Wolf Bay Watershed Management Plan

Submitted to:

Mobile Bay National Estuary Program

Submitted by:

VOLKERT

ALLEN
ENGINEERING
AND SCIENCE

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Acknowledgments

The project team of Volkert, Inc. and Allen Engineering and Science would like to acknowledge the following individuals and organizations that have provided guidance, input, and resources during the preparation of this Plan:

Steering Committee Members

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Others

The City of Foley for providing the use of the Graham Creek Nature Preserve to hold Steering Committee and public involvement meetings.

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Cover photography by Tommy Patterson and Leslie Gahagan.

Executive Summary

In 2018 the Mobile Bay National Estuary Program (MBNEP) executed a contract with the team of Volkert, Inc. and Allen Engineering and Science to develop a comprehensive Watershed Management Plan (WMP) for the Wolf Bay Watershed (Watershed) in Baldwin County, Alabama. The Wolf Bay Watershed comprises three sub-watersheds, including the Sandy/Wolf Creek, Miflin Creek, and Graham Bayou watersheds. The entirety of the Wolf Bay Watershed encompasses approximately 36,296 acres (**Figure ES-1**).

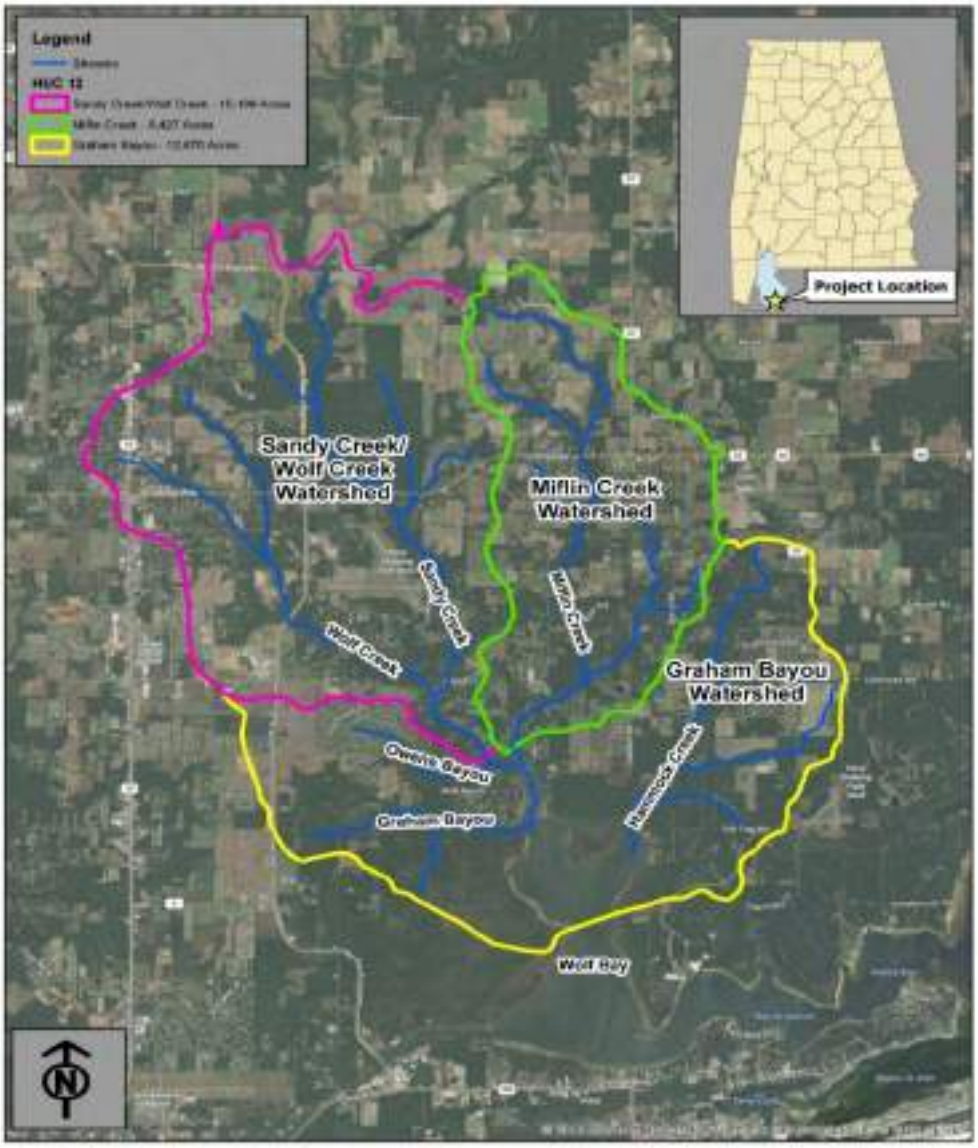

Figure ES.1 Wolf Bay Watershed Including Sub-watersheds

Plan Purpose and Vision

This WMP is meant to serve as a guide to resource managers, policy makers, stakeholder organizations, and citizens of the Watershed so that they might make informed decisions about potential actions that have a direct effect on the hydrological and biological integrity of the Watershed. With this purpose in mind, the WMP describes the current conditions of the Watershed, areas of concern within the Watershed, and potential management actions that could improve Watershed conditions and prevent future degradation. Because Wolf Bay is listed as an Outstanding Alabama Water (OAW), the vision of the WMP is to identify specific and achievable management measures to restore, protect, conserve, and preserve resources in the Watershed and maintain OAW status.

Public Participation

Public participation is a necessary part of the watershed management planning process. Not only was the community given the opportunity to voice concerns regarding known issues within the watershed, but they also had an opportunity to prioritize issues of concern and recommend potential strategies to address them.

One of the first steps in the Wolf Bay Watershed planning process was the formation of a 14-member Steering Committee which included residents, municipal representatives, community business leaders, recreational users, and other stakeholders. Throughout the process, the Steering Committee provided direction to the WMP Team on the priorities that needed to be addressed and provided insight about techniques and strategies that should be implemented. Three Steering Committee meetings were held during the planning process.

Other community outreach strategies employed by the WMP Team included attendance at several small community meetings and events as well as hosting one large community meeting to gather input. The Team developed an initial online survey to gather general perceptions of the Watershed and to gain input regarding known critical issues and areas, potential management measures, and recreational use. A second online survey was conducted to rank the critical issues and concerns that were previously identified.

Identification of Critical Issues

The WMP Team worked closely with the 14-member Wolf Bay WMP Steering Committee to determine goals and objectives for the Wolf Bay WMP. Their input, along with the input of numerous other stakeholders throughout the Watershed, was also solicited to identify issues and areas of concern that need to be addressed throughout this WMP. Through a series of meetings, surveys literature and field reviews, the following critical issues were identified to be addressed:

1. Maintenance and improvement of **water quality** throughout the Watershed was consistently ranked as the top priority. This includes identifying necessary steps to reduce inputs of nutrients from surrounding agricultural lands as well as residential areas through education of citizens and use of best management practices (BMPs). The identification of sources of pathogens entering the Watershed was also deemed a high priority. The targeting of sources contributing pathogens to surface waters and identification of steps needed to reduce or eliminate those inputs was deemed necessary. Another concern for stakeholders was litter, as it is unsightly in natural areas and degrades the quality of surface waters used for recreation. Litter reduction educational campaigns, as well as potential sites for litter traps were identified within the WMP. Invasive species pose a substantial risk to the overall ecological function of the Watershed and education regarding identification of invasive species and strategies for control of invasive aquatic and terrestrial plants and animals were a concern among Watershed stakeholders.
2. Baldwin County and particularly the area within the Wolf Bay Watershed are among the fastest growing areas in all of Alabama. Concerns that **future development** could have a detrimental impact on the streams and other surface waters of the Watershed were repeatedly expressed in surveys. Emphasis was placed on the amount of sediment entering the streams from erosion at construction sites not following proper BMP protocols. A review of standards and practices related to construction BMPs for each municipality within the Watershed as well as for Baldwin County was conducted to ensure proper regulations were in place to minimize sediment inputs from development activities. Another concern expressed related to future development was the increasing number of impervious surfaces created by development and the effects that increased runoff would have on the physical properties of riparian areas bordering streams and the stream channels themselves.
3. **Recreation** has always been a primary interest among the residents and stakeholders of the Wolf Bay Watershed. The Watershed contains beautiful streams and other natural areas that should be explored and utilized by people of all ages. However, due to a lack of boating access points throughout the Watershed, it has become difficult for people to explore this hidden treasure. Stakeholders feel that increased access to the Watershed will lead to an increased sense of ownership among users and will result in greater protection and management of the natural resources within it. Boat launches, blueway trails, and hiking trails were listed as improvements that could be made to increase recreational utilization.

Recommended Management Measures

The WMP Team, with input from the Steering Committee, developed a list of recommended Management Measures to address the Critical Issues identified through stakeholder input and field reconnaissance. Some of the recommend Management Measures include:

- Reduce the amount of sediments, nutrients, and pathogens entering streams and tributaries from agricultural lands through installation of agricultural BMPs
- Paving and/or installation of BMPs on dirt roads to prevent sediments from entering surface waters
- Developer and contractor education regarding construction BMPs that will provide long-term water quality benefits to the Watershed
- Identification of potential stream restoration projects targeting areas of unstable streambanks and sedimentation within stream channels
- Education of farmers and homeowners about timing of fertilization to prevent excess nutrient inputs to surface waters of the Watershed
- Establishment of an invasive species control program along road and transmission line rights of way as well as invasive species education for local landowners
- Reduction of litter entering waterways through signage and educational programs throughout the Watershed
- Protection of water quality and ecosystem function through strategic acquisition of conservation tracts
- Promotion of recreation throughout the Watershed leading to stakeholder "buy-in" for protection of water quality and natural resources

Implementation Strategies

Successful implementation of the previously discussed Management Measures will require a clear plan of action carried out by a collaborative group of stakeholders including members of the community and various government agencies. The prioritization of critical issues and areas, an estimation of associated costs pertaining to management strategies, and division into short and long-term goals are all necessary for success. The development of this WMP serves to build upon the existing interest in protection of the Wolf Bay Watershed and will hopefully carry momentum through the implementation of the recommended management strategies.

Successfully addressing the critical issues identified in this WMP begins with the Wolf Bay Watershed Watch (WBWW). Many of the issues facing the Watershed extend beyond political and jurisdictional

boundaries. The WBWW brings together stakeholders from different areas and backgrounds throughout the Watershed with a common goal of carrying out the implementation of the recommended management measures. The formation of the Steering Committee for this WMP brought together community leaders and stakeholders with a passion for improving the Watershed. Now is the time for Steering Committee members to carry their enthusiasm forward through the WBWW to ensure that the ideas and strategies identified in this WMP are carried out.

Management measures carried out in the short-term are designed to help build stakeholder confidence and build on momentum created through development of this WMP. These actions were chosen based on the likelihood of successful implementation within the next two years. Actions identified for the short-term include:

- Municipal and county staff as well as public training regarding Low Impact Development (LID)/Green Infrastructure (GI) practices and post-construction BMPs
- Construction BMP education for the public
- Public education on nutrients
- Municipal and county staff, local utilities, and public education and training in regard to invasive species
- Installation of signage at various locations in the Watershed to raise awareness among citizens about their individual and accumulated effects on the Watershed
- Stream-specific projects including engineering and design for the restoration and stabilization of the Wolf Creek headwaters
- Monthly monitoring for pathogens in Hammock, Sandy, and Miflin Creeks

Not all the critical issues identified within this WMP can be addressed within a two-year timeframe. Some projects will require additional analysis, planning, and data collection before implementation; therefore, classifying them as long-term management measures. For the Wolf Bay Watershed, these measures include:

- Comprehensive post-construction BMP inventory for the entire watershed
- Invasive species control plan for the entire watershed
- Implementation of agricultural buffers bordering riparian areas
- Installation of exclusion fencing and alternative water sources to keep livestock out of stream channels
- Rehabilitation of 8.6 miles of aging sanitary sewer mains within the City of Foley

- Construction of four aquifer storage recovery wells to connect reuse water from the Riviera Treatment facility to the wells for groundwater injection
- Septic tank inventory for Baldwin County
- Stream restoration and stabilization projects including engineering and design and construction at various stream reaches throughout the watershed
- Property acquisition for conservation and management along with development of public access
- Road paving of existing dirt roads
- Installation of litter traps

To ensure the long-term success of the management actions listed in this WMP, the WBWW should build on its current monitoring and reporting program. The group should develop criteria to judge success and submit an annual report documenting accomplishments and success stories and submit to MBNEP. The reports should include a summary of watershed conditions including monitoring and sampling results, an update on the status of management measures implemented to date, and a summary of anticipated management measures to be implemented in the coming year. More frequent reporting may be helpful in critical watershed areas where more frequent monitoring is needed to track success of specific management actions.

Chapter 1 Introduction

A watershed is a topographically defined area of land where the water within it flows to a common point such as a lake, stream, river, bay, or estuary. A properly functioning watershed provides quality waters, wildlife habitat, and protects homes and businesses from flooding. Everyone who lives in a watershed plays a role in protecting and sustaining the ecological features contained within it.

The Mobile Bay National Estuary Program (MBNEP) identified three goals in the Comprehensive Conservation Management Plan as part of its five-year strategy (2013–2018) for improving conditions within Mobile Bay: 1) improve trends in water quality in priority watersheds that discharge into priority fishery nursery areas; 2) improve ecosystem function and resilience through protection, restoration, and conservation of habitats, including beaches, bays, backwaters, and rivers; and 3) restore and/or expand human connections to Alabama's coastal resources. To achieve these goals, the MBNEP identified a need for comprehensive watershed planning within the Mobile Bay estuary. To assist the MBNEP in achieving this objective, the National Fish and Wildlife Foundation (NFWF) and the Gulf Coast Ecosystem Restoration Council (Council) provided funding to the MBNEP to develop a comprehensive management plan for the Wolf Bay Watershed.

For the purposes of this Plan, the boundaries of the Watershed are defined as the three northern Hydrologic Unit Code (HUC_12) sub-watersheds that include the Sandy/Wolf Creek Watershed (HUC_12 031401070201) with an area of 15,199 acres (23.75 square miles), Miflin Creek Watershed (HUC_12 031401070202) that contains 8,427 acres (13.17 square miles), and the Graham Bayou Watershed (HUC_12 031401070203) with an area of 12,670 acres (19.8 square miles).

1.1 Plan Overview

This WMP has been written in a concise manner to be understandable by all citizens within the Watershed, yet it provides enough technical detail to allow the WMP to be used to support financial grant applications. The WMP charts a conceptual course for improving and protecting the things that people value most about living in coastal Alabama, including:

- Water Quality
- Fisheries and Wildlife

- Environmental Health and Resilience
- Access
- Culture and Heritage
- Beaches and Shorelines

A particular focus in the WMP has been placed on strategies for conserving and restoring coastal habitats identified by MBNEP's Science Advisory Committee as most threatened by anthropogenic stressors. These habitat types include freshwater wetlands; streams, rivers, and riparian buffers; and intertidal marshes and flats. The WMP is divided into individual components and is organized into the following chapters:

Chapter 2: Literature Review provides a summary of pertinent scientific information about the Watershed which is useful in the development of the WMP.

Chapter 3: Community Engagement provides a summary of the public engagement program established to inform the public about the Watershed planning effort, communicate the importance of stakeholder involvement, identify stakeholder issues, and prioritize issues to be addressed.

Chapter 4: Watershed Characterization provides background information about the Watershed to characterize its geography, hydrology, wetlands, soils, biology, land use, demographics, and cultural history and heritage to provide an understanding of current conditions within the Watershed.

Chapter 5: Watershed Conditions includes an evaluation of existing conditions within the Watershed such as potential sources of pollutants, surface water flow, sediment transport, water quality, biological conditions, habitat conditions, and shoreline assessments.

Chapter 6: Climate Vulnerability Assessment provides an assessment of vulnerabilities associated with climate change and sea level rise within the Watershed.

Chapter 7: Identification of Critical Issues and Areas identifies the critical issues and areas within the Watershed to be addressed by the WMP based on public input, review of literature, results of field reconnaissance, and professional judgement.

Chapter 8: Management Measures provides recommended management measures for each critical issue challenging the Watershed, including suggestions for initial organization to coordinate WMP implementation, public education, engagement and involvement, and methods to measure success.

Chapter 9: Implementation Strategies provides ways to address the critical issues identified for the Watershed by implementing recommended management measures and identifies associated costs and effective organizational approaches. It provides temporal guidance to achieve success for management measures that can be implemented immediately versus those that will take more time.

Chapter 10: Regulatory Review presents regulatory drivers and constraints to effective implementation of the WMP, including regulatory inconsistencies and deficiencies that need to be addressed. It also identifies enforcement mechanisms.

Chapter 11: Financing Alternatives identifies potential sources of funding and examines innovative mechanisms and alternatives for leveraging funding sources.

Chapter 12: Monitoring explores methods to track the performance of implemented management measures, tools for measuring success, how to adaptively manage as implementation commences, and recommendations for reporting.

1.2 EPA Nine Key Elements

This WMP was developed to conform to the United States Environmental Protection Agency's (EPA's) nine elements of watershed planning. These elements can be summarized as the following:

- Build partnerships, including identification of key stakeholders and solicitation of community input and concerns (Element 1)
- Characterize the watershed, including creation of a natural and cultural resource inventory, identification of causes and sources of impairments, identification of data gaps and estimation of pollutant loads (Element 2)
- Set goals and identify solutions, including determination of pollutant reduction loads needed and management measures to achieve goals (Elements 2-3)

- Design an Implementation Program, including an implementation schedule, interim milestones, criteria to measure progress, monitoring components, information/education programs, and the identification of technical and financial assistance needed to implement the plan (Elements 4-9)

1.3 Coastal Nonpoint Control Program

Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) requires states and territories with approved Coastal Zone Management Programs to develop a Coastal Nonpoint Pollution Control Program. This program is jointly administered by the National Oceanic and Atmospheric Administration (NOAA) and the EPA and establishes a set of management measures for controlling nonpoint source pollution problems in coastal waters. Management measures are defined in Section 6217(g) as "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, and other alternatives". The five main sources of nonpoint source pollution identified in coastal areas include:

- Agriculture
- Forestry
- Urban Areas
- Marinas and Recreational Boating
- Hydromodification (Channelization and Channel Modification, Dams, and Streambank and Shoreline Erosion.

This WMP provides recommended management measures that conform to Section 6217(g) guidance for coastal nonpoint source pollution control in the watershed.

Chapter 2 Literature Review

A literature review was conducted by searching online for available documentation on the Watershed, obtaining copies of historical data files maintained by the WBWW, and reviewing the current pre-restoration analysis study funded by the MBNEP which is included as **Appendix A** to this document. Thirteen different literature sources specific to the Watershed were identified and are summarized in the sections below.

2.1 Overview of the Wolf Bay Watershed

Worldwide, more than 40% of the population lives within 60 miles of the coast. The continental U.S. coastal zone represents 17% of the nation's land area but contains greater than 50% of the population (Alabama Coastal Foundation, 2005). Alabama and other southeastern states of the south Atlantic-Gulf region are the fastest growing areas in the United States. As population, agricultural, and industrial centers have expanded along seacoasts, demands for freshwater resources have resulted in widespread water depletion and contamination in coastal regions. Inevitable water supply and quality problems arise from population growth, underscoring the need to protect water resources from degradation (Lee et al., 2007). The implications of this growth, both short-term and long-term, indicate that management of growth with regard to resource protection will be a challenge in the Watershed (Wolf Bay Plan, 2005).

Baldwin County is among the fastest growing areas in Alabama, with a 43% increase in population from 1990 to 2000. From 2010 to 2016, Baldwin County experienced a 14.4% population increase compared to a 1.7% growth rate for the rest of the State during the same period. Much of the growth is due to the City of Foley's population rise of 20.5% from 2010 to 2016 (Alabama Water Watch, 2007; US Census, 2016; Cook, 2017). This rapid expansion of urban/suburban development contributes both point source and nonpoint source pollutants to Wolf Bay and its tributaries. Pollutants include eroded soils from construction sites and stormwater-impacted stream banks, increased volumes of municipal wastewater discharge, lawn chemicals, and oil from parking lots, among others (Alabama Water Watch, 2007).

Stream channels in the northern parts of the Watershed, including the headwaters of Wolf, Sandy, and Miflin creeks, are characterized by relatively high elevation (maximum 100 ft. MSL), with topography that decreases in relief from north (upstream) to south (downstream) towards Wolf Bay (Cook, 2017). The southern reaches of these tributaries experience daily tidal fluctuations of up to two feet. Wolf Bay itself

flows into the Intracoastal Waterway, which flows into either Perdido or Mobile bay depending on winds and tides, and ultimately into the Gulf of Mexico (Alabama Water Watch, 2007).

Land use within the Watershed includes forests (23%), agriculture (27%), urban/suburban (27%), wetlands/water (16%) and other uses (7%) (Mobile Bay National Estuary Program, 2018). Since 1992, urban/suburban land use increased from 4% to 27%, while agricultural area has declined from 46% to 27%, and forestlands declined from 32% to 23% of the Watershed. Within the agriculture sector, there has been a significant shift from row crops to sod farms (Alabama Water Watch, 2007). Cook (2017) states that forests (including forested wetlands) are the most dominant land use/cover type in the Watershed. Agriculture is the second largest land use and dominates the headwaters and areas of higher elevations. Developed land is listed as covering roughly 16% of the Watershed.

The aquifer in the Wolf Bay Watershed is the Miocene/Pliocene Aquifer, comprising over 500 feet of inter-layered sands, gravels and clays. Baldwin County is unique in that the entire county serves as the recharge area of this aquifer (Wolf Bay Plan, 2005). However, the increase in urban/suburban land use and associated impermeable surfaces has reduced the amount of freshwater infiltration to the aquifer. This fact is especially pertinent in consideration that groundwater pumping for municipal, irrigation, and industrial use has increased six-fold since 1966. These increasing groundwater withdrawals along the coast of Baldwin County could lead to intrusion of seawater into freshwater-bearing aquifers (Lee et al., 2007).

Wolf Bay serves as a nursery ground for many types of commercially and recreationally important species of fish, crab, shrimp, and other organisms. Additionally, the U.S. Fish and Wildlife Service has documented several species listed as threatened or endangered, including Florida manatee (*Trichechus manatus latirostris*), Alabama red-bellied turtle (*Pseudemys alabamensis*), Gulf Sturgeon (*Acipenser oxyrinchus desotoi*), American bald eagle (*Haliaeetus leucocephalus*), wood stork (*Mycteria americana*), and the red cockaded woodpecker (*Picoides borealis*) (Mobile Bay National Estuary Program, 2018). Imperiled habitats within the Watershed include Gulf Coast pitcher plant bogs, Atlantic white cedar swamps, and long leaf pine savannahs (Wolf Bay Plan, 2005).

WBWW began the process of obtaining an "Outstanding Alabama Water" (OAW) classification for Wolf Bay in 2001. In April 2007, the Bay was designated an OAW by ADEM, the highest of seven levels of waterbody use classifications. Wolf Bay was one of five waterbodies statewide and the first bay in Alabama to attain OAW classification. Under OAW classification, the Wolf Bay is protected by higher water quality standards, including more stringent restrictions on wastewater and toxic substance discharge in the Bay, a

higher minimum dissolved oxygen level, and lower acceptable year-round pathogen concentration (Alabama Water Watch, 2007). The classification extends from the Intracoastal Waterway to Moccasin Bayou (Mobile Bay National Estuary Program, 2018). The waterbody is also classified for swimming, fish and wildlife, and shellfish harvesting (Hydro Engineering Solutions, 2013).

Baldwin County has a mild but humid climate with average annual rainfall of around 61 inches (Hydro Engineering Solutions, 2013). In the contiguous United States, this region is second only to the Pacific Northwest in total annual rainfall, and the frequency of thunderstorms over coastal Alabama is exceeded only by the Florida peninsula (Wolf Bay Plan, 2005). The summer months are typically the wettest with driest months typically during the winter. Annual rainfall is generally well distributed although significant rain events can be experienced due to proximity to the coast and exposure to hurricanes and tropical storms. The warmest month is July with the coldest month being January (Hydro Engineering Solutions, 2013).

2.2 Discharge

In 2013, Hydro Engineering Solutions conducted a watershed study on Wolf Bay for the Baldwin County Commission and Highway Department. The purpose of the study was to gain an understanding of the Watershed and determine its sensitivity to land use changes in areas expecting future growth. The study projected that the main area of future development would occur along the Foley Beach Express. The Wolf Creek and Sandy Creek basins were the two sub-watersheds projected to experience the most impact from this development. Results indicate additional development around the municipalities of Foley and Elberta will increase peak discharges downstream if they are not detained and that development of each area will cause a negative impact to the downstream reaches of Wolf and Sandy Creeks. Without detention, peak discharges will occur earlier and increase discharge in local Bay tributaries. The existing regional ponds are not sufficient to handle discharge increases at the outlet of Wolf Bay and local detention needs to be employed in the upper portions of the Watershed. Protections from in-stream erosion can be accomplished by using local detention on smaller, more frequent rain events which will protect against stream degradation that could occur with increased runoff. The study used a drainage area of 56.06 square miles and determined that the 100-year peak discharge was 10,620 cubic feet per second (cfs). A follow-up to the study was published in 2020 and determined that the 2013 model produced discharges in line with updated regression equations and is still an applicable tool for analyzing stormwater impacts based on future developments (Hydro Engineering Solutions, 2020). A copy of the 2020 report by Hydro Engineering Solutions is included with this document as **Appendix B**.

Wang et al. (2014) predicted a slight increase in precipitation with high flows expected to increase and low flows expect to decrease. Monthly average streamflow and surface runoff were projected to increase in spring and summer but especially in fall. Land use/land cover change does not have a significant effect on monthly average streamflow, but would affect partitioning of streamflow, causing higher surface runoff and lower baseflow.

2.3 Sediment

When rainfall totals are high, the combination of flood runoff, erosion, and the destruction of trees and buildings along the shoreline results in the transport of large amounts of sediment and debris into parts of the Wolf Bay Watershed and into Wolf Bay itself (Wolf Bay Plan, 2005). In 2005, Alabama Soil and Water Conservation Committee reported that urban land use in the Watershed consisted of 14,000 acres, or 22% of the total land use. However, 63% of measured sedimentation in the Watershed (240,000 tons) originated from developing urban land. In comparison, forest land, which comprises 53% of the Watershed, contributes under 3% of total sedimentation, while agriculture uses 10% of the land and contributes less than 1% of total sedimentation (Lee et al., 2007).

Cook (2017) established 14 monitoring sites on 10 streams throughout the Wolf Bay Watershed (**Figure 2.1** and **Table 2.1**). Water samples were collected and analyzed for total suspended sediments (TSS) and showed that TSS loads were highest at Sandy Creek at U.S. Highway 98 (929 tons/year) and Wolf Creek at Swift Church Road (861 tons/year). For comparison, the next highest load was only 460 tons/year. It was also noted that, although the Wolf Creek sampling site on Swift Church Road is downstream from the Wolf Creek site on Doc McDuffie Road, the suspended sediment load is 8.7 times larger at the Doc McDuffie Road location. This is due to the proximity of the downstream sampling point to the reach of Wolf Creek with tidal influence (**Figure 2.2**). When sediment loads were normalized to negate the influence of drainage area size and stream discharge, the east and west unnamed tributaries to Sandy Creek had the largest suspended sediment loads in the Wolf Bay Watershed (**Figure 2.3**).

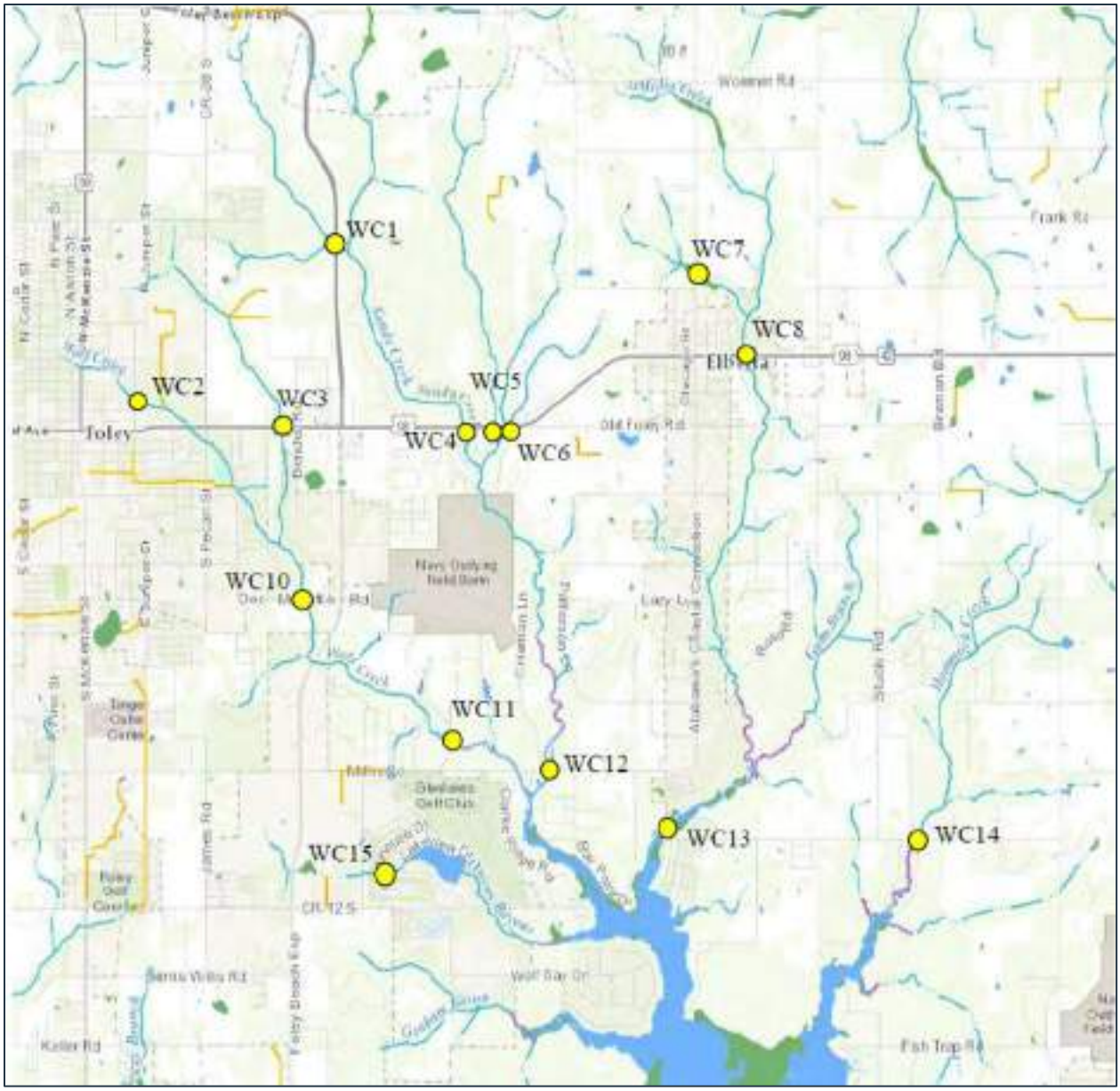

Figure 2.1 Cook (2017) Monitoring Sites for Streams in the Wolf Bay Watershed

Table 2.1 Corresponding Site Codes and Locations for Cook (2017) Monitoring Sites

Site Code	Location Description	Latitude	Longitude
WC1	Sandy Creek at Foley Beach Expressway	30.42614	-87.64850
WC2	Wolf Creek at North Poplar Street	30.40967	-87.67639
WC3	Unnamed tributary to Wolf Creek at US Highway 98	30.40690	-87.65579
WC4	Sandy Creek at US Highway 98	30.40684	-87.63024
WC5	Unnamed tributary at US Highway 98 1,200 feet from confluence with Sandy Creek	30.40667	-87.62627
WC6	Unnamed tributary to Sandy Creek at US Highway 98	30.40671	-87.62481
WC7	Elberta Creek at Baldwin County Road 83	30.42262	-87.59837
WC8	Miflin Creek at US Highway 98	30.41433	-87.59159
WC10	Wolf Creek at Doc McDuffie Road	30.38979	-87.65302
WC11	Wolf Creek at Swift Church Road	30.37350	-87.63262
WC12	Sandy Creek at Baldwin County Road 20	30.37041	-87.61852
WC13	Miflin Creek at Baldwin County Road 20	30.36395	-87.60249
WC14	Hammock Creek at Baldwin County Road 20	30.36303	-87.56769
WC15	Owens Bayou at Lakeview Drive	30.35980	-87.63927

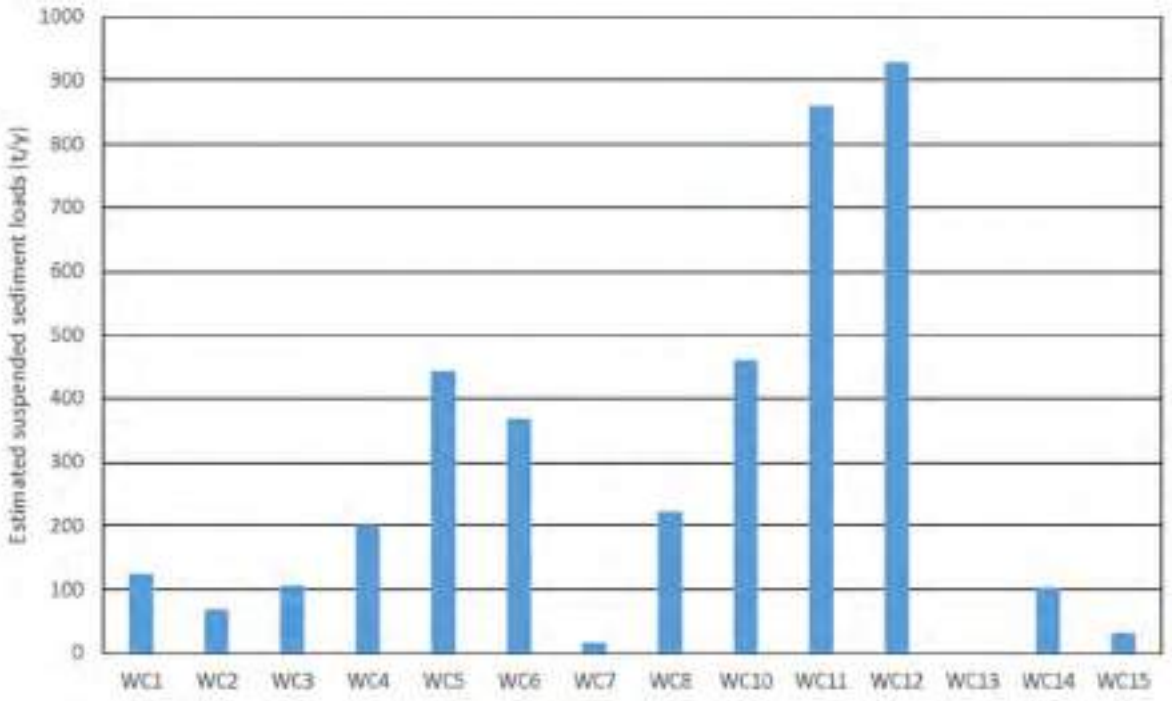

Figure 2.2 Estimated Annual Suspended Sediment Loads for Wolf Bay Watershed Monitored Sites (Source: Cook, 2017)

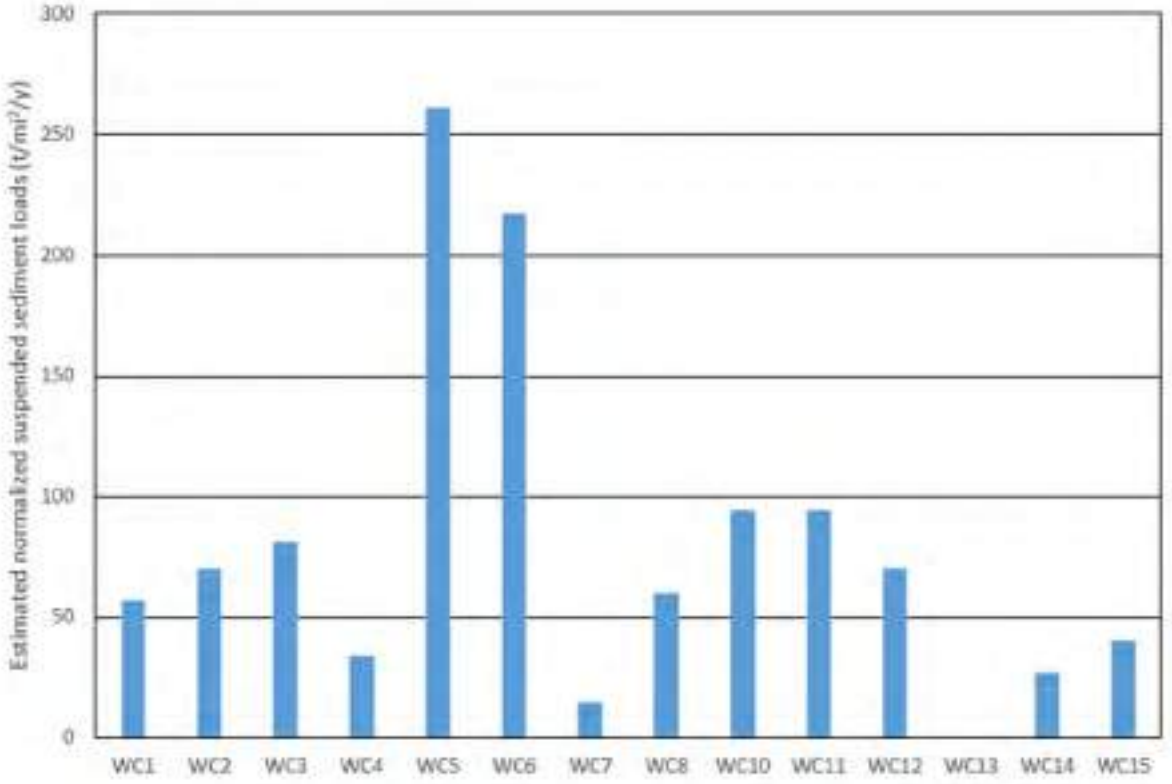

Figure 2.3 Estimated Normalized Suspended Sediment Loads for Wolf Bay Watershed Monitored Sites (Source: Cook, 2017)

Bed sediment loads are composed of particles that are too large or dense to be carried in suspension by stream flow. The sample site on Wolf Creek at Doc McDuffie Road showed bed sediment loads (10,471 tons/year) that were six times larger than the next largest load. Even after normalization relative to drainage area, Wolf Creek at McDuffie Road had more than twice the load of the next largest site sampled. These results are due to excessive upstream erosion, which contributes a disproportionately large amount of bed sediment (Cook, 2017).

For total sediment loads, data normalized to negate the influence of drainage area size and stream discharge showed that Wolf Creek at Doc McDuffie Road exhibited the highest levels of total sediment load. The west and east unnamed tributaries of Sandy Creek had the next highest amounts but were still half that of the Wolf Creek at Doc McDuffie Road site. On average, bed sediment makes up 72% of the total sediment loads for streams with measurable suspended and bed sediment. Without human impact, watershed erosion rates, called the geologic erosion rate, would be 64 t/mi^2/yr (Maidment, 1993). Normalized sediment loads show that 9 of 13 monitored watersheds were from 1.1 to 34.9 times greater than the geologic erosion rate (**Figure 2.4**) (Cook, 2017).

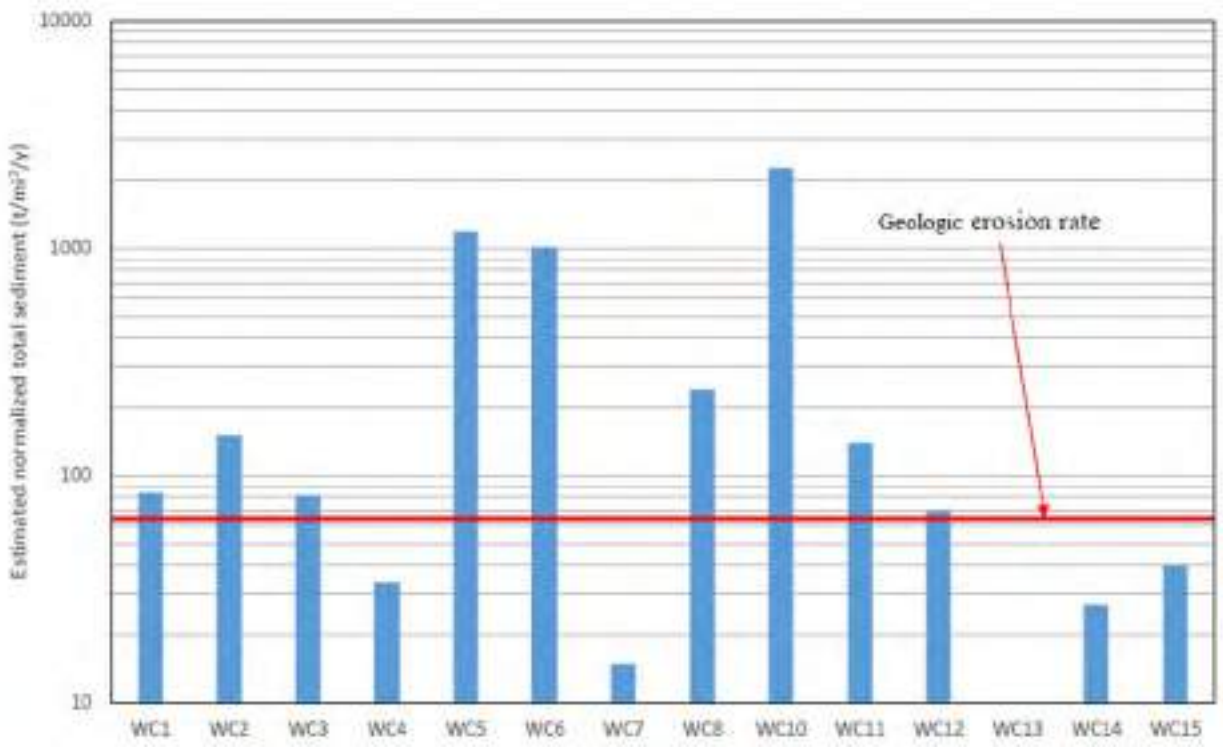

Figure 2.4 Estimated Normalized Total Sediment Loads for Wolf Bay Watershed Monitored Sites (Source: Cook, 2017)

2.4 Turbidity

Sampling conducted from 2004-2007 showed an increasing trend in turbidity in Wolf Bay. It was suggested that the upward trend was likely from a combination of eroded soils washing off the Watershed into the Bay along with increased levels of nutrients which stimulated the growth of algae (Alabama Water Watch, 2007).

Cook (2017) found that sampled turbidity values were highest at the unnamed tributary at US Highway 98, Wolf Creek at Swift Church Road, and another sampling site on the unnamed tributary at US Highway 98 which exhibited NTUs of 110, 77 and 75, respectively. Although land-use data indicates that watersheds with dominant urban development and/or agriculture are more likely to exhibit higher turbidity concentrations in streams, that was not necessarily the finding in this case. The Wolf Creek sampling point off Poplar Street in Foley had the highest percentage of residential development (84.8%) but showed average turbidity in the lower 40 NTU range. Average turbidity for all Wolf Bay Watershed sites exceeded the ADEM standard of 9.7 NTU by three to 24 times (**Figure 2.5**) (Cook, 2017).

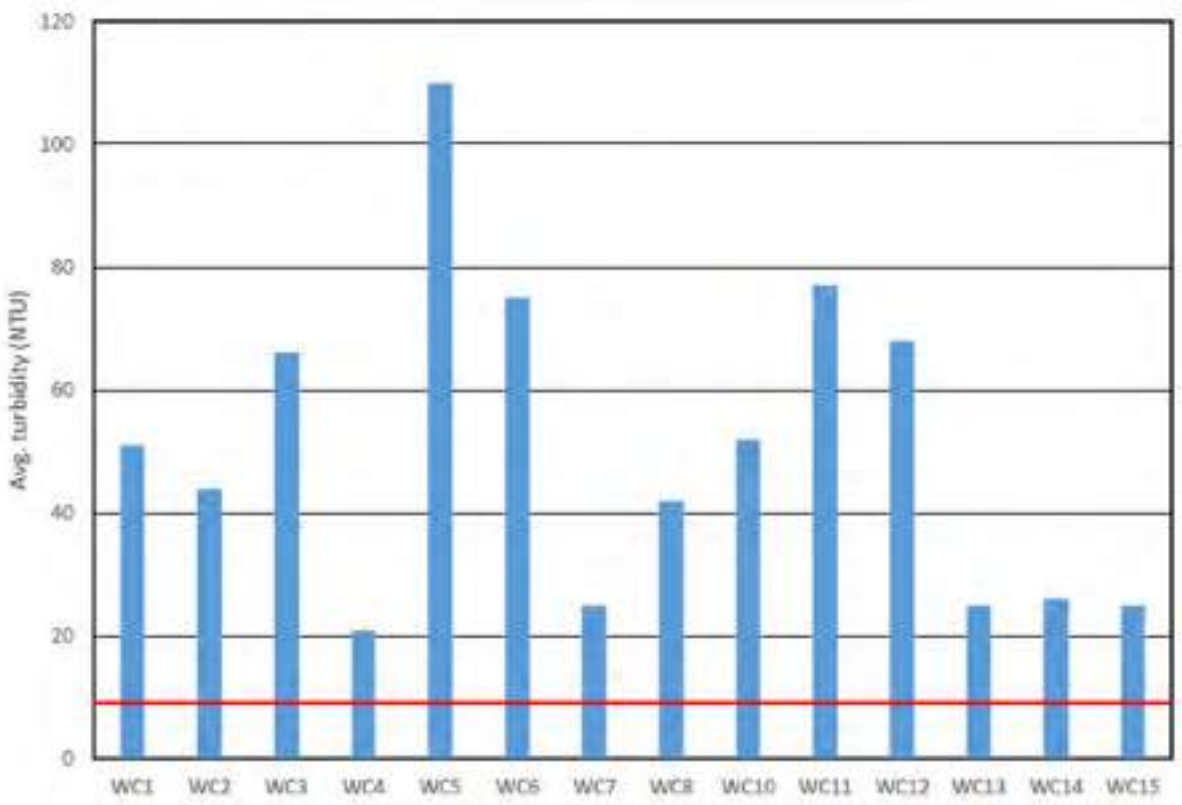

Figure 2.5 Average Turbidity for Wolf Bay Watershed Monitored Sites with ADEM Reference Value (Source: Cook, 2017)

Residents have reported that following rain events, Sandy Creek turns a milky color. While the exact cause is unknown, it is believed that the increase in development has led to an increase in the erosion rate which has uncovered a white clay layer within the stream banks. Another common complaint is related to the turbidity of Wolf Creek. Much of the land under construction in the City of Foley drains into Wolf Creek, providing a potential cause. The City recently passed an ordinance requiring low impact development to reduce runoff into streams. This, coupled with the required water quality component of treating the first inch of rainfall prior to discharge, should result in better water quality (Wolf Bay Watershed Watch, 2017).

2.5 Water Chemistry

2.5.1 pH

Monitoring by the WBWW showed an increase in alkalinity and pH from 1998-2000. Scientists believe this trend can be attributed to the drought cycle occurring at that time (Alabama Coastal Foundation, 2005). Since the drought subsided, 10 years of data show a trend that the water in Wolf Bay is becoming more acidic (Singleton, 2016).

2.5.2 Nutrients

Excessive nutrient enrichment can cause blooms of algae and associated bacteria that can cause taste and odor problems in drinking water and decrease oxygen concentration to eutrophic levels. Certain toxins can also be produced during blooms of particular algal species (Cook, 2017). In 2012, ADEM collected water quality samples from designated sampling points in Miflin Creek, Sandy Creek, Wolf Creek, and Wolf Bay during the growing season of March-October. Mean total nitrogen values at the Wolf Creek station were the lowest for those sites since 2005 but were still the highest among all stations sampled (ADEM, 2014). Cook (2017) found the highest total nitrogen concentrations in sampling locations in Miflin and Sandy creeks. Both of these watersheds are dominated by row crop and turf agricultural land use. The ADEM reference concentration for total nitrogen was exceeded in 83% of samples collected (**Figure 2.6**).

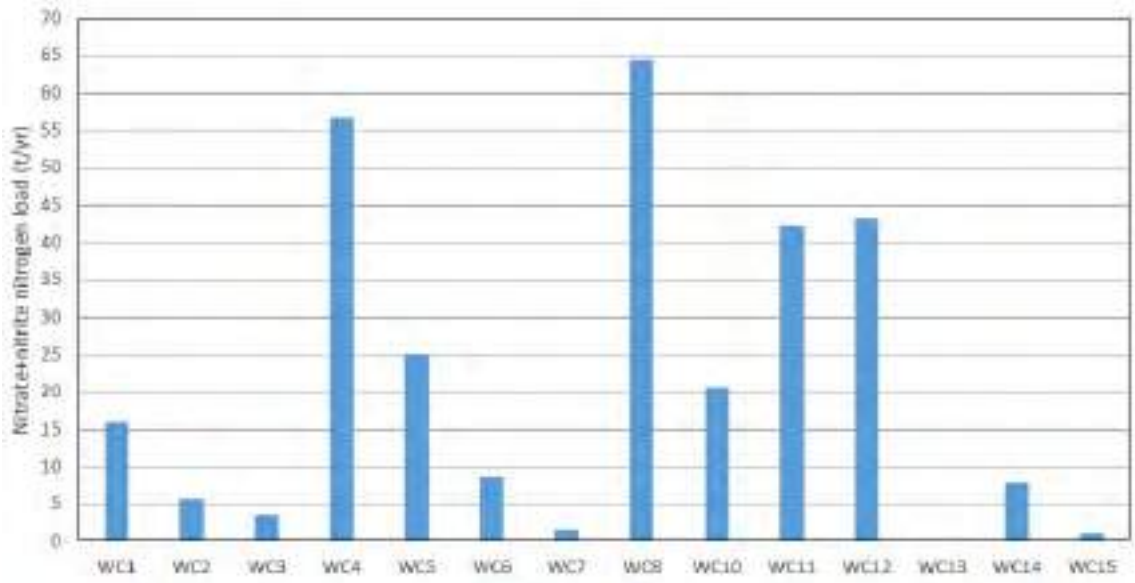

Figure 2.6 Estimated Nitrate+Nitrite Nitrogen Loads for Wolf Bay Watershed Monitored Streams (Source: Cook, 2017)

ADEM (2014) found that total phosphorous values at the Wolf Creek site increased from 2005-2008 but were lower from 2009-2012. Total phosphorous values were still highest for the Wolf Creek site compared to other sites in the 2012 sampling. Cook (2017) found that two of the Wolf Creek monitoring sites exhibited the highest levels of phosphorous among 14 sample sites throughout the Watershed. It was also noted that 10 of the 14 sites had average phosphorous concentrations above the 0.04 mg/L reference established by ADEM (**Figure 2.7**) (Cook, 2017).

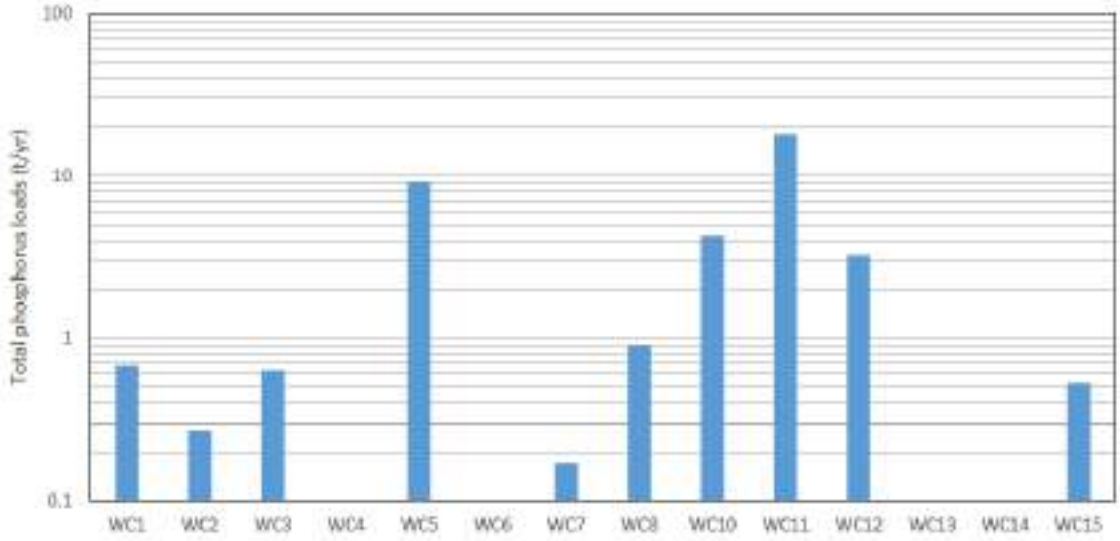

Figure 2.7 Estimated Total Phosphorous Loads for Wolf Bay Watershed Monitored Streams (Source: Cook, 2017)

Relatively high average concentrations and loadings of nitrogen and phosphorus in most of the monitored Wolf Bay Watershed streams originate from sources related to urban, residential, and agricultural land use that dominate specific parts of the Watershed (Cook, 2017).

2.5.3 Dissolved Oxygen

Biological processes contribute to depletion of dissolved oxygen (DO) in surface water. DO concentrations in the Wolf Bay Watershed are significantly affected by water temperature, stream discharge, and concentrations of organic material in the water. The ADEM reference standard for dissolved oxygen is 5.0 mg/L in although the Wolf Bay Watershed is held to a higher standard of 6.94 mg/L, due to its OWA status (Cook, 2017).

In the summer of 2000, citizen data documented a sharp decline in DO in Wolf Creek that was likely due to low flows and stagnancy caused by drought. Data also indicated that DO levels increased to around 6-9 ppm later in the year, when water temperatures decreased and flow increased (Alabama Water Watch, 2002). Growing season averages in 2005 and 2006 indicated poor water quality with dissolved oxygen concentrations of 2.2 ppm in Wolf Creek headwaters in the City of Foley, but they recovered to 7.7 ppm downstream where the Creek empties into Wolf Bay. The low oxygen levels were believed to be the result of contributions of spring water (which are low in oxygen) and discharge from wastewater treatment plants, which depletes DO as organic matter decomposes (AWW, 2007). In 2010, the headwaters of Wolf Creek continued to consistently display extremely low oxygen. To address the issue, the City of Foley partnered with the Mobile Bay National Estuary Program (MBNEP) to perform a natural stream restoration in 2010. Since then, the stream has returned to normal ranges for oxygen (Wolf Bay Watershed Watch, 2017).

Sampling in 2012 showed DO concentrations in Miflin Creek were below the ADEM criteria limit of 5 mg/L for waters designated for “Fish and Wildlife” use in June, August and October. DO concentrations in Wolf Bay were below the criteria in June and July. Sandy Creek was below the criteria for all months sampled. All samples in Wolf Creek were above the ADEM criteria (ADEM, 2014).

Cook (2017) measured DO at 14 monitoring sites throughout the Wolf Bay Watershed from December 2016 through August 2017. During that time, the sampling site at Elberta Creek at Baldwin County Road 83 had the lowest average DO at 6.3 mg/L. Conversely, the sampling point on the unnamed tributary to

Sandy Creek at US Highway 90 had the highest average DO at 8.6 mg/L. Twelve of the 14 sites had measured DO values less than the ADEM reference standard for OAWs of 6.94 mg/L (**Table 2.2**).

Table 2.2 Dissolved Oxygen Measured in Monitored Streams in the Wolf Bay Watershed (Source: Cook, 2017)

Site	Dissolved Oxygen (mg/L)			Average DO saturation (% atmospheric saturation)
	Maximum	Minimum	Average	
WC1	9.5	6.1	7.8	89
WC2	8.5	4.9	7.5	88
WC3	8.4	3.8	6.6	76
WC4	9.6	6.6	8.2	94
WC5	9.6	7.9	8.6	97
WC6	9.3	7.0	7.9	89
WC7	7.9	4.5	6.3	71
WC8	8.2	5.5	6.9	77
WC10	8.4	5.2	6.9	77
WC11	9.1	5.4	7.6	85
WC12	8.3	4.5	6.9	77
WC13	9.1	4.8	7.2	81
WC14	8.3	4.2	6.6	74
WC15	N/A[1]	N/A	N/A	N/A

[1] Insufficient number of samples collected.

2.5.4 Pathogens

Five sampling events conducted by the WBWW from 1999-2002 showed that Wolf Creek had unsafe levels of *E. coli* (above 600 colonies/100 mL of water). Levels returned to "safe for frequent human contact" (less than 200 colonies/100 mL of water) after April of 2003 (Alabama Watershed Watch, 2007). Riviera Utilities is working on permitting a major upgrade to their wastewater treatment plant located on Wolf Creek. This upgrade should reduce occurrences of overflows from the plant. Other efforts to reduce pathogens in the Watershed include landowners on North Hammock Creek excluding cows from accessing the stream by installing exclusion fencing and a septic tank workshop was held to provide homes a free pump out voucher to prevent future septic tank failures (Wolf Bay Watershed Watch, 2017).

Cook (2017) collected samples during a low discharge event on August 3, 2017, since during low flow events, impacts of runoff are minimized and bacteria concentrations in streams are more likely to represent point sources, including municipal and industrial wastewater discharge and sewer line leaks. Wolf Creek at Swift Church Road and Wolf Creek at Doc McDuffie Road had the highest most probable number of *E. coli* colonies (mpn) for the low discharge event. The numbers recorded are relatively low for surface water

and most likely do not represent any particular pathogen point source. It was noted, however, that when correlated to watershed area, the sampling site at Elberta Creek at Baldwin County Road 83 exhibited relatively high bacteria counts and may represent a source of pathogens above background levels.

2.5.5 Conductance

Generally, specific conductance (SC) was relatively low due to no significant contaminant sources in the Watershed, and most SC measurements were made immediately after precipitation events. Fluctuations of SC in streams with tidal influence correspond to tidal cycles, with relatively high SC at high tide due to salinity and relatively low SC at low tide or at times of large rainfall volumes. Median measured SC for all Watershed sites exceeded the ADEM standard of 20.4 mS/cm (Cook, 2017).

2.6 Conclusion

Cook (2017) concluded that when all parameters are considered with respect to water quality and potential remediation and restoration, watersheds upstream from Wolf Creek sites at Doc McDuffie Road and Swift Church Road and the unnamed tributaries to Sandy Creek from sites along US Highway 98 have the highest degree of impairment and should be considered primary targets for remediation and restoration.

Future research efforts by Dr. Chris Anderson (Auburn University) and others will provide data on the effects of management actions undertaken as a result of this WMP. Continued research is vital to determine which management actions are having a positive impact and which actions need to be modified to achieve the desired outcome or improvement.

Chapter 3 Community Engagement

3.1 Public Participation

Input from and participation of residents, municipal representatives, community business leaders, recreational users, and other stakeholders is a vital component in the development of a comprehensive WMP. People from various backgrounds bring different perspectives to the WMP planning and development process, which leads to a better, more robust plan. Participation by stakeholders leads to a feeling of ownership of the plan for managing the Watershed, resulting in a willingness to participate in actions and initiatives that protect the resources found within it. Public participation is invaluable to the WMP Team because it provides a local perspective on issues facing the Watershed that might not have been known otherwise. Similarly, community participation also provides critical insight about which management measures and implementation strategies should be prioritized and would have the best chance of success. The Wolf Bay Watershed Team made every effort to include the Watershed communities and other stakeholders in every phase of the planning and development process along the way.

3.1.1 Steering Committee Membership

The first step in our community engagement strategy was the formation of a Steering Committee representing the varied interests across the Watershed. A diverse and passionate committee of local, state, and federal representatives was engaged to form the Wolf Bay Steering Committee. **Table 3.1** includes the members and their affiliations.

Table 3.1 Wolf Bay Steering Committee Members and Affiliated Organizations

Name	Affiliation	Email Address
Ralph Hellmich	City of Foley	RHellmich@ogb.state.al.us
Phillip Hinesley	Sea Grant/Tourism	PHinesley@gulfshores.com
Tony Schachle	Riviera Utilities	tschachle@rivierautilities.com
Christian Miller	Mobile Bay National Estuary Program	cmiller@mobilebaynep.com
Leslie Gahagan	City of Foley and Wolf Bay Watershed Watch	lgahagan@cityoffoley.org
Jackie McGonigal	Wolf Bay Watershed Watch	jackie@gulfcenter.org
Shannon McGlynn	Alabama Department of Environmental Management	smcglynn@adem.alabama.gov

Name	Affiliation	Email Address
Casey Fulford	Baldwin County Soil and Water Conservation District	casey@alconservationdistricts.org
Patric Harper	U.S. Fish and Wildlife Service	Patric_Harper@fws.gov
Homer Singleton	Wolf Bay Watershed Watch	1fishawk@gmail.com
Paul Hopper	Town of Elberta	phopper@townofelberta.com
Caryn Woerner	Town of Elberta	cwoerner@townofelberta.com
Leah Tucker	Elberta High School	lktucker@bcbe.org
Will Underwood	Alabama Department of Conservation and Natural Resources	will.underwood@dcnr.alabama.gov

3.1.2 Steering Committee Meetings

The 14-member Steering Committee was the driving force behind the direction and focus of Wolf Bay WMP development. Throughout the process, the Steering Committee provided direction to the WMP Team on the priorities that needed to be addressed and provided insight about techniques and strategies that should be implemented. Three Steering Committee meetings were held during the planning process:

Steering Committee Meeting #1: The first Steering Committee meeting was held on June 18, 2018 at Graham Creek Nature Preserve. Agenda items for the meeting included:

- Introducing committee members to the project.
- Providing a project overview.
- Obtaining input on community engagement and outreach.
- Discussing known critical issues and concerns.

Steering Committee Meeting #2: The second Steering Committee meeting was held September 17, 2019 at Graham Creek Nature Preserve. Meeting highlights included:

- Review of plan progress to date including stakeholder engagement.
- Discussion on the findings of the Climate Vulnerability Analysis.
- Reporting on observations noted during field assessments.

Steering Committee Meeting #3: The third Steering Committee meeting was held on February 11, 2020 at Graham Creek Nature Preserve. Committee members were asked to provide input on:

- Prioritization of critical issues and concerns identified through stakeholder engagement, literature reviews, and field assessment.
- Potential management measures and projects to address critical issues and concerns.

See **Appendix C, Section I** for minutes from the Steering Committee meetings.

3.2 Community Engagement and Outreach

3.2.1 Stakeholder Involvement Meetings

Building on suggestions from the Steering Committee, the WMP team attended several small community meetings and events and hosted one large meeting to inform the community about the project and gather input. Small group meetings and community events attended are listed in **Table 3.2**.

Table 3.2 Small Group and Community Events Attended to Gather Input for the Wolf Bay WMP

Event	Location	Date
Voting/Polling Location	Graham Creek Nature Preserve	July 7, 2018
City of Foley Planning Commission Work Session	Foley City Hall	August 8,2018
PLAN Meeting	Graham Creek Nature Preserve	August 9, 2018
Town of Elberta Council Workshop Meeting	Elberta Town Hall	August 14, 2018
Wolf Bay Watershed Watch Annual Meeting	Graham Creek Nature Preserve	February 2, 2019
Wolf Bay Watershed Watch Annual Fishing Tournament	Graham Creek Nature Preserve	November 2, 2019
Wolf Bay Watershed Watch Annual Meeting	Graham Creek Nature Preserve	January 25, 2020

One large community meeting was held on October 2, 2018, at the Graham Creek Nature Preserve (**Figure 3.1**). Participants were asked to identify planning priorities within the Watershed. Priorities identified were:

- Conservation/restoration

- Water quality
- Stormwater management
- Sustainable development planning
- Flooding/wastewater overflows
- Retrofitting for green infrastructure
- Ecotourism and recreation
- Education
- Access to the Watershed
- Groundwater protection/recharge
- Sea level rise/climate change

Figure 3.1 Community Outreach Meeting held at Graham Creek Nature Preserve

Participants were then asked to vote for their top four priorities. The top priority to address in the WMP was to identify conservation/restoration opportunities; the second and third priorities were to improve water quality and stormwater management, respectively; and the fourth priority was to implement sustainable development planning concepts. Attendees were also asked to place stars on maps placed on tables around

the room to identify potential critical issues or areas. Although pertinent information was gained from the meeting, a second meeting was not scheduled, due to the low attendance.

3.2.2 Community Outreach Tools

The WMP Team prepared and submitted an article that was included in the City of Foley Summer 2018 Newsletter that described the planning process and encouraged participation in the planning effort. The Team also developed a watershed fact sheet along with an online survey to be used during early community engagements. The survey was created to gather general perceptions of the Watershed and to gain input regarding known critical issues and areas, potential management measures, and recreational use in the Watershed. A link to the survey was emailed to numerous stakeholders and provided in hard copy form during community engagements. Over 100 survey responses were received. A summary of the findings is provided below.

- The majority of the respondents live in the Watershed.
- Approximately half of the respondents have lived in the Watershed for more than ten years.
- 59% of the respondents believe the Watershed is in good overall condition.
- 69% of the respondents believe the recreational opportunities need improvement.
- Most desired areas for recreational improvement include boat, canoe, and kayak launches; hiking/biking trails; parking; camping areas; and signage.
- 78% of the respondents use the Watershed for recreational fishing and would use a public access point if provided.
- The prioritized desired management actions were as follows: 1. Land Preservation, 2. Regional Detention, 3. Stream Restoration, 4. Living Shorelines, 5. Stream Buffers, 6. Litter Traps, 7. Nutrient Reduction, 8. Invasive Species Control, and 9. Public Access Improvements.
- 47% of respondents would support a permit or user fee, and 42% would support municipal bonds.
- 87% of respondents would attend a watershed educational workshop.

A link to a second online survey was distributed in January 2020 to rank the critical issues and concerns identified in the Watershed. The survey was also distributed to the Steering Committee and the email distribution list for the WBWW. According to the 20 respondents of the second survey, the issues facing the Watershed were ranked as follows:

1. Water Quality
2. Future Development
3. Litter
4. Invasive Species
5. Stream Navigability
6. Public Recreation

A Wolf Bay Watershed fact sheet along with survey questions and results can be found in **Appendix C, Section II**.

3.3 Conclusions for Community Engagement

Most stakeholders believe the Watershed is in good shape, overall. The majority of people who utilize the surface waters of the Watershed do so for recreational purposes. The primary concerns expressed by the Steering Committee and other stakeholders include maintaining a high level of water quality in the face of continued development throughout the Watershed. Stakeholders also felt strongly about improving access to the Watershed for recreation. The majority of stakeholders would support increasing public access and expanding recreational opportunities; would volunteer to monitor or serve on a watershed group; and would participate in educational workshops. In summary, the Wolf Bay Watershed is believed to be a treasured resource and stakeholders showed a strong desire for the WMP to focus on preserving the Watershed conditions and character.

Chapter 4 Watershed Characterization

Characterizing the Watershed is an important step in the watershed planning process. It provides information on the current conditions of the Watershed and provides a baseline to gauge the needs for corrective actions to address critical issues.

4.1 Watershed Boundary

The Wolf Bay Watershed is located in south-central Baldwin County, Alabama, between Perdido Bay to the east and Bon Secour Bay to the west. The focus of this WMP is a complex comprising the three northern 12-digit HUC sub-watersheds draining to Wolf Bay: the 15,199-acre (23.75 square mile) Sandy/Wolf Creek Watershed (HUC_12 031401070201, the 8,427-acre (13.17 square mile) Miflin Creek Watershed (HUC_12 031401070202), and the 12,670-acres (19.8 square mile) Graham Bayou Watershed (HUC_12 031401070203) (**Figure 4.1**).

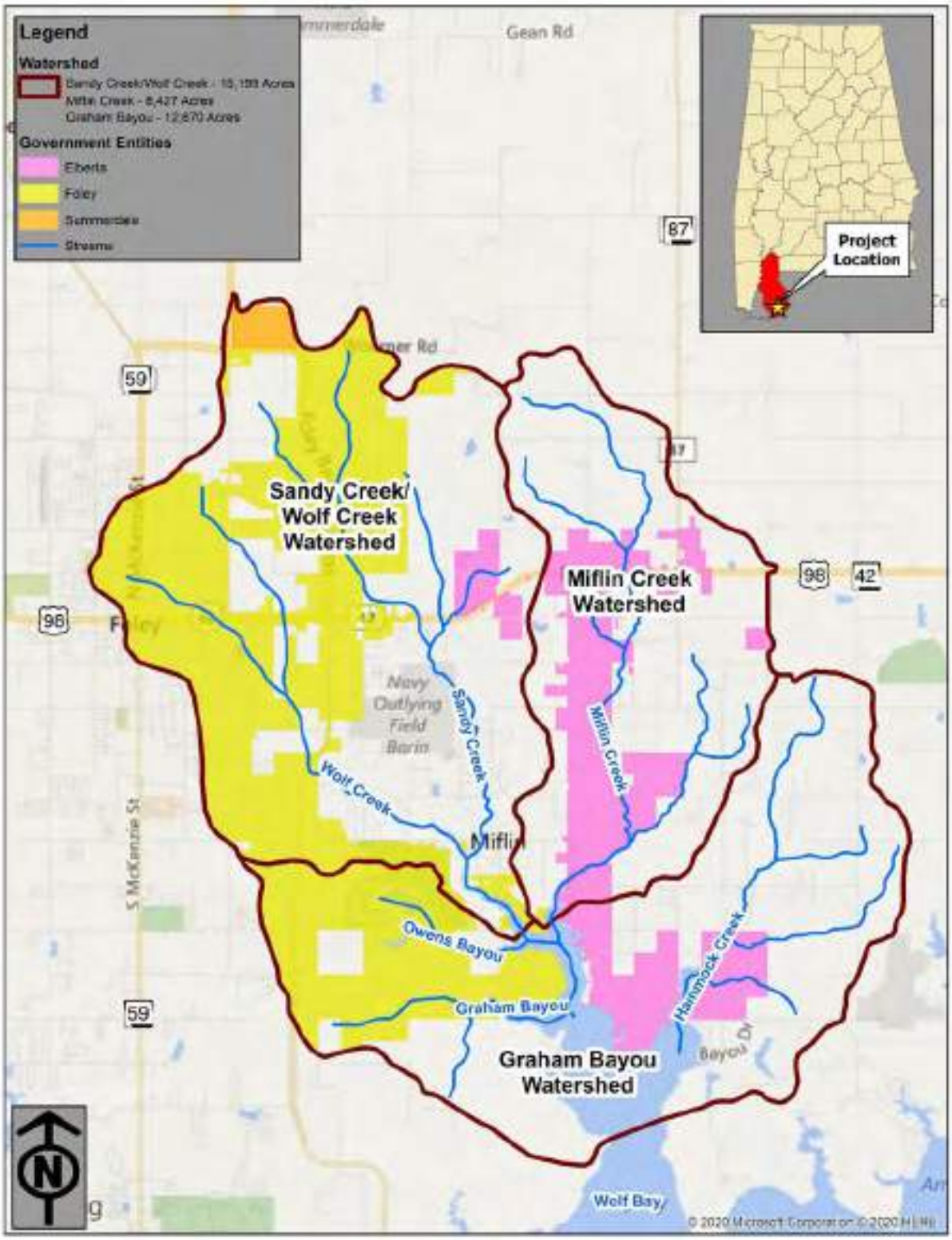

Figure 4.1 Boundary of the Wolf Bay Watershed Including Sub-Watersheds and Government Entities

4.2 Physical Setting

4.2.1 Physiography

The Watershed encompasses portions of the Southern Pine Hills and Coastal Lowlands physiographic provinces (**Figure 4.2**). The Southern Pine Hills physiographic province consists of mostly upland areas, while the Coastal Lowlands province is primarily flat with some very gently undulating areas. The boundary of the Coastal Lowlands and the Southern Pine Hills is defined by the Pamlico marine scarp (Jones 2004).

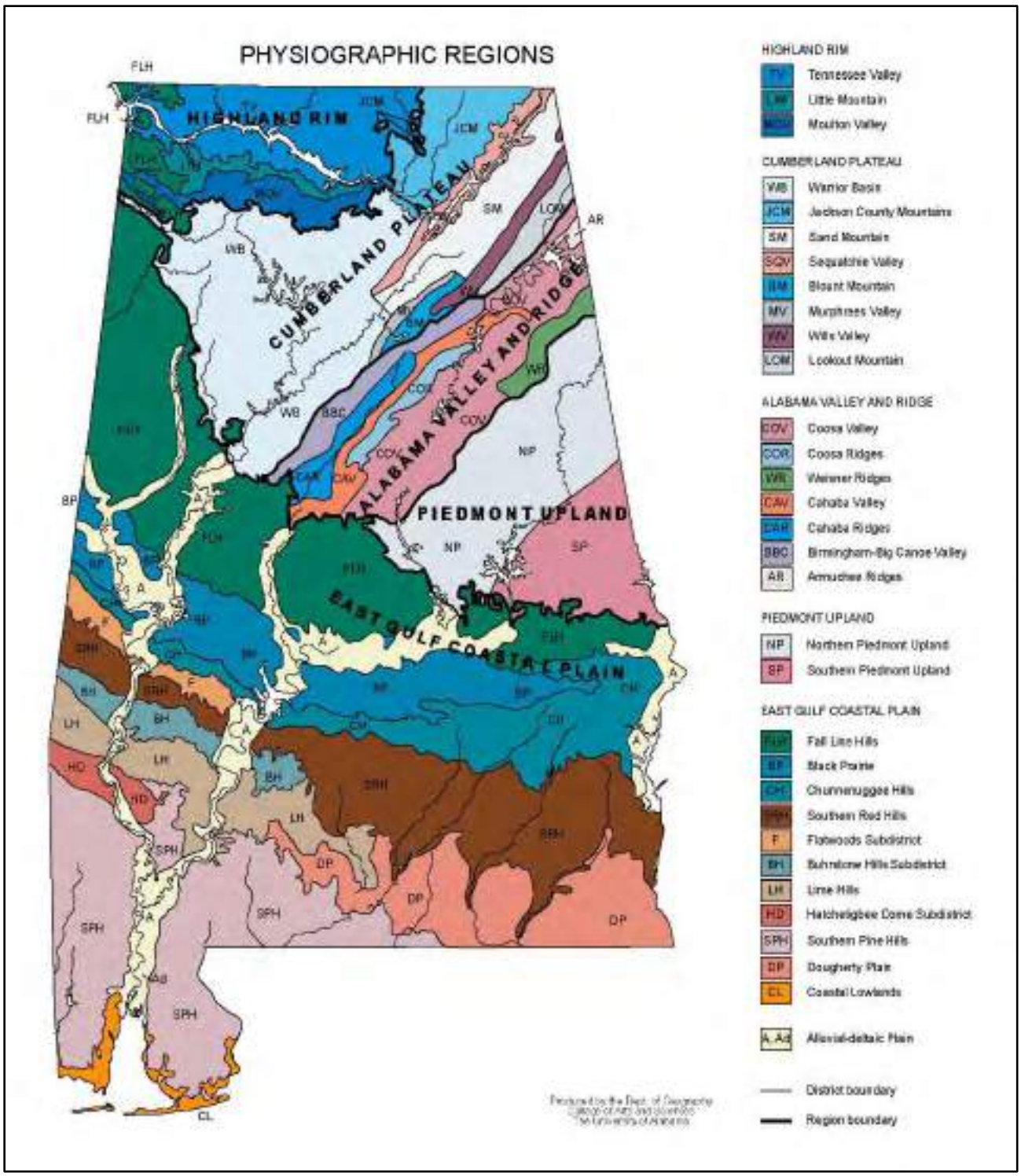

Figure 4.2 Alabama Physiographic Provinces (Source: University of Alabama, 2016)

4.2.2 Geology

Geologic formations are the underlying layers of rock beneath the earth's surface. These layers are defined according to their age and composition. Knowledge of underlying geologic formations is important for understanding watershed conditions and is used for sustainable land-use planning because the varying properties of geologic formations determine: 1) the quantity and quality of groundwater that can be withdrawn in an area and 2) the types of land use activities that occur in a given area (e.g., agriculture or urban development). This is largely due to the fact that each geologic unit is associated with certain aquifers and soil types. Two geologic formations underlie the Watershed—the Citronelle Formation and alluvial, coastal, low terrace deposits (**Figure 4.3**).

The Citronelle Formation ranges from middle Pliocene to pre-Nebraskan Pleistocene in age. Citronelle sediments consist of non-fossiliferous, moderate-reddish-brown, fine-to-very-coarse quartz sand; light-gray, orange, and brown sandy clay; and clayey gravel of non-marine origin. In many areas, layers of sandy clay and clayey sand, which range in thickness from 5 to 15 feet, are interbedded with gravelly sand. Sediment type, specifically clay content, often changes abruptly over short distances. Gravels of the Citronelle Formation generally consist of quartzite and chert (Gillett et al. 2000).

Alluvial, low terrace, and coastal deposits consist of very-fine-to-coarse sand that is gravelly in many exposures. Sediments consist of very-fine-to-coarse sand that is sometimes gravelly in nature, interbedded with clay and sandy clay. Thickness of the alluvial, low terrace, and coastal deposits is believed to range from zero to 200 feet (Gillett et al. 2000).

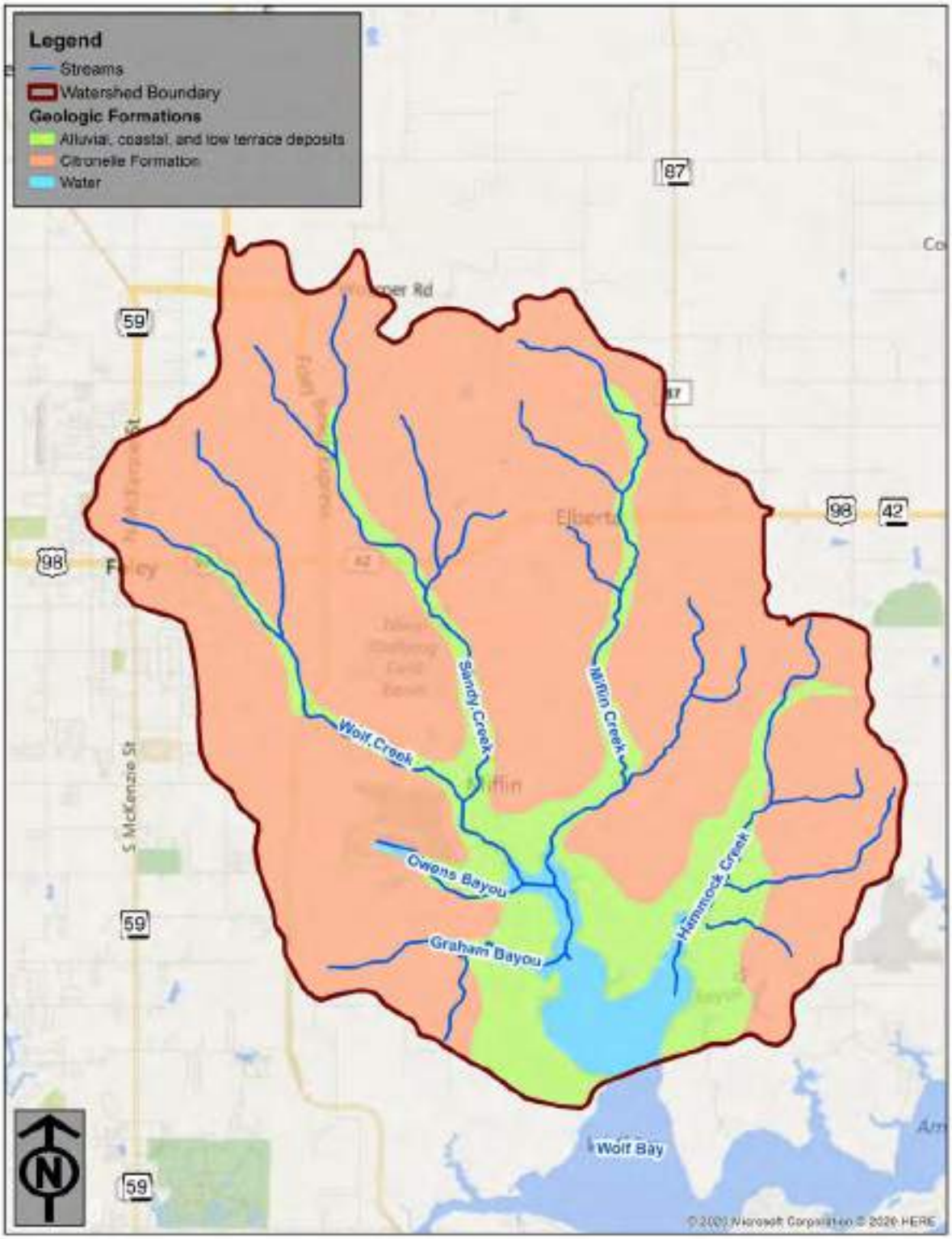

Figure 4.3 Geologic Formations of the Wolf Bay Watershed

4.2.3 Topography

The topography in the upper portion of the Watershed is relatively high, with the maximum elevation approximately 100 ft above mean sea level. Moving southward through the Watershed, the topography gradually declines, with the lower portion of the Watershed having minimal changes in elevation.

4.2.4 Soils

Soils are an important element of watersheds, because they influence surface water flow and groundwater recharge rates. Soil types also determine land uses within watersheds, because certain soil types are more suitable for specific uses, such as agriculture or urban and residential development, than others. Because a diverse range of soil types is often present within a given geographic area, soils have been grouped into soil associations and illustrated on a general map presented as **Figure 4.4**. This map is useful to people who want a general idea of soils, to compare different parts of a county, or to know the possible location of areas suitable for a certain kind of farming or other land use (USDA 1964).

Two soil associations encompass the Watershed – the Lakeland-Plummer association and the Norfolk-Klej-Goldboro association. The properties of and suitable land use for each of these soil associations are described in more detail below.

The Lakeland-Plummer association consists of nearly level, poorly-drained-to-very-poorly drained soils of bottom lands and of gently sloping to moderately steep, somewhat-excessively drained, loamy-fine sands of the uplands. These areas are along creeks and rivers in the southern and eastern parts of Baldwin County. In some places, the soils in this association developed in unconsolidated Coastal Plain material. In other places they developed in alluvium washed from soils formed in Coastal Plain material. A large acreage in this association is probably best suited to pines and has little potential for row crops (USDA 1964).

The Norfolk-Klej-Goldsboro association primarily consists of nearly level or very-gently sloping soils of uplands and of soils of the associated bottom lands. It is located in the southern and southeastern parts of Baldwin County near Foley and Elberta. In some places, the soils developed in unconsolidated Coastal Plain material. In other places they developed in alluvium that washed from soils formed in the Coastal Plain. This association is located within the second most important agricultural area in the County. It is well suited for row crops, as well as pastureland (USDA 1964).

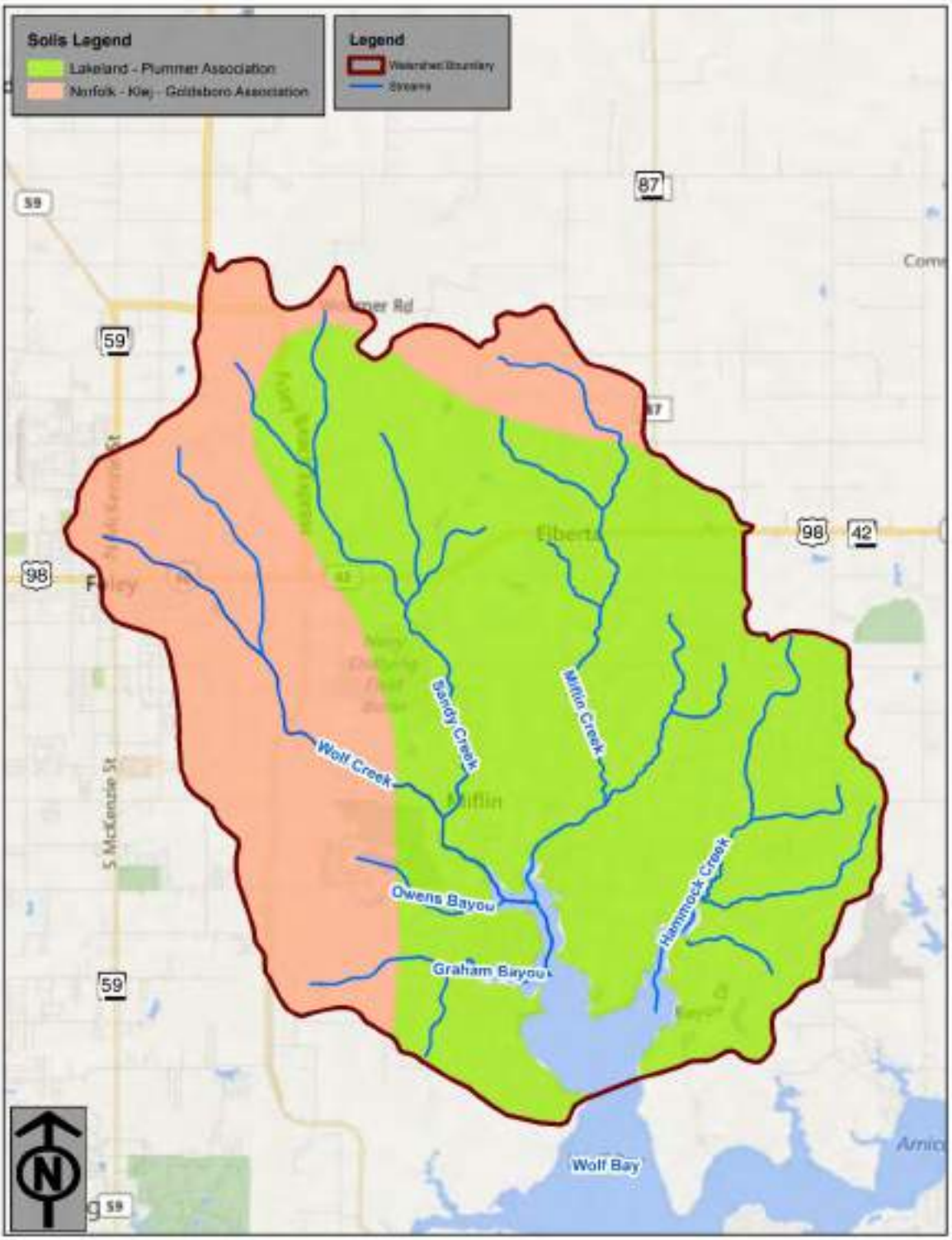

Figure 4.4 USDA Soils Associations Map

4.3 Hydrology

4.3.1 Climate & Rainfall

Baldwin County has a mild, but humid, climate with average annual rainfall of approximately 61 inches (Hydro Engineering Solutions, 2013). In the contiguous United States, the region is second only to the Pacific Northwest in total annual rainfall, with the frequency of thunderstorms over coastal Alabama being surpassed only by the Florida peninsula (Wolf Bay Plan, 2005). The summer months are typically the wettest, with the driest months typically in the winter. Annual rainfall is generally well-distributed, although significant rain events can be experienced due to proximity to the coast and exposure to hurricanes and tropical storms. On average, the warmest month is July, and the coldest is January (Hydro Engineering Solutions, 2013). **Table 4.1** shows the mean monthly temperature and precipitation values for the city of Foley, which is representative of the Watershed, as reported by Intellicast.

Table 4.1 Mean Annual Temperature and Precipitation in Foley, Baldwin County, Alabama (Source: Intellicast, 2019)

Month	High Temperature (°F)	Low Temperature (°F)	Precipitation (inches)
January	61	39	6.14
February	65	41	5.08
March	71	47	6.94
April	77	53	4.49
May	84	61	4.97
June	89	68	5.44
July	91	71	8.37
August	90	71	6.71
September	87	67	6.43
October	80	55	3.66
November	71	47	5.54
December	63	41	4.15

4.3.2 Surface Water Resources

Surface waters include bodies of water on the earth's surface (as opposed to underground), such as rivers, streams, lakes, and ponds. Surface waters are a critical resource within any watershed and may be used for drinking water supplies, agriculture, industrial uses, navigation, or recreation. The major surface water resources in the Watershed are the upper portion of Wolf Bay (also known as Moccasin Bayou), Wolf Creek, Sandy Creek, Miflin Creek, Graham Bayou, Owens Bayou, and Hammock Creek. Within the

Watershed, surface waters have a general flow pattern and direction, which channel waters within boundaries to the lower points of elevation. In the case of the Wolf Bay Watershed, Owen's Bayou collects the water from Wolf, Sandy and Miflin creeks. From there, Owen's Bayou, Graham Bayou and Hammock Creek discharge to the lowest point of elevation, Wolf Bay. Surface waters are replenished during precipitation events or by springs (points where groundwater flows to the surface). **Figure 4.5** shows the major surface water resources within the Watershed.

Figure 4.5 Surface Waters Within Wolf Bay Watershed

4.3.3 Ground Water Resources

Groundwater resources are critical to understanding watershed conditions and for sustainable land use planning, because they affect surface water features and can are useful in determining the types and intensities of specific land uses in the watersheds.

This Watershed is underlain by two major aquifers—the Miocene-Pliocene aquifer and the watercourse aquifer (sometimes referred to as the Beach Sand aquifer), shown in **Figure 4.6**. The Miocene-Pliocene aquifer is associated with the Citronelle Formation and is approximately 3,400 feet thick in southern Baldwin County. Groundwater from the Miocene-Pliocene aquifer is generally soft and low in dissolved solids but may contain iron in excess of 0.3 milligram per liter (mg/L) and be corrosive. However, dissolved solids and chloride content generally increase closer to the coastal areas of the Watershed. The Miocene-Pliocene aquifer may yield more than 2 million gallons of water per day at each well. According to the Alabama Department of Environmental Management's (ADEM's) GIS database, there are eight permitted public drinking water wells located within the Watershed.

The watercourse aquifer is associated with alluvial, low-terrace, and coastal deposits. Groundwater from the watercourse aquifer is generally much harder than that of the Miocene-Pliocene aquifer and is high in iron, chloride, and dissolved solids, particularly in extreme coastal areas. It is also highly acidic and may be corrosive. Wells in this aquifer may yield up to 10 gallons per minute.

The recharge areas for both aquifers include all of Mobile and Baldwin counties and parts of Washington County. Rainfall is the major source of recharge for these aquifers. The Miocene-Pliocene and watercourse aquifers are considered to be unconfined, because they are hydraulically connected to the land surface by sand and gravel beds. Because sand units between the two aquifers are not completely separated by clay lenses, the watercourse aquifer locally provides recharge for the underlying Miocene-Pliocene aquifer (Gillett et al. 2000).

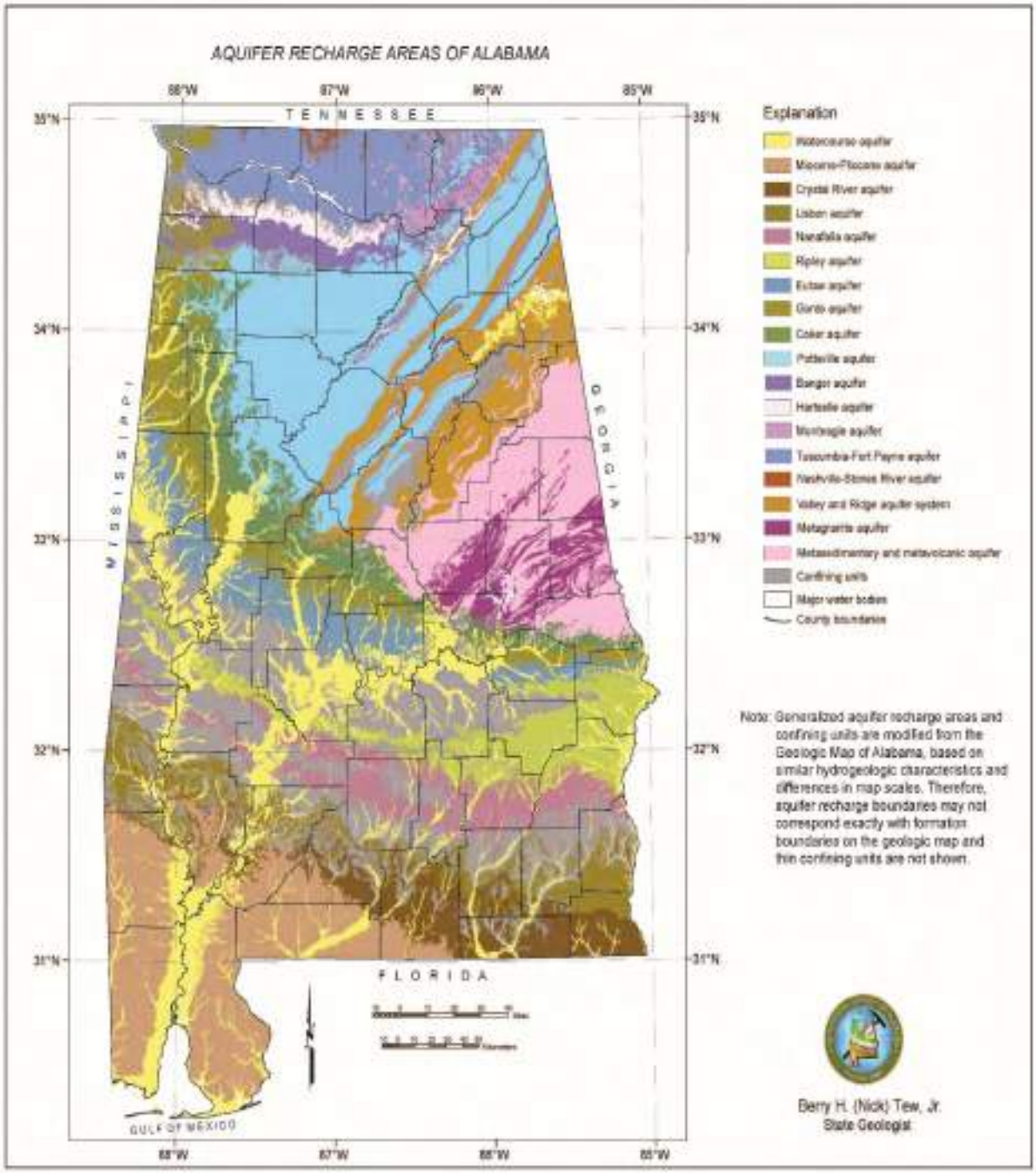

Figure 4.6 Aquifer Recharge Areas (Source: Geological Survey of Alabama, 2018)

4.4 Floodplains and FEMA Flood Zones

Floodplains are low-lying areas adjacent to rivers, bays, or other waterbodies that are subject to periodic flooding. The Federal Emergency Management Administration (FEMA) designates flood zones based on the frequency and probability of flooding. **Figure 4.7** shows the 500-year, 100-year, and regulated floodway designations for the Watershed. Areas located within the 500-year flood zone have a 0.2% annual chance of flooding. Areas within the 100-year flood zone have a 1% annual chance of flooding. Regulated floodways are the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights (FEMA 2019).

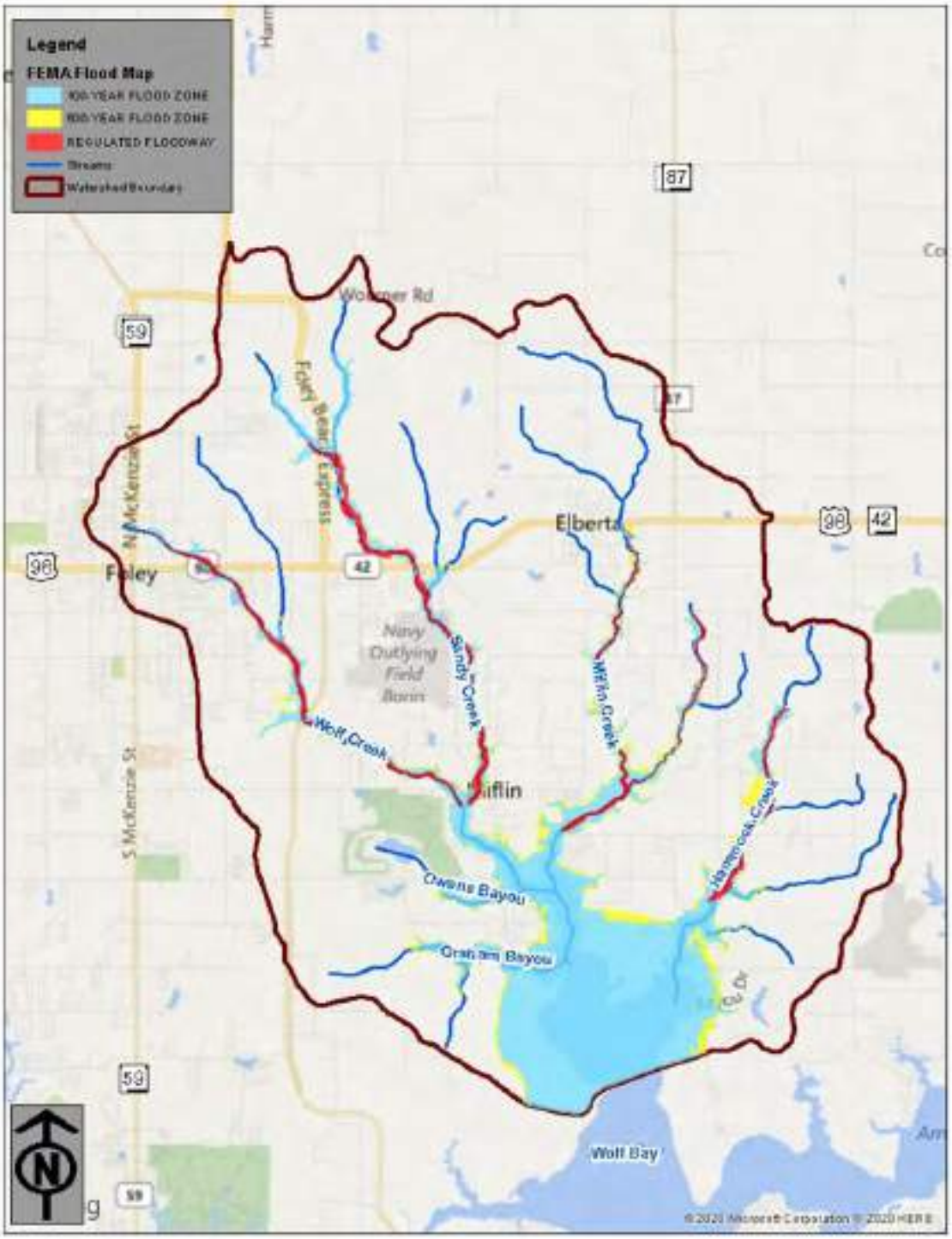

Figure 4.7 FEMA Flood Zones Within Wolf Bay Watershed

4.5 Streams

As discussed previously in Section 4.3.2, there are six major streams in the Watershed. These streams are perennial and can be characterized as low-gradient, sandy-bottom streams with broad floodplains. **Table 4.2** reflects the length of each stream and the drainage areas associated with each one.

Table 4.2 Watershed Stream Lengths and Associated Drainage Areas

Stream	Length (ft)	Drainage Area (ac)
Wolf Creek	49,166	6,184
Sandy Creek	42,368	8,579
Owens Bayou	12,029	1,442
Hammock Creek	32,805	3,676
Graham Bayou	15,041	2,061
Miflin Creek	50,603	8,438

4.6 Habitats

A habitat is a type of natural environment characterized by physical and biological factors and utilized by resident fauna. Physical factors include soil type, humidity, range of temperature, hydrologic and geological features. Biological components can include availability of food, refuge, nursery area, or the presence/absence of predators. Habitats are not necessarily geographical locations, and they change over time.

4.6.1 Uplands

A vast majority of the forested uplands in the Watershed have historically been cleared for agriculture or development. According to National Land Cover Database (NLCD) 2016 land cover imagery, forested upland areas that remain intact include evergreen forest, shrub/scrub, mixed forest, and deciduous forest making up 23% of the Watershed.

4.6.2 Wetlands

Wetlands, as defined by the U.S. Army Corps of Engineers (33 CFR 328.3) and the U.S. Environmental Protection Agency (40 CFR 230.3), are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and other similar areas. Wetlands found in coastal Alabama provide spawning grounds, nurseries, shelter, and food for finfish, shellfish, birds, and other wildlife. They also help improve surface water quality by filtering and retaining residential, agricultural, and urban wastes, as well as providing a buffer against storm and wave damage and helping stabilize shorelines (USEPA, 2019). The four types of wetlands found in the Watershed include palustrine wetlands, estuarine wetlands, riverine wetlands, and lacustrine wetlands as shown in **Figure 4.8**. These four wetland types are described below.

4.6.2.1 Palustrine Wetlands

The palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergent vegetation, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand (ppt) (USFWS, 2019a). According to USFWS's National Wetland Inventory (NWI) data, there are approximately 2,969 acres of palustrine wetlands found in the Watershed. Of these wetlands, 2,544 acres (86%) are considered freshwater forested/shrub wetlands, 253 acres (9%) are considered freshwater ponds, and 172 acres (6%) are considered freshwater emergent wetlands.

4.6.2.2 Estuarine Wetlands

The estuarine system consists of deep-water tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land (USFWS, 2019b). According to the USFWS's NWI data, there are approximately 284 acres of estuarine wetlands located in the Watershed.

4.6.2.3 Riverine Wetlands

The riverine system includes all wetlands and deep-water habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergent vegetation, emergent mosses, or

lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5 ppt (USFWS, 2019c). According to the USFWS's NWI data, there are approximately 233 acres of riverine wetlands found in the Watershed.

4.6.2.4 Lacustrine Wetlands

The lacustrine system includes wetlands and deep-water habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergent vegetation, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 8 hectares (ha) (~20 acres) (USFWS, 2019d). According to the USFWS's NWI data, there are approximately 54 acres of lacustrine wetlands in the Watershed.

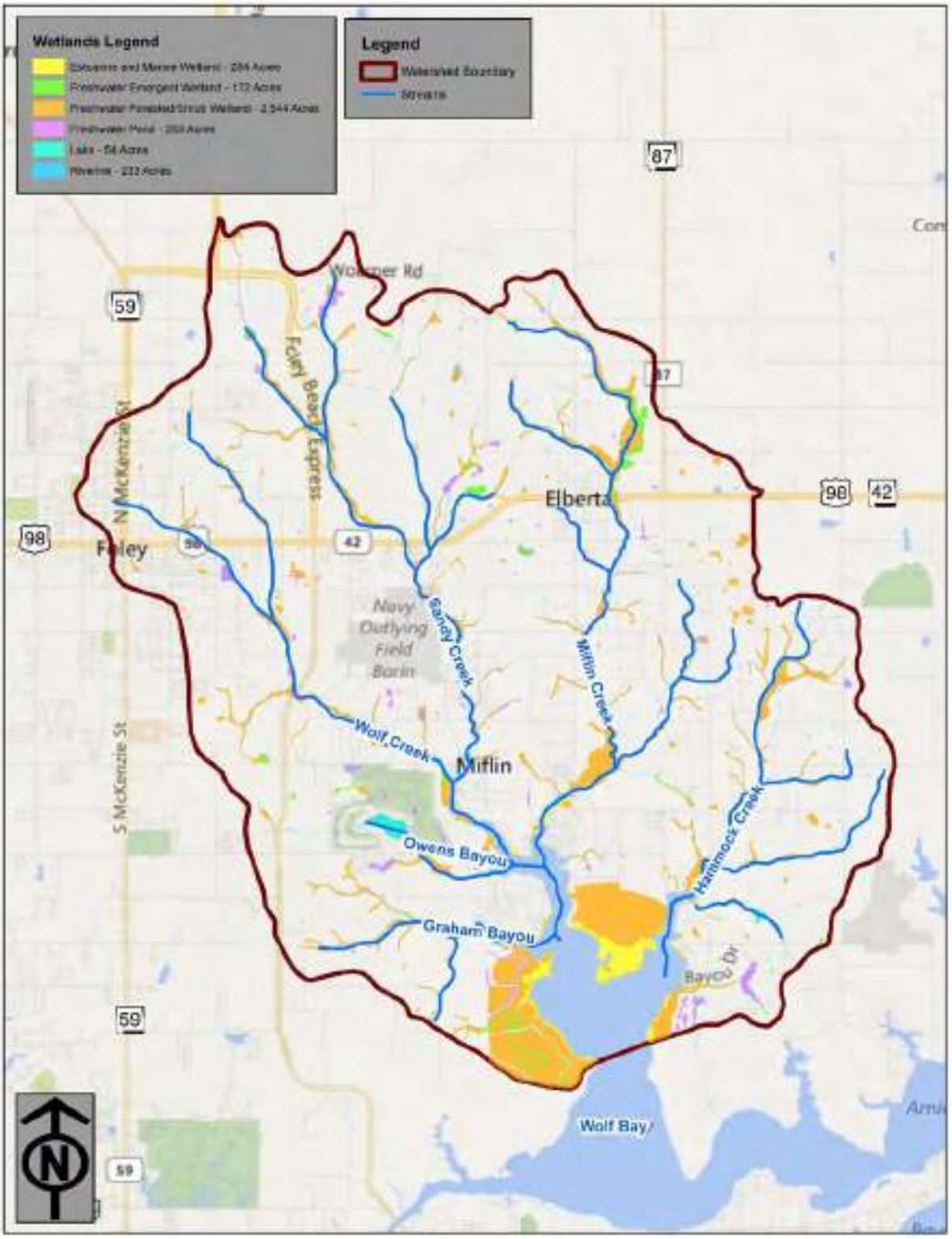

Figure 4.8 USFWS National Wetland Inventory Map

4.7 Biological Resources

4.7.1 Flora

Native vegetation typically found within the upland forests of the Watershed include longleaf pine (*Pinus palustris*) (**Figure 4.9**), loblolly pine (*Pinus taeda*), southern magnolia (*Magnolia grandiflora*), live oak (*Quercus virginiana*), yaupon holly (*Ilex vomitoria*), sparkleberry (*Vaccinium arboretum*), American holly (*Ilex opaca*), and bracken fern (*Pteridium aquilinum*).

Figure 4.9 Longleaf Pine Ecosystem

Native vegetation found in wetlands varies, depending on wetland habitat type. Wet pine flats typically contain wiregrass (*Aristida spp.*), pitcher plants (*Sarracenia spp.*) (**Figure 4.10**), yellowed grass (*Xyris spp.*) sedges, *Carex spp.*, pipewort (*Eriocaulon spp.*), foxtail (*Lycopodium spp.*), and pine (*Pinus spp.*). Bayhead drain wetlands consist of sweetbay magnolia (*Magnolia virginiana*), red maple (*Acer rubrum*),

swamp titi (*Cyrilla racemiflora*), wax myrtle (*Myrica cerifera*), slash pine (*Pinus elliottii*), water oak (*Quercus nigra*). Bottomland hardwood wetlands typically include bald cypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), tulip poplar (*Liriodendron tulipifera*), cinnamon fern (*Osmunda cinnamomea*), chain fern (*Woodwardia spp.*), and royal fern *(Osmunda regalis*). Freshwater emergent wetlands are mostly dominated by soft rush (*Juncus effuses*) and bulrushes (*Scirpus spp.*). Estuarine wetlands are typically dominated by black needle rush *(Juncus roemerianus*) and saltmarsh cordgrass (*Spartina alterniflora).*

Figure 4.10 Purple Pitcher Plant (*Sarracenia purpurea*) in the Wolf Bay Watershed

4.7.2 Fauna

Common mammal species known to occur in the Watershed include the common gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), rabbit (*Sylvilagus floridanus*), nine-banded armadillo (*Dasypus novemcinctus*), Virginia opossum (*Didelphis virginia*), and whitetail deer (*Odocoileus virginianus*). Herpetofauna species found in the Watershed include the black racer (*Coluber constrictor*), cottonmouth/water mocassin (*Agkistrodon piscivorus*), copperhead (*Agkistrodon contortrix*) (**Figure 4.11**), five-lined skink (*Eumeces fasciatus*), snapping turtle (*Chelydra serpentina serpentina*),

yellow-bellied slider (*Trachemys scripta scripta*), and American alligator (*Alligator mississippiensis*). Common fish species include red drum (*Sciaenops ocellatus*), speckled trout (*Cynoscion nebulosus*), mullet (*Mugil cephalus*), and bream (*Abramis brama*).

Figure 4.11 Copperhead snake in Miflin Creek

The coastal region of Alabama is especially important for migratory birds, which use the area as stopover habitat during spring and fall migrations between North America and Central and South America. **Table 4.3** lists migratory birds likely to occur in the Watershed that are of priority concern.

Table 4.3 Migratory Birds of Concern in the Wolf Bay Watershed

Species
American Kestrel (*Falco sparverius*)
American Oystercatcher (*Haematopus palliates*)
Bachman's Sparrow (*Aimophila aestivalis*)
Bald Eagle (*Haliaeetus leucocephalus*)
Black Skimmer (*Rynchops niger*)
Bonaparte's Gull (*Chroicocephalus philadelphia*)
Brown Pelican (*Pelecanus occidentalis*)
Cerulean Warbler (*Dendroica cerulea*)
Clapper Rail (*Rallus crepitans*)
Common Ground-dove (*Columbina passerine exigua*)
Common Loon (*Gavia immer*)
Common Tern (*Sterna hirundo*)
Double-crested Cormorant (*Phalacrocorax auritus*)
Dunlin (*Calidris alpine arcticola*)
Gull-billed Tern (*Gelochelidon nilotica*)
Herring Gull (*Larus argentatus*)
Kentucky Warbler (*Oporornis formosus*)
Least Tern (*Sterna antillarum*)
Lesser Yellowlegs (*Tringa flavipes*)
Northern Gannet (*Morus bassanus*)
Prairie Warbler (*Dendroica discolor*)
Prothonotary Warbler (*Protonotaria citrea*) (**Figure 4.12**)
Red-breasted Merganser (*Mergus serrator*)
Red-headed Woodpecker (*M. erythrocephalus*)
Ring-billed Gull (*Larus delawarensis*)
Royal Tern (*Thalasseus maximus*)
Ruddy Turnstone (*Arenaria interpres morinella*)
Short-billed Dowitcher (*Limnodromus griseus*)
Swallow-tailed Kite (*Elanoides forficatus*)
Willet (*Tringa semipalmata*)
Wood Thrush (*Hylocichla mustelina*)

Figure 4.12 Prothonotary Warbler (Photo: Audubon)

4.7.3 Threatened and Endangered Species

The Endangered Species Act of 1973 (ESA) provides for the conservation of species designated by USFWS as endangered or threatened throughout all or a significant portion of their range and the ecosystems upon which they depend. The ESA prohibits take of any endangered or threatened species, where "take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." When a species is listed as endangered or threatened under the ESA, USFWS can also designate critical habitat, which is defined as "a specific geographic area(s) that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection."

The USFWS Information for Planning and Consultation (IPaC) project planning tool identified 10 species listed as endangered or threatened that could potentially occur in the Watershed (**Table 4.4**). There are no designated critical habits within the Watershed.

Table 4.4 Federally Listed Threatened and Endangered Species

Common Name	Scientific Name	Status
Birds		
Piping plover	*Charadrius melodus*	Threatened
Red knot	*Calidris canutus rufa*	Threatened
Wood stork	*Mycteria americana*	Threatened
Mammals		
West Indian manatee	*Trichechus manatus*	Threatened
Reptiles		
Alabama red-bellied turtle	*Pseudemys alabamensis*	Endangered
Eastern indigo snake (**Figure 4.13**)	*Drymarchon corais couperi*	Threatened
Gopher tortoise	*Gopherus polyphemus*	Candidate
Kemp's Ridley sea turtle	*Lepidochelys kempii*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Fish		
Gulf sturgeon	*Acipenser oxyrinchus*	Threatened

Figure 4.13 Eastern Indigo Snake (Photo: AL.com)

4.7.4 Essential Fish Habitat

Essential Fish Habitat (EFH) includes all types of aquatic habitat where fish spawn, breed, feed, or grow to maturity. It covers federally managed fish and invertebrates, but it does not apply to strictly freshwater

species (NOAA Fisheries). In this Watershed, EFH is managed by NOAA National Marine Fisheries and the Gulf of Mexico Fishery Management Council (GMFMC). Using the GMFMC's Essential Fish Habitat Portal (https://portal.gulfcouncil.org/EFHreview.html), eight aquatic species were identified to have EFH in the Watershed. **Table 4.5** lists these species and their life stages in the Watershed.

