Dewberry

MOBILE BAY NATIONAL ESTUARY PROGRAM

Bayou La Batre Watershed Management Plan

August 10th, 2018

SUBMITTED BY:

Dewberry
203 Aberdeen Parkway
Panama City, FL 32405
850.522.0644

SUBMITTED TO:

Mobile Bay National Estuary Program
118 North Royal Street #601

Mobile, AL 36602
251.380.7940

SUBCONSULTANTS

ESA

Dauphin Island Sea Lab Alabama

Biohabitats

PARKER-MARTIN CONSULTING GROUP

SCE

Executive Summary

The Mobile Bay National Estuary Program (MBNEP), in partnership with Mobile County Soil and Water Conservation District, contracted with Dewberry to develop the Bayou La Batre Watershed Management Plan (WMP). Dewberry brought together a team of highly qualified experts to develop this WMP and focused the plan around the six values identified in the MBNEP Comprehensive Conservation and Management Plan:

- **Water**: Environmental Science Associates
- **Coastlines**: South Coast Engineers
- **Access**: Biohabitats
- **Fish**: Dauphin Island Sea Lab
- **Heritage**: Parker Martin Consulting Group
- **Resiliency**: Dewberry.

This WMP is organized into the following sections:

- **Section 1** provides an introduction to the plan and an overview of the purpose.
- **Section 2** describes the Bayou La Batre Watershed, providing background on characteristics and current conditions—including topography, hydrology, habitats, demographics, land use, etc.—to provide an understanding of current and historical conditions and insight into the problems of concern.
- **Section 3** evaluates the existing conditions within the Watershed and helps to focus management efforts to address the most pressing needs.
- **Section 4** identifies the critical areas and issues within the Watershed. These issues help shape the overall goals of the WMP and determine what information is needed to accurately define and address community concerns.
- **Section 5** discusses the goals and objectives used to guide the development of the management measures and also examines regulatory drivers and constraints to restoration.
- **Section 6** describes the conceptual management measures considered to address the challenges and features of this WMP.
- **Section 7** provides implementation strategies that include timelines, potential action items, and prospective partnerships to help facilitate the implementation of the identified management measures.
- **Section 8** discusses the regulatory framework of laws, regulations, and ordinances that pertained to water quality, stormwater management, erosion and sediment control, coastal zone issues, wetlands and other surface waters, and land disturbance activities, as under the jurisdiction of the Federal, State, County, and City of Bayou La Batre governmental entities.
- **Section 9** presents a financial strategy, including available sources of funding (i.e., grants, partnerships, etc.) for restoration projects, and examines innovative mechanisms and alternatives for leveraging funding sources.
- **Section 10** details the public outreach and community involvement efforts needed for successful implementation of this WMP.

- **Section 11** outlines a monitoring program to evaluate the success of the management measures over the 10-year planning period.

THE WATERSHED

The Bayou La Batre Watershed is located in the Escatawpa River Basin and forms in southern Mobile County. The Watershed is defined by the U.S. Geological Survey (USGS) 12-digit hydrologic unit code (HUC) as HUC 031700090102 (USGS 2013) and receives drainage from several named tributaries: Hammer Creek, Bishop Manor Creek, and Carls Creek; and multiple unnamed tributaries, which all flow south into the Bayou. The total drainage area of the Watershed is approximately 19,562 acres (30.6 square miles) and includes the 5.46 mile length of Bayou La Batre, a tidally influenced waterbody, with a water use classification of Fish & Wildlife (ADEM 2009).

According to the National Land Cover Database 2011 (Homer et al., 2015), the land use and land cover within the Bayou La Batre Watershed is primarily characterized by three classifications: urban (14%), upland communities (56%) and wetland communities (29%). These three classifications total 99% of the land use and land cover of the Bayou La Batre Watershed.

CRITICAL ISSUES AND AREAS

The WMP Team carefully listened to the community and stakeholders to gain insight into their issues, needs, and concerns. The result of this engagement reflects the depth of understanding among stakeholders that protecting the quality of the Watershed is intrinsically tied to protecting the local culture and economy. A combination of responses to (a) Improved water quality, (b) Protecting wetland habitats and (c) Preservation of natural sites represents 46% of all stakeholder primary concerns. This extensive public outreach and engagement process resulted in a community common vision for the Watershed:

Vision: *To transform the Bayou and its watershed into a healthy and vibrant community amenity to Coastal Alabama that supports robust habitat; provides increased public access; serves as an economic engine supporting the seafood and shipbuilding industry and ecotourism; and celebrates and preserves the rich culture and heritage of the area.*

In developing this plan, the WMP Team utilized a community-centered, comprehensive approach to watershed management planning. The WMP Team incorporated the U.S. Environmental Protection Agency (EPA)'s six steps in watershed planning, guidance from the MBNEP Comprehensive Conservation and Management Plan (CCMP), Clean Water Act Section 319, as well as other regional planning initiatives. The goal was to establish a WMP that was founded on equitable and practical restoration and remediation alternatives. In developing this comprehensive, community-based approach, the WMP Team endeavored to provide a clear vision to guide the planning process while always keeping the end goal in view – restoring the ecological and cultural vitality of the Watershed and its community.

The critical areas and issues to address in restoration of the Bayou La Batre Watershed have been prioritized into the categories listed below.

- **Water quality** - Identifies actions to reduce point and non-point source pollution

(including stormwater runoff and associated trash, nutrients, pathogens, erosion and sedimentation)

- **Fish/Habitat** - Identifies actions to reduce the incidence and impacts of invasive flora and fauna and improve habitats necessary to support healthy populations of fish and shellfish.
- **Access** - Characterizes existing opportunities for public access, recreation, and ecotourism through access to open spaces and waters within the watershed.
- **Heritage** – Identifies customary uses of biological resources and identifies actions to preserve culture, heritage and traditional ecological knowledge of the watershed
- **Coastlines** - Assesses shoreline conditions and identifies strategic areas for shoreline stabilization and fishery enhancements
- **Resiliency** - Identifies vulnerabilities in the watershed from increased sea level rise, storm surge, temperature increases and precipitation and methodology for improving watershed resiliency through planning and management

This comprehensive approach to watershed management will maximize benefits to upland agriculture, urban growth, seafood harvesting, boat building, and the overall quality of life for citizens in the watershed

RECOMMENDED MANAGEMENT MEASURES

The Watershed Management Team developed a list of recommended Management Measures to achieve the goals established for the Bayou La Batre Watershed (discussed in detail in Sections 6 and 7).

- Reduce the amount of trash in and entering the bayou and tributaries
- Reduce nutrients and sediments in stormwater runoff and address nuisance flooding in yards and streets
- Remove sanitary leaks, Sanitary Sewer Overflows and illicit discharges into the bayou and tributaries
- Reduce the occurrence of nuisance and/ or exotic species with focus on the bayou
- Promote habitat protection, conservation, and restoration
- Increase citizen access to coastal resources
- Promote tourism, ecotourism, and diversify the local economy
- Promote resiliency and adaptive management strategies
- Address the City of Bayou La Batre's comprehensive planning and development
- Promote environmental outreach and education

IMPLEMENTATION OF MANAGEMENT MEASURES

Momentum has been building over the years to transform the Bayou and its watershed into a healthy and vibrant community that supports robust habitat; provides increased public access; serves as an economic engine supporting the seafood and shipbuilding industry and ecotourism; and celebrates and preserves the rich culture and heritage of the area. With the development of this WMP and the activities involved (i.e. public meetings, committee meetings), the timing is right to build upon the involvement of current audiences and invite more to participate in this work.

Implementation of the Bayou La Batre Watershed Management Plan will require leadership and substantial funding. The initial leadership to begin implementation of the Watershed Management Plan will be provided and led by the South Mobile County Community Development Corporation (SMCCDC). Upon approval of the Bayou La Batre Watershed Management Plan, the SMCCDC should begin immediately to implement the recommended management measures. Many of the management measures can be implemented concurrently as the necessary funding becomes available.

To achieve maximum effectiveness, implementation efforts should monitor a variety of management measures and indicators, including but not limited to the following.

- acres of wetlands preserved
- acres of wetlands restored
- miles or acres of riparian buffer restored
- acres treated for invasive plant removal
- number of septic tanks inspected and serviced and/or taken out of service
- number of alternative on-site sewage disposal systems installed
- miles of livestock exclusion fencing installed
- number and type of agricultural Best Management Practices (BMPs) implemented,
- miles of waterway restored

In addition, a comprehensive watershed water monitoring system should be designed and implemented to accurately monitor trends in Watershed conditions and parameters. All monitoring activities should be conducted in accordance with the *Mobile Bay Subwatershed Restoration Monitoring Framework*, and state and federal Standard Operation Procedures (SOPs). A vital element of the Watershed Monitoring Program will be volunteer citizen participation to enable successful implementation and establish a sense of community ownership within the Watershed.

Acknowledgements

Development of the Bayou La Batre (BLB) Watershed Management Plan (WMP) was made possible by funding provided by the National Fish and Wildlife Foundation (NFWF) Gulf Environmental Benefit Fund (GEBF). The Mobile Bay National Estuary Program (MBNEP) was the recipient of this funding and partnered with the Mobile County Soil and Water Conservation District (MCSWCD) to select a consultant team to prepare the WMP.

Dewberry was selected to manage and prepare the WMP. Dewberry personnel were responsible for project management and leading the environmental health and resiliency, finance, management measures, and implementation tasks. The Dewberry Watershed Management Planning Team (WMP Team) consisted of the following firms: Environmental Science Associates (ESA) was the lead for water quality evaluations; South Coast Engineers led shoreline evaluations; Dauphin Island Sea Lab (DISL) led habitat assessments; Biohabitats evaluated public access opportunities in the watershed; and Parker Martin Consulting Group (PMCG) led the public outreach and culture and heritage tasks.

The WMP Team would like to acknowledge the following individuals for their insights and assistance in developing this WMP.

Bayou La Batre Steering Committee

Reang Ly Ang, Vietnamese Community
Kieu Lien Atwell, Vietnamese Community
Reverend Dennis Bennet, Freewater Baptist Church
Lori Bosarge, Coastal Response Center
Bountrath Bouasanouvong, Laotian Community
Ken Buck, Buck Farms
Sharon Castelin, Citizen Stakeholder
Ida Mae Coleman, BLB City Commission
Chris Collier, Business Owner
Bobby Dixon, Citizen Stakeholder
Bret Dungan BLB Mayor (2013-2015)
David Esfeller, Esfeller Farms
Judy Haner, The Nature Conservancy
Reverend Joseph Hayes, Sweet Bethel Baptist Church
Philip Hinesley, Alabama Department of Conservation and Natural Resources (ADCNR)
Lynn Huynh, Vietnamese Community
Annette Johnson, BLB Mayor (2015-2016)
Cristie Keovoravong, Laotian Community
Col. Roosevelt Lewis, BLB Planning Commission
Nancy McCall, Citizen Stakeholder
Shannon McGlynn, Alabama Department of Environmental Management (ADEM)
Christian Miller, MBNEP
Roger Milne, Citizen Stakeholder
Joyce Nicholas, Natural Resources Conservation Service (NRCS)
Randy Nicholas, MCSWCD

Thi Nguyen, Vietnamese Community
Andy Overstreet, Businessman
Wanda Overstreet, Citizen
Dena Pigg, BLB Chamber of Commerce
Jeremy Sessions, Citizen Stakeholder
Randy Shaneyfelt, ADEM
Terry Sue Smith, Citizen Stakeholder
Velma Jean Steel, Citizen Stakeholder
Julian Stewart, Alma Bryant High School
Roberta Swann, MBNEP

The WMP Team would also like to acknowledge the following people who provided data, information, and assistance vital to the development of this WMP:

Ernie Anderson, Seafood Association
Raymond Barbour, Junior Barbour Seafood
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Marlon Cook, Cook Hydrogeology, LLC
Doug Cote, Mobile Area Water and Sewer System (MAWSS)
Ron Davis, Mobile County Revenue Commission (MCRC)
Bentley Dearmon, NRCS
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Bill Hibberts, City of BLB
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Jenny Jacobson, U.S. Army Corps of Engineers (USACE)
Steve Jones, GSA
Scott Kearney, City of Mobile
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Heat Lannie, BLB Chamber of Commerce
Mike McClantoc, BLB Utility Board
Ashley Peters, ADCNR
Victoria Phaneuf, University of Arizona
Sylvia Raley, BLB Utility Board
Justin Rigdon, ADEM
Greg Ryland, CDG Engineers and Associates
Travis Short, Horizon Shipbuilding
Dr. Eric Sparks, MS-AL Sea Grant
Lynn Stewart, Alma Bryant High School
Jody Thompson, Auburn University
David Tidwell, GSA
Dr. Barry Vittor, Vittor and Associates, LLC
Dr. Bill Walton, Auburn University
Jimmy Warren, City of Bayou La Batre
Brad Williams, NRCS

The development of this WMP was a collaborative effort among the managing agencies (NFWF, MBNEP, MCSWCD), WMP Team, BLB Steering Committee, resource agencies, and the communities in and around the Bayou La Batre Watershed. The WMP Team sincerely appreciate everyone's passion and commitment to the betterment of the Bayou La Batre Watershed.

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ACAMP	Alabama Coastal Area Management Program Strategic Plan 2013-2018
ACNPCP	Alabama Coastal Nonpoint Pollution Control Program
ACES	Alabama Cooperative Extension System
ADCNR	Alabama Department of Conservation and Natural Resources
ADCNRSLD	Alabama Department of Conservation and Natural Resources -State Lands Division
ADECA	Alabama Department of Economic and Community Affairs
ADEM	Alabama Department of Environmental Management
AGCRC	Alabama Gulf Coast Recovery Council
ALEA	Alabama Law Enforcement Agency
ARWA	Alabama Rural Water Association
ACS	American Community Survey
AWW	Alabama Water Watch
BLB	Bayou La Batre
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
CELCP	Coastal and Estuarine Land Conservation Program
CIAP	Coastal Impact Assistance Program
CoNED	Coastal National Elevation Database
CTP	Coastal Training Program
CCMP	Comprehensive Conservation & Management Plan 2013-2018
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFU	Colony forming units
DISL	Dauphin Island Sea Lab
DOQQs	Digital Orthographic Quarter Quadrangles

DIN	Dissolved inorganic nitrogen
DHNRDAT	Deepwater Horizon Natural resources Damage Assessment Trustees
DIP	Dissolved inorganic phosphorous
ESA	Environmental Science Associates
ETJ	Extraterritorial Jurisdiction
FEMA	Federal Emergency Management Agency
GED	General Educational Development
GIS	Geographic information system
GSA	Geological Survey of Alabama
GEBF	Gulf Environmental Benefit Fund
GIWW	Gulf Intracoastal Waterway
GOMA	Gulf of Mexico Alliance
GOMESA	Gulf of Mexico Energy Security Act
IWD	Inverse Distance Weighting
IC	Impervious Cover
ICM	Impervious Cover Model
I & I	Inflow and Infiltration
IPCC	Intergovernmental Panel on Climate Change
HCRT	Habitat Conservation & Restoration Team
HUC	Hydrological Unit Code
LULC	Land Use and Land Cover
LQ	Local quotient
LLPI	Longleaf Pine Initiative
MEOWs	Maximum Envelopes of Water
MOMs	Maximum of MEOWs
MST	Microbial source tracking

MBNEP	Mobile Bay National Estuary Program
EMO2	Mobile Bay Version 3
MCSWCD	Mobile County Soils and Water Conservation District
MELC	Multi-Resolution Land Characteristics
MS4	Municipal Separate Stormwater Sewer System
NASA	National Aeronautics and Space Administration
NASS	National Agricultural Statistics Service
NFWF	National Fish and Wildlife Foundation
NFIP	National Flood Insurance Program
NHC	National Hurricane Center
NHD	National Hydrography Database
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination Systems
NPR	national Public Radio
NRPA	National Recreation and Park Association
NWS	National Weather Service
NWI	National Wetlands Inventory
NRDA	Natural Resource Damage Assessment
NAVD	North American Vertical Datum
NRCS	Natural Resources Conservation Service
PMCG	Parker Martin Consulting Group
POM	Particulate organic material
PALS	People Against A Littered State
PSGM	Prescott Spatial Growth Model

PIC	Project Implementation Committee
RL	Repetitive Loss
RCRA	Resource Conservation Recovery Act
RESTORE	Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act
SSO	Sanitary Sewer Overflow
SAC	Science Advisory Committee
SLR	Sea Level Rise
SRL	Severe Repetitive Loss
SCE	South Coast Engineers
SMCCDC	South Mobile County Community Development Corporation
SMCTA	South Mobile County Tourism Authority
SFHA	Special Flood Hazard Areas
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operation Procedures
TNC	The Nature Conservancy
TMDL	Total Maximum Daily Load
TSS	Total suspended solids
SSO	Sanitary sewer overflows
SLAMM	Sea Levels Affecting Marches Model
SLOSH	Sea, Lake, Overland Surges from Hurricanes Model
UST	Underground Storage Tanks
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
DOI	U.S. Department of the Interior
EPA	U.S. Environmental Protection Agency

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USCB	United States Census Bureau
ULI	Urban Land Institute
FWS Next Steps	Vision for a Health Gulf of Mexico Watershed; Next Steps for a Healthy Gulf of Mexico Watershed
WWTF	Wastewater Treatment Facility
WERF	Water Environment Research Foundation
WMP	Watershed management plan
WMP	Team Watershed management planning team
WMTF	Watershed Management Task Force
WLFW	Working Lands for Wildlife

1 Introduction

1.1 Plan Purpose

The Mobile Bay National Estuary Program (MBNEP) received funding from the National Fish and Wildlife Foundation (NFWF) Gulf Environmental Benefit Fund (GEBF) to develop watershed management plans (WMPs) for several intertidal watersheds along the Alabama coast.

The Bayou La Batre Watershed was identified as one of the priority watersheds by the MBNEP Project Implementation Committee (PIC), and the MBNEP partnered with the Mobile County Soil and Water Conservation District (MCSWCD) to develop the Bayou La Batre WMP. The goal of the plan is to provide a roadmap for restoring and conserving the watershed and improving water and habitat quality in areas where resources could have been damaged by the Deepwater Horizon Oil Spill. This WMP charts a conceptual course for improving and protecting the things people value most about living along the Alabama coast as identified in the MBNEP Comprehensive Conservation and Management Plan (CCMP).

The Bayou La Batre WMP is centered on these six values and addresses the following:

- **Water**: Identifies actions to reduce point and non-point source pollution and remediate past effects of environmental degradation, thereby reducing outgoing pollutant loads into Portersville Bay, Mississippi Sound, and the Gulf of Mexico.

- **Coastlines**: Assesses shoreline conditions and identifies strategic areas for shoreline stabilization and fishery enhancements.

- **Access**: Characterizes existing opportunities for public access, recreation, and ecotourism and identifies potential sites to expand access to open spaces and waters within the watershed.

- **Fish**: Identifies actions to reduce the incidence and impacts of invasive flora and fauna and improve habitats necessary to support healthy populations of fish and shellfish. Provides a strategy for conserving and restoring coastal habitat types; providing critical ecosystem services; and identified by the MBNEP's Science Advisory Committee (SAC) as most threatened by anthropogenic stressors. These habitat types: freshwater wetlands; streams, rivers and riparian buffers; and intertidal marshes and flats, were classified as most stressed from dredging and filling, fragmentation, and sedimentation, all related to land use change.

- **Heritage**: Characterizes customary uses of biological resources and identifies actions to preserve culture, heritage, and traditional ecological knowledge of the watershed.

- **Resiliency**: Identifies vulnerabilities in the watershed from accelerated sea level rise, storm surge, temperature increases, and precipitation and improves watershed resiliency through adaptation strategies.

The watershed management planning team (WMP Team) developed a community-centered, comprehensive approach to watershed management planning. This approach incorporated EPA's six steps in watershed planning with EPA's nine key watershed management elements into a broad overall watershed management approach for improvement and protection of the six things people value most about living along the Alabama coast. The WMP incorporates guidance from the MBNEP CCMP, Alabama Department of Environmental Management's (ADEM) 319 checklist, as well as other regional planning initiatives. The overall goal was to establish a plan that was founded on equitable, practical, and buildable restoration and remediation alternatives. In developing this comprehensive, community based approach, the WMP provides a clear vision to guide the planning process while always keeping the end goal in view – restoring the ecological and cultural vitality of the watershed and its community.

1.2 Period Addressed by the Plan

The scope and breadth of the recommended improvements from this WMP to restore water quality and habitat in Bayou La Batre will require significant time to implement. This WMP provides a 10-year framework to begin the implementation of recommended actions. This time frame is subject to change, depending on the availability of funds, success of recommended projects, and watershed response. As part of the recommended adaptive management approach, a review of the WMP recommendations should be performed every year, with an in-depth assessment every three to five years. This review should consider monitoring results from implemented projects and whether changes are warranted to the project type, scope, or area of implementation to achieve the stated goals and objectives of the WMP.

1.3 Watershed Management Planning Team

The MBNEP, in partnership with MCSWCD, contracted with Dewberry to develop the Bayou La Batre WMP. Dewberry brought together a team of highly qualified experts to develop this plan. The team was developed around the six values identified in the MBNEP CCMP:

- **Water**: Environmental Science Associates (ESA)
- **Coastlines**: South Coast Engineers (SCE)
- **Access**: Biohabitats
- **Fish**: Dauphin Island Sea Lab (DISL)
- **Heritage**: Parker Martin Consulting Group (PMCG)
- **Resiliency**: Dewberry

The development of this plan involved sustained collaboration between the MBNEP; MCSWCD; NRCS; WMP Team; municipal, county, state, and federal officials; and local stakeholders and citizens. The WMP Team would like to acknowledge the following organizations for their continued support in the development and implementation of this WMP:

- Mobile Bay National Estuary Program (MBNEP)
- Mobile County Soil and Water Conservation District (MCSWCD)
- Natural Resources Conservation Service (NRCS)
- City of Bayou La Batre
- Bayou La Batre Utilities Board
- Bayou La Batre WMP Steering Committee
- Alma Bryant High School
- Alabama Department of Conservation and Natural Resources (ADCNR)
- Alabama Department of Environmental Management (ADEM)
- US Fish and Wildlife Service (USFWS)
- The Nature Conservancy (TNC)
- Mobile County Revenue Commission
- US Army Corps of Engineers (USACE)
- US Geological Survey (USGS)
- US Department of the Interior (DOI)
- US Department of Agriculture (USDA)
- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration (NOAA)
- City of Mobile
- Geological Survey of Alabama (GSA)
- Alabama Marine Resources Division
- Mississippi-Alabama Sea Grant Consortium
- Auburn University
- Bayou La Batre Chamber of Commerce
- South Mobile County Community Development Corporation (SMCCDC)

1.4 Document Overview

This WMP is organized into the following sections:

- **Section 2** describes the Bayou La Batre Watershed, providing background on characteristics and current conditions—including topography, hydrology, habitats, demographics, land use, etc.—to provide an understanding of current and historical conditions and insight into the problems of concern.
- **Section 3** evaluates the existing conditions within the Watershed and helps to focus management efforts to address the most pressing needs.
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1.5 Public Participation

The challenge of engaging citizens in a watershed study is always complex and was made even more daunting by the socioeconomic structures and language barriers within the Bayou La Batre (BLB) community. The WMP Team recognized these challenges and, as such, expended much of their effort on developing an authentic public participation and stakeholder engagement program. The outreach program was designed to be an integral part of the watershed management planning process—equally as important as the scientific assessments, if not more so. This program was centered on the principal of building a partnership with the community and local stakeholders and connecting with each community segment in an appropriate manner.

1.5.1 Stakeholder Outreach and Engagement

Early in the process, the WMP Team identified key community leaders and stakeholders to ensure successful participation by the maximum number of citizens within the watershed and surrounding areas with an emphasis on inclusion from both English-speaking and non-English-speaking populations. This included business owners, commercial fishermen, private landowners, environmental groups, school groups, church and civic groups, recreational water users, and the general citizenry. Partners, such as local, county, state, and federal agencies, were also identified and included in outreach efforts.

A major public awareness campaign was implemented to alert the citizens that a watershed management study was being undertaken and why the study would be important to each of them, their livelihoods, their communities, and the future of the region that they call "home."

Public participation was encouraged using electronic notices, media/press releases, and targeted announcements in multiple languages including English, Cambodian, Vietnamese, and Laotian.

One-on-one interviews were conducted with key stakeholders identified as centers of influence within their groups/communities. Part of the interview process included identifying the most appropriate methods for reaching each of their constituent groups. A Bayou La Batre Watershed Steering Committee was then formed using these important community leaders as the nucleus.

Based on responses from these centers of influence, the WMP Team created a contact database arranged by language capability (Vietnamese, English, etc.) and by subset (commercial fishermen, business owners, etc.). Materials were subsequently developed and printed in all four languages and initially distributed by the identified centers-of-influence individuals to help encourage citizen participation. Printed materials were also later distributed to the community at large via inclusion with the City of Bayou La Batre monthly newsletter, monthly BLB Utilities Board statements, and other formats.

1.5.2 Community Meetings

Community meetings were held with each subset of the citizenry, as identified and recommended by the Steering Committee. The goals were to inform the citizenry relative to the function and processes of the watershed and obtain their input. Meetings were held in English, Vietnamese, Cambodian, and Laotian. Local bilingual citizens were identified to serve as interpreters/translators for citizen meetings and as writers for the development of supplemental materials.

Each meeting had a set of basic objectives. The focus for initial meetings was to introduce the concept of watersheds and why protecting the local watershed was critical to the economy and quality of life in Bayou La Batre for future generations. Participants were introduced to specifics of the WMP, including timelines and products. The goals were to realize the critical nature of individual responsibility and recognize the importance of their direct participation in protecting the quality and heritage of the local watershed.

Subsequent community meetings focused on identifying interim results of the assessment and obtaining feedback on prioritizing projects and identifying next steps. This feedback was used to create a consensus of current watershed conditions and define the local citizen vision, goals, and objectives for improvements. As a supplement to the standard community meetings, the WMP Team held special neighborhood meetings to help reach non-English-speaking and other minority populations.

Section 10 presents further information on the community participation and stakeholder engagement program. The WMP Team endeavored to keep the community engaged and informed of milestones and accomplishments. Citizens were continuously encouraged to participate in community meetings, surveys, and engagement activities throughout the watershed management planning process.

2 Watershed Description

The Bayou La Batre Watershed covers over 19,562 acres in south Mobile County and the Bayou flows southwesterly into Portersville Bay and Mississippi Sound. The City of Bayou La Batre is the main urban center in the Watershed.

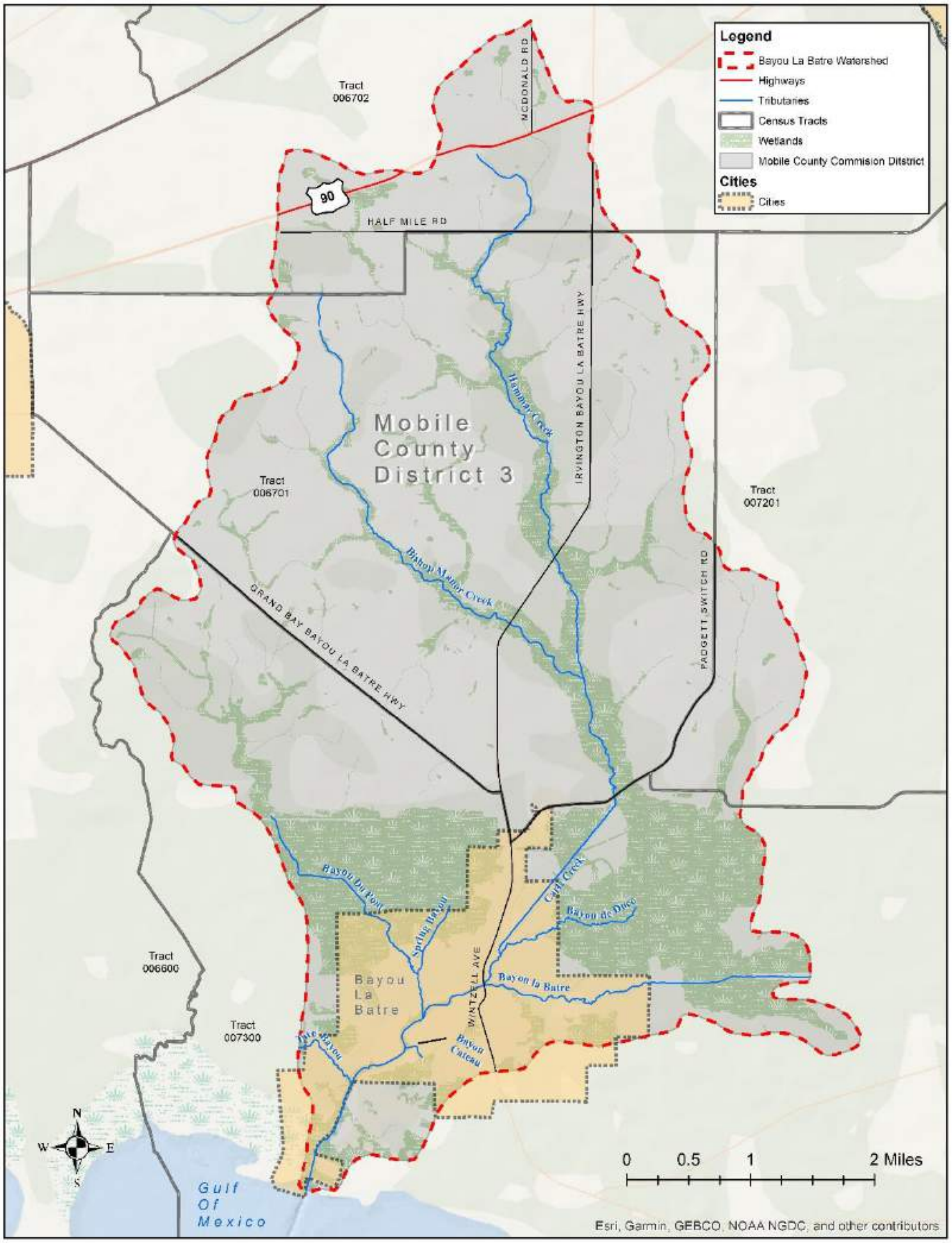


Figure 2.1 Overview map of the Bayou La Batre Watershed

2.1 Physical and Natural Setting

Bayou La Batre is located in the Escatawpa River Basin and forms in southern Mobile County, within the limits of the City of Bayou La Batre. It receives drainage from several named tributaries: Hammar Creek, Bishop Manor Creek, and Carls Creek; and multiple unnamed tributaries, which all flow south into the Bayou. Bayou La Batre, Carls Creek and several of the unnamed tributaries are all tidally influenced. The total length of Bayou La Batre is 5.46 miles and the waterbody has a use classification of Fish & Wildlife (ADEM 2009).

2.1.1 Watershed Boundary

The Bayou La Batre Watershed is located in Mobile County, Alabama, and is defined by the U.S. Geological Survey (USGS) 12-digit hydrologic unit code (HUC) HUC 031700090102 (USGS 2013). USGS HUC cataloging units represent the geographic area for parts of all surface drainage basins and are effective for evaluating and managing water resources at the local level (Exum *et al*. 2005). However, water network systems found within the area defined by the USGS HUC-12 boundaries have the potential to receive surface flows from areas outside the defined boundary, as HUCs at any hierarchical level are not synonymous with true "watersheds" (Exum *et al*. 2005). For the purposes of this WMP the defined boundary for the Bayou La Batre Watershed is given by the HUC-12 boundary established by the National Hydrography Database (NHD), USGS (2013).

Draining a total area of 19,562 acres (30.6 square miles), the Bayou La Batre Watershed receives its name from its principal tributary, Bayou La Batre. The Bayou is considered the major waterbody in the Watershed and receives flows from Hammar Creek, Bishop Manor Creek, Carls Creek, Snake Bayou, and numerous unnamed canals, ditches, waterway connections, and artificial features (USGS 2013). The cumulative stream network system of the Bayou La Batre Watershed (approximately 73 miles) drains to the south and west thorough the mouth of the Bayou La Batre River and into Portersville Bay, located along the northern portion of Mississippi Sound in coastal Alabama (see **Figure 2.2**).

2.1.2 Hydrology & Climate

2.1.2.1 Surface Water Resources

Bayou La Batre (the waterbody) is located in the Escatawpa River Basin and forms in southern Mobile County. The total drainage area of Bayou La Batre is 30.6 square miles. The Bayou empties into Portersville Bay, Mississippi Sound, and the Gulf of Mexico. The general tidal pattern along the northern Gulf is diurnal, with one high and one low tide in a 24-hour period. During periods of rainfall, natural flow in the Bayou comes from runoff, while during periods of drought, it functions as a tidal system, and the primary source of water is from the Mississippi Sound. Wind and tidal action influence water movement in the Bayou, and at times the waterway can become stagnant (USACE 2014).

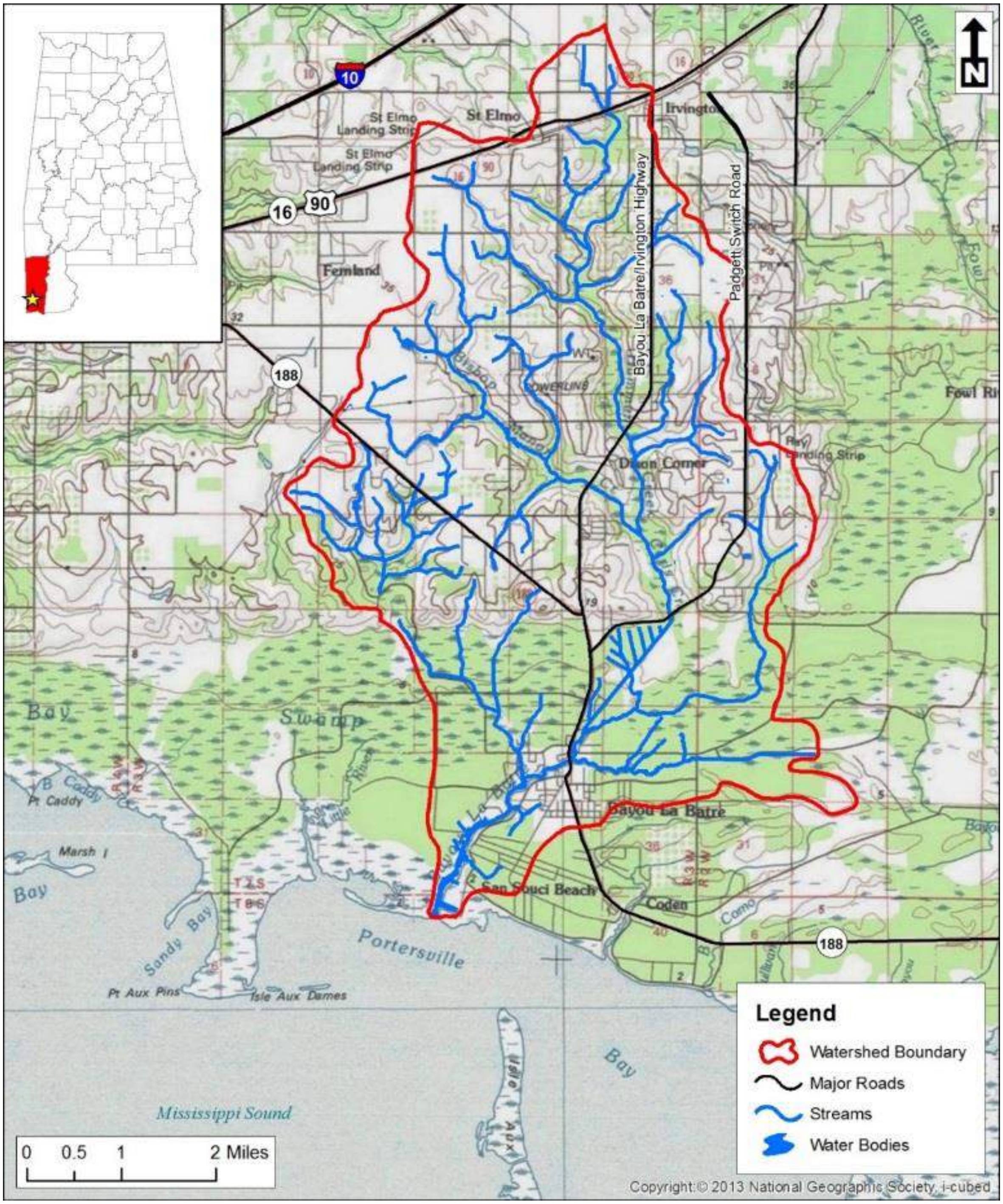


Figure 2.2 Bayou La Batre Watershed boundary

2.1.2.2 Groundwater Resources

The principal sources of groundwater in Mobile County are the Miocene-Pliocene and alluvial aquifers. The Miocene-Pliocene aquifer consists of sediments belonging to the Miocene Series undifferentiated, and the Citronelle Formation of Pliocene age. Although the Miocene and Pliocene sediments are separate geologic units in southern Alabama, they are grouped together as one aquifer because the geologic contact between the units is difficult to determine and the units are often hydraulically connected. A coastal alluvial aquifer underlies the flood plain deposits adjacent to the Mobile River Delta, Mobile Bay, and coastal Mississippi. The alluvial aquifer consists of Quaternary-age channel and flood-plain deposits bordering the Mobile River (USACE 1988).

Both aquifers are accessible to direct recharge through direct infiltration from rainfall and periodic freshwater inundation. The surface level of the Miocene-Pliocene aquifer ranges from 50-100 feet below ground and extends to depths ranging from 1000-2000 feet. The coastal-alluvial aquifer is relatively thin, and extends from the ground surface to about 150 feet. A transition to saline water often occurs to the south. Some aquifers in the southern part of Mobile County have salinities that exceed 6.5%. Within Mobile County, there are no sole source aquifers designated pursuant to Section 1424 (3) of the Safe Drinking Water Act (PL93-523, amended by P295-190) (Barry A. Vittor and Assoc. 2007).

2.1.2.3 Climate

The Watershed is located in a humid, subtropical climate region and is characterized by temperate winters and long, hot summers with rainfall that is fairly evenly distributed throughout the year. Annual temperatures range from below freezing to over 100 degrees Fahrenheit, with a normal mean annual temperature of 68 degrees Fahrenheit along the coast (USACE 2014). Average annual precipitation is 68.1 inches (Summersell 2008). Summer temperatures are generally warm, being moderated by sea breezes, and are influenced to a considerable extent by the mild water temperatures of the Gulf of Mexico. Prevailing southerly winds provide moisture for high humidity from May through September. Winter temperatures are relatively mild, and are greatly influenced by seasonal cold fronts. The area averages 15-20 cold fronts per year, occurring from October through March. The cold fronts bring cold air and strong, predominantly northerly winds with speeds that can exceed 25 to 30 knots (Barry A. Vittor and Assoc. 2007). **Table 2.1** presents the monthly climate statistics for the area.

Table 2.1 Monthly climate statistics for Mobile County (1981-2010)

Month	Maximum Temperature (Deg. F)	Minimum Temperature (Deg. F)	Average Temperature (Deg. F)	Precipitation (Inches)
January	60.8	40.0	50.4	5.65
February	64.4	43.3	53.8	5.12
March	71.2	49.1	60.2	6.14
April	77.5	55.4	66.4	4.79
May	84.5	63.7	74.1	5.14
June	89.2	70.4	79.8	6.11
July	91.0	72.7	81.8	7.25
August	90.7	72.6	81.6	6.96
September	87.0	68.0	77.5	5.11

October	79.2	57.6	68.4	3.69
November	70.6	48.6	59.6	5.13
December	62.7	42.2	52.4	5.06
Annual	77.4	57.0	67.2	66.15

Source: NWS 2016a

Hurricanes occur regularly in the Gulf of Mexico, bringing heavy rains, wind, and coastal flooding. Hurricane season runs from June 1st to November 30th. One of the more recent hurricanes that caused significant damage in the Watershed was Hurricane Katrina. On August 29, 2005, Hurricane Katrina's storm surge severely damaged the City of Bayou La Batre. Approximately 65% of all occupied housing units in the City were damaged or destroyed. In addition, the existing municipal wastewater treatment plant (WWTP) suffered severe damage from the storm surge and was eventually replaced (Summersell 2008).

During the last century, coastal Alabama suffered from the effects of many hurricanes; although not an exhaustive list, the following 18 hurricanes impacted the area (NWS 2016b):

- Category 3 - Unnamed hurricane in July 1916;
- Category 3 - Unnamed hurricane in October 1916;
- Category 3 - Unnamed hurricane in September 1926;
- Category 2 - Hurricane Baker in August 1950;
- Category 5 - Hurricane Camille in August 1969;
- Category 3 - Hurricane Frederic in September 1979;
- Category 3 - Hurricane Elena in 1985;
- Category 2 - Hurricane Erin in August 1995;
- Category 3 - Hurricane Opal in October 1995;
- Category 1 - Hurricane Danny in July 1997;
- Category 2 - Hurricane George in 1998;
- Category 3 - Hurricane Ivan in September 2004;
- Category 1 - Hurricane Cindy in July 2005;
- Category 3 - Hurricane Dennis in July 2005;
- Category 3 - Hurricane Katrina in August 2005;
- Category 4 - Hurricane Gustav in September 2008;
- Category 4 - Hurricane Ike in September 2008;
- Category 1 - Hurricane Isaac in August 2012

2.1.2.4 Rainfall & Flooding

Receiving an average of 68.1 inches of rain per year, this is one of the wettest areas in the nation (NWS 2016a). Rainfall typically comes with cold fronts that move through the region during the winter months or from air-mass thunderstorms more prevalent in the summer months. **Table 2.1** in the previous section provides monthly and annual average rainfall statistics.

The area is also susceptible to extreme weather events that can cause intense rainfall and flooding. Hurricane Danny deposited 43 inches of rainfall in a 24-hour period in portions of Mobile County in 1997. Due to the area's low elevation, soil characteristics, and tidal flux, lowland and wetland flooding occurs frequently in specific areas of the Watershed. Currently areas along Davenport St. in the City of Bayou La Batre encounter frequent flooding events (**Figure 2.3**). In addition to flooding caused by intense rainfall, the area is also vulnerable to flooding from storm surges. Storm surges from Hurricane Katrina in the Bayou La Batre area were 12 to 14 feet, and many homes were engulfed by the flood waters (NWS 2016c).

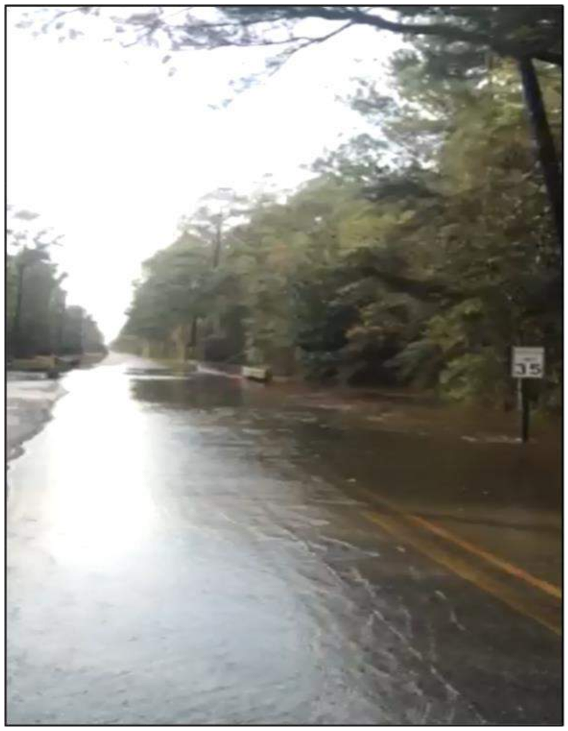


Figure 2.3 Davenport Street flooding (December 2015)

2.1.3 Topography & Floodplains

The Bayou La Batre area is classified as primarily coastal lowlands, with upper areas of the Watershed lying within the Southern Pine Hills physiographic district. Elevations range from sea level to about 40 feet in elevation (**Figure 2.4**).

Flood zones are commonly used to identify areas of risk in floodplain management. Flood zones and flood hazard areas are identified by the Federal Emergency Management Agency (FEMA). FEMA identifies an area of special risk as a Special Flood Hazard Area (SFHA). SFHAs are defined as areas that will be inundated by a flood event having a one-percent chance of being equaled or exceeded in any given year. During the span of a 30-year mortgage, a home in the one-percent annual chance floodplain has a 26% chance of being flooded at least once during those 30 years (USGS 2010). The one-percent annual chance flood is also referred to as the base flood or 100-year flood (FEMA 2016).

Much of the lower portion of the Bayou La Batre Watershed is located within the 100-year floodplain and identified as FEMA Flood Zone A/AE (**Figure 2.5**).The area around the mouth of the Bayou is located in FEMA Flood Zone VE, which indicated a one-percent annual chance flood hazard area with storm-induced velocity wave action. Portions of the eastern most part of the lower Watershed are in areas of moderate and minimal flood hazard, and identified as Zone X (shaded and unshaded respectively). Most of the upper Watershed is identified as being in minimal flood hazard Zone X (unshaded), with only those areas within the tributaries' immediate floodplain designated as Zone A/AE.

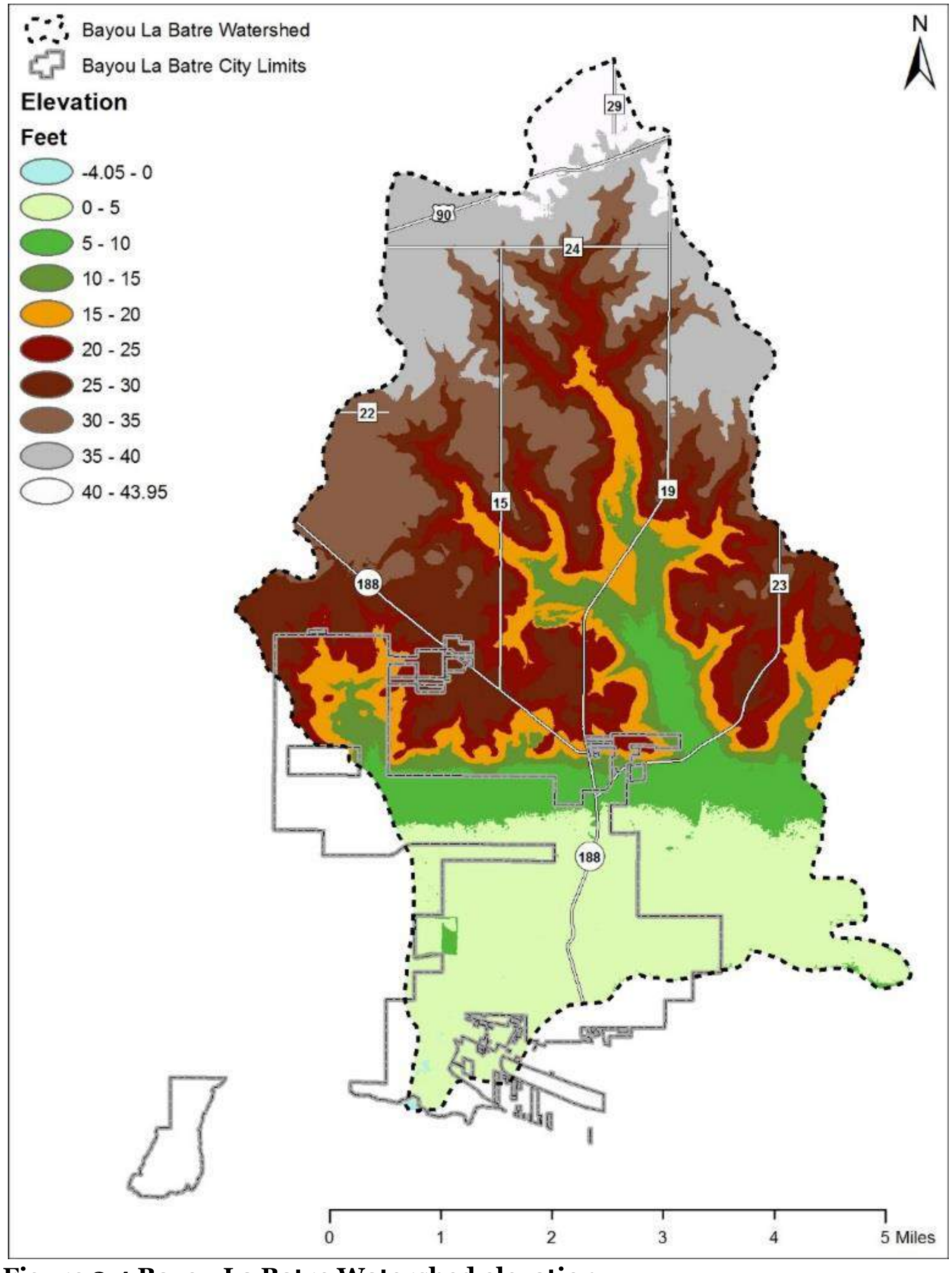


Figure 2.4 Bayou La Batre Watershed elevation

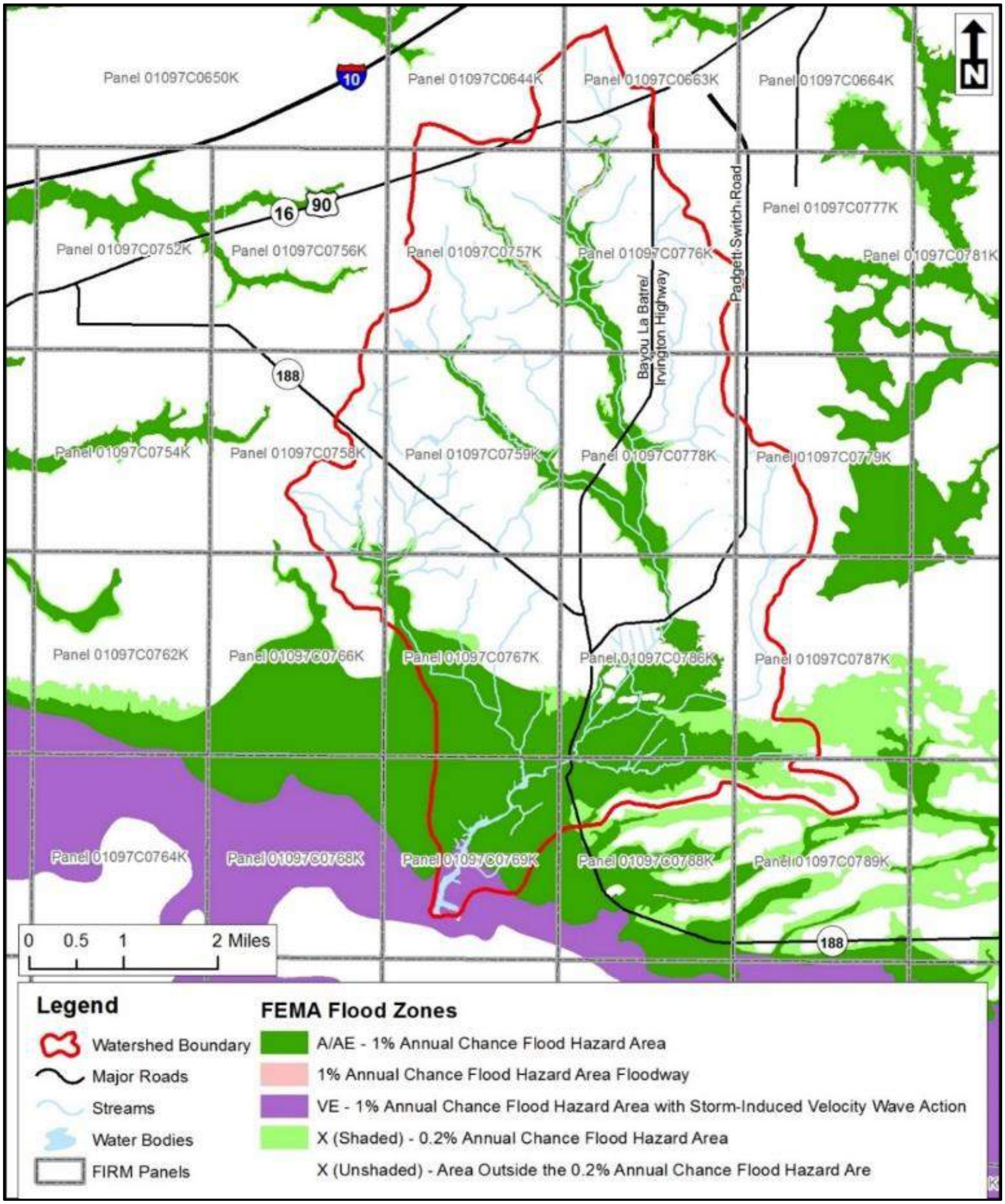


Figure 2.5 FEMA hazard zones in the Bayou La Batre Watershed

2.1.3.1 Geology

The Bayou La Batre Watershed is underlain by consolidated and unconsolidated sediments that range in age from Holocene to Miocene. Miocene sediments that outcrop in the coastal area consist of consolidated light gray to variegated and mottled consolidated clays inter-bedded with sand and gravel zones. The Pliocene-age Citronelle Formation overlies the Miocene deposits. The Citronelle Formation consists predominately of reddish brown to orange and yellow gravelly sand. Semi-consolidated to unconsolidated sediments of Pleistocene and Holocene age overlay the Citronelle Formation in Mississippi Sound (USACE 2014).

