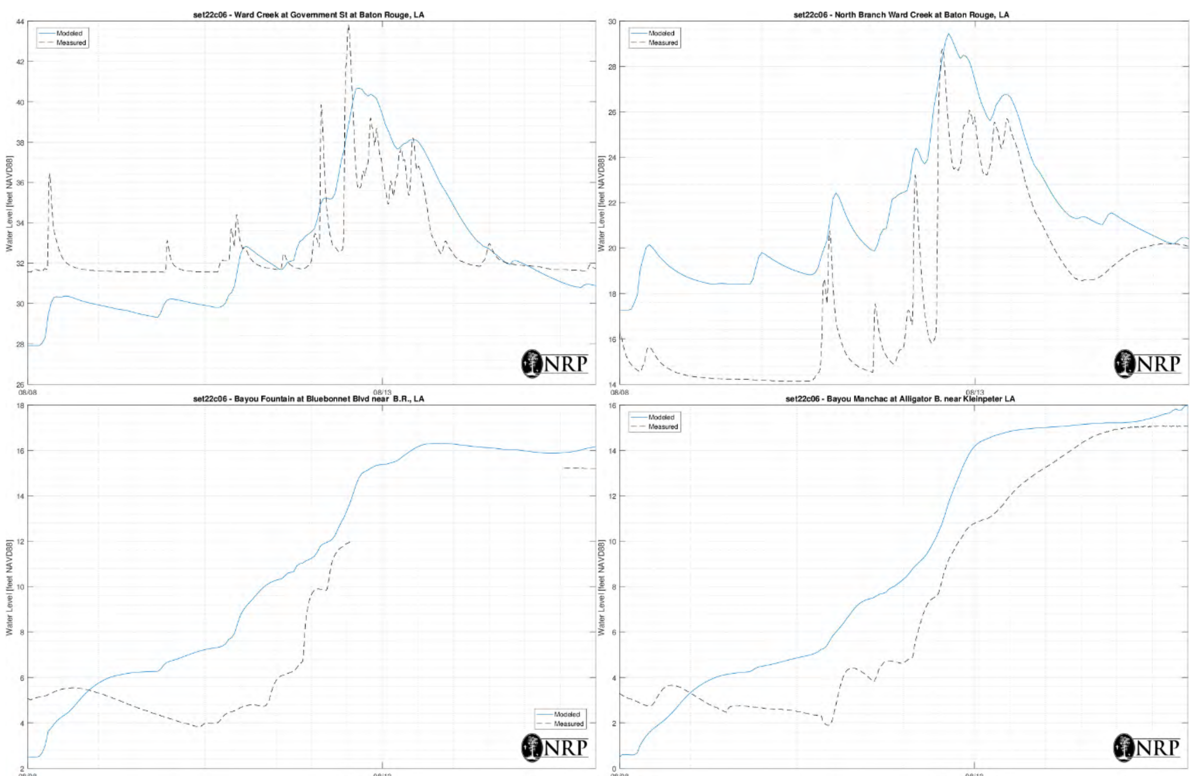


Figure 4-19. August 2016 water level preliminary calibration results at USGS Station on the Bayou Manchac Basin.

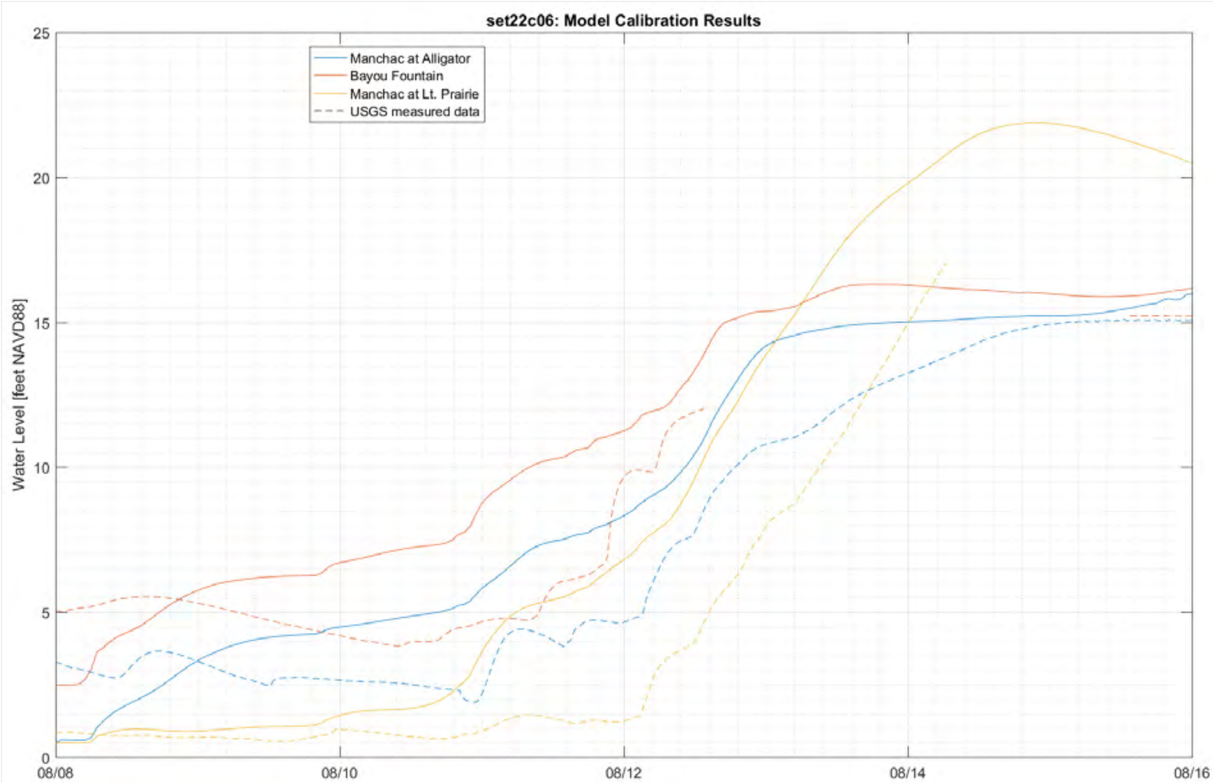


Figure 4-20. August 2016 water level preliminary calibration results at USGS Station on the Bayou Manchac Basin.

4.3.3 High Water Mark Comparisons

High Water Mark (HWM) comparisons were not used in the preliminary model calibration. As the regional model is further developed in the next phases of the SMP, additional calibration will be performed, including comparisons to HWM data.

5 CONCLUSIONS

The Phase I Regional, Conceptual-Level Model was able to provide an understanding the hydraulic system of rivers, bayous, and canals. It is an acceptable tool which can be used to identify, from a macro-level, problems areas and potential projects as well as estimate regional impacts of large scale projects influencing the Comite and Amite Rivers within East Baton Rouge Parish. Additionally, this model provides a foundation for the development of the future, more detailed models for the next phase of the Stormwater Master Plan when new LiDAR and additional survey are performed.