Table 4.5 Managed Fishery Species

Common Name	Scientific Name	Life Stage
Brown shrimp	*Farfantepenaeus aztecus*	Juvenile, postlarval
Cobia	*Rachycentron canadum*	Eggs, larvae
Gray snapper	*Lutjanus griseus*	Adult
Lane snapper	*Lutjanus synagris*	Larvae, postlarval
Pink shrimp	*Farfantepenaeus duorarum*	Larvae
Red drum	*Sciaenops ocellatus*	Larvae, postlarval, juvenile, adult
Spanish mackerel	*Scomberomorus maculatus*	Juvenile, adult
White shrimp	*Litopenaeus setiferus*	Postlarval, juvenile

4.7.5 Invasive Species

Invasive species are plants and animals that have been introduced to areas outside their native range by human activity or other means and have the potential to cause ecological damage and/or economic loss. The potential for harm distinguishes invasive species from non-native species, which have also been introduced outside their native range but do not pose an ecological or economic threat. The Alabama Invasive Plant Council maintains a list of plant species considered to be invasive within the State of Alabama. The statewide invasive plant list (most recently updated in 2012) contains 65 confirmed species and 26 additional species with the potential to become invasive in Alabama. The most common invasive species in the Watershed are described below:

- **Cogongrass (*Imperata cylinrica*)** is a fast-spreading invasive weed that has proven to be extremely difficult to eradicate. Cogongrass poses a threat to both wildlife habitat and economic interests within the Watershed. It affects agriculture by interfering with crop production and degrades wildlife habitat by displacing or outcompeting native vegetation. Cogongrass is also highly flammable, posing a potential fire hazard to nearby homes. Cogongrass has expanded rapidly since it was first introduced into the United States in Mobile County in 1911 (ALIPC, 2004).

- **Chinese privet (*Ligustrum sinense*)** is an invasive shrub first introduced into the United States as an ornamental plant in 1853. Chinese privet spreads rapidly and commonly occupies fence rows, forested creek bottoms, and upland forests. The dense, stemmy infestations can reach 30 feet in height, displace most native species, and prevent regeneration of bottomland hardwood and upland pine forests (ALIPC, 2019).

- **Chinese tallow (*Triadica sebifera*)** (or popcorn tree) is a deciduous species that is spread by seed dispersal from birds and water. It was first brought into South Carolina in the 1700s, before spreading widly by federally sponsored plantings along the Gulf Coast during the early 1900s. This species is common throughout south Alabama and infests stream banks, riverbanks, and wet areas, as well as upland forests. Chinese tallow is an aggressive species with the potential to rapidly replace native bottomland forest vegetation (ALIPC, 2019).

- **Kudzu (*Pueraria montana*)** is an extremely fast-growing invasive vine that can cover trees, buildings, fences, road signs, and telephone and utility poles. Kudzu is one of the most notorious invasive species in the south and has proven nearly impossible to eradicate. It was intentionally introduced into the United States from the 1930s to the 1950s for erosion control, before its potential risk as an invasive species was recognized (ALIPC, 2019).

- **Japanese Climbing Fern (*Lygodium japonicum*)** is a perennial viney fern that was introduced into the United States in the 1930s. Although it dies back each winter, prior year's vines provide a trellis for expansive new growth that eventually covers shrubs and trees. Native plant species are displaced, wildlife habitat is destroyed, and access to lands is denied by this species (ALIPC, 2019).

- **Alligator Weed (*Alternanthera philoxerodies*)** is an herbaceous freshwater perennial invader that forms dense mats in water bodies, wetlands, and low-lying, as well as upland areas. The thick mats in water replace native species, accelerate succession from open water to marsh, cause fish kills, and prevent recreational use. By slowing drainage, it also exacerbates flooding (ALIPC, 2019).

- **Feral Swine (*Sus scrofa*)** are omnivorous wild boars with high reproductive rates. They lack natural predators and display destructive rooting behavior. This animal likely originated in Southeast Asia and was introduced to the Americas by early colonization. The feral hog's ability to adapt and survive has created one of the greatest pests in North America. The U.S. Department of Agriculture estimates that feral hogs cause more that $800 million of agricultural damage annually (USDA, 2020).

4.8 Political Institutions

Four local governmental entities have jurisdictional control within the Watershed. These include the City of Foley, the towns of Elberta and Summerdale, and Baldwin County. **Figure 4.14** shows that of the total Watershed area, the City of Foley maintains jurisdiction of approximately 28%, the town of Elberta approximately 10%, and the town of Summerdale less than 1%, leaving Baldwin County with jurisdiction of the remaining approximately 61% of the Watershed.

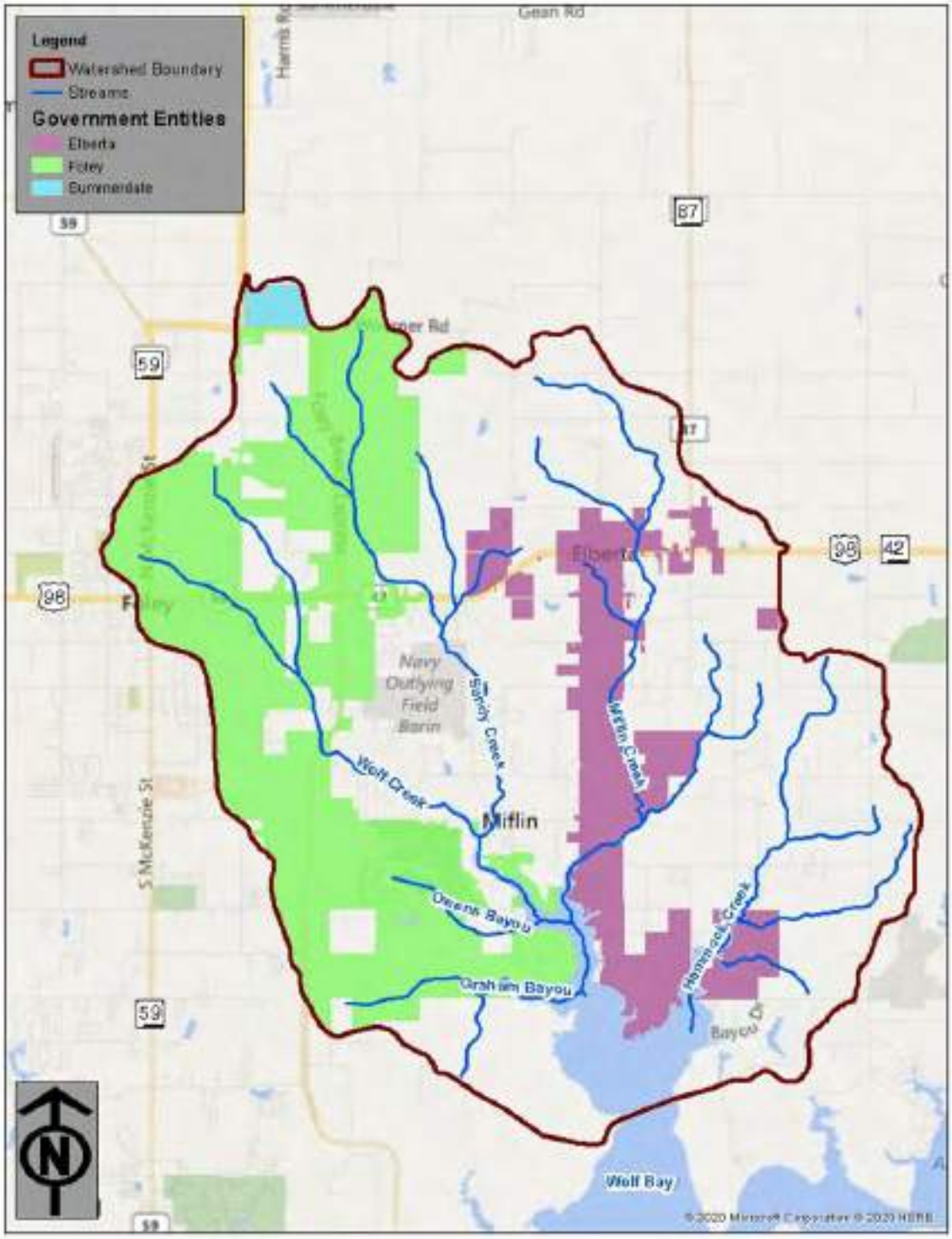

Figure 4.14 Government Entities Within Wolf Bay Watershed

4.9 Population and Demographics

Population and population growth are important considerations in watershed planning because population growth is intrinsically tied to land use, development, and various environmental stressors on a watershed, such as increased stormwater runoff, nutrient loading, and flooding. Current and projected populations for Baldwin County and the Watershed are assessed in this Plan.

Other demographic characteristics, such as ethnic composition, age distribution, income and poverty levels, are important for characterizing populations of watersheds. Each of these characteristics are assessed within the Watershed as well as Baldwin County and are described in this section.

4.9.1 Population

Baldwin County is the largest county in Alabama by land area and among the most populated counties in the State. The population of Baldwin County increased by approximately 30% from 2000 to 2010, according to the U.S. Census Bureau. **Table 4.6** shows the population and growth rates (% change over 10-year periods) in Baldwin County from the years 2000 and 2010 and projections of population growth through 2040. County-level population growth projections are published by The University of Alabama's Center for Business and Economic Research (UACBER) (UACBER 2019).

Table 4.6 Baldwin County Past, Current, and Future Population (Source: U.S. Census Bureau and Center for Business and Economic Research, The University of Alabama, April 2019)

	U.S. Census Population		Projected Population		
	2000	2010	2020	2030	2040
Baldwin	140,415	182,265	222,554	261,777	300,899
Percent Increase	--	30	22	18	15

4.9.2 Population Trends and Projections

Demographic data was collected from the U.S. Census Bureau's American Fact Finder website (U.S. Census Bureau, 2016). The data collected is broken down into specific levels of geographic units: tracts, block groups, and blocks, with tracts the largest unit and blocks the smallest. Block groups and blocks were used to collect data for the three sub-watersheds within the Watershed complex. Block groups, as defined

by the U.S. Census Bureau, generally contain between 600 and 3,000 people, from a cluster of blocks. Blocks are typically bounded by existing physical features, natural features, or political boundaries (e.g., roads, rivers, or state boundaries), but the U.S. Census Bureau does not use watershed boundaries to define census block boundaries (U.S. Census Bureau 2010). As a result, select census blocks exist partially within and partially outside one or more of the project sub-watersheds.

Population growth projections from UACBER are published at the county-level only, and projections for smaller geographic units are not currently available. To estimate future population trends for the sub-watersheds, the percent change that UACBER projected for the county-level population was applied to the estimated 2010 population (**Table 4.7**). The resulting calculations estimate the future population in the sub-watersheds through 2040. However, because factors influencing population trends at the county level may differ from those in each of the sub-watersheds, these watershed level projections should be considered in coordination with local regulations, demographics, and geographic features that may alter future trends from the projections.

Table 4.7 Population Projections by Sub-Watershed (Source: U.S. Census Bureau and Center for Business and Economic Research, The University of Alabama, April 2019)

Watershed	U.S. Census Population	Projected Population		
	2010	2020	2030	2040
Graham Bayou	3,515	4,288	5,060	5,313
Miflin Creek	3,443	4,200	4,956	5,204
Sandy Creek/Wolf Creek	8,825	10,767	12,705	13,340

4.9.3 Ethnic Composition

4.9.3.1 Baldwin County Ethnic Composition

Figure 4.15 shows the ethnic composition of Baldwin County based on 2010 census data. Baldwin County is numerically dominated by individuals who identify themselves as white alone, followed by individuals who identify as black/African American, with all other ethnicity groups representing 5% of the population.

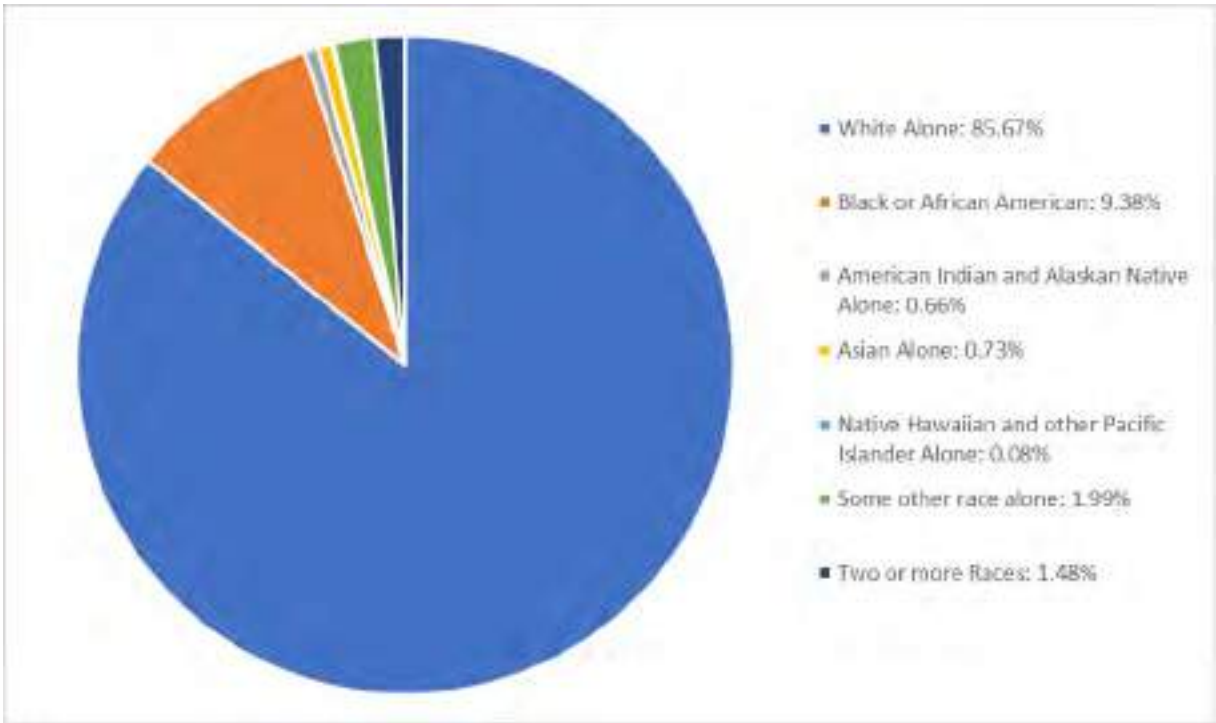

Figure 4.15 Ethnicity Composition of Baldwin County (Source: 2010 U.S. Census Bureau)

4.9.3.2 Ethnic Composition by Sub-Watershed

Table 4.8 shows the ethnic composition of the three sub-watersheds. The composition was calculated based on the census blocks that are within each sub-watershed. The ethnic composition of the three sub-watersheds differ slightly compared to Baldwin County. All three sub-watersheds are predominantly composed of individuals who identify themselves as white alone, followed by those who identify as black/African American or other minorities. Compared to Baldwin County, the sub-watersheds have a lower total minority percentage, except for Sandy Creek Watershed which is slightly higher than Baldwin County.

Table 4.8 Ethnicity Composition by Sub-Watershed (Source: 2010 U.S. Census Bureau)

Geographic Area	Population Total	Ethnicity (%)							
		White Alone	Black or African American	American Indian and Alaskan Native Alone	Asian Alone	Native Hawaiian and other Pacific Islander Alone	Some other race alone	Two or more Races	Total Minority
Graham Bayou	3,515	94.77%	1.42%	0.40%	0.97%	0%	1.11%	1.34%	5.23%
Miflin Creek	3,443	92.80%	0.93%	0.64%	0.67%	0.03%	2.79%	2.15%	7.20%
Sandy Creek/ Wolf Creek	8,825	80.53%	10.73%	0.93%	1.08%	0.07%	4.95%	1.71%	19.47%

4.9.4 Age Distribution

4.9.4.1 Baldwin County Age Distribution

Table 4.9 presents the age distribution of Baldwin County and the State of Alabama, based on the 2010 census data. The majority of the Baldwin County population falls within the age group of 30 to 49, followed closely by the 17 and under age group, and then the 50 to 64 age group.

Table 4.9 Age Distribution of Baldwin County and the State of Alabama (Source: 2010 U.S. Census Bureau)

Geographic Area	Population Total	Population Age (Percent of Population)				
		17 and Under	18 to 29	30 to 49	50 to 64	65 and Older
Alabama	4,779,736	24%	16%	27%	20%	13%
Baldwin County	182,265	23%	13%	26%	21%	17%

4.9.4.2 Age Distribution by Sub-Watershed

Table 4.10 represents the age distribution of the population within the three sub-watersheds. The age distribution of the sub-watersheds is mostly consistent with the overall age distribution of Baldwin County.

However, Graham Bayou Watershed has a slightly higher population of people ages 65 and older (25%) compared to Baldwin County (17%).

Table 4.10 Age Distribution by Sub-Watershed (Source: 2010 U.S. Census Bureau)

Geographic Area	Population Total	Population Age (Percent of Population)				
		17 and Under	18 to 29	30 to 49	50 to 64	65 and Older
Graham Bayou	3,515	18%	12%	21%	24%	25%
Miflin Creek	3,443	21%	18%	24%	22%	15%
Sandy Creek/Wolf Creek	8,825	21%	15%	23%	21%	20%

4.9.5 Income and Poverty

Table 4.11 shows the average household size and median household income compared to the standard HHS Poverty Guidelines in Alabama, Baldwin County, and each of the three sub-watersheds. Median household income is estimated based on block groups that completely or partially intersect each sub-watershed. The median income in each sub-watershed is lower than that of Baldwin County. Sandy Creek has the lowest median income of the three sub-watersheds, but it is not below the poverty guidelines for household size. Overall, the median income of the three watersheds compare similarly to Baldwin County.

Table 4.11 Income and Poverty Levels (Source: 2010 U.S. Census Bureau, 2017 American Community Survey, and the U.S. Department of Health and Human Services)

Geographic Area	Population Total	Average Household Size	Median Income (2017)	HHS Poverty Guidelines	Below HHS Poverty Guidelines
Alabama	4,779,736	3	$46,472	$21,330	No
Baldwin County	182,265	3	$52,562	$21,330	No
Graham Bayou	3,515	3	$49,016	$21,330	No
Miflin Creek	3,443	3	$50,355	$21,330	No
Sandy Creek/Wolf Creek	8,825	3	$44,211	$21,330	No

4.9.6 Economics

Because of the proximity of the Watershed to the Alabama Gulf coast, tourism plays an important role in the local economy. According to the Alabama Department of Tourism's calendar year 2017 Economic Impact Report, released April 16, 2018, Baldwin County's estimated 6.4 million visitors represented 24.1% of all visitors to the State. In 2017, travelers spent more than $4.4 billion in Baldwin County, an increase of $491 million from 2015, while total travel-related earnings (both direct and indirect) of $1.5 billion represented 30% of the Statewide total.

4.9.7 Education

Table 4.12 shows the educational attainment for the population aged 25 years and older in Alabama, Baldwin County, and each of the three sub-watersheds. The population totals for the sub-watersheds are higher than in previous tables because block group population totals were used to determine total population.

Table 4.12 Educational Attainment for the Population 25 Years and Over (Source: 2010 U.S. Census Bureau, 2017 American Community Survey)

	Alabama	Baldwin County	Graham Bayou Watershed	Miflin Creek Watershed	Sandy Creek/Wolf Creek Watershed
Total Population	3,276,637	143,022	8,881	3,892	16,944
No Schooling Completed	41,118 (1%)	1,131 (1%)	67 (2%)	46 (1%)	152 (1%)
12th Grade or Less	439,941 (13%)	12,866 (9%)	844 (10%)	326 (8%)	1,341 (8%)
High School Diploma	831,994 (25%)	32,709 (23%)	1,607 (18%)	1,188 (31%)	4,682 (28%)
GED	180,557 (6%)	7,062 (5%)	747 (8%)	249 (6%)	1,065 (6%)
Some College (less than 1 year, no degree)	198,453 (6%)	9,207 (6%)	567 (6%)	220 (6%)	1,239 (7%)
Some college (1 or more years, no degree)	513,751 (16%)	22,319 (16%)	1,833 (21%)	603 (15%)	3,012 (18%)
Associate Degree	267,245 (8%)	13,760 (10%)	910 (10%)	348 (9%)	1,715 (10%)

	Alabama	Baldwin County	Graham Bayou Watershed	Miflin Creek Watershed	Sandy Creek/Wolf Creek Watershed
Bachelor's Degree	503,930 (15%)	29,237 (20%)	1,630 (18%)	673 (17%)	2,641 (16%)
Master's Degree	216,001 (7%)	10,714 (7%)	549 (6%)	211 (5%)	940 (6%)
Professional School Degree	49,452 (2%)	2,885 (2%)	114 (2%)	15 (1%)	46 (1%)
Doctorate Degree	34,195 (1%)	1,132 (1%)	13 (0%)	13 (0%)	111 (1%)

4.10 History and Culture of the Watershed

There are three distinct communities within the Watershed: The City of Foley, the Town of Elberta, and the Miflin community. A brief history of each is discussed in the following sections.

4.10.1 City of Foley

The Forward City, as it is known today, lives up to its name. While some might have skipped over the area now known as Foley to develop closer to the pristine beaches of Alabama's Gulf coast, John B. Foley (of Chicago) purchased 50,000 acres north of the beach and formed the Magnolia Land Company in 1902. He recognized the economic value of the location between what is now Miflin and Bon Secour landings, rich soils perfect for farming, and the mild climate that would attract settlers looking to migrate from the Midwest. Business flourished after Foley and the Ham brothers constructed the Foley Depot and the accompanying railroad in 1905. This line connected Bay Minette and Fort Morgan. Trains from the Louisville and Nashville Railroad operated on this line (Outlaw and Taylor, 2013). Many accommodations, general stores, and real estate agencies were built near the depot to entice visitors to purchase land, the first of which was the Magnolia Hotel. Mr. Foley constructed a windmill to provide the hotel with running water and plumbing. The Magnolia Hotel changed hands many times but is still in use today. Since its opening, five U.S. presidents have passed through its front door (The Hotel Magnolia, 2019).

Figure 4.16 Foley Train Depot, Present Day

Because of the success of the community, the population of the area increased rapidly. As problems arose, the resilient and entrepreneurial people of South Baldwin County met every need. The Foley Municipal Airport was constructed in 1933, but with the start of World War II, the City released the airport for use by the Navy. Barin Field was used as an extension of Pensacola Naval Air Station for torpedo bomber and fighter training. The western portion of Barin Field was later purchased and is now occupied by the four lane Foley Beach Express. The eastern portion of Barin Field is still used as a satellite airport for Pensacola NAS flight practice. Baldwin County's first hospital, Sibley Holmes Memorial Hospital, opened in Foley in 1936 and was run by Mr. William C. Holmes. Today, the hospital is preserved as a museum with operating and waiting rooms, pharmacy, and medical equipment from the era in the Foley Downtown Historic District (Outlaw and Taylor, 2013).

Figure 4.17 Early Foley Cotton Gin, Grist Mill and Rice Huller Facility

4.10.2 Town of Elberta

On November 3, 1903, a group of German businessmen from Chicago created the Baldwin County Colonization Company for the purpose of starting a German settlement on 55,000 acres of land known as the "Elberta District." The settlers were amazed by the mild climate, long growing seasons, rich soil, and diversity of crops that could be grown there. They established a model farm and brought visitors from the north on the "Pine Knot Special" to see the opportunities that could be found in Baldwin County. They placed ads in northern newspapers that read, "Come to Baldwin County – The Land of Milk and Honey." Land was sold in 20-acre tracts, and a tract in Gulf Shores could be purchased for one dollar. Tracts in other parts of the County were sold for $5 to $50, depending on farming suitability. The town was incorporated in 1952, thanks to a movement sponsored by the Elberta Lion's Club, and the first mayor was elected in 1953.

Known as “The Town of Friendship”, the people of Elberta represent many nationalities and speak over 60 languages. The State Bank of Elberta (later renamed South Baldwin Bank) was one of the few banks in the United States that did not close during the national bank holiday of the Great Depression of the early 1930’s (The Gulf Telephone Company, 1983).

4.10.3 Miflin Community

Miflin bears the name of a gentleman who established his business in 1850 beside the creek that was also named for him. Not much is known of the founder, other than he raised sugar cane and operated a turpentine and grist mill. The creek was dammed to furnish power for the mill. In the early 1900’s, Miflin was a thriving logging community. Turpentine mills also flourished, as the sap harvested from pine trees was used for medicinal purposes, as well as building boats. Two hundred and fifty barrels of the resin and spirits would be taken to Mobile through the Gulf, because the intracoastal waterway had not yet been built. Logs were floated up and down Sandy Creek by rafts pulled by oxen. Railroad tracks were constructed to the edge of the creek from far into the pine forests. Believed to be the first railroad in Baldwin County, it connected the Southern States Lumber Company’s logging camp and their sawmill at Miflin. The logging camp building stood exactly where the center of the Town of Foley now exists. Once a week, a steamer transported the logs to a mill in Millview, Florida. Homes and a large commissary were also located on the bank of Sandy Creek. One of the largest sawmills was located on Wolf Creek. After the timber was cut out, the logging business moved to Seminole, Alabama, and most of the residents moved with it (Schmidt, 2012; The Foley Onlooker, 1959).

Peterson’s Point was a popular destination for dances on Saturday nights and all-night turtle hunts. The site later became home to the Wolf Bay Lodge. The first bridge across Miflin Creek was a turntable bridge built in 1909 to replace the hand-drawn ferry that previously existed. The turntable bridge permitted the passage of sloops and pleasure boats up the Creek. The first winery in Alabama was in Miflin, until a change in state law forced its closure (Schmidt, 2012; Fuller, Date Unknown).

Figure 4.18 Peterson's Point, Date Unknown

The creeks and Bay have always been an important part of the life of the community. Timber mills in the area were powered by water. Mail and goods where transported to and from the area via the waterways. It was reported that, prior to the construction of the intracoastal waterway, there were plentiful oyster beds along the banks of Miflin Creek. Fishing was also prevalent in the creek, with stories of one angler catching so many redfish that his boat sank under the weight. Prizes from many fishing rodeos were won from fish caught on Sandy or Miflin creeks. In that day, most people fished to provide food for themselves and their families, and not commercially (The Foley Onlooker, 1959, Mobile Press Register, 1987).

4.10.4 Historical Sites

A review was conducted of the Alabama Register of Landmarks & Heritage as well as the National Register of Historic Places. There are three known historically significant sites listed on the National Register of Historic Places located in the Watershed. A list of these sites is provided in **Table 4.13**.

Table 4.13 Historically Significant Sites Within the Watershed (Source: National Register of Historic Places)

Locale	Name	Date	Status	Comment
Foley	Foley Downtown Historic District	1907-1954	National Register of Historic Places	Listed 1/19/05. Contains parts of Alston, N&S; McKenzie; Highway 98E. & W.; Laurel; Myrtle; Rose & W. Orange
Elberta	St. Mark's Lutheran Church	1927	National Register of Historic Places	Listed 8/25/88. Rural Churches of Baldwin County
Miflin	Swift Presbyterian Church (**Figure 4.19**)	1907	National Register of Historic Places	Listed 8/25/88. Rural Churches of Baldwin County

Figure 4.19 Swift Presbyterian Church, Listed on the National Register of Historic Places

4.11 Public Access in the Watershed

Outdoor recreational activities in coastal Alabama are an important way of life for many. Some of these activities include fishing, hunting, boating, swimming, shrimping, and wildlife watching. There are currently two publicly owned recreational facilities that provide water access within the Watershed, Graham Creek Nature Preserve and Wolf Creek Park, as shown in **Figure 4.20**. Both facilities are owned and operated by the City of Foley.

The Upper Wolf Bay Savanna and Marsh Forever Wild Tract was acquired by the Alabama Forever Wild Land Trust in July 2017. Currently, there are no public recreational opportunities available on the site. It is anticipated, however, that future opportunities will be provided that are consistent with the protection of the property.

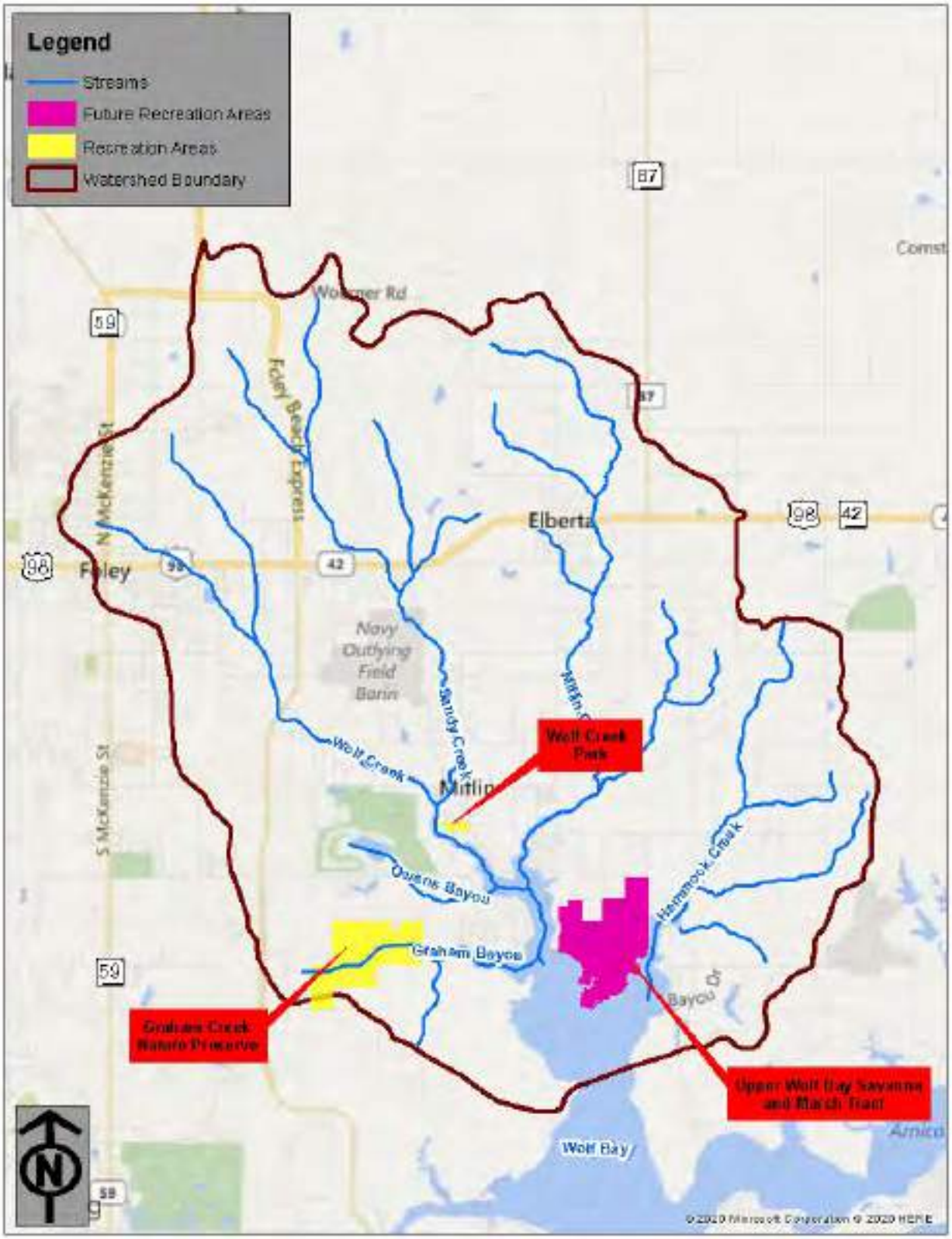

Figure 4.20 Publicly Owned Recreational Areas

The 484-acre Graham Creek Nature Preserve comprises abundant natural habitats, including pine savannahs, wetlands, and tidal marshes. Recreational features within the Preserve include a canoe and kayak launch (**Figure 4.21**), walking and hiking trails, picnic areas, bird watching, an archery park, three full disc golf courses, and a Nature Explore Outdoor Classroom. Throughout the Preserve, interpretive signage identifies populations of rare plant and animal species and their habitats. The 25-acre Wolf Creek Park provides recreational features such as a canoe and kayak launch, a fishing pier, and picnic areas. It has a noted shore bird rookery within the sheltered cove on the property.

Historically, water access in the Watershed for motorboats was provided through a privately owned and maintained boat launch. Members of the community were asked to provide a nominal fee to use the launch to help with maintenance and upkeep of the facility. This launch has been permanently closed. Some of the neighborhoods in the Watershed have launches, but they are not available to the public. The nearest public launches to the Watershed are Josephine Park in the Josephine community or Canal Park in the City of Gulf Shores. The Josephine Park launch has two ramps and approximately 10 parking spaces. The Canal Park has one ramp and approximately 34 parking spaces. Space availability at these launches is insufficient for the Wolf Bay Watershed community.

Figure 4.21 Graham Creek Nature Preserve Kayak Launch

4.12 Land Use and Land Cover

4.12.1 Historic Land Use

Land use is among the most important drivers of watershed conditions and often determines when, where, and which stressors occur. The Watershed has a long history of human use and has changed drastically over time. **Figure 4.22** is based on land use data collected between 1970 and 1985 and is intended to establish a baseline from which to measure growth and change in in recent decades. From 1970-1985, agriculture (approximately 46%) and forested areas including wetlands (approximately 42%) dominated the Watershed. Commercial, residential, and industrial development comprised approximately 3% of the Watershed and was primarily centered around the City of Foley, Barin Field, and the Town of Elberta.

Figure 4.23 reflects the National Land Cover Database (NLCD) land cover imagery collected in 2006. Agricultural land use (approximately 38% of the Watershed) declined 8% from 1970-1985, while development land use (approximately 14% of the Watershed) rose by 11%. Forested areas including wetlands (approximately 40% of the Watershed) decreased slightly by 2%.

Figure 4.24 is based on the NLCD 2011. Agricultural land use (approximately 37% of the Watershed) declined slightly by 1% from 2006 while development land use (approximately 15% of the Watershed) rose slightly by 1%. Forested areas including wetlands remained unchanged from 2006.

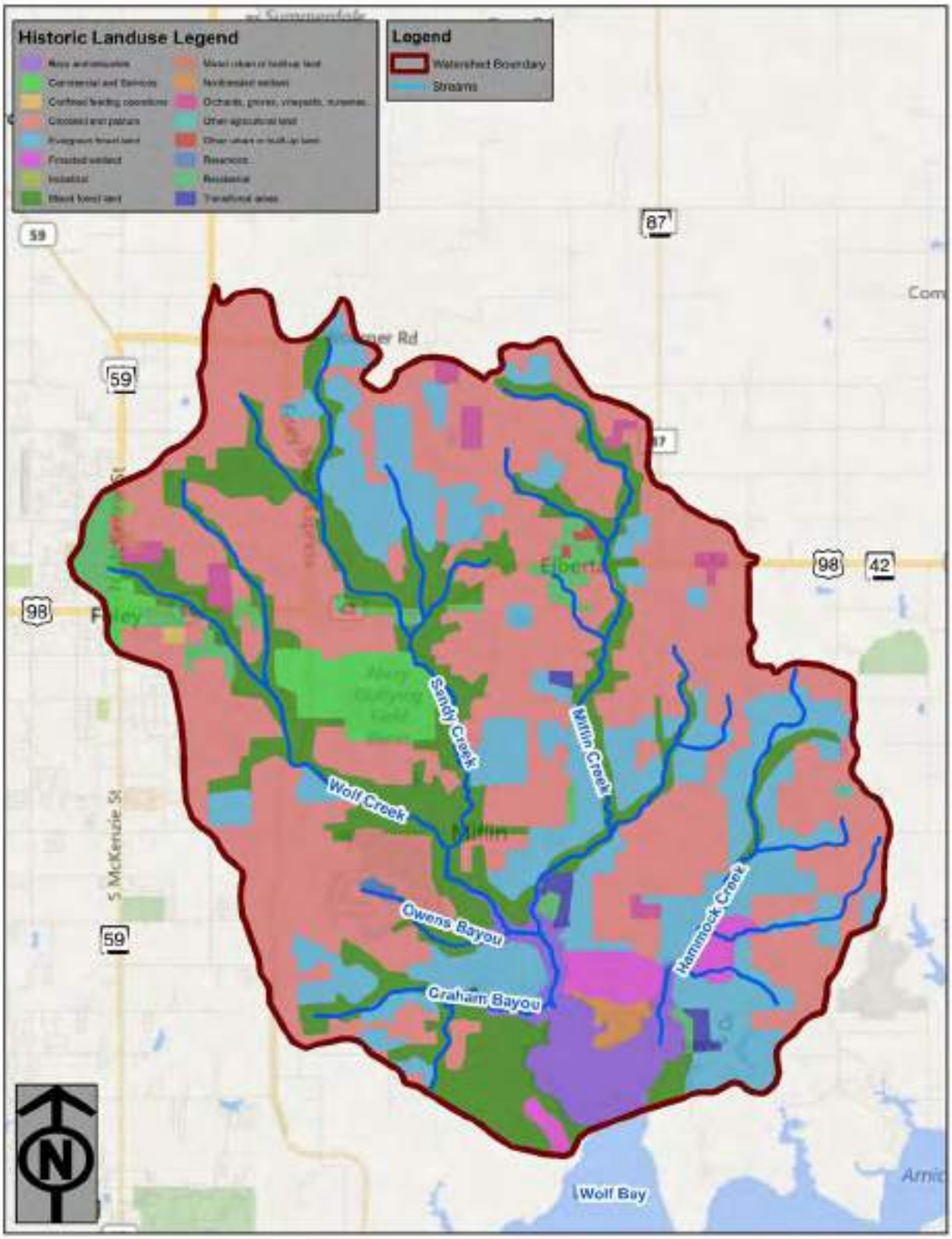

Figure 4.22 1970-1985 Land Use/Cover

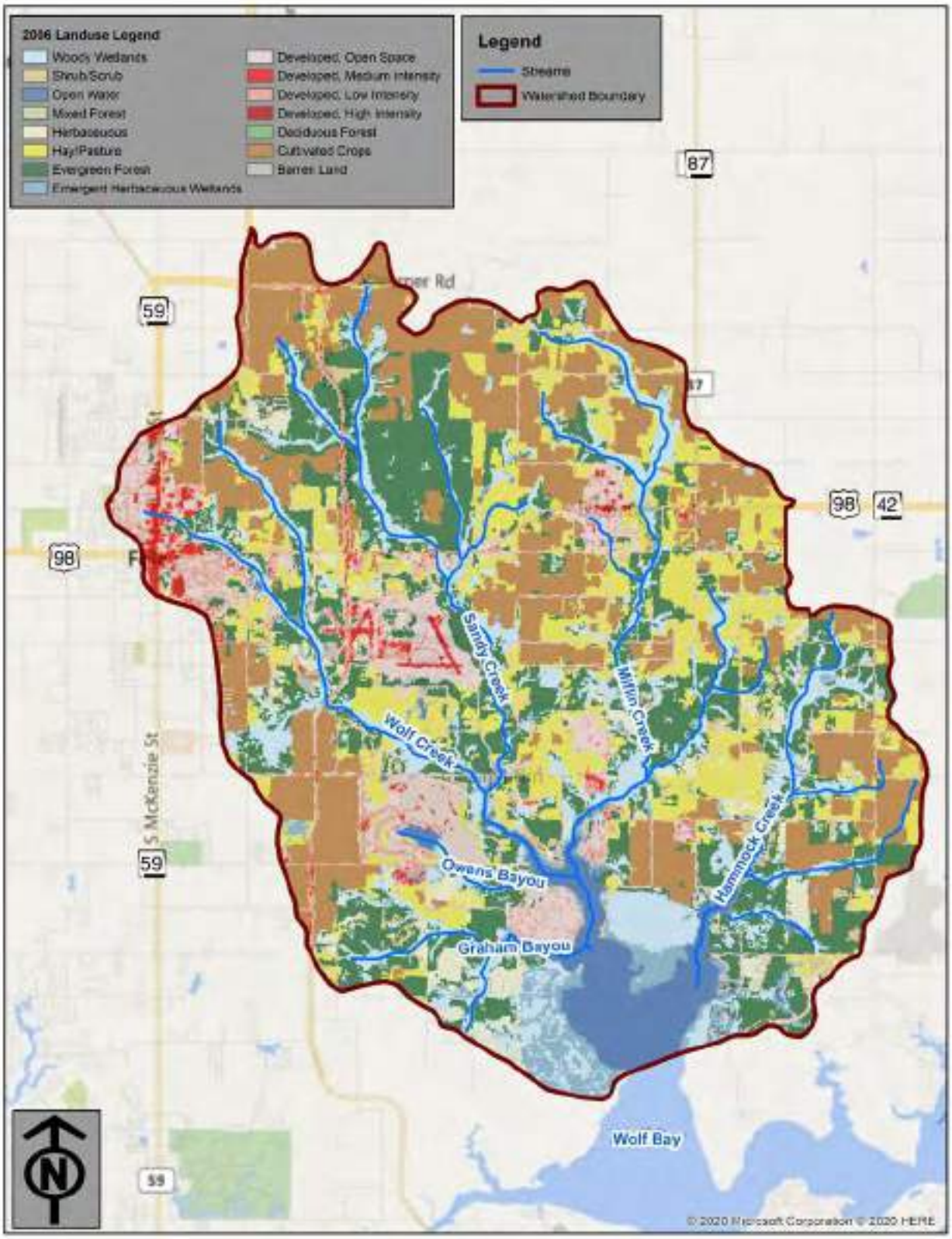

Figure 4.23 2006 Land Use/Cover

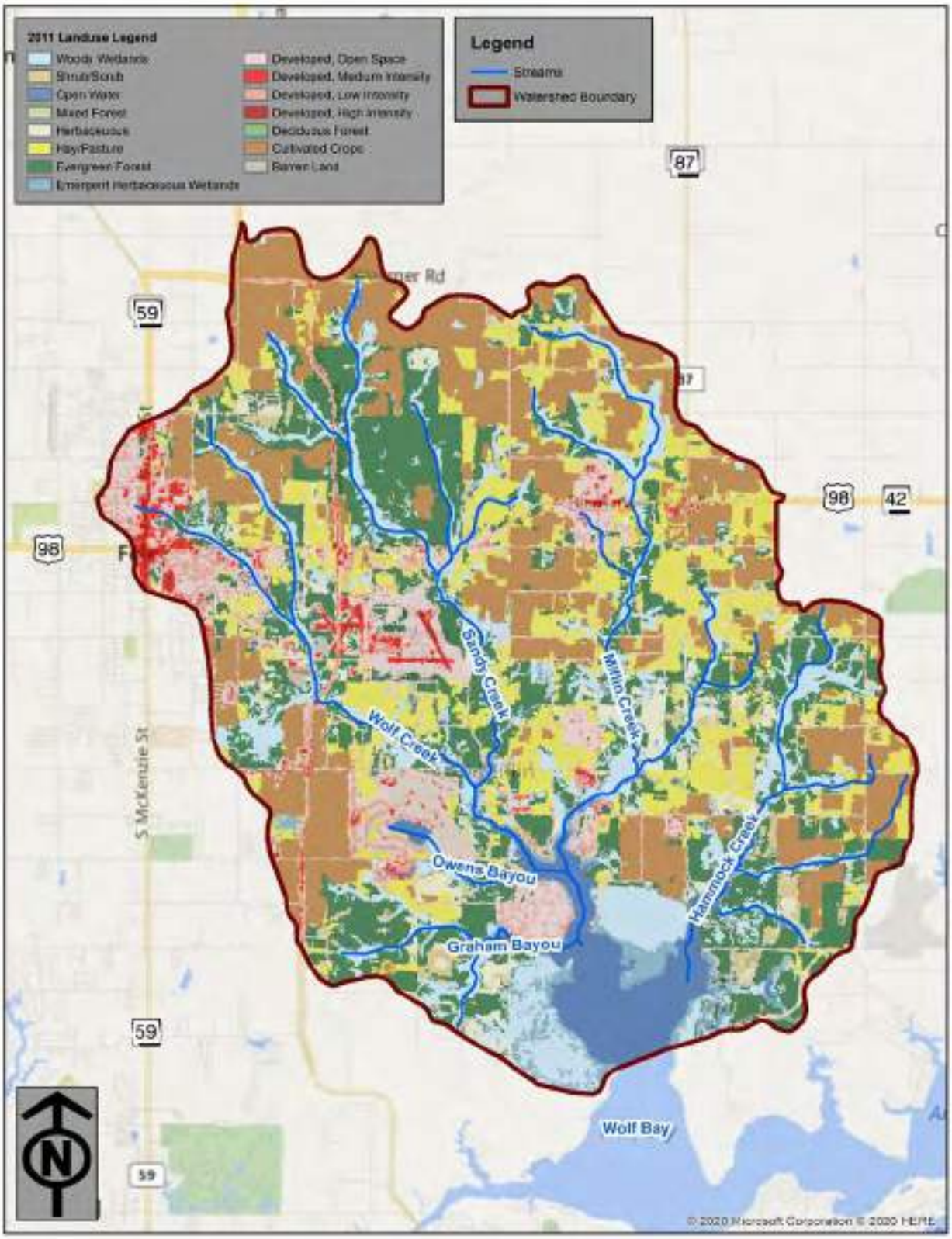

Figure 4.24 2011 Land Use/Cover

4.12.2 Current Land Use

Figure 4.25 reflects the NLCD 2016 land use data for the Watershed. In 30 years, agricultural land use decreased by approximately 11% to a coverage of 35% in the Watershed, while development has increased by approximately 12% to a coverage of 15% in the Watershed. Forested areas including wetlands have decreased slightly by approximately 3% to 39%. In comparing the historical data to the 2016 data, the decrease in agricultural land use and increase in development land use reflects the changing cultural and socioeconomic conditions in the Watershed.

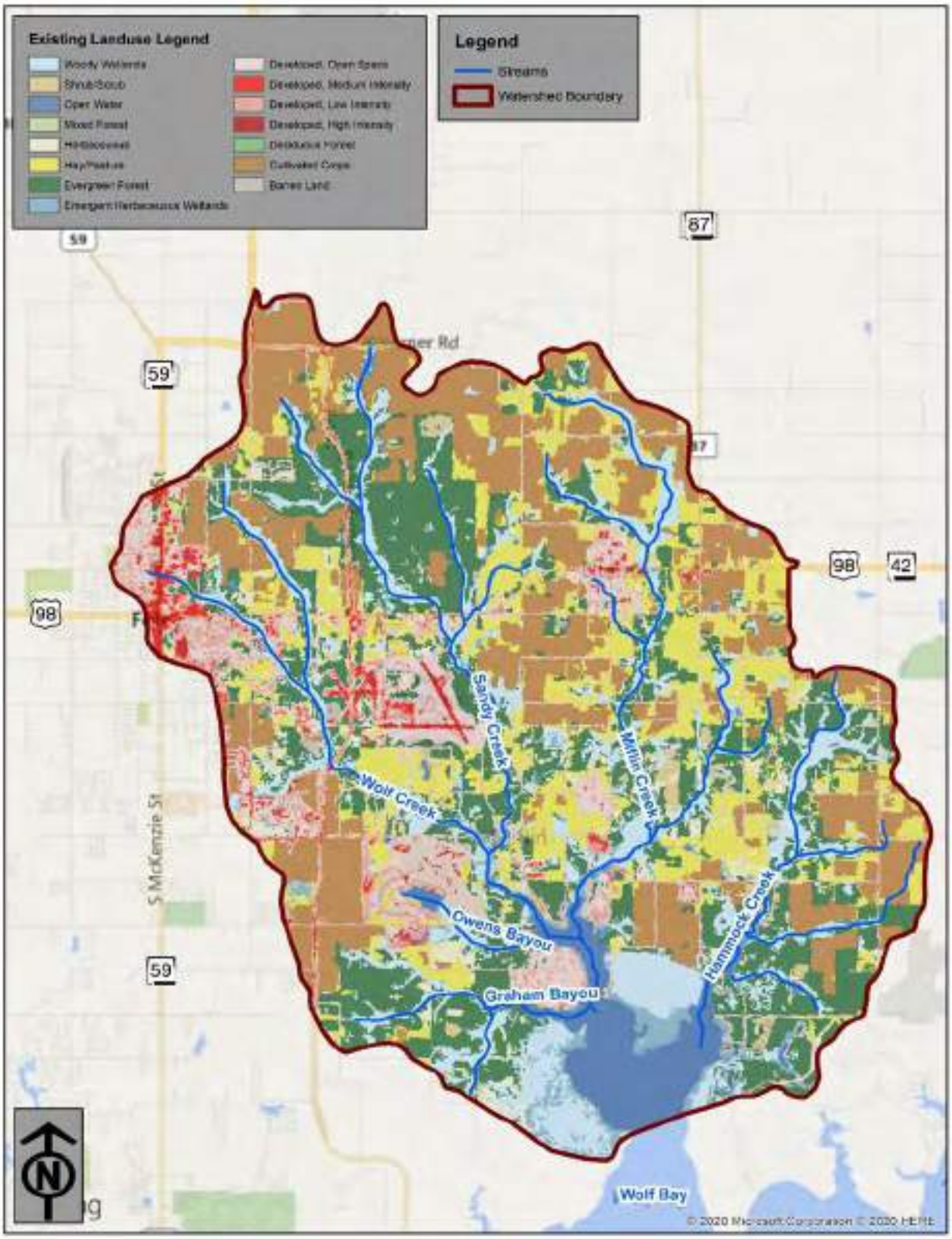

Figure 4.25 2016 Land Use/Cover

4.12.3 Future Land Use

Table 4.14 shows the predicted percent cover of land use types (agriculture, development, and forested areas/wetlands) within the Watershed through 2040. These estimates are based on the rate of change of each land use category within the Watershed from 1970-1985 to 2016 and coincides with the predicted increase in population (**Table 4.7** in Section 4.8.2).

Table 4.14 Future Land Use Projections

Land Use	1970-1985	2006	2011	2016	2020	2030	2040
Agriculture	46%	38%	37%	35%	33%	30%	26%
Development	3%	14%	15%	15%	18%	22%	26%
Forested Areas/Wetlands	42%	40%	40%	39%	39%	38%	37%

4.12.4 Impervious Cover

Impervious cover includes surfaces that do not allow precipitation to infiltrate into the ground, therefore, increasing the volume and velocity of storm water runoff to surface waters. Examples of impervious cover include paved roadways, and parking lots, sidewalks, and rooftops. Impervious surfaces can affect water quality by increasing the rates of erosion and sedimentation and the loading rates of nutrients and other pollutants transported by stormwater runoff. According to the 2016 NLCD impervious cover dataset, approximately 5,679 acres of the Watershed are currently encapsulated with impervious cover (**Figure 4.26**). Of that total, 2,613 acres (46.01%) is paved roadway. As the area continues to grow, the amount of impervious cover will increase.

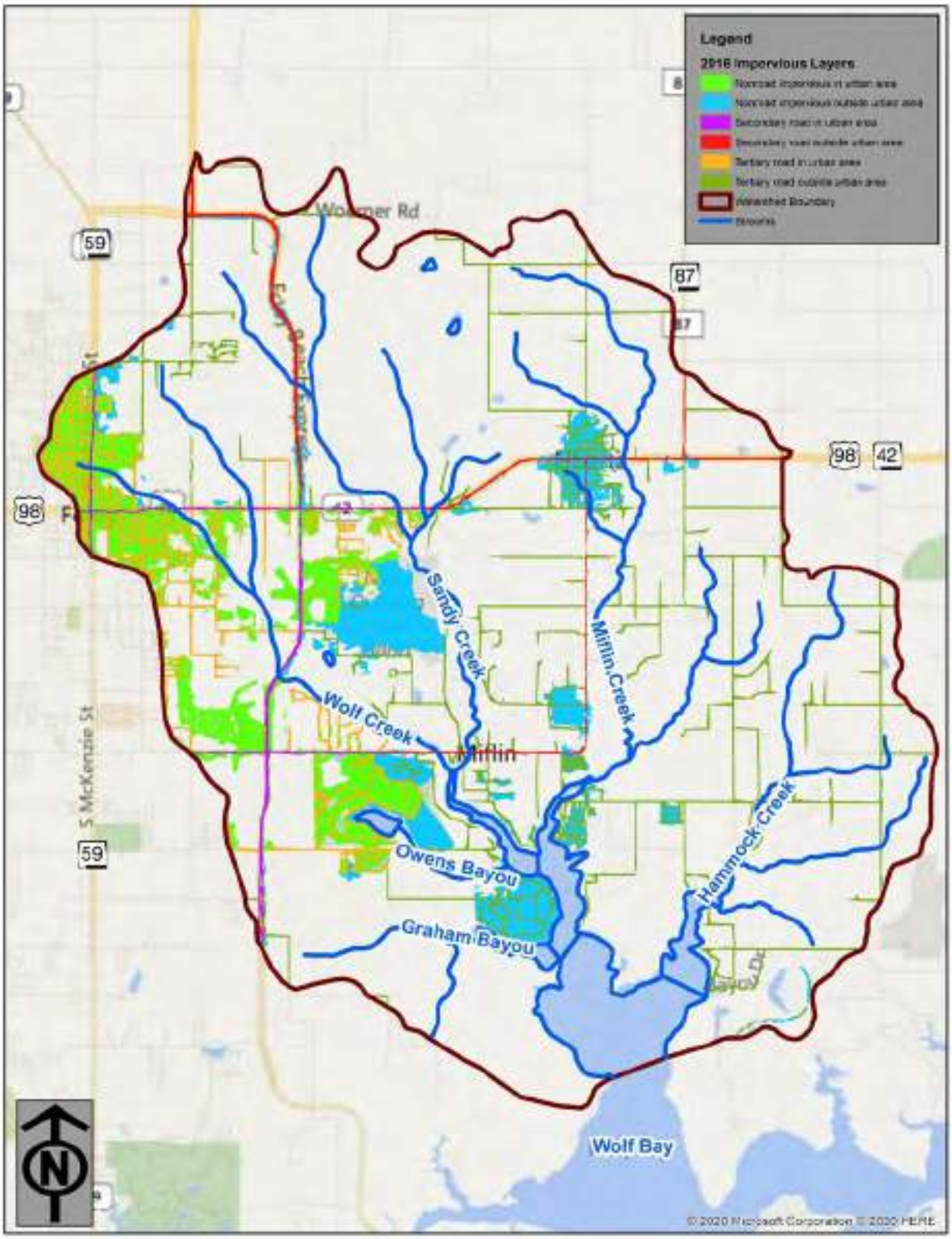

Figure 4.26 2016 NLCD Impervious Cover

Chapter 5 Watershed Conditions

5.1 Water Quality Standards

Discharge of pollutants into waterways within the Wolf Bay Watershed is regulated through federal and State programs administered by the Alabama Department of Environmental Management (ADEM). These programs include the Clean Water Act (CWA) Section 303(d) Impaired Waters and Total Maximum Daily Load (TMDL) program and the National Pollutant Discharge Elimination System (NPDES) program.

5.1.1 Water Use Classification and Water Quality Criteria

Under the guidance of the U.S. Environmental Protection Agency (USEPA), ADEM is responsible for establishing Water Use Classifications (WUCs) for waters in Alabama. Each WUC is accompanied by specific water quality standards. WUC, and associated water quality standards to support such uses, were established through public participation in the initial establishment and periodic review of water quality standards by ADEM (ADEM 2019). **Table 5.1** summarizes thresholds for water quality standards for each of the seven WUCs in Alabama.

Table 5.1 Alabama Water Use Classifications and Water Quality Standards (Source: ADEM 2018)

Water Use Classification	pH	Water Temp.	Dissolved Oxygen	Fecal Coliform Bacteria (geometric mean)[a]	Enterococci Bacteria (geometric mean)[b]	Turbidity (above background)
Outstanding Alabama Water	6.0–8.5[a] 6.5-8.5[b]	≤ 90°F	≥ 5.5 mg/L	126 colonies/ 100 ml	35 colonies/ 100 ml	≤ 50 NTU
Public Water Supply	6.0–8.5[a] 6.5–8.5[b]	≤ 90°F	≥ 5.0 mg/L	126 colonies/ 100 ml[C]	35 colonies/ 100 ml[C]	≤ 50 NTU
Swimming and Other Whole-Body Water-Contact Sports	6.0–8.5[a] 6.5–8.5[b]	≤ 90°F	≥ 5.0 mg/L	126 colonies/ 100 ml	35 colonies/ 100 ml	≤ 50 NTU
Shellfish Harvesting	6.5–8.5[b]	≤ 90°F	≥ 5.0 mg/L	N/A	35 colonies/ 100 ml[C]	≤ 50 NTU

Water Use Classification	pH	Water Temp.	Dissolved Oxygen	Fecal Coliform Bacteria (geometric mean)[a]	Enterococci Bacteria (geometric mean)[b]	Turbidity (above background)
Fish and Wildlife	6.0–8.5[a] 6.5–8.5[b]	≤ 90°F	>5.0 mg/L	126 colonies/ 100 ml[C]	35 colonies/ 100 ml[C]	≤ 50 NTU
Limited Warmwater Fishery	6.0–8.5[*] 6.5–8.5[b]	≤ 90°F	≥ 3.0 mg/L	548 colonies/ 100 ml	No geometric mean	≤ 50 NTU
Agricultural and Industrial Water Supply	6.0–8.5[a] 6.5–8.5[b]	≤ 90°F	≥ 3.0 mg/L	700 colonies/ 100 mla	No geometric mean	≤ 50 NTU

notes: mg/L – milligram per liter; ml – milliliter; NTU – nephelometric turbidity units

[a] Freshwater

[b] Marine and estuarine waters

[C] Incidental water contact and whole-body water-contact recreation months of May-October

WUCs in the Watershed include Outstanding Alabama Water (OAW), Swimming and Other Whole-Body Water-Contact Sports (S), Shellfish Harvesting (SH) and/or Fish and Wildlife (F&W). **Table 5.2** and **Figure 5.1** reflect the use classifications for each surface water body found in the Watershed. Streams with portions below +10 feet MSL are considered "coastal waters" and the portions above +10 feet MSL are considered "non-coastal waters".

Table 5.2 Use Classifications of Surface Waters in the Wolf Bay Watershed (Source: ADEM 2019)

Waterbody	From	To	Classification
Wolf Bay and all connecting coves and bayous	Intracoastal Waterway	Moccasin Bayou	OAW/SH/S/F&W
Wolf Bay and all connecting coves and bayous	Moccasin Bayou	Its source	SH/S/F&W
Miflin Creek	Wolf Bay	10 feet above MSL	S/F&W
Hammock Creek	Wolf Bay	10 feet above MSL	S/F&W
Wolf Creek	Wolf Bay	10 feet above MSL	F&W
Sandy Creek	Wolf Bay	10 feet above MSL	S/F&W
Miflin Creek	10 feet above MSL	Its source	F&W
Hammock Creek	10 feet above MSL	Its source	S/F&W

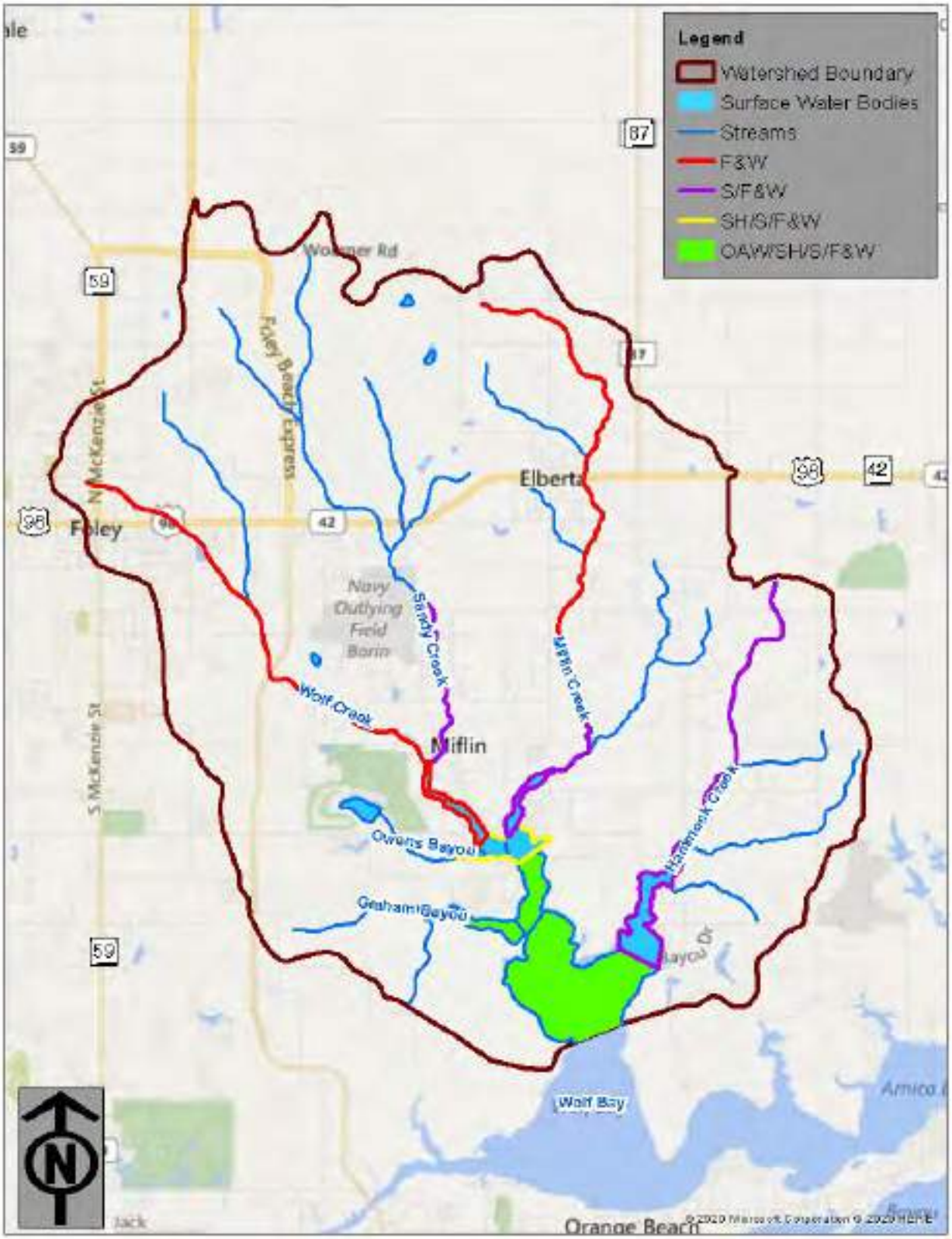

Figure 5.1 Use Classifications of Surface Waters

5.1.2 CWA Section 303(d) Impaired Waters and TMDL Program

The goal of the CWA, administered by the USEPA, is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 United States Code §1251[a]). Under Section 303(d) of the CWA, states are required to identify impaired waters and submit a list of these waters to the USEPA. These are waters that are too polluted or otherwise degraded to fully support their designated uses, based on water quality standards established by each state. In Alabama, ADEM is responsible for compiling and submitting a list of 303(d) impaired waters to USEPA. The 303(d) list includes the causes and sources of water quality impairment for each listed waterbody.

For waterbodies included on the 303(d) list, the state must calculate the maximum amount of each pollutant causing water quality impairment that can be allowed, such that the water quality standards for the waterbody are maintained. This calculation is known as a total maximum daily load, or TMDL. TMDLs are developed according to a specified schedule and must be approved by USEPA after an opportunity for public comment. Waterbodies can be removed from the 303(d) list after a TMDL is developed or after other changes have been made to correct water quality issues.

According to the Draft 2020 Alabama 303(d) list, there are three water bodies within the Watershed that have been declared impaired. Wolf Creek is listed for metals (mercury). Both Sandy Creek and Miflin Creek are listed for pathogens (enterococcus) and metals (mercury). No TMDLs have yet been developed for these waterbodies.

5.1.3 CWA Section 402 NPDES Permitting Program

Section 402 of the CWA established the NPDES permitting program to regulate discharges from all construction sites on an acre or greater of land, as well as municipal, industrial, and commercial facilities discharging wastewater or stormwater directly from a point source (pipe, ditch, or channel) into surface waters of the United States. Two types of permits are issued under the NPDES program. One is a general permit, and the second is an individual permit. The general permit covers a group of discharges with similar qualities within a given geographical location. An individual permit is a permit specifically tailored to an individual facility (USEPA, 2019).

Using the USEPA EnviroMapper database, seven municipal, industrial, or commercial facilities with general NPDES permits were identified within the Watershed. See **Figure 5.2** for NPDES facility locations.

These facilities include:

1. Ready Mix USA, LLC
2. Mobile Asphalt Company
3. Ascend Performance Materials
4. City of Foley, Public Works (Pesticide Permit)
5. Vulcan, Inc.
6. City of Foley, Foley Dirt Pit
7. Kelpet Dirt Pit

Due to the temporary nature of the discharges associated with the NPDES Construction General permit, those permitted sites are not identified on this map.

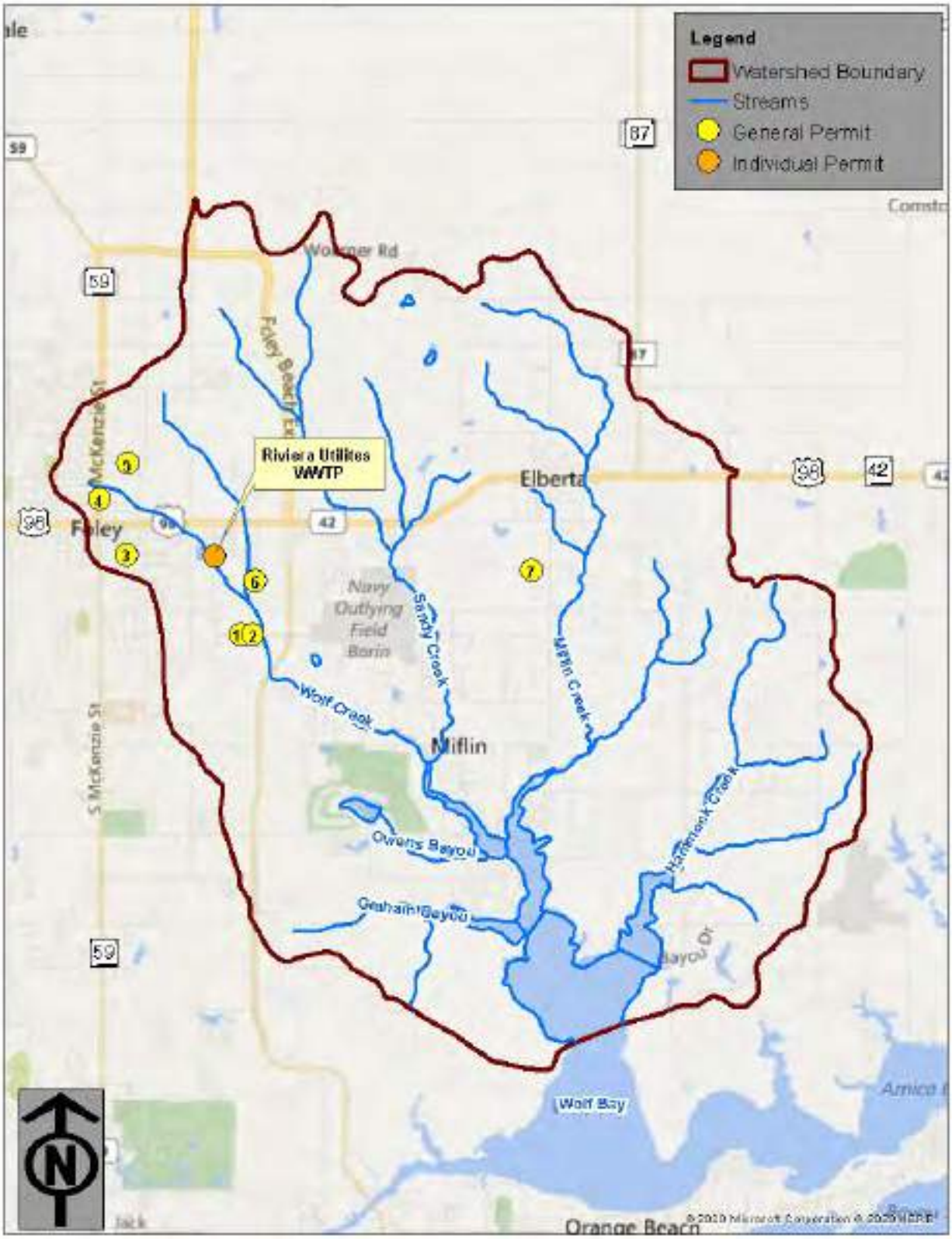

Figure 5.2 General and Individual NPDES Permits Within the Watershed

Riviera Utilities (**Figure 5.3**), also known as the Utilities Board of the City of Foley, has an individual NPDES permit (AL0049042) for biosolids and for stormwater discharge into Wolf Creek. They are currently in the process of upgrading the wastewater treatment plant to include:

- Increase from 2.0 million gallons per day (MGD) to 3.5 MGD permitted treatment capacity
- Design capacity of 4.0 MGD with a 10.0 MGD peak
- Installation of new:
    - Influent pump station
    - Headworks
        - Rotary drum screens
        - Vortex grit removal
    - Granular activated sludge treatment process
    - Tertiary filters
    - Septage receiving station
- Enhanced nutrient removal with a process guarantee of:
    - Phosphorus <1.5 mg/L
    - Total nitrogen <5mg/L

Figure 5.3 Riviera Utilities Wastewater Treatment Facility

5.1.4 NPDES Municipal Separate Storm Sewer Systems (MS4) Program

An MS4 is a conveyance or system of conveyances that is:

- owned by a state, city, town, village, or other public entity that discharges to waters of the United States,
- designed or used to collect or convey stormwater (e.g., storm drains, pipes, ditches),
- not a combined sewer, and
- not part of a sewage treatment plant, or publicly owned treatment works (POTW).

To prevent harmful pollutants from being washed or dumped into MS4s, certain operators such as cities, public universities, departments of transportation, hospitals, and prisons are required to obtain NPDES permits and develop stormwater management programs (EPA, 2019).

The 1990 Phase I regulation requires medium to large municipalities or certain counties with a population of at least 100,000 or more to obtain NPDES individual permit coverage for their stormwater discharges. The 1999 Phase II regulation requires small MS4s in the U.S. Census Bureau defined urbanized areas, as well as MS4s designated by the permitting authority, to obtain NPDES coverage for their stormwater discharges. Phase II also includes non-traditional MS4s such as public universities, departments of transportation, hospitals, and prisons (EPA, 2019). Phase II MS4s are covered by statewide general permits in Alabama.

Currently the City of Foley, the Town of Elberta, and the Town of Summerdale, along with the portions of the Watershed that fall under Baldwin County jurisdiction, qualify for an exemption under the NPDES MS4 program. However, due to rapid growth, the City of Foley is anticipating that the 2020 census results will require that they obtain a Phase II general permit. Phase II MS4 permittees are required to develop and implement a storm water management plan that includes programs on public education and public involvement on storm water impacts, illicit discharge detection and elimination (IDDE), construction site storm water runoff control, post-construction stormwater management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations.

5.2 Potential Nonpoint Source Pollutants

Nonpoint source (NPS) pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification. NPS pollution can include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas.
- Oil, grease, and toxic chemicals from urban runoff and energy production.
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks.
- Salt from irrigation practices and acid drainage from abandoned mines.
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems.
- Atmospheric deposition and hydromodification (EPA, 2019).

5.2.1 Agriculture

According to the National Land Cover Database (NLCD) 2016, agricultural land use makes up approximately 35% of the Watershed. If conservation practices are not properly implemented, water quality can be greatly affected by agricultural runoff. Examples of improper agricultural practices include:

- Poorly located or managed animal feeding operations and manure
- Overgrazing
- Plowing too often
- Plowing at the wrong time
- Improper fertilizer application

Agricultural activities in the Watershed include row crops (such as corn, peanuts and soybeans), sod farming, and animal grazing. Based on aerial imagery, most of the row crop areas have agricultural buffer strips. Many farmers in the Watershed employ the use of cover crops, no till planting, conservation crop rotation, contour farming, and variable rate nutrient application. Precision agriculture is also commonly used to reduce the impacts on the natural resources. Irrigation of crops and turf in the Watershed is mixed between conventional irrigation and variable rate irrigation. Variable rate irrigation waters the crops based on plant moisture index and reduces the overall water demand.

There are several farms within all three sub-watershed that engage in cattle farming (either for dairy or beef production). Most of these cattle are allowed to roam about large pastures and even wade in or drink from creeks and drains. During field reconnaissance, cattle were observed in the riparian areas of the headwaters of Miflin, Sandy, and Hammock Creeks. This creates opportunities for streams or creeks to be impacted by animal waste. Despite the possibility, a recent study conducted by Cook (2017) suggests that the nutrient loads and bacterial concentrations that usually accompany large-animal farming are not yet present within the Watershed.

5.2.2 Forestry

Approximately 39% of the Watershed comprises forested area, including wetlands. Potential sources of pollution associated with timbering activities include:

- Removal of streamside vegetation
- Road construction and use
- Harvesting
- Mechanical preparation for tree planting

The Alabama Forestry Commission provides guidance on best management practices to the timber industry; however, they are not an environmental regulatory or enforcement agency. Our field investigations showed no evidence of impacts to the Watershed due to forestry operations.

5.2.3 Impervious Cover

Impervious cover is a large contributor to NPS pollution. During field reconnaissance, several large tracts of land along the Foley Beach Express in the northwest section of the Watershed were listed for sale. Also, the City of Orange Beach is working towards constructing a bridge that will connect Orange Beach to the eastern side of the Watershed. If this bridge is constructed, it is reasonable to assume that current undeveloped property and agricultural fields could potentially be converted to residential and commercial developments. Careful planning and management of future growth are essential in maintaining water quality and the overall health of the Watershed. Implementing low impact development techniques on new developments and redevelopments in the Watershed will help reduce water quality impacts from impervious surfaces.

5.3 Surface Water Flow

The nature of water flow in streams is greatly influenced by land use and the management of its contributing watershed. The conversion of natural area to farmland changes how water drains from the landscape, and this process is more pronounced when natural areas are converted to impervious surfaces. Stormwater that cannot be absorbed by these surfaces contributes to an increase in volume and velocity of runoff following storm events.

Stream channels in the northern part of the Watershed, including the headwaters of Sandy, Wolf and Miflin creeks, usually exhibit flashy discharge events due to relatively high elevations (maximum 100 feet MSL) with topography that decreases in relief from north to south towards Wolf Bay (Cook, 2017).

Within the Watershed, there is one United States Geological Survey (USGS) stream flow monitoring station (USGS 02378170) located on Wolf Creek at Doc McDuffie Road. This station monitors the general water flow characteristics of the northwest portion of the Watershed. It is reasonable to assume that general water flow characteristics of Wolf Creek are comparable to flow characteristics typical of the entire Watershed because of similarities in the land use, topography, and soils of the surrounding areas. During rainfall events, stream flows increase rapidly over several hours. Flows decrease relatively quickly during the first few hours after the event, then taper down slowly over days until resuming base flow conditions. This change in stream flow over time, or stream flow hydrography, is typical of partially developed watersheds. **Figure 5.4** depicts the peak discharge over an annual time period.

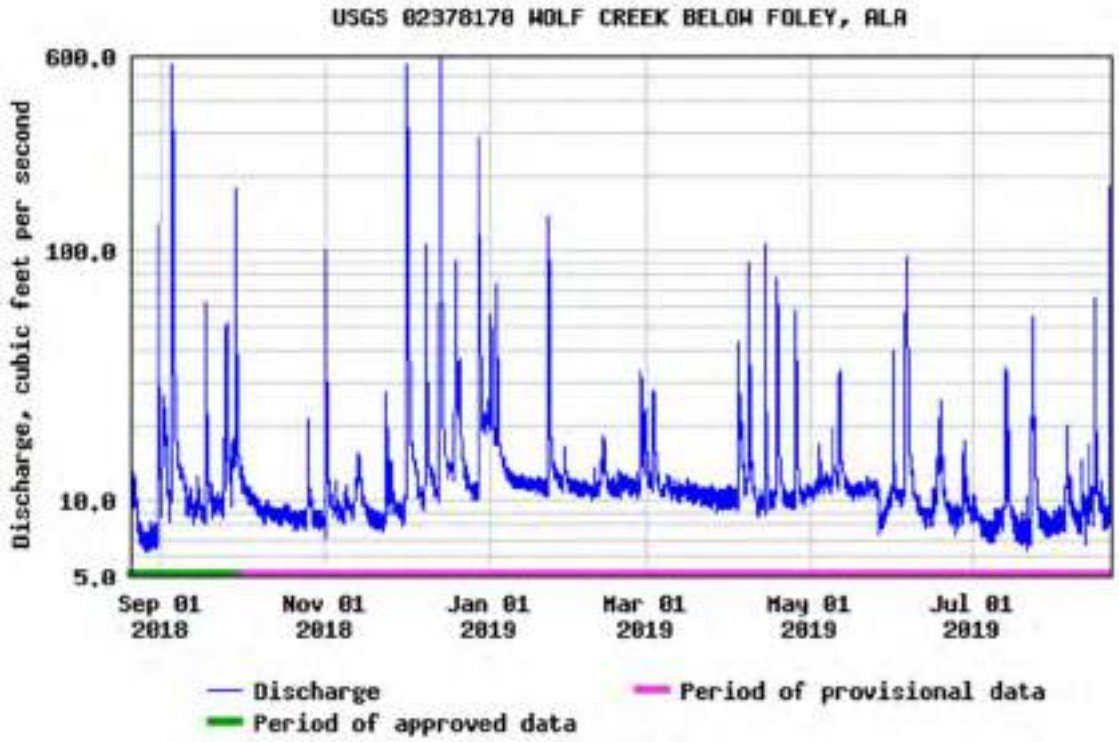

Figure 5.4 USGS Peak Discharge Over an Annual Time Period

Station data can be accessed using the following link:
https://waterdata.usgs.gov/al/nwis/inventory/?site_no=02378170&agency_cd=USGS

The smaller tributaries within the Watershed either become parched during dry weather conditions or convey low discharge rates and velocities, but during intense rainfall events, the tributaries are extremely flashy with high discharge rates and velocities occurring quickly (Cook, 2017). Impaired stream conditions during dry weather could be, at least in part, the result of reduced groundwater infiltration due to impervious cover.

5.4 Sediment Transport

Sediment is transported in watersheds by overland flow, which is concentrated in small depressions and gullies and eventually discharged into streams that transport the sediment with material eroded from the stream banks and bottom until it is ultimately deposited. Erosion rates are accelerated by human activity and poor land management practices that increase the volume and velocity of stormwater runoff, resulting in negative impacts to the habitats of the receiving waterbodies.

Results from the 2017 Cook study show that six of the 15 sites monitored within the Wolf Bay Watershed conveyed both suspended and bed load sediment. Of the six sites, Wolf Creek at Doc McDuffie Road, the west unnamed tributary to Sandy Creek at US Highway 98, the east unnamed tributary to Sandy Creek at US Highway 98, and Wolf Creek at Swift Church Road had the largest total sediment loads (10,931, 1,995, 1,715, and 1,257 tons per year [t/yr], respectively). During field reconnaissance, land use upstream and in the vicinity of these monitoring locations were surveyed to identify input sources that contribute to erosion and sediment in each of these stream locations. The headwaters of Wolf Creek above the Doc McDuffie Road site are characterized by urban (western headwater branch) and agricultural (eastern headwater branch) land use. Fern Avenue Extension is being constructed from State Route 59 to the Foley Beach Express (FBE) across the eastern headwater. With the addition of this new roadway, current agricultural land use has the potential to be converted to urbanized land use, therefore, increasing the potential of flashy, high-velocity flows in the eastern branch. Property access was granted at two locations downstream of the Doc McDuffie location and the monitoring site at Swift Church Road. Immediately downstream of the Doc McDuffie location, the streambanks were stabilized, and it appeared the stream was able to access the floodplain (**Figure 5.5**). Further downstream between the FBE and Swift Church Road, extensive stream bank erosion has occurred (**Figure 5.6**). Interviewing the property owner, who has owned the property for over 30 years, revealed that noticeable erosion did not occur until the April 2014 flood.

Figure 5.5 Stabilized Stream Segment Downstream of Doc McDuffie Road

Figure 5.6 Unstable Stream Segment Between FBE and Swift Church Road

Upstream of the west unnamed tributary to Sandy Creek is mainly forested with agricultural input, and upstream of the east unnamed tributary, home construction has started again in the Sandy Creek Farms Subdivision. Historical aerials were also reviewed for these two locations to help identify potential input sources. During the period between February 2017 and November 2017, upstream of the eastern unnamed tributary, a historic pond was drained, allowing the stream to reestablish. Erosion on the western unnamed tributary is highly visible in the February 2017 Google Earth aerial (**Figure 5.7**), and erosion on the eastern unnamed tributary is highly visible in the November 2017 Google Earth aerial (**Figure 5.8**).

Figure 5.7 February 2017 Google Earth Aerial Image

Figure 5.8 November 2017 Google Earth Aerial Image

5.5 Water Quality

Water quality is an important factor for healthy ecosystems, safe access to natural resources, and public health and safety. Water quality also determines the types of uses and activities for which a waterbody is suitable, as described in **Section 5.1.1**. Use of surface waters for public water supplies, fishing, swimming, and agriculture depends upon water quality. Poor water quality can render waters unsuitable for these uses and have detrimental effects on the natural environment. Many factors affect water quality, including land use, climate, groundwater, and geological resources. Water quality may be the single most important factor in determining the overall health of a watershed.

A water quality assessment was performed as part of the pre-restoration study conducted by Cook (2017) for the Watershed. Samples were collected and analyzed for nitrogen, total phosphorus, dissolved oxygen, and pathogens. The analysis concluded that for the 15 sites monitored, every site had an average nitrogen

concentration above the ADEM established reference standard (0.3258 mg/L); ten of the 15 sites had an average total phosphorus concentration above the ADEM established reference standard (0.04 mg/L); and 12 of the 14 sites had average dissolved oxygen values less than the ADEM reference standard (6.94 mg/L).

Seven sites were sampled for pathogens during the low discharge event. Each site had relatively low numbers for surface water and most likely did not represent a particular point source. When the samples were correlated with watershed area, Cook (2017) suggested that the sample site located on Elberta Creek (tributary to Miflin Creek) had relatively high numbers and may represent a source of pathogens above background levels. Field reconnaissance identified cattle grazing upstream of the sample point.

5.6 Biological Conditions

The Graham Creek Preserve serves as a home to several State of Alabama-listed endangered and threatened plant species (**Table 5.3)**.

Table 5.3 State of Alabama Listed Threatened and Endangered Plant Species

Species	Status
Rush Featherling (*Pleea tenuifolia*)	Endangered
Shortleaf Rosegentian (*Sabatia brevifolia*)	Endangered
White Top Pitcherplant (*Sarracenia leucophylla*)	Endangered
White Arrow Arum (*Peltandra sagittifolia*)	Endangered
Pineland Bogbutton (*Lachnocaulon digynum*)	Endangered

In addition to many common animals, such as the common gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), rabbit (*Sylvilagus floridanus*), nine-banded armadillo (*Dasypus novemcinctus*), Virginia opossum (*Didelphis virginia*), and whitetail deer (*Odocoileus virginianus*), the Preserve also provides shelter for the gopher tortoise (*Gopherus polyphemus*) and the bald eagle (*Haliaeetus leucocephalus*). The gopher tortoise is currently listed as a candidate species for listing as a threatened species with the USFWS under the Endangered Species Act. The bald eagle is federally protected under the Bald and Golden Eagle Protection Act.

5.7 Habitat Conditions

There are three habitat restoration/management areas located within the Watershed. The first site is a restoration site of approximately 2,200 feet of Wolf Creek between State Route 59 and North Poplar Street in an urbanized area. The historically channelized stream reach was restored by creating meanders in the stream and reestablishing the floodplain. The floodplain was then planted with native vegetation. The implementation of this project reduced streamflow velocities and helps limit erosion downstream.

The second area is the Graham Creek Preserve. The Preserve comprises 484 acres of natural habitat, including wet pine flats, bottomland hardwood wetlands, and tidal marshes. Habitat restoration activities at this park include prescribed burning and invasive species treatment in wetland areas.

The third area is referred to as the Upper Wolf Bay Savanna and Marsh Forever Wild Tract. This is a 568-acre tract that lies on the north shore of Wolf Bay. A management plan was prepared for this property in May 2018. In the plan, management goals set forth include inventorying, enhancing, restoring, and protecting the biodiversity of the natural communities currently on the property and those which may naturally succeed the existing communities, particularly sensitive populations which exist within the tract.

5.8 Stream and Shoreline Assessment

5.8.1 Shoreline Type Classification

Jones and Tidwell (2011) identified nine shoreline classification types within the Wolf Bay Watershed. **Table 5.4** shows that vegetated shorelines with a low bank were most frequently identified followed by marsh and open vegetated fringe organic shorelines. **Figure 5.9** provides a visual illustration of shoreline classification types throughout the Watershed.

Table 5.4 Wolf Bay Watershed Shoreline Classification Types

Shoreline Type	Length (ft)
Artificial	1,263
Inlet	1,155
Organic (Marsh)	34,480
Organic (Open, Veg. Fringe)	56,864
Organic (Swamp Forest)	1,248
Pocket Beach	346
Sediment Bank (low)	6,404
Vegetated Bank (High)	9,315
Vegetated Bank (Low)	89,493
TOTAL	200,568

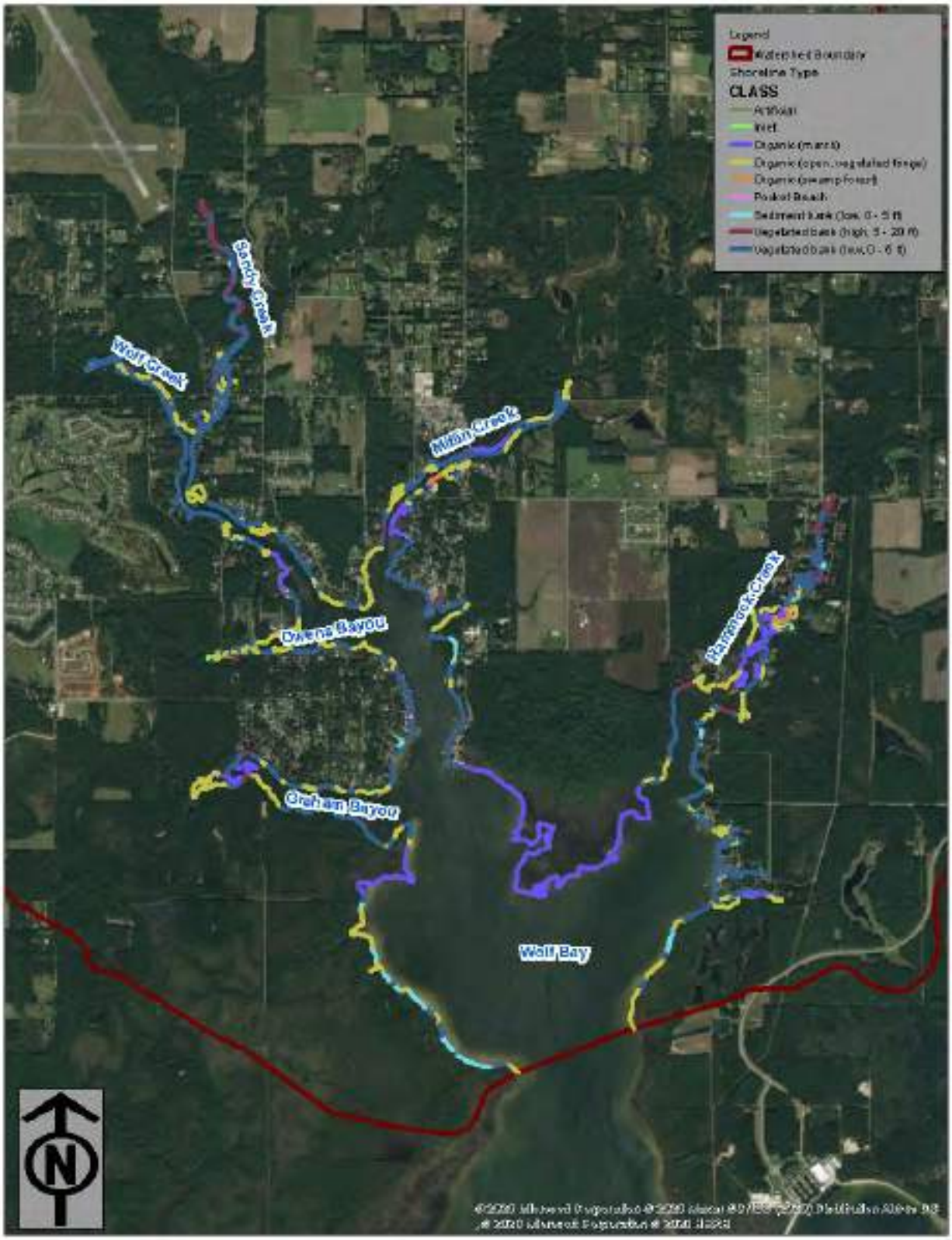

Figure 5.9 Shoreline Classification Types Along Water Bodies in the Wolf Bay Watershed

5.8.2 Shoreline Protection Methods

Jones and Tidwell (2011) also identified shoreline protection methods through field observations of approximately 63,190 linear feet of shoreline. throughout the Wolf Bay Watershed. Natural, unretained shorelines made up the majority of the shorelines throughout the Watershed followed by bulkhead protection strategies. **Table 5.5** lists shoreline protection methods and their corresponding lengths along surface waters within the Watershed. **Figure 5.10** provides a visual illustration of shoreline protection methods throughout the Wolf Bay Watershed.

Table 5.5 Wolf Bay Watershed Shoreline Protection Methods

Shoreline Protection Method	Length (ft)
Abutment	108
Artificial	28
Beach Nourishment	14
Boat Ramp	211
Bulkhead (concrete)	210
Bulkhead (cresote)	51
Bulkhead (steel, wood)	8,103
Bulkhead (w/groin)	35
Bulkhead (w/ retaining wall)	38
Bulkhead (w/riprap)	376
Groin	20
Natural	52,127
Rubble/Riprap	1,841
Sill (wood)	21
TOTAL	63,190

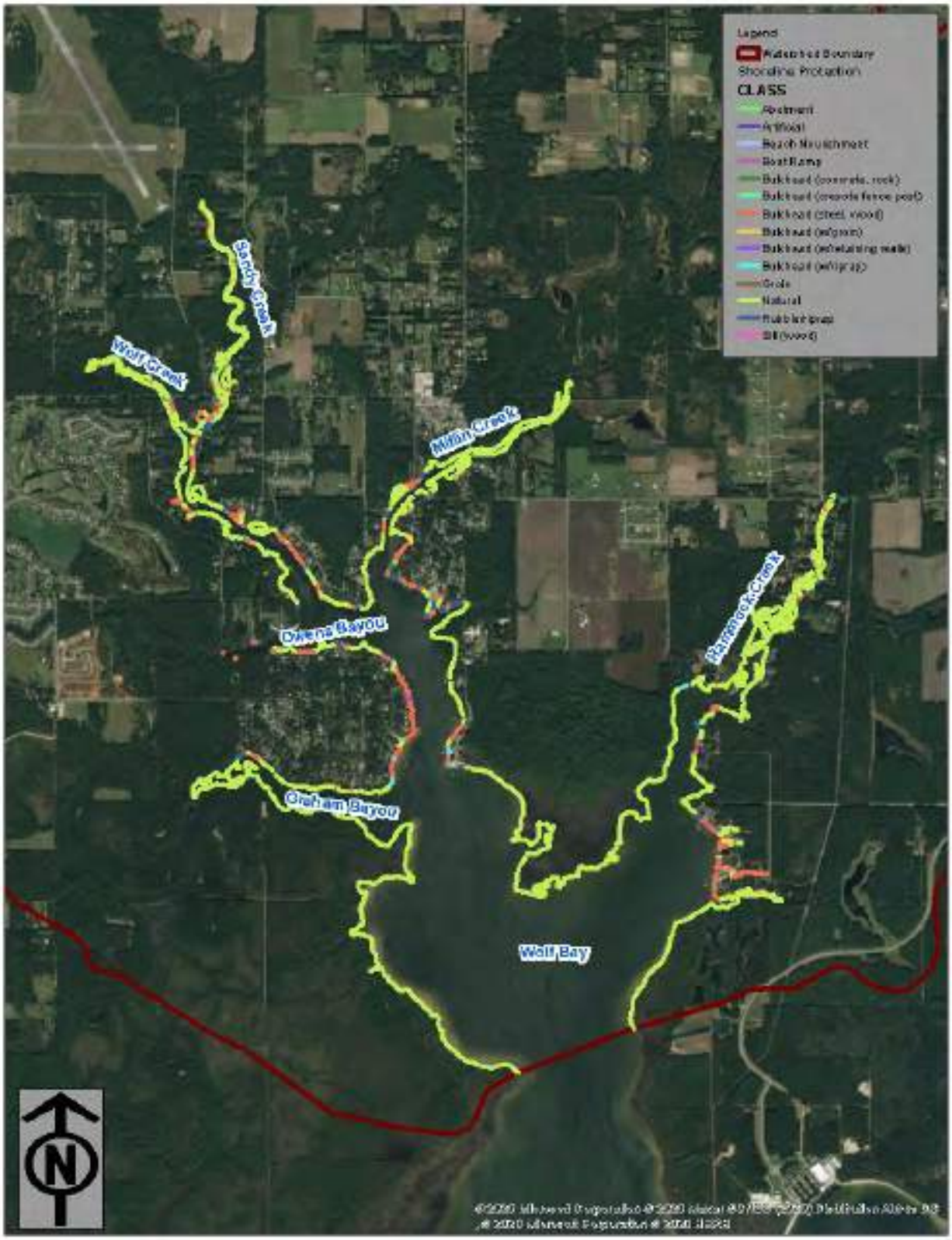

Figure 5.10 Shoreline Protection Methods Along Water Bodies in the Wolf Bay Watershed

5.8.3 North Wolf Bay (Moccasin Bayou), Graham Bayou, and Owens Bayou

The shorelines of northern Wolf Bay (Moccasin Bayou), Graham Bayou, and Owens Bayou are either emergent wetlands, are protected by bulkheads or rip rap, or are living shorelines. Currently, there are no known areas of concern for the shorelines along this portion the Bay.

5.8.4 Wolf Creek

Wolf Creek contained minimal amounts of litter. Invasive species noted included Chinese tallow, cogon grass, and alligator weed (**Figure 5.11**). Chinese tallow and cogon grass were observed at the County Road 20 bridge crossing. Areas of alligator weed were identified downstream of the Swift Church Road bridge. There were small areas of bank instability/sloughing observed and sediment deposition in the forms of sand bars along the channel throughout the stream (**Figure 5.12**). Overall, the stream was generally very shallow with many impediments to flow (fallen trees) throughout.

Figure 5.11 View of Alligator Weed in Wolf Creek

Figure 5.12 Example of Bank Instability/Sloughing Along Wolf Creek

5.8.5 Sandy Creek

Sandy Creek contained only minimal amounts of litter and invasive species, including Chinese tallow. Numerous trees were noted (mainly cedar) leaning out of the banks over the channel that could result in potential future bank failure and/or channel blockage (**Figure 5.13**). Some bank instability was observed primarily in the residential areas. There were several small pipe outfalls (some flowing) protruding out of the banks and bulkheads along the stream (**Figure 5.14**). The effluent water appeared to be clear and no odor was detected.

Figure 5.13 Example of Trees Leaning Over the Sandy Creek Channel

Figure 5.14 Example of Outfall Pipe Located Along Sandy Creek

5.8.6 Miflin Creek

There was no litter noted and there were few to no invasive species found along Miflin Creek. There were many log jams throughout the Creek that make it difficult to navigate by motorboat, as shown in **Figure 5.15**. Bank stability was satisfactory in all but two places, where head cutting was observed. The water in this reach was exceptionally clear, and more fish were observed in Miflin Creek than in any other water body surveyed.

Figure 5.15 Example of Log Jam Found in Miflin Creek

5.8.7 Hammock Creek

While no litter was observed in or along Hammock Creek, there were invasive species noted. Large privet thickets, such as those shown in **Figure 5.16**, along with Japanese climbing fern, were overserved along the stream banks, and cogon grass was found at the County Road 20 bridge crossing. The banks upstream of the County Road 20 bridge were extremely eroded, and there were numerous log jams observed in the stream as shown in **Figure 5.17**. Sand and sediment bars were present throughout the channel.

Hammock Creek south of the County Road 20 bridge is bordered by residences until it reaches Wolf Bay. There were some examples of bank erosion noted, but these were sparse and likely caused by neglected properties or home construction activities. The channel appears maintained to allow access to boaters.

Figure 5.16 Example of Privet Thicket Along the Shore of Hammock Creek

Figure 5.17 Example of Eroded Streambanks and Log Jams Found Along Hammock Creek

Chapter 6 Climate Vulnerability Assessment

6.1 Introduction to Climate Vulnerability

Given the significant amount of data collected and analyzed with respect to climate change, climate vulnerability, and sea level rise, it is important to analyze and discuss those impacts on a more local (watershed) scale. This chapter will provide an overview and analysis of the potential impacts of climate change, combined with an assessment of the Wolf Bay Watershed's vulnerability and potential resilience to climate change and, particularly, sea level rise. This issue has the potential to affect not only ecologic function and migration patterns but also patterns of man-made development. Particular issues of concern include the ability of natural habitats to migrate and adapt to changes effected by sea level rise and the need for local governments to plan accordingly when siting critical infrastructure, such as water and wastewater conveyances and treatment, public safety facilities, and emergency response facilities.

Through Chapter 6, we will review and discuss a number of analytical tools created by the Mississippi/Alabama Sea Grant Consortium, The Nature Conservancy, NOAA's Digital Coast website, along with other models, tools, and resources that provide information relevant to climate vulnerability in the Wolf Bay Watershed. Additionally, this Chapter will utilize existing models such as the Sea Level Affecting Marshes Model (SLAMM), the Coastal Resilience Index, and the Coastal Vulnerability Index.

6.2 Sea Level Rise Data Overview

Regional sea level trend data derived from the NOAA Tides and Currents website indicates an average sea level rise trend of approximately 3.07 millimeters per year. Data analyzed were collected from tide gauges at Dauphin Island, Alabama, and Pensacola, Florida, shown in **Figure 6.1**.

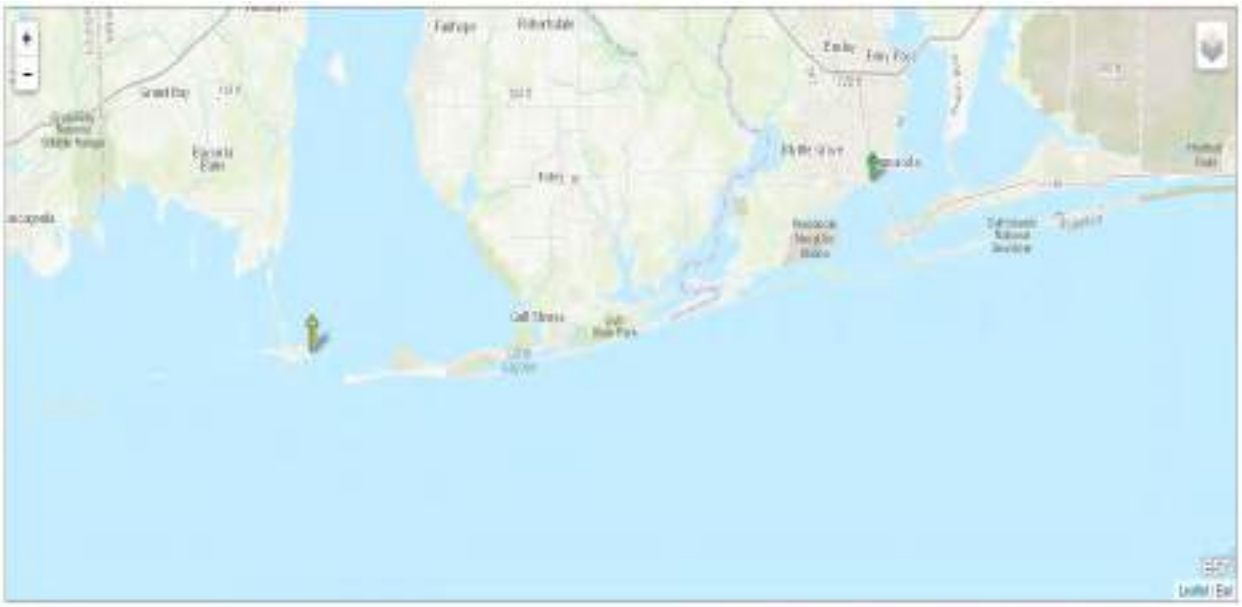

Figure 6.1 Locations of Tide Gauges Used for Data Analysis

The linear trend for Dauphin Island is 3.74 mm/yr while Pensacola is 2.40 mm/yr, with an average of 3.07 mm/yr between the two stations. This trend translates to 1.23 feet and 0.79 feet of sea level rise at the Dauphin Island and Pensacola Stations, respectively over 100 years with a regional average of approximately 1.01 feet of sea level rise. **Figures 6.2 and 6.3** depict the linear trend for the Dauphin Island and Pensacola tide gauges, respectively, from 1900 and projected through 2020.

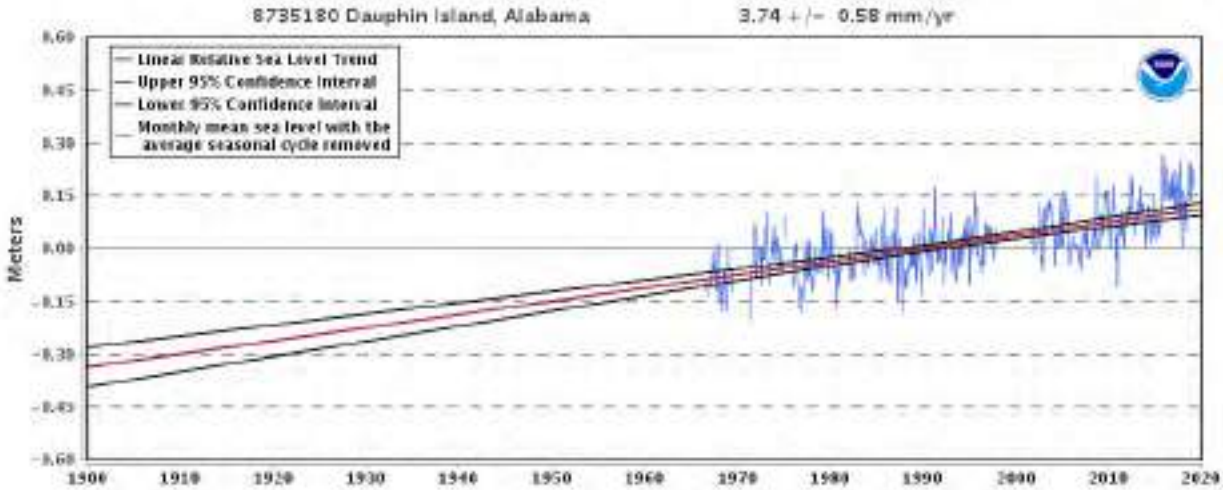

Figure 6.2 Sea Level Rise Trends for Dauphin Island, Alabama Through 2020 (Source: NOAA, 2020)

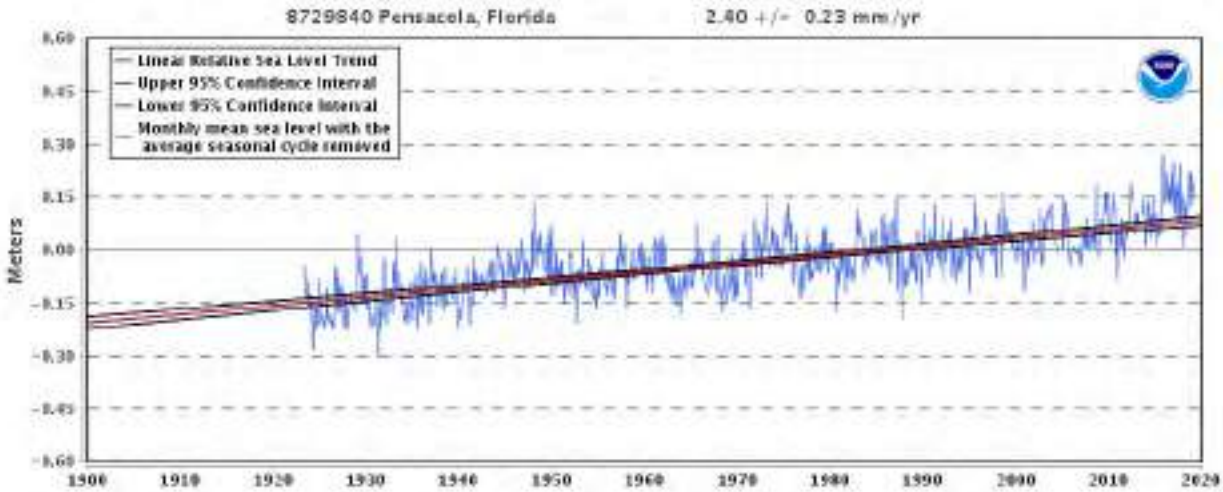

Figure 6.3 Sea Level Rise Trends for Pensacola, Florida Through 2020 (Source: NOAA, 2020)

Given the trends illustrated through these tide gauges, it is necessary to investigate the Watershed's resilience and vulnerability to sea level changes over time. The first step in this process is to utilize three specific tools: the Coastal Vulnerability Index, developed by the U.S. Geologic Survey (USGS); the existing SLAMM Model data prepared by Warren Pinnacle Consulting, Inc. through the U.S. Fish and Wildlife Service depicting a 0.5-meter sea level rise scenario; and the Coastal Resilience Index, developed by the Mississippi–Alabama Sea Grant Consortium. The following sections will provide descriptions of these tools.

6.3 Coastal Vulnerability Index

The USGS Coastal Vulnerability Index (CVI) is designed to analyze the relative susceptibility of coastal regions to sea level rise. The CVI and subsequent classifications are based on variables including geomorphology, regional coastal slope, tide range, wave height, relative sea level rise, and shoreline erosion and accretion rates. This combination of variables provides an overview of regions where physical changes are likely to occur due to sea level rise.

Table 6.1 Ranking of Coastal Vulnerability Index

Variable	Very Low 1	Low 2	Moderate 3	High 4	Very High 5
Geomorphology	Rocky, cliffed coasts, fiords	Medium cliffs, indented coasts	Low cliffs, Glacial drift, Alluvial Plains	Cobble beaches, Estuary, Lagoon	Barrier beaches, sand beaches, Salt marshes, Mud flats, Deltas, Mangrove, Coral reefs
Coastal Slope (%)	>11.5	11.5 to 5.5	5.5 to 3.5	3.5 to 2.2	<2.2
Sea Level Rise (in/yr)	<.07	.07 to .098	.098 to .12	.12 to .134	>.134
Shoreline Erosion/Accretion (ft/yr)	>6.56	3.28 to 6.56	-3.28 to +3.28	-3.61 to 6.56	>-6.56
Mean Tide Range (ft)	19.69	13.45 to 19.69	6.56 to 13.12	3.28 to 6.23	<3.28
Mean Wave Height (ft)	1.81	1.81 to 2.79	2.79 to 3.44	3.44 to 4.10	>4.10

The Coastal Vulnerability Index uses the variables as indicated in **Table 6.1** which are then applied to the formula as follows: $CVI=\sqrt{((a*b*c*d*e*f)/6)}$, where:

- a = geomorphology
- b = coastal slope
- c = relative sea-level rise rate
- d = shoreline erosion/accretion rate
- e = mean tide range
- f = mean wave height

The results of the index for Wolf Bay Watershed indicate that the lower end of the Watershed is at low-to-moderate risk of impacts from sea level rise. Identification of a low-to-moderate risk indicates that approximately 10 to 35% of the shoreline indicated in **Figure 6.4** is at risk of impacts to sea level rise. Anecdotally, recent events across the Gulf Coast reveal that combinations of high tide and storm events tend to result in more frequent flooding of roads and properties in close proximity to the shoreline. Low to moderate wave action along the northern coastline of Wolf Bay will serve to mitigate these high tide/storm event impacts. However, a significant tropical event directly affecting Wolf Bay would have the effect of

magnifying flooding in the lower reaches of the watershed. **Figure 6.4** illustrates the results of the CVI for the Watershed based on USGS data utilizing the CVI calculations for Wolf Bay.

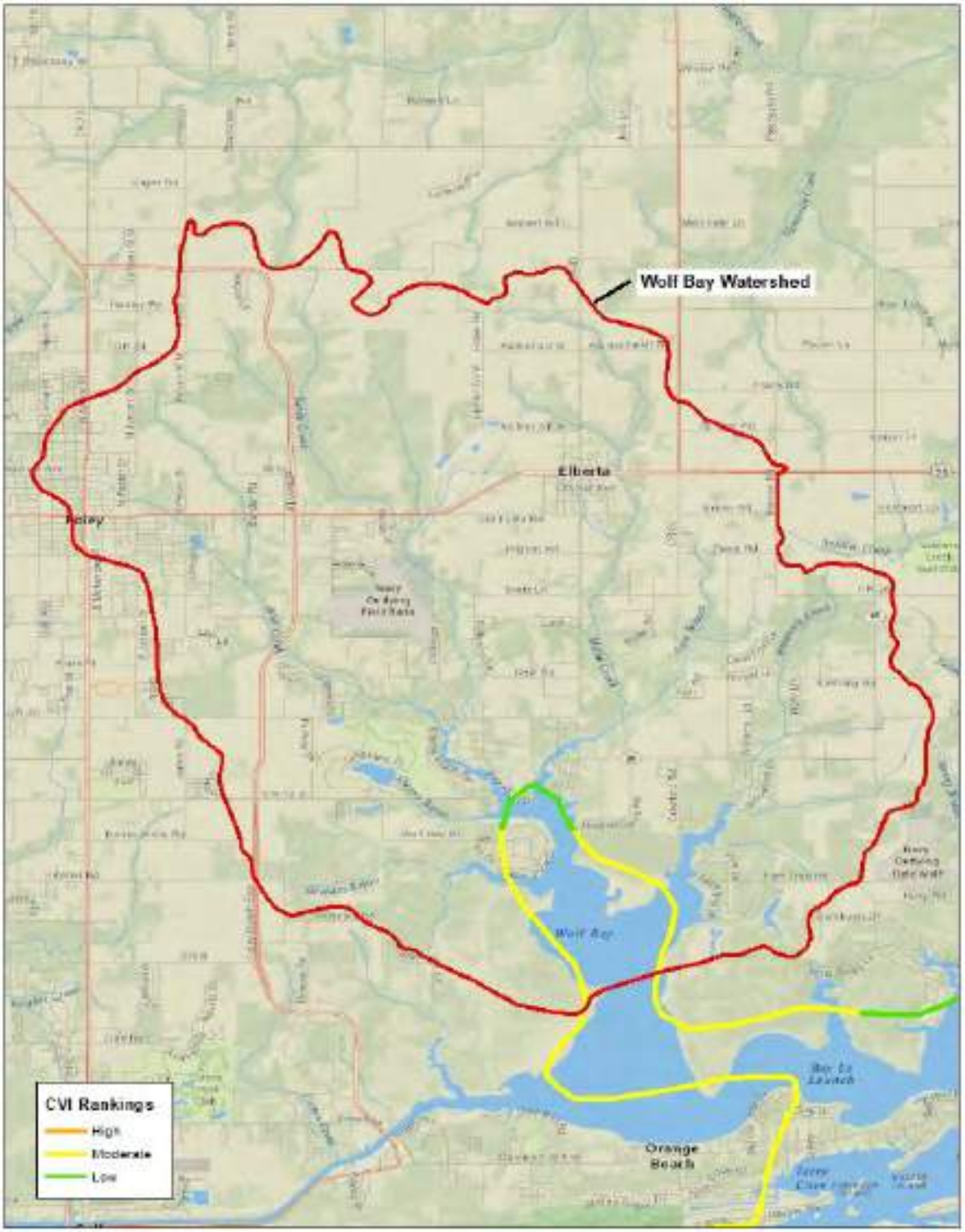

Figure 6.4 Coastal Vulnerability Index Map for Wolf Bay Watershed

6.4 SLAMM Model for Wolf Bay

Tidal marshes are some of the most vulnerable habitats to the effects of sea level rise. The Sea Level Affecting Marshes Model (SLAMM) was developed by EPA contractor Warren Pinnacle Consulting, Inc. to support planning efforts and management decisions related to sea level rise. The model simulates changes in tidal marsh area and habitat type in response to sea level rise. SLAMM simulates five primary processes that affect tidal marshes: inundation, erosion, overwash (when barrier islands are submerged), saturation (a rise in the groundwater table), and accretion (the rise of the marsh surface elevation as a result of sediment deposition). The model allows the user to input local data [i.e., local accretion rates and local subsidence rates (gradual lowering of the land surface)] and modify an array of parameters (i.e., rate of sea level rise) to customize the model.

The SLAMM Model performed by Warren Pinnacle Consulting, Inc. through the U.S. Department of the Interior and the U.S. Fish and Wildlife Service depicts a 0.5-meter sea level rise scenario. The potential impacts in this scenario affect marshes in the lower portion of the Watershed. Because the majority of the Watershed are undeveloped uplands, only a minimal amount of marsh area will be impacted based on model predictions. While some freshwater swamp habitats within the Watershed may be converted to salt marsh and open water habitats, the acreages would be minimal based on the higher topography and distance of the Watershed from the Gulf of Mexico. Areas of developed uplands include the City of Foley, the Town of Elberta, and the Glen Lakes and Graham Creek Estates Subdivisions.

