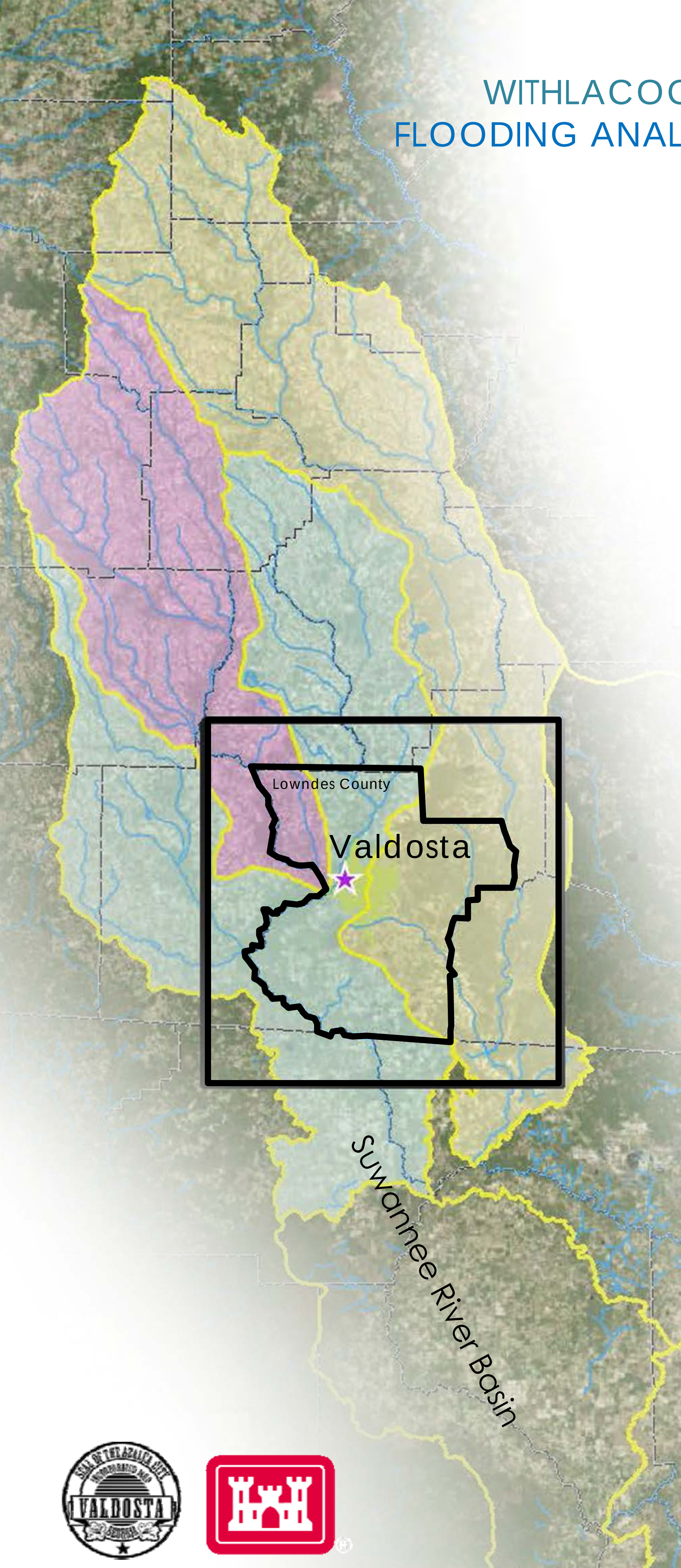
WITHLACOOCHEE RIVER AND SUGAR CREEK
FLOODING ANALYSIS FOR THE CITY OF VALDOSTA
Lowndes County, Georgia



JUNE 2014
U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT
Planning Assistance
to States Report

WITHLACOOCHEE RIVER AND SUGAR CREEK FLOODING ANALYSIS
PLANNING ASSISTANCE TO STATES

CITY OF VALDOSTA
LOWNDES COUNTY, GEORGIA

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HOW TO USE THIS DOCUMENT: This report is divided into an Executive Summary, Chapters 1-5, and four appendices as reference for technical information. Appendix D includes a series of maps, to be used independently as a packet for spatial reference while reading the text.

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Flooding During 2009

Executive Summary

City of Valdosta
Lowndes County

U.S . Army Corps of Engineers Planning Assistance to States Program
Withlacoochee River and Sugar Creek Flooding Analysis
City of Valdosta
Lowndes County

Executive Summary

LOCATION:
City of Valdosta, Lowndes County, Georgia

SPONSOR:
The City of Valdosta

STUDY AUTHORITY:
Planning Assistance to States (PAS), Section 22, Water Resources and Development Act (WRDA) of 1974, Public Law 93-251.

BACKGROUND

The City of Valdosta is located in south-central Georgia along the I-75 corridor, in Lowndes County. It has a population of over 54,000 people and a land area of approximately 37 square miles. The city is in the coastal plain and is in the lower portion of the Suwannee River basin, which extends from Georgia into Florida and discharges into the Gulf of Mexico. The City of Valdosta drains into the Withlacoochee sub-basin and the Alapaha sub-basin. The project area drains only into the Withlacoochee sub-basin. The Little River sub-basin, although not within city limits, joins with the Withlacoochee sub-basin west of city limits, and also influences the study area. The main waterways in the study area are Withlacoochee River, Sugar Creek, and Two Mile Branch which feeds into Sugar Creek. Reference Figure ES-1 for an overview of the project area.

PURPOSE OF THIS REPORT

This Planning Assistance to States (PAS) study report delivers a preliminary analysis of structural and non-structural solutions, with a scope comparable to a United States Army Corps of Engineers (USACE) Section 905(b)[1] Analysis or Reconnaissance Report, and concludes with an economically justified solution for flood risk reduction in the study area, to reduce the potential for localized flood damages resulting from regional flooding problems. This report will assist in establishing potential Federal interest in pursuing future flood risk management studies in the study area and surrounding watershed(s) under other authorities, such as the Continuing Authority Program or Watershed Study Authority. There is no federal action associated with this flooding analysis and any Federal participation from the U.S. Army Corps of Engineers (USACE) would require a Department of the Army Decision Document under a study authority as listed above and associated National Environmental Policy Act (NEPA) documentation.

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[1] Section 205(b) of the 1986 Water Resources Development Act

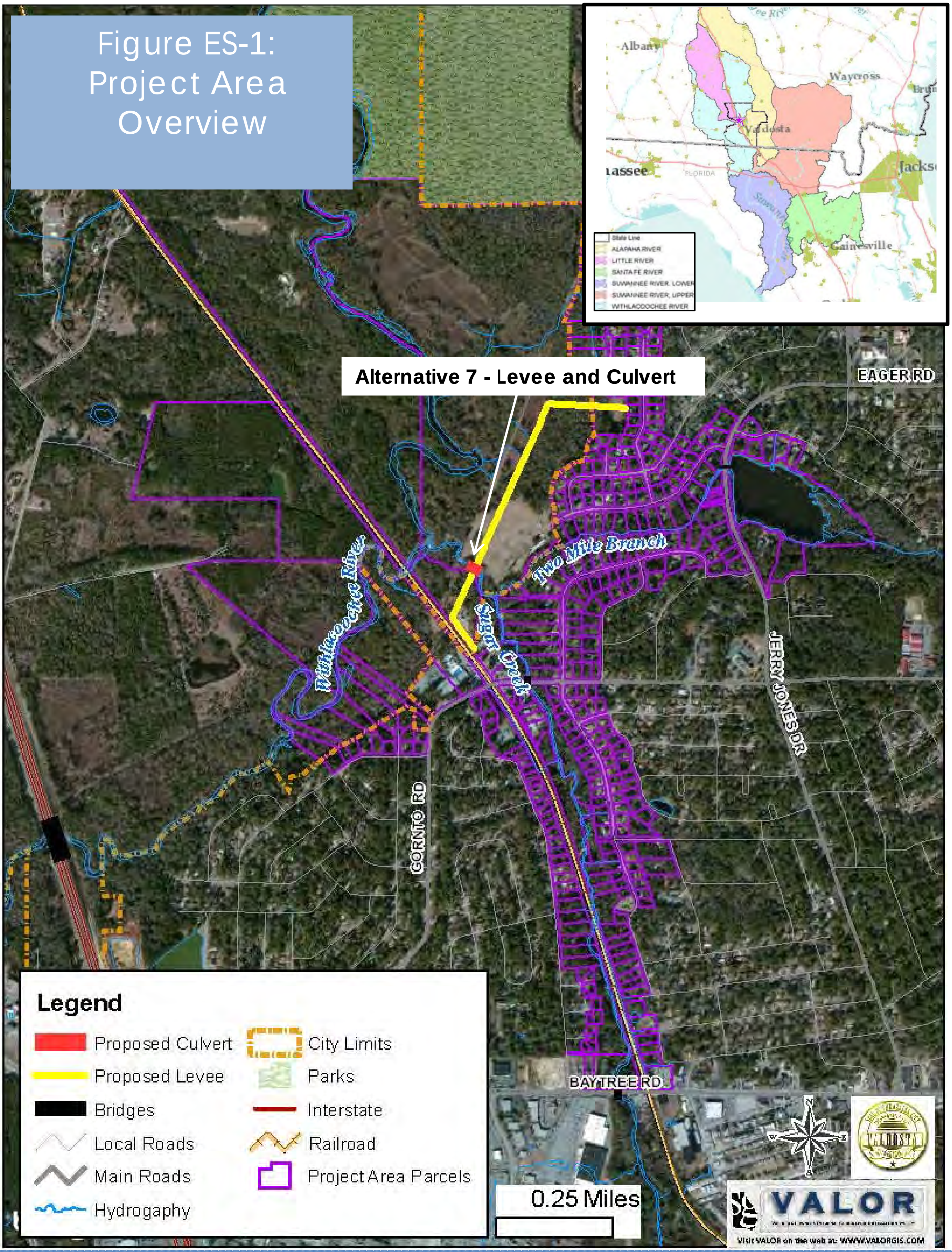


Figure ES-1: Overview of project area, affected parcels, and Alternative 7, which includes a levee and 6-barrel culvert at the confluence of the Withlacoochee River and Sugar Creek.

STUDY PURPOSE AND NEED

The purpose of the Withlacoochee River and Sugar Creek Flooding in Valdosta, Georgia Study is to examine flooding in the northwest portion of the city caused by overflows from Sugar Creek and the Withlacoochee River. The study also includes Two Mile Branch, which is another stream that discharges into Sugar Creek just before it enters the Withlacoochee River. This report provides an analysis of the flood impacts in the study area from 10-, 50- and 100-year storm events using USACE methodology and existing data. Based on this analysis, possible flood risk management alternatives are developed and evaluated, resulting in a recommendation.

Definitions of storm events referred to in the report:
10-year event: A storm event that has a 10 percent chance of occurring in any year. 50-year event: A storm event that has a 2 percent chance of occurring in any year. 100-year event: A storm event that has a 1 percent chance of occurring in any year.

The flooding experienced by the community is due to rising water in the Withlacoochee River and Little River which backs up into Sugar Creek and Two Mile Branch where it overflows into the study area. The flooding generally does not occur when local rainfall and runoff events are centered over Valdosta. Rather, it occurs several days later as upstream flows from the Withlacoochee River and Little River arrive, resulting in a significant rise of water stages in the adjacent sections of the Withlacoochee River. This has been termed “sunny-day” flooding by the local community.

Regional Impacts

During March and April of 2009, south Georgia and north Florida experienced historic flooding which resulted in 46 counties in Georgia and 17 counties in Florida declared as Federal Disaster Areas. According to the U.S. Geological Services (USGS) Fact Sheet 2009-3079, the Federal Emergency Management Agency (FEMA) reported that 1,875 homes and 29 businesses were affected by floodwaters and approximately $60 million in public infrastructure damage occurred in Georgia. Based on data collected during the 2009 storm event by the Lowndes County Emergency Management in cooperation with the Georgia Emergency Management Agency (GEMA) and FEMA, there were 172 residential and commercial properties impacted by flooding in Greater Lowndes County.

Local Impacts

During the 2009 flood event in Lowndes County, 172 properties were impacted and resulted in Lowndes County government having $4.1 million in documented damages to public infrastructure.[2]

Approximately half of the properties impacted were located in the City of Valdosta near the confluence of Sugar Creek and the Withlacoochee River, with an estimated $2.5 million in damages to private residences in the study area. The properties within the city limits of the study, which include portions of Gornto Road, Lake Drive, Meadowbrook Drive, Park Lane, Ravenwood Circle, Winding Circle and Winding Way, were under water due to an overflow from Sugar Creek and the Withlacoochee River. Outside of the study area, but still within Lowndes County it is estimated that there was between $1.5 - $2 million dollars of additional damage to private property. Some of the impacts to residential and commercial properties, as well as institutional functions, are shown in Executive Summary, Figure ES-2. Several businesses in the study area were significantly flooded, such as the Young Men's Christian Association (YMCA) and Mediacom, with estimated damages of $2.1 million. In addition, a portion of the Norfolk Southern Railway line went under water for a period of time but no estimated damage figures have been provided. Throughout Lowndes County, 10 bridges and close to 100 state and local roads were impacted, including a portion of U.S. Highway 84. In Lowndes County, but outside the immediate study area, the city's Withlacoochee Wastewater Treatment Plant, which serves more than 70 percent of the city's residents, commercial businesses, hotels and restaurants, was also significantly damaged by flood waters. The treatment plant experienced a complete loss of function for nine days and continued to be only partially operational for more than a month.

One of the public/institutional facilities impacted in Valdosta during the flood was the primary Mediacom transmission point, which services the cities of Valdosta, Hahira, Remerton, Nashville, and Adel, along with Lowndes and Brooks counties. When the transmission point went under more than six feet of water, nearly 12,000 customers lost telephone, internet and cable services, with the majority of customers without service for five days.

In February and March of 2013, the City of Valdosta experienced flooding again at the confluence of Withlacoochee River and Sugar Creek, and Two Mile Branch, as well as throughout Lowndes County and neighboring communities. In Valdosta, multiple properties were flooded, yet only one commercial property had water enter the structure during this flood. Throughout Lowndes County, 13 roads and bridges were closed, including U.S. Highway 84. The city's Withlacoochee Wastewater Treatment Plant was impacted again due to flood inundation and had a loss of function for three days before becoming fully operational.

[2] Damages reported by Lowndes County Emergency Management Agency

The impacts of these flood events to human safety, as well as damages to residential areas, commercial areas, roads, bridges, and institutional facilities in the last five years within the City of Valdosta have established the need to conduct a flood analysis to examine a feasible solution to lessen future flood damages.

PLAN FORMULATION AND CONCLUSIONS

The USACE certified Hydrologic Engineering Centers River Analysis System (HEC-RAS) model was calibrated to the 2013 event. Hypothetical events were then developed for the 10-, 50- and 100-year storm events and applied to the existing condition and with-project HEC-RAS model. The return period of a storm event can be classified in several different ways. The storm event can be referred to in terms of rainfall, flow, or stage. Additionally, characterization of a storm event based on an analysis of these factors at several different locations can produce different results making it sometimes difficult to identify the frequency of the storm event. For this flood analysis, three events were examined for the with-project and without-project conditions: 10-year flood, 50-year flood, and 100-year flood. Although the frequency of the 2009 and 2013 storm events were characterized by others as much larger storm events, the statistical frequency analysis of the 2009 and 2013 events were determined to be 39 and 15 years, respectively.

Results clearly indicated that flooding in the City of Valdosta (in the existing condition) is not a result of conveyance or structural issues within the city's flood control system during direct rainfall events. Model results indicated that the flooding is due to rising water in the Withlacoochee River and Little River rising which backs up into Sugar Creek and Two Mile Branch. This confirms the community's "sunny-day" anecdotal observations. Model confirmation of the problem set the stage for the formulation of alternatives.

Several alternatives were identified, compared and evaluated, resulting in one chosen as a potential feasible local solution for the purpose of this report. The alternative which was developed for this report, Alternative 7, is one feasible solution for localized flooding problems. It is important to note that the underlying problems related to the frequency, depth and duration of water (causing flooding and droughts in the region) are due to the overall river basin and watershed complexity.

Alternative 7 proposes to construct an earthen levee at the confluence of the Withlacoochee River and Sugar Creek, including a culvert structure with six barrels, measuring 6-feet by 6-feet each, and flap gates at the west end. When water levels in upstream Sugar Creek are higher than downstream levels in the Withlacoochee River, the flap gates will open and water will flow into the Withlacoochee River. When water levels in the Withlacoochee River are higher than Sugar Creek, the flap gates will close, preventing water from backing up into Sugar Creek and minimizing the potential for flooding adjacent properties. This solution is most effective at reducing the depth and duration of flooding in the study area east of the levee and culvert structure; however, it does not prevent flooding.

Regarding depth, according to the HEC-RAS model results, the reduction in the maximum surface elevation for the 100-year event would be 2.8 feet. Regarding duration, as one example, the model indicated that homes sustaining damage at an elevation of 138 feet are currently inundated by the 100-year event for more than 2 days, but with the levee and culverts in place, inundation would be reduced to 3 hours. In effect, there would be access to more property for more time. There would be no additional project-induced flooding of property owners on the west side of the levee/culvert structure than what is already experienced.

The preliminary cost of Alternative 7 was estimated to be approximately $3.6 million, which includes 25% contingency; however, this estimate does not include design, permitting, real estate, construction management, or operation and maintenance. Average annual[3] benefits were estimated to be $217,000 through an analysis which used the number of parcels affected as a proxy for structures damaged. Average annual cost is approximately $156,000. The benefit to cost ratio is 1.4 to 1.

In conclusion, the complex Suwannee River Basin and sub-basins combined with topography, frequency, timing, and duration of rainfall have led to droughts causing inefficient water supplies and flooding which causes damages and impacts human safety. There is an opportunity for a future potential overall study to examine the regional problem in greater detail with a holistic approach to reduce damages and improve safety to residents during flood events.

[3] Annualized using a 3.5% discount rate over a 50-year period of analysis.

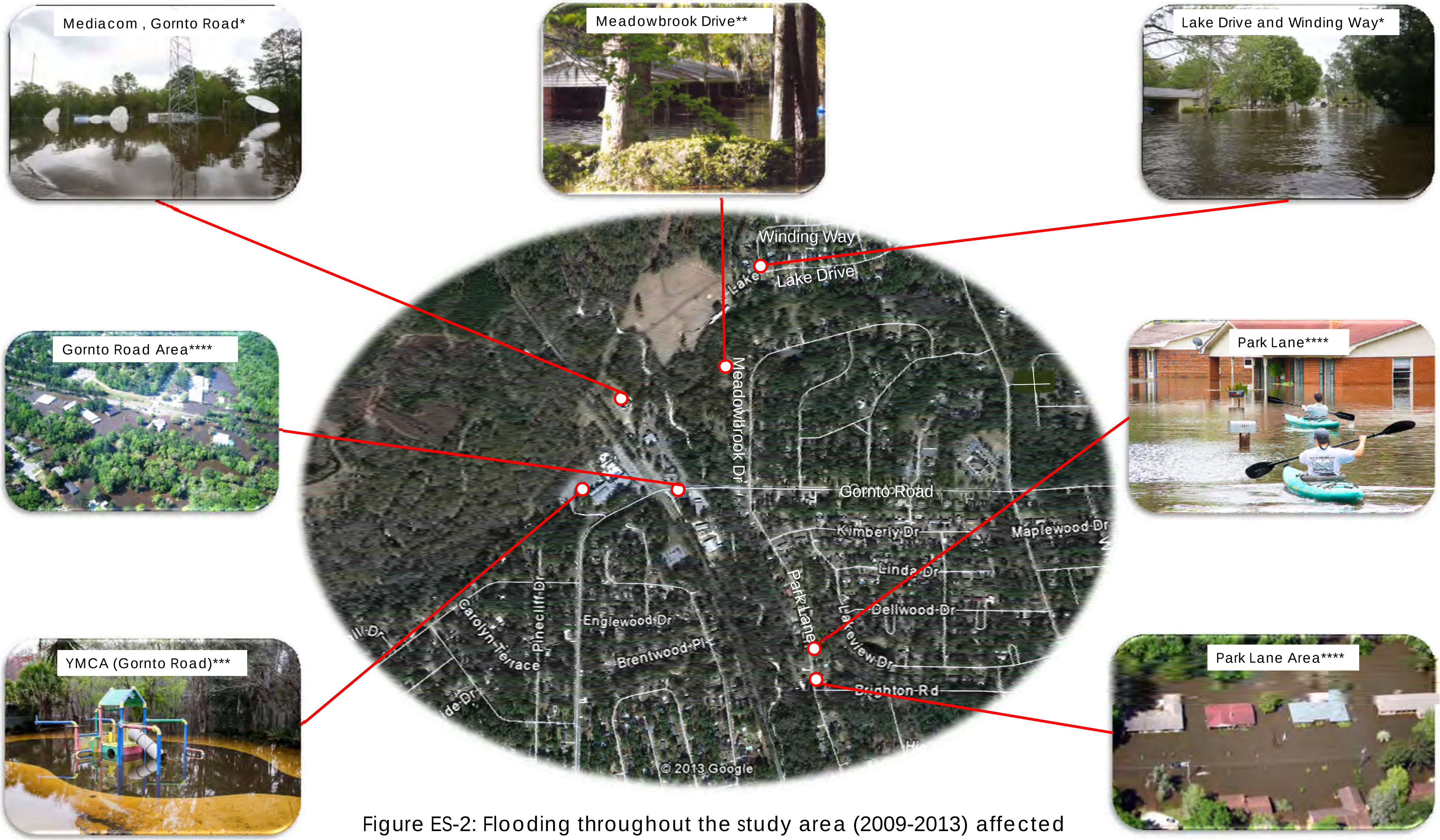
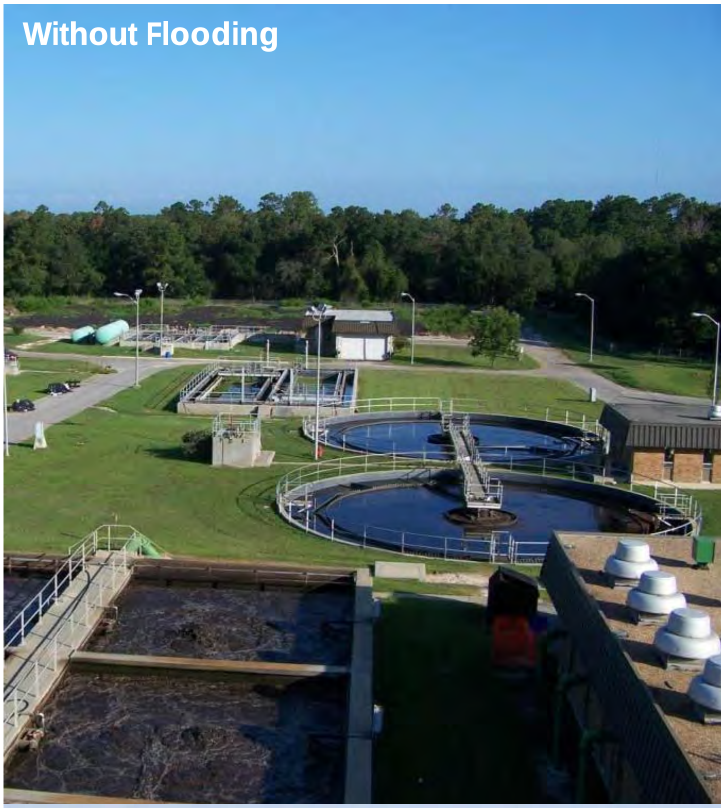


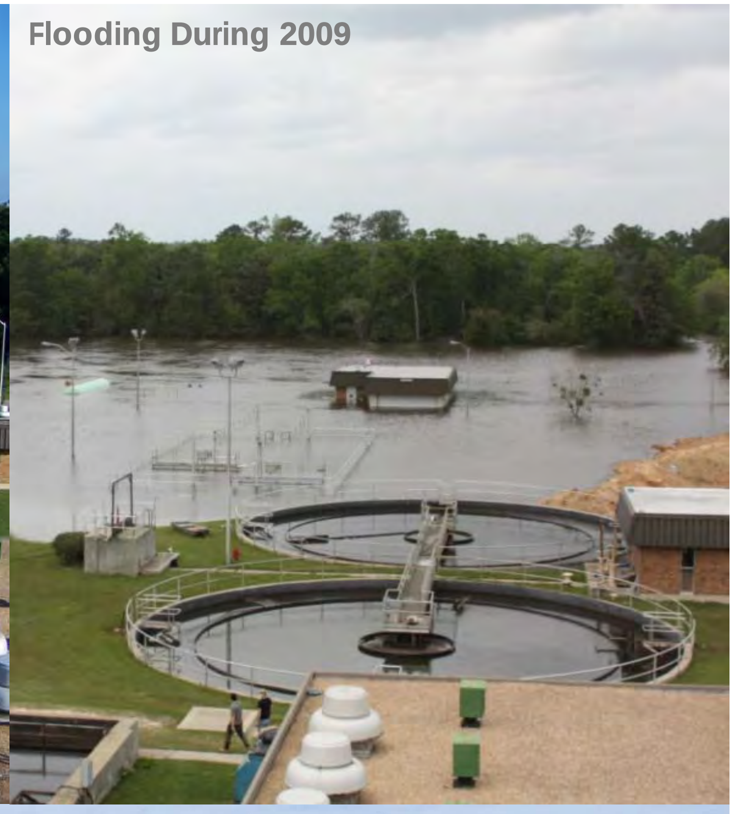
Figure ES-2: Flooding throughout the study area (2009-2013) affected residential and commercial properties, as well as institutional functions.

*Photo Courtesy of Lowndes County EMA, 2009
** Photo Courtesy of Dennis Schunhoff, 2009
*** Photo Courtesy of Valdosta Daily Times, 2013
**** Photo Courtesy of Valdosta Daily Times, 2009

Without Flooding



Flooding During 2009



Withlacoochee Wastewater Treatment Plant

Flooding During 2013

1.0 INTRODUCTION

City of Valdosta

Lowndes County

Chapter 1: Table of Contents

1 INTRODUCTION

STUDY AUTHORITY

The Withlacoochee River and Sugar Creek Flooding Analysis study was authorized under the Planning Assistance to States (PAS) provision, Section 22 of the Water Resources Development Act (WRDA) of 1974, Public Law 93-251, as amended, by Section 319 of the WRDA of 1990 and Section 2013 of the WRDA of 2007.

REPORT PURPOSE

This PAS study report delivers a preliminary analysis of structural and non-structural solutions, proposing a feasible solution for local implementation of a flood risk reduction project in the study area. The scope of this report is comparable to a United States Army Corps of Engineers (USACE) Section 905(b)[1] Analysis or Reconnaissance Report. This PAS study report will include a preliminary analysis of Federal interest, cost, benefits and environmental impacts, comparison of potentially feasible local solutions, and an estimate of the costs of preparing a watershed study or feasibility report. This report will assist in establishing potential Federal interest in pursuing future flood risk management studies in the study area and surrounding watershed(s) under other authorities, such as the Continuing Authority Program or Watershed Study Authority. This report is not associated with a Federal action to implement the findings of this flood analysis. Any participation from the U.S. Army Corps of Engineers (USACE) with implementation would require a Department of the Army Decision Document under a study authority as listed above and associated National Environmental Policy Act (NEPA) documentation.

The information presented in this report was generated to execute a preliminary analysis of flood impacts in the City of Valdosta caused by overflows of the Withlacoochee River, Sugar Creek, and Two Mile Branch confluence. When comparing this information to similar flood analyses, it should be noted that the results presented in this report are a product of the data and the method used. The analysis conducted was based on existing, readily available data, professional and technical judgment and USACE principles of flooding analyses.

Several alternatives were explored, resulting in one selected as a potentially feasible local solution under the extent of this report's authority and purpose. It is important to note that the underlying problem appears to be due to the overall Suwannee River Basin and sub-basin complexity, combined with topography, frequency, timing, and duration of rainfall which a future study could address in greater depth and more holistically.

[1] Section 205(b) of the 1986 Water Resources Development Act

STUDY SPONSOR

The non-federal sponsor for the study is the City of Valdosta, Georgia.

STUDY PURPOSE AND NEED

The purpose of the Withlacoochee River and Sugar Creek Flooding in Valdosta, Georgia study is to examine flooding in the northwest portion of the city caused by water from the Withlacoochee River and Little River rising and backing up into Sugar Creek and the Two Mile Branch tributary. This report will evaluate the potential flood impacts of 10-, 50- and 100-year storm events, using existing and readily available data, implementing USACE principles and technical judgment, to present potential solutions for flood risk management in the study area.

Definitions of storm events referred to in the report:

10-year event: A storm event that has a 10 percent chance of occurring in any year.

50-year event: A storm event that has a 2 percent chance of occurring in any year.

100-year event: A storm event that has a 1 percent chance of occurring in any year.

The City of Valdosta is located in south-central Georgia along the I-75 corridor, in Lowndes County. The city has a population of over 54,000 people and a land area of approximately 37 square miles.

Basin Characteristics

The city is located in the Georgia coastal plain in the central to lower portion of the Suwannee River basin (Reference Appendix D, Map 1), which extends into Florida and discharges into the Gulf of Mexico. The city drains into the Withlacoochee sub-basin and Alapaha River sub-basin, with the entire project area draining only into the Withlacoochee River sub-basin (Reference Appendix D, Map 2). The Little River sub-basin, although not within city limits, joins with the Withlacoochee sub-basin west of city limits, and also influences the study area. The main waterways in the project area are the Withlacoochee River, Sugar Creek, and Two Mile Branch which feeds into Sugar Creek (Reference Appendix D, Map 3).

The Withlacoochee River has a wide floodplain, which varies between 3,000 and 5,000 feet in the vicinity of the city. At the city, its drainage area is approximately 537 square miles.

Downstream of the city, the Withlacoochee River has a confluence with the Little River. Since the drainage area of the Little River, approximately 850 square miles, is larger than that of the Withlacoochee River at their confluence, flows from the Little River often exceed flows from the Withlacoochee River. Two Mile Branch drains into Sugar Creek approximately 1,000 feet above the confluence with the Withlacoochee River.

The flooding that has been experienced by the community is due to water in the Withlacoochee River and Little River rising and backing up into Sugar Creek and Two Mile Branch. The flooding generally does not occur when local rainfall and runoff events are centered over Valdosta. Rather, it occurs several days later as upstream flows from the Withlacoochee and Little River basins arrive, resulting in a significant rise of water stages in the adjacent sections of the Withlacoochee River. This has been termed “sunny-day” flooding by the local community.

Regional Impacts

During March and April of 2009, south Georgia and north Florida experienced historic flooding which resulted in 46 counties in Georgia and 17 counties in Florida declared as Federal Disaster Areas. According to the U.S. Geological Services (USGS) Fact Sheet 2009-3079, the Federal Emergency Management Agency (FEMA) reported that 1,875 homes and 29 businesses were affected by floodwaters and approximately $60 million in public infrastructure damage occurred in Georgia. Based on data collected during the 2009 storm event by the Lowndes County Emergency Management in cooperation with the Georgia Emergency Management Agency (GEMA) and FEMA, there were 172 residential and commercial properties impacted by flooding in Greater Lowndes County.

Local Impacts

During the 2009 flood event in Lowndes County, 172 properties were impacted and resulted in Lowndes County government having $4.1 million in documented damages to public infrastructure[2]. Approximately half of the properties impacted were located in the City of Valdosta near the confluence of Sugar Creek and the Withlacoochee River, with an estimated $2.5 million in damages to private residences in the study area. The properties within the city limits of the study, which include portions of Gornto Road, Lake Drive, Meadowbrook Drive, Park Lane, Ravenwood Circle, Winding Circle and Winding Way, were under water due to an overflow from Sugar Creek and the Withlacoochee River. Outside of the study area, but still within Lowndes County it is estimated that there was between $1.5 - $2 million dollars of additional damage to private property. Some of the impacts to residential and commercial properties, as well as institutional functions, are shown in Executive Summary, Figure ES-2. Several businesses in the study area were significantly flooded, such as the Young Men’s Christian Association (YMCA) and Mediacom, with estimated damages of $2.1 million. In addition, a portion of the Norfolk Southern Railway line went under water for a period of time but no estimated damage figures have been provided. Throughout Lowndes County, 10 bridges and close to 100 state and local roads were impacted, including a portion of U.S. Highway 84. In Lowndes County, but outside the immediate study area, the city’s Withlacoochee Wastewater Treatment Plant, which serves more than 70 percent of the city’s residents, commercial businesses, hotels and restaurants, was also significantly damaged by flood waters. The treatment plant experienced a complete loss of function for nine days and continued to be only partially operational for more than a month.

One of the public/institutional facilities impacted in Valdosta during the flood was the primary Mediacom transmission point, which services the cities of Valdosta, Hahira, Remerton, Nashville, and Adel, along with Lowndes and Brooks counties. When the transmission point went under more than six feet of water, nearly 12,000 customers lost telephone, internet and cable services, with the majority of customers without service for five days.

[2] Damages reported by Lowndes County Emergency Management Agency

In February and March of 2013, the City of Valdosta experienced flooding again at the confluence of Withlacoochee River and Sugar Creek, and Two Mile Branch, as well as throughout Lowndes County and neighboring communities. In Valdosta, multiple properties were flooded, yet only one commercial property had water enter the structure during this flood. Throughout Lowndes County, 13 roads and bridges were closed, including U.S. Highway 84. The city's Withlacoochee Wastewater Treatment Plant was impacted again due to flood inundation and had a loss of function for three days before becoming fully operational. Impacts to local county roads and infrastructure are estimated at $50,000.

The impacts of these flood events to human safety, as well as damages to residential areas, commercial areas, roads, bridges, and institutional facilities in the last five years within the City of Valdosta have established the need to conduct a flood analysis to examine a feasible solution to lessen future flood damages.

PRIOR STUDIES AND REGULATIONS

As a growing community, the City of Valdosta has a long history of flood management measures that have been implemented to better protect its citizens and businesses. Activities vary from participating in national programs such as the National Flood Insurance Program (NFIP), which is administered by FEMA and works closely with private insurance companies to offer flood insurance to property owners and renters, to land development regulations. The pertinent prior studies include:

<u>1977 – Flood Insurance Study (FIS)</u>
In September 1977, the first Flood Insurance Study (FIS) was issued. Flood hazard data required for the study were determined using standard hydrologic and hydraulic study methods. Floods having recurrence intervals of 10-, 50-, 100 and 500 years were selected as having special significance for flood plain management and flood insurance premium rates. Water surface profiles were developed using the USACE Hydrologic Engineering Center (HEC) program. Flood Insurance Rate Maps (FIRMs) were generated based on the FIS. The first effective map was January 19, 1978. The latest effective date for both the FIS and FIRMs is September 26, 2008 and is a digital version of the original maps.

<u>1996 – Master Stormwater Management Plan</u>
The city hired Reynolds, Smith and Hills, Inc (RS&H) to conduct its first stormwater management plan, which was completed in 1996. This study included analysis of the existing system, hydrologic/hydraulic modeling, determination of deficiencies, and outlined a 10-year Capital Improvements Plan (CIP). The XP-SWMM[3] model was used and the plan's primary focus was on flood control, but did not consider water quality elements that are essential for the city's sustainable growth.

<u>2002 – Phase II Stormwater Community</u>
In July 2002, the city was notified by the Georgia Environmental Protection Division (EPD) that it met the requirements under the National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Final Rule that requires certain cities and counties to obtain a Municipal Separate Stormwater Sewer System (MS4) NPDES permit. As part of the requirement, the city had to apply for coverage under a

[3] XP-SWMM is a comprehensive software package for dynamic modeling of stormwater systems, sanitary or combined systems, and river systems. It simulates natural rainfall-runoff processes and the hydraulic performance of drainage systems used to manage our water resources.

NPDES permit by March 2003 and to develop, implement and enforce a Stormwater Management Program (SWMP) that addresses the following six minimum control measures (MCM):

- Public Education and Outreach on Stormwater Impacts
- Public Involvement / Participation
- Illicit Discharge Detection and Elimination (IDDE)
- Construction Site Stormwater Runoff Control
- Post – Construction Stormwater Management in New Development and Redevelopment
- Pollution Prevention / Good Housekeeping for Municipal Operations

Within each MCM, the city had to select Best Management Practices (BMPs) and set measurable goals. In addition, the city is required to provide an annual report to the Georgia EPD that outlines the activities to ensure the city remains in compliance. The NPDES Permit must be renewed every five years and the 2012 -2017 permit and SWMP is available online at www.valdostacity.com/stormwater.

2006 – Stormwater Utility Ordinance

To improve the city's overall stormwater management as well as to help comply with the NPDES permit requirements, the city adopted the Stormwater Utility Ordinance in March 2006. The ordinance established a fair and equitable rate structure, while providing a dedicated funding source to carry out the overall operation and maintenance of the city's stormwater system. In conjunction with the Stormwater Utility Ordinance, the city also created an Adjustment and Credit Manual. This manual outlines the guidelines under which the city will grant adjustments and credits to stormwater user fees for non-residential properties. These documents are available online at:
www.valdostacity.com/stormwater.

2006 – Stormwater Ordinance

In December 2006 the city adopted the Stormwater Ordinance to formally establish a set of stormwater management requirements and procedures to provide reasonable guidance for the regulation of post – development stormwater runoff for both new development and redevelopment. By regulating the post – development stormwater discharges, it assists in controlling and minimizing increases in stormwater runoff rates and volumes, soil erosion and sedimentation, stream channel degradation, and non-point source pollution.

2006 -- Greater Lowndes 2030 Comprehensive Plan

The Greater Lowndes 2030 Comprehensive Plan was completed in 2006 and is a road map for ensuring growth and development in the Greater Lowndes Communities occurs in a way as to maintain its quality of life and unique community character. The Plan includes forecasts and discussions of population, economic development, housing, natural and cultural resources, national register eligibility lists, community facilities and services, and intergovernmental coordination.

2007 – Two Mile Branch Watershed Management Plan

In 2007, Stantec Consulting Services Inc completed the Two Mile Branch Watershed Management Plan as part of a Section 319(h) grant. The purpose of this study was to evaluate Two Mile Branch, which is listed on the impaired water 303(d) list by the Georgia EPD for fecal coliform, and to identify potential solutions. No new data was collected, but existing information such as water quality monitoring data, Geographical Information System (GIS) watershed studies, and stormwater related ordinances were used during the evaluation. Several structural and non-structural BMPs, along with education and outreach activities, were identified to help reduce the fecal coliform levels in Two Mile Branch. This document is available online at www.valdostacity.com/stormwater.

2009 – Land Development Regulations

The city utilizes a series of regulations to ensure the overall development of the community is consistent with the Greater Lowndes 2030 Comprehensive Plan. Due to numerous changes over the years, the city reviewed each of the regulations and ordinances, updated as necessary, and compiled them into one document, known as the Land Development Regulations (LDR). The LDR is divided into three main sections, which include Title 1 - Administration, Title 2 - Land Use and Zoning, and Title 3 - Development and Permitting. Within this document there are several sections that are directly or indirectly related to flood management, which include but are not limited to:

- Chapter 306: Soil Erosion, Sedimentation, and Pollution Control
- Chapter 310: Stormwater Management
    - Article 1: Post Development Stormwater Management
    - Article 2: Stormwater Utility
    - Article 3: Illicit Discharge
    - Article 4: Stream Buffer Protection
- Chapter 320: Flood Damage Prevention

The LDR was adopted in December 2008 and became effective January 2009. This document is available online at www.valdostacity.com.

2010 – Master Stormwater Management Plan Update

To ensure that the city's policies, activities, and programs address existing and future conflicts between flooding and development, while improving water quality, the city hired the consultant firm Camp, Dresser and McKee, now known as CDM Smith, in 2008 to update its stormwater management plan. The update was completed in 2010 and included the following:

- Definitions of levels of service
- Establishment of a benchmark network (NAVD88[4])
- Geomorphic assessment of Sugar Creek
- Update and upgrade of existing models (SWMM version 5.0.014)
- Identification of problem areas
- Development of flood control and water quality improvements
- Ranking of future capital improvement projects

This document is available online at www.valdostacity.com/stormwater.

[4] North American Vertical Datum of 1988 (NAVD88) is the vertical control datum of orthometric height established for vertical control surveying in the United States of America based upon the General Adjustment of the North American Datum of 1988.

Park Lane Without Flooding

Flooding During 2009

2.0 EXISTING/FUTURE WITHOUT PROJECT CONDITIONS

City of Valdosta
Lowndes County

Chapter 2: Table Of Contents

2 EXISTING AND FUTURE CONDITIONS

> Reference Appendix A, Hydrology and Hydraulics Analysis, and Appendix D, Maps, throughout this Chapter.

This chapter describes the existing physical, built, natural, and economic environment in the study area within the City of Valdosta. This chapter provides both the existing conditions (a baseline) as well as a broad forecast of the future conditions, located in blue boxes at the end of each section, for each main category.

2.1 PHYSICAL ENVIRONMENT

2.1.1 RIVER BASINS, WATERSHEDS AND HYDROLOGY

Lowndes County is located within the Suwannee River Basin, which is 9,950 square miles, and is one of the last large intact river drainages remaining in the United States (Reference Appendix D, Map 1). In Lowndes County, the Suwannee River Basin can be subdivided into 3 sub-watersheds: the Withlacoochee, the Little River, and the Alapaha (Reference Appendix D, Map 2).

The Withlacoochee sub-watershed encompasses approximately 50% of the county's total land area, which includes the north central and southwest portion of the county. Major tributaries of the Withlacoochee River include: Bay Branch, Cherry Creek, Spring Branch, Sugar Creek, Tiger Creek, and Two Mile Branch. The Little River sub-watershed is located in the northwest portion of the county. The major tributaries of the Little River include: Big Creek, Franks Creek, and Steep Hill Branch. The remaining portion of the county (along the eastern border with Lanier and Echols) is within the Alapaha sub-watershed; each sub-watershed flows southeastward to the Suwannee River in Florida and then eventually to the Gulf of Mexico. (Comprehensive Plan 2030)

The project area is at the confluence of two waterways: the Withlacoochee River and Sugar Creek (Reference Appendix D, Map 3). This study also includes Two Mile Branch, which discharges into Sugar Creek just before it enters the Withlacoochee River. The project area drains into the Withlacoochee sub-basin that is also joined by the Little River sub-basin just west of the city limits.

The Withlacoochee River is densely vegetated, relatively flat, and has a wide floodplain, which varies between 3000 and 5000 feet in the vicinity of Valdosta, Georgia. At Valdosta, its drainage area is approximately 537 square miles.

There is approximately 39 feet of elevation drop in the 16.9 miles of river reach beginning at McMillan Road (USGS Gage 023177483), near Bemiss, Georgia, and ending at US 84 (USGS

Gage 02318500), near Quitman, Georgia. The reach immediately below the confluence of Sugar Creek with the Withlacoochee River is essentially flat and has less than 0.5 foot of elevation drop over the next 6.9 miles.

In contrast to the Withlacoochee River, the topography of the City of Valdosta and its creeks is much steeper. The lower reach of Sugar Creek, which drains directly into the Withlacoochee River, has an average slope of over 18 feet per mile. Two Mile Branch is another stream that drains into Sugar Creek and is approximately 1000 feet upstream of the confluence with the Withlacoochee River, and has an average slope of 35 feet per mile.

Downstream of the City of Valdosta, the Withlacoochee River has a confluence with the Little River. The Little River is also heavily vegetated and relatively flat. Since the drainage area of the Little River (approximately 850 square miles), is larger than that of the Withlacoochee River at their confluence, flows from the Little River often exceed flows from the Withlacoochee River.

CONFIRMATION OF EXISTING CONDITIONS

The USACE conducted modeling during this study using the certified model Hydrologic Engineering Centers River Analysis System (HEC-RAS)[1]. Reference Appendix A for details of how the modeling was conducted, as well as assumptions and results.

Modeling existing conditions for the 10-, 50-, and 100-year storm frequencies clearly showed that the flooding that occurs in the City of Valdosta is not due to any conveyance or structural issues within the city's flood control system. **The flooding is due to rising water in the Withlacoochee River and Little River which backs up into Sugar Creek and Two Mile Branch.** This conclusion from the modeling has also been previously confirmed anecdotally from observations during the 2009 and 2013 flood events. City of Valdosta representatives noted that flooding of the properties along Sugar Creek and Two Mile Branch did not occur during the time that the local rainfall and runoff event was centered over Valdosta, but that "sunny-day" flooding of these properties occurred several days later as upstream flows from the Withlacoochee and Little River basins arrived and resulted in a significant rise of water stages in the adjacent sections of the Withlacoochee River.

[1] A USACE certified model.

2.1.2 EROSION AND SEDIMENTATION

There are often areas of erosion and sedimentation within an urban environment, such as along ditches and waterways. As identified in the Two Mile Branch study, the single largest source of sediment was the channel itself and will continue until measures are taken to stabilize the stream in combination with stormwater control measures. Projects have been identified in the Two Mile Branch study as well as the city's Master Stormwater Management Plan to both help address water quality and water quantity. This can be accomplished by retrofitting existing conditions or new/re-developments that occur and must meet new regulations.

In addition, the city has an ordinance and active Soil Erosion and Sediment Control program. As the Local Issuing Authority (LIA), the city's program addresses erosion and sedimentation (E&S) from land-disturbing activities as defined by the Georgia Soil and Water Conservation Commission (GSWCC). In addition, after December 31, 2006, all persons involved in land development design, review, permitting, construction, monitoring, or inspection of any land disturbing activity must meet the education and training certification requirements. The degree of education and training is dependent on the level of involvement with the land disturbance activity process. As the LIA, when a site is found to not be in compliance, the necessary enforcement actions are in place so that compliance can be achieved.

2.1.3 CLIMATE

The average temperatures in Valdosta, Georgia range from a low of 36 degrees Fahrenheit (F) and high of 62 degrees F in the average coldest month (January) to a low of 70 degrees F and a high of 92 degrees in the average hottest month (July).

FUTURE CONDITIONS – PHYSICAL ENVIRONMENT

Conditions in the physical environment for the hydrologic system and climate will most likely continue to be the same in the future and flooding will continue to occur. Erosion and sedimentation could vary (improve or remain constant) depending on the enforcement of best management practices.

2.2 BUILT ENVIRONMENT

2.2.1 RESIDENTIAL AND COMMERCIAL STRUCTURES

Within the study area, there are 347 real estate parcels which are mostly residential. According to USACE modeling and analysis during this study, 221 parcels in the study area could be affected by the 100-year storm. Past storms from 2009 and 2013 have flooded residential and commercial properties within the project area, as well as institutional facilities, as shown on the graphic illustration in Figure ES-2. In 2009, the major media provider in the area, Mediacom, was flooded and resulted in failure to provide telephone, internet and cable services to nearly 12,000 customers with the majority of customers without service for five days. Mediacom has since elevated its structures by approximately 8 feet. Infrastructure in the project area can be found on Map 7, Appendix D.

2.2.2 WATER SUPPLY

Typical of coastal plain areas, most of the consumer water comes from groundwater. The City of Valdosta Water Treatment Plant obtains the city's water supply from 7 wells that are drilled into an underground layer of porous, water-bearing limestone known as the Upper Floridan Aquifer. This state-of-the-art plant is located north of the city and supplies drinking water for local residents, businesses, and industries. The plant was renovated and expanded in 2007 and was the first municipal plant in Georgia to use ozone technology as the primary treatment process.

2.2.3 WASTEWATER TREATMENT

The City of Valdosta operates two wastewater treatment facilities, the Withlacoochee River Water Pollution Control Plant (WPCP) and the Mud Creek WPCP. The Withlacoochee River plant serves the project area within the city limits and has a capacity of 8.0 million gallons per day (MGD) as an average annual daily flow with the capacity to treat peak flows up to 12.0 MGD. Due to the significant flooding of the Withlacoochee plant and sewer collection system, the city is in the process of replacing the existing 54" gravity trunk line with a new force main and relocating the plant for an estimated total of $56 million.