2.1.3.2 Soils

Soils within the Watershed consist of varying associations as presented in **Table 2.2** and **Figure 2.6** below. There are six primary soil associations (associations with greater than 10% watershed coverage) identified in the Watershed: the Bayou Escambia (15.8%), Saucier sandy loam (14.4%), Notcher sandy loam (13.8%), Heidel sandy loam (11.3%), Troup sandy loam (11.3%), and Johnston-Pamlico association (10.9%). The bottom portion of the Watershed primarily consists of the Bayou-Escambia association and the Johnston-Pamlico association, which are generally poorly drained soils (USDA 1980). The upper portion of the Watershed contains a broader mix of soil associations.

2.1.3.3 Sediments

The U.S. Army Corps of Engineers (USACE) conducted an environmental assessment as part of their dredging program for the Bayou La Batre channel. The sediments located in the bottom portion of the sediment column in the Bayou channel consisted of inorganic clays of high plasticity, poorly-graded sands, sand-silt mixtures and sandy clay mixtures (USACE 2014). The material in the upper portion to be dredged was predominantly silty, organic material deposited since the previous maintenance cycle (USACE 2014). USACE found that sediment samples collected within the inner channel contained high concentrations of metals and other constituents. Their analyses indicated highly variable concentrations of nutrients, heavy metals, high-molecular-weight hydrocarbons, and pesticides. Elutriate testing performed on the sediments indicated that, with the exception of iron and nickel, these compounds were tightly bound to the sediments and would not be released to the water column with disturbance, such as dredging (USACE 2014).

Table 2.2 Soils in the Bayou La Batre Watershed

Category	Square Feet	Acres	Square Miles	Percentage of Watershed
Axis mucky sandy clay loam	8,672,035.9	199.1	0.3	1.0%
Bama sandy loam	39,450,377.3	905.7	1.4	4.6%
Bayou-Escambia association	134,356,310.6	3084.4	4.8	15.8%
Benndale sandy loam	5,021,985.7	115.3	0.2	0.6%
Dorovan-Bibb association	20,656,559.2	474.2	0.7	2.4%
Escambia sandy loam	1,908,080.0	43.8	0.1	0.2%
Grady loam	14,484,514.3	332.5	0.5	1.7%
Harleston sandy loam	662,505.9	15.2	0.0	0.1%
Heidel sandy loam	96,007,886.1	2204.0	3.4	11.3%
Johnston-Pamlico association	93,131,481.4	2138.0	3.3	10.9%
Malbis sandy loam	22,899,733.9	525.7	0.8	2.7%
Notcher sandy loam	117,436,289.0	2696.0	4.2	13.8%
Pactolus loamy sand	6,741,109.8	154.8	0.2	0.8%
Pamlico-Bibb complex	25,936,730.8	595.4	0.9	3.0%
Pits	1,374,278.4	31.5	0.0	0.2%
Poarch sandy loam	7,159,133.8	164.4	0.3	0.8%
Robertsdale loam	15,536,261.0	356.7	0.6	1.8%
Saucier sandy loam	122,380,739.8	2809.5	4.4	14.4%
Smithton sandy loam	1,326,628.3	30.5	0.0	0.2%
Troup-Heidel complex	12,769,537.1	293.1	0.5	1.5%
Troup loamy sand	96,658,612.3	2219.0	3.5	11.3%
Water	7,554,995.6	173.4	0.3	0.9%

Source: USDA 1980

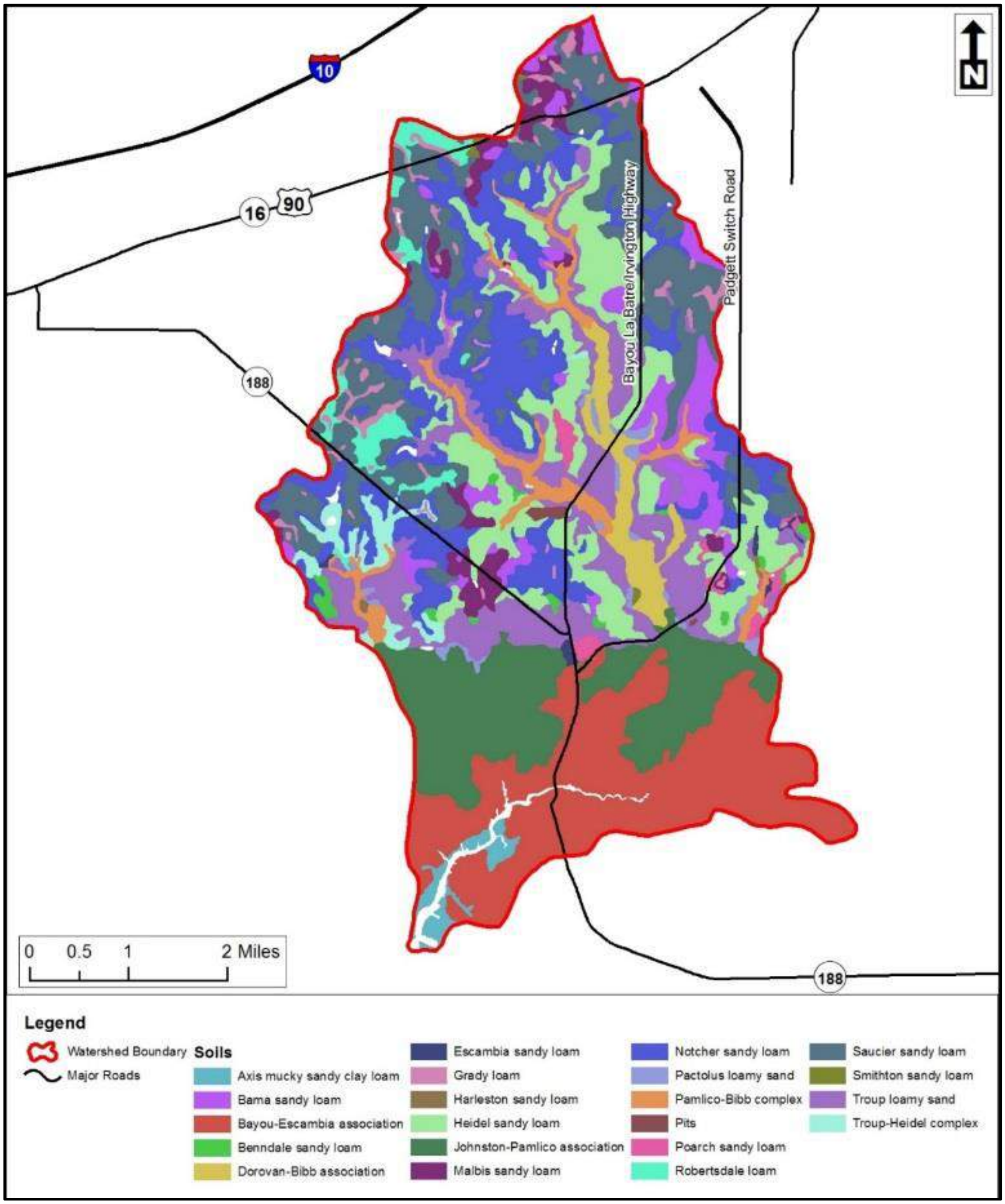


Figure 2.6 Soils in the Bayou La Batre Watershed

2.1.4. Vegetation and Wildlife

Coastal Alabama supports one of the largest varieties of plant and wildlife species in the state. Habitats in the area include coastal maritime forests, forested wetlands, emergent wetlands, submerged aquatic vegetation, streams, tidal creeks, tidal flats, brackish-salt marshes, scrub/shrub wetlands, beaches, mudflats, estuarine, marine, and open-water benthic habitats. These areas are home to a diverse, resilient, and environmentally-significant group of species, including some considered threatened and endangered (USACE 2014).

2.1.4.1 Vegetation

Naturally-occurring vegetative communities within the Watershed are typical of those found adjacent to Mississippi Sound in the northern Gulf of Mexico. However, these communities are sparse and fragmented within the area due to the amount of development.

Terrestrial uplands dominate higher-ground areas that are not normally subject to riverine flooding or tidal inundation. These upland areas are primarily agricultural or residential containing varieties of pine and scrub oaks. Natural upland vegetation complexes found in the area include longleaf pine-oaks, moist pinelands, bay forests, monoculture pine, maritime strand, and beach dune associations. The most dominant upland association is longleaf pine-oaks. This complex is well-adapted to the dry, sandy sites in the coastal plain region (USACE 2014). Longleaf pine (*Pinus palustris*) is the dominant species in this habit. Other species occurring in the community include southern red oak (*Quercus falcata*), laurel oak (*Q. laurifolia*), live oak (*Q. virginiana*), southern magnolia (*Magnolia grandiflora*), flowering dogwood (*Cornus florida*), persimmon (*Diospyros virginiana*), winged sumac (*Rhus copallina*), sparkleberry (*Vaccinium arboreum*), and broomsedge (*Andropogon* spp.) (USACE 2014). Shrubby plants (sumac, huckleberry, gallberry) can be found in the understory along with associated herbs and grasses (Barry A. Vittor and Assoc. 2007).

Maritime forests cover the middle portion of the Watershed. These forests predominantly contain slash pine (*Pinus elliottii*) with an understory of saw palmetto (*Serenoa repens*) and wax myrtle (*Myrica cerifera*) (USACE 2014). This area has a higher water table than the longleaf pine-oaks community. This strip of moist pinelands divides the longleaf pine-oak forests and coastal swamps. Sedges, grasses, and other herbaceous plants grow in the understory area (USACE 2014).

The forest area transitions when entering sandy areas near the coast. Terrestrial grasses make up the majority of the groundcover and include broomsedge (*Andropogon virginicus*), switchgrass (*Panicum virgatum*), and warty panicgrass (*Panicum verrucosum*). Non-native cogongrass (*Imperata cylindrica*) occurs in scattered patches in the Watershed (Barry A. Vittor and Assoc. 2007). The coastal and lowland waterways in the Watershed are fringed with marsh grasses such as black-needlerush (*Juncus roemerianus*) and smooth cordgrass (*Spartina alterniflora*) (USACE 2014).

2.1.4.2 Wildlife

Coastal faunal assemblages within the Watershed include a variety of amphibians, reptiles, birds, and mammals. These animals occur in all habitats found within the system and utilize various aspects of the Bayou, tributaries, and surrounding lands.

Mammals found within the Watershed and surrounding area include marsupials, moles, shrews, bats, armadillos, rabbits, rodents, carnivores, and hoofed mammals (USACE 2014). Mammals occur within all the Watershed’s habitats, while the long leaf pine-oaks community and the pine savannah community support populations of white-tailed deer and smaller mammals such as opossum, raccoon, armadillo, cottontail rabbit, gray squirrel, and fox (Barry A. Vittor and Assoc. 2007). Mammals, such as the marsh rabbit, cotton rat, swamp rabbit, and river otter are also common in the Watershed (USACE 2014).

Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. There is a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are also found in the coastal area (USACE 2014).

Due to the location of the Watershed along the coast, the area supports many populations of transient and resident birds. Migratory birds can be observed during the spring and fall, while permanent residents such as ospreys, gulls, and pelicans can be seen year round. Over 300 species of birds have been recorded as migratory or permanent residents within the area, with several species breeding in the area (USACE 2014). Shorebirds include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns (USACE 2014).

2.1.4.3 Protected Species

Table 2.3 presents species identified by the U.S. Fish and Wildlife service as threatened, endangered, or in recovery in Mobile County. All of these species are potentially found within the Bayou La Batre Watershed and surrounding area.

Table 2.3 Federally protected species documented from Mobile County, AL

Group	Name	Status
Birds	Bald eagle *(Haliaeetus leucocephalus)*	R
	Wood stork (*Mycteria 40olyphemu)*	T
	Piping plover (*Charadrius melodus)*	T
	Red knot (*Calidris canutus rufa*)	T
Clams	Alabama heelsplitter (*Potamilus inflatus*)	T
	Southern clubshell (*Pleurobema decisum*)	E
Fish	Alabama sturgeon (*Scaphirhynchus suttkusi*)	E
	Atlantic sturgeon—Gulf subspecies (*Acipenser oxyrinchus)*	T
Mammals	West Indian manatee (*Trichechus manatus)*	E
Reptiles	Hawksbill sea turtle (Eretmochelys)	E
	Leatherback sea turtle (Dermochelys coriacea)	E
	Kemp's ridley sea turtle (*Lepidochelys kempii)*	E
	Loggerhead sea turtle (*Caretta caretta)*	T
	Alabama red-bellied turtle (*Pseudemys alabamensis)*	E
	Eastern indigo snake *(Drymarchon corais couperi)*	T
	Black pine snake *(Pituophis melanoleucus lodingi)*	T
	Gopher tortoise *(Gopherus 40olyphemus)*	T

R = Recovery, T = Threatened, E = Endangered. Source: USFWS 2016

2.1.4.4 Sensitive Areas

The area within the Bayou La Batre Watershed contains some potentially sensitive areas for vegetation and wildlife. Adjacent coastal areas have been deemed critical habitat for Atlantic sturgeon (gulf subspecies, Acipenser oxyrinchus) and piping plover (Charadrius melodus), and the area is vital to numerous species of migratory birds. A portion of the Watershed contains wetlands typical along the Alabama coast. These wetlands provide many ecosystem services necessary to sustain viable habitat and support the region both functionally and economically.

2.1.4.5 Invasive Species

Non-native invasive species can significantly impact natural systems and ecosystem function. Invasive plants can be fast growing and spread quickly, outcompeting native vegetation. Invasive animals can often find only limited local competition for food and no natural predators in the local area. The following invasive species presented in **Table 2.4** are potentially found within the Watershed and surrounding areas.

Table 2.4 Invasive species in coastal Alabama

Group	Species
Animals	Asian clam (*Corbicula spp.*)
	Asian tiger shrimp (*Penaeus monodon*)
	Giant apple snail (*Pomacea maculata*)
	Wild hogs (*Sus scrofa*)
	Nutria (*Myocaster coypus*)
Plants	Chinese tallow (*Triadeca sebifera*)
	Chinese privet (*Ligustrum sinense*)
	Chinese wisteria (*Wisteria sinensis*)
	Alligatorweed (*Alternanthera philoxeroides*)
	Persian Silk Tree/ Mimosa Tree (*Albizia julibrissin*)
	Air potato (*Dioscorea bulbifera*)
	Water hyacinth (*Eichhornia crassippies*)
	Cogon grass (*Imperata cylindrica*)
	Salvinia (*Salvinia spp.*)
	Kudzu (*Pueraria spp.*)
	Eurasian watermilfoil (*Myriophyllum spicatum*)
	Common reed (*Phragmites australis*)
	Japanese honeysuckle (*Lonicera japonica*)

Plants	Japanese climbing fern (*Lygodium japonicum*)
	Golden bamboo (*phyllostachys aurea*)
	Phragmites (*Phragmites australis*)
	Torpedo grass (*Panicum repens*)

2.2 Land Use and Land Cover

Land use describes how people use the landscape (farming, forestry, residential development, commercial development, etc.), while land cover describes the landscape or surface of the land (water, wetlands, forest, impervious surfaces, etc.). Changes in land use and land cover (LULC) are used to assess and explain past, current, or future trends and consequences altered landscapes have on ecosystems at local, regional, or global scales.

Understanding LULC changes for landscapes at the watershed level are important because differing land covers and land uses can significantly impact local water resources including sediment and pollutant loads of streams as well as stormwater runoff velocities, volumes, and timing within watersheds. The following sections describe and evaluate LULC trends within the Bayou La Batre Watershed to provide insight into the type, location, and extent of LULC changes over time.

The original LULC datasets of interest for this watershed management plan (WMP) were clipped to the 12-digit HUC watershed boundary, as defined in **Section 2.1.1.** This data-editing process facilitated the uniform assessment of the spatial data and information such that differing sources and years of data could be compared. However, despite all efforts to assess and interpret spatial data through a uniform process, discrepancies among the various LULC datasets still exist. For example, quantitative information presented in the following sections regarding total land area (acres) from different sources over the years do not match each other or the total acreage for the Watershed as defined in **Section 2.1.1.** This discrepancy is suggested to be the result of various mapping and remote sensing technologies used over the years by different sources. Other potential discrepancies are described in the following sections.

2.2.1 Historic Land Use and Land Cover

In 2008, the National Aeronautics and Space Administration (NASA) Stennis Space Center led an effort with multiple Gulf of Mexico Alliance (GOMA) partners, including the MBNEP, to use remote sensing imagery to investigate LULC changes for Mobile and Baldwin counties from 1974 to 2008 (Spruce *et al.* 2009). This study focused on a regional analysis of urban expansion at the watershed level using Landsat images for the following years: 1974, 1979, 1984, 1988, 1991, 1996, 2001, 2005, and 2008. The LULC change analysis considered a modified Anderson Level I classification system that included: barren, non-woody wetland, open water, upland herbaceous, upland forest, urban, and woody wetland. This classification scheme is used throughout the LULC sections for consistency among dataset comparison in this WMP.

Historical LULC analyses from the years 1974 and 2008 are presented for the Bayou La Batre Watershed (see **Figure 2.7**) and are summarized in **Table 2.5** (Spruce *et al.* 2009). As previously noted, there is a discrepancy in the total area (acres) shown in **Table 2.5** for the years 1974 and 2008. This is the result of differing Landsat techniques used to derive the data at different time periods. For example, the 1974 data were sampled at a 60-meter resolution and processed into a four-channel data stack of visible and near infrared bands, while the 2008 data were acquired at a 30-meter resolution and processed into a six-channel data stack of visible, near-infrared, and shortwave infrared reflectance bands (Spruce *et al.* 2009). More information on the accuracy and development of the 2008 NASA LULC products can be found in Spruce *et al.* (2009) or Ellis *et al.* (2008).

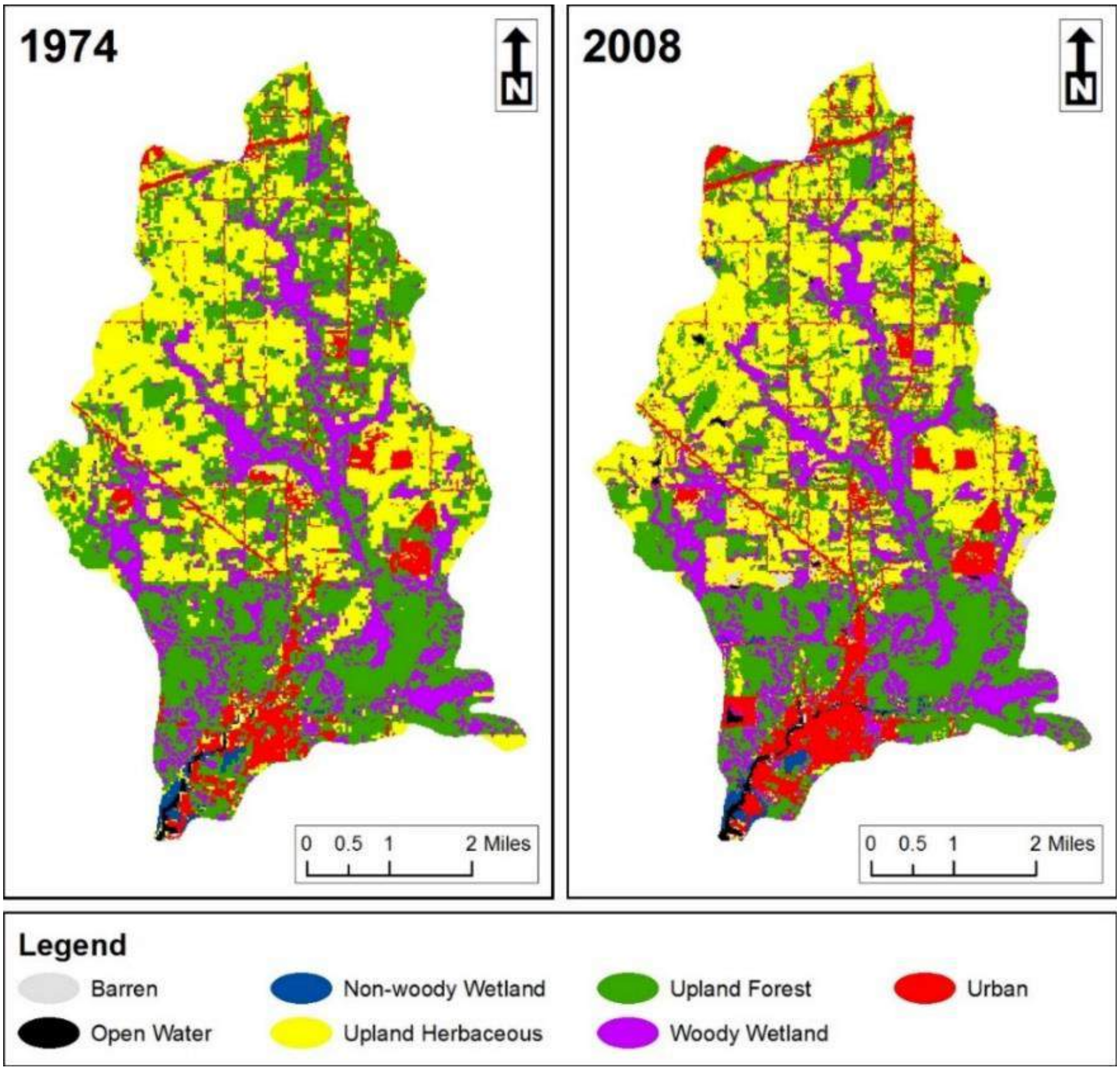


Figure 2.7 LULC change from 1974 to 2008 (Spruce *et al.* 2009)

Figure 2.5 graphically presents the historical LULC for the Bayou La Batre Watershed in 1974 and 2008. From 1974 to 2008, the Bayou La Batre Watershed experienced slight increases in urbanization from approximately 8% to approximately 12%, accompanied by increases in upland herbaceous (agricultural land) from approximately 32% to 34% (Spruce *et al.*2009). The most notable LULC change within the Watershed over the 34-year time period was the decline in upland forests from approximately 40% to 33% of the Watershed area (Spruce *et al.* 2009). The effects of increased urbanization on the Watershed is further addressed in **Section 2.2.2.8**

Table 2.5 Bayou La Batre Watershed LULC from 1974 to 2008 (Spruce et al. 2009)

Class Name	1974		2008	
	Total Area (Acres)	Percent %	Total Area (Acres)	Percent %
Open Water	58	0.30 %	169	0.87 %
Barren	14	0.07 %	92	0.48 %
Upland Herbaceous	6,252	32.20 %	6,637	34.17 %
Non-Woody Wetland	173	0.89 %	203	1.05 %
Upland Forest	7,822	40.29 %	6,347	32.68 %
Woody Wetland	3,529	18.18 %	3,705	19.08 %
Urban	1,567	8.07 %	2,268	11.68 %
Total	**19,415**	**100 %**	**19,421**	**100 %**

2.2.2 Current Land Use and Land Cover

Current land cover for the Bayou La Batre Watershed is shown in **Figure 2.8** and **Table 2.6**, which present the 2011 National Land Cover Database (NLCD) Land Cover data clipped to the Watershed's 12-digit HUC boundary (see **Section 2.1.1**) (Homer *et al.* 2015). The 2011 NCLD is the most up-to-date iteration of the NLCD and features Landsat-based, 30-meter resolution land cover data for the contiguous United States (Jin *et al.* 2013). The NLCD was developed by the Multi-Resolution Land Characteristics (MRLC) Consortium, which is a partnership led by the USGS between various federal agencies. For consistency of reporting and comparing LULC datasets within this WMP, the classification scheme of the NLCD 2011 data herein is presented according to its reclassification to the LULC scheme provided by Spruce *et al.* (2009) (see **Section 2.2.1**). **Table 2.7** shows the original NLCD 2011 classification scheme and its simplification to the scheme of historical datasets developed by Spruce *et al.* (2009) (see **Section 2.2.1**).

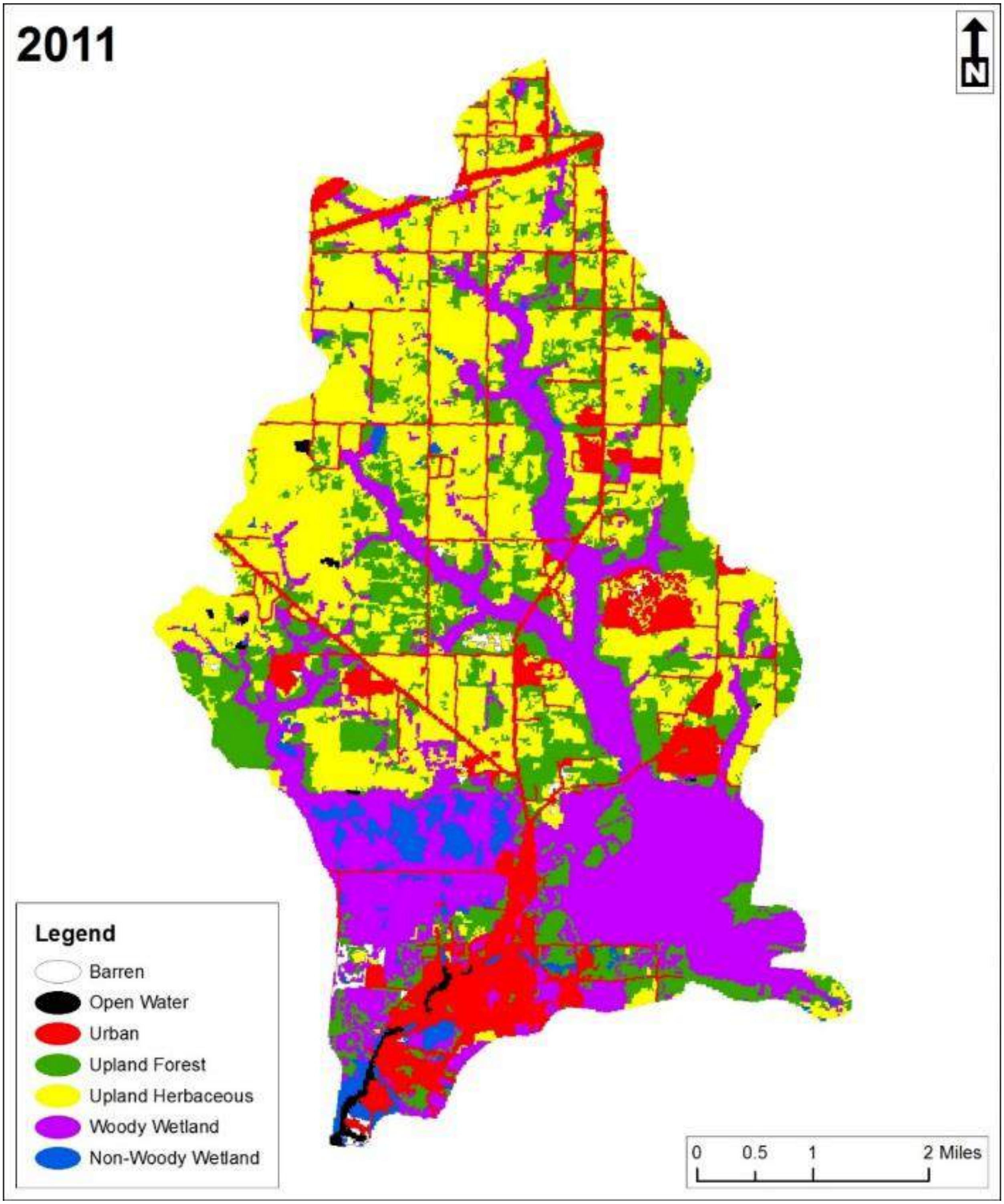


Figure 2.8 Current LULC in the Bayou La Batre Watershed (Home *et al.* 2015)

Table 2.6 Approximate Total LULC for the Bayou La Batre Watershed according to reclassified Homer *et al.* (2015) LULC data clipped to the Watershed boundary

Class Name	2011	
	Total Area (Acres)	Percent (%)
Open Water	100.52	0.51
Barren	120.54	0.62
Upland Herbaceous	6,986.39	35.73
Non-Woody Wetland	514.17	2.63
Upland Forest	3,984.67	20.38
Woody Wetland	5,162.67	26.40
Urban	2,685.60	13.73
Total	**19,554.55**	**100**

Table 2.7 Remapping LULC classes of 2011 National Land Cover Database to the classification scheme of Spruce *et al.* (2009)

2011 NLCD Land Use Land Cover Classification	Simplified Classification
Developed, Open Space	Urban
Developed, Low Intensity	
Developed, Medium Intensity	
Developed, High Intensity	
Grassland/Herbaceous	Upland Herbaceous
Pasture/Hay	
Cultivated Crops	
Deciduous Forest	Upland Woods
Evergreen Forest	
Mixed Forest	
Scrub/Shrub	
Woody Wetlands	Woody Wetland
Emergent Herbaceous Wetlands	Non-Woody Wetland
Open Water	Open Water
Barren Land (Rock/Sand/Clay)	Barren

According to the reclassified Homer *et al.* (2015) 2011 NLCD data, the Bayou La Batre Watershed land cover classes of barren, upland herbaceous, non-woody wetland, urban, and woody wetland increased in total area (acres) compared to 1974 (see **Figure 2.9**). Upland herbaceous has continued to rise from approximately 32% of the total Watershed area in 1974 to nearly 36% in 2011. Similarly, urban classification has continued to rise from approximately 8% of the total Watershed area in 1974 to nearly 14% of the total Watershed area in 2011. Upland forest has continued to decline from approximately 40% of the Watershed coverage in 1974 to approximately 20% of the Watershed coverage in 2011. However, **Figure 2.9** indicates that some of the losses in upland forest have likely occurred because of land cover reclassification due to differences in data sources and interpretation. It is suggested that this reclassification could be the result of advancing geospatial and remote sensing technologies used in 2011 compared to those used to collect and assess the 1974 data. Further user caution is advised when comparing NASA's 1974 LULC data to the NLCD's 2011 land cover data, given that the total Watershed acreage for Bayou La Batre reported between the two studies differs by nearly 140 total acres. It is unclear to what degree these discrepancies contribute to the LULC changes and trends observed when comparing these datasets. It is recommended that future studies take great care in determining LULC changes within the Watershed region so statistical relevance between multiple years can be accurately and precisely obtained.

2.2.3 Fisheries

Commercial fishing and processing industries are vital to the community of Bayou La Batre. Shrimp, oysters, crabs, and finfish are the area's primary seafood products. The annual commercial fisheries landing statistics for Alabama in 2008 include over 24 million pounds with a landed value of over $44 million. The two nationally-ranked commercial fishery ports in Alabama are Bayou La Batre, with 19 million pounds landed annually with a landed value of over $36 million, and Bon Secour-Gulf Shores with five million pounds landed and a landed value of over $7 million. (NOAA Fisheries 2016).

NOAA Fisheries (2016) presents landings associated with the local fishing community and in the terms of a local quotient (LQ). The LQ specifies the top species that were most important in terms of pounds landed and value out of all species landed within the community (**Figure 2.11**).

Aquaculture is also important to the Bayou La Batre economy and culture. While aquaculture operations are located outside of the official Watershed boundaries, they are still an important aspect of the local community.

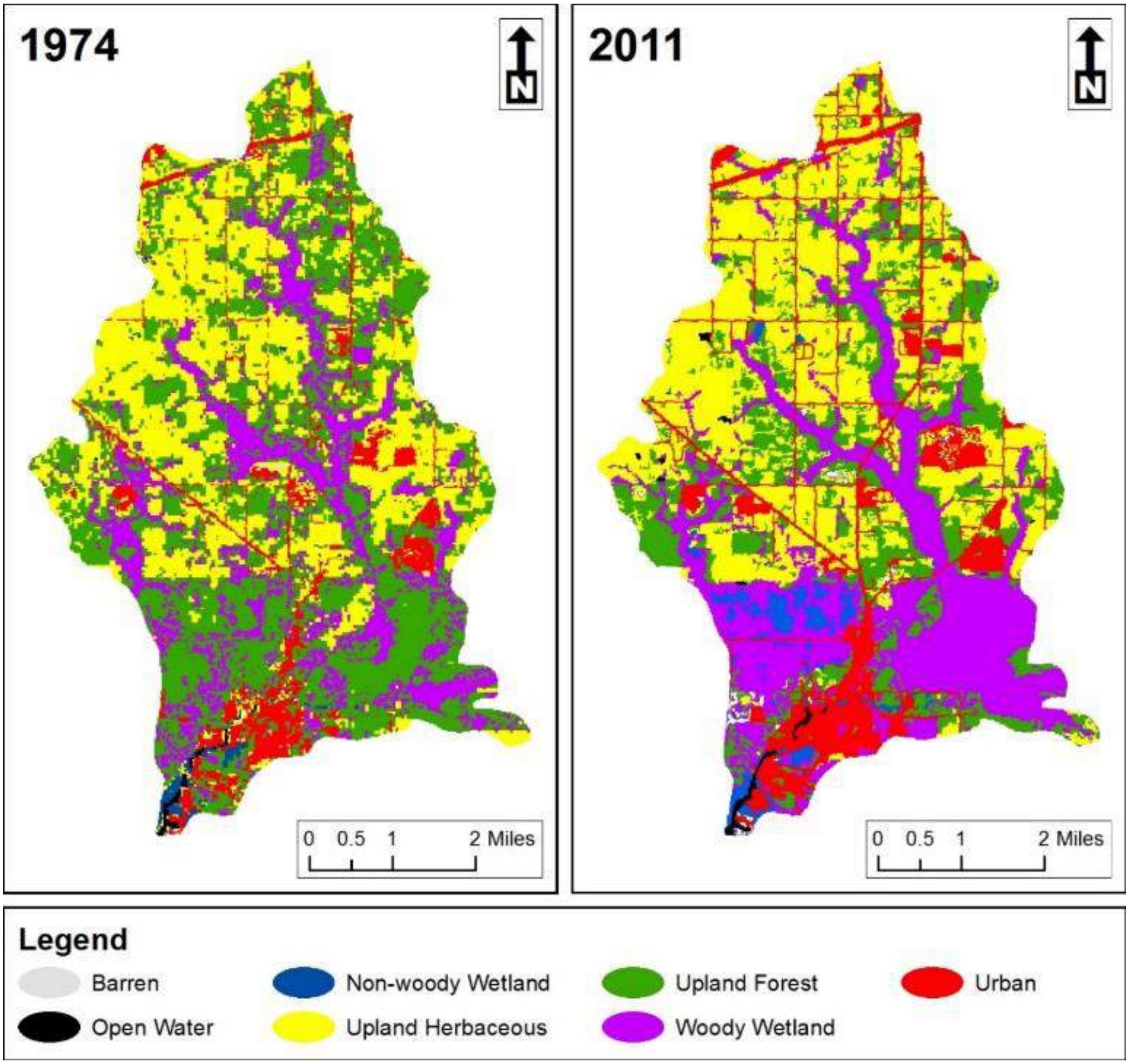
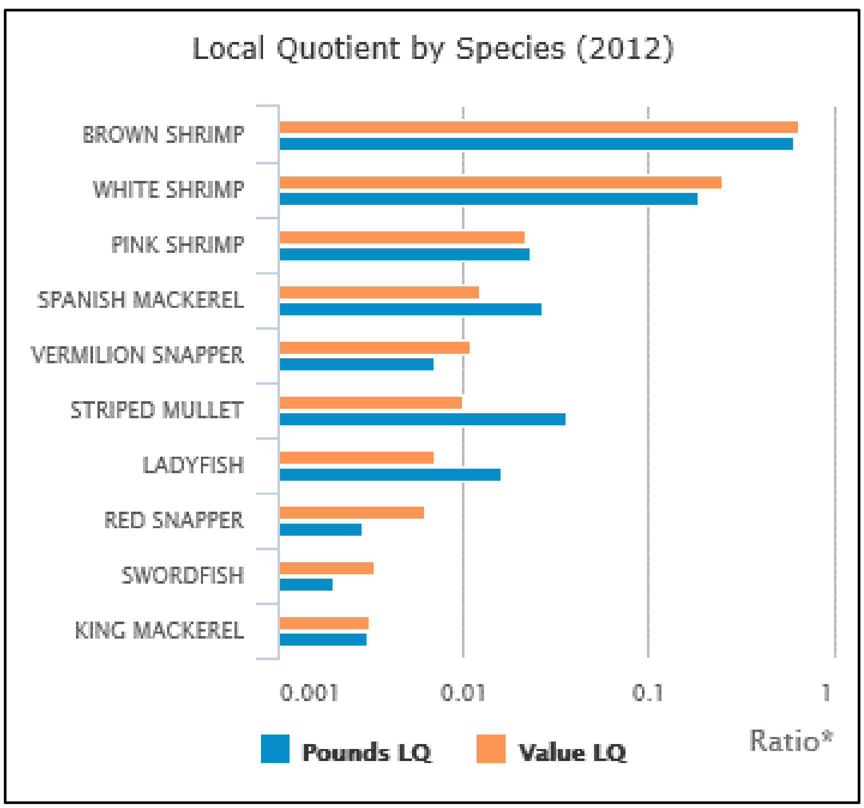


Figure 2.9 1974 vs. 2011 LULC

Figure 2.10 Fishing vessels in Bayou La Batre



*Scale is logarithmic Source: NOAA Fisheries (2016)

Figure 2.11 Fish species landed in Bayou La Batre

2.2.4 Wetlands

According to Homer *et al.* (2015) 2011 NLCD data, wetlands make up roughly 29% of the total Watershed area, with woody wetlands comprising nearly 5,163 acres or 26.4% and non-woody wetlands comprising nearly 514 acres or 2.6% (see **Figure 2.8**). National Wetland Inventory (NWI) data (USFWS 2010) is also routinely used to classify wetlands and incorporates the Cowardin (1979) classification (see **Figure 2.12**). Cowardin (1979) distingushes wetlands into five distinct categories for classification: Estuarine, Lacustrine, Marine, Palustrine, and Riverine systems.

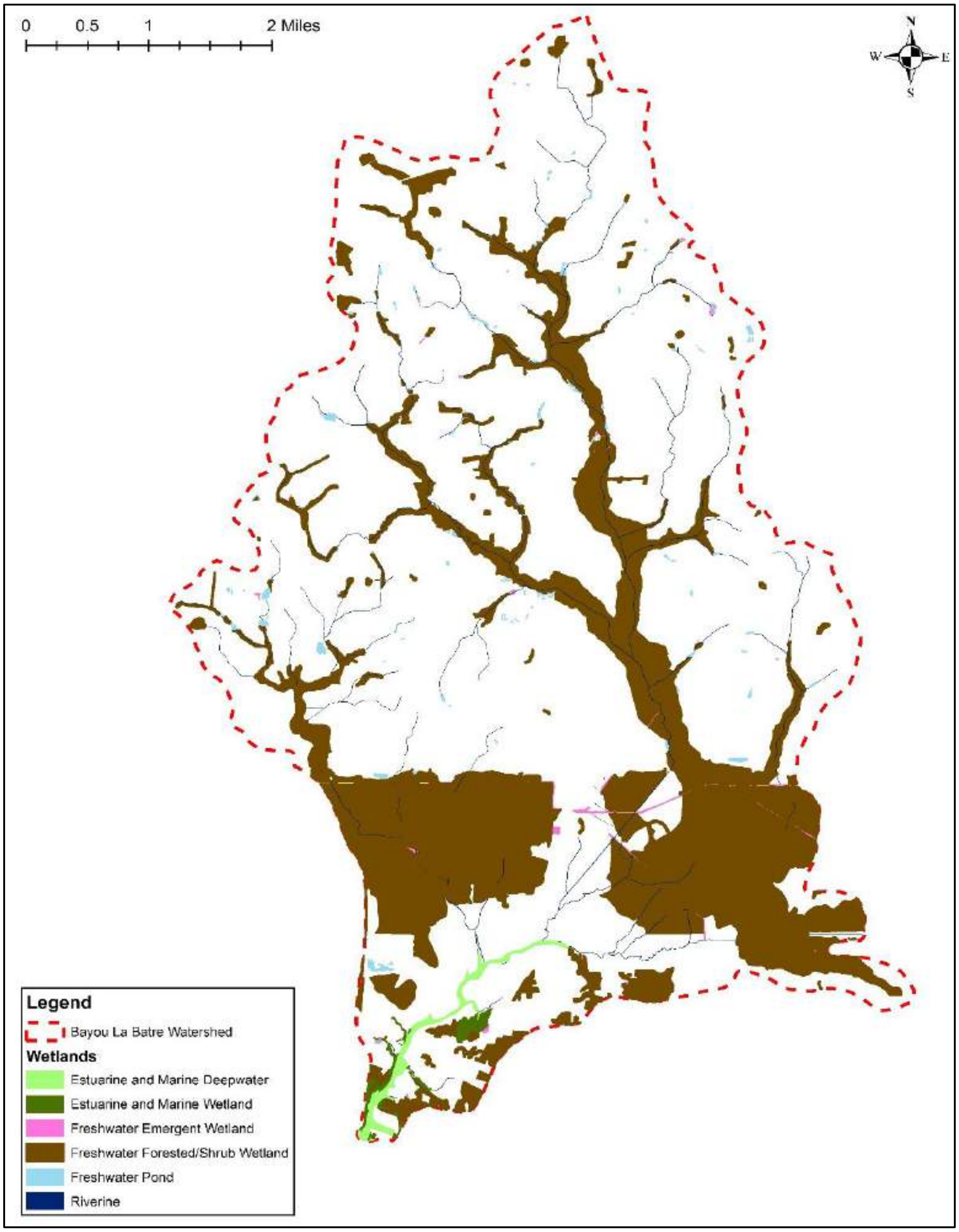


Figure 2.12 NWI data of the Bayou La Batre Watershed

The overall health of the Bayou La Batre Watershed depends upon the existence of its wetlands, which contribute to the vitality of an ecosystem by storing, changing, and transmitting surface water and groundwater. Through these processes, pollution is removed, nutrients are recycled, groundwater is recharged, and biodiversity is enhanced. Wetlands within the Bayou La Batre Watershed include: Palustrine (Freshwater Emergent, Freshwater Forested/Shrub, Freshwater Pond, and Lake), Riverine, Estuarine and Marine (Deepwater and Wetland). **Table 2.8** illustrates the acreage of each wetland type and the percentage of each type within the watersheds that comprise the Bayou La Batre Watershed

Table 2.8 NWI Wetland type within the Bayou La Batre Watershed

Wetland Type	Acreage	Percent of Watershed
Freshwater Emergent	70.65	0.36%
Freshwater Forested/Shrub	4,302.82	22.00%
Freshwater Pond	87.35	0.45%
Riverine	186.83	0.96%
Estuarine and Marine Deepwater	96.32	0.49%
Estuarine and Marine	71.35	0.036%
TOTAL	4,815.31	24.62%

From NWI data, the Bayou La Batre Watershed contains approximately 4,815 acres or 24.62% of the Watershed's area. Wetland acreage discrepances when compared with the 2011 NLCD data can be attributed to differences in the technologies and methods used to derive the datasets.

The Palustrine System

The Palustrine (freshwater) system, as shown in **Figure 2.13**, includes all non-tidal wetlands dominated by trees, shrubs, persistent emergent plants, emergent mosses or lichens, and all such wetlands that occur in areas where salinity due to ocean-derived salts is below 0.5%. The Palustrine system is bounded by upland.

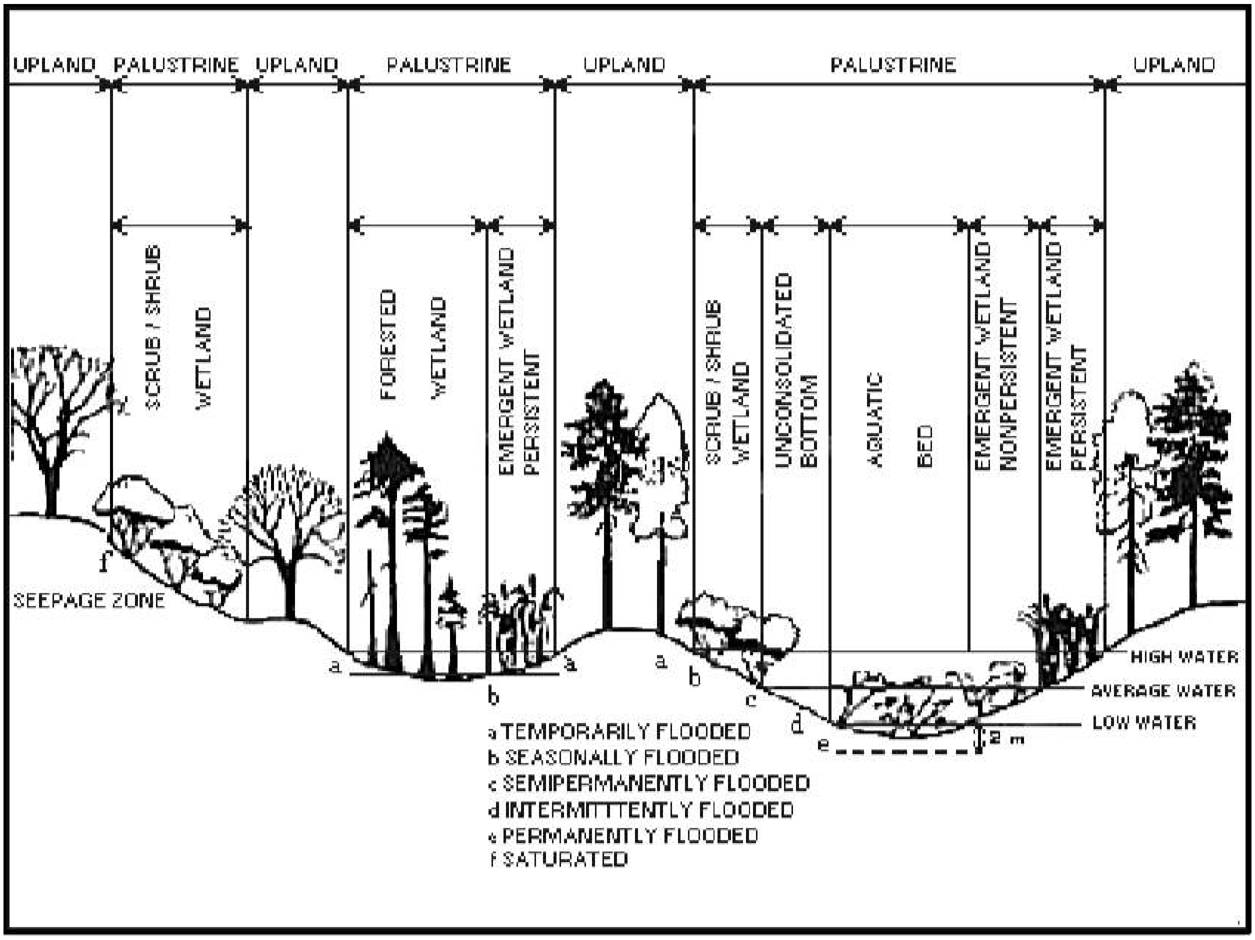


Figure 2.13 The Palustrine wetland system (Cowardin 1979)

The Estuarine System

The Estuarine system, shown in **Figure 2.14**, consists of deepwater tidal habitat 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. The Estuarine system extends (1) upstream and landward to where ocean-derived salts measure less than 0.5% during the period of average annual low flow; (2) to an imaginary line closing the mouth of a river, bay, or sound; and (3) to the seaward limit of emergent wetlands, shrubs, or trees where they are not included in (2). It also includes offshore areas of continuously diluted sea water. It contains two sub-systems: subtidal (where the substrate is continuously submerged) and intertidal (where the substrate is exposed and flooded by tides including the associated splash zone).