6.5 Other Risk Scenarios

The NOAA Flood Exposure Mapper provides insight into potential impacts of a variety of flooding scenarios on Wolf Bay and the Wolf Bay Watershed. The Coastal Flood Hazard Composite takes into consideration high tide flooding, FEMA Flood Zones, and storm surge and sea level rise scenarios. While the lower portion of the Watershed is at low-to-moderate risk of impacts from sea level rise, the combination of these scenarios presents a more elevated risk, particularly to those developed properties in close proximity to the Wolf Bay shorelines. On the following Coastal Flood Hazard Composite Map (**Figure 6.5**), darker colors indicate higher risks of combined flooding risks from high tides, storm surge, and sea level rise.

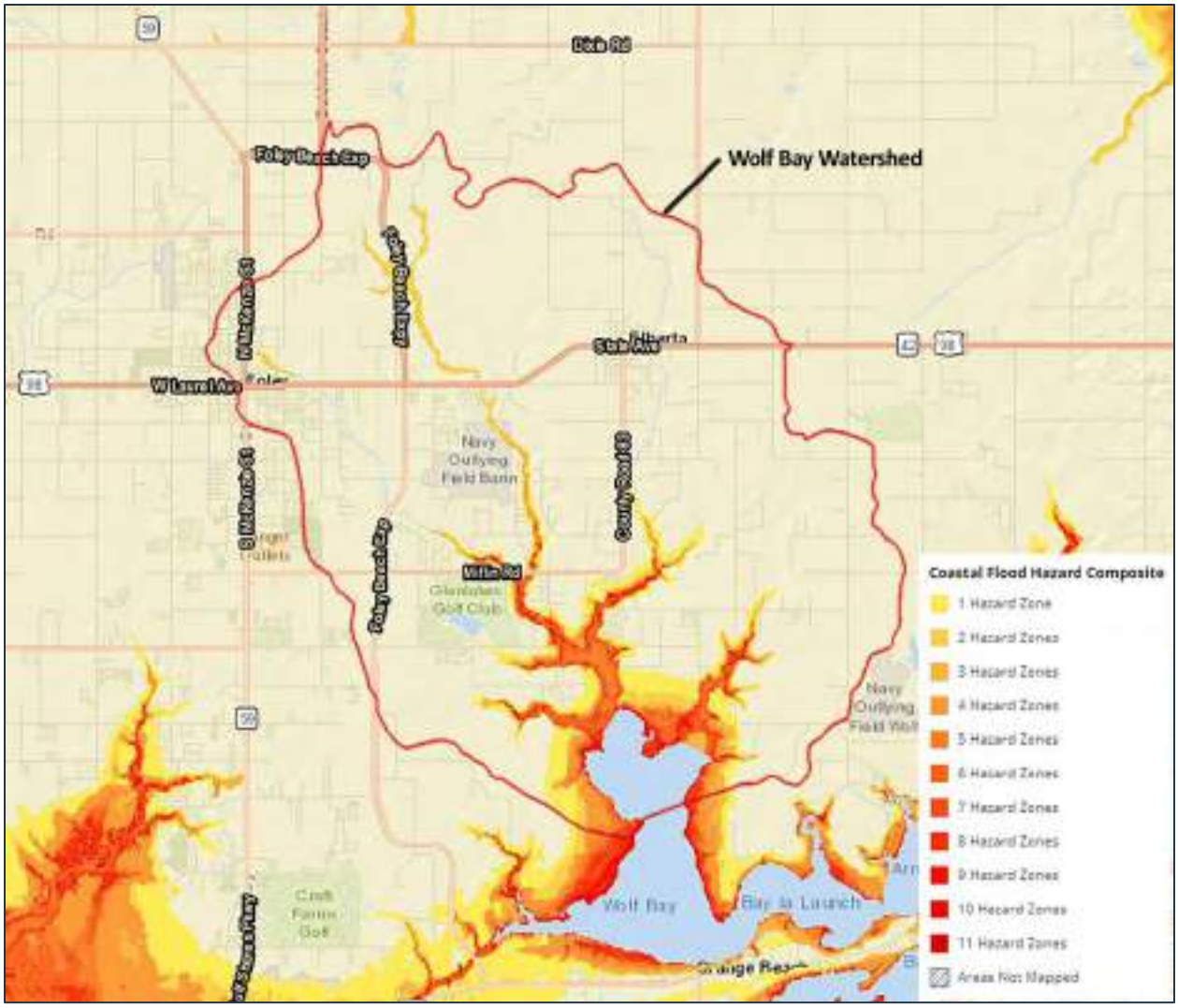

Figure 6.5 Coastal Flood Hazard Composite Map

In comparison, **Figure 6.6** shows developed lands and areas converted to development between 1996 and 2011. While the majority of the Watershed remains undeveloped or utilized for agricultural purposes, the pace of development in the Watershed increases the risk of vulnerability and exposure to a variety of climate change and flooding scenarios. As urbanization increases in the Watershed, so does the overall percentage of impervious surfaces and the potential for water quality and quantity issues in the Watershed.

Further exploration of the NOAA Flood Exposure Mapper by overlaying the coastal flood composite layer with development and development patterns reveals a scenario where future developments may be at risk, if not properly planned with respect to vulnerability scenarios.

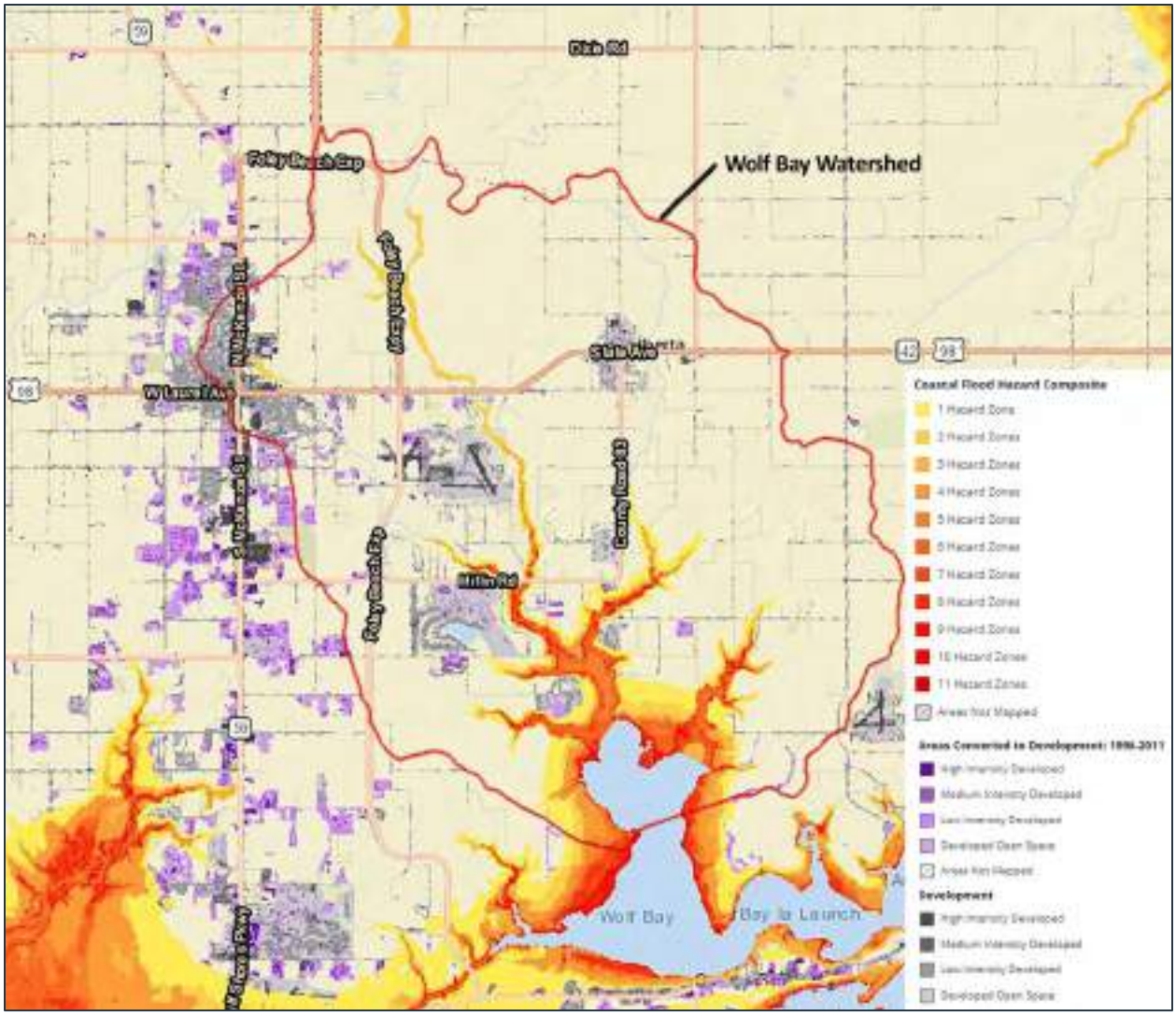

Figure 6.6 Developed Lands in Comparison to NOAA Flood Exposure Mapper

Sea level rise and resulting composite flooding also have potential to negatively impact natural areas, open space, and wetland areas. Through the current state of development in the Watershed, these undeveloped areas also have potential to mitigate impacts of flooding, storm surge, and sea level rise. As urbanization increases, efforts should be taken to protect and preserve natural areas, including wetlands, to maximize the benefit these features provide to minimize flooding and sea level rise impacts. **Figure 6.7** reflects natural areas and open space relative to composite flood risks and **Figure 6.8** reflects the wetlands potential for mitigation relative to the same composite flood risks.

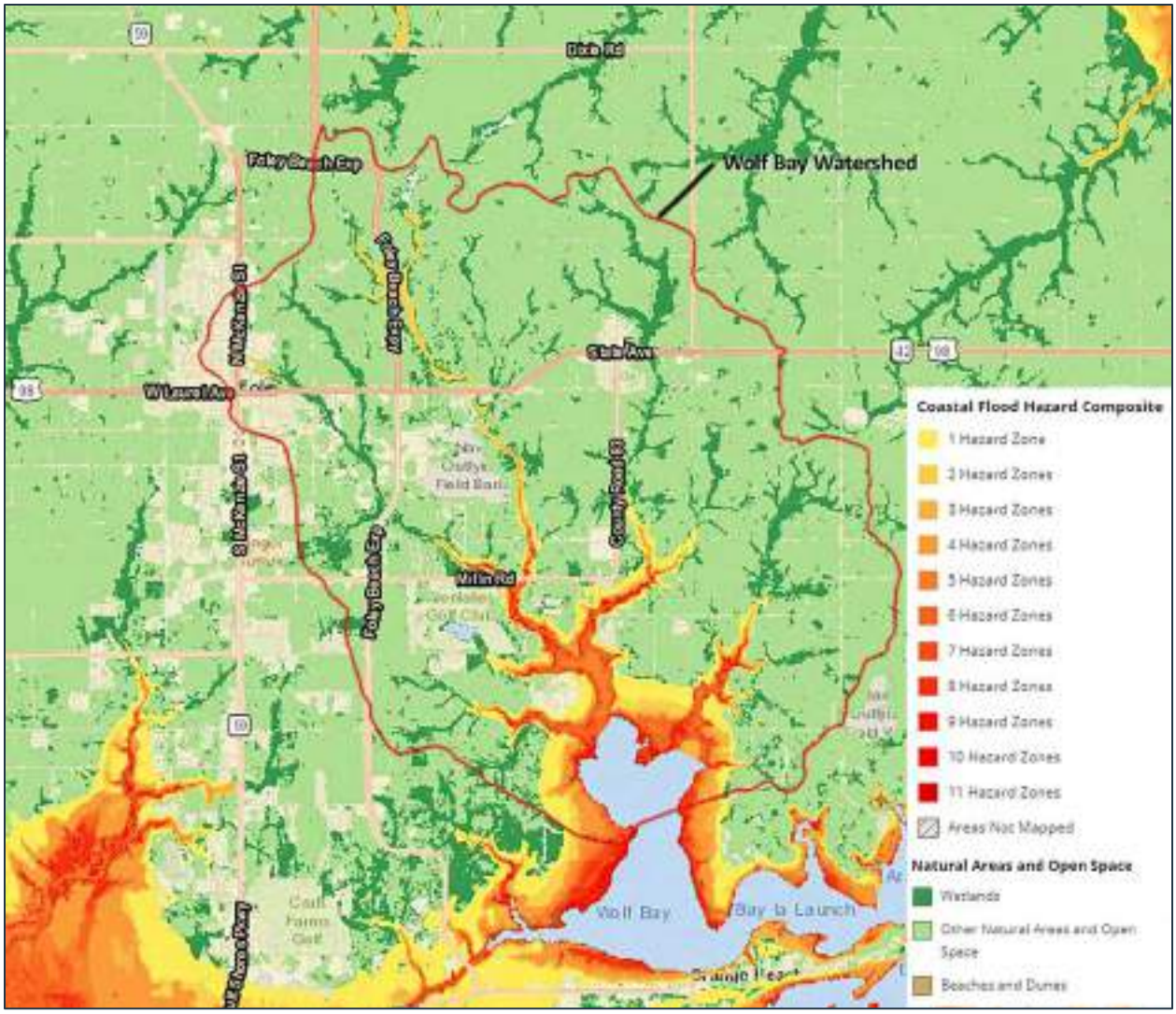

Figure 6.7 Natural Areas and Open Space Relative to Composite Flood Risks

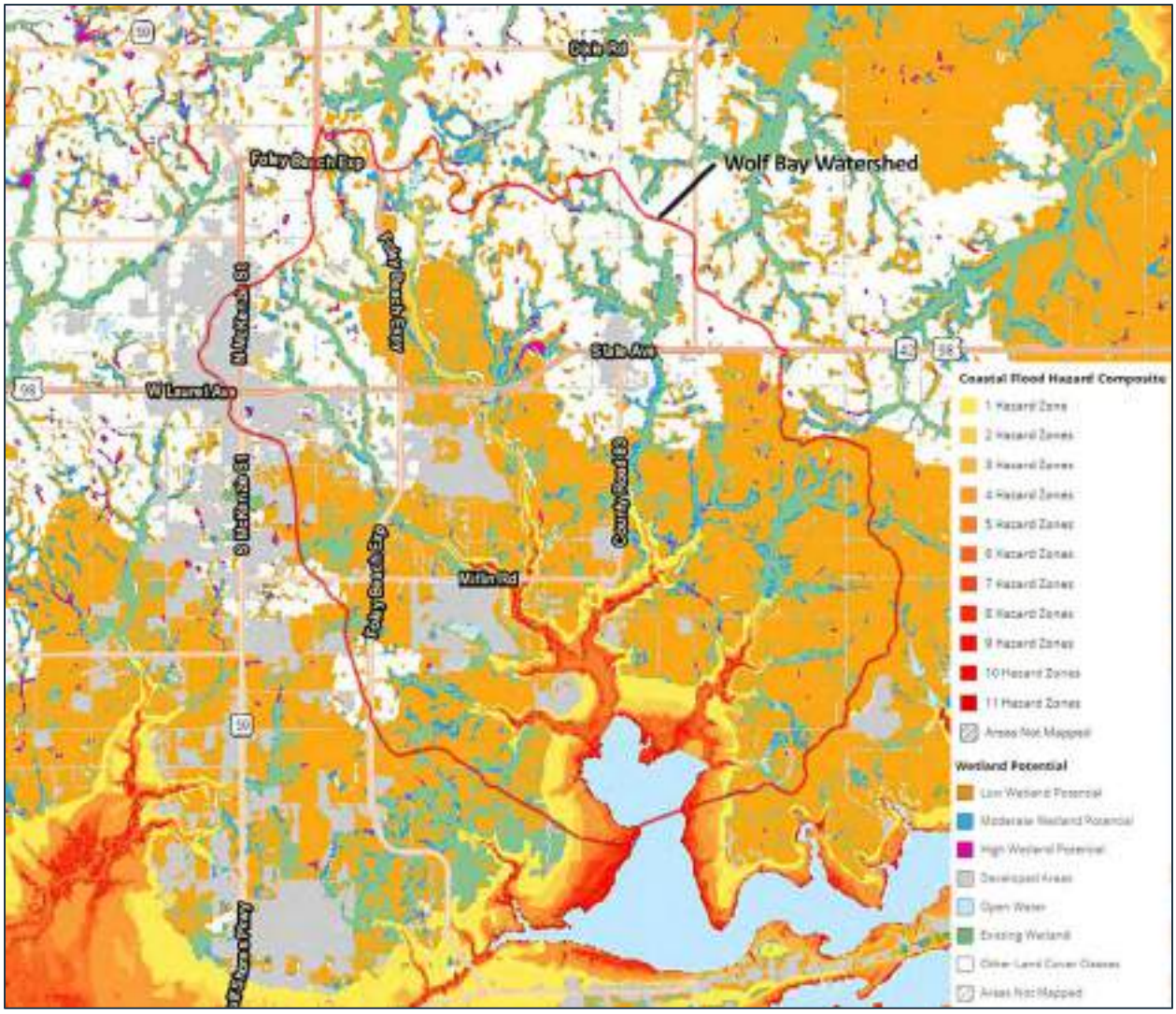

Figure 6.8 Flood Mitigation Potential for Wetlands

6.6 Coastal Resilience Index

The Coastal Resilience Index (CRI) was developed by the Mississippi–Alabama Sea Grant Consortium to provide communities with a tool to examine their relative resilience to hazard events that may also include the effects of sea level rise. The CRI exists as a series of topics within which communities rank themselves to determine potential resilience. The results of responses to these categories are then compiled to provide a relative indicator of community resilience. The results of the CRI examine seven categories of resilience that include:

- Critical Infrastructure,
- Critical Facilities,

- Transportation Systems,
- Community Plans,
- Mitigation Measures,
- Business Plans, and
- Social Systems.

A community's ranking in these seven categories indicates its relative resilience to natural hazards and, by default, to climate change and the effects of sea level rise. For the purposes of this Plan, a CRI was created for the City of Foley, the Town of Elberta, and the unincorporated portions of the Watershed and are included in **Appendix D** of this Plan. All three indices were based on a storm scenario that would include 6-8 inches of rain in a 24-hour period, a storm surge in excess of 12 feet at Perdido Pass, and a track that would take the storm directly through Perdido Pass and into Wolf Bay. The scenario also includes a landfall location west of Foley that would put the most heavily developed areas of the Watershed on the strong side of the storm. The following section addresses results of the CRIs for each area.

6.6.1 Foley

Due to a demonstrated planning capacity and well-qualified and professionally certified staff, the City of Foley scored high on the CRI in all seven categories. Examples of elements contributing to a high score include participation in the FEMA Community Rating System (CRS) that serves to enhance the City's ability to prepare for flood events and also reduces flood insurance premiums for residents and businesses. Additionally, the City has a Certified Flood Plain Manager, a planner certified through the American Institute of Certified Planners (AICP), and certified building inspectors who implement the International Building Code for the City. The City also has a strong network of supporting social systems, including religious institutions, civic organizations, and an active Chamber of Commerce. Finally, the City does not appear to have critical infrastructure or facilities located in FEMA-designated flood plains or flood hazard areas.

6.6.2 Elberta

The Town of Elberta scored medium to high on the CRI. As with Foley, the Town does not appear to have critical facilities or infrastructure located in flood plains or flood hazard areas. However, the Town does not have the staff strength of Foley (lacking certified planners, certified flood plain managers, etc.).

Additionally, the Town's social systems and community plans do not appear as robust in comparison to Foley. The Town's CRI ranks relatively highly and above medium.

6.6.3 Baldwin County

As with both Foley and Elberta, the unincorporated portions of Baldwin County within the Watershed do not appear to have critical facilities and infrastructure located in flood plains or flood hazard areas. The County does have good staff strength with certified planners and flood plain managers. As a result, the County scored highly in the CRI.

6.6.4 Coastal Resilience Index Summary

Generally speaking, the communities within the Watershed scored very well in the CRI. Per the CRI, a high ranking indicates that a community is well prepared for a storm event. In particular, if a community scores high in the critical infrastructure category (as all three did), then the community will probably not incur significant damage and can be functional with basic services in less than two weeks after an event.

Prior to the finalization of this plan, Hurricane Sally made landfall on the Alabama Gulf Coast on September 16, 2020. Representatives of Foley, Elberta, and Baldwin County were contacted to see if there was anything identified post-storm that could be improved upon to prepare for future storm events. Routine maintenance of waterways and drainages along with coordination of these activities between the responsible entities was identified as an area that could be improved upon.

6.7 Climate Change Management Measures

Local and regional responses to sea level rise generally fall into one of three primary categories: armoring, retreating, or adapting. Armoring strategies are those intended to physically armor the shoreline against rising sea levels. Retreating strategies are associated with policies related to "no-build" zones, deed restrictions, rolling easements, and other mechanisms designed to minimize impacts to the human and built environment. Adaptation strategies include measures such as elevation of structures and consideration of sea level rise into local and regional planning documents, such as comprehensive plans and local hazard mitigation plans. In determining specific pathways of response to sea level rise, it is rarely an "either-or"

scenario but rather a decision process to determine which combination of pathways or strategies are most effective and sustainable for a given situation.

Retreating may also have the potential to raise legal issues related to Fifth Amendment rights and certain legal considerations related to common law and the Public Trust Doctrine. The Fifth Amendment to the U.S. Constitution states in part that "no person shall be deprived of life, liberty, or property without due process of law, nor shall private property be taken for public use without just compensation." This "takings clause" of the Fifth Amendment brings to light sensitive issues as they relate to shoreline retreat, extension of shoreline buffers, and other legal mechanisms such as rolling easements. The Public Trust Doctrine is a legal principal taken from English Common Law. Its essence is that waters of the state are a public resource owned by and available to all citizens equally for purposes of navigation, commerce, fishing, recreation, and similar uses. Essentially, the Public Trust Doctrine limits public and private use of tidelands and other shorelands to protect the public's right to use the waters of the state. Legal issues related to takings and public use rights are complex, and it is not the intention of this Plan to discuss in detail or clarify those issues as they relate to planning and mitigation strategies. Rather, this Plan seeks to provide a menu of potential mitigation, planning, and policy options to local and regional entities. Local governments seeking to enact policies or planning measures relating to taking of private land for public use or the Public Trust Doctrine should consult with legal counsel before enacting such measures.

The various options that exist for local and regional responses to sea level rise, including a "no-action" option must also be weighed within the contexts of sustainability, environmental sensitivity, local political feasibility, and fiscal feasibility. **Figures 6.9 – 6.12** depict the relative feasibility of different response options.

Figure 6.9 Response Pathways: Environmental Sensitivity

Figure 6.9 represents the relative environmental sensitivity of the three primary sea level rise response pathway approaches with armoring generally being the least environmentally sensitive and retreating options being the most environmentally sensitive. Exceptions to this may exist, depending on the particular strategy or set of strategies to be employed. Overall environmental sensitivity will be dependent on the particular ecosystem potentially impacted by a given strategy, materials employed in execution of the strategy, and the potential long or short-term nature of the strategy.

Figure 6.10 Response Pathways: Sustainability

Figure 6.10 illustrates the relative sustainability of the three primary sea level rise response pathways with adaptation being generally the least sustainable and options associated with the retreat pathway seen as the most sustainable. Exceptions to this illustration of relative sustainability will exist depending on the particular strategy or set of strategies to be employed.

Figure 6.11 Response Pathways: Political Feasibility

Figure 6.11 illustrates the relative political feasibility of the three primary sea level rise response pathways. In general terms, options related to retreating from sea level rise are seen as the least politically feasible, and options related to armoring are seen as the most politically feasible. This illustration of political feasibility has a high potential for variability due to potential variations in local and state political climates, local stakeholder views on sea level rise and apparent risks, and local and state regulations governing implementation of various sea level rise response options.

Figure 6.12 Response Pathways: Fiscal Feasibility

Figure 6.12 illustrates the relative fiscal or financial feasibility of the three primary sea level rise response pathways with armoring generally seen as the least fiscally feasible (or most expensive) long-term option and adaptation seen as the most fiscally feasible (or least expensive) long-term option. As with the other variables illustrated in **Figures 6.9 – 6.12,** some variation will exist with respect to fiscal feasibility of a given response option or set of options.

6.7.2 Armoring

Sea level rise mitigation measures and strategies related to armoring are generally engineer-designed structures or systems intended to hold back the sea and protect primarily man-made assets from impacts of increases in sea level. Examples include levees, groins, sea walls, and other hard structures. It is important to understand that living shoreline approaches, often used in tandem with more traditional shoreline stabilization methods, often fall into the "armoring" category of sea level rise responses. **Table 6.2** provides specific details of armoring practices that could potentially be deployed within the Wolf Bay Watershed.

Table 6.2 Armoring Strategies

Armoring Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Trap sand through construction of groins – a barrier-type structure that traps sand by interrupting longshore transport.	Maintenance of sediment transport.	Preserve coastal land/development; maintain shorelines.	Creates more natural shoreline than bulkheads or revetments; quick fix.	Can potentially trigger or accelerate erosion on the down drift side and loss of beach habitat.	$1,700 - $1,950/ LF
Install rock sills and other artificial breakwaters in front of tidal marshes along energetic estuarine shores.	Shoreline maintenance ("soft" measures").	Preserve coastal land / development; maintain water quality.	Naturally protect shorelines and marshes and inhibit erosion inshore of the reef; while promoting sediment deposition.	May not be sustainable in the long-term because breakwaters are not likely to provide reliable protection against erosion in major storms.	$125 - $200/ LF
Composite systems – Incorporation of elements of two or more methods (e.g. breakwater, sand fill, and planting vegetation.	Shoreline maintenance (living shorelines).	Preserve coastal land / development.	Incorporates benefits of multiple systems; can address longer stretches of coastline.	Living shoreline approaches may require more maintenance over time.	$12 - $16/ LF
Harden shorelines with bulkheads – anchored, vertical barriers constructed at the shoreline to block erosion.	Shoreline Maintenance ("hard" measures).	Preserve coastal land / development.	Most common; simple materials used for construction; quick fix.	Loss of intertidal habitats; adjacent properties must be bulkheaded to maintain consistent shorefront	$100 - $200/ LF

Armoring Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Harden shorelines with revetments that armor the slope face of the shoreline.	Shoreline maintenance ("hard" measures).	Preserve coastal land / development.	Simple materials used for construction; quick fix.	Loss of intertidal habitats; often constructed poorly and lead to destabilization of banks, increasing erosion.	$115 - $180/ LF
Harden shorelines with breakwaters – structures placed offshore to reduce wave action.	Shoreline maintenance ("hard" measures).	Maintain water quality; preserve coastal land / development.	Employs materials that are locally available; creates good habitat for marshes and other calm water systems.	Down drift coast may be deprived of sediment, increasing erosion; loss of habitat.	$200 - $280/ LF
Headland control – reinforce or accentuate an existing geomorphic feature or create an artificial headland (e.g. geotextile tube).	Shoreline maintenance ("hard" measures).	Preserve coastal land / development.	Can be cost effective.	May reduce sediment supply to adjacent shores, increasing erosion; loss of habitat.	$150 - $180/ LF

6.7.3 Retreating

Sea level rise mitigation strategies involving retreat are typically policy-related measures that seek to prevent or minimize development in near shore areas of the coastline. Examples of retreat options include enhanced buffer zones, no-build zones, conservation easements, and rolling easements. Since these policies are typically associated with land use and land ownership rights, care should be taken in choosing options presented here. As previously mentioned, legal issues associated with Fifth Amendment rights and rights provided through the Public Trust Doctrine have the potential to be associated with these particular measures. **Table 6.3** provides a variety of options related to measures and strategies associated with the retreat option.

Table 6.3 Retreating Strategies

Retreating Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Allow coastal wetlands to migrate inland (e.g. through setbacks, density restrictions, land purchases).	Maintaining / restoring wetlands.	Preservation of habitat for vulnerable species; preservation of coastal land / development.	Maintains species habitats; maintains protection for inland ecosystems.	In highly developed areas, there is often little or no land available for wetland migration or could potentially be costly to landowners.	Costs are very relative based on land acquisition costs. Other costs (setbacks, density restrictions, etc.) are negligible.
Land exchange programs – owners exchange property in the floodplain for publicly-owned land outside of the floodplain (i.e. transfer of development rights).	Preservation of coastal land / development.	Preserves habitat for vulnerable species; maintain / restore wetlands.	Preserves open spaces; more land available to protect estuaries.	Program is voluntary; land must be available for development elsewhere.	Other than administrative costs, implementation costs are negligible.
Land acquisition program – purchase of coastal land that is damaged or prone to damage and reuse for conservation purposes.	Preservation of coastal land / development.	Preserve habitat for vulnerable species; maintain / restore wetlands.	Can provide a buffer to inland areas; prevents development on the land.	Can be cost prohibitive; land may not be available; voluntary.	Costs are relative based on site-specific land acquisition costs.

Retreating Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Create marsh by planting the appropriate species – typically grasses, sedges, or rushes – in the existing substrate.	Shoreline maintenance (Living shorelines).	Maintain water quality; maintain / restore wetlands; preserve habitat for vulnerable species; invasive species management.	Provides protective barrier; maintains and often increases habitat.	Conditions must be right for marsh to survive (e.g. sunlight for grasses, calm water) can be affected by seasonal changes.	$2.50 – $5.50/ sq. yard
Restrict or prohibit development in erosion zones.	Shoreline maintenance (Living shorelines).	Preserve coastal land / development; maintain / restore wetlands.	Allows for more land available to protect estuaries.	Will not help areas already developed; difficult to get all parties to agree; potential takings issues.	Other than administrative costs, implementation costs are negligible.
Increase shoreline setbacks.	Shoreline Maintenance (Living shorelines).	Preserve coastal land / development.	Protects coastal property in the long term and prevents development directly on the shoreline.	Will not help areas already developed; potential takings issues.	Other than administrative costs, implementation costs are negligible.
Retreat from, and abandonment of, coastal barriers.	Preservation of habitat for vulnerable species.	Maintain / restore wetlands.	May help protect estuaries, allowing them to return to their natural habitat.	Generally, not politically favored due to the high value of coastal property and infrastructure; potential takings issues.	Other than administrative costs, implementation costs are negligible.

Retreating Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Purchase upland development rights or property rights.	Preservation of habitat for vulnerable species.	Maintain / restore wetlands; maintain water quality.	Protects habitats downstream.	Costly; uncertainty about sea level rise leads to uncertainty in the amount of property purchased; similar to transfer of development rights.	Costs are relative based on site-specific land acquisition costs.

6.7.4 Adapting

Policies and strategies related to adaptation are those that provide some level of flexibility in policy, design, and implementation of strategies. Adaptation strategies include measures such as elevation of structures and including consideration of sea level rise into local and regional planning documents, such as comprehensive plans and local hazard mitigation plans. As previously mentioned, these strategies are not meant to be a "one size fits all" approach but rather a "treatment train" approach should be considered and adopted that uses one or more strategies working concurrently and in concert to address specific management goals. **Table 6.4** provides details on a variety of adaptation strategies.

Table 6.4 Adaptation Strategies

Adaptation Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Prohibit hard shore protection.	Maintain / restore wetlands.	Preserve habitat for vulnerable species; maintain sediment transport.	Allows for species migration.	Alternatives of bulkhead construction are more expensive and may be more difficult to obtain permits.	Other than administrative costs, implementation costs are negligible.
Incorporate wetland protection into infrastructure planning (e.g. transportation planning, sewer utilities).	Maintain / restore wetlands.	Maintain water quality; preserve habitat for vulnerable species.	Protects valuable and important infrastructure.		Other than administrative costs, implementation costs are negligible.
Identify and protect ecologically significant areas such as nursery grounds, spawning grounds, and areas of high species diversity (e.g. coastal preserves).	Maintain / restore wetlands.	Invasive species management; preserve habitat for vulnerable species.	Protecting critical areas will promote biodiversity and ecosystem services (e.g. producing and adding nutrients to coastal systems serving as refuges and nurseries for species).	Some areas / circumstances may require federal or state protection.	Other than administrative costs, implementation costs are negligible.
Trap or add sand through beach nourishment – the addition of sand to a shoreline to enhance or create a beach area.	Maintain sediment transport.	Preserve habitat for vulnerable species; preserve coastal land / development; maintain shorelines.	Creates protective beach for inland areas; replenishes sand lost to erosion; potentially creates new public access and tourism / recreation areas.	Periodic maintenance cycle required; potentially high costs to import beach material.	$15 - $20/ cubic yard

Adaptation Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Create a regional sediment management plan.	Maintain sediment transport.	Maintain water quality.	Preserves natural sediment flow and protects water quality of downstream reaches.	Improvements and plan recommendations may be costly.	Other than administrative costs, implementation costs are negligible.
Develop adaptive stormwater management practices (e.g. promoting natural buffers, adequate culvert sizing).	Maintain sediment transport.	Maintain water quality.	Preserves natural sediment flow and protects water quality of downstream reaches.	Improvements and retrofits may be costly.	Other than administrative costs, implementation costs are negligible.
Integrate coastal management into land use planning.	Preservation of coastal land / development.	Preserves habitat for vulnerable species; maintain / restore wetlands.	Potentially requires more state agency oversight; allows for conservation and management goals to be incorporated locally; allows for locally comprehensive coastal management in cooperation with state efforts.	May be difficult to have local and state agencies agree on specific plan elements; private property rights; current legislation is prescriptive but not required.	Other than administrative costs, implementation costs are negligible.

Adaptation Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Consider Integrated Coastal Zone Management – using an integrated approach to achieve sustainability and resilience.	Preservation of coastal land / development.	Preserve habitat for vulnerable species; maintain / restore wetlands; maintain water availability; maintain water quality; maintain sediment transport; maintain shorelines.	Considers all stakeholders in planning, balancing objectives; addresses all aspects of climate change.	Stakeholders must be willing to compromise; requires much more effort in planning.	Other than administrative costs, implementation costs are negligible.
Incorporate consideration of climate change and sea level rise impacts into planning for new infrastructure. (homes, buildings, water, sewer, streets, critical facilities, etc.	Preservation of coastal land / development.	Preserve habitat for vulnerable species; maintain / restore wetlands.	Engineering could be modified to account for changes in precipitation or seasonal timing of flows; siting decisions could take into account sea level rise.	Landowners may resist relocating away from prime coastal locations.	Other than administrative costs, implementation costs are negligible.
Strengthen rules that prevent the introduction of invasive species (e.g. enforce no discharge zones for ballast water).	Invasive species management.	Maintain / restore wetlands; preserve habitat for vulnerable species.	Prevents difficult and costly eradication of invasives by preventing their introduction.	May require state action; may be difficult to regulate.	Other than administrative costs, implementation costs are negligible.

Adaptation Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Expand the planning horizon of land use and comprehensive planning to incorporate longer climate predictions.	Preservation of habitats for vulnerable species.	Preserve coastal land / development.	Could inhibit risky development and prove protection for estuarine habitats.	Land use plans rarely incorporate hard prohibitions against development close to sensitive habitats and have limited durability over time; current legislation is prescriptive, not required.	Other than administrative costs, implementation costs are negligible.
Consider modifications to local Flood Hazard Prevention Ordinances to increase freeboard requirements.	Preserve coastal land / development.	Maintain water quality; protect life and property; increased resiliency.	Provide for additional protection of residential structures from higher tides, storm surges, flooding.	Will require local adoption; will increase costs of development in coastal zones and flood prone areas.	Other than administrative costs, implementation costs are negligible.
Consider incorporation of sea level rise and climate change impacts into local, regional, and state hazard mitigation plans.	Preserve coastal land / development.	Protect life and property; increased resiliency.	Enhances a proven and required planning mechanism; includes input from stakeholders.	Will require local adoption.	Other than administrative costs, implementation costs are negligible.
Incorporate risk-based land use planning into local comprehensive plans.	Preserve coastal land / development.	Protect life and property; increased resiliency.	Integrates natural hazards into local land use planning; potentially provides incentives for selection of alternative development sites.	Availability of alternate land for development; requires local adoption; current legislation is prescriptive, not required.	Other than administrative costs, implementation costs are negligible.

Adaptation Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
Integrate climate change and sea level rise impacts into due diligence for investment and lending.	Preserve coastal land / development.	Protection of life and property; increased resiliency.	Allows investors and asset managers to manage risks associated with real estate located in potentially impacted areas.	Will require cooperation among financial and real estate sectors.	Other than administrative costs, implementation costs are negligible.
For communities currently participating in FEMA's Community Rating System (CRS), consider program or policy changes that would specifically address Activity 430 – Credit for Higher Regulatory Standard, Activity 430 – Credit for Coastal A Zone Regulations, and Activity 610 – Credit for Flood Warning Systems.	Preserve coastal land / development;	Protection of life and property; enhanced resiliency.	Potentially increased premium discounts for National Flood Insurance policy holders; enhanced protection in flood prone areas.	Requires existing participation in the CRS system, Rating upgrades can potentially be expensive and time consuming.	Other than administrative costs, implementation costs are negligible.

Adaptation Strategy	Benefiting System	Secondary Management Goals Addressed	Benefits	Constraints	Relative Costs
For communities not currently participating in FEMA's CRS, consider enrollment in the program.	Preserve coastal land / development.	Protection of life and property; enhanced resiliency.	Potentially increased premium discounts for National Flood Insurance policy holders; enhanced protection in flood prone areas.	Application and enrollment in the program can be expensive and time consuming.	Other than administrative costs, implementation costs are negligible.

Chapter 7 Identification of Critical Issues and Areas

The critical issues and geographical areas described in this chapter were identified through multiple sources over the course of this project, including firsthand knowledge and expertise of the Wolf Bay WMP Steering Committee, as well as feedback from citizens who live, work and recreate within the Watershed. The WMP team also conducted field reconnaissance throughout the Watershed and analyzed research findings along with historic data to determine Watershed issues and the areas in which they occur.

7.1 Water Quality

Water quality is a broad term that can be measured by multiple indices and provides a means of qualifying how "healthy" a watershed may or may not be. Water quality was consistently listed by stakeholders in the Watershed as their most critical concern, due to its effect on recreation and usage by those who live and recreate within the Watershed. Maintaining or improving existing water quality is also important, as Wolf Bay is designated as an Outstanding Alabama Water. Several factors influencing water quality in the Watershed include:

- Nutrients
- Pathogens
- Litter
- Invasive Species
- Erosion and Sedimentation

7.1.1 Nutrients

Excessive nutrients in a body of water can degrade water quality by causing blooms of plants and algae that can deplete oxygen levels, degrade aquatic habitats for fish and wildlife, impair recreational usage and cause taste and odor problems in drinking water. Nutrients of concern within the Watershed are nitrogen and phosphorus. As discussed in Chapter 2, Cook (2017) found nitrogen levels that exceeded the ADEM reference concentrations in both Miflin and Sandy creeks. Both of their sub-watersheds are dominated by row crops and turf agriculture (**Figure 7.1**) which is a likely source of the excess nitrogen in these streams. Cook also noted that 10 of the 14 sites monitored throughout the Wolf Bay Watershed had phosphorous

concentrations above the ADEM reference. The two highest levels of phosphorous were documented at sampling locations along Wolf Creek. It is unknown if these elevated phosphorus levels are attributed to runoff from urban, residential, or agricultural land use or a combination thereof.

Figure 7.1 Turf Operation in the Watershed

7.1.2 Pathogens

One critical concern raised during Steering Committee meetings was the presence of livestock within Hammock Creek, which could potentially lead to unsafe levels of *Escherichia coli* (*E. coli)*, a bacterial pathogen found in human and animal intestines and an indicator of pathogen pollution. Wolf Bay Watershed Watch (2017) reported that livestock had been removed from Hammock Creek, although Steering Committee members reported that the practice continues. Field reconnaissance verified the presence of cattle in a headwater tributary of Hammock Creek (**Figure 7.2)**. It should also be noted that wooded buffers along streams and tributaries can concentrate wildlife, leading to increased inputs of fecal coliform bacteria into the waterbody. Sampling conducted by Cook (2017) showed the highest concentrations of *E. coli* at two sampling points within Wolf Creek and one sampling point on Elberta Creek (tributary to Miflin

Creek). Cook concluded that the sampling numbers for the three locations were relatively low for surface water and most likely did not represent any particular pathogen point source.

Figure 7.2 Livestock Grazing Within Riparian Area of Hammock Creek Tributary

According to the Sewage Spill Explorer created by Mobile Baykeeper (www.mobilebaykeeper.org/sewage-spills) there have been 16 sanitary sewer overflows (SSOs) within the Watershed since 2016 (**Figure 7.3**). Listed causes for these SSOs include broken sewer pipes, lift station failures, line blockages due to grease, and overflows due to heavy rainfall. Six of the SSOs within the Watershed occurred at the Riviera Utilities Wastewater Treatment Facility due to system overload caused by heavy rainfall and power outages.

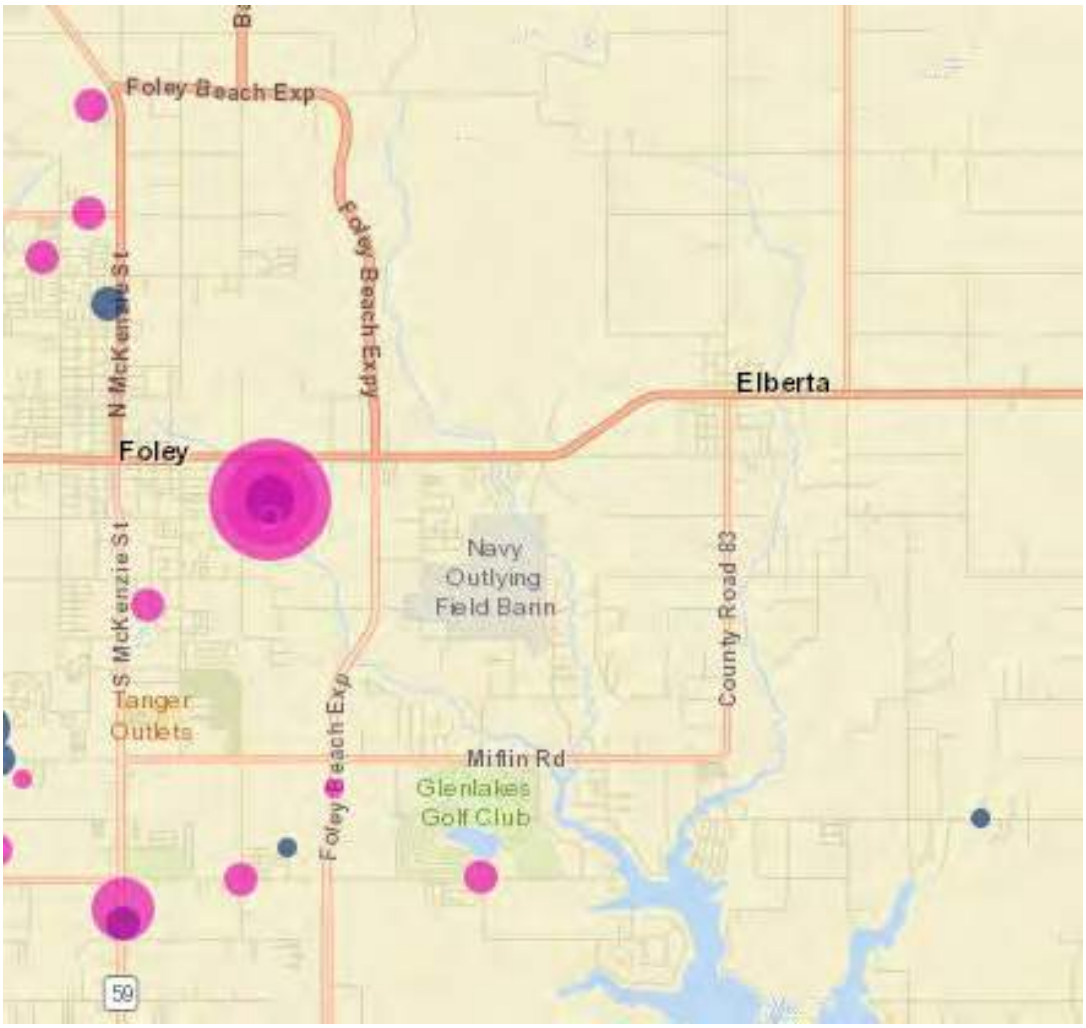

Figure 7.3 Locations of Sanitary Sewer Overflows Within the Wolf Bay Watershed (Source: mobilebaykeeper.org)

7.1.3 Litter

Litter is an issue in any watershed, as it originates from numerous sources from which it is carried into waterbodies by stormwater runoff. Field investigations throughout the Watershed did not document unusually large concentrations of litter within any of the major stream systems. Litter found along banks in areas where people frequently gather, will likely make its way into the waterbody at some point. Submerged items, such as tires and steel barrels, were observed in Sandy Creek in close proximity to some of the houses lining the banks. Common household refuse could be seen both in the channel and along the banks of Wolf Creek, which was previously listed as a potential problem area as shown **Figure 7.4** and **Figure 7.5**.

Figure 7.4 Litter in Wolf Creek

Figure 7.5 Trash Along Bank of Wolf Creek

7.1.4 Invasive Species

Non-native, invasive species can be extremely detrimental to wildlife habitats and ecosystem functions within watersheds. Invasive species are ideally suited to colonizing recently disturbed habitats, such as streams banks disrupted by new sediment deposited during flood conditions. Once established, these species are capable of out-competing native species and are costly to eradicate or control. Field investigations of the major streams in the Watershed revealed several species of aquatic and terrestrial invasive species.

Each of the major streams had some Chinese tallow found along the banks, particularly in more open areas of human settlement (**Figure 7.6**). Chinese tallow can be particularly problematic in coastal watersheds due to its ability to thrive in freshwater and saline soils. It is shade tolerant, flood tolerant and allelopathic making it ideally suited for invasion of stream banks within forested areas. Mature trees can produce 100,000 seeds per year which are spread by birds and water. Seeds remain viable in soil and leaf litter for two to seven years. Chinese tallow is capable of producing dense infestations through surface root sprouting (Miller et al., 2015).

Cogon grass was also found at almost every road or utility crossing along each stream (**Figure 7.7**). Cogon grass is particularly well adapted to road and utility crossings due to its ability to invade areas of open sunlight through wind-dispersed seeds and seeds transported by attaching to mowing and other equipment operating along these areas. Once established, the grass rapidly expands in a circular pattern through branching rhizomes that fill soils to a depth of 0.6 to 10 feet which excludes almost all other vegetation (Miller et al., 2015).

Alligatorweed was observed in Sandy Creek. Alligatorweed is problematic within watercourses due to its creation of mats on the water surface which can impede boat access. This weed can thrive in freshwater or slightly brackish water which makes it well suited for infestation of streams in the Wolf Bay Watershed. Alligatorweed occupies new areas by stem fragments moved by water and spreads rapidly by rooting at nodes. It produces deep mats that prevent other plants from germinating and will overtop other aquatic and upland plants (Miller et al., 2015).

Of all streams surveyed, Hammock Creek had the largest infestation of invasive species with Japanese climbing fern and Chinese privet being prevalent along the water's edge (**Figure 7.8**). Japanese climbing fern can climb up to 90 feet, forming dense mats that can smother shrubs and trees. Often found in open forests, the fern colonizes other vegetation through rhizomes and spreads to other areas by wind-dispersed

spores that can also attach to clothing. Vines will die back in winter which provides a trellis for next year's growth.

Chinese privet is one of the most common invasive shrubs found in the Southeast. The shrub forms thickets up to 30 feet in height with long, leafy branches. Chinese privet is shade tolerant, making it highly suitable for bottomland hardwood forests bordering streams and wetland areas. This invasive shrub colonizes areas through abundant production of seeds that are consumed and dispersed by a wide variety of birds and other wildlife and then expands its infestation through root sprouts.

Figure 7.6 Chinese Tallow Tree Along Sandy Creek

Figure 7.7 Cogon Grass at Utility Crossing on Sandy Creek

Figure 7.8 Japanese Climbing Fern Along Hammock Creek

7.1.5 Erosion and Sedimentation

Erosion and sedimentation are naturally occurring processes within watershed systems. However, those processes can be exacerbated by increased runoff during rainfall events due to increased amounts of impervious surfaces and a lack of bank stability, caused by fast moving water and exacerbated by vegetation removal or other anthropogenic alterations along the stream bank.

Cook (2017) found that total sediment loads, which include both suspended sediments as well as bed sediment loads for each stream, were highest within Wolf Creek at the Doc McDuffie Road sampling location. Sediment loads in east and west tributaries of Sandy Creek were also notably high, but only half as high as the Wolf Creek site.

Field reconnaissance along the lower reaches of Wolf and Sandy creeks revealed bank instability and sloughing; the majority being associated with residential construction areas or areas lacking significant vegetation structure along the shoreline (**Figures 7.9** and **7.10**). Several sediment bars were documented within the channel of Wolf Creek (**Figure 7.11**), although none were noted in the lower reach of Sandy Creek. During investigations into the higher sediment loads found by Cook (2017) on the two unnamed tributaries to Sandy Creek, aerial photos showed a headcut on the western tributary potentially contributing to the sediment load. Also, a pond on the eastern tributary was breached, creating slope riling and unstable stream banks at the former pond location, also potentially contributing to sediment loads at the sampling point (see previous **Figures 5.7 and 5.8**).

Figure 7.9 Bank Sloughing Along Wolf Creek

Figure 7.10 Bank Failure at Residence Along Wolf Creek

Figure 7.11 Area of Sediment Deposition Within Wolf Creek

Both branches of Miflin Creek exhibited similar conditions with minimal bank erosion and some sediment deposition within the channels. Field personnel noted that Miflin Creek exhibited the clearest and deepest water of any creeks surveyed. Additionally, more fish, both in abundance and species, were visually observed in Miflin Creek compared to the other creeks in the Watershed. Hammock Creek exhibited the most bank erosion and instability in the reach north of CR 20 to the headwaters area. Numerous areas of bank failure were documented along this reach, leading to substantial sedimentation within the stream channel (**Figures 7.12 and 7.13**). Areas of overland flow outside of the stream banks were observed and likely the result of the erosion/sedimentation processes occurring within this area.

Figure 7.12 Bank Erosion/Sedimentation Within Hammock Creek

Figure 7.13 Bank Erosion Along Hammock Creek

7.2 Future Development

Baldwin County is one of the fastest growing areas in Alabama, and the Wolf Bay Watershed is one of the fastest growing areas in Baldwin County. Future development within the Watershed has potential to significantly impact the nature of stormwater management and water quality within the Watershed. While a significant percentage of the Watershed area is undeveloped or agricultural in nature, developments such as OWA in the eastern portion of the Watershed will likely continue to occur in response to increasing demands for tourism destinations within the County and the Watershed. Several large tracts of land along the Foley Beach Express in the northwest portion of the Watershed are currently listed for sale (**Figure 7.14**). Additionally, if the City of Orange Beach moves ahead with plans to construct a bridge connecting Orange Beach with the eastern portion of the Watershed, current undeveloped property has the potential to be targeted for development. These types of commercial and infrastructure developments do not necessarily translate to increases in population. However, they do contribute to increased impervious cover, traffic, and

potential impacts to water quality. Given the potential for more of these developments to occur in the Watershed, it is imperative that the County, the City of Foley, and the Town of Elberta work to ensure that appropriate plans and regulations are in place to guide development in an appropriate manner.

Figure 7.14 Area of Potential Development

7.2.1 City of Foley

The City of Foley is the most urbanized area within the Watershed and has highest projected rate of population growth and the highest percentage of impervious cover. The City also has the Watershed's strictest stormwater regulations, which comprehensively address construction phase BMP requirements, post-construction stormwater requirements, coastal area resource protection, low impact development standards, and shoreline stabilization (where applicable). Additionally, the City's *Manual for Design and Construction Standards* requires specific standards for development activities as well as requiring implementation of low impact development standards. The City of Foley's estimated 2018 population was 18,928, representing a 140% increase since the 2000 census. As the City's population and level of development continue to increase, regulations pertaining to implementation of stormwater management

BMPs on a City-wide level will become increasingly necessary to ensure the City's growth does not adversely impact water quality in the Watershed.

7.2.2 Town of Elberta

In its current state, the Town of Elberta retains a small-town feel with a level of development relative to its population of 1,723 people based on the most recent census population estimate. However, the current population is in stark contrast to the 2000 population of 552 people (170% increase). Many of Elberta's ordinances, specifically those related to stormwater management, either cite by reference or mirror Baldwin County's ordinances. As with the City of Foley, it is important that Elberta continue to increase the level of regulation specific to stormwater management and water quality to ensure that the Town is prepared for future growth.

7.2.3 Baldwin County

Baldwin County will continue to experience significant population growth. From 2000 to 2020, population in Baldwin County increased 58.5%, with projected increases of 35% over the next 20 years. Significant population increases in Baldwin County and the Watershed will result in significant land use changes from agricultural and forested lands to developed uses. Current land use data indicates that undeveloped land uses represent approximately 78% of the total land area in the County. Projections for 2040 indicate a reduction of undeveloped land uses to 63%. This translates to an increase in impervious cover and related adverse impacts on water quality. As with the City of Foley and the Town of Elberta, Baldwin County should consider strengthening regulation related to stormwater management, water quality, new development and post-construction management within the County. The County should also consider enacting regulations to require Low Impact Development in a manner similar to the City of Foley's *Manual for Design and Construction Standards*.

7.3 Recreation

Boating access in the Watershed is lacking. The ability to access a watercourse by boat influences other recreational activities such as fishing and swimming. The private launch that historically provided access at the former site of the Wolf Bay Lodge is closed. The nearest public launches are Josephine Park in the Josephine community or Canal Park in the City of Gulf Shores, both located outside of the Watershed and

with limited parking spaces that fill up very quickly. Additionally, obstacles to stream navigability were noted during field reconnaissance in the upper reaches of Wolf Creek, Sandy Creek, Miflin Creek, and Hammock Creek. Numerous log jams made it difficult to navigate each stream by boat (**Figure 7.15**).

Figure 7.15 Overhanging Trees Preventing Boat Access in Sandy Creek

Chapter 8 Management Measures

The Wolf Bay Watershed lies within one of the fastest growing regions of the entire southeastern United States. Growing populations have led to increased development, resulting in increased stress to the natural systems of the area. Excessive stormwater runoff due to increased impervious surface area; erosion and sedimentation resulting from runoff, construction, and changes in land use from rural to urban; litter issues; and invasive species are just a few of the issues currently facing the Watershed.

The management measures recommended in this chapter were derived from a combination of several inputs. A literature review was conducted at the beginning of the project to assimilate all available information regarding existing conditions in the Watershed and where problem areas historically occurred. Field reconnaissance was also conducted throughout the Watershed to document current conditions and where future issues might arise. Throughout this process, the Steering Committee, formed at the onset of Plan development, was consulted to gather information about observed conditions within the Watershed and identify priorities for conservation and management. Other Watershed stakeholders were also engaged through online and written surveys designed to identify management priorities.

8.1 Water Quality

As discussed in previous chapters, water quality is a broad term that reflects a combination of several parameters that are directly tied to the overall health of a watershed. The factors influencing water quality also affect the ability of stakeholders to utilize those waters for any number of uses. Because Wolf Bay is currently designated as an Outstanding Alabama Water, it is not only important to maintain water quality within the Watershed, but also to ensure future actions and land uses do not degrade the system. As discussed previously, the major factors influencing water quality within the Wolf Bay Watershed include:

- Erosion and Sedimentation
- Nutrients
- Pathogens

8.1.1 Erosion and Sedimentation

Sediment transport within a watershed is a natural ecological process. Sediment within a system can include particles carried by overland flow into stream channels after erosion of streambanks or geologic formations and transported and deposited through varying levels of stream flow. However, anthropogenic activities such as agriculture and development amplify these processes by exposing soils and decreasing infiltration rates by increasing impervious surfaces. Based on the 2016 NLCD impervious cover dataset, approximately 5,679 acres (16%) of the Watershed is covered by impervious surfaces. This number will continue to increase due to projected growth in the Watershed.

8.1.1.1 Agriculture

Agriculture encompasses approximately 35% of the land use within the Wolf Bay Watershed. Agricultural activities include row crops, sod, and livestock farming operations, which can significantly impact the amount of sediment entering a stream system if not managed properly. Improper agricultural practices, such as poorly located animal feeding operations, overgrazing, and plowing too frequently or at improper times, can contribute to excessive sediment loads entering surface waters. These adverse impacts can be avoided by using relatively simple management measures.

Agricultural buffers assume many forms, including contour buffer strips, field borders, filter strips, grassed waterways, riparian buffers, and wetlands. Regardless of the type of buffer used, all serve to slow runoff and allow time for infiltration through the soil profile, which can eliminate significant quantities of stormwater or irrigation runoff before it enters a waterway. This decrease in flow rate across an area also allows for sediments and other solid particles to fall out before reaching surface waters. Buffers also serve to stabilize streambanks further reducing erosion from areas directly adjacent to stream channels. Root systems of grasses, shrubs, and trees hold soils in place along field drainages, preventing rills and gullies from forming and contributing large amounts of sediment to adjacent waterways. Organic matter within buffer areas adjacent to streams also dissipates raindrop energy, protecting soil particles from becoming dislodged and transported across the landscape. The NRCS and Alabama Soil and Water Conservation District provide incentive programs to the agriculture community for incorporating agricultural buffer strips.

Livestock operations are found in the headwaters of the Miflin, Sandy and Hammock Creeks and have the potential to create erosion and sedimentation issues along streams. Livestock allowed to enter streams can

create unstable streambanks by overgrazing vegetation that holds soils in place. Livestock allowed to enter stream channels for water can also displace bed sediments and increase turbidity, which can be detrimental to fish species and overall water quality. The use of exclusion fencing with a recommended distance of at least 30 feet from surface waters will prevent livestock from overgrazing within riparian and wetland areas, allowing appropriate vegetation to create a natural buffer strip between the pasture and the watercourse. Additionally, alternative water sources for livestock located away from naturally occurring surface waters allow animals to fully utilize their range and reduces impacts to streams.

Appendix E contains a copy of the NRCS Conservation Catalog for Alabama which contains detailed descriptions of various BMPs for agriculture.

The Natural Resources Conservation Service (NRCS) and Farm Service Agency offer numerous programs for public and private landowners. A brief description of relative programs appears below, and more information can be found in **Appendix F**.

- The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land.
- The Conservation Stewardship Program (CSP) helps landowners build on existing conservation efforts while strengthening their farming operation.
- The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.
- The Emergency Watershed Protection Program (EWP) is a federal emergency recovery program that helps local communities recover after a natural disaster.
- The Regional Conservation Partnership Program (RCPP) promotes coordination of NRCS conservation activities with partners that offer value-added contributions to expand our collective ability to address on-farm, watershed, and regional natural resource concerns.
- The Watershed and Flood Prevention Program (WFPO) provides technical and financial assistance to States, local governments, and Tribes to plan and implements the protection and restoration of watersheds up to 250,000 acres.

As with any of the factors that degrade water quality and the associated management measures recommended to prevent them, education of stakeholders is vital to long-term success and implementation. Outreach to farmers and ranchers within the Watershed is vital to ensure water quality is protected while productivity is maintained. Management measure demonstration projects on local farms could increase their implementation throughout the Watershed.

Potential locations for agricultural buffers within the Wolf Bay Watershed and associated acreages can be found in **Table 8.1.** Potential locations for livestock exclusion fencing and locations for alternative water sources can be found in **Tables 8.2 and 8.3**, respectively. Potential locations for all agricultural BMPs within the watershed are illustrated in **Figure 8.1**.

Table 8.1 Potential Locations for Buffers Within Agricultural Areas of the Wolf Bay Watershed

Site No.	Description of Location	Acres	Latitude	Longitude
AB-1	Headwater of Wolf Creek	164	30.429982	-87.671793
AB-2	Headwater of Sandy Creek	89	30.441507	-87.660474
AB-3	Headwater of Sandy Creek	94	30.449948	-87.643315
AB-4	Headwater Tributary to Miflin Creek	110	30.432856	-87.610569
AB-5	Headwater of Miflin Creek	308	30.442681	-87.610904
AB-6	Headwater Tributary to Miflin Creek	89	30.400876	-87.577824
AB-7	Headwater Tributary to Miflin Creek	58	30.392460	-87.568102
AB-8	Headwater to Hammock Creek	47	30.396957	-87.555799
AB-9	Headwater Tributary to Hammock Creek	136	30.372257	-87.547044
AB-10	Headwater Tributary to Hammock Creek	264	30.369732	-87.539920

Table 8.2 Potential Locations for Cattle Exclusion Fencing Within Agricultural Areas of the Wolf Bay Watershed

Site No.	Description of Location	Length (ft)	Latitude	Longitude
CEF-1	Headwater of Sandy Creek	5,174	30.434796	-87.610401
CEF-2	Headwater of Sandy Creek	3,248	30.419298	-87.610663
CEF-3	Headwater of Miflin Creek	997	30.367275	-87.549170

Table 8.3 Potential Locations for Alternative Water Sources Within Agricultural Areas of the Wolf Bay Watershed

Site No.	Description of Location	Latitude	Longitude
AWS-1	Headwater of Sandy Creek	30.430041	-87.620014
AWS-2	Headwater of Sandy Creek	30.420302	-87.611999
AWS-3	Headwater of Hammock Creek	30.367529	-87.549064

Figure 8.1 Potential Locations for Buffers Within Agricultural Areas Within Wolf Bay Watershed

8.1.1.2 Forestry

Approximately 39% of the Watershed is currently forested. While forestry practices do not typically contribute as much sediment to surface waters as construction or agriculture, effects can be significant without proper management. Removal of overstory trees combined with operation of logging equipment throughout an area can compact soils, expose them to erosive weather forces, and increase overland flow transporting sediment. Additionally, improper construction of logging roads and loading docks create erosion problems along slopes due to exposed soils. Stream crossings and use of logging equipment within riparian areas can also exacerbate channel erosion by compromising bank integrity if proper techniques are not utilized.

The use of recommended management measures for forest operations can significantly reduce the amount of soil transported into streams and other waterways within the Watershed. Streamside management zones act as vegetated buffers, intercepting stormwater runoff and allowing sediments to fall out before reaching watercourses. Water crossings utilizing culverts or temporary bridges also help to maintain bank stability and prevent erosion directly adjacent to a stream. Forest roads and loading decks should employ a series of broad-based dips, turnout ditches, and water bars to slow runoff and hold sediments in place. More detailed descriptions of forestry management measures can be found in the *Alabama's Best Management Practices for Forestry* handbook. This handbook can be accessed at http://www.forestry.alabama.gov/Pages/Management/Forms/2007_BMP_Manual.pdf and can also be found in **Appendix G**.

8.1.1.3 Unpaved Roads

Unpaved roads, if not properly constructed and maintained, have the potential to contribute large amounts of sediment into watercourses within the Watershed. Stabilization of these roads by paving most effectively prevents sediments from entering surface waters, but it leads to increased runoff which can affect sedimentation downslope. It is important to combine paved road surfaces with LID management measures allowing for stormwater infiltration adjacent to these impervious surfaces. For non-paved roads, incorporation of management measures into the designs can affect meaningful reductions on sedimentation impacting surface waters and wetlands in close proximity to these roads. Recommended management measures for non-paved roads include:

- Contouring of the road surface to disperse water into a vegetated swale and/or drainage outlet adjacent to the roadway.
- Use of stone or other aggregate material to provide a stable driving surface while holding soil in place.
- Application of drainage outlets that divert water into vegetated areas that serve as natural filters and allow runoff water to infiltrate the soil profile.
- Paving of roads in combination with stormwater management for control and disbursement of runoff

It is also important to remember that, over time, sediment can build up within swales or other holding areas, increasing the amount of flooding and sediment discharge. Periodic maintenance is necessary to maximize environmental benefits and keep road maintenance costs low. **Table 8.4** lists roads identified by the Steering Committee and through field reconnaissance within the Wolf Bay Watershed as candidates for paving and/or implementation of management measures. Roadway segments are listed in order of priority based on their proximity and potential impact to the headwaters of the Watershed. At the time of this publication, funding had been allocated for the paving of Breman Road and was in the process of right-of-way acquisition while Woerner Road had been placed on the priority list for paving consideration. **Figure 8.2** identifies the map locations of these stretches of road within the Watershed.

Table 8.4 Unpaved Road Targets for Management Measure Implementation

Project ID	Road Name	Length (Miles)	Latitude	Longitude
RP-1	Woerner Road	1.2	30.444147	-87.602962
RP-2	Kleinschmidt Road	0.9	30.436165	-87.590658
RP-3	Bruhn Road	1.0	30.406877	-87.572472
RP-4	Breman Road	1.5	30.393321	-87.564641
RP-5	Roscoe Road	0.8	30.339496	-87.649473

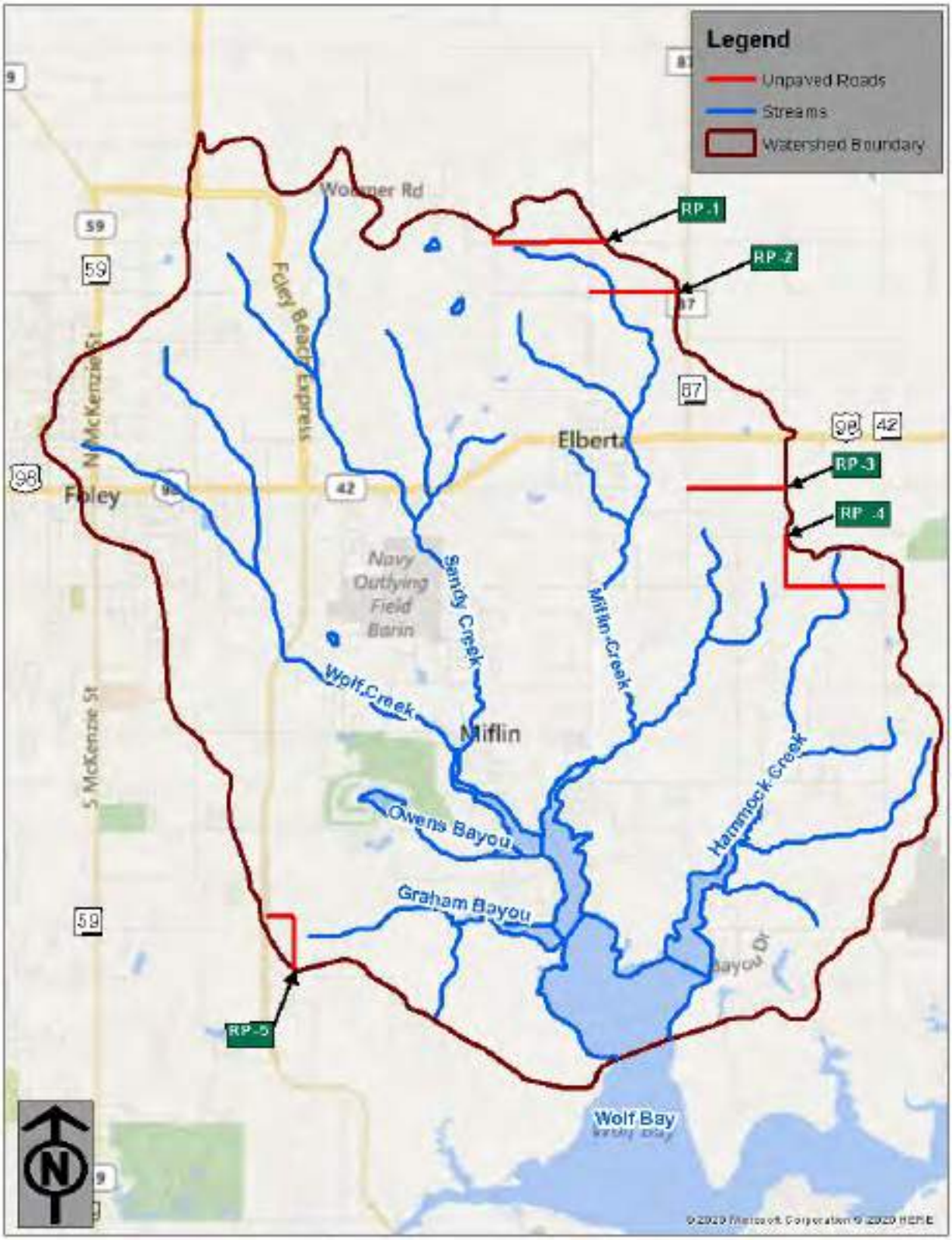

Figure 8.2 Locations of Unpaved Road Segments Within the Wolf Bay Watershed

8.1.1.4 Construction

The Wolf Bay Watershed lies within one of the fastest growing areas of Alabama. As more development occurs within the Watershed, so does the potential for sediment inputs from poorly managed construction sites. Relative to size, the erosion and sediment input potential from construction sites is greater than that of any other land use due to the amount of exposed and disturbed sediment combined with the high rainfall totals observed in this region throughout the year.

While the City of Foley does have a post-construction BMP inventory, similar inventories should be developed for the Town of Elberta and Baldwin County. An inventory of post-construction stormwater BMPs is important to ensure that proper and routine maintenance and inspections are conducted on BMPs. It is also important for planning purposes to understand where coverage gaps may exist.

Given the historic and potential population and development growth rates in the Watershed, the following potential solutions are recommended:

- Baldwin County and the Town of Elberta should enact Low Impact Development (LID) /Green Infrastructure (GI) requirements similar to those that exist in the City of Foley's *Manual for Design and Construction Standards*. LID/GI requirements provide benefits to general public health, safety, and welfare while providing incentives to developers such as reduced lot sizes, lot lines, and setbacks.
- Baldwin County and the Town of Elberta should consider adoption of enhanced post-construction stormwater regulations to ensure any potential impacts from development and resulting increased imperviousness does not result in long-term adverse impacts to water quality.
- A comprehensive inventory of post-construction BMPs should be conducted throughout the Watershed. The inventory should include the type of BMP, date of installation, responsible party for maintenance, and an inspection of each BMP to ensure they are functioning properly.
- The proposed comprehensive inventory of post-construction BMPs should be used as part of a watershed-wide assessment of BMP needs to include retention basins, detention basins, and other types of BMPs that would provide long-term water quality benefits in the Watershed.
- Provide homeowner associations with educational material on stormwater detention pond maintenance.

Developer and contractor education are important management measures recommended for the Watershed. Informational brochures on construction BMPs should be provided early in the development process by the jurisdictional authority to education individuals on the benefits of properly implementing and maintaining these practices.

8.1.1.5 Stream Instability

Field reconnaissance and discussions with Watershed stakeholders were used to identify streams and tributaries exhibiting unstable banks or excessive sediment loads within the channels. These issues are likely caused by the excessive amounts of water moving through the streams due to reduced infiltration caused by impervious surfaces throughout the Watershed. Unfortunately, sediments from these streams and tributaries are transported to other regions of the waterway, causing downstream shoaling and reducing the capacity of that stream reach to carry water within streambanks. This creates overland flow situations that lead to property damage and further streambank instability.

Certain Watershed streams with reaches of bank instability have been identified as candidates for stream restoration activities to lessen in-stream sediment inputs and protect private properties from further erosion and degradation. In most cases, the most effective means of stabilizing streambanks is the reshaping of the bank combined with armament using rock or articulated concrete mats and the replanting of selected species of vegetation. In reshaping a streambank, the angle is reduced to eliminate undercutting and provides a gradient suitable for replanting. This reduces sloughing and promotes the establishment of vegetation that will maximize rooting depth and density which will stabilize riparian soils. Plants should be specifically chosen for their ability to thrive in riparian environments with specific soil and hydrology characteristics to ensure prolonged sustainability. Until vegetation is established, it is recommended that natural fiber matting be used to protect soil from runoff and dissipate raindrop energy which could lead to erosion.

Table 8.5 along with **Figure 8.3** identify locations for potential stream restoration projects that could protect properties and prevent further stream degradation.

Table 8.5 Locations Potential for Stream Restoration Projects in the Wolf Bay Watershed

Site No.	Description of Location	Stream Length (ft)	Latitude	Longitude
SR-1	Lower Wolf Creek stream/habitat restoration	300	30.370373	-87.623733
SR-2	Wolf Creek bank stabilization	700	30.375446	-87.635748
SR-3	Wolf Creek headwater/habitat restoration	3,800	30.380993	-87.655864
SR-4	Wolf Creek headwater/habitat stabilization	500	30.393585	-87.655605
SR-5	Sandy Creek headwater stabilization	1,175	30.421461	-87.628547
SR-6	Sandy Creek headwater/habitat restoration	1,600	30.416868	-87.620998
SR-7	Hammock Creek stream/habitat restoration	1,600	30.366057	-87.565365

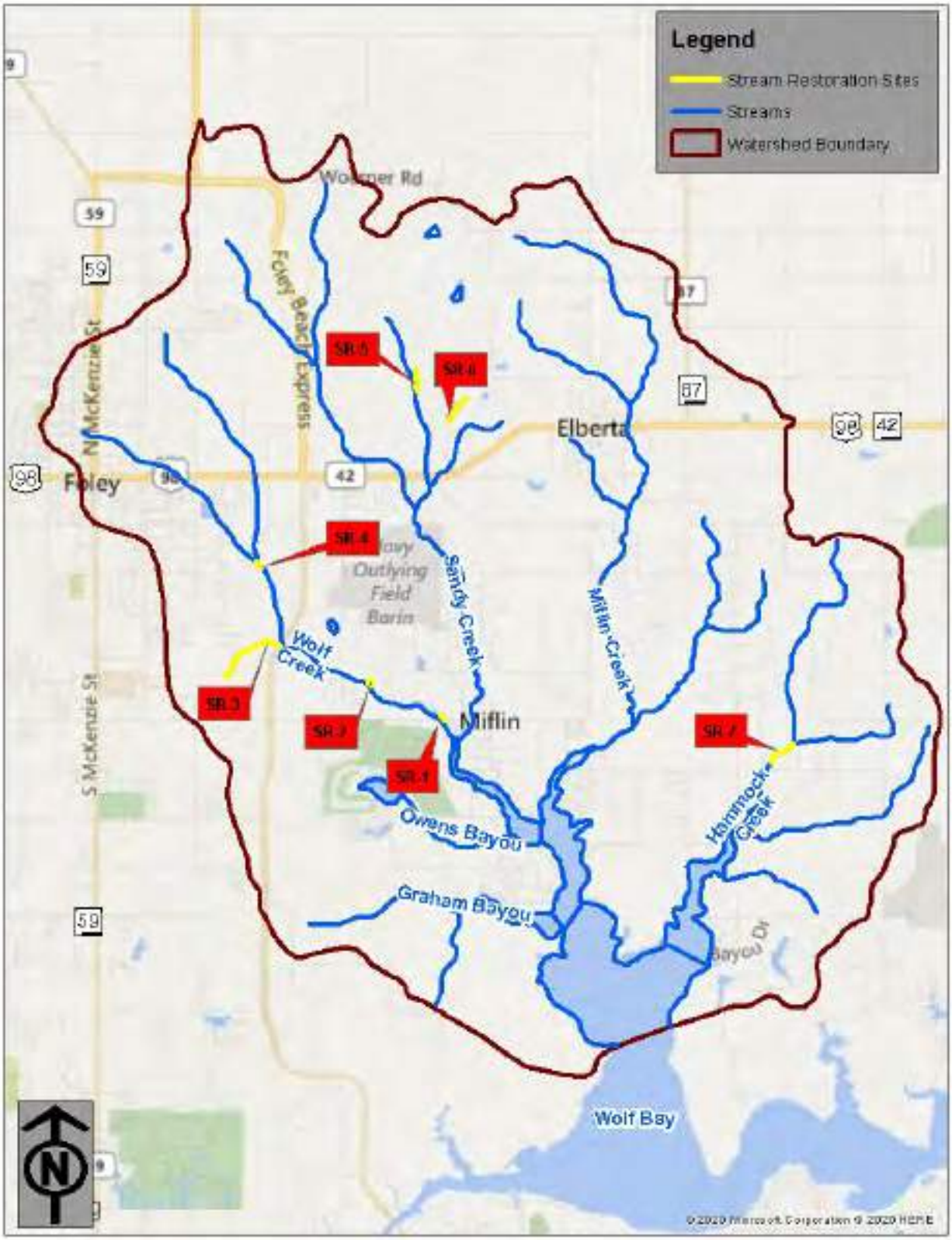

Figure 8.3 Potential Locations for Stream Restoration Projects in the Wolf Bay Watershed

8.1.2 Nutrients

Excessive nutrient inputs to streams and other waterbodies within the Watershed primarily result from fertilizers related to farming and landscaping associated with municipal recreation fields, golf courses, and residential dwellings. The use of fertilizers is a common practice to enhance agricultural productivity and produce more aesthetically pleasing landscapes. However, these fertilizers also have the potential of entering local watercourses, increasing nutrient levels (particularly nitrogen and phosphorous) within surface waters. Increased levels of these nutrients can lead to algal blooms, which can decrease dissolved oxygen levels available for fish and other aquatic species and increase turbidity, blocking sunlight necessary for submerged aquatic vegetation. Fortunately, there are simple steps that can be taken by farmers, municipal staff, commercial operators, and homeowners to drastically reduce amounts of fertilizer and nutrients entering streams.

The timing and amount of fertilization used on a crop or grassed area is extremely important in keeping excess nutrients from entering a water body. It begins with application of the proper amount of fertilizer for the type of vegetation and area being fertilized. Application rates are established to provide for the maximum uptake of nutrients by plants across a given area. Excessive amounts of applied fertilizer can leach through the soil profile and into groundwater or be transported to streams or other waterbodies by runoff before plants can utilize them. Application of precision fertilization techniques, whereby fertilizers are applied directly at the roots, of the plants also maximizes uptake by the plant and saves costs versus broadcast techniques. Applying fertilizers to saturated soils should always be avoided, as this increases the risk of overland transport via runoff.

The use of buffer strips of vegetation along field borders and drainage swales within agriculture fields can also prevent excess nutrients from entering streams. Buffer strips slow runoff and facilitate nutrient uptake by plants, as well as filtering through organic matter and the soil profile. Cover crops can also provide nutrient reduction benefits by reducing the amount of nutrients leaching through the soil profile and slowing overland flow of nutrients into surface waters.

As with many agricultural management measures, education programs and financial incentives for farmers play a key role in widespread implementation throughout the Watershed. The NRCS and Alabama Soil and Water Conservation District provide incentive programs to the agriculture community for incorporating agricultural buffer strips, conservation crop rotation, variable rate nutrient application, and precision agriculture. Workshops, targeted literature, and site visits from extension experts could go a long way in

showing farmers and ranchers the benefits of conservation practices such as precision fertilization, buffer strips, and cover crops. Farmers are also reluctant to take land out of production for BMPs, so incentive programs are also vital to promote widespread implementation.

Golf courses and recreational fields operators should employee knowledgeable staff for nutrient application and incorporate monitoring on discharge areas for increased algal growth. Homeowners and landscape contractors can also benefit from information about the proper use and timing of fertilization. Simple steps, such as application at the recommended rate and removal of excess fertilizer from streets, sidewalks, and driveways, can prevent excess nutrients from entering waterways through stormwater drainage systems. Dissemination of information through local newspapers, garden clubs, and homeowner associations will help to raise awareness about downstream effects of improper fertilizer use.

8.1.3 Pathogens

Sandy Creek and Miflin Creek are currently listed on the draft 2020 Alabama 303(d) list of impaired streams due to unsafe levels of *Enterococcus faecalis* bacteria. The justification for this listing comes from data collected by ADEM from 2013 to 2015, where the Enterococci criterion was exceeded in five out of 16 samples in Sandy Creek and three out of 16 samples in Miflin Creek. The listing remains, despite Cook's (2017) study that found relatively low levels of *E. coli* in the Watershed streams (which is often directly linked to *Enterococcus faecalis*). Overall, the Wolf Bay Watershed has not historically shown significant levels of pathogens within the waters sampled by ADEM or in samples submitted by volunteers from Wolf Bay Watershed Watch. However, management measure implementation and outcomes should constantly be evaluated and to ensure pathogens do not become an issue of particular concern in the future.

Potential sources of pathogens within the Watershed can primarily be attributed to sanitary sewer overflows from the local wastewater treatment plant, discharges from rural septic systems, and livestock grazing operations. It is also worth noting pet waste from residential areas and wildlife waste from narrow vegetated areas directly adjacent to surface waters can also have effects on pathogen levels within Watershed streams.

Use of livestock exclusion fencing, alternative water sources, and vegetated buffer strips between pasture lands and waterbodies have proven extremely effective at preventing runoff of animal waste into surface waters. **Figure 8.4** shows unexcluded cattle within riparian areas of and with unrestricted access to a headwater of Sandy Creek. The use of exclusion fencing also prevents livestock from overgrazing riparian areas adjacent to streams and accessing stream channels. The excluded area is then allowed to revert to

more natural vegetation, which serves numerous purposes in promoting water quality as discussed in previous sections. Additionally, the use of alternative water sources provides better water quality for livestock than stream watering and promotes better forage utilization across the property, leading to increased herd health and production. Reference **Figure 8.1** for a map of potential locations for agricultural BMPs that could aid in reducing pathogen inputs to surface waters within the Watershed.

Figure 8.4 Cattle within Riparian Area of Sandy Creek Tributary

Riviera Utilities, a local wastewater treatment plant, is currently permitted to discharge treated wastewater into Wolf Creek. Riviera is currently in the process of completing a major upgrade to their wastewater treatment facility which will reduce overflows from the plant during major rain events. Riviera is also in the process of replacing Gulftel Lift Station which is located on the east side of Hwy 59 just south of CR24. This project will reduce the potential for SSOs as well as increase capacity at the treatment plant during rain events. Other projects currently in the planning stages for Riviera Utilities include:

- Rehabilitation of 8.6 miles of aging sanitary sewer mains within the City of Foley. The goals of the project are to reduce accidental discharges of untreated/partially-treated wastewater into the Watershed; prevent exfiltration of wastewater into groundwater; and reduce wastewater treatment facility peak flows during rain events so that treatment processes are not overloaded and only high quality effluent is discharged into Wolf Creek.
- The construction of four Aquifer Storage Recovery (ASR) wells and the necessary transmission mains to connect the Class A reuse water from the Wolf Creek Wastewater Treatment Facility to the aquifer storage recovery wells for groundwater injection. The reuse water will then be stored and recovered for the irrigation needs of the area.

While much of the Watershed is connected to wastewater treatment systems, many of the more rural areas still rely on septic tank systems. Many of these systems are becoming aged and could possibly be leaking, thus contributing pathogens to the Watershed. Baldwin County would benefit from a septic tank inventory to establish a baseline of tank locations and potential sources of contamination. Education and incentives for county residents to maintain properly functioning septic systems combined with enforcement of regulations should be a priority for County officials. Additionally, enforcement of unregulated septic systems should also be a priority throughout the County.

8.2 Invasive Species

Invasive species disrupt complex relationships formed by native plants and animals over thousands of years and disturb communities of plants and animals that rely on each other for existence. Through field reconnaissance, the invasive species most commonly observed within the Watershed were cogongrass, Japanese climbing fern, Chinese privet, alligatorweed, and Chinese tallow tree (**Figure 8.5**).

Figure 8.5 Chinese Tallow Tree Along the Bank of Sandy Creek

Understanding how to identify and map problem areas has been a long-standing goal of resource managers and is necessary to better manage the threats from invasive species within a watershed. Invasive species are a major threat to ecosystems due to their ability to spread rapidly, disrupt natural plant and animal communities, and even alter hydrology. Mapping of infested areas and monitoring the spread of these species through the Watershed would provide necessary information on how the area is being impacted. In order to provide a quantitative evaluation of invasive species within the Wolf Bay Watershed, a sampling strategy should be designed to document invasive species and the amount of colonization along major waterways within the Watershed. Subsequent to identifying problem areas, eradication policies and procedures should be implemented with the goal of restoring natural communities and functions within these ecosystems.

Eradication of invasive species within a target area is an obtainable goal if multiple modes of treatment are incorporated in control strategies. Applying a combination of techniques, including physical, chemical, and biological approaches, has proven to be the most effective strategy towards eliminating invasive species. Physical control includes variations of pulling, digging, mulching, and prescribed burning in both terrestrial and aquatic environments. Physical removal alone can be beneficial but has proven to be more effective when coupled with chemical treatment through various herbicide application techniques. The identification of invasive communities, their stage of growth, and the surrounding native species that may be affected by chemical application is key to the safe use of this method.

Management and protection of existing native communities is a priority when the goal is restoration of those communities. Replanting reference natural species following the eradication of invasive species helps to stabilize soils, provides cover for wildlife, and helps prevent other invasive species from reestablishing in the area.

While some invasives, such as Chinese tallow and alligatorweed, were not found in great abundance throughout the Watershed, it is important to understand how quickly these species can spread if not controlled. Invasive plants occupy disturbed areas and habitat edges due to lack of canopy coverage and exposed soils. Transportation corridors, utility rights of way, and riparian areas adjacent to streams, which are frequently disturbed, progress into invaded states more readily than natural areas. These areas, if left unchecked, serve as entryways for invasive species to spread and destroy natural habitats, forming more homogenous stands of invasive species. This makes the watercourses within the Wolf Bay Watershed particularly vulnerable to encroachment of invasive species.

Field investigators noted infestations of cogongrass along transmission line and county road rights of way throughout the Watershed. If not controlled, these areas could potentially spread to other portions of the Watershed. The need exists for establishment of a program dedicated to the control of cogongrass along right of ways managed by utility corporations and the county road department. A control program should be implemented by the managing company or agency to monitor and conduct periodic control measures to prevent cogongrass from spreading from these corridors into sensitive habitats such as riparian areas of the Watershed. Education and training of these entities in the value of equipment cleaning and inspection before transport will also help to control the spread from one area of the Watershed to another.

Management of invasive species within a watershed can often be difficult due to access to lands in private ownership. The development of an invasive species management plan for the Watershed would help to

provide direction for management and control of invasive species by providing achievable goals during the process. The plan would also provide the benefit of identifying priority areas for management and proven techniques for control. Providing educational outreach on management methods, including prescribed burning, to landowners is necessary to enable citizens to identify and subsequently remove invasive species on their properties before they multiply and spread. Outreach through local schools as well as through publications such as pamphlets and articles in newspapers will help raise awareness throughout the community about invasive species and the threats they pose.

8.3 Litter

Litter within the Wolf Bay Watershed comes from a variety of sources. Whether intentionally discarded on the ground, illegally dumped, or improperly handled at some point after containment, litter often makes its way into streams and other receiving waterbodies via overland flow or through the municipal drainage systems within the Watershed. Litter is the most visibly noticeable of all watershed impairments and has a direct impact on water quality, wildlife habitat, and recreational enjoyment.

Reduction of litter begins with education and awareness among those who live, recreate, work, and even pass through the Watershed. Making people aware of how trash eventually enters surface waters should be a continuous effort. Outreach to schools, businesses, homeowner associations, construction workers, and recreational users can pay dividends in educating people on how their actions can have a direct and noticeable impact on the health of the Watershed. Signage strategically placed where trash accumulates like roadways, boat launches, and fishing locations, is useful in raising awareness about the proper disposal of refuse. **Figure 8.6** shows potential locations for placement of signage designed to raise awareness about human impacts to the Watershed. Efforts should also be made to curtail illegal dumping in rural areas and impose harsh fines for violations. Additionally, community "clean-ups" among citizens and user groups can promote a sense of stewardship of the Watershed in addition to providing an immediate improvement on the landscape. Each year on the 3rd Saturday in September, the Alabama Coastal Cleanup is held. The current check-in site in the Watershed is located at Wolf Creek Park. This community event is anchored by volunteers from the Wolf Bay Watershed Watch, City of Foley, Riviera Utilities, and the Boy Scouts of America.

Figure 8.6 Potential Locations for "Watershed Awareness" Signage

In discussions with the Steering Committee, Wolf Creek was identified as an area of concern due to the amount of litter being observed. Litter traps were suggested as a means of removing trash that is ultimately transported downstream via Wolf Creek. These litter traps would be placed at strategic locations within tributaries to Wolf Creek and would collect litter before it makes its way into the Wolf Creek channel. The traps would require periodic cleanings to ensure proper function. The Steering Committee identified three potential locations for litter traps associated with Wolf Creek which are listed in **Table 8.6** and illustrated in **Figure 8.7**. An example of accumulated trash within Wolf Creek is shown in **Figure 8.8**.

Table 8.6 Steering Committee suggestions for litter trap locations along Wolf Creek

Site No.	Description of Location	Latitude	Longitude
LT-1	Wolf Creek at Pecan Street	30.404873	-87.666267
LT-2	Wolf Creek at Highway 98	30.406869	-87.669201
LT-3	Wolf Creek at Poplar Street	30.409243	-87.676309

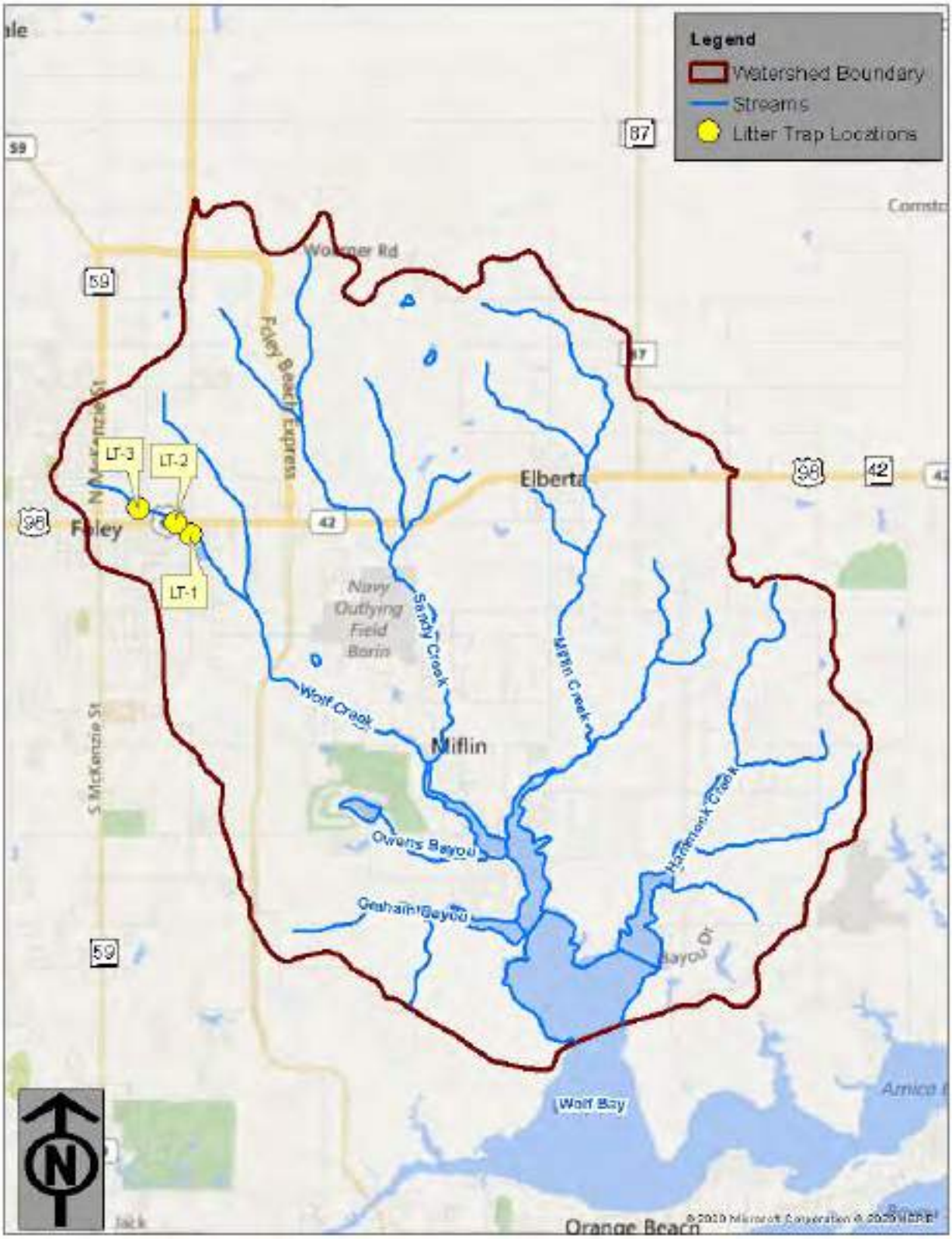

Figure 8.7 Potential Litter Trap Locations Along Wolf Creek

Figure 8.8 Litter in Wolf Creek

8.4 Conservation Land Acquisition and Recreational Access

Acquisition of conservation lands through direct purchase or easement programs is one of the best tools available to protect surface waters within a watershed. Riparian areas protected by trees and other vegetation provide excellent buffers between surface waters and other land uses. With the majority of residents within the Wolf Bay Watershed receiving their drinking water from groundwater sources, intact riparian areas can improve the quality of the groundwater and provide economic value through reduced costs for water treatment. Tracts of land set aside for conservation connect terrestrial and freshwater ecosystems and provide habitat for species of concern. Protecting these areas through acquisition and easement programs prevents future development and helps maintain the balance of natural systems throughout the Watershed. Conservation tracts also provide recreational opportunities like boating, fishing, and hiking, which can be critical to community economic development and provide stakeholders with a sense of ownership that further promotes wise stewardship of the Watershed's natural resources. **Table 8.7** lists tracts of land within

the Watershed identified by the Steering Committee for potential land acquisitions for conservation. **Figure 8.9** illustrates those tracts within the Watershed.

Table 8.7 Locations for Potential Conservation Land Acquisitions

Site No.	Sub-Watershed	Acreage	Description
CLA-1	Sandy Creek/Wolf Creek	1,820	Nine adjacent parcels in the headwater areas of the Sandy Creek/Wolf Creek sub-watershed. These parcels front the Foley Beach Express to the west and are adjacent to U.S. Highway 98 to the south. As the area continues to develop, acquisition of these parcels would provide long term protection of the headwaters of Sandy Creek.
CLA-2	Sandy Creek/Wolf Creek	2.9	Parcel is directly adjacent to Wolf Creek Park. Would provide expansion of the park.
CLA-3	Sandy Creek/Wolf Creek	5.5	Parcel is located along Wolf Creek. Would provide water access to the public.
CLA-4	Miflin Creek	515	Eight adjacent parcels in the headwater areas of the Miflin Creek sub-watershed. Similar to the large cluster of parcels identified in the Sandy Creek/Wolf Creek sub-watershed, due to projected development, acquisition of these parcels would provide protection to Miflin Creek and associated headwater tributaries.
CLA-5	Graham Bayou	1,382	Seven adjacent parcels, approximately 1,382 acres, were identified as potential acquisitions in the Graham Bayou sub-watershed. These parcels are directly adjacent to the Graham Creek Nature Preserve, Graham Bayou, and Wolf Bay.

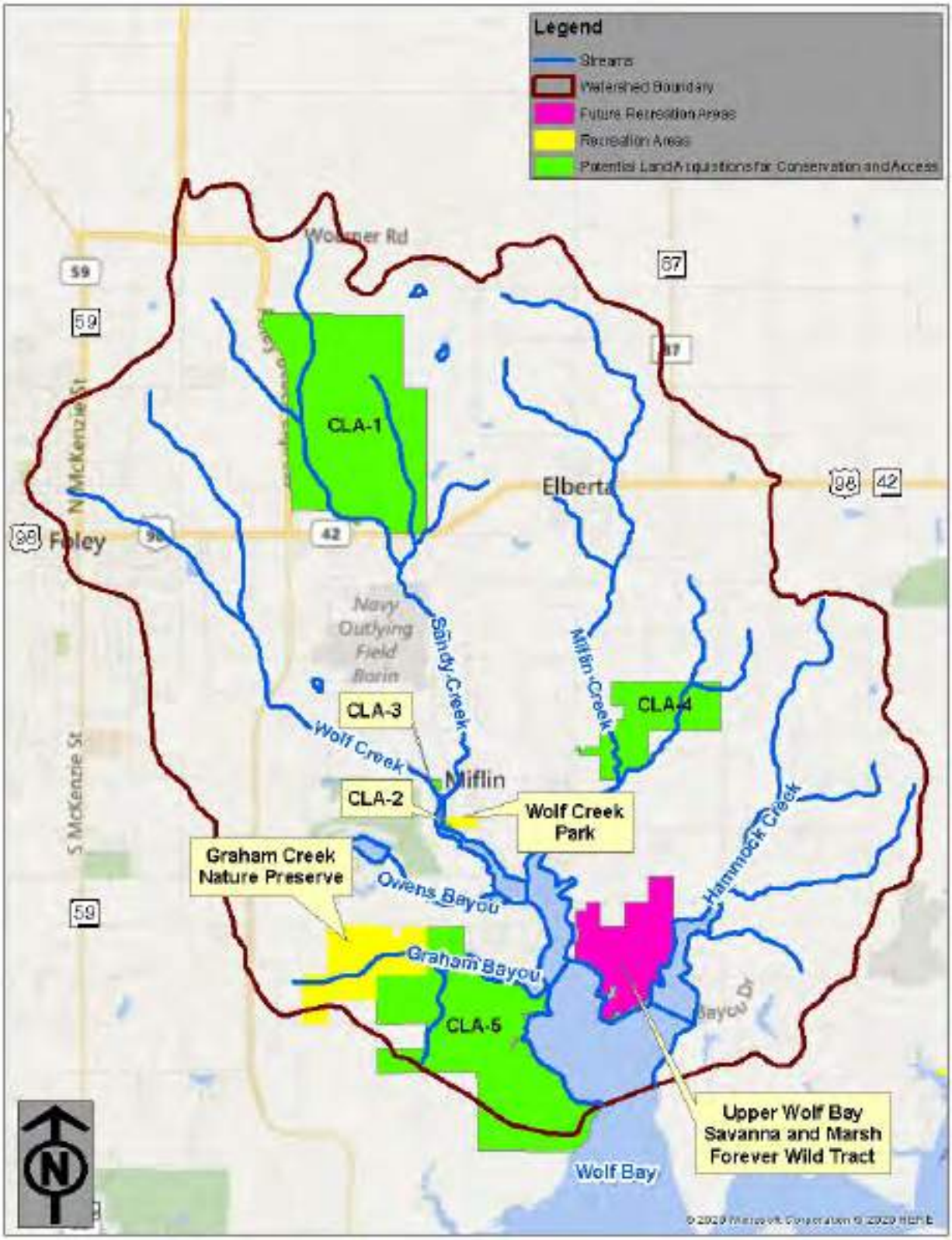

Figure 8.9 Locations of Potential Conservation Land Acquisitions Within the Wolf Bay Watershed

One of the most effective means of addressing water quality in a watershed is to ensure that residents in the watershed have access to recreational opportunities. The more residents take advantage of opportunities to enjoy natural resources in a watershed, the more respect and ownership they will feel for them. Recreational opportunities in the Watershed are very limited at this point, with a lack of public boat launches and limited opportunities for residents who do not own a boat.

The Watershed's premier access venue is the 484-acre Graham Creek Nature Preserve. The Preserve includes natural habitats and recreational features including canoe and kayak launches, hiking trails, picnic areas, an archery park, three-disc golf courses, and natural playgrounds. Wolf Creek Park offers recreational access with a canoe and kayak launch, fishing pier, and picnic areas.

In order to take full advantage of recreational opportunities in the Watershed, the following recommendations should be considered to enhance public access to the Watershed and associated natural resources:

- Develop of a series of blueway trails to include Wolf Creek, Miflin Creek, Graham Creek, and Hammock Creek, which each tie into Wolf Bay, would enhance public access and connection to the Watershed's natural resources. Appropriate planning should consider physical barriers, wayfinding, signage, and other elements necessary for a successful blueway system.
- Work with Alabama Forever Wild Land Trust to add appropriate recreational amenities to the Upper Wolf Bay Savanna and Marsh Forever Wild Tract.

8.5 Projects Previously Submitted for Deepwater Horizon Funding

Table 8.8 lists proposed projects that have been submitted through the various portals related to funding from the Deepwater Horizon Oil Disaster. The projects listed below were compiled from the Alabama Coastal Restoration website (www.alabamacoastalrestoration.org) and the NOAA Gulf Spill Restoration website (www.gulfspillrestoration.noaa.gov). Only projects that would directly affect improvements in water quality or ecosystem function were included in this list. Copies of summary sheets describing these projects are located in **Appendix H**.

Table 8.8 Wolf Bay Watershed Ecosystem Restoration Projects Submitted for Deepwater Horizon Disaster Funding

Project Name	Organization	Primary Classification	Estimated Cost
Wolf Creek Park Expansion	City of Foley	Ecological/Environmental	$325,000
Graham Creek Nature Preserve Expansion	City of Foley	Ecological/Environmental	$650,000
Nutrient Reduction Projects-Mobile and Baldwin Counties	U.S. Department of Agriculture	Ecological/Environmental	$6,000,000
Rehabilitation of Sanitary Sewer Mains – Foley, AL	Riviera Utilities	Restoration/Protection	$1,250,000
Long Bayou and Portage Creek Preservation and Enhancement	City of Orange Beach	Restoration/Protection	$14,273,000

Chapter 9 Implementation Strategies

Addressing management challenges within the Wolf Bay Watershed requires a pallet of management measures with varying scales and scopes, as described in Chapter 8. Successful implementation of these management measures calls for a clear and concise approach executed by a collaborative group of stakeholders, including community members and local, State, and federal agencies.

This chapter provides a strategy to address the critical issues and areas identified in the Watershed by prioritizing management measure recommendations, estimating associated costs, and presenting a two-phased (short-term and long-term) implementation approach to achieve success. Components for completing this WMP were reviewed during its preparation, and a checklist of these components is presented as **Appendix I**.

9.1 Watershed Management Task Force – Wolf Bay Watershed Watch

Successfully addressing the critical issues and areas identified in this WMP will require an entity who will champion watershed management and build off the momentum generated through developing the WMP. Many of the critical issues and areas extend beyond political and jurisdictional boundaries and will require the cooperation of landowners and the general public. Therefore, it is recommended that the Wolf Bay Watershed Watch (WBWW) assume primary responsibility of overseeing implementation of recommended management measures, many of which can be implemented simultaneously, and provide a platform for coordination on matters that affect local watershed conditions and natural and recreational resources. The Wolf Bay Watershed Watch currently has a Board of Directors representing various sectors of the Watershed. The Board meets monthly to discuss issues in the watershed; therefore, overseeing plan implementation would fit within their existing framework.

9.2 Phase One Implementation: Short Term

Feedback gained through stakeholder engagement and public outreach efforts stressed the need for short-term wins or tangible successes promptly following WMP adoption. This will help to nourish stakeholder confidence and build on the momentum generated through WMP development. Parallel with this need to

capture early successes is the need to foster and harness interest in environmental stewardship of the Watershed. With these considerations in mind, management measures were grouped into two phases: short-term and long-term. The short-term management measures described in this section were chosen based on the likelihood of successful implementation within the next two years.

Table 9.1 describes each measure and provides rough order-of-magnitude cost estimates to implement each measure. The preparation of detailed cost estimates was not possible due to the conceptual level of planning that guided development of this WMP. These cost estimates are intended for preliminary budgetary consideration. A more detailed description of each recommended management measure is provided in Chapter 8.

Table 9.1 Short-Term Management Measures (0-2 Years)

Chapter/ Section	Management Measure	Project ID	Potential Project Location	Sub-Watershed	Linear Feet (ft)	Acre (ac)	Estimated Cost per Unit	Estimated Total Cost
Overall Watershed								
8.1.1.4	LID/GI and Post-Construction Requirements	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	Admin Costs
8.1.1.4	LID/GI and Post-Construction Education (Local Government Staff)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	Admin Costs
8.1.1.4	LID/GI and Post-Construction Education (Public)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	$2,000/yr
8.1.1.4	Construction BMP Education (Public)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	$2,000/yr
8.1.2	Nutrient Education (Local Government Staff)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	Admin Costs
8.1.2	Nutrient Education (Public)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	$2,000/yr

Chapter/ Section	Management Measure	Project ID	Potential Project Location	Sub-Watershed	Linear Feet (ft)	Acre (ac)	Estimated Cost per Unit	Estimated Total Cost
8.1.2	Nutrient Education (Public)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	$5,000/per subdivision
8.1.3	Invasive Species Education and Training (Local Government Staff and Local Utilities)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	Admin Costs
8.1.3	Invasive Species Education and Training (Public)	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	$2000/yr
8.3	Watershed Signage	WS-1	Fern Ave	Sandy/Wolf	N/A	N/A	N/A	$100/sign
		WS-2	CR 83 North	Miflin Creek	N/A	N/A	N/A	$100/sign
		WS-3	CR 83 South	Miflin Creek	N/A	N/A	N/A	$100/sign
		WS-4	Doc McDuffie Rd	Sandy/Wolf	N/A	N/A	N/A	$100/sign
		WS-5	Hwy 98 W	Sandy/Wolf	N/A	N/A	N/A	$100/sign
		WS-6	Hwy 98 E	Miflin	N/A	N/A	N/A	$100/sign
		WS-7	CR 20	Graham Bayou	N/A	N/A	N/A	$100/sign
		WS-8	CR 20	Sandy/Wolf	N/A	N/A	N/A	$100/sign
Restoration and Protection								
8.1.1.4	Stream/Habitat Restoration (Engineering and Design)	SR-2	Wolf Creek	Sandy/Wolf Creek	700	N/A	N/A	$70,000
		SR-3	Wolf Creek	Sandy/Wolf Creek	3800	N/A	N/A	$380,000
		SR-4	Wolf Creek	Sandy/Wolf Creek	500	N/A	N/A	$50,000
Pathogen Monitoring								
8.1.1.5	Monthly Bacteriological Monitoring	MP-1	Sandy Creek	Sandy/Wolf Creek	N/A	N/A	N/A	$367/yr

Chapter/ Section	Management Measure	Project ID	Potential Project Location	Sub-Watershed	Linear Feet (ft)	Acre (ac)	Estimated Cost per Unit	Estimated Total Cost
		MP-2	Miflin Creek	Miflin	N/A	N/A	N/A	$367/yr
		MP-3	Hammock Creek	Graham Bayou	N/A	N/A	N/A	$367/yr
Access								
8.4	Blueway Signage	TBD	TBD	TBD	N/A	N/A	$1,300/sign	TBD

9.3 Phase Two Implementation: Long Term

Not all of the critical issues identified within this WMP can be addressed within two years of WMP adoption. Although some projects listed as long-term can be initiated within a two-year period, additional analysis, planning, data collection, design, etc. will push completion of project implementation beyond that range. **Table 9.2** summarizes recommended long-term management measures and includes rough order-of-magnitude cost estimates to implement each measure.

Table 9.2 Long-Term Management Measures (2+ Years)

Chapter/ Section	Mangement Measure	Project ID	Potential Project Location	Sub-Watershed	Linear Feet (ft)	Acre (ac)	Estimated Cost per Unit	Estimated Total Cost
Overall Watershed								
8.1.1.4	Comprehensive Post-Construction BMP Inventory	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	$25,000
8.2	Invasive Species Control Plan	N/A	TBD	Sandy/Wolf, Miflin, Graham Bayou	TBD	TBD	TBD	TBD
8.1.3	Rehab of Sewer Mains in Foley	N/A	Wolf Creek	Sandy/Wolf	45,408	N/A	N/A	$1,250,000
8.1.3	Aquifer Recovery Storage Wells	N/A	Wolf Creek	Sandy/Wolf	N/A	N/A	N/A	$3,532,083
8.1.3	Septic Tank Inventory	N/A	N/A	Sandy/Wolf, Miflin, Graham Bayou	N/A	N/A	N/A	$30,000

Chapter/ Section	Mangement Measure	Project ID	Potential Project Location	Sub-Watershed	Linear Feet (ft)	Acre (ac)	Estimated Cost per Unit	Estimated Total Cost
Restoration and Protection								
8.1.1.1	Agricultural Buffer	AB-1	Wolf Creek	Sandy/Wolf	N/A	164	Low- $13,000/ac High- $30,000/ac	Low- $2.132M High - $4.92M
		AB-2	Sandy Creek	Sandy/Wolf	N/A	89	Low- $13,000/ac High- $30,000/ac	Low - $1.157M High - $2.67M
		AB-3	Sandy Creek	Sandy/Wolf	N/A	94	Low- $13,000/ac High- $30,000/ac	Low- $1.222M High - $2.82M
		AB-4	Miflin Creek	Miflin	N/A	110	Low- $13,000/ac High- $30,000/ac	Low - $1.43M High - $3.3M
		AB-5	Miflin Creek	Miflin	N/A	308	Low- $13,000/ac High- $30,000/ac	Low - $4.004M High - $9.24M
		AB-6	Trib to Miflin Creek	Miflin	N/A	89	Low- $13,000/ac High- $30,000/ac	Low - $1.157M High - $2.67M
		AB-7	Trib to Miflin Creek	Miflin	N/A	58	Low- $13,000/ac High- $30,000/ac	Low - $754,000 High - $1.74M
		AB-8	Hammock Creek	Graham Bayou	N/A	47	Low- $13,000/ac High- $30,000/ac	Low - $611,000 High - $1.41M
		AB-9	Hammock Creek	Graham Bayou	N/A	136	Low- $13,000/ac High- $30,000/ac	Low - $1.768M High - $4.08M
		AB-10	Trib to Hammock Creek	Graham Bayou	N/A	264	Low- $13,000/ac High- $30,000/ac	Low- $3.432M High - $7.92M

Chapter/ Section	Mangement Measure	Project ID	Potential Project Location	Sub-Watershed	Linear Feet (ft)	Acre (ac)	Estimated Cost per Unit	Estimated Total Cost
8.1.1.1	Cattle Exclusion Fencing	CEF-1	Sandy Creek	Sandy/Wolf	5,174	N/A	Low- $2.00/ft High- $2.40/ft	Low- $10,348 High - $12,417.60
		CEF-2	Sandy Creek	Sandy/Wolf	3,248	N/A	Low- $2.00/ft High- $2.40/ft	Low- $6,496 High - $7,795.20
		CEF-3	Miflin Creek	Miflin	997	N/A	Low- $2.00/ft High- $2.40/ft	Low- $1,994 High - $2,392.80
	Alternative Water Source	AWS-1	Sandy Creek	Sandy/Wolf	N/A	N/A	N/A	$6,000
		AWS-2	Sandy Creek	Sandy/Wolf	N/A	N/A	N/A	$6,000
		AWS-3	Hammock Creek	Graham Bayou	N/A	N/A	N/A	$6,000
8.1.1.4	Stream/Habitat Restoration (Engineering and Design)	SR-1	Wolf Creek	Sandy/Wolf	300	N/A	N/A	$30,000
		SR-5	Sandy Creek	Sandy/Wolf	1,175	N/A	N/A	$117,500
		SR-6	Hammock Creek	Sandy/Wolf	1,600	N/A	N/A	$160,000
		SR-7	Wolf Creek		1,600	N/A	N/A	$160,000
	Stream/Habitat Restoration (Construction)	SR-2	Wolf Creek	Sandy/Wolf	700	N/A	N/A	$700,000
		SR-3	Wolf Creek	Sandy/Wolf	3800	N/A	N/A	$3,800,000
		SR-4	Wolf Creek	Sandy/Wolf	500	N/A	N/A	$500,000
Conservation and Access								
8.4	Public Boat Launch		Wolf Creek	Sandy/Wolf	N/A	5.5	N/A	$1,600,000
8.4	Land Acquisitions	CLA-1	Sandy Creek	Sandy/Wolf	N/A	1,820	N/A	$9,100,000
		CLA-2	Wolf Creek	Sandy/Wolf	N/A	2.9	N/A	$325,000
		CLA-3	Wolf Creek	Sandy/Wolf	N/A	5.5	N/A	$1,600,000
		CLA-4	Miflin Creek	Miflin	N/A	515	N/A	$2,575,000

Chapter/ Section	Mangement Measure	Project ID	Potential Project Location	Sub-Watershed	Linear Feet (ft)	Acre (ac)	Estimated Cost per Unit	Estimated Total Cost
		CAL-5	Graham Bayou/ Wolf Bay	Graham Bayou	N/A	1,382	N/A	$8,564,000
BMPs								
8.1.1.3	Road Paving	RP-1	N/A	Miflin	6,336	N/A	$500,000/ 5280 ft	$600,000
		RP-2	N/A	Miflin	4,752	N/A	$500,000/ 5280 ft	$450,000
		RP-3	N/A	Miflin	5,280	N/A	$500,000/ 5280 ft	$500,000
		RP-4	N/A	Graham Bayou	7,920	N/A	$500,000/ 5280 ft	$750,000
		RP-5	N/A	Graham Bayou	4,224	N/A	$500,000/ 5280 ft	$400,000
8.1.1.5	Litter Traps	LT-1	Wolf Creek	Sandy/Wolf	N/A	N/A	N/A	$5,000 install/ $12,000 annual maint.
		LT-2	Wolf Creek	Sandy/Wolf	N/A	N/A	N/A	$5,000 install/ $12,000 annual maint.
		LT-3	Wolf Creek	Sandy/Wolf	N/A	N/A	N/A	$5,000 install/ $12,000 annual maint.