2.2.4 FLOODPLAIN DEVELOPMENT

In Greater Lowndes County and the City of Valdosta, flood zones have been identified by FEMA. This information is available in hard copy and digital format and used by staff for development purposes. While new or re-development is allowed in Zone A and Zone AE (100 year flood zones) it must meet FEMA standards that have been adopted locally. New or re-development is not allowed within floodways.

FUTURE CONDITIONS – BUILT ENVIRONMENT

Conditions in the built environment will most likely continue to be the same in the future. Future storms will continue to affect the study area through flooding, loss of city facilities, and threatening human safety. Floodplain development could be influenced by human action.

2.3 NATURAL ENVIRONMENT

2.3.1 WETLANDS

Wetlands exist along floodplains of the major rivers but most are primarily in small pockets which are connected by numerous small streams. Wetlands account for roughly 75,960 acres in Lowndes County. (2030 Comprehensive Plan)

2.3.2 GROUNDWATER RECHARGE AREAS

All aquifer recharge areas are vulnerable to both urban and agricultural development. Pollutants from stormwater runoff and septic tanks in urban areas and excess pesticides and fertilizers in agricultural areas can access a groundwater aquifer more easily through these recharge areas. Once in the aquifer, pollutants can spread uncontrollably to other parts of the aquifer thereby decreasing or endangering water quality for an entire region. Groundwater recharge areas make up 77,991 acres, or 23.9%, of Lowndes County. (2030 Comprehensive Plan)

2.3.3 PROTECTED RIVER CORRIDORS

River corridors within Lowndes County and the City of Valdosta total approximately 66-miles in length. Under the Mountain and River Corridor Protection Act, Lowndes County and the City of Valdosta are required to adopt a "Corridor Protection Plan" for designated river segments (in accordance with the minimum criteria contained in the Act and as adopted by the Georgia Department of Natural Resources). The current zoning map for Lowndes County and development regulations indicates a "Flood Hazard" zoning district around all of the designated corridors within Lowndes County. The district generally follows Federal Emergency Management Agency's (FEMA) designated floodplain boundaries, which typically include a much wider area than the state designated corridor, which is 25 feet on each side of the river. The zoning district allows plant nurseries and commercial greenhouses as a permitted use, and the following uses by special exception: public recreation center, school, commercial amusement, hunting preserves, riding stables, bait & tackle shops, nursery schools, transmission towers, and utility substations. The City of Valdosta currently has no special flood hazard zoning district and most of the city's affected portion is currently zoned low-density single-family residential. (2030 Comprehensive Plan)

2.3.4 FLOODPLAINS

Flood hazards along the major rivers and streams usually occur in late winter and early spring. The Federal Emergency Management Agency (FEMA) has prepared official flood area maps, also known as Flood Insurance Rate Maps (FIRMs) for both Lowndes County and the City of Valdosta. Flood prone areas in Lowndes County in general are adjacent to the Withlacoochee and Little Rivers and in nearby riverine wetlands. Other flooding corridors exist in urban areas and influence development patterns. (2030 Comprehensive Plan)

2.3.5 WATER RESOURCES

The annual precipitation for Lowndes County averages 52 inches, representing the volume of water directly entering ponds, rivers, and streams. Surface drainage flows in a dendritic, or branching tree-like, pattern, which generally directs water eastward and southeastward. (2030 Comprehensive Plan)

2.3.6 ENVIRONMENTAL RESOURCES

The U.S. Fish and Wildlife Service (USFWS) has identified four threatened, endangered, or candidate species, and/or designated critical habitat in Lowndes County as of August 2013 (See **Table 2-1**). Prior to design, impacts to the following species should be identified and coordinated with Georgia Ecological Services Field Office.

Table 2-1. USFWS threatened, endangered or candidate species

Type	Scientific Name	Common Name	Status
Amphibian	Notophthalmus perstriatus	Striped newt	Candidate
Bird	Mycteria americana	Wood stork *Population: AL, FL, GA, SC*	Endangered
Reptile	Drymarchon corais couperi	Eastern Indigo snake *Population: Entire*	Threatened
Reptile	Gopherus polyyphemus	Gopher tortoise *Population: Eastern*	Candidate

In addition, the USFWS provides wetland information through the National Wetlands Inventory Program (NWI). Impacts to wetlands must be considered both in and outside of the project area due to the hydrologic nature of wetlands.

The Georgia Department of Natural Resources (DNR) – Wildlife Resources Division has identified 53 rare elements, which includes plants, animals and other natural communities/occurrences in Lowndes County (See **Table 2-2**). The species listed with the status of “US” indicates they have a federal status of Protected or Candidate, which are also protected in Georgia. Those listed with “GA” are Georgia protected species. Those without a status designation are rare elements.

Table 2-2. Georgia DNR protected species

Type	Scientific Name	Common Name	Status
Amphibian	Ambystoma cingulatum	Frosted Flatwoods Salamander	US
	Ambystoma tigrinum tiginum	Eastern Tiger Salamander	
	Notophthalmus perstriatus	Striped Newt	GA
	Pseudobranchus striatus striatus	Broad-striped Dwarf Siren	
Bird	Aimophila aestivalis	Bachman’s Sparrow	GA
	Botaurus lentiginosus	American Bittern	
	Elanoides forticatus	Swallow-tailed Kite	GA
	Grus Canadensis pratensis	Florida Sandhill Crane	
	Haliaeetus leucocephalus	Bald Eagle	GA
	Lanius ludovicianus migrans	Migrant Loggerhead Shrike	
	Mycteria Americana	Wood Stork	US
	Nyctanassa violacea	Yellow-crowned Night-heron	
	Plegadis falcinellus	Glosspy Ibis	
Fish	Alosa alabamae	Alabama Shad	GA
	Ameiurus serracanthus	Spotted Bullhead	GA
	Elassoma gilbert	Gulf Coast PygmySunfish	
	Fundulus chrysotus	Golden Topminnow	
	Fundulus cingulatus	Banded Topminnow	
	Micropterus notius	Suwannee Bass	GA
	Pteronotropis metallicus	Metallic Shiner	
	Umbra pygmaea	Eastern Mudminnow	
Mammal	Ursus americanus floridanus	Florida Black Bear	

Plant	Agalinis aphylla	Scale-leaf Purple Foxglove	
	Agalinis divaricate	Pineland Purple Foxglove	
	Agalinis Georgiana	Georgia Purple Foxglove	
	Baptisia lecontei	Leconte Wild Indigo	
	Carex fissa var. aristata	Sedge	
	Carex lupuliformis	Hop Sedge	
	Drosera tracyi	Tracy's Dew-threads	
	Epidendrum magnolia	Greenfly Orchid	GA
	Fuirena scirpoidea	Southern Umbrella-sedge	
	Lachnocaulon beyrichianum	Southern Bog-button	
	Lisea aestivalis	Pond Spice	
	Lobelia boykinii	Boykin Lobelia	
	Macbridea caroliniana	Carolina Bogmint	GA
	Oxypolis ternate	Savanna Cowbane	
	Polygala leptostachys	Georgia Milkwort	
	Quercus austrina	Bluff White Oak	
	Sarracenia flava	Yellow Flytrap	GA
	Sarracenia minor var. minor	Hooded Pitcherplant	GA
	Tragia cordata	Heartleaf Nettle Vine	
	Triphora trianthophora	Three-birds Orchid	
Reptile	Clemmys guttata	Spotted Turtle	GA
	Crotalus adamanteus	Eastern Diamond-backed Rattlesnake	
	Drymarchon couperi	Eastern Indigo Snake	US
	Gopherus polyphemus	Gopher Tortoise	US
	Macrochelys temminckii	Alligator Snapping Turtle	GA
	Pituophis melanoleucus mugitus	Florida Pine Snake	
	Pseudemys concinna suwanniensis	Suwannee River Cooter	
	Regina alleni	Striped Crayfish Snake	
	Tantilla relicta	Florida Crowned Snake	

2.3.7 WATER QUALITY

Based on the Georgia Department of Natural Resources (DNR) –EPD 2012 305(b) and 303(d) list, there are nine stream segments designated as not-supporting/impaired in Lowndes County, as shown below in **Table 2-3**. An impaired stream is defined as containing more than the legal limit of pollutants and is determined to not meet water quality standards.

Table 2-3. 2012 305(b) and 303(d) list of stream segments designated as not supporting/impaired in Lowndes County.

Reach Name	Reach Location	County	Criterion Violated	Extent (miles)
Alapaha River	U.S. Hwy. 129/Ga. Hwy. 11 to Stateline	Berrien/ Atkinson/ Lanier/ Lowndes/ Echols County	TWR[2]	102
Cat Creek	Beaverdam Cr. downstream SR 37 to Beatty Mill Creek	Berrien/ Lowndes County	DO[3]	4
Franks Creek	St. Rt. S1780 to Little River near Hahira	Lowndes County	FC[4]	9
Mud (Swamp) Creek	D/S Valdosta Mud Cr. WPCP to Alapahoochee River	Lowndes County	FC	10
Two Mile Branch	Headwaters to Sugar Cr., Valdosta	Lowndes County	FC	2
Withlacoochee River	New River to Bay Branch	Cook/Berrien/ Lowndes County	TWR	23
Withlacoochee River	Bay Branch to Little River	Lowndes County	FC, TWR	9
Withlacoochee River	Little River to Okapilco Creek	Brookes/Lowndes County	FC, TWR	15
Withlacoochee River	Okapilco Creek to Stateline	Brookes/Lowndes County	TWR	14

Source: Georgia's 2010 Integrated 305(b).303(d) Report by Georgia Environmental Protection Division, Department of Natural Resources.

The Southern Georgia Regional Commission has partnered with the Georgia Environmental Protection Division (EPD) to develop local Total Maximum Daily Load (TMDL) Implementation Plans for stream segments in the Suwannee Basin that had been identified as impaired water bodies. Two Mile Branch is located within the study area.

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[2] TWR: Trophic-Weighted Residue Value of mercury in fish tissue exceeding the EPD human health standard of 0.3 mg/kg

[3] DO: Dissolved Oxygen.

[4] FC: Fecal Coliform

2.3.1 CULTURAL RESOURCES

The area directly affected by the 2009 and 2013 flood events in Valdosta is primarily residential in character and land use (Reference Appendix D, Map 4). The Meadowbrook, Dellwood Acres, and surrounding subdivisions were built beginning in the 1960s through the 1980s; therefore, houses in these neighborhoods built in 1963 or earlier have reached the minimum 50-year criterion used by the National Register of Historic Places (NRHP) to identify potentially historic resources. Additionally, these neighborhoods contain mostly ranch style houses, which have reached historical status. The State Historic Preservation Office – Georgia DNR, Historic Preservation Division (HPD) - has created a statewide historic context for use when identifying the ranch house type. Because of this, a survey of the flood area was conducted and houses with a construction date of 1964 and older were identified and photographed as potential historic resources.

The Lowndes County Historic Resources Survey of 2000 – 2004 (Valdosta Heritage Foundation, Catherine Wilson-Martin, accessible through www.gnahrgis.org) identified other historic resources in or near the flood area, which can also be seen on Map 6 (Appendix D):

- ID#43647 – Crocked Creek Rd. House, ca. 1940
- ID#43648 – Crocked Creek Rd. House, ca. 1890
- ID#43719 – Troupville Cemetery (Black), ca. 1840
- ID#45992 – 103 Wayne Avenue House, ca. 1952
- ID#46485 – Joree Mill Pond Dam, ca. 1870
- ID#71706 – 2605 Pebblewood Dr. House, ca. 1866 (moved from downtown, Henry Holliday House)
- ID#71711 – Troupville Cemetery, ca. 1830

2.3.2 RECREATION RESOURCES

The City of Valdosta and Lowndes County have an established Parks and Recreation program which provides recreational opportunities to the community. A Master Plan was recently completed which provides recommendations for future opportunities. (Comprehensive Plan 2030)

While the existing recreational resources are limited in the project area, there is an opportunity for parks, conservation areas, greenspace and trails.

The study area is an established suburban environment that primarily consists of residential development with some commercial uses along the Gornto Road portion. The majority of the project area within the county is wooded and privately owned.

The main waterways in the project area are Sugar Creek, Two Mile Branch, and the Withlacoochee River. Each of these waterways has a classification use of "Fishing" by the Georgia Environmental Protection Division. Under most normal conditions, the water level is very low and would not allow for boating activities, especially within Sugar Creek and Two Mile Branch.

FUTURE CONDITIONS – NATURAL ENVIRONMENT

Conditions in the natural environment will most likely continue to be generally the same in the future. Water quality and recreational resources could vary in the future depending on human actions.

2.4 SOCIO-ECONOMIC ENVIRONMENT

2.4.1 GENERAL

The City of Valdosta is located in Lowndes County, Georgia. As of the 2010 Census, the county population was 109,233. Valdosta is home to about half of the county population with 54,518 people. The median age is 26.9 years. 43.3% is white, and 51.1% is black or African American.

2.4.2 LOCAL ECONOMY AND DEMOGRAPHICS

Lowndes County has 43,921 housing units, with 39,747 occupied, while Valdosta has just over half of those at 22,709 housing units, with 20,471 occupied. The average household size is 2.46.

There are 2,725 businesses in Lowndes County, with 1509 in Valdosta[5]. The largest number of establishments is in the retail trade and health care industries. However, the manufacturing industry has the highest total value of revenue, followed by retail trade. The median household income in Valdosta is $30,879[6].

During the 2009 flood, about 80 structures in the study area were impacted by flooding. Several businesses in the study area were significantly flooded, such as the Young Men's Christian Association (YMCA) and Mediacom, with estimated damages of $2.1 million. In

[5] 2007 Economic Census
[6] 2008-2012 American Community Survey 5-Year Estimates

addition, a portion of the Norfolk Southern Railway line went under water for a period of time but no estimated damage figures have been provided. Throughout Lowndes County, 10 bridges and close to 100 state and local roads were impacted, including a portion of U.S. Highway 84. In Lowndes County, but outside the immediate study area, the city's Withlacoochee Wastewater Treatment Plant, which serves more than 70 percent of the city's residents, commercial businesses, hotels and restaurants, was also significantly damaged by flood waters.

In February and March of 2013, the City of Valdosta experienced flooding again within the study area. In Valdosta, multiple properties were flooded, yet only one commercial property had water enter the structure during this flood. Throughout Lowndes County, 13 roads and bridges were closed, including U.S. Highway 84. The city's Withlacoochee Wastewater Treatment Plant was impacted again due to flood inundation and had a loss of function for three days before becoming fully operational. Impacts to Lowndes County Government roads and infrastructure are estimated at $50,000.

2.4.3 LAND USE

As the city continues to grow and develop, quality long term planning is essential to preserving the community's unique character and high quality of life. As part of the Greater Lowndes 2030 Comprehensive Plan, which was completed in October 2006, future growth and development were based on infrastructure plans for transportation, water, sewer, and the development suitability of land, existing land uses, and existing zoning. Existing and future land use can be found on Map 4 and Map 5 (Appendix D), respectively.

As part of the 2010 Stormwater Master Plan, CDM Smith utilized existing GIS land use information to summarize the land use distribution for the city, which included:

- 29% residential (low, medium, high density)
- 25% forest, open, and park
- 16% agricultural
- 15% heavy industrial and roadways
- 14% light industrial, commercial and institutional
- 1% wetlands, watercourses and water bodies

For the specific study area, the land use can be can be classified as:

- 29% residential
- 56% undeveloped / Conservation
- 1% transportation utility
- 4% public / institutional
- 3% commercial
- 6% parks / recreation / conservation
- 1% industrial

FUTURE CONDITIONS – ECONOMIC ENVIRONMENT

Conditions in the economic environment will most likely continue to be the same in the future.

Flooding During 2009

Gornto Road Without Flooding

3.0 PLAN FORMULATION

City of Valdosta

Lowndes County

Chapter 3: Table Of Contents

3 PLAN FORMULATION

3.1 PLAN FORMULATION RATIONALE

꧁ Reference Appendix A, Hydrology and Hydraulics Analysis, and Appendix D, Maps, throughout this Chapter.

Plan formulation for this study followed U.S. Army Corps of Engineers (USACE) guidance for a report with a scope comparable to a USACE Section 905(b)[1] Analysis or Reconnaissance Report.

As such, structural and non-structural management measures were first formulated to lay out a basis for alternatives. A management measure is a feature (a structural element that requires construction or assembly on-site) or an activity (a nonstructural action) that can stand alone or be combined with other management measures to form alternative plans. Management measures were then combined to form alternative plans, and the plans were then evaluated based on limited economic, engineering and environmental factors. After evaluation and comparison of alternative plans, one alternative was selected as a feasible local solution to be modeled and further developed with a preliminary design and cost.

3.2 PROBLEMS AND OPPORTUNITIES

3.2.1 PROBLEMS

Regionally, the complex Suwannee River Basin and sub-basins combined with topography, frequency, timing, and duration of rainfall have led to droughts causing inefficient water supplies and flooding which causes damages and impacts human safety. Within the City of Valdosta, the flooding events in the last five years have impacted human safety as well as led to excessive damages to residential areas, commercial areas, roads, bridges and city facilities.

3.2.2 OPPORTUNITIES

There is an opportunity for an overall watershed study to reduce damages and improve safety to residents during flood events, as well as to curb the drought problems with a broad regional solution. There is an opportunity with this local study to reduce the depth and duration of flooding within the Sugar Creek and Two Mile Branch watershed in the study area. There could be an opportunity to investigate multiple purposes for solutions, such as recreational opportunities during certain reasonable timeframes.

[1] Section 205(b) of the 1986 Water Resources Development Act

3.3 CONSTRAINTS AND OBJECTIVES

3.3.1 CONSTRAINTS

The planning constraints that limited or influenced the type of measures that were considered include:

1. Although this study recognizes a need for a regional solution, the scope is limited to the flood prone areas at the confluence of the Withlacoochee River and Sugar Creek, including Two Mile Branch.

2. Avoiding induced flooding of adjacent properties within the study area.

3. Avoiding or minimizing impacts to environmental and cultural resources that could be found within the study area.

3.3.2 OBJECTIVES

An analysis of the problems, needs, and opportunities in the study area related to water and land related resources resulted in the identification of three planning objectives:

1. Improve safety for residents during flood events in Valdosta, within the study area.

2. Reduce property losses (damages) in Valdosta due to flooding, within the study area.

3. Minimize impacts to environmental resources within the study area.

3.4 SUMMARY OF MANAGEMENT MEASURES

This section describes both non-structural management measures and structural management measures. Non-structural management measures can be used to manage the risk of flooding for cities and their residents. These measures do not require construction, but instead focus on a good understanding of the flood hazard. Structural management measures, in contrast, involve construction or an investment in infrastructure. In many cases, a combination of structural and non-structural measures can be effective.

Four non-structural and four structural management measures were identified to fully or partially address the planning objectives previously identified. In addition, although not a specific part of this study, an additional measure was identified which could address regional problems.

The non-structural measures considered are: full acquisition/buy out, flood proofing, elevation, and education. The structural measures considered for this localized study include varied channel improvements and levees and/or floodwalls. For an overall regional approach, a more broad structural measure was identified, such as storage reservoirs. All measures considered are described below:

- **No Action**: The no-action alternative is always considered. This alternative is used to compare the performance of the other alternatives.

- **Local Non-Structural**

  - Full acquisition/buy-out – Residents would be relocated outside of the flood prone areas. An acquisition program would increase public safety, reduce flood vulnerability, and reduce future flood damages.
  - Flood proofing – Flood proofing is a change and/or adjustments, which allow flood waters to rise around or within a structure with little or no damaging effects to the structure. Flood proofing techniques do not eliminate residual nuisance damage, loss of access, loss of business, possible utility and community interruptions, and potential danger to public health and safety.
  - Elevation – Involves raising the buildings in place so that the structure sees a reduction in frequency and/or depth of flooding during high-water events. Elevation can be done on fill, foundation walls, piers, piles, posts or columns. Selection of proper elevation method depends on flood characteristics such as flood depth or velocity. Residential and/or commercial structures would be raised above the 2073 flood elevations predicted by the model.
  - Education – Outreach to the community about flood risk in their zones could be a useful tool. The first step is educating officials and planners about the existence and nature of a flood hazard, who can in turn educate the public. A critical tool for educating the public is floodplain mapping. Once generally aware of the flood hazards, education on how to respond to the threat and reality of flooding is necessary.

- **Local Structural**
  - Channel improvements along the Withlacoochee River and Sugar Creek to reduce flooding.

    - Channelization of the Withlacoochee River.
    - Change in the confluence of Withlacoochee River and Little River.
    - Change in water profile of the Withlacoochee River.

  - Levee - A levee could provide considerable flood protection to the detailed study area and to the urban development located to the east of the flood plain.

- **Regional Structural**
    - Storage Reservoirs- Upstream storage reservoirs could provide a regional solution by capturing excess flood waters to be release during periods when water stages are low.

MEASURES ELIMINATED FROM DETAILED EVALUATION

Due to the limited scope and local focus of this study, the regional structural measure, storage reservoir, could not be evaluated further; however, it does remain a valid measure for a larger overall scope. For this localized study, all other measures are carried forward as viable options.

3.5 SUMMARY OF INITIAL ARRAY OF ALTERNATIVES

For the study, alternatives were formulated and evaluated based on the objectives stated earlier that include:

1. Improve safety for citizens during flood events in Valdosta, within the study area,

2. Reduce property losses (damages) in Valdosta due to flooding, within the study area, and

3. Avoid or minimize impacts to environmental and cultural resources within the study area.

The initial array consisted of seven alternatives. The seven alternatives included Alt. 1 Full acquisition; Alternative 2 Elevation; Alternative 3 Elevation and acquisition; Alternative 4 Flood proofing; Alternative 5 Channelization of the Withlacoochee; Alternative 6. Alteration of the confluence of the Withlacoochee River and the Little River; and Alternative 7 Flood control levee and structure in Sugar Creek at confluence with Withlacoochee River. Alternatives were screened based on the available economic, engineering and environmental factors, and a model run was conducted for the remaining structural alternative over a 50 year period of analysis.

3.5.1 NON-STRUCTURAL ALTERNATIVES

All of the non-structural alternatives, acquisition, elevation and flood proofing, were examined with the exception of education. This section describes the possible non-structural alternatives.

To determine the number of parcels, as defined by the Lowndes County Property Appraisers data, considered when estimating the cost of non-structural alternatives 1 to 4 the below equation was used:

HEC-RAS elevation data for parcels impacted by 100-year event (ft) – Lowndes County Property Appraisers Topography data (ft) = Depth of standing water per parcel (ft)

A total of 221 parcels were identified as being affected by the 100-year event based on the flood analysis conducted for this report. The number of parcels affected was used as a proxy for structures damaged. For the purposes of estimating cost of alternatives 1 to 4 the **Table 3-1** was used.

Table 3-1. Depth of standing water per parcel for 221 parcels identified as being affected by the 100-year event.

Depth of standing water (ft)	Number of affected parcels (100-yr event)
0	9
1	32
2	23
3	19
4	27
5	15
6	16
7	8
8	7
9	10
10+	55
Total	221

Note: The data presented in this table may not directly correlate to the below calculations of cost estimates of non-structural alternatives. Detailed information yields structures and parcel data needed to calculate the number of structures and parcels considered for each non-structural alternative below.

Alternative 1 – Full acquisition:

Based on the hydrologic and hydraulic (H&H) flood analysis conducted for this report (reference Appendix A), this alternative considers only the 221 parcels identified as being affected by a 100-year flood event in the project area. The rough order of magnitude reconnaissance level cost for this alternative assumes $100,000 relocation assistance per structure, $20,000 acquisition cost per parcel, and the current value is equal to the property value and land value data collected from the Lowndes County Property Appraiser website in 2013. The relocation assistance cost per structure and acquisition cost per parcel is based on a Louisiana Coastal protection and restoration study[2] that examined nonstructural components. The relocation assistance, as a conservative cost-estimating approach, is included in the cost of non-structural measures for the purposes of this report, however the Uniformed Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public

2 Louisiana Coastal Protection and Restoration Final Technical Report, Nonstructural Plan Component Appendix, June 2009, U.S. Army Corps of Engineers.

Law 91-646[3]) benefits should be appropriately applied if this alternative is further evaluated in future studies. The relocation assistance was not included in the estimated acquisition cost of 29 parcels that were identified as vacant lots based on the Lowndes County Property Appraiser data. Although 9 of the parcels did not include a depth of standing water, they are considered due to their location within the flooded zone of the project area. The cost of relocation was not applied to these 9 parcels, only acquisition cost. A 10% contingency is applied to the total estimated alternative cost to account for unknown cost factors which apply to the local project area. The rough order of magnitude reconnaissance level cost for acquisition of 221 parcels is $58,096,524, as calculated by the below equation:

Current Property Value + Relocation Assistance + Acquisition Cost =(Total + 10% Contingency)

Alternative 2 - Elevation:

Based on the hydrologic and hydraulic (H&H) flood analysis conducted for this report, this alternative considers only the structures identified as being affected by a 100-year flood event in the project area. The rough order of magnitude reconnaissance level construction cost for this alternative assumes: 1) all properties are one-story slab, 2) elevation by fill, 3) cost captures mobilization and clean-up, 4) all properties will be elevated no more than 8 ft, and 5) data from a similar study in Louisiana[4] is appropriate for use of calculating this level of cost estimate.

To calculate the cost of each elevation alternative, the average cost per foot elevated was derived from interviews with managers of three structure-raising firms in Louisiana. **Table 3-2** captures the average costs developed for elevating structures from 1 to 8 feet based on square footage. The corresponding cost from **Table 3-4** were multiplied by the square footage of each property as identified by Lowndes County Property Appraisers data to estimate the total cost to elevate each structure. To establish the height of elevation for each property impacted by the 100-year flood event, the average topographic elevation for each structure was calculated from Lowndes County Tax information then subtracted from the average water surface elevation during a 100-year flood event as identified by the H&H analysis performed for this report. For future studies, cost derived from local businesses and specific structure types should be identified to estimate a total cost for each elevation alternative.

[3] Public Law 91-646: To provide for uniform and equitable treatment of persons displaced from their homes, businesses, or farms by Federal and federally assisted programs and to establish uniform and equitable land acquisition policies for Federal and federally assisted programs.
[4] Elevation Cost Spreadsheet, Based on Interviews with Louisiana structure raising firms

Table 3-2. Typical cost per square foot estimate to elevate a structure 1 to 8 feet for a one story slab house.

Structure Type	Average Cost per Height Elevated (feet)							
	1	2	3	4	5	6	7	8
One-Story Slab	$69	$69	$70.5	$73	$73	$74.5	$74.5	$77

*Note: The cost used is based on Louisiana data.

Four elevation alternatives, briefly described in this paragraph, were developed based on the criteria outlined in **Table 3-2** and information from **Table 3-1**. Alternative 2A consists of elevating 80 structures identified by the 100-year flood event as being impacted by 3 to 8 feet of standing water. Alternative 2B consists of elevating 119 structures identified by the 100-year flood event as being impacted by a minimum of 3 feet of standing water. Alternative 2C consists of elevating 130 structures identified by the 100-year flood event as being impacted by a maximum of 8 feet of standing water. Alternative 2D consists of elevating 170 structures identified by the 100-year flood event as being impacted by a minimum of 1 foot of standing water.

Table 3-3 outlines the four elevation alternatives and rough order of magnitude reconnaissance level cost estimates. For Alternative 2A, all 80 structures with 3 feet of impacts, but no greater than 8 feet of impacts from a 100-year flood event, the estimated cost of elevating the structures is $12,262,439. When including elevation of structures to 8 feet with greater than 8 feet of impacts, for a total of 119 structures (Alternative 2B), the estimated cost is $19,450,312. For Alternative 2C, all 130 structures in the project area impacted by 8 or less feet of water, the estimated cost for elevating the structures to a maximum of 8 feet is $18,828,341. When including elevation of structures to 8 feet with greater than 8 feet of impacts, total of 170 structures (Alternative 2D), the estimated cost increases to $26,016,214. Note that the costs mentioned above are only rough order of magnitude approximations based on the assumptions described above. For all the elevation alternatives cost estimates include a 5% contingency to capture unknown cost factors.

Table 3-3. Elevation alternatives rough order of magnitude reconnaissance level construction cost.

Alt 2 ID	Number of Structures	Criteria (100-year event)	Estimate (w/out contingency)	Estimate (w/ 5% contingency)
2A	80	3ft to 8 ft of impacts	$12,262,439	$12,875,560
2B	119	3ft and greater impacts	$19,450,312	$20,422,827
2C	130	8ft or less of impacts	$18,828,341	$19,769,758
2D	170	all structures with impacts	$26,016,214	$27,317,024

Note: Of the 221 parcels identified as being impacted by the 100-year flood event, 45 did not have square footage data for structures and were not included in the above estimates. For this reason a direct comparison cannot be made to Table 3-3 for Alternatives 2B, C and D affected parcel counts.

Alternative 3 – Elevation and Acquisition:

Another possible alternative is combining the elevation and acquisition measures. This alternative considers the properties from alternatives 1 and 2, assumptions from alternatives 1 and 2, and captures the cost as estimated for alternatives 1 and 2, before including contingency, adding them to estimate the cost for the three alternatives. The three elevation and acquisition alternatives, briefly described in this paragraph, were developed based on the criteria outlined in **Table 3-4** and information from **Table 3-1**. Alternative 3A consists of elevating 92 structures identified by the 100-year flood event as being impacted by a maximum of 4 feet of standing water and acquiring all of the remaining 111 parcels, including structures where applicable. Alternative 3B consists of elevating 80 structures identified by the 100-year flood event as being impacted by 3 to 8 feet of standing water and acquiring all parcels (72) with greater than 8 feet of standing water. Alternative 3C consists of elevating 130 structures identified by the 100-year flood event as being impacted by a maximum of 8 feet of standing water and acquiring all of the remaining 72 parcels, including structures where applicable. A 15% contingency was applied to the total cost estimate of each variation of Alternative 3.

For Alt 3A, the 92 structures elevated up to 4 feet and the 111 properties acquired, the estimated cost is $39,938,978. For Alt. 3B, the 80 structures elevated 3 feet to 8 feet and the 72 acquired, the estimated cost is $30,667,128. For Alt. 3C, the 130 properties elevated up to 8 feet and 72 properties acquired, the estimated cost is $37,355,700.

Table 3-4. Elevation and acquisition combination alternatives (rough order of magnitude reconnaissance level construction cost)

Alt 3 ID	Criteria (100-year event)	Elevation	Elevated Structures	Acquisition	Parcels and Structures Acquired	Estimate (w/out contingency)	Estimate (w/ 15% contingency)
3A	Elevate to 4 ft, acquire remaining	$12,727,993	92	$27,210,985	111	$39,938,978	$45,929,824
3B	Elevate from 3ft to 8 ft, acquire remaining (not to include structures/properties with less than 3 ft impact)	$12,262,439	80	$18,527,359	72	$30,667,128	$35,267,197
3C	Elevate up to 8 ft and acquire remaining	$18,828,341	130	$18,527,359	72	$37,355,700	$42,959,054

Alternative 4 - Flood Proofing:

Wet flood proofing measures allow floodwater to enter the structure, vulnerable items such as utilities appliances and furnaces are relocated or waterproofed to higher locations. By allowing floodwater to enter the structure, hydrostatic forces on the inside and outside of the structure can be equalized reducing the risk of structural damage. This alternative was not evaluated for the purposes of this report, because the elevation alternative, which is a similar concept, was estimated.

Dry flood proofing involves sealing building walls with waterproofing compounds, impermeable sheeting, or other materials to prevent the entry of floodwaters into damageable structures. It is most applicable in areas of shallow, low velocity flooding.

Table 3-5. Dry flood proofing cost estimate factors (Southern Tier Central Regional Planning and Development Board).

Item	Cost/square foot
Sprayed-on cement (above grade)	$3.50
Waterproof membrane (above grade)	$1.17
Perimeter Drainage	$33*
Flood Shields (metal)	$77

*Linear Feet

For the purposes of estimating a cost for dry flood proofing, only the 74 structures impacted by the 100-year flood event by 3 ft or less were considered. The assumptions used in the estimate of this alternative are the costs used by Southern Tier Central Regional Planning and Development Board, shown in **Table 3-5**, and an assumption that the average perimeter of a structure is 200 ft. If this alternative is to be considered in future evaluations, actual perimeter size and local cost would be required. A 10% contingency was applied to the total estimate of the different dry flood proofing methods to account for lack of specific data related to the region and the properties. For the 67 structures with sprayed on cement the estimated cost is $509,012; for waterproof membrane is estimated at $170,155; for perimeter drainage is estimated at $488,400; and metal flood shields are estimated at $11,198,264 without contingency. These estimates are shown below in **Table 3-6**.

Table 3-6. Dry flood proofing alternatives rough order of magnitude reconnaissance level construction cost for 74 structures impacted by 3 ft or less during 100-year flood event

Method	Estimate (w/out contingency)	Estimate (w/contingency)
Sprayed on Cement	$509,012	$559,913
Waterproof membrane (above grade)	$170,155	$187,171
Perimeter drainage	$488,400	$537,240
Flood Shields (metal)	$11,198,264	$12,318,090

3.5.2 STRUCTURAL ALTERNATIVES

Alternative 5 - Channelization of the Withlacoochee River:

Channelization of the Withlacoochee River would result in cleaning out and eliminating of the natural oxbows of the river, changing flow patterns and velocities. Some backfilling/dredging of forested floodplain would also likely be necessary to accommodate construction of this alternative. Compensatory mitigation would likely be required with some replacement of forested floodplain wetland function required.

Alternative 6 - Alteration of the confluence of the Withlacoochee River and the Little River:

This alternative would provide a levee located within the Withlacoochee River floodway about 2 miles downstream of I-75. The levee would maintain separation of flow in the Withlacoochee and Little Rivers and effectively move the confluence of the rivers far enough downstream to eliminate backflow from the Little River entering the Withlacoochee River and then Valdosta. In addition to the levee, channel construction on either side of the levee would provide enough conveyance to reduce stages to non- damaging levels.

Alternative 7 - Flood control levee and structure in Sugar Creek at confluence with Withlacoochee River:

This alternative consists of an earthen levee placed across the lower portion of Sugar Creek near the confluence of the Withlacoochee River and Sugar Creek. The levee would merge with areas of higher elevation to the east and west of the confluence. Several culverts with a flap gate would be constructed that would allow water flow to leave the Sugar Creek basin during normal rainfall events. When stages within the Withlacoochee River rise above those of the Sugar Creek basin, the flap gates would close and prevent the backwater flow of the Withlacoochee from discharging south into the Sugar Creek basin. Environmental impacts resulting from this alternative are expected to be extremely limited as it is likely that most, if not all, of the levee could be constructed within the area of the existing horse farm. Functionality of this alternative could be improved by the construction of a stormwater basin directly behind the levee that could be used to store flood flows from the Sugar Creek basin during times that the flap gates are closed to prevent backwater flow.

3.6 COMPARISON AND EVALUATION OF INITIAL ARRAY OF ALTERNATIVES

Each of the alternatives were compared and evaluated based on the below listed criteria.

- Impact Assessment
  - National Economic Development (NED)
  - Environmental Quality (EQ)
  - Regional Economic Development (RED)
  - Other Social Effects (OSE)
- Contributions to Planning Objectives
  - Improve safety for residents during flood events in Valdosta, within the study area.
  - Reduce property losses (damages) in Valdosta due to flooding, within the study area.
  - Minimize impacts to environmental resources within the study area.
- Response to planning constraints
  - Although this study recognizes a need for a regional solution, the scope is limited to the flood prone areas at the confluence of the Withlacoochee River and Sugar Creek, and at Two Mile Branch.
  - Avoiding induced flooding of adjacent properties within the study area.
  - Avoiding or minimizing impacts to environmental and cultural resources that could be found within the study area.
- Response to evaluation criteria
  - Completeness
  - Effectiveness
  - Efficiency
  - Acceptability

Tables 3-7, 3-8, 3-9 and 3-10 summarize the comparison and evaluation of the initial array of alternatives (A no-action plan and Alternatives 1-7) based on the above listed criteria. The non-structural alternatives of Alternative 1 – Full Acquisition, Alternative 2 – Elevation, Alternative 3 - Elevation and Acquisition, and Alternative 4 – Flood proofing are viable solutions; however, they were not considered further due to the challenges associated with implementation and interest of non-Federal sponsor to pursue a structural alternative. Only Alternatives 5-7 were developed in more detail in the next section because they are the most practicable, acceptable, and efficient flood control measures to reduce flood waters from entering damage-susceptible areas. The final array consisted of three alternatives, which are Alternative 5 Channelization of the Withlacoochee River; Alternative 6 Alteration of the confluence of the Withlacoochee River and the Little River; and Alternative 7 Flood control levee and structure in Sugar Creek at confluence with Withlacoochee River.

Table 3-7. Comparison and Evaluation of Alternatives Based on the Four Accounts

1. Alternatives	No Action (baseline)	Alt 1 - Full Acquisition	Alt 2 - Elevation	Alt 3 - Elevation and Acquisition	Alt 4 - Flood Proofing	Alt 5 - Channelization of the Withlacoochee River	Alt 6 - Alter Confluence of Withlacoochee River and Little River	Alt 7 - Flood Control Levee and Structure in Sugar Creek at confluence with Withlacoochee River
A. Impact Assessment (4 Accounts)								
(1) National Economic Development (NED)	O - Would not produce any additional benefits to the nation; Could negatively impact national economic development when losses and damages occur	O - It is highly unlikely that full acquisition would be justified with a BCR over 1.0 and therefore this alternative would not meet the NED objective	O - It is highly unlikely that elevating structures would be justified with a BCR over 1.0 and therefore this alternative would not meet the NED objective	O - It is highly unlikely that this combination of alts would be justified with a BCR over 1.0 and therefore this alternative would not meet the NED objective	P - Options within this alternative could potentially be justified (ie: sprayed on cement, perimeter drainage, flood shields for some properties) with a BCR over 1.0 and therefore this alternative could possibly meet the NED objective	P - This alternative could be potentially justified with a BCR over 1.0, but the associated possible mitigation is unknown at this time and could make the BCR fall to less than 1.0; therefore this may or may not meet the NED objective.	P - This alternative could be potentially justified with a BCR over 1.0, but the associated possible mitigation is unknown at this time and could make the BCR fall to less than 1.0; therefore this may or may not meet the NED objective.	P - This alternative meets the NED objective with a BCR over 1.0 if onsite material can be used for the levee. If onsite material cannot be used, it may not be justified.
(2) Environmental Quality (EQ)	P - Environment in its natural state would remain unchanged; however, flooding events could impact negatively the natural environment	P - There would be minimal to no negative construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	P - There would be minimal construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	P - There would be minimal construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	P - There would be no construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	O - It is very unlikely that this would meet the environmental objective, since historical lessons on environmental impacts have been learned from removing natural oxbows	O - It is very unlikely that this would meet the environmental objective, since moving the confluence of the river could have negative environmental impacts	P - The levee could be built in an unvegetaed area which is already cleared and therefore would have minimal environmental impacts.
(3) Regional Economic Development (RED)	O - Could negatively impact regional development and growth when losses and damages occur	O - If all the land was purchased, no regional economic development would occur (former businesses, etc would no longer contribute to economy)	P - There could be some regional benefits; for example, businesses that had to close for repair in the past after flooding events may be able to remain open, and residents who may have not been able to take advantage of services in the past after flood events may be able to	P - There could be some regional benefits; for example, businesses that had to close for repair in the past after flooding events may be able to remain open, and residents who may have not been able to take advantage of services in the past after flood events may be able to	P - There could be some regional benefits; for example, businesses that had to close for repair in the past after flooding events may be able to remain open, and residents who may have not been able to take advantage of services in the past after flood events may be able to	P - If this alt provided a significant reduction in damages to the community, there could be some regional benefits; for example, businesses that had to close for repair in the past after flooding events may be able to remain open, and residents who may have not been able to take advantage of services in the past after flood events may be able to	P - If this alt provided a significant reduction in damages to the community, there could be some regional benefits; for example, businesses that had to close for repair in the past after flooding events may be able to remain open, and residents who may have not been able to take advantage of services in the past after flood events may be able to	P - If this alt provided a significant reduction in damages to the community, there could be some regional benefits; for example, businesses that had to close for repair in the past after flooding events may be able to remain open, and residents who may have not been able to take advantage of services in the past after flood events may be able to
(4) Other Social Effects (OSE)	O - Could negativley impact human safety if nothing is done to reduce flooding impacts	P - Human safety would improve during flooding events, as it would be unlikely many humans would be in the area. However, acquistion may be opposed by many in the community and could negatively impact livelihood.	P - Human safety would improve to an extent since homes and buildings could be at a lower risk of flooding	P - Human safety would improve to an extent since homes and buildings could be at a lower risk of flooding and those who were most affected could be targeted for land acqusition	P - Human safety would improve to an extent since residential and commercial property owners could better protect themselves and their property during flood events. However, flooding of surrounding areas would still occur and could have a negative impact on the community and environment.	O - Human interactions with the river would change and the environmental impact from this alternative could have a negative impact on the community	O - Human interactions with the river would change and the environmental impact from this alternative could have a negative impact on the community	P - The community may not like the idea of such a large levee. However, potential outreach or recreational opportunities may exist near the levee during appropriate times.

F-Fully meets objective; P-Partially meets objective; O-Does not meet objective

Table 3-8. Comparison and Evaluation of Alternatives Based on the Planning Objectives

A. Contribution to Planning Objectives	No Action (baseline)	Alt 1 - Full Acquisition	Alt 2 - Elevation	Alt 3 - Elevation and Acquisition	Alt 4 - Flood Proofing	Alt 5 - Channelization of the Withlacoochee River	Alt 6 - Alter Confluence of Withlacoochee River and Little River	Alt 7 - Flood Control Levee and Structure in Sugar Creek at confluence with Withlacoochee River
(1) Improve safety for residents during flood events in Valdosta, within the study area.	O - If nothing is done, safety will remain unchanged for residents	F - Human safety would improve during flooding events, as it would be unlikely many humans would be in the area.	P - Human safety would improve to an extent since homes and buildings could be at a lower risk of flooding	P - Human safety would improve to an extent since homes and buildings could be at a lower risk of flooding and properties most affected or at the highest risk in the past would be acquired	P - Human safety would improve to an extent since residential and commercial property owners could better protect themselves and their property during flood events. Humans outside of protected structures however would still be at higher risk.	P - If this alt provided a significant reduction in flooding to the community, it could improve human safety	P - If this alt provided a significant reduction in flooding to the community, it could improve human safety	P - If this alt provided a significant reduction in flooding to the community, it could improve human safety
(2) Reduce property losses (damages) in Valdosta due to flooding, within the study area.	O - If nothing is done, damages to property will continue to occur within the study area.	F - Damages to land would still occur but there would be no human property to be damaged	P - There would be a reduction of property damages to those structures that were elevated; other objects that remain at ground level (ie: cars, pools, etc) could still be impacted.	P - There would be a reduction of property damages to those structures that were elevated or acquired; other objects that remain at ground level (ie: cars, pools, etc) could still be impacted.	P - There would be a reduction of property damages to those structures that were flood proofed; other objects that remain at ground level which cannot be flood proofed (ie: cars, pools, etc) could still be impacted.	P - If this alt provided a significant reduction in flooding to the community, it could reduce damages	P - If this alt provided a significant reduction in flooding to the community, it could reduce damages	P - If this alt provided a significant reduction in flooding to the community, it could reduce damages
(3) Minimize impacts to environmental resources within the study area.	P - If nothing is done, the environment will remain in its natural state; however, flood events could negatively impact the natural environment	P - There would be no negative construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	P - There would be minimal to no negative construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	P - There would be minimal to no negative construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	P - There would be minimal to no negative construction impacts to the environment associated with this alternative; however, flooding would still occur and could have negative impacts to the natural environment during flood events	O - This alt would very likely have negative impacts to the environment by removing the natural oxbows and altering the flow of the river	O - This alt would very likely have negative impacts to the environment by moving the confluence of the river	P - This alt would very likely have minimal environmental impacts

F-Fully meets objective; P-Partially meets objective; O-Does not meet objective

Table 3-9. Comparison and Evaluation of Alternatives Based on the Planning Constraints

1. Alternatives	No Action (baseline)	Alt 1 - Full Acquisition	Alt 2 - Elevation	Alt 3 - Elevation and Acquisition	Alt 4 - Flood Proofing	Alt 5 - Channelization of the Withlacoochee River	Alt 6 - Alter Confluence of Withlacoochee River and Little River	Alt 7 - Flood Control Levee and Structure in Sugar Creek at confluence with Withlacoochee River
C. Response to Planning Constraints								
(1) Limited to the flood prone areas within the study area (not regional)	N/A	F - This constraint would be met.	F - This constraint would be met.	F - This constraint would be met.	F - This constraint would be met.	P - This constraint may not be met, depending on which adjacent segments of the Withlacoochee would be channelized	P - This constraint may not be met, depending on where the confluence was moved to	F - This constraint would be met
(2) Avoid induced flooding to adjacent propeties within the study area.	N/A	F - There would still be flooding to adjacent properties, but no more then they would have normally experienced.	F - There would still be flooding to adjacent properties, but no more then they would have normally experienced.	F - There would still be flooding to adjacent properties, but no more then they would have normally experienced.	F - There would still be flooding to adjacent properties, but no more then they would have normally experienced.	P - It is unknown without modeling if adjacent property owners would be more or less flooded as a result of this alt	P - It is unknown without modeling if adjacent property owners would be more or less flooded as a result of this alt	F - No induced flooding would occur to adjacent property owners more than what it already experienced
(3) Avoid or minimize impacts to environmental and cultural resources in the study area.	N/A	P - Cultural resources could potentially be relocated; ones that cannot could be negatively impacted during flood events. No additional impacts to the environment.	F - Cultural resources could be elevated to be protected; No additional impacts to the environment.	F - Cultural resources could be elevated to be protected; No additional impacts to the environment.	F - Cultural resources could be flood proofed to be protected; No additional impacts to the environment.	P - Cultural resources could be at a lower risk for flooding and damage; Flooding to the natural environment could be improved, yet channelization of the river could have negative long term environmental impacts	P - Cultural resources could be at a lower risk for flooding and damage; Flooding to the natural environment could be improved, yet moving the confluence of the river could have negative long term environmental impacts	F - Cultural resources would not be negatively affected by this alternative; minimal to no environmental impacts

F-Fully meets objective; P-Partially meets objective; O-Does not meet objective

Table 3-10. Comparison and Evaluation of Alternatives Based on the USACE Evaluation Criteria

1. Alternatives	**No Action (baseline)**	**Alt 1 - Full Acquisition**	**Alt 2 - Elevation**	**Alt 3 - Elevation and Acquisition**	**Alt 4 - Flood Proofing**	**Alt 5 - Channelization of the Withlacoochee River**	**Alt 6 - Alter Confluence of Withlacoochee River and Little River**	**Alt 7 - Flood Control Levee and Structure in Sugar Creek at confluence with Withlacoochee River**
D. Response to Evaluation Criteria								
(1) Completeness	O - Not considered complete because it does not provide investments or actions to ensure realization to meet the planning objectives	P - Considered to partially meet the objective since only ROM aquistion costs have been obtained; only partially includes the necessary means to meet the planning objectives.	P - Considered to partially meet the objective since only ROM elevation costs have been obtained; only partially includes the necessary means to meet the planning objectives.	P - Considered to partially meet the objective since only ROM costs have been obtained; only partially includes the necessary means to meet the planning objectives.	P - Considered to partially meet the objective since only ROM costs have been obtained; only partially includes the necessary means to meet the planning objectives.	P - Considered to partially meet the objective since no costs have been obtained and only assumptions can be made about mitigation; only partially includes the necessary means to meet the planning objectives.	P - Considered to partially meet the objective since no costs have been obtained and only assumptions can be made about mitigation; only partially includes the necessary means to meet the planning objectives.	F - Considered to fully meet the objective since objective provides and accounts for all necessary actions to ensure realization of planning objectives
(2) Effectiveness	O - Not effective in meeting planning objectives	P - Partially effective since it does contribute to some of the planning objectives	P - Partially effective since it does contribute to some of the planning objectives	P - Partially effective since it does contribute to some of the planning objectives	P - Partially effective since it does contribute to some of the planning objectives	P - Partially effective since it does contribute to some of the planning objectives	P - Partially effective since it does contribute to some of the planning objectives	F - Fully effective since it contributes to the planning objectives
(3) Efficiency	O - Not efficient in meeting the planning objectives	P - Partially efficient since it is probably not the most cost effective method	P - Partially efficient since it is probably not the most cost effective method	P - Partially efficient since it is probably not the most cost effective method	P - Partially efficient since it is probably not the most cost effective method	P - Partially efficient since it is probably not the most cost effective method	P - Partially efficient since it is probably not the most cost effective method	F - Fully efficient since it is currently the most cost effective method (if local onsite material is used)
(4) Acceptability	P - Currently accepted as the status quo and is compatible with existing laws, regulations, and public policies; however, it does not achieve full acceptability since flood events cause negative impacts within the community	P - This could be favorable to some resident/businesses yet very unfavorable to other residents/businesses.	P - This could be favorable to residents and businesses	P - This could be favorable to residents and businesses	P - This could be favorable to residents and businesses	O - This would likely not be favorable to the community and environmental agencies	O - This would likely not be favorable to the community and environmental agencies	P - This may be viewed favorably by some of the community since it is effective at reducing depth and duration of flooding; it may be viewed unfavorably for aesthetic reasons

F-Fully meets objective; P-Partially meets objective; O-Does not meet objective

EVALUATION OF THE FINAL ARRAY OF ALTERNATIVES

Alternative 5 - Channelization of the Withlacoochee River

Changing flow patterns and velocities would likely cause some scouring of the bottom and shoreline in some areas. The channelization could create greater negative environmental impacts than the other alternatives. Altering the natural meander of a river eliminates the dynamic oxbow habitat which serves as a unique and critical wildlife habitat and supports biodiversity. This alternative may also have additional downstream impacts, from altered flows and velocities, making implementation difficult without potentially causing additional problems in the region.