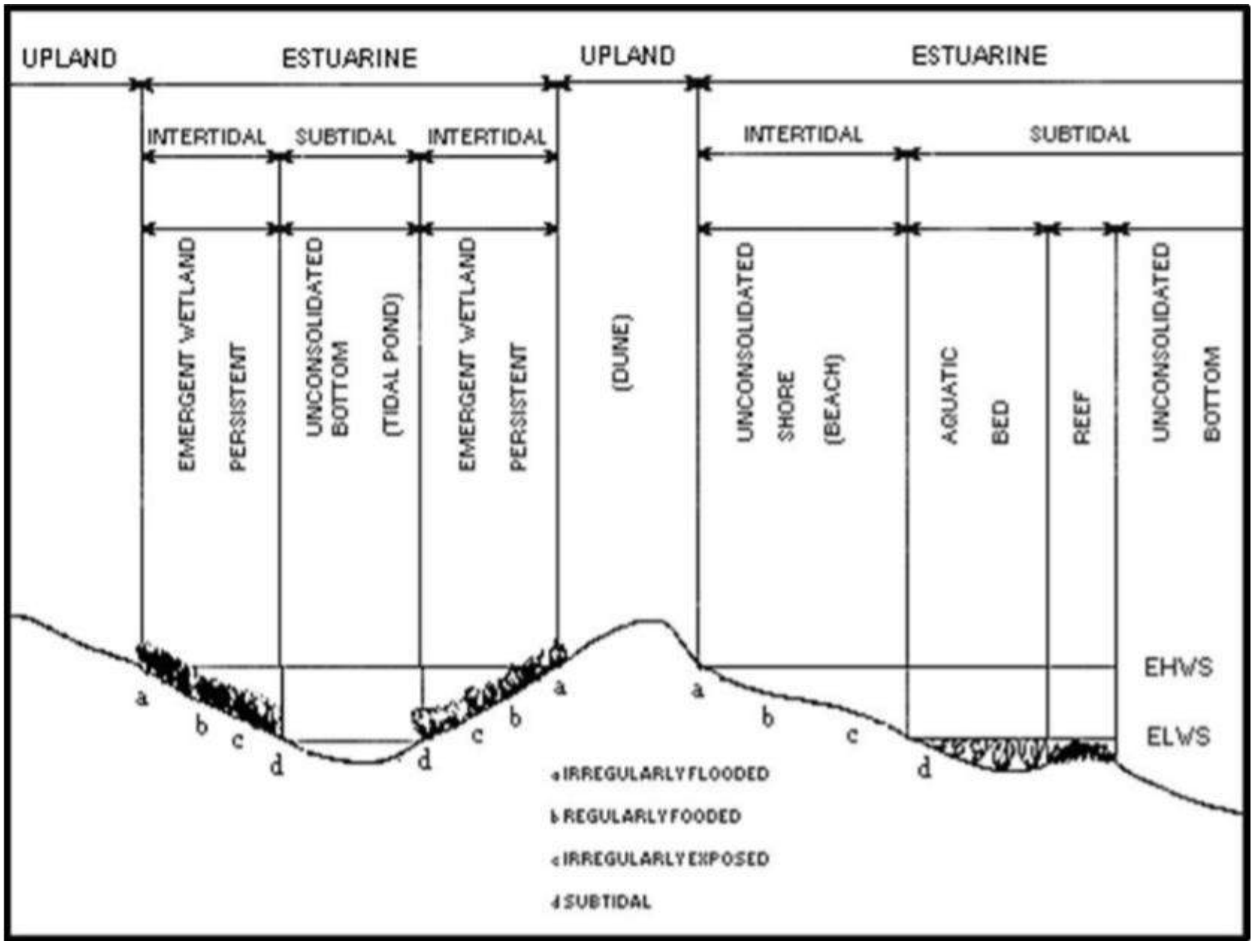


Figure 2.14 The Estuarine wetland system (Cowardin 1979)

The Riverine System

The Riverine system, shown in **Figure 2.15**, includes all wetlands and deepwater habitats contained within a channel with two exceptions: (1) wetlands dominated by trees, shrubs, emergent vegetation, emergent mosses, or lichens, and (2) habitats with water containing oceanderived salts in excess of 0.5%. The Riverine system is bounded on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetlands dominated by trees, shrubs, emergent vegetation, emergent mosses, or lichens. In braided streams, the system is bounded by the banks forming the outer limits of the depression within which the braiding occurs.

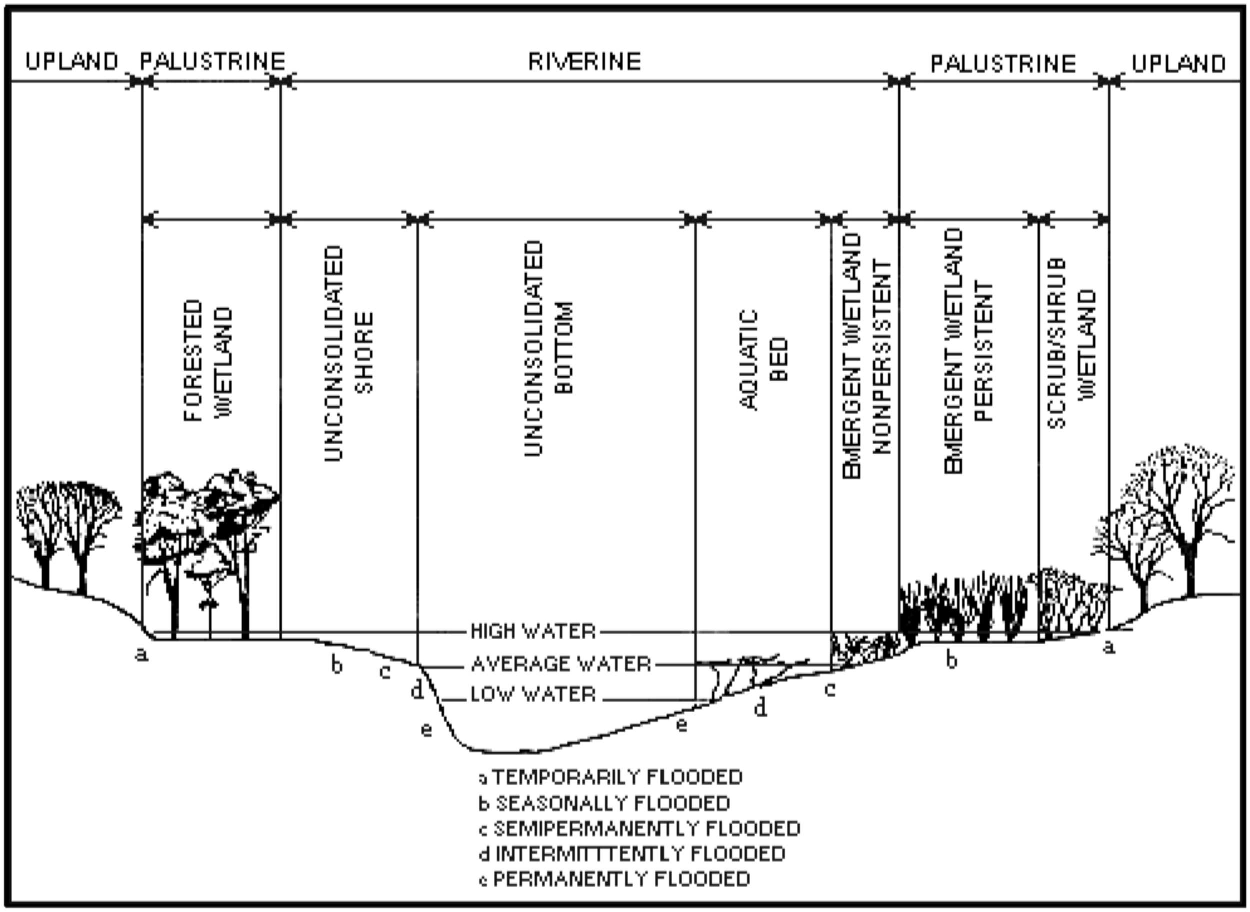


Figure 2.15 The Riverine wetland system (Cowardin 1979)

2.2.5 Streams

Table 2.9 and **Figure 2.15** reveal that the Bayou La Batre Watershed contains approximately 13.08 miles (69,054.51 linear feet) of stream network systems and pproximately 11.18 miles (59,055.17 linear feet) of surface drainage systems (USGS 2017). Named surface drainages in this Watershed include Hammer Creek, Bishop Manor Creek, Carls Creek, Tate Bayou, Spring Bayou, Bayou la Batre, Bayou Du Pont, Bayou de Duce, and Bayou Cateau.

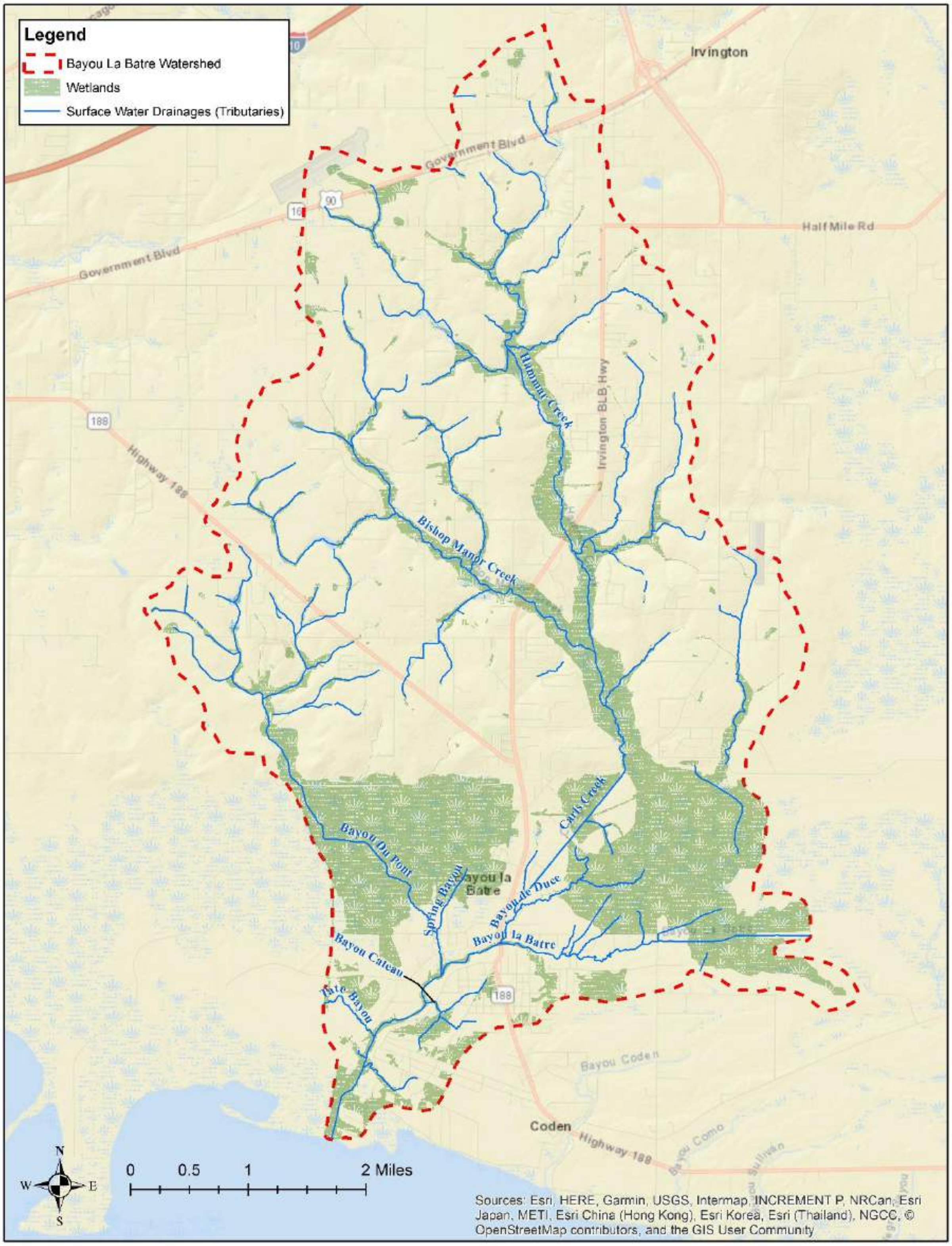


Figure 2.16 Major surface water drainage systems in the Bayou La Batre Watershed (USGS 2017)

Table 2.9 Named surface water drainages in the Bayou La Batre Watershed (USGS 2017)

Surface Water Drainages	Linear Feet (ft)	Miles (mi)
Tate Bayou	3,610.72	0.68
Spring Bayou	5,355.93	1.01
Hammar Creek	29,636.81	5.61
Carls Creek	14,621.24	2.77
Bishop Manor Creek	24,796.46	4.70
Bayou la Batre	28,722.76	5.44
Bayou du Pont	10,858.09	2.06
Bayou du Duce	9,483.75	1.80
Bayou Cateau	1,023.92	0.19
TOTAL	128,109.68	24.26

2.2.5.1 Designated and Desired Uses

Code of Alabama Section 335-6-11 establishes the designated use classification system for Alabama surface waters. There are seven basic classifications including:

1. Outstanding Alabama Water
2. Public Water Supply
3. Swimming and Other Whole Body Water-Contact Sports
4. Shellfish Harvesting
5. Fish and Wildlife
6. Limited Warmwater Fishery
7. Agricultural and Industrial Water Supply

In addition to these classifications, there are two additional special designations: Outstanding National Resource Waters and Treasured Alabama Lakes. Designated use classifications essentially define the existing and/or intended use of a particular water body. Code of Alabama Section 3356-10 defines the water quality criteria that corresponds with specific designated uses. These criteria establish water quality standards and other measures developed to protect designated uses of each waterbody.

All surface waters in the Bayou La Batre Watershed have a water use designation of Fish and Wildlife (F&W). **Table 2.10** lists the specific water quality criteria for the F&W classification within the Watershed.

Table 2.10 ADEM water quality criteria for F&W classification in the Bayou La Batre Watershed

Fish and Wildlife:	
Criteria	**Standard**
pH	6.0 to 8.5 s.u.
Water Temperature	< 90°F
Dissolved Oxygen	> 4.0 mg/L to 5.0 mg/L (at mid depth or 5 ft dependent on total depth) depending on water type
Fecal Coliform Bacteria	< 200 colonies/100mL (geometric mean June - Sept.)
	< 1000 colonies/100mL (geometric mean Oct. - May)
	< 2000 colonies/100mL (single sample max.)
Fecal Coliform Bacteria	< 1000 colonies/100mL (geometric mean Oct. - May)
	< 2000 colonies/100mL (single sample max.)
	< 100 colonies/100mL (geometric mean June - Sept.)
Turbidity	< 50 NTU above background

*Pre-2004 criteria and standard
Source: ADEM Admin. Code R. 335-6-10-.09

2.2.6 Forested Areas

According to Homer et al. (2015) 2011 NLCD data, forests (upland woods) comprise 20.4% of the total Watershed area or 3,985 total acres (see **Figure 2.8**). The upland woods classification for forests collectively represents four land cover classifications: deciduous forest, evergreen forest, mixed forest, and scrub/shrub, as defined by Homer et al. (2015). Deciduous forest comprises 0.5% of the total Watershed area or 89.8 acres; evergreen forest comprises 10.7% of the total Watershed area or 2,102 acres; mixed forest comprises 0.9% of the total Watershed area or 172.8 acres; and scrub/shrub comprises 8.3% of the total Watershed area or 1,619.9 acres.

The upland, non-wetland forest is located primarily in the southern portion of the Watershed adjacent to the forested wetlands. In the coastal region, slash and long-leaf pines make up the majority of trees with saw-tooth palmetto interspersed on the forest floor. As elevation increases, the maritime forest transitions to a variety of hardwoods and shrubs. Small pockets of upland forest comprise the small percentages found in the northern part of the Watershed.

2.2.7 Agricultural Lands

According to Homer *et al*. (2015) 2011 NLCD data, agriculture lands (upland herbaceous) comprise nearly 35.7% of the Watershed or 6,986 total acres (see **Figure 2.8**). The upland herbaceous classification for agricultural land collectively represents three land cover classifications: grassland/herbaceous, pasture/hay, and cultivated crops. The specific NLCD 2011 land use/land cover classifications presented here as agricultural areas are defined in Homer *et al*. (2015). Grassland/herbaceous comprise 5% of the total Watershed area or 989.4 acres; pasture/hay comprise 26.4% of the total Watershed area or 5,158.9 acres; and cultivated crops comprise 4.3% of the total Watershed area or 838.2 acres.

These LULC statistics generally present lands that have the potential for agricultural use and may or may not be actively used for that specific purpose. The United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) is another source for agricultural land use statistics. NASS lists 2,516 acres used for crops and hayland in the Watershed area. However, this data is not sorted by specific watershed, so acreages presented here are estimates based on local zip codes (NRCS 2016). Additionally, not all agricultural producers report to NASS, so these estimates based on available information only.

Lands used for farming and agricultural practices are primarily found in the northwestern portion of the Watershed. The main crops found in the Watershed are a rotation of cotton and peanuts, with occasional fields of corn and/or soybeans. The majority of agricultural producers plant a cover crop after conventional tillage; fall forages are planted into permanent pastures for winter grazing (NRCS 2016).

2.2.8 Open Space

According to the NLCD 2011, nearly 58.1% of the Watershed is comprised of undeveloped and open space areas that include wetlands, forested areas, and developed, open space (Homer *et al*. 2015). **Table 2.11** below quantifies each of these classifications. **Figure 2.16** follows with a graphical presentation of the total open space areas within the Watershed.

Table 2.11 Bayou La Batre Watershed open space areas (Home *et al.* 2015)

	Total Watershed Area (acres)	Total Watershed Area (%)
Wetlands		
Non-Woody Wetlands (Emergent Herbaceous Wetlands)	514.17	2.6
Forested Areas		
Deciduous Forest	89.84	0.5
Evergreen Forest	2,102.02	10.7
Mixed Forest	172.79	0.9
Shrub/ Scrub	1,619.86	8.3
Developed, Open Space		
Developed, Open Space	1,694.14	8.7
Total Open Space within the Watershed:		
Wetlands, forested areas, and developed, open space	11,355.5	58.1

2.2.9 Recreation

At the Watershed scale there are few existing opportunities for open space access and recreation. These are mainly limited to the existing public parks and very few locations along the Bayou where there is current access to the water for kayaking or fishing. The existing parks include Zirlott Park, Ralston Park, Bosarge Park, John Thomas Park, Leroy Cain Park, & Maritime Park. Visual access (nature observation) is mainly gained at Lightning Point and the City Docks area. This area is also an important location for sustenance fishing. Another important area is St. Margaret's Catholic Church, where the annual Blessing of the Fleet is held.

Existing recreational activities within the Watershed include birding (the city is the last stop on the Alabama Coastal Birding Trail's Dauphin Island to Bayou La Batre Loop), fishing, cycling, walking/hiking, swimming, nature observation, picnicking, and boating/canoeing/kayaking.

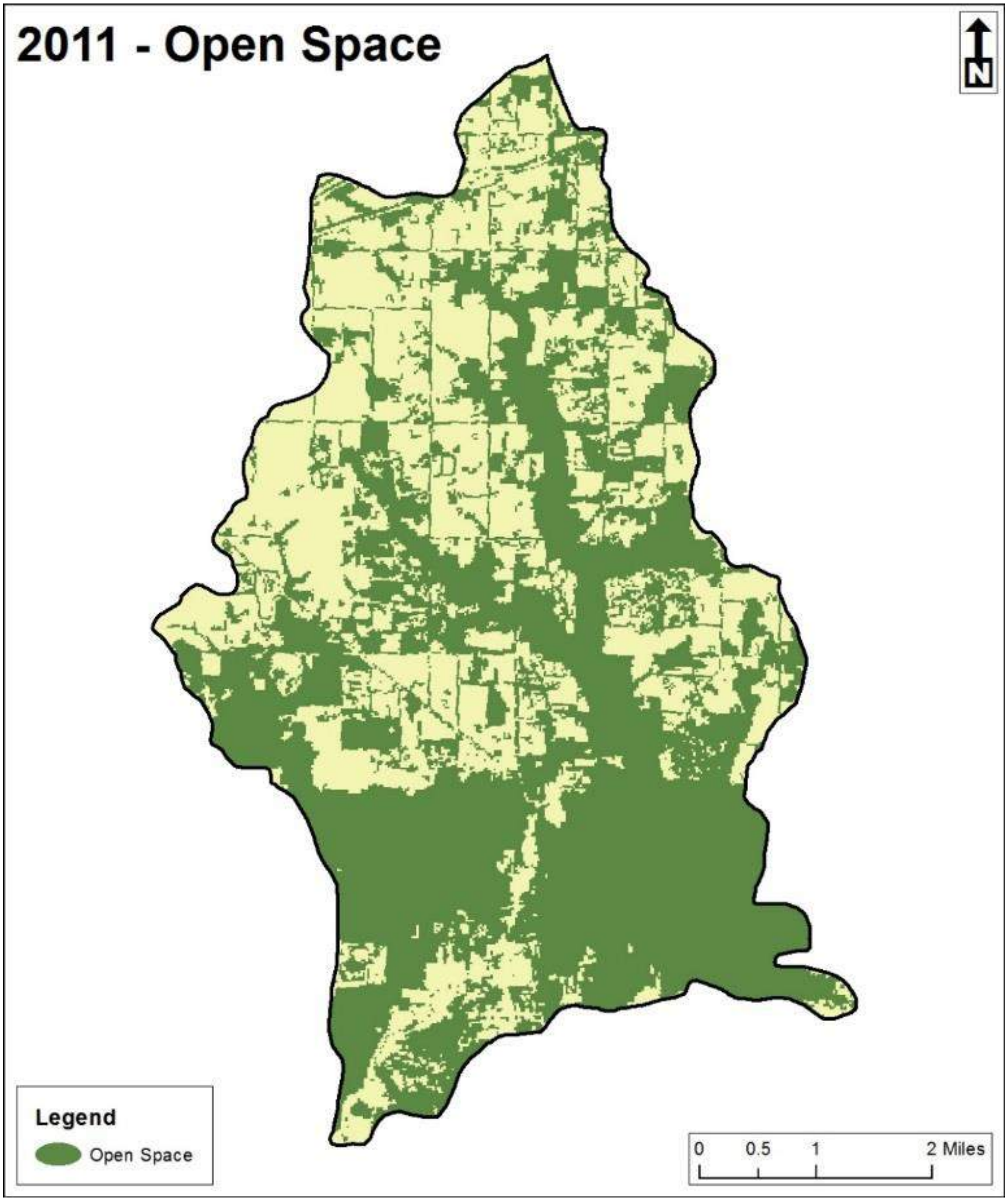


Figure 2.17 Bayou La Batre Watershed open space areas (Homer et al. 2015)

2.2.10 Developed Areas

Developed areas account for 4.5% or 872.9 acres of the total area of the Bayou La Batre Watershed. These developed areas are primarily low-intensity development, which primarily consist of single-family housing units. Medium and high-intensity development make up a much smaller percentage of the overall Watershed, and specific percentages are presented in **Table 2.12** below.

Table 2.12 Bayou La Batre percent developed imperviousness (Homer et al. 2015)

Percent Developed Imperviousness Class	Total Watershed Area (Acres)	Total Watershed Area (%)
Developed, Low-Intensity (imperviousness from 20 - 49%)	619.6	3.2%
Developed, Medium-Intensity (imperviousness from 50 -79%	220.8	1.1%
Developed, High-Intensity (imperviousness > 79%)	32.5	0.2%
Total	**872.9**	**4.5 %**

The highest-percentages of development are found near major roadways and within the City of Bayou La Batre (see **Figure 2.18**). Developed land cover for the Watershed is further investigated in **Section 2.2.11** in terms of impervious surface cover, which is a useful indicator for understanding the impact of development on urbanizing watersheds. Urban land type is important when considering stressors to watershed health. It also helps determine what best management practices (BMPs) should be employed to improve or preserve water resources within watersheds.

2.2.11 Impervious Cover

Impervious cover (IC) is a collective term used to describe all hard surfaces (i.e. rooftops, driveways, roads, parking lots, patios, compacted soils, etc.) that allow little to no water infiltration into the soil. By restricting the infiltration of water, IC fundamentally alters the hydrology of urban watersheds by generating increased stormwater runoff and reducing the amount of rainfall that soaks into the ground. As a result IC is often used to explain or predict changes in stream quality as a response to watershed development.

Impervious cover is the best indicator to measure the intensity of watershed development and to predict the severity of development impacts on the network of streams within a watershed. The extent of IC in a watershed is closely linked to the specific LULC cover types that reflect intensive land uses traditionally associated with urban growth. Typically, increases in IC result in the fragmentation of natural area remnants, create interruptions in the stream corridor, reflect encroachments into and expansion of developments within floodplains, and increase the density of stormwater hotspots. Relatedly, the potential for sediment erosion is known to increase in developing watersheds as impervious cover replaces natural vegetation.

The Center for Watershed Protection has developed an impervious cover model (ICM), which relates IC with research findings into a general watershed planning model (Schueler 2003). As shown in **Figure 2.17**, Schueler's (1994) three imperviousness classes of impact provide a useful initial guide to stream quality in the Southeastern United States:

- **Sensitive streams** have 0 to 10% imperviousness and typically have good water quality, good habitat structure, and diverse biological communities if riparian zones are intact and other stresses are absent.

- **Impacted streams** have 10 to 25% imperviousness, show clear signs of degradation, and only fair in-stream biological diversity.

- **Non-supporting streams** have >25% impervious, a highly unstable channel and poor biological condition supporting only pollutant-tolerant fish and insects.

The ICM predicts that when watershed IC exceeds 10%, stream quality is likely degraded, with the degradation increasing to severe when watershed IC exceeds 25%. While impervious cover is a more robust and reliable indicator of overall stream quality beyond the 10% IC threshold, several studies cited in Schueler (2003) have documented stream degradation at levels of watershed imperviousness below the 10% threshold.

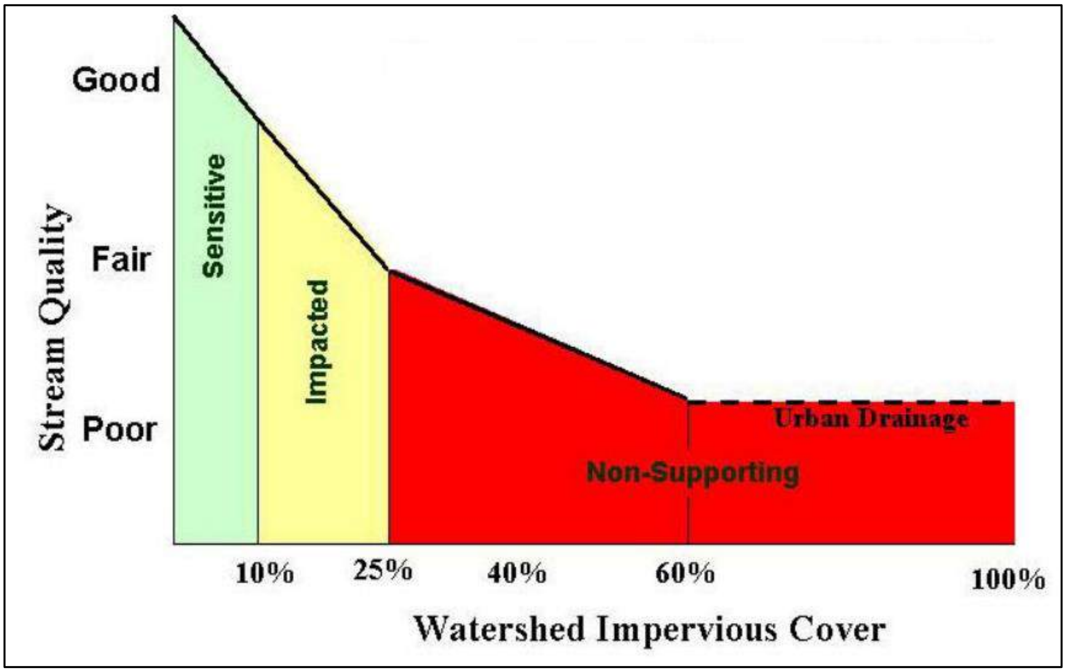


Figure 2.18 The Center for Watershed Protection's Impervious Cover Model (Schueler 2003)

The NLCD 2011 Percent Developed Imperviousness data layer (Xian *et al.* 2011) was used to assess impervious surfaces within the Watershed. The 2011 NLCD Percent Developed Imperviousness dataset presents estimates of land cover imperviousness with values ranging from 0-100% imperviousness for the contiguous United States at 30-meter resolution (Xian *et al.* 2011). A pixel (30x30 meter resolution) with a value of zero has no impervious surface. While a pixel with a value of 100 is completely covered with impervious surfaces. Pixels with values in between are only partially covered with impervious surfaces.

According to Xian *et al.* (2011) the total impervious surface area of the Bayou La Batre Watershed covers approximately 487.4 acres (2.49%) of the 19,554.6-acre Watershed (see **Figure 2.**). Based on the results of calculating the total impervious surface area for the Bayou La Batre Watershed from the 2011 NLCD Percent Imperviousness dataset, the Watershed stream quality is listed as sensitive. This indicates that the Watershed impervious cover is between 0-10%, corresponding to a sensitive stream quality as presented in **Figure 2.**. The highest percentages of imperviousness are found near development, i.e. the major roadway/

transportation networks and within the City of Bayou La Batre. The City of Bayou La Batre's municipal boundaries encompass over half, approximately 54.2% (264.3 acres), of the impervious surface area (487.4 acres) within the Watershed.

However, the most accurate way to calculate impervious surfaces is to digitize the surfaces using the most up to date aerial imagery available. The 2011 NLCD Percent Imperviousness dataset (Xian *et al*. 2011) relies on satellite imagery that use night-time light signatures to determine LULC. Investigations regarding the validity of this NLCD product have shown that the results tend to underestimate the percentage of impervious cover. In the case of the Bayou La Batre Watershed, impervious areas are small due to the large-lot, residential type of land use. Average houses are much smaller than the 30-meter pixels that can be categorized as impervious. Each pixel can be assigned a fraction of impervious cover ranging from 1 to 100%. Approximately 13% of the total land cover area within the Bayou La Batre Watershed has some fraction of impervious surface. Although, the majority of the total land cover area in the Watershed, 87% (17,006.9 acres), has no measurable level of IC. As shown in **Figure 2.18**, 92.6% of the Watershed features 10% or less IC.

The transportation system within the Bayou La Batre Watershed consists of several common means of conveyance including: road and highway systems; railway systems; waterway network systems; and two public airfields. Common to most developing watersheds, locations for development and urbanization are closely linked to the location and type of transportation infrastructure. For the Bayou La Batre Watershed, development is predominately concentrated along the waterway network and the road and highway system, which are discussed in more detail in the following sections.

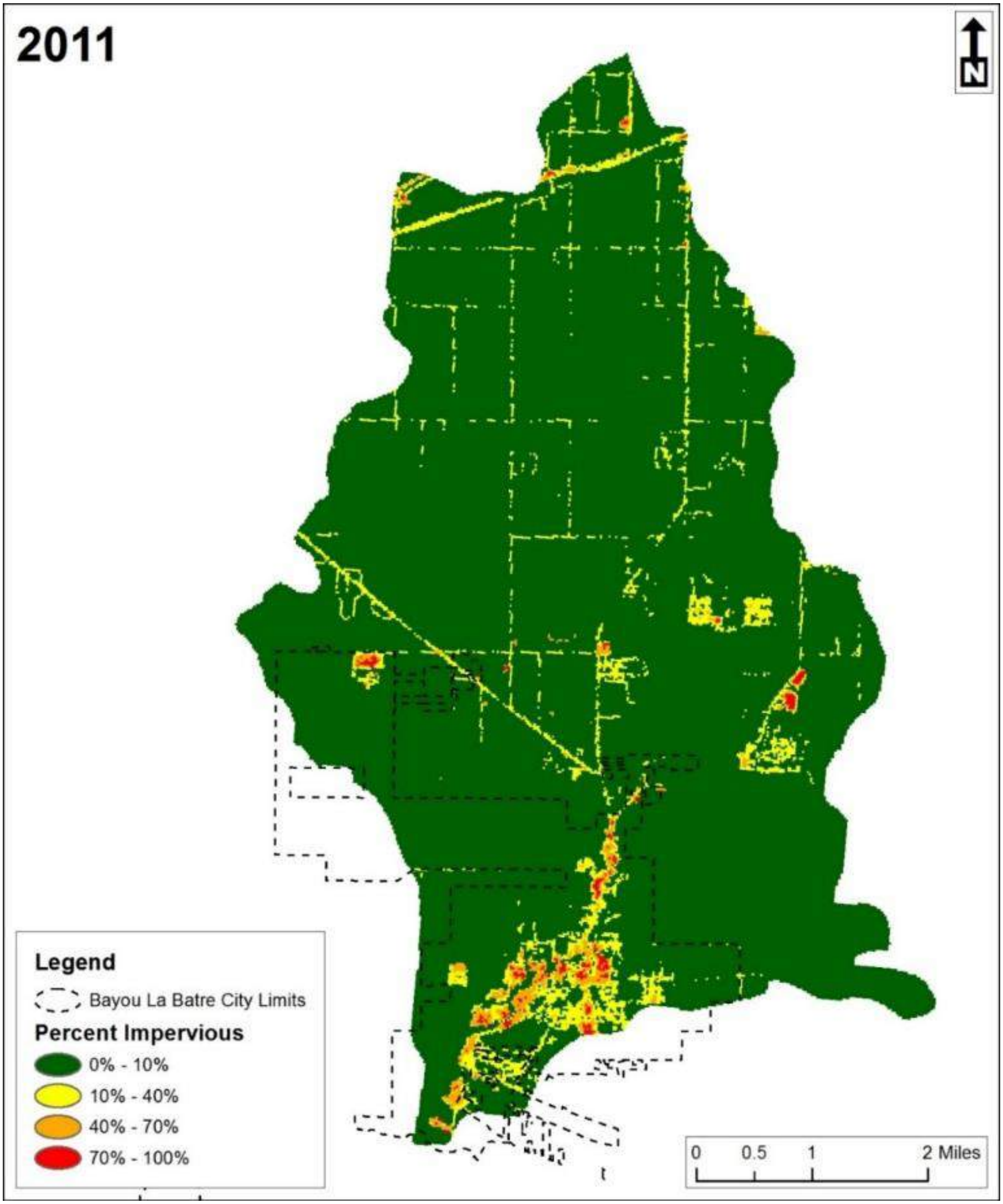


Figure 2.19 Bayou La Batre Watershed percent imperviousness (Xian *et al.* 2011)

2.2.12 Transportation

2.2.12.1 Roads

Highways greatly influence the location, type, and pattern of land use. Eight roadways in particular have played a major role in influencing land use change within the Watershed: U.S. 90 (also known as State Route 16); State Route 188 (also known as Wintzell Avenue); and County Roads 15, 39, 22, 23, 24, and 19 (see **Figure 2.19**).

2.2.12.2 Navigation Channels, Ports, and Harbors

Bayou La Batre is a tidally-influenced coastal waterbody that primarily has privately-owned and operated seafood processing plants, commercial offloading docks, shipbuilding facilities, and marinas along its banks (ADEM 2008). The USACE oversees the continued operations and maintenance activities of the federally authorized channel within Bayou La Batre (USACE 2014) (see **Figure 2.20**).

Authorization to maintain sufficient channel depths began in 1965 as authorized by the 1965 River and Harbor Act. ADEM (2008) summarizes the maintenance effort, *"From the mouth of the Bayou, a 12-ft-deep by 100-ft-wide channel to a point about 2,800 feet south of the highway bridge, thence a channel 12 x 75 feet to the bridge, an overall distance of about 33,500 feet, with channel widened 0.6 miles below bridge to provide turning basin 12 feet deep and about 2.6 acres in area."* Project improvements for the navigation channel were authorized by the 1990 Water Resources Development Act (WRDA). According to ADEM (2008) improvements included, *"an18-foot-deep by 100-foot-wide channel up Bayou La Batre through and including the existing turning basin with a transition to a 14-foot-deep by 75-foot-wide channel to a point 1,500 feet above Highway 188 bridge; and a 14-foot-deep by 50-foot-wide side channel up Snake Bayou for 500 feet, then a 12-foot-deep by 50-foot-wide channel for an additional 800 feet."* The Bayou La Batre navigation channel, approximately 23 miles long, provides access and safe navigation of commercial and recreational vessels to the Gulf of Mexico and Gulf Intracoastal Waterway (GIWW).

Additionally, the City of Bayou La Batre Port Authority was registered in 1988 as a domestic nonprofit corporation.

Bayou La Batre is home to a variety of sizes of fishing vessels, with most vessels measuring less than 90-feet. NOAA Fisheries (2016) provides the following graph (**Figure 2.21**) that gives an overview of vessel size in Bayou La Batre. The majority of vessels (60%) are from 70 to 89-feet, with vessels measuring 50 to 69-feet making up the next largest category. Many vessels are constructed in Bayou La Batre, which is home to several shipbuilding facilities (**Figure 2.22**).

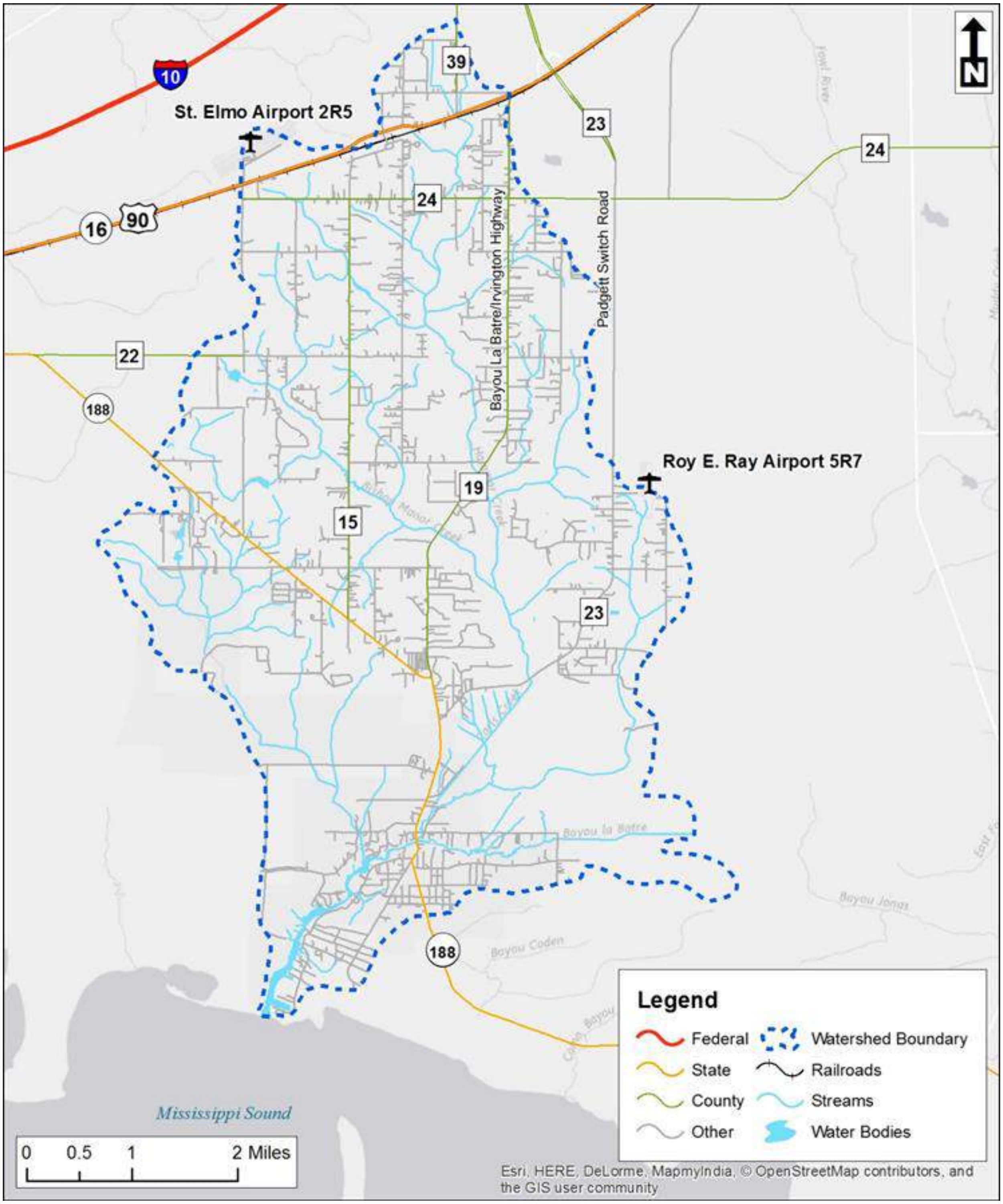


Figure 2.20 Transportation networks in the Bayou La Batre Watershed

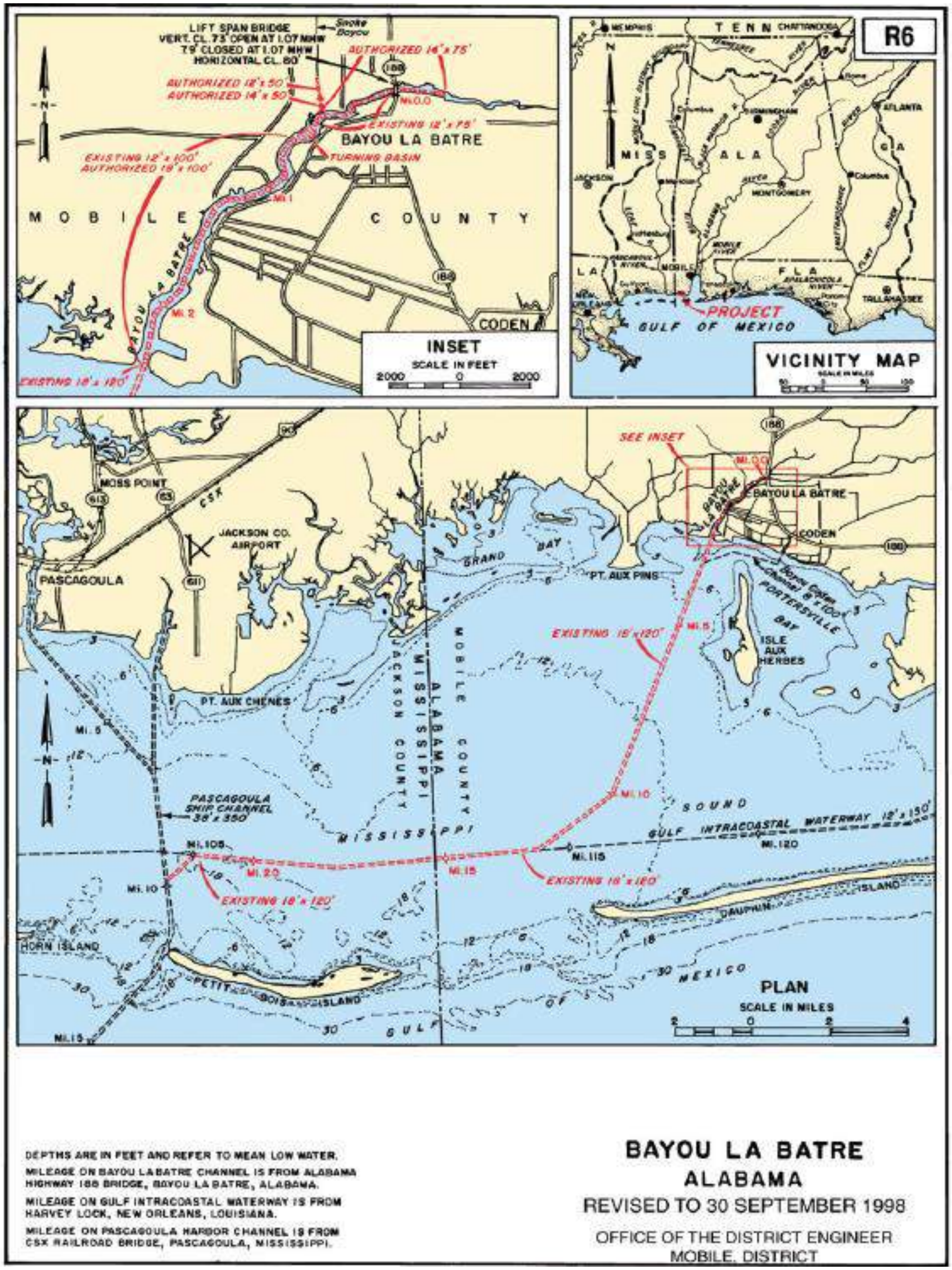


Figure 2.21 Bayou La Batre channel dredging. Source: USACE 2008

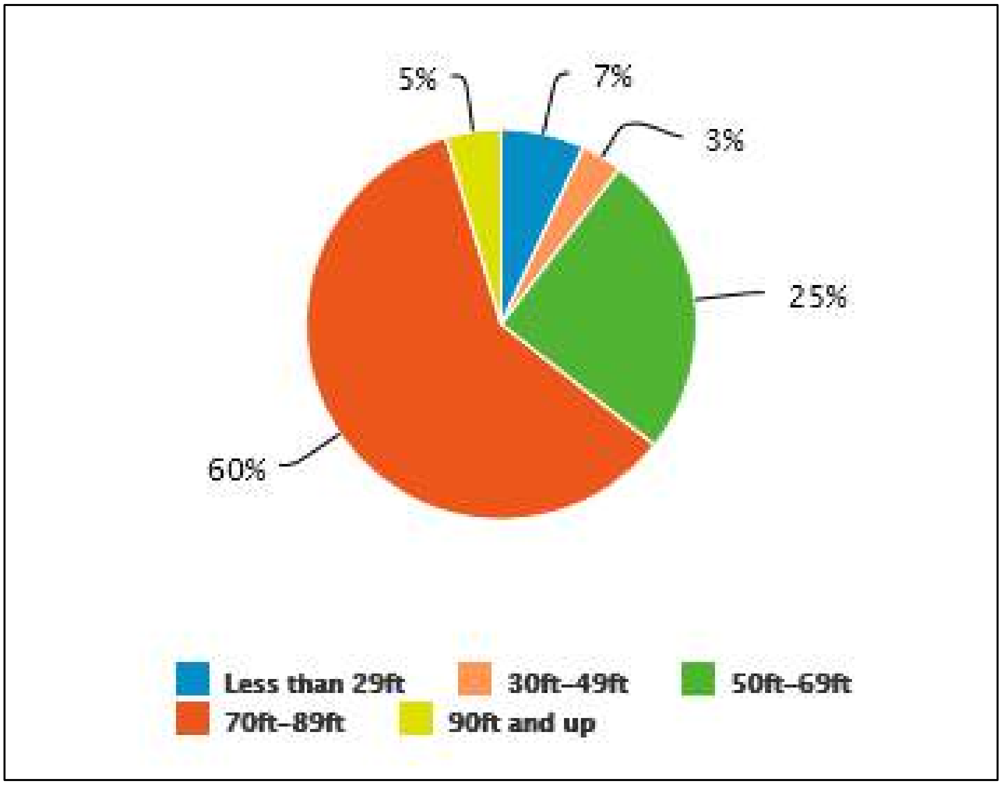


Figure 2.22 Number of commercial vessels by size in Bayou La Batre (NOAA Fisheries 2016)

Figure 2.23 Shipbuilding facility in Bayou La Batre

2.2.13 Political Institutions and Boundaries

Relevant authorities within the Watershed include: the City of Bayou La Batre; the City of Mobile; Mobile County; the State of Alabama; and the United States Federal Government. However, the two main political entities exercising governmental authority within the Bayou La Batre Watershed are the City of Bayou La Batre and Mobile County (see **Figure 2.23**). Approximately 80.4% (15,727 acres) of the Watershed lies within unincorporated Mobile County. The remaining area within the Watershed, 19.6% (3,835 acres), is located within the municipal boundary of the City.

The unincorporated areas of Mobile County within the Watershed are contained within Mobile County's Planning District No. 3, and include portions of several unincorporated towns including: Irvington, St. Elmo, and Dixon Corner. However, the planning jurisdiction of the City of Mobile extends beyond its municipal boundaries as allowed by the extraterritorial jurisdiction (ETJ) provision of Alabama State Law. The ETJ provision allows cities within the State the authority to review all planned subdivision developments within their ETJ, which extends a maximum of five miles outside their corporate limits. Therefore, all developments within the neighboring unincorporated lands of Mobile County within five miles of municipal city boundaries exercising their ETJ rights are subject to review by the cities where appropriate. **Figure 2.23** shows the northern region of the Watershed which falls under this provision for the City of Mobile.

The City of Bayou La Batre is not currently exercising their ETJ rights for a five-mile planning jurisdiction for the City. Therefore, there are no GIS data reflective of this boundary shown in **Figure 2.23**. It is a recommendation of this WMP that if the City of Bayou La Batre seeks to exercise this right in the future that this figure be updated as appropriate, and that the City seek funds to organize and digitize their map library inventory to better facilitate future city planning efforts and land planning projects.

In addition to the City of Bayou La Batre and Mobile County, there are several notable State of Alabama land holdings within the Watershed. State land holdings include state-maintained roadways (Hwy 188 and State Route 16) and their associated rights-of-ways, as well as state wildlife management areas. As shown in **Figure 2.23**, a portion of the Alabama Department of Conservation and Natural Resources' (ADCNR) wildlife management area, better known as the State's Grand Bay Savanna Forever Wild Land Tract, are contained within the Bayou La Batre Watershed boundary.

The only significant federal land holdings within the watershed include US Hwy 90 and its associated rights-of-way.

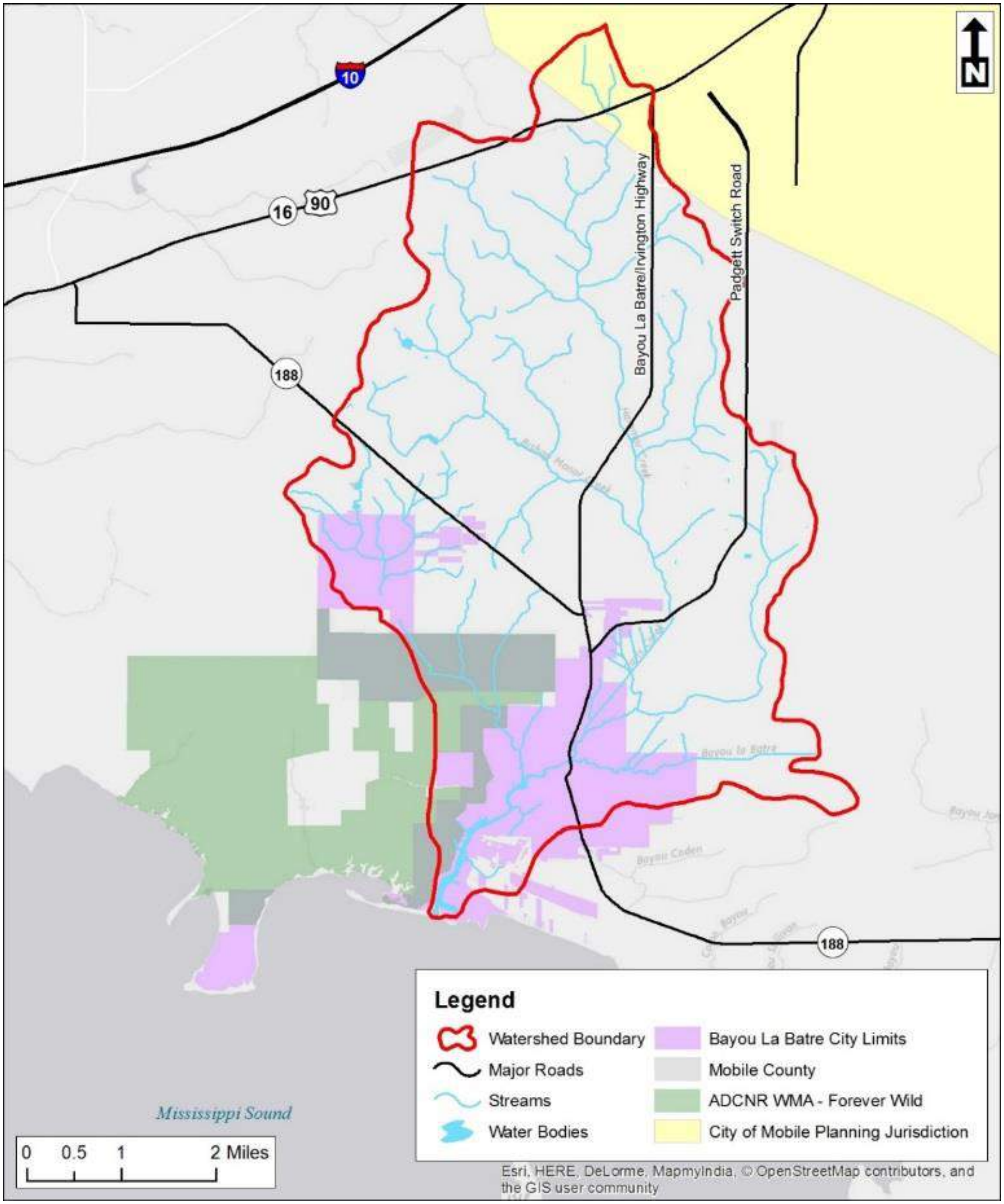


Figure 2.24 Political institutions within the Bayou La Batre Watershed

2.2.14 Future Land Use

A future land use data layer was created as part of a larger study that also included a review of historical land use (see **Section 2.2.1**) (Estes *et al.* 2012). The study involved the application of a spatial growth model, the Prescott Spatial Growth Model (PSGM), to the 2001 NLCD to predict a future LULC for 2030 throughout Mobile Bay.