9.4 Accountability and Reporting

On a routine basis (e.g., annually), the WBWW should assess progress towards meeting WMP goals and objectives (see Chapter 1). Results of performance monitoring, as discussed in Chapter 12, should be used to assess whether specific management measures are addressing the critical issues and areas they were designed to address or whether adjustments are required. Additionally, the WBWW should develop criteria to judge success with input from stakeholders and the general public. On an annual basis, a report card should be prepared documenting accomplishments and success stories and reporting on conditions within the Watershed.

A regular reporting schedule is necessary to archive and track monitoring data and assess the overall success of management actions. Progress reports for the Watershed should be prepared and submitted to MBNEP. Reporting should be conducted on at least an annual basis, although interim reporting may be helpful in critical watershed areas or where more frequent monitoring is needed to track success of specific management actions. Annual reports should include at a minimum: a summary of watershed conditions including field results from monitoring and sampling activities, an update on the status of management measures implemented to date, and a summary of anticipated management measures to be implemented during the next 12 months.

Chapter 10 Regulatory Review

The implementation of best management practices (BMPs) recommended in the Wolf Bay WMP may be subject to a variety of federal, State, and local regulations. Many of these regulations are restrictive in nature and require a permits or other approvals for implementation of projects. Others are more permissive in nature, encouraging appropriate levels of innovation and the use of BMPs designed to improve environmental conditions. This chapter of the Wolf Bay WMP seeks to identify applicable regulations and identify regulatory overlaps, gaps, and any inconsistencies that may hinder implementation of the Plan's recommendations. This regulatory framework will outline the applicable federal, State, and local regulations, laws, and ordinances that relate to water quality, sediment and erosion control, coastal zone activities, wetlands, land development, and other land disturbance activities. In addition to regulations enforced through the U.S. Government and the State of Alabama, this chapter will also highlight local ordinances in Baldwin County, the City of Foley, and the Town of Elberta.

Table 10.1 provides a comprehensive overview of the applicable federal, State, and local regulations related to water resources. Regulatory requirements that govern activities in the Wolf Bay Watershed include:

- The Clean Water Act, 33 USC § 1251, et seq.
- The Coastal Zone Management Act, 16 USC § 1451
- The Alabama Water Pollution Control Act, Code of Alabama 1975 § 22-22-1
- The Alabama Water Quality Criteria, Code of Alabama 1991 § 336-6-10
- Construction Site Stormwater and State MS4 NPDES Program, Code of Alabama 1977 § 335-6-6
- The Alabama Watershed Management Authority Act, Code of Alabama 1991 § 91-602
- The Baldwin County Flood Damage Protection Ordinance
- The Baldwin County Subdivision Regulations
- The Baldwin County Zoning Ordinances
- The Baldwin County Stormwater Management Plan, NPDES Permit No. ALR040042
- The City of Foley Code of Ordinances
    - Chapter 4, Buildings, Construction and Related Activities
        - Article II: Flood Damage Prevention
        - Article III: Permits and Fees
        - Article VII: Lot Clearing and Weed Removal

        - Article VIII: Shoreline Construction Activities
    - Chapter 6.5, Environment
        - Article III: Erosion and Sediment Control
        - Article V: Illicit Discharges
        - Article VI: Environmental Permits Related to Land Disturbance
    - Appendix A, Zoning
    - Appendix B, Subdivision Regulations
- Town of Elberta Code of Ordinances
    - Chapter 8, Buildings and Building Regulations
    - Chapter 14, Floods
        - Article II: Flood Damage Prevention
    - Appendix A, Subdivision Regulations
    - Appendix B, Zoning

Table 10.1 Overview of Water-Related Regulations in the Wolf Bay Watershed

Regulation/Ordinance	Regulatory Authority	Jurisdiction
Federal Regulations		
Clean Water Act: §303(d) 1972	USEPA and ADEM • Impaired Waters List and TMDL Development/Implementation	Federal and State
Clean Water Act: §319 1972	USEPA and ADEM • Non-Point Source Management • Provides funding for local and state non-point source pollution programs	Federal and State
Clean Water Act: §401 1972	USEPA and ADEM • Provides for and requires state water quality criteria • Supported on the State level by ADEM Administrative Code 335-6-10	Federal and State
Clean Water Act: §402 1972	USEPA and ADEM • Establishes and regulates the National Pollution Discharge Elimination System (NPDES) which also includes the Municipal Separate Storm Sewer System (MS4)	Federal and State

Regulation/Ordinance	Regulatory Authority	Jurisdiction
Clean Water Act: §404 1972	USACE • Regulates the discharge of dredged or fill materials into waters of the U.S., including wetlands	Federal
Coastal Zone Management Act, 16 USC § 1451	NOAA, ADEM, and ADCNR • Management of the nation's coastal resources	Federal and State
State Regulations		
Alabama Water Pollution Control Act	ADEM • State of Alabama companion regulation to the CWA and includes water quality criteria, impaired waters, TMDLs, NPDES, etc.	State
Alabama Water Quality Criteria	ADEM • A subset of the Alabama Water Pollution Control Act that includes the 303(d) Impaired Waters List and TMDLs	State
NPDES Program	ADEM • A subset of the Alabama Water Pollution Control Act that includes MS4 permitting for local governments and other public entities	State
Alabama Coastal Zone Program	ADEM, ADCNR-SLD • ADEM – Permitting, monitoring, and enforcement • ADCNR-SLD – Planning and policy development	State
Alabama Watershed Management Authority Act	State of Alabama • Provides for the establishment and management of Watershed Management Authorities	State
Baldwin County Regulations		
Baldwin County Flood Damage Protection Ordinance	Baldwin County • Promote public health, safety, and welfare by minimizing losses due to flood conditions	Local

Regulation/Ordinance	Regulatory Authority	Jurisdiction
Baldwin County Subdivision Regulations	Baldwin County • Establishes regulations for development or expansion of subdivisions. • Applicable sections include • Article 5, Section 5.11 (Drainage Systems) • Article 5, Section 5.12 (Stormwater Detention/Retention Management • Article 5, Section 5.13 (Erosion and Sediment) • Article 5, Section 5.19 (Additional Regulations Applicable to Flood Prone Areas) • Appendix 2 (Stormwater Calculations and Submittal Requirements)	Local
Baldwin County Zoning Ordinances	Baldwin County • Intended to protect health, safety, and welfare by encouraging the appropriate use of lands and natural resources. • Applicable Sections include: • Article 11 (Conservation Developments) • Article 13, Section 13.4 (Utilities (including wastewater)) • Article 13, Section 13.5 (Sewage Treatment Plants) • Article 13, Section 13.11 (Stormwater Management) • Article 13, Section 13.12 (Erosion Control) • Article 17 (Landscaping and Buffers)	Local
City of Foley Code of Ordinances		
Chapter 4, Buildings, Construction and Related Activities	City of Foley • Regulates building construction including lot development and other land disturbing activities and also includes provisions for flood damage prevention	Local
Chapter 6.5, Environment	City of Foley • Generally referred to as the Erosion and Sediment Control Ordinance and addresses erosion and sediment control, illicit discharges, and permits for land disturbance activities	Local
Appendix A, Zoning	City of Foley • Provides for the orderly growth and development and encourage the most advantageous use of land and resources	Local
Appendix B, Subdivision Regulations	City of Foley • Established standards and procedures for development of new or expansion of existing subdivisions.	Local

Regulation/Ordinance	Regulatory Authority	Jurisdiction
Manual for Design and Construction Standards	City of Foley • Includes provisions for conservation areas, Low Impact Development (LID) techniques, and Green Infrastructure (GI) in development and redevelopment	Local
Town of Elberta Code of Ordinances		
Chapter 8, Buildings and Building Regulations	Town of Elberta and Baldwin County • Elberta adopted the Baldwin County Building Regulation by reference.	Local
Chapter 14, Floods	Town of Elberta • Promote public health, safety, and welfare by minimizing losses due to flood conditions	Local
Appendix A, Subdivision Regulations	Town of Elberta • Established standards and procedures for development of new or expansion of existing subdivisions.	Local
Appendix B, Zoning	Town of Elberta • Provides for the orderly growth and development and encourage the most advantageous use of land and resources	Local

In addition to the above matrix that outlines a wide variety of regulatory mechanisms potentially affecting the Wolf Bay Watershed, the matrix presented in **Table 10.2** reviews specific stormwater regulations affecting the Watershed. The stormwater matrix below was derived from the South Alabama Stormwater Regulatory Review Report (2018) and includes an overview of stormwater regulations from the federal to the municipal level. The matrix also provides a good example of regulatory overlap and illustrates the level of regulation delegated from the federal level to the state level and ultimately to the local level. Typically, it is incumbent upon the local governments (counties and municipalities) to fill in regulatory gaps that potentially affect the local landscape and specific issues found at the local government level.

Table 10.2 Mobile Bay National Estuary Program: South Alabama Stormwater Regulatory Requirements, January 2018

Regulatory Category	US EPA	ADEM	Baldwin County	City of Foley	Town of Elberta
Construction Phase BMPs Requirements	Yes	Yes	Yes	Yes	Yes
Design Standards	Not specified	AL Handbook	AL Handbook	AL Handbook	Not specified
BMP Design Storm	2yr-24hr	2yr-24hr	Not Specified	Not Specified	10/25-year
Site Size	>1 acre	>1 acre	Any	>/= 500 ft^2 / 1/2 acre	>1 acre

Regulatory Category	US EPA	ADEM	Baldwin County	City of Foley	Town of Elberta
Stabilization Time	Immediate/14 days	Immediate/13 days	10 or 13 days	Immediate	14 days
Site Inspections	1 per week or per 2 weeks + 1/4" Rain	State-Random / Con. 1/month +3/4" rain	Yes	City-Random / Contractor - "regular"	City-Random / Contractor - "regular"
BMP Repair/Maintenance Time	Immediate/7 days	5 days	Not Specified	2 Days	Not specified
Non-compliance Reporting	Yes	Yes	No	No	No
Buffer Requirement	50'	Yes - 25'	No	30' Wetland / 50' Waterway	5' - 30' Wetland / 25' Waterway
Post Construction Stormwater Requirements	No	No	Yes	Yes	Yes
Stormwater Quality	No	No	No	Yes - Treat First Flush (1.25")	No
Stormwater Quantity	No	No	Yes-Considers timing	Yes	Yes
Design Storm	N/A	N/A	2 - 100 yr.	2 - 100 yr.	25 year
Site Size	N/A	N/A	Any	500 ft.^{2}	Varies 1 - 10 acre
Routine Inspection	N/A	N/A	No	Annual by City	No
Maintenance	N/A	N/A	Developer/Owner	Owner	Landowner
Reporting	N/A	N/A	No	No	No
Calculation Method	N/A	N/A	NRCS	Various	Rational Method
Coastal Area Resource Protection	Yes	Yes	No	Yes	No
Wetland/Stream Buffer	50 ft.	25 ft.	N/A	30' Wetland / 50' Waterway	5' - 30' Wetland / 25' Waterway
Permit Requirement	Yes - USACE	Yes	N/A	USACE/ADEM	USACE/ADEM
Low Impact Development	No	No	No	Yes	No
Development Size	N/A	N/A	N/A	N/A	N/A
Impervious Cover	No	No	No	N/A	N/A
On-Site Retention	No	No	No	Yes - 1.23"	N/A
LID Standards	No	No	No	LID Handbook	N/A

Regulatory Category	US EPA	ADEM	Baldwin County	City of Foley	Town of Elberta
Impediments to LID	N/A	N/A	N/A	No	N/A
Shoreline Stabilization	N/A	Yes	No	Yes	Yes
Piers and Bulkheads	N/A	Yes	N/A	Yes	Yes
Living Shorelines	N/A	No	N/A	No	Optional
MS4 Permit Coverage	N/A	N/A	ALR040042	No	No

10.2 Overview of Applicable Laws, Regulations, and Ordinances

10.2.1 Federal Regulations

Several federal agencies and regulations manage and govern activities in the nation's wetlands, groundwater, freshwater, and coastal resources. Most of these programs are managed through the United States Army Corps of Engineers (USACE), the United States Environmental Protection Agency (USEPA), and National Oceanic and Atmospheric Administration (NOAA). In forthcoming sections, we will discuss regulatory overlaps. Many of these overlaps occur through a top-down regulatory approach that begins at the federal level and extends to the state and sometimes even the local level. Federal regulations relative to this Plan and designed to protect water quality and regulate activities in the nation's waters are provided below.

10.2.1.1 Federal Water Pollution Control Act and the Clean Water Act

The most notable set of regulations addressing water quality and aquatic resource protection are found in the Federal Water Pollution Control Act (FWPCA) of 1948, amendments to the Act in 1972, and the Clean Water Act (CWA) amendments to the FWPCA enacted in 1977. The original FWPCA was the first major law to address water pollution in the U.S. However, by the 1970's two-thirds of the nation's lakes, rivers, and coastal waters were unsafe for fishing or swimming. The 1972 and 1977 amendments were extensive and wide-ranging and accomplished the following:

- Established a system to regulate pollutant discharges into waters of the U.S.
- Granted the USEPA authority to implement water pollution control programs.
- Retained existing requirements to set water quality standards for all contaminants in surface waters.

- Prohibited the discharge of a pollutant from a point source into navigable waters unless the discharger obtains a permit under the law's provisions.
- Funded the construction of wastewater treatment facilities.
- Recognized the importance of planning when addressing critical issues caused by non-point source pollution.

Within the CWA are a number of sections particularly pertinent to watershed planning and coastal resources. These sections are outlined below.

10.2.1.2 Clean Water Act §303(d) 1972

Section 303(d) of the Clean Water Act provides for establishment of water quality criteria and requires states to maintain a listing of impaired waters. Section 303(d) also requires that Total Maximum Daily Loads (TMDL) be established for impaired waters. A TMDL establishes the allowable loading of a given pollutant that a receiving water can handle without an increase of impairment for that specific pollutant. Typically, once a TMDL is established for a particular stream segment, it is removed from of the 303(d) list.

10.2.1.3 Clean Water Act §319 1972

Section 319 provides grant funding to states, territories, and tribes to support a variety of water quality initiatives including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, watershed planning, and monitoring to assess the success of nonpoint source implementation projects. As a funding source, it is less regulatory and more of an assistance program. However, since it directly addresses water quality issues, it bears mention in this section of the Wolf Bay Plan.

10.2.1.4 Clean Water Act §401 1972

Section 401 of the CWA determines that a federal agency may not issue a permit to conduct activities that may result in a discharge into waters of the U.S. without a state or tribal entity issuing a Section 401 water quality certification verifying or waiving compliance with existing water quality requirements. Section 401 is supported on the state level in Alabama by the Alabama Department of Environmental Management (ADEM) Administrative Code 335-6-10. Section 401 is an important tool that allows states to protect water

quality within their borders in collaboration with federal agencies. Section 401 seeks to provide for a robust state role in the federal permitting process but also places limitations on how that role is implemented within the federal construct of the CWA.

10.2.1.5 Clean Water Act §402 1972

Section 402 of the CWA established and regulates discharges under the National Pollution Discharge Elimination System (NPDES). Under NPDES, USEPA grants permits for a number of land disturbance and discharge activities, including concentrated animal feeding operations, publicly owned treatment works, combined sewer overflows, construction, and sanitary sewer overflows. The program also established the Municipal Separate Storm Sewer System (MS4), that provides permits to local governments and other entities and regulates the management of non-point source pollutants, commonly referred to as stormwater runoff.

10.2.1.6 Clean Water Act §404

Section 404 authorizes a permitting process specific to activities that may impact jurisdictional wetlands and is designed to ensure protection of the nation's wetlands. Section 404 includes specific guidance relative to discharges of dredge or fill materials into waters of the U.S. Section 404 specifically established the USACE as the primary permitting authority to issue permits and to oversee permitted activities. The program also requires that all 404 permitted activities be consistent with state water quality standards and coastal program requirements that may exist.

10.2.1.7 Coastal Zone Management Act 16 USC §1451

The Coastal Zone Management Act (CZMA) was borne of a congressional recognition that continued growth in the nation's coastal zones presents challenges with respect to protection of natural areas and water quality within the coastal zones. The CZMA includes three primary programs: the National Coastal Zone Management Program, the National Estuarine Research Reserve System, and the Coastal and Estuarine Land Conservation Program. The CZMA program seeks to balance competing land and water issues through state coastal management programs. The program also provides matching funds to state and local governments to purchase threatened coastal and estuarine lands or to obtain conservation easements. The Act provides for NOAA to have primary management responsibility of the program.

10.2.2 State Regulations

The majority of federal regulations previously discussed are delegated to the states to administer, providing the states enact and implement equivalent state statutes and programs. For the State of Alabama, the majority of regulations related to the environment and water quality are administered through ADEM. With the exception of the CZMA, the regulations discussed below are applicable statewide.

10.2.2.1 Alabama Water Pollution Control Act

The Alabama Water Pollution Control Act is the state equivalent of the federal CWA and prohibits discharges of pollutants to state waters without a permit. It also lays the foundation for the state's authority to implement a variety of water quality programs as discussed below.

10.2.2.2 Alabama Water Quality Certification

As a subset of the Alabama Water Pollution Control Act, the Water Quality Certification Program dictates that permit applications must be filed with and approved by the state to ensure dredged or fill materials will not cause or contribute to a violation of water quality standards. These standards are also communicated by the state through a 303(d) Impaired Waters Report and published TMDLs.

10.2.2.3 National Pollution Discharge Elimination System Program

This program is the state delegate program of Section 402 of the CWA and establishes a permitting program for discharge of pollutants to waters of the U.S. ADEM administers this program through its Water Quality Program. ADEM characterizes facilities discharging pollutants based on the size and type of facility and level of treatment required prior to discharge. Generally, larger facilities such as sewage treatment plants are authorized to discharge under individual permits, while smaller facilities such as construction sites receive authorization under a general permit.

The program also includes the NPDES Municipal Separate Storm Sewer System (MS4). This program issues permits to large municipalities, urban areas, entities with high population densities such as a university, and most departments of transportation (DOTs). MS4 permits require that covered entities develop and implement a Stormwater Management Program Plan that includes the following six minimum measures:

- Public Education and Outreach on Stormwater Impacts
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination
- Construction Site Stormwater Management
- Post Construction Stormwater Management
- Pollution Prevention and Good Housekeeping for Municipal Operations

MS4 permits may require stormwater or stream monitoring for stream segments included in the state's 303(d) list or with an approved TMDL. The programs typically encourage low impact development and implementation of green infrastructure practices. The MS4 permits also require submittal of an annual report of activities and accomplishments related to the six minimum measures to be submitted to ADEM. Most MS4s operate under a general permit. However, some non-municipal MS4s such as DOTs have opted for coverage under an individual permit.

10.2.2.4 Alabama Coastal Area Management Program

This program is administered by ADEM with the Alabama Department of Conservation and Natural Resources (State Lands Division) providing additional support and planning oversight. The Alabama CZMA provides the statutory basis for the Alabama Coastal Area Management Program. The Program is designed to "promote, improve, and safeguard the lands and waters located in the coastal areas of the State through a comprehensive and cooperative program designed to preserve, enhance, and develop such valuable resources for the present and future well-being and general welfare of the citizens of the State". The Program regulates and permits development activities of greater than five acres that have potential to impact wetlands. The Program also regulates and permits shoreline stabilization, docks and piers, construction on beaches or dunes, and other similar activities impacting coastal resources.

10.2.2.5 Alabama Watershed Management Authority Act

This program is not regulatory; however, it does provide a statutory basis for creation of Watershed Management Authorities. The general intent of the Act is to allow for the establishment of Watershed Management Authorities whose purpose is to protect and manage the watersheds of the State. Through the Act, Watershed Management Authorities may be formed in any watershed in the State. Their primary

purpose is to develop and execute plans and programs relating to water conservation and usage; flood prevention; flood control; water pollution control; wildlife habitat protection; agricultural and timberland protection; erosion prevention; and control of erosion, flood water, and sediment damages within the watershed.

10.2.3 Local Government Regulations and Ordinances

Three local government entities exist within the Wolf Bay Watershed: Baldwin County, the City of Foley, and the Town of Elberta. Each of these entities have a variety of regulations and ordinances that regulate development in the Watershed and are designed to protect water quality and natural resources in the Watershed. Many of the ordinances enacted by the local governments are similar. However, they do have varying levels of detail with respect to requirements and implementation of the ordinances.

The State of Alabama is a "Dillon's Rule" State. Under Dillon's Rule, a municipal government has the authority to act only when:

1. The power is granted in the express words of the statute, private act, or charter creating the municipality.
2. The power is necessarily or fairly implied in, or incident to the powers expressly granted; or
3. The power is one that is neither expressly granted nor fairly implied from the express grants of power but is otherwise implied as essential to the declared objects and purposes of the municipality.

Thirty-one states in the U.S. employ Dillon's rule to all municipalities. Another eight states apply Dillon's rule to only certain municipalities. The remaining states employ home rule, with the exception of Florida, which applies home rule to everything except taxation.

10.2.3.1 Baldwin County

10.2.3.1.1 Baldwin County Flood Damage Protection Ordinance

The overarching goal of the Baldwin County Flood Damage Protection Ordinance is to minimize losses due to flood conditions. Through this ordinance, the County regulates construction and development in the floodplain to ensure buildings are protected from flood damage. Baldwin County participates in the National Flood Insurance Program (NFIP) and the Community Rating System (CRS). The CRS program

includes incentives for NFIP communities to implement more stringent floodplain standards than those normally required by the NFIP. The CRS program rewards these efforts with discounts on flood insurance premiums. Baldwin County currently has a CRS rating of a Class 6, which results in a 20% reduction in flood insurance premiums for properties located within a FEMA designated Special Flood Hazard Area (SFHA). Additionally, the County has flood damage prevention requirements specific to properties located within SFHAs that are coastal in nature, including the Coastal High Hazard VE Zone and the Coastal High Hazard AE Zone.

10.2.3.1.2 Baldwin County Subdivision Ordinance

The Baldwin County Subdivision Ordinance (August 2019), establishes regulations for development or expansion of subdivisions. A number of provisions of the Ordinance are specific to water quality and protection of natural resources. These include:

- **Article 5, Section 5.11 (Drainage Systems):** This section provides for minimum design standards for drainage systems in subdivisions and requires that stormwater drainage systems be separate from and independent of any sanitary sewer systems.
- **Article 5, Section 5.12 (Stormwater):** This section requires developments that will produce an increase in stormwater runoff to include stormwater management facilities as part of the development. It also requires detailed engineering calculations that include historical runoff, and proposed development runoff. The section requires that post-development runoff be equal to or less than pre-construction conditions for two, five, 10, 25, 50, and 100-year storm events. Subsection 5.12.2 (3) provides for specific requirements for subdivisions developed within the Wolf Bay Watershed and requires that subdivisions proposed in the Wolf Bay Watershed be modeled according to the Wolf Bay Watershed Study Model (Hydro Engineering Solutions, 2013 and 2020).
- **Article 5, Section 5.13 (Erosion and Sedimentation):** This section imposes requirements on persons engaged in land disturbance activities to incorporate planning and implementation of effective erosion and sediment controls. The provision includes construction requirements and requirements for protection of adjacent properties.
- **Article 5, Section 5.19 (Additional Regulations Applicable in Flood Prone Areas):** This section, by reference, enforces the County's Flood Damage Protection Ordinance by requiring all subdivisions within or containing FEMA designated SFHAs to comply with the Flood Damage Ordinance and be consistent with the need to minimize flood damage to the development itself and to minimize future flood damages to adjacent properties.

- **Appendix 2 (Stormwater Calculations and Submittal Requirements):** Appendix 2 requires subdivision design engineers to submit a design narrative summarizing the assumptions, calculations, and results of the design for the entire project including:
    - A design narrative summary,
    - Evaluations of pre and post differential runoff,
    - Evaluations of required retention/detention ponds,
    - Pond routing calculations in legible tabulated form,
    - Inlet and gutter details,
    - Culvert pipe details, and
    - Open channel drainage system details.

10.2.3.1.3 Baldwin County Zoning Ordinance

The Baldwin County Zoning Ordinance is intended to protect health, safety, and welfare by encouraging the appropriate use of lands and natural resources in the County. As with the Subdivision Ordinance, specific sections of the Zoning ordinance are intended to be protective of water quality and natural resources. These include:

- **Article 11 (Conservation Developments):** The intent of this section is to "promote flexibility of design to promote environmentally sensitive and efficient use of the land to preserve in perpetuity unique or sensitive natural resources such as groundwater, floodplains, wetlands, streams, steep slopes, woodlands, and wildlife habitat". The Conservation Development Article is a perfect example of a regulation that is permissive in nature. By allowing for unified control of the development, allowing for clustered development on less sensitive lands, and by waiving minimum lot and yard sizes, this Article encourages conservation and protection of sensitive lands. The Article includes a number of flexible standards providing that the design allows for:
    - Improved site design,
    - Protection of natural features within the development,
    - Maintenance of harmony with neighboring land uses,
    - Promotion of the objectives and purpose of the master plan with respect to protection of natural resources, and
    - Promotion of the intent and purpose of the Article.

- **Article 13, Section 13.4 (Utilities including wastewater):** This section requires that developments include provisions for proper wastewater collection and transmission, including provisions for septic tanks. The section requires submission of a utility plan illustrating plans and specifications for proposed water supply, sewage disposal, refuse collection, fire protection, and other utilities.
- **Article 13, Section 13.5 (Sewage Treatment Plants):** This section requires that on-site sewage treatment plants utilize the best available technology and provide, at a minimum, tertiary treatment.
- **Article 13, Section 13.11 (Stormwater Management):** Section 13.11 requires that a Stormwater Management Plan be developed for all major projects. The plan must be prepared by an engineer licensed in the State of Alabama and must be submitted in conjunction with an application for a land use certificate. The section also ensures that reasonable provisions for the proper handling of surface drainage are incorporated into the development's design.
- **Article 13, Section 13.12 (Erosion Control):** The purpose of this section is to further the maintenance of safe conditions by preventing and controlling water pollution, erosion, and undesirable sediment transfer. It also seeks to protect natural areas such as spawning grounds, fish and wildlife habitats, and other natural systems. The section outlines specific design principles, design criteria, and erosion and sediment control requirements. The section requires development, submittal, and implementation of an erosion control plan for both small (less than 1 acre) and large projects (greater than 1 acre).
- **Article 17 (Landscaping and Buffers):** This section outlines requirements for on-site landscaping and buffers between adjacent properties. The section outlines provisions for tree protection and provides recommended native species for development of new on-site landscaped and buffered areas.

10.2.3.2 City of Foley Code of Ordinances

The City of Foley maintains a comprehensive code of ordinances, many of which are directly related to land development and include provisions for protection of water quality and natural resources. This section will outline specific chapters and articles of the City of Foley code of ordinances that are relevant to this WMP.

10.2.3.2.1 Chapter 4: Buildings, Construction, and Related Activities

Chapter 4 of the Foley Code of Ordinances outlines provisions, policies, and procedures for development within the City. Chapter 4 outlines specific permitting processes and includes regulations relative to flood prone areas, design and construction standards, lot clearing, and shoreline construction activities.

Article II seeks to protect human life and health, to minimize damage to public facilities and infrastructure from flood events, to maintain a stable tax base by providing for sound use and development in flood prone areas, to minimize expenditure of public funds for costly flood control projects, to minimize the need for rescue and relief efforts during flood events, to minimize prolonged business interruptions; and to ensure that potential home buyers are notified that a given property is in a flood area.

The Article requires issuance of a permit from the City for development in FEMA designated SFHAs and includes a series of general and specific standards designed to reduce or minimize risk of development in SFHAs. Examples of standards include a requirement that structures within a SFHA be elevated so the lowest finished floor is one foot above the base flood elevation (BFE). The article also includes variance procedures and other processes for relief of the general and specific standards. However, relief from these standards requires stringent engineering controls and illustration of design elements that will minimize the impacts of flooding.

Article VIII references USACE, ADCNR, and ADEM regulations specific to development and improvements on State-submerged lands. The article includes provisions for application for and issuance of permits for development and repair of riparian structures, including piers, docks, boathouses, retaining walls, and bulkheads. Issuance of permits for these activities requires an inspection by the City's Environmental Department and establishes standards for shoreline protection associated with the aforementioned development activities.

10.2.3.2.2 Chapter 6.5: Environment

Chapter 6.5 contains four key articles, including Article III: Erosion and Sediment Control, Article IV: Heritage Tree Preservation, Article V: Illicit Discharges Ordinance, and Article VI: Environmental Permits Related to Land Disturbance.

Article III outlines provisions for permits related to development activities that have potential to contribute to erosion and sediment transfer. The Article requires a permit for land disturbing activities that uncover more than five hundred square feet of ground and requires submission of an erosion and sediment control plan outlining specific BMPs designed to minimize erosion and sediment transfer. The Article also outlines specific design requirements related to clearing and grading, erosion control, sediment controls, protection of waterways and water courses, and construction site access.

Article IV identifies specific species of heritage trees to be protected and preserved during land disturbance and other construction activities. The Article includes provisions for permitting of removal of heritage trees, inclusion of heritage trees in submitted site plans, and provision for replacement of removed heritage trees.

Article V is the City's Illicit Discharge Ordinance. The ordinance applies to all lands within the corporate limits of the City and is intended to regulate the contribution of pollutants to the MS4, to prohibit illicit connections and discharges to the MS4, and to establish the City's legal authority to conduct inspections and monitor as necessary to enforce the provisions of the ordinance. Article V includes specific discharge prohibitions and suspension of MS4 access. Additionally, it includes provisions for discharge monitoring, protection of waterways and watercourses, required notification of spills and discharges, and enforcement.

Article VI outlines processes and procedures required by the City to obtain a permit for land disturbance activities. The stated purpose of the Article is to provide minimum standards to ensure effective stormwater management, drainage management, tree protection and restoration, and construction of BMPs for land disturbance activities affecting more than five hundred square feet of land. The Article outlines specific BMP plan requirements, including a landscape plan and tree survey of proposed development sites.

10.2.3.2.3 Appendix A: Zoning

The purpose of the City's Zoning Ordinance is to promote the public health, safety, morals, and general welfare of the citizens by providing for orderly development and growth of the City; by avoiding congestion of public streets; by conserving life, property, and natural resources; and allowing for and encouraging the most advantageous use of land and resources for the public good. The ordinance is organized into 25 articles, the most relevant of which are discussed here.

Article X, Section 10.2: Landscaping, and Buffer Requirements requires buffering where necessary to provide separation between abutting lots, particularly between abutting lots with differing or conflicting

uses. The ordinance encourages the use of vegetative buffers, which provides benefits for stormwater management and control of non-point source pollutants.

Article XIX, Section 19.2: Open Space and Preservation Districts allows for establishment of open space and preservation districts that may include public parks, playgrounds, hiking and nature trails, wildlife sanctuaries, nature preserves, canoe, kayak, and boat launches, and other similar uses.

10.2.3.2.4 Appendix B: Subdivision Regulations

The City of Foley Subdivision Regulations establish policies and procedures for development of new or modifications to existing subdivisions. The regulations stipulate requirements for drainage, sewage disposal, retention ponds, and land stabilization. The ordinance also addresses development near or adjacent to floodways and requires specific setbacks for developments near floodways. Additionally, the regulations address general flooding and flood hazard areas, wetlands, and the need for permitting of developments in these areas in similar fashion to the City's Flood Damage Prevention Ordinance.

10.2.3.2.5 Manual for Design and Construction Standards

The City of Foley's *Manual for Design and Construction Standards*, enacted as Ordinance 17-2029-ORD, provides standards for a variety of construction related activities. Most notably for the purposes of this Chapter, it provides specific standards for acquisition and maintenance of conservation green space and conservation easements. The ordinance also provides standards for and requires the use of LID and GI practices in development and redevelopment. Section 4.6 of the *Manual for Design and Construction Standards* calls for the design and integration of LID techniques to promote the health, safety, and general welfare of the community. The ordinance also requires close collaboration between the design engineer and the City's Engineering and Environmental Departments to ensure that LID practices are designed on a site-specific basis and that specific LID techniques and practices provide the optimum solutions for the site in question.

Specific design requirements include a provision that stormwater management practices retain the first 1.25" of stormwater and allows this standard to be achieved through infiltration, evapotranspiration, and the use of retention or detention BMPs. The ordinance also requires the engineering design to utilize hydraulic and hydrologic analysis to demonstrate that any post-development increases in discharge from a

two-year storm be infiltrated on site. Additionally, any redevelopment activities that modify over 30% of the site valuation achieve the capture and retaining of the first 1.25" of runoff through LID and GI practices.

10.2.3.3 Town of Elberta Code of Ordinances

In similar fashion to the City of Foley, the Town of Elberta maintains and enforces a Code of Ordinances generally designed to regulate a variety of activities in the Town, including land development, building construction, flood prone areas, zoning, and subdivision development.

10.2.3.3.1 Buildings and Building Codes

Elberta has adopted the County's building codes by reference. As such, the provisions for Elberta's building codes are identical to Baldwin County's.

10.2.3.3.2 Chapter 4, Article II: Flood Damage Prevention

The Town of Elberta's Flood Damage Prevention Ordinance is very similar to Foley's and is intended to protect human life and health, to minimize damage to public facilities and infrastructure from flood events, to maintain a stable tax base by providing for sound use and development in flood prone areas, to minimize expenditure of public funds for costly flood control projects, to minimize the need for rescue and relief efforts during flood events, to minimize prolonged business interruptions, and to ensure that potential home buyers are notified that a given property is in a flood area.

The Article requires issuance of a permit from the Town for development in FEMA-designated SFHAs and includes a series of general and specific standards designed to reduce or minimize risk of development in SFHAs. Examples of standards include a requirement that structures within a SFHA be elevated so the lowest finished floor is one foot above the BFE. The article also includes variance procedures and other processes for relief of the general and specific standards. However, relief from these standards requires stringent engineering controls and illustration of design elements that will minimize the impacts of flooding.

10.2.3.3.3 Appendix A: Subdivision Regulations

The Town of Elberta's Subdivision Regulations provide for the orderly development of new subdivisions and modification of existing subdivisions. The ordinance addresses the orderly placement of streets, lots,

and other elements of subdivisions and addresses drainage and other elements critical to this Watershed Management Plan.

Article 3 – Definitions: This Article references floodplains, floodways, and other FEMA designated SFHAs. Users should cross-reference the Town's Flood Damage Prevention Ordinance for specific requirements for developments encroaching in flood prone areas.

Article 5, Section 5.7 – Drainage: This Article provides general policies and design standards for drainage associated with subdivisions developed within the Town of Elberta. As with other design elements, the Town requires submission of a subdivision plat that illustrates planned drainage improvements to include surface and subsurface drainage systems and dedication of common areas to be used for stormwater management and drainage such as retention basins. The ordinance requires that drainage systems for all subdivisions be designed to accommodate flows from at least a 25-year frequency design storm.

Article 5, Section 5.8 – Erosion and Sedimentation: This Article imposes requirements on persons engaged in land-disturbing activities requiring planning and implementation of effective sediment controls for subdivision development sites. The ordinance requires that an erosion and sediment control plan be a part of the construction plans to be filed with the Town prior to beginning any construction activities. The ordinance also states that when conflicts exist between federal, state, or local laws, the more restrictive provision applies. Section 5.8 outlines basic control objectives, including identification of critical areas, limitations on exposed areas at any one time, limitations on the time of exposure, minimization of stormwater runoff and sediment transfer during construction, and permanent protection of downstream stream banks and channels. The ordinance applies to all subdivision developments comprising more than one acre.

Article 5, Section 5.9 – Stormwater Detention: This Article indicates that subdivision developments producing an increase in the amount of stormwater runoff be required to construct stormwater detention ponds or other approved types of detention devices or structures. The ordinance also provides detailed design criteria for detention structures. Also significant is the provision that responsibilities for maintenance of such structures and facilities remain with the developer throughout the construction process and until the Town accepts the subdivision improvements in their entirety.

Article 7 – Required Improvements: Article 7 outlines a number of improvements required by subdivision developers, including streets, curbs and gutters; sidewalks; water and wastewater systems;

utilities; and drainage common areas. Specifically, the requirements for drainage common areas address subdivisions that are traversed by a watercourse, drainageway, or stream and requires the establishment of drainage rights-of-way conforming to the lines of the watercourse at a minimum of 15 feet in width to allow for public maintenance when necessary.

10.2.3.3.4 Appendix B: Zoning Ordinance

As with other zoning ordinances, the Town of Elberta's is intended to promote public health, safety, and welfare by ensuring proper use of land within the Town and that incompatible uses are minimized.

Article VIII, Sections 7.6 and 7.7: This Article's sections address surface drainage and erosion and sediment control and are generally consistent with provisions included in the Town's Subdivision Ordinance. More specific provisions are outlined in later sections of the Ordinance.

Article VIII, Section 8.13 – Flood Hazard Areas: This Article references the FEMA Flood Insurance Rate Maps for Baldwin County.

Article XI – Erosion and Sediment Control: This Article goes beyond the Town's Subdivision Ordinance by outlining provisions for erosion and sediment control for all developments with land disturbance activities greater than one acre. Article XI outlines basic control objectives, standards, and provisions for submission of erosion and sediment control plans, as well as processes for review of submitted plans.

10.3 Regulatory Overlap

Regulatory overlap is evident in the delegation of regulatory implementation authority from the federal to the state level, and in some cases to local (municipal and county) authorities. A good example of regulatory overlap is the NPDES MS4 Program. The regulations begin on the federal level, with states receiving permitting authority from USEPA and continues to local authorities through permits issued from ADEM. Regulatory overlap does not appear to be a significant issue with respect to the development and implementation of the Wolf Bay WMP. However, it does illustrate the need for consistent coordination and communication between USEPA, ADEM, and local authorities to ensure that regulations are applied consistently across varying jurisdictional levels. Regulations discussed in this chapter are often referred to as "minimum standards," meaning that states and local authorities have the authority to establish more

stringent standards to ensure that priorities at these governmental levels are clearly addressed through the regulations.

10.4 Regulatory Gaps

One regulatory gap that appears to be consistent among all three local authorities is the absence of a strong post-construction provision relative to stormwater runoff, erosion, and sediment controls. While all three entities address standards for retention/detention structures in subdivisions, we did not identify regulations that address the same for all types of development activities. This is due in part to the absence of a strong post-construction standard on both the federal and State levels. Therefore, it becomes incumbent upon local entities to fill regulatory gaps to protect water quality and other natural resources from direct and indirect impacts associated with development and redevelopment.

10.5 Recommendations and Opportunities

Our review of the local regulatory environment indicates that the level of regulation for each of the three local authorities appears to be appropriate, given the scale and level of development currently being experienced. From our research and review of the regulatory environment in the Wolf Bay Watershed, we observed what appears to be an appropriate level of regulation, particularly with respect to local authorities.

However, given the County's rapid rate of growth, all local authorities should comprehensively review regulations specific to natural resource protection to ensure that future developments are implemented in ways that protect the Watershed's bountiful natural resources. Outside of the City of Foley, we see opportunities for regulatory provisions that encourage and incentivize the use of LID and GI practices. These incentives can be incorporated into local zoning and subdivision ordinances, as well as local building codes. Opportunities to reduce impervious cover in new developments can also be included in these ordinances through parking lot ratios, requirements for buffers and percentages of green space, and landscaped areas in new developments.

Baldwin County and the City of Foley both participate in the FEMA Community Rating System (CRS). Baldwin County is at a Class 7, Foley is at a Class 8, and Elberta is not currently enrolled in CRS. We recommend that Baldwin County and Foley seek to improve their current CRS Class and that Elberta strongly consider participating in CRS. One activity that can greatly improve Baldwin County's and Foley's

ratings is development and implementation of a FEMA compliant Watershed Master Plan. A Watershed Master Plan differs from a Watershed Management Plan in that it focuses on water quantity, establishes baseline flooding conditions, and projects changes in flooding conditions based on potential future developments.

All local authorities should consider implementation of environmental courts into the county or municipal court systems. Environmental courts separate specific environmental violations from traditional municipal courts and can address violations related to development codes, litter, property maintenance, and enforcement of local stormwater (MS4) regulations. Examples of successful environmental courts in Alabama include Mobile County, the City of Birmingham, and the City of Montgomery.

It is also recommended that Baldwin County and the Town of Elberta adopt an ordinance similar to the City of Foley's *Manual for Design and Construction Standards*. Adoption of a similar ordinance would allow the County and Elberta to proactively address stormwater, drainage, and water quality issues as growth and increases in impervious cover continue to affect water quality in those two jurisdictions.

Baldwin County, the City of Foley, and the Town of Elberta would a benefit from communicating on a regular basis in an effort to coordinate actions and regulatory changes related to stormwater management on a watershed scale across municipal and political boundaries. Monthly meetings of the Plan Lower Alabama Now (PLAN) group (of which each is an active member) could provide opportunities for updates and coordination. Each should consider adoption of a consistent post-construction stormwater ordinance to ensure that regulations affecting development activities continue to have a positive impact on water quality once construction on a site is complete. It is our recommendation that the model originally developed in 2013 by Hydro Engineering Solutions serve as a guide when updating regulations and approving new development throughout the Watershed. This model was reevaluated in 2020 using data from a September 2018 rainfall event which produced 5 inches of rain within a ten-hour period. It was determined from this event that the previously calibrated Wolf Bay model from 2013 provided similar results for timing and peak discharge (Hydro Engineering Solutions, 2020).

Additionally, several communities in Alabama have "stand-alone" post-construction ordinances including:

- Jacksonville: https://www.jacksonville-al.org/wp-content/uploads/2019/05/POST_CONSTRUCTION_STORMWATER_MANAGEMENT_ORDINANCE_No_O_592_17.pdf;

- Alabaster: https://www.cityofalabaster.com/DocumentCenter/View/2685/Ordinance-181001-075-Stormwater-Management-Post-Construction-PDF;
- Helena: http://www.cityofhelena.org/Sites/Helena/Documents/City%20Ordinances/Ord%20859-18%20Stormwater.pdf.

When the State of Alabama, through ADEM, drafts its next State MS4 permit, the State should consider a heightened emphasis on post-construction stormwater regulations and standards to ensure that all regulated MS4s within the State are basing their ordinances on a consistent set of standards.

Chapter 11 Financing Alternatives

The funding of projects and activities on a watershed scale can be a complex process. Watershed boundaries do not follow municipal jurisdictions; therefore, successful implementation of the management measures described in Chapter 8 depends on the long-term commitment of significant financial resources and cooperation between local, county and state governments, non-profits, utilities, as well as the surrounding communities.

A variety of federal, state, and local funding sources, along with public-private partnerships, should be considered to fund implementation of management measures. Leveraging multiple funding opportunities simultaneously will maximize the implementation potential of the WMP. Ultimately, success will be linked to the degree of coordination and level of financial resources available.

Some of the financial structures described in the following sections will be applicable across the entire Watershed, while others will only be useful within certain areas and apply to particular management measures. Many of the financing alternatives will require public-private partnerships between landowners and sponsors, such as local governments, utilities, or civic/non-profit organizations.

11.1 Funding and Regional Planning

Multi-organizational partnerships that incorporate stakeholders across all sectors in the Watershed are effective because of their ability to strengthen local capacity and eliminate duplicative efforts. Because a structure is needed to guide multi-stakeholder initiatives, it is imperative that a WMTF be created to see common goals across multiple entities come to fruition. A cooperative approach allows entities such as governments, non-profits, utilities, and the public to come together to collaborate on project funding, as well as implementation. Aligning efforts and increasing program efficiency requires: 1) a common agenda, 2) shared measurement system, 3) mutually reinforcing activities, 4) continuous communication, and 5) backbone support organizations. **Table 11.1** presents entities that should be considered in the financial planning and implementation process for projects in the Watershed.

Table 11.1 Organizations to be Included in Financial Planning and Implementation

Alabama Coastal Foundation	Alabama Department of Conservation and Natural Resources	Alabama Department of Environmental Management
Alabama Department of Public Health	Alabama Department of Transportation	Alabama Forestry Commission
Alabama Forest Resources Center	Alabama Water Watch	Alabama Wildlife Federation
Auburn University Marine Extension and Research Center	Baldwin County-Alabama Cooperative Extension	Baldwin County Commission
Baldwin County Health Department	Baldwin County Public Schools	Baldwin County Soil and Water Conservation District
City of Foley	Dauphin Island Sea Lab	Geological Survey of Alabama
Gulf Coast Ecosystem Restoration Council	Mobile Bay National Estuary Program	National Fish and Wildlife Foundation
National Oceanic and Atmospheric Administration	National Science Foundation	Riviera Utilities
Southeastern South Aquatic Resources Partnership	The Nature Conservancy	Town of Elberta
University of South Alabama	USDA, Forest Service	USDA, Natural Resource Conservation Service
US Army Corps of Engineers	US Environmental Protection Agency	US Fish and Wildlife Service
US Geological Survey	US National Park Service	Wolf Bay Watershed Watch

11.2 Financial Strategy

11.2.1 Federal Funding Programs

The United States government provides numerous sources of funding, usually through grants, loans and revenue sharing, that may be used by municipalities and non-profits to conduct studies and construct projects related to watershed protection, stream restoration, and storm water management. Attempting to combine multiple federal funding sources for one single project can be problematic and is often not permissible.

11.2.1.1 U.S. Environmental Protection Agency

The USEPA administers grant money to state and local governments to support collaborative partnerships to protect and restore the nation's water resources. Financial support for non-point source and pollution control measures, including Section 319 (non-point source management) and Section 106 (water pollution

control) are provided by the USEPA. In addition, the USEPA Gulf of Mexico Program helps fund environmental education, habitat restoration, coastal resilience and water quality improvements. More information on these grants and other USEPA grant opportunities is discussed further in **Appendix F**.

11.2.1.2 National Oceanic and Atmospheric Administration

NOAA is another federal agency that provides financial resources to conserve and manage coastal and marine ecosystems. The Marine Debris Removal Program grant and the Marine Debris Prevention, Education and Outreach grant are two provided by NOAA that can support litter reduction efforts. The Community-Based Restoration Program leverages local resources and promotes community involvement in habitat restoration activities. See **Appendix F** for more information regarding NOAA-specific funding resources.

11.2.1.3 U.S. Department of Agriculture, Natural Resources Conservation Service

Funding opportunities for all rural producers and riparian landowners in the Watershed are provided by the U.S. Department of Agriculture, Natural Resources Conservation Service in Bay Minette. These programs include the Baldwin County Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), Emergency Watershed Protection Program (EWP), Regional Conservation Partnership Program (RCPP), Watershed and Flood Prevention Operations Program (WFPO) and Agricultural Conservation Easement Program (ACEP). These programs provide applicants with financial assistance to address erosion control, soil quality, grazing lands, forestry/wildlife heath, irrigation water management, and invasive species control. The Baldwin County District Conservationist works with agricultural producers to determine specific qualification and levels of financial assistance available within each program. **Appendix F** presents additional information about EQIP, CSP, EWP, WFPO, and ACEP.

11.2.1.4 Alabama Gulf Coast Recovery Council

The Alabama Gulf Coast Recovery Council was created with the passage of the Resources and Ecosystems Sustainability, Tourists Opportunities, and Revived Economies of the Gulf Coast States (RESTORE) Act of 2012 to administer funds received from civil penalties from the 2010 *Deepwater Horizon* oil spill. The Council can designate RESTORE funds to WMP projects that restore and protect natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast region. More information on RESTORE funds can be found in **Appendix F**.

11.2.2 State Funding Programs

The following section presents funding sources provided by the Alabama Department of Conservation and Natural Resources and the Alabama Department of Environmental Management. The funding provided by these State entities is typically used to implement water quality, coastal resiliency, emergency preparedness, and conservation-based projects.

11.2.2.1 Alabama Coastal Area Management Program

The Alabama Coastal Area Management Program (ACAMP) was approved by NOAA in 1979 as a part of the National Coastal Zone Management Program. The ACAMP provides annual funding opportunities related to coastal planning. The program is intended to assist local government planning agencies in providing education and addressing coastal habitat protection, wetland protection, and coastal nonpoint source pollution control measures.

11.2.2.2 Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) is a low interest program intended to finance public water and wastewater infrastructure improvements and stormwater/non-point source projects. For example, a municipality might consider financing streambank restoration and buffer projects by securing a CWSRF loan. Financial resources provided by the State of Alabama are also covered in **Appendix F**.

11.2.3 Private Funding Programs

The National Fish and Wildlife Foundation, created by Congress in 1984, is a nonprofit organization that works with both public and private sectors to protect and restore the nation's fish, wildlife, plants, and habitats. Several WMP implementation projects have already been funded by NFWF throughout Baldwin County through the Gulf Environmental Benefit Fund with monies derived from criminal penalties related to the *Deepwater Horizon* oil spill. The Five Star Urban Waters Program is intended to fund shoreline erosion, streambank stabilization, and stormwater runoff projects. The Gulf Coast Conservation Grants Program supports conservation projects that preserve threatened coastal ecosystems. These NFWF grants provide invaluable opportunities to craft cross-sector conservation partnerships in the Watershed.

Other notable grant resources include the Healthy Watersheds Consortium Program and the Gulf of Mexico Alliance's Gulf Star Program. **Appendix F** presents a full list of private, and private/public partnership funding resources.

11.2.4 Funding of Local Stormwater Programs

In 2010, the Baldwin County Commission proposed a stormwater referendum to address water quality and drainage issues. Despite the Commission's effort to manage stormwater at the watershed scale, residents strongly opposed the new plan. The referendum was unpopular among voters and became referred to locally as the "rain tax" plan. Despite local criticism, watershed-scale stormwater management is a growing trend throughout the United States. Stormwater drain fees, property taxes, general funds, and special assessment districts are just a few examples of regional funding mechanisms that have successfully financed stormwater initiatives in other areas of the country. These options should be considered as viable alternatives for financing a regional stormwater program in south Baldwin County.

11.2.5 Listing of Previously Discussed Resources

Table 11.2 lists financial resources discussed above, as well as additional resources that could support implementing management measures recommended in the WMP. Four different funding categories are presented in the table: (1) financial assistance, (2) technical assistance, (3) water quality monitoring and (4) information and education. Additional information on funding sources and website links are located in **Appendix F**.

Table 11.2 Listing of Potential Funding Sources and Descriptions

Funding Source	Description	Type	Actions Funded
Alabama Coastal Area Management Program	Annual Grant Program	State	Financial Assistance, Water Quality Monitoring
Alabama Department of Environmental Management	Section 319 Grant Funds	State	Financial Assistance, Water Quality Monitoring
	Clean Water SRF		
Department of the Interior	Land and Water Conservation Fund	Federal	Financial Assistance
Alabama Gulf Coast Recovery Council	RESTORE Act	Federal	Financial Assistance
National Oceanic and Atmospheric Administration	Community-based Marine Debris Removal	Federal	Financial Assistance

Funding Source	Description	Type	Actions Funded
	NOAA Marine Debris Prevention, Education and Outreach Partnership Grant	Federal	Financial Assistance, Information and Education
	NOAA Gulf of Mexico Bay-Watershed Education and Training (B-WET) Program	Federal	Financial Assistance, Information and Education
	RESTORE Act Science Program	Federal	Financial Assistance
	FY2020 Broad Agency Announcement	Federal	Financial Assistance, Information and Education
	Environmental Literacy Grants	Federal	Financial Assistance, Information and Education
	Community-based Restoration Program	Federal	Financial Assistance, Technical Assistance
National Science Foundation	Environmental Engineering and Sustainability Program	Federal	Technical Assistance, Water Quality Monitoring
USDA, Natural Resource Conservation Service	Environmental Quality Incentives Program	Federal	Financial Assistance, Technical Assistance, Water Quality Monitoring
	Conservation Stewardship Program	Federal	Financial Assistance, Technical Assistance
	Emergency Watershed Protection Program	Federal	Financial Assistance, Technical Assistance
	Watershed and Flood Prevention Operations Program	Federal	Financial Assistance, Technical Assistance
	Agricultural Conservation Easement Program	Federal	Financial Assistance, Technical Assistance
USEPA	106 Grant Funds (Water Pollution Control)	Federal	Financial Assistance, Water Quality Monitoring
	National Wetland Program Development Grants	Federal	Financial Assistance, Technical Assistance, Water Quality Monitoring
	Source Water Protection Grants	Federal	Information and Education, Financial Assistance, Water Quality Monitoring

Funding Source	Description	Type	Actions Funded
	Urban Water Small Grants	Federal	Technical Assistance, Water Quality Monitoring
	Gulf of Mexico (and the Gulf of Mexico Partnership Gulf Guardian Awards)	Federal	Financial Assistance, Water Quality Monitoring
USFWS	Partners for Fish and Wildlife	Federal	Financial Assistance, Technical Assistance
	Coastal Program	Federal	Financial Assistance, Technical Assistance
	National Coastal Wetlands Grant	Federal	Financial Assistance
	Boating infrastructure Grant Program (Tier 2-National)	Federal	Financial Assistance
	Boating infrastructure Grant Program (Tier 1-State)	Federal	Financial Assistance
	Natural Resource Damage Assessment, Restoration and Implementation	Federal	Financial Assistance
	State Wildlife Refuge Partnership	Federal	Financial Assistance
	Urban Wildlife Refuge Partnership	Federal	Financial Assistance, Information and Education
	National Fish Habitat Action Plan	Federal	Financial Assistance, Technical Assistance
Conservation Alabama Foundation	Watershed Management Plan Outreach Grant Program	Private-Public Partnership	Information and Education
US Endowment for Forestry and Communities, Inc.	Healthy Watersheds Consortium Grant Program	Private-Public Partnership	Financial Assistance, Technical Assistance, Water Quality Monitoring
Gulf of Mexico Alliance	Gulf Star Grants Program (1-Coastal Resiliency, 2-Data and Monitoring, 3-Education and Engagement, 4-Wildlife and Fisheries)	Private-Public Partnership	Information and Education, Financial Assistance, Water Quality Monitoring
Cornell Douglas Foundation Grants	Cornel Douglas Foundation Grants	Private	Financial Assistance, Information and Education

Funding Source	Description	Type	Actions Funded
The Home Depot	Community Impact Grants Program	Private	Financial Assistance
The Kresge Foundation	Environmental: (1-Climate Resilience in Coastal Cities and Regions, 2-Sustainable Water Resource Management in Changing Climate)	Private	Financial Assistance
Gulf of Mexico Research Initiative	RFP - IV	Private	Financial Assistance
Gulf Research Program	Capacity Building Grants	Private	Information and Education
Legacy Partners in Environmental Education	Environmental Education Grants	Private	Financial Assistance, Information and Education
National Education Association Foundation	Captain Planet Foundation Grants for the Environment	Private	Financial Assistance, Information and Education
National Environmental Education Foundation	Everyday Capacity Building Grants	Private	Financial Assistance, Information and Education
NFWF	Conservation Partners Program	Private	Technical Assistance, Information and Education
	Gulf Environmental Benefit Fund	Private	Financial Assistance
	National Wildlife Refuge Friends Program (project specific grants)	Private	Financial Assistance, Information and Education
	Five Star & Urban Waters Restoration Program	Private	Financial Assistance, Information and Education, Water Quality Monitoring
	Gulf Coast Conservation Grant Program	Private	Financial Assistance

Chapter 12 Monitoring

A watershed monitoring program is an integral component of a WMP. It not only evaluates the water quality (physical, chemical, and biological) of the waterbodies within the Watershed but also assesses specific watershed characteristics (i.e., riparian corridors and land use/land cover) that may be related to water quality observations. It also provides a quantitative method by which to evaluate successes and failures of implemented management measures. The Wolf Bay Watershed monitoring program should utilize the guidance set forth in the *Mobile Bay Subwatershed Restoration Monitoring Framework* prepared by the Science Advisory Committee: Monitoring Working Group in 2015.

12.1 Monitoring Parameters

Based on literature reviews, field reconnaissance, Steering Committee input, and public input gathered during the development of this WMP, the following water quality parameters (physical and chemical) and watershed characteristics are recommended to be monitored.

12.1.1 Standard Field Parameters

Standard field parameters are physical characteristics (abiotic factors) of water which should be measured each time sampling is conducted. These parameters include water temperature, specific conductivity, dissolved oxygen, alkalinity, hardness, and pH. Standard field parameters can serve as indicators of watershed health, while providing a context for interpreting other measured or observed field data. These parameters are correlated with one another, as well as biological factors within the system, and have important influences on the overall watershed.

12.1.2 Turbidity

Turbidity is a physical characteristic that measures water clarity based on the amount of sediment or other materials suspended in the water. Elevated turbidity levels can degrade watershed conditions by disrupting primary production (plant and algal growth) and adversely impacting the health of fish and other aquatic organisms. Turbidity typically increases following rain events because loose sediments are transported to waterbodies by storm runoff. Therefore, targeted measurements of turbidity can be a good indicator of non-

point sources and may help to identify areas where improvements or additional management measures (such as stream restoration or installation of buffer strips or retention basins) are needed.

12.1.3 Nutrients

Unlike standard field parameters and turbidity, nutrient concentrations cannot be easily measured in the field. Chemical analysis of water samples is performed at facilities with appropriate laboratory instrumentation to determine the presence and concentration of specific nutrients in a water sample. When elevated nutrient concentrations are discovered at specific sampling locations, evaluation of adjacent land use and land cover can be conducted to determine potential sources, such as agriculture, lawns, or septic sewer outfalls. Existing water quality data indicates that elevated nitrogen and phosphorus concentrations are both a concern in some locations in the Watershed.

12.1.4 Pathogens

Sandy Creek and Miflin Creek were recently placed on the draft 2020 Alabama 303(d) list for pathogens (Enterococcus). High pathogen concentrations pose a public health risk and, for this reason, can result in restricted uses of waterways (such as swimming or fishing). Enterococcus is a strain of bacteria that originates in the guts of humans and other animals and is typically used as an indicator for pathogens in water. Pathogen concentrations peak immediately after rainfall events, because they are usually carried to waterbodies via stormwater runoff. Pathogen monitoring data can help identify certain types of sources, such as agriculture or faulty septic systems, and may guide decision makers in determining where improvements or additional management measures (such as buffer strips) are needed. Pathogen concentrations are measured by collecting water samples in the field for incubation in a laboratory to quantify bacterial growth. Pathogen concentrations cannot be easily measured in the field.

12.1.5 Erosion and Sedimentation

Erosion and sedimentation within watershed streams can be measured by collection of water samples which can then be filtered. Remaining sediments are dried and weighed for analysis and comparison. Grab samples during and immediately after storm events are used to determine if streams are impaired by sediment issues. The amount of soil loss or accretion can also be measured by the use of stationary erosion stakes which illustrate the amount of soil lost or gained around the stake over a period of time. Areas of measurable erosion and sedimentation were identified through the WMP process in Wolf Creek between the Foley

Beach Express and Swift Church Road and at Doc McDuffie Road, in two unnamed tributaries of Sandy Creek north of Highway 98, and in Hammock Creek north of County Road 20. It is recommended that total suspended solids (TSS) be monitored in addition to turbidity in the vicinity of these identified areas.

12.1.6 Invasive Species

Although not abundantly present, invasive species have been identified as an issue in the Watershed. While quantitative assessments of invasive species throughout the Watershed may not be feasible, sampling teams should make visual assessments of the presence of invasive species during routine water quality sampling activities. These observations should be documented in field notes and photographed when possible. Sampling teams should be trained in the identification of the four major invasive plants (cogongrass, Chinese tallow, Chinese privet, and alligator weed) that are known to occur, as well as other species which may occur.

12.1.7 Litter Monitoring

While litter can be difficult to quantify, sampling teams should make visual observations during routine water quality sampling to generally assess litter conditions at various points throughout the Watershed. These observations should be documented in field notes and photographed when possible. Litter monitoring may also help identify areas within the Watershed that should be targeted for future action.

Another option for documenting trash amounts and locations throughout the Watershed is through the Escaped Trash Assessment Protocol (ETAP). ETAP was created by the Trash Free Waters Program of the EPA to provide a uniform method to collect data on trash types, amounts, and what areas pose the greatest risk to humans and wildlife. Groups such as the WBWW can upload data to a publicly available database and a summary report will be generated. This data helps to identify trends over time as well as mitigation and source reduction measures. Groups can add features to the methodology to address the types of data they want to produce, such as certain item types or volume of trash collected. More information on the program and program protocols can be found at https://dpa730eaqha29.cloudfront.net/myedmondsnews/wp-content/uploads/2018/07/Reference-Manual_ETAP-June-2018.pdf

12.2 Sample Collection Locations

The Wolf Bay Watershed is unique when compared to adjacent watersheds in that it currently has an established water quality monitoring program. The program employs both municipal and citizen volunteer sampling locations. According to the Alabama Water Watch (AWW) website, there are currently three sampling locations actively being monitored by the city of Foley and eight sites being monitored by members of the Wolf Bay Watershed Watch (**Table 12.1**). Based on data gathered through literature reviews, field reconnaissance, and collaboration with members of the Steering Committee, six additional sites have been identified for sampling. **Table 12.2** provides information for each of the newly identified monitoring sites. **Figure 12.1** illustrates the sampling locations.

Table 12.1 Sample Collection Locations

AWW Site Code	Current Sampling Group	Latitude	Longitude	Current Sampling Parameters	Recommended Additional Sampling Parameters
4012016	City of Foley	30.409623	-87.676263	Standard Parameters and Turbidity	
4012027	City of Foley	30.388458	-87.652879	Standard Parameters, Turbidity and Nutrients	Total Suspended Solids
4012047	City of Foley	30.344697	-87.623978	Standard Parameters, Turbidity and Bacteria	
4012022	Wolf Bay Watershed Watch	30.36321	-87.567792	Standard Parameters, Turbidity, and Nutrients	Bacteria
4012062	Wolf Bay Watershed Watch	30.363962	-87.602255	Standard Parameters, Turbidity, and Nutrients	Bacteria
4012061	Wolf Bay Watershed Watch	30.363933	-87.620412	Standard Parameters, Turbidity, and Bacteria	
4012020	Wolf Bay Watershed Watch	30.355732	-87.610053	Standard Parameters, Turbidity, and Bacteria	

AWW Site Code	Current Sampling Group	Latitude	Longitude	Current Sampling Parameters	Recommended Additional Sampling Parameters
4012028	Wolf Bay Watershed Watch	30.406977	-87.630185	Standard Parameters, Turbidity, and Bacteria	Nutrients
4012063	Wolf Bay Watershed Watch	30.355784	-87.627068	Standard Parameters and Turbidity	Nutrients
4012060	Wolf Bay Watershed Watch	30.3711	-87.619028	Standard Parameters, Turbidity, and Bacteria	
4012042	Wolf Bay Watershed Watch	30.325373	-87.587554	Standard Parameters, Turbidity, and Bacteria	

Table 12.2 Recommended Additional Sampling Locations

Recommended Sites	Latitude	Longitude	Recommended Sampling Parameters
Unnamed Tributary to Sandy Creek	30.406836	-87.626341	Standard Parameters, Turbidity, and Total Suspended Solids
Unnamed Tributary to Sandy Creek	30.406583	-87.624872	Standard Parameters, Turbidity, and Total Suspended Solids
County Road 83 at Elberta Creek	30.423199	-87.598111	Standard Parameters, Turbidity, Bacteria, and Nutrients
Highway 98 at Miflin Creek	30.414399	-87.591348	Standard Parameters, Turbidity, Bacteria, and Nutrients
County Road 95 at Tributary to Hammock Creek	30.368244	-87.548332	Standard Parameters, Turbidity, Bacteria, and Nutrients
Wolf Creek at Swift Church Road	30.37348	-87.63258	Standard Parameters, Turbidity, and Total Suspended Solids

Figure 12.1 Active and Proposed Sample Collection Locations

12.3 Monitoring Program Approach and Schedule

Because water quality parameters and watershed characteristics are affected by many factors and can change quickly, annual or quarterly sampling may not be sufficient to track changes and monitor overall trends. It is important to note that each sampling data point represents a snapshot of watershed conditions at a certain point in time. A larger data set will provide context for each data point and help to identify outliers that may not be representative of overall watershed conditions. It is recommended that sampling be conducted at each of the designated sample collection locations on an at-least monthly basis. This sampling schedule should be sufficient to accurately monitor trends in water quality parameters and watershed characteristics without being overly burdensome for sampling teams or cost prohibitive for managers.

12.4 Citizen Volunteer Monitoring

The Wolf Bay Watershed Watch began volunteer water quality monitoring in the Watershed in 1998. Much of the data collected through this effort was instrumental in Wolf Bay being declared an OAW by ADEM and the USEPA in 2007. In recent years, the number of active water quality monitoring volunteers has declined, and data collected has not been consistent. In an effort to revive the program, the WBWW (**Figure 12.2**) is working to recruit local schools and community groups to adopt sampling locations that were previously monitored or that have been identified in this Plan. Citizen participation in water quality monitoring will not only enable successful implementation but will also establish a sense of community ownership within the Watershed.

Figure 12.2 Wolf Bay Watershed Watch Group Logo

12.5 Adaptive Management

Adaptive management will be implemented to maximize the effectiveness and efficiency of implemented management measures. Adaptive management should consist of an annual review of sampling data and comparison of watershed conditions against goals and objectives identified in this WMP. This review and comparison will allow decision makers to evaluate the success of implemented management measures and recommend changes or additional management measures needed to achieve stated goals and objectives. Adaptive management will ensure that implementation strategies are constantly being evaluated and updated, based on the best available science, and adjusted according to changing watershed conditions. Adaptive management will also ensure that staff time and funding resources are used in the most efficient way possible to produce measurable results.

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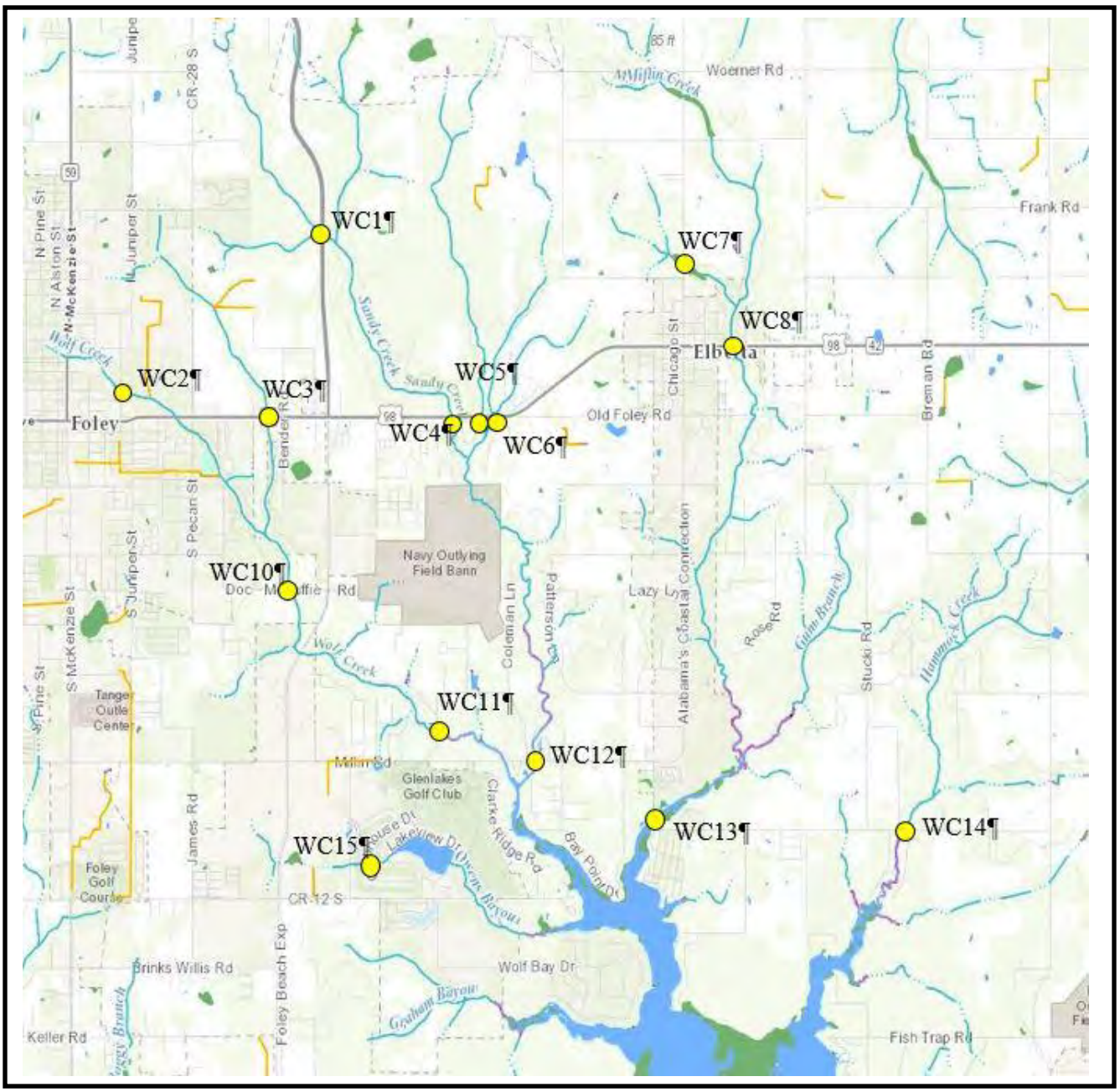
APPENDIX A:
Marlon Cook Research Study (2017)

PRE-RESTORATION ANALYSIS OF DISCHARGE, SEDIMENT TRANSPORT RATES, WATER QUALITY, AND LAND-USE IMPACTS INTHE WOLF BAY WATERSHED, BALDWIN COUNTY, ALABAMA



PRE-RESTORATION ANALYSIS OF DISCHARGE, SEDIMENT TRANSPORT RATES, WATER QUALITY, AND LAND-USE IMPACTS IN THE WOLF BAY WATERSHED, BALDWIN COUNTY, ALABAMA

By

Marlon R. Cook,
Poly, Inc.

Funding for this project was provided by the
Mobile Bay National Estuary Program

September, 2017

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INTRODUCTION

Baldwin County is among the fastest growing areas in Alabama with a 14.4 percent (%) population increase between 2010 and 2016, compared to a 1.7% growth rate for the rest of the state for the same period (US Census, 2016). However, with rapid growth comes quality of life issues, including traffic, increasing water demand, loss of natural landscapes, and watershed degradation. When activities related to population and economic growth are combined with highly erodible soils and cyclonic storms that produce high intensity rainfall events, deleterious water-quality and biological habitat impacts can be severe. Previous investigations of sediment transport and general water quality have shown dramatic increases in sediment loading and loss of biological habitat in streams downstream from areas affected by rapid runoff and erosion from particular types of land uses. Other areas are virtually unimpacted by land-use change and are characterized by natural landscapes dominated by forests and wetlands. Results of these investigations are valuable in quantifying impacts so that limited regulatory and remedial resources may be focused to remediate problem areas or to preserve relatively pristine watersheds.

The city of Foley is an example of Baldwin County rapid population growth with a 20.5% increase between 2010 and 2016 (US Census, 2016). The city is on a watershed divide, where runoff from the southern and western parts of the city drains into Bon Secour River, Bon Secour Bay, and Mobile Bay and the eastern part drains into Wolf Creek, Wolf Bay, Perdido Bay, and the Gulf of Mexico.

The purpose of this investigation is to assess general hydrogeologic and water quality conditions and to estimate nutrient loads and sediment transport rates for tributaries to Wolf Bay including Owens Bayou, Hammock Creek, Miflin Creek, Sandy Creek, and Wolf Creek and their tributaries (fig. 1). These data will be used to quantify water quality impacts and to support development of a watershed management plan, designed to preserve, protect, and restore the Wolf Bay watershed.

ACKNOWLEDGMENTS

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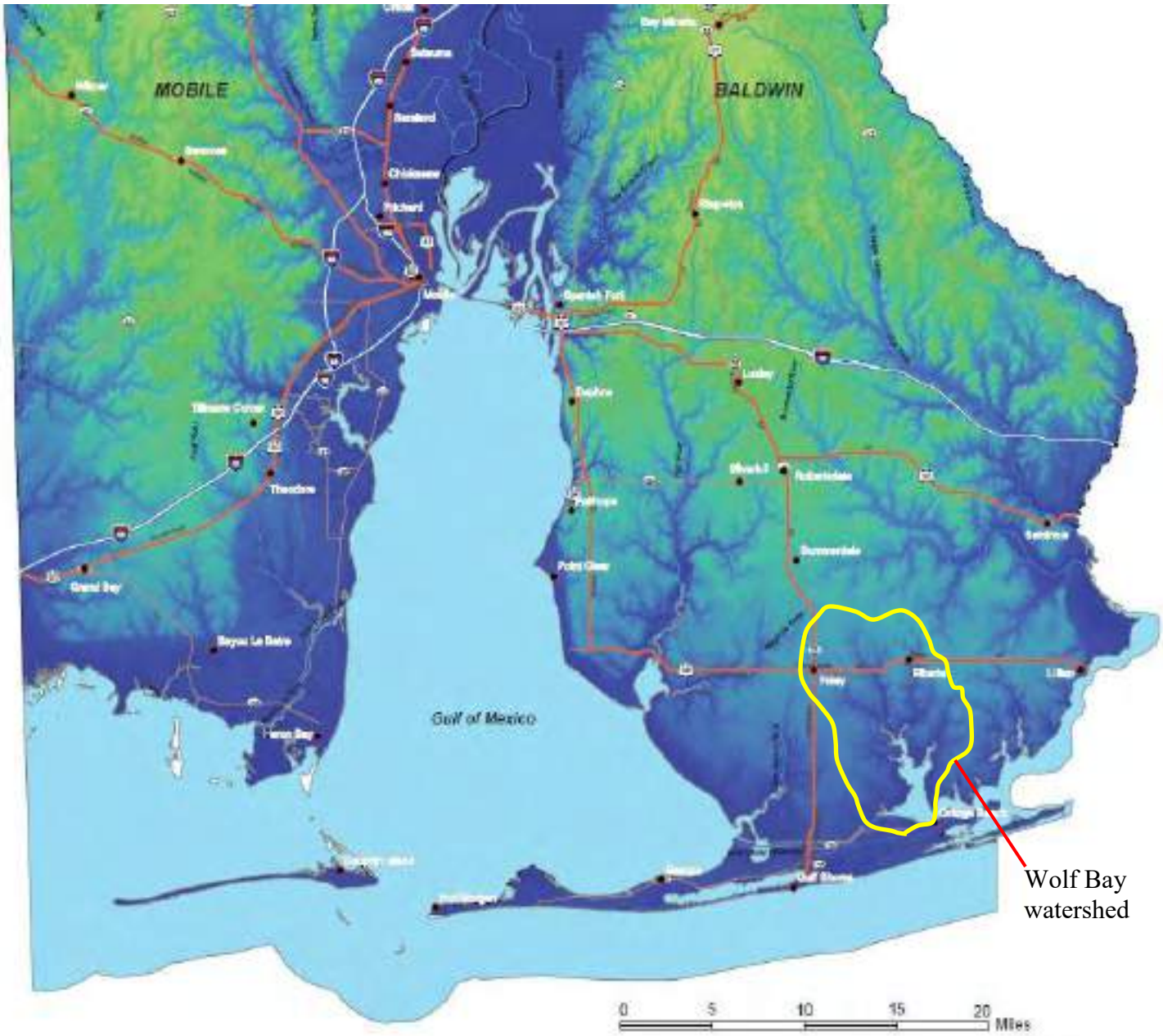

Figure 1.—Mobile and Baldwin Counties with the Wolf Bay watershed.

city of Foley, provided technical assistance; and Mr. Tony Darling, Riviera Utilities, provided bacterial analyses for the project.

PROJECT AREA

The Wolf Bay watershed covers about 54 square miles (mi^2) (US Geological Survey (USGS), 2017) in two major tributary watersheds; Wolf Creek (44.4 mi^2) and Hammock Creek (9.7 mi^2). The project area has 14 monitoring sites on 10 streams, extending from headwaters north of US Highway 98 to brackish reaches along the norther margin of Wolf Bay (fig. 2). Elevations in the project area vary from about 85 feet above mean sea level (ft MSL) at the headwaters to sea level at the mouth. There are currently no streams in the Wolf Bay watershed that are on the Alabama Department of Environmental Management (ADEM) 303(d) list of impaired waters in Alabama (ADEM, 2017). In 2007 Wolf Bay was declared an Outstanding Alabama Water.

PROJECT MONITORING STRATEGY AND SITE CHARACTERISTICS

The strategy employed for the Wolf Bay project was to select monitoring sites on as many tributaries as possible, based on accessibility and reach length. Each stream reach was monitored over a wide range of measured discharge from base flow to high flow. Water samples were collected for measurement of specific conductance, pH, temperature, turbidity, salinity (where applicable), and dissolved oxygen. Laboratory analyses was performed for total suspended solids, nitrate+nitrite nitrogen, and total phosphorus. Bed sediment transport rates were measured and daily and annual loads were estimated for suspended and bed sediment, nitrogen, and phosphorus.

Site WC1 is on Sandy Creek at the Foley Beach Expressway, about 2.5 miles downstream from the headwaters (latitude (lat) 30.42614, longitude (long) -87.64850). The watershed upstream from site WC1 covers 1,408 acres (2.2 mi^2) (USGS, 2017) (fig. 2).

Site WC2 is on Wolf Creek at north Poplar Street, about 1 mile downstream from the headwaters (lat 30.40967, long -87.67639). The watershed upstream from site WC2 covers 634 acres (0.99 mi^2) (USGS, 2017) (fig. 2).

Site WC3 is on an unnamed tributary to Wolf Creek at US Highway 98 (lat 30.40690, long -87.65579). The watershed upstream from site WC3 covers 826 acres (1.3 mi^2) (USGS, 2017) (fig. 2).

Site WC4 is on Sandy Creek at US Highway 98, (lat 30.40684, long -87.63024).

The watershed upstream from site WC4 covers 3,776 acres (5.9 mi^2) (USGS, 2017) (fig. 2).

Site WC5 is on an unnamed tributary at US Highway 98 about 1,200 ft from the confluence with Sandy Creek, (lat 30.40667, long -87.62627). The watershed upstream from site WC5 covers 1,088 acres (1.7 mi^2) (USGS, 2017) (fig. 2).

Site WC6 is on an unnamed tributary to Sandy Creek at US Highway 98, (lat 30.40671, long -87.62481). The watershed upstream from site WC6 covers 1,114 acres (1.74 mi^2) (USGS, 2017) (fig. 2).

Site WC7 is on Elberta Creek at Baldwin County Road 83, (lat 30.42262, long -87.59837). The watershed upstream from site WC7 covers 704 acres (1.1 mi^2) (USGS, 2017) (fig. 2).

Site WC8 is on Miflin Creek at US Highway 98, about 3.2 mi from the headwaters (lat 30.41433, long -87.59159). The watershed upstream from site WC8 covers 2,368 acres (3.7 mi^2) (USGS, 2017) (fig. 2).

Site WC10 is on Wolf Creek at Doc McDuffie Road, (lat 30.38979, long -87.65302). The watershed upstream from site WC10 covers 3,136 acres (4.9 mi^2) (USGS, 2017) (fig. 2).

Site WC11 is on Wolf Creek at Swift Church Road, (lat 30.37350, long -87.63262). The watershed upstream from site WC11 covers 5,696 acres (8.9 mi^2) (USGS, 2017) (fig. 2).

Site WC12 is on Sandy Creek at Baldwin County Road 20, (lat 30.37041, long -87.61852). Sandy Creek at site WC12 is tidally influenced. The watershed upstream from site WC12 covers 8,512 acres (13.3 mi^2) (USGS, 2017) (fig. 2).

Site WC13 is on Miflin Creek at Baldwin County Road 20, (lat 30.36395, long -87.60249). Miflin Creek at site WC13 is tidally influenced. The watershed upstream from site WC13 covers 8,000 acres (12.5 mi^2) (USGS, 2017) (fig. 2).

Site WC14 is on Hammock Creek at Baldwin County Road 20, (lat 30.36303, long -87.56769). Hammock Creek at site WC12 is tidally influenced. The watershed upstream from site WC14 covers 2,432 acres (3.8 mi^2) (USGS, 2017) (fig. 2).

Site WC15 is on Owens Bayou at Lakeview Drive, 1.0 mi from the headwaters (lat 30.35980, long -87.63927). Site WC15 is 300 ft upstream from Lake Muriel. The watershed upstream from site WC15 covers 512 acres (0.8 mi^2) (USGS, 2017) (fig. 2).

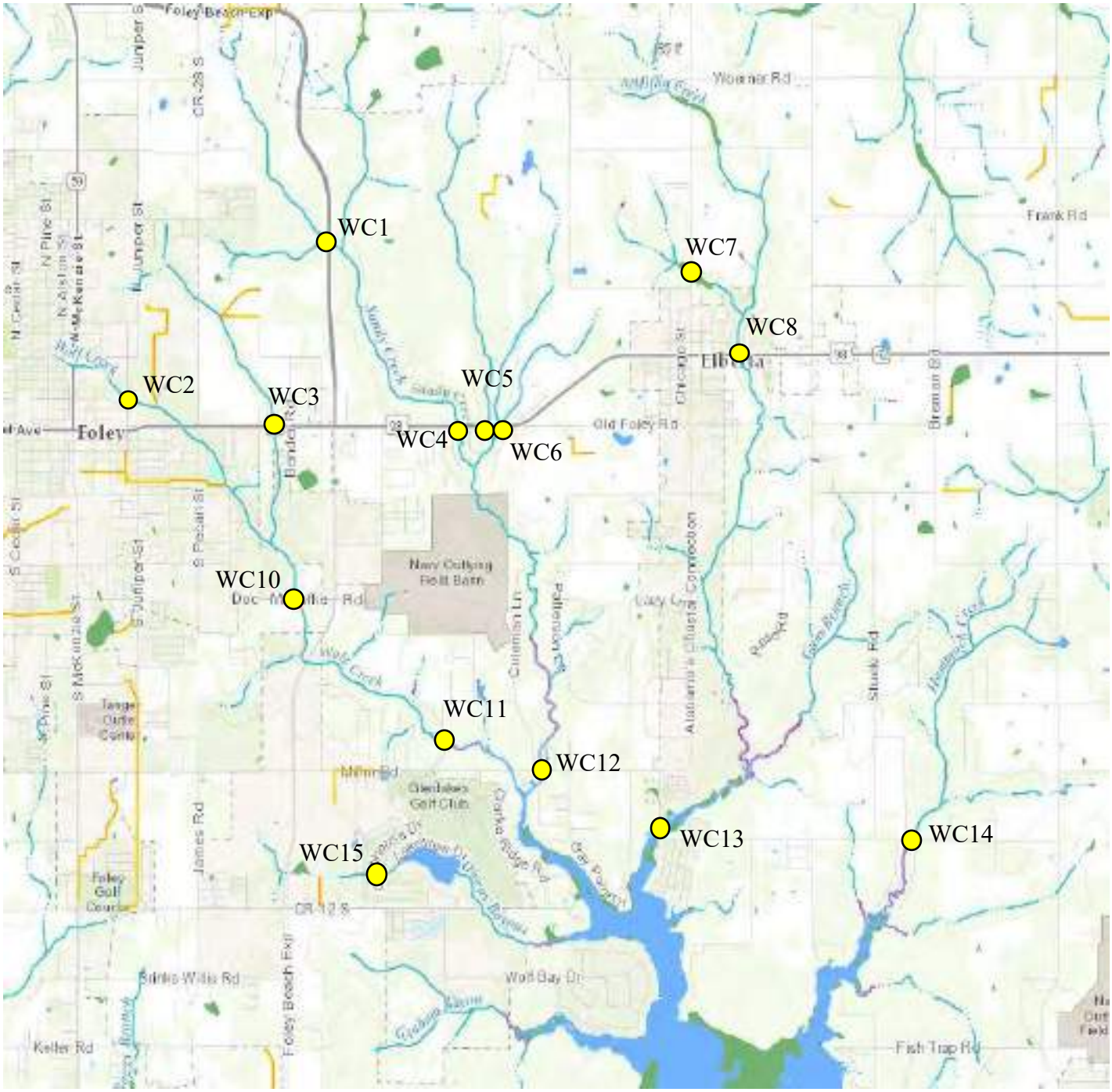

Figure 2.—Monitoring sites for streams in the Wolf Bay watershed.

LAND USE

Land use is directly correlated with water quality, hydrologic function, ecosystem health, biodiversity, and the integrity of streams and wetlands. Land-use classification for the project area was calculated from the USDA National Agricultural Statistics Service 2013 Alabama Cropland Data Layer (NASS CDL) raster dataset. The CDL is produced using satellite imagery from the Landsat 5 TM sensor, Landsat 7 ETM+ sensor, the Spanish DEIMOS-1 sensor, the British UK-DMC 2 sensor, and the Indian Remote Sensing RESOURCESAT-1 (IRS-P6) Advanced Wide Field Sensor (AWiFS) collected during recent growing seasons (USDA, 2013). Figure 3 shows land use, subdivided into 17 classified types defined as developed, forested, grassland, wetlands, barren areas, open water, and agriculture, subdivided into eight specific crops (fig. 3).

The dominant land use/land cover category in the Wolf Bay watershed is forest, which includes forested wetlands (fig. 3). Most streams flow through forested floodplains or are anastomosing. Wetlands are important because they provide water quality improvement and management services such as: flood abatement, storm water management, water purification, shoreline stabilization, groundwater recharge, and streamflow maintenance. Agriculture is the second largest land use/land cover and dominates headwaters and areas of higher elevation. Crops consist of peanuts, soybeans, corn, cotton, pecans, and pasture and hay (fig. 3). Developed land is dominated by residences and commercial development, primarily along roadways, and residential development on land previously used for agriculture. Developed land covers about 16% of the watershed (USGS, 2017) (fig. 3). Land uses and their specific impacts are discussed in detail in the Conclusions and Sources of Water-Quality Impacts section of this report.

STREAM FLOW CONDITIONS

Stream flow characteristics are determined by a number of factors including climate, topography, hydrogeology, land use, and land cover. Numerous streams in Baldwin County exhibit flashy discharge due to relatively high topographic relief and land-use change. Stream channels in the northern parts of the watershed, including the headwaters of Wolf, Sandy, and Miflin Creeks, are characterized by relatively high elevation (maximum 100 ft MSL), with topography that decreases in relief from north (upstream) to south (downstream) towards Wolf Bay. Monitored tributary floodplains are dominated by forest and wetlands, with channels that are in part, anastomosing, and

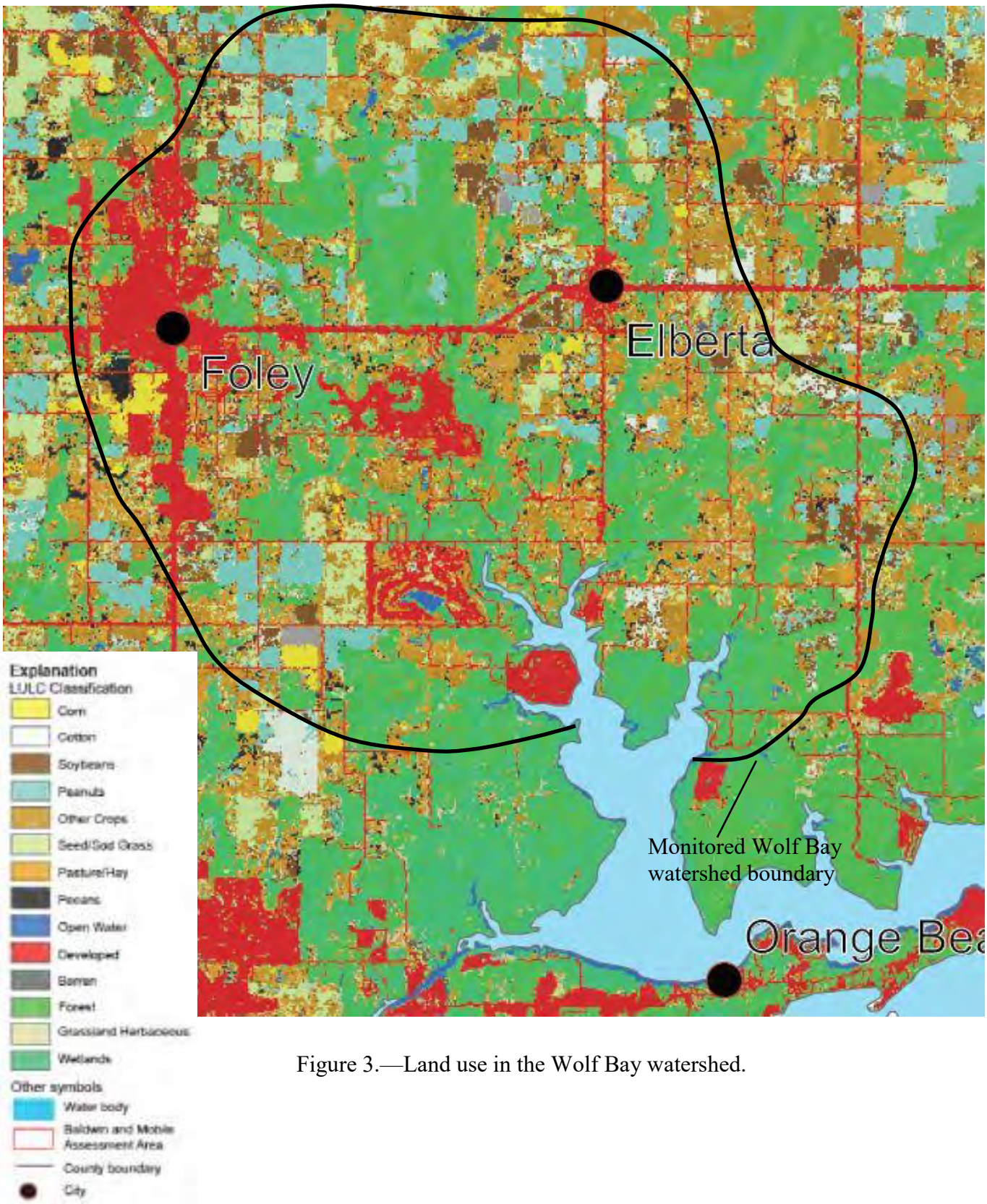

Figure 3.—Land use in the Wolf Bay watershed.

stream gradients that vary from 14.3ft/mi for Wolf Creek, 15.7 ft/mi for Sandy Creek, 16.1 ft/mi for Miflin Creek, and 26.5 ft/mi for Hammock Creek (table 1).

A wide range of discharge events are required to adequately evaluate hydrologic conditions and water quality in the Wolf Bay watershed. Table 1 shows that sampling occurred during discharge conditions from base flow to flood. For example, for the project period, minimum average daily discharge for Wolf Creek at Doc McDuffie Road (site WC10) was 6.8 cubic ft/second (cfs) (October 28, 2016) and the maximum was 149 cfs, on April 3, 2017. Average daily discharge for each monitored stream is required to adequately estimate constituent loading. Discharge data collected at the USGS stream gaging site 02378170, Wolf Creek below Foley, Alabama was used as a basis for average daily discharge calculation for each monitored stream.

Table 1.—Stream-flow characteristics for monitored sites in the Wolf Bay watershed.

Monitored site	Average measured discharge (cfs)	Maximum measured discharge (cfs)	Minimum measured discharge (cfs)	Average discharge per unit area (cfs/mi^2)	Stream gradient (ft/mi)
WC1	22	44	5.1	10.0	21.0
WC2	16	35	0.8	16.0	18.8
WC3	44	180	1.0	34.0	18.6
WC4	48	170	14.0	8.1	18.6
WC5	9	29	0.7	5.3	22.9
WC6	11	31	1.0	6.5	29.8
WC7	22	63	2.7	20.0	27.3
WC8	41	140	3.9	11.1	18.5
WC10	55	149	6.8	11.3	18.5
WC11	159	718	17.5	17.9	16.1
WC12	398	940	151.0	29.9	12.5
WC13	N/A[1]	N/A	N/A	N/A	12.7
WC14	62	218	10.0	16.3	24.1
WC15	25	60	2.7	31.6	15.0

[1]Discharge not measured due to tidal influence

SPECIFIC CONDUCTANCE

Surface water in each project watershed is characterized by a unique specific conductance (SC) (microseimens/centimeter (µS/cm)) profile based on physical and chemical properties. The variability of SC is influenced by differences in stream temperature, discharge, total dissolved solids, local geology, soil conditions, and ionic influxes from nonpoint sources of pollution or from seawater in reaches of streams with

tidal influence. Streams without significant contaminant sources exhibit increased SC values with decreasing discharge due to increasing volumes of relatively high SC groundwater inflow and decreased SC with increasing discharge due to increasing volumes of relatively low SC runoff. The opposite SC character is exhibited for streams with significant contaminant sources where relatively high conductance runoff causes increasing SC with increasing discharge. Fluctuations of SC in streams with tidal influence correspond to tidal cycles with relatively high SC (salt water) at high tide and relatively low SC (fresh water) at low tide or at times of large rainfall runoff volumes. Table 2 shows SC in monitored streams in the Wolf Bay watershed. Sites WC12 (Sandy Creek), WC13 (Miflin Creek), and WC14 (Hammock Creek) were influenced by tidal influx (table 2). Generally, SC was relatively low due to no significant contaminant sources in the watershed and most SC measurements were made immediately after precipitation events (table 2). The Alabama Department of Environmental Management (ADEM) established reference sites on streams throughout Alabama to determine reference water-quality standards for selected level IV ecoregions. The ADEM reference median concentration for SC for ecoregion 65f, which includes the Wolf Bay watershed is 20.4 µS/cm (ADEM, 2010). Median measured SC for all Wolf Bay watershed sites exceeded the ADEM standard (table 2).

Table 2.—Measured specific conductance values for Wolf Bay watershed monitoring sites.

Monitored site	Average SC (µS/cm)	Maximum SC (µS/cm)	Minimum SC (µS/cm)	ADEM median reference (µS/cm)	Median SC (µS/cm)
WC1	75	101	56	20.4	71
WC2	98	140	41	20.4	92
WC3	67	117	35	20.4	66
WC4	99	302	39	20.4	54
WC5	57	87	31	20.4	56
WC6	61	82	47	20.4	62
WC7	60	75	44	20.4	59
WC8	68	94	33	20.4	64
WC10	101	159	47	20.4	111
WC11	109	269	41	20.4	77
WC12	3,976	14,000	38	20.4	429
WC13	12,673	16,200	3,640	20.4	14,450
WC14	2,008	12,000	29	20.4	61
WC15	65	104	34	20.4	56

TURBIDITY

Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms (Eaton, 1995). Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the stream (Eaton, 1995). Turbidity values measured in nephlametric turbidity units (NTU) from water samples may be utilized to formulate a rough estimate of long-term trends of total suspended solids (TSS) and therefore may be used to observe trends in suspended sediment transport in streams.

Analyses of turbidity and stream discharge provide insights into hydrologic, land-use, and general water-quality characteristics of a watershed. Average measured turbidity shown in figure 4, illustrates that sites WC5 (unnamed tributary at US Highway 98), WC11 (Wolf Creek at Swift Church Rd), and WC6 (unnamed tributary at US Highway 98) have the highest turbidity (110, 77, and 75 NTUs, respectively).

Commonly, excessive turbidity is closely tied to land uses that cause land disturbances that lead to erosion or to land uses that cause excessive runoff. Evaluation of land-use data indicates that watersheds with dominant urban development and/or agriculture are more likely to have streams with significant turbidity concentrations. Although there are a number of areas in the Wolf Bay watershed that are undergoing conversion from agriculture to commercial and residential development, the majority of human activity in the watershed continues to be agricultural. Wolf Creek sites WC2, WC10, and WC11 have the highest percentage of residential and commercial development related to the city of Foley (84.8 and 43.2, and 35.4 percent, respectively). Site WC15 (Owens Bayou at Lakeview Drive) has 22.0 percent urban development related to the Glenn Lakes subdivision and the city of Foley. agricultural land use. The ADEM reference concentration for turbidity is 9.7 NTU for ecoregion 65f (90th %ile). Average turbidity for all Wolf Bay watershed sites exceeded the ADEM standard by 3 to 24 times (fig. 4).

SEDIMENTATION

Sedimentation is a process by which eroded particles of rock are transported primarily by moving water from areas of relatively high elevation to areas of relatively low elevation, where the particles are deposited. Upland sediment transport is primarily accomplished by overland flow and rill and gully development. Lowland or flood plain

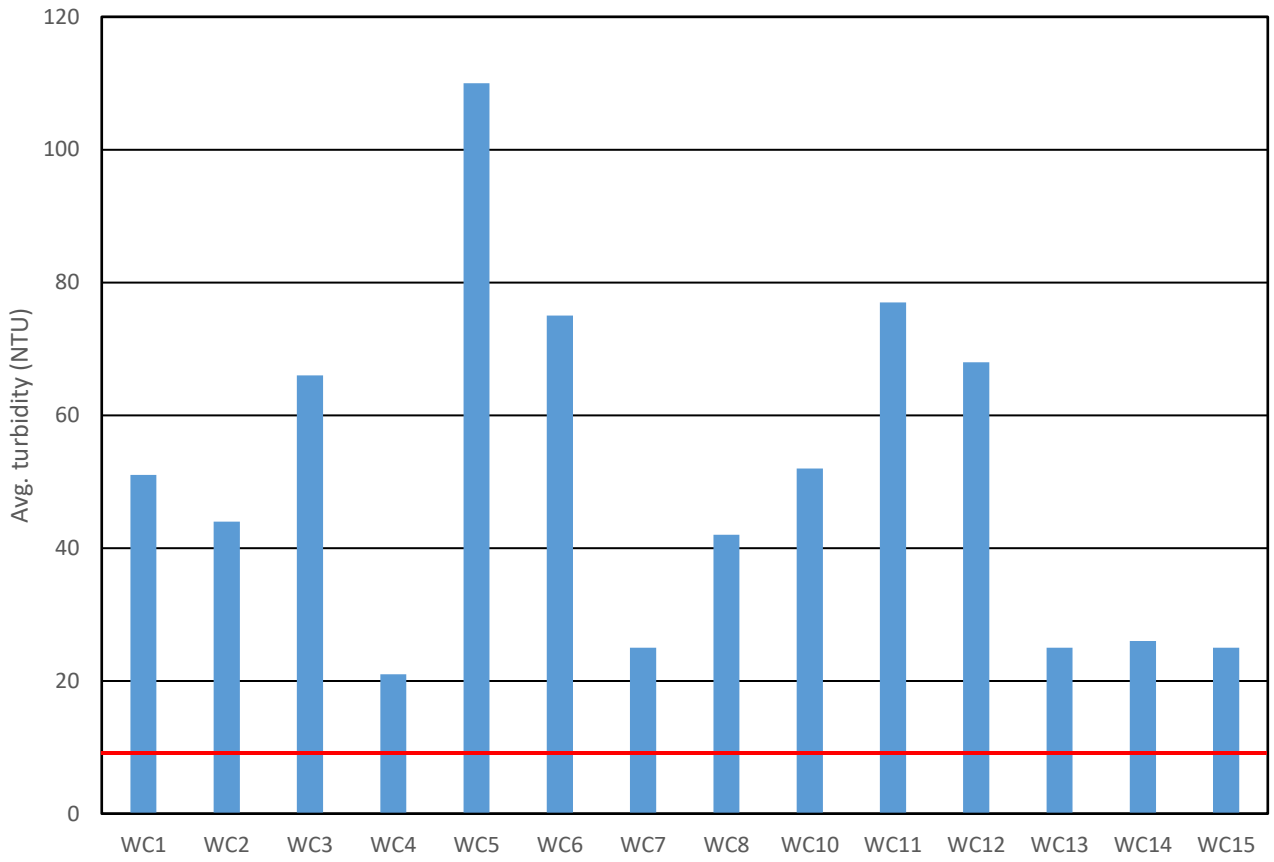

Figure 4.—Average turbidity for Wolf Bay watershed monitored sites with ADEM reference value.

transport occurs in streams of varying order, where upland sediment joins sediment eroded from flood plains, stream banks, and stream beds. Erosion rates are accelerated by human activity related to agriculture, construction, timber harvesting, unimproved roadways, or any activity where soils or geologic units are exposed or disturbed. Excessive sedimentation is detrimental to water quality, destroys biological habitat, reduces storage volume of water impoundments, impedes the usability of aquatic recreational areas, and causes damage to structures.

Precipitation, stream gradient, geology, soils, and land use are all important factors that influence sediment transport characteristics of streams. Sediment transport conditions in the Wolf Bay watershed were evaluated and quantified by tributary, in order to evaluate factors impacting erosion and sediment transport at a localized scale. In addition to commonly observed factors above, wetlands, vegetation, and tidal effects in the downstream part of the watershed also play prominent roles in sediment transport and overall water quality in the Wolf Bay watershed. Estimates of sediment loads for this

assessment are based on measured sediment and stream discharge. Therefore, a stream flow dataset composed of values ranging from base flow to flood is desirable. Observed stream flow conditions are shown in table 1.

SEDIMENT LOADS TRANSPORTED BY PROJECT STREAMS

The rate of sediment transport is a complex process controlled by a number of factors primarily related to land use, precipitation runoff, erosion, stream discharge and flow velocity, stream base level, and physical properties of the transported sediment. Deterrents to excessive erosion and sediment transport include wetlands, forests, vegetative cover and field buffers for croplands, limitations on impervious surfaces, and a number of constructed features to promote infiltration of precipitation and to store and slow runoff. Currently, except for the northwest margin of the watershed, dominated by the city of Foley, and a few large residential developments, the Wolf Bay watershed is characterized by a relatively rural setting, extensive row crop and turf agriculture, floodplains dominated by abundant wetlands, anastomosing stream channels, and forest. Anthropogenic impacts to stream flow, sediment transport, and water quality include erosion from agricultural fields, increased runoff and land disturbance related to residential development and commercial areas of Foley and Elberta.

Sediment loads in streams are composed of relatively small particles suspended in the water column (suspended solids) and larger particles that move on or periodically near the streambed (bed load). Seven Wolf Bay watershed monitoring sites had measurable suspended and bed sediment loads. Only suspended sediment could be measured at six sites due to flow and channel conditions and one site (WC13, Miflin Creek at Baldwin County Road 20) had no measurable sediment loads due to tidal influx.

SUSPENDED SEDIMENT

The basic concept of constituent loads in a river or stream is simple. However, the mathematics of determining a constituent load may be quite complex. The constituent load is the mass or weight of a constituent that passes a cross-section of a stream in a specific amount of time. Loads are expressed in mass units (tons or kilograms) and are measured for time intervals that are relative to the type of pollutant and the watershed area for which the loads are calculated. Loads are calculated from concentrations of constituents obtained from analyses of water samples and stream discharge, which is the volume of water that passes a cross-section of the river in a specific amount of time.

Suspended sediment is defined as that portion of a water sample that is separated from the water by filtering. This solid material may be composed of organic and inorganic particles that include algae, industrial and municipal wastes, urban and agricultural runoff, and eroded material from geologic formations. These materials are transported to stream channels by overland flow related to storm-water runoff and cause varying degrees of turbidity. Figure 5 is an x-y plot of average turbidity and average total suspended solids (TSS) for each monitored Wolf Bay watershed site. It shows an excellent correlation between turbidity and TSS. The ADEM reference concentration for TSS for ecoregion 65f, which includes the Wolf Bay watershed is 13.2 mg/L (90th %ile).

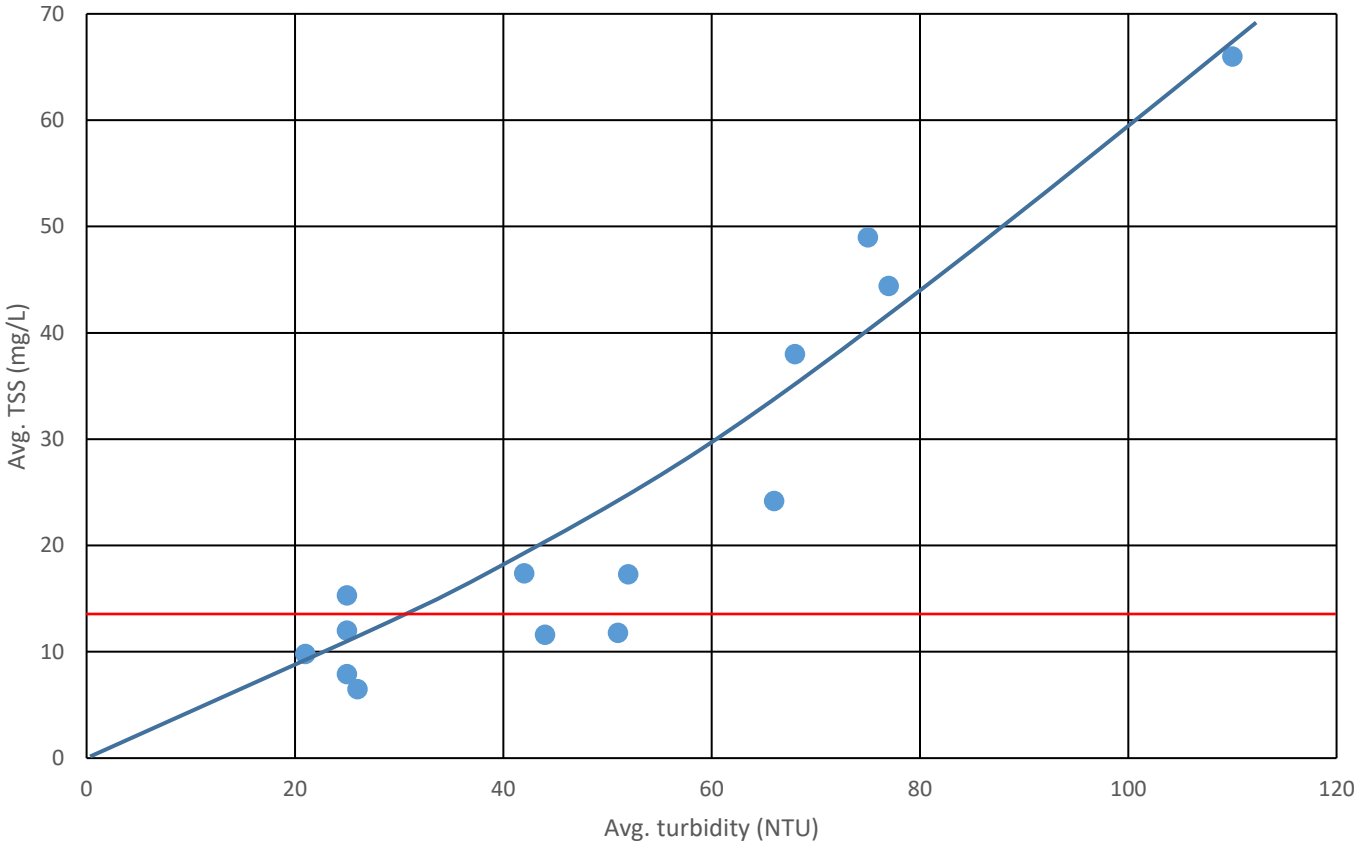

Figure 5.—Average turbidity and TSS for Wolf Bay watershed monitored sites with ADEM reference value (red).

Annual suspended sediment loads were estimated for Wolf Bay watershed monitored streams using the computer regression model Regr_Cntr.xls (*Regression with Centering*) (Richards, 1999). The program is an Excel adaptation of the U.S. Geological Survey (USGS) seven-parameter regression model for load estimation in perennial streams (Cohn and others, 1992). The regression with centering program requires total

suspended solids (TSS) concentrations and average daily stream discharge to estimate annual loads.

Although average daily discharge for project streams was not available from direct measurement for the monitored sites, it was calculated by establishing a ratio between periodic measured discharge in project streams and discharge values for the same times obtained from USGS stream gaging site, 02378170, Wolf Creek below Foley, Alabama. This site is at the Doc McDuffie Road crossing of Wolf Creek, about 0.3 mi west of the Foley Beach Expressway.

Concentrations of TSS in mg/L were determined by laboratory analysis of periodic water grab samples. These results were used to estimate the mass of suspended sediment for the period of stream flow (August 15, 2016 to August 14, 2017). Sandy Creek at Baldwin Co. Rd. 20 (WC12), Wolf Creek at Swift Church Rd. (WC11), Wolf Creek at Doc McDuffie Rd. (WC10), west unnamed tributary to Sandy Creek at US Highway 98 (WC5), east unnamed tributary to Sandy Creek at US Highway 98 (WC6), had the largest suspended sediment loads (929, 861, 460, 444, and 368 tons per year (t/yr), respectively (fig. 6, table 3).

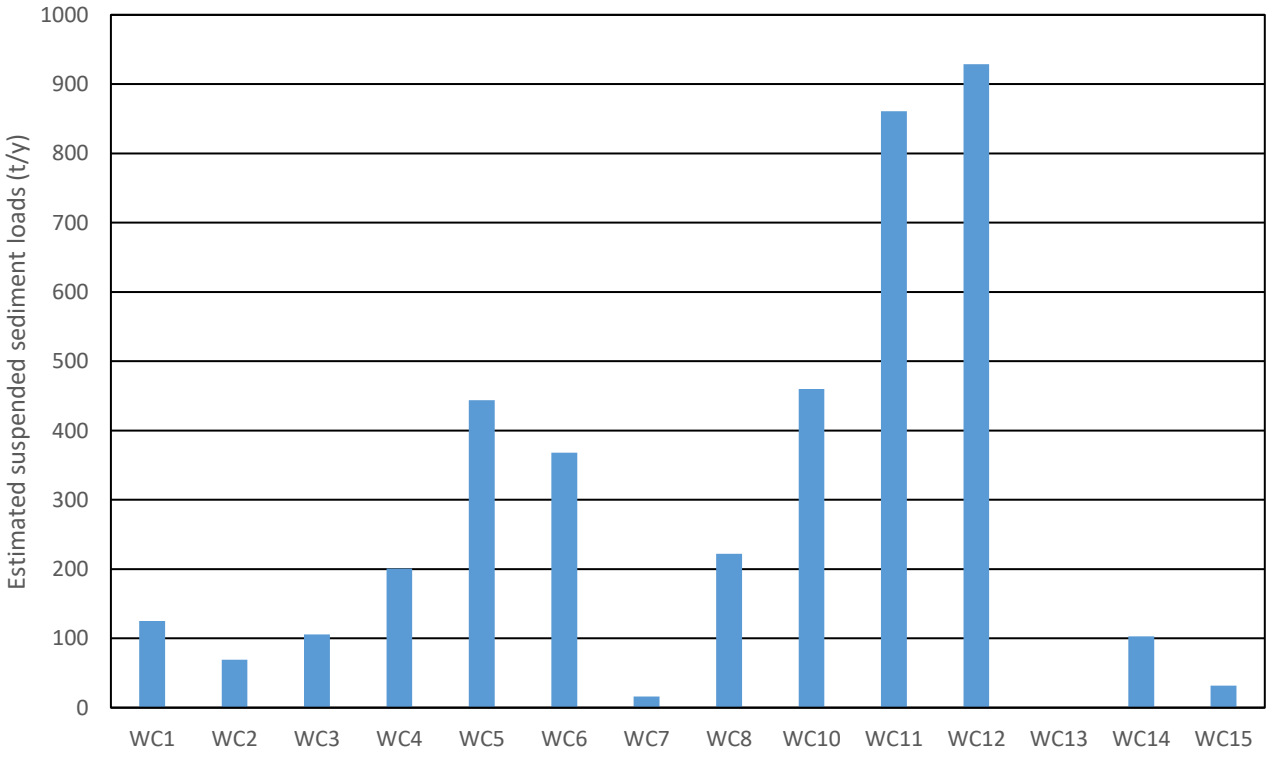

Figure 6.—Estimated annual suspended sediment loads for Wolf Bay watershed monitored sites.

Table 3.—Measured discharge, turbidity, TSS, and estimated suspended sediment loads in monitored streams in the Wolf Bay watershed.

Monitored site	Average daily discharge (cfs)	Average turbidity (NTU)	Maximum turbidity (NTU)	Average TSS (mg/L)	ADEM Level IV Ecoregion 65f reference standard for TSS (mg/L)	Maximum TSS (mg/L)	Estimated suspended sediment load (t/yr)	Estimated normalized suspended sediment load ($t/mi^2/yr$)
WC1	7.7	51	115	12	13.2	24	125	57
WC2	3.4	44	144	12	13.2	30	69	70
WC3	4.6	66	127	24	13.2	61	106	81
WC4	21	21	63	10	13.2	36	201	34
WC5	6.0	110	365	365	13.2	275	66	261
WC6	6.0	75	260	49	13.2	216	368	217
WC7	3.9	25	55	8	13.2	22	16	15
WC8	13	42	141	17	13.2	52	222	60
WC10	17	52	174	17	13.2	74	460	94
WC11	31	77	237	44	13.2	139	861	94
WC12	46	75	198	38	13.2	128	929	70
WC13	N/A	25	56	15	13.2	24	N/A[1]	N/A
WC14	13	26	96	7	13.2	15	103	27
WC15	2.7	25	36	12	13.2	19	32	40

[1]Suspended sediment loading not estimated due to tidal influence

Suspended sediment loads generally increase from upstream to downstream due to increasing volumes of sediment in stream channels and increased flow velocity that transports larger sediment volumes. Although site WC11 is downstream from site WC10 the suspended sediment load at site WC10 is 8.7 times larger. This is due to the proximity of site WC11 to the reach of Wolf Creek with tidal influence. At times of high discharge and especially when the tide is rising, water backs up past site WC11, causing relatively low velocity flow and corresponding small volume of suspended sediment transport (fig. 2).