Alternative 6 - Alteration of the confluence of the Withlacoochee River and the Little River

This alternative would effectively move the confluence of the rivers far enough downstream to eliminate backflow from the Little River into Valdosta. In addition to the levee, channel construction on either side of the levee would provide enough conveyance to reduce stages to non-damaging levels. This alternative could have environmental impacts, access issues and potentially higher costs.

Alternative 7 - Flood control levee and structure in Sugar Creek at confluence with Withlacoochee River

This alternative appears to be effective at reducing the duration and depth of flooding in the study area. Environmental impacts resulting from this alternative are expected to be extremely limited, compared to the other alternatives.

PLAN FORMULATION EVALUATION

Based on the preliminary plan formulation, Alternative 7 could potentially best meet the project objectives. Therefore, with the non-federal sponsor’s approval, Alternative 7 was examined in more detail as a feasible solution to be developed for this report purpose and was modeled in the U.S. Army Corps of Engineering (USACE) certified model Hydrologic Engineering Centers River Analysis System (HEC-RAS).

MODEL CONFIRMATION

Full details on the model setup and results can be found in Appendix A. The HEC-RAS model showed that Plan 7 is effective at reducing the duration and depth of flooding. The maximum water surface elevations on the east side of the levee/culvert structure were shown to be reduced for all modeled storm frequencies; however, the benefits increase as the intensity of the storm event increases. For the 10-year event, the reduction in maximum water surface elevation is approximately 0.1 feet. For the 50-year event, the reduction in maximum water surface elevation is approximately 1.7 feet. The levee reduces the maximum 100-year event water surface elevation by 2.8 feet.

At the beginning of the model simulation, before the Withlacoochee River stage begins to rise, the culvert structure is able to pass the local runoff from Sugar Creek and Two Mile Branch. However, the culvert flap gates close and creek flows are no longer allowed to discharge once the Withlacoochee River nears its peak and rises above the water stage in Sugar Creek upstream of the levee. While the alternative plan does reduce flood impacts, it does not completely eliminate flooding due to the loss of discharge capacity when the flap gates close. This effect could possibly be mitigated by creating or securing more upstream storage[5] that could be utilized only when the Withlacoochee River is at extreme levels and the structure flap gates close.

Comparison of the existing conditions and alternative plan stage hydrographs also show a considerable reduction in the duration of flooding. For example, homes which sustain damage at an elevation of 138 feet, NAVD88 would be inundated by the 100-year event for more than 2 days in the existing condition, but that level of inundation would have been reduced to less than 3 hours with the levee in place. The benefit would be access to property for more time, and possibly less water damage from a lesser depth and shorter duration of standing water.

SELECTION OF THE PLAN

In conclusion, Alternative 7, the structural alternative plan utilizing a levee with culverts extending across the confluence of Sugar Creek and the Withlacoochee River, could be effective at reducing the depth and duration of flooding within the study area. It would not cause any additional flooding at the adjacent area west of the levee. As a result, this plan was selected to be developed into a cursory conceptual design with a preliminary cost estimate, as a potential feasible solution to the local flooding problems in the study area.

[5] Potential upstream sites were previously identified in the 2010 stormwater master plan.

Mediacom, Gornto Road, During 2009 flood

Mediacom, Gornto Road, Existing Conditions (raised)

4.0 SELECTED PLAN AND CONCLUSION

City of Valdosta
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Chapter 4 : Table Of Contents

4 SELECTED PLAN

This chapter discusses more details of Alternative 7, which has been selected for further analysis, as a potential feasible solution for the study area. Many alternatives were explored in Chapter 3, but one was chosen as a potential feasible local solution for the purpose of this report, known as the selected plan. It is important to note that the underlying problems of frequency, depth, and duration of rainfall (causing flooding and droughts in the region) are complicated by the overall river basin and watershed complexity, which a future study could address in greater depth and more holistically.

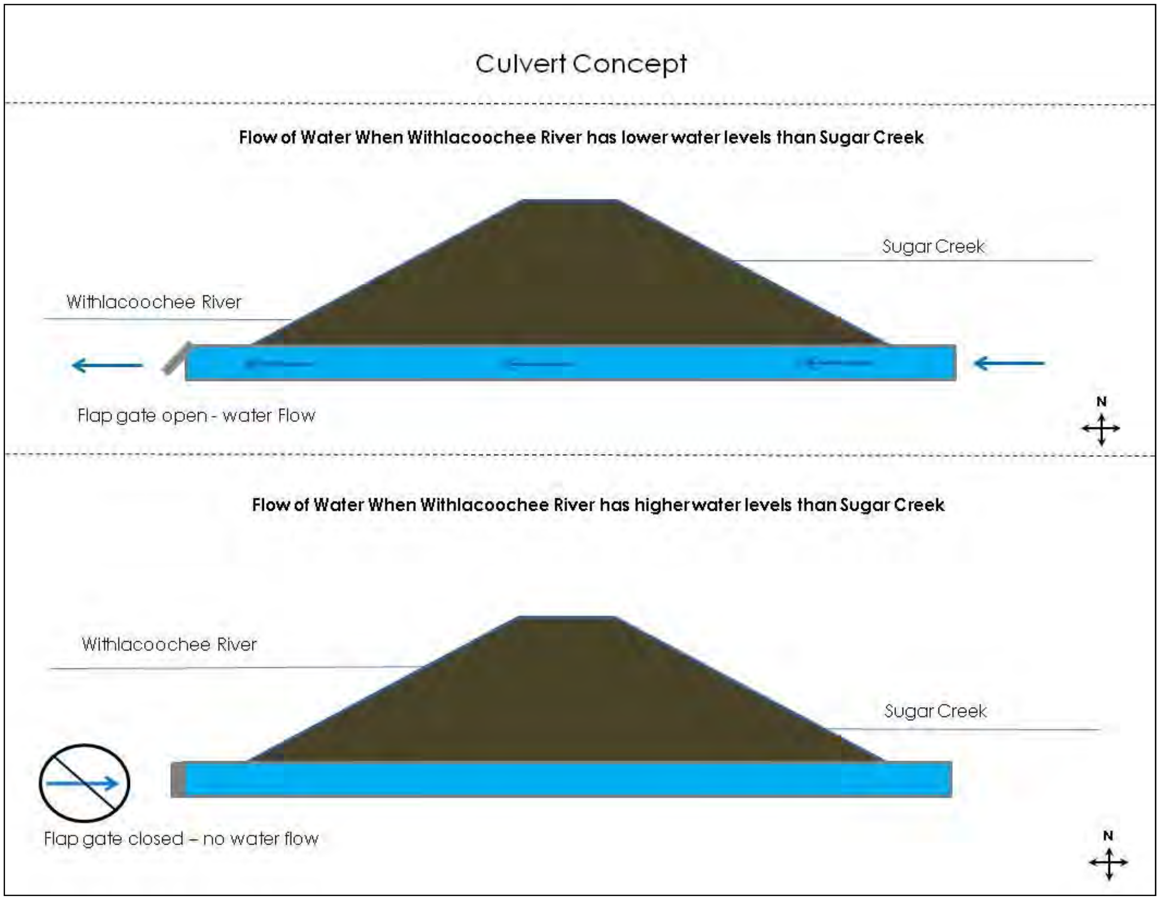
4.1 OVERVIEW OF THE SELECTED PLAN

Reference Appendix A (Hydrology and Hydraulics Analysis), Appendix B (Socio-Economic Analysis), Appendix C (Cost Estimate) and Appendix D (Maps) throughout this Chapter.

The alternative that was developed for this report is one feasible solution for localized flooding problems. The selected plan, Alternative 7, proposes to construct an earthen levee at the confluence of the Withlacoochee River and Sugar Creek, including a culvert structure with six barrels, measuring 6-feet by 6-feet each, and flap gates at the west end. (Reference Appendix D, Map 8). As shown in

Figure 4-1, when water levels in the upstream Sugar Creek are higher than downstream levels in the Withlacoochee River, the flap gates will open and water will flow to the Withlacoochee River. When water levels in the Withlacoochee River are higher than Sugar Creek, the flap gates will close, preventing water from backing up into Sugar Creek. This solution is most effective at reducing the depth and duration of flooding in the study area within the Sugar Creek and Two Mile Branch watershed; however, it is important to note that it will not prevent flooding.

Figure 4-1. Culvert Concept



4.2 DESCRIPTION OF THE SELECTED PLAN

4.2.1 FEATURES AND ASSUMPTIONS

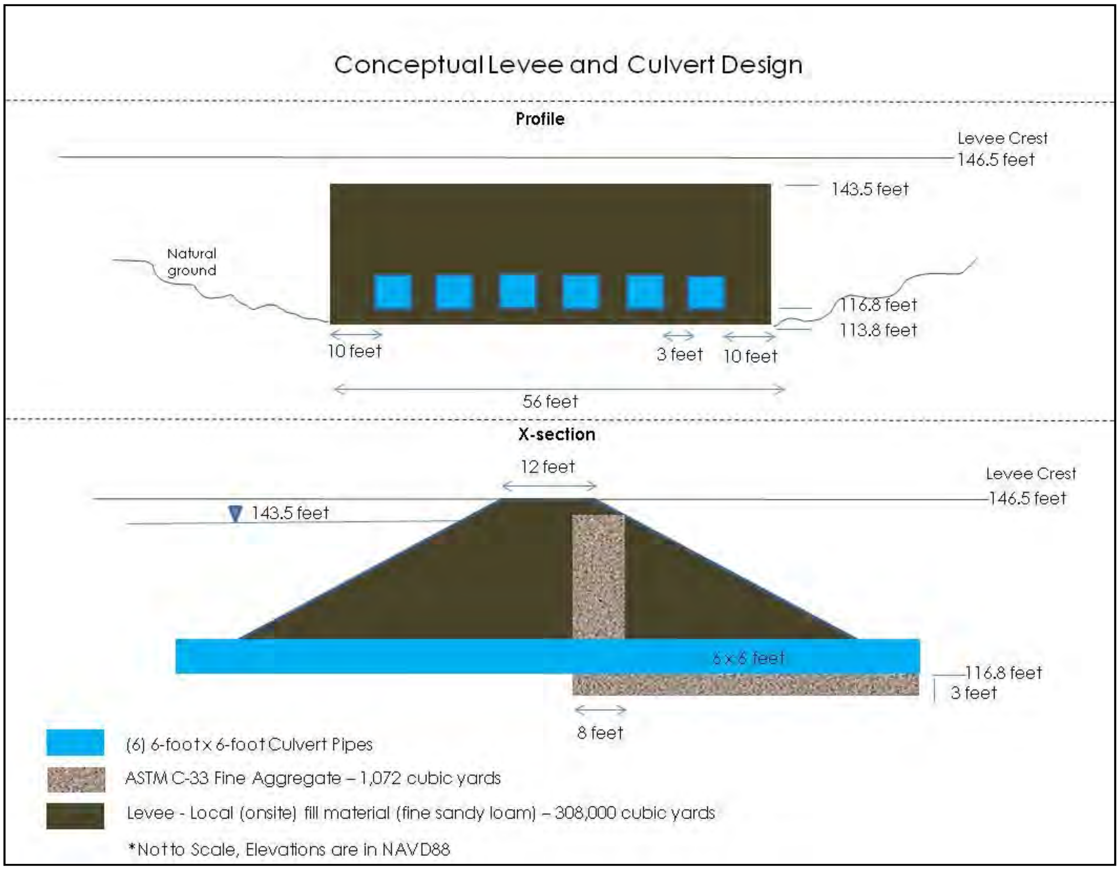
With a primary intent of providing a basis for quantities and costs, the following design features and concepts have been assumed based on modeling and best engineering judgment. The culvert structure, shown conceptually in **Figure 4-2** with six barrels measuring 6 feet by 6 feet with flap gates, would be approximately 188 feet in length and would be placed at an elevation of approximately 115.5 feet (NAVD88[1]) which is the lowest line of elevation in Sugar Creek. The conceptual levee design assumed side slopes at 3H:1V (horizontal: vertical) with a 12-foot top width. The levee would be approximately 3950 feet in length with average height of 24 feet. The length of the levee is longer than would typically be needed due to the need to tie the levee into higher ground, to prevent flow of

[1] NAVD88: North American Vertical Datum of 1988: The vertical control datum of othormetric height established for vertical control surveying in the United States of America based upon the General Adjustment of the North American Datum of 1988.

water around the culvert structure, and as a result of the variable topography. The total quantity of earthen levee material required was estimated to be 308,000 cubic yards, assuming the use of onsite borrow material from an unidentified site. According to soil maps of Lowndes County, suitable levee fill material can be found near the project site. The levee would be grassed, with a total surface area of approximately 23,600 square yards. Clearing and grubbing would be required for an area of approximately 6 acres. There would be a filter diaphragm around the pipe to prevent piping along the conduit. The filter material would be ASTM[2] C-33 fine aggregate (i.e. standard concrete sand). The total volume of filter material will be 1,072 cubic yards.

The culverts would also require erosion control. Conceptual quantities and costs assume placement of 8-inch stone at 60-foot width for a distance of 50-feet upstream and 100-feet downstream of the culvert structure.

Figure 4-2. Conceptual Levee and Culvert Design



[2] American Society for Testing and Materials (ASTM) is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

4.2.2 OPERATION AND MAINTENANCE

The levee and culvert structure, with erosion control feature, would be operated and maintained by the local sponsor, the City of Valdosta. The cost of operation and maintenance for the levee and culverts were not included in the cost estimate for Alternative 7.

4.2.3 REAL ESTATE REQUIREMENTS

The tentative location for this conceptual design of levee and culvert structure would require acquisition of land or easements on land between the confluence of the Withlacoochee River and Sugar Creek. Real estate costs for lands and easements needed to construct the levee and culverts were not included in the cost estimate for Alternative 7.

4.2.4 ACCESS DURING CONSTRUCTION

It is assumed that Gornto Road or Meadowbrook Road could provide direct access for construction, however access must be verified prior to construction.

4.2.5 MODELING

Appendix A, Hydrology and Hydraulics Analysis, can be referenced for further details of the following discussion of modeling.

The USACE certified Hydrologic Engineering Centers River Analysis System (HEC-RAS) model was calibrated to the 2013 event. Hypothetical events were then developed for the 10-, 50- and 100-year storm events and applied to the existing condition and with-project HEC-RAS models.

The preliminary levee design is intended to protect the study area against the Standard Project Flood (SPF)[3] event within the Withlacoochee River and is designed with three additional feet of freeboard[4]. The SPF event is estimated to be approximately 40% of the Probable Maximum Precipitation (PMP)[5]. For the preliminary design, the rainfall for the SPF event was estimated to be 13.2 inches. This equates to approximately 110% of the 100-year storm event. An estimate of the maximum water surface elevation in the Withlacoochee River was then made based upon a correlation between maximum water surface elevation and rainfall volume. This correlation resulted in an estimated SPF peak water surface

[3] Standard Project Flood: The design flood event used to establish the height of the proposed levee feature.
[4] Freeboard is defined as a factor of safety usually expressed in feet above a flood level for purposes of floodplain management.
[5] Probable Maximum Precipitation: The theoretical maximum depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year.

elevation of 143.5 feet, NAVD88[6], plus three feet of freeboard, producing a design levee crest elevation of 146.5 feet, NAVD88.

The described structural features were incorporated into the HEC-RAS model geometry and the four rainfall events (i.e., the year 2013 event and the hypothetical 10-, 50-, and 100-year events) were applied. The with-project maximum water surface elevations were at or below the existing condition profiles at all locations.

The model showed that the plan was effective at reducing flooding. The maximum water surface elevations on the east side of the levee/culvert structure were reduced for all modeled storm frequencies; however, the benefits were much greater as the intensity of the storm event increases. For the 10-year event, the reduction in maximum water surface elevation was approximately 0.1 feet. For the 50-year event, the reduction in maximum water surface elevation was approximately 1.7 feet. For the 100-year event the levee and culvert solution reduced the maximum water surface elevation by 2.8 feet.

At the beginning of the simulation, before the Withlacoochee River stage began to rise, the culvert structure was able to pass the local runoff from Sugar Creek and Two Mile Branch. However, once the Withlacoochee River nears its peak and rises above the water stage in Sugar Creek upstream of the levee, the culvert flap gates close and the creeks are no longer able to discharge. While the selected plan did reduce flood impacts in the model, it did not completely eliminate flooding, due to the loss of discharge capacity when the flap gates close. This effect could possibly be mitigated by creating or securing more upstream storage that could be utilized only when the Withlacoochee River is at extreme levels and the structure flap gates close.

Comparison of the existing conditions and alternative plan stage hydrographs also show a considerable reduction in duration of flooding. For example, as shown in **Figure 4-3**, homes which sustain damage at an elevation of 138 feet, NAVD88 would be inundated by the 100-year event for more than two days in the existing condition, but that level of inundation would have been reduced to less than three hours with the levee in place.

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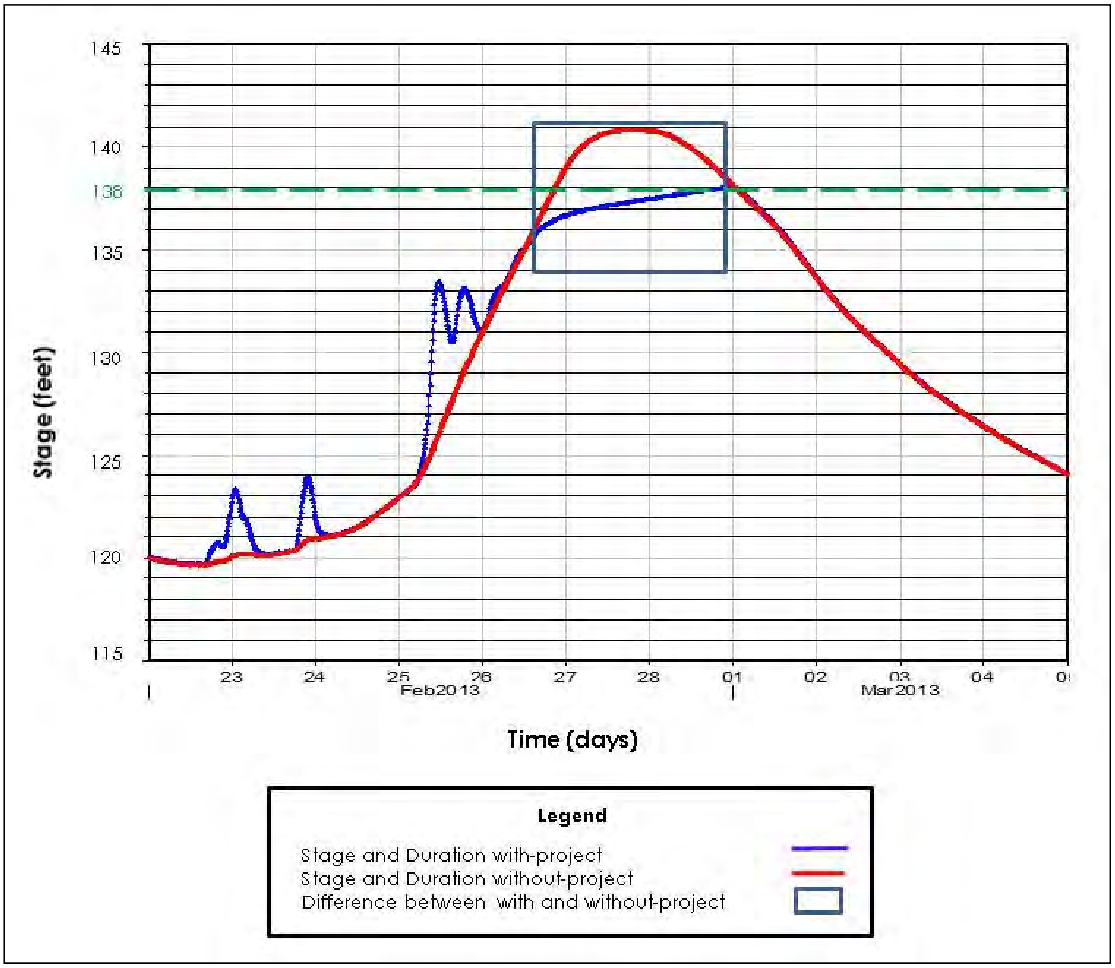
[6] NAVD88: North American Vertical Datum of 1988: The vertical control datum of othormetric height established for vertical control surveying in the United States of America based upon the General

Figure 4-3. Hydrograph for 100-year storm



In conclusion, the structural alternative plan utilizing a levee with culverts extending across the confluence of Sugar Creek and the Withlacoochee River can be effective at reducing the depth and duration of flooding within the Sugar Creek and Two Mile Branch watershed.

4.3 COST ESTIMATES

The estimate for construction cost of the selected plan was performed with MII[7], using 2013 price levels, and is shown in **Table 4-1**. Construction time was estimated to be approximately

[7] MII is the second generation of the Micro-Computer Aided Cost Estimating System (MCACES). It is a detailed cost estimating software application that was developed in conjunction with Project Time & Cost, Inc. (PT&C). MII is one of several modules of an integrated suite of cost engineering tools called Tri-Service Automated Cost Engineering Systems (TRACES). It interfaces with other PC based support modules and databases used by the Tri-Service Cost Engineering community. MII provides an integrated cost estimating system (software and databases) that meets the U.S. Army Corps of Engineers (USACE) requirements for preparing cost estimates.

305 days. The cost was estimated to be approximately $3.6 million, using the design and assumptions as described in the previous section. Other assumptions include: onsite borrow material from unidentified site, cast in place of six 6-foot by 6-foot rectangular culverts, purchased ready-mix concrete, riprap stone, and filter material ASTM C-33 (concrete sand) site delivered. The detailed cost estimate and all assumptions can be found in Appendix C, Cost Estimate. The cost estimate does not include design, permitting, real estate, construction management, or operation and maintenance. In addition, if using onsite borrow material is not feasible the estimated cost would at a minimum double; however, this is considered to be a low risk since according to soil maps of Lowndes County, suitable levee fill material can be found near the project site. The cost as shown below includes a 25% contingency.

Table 4-1. Cost estimate for Selected Plan (2014 price level)

ESTIMATED Selected Plan Cost	
Mobilization, Demobilization, Preparation Work	$268,391
Clearing and Grubbing	$26,537
Levee Construction	$1,670,699
Care and Diversion of Water	$178,927
Culvert Structure	$1,392,683
Site Grading and Landscaping	$44,449
ESTIMATED COST	**$3,581,686**

4.4 ECONOMIC JUSTIFICATION

Appendix B, Socio-Economic Analysis, can be referenced for further details of the following discussion of modeling project benefits were calculated as consistently as possible with USACE guidance for urban flood damage reduction[8].

4.4.1 METHODS FOR CALCULATING PROJECT BENEFITS

Project benefits were calculated as consistently as possible with USACE guidance for urban flood damage reduction[9]. However, due to the limited scope of this study, the calculation of benefits was based on existing and readily available data, professional and technical judgment and USACE principles of flooding analyses.

MODELING AND ASSUMPTIONS

The level of detail normally required for an urban flood risk management study was unavailable or incomplete, therefore assumptions were made in completing the analysis. Typically, at least six to eight flood events are modeled with a hydrologic model to determine the damage-frequency curve. In this study, only three flood events were available with sufficient data to include in the model. A Microsoft excel spreadsheet was used to

[8] Institute for Water Resources Report 88-R-2 National Economic Development Procedures Manual – Urban Flood Damage

[9] Institute for Water Resources Report 88-R-2 National Economic Development Procedures Manual – Urban Flood Damage

analyze the annual damages instead of an economic simulation model, such as HEC-FDA (Hydrologic Engineering Center – Flood Damage Analysis). A stage-damage relationship was not established because the first-floor elevations inventory was incomplete or unavailable. Therefore, only the spatial extent of the water surface elevation in each modeled flood event was compared with the parcel boundaries. The number of parcels affected was used as a proxy for structures damaged. The duration of inundation during flood events was not considered. Finally, total structure values from the Lowndes County Assessor's Office were used instead of depreciated replacement costs[10]. All of these assumptions, as well as other assumptions described below, were implemented due to the limited scope of this analysis.

As described above, the results of this economic analysis were accomplished with preliminary data, without the use of economic modeling and with assumptions appropriate for the scope of this study. If a future study were conducted as a feasibility level study, more data would be gathered and the USACE certified model HEC-FDA would be used, and the results of the analysis could vary. **It should be noted that this analysis is appropriate as a comparison in the without-project and with-project scenarios, rather than trying to use the results of this analysis for drawing conclusions about flood risks and flood depths concerning specific parcels located in the project area.**

ESTABLISHMENT OF FUTURE WITHOUT-PROJECT CONDITION

The return period of a storm event can be classified in several different ways. The storm event can be referred to in terms of rainfall, flow, or stage. Additionally, characterization of a storm event based on an analysis of these factors at several different locations can produce different results making it sometimes difficult in identifying the frequency of the storm event (i.e.: 10, 50 or 100 year event). For purposes of this analysis, flood conditions for varying frequency flood events were simulated using a computer model. For this flood analysis, three events were examined for the with-project and without-project conditions: 10-year flood, 50-year flood, and 100-year flood. Although the frequency of the 2009 and 2013 storm events were characterized by others as much larger storm events, the statistical frequency analysis of the 2009 and 2013 events were determined to be 39 and 15 years, respectively. Ideally, to determine the frequency of these events, flood stages occurring near the impacted areas within the City of Valdosta would have been evaluated however there were not sufficient records to perform this statistical analysis. Additionally, GIS maps were provided in 10-meter grids of water surface elevation and inundation depths for the 2013, 10-year, 50-year, and 100-year events for use in analyzing flood depths in both the with and without project condition. Calibration of the existing condition hydraulic model used data collected during the 2013 event to simulate flood conditions in the project area.

The flooding experienced during the 2009 and 2013 events were extremely large in geographic scale, producing massive flooding of the Withlacoochee River and Little River. The confluence of these two swollen rivers likely caused elevated water levels in the Withlacoochee River, near Valdosta, producing a backwater effect which caused water to

[10] Structure values were calculated as total assessed value minus land value, as reported by the Lowndes County Assessor's Office.

rise and back up into Sugar Creek and Two Mile Branch at a considerable time after the rain event in Valdosta. The flooding experienced in the City of Valdosta during the 2009 and 2013 events do not appear to be the result of the local bridges or railways impeding the flow of flood waters, and were not the result of direct rainfall which fell on the City that caused these flood events. Since there is a level of confidence that the flooding was due to (spatially) large rainfall events that occurred over the entire Withlacoochee River and Little River basins, it makes the most sense to characterize the events based upon flow or stage (flow is derived from stage) at the downstream boundary condition location (Withlacoochee River at US84, near Quitman, Ga.). Based on model outputs, and information from the Lowndes County Assessor's Office, parcels where flooding could be reduced were identified. This area is referred to as the "project area." The project area consisted of 347 real estate parcels that are mostly residential. See Map 4 (Appendix D) for a detailed map of the project area, shown as the parcels outlined in purple. The total value of all structures in the project area is approximately $41,700,000.

Once the project area parcels were identified, the next step was to compare the parcel boundaries to the spatial extent of water surface during flood events. Using geographic information system (GIS) software, parcels within the project area were identified that would experience flooding in each project condition for each flood event: 10-year flood, 50-year flood, and 100-year flood for the without-project conditions. Using this analysis, it was estimated that approximately 221 parcels could be affected by the 100-year storm. Note that for this entire analysis, the number of parcels affected are being used as a proxy for structures damaged. Actual damage to a structure would vary with the location within the parcel and the first floor elevation.

ESTABLISHMENT OF FUTURE WITH-PROJECT CONDITION

The same method used above for the without-project conditions was again used for the with-project conditions for each flood event: 10-year flood, 50-year flood, and 100-year flood. A summary of the flood-affected parcels for each condition is shown in **Table 4-2**. The parcels counted in this table only represent those that have some flood water on the property and do not necessarily represent parcels that are expected to have structure damage.

Table 4-2. Summary of Number of Affected Parcels by Flood Event

	Number of Parcels Affected			
Flood (yr)	**Without-Project**	**With-Project**	**Difference**	**Percent Difference**
10	122	119	3	2.5%
50	176	157	19	10.8%
100	221	188	33	14.9%

Note: Affected parcels will not necessarily have structure damage.

The results shown in **Table 4-2** indicate that a significant number of parcels will continue to be affected by local flood events by experiencing some flood water on the parcel. Although flooding will not be completely prevented, the depth and duration of flooding would be reduced in the with-project condition.

RESULTS

After identifying flood-affected parcels for each condition, an assumption was made to estimate flood damage benefits. The assumption made for this analysis was that parcels would be used as a proxy for structures, i.e. any structure on a flood-affected parcel would be considered damaged. The total structure values were calculated using total structure value information from the Lowndes County Assessor's Office. Content value was then also included in the total damage calculations for each condition. For this analysis, content value was assumed to be 50% of structure value. In the absence of a full dataset of first-floor elevations for each structure, and detailed depreciated replacement cost information, these assumptions were made to estimate damages within the scope of this study. If a more detailed study including the use a full dateset of surveyed first floor elevations were completed, estimated damages may differ significantly from the results shown in this section. The with- and without-project conditions for each flood event were compared to determine the total damages reduced by the project. **Table 4-3** shows a summary of the total damage reduction for each condition by flood event.

Table 4-3. Summary of Total Damage Reduction for Each Condition by Flood Event

	Structure Damages		
Flood (yr)	**Without-Project**	**With-Project**	**Difference**
10	$ 12,792,000	$ 12,569,000	$ 223,000
50	$ 18,279,000	$ 16,613,000	$ 1,666,000
100	$ 22,958,000	$ 19,258,000	$ 3,700,000
	Content Damages		
Flood (yr)	**Without-Project**	**With-Project**	**Difference**
10	$ 6,396,000	$ 6,284,000	$ 112,000
50	$ 9,139,000	$ 8,306,000	$ 833,000
100	$ 11,479,000	$ 9,629,000	$ 1,850,000
	Total Damages		
Flood (yr)	**Without-Project**	**With-Project**	**Difference**
10	$ 19,188,000	$ 18,853,000	$ 335,000
50	$ 27,418,000	$ 24,919,000	$ 2,500,000
100	$ 34,437,000	$ 28,887,000	$ 5,550,000

Once the total damage reductions for each condition and flood event were determined, damages at each frequency were determined, which is discussed more in Appendix B, Socio-Economic Analysis. The total expected annual reduced damages (average annual benefits) was calculated to be $217,000.

Finally, the average annual benefits from the project were compared to the average annual costs to determine the benefit-cost ratio (BCR). The BCR is essentially a return on investment, representing how much will be returned in the form of reduced flood damages for each dollar spent. The annualized benefits, costs, and BCR are summarized in **Table 4-4**.

For the selected plan, the benefit-cost ratio is 1.4 to 1. The average annual net benefit is $61,000.

Table 4-4. Summary of Selected Plan Benefit-Cost Ratio

Estimated Cost*	$ 3,600,000
Interest During Construction	$ 48,000
Project Economic Cost	$ 3,648,000
Average Annual Cost	$ 156,000
Average Annual Benefits	$ 217,000
Net Benefits	$ 61,000
Benefit-Cost Ratio (x:1)	1.4

Note: Annualized using a 3.5% discount rate over the standard USACE 50-year period of analysis. *Estimated Cost only captures cost of construction and does not include the cost of real estate or operations and maintenance.

Finally, note again that the level of detail used in this analysis is equivalent to a "rough order of magnitude" estimate. Therefore, caution should be used when reporting this information or using it for investment decisions.

4.5 ENVIRONMENTAL IMPACTS OF SELECTED PLAN

Since this report is under the Section 22 Provision of Planning Assistance to States and there is no Federal action for this plan, a full environmental analysis is not required for this report under the National Environmental Policy Act (NEPA). However, a cursory analysis of environmental impacts will be discussed below and is also assessed in **Tables 3-7, 3-8, and 3-9**.

The tentative location for this conceptual design of levee and culvert structure would require acquisition of land or easements on land between the confluence of the Withlacoochee River and Sugar Creek, which according to land use maps is currently a mix of commercially owned and undeveloped land. A more detailed investigation of property owners and habitat on the land would be required prior to further plans. There would be temporary noise and aesthetic disturbances to the community, habitat and riverine system during construction. Recreational and educational outreach opportunities for the community near the levee could be investigated prior to further plans.

4.6 CONCLUSION

In conclusion, the complex Suwannee River Basin and sub-basins combined with topography, frequency, timing, and duration of rainfall have led to droughts causing inefficient water supplies and flooding which causes damages and impacts human safety. There is an opportunity for a future potential overall watershed study to examine the region more holistically to reduce damages and improve safety to residents during flood events, as well as to curb the drought problems with a broad regional solution.

The flooding events in the last five years in the City of Valdosta have impacted human safety as well as led to excessive damages to residential areas, commercial areas, roads, bridges and city facilities. There is an opportunity with this local study to reduce the depth and duration of flooding within the Sugar Creek and Two Mile Branch watershed in the study area. There could be an opportunity to investigate multiple purposes for solutions, such as recreational opportunities during certain reasonable timeframes.

The USACE model (HEC-RAS) showed that the flooding that is occurring in the city of Valdosta in the existing condition is not due to conveyance or structural issues within the city's flood control system during direct rainfall. The flooding is due to water in the Withlacoochee River and Little River rising and backing up into Sugar Creek and Two Mile Branch days after the rainfall, which confirms "sunny- day" anecdotal observations of the community.

Several alternatives were identified, compared and evaluated, resulting in one chosen as a potential feasible local solution for the purpose of this report. The alternative which was developed for this report, Alternative 7, is one feasible solution for localized flooding problems. Alternative 7 proposes to construct an earthen levee at the confluence of the Withlacoochee River and Sugar Creek, including a culvert structure with six barrels, measuring 6-feet by 6-feet each, and flap gates at the west end. When water levels in the upstream Sugar Creek are higher than downstream levels in the Withlacoochee River, the flap gates will open and water will flow to the Withlacoochee River. When water levels in the Withlacoochee River are higher than Sugar Creek, the flap gates will close, preventing water from backing up into Sugar Creek.

While the selected plan did reduce flood impacts in the model for property and structures east of the levee, it did not completely eliminate flooding, due to the loss of discharge capacity when the flap gates close (when water levels in the Withlacoochee River are higher than Sugar Creek). This effect could possibly be mitigated by creating or securing more upstream storage that could be utilized only when the Withlacoochee River is at extreme levels and the structure flap gates close. Upstream storage was not addressed in this study, but could be addressed in a future study.

The selected plan is most effective at reducing the depth and duration of flooding on the east side of the levee in the study area. In effect, there would be access to more property for more time. There would be no additional project-induced flooding of property owners on the west side of the levee than what is already experienced.

It is important to note that the underlying problems related to the frequency, depth and duration of water (causing flooding and droughts in the region) are due to the overall river basin and watershed complexity, which a future study could address in greater depth and more holistically. A future study is recommended to address the local and regional problem in more detail.

4.7 FUTURE USACE STUDY OPPORTUNITIES AND AUTHORITIES

This report will assist in establishing potential Federal interest in pursuing future flood risk management studies in the study area and surrounding watershed(s) under other authorities, such as the Continuing Authority Program or Watershed Study Authority. Each of these types of studies is listed below.

4.7.1 CONTINUING AUTHORITIES PROGRAM

Under the Section 205 Flood Control Continuing Authorities Program, the City can request USACE initiate a study to establish Federal interest. USACE would then prepare a Study Initiation Report (SIR) to request funding to initiate the Federal Interest Determination (FID). The first $100,000 invested for the FID would be 100% Federal, any additional expense would be cost shared. If the City determines it is not interested in signing a Feasibility Cost Share Agreement (FCSA), then it will not owe funds to the USACE for previous work. The entire Federal cost share for a project within Section 205 is currently $7,000,000, but anticipated to be $10,000,000 upon the approval of the next Water Resources Development Act.

It is important to note, that a letter of request from the city will allow for the project to get on the waiting list for new funding. Currently new start projects are not being funded. Also, the duration of the process from study to construction can range from approximately 3 to 5 years. A possible area of study is the Withlacoochee and Little River sub-basins, if within the scope of Section 205. The city can coordinate with nearby city and counties within the proposed study area to contribute funds for the study.

4.7.2 WATERSHED STUDY

The general scope of a Suwannee River watershed study would be integrated water resource management between Florida and Georgia. The study would seek sustainable solutions to the water resource problems within the Suwannee River basin in a holistic manner by taking into consideration environmental protection, economic development and social well-being via interagency cooperation. The study would propose sustainable alternatives to achieve multiple goals in the watershed over the long term.

As traditionally executed in Watershed studies, the potential non-Federal sponsor(s) will be identified during the Initial Watershed Assessment (recon study). USACE would act as the lead agency for the watershed planning study.

The reconnaissance phase of a Suwannee River watershed study is estimated to cost $150,000 and would identify the complexity of the challenges occurring within the watershed related to the problems experienced in the upper, middle and lower Suwannee River basin such as flooding, droughts, environmental degradation, and reduced recreation activities. The watershed study itself would involve a vulnerability analysis of communities located in the upper, middle and lower river basins for damages and potential benefits, requiring extensive and indepth engineering and environmental analysis. This would involve considerable work in creating/calibrating a surface water model for a watershed located in two states, while addressing a variety of issues which include flooding, droughts and environmental degradation of fragile riverine wetlands. Although significant amount of information has been compiled by numerous agencies over the last several years, the existing data would have to be evaluated for usability, and then incorporate into the surface water model. This could involve the refinement of existing topographical information or development of new information in areas to assess conditions. Additionally, numerous meetings/workshops would be needed in both Florida and Georgia to identify the objectives of the watershed study, locate available information, and identify information gaps in developing a path forward.

5.0 ACRONYMS, REFERENCES, AND INDEX

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5 ACRONYMS, REFERENCES, AND INDEX

5.1 ACRONYMS

ASTM – American Society for Testing and Materials
BCR – Benefit to Cost Ratio
BMP – Best Management Practice
CIP – Capital Improvements Plan
CDM Smith – Camp, Dresser, McKee and Smith
DEM – Digital Elevation Models
DNR – Department of Natural Resources
DO – Dissolved Oxygen
EPA – Environmental Protection Agency
EPD – Environmental Protection Division
E&S - Erosion and Sedimentation
EQ – Environmental Quality
FC – Fecal Coliform
FEMA – Federal Emergency Management Agency
FID – Federal Interest Determination
FIRM – Flood Insurance Rate Maps
FIS – Flood Insurance Study
FCSA – Feasibility Cost Share Agreement
GEMA - Georgia Emergency Management Agency
GIS – Geographic Information Systems
GSWCC - Georgia Soil and Water Conservation Commission
HEC – Hydrologic Engineering Center
HEC-FDA – Hydrologic Engineering Center – Flood Damage Analysis
HEC-RAS - Hydrologic Engineering Center River Analysis System
HEC-SSP - Hydrologic Engineering Center Statistical Software Package
H&H – Hydrologic and Hydraulic
HPD – Historic Preservation Division
IDDE – Illicit Discharge Detection and Elimination
IfSAR – Interferometric Synthetic Aperture Radar
LDR – Land Development Regulations
LIA - Local Issuing Authority
LIDAR – Light Detection and Ranging
MCM – Minimum Control Measures
MGD – Million Gallons Per Day
MS4 – Municipal Separate Stormwater Sewer System
NAVD88 – North American Vertical Datum of 1988
NED – National Economic Development
NED – National Elevation Dataset
NEPA – National Environmental Policy Act
NFIP – National Flood Insurance Program

NOAA – National Oceanic and Atmospheric Administration
NPDES – National Pollutant Discharge Elimination System
NRHP – National Register of Historic Places
NWI – National Wetlands Inventory
OSE – Other Social Effects
PAS – Planning Assistance to State
PMF – Probable Maximum Flood
PMP – Probable Maximum Precipitation
RS&H – Reynolds, Smith and Hills, Inc
SIR – Study Initiation Report
SPF – Standard Project Flood
SWMP – Stormwater Management Program
TMDL – Total Maximum Daily Load
TWR – Trophic Weighted Residue
USACE- U.S. Army Corps of Engineers
USFWS – U.S. Fish and Wildlife Service
USGS – U.S. Geological Survey
WPCP – Water Pollution Control Plant
YMCA – Young Men's Christian Association

5.2 REFERENCES

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Elevation Cost Spreadsheet, Based on Interviews with Lousiana structure raising firms

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SEAL OF THE AZALEA CITY
INCORPORATED 1860
VALDOSTA
GEORGIA


During 2009 Flooding


Meadowbrook Without Flooding

Appendix A: Hydrology and Hydraulic Analysis

City of Valdosta
Lowndes County

Flood Analysis of the Withlacoochee River and Sugar Creek Confluence

City of Valdosta, Georgia

Section 22 – Planning Assistance to States Study

Hydrology and Hydraulics Analysis

Last Updated: 27MAR2014

US Army Corps
of Engineers®
Jacksonville District

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1 Introduction

1.1 Location

Valdosta is the county seat of Lowndes County located in south-central Georgia along the I-75 corridor. The city has a population of over 54,000 people and a land area of approximately 37 square miles. Areas within the city drain to two watersheds with approximately 20 square miles draining to the Withlacoochee sub-watershed and 17 square miles to the Alapaha sub-watershed. The main waterways in the project area are the Withlacoochee and Little Rivers, Two Mile Branch and Sugar Creek.

1.2 Study Purpose

During March and April of 2009, South Georgia and North Florida experienced historic flooding which resulted in 46 counties in Georgia and 17 counties in Florida being declared Federal Disaster Areas. In Lowndes County alone, there were 172 properties impacted and approximately half of those properties were located in the City of Valdosta, near the confluence of the Withlacoochee River and Sugar Creek, including Two Mile Branch. In the study area, portions of Gornto Road, Lake Drive, Meadowbrook Drive, Park Lane, Ravenwood Circle, Winding Circle, and Winding Way were under water due to overflow from Sugar Creek and the Withlacoochee River. The Norfolk Southern Railway line went under water at the Withlacoochee River due to flooding.

In February and March of 2013, the city of Valdosta at the confluence of Sugar Creek, Two Mile Branch and the Withlacoochee River was once again impacted by flood waters. Throughout Greater Lowndes County, 13 roads and bridges were closed, including US Highway 84, and the Withlacoochee wastewater treatment plant had to be shut down.

The purpose of this flood analysis study is to examine and attempt to reduce flooding caused by overflows from Sugar Creek, Two Mile Branch and the Withlacoochee River in the northwest portion of the City of Valdosta. This report will evaluate the flood impacts of the 10-, 50-, and 100-year storm events and present a potential alternative solution for flood risk reduction in the study area.

1.3 Basin characteristics

The Withlacoochee River is densely vegetated, relatively flat, and has a very wide floodplain, which varies between 3000 and 5000 feet in the vicinity of Valdosta, Georgia. At Valdosta, its drainage area is approximately 537 mi^2. Figure 1 shows a map of the Withlacoochee watershed.

Figure 1. Map of Withlacoochee Watershed

There is approximately 39 feet of elevation drop in the 16.9 miles of river reach beginning at McMillan Road (USGS Gage 023177483), near Bemiss, Georgia, and ending at US84 (USGS Gage 02318500), near Quitman, Georgia. Figure 2 shows a profile plot of the ground elevations along the bank of the Withlacoochee River within the study area. The reach immediately below the confluence of Sugar Creek with the Withlacoochee River (Station 55635 in Figure 2) is essentially flat and has less than 0.5 foot of elevation drop over the next 6.9 miles.

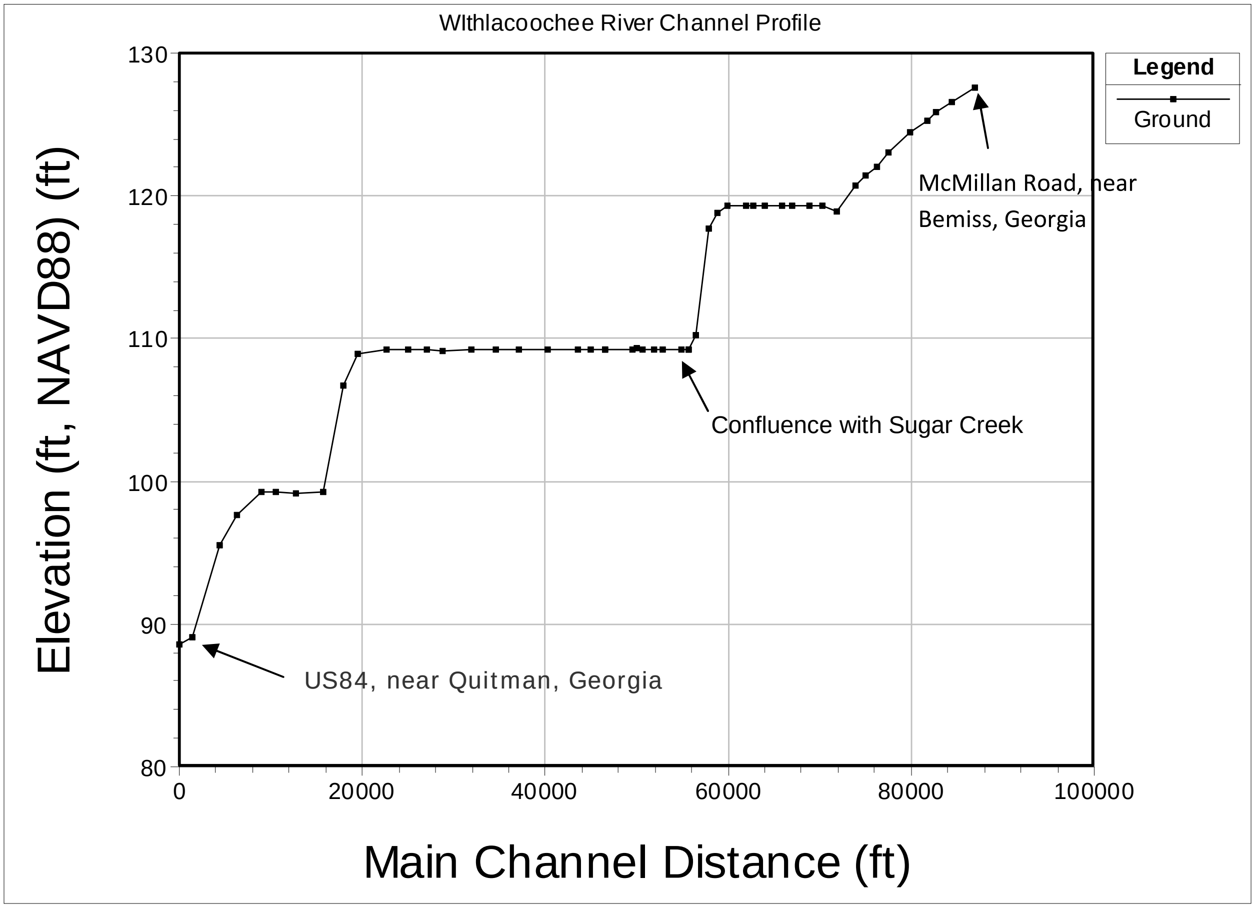


Figure 2. Withlacoochee River Channel Profile Within Model Domain

In contrast to the Withlacoochee River, the topography of the City of Valdosta and its creeks has much steeper slopes. The lower reach of Sugar Creek, which drains directly into the Withlacoochee River, has an average slope of over 18 feet per mile over the model domain. Two Mile Branch, which drains into Sugar Creek approximately 1000 feet above the confluence with the Withlacoochee River, has an average slope of 35 feet per mile over the model domain.