"PSGM is an Arc geographic information system (GIS) compatible application that allocates future growth into available land based on user-defined parameters. The purpose of the PSGM is to help users develop alternative future patterns of LULC based on socio-economic projections such as population, employment and other controlling factors. When creating scenarios based on future development, the PSGM requires several inputs:

- **Developable land** must be provided as an input grid that represents areas suitable for accepting future growth.
- **Growth projections** quantify the demand for land area to be developed for each time horizon for each LULC type. These projections are derived from socio-economic drivers using a PSGM utility that determines the growth for each urban LULC category (industrial, high-density residential, etc.).
- **Suitability rules** for location of future growth are specified using a PSGM table interface. When the PSGM runs, it allocates the new growth onto the developable land grid, in the order of most to least suitable land. The output of the PSGM is a series of growth grids, one for each time step and LULC type, showing the anticipated future growth pattern."

Estes *et al.* (2012) predicted future land needs for residential development by using census population data for the counties in the study area along with population projections available from 2005 to 2025 at five-year intervals. Future commercial land use was determined using employment data for the counties. Estes *et al.* (2012) also assumed current LULC trends would not change and that people would be drawn to development along shorelines without infringing upon wetland areas. The resulting demand for land did not exceed the amount of land suitable for development.

According to Estes *et al.* (2015), the Bayou La Batre Watershed, in addition to Fish River, Fowl River, Dog River, and upper Chickasaw Watersheds, showed the largest change in LULC from agricultural/pasture rural environment to increasing urbanization by year 2030. This qualification is based on LULC change data from 1948 to 2001 and coupled demographic and urban growth models projecting and predicting urban land use to year 2030 for Mobile and Baldwin County (see **Figure 2.24**). **Table 2.13** compares the results of 2030 projected LULC with historical LULC from 1974 and 2008 (see **Section 2.2.1**). Trends in future LULC indicate the continued decline in upland forests and the expansion of urbanization.

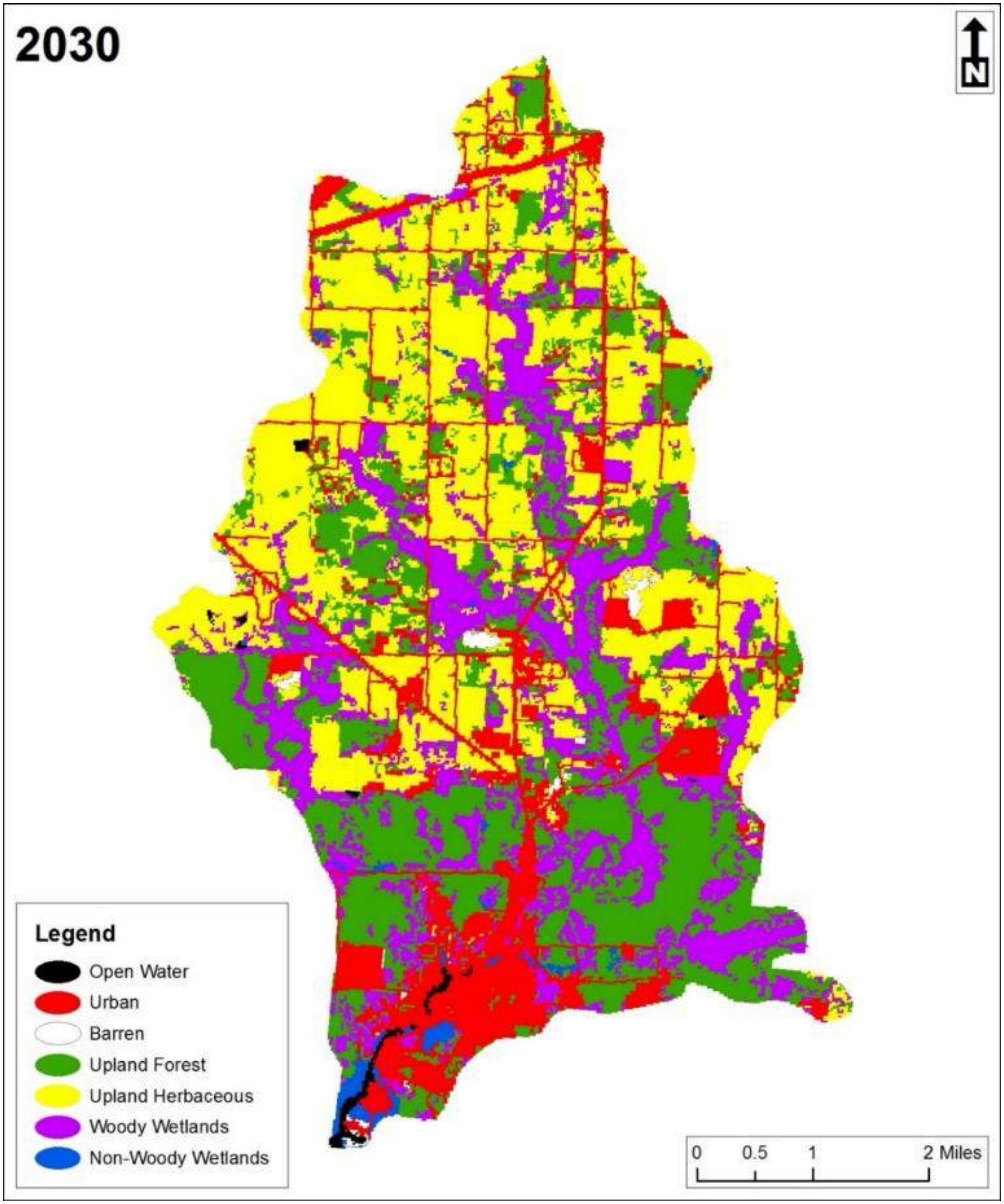


Figure 2.25 Bayou La Batre Watershed predicted LULC for 2030 (Estes *et al.* 2015)

Table 2.13 Comparison of future and historical LULC in the Bayou La Batre Watershed (Spruce *et al.* 2009 and Estes *et al.* 2015)

	1974		2008		2030 Projection	
Class Name	Total Area (Acres)	Percent %	Total Area (Acres)	Percent %	Total Area (Acres)	Percent %
Open Water	58	0.30	169	0.87	95.18	0.49
Barren	14	0.07	92	0.48	108.75	0.55
Upland Herbaceous	6,252	32.20	6,637	34.17	6,384.97	32.65
Non-Woody Wetland	173	0.89	203	1.05	189.71	0.97
Upland Forest	7,822	40.29	6,347	32.68	5,527.39	28.27
Woody Wetland	3,529	18.18	3,705	19.08	3,952.21	20.21
Urban	1,567	8.07	2,268	11.68	3,296.47	16.86
Total	**19,415**	**100**	**19,421**	**100**	**19,554.68**	**100**

2.3 Demographic Characteristics

Demographic data specific to the Bayou La Batre Watershed are not available. Therefore, demographic distributions within the Watershed were determined by overlaying the Watershed boundary (see **Section 2.1.1**) on the 477 Census Blocks and 11 Census Block Groups that cover the same geographical area. Census Blocks are the geographical units used by the United States Census Bureau (USCB). Census Blocks are the smallest geographical unit for which the USCB publishes demographic data; the next biggest spatial entity is Census Block Groups. There were 11 Census Block Groups that fall within the Bayou La Batre Watershed boundary. The demographic distributions were derived from an area-weighted average of the combined Census Blocks or Census Block Groups that comprise the Watershed area. The estimates provided in the following sections are for informational purposes only.

2.3.1 Population

The Bayou La Batre Watershed encompasses portions of the City of Bayou La Batre and unincorporated areas of Mobile County, Alabama. The total area-weighted population estimates from the 2010 Census Block redistricting data (USCB 2010), which intersect these jurisdictions and encompass the Bayou La Batre Watershed was 10,533 people, of which approximately 2,321 lived within the City of Bayou La Batre and 8,212 people lived within unincorporated Mobile County (See **Figure 2.25**) (USCB 2010).

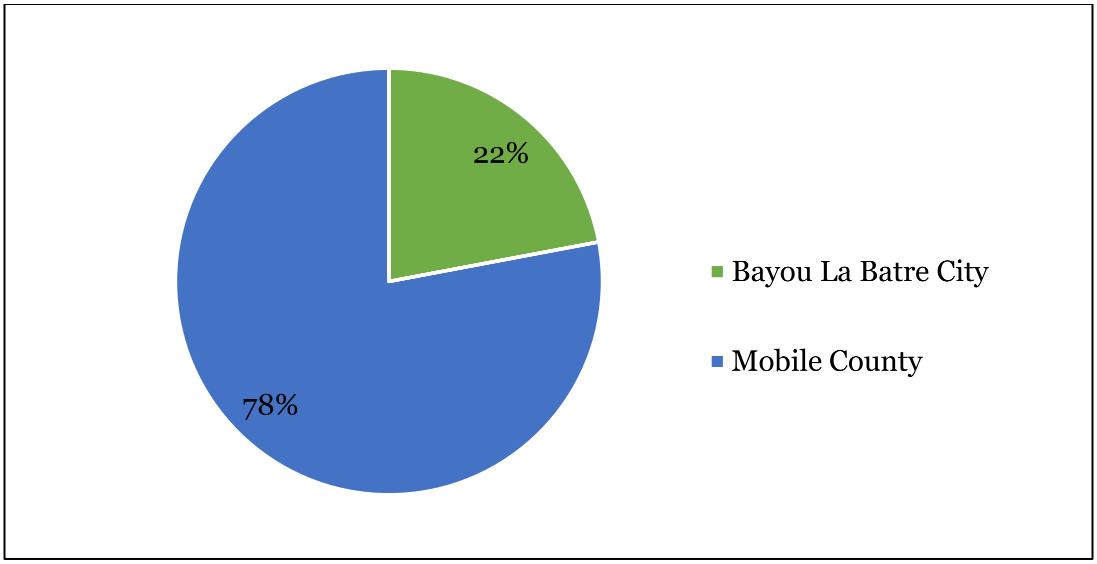


Figure 2.26 Total population (area-weighted by jurisdiction located within the Bayou La Batre Watershed boundary

Both Mobile County and the City of Bayou La Batre have multi-ethnic populations. According to estimates obtained from the 2010 Census redistricting data (USCB 2010), the ethnic distribution of people located within the Watershed boundary for Mobile County is approximately 77% White; 12% African American; 8% Asian; 1% Hawaiian and Pacific Islander; and 2% Other (see **Figure 2.26**).

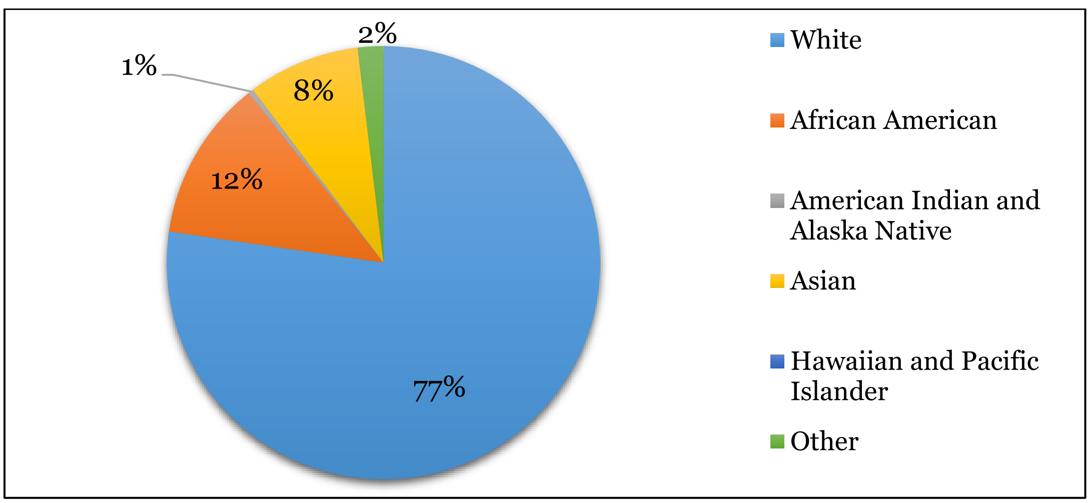


Figure 2.27 Ethnic groups lcoated within portion of Mobile County contained within the Bayou La Batre Watershed

According to estimates obtained from the 2010 Census redistricting data (USCB 2010), the ethnic distribution of the City of Bayou La Batre's population located within the Watershed boundary is approximately 64% White; 24% Asian; 11% African American; and 1% Other (see **Figure 2.27**).

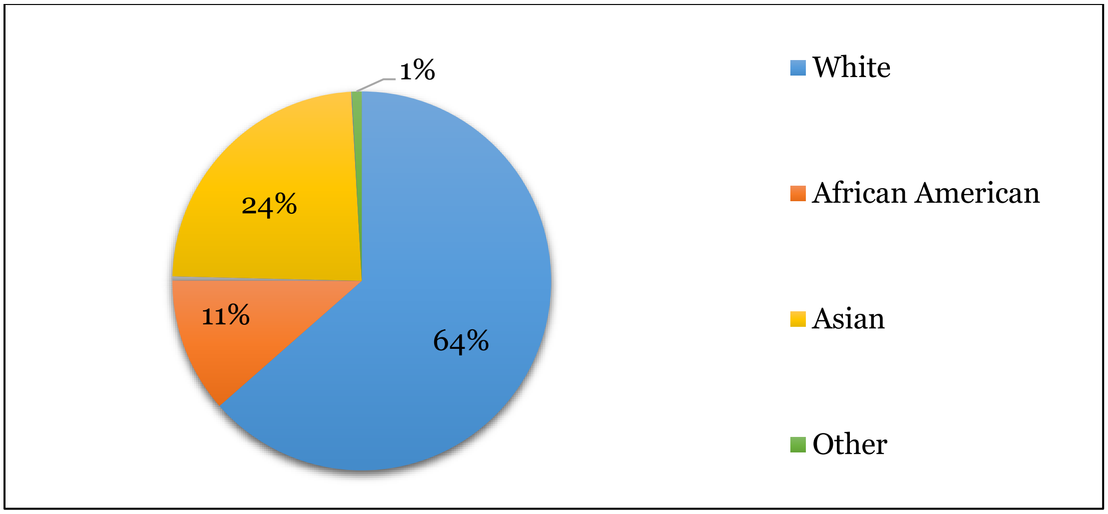


Figure 2.28 Ethnic groups located within portions of the City of Bayou La Batre contained within the Bayou La Batre Watershed

The estimated ethnic distributions for the entire Watershed are similar to those of Mobile County with: 74% White; 12% African American; 12% Asian (see **Figure 2.28**).

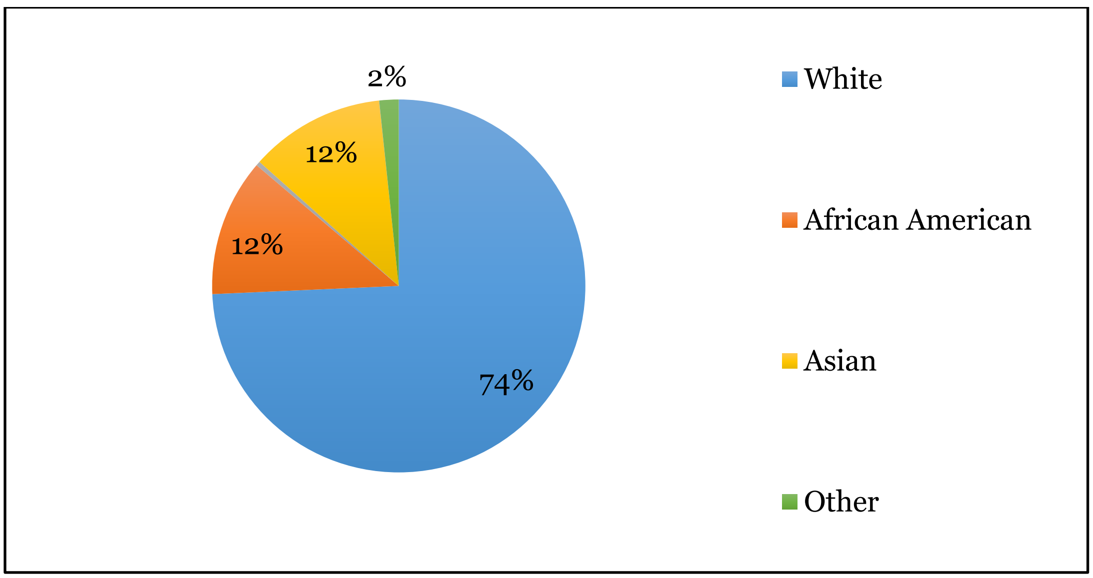


Figure 2.29 Ethnicity for all census block groups intersecting the Bayou la Batre Watershed boundary

The total area-weighted population (see **Figure 2.28**) does not exactly match the total area-weighted population by race (see **Figure 2.25**, **Figure 2.26**, and **Figure 2.27**); this is a function of the limitations of the area-weighted technique used to estimate information provided from the 2010 Census redistricting data.

2.3.2 Economics

Household income data for the Watershed were summarized as area-weighted estimates from information provided in the American Community Survey (ACS) five-year, 2013 data (ACS 2013). The data were provided on the Census Block Group level that are large geographies, not recommended for area-weighted estimates. These estimates are for informational purposes only.

The median household income for the Bayou La Batre Watershed is approximately $30,000 to $34,999 (see **Table 2.14** and **Table 2.15**).

Table 2.14 Household income data from census block groups intersecting Bayou La Batre Watershed

	Number of Households with Income ($ x 1000)															
	Less than $10	$10 to $15	$15 to $20	$20 to $25	$25 to $30	$30 to $35	$35 to $40	$40 to $45	$45 to $50	$50 to $60	$60 to $75	$75 to $100	$100 to $125	$125 to $150	$150 to $200	$200 or more
City of Bayou La Batre (within HUC12)	71	67	21	27	30	36	14	23	21	33	31	12	1	10	1	0
Mobile County (within HUC12)	336	226	120	199	117	122	35	115	73	220	311	234	67	84	33	14

Table 2.15 Household income data by percentages from census block groups intersecting Bayou La Batre Watershed

	Number of Households with Income ($ x 1000)															
	Less than $10	$10 to $15	$15 to $20	$20 to $25	$25 to $30	$30 to $35	$35 to $40	$40 to $45	$45 to $50	$50 to $60	$60 to $75	$75 to $100	$100 to $125	$125 to $150	$150 to $200	$200 or more
Percent of Households (within HUC12)	15%	11%	5%	8%	5%	6%	2%	5%	3%	9%	13%	9%	3%	3%	1%	1%

2.3.3 Languages

Both Mobile County and the City of Bayou La Batre have multi-ethnic populations. Within the entire Bayou La Batre Watershed, the most common household languages include: English only 90%; Asian 6%; and Spanish 3%; (see **Figure 2.29**) (ACS 2013). Spoken languages for the population are given in **Table 2.16** in relation to the jurisdictional boundaries contained within the Bayou La Batre Watershed. Data were summarized as area-weighted estimates from information provided in the American Community Survey five-year, 2013 data (ACS 2013). The data were provided on the Census Block Group level that are large geographies, not recommended for area-weighted estimates. These estimates are for informational purposes only.

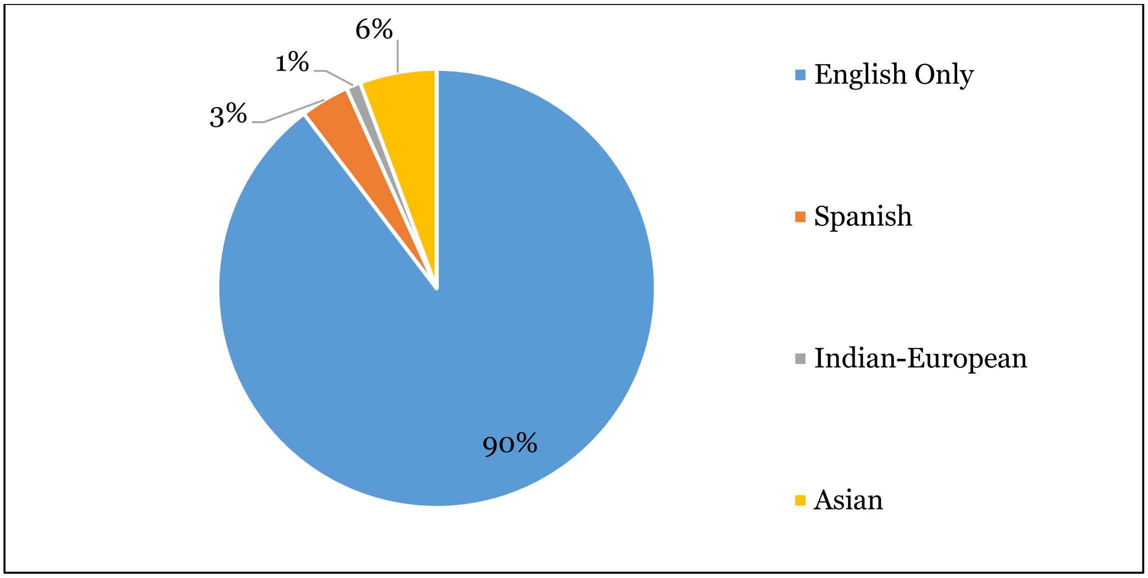


Figure 2.30 Spoken languages within the Bayou La Batre Watershed

Table 2.16 Number of households spoken language statistics for all census block groups intersecting the Bayou La Batre HUC12 sub-basin

	Languages (Number of Households Speaking)			
	English Only	Spanish	Indian-European	Asian
City of Bayou La Batre (within HUC12)	315	4	14	71
Mobile County (within HUC12)	2119	94	15	83

Further investigations into specific spoken household languages were not possible, but the most common Asian languages spoken within the Watershed are known to include Vietnamese, Cambodian, and Laotian.

2.3.4 Education

According to area-weighted estimates of Educational Attainment information provided in the 2013 American Community Survey (ACS) from the Census Block Groups within the Bayou La Batre Watershed, approximately 76% of people aged 25 and above attained only a High School Diploma, General Educational Development (GED) or equivalent (See **Table 2.17** and **Figure 2.30**), (ACS 2013). Education data is for people aged 25 and above only. Education data are not included for people who did not complete high school or people who dropped out of college. Data were summarized as area-weighted estimates from information provided in the American Community Survey (ACS) five-year, 2013 data. Data were provided on the Census Block Group level that are large geographies, not recommended for area-weighted estimates. These estimates are for informational purposes only.

Table 2.17 Education attainment statistics for all census block groups intersecting Bayou La Batre HUC12 sub-basin

	Education Attainment (Number of People)						
	High School Diploma	GED or Equivalent	Associate Degree	Bachelor Degree	Master Degree	Professional School Degree	Doctorate Degree
City of Bayou La Batre (within HUC12)	201	38	28	30	26	0	0
Mobile County (within HUC12)	1360	299	298	125	93	1	0

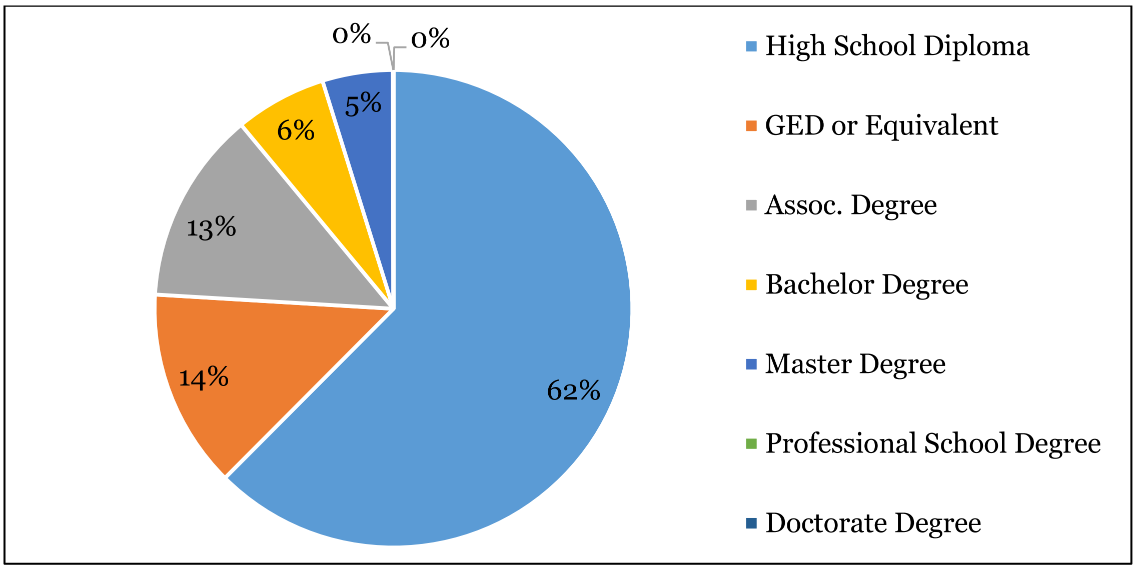


Figure 2.31 Education attainment by percentages from census block groups intersecting Bayou La Batre Watershed

3 Watershed Conditions

This section presents a narrative summary of existing watershed conditions in the Bayou La Batre Watershed from the review of previously collected data and findings as well as field sampling results gathered by the Dewberry team and others. Appendix A provides a full suite of summary plots containing data collected as part of this study, as well as data provided by others.

3.1 Existing Water Quality

Understanding the distinction between freshwater and tidal influences is important to the characterization of existing water quality conditions in the Watershed. In the Bayou La Batre River, the dividing line between the freshwater and tidal segments is generally considered to be upstream of Hemley Road. However, *in situ* data are not available upstream of this point to verify that the river mainstem and tributaries are neither physically nor chemically influenced by tide. Downstream of this point, the Bayou La Batre River is tidally influenced, both physically (e.g., tidal elevation fluctuations) and chemically (e.g., salt wedge intrusion), and this portion of the River is referred to as the Bayou La Batre River Estuary (**Figure 3.1**).

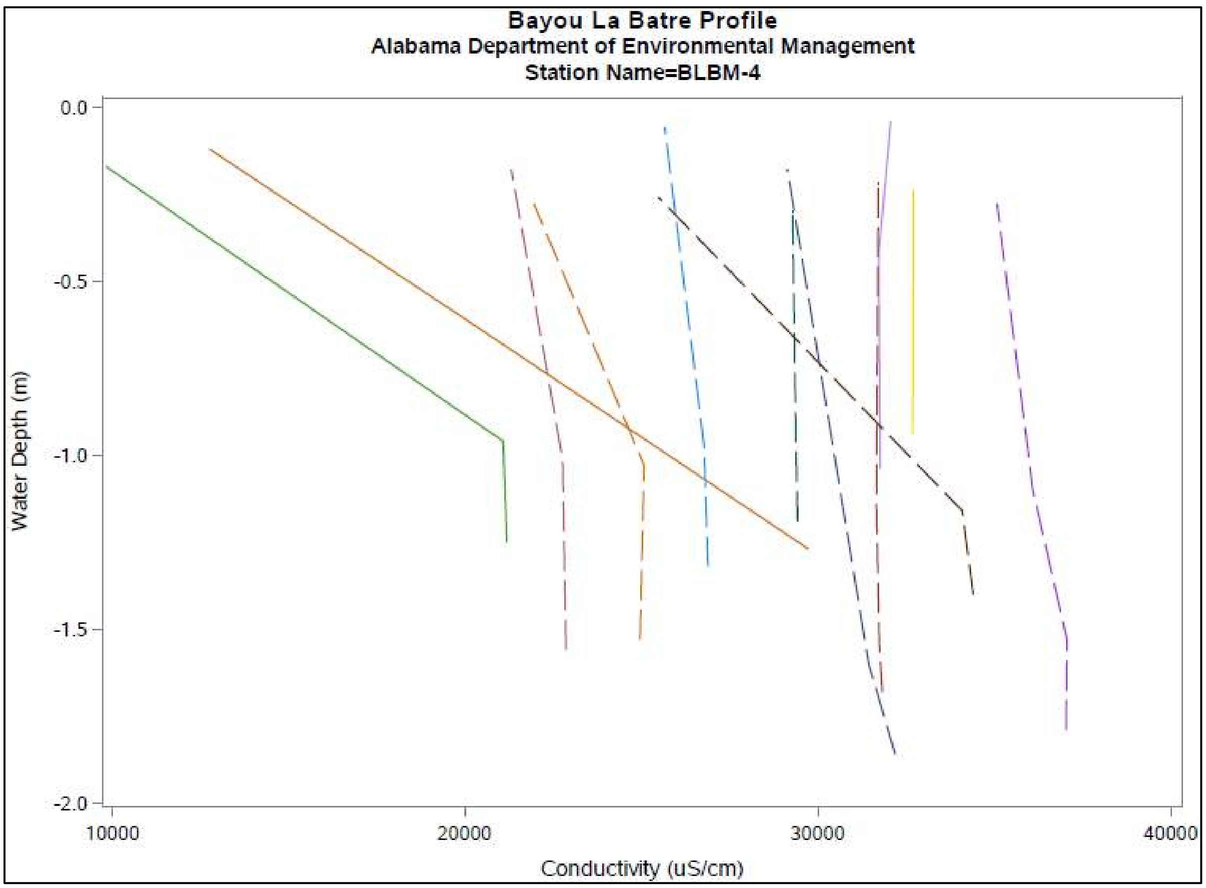


Figure 3.1 Increasing specific conductance with water depth profiles from data obtained at the most upstream sampling station, Hemley Road (Station BLBM-4). Line color and symbology represents independent sampling dates. Source: ADEM

There are two reasons these distinctions are important. First, the chemistry and biology of freshwater streams and rivers are very different from those of tidal estuaries. Accordingly, the ecosystem functions and services provided by rivers and estuaries are also distinctly different. However, there is also an intimate relationship between the freshwater and tidal portions of a water body in that quality, quantity, and timing freshwater deliveries essentially determines the overall health of the estuary. Secondly, regulatory guidance concentrations and standards differ between freshwater and tidal segments for many water quality parameters. Therefore, in relating existing data to various measures of water quality, the applicable criteria are different in most cases.

Characterization of existing water quality can be broken down into the general classes of water quality parameters. These include the following:

- **Physicochemical parameters** - these are measures of the general physical and chemical properties of a water body related to water column mixing and density stratification, in estuaries, including:
  - Temperature
  - Salinity
- **Geochemical parameters** – these are measures of geological inputs into a water body that affect water clarity and sedimentation, including:
  - Total suspended solids
  - Turbidity
  - Specific conductance
  - pH
- **Trophic parameters** – these are measures of primary production (e.g., algal and macrophytic photosynthesis), related processes (e.g., respiration), and drivers (nutrients) in a water body, including:
  - Chlorophyll-a
  - Dissolved oxygen
  - Nitrogen – both total and inorganic
  - Phosphorus - both total and inorganic
- **Pathogens** – these are bacterial constituents that are used as indicators of more noxious human pathogens associated with animal waste products (e.g., viruses, disease causing bacteria), including:
  - Fecal coliform
  - Enterococci
- **Contaminants** – these are chemical constituents that are potentially toxic to aquatic organisms and humans, including:
  - Heavy metals
  - Organics.

The water quality parameters listed above are measures and/or indicators of different characteristics of the waterbody. While there is some overlap in the classes of water quality parameters listed above, they are measures and/or indicators of different characteristics. The cumulative assessment of these parameters can be used to determine the overall water quality of a particular water body with regard to its designated uses. In the sections that follow, water quality in the Bayou La Batre Estuary is characterized with regard to the various classes of water quality parameters.

3.1.1 Data Sources

Determination of water quality conditions was based on the following data sources:

- **Dauphin Island Sea Lab (DISL)** – data collected specifically to support the development of the Bayou La Batre Watershed Management Plan
  - Physicochemical and trophic data collection in both the Bayou La Batre Estuary and freshwater segments during the period 2015-2016
- **Alabama Department of Environmental Management (ADEM)** – programmatic ambient monitoring and assessment data
  - Physicochemical, trophic, pathogen, and contaminant data collection in the Bayou La Batre Estuary during the period 1999-2015
- **Environmental Science Associates (ESA)** – data collected specifically to support the development of the Bayou La Batre Watershed Management Plan
  - Pathogen microbial source tracking study completed in 2015.

Table 3.1 provides a summary of the programmatic data collected by ADEM in the Bayou La Batre Watershed.

Table 3.1 Summary of ADEM data collection in the Bayou La Batre Watershed

Station Name	BBM-1	BBM-3	BBM-5		BBM-6	BBM-9	BLB-1	BLBM-1	BLBM-2	BLBM-3	BLBM-4	HMC-1	HMC-2
First Sampling Date	16-Aug-06	16-Aug-06	17-Aug-06		17-Aug-06	17-Aug-06	29-Mar-78	8-May-01	8-May-01	8-May-01	8-May-01	17-May-99	17-May-99
Last Sampling Date	26-Mar-07	27-Mar-07	26-Mar-07		27-Mar-07	28-Mar-07	8-Oct-15	8-Oct-15	27-Mar-07	14-Sep-07	28-Mar-07	17-Oct-11	13-Sep-99
Alkalinity, total	3	3	4		3	3	291	40	9	8	9	7	-
Biochemical oxygen demand, standard conditions	3	2	4		3	2	179	37	14	5	7	-	-
Chemical oxygen demand	-	-	-		-	-	7	-	-	-	-	-	-
Chlorophyll a	3	3	4		3	3	60	33	3	4	2	1	-
Depth, bottom	3	3	4		3	3	47	43	14	15	14	9	-
Depth, data-logger (non-ported)	16	23	6		17	12	311	326	92	49	41	2	-
Depth, Secchi disk depth	3	3	4		3	3	50	48	15	14	-	-	-
Dissolved Aluminum	-	-	-		-	-	5	4	-	-	-	7	-
Dissolved Antimony	-	-	-		-	-	5	3	-	-	-	-	-
Dissolved Arsenic	-	-	-		-	-	5	5	-	-	-	-	-
Dissolved Cadmium	-	-	-		-	-	1	2	-	-	-	4	-
Dissolved Chromium	-	-	-		-	-	6	5	-	-	-	-	-
Dissolved Copper	-	-	-		-	-	4	4	-	-	-	-	-
Dissolved Iron	-	-	-		-	-	5	3	-	-	-	8	-
Dissolved Lead	-	-	-		-	-	7	4	-	-	-	-	-
Dissolved Manganese	-	-	-		-	-	9	7	-	-	-	8	-
Dissolved Mercury	-	-	-		-	-	1	2	-	-	-	1	-
Dissolved Nickel	-	-	-		-	-	4	3	-	-	-	-	-
Dissolved Orthophosphate as P	-	-	-		-	-	3	1	-	-	-	-	-

Dissolved oxygen (DO)	16	23	7		17	12	559	334	101	59	49	15	4
Dissolved oxygen saturation	-	-	-		-	-	21	29	-	-	-	2	-
Dissolved Selenium	-	-	-		-	-	4	4	-	-	-	-	-
Dissolved Silver	-	-	-		-	-	2	3	-	-	-	-	-
Dissolved Thallium	-	-	-		-	-	7	7	-	-	-	-	-
Dissolved Zinc	-	-	-		-	-	4	4	-	-	-	-	-
Enterococcus	3	3	3		3	3	50	49	15	15	15	-	-
Escherichia coli	-	-	-		-	-	-	-	-	-	-	9	-
Fecal Coliform	3	3	3		3	3	214	21	17	19	17	4	4
Flow	2	-	-		3	2	8	12	-	12	-	15	-
Hardness, Ca, Mg	2	2	3		2	2	270	30	10	13	10	8	-
Inorganic Inorganic nitrogen (nitrate and nitrite) as N	-	-	-		-	-	2	-	-	-	-	13	4
Inorganic nitrogen (nitrate and nitrite) as N	1	2	3		1	1	276	37	13	17	14	-	-
Kjeldahl nitrogen	3	3	4		3	3	182	39	17	18	16	13	4
Light attenuation, depth at 99%	3	3	4		3	3	51	48	15	14	-	-	-
Non-volatile Atrazine	-	-	-		-	-	-	-	-	-	-	1	-
Orthophosphate as P	1	1	3		3	3	35	25	6	6	4	-	-
pH	16	23	6		17	12	566	334	100	59	49	-	4
Phosphorus	3	3	4		3	3	181	40	17	18	17	-	4
RBP Stream depth - pool	-	-	-		-	-	-	-	-	-	-	-	1
Salinity	16	23	8		17	12	535	329	102	64	54	-	-
Temperature, water	16	23	6		17	12	566	334	100	59	49	-	4

Total Aluminum	-	-	-		-	-	11	11	-	1	-	-	-
Total Ammonia-nitrogen as N	2	3	4		3	3	87	29	10	13	16	-	1
Total Antimony	-	-	-		-	-	1	-	-	-	-	-	-
Total Cadmium	-	-	-		-	-	1	-	-	-	-	-	-
Total Calcium	-	-	-		-	-	2	2	-	-	-	-	-
Total Chloride	3	3	4		3	3	286	40	9	8	9	-	-
Total Chromium	-	-	-		-	-	1	2	-	-	-	-	-
Total Conductivity	16	23	6		17	12	469	238	100	59	49	-	4
Total Copper	-	-	-		-	-	2	1	-	-	-	-	-
Total dissolved solids	3	3	4		3	3	294	41	9	8	9	-	4
Total Iron	-	-	-		-	-	12	11	-	1	-	-	-
Total Kjeldah nitrogen	-	-	-		-	-	6	5	-	-	-	-	-
Total Lead	-	-	-		-	-	3	1	-	-	-	-	-
Total Magnesium	-	-	-		-	-	2	2	-	-	-	-	-
Total Manganese	-	-	-		-	-	11	11	-	1	-	-	-
Total Nickel	-	-	-		-	-	-	1	-	-	-	-	-
Total Phosphorus	-	-	-		-	-	10	9	-	-	-	-	-
Total Silver	-	-	-		-	-	1	1	-	-	-	-	-
Total Specific conductance	-	-	-		-	-	65	73	-	-	-	-	-
Total suspended solids	3	3	4		3	3	272	48	17	10	17	-	-
Total Thallium	-	-	-		-	-	3	2	-	1	-	-	-
Turbidity	3	3	4		3	3	299	50	17	18	17	-	4
Zinc	-	-	-		-	-	7	6	-	1	-	-	-

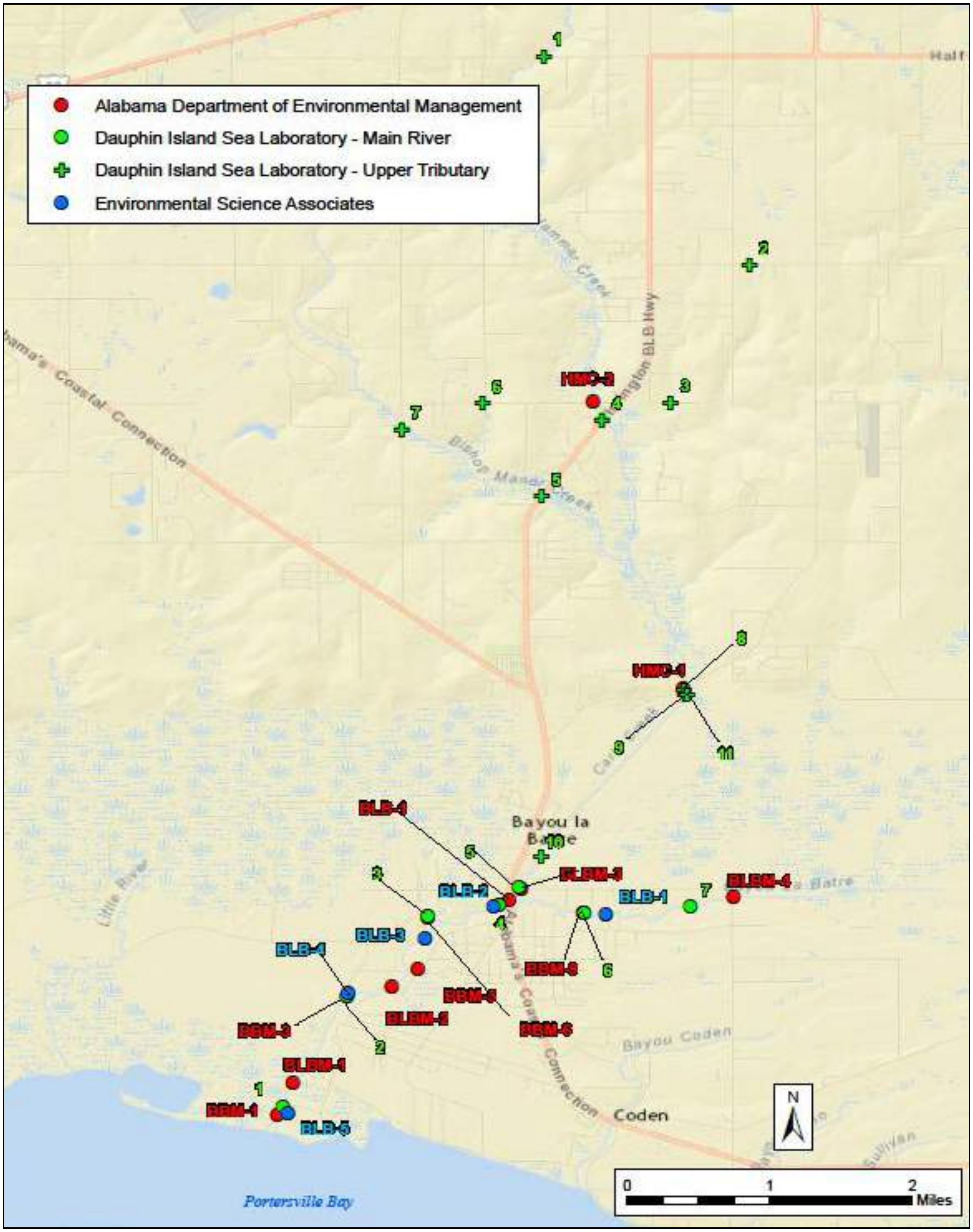


Figure 3.2 Location of water quality sampling stations in the Bayou La Batre Watershed

3.1.2 Water Quality Assessment of Bayou La Batre Estuary

A feature common to all estuaries is the mixing of freshwater from the watershed with salt water. Within the physical boundaries of an estuary this mixing is often uneven due to density differences between fresh and salt water. As a result, virtually all estuaries exhibit density stratification to some extent, where denser saltier water flows upstream along the bottom, while freshwater flows downstream along the surface. **Figure 3.3** graphically illustrates this phenomenon.

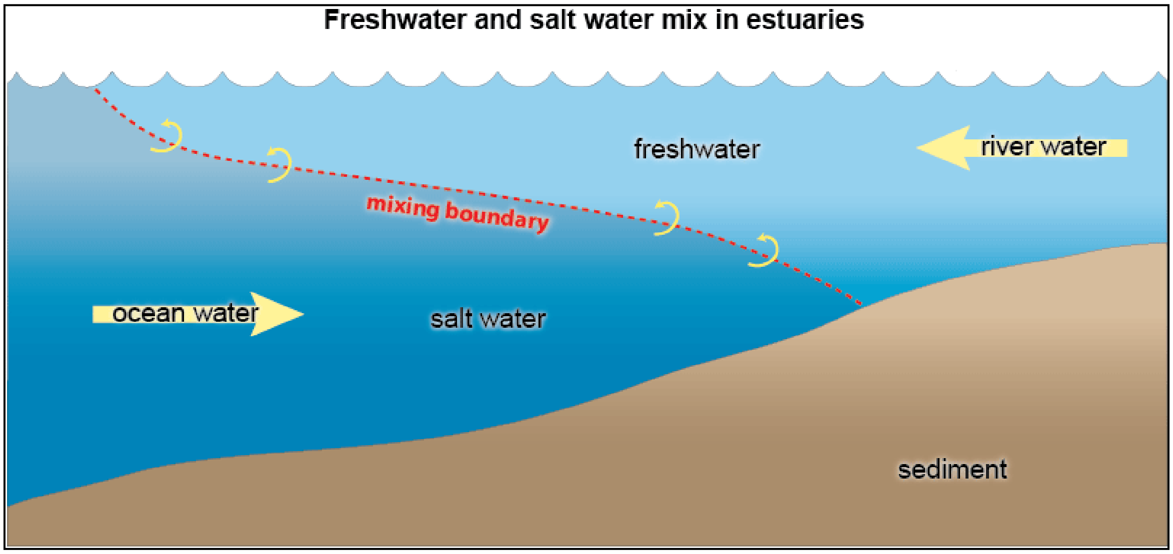


Figure 3.3 Graphic depiction of estuarine mixing and stratification

This stratification often prevents efficient chemical mixing between the fresh and salt water layers, which is normally not a problem. However, if there is too much bacterial respiration occurring in the bottom sediments due to the breakdown of excessive organic production (e.g., algae blooms; dissolved and particulate organic matter), stratification can result in dissolved oxygen deficits which in turn can adversely impact living resources such as fish and shellfish.

Data collected by ADEM as part of their long-term monitoring program indicates that Bayou La Batre Estuary does exhibit density stratification, primarily during lower river flows, as shown in **Figure 3.4**.

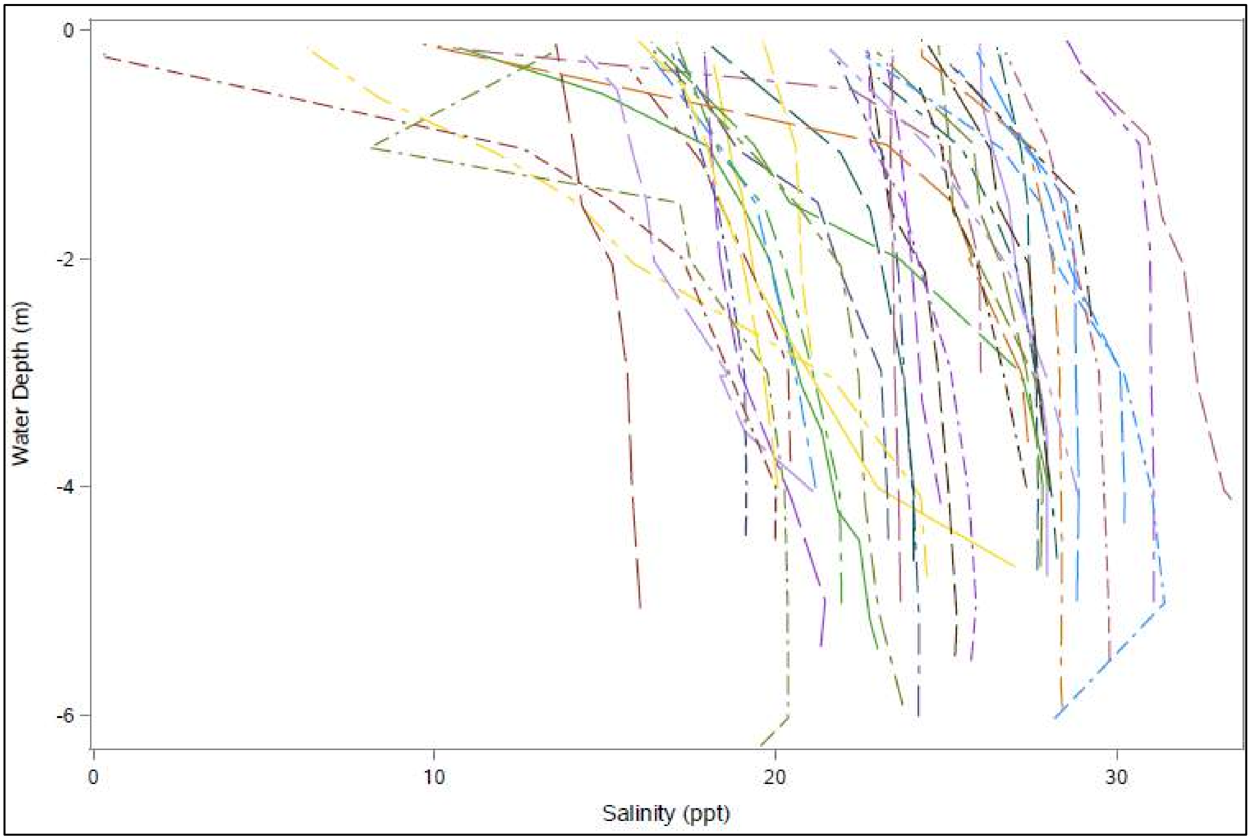


Figure 3.4 Increasing salinity with water depth profiles in the Bayou La Batre Estuary (Station BLB-1). Line color and symbology represents independent sampling dates. Source: ADEM

Unfortunately, this stratification also results in significant dissolved oxygen deficits along the bottom as shown in **Figure 3.5**. As noted above, such dissolved oxygen deficits result from excessive bacterial respiration along the bottom, which is indicative of the delivery of excessive organic matter from the freshwater river and/or excessive algal production within the tidal estuary itself. Estuarine algal production in turn is a function of nutrients delivered to an estuary from freshwater rivers, with nitrogen and phosphorus being the most important.

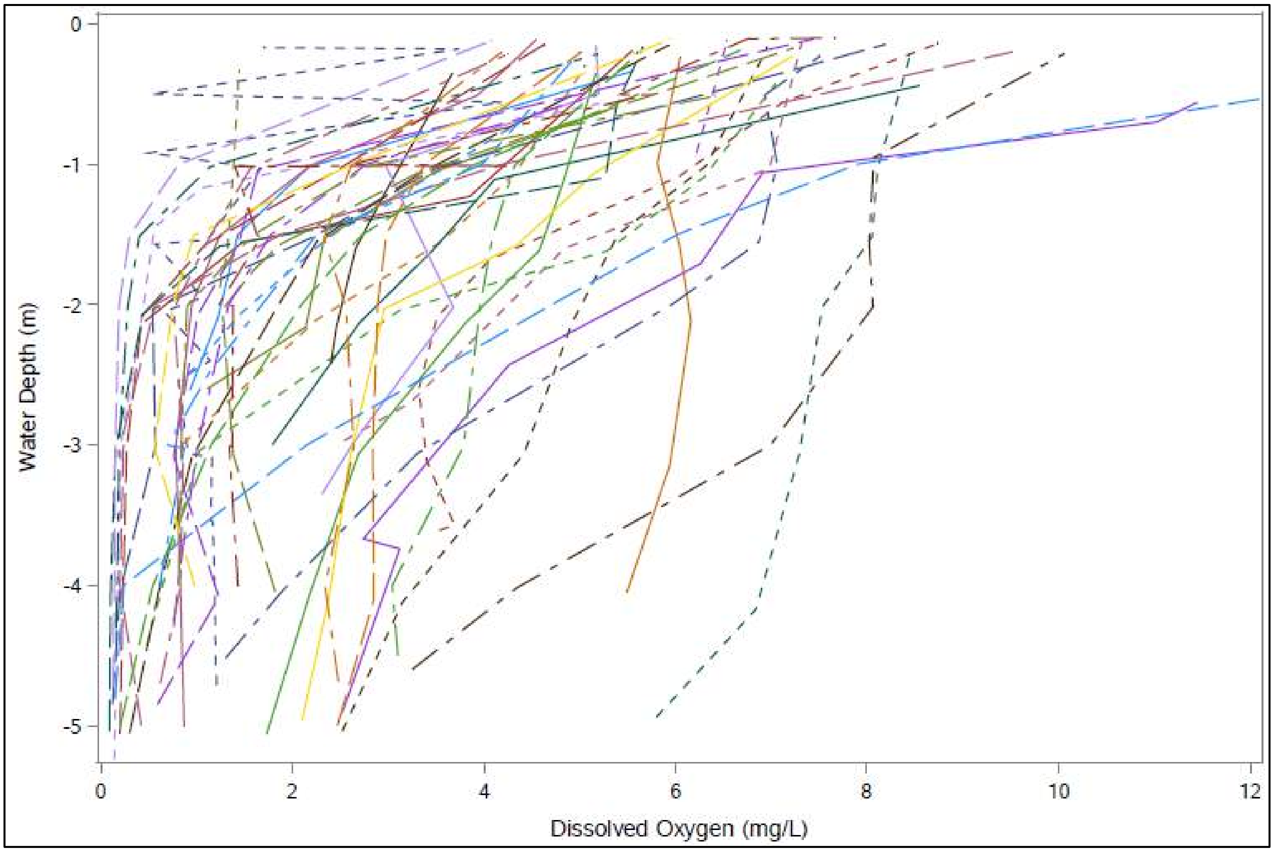


Figure 3.5 Decreasing dissolved oxygen with water depth profiles in the Bayou La Batre Estuary (Station BLB-1). Line color and symbology represents independent sampling dates. Source: ADEM

The U.S. Environmental Protection Agency (EPA) has developed national and regional criteria for estuarine trophic parameters, which can be used as an index of general estuarine health as well as comparative measures between different estuaries (EPA 2012). With regard to nutrients, EPA has developed criteria for dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP), as these forms are the most readily available to phytoplankton (e.g., algae). ADEM on the other hand has developed criteria for total nitrogen (e.g., both particulate and dissolved forms) and total phosphorus. **Table 3.2** shows estuarine trophic criteria developed by both EPA and ADEM.