Normalizing suspended loads to unit watershed area permits comparison of monitored watersheds and negates the influence of drainage area size and discharge on sediment loads. Normalized loads for monitored sites in the Wolf Bay watershed are portrayed on figure 7, which shows the largest normalized suspended sediment loads at west unnamed tributary to Sandy Creek at US Highway 98 (WC5) (261 $t/mi^2/yr$), east unnamed tributary to Sandy Creek at US Highway 98 (WC6) (217 $t/mi^2/yr$), Wolf Creek

at Doc McDuffie Rd. (WC10) (94 t/mi^2/yr), and Wolf Creek at Swift Church Rd. (WC11) (94 t/mi^2/yr) (table 3).

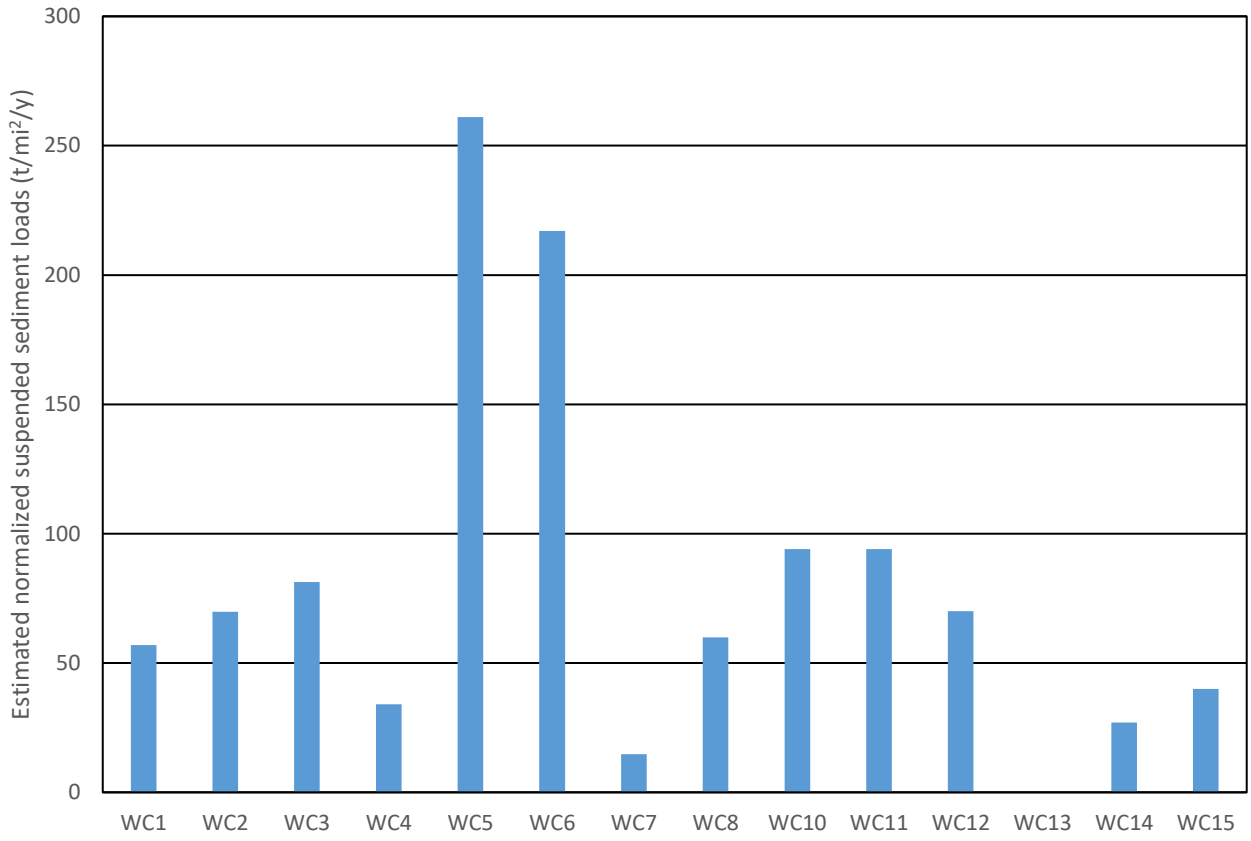

Figure 7.—Estimated normalized suspended sediment loads for Wolf Bay watershed monitored sites.

BED SEDIMENT

Transport of streambed material is controlled by a number of factors including stream discharge and flow velocity, erosion and sediment supply, stream base level, and physical properties of the streambed material. Most streambeds are in a state of constant flux in order to maintain a stable base level elevation. The energy of flowing water in a stream is constantly changing to supply the required power for erosion or deposition of bed load to maintain equilibrium with the local water table and regional or global sea level. Stream base level may be affected by regional or global events including fluctuations of sea level or tectonic movement. Local factors affecting base level include fluctuations in the water table elevation, changes in the supply of sediment to the stream caused by changing precipitation rates, and/or land use practices that promote excessive erosion in the floodplain or upland areas of the watershed.

Bed sediment loads are composed of particles that are too large or too dense to be carried in suspension by stream flow. These particles roll, tumble, or are periodically suspended as they move downstream. Traditionally, bed load sediment has been difficult to quantify due to deficiencies in monitoring methodology or inaccuracies of estimating volumes of sediment being transported along the streambed. This is particularly true in streams that flow at high velocity or in streams with excessive sediment loads.

In 1998, Marlon Cook developed a portable bed load sedimentation rate-monitoring device in response to the need for accurate bed sediment transport rates in shallow streams with sand or gravel beds (Cook and Puckett, 1998). The device was utilized to measure bed sediment transport rates periodically over a range of discharge events at six Wolf Bay watershed sites (WC1, WC2, WC5, WC6, WC8, and WC10). All other sites had deep channels with slow moving water, anastomosing reaches with no sand bed, or hard surface beds where all sediment was assumed to be suspended.

As with suspended sediment, it is possible to use discharge/sediment relationships to develop regression models to determine mean daily bed load volumes and annual bed sediment loads. Figure 8 shows estimated annual bed sediment loads for sites with measurable bed sediment. Figure 9 shows estimated annual bed sediment loads normalized with respect to watershed drainage area. Table 4 gives average measured stream discharge, annual bed sediment loads, and normalized annual bed sediment loads for monitoring sites in streams with measurable bed sediment in the project area. Sites WC10 (Wolf Creek at Doc McDuffie Rd) and WC5 (west unnamed tributary to Sandy Creek at US Highway 98), and WC6 (east unnamed tributary to Sandy Creek at US Highway 98) had the largest bed sediment loads with 10,471, 1,551 and 1,347 t/yr, respectively. After normalization of bed sediment loads relative to drainage area, sites WC10 (Wolf Creek at Doc McDuffie Rd), WC5 (west unnamed tributary to Sandy Creek at US Highway 98), and WC6 (east unnamed tributary to Sandy Creek at US Highway 98) had the largest loads with 2,137, 912, and 792 tons/mi^2/yr, respectively. Table 4 shows that discharge and bed sediment loads do not correlate well in streams in the Wolf Bay watershed. This is particularly true for site WC5 and WC6 where excessive upstream erosion contributes an disproportionately large amount of bed sediment. Bed sediment loading could not be estimated for site WC11, where transport rates could not be measured during rising or high tide conditions, which caused backwater impacts.

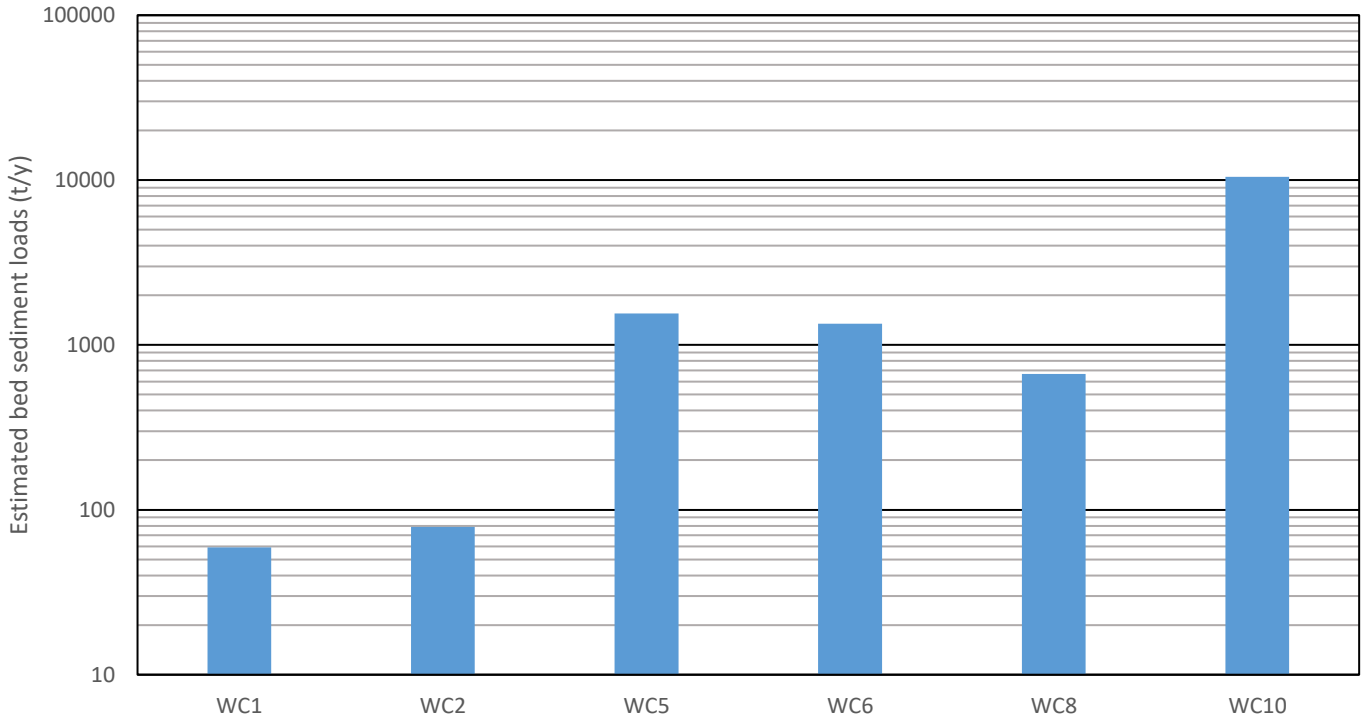

Figure 8.—Estimated bed sediment loads for Wolf Bay watershed monitoring sites with measurable bed sediment.

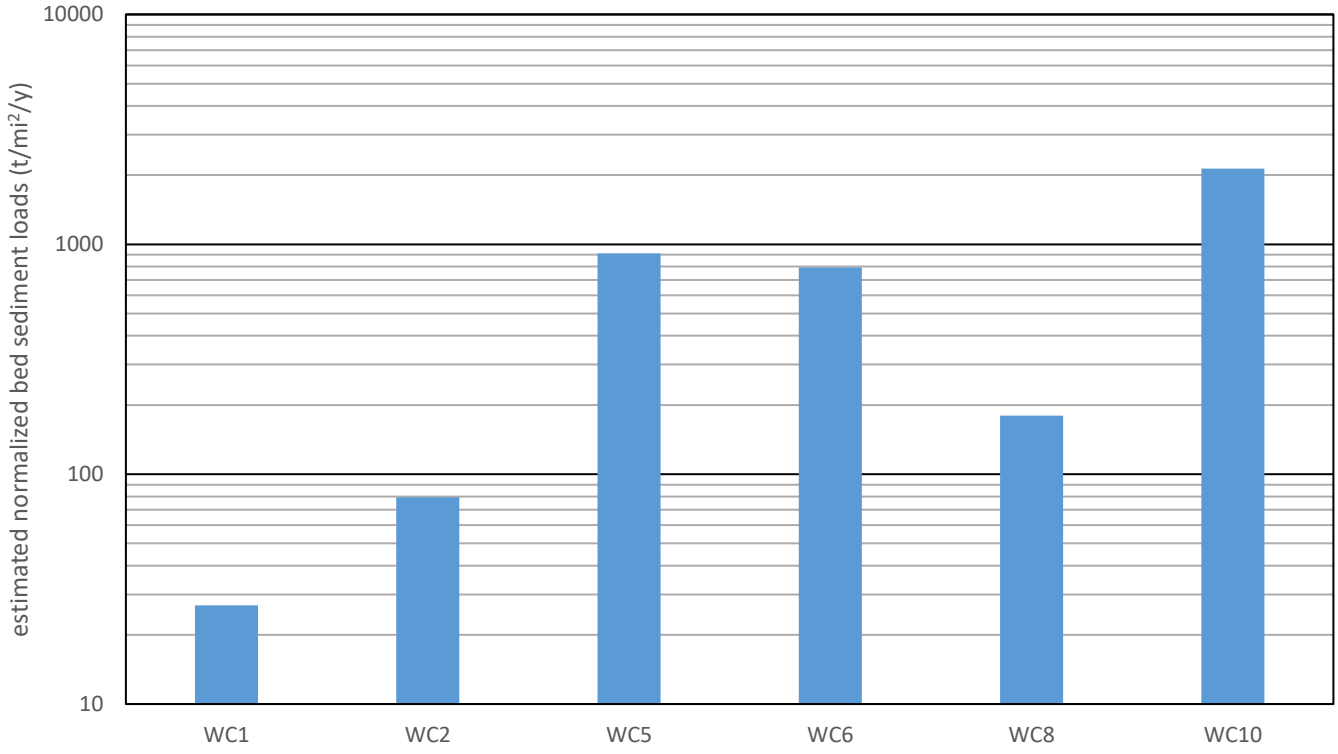

Figure 9.—Estimated normalized bed sediment loads for Wolf Bay watershed sites with measurable bed sediment.

Table 4—Average measured discharge and estimated bed sediment loads for monitoring sites on streams with measurable bed sediment in the project area.

Monitored site	Average discharge (cfs)	Estimated annual bed sediment loads (tons/yr)	Estimated normalized annual bed sediment loads (tons/mi ^{2}/yr)
WC1	22	59	27
WC2	16	79	80
WC5	9	1,551	912
WC6	11	1,347	792
WC8	41	668	180
WC10	55	10,471	2,137

BED SEDIMENT GRAIN SIZE ANALYSES

Sedimentation processes, including erosion, transport, deposition, and consolidation and sorting, are critical considerations in evaluating stream stability and developing restoration designs. The form of a channel is a consequence of the magnitude, timing, and frequency of both runoff and sediment yield from the watershed. The composition of streambed and banks is an important facet of stream character, which influences channel form and hydraulics, erosion rates, sediment supply, and other parameters. Sediment characteristics that may be important in executing stream restoration projects include the sediment size, shape, specific weight, fall velocity, and parent geology (Fischenich and Little, 2007).

The composition of streambed and banks is an important facet of stream character, which influences channel form and hydraulics, erosion rates, sediment supply, and other parameters. Particle-size data are usually reported in terms of di, where i represents some percentile of the distribution, and di for a particle grain size, usually expressed in millimeters, where i percent of the total sample by weight is finer. For example, 84 percent of the total sample would be finer than the d84 particle size (Fischenich and Little, 2007).

Bed sediment samples were collected at three Wolf Bay watershed monitoring sites with measurable bed sediment. One cubic ft of wet sediment was weighed on site and a representative subsample was placed in a one gallon plastic bag for transport. Samples were dried and sieved and data were analyzed according to procedures

developed by the North Carolina Stream Restoration Institute at North Carolina State University (Doll and others, 2003). Samples were-sieved, using a sieve set that retains material with the following sizes in millimeters: >4, 2-4, 2-0.5, 0.5-0.25, 0.25-.11, a bottom pan for silt and clay. Retained material on each sieve was weighed and the weights (less tare weight) were recorded by size class. The percentage of each size class relative to the total weight was determined. The percentage of finer material to each class was also determined. The percentages are represented for sites WC6, WC8, and WC10 on graphs in figure 10.

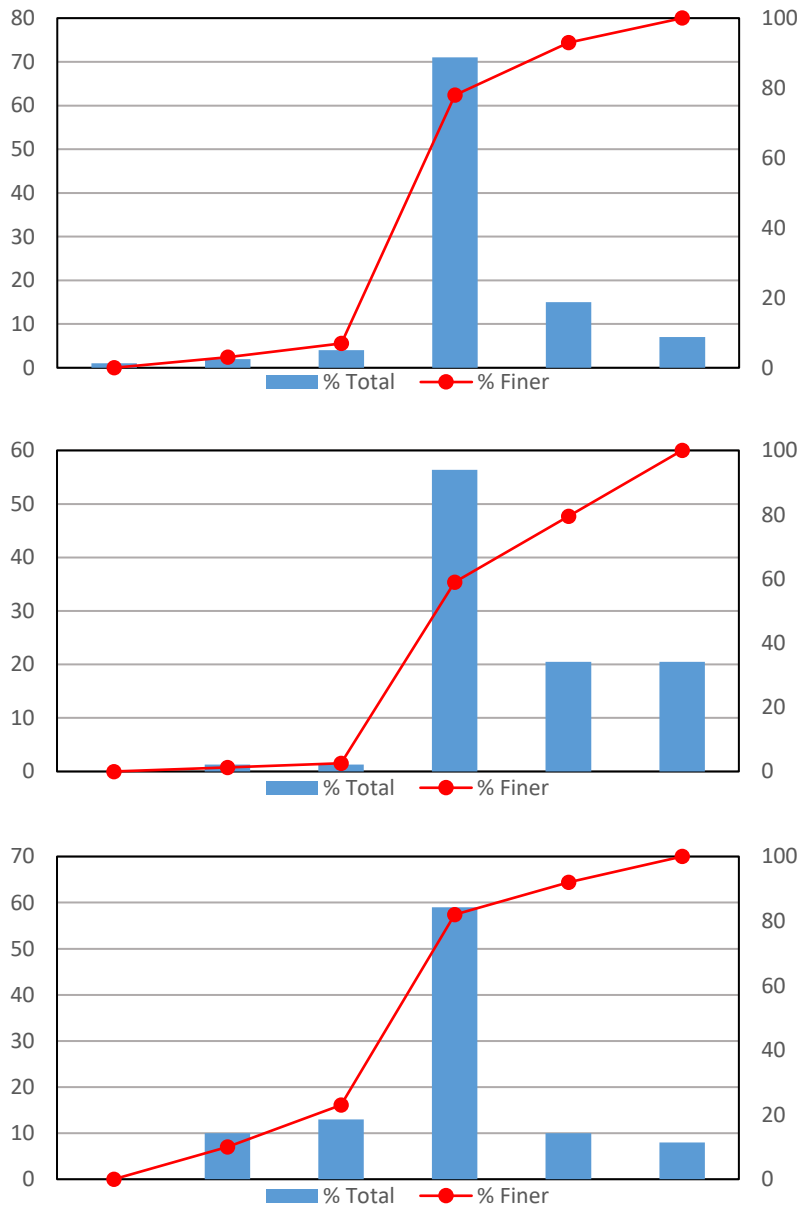

Figure 10.—Results of sieve analysis for Wolf Bay watershed sites WC6 (top), WC8 (center), and WC10 (bottom).

TOTAL SEDIMENT LOADS

The total sediment loads in a stream is composed of suspended and bed sediment. Six monitored sites had both suspended and bed sediment loads. On average, bed sediment makes up 72% of the total sediment loads for streams with measurable suspended and bed sediment. Table 5 and figures 11 and 12 show total sediment loads for monitored reaches in the Wolf Bay watershed. Wolf Creek at Doc McDuffie Road (WC10), west unnamed tributary to Sandy Creek at US Highway 98 (WC5), east unnamed tributary to Sandy Creek at US Highway 98 (WC6), and Wolf Creek at Swift Church Road (WC11) had the largest total sediment loads (10,931, 1,995, 1,715, and 1,257 tons per year (t/yr), respectively (fig. 11, table 5).

Table 5—Watershed area, average measured discharge, and estimated total sediment loads for monitoring sites in the project area.

Monitored site	Monitored watershed area (mi^2)	Average annual daily discharge (cfs)	Estimated annual total sediment loads (tons/yr)	Estimated normalized annual total sediment loads ($tons/mi^2/yr$)
WC1	2.2	7.7	113	33
WC2	1.0	3.4	216	64
WC3	1.3	4.6	62	28
WC4	5.9	21	5,560	180
WC5	1.7	6.0	13,317	300
WC6	1.7	6.0	1,786	196
WC7	1.1	3.9	9,744	2,031
WC8	3.7	13	20,430	299
WC10	4.9	17	1,701	107
WC11	8.9	31	3,090	107
WC12	13.3	46	6,440	546
WC13	12.5	N/A	477	116
WC14	3.8	13	24,295	201
WC15	0.8	2.7	504	158

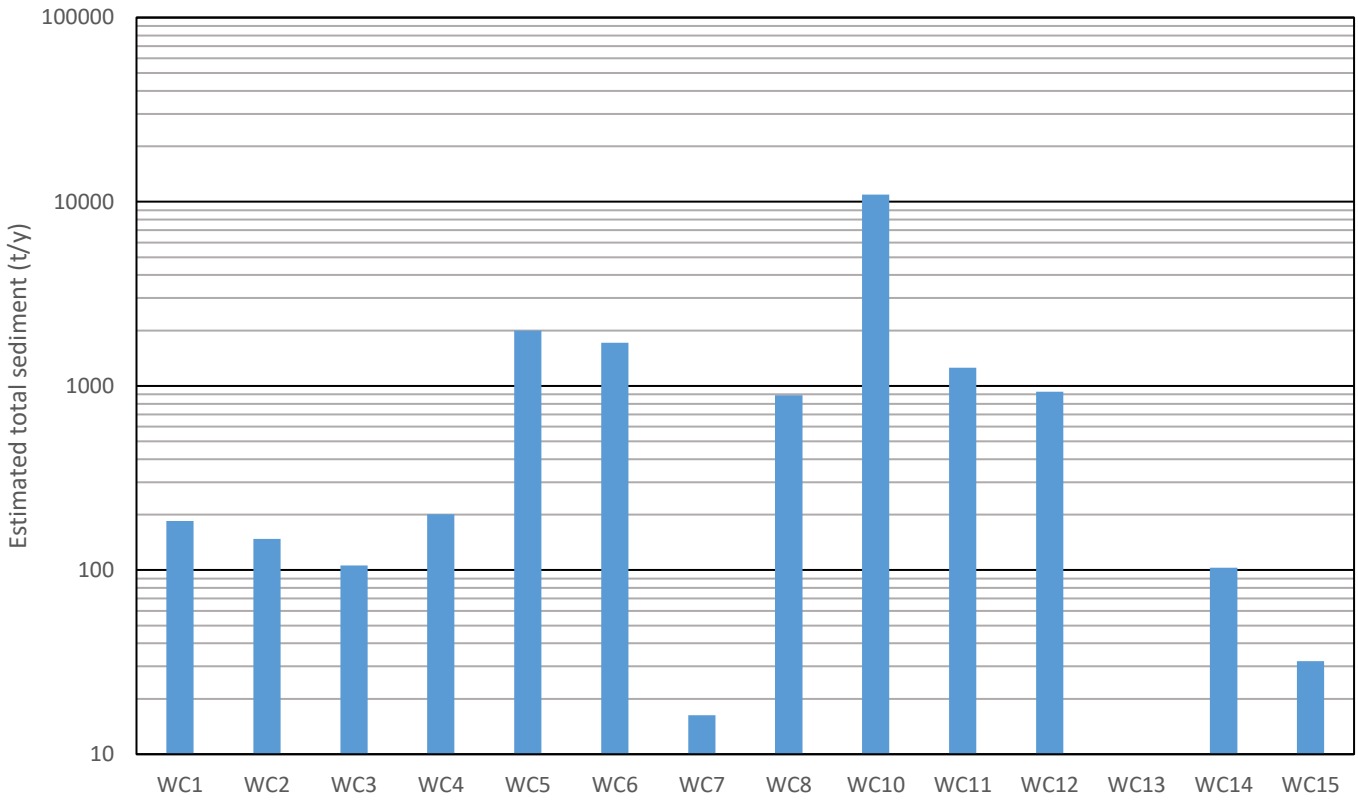

Figure11.—Estimated total sediment loads for Wolf Bay watershed monitored sites.

Normalizing sediment loads to unit watershed area permits comparison of monitored watersheds and negates the influence of drainage area size and discharge on sediment loads. Normalized total sediment loads for monitored sites in the Wolf Bay watershed are portrayed on figure 12, which shows the largest normalized total sediment loads at Wolf Creek at Doc McDuffie Road (WC10) (2,231 t/mi^2/yr), west unnamed tributary to Sandy Creek at US Highway 98 (WC5) (1,173 t/mi^2/yr), east unnamed tributary to Sandy Creek at US Highway 98 (WC6) (1,009 t/mi^2/yr), and Miflin Creek at US 98 (WC8) (240 t/mi^2/yr).

Without human impact, watershed erosion rates, called the geologic erosion rate, would be 64 t/mi^2/yr (Maidment, 1993). Normalized sediment loads show that 9 of 13 monitored watersheds were from 1.1 to 34.9 times greater than the geologic erosion rate (fig. 12). Sites WC4 (Sandy Creek at US Highway 98), WC7 (Elberta Creek), and WC14 (Hammock Creek), and WC15 (Owens Bayou) were at or below the geologic erosion rate (fig. 12). Sediment loads generally increase from upstream to downstream due to increasing volumes of sediment in stream channels and increased flow velocity that

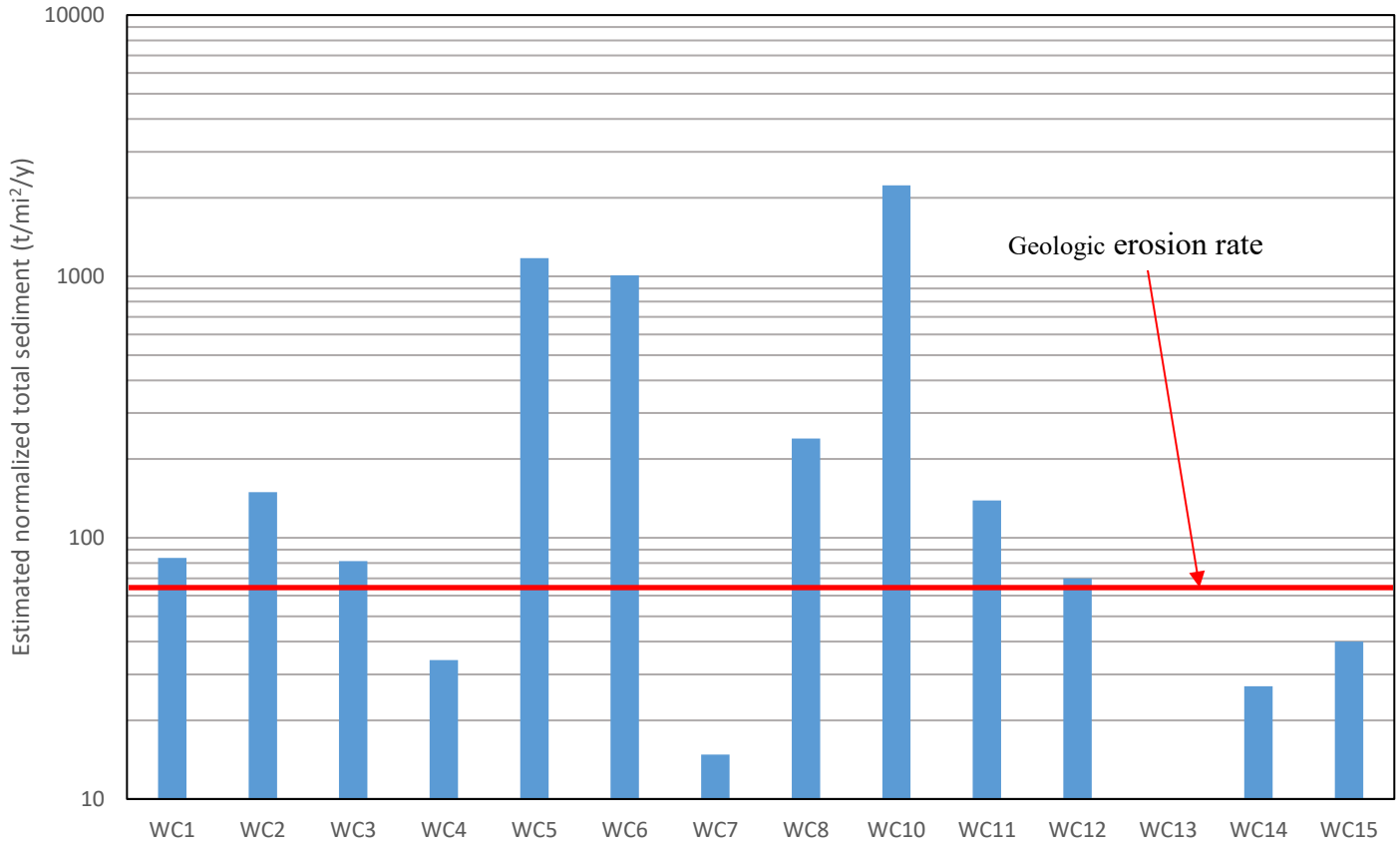

Figure 12.—Estimated normalized total sediment loads for Wolf Bay monitored sites.

transports larger sediment volumes. This is illustrated in Sandy Creek, where increasing sediment loads occur at sites WC1 (upstream), WC4 (mid reach), and WC12 (downstream) (fig. 11).

Comparisons of sediment loads from other watersheds are helpful in determining the severity of erosion problems in a watershed of interest. Figure 13 shows comparisons of estimates of normalized total sediment loads from Wolf Bay watershed sites WC5, WC6, and WC10 with sites in six previously monitored watersheds in Mobile and Baldwin Counties, including Dog River tributary, Spencer Branch site DR2 (at Cottage Hill Road in the city of Mobile) (Cook, 2012), Fowl River site FR2 (at Half-Mile Road) (Cook, 2015), D'Olive Creek site DC3 (at U.S. Highway 90 in Daphne) (Cook, 2008), D'Olive Creek tributary Joes Branch site JB7 (at North Main Street in Daphne) (Cook, 2008), Magnolia River site MR4 (at U.S. Highway 98) (Cook, 2009), and Bon Secour River site BSR3 (County Road 12 in Foley) (Cook, 2013) (fig. 13).

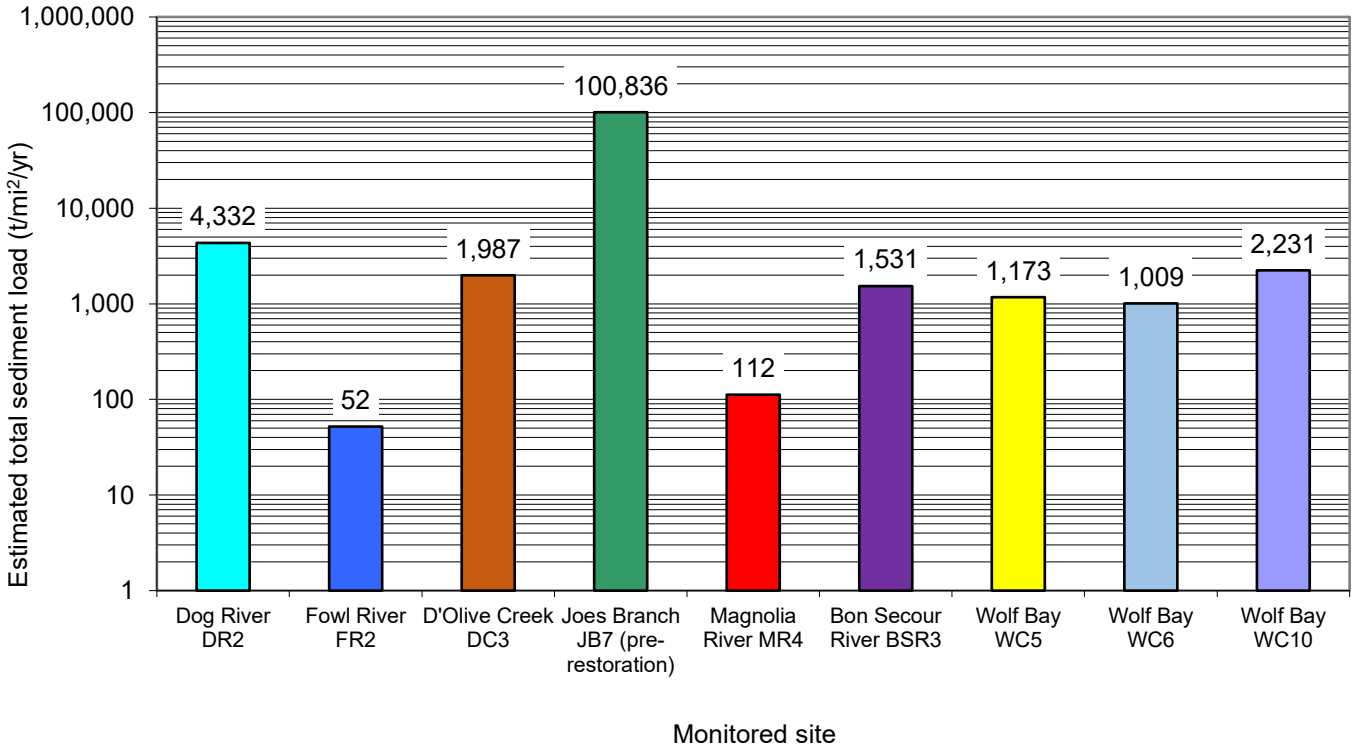

Figure 13.—Comparisons of estimated normalized total sediment loads for sites in previously monitored watersheds with Wolf Bay watershed sites WC5, WC6, and WC10.

Land use is a major factor in the magnitude of erosion and stream sediment loading. Figure 14 shows total sediment loads and urban development as a percentage of total monitored watershed area. Three major urban development/sediment load relationships are identified on the graph. First are watersheds with relatively large urban development (>20%) and corresponding, relatively large sediment loads, which includes Wolf Creek sites WC10 and WC11 (fig. 14). The second are watersheds with relatively large urban development (>20%) and relatively small sediment loads, which includes Wolf Creek site WC2 and Owens Bayou site WC15 (fig. 14). Site WC2 is near the headwaters of Wolf Creek near downtown Foley and is immediately downstream from a restored reach that has significantly slowed urban runoff and has successfully limited erosion and sediment transport upstream from the monitoring site. Site WC15 is in Glenn Lakes subdivision, immediately upstream from Lake Muriel and near the headwaters of Owen Bayou. The reach upstream from the site has row crop agriculture and fallow fields along the drainage divide that separates Owens Bayou from the Bon Secour watershed, but further downstream land use is residential development, where the stream channel has

significant armoring with limestone riprap. The third is watersheds with relatively small urban development (<20%) and relatively large sediment loads, which includes unnamed tributaries to Sandy Creek at US Highway 98 (WC5 and WC6) and Miflin Creek at US Highway 98 (WC8) (fig. 14). These watersheds are dominated by forested floodplains and row crop agricultural land use at higher elevations.

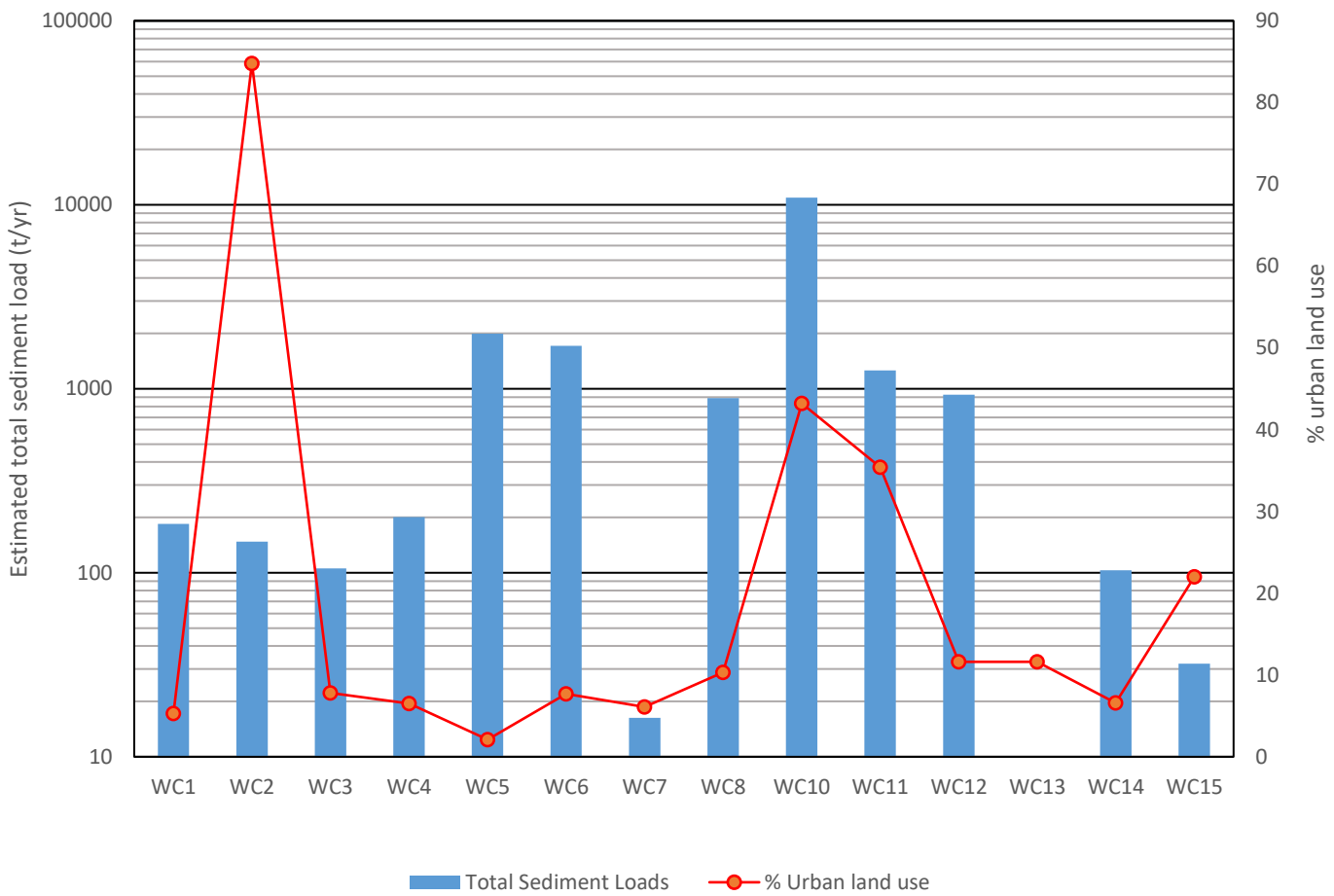

Figure 14.—Estimated total sediment loads and % urban land use in Wolf Bay watershed monitored sites.

NUTRIENTS

Excessive nutrient enrichment is a major cause of water-quality impairment. Excessive concentrations of nutrients, primarily nitrogen and phosphorus, in the aquatic environment can lead to increased biological activity, increased algal growth, decreased dissolved oxygen concentrations at times, and decreased numbers of species (Mays, 1996). Nutrient-impaired waters are characterized by numerous problems related to growth of algae, other aquatic vegetation, and associated bacterial strains. Blooms of

algae and associated bacteria can cause taste and odor problems in drinking water and decrease oxygen concentrations to eutrophic levels. Toxins also can be produced during blooms of particular algal species. Nutrient-impaired water can dramatically increase treatment costs required to meet drinking water standards. Nutrients discussed in this report are nitrate (NO_3-nitrite) and phosphorus (P-total).

NITROGEN

The U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) for nitrate in drinking water is 10 mg/L. Typical nitrate (NO_3 as N) concentrations in streams vary from 0.5 to 3.0 mg/L. Concentrations of nitrate in streams without significant nonpoint sources of pollution vary from 0.1 to 0.5 mg/L. Streams fed by shallow groundwater draining agricultural areas may approach 10 mg/L (Maidment, 1993). Nitrate concentrations in streams without significant nonpoint sources of pollution generally do not exceed 0.5 mg/L (Maidment, 1993).

Water samples were collected from August 2015 through August 2016 at Wolf Bay watershed monitoring sites for discharge events from base flow to bank full. In order to compare Wolf Bay watershed samples to the ADEM reference concentration (0.3258 mg/L nitrate+nitrite nitrogen = 90th %ile) for Ecoregion 65f, samples were analyzed for nitrate+nitrite nitrogen.

Nitrogen concentrations are highly variable for each monitoring site, due to temporal variations in the sources of nitrate and highly variable stream discharge. Nitrogen and discharge commonly form negative regressions, indicating that increased discharge results in decreased concentrations of nitrogen. Nitrate+nitrite nitrogen loads were estimated using regressions generated from measured nitrate concentrations and discharge. The largest nitrate+nitrite nitrogen loads were at sites WC8 (Miflin Creek), WC4 (Sandy Creek at US Highway 90), WC12 (Sandy Creek at Baldwin Co Rd 20), and WC11 (Wolf Creek) with 64.4, 56.7, 43.2, and 42.3 t/yr, respectively (table 6, fig. 15). The largest normalized nitrate+nitrite nitrogen loads were at sites WC8, WC5 (unnamed tributary to Sandy Creek at US Highway 90), WC4, and WC1 (Sandy Creek at Foley Beach Expressway), with 17.4, 14.7, 9.6, and 7.3 t/mi^2/yr (table 6, fig. 16).

Table 6.—Measured nitrate+nitrite nitrogen concentrations and estimated loads in monitored streams in the Wolf Bay watershed.

Monitored site	Average nitrate+nitrite (mg/L)	Maximum nitrate+nitrite (mg/L)	Minimum Nitrate+nitrite (mg/L) (% samples BDL[1])	% samples above 0.3258 mg/L ADEM reference concentration	Estimated Nitrate+nitrite load (t/yr)	Estimated normalized Nitrate+nitrite load ($t/mi^2/yr$)
WC1	1.3	2.1	0.7 (0)	100	16.0	7.3
WC2	0.5	1.0	0.2 (0)	86	5.7	5.8
WC3	0.4	0.8	0.2 (0)	57	3.6	2.8
WC4	1.2	1.6	0.7 (0)	100	56.7	9.6
WC5	2.7	5.8	0.5 (0)	100	25.0	14.7
WC6	1.5	2.3	0.6 (0)	100	8.5	5.0
WC7	0.4	0.6	0.2 (0)	86	1.6	1.4
WC8	1.5	3.5	0.1 (0)	89	64.4	17.4
WC10-	1.0	1.4	0.3 (0)	100	20.6	4.2
WC11	1.1	1.8	0.5 (0)	100	42.3	4.8
WC12	0.6	0.9	0.2 (0)	71	43.2	3.3
WC13	0.1	0.6	BDL (67)	17	N/A[2]	N/A
WC14	0.6	0.9	0.2 (0)	83	7.9	2.1
WC15	0.4	0.4	0..3 (0)	66	1.1	1.4

[1] Below detection limit
[2] Insufficient data for load estimation

PHOSPHORUS

Phosphorus in streams originates from the mineralization of phosphates from soil and rocks or runoff and effluent containing fertilizer or other industrial products. The principal components of the phosphorus cycle involve organic phosphorus and inorganic phosphorus in the form of orthophosphate (PO_4) (Maidment, 1993). Orthophosphate is soluble and is the only biologically available form of phosphorus. Since phosphorus strongly associates with solid particles and is a significant part of organic material, sediments influence water column concentrations and are an important component of the phosphorus cycle in streams.

The natural background concentration of total dissolved phosphorus is approximately 0.025 mg/L. Phosphorus concentrations as low as 0.005 to 0.01 mg/L may cause algae growth, but the critical level of phosphorus necessary for excessive algae is around 0.05 mg/L (Maidment, 1993). Although no official water-quality criterion for

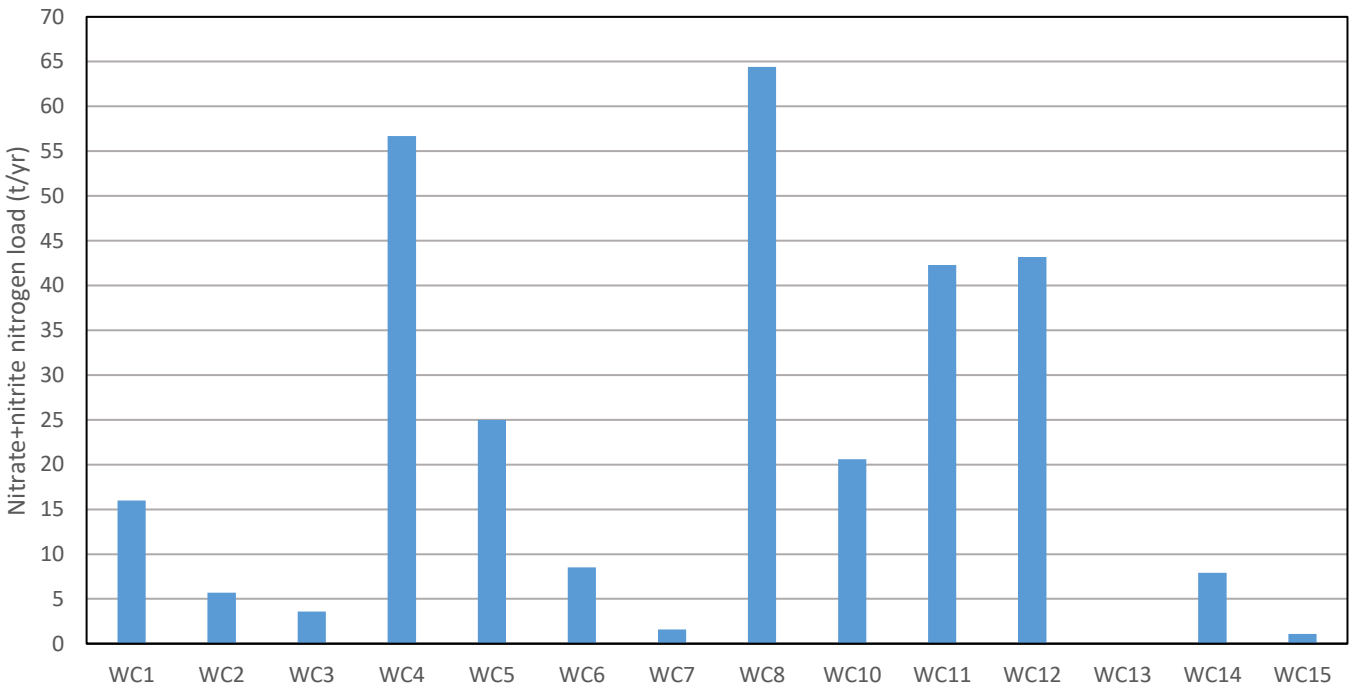

Figure 15.—Estimated nitrate+nitrite nitrogen loads for Wolf Bay watershed monitored streams.

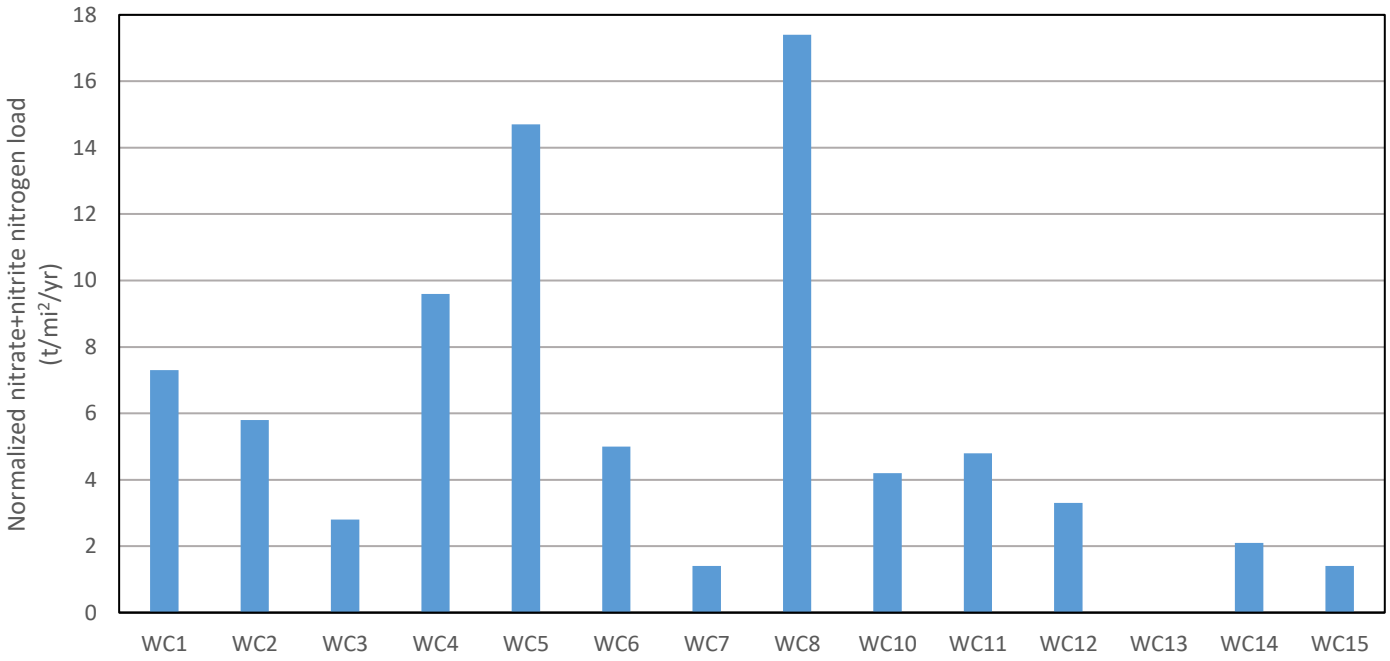

Figure 16.—Estimated normalized nitrate+nitrite nitrogen loads for Wolf Bay monitored streams.

phosphorus has been established in the United States, total phosphorus should not exceed 0.05 mg/L in any stream or 0.025 mg/L within a lake or reservoir in order to prevent the development of biological nuisances (Maidment, 1993). ADEM established a reference standard for total phosphorus for level IV ecoregion 65f (including the Wolf Bay

watershed) of 0.04 mg/L (90th %ile). In many streams phosphorus is the primary nutrient that influences excessive biological activity. These streams are termed "phosphorus limited."

Ten of 14 Wolf Bay watershed monitoring sites had average phosphorus concentrations above the 0.04 mg/L reference criterion (table 7). Wolf Creek sites WC10 and WC11 have the largest average phosphorus concentrations, 0.69 and 0.39 mg/L, respectively. Ten of 14 sites had sufficient phosphorus data to estimate annual loads. The largest phosphorus loads were at sites WC11 (Wolf Creek) and WC5 (unnamed tributary to Sandy Creek), with 17.8 and 9.1 t/yr, respectively (table 7, fig. 17). When loads are normalized with respect to drainage area, Wolf Creek sites WC11 and WC10 had the largest loads with 2.0 and 0.9 t/mi^2/yr (table 7, fig. 18).

Table 7.—Measured total phosphorus concentrations and estimated loads in monitored streams in the Wolf Bay watershed.

Monitored site	Average total phosphorus (mg/L)	Maximum total phosphorus (mg/L)	Minimum total phosphorus (mg/L) (% samples BDL)	Samples above 0.04 mg/L ADEM criterion (%)	Estimated total phosphorus load (t/yr)	Estimated normalized total phosphorus load (t/mi^2/yr)
WC1	0.08	0.16	BDL (38)	63	0.68	0.31
WC2	0.08	0.13	BDL (25)	75	0.27	0.30
WC3	0.19	0.30	0.08 (0)	100	0.63	0.48
WC4	BDL	BDL	BDL (100)	0	N/A	N/A
WC5	0.07	0.18	BDL (50)	100	9.10	0.21
WC6	0.04	0.10	BDL (86)	14	N/A	N/A
WC7	0.06	0.10	BDL (29)	71	0.17	0.15
WC8	0.06	0.12	BDL (33)	67	0.90	0.23
WC10-	0.69	1.64	0.19 (0)	100	4.30	0.90
WC11	0.39	0.73	0.18 (0)	100	17.80	2.0
WC12	0.09	0.15	BDL (29)	71	3.20	0.24
WC13	BDL	BDL	BDL (100)	0	N/A	N/A
WC14	0.03	0.08	BDL (17)	17	N/A	N/A
WC15	0.19	0.25	0.14 (0)	100	0.53	0.66

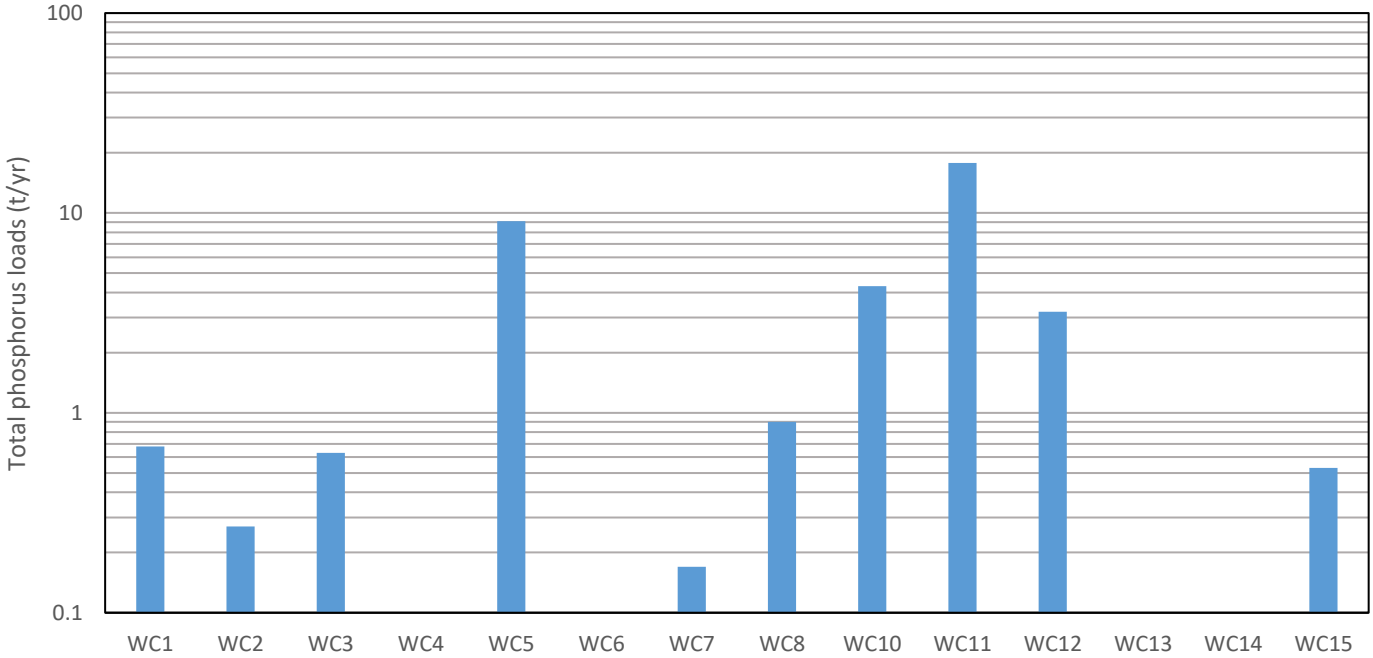

Figure 17.—Estimated total phosphorus loads for Wolf Bay monitored streams.

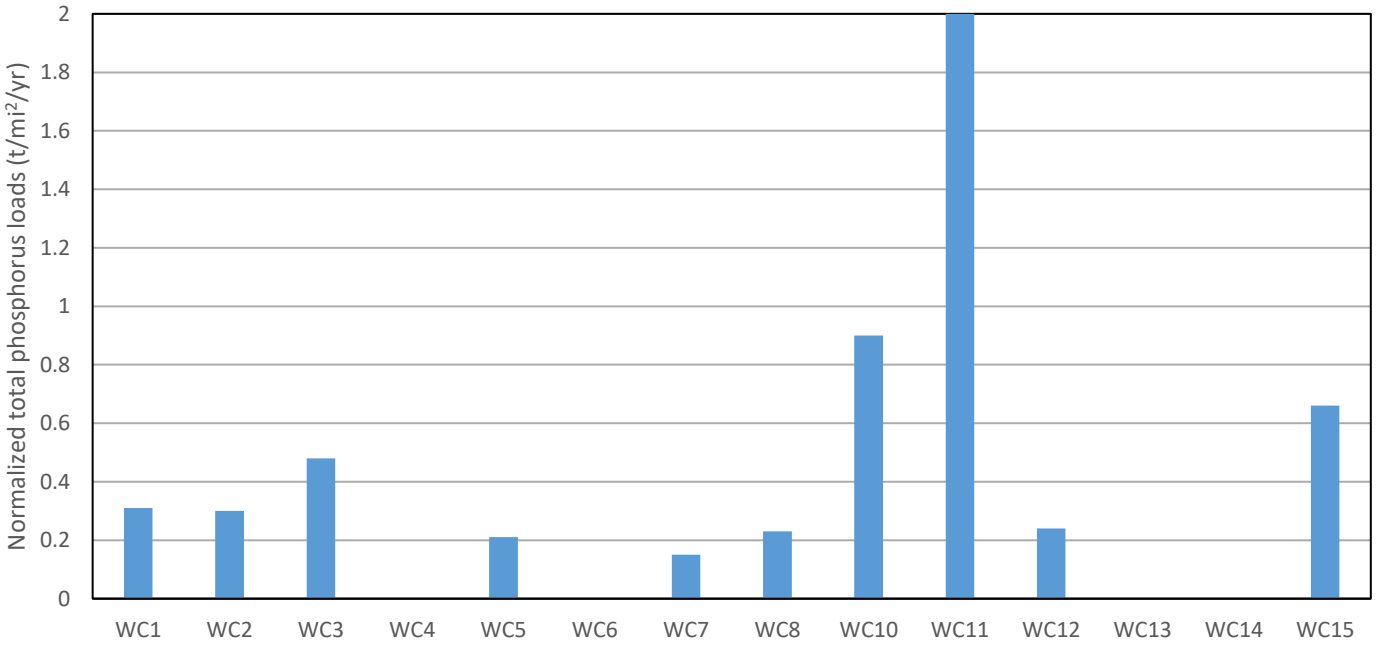

Figure 18.—Estimated normalized total phosphorus loads for Wolf Bay monitored streams.

DISSOLVED OXYGEN

Dissolved oxygen (DO) concentration is an essential constituent that affects the biological health and the chemical composition of surface waters. Biological processes, oxidation, and sediment loads all contribute to depletion of DO in surface water. The

ADEM standard for DO in surface water classified as Fish and Wildlife is 5.0 mg/L except under extreme conditions when it may be as low as 4.0 mg/L. ADEM established a reference standard for dissolved oxygen for level IV ecoregion 65f (including the Wolf Bay watershed), which is 6.94 mg/L.

The equilibrium concentration of DO in water that is in contact with air is primarily related to water temperature and barometric pressure and secondarily related to concentrations of other solutes (Hem, 1985). Equilibrium DO in water at 10° C and 25° C is 11.27 mg/L and 8.24 mg/L, respectively. DO concentrations in the project watersheds are significantly affected by water temperature, stream discharge, concentrations of organic material in the water, and oxygen-consuming pollutants. These factors are represented in table 8 where observed DO is compared to the 100 percent dissolved oxygen saturation for the observed stream temperature for each of the monitoring periods.

Dissolved oxygen was measured at Wolf Bay watershed monitoring sites from December 2016 through August 2017. Stream water temperatures during the monitoring period varied from 16.4 to 26.3°C. Site WC7 (Elberta Creek at Baldwin Co Rd 83) had the lowest average DO (6.3 mg/L) and site WC5 (unnamed tributary to Sandy Creek at US Highway 90) had the highest average DO (8.6 mg/L). Values lower than the ADEM Fish and Wildlife standard (5.0 mg/L) were measured at sites WC2, WC3, WC7, WC12, WC13, WC14, and WC15 (fig. 16). Twelve of 14 sites had measured DO values less than the ADEM reference standard (6.94 mg/L) (table 8). Average DO and water temperature values were compared with atmospheric DO saturation (table 8). Sites WC7 and WC14 (Hammock Creek at Baldwin Co Rd 20) had the lowest percentage of atmospheric saturation and site WC5 had the highest percentage (table 8).

Table 8.—Dissolved oxygen measured in monitored streams in the Wolf Bay watershed.

Site	Dissolved oxygen (mg/L)			Average DO saturation (% atmospheric saturation)
	Maximum	Minimum	Average	
WC1	9.5	6.1	7.8	89
WC2	8.5	4.9	7.5	88
WC3	8.4	3.8	6.6	76
WC4	9.6	6.6	8.2	94
WC5	9.6	7.9	8.6	97
WC6	9.3	7.0	7.9	89
WC7	7.9	4.5	6.3	71
WC8	8.2	5.5	6.9	77
WC10-	8.4	5.2	6.9	77
WC11	9.1	5.4	7.6	85
WC12	8.3	4.5	6.9	77
WC13	9.1	4.8	7.2	81
WC14	8.3	4.2	6.6	74
WC15	N/A[1]	N/A	N/A	N/A

[1] Insufficient number of samples collected.

PATHOGENS

In 1986 the US Environmental Protection Agency (EPA) recommended Escherichia coli (E. coli) as the bacterial indicator to assess concentrations of bacteria in fresh water. On December 11, 2009, ADEM adopted the E. coli criteria as the bacterial indicator for Alabama freshwater bodies. Criterion for acceptable bacteria levels for the Fish &Wildlife use classification (fresh water) is described in ADEM Admin. Code R. 335-6-10-.09(5)(e)7(i) and (ii) as follows:

7. Bacteria:

(i) In non-coastal waters, bacteria of the E. coli group shall not exceed a geometric mean of 548 colonies/100 ml; nor exceed a maximum of 2,507 colonies/100 ml in any sample.

During this assessment samples were collected during a low discharge event on August 3, 2017. Samples were analyzed for E. coli by personnel from the Riviera

Utilities Wolf Creek wastewater treatment plant, using the IDEXX Quanti Tray 2000 method. Experience shows that bacteria concentrations in streams at low flow are more likely to represent point sources, including municipal and industrial waste-water discharge and sewer line leaks, where impacts of runoff are minimized.

The IDEXX Quanti Tray 2000 method results in a most probable number (mpn) of E. coli colonies in a 100-ml sample. The ADEM single sample criterion maximum is 2,507 mpn. Sites WC2, WC3, WC4, WC7, WC8, WC10, and WC11 were sampled during the low discharge event. Sites WC12, WC13, and WC14 were not sampled due to tidal influence. Sites WC11 (Wolf Creek at Swift Church Road), WC10 (Wolf Creek at Doc McDuffie Road, and WC7 (Elberta Creek at Baldwin Co Rd 83) had the highest mpn for the low discharge event with 313, 186, and 186 colonies, respectively (fig. 19). These numbers are relatively low for surface water and most likely do not represent any particular pathogen point source. E-coli was evaluated against stream discharge and watershed area. Discharge did not correlate well, however figure 19 shows a good correlation between watershed area and E-coli, accept at site WC7, where bacteria counts are relatively high and may represent a source of pathogens above background levels.

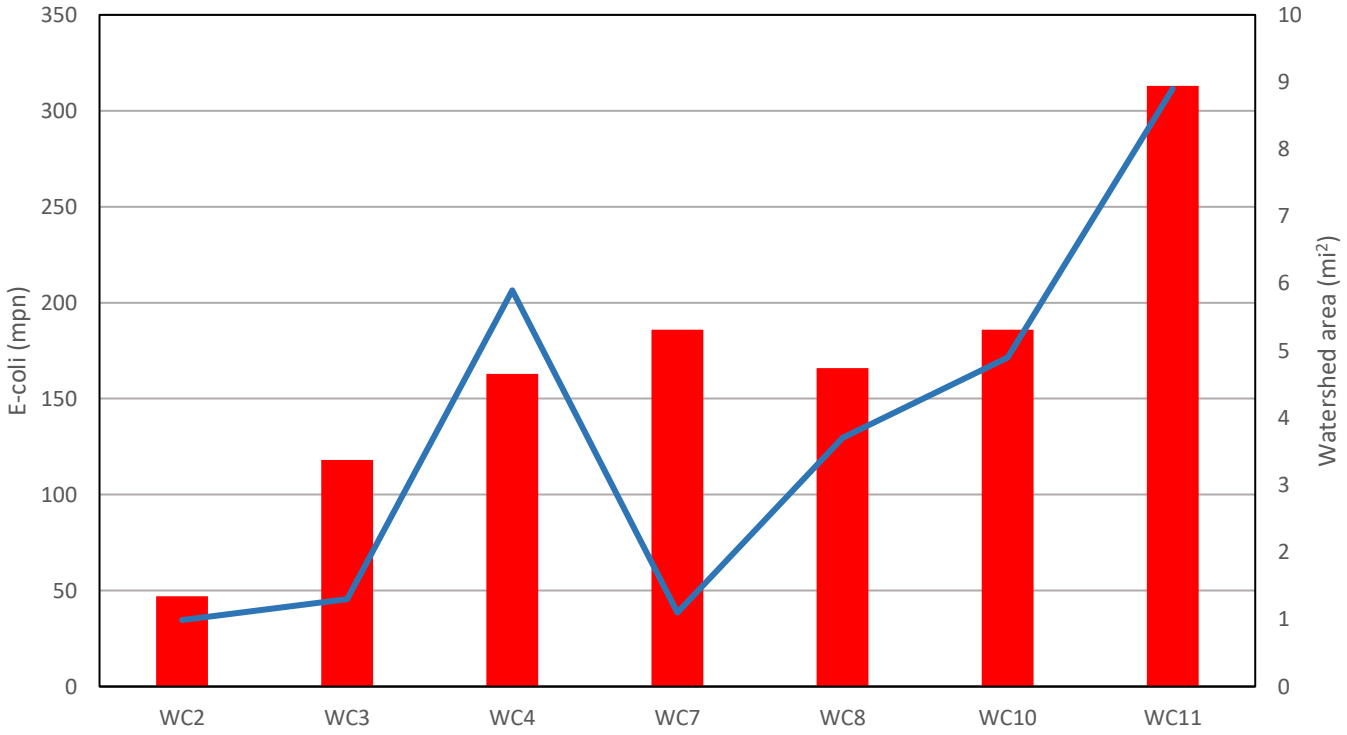

Figure 19.—E. coli mpn for a low discharge event and watershed area at selected Wolf Bay watershed monitoring sites.

CONCLUSIONS AND SOURCES OF WATER-QUALITY IMPACTS

Evaluations of sediment loads, water-quality analyses, land-use data, and aerial imagery led to conclusions of probable sources of water quality and habitat impairments in the Wolf Bay watershed. Stream flow conditions are important factors that influence erosion, sediment transport, and attenuation of nutrients and other contaminants that impact water quality in a watershed. Topographically and hydrologically, the Wolf Bay watershed can be divided into two regions; non-tidally influenced streams with uplands dominated by agriculture and commercial and residentially development, north of Miflin Road (Baldwin Co Rd 20) (fig. 20);and downstream, tidally influenced estuaries south of Miflin Road and east of Foley Beach Expressway, dominated by wetlands and coastal marsh with upland areas dominated by residential development with limited agriculture (fig. 20). These are most likely drown stream channels that formed during the previous low stand in sea level (fig. 20). The watershed is primarily rural but impacted by land-use conversion from agriculture to commercial and residential. Urban impacts to tributaries come from the towns of Foley and Elberta (fig. 20).

No streams in the Wolf Bay watershed are currently on the ADEM 303-D list of impaired waters. However, results of this assessment show that several stream reaches are impacted by excessive erosion and sedimentation. The largest suspended sediment loads in the Wolf Bay watershed occur in Sandy Creek upstream from Baldwin Co. Rd. 20 (WC12), in Wolf Creek upstream from Swift Church Rd. (WC11) and upstream from Doc McDuffie Rd. (WC10), in the west unnamed tributary to Sandy Creek upstream from US Highway 98 (WC5), and the east unnamed tributary to Sandy Creek upstream from US Highway 98 (site WC6). The mass of suspended sediment estimated at these sites were 929, 861, 460, 444, and 368 tons per year (t/yr), respectively. When normalized relative to drainage area, the largest suspended sediment loads were in the west unnamed tributary to Sandy Creek at US Highway 98 (WC5) (261 t/mi^2/yr), east unnamed tributary to Sandy Creek at US Highway 98 (WC6) (217 t/mi^2/yr), Wolf Creek at Doc McDuffie Rd. (WC10) (94 t/mi^2/yr), and Wolf Creek at Swift Church Rd. (WC11) (94 t/mi^2/yr).

Six sites (WC1, WC2, WC5, WC6, WC8, and WC10) had measurable bed sediment. Sites WC10 (Wolf Creek at Doc McDuffie Rd) and WC5 (west unnamed tributary to Sandy Creek at US Highway 98), and WC6 (east unnamed tributary to Sandy

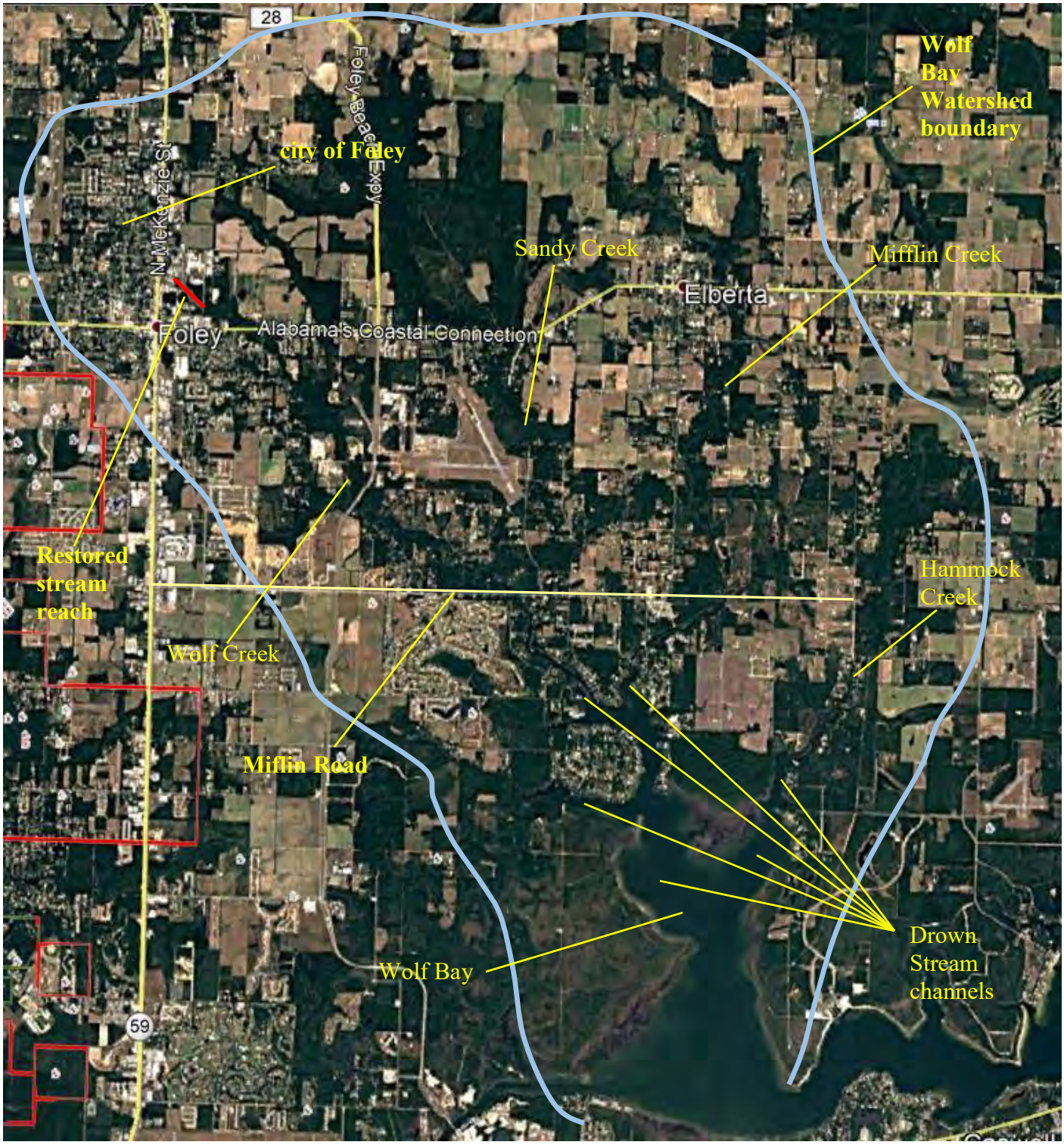

Figure 20. Image of the Wolf Bay watershed (Google Earth, 2017).

Creek at US Highway 98) had the largest bed sediment loads with 10,471, 1,551 and 1,347 t/yr, respectively. After normalization of bed sediment loads relative to drainage area, sites WC10 (Wolf Creek at Doc McDuffie Rd), WC5 (west unnamed tributary to

Sandy Creek at US Highway 98), and WC6 (east unnamed tributary to Sandy Creek at US Highway 98) had the largest loads with 2,137, 912, and 792 tons/mi^2/yr, respectively.

Wolf Creek at Doc McDuffie Road (WC10), west unnamed tributary to Sandy Creek at US Highway 98 (WC5), east unnamed tributary to Sandy Creek at US Highway 98 (WC6), and Wolf Creek at Swift Church Road (WC11) had the largest total sediment loads (10,931, 1,995, 1,715, and 1,257 tons per year (t/yr), respectively. The largest normalized total sediment loads occurred at Wolf Creek at Doc McDuffie Road (WC10) (2,231 t/mi^2/yr), west unnamed tributary to Sandy Creek at US Highway 98 (WC5) (1,173 t/mi^2/yr), east unnamed tributary to Sandy Creek at US Highway 98 (WC6) (1,009 t/mi^2/yr), and Miflin Creek at US 98 (WC8) (240 t/mi^2/yr). On average, bed sediment makes up 69% of total sediment loads for streams with measurable bed sediment.

Without human impact, watershed erosion rates, called the geologic erosion rate, would be 64 t/mi^2/yr (Maidment, 1993). Normalized sediment loads show that 9 of 13 monitored watersheds were from 1.1 to 34.9 times greater than the geologic erosion rate (fig. 12). Sites WC4 (Sandy Creek at US Highway 98), WC7 (Elberta Creek), and WC14 (Hammock Creek), and WC15 (Owens Bayou) were at or below the geologic erosion rate.

Site WC10 (Wolf Creek at Doc McDuffie Road) had the largest normalized estimated sediment loads in the Wolf Bay watershed. An evaluation of aerial imagery (Google Earth, January 2013 and February 2017) indicates that the watershed upstream from the monitoring site has three primary land uses that contribute to erosion and sediment that is being transported by Wolf Creek (fig. 20). The central and western headwaters area (upstream from Foley Beach Expressway) is in the city of Foley where urban runoff is characterized by flashy high velocity flows (fig. 20). One positive feature in this area is a 2,200 ft long channelized reach of Wolf Creek upstream from North Poplar Street that was restored in 2014 and includes meanders and natural vegetation that reduces streamflow velocities and limits erosion downstream. Figure 21 shows before and after imagery of the restored reach.

The western part of the headwaters area including the unnamed tributary upstream from site WC3 (north of US Highway 98) is dominated by row crop agriculture (fig. 20). Land use in the downstream part of the watershed is characterized by a mix of forested residential areas, row crop agriculture and industrial and construction sites, including the

Figure 21.—Before and after restoration of a channelized reach of Wolf Creek in Foley (Google Earth, 2013 and 2017).

OWA amusement park construction site (figs. 20). Construction on the OWA site (at the intersection of Baldwin County Road 20 and Foley Beach Expressway) began in late 2014 after aerial image 1 in figure 22 was acquired in January 2013. Figure 22 shows the

progression of the site preparation from pre-construction in January 2013 to partial site preparation in February 2015 to the beginning stages of construction in February 2017.

Figure 22.—Progression of site preparation from 2013 to 2017 for the OWA amusement park (Google Earth, 2013, 2015, 2017).

Impacts of OWA construction on Wolf Creek were monitored throughout the major construction period in 2017 using upstream site WC10 and downstream site WC11. Normalization of turbidity, TSS, and suspended sediment loads data from sites WC10 and WC11 indicate little or no impact from sediment contributed to Wolf Creek from the OWA site. Contractors and the city of Foley are commended for limiting erosion and retaining sediment on site during this major construction project. Although a single dominant source of sediment could not be determined from evaluation of aerial photography, all of the land uses listed above play a role in sediment loads estimated for Wolf Creek.

Sites WC5 (west unnamed tributary to Sandy Creek at US Highway 98), WC6 (east unnamed tributary to Sandy Creek at US Highway 98), and WC8 (Miflin Creek at US 98) had excessive sediment loads and are all in the same general geographic area near the town of Elberta along US Highway 98. Land use in all three watersheds is dominated by row crop and turf agriculture. The upland row crop fields are drained by a series of ditches that form headwaters of streams and are incised, in part, contributing excessive amounts of sediment during large rain events.

Bed sediment samples were collected at sites WC6 (east unnamed tributary at US Highway 98), WC8 (Miflin Creek at US Highway 98), and WC10 (Wolf Creek at Doc McDuffie Road). Wet samples were weighed to determine the mass in pounds per cubic ft (lbs/ft^3), which was 90, 105, and 118 lbs/ft^3, respectively. Samples were sieved to determine sediment grain sizes. Grain size classes were dominated by medium-grained sands, which are sourced from erosion of the Citronelle Formation.

Water samples were collected from December 2016 through August 2017 at Wolf Bay watershed monitoring sites for discharge events from base flow to bank full. Samples were analyzed for nitrate+nitrite nitrogen and total phosphorus. Analytical results were compared with reference concentrations for nitrate+nitrite nitrogen (0.3258 mg/L) and total phosphorus (0.04 mg/L) established by ADEM for Ecoregion 65f, which includes the Wolf Bay watershed. The ADEM reference concentration for nitrate+nitrite nitrogen was exceeded in 83% of samples collected. The largest nitrate+nitrite nitrogen loads were at sites WC8 (Miflin Creek), WC4 (Sandy Creek at US Highway 90), WC12 (Sandy Creek at Baldwin Co Rd 20), and WC11 (Wolf Creek) with 64.4, 56.7, 43.2, and 42.3 t/yr, respectively. The largest normalized nitrate+nitrite nitrogen loads were at sites WC8,

WC5 (unnamed tributary to Sandy Creek at US Highway 90), WC4, and WC1 (Sandy Creek at Foley Beach Expressway), with 17.4, 14.7, 9.6, and 7.3 t/mi^2/yr. These watersheds are all dominated by row crop and turf agricultural land use.

The ADEM reference concentration for total phosphorus was exceeded in 63% of samples collected from Wolf Bay monitoring sites. The largest phosphorus loads were at sites WC11 (Wolf Creek) and WC5 (unnamed tributary to Sandy Creek), with 17.8 and 9.1 t/yr, respectively. When loads are normalized with respect to drainage area, Wolf Creek sites WC11 and WC10 had the largest loads with 2.0 and 0.9 t/mi^2/yr, respectively. The watershed upstream from site WC5 is dominated by row crop agriculture and land use upstream from sites WC10 and WC11 is dominated by urban development. Relatively large average concentrations and loadings of nitrogen and phosphorus in most of the monitored Wolf Bay watershed streams originate from sources related to unban, residential, and agricultural land use that dominate specific parts of the watershed.

The ADEM standard for DO in surface water classified as Fish and Wildlife is 5.0 mg/L except under extreme conditions when it may be as low as 4.0 mg/L. ADEM established a reference standard for dissolved oxygen for level IV ecoregion 65f (including the Wolf Bay watershed), which is 6.94 mg/L.

Dissolved oxygen was measured at Wolf Bay watershed monitoring sites from December 2016 through August 2017. Stream water temperatures during the monitoring period varied from 16.4 to 26.3°C. Site WC7 (Elberta Creek at Baldwin Co Rd 83) had the lowest average DO (6.3 mg/L) and site WC5 (unnamed tributary to Sandy Creek at US Highway 90) had the highest average DO (8.6 mg/L). Land use in the upland areas along the margins of the Elberta Creek watershed upstream from site WC7 is primarily row crop agriculture. However, the floodplain of the creek is a large wooded wetland with a small beaver pond immediately upstream from Baldwin County Road 83.Values lower than the ADEM Fish and Wildlife standard (5.0 mg/L) were measured at sites WC2, WC3, WC7, WC12, WC13, WC14, and WC15. Twelve of 14 sites had measured DO values less than the ADEM reference standard (6.94 mg/L)

When all assessed constituents are considered with respect to water quality and potential remediation and restoration, watersheds upstream from Wolf Creek sites WC10 and WC11, and unnamed tributaries to Sandy Creek upstream from sites WC5 and WC6

have the highest degree of impairment and should be considered primary targets for various types of remediation and restoration.

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APPENDIX A

FIELD AND ANALYTICAL DATA

Sandy Creek					30.42614			Area				
at Foley Beach Expressway					87.6485			2.2 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS	Bed Sed	Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L	T/d	mg/L	mg/L
WC1	12/07/16	1630	5.1	17.6	65	13	6.1	8.3	3	0.08	1.9	<.05
WC1	12/14/16	915	17.3	18.1	56	42	5.9	7.5	6.0	0.46	0.689	<.05
WC1	01/21/17	1120	24.0	20.0	57	43	5.8	7.7	18.5	0.81	0.803	0.095
WC1	02/08/17	1645	13.8	20.6	101	48	6.1	6.1	9.6	0.42	1.32	0.162
WC1	02/21/17	1825	28.0	18.2	78	43	5.1	9.5	9.6	1	1.38	0.061
WC1	03/30/17	1750	5.3	20.6	88	21	6.1	6.9	5.2	0.04	2.1	<.05
WC1	04/03/17	1620	38.0	22.3	92	115	5.2	8.3	24.0	1.35	0.941	0.112
WC1	05/04/17	1025	44.0	20.3	64	84	5.1	8.4	18.4	1.55	0.84	0.108

Wolf Creek					30.40967			Area				
at N. Poplar St.					87.67639			0.99 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS	Bed Sed	Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L	T/d	mg/L	mg/L
WC2	12/07/16	1515	0.8	18.0	89	19	6.1	7.8	6	0.003		<.05
WC2	12/14/16	800	1.4	19.2	76	31	6.6	8.0	7.2	0.01	0.397	0.097
WC2	01/21/17	1000	52	18.7	113	144	5.7	7.8	30	2.9	<0.3	0.101
WC2	03/30/17	1650	5.3	21.6	139	43	6.1	7.5	16.0	0.35	0.498	0.057
WC2	04/03/17	1710	33	22.7	52	40	6.6	7.9	13.2	1.8	0.404	0.133
WC2	04/30/17	2020	2.2	24.1	140	9	6.4	8.5	2.4	0.2	0.968	<.05
WC2	05/04/17	1055	9.7	21.3	41	26	6.4	8.3	6.4	0.45	0.288	0.105
WC2	05/12/17	1515	35	22.1	138	70	6.4	6.4	20.0	1.9	0.569	0.064
WC2	08/03/17	1440	2.8	26.3	92	16	6.5	4.9	3.0	0.25		

Unnamed tributary					30.4069			Area				
at US Hwy 98 crossing					87.65579			1.3 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC3	12/07/16	1600	2.0	17.8	67	19	6.0	7.6	6			
WC3	12/14/16	840	10.6	18.4	54	25	6.3	5.8	5.6		0.503	0.219
WC3	01/21/17	1050	30.0	18.5	50	127	6.0	8.1	60.7		<0.3	0.180
WC3	03/30/17	2055	1.5	19.0	78	94	5.9	5.6	31.6		0.361	0.138
WC3	04/03/17	1645	180.0	21.7	37	121	6.1	8.3	31.2		0.772	0.216
WC3	04/30/17	2030	0.8	23.3	117	39	6.2	4.9	18.8		<0.3	<.05
WC3	05/04/17	1145	170.0	20.2	35	68	6.3	8.4	16.8		0.444	0.223
WC3	05/12/17	1530	3.0	22.8	66	59	6.6	7.0	35.3		0.15	0.080
WC3	08/03/17	1420	1.0	23.9	99	38	6.0	3.8	12.0			

Sandy Creek					30.40682			Area				
at US Highway 98 crossing					87.63024			5.9 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC4	12/13/16	1400	14.9	21.1	138	2	5.5	6.6	2		1.570	<.05
WC4	01/19/17	830	17.8	20.8	65	7	6.0	8.3	3.0			
WC4	01/21/17	1150	51.1	20.0	49	32	5.8	7.9	11.6		0.752	<.05
WC4	02/21/17	2115	65.5	18.0	49	33	6.0	9.5	15.6		0.875	<.05
WC4	03/30/17	2000	28	19.7	53	16	6.1	7.6	6.0		1.41	<.05
WC4	04/03/17	1820	170	20.9	39	63	5.9	9.6	36.4		0.986	<.05
WC4	04/30/17	2230	14.3	23.0	302	6	6.4	9.0	2		1.52	<.05
WC4	05/04/17	1510	92	20.7	189	43	5.6	9.3	17.6		0.733	<.05
WC4	05/12/17	1550	14	21.1	52	7	6.2	7.7	2		1.580	<.05
WC4	08/03/17	1340	16.3	22.7	54	5	6.1	6.7	2.0			

West unnamed tributary					30.40667			Area				
at US Highway 98					87.62627			1.7 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS	Bed Sed	Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L	T/d	mg/L	mg/L
WC5	12/13/16	1415	0.74	21.2	87	2	5.7	7.9	2	0.62	5.800	<.05
WC5	12/14/16	1030	3.3	19.0	56	26	5.7	8.1	5.6	2.6	1.850	<.05
WC5	01/19/17	900	2.7	20.9	70	12	5.8	8.1	10	0.18		
WC5	01/21/17	1215	17.9	20.8	42	355	5.4	9.6	248.0	7.8	0.451	0.072
WC5	02/22/17	915	7.5	17.8	47	71	6.1	8.7	29.2	12.7	1.660	0.095
WC5	04/03/17	1840	29	20.9	31	270	5.9	9.6	147.0	26.7	1.580	0.176
WC5	05/12/17	1605	3	20.8	69	31	5.8	8.0	18.0	2.0	4.660	<.05

East unnamed tributary					30.40671			Area				
at US Highway 98					87.62481			1.7 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS	Bed Sed	Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L	T/d	mg/L	mg/L
WC6	12/13/2016	1445	1.9	21.6	74	5	6.1	7.9	3.33	0.14	2.26	<.05
WC6	12/14/2016	1100	4.8	19.3	63	17	6.2	7.9	8.8	0.5	1.23	<.05
WC6	1/19/2017	915	1.5	21.9	63	18	6.1	7.6	15	2.3		
WC6	1/21/2017	1300	30.6	20.8	47	61	6.0	8.6	31.2	18.7	0.570	<.05
WC6	2/22/2017	1000	5.4	19.2	60	22	6.1	9.3	29.2	3.3	1.660	0.095
WC6	4/3/2017	1915	20.9	21.7	49	260	6.1	8.1	216	12.8	1.360	<.05
WC6	5/1/2017	115	1	24.2	82	27	6.1	7.0	12	0.5	1.950	<.05
WC6	5/12/2017	1615	22	22.8	48	192	6.1	7.0	77.5	13	1.320	<.05

Elberta Creek					30.42262			Area				
at Baldwin Co Road 83					87.59837			1.1 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC7	12/14/16	1140	15.0	18.5	64	11	5.7	5.3	3.2		0.150	0.051
WC7	02/09/17	1050	11.2	17.2	62	11	6.1	7.2	2		0.417	0.088
WC7	02/21/17	2150	63.0	17.1	56	19	6.0	7.1	4.8		0.631	0.068
WC7	03/30/17	2040	53.0	19.5	56	35	5.9	6.6	10		0.486	<.05
WC7	04/03/17	1950	23.0	20.4	44	39	5.9	7.2	10		0.559	0.057
WC7	04/30/17	2250	2.7	22.9	75	19	5.9	4.5	8		0.343	<.05
WC7	05/12/17	1630	2.9	21.2	55	55	5.9	7.9	21.5		0.403	0.097
WC7	08/03/17	1405	3.2	23.9	64	13	6.0	4.5	4.0			

Miflin Creek					30.41433			Area				
at US Highway 98					87.59159			3.7 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS	Bed Sed	Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L	T/d	mg/L	mg/L
WC8	12/14/16	1210	14.9	18.8	62	32	6.1	6.7	12.0	2	0.572	0.057
WC8	02/09/17	1110	14.0	17.5	62	12	6.2	5.5	2.0	1.8	0.122	0.052
WC8	02/21/17	2130	38.9	17.5	53	32	6.1	7.1	9.2	5	0.831	0.061
WC8	03/30/17	2020	45.0	20.2	64	44	6.3	6.9	24.0	5.5	0.916	0.088
WC8	04/03/17	1940	70.0	20.6	43	74	6.1	8.0	35.6	7.5	0.880	0.060
WC8	04/30/17	2310	13.0	23.0	94	13	6.0	5.6	2.8	1.7	3.140	<.05
WC8	05/12/17	1640	12.0	21.2	86	12	6.0	6.5	4.8	1.6	3.450	<.05
WC8	08/03/17	1355	3.9	23.2	85	9	6.1	7.4	4.0	0.24	3.300	<.05
WC8	08/04/17	950	140.0	23.5	65	141	6.5	8.2	52.0	10	0.400	0.115
WC8	08/29/17	2100	55.0	185.5	614	55		61.9	28.0	6.4		

Wolf Creek					30.38979			Area				
at Doc McDuffie Road crossing					87.65302			4.9 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS	Bed Sed	Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L	T/d	mg/L	mg/L
WC10	10/28/16	930	6.8						2	0.14		
WC10	01/18/17	1600	12.4	21.2	159	10	6.4	6.3	2	1.1	1.420	1.580
WC10	01/21/17	1410	129	20	56	96	6.4	8.4	46.7	65	0.332	0.256
WC10	02/09/17	1000	12.3	17.6	111	11	6.4	5.2	2	0.22	1.300	0.411
WC10	02/21/17	1940	63.7	18.7	74	63	6.3	7	15.6	52	0.682	0.703
WC10	03/30/17	1820	15.8	21.1	145	23	6.4	6.5	12.4	6.8	1.360	1.640
WC10	04/03/17	1800	149	20.9	49	174	6.5	8.2	63.0	70	0.790	0.226
WC10	04/30/17	2045	11	23.9	147	8	6.4	6.3	2.0	0.8	1.180	0.533
WC10	05/04/17	1230	140	21	47	67	6.5	7.8	23.6	68	0.528	0.187
WC10	8/3/2017	1310	13.4	23.4	118	12	6.3	6.3	4.0			

Wolf Creek					30.3735			Area				
at Swift Church Road					87.63262			8.9 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC11	01/18/17	1400	17.5	23.3	195	11	6.1	8.8	2		1.640	0.733
WC11	01/21/17	1500	214.0	20.1	70	237	6.4	9.1	139		0.510	0.388
WC11	02/09/17	855	30.0	17.2	269	17	6.6	6.0	8		1.550	0.249
WC11	02/21/17	2000	113.0	18.7	74	63	6.3	7.0	35.2		0.707	0.443
WC11	02/22/17	815	42.9	17.9	80	42	6.5	8.7	13.6		1.070	0.442
WC11	03/30/17	1900	22.5	20.8	98	13	6.4	7.3	2.4		1.750	0.588
WC11	04/03/17	1740	277.0	21.3	47	147	6.6	8.4	81.5		0.615	0.180
WC11	04/30/17	2105	20.0	23.2	99	8	6.4	7.0	9.2		1.640	0.259
WC11	05/04/17	1220	265.0	20.5	43	121	6.5	8.4	56.0		0.521	0.190
WC11	08/03/17	1300	24.0	23.2	180	11	5.5	7.0	9.0			
WC11	08/30/17	900	718.0	24.6	41	180	6.4	5.4				

Sandy Creek					30.37041			Area				
at Baldwin Co Road 20					87.61852			13.3 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC12	01/18/17	1525		21.0	3,300	22	6.3	7.1	8.4		0.15	0.245
WC12	01/21/17	1430	348	20.3	184	27	6.2	8.2	8.4		0.824	0.061
WC12	02/09/17	825		16.4	14,000	26	6.8	5.1	18.4		0.15	0.025
WC12	02/21/17	2050	156	18.5	437	630	6.3	7.3	128		0.940	0.146
WC12	04/03/17	2200	151	20.0	420	145	6.1	8.3	52.4		0.872	0.093
WC12	04/30/17	2330		23.5	1,330	9	6.1	6.6	2		0.688	0.025
WC12	05/04/17	1210	397	21.1	172	95	6.2	7.8	31.2		0.587	0.059
WC12	08/30/17	840	940	24.4	38	198	6.0	4.5	55.0			

Miflin Creek					30.36395			Area				
at Baldwin Co Road 20					87.60249			12.5 mi^2				
Site	Date	Time		Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
				°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC13	01/18/17	1515		21.1	13,900	15	6.6	4.9	8.8		<.3	<.05
WC13	02/09/17	810		17.5	16,200	14	6.7	4.8	13.2		<.3	<.05
WC13	02/21/17	2030		20.0	15,400	18	6.6	8.2	18.0		<.3	<.05
WC13	04/03/17	2140		20.4	3,640	56	6.3	8.2	24.0		0.545	<.05
WC13	04/30/17	2140		25.6	15,000	18	7.0	7.7	12.8		<.3	<.05
WC13	05/04/17	1450		23.8	11,900	31	6.8	9.1	15.2		0.222	<.05

Hammock Creek					30.36303			Area				
at Baldwin Co Road 20					87.56769			3.8 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC14	01/18/17	1500	16.2	22.1	1580	4	5.6	7.0	2		0.447	0.081
WC14	02/09/17	755	10.0	17.5	61	8	5.1	5.9	2		0.914	<.05
WC14	02/21/17	2015	81.0	17.8	46	22	5.7	8.2	5.2		0.595	<.05
WC14	04/03/17	2120	85.0	20.0	43	31	5.3	7.7	8.4		0.724	<.05
WC14	04/30/17	2130	15.0	24.6	12000	4	6.2	4.2	5.2		0.2	<.05
WC14	05/04/17	1435	10.0	21.4	297	18	5.8	8.3	7.6		0.512	<.05
WC14	08/30/14	820	218.0	24.2	29	96	5.8	4.6	15.0			
Owens Bayou					30.3598			Area				
at Glen Lakes Lakeview Drive					87.63927			0.8 mi^2				
Site	Date	Time	Dis	Temp	Cond	Turb	pH	DO	TSS		Nitrate + Nitrite	Total P
			cfs	°C	mS/cm	NTU		mg/L	mg/L		mg/L	mg/L
WC15	08/29/17	2015	2.7	26.3	104	10	6.7	5.6	2		0.418	0.135
WC15	08/29/17	2150	13.3	25.9	56	28	6.8	3.7	19.2		0.319	0.175
WC15	08/30/17	750	60.0	24.8	34	36	6.8	5.4	14.8		0.390	0.245

APPENDIX B:
Hydro Engineering Solutions Study (2020)

MBNEP

118 N Royal St Suite 601
Mobile, AL 36602

Wolf Bay Watershed Study

June 2020

Prepared By:

HYDRO ENGINEERING SOLUTIONS
A DIVISION OF HYDRO, LLC

2124 Moore's Mill Road ♦ Suite 120 ♦ Auburn, Alabama 36830

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1. Executive Summary

This report is a modification to the Wolf Bay Watershed Study report submitted to Baldwin County on September 2013 by Hydro-Engineering Solutions, A Division of Trimble. The 2013 calibrated GSSHA hydrologic model was reexamined with the September 4, 2018 rainfall event from Tropical Storm Gordon to see if the GSSHA model was still applicable.

During the September 4, 2018 rainfall event, the watershed experienced approximately 5" of rain in 10 hours. This equates to a 2-year recurrence interval. It was determined from this rainfall event that the previously calibrated Wolf Bay model from 2013 provided reasonable results for both timing and peak discharge. The model was also run with the updated NOAA Atlas 14 precipitation depths for a 100 year-event and then compared to the updated 100-year rural regression equations found in *Magnitude and frequency of floods in Alabama, 2015:* It has been determined that the previously calibrated 2013 Wolf Bay watershed model produces discharges in line with the updated regression equations and is still an applicable tool for analyzing stormwater impacts based on future developments.

2. Introduction

2.1. Description

Wolf Bay is an estuary located in the southeastern part of Baldwin County, AL (Figure 2-1). Wolf Bay drains through a series of other bays and ultimately drains into the Gulf of Mexico. The portion of the watershed that is being analyzed for this study drains approximately 56 square miles. There are generally 5 sub-basins that make up the drainage area for Wolf Bay being studied (Figure 2-2). The major creeks that make up these sub-basins include Wolf Creek, Sandy Creek, Miflin Creek, Hammock Creek, Owens Bayou, and Graham Bayou. The southern end of the creeks experience daily tidal fluctuations with about 2 feet of change. There are two municipalities found within the study area. The first is Foley, which is located on the northwestern boundary of the Wolf Creek sub-basin. The second is Elberta, which is located in the northern part of the Miflin Creek Sub-basin. The municipalities of Gulf Shores and Orange Beach also drain into Wolf Bay; however, this is below the area of interest.

The ADEM classification for Wolf Bay and all connecting coves and bayous is OAW / S / F&W / SH. The OAW (Outstanding Alabama Water) classification is the highest level of waterbody classifications. It indicates “high quality waters that constitute an outstanding Alabama resource of exceptional recreational and ecological significance.” The OAW designation was granted in 2007. The other classifications indicate that the waterbody is also used for swimming (S), fish and wildlife (F&W), and shellfish harvesting (SH).

Figure 2-1
Location Map and Watershed Boundary

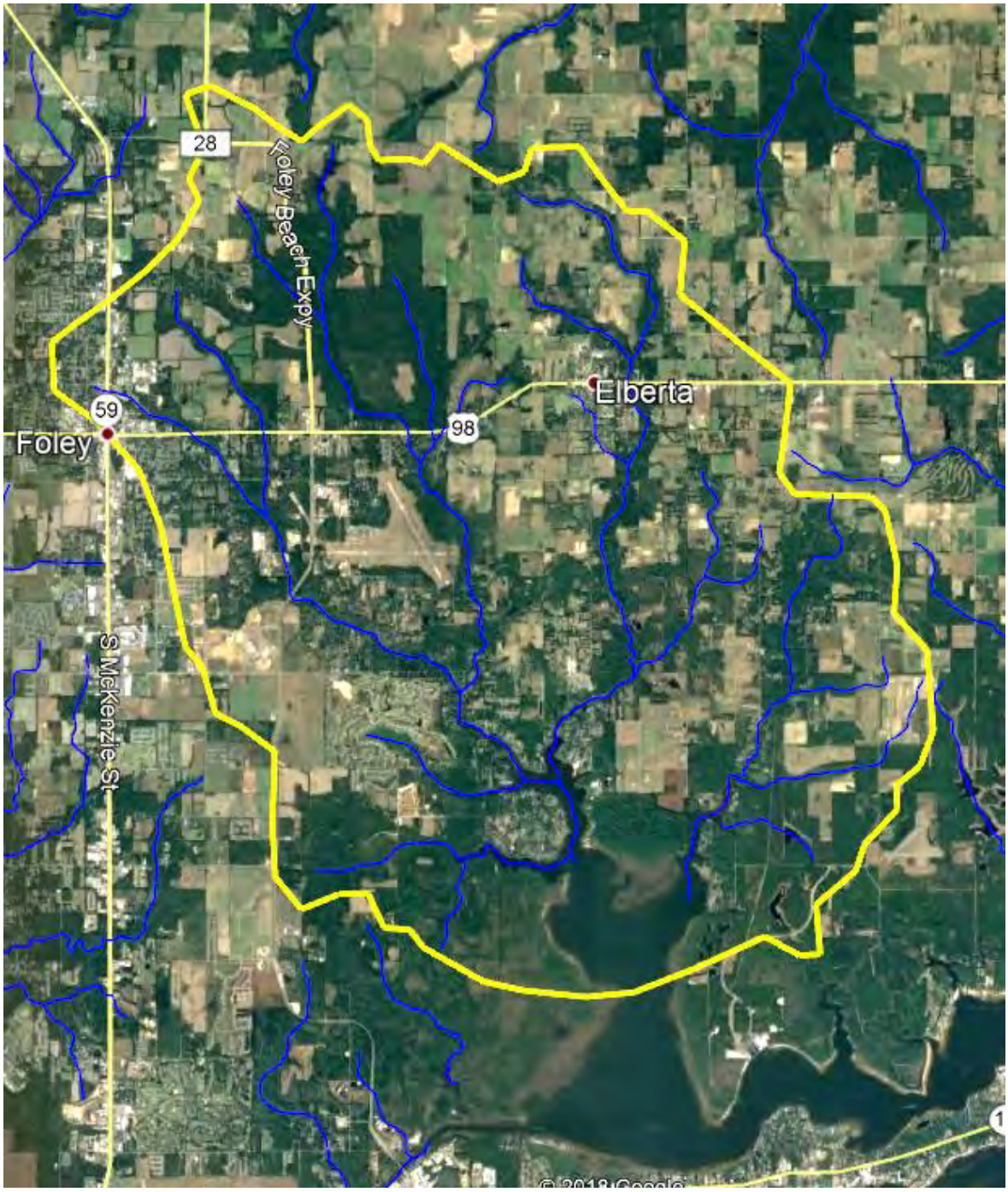


Figure 2-2
Wolf Bay Sub-basins

2.2. Climate

Baldwin County has a mild but humid climate. Data obtained from "weatherdb.com" indicates the average annual rainfall for Baldwin County (Foley and Elberta area) is around 61 inches. The summer months are typically the wettest with the winter typically being the driest months. The average high and low temperatures are 77 degrees and 55 degrees respectively. The warmest month is typically July with the coldest month being January.

Although the yearly rainfall is generally well distributed, significant rain events can be experienced in the watershed due to proximity to the coast and exposure to hurricanes. The hurricane season usually occurs in the late summer to early fall. Table 2-1 lists select hurricanes indicated by the date of occurrence, the hurricane name, and the range of rainfall related to the storm.

Table 2-1
Hurricane Event and Related Precipitation

Date	Hurricane	Precipitation (inches)
Oct 3-5, 1995	Opal	9-12
July 18-25, 1997	Danny	18-24
Sept 21-Oct 1, 1998	Georges	9-18
Sept 13-26, 2004	Ivan	7-10
July 5-13, 2005	Dennis	3-4
Aug 23-31, 2005	Katrina	2-3
Sept 1-4, 2011	Tropical Storm Lee	7-11

2.3. Physiography

According to the *Soil Survey of Baldwin County*, "Baldwin County is a part of the Gulf Coastal Plain physiographic region known as the Lower Coastal Plain. The county is underlain by five different kinds of deposits or geologic formations…" These are 1) River floodplains and terraces 2) Marine terraces 3) Areas of coastal beaches 4) Areas underlain by Hattiesburg clay and 5) Plateaus and ridgetops underlain by the Citronelle formation. The Wolf Bay watershed falls within area 2. Area 2 is underlain by deposits on marine terraces. This area is nearly level to gently sloping and is at an elevation that ranges from 10 to 100 feet above sea level. Figure 2-3 indicates the physiographic area of the study.

Figure 2-3
Physiographic areas of Wolf Bay Watershed

2.4. Land Use

According to *Baldwin County Profile – An Analysis of the Demographics and Other Characteristics that Constitute Baldwin County* published by the Planning and Zoning Department of the Baldwin Count Commission May 2008, the majority of Baldwin County is made up of agriculture, upland forested areas, and wetlands. These three land uses make up approximately 83.06% of the land use. Residential land use accounts for about 8.88% and commercial and industrial accounts for about 0.75%.

According to *Citizen Volunteer Water Monitoring on Wolf Bay* published by the Alabama Water Watch in 2008, the majority of the Wolf Bay Watershed is made up of agriculture, upland forested areas, and urban development. From 2005 data, these three land uses make up approximately 27%, 23%, and 27% of the land use respectively. As compared to 1992, agricultural and forested areas have decreased while urban development has increased. The percentages of land use in 1992 for agriculture, forests, and urban are 46%, 32%, and 4%. Water and wetlands for the area account for approximately 18% of the land use.

3. Model

3.1. General

The hydrologic model used to evaluate the Wolf Bay watershed is the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) model. GSSHA is developed and maintained by the US Army Engineer Research and Development Center (ERDC) Hydrologic Modeling Branch, in the Coastal and Hydraulics Laboratory. GSSHA is a physically-based, distributed parameter hydrologic model with sediment and constituent fate and transport capabilities. Features include two dimensional (2-D) overland flow, 1-D stream flow, 1-D infiltration, 2-D groundwater, and full coupling between the groundwater, shallow soils, streams, and overland flow. Sediment and constituent fate and transport are simulated in the shallow soils, overland flow plane, and in streams and channels. GSSHA can be used as an episodic or continuous model where soil surface moisture, groundwater levels, stream interactions, and constituent fate are continuously simulated. Parameters used to generate a GSSHA simulation include rainfall data, digital terrain data, land use data, and soils data.

3.2. Rainfall Data

One of the strengths of the GSSHA model is the ability to perform long-term simulations. A key element in forecasting discharges for future storm occurrences depends upon good rainfall data. For the rainfall component used in the simulations, Hydro-Engineering Solutions (Hydro) obtained storm data from three different monitoring sources.

For the rainfall component used in the original simulations, Hydro-Engineering Solutions (Hydro) employed the use of RainWave. RainWave offers precipitation-monitoring services that allow a user to enter a latitude and longitude for a point of interest. Once this point is entered into the system, various rainfall data can be obtained. For the modeling simulations 5-minute rainfall intervals were utilized. This data can then be formatted for a GSSHA long-term simulation. Figure 3-1 indicates the RainWave point locations used for gathering rainfall distribution data. It should be noted that RainWave no longer provides precipitation services.

Figure 3-1
2013 RainWave Point Locations

The second source for gathering rainfall data is from weather stations that Hydro deployed throughout the watershed (Figure 3-2). On June 6, 2018 a weather station (MBNEP 124) was installed at Foley High School just west of the Wolf Bay watershed boundary. The second weather station (MBNEP 136) was installed at a residence in Elberta on May 15, 2019.

The Davis Instruments, Corp.'s Vantage Pro 2 Precision Weather Station was used for data collection. Information collected from this weather station include: rainfall, temperature, humidity, wind speed, and barometric pressure. The data is sent to Weatherlink.com, which is Davis' global weather network. Weatherlink software was used for data retrieval for each station. After a storm event, data would be retrieved and processed for use in the GSSHA model.

The third source of rainfall used was obtained from Weather Underground. Weather Underground is a weather service that provides real-time weather information over the internet. According to their website, "Our brand mission is to make quality weather information available to every person on this planet." The service makes use of "the generous and passionate community of weather enthusiasts that share weather data and content..." The information is obtained from the members who send real-time data from their personal weather stations. The weather stations available are plotted on a map (Wundermap) based on the parameter selected. The parameters available in which to sort the gauges are temperature/wind, temperature, dew point/humidity, and precipitation. Figure 3-3 indicates two of the available precipitation gauges that can also be used for analyzing the watershed. These two gauges are Kalfoley3 at Myrtle Court and Kalelber4 near Bingham Street and Anthony Lane.

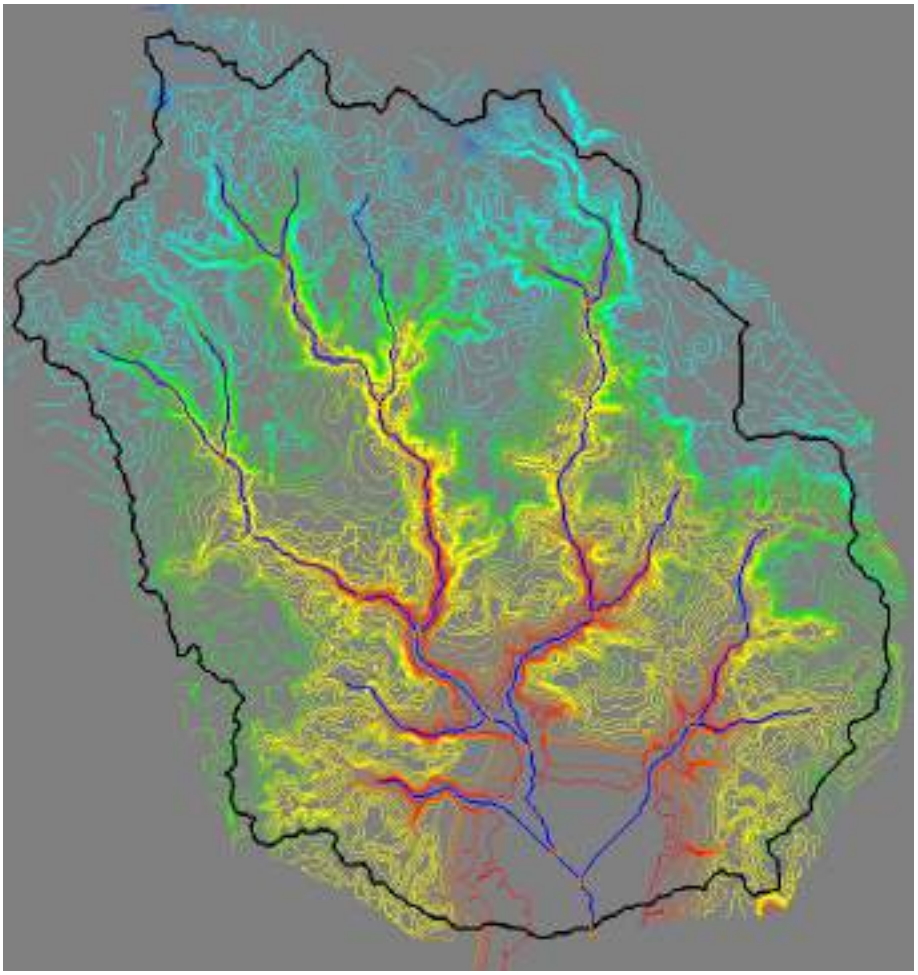
Figure 3-2
HES Weather Station Locations

Figure 3-3
Weather Underground Gauge Locations

3.3. Digital Terrain Data

The GSSHA model uses digital terrain data to incorporate topography into the hydrologic model. For the original model, one-foot Light Detection and Ranging (LiDAR) data provided by Baldwin County was used to generate the digital elevation model (DEM). Due to the size of the drainage area, the file size of the LiDAR contours was too large for WMS to process. Contour intervals within the steep sections of the watershed that would not affect creation of the DEM were removed in order to reduce file size. Once the DEM was built, it was used for basin delineation. The DEM data was also used for generating cell elevations for the gridded model. Figure 3-4 indicates the topographic data that was used in the model.

Figure 3-4
Wolf Bay Watershed with Topographic Data



The GSSHA model requires all units to be in the International System of Units. It was therefore necessary to convert the State Plane AL-W data to UTM Zone 16 data. The units were also converted from feet to meters. After proper conversion, the DEM data can be used for automatic delineation of the basin, as well as, for generating cell elevations for the gridded model.