Eleven miles downstream of the City of Valdosta, the Withlacoochee River has a confluence with the Little River. The Little River is also heavily vegetated and relatively flat. Since the drainage area of the Little River (approximately 850 mi^2), shown in Figure 3, is larger than that of the Withlacoochee River at their confluence, flows from the Little River often exceed flows from the Withlacoochee River.

Figure 3. Map of Little River Watershed

2. Hydrologic and Hydraulic Modeling

2.1 Modeling Platform

The project area was modeled using HEC-RAS version 4.1. HEC-RAS is a one dimensional hydraulic numerical model platform developed and distributed by the USACE that uses standard step mathematical analysis to provide steady and unsteady water surface profile computations, sediment transport/movable boundary computations, water quality analysis and several hydraulic design computations. The user interacts with the system through the use of a Graphical User Interface (GUI).

The HEC-RAS platform allows the modeler to formulate different alternative plans based on modifications to plan geometry, specification of hydraulic parameters such as channel roughness, and variation in water surface profiles associated with changes in the magnitude and timing of flows. Results from several simulations can be compiled in tabular and graphical form for comparison.

2.2 Model Setup

2.2.1 HEC-RAS Model Geometry

The National Elevation Dataset (NED) was used to provide topographic information for the hydraulic model. The NED is a seamless raster product primarily derived from USGS 10- and 30-meter Digital Elevation Models (DEMs), and from high resolution data sources such as light detection and ranging (LIDAR), interferometric synthetic aperture radar (IfSAR), and high resolution imagery. NED data can be downloaded from the National Map Viewer (www.nationalmap.gov) as 1 arc-second (approximately 30 meters) resolution for the continental United States.

All geometric pre-processing was completed in ESRI ArcMap version 10, using HEC-GeoRAS version 10. HEC-GeoRAS is an ArcMap extension for the development of HEC-RAS models. GeoRAS is used to extract cross-section information from the DEM topography which is then imported into HEC-RAS. Once flood models are developed within HEC-RAS, results are then exported from HEC-RAS and processed with ArcMap/GeoRAS to produce inundation maps.

In addition to the NED dataset, existing survey data was provided by the City of Valdosta. This data was used to supplement cross-section data for Sugar Creek and Two Mile Branch.

All model inputs utilized the NAVD88 (vertical) and NAD83 (horizontal) datums.

The HEC-RAS model consisted of four different rivers and creeks. Within the City of Valdosta, Sugar Creek and Two Mile Branch were modeled. The confluence of these streams with the Withlacoochee River represent the location of severe flooding experienced in 2009 and 2013. Below the confluence, the Withlacoochee River flows southwesterly towards the confluence with the Little River approximately 2.3 miles downstream from the City of Valdosta. Generally it is good modeling practice to set up boundary conditions, applied at the model extents, far from the area of interest. In the Withlacoochee River, the model boundaries were located approximately 5.8 miles upstream and 11.1 miles downstream of the project area. The Little River was represented for approximately 4.5 miles upstream of its confluence with the Withlacoochee River. Sugar Creek and Two Mile Branch were represented for approximately 1.6 and 2.6 miles, respectively, from their confluence with the Withlacoochee River. Figure 4 shows a network schematic of the HEC-RAS model, with cross-section and boundary condition locations indicated.

The model includes the I-75 Bridge spanning the Withlacoochee River approximately 1 mile downstream of the project area. Bridge information was provided by the Georgia Department of Transportation.

A Manning's n value of 0.1 was used throughout the model. From "Open-Channel Hydraulics" [Chow, 1959], this value is consistent with main channels with weedy reaches and floodplains with stands of timber and medium to dense brush.

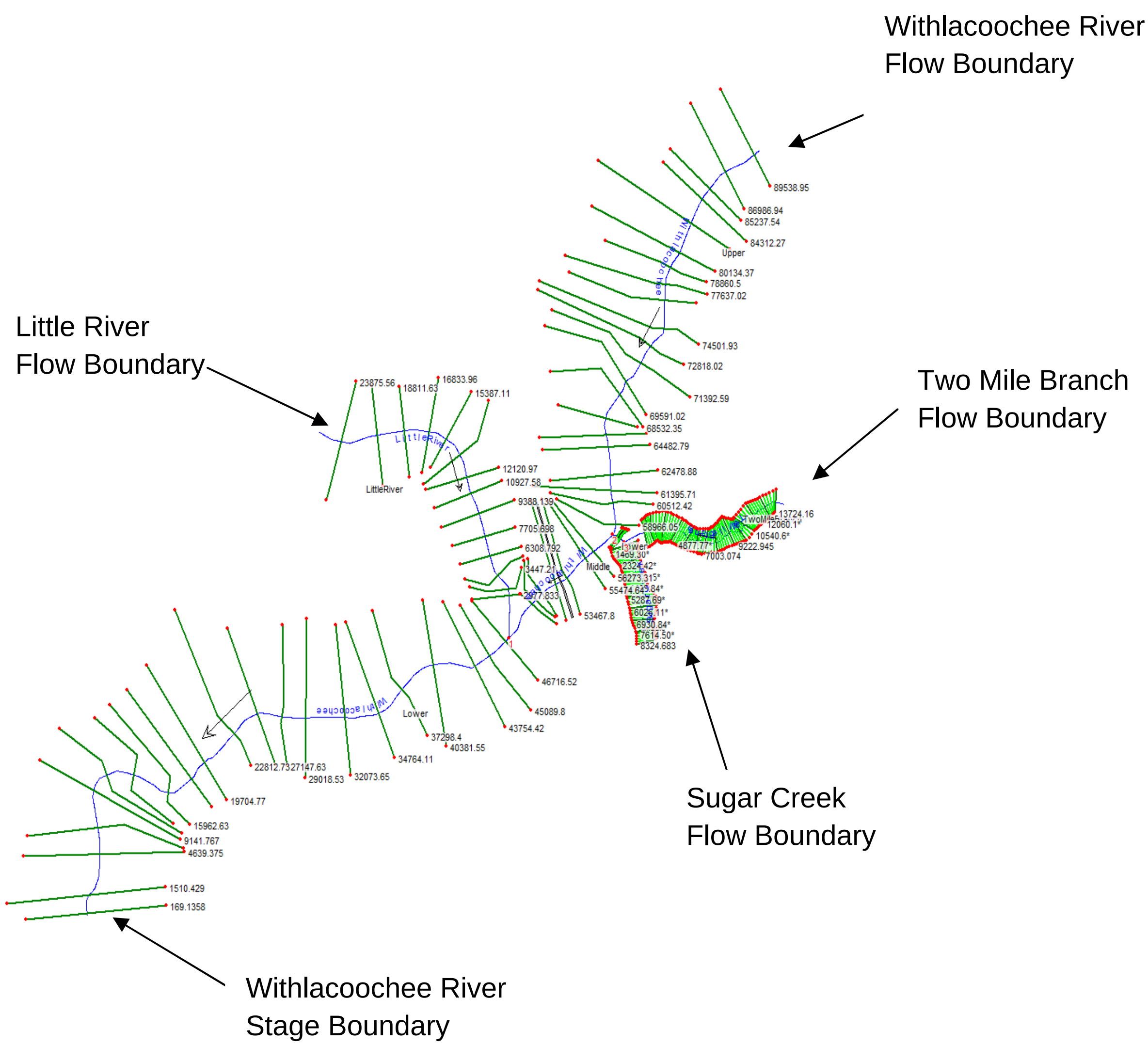


Figure 4. HEC-RAS Model Schematic

2.2.2 HEC-RAS Model Boundary Conditions

Flow and stage boundary conditions must also be provided to the HEC-RAS model. For the Withlacoochee River and Little River, USGS gage data was used. At the upstream model boundary in the Withlacoochee River, flow data was derived from USGS gage 023177483 in the Withlacoochee River at McMillan Road, near Bemiss, Georgia. At the downstream model boundary in the Withlacoochee River, stage data was derived from USGS gage 02318500 in the Withlacoochee River at US 84, near Quitman, Ga.

At the upstream model boundary in the Little River, flow data was derived from USGS gage 02318380 in the Little River at GA122, near Hahira, Ga. Flows from the gage were scaled relative to the overall contributing drainage basin size due to the distance from this gage to the model boundary. The USGS reports that the Little River drainage basin size above gage 02318380 is 776 $miles^2$. The drainage basin size below the gage was estimated, using GIS, at approximately 67.4 $miles^2$. This produced a scaling factor of approximately (776 + 67.4)/(776) = 1.087 to be applied to the USGS gage 02318380 flows.

No flow or stage gages were available within the City of Valdosta for the Sugar Creek and Two Mile Branch reaches. However an existing EPA SWMM hydrologic model was provided by the City of Valdosta. Rainfall events were applied to the EPA SWMM model and flows were extracted and applied to the HEC-RAS model. Rainfall data applied to the SWMM model were derived from the nearby USGS site 2317755 in the Withlacoochee River at US 41, near Valdosta, Ga.

2.3 Model Calibration

City of Valdosta staff reported severe flood impacts during the flood events of 2009 and 2013. The 2013 event was chosen for initial model setup and calibration due to boundary condition data gaps for the 2009 event. The period from 22FEB2013 through 05MAR2013 was chosen as the calibration simulation period. Figure 5 shows the rainfall hyetograph for the storm event recorded by the nearby USGS 2317755 rainfall gage.

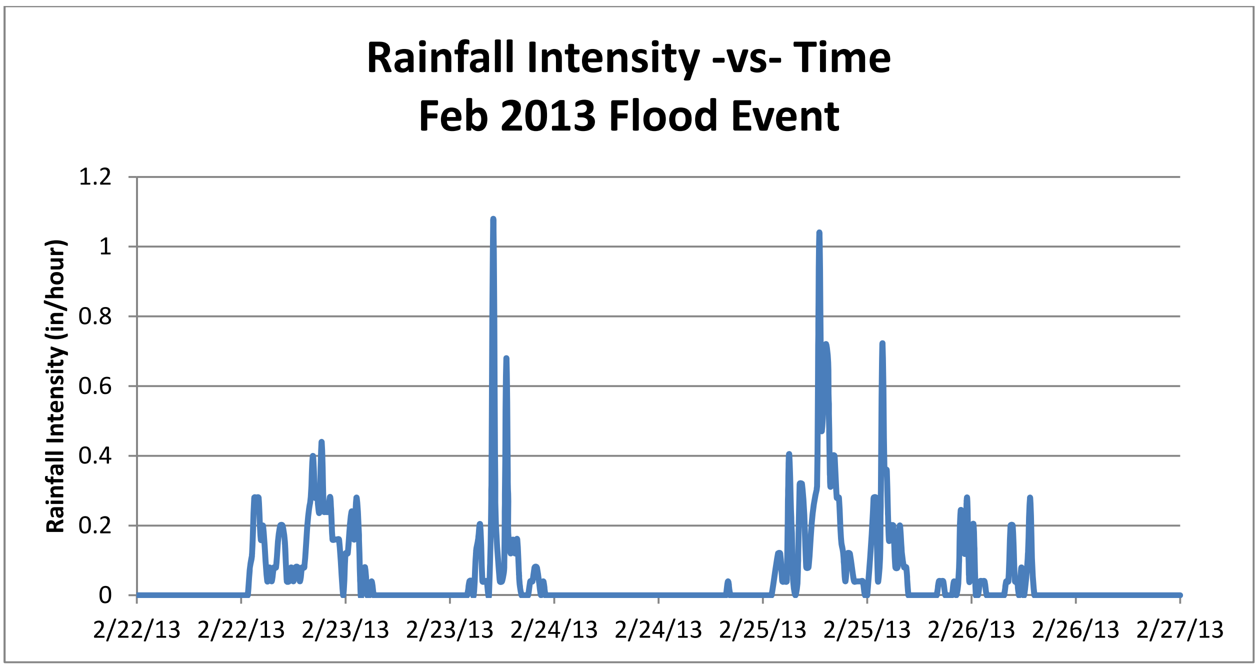


Figure 5. 2013 Rainfall Hyetograph (Measured at USGS 2317755 Gage)

The observed rainfall event shown in Figure 5 was applied to the existing SWMM model, which calculated rainfall runoff hydrographs. These inflow hydrographs, shown in Figure 6, were then applied as upstream boundary conditions for Sugar Creek and Two Mile Branch in the HEC-RAS hydraulic model.

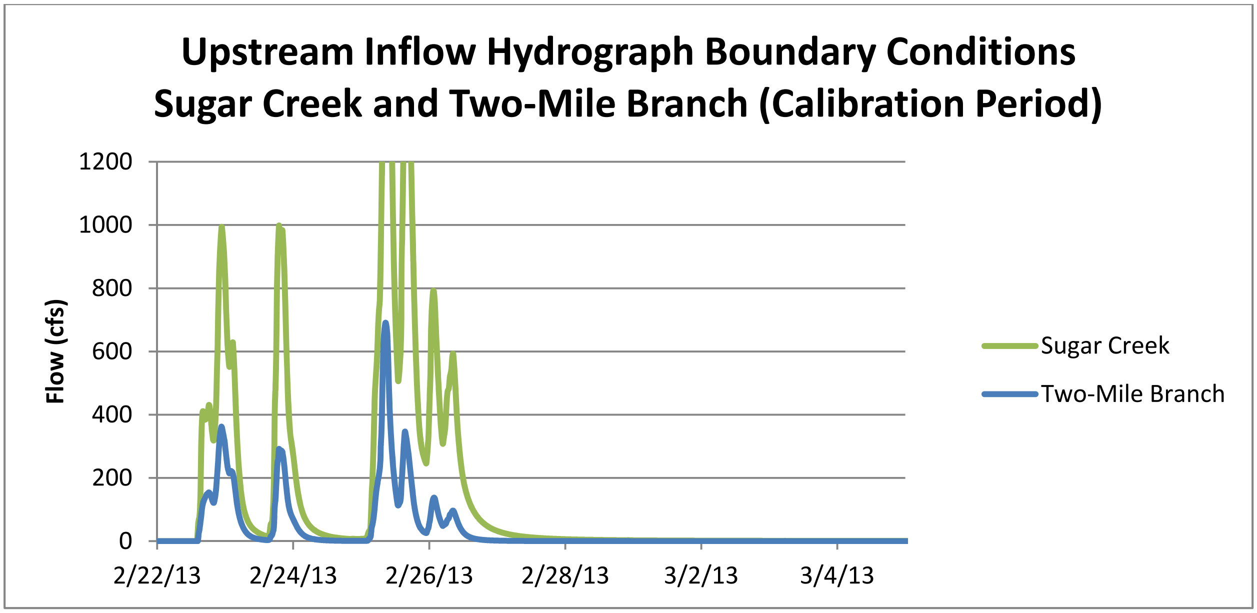


Figure 6. Inflow Hydrographs for Sugar Creek and Two Mile Branch.

Observed upstream inflow hydrographs for the Little River and the Withlacoochee River are shown in Figure 7 and the observed downstream stage hydrograph in the Withlacoochee River is shown in Figure 8. From Figure 7, it is evident that the Little River provides a greater contribution of water to the system, nearly doubling the inflow of the Withlacoochee River.

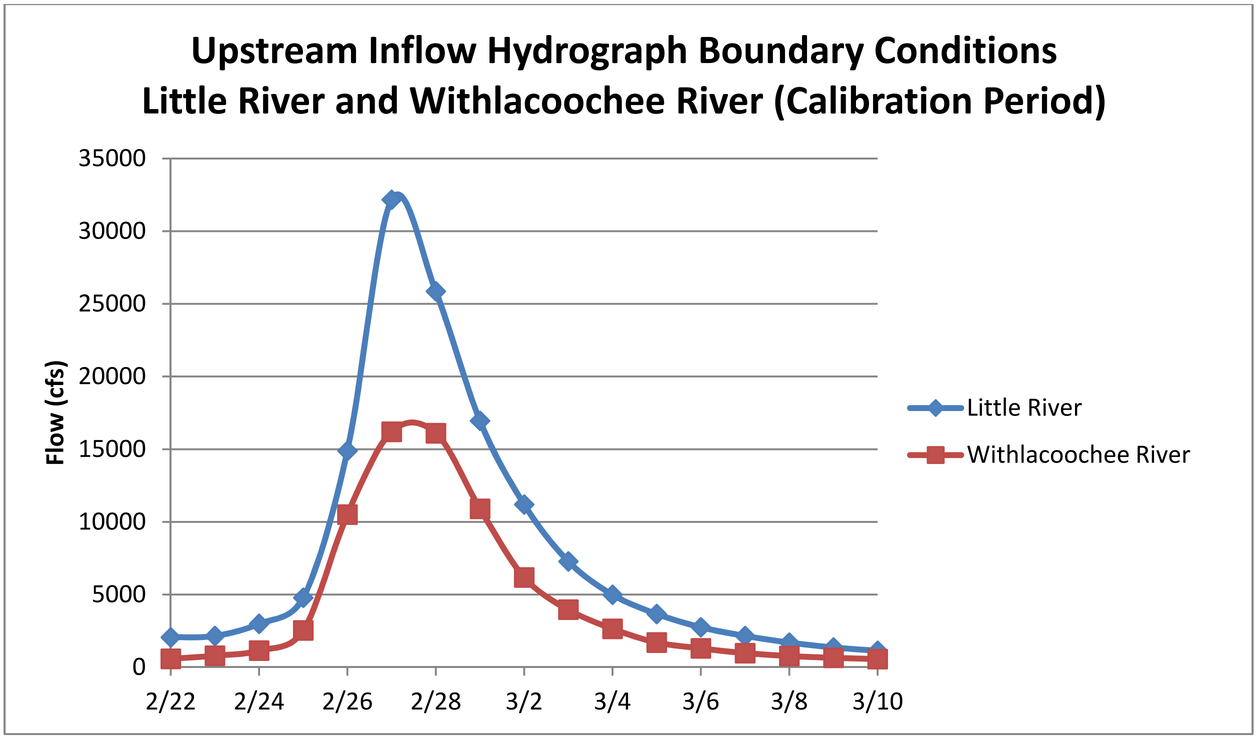


Figure 7. Upstream Inflow Hydrographs for the Little River and the Withlacoochee River.

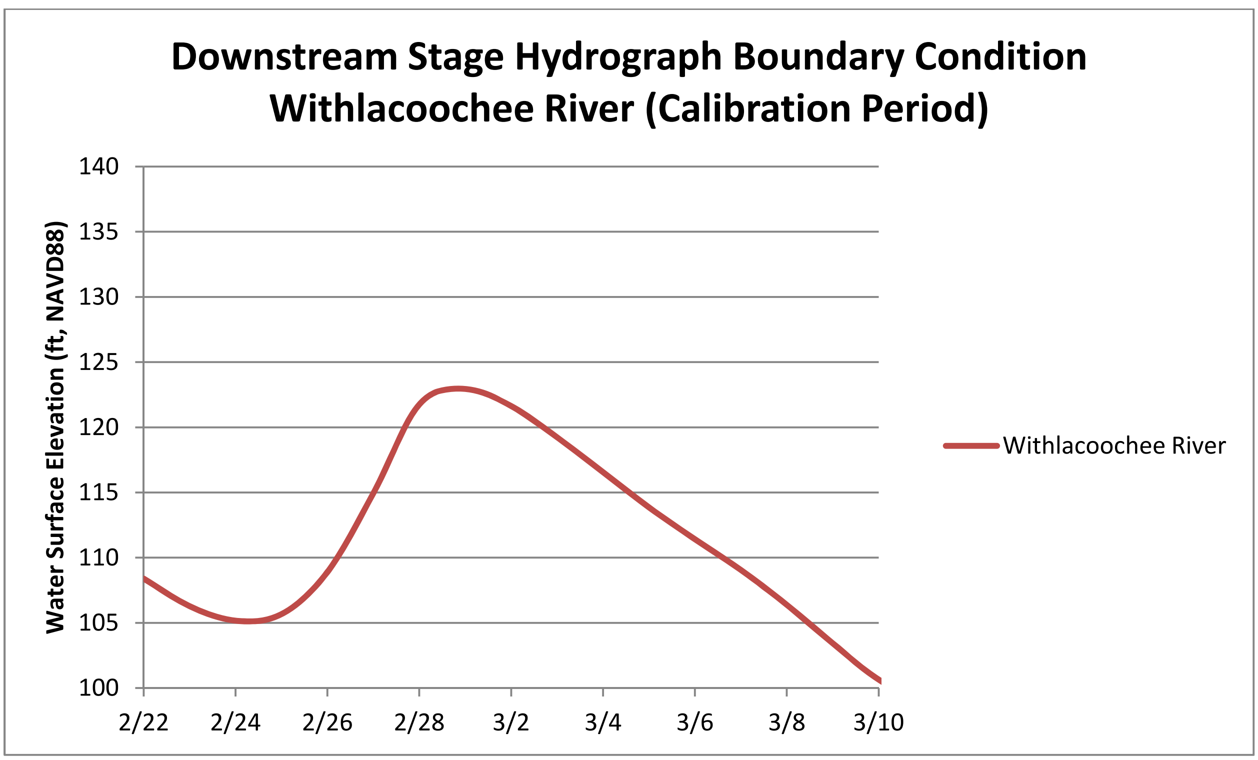


Figure 8. Observed Downstream Stage Hydrograph in the Withlacoochee River.

With the boundary conditions applied as described above, the HEC-RAS model then calculates stage and flow at all modeled cross-section locations. The USGS gage 02317755 was chosen as a calibration point for comparison between measured and simulated flows. This gage is approximately 2 miles upstream from the area of flood interest and contained stage data (daily maxima) for the 2013 storm event. Model parameters can be adjusted within reasonable bounds until the model produces stages in agreement with the measured data. Figure 9 shows a plot of observed and simulated water surface elevations at US41, near Valdosta, Ga.

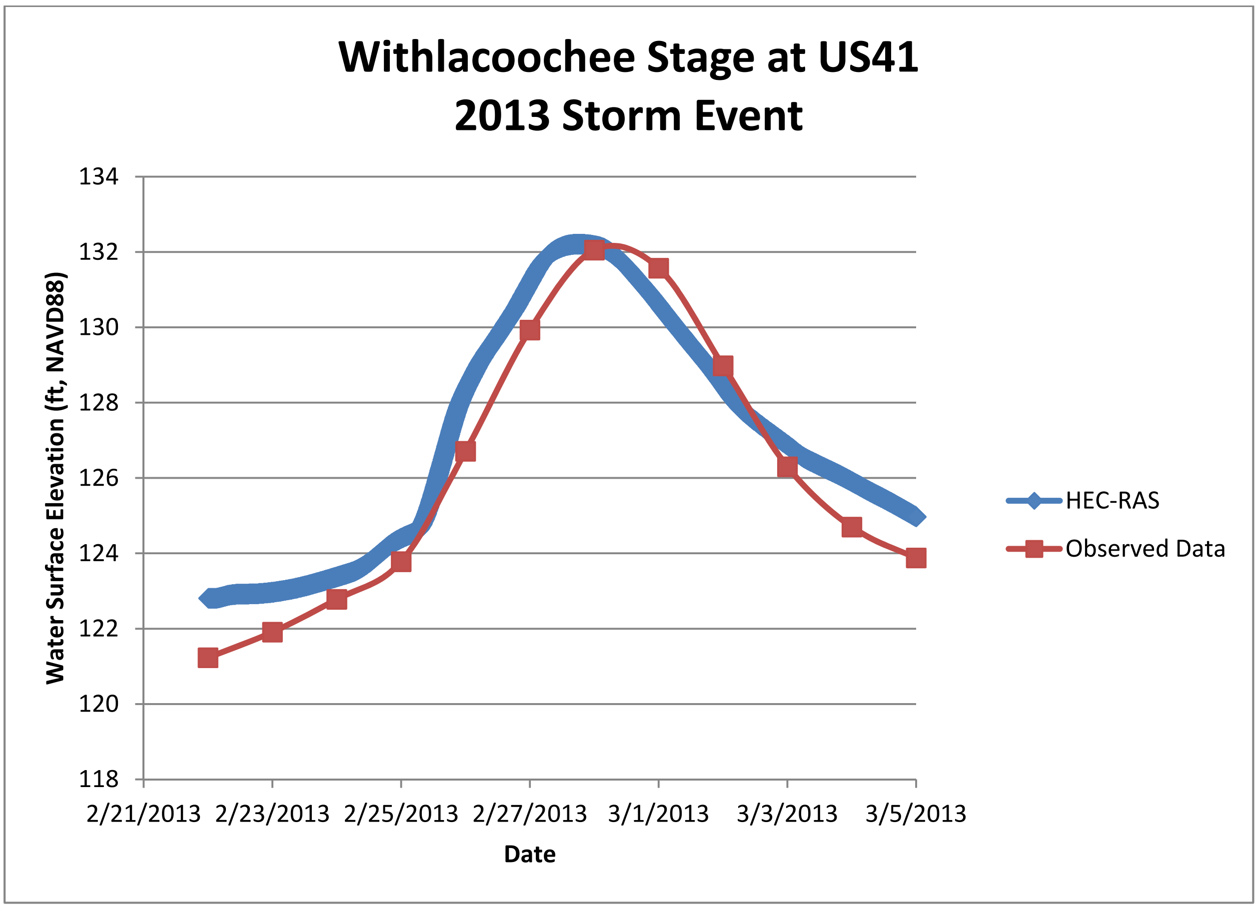


Figure 9. Stage at US41, Near Valdosta, Ga, Observed and Model Data.

2.4 Storm Event Modeling

Once the existing conditions model was calibrated to the 2013 event, hypothetical 10-, 50-, and 100-year storm events were developed and applied to the HEC-RAS model. Development of a hydrologic model of the entire upstream Withlacoochee and Little River basins was far beyond the scope of this study, therefore the HEC-RAS model boundary conditions for the synthetic events were derived from a scaling of the observed 2013 flows and stages. To accomplish this, a frequency analysis was performed on the observed time-series at each of the USGS gages that were used as boundary conditions (either flow or stage) for the HEC-RAS model. Since unregulated riverine flows are known to fit a Log-Pearson Type III probability distribution, the USACE Statistical Software Package (HEC-SSP) was used to perform a Bulletin 17B type flow-frequency analysis on each of the gages. The 10-, 50- and 100-yr peak flow values were derived at each gage and then compared to the peak flow from the 2013 event in order to determine the scaling factor. The time-series flow values for the 10-, 50- and 100-yr synthetic events were then produced by applying the appropriate scaling factor to the time-series flow values of the 2013 event.

Figure 10 shows the frequency plot for the upstream boundary condition in the Withlacoochee River. From this HEC-SSP flow frequency analysis, the peak flow rates for the 10-, 50-, and 100-year events were computed as 17,561 cfs, 39,260 cfs, and 52,489 cfs. The peak flow from the 2013 event was measured at 16,200 cfs. This produced scaling factors of 1.084, 2.423 and 3.240 to be applied to the 2013 time-series of flows in order to generate the time-series for the 10-, 50-, and 100-year synthetic events.

Table 1. Scaling Factors for Withlacoochee River and Little River Flow Boundary Conditions.

	2013 Flood Event (Peak Flow at USGS Gage, cfs)	10-Year Peak Flow (cfs)	10-Year Scaling Factor	50-Year Peak Flow (cfs)	50-Year Scaling Factor	100-Year Peak Flow (cfs)	100-Year Scaling Factor
Upstream Withlacoochee River (USGS gage 023177483)	16,200	17,561	1.084	39,260	2.423	52,489	3.240
Upstream Little River (USGS Gage 02318000)	22,300	15,032	.6741	31,607	1.417	41,509	1.861
Upstream Little River (USGS Gage 02318380)	32,167	21,684	.6741	45,594	1.417	59,879	1.861

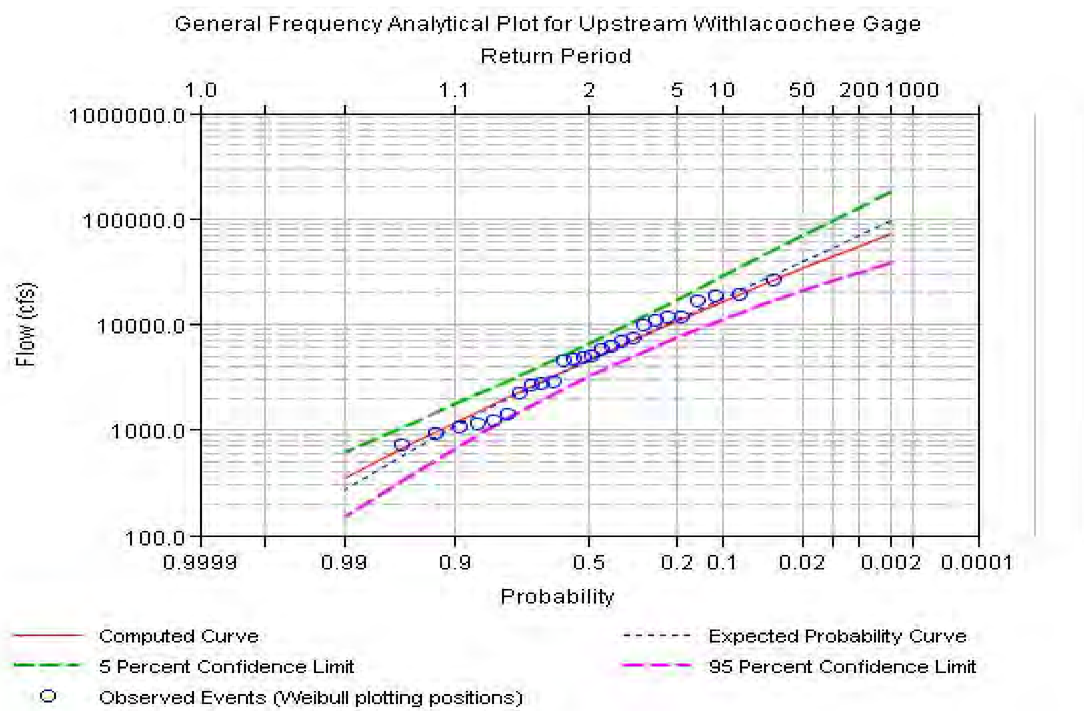


Figure 10. Flow Frequency Analyses for Upstream Boundary Condition in the Withlacoochee River.

For generation of the 10-, 50- and 100-year time-series of flows at the upstream flow boundary on the Little River, the intent was to use data from USGS gage 02318380 that had been used for observed flows during the 2013 calibration event. However, only four years of flow data are available for this gage. This period of record is insufficient for a statistical frequency analysis. Therefore, the next upstream gage on the Little River, USGS gage 02318000 near Adel, Georgia was used for the frequency analysis to establish scaling factors. This gage had more than 40 years of flow data. Figure 11 shows the frequency plot for flow in the Little River at USGS gage 02318000. From this analysis, the peak flow rates for the 10-, 50-, and 100-year events were 15,032 cfs, 31,607 cfs, and 41,509 cfs. The peak flow from the 2013 event at USGS gage 02318000 was measured at 22,300 cfs. This produced scaling factors for the 10-, 50-, and 100-year events of 0.6741, 1.417, and 1.861. These scaling factors were then transferred and applied to the 2013 event time series at USGS gage 02318380 shown in Figure 7, producing peak flows of 32,167 cfs, 21,684 cfs, 45,594 cfs, and 59,879 cfs for the 2013, 10-, 50-, and 100-year events, respectively.

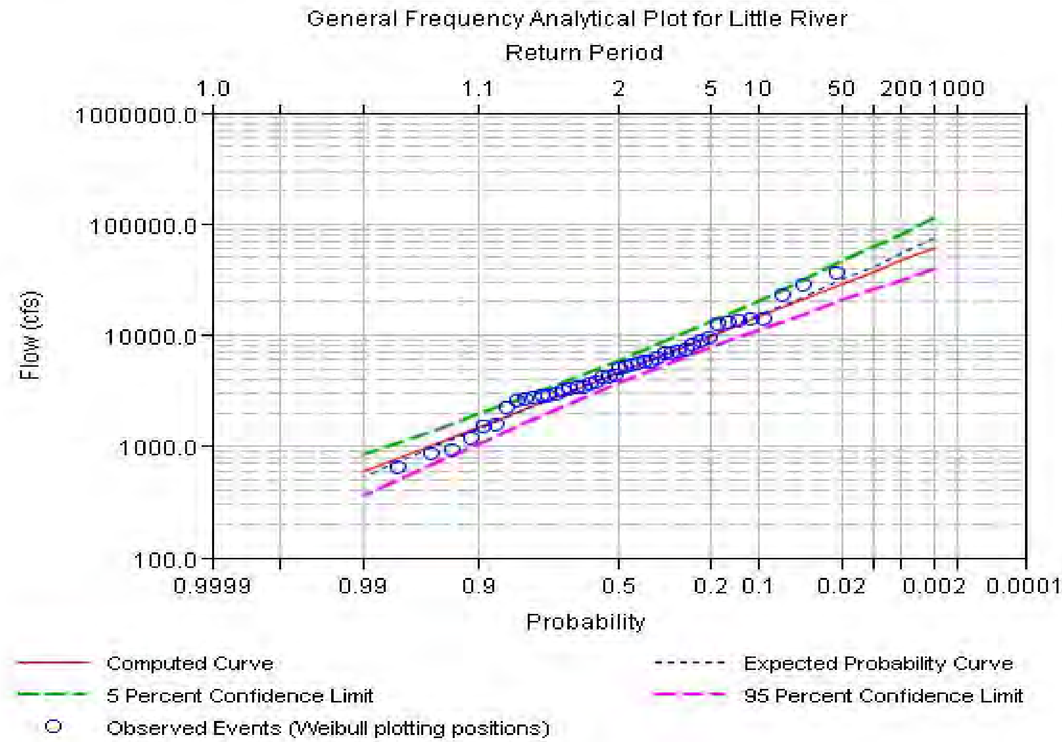


Figure 11. Flow Frequency Analyses for Upstream Boundary in the Little River.

For the downstream Withlacoochee River stage boundary condition, the above frequency analysis was performed using flow data. The flow frequency plot at the downstream Withlacoochee River boundary is shown in Figure 12. From the frequency analysis, the 10-, 50-, and 100-year peak flows were calculated to be 32,296 cfs, 63,676 cfs, and 79,525 cfs, respectively. The peak flow for the 2013 event was 39,900 cfs. Using a correlation between stage and flow at the gage, peak water surface elevations were then developed. Peak stages for the 10-, 50-, and 100-year events are 112.7, 119.5, and 122.9 feet (NAVD88), respectively. Peak stage for the 2013 event was 114.77 feet, NAVD88. Resulting stage scaling factors for the 10-, 50-, and 100-year events are .983, 1.041, and 1.071, respectively. The 2013 event stage hydrograph represented in Figure 8 was then adjusted by these factors to produce the desired 10-, 50- and 100-year stage hydrograph (i.e., time-series of values) boundary conditions.

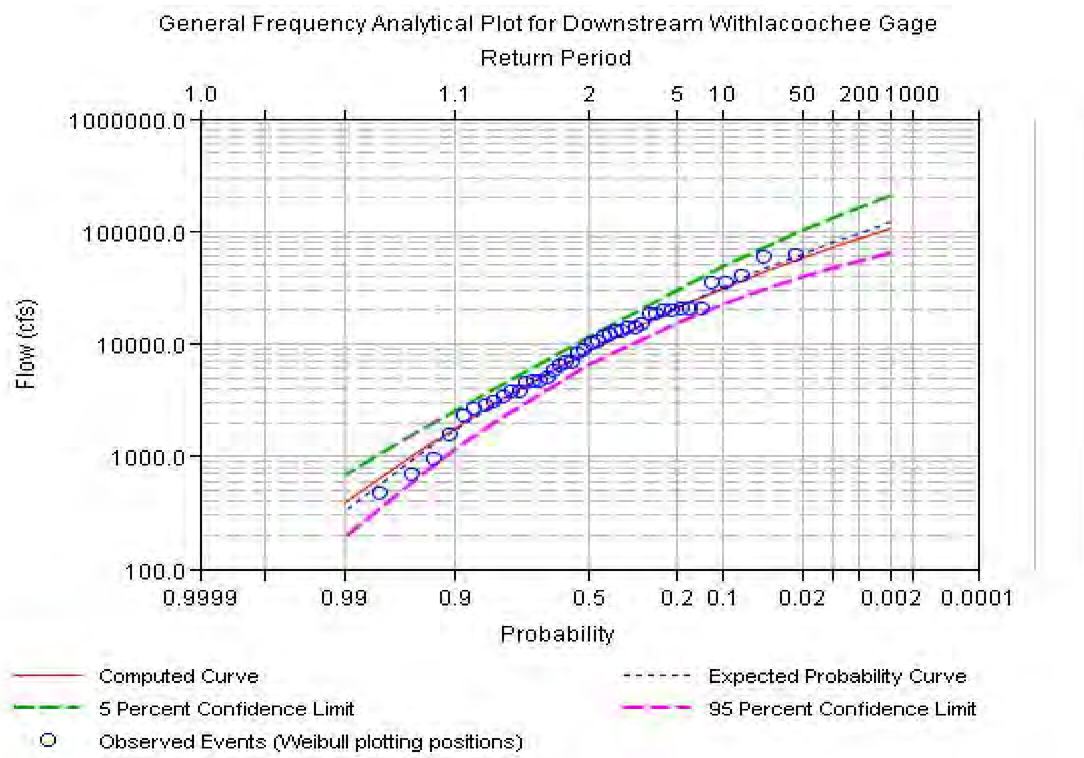


Figure 12. Flow Frequency Analyses for Downstream Boundary in the Withlacoochee River.

Table 2. Peak Flow at Withlacoochee River Downstream Boundary.

	2013 Flood Event (Peak Flow at USGS Gage)	10-Year Peak Flow (From Frequency Analysis)	50-Year Peak Flow (From Frequency Analysis)	100-Year Peak Flow (From Frequency Analysis)
Downstream Withlacoochee River (USGS gage 02318500)	39,900 cfs	32,296 cfs	63,676 cfs	79,525 cfs

Table 3. Peak Stage at Withlacoochee River Downstream Boundary.

	2013 Flood Event (Peak Stage at USGS Gage, ft NAVD88)	10-Year Peak Stage (From Correlation, ft NAVD88)	50-Year Peak Stage (From Correlation, ft NAVD88)	100-Year Peak Stage (From Correlation, ft NAVD88)
Downstream Withlacoochee River (USGS gage 02318500)	114.7	112.7	119.5	122.9

Table 4. Scaling Factors at Withlacoochee River Downstream Stage Boundary.

	2013	10-Year Stage Scaling Factor	50-Year Stage Scaling Factor	100-Year Stage Scaling Factor
Downstream Withlacoochee River (USGS gage 02318500)	1	.983	1.041	1.071

The NOAA Atlas 14 precipitation frequency estimates were used to determine cumulative rainfall volumes for the synthetic storms. Total rainfall volumes for the 10-, 50-, and 100-year events (4-day duration) were estimated to be 7.94", 10.77", and 12.09", respectively. Total observed rainfall for the 2013 event was 7.13", measured at USGS gage 02317755 at US 41. Resulting rainfall scaling factors, developed from these total 4-day volumes, for the 10-, 50-, 100-year storms were 1.11, 1.51, and 1.69, respectively and are shown in the below Table 5. The rainfall hyetograph time-series (see Figure 5, Section 2.3, Model Calibration) were then multiplied by these scaling factors to provide rainfall inputs into the SWMM models of Sugar Creek and Two Mile Branch. The SWMM model then produced flow hydrographs used as inflow boundary conditions for the HEC-RAS model.

Table 5. Cumulative Rainfall Totals and Scaling Factors for 2013, 10-, 50-, and 100-Year Events

	2013 Event (from USGS Gage 02317755)	10-Year (From Atlas 14)	10-Year Scaling Factor	50-Year (From Atlas 14)	50-Year Scaling Factor	100-Year (From Atlas 14)	100-Year Scaling Factor
Cumulative Rainfall	7.13"	7.94"	1.11	10.77"	1.51	12.09"	1.69

2.5 Existing Condition Modeling Results

Once all model boundaries (upstream flows, lateral inflows and downstream stage) are developed and applied, the HEC-RAS model can be run to calculate water surface elevation and flow at all cross-section locations. Water surface elevations are then exported from HEC-RAS into ArcMap/HEC-GeoRAS where maps showing water inundation depths and maximum extents of flooding are produced. Figures 13 through 16 show inundation maps for the 2013 flood event and the 10-, 50-, and 100-year storm events.

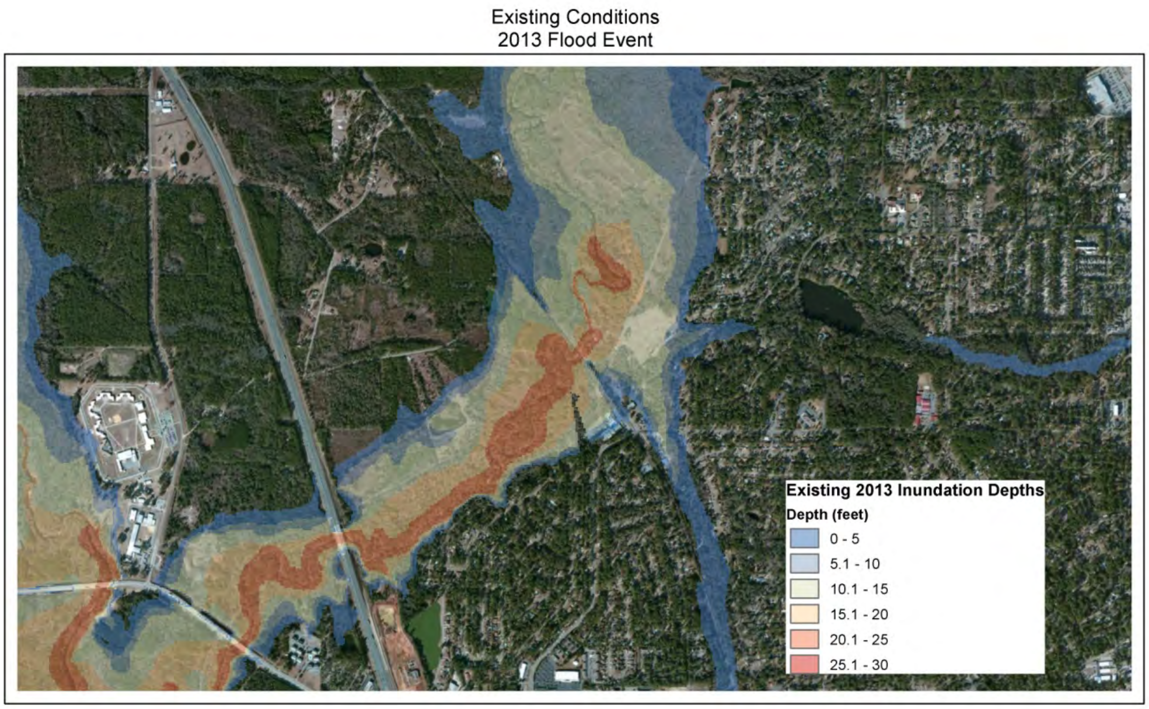


Figure 13. Existing Conditions Flood Inundation Depths for 2013 Event.

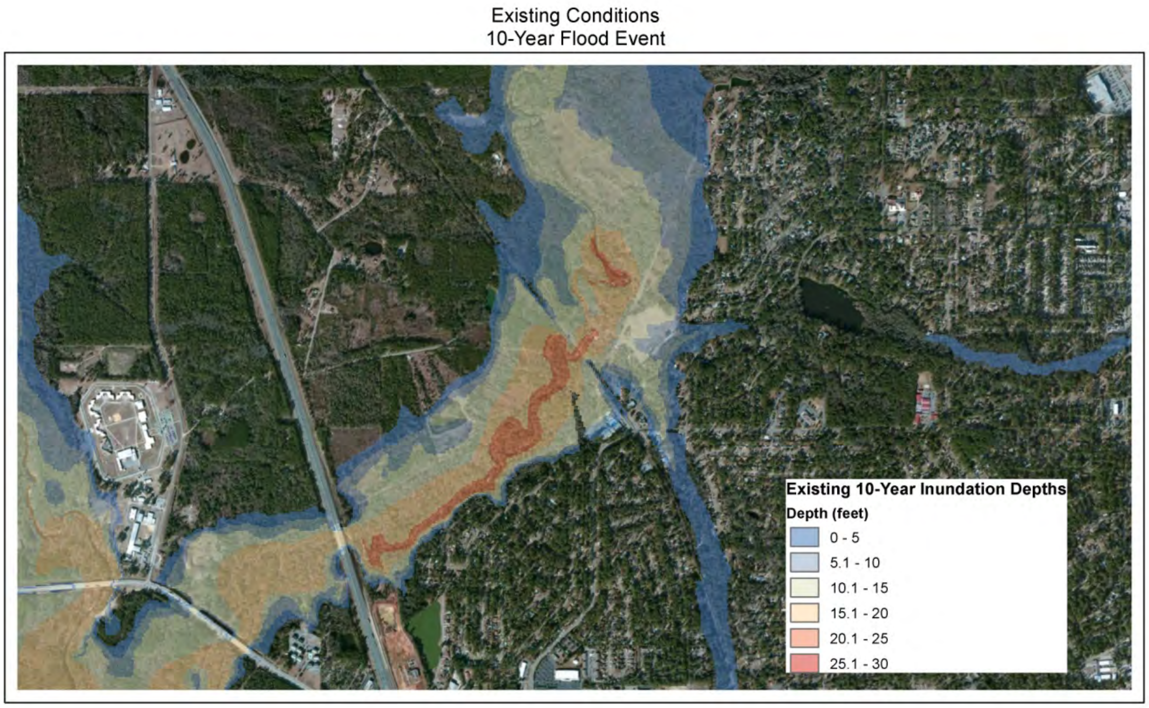


Figure 14. Existing Conditions Flood Inundation Depths for 10-year Event.