As part of this study, surface water quality data from ADEM were plotted with respect to the above criteria (**see Appendix A**). With regard to nutrients, the data indicated that nitrogen concentrations delivered to the Bayou La Batre Estuary are potentially problematic, as shown in **Figures 3.6** and **3.7** for total nitrogen and dissolved inorganic nitrogen, respectively. A similar trend was evident in the recent DISL dissolved inorganic nitrogen data collected to better inform the development of the WMP (**Figure 3.8**). Similarly, total phosphorus and dissolved inorganic phosphorus were elevated when compared to the EPA criteria (**Figures 3.9 and 3.10**).

A correlation evaluation between total nitrogen or total phosphorus and algal production (measured in terms of the concentrations of chlorophyll-a, the primary photosynthetic pigment contained in phytoplankton cells) provided insight regarding the "limiting nutrient" within the Bayou La Batre Estuary. A significant direct correlation between total nitrogen and chlorophyll-a was evident (p=<0.0001). No correlation was found between phosphorus and chlorophyll-a. As such, nitrogen was identified as the parameter of concerns in terms of mitigating phytoplankton production.

Table 3.2 Applicable estuarine trophic criteria for the Bayou La Batre River

Parameter	Units	Good	Fair	Poor	Source
Total N	mg/l	0.4	0.4-0.8	>0.9	ADEM 2008
DIN	mg/l	0.1	0.1-0.5	>0.5	EPA 2012
Total P	mg/l	0.02	0.02-0.04	>0.04	ADEM 2008
DIP	mg/l	0.01	0.01-0.05	>0.05	EPA 2012
Chlorophyll-a	µg/l	5	5-20	>20	EPA 2012
Water clarity	%	>10	5-10	<5%	EPA 2012
DO (bottom waters)	mg/l	5	2-5	<2	EPA 2012

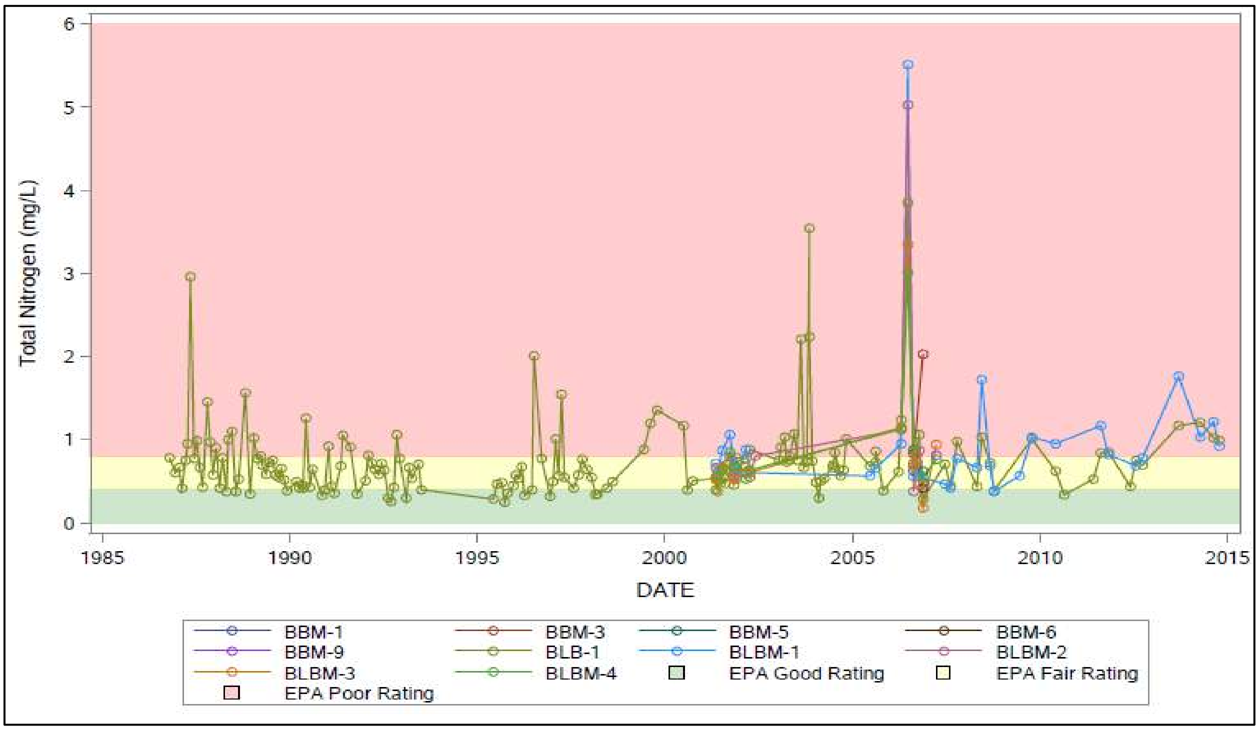


Figure 3.6 Time series of total N concentrations in Bayou La Batre with EPA criteria. Line color and symbology represents independent sampling stations. Source: ADEM

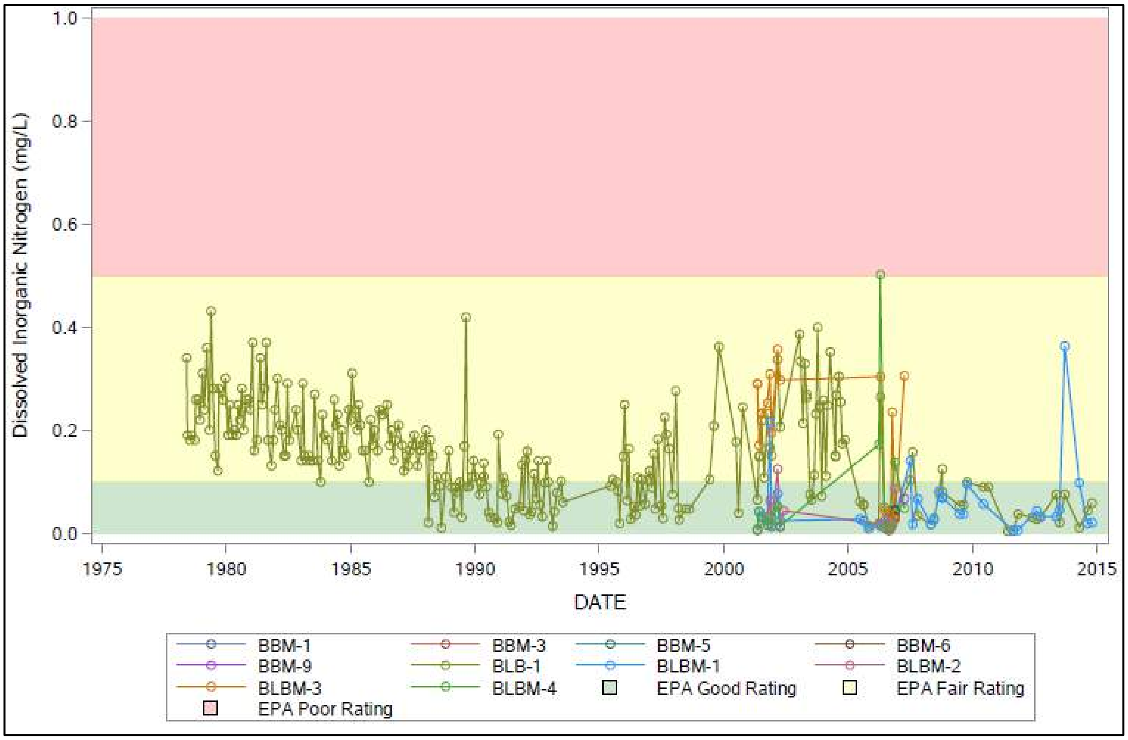


Figure 3.7 Time series of dissolved inorganic N concentrations in Bayou La Batre with EPA Criteria. Line color and symbology represents independent sampling stations. Source: ADEM

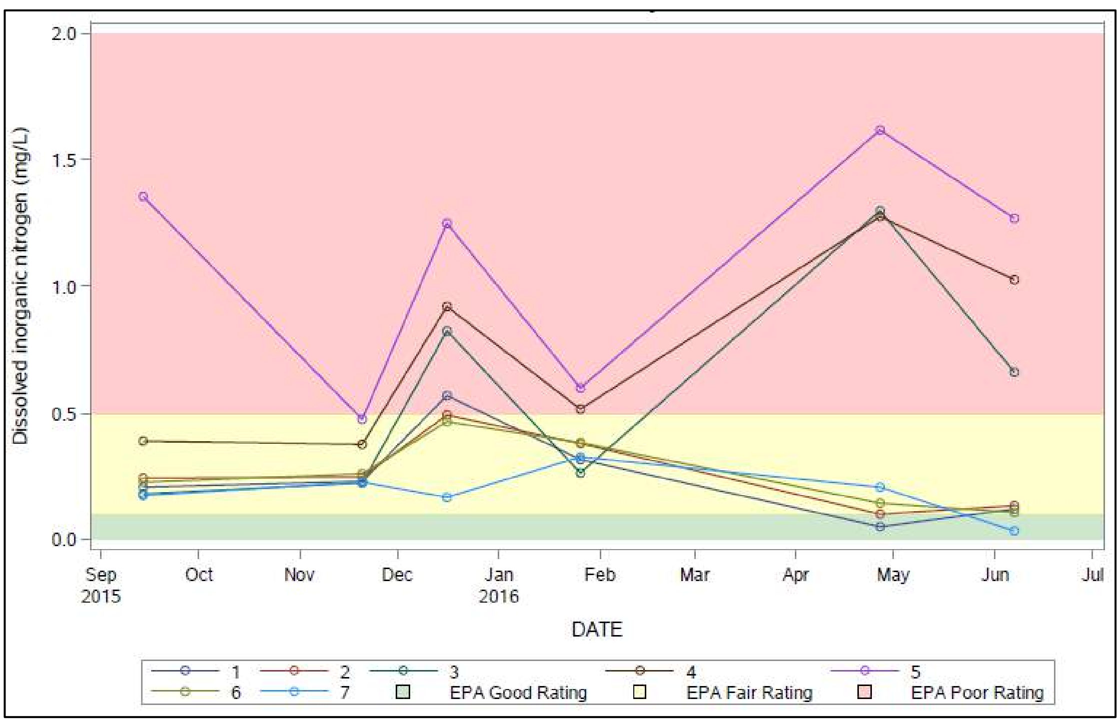


Figure 3.8 DISL recent dissolved inorganic N concentrations in Bayou La Batre with EPA Criteria. Line color and symbology represents independent sampling stations. Source: DISL

Figure 3.9 Time series of total P concentrations in Bayou La Batre with EPA criteria. Line color and symbology represents independent sampling stations. Source: ADEM

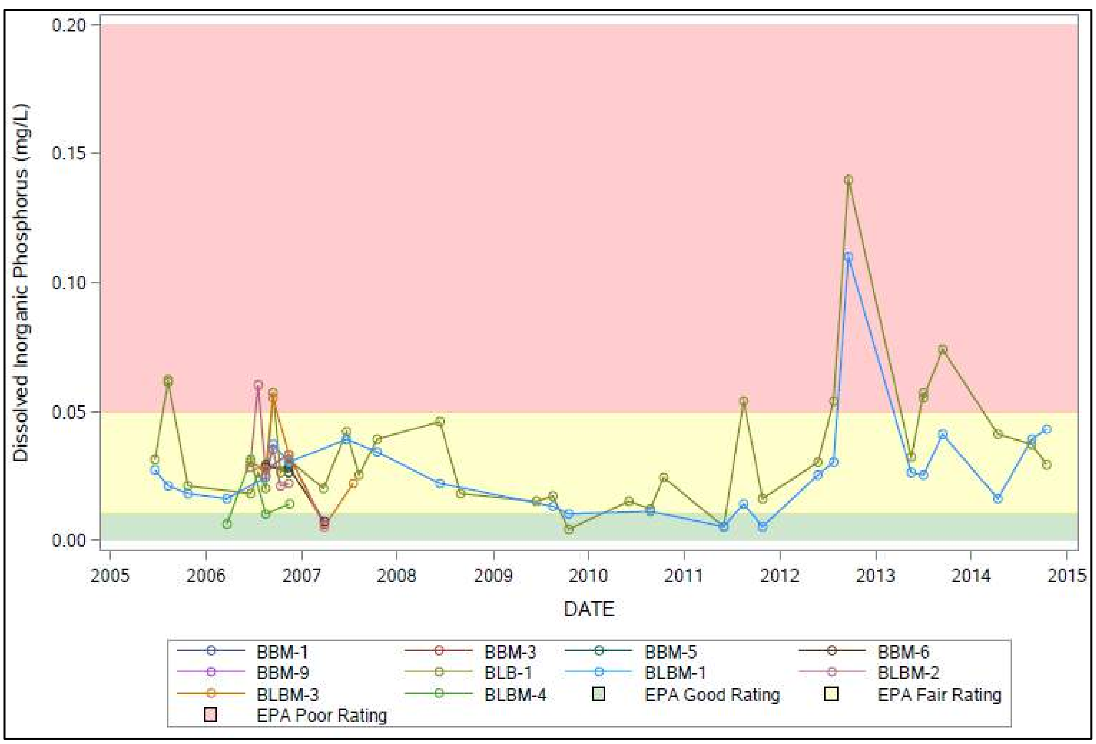


Figure 3.10 Time series of dissolved inorganic P concentrations in Bayou La Batre with EPA Criteria. Line color and symbology represents independent sampling stations. Source: ADEM

While nutrient concentrations delivered to the Bayou La Batre Estuary appear to be enriched, excessive algal production was episodic and not chronic. As shown in **Figure 3.11**, chlorophyll-a concentrations in the Bayou La Batre Estuary have remained in the "good" or "fair" rating in recent years, with a possible improving trend. Tree shade and tannins in the river water may reduce water clarity and the ability of phytoplankton to assimilate and photosynthesize available nutrients. A review of the total suspended solids (TSS) and particulate organic material (POM) data, collected by DISL, indicates that on average the proportion of TSS due to organic matter is about 80% which is considerable greater than the 20% to 50% ratio reported for the East Coast (Meade 1978). The water clarity in Bayou La Batre (as measured by Secchi Depth) is approximately 1 meter. A reduction in water clarity is likely contributed by the elevated particulate organic matter in the water column which moderates the assimilation of inorganic nutrients by phytoplankton. The elevated POM could be explained by the salting out of dissolved organic compounds by increasing salinities (4 to 16 ppt). Sufficient data are not available to determine the exact proportion between sediment and colloidal suspensions which could be used to inform potential corrective actions.

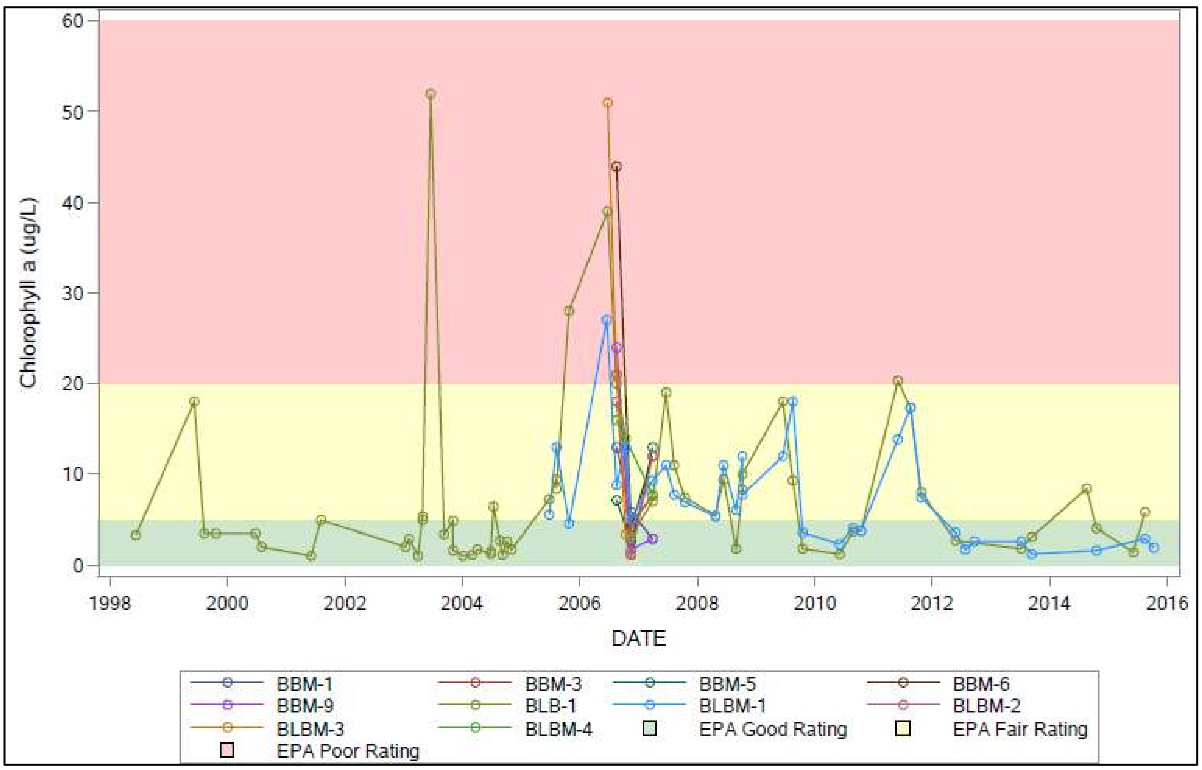


Figure 3.11 Time series of chlorophyll-a concentrations in Bayou la Batre with EPA criteria. Line color and symbology represents independent sampling stations. Source: ADEM

As discussed above, the bacterial breakdown of excessive organic matter along the bottom during periods of density stratification can lead to dissolved oxygen deficits (Turner *et al.* 2006). Furthermore, excessive algal production during daylight hours can result in supersaturated dissolved oxygen concentrations. Therefore, a typical signature of water bodies with enriched nutrient and/or organic inputs are wide fluctuations in dissolved oxygen concentrations. **Figures 3.12** and **3.13** show this pattern in bottom dissolved oxygen concentrations in both ADEM and DISL data.

While the Bayou La Batre Estuary does appear to be somewhat enriched with regard to nutrients and total organic carbon inputs, it does not exhibit excessive algal production, as measured by chlorophyll-a concentrations (**Figure 3.14**). It is possible that algal production is limited by water column light extinction from color and/or turbidity; however, secchi depth and light attenuation data indicate sufficient light to 2 meters.

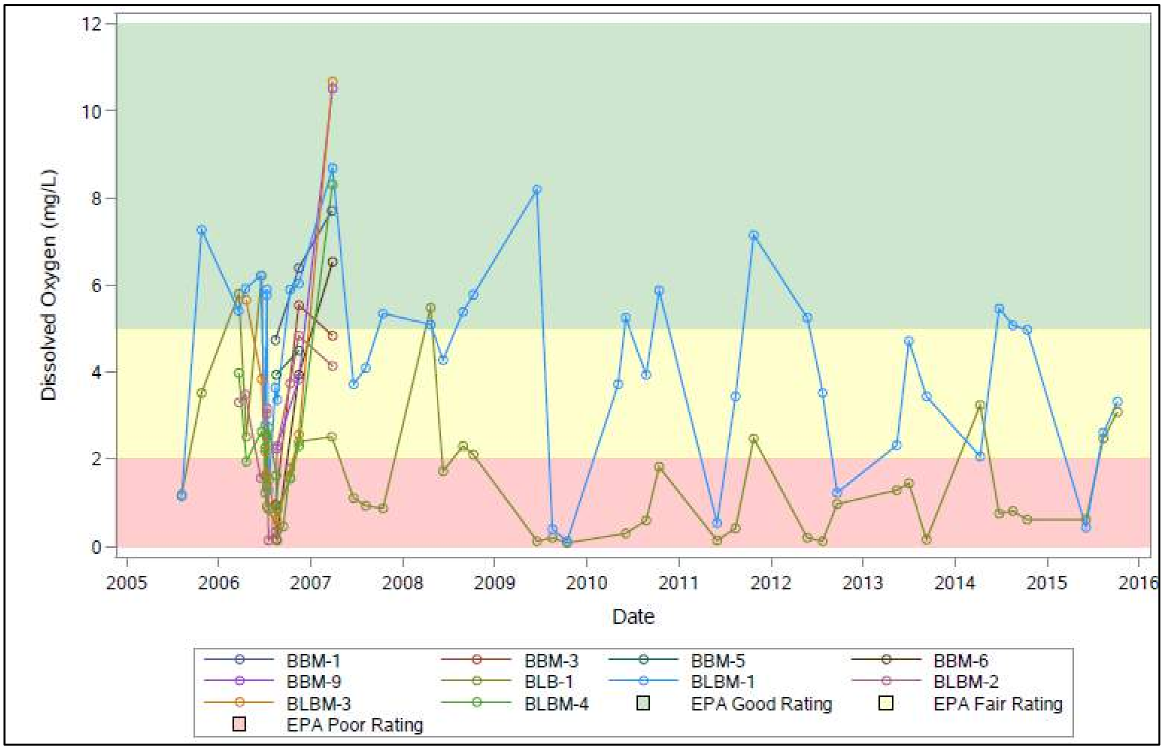


Figure 3.12 Time series of bottom dissolved oxygen concentrations in Bayou La Batre with EPA Criteria. Line color and symbology represents independent sampling stations. Source: ADEM

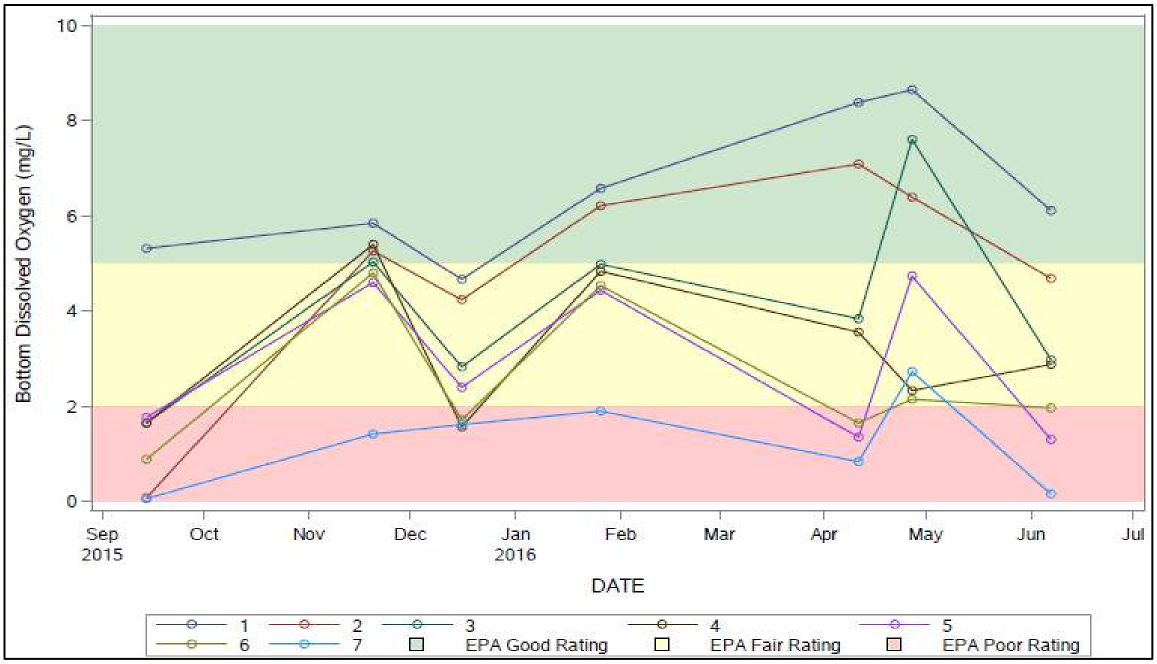


Figure 3.13 Time series of bottom dissolved oxygen concentrations in Bayou la Batre with EPA Criteria. Line color and symbology represents independent sampling stations. Source: DISL

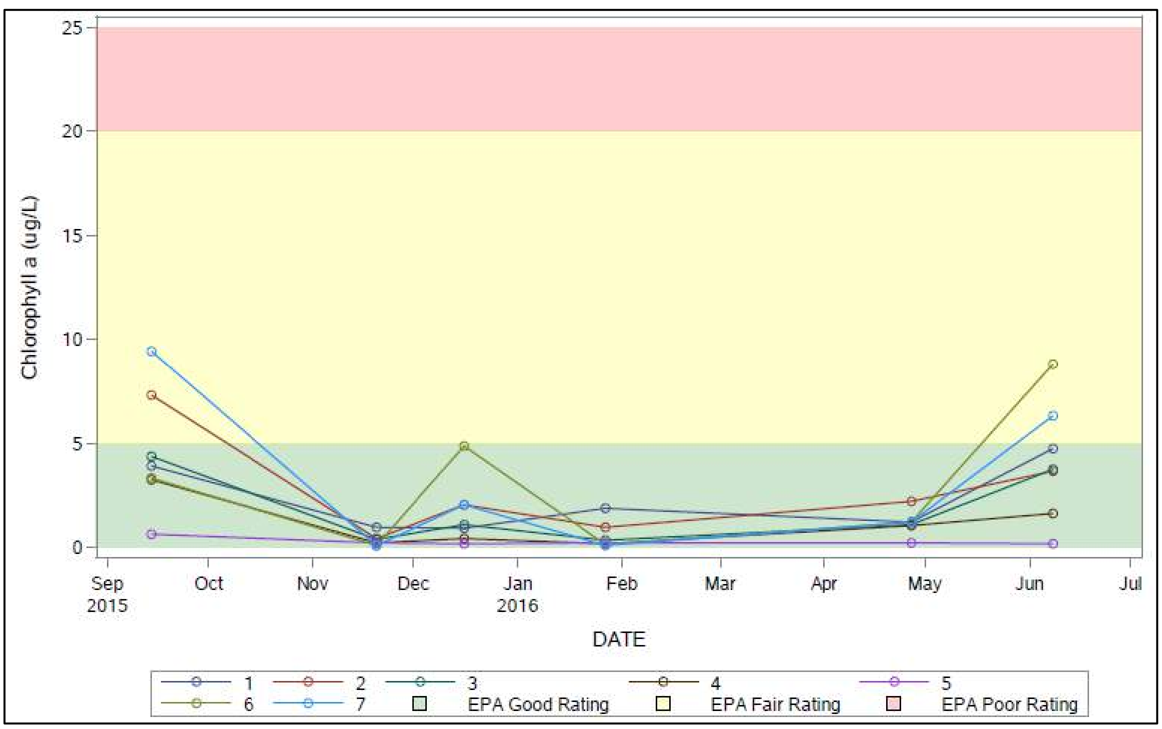


Figure 3.14 Time series of chlorophyll-a concentrations in Bayou La Batre with EPA Criteria. Line color and symbology represents independent sampling stations. Source: DISL

3.1.3 Pathogens

Bacterial concentrations are used as indicators of the presence of fecal material in drinking and recreational waters, specifically *Escherichia coli* (*E. coli*) and *Enterococci* sp. (common name - enterococcus). Measured concentrations of either bacteria indicate the possible presence of other disease-causing bacteria, viruses, and protozoans. Such pathogens may pose health risks to people fishing and swimming in a waterbody. Sources of bacteria include improperly functioning wastewater treatment plants, leaking septic systems, storm water runoff, decaying animal remains, and runoff from animal manure and manure storage areas.

If pathogens are present in waterbodies they can cause adverse conditions such as cloudy water, unpleasant odors, and decreased levels of dissolved oxygen. Enterococci levels should be measured in marine and fresh waters while *E. coli* should only be measured in fresh waters. Acceptable levels of both *E. coli* and enterococci are measured in cfu (colony forming units) and commonly include both a 30-day mean and a single sample maximum. As defined by the EPA, suitable levels for enterococci in marine waters are 35 cfu/100ml for a 30-day mean and 104 – 501 cfu/100ml for a single sample, while levels in fresh water should be less than 33 cfu/100ml for a 30-day mean and 61 – 151 cfu/100 ml as a single sample reading.

An analysis of data collected by ADEM indicate that the Bayou La Batre River is periodically impaired for bacteria, as measured by enterococcus, particularly the middle segments of the River (e.g., S. Wintzell Road). In 2008, Bayou La Batre was designated as impaired for pathogens based on the samples collected by ADEM in 2006 and 2007. A Total Maximum Daily Load (TMDL) was developed to address pathogens in Bayou La Batre River calling for a 76 percent reduction in bacterial loads, largely attributed to agricultural runoff and sanitary sewer overflows (SSO), to the waterbody (ADEM 2009).

Figure 3.15 shows a time series of enterococcus concentrations along with both the Alabama coastal swimming and coastal fish and wildlife regulatory standards (104 and 275 cfu/100ml, respectively). It should be noted that bacterial concentrations in surface waters can be notoriously sporadic and variable, with occasional spikes associated with large rains events. Since there are many potential sources of bacterial pollution in surface waters it is important to clearly identify the sources of greatest concern with regard to the specific management objectives for the subject water body.

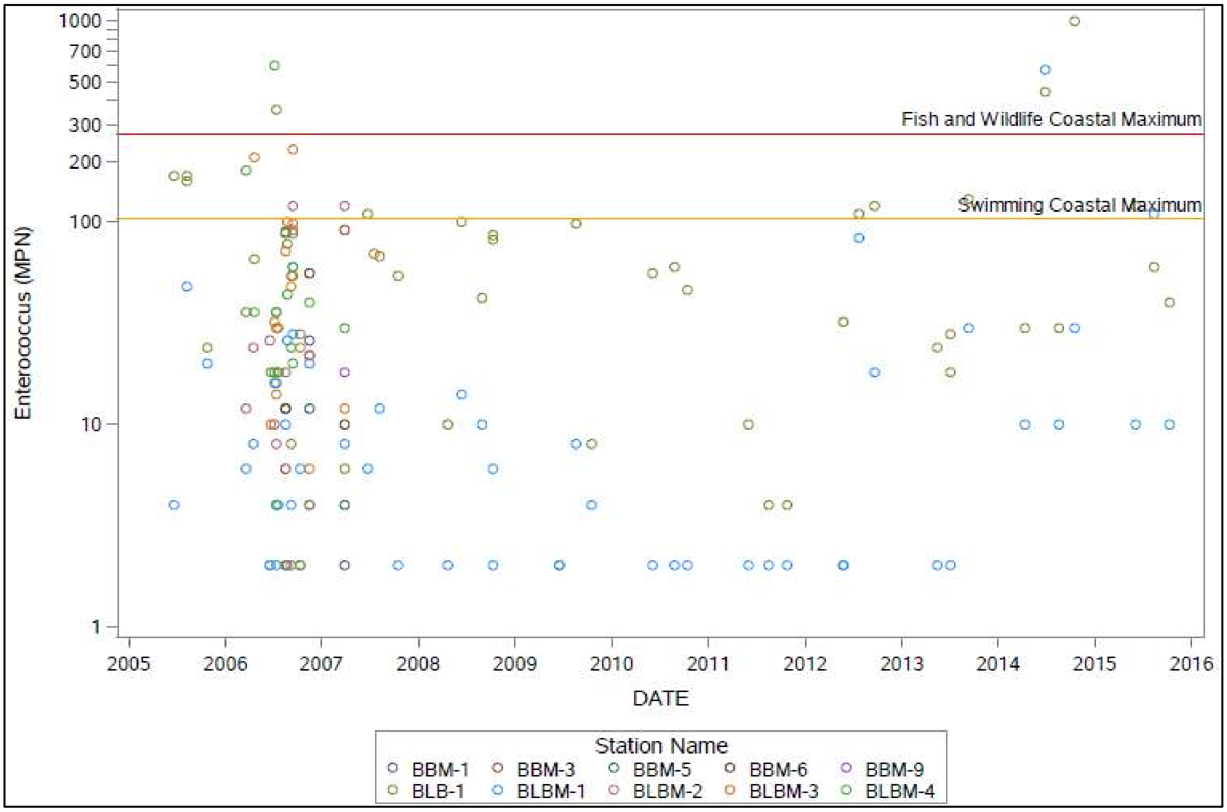


Figure 3.15 Enterococcus concentrations in the Bayou la Batre River (ADEM ambient data)

ESA conducted a microbial source tracking (MST) study in the Watershed to further investigate these impairments. The study was conducted specifically to determine if human waste was a source of the observed bacterial concentrations.

Current regulatory limits are based on counts of colony forming units (cfu) of *E. coli and Enterococcus* sp. (Enterococci). The MST methodology differs substantially from these methods. The MST methodology involves the detection and quantification of DNA from human-specific bacteria of the genus *Bacteroides*. Fecal *Bacteroides* are considered for several reasons to be a more accurate indicator of human waste pollution than are the traditional indicator organisms *E. coli* and Enterococci. First, they are more abundant in the feces of warm blooded animals than are *E. coli* and Enterococci. Second, *Bacteroides* are strict anaerobes; whereas *E. coli* and Enterococci are facultative anaerobes and as such are able to proliferate in soil and sediments. Therefore, the presence of *Bacteroides* in surface waters is a strong indicator of fecal contamination. Finally, certain strains of the *Bacteroides* genus such as *B. dorei* have been found to be specific to humans, and as such can be used as very reliable indicators of human fecal contamination.

The MST methodology avoids the randomness effect of culturing and selecting bacterial isolates by filtering the entire portion of a water sample for *Bacteroides*. This is an advantage for highly contaminated water systems with known potential multiple sources of fecal contamination. Next, the methodology uses quantitative PCR (qPCR) DNA technology to determine the presence of human gene biomarkers from human-specific strains of *Bacteroides*. The methodology is considered to be much more definitive than traditional methods in terms of determining the presence of human fecal contamination in surface waters.

For the Bayou La Batre River MST study, surface water samples were collected during a period between rain events on December 16, 2015, from five locations along the River's main stem including (**Figure 3.2**):

- Bayou La Batre River 0.5 mi. upstream of Wintzell Bridge
- Bayou La Batre River 200 ft. downstream of Wintzell Bridge
- Bayou La Batre River 0.5 mi. downstream of Wintzell Bridge
- Bayou La Batre River between Cain St. and Faith St.
- Bayou La Batre Estuary entrance at Portersville Bay.

Bayou La Batre River samples were sent via overnight delivery to Source Molecular in Miami, FL for MST analysis. Samples were analyzed for two *Bacteroides* human gene biomarkers to improve the confidence in the results. In addition, for comparison with regulatory criteria and associated methods, the samples were also analyzed for Enterococcus, *E.coli* and Fecal Coliform bacteria. The results are shown in **Table 3.3**. These results indicate that there are low levels of bacteria present in Bayou La Batre River surface waters at the time of sampling, additionally there is evidence that the sources of those bacteria included human fecal waste. While human markers were detected at four of the sampling locations, the analysis performed provided a qualitative rather than quantitative determination. As such, the percentage of bacteria due to a human source is unknown and additional studies should be completed to further assess potential bacteria contributions to the watershed from both human and other sources.

Table 3.3 Summary of Bayou La Batre River MST study results

Station Indicator	1	2	3	4	5
E. coli (cfu/100mL)	1,414	613	>2,420	>2,420	1,414
Enterococci sp. (cfu/100mL)	108	142	192	488	24
Fecal Coliform (cfu/100mL)	44	42	49	13	2
Human Bacteroides ID-1 (Dorei)	Trace	Present	Present	Present	Absent
Human Bacteroides ID-2 (EPA)	Absent	Trace	Present	Trace	Absent

The advancement of MST technology has allowed the range of species-specific DNA indicators to increase. It is now possible to analyze water samples for indicators of fecal waste from cattle, horses, pigs, dogs, deer, and various species of birds. However, given the commercial facilities and reported SSOs located along the Bayou La Batre River, the MST study focused on human fecal waste indicators because they are best correlated with human pathogens and threats to human health from water contact recreation. While bacteria inputs from other warm-blooded animals can be effectively addressed through best management practices (e.g., cattle exclusion from stream crossings), human wastewater infrastructure improvements typically require costly capital investments.

The Bayou La Batre River MST study was conducted during the dry season; however, the samples were collected during a period of intermittent rain events. Dry season conditions are preferred to better isolate any inflows from human wastewater infrastructure including leaking sewer lines, pump stations and septic tanks. During wet periods with higher river flows inputs from human wastewater infrastructure are typically diluted and/or masked by other inputs from storm water runoff. Despite the selection of these conditions, the Enterococcus analysis indicated concentrations exceeding the swimming coastal maximum criteria at Station 4, which is located on Bayou La Batre between Cain and Faith Street. Bacteria concentrations appear to peak downstream of Wintzell Bridge (Stations 3 and 4) and the identification of human waste was documented at Station 3 for both indicators.

3.1.4 Contaminants

As presented in **Table 3.1**, ADEM has monitored metals in the Bayou La Batre River Watershed at selected stations at the mouth of the estuary (BLB1, BLBM) and HMC-1 located along a major tributary to the River. Copper was found to exceed the acute regulatory criteria in the Bayou La Batre Estuary at site BLB-1 in October 2015. Mercury exceeded the chronic regulatory criteria at site BLBM-1 in 2010 and 2012. Copper is relatively rare and may be from local sources.

3.2 Existing Water Quality

In consideration of the information presented above, the following conclusions have been developed for the Bayou La Batre River Estuary.

- The Bayou La Batre River Estuary exhibits episodic density stratification attributed to the influence of freshwater inputs.
- The Bayou La Batre River Estuary stratification results in suppressed dissolved oxygen concentrations on the bottom which frequently drop below both regulatory and guidance criteria, potentially resulting in adverse impacts to living resources including fish and shellfish.
- Nitrogen and Phosphorus concentrations in Bayou La Batre River Estuary are elevated above guidance criteria for southeastern streams and estuaries and appear to be enriched by anthropogenic activities in the watershed. However, nutrient enrichment is apparently not assimilated into excessive algal production, as measured by chlorophyll-a concentrations.
- Nitrogen has been identified as the limiting nutrient most directly impacting phytoplankton production. However, particulate organic matter is likely contributing to light inhibition resulting in episodic phytoplankton blooms as opposed to a chronic problem.
- Bacteria concentrations in Bayou La Batre exceed applicable regulatory criteria; which has resulted in the development of a TMDL requiring a 76 % reduction of bacterial loads within the watershed. The MST study did show evidence of human fecal waste inputs to the river. However, other sources of indicator bacteria include non-human waste (i.e., cattle, wildlife) as well as decomposing vegetation.
- Bayou La Batre is relatively enriched with regard to copper and mercury, elevated copper indicate anthropogenic sources in the watershed.

- Evidence of periodic dissolved oxygen deficits could be indicative of excessive organic production. Additionally, elevated bacteria loads have been documented within the waterway. Measures to reduce both nutrient and bacterial inputs are recommended.

3.2.1 Watershed Water Quality Assessment Conclusion

Water quality conditions can vary substantially on small scales, both spatial and temporal, influenced by localized pollutant loadings, rainfall, and hydrologic alterations. After evaluating the magnitude and frequency of exceedances above or below the referenced regulatory criteria, each of the key water quality parameters were classified as “Fair”, “Good” or “Poor” to assist in prioritizing management actions (**Table 3.4**). In consideration of the information presented above, the following conclusions have been developed for the Bayou La Batre River Estuary.

Table 3.4 Relative water quality summary assessment of Bayou La Batre Watershed

Parameter Class	Bayou La Batre Watershed
Dissolved Oxygen	Fair
Chlorophll-a	Good
Nutrients	Poor
Bacteria	Fair
Metals*	Fair

3.3 Habitats and Ecosystem Services

Habitats within the Watershed are typical of those found adjacent to Mississippi Sound in the northern Gulf of Mexico. Terrestrial uplands containing varieties of pine and oaks dominate higher-ground areas and are primarily used for agricultural or residential purposes. Maritime forests consisting of primarily slash pine, saw palmetto, and wax myrtle cover the middle portion of the Watershed and transitions from forest to predominantly grasses when entering sandy areas near the coast. These habitats provide storm event/shoreline protection, critical nutrient removal, and habitat for a variety of freshwater and estuarine species.

Numerous anthropogenic activities including increased development, population growth, etc. have impacted natural habitats, native flora and fauna, as well as those migratory species that utilize the Watershed. As human interaction with the areas natural habitats and ecosystems continues to increase, the overall extent and health of these areas have deteriorated due to, amongst other factors, land use land cover change, climate change, and pollution.

Natural communities within the upper and mid-watershed have become sparse and fragmented due to the amount of development. Increased development, in combination with the mid-watersheds’ sediment composition of compacted clays, results in minimal surface water infiltration. As a result, flooding is frequent during intense rain events in those areas southwest of Carl’s Creek and north of Bayou La Batre, especially along Davenport Road.

Most of the coastal and lowland areas in the Watershed are protected by bulkheads or revetment materials, greatly impacting the establishment and growth of marsh vegetation (see **Figure 3.16**). While human activities have greatly altered the coastal environment, natural processes such as high water events, sea level rise, and wave action have also contributed to the observed changes. A more detailed analysis of shorelines in the Watershed is provided in **Section 3.5**.

Figure 3.16 Revetment materials observed along shoreline of Bayou La Batre

Increased development and human-natural community interaction has also resulted in numerous non-native species to be introduced in the Watershed (see **Figure 3.17**). A preliminary non-native species inventory conducted by Dewberry staff identified 10 non-native species in the Watershed including:

- Torpedo grass - *Panicum repens*
- Cogon grass - *Imperata cylindrica*
- Persian silk tree (Mimosa tree) - *Albizia julibrissin*
- Chinese privet - *Ligustrum sinense*
- Chinese wisteria - *Wisteria sinensis*
- Air potato - *Dioscorea bulbifera*
- Japanese honeysuckle - *Lonicera japonica*
- Phragmites - *Phragmites australis*
- Japanese climbing fern – *Lygodium japonicum*
- Golden bamboo - *Phyllostachys aurea.*

Figure 3.17 Example of cogon grass and Japanese climbing fern adjacent to a tributary of Bayou La Batre

3.4 Sea Level Rise

Rising sea level has consequences because of its potential to alter ecosystems and habitability of coastal regions as well as increased flooding and storm surge. The vulnerability of coastal areas varies with shoreline physical attributes and the amount of development. Sea level rise impacts in the coastal zone include higher and more frequent flooding, shoreline erosion, loss of wetlands and near shore coastal habitats, upward and landward migration of beaches or loss of beaches, increased near-shore wave energy, damage to coastal infrastructure, and economic impacts. Computer models, such as the Sea Levels Affecting Marshes (SLAMM) Model and Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Model, can help estimate the effects of sea level rise in a particular area.

3.4.1 SLAMM Model

The SLAMM Model was developed by the EPA to evaluate the effects of sea level rise on marsh habitats. The model maps habitat distribution over time in response to sea level rise, accretion and erosion, and freshwater influence. A complete SLAMM Report is provided in Appendix B.

3.4.1.1 SLAMM Model Inputs

The following data sources were used in determining the SLAMM model inputs:

- USGS National Elevation Dataset (1/3 arc-second resolution DEM dataset) (2013)
- National Wetlands Inventory (NWI) (2002)

- National Land Cover Database (NLCD) (2011)
- NOAA Tidal Gage (approximately 2.5 miles upstream of the mouth of the bayou)
- IPCC 2013 Report
- Callaway et al. 1997: Study of sediment accretion along low-lying sites within the Gulf of Mexico
- O'Sullivan and Criss (1995-1997): Study of linear loss of shoreline in Point au Chenes Bay

SLAMM was run with the following inputs to look at habitat evolution at Bayou La Batre under baseline conditions.

3.4.1.2 Topography and Bathymetry

Bayou La Batre is a low energy tidal creek with relatively low sediment inputs, and fairly low tidal amplitudes and current velocities. Even though the Bayou occasionally receives big freshwater inflows from major rainfall events, the flows and sediment loads are buffered by the large forested wetlands in the headwaters (**Figure 3.18**).

3.4.1.3 Vegetation

A baseline condition map of habitats in the Watershed was created by combining NWI data with a map of imperviousness (National Land Cover Database 2011) to delineate between developed and undeveloped upland (**Figure 3.19**). Vegetation was categorized into habitat types to represent those common to the Estuary and defined for different areas based on the elevation of the area relative to tidal datums (i.e., as a surrogate for the frequency of tidal inundation) and whether the area is within the zone of freshwater influence. The model uses an additional datum called the "salt elevation," which is based on the high astronomical tide (1.85 ft NAVD at Bayou La Batre Bridge). **Figure 3.20** shows the different elevation-based habitat zones used in SLAMM and include: uplands established at the highest elevations, followed by freshwater swamp and marsh, salt marsh, tidal flat, and lastly, open water habitat.