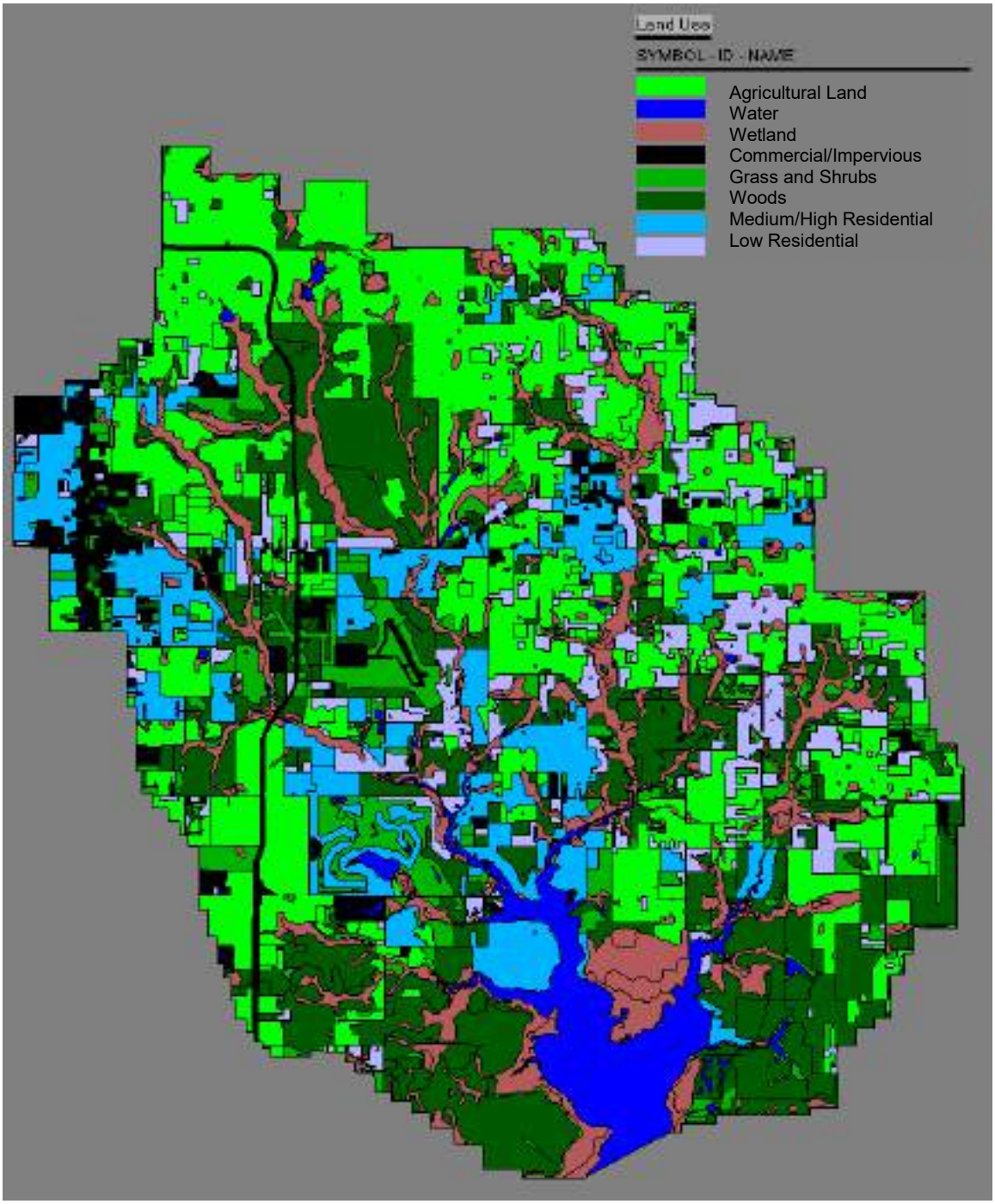
3.4. Land Use

The land use component of the model is necessary to define the various overland flow types throughout the basin. The roughness of each land use type is described by a Manning's 'n' value. A shapefile of the land use was provided by Baldwin County. The shapefile was converted to feature objects to be used in the model. It was necessary to simplify some of the land use descriptions for calibration purposes. Using geo-referenced aerial photography provided by Baldwin County, land use was checked to ensure all areas were properly assigned. Table 3-1 lists the land use types and the respective calibrated 'n' values assigned to them. Figure 3-5 indicates the land use assignments.

Table 3-1
Land Use and Manning's 'n' Values

GSSHA ID	Land Use	Manning's 'n'
2	Agriculture	0.250
5	Water	0.150
6	Wetlands	0.180
12	Commercial	0.011
32	Grass / Brush / Shrubs	0.260
36	Woods – Good	0.320
95	Med Residential	0.090
97	Low Residential	0.110

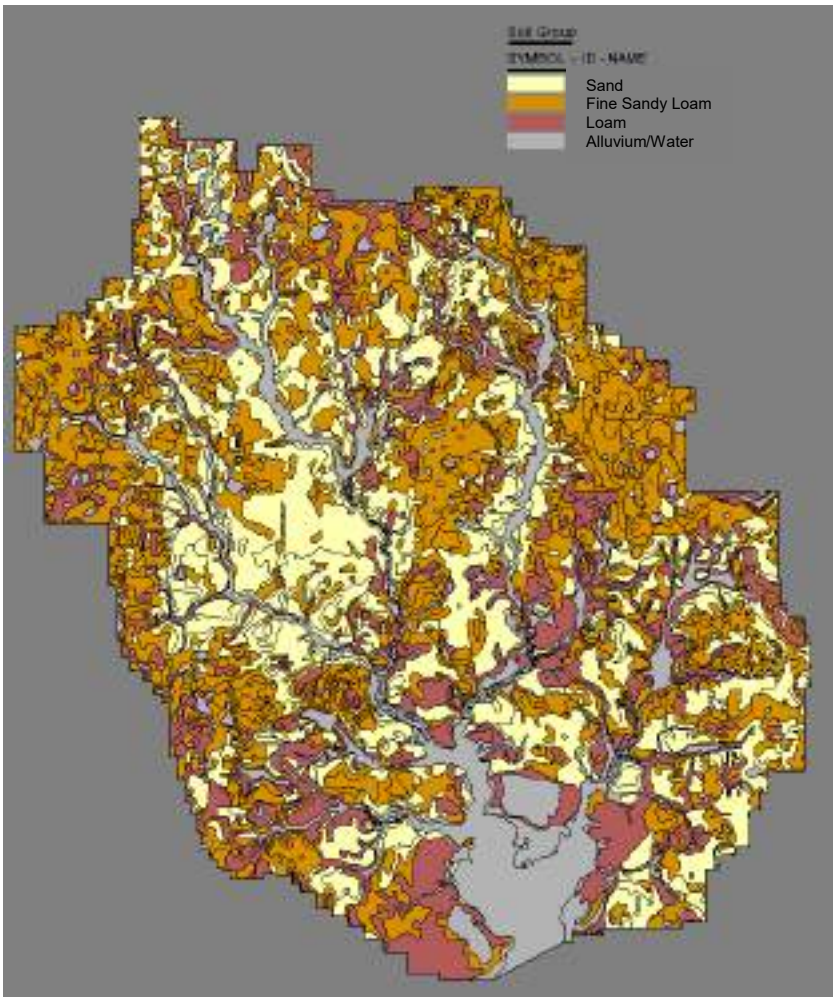
Figure 3-5
Original Digitized Land Use



3.5. Soils

Similarly to the land use, the GSSHA model has the capability to incorporate specific characteristics of the soils located within a drainage basin. The soils coverage is used for defining infiltration into the soil. The infiltration method used is Green and Ampt (G&A) with soil moisture redistribution. Soil parameters used by the G&A method include hydraulic conductivity, porosity, capillary head, pore distribution index, residual saturation, and field capacity. This allows the GSSHA model to evaluate the soil's ability to infiltrate stormwater in determining the peak discharge and volume of storm events. Soils data shapefiles provided by Baldwin County were converted to feature objects to be used in the model. Figure 3-6 indicates the soil data that has been incorporated into the model.

Figure 3-6
Original Digitized Soils Data



3.6. Combined Coverage

A combined land use / soils coverage layer can be generated in order to incorporate a more detailed way to specify infiltration. Instead of defining the infiltration parameters with just soils, it can be defined based on a soil type and specific land use. For example, a sandy loam may have woods described as the land use in one part of the watershed and a parking lot in another. Instead of applying the infiltration values for just a sandy loam, a combined coverage can utilize an infiltration value for the woods and a separate one for the parking lot. This can help better replicate the infiltration and timing related to the ground cover and soil type.

3.7. Gridded Model

Once all of the variables mentioned above have been incorporated into the model, it was necessary to divide the model into individual grid cells. For the Wolf Bay model a 70 meter x 70 meter (230 feet x 230 feet) grid size was utilized (Figure 3-7). The settings for GSSHA require the units to be in the International System of Units (SI). The total drainage area to the designated outlet is approximately 56 square miles. Over the entire watershed this generates approximately 25,900 grid cells. Figures 3-7, 3-8, 3-9, and 3-10 indicate the gridded topographic data, the gridded land use, the gridded soil types, and the gridded combined layer.

Figure 3-7
Gridded Topographic Data

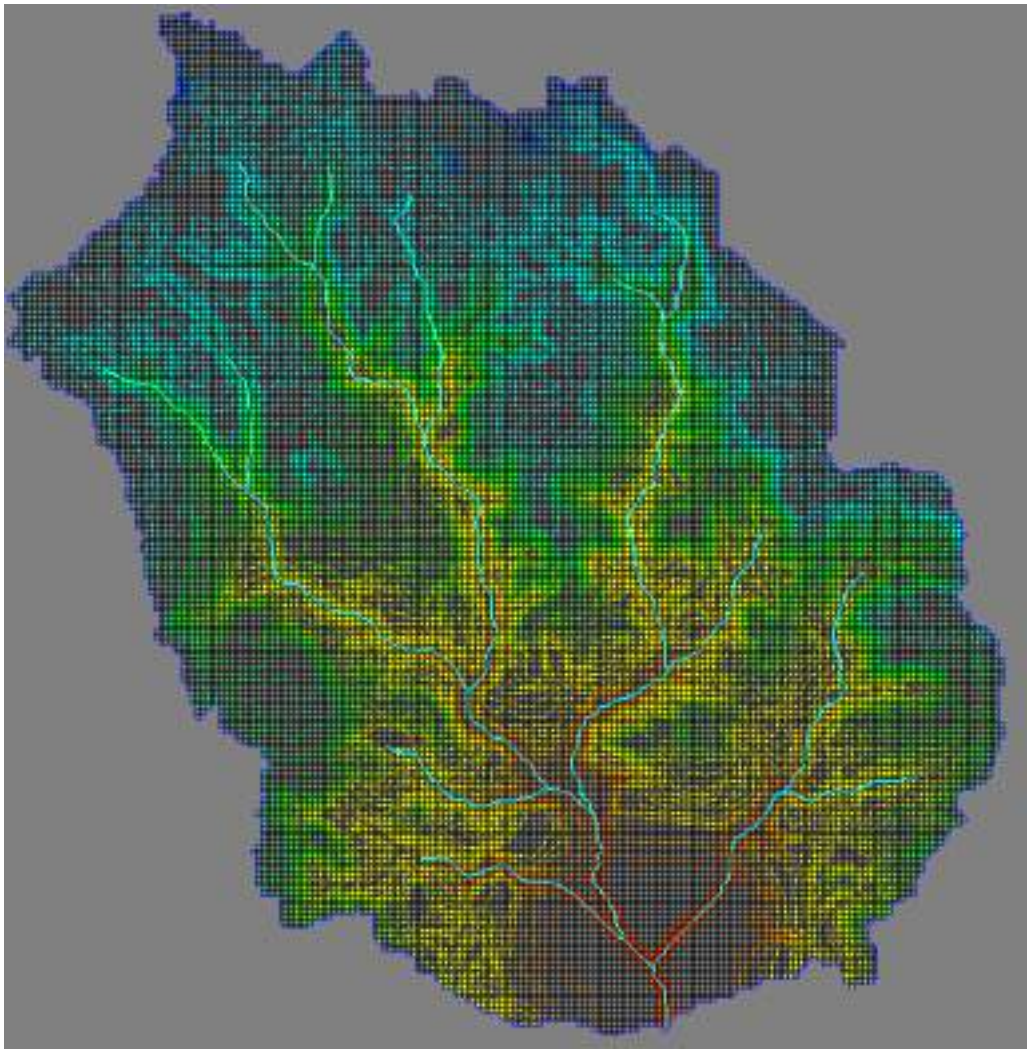


Figure 3-8
Gridded Land Use

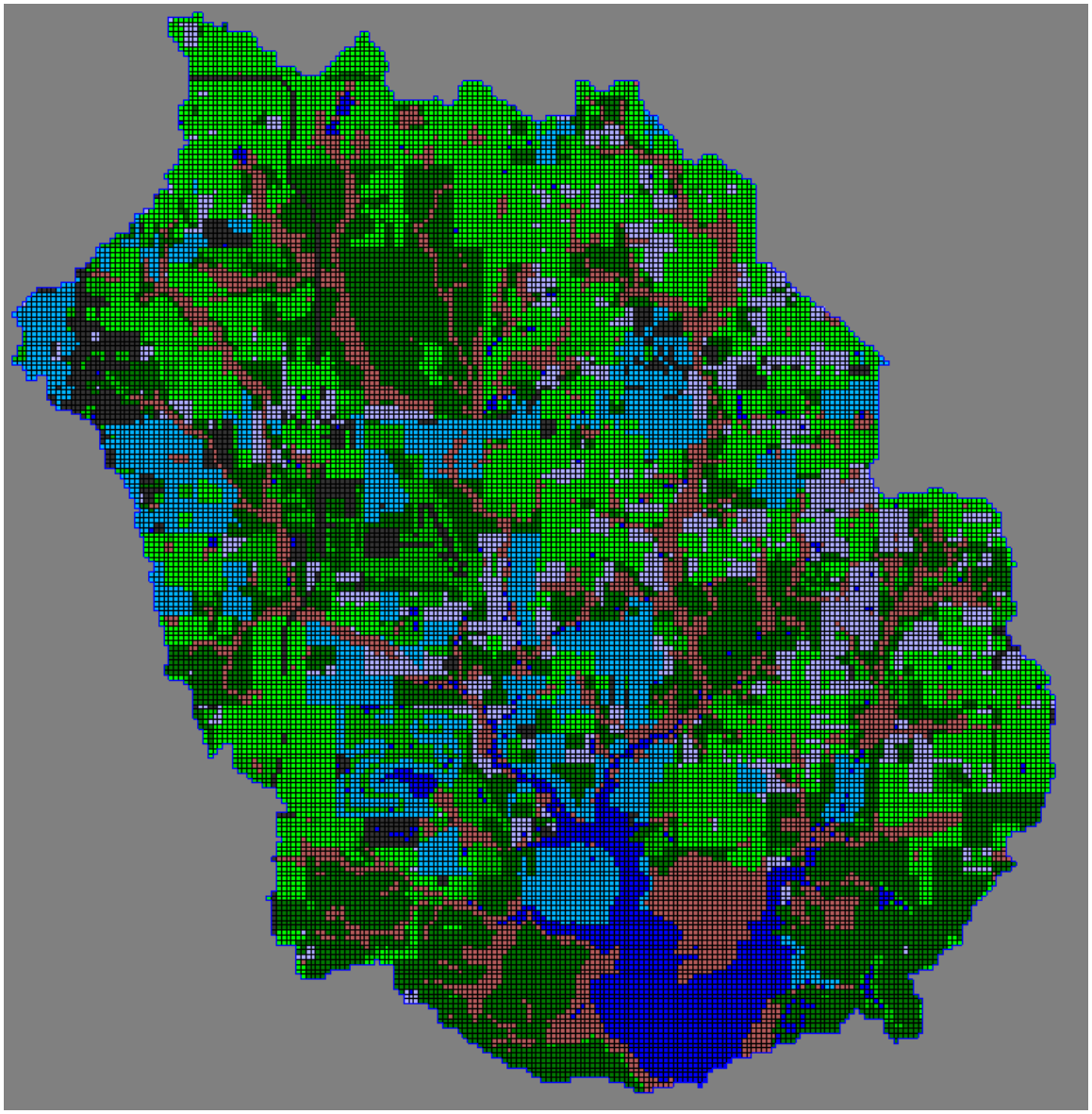


Figure 3-9
Gridded Soil Types

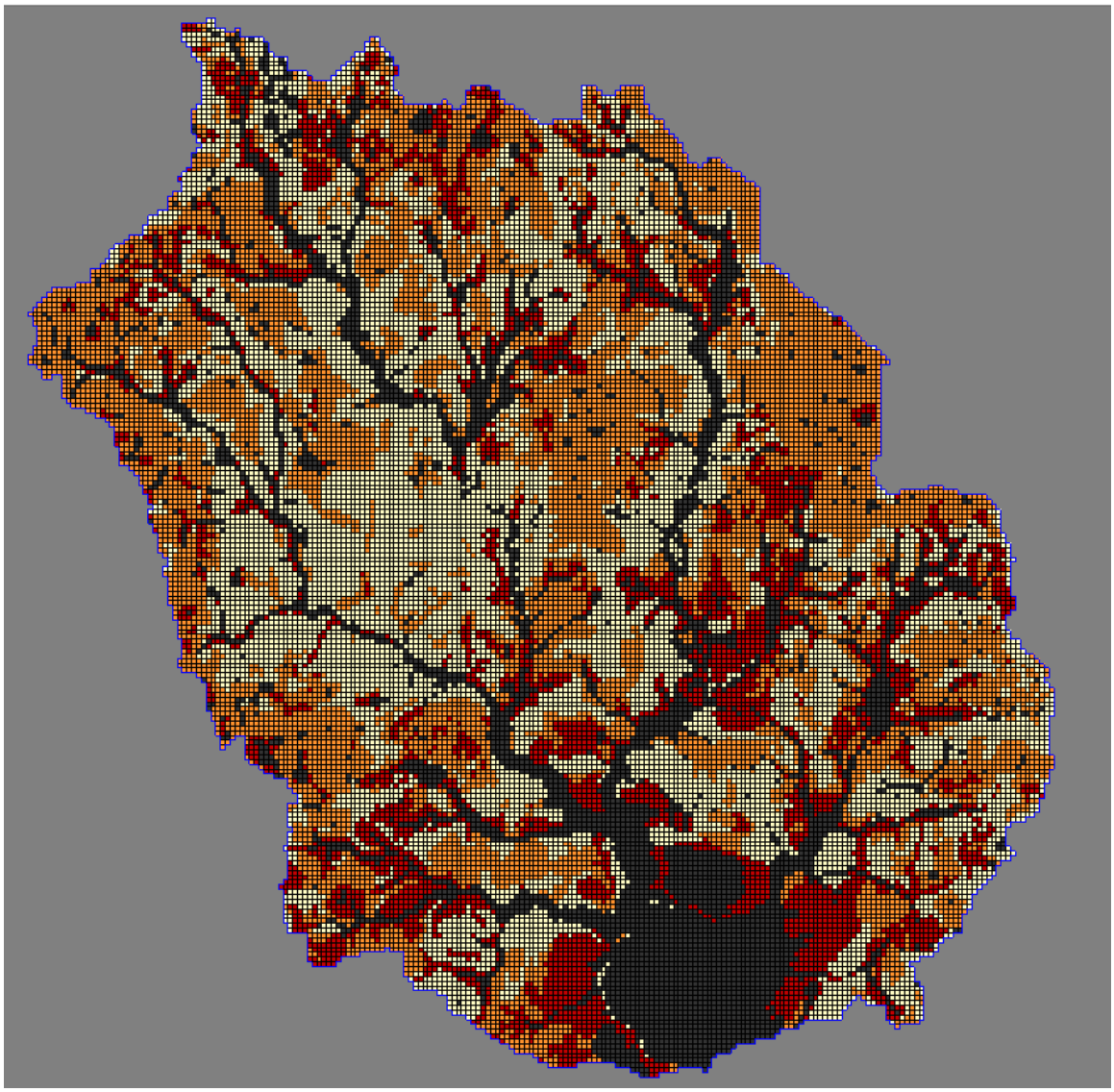
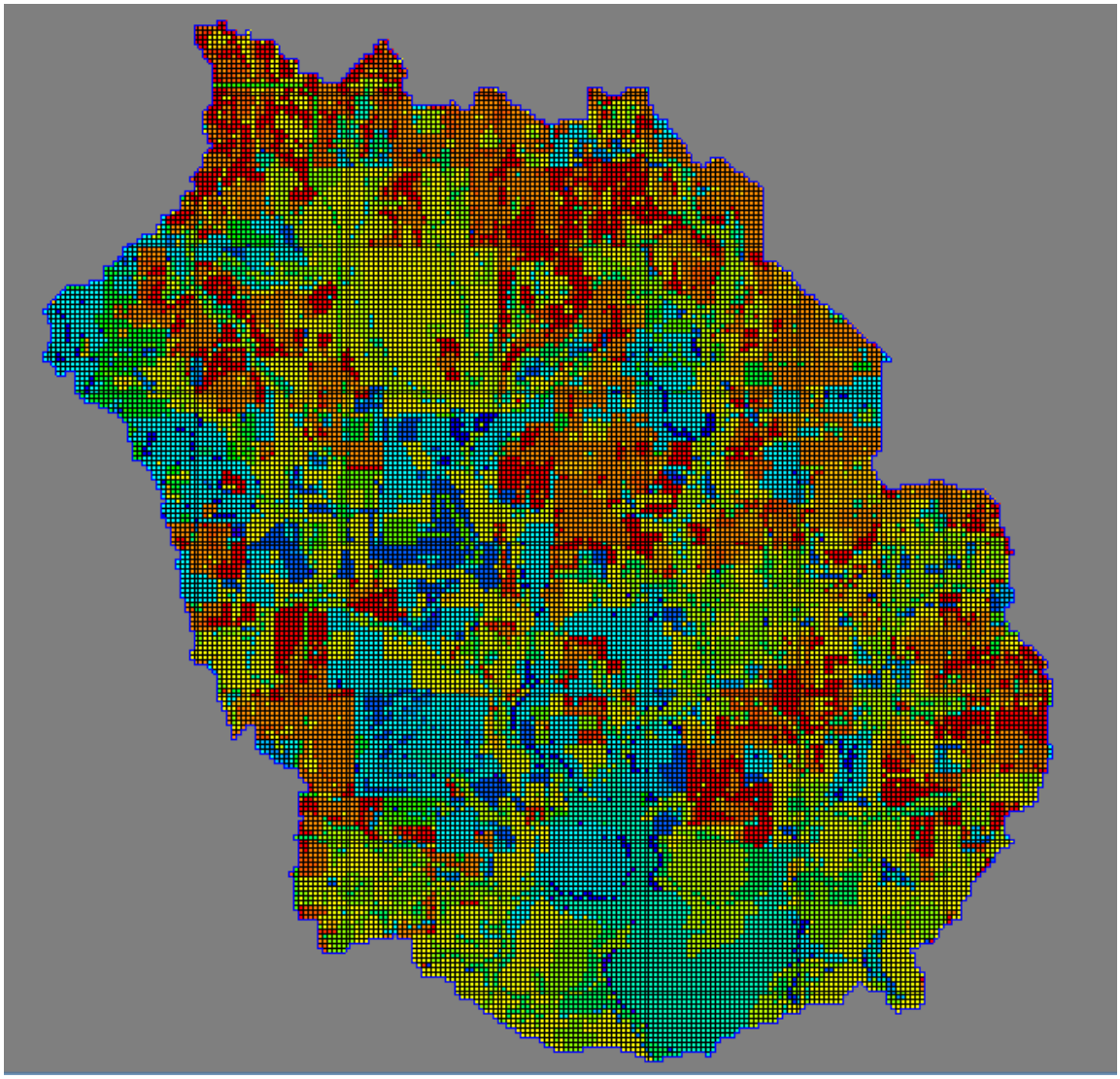


Figure 3-10
Gridded Combined Land Use and Soils Data



4. Calibration

4.1. Calibration (2013)

For a model to be used for forecasting it is best to calibrate to real world storm events. Calibration requires both historic rainfall data and river water surface elevations (stages) or discharges during the rain event. With the rainfall being obtained by RainWave, it was necessary to find or install gauges in the watershed to determine stream stages. A site visit was performed in order to determine the best location for installing the monitoring gauges. The USGS currently has an operating gauge on Doc McDuffie Road over Wolf Creek (USGS 02378170). Available parameters for this site are discharge and gage height. Three Solinst Leveloggers were installed throughout the Wolf Bay Watershed (Figure 4-1). The first gauge was installed on Swift Church Road over Wolf Creek. The second gauge was installed on Sandy Creek located in the property boundary of the Barin Nolf Naval Airfield. The last gauge was installed on CR 20 over Hammock Creek. These locations were chosen in order to maximize the drainage area in which to calibrate, for ease of access, and for limiting the possibility of being tampered with. Due to the very flat topography, these sites experience tidal influence.

The leveloggers were installed on May 28, 2013. After installation, the watershed experienced a large rain event on July 4, 2013. For this storm the maximum average rainfall over a 12-hour period was around 5.7 inches. This occurred between 7:00 p.m. on July 3rd to 7:00 a.m. on July 4th. The maximum rainfall during that time was 6.8 inches which occurred at RainWave gauge point 10. The cumulative rainfall for the July 4th event can be found in Figure 4-2. Figures 4-3, 4-4, 4-5, and 4-6 indicate the differences between the discharges from the field measured data and the modeled GSSHA discharges.

Figure 4-1
USGS Gauge and Levelogger Locations (2013)

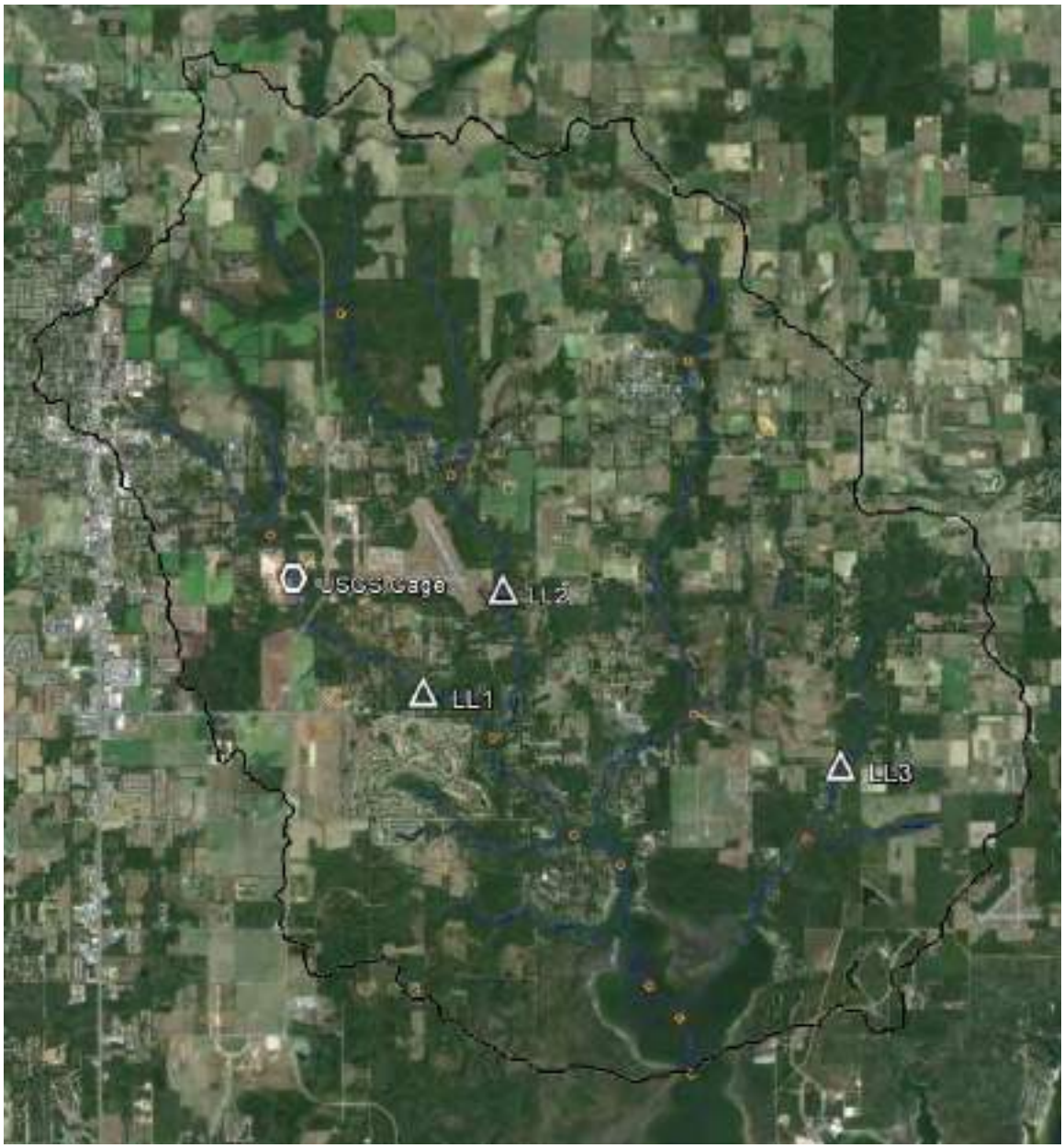


Figure 4-2
July 3-8, 2013 – Total Cumulative Rainfall

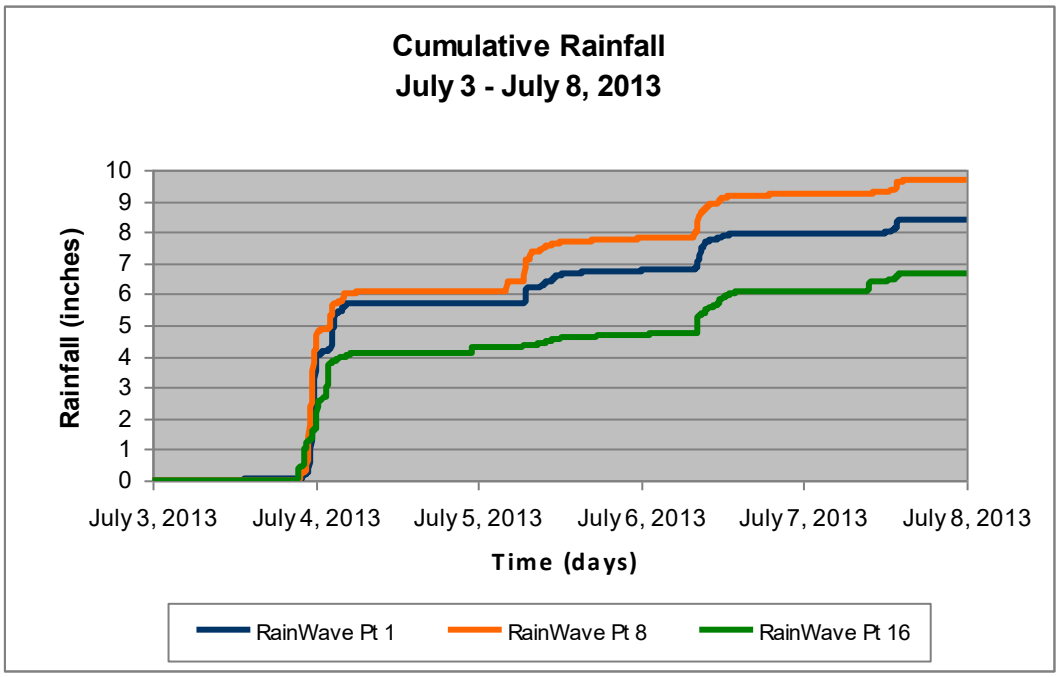


Figure 4-3
Wolf Bay Watershed – Doc McDuffie Road Calibration

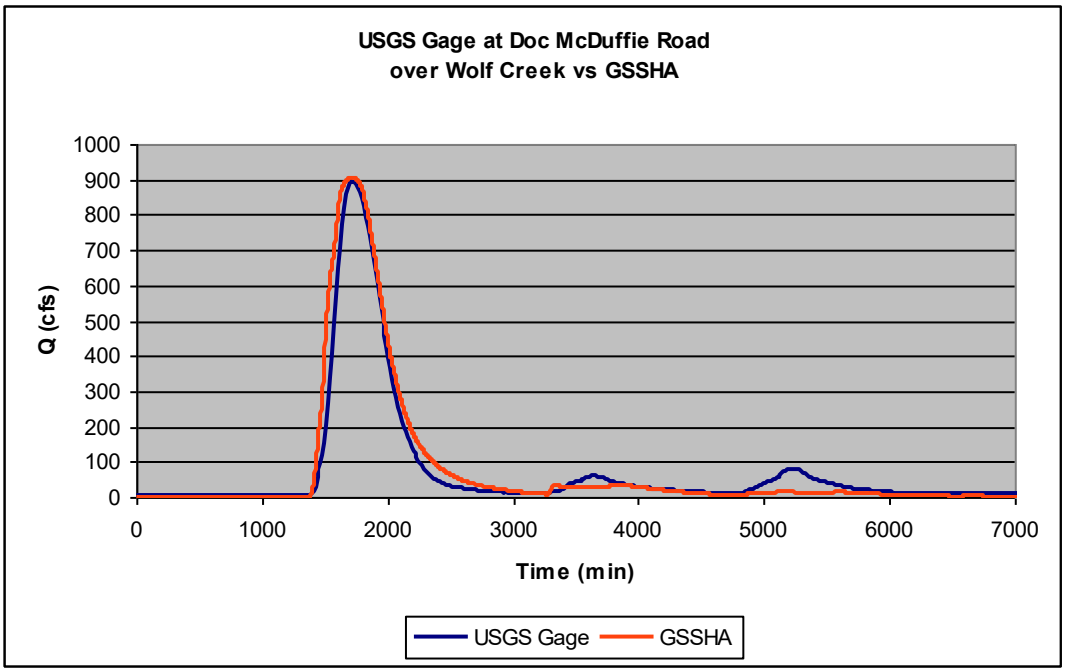


Figure 4-4
Wolf Bay Watershed – Swift Church Road Calibration

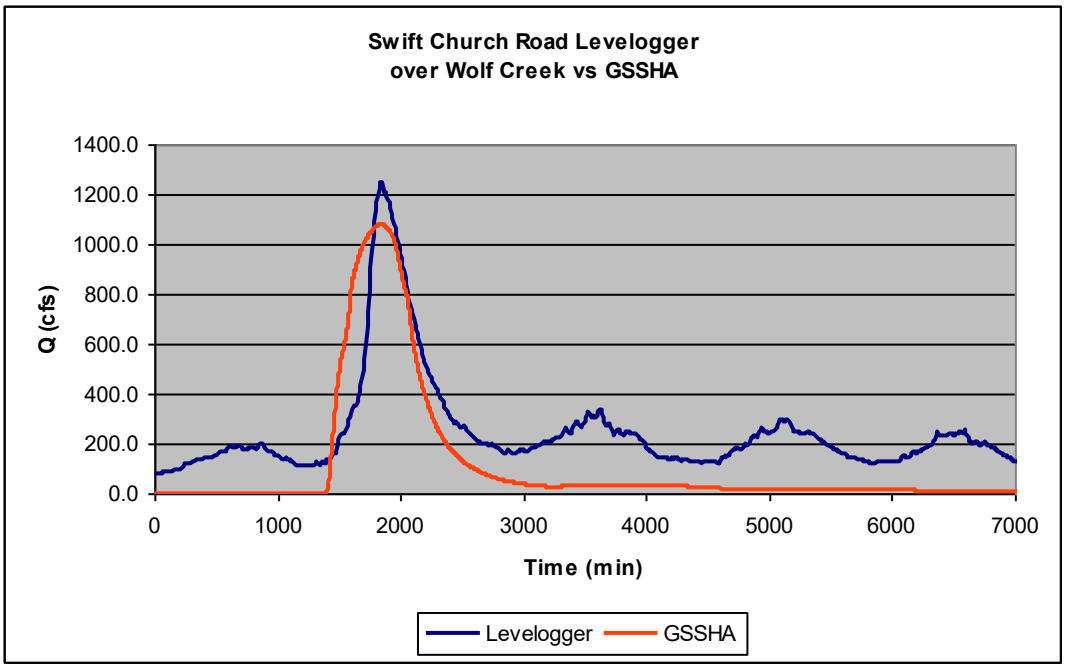


Figure 4-5
Wolf Bay Watershed – Sandy Creek Calibration

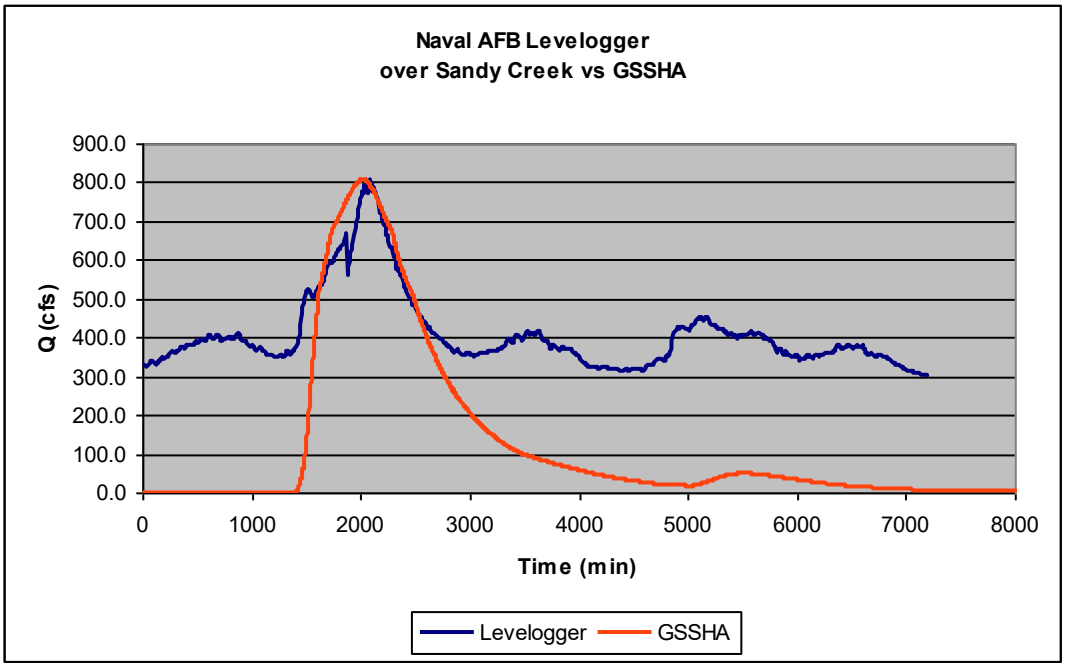
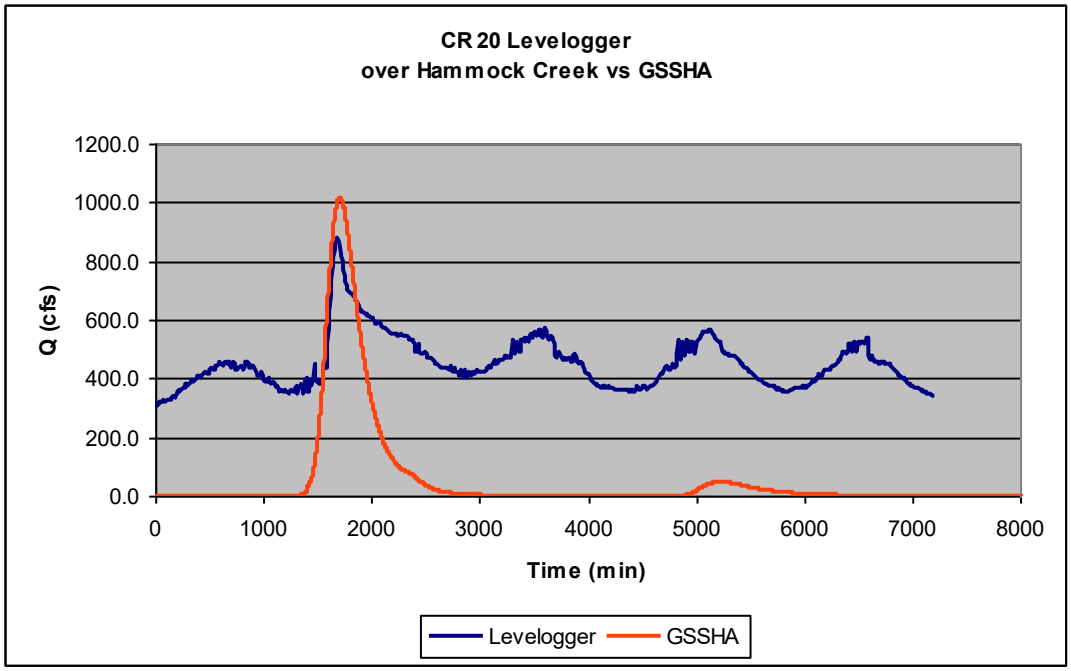


Figure 4-6
Wolf Bay Watershed – Hammock Creek Calibration



4.2. Validation (2019)

For the 2019 analysis, a new stream gauge (MBNEP 23) was installed on Sandy Creek (Figure 4-7). A Telog RU-33 gauge with a level logger sensor was used for measuring stream data. This gauge contains a Recording Telemetry Unit (RTU) which forwards data wirelessly to a host computer which can be accessed through the internet. After a rain event, level data can easily be downloaded from the Telog Enterprise website.

This RU-33 gauge was installed approximately 60' downstream from the centerline of HWY 98. A crest stage gage was also installed approximately 280' downstream of the RU-33 gauge. This simple gage is constructed with PVC pipe, a wooden rod, and some crushed cork. During a flooding event, the cork would rise with the water level and then be deposited on the wooden rod. A measurement of the cork marking can be used to determine maximum stage height during the storm. These cork gauge marks were used in conjunction with the RU-33 highwater readings in order to obtain the water surface slope during the flood event.

The USGS continues to have an operating gage on Doc McDuffie Road over Wolf Creek (USGS 02378170) (Figure 4-7). Available parameters for this USGS gage are discharge and gage height.

Looking at the stage data collected from June 13, 2018 to June 10, 2020 it could be seen that the largest storm event occurred on September 4, 2018 (Figure 4-8). Rainfall from Tropical Storm Gordon produced a total of 5” - 6” of rain throughout the watershed. Figures 4-9 and 4-10 indicate the total rainfall maps for the September 4, 2018 rain event generated by the NWS Advanced Hydrologic Prediction Service and the Birmingham NWS Forecast Office. Figure 4-11 indicates the distribution of rainfall for the storm event. The calibrated model output for the Sandy Creek gauge can be found in Figure 4-12 and for the USGS Wolf Creek gauge in Figure 4-13.

Figure 4-7
USGS Gauge and RU-33 Location (2019)

Figure 4-8
MBNEP 23 Gauge Height Readings – June 2018-June 2020

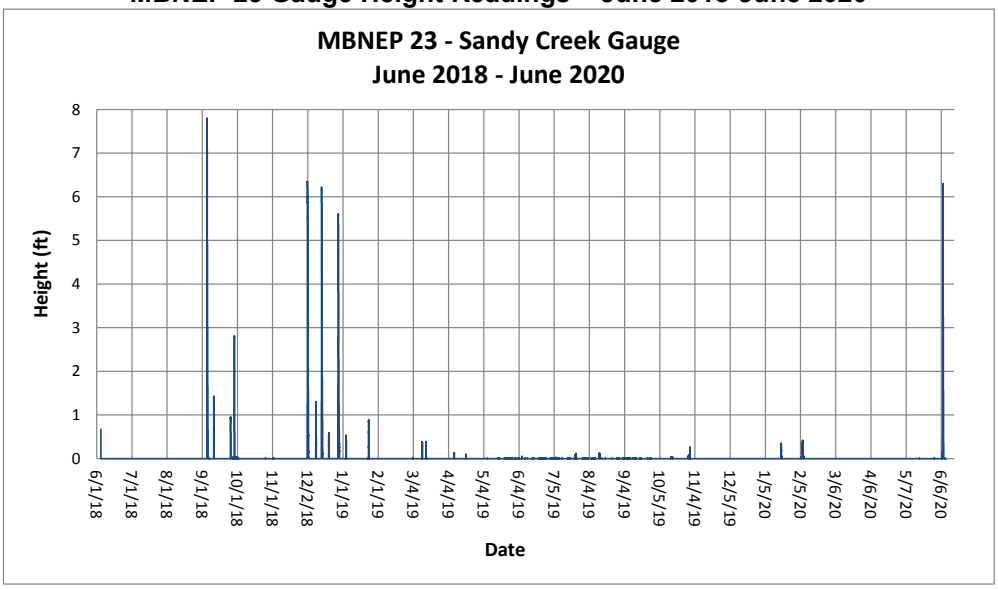
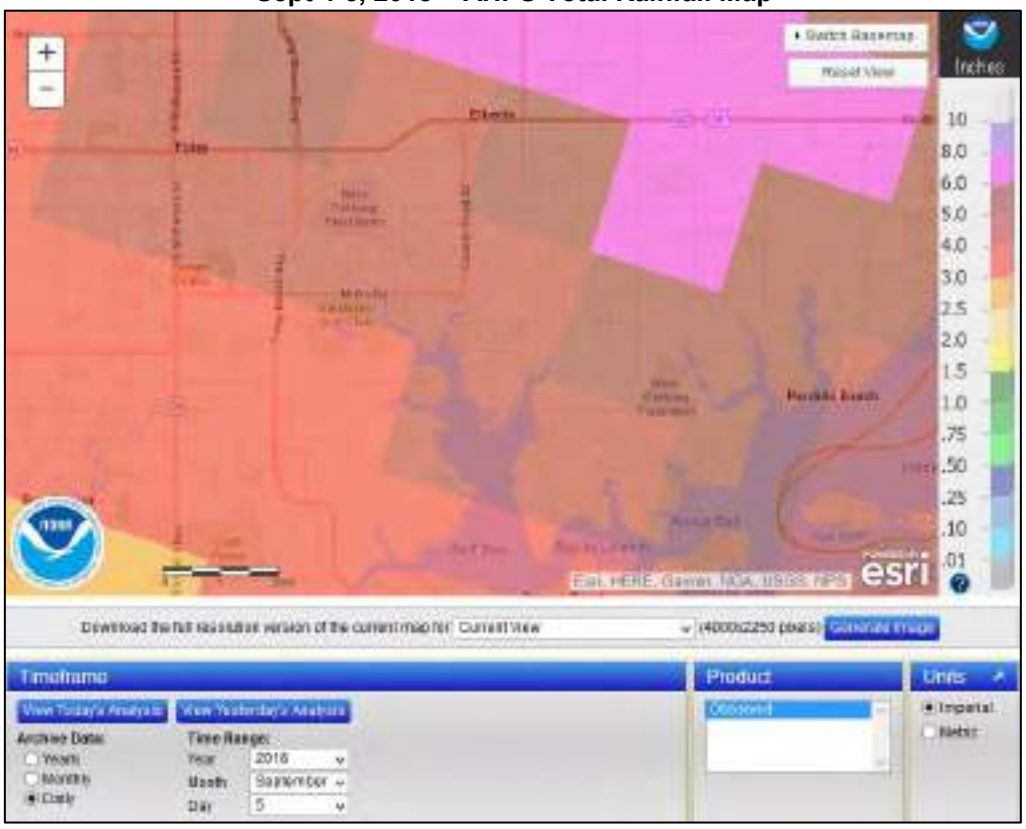
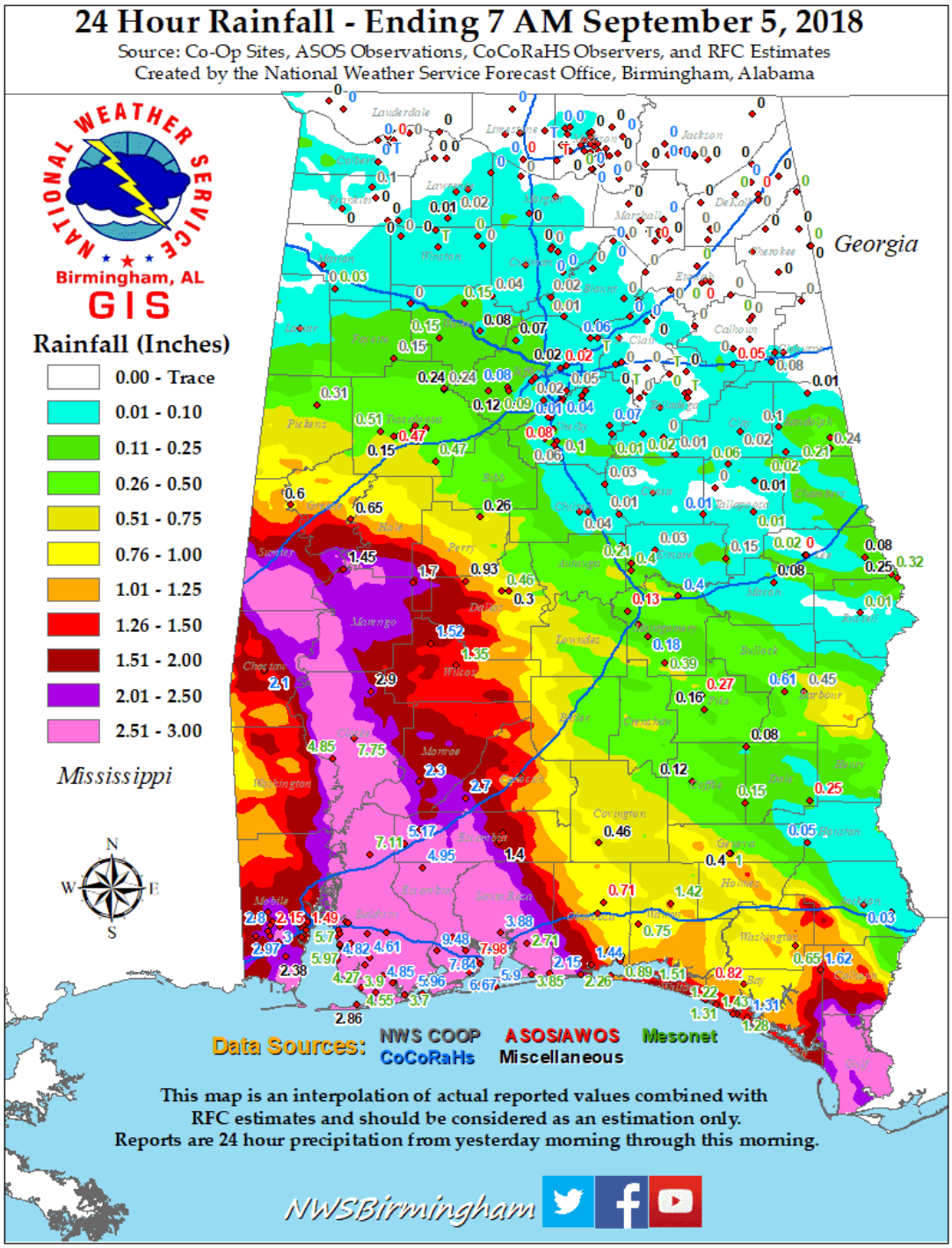


Figure 4-9
Sept 4-5, 2018 – AHPS Total Rainfall Map



Source: https://water.weather.gov/precip/

Figure 4-10
Sept 4-5, 2018 – Total Rainfall Map



Source: https://www.weather.gov/bmx/rainfallplots

Figure 4-11
Sept 4-5, 2018 – Total Rainfall Distribution

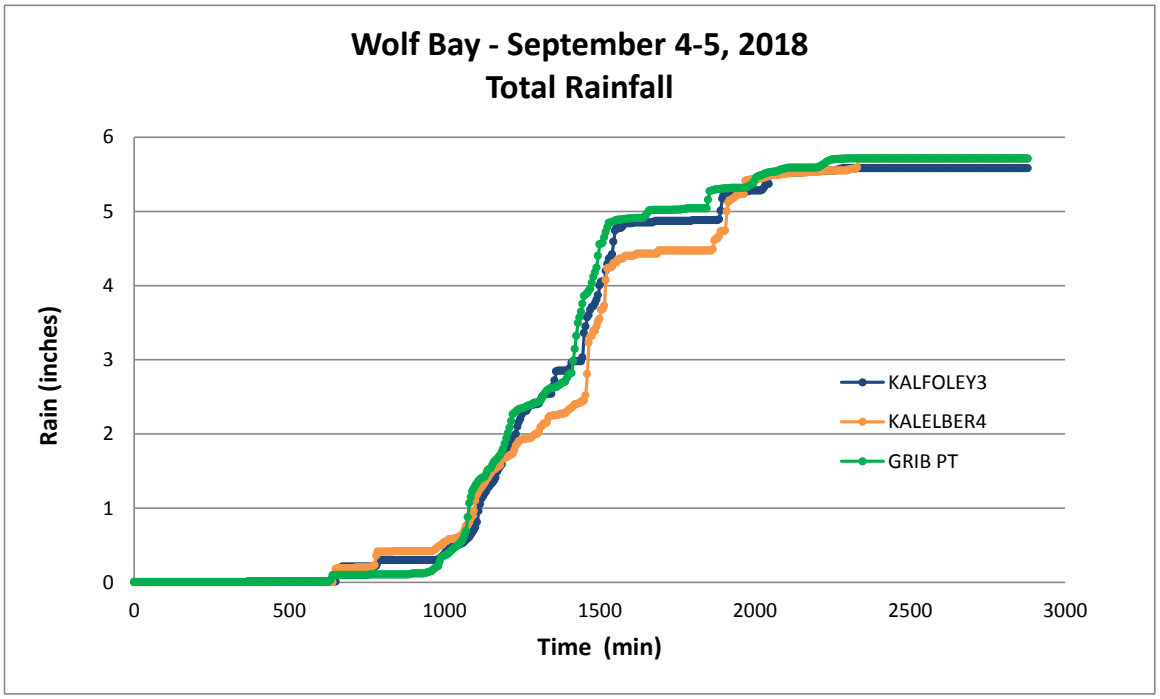


Figure 4-12
Sept 4-5, 2018 – Sandy Creek Calibration

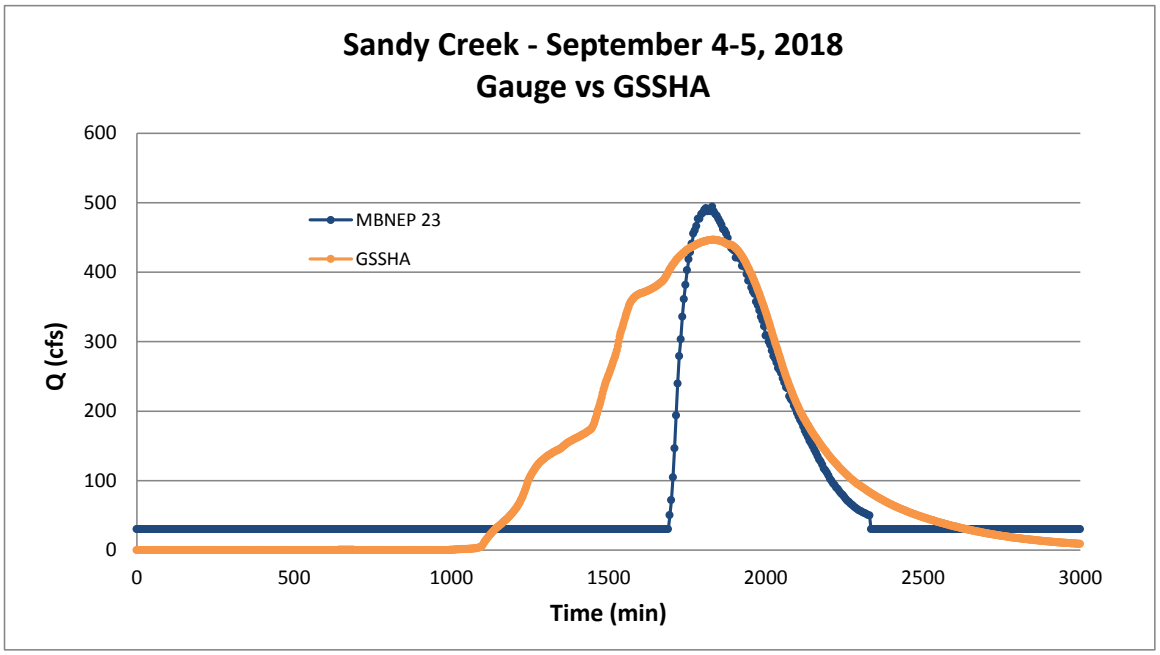
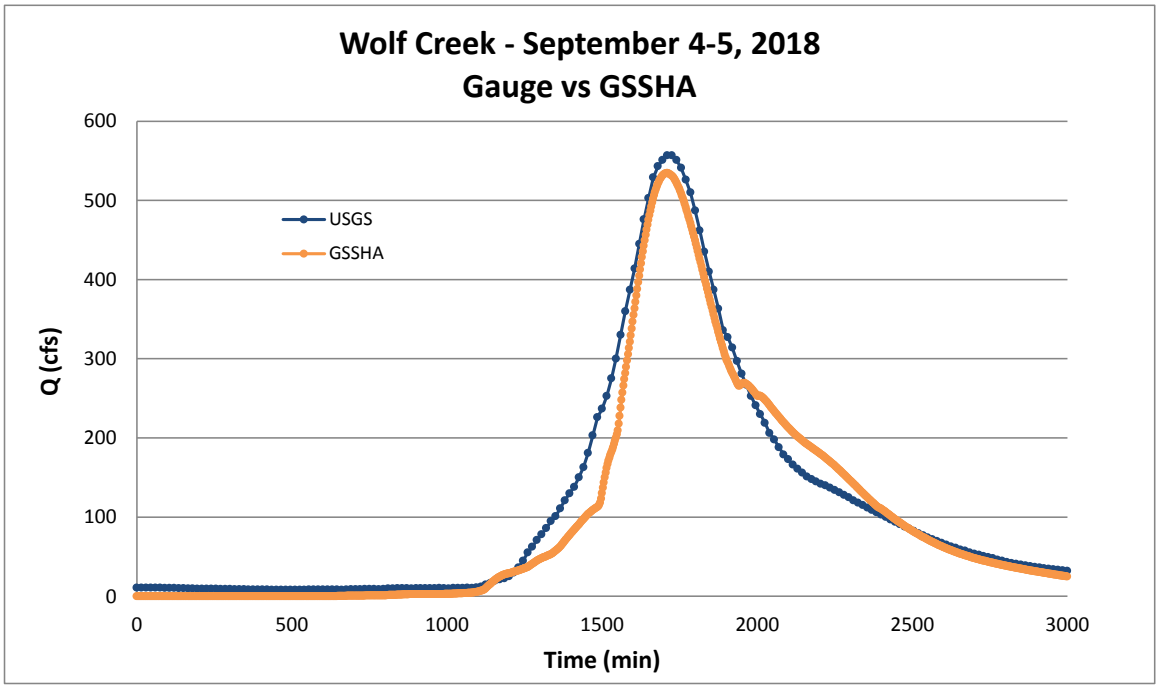


Figure 4-13
Sept 4-5, 2018 – Wolf Creek Calibration



5. Results and Conclusions

5.1. Results and Conclusions

During the evaluation period between the middle of June 2018 and June 2020 the Wolf Bay watershed experienced very few rain storms that produced enough discharge for analyzing. The largest storm occurred on September 4, 2018 when Tropical Storm Gordon generated approximately 5.5" of rain with about 5" occurring in 10 hours. Interpolating from NOAA Atlas 14 for this rainfall depth and time period it was determined that this is equivalent to a 2-year storm. Using the previously calibrated model from 2013, the results translated well to the smaller 2018 storm event.

The model was also run with the updated NOAA atlas precipitation values for a 100 year-event and then compared to the updated 100-year rural regression equations found in the publication, *Anderson, B.T., 2020, Magnitude and frequency of floods in Alabama, 2015: U.S. Geological Survey Scientific Investigations Report 2020-5032, 148p., https://doi.org/10.3133/sir20205032.* It has been determined that the previously calibrated 2013 Wolf Bay watershed model produces discharges in line with the updated regression equations and is still an applicable tool for analyzing stormwater impacts based on future developments.

6. References

1. Anderson, B.T., 2020, Magnitude and frequency of floods in Alabama, 2015: U.S. Geological Survey Scientific Investigations Report 2020-5032, 148p., https://doi.org/10.3133/sir20205032

2. Hedgecock, T.S., and Feaster, T.D., 2007, *Magnitude and frequency of floods in Alabama, 2003*: U.S. Geological Survey Scientific Investigations Report 2007-5204.

3. NOAA Atlas 14 Point Precipitation Frequency Estimates: AL**,** NOAA's National Weather Service, Hydrometeorological Design Studies Center, https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=al_. Accessed September 2017.

4. NWS Advanced Hydrologic Prediction Service: NOAA's National Weather Service, https://water.weather.gov/precip/, Accessed January 2020.

5. NWS Alabama Rainfall Plots: NOAA's National Weather Service, https://www.weather.gov/bmx/rainfallplots, Accessed January 2020.

6. Soil Survey of Baldwin County Alabama. United States Department of Agriculture Soil Conservation Service. Series 1960, No 12. December 1964.

7. Villafana, David. Baldwin County Profile – An Analysis of the Demographics And Other Characteristics that Constitute Baldwin County. Baldwin County Commission – Planning and Zoning Department. May 2008.

APPENDIX C:
Public Involvement Materials

Section I.
Steering Committee Notes

SUMMARY OF

WOLF BAY WATERSHED

STEERING COMMITTEE KICK-OFF MEETING

June 18, 2018

Members in Attendance:

Caryn Woerner
Tony Schachle
Leslie Gahagan
Patric Harper
Katy Hines
Brett Gaar
Paige Felts
Sherry Allison
Phillip Hinesley
Melissa Pringle
Brad Young
Paul Hopper
Casey Fulford
Christian Miller
Shannon McGlynn

Members Absence but Confirmed:

Ralph Hellmich
Skip Gruber

- **Additional Steering Committee Members:**
  - Representative from Forever Wild (Will Underwood)
  - Farmers Co-op? Hope Cassebaum
  - OAW - currently changing management so we will wait for contact
  - Representative from Wolf Bay Plantation Harbor RV Resort in Elberta (includes 60 undeveloped acres)
  - Representative from the Elberta Schools (Leah Tucker) (Leslie to call)

- **WMP Goals/Objectives:**
  - Resilience
  - Conservation
  - Stormwater Management and Green Infrastructure
  - Identification of Restoration Projects/Areas
  - Identification of Pollution Sources
  - Maintain OAW Status
  - Heritage/Culture
  - Public Access
  - Living Shorelines
  - Community Involvement
  - Stream Restoration
  - Identify Additional Water Quality Sampling Points
  - Well Head Protection Program

  Notes and Discussion for Goals/Objectives:
  - Group Conservation/ID Restoration Project Areas/Green Infrastructure (Ranked #2 by Steering Committee)
  - ID Water Quality Monitoring Sites – Where are the best sites located? Where are additional sites needed?
  - Maintain OAW (Outstanding Alabama Water) status – Wolf Creek is not an OAW/ Riviera approximately 2 years out from bring new treatment plant online that discharges to Wolf Creek
  - Resilience: Plan for Sea Level Rising – Flooded Homes from previous storms along Wolf Creek
  - Stormwater Management: - encompasses all aspects of stormwater management (Ranked #1 by Steering Committee)
  - Shoreline Erosion/Stream Restoration: minimal but some streambanks eroding in headwaters; education on Living Shorelines
  - Heritage and Culture: Baldwin County Heritage Museum in Elberta and Train depot in Foley
  - ID Non-point Pollution Sources – phosphorus huge issue in watershed
  - Public Access (Ranked #3 by Steering Committee)
  - Coastal Clean-up: Requires new location with public access – suggested options: Wolf Creek Park Kayak and Canoe Launch area and Graham Creek Nature Preserve
  - Wellhead Protection Requirements

Top Three Priorities:

1. Stormwater Management
2. Conservation/ID Restoration Project Areas/Green Infrastructure
3. Public Access

- **WMP Goals Schedule:**
  - Short-term: less than 5 years
  - Mid-term: 5-10 years
  - Long-term: more than 10 years

- **Community Involvement:**
  - Target Audience Meetings vs. Large Audience Meetings: Consider using the small meetings used to promote the big community meeting
  - What are Good Platforms?
    - PLAN (speaker needed)/ contact Miriam Boutwell, City of Foley
    - City of Foley Planning Commission Meetings
    - Town of Elberta Planning Commission Meetings
    - Baldwin County Commission Meetings
    - Voting Precincts in Run-off Election on July 17 (3 precincts) – provide brochure/handout/Survey Monkey or sheet with link to Survey Monkey to voters
    - Elberta Sausage Festival in October
    - BBQ and Blues in March
    - Hot Air Balloon in May
    - Art in the Park
    - Wolf Bay Watershed Watch Fishing Tournament
    - Farmer's Market
    - Riviera Utilities Bills
    - City of Foley newsletter

- **Specific Target Audience Groups:**
  - Wolf Bay Plantation Harbor RV Resort (retired people) on Miflin Creek
    -Beulah Heights on Wolf Creek
  - Leisure Lakes – neighborhoods around Graham Creek Nature Preserve
  - Agriculture: Co-op board meetings; Farmer's co-op; riparian buffers and funding opportunities; identify 1-2 farmers in area.
  - Baldwin County Contractors/Developers/Realtors – DR Horton (Caryn to call)
  - Dr. Kurtts – voice of all people in town

- **Handouts/Survey Monkey/Brochures:**
  - Draft a Watershed 101 Brochure with Survey Monkey Link
  - Draft a More Developed Brochure about the WMP at the End of the Project
  - Draft Bullet Points to be used at the Small Meetings
  - Places to put brochures:
    - Baldwin County Property Taxes
    - Riviera Utilities Bills
    - City of Foley Newsletter
    - Foley City Hall
    - Foley Public Library
    - Elberta Town Hall
    - Newspaper in Elberta
    - Mobile Bay NEP Website
    - Wolf Bay Watershed Watch Newsletter
    - Elberta Co-op

- **Specific Concerns and Issues**
  - Sandy Creek: Massive erosion; white/cloudy water at times. (Leslie)
  - South of Old Foley Road on County Road 83. Stream restoration needed on east side of road – beavers
  - Elberta Hardware near Highway 98 at Miflin Creek – stream incising
  - Hammock Creek requires additional studies on Highway 95 to County Road 20. NCRS threatened to take funds away; seafood processing
  - Wolf Creek: sediment problem: upstream of Doc McDuffie Road between Riviera Utilities and Doc McDuffie Road
  - Stream Restoration downstream of Poplar
  - County Road 83 and Miflin Creek (Gum Branch): research conditions at this location
  - Wolf Creek at Swift Church Road: sand wasting, tree dredge removal; potential sediment loss from OWA (County Road 20)
  - Lack of Public Access

- **Other Issues:**
  - County Road 20 below Baldwin County Sewer lift station
  - Nutrient Issues
  - Sediment problems on Sandy Creek from flood of 2014 (silting in)
  - Two proposed bridges could change character of Elberta and County Road 20

- **Land Acquisition for Conservation or Conservation Easements:**
  - Forever Wild - 480 acres / could be used for public access and boat launch and parking for vehicles/trailers over
  - 40 acres next to Graham Creek Nature Preserve (Downing Trust)
  - 6 acres off County Road 20 unusable (40 feet off roadway and remainder wetlands)
  - Barber property
  - Tom Slinker property
  - Wolf Creek Park 5 acres south – close off loop – bird nesting area
  - Baldwin County Construction Property
  - Consulting with Foley Family near Headwaters
  - Woerner property

- **Signage** :
  - You are in the Wolf Bay Watershed
  - Inventory What Signs Already in Stock (Christian working with Leslie on this)
  - MBNEP may have funding for 10 signs
  - Cannot place on state highways
  - Christian to send watershed template to Melissa
  - Locations:
    - County Road 20
    - County Road 83

- **Short-term Goals:**
  - Trash and Litter – Litter Getter?
    - Wolf Creek: north of 98
    - 98 to Foley near Fernwood

- **Best Management Practices**
    - Conservation/Acquisition Easements
    - Signage
    - Streambank Restoration
    - NRCS Streambank funding
    - Fish and Wildlife (Patric) Riparian work through Partners for Fish and Wildlife Program
    - Coordination of Stormwater and Development Regulation (Foley, Elberta, Baldwin County)
    - Living Shorelines instead of Bulkheads
    - Regional Detention

- **Steering Committee and Future Meetings**
    - Steering Committee to meet Quarterly
    - Send out Steering Committee List
    - Next Steering Committee Meeting in August
    - Large Community Meeting in September

- **Action Items:**
    - A simple handout with bullet points that can be used at the smaller meeting venues
    - A Wolf Bay Watershed 101 factsheet that can be distributed far and wide
    - Secure dates, times and locations for small meetings and identify a person to attend and present at those meetings
    - We need to establish a date in August for our next quarterly meeting and a date in September for our community watershed meeting
    - Literature review for the watershed for Watershed Characterization
    - GIS mapping of land use for Watershed Characterization

Wolf Bay Watershed
Steering Committee Meeting
September 17, 2019
Graham Creek Nature Preserve
11:30 AM

Caryn Woerner
Tony Schachle
Leslie Gahagan
Patric Harper
Brett Gaar
Homer Singleton
Paige Felts
Phillip Hinesley
Brad Young
Casey Fulford
Christian Miller

Community Involvement
First community meeting held in October 2018 had low turnout (16 attendees). Steering committee members were asked for ideas to better engage the community.
Ideas mentioned included:
-Elberta Sausage Festival booth in October
-Wolf Bay Watershed Watch Fishing Tournament booth in October
- Foley Farmer's Market
- Local churches
- Baldwin Heritage Museum
- Facebook

Watershed Characterization:
The watershed characterization section of the plan was submitted to the NEP in May 2019. Comments have been received on that chapter and they are being addressed.

Climate Vulnerability Analysis:
The climate vulnerability analysis section of the plan was submitted to NEP in June 2019 for their review and comment. Several models were used to analyze vulnerability within the watershed but the Coastal Resiliency Index (CRI) was discussed at the meeting. The CRI takes into account seven categories of resiliency and rates municipalities vulnerabilities based on these categories.

The City of Foley scored high in all seven categories thanks to a strong planning background with qualified and certified staff. The Town of Elberta scored medium to high with the only difference being the lack of certified staff. Baldwin County also scored high on the index due to the presence of Certified Planners and Flood Plain Managers on staff.

Watershed Conditions:
The watershed conditions section was submitted to NEP in August 2019 for their review and comment.
- There are no 303d listed streams in the watershed
- There are five General NPDES permitted sites in the watershed for municipal, industrial, or commercial facilities.
    -USA Concrete

-Mobile Asphalt
-Ascend
-City of Foley
-Vulcan

- Riviera Utilities holds an individual permit for the sewage treatment plant. The plant is currently in the process of upgrading its system and it is anticipated that the upgrades will be completed in the Spring of 2020.
- Currently there are no MS4s in the watershed; however, the City of Foley is anticipating becoming a Phase II MS4 after the 2020 census.
- Non-point source pollutants in the watershed include agriculture, forestry, and impervious cover.

Groundtruthing of Stream Conditions

- Miflin Creek – Explored east and west branches of Miflin Creek until impassable by boat. Stream had numerous logs and overhanging trees across channel which made boat passage very difficult. Water was clear and deep and more fish species were observed within Miflin than any of the other streams. Minimal bank stabilization issues and very few invasive species documented until reaching confluence of two channels within residential area and utility crossing.

- Hammock Creek – Boat access is impossible north of the CR 20 bridge due to the amount of fallen logs and natural debris within the stream. Bank is extremely unstable for the entire reach north of the bridge with bank subsidence and trees falling into channel. Obstructions in channel leading to overland flow throughout reach. Large privet thickets and large amounts of Japanese climbing fern observed. Cogon grass observed at bridge crossing. South of bridge channel appears to have been dredged for boating. Minimal bank issues observed and typically due to construction activities not incorporating BMPs.

- Sandy Creek – Minimal debris in channel and appeared to have been maintained for boating access. Minimal amounts of tallow trees observed along the bank and no cogon grass. Many cedar trees leaning over channel which will likely create access problem and bank subsidence in the future. Some bank instability noted, primarily along residences due to a lack of shoreline management. Sandy was the only creek with outfalls from the residences. Some were stormwater runoff outlets and some appeared to be artesian outflows.

- Wolf Creek – Some litter observed at log jam in channel but otherwise very minimal amounts. Some alligator weed and hydrocotyle observed that could become problematic in the future. Evidence of bank instability at various points and stream depth was generally very shallow throughout reach. One residence upstream had significant erosion cutting into backyard and subsequent sandbars just downstream, creating scenario for potential flooding or overland flow.

- Unnamed Tributary (UT) to Sandy Creek – In reviewing Marlon Cook's study of the watershed, two UTs of Sandy Creek exhibited large total sediment loads. Landuse in this area is predominately forested and agriculture with some single family residential. After reviewing historical aerials of the area, it appears there is a headcut on the western UT that potentially is contributing to the sediment load. Also, there was a pond historically located upstream from the sampling point at US 98 on eastern UT. The pond has been drained and the aerials show slope riling and unstable stream banks in the pond location.

Critical Concerns and Issues
- Development
- Public recreation
- Tree falls in navigable streams
- Litter in Wolf Creek
- Invasive species
- Bank erosion along section of Wolf Creek between the Foley Beach Express and Swift Church Road
- Livestock in Hammock Creek

BMPs
- Regional detention
- Litter trap in Wolf Creek
- Local regulations
- Equipment management (mowers, bush hogs)

Wolf Bay Watershed
Steering Committee Meeting
February 11, 2020
Graham Creek Nature Preserve
11:00 AM

Caryn Woerner
Tony Schachle
Leslie Gahagan
Patric Harper
Brett Gaar
Homer Singleton
Jackie McGonigal
Paige Felts
Phillip Hinesley
Brad Young
Casey Fulford
Christian Miller
Ralph Hellmich

The purpose of the meeting was to discuss potential management measures and projects in each of the three sub-watersheds that will be included in the watershed management plan. In all three sub-watersheds, agricultural buffers were recommended in the headwaters. Also, educational outreach to HOAs, contractors, elected officials, etc. was recommended.

Wolf Creek /Sandy Creek

Potential restoration/stabilization/ enhancement projects:

- Unnamed tributary to Wolf Creek adjacent to Pride Drive and OWA – Tributary has been filled in with sediment and is dominated by invasive species. Tree canopy is dying. Need to implement a habitat restoration plan that includes a stream restoration component.

- Detention pond east of Pride Drive/ north of wetlands associated with unnamed tributary – retrofit existing pond and look for areas to add filter strips to treat runoff from adjacent soccer fields and developed areas.

- Wolf Creek bank stabilization at residence located off of Hilltop Drive – Project includes the stabilization of approximately 500 linear feet of stream bank that is severely eroding along Wolf Creek.

- Sandy Creek Farms - Stream restoration/stabilization where pond dam broke.

- Bird Farm property - Stream restoration/stabilization on unnamed tributary to Sandy Creek.

- Analyze Wolf Creek between Doc McDuffie Road and South Pecan Street and the unnamed tributary between Doc McDuffie Road and Highway 98 for source of sediment deposited at bridge over Wolf Creek at Doc McDuffie Road.

- Invasive species management along ROWs

Potential conservation acquisitions:

Parcel ID	Acreage
54-06-23-0-000-001.000	432
54-06-14-0-000-004.000	453
54-06-13-0-000-006.000	122
54-06-23-0-000-001.001	147
54-06-24-0-000-002.000	328
54-07-25-0-000-003.000	152
54-07-26-0-000-002.000	102
54-07-26-0-000-002.018	59
54-05-15-0-000-006.002	25
61-01-12-0-000-009.011	2.9

Potential litter trap locations:

- Wolf Creek at Pecan Street
- Wolf Creek at Highway 98
- Wolf Creek at Poplar Street

Potential recreational boat launch location:

Parcel ID 61-01-12-0-000-022.000 – east bank of Wolf Creek south of County Road 20 (Miflin Road) bridge

Miflin Creek

Potential restoration/stabilization/ enhancement projects:

- Invasive species management along ROWs

- Fencing to keep livestock out of creek in the head waters

Potential conservation acquisitions:

Parcel ID	Acreage
62-03-05-0-001-008.000	67
62-02-04-0-001-003.000	130
62-02-04-0-001-003.001	30
62-03-05-0-001-001.000	80
62-03-05-0-001-002.000	168
62-03-05-0-001-002-002	13
62-03-05-0-001-002.005	7.40
62-03-05-0-001-012.002	20

Dirt road to be paved:

- Woerner Road

Graham Bayou

Potential restoration/stabilization/ enhancement projects:

- Hammock Creek north of County Road 20 – Stream restoration/ bank stabilization
- Invasive species management along stream bank and ROWs
- Fencing to keep livestock out of headwaters in creeks

Potential conservation acquisitions:

Parcel ID	Acreage
62-09-29-0-000-002.000	53
61-06-13-0-000-003.000	125
62-04-18-0-001-005.007	2.25
61-06-24-0-000-003.000	240
61-06-24-0-000-001.000	330
62-04-19-0-000-001.000	410
62-09-30-0-000-001.000	622

Potential recreational access:

- Forever Wild Tract – kayak launch and trails
- Back Bay Blueway – signage and platforms

Dirt roads to be paved:

- Russian Road
- Roscoe Road

Monitoring Locations:

Current monitoring locations:

- Wolf Creek at North Poplar Street – City of Foley

- Wolf Creek at Doc McDuffie – City of Foley
- Miflin Creek at County Road 20 – City of Foley
- Hammock Creek at County Road 20 – City of Foley
- Wolf Creek at Wolf Creek Kayak Launch – South Baldwin Christian Academy

Recommended additional monitoring sites:

- Unnamed tributaries to Sandy Creek at Highway 98 – sediment concerns
- Hammock Creek at County Road 95 – bacteria and DO concerns
- Elberta Creek at County Road 83 – bacteria concerns
- Miflin Creek at Highway 98
- Wolf Bay
- Owen's Creek at County Road 12
- Graham Creek

Section II.
Fact Sheets, Initial Survey Initial Survey Results

Watershed Planning
Wolf Bay Watershed

What is a Watershed?

A watershed is an area of land where the water within it to a common point such as a lake, stream, river, bay, or estuary. A properly functioning watershed provides water quality, wildlife habitat, and protects homes and businesses from We all live in a watershed, and we all play a role in protecting our watershed.

What is a Healthy Watershed?

A healthy watershed is one in which natural land cover supports:

- The natural processes of hydrology across the landscape,
- Habitat that supports native wildlife both on the land and in the water, and
- Water quality conditions that support healthy biological communities.

atershed

Healthy watersheds provide many important functions including:

- Nutrient cycling,
- Carbon storage,
- Erosion/sedimentation control,
- Biological diversity,
- Soil formation,
- Wildlife movement corridors,
- Water storage,
- W
- Flood control,
- Food,
- Timber,
- Recreation,
- Reduced vulnerability to invasive species, and
-

Tips to Improve Your Watershed

When we each do our part on a small scale, we can have a major impact on our watershed. The EPA tips on how you can help keep your watershed clean and healthy.

- Conserve water every day. T
- Don't pour toxic household chemicals down the drain; take them to a hazardous waste center.
- Use hardy plants that require little or no watering, fertilizers or pesticides in your yard.
- Recycle yard waste in a compost pile & use a mulching mower.
-
- Never pour used oil or antifreeze into the storm drain or the street.
- Pick up after your pet, and dispose of the waste in the toilet or the trash.
- Drive less - walk or bike; many pollutants in our waters come from car exhaust and car leaks.

Watershed Planning
Wolf Bay Watershed

What Can You Do to Help?

Please complete the survey at
https://www.surveymonkey.com/r/WolfBay

Wolf Bay Facts and Figures:

- Wolf Bay is located on the Gulf of Mexico in Baldwin County, Alabama nestled between Perdido Bay to the east and Mobile Bay to the West.
- Wolf Bay is an estuary where freshwater and saltwater mix to create a diverse environment that fosters a rich array of plant and animal life.
- The Wolf Bay watershed covers about 44,700 acres, which is approximately 23% forest, 27% urban/suburban, 27% agricultural, 16% wetlands and 7% other uses.
- Streams that into Wolf Bay include Wolf Creek, Sandy Creek, Creek, Graham Creek, Owens Bayou, Moccasin Bayou, and Hammock Creek. Wolf Bay, in turn, into the Intracoastal Waterway, which into either Perdidio Bay or Mobile Bay, depending on the moon, wind, and tide, and ultimately into the Gulf of Mexico.
- Wolf Bay and its watershed hosts a tremendous diversity of habitats including bald eagles, Florida manatees, sea turtles, Gulf sturgeons, red-cockaded woodpeckers, American alligators, Alabama red-bellied turtles and Eastern indigo snakes.
- The watershed is undergoing dramatic changes as forested and agricultural lands are converted into residential and commercial developments.
- The Wolf Bay Watershed Watch (WBWW) formed in 1998 and tests water quality.
- WBWW volunteer monitors have taken approximately 2,500 water quality samples at 44 sites.

Steps in the Watershed Planning Process	
Step 1:	Build partnerships
Step 2:	Characterize your watershed
Step 3:	Finalize goals and identify solutions
Step 4:	Design an implementation program
Step 5:	Implement the watershed plan
Step 6:	Measure progress and make adjustments

Sources:
Mobile Bay National Estuary Program
www.mobilebaynep.com/the_watersheds/wolf_bay_watershed/

Environmental Protection Agency
https://www.epa.gov/hwp

The Nature Conservancy
https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/indiana/journeywithnature/watersheds-101.xml

1. Wolf Bay Watershed

The Wolf Bay watershed covers approximately 44,700 acres on the Gulf of Mexico in Baldwin County, Alabama. It is located between Perdido and Mobile Bays. Wolf Bay is an estuary where fresh and saltwater mix, thus sustaining a diverse ecosystem of plant and animal life. Your responses to this survey regarding the Wolf Bay watershed will help us improve water quality and plan for new investments for the future!

1. Do you live in the Wolf Bay Watershed?

- [ ] Yes
- [ ] No

2. How long have you lived in the watershed?

- ( ) More than 10 years
- ( ) 6-10 years
- ( ) One to five years
- ( ) Do not live in the watershed

3. In your opinion, what is the overall condition of the watershed?

- ( ) Excellent
- ( ) Good
- ( ) Fair
- ( ) Poor

4. Please indicate any areas that you believe to have cultural, historic, or environmental significance in the watershed.

5. Prioritize the importance of the following watershed issues in the Wolf Bay Watershed in order from 1 to 8 (1 being the most important, 8 being the least important)

- Litter
- Stormwater management/Flooding
- Erosion/ Sediment control
- Water quality (i.e. nutrients, bacteria/pathogens)
- Growth management
- Invasive plant species
- Public access
- Habitat protection

6. Do you or your family use the watershed for any of the following recreational purposes? Select as many answers as apply.

- ☐ Fishing
- ☐ Swimming
- ☐ Walking/ Hiking
- ☐ Wildlife watching
- ☐ Canoeing/ Kayaking
- ☐ We do not use the watershed for recreational purposes
- ☐ Other (please specify)

7. In your opinion, do recreational opportunities in the watershed need improvement?

- ○ Yes
- ○ No

8. If your answer is yes, please select all of the activities that you would like to see offered in the watershed.

- [ ] Walking/Hiking
- [ ] Canoeing/ Kayaking
- [ ] Swimming
- [ ] Wildlife watching
- [ ] Other (please specify)

9. What improvements are needed in order to support the activities identified in Question 8?

- [ ] Motorized boat launches
- [ ] Canoe/kayak put-ins
- [ ] Hiking/biking trails
- [ ] Swimming access and/or beaches
- [ ] Other (please specify)
- [ ] Wildlife blinds
- [ ] Camping areas
- [ ] Signage
- [ ] Parking

10. Would you use a public recreation access point if one was provided?

- ( ) Yes
- ( ) No

11. Do you use the watershed for any of the following commercial, industrial or agricultural purposes?

- [ ] Chartering
- [ ] Shrimping
- [ ] Recreational fishing
- [ ] Farming
- [ ] Permitted industrial activity
- [ ] Other (please specify)

12. Prioritize Management Actions you would like to see implemented in the watersheds in order from 1 to 9 (1 being the most important, 9 being the least important).

- Litter traps
- Land preservation through purchase or easements
- Regional detention basins for flood control
- Living shorelines
- Stream buffers
- Stream restoration
- Invasive species control
- Nutrient reduction
- Public access

13. Which of the following funding options would you support to improve conditions in the Wolf Bay Watershed?

- [ ] Municipal bonds
- [ ] Permit or user fees
- [ ] New revenues
- [ ] Unsure
- [ ] I would not support any funding option to improve conditions in the watershed

14. Which of the following activities would you participate in to help improve the quality of the Wolf Bay watershed?

- [ ] Volunteer water monitor (collecting samples and evaluating physical, chemical and biological features of water)
- [ ] Participating in a local watershed group. (Assisting a grassroots organization whose mission is to protect and preserve resources in a watershed)
- [ ] Watershed clean up day volunteer
- [ ] Serving on a committee to oversee implementation of the watershed management plan
- [ ] Other (please specify)

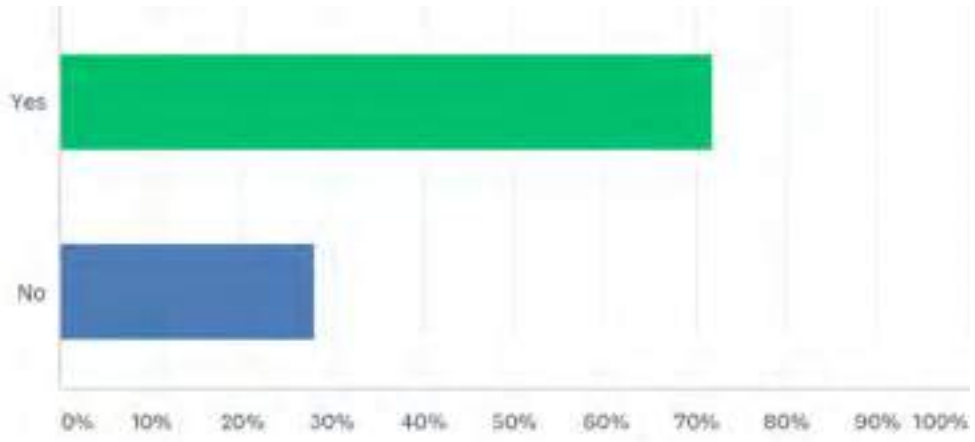
15. Would you attend watershed educational workshops if they were provided?

- ◯ Yes
- ◯ No

16. If you would like to be informed of the project milestones and meetings,please provide your name, e-mail, or mailing address below.

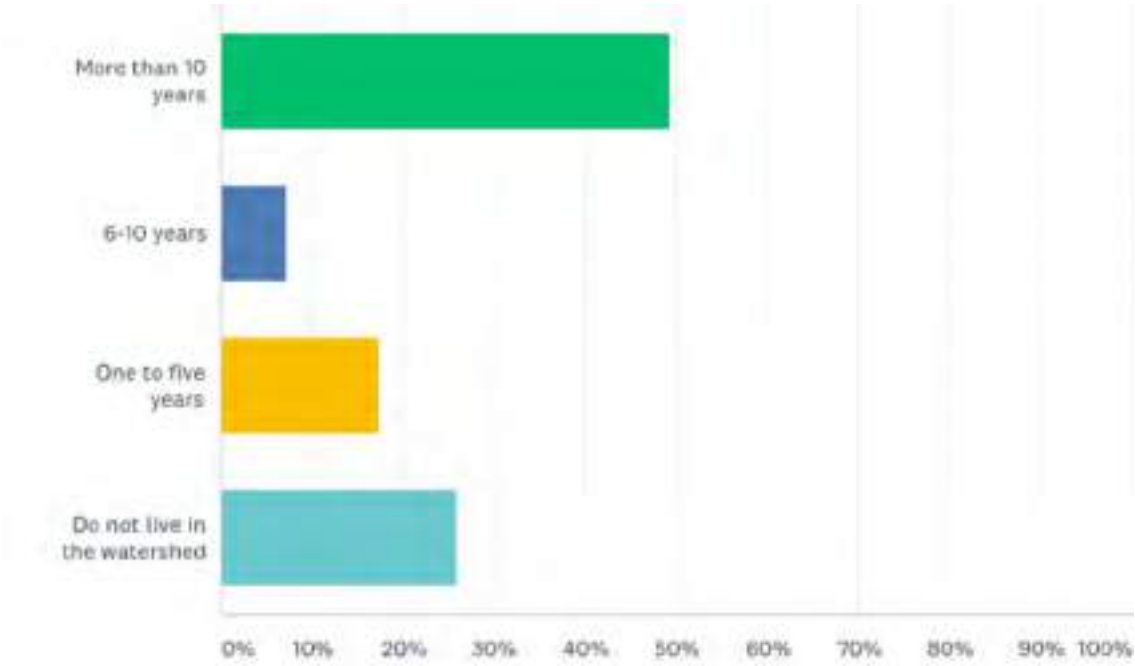
Name	
Company	
Address	
Address 2	
City/Town	
State/Province	
ZIP/Postal Code	
Country	
Email Address	
Phone Number	

Q1: Do you live in the Wolf Bay Watershed?



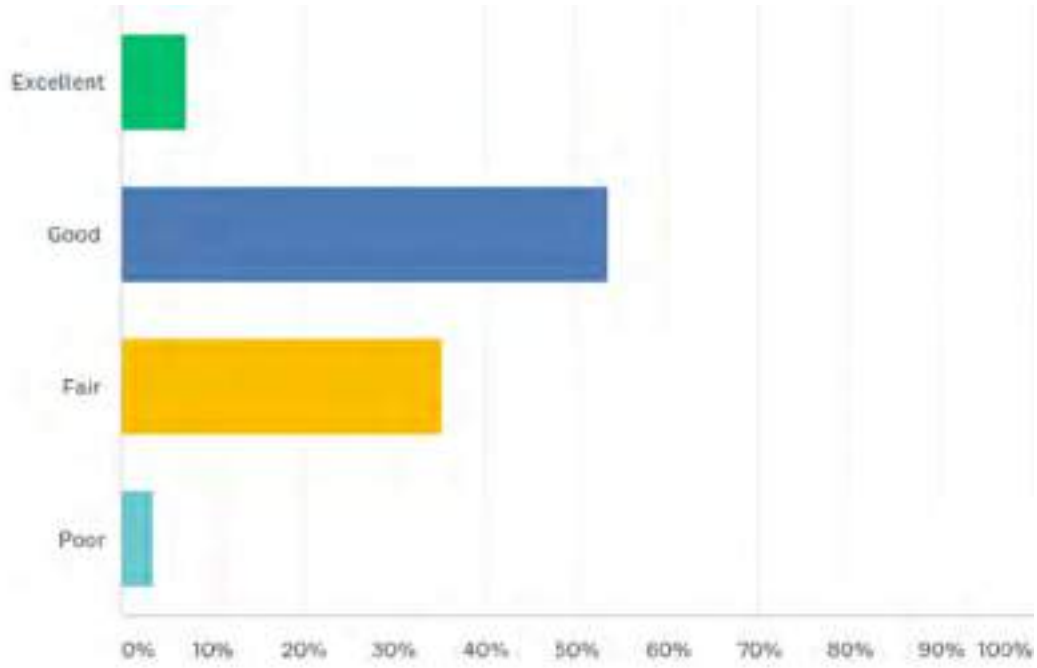
ANSWER CHOICES	RESPONSES	
Yes	71.95%	59
No	28.05%	23
Total Respondents: 82		

Q2: How long have you lived in the watershed?



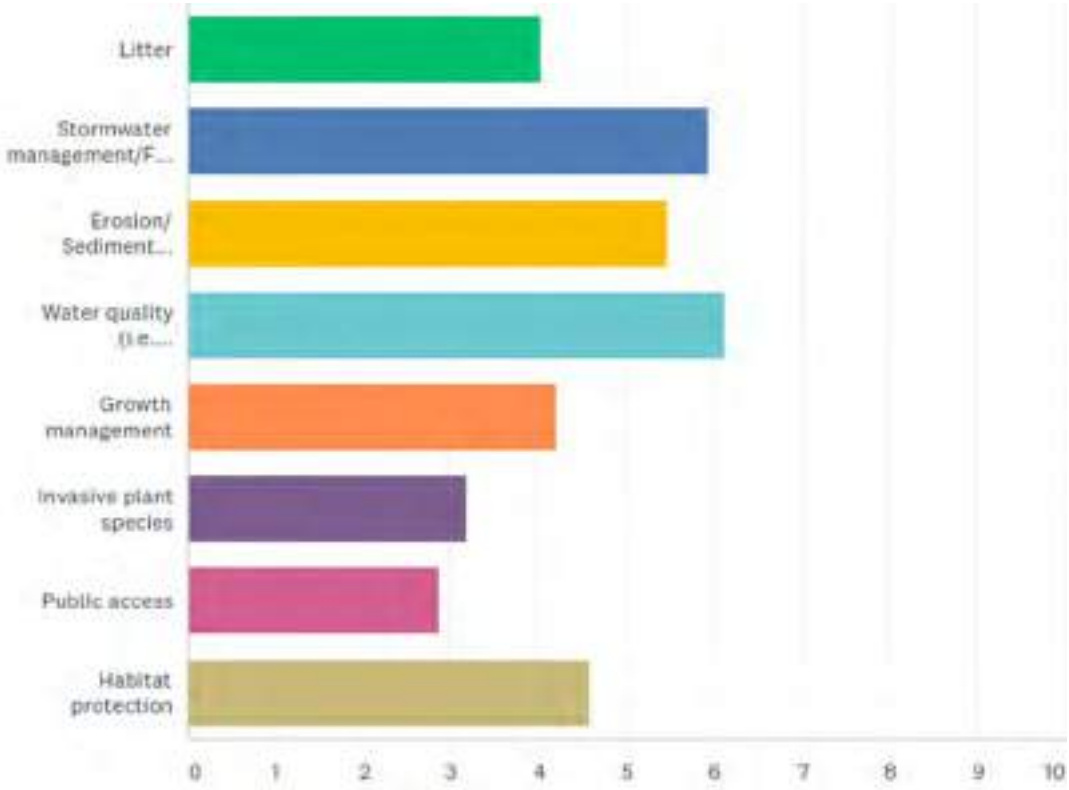
ANSWER CHOICES	RESPONSES	
More than 10 years	49.38%	40
6-10 years	7.41%	6
One to five years	17.28%	14
Do not live in the watershed	25.93%	21
TOTAL		81

Q3: In your opinion, what is the overall condition of the watershed?



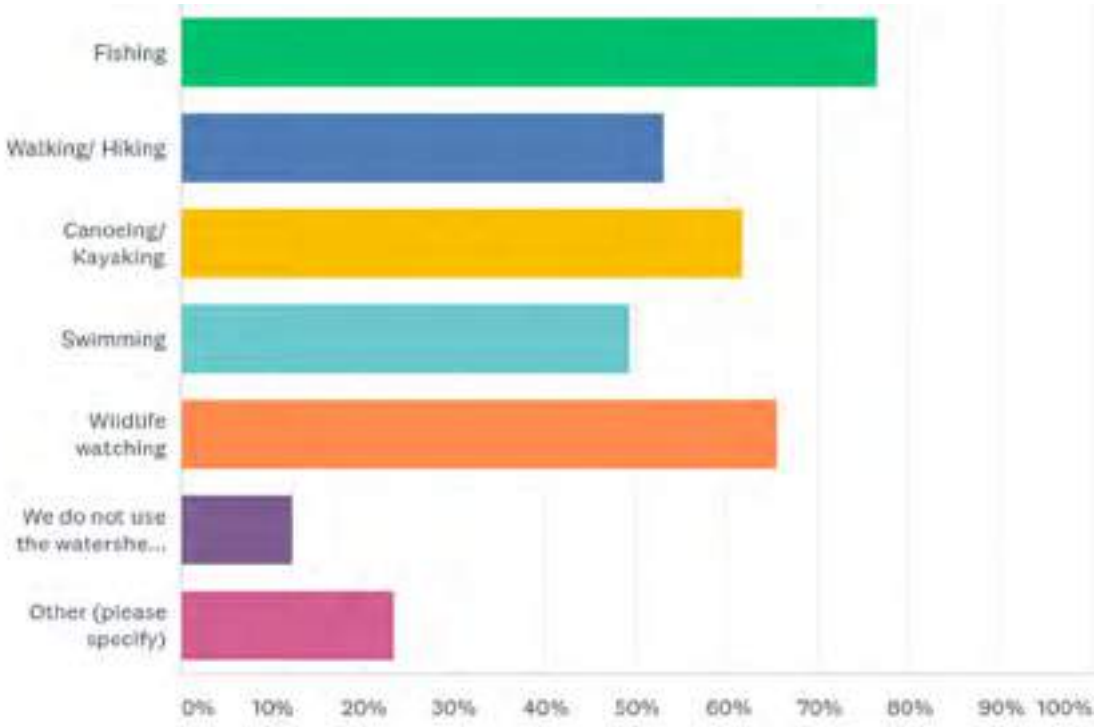
ANSWER CHOICES	RESPONSES	
Excellent	7.32%	6
Good	53.66%	44
Fair	35.37%	29
Poor	3.66%	3
TOTAL		82

Q5: Prioritize the importance of the following watershed issues in the Wolf Bay Watershed in order from 1 to 8 (1 being the most important, 8 being the least important)



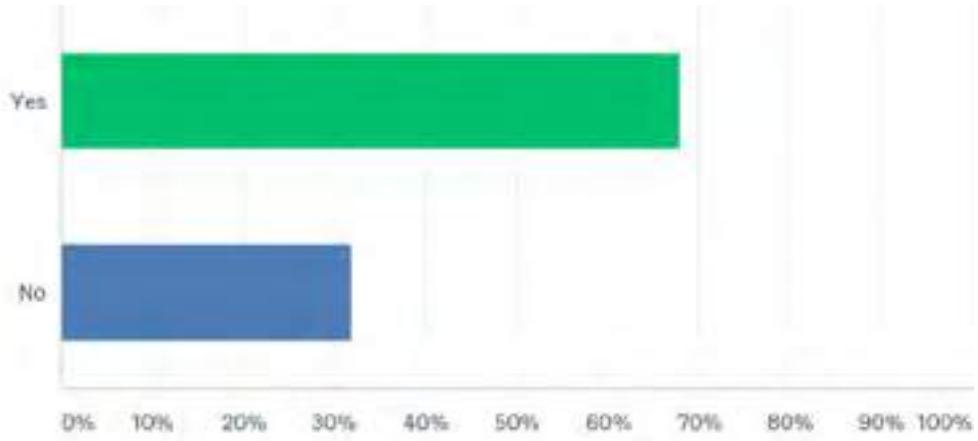
	1	2	3	4	5	6	7	8	TOTAL	SCORE
Litter	7.59% 6	7.59% 6	15.19% 12	7.59% 6	17.72% 14	17.72% 14	8.86% 7	17.72% 14	79	4.03
Stormwater management/Flooding	20.78% 16	25.97% 20	22.08% 17	11.69% 9	5.19% 4	9.09% 7	1.30% 1	3.90% 3	77	5.94
Erosion/ Sediment control	11.69% 9	20.78% 16	20.78% 16	18.18% 14	12.99% 10	12.99% 10	1.30% 1	1.30% 1	77	5.49
Water quality (i.e. nutrients, bacteria/pathogens)	34.67% 26	16.00% 12	18.67% 14	12.00% 9	6.67% 5	5.33% 4	2.67% 2	4.00% 3	75	6.13
Growth management	12.50% 10	10.00% 8	5.00% 4	8.75% 7	20.00% 16	12.50% 10	27.50% 22	3.75% 3	80	4.20
Invasive plant species	1.27% 1	3.80% 3	5.06% 4	15.19% 12	10.13% 8	20.25% 16	30.38% 24	13.92% 11	79	3.19
Public access	6.25% 5	5.00% 4	3.75% 3	7.50% 6	10.00% 8	8.75% 7	16.25% 13	42.50% 34	80	2.86
Habitat protection	9.88% 8	9.88% 8	12.35% 10	18.52% 15	19.75% 16	13.58% 11	7.41% 6	8.64% 7	81	4.58

Q6: Do you or your family use the watershed for any of the following recreational purposes? Select as many answers as apply.



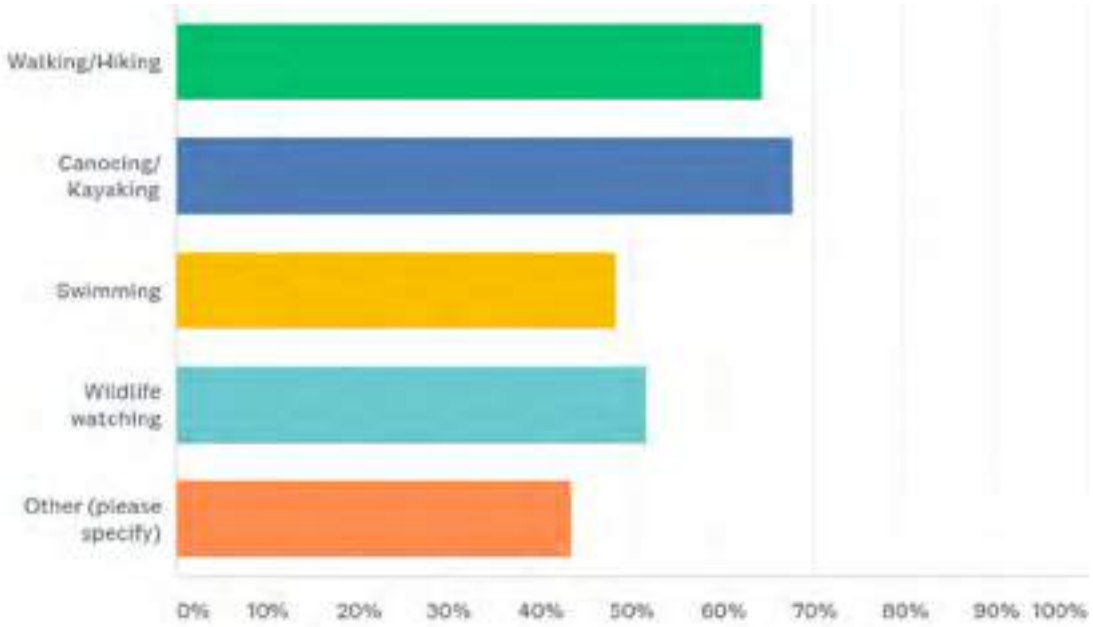
ANSWER CHOICES	RESPONSES	
Fishing	76.54%	62
Walking/ Hiking	53.09%	43
Canoeing/ Kayaking	61.73%	50
Swimming	49.38%	40
Wildlife watching	65.43%	53
We do not use the watershed for recreational purposes	12.35%	10
Other (please specify)	23.46%	19
Total Respondents: 81		

Q7: In your opinion, do recreational opportunities in the watershed need improvement?



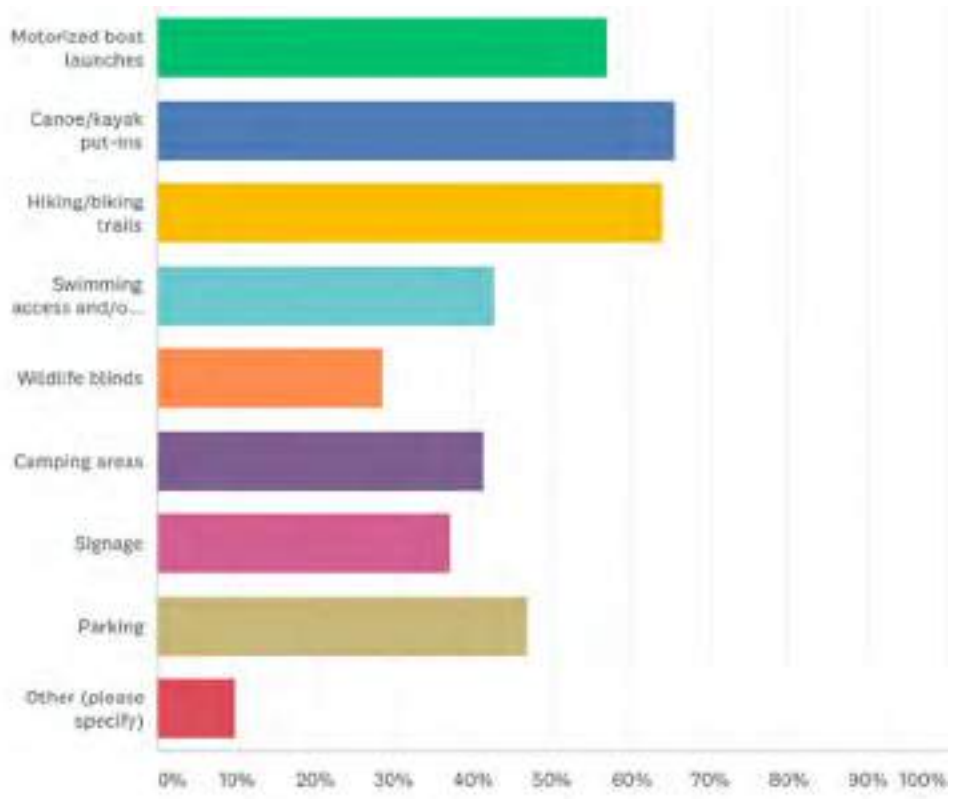
ANSWER CHOICES	RESPONSES	
Yes	67.90%	55
No	32.10%	26
TOTAL		81

Q8: If your answer is yes, please select all of the activities that you would like to see offered in the watershed.



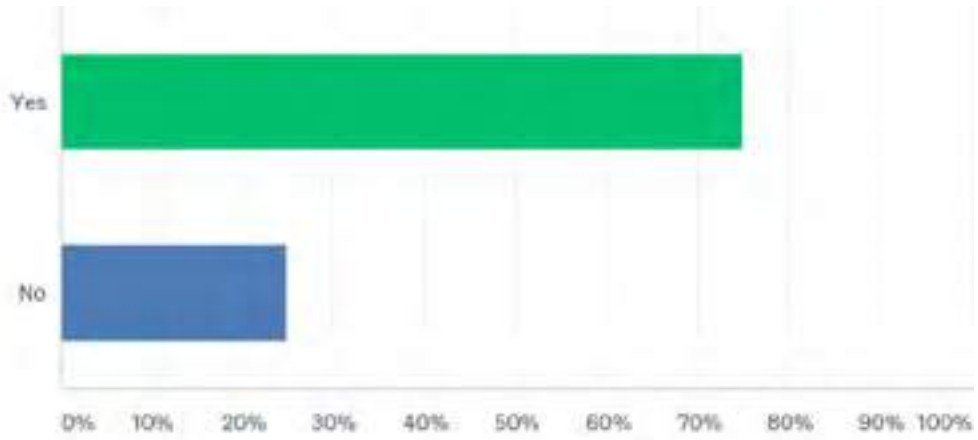
ANSWER CHOICES	RESPONSES	
Walking/Hiking	64.52%	40
Canoeing/ Kayaking	67.74%	42
Swimming	48.39%	30
Wildlife watching	51.61%	32
Other (please specify)	43.55%	27
Total Respondents: 62		

Q9: What improvements are needed in order to support the activities identified in Question 8?



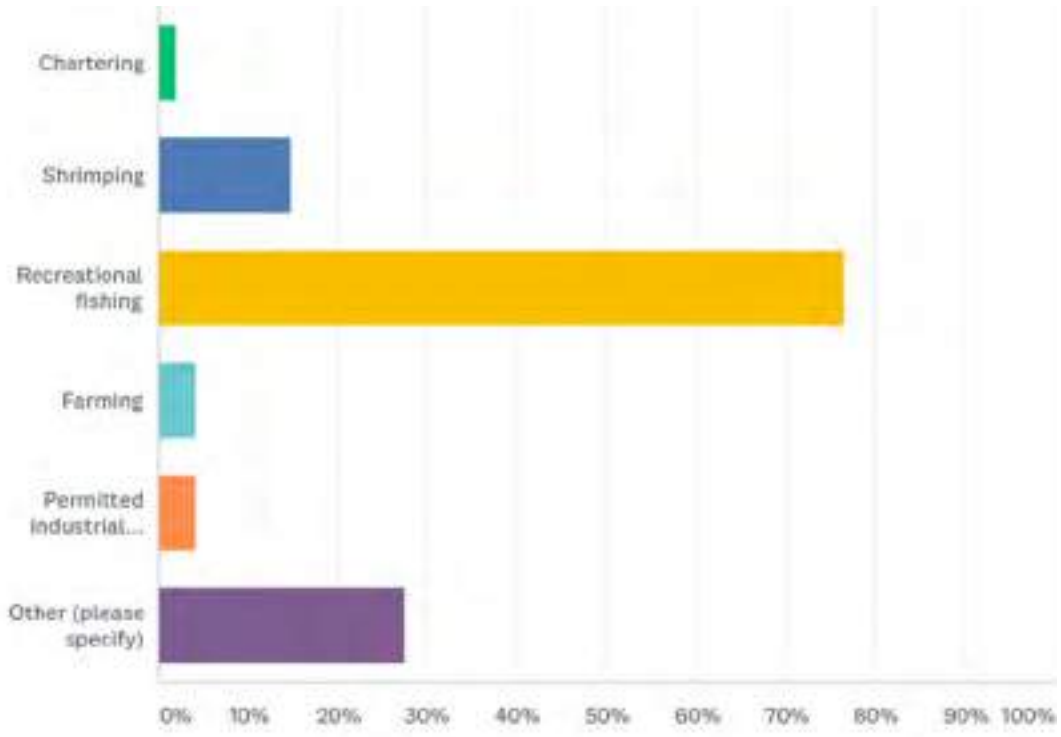
ANSWER CHOICES	RESPONSES	
Motorized boat launches	57.14%	40
Canoe/kayak put-ins	65.71%	46
Hiking/biking trails	64.29%	45
Swimming access and/or beaches	42.86%	30
Wildlife blinds	28.57%	20
Camping areas	41.43%	29
Signage	37.14%	26
Parking	47.14%	33
Other (please specify)	10.00%	7
Total Respondents: 70		

Q10: Would you use a public recreation access point if one was provided?



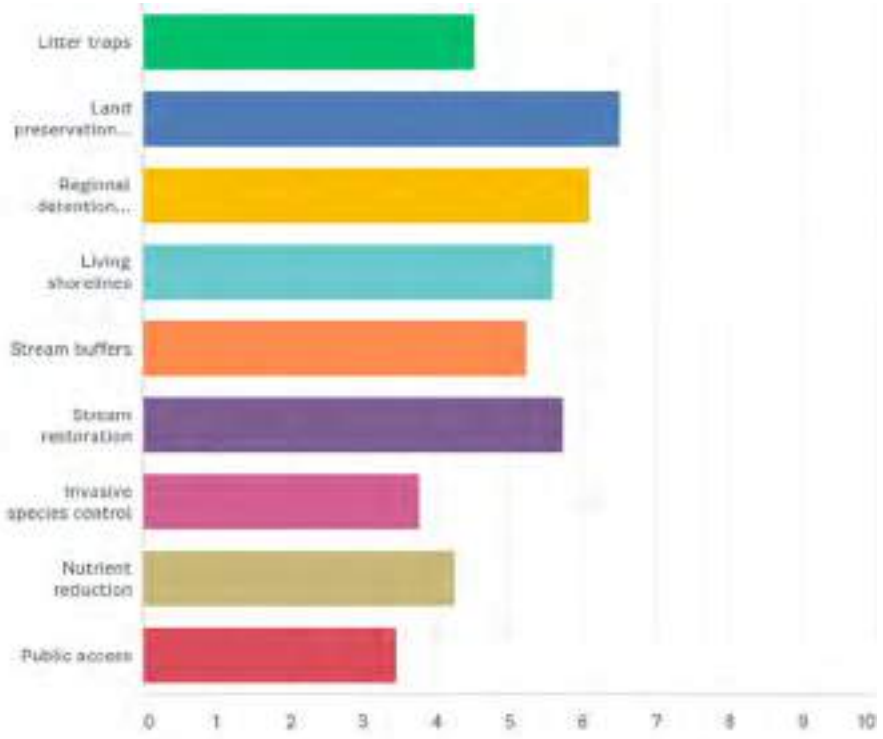
ANSWER CHOICES	RESPONSES	
Yes	75.00%	60
No	25.00%	20
TOTAL		80

Q11: Do you use the watershed for any of the following commercial, industrial or agricultural purposes?



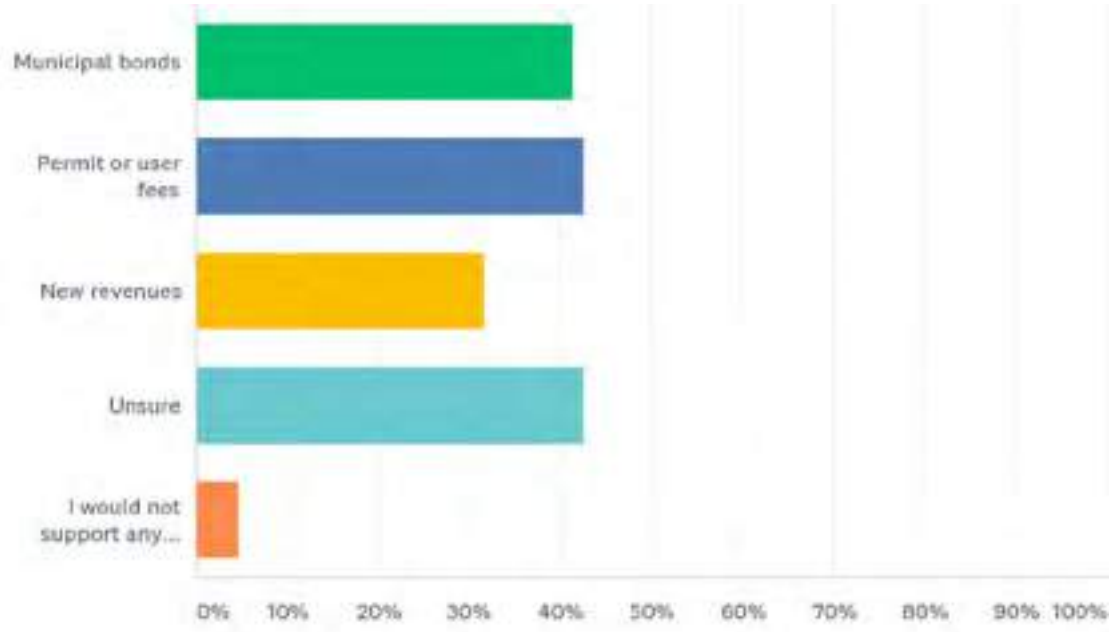
ANSWER CHOICES	RESPONSES	
Chartering	2.13%	1
Shrimping	14.89%	7
Recreational fishing	76.60%	36
Farming	4.26%	2
Permitted industrial activity	4.26%	2
Other (please specify)	27.66%	13
Total Respondents: 47		

Q12: Prioritize Management Actions you would like to see implemented in the watersheds in order from 1 to 9 (1 being the most important, 9 being the least important).