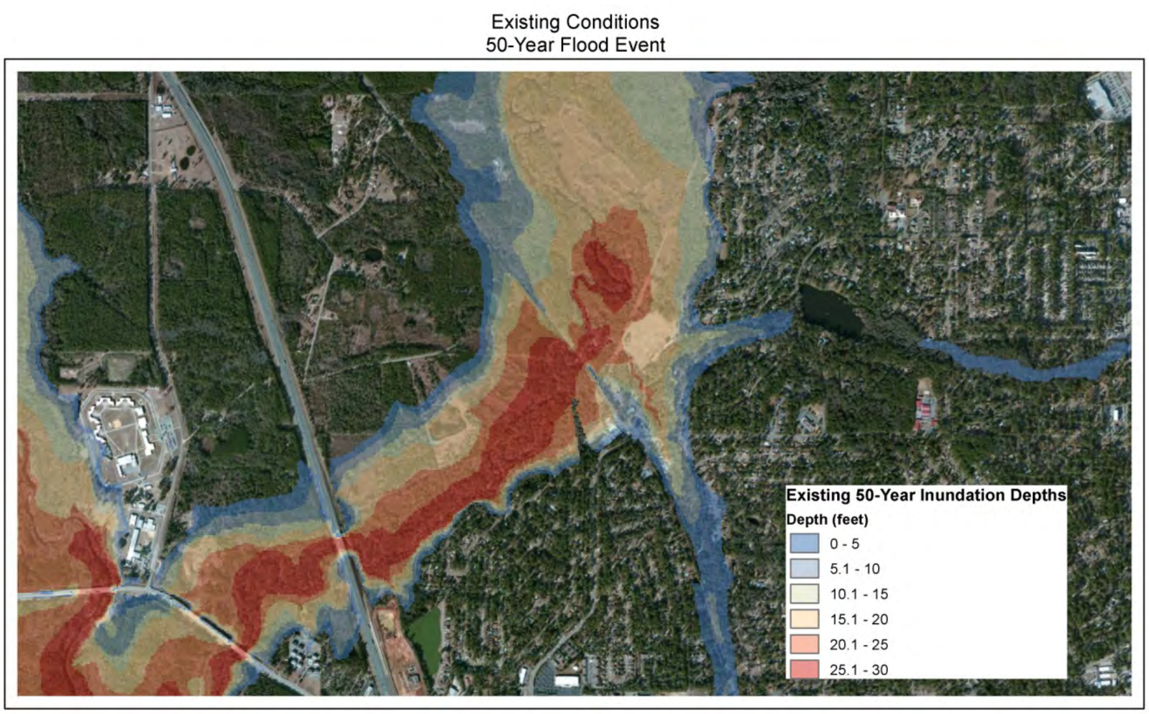


Figure 15. Existing Conditions Flood Inundation Depths for 50-Year Event

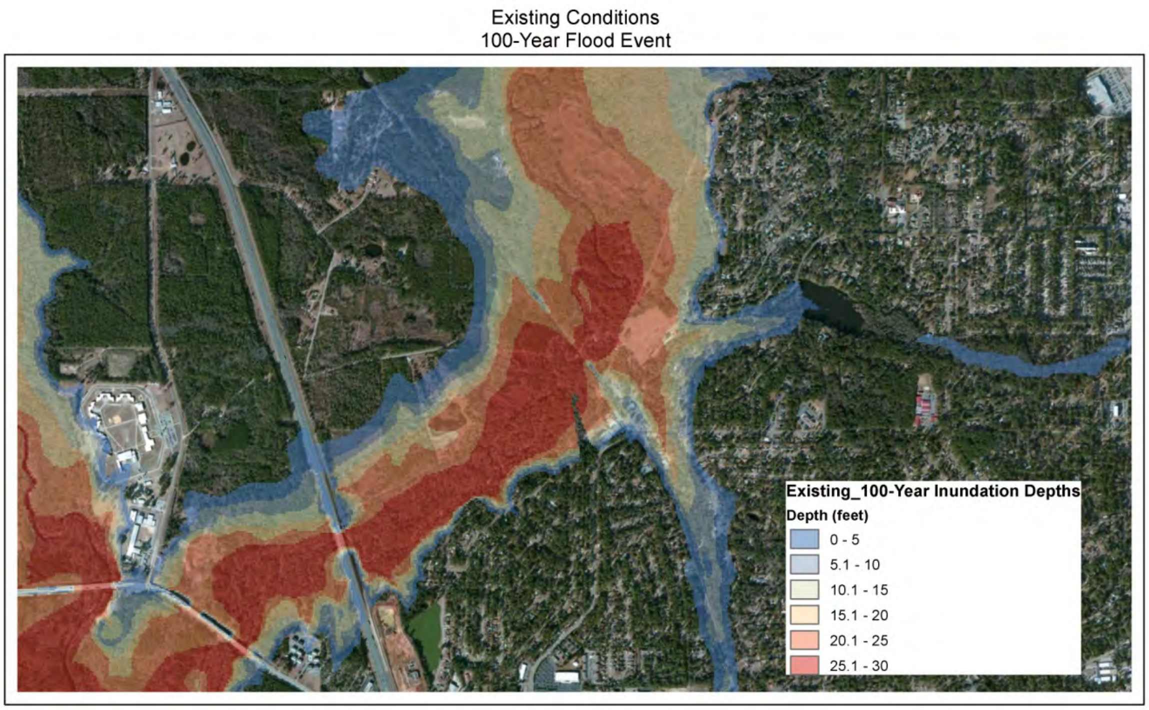


Figure 16. Existing Conditions Flood Inundation Depths for 100-year Event

Review of the HEC-RAS water surface profiles, shown in Figures 17 through 20 indicate that the flooding within the City of Valdosta during the 2013 storm event is clearly caused by water in the Withlacoochee River backing up into Sugar Creek. Figure 17 shows the profile of maximum water surface elevations for the 2013 event. The maximum water surface elevation in the Withlacoochee River at the confluence with Sugar Creek is 130.92 ft, NAVD88. Without any hydraulic control structure or levee preventing the backing up flow, the water from the Withlacoochee River rises into Sugar Creek and Two Mile Branch until, at a minimum, even without contributing flows from upstream in Sugar Creek and Two Mile Branch, flood levels will reach at least 130.92 ft, NAVD88. Within Sugar Creek and Two Mile Branch, one must travel more than ½ mile upstream from the confluence with the Withlacoochee River to the point where the water surface elevation of 130.92 ft, NAVD88 would intersect the ground surface. Viewing the water surface elevations of the 10-, 50, and 100-year events shown in Figures 18 through 20 reveal a similar backwater effect. Maximum water surface elevations in the Withlacoochee River reached 129.52, 137.55, 140.86 ft, NAVD88, respectively.

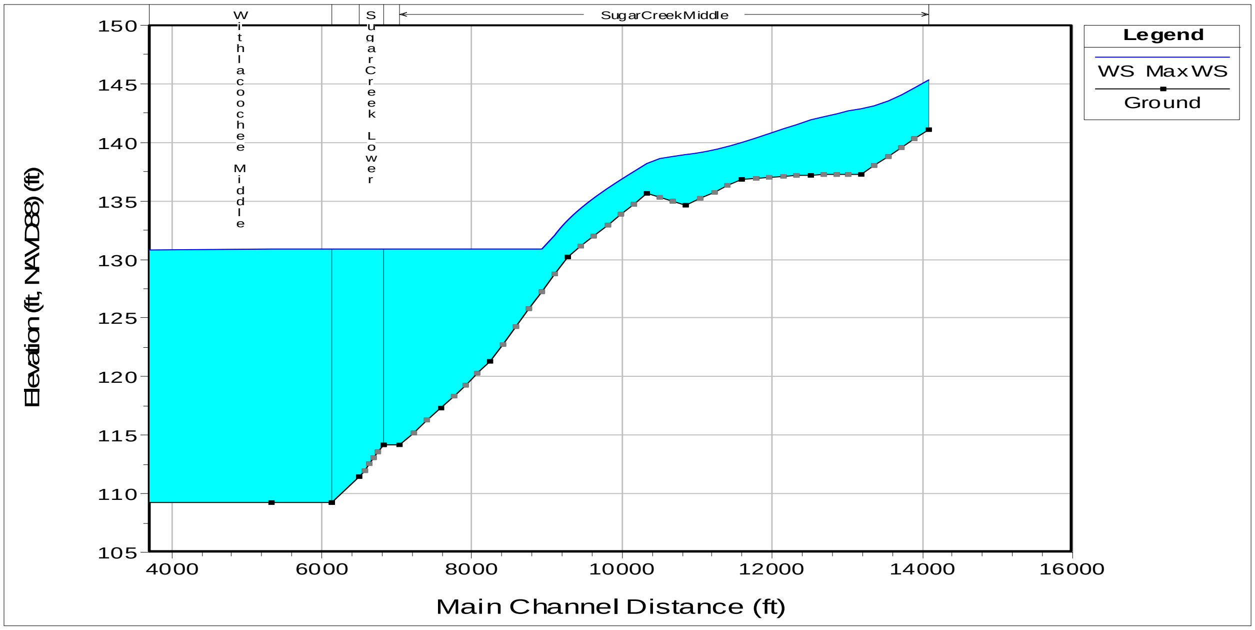


Figure 17. Maximum Water Surface Profile (Withlacoochee River and Sugar Creek) for 2013 Event.

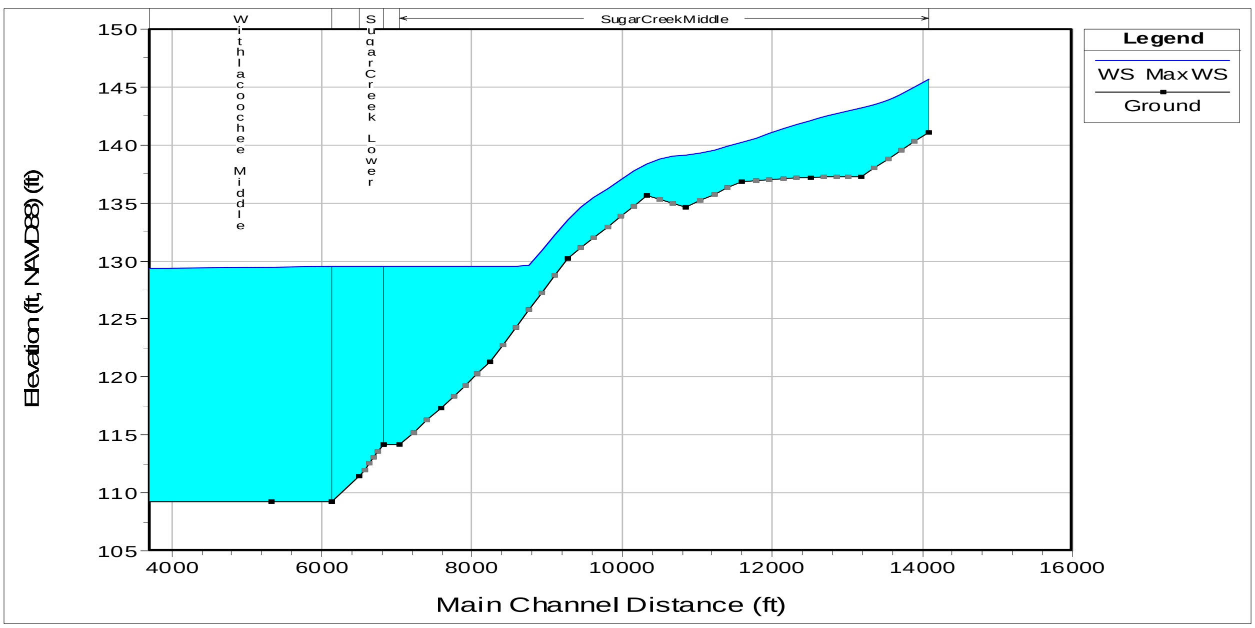


Figure 18. Maximum Water Surface profile (Withlacoochee River and Sugar Creek) for 10-Year Event.

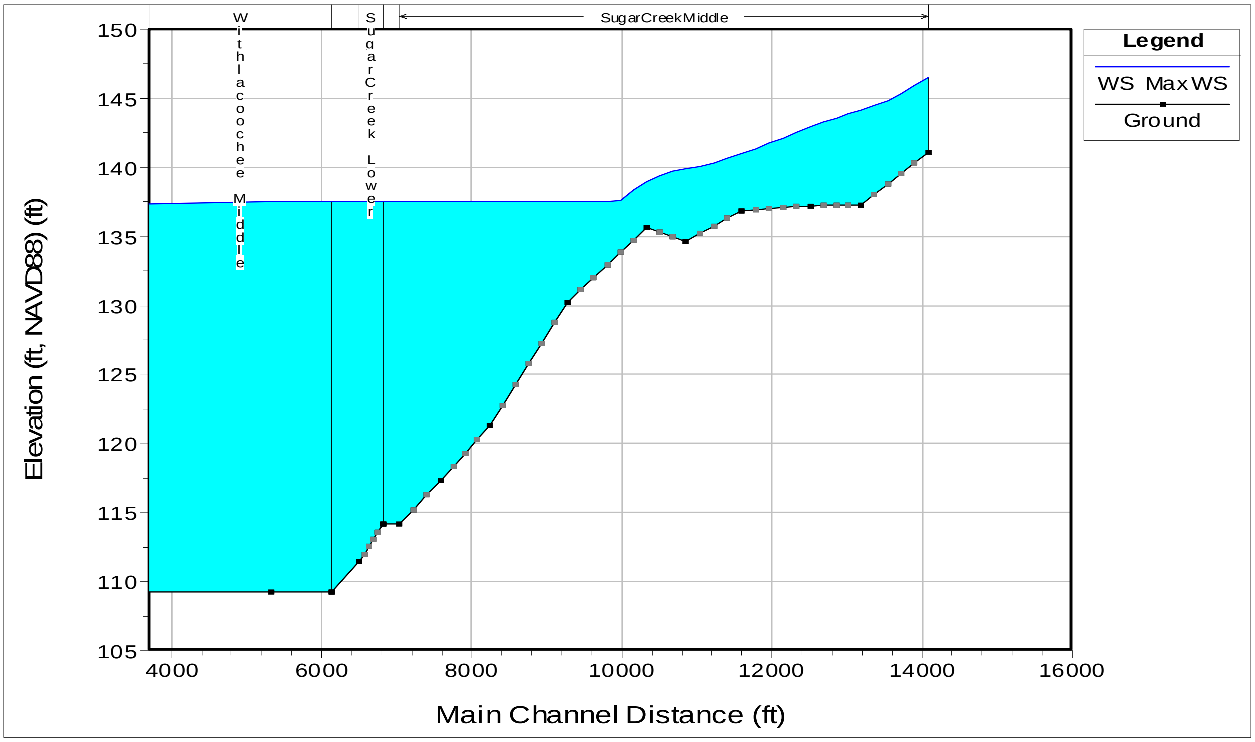


Figure 19. Maximum Water Surface Profile (Withlacoochee River and Sugar Creek) for 50-Year Event.

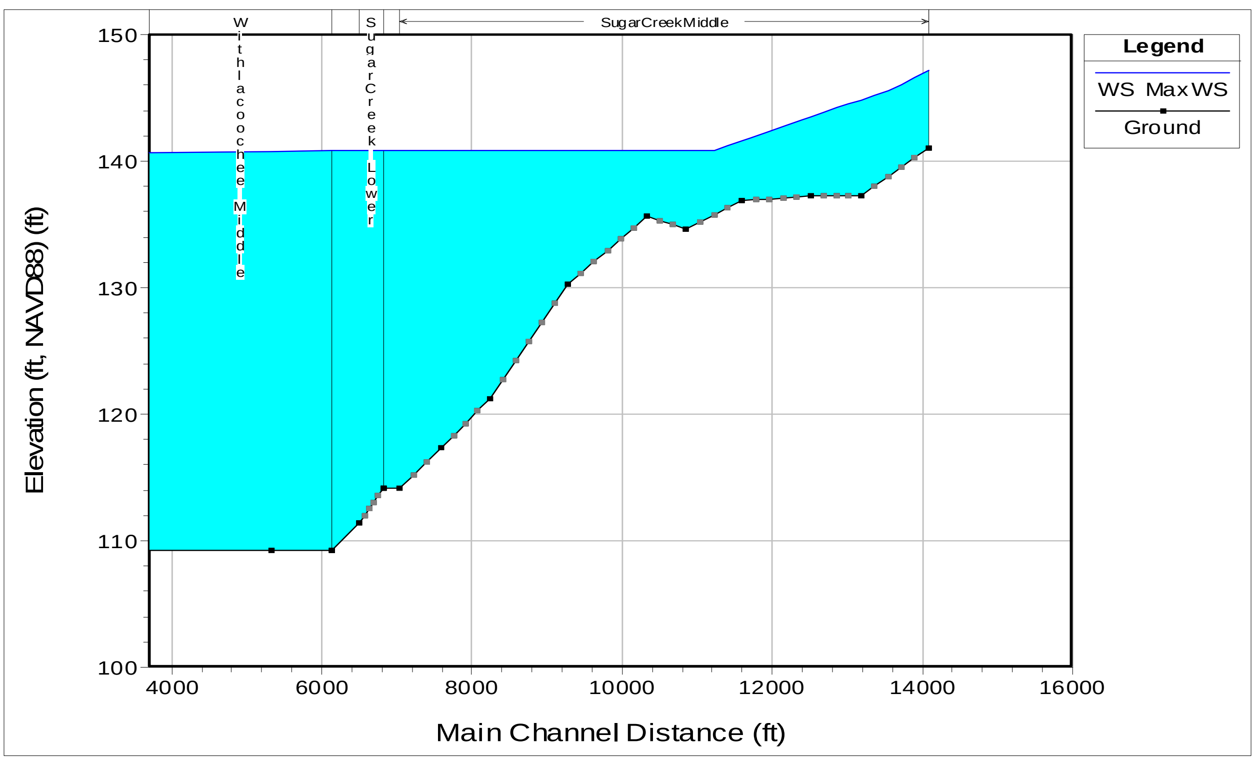


Figure 20. Maximum Water Surface Profile (Withlacoochee River and Sugar Creek) for 100-Year Event.

Figures 21 through 24 show the stage and flow hydrographs at the confluence of Sugar Creek with the Withlacoochee River. It is clear, once again, that the cause of the flooding within the City of Valdosta is not due to local rainfall runoff. It is due to the backing up of water from the Withlacoochee River into Sugar Creek and Two Mile Branch. From the flow hydrograph, the maximum discharge from rainfall runoff occurs on the morning of 25FEB2013. However, maximum water surface elevations are not reached until the afternoon of 27FEB2013. This effect is seen in the 10-, 50-, 100-year storms as well.

The existing condition HEC-RAS models clearly show that the flooding that occurs in the City of Valdosta is not due to any conveyance or structural issues within the City's flood control system. The flooding is due to water in the Withlacoochee River and Little River rising and backing up into Sugar Creek and Two Mile Branch. This conclusion from the modeling had also been previously confirmed anecdotally from observations during the 2009 and 2013 flood events. City of Valdosta representatives noted that flooding of the properties along Sugar Creek and Two Mile Branch did not occur during the time that the local rainfall and runoff event was centered over Valdosta, but that "sunny-day" flooding of these properties occurred several days later as upstream flows from the Withlacoochee and Little River basins arrived and resulted in a significant rise of water stages in the adjacent sections of the Withlacoochee River.

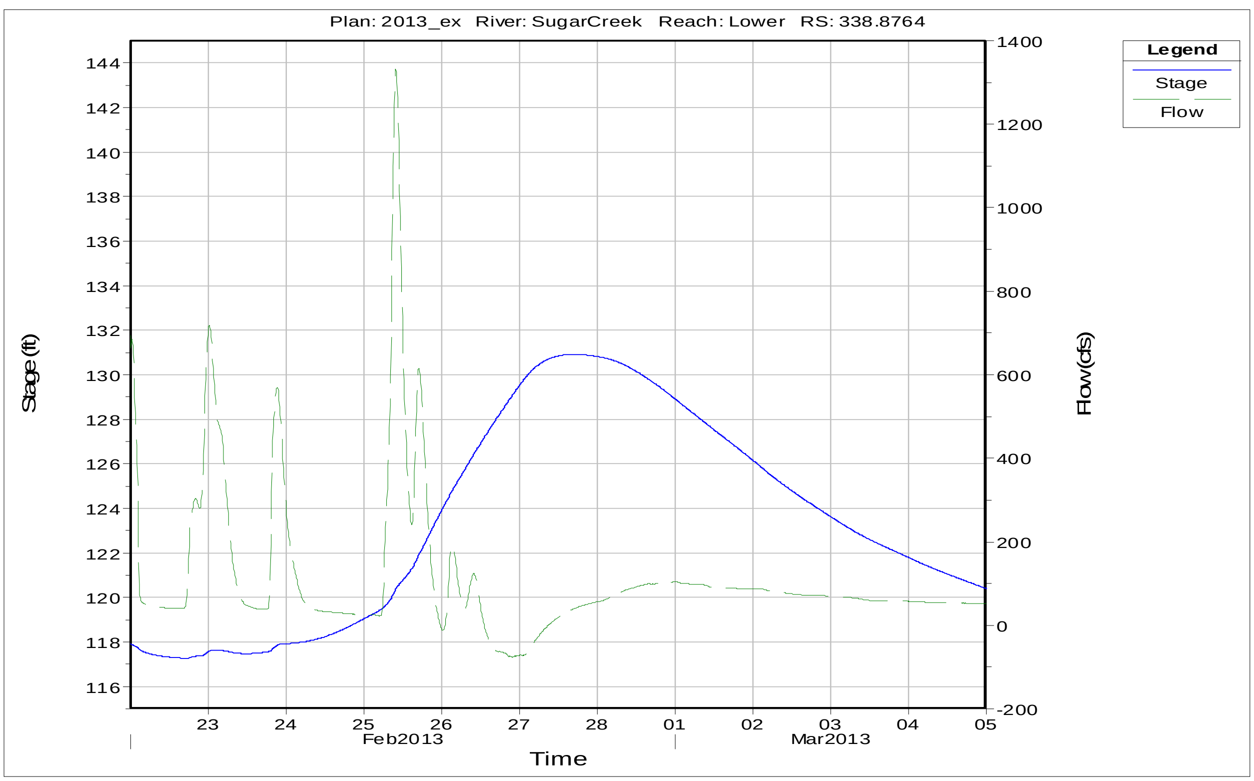


Figure 21. Stage and Flow Hydrograph at Confluence of Sugar Creek and Withlacoochee River (2013 Event)

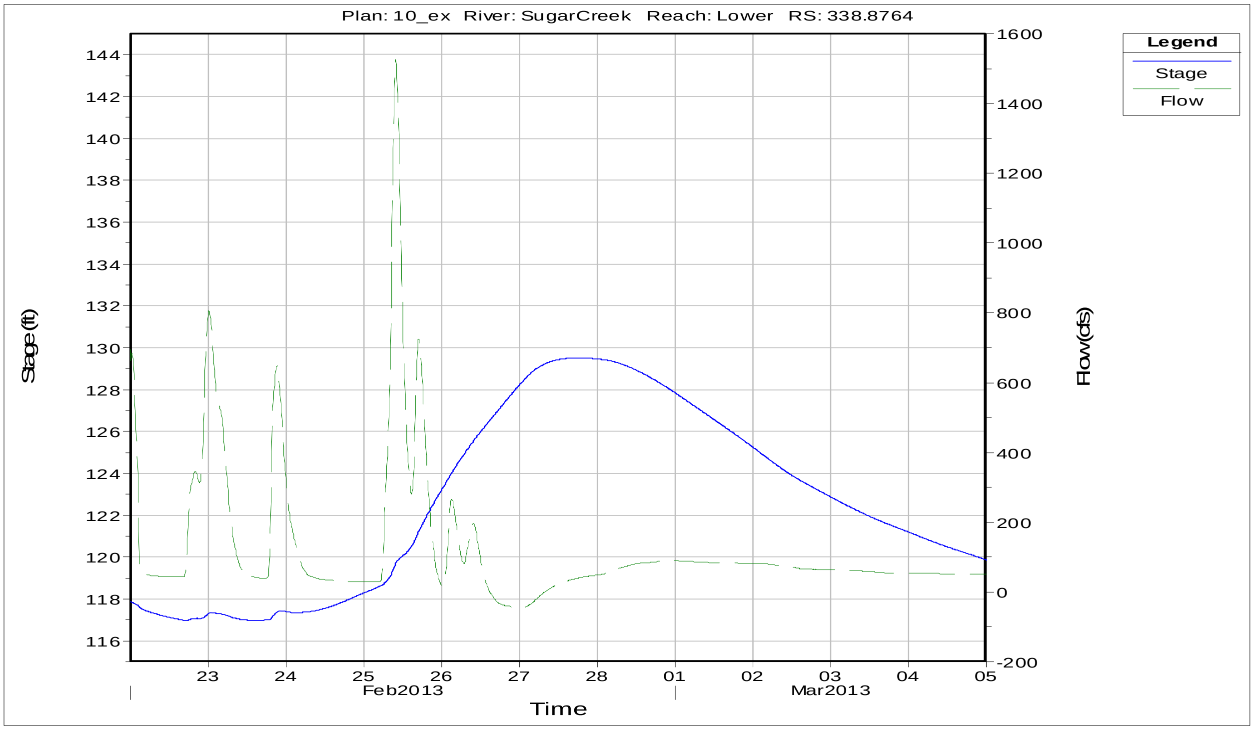


Figure 22. Stage and Flow Hydrograph at Confluence of Sugar Creek and Withlacoochee River (10-Year Event)

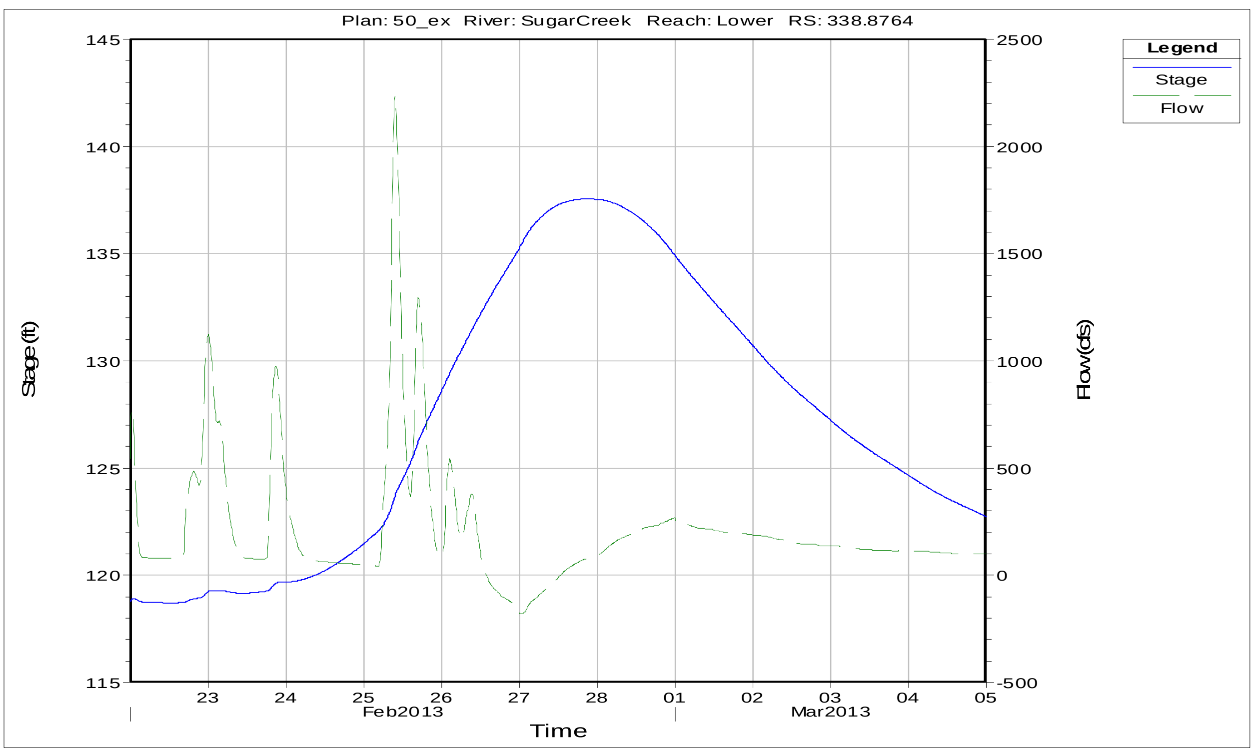


Figure 23. Stage and Flow Hydrograph at Confluence of Sugar Creek and Withlacoochee River (50-Year Event)

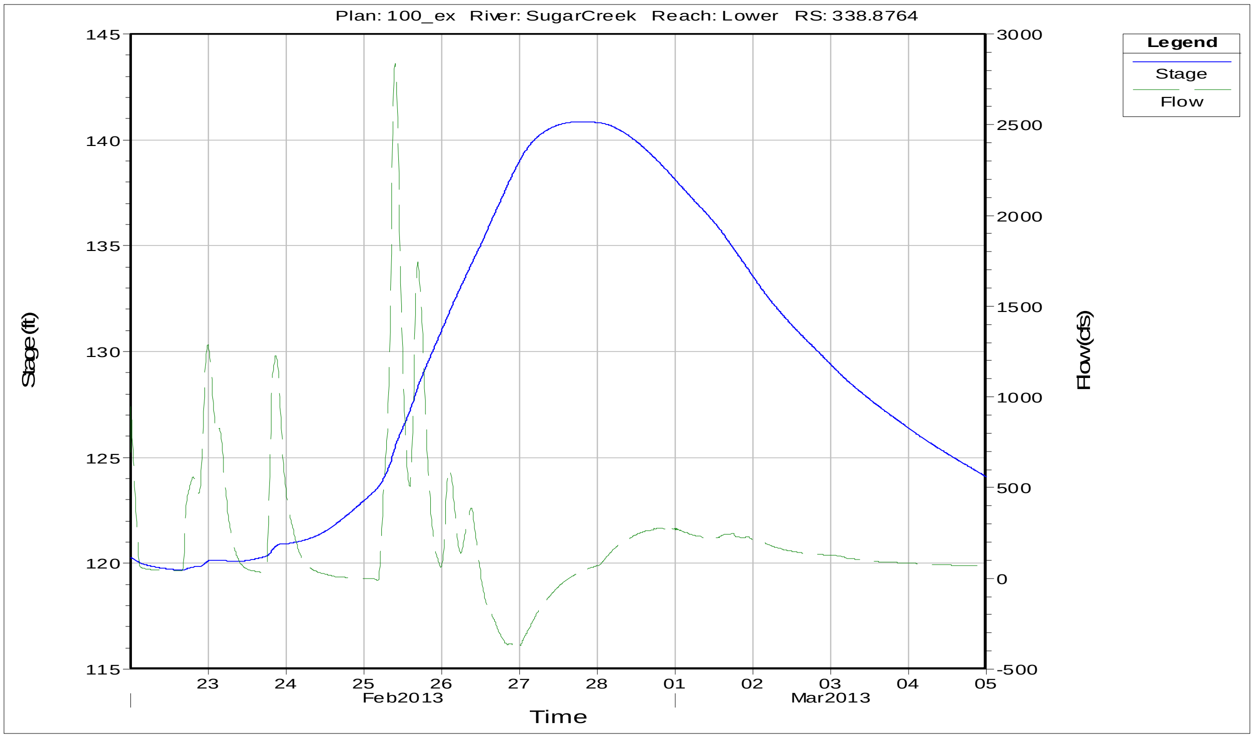


Figure 24. Stage and Flow Hydrograph at Confluence of Sugar Creek and Withlacoochee River (100-Year Event)

2.6 Alternative Plans

In response to the flooding in Valdosta, USACE has proposed several structural alternative plans for potential reduction of flood damages. Two of these plans involved channel improvements in the Withlacoochee River and one plan involved a levee structure to prevent Withlacoochee River flood waters from backing up into the Sugar Creek.

2.6.1 Channelization of the Withlacoochee River

Channelization of the Withlacoochee would result in cleaning out and elimination of the natural oxbows of the river, changing flow patterns and likely causing some scouring of the bottom and shoreline in areas where velocities would be altered. Some backfilling/dredging of forested floodplain would also likely be necessary to accommodate construction of this alternative. Compensatory mitigation would likely be required with some replacement of forested floodplain wetland function required. This alternative was eliminated due to potential environmental impacts, access issues and high potential costs.

2.6.2 Alteration of the confluence of the Withlacoochee River and the Little River

This alternative would provide a levee located within the Withlacoochee River floodway about 2 miles downstream of I-75. The levee would maintain separation of flow in the Withlacoochee and Little Rivers and effectively move the confluence of the rivers far enough downstream to eliminate backflow from

Little River into Valdosta. In addition to the levee, channel construction on either side of the levee would provide enough conveyance to reduce stages to non-damaging levels. This alternative was also eliminated from consideration due to environmental impacts, access issues and high potential costs.

2.6.3 Flood control levee and structure in Sugar Creek at confluence with Withlacoochee River

This alternative consists of an earthen levee placed across the lower portion of Sugar Creek near the confluence with the Withlacoochee River, including a system of flap-gated box culverts to allow drainage from the Sugar Creek and Two Mile Branch.

The levee was designed to protect against the Standard Project Flood (SPF) event within the Withlacoochee River and is designed with three additional feet of freeboard. The SPF event is estimated to be approximately 40% of the Probable Maximum Flood (PMF). Based on NOAA HydroMeteorological Report No. 52 (HMR 52) and a basin size of approximately 1500mi^2, the cumulative three-day PMP rainfall event is estimated at 33 inches. Therefore, the rainfall for the SPF event is estimated as (0.40) x (33) = 13.2 inches. This equates to approximately 110% of the 100-year storm event. An estimate of the maximum water surface elevation in the Withlacoochee River was then made based upon a correlation between maximum water surface elevation and rainfall volume. This correlation resulted in an estimated SPF peak water surface elevation of 143.5 ft, NAVD88, plus three feet of freeboard, producing a design levee crest elevation of 146.5 ft, NAVD88.

With a primary intent of providing a basis for quantities and costs, the conceptual levee design assumed side slopes at 3H:1V (horizontal:vertical) with a 12-foot top width. The levee is approximately 3950 feet in length with average height of 24 feet. Total quantity of earthen levee material is estimated at 308,000 yd^3. The levee would be grassed, with a total surface area of approximately 23,600 yd^2. Clearing and grubbing would be required for an area of approximately 6 acres.

The structural alternative will also include a box culvert structure to convey flood flows out of the City of Valdosta via Sugar Creek. The culvert consists of six concrete barrels with headwalls. The 6’X6’ barrels would be equipped with flap gates. These flap gates would open when water levels upstream in Sugar Creek are higher than water levels downstream in the Withlacoochee River. When water levels in the Withlacoochee River are higher, the negative head gradient would cause the flaps to close, preventing water from backing up into Sugar Creek. The culvert will be approximately 188’ in length and will be placed at an elevation of approximately 115.5 ft, NAVD88 in the existing Sugar Creek thalweg. Figure 25 shows the alignment of the levee and culvert features.

The culverts will also require erosion control. Conceptual quantities and costs assume placement of 8-inch stone at 60-foot width for a distance of 50-feet upstream and 100-feet downstream of the culvert structure.

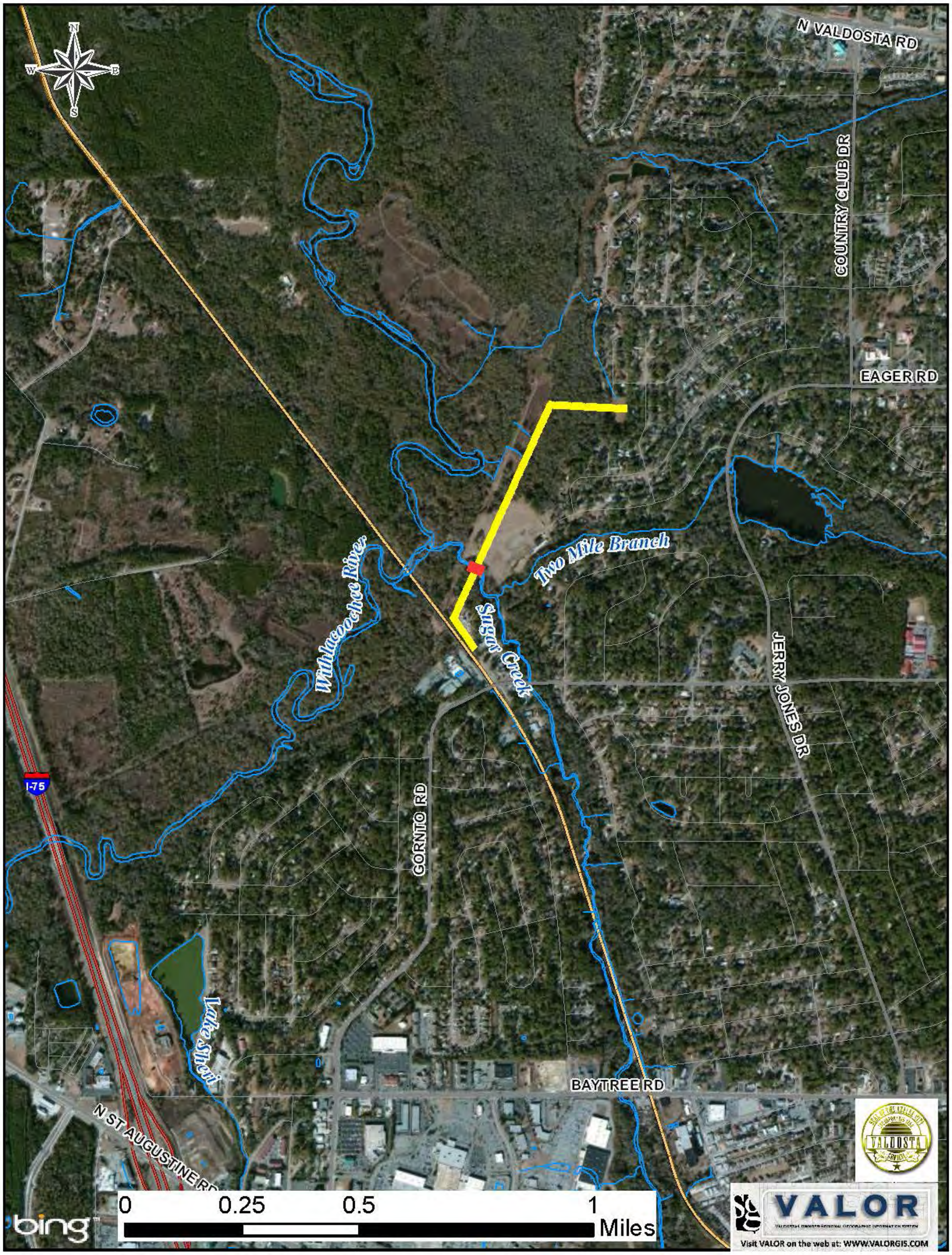


Figure 25. Location of Proposed Levee (in yellow) and Box Culverts (in red)

The described structural features were incorporated into the HEC-RAS model geometry and the four rainfall events (i.e., 2013, 10-, 50- and 100-year) were applied. Figures 26 through 29 show the flood inundation depth maps for the levee/culvert structure alternative. In addition, Figures 29 through 32 show the stage hydrographs upstream (blue) and downstream (red) of the proposed levee and structure. Figures 34 through 45 show the maximum water surface elevation profile comparisons between existing and with-project conditions for Sugar Creek and Two Mile Branch and the Withlacoochee River. The with-project maximum water surface elevations are at or below the existing condition profiles at all locations. Note that in Figures 42 through 45, the existing and with-project lines overlap as the proposed project will not affect water levels in the Withlacoochee River.

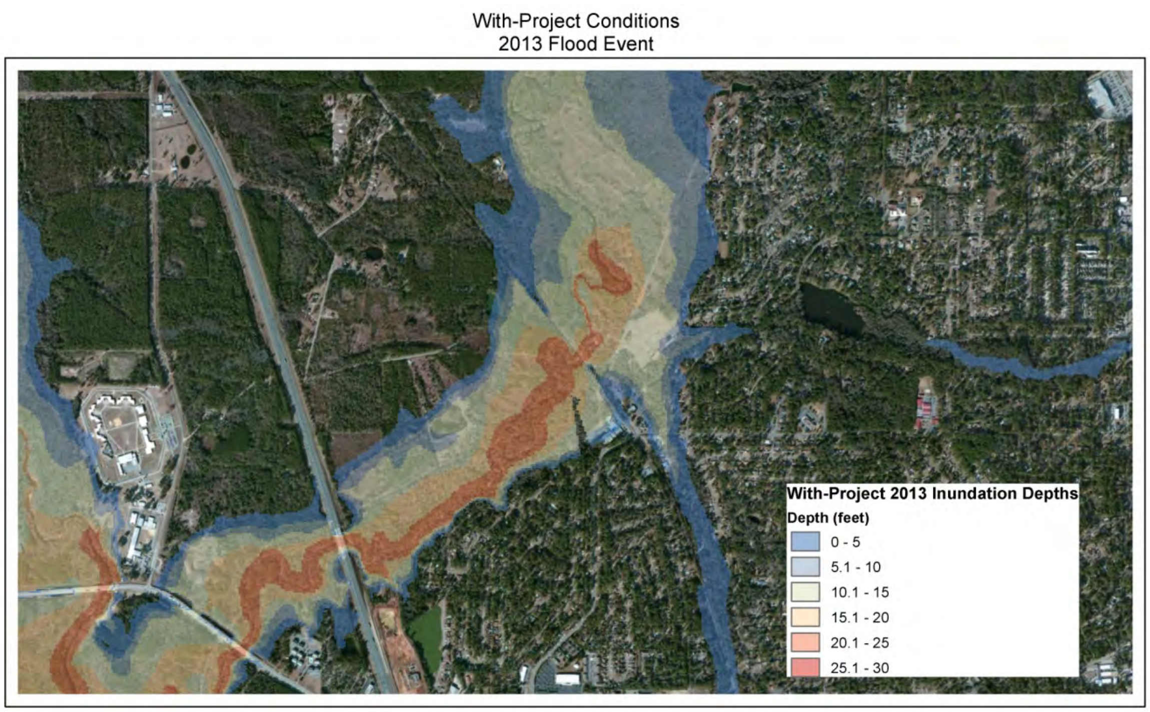


Figure 26. With-Project Condition Flood Inundation Depths for 2013 Event.

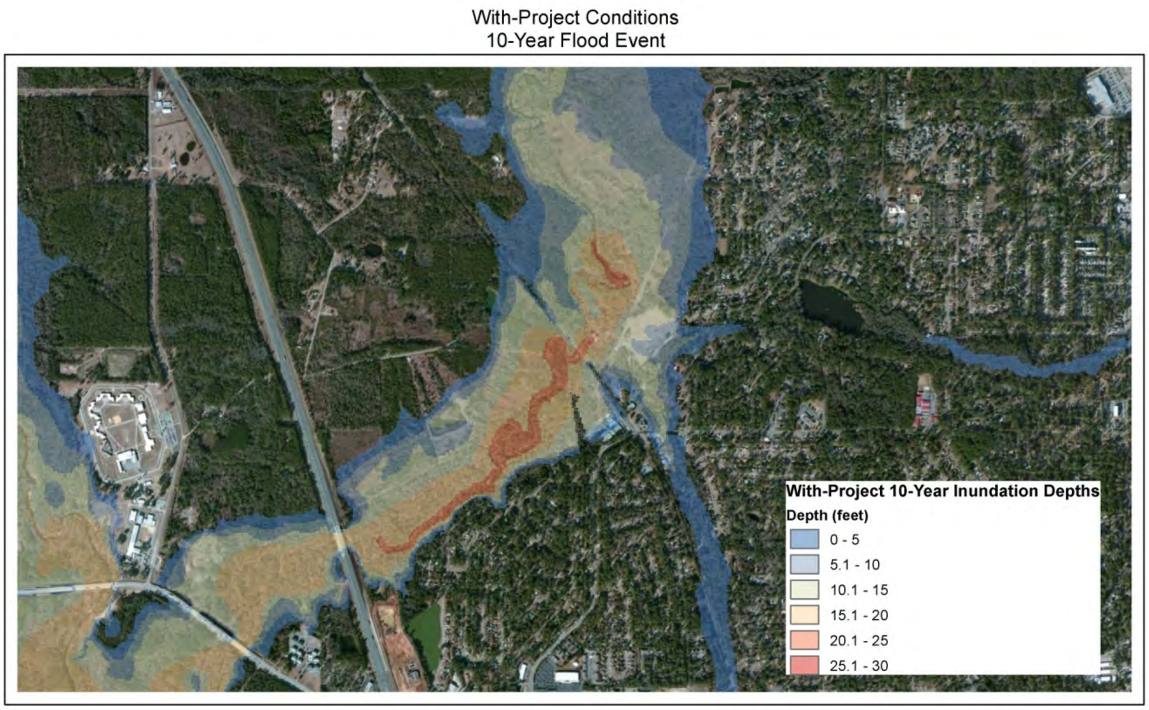


Figure 27. With-Project Condition Flood Inundation Depths for 10-Year Event.

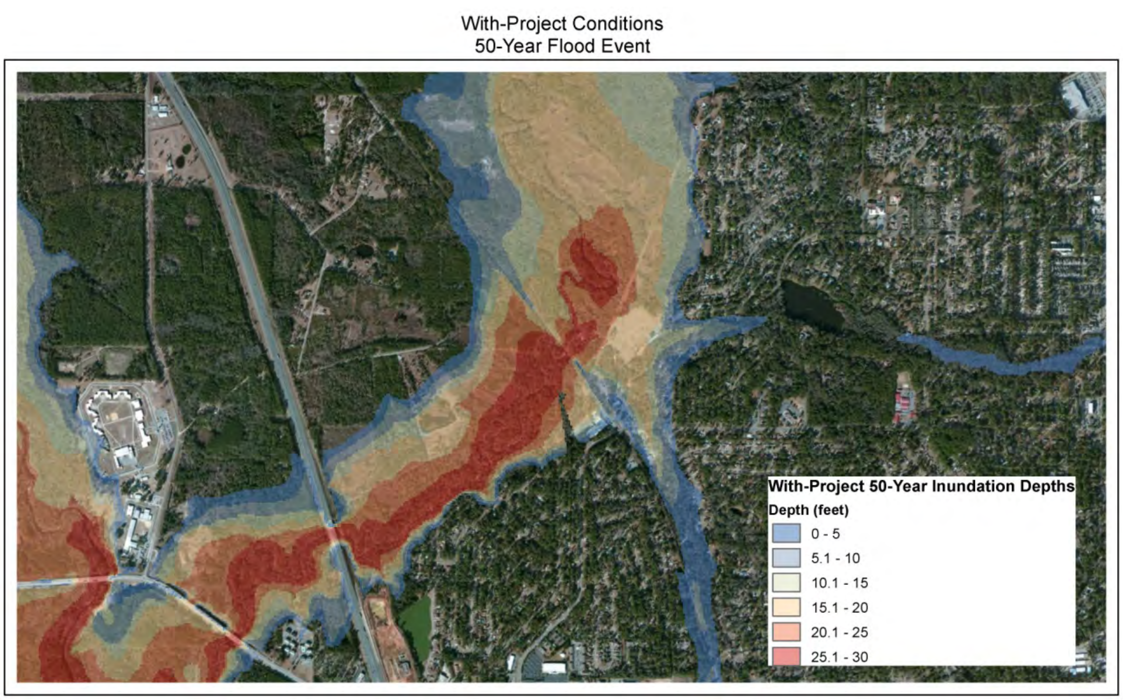


Figure 28. With-Project Condition Flood Inundation Depths for 50-Year Event.