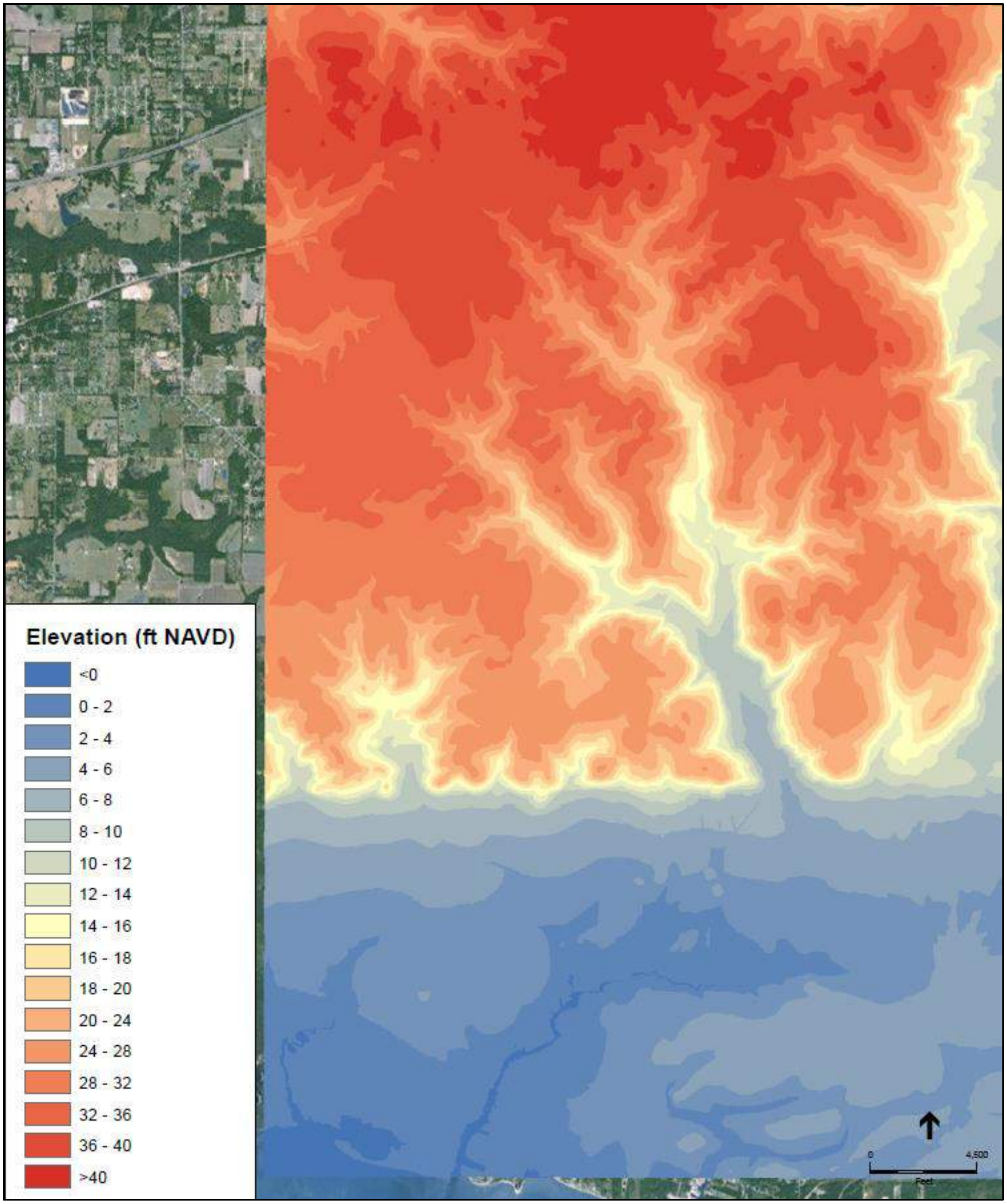


Figure 3.18 Topography and bathymetry of Bayou La Batre

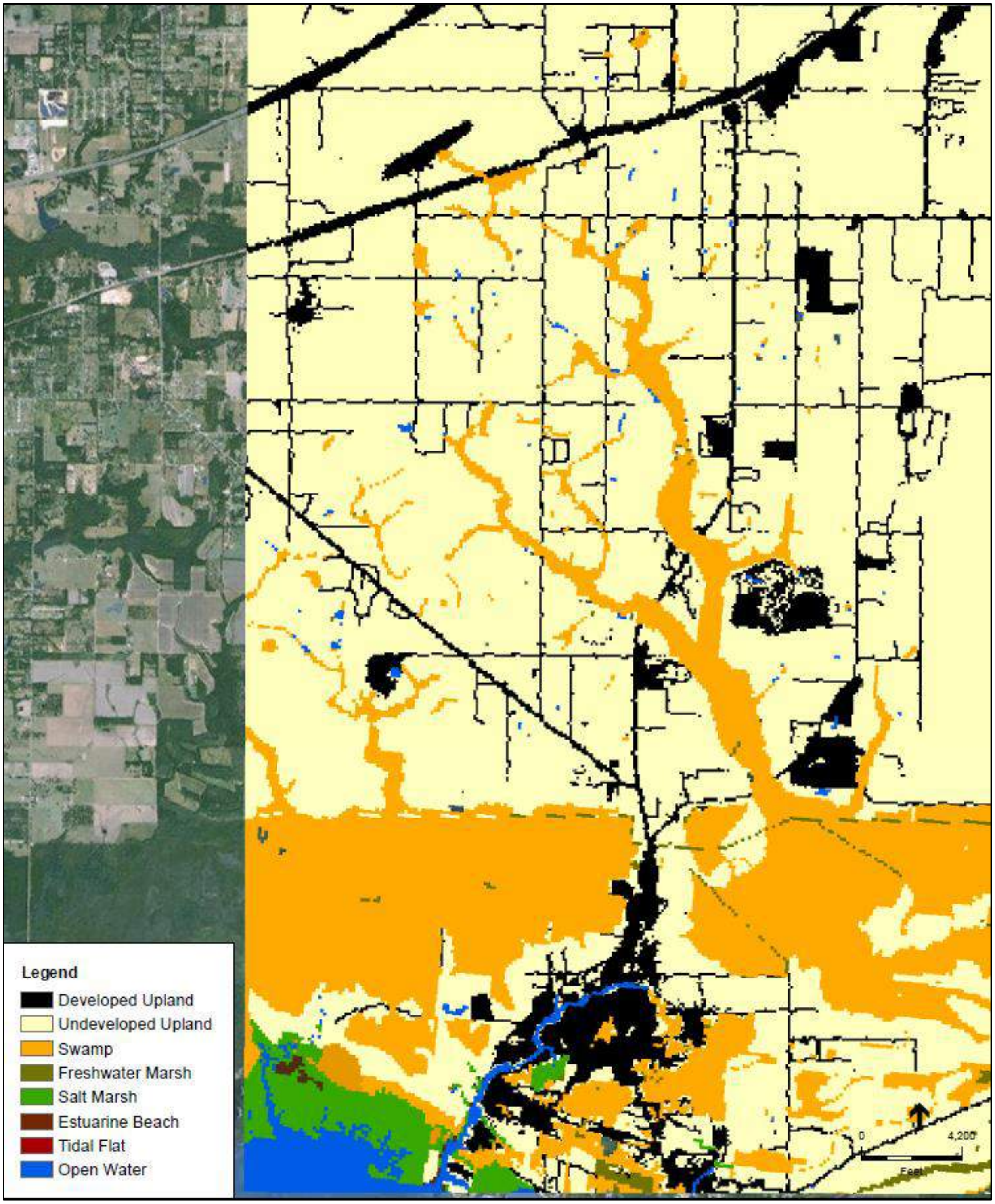


Figure 3.19 Vegetation map of Bayou La Batre

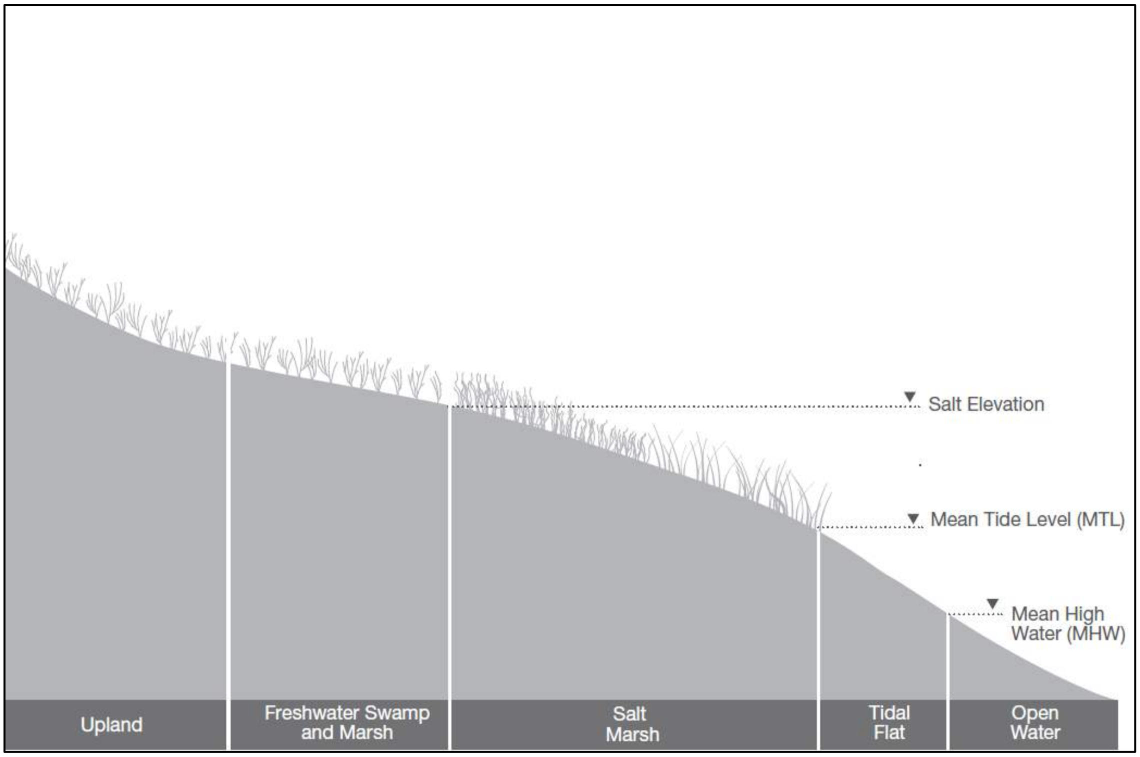


Figure 3.20 Conceptual habitat elevation zone model

3.4.1.4 Tidal Water Levels

Tides and tidal inundation within the Bayou La Batre Estuary are important processes affecting habitats, since salt marsh and intertidal habitats are established within zones corresponding to tidal inundation. The Alabama coast experiences diurnal tides that exhibit strong spring-neap variability. Tidal data for the Bayou La Batre tide gage (2.5 miles upstream of the mouth of the bayou) were utilized for the model. In addition, a "salt elevation" datum was used to set the limit between freshwater habitats. The salt elevation is set to 1.85 ft NAVD at the Bayou La Batre Bridge, based on the high astronomical tide elevation (**Table 3.5**).

Table 3.5 Tidal data used in the Bayou La Batre SLAMM model (values in feet NAVD)

Tidal Datum	Bayou La Batre Bridge[1]
Salt Elevation	1.85
MHHW	0.93
MHW	0.79
MTL	0.11
MSL	0.05
MLW	-0.56
MLLW	-0.68

1. Data from NOAA Tides and Currents

3.4.1.5 Sea Level Rise

The Intergovernmental Panel on Climate Change (IPCC 2013) provides guidance and predictions for sea level rise. These predictions for 2100 are:

- Low Emissions: 14 to 28"
- Medium Emissions: 15 to 29"
- High Emissions: 21 to 39".

The Bayou La Batre SLAMM Model was run with a low average emission of 21 inches and a high average emission of 29 inches (averages of the low range and high range values from the IPCC (2013) predictions for the 2100 prediction datum sets).

3.4.1.6 Accretion and Erosion

An accretion rate of 0.22 in/yr (0.57 m/ yr) was utilized in the model. This rate was utilized based on the similar sedimentation rates from: one sample at the upper end of the marsh and adjacent to a tidal creek (0.24 in/yr (6.1 mm/yr), O'Sullivan and Criss report in Point au Chenes Bay (eight miles west of Bayou La Batre - 22 in/yr [0.57 m/ yr]), and the Callaway et al (1997) study (conducted approximately 50 miles west, in Biloxi Bay, Mississippi - 0.22 in/yr [5.6 mm/yr]).

3.4.1.7 Freshwater Inflow

The Bayou La Batre fluvial system drains 75 square kilometers, and the average discharge is 4.9 cubic feet per second (Rodriguez *et al*. 2008). The study area includes significant areas of swamp and marsh habitats which are influenced by rainfall and freshwater flow. Thus, the analysis assumed the inflow would remain unchanged in the future based on the extent of freshwater marsh present in the estuary.

3.4.1.8 SLAMM Results

Based on both sea level rise scenarios (low and high emissions) that were included within the SLAMM Model, upland and freshwater swamp habitats are projected to be converted to saltmarsh and open water habitats. Under the low scenario, salt marsh acreage increases as upland and freshwater swamp habitat fall lower in the tidal frame (acreages shown for both low and high emissions in **Table 3.6**). Under the high scenario, an even greater area of land is converted to salt marsh. In this scenario, tidal swamps encroach on upland habitat resulting in an increase of freshwater swamps by 2100.

Figure 3.21 shows the 2100 habitat maps for low and high sea level rise scenarios. With sea level rise, much of the developed lands surrounding the Bayou will be at risk of frequent flooding. If these areas are abandoned over time through managed retreat, the model predicts these areas could convert to swamp and marsh habitat. If habitat is allowed to migrate, the model predicts a total of 79 acres of developed upland could be converted to marsh and swamp habitat.

Accretion rates show only minor differences in habitat acreages, which is not surprising based on the small range of accretion rates found in the literature. The only noticeable change between both scenarios occurred within the salt marsh category, as the frequency of inundation at the mouth of the Bayou increased, converting brackish marsh to salt marsh.

Table 3.6 Bayou La Batre habitat acreages for low and high emission rates of sea level rise at 2100 and the differences between 2002 and 2100

Habitat	Modeled Acreage in 2002	Acreage in 2100		Acreage difference 2100-2002	
		Low	High	Low	High
Developed Upland	1,554	1,491	1,474	-62	-79
Undeveloped Upland	9,444	9,418	9,397	-27	-48
Freshwater Swamp	2,935	2,933	2,948	-2	13
Freshwater Marsh	73	91	95	19	22
Salt Marsh	244	305	320	61	77
Tidal Flat	0	9	10	9	10
Estuarine Beach	12	12	12	0	0
Open Water	232	234	238	2	6

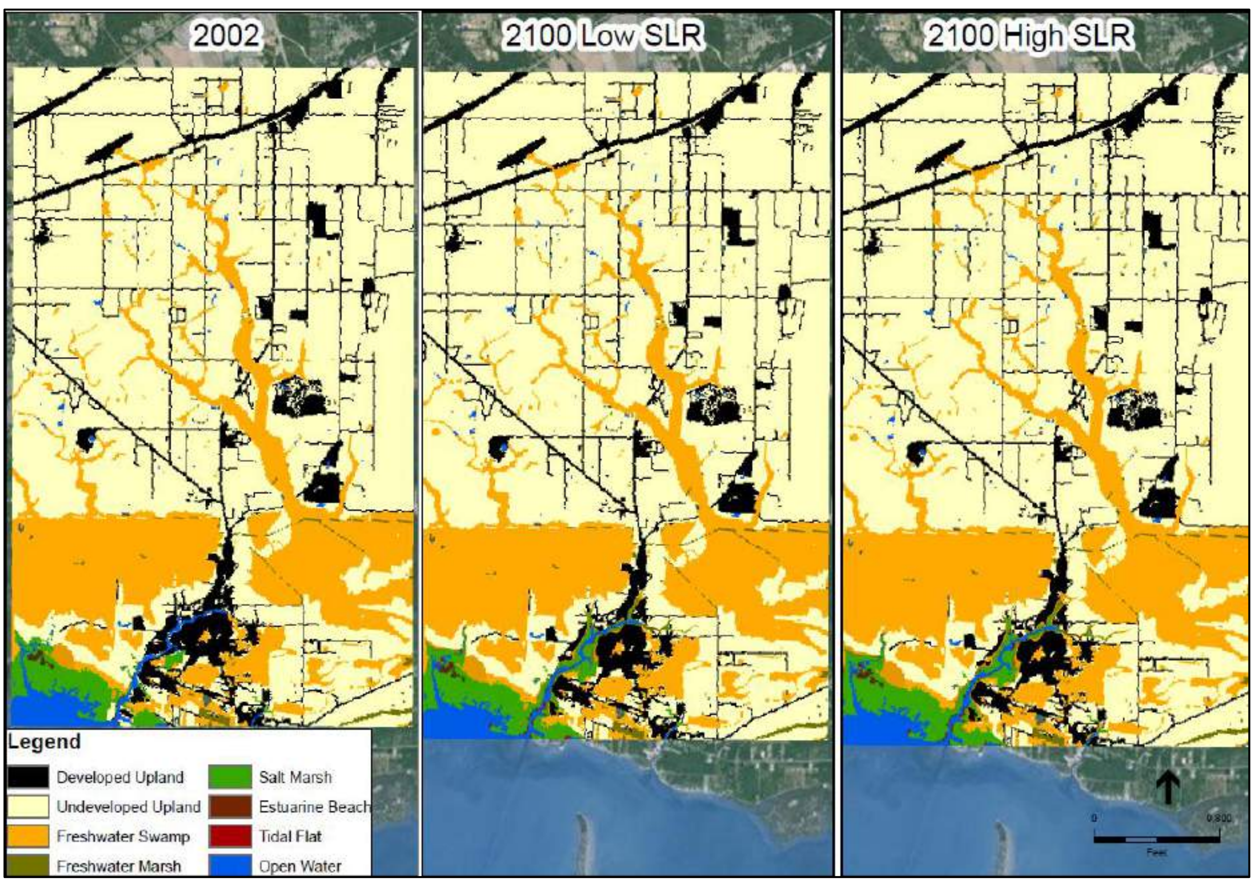


Figure 3.21 2002 modeled vegetation versus low and high sea level rise scenarios for Bayou La Batre

3.4.1.9 SLAMM Conclusions

The Bayou La Batre SLAMM model was used to simulate macro-level habitat conversions in response to sea level rise and related geomorphologic processes. With sea level rise, much of the developed lands surrounding the bayou will be at risk for frequent flooding. If these areas are abandoned over time through managed retreat, the model predicts these areas could convert to swamp and marsh habitat.

Accretion rates only affect a few habitats near the bayou. Lower accretion rates result in more inundation compared to higher accretion rates, since the topography sinks compared to the tide levels. The small difference in accretion rates could determine whether land is below or above the salt elevation and hence a saltwater or freshwater habitat. Further analysis of erosion and accretion in the area is recommended in order to validate the sedimentation assumptions.

3.4.2 SLOSH Model

The Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is a two-dimensional numerical model developed by the National Weather Service to estimate storm surge heights from historical, hypothetical, or predicted hurricanes. The model is subdivided into 34 basins covering the entire Atlantic and Gulf of Mexico shorelines, as well as Hawaii, Puerto Rico, the Virgin Islands, and the Bahamas.

For each basin, the National Hurricane Center (NHC) runs thousands of hypothetical hurricanes under different storm conditions. These runs are used to generate Maximum Envelopes of Water (MEOWs) and Maximum of MEOWs (MOMs).

MEOWs provide a worst case scenario for each category of storm, forward speed, radius of maximum wind, landfall location, and tidal levels. MOMs are considered to be the worst case scenario for each category of storm.

3.4.2.1 SLOSH Model Inputs

For Bayou La Batre, the SLOSH model used is the Mobile Bay Version 3 (EMO2), developed by the NHC in 2008. The Category 3 MOM with an initial tidal level of 1.4 feet was used for this scenario. Storm surge elevations are in the North American Vertical Datum of 1988 (NAVD88).

3.4.2.2 Sea Level Rise Scenarios

The Bayou La Batre Sea Level Rise (SLR) scenarios are based on the ongoing NOAA-funded and aforementioned research *Ecological Effects of SLR in the Gulf of Mexico*. For this study, Global SLR Scenarios for the United States National Climate Assessment (2012) were used and three scenarios were modeled including intermediate-low, intermediate-high, and highest.

3.4.2.3 Digital Elevation Model

The digital elevation model used for the SLOSH analysis was the Coastal National Elevation Database (CoNED) from the U.S. Geological Survey (USGS) (https://lta.cr.usgs.gov/coned_tbdem). The CoNED dataset integrates various sources of both topographic and bathymetric data into a seamless product with a common horizontal and vertical datum (NAD83 and NAVD88, respectively). As such, the vertical and horizontal accuracies vary between datasets, but this product is determined to be the best available topographic data for the study area.

3.4.2.4 SLOSH Model

Storm surge data from the EMO_2 basin were exported from the SLOSH display program and imported into ArcGIS. Centroids of the SLOSH grids were exported to an ESRI point shapefile. Points lying outside of the Bayou La Batre HUC 12 basin were removed from the data set. A water surface was created from the centroids using the Inverse Distance Weighting (IDW) tool within ArcGIS. The methodology of using IDW for water surface creation from SLOSH is common practice and documented by FEMA.

In order to model the anticipated sea level rise scenarios, the increased sea levels from the highest (6.6 feet), intermediate-high (3.9 feet) and intermediate-low (1.6 feet) scenarios were added to the storm surge heights and water surfaces were created from these. To determine the inland extent of flooding, the water depth was determined by subtracting the ground elevation from the water surfaces.

3.4.2.5 SLOSH Results

Figure 3.22 depicts the extent of combined SLOSH and SLR inundation under each scenario (intermediate-low, intermediate-high and highest). A category 3 hurricane storm surge affects 963 buildings within the study area including residential, commercial, and retail properties (**Figure 3.23**). The intermediate-low scenario inundates an additional 183 buildings, intermediate-high scenario an additional 79 buildings, and the highest scenario inundates an additional 70 buildings.

In addition to buildings, a category 3 hurricane storm surge affects 190 roads within the Watershed including major road corridors such as 188 (Wintzell Avenue) and Padgett Switch Road. The intermediate-low, intermediate-high, and highest scenarios include an additional 19, 6, and 21 roads, respectively. While the determination of exact flooding depths is not available for roadways, the potential to have these roads impassable during storm events is a major concern. State road 188 and Padgett Switch road serve as evacuation routes and are connections to local emergency facilities. Of a greater concern are the emergency facilities themselves, of which the Mostellar Medical Center, Bayou La Batre Fire Department, Irvington Fire Department, and the Bayou la Batre Police Department are all projected to be impacted by flooding or restricted access from storm surge.

The habitat and water quality changes that may occur due to the increased inundation depths from a category 3 hurricane include:

- Increased depth of flooding from extreme events will put more land areas at risk further threatening the stability of soils and foundational materials. This would increase the sediment loads and associated pollutant loadings (i.e. heavy metals), increased nutrients, and Biochemical Oxygen Demand (BOD) from increased organic debris to the bayou and its tributaries.

- Increased depth of flooding from extreme events will put new land areas at risk increasing the frequency of SSO leading to higher pathogen loads entering the Bayou and its tributaries.

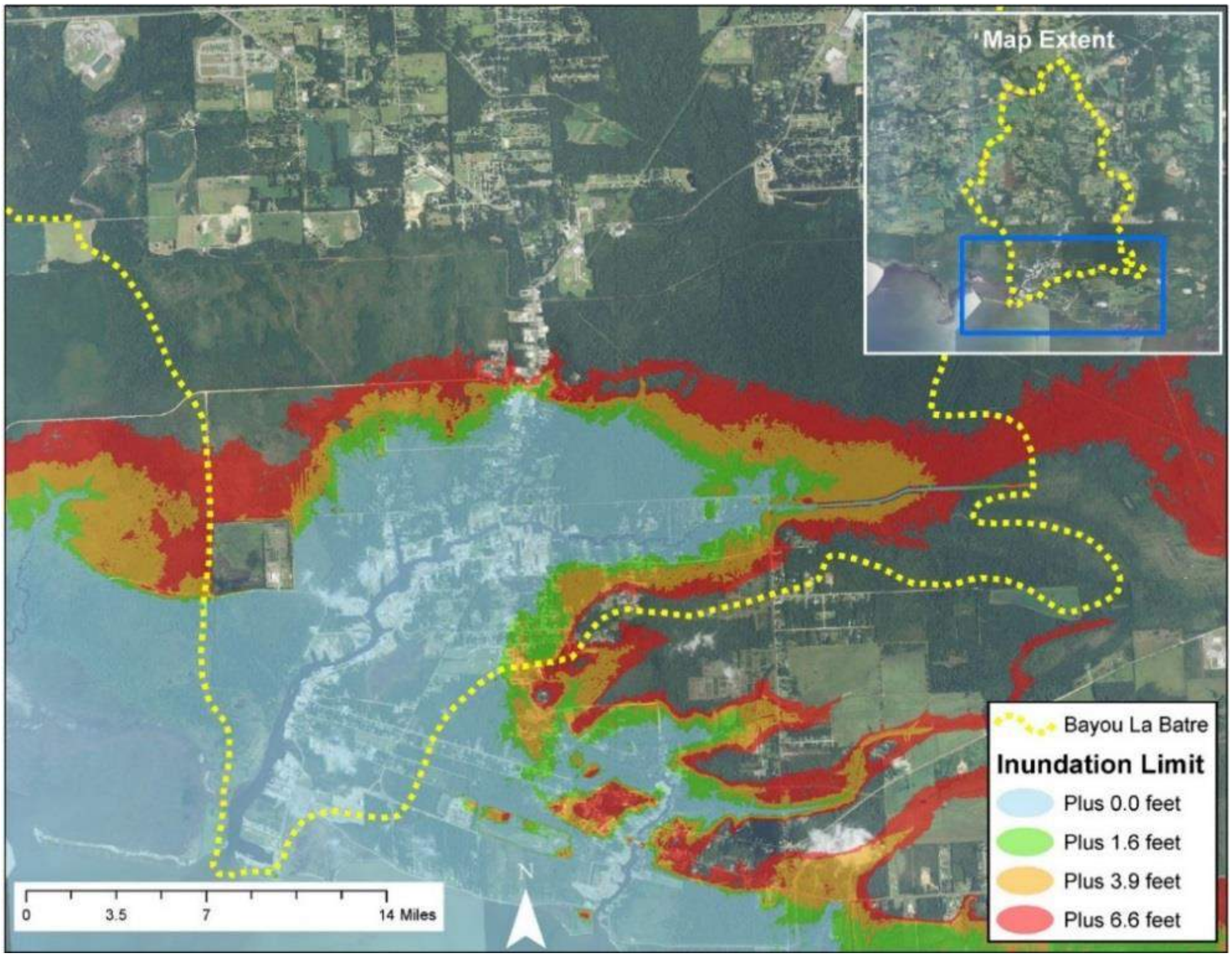


Figure 3.22 Depth grid showing SLR scenarios and Category 3 storm surge

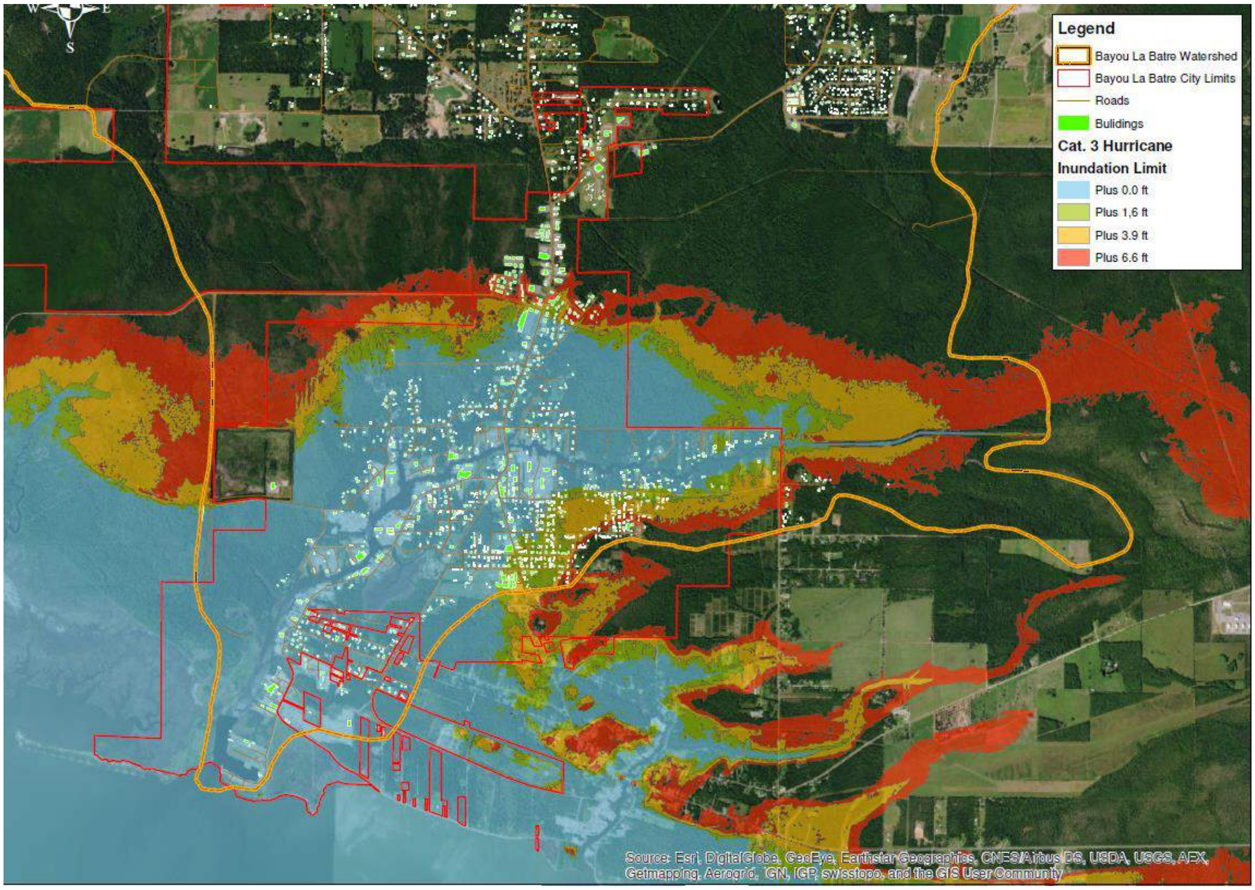


Figure 3.23 Depth grid showing SLR scenarios and Category 3 storm surge including roads and buildings

3.5 Shorelines

There are some previous studies and existing data regarding characterization of shorelines, historic shoreline positions, and coastal processes within, or very near to, the Watershed. The primary shorelines of concern in this study are those along the main stem of the bayou (along the channel and up into the stream), and those adjacent to the mouth of the navigation channel.

A comprehensive characterization of watershed shoreline type and condition was performed by the Geological Survey of Alabama (Jones & Tidwell 2012). That report documents the lengths and percentages (of total shoreline) of shore protection and shoreline type along the main channel of Bayou La Batre and also along Portersville Bay, among many other areas of south Alabama. These data are presented photographically in a GIS-type format and also tabulated. Also shown in the figures are the locations of private and public boat launches.

While no published reports on shoreline position and/or shoreline change were found during this study, a number of existing data sets are available and can be used to describe changes in shoreline position over time. Such data sets include digitized shorelines available from the National Geodetic Survey and aerial photography from which shorelines can be digitized.

There is comparatively little existing information regarding the coastal processes within the bayou itself, but that is to be expected given its size and limited fetch. The primary wave action within the bayou is certainly related to its frequent boat traffic. There is, however, some information about the coastal processes of Mississippi Sound and more specifically the area of Portersville Bay adjacent to the mouth of the bayou. In their feasibility report on navigation improvements, the US Army Corps of Engineers (USACE 1988) generally describes the coastal processes and major shoreline changes within Portersville Bay during the 1900s. More recently, South Coast Engineers performed a coastal processes study as part of the Little Bay restoration project that was constructed immediately west of the mouth of the bayou in 2009/2010 (Douglass *et al.* 2012). DISL has performed extensive physical and biological monitoring of that project since its construction (Sharma *et al.* 2016).

3.5.1 Existing Data

Shoreline position data are typically derived from old surveys, nautical charts, and aerial photography of acceptable resolution, or a combination thereof. The National Geodetic Survey's National Shoreline Data Explorer is an online repository of shoreline position data, some of which is provided in vector format for viewing in GIS software. An example of such data is provided in **Figure 3.24**, which shows the shoreline positions of 1916, 1958, and 1987 using vector shoreline data, and in 2013 by aerial imagery. Additional shoreline positions were not developed for this study, but they could be digitized using any aerial imagery of acceptable resolution. A listing of available vector shorelines and suitable aerial imagery for this study area is provided in **Table 3.7**

Table 3.7 List of existing shoreline position and aerial imagery data

Year	Type	Source
1916	Vector Shoreline	https://www.ngs.noaa.gov/NSDE/
1940	Aerial Photography	http://alabamamaps.ua.edu/aerials/
1945	Vector Shoreline	https://www.ngs.noaa.gov/NSDE/
1950	Aerial Photography	http://alabamamaps.ua.edu/aerials/
1958	Vector Shoreline	https://www.ngs.noaa.gov/NSDE/
1987	Vector Shoreline	https://www.ngs.noaa.gov/NSDE/
1997	Aerial Photography	Google Earth
2006	Aerial Photography	Google Earth
2007	Aerial Photography	Google Earth
2008	Aerial Photography	Google Earth
2010	Aerial Photography	Google Earth
2011	Aerial Photography	Google Earth
2012	Aerial Photography	Google Earth
2013	Aerial Photography	Google Earth
2015	Aerial Photography	Google Earth
2015	Vector Shoreline	https://www.ngs.noaa.gov/NSDE/

3.5.2 Shoreline Conditions

The current shoreline conditions are best summarized in a GSA report by Jones & Tidwell (2012). In that report, lengths and percentages of the overall shoreline are tabulated in terms of shore protection type and shoreline composition.

Nearly 80,000 feet of shoreline within the Watershed were assessed as part of the Jones & Tidwell (2012) study. A graphical representation of shore protection types and private/public boat launches is shown in **Figure 3.25**. While approximately 40% of the Bayou La Batre shoreline can be classified as natural and/or unretained, much of it is confined to the upper reaches of the watershed where the channels narrow considerably. There is one contiguous stretch of natural, marsh shoreline along the western bank of the channel extending from the mouth of the bayou to approximately 1 mi north. Otherwise, the shoreline is mostly protected by bulkheads or revetment materials as demonstrated in **Table 3.8**.

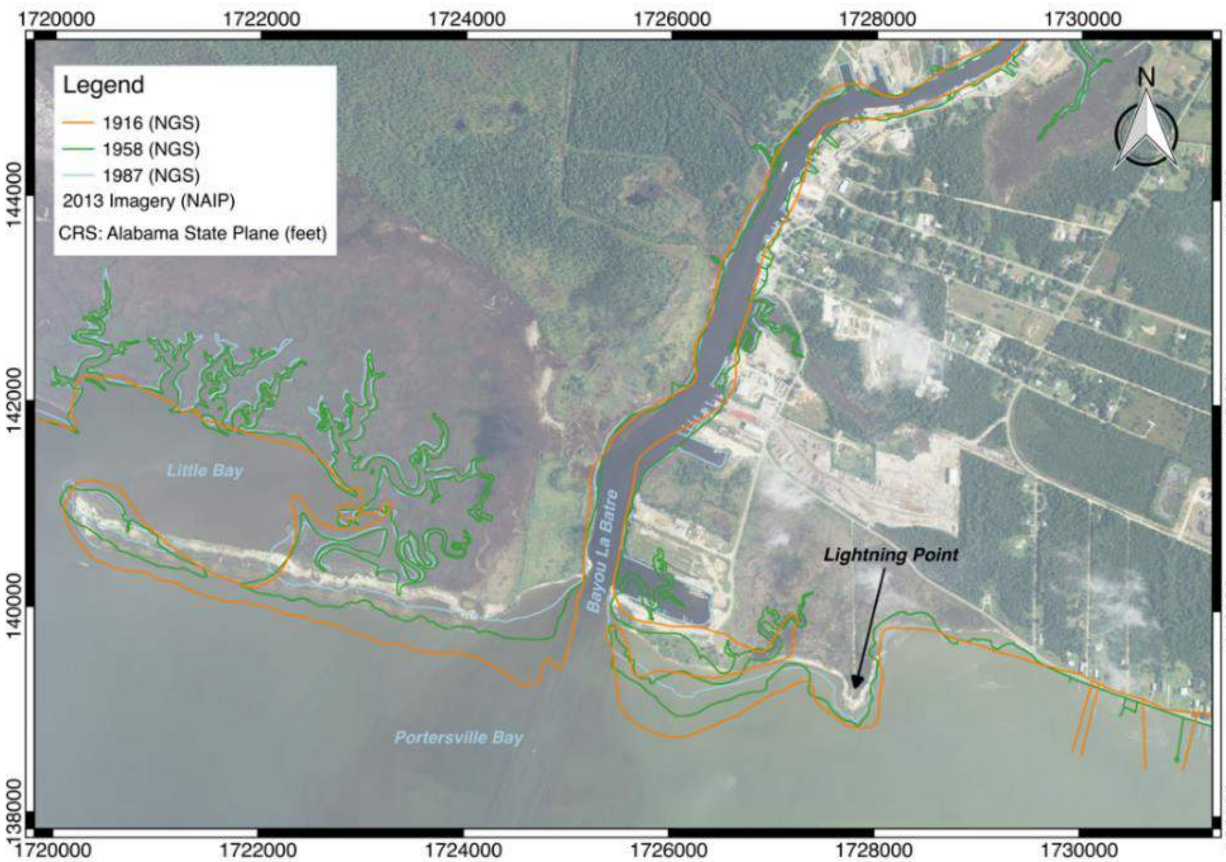


Figure 3.24 Shoreline positions near the mouth of Bayou La Batre for the period 1916 - 2013. The background imagery shows the approximate position of the present day shoreline (2013)

Table 3.8 Lengths and percentages of shore protection by type (Jones and Tidwell 2012)

Bayou La Batre		
Shore protection classification	**Length (ft)**	**Percent**
Abutment	721	0.9
Artificial	76	0.1
Boat Ramp	179	0.2
Bulkhead (concrete, rock w/riprap)	1,792	2.3
Bulkhead (concrete, rock)	7,665	9.6
Bulkhead (steel, wood)	22,373	28.1
Bulkhead (w/riprap)	1,733	2.2
Cement	94	0.1
Natural, unretained	31,487	39.6
Oyster Shells	1,445	1.8
Rubble/riprap	11,846	14.9
Sill (Steel Sheeting)	146	0.2
Total	79,558	100.0

Of the natural, unretained shoreline throughout Bayou La Batre, the two largest individual categories are low vegetated bank (~43%) and organic, vegetated fringe (8%). A detailed list of the lengths and percentages of shoreline by composition/type is provided in **Table 3.9.**

Table 3.9 Lengths and percentages of shoreline by composition (Jones and Tidwell 2012)

Bayou La Batre		
Shoreline type classification	**Length (ft)**	**Percent**
Artificial	23,211	33.5
Inlet	696	1.0
Organic (marsh)	3,129	4.5
Organic (open, vegetated fringe)	5,553	8.0
Sediment bank (high, 5 - 20 ft)	605	0.9
Sediment bank (low, 0 - 5 ft)	3,890	5.6
Vegetated bank (high, 5 - 20 ft)	2,542	3.7
Vegetated bank (low, 0 - 5 ft)	29,697	42.8
Total	69,323	100.0

3.5.3 Shoreline Vulnerability

Over 60% of the watershed's primary, tidal shoreline is protected with some type of hard armoring. About 85% of the natural shoreline in the watershed is located in its upper reaches and/or where the channel or stream narrows considerably. In those locations the primary vulnerability is streambank erosion due to high flow events (**Figure 3.26**).

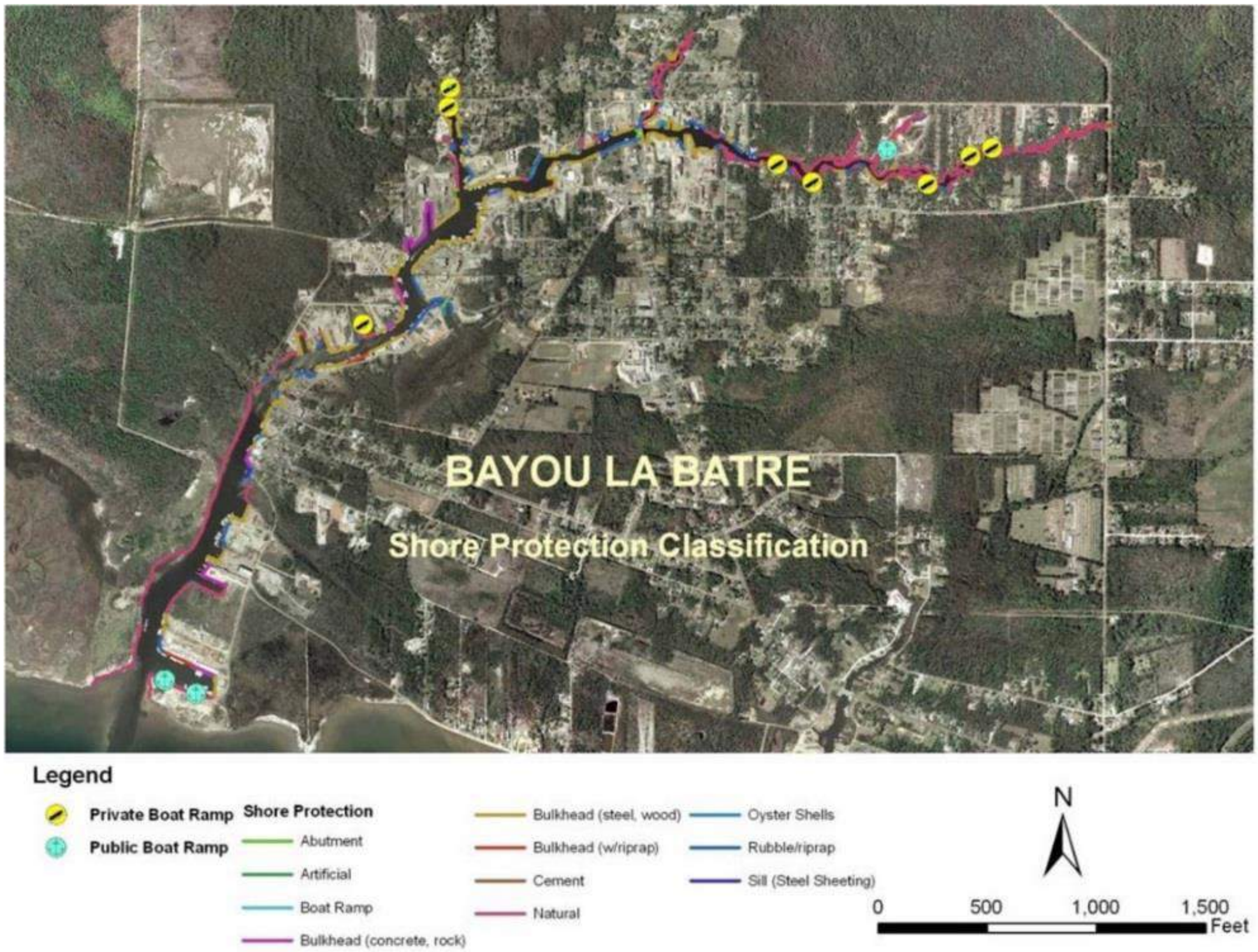


Figure 3.25 Graphical representation of shore protection types and boat launch locations (Jones and Tidwell 2012)

Only about 15% of the natural shoreline is located in an area that could be considered vulnerable to natural hazards like hurricane storm surge and waves, and also to boat wakes. That segment, which is mostly emergent marsh, is located along the first 1.0-mile of shoreline along the western bank just north of the mouth of the bayou (**Figure 3.27**). However, the deterioration of most shoreline bulkheads in this watershed has allowed erosion to occur behind them (**Figure 3.28**). The failing or failed bulkheads, then, constitute another form of potential shoreline vulnerability.

Figure 3.26 Photo of typical bank failure and undercutting in the upper reaches of the Watershed (Photo Credit Bret Webb)

Figure 3.27 Vegetated shoreline along the western bank of the channel (Photo Credit Bret Webb)

Figure 3.28 Typical example of failing or failed armored shoreline with upland erosion (Photo Credit Bret Webb)

3.6 Access

The question of access considers residents' needs and visitors' potential desires to experience the Bayou and the broader Watershed, both by water and by land. There is currently only limited access for recreational activities, both passive and active, in Bayou La Batre. Public access is limited to only a few locations along the Bayou, namely Lightning Point, St. Margaret's Church, and a few locations where kayaks and small boats can be put in. There are a great many opportunities to improve public access throughout the Watershed and create a more cohesive story of watershed, cultural, and ecological connections through improved trails and public open space.

3.6.1 Previous Studies & Existing Data

Bayou La Batre is known for its reliance on aquatic resources and its historic role in the regional maritime economy. There is a desire within Bayou la Batre for more green space and parks; increased recreational opportunities, such as walking and bike trails, nature observation, and wharfs that reach out into the bay with fishing and boat access (including canoes and kayaks).

Biohabitats reviewed relevant data and reports with a focus on access and recreation in the watershed. Staff also collected observation-based information on access and recreation during a site visit that included a van tour of the watershed and a boat tour of the lower portions of the bayou, part of a 2-day workshop that Dewberry held in April 2015.

Bayou La Batre is also inherently connected to city of Mobile and thus the question of access considers both residents' needs and visitor's potential desires to experience the Bayou and the broader Watershed, as well as areas beyond the Watershed boundaries. With regard to connectivity, the main roads into south Mobile County are I-10 and state highway 90. Bayou La Batre is approximately 12 miles south of I-10, and primary access to town is on SR 188. The Coastal Connection Byway (a nationally designated scenic byway that connects cultural, historic, and environmental highlights along the Alabama Coast) is approximately 130 miles long traversing two Alabama Counties – Mobile and Baldwin. The Coastal Connection passes through the City of Bayou la Batre on SR 188. Bayou la Batre is considered one of the highlights along this scenic byway, with its ties to the shrimping and fishing economy, as well as historic shipbuilding. The annual Blessing of the Fleet, the first Sunday in May, is touted as a special destination along the byway for experiencing the cultural, environmental, and edible highlights of the region.

According the previous documentation very few of the roads within the watershed have sidewalks, and many are narrow and winding, including parts of SR 188.

> "Travel on foot or by bicycle is difficult and dangerous, and, given the absence of public transportation, residents generally accept that working in the area requires an automobile. It is noteworthy that many of the Mobile area's heavy industries, as well as the tourist, recreation, and commercial fishing industries, capitalize on the area's coastal resources." (Austin, McGuire & Woodson, 2014)

Before the 2005 hurricanes there was debate within the local community about access and what form of redevelopment would be appropriate in Bayou La Batre. While many residents acknowledged a need for alternatives to the fishing industry others worried that a community historically built around the maritime industries could lose its unique character as a fishing community if the focus shifted to a vacation destination with marinas, condominiums and an emphasis on sport fishing and boating. The concern was that the town would start to take on the character of much larger and more commercial coastal communities (Austin, McGuire & Woodson, 2014)

After Katrina, the Urban Land Institute (ULI) was invited to Bayou La Batre to assist the community in planning and redevelopment efforts (ULI 2006). The ULI's recommendations associated with access, open space, and recreation focused on:

- Improvement of Old Town Center, including park and plaza design, and streetscape improvements[1]
- Lightning Point Marina (public dock) improvements
- A tourist trail that includes scenic byway roads, improved conditions for bike access, and preservation of natural areas for access and enjoyment

Stakeholder surveys conducted during this most recent planning process (2015) concluded that recreational opportunities in Bayou La Batre should be improved or expanded. Public access is a top-rated amenity and respondents mentioned that within the next decade they would like to see public access include more greenspace and parks, increased recreational use, bike trails, wharfs

[1] More recent discussions with community members have concluded this is no longer the case.

along the bay and fishing piers, more playgrounds and walking trails, more places to fish, and more tourist attractions (Magnoli 2015). Furthermore, stakeholders noted that churches, schools, cemeteries and the Bayou are at the top of the list of resources that deserve special protection. The following recreational priorities were currently noted by stakeholders: fishing, walking/hiking, swimming, nature observation, boating, canoeing/kayaking (Magnoli 2015).

Based on the examination of existing reports from prior planning efforts, the following list was prepared as a starting point for considering open space and access as an overlay in the current watershed management plan:

a. Walkways near the water (Walking/hiking)
b. Access to the water
c. Canoeing/kayaking
d. Nature observation and access to public open space areas
e. Biking
f. Recreation
g. Birding
h. Fishing
i. Tourism
j. Cultural connections and open space

As noted previously, the main focus of this plan is on the Watershed, but it is also valuable to understand the broader connections in the region, whether they be roads and other transport networks or open space, or natural resource areas that serve as connections to the history and ecology of Bayou La Batre.

3.6.2 Public Access & Open Space

There was limited availability of existing GIS data for the Watershed pertaining to access, with the exception of basic data: watershed boundary, streets and roads, schools, churches, and other publicly owned points of interest. Further data was requested and obtained from Mobile County, the Mobile Bay National Estuary Program, the Mobile County Revenue Commission and Dewberry. This data included planimetric features, parcel boundaries, land use and hydrology, among other layers. The parcel data did not contain ownership information so an additional request was made to the County and information was received in excel format, and then joined to the existing parcels shapefile using a property assessment number.

Features relevant to the project were compiled and organized into a File Geodatabase. Using the available datasets, parcels were separated between public and private and displayed on a map (see **Figure 3.32**). Additional public access and recreation features such as cemeteries, schools, libraries, and churches were plotted and color coded for display. Along with these points of interest, linear features such as birding trails, bike paths and potential Blueway trails were manually digitized using GPS data and aerial imagery. Once all features for access and recreation had been created, they were organized into seven subset categories (Cemetery, Church, Library, Natural Area, Property for Sale, Recreation, & School) and three main categories (Civic, Cultural, Recreation/Open Space) for display in final graphics.

3.6.3 Property Ownership

Publicly owned lands and those properties associated with institutions that open their doors to a broad cross-section of the community are the most relevant lands to focus on for expanded recreation and access in the Watershed. Therefore the most relevant data associated with property ownership included cemeteries, churches, the library, natural areas, recreation areas including parks, and schools.

3.6.4 Access and Recreation Opportunities

Based on the existing data and the feedback from the community there are a great many opportunities to improve public access throughout the Watershed and create a more cohesive story of watershed, culture and local ecology.

3.6.4.1 Parks and Open Space Access

A highlight of the current access to the Bayou is Lightning Point at the City Docks, which offers expansive views of the wetlands to the west and of Dauphin Island. Presently, there are a limited number of publicly owned lands along the Bayou, limiting direct access to the Bayou for fishing or canoeing/kayaking. Lightning Point is also an important location for sustenance fishing for the local community. It was noted that the access at City Docks at Lightning Point could be improved, and there was also mention of a need for a pier for tourists in Portersville Bay.

Figure 3.29 Aerial view of Lightning Point

Figure 3.30 Boat launch and accessory piers at Lightning Point

Larger parcels within the Watershed are publicly held land and provide opportunity for bird- or wildlife-watching (Grand Bay Savanna Tract of Forever Wild). Some of these parcels are also in the vicinity of schools or other institutions leading to future opportunities to provide increased access and curricular synergies. The existing parks with recreation and open space access include Zirlott Park, Ralston Park, Bosarge Park, John Thomas Park, Leroy Cain Park, & Maritime Park. Within each of these parks there are opportunities to showcase and interpret the Watershed through signage, maps, and stewardship or water quality treatment practices that highlight their relationship with the Watershed (stormwater best management practices).

As noted above, an important access point that is enjoyed by locals and visitors alike is St. Margaret's Catholic Church, in the heart of the Watershed and directly along the Bayou. The annual Blessing of the Fleet at St. Margaret's opens the shrimp season and serves as a festive occasion that combines religious ceremony with local heritage (see **Figure 3.31**). The event is based on European customs of fishing villages offering prayers for abundant catches and for protection at sea. This popular festival includes the decoration of boats, a religious ceremony, and a parade down Main Street. St Margaret's sits at the apex of access both to the Bayou and within the Watershed as a whole.

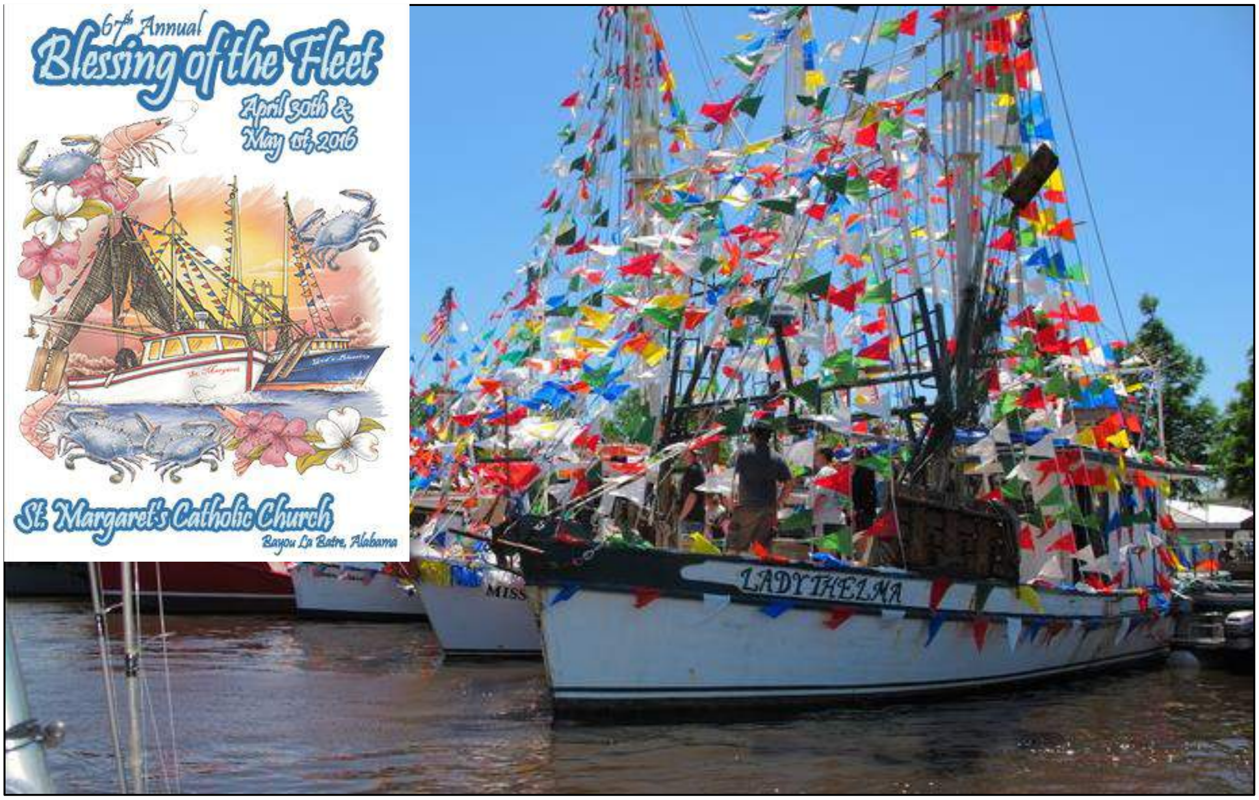


Figure 3.31 Blessing of the Fleet at St. Margaret's. Source CNN

It was noted in the literature that the Bayou La Batre shrimping port has the opportunity to embrace the concept of a working waterfront that celebrates seafood processing and fishing, with tourism, not unlike San Francisco's Fisherman's Wharf- although perhaps at a much different scale. More discussion of this concept is included in the implementation/management section.