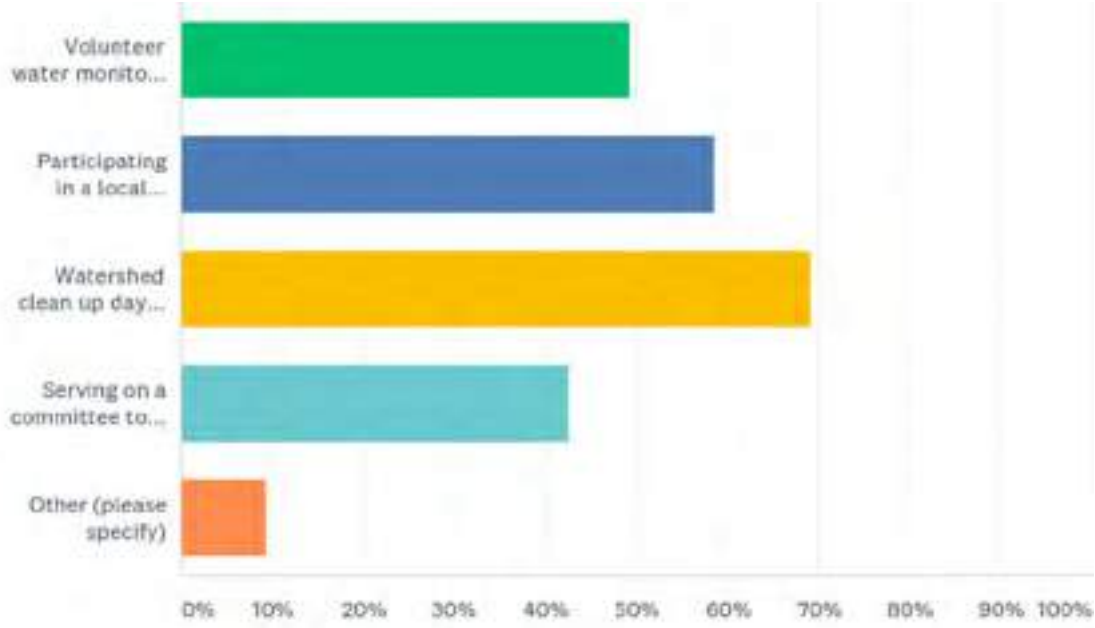
	1	2	3	4	5	6	7	8	9	TOTAL	SCORE
Litter traps	7.79% 6	7.79% 6	7.79% 6	11.69% 9	15.58% 12	10.39% 8	15.58% 12	7.79% 6	15.58% 12	77	4.55
Land preservation through purchase or easements	30.26% 23	15.79% 12	11.84% 9	14.47% 11	3.95% 3	9.21% 7	2.63% 2	7.89% 6	3.95% 3	76	6.53
Regional detention basins for flood control	18.92% 14	18.92% 14	16.22% 12	6.76% 5	9.46% 7	10.81% 8	9.46% 7	6.76% 5	2.70% 2	74	6.11
Living shorelines	13.16% 10	7.89% 6	10.53% 8	21.05% 16	17.11% 13	13.16% 10	9.21% 7	5.26% 4	2.63% 2	76	5.61
Stream buffers	2.63% 2	14.47% 11	10.53% 8	17.11% 13	19.74% 15	14.47% 11	13.16% 10	6.58% 5	1.32% 1	76	5.26
Stream restoration	12.50% 10	16.25% 13	15.00% 12	11.25% 9	11.25% 9	12.50% 10	13.75% 11	6.25% 5	1.25% 1	80	5.76
Invasive species control	2.60% 2	6.49% 5	9.09% 7	2.60% 2	9.09% 7	16.88% 13	15.58% 12	27.27% 21	10.39% 8	77	3.79
Nutrient reduction	7.79% 6	10.39% 8	7.79% 6	7.79% 6	9.09% 7	7.79% 6	12.99% 10	19.48% 15	16.88% 13	77	4.26
Public access	5.19% 4	3.90% 3	12.99% 10	9.09% 7	6.49% 5	2.60% 2	5.19% 4	10.39% 8	44.16% 34	77	3.47

Q13: Which of the following funding options would you support to improve conditions in the Wolf Bay Watershed?



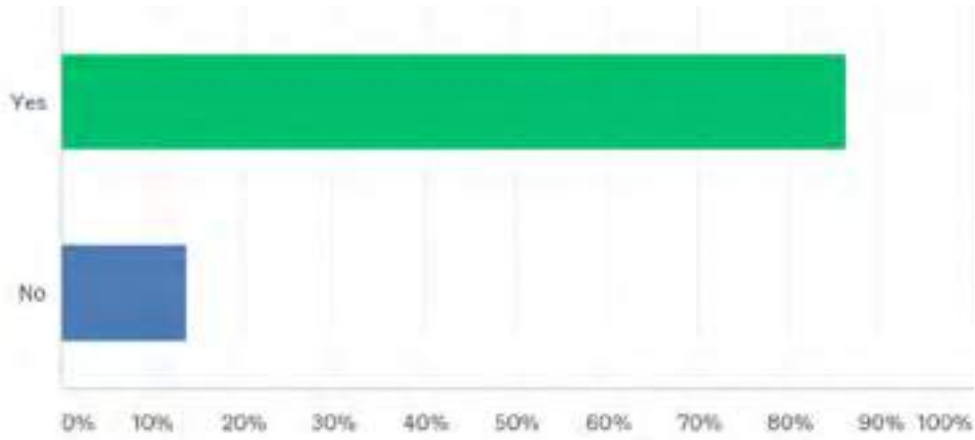
ANSWER CHOICES	RESPONSES	
Municipal bonds	41.46%	34
Permit or user fees	42.68%	35
New revenues	31.71%	26
Unsure	42.68%	35
I would not support any funding option to improve conditions in the watershed	4.88%	4
Total Respondents: 82		

Q14: Which of the following activities would you participate in to help improve the quality of the Wolf Bay watershed?



ANSWER CHOICES	RESPONSES	
Volunteer water monitor (collecting samples and evaluating physical, chemical and biological features of water)	49.33%	37
Participating in a local watershed group. (Assisting a grassroots organization whose mission is to protect and preserve resources in a watershed)	58.67%	44
Watershed clean up day volunteer	69.33%	52
Serving on a committee to oversee implementation of the watershed management plan	42.67%	32
Other (please specify)	9.33%	7
Total Respondents: 75		

Q15: Would you attend watershed educational workshops if they were provided?



ANSWER CHOICES	RESPONSES	
Yes	86.25%	69
No	13.75%	11
TOTAL		80

Section III.

Final Survey Question and Results

Ranking of Issues and Concerns in the Wolf Bay Watershed

20	20:20	Closed
Responses	Average time to complete	Status

...

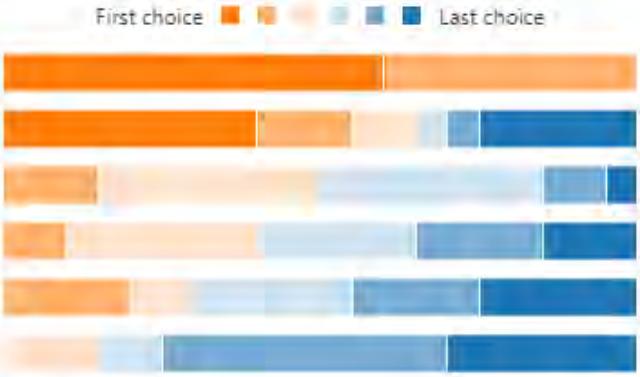
View results

Open in Excel

1. Please rank the following identified watershed issues and concerns by arranging them 1-6 in order of importance to you (1 being the most important and 6 being the least important).

More Details

Rank	Options
1	Water Quality
2	Future Development
3	Litter
4	Invasive Species
5	Stream Navigability
6	Public Recreation



APPENDIX D:
Community Resilience Index Worksheets for the City of Foley, Town of Elberta, and Baldwin County, Alabama

COASTAL RESILIENCE INDEX

"On the road to coastal resilience"

A Community Self-Assessment

Understanding how prepared your community is for a disaster

November 2010

Suggested citation:
Sempier, T.T., D.L. Swann, R. Emmer, S.H. Sempier, and M. Schneider. 2010.
Coastal Community Resilience Index: A Community Self-Assessment. MASGP-08-014.
Document designed by Diana Reid, The University of Southern Mississippi and
Melissa Schneider, Mississippi-Alabama Sea Grant Consortium

Sea Grant
Texas • Louisiana • Florida
Mississippi-Alabama

Supplemental information and additional recourse are available on the Web at masgc.org/ri
MASGP-08-04

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Disclaimer: Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected using the Coastal Resilience Index for the purpose of evaluating the post-disaster adaptability of a community, and planning safety enhancements of that community, shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data. Information compiled using the Coastal Resilience Index is speculative, and is not presented to the community as a definitive statement of fact or prediction, but rather an assessment that may encourage a community to seek further consultation.

TABLE OF CONTENTS

Resilience Index Team

Community Name City of Foley, Alabama

Date Completed 4/25/2013

Name	Title

Date proposed for next Index assessment _____

Additional information and resources can be found at masgc.org/ri

INTRODUCTION

The purpose of this self-assessment is to provide community leaders with a simple and inexpensive method of predicting if their community will reach and maintain an acceptable level of functioning after a disaster. Experienced local planners, engineers, floodplain managers or administrators can complete this self-assessment using existing sources of information from their community. The goal is for every community to become highly resilient. The assessment may identify problems your community should address before the next disaster and where resources should be allocated. Results of the assessment are presented as a Resilience Index that estimates the adaptability of your community to a disaster. This self-assessment was created to identify areas in which your community may become more resilient. Your community's unique Resilience Index is an internal evaluation tool and should not be used to compare your community with others. The Resilience Index and methodology does not replace a detailed study just as a self-examination for skin cancer is not a substitute for a check-up and tests by a dermatologist. But, the Resilience Index resulting from this Community Self-Assessment may encourage your community to seek further consultation.

DISASTER RESILIENCE is the capacity of a community exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure.

RESILIENCE is determined by the degree to which the community is capable of organizing itself to increase its capacity for learning from past disasters.

Definitions are from the Subcommittee on Disaster Reduction. 2005. Grand Challenges for Disaster Resilience. National Science Technology Council, Committee on Environment and Natural Resources. Washington, D.C.: National Science and Technology Council.

NOTE: This Community Self-Assessment is date-specific and should be periodically applied as the community grows and/or the landscape changes, such as when shoreline erosion accelerates. Your community officials should conduct new assessments on a regular basis (annual, biannual, etc.) because of this growth and/or change.

RESULTS OVERVIEW

After completing this self-assessment, you should complete the summary that will help you calculate your Resilience Index (see pages 9 and 10). The Resilience Index used in this self-assessment will be defined as LOW, MEDIUM or HIGH.

The rating will give you an idea of how long it may take your community to provide basic services and reoccupy homes and businesses after a disaster. For more details about interpreting Resilience Index results, go to page 11.

BUILD YOUR SCENARIOS

Use the definitions of Bad and Future Storm below to complete the table. Decide as a group what the best benchmarks would be based upon your past experience, historical records, and prior knowledge. You will then refer to these benchmark storms to complete the rest of the Index.

Bad Storm: Select a benchmark storm you will use to answer questions on the Index. Look back at histori-cal events to help you determine as a group which storm would be the best to use. Remember, this is a self-assessment, so try and select a benchmark you feel will give you the most information about where the community vulnerabilities may be.

Future Storm (greater intensity): Select a storm which would be 50 percent worse than the "bad storm" you selected. For example, what if the storm surge was higher? The rainfall greater? This is to assist you in preparing for a future event that has not been witnessed in the historical records.

Variables	**Bad Storm (benchmark) Scenario 1** Name:	**Future Storm (greater intensity) Scenario 2** Name:
Wind speed at landfall (mph)	Ivan, 2004	Unnamed
Rain (total/24hours)	6-7 Inches	6-8 Inches
Storm Surge (height in feet)	8.8 Feet at Perdido Pass	12+ Feet at Perdido Pass
Direction	Northeast	North through the Bay and west of Foley
Speed of Movement	25-30 MPH	10-15 MPH
Duration	24-30 Hours	36-48 Hours
Tidal Influence (high or low)	High	High
Landfall Location	Gulf Shores	West of Foley (potential for highest wind impacts)

CRITICAL INFRASTRUCTURE AND FACILITIES

The following are key indicators that will give a preliminary assessment of your community's disaster resilience. A more detailed assessment process is available in the FEMA 386-2 publication (fema.gov).

- Place a check mark in the column where your community's critical infrastructure and facilities are located. You may need to use flood maps to determine where the boundaries would be. If the facility is located in multiple areas, put a check in all that are applicable. Then put a check mark in the last column if the infrastructure or facility is functional after a disaster (assuming Scenario 1). Use the total check marks in the last column for Section A and Section B to complete page 9, "Determining Your Resilience Index".

	Special Flood Hazard Area (SFHA)	Bad Storm Scenario 1	Future Storm Scenario 2	Infrastructure or facility functions after disaster
Example: Power grid		√		√
Section A: Critical Infrastructure				
Wastewater treatment system		✔	✔	✔
Power grid		✔	✔	✔
Water purification system		✔	✔	✔
Transportation/ evacuation routes		✔	✔	✔
Total check marks for Section A:	4	4	4	4
Section B: Critical Facilities*				
City Hall or other local government building(s)		✔	✔	✔
Police station or other law enforcement building(s)		✔	✔	✔
Fire station(s)		✔	✔	✔
Communications main office or substations		✔	✔	✔
Emergency operation center		✔	✔	✔
Evacuation shelter(s)		✔	✔	✔
Hospital(s)		✔	✔	✔
Critical record storage		✔	✔	✔
Total check marks for Section B:	0	8	8	8

**Critical facilities may be defined a certain way in an ordinance. However, each community may identify other structures they consider critical. If you need assistance locating critical infrastructure and facilities, you can refer to the mapping tool that accompanies the Index.*

TRANSPORTATION ISSUES

2. Assuming scenario 1, if any of the following effect your transportation/evacuation route(s), will your community regain a pre-storm level of service in one week? Check Yes or No

Transportation issue*	Yes	No
Example: Will flood-prone areas (tunnels, roads in low-lying areas) be operational within one week?	√	
Will primary bridge(s) be out for less than one week?	✔	
Will roads blocked by storm debris (trees, wrack) be cleared in less than one week?	✔	
Will washouts (roads) be passable in less than one week?	✔	
Will flood-prone areas (tunnels, roads in low-lying areas) be operational within one week?	✔	
Is public transportation available to assist evacuation of residents unable to evacuate on their own?		✔
Is there more than one evacuation route?	✔	
Is there a plan for post-storm traffic management?	✔	
Total number of Yes answers and No answers:	6	1

ADDITIONAL NOTES

DID YOU KNOW?

Communities can receive up to 50 points through the National Flood Insurance Program's Community Rating System for protecting critical access routes.

*Some communities use waterways as transportation infrastructure and/or evacuation routes (canals, docks, streams, marinas, and ferries).

3. COMMUNITY PLANS AND AGREEMENTS

Does your community have the following plans, personnel or agreements in place? Check Yes or No.

Does your community:	Yes	No
Example: Have a certified floodplain manager?		√
Participate in the FEMA Community Rating System? (Rating of 8 or lower)	✔	
Use an early flood warning system?	✔	
Have a certified floodplain manager?	✔	
Have planning commissioner(s) with formal training in planning?	✔	
Have a planning staff with credentials from the American Institute of Certified Planners (AICP)?	✔	
Have a FEMA-approved and state EMS-approved mitigation plan?	✔	
If you have an approved mitigation plan, has it been revised in the past two years?		✔
Have Memorandums of Understanding (MOUs) or Memorandums of Agreement (MOAs) with neighboring communities to help each other during times of disaster?	✔	
Have a comprehensive plan or strategic plan that addresses natural disasters?		✔
Have a floodplain manager or planner who participates in the following organizations: Association of State Floodplain Managers or State Floodplain Management Association?	✔	
American Planning Association (APA) or state APA chapter?	✔	
American Society of Civil Engineers (ASCE) or state or local section of ASCE?	✔	
American Public Works Association?	✔	
Have first-hand experience with disaster recovery within the last 10 years?	✔	
Have a communication system to use before, during and after a disaster?	✔	
Total number of Yes answers and No answers:	13	2

ADDITIONAL NOTES

DID YOU KNOW?

Communities with a multi-hazard mitigation plan can receive up to 294 points through the Community Rating System.

MITIGATION MEASURES

4. Has your community implemented the following ongoing mitigation measures or projects? Check Yes or No.

Mitigation measures in place	Yes	No
Example: Relocation of buildings and infrastructure		√
Elevation of residential, nonresidential buildings, or infrastructure to National Flood Insurance Program standards for your community*	✔	
Relocation of buildings and infrastructure from flood-prone areas	✔	
Flood-proofing of nonresidential structures	✔	
Education programs about mitigation options for your community	✔	
Acquisition of repetitive loss structures, infrastructure, or property	✔	
Incentives-based mitigation measures		✔
Adoption of the most recent International Building Codes	✔	
Hiring certified building inspectors	✔	
Staffing an adequate number of people to enforce building codes	✔	
Have completed or planned shoreline restoration projects for critically eroding areas		✔
Require the protection and maintenance of sensitive coastal habitats, ecosystems, and natural features (dunes, barrier islands, salt marshes, mangroves)		✔
Have undeveloped public lands, such as parks, forests or preserves in the coastal high hazard areas (V-zone on FIRM map)		✔
Total number of Yes answers and No answers:	8	4

ADDITIONAL NOTES

DID YOU KNOW?

Creating permanent no-build areas can earn a community up to 900 points through the Community Rating System. For buildings in hazardous areas that cannot be relocated or removed, retrofitting of existing structures is an option that can earn communities up to 2,800 points.

**Note that the Association of State Floodplain Managers recommends communities consider higher elevations than the minimum National Flood Insurance Program standard.*

BUSINESS PLANS

5. What assets do the large retail stores (The Home Depot, Wal-Mart, etc.), grocery stores and fuel distributors in your community have to reopen after a disaster? If more than 50% of the businesses in your community have the following equipment or plans, mark yes. If fewer than 50% have the equipment or plans, check no.

Business equipment/plans*	Yes (50% or more)	No (Less than 50%)
Example: Generators		√
Generators	✔	
Backup options for basic needs (water, sewer, food, and communications)	✔	
Plans to bring in staff to help reopen the business (considering impacts to staff)	✔	
Plans for restocking	✔	
Plans for ice distribution	✔	
Total number of Yes and No answers:	5	0

ADDITIONAL NOTES

DID YOU KNOW?

Communities that create a Post Disaster Recovery Plan can earn up to 10 points through the Community Rating System. This requires working with all sectors of the community.

*Businesses may include functioning marinas or ports as important distribution points after a disaster. If so, consider the assets these businesses have to reopen after a disaster.

SOCIAL SYSTEMS

6. Are there social systems that define your community or serve as the core of your community? Check Yes or No.

Social system category	Yes	No	If yes, describe relationship
Example: Strong faith-based networks	√		*Church networks*
Strong faith-based networks (counted on during a disaster)	✔		Church networks
Cultural identity (unified Hispanic, Asian or other ethnic communities)	✔		Strong ethnic groups
Neighborhood associations Support members in times of need	✔		Multiple
Business cooperative or working relations (industries that employ many residents, Chamber of Commerce, other business-related networks, etc.)	✔		Chamber of Commerce
Strong civic organizations (Kiwanis Club, Rotary Club, etc.)	✔		Multiple
Total number of Yes answers and No answers:	5		

ADDITIONAL NOTES

DID YOU KNOW?

Several agencies, organizations, and programs provide information on flooding, erosion, and other coastal hazards. Communities that make hazard information available and accessible to the general public can earn up to 30 points through the Community Rating System.

DETERMINING YOUR RESILIENCE INDEX

To determine your Resilience Index for each section, use the following tables, which are based on the totals you entered for each section of the Index.

Section 1A: Critical Infrastructure

Total number of infrastructure functioning after a disaster:_____

Number of check marks	Percentage of infrastructure and facilities functioning after a disaster	Resilience Index
0	0%	LOW
1	25%	LOW
2	50%	MEDIUM
3	75%	MEDIUM
4	100%	HIGH

Your critical infrastructure Resilience Index is High.

Find out what your Resilience Index means on Page 11.

Section 1B: Critical Facilities

Total number of critical facilities functioning after a disaster: _____

Number of check marks	Percentage of critical facilities functioning after a disaster	Resilience Index
1	13%	LOW
2	25%	LOW
3	38%	LOW
4	50%	MEDIUM
5	63%	MEDIUM
6	75%	MEDIUM
7	88%	HIGH
8	100%	HIGH

Your critical facilities Resilience Index is High

Find out what your Resilience Index means on Page 11.

Sections 2-6: Transportation, Community Plans, Mitigation Measures, Business Plans and Social Systems

Use the box labeled "Total number of Yes answers" from Sections 2-6 to complete the following chart.

Sections 2-6	Number of Yes answers	Translate number of Yes answers to Resilience Index	Resilience Index	Comments
(Example) Section 2: Transportation issues	*1*	*2 or fewer (LOW)* *3 to 4 (MEDIUM)* *5 or more (HIGH)*	*LOW*	*A road construction project will create an additional evacuation route within a year. Also, we are in talks with the local public transportation provider about a program to assist evacuation.*
Section 2: Transportation Issues	6	2 or fewer (LOW) 3 to 5 (MEDIUM) 6 or more (HIGH)	High	
Section 3: Community Plans and Agreements	13	4 or fewer (LOW) 5 to 8 (MEDIUM) 9 or more (HIGH)	High	
Section 4: Mitigation Measures	8	4 or fewer (LOW) 5 to 8 (MEDIUM) 9 or more	High	
Section 5: Business Plans	5	1 or fewer (LOW) 2 to 3 (MEDIUM) 4 or more (HIGH)	High	
Section 6: Social Systems	5	1 or fewer (LOW) 2 to 3 (MEDIUM) 4 or more (HIGH)	High	

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Example: Power grid		√		√
Section A: Critical Infrastructure				
Wastewater treatment system		✔	✔	✔
Power grid		✔	✔	✔
Water purification system		✔	✔	✔
Transportation/ evacuation routes		✔	✔	✔
Total check marks for Section A:	4	4	4	4
Section B: Critical Facilities*				
City Hall or other local government building(s)		✔	✔	✔
Police station or other law enforcement building(s)		✔	✔	✔
Fire station(s)		✔	✔	✔
Communications main office or substations		✔	✔	✔
Emergency operation center		✔	✔	✔
Evacuation shelter(s)		✔	✔	✔
Hospital(s)		✔	✔	✔
Critical record storage		✔	✔	✔
Total check marks for Section B:	0	8	8	8

**Critical facilities may be defined a certain way in an ordinance. However, each community may identify other structures they consider critical. If you need assistance locating critical infrastructure and facilities, you can refer to the mapping tool that accompanies the Index.*

TRANSPORTATION ISSUES

2. Assuming scenario 1, if any of the following effect your transportation/evacuation route(s), will your community regain a pre-storm level of service in one week? Check Yes or No

Transportation issue*	Yes	No
Example: Will flood-prone areas (tunnels, roads in low-lying areas) be operational within one week?	√	
Will primary bridge(s) be out for less than one week?	✔	
Will roads blocked by storm debris (trees, wrack) be cleared in less than one week?	✔	
Will washouts (roads) be passable in less than one week?	✔	
Will flood-prone areas (tunnels, roads in low-lying areas) be operational within one week?	✔	
Is public transportation available to assist evacuation of residents unable to evacuate on their own?		✔
Is there more than one evacuation route?	✔	
Is there a plan for post-storm traffic management?	✔	
Total number of Yes answers and No answers:	6	1

ADDITIONAL NOTES

DID YOU KNOW?

Communities can receive up to 50 points through the National Flood Insurance Program's Community Rating System for protecting critical access routes.

*Some communities use waterways as transportation infrastructure and/or evacuation routes (canals, docks, streams, marinas, and ferries).

3. COMMUNITY PLANS AND AGREEMENTS

Does your community have the following plans, personnel or agreements in place? Check Yes or No.

Does your community:	Yes	No
Example: Have a certified floodplain manager?		√
Participate in the FEMA Community Rating System? (Rating of 8 or lower)	✔	
Use an early flood warning system?	✔	
Have a certified floodplain manager?	✔	
Have planning commissioner(s) with formal training in planning?	✔	
Have a planning staff with credentials from the American Institute of Certified Planners (AICP)?	✔	
Have a FEMA-approved and state EMS-approved mitigation plan?	✔	
If you have an approved mitigation plan, has it been revised in the past two years?		✔
Have Memorandums of Understanding (MOUs) or Memorandums of Agreement (MOAs) with neighboring communities to help each other during times of disaster?	✔	
Have a comprehensive plan or strategic plan that addresses natural disasters?		✔
Have a floodplain manager or planner who participates in the following organizations: Association of State Floodplain Managers or State Floodplain Management Association?	✔	
American Planning Association (APA) or state APA chapter?	✔	
American Society of Civil Engineers (ASCE) or state or local section of ASCE?	✔	
American Public Works Association?	✔	
Have first-hand experience with disaster recovery within the last 10 years?	✔	
Have a communication system to use before, during and after a disaster?	✔	
Total number of Yes answers and No answers:	13	2

ADDITIONAL NOTES

DID YOU KNOW?

Communities with a multi-hazard mitigation plan can receive up to 294 points through the Community Rating System.

MITIGATION MEASURES

4. Has your community implemented the following ongoing mitigation measures or projects? Check Yes or No.

Mitigation measures in place	Yes	No
Example: Relocation of buildings and infrastructure		√
Elevation of residential, nonresidential buildings, or infrastructure to National Flood Insurance Program standards for your community*	✔	
Relocation of buildings and infrastructure from flood-prone areas	✔	
Flood-proofing of nonresidential structures	✔	
Education programs about mitigation options for your community	✔	
Acquisition of repetitive loss structures, infrastructure, or property	✔	
Incentives-based mitigation measures		✔
Adoption of the most recent International Building Codes	✔	
Hiring certified building inspectors	✔	
Staffing an adequate number of people to enforce building codes	✔	
Have completed or planned shoreline restoration projects for critically eroding areas		✔
Require the protection and maintenance of sensitive coastal habitats, ecosystems, and natural features (dunes, barrier islands, salt marshes, mangroves)		✔
Have undeveloped public lands, such as parks, forests or preserves in the coastal high hazard areas (V-zone on FIRM map)		✔
Total number of Yes answers and No answers:	8	4

ADDITIONAL NOTES

DID YOU KNOW?

Creating permanent no-build areas can earn a community up to 900 points through the Community Rating System. For buildings in hazardous areas that cannot be relocated or removed, retrofitting of existing structures is an option that can earn communities up to 2,800 points.

**Note that the Association of State Floodplain Managers recommends communities consider higher elevations than the minimum National Flood Insurance Program standard.*

BUSINESS PLANS

5. What assets do the large retail stores (The Home Depot, Wal-Mart, etc.), grocery stores and fuel distributors in your community have to reopen after a disaster? If more than 50% of the businesses in your community have the following equipment or plans, mark yes. If fewer than 50% have the equipment or plans, check no.

Business equipment/plans*	Yes (50% or more)	No (Less than 50%)
Example: Generators		√
Generators	✔	
Backup options for basic needs (water, sewer, food, and communications)	✔	
Plans to bring in staff to help reopen the business (considering impacts to staff)	✔	
Plans for restocking	✔	
Plans for ice distribution	✔	
Total number of Yes and No answers:	5	0

ADDITIONAL NOTES

DID YOU KNOW?

Communities that create a Post Disaster Recovery Plan can earn up to 10 points through the Community Rating System. This requires working with all sectors of the community.

*Businesses may include functioning marinas or ports as important distribution points after a disaster. If so, consider the assets these businesses have to reopen after a disaster.

SOCIAL SYSTEMS

6. Are there social systems that define your community or serve as the core of your community? Check Yes or No.

Social system category	Yes	No	If yes, describe relationship
Example: Strong faith-based networks	√		*Church networks*
Strong faith-based networks (counted on during a disaster)	✔		Church networks
Cultural identity (unified Hispanic, Asian or other ethnic communities)	✔		Strong ethnic groups
Neighborhood associations Support members in times of need	✔		Multiple
Business cooperative or working relations (industries that employ many residents, Chamber of Commerce, other business-related networks, etc.)	✔		Chamber of Commerce
Strong civic organizations (Kiwanis Club, Rotary Club, etc.)	✔		Multiple
Total number of Yes answers and No answers:	5		

ADDITIONAL NOTES

DID YOU KNOW?

Several agencies, organizations, and programs provide information on flooding, erosion, and other coastal hazards. Communities that make hazard information available and accessible to the general public can earn up to 30 points through the Community Rating System.

DETERMINING YOUR RESILIENCE INDEX

To determine your Resilience Index for each section, use the following tables, which are based on the totals you entered for each section of the Index.

Section 1A: Critical Infrastructure

Total number of infrastructure functioning after a disaster:_____

Number of check marks	Percentage of infrastructure and facilities functioning after a disaster	Resilience Index
0	0%	LOW
1	25%	LOW
2	50%	MEDIUM
3	75%	MEDIUM
4	100%	HIGH

Your critical infrastructure Resilience Index is High.

Find out what your Resilience Index means on Page 11.

Section 1B: Critical Facilities

Total number of critical facilities functioning after a disaster: _____

Number of check marks	Percentage of critical facilities functioning after a disaster	Resilience Index
1	13%	LOW
2	25%	LOW
3	38%	LOW
4	50%	MEDIUM
5	63%	MEDIUM
6	75%	MEDIUM
7	88%	HIGH
8	100%	HIGH

Your critical facilities Resilience Index is High

Find out what your Resilience Index means on Page 11.

Sections 2-6: Transportation, Community Plans, Mitigation Measures, Business Plans and Social Systems

Use the box labeled "Total number of Yes answers" from Sections 2-6 to complete the following chart.

Sections 2-6	Number of Yes answers	Translate number of Yes answers to Resilience Index	Resilience Index	Comments
(Example) Section 2: Transportation issues	*1*	*2 or fewer (LOW)* *3 to 4 (MEDIUM)* *5 or more (HIGH)*	*LOW*	*A road construction project will create an additional evacuation route within a year. Also, we are in talks with the local public transportation provider about a program to assist evacuation.*
Section 2: Transportation Issues	6	2 or fewer (LOW) 3 to 5 (MEDIUM) 6 or more (HIGH)	High	
Section 3: Community Plans and Agreements	13	4 or fewer (LOW) 5 to 8 (MEDIUM) 9 or more (HIGH)	High	
Section 4: Mitigation Measures	8	4 or fewer (LOW) 5 to 8 (MEDIUM) 9 or more	High	
Section 5: Business Plans	5	1 or fewer (LOW) 2 to 3 (MEDIUM) 4 or more (HIGH)	High	
Section 6: Social Systems	5	1 or fewer (LOW) 2 to 3 (MEDIUM) 4 or more (HIGH)	High	

ADDITIONAL NOTES

Resilience Index Team

Community Name City of Foley, Alabama

Date Completed 4/25/2013

Name	Title

Date proposed for next Index assessment _____

Additional information and resources can be found at masgc.org/ri

INTRODUCTION

The purpose of this self-assessment is to provide community leaders with a simple and inexpensive method of predicting if their community will reach and maintain an acceptable level of functioning after a disaster. Experienced local planners, engineers, floodplain managers or administrators can complete this self-assessment using existing sources of information from their community. The goal is for every community to become highly resilient. The assessment may identify problems your community should address before the next disaster and where resources should be allocated. Results of the assessment are presented as a Resilience Index that estimates the adaptability of your community to a disaster. This self-assessment was created to identify areas in which your community may become more resilient. Your community's unique Resilience Index is an internal evaluation tool and should not be used to compare your community with others. The Resilience Index and methodology does not replace a detailed study just as a self-examination for skin cancer is not a substitute for a check-up and tests by a dermatologist. But, the Resilience Index resulting from this Community Self-Assessment may encourage your community to seek further consultation.

DISASTER RESILIENCE is the capacity of a community exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure.

RESILIENCE is determined by the degree to which the community is capable of organizing itself to increase its capacity for learning from past disasters.

Definitions are from the Subcommittee on Disaster Reduction. 2005. Grand Challenges for Disaster Resilience. National Science Technology Council, Committee on Environment and Natural Resources. Washington, D.C.: National Science and Technology Council.

NOTE: This Community Self-Assessment is date-specific and should be periodically applied as the community grows and/or the landscape changes, such as when shoreline erosion accelerates. Your community officials should conduct new assessments on a regular basis (annual, biannual, etc.) because of this growth and/or change.

RESULTS OVERVIEW

After completing this self-assessment, you should complete the summary that will help you calculate your Resilience Index (see pages 9 and 10). The Resilience Index used in this self-assessment will be defined as LOW, MEDIUM or HIGH.

The rating will give you an idea of how long it may take your community to provide basic services and reoccupy homes and businesses after a disaster. For more details about interpreting Resilience Index results, go to page 11.

BUILD YOUR SCENARIOS

Use the definitions of Bad and Future Storm below to complete the table. Decide as a group what the best benchmarks would be based upon your past experience, historical records, and prior knowledge. You will then refer to these benchmark storms to complete the rest of the Index.

Bad Storm: Select a benchmark storm you will use to answer questions on the Index. Look back at histori-cal events to help you determine as a group which storm would be the best to use. Remember, this is a self-assessment, so try and select a benchmark you feel will give you the most information about where the community vulnerabilities may be.

Future Storm (greater intensity): Select a storm which would be 50 percent worse than the "bad storm" you selected. For example, what if the storm surge was higher? The rainfall greater? This is to assist you in preparing for a future event that has not been witnessed in the historical records.

Variables	**Bad Storm (benchmark) Scenario 1** Name:	**Future Storm (greater intensity) Scenario 2** Name:
Wind speed at landfall (mph)	Ivan, 2004	Unnamed
Rain (total/24hours)	6-7 Inches	6-8 Inches
Storm Surge (height in feet)	8.8 Feet at Perdido Pass	12+ Feet at Perdido Pass
Direction	Northeast	North through the Bay and west of Foley
Speed of Movement	25-30 MPH	10-15 MPH
Duration	24-30 Hours	36-48 Hours
Tidal Influence (high or low)	High	High
Landfall Location	Gulf Shores	West of Foley (potential for highest wind impacts)

CRITICAL INFRASTRUCTURE AND FACILITIES

The following are key indicators that will give a preliminary assessment of your community's disaster resilience. A more detailed assessment process is available in the FEMA 386-2 publication (fema.gov).

- Place a check mark in the column where your community's critical infrastructure and facilities are located. You may need to use flood maps to determine where the boundaries would be. If the facility is located in multiple areas, put a check in all that are applicable. Then put a check mark in the last column if the infrastructure or facility is functional after a disaster (assuming Scenario 1). Use the total check marks in the last column for Section A and Section B to complete page 9, "Determining Your Resilience Index".

	Special Flood Hazard Area (SFHA)	Bad Storm Scenario 1	Future Storm Scenario 2	Infrastructure or facility functions after disaster
Example: Power grid		√		√
Section A: Critical Infrastructure				
Wastewater treatment system		✔	✔	✔
Power grid		✔	✔	✔
Water purification system		✔	✔	✔
Transportation/ evacuation routes		✔	✔	✔
Total check marks for Section A:	4	4	4	4
Section B: Critical Facilities*				
City Hall or other local government building(s)		✔	✔	✔
Police station or other law enforcement building(s)		✔	✔	✔
Fire station(s)		✔	✔	✔
Communications main office or substations		✔	✔	✔
Emergency operation center		✔	✔	✔
Evacuation shelter(s)		✔	✔	✔
Hospital(s)		✔	✔	✔
Critical record storage		✔	✔	✔
Total check marks for Section B:	0	8	8	8

**Critical facilities may be defined a certain way in an ordinance. However, each community may identify other structures they consider critical. If you need assistance locating critical infrastructure and facilities, you can refer to the mapping tool that accompanies the Index.*

TRANSPORTATION ISSUES

2. Assuming scenario 1, if any of the following effect your transportation/evacuation route(s), will your community regain a pre-storm level of service in one week? Check Yes or No

Transportation issue*	Yes	No
Example: Will flood-prone areas (tunnels, roads in low-lying areas) be operational within one week?	√	
Will primary bridge(s) be out for less than one week?	✔	
Will roads blocked by storm debris (trees, wrack) be cleared in less than one week?	✔	
Will washouts (roads) be passable in less than one week?	✔	
Will flood-prone areas (tunnels, roads in low-lying areas) be operational within one week?	✔	
Is public transportation available to assist evacuation of residents unable to evacuate on their own?		✔
Is there more than one evacuation route?	✔	
Is there a plan for post-storm traffic management?	✔	
Total number of Yes answers and No answers:	6	1

ADDITIONAL NOTES

DID YOU KNOW?

Communities can receive up to 50 points through the National Flood Insurance Program's Community Rating System for protecting critical access routes.

*Some communities use waterways as transportation infrastructure and/or evacuation routes (canals, docks, streams, marinas, and ferries).

3. COMMUNITY PLANS AND AGREEMENTS

Does your community have the following plans, personnel or agreements in place? Check Yes or No.

Does your community:	Yes	No
Example: Have a certified floodplain manager?		√
Participate in the FEMA Community Rating System? (Rating of 8 or lower)	✔	
Use an early flood warning system?	✔	
Have a certified floodplain manager?	✔	
Have planning commissioner(s) with formal training in planning?	✔	
Have a planning staff with credentials from the American Institute of Certified Planners (AICP)?	✔	
Have a FEMA-approved and state EMS-approved mitigation plan?	✔	
If you have an approved mitigation plan, has it been revised in the past two years?		✔
Have Memorandums of Understanding (MOUs) or Memorandums of Agreement (MOAs) with neighboring communities to help each other during times of disaster?	✔	
Have a comprehensive plan or strategic plan that addresses natural disasters?		✔
Have a floodplain manager or planner who participates in the following organizations: Association of State Floodplain Managers or State Floodplain Management Association?	✔	
American Planning Association (APA) or state APA chapter?	✔	
American Society of Civil Engineers (ASCE) or state or local section of ASCE?	✔	
American Public Works Association?	✔	
Have first-hand experience with disaster recovery within the last 10 years?	✔	
Have a communication system to use before, during and after a disaster?	✔	
Total number of Yes answers and No answers:	13	2

ADDITIONAL NOTES

DID YOU KNOW?

Communities with a multi-hazard mitigation plan can receive up to 294 points through the Community Rating System.

MITIGATION MEASURES

4. Has your community implemented the following ongoing mitigation measures or projects? Check Yes or No.

Mitigation measures in place	Yes	No
Example: Relocation of buildings and infrastructure		√
Elevation of residential, nonresidential buildings, or infrastructure to National Flood Insurance Program standards for your community*	✔	
Relocation of buildings and infrastructure from flood-prone areas	✔	
Flood-proofing of nonresidential structures	✔	
Education programs about mitigation options for your community	✔	
Acquisition of repetitive loss structures, infrastructure, or property	✔	
Incentives-based mitigation measures		✔
Adoption of the most recent International Building Codes	✔	
Hiring certified building inspectors	✔	
Staffing an adequate number of people to enforce building codes	✔	
Have completed or planned shoreline restoration projects for critically eroding areas		✔
Require the protection and maintenance of sensitive coastal habitats, ecosystems, and natural features (dunes, barrier islands, salt marshes, mangroves)		✔
Have undeveloped public lands, such as parks, forests or preserves in the coastal high hazard areas (V-zone on FIRM map)		✔
Total number of Yes answers and No answers:	8	4

ADDITIONAL NOTES

DID YOU KNOW?

Creating permanent no-build areas can earn a community up to 900 points through the Community Rating System. For buildings in hazardous areas that cannot be relocated or removed, retrofitting of existing structures is an option that can earn communities up to 2,800 points.

**Note that the Association of State Floodplain Managers recommends communities consider higher elevations than the minimum National Flood Insurance Program standard.*

BUSINESS PLANS

5. What assets do the large retail stores (The Home Depot, Wal-Mart, etc.), grocery stores and fuel distributors in your community have to reopen after a disaster? If more than 50% of the businesses in your community have the following equipment or plans, mark yes. If fewer than 50% have the equipment or plans, check no.

Business equipment/plans*	Yes (50% or more)	No (Less than 50%)
Example: Generators		√
Generators	✔	
Backup options for basic needs (water, sewer, food, and communications)	✔	
Plans to bring in staff to help reopen the business (considering impacts to staff)	✔	
Plans for restocking	✔	
Plans for ice distribution	✔	
Total number of Yes and No answers:	5	0

ADDITIONAL NOTES

DID YOU KNOW?

Communities that create a Post Disaster Recovery Plan can earn up to 10 points through the Community Rating System. This requires working with all sectors of the community.

*Businesses may include functioning marinas or ports as important distribution points after a disaster. If so, consider the assets these businesses have to reopen after a disaster.

SOCIAL SYSTEMS

6. Are there social systems that define your community or serve as the core of your community? Check Yes or No.

Social system category	Yes	No	If yes, describe relationship
Example: Strong faith-based networks	√		*Church networks*
Strong faith-based networks (counted on during a disaster)	✔		Church networks
Cultural identity (unified Hispanic, Asian or other ethnic communities)	✔		Strong ethnic groups
Neighborhood associations Support members in times of need	✔		Multiple
Business cooperative or working relations (industries that employ many residents, Chamber of Commerce, other business-related networks, etc.)	✔		Chamber of Commerce
Strong civic organizations (Kiwanis Club, Rotary Club, etc.)	✔		Multiple
Total number of Yes answers and No answers:	5		

ADDITIONAL NOTES

DID YOU KNOW?

Several agencies, organizations, and programs provide information on flooding, erosion, and other coastal hazards. Communities that make hazard information available and accessible to the general public can earn up to 30 points through the Community Rating System.

DETERMINING YOUR RESILIENCE INDEX

To determine your Resilience Index for each section, use the following tables, which are based on the totals you entered for each section of the Index.

Section 1A: Critical Infrastructure

Total number of infrastructure functioning after a disaster:_____

Number of check marks	Percentage of infrastructure and facilities functioning after a disaster	Resilience Index
0	0%	LOW
1	25%	LOW
2	50%	MEDIUM
3	75%	MEDIUM
4	100%	HIGH

Your critical infrastructure Resilience Index is High.

Find out what your Resilience Index means on Page 11.

Section 1B: Critical Facilities

Total number of critical facilities functioning after a disaster: _____

Number of check marks	Percentage of critical facilities functioning after a disaster	Resilience Index
1	13%	LOW
2	25%	LOW
3	38%	LOW
4	50%	MEDIUM
5	63%	MEDIUM
6	75%	MEDIUM
7	88%	HIGH
8	100%	HIGH

Your critical facilities Resilience Index is High

Find out what your Resilience Index means on Page 11.

Sections 2-6: Transportation, Community Plans, Mitigation Measures, Business Plans and Social Systems

Use the box labeled "Total number of Yes answers" from Sections 2-6 to complete the following chart.

Sections 2-6	Number of Yes answers	Translate number of Yes answers to Resilience Index	Resilience Index	Comments
(Example) Section 2: Transportation issues	*1*	*2 or fewer (LOW)* *3 to 4 (MEDIUM)* *5 or more (HIGH)*	*LOW*	*A road construction project will create an additional evacuation route within a year. Also, we are in talks with the local public transportation provider about a program to assist evacuation.*
Section 2: Transportation Issues	6	2 or fewer (LOW) 3 to 5 (MEDIUM) 6 or more (HIGH)	High	
Section 3: Community Plans and Agreements	13	4 or fewer (LOW) 5 to 8 (MEDIUM) 9 or more (HIGH)	High	
Section 4: Mitigation Measures	8	4 or fewer (LOW) 5 to 8 (MEDIUM) 9 or more	High	
Section 5: Business Plans	5	1 or fewer (LOW) 2 to 3 (MEDIUM) 4 or more (HIGH)	High	
Section 6: Social Systems	5	1 or fewer (LOW) 2 to 3 (MEDIUM) 4 or more (HIGH)	High	

ADDITIONAL NOTES

INTERPRETING RESILIENCE INDEX RESULTS

RESILIENCE INDEX: A Resilience Index is an indicator of your community's ability to reach and maintain an acceptable level of functioning and structure after a disaster.

After completing the Summary section of this self-assessment, your Resilience Index was identified as LOW, MEDIUM or HIGH in different categories.

LOW Resilience Index. A low Resilience Index indicates that your community should pay specific attention to this category and should make efforts to address the areas of low rating. If the criticall infrastructure category received this rating, then reoccupation of your community may take more than 18 months before basic services are restored.

MEDIUM Resilience Index. A medium Resilience Index indicates that more work could be done to improve your Resilience in this category. If the critical infrastructure category received this rating, reoccupation of your community may take less than 2 months before basic services are restored.

HIGH Resilience Index. A high Resilience Index indicates that your community is well prepared for a storm event. If the critical infrastructure category received this rating, then the community probably will not suffer or will have minimal damage (can be functional in less than two weeks) to basic services.

NEXT STEPS

Regardless if your city has a HIGH, MEDIUM or LOW Resilience Index, you should learn about and investigate the weaknesses you have identified during this process. Refer to the references page for additional information on resources, training, and support.

For more information, contact the NOAA Gulf of Mexico Coastal Storms Program Outreach Coordinator, Mississippi-Alabama Sea Grant Consortium, 703 East Beach Drive, Ocean Springs, MS 39564 or (228) 818 8829.

ACKNOWLEDGMENTS

Appreciation is extended to the following communities for donating their time, sharing their expertise and assisting us in strengthening the Index through their participation as a pilot community. In alphabetical order:

Bayou La Batre, AL
Biloxi, MS Cameron Parish, LA Cedar Key, FL
Dauphin Island, AL
Ft. Myers Beach, FL
Gulf Shores, AL
Marco Island, FL
Ocean Springs, MS
Orange Beach, AL
Pascagoula, MS
Pass Christian, MS
Port Arthur, TX
Sarasota, FL
St. Tammany Parish, LA
Steinhatchee, FL

A special thank you to members of the Gulf of Mexico Alliance Resilience Team and Gulf of Mexico Sea Grant Extension Specialists for their assistance in making suggested changes, pilot testing the draft versions, and promoting the use of the Index in local communities.

REFERENCES

Useful Definition

Critical facility (also called critical action) means facilities for which the effects of even a slight chance of flood-ing would be too great. The minimum floodplain of concern for critical facilities is the 0.2 percent chance flood level. Critical facilities include, but are not limited to facilities critical to the health and safety of the public such as: emergency operations centers, designated public shelters, schools, nursing homes, hospitals, police, fire and emergency response installations, vital data storage centers, power generation and water and other utilities (including related infrastructure such as principal points of utility systems) and installations which produce, use or store hazardous materials or hazardous waste (as defined under the Clean Water Act and other Federal statutes and regulations). Such facilities and access to such facilities will be constructed outside the one percent chance Special Flood Hazard Area or elevated/protected to or above the 0.2 percent chance flood level.

Additional Resources

Resilience Index Critical Facilities Mapping Tool: **www.csc.noaa.gov/criticalfacilities**
Risk and Vulnerability Assessment Tools: **www.csc.noaa.gov/rva_tools**
Community Rating System: **http://www.fema.gov/business/nfip/crs.shtm**
StormSmart Coasts Network: **http://stormsmart.org**
NOAA Coastal Storms Program: **www.coastalstorms.noaa.gov**
Gulf of Mexico Alliance Resilience Team: **www.gulfofmexicoalliance.org/issues/resilience.html**

Training

Gulf of Mexico Sea Grant College Programs: **http://gulfseagrant.org**
- Florida Sea Grant: **http://www.flseagrant.org**
- Louisiana Sea Grant: **http://www.laseagrant.org**
- Mississippi-Alabama Sea Grant: **http://www.masgc.org**
- Texas Sea Grant: **http://texas-sea-grant.tamu.edu**

Coastal Services Center: **http://www.csc.noaa.gov/training/**

National Estuarine Research Reserves Coastal Training Program: **http://gulfalliancetraining.org/**

Federal Emergency Management Agency: **http://training.fema.gov/**
AL Emergency Management Agency Training: **http://ema.alabama.gov/Organization/Preparedness/Training.cfm**
FL Division of Emergency Management Training: **http://floridadisaster.org/TrainingCalendar/index.asp**
LA Homeland Security & Emergency Preparedness Training: **http://www.ohsep.louisiana.gov/Training/**
MS Emergency Management Agency Training: **http://www.msema.org/training/**
TX Division of Emergency Management Training: **http://www.txdps.state.tx.us/dem/pages/Training.htm**

Networking

StormSmart Connect: **http://stormsmartconnect.org**

Contacts

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Jody Thompson
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In Memoriam

DR. ROD EMMER

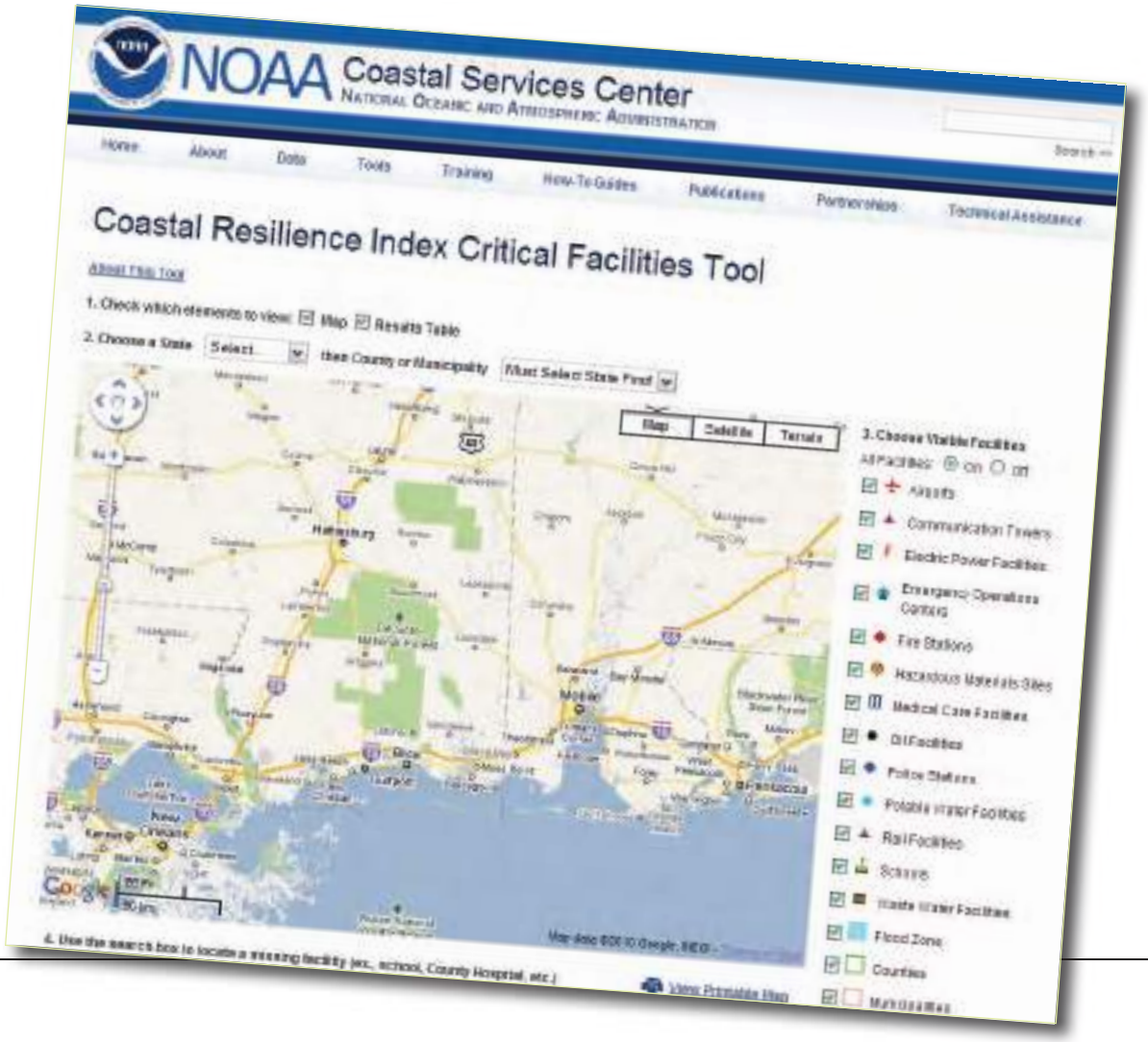
1944 — 2008

The original concept for the Resilience Index was born from the work Dr. Emmer conducted in local communities through Louisiana Sea Grant. With his passing, the Gulf region lost a great resource of knowledge and experience in the fields of floodplain management, hazard mitigation, geography, and culture. Although he was not able to see this final version of the Index, it is sincerely hoped he would approve of the transformation this tool has made and its potential to assist many communities across the Gulf and the nation.
(Photo courtesy of Louisiana Sea Grant)

Coastal Resilience Index Critical Facilities Tool

http://csc.noaa.gov/criticalfacilities/

- assists communities in completing sections of the Index
- includes drop down menus for selecting your state, them county or municipality
- generate and print reports directly from the site



StormSmart Coasts Network

https://stormsmart.org

- Learn how to identify your community's risks
- Find ways to reduce those risks (and the funding to do so)
- Discover what other communities across the Gulf and the nation are doing to address the risks
- Find others working to protect their communities

StormSmart Coasts

Connect. Communicate. Collaborate.

APPENDIX E:
NRCS Conservation Practices Catalog for the State of Alabama

USDA

United States Department of Agriculture

Natural Resources
Conservation Service

ALABAMA

Natural Resources Conservation Service

CONSERVATION PRACTICE CATALOG

As a landowner or farm operator, you face many decisions when managing your natural resources. When you evaluate options for your operation, consider installing conservation practices listed in this catalog to help improve your resource management and cropping systems. A conservation plan can be developed to improve management for additional resource concerns. NRCS staff are your local soil and water conservation district (SWCD) partners and are ready to help you make the right choices to protect your operation and resources.

Helping People Help the Land

USDA is an equal opportunity provider, employer and lender.

October 2016

This document is not to be used as technical guidance or policy. All NRCS practices shall be applied according to current Conservation Practice Standards available in the Field Office Technical Guide, Section IV (http://efotg.sc.egov.usda.gov/efotg_locator.aspx?map=).

For information on the USDA Natural Resources Conservation Service in Alabama, visit www.al.nrcs.usda.gov or follow us on Twitter at http://twitter.com/NRCS_AL

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Access Control - 472

Practice Description
The temporary or permanent exclusion of animals, people, vehicles, and/or equipment from an area

Purpose
Acheive and maintain by monitoring and managing animals people, vehicles, coordination with the practices, measures conservation plan

Access Road - 560

Practice Description
A travel-way for equipment and vehicles constructed to provide

-

hicular travel for resource activities involving the management of timber, livestock, agriculture, wildlife habitat, and other conservation enterprises while protecting the soil, water, air
and other adjacent natural resources

Purpose
This practice is planned where access is needed from a private or public road or highway to a land use enterprise or conservation measure, or where travel ways are needed in a planned land use area. Access roads range from seasonal use roads, designed for low speed and rough driving conditions, to all-weather roads heavily used by the public and designed with safety as a high priority. Some roads are only constructed for a single purpose; i.e. control of

forest management activities, access to remote recreation areas, or access for maintenance of facilities.

Agrichemical Handling Facility - 309

Practice Description
A facility with an impervious surface to provide an environmentally safe area for on-farm agrichemicals. Provides a safe environment to store, mix, load and cleanup agrichemicals, retain incidental spillage, retain leakage, and reduce surface water, groundwater, air, and/or soil pollution

Purpose
Practice applies where:

• The handling of agrichemicals creates

pollution of surface water, groundwater, air or soil and a facility is needed to properly manage and handle the chemical operation;
• An adequate water sup-

application equipment tanks, rinsing application equipment and chemical containers as needed;
• Soils and topography are suitable for construction.

NOTE: This practice does not apply to the handling or storage of fuels, or to commercial or multi-landowner agrichemical handling operations.

Amendments for Treatment of Ag Waste - 591

Practice Description
The treatment of manure, wastewater, storm water runoff from high use areas, and other wastes, with chemical or biological additives

Purpose
This practice applies where the use of a chemical or biological amendments will alter the physical and chemical characteristics of animal waste as a part of a planned waste management system to:

• Improve or protect air quality
• Improve or protect water quality
• Improve or protect animal health
• Alter the consistency of the waste stream of facilitates implementation of a waste management system

Anerobic Digester - 366

Practice Description
A component of a waste management system that provides biological treatment in the absence of oxygen

Purpose
This practice is applied for the treatment of manure and other byproducts of animal agricultural operations for one or more of the following reasons:

• Capture biogas for energy production
• Manage odors
• Reduce the net effect of greenhouse gas emissions
• Reduce pathogens

Animal Mortality Facility - 316

Practice Description
An on-farm facility for the treatment or disposal of livestock and poultry carcasses for routine and catastrophic mortality events

Purpose
This practice is applied for one or more of the following purposes:

• Reduce impacts to surface and groundwater resources
• Reduce the impact of odors
• Decrease the spread of pathogens

Animal Trails and Walkways - 575

Practice Description
Established lanes or travel ways that facilitate animal movement

Purpose
This practice is applied to achieve one or more of the following:

• Provide or improve access to forage, water, working/handling facilities, and/or shelter
• Improve grazing ef-

and/or
• Protect ecologically sensitive, erosive and/or potentially erosive sites

Anionic Polyacrylamide Erosion Control - 450

Practice Description
Application of water-soluble Anionic Polyacrylamide (PAM) to meet a resource concern

Purpose
This practice is applied as part of a conservation system to support one or more of the following:

• Reduce soil erosion by water or wind
• Improve water quality
• Improve air quality by reducing dust emissions

Aquaculture Ponds - 397

Practice Description
A water impoundment constructed and managed for commer-

and other aquaculture products

Purpose
This practice applies to all types of ponds

commercial production

and plants. The purpose of the practice is to provide a favorable water environment for producing, growing, harvesting, and marketing commercial aquaculture crops.

Brush Management - 314

Practice Description
The management or removal of woody (non-herbaceous or succulent) plants including those that are invasive and noxious

Purpose
This practice is applied to achieve one or more of the following:

• Create the desired plant community consistent with the ecological site
• Restore or release desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality or

• Maintain, modify, or

habitat
• Improve forage accessibility, quality and quantity for livestock and wildlife
• Manage fuel loads to achieve desired conditions

Channel Bed Stabilization - 584

Practice Description
Measure(s) used to stabilize the bed or bottom of a channel. This practice applies to the beds of existing or newly constructed alluvial or threshold channels that are undergoing damaging aggradation or degradation and that cannot be feasibly controlled by clearing or snagging, by the establishment of vegetative protection, by the installation of bank protection, or by the installation of upstream water control measures

Purpose
This practice may be applied as part of a conservation management system to support one or more of the following:

• Maintain or alter channel bed elevation or gradient
• Modify sediment transport or deposition
• Manage surface water and groundwater levels

areas, and wetlands

Clearing and Snagging - 326

Practice Description
Removal of vegetation along the bank (clearing) and/or selective removal of snags, drifts, or other obstructions (snagging) from natural or improved channels and streams

Purpose
Reduce risks to agricultural resources or civil infrastructure by removing obstructions that

sediment transport in order to accomplish one or more of the following:

•
and direction
• Prevent excessive bank erosion by eddies or

• Reduce the undesirable formation of bars; and/or;
• Minimize blockages by debris and ice

Combustion System Improvement - 372

Practice Description
Installing, replacing, or

combustion systems and/ or related components or devices for air quality and ener improvement

Purpose
This practice is applied to achieve one or more of the following:

• To improve air quality by addressing the air quality resource concerns for particulate matter and ozone precursors by mitigating actual or potential emissions of oxides of nitrogen and/or

• To improve the energy

combustion systems

Composting Facility - 317

Practice Description
A facility to process raw organic by-products such as, animal mortality and manure into biologically stable organic material

Purpose
This practice is applied to reduce the pollution potential of organic agricultural wastes to surface and groundwater by one or more of the following:

• Reduces volume by 25 to 50 percent
• Improves fertilizing capabilities by converting nitrogen to less soluble form
• Aids in nutrient management

Conservation Cover - 327

Practice Description
Establishing and maintaining permanent vegetative cover

Purpose
This practice may be applied to accomplish one or more of the following:

• Reduce soil erosion and sedimentation
• Improve water quality
• Enhance wildlife habitat

Conservation Crop Rotation - 328

Practice Description
Growing crops in a recurring sequence on the

Purpose
This practice may be applied as part of a conservation management system to support one or more of the following:

• Reduce sheet and rill erosion
• Reduce soil erosion from wind
• Maintain or improve soil organic matter content
• Manage the balance of plant nutrients
• Improve water use ef-

• Manage plant pests (weeds, insects, and diseases)
• Provide food for domestic livestock
• Provide food and cover for wildlife

Constructed Wetland - 656

Practice Description

with hydrophytic vegetation for water treatment

Purpose
For treatment of wastewater and contaminated runoff from agricultural processing, livestock, and aquaculture facilities, or for improving the quality of storm water runoff or other water

water quality discharge criteria

Contour Buffer Strips - 332

Practice Description
Narrow strips of permanent, herbaceous vegetative cover established around the hill slope, and alternated down the slope with wider cropped strips that are farmed on the contour

Purpose
This practice is applied to achieve one or more of the following:

• Reduce sheet and rill erosion
• Reduce transport of sediment and other water-borne contaminants downslope
• -
tion

Contour Farming - 330

Practice Description
Using ridges and furrows formed by tillage, planting and other farming operations to change the direction of runoff from directly downslope to around the hillslope

Purpose
This practice is applied to achieve one or more of the following:

• Reduce sheet and rill erosion
• Reduce transport of sediment, other solids and the contaminants attached to them
• -
tion

Contour Orchard and Other Perennial Crops - 331

Practice Description
Planting orchards, vineyards, or small fruits so that all cultural operations are done on the countour

Purpose
• Reduce soil erosion
• Reduce water loss

Cover Crop - 340

Practice Description
Crops including grasses, legumes and forbs for seasonal cover and other conservation purposes

Purpose
This practice is applied to achieve one or more of the following:

• Reduce erosion from wind and water
• Increase soil organic matter content
• Promote biological

• Increase biodiversity
• Weed suppression
• Provide supplemental forage
• Soil moisture management
• Minimize and reduce soil compaction

Critical Area Planting - 342

Practice Description
Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices

Purpose

• Stabilize areas with existing or expected high rates of soil erosion by water.
• Stabilize areas with existing or expected high rates of soil erosion by wind
• Rehabilitate and re-vegetate degraded sites that cannot be stabilized through normal farming practices.
• Stabilize coastal areas, such as sand dunes and riparian areas.

Dam - 402

Practice Description

can impound water for

purposes

Purpose
This practice is applied to achieve one or more of the following:

• Reduce downstream

• Provide permanent water storage for one or

as irrigation or livestock supply - nicipal or industrial uses, or recreational uses
• Create or improve habi-

Deep Tillage - 324

Practice Description
Performing tillage operations below the normal tillage depth to modify adverse physical or chemical properties of a soil

Purpose
This practice is applied to achieve one or more of the following:

• Bury or mix soil deposits from wind or water

• Reduce concentration of soil contaminants, which inhibit plant growth
• Fracture restrictive soil layers

Dike - 356

Practice Description
A berm or ridge, or ridge and channel combination of compacted soil to channel water to a desired location or away from an undesired location

Purpose
This practice is applied to achieve one or more of the following:

• Protect people and

• Control water level in connection with crop

wildlife management; or wetland maintenance, improvement, restoration, or construction
• Direct water to stable outlets or traps
• Direct clean water away from disturbed or polluted areas

Diversion - 362

Practice Description
A channel constructed across the slope with a supporting ridge on the lower side

Purpose
This practice may be applied as part of a resource management system to support one or more of the following purposes:

• Break up concentrations of water on long slopes, on undulating land surfaces, and on land that is generally considered

terracing
• Increase or decrease the drainage area above ponds
• Protect terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above
• Intercept surface and

• Reduce runoff damages from upland runoff

Drainage Water Management - 554

Practice Description
The use of structures for water control in the process of managing water discharges from surface and/or subsurface agricultural drainage systems

Purpose
The purpose of this practice is:

• Reduce nutrient, pathogen, and/or pesticide loading from drainage systems into downstream receiving waters
• Improve productivity, health, and vigor of plants
• Reduce oxidation of organic matter in soils
• Reduce wind erosion or particulate matter (dust) emissions
• Provide seasonal wildlife habitat

Dry Hydrant - 432

Practice Description
A non-pressurized permanent pipe assembly system installed into water source that permits the withdrawal of water by suction. To provide all weather access to an available water source

Purpose
Where a dependable source of water is available, where transport vehicles can access the site, and where a source of water is needed for

Early Successional Habitat Development / Management - 647

Practice Description
Manage plant succession to develop and maintain early successional habitat

and/or natural communities. To provide habitat for species requiring early successional habitat for all or part of their life cycle

Purpose
This practice is applied on all lands that are suitable for the kinds of desired wildlife and plant species. Management will be designed to achieve the desired plant community structure (e.g., density, vertical and horizontal cover) and plant species diversity.

Farmstead Energy Improvement - 374

Practice Description
Installing, replacing, or

equipment systems and/or related components or devices which results in an on-farm and/or off-site reduction in actual or potential emissions of greenhouse gases

Purpose
This practice is applied to achieve the following:

• Reduce net greenhouse gas emissions (on farm and/or off-site) from agricultural systems or components by implementing the recommendations from on-site energy audits

Fence - 382

Practice Description
A constructed barrier to animals or people

Purpose
This practice facilitates the accomplishment of conservation objectives by providing a means to control movement of animals, people, and vehicles.

Feral Swine Management Conservation Activity - 297

Practice Description
Feral swine management is a component of an area wide effort of assessment, planning, exclusion, scouting, control, and monitoring to document and reduce resource damage caused by
feral swine and focus interagency management efforts to reduce adverse resource impacts and health concerns for other animals and humans.

Purpose
• Determine locations and intensity of feral swine impacts upon resource conditions and potential means to reduce or eliminate these impacts
• Develop a management plan to address feral-swine-impacted resources of concern using a conservation practice or system of conservation practices
• Evaluate the effectiveness of a practice or system of practices in reducing resource impacts from feral swine

Field Border - 386

Practice Description
A strip of permanent vegetation established at the edge or around the

Purpose
This practice may be applied to accomplish one or more of the following:

• Reduce soil erosion
• Provide turn rows for farm machinery
• Soil and water quality protection
• Management of harmful insect populations
• Provide wildlife food and cover
• Increase carbon storage in biomass and soils
• Improve air quality

Filter Strip - 393

Practice Description
A strip or area of herbaceous vegetation that removes contaminants

Purpose
This practice is applied to achieve one or more of the following:

• Reduce suspended solids and associated contaminants in runoff
• Reduce dissolved contaminant loadings in runoff
• Reduce suspended solids and associated contaminants in irrigation tailwater

Firebreak - 394

Practice Description
A permanent or temporary strip of bare or vegetated land planned to

Purpose
This practice applies on all land uses where

is needed or prescribed burning is applied to accomplish one or more of the following:

• Reduce the spread of

• Contain prescribed burns

Fishpond Management - 399

Practice Description
Managing impounded water for the production

organisms

Purpose
This practice is applied in warm and cold water ponds, lakes, and reservoirs not managed for commercial aquaculture purposes to accomplish one or more of the following:

• To provide favorable

aquatic organisms.
• To develop and maintain a desired species composition and ratio.
• To develop and maintain a desired level of production

Forage and Biomass Planting - 512

Practice Description
Establishing adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production

Purpose
This practice is applied to achieve one or more of the following:

•Improve or maintain livestock nutrition and/or health
•Provide or increase forage supply during periods of low forage production
• Reduce soil erosion
• Improve soil quality and water quality
• Produce feedstock for biofuel or energy production

Forage Harvest Management - 511

Practice Description
The timely cutting and removal of forages from , green-chop or ensilage

Purpose
• Optimize yield and quality of forage at the desired levels
• Promote vigorous plant re-growth
• Manage for the desired species composition
• Use forage plant biomass as a soil nutrient uptake tool
• Control insects, diseases and weeds
• Maintain and/or improve wildlife habitat

Forest Stand Improvement - 666

Practice Description
The manipulation of species composition, stand structure and stocking by cutting or killing selected trees and understory vegetation

Purpose
This practice may be applied to accomplish one or more of the following:

• Increase the quantity and quality of forest products by manipulating stand density and structure
• Harvest forest products
• Initiate forest stand regeneration
•
• Improve forest health reducing the potential of damage from pests and moisture stress
• Restore natural plant communities
• Achieve or maintain a desired native understory plant community for special forest products, grazing, and browsing
• Improve aesthetic and recreation, values
• Improve wildlife habitat
• Alter water yield
• Increase carbon storage in selected trees

Forest Trails and Landings - 655

Practice Description
A temporary or infrequently used route, path or cleared area. Trails and landings including skid trails are applicable on forest land. They typically connect to an Access Road (560)

Purpose
This practice may be applied to accomplish one or more of the following:

• Provide routes for temporary or infrequent travel by people or equipment for management activities
• Provide periodic access for removal and collection of forest products

Fuel Break - 383

Practice Description
A strip or block of land on which the vegetation, debris and detritus have been reduced and/

diminish the risk of the

strip or block of land

Purpose
This practice applies on all land where protection

to control and reduce the

by treating, removing or modifying vegetation, debris and detritus.

Grade Stabilization Structure - 410

Practice Description
A structure used to control the grade and head cutting in natural or

Purpose
The purpose of this practice is to stabilize the grade and control erosion

channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

Grassed Waterways - 412

Practice Description
A shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet

Purpose
This practice is applied to achieve one or more of the following:

• Convey runoff from terraces, diversions, or other water concentrations without causing

• Reduce gully erosion
• Protect/improve water quality

Heavy Use Area Protection - 561

Practice Description
The stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, by surfacing with suitable materials, and/or by installing needed structures

Purpose
This practice is applied to achieve one or more of the following:

• Reduce soil erosion
• Improve water quantity and quality
• Improve air quality
• Improve aesthetics
• Improve livestock health

Hedgerow Planting - 422

Practice Description
Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose

Purpose
This practice may be installed to accomplish one or more of the following:

• Habitat, including food, cover, and corridors for terrestrial wildlife
• To enhance pollen, nectar, and nesting habitat for pollinators
• Food, cover, and shade for aquatic organisms that live in adjacent streams or watercourses
• To provide substrate for

invertebrates as a component of integrated pest management
• To intercept airborne particulate matter
• To reduce chemical drift and odor movement
• Screens and barriers to noise and dust
• To increase carbon storage in biomass and soils
• Living fences
• Boundary delineation and contour guidelines

Herbaceous Weed Control - 315

Practice Description

The removal or control of herbaceous weeds including invasive, noxious and prohibited plants

Purpose

• Enhance accesibility, quantity, and quality of forage and/or browse.
• Restore or release native ore create desired plant communities and wildlife habitats consistent with the ecological site.
• Protect soils and control erosion
•
hazard and improve air quality

Integrated Pest Management - 595

Practice Description

A -
tion of pest prevention, pest avoidance, pest monitoring, and pest suppression strategies

Purpose

This practice is applied on all lands where pests will be managed to accomplish one or more of the following:

• Prevent or mitigate off-site pesticide risks to water quality from leaching, solution runoff and adsorbed runoff losses
• Prevent or mitigate off-site pesticide risks to soil, water, air, plants, animals and humans from drift and volatilization losses
• Prevent or mitigate on-site pesticide risks to pollinators and other ben-

direct contact
• Prevent or mitigate cultural, mechanical and biological pest suppression risks to soil, water, air, plants, animals and humans

Irrigation Canal or Lateral - 320

Practice Description

A permanent channel constructed to convey irrigation water from the source of supply to one or more irrigated areas

Purpose

Apply this practice to

distribution and use of water on irrigated land to accomplish one or more of the following:

• Where a canal or lateral and related structures are needed as an integral part of an irrigation water conveyance system
• Where water supplies for the area served

irrigation practical for the crops to be grown and the irrigation water application methods to be used

Conservation Practice Standard Irrigation Field Ditch (388) should be used for on-farm irrigation water conveyance and/or distribution of less than 25 cubic feet per second

Irrigation Field Ditch - 388

Practice Description
A permanent irrigation ditch constructed in or with earth materials, to convey water from the source of supply to a

irrigation system

Purpose
This practice may be applied as part of an irrigation water management

convey and distribute irrigation waters. This standard is limited to open channels and elevated ditches of 25 cubic feet per second or less in capacity and constructed of earth materials. The practice applies

needed as an integral part of an irrigation water distribution system design to facilitate the conservation use of soil and water resources.

Irrigation Land Leveling - 464

Practice Description
Reshaping the surface of land to be irrigated, to planned lines and grades

Purpose
This practice applies to the leveling of land irrigated by surface or subsurface irrigation systems. The leveling is based on a detailed engineering survey, design, and layout. Land to be leveled shall be suitable for irrigation and for the proposed methods of water application. Soils shall be deep enough that, after leveling, an adequate usable root zone remains that will permit satisfactory crop production with proper conservation measures. Limited areas of shallow soils may be leveled to provide adequate irrigation grades or an improved alignment.

work must not result in exposed areas of highly permeable soil materials that would inhibit proper distribution of water over

Irrigation Pipeline - 430

Practice Description
A pipeline and appurtenances installed in an irrigation system to convey water

Purpose
This practice is applied to convey water from a source of supply to an irrigation system or storage reservoir.

Irrigation Reservoir - 436

Practice Description
An irrigation water storage structure made by constructing a dam, embankment, pit, or tank

Purpose
This practice may be applied as part of a resource conservation system to achieve one or more of the following:

• Store water to provide a reliable irrigation water supply or regulate avail-

• Improve water use ef-

• Provide storage for tailwater recovery and reuse
• Provide irrigation runoff retention time to increase breakdown of chemical contaminants
• Reduce energy consumption

Irrigation System, Microirrigation - 441

Practice Description
An irrigation system for frequent application of small quantities of water on or below the soil surface: as drops, tiny streams or miniature spray through emitters or applicators placed along a water delivery line

Purpose
This practice may be applied as part of a conservation management system to support one or more of the following purposes:

• T -
formly apply irrigation water and maintain soil moisture for plant growth
• Prevent contamination of ground and surface

and uniformly applying chemicals
•Establish desired vegetation

Irrigation System, Sprinkler - 442

Practice Description
An irrigation system in which all necessary equipment and facilities -
ciently applying water by means of nozzles operated under pressure

Purpose
This practice may be applied as part of a conservation management system to achieve one or more of the following:

-
ly apply irrigation water to maintain adequate soil water for the desired level of plant growth and production without causing excessive water loss, erosion, or water quality impairment
• Climate control and/or

• Applying chemicals, nutrients, and/or waste water
• Leaching for control or reclamation of saline or sodic soils
• Reduction in particulate matter emissions to improve air quality

Irrigation System, Surface and Subsurface - 443

Practice Description
A system in which all necessary earthwork, multi-outlet pipelines, and water-control structures have been installed for distribution of water by surface means, such as furrows, borders, and contour levees, or by subsurface means through water table control

Purpose
Applied as part of a resource conservation system to achieve one or more of the following:

•
distribute irrigation water to the surface point of application without causing excessive water loss, erosion, or water quality impairment
•
distribute irrigation water to the subsurface point of application without causing excessive water loss or water quality impairment
• Apply chemicals and/or nutrients as part of a surface irrigation system in a manner which protects water quality
• Improve energy use

Irrigation Tailwater Recovery - 447

Practice Description
A planned irrigation system in which all facilities utilized for the collection, storage, and transportation of irrigation tailwater and/or rainfall runoff for reuse have been installed

Purpose
This practice shall be applied as part of a conservation management system to support one or more of the following:

• Conserve irrigation water supplies
• Improve off-site water quality

Irrigation Water Management - 449

Practice Description
The process of determining and controlling the volume, frequency and application rate of irrigation water in a planned,

Purpose
This practice is applied to achieve one or more of the following:

• Manage soil moisture to promote desired crop response
• Optimize use of available water supplies
• Minimize irrigation induced soil erosion
• Decrease non-point source pollution of surface and groundwater resources
• Manage salts in the crop root zone
• Manage air, soil, or plant micro-climate
• Proper and safe chemigation or fertigation
• Improve air quality by managing soil moisture to reduce particulate matter movement

Karst Sinkhole Treatment - 527

Practice Description
The treatment of sinkholes in karst areas to reduce contamination of groundwater resources, and/or to improve farm safety

Purpose
This practice may be applied as part of a conservation management system in karst topography, which is an area underlain by solutioned carbonate bedrock with sinkholes and caverns. The practice supports one or more of the following purposes:

- Improve water quality
- Improve farm safety

Land Clearing - 460

Practice Description
Removing trees, stumps, and other vegetation to achieve a conservation objective

Purpose
This practice applies to wooded areas where the removal of trees, stumps, brush, and other vegetation is needed in carrying out a conservation plan to allow needed land use adjustments and improvements in the interest of conservation.

Land Reclamation, Abandoned Mined Land - 543

Practice Description
Reclamation of land and water areas adversely affected by past mining activities

Purpose
Apply this practice to abandoned mined land that degrades the quality of the environment and prevents or interferes

of soil, water, air, plant or animal resources, or endangers human health and safety to accomplish one or more of the following:

- Stabilize abandoned mined areas to decrease erosion and sedimentation, support desirable vegetation and improve off-site water quality and or quantity
- Maintain or improve landscape visual and functional quality
- Protect public health, safety and general welfare

Land Reclamation, Landslide Treatment - 453

Practice Description
Managing natural materials, mine spoil (excavated over-burden), mine waste or overburden to reduce down-slope movement.

Purpose
Apply where in-place material, mine spoil, waste, or overburden, or rock cut road banks are unstable, moving, or judged to have potential of moving down slope in a manner that will cause damage to life, property, or the environment to accomplish one or more of the following:

• Repair unstable slopes caused by slope failure, and reduce the chance of enlargement or movement of slope surfaces
• Protect life and property
• Prevent excessive erosion and sedimentation
• Improve water quality and landscape resource quality
• Create a condition conducive to establishing surface protection and

This practice does not apply to constructed embankment surfaces (road

and terraces.

Land Smoothing - 466

Practice Description
Removing irregularities on the land surface. To improve surface drainage, provide for more uniform cultivation, and improve equipment

.

Purpose
This practice applies on areas where depressions, mounds, old terraces, turn-rows, and other surface irregularities interfere with the application of needed soil and water conservation and management practices. It is limited to areas having adequate soil depth or where topsoil can be salvaged and replaced. This practice does not apply to the regular maintenance on irrigated land or on land that has been

standards Precision Land Forming (462) or Irrigation Land Leveling (464).

Lighting System Improvement - 670

Practice Description
Complete replacement or

more components of an existing agricultural lighting system.

Purpose
This practice may be applied as part of a conservation management system to reduce energy use.

Livestock Shelter Structure - 576

Practice Description
A permanent or portable structure with less than four walls and/or a roof to provide for improved utilization of pastureland and rangeland and to shelter livestock from negative environmental factors. This structure is not to be construed to be a building

Purpose
• To provide protection for livestock from excessive heat, wind, cold, or snow.
• Protect surface waters from nutrient and pathogen loading.
• Protect wooded areas from accelerated erosion and excessive nutrient deposition by providing alternative livestock shelter/shade location.
• Improve the distribution of grazing livestock to enhance wildlife habitat, reduce overused areas, or correct other resource concerns resulting from improper livestock distribution

Mulching - 484

Practice Description
Applying plant residues or other suitable materials produced off site, to the land surface

Purpose
This practice is applied to achieve one or more of the following:

• Conserve soil moisture
• Moderate soil temperature
• Provide erosion control
• Suppress weed growth
• Establish vegetative cover
• Improve soil condition and increase soil fertility

Nutrient Management - 590

Practice Description
Managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments

Purpose
This practice is applied to achieve one or more of the following:

• Budget and supply nutrients for plant production
• Properly utilize manure or organic by-products as a plant nutrient source
• Minimize agricultural non-point source pollution of surface and groundwater resources
• Protect air quality by reducing nitrogen emissions (ammonia and NO2 compounds) and the formation of atmospheric particulates
• Maintain or improve the physical, chemical and biological condition of soil

Obstruction Removal - 500

Practice Description
Removal and disposal of buildings,
structures, other works of improvement, vegetation, debris or other materials

Purpose
To safely remove and dispose of unwanted obstructions in order to apply conservation practices or facilitate the planned land use.

CONDITIONS WHERE PRACTICE APPLIES
On any land where existing obstructions interfere with planned land use development, public safety or infrastructure. This standard is not intended for the removal of obstructions from aquatic environments

Open Channel - 582

Practice Description
Pipeline having an inside diameter of 4 inches or less where conveyance of water is desirable or necessary to conserve the supply, or maintain the quality of water

Purpose
This practice is applied to improve water quantity and quality by conveying water from a source of supply to points of use for livestock or wildlife; make practical the exclusion of livestock from ponds and streams.

Pipeline (Livestock Pipeline) - 516

Practice Description
A pipeline and appurtenances installed to convey water for livestock and wildlife

Purpose
This practice may be applied as part of a resource management system to achieve one or more of the following purposes:
• Convey water to the points of use for livestock or wildlife
• Reduce energy use
• Develop renewable energy systems

Pond - 378

Practice Description
A water impoundment made by constructing an embankment or by excavating a pit or dugout. Ponds constructed by the

to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment

embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more

Purpose
This practice is applied to provide water

control, and other related uses, and to maintain or improve water quality.

Pond Sealing or Lining, Bentonite Sealant - 521c

Practice Description
A liner for a pond or waste storage impoundment consisting of a compacted soil-bentonite mixture.

Purpose
This practice is applied to reduce seepage losses from ponds or waste impoundments for water conservation and environmental protection to accomplish one or more of the following:

• Soils are suitable for treatment with bentonite
• Ponds or waste storage impoundments require treatment to reduce seepage rates and to impede the migration of contaminants to within acceptable limits

Pond Sealing or Lining, Compacted Clay Treatment - 521d

Practice Description
A liner for a pond or waste storage impoundment constructed using compacted soil without soil amendments

Purpose
Apply this practice to reduce seepage losses from ponds or waste storage impoundments constructed for water conservation and environmental protection to accomplish one or more of the following:

• In-place soils at the site would exhibit seepage rates in excess of acceptable limits or would allow an unacceptable migration of contaminants from the impoundment
• An adequate quantity of soil suitable for constructing a clay liner without amendments is available at an economical haul distance

Pond Sealing or Lining, Flexible Membrane - 521a

Practice Description
Pond sealing with a

installing a liner made of

-

rial to reduce seepage to an acceptable level

Purpose
This practice is used to improve the functionality of a pond, and prevent damage to the natural resources including unacceptable loss of water from seepage. This method of pond sealing is relatively expensive, but often necessary for sandy textured sites and projects that require a very effective sealant. Ponds to be lined may include Irrigation Storage Reservoirs, Irrigation Pits, Waste Treatment Lagoons, Waste Treatment Ponds, and Ponds For Livestock/Wildlife.

Pond Sealing or Lining, Soil Dispersant - 521b

Practice Description
A liner for a pond or waste storage impoundment consisting of a compacted soil-dispersant mixture

Purpose
Apply this practice to reduce seepage losses from ponds or waste impoundments for water conservation and environmental protection to accomplish one or more of the following:

- Soils are suitable for treatment with dispersants
- Ponds or waste storage impoundments require treatment to reduce seepage rates and to impede the migration of contaminants to within acceptable limits

Precision Land Forming - 462

Practice Description
Reshaping the surface of land to planned grades

Purpose
All precision land forming shall be planned as an integral part of an overall system to facilitate the conservative use to improve surface drainage and control erosion.

Prescribed Burning - 338

Practice Description

a predetermined area

Purpose
This practice is applied to achieve one or more of the following:

• Control undesirable vegetation
• Prepare sites for harvesting, planting or seeding.
• Control plant disease.

• Improve wildlife habitat
• Improve plant production quantity and/or quality
• Remove slash and debris
• Enhance seed and seedling production
• Facilitate distribution of grazing and browsing animals
• Restore and maintain ecological sites

Prescribed Grazing - 528

Practice Description
Managing the harvest of vegetation with grazing and/or browsing animals

Purpose
This practice may be applied as a part of conservation management system to achieve one or more of the following:

• Improve or maintain desired species composition and vigor of plant communities
• Improve or maintain quantity and quality of forage for grazing
• Improve or maintain surface and/or subsurface water quality and quantity
• Improve or maintain riparian and watershed function
• Reduce accelerated soil erosion, and maintain or improve soil condition
• Improve or maintain the quantity and quality of food and/or cover available for wildlife

to achieve desired conditions

Pumping Plant - 533

Practice Description
A facility that delivers water at a designed

Includes the required pump, associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy sources, and protective structures.

Purpose
This practice may be applied as a part of a resource management system to achieve one or more of the following:

• Delivery of water irrigation, water facilities
• Removal of excessive surface water

water on irrigated land
• Transfer of animal waste as part of a manure transfer system
• Improve energy use

• Improve air quality

Residue & Tillage Management, Reduce Till - 345

Practice Description
Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting the soil-disturbing activities used to grow crops in systems

surface is tilled prior to planting.

Purpose
This practice is applied as part of a conservation management system to support one or more of the following purposes:

• Reduce sheet and rill erosion
• Reduce tillage-induced particulate emissions
• Maintain or increase soil quality and organic matter content
• Reduce energy use
• Increase plant-available moisture

Residue Management, No-Till, and Strip Till - 329

Practice Description
Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue and plant crops.

Purpose
This practice is applied to achieve one or more of the following:

• Reduce sheet and rill erosion
• Reduce wind erosion
• Improve soil organic matter content
• Reduce CO2 losses from soil
• Increase plant-available moisture
• Provide food and escape cover for wildlife

Restoration and Management of Rare and Declining Habitats - 643

Practice Description
Restoring and managing rare and declining habitats and their associated wildlife species to conserve biodiversity.

Purpose
This practice may be installed to provide habitat for rare and declining species.

Riparian Forest Buffer - 391

Practice Description
An area predominantly trees and/or shrubs located adjacent to and up-gradient from water-courses or water bodies

Purpose
This practice is applied to achieve one or more of the following:

• Create shade to lower or maintain water temperatures to improve habitat for aquatic organisms
• Create or improve riparian habitat and provide a source of detritus and large woody debris
• Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow

• Reduce pesticide drift entering the water body
• Restore riparian plant communities
• Increase carbon storage in plant biomass and soils

Road / Trail / Landing Closure - Treatment - 654

Practice Description
The closure, decommissioning, or abandonment of roads, trails, and/or landings and associated treatment to achieve conservation objectives.

Purpose
To minimize various resource concerns associated with existing roads, trails, and/or landings by closing them and treating to a level where one or more the following objectives are achieved:

• Controlling erosion (road, sheet and rill, gully, wind), chemical residues and off-site movement, sediment deposition and damage, accentuated storm runoff, and particulate matter generation;
• Restoring land to a productive state by reestablishing adapted plants and habitat (wildlife food, cover, and shelter), reconnecting wildlife habitat and migration corridors including streams and riparian areas, and controlling noxious and invasive species;
• Reestablishing drainage patterns that existed prior to construction of the road, trail, or landing to restore the form and integrity of associated hill slopes, chan-

their related hydrologic and geomorphic processes;
• Minimizing human impacts to the closure area to meet safety, aesthetic, sensitive area protection, or wildlife habitat requirements

Roof Runoff Structure - 558

Practice Description
Structures that collect, control, and transport precipitation from roofs

Purpose
This practice may be installed to improve water quality, reduce soil

-

tion, protect structures, improve animal health, and/or increase water quantity.

Roofs and Covers - 367

Practice Description
A rigid, semi-rigid, or

membrane, composite material, or roof structure placed over a waste management facility

Purpose
This practice is applied to achieve one or more of the following:

• Water quality improvement
• Diversion of clean water from animal management areas (i.e. barnyard, feedlot or exercise area) and/or waste storage facilities
• Capture of biogas for energy production
• Reducing net effect of greenhouse gas emissions
• Air quality improvement and odor reduction

High Tunnel System - 325

Practice Description
An enclosed polyethylene, polycarbonate, plastic, or fabric covered structure that is used to cover and protect crops from sun, wind, execessive rainfall, or cold to extend the growing season in an envrionmentally safe manner

Purpose
Improve plant health and vigor.

Sediment Basin - 350

Practice Description
A basin constructed to collect and store debris or sediment

Purpose
This practice is applied to achieve one or more of the following:

• Preserve the capacity of reservoirs, wetlands, ditches, canals, diversion, waterways, and streams
• Prevent undesirable deposition on bottom lands and developed areas
• Trap sediment originating from construction sites or other disturbed areas
• Reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural waste solids, and other detritus

Shallow Water Development and Management - 646

Practice Description
The inundation of lands to provide habitat for and/or wildlife

Purpose
To provide habitat for wildlife such as shore-birds, waterfowl, wading

reptiles, amphibians and other species that require shallow water for at least a part of their life cycle.

Silvopasture Establishment - 381

Practice Description
An application estab-lishing a combination of trees or shrubs and compatible forages on the same acreage

Purpose
This practice is applied to achieve one or more of the following:

• Provide forage for live-stock and the production of wood products
• Increase carbon seques-tration
• Improve water quality
• Reduce erosion
• Enhance wildlife habitat
•
• Provide shade for livestock
• Develop renewable energy systems

Solid/Liquid Waste Separation Facility - 632

Practice Description
A
device, settling tank, settling basin, or settling channel used to separate a portion of solids from a liquid waste stream

Purpose
This practice is applied to partition solids, liquids and their associated nutrients as part of a con-servation management system to achieve one or more of the following:

• Improve or protect air quality
• Improve or protect water quality
• Improve or protect animal health
• Meet management objectives

Spoil Spreading - 572

Practice Description
Disposal of surplus excavated materials

Purpose
This practice applies to sites where spoil material is available from the excavation of open channels, ponds or other construction sites to dispose of excess soil from construction activities in an environmentally sound manner that minimizes soil erosion, protects water quality

and landscape

Spring Development - 574

Practice Description
Collection of water from springs or seeps to provide water for a conservation need

Purpose
In areas where a spring or seep will provide a dependable supply of suitable water to improve the quantity and/or quality of water for livestock, wildlife or other agricultural uses

Stream Crossing - 578

Practice Description
Controlling the quantity and quality of stormwater runoff

Purpose
To control stormwater runoff to achieve one or more of the following:
• Minimize erosion and sedimentation during and following construction activities.
• Reduce the quantity of stormwater leaving developing or developed sites.
• Improve the quality of stormwater leaving developing or developed sites

Storm Water Runoff Control - 570

Practice Description
A stabilized area or structure constructed across a stream to provide a travel way for people, livestock,equipment, or vehicles

Purpose
This practice may be applied to achieve improved water quality by the following:

• Reduce sediment, nutrient, organic, and inorganic loading of the stream
• Reduce stream bank and streambed erosion
• Provide crossing for access to another land unit
• Provide limited access for livestock water use

Stream Habitat Improvement and Management - 395

Practice Description
Maintain, improve or restore physical, chemical and biological functions of a stream, and its associated riparian zone, necessary for meeting the life history requirements of desired aquatic species.

Purpose
This practice is applied to achieve one or more of the following:

• Provide suitable habitat

aquatic species
• Provide stream channel and associated riparian conditions that maintain stream corridor ecological processes and hydrological connections of diverse stream habitat types important to aquatic species

Streambank and Shoreline Protection - 580

Practice Description
Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries

Purpose
This practice is applied to achieve one or more of the following:

• To prevent the loss of land or damage to land uses, or facilities adjacent to the banks of streams or constructed channels, shoreline of lakes, reservoirs, or estuaries including the protection of known historical, archeological, and traditional cultural properties
• T
capacity of streams or channels
• Reduce the off-site or downstream effects of sediment resulting from bank erosion
• To improve or enhance the stream corridor for

aesthetics, and recreation

Stripcropping - 585

Practice Description
Growing planned rotations of row crops, forages, small grains, or fallow in a systematic arrangement of equal width strips across a

Purpose
This practice may be applied to achieve one or more of the following:

• Reduce soil erosion from water and transport of sediment and other water-borne contaminants
• Reduce soil erosion from wind
• Protect growing crops from damage by wind-borne soil particles

Structure For Water Control - 587

Practice Description
A structure in a water management system that conveys water, controls the direction or rate of , maintains a desired water surface elevation or measures water

Purpose
The practice may be applied as a management component of a water management system to control the stage, discharge, distribution, delivery or direction of .

Structure for Wildlife - 649

Practice Description
A structure installed to replace or modify a -
life habitat component.
PURPOSE
To provide structures, in proper amounts, locations and seasons to:

Purpose
A structure installed to replace or modify a -
life habitat component.
PURPOSE
To provide structures, in proper amounts, locations and seasons to:
• Enhance or sustain non-domesticated wildlife; or
• Modify existing structures that pose a hazard to wildlife

Surface Drain Field Ditch - 607

Practice Description
A graded ditch for collecting excess water in

Purpose
This practice may be applied as part of a resource conservation system to achieve one or more of the following:

• Interception of excess subsurface water and conveyance to an outlet
• Collection or interception of excess surface water
from natural and graded land surfaces or channel

conveyance to an outlet
• Drainage of surface depressions

Surface Drain, Main or Lateral - 608

Practice Description
An open drainage constructed to a designed cross section alignment and grade

Purpose
This practice is applied as part of a water management system (tailwater recovery) to collect and convey excess irrigation water to storage area for reuse through out the growing season.

Terrace - 600

Practice Description
An earthen embankment, or a combination ridge and channel, constructed

Purpose
This practice is applied as a part of a resource management system for one or more of the following purposes:

• Reduce erosion by reducing slope length
• Retain runoff for moisture conservation

Tree/Shrub Establishment - 612

Practice Description
Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration

Purpose
This practice is applied to establish woody plants for:

• Forest products such as timber, pulpwood, and energy biomass
• Wildlife habitat
• Long-term erosion control and improvement of water quality
• Treating waste
• Storing carbon in biomass
• Energy conservation
• Improving or restoring natural diversity
• Enhancing aesthetics

Tree/Shrub Pruning - 660

Practice Description
The removal of all or part of selected branches, leaders or roots from trees and shrubs

Purpose
This practice when applied may achieve one or more of the following:

• Improve the appearance of trees or shrubs, e.g., ornamental plants and Christmas trees
• Improve the quality of wood products
• Improve the production of plant products, e.g., nuts, fruits, boughs and tips
•
safety hazards
• Improve the growth and vigor of understory plants
• Adjust the foliage and branching density or rooting length for other

wind and snow control, noise abatement, access control, and visual screens and managing competition
• Improve health and vigor of woody plants e.g. disease, insect and injury management

Tree/Shrub Site Preparation - 490

Practice Description
Treatment of areas to improve site conditions for establishing trees and/or shrubs

Purpose
This practice when applied may achieve one or more of the following:

• Encourage natural regeneration of desirable woody plants
• -
lishment of woody plants

Underground Outlet - 620

Practice Description
A conduit or system of conduits installed beneath the surface of the ground to convey surface water to a suitable outlet.

Purpose
This practice is applied to carry water to a suitable outlet from terraces, water and sediment control basins, diversions, waterways, surface drains or other similar practices without causing damage

Upland Wildlife Habitat Management - 645

Practice Description
Provide and manage upland habitats and connectivity within the landscape for wildlife.

Purpose
Treating upland wildlife habitat concerns identi- -
tion planning process that enable movement, or provide shelter, cover, food in proper amounts, locations and times to sustain wild animals that inhabit uplands during a portion of their life cycle.

Vegetated Treatment Area - 635

Practice Description
An area of permanent vegetation used for agricultural wastewater treatment.

Purpose
To improve water quality by reducing loading of nutrients, organics, pathogens, and other contaminants associated with livestock, poultry, and other agricultural operations.

Waste Facility Closure - 360

Practice Description
The closure of waste impoundments (treatment lagoons and liquid storage facilities), that are no longer used for their intended purpose, in an environmentally safe manner

Purpose
This practice is applied to achieve one or more of the following:

- Protect the quality of surface water and groundwater resources
- Eliminate a safety hazard for humans and livestock
- Safeguard the public health

Waste Recycling - 633

Practice Description
Using agricultural wastes such as manure and wastewater or other organic residues

Purpose
This practice is applied to achieve one or more of the following:

- Protect water quality
- Protect air quality
- Provide fertility for production and forest products
- Improve or maintain soil structure
- Provide feedstock for livestock
- Provide a source of energy

Waste Storage Facility - 313

Practice Description
A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by building a structure

Purpose
This practice is installed to temporarily store wastes such as manure, to protect from runoff as a component of an agricultural waste management system.

Waste Transfer - 634

Practice Description
A system using structures, conduits or equipment to convey by-products (wastes) from agricultural operations to points of usage

Purpose
To transfer agricultural material associated with production, processing, and/or harvesting through a hopper or reception pit, a pump (if applicable), a conduit, and/or hauling equipment to:

• A storage/treatment facility
• A loading area, and/or
• Agricultural land for

resource

Waste Treatment - 629

Practice Description
The mechanical, chemical or biological treatment of agricultural waste

Purpose
To use mechanical, chemical, or biological treatment facilities and/processes as part of an agricultural waste management system:

• Improve ground and surface water quality by reducing the nutrient content, organic strength, and/or pathogen levels of agricultural waste
• Improve air quality by reducing odors and gaseous emissions
• Produce value added by-products
• Facilitate desirable waste handling, storage, or land application alternatives

Waste Treatment Lagoon - 359

Practice Description
A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout

Purpose
To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

• Where the lagoon is a component of a planned agricultural waste management system
• Where treatment is needed for organic wastes generated by agricultural production or processing
• On any site where the lagoon can be constructed, operated and maintained without polluting air or water resources
• To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads

Water Harvesting Catchment - 636

Practice Description
The closure of waste impoundments (treatment lagoons and liquid storage facilities), that are no longer used for their intended purpose, in an environmentally safe manner

Purpose
This practice is applied to achieve one or more of the following:

- Protect the quality of surface water and groundwater resources
- Eliminate a safety hazard for humans and livestock
- Safeguard the public health

Water and Sediment Control Basin - 638

Practice Description
An earthen embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet

Purpose
This practice may be applied as part of a resource management system for one or more of the following purposes:

- Reduce watercourse and gully erosion
- Trap sediment
- Reduce and manage on-site and downstream runoff

Watering Facility - 614

Practice Description
A permanent or portable device to provide an adequate amount and quality of drinking water for livestock and or wildlife

Purpose
To provide access to drinking water for livestock and/or wildlife in order to:

- Meet daily water requirements
- Improve animal distribution

Water Well - 642

Practice Description
A hole drilled, dug, driven, bored, jetted or otherwise constructed to an aquifer for water supply

Purpose
This practice is applied to achieve one or more of the following:

• Provide water for livestock, wildlife, irrigation, and other agricultural uses
• Facilitate proper use of vegetation, such as keeping animals on rangeland and pastures and away from streams, and providing water for wildlife

Water Well Decommissioning - 351

Practice Description
The sealing and permanent closure of an inactive, abandoned, or unusable water well

Purpose
This practice is applied to achieve one or more of the following:

• Eliminate physical hazard to people, animals, and farm machinery; and to prevent entry of animals, debris, or other foreign substances
• Prevent contamination of groundwater by

• Restore the natural hydrogeologic conditions, to the extent possible, by preventing vertical cross-contamination or commingling of groundwaters between separate water bearing zones
• Eliminate the possibility of the water well being used for any other purpose
• Allow future alternative use or management of the site

Wetland Creation - 658

Practice Description
The creation of a wetland on a site that was historically non-wetland

Purpose
This practice may be applied as part of a resource management system to create wetland functions and values.

Wetland Enhancement - 659

Practice Description
The rehabilitation of a degraded wetland or the re-establishment of a former wetland so that soils, hydrology, vegetative community, and habitat are a close approximation of the original natural condition and boundary that existed prior to the modi-

Purpose
T -
land conditions to favor -
tions and targeted species by:

• Hydrologic enhancement (depth duration and season of inundation, and/or duration and season of soil saturation)
• Vegetative enhancement (including the removal of undesired species, and/or seeding or planting of desired species)

Wetland Restoration - 657

Practice Description
The rehabilitation of a degraded wetland or the reestablishment of a wetland so that soils, hydrology, vegetative community, and habitat are a close approximation of the original natural condition that existed

the extent practicable

Purpose
To restore wetland function, value, habitat, diversity, and capacity to a close approximation of the pre-disturbance by:

• Restoring hydric soil
• Restoring hydrology (depth duration and season of inundation, and/or duration and season of soil saturation)
• Restoring native vegetation (including the removal of undesired species, and/or seeding or planting of desired species

Wetland Wildlife Habitat Management - 644

Practice Description
Retaining, developing or managing wetland habitat for wetland wildlife

Purpose
To maintain, develop, or improve wetland habitat for waterfowl, shorebirds, fur-bearers, or other wetland dependent

fauna on or adjacent to wetlands, rivers, lakes and other water bodies where wetland associated wildlife habitat can be managed. This practice applies to natural wetlands and/or water bodies as well as wetlands that may have been previously restored (657), enhanced (659), and created (658).

Woody Residue Treatment - 384

Practice Description
Treating woody plant residues created during forestry, agroforestry and horticultural activities to achieve management objectives

Purpose
This practice is applied to achieve one or more of the following:

• Reduce hazardous fuels
• Reduce the risk of harmful insects and disease
• Protect/maintain air quality by reducing the

• Improve access to forage for grazing and browsing animals
• Enhance aesthetics
• Reduce the risk of harm to humans and livestock
• Improve the soil organic matter
• Improve the site for

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County/Field Service Center Index

County	Field Service Center	Phone
Autauga	Autaugaville	(334) 365-5532
Baldwin	Bay Minette	(251) 937-3297
Barbour	Clayton	(334) 775-3266
*Bibb	Centerville	(334) 926-4360
Blount	Oneonta	(205) 274-2363
*Bullock	Union Springs	(334) 738-2079
Butler	Greenville	(334) 382-8538
Calhoun	Anniston	(256) 835-7821
*Chambers	LaFayette	(334) 864-9983
Cherokee	Centre	(256) 927-8732
*Chilton	Clanton	(205) 646-0277
*Choctaw	Butler	(205) 459-2496
Clarke	Jackson	(251) 246-0245
*Clay	Ashland	(256) 354-7512
*Cleburne		(256) 463-2877
Coffee	New Brockton	(334) 894-5581
Colbert	Tuscumbia	(256) 383-4323
Conecuh	Evergreen	(251) 578-1520
*Coosa	Rockford	(256) 377-4750
Covington	Andalusia	(334) 222-3519
Crenshaw	Luverne	(334) 335-3613
Cullman	Cullman	(256) 734-6471
Dale	Ozark	(334) 774-4749
Dallas	Selma	(334) 872-2611
Dekalb	Rainsville	(256) 638-6398
Elmore	Wetumpka	(334) 567-2264
Escambia	Brewton	(251) 867-3185
Poarch Band of Creek Indians		(251) 368-0826
Etowah	Gadsden	(256) 546-2336
Fayette	Fayette	(205) 932-8959
Franklin	Russellville	(256) 332-0274
Geneva	Geneva	(334) 684-2235
Greene	Eutaw	(205) 372-3271
Hale	Greensboro	(334) 624-3856
Henry	Abbeville	(334) 585-2284
Houston	Dothan	(334) 793-2310
Jackson	Scottsboro	(256) 574-1005
Jefferson	Bessemer	(205) 424-9990
Lamar	Vernon	(205) 695-7622
	W	

County/Field Service Center Index

County	Field	k	Phone
Laurderdale	Florence		(256) 764-5833
Lawrence	Moulton		(256) 974-1174
Lee	Opelika		(334) 745-4791
Limestone	Athens		(256) 232-4025
Lowndes	Haynesville		(334) 548-2767
Macon	Tuskegee		(334) 725-3321
Madison	Huntsville		(256) 532-1677
Marengo	Linden		(334) 295-8724
Marion	Hamilton		(205) 921-3103
Marshall	Guntersville		(256) 582-3923
Mobile	Mobile		(251) 441-6505
Monroe	Monroeville		(251) 743-2587
Montgomery	Montgomery		(334) 279-3579
Morgan	Hartselle		(256) 773-6541
Perry	Marion		(334) 683-9017
Pickens	Carrollton		(205) 367-8168
Pike	Troy		(334) 566-2300
Randolph	Wedowee		(256) 357-4561
Russell	Phenix City		(334) 297-6692
Shelby	Columbiana		(205) 669-5121
*St. Clair	Pell City		(205) 338-7215
Sumter	Livingston		(205) 652-5105
Talladega	Talladega		(256) 362-8210
Tallapoosa	Alexander City		(256) 329-3084
Tuscaloosa	Tuscaloosa		(205) 553-1733
Walker	Jasper		(205) 387-1879
*Washington	Chatom		(251) 847-6041
Wilcox	Camden		(334) 682-4117
*Winston	Double Springs		(205) 489-5227

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Helping People Help the Land

APPENDIX F:
Financial Alternatives

Federal Funding

Department of the Interior's Land and Water Conservation Fund

The Land and Water Conservation Fund (LWCF) is a program supporting the protection of federal public lands and waters---including national parks, forests, wildlife refuges and recreation area---and voluntary conservation on private land. LWCF investments secure public access, improve recreational opportunities, and preserve ecosystem benefits for local communities.

The LWCF State Grants program provides matching grants to states and local governments for the acquisition and development of public outdoor recreation areas and facilities. Over its first 55 years (1965-2020), LWCF provided more than $3.9 billion to acquire new federal recreation lands as grants to state and local governments. The fund has provided 41,999 grants to state and local governments.

https://www.doi.gov/lwcf

Alabama Gulf Coast Recovery Council

The Alabama Gulf Coast Recovery Council is made up of 10-member council that is chaired by Governor Kay Ivey and co-chaired by the Director of the Alabama State Port Authority, James Lyons. Other members of the council include the chairman of the Baldwin County Commission, the president of the Mobile County Commission, and the mayors of Bayou La Batre, Dauphin Island, Fairhope, Gulf Shores, Mobile, and Orange Beach. Projects for funding consideration can be submitted through the Alabama Coastal Restoration portal.

https://www.alabamacoastalrestoration.org/Projects

National Fish Habitat Action Plan

The mission of the National Fish Habitat Action Plan is to protect, restore, and enhance the nation's fish and aquatic communities through partnerships that foster fish habitat conservation and improve the quality of life for the American people. This mission will be achieved by: 1) supporting existing fish habitat partnerships and fostering new efforts, 2) mobilizing and focusing national and local support for achieving fish habitat conservation goals, 3) setting national and regional fish habitat conservation goals, 4) measuring and communicating the status and needs of fish habitats, and 5) providing national leadership and coordination to conserve fish habitats.

http://www.fishhabitat.org/

National Oceanic and Atmospheric Administration's Community-based Marine Debris Removal Grant Program

The National Oceanic and Atmospheric Administration's (NOAA) Marine Debris Program offers funding that supports driven, community-based marine debris prevention and removal projects. These projects benefit coastal habitats, waterways, and wildlife including migratory fish.

https://marinedebris.noaa.gov/funding/funding-opportunities

National Oceanic and Atmospheric Administration's Marine Debris Prevention, Education and Outreach Partnership Grants

NOAA's Marine Debris Program offers funding to support activities to educate the public about the issue of marine debris that: 1) encourage changes in behavior to reduce and address marine debris; 2) develop and implement activities to reduce and prevent marine debris working with students, teachers, industries, and the public; and, 3) engage the public in active, personal participation (e.g., a small-scale shoreline cleanup with students or other hands-on activities). This grant's purpose is to involve audiences in measurable behavior changing activities and limit the increase of marine debris in the world's oceans.

https://marinedebris.noaa.gov/funding/funding-opportunities

National Oceanic and Atmospheric Administration's Gulf of Mexico Bay-Watershed Education and Training Program

NOAA Gulf of Mexico Bay-Watershed Education and Training (Gulf B-WET) Program is an environmental education program that promotes locally relevant, authentic, experiential learning focused on K–12 audiences. The primary delivery of Gulf B-WET is through competitive funding that promotes Meaningful Watershed Educational Experiences, which are multi-stage activities that include learning both outdoors and in the classroom and aim to increase the environmental literacy of all participants. Teachers should support students to investigate topics both locally and globally that are of interest. Students should strive to identify actions that are available to address the environmental issues within their focus area.

http://sero.nmfs.noaa.gov/outreach_education/gulf_b_wet/

National Oceanic and Atmospheric Administration's RESTORE Act Science Program

This funding opportunity focuses on living coastal and marine resources and their habitats and continues the Science Program's commitment to producing timely and high-quality scientific findings and products to support the management and sustainability of the Gulf of Mexico ecosystem, including its fisheries. The funding competition has two priorities. A research priority directed at six specific areas of living coastal and marine resource research, and a decision-support tool priority directed at improving the tools available for resource management. To receive funding, applicants need to directly address a resource management need and have a clear plan for how their research findings or decision-support tool will be used by specific resource managers.

https://restoreactscienceprogram.noaa.gov/funding-opportunities

National Oceanic and Atmospheric Administration's Broad Agency Announcement

The Broad Agency Announcement is a mechanism to encourage research, education and outreach, innovative projects, or sponsorships that are not addressed through NOAA's competitive discretionary programs. Project proposals included in RFPs must address one or more of the following four long-term mission goal descriptions contained in the NOAA Strategic Plan: 1) climate adaptation and mitigation, 2) weather-ready nation, 3) healthy oceans, 4) resilient coastal communities and economies.

https://www.fisheries.noaa.gov/grant/fy-2018-2020-broad-agency-announcement

National Oceanic and Atmospheric Administration's Community-based Restoration Program

The NOAA Restoration Center's Community-based Restoration Program invests money and technical expertise in high-priority habitat restoration projects that instill strong conservation values and engage citizens in hands-on activities. Through this program, NOAA, its partners, and thousands of volunteers are actively restoring coastal, marine, and migratory fish habitat across the nation. In 2007, NOAA's Community-based Restoration Program and the Southeast Aquatic Resources Partnership (SARP) formed a long-term partnership to fund, implement and monitor restoration projects benefitting marine and anadromous fish habitat in the nine southeastern states. The program: 1) invests millions of dollars annually in restoration, 2) leverages double and triple the outcome by working with partner organizations, 3) provides restoration science and technical guidance, including assistance with environmental compliance, and monitoring, 4) promotes community involvement and stewardship of local projects, and 5) implements special initiatives to remove marine debris and re-open coastal river habitat to fish that migrate inland from the ocean.

http://www.habitat.noaa.gov/restoration/programs/crp.html

National Oceanic and Atmospheric Administration's Environmental Literacy Program

The Environmental Literacy Program supports long-term partnerships that enable the education community to incorporate and deliver the latest scientific information on the topics of the ocean, coasts, weather, and climate. NOAA's Office of Education regularly offers the Environmental Literacy Grant competition. Annual environmental literacy grants are creating new models for how education can improve community resilience.

http://www.noaa.gov/office-education/elp/grants

Natural Resource Damage Assessment Restoration and Implementation

The objective of the Natural Resource Damage Assessment Restoration and Implementation Program is to restore natural resources injured by oil spills or hazardous substance releases. Assistance is provided to individuals and groups to fund assessments, implementation, recovery of damages, or any related restoration activity necessary to meet the intent of the Natural Resource Damage Assessment and Restoration Program.

https://www.darrp.noaa.gov/

National Science Foundation's Environmental Engineering and Sustainability Program

The Environmental Engineering and Sustainability (EES) Cluster is home to three programs with a mission to promote and encourage transformative research in sustainable engineering and systems that support the natural environment. EES programs seek projects that identify, monitor, and mitigate impacts of human activities, advance resource and energy conservation and recovery, investigate the interface between nanoparticles and surrounding environments to elucidate impacts and/or develop novel applications, and support cost-effective solutions to protect ecological and human health in a sustainable manner. The EES Cluster has multiple topics that cross programs both within CBET and throughout NSF.

https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505692&org=NSF

U.S. Department of Agriculture, Natural Resources Conservation Service's Environmental Quality Incentives Program (Baldwin County)

The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland. The EQIP may also help producers meet federal, state, tribal, and local environmental regulations. Contact the Baldwin County District Conservationist for more information.

https://www.nrcs.usda.gov/wps/portal/nrcs/site/al/home/

U.S. Department of Agriculture, Natural Resources Conservation Service's Conservation Stewardship Program

The Conservation Stewardship Program (CSP) helps landowners build on existing conservation efforts while strengthening their farming operation. Financial and technical assistance can help improve grazing conditions, increase crop yields, or develop wildlife habitat. The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), office works directly with producers to design a custom CSP plan. Bundles have enhancements grouped according to land use—crop, pasture, range and forest-as well as our agency initiatives. Bundles receive a higher level of financial assistance to encourage the holistic approach to generate additional conservation benefits.

https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

U.S. Department of Agriculture, Natural Resources Conservation Service's Agricultural Conservation Easement Program

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands. Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species; improve water quality by filtering sediments and chemicals; reduce flooding; recharge groundwater; protect biological diversity; and provide opportunities for educational, scientific and limited recreational activities.

https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/

U.S. Department of Agriculture, Natural Resources Conservation Service's Emergency Watershed Protection Program

The Emergency Watershed Protection Program (EWP) is a federal emergency recovery program that helps local communities recover after a natural disaster. Administered by the USDA's NRCS, the purpose of the EWP is to undertake emergency measures, including the purchase of flood plain easements for runoff retardation and soil erosion prevention, to safeguard lives and property from floods, drought and the products of erosion that may occur during, or as a result of, a natural disaster.

https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

U.S. Department of Agriculture, Natural Resources Conservation Service's Regional Conservation Partnership Program

The Regional Conservation Partnership Program (RCPP) promotes coordination of NRCS conservation activities with partners that offer value-added contributions to expand our collective ability to address on-farm, watershed, and regional natural resource concerns. Through RCPP, NRCS seeks to co-invest with partners to implement projects that demonstrate innovative solutions to conservation challenges and provide measurable improvements and outcomes tied to the resource concerns they seek to address.

https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/rcpp/

U.S. Department of Agriculture, Natural Resources Conservation Service's Watershed and Flood Prevention Operations Program

Administered by the USDA's NRCS, the Watershed and Flood Prevention Program (WFPO) provides technical and financial assistance to States, local governments and Tribes to plan and implements the protection and restoration of watersheds up to 250,000 acres. NRCS is investing $150 Million in 51 new projects in 48 states through the WFPO Program that include watershed protection, flood mitigation, water quality improvements, soil erosion and reduction, water management, sediment control, fish and wildlife management and hydropower.