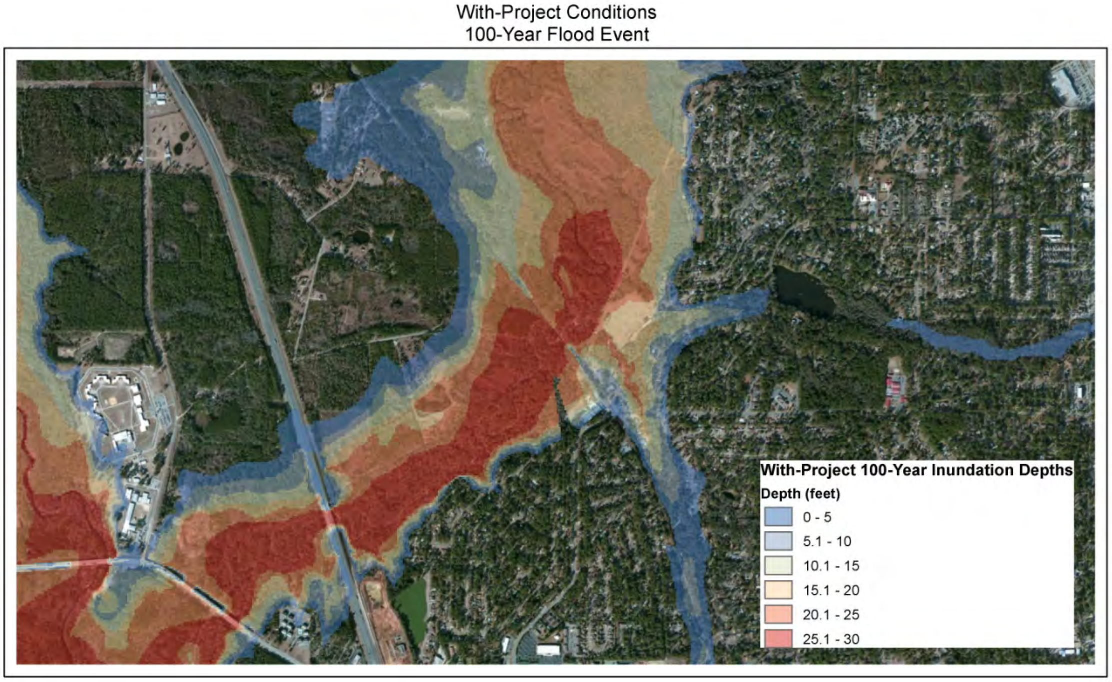


Figure 29. With-Project Condition Flood Inundation Depths for 100-year Event.

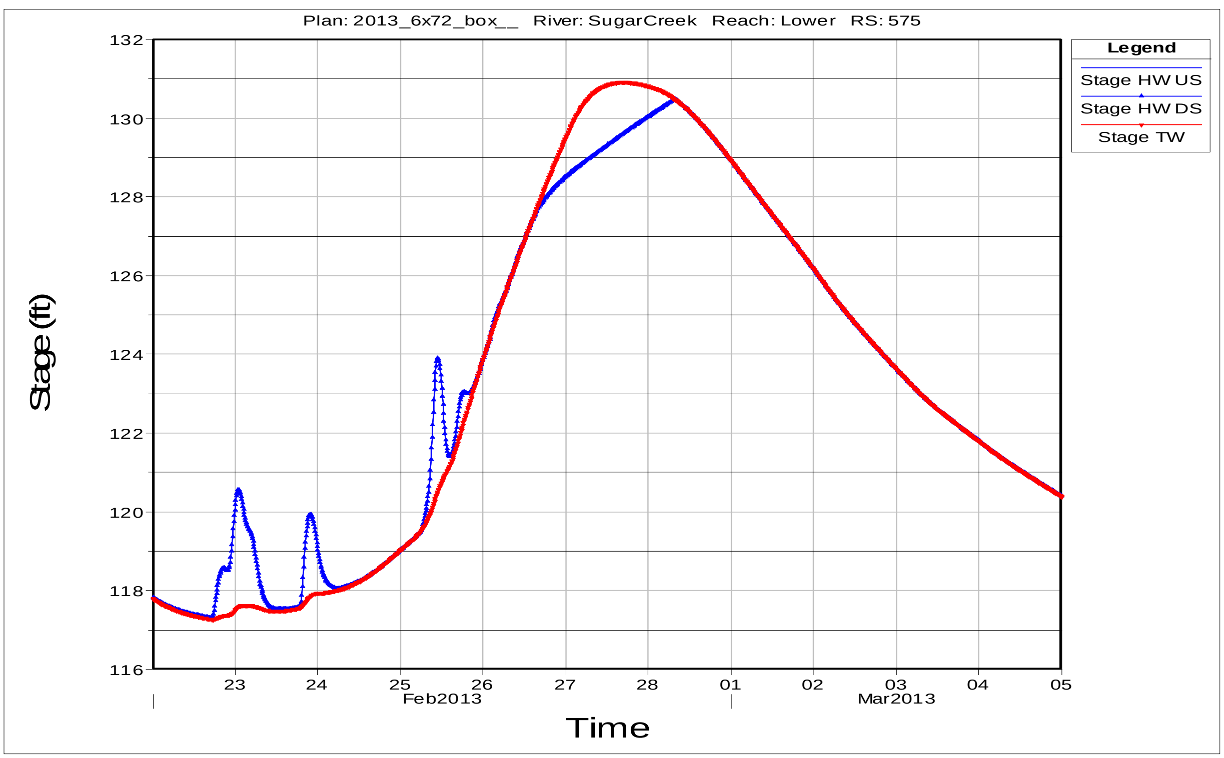


Figure 30. Headwater and Tailwater Stage at Culvert Structure During 2013 Event.

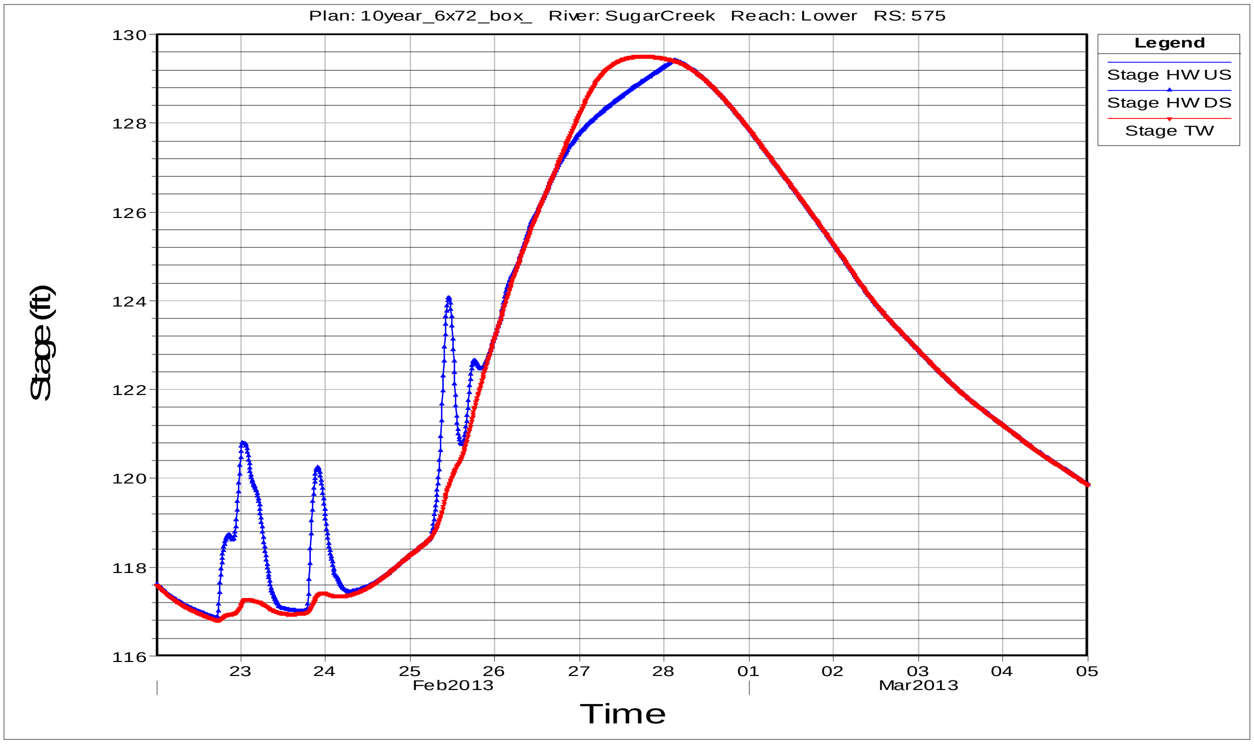


Figure 31. Headwater and Tailwater Stage at Culvert Structure During 10-Year Event.

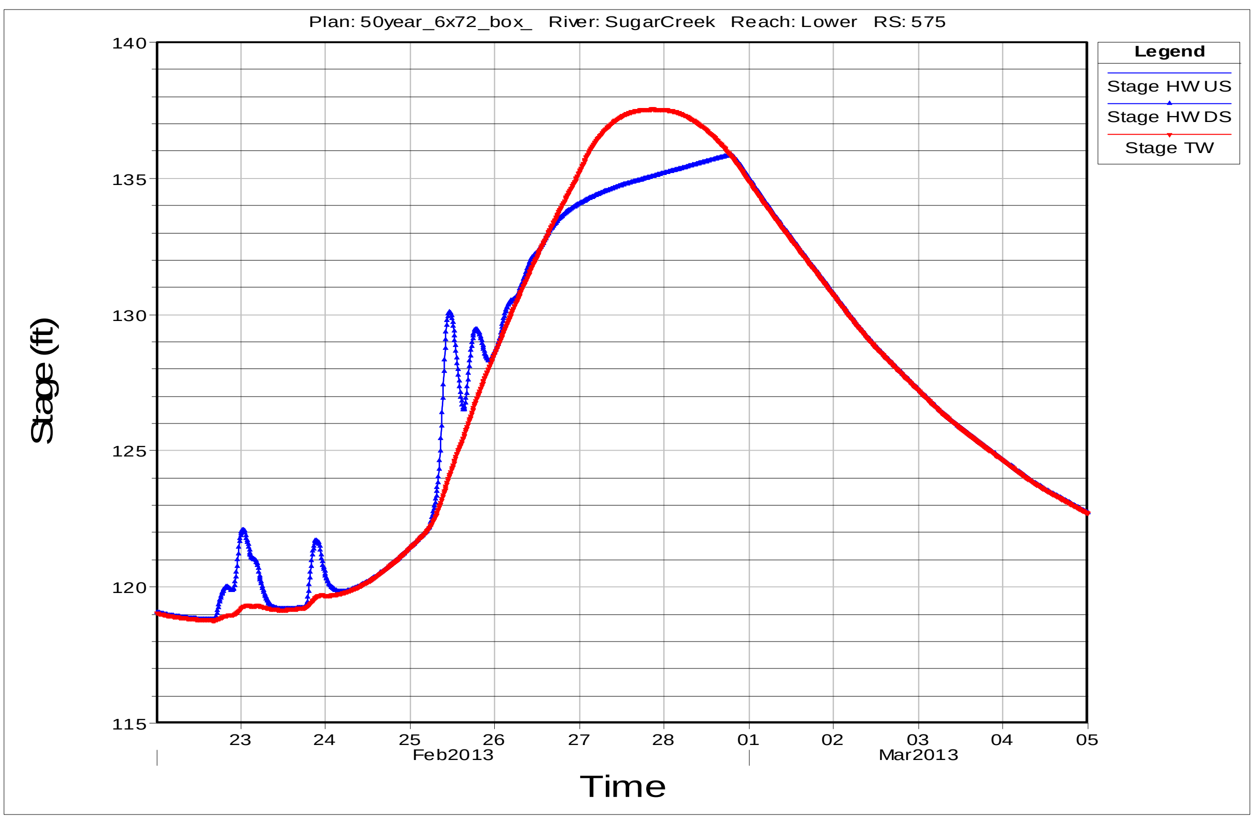


Figure 32. Headwater and Tailwater Stage at Culvert Structure During 50-Year Event.

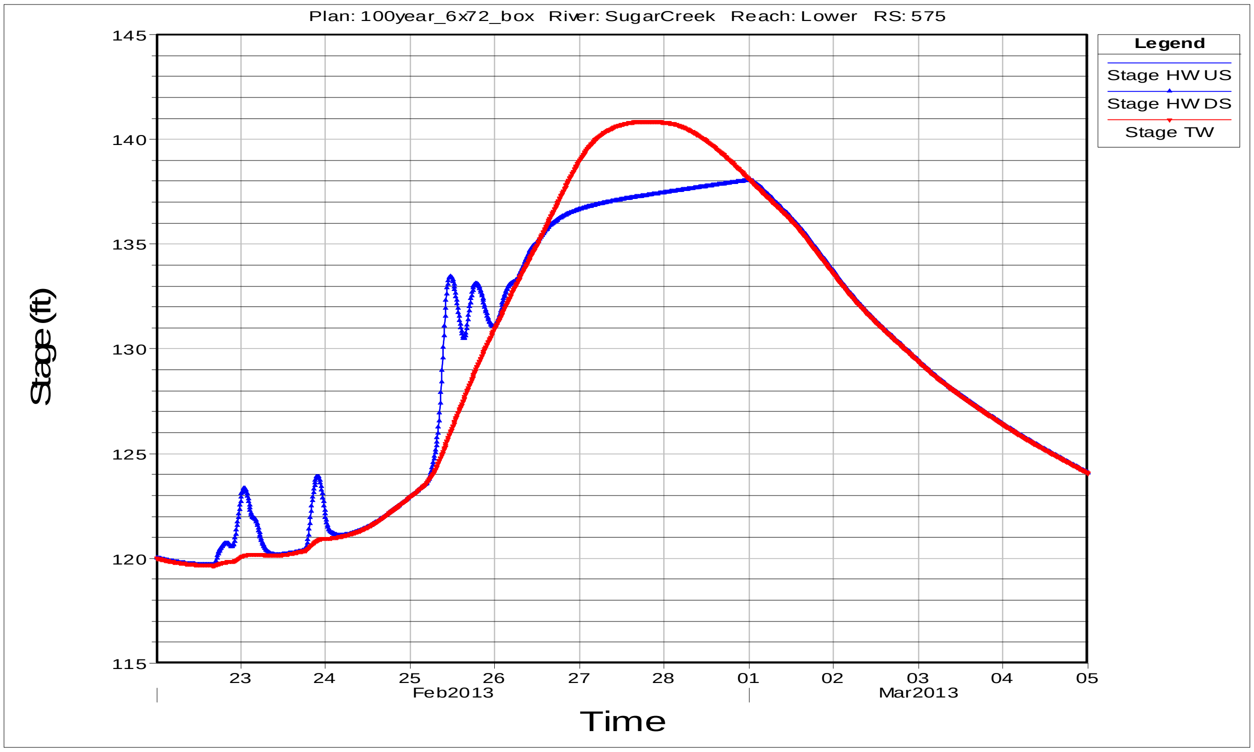


Figure 33. Headwater and Tailwater Stage at Culvert Structure During 100-Year Event.

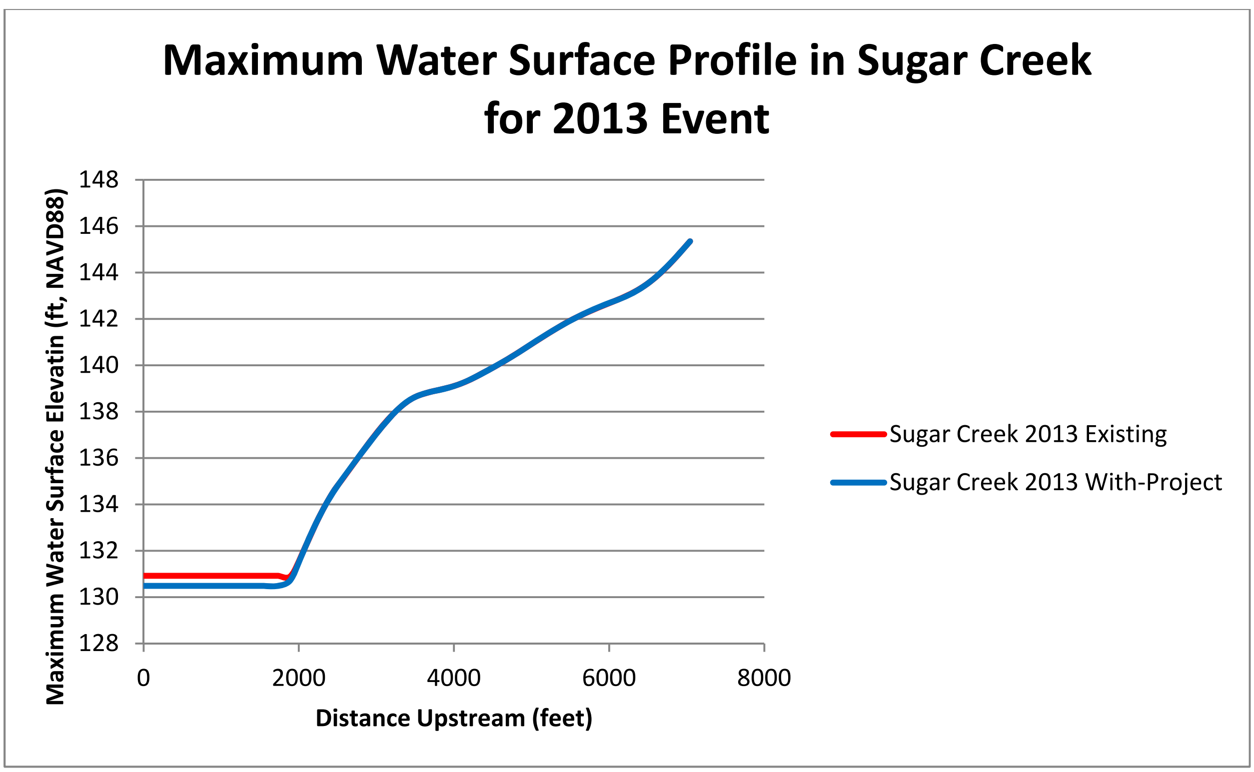


Figure 34. Maximum Water Surface Profile in Sugar Creek for 2013 Event.

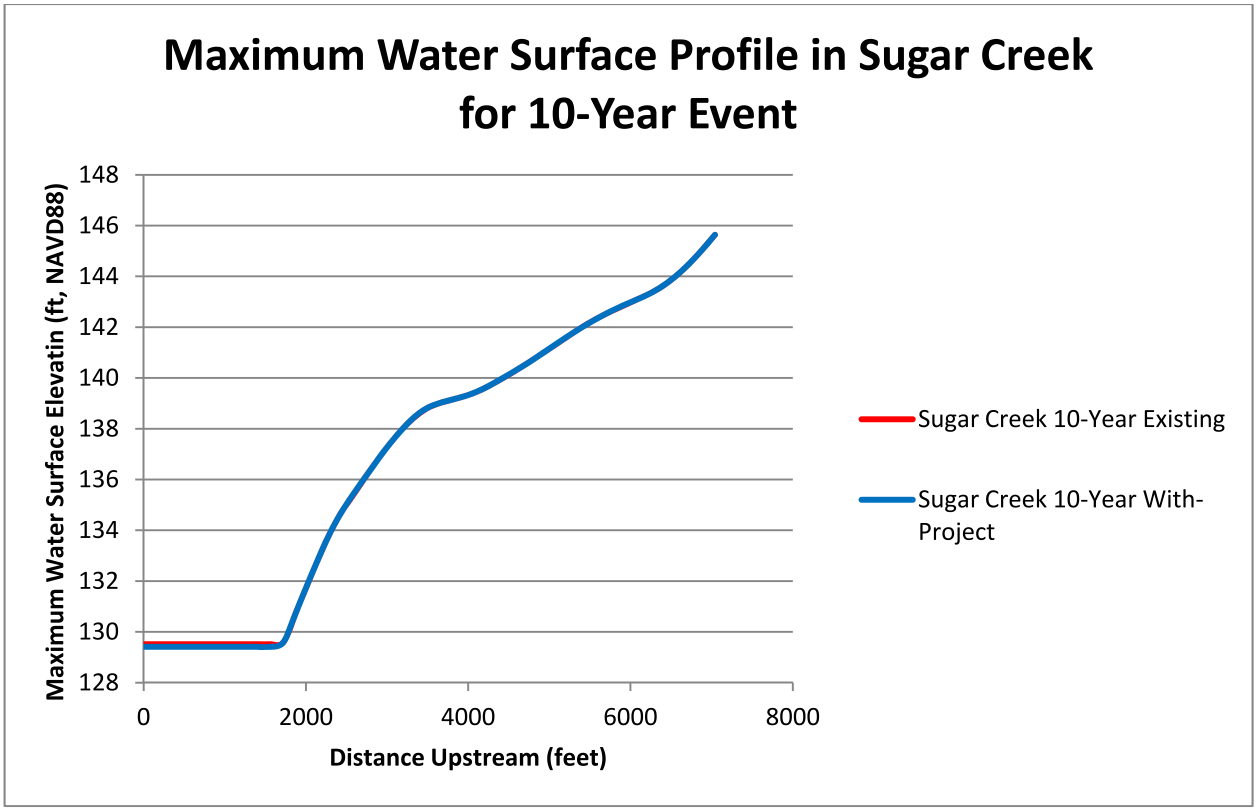


Figure 35. Maximum Water Surface Profile in Sugar Creek for 10-Year Event.

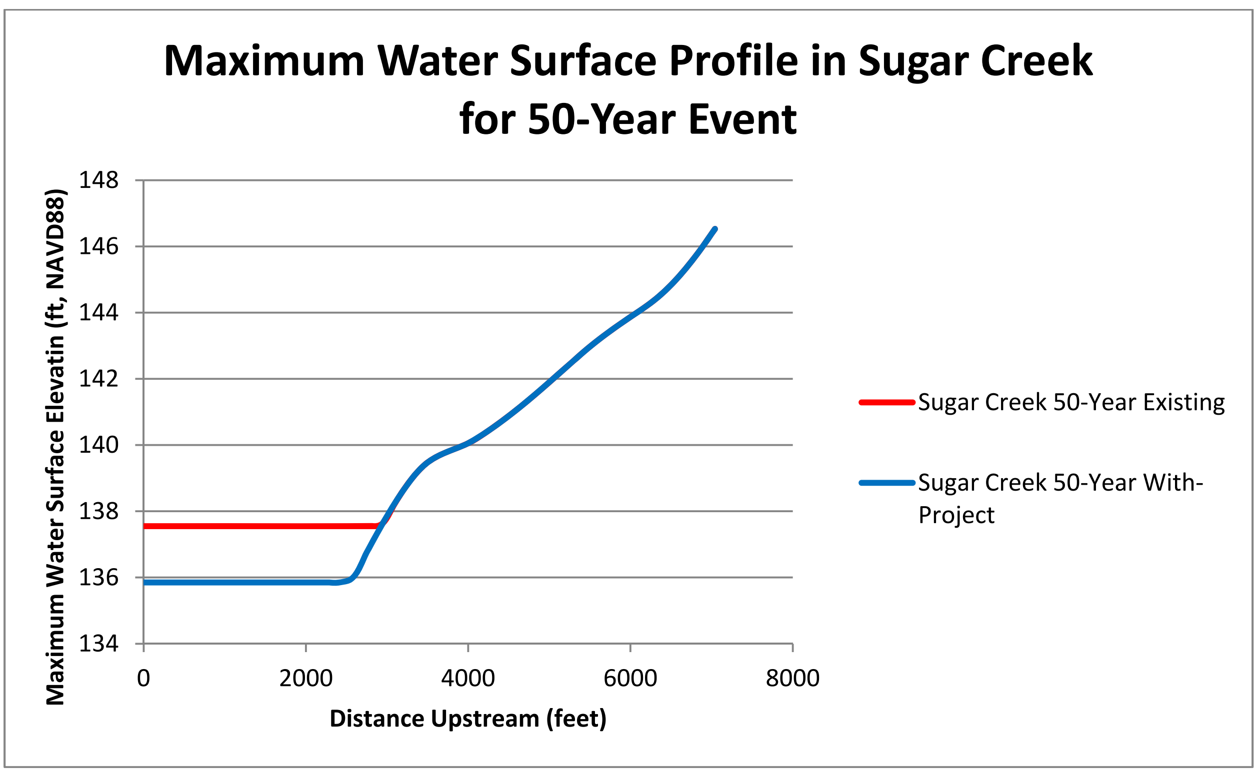


Figure 36. Maximum Water Surface Profile in Sugar Creek for 50-Year Event.

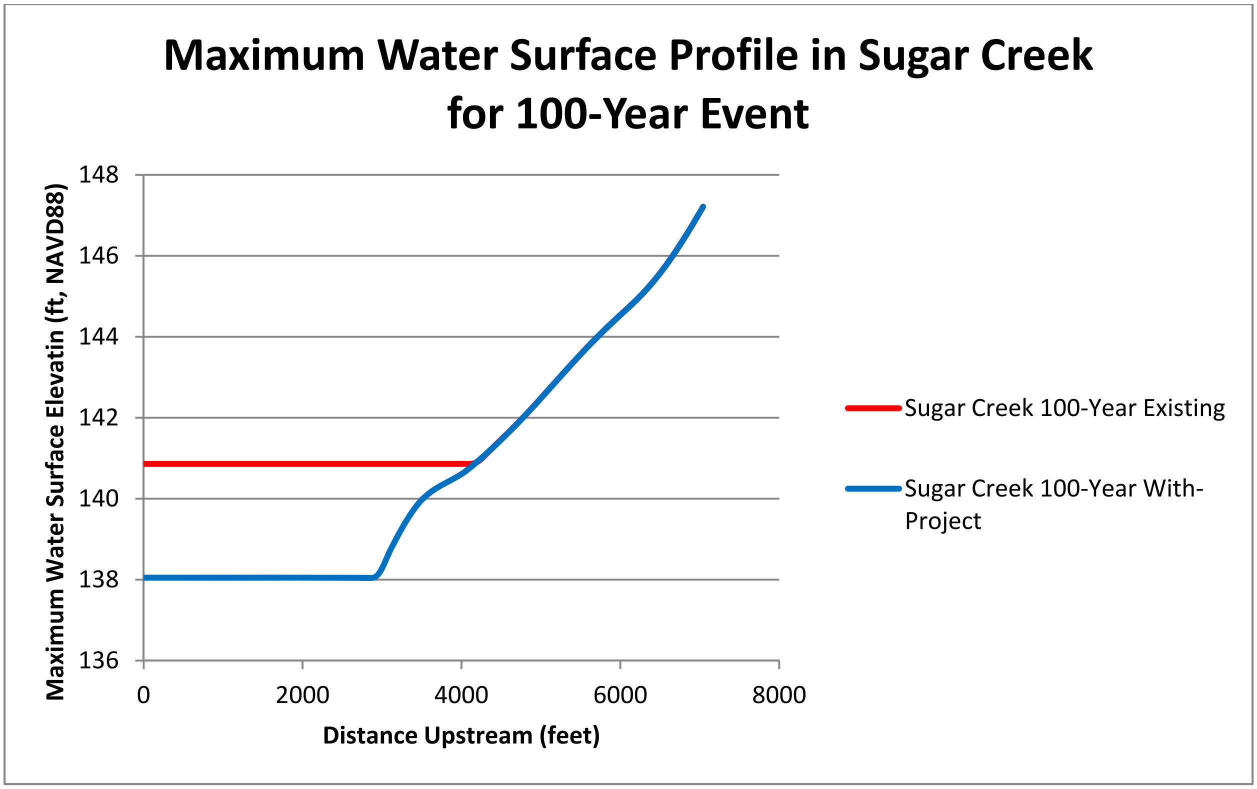


Figure 37. Maximum Water Surface Profile in Sugar Creek for 100-Year Event.

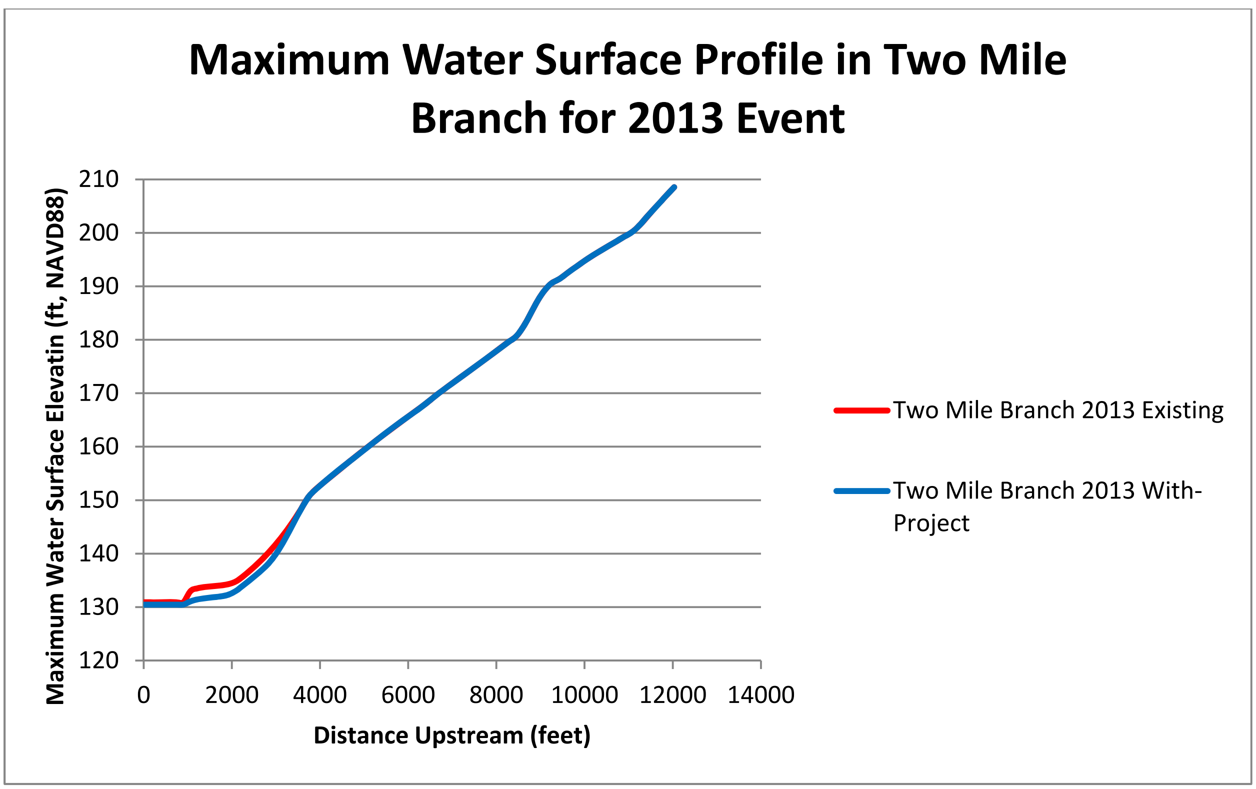


Figure 38. Maximum Water Surface Profile in Two Mile Branch for 2013 Event.

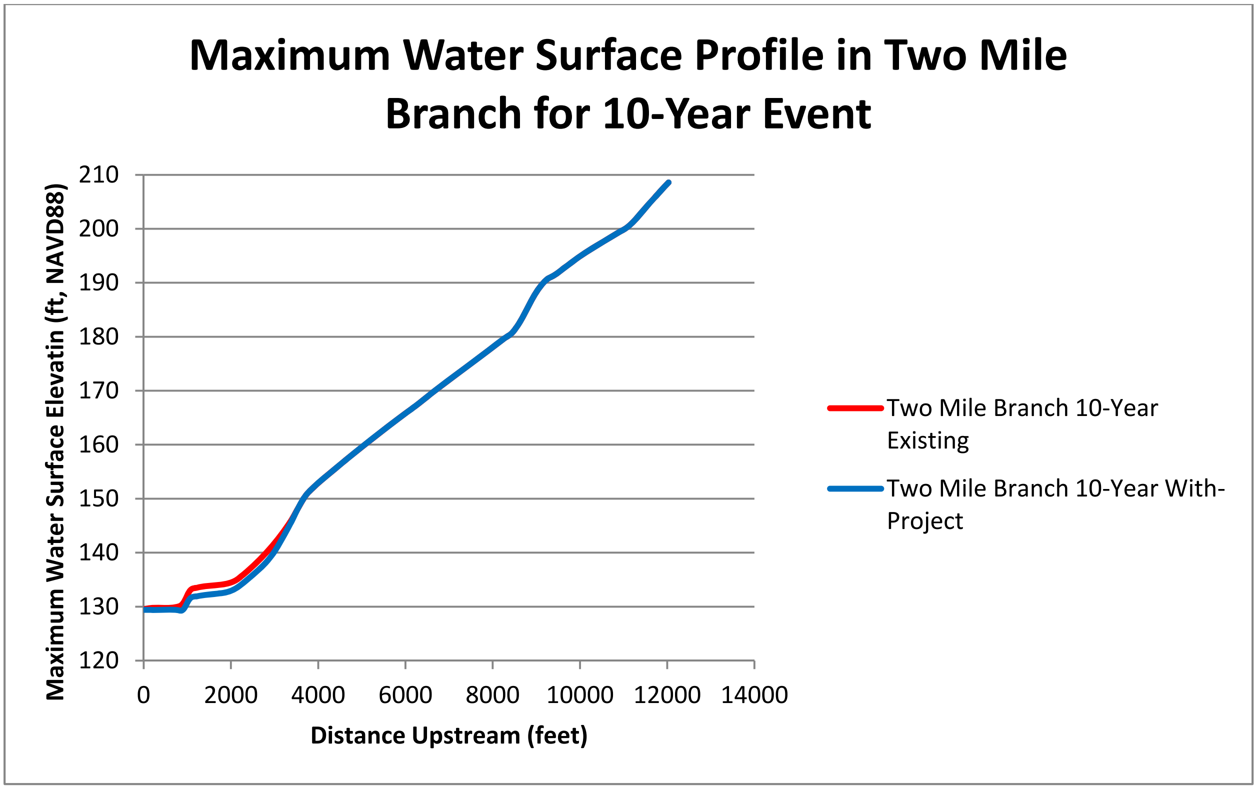


Figure 39. Maximum Water Surface Profile in Two Mile Branch for 10-Year Event.

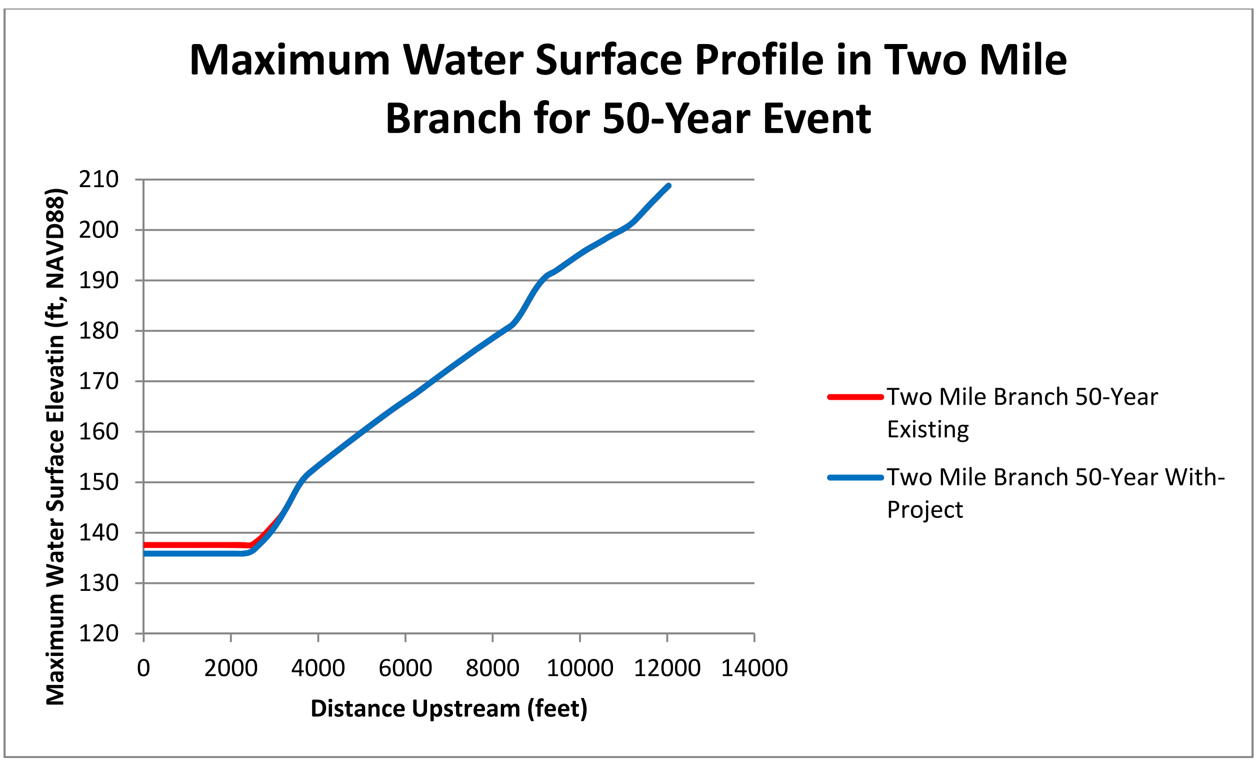


Figure 40. Maximum Water Surface Profile in Two Mile Branch for 50-Year Event.

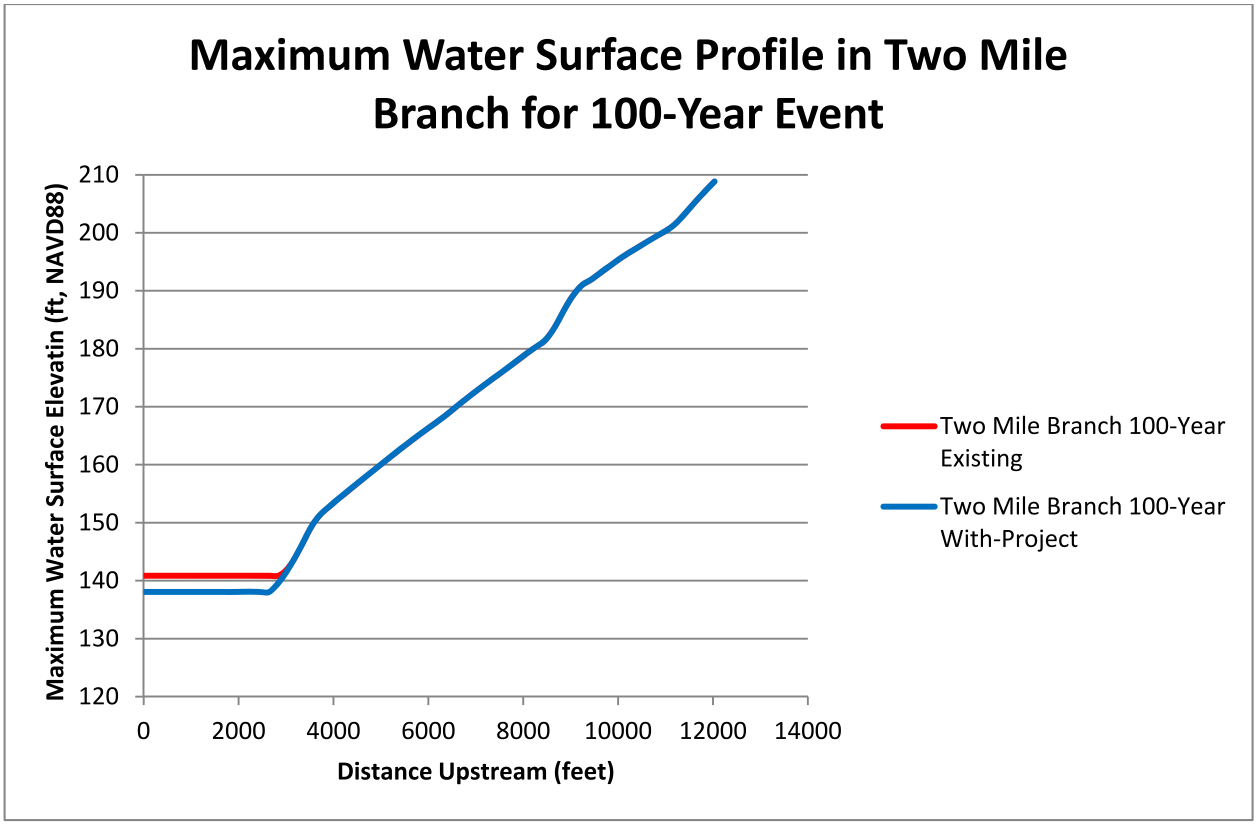


Figure 41. Maximum Water Surface Profile in Two Mile Branch for 100-Year Event.

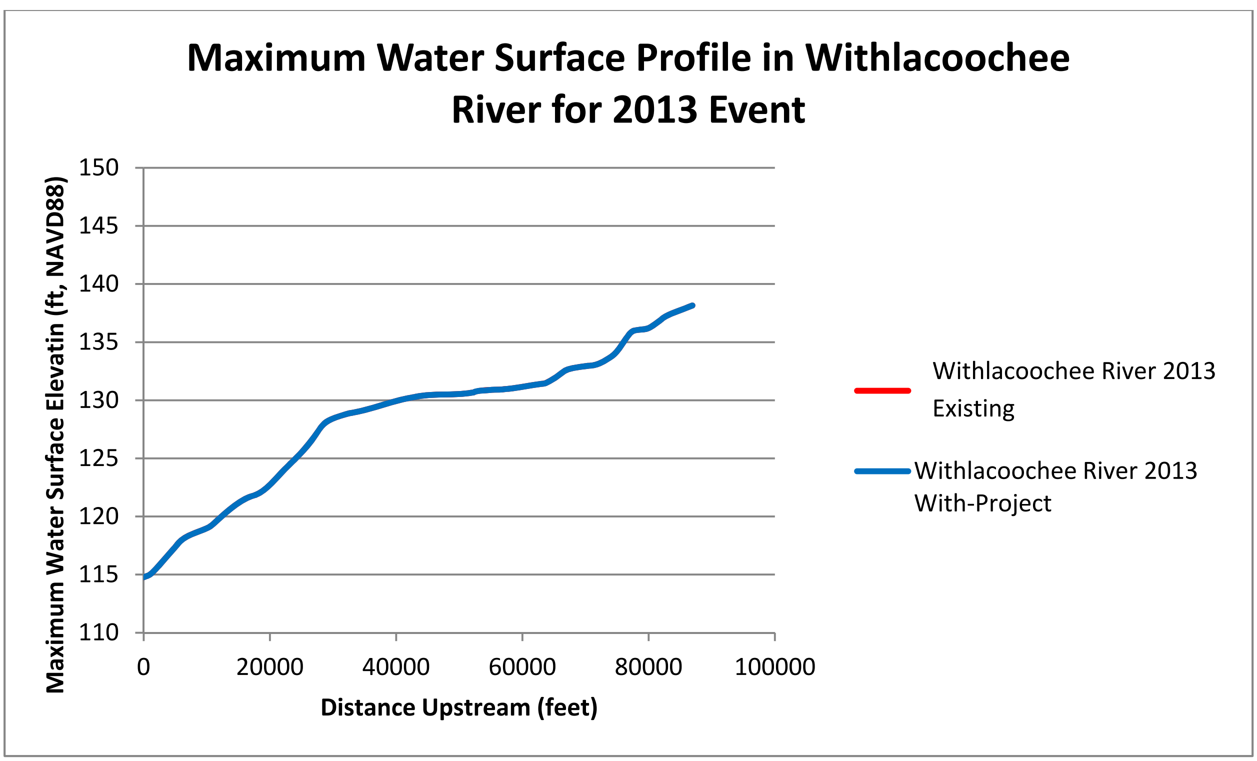


Figure 42. Maximum Water Surface Profile in Withlacoochee River for 2013 Event.

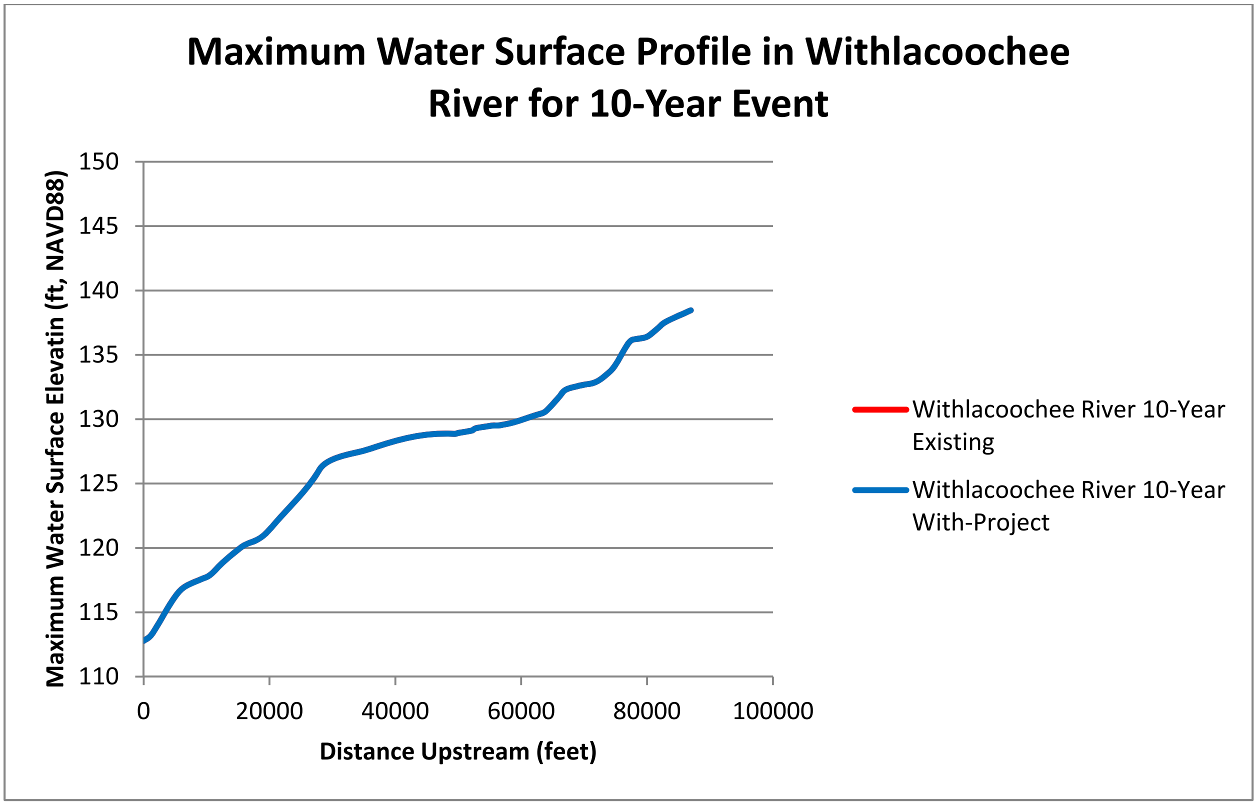


Figure 43. Maximum Water Surface Profile in Withlacoochee River for 10-Year Event.

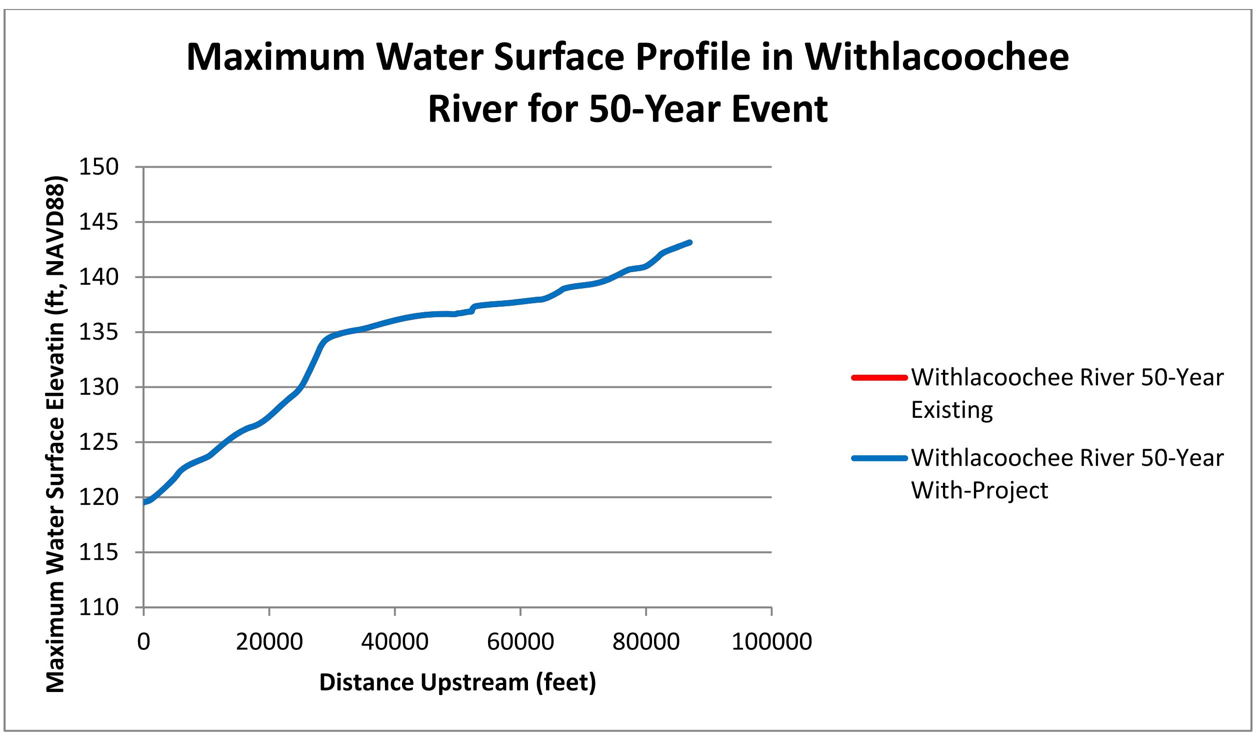


Figure 44. Maximum Water Surface Profile in Withlacoochee River for 50-Year Event.