ID	NAME
1	Snake Bayou
2	Alexander Cemetery
3	Odd Fellows Cemetery
4	Original Cemetery
5	St. Margaret's Cemetery
6	St. Margaret's Catholic Church
7	First Baptist Church of Bayou LaBatre
8	First United Methodist Church
9	Pine Air Baptist Church
10	First Baptist Church of Irvington
11	First Baptist Church of St. Elmo
12	Freewater Baptist Church
13	Irvington Assembly of God
14	New Welcome Baptist Church
15	First Church of Nazarene
16	Wesleyan Church
17	Sweet Bethel Baptist Church
18	Greater New Hope Baptist Church
19	Perfect Alternative Baptist
20	Coden United Methodist Church
21	Coden Bible Church
22	Public Library
23	Bird Santuary
24	Southern Timberland Parcels - For Sale
25	Southern Timberland Parcels - For Sale
26	Southern Timberland Parcels - For Sale
27	Southern Timberland Parcels - For Sale
28	Southern Timberland Parcels - For Sale
29	Southern Timberland Parcels - For Sale
30	Southern Timberland Parcels - For Sale
31	City ownership of Lightning Point - City Docks
32	Mars Avenue Road Access
33	City Access at Tram Avenue
34	Community Center
35	Coden Belt Road - Birding
36	Bayou LaBatre Ponds - Birding
37	Zirlott Park
38	Raltson Park
39	Silver King Golf Club
40	Bosarge Park
41	John Thomas Park
42	Leroy Cain Park
43	Maritime Park
44	Grand Bay Savanna Forever Wild Tract - Birding
45	Dixon Elementary
46	Alba Middle
47	St. Elmo
48	Booth Elementary
49	Bryant High

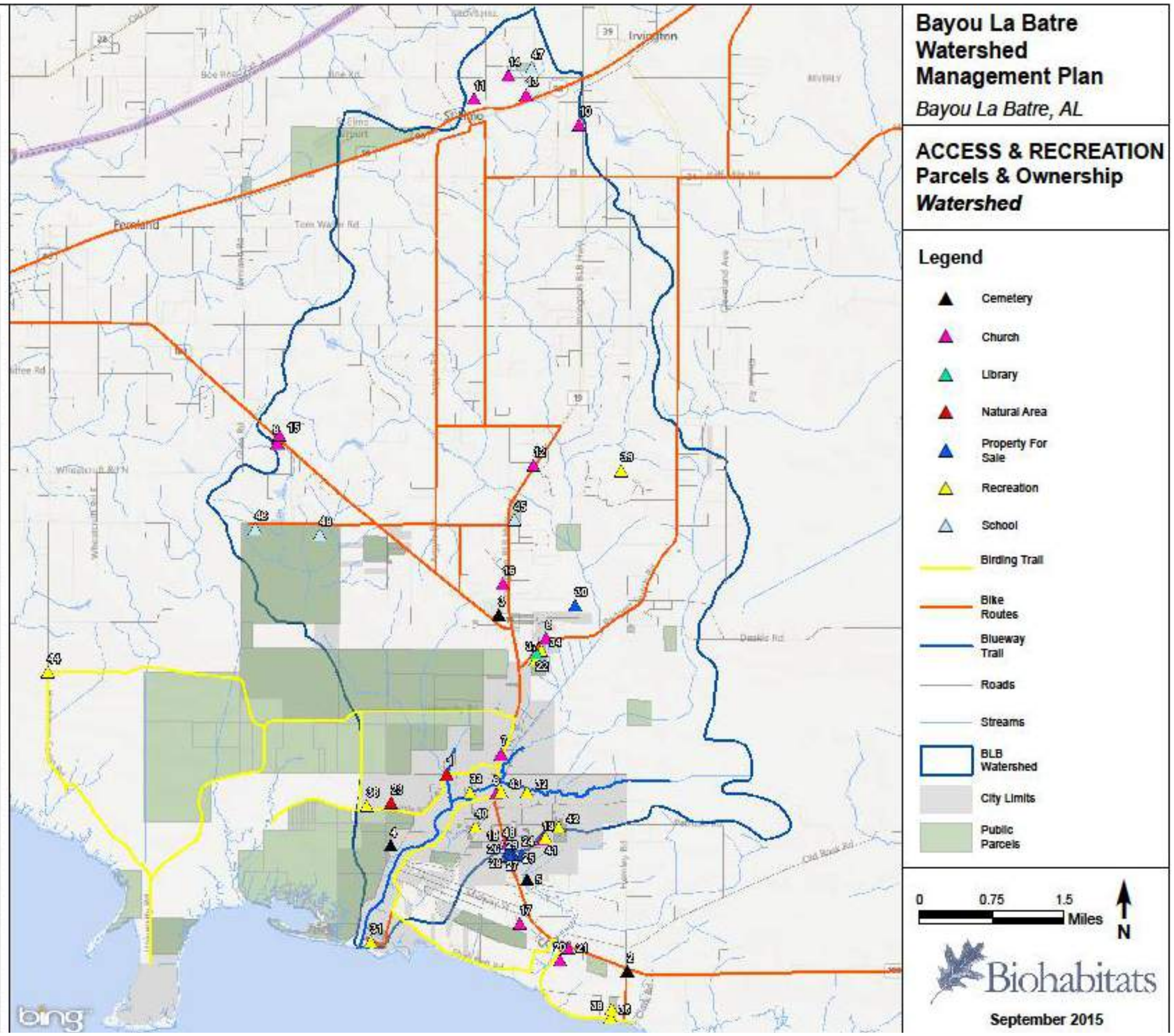


Figure 3.32 Access and recreation opportunities in the Watershed

3.6.4.2 Trails- Connectivity and Circulation (Greenway and Blueway network)

A site visit by the project team during this planning effort explored the opportunity for a kayak/canoe Blueway trail along the Bayou. It was determined that it would be a great way to experience the native wildlife and natural systems that define the Bayou. Further study and interviews with the community are needed to understand the viability of such a trail, and the extents to which the trail could reach into the upper reaches behind private property.

Figure 3.33 Canoe tour of Bayou La Batre

Starting at Lightning Point at the City Docks, there is the opportunity for a cultural walking tour of downtown and along the Bayou, extending through the Watershed as a biking or auto tour that connects with access to key locations and views of important landmarks. Later sections discuss the potential of a Greenway/Multiuser Trail along Shell Belt Road. A few roads, including SR 188, in the Watershed are important parts of the Alabama Coastal Birding trail and popular cycling routes (based on data acquired online mapping from Strava labs of cycling routes in the region).

Forever Wild's Grand Bay Savanna tract is the last stop on the Dauphin Island / Bayou la Batre loop of the Alabama Coastal Birding Trail. This property is along the western edge of the Watershed and includes four continuous parcels that together total 5,300 acres of land managed by the ADCNR State Lands Division and a community hunting area managed by the ADCNR Wildlife and Freshwater Fisheries Division. Access is afforded to the site via Henderson Camp Road or Marine Laboratory Road. Habitats found within this site include marsh, bog, and lowland forest representative of the northern Gulf Coast. It is noted as one of the premier locations to see Whimbrel (*Numenius phaeopus*) flocks during their migration. Other species seen here in the winter months include American kestrel (*Falco sparverius*), loggerhead shrike

(*Lanius ludovicianus*), field sparrow (*Spizella pusilla*), eastern meadowlark (*Sturnella magna*), as well as the painted bunting (*Passerina ciris*) during spring. Because a large portion of this site is part of the Grand Bay Savanna Hunting Area in cooperation with the Forever Wild Land Trust, precautions are suggested during hunting season to ensure the safety of visitors. Spring and fall migration offer the greatest opportunity for birding. (The Alabama Coastal Birding Trail 2012)

3.6.4.3 Regional Connectivity

There are a number of important natural areas/refuges and access points that are located outside of the Watershed that provide great connections to open space and natural resource areas via the Coastal Connection or regional biking routes. These include:

- Point aux Pins to the west
- Bellingrath Gardens to the east
- Dauphin Island to the south
- Grand Bay National Wildlife Refuge and Grand Bay Savanna (further to the west of the Forever Wild tract along the state line)
- Coffee Island and Cat Island habitat recovery project to the south
- Helen Wood Park Oyster restoration south of Mobile
- The Mississippi Sand Hill Crane National Wildlife Refuge
- The Nature Conservancy has a few areas in southern Alabama, including Dennis Cove, north and west of Mobile, Rabbit Island Preserve (near Perdido Key), and Splinter Hill Bog, north east of Mobile, and west of Bayou la Batre in Mississippi the TNC also has the Red Creek Mitigation Area and the Old Fort Bayou Mitigation Bank.

The town of Coden, to the southeast of Bayou la Batre, is technically not within the Watershed but is very closely linked to the town. There are further opportunities to celebrate the regional history, ecology, and cultural heritage by enhancing connections between Bayou La Batre and Coden, and their shared natural and cultural heritage.

3.7 Historical, Cultural and Heritage

There is substantial evidence of Indian cultures in the region surrounding the Bayou La Batre waterway dating back to over 8,000 years. Even then, these communities depended on the abundance of the coastal fisheries for food and trade. In 1699, the area was claimed by the French and dubbed the "French Coast."

In 1786, Joseph Bosarge, a Frenchman, petitioned the Spanish Governor for a tract of land on the West Bank of the waterway. His petition was granted and he and several other French families became the original settlers to the area. The French maintained a battery of artillery on the west bank of the waterway and thus named it Bayou de la Batre or Bayou La Batre in English.

As Spanish settlers later moved into the area, there was a lasting fusion of the two cultures. The area was recognized far and wide for its seafood, cooking styles, and work ethic.

3.7.1 Existing Data or "A Culture Dependent on Coastal Resources"

In the late 1800s, the area was also known for its hotels, riverboat excursions, canning industries and sport fishing. A railroad brought tourists from throughout the United States to enjoy the waters of Portersville Bay and the beauty of the natural habitats surrounding Bayou La Batre. The hurricanes of 1906 and 1916 destroyed most of these businesses and facilities as well as a substantial portion of the residences.

In the 1970's, substantial numbers of families from southeastern Asia (Cambodia, Vietnam and Laos) immigrated to the United States and many of these located in south Mobile County. Given their own heritage and their cultural reliance on the seafood industries, a large number of these immigrants located in the area of the Bayou la Batre watershed. With support from the U.S. Government, they quickly assimilated into the local seafood industry as boat owners or seafood shop workers. As with all cases where there is rapid blending of dissimilar cultures/languages and a competition for local jobs and resources, the transition was not always without challenges.

In addition, Hurricane Katrina in 2005 and the BP Deepwater Horizon Oil spill in 2010 both dealt devastating blows to the area and its inhabitants. In both cases, jobs and family incomes were eliminated or severely disrupted and many moved from the area and/or chose to pursue livelihoods that were not dependent on coastal resources.

Seafood harvesting and processing as well as shipbuilding remain the two driving economic forces in the City of Bayou La Batre which surrounds a vast majority of the Bayou La Batre waterway. Residents in the upper reaches of the waterway include small traditional farmers as well as people employed principally in service industries and local businesses.

3.7.2 Culture and Heritage or "Transitioning of Cultures and Heritages"

From the time the Watershed was settled, the harvest of naturally grown (wild) shrimp, crab and oysters have provided a substantial economic basis for the people living in and around the Bayou La Batre waterway and watershed. Sport fishing has played its part in this economy but with varying degrees of success over the years. During the course of the Watershed study, residents of the Watershed repeatedly stressed the need for a more diversified economy for the area. In particular, considerable emphasis was placed on the need for a more unified and tangible ecotourism industry that could bring good jobs for local citizens while preserving the natural beauty and heritage of the area.

The people of the Watershed have an enduring work ethic, a resilience beyond compare and a commitment to protect their natural world for future generations. Perhaps this is why the area has been successful in reinventing itself many times over the past two hundred and fifty (250) years.

Perhaps it is the mutual need of those of French, Spanish, African, Cambodian, Vietnamese and Laotian roots to merge their lives and livelihoods to assure that boat building, seafood harvesting and ecotourism continue to provide a source of stability for coming generations. All will depend on protection and resources afforded by the waterway and its natural habitats for their future.

4 Identification of Critical Areas and Issues

This section presents the critical areas within the Bayou La Batre Watershed and identifies issues to be addressed by the implementation program.

4.1 Water Quality

One of the most critical components of a healthy watershed is water quality. The quality of water can impact many components of the watershed, including supporting habitats for plants and animals; providing sources of irrigation water for farms and ranches and drinking water for residents; and providing aquatic recreational opportunities for the community.

4.1.1 Water Quality Issues

The following water quality issues were identified as the most critical to the overall health of the Watershed:

- Stormwater Runoff
- Nutrients
- Trash
- Sedimentation
- Pathogens

4.1.1.1 Stormwater Runoff

Stormwater runoff is an issue impacting many areas of the Watershed and can be a primary source of pollutants, including trash, nutrients, pathogens, and chemicals which can negatively impact local waterbodies. Excess water quality pollutants in the Watershed commonly produce elevated nutrient and pathogen levels and low dissolved oxygen concentrations. These can reduce the abundance and health of all aquatic organisms in the Watershed. Elevated nutrients and pathogens can also affect human health and welfare by making the water unsafe for human contact and producing algal blooms that limit recreation.

Within the Watershed there is limited infrastructure in place to manage stormwater runoff. Much of the upper watershed is characterized by vegetated ditches and swales with no best management practices (BMPs) in place to help manage pollutants. Similarly, the City of Bayou La Batre has limited stormwater infrastructure and BMPs to help manage runoff and prevent pollutants from entering the Bayou and other waterbodies.

Figure 4. 1 Gullying and erosion in the upper Watershed from stormwater runoff

4.1.1.2 Nutrients

Nutrient enrichment is one of the leading causes of water quality impairment in the State and the entire nation, and the quantity of nutrients reaching surface waters has dramatically increased over the past decades (United States Environmental Protection Agency (USEPA) 2009). Nitrogen and phosphorus loadings to a water body can impact water quality by stimulating plant and algal growth, which subsequently may result in depletion of dissolved oxygen, degradation of habitat, harmful algal blooms, impairment of a water body's designated uses, and impairment of drinking water sources (Water Environment Research Foundation (WERF) 2010).

Eutrophication in general is excessive richness of nutrients in a water body, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen. Eutrophication can be exacerbated by land uses (Gill *et al.* 2005) or other anthropogenic activities. The accelerated eutrophication caused by human activities is termed "cultural eutrophication". Increased nutrients associated with eutrophication can increase algal growth (algal blooms) (Smith *et al.* 1999), in turn increasing turbidity, particulate organic matter, and dissolved organic matter.

Nitrogen and phosphorus concentrations in Bayou La Batre River estuary are elevated above guidance criteria for southeastern streams and estuaries and appear to be enriched by anthropogenic activities in the Watershed. However, the elevated nutrient concentrations do not appear to translate into chronic excessive algal production, as measured by chlorophyll-a concentrations. Chlorophyll-a concentrations are predominantly within the "good" range as identified EPA with only episodic peaks which appear to be decreasing in frequency since 2012. As presented in **Section 3.1.2**, the WMP team identified nitrogen as the "limiting nutrient" in terms of mitigating phytoplankton production, as such, the concentration of chlorophyll-a was directly impacted by the availability of nitrogen. Therefore, corrective actions to address phytoplankton production should focus on the reduction in nitrogen loading to the estuary. Nutrient enrichment within the Watershed could be attributed to the following anthropogenic sources: stormwater runoff, failed septic system, sanitary sewer leakage, periodic sanitary pump station overflows, illicit discharges, and/or illicit connections.

4.1.1.3 Trash

Trash is an endemic problem throughout the Watershed. It comes from numerous residential and commercial sources and can end up in the local waterbodies through both intentional and unintentional means. Anything that is discarded or blown into the Watershed will eventually be conveyed to a stream, wetland, or the Bayou by stormwater runoff. Regardless of its source, trash can significantly impact upland and coastal habitats and diminish the quality of recreational activities throughout the Watershed.

Figure 4.2 Trash along Bayou La Batre shoreline

Figure 4.3 Trash stacked along Bayou La Batre with no containment

4.1.1.4 Sedimentation

Sedimentation is a natural process in which material such as sand and rock particles are transported by moving water downstream within the Watershed where the material can be deposited. Some of the primary sources of sedimentation are surface runoff from unpaved roads and streambank erosion, both of which are occurring within the Watershed.

Cook (2016) analyzed sedimentation within the Watershed and reports that, when compared with data from other watersheds in Baldwin and Mobile counties, the Bayou La Batre Watershed has moderately-sized sediment loads which are significantly larger than the geological erosion rate. This is the natural rate of erosion that would have occurred were there no human impacts to the watershed. Within the Bayou, Cook presents three primary sources of elevated sediment which include: 1) estuary streams with tidal influence that have constantly elevated turbidity and suspended sediment due to tidal movement; 2) three upstream, unnamed tributaries to the Bayou that have relatively severe stream erosion (see **Figure 15** in **Appendix B**); and 3) stormwater runoff from the City of Bayou La Batre. Sources of sediments in other areas of the watershed include streambank erosion, runoff from row crop agriculture, sand mining operations, unpaved roads, and urban runoff.

Figure 4.4 Unpaved roads in upper Watershed

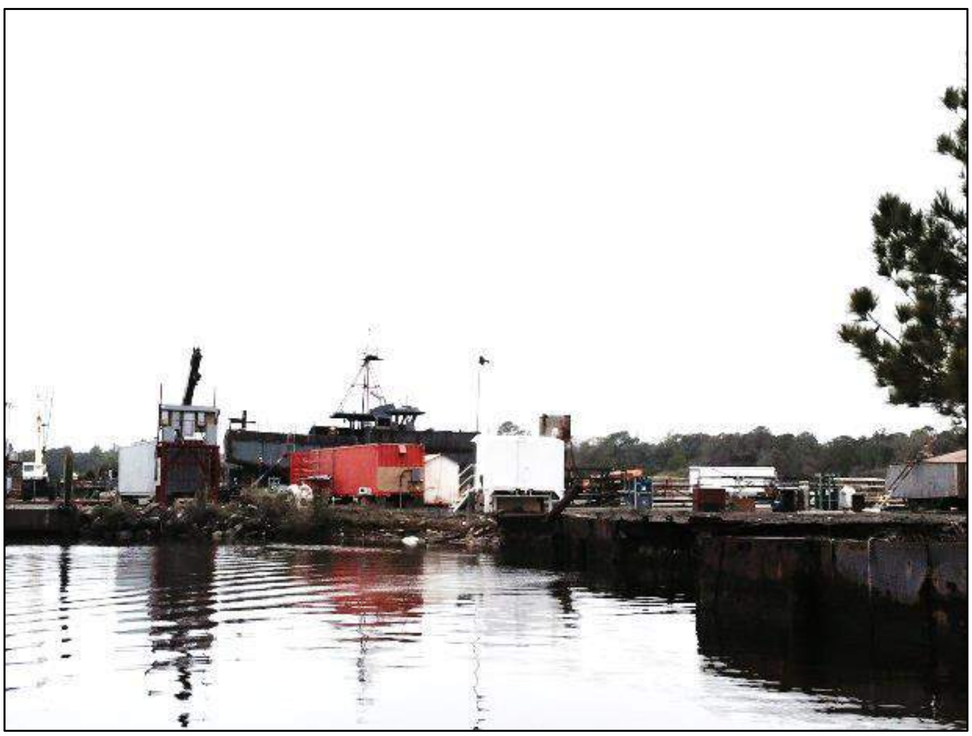


Figure 4.5 Denuded area along the Industrial Shoreline

Cook concludes: "…water quality and habitats could be improved and protected for the future by employing best management practices that prevent destruction of wetlands, prevent erosion and sediment transport from areas of timber harvesting and row crop agriculture, and control runoff from urban areas, including construction sites and areas with significant bare and impervious surfaces.”

4.1.1.5 Pathogens

As presented in **Section 3**, the Bayou was placed on Alabama’s 303(d) list of impaired waters for pathogens; and pathogens were detected during water quality sampling undertaken as part of this watershed study. Results from four of five microbial source tracking samples collected indicated presence of human bacteria (see **Section 3.1.3**); however, the proportion of human waste as a source is unknown relative to other potential sources (i.e., bacteria associated with the decomposition of vegetation, wildlife or animal waste).

The presence of elevated concentrations of pathogens in surface waters could be a serious threat to human health and safety because they indicate the potential for the presence of disease-causing micro-organisms. In many watersheds, pathogens are typically seen in higher numbers after rain events as a result of runoff laden with gross pollutants, often from sanitary sewer overflows (SSOs). While the presence of pathogens during wet-weather can be attributed to a variety of potential sources, the presence on pathogens in dry-weather conditions can be indicative of direct inputs of bacteria into the surface water system. These are typically from a wastewater source such as a failed septic system, sanitary sewer leakage, periodic sanitary pump station overflows, illicit discharges, illicit connections, or pets and wildlife.

There are three primary, potential sources of human bacteria within the Bayou which include: septic tanks, sanitary sewer inputs, and vessel discharges. Many septic systems in the watershed and surrounding areas have been, or will be, removed, and those homes will be connected to the centralized wastewater treatment facility (WWTF) system. In regards to vessel discharges, there are regulations for proper disposal of sanitary waste from commercial vessels; however, currently no pump-out stations exist in the Bayou.

Lastly, there have been documented SSOs, which primarily occur during large rain events. This is a common problem among older urban sanitary sewer systems. This condition occurs during intense rain events that infiltrate and overtax the compromised sanitary sewer system, allowing sewage to escape the sanitary system to become a direct pollution source for creeks, streams, and the Bayou. This process is referred to as “Infiltration and Inflow” or I & I. Infiltration and Inflow occurs when stormwater runoff and/or groundwater enters the sanitary sewer system through cracked pipes, leaky manholes, or improperly connected storm drains, down spouts, and sump pumps. The stormwater and groundwater combine with raw sewage, exceeding the design capacity of the sanitary sewer system and causing overflows. Overflows can increase pollutant loads, including oxygen-demanding substances, nutrients, and pathogens to surface waters.

While the WWTF was upgraded after Hurricane Katrina, the conveyance system was not and is in need of improvements and upgrades. The following table documents the sanitary sewer overflows reported by the Bayou La Batre Utilities Board to the Mobile County Health Department (**Table 4.1**). **Appendix C** presents the detailed overflow reports.

Table 4. 1 Sanitary sewer overflows in Bayou La Batre

SITE	Approximate gallons discharged per date (Apr. 2015 to Dec. 2016)								
	Jun. 24, 2015	Aug. 5, 2015	Nov. 8, 2015	Dec. 23, 2015	Dec. 30, 2016	Jan. 22, 2016	Mar. 11, 2016	Mar. 27, 2016	Aug. 11, 2016
Shell Belt Road @ Jones Street				6300	1215*	1800	2000	1260	500
Little River Road @ Seafood House Road	1000	1000							
Shell Belt Road @ Marshall Marine		1200	1500						
Little River Road @ Bryant Street		1000		200					
Alba Street @ Fifth Avenue				2500	1215*				
Shell Belt Road @ Mallette Street				1260			2000		
Mars Road @ Hemley Avenue		250							
Warner Street @ Dana's Seafood		300							
Shell Belt Road @ Olympic Shellfish		1000							
9300 Little River Rd.				200					
Seafood House Road & Powell Street						420			
Alba Street & Fifth Avenue						480			
9315 Little River. Rd.							2000		

*Reported amount was 2430 gal. for both sites combined.

Other concerns related to I & I are the impacts that the increased water volume are having on the WWTF. When excess stormwater and groundwater enter the treatment system during large storm events, the WWTF is forced to treat water that was not originally intended to enter the treatment system. These "spikes" in flow are then transported through the system and result in large pulses from the WWTF outfall into Portersville Bay. While the treatment facility and receiving water are not geographically located in the Watershed, they are impacted by activities and systems located in the Watershed that may have negative impacts on them and surrounding systems.

A notable impact includes the resulting closures of Portersville Bay to oyster harvesting during large rain events, significantly impacting oyster farming operations. When runoff into Portersville Bay exceeds dilution levels set by the U.S. Food and Drug Administration, the area is closed to aquaculture, since fresh water entering the bay creates conditions conducive to bacterial growth. This issue is also exacerbated when the WWTF, which also treats stormwater runoff due to I & I, discharges near its volume limit. When the treatment facility nears its discharge volume limit, the Alabama Department of Health will shut down oyster farming in Portersville Bay as a precaution. These precautionary measures are based on water volume, not WWTF discharge water quality. Too much fresh water in Porterville Bay is correlated with chances for harmful bacteria to be present, and the regulatory agencies are obligated to predict when these conditions may occur to protect human health (Edge 2015).

4.1.2 Pollutant Source Assessment

Maintaining water quality can be challenging since it is impacted by activities within the Watershed and surrounding areas. Chemical and physical constituents from runoff, aerial deposition, and soil and sediment transported through the aquatic system can have negative impacts on water quality within the watershed.

The following section presents potential sources of pollutants into the receiving waters of the Bayou La Batre Watershed.

4.1.2.1 Nonpoint Sources

Nonpoint source pollution comes from many different sources, as opposed to point source pollution, which can be directly attributed to a specific source, like an industrial discharge. Nonpoint source pollution generally comes from runoff from overland flow, atmospheric deposition, and other diffuse sources. These nonpoint sources of pollution can convey natural and anthropogenic pollutants into waterbodies.

Many pollutants are grouped into the general term “gross pollutant”, which is used to describe trash and organic debris like decaying branches, leaves, vegetation, and grass clippings. Gross pollutants were commonly observed throughout the Watershed. Gross pollutants can block drainage systems, resulting in decreased flows and localized flooding, and are a primary concern in the Watershed. Removing these pollutants from the watershed and surface water system will be an essential element of Watershed and Bayou restoration efforts, improving the water quality and aesthetics of the area.

4.1.2.1.1 Agriculture

Agricultural runoff can be an important source of nonpoint source pollution and a primary source of erosion and sedimentation. The primary agricultural nonpoint source pollutants are nutrients, sediment, animal wastes, salts, and pesticides. Agricultural activities also have the potential to directly impact the habitat of aquatic species through physical disturbances caused by livestock or equipment. As presented in **Section 2**, agricultural lands make up approximately 36% of the Watershed (6,986 total acres).

Figure 4.6 Agricultural runoff including numerous sources of adjacent pollution

4.1.2.1.2 Cropland

Depending on crop type and management, croplands are a potentially significant source of nutrients, sediment, and pesticides in a watershed. Croplands can experience increased erosion, delivering sediment loads and attached pollutants to receiving waterbodies. Fertilizer and pesticide applications to crops increase the availability of these pollutants (USEPA 2003).

Agricultural croplands, generally located in the northwest portion of the Watershed, are the dominant land use in the headwaters of Carls Creek tributaries (Cook 2016). These crops include peanuts, soybeans, corn, cotton, and pecans.

Cook (2016) lists row crop agriculture as a source of turbidity and sedimentation in the Watershed. Excess turbidity can be directly correlated with land uses that disturb the soil and lead to erosion or excessive runoff. Cook's observations, recorded during monitoring, included at least seven fields used for row crop agriculture in the headwaters of Bishop Manor and Hammar Creeks that have streams or drainage ditches running through them with no vegetative buffer or sediment detention. Cook's sampling results for one of these streams showed the highest turbidity reading during a storm event (see **Figure 16** in **Appendix D**). Part of this headwater stream flows through row crop fields.

Cook (2016) reports, when compared to sediment transport rates and water-quality data in watersheds in Baldwin and Mobile counties, streams in the Bayou La Batre Watershed have moderately-sized sediment loads and generally good water quality. Cook attributes this to the relatively rural setting, extensive wetlands and forests, and use of winter cover crops on agricultural fields.

4.1.2.1.3 Livestock

Livestock operations can be a significant source of nutrients and bacteria and can increase erosion in a watershed. Streambank erosion can be caused by a reduction of woody vegetation along the stream caused by intensive cattle grazing or when livestock trample streambanks. Major surface water quality problems associated with bacteria have been linked to grazing animals, particularly when they are not fenced out from streams and farm ponds. Livestock on rangeland can contribute pollutants to the land that are picked up in runoff, whereas livestock in streams deposit nutrient and bacteria loads directly to the streams.

Livestock operations are present in the Watershed; however, elevated nutrient concentrations were episodic in comparison to the EPA water quality criteria. Additionally, pathogen investigations focused on human sources of bacteria and did not target non-human inputs.

Figure 4.7 Gullying on agricultural lands

4.1.2.1.4 Wildlife

Wildlife is a natural background source of pollutants and can contribute to bacteria or nutrients in the Watershed. Birds, feral hogs, and other animals can be a source of pathogens that can be hazardous to human health. Although some studies suggest that these types of pathogens may pose less risk to humans than exposure to water contaminated with human sewage (Wagner *et al.* 2016). Wagner *et al.* (2016) reports that in predominantly rural watersheds, wildlife can contribute about half of the bacteria sampled.

4.1.2.1.5 Silviculture

Silviculture can be a significant source of sediment and other pollutants to a waterbody. The primary silviculture activities causing increased pollutant loads are road construction and use, timber harvesting, site preparation, prescribed burning, and chemical applications. Without adequate controls, forestry operations can cause in-stream sediment concentrations and accumulation to increase because of accelerated erosion.

Silviculture activities can also cause elevated nutrient concentrations as a result of decaying organic matter and prescribed burns. Organic and inorganic chemical concentrations can increase because of fertilizer and pesticide applications. Harvesting can also lead to in-stream accumulation of organic debris, which can lead to hypoxic conditions. Other waterbody impacts include increased temperature from the removal of shade-providing riparian vegetation and increased streamflow due to increased overland flow, reduced evapotranspiration, and runoff channeling (USEPA 2008).

Timber harvesting in the watershed appears to be occurring primarily on private lands.

4.1.2.1.6 Septic Systems

Septic systems can contribute significant nutrient and bacteria loads to receiving waterbodies because of system failure and surface or subsurface malfunctions.

Many of the septic systems in the Watershed have already been removed through the Coastal Impact Assistance Program (CIAP), and are connected to the WWTF system. The Energy Policy Act of 2005 established CIAP, which authorizes funds to be distributed to Outer Continental Shelf (OCS) oil and gas producing States for the conservation, protection, and preservation of coastal areas, including wetlands. The State of Alabama is one of six states eligible to receive CIAP funding and have directed some of that funding to a septic to sewer program for South Mobile County. Other communities in neighboring areas will be connected as part of the next phase of the CIAP-funded program that is ongoing (Lagniappe 2014).

4.1.2.1.7 Urban Runoff

Urban or developed areas typically experience greater magnitudes of stormwater runoff than more rural areas due to their higher percentages of impervious area. Without opportunities to infiltrate, runoff from developed areas transports pollutants to waterbodies.

As presented in **Section 2**, approximately 13% of the total land cover area within the Bayou La Batre watershed has some fraction of impervious surface. The majority of the total land cover area in the Watershed, 87% (17,007 acres), has no measurable level of impervious cover (IC). Models predict that when watershed IC exceeds 10%, stream quality is likely degraded, with the degradation increasing to severe when watershed IC exceeds 25%.

4.1.2.1.8 Streambank Erosion

Streambank erosion is the direct removal of banks and beds by flowing water, exacerbated by increased volumes and velocities of stormwater runoff associated with increased IC. Usually this type of erosion is initiated by heavy rainfalls, but it can also occur more gradually over time as a result of weathering. Erosion of stream or river banks causes increased sediment loads carried by or deposited in the water. Deposition of material downstream as flow slows causes problems on productive wetlands and shoaling in reservoirs. Other problems include reduction of water quality due to high sediment loads, light-blocking turbidity and deposition of silt causing loss of native aquatic habitats, damage to public utilities (roads, bridges, and dams) and maintenance costs associated with trying to prevent or control erosion sites. Catchments with little vegetative cover and steep gradients will often have high rates of runoff that result in high-velocity stream flows. Stream channelization, dredging, or realignment to accommodate roads or rail lines leads to increased stream power and velocity, which in turn will increase the energy applied to stream banks. The erosive impact of these high-velocity stream flows will depend on the stability of the bank material. For instance, sand will erode more easily than gravel and silt will erode more easily than sand (USEPA 2008).

Figure 4.8 Eroding streambank along upper Bayou La Batre

4.1.2.1.9 Atmospheric Deposition

Pollution from the air may deposit into water bodies, affecting water quality. Airborne pollution can fall to the ground in raindrops, in dust, or simply due to gravity. There are five categories of air pollutants with the greatest potential to harm water quality: nitrogen, mercury, other metals, combustion emissions, and pesticides. These pollutants all have the ability to settle into bodies of water damaging ecosystems and threatening public health. Both natural and anthropogenic processes can lead to air pollution. Driving cars, operating power plants, and spraying pesticides all release pollutants into the atmosphere (USEPA 2008).

A report by MBNEP, based on data compiled by the National Atmospheric Deposition Program and Mercury Deposition Network, reported that atmospheric mercury deposition in the Mobile Bay area occurs at intermediate levels when compared to other areas of the nation (Summersell 2008).

Nearby, Fowl River was listed on the State of Alabama 303(d) list for impairment from mercury concentrations. The recent Fowl River WMP reports that atmospheric deposition appears to be the source of mercury found in fish. In 2002, the State Health Department issued a fish consumption advisory, warning people not to consume fish from Fowl River, and that remained in effect as of 2015 (GMC 2016).

4.1.2.2 Point Sources

Point sources are regulated through National Pollutant Discharge Elimination System (NPDES) permits that allow discharges at specific locations from pipes, outfalls, and conveyance channels.

4.1.2.2.1 NPDES Permits

The Clean Water Act authorized the NPDES permit program which controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Individual homes that are connected to a municipal treatment system, use a septic system, or do not have a surface discharge do not need an NPDES permit. However, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

4.1.2.2.2 Construction General Permit

The State of Alabama's NPDES Construction General Permit requires developers/contractors to install and maintain BMPs on construction sites (one acre and larger) to minimize the discharge of sediment and turbid water. The City of Bayou La Batre is the local issuing authority for annual business licenses and land-disturbing permits within City limits and is therefore responsible for ensuring construction erosion and sediment controls are properly implemented and maintained.

During field visits, sites were observed with poorly maintained BMPs (fallen fencing or accumulated sediment that has not been removed (**Figure 4.9**). During each rainfall event, turbid water, sediment, and other pollutants from these sites may be transported to waterbodies in the surface water system. It is important that construction site requirements are enforced to prevent sediment from accumulating, reducing conveyance capacity, and adding to pollutant loads. Once sediment accumulates, removal is expensive and time consuming. In some cases, as water depth decreases from accumulated sediment, opportunistic, invasive vegetation can establish itself. Invasive/nuisance vegetation can be highly adaptable and aggressive, suppressing or completely out-competing local, native vegetation. Managing or completely eradicating established populations of nuisance species is also expensive and time consuming.

Figure 4.9 Inoperative BMP along upper Bayou

4.1.2.2.3 Industrial and Commercial NPDES Permits

A number of industrial and commercial companies are located within the Bayou La Batre estuary, the majority of which includes company's engaged in shipyard building and repair services. Shipyard processes (including surface preparations, painting, metal working, welding, fiberglass work, and cleaning) often produce various pollutants that can enter a water body if left unregulated. NPDES permits require industrial and commercial sites to capture pollutants which would otherwise leave the sites via storm runoff and pollute local waters. However, issuance of a NPDES permit only ensures that a state's mandatory standards and the federal minimum standards are being met. **Table 4.2** provides the current NPDES permits for commercial businesses located within the Bayou La Batre watershed.

Table 4.2 Active NPDES permitted outfalls in the Bayou La Batre Watershed (individual, general, construction, mining, and UIC sites permits listed by ADEM)

Permit #	Facility	Address	Latitude	Longitude
AL0064467	2 Gulf Hauling Pit 1	Corner of 4-Mile Rd & Irvington-Bayou La Batre Hwy	30.4467	-88.2461
AL0076104	Miller Pit #3	Ramsey Road	30.486111	-88.313889
AL0079235	Caterpillar Inc	13874 Shell Belt Road	30.38193	-88.26522
AL0079235	Caterpillar Inc	13874 Shell Belt Road	30.38193	-88.26522
ALG030024	Landry Boat Works Inc	8655 East Davenport Street	30.406644	-88.245531
ALG030024	Landry Boat Works Inc	8655 East Davenport Street	30.406644	-88.245531
ALG030029	Raymond & Associates, LLC	14562 Shell Belt Road	30.387736	-88.266042
ALG030029	Raymond & Associates, LLC	14562 Shell Belt Road	30.387736	-88.266042
ALG030029	Raymond & Associates, LLC	14562 Shell Belt Road	30.387736	-88.266042
ALG030031	J. R. Gazzier LLC	9280 Seafood House Rd	30.398611	-88.260278
ALG030031	J. R. Gazzier LLC	9280 Seafood House Rd	30.398611	-88.260278
ALG030035	S And S Marine Repair Inc	13874 Shell Belt Road	30.402739	-88.253939
ALG030036	Steiner Shipyard Inc	8640 Hemley Street	30.4025	-88.245556
ALG030036	Steiner Shipyard Inc	8640 Hemley Street	30.4025	-88.245556
ALG030038	Master Marine Inc	14284 Shell Belt Road	30.394722	-88.263889
ALG030038	Master Marine Inc	14284 Shell Belt Road	30.394722	-88.263889
ALG030038	Master Marine Inc	14284 Shell Belt Road	30.394722	-88.263889
ALG030043	Boconco Inc	14530 Shell Belt Road	30.388675	-88.265497

ALG030043	Boconco Inc	14530 Shell Belt Road	30.388675	-88.265497
ALG030045	Gulf Coast Steel Inc	14750 City Dock Road	30.3842	-88.2673
ALG030045	Gulf Coast Steel Inc	14750 City Dock Road	30.3842	-88.2673
ALG030049	Jemison Boat Dock	9315 Little River Rd	30.4011	-88.2617
ALG030049	Jemison Boat Dock	9315 Little River Rd	30.4011	-88.2617
ALG030050	Bowen Realty, Inc	8575 E Davenport St.	30.407047	-88.243994
ALG030062	Horizon Shipbuilding, Inc.	9195 Little River Road	30.403311	-88.258533
ALG030068	Williams Fabrication, Inc.	9335 Seafood House Road	30.398333	-88.261667
ALG110407	Bay Concrete	8631 Boe Rd	30.50825	-88.245194
ALG110407	Bay Concrete	8631 Boe Rd	30.50825	-88.245194
ALG110407	Bay Concrete	8631 Boe Rd	30.50825	-88.245194
ALG150075	Sea Pearl Seafood Co Inc	14120 Shell Belt Road	30.396876	-88.259024
ALG150080	Bayou Marine Products LLC	13790 Tram Ave	30.405	-88.254444
ALG150080	Bayou Marine Products LLC	13790 Tram Ave	30.405	-88.254444
ALG150082	Bryant Products Inc.	13725 Tram Ave	30.405556	-88.2525
ALG150083	International Oceanic Enterprises Inc.	9225 Seafood House Road	30.398522	-88.260333
ALG150083	International Oceanic Enterprises Inc.	9225 Seafood House Road	30.398522	-88.260333
ALG150084	Fishermen Marine LLC	13842 b Shell Belt Road	30.403553	-88.250611
ALG890123	Landry Dirt Pit	South end Lloyd Rd. off St. Hwy 188	30.428889	-88.269031
ALG890310	St Elmo Pit	North End of Beverly Road	30.502378	-88.250811
ALR108152	Bayou La Batre WWTP Influent / Effluent Line	Along Railroad St Between New WWTP & Old WWTP	30.384531	-88.252172

ALR10A865	Family Dollar - Irvington, AL	Irvington Bayou La Batre Hwy and Half Mile Road	30.494645	-88.233701
ALR10AC74	R & A Oysters	NE Corner of Four Mile Rd & Argyle Rd	30.443333	-88.261111
ALR10AI73	MCR-2004-318 # 2	Off Highway 90 (north side) - Louis Tillman Rd	30.496172	-88.293344
ALR10AU42	First Baptist Church of Bayou La Batre	9074 Bayou La Batre - Irvington Highway	30.410278	-88.246944
ALSI9949492	Irvington Seafood Inc.	11125 Beverly Road	30.44	-88.21667
ALSI9949646	South Mobile County Elementary	Grand Bay -Wilmer Road at Smith Road	30.516314	-88.242844
ALSI9949646	South Mobile County Elementary	Grand Bay -Wilmer Road at Smith Road	30.516314	-88.242844

As previously mentioned in Chapter 3, elevated levels of both copper and mercury have been recorded within the Bayou La Batre estuary. A potential source for the elevated metals could be the industrial processes that occur adjacent to the waterbody. Paint chips or fragments (containing antifouling compounds) produced from activities including sandblasting and/or stripping could wash into the Bayou La Batre system if BMP's are not implemented sufficiently (**Figure 4.10** and **Figure 4.11**).

4.1.2.2.4 Phase I and II Stormwater Permits

The Municipal Separate Stormwater Sewer System (MS4) NPDES Program, administered by ADEM, requires certain designated municipalities and other entities to obtain an MS4 permit (either Phase I or Phase II). Phase I of the NPDES Program applies to large and medium MS4s and 11 industrial categories including construction sites disturbing five acres of land or more. Phase II of the NPDES Program applies to additional MS4s and construction sites disturbing equal to or greater than one but less than five acres of land. Portions of Mobile County are located within a Phase II MS4 permitted area and the corporate boundaries of the City of Mobile are covered under a Phase I MS4 permit (USEPA 2003).

Approximately 3,281 acres within the Bayou La Batre watershed falls within Mobile County's MS4 permit (Mobile County 2017).

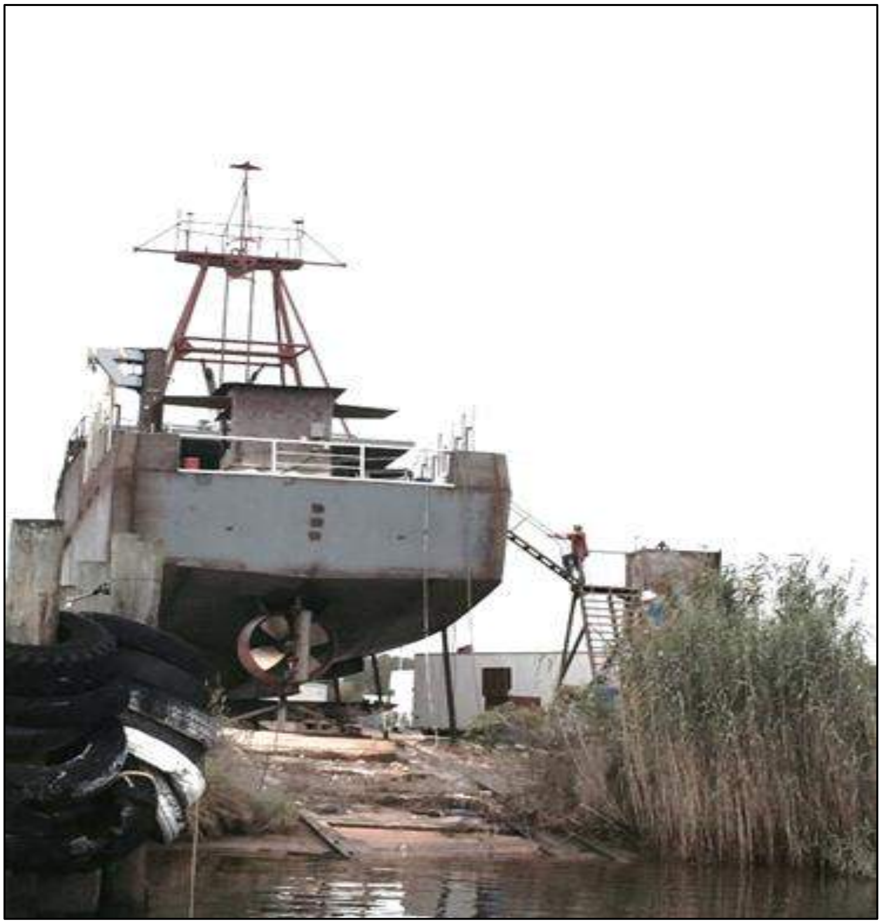


Figure 4.10 Ship repair along the Bayou La Batre shoreline

Figure 4.11 A ship in the process of being painted

4.1.2.2.5 CAFO Permits

Concentrated Animal Feeding Operations (CAFOs) are potential sources of pollutants to waterbodies. Manure and wastewater from these operations have the potential to contribute pollutants like nitrogen and phosphorus, organic matter, sediments, pathogens, hormones, and antibiotics to the environment.

There are currently no CAFOs located or permitted in the Bayou La Batre watershed (ADEM 2009).

4.1.2.2.6 Hazardous Waste

A hazardous waste is a waste with a chemical composition or other properties that make it capable of causing illness, death, or some other harm to humans and other life forms when mismanaged or released into the environment. Different categories of hazardous waste are classified based on the characteristics of the waste material (e.g. ignitability, corrosivity, reactivity, or toxicity).

There are currently no permitted landfills (construction/demolition or municipal waste) located within the Watershed.

4.1.2.2.7 CERCLA Sites

The Superfund Program was created by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), amended by the Superfund Amendments and Reauthorization Act (SARA) and is administered by the EPA. The acts established authority for the government to respond to the release/threat of release of hazardous wastes, including cleanup and enforcement actions. Long-term cleanups at National Priority List sites last more than a year while short-term /emergency cleanups are usually completed in less than a year. The Office of Superfund Remediation and Technology Innovation, under the Office of Solid Waste and Emergency Response provides the policy, guidance and direction for this program (USEPA 2008).

EPA does not currently list any CERCLA sites within the Watershed.

4.1.2.2.8 RCRA Sites

The Resource Conservation and Recovery Act (RCRA) regulates hazardous and non-hazardous wastes that may impact the Watershed. This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. The RCRA also sets forth a framework for the management of non-hazardous wastes.

There are currently no RCRA sites located within the Watershed.

4.1.2.2.9 Brownfields

Brownfields are largely abandoned properties where redevelopment may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

ADEM (2017) does not currently list any active brownfield properties within the Watershed.

4.1.2.2.10 Underground Storage Tanks

Underground storage tanks (USTs) have the potential to leak with no visible evidence until serious environmental pollution has occurred. The Groundwater Branch of ADEM administers and provides technical support for regulatory programs related to groundwater protection or cleanup. This Branch directly administers the UST Program and the Underground Injection Control Program.

ADEM maintains a list of USTs which is available on their website. While not all of the facilities on that list included geographic location, the following were identified within the Watershed (**Table 4.3**).

Table 4.3 UST facilities located in the Watershed

ACCOUNT NO.	SITE ID CO	SITE ID NO.	SITE NAME
10365.000000	97.000000	1786.000000	SCHAMBEAU'S STORE INC
10975.000000	97.000000	288.000000	CIRCLE K #8250
13364.000000	97.000000	18257.000000	BAYOU MARATHON
13929.000000	97.000000	18313.000000	IRVINGTON FOOD MART
14001.000000	97.000000	8390.000000	RACEWAY #0747
14746.000000	97.000000	3340.000000	EZ SERVE #4157-01
16799.000000	97.000000	14690.000000	WINTZELLS SUPPLY
16799.000000	97.000000	14691.000000	WINTZELLS SUPPLY
16825.000000	97.000000	14692.000000	DEAKLES UNION 76
17404.000000	97.000000	15550.000000	ST. ELMO AVIATION
17682.000000	97.000000	9969.000000	MANNING SERVICE CENTER
17698.000000	97.000000	15595.000000	CITY OF BAYOU LA BATRE POLICE DEPT
19032.000000	97.000000	1977.000000	R C MYSTIK
19187.000000	97.000000	16133.000000	GREG MORAVEC
19503.000000	97.000000	17044.000000	FISHERMEN MARINE PRODUCTS
19505.000000	97.000000	17048.000000	GULF CITY SEAFOODS INC

19505.000000	97.000000	17049.000000	GULF CITY MARINE
19534.000000	97.000000	17115.000000	INTERNATIONAL OCEANIC ENTERPRISES
20378.000000	97.000000	1976.000000	PALMER'S QUICK STOP #1
22271.000000	97.000000	16434.000000	BAYOU MARINE PRODUCTS
23223.000000	97.000000	449.000000	ST. ELMO PETRO
23787.000000	97.000000	18332.000000	PALMER'S GROCERY #2
24190.000000	97.000000	7148.000000	REY'S FOOD MART
24235.000000	97.000000	18666.000000	LAMBODAR, LLC
24669.000000	97.000000	10962.000000	DIXONS GROCERY STORE

4.2 Habitats

Naturally-occurring vegetative communities within the Watershed are typical of those found adjacent to Mississippi Sound in the northern Gulf of Mexico and are described in detail in **Section 2**.

4.2.1 Degraded Streams & Wetlands

The cumulative stream network system of the Watershed (approximately 73 miles) drains to the south and west thorough the mouth of the Bayou La Batre River into Portersville Bay. As described previously, sedimentation is a necessary and natural process involving the detachment, transport, and deposition of particulate matter within the water column or substrates of waterways including streams, rivers, impoundments, and wetlands. This process impacts stream communities through a variety of direct and indirect processes on both channel morphology (channel scouring and filling) and impairment of water quality, including increased stream water column turbidity and altered water chemistry, as well as introducing chemical contaminants and other pollutants.

Most observed stream and wetland impairments occurred at the road-stream crossings. Road systems typically occupy a relatively small portion of the landscape, yet their construction and maintenance has a great impact on water quality and aquatic ecosystems (Gucinski *et al.* 2000). Of the multiple sources of stream-bound sediments, one of the most pervasive is the road-stream crossing. This direct connection between roads and streams introduces risk of exposure to toxic chemical materials (USFWS 2005).

Figure 4.12 Bank scour associated with a road culvert crossing

In addition to excessive sediment inputs to streams and wetlands originating from unpaved roads, other observed negative water quality impacts associated with road-stream crossings were a result of elevated and/or closed bottom culverts.

Elevated and closed bottom culverts have the potential to create a migratory barrier to animal movement and alter the channel bed, hydraulic gradient bottom and ability of the waterbody to transport water and sediment.

Closed bottom culverts prevent the natural aggradation and degradation of the channel bed. Instances of channel degradation or a lowering of the streambed gradient, result in hydrologic impairments (i.e., “hydraulic jumps” and a “backing” of water upstream of crossing impoundments) as well as migratory barriers to aquatic fauna, fragmenting and isolating populations and reducing access to vital habitats. The “backing” of water can result in a drastic reduction in stream velocity immediately upstream of the crossing, creating stagnant water, along with a reduction in sediment transport capacity resulting in deposition. Over-widened closed bottom culverts (i.e. greater than the channel’s bankfull width) result in a decrease in sediment transport capacity within the crossing promoting deposition of sediment and channel aggradation. This frequently results in necessity of routine maintenance of the crossing structure to remove excess sediment.

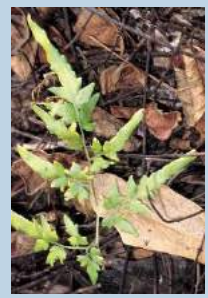
Figure 4.13 Elevated and clogged culvert crossing preventing upstream migration of aquatic organisms

4.2.2 Invasive Species

Non-native, invasive species can significantly impact natural systems and ecosystem function. Invasive/nuisance vegetation can be highly adaptable and aggressive, suppressing or completely out-competing local, native vegetation. Managing or completely eradicating established populations of nuisance species is also expensive and time consuming. Non-native/invasive species are commonly found in disturbed or degraded ecosystems that have been impacted directly or secondarily from anthropogenic activity. **Section 2** and **Table 4.4** below provide a list of potential invasive species found within the Watershed and surrounding areas.