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/watersheds/?cid=nrcs143_010955

U.S. Endowment and U.S. Environmental Protection Agency's Healthy Watersheds Consortium Grant Program

The Healthy Watersheds Consortium Grant Program goal is to accelerate strategic protection of healthy, freshwater ecosystems and their watersheds. This goal will be achieved by: 1) funding key projects identified in existing watershed protection or conservation plans, 2) building the sustainable organizational infrastructure, social support, and long-term funding commitments necessary to implement large-scale protection of healthy watersheds, and 3) supporting innovative or catalytic projects that may accelerate or broadly advance the field of practice for watershed protection efforts.

http://www.usendowment.org/healthywatersheds.html

U.S. Environmental Protection Agency's Water Pollution Control (Section 106) Grant Program

Under Section 106 of the CWA (33 U.S. Code §1256), the U.S. Environmental Protection Agency (USEPA) provides assistance to states (including territories and the District of Columbia), interstate agencies, and eligible tribes to establish and implement ongoing water pollution control programs. Each state and territory has established programs to protect and restore fresh waters, coastal waters, and wetlands as outlined in the CWA. Section 106 grants support the implementation of these CWA programs including: 1) monitoring and assessing ambient water quality, 2) developing and reviewing water quality standards, 3) developing total maximum daily loads, 4) providing permits to dischargers through the NPDES, 5) overseeing and enforcing NPDES permits, 6) developing watershed and groundwater plans; and 7) providing training and public information.

https://www.epa.gov/water-pollution-control-section-106-grants/grants-state-and-interstate-agencies-under-section-106

U.S. Environmental Protection Agency's Wetland Program Development Grants

The Wetland Program Development Grants provide eligible applicants an opportunity to conduct projects that promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. The program is meant to build the capacity of state/tribal/local governments to increase the quantity and quality of wetlands in the U.S. by conserving and restoring wetland acreage and improving wetland condition. Core elements must include one or more of the following: 1) monitoring and assessment, 2) voluntary restoration and protection, 3) regulatory approaches including CWA 401 certification, and 4) wetland-specific water quality standards.

https://www.epa.gov/wetlands/wetland-program-development-grants

U.S. Environmental Protection Agency's Urban Waters Small Grants

The mission of USEPA's Urban Waters Program is to help local residents and their organizations, particularly those in underserved communities, restore their urban waters in ways that also benefit community and economic revitalization. Urban Waters Small Grants are expanding the ability of communities to engage in activities that improve water quality in a way that also advances community priorities.

https://www.epa.gov/urbanwaters/urban-waters-small-grants

U.S. Environmental Protection Agency's Gulf of Mexico Program

Since its inception in 1988, the Gulf of Mexico Program has developed multiple jurisdictional agreements with federal and state partners as well as international partners. With the cooperation of its partners, the Gulf of Mexico Program successfully implements and funds projects that lead to a thriving ecosystem. The projects center on: 1) improving and/or restoring water and habitat quality to meet water quality standards in watersheds throughout the five Gulf States and the Mississippi River Basin, 2) promoting and supporting environmental education and outreach to the inhabitants of the Gulf of Mexico watershed, 3) strengthening community resilience by promoting and supporting environmental education and outreach to the general public and vulnerable communities, 4) protecting, enhancing, or restoring coastal and upland habitats within the Gulf of Mexico watershed.

https://www.epa.gov/aboutepa/about-gulf-mexico-program-gmp

U.S. Environmental Protection Agency's Source Water Protection Funding

The program goal is to support the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects (including health and welfare effects), extent, prevention, reduction, and elimination of water pollution. Funding priorities include, but are not limited to, training, surveys, studies, investigations, and demonstration projects to support water quality improvement, watershed planning and management, nonpoint source planning, wetlands protection, coastal and estuarine planning, treatment technologies, water efficiency, and environmental management systems.

https://www.epa.gov/sourcewaterprotection/source-water-protection-funding

U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program

Through voluntary agreements the Partners program provides expert technical assistance and cost-share incentives directly to private landowners to restore fish and wildlife habitats. Field biologists work one-on-one with landowners and partners to plan, implement, and monitor activities. Working together with more than 45,000 landowners and 3,000 conservation partners, the Program has successfully restored over 1,000,000 acres of wetland habitat; 3,000,000 acres of upland habitat and 11,000 miles of streams.

https://www.fws.gov/partners/

U.S. Fish and Wildlife Service Coastal Program
The Coastal Program is one of USFWS's most effective resources for restoring and protecting fish and wildlife habitat on public and privately owned lands. Working with partners, locally based staff provide technical assistance for habitat conservation design and planning and financial assistance for habitat restoration and protection projects.

https://www.fws.gov/coastal/

U.S. Fish and Wildlife Service National Coastal Wetlands Conservation Grant Program

The National Coastal Wetlands Grant annually delivers conservation dollars to help coastal states and U.S. territories to protect and restore coastal wetlands. Funding is provided through the Sport Fish Restoration and Boating Trust Fund. State and local governments, private landowners, conservation groups and other partners contribute additional funds to these projects, which acquire, restore, or enhance coastal wetlands and adjacent uplands to provide long-term conservation benefits to fish and wildlife and their habitats.

https://www.fws.gov/coastal/coastalgrants/

U.S. Fish and Wildlife Service Boating Infrastructure Grant Program

The Boating Infrastructure Grant Program provides grant funds to the states, the District of Columbia, and insular areas to construct, renovate, and maintain tie-up facilities with features for transient boaters in vessels 26 feet or more in length and to produce and distribute information and educational materials about the program. The Boating Infrastructure Grant Program includes two funding tiers: Tier One (non-competitive) and Tier Two (nationally competitive). Under Tier One, each state, the District of Columbia, and insular areas may receive funding for eligible

projects up to $200,000 annually. Tier Two funds are made available through a nationally competitive process. Tier Two proposals received are reviewed, evaluated, and ranked by a national panel, with the final decision for funding made by the Director of USFWS. The ranking criteria, eligible projects, and regulations are listed in 50 CFR 86.

https://wsfrprograms.fws.gov/Subpages/GrantPrograms/BIG/BIG.htm

U.S. Fish and Wildlife Service State Wildlife Grant Program

The State Wildlife Grant Program provides federal grant funds to state fish and wildlife agencies for developing and implementing programs that benefit wildlife and their habitats, including species that are not hunted or fished. Grant funds may be used to address a variety of conservation needs, such as research, fish and wildlife surveys, species restoration, habitat management, and monitoring, that are identified within a state's Wildlife Action Plan. These funds may also be used to update, revise, or modify a state's Wildlife Action Plan.

https://wsfrprograms.fws.gov/Subpages/GrantPrograms/SWG/SWG.htm

U.S. Fish and Wildlife Service Urban Wildlife Conservation Program

The goal of the Urban Wildlife Refuge Program is to engage urban communities as partners in wildlife conservation. Excellence may be achieved through the eight standards that serve as a framework for collaboration among the Service and urban communities, whether such collaboration is on or off USFWS lands. The eight standards are: 1) know and relate to the community, 2) connect urban people with nature via stepping stones of engagement, 3) build partnerships, 4) be a community asset, 5) ensure adequate long-term resources, 6) provide equitable access, 7) ensure visitors feel safe and welcome, and 8) model sustainability.

https://www.fws.gov/urban/soe.php

State Funding

Alabama Clean Water State Revolving Fund

The Clean Water State Revolving Fund and the Drinking Water State Revolving Fund are low interest loan programs intended to finance public water and wastewater infrastructure improvements and stormwater/nonpoint source projects in Alabama. Stormwater/nonpoint source projects can include decentralized wastewater treatment, streambank restoration, green roofs, permeable pavements, rain gardens, and bio-infiltration practices.

http://www.adem.state.al.us/programs/water/srfguidance.cnt

Alabama Coastal Area Management Program

Annual Alabama Coastal Area Program (ACAMP) activities include Coastal Cleanup, implementation of public access construction projects, planning support for local governments, and providing grant funds to Alabama's coastal communities and partners. ACAMP's annual grant program supports projects that protect, enhance, and improve the management of natural,

cultural, and historical coastal resources and that increase the sustainability, resiliency, and preparedness of coastal communities and economies.

http://www.outdooralabama.com/alabama-coastal-area-management-program

Alabama Department of Environmental Management Section 319 Grant Funds

Alabama Nonpoint Source Implementation Grants are to fund projects in support of Alabama's Nonpoint Source Management Program. Funding is distributed via a competitive process to projects that will lead to direct reductions in pollutant loads and measurable water quality improvements.

http://adem.alabama.gov/programs/water/nps/319grant.cnt

Private Funding

Conserve Alabama Foundation Watershed Management Outreach Program

In partnership with The Nature Conservancy in Alabama and the Mobile Bay National Estuary Program, Conservation Alabama Foundation develops information and materials to distribute to coastal communities that are involved in the watershed management planning process. Conservation Alabama Foundation's role is to make sure the community is kept up to date and aware of the plan itself and its progress.

https://www.conservationalabamafoundation.org/

Cornell Douglas Foundation Grant Program

The Cornell Douglas Foundation provides grants to organizations that advocate for environmental health and justice, encourage stewardship of the environment, and further respect for sustainability of resources. The average grant amount is $10,000. Watershed protection and land conservation are among several other areas of interest. Environmental focus areas must include one or more of the following: 1) animals/wildlife, 2) biodiversity, 3) conservation, 4) environmental health, 5) environmental justice, 6) habitats/ecosystems, 7) plants, 8) pollution, 9) stormwater, 10) sustainability, 11) trees/forests, 12) water, and 13) watersheds.

https://cornelldouglas.org/

Gulf of Mexico Research Initiative RFP Opportunities

The objectives of the Gulf of Mexico Research Initiative are to investigate the impacts of the oil, dispersed oil, and dispersant on the ecosystems of the Gulf of Mexico and affected Gulf coastal states in a broad context of improving fundamental understanding of the dynamics of such events, the associated environmental stresses, and the public health implications. The Gulf of Mexico Research Initiative will also develop improved spill mitigation, oil and gas detection, characterization, and remediation technologies. The ultimate goal is to improve society's ability to understand and respond to the impacts of petroleum pollution and related stressors to the marine and coastal ecosystems, with an emphasis on conditions in the Gulf of Mexico.

Research themes include: 1) physical distribution, dispersion, and dilution of petroleum (oil and gas), its constituents, and associated contaminants (e.g., dispersants) under the action of physical

oceanographic processes, air-sea interactions, and tropical storms; 2) chemical evolution and biological degradation of the petroleum/dispersant systems and subsequent interaction with coastal, open-ocean, and deep-water ecosystems; 3) environmental effects of the petroleum/dispersant system on the sea floor, water column, coastal waters, beach sediments, wetlands, marshes, and organisms; and the science of ecosystem recovery; 4) technology developments for improved response, mitigation, detection, characterization, and remediation associated with oil spills and gas releases, and 5) impact of oil spills on public health, including behavioral, socioeconomic, environmental risk assessment, community capacity, and other population health considerations and issues.

http://gulfresearchinitiative.org/request-for-proposals/

Gulf Research Program Capacity Building Grants

These grants support projects conducted by community and/or regionally focused organizations that seek to advance understanding of how science can serve community needs and to extend the use of such information to address coastal challenges. Proposed projects should seek to improve the capacity of organizations by supporting the development, expansion, testing, and/or evaluation of strategies, programs, and approaches for achieving these goals. For the purposes of these grants, "community and/or regionally-focused organizations" are defined as nonprofit and nonacademic entities that support educational, service, and/or coordination activities and that typically include some engagement of community residents, decision-makers, and/or leaders at a regional, state, or local level.

https://www.nationalacademies.org/gulf/gulf-research-program

Gulf Star Grants Program

Gulf Star is a public-private partnership administered by the Gulf of Mexico Alliance, a 501c3 public charity with flexibility to collaborate with others in the Gulf region. Gulf Star partners are agencies, businesses, private organizations, and citizens that provide funding for projects that are tied directly to Gulf economies, such as sustainable seafood, loss of critical habitats, coastal resilience, water resources, living marine resources, and monitoring. Priority issues include: Coastal Resiliency, Data & Monitoring, Education & Engagement, and Wildlife & Fisheries.

https://gulfofmexicoalliance.org/tools-and-resources/gulfstar/

Legacy Environmental Education Grants

Legacy provides environmental education grants annually through the Legacy Grants Program. Funds for this program are allocated specifically to assist with helping to create environmentally responsible citizens through education. Any non-profit, tax-exempt Alabama organization or school planning a community based environmental program is encouraged to apply. Grants are available in any amount up to $10,000.

http://legacyenved.org/legacy-grants/

National Education Association Foundation Captain Planet Foundation Grants for the Environment

The Captain Planet Foundation funds hands-on environmental projects that encourage innovative programs that empower children and youth around the world to work individually and collectively to solve environmental problems in their neighborhoods and communities. The maximum award is $2,500.

https://www.neafoundation.org/pages/resources-other-grant-opportunities

National Environmental Education Foundation Everyday Capacity Building Grants

Everyday Capacity Building Grants provide "Friends Groups" with grant funds of up to $5,000 to help build their capacity to serve public lands. That help often comes from nonprofit organizations whose missions are focused on serving public land sites in the nation and the improvement and responsible use of those sites. Sometimes these organizations are called Friends Groups, sometimes Cooperating Associations, and sometimes, simply, a partner. They are invaluable in supporting, promoting and helping maintain public lands.

https://www.neefusa.org/grants

National Fish and Wildlife Foundation's Conservation Partners Program

The Conservation Partners Program is a collaborative effort between the U.S. Department of Agriculture's NRCS, National Fish and Wildlife Foundation (NFWF), and other regional/initiative-specific partners.

The purpose of the partnership is to provide grants on a competitive basis to increase technical assistance capacity to advance the implementation of three complementary programs: NRCS's Landscape Conservation Initiatives, NFWF's Conservation Priorities, and the NRCS-USFWS partnership—Working Lands for Wildlife. To maximize benefits to these three programs, the program also seeks to target investments in certain identified Program Priority Areas.

https://www.nfwf.org/programs/conservation-partners-program

National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund (Alabama)

To date, the NFWF has awarded nearly $52 million from the Gulf Environmental Benefit Fund for 13 restoration projects in the state of Alabama. These projects were selected for funding following extensive consultation with the Alabama Department of Conservation and Natural Resources, USFWS, and NOAA. The Alabama projects address high-priority conservation needs tied to damage from the Deepwater Horizon oil spill. They represent important efforts to protect and enhance natural and living resources, as well as significant planning efforts to develop future projects for consideration under the Gulf Environmental Benefit Fund.

https://www.nfwf.org/gulf-environmental-benefit-fund

National Fish and Wildlife Foundation's National Wildlife Refuge Friends Grant Program

National Wildlife Refuge Friends organizations play an important role in building critical community support for their local National Wildlife Refuges. The Program funds projects that assist organizations in being effective co-stewards of important natural resources within the National Wildlife Refuge System. The program's goals are to assist refuge Friends organizations

in developing projects, expanding and increasing their capacity and skills, meeting local refuge conservation challenges, and gaining and building community recognition.

https://www.nfwf.org/programs/national-wildlife-refuge-friends

National Fish and Wildlife Foundation's Five Star and Urban Waters Restoration Program

The Five Star and Urban Waters Restoration Program seeks to develop nationwide-community stewardship of local natural resources, preserving these resources for future generations and enhancing habitat for local wildlife. Projects seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. Funded priorities include: 1) on-the-ground wetland, riparian, in-stream and/or coastal habitat restoration; 2) meaningful education and training activities, either through community outreach, participation and/or integration with K-12 environmental curriculum; 3) measurable ecological, educational, and community benefits; and 4) partnerships (Five Star projects should engage a diverse group of community partners to achieve ecological and educational outcomes).

https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program

National Fish and Wildlife Foundation's Gulf Coast Conservation Grant Program

The NFWF is soliciting proposals to support conservation projects that enhance coastal habitats of the Gulf of Mexico and bolster priority fish and wildlife populations, while strengthening resilience within the coastal region. The Gulf Coast Conservation Grants Program supports priority conservation needs of the Gulf that are not otherwise expected to be funded under the NFWF's Gulf Environmental Benefit Fund or other funding opportunities associated with the Deepwater Horizon oil spill (e.g., RESTORE Act, Natural Resource Damage Assessment, Gulf of Mexico Research Initiative, etc.). The program seeks to advance innovative restoration concepts and approaches and fund species and habitat projects benefitting Gulf coastal ecosystems and communities.

https://www.nfwf.org/programs/gulf-coast-conservation-grants-program

The Home Depot's Community Impact Grants Program

The Home Depot Foundation offers grants up to $5,000 to IRS-registered 501c designated organizations and tax-exempt public service agencies in the U.S. using the power of volunteers to improve the physical health of their community. Grants are given in the form of The Home Depot gift cards for the purchase of tools, materials, or services.

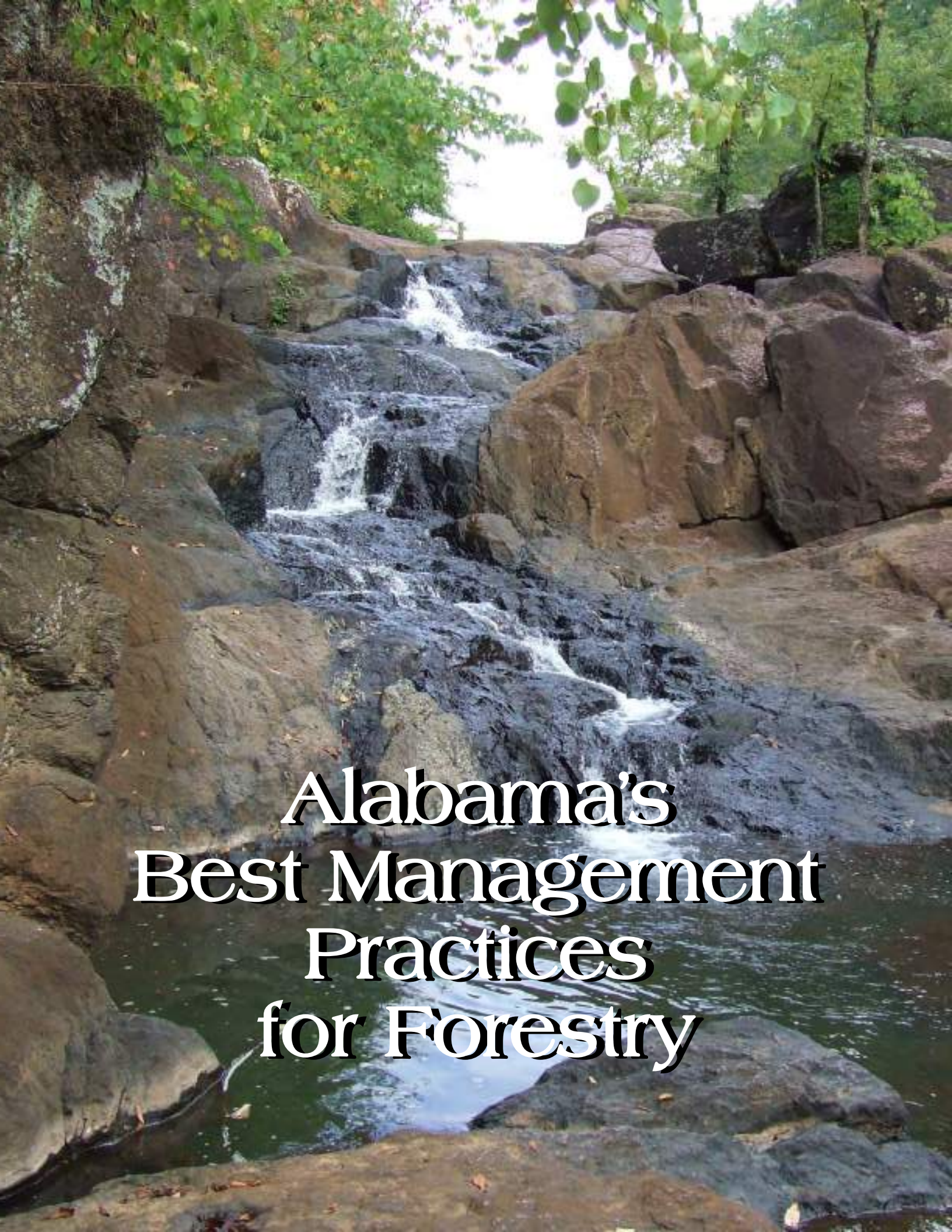
https://corporate.homedepot.com/foundation/communityimpactgrants

The Kresge Foundation's Environmental Grant Program

The program is offered to assist communities that address climate change mitigation measures. Focus areas include: 1) climate resilience and urban opportunity, 2) climate resilience in coastal cities and regions, 3) sustainable water resources management in a changing climate, and 4) urban energy resilience.

https://kresge.org/programs/environment

APPENDIX G:
Alabama's Best Management Practices for Forestry



Alabama's Best Management Practices for Forestry

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FOREWORD

Water Quality Management in Alabama

The Alabama Environmental Management Act authorizes the Alabama Department of Environmental Management (ADEM) to establish and enforce water quality standards, regulations and penalties in order to carry out the provisions of state and federal water quality laws. From that authorization, ADEM Administrative Code prohibits the deposition of pollutants into or the degradation of the physical, chemical, or biological integrity of waters of the state (see glossary for definitions). With regard to silviculture, nonpoint source pollutants include, but are not limited to, sediment, organic materials, temperature, trash, pesticides and nutrients (see glossary for definitions and impacts) that are man induced.

In addition, the Alabama Water Pollution Control Act states that ADEM shall have the authority to propose remedial measures necessary to clean up waters that have been determined to be polluted. ADEM advocates, however, that avoiding environmental problems through voluntary application of preventative techniques is much less expensive, more cost effective and practical than restoration after the fact.

The Alabama Forestry Commission's Role in Best Management Practices

The Alabama Forestry Commission was established and is mandated by Code of Alabama, 1975, Section 9-3-4 (1), to protect, conserve, and increase the timber and forest resources of the state. All citizens of Alabama are our valued customers. However, as the lead agency for forestry in the state, we seek to strike a balance between serving Alabama forest owners' needs and enhancing the benefits flowing to society from their forests. Our mission is to promote environmentally and economically sound forestry practices, and we are committed to optimizing available resources to achieve this mission.

The Alabama Forestry Commission is not an environmental regulatory or enforcement agency, but it does accept the responsibility to maintain and update *Alabama's Best Management Practices (BMPs) for Forestry* whenever necessary to help Alabama's forestry community meet state water quality needs. The Commission will work in a cooperative manner with all state and federal agencies concerned, and is determined to utilize technical expertise from within and without the forestry community in any BMP revision process.

The Alabama Forestry Commission also accepts responsibility to provide education and technical assistance to landowners, loggers, foresters, vendors and the general public to ensure that good stewardship principles are understood and used.

Purpose of Best Management Practices

Alabama's Best Management Practices for Forestry are **non-regulatory guidelines** (except for the U.S. Army Corps of Engineer's baseline BMPs on pages 16 and 17 which are mandatory) suggested to help Alabama's forestry community maintain and protect the physical, chemical and biological integrity of waters of the state as required by the Federal Water Pollution Control Act, the Alabama Water Pollution Control Act, the Clean Water Act, the Water Quality Act, and the Coastal Zone Management Act.

The BMPs in this booklet lay out a framework of sound stewardship practices that, when consistently applied, will contribute positively to maintaining a high degree of water quality flowing from a forest. These BMPs are not intended to be all inclusive. Rational and objective on-site judgement must be applied to ensure that water quality standards are maintained.

The most important guidance that these BMPs can offer the forestry community is to **think and plan before you act**. Adequate forethought will pay off in two ways: to avoid unnecessary site disturbance or damage in the first place and to minimize the expense of stabilizing or restoring unavoidable disturbances when the operation is finished.

The enclosed BMPs are directed only toward the maintenance of water quality.

However, these BMPs will have an indirect, positive impact on other forest resource values. Sound stewardship principles that enhance wildlife habitat, clean air, aesthetics and general environmental quality are compatible with water quality BMPs and the Alabama Forestry Commission encourages their use when applicable to the landowner's objectives.

Following sound stewardship principles in carrying out forestry practices will ensure that our forests continue to meet the needs of their owners, provide jobs, forest products, clean water and a healthy environment without costly regulations. Only through sound stewardship principles will all of these needs be met.

Responsibility

Responsibility for maintaining water quality standards during a forestry operation has been broadly interpreted to include all parties involved in the authorization, planning or implementation of the operation. **The responsible parties may include professional forestry practitioner(s) such as forest resource managers, timber purchasers, loggers, vendors, forest engineers or others.**

Due to this inherent responsibility it is in the best interest of all those involved in silvicultural operations to make every effort to prevent and correct violations of state and federal water quality laws, regulations and standards by consistently implementing BMPs.

SPECIFICATIONS FOR INDIVIDUAL BMPs

1. STREAMSIDE MANAGEMENT ZONES

A streamside management zone (SMZ) is a strip of land immediately adjacent to a water of the state where soils, organic matter and vegetation are managed to protect the physical, chemical and biological integrity of surface water adjacent to and downstream from forestry operations. Table 1 provides guidelines for protecting the critical area within a SMZ.

Landowners should have adequate streamside management zones marked before negotiating bids for timber sales.

Harvesting in streamside management zones should be done so as to protect the forest floor and under story vegetation from damage. Do not remove (harvest) trees from banks, beds, or steep slopes if it will destabilize the soil and cause degradation of the water. Trees on the south and west banks provide the most critical shading of water. Fell and skid trees directly away from waters of the state. According to Alabama Department of Environmental Management (ADEM) regulations, any tops or other logging debris dropped into the water or channel must be removed; **however, organic debris in the water prior to harvest should not be removed from the stream.** Stabilize wheel ruts if they could carry sediment into waters of the state. Locate log decks and roads outside of SMZs (except at proper stream crossings and access points or unless steep topography/wetland conditions necessitate location within the SMZ).

Courtesy of the South Carolina Forestry Commission

Table 1: SMZ Minimum Standards[1]

Purpose:	Protect banks, bed, and floodplains from erosion; control direct deposition of pollutants; provide shade, food, and cover for aquatic ecosystems; filter out pollutants from uplands.	
Management	**Perennial Stream**	**Intermittent Stream**
Minimum width on each side of channel	In no cases should SMZs be less than 35 feet from a definable bank.[2] A landowner's personal management objectives, on-site condition or stream sensitivity may require wider SMZs and more stringent control of forestry operations within the SMZ. For example, width should be extended to account for erodibility of soil, steepness of slopes and activities to be performed outside of the SMZ.[3] SMZs must always be wide enough to maintain water quality standards.	
Delineation	Outside boundaries should be well marked before operations begin.	
Roads	Follow state and federal BMPs (see Sections 2, 3, and 6) for roads and stream crossings.	
Harvesting Method	Partial cut only within minimum of 35 feet; partial cut or regeneration cut can take place beyond 35 feet.	Partial cut or regeneration cut when water quality degradation can be avoided.
Minimum Residual Cover	50% Crown cover	Vegetative[4]
Reforestation	Natural regeneration, hand planting, direct seeding.	
Mechanical Site Preparation	No	
Herbicide	If herbicide is used, adhere strictly to label restrictions. Direct application is preferred over broadcast spraying.	
Fertilizer	No	

[1]*In cases where the stream channel is significantly braided, the forest should be managed under wetland BMP management recommendations (Section 6).*

[2]*If wildlife is a major objective, a minimum SMZ of 50 feet is recommended.*

[3]*USDA Natural Resources Conservation Service can provide information on soil erodibility.*

[4]*Permanent residual tree cover is not required along intermittent streams as long as other vegetation and organic debris are left to protect the forest floor during regeneration.*

2. STREAM CROSSINGS

The crossing of streams by roads, skid trails, or firebreaks should be avoided. Stream crossings cause a break in the canopy and filtration strip provided by an SMZ. It may take a large amount of time and effort to stabilize water quality impairment from excessive stream crossings. If stream crossings are unavoidable, use the fewest number, cross the stream/SMZ by the least disruptive manner possible, and control sediment and other pollutants.

In general, stream crossings should be located where the bank and SMZ will be least disturbed. They should be installed at right angles to the stream where the stream channel is straight, and should have gentle slopes and straight paths in and out of the SMZ. Water diversions should divert upland runoff so that sediment and other pollutants can be filtered out on the forest floor before reaching the stream. At no time should a perennial or intermittent stream be crossed without providing a way for normal passage of water or aquatic animals within the channel. **Follow mandatory federal BMPs listed on pages 19 and 20 when roads cross streams or any other wetlands.**

Log crossings involve placing hollow or solid logs into shallow channels. Green and/or small diameter tops, limbs and brush should not be used for this purpose. The surface can be improved by use of secured decking or portable logging mats; do not use fill dirt. All log crossings must be removed when the logging operation is complete.

Fords can be used where the stream bed is firm, banks are low and stream is shallow. Banks should be back bladed away from water and used to improve the approaches. Rock may be brought in to stabilize the approaches and stream bottom.

Culverts, properly sized and installed, should be used to reduce road washouts and impoundments of water. Culvert sizes in Table II are best estimates for normal rainfall but may not handle the largest storm events. One large pipe is better than several smaller pipes. Culverts should be long enough to extend at least one foot beyond the fill on either end. Fill material upstream and down must be stabilized. Possible techniques include use of sand bags, concrete, rip-rap, hay bales, mulch, and vegetation. Culverts should be cleaned out regularly.

Proper culvert installation.

After an operation or phase of an operation has been completed or is going into a period of inactivity, all temporary crossings must be removed and the site stabilized; all permanent crossings must be stabilized and maintained.

Table II

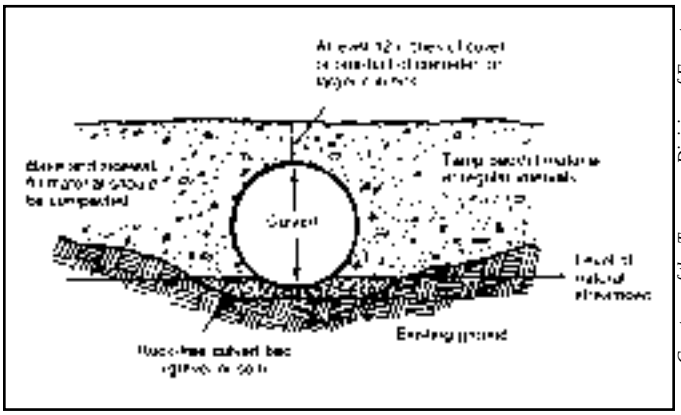
Recommended Diameters for Culverts

Drain Area (acres)	Lower Coastal Plain	Upper Coastal Plain	Piedmont	Mountains
10	12”	12”	12”	18”
50	30”	18”	30”	36”
100	48’’	30”	42”	48”
200	60”	42”	54”	two 48” pipes

Cleared stream crossing, stabilized with hay.

Culvert Installation

- Place culvert on stream bottom; do not dig below natural stream level to bury pipe.
- Culvert should have 2-3% pitch downstream for self-cleaning.
- Compact lower half of fill during installation.
- Earth cover over pipe should be a minimum of 12” or half the culvert’s diameter, whichever is greater. Make fill over a culvert the high spot in the stream crossing.
- Provide for stream overflow away from culvert fill to prevent blowouts.



Courtesy of the Tennessee Division of Forestry

Proper installation prevents culverts from being crushed by heavy roads.

***Bridges** create the least disruption to stream flow. According to the Alabama Department of Environmental Management (ADEM) and Corps of Engineer regulations, banks and fill material must be stabilized and protected from erosion. Spans must be installed to permit passage of all expected high flow.*

Portable bridges can be used in a way that protects water quality and reduces effort and expense in the long run.

3. FOREST ROADS

Crowned forest road.

Proper planning and location of roads will minimize the potential for deposition of pollutants into waters of the state, future maintenance and expense, and the amount of land taken out of production. Old roads should be reopened only if they are properly located and drainage devices will function properly. New roads must avoid streamside management zones (except at proper stream crossings and access points or unless steep topography/wetland conditions necessitate location within the SMZ), troublesome or sensitive moisture-laden soils, eroded gullies, etc. Road grades should also be minimized where soils are highly erodible and/or topography is steep. Dredge and fill operations which may alter the flow, circulation or reach of waters of the state, especially wetlands, may require a permit from the Corps of Engineers.

Adequate drainage is the most important factor in controlling soil erosion and keeping roads in a serviceable condition. Construction techniques such as crowned roads, turnout ditches, out-sloping and in-sloping should be used to provide some slope to flat roads which would hold water.

Crowned roads are designed to quickly drain road surfaces from the center of the road to side ditches. This technique helps to prevent water from soaking into the road and making it soft and muddy.

Turnout ditches should be installed at appropriate intervals to disperse water collected in roadside ditches away from the road base into surrounding vegetation.

Outsloped roads in hilly or mountainous terrain are graded at a 2-4% pitch to the downhill side of the road to drain off water as quickly as possible. Avoid berms of dirt along the outer edge of outsloped roads because they hold water in the road.

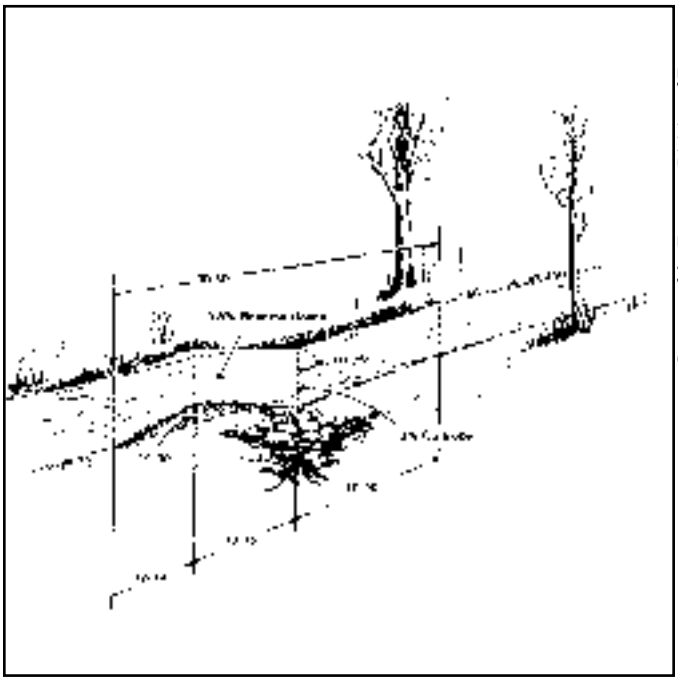
Insloped roads may be preferable when roads are built on side slopes with slippery soils and/or in steep terrain. Water collecting in the inside ditch, however, will have to be drained under the roads through culverts and be dispersed into vegetation on the outside of the road.

Construction of permanent roads should take place with the following considerations:

- Use at least the minimum design standard consistent with anticipated traffic and reasonable safety.
- Merchantable timber should be cleared from the right of way before the arrival of grubbing equipment.
- Stumps, logs, slash and other organic debris should not be covered with fill material and incorporated into road beds.
- Minimize the amount of soil on the road banks or roadsides that is exposed to soil erosion. Balancing cuts and fills whenever practical is one means of minimizing soil exposure. Stabilize these areas as they are created to minimize any problems.
- Functional water diversion techniques or devices should be installed at the same time that roads are constructed. Drainage water should be dispersed onto the undisturbed forest floor whenever possible.

Excessive road steepness, on the other hand, may allow surface water to build up velocity and cause erosion. A variety of water diversion devices can be used to direct water from roads and ditches into vegetated areas upslope from streams in order to slow water down and filter out sediment.

Broad-based dips are an effective means of diverting water off a permanent road without interfering with truck or skidder traffic. They hold up well and remain effective under traffic as long as the outfall remains below the dip in the road grade. Gravel in the bottom of the dip may be necessary on some soils to hold up vehicles operating in wet conditions.



Courtesy of the Tennessee Division of Forestry

Broad-based dips are designed to move water off roads and facilitate the ease of vehicle use.

Water bars (and turnouts) installed at 30-45 degree angles are best used to stabilize temporary roads and skid trails that will no longer be used. Water bars may not hold up well or maintain their effectiveness when they are packed down or rutted by truck, skidder or four-wheeler traffic. A series of small water bars, well anchored into the hillside, can be constructed by a skidder or bulldozer.

Outfall protection should be provided to prevent erosion by absorbing the energy of water falling from the outlet end of water diversion devices. Use rocks, concrete, mulch, woody debris or dense vegetation. Outfalls must never be installed where runoff can be discharged or flushed directly into waters of the state.

Table III

Diversion devices can generally be installed using the following spacing guide. However, soil erodibility and natural drainage opportunities should also be considered for determining appropriate spacings. The USDA Natural Resources Conservation Service can provide information about the erodibility of soils.

% Slope	Distance between water bars	Distance between broad-base dips and turnouts
3%	200’	235’
5%	135’	180’
10%	80’	140’
15%	60’	125’
20%	45’	
30%	35’	
40%	30’	

Maintenance of permanent roads should take place with the following considerations:

- Regular periodic inspection should start immediately after construction to determine maintenance requirements that prevent excessive erosion, impairment of natural drainage, or water quality problems.
- After an operation is completed, rutted or channeled roads should be reshaped and stabilized with functional water diversion devices to allow good drainage and control erosion.
- Seeding and mulching may be necessary to stabilize roadsides and closed temporary roads.
- Special soil stabilizing materials are available for particularly vulnerable areas (see USDA Natural Resources Conservation Service for dealers).

Control non-essential traffic during wet weather on roads which have a high potential for erosion; particularly immediately following construction.

A single large water bar constructed by a bulldozer can be used to close temporary roads to any further two-wheel drive traffic.

4. TIMBER HARVESTING

Harvesting activities should be conducted to ensure long-term maintenance of water quality. The following suggestions will help timber harvesters achieve this objective.

Temporary access roads (logging roads) and landing locations should be planned before operations begin to minimize soil disturbance. Road construction should be kept to a minimum, consistent with reasonable skidding distance. Spring heads, natural drainages and gullies should be avoided. Landings should also be kept as small as possible, consistent with safe and efficient operation. Logging roads and landings must be located on firm ground, outside of Streamside Management Zones and above the ordinary high water mark of streams.

Landings must be located to prevent the adverse impact of skidding on water quality. Locating logging decks uphill and skidding up to them results in a cone-shaped pattern of skid trails which disperses water running downhill. If the logging deck is on the lower slope, the V-shaped pattern of skid trails could concentrate runoff and erode the logging deck areas. If the trees must be skidded downhill, erosion can be minimized by using several, smaller logging decks with fewer, smaller skid trails leading to any one.

When operations are completed, landings and temporary roads should be stabilized with water diversion devices and/or vegetation where there is a possibility of significant erosion and/or water quality degradation.

Felling should be done carefully to minimize the impact of subsequent phases of logging operations on water quality. Timber cut in Streamside Management Zones should be harvested in accordance with recommended guidelines on pages 4 and 5.

Skidding should be done to avoid disrupting natural drainages, prevent excessive soil displacement, and minimize impacts of rutting, compaction, and puddling on water quality and soil stability.

Stream channels and natural drainages must not be used as skid trails. They should be crossed following guidelines in Section 2.

Where slopes are steep but short in duration, trees can be felled uphill and winched to the skidder. Skid trails on steep slopes should have occasional breaks in grade and upon completion of use, must be water barred. Erosion in skid trails can sometimes be reduced by covering them with logging slash. Logging slash can also be scattered over temporary landings to help stabilize them.

When wet and/or soft ground conditions cannot be avoided, it is better to concentrate soil compaction from skidder traffic on a few trails that can be stabilized rather than disperse the effects over many trails.

Cut-to-length harvesting systems offer state-of-the-art equipment and best available technology to maximize timber production and protect water quality and other forest resources at the same time.

Primary benefits of this system are from forwarders (or prehaulers) which can haul wood off the ground for long distances and need only minimum skid trails or landings. Less soil is displaced, rutted, and compacted. The on-board loader can be used to place logs for stream crossings and easily remove them when the crossing is no longer needed. In addition to high initial costs, however, this equipment is also limited by very steep terrain.

Trash disposal must be properly handled throughout the operation in accordance with all applicable laws. Fuel, lubricants and other toxic chemicals must never be drained into the soil. Food and drink containers, discarded equipment parts, and used fluids must be properly removed and disposed of. Trash must not be burned or buried on site.

5. REFORESTATION / STAND MANAGEMENT

Bedding on a contour.

Mechanical site preparation treatments must be used in such a manner as to minimize displacement of forest litter and topsoil, soil compaction and erosion, stream sedimentation and the deposition of debris into waters of the state. The degree of mechanical site preparation should be limited to the amount that is needed to get a well stocked stand of desirable trees. In general, mechanical site preparation should be excluded from soils with slopes exceeding 25%. No mechanical site preparation should be used in SMZs.

Drum chopping is one of the most desirable methods of mechanical site preparation for the protection of soil and water quality. When chopping is done on steep slopes it should always be done up and down hill so that sediment can be trapped in the slits created by the chopper blades.

Bedding on slopes exceeding 2% should follow the contour. On slopes 2% or less, beds should follow the natural drainage of the land. *Ripping and/or sub-soiling* should be done on the contour.

Disking should be done on the contour and restricted to areas with slopes 10% or less.

Shearing requires that the operator keep the blade out of the soil to minimize soil disturbance. Avoid over-raking the area. The retention of small limbs, twigs, bark and rock on the ground surface helps reduce soil erosion.

Windrows should be laid out on the contour of the land 100 to 300 feet apart depending upon the slope of the land and erodibility of the soil. Topsoil should not be pushed into windrows. Debris may not be piled into any water of the state.

Straight blade bulldozing is the least desirable method of mechanical site preparation.

Windrows.

Chemical site preparation, with or without the use of fire, can duplicate or surpass mechanical site preparation results with less water quality impact.

Herbicide applications must follow the manufacturer's label instructions, EPA guidelines and Alabama State Law. Herbicides should not be aerially or broadcast applied in SMZs. Under no circumstances should herbicides be applied directly onto or allowed to drift or wash into surface waters unless labeled for such applications. Do not mix or clean equipment or herbicide containers in or near streams or water bodies. Frequent inspection of equipment is recommended.

Prescribed burning should be designed and managed to minimize adverse environmental effects. Avoid intense spray and burns on steep slopes and highly erodible soils if water quality would be impacted.

Constructed firebreaks can be tied into existing natural barriers to minimize the need for fresh soil disturbances. Firebreaks should be stabilized with water diversion devices to minimize erosion and conveyance of sediment laden runoff into waters of the state. Vegetating firebreaks can further reduce erosion and the movement of sediment and other pollutants into waters of the state.

Wildfires demand that the primary objective of firebreak construction is to bring the fire under control.

Tree planting with a furrow type machine should be done on the contour.

Planting on a contour.

Constructed firebreak.

6. FORESTED WETLAND MANAGEMENT

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support (and under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions.

The U.S. Army Corps of Engineers, using the *Federal Manual for Delineating Jurisdictional Wetlands*, determines under which conditions hydrophytic vegetation, hydric soils, and wetland hydrology must be present on the same site, under normal circumstances, for an area to be classified as a wetland. Jurisdictional wetlands may be found in the following

- Coves and lower slopes
- Branch bottoms
- Creek bottoms
- River bottoms
- Muck swamps
- Peat swamps and cypress/gum ponds
- Wet flats

Section 404 of the Clean Water Act usually requires that a permit be obtained from the Corps of Engineers before a discharge of dredged or fill materials can be made into waters of the United States (U.S.), including wetlands. A regulated discharge occurs when fill or dredged material is deposited into wetlands.

Exemptions for forestry activities from having to obtain an individual Section 404 permit from the Corps of Engineers may apply if the activities meet the following conditions:

1. It is not part of an activity whose purpose is to convert a wetland into an upland, where the flow or circulation of the waters of the U.S. may be impaired or the reach of water reduced; and

2. It is part of an established (i.e. ongoing) silvicultural, farming or ranching operation and not a new use to which the wetland was not previously subject; and

3. It uses "normal" silvicultural, farming or ranching activities which are in compliance with federal BMPs (listed under "Roads and Stream Crossings . . ." on, pages 19 and 20); and

4. It has not lain idle for so long that hydrological modifications will be necessary to resume operations; and

5. It does not contain any toxic pollutant listed under Section 307 of the Clean Water Act.

What is an established silvicultural operation? Established or ongoing operations are included in a management system (not necessarily written) which is planned over conventional rotation cycles for a property or are introduced as part of an ongoing operation.

Evidence of use of the property may be used to determine whether an operation is ongoing. Such evidence includes the following:

1) a history of harvesting with either natural or artificial regeneration; 2) a history of fire, insect, and disease control to protect the maturing timber; and 3) the presence of stumps, logging roads, landings, or other indications of established silvicultural operations that will continue on the site.

While past management may have been relatively non-intensive, intensification of management involving artificial regeneration and other practices can occur as part of a conventional rotation and be considered an established operation.

Although wetland regulations do not require a written forest management plan, it is in a landowner's best interest to have one to document that operations are established, that BMPs are implemented and effective, and that all activities are consistent with other Section 404 exemption criteria.

A change in ownership between landowners (both of which manage forested wetlands for silvicultural purposes) has no bearing on whether a forestry operation is part of an established ongoing activity. Continuation or strict adherence to a management plan written for the previous owner is not required by Section 404 silvicultural exemptions.

"Normal" silvicultural activities (such as road construction, timber harvesting, mechanical or chemical site preparation, reforestation, timber stand improvement, and minor drainage) conducted as part of established ongoing silvicultural operations are exempt from Section 404 Corps of Engineers permit requirements as long as the appropriate measures are implemented. Those measures are listed under "Roads and Stream Crossings. . ." on pages 19-20. *Alabama's Best Management Practices for Forestry* are not required for exemption from Section 404 Corps of Engineer permit requirements; they are, however, **strongly** recommended to minimize nonpoint source pollution of waters of the state and/or waters of the U.S.

A forestry activity or operation WILL require a 404 permit from the Corps of Engineers when the following applies:

1. The activity results in the immediate or gradual conversion of a wetland to an upland as a consequence of altering the flow and circulation or reducing the reach of waters of the U.S.

   Changes in flow, circulation or reach of waters can be affected by permanent major drainage such as channelization or by placement of fill material. A discharge which changes the bottom elevation of waters of the U.S., without converting it to dry land, does not reduce the reach of waters but may alter flow or circulation and therefore may be subject to permitting requirements.

   The criteria that are used to determine if a wetland has been converted include a change in hydrology, soils and vegetation to such an extent that the area no longer qualifies as a jurisdictional wetland according to the *Federal Manual for Delineating Jurisdictional Wetlands.*

2. A new activity results in a change from the past, historical use of the wetland into a different use to which it was not previously subject where the flow or circulation of waters is impaired or the reach of the water is reduced. Such a change does not meet the established, ongoing requirement and causes the activity or operation to lose its exemption.

   Examples of this situation are areas where tree harvesting has been the established use and the landowner wishes to convert the site for use as pasture, green tree reservoir, agriculture, real

estate or aquaculture. In such cases the landowner must first obtain a 404 permit before proceeding with the change. (Changes of use to farm stock ponds may be exempt under a nationwide Corps of Engineers permit).

3. Roads and stream crossings are constructed in a wetland without following the mandatory, federal BMPs listed under the wetland road regulations.

4. The area has lain idle for so long that hydrologic modifications are necessary to resume operations. This does not refer to temporary water management techniques such as minor drainage, plowing, bedding and seeding which exempt, normal silvicultural activities as long as they don't result in the conversion of wetlands to uplands. However, it does apply to reopening ditches which were once established as permanent wetland drainage structures but have lost their effectiveness for this purpose as they filled in with soil and vegetation.

BMPs for wetlands are not intended to make up for uncontrolled negative impacts on uplands but are part of the overall management of the full landscape to protect water quality.

Streamside management zones should be established and managed around the perimeter of all major drainages and open bodies of water (i.e., main stream courses, oxbow lakes, sloughs) contained within wetlands.

Minor drainage refers to installation of ditches or other water control facilities for temporary dewatering of an area. Minor drainage is considered a normal silvicultural activity in wetlands to temporarily lower the water level and minimize adverse impacts on a wetland site during road construction, timber harvesting and reforestation activities. Minor drainage does not include construction of a canal, dike or any other structure which continuously drains or significantly modifies a wetland or other aquatic area.

Minor drainage is exempt from needing an individual 404 permit if it is part of an ongoing silvicultural operation and does not result in the immediate or gradual conversion of a wetland to an upland or other uses. Artificial drainage must be managed. Once silvicultural activity has been completed the hydrology that existed prior to the activity should be restored by closing drainage channels.

Roads and stream crossings within wetlands and other waters of the U.S. *must* be constructed and maintained in accordance with the following U.S. Army Corps of Engineer baseline BMPs (from Section 404, Corps of Engineers Permit Requirements, 40 CFR Part 233.22) in order to retain exemption status for the road operation:

1. Permanent roads, temporary access roads and skid trails (all for forestry) in waters of the U.S. shall be held to the minimum feasible number, width, and total length consistent with the purpose of specific silvicultural operations, and local topographic and climatic conditions;

2. All roads, temporary or permanent, shall be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) to minimize discharges of dredged or fill material into waters of the U.S.;

3. The road fill shall be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows;

4. The fill shall be properly stabilized and maintained during and following construction to prevent erosion;

5. Discharges of dredged or fill material into waters of the U.S. to construct a road fill shall be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers, or other heavy equipment within waters of the U.S. (including adjacent wetlands) that lie outside the lateral boundaries of the fill itself;

6. In designing, constructing and maintaining roads, vegetative disturbance in the waters of the U.S. shall be kept to a minimum;

7. The design, construction and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body;

8. Borrow material shall be taken from upland sources whenever feasible;

9. The discharge shall not take, or jeopardize the continued existence of a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species;

10. Discharges into breeding and nesting areas for water fowl, spawning, and wetlands shall be avoided if less harmful alternatives exist;

11. The discharge shall not be located in the proximity of a public water supply intake;

12. The discharge shall not occur in areas of concentrated shellfish production;

13. The discharge shall not occur in a component of the National Wild and Scenic River System;

14. The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts; and

15. All temporary fills shall be removed in their entirety and the area restored to its original elevation.

Roads must be constructed and maintained in accordance with BMPs to assure that flow and circulation pattern and chemical and biological characteristics of waters of the U.S. are not impaired, that the reach of the waters of the U.S. is not reduced and that any adverse effect on the aquatic environment will be otherwise minimized.

Minor drainage is allowed (i.e., to maintain a dry road bed) unless it becomes obvious that BMPs have not been followed or that the road is serving some function other than conveyance of vehicles (i.e., a continuous roadside barrow ditch may not be used to drain adjacent wetlands.

Timber harvesting using normal methods and equipment may be appropriate if harvesting is timed during dry periods.

Harvesting during wet periods or sites that remain wet require special precautions and harvesting systems to minimize water quality hazards and other negative site impacts. Site damaging effects from harvesting equipment such as rutting, puddling and compaction should be controlled and minimized. For example, concentrate skidder traffic on a few trails rather than over the entire area. Do not harvest sites during periods of flowing water whether from overbank flooding or other water accumulation.

Reforestation in wetlands is not much different from regenerating uplands in regards to water quality; the main factors to consider are the site's potential for erosion/sedimentation and hydrology.

Land clearing is an exempt silvicultural activity if it is associated with timber harvesting or reforestation operations. However, land clearing using mechanical equipment for purpose of removing vegetation in preparation for converting the site to a different land use is not part of an established silvicultural operation and is not exempt from having to go through the Corps of Engineer permitting process.

Herbicides bearing the "wetlands" warning on the label can be applied to vegetation on dry soils of jurisdictional wetland areas but must not be applied directly to surface water or to inter-tidal areas below the main high water mark.

Bedding is the construction of earthen mounds from surrounding soil resulting in adjacent and alternating "beds" and furrows. Seedling beds create temporary elevated soil conditions which allow seedlings to escape saturated soil conditions and have a greater opportunity to survive and grow.

Bedding is considered a normal silvicultural activity that is exempt from Section 404 permitting requirements if the following conditions exist:

- The bedding does not result in the gradual or immediate conversion of a wetland to upland as a consequence of impairing the flow or circulation or reducing the reach of waters of the U.S.; and
- It is performed as part of an established, ongoing silvicultural operation.

However, if bedding were to significantly alter the flow, circulation, or reach of waters of the U.S. and consequently result in conversion of a wetland to an upland, the exemption would no longer apply.

Species composition change (i.e., bottomland hardwood to pine plantation) resulting from intensification of management is considered a normal, silvicultural activity that is exempt from 404 permitting if the property is in silvicultural usage before and after the harvesting and planting.

However, a species composition change is not exempt if the activities used to clear, prepare or plant the site would result in a change in use that is accompanied by an impairment of the flow or circulation or the reduction of the reach of waters. An example of such a new use situation would be where the change in species composition would cause a conversion of wetlands to uplands.

Removal of beaver dams and other blockages to remove impounded surface water is considered exempt from 404 permitting as long as the process does not include enlarging or extending the dimension or changing the bottom elevation of the affected drainage way as it existed prior to the formation of the blockage, or without changing the use of the land in question.

Beaver dams can be dismantled by hand without any problems. Dynamite and heavy equipment can also be used to destroy dams as long as they are not used to construct drainage channels that will result in conversion of wetlands to uplands. However, when dynamite or heavy equipment is to be used to remove beaver dams or other blockages, the Corps of Engineers should be contacted for possible permit requirements.

***Before and After**: Top photo shows blockage caused by beaver dam. Bottom photo illustrates flow restored.*

7. Revegetation/Stabilization

Skid trail stabilized with logging slash.

As already pointed out in previous sections, some temporary haul roads, skid trails, log landings, firebreaks and other forestry related soil disturbing activities require the establishment of a vegetative cover to stabilize mineral soil surfaces so as to reduce erosion and runoff of sediment into state waters. The USDA Natural Resources Conservation Service can provide a detailed plan for establishing vegetation on these disturbed sites.

Site preparation, such as smoothing or reshaping rutted roads and landings, may be required before conventional equipment can be used for seedbed preparation, seeding, mulching and drainage improvement. Heavily compacted areas may require ripping and/or disking to allow water infiltration and provide a suitable seedbed for root growth.

Agricultural limestone and fertilizer may be needed to ensure success in establishing a vegetative cover. Soil tests are recommended. Incorporate lime and fertilizer into the top 2-4" of soil on slopes less than 6%; into the top 2"of soil on slopes of 6-10%; and onto the surface only on slopes greater than 10%.

Plant species recommendations can be obtained from the local county office of the USDA Natural Resources Conservation Service or Cooperative Extension Service. Areas treated by temporary seeding or mulch should be reseeded with permanent vegetative species as soon as possible during the correct growing season to ensure stabilization of disturbed areas. Disking or mowing of temporary cover is recommended before application of permanent seed and fertilizer.

Mulch is recommended for critical situations to hold seed, lime and fertilizer in place, maintain moisture and prevent extreme temperatures on the soil surface. Mulch needs to be applied immediately after seeding to provide best benefits.

Vegetative establishment for control of erosion and sedimentation can be considered successful once a 75% cover has been obtained. Within one

Vegetated forest road.

year of establishment, a second broadcast application of fertilizer at half the original rate is recommended to ensure plant survival and growth.

Silt screen and hay bales can be used to filter runoff water from closed roads and skid trails to prevent or stop sediment from flowing downslope into waters of the state. When using silt screen, 5-6 foot-long posts should be staked 5-10 feet apart across the problem area. The porous material is stapled 3 feet high on the post and excess material at the bottom of the screen is folded uphill and anchored down with rocks or fill material. Hog wire can be stapled to the stakes before the material is attached to give strength to the silt screen as intercepted sediment builds up.

Square hay bales can be used for the same purpose by lining them up across the road, end to end and one to two bales high. Stake the bales in place on their sides with the strings off the ground to prevent rotting.

Gully stabilization should receive high priority during all land management activities. The most effective way to reduce sediment production and/or reduce the change of reactivating the erosion process in healed gully systems is to avoid operating in them and maintain all existing vegetation. Site preparation, including herbicide and burning, should be excluded.

Actively eroding gully systems need to be stabilized. The USDA Natural Resources Conservation Service can provide technical assistance in planning and installing gully stabilization measures.

APPENDICES

Glossary

ADEM – The state regulatory agency (Alabama Department of Environmental Management) which administers and enforces the Alabama Water Pollution Control Act.

Approaches – The entry and exit of a road or skid trail through a stream crossing.

Aquatic ecosystem – An interacting community of plants and animals (i.e., insects, crayfish, fish and amphibians) requiring an abundance of water during some part of their life cycle.

Backblade – To pull dirt by dropping a dozer blade into the soil and operating the tractor in reverse.

Back slope – The soil profile in the side of a hill that is exposed from cut and fill type road construction.

Banks – The sides of a channel which holds or carries water.

Bed – The bottom of a stream.

Bedding – A mechanical site preparation technique where top soil is mounded into rows. Trees planted on top of the row will be well drained and will benefit from a concentration of nutrients and organic matter during initial stages of growth.

Biological integrity of waters of the state – The ability of a body of water to support the natural level of diverse plants and animals that would normally occur without man-made disturbance or manipulation of the landscape.

Broad based dip – An alteration of a road grade to intercept water from the surface and dispel it to the side without seriously interfering with vehicular traffic.

Canopy – The upper leafy branches of dominant and codominant trees and shrubs which intercept sunlight and shade the ground.

Chemical integrity of waters of the state – The natural range of nutrient and pH levels which would normally occur in waters passing through an undisturbed site.

Compaction – The result of all air and moisture holding spaces being squeezed out from between soil particles by operation of heavy equipment during unfavorable ground conditions. All soils are generally more easily compacted when wet. Compacted soil is less productive and more erodible.

Contour – An imaginary line on the surface of the earth connecting points of the same elevation.

Corps of Engineers – The federal regulatory agency, a branch of the U.S. Army, which administers and enforces the Section 404 permitting program of the Clean Water Act.

Critical shading of water – Shading when water receives the greatest protection from overheating and ultraviolet exposure caused by solar radiation.

Cross drain – A pipe, ditch or channel which safely conveys water from one side of the road to the other.

Crown – The top of a tree consisting of trunk and expanding branches.

Culverts – Usually metal or plastic pipe but can be a constructed wooden trough.

Cut and fill – Earthen material which is dug out of a hill and placed down slope to provide a relatively level road bed.

Deck – An area cleared to provide a site for loading logs onto a transport vehicle.

Decking – Rough or unfinished lumber used to provide a stable surface for roads, stream crossings or landings.

Definable bank – The bounds of a water body at or below its normal flow level which is usually devoid of terrestrial plants and accumulations of light organic debris.

Deposition – The act of depositing or putting into.

Destabilize (the soil) – To expose and/or loosen soil thus making it more susceptible to erosion.

Direct seeding – Artificially placing seed by hand, land machine or aircraft onto a germination surface.

Disking – Breaking up plants (above and below ground portions), organic matter and soil in preparation to improve the ground for replanting and to reduce plant competition.

Diversion device – A structure to intercept and re-route water from a road surface.

Drainage device – Same as diversion device.

Dredge – Earthen material that is dug from a channel or removed from the bottom of a water body, often to improve drainage.

Ephemeral streams – Low places in the landscape that only flow shortly after significant rainfall. Does not have a well defined channel.

EPA – The U.S. Environmental Protection Agency. The federal agency created and mandated by the U.S. Congress to administer and enforce the Clean Water Act upon waters of the United States.

Erosion – The dislodging and carrying away of soil particles by wind or water.

Fell – To cut or knock down standing trees or other vegetation.

Fill – To raise the elevation of a surface by depositing dredged or excavated material onto it.

Filtration strip – A strip of land where vegetation, mulch, or fabric is maintained or placed to intercept and prevent upland sediment and other pollutants from flowing into water.

Firebreaks – Natural or artificially constructed barriers to the spread of fire.

Floodplain – Areas adjacent to bodies of water that are most prone to flooding when the water overflows its banks.

Forest floor – Accumulations of organic debris and low vegetation on the ground beneath a stand of trees.

Forest resource managers – This group includes foresters, wildlife biologists, recreational planners and other developers.

Fragile area – Areas that are easily altered physically, biologically, or chemically, and are difficult or slow to recover.

Grade – The steepness of rise or fall of a road surface.

Ground cover – Low growing vegetation such as grass, forbs, vines, or shrubs.

Ground water – Water stored and/or flowing out of sight under the surface of the ground.

Hand planting – Re-establishing vegetation by planting seed or seedlings into prepared planting holes in the ground.

Harvests – Gathering merchantable portions of trees for commercial or domestic use.

Herbicide – a natural or synthetic chemical pesticide applied specifically to control competition from undesirable plant species.

High flow – The increased volume and speed of water that exceeds a stream's normal rate of flow.

High water mark – Physical evidence of past flooding such as discoloration of the lower portions of vegetation or debris suspended in branches off the ground.

Implementation – The carrying out of instructions contained in a management plan, harvest plan or reforestation plan (written or verbal).

Impoundments – An accumulation of water into pools or ponds formed by blocking the natural drainage.

Inslope – Sloping of a road surface so drainage is toward a ditch between the road and hill.

Intermittent bodies of water – Contain water within well defined channels during part of the year.

Label restrictions – Explicit instructions from the manufacturer with approval from federal and state authorities on when, where, and how a particular pesticide may be applied. Instructions also usually include worker and environmental safety precautions.

Landing - A site where logs are sorted and loaded onto trucks for hauling to handling or processing facilities.

Litter Layer – The natural buildup of dead leaves, branches and stems of dead trees and other forest vegetation which accumulate on the ground and then decay with time.

Log decks – Same as landings.

Mechanical planter – A tree planting machine pulled by a tractor and manned by a person who places trees into the ground.

Mechanical site preparation – Use of heavy machinery such as bulldozers with special attachments that clear debris or incorporate it into the soil to improve planting, sprouting, growth and or survival conditions for new forest trees.

Minimum residual cover - The fewest number of trees necessary to provide shade, natural recruitment of organic material, and soil holding capability for protection of the biological integrity of aquatic ecosystems.

Mulch – A coarse material used to protect soil from rainfall impact and erosion and to improve germination and growth of vegetation. Examples are hay, straw, bark and geotextile fabric.

Natural barrier – Areas that are devoid of fuel or food to support a spreading fire or insect or disease epidemic.

Natural drainage – Perennial, intermittent and ephemeral stream courses in a watershed that collect and expel runoff water.

Natural regeneration – Young trees that originate from seed or sprouts of trees that do or did grow on the site.

Nonpoint source – Water pollution which is not traceable to any discrete or identifiable facility but comes from a broad treatment area.

Normal passage of water and/or aquatic animals – Movement of water or animals which has not been obstructed or inhibited as the result of man-made activity.

Nutrients – Substances that nourish such as nitrogen, potassium and phosphorus in fertilizer. Excess nutrients can destabilize aquatic ecosystems.

Organic debris – Refuse such as tree tops, limbs or severely damaged tree stems which are left following road construction, logging, or site preparation.

Organic matter – Dead plant parts or animals. While natural recruitment of organic matter is part of the energy and nutrient cycles of an aquatic ecosystem, decay of excess amounts in water depletes oxygen needed by fish and other aquatic animals. Tops and other debris can sometimes block and divert the flow of streams causing additional erosion.

Partial cut – A selective timber harvest method where particular trees are usually designated to remain in the stand and the rest are removed in a thinning harvest.

Perennial bodies of water – Contain water within well defined channels virtually year round under normal climate conditions.

Permanent road – A road constructed, used and maintained beyond the time period of a single operation such as a timber sale.

Pesticide - See herbicide for specific application.

Physical integrity of waters of the state – The retention of water in its natural condition without alteration of stream course, depth, clarity or freedom of obstructions that might occur as the direct result of man-made activity.

Plowed fire control line – A man-made fire break constructed by a heavy piece of equipment such as a small bulldozer pushing or pulling a heavy duty plow designed for cutting through the forest floor and root mat to clear combustible material and expose mineral soil.

Pollutants – Man-induced elements such as sediment, organic debris, increased temperature, nutrients, chemicals, trash and soil degradation which exceed a water's natural ability to neutralize before changes in the physical, chemical or biological integrity of waters of the state occur.

Portable bridge – a stream crossing device that is preassembled, installed across a channel and removed following completion of an activity with minimum adverse impact to water quality.

Portable logging mats – Temporary road or stream crossing surface constructed of rough cut lumber nailed or bolted together. These are usually expected to be removed and reused following completion of a particular operation.

Prescribed burning – Preplanned fire that is deliberately set in a time and manner when prescribed conditions will allow accomplishment of specific objectives and is under control until it burns out or is extinguished.

Puddling – The destruction of root systems and soil structure by the tearing and churning action of heavy equipment operating in saturated soils. Puddled soils are more susceptible to erosion than undisturbed soils.

Reforestation – The restocking of a forest stand through natural regeneration or artificially planted seed or seedlings.

Regeneration – A young stand of a forest.

Regeneration cut – Either partial harvests where selected trees are left to provide adequate seed or silvicultural clearcuts where all merchantable and non-merchantable tree stems are removed or felled to encourage sprouting of desirable tree species.

Riprap – Large stones which are arranged over loose soil to protect it from erosion.

Rutting – Impression left in the ground after soil is compacted by the wheels or tracks of heavy equipment operating in soft earth. Deep rutting can disrupt surface and subsurface hydrology on flat lands and cause soil erosion on steep lands by concentrating surface runoff.

Sediment – Accumulations of loose soil particles. Excessive amounts of sediment can pollute water needed for aquatic ecosystems, drinking, wildlife, outdoor recreation, and industrial use.

Shearing and raking – A site preparation technique that uses a large tractor equipped with a special cutting blade to cut down trees just above the ground surface and a second tractor equipped with a specialized raking blade that pushes the felled trees and other debris into piles or windrows.

Side bank – Same as back slope.

Silviculture – The care and cultivation of forest trees; forestry.

Site preparation – Use of machines, herbicides, fire or combinations thereof to dispose of slash, improve planting conditions and provide initial control of competing vegetation.

Skid – To drag logs with a specialized tractor to a landing.

Skid trails – Paths where logs have been dragged.

Slash – Unmerchantable debris such as brush or tree stems, tops, branches or leaves that are left following a commercial timber harvest operation.

Slough – An open water inlet from a larger body of water.

Soil stabilizing materials – Silt fencing, straw blankets, geotextile fabric, geoweb, etc., applied to protect soil from erosion.

Soil type – Consistent characteristics of an identifiable soil such as particle sizes, moisture holding capacity, plasticity and ease of compaction.

Span – A structural beam designed to hold other bridge components and traffic above a stream or channel.

Steep gradient – A high rate of ascent or descent on a road.

Stringent – Tightly regulated or controlled.

Surface water – Exposed water above the ground surface.

Temperature – The degree of hotness or coldness of an environment. Removal of vegetative shade from banks of streams and shores will directly raise water temperature and indirectly result in lower dissolved oxygen levels. These influences place some fish and other organisms under stress.

Temporary access roads – Roads not expected to be maintained much longer than the activity for which they were installed to support.

Timber purchasers – Agents who locate commercial stands of timber and negotiate terms of purchase on either their own behalf or on the behalf of timber brokerage or forest product companies.

Topography – The lay of the land.

Tops – The upper (usually referring to unmerchantable) portions of trees.

Trash – Unnaturally occurring, man-made refuse or discarded substances. Openly discarded trash and petroleum wastes may be carried into waters of the state by storm runoff and is unsightly.

Understory vegetation – Small trees, shrubs or other plants which grow beneath the canopy of more dominant trees.

Upland runoff – Surface drainage water which flows from higher elevations of a landscape into the natural drainage system of a watershed.

Vendors – Contractors who provide tree harvesting, site preparation, tree planting or other forestry services for a fee.

Washouts – Clearing of natural or man made obstructions of drainage systems during high stream flows.

Water bar – A long mound of dirt constructed to prevent soil erosion and water pollution by diverting drainage from a road or skid trail into a filter strip.

Water bodies – Branches, creeks, rivers, ponds, lakes, bays, etc.

Water diversions – Structures or devices which change the direction of drainage flow.

Water quality impairment – The reduction of water quality below established water quality standards.

Waters of the State – Include every watercourse, stream, river, wetland, pond, lake, coastal, ground or surface water, wholly or partially in the state, natural or artificial which is not entirely confined and retained on the property of a single landowner.

Waters of the United States (U.S.) – Include all waters such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands and sloughs which are susceptible to use in interstate or foreign commerce, recreation, fish and shellfish production and industrial use; impoundments of waters just described; tributaries of waters just described (other than waters that are themselves wetlands).

Wildfire – Fires burning without the control of a responsible person.

Windrows – Long piles of accumulated debris.

Wing ditch – A secondary "turn out" ditch that diverts drainage water from primary roadside ditches, to be filtered out into the surrounding area.

Additional Resources

Additional information pertaining to silvicultural BMPs and water quality is available from the following publications and sources of assistance:

Streamside Management Zones

Comerford, N.B., D.G. Neary and R.S Mansel. *The Utility of Buffer Strips to Protect Forested Wetlands from Impacts Due to Forest Silvicultural Operations,* Gainesville, FL, National Council of the Paper Industry for Air and Stream Improvement, In Press.

Dickson, J.G. and J.C. Huntley. "Riparian Zones and Wildlife in Southern Forests," *Managing Southern Forests for Wildlife and Fish*, Ed. J. Dickson and O. Maughan, USDA Forest Service General Technical Report 50-65, (1987), 37-39.

Helfrich, L.A. et al. *Landowner's Guide to Managing Streams in the Eastern United States,* Virginia Cooperative Extension Service Publication 420-141, 1986.

James, B.R. "Riparian Vegetation Effects on Nitrate Removal from Groundwater," *Journal of Environmental Quality*, University of Maryland, In Press.

Kundt, J.F. et al. *Streamside Forests: The Vital Beneficial Resource*, Maryland Cooperative Extension Service, 1988.

Miller, E. "Effects of Forest Practices on Relationships Between Riparian Areas and Aquatic Ecosystems," *Managing Southern Forests for Wildlife and Fish*, Ed. J. Dickson and O. Maughan, USDA Forest Service General Technical Report 50-65, (1987), 40-47.

Practical Approaches to Riparian Resource Management: An Educational Workshop, Billings, MT, US Bureau of Land Management BLM-MT-PT-89-001-4351, 1989.

Rudolph, D.G and J.G. Dickinson. "Streamside Zone Width and Amphibian and Reptile Abundance," *The Southwestern Naturalist,* 35, (1990), 472-476.

Schilling, Erik B. and B. Graeme Lockaby. *Streamside Management Zones in Alabama: Functions and Management,* Auburn University Center for Forest Sustainability.

Swift, L.W. "Filter Strip Widths for Forest Roads in Southern Appalachians," *Southern Journal of Applied Forestry*, 10 (1984), 27-34.

Warmwater Streams Symposium: A National Symposium on Fisheries Aspects of Warmwater Streams, Southern Division American Fisheries Society, (1980).

Stream Crossings

Baker, C.O. and F.E. Votapka. "Fish Passage Through Culverts," *USDA Forest Service Technology and Development Center Report No. FHWA-FL-90-006*, 1990.

Mason, L. *Portable Wetland Area and Stream Crossings*, USDA Forest Service Technology and Development Center, 1990.

Forest Roads

Kochenderfer, J.N. *Cost of and Soil Loss in "Minimum-Standard" Forest Truck Roads Constructed in the Central Appalachians,* USDA Forest Service Research Paper NE-544, 1984.

Swift, L.W. "Soil Losses from Roadbeds and Cut and Fill Slopes in the Slopes in the Southern Appalachian Mountains," *Southern Journal of Applied Forestry,* 8, (1984), 209-215.

Swift, L.W. "Gravel and Grass Surfacing Reduces Soil Loss from Mountain Roads," *Forest Science,* 30, (1984), 656-670.

The Layman's Guide to Private Access Road Construction in the Southern Appalachian Mountains, Tennessee Valley Authority, Waynesville, N. C.: Haywood Press, Inc. 1985.

Wallbridge, T.A., Jr. *The Paper Location of Forest Roads*, Blackburge, AA, Virginia Polytechnical Institute and State University, 1989.

Wallbridge, T.A., Jr. *The Direct Location of Forest Roads*, Blacksburg, VA, Virginia Polytechnical Institute State University, 1990.

Timber Harvesting

Brinker, R.W. *Best Management Practices for Timber Harvesters*, Alabama Cooperative Extension Service Circular ANR-539, 1989.

Simmons, F.C. *Handbook for Eastern Timber Harvesting,* USDA Forest Service Northeastern Area State and Private Forestry, 1979.

Swindel, B.F. "Multi-Resource Effects of Harvest, Site Preparation and Planting in Flatwoods," *Southern Journal of Applied Forestry*, 7, (1983), 6-15.

Reforestation/Stand Management

Beasley, R.S., and A. Granillo, "Water Yields and Sediment Losses from Chemical and Mechnical Site Preparation in Southwest Arkansas," *Forestry and Water Quality. A Mid-South Symposium*, Arkansas Cooperative Extension Service, 1985.

Wetlands

Gosselink, J.G. and L.C. Lee. *Cumulative Impact Assessment in Bottomland Hardwood Forest*, Baton Rouge, LA, Center for Wetlands Resources, Louisiana State University LSU-CEI-86-09, 1987.

Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Federal Interagency Committee for Wetland Delineation, 1989.

Forested Wetlands of the Southeast: Review of Major Characteristics and Role in Maintaining Water Quality, USDI Fish and Wildlife Service Publication 163, 1986.

Forested Wetlands of the United States: Proceedings of the Symposium, USDA Forest Service Southeastern Forest Experiment Station General Technical Report SE-50, 1988.

Good, R.E., D.F. Whigham and R. L. Simpson. *Freshwater Wetlands: Ecological Processes and Management Potential*, New York, Academic Press, 1978.

Kellison, R.C. et al. *Regenerating and Managing Natural Stands of Bottomland Hardwoods,* American Pulpwood Association, 88-A-6, 1988.

Kibby, H.V. "Effects of Wetlands on Water Quality," *Proceedings of the Symposium on Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems,* USDA Forest Service Publication GTR-WO-12, 1978.

Larson, J.S. "Wetland Value Assessment: State of the Art," *National Wetlands Newsletter*, Vol. 3, No. 2, Mar-Apr 1981.

National List of Plant Species That Occur in Wetlands: Southeast (Region 2), U.S. Fish and Wildlife Service, Biological Report 88 (26.2), 1988.

National Wetlands Policy Forum, The Conservation Foundation, 1989.

Wharton, C. H. et al. *Forested Wetlands of Florida, Their Management and Use,* Gainesville, FL, Center for Wetlands, University of Florida, 1977.

General BMPs

Alabama Nonpoint Source Management Program, Montgomery, Alabama. Alabama Department of Environmental Management. October 2000. http://www.adem.state.al.us/Education%20Div/Nonpoint%20Program/ManagePlan/partIIsi.pdf

Best Management Practices for Silvicultural Activities on TVA Lands, Norris, TN, Division of Land Resources, Tennessee Valley Authority, 1990.

Burns, R.G., and J.D. Hewlett. "A Decision Model to Predict Sediment Yield from Forest Practices," *Water Resources Bulletin 19*, (1983), 9-14.

Dissmeyer, G.E. and G.R. Foster. *A Guide for Predicting Sheet and Rill Erosion on Forest Land,* USDA Forest Service State and Private Forestry Southeastern Area, Technical Publication SA-TP 11, 1980.

Dissmeyer, G.E. and N.D. Kidd. "Multiresource Inventories: Watershed Condition of Commercial Forest Land in South Carolina," *USDA Forest Service Research Paper SE-247*, 1984.

Erosion Control on Forest Land in Georgia, Georgia Cooperative Extension Service, 1979.

Forestry and Water Quality: A mid-south symposium, Arkansas Cooperative Extension Service, 1985.

Glasser, S.P. *Summary of Water Quality Effects from Forest Practices in the South*, Atlanta, GA, USDA Forest Service Southern Region, 1982.

Golden, M.S. et al. *Forestry Activities and Water Quality in Alabama: Effects, Recommended Practices, and an Erosion Classification System,* Alabama Agricultural Experimental Station Auburn University, Bulletin 555, 1984.

Golden, M.S. et al. *Guidelines for Refinement of Best Management Practices in Alabama*, Auburn University, AL, Department of Forestry, 1984.

National Management Measures to Control Nonpoint Source Pollution from Forestry, U.S. Environmental Protection Agency, Office of Water, Washington DC 20460 (4503F) EPA-841-B-05-001 April 2005. http://www.epa.gov/owow/nps/forestrymgmt/ (May 2005).

Sources of Technical Assistance

Technical assistance and/or additional information may be available from the following agencies and organizations to help you plan forestry operations that may affect water quality.

Alabama Department of Conservation and Natural Resources

64 North Union Street, Suite 468
Montgomery, AL 36130
(334) 242-3465
www.outdooralabama.com

Alabama Department of Environmental Management (ADEM)

1400 Coliseum Boulevard
Montgomery, AL 36110-2059
or
P. O. Box 301463
Montgomery, AL 36130-1463
(334) 271-7700
http://www.adem.alabama.gov

Alabama Cooperative Extension System

109-D Duncan Hall
Auburn University, AL 36849
(334) 844-4444
www.aces.edu

Alabama Forestry Association

555 Alabama Street
Montgomery, AL 36104
(334) 265-8733
www.alaforestry.org

Alabama Forestry Commission

513 Madison Avenue
Montgomery, AL 36130
(334) 240-9365 or 240-9332
www.forestry.state.al.us

American Forest and Paper Association

1111 19th St. NW, Suite 800
Washington, DC 20036
(800) 878-8878
www.afandpa.org

U.S. Army Corps of Engineers

Mobile District
P.O. Box 2288
Mobile, AL 36628
(251) 471-5966
www.sam.usace.army.mil

Nashville District
P.O. Box 1070
Nashville, TN 37202
(615) 736-7161
www.orn.usace.army.mil

U.S. Environmental Protection Agency (EPA)

Region 4
Sam Nunn Atlanta Federal Center
61 Forsyth Street SW
Atlanta, GA 30303-8960
(404) 562-9900 or 1-800-241-1754
http://www.epa.gov/region04/about/index.html

USDA Forest Service

2946 Chestnut Street
Montgomery, AL 36107
(334) 832-4470
www.fs.fed.us

USDA Natural Resources Conservation Service

P.O. Box 311
Auburn, AL 36830
(334) 887-4560
www.nrcs.usda.gov/programs

U.S. Fish and Wildlife Service

1208-B Main Street
Daphne, AL 36526-4419
(251) 441-5181
www.fws.gov

Alabama Forestry Commission
2007

APPENDIX H:
Projects Submitted for Deepwater Horizon Funding

Project ID Number is 158

This project suggestion for the following funding source(s)	Alabama Gulf Coast Recovery Council (AGCRC) Gulf Coast Ecosystem Restoration Council (Federal Council) National Fish and Wildlife Foundation (NFWF)

A. General Information

Suggestion State:

Organization:	City of Foley	**Organization Website:**	http://www.cityoffoley.org
Contact Name:	Leslie Gahagan	**Title:**	Mrs.
Contact Address:	200 North Alston Street Foley, AL 36535		
Phone Number:	251-971-1471	**Email:**	lgahagan@cityoffoley.org
Suggestion State:	Reviewed	**Suggestion Date:**	10/16/2014

B. Project Classification - Primary

Ecological/Environmental

C. Project Classification - Secondary

D. Project Information

Project Name:	Graham Creek Nature Preserve Expansion				
Project Location:	East of 23460 Wolf Bay Drive, Foley				
Project State(s):	AL	**County(s):**	Baldwin		
Watershed/Basin:	Wolf Bay Watershed	**Latitude:**	30.648	**Longitude:**	-87.623
Project Size:	125 Acres	**Affected Area:**	Wolf Bay Watershed		

E. Project Description

The City owns Graham Creek Nature Preserve, a 484 acre park that contains head water wetlands, pine savannas, mixed forests and tidal wetlands habitat with recreational and educational opportunities for the community and tourists alike. Graham Creek Preserve is bisected by Graham Creek and is bordered by this requested property acquisition along the northeastern boundary. This property would expand the park with 125 acres of pine savanna along the northern side and tidal wetlands along Graham Creek through the southern interior. With this expansion visitors could access coastal habitats for bird watching, fishing, kayaking, hiking and other recreational opportunities. The existing educational programs would be expanded to incorporate this large area of shoreline. Educational signage would inform visitors of the natural ecosystem and native species. The site contains a variety of species of pitcher plants and rare orchids that would proliferate under proper management techniques such as prescribed burning operations. There are several gopher tortoise colonies that exist on this land as well. Tidal wetlands along the edges of the sinuous stream channel provide excellent protected nursery grounds for fish and shellfish. This property is also a favorite wintering site for Brown Pelicans, Wood Ducks and many other bird species. The City would include the property as part of the nature parks system for management, maintenance, restoration (removal of invasive exotic plant species and prescribed burning operations), water quality monitoring and eco-tourism marketing. The development pressures on this tract of land are great as the property to the north has a planned subdivision and the property to the east is developed as a residential subdivision. This last remaining undeveloped land along Graham Creek will be key in protection of this entire ecologically sensitive habitat.

F. Project Status

Property/Resource Acquisition: Current Landowner or Holder of the Easement:	Downey Family Limited Partnership		**Recent Appraisal?** Yes
Project Planning/Design:	N/A	**Project Permitting**	No Permits
Time to Implement:	3 months	**Time to Project Completion:**	3 months
Can be implemented in phases?	No	No Phases	
Is this project included under a regional or statewide plan/initiative?			Yes
If so, list:	AL Coastal Area Management Plan; Wolf Bay Watershed Management		

	Plan
Potential Government Barriers:	None

G. Project Cost

Estimated Cost:	$650,000.00	**Estimated Cost of Monitoring:**	$0.00	**Maintenance/Operational Cost:**	$7,500.00
Nature of Cost:	Prescribed Burn Operations	**Sources for Funding Costs:**	City Budget Funds		
Cost Per Unit:	$5,200.00 per acre	**Level of Confidence:**	High		
Basis/Method of Estimation:	Based on Appraisal Figure	**New business startup or expansion?**	No		
Matching Funds Available:	No Matching Funds				

Project Partners:

Organization	Involvement	Contact	Title	Email	Address	Phone Number
Wolf Bay Watershed Watch	Partner with promotions and maintenance	Leslie Gahagan	President	leslielassitter@yahoo.com	P.O. Box 63 Elberta, AL 36530	251-269-1224

H. Project Impact on Community

Transformational Attributes:	Enhancement of Environmental Quality and Habitat Preservation	**Regional Impact:**	Both ecologically through habitat preservation and economically through eco-tourism		
Economic Diversification?	No	**How?**			
Employment:	No appreciable impact	**Avoided Costs:**	Estuary and shoreline erosion	**Costs of "No Action":**	Loss of habitat in coastal area
Indirect Benefits:	Riverine flood protection; passive recreation and educational opportunities	**Environmental Benefits:**	Habitat preservation and head water wetland protection		
Environmental Impacts:	None	**Measurement of Success:**	Sustainment of natural habitat and restoration through prescribed burn operations		

I. Nature of Project

Project Nature	Restoration, Maintenance/Management, Protection/Conservation, Land Acquisition		
Data Collection & Monitoring --Fisheries Stock Assessment?	No	**If so, describe:**	
Data Collection & Monitoring --Other?	No	**If so, describe:**	
Best Available Science?	Yes	**If so, describe:**	Site is adjacent to an existing 484 acre nature preserve for large habitat and coastal head water and tidal wetland protection
Best Management Practices?	No	**If so, describe:**	
Adaptive Management?	No	**If so, describe:**	
Education Component?	Yes	**If so, describe:**	Interpretive signage with public coastal access will be implemented. This property will be combined with existing nature preserve educational programs.
Stewardship Opportunities?	Yes	**If so, describe:**	Partnerships with various groups may be developed to enhance the property.

J. Project Habitat(s):

Upland , Marine/Estuarine Wetlands

K. Resource Benefit(s):

Benefit(s):	Marine Mammals | Shellfish | Birds | Terrestrial Wildlife | Sediment/Benthos | Reptiles/Amphibians | Shoreline | Fish | Vegetation | Recreational Use		
Benefit State- or Federally-listed Species?	Yes	**If so, list:**	Eastern Indigo Snake - Threatened Alabama Red Bellied Turtle - Endangered Gulf Sturgeon - Threatened Gopher Tortoise - Under Consideration

L. Tourism Promotion Activities

Tourism Type:	Eco Tourism; Recreational Fishing and Kayaking			
Tourism Event:	**Established Long-term Recurring Event?**	N/A	**New Event?**	N/A
Tourism Marketing Plan / Program:	**For a Specific Event?**	N/A	**For a Designated Area?**	Yes
	Align with Existing Area Goals?	Yes	**If so, List:**	Local Eco tourism through CVB; Gulf Coast CVB
Geographic Area of Promotion:	Local, Regionally, State and National Promotion			
Capital of Equipment or Facilities needed for Successful Completion?	N/A	**If so, Describe:**		
Tourism Site?		Yes	**Other:**	N/A

M. Seafood Promotion Activities

Project Benefits Description:	N/A	**New Program?**	N/A
Existing Program?	N/A	**If so, describe:**	
Seafood Industry:			
Geographic Area of Promotion:	N/A		
Proposed by an Organization or Commission?	Yes	**Commissioner**	**Affiliation**
		N/A	N/A
		N/A	N/A

Project ID Number is 159

This project suggestion for the following funding source(s)	Alabama Gulf Coast Recovery Council (AGCRC) Gulf Coast Ecosystem Restoration Council (Federal Council) National Fish and Wildlife Foundation (NFWF)

A. General Information

Suggestion State:

Organization:	City of Foley	**Organization Website:**	http://www.cityoffoley.org
Contact Name:	Leslie Gahagan	**Title:**	Mrs.
Contact Address:	200 North Alston Street Foley, AL 36535		
Phone Number:	251-971-1471	**Email:**	lgahagan@cityoffoley.org
Suggestion State:	Reviewed	**Suggestion Date:**	10/16/2014

B. Project Classification - Primary

Ecological/Environmental

C. Project Classification - Secondary

D. Project Information

Project Name:	Wolf Creek Park Expansion				
Project Location:	South of Wolf Creek Park on Hance Lane, Elberta				
Project State(s):	AL	**County(s):**	Baldwin		
Watershed/Basin:	Wolf Bay Watershed	**Latitude:**	30.364	**Longitude:**	-87.619
Project Size:	5 Acres	**Affected Area:**	Wolf Bay Watershed		

E. Project Description

The City owns Wolf Creek Park, a 25 acre property that contains coastal habitat with recreational and educational opportunities for the community and tourists alike. Wolf Creek Park is the northern boundary of the requested acquisition. This property would expand the park with the remainder of the coastal bird rookery habitat along the creek and interior cove. With this expansion visitors could access coastal habitats for bird watching, fishing and kayaking. Educational signage would inform visitors of the natural ecosystem and native species. The site contains a variety of species of pitcher plants and rare orchids that would proliferate under proper management techniques such as prescribed burning operations. Also there is a natural cypress wetland along the interior side of the shoreline. Tidal wetlands along the cove provide excellent protected nursery grounds for fish and shellfish. Ornithologists have noted the large aquatic bird populations that nest on this property as well. Furthermore, the property can absorb tidal surges to prevent coastal flooding upstream. The City would include the property as part of the nature parks system for management, maintenance, restoration (removal of invasive exotic plant species), water quality monitoring and eco- tourism marketing.

F. Project Status

Property/Resource Acquisition: Current Landowner or Holder of the Easement:	Susanna Gordon		**Recent Appraisal?** Yes
Project Planning/Design:	N/A	**Project Permitting**	No Permits
Time to Implement:	3 months	**Time to Project Completion:**	3 months
Can be implemented in phases?	No	No Phases	
Is this project included under a regional or statewide plan/initiative?			Yes
If so, list:	AL Coastal Area Management Plan; Wolf Bay Watershed Management Plan		
Potential Government Barriers:	None		

G. Project Cost

Estimated Cost:	$325,000.00	**Estimated Cost of Monitoring:**	$0.00	**Maintenance/Operational Cost:**	$0.00
Nature of Cost:	NA	**Sources for Funding Costs:**	NA		
Cost Per Unit:	$72,222.00 per linear foot	**Level of Confidence:**	High		
Basis/Method of Estimation:	High Based on Appraisal Figure	**New business startup or expansion?**	No		
Matching Funds Available:	No Matching Funds				

Project Partners:

Organization	Involvement	Contact	Title	Email	Address	Phone Number
Wolf Bay Watershed Watch	Partner with promotions and maintenance	Leslie Gahagan	President	leslielassitter@yahoo.com	P.O. Box 63 Elberta, AL 36530	251-269-1224

H. Project Impact on Community

Transformational Attributes:	Enhancement of Environmental Quality and Aquatic Bird Habitat	**Regional Impact:**	Both ecologically through habitat preservation and economically through eco-tourism		
Economic Diversification?	No	**How?**			
Employment:	No appreciable impact	**Avoided Costs:**	Estuary and shoreline erosion	**Costs of "No Action":**	Loss of habitat in coastal area including bird nesting habitat
Indirect Benefits:	Tidal surge and riverine flood protection; passive recreation and educational opportunities	**Environmental Benefits:**	Habitat preservation		
Environmental Impacts:	None	**Measurement of Success:**	Sustainment of natural habitat and continued existence of bird rookery		

I. Nature of Project

Project Nature	Restoration, Maintenance/Management, Land Acquisition		
Data Collection & Monitoring --Fisheries Stock Assessment?	No	**If so, describe:**	
Data Collection & Monitoring --Other?	No	**If so, describe:**	
Best Available Science?	Yes	**If so, describe:**	Site is a noted bird rookery by ornithologists that needs conservation.
Best Management Practices?	No	**If so, describe:**	
Adaptive Management?	No	**If so, describe:**	
Education Component?	Yes	**If so, describe:**	Interpretive signage with public coastal access will be implemented.
Stewardship Opportunities?	Yes	**If so, describe:**	Partnerships with various groups may be developed to enhance the property.

J. Project Habitat(s):

Upland, Marine/Estuarine Wetlands

K. Resource Benefit(s):

Benefit(s):	

	Marine Mammals | Shellfish | Birds | Terrestrial Wildlife | Sediment/Benthos | Reptiles/Amphibians | Shoreline | Fish | Vegetation | Recreational Use		
Benefit State- or Federally-listed Species?	Yes	**If so, list:**	Eastern Indigo Snake - Threatened Alabama Red Bellied Turtle -Endangered Gulf Sturgeon - Threatened Gopher Tortoise - Consideration

L. Tourism Promotion Activities

Tourism Type:	Eco Tourism; Recreational Fishing and Kayaking			
Tourism Event:	**Established Long-term Recurring Event?**	N/A	**New Event?**	N/A
Tourism Marketing Plan / Program:	**For a Specific Event?**	N/A	**For a Designated Area?**	Yes
	Align with Existing Area Goals?	Yes	**If so, List:**	Local Eco tourism through CVB; Gulf Coast CVB
Geographic Area of Promotion:	Local, Regionally, State and National Promotion			
Capital of Equipment or Facilities needed for Successful Completion?	No	**If so, Describe:**		
Tourism Site?		Yes	**Other:**	None

M. Seafood Promotion Activities

Project Benefits Description:	N/A	**New Program?**	N/A
Existing Program?	N/A	**If so, describe:**	
Seafood Industry:			
Geographic Area of Promotion:	N/A		
Proposed by an Organization or Commission?	No	No Commissioners	

Project ID Number is 362

This project suggestion for the following funding source(s)	Alabama Gulf Coast Recovery Council (AGCRC) Gulf Coast Ecosystem Restoration Council (Federal Council) National Fish and Wildlife Foundation (NFWF)

A. General Information

Suggestion State:

Organization:	United States Department of Agriculture	**Organization Website:**	https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/contact/conservation/?cid=nrcseprd330209
Contact Name:	Homer Wilkes	**Title:**	Division Director
Contact Address:	7578 Old Canton Road Madison, MS 39110		
Phone Number:	601-607-3131 102	**Email:**	homer.wilkes@ms.usda.gov
Suggestion State:	Reviewed	**Suggestion Date:**	2/3/2017

B. Project Classification - Primary

Ecological/Environmental

C. Project Classification - Secondary

Ecological/Environmental | Planning Assistance

D. Project Information

Project Name:	Nutrient Reduction Projects - Mobile and Baldwin Counties				
Project Location:	Mobile and Baldwin Counties				
Project State(s):	AL	**County(s):**	Baldwin , Mobile		
Watershed/Basin:	Dog River, Bonsecour, and Wolf Bay	**Latitude:**	30.471900	**Longitude:**	-87.701300
Project Size:	6000 Acres	**Affected Area:**	9000		

E. Project Description

Excessive nutrient enrichment, or eutrophication, of Gulf Coast estuaries and their watersheds is a chronic threat that can lead to hypoxia (low oxygen levels), harmful algal blooms, habitat losses, and fish kills (PDARP/PEIS Section 5.5.4). The Nutrient Reduction restoration is consistent with the needs of the Alabama coastal watersheds. The watershed would benefit from activities implemented to restore and enhance the ecological and hydrological integrity of water resources. This project would address nutrient and sediment reduction in the Dog River, Bon Secour, and Wolf Bay Watersheds. The Nutrient Reduction Projects would be implemented by NRCS in the coastal watersheds in Alabama for the purpose of improving water quality by implementing conservation practices to reduce nutrient and sediment runoff. NRCS and its conservation partners would assist private landowners by developing conservation plans that identify natural resource concerns and conservation practices the landowner can implement to reduce nutrient and sediment runoff. Through this project, landowners would receive financial assistance to apply conservation practices near the source of soil erosion and nutrient application with additional conservation practices. The cost of $6.0 M ($2 M for each watershed) for development and implementation of conservation plans and practices in the watersheds. USDA-NRCS would implement this proposed alternative by helping landowners voluntarily implement conservation practices that reduce nutrient and sediment runoff. Through their experience with the Environmental Quality Incentives Program (EQIP), USDA-NRCS is knowledgeable about activities required for the successful implementation of the proposed conservation practices.

F. Project Status

Property/Resource Acquisition: **Current Landowner or Holder of the Easement:**	N/A		**Recent Appraisal?** No
Project Planning/Design:	Not Started	**Project Permitting**	No Permits
Time to Implement:	48 months	**Time to Project Completion:**	50 months
Can be implemented in phases?	Yes	**Phase**	**Cost**

Planning (per watershed)	$500,000.00
Implementation (per watershed)	$1,500,000.00

Is this project included under a regional or statewide plan/initiative?	Yes
If so, list:	Mobile Bay National Estuary Program
Potential Government Barriers:	N/A

G. Project Cost

Estimated Cost:	$6,000,000.00	**Estimated Cost of Monitoring:**	$800,000.00	**Maintenance/Operational Cost:**	$300,000.00
Nature of Cost:	Vegetation Management	**Sources for Funding Costs:**	NRDA		
Cost Per Unit:	$668.00 per acre	**Level of Confidence:**	High		
Basis/Method of Estimation:	Historical Receipts	**New business startup or expansion?**	No		

Matching Funds Available:

Fund Source	Amount
USDA-NRCS	$3,000,000.00

Project Partners:

Organization	Involvement	Contact	Title	Email	Address	Phone Number
Enviromental protection Agency	Monitoring and Data Collection - Administrative Assistance	Gale Bonanno	USEPA Headquarters	bonanno.gale@epa.gov	1200 Pennsylvania Avenue, N. W. Washington DC, DC 20460	202-564-2243

H. Project Impact on Community

Transformational Attributes:	Nutrient and Sediment Reduction - Water Quality	**Regional Impact:**	Nutrient and Sediment Reduction - Water Quality		
Economic Diversification?	No	**How?**			
Employment:	N/A	**Avoided Costs:**	N/A	**Costs of "No Action":**	N/A
Indirect Benefits:	Wildlife Habitat	**Environmental Benefits:**	Nutrient and Sediment Reduction - Water Quality and Habitat		
Environmental Impacts:	Nutrient and Sediment Reduction - Water Quality and Habitat	**Measurement of Success:**	Nutrient and Sediment Reduction		

I. Nature of Project

Project Nature	Restoration , Maintenance/Management , Protection/Conservation		
Data Collection & Monitoring --Fisheries Stock Assessment?	No	**If so, describe:**	
Data Collection & Monitoring --Other?	Yes	**If so, describe:**	Water Quality
Best Available Science?	Yes	**If so, describe:**	NRCS CEAP Model
Best Management Practices?	Yes	**If so, describe:**	NRCS Conservation Practices
Adaptive Management?	No	**If so, describe:**	
Education Component?	Yes	**If so, describe:**	Conservation Planning with the Participant
Stewardship Opportunities?	No	**If so, describe:**	

J. Project Habitat(s):

Upland , Marine/Estuarine Wetlands , Riverine , Freshwater Wetlands

K. Resource Benefit(s):

Benefit(s):	Marine Mammals | Shellfish | Water Column | Birds | Terrestrial Wildlife | Sediment/Benthos | Reptiles/Amphibians | Corals | Fish | Vegetation		
Benefit State- or Federally-listed Species?	Yes	**If so, list:**	Alabama Sturgeon

L. Tourism Promotion Activities

Tourism Type:	N/A			
Tourism Event:	**Established Long-term Recurring Event?**	N/A	**New Event?**	N/A
Tourism Marketing Plan / Program:	**For a Specific Event?**	N/A	**For a Designated Area?**	N/A
	Align with Existing Area Goals?	N/A	**If so, List:**	
Geographic Area of Promotion:	N/A			
Capital of Equipment or Facilities needed for Successful Completion?	N/A	**If so, Describe:**		
Tourism Site?		N/A	**Other:**	N/A

M. Seafood Promotion Activities

Project Benefits Description:	N/A	**New Program?**	N/A
Existing Program?	N/A	**If so, describe:**	
Seafood Industry:			
Geographic Area of Promotion:	N/A		
Proposed by an Organization or Commission?	No	No Commissioners	

Rehabilitation of Sanitary Sewer Mains - Foley, Alabama

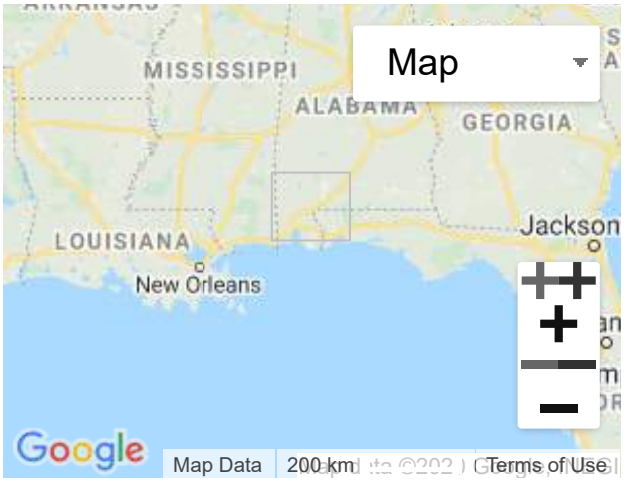
General Information

Project Description:
The Utilities Board of the City of Foley (Riviera Utilities), in partnership with the City of Foley, desires to rehabilitate up to 8.6 miles of aged, deficient sanitary sewer mains within the City's sewer collection system. Most of the collection system in and around downtown Foley was constructed of vitrified clay pipe 40-70 years ago. Riviera Utilities has identified, inspected and cataloged these deficiencies during routine internal video inspections. Deficiencies in the clay pipe include broken pipes, offset joints, root intrusion, and active groundwater infiltration / stormwater inflow (I/I). Where possible, mains will be rehabilitated using trenchless construction methods such as pipe relining and pipe bursting to minimize construction costs. These areas fall within the watersheds of Wolf Bay and Bon Secour Bay/Oyster Bay. Treated effluent is discharged from Riviera's Wastewater Treatment Facility (WWTF) to Wolf Creek, which flows to Wolf Bay. Ultimately, flow from these watersheds enters the Intracoastal Waterway, Perdido Bay, Mobile Bay, and the Gulf. Wolf Bay is a pristine estuary designated by ADEM as an "Outstanding Alabama Water". Bon Secour Bay and Oyster Bay are popular locations for sport fishing and shellfish harvesting and are bordered by the Bon Secour National Wildlife Refuge. Both watersheds host very diverse habitats that do support or have historically supported several Federally listed species including bald eagles, Florida manatees, Kemp's Ridley sea turtles, Gulf sturgeons, American alligators, Alabama red-bellied turtles and Eastern indigo snakes. This project's goal is long-term improvement of water quality by the reduction of accidental discharges of untreated/partially-treated wastewater to these watersheds, surrounding waters, and the Gulf. Such discharges are detrimental to aquatic, estuarine, and upland habitats within these watersheds. Also, they can create public health hazards by making water bodies temporarily unsuitable for human contact, commercial/sport fishing, and recreational use. Project objectives are as follows: (1) Minimize possibility of wastewater discharges by (a) regaining hydraulic

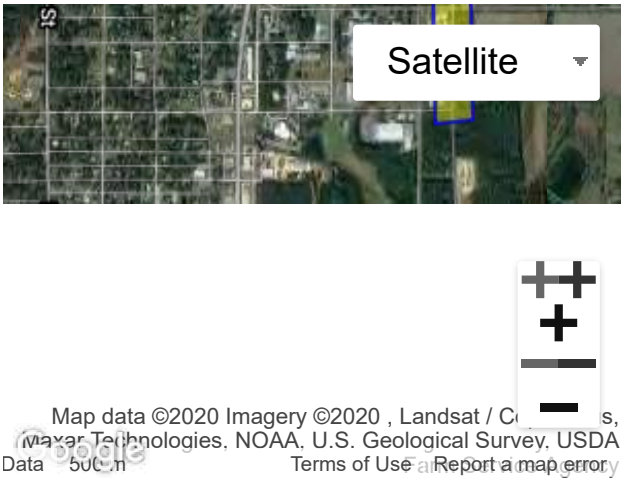
Geographic Information

State: AL
County/Parish: Baldwin
Watershed/Basin: Wolf Bay & Bon Secour Bay/Oyster Bay
Affected Area (acres): 40000
Location Description: Foley, Alabama corporate limits

Location Overview
(lat: 30.405265, long: -87.675808)



Detail Map
(size: , 8.6 miles)



capacity lost in the collection system due to I/I and pipe deficiencies, and (b) correcting pipe deficiencies that can directly lead to a manhole overflow; (2) Prevent exfiltration of wastewater into groundwater; 3) Reduce WWTF peak flows during rain events so that treatment processes are not overloaded and high quality effluent is discharged to Wolf Creek.

Organization Name:THE UTILITIES BOARD OF THE CITY OF FOLEY, ALABAMA (dba RIVIERA UTILITIES)

Activity(s):

- Restoration
- Protection

Habitat(s):

- Subtidal (Nearshore/Offshore)
- Upland
- Marine/Estuarine Wetlands
- Freshwater Wetlands

Status

Property/Resource Acquisition: N/A

Project Planning/Design: In Progress

Project Permitting: N/A

Time to Implementation: 0-3 months

Time to Project Completion: 4-6 months

Included in Regional Plan? No

Cost

Estimated Cost: US$1,250,000.00

Funding Available: US$0.00

Partners

Organization

WOLF BAY WATERSHED WATCH
CITY OF FOLEY, ALABAMA

APPENDIX I:
Watershed Management Plan Checklist

Watershed Management Plan Component Checklist
Watershed Management Plan Title: Wolf Bay Watershed Management Plan
Waterbody ID, Hydrologic Unit Code, Watershed Boundary Data Set, or Hydrologic Response Unit: **HUC_12 0301401070201, HUC_12 031401070202, HUC_12 031401070203**
River Basin: **Wolf Bay Watershed**
County(ies): **Baldwin**
Title of TMDL: a) A TMDL for This Watershed is (“X” as applicable): ( ) Approved ( ) In Draft b) No TMDL Has Been Developed to Date: (X) c) The Watershed Plan Addresses a Non-Impaired or Threatened Waterbody: (X) Yes ( ) No
Comments:

Component (A) Watershed Conditions	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan assesses the conditions of shorelines, wetlands, and riparian areas. (If "No" or "N/A" provide comments below.) Comments:	X			Section 5.8	92 - 97
II. The plan characterizes watershed biological resources, including fauna, flora, invasive species, and threatened and endangered species. (If "No" or "N/A" provide comments below.) Comments:	X			Section 4.7	44 - 50
III. The plan characterizes customary uses of biological resources. (If "No" or "N/A" provide comments below.) Comments:	X			Section 4.7	44 - 50
IV. The plan identifies vulnerabilities on the watershed from increased sea level rise, storm surge, temperature increases, and precipitation. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 6	106 - 126
V. The plan characterizes existing opportunities for public access, recreation, and ecotourism. (If "No" or "N/A" provide comments below.) Comments:	X			Section 7.3 Section 8.4	145 – 146 170 – 173

Component (B) Identification of Pollutant Causes and Sources	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan identifies the pollutant *causes* and *sources* or groups of similar sources that will need to be managed to achieve the load reductions identified in a TMDL, or elsewhere in this plan. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 7	132 - 147
II. The plan addresses *other* watershed/natural resource/stakeholder issues and concerns that *may be* problematic, but are *not* addressed by a TMDL. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 7	132 - 147

Component (C) Pollutant Load Reduction Estimates	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan provides estimates of load reductions needed to achieve a TMDL. (If "No" or "N/A" provide comments below.) Comments: There are no TMDLs approved for this watershed.			X		
II. The plan provides *estimates* of potential load reductions for each pollutant cause or source, or groups of similar sources that need to be managed. (If "No" or "N/A" provide comments below.) Comments: This WMP identifies critical issues and areas and recommends management measures to address each in a broad context. A more detailed identification of site-specific pollutant causes or sources is needed before detailed BMPS can be designed and a reduction of pollutant loads can be calculated.		X		Chapter 7, Chapter 8	
III. The plan provides locations where *potential* BMPs may be implemented. (If "No" or "N/A" provide comments below.) Comments:	X			Section 8.1 Section 8.3 Section 8.4	147 – 161 166 – 170 170 - 173
IV. A reasonable approach is used to *estimate* pollutant load reductions (assumptions and limitations should be stated). (If "No" or "N/A" provide comments below.) Comments: This WMP identifies critical issues and areas and recommends management measures to address each in a broad context. A more detailed identification of site-specific pollutant causes or sources is needed before detailed BMPS can be designed and a reduction of pollutant loads can be calculated.		X		Chapter 7, Chapter 8	

Component (D) Best Management Practices	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan identifies *potential* BMPs to be installed in "critical" areas. Comments; (If "No" or "N/A" provide comments below.)	X			Chapter 8	147 - 175
II. The plan identifies actions to improve habitats necessary to support healthy populations of fish and shellfish. (If "No" or "N/A" provide comments below.) Comments:	X			Section 8.1	147 - 161
III. The plan identifies actions to reduce the incidence and impacts of invasive flora and fauna. (If "No" or "N/A" provide comments below.) Comments:	X			Section 8.2	163 - 166
IV. The plan identifies actions to preserve culture, heritage, and traditional ecological knowledge of the watershed. (If "No" or "N/A" provide comments below.) Comments:	X			Section 4.10 Section 7.2 Section 12.4	58 – 63 143 - 145 221 - 222
V. The plan recommends strategies to remediate effects of environmental degradation. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 8 Chapter 9	147 – 173 175 - 181
VII. The plan identifies strategic areas for shoreline stabilization, wetland and stream restoration/conservation, and fishery enhancements. (If "No" or "N/A" provide comments below.) Comments:	X			Section 8.1.1.5	157 - 159
VIII. The plan provides recommendations to improve watershed resiliency through adaptation strategies. (If "No" or "N/A" provide comments below.) Comments:	X			Section 6.7	117 - 125
IX. The plan identifies potential sites to expand access to open spaces and waters within the watershed. (If "No" or "N/A" provide comments below.) Comments:	X			Section 8.4	170 - 173
X. The plan incorporates established programs in implementation strategies (Clean Marina, Alabama Water Watch, Community Ratings System, Smart Yards, etc) . (If "No" or "N/A" provide comments below.) Comments:	X			Section 9.1 Section 12.3 Section 12.4	175 221 221 - 222

Component (E) Financial and Technical Assistance	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I: The plan provides estimates of the financial and technical assistance that will be needed to implement the plan. (If "No" or "N/A" provide comments below.) Comments:	X			Section 9.2 Section 9.3	175 – 178 178 – 181
II: The plan identifies sources and authorities that will be relied upon to implement the plan. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 11	207 - 211
III. The plan contains a strategy for driving regulatory change. (If "No" or "N/A" provide comments below.) Comments:	X			Section 10.3 Section 10.4 Section 10.5	203 – 204 204 204

Component (F) Education and Outreach	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan provides an information/education component that will enhance public understanding of the plan and encourage their early and continued participation in project development. (If "No" or "N/A" provide comments below.) Comments:	X			Section 8.1 Chapter 9	147 – 161 175 - 181

Component (G) Plan Implementation Schedule	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan provides a reasonably expeditious schedule for implementing management measures. (Should base implementation timetable on BMPs in "C" above.) Comments: (If "No" or "N/A" provide comments below.)	X			Section 9.2 Section 9.3	175 – 178 178 - 181

Component (H) Interim Milestones	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan provides a list or description of interim milestones for determining whether NPS management measures are being implemented. (If "No" or "N/A" provide comments below.) Comments:	X			Section 9.4	181 – 182

Component (I) Monitoring and Assessment	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards, and if not, the criteria for determining whether the watershed plan needs to be revised - or if a NPS TMDL has been established - whether the NPS TMDL needs to be revised. (If "No" or "N/A" provide comments below.) Comments:	X			Chapter 12	215 - 222
The plan identifies key locations for volunteer water monitoring. (If "No" or "N/A" provide comments below.) Comments:	X			12.4	221 - 222

Component (J) Plan Implementation Effectiveness	Yes	No	N/A	Chapter, Section, Table, List, etc.	Page No.(s)
I. A monitoring component to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item (I). (If "No" or "N/A" provide comments below.) Comments:	X			Section 12.5	222