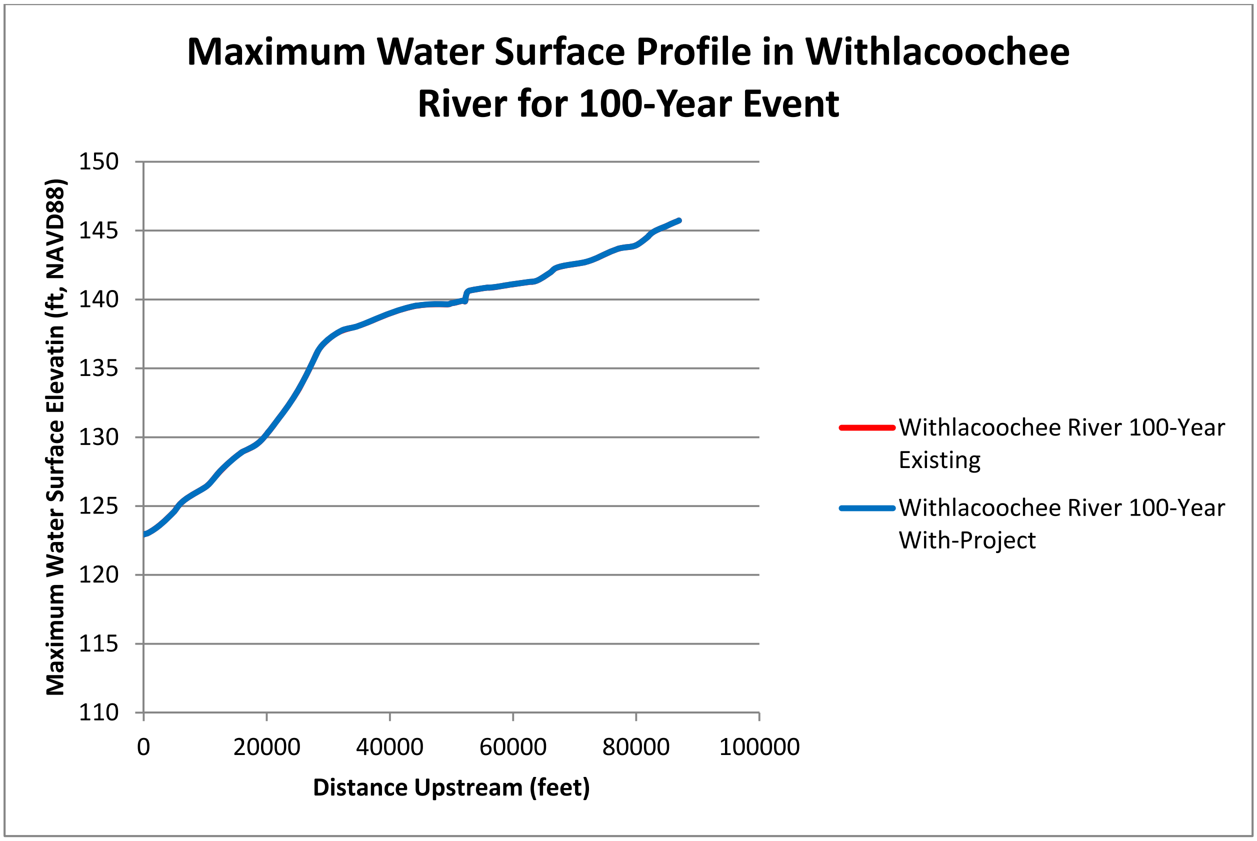


Figure 45. Maximum Water Surface Profile in Withlacoochee River for 100-Year Event.

3. Results and Conclusion

The figures show that the alternative plan is effective at reducing flooding. The maximum water surface elevations on the protected side of the levee/culvert structure are reduced for all modeled storm frequencies, however, the benefits are much greater as the intensity of the storm event increases. For the 10-year event, the reduction in maximum water surface elevation is approximately 0.1 feet. For the 50-year event, the reduction in maximum water surface elevation is approximately 1.7 feet. The 100-year event reduces the maximum water surface elevation by 2.8 feet.

At the beginning of the simulation, before the Withlacoochee River stage begins to rise, the culvert structure is able to pass the local runoff from Sugar Creek and Two Mile Branch. However, the culvert flap gates close and creek flows are no longer allowed to discharge once the Withlacoochee River nears its peak and rises above the water stage in Sugar Creek upstream of the levee. While the alternative plan does reduce flood impacts, it does not completely eliminate flooding due to the loss of discharge capacity when the flap gates close. This effect could possibly be mitigated by creating or securing more upstream storage that could be utilized only when the Withlacoochee River is at extreme levels and the structure flap gates close.

Comparison of the existing conditions and alternative plan stage hydrographs also show a considerable reduction in duration of flooding. For example, homes which sustain damage at an elevation of 138 feet, NAVD88 would be inundated by the 100-year event for more than 2 days in the existing condition, but that level of inundation would have been reduced to less than 3 hours with the levee in place.

In conclusion, the structural alternative plan utilizing a levee with culverts extending across the confluence of Sugar Creek and the Withlacoochee River can be effective at reducing the depth and duration of flooding within the Sugar Creek and Two Mile Branch watershed. Economic analysis will determine if the flood damage reduction benefits and costs associated with the structural alternative are preferable to the benefits and costs associated with flood proofing measures or the non-structural alternative of real estate acquisition of the affected properties.

4. References

- Chow, Ven Te. Open-Channel Hydraulics. McGraw-Hill, New York. 1959.
- HMR 52. Probable Maximum Storm (Eastern United States). User's Manual. US Army Corps of Engineers. 1987.

5. Simulation Tools

- HEC-RAS Version 4.1
- HEC-GeoRAS Version 10
- ESRI ArcMap Version 10
- EPA SWMM Version 5.0


During 2009 flood

Appendix B: Socio-Economic Analysis

City of Valdosta
Lowndes County

Local Economy and Demographics

The City of Valdosta is located in Lowndes County, Georgia. As of the 2010 Census, the county population was 109,233. Valdosta is home to about half of the county population with 54,518 people. The median age is 26.9 years. 43.3% is white, and 51.1% is black or African American.

Lowndes County has 43,921 housing units, with 39,747 occupied, while Valdosta has just over half of those at 22,709 housing units, with 20,471 occupied. The average household size is 2.46 people.

There are 2,725 businesses in Lowndes County, with 1,509 in Valdosta[1]. The largest number of establishments is in the retail trade and health care industries. However, the manufacturing industry has the highest total value of revenue, followed by retail trade. The median household income in Valdosta is $30,879[2].

Methods for Calculation of Project Benefits

Project benefits were calculated as consistently as possible with USACE guidance for urban flood damage reduction[3]. However, due to the limited scope of this study, there was some deviation from USACE guidance. The level of detail normally required for an urban flood risk management study was unavailable or incomplete, and simplifying assumptions were made to fill in the gaps. Typically, at least six to eight flood events are modeled with a hydrologic model to determine the damage-frequency curve. In this study, only three flood events were available with sufficient data to include in the model. A Microsoft Excel spreadsheet was used to analyze the annual damages instead of an economic simulation model, such as Hydrologic Engineering Center – Flood Damage Analysis (HEC-FDA). Again, this was done due to insufficient data that is required for the HEC-FDA model. A stage-damage relationship was not established because the first-floor elevations inventory was incomplete or unavailable. Therefore, only the spatial extent of the water surface elevation in each modeled flood event was compared with the parcel boundaries. The number of parcels affected was used as a proxy for structures damaged. The duration of inundation during flood events was not considered. Finally, total structure values from the Lowndes County Assessor's Office were used instead of depreciated replacement costs, because a real estate appraisal was not conducted[4]. All of these assumptions, as well as other assumptions described in the section below, were implemented due to the limited scope of this analysis.

As described above, the results of this economic analysis were accomplished with preliminary data, without the use of economic modeling, and with assumptions appropriate for the scope of this study. If

[1] 2007 Economic Census
[2] 2008-2012 American Community Survey 5-Year Estimates
[3] Institute for Water Resources Report 88-R-2 National Economic Development Procedures Manual – Urban Flood Damage
[4] Structure values were calculated as total assessed value minus land value, as reported by the Lowndes County Assessor's Office.

a future study were conducted as a feasibility level study, more data would be gathered and the USACE certified model HEC-FDA would be used, and the results of the analysis could vary. Note that this analysis is most appropriate for a comparison of without-project and with-project scenarios, rather than for drawing conclusions about specific parcel risk.

Establishment Of Future Without-Project Condition

Flood conditions were simulated in a computer model for varying frequency flood events. Three events were examined for the without-project conditions: 10-year flood, 50-year flood, and 100-year flood. Based on model outputs, and information from the Lowndes County Assessor's Office, parcels where flooding could be reduced were identified. This area is referred to as the "project area." The project area consisted of 347 real estate parcels that are mostly residential. See Figure 1 for a detailed map of the project area, shown as the parcels outlined in purple. The total value of all structures in the project area is approximately $41,700,000.

Once the project area parcels were identified, the next step was to compare the parcel boundaries to the spatial extent of water surface during flood events. Using geographic information system (GIS) software, parcels within the project area were identified that would experience flooding in each project condition for each flood event: 10-year flood, 50-year flood, and 100-year flood for the without-project conditions. Using this analysis, it was estimated that approximately 221 parcels could be affected by the 100-year storm. Note that for this entire analysis, the number of parcels affected are being used as a proxy for structures damaged. Actual damage to a structure would vary with the location within the parcel and the first floor elevation. Establishment of Future With-Project Condition

The same method used above for the without-project conditions was again used for the with-project conditions for each flood event: 10-year flood, 50-year flood, and 100-year flood. A summary of the flood-affected parcels for each condition is shown in Table 1. The parcels counted in this table only represent those that have some flood water on the property and do not necessarily represent parcels that are expected to have structure damage.

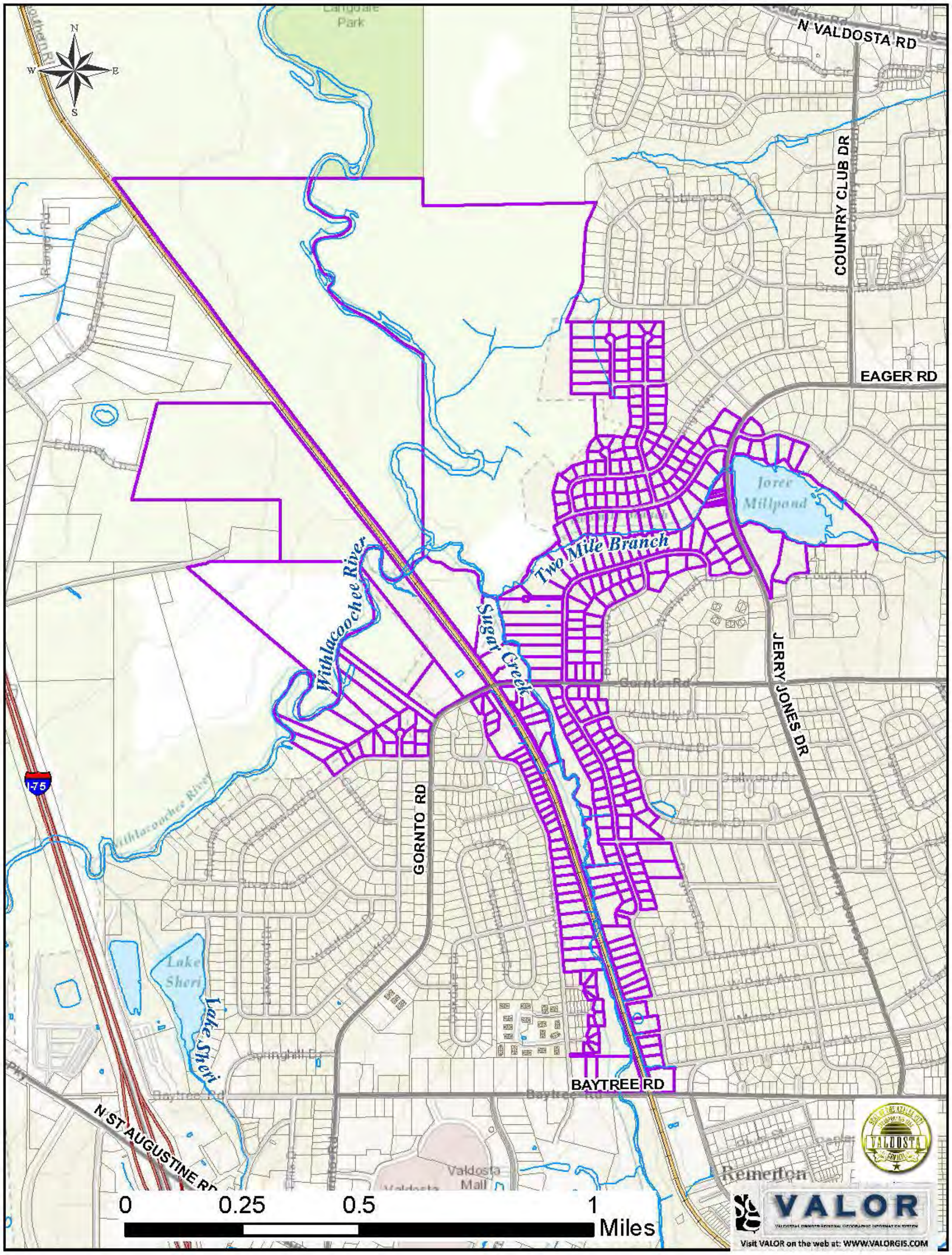
Table 1. Summary of Number of Affected Parcels by Flood Event

Flood (yr)	Number of Parcels Affected			
	Without-Project	With-Project	Difference	Percent Difference
10	122	119	3	2.5%
50	176	157	19	10.8%
100	221	188	33	14.9%

Note: Affected parcels will not necessarily have structure damage.

The results shown in Table 1 indicate that a significant number of parcels will continue to be affected by local flood events by experiencing some flood water on the parcel. Although flooding will not be completely prevented, the depth and duration of flooding would be reduced in the with-project condition.

Figure 1. Map of Project Area Parcels



Results

After identifying flood-affected parcels for each condition, an assumption was made to estimate flood damage benefits. The assumption made for this analysis was that parcels would be used as a proxy for structures, i.e. any structure on a flood-affected parcel would be considered damaged. The total structure values were calculated using total structure value information from the Lowndes County Assessor's Office. Content value was then also included in the total damage calculations for each condition. For this analysis, content value was assumed to be 50% of structure value. In the absence of a full dataset of first-floor elevations for each structure, and detailed depreciated replacement cost information, these assumptions were made to estimate damages within the scope of this study. If a more detailed study were completed, estimated damages may differ significantly from the results shown in this section. The with- and without-project conditions for each flood event were compared to determine the total damages reduced by the project. Table 2 shows a summary of the total damage reduction for each condition by flood event.

Table 2. Summary of Total Damage Reduction for Each Condition by Flood Event

	Structure Damages		
Flood (yr)	Without-Project	With-Project	Difference
10	$ 12,792,000	$ 12,569,000	$ 223,000
50	$ 18,279,000	$ 16,613,000	$ 1,666,000
100	$ 22,958,000	$ 19,258,000	$ 3,700,000
	Content Damages		
Flood (yr)	Without-Project	With-Project	Difference
10	$ 6,396,000	$ 6,284,000	$ 112,000
50	$ 9,139,000	$ 8,306,000	$ 833,000
100	$ 11,479,000	$ 9,629,000	$ 1,850,000
	Total Damages		
Flood (yr)	Without-Project	With-Project	Difference
10	$ 19,188,000	$ 18,853,000	$ 335,000
50	$ 27,418,000	$ 24,919,000	$ 2,500,000
100	$ 34,437,000	$ 28,887,000	$ 5,550,000

Once the total damage reductions for each condition and flood event were determined, they were plotted and a power regression equation was derived from the data points. The regression equation was then used to extrapolate the damage reduction for other flood events that were not modeled. Figure 2 shows the damage reduction curve for the entire set of flood event frequencies. The “frequency” axis shows how often a flood event will occur as a probability. For example the 10% frequency indicates a storm that will occur with a probability of 1 in 10 years. Only hydrologic model results from the 10 year, 50 year, and 100 year floods were available. These events correspond to the 10%, (1 in 10 years) 2% (1 in 50 years), and 1% (1 in 100 years) frequencies, respectively. The “reduced damages” axis shows the amount of flood damages that will be reduced in millions of dollars.

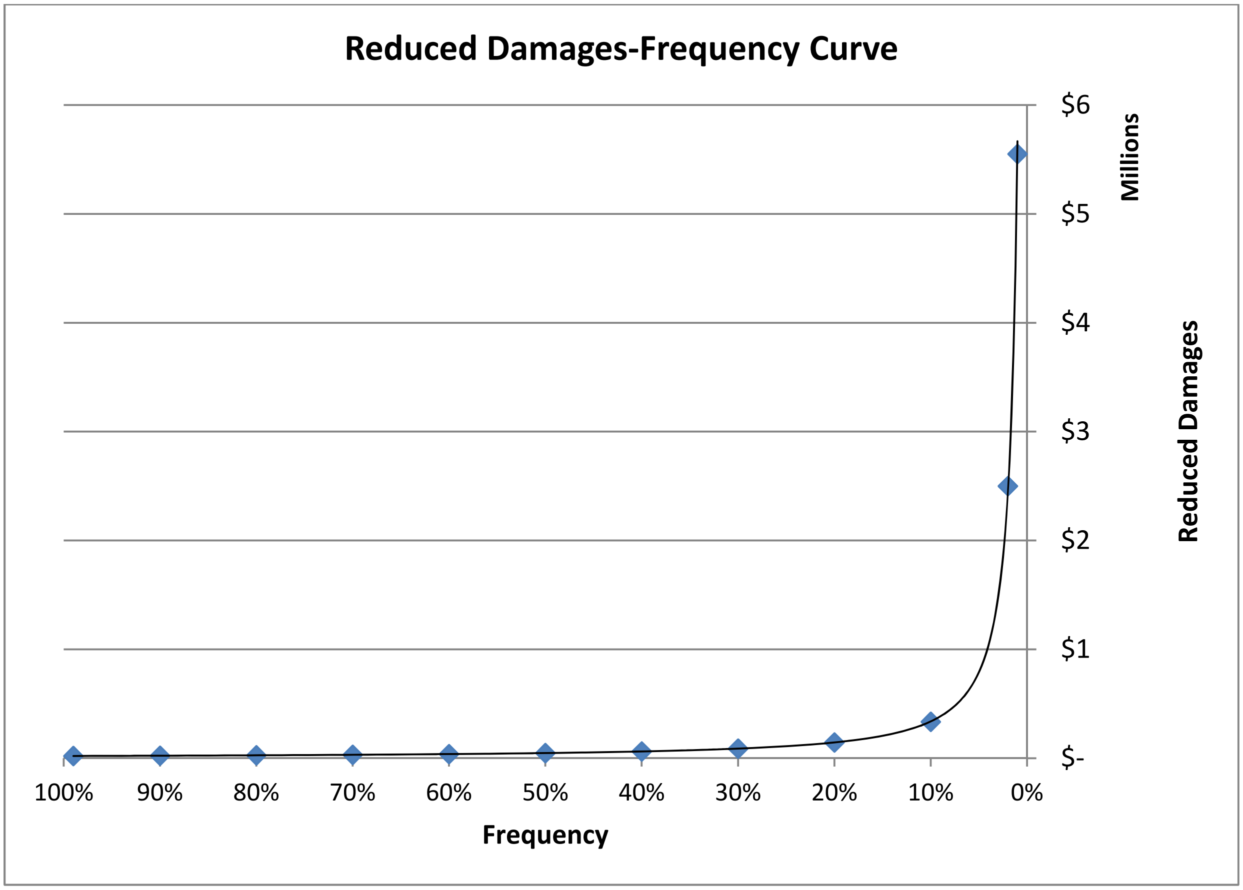


Figure 2. Damage Reduction-Frequency Curve for Flood Event Impacts to the Project Area

The total area under the damage reduction-frequency curve was then calculated. The sum of all damages reduced at each frequency is the total expected annual reduced damages. The total expected annual reduction in damages is equivalent to the average annual benefits. Table 3 shows the calculation of total expected annual reduced damages.

Table 3. Calculation of Expected Annual Damages

Frequency	Reduced Damages at Frequency	Frequency Interval	Average Reduced Damages over Interval	Expected Annual Reduced Damages over Interval
1%	$ 5,550,000			
2%	$ 2,500,000	0.01	$ 4,025,000	$ 40,200
10%	$ 335,000	0.08	$ 1,417,000	$ 113,400
20%	$ 144,000	0.1	$ 240,000	$ 24,000
30%	$ 88,000	0.1	$ 116,000	$ 11,600
40%	$ 62,000	0.1	$ 75,000	$ 7,500
50%	$ 47,000	0.1	$ 54,000	$ 5,400
60%	$ 38,000	0.1	$ 42,000	$ 4,200
70%	$ 31,000	0.1	$ 34,000	$ 3,400
80%	$ 26,000	0.1	$ 29,000	$ 2,900
90%	$ 23,000	0.1	$ 25,000	$ 2,500
100%	$ 20,000	0.09	$ 22,000	$ 1,900
		Total Expected Annual Reduced Damages:		$ 217,000

Finally, the average annual benefits from the project are compared to the average annual costs to determine the benefit-cost ratio (BCR). The BCR is essentially a return on investment: for each dollar spent, how much will be returned in the form of reduced flood damages. The annualized benefits, costs, and BCR are summarized in Table 4. For the selected alternative, the benefit-cost ratio is 1.4:1. The average annual net benefits are $61,000. Finally, note again that the level of detail used in this analysis is equivalent to a "rough order of magnitude" estimate. Therefore, caution should be used when reporting this information for investment decisions.

Table 4. Summary of Project Benefit-Cost Ratio

Total Project First Cost	$ 3,600,000
Interest During Construction	$ 48,000
Total Project Economic Cost	$ 3,648,000
Average Annual Cost	$ 156,000
Average Annual Benefits	$ 217,000
Net Benefits	$ 61,000
Benefit-Cost Ratio (x:1)	1.4

Note: Annualized using a 3.5% discount rate over a 50-year period of analysis.

Gornto Road at Sugar Creek looking east

During 2009 flood

Appendix C: Cost Estimate

City of Valdosta
Lowndes County

City of Valdosta Budget Cost Estimate Project

This is a budget estimate for a flood protection project for the City of Valdosta, which consist of construction of levee and drainage structures.

Estimated by	Lisis Batista, USACE-SAJ-EN-TC
Designed by	USACE-SAJ-EN-WM (Preliminary design)
Prepared by	Lisis Batista
Preparation Date	1/28/2014
Effective Date of Pricing	10/1/2013
Estimated Construction Time	305 Days

Designed by	Design Document: Not available
USACE-SAJ-EN-WM (Preliminary design)	Document Date: 1/28/2014
Estimated by	District: Jacksonville District
Lisis Batista, USACE-SAJ-EN-TC	Contact: Lisis Batista
Prepared by	Budget Year: 2014
Lisis Batista	UOM System: Original

Direct Costs

LaborCost
EQCost
MatlCost
SubBidCost

Timeline/Currency

Preparation Date	1/28/2014
Escalation Date	9/30/2013
Eff. Pricing Date	10/1/2013
Estimated Duration	305 Day(s)
Currency	US dollars
Exchange Rate	1.000000

Costbook CB12EB-b: MII English Cost Book 2012-b

Labor LFL2010: Labor_Florida_2010B_4.1

Labor Rates

Nat'l Labor 2012
LaborCost2
LaborCost3
LaborCost4

Equipment EP11R03: MII Equipment 2011 Region 03

03 SOUTHEAST

Sales Tax	8.35
Working Hours per Year	1,530
Labor Adjustment Factor	0.86
Cost of Money	2.13
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15
Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50

Fuel

Electricity	0.087
Gas	3.327
Diesel Off-Road	3.403
Diesel On-Road	3.946

Shipping Rates

Over 0 CWT	15.58
Over 240 CWT	14.19
Over 300 CWT	12.14
Over 400 CWT	10.20
Over 500 CWT	6.13
Over 700 CWT	6.13
Over 800 CWT	9.25

Date	Author	Note
1/28/2014 3:16:31 PM	Lisis Batista	Project Name: City of Valdosta Flood Control Budget Cost Estimate

Estimate type: This is a budget level cost estimate for Construction Only, City of Valdosta, GA Planning Assistance to State. This estimate does not include costs associated with engineering design, construction management, and real estate.

Acquisition Plan: TBD

Sub-contracting Plan: Grass seeding subcontractor

Scope of Work: General scope of work involves levee and drainage structures construction for flood Control.

Documents Used as the Basis for this Estimate: Scope of work, and project layout document provided by SAJ-EN-WM, dated 01/28/2014.

Narrative and Analytical Description on Rate/Price/Cost Development:
Budget costs provided by Scruggs Company, includes truck delivered.

Quantity Calculations/Sources/Verification of QA:
Quantities were provided by Brian Cornell, SAJ-EN-WM, spot checked by Lisis Batista, SAJ-EN-TC.

Effective Dates for Labor, Equipment and Material Pricing: January 2014.

Supporting Databases: MII & Bureau of Labor Statistics, occupational employment statics labor rates for heavy and civil engineering construction tables.
Equipment DB: USACE Equipment Pamphlet, Region3; Labor DB: BLS; Materials: MII Unit Price Book and price quotes from vendors)

Major Project Features: Levee Construction and CIP Reinforced Concrete Culverts, 72" x 72", 6 barrels.

Federal and non-Federal Cost Sharing Requirements: Not known at this time.

Construction Schedule (including date of mid-point of construction): The project schedule takes into account procurement and delivery of six 72" x 72" flapgates. Since flapgates of this size are not standard items a three months window has been accounted for ordering and delivery.

Construction Windows: Not defined at this time

Escalation: N/A

Date **Author** **Note**

General Assumptions: Purchase of rock quarry truck delivered.

Project cost is driven by cost associated with construction of 6 - 72" x 72" drainage culverts.

Levee fill material: Assumes using on-site fill material. According to Soils maps of Lowndes County, the 4 soil types in the area of the levee are...

1) Withlacoochee River floodplain: Thompson Fine Sandy Loam
2) Upland area: Norfolk Fine Sandy Loam
3) Area along railroad and that levee tie to high ground: Ruston Fine Sandy Loam
4) Creek beds: Plummer Fine Sand.

Price quotes for ready mix cement, filter sand, and riprap stone were provided by Scruggs Company.

Other assumptions includes cast in place of six 6’ x 6’ rectangular culverts. Purchased ready-mix concrete, riprap stone, and filter material ASTM C-33 (concrete sand) pricing provided by Scruggs Company, site delivered.

1. Taxes: 7%
2. FOOH: 19% (Calculated)
3. HOOH: 8% (Typical)
4. Profit: 10% (Typical)
5. Bond: 1%
6. Price Level: 2014
7. Productivity/Overtime Usage: N/A
8. Contingency: 25%
9. PED costs: N/A
10. S&A costs: N/A

Site Access: Project can be access directly from Gornto Rd.

Borrow Areas: Assumed to be located along Levee on the floodplain side.

Site Conditions: Not known

Unusual Conditions (Soil, Water, Weather): Not known

Date	Author	Note
		Weather Days:
		Unique Construction Techniques: N/A
		Equipment and Labor Availability and Distance Traveled:
		Environmental Concerns During Construction: Not known at this time.
		Volatile Cost Items: None
		Risk Analysis: N/A

Direct Cost Markups	**Category**	**Method**
Productivity	Productivity	Productivity
Overtime	Overtime	Overtime

	Days/Week	*Hours/Shift*	*Shifts/Day*	*1st Shift*	*2nd Shift*	*3rd Shift*
Standard	*5.00*	*8.00*	*1.00*	*8.00*	*0.00*	*0.00*
Actual	*5.00*	*8.00*	*1.00*	*10.00*	*0.00*	*0.00*

Day	*OT Factor*	*Working*	*OT Percent*	*FCCM Percent*
Monday	*1.50*	*Yes*	*10.00*	*(20.00)*
Tuesday	*1.50*	*Yes*		
Wednesday	*1.50*	*Yes*		
Thursday	*1.50*	*Yes*		
Friday	*1.50*	*Yes*		
Saturday	*1.50*	*No*		
Sunday	*2.00*	*No*		

Sales Tax	TaxAdj	Running % on Selected Costs
MatlCost		

Contractor Markups	**Category**	**Method**
JOOH (Small Tools)	Allowance	% of Labor
JOOH	JOOH	JOOH (Calculated)
JOOH_Sub	Allowance	Running %
HOOH	HOOH	Running %
Profit	Profit	Running %
Bond	Bond	Running %
Excise Tax	Excise	Running %

Owner Markups	**Category**	**Method**
Escalation	Escalation	Escalation

StartDate	*StartIndex*	*EndDate*	*EndIndex*	*Escalation*
2/4/2014	*0.00*	*2/4/2014*	*0.00*	*0.00*

Contingency	Contingency	Running %
SIOH	SIOH	Running %

Description	Quantity	UOM	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Project Cost Summary Report			**2,865,349**	**0**	**716,337**	**0**	**3,581,686**
CONSTRUCTION FEATURES	**1**	**EA**	**2,865,349**	**0**	**716,337**	**0**	**3,581,686**
11. LEVEES & FLOODWALLS	**1**	**EA**	**2,865,349**	**0**	**716,337**	**0**	**3,581,686**
11.01 Levees	**1**	**EA**	**2,865,349**	**0**	**716,337**	**0**	**3,581,686**
Mob, Demob and Prep Work	**1**	**LS**	**214,713**	**0**	**53,678**	**0**	**268,391**
Clearing & Grubbing	**10**	**ACR**	**21,229**	**0**	**5,307**	**0**	**26,537**
Levee Construction	**308,000**	**CY**	**1,336,559**	**0**	**334,140**	**0**	**1,670,699**
Care of Diversion of Water	**1**	**LS**	**143,142**	**0**	**35,785**	**0**	**178,927**
Drainage Structures RCP	**1,128**	**LF**	**1,114,147**	**0**	**278,537**	**0**	**1,392,683**
Associated General Items	**1**	**EA**	**35,560**	**0**	**8,890**	**0**	**44,449**

Description	Quantity	UOM	Contractor	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Contract Cost Summary Report				**1,997,821**	**8,899**	**2,006,720**	**858,630**	**2,865,349**
CONSTRUCTION FEATURES	**1**	**EA**		**1,997,821**	**8,899**	**2,006,720**	**858,630**	**2,865,349**
11. LEVEES & FLOODWALLS	**1**	**EA**		**1,997,821**	**8,899**	**2,006,720**	**858,630**	**2,865,349**
11.01 Levees	**1**	**EA**		**1,997,821**	**8,899**	**2,006,720**	**858,630**	**2,865,349**
Mob, Demob and Prep Work	**1**	**LS**	**Prime**	**150,000**	**0**	**150,000**	**64,713**	**214,713**
USR Mob, Demob, & Prep Work	1	LS	Prime	150,000	0	150,000	64,713	214,713
Clearing & Grubbing	**10**	**ACR**	**Prime**	**14,831**	**0**	**14,831**	**6,398**	**21,229**
RSM 311110100020 Clearing & grubbing, cut & chip light trees, to 6" diameter	10	ACR	Prime	14,831	0	14,831	6,398	21,229
Levee Construction	**308,000**	**CY**	**Prime**	**933,730**	**0**	**933,730**	**402,829**	**1,336,559**
Equipment Costs	**562**	**HR**	**Prime**	**541,509**	**0**	**541,509**	**233,617**	**775,126**
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6, REAR DUMP	2,248	HR	Prime	182,596	0	182,596	78,776	261,372
MAP T15CA012 TRACTOR, CRAWLER (DOZER), 240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)	1,124	HR	Prime	105,644	0	105,644	45,577	151,221
EP R50SI013 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, SMOOTH, 11.5 TON, 84" WIDE, 3X2, SOIL COMPACTOR	1,124	HR	Prime	53,703	0	53,703	23,168	76,871
GEN T15Z6500 TRACTOR, CRAWLER (DOZER), 136-180 HP (101-134 KW), POWERSHIFT, W/UNIVERSAL BLADE	562	HR	Prime	35,264	0	35,264	15,213	50,477
MAP T60KI001 TRUCK, WATER, OFF-HIGHWAY, 5,000 GAL, W/CAT 613C TRACTOR	562	HR	Prime	33,332	0	33,332	14,380	47,713
GEN H25Z3210 HYDRAULIC EXCAVATOR, CRAWLER, 140,000 LB (65,503 KG), 3.50 CY (2.7 M3) BUCKET, 31.4' (9.6 M) MAX DIGGING DEPTH	1,124	HR	Prime	130,970	0	130,970	56,503	187,472
Labor Costs	**562**	**HR**	**Prime**	**162,128**	**0**	**162,128**	**69,945**	**232,073**
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	2,810	HR	Prime	51,651	0	51,651	22,283	73,935
MIL B-EQOPRCRN Equip. Operators, Heavy	2,810	HR	Prime	67,739	0	67,739	29,224	96,963
MIL B-EQOPRMED Equip. Operators, Medium	1,124	HR	Prime	22,539	0	22,539	9,724	32,262
MIL B-LABORERG Laborers, General (Lowest paid)	562	HR	Prime	9,499	0	9,499	4,098	13,597
MIL B-POWDERMN Laborers, Skilled / Powdermen	562	HR	Prime	10,700	0	10,700	4,616	15,316
Removal of 1.5' In Situ Organic Material	**75,651**	**LCY**	**Prime**	**100,047**	**0**	**100,047**	**43,162**	**143,209**
Equipment Costs	**120**	**HR**	**Prime**	**78,232**	**0**	**78,232**	**33,751**	**111,983**
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6, REAR DUMP	480	HR	Prime	38,989	0	38,989	16,820	55,809
MAP T15CA012 TRACTOR, CRAWLER (DOZER), 240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)	120	HR	Prime	11,279	0	11,279	4,866	16,145
GEN H25Z3210 HYDRAULIC EXCAVATOR, CRAWLER, 140,000 LB (65,503 KG), 3.50 CY (2.7 M3) BUCKET, 31.4' (9.6 M) MAX DIGGING DEPTH	240	HR	Prime	27,965	0	27,965	12,065	40,030
Labor Costs	**120**	**HR**	**Prime**	**21,814**	**0**	**21,814**	**9,411**	**31,225**
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	480	HR	Prime	8,823	0	8,823	3,806	12,629
MIL B-EQOPRCRN Equip. Operators, Heavy	360	HR	Prime	8,678	0	8,678	3,744	12,422
MIL B-LABORERG Laborers, General (Lowest paid)	120	HR	Prime	2,028	0	2,028	875	2,903
MIL B-POWDERMN Laborers, Skilled / Powdermen	120	HR	Prime	2,285	0	2,285	986	3,270

Description	Quantity	UOM	Contractor	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Sample & Testing	**1**	**EA**	**Prime**	**30,000**	**0**	**30,000**	**12,943**	**42,943**
USR Sample & Testing	1	LS	Prime	30,000	0	30,000	12,943	42,943
Hauling & Spreading of 1.5' of Organic Material	**75,651**	**LCY**	**Prime**	**100,047**	**0**	**100,047**	**43,162**	**143,209**
Equipment Costs	**120**	**HR**	**Prime**	**78,232**	**0**	**78,232**	**33,751**	**111,983**
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6, REAR DUMP	480	HR	Prime	38,989	0	38,989	16,820	55,809
MAP T15CA012 TRACTOR, CRAWLER (DOZER), 240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)	120	HR	Prime	11,279	0	11,279	4,866	16,145
GEN H25Z3210 HYDRAULIC EXCAVATOR, CRAWLER, 140,000 LB (65,503 KG), 3.50 CY (2.7 M3) BUCKET, 31.4' (9.6 M) MAX DIGGING DEPTH	240	HR	Prime	27,965	0	27,965	12,065	40,030
Labor Costs	**120**	**HR**	**Prime**	**21,814**	**0**	**21,814**	**9,411**	**31,225**
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	480	HR	Prime	8,823	0	8,823	3,806	12,629
MIL B-EQOPRCRN Equip. Operators, Heavy	360	HR	Prime	8,678	0	8,678	3,744	12,422
MIL B-LABORERG Laborers, General (Lowest paid)	120	HR	Prime	2,028	0	2,028	875	2,903
MIL B-POWDERMN Laborers, Skilled / Powdermen	120	HR	Prime	2,285	0	2,285	986	3,270
Care of Diversion of Water	**1**	**LS**	**Prime**	**100,000**	**0**	**100,000**	**43,142**	**143,142**
USR Earthen Cofferdam	1	LS	Prime	100,000	0	100,000	43,142	143,142
Drainage Structures RCP	**1,128**	**LF**	**Prime**	**778,351**	**0**	**778,351**	**335,796**	**1,114,147**
Excavation	**1**	**LS**	**Prime**	**3,000**	**0**	**3,000**	**1,294**	**4,294**
USR Trench Excavation	1	LS	Prime	3,000	0	3,000	1,294	4,294
Filter Material	**1,072**	**CY**	**Prime**	**18,083**	**0**	**18,083**	**7,801**	**25,884**
Labor Costs	**6**	**HR**	**Prime**	**732**	**0**	**732**	**316**	**1,047**
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	12	HR	Prime	221	0	221	95	316
MIL B-EQOPRCRN Equip. Operators, Heavy	12	HR	Prime	289	0	289	125	414
MIL B-EQOPRMED Equip. Operators, Medium	6	HR	Prime	120	0	120	52	172
MIL B-LABORERG Laborers, General (Lowest paid)	6	HR	Prime	101	0	101	44	145
Equipment Costs	**6**	**HR**	**Prime**	**2,210**	**0**	**2,210**	**953**	**3,164**
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6, REAR DUMP	12	HR	Prime	975	0	975	421	1,395
MAP T15CA012 TRACTOR, CRAWLER (DOZER), 240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)	6	HR	Prime	564	0	564	243	807
EP R50SI013 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, SMOOTH, 11.5 TON, 84" WIDE, 3X2, SOIL COMPACTOR	6	HR	Prime	287	0	287	124	410
EP L40CA024 LOADER, FRONT END, WHEEL, 3.50 CY BUCKET, ARTICULATED, 4X4	6	HR	Prime	385	0	385	166	551
Material Costs	**1,072**	**CY**	**Prime**	**15,141**	**0**	**15,141**	**6,532**	**21,673**
USR Cement Sand (ASTM C-33)	1,179	CY	Prime	15,141	0	15,141	6,532	21,673
6 - 72" x 72" RCP	**1,128**	**LF**	**Prime**	**726,561**	**0**	**726,561**	**313,452**	**1,040,014**
Cast In Place Concrete	**1,038**	**CY**	**Prime**	**545,913**	**0**	**545,913**	**235,517**	**781,431**
Formwork	**23,496**	**SFC**	**Prime**	**35,244**	**0**	**35,244**	**15,205**	**50,449**
USR Material	23,496	SFC	Prime	35,244	0	35,244	15,205	50,449
Material Costs	**1**	**EA**	**Prime**	**205,194**	**0**	**205,194**	**88,525**	**293,719**
USR Concrete	1,038	CY	Prime	139,943	0	139,943	60,374	200,317
USR Reinforcing Steel	129,750	LB	Prime	65,251	0	65,251	28,151	93,402

Description	Quantity	UOM	Contractor	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Labor Costs	**1,386**	**HR**	**Prime**	**245,899**	**0**	**245,899**	**106,086**	**351,985**
MIL B-CARPNTER Carpenters	5,544	HR	Prime	91,882	0	91,882	39,640	131,522
MIL B-RODMAN Rodmen, (Reinforcing)	2,772	HR	Prime	74,664	0	74,664	32,212	106,876
MIL X-LABORER Outside Laborers, (Semi-Skilled)	2,772	HR	Prime	26,577	0	26,577	11,466	38,043
MIL X-CEMTFINR Outside Cement Finishers	2,772	HR	Prime	52,775	0	52,775	22,768	75,543
Equipment Costs	**1,386**	**HR**	**Prime**	**59,576**	**0**	**59,576**	**25,702**	**85,278**
EP C55OE006 CONCRETE PUMP, 22 CY/HR,TRAILER MTD (OPEN LOOP HYDRAULIC SYSTEM)	1,386	HR	Prime	30,230	0	30,230	13,042	43,272
EP C75BD004 CRANES, HYDRAULIC, SELF-PROPELLED, YARD, 4.0 TON, 19' BOOM, 4X2, NON-ROTATING OPERATOR'S CAB	1,386	HR	Prime	29,345	0	29,345	12,660	42,005
Flapgates	**1**	**EA**	**Prime**	**180,648**	**0**	**180,648**	**77,935**	**258,583**
USR 6 - 72" x 72" Flapgates hydraulic structures	6	EA	Prime	180,648	0	180,648	77,935	258,583
Backfill	**1**	**LS**	**Prime**	**4,000**	**0**	**4,000**	**1,726**	**5,726**
USR Backfill	1	LS	Prime	4,000	0	4,000	1,726	5,726
Erosion Control	**520**	**CY**	**Prime**	**26,707**	**0**	**26,707**	**11,522**	**38,229**
USR Riprap Stone	520	TON	Prime	26,707	0	26,707	11,522	38,229
Associated General Items	**1**	**EA**	**Prime**	**20,909**	**8,899**	**29,808**	**5,752**	**35,560**
Site Grading and Landscaping	**1**	**EA**	**Landscaping Sub**	**20,909**	**8,899**	**29,808**	**5,752**	**35,560**
Grass Seeding	**24**	**ACR**	**Landscaping Sub**	**20,909**	**8,899**	**29,808**	**5,752**	**35,560**
USR Grassing (Seeding & Mulching)	24	EA	Landscaping Sub	20,909	8,899	29,808	5,752	35,560

Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
Project Direct Costs Report				**458,983**	**767,995**	**247,043**	**523,801**	**0**	**1,997,821**
CONSTRUCTION FEATURES	**1**	**EA**		**458,983**	**767,995**	**247,043**	**523,801**	**0**	**1,997,821**
11. LEVEES & FLOODWALLS	**1**	**EA**		**458,983**	**767,995**	**247,043**	**523,801**	**0**	**1,997,821**
11.01 Levees	**1**	**EA**		**458,983**	**767,995**	**247,043**	**523,801**	**0**	**1,997,821**
(Note: Note: Estimated construction time (includes bad weather and contingencies) is 10 months.)									
Mob, Demob and Prep Work	**1**	**LS**	**Prime**	**0**	**0**	**0**	**150,000**	**0**	**150,000**
(Note: It is estimated that the project will be done by a local contractor; therefore it is estimated that mobilization of personnel and equipment will be from within the vicinity area, at the most from 50 miles away. Lump sum for this work includes mobilization of heavy and minor equipment; personnel; prepare haul roads; standby time; install/remove temporary site work, facilities, & utilities; & travel costs.)									
USR Mob, Demob, & Prep Work	1	LS	Prime	0	0	0	150,000	0	150,000
Clearing & Grubbing	**10**	**ACR**	**Prime**	**6,596**	**8,235**	**0**	**0**	**0**	**14,831**
(Note: Quantities for clearing and grubbing were provided by EN-WM. Area is described as light density with 6" dia. trees.)									
RSM 311110100020 Clearing & grubbing, cut & chip light trees, to 6" diameter	10	ACR	Prime	6,596	8,235	0	0	0	14,831
(Note: Clearing Grubbing quantities provided by SAJ-EN-WM)									
Levee Construction	**308,000**	**CY**	**Prime**	**205,756**	**697,974**	**0**	**30,000**	**0**	**933,730**
Equipment Costs	**562**	**HR**	**Prime**	**0**	**541,509**	**0**	**0**	**0**	**541,509**
(Note: Equipment used: 2 Excavators, 4 trucks, 3 dozers, 2 Rollers, and 1 Water Truck. Excavator productivity: 30 seconds/cycle = 2 cycles/min Excavator Production: 2 (exc) x 3.5 cy x 2 cycles/min x 60 min/hr x 0.83 eff x 0.9 bf (weather + contingency) = 627.5 cy/ hrs Use estimated number of hours = 630 cy/hr 354,200 lcy / 630 cy/hr = 562 hrs)									
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6, REAR DUMP	2,248	HR	Prime	0	182,596	0	0	0	182,596
(Note: Assumes two trucks per excavator)									
MAP T15CA012 TRACTOR, CRAWLER (DOZER), 240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)	1,124	HR	Prime	0	105,644	0	0	0	105,644
EP R50SI013 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, SMOOTH, 11.5 TON, 84" WIDE, 3X2, SOIL COMPACTOR	1,124	HR	Prime	0	53,703	0	0	0	53,703
(Note: Assumes one roller per excavator)									
GEN T15Z6500 TRACTOR, CRAWLER (DOZER), 136-180 HP (101-134 KW), POWERSHIFT, W/UNIVERSAL BLADE	562	HR	Prime	0	35,264	0	0	0	35,264
MAP T60KI001 TRUCK, WATER, OFF-HIGHWAY, 5,000 GAL, W/CAT 613C TRACTOR	562	HR	Prime	0	33,332	0	0	0	33,332
(Note: Assumes one water trucks (one per excavator))									
GEN H25Z3210 HYDRAULIC EXCAVATOR, CRAWLER, 140,000 LB (65,503 KG), 3.50 CY (2.7 M3) BUCKET, 31.4' (9.6 M) MAX DIGGING DEPTH	1,124	HR	Prime	0	130,970	0	0	0	130,970
(Note: Assumes two excavators)									
Labor Costs	**562**	**HR**	**Prime**	**162,128**	**0**	**0**	**0**	**0**	**162,128**
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	2,810	HR	Prime	51,651	0	0	0	0	51,651
(Note: Assumed Davis Bacon Truck Drivers: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2- off-hwy truck drivers per excavator)									
MIL B-EQOPRCRN Equip. Operators, Heavy	2,810	HR	Prime	67,739	0	0	0	0	67,739
(Note: Assumed Davis Bacon Power Equip. Operators: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2 - equip ops - heavy)									

Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
MIL B-EQOPRMED Equip. Operators, Medium	1,124	HR	Prime	22,539	0	0	0	0	22,539
(Note: Assumed Davis Bacon Power Equip. Operators: Group 2 General Decision Number: WA120001 02/17/2012 WA1 2- Equip Op.)									
MIL B-LABORERG Laborers, General (Lowest paid)	562	HR	Prime	9,499	0	0	0	0	9,499
(Note: Assumed Davis Bacon Laborers: Group 2 General Decision Number: WA120038 02/10/2012 WA38 1 - Flag persons)									
MIL B-POWDERMN Laborers, Skilled / Powdermen	562	HR	Prime	10,700	0	0	0	0	10,700
(Note: Assumed Davis Bacon Laborers: Group 5: Powderman General Decision Number: WA120038 02/10/2012 WA38 Grade checker laborer 1 - skilled laborers)									
Removal of 1.5' In Situ Organic Material	**75,651**	**LCY**	**Prime**	**21,814**	**78,232**	**0**	**0**	**0**	**100,047**
(Note: Assumes the removal of 2 feet deep of in-situ organic material to be excavated and stockpile. Upon completion of levee construction, organic material will be spreaded and uniformily compacted along the project site (levee slope, borrow area, or toe levee). Quantity: 1.5' (assumed depth) x 3947' (length) x 300' (width of B/A)) x 1.15 (swell) / 27 cy/cf = 75,651 lcy)									
Equipment Costs	**120**	**HR**	**Prime**	**0**	**78,232**	**0**	**0**	**0**	**78,232**
(Note: Equipment used: 4 trucks, 2 dozers, 2 excavators Excavator productivity: 30 seconds/cycle = 2 cycles/min Excavator Production: 2 (exc) x 3.5 cy x 2 cycles/min x 60 min/hr x 0.83 eff x 0.9 bf (weather + contingency) = 627.5 cy/ hrs Use estimated number of hours = 630 cy/hr 75,651 / 630 cy/hr = 120 hrs)									
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6, REAR DUMP	480	HR	Prime	0	38,989	0	0	0	38,989
(Note: Assumes two trucks per excavator)									
MAP T15CA012 TRACTOR, CRAWLER (DOZER), 240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)	120	HR	Prime	0	11,279	0	0	0	11,279
GEN H25Z3210 HYDRAULIC EXCAVATOR, CRAWLER, 140,000 LB (65,503 KG), 3.50 CY (2.7 M3) BUCKET, 31.4' (9.6 M) MAX DIGGING DEPTH	240	HR	Prime	0	27,965	0	0	0	27,965
(Note: Assumes two excavators)									
Labor Costs	**120**	**HR**	**Prime**	**21,814**	**0**	**0**	**0**	**0**	**21,814**
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	480	HR	Prime	8,823	0	0	0	0	8,823
(Note: Assumed Davis Bacon Truck Drivers: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2- off-hwy truck drivers per excavator)									
MIL B-EQOPRCRN Equip. Operators, Heavy	360	HR	Prime	8,678	0	0	0	0	8,678
(Note: Assumed Davis Bacon Power Equip. Operators: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2 - equip ops - heavy)									
MIL B-LABORERG Laborers, General (Lowest paid)	120	HR	Prime	2,028	0	0	0	0	2,028
(Note: Assumed Davis Bacon Laborers: Group 2 General Decision Number: WA120038 02/10/2012 WA38 1 - Flag persons)									
MIL B-POWDERMN Laborers, Skilled / Powdermen	120	HR	Prime	2,285	0	0	0	0	2,285
(Note: Assumed Davis Bacon Laborers: Group 5: Powderman General Decision Number: WA120038 02/10/2012 WA38 Grade checker laborer 1 - skilled laborers)									
Sample & Testing	**1**	**EA**	**Prime**	**0**	**0**	**0**	**30,000**	**0**	**30,000**
(Note: Includes an allowance of $30,000 to account for sampling, compaction and gradation test, etc.)									
USR Sample & Testing	1	LS	Prime	0	0	0	30,000	0	30,000
Hauling & Spreading of 1.5' of Organic Material	**75,651**	**LCY**	**Prime**	**21,814**	**78,232**	**0**	**0**	**0**	**100,047**
(Note: Organic material will be taken from the stockpile, hauled and spreaded on the slopes of the levee. Quantity: 1.5' (assumed depth) x 3947' (length) x 300' (width of B/A)) x 1.15 (swell) / 27 cy/cf = 75,651 lcy)									
Equipment Costs	**120**	**HR**	**Prime**	**0**	**78,232**	**0**	**0**	**0**	**78,232**
(Note:)									
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6, REAR DUMP	480	HR	Prime	0	38,989	0	0	0	38,989
(Note: Assumes two trucks per excavator)									
MAP T15CA012 TRACTOR, CRAWLER (DOZER),	120	HR	Prime	0	11,279	0	0	0	11,279

Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)									
GEN H25Z3210 HYDRAULIC EXCAVATOR, CRAWLER, 140,000 LB (65,503 KG), 3.50 CY (2.7 M3) BUCKET, 31.4' (9.6 M) MAX DIGGING DEPTH	240	HR	Prime	0	27,965	0	0	0	27,965
(Note: Assumes two excavators)									
Labor Costs	**120**	**HR**	**Prime**	**21,814**	**0**	**0**	**0**	**0**	**21,814**
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	480	HR	Prime	8,823	0	0	0	0	8,823
(Note: Assumed Davis Bacon Truck Drivers: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2- off-hwy truck drivers per excavator)									
MIL B-EQOPRCRN Equip. Operators, Heavy	360	HR	Prime	8,678	0	0	0	0	8,678
(Note: Assumed Davis Bacon Power Equip. Operators: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2 - equip ops - heavy)									
MIL B-LABORERG Laborers, General (Lowest paid)	120	HR	Prime	2,028	0	0	0	0	2,028
(Note: Assumed Davis Bacon Laborers: Group 2 General Decision Number: WA120038 02/10/2012 WA38 1 - Flag persons)									
MIL B-POWDERMN Laborers, Skilled / Powdermen	120	HR	Prime	2,285	0	0	0	0	2,285
(Note: Assumed Davis Bacon Laborers: Group 5: Powderman General Decision Number: WA120038 02/10/2012 WA38 Grade checker laborer 1 - skilled laborers)									
Care of Diversion of Water	**1**	**LS**	**Prime**	**0**	**0**	**0**	**100,000**	**0**	**100,000**
(Note: At this time there is not enough design information to develop estimates for an earthen cofferdam, therefore, an allowance of a $100k has been assumed to pay for ditch plug-ins, de-watering, and construction of diversion ditch/cofferdam.)									
USR Earthen Cofferdam	1	LS	Prime	0	0	0	100,000	0	100,000
Drainage Structures RCP	**1,128**	**LF**	**Prime**	**246,631**	**61,786**	**247,043**	**222,892**	**0**	**778,351**
(Note: Estimated Culvert Construction Time: To simplify, it is assumed each barrel will be separated into four unique segments. Thus, for each barrel there are 4 segments of equal length: 4 * 47' = 188' length Sequence of construction for a 47' long segment is: 1-Prep. Formwork + install ground slab formwork – ½ day 2-Cut, bend + install rebar on bottom slab – ½ day 3-Pour CIP and finishes– ½ day 4-Prep/install formwork wall – 1 day 5-Cut, bend, + install rebar walls– 1 day 6-Pour CIP and finishes – ½ day 7-Prep/install/shoring of top slab – 1 day 8-Cut, bend, + install rebar walls – ½ day 9-Pour CIP and finishes – ½ day 10-Strip all formwork – ½ day Number of days required to build a 47' long pipe segment is 6.5 days, use 7 days. Days required to build a barrel (188' long): 4 (segments) x 7 days = 28 days 28 day x 6 barrels = 168 days /22 days (working days per month) = 7.6 months, use 8 months (includes bad weather +)									
Excavation	**1**	**LS**	**Prime**	**0**	**0**	**0**	**3,000**	**0**	**3,000**
(Note: Since there is not enough information for excavation of drainage structures, an allowance of $3,000 has been assumed; the material to be excavated will be hauled and disposed onsite.)									
USR Trench Excavation	1	LS	Prime	0	0	0	3,000	0	3,000
Filter Material	**1,072**	**CY**	**Prime**	**732**	**2,210**	**15,141**	**0**	**0**	**18,083**
(Note: Quantities for filter material ASTM C-33 (i.e. concrete sand) provided by EN-WM. Pricing provided by Scruggs Company includes delivery to onsite stockpile.)									
Labor Costs	**6**	**HR**	**Prime**	**732**	**0**	**0**	**0**	**0**	**732**
(Note: Quantity: 346,704.30 lcy / 630 cy/hr = 550.3 hrs, use 550 hrs.)									
MIL X-TRKDVRHV Outside Truck Drivers, Heavy	12	HR	Prime	221	0	0	0	0	221
(Note: Assumed Davis Bacon Truck Drivers: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2- off-hwy truck drivers)									
MIL B-EQOPRCRN Equip. Operators, Heavy	12	HR	Prime	289	0	0	0	0	289
(Note: Assumed Davis Bacon Power Equip. Operators: Group 1 General Decision Number: WA120001 02/17/2012 WA1 2 - equip ops - heavy)									
MIL B-EQOPRMED Equip. Operators, Medium	6	HR	Prime	120	0	0	0	0	120
(Note: Assumed Davis Bacon Power Equip. Operators: Group 2 General Decision Number: WA120001 02/17/2012 WA1 1- Equip Op.)									
MIL B-LABORERG Laborers, General (Lowest paid)	6	HR	Prime	101	0	0	0	0	101
(Note: Assumed Davis Bacon Laborers: Group 2 General Decision Number: WA120038 02/10/2012 WA38 1 - Flag persons)									
Equipment Costs	**6**	**HR**	**Prime**	**0**	**2,210**	**0**	**0**	**0**	**2,210**
(Note: Assumes one loader, 2 truck, Loader productivity: 30 seconds/cycle = 2 cycles/min Loader Production: 1 (load) x 3.5 cy x 2 cycles/min x 60 min/hr x 0.83 eff x 0.9 bf (weather + contingency) = 313.74 cy/ hrs Horizontal layer of drainage material is considered at 300 cy/hr Vertical layer of drainage material is considered to take longer, therefore, we anticipate an average productivity of 100 cy/hr. Therefore the average productivity is (300 cy/hr +100 cy/hr)/2 = 200 cy/hr)									
EP T55JD002 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 22 CY, 29 TON, 6X6,	12	HR	Prime	0	975	0	0	0	975

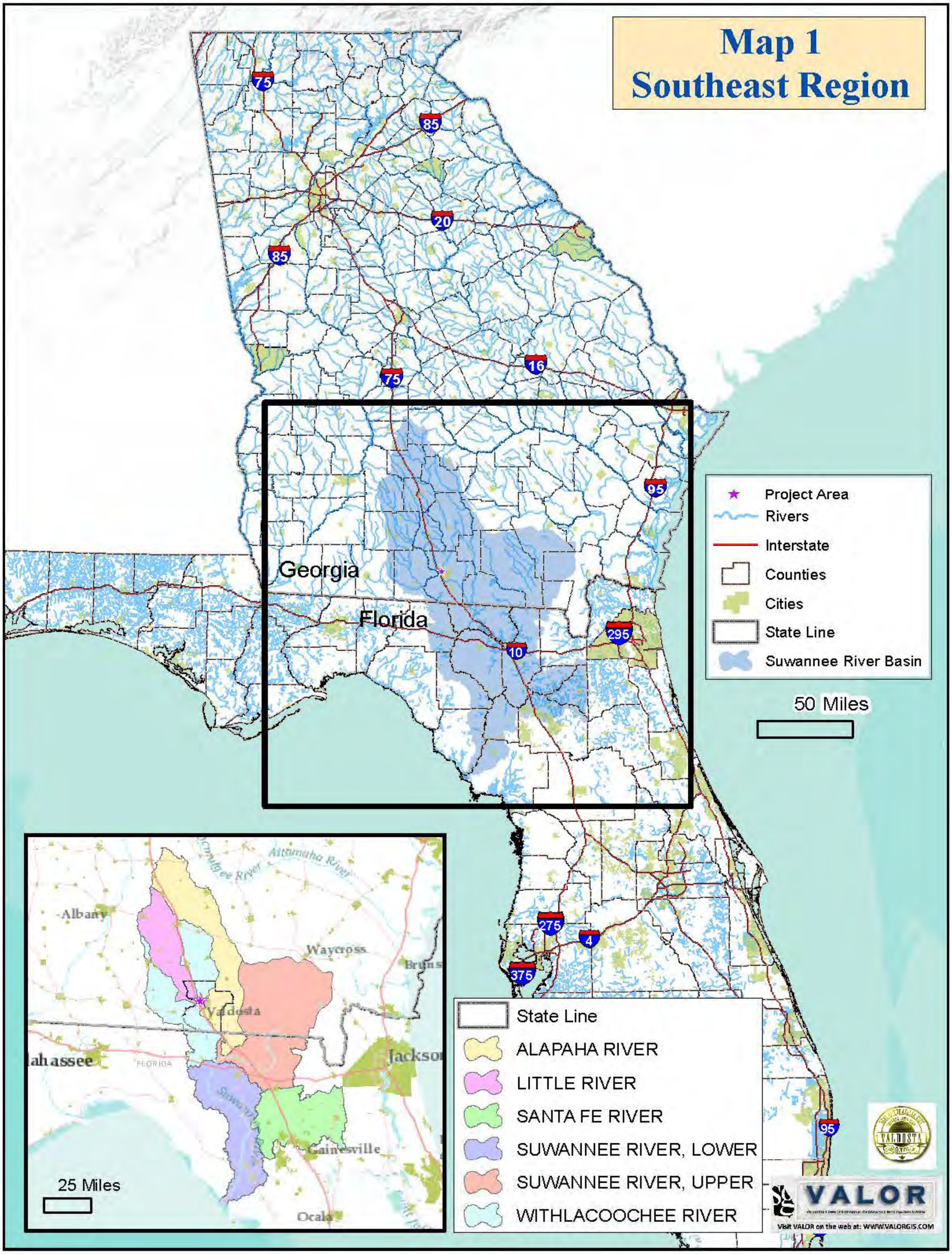
Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
REAR DUMP									
(Note: Assumes two trucks)									
MAP T15CA012 TRACTOR, CRAWLER (DOZER), 240 HP, POWERSHIFT, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS)	6	HR	Prime	0	564	0	0	0	564
EP R50SI013 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, SMOOTH, 11.5 TON, 84" WIDE, 3X2, SOIL COMPACTOR	6	HR	Prime	0	287	0	0	0	287
(Note: Assumes one roller per excavator)									
EP L40CA024 LOADER, FRONT END, WHEEL, 3.50 CY BUCKET, ARTICULATED, 4X4	6	HR	Prime	0	385	0	0	0	385
Material Costs	**1,072**	**CY**	**Prime**	**0**	**0**	**15,141**	**0**	**0**	**15,141**
USR Cement Sand (ASTM C-33)	1,179	CY	Prime	0	0	15,141	0	0	15,141
(Note: Includes 10% of material lost.)									
6 - 72" x 72" RCP	**1,128**	**LF**	**Prime**	**245,899**	**59,576**	**205,194**	**215,892**	**0**	**726,561**
(Note: 6 - 72"x72" (1810mm x 1810mm) RCP barrels to be casted in place, thus, allowance for lifting devices and placement of the structures will not be required. Levee bottom width is 154 feet, pipe length is 188' 6 barrels at a length of 188' each = 1,128 LF)									
Cast In Place Concrete	**1,038**	**CY**	**Prime**	**245,899**	**59,576**	**205,194**	**35,244**	**0**	**545,913**
(Note: Note: Drainage Structures estimated construction time (includes bad weather and contingencies) is 8 months = 8 mo x 4.33 wks/mo x 40 hrs/wk = 1385.6 hrs, say 1386 hrs. Assumes drainage structure wall, bottom & top slab thickness of 12." Pipe length is 188 lf Quantity: 6 -72" x 72" barrels: ((46' * 1') + (2 x 6' x 1') + (5 x 6'x 1.5') + (46' x 1')) x 188 lf = 28,012 cf / 27 cy/cf = 1,037.5 cy, use 1,038 cy.)									
Formwork	**23,496**	**SFC**	**Prime**	**0**	**0**	**0**	**35,244**	**0**	**35,244**
(Note: Pricing includes material, shoring, bracing, ties, etc)									
USR Material	23,496	SFC	Prime	0	0	0	35,244	0	35,244
Material Costs	**1**	**EA**	**Prime**	**0**	**0**	**205,194**	**0**	**0**	**205,194**
(Note: Ready mix concrete pricing is $126/cy, 3000 PSI site delivered from Scruggs Company.)									
USR Concrete	1,038	CY	Prime	0	0	139,943	0	0	139,943
USR Reinforcing Steel	129,750	LB	Prime	0	0	65,251	0	0	65,251
(Note: Assumed 125 lbs of steel per cubic yard, see quantity link for calcs = 129,750 lbs)									
Labor Costs	**1,386**	**HR**	**Prime**	**245,899**	**0**	**0**	**0**	**0**	**245,899**
(Note: Note: Drainage Structures estimated construction time (includes bad weather and contingencies) is 8 months = 8 mo x 4.33 wks/mo x 40 hrs/wk = 1385.6 hrs, say 1386 hrs.)									
MIL B-CARPNTER Carpenters	5,544	HR	Prime	91,882	0	0	0	0	91,882
(Note: Assumed Davis Bacon CARPENTER 4- Carpenters General Decision Number: WA120001 02/17/2012 WA1 4- Carpenters)									
MIL B-RODMAN Rodmen, (Reinforcing)	2,772	HR	Prime	74,664	0	0	0	0	74,664
(Note: Assume Davis Bacon IRONWORKER General Decision Number: WA120001 02/17/2012 WA1 2- Rodmen)									
MIL X-LABORER Outside Laborers, (Semi-Skilled)	2,772	HR	Prime	26,577	0	0	0	0	26,577
(Note: Assumed Davis Bacon Laborers: Group 3: General Laborer General Decision Number: WA120038 02/10/2012 WA38 2 - Laborers)									
MIL X-CEMTFINR Outside Cement Finishers	2,772	HR	Prime	52,775	0	0	0	0	52,775
(Note: Assumed Davis Bacon CEMENT MASON/CONCRETE FINISHER General Decision Number: WA120038 02/10/2012 WA38 2 - Masons)									
Equipment Costs	**1,386**	**HR**	**Prime**	**0**	**59,576**	**0**	**0**	**0**	**59,576**
(Note: Note: Drainage Structures estimated construction time (includes bad weather and contingencies) is 8 months = 8 mo x 4.33 wks/mo x 40 hrs/wk = 1385.6 hrs, say 1386 hrs)									
EP C55OE006 CONCRETE PUMP, 22 CY/HR,TRAILER MTD (OPEN LOOP HYDRAULIC SYSTEM)	1,386	HR	Prime	0	30,230	0	0	0	30,230
EP C75BD004 CRANES, HYDRAULIC, SELF-PROPELLED, YARD, 4.0 TON, 19' BOOM,	1,386	HR	Prime	0	29,345	0	0	0	29,345

Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
4X2, NON-ROTATING OPERATOR'S CAB									
Flapgates	**1**	**EA**	**Prime**	**0**	**0**	**0**	**180,648**	**0**	**180,648**
(Note: Pricing calculated as 30% higher than the cost associated with a 72" dia aluminum flapgate (unit price book for circular 72' dia is $23,160) $23,160 x 1.30 = $30,108 each (self contained aluminum, 72" x 72", incl. anchor bolts & grout))									
USR 6 - 72" x 72" Flapgates hydraulic structures	6	EA	Prime	0	0	0	180,648	0	180,648
Backfill	**1**	**LS**	**Prime**	**0**	**0**	**0**	**4,000**	**0**	**4,000**
(Note: Maximum and minimum fill heights depend on the embedment material, compaction level and pipe strength. Since there is not enough design information an allowance of $4,000 has been assumed for backfill.)									
USR Backfill	1	LS	Prime	0	0	0	4,000	0	4,000
Erosion Control	**520**	**CY**	**Prime**	**0**	**0**	**26,707**	**0**	**0**	**26,707**
(Note: Erosion control is provided at the inlet and outlet of the culvert structure. For estimating purposes assumed 8-inch stone, 12" deep (type III). Downstream will be 60' wide x 100' length. Upstream will be 60' wide x 50' length. Quantity: (60' x 100' x 1' + 60' x 50' x 1') / 27 cy/cf x 1.1 (waste factor & overbuilt) = 366.7 cy used 370 cy Conversion factor: 1 cy x 27 cy/sf 140 lb (weight of stone)/cf x 0.75 (solid)/ 2000 Ton/lb = 1.4 Ton/cy Number of estimated Tons = 370 cy x 1.4 Ton/cy = 518 Tons, use 520 Tons Pricing: $48/Ton provided by Scruggs Company located at Valdosta, Ga, budget quote includes delivery to the project site.)									
USR Riprap Stone	520	TON	Prime	0	0	26,707	0	0	26,707
Associated General Items	**1**	**EA**	**Prime**	**0**	**0**	**0**	**20,909**	**0**	**20,909**
Site Grading and Landscaping	**1**	**EA**	**Landscaping Sub**	**0**	**0**	**0**	**20,909**	**0**	**20,909**
Grass Seeding	**24**	**ACR**	**Landscaping Sub**	**0**	**0**	**0**	**20,909**	**0**	**20,909**
(Note: Given area 23 Acres, spot checked by CESAJ-EN-WM includes Average levee high of 24' with 3H:1V slopes which yields 76' long slopes. Then, (2 slopes x 76' + 12 (crest)) x 3,947' feet (long) / 43560 SF/Acr = 14.8 Acres. Plus 9 acres (100' wide x 3947 / 43560) to account for seeding of berm between the levee and borrow area for a total of 23.8 acres. Use 24 Acres.)									
USR Grassing (Seeding & Mulching)	24	EA	Landscaping Sub	0	0	0	20,909	0	20,909
(Note: Historical pricing cost from EN-TC database of $871.20 provided by Commercial Hydroseeding)									

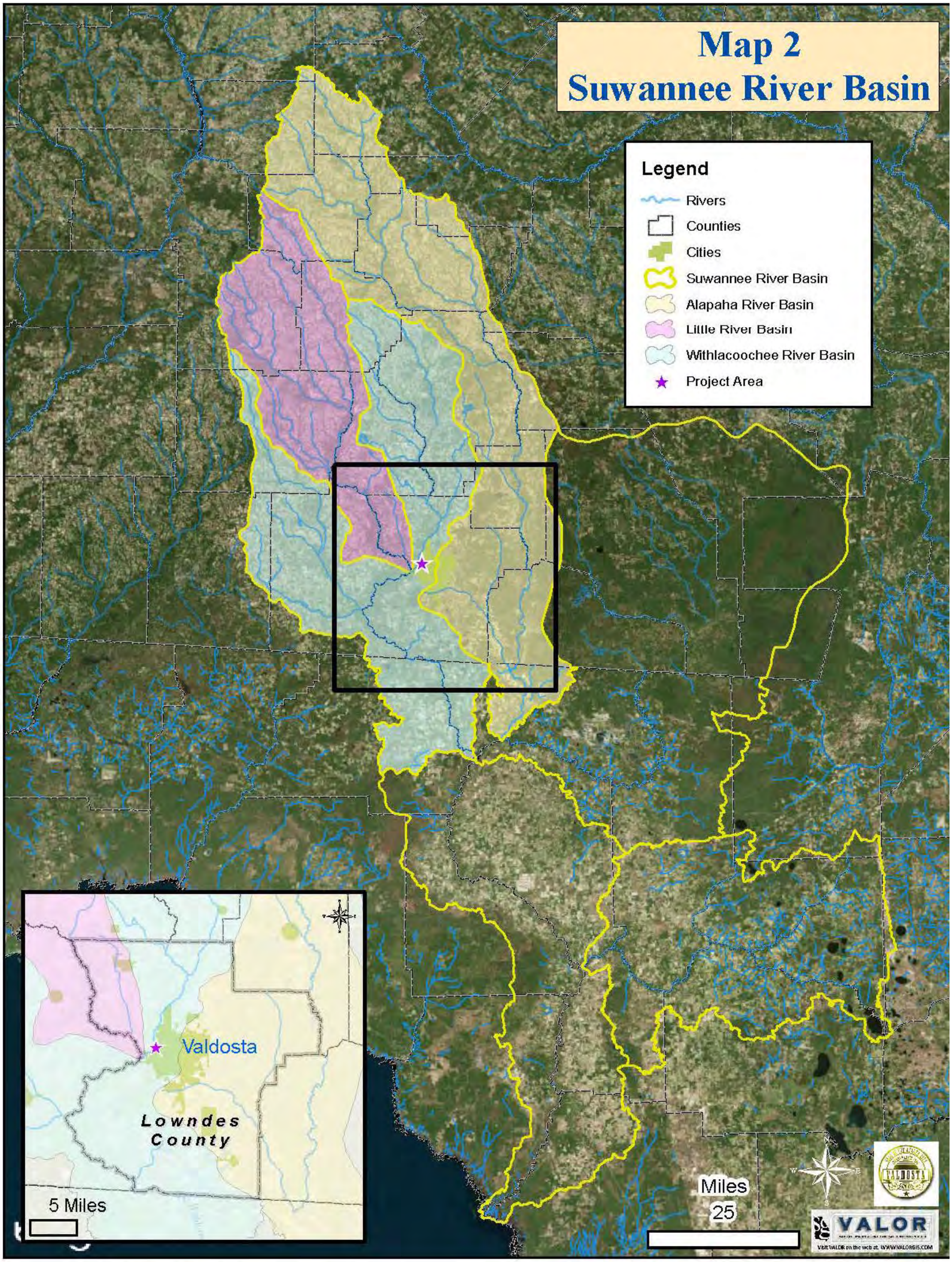
Gornto Bridge Flooding 2009

Appendix D: Maps

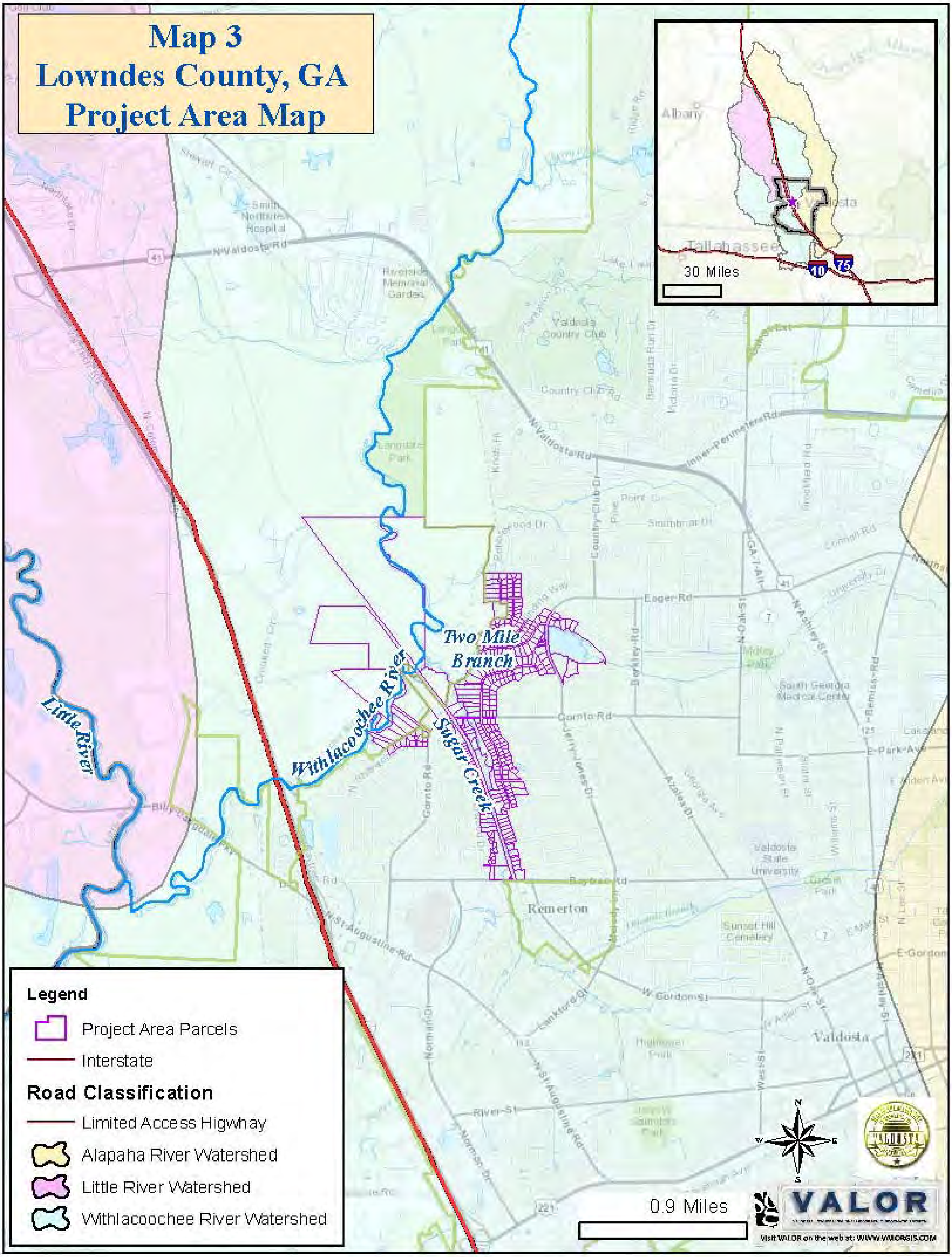
City of Valdosta
Lowndes County



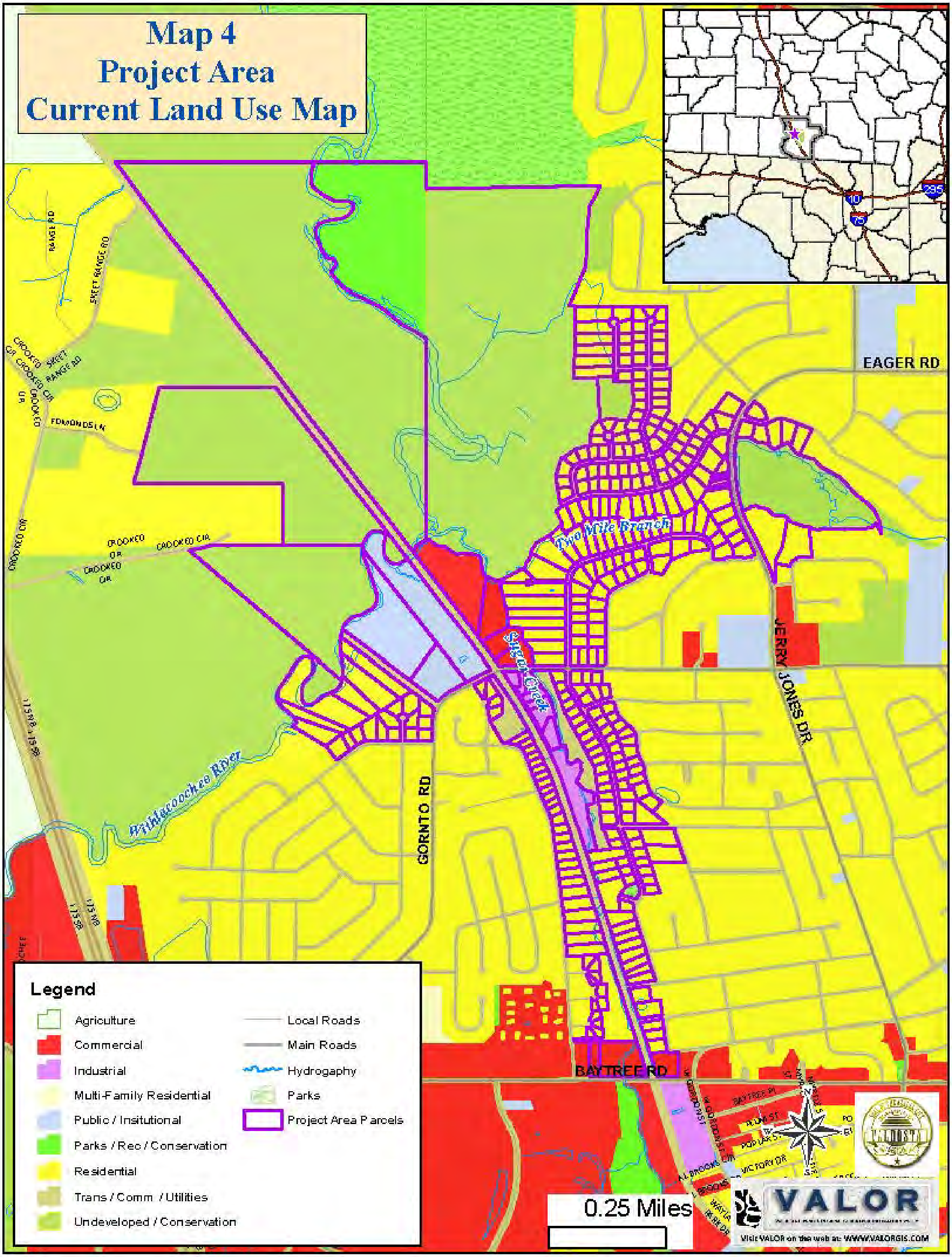
MAP 1: Location of Valdosta in the southeastern region of the U.S., in relation to the Georgia/Florida state line, and within the Suwannee River Basin.



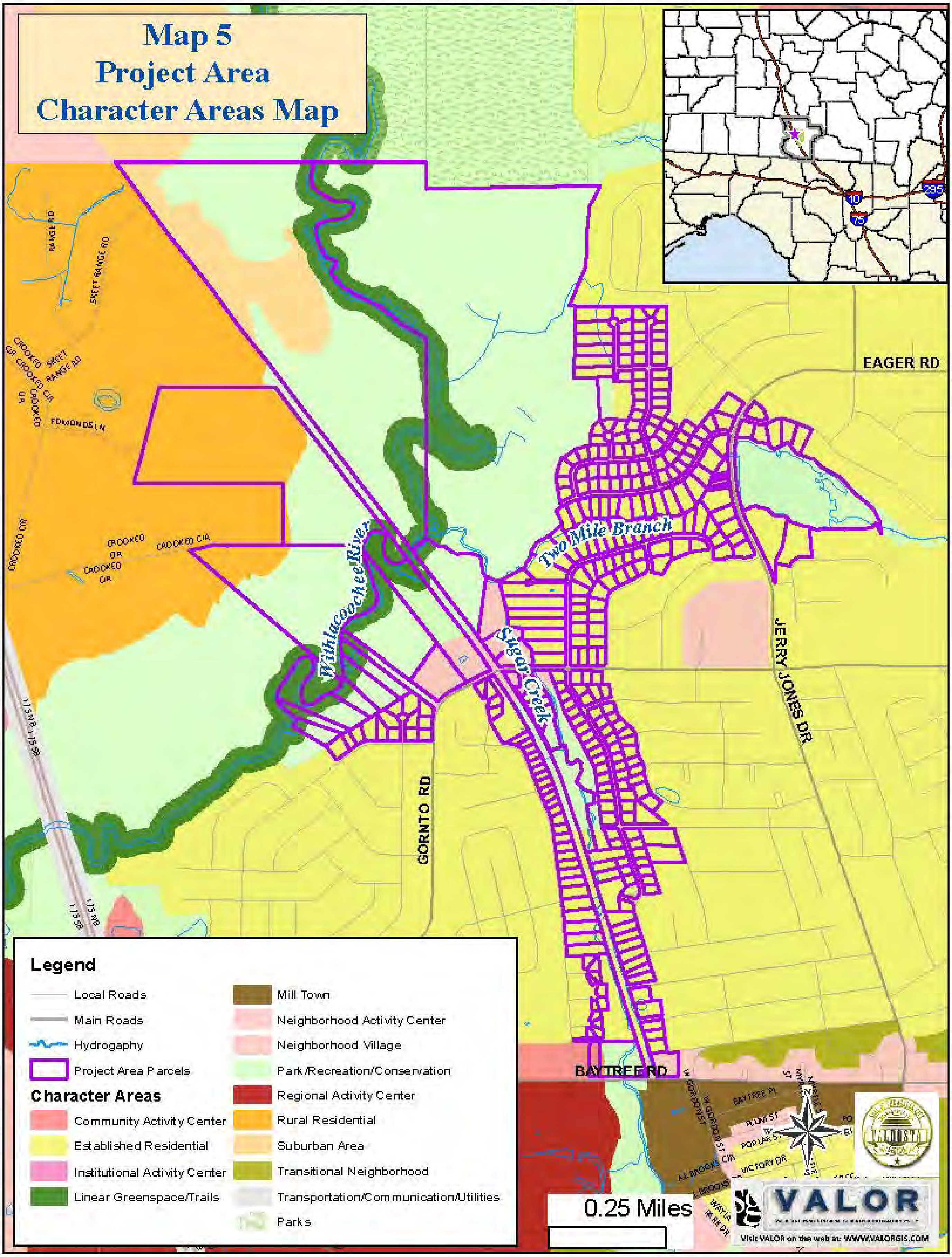
MAP 2: Location of Valdosta within the boundaries of the three sub-basins of the Suwannee River Basin which most influence its hydrology.



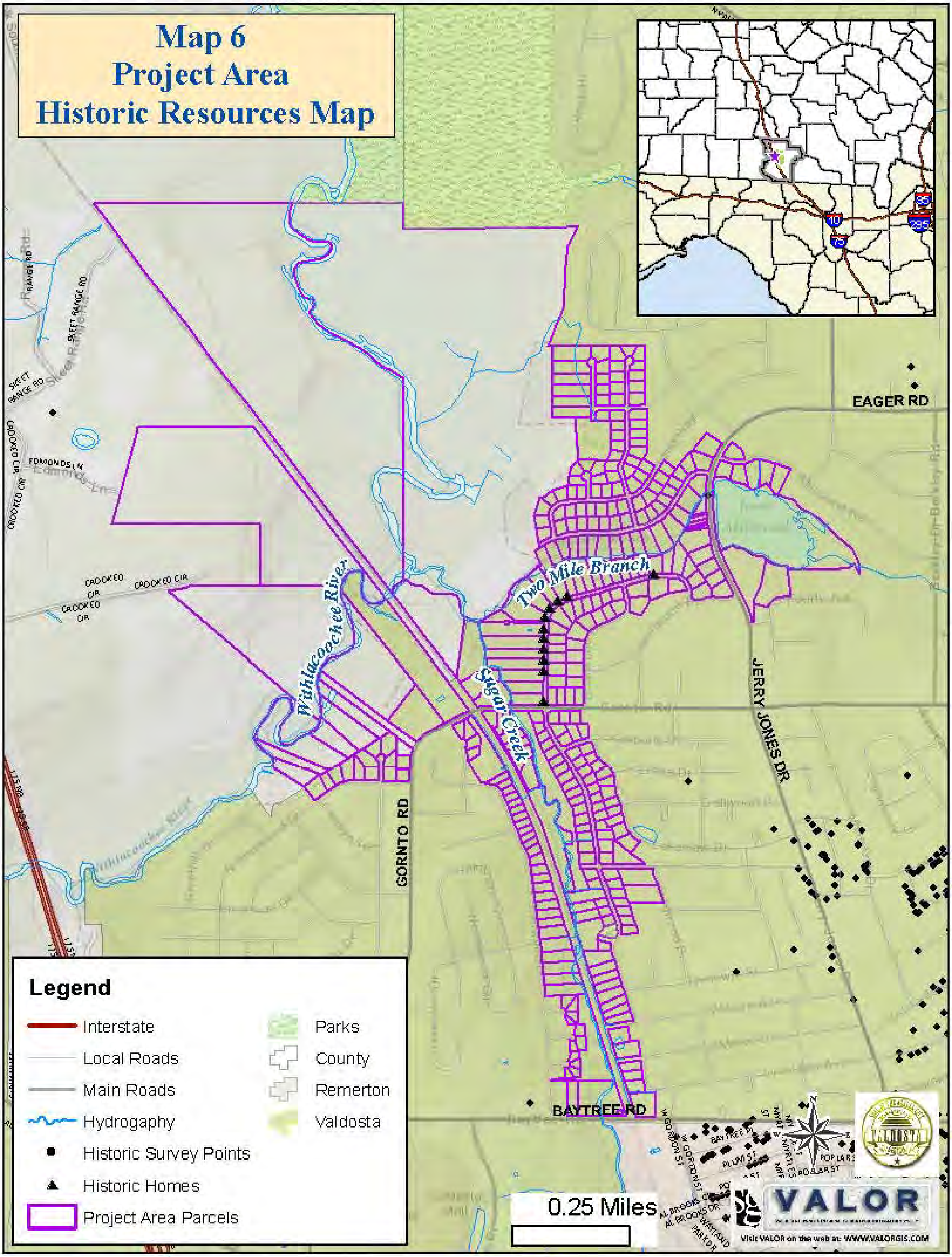
MAP 3: The project area and affected parcels, at the confluence of the Withlacoochee River and Sugar Creek, including Two Mile Branch which is a tributary of Sugar Creek.



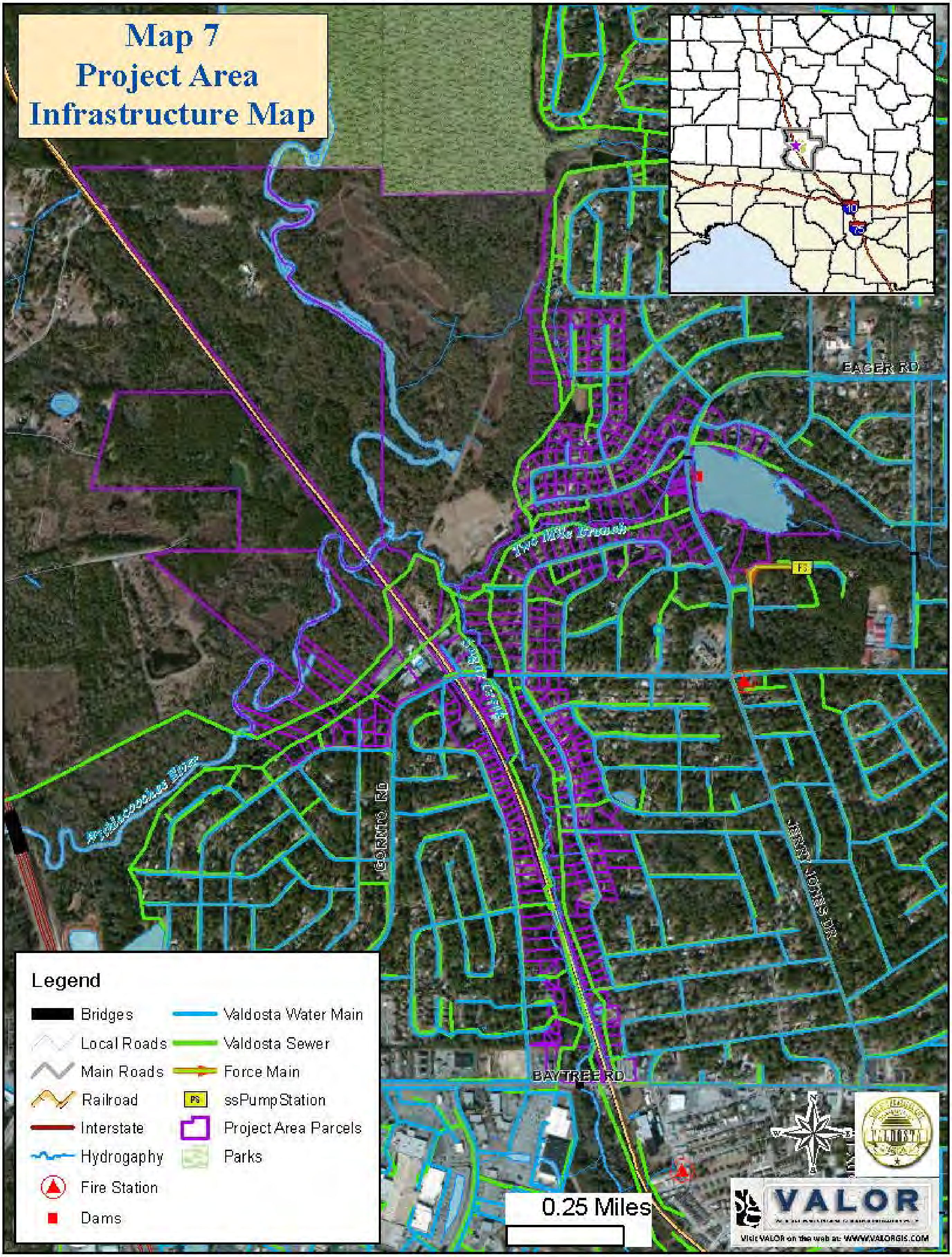
MAP 4: Current land use within the project area, which includes a mix of residential, commercial, public, industrial, parks, utilities, and conservation areas.



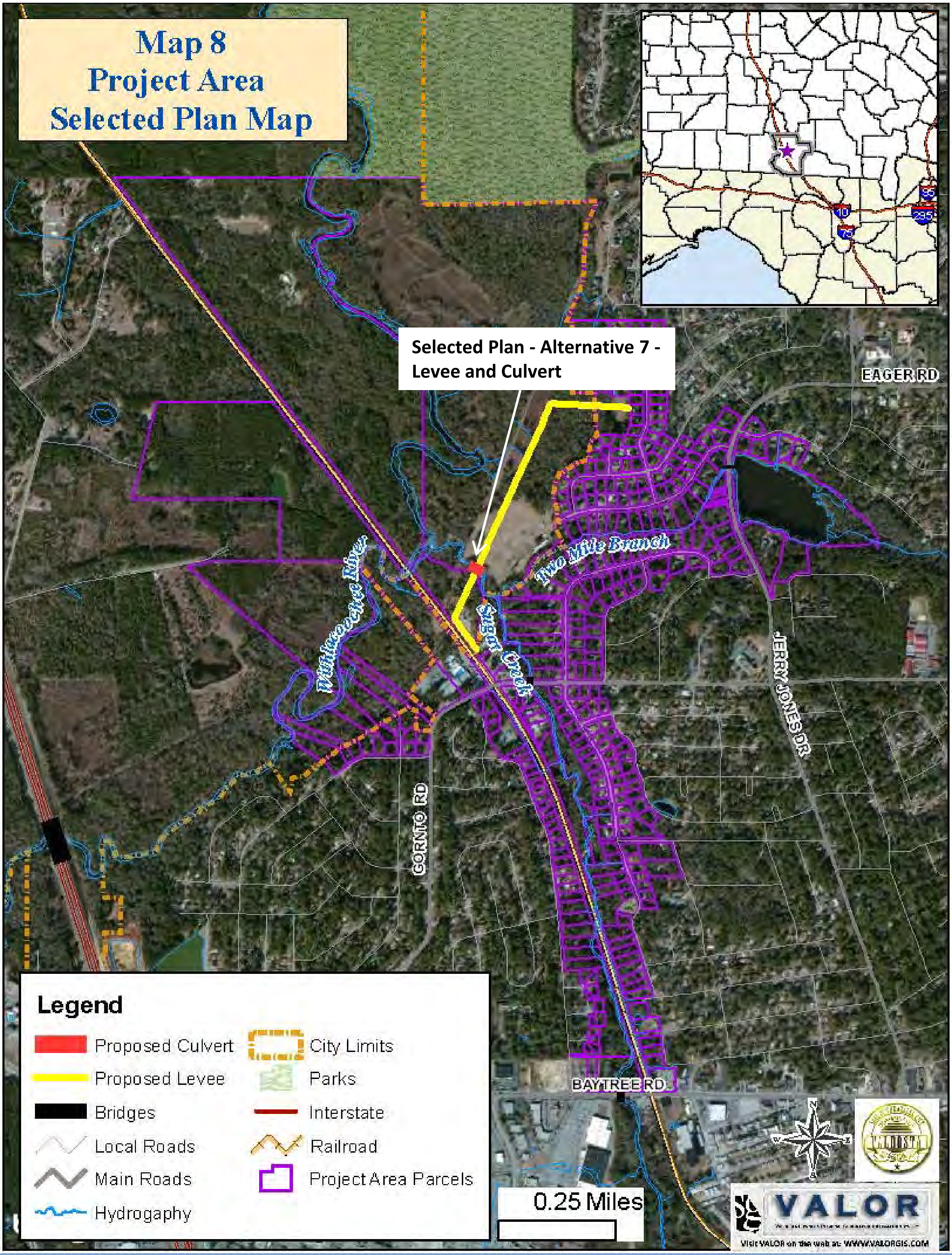
MAP 5: Future projected (or character) land use in the project area, which includes potential for parks/recreation, greenspace, neighborhood/community activities.



MAP 6: Historic homes within the project area.



MAP 7: Infrastructure, including critical infrastructure, within the project area.



MAP 8: Conceptual location for Alternative 7, which includes a levee and 6-barrel culvert at the confluence of the Withlacoochee River and Sugar Creek.