Table 4.4 Observed invasive species in the Watershed

	Species	Occurrence	Photo (Source: AL Invasive Plant Council)
Plants	Chinese tallow (*Triadeca sebifera*)	Typical of wetland ecosystems (disturbed and undisturbed), including frequently inundated wetlands and floodplains.	
	Chinese privet (*Ligustrum sinense*)	Typical of occasionally flooded wetland ecosystems, such as wetland hardwoods and floodplains. Common in areas adjacent to urban floodways and water courses.	
	Chinese wisteria (*Wisteria sinensis*)	Typical of disturbed upland ecosystems in urban environments around easements and Right of Ways.	
	Persian Silk Tree/ Mimosa Tree (*Albizia julibrissin*)	Typical of disturbed upland ecosystems, specifically in Right of Ways and residential areas.	
	Air potato (*Dioscorea bulbifera*)	Typical of disturbed and urban upland ecosystems, specifically in easements, Right of Ways and residential areas. Tends to grow vertically within canopies and manmade structures.	
	Water hyacinth (*Eichhornia crassippies*)	Typical of open water ecosystems, especially in closed basin nutrient rich waterbodies. Can be found in streams and riverine systems.	
	Cogon grass (*Imperata 150ylindrical*)	Typical of disturbed upland ecosystems, specifically in Right of Ways, easements and residential areas.	
Plants	Kudzu (*Pueraria spp.*)	Typical of disturbed and urban upland ecosystems, specifically in easements, Right of Ways and residential areas. Tends to grow vertically within canopies and over manmade structures.	

	Species	Occurrence	Photo (Source: AL Invasive Plant Council)
	Common reed (*Phragmites australis*)	Typical of shorelines along open water and herbaceous wetland ecosystems, including brackish water environments. Can be found along roadsides and ditches.	
	Japanese honeysuckle (*Lonicera japonica*)	Typical of disturbed and urban upland ecosystems, specifically in easements, Right of Ways and residential areas. Tends to grow vertically within canopies and over manmade structures.	
	Japanese climbing fern (*Lygodium japonicum*)	Typical of disturbed upland and transitional ecotones, especially adjacent to managed right of ways, embankments and ditches.	
	Golden bamboo (*phyllostachys aurea*)	Typical of disturbed and urban upland ecosystems, specifically in easements, Right of Ways and residential areas where there is limited over-story and ample sunlight.	
	Torpedo grass (*Panicum repens*)	Typical of wetlands, ecotones and Right of Ways, especially along ditches. Can be found in standing water environments.	

4.2.3 Altered Hydrology

Apart from road-stream crossings, other observed stream impediments were a result of alternations to the natural dimension, pattern, and profile of waterbodies as well as their connectivity to the floodplain. These alternations can cause a variety of impairments to water quality, channel morphology, and quality of aquatic habitat. Specific impacts to waterbodies observed in the Watershed include floodplain fill from dredging and straightening (i.e., channelizing) of the stream channel. Both activities create incised channels characterized as having high bank erosion rates, lateral channel migration, and increased sediment supplies (i.e. bed aggradation and bar deposition) that often results in a loss of aquatic habitat.

Figure 4.14 Channelized and incised tributary to Bayou La Batre

4.2.4 Salt Marsh Habitat

Salt marsh communities in the Bayou La Batre Watershed have been subjected to significant erosional and biological degradation. Conservation and restoration of existing communities should be a priority of the management plan. One such effort is the Little Bay Finfish and shellfish nursery habitat Restoration program. This program is funded through the Alabama Department of Conservation and Natural Resources-State Lands Division by the NOAA Fisheries Emergency Disaster Relief Program (EDRP). The restoration site is located along the western shoreline of Bayou La Batre in Mobile County, Alabama. The project includes placement of breakwaters to reduce erosional wave action, as well as placement of sandy fill and revegetation of coastline using native vegetation plugs. If the project is successful, as much as 34 acres of saltmarsh would be restored within the Bayou La Batre Watershed (Ocean Conservancy, 2011). Additionally, salt marsh habitat is expected to proliferate as sea levels rises. According to the Sea Levels Affecting Marshes Model (SLAMM), between 61 and 77 acres of upland communities are predicted to transform into saltmarsh ecosystems by the year 2100. This prediction estimates between 25-30% more saltmarsh habitat by 2100. The Sea Levels Affecting Marshes Model (SLAMM) was developed by the Environmental Protection Agency (EPA) to evaluate the effects of sea level rise on marsh habitats. The model maps habitat distribution over time in response to processes including SLR, accretion and erosion, tides, and freshwater influence.

Figure 4.15 Evidence of filling of saltmarsh habitat at Lightning Point

4.3 Resiliency

Results of the Sea Level Affecting Marsh Model (SLAMM), Sea, Lake and Overland Surges from Hurricanes (SLOSH), and Sea, Lake and Overland Surges from Hurricanes plus Sea Level Rise (SLOSH+SLR) models provide some indication of the watershed's vulnerabilities as they relate to SLR, storm surge, and resiliency. The SLOSH results indicate that many of the City of Bayou La Batre's buildings will be impacted by Category 3 storm surge, and even more will be impacted by a Category 3 storm surge when incorporating the most conservative SLR projections (IPCC 2013 intermediate level). Essentially all of the built environment within the floodplain is vulnerable to impacts from major storms and localized flooding events. As sea levels rise, so do local mean high water levels (MHWLs), so therefore floodplain delineations can change.

4.3.1 Vulnerability

The Intergovernmental Panel on Climate Change (IPCC) describes climate vulnerability as a function of the character, rate, and magnitude of the stressor, the sensitivity of the system to the stressor, and the ability of the system to adjust to the change, moderate potential damages, cope with consequences, and/or take advantage of opportunities. The specific vulnerability of a particular estuary depends on physical features such as elevation gradient, estuarine depth, size, geomorphology, and species composition.

As far as the built environment, it is important to identify services and associated facilities that are critical or essential to normal daily operations following a disaster event. These are called "essential facilities" or "critical facilities," which typically include emergency services such as police, fire, and EMS; medical facilities such as hospitals, clinics, and elderly care centers; fueling stations; shelters; schools; hazardous material sites; wastewater treatment operations; and potable water supplies. Government facilities such as City Hall and Public Works are also essential to disaster response and recovery. In total, there are 11 government facilities, 15 educational facilities, 117 industrial facilities, 59 religious facilities, 35 agricultural facilities, 427 commercial facilities, and 6,830 residential buildings in the Bayou La Batre Watershed. A review of facilities in the Bayou La Batre Watershed reveals that several essential facilities are located within the 100-year floodplain (see **Figure 4.16** and **Table 4.5**). Specifically, the Bayou La Batre City Hall, Police Station, and Fire Station are all located in the 100-year floodplain and are vulnerable to isolated flooding events and flooding associated with tropical storms and hurricanes.

Table 4.5 Essential facilities in the Bayou La Batre Watershed

Government Facilities	Address	100-Year Flood Zone	Evacuation Zone[1]
Bayou La Batre Community Center, Senior Citizen's Center, Public Library, and Chamber of Commerce	12747 Padgett Switch Rd 36544	No	1
Bayou La Batre Utilities Board	13321 North Wintzell Ave 36509	Yes	1
Bayou La Batre Public Works Department	8330 Rabby St 36509	No	1
Bayou La Batre City Hall	13785 South Wintzell Ave 36509	Yes	1
Clinics			
Mostellar Medical Clinic	12701 Padgett Switch Rd 36544	No	1
St. Margaret Catholic Church Providence Hospital Clinic	13790 S Wintzell Ave 36509	Yes	1
Bayou Clinic	13833 Tapia Ln 36509	Yes	1
Fire Stations			
St. Elmo Irvington Fire Department	8701 Half Mile Rd 36544	No	1

Government Facilities	Address	100-Year Flood Zone	Evacuation Zone[1]
Bayou La Batre Fire Department	13775 S Wintzell Ave 36509	Yes	1
Police Station			
Bayou La Batre Police Department	8725 Delcambre St 36509	Yes	1
Schools			
St. Elmo Elementary School	8666 McDonald Rd 36568	No	1
Dixon Elementary School	8650 Four Mile Rd 36544	No	1
Alma Bryant High School	14001 Hurricane Rd 36544	No	1
Anna Booth Elementary School	1701 Hurricane Blvd 36544	No	1
Alba Middle School	14180 S Wintzell Ave 36509	No	1
Elderly Care Facilities			
Mackey's Home	8571 Three Mile Rd 36544	Yes	1

1. The Evacuation Zone corresponds to the Evacuation Zone descriptions in Section 4.3.5

4.3.1.1 Flooding

The December 2015 update to the Mobile County Multi-Hazard Mitigation Plan indicates that flooding and hurricanes are among the highest hazard exposure rates in Bayou La Batre, along with severe storms, tornados, droughts, and winter storms. Hazard exposure rates are statistical assessments identifying areas that are at risk and exposed to certain natural phenomena. Currently, the total of all residential building values in Bayou La Batre equals $1,428,301, and the total of all non-residential building values equals $531,483 for a combined total of $1,959,784. HAZUS estimates that a 100-year flood event would result in $7.72 million in economic losses in Bayou La Batre.

There are 230 active National Flood Insurance Program (NFIP) policies in Bayou La Batre with a total insurance valuation of $55,989,400. There are 78 repetitive loss (RL) structures and two severe repetitive loss (SRL) structures in Bayou La Batre. An RL property is a building which has had two flood insurance claims within a ten-year period, and an SRL property is a building which has had four or more insurance claims with at least two occurring in a ten-year period with the total claims exceeding $20,000. Along with the essential facilities identified in **Section 3.4**, these areas should be targeted for mitigation, as they are most vulnerable to future impacts from flooding. Mitigation options will be discussed in **Section 4.3.3** below, but generally include acquisition, relocation, elevation, or flood proofing.

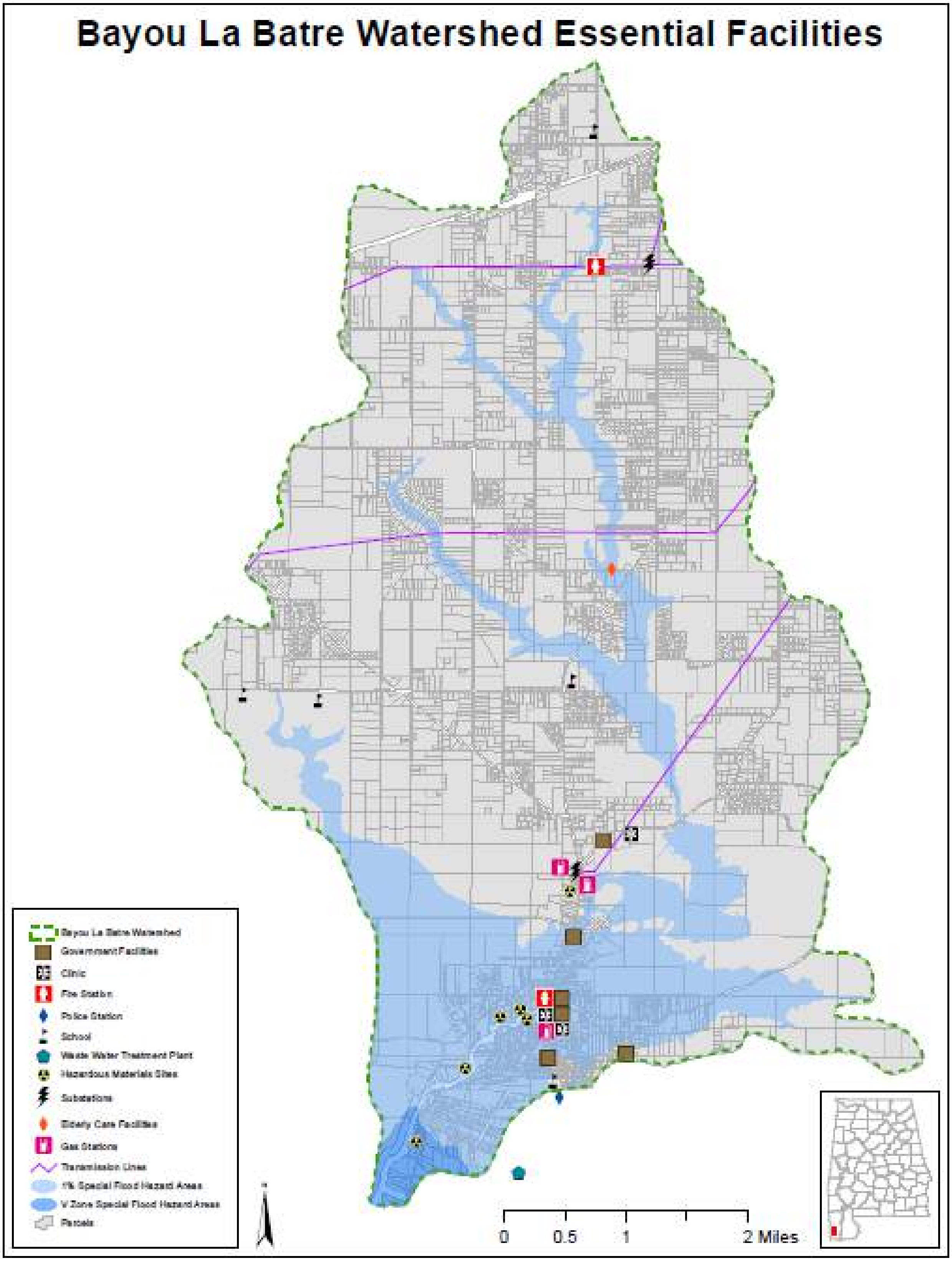


Figure 4.16 Essential facilities in the Bayou La Batre Watershed

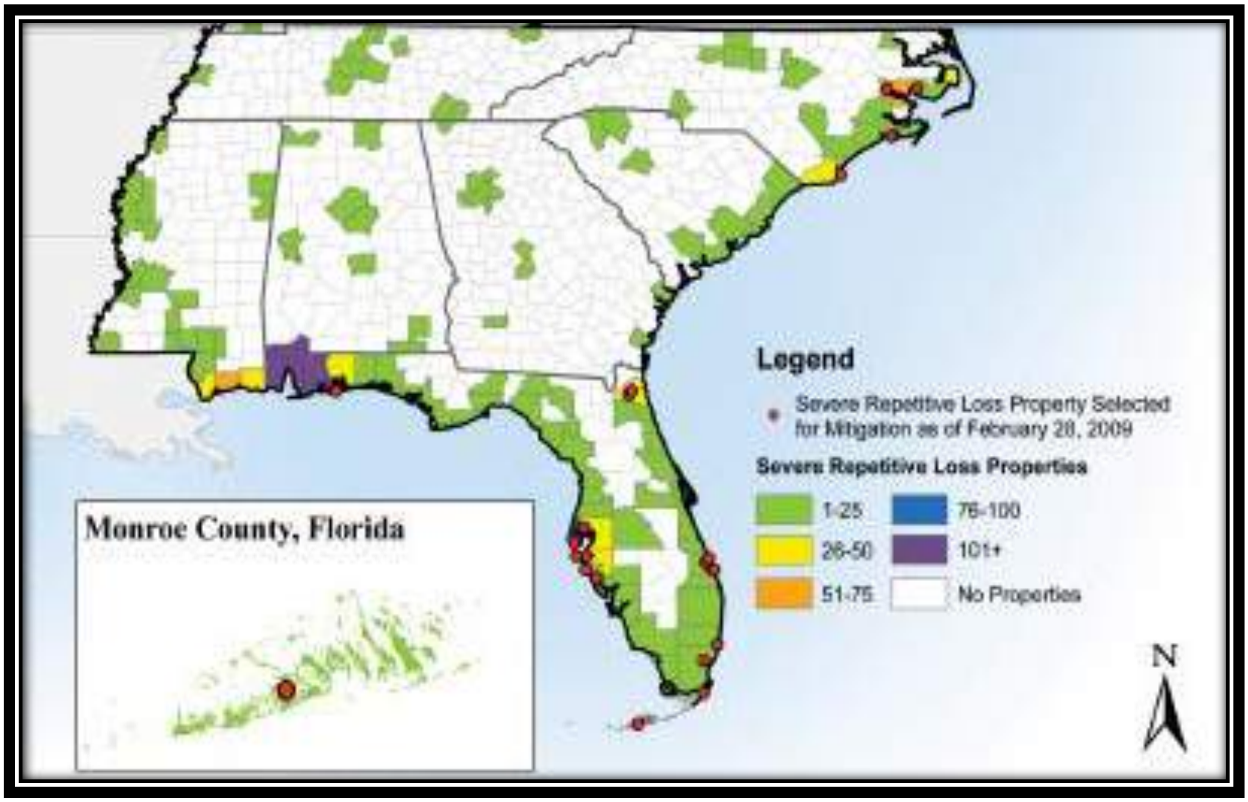


Figure 4.17 Severe repetitive loss properties in FEMA Region IV, FEMA 2009

4.3.1.2 Hurricanes

Unfortunately, Bayou La Batre residents recognize the significant hazard represented by hurricanes to coastal communities through high tides, high winds, and flooding. In 2005, Hurricane Katrina sent nearly 14 feet of water over Bayou La Batre, inundating homes and businesses (Elliott 2015). The City dock was wiped out, along with much of the town's seafood industry along Shell Belt Road and the City's industrial hub (Associated Press 2015). Flood waters and winds in excess of 100 miles per hour damaged or destroyed 65 percent of all occupied housing units. In the aftermath of the storm, roughly 1,000 Bayou La Batre residents faced homelessness. Public buildings, schools, businesses, and churches were heavily damaged or destroyed. The municipal wastewater treatment plant was flooded and sustained permanent damage. The Gadsden Times (Beyerle 2005) reported that virtually all residences in nearby Coden were damaged or destroyed. The Mose Hudson Tapia Public Library in Bayou La Batre was completely destroyed, and materials contaminated by mold could not be salvaged. The City built a new facility, renamed City of Bayou La Batre Public Library, at a new location, approximately two miles north in Irvington, that opened in early 2007. "The new library is far enough away that, even if we had severe flooding, the building would be okay," said Library Director Patricia Sebert (Dankowski, 2015).

Hazard mitigation is an important concept that involves taking action to reduce or prevent future damage from a disaster. Hazard mitigation generally involves four primary elements: 1) identifying hazards, 2) assessing risks and vulnerabilities, 3) developing and prioritizing mitigation actions, and 4) implementing mitigation actions.

4.3.1.3 Sea Level Rise (SLR)

The Sea Levels Affecting Marshes Model (SLAMM) was developed by the Environmental Protection Agency (EPA) to evaluate the effects of sea level rise on marsh habitats. The model maps habitat distribution over time in response to processes including SLR, accretion and erosion, tides, and freshwater influence. Since tidal inundation from SLR is expected to be a major driver of habitat succession within the Bayou La Batre estuary, a SLAMM Report was generated (**Appendix B**) and used to simulate macro-level habitat conversions in response to SLR and related geomorphologic processes.

SLAMM is based on the conceptual model that Bayou La Batre habitats change over the long-term in the response to the processes presented above. These processes provide the conceptual basis or framework for the habitat projection model, which utilizes the base environmental conditions and projects possible future conditions in the estuary. For the SLAMM analysis, a low SLR average scenario of 21 inches and a high SLR average scenario of 29 inches were utilized for the 2100 prediction.

To evaluate how habitats will evolve over time, existing habitat conditions are mapped by combining the National Wetlands Inventory (NWI; 2002) data with a map of imperviousness (National Land Cover Database (NLCD) 2011) to delineate between developed and undeveloped upland. Vegetation is then categorized into habitat types according to the SLAMM NWI habitat cross-walk.

Based on both SLR scenarios that were included within the SLAMM, some upland and freshwater swamp vegetation community types are projected to be converted to saltmarsh and open water habitats. Under both low and high SLR scenarios utilized, there is a loss of upland habitat and an increase of salt marsh, tidal flat, and open water acreage (acreages shown for both low and high scenarios in **Table 4.6**, however the modeled higher rates of sea-level rise predicts an accelerated land conversion rate. **Table 4.6** details the model results for habitat maps (year 2100) for low and high SLR scenarios. If habitat is allowed to convert, the model predicts a total of 79 acres of developed upland could be altered to fresh water wetland habitats.

4.3.2 Adaptation Planning

EPA's Climate Ready Estuaries: Synthesis of Adaptation Options for Coastal Areas (2009) describes adaptation strategies as physical changes, technological advancements, or management decisions. The document lists several potential adaptation strategies based on management goals common to estuarine programs, such as maintain/restoring wetlands, maintaining sediment transport, maintaining shorelines, invasive species management, preserving habitat, and maintaining water quality. An excerpt of several of the adaptation strategies for each potential stressor is located in **Table 4.7**.

Table 4.6 Habitat acreages for low and high SLR scenarios at 2100

Habitat	Model Acreage	Acreage in 2100		Acreage Difference 2100-2002	
	In 2002	Low	High	Low	High
Developed Upland	1,554	1,491	1,474	-62	-79
Undeveloped Upland	9,444	9,418	9,397	-27	-48
Freshwater Swamp	2,935	2,933	2,948	-2	13
Freshwater Marsh	73	91	95	19	22
Salt Marsh	244	305	320	61	77
Tidal Flat	0	9	10	9	10
Estuarine Beach	12	12	12	0	0
Open Water	232	234	238	2	6

4.3.3 Evacuation Planning

Bayou La Batre is located in Zone I of the Mobile County Zoning Evacuation Map. Zone I residents are strongly advised to evacuate the area in the event of a Category 1 hurricane or greater, especially for residents in mobile homes and low-lying, flood-prone areas. Zones to evacuate will be announced using local media. Residents of Bayou La Batre and Grand Bay are advised to take Highway 188 or Mobile County Road 19 to I-10 East to I-65 North (Mobile County Emergency Management Agency, 2016). Other items of note by the Mobile County Emergency Management Agency (2016) include:

- All southbound traffic will be halted, and all four lanes will be used for northern traffic.
- If necessary, the Governor can also direct reverse-laning for I-65.
- Road closures will be available on local media and on the www.dot.alabama.gov website.
- Please do not contact the Alabama State Troopers office unless you have an emergency or accident to report due to congestion on their phone systems as they need to keep access to all available telephone lines open.
- High winds and damaging rains are a danger to automobiles on raised highways and bridges. Drivers of RV's, busses and other high profile vehicles should use extreme caution.

The Zoning Evacuation Map is provided in **Figure 4.18**.

Table 4.7 Adaptation strategies for potential stressors in the Bayou La Batre Watershed

Adaptation Option	Climate Stressor Addressed	Additional Management Goals Addressed	Benefits	Constraints	Examples
Manage realignment and deliberately realign engineering structures affecting rivers, estuaries, and coastlines	Changes in precipitation; Sea level rise; Changes in storm intensity	Preserve habitat for vulnerable species; Maintain/ restore wetlands; Maintain sediments transport	Reduces engineering costs; protects ecosystems and estuaries; allows for natural migration of rivers	Can be costly	United Kingdom/ European Union
Land acquisition program- purchase coastal land that is damaged and use it for conservation	Altered timing of seasonal changes; Increases in air and water temperatures; Sea level rise; Change in storm intensity	Preserve habitat for vulnerable species; Maintain/ restore wetlands	Can provide a buffer to inland areas; prevents development on the land	Can be expensive; land may not be available	New Jersey Coastal Blue Ares (see text box page 10)
Integrated Coastal Zone Management (ICZM)- using an integrated approach to achieve sustainability	Changes in precipitation; Sea level rise; increases in air and water temperatures; Changes in storm intensity	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	European Union; Australia26
Incorporate consideration of climate change impacts into planning for new infrastructure (e.g. homes, businesses)	Sea level rise; Changes in precipitation; Changes in storm intensity	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	Land owners will likely resist relocating away for prime coastal locations	Rhode Island State Building Code 27

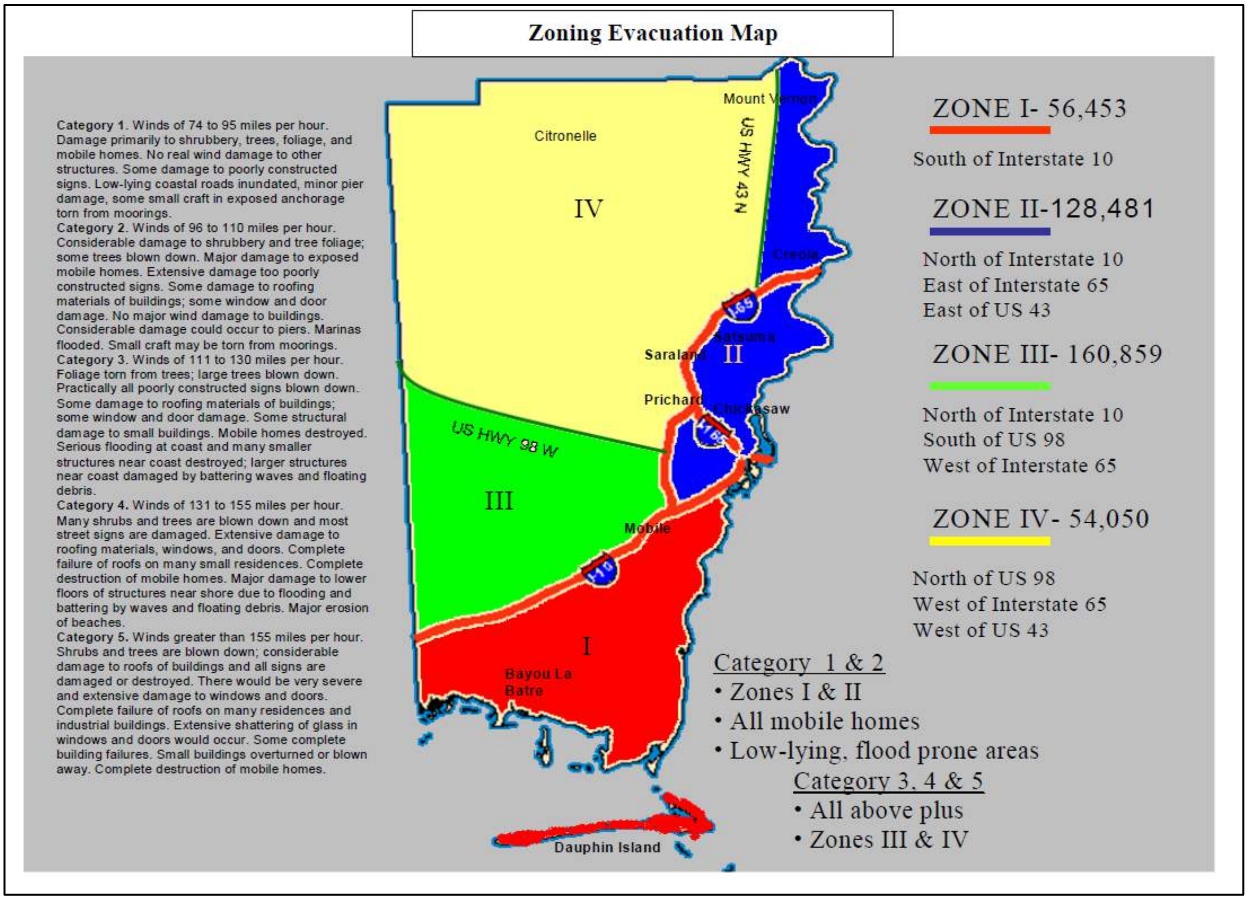


Figure 4.18 Zoning evacuation map for Mobile County

4.4 Coastlines

The critical issues facing shorelines in this Watershed fall into two broad categories: erosion and access. Each of these are further discussed in the subsections that follow.

4.4.1 Bank and Shoreline Erosion

The erosional tendencies of shorelines within the Watershed are strongly dependent upon location. Shorelines along Portersville Bay experience much more long-term change than anywhere else, due to the relatively lack of shoreline armoring as compared to other shorelines throughout the watershed. Also, these shorelines are subjected to frequent natural and boat wake wave action. The natural shorelines susceptible to erosion in the upper reaches of the watershed are dependent upon changes in streamflow during storm events, not coastal processes.

As demonstrated in **Section 3**, there have been dramatic changes in shoreline position near the mouth of Bayou La Batre. These changes are most pronounced from Little Bay to Lightning Point (see **Figure 3.24**). The shoreline near the mouth of the Bayou has retreated by 750 to 1000 feet on both side, and approximately 200 feet near Lightning Point. These bay shorelines are most susceptible to the daily wave action and boat traffic, and in more critical cases, severe weather. These are critical shorelines that can and should be restored to a historic position and appropriately stabilized with native materials and some limited use of structure to attenuate wave energy.

4.4.2 Land Ownership

A secondary issue related to shorelines is access, which is a function of land ownership in the Watershed. Access will be covered more fully in the subsequent report section, but it is important to mention here within the context of shoreline use. Much of the shoreline south of the Bayou La Batre Bridge is privately owned and armored to support the commercial industries of boat manufacturing and seafood harvesting. In fact, there are only two locations along the main channel that are owned by the City: the end of Mars Avenue and south of the end of Powell Avenue. Both of these waterfront locations would be suitable for public access to the Bayou. These shorelines, currently in a natural form, could be enhanced to facilitate public use and recreation, including the potential addition of infrastructure to support a kayak launch. Separating kayaks from the traditional public boat launches is becoming necessary at launches that are heavily used by both groups. With regard to the potential for comprehensive shoreline restoration and/or enhancement along Portersville Bay, all of the land from the mouth of the Bayou to east of Lightning Point is privately owned. In November of 2016, NFWF awarded The Nature Conservancy approximately six million dollars for the purposes of acquiring and restoring coastal shoreline at the mouth of the Bayou La Batre River (Lightning Point). Specifically, the project includes the acquisition of more than 100 acres of coastal habitat and restoration of approximately 28 acres of marsh and 1.5 miles of intertidal nearshore breakwater.

4.5 Access

Access to the Watershed and its amenities are limited, as much of the coastal shoreline is privately owned.

4.5.1 Waterway Accessibility

As previously mentioned, there are but a few limited points of access to enter the waterway. That said, the Bayou offers a great opportunity for a blueway trail that could start at Lightning Point and continue up the tributaries that join to create the Bayou. As noted elsewhere commercial traffic in the lower portions of the Bayou will be an important consideration when it comes to safe transit of smaller vessels.

4.5.2 Land Ownership

Besides the opportunities for partnership with private landowners like churches, public institutions, and restaurants, mentioned above, there is an opportunity to consider strategic acquisition of properties currently on the market, for a gateway open space that welcomes and orients visitors to the Watershed and the Bayou. There would need to be future detailed studies and interviews with landowners along the Bayou and along the main trails and routes noted through the watershed to explore future land acquisition or easements for expanded public access and recreational synergies.

4.6 Heritage

The culture, heritage, and history of the people of the City of Bayou La Batre, Coden, Dixon Corner, Irvington and similar communities has revolved around the resources provided by the Bayou La Batre Watershed. From the 1600's until today, thousands of individuals and families have derived incomes and livelihoods from the regional coastal waters that were accessed from Bayou La Batre. Even in the toughest financial times, families have traditionally been able to eke out a reasonable living and raise their children. In the best of times, everyone flourished and enjoyed the natural bounties derived from harvesting the local waters. The people of the Bayou La Batre waterway and Watershed have traditionally exhibited an adaptive spirit, an amazing work ethic and a belief that tomorrow would be better than today.

There is little doubt that the future of the communities that make up the Bayou La Batre Watershed is in doubt in many ways. The challenges are immense but are outweighed by the opportunities if one will only step back and envision what the future can hold. With a little planning and visionary leadership, the Bayou La Batre Watershed can continue to provide the basis for a vibrant local economy – but perhaps an economy that looks slightly different from that of today.

4.6.1 Economic Diversity

The economy of the south Mobile County area surrounding the Bayou La Batre Watershed is currently almost totally dependent on the harvest of "wild" seafood and boat building. Hurricane Katrina in 2005 and the BP Deepwater Horizon Oil Spill of 2010 painfully illustrated the need for a more diversified economy, as fishing and boatbuilding were virtually shut down for many months each time.

For decades, the rich bounty of the Gulf and local waters has sustained the communities of the Bayou La Batre Watershed. However, multiple demands have stressed the ability of the natural system to sustain the local economy as effectively as in the past. The local commitment to the seafood industry has been diminishing, and the local emphasis has shifted more and more to the shipbuilding sector. However, the fact remains that demands on the seafood industry have taken their toll on the natural ecosystems and substantially jeopardized the fragile community economic structure, based on both the seafood industry and shipbuilding.

The Seafood Economy – The network of different professions and individuals that benefit directly and indirectly from the seafood industry is myriad. Some include boat owners, boat deck hands, fuel suppliers, ice suppliers, boat outfitters, grocery stores, net makers, seafood processors and workers, truck drivers, and many more. When a seafood company goes out of business, all of the individuals, families, and companies in the chain are negatively impacted. Many of the companies, jobs, and families have left. In 2005, there were approximately thirty seafood companies operating in Bayou La Batre processing shrimp, crab and oysters. Today, there are only eight.

For the economy of the region surrounding the Bayou La Batre Watershed to flourish again, the existing seafood industry must be protected, which should help to establish opportunities for the next generation of seafood entrepreneurs. For example, Alabama universities, high schools and researchers have teamed up over the last few years to promote the development of cultivated off-bottom oyster farms. These operations are able to produce an oyster that demands a higher price for the growers/harvesters and is less susceptible to natural elements.

The Boat Building Economy – Bayou La Batre is home to a number of boat yards that manufacture and repair a substantial number of vessels each year. Most of these are "push boats" or vessels designed to support the oil industry. The industry is currently thriving but is directly impacted by the world economy and the cyclic nature of government funding.

It should be noted that approximately 60% of the residential housing inventory within the Bayou La Batre Watershed was destroyed by Hurricane Katrina in 2005 and has not been rebuilt. As a result, hundreds of men and women who work for the shipyards leave Bayou La Batre each evening and return to their homes in other communities. This means that their incomes are spent in those other communities, and their economic multiplier effect does not benefit Bayou La Batre Watershed area.

It is also worth noting that, with all of the boat building companies in Bayou La Batre, only one shrimp boat has been constructed in the area in the last fifteen years. This is yet another indicator of the declining seafood industry.

4.6.2 Tourism

Data collected from stakeholders of the Bayou La Batre Watershed and extensive discussions at meetings of the Steering Committee and open community meetings illustrate definitively the belief that the natural resources of the waterway hold the key to future economic stability. In 2008, a developer proposed the purchase of properties throughout the City of Bayou La Batre and the greater Bayou La Batre Watershed. The design was to convert the community into a tourist mecca similar to Gulf Shores or Orange Beach. The plan was not met with favor among most of the locals and ultimately the plan was unsuccessful.

Given that scenario, it was surprising that community residents and other stakeholders expressed overwhelming support for the development of a comprehensive tourism "industry" focused on using the local natural resources as the basis for ecotourism, new jobs, and increased economic diversity. In many ways, the reincarnation of Apalachicola, Florida, provided a model on which to create a plan for Bayou La Batre.

Ecotourism is a form of tourism that aims to be both socially conscious and ecologically sensitive. It typically focuses on activities related to local flora, fauna, and cultural attractions.

When considered as a third economic driver for the Bayou La Batre watershed area, ecotourism has the potential to create a number of supporting businesses and substantial employment. The seafood industry and, more recently, shipbuilding have been the lifelines for the community. Stakeholders have responded overwhelmingly that the potential diversity afforded by responsible ecotourism is the most logical method for stabilizing the region's economy.

Nature excursions and sightseeing trips, birding trails, hiking and biking trails, environmental instruction centers, canoeing, kayaking, sport fishing, rustic camping, and wildlife photography are just a small list of the ecotourism options that could be promoted within the Watershed. Watershed stakeholders believe overwhelmingly that ecotourism activities could be developed and promoted without bringing damage to the community's fragile ecosystems or its heritage and culture.

4.6.3 Working Waterfront

Information collected throughout the planning process strongly suggests that the community can build an economy based on its natural assets while simultaneously coexisting with the current seafood and marine industries. The trend for communities such as Bayou La Batre is to create working waterfronts that provide community access to the waterway while blending tourism with commercial sites. The Bayou is primed to deliver such a unique experience.

Commercial activities such as seafood processing and shipbuilding require waterfronts for their operations and survival. These water-dependent industries have tremendous economic impacts on the Watershed and the State. In Bayou La Batre, it is imperative that these working waterfronts be preserved to protect each watershed's economic engines and the traditional community culture and character.

Most coastal communities are putting substantial effort into ensuring waterfront access for fishermen and water-dependent businesses – as well as for public access. In many areas of the United States, steps are being taken through legislative action, tax incentives, the formation of special interest groups, and grants to ensure that an adequate inventory of the current working waterfront properties is maintained.

Along the Bayou La Batre waterway, access by commercial entities is not considered an issue. In fact, the entire waterfront from just above the Bayou La Batre Bridge (drawbridge) to the mouth of the waterway, is totally commercial with almost no access at all by the public. Currently, the only location where the public can launch a boat, fish by rod and reel, or launch a canoe or kayak is at the City Docks, located at the far southern reaches of the Bayou.

One of the highest priorities of stakeholders completing surveys was the need for additional public access points. For the Bayou La Batre Watershed to be the genesis of a balanced community and a sustainable economy, both the public and commercial interests must have access.

4.6.4 Cultural Preservation

The future of the Bayou La Batre Watershed and its stakeholders now appears to depend once again on the proper preservation and engagement of its natural ecosystems. For nearly 120 years, the community's livelihood and economic base was derived from the harvest of natural resources from regional waters. Shipbuilding tended to supplement the economy as the seafood industry was battered by natural and man-caused disasters. Now, the community's reliance on the abundance of land-based and water-derived natural resources deployed to promote a vibrant ecotourism industry is probably the key to its survival.

As this new industry unfolds, it is imperative that residents' deep and abiding love of the history, culture, and productivity of the Bayou be protected and nurtured. The indomitable spirit of the people must be embraced and cultivated to create new vistas for the next generations and new opportunities for entrepreneurial expression, as well as healthy connections to the past.

5 Bayou La Batre Watershed Goals and Objectives

The MBNEP has outlined the following goals and objectives for its watershed management planning efforts:

- Provide a roadmap for restoring/conserving the Watershed and improving water and habitat quality
- Chart a conceptual course for improving/protecting the things people value most about living along the Alabama coast:
    - Water Quality
    - Fish/ Habitats
    - Coastlines
    - Resiliency
    - Access
    - Heritage
- Provide a strategy for conserving and restoring coastal habitat types providing critical ecosystem services
- Develop a comprehensive plan to maximize environmental health and public benefit by identifying actions to improve the environment; promote community ownership, knowledge, and involvement in watershed management; provide additional accessibility; and restore and conserve priority habitats

5.1 Vision

The WMP Team carefully listened to the community and stakeholders to gain insight into their issues, needs, and concerns. Throughout this extensive public outreach and engagement process, the WMP Team has encapsulated what they heard from the community into this common vision for the Watershed:

Vision: *To transform the Bayou and its watershed into a healthy and vibrant community amenity to Coastal Alabama that supports robust habitat; provides increased public access; serves as an economic engine supporting the seafood and shipbuilding industry and ecotourism; and celebrates and preserves the rich culture and heritage of the area.*

The Bayou serves as a focal point and key geographical feature of the Watershed and Coastal Alabama. Investing in its restoration and improvement will provide a sense of place for the local community, support their way of life, and attract visitors from outside of the area.

5.2 Goals and Objectives

5.2.1 Goals and Objectives Development

Input gathered from the BLB Steering Committee, residents, and other stakeholders was used to shape the goals and objectives of the WMP. As part of this process, the following items were noted:

Success Factors:

To be successful, the WMP needs to provide:

- useful information for local and regional planning and management efforts.
- scientific validation of issues and concerns.
- a roadmap to a fishable/swimmable bayou.
- increased recreational opportunities.
- recommendations for multi-use, multi-benefit projects for a sustainable community.
- provide tools to increase community resilience.

Challenges and Concerns:

- **Water Quality**
    - Fishable, swimmable waterbodies
    - Portersville Bay water quality—Portersville Bay is intrinsically tied to BLB environmental and socioeconomic health
    - Waste water treatment plant (WWTP) outfall
    - Septic tanks
    - Live aboard vessels
    - Trash
    - Shipbuilding debris
    - Stormwater runoff
    - Industrial pollution
- **Fish/Habitats**
    - Pressure from land use changes and development
    - Many coastal wetlands in private ownership
    - Invasive species
- **Coastlines**
    - Eroding banks along upper Bayou
    - Eroding shoreline at Lightning Point

- **Resiliency**
  - Community and emergency services and many town areas in floodplain
  - Neighborhood flooding
  - Debris in conveyances and channels clogging stormwater flow
  - Previous destruction from hurricanes
  - Sea level rise
- **Access**
  - Need more public access to water
  - Much of bayou under private ownership
  - City docks underutilized and in disrepair and one of the few places for public to access bay and bayou
  - Boat ramp improvements and expansion
- **Heritage**
  - Diverse community
  - Conflicting users of Bayou and Watershed
  - Community economics driven by two industries—shipbuilding and seafood
  - Declining industries
  - Static population
  - Lack of awareness of issues
  - Community support of recommendations
  - Funding for improvements

Community Priorities:

- **Water Quality**
  - Improve water quality
  - Reduce trash in waterways
- **Fish/Habitats**
  - Protect wetlands for nursery and breeding habitat
  - Protect habitat of our seafood
  - Ensure sustainable fisheries
  - Wildlife refuge
  - Preservation
  - Keep area natural
  - Acquire more greenspace

- **Coastlines**
  - Maintain deep water channel for industry
  - Protection from erosion
- **Resiliency**
  - Harbor of Refuge
  - Improvements in community health
- **Access**
  - More access points along Bayou
  - Improvements to City Docks
  - Improvements to boat ramps
  - More recreational trails near Bayou and waterways
  - Increased recreational use
  - More fishing piers
  - More parks
- **Heritage**
  - Community education and buy-in
  - Diversify economy
  - Promote ecotourism.
  - Promote Hwy 188 corridor.
  - Tie into regional assets.
  - Expand economy and job opportunities.
  - Need more businesses and restaurants
  - Cultural preservation.
  - Improve Bayou image.
  - Public engagement and awareness of WMP.
  - Market and promote the Bayou.
  - Educate all – especially the younger generation
  - Enforcement of laws governing the violations

All of the above community and public input was considered to create the goals below.

5.2.2 Community Goals

1. Improve water quality to support residents, public, and seafood industry.
2. Improve and protect habitats for the benefit of fish, wildlife, and residents.
3. Protect shorelines.
4. Make the community more climate resilient, and provide harbor of refuge for its fleet.

5. Provide more recreational opportunities in the Watershed and more access to the Bayou.
6. Celebrate and market the rich culture and heritage of the community to provide a sense of place and foster economic development.

5.2.3 Community Objectives

To achieve the goals presented above, the following objectives were developed:

1. Eliminate sanitary sewer overflows and unpermitted discharges.
2. Improve WWTP collection system to reduce groundwater and surface water infiltration and inflow.
3. Improve watershed drainage system to manage stormwater runoff.
4. Reduce amount of trash in waterways.
5. Restore and protect streams and waterways to reduce and control sedimentation, improve habitats, and manage invasive species.
6. Implement engineering measures to restore natural watershed hydrology to the extent feasible.
7. Acquire lands for flood control, habitat preservation, and public access.
8. Increase public access to the waterfront.
9. Develop greenway trails, blueway trails, and scenic destinations for recreation and to attract and promote ecotourism.
10. Develop a community master plan to relocate critical City and emergency services out of floodplain and revitalize community.

5.3 Planning Alignment

In developing this plan, the WMP Team utilized a community-centered, comprehensive approach to watershed management planning. The WMP Team incorporated the U.S. Environmental Protection Agency (EPA)'s six steps in watershed planning with EPA's nine key watershed management elements into a broad overall watershed management approach for improvement and protection of the six things people value most about living along the Alabama coast (Water quality, Fish/Habitats, Environmental health and resiliency, Access, Culture and heritage, and Shorelines). The team also incorporated guidance from the MBNEP Comprehensive Conservation and Management Plan (CCMP), Clean Water Act Section 319, ADEM, as well as other regional planning initiatives. The goal was to establish a WMP that was founded on equitable and practical restoration and remediation alternatives. In developing this comprehensive, community-based approach, the WMP Team endeavored to provide a clear vision to guide the planning process while always keeping the end goal in view – restoring the ecological and cultural vitality of the Watershed and its community.

The following sections give a brief background of the planning and guidance principals that this WMP is based on.

5.3.1 EPA Six Steps in Watershed Planning

The EPA has identified six steps to follow during the watershed planning and implementation process. The development of this WMP involved steps one through four. Steps five and six guide

WMP implementation. These six steps are inclusive of the nine key elements required by the EPA for the watershed planning process and are presented in the following section.

- Step 1: Build Parnerships
- Step 2: Characterize the Watershed
- Step 3: Finalize Goals and Identify Solutions
- Step 4: Design an Implementation Program
- Step 5: Implement Watershed Plan
- Step 6: Measure Progress and Make Adjustments

5.3.2 EPA Nine Elements

The EPA has also identified nine key elements of watershed planning that are included within the six steps of watershed planning. These nine elements are considered critical for achieving improvements in water quality and their relevant sections in this WMP are as follows:

- **a) Identify causes and sources of pollution (Sections 3 and 4)**
- **b) Estimate pollution loading into the watershed and the expected load reductions (Section 4)**
- **c) Describe managment measures that will achieve load reductions and targeted critical areas (Section 6)**
- **d) Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan (Sections 7 and 8)**
- **e) Develep an information/education component (section 9)**
- **f) Develop a project schedule (Section 7)**
- **g) Decribe the interim, measurable milestones (Section 7)**
- **h) Identify indicators to measure progress (Section 7)**
- **i) Develop a monitoring program (Section 10)**

6 Watershed Management Measures

In previous sections, the condition and challenges facing the Bayou La Batre watershed have been described. This section presents the management measures recommended for achieving the goals and objectives identified for the Bayou La Batre Watershed restoration plan. It is anticipated that successful facilitation of the Bayou La Batre Watershed Plan will be the responsibility of a cross section of all major Watershed stakeholder groups.

6.1 Restoration and Management Priorities

In Chapter 4, the critical areas and issues to address in restoration of the Bayou La Batre Watershed have been prioritized into the categories listed below. Structural and non-structural BMPs as well as strategies and goals will be identified. This comprehensive approach to watershed management will maximize benefits to upland agriculture, urban growth, seafood harvesting, boat building, and the overall quality of life for citizens in the watershed.

- Water quality - Identifies actions to reduce point and non-point source pollution (including stormwater runoff and associated trash, nutrients, pathogens, erosion and sedimentation) and notes remediation efforts for past environmental degradation.
- Fish/Habitat - Identifies actions to reduce the incidence and impacts of invasive flora and fauna and improve habitats necessary to support healthy populations of fish and shellfish.
- Access - Characterizes existing opportunities for public access, recreation, and ecotourism through access to open spaces and waters within the watershed.
- Heritage – Identifies customary uses of biological resources and identifies actions to preserve culture, heritage and traditional ecological knowledge of the watershed
- Coastlines - Assesses shoreline conditions and identifies strategic areas for shoreline stabilization and fishery enhancements
- Resiliency - Identifies vulnerabilities in the watershed from increased sea level rise, storm surge, temperature increases and precipitation and methodology for improving watershed resiliency through planning and management

6.2 Water Quality

As described in previous sections, water quality is critical to ensure the health of the watershed and for realizing the benefits from its varied uses. Based on data collected for the watershed, Bayou La Batre faces a number of contributors to water quality degradation including stormwater runoff, nutrients, trash, sedimentation, and pathogens.

The Bayou La Batre Watershed study also identified a number of specific water related activities that need to be undertaken to help address these issues including the following:

- Identifying, mapping and remediating zones within the watershed with high sediment and high nutrient yields/loadings

- Prioritizing erosion zones along Bayou La Batre and its tributaries and implementing restoration and bank stabilization to reduce sediments
- Reducing the number of unpaved roads
- Conducting detailed pathogen source tracking and identification efforts in areas of the Watershed with frequent high pathogen levels to distinguish between wildlife, livestock, pets, and human contributions in order to develop detailed plans to remediate pathogen sources.
- Extending and monitoring the current effluent outfall line
- Eliminating the volume of trash currently entering the waterway

6.2.1 Stormwater Runoff

Currently, the Watershed has limited mitigation measures in place to manage stormwater runoff. Effective stormwater management must utilize a combination of planning and regulations, infrastructure, and BMPs.

6.2.1.1 Stormwater Management for Urban Watershed Areas

Stormwater management for urban areas of the Bayou La Batre Watershed will be most effective if implementation includes both structural and non-structural BMPs. Installation of regional detention areas and improvements to existing infrastructure in the City of Bayou La Batre will function most effectively if planning and development regulations address stormwater runoff and downstream flooding by incorporating onsite measures into the designs of future development.

6.2.1.2 Develop a Stormwater Master Plan

Developing a Stormwater Master Plan for the City of Bayou La Batre will provide the framework for implementing structural BMPs and planning in order to accommodate future development. The first aspect of a Stormwater Master Plan is to assess the condition and effectiveness of the City's existing stormwater infrastructure. This would include performing an inventory of all existing structures and mapping sub-basins in order to prioritize the replacement/repair of structures in poor condition and to identify areas of local flooding where existing infrastructure is inadequate.

Mapping drainage structures and associated sub-basins will provide a City-wide guide to the collection of stormwater and the locations of discharges and allow problem areas to be targeted and improved. Developing a Geographical Information System (GIS) model of the existing infrastructure will provide a useful tool for storing the data produced in the Stormwater Master Plan. A GIS model can be maintained and modified to include new infrastructure as the City system develops and changes.

The Stormwater Master Plan will also compare feasibility and costs of implementing stormwater management measures in order to identify appropriate BMPs for each sub-basin within the watershed. The Plan should identify the anticipated benefits of the recommended structural solutions and prioritize the recommended measures in order to provide the City a plan for implementation.

Development of a Stormwater Master Plan will identify areas within the City that are most prone to flooding and that are most appropriate for regional detention, open space, as well as areas that are least suitable for development. Restricting growth within these areas and utilizing them for regional stormwater management will reduce flooding in surrounding neighborhoods while also providing green space for recreation. The Stormwater Master Plan will identify these areas for future property acquisition by the City and allow implementation of recommended improvements.

6.2.1.3 Stormwater Management Requirements for New Development

In addition to development of a Stormwater Master Plan and implementation of structural management measures, adopting stormwater management regulations for development will ensure that regional management measures and existing infrastructure function properly. Modifying the City of Bayou La Batre's Zoning Ordinance Regulations and Comprehensive Plan to include stormwater management for new development is a recommended measure for mitigating runoff. It is not feasible to expect that regional BMP measures implemented by the City will be able to collect, treat, and attenuate all sub-basins within the City of Bayou La Batre. Requiring onsite stormwater treatment facilities ensures that the effects of new development on water quality within the Watershed are mitigated. In addition, developing requirements for stormwater attenuation based on impervious cover for new developments reduces the risk of flooding to downstream properties.

6.2.1.4 Stormwater Discharges

The City of Bayou La Batre has relatively few structural BMPs in place for treatment of stormwater runoff. **Figure 6.1** is an example of an observed untreated stormwater discharge in Bayou La Batre. Urban stormwater runoff contains nutrients from fertilizers and pesticides applied to green spaces such as yards and golf courses. In addition, urban stormwater contains oils, petroleum, and hydrocarbons associated with vehicular traffic, which is collected by storm drains in streets and parking lots. Implementing areas for regional treatment prior to allowing stormwater collected by urban infrastructure to discharge into the Watershed's surface waters can drastically improve water quality for the Watershed. As described previously it is recommended that the City of Bayou La Batre adopt regulations for new development that would require onsite water quality treatment facilities prior to discharging into the City's stormwater infrastructure.

Figure 6.1 Existing untreated stormwater discharge in Bayou La Batre

6.2.1.5 Sustaining Watershed Hydrology by Promoting Low Impact Development (LID)

Hydrology is the scientific discipline concerned with the occurrence, distribution, and circulation of water and its interactions with living things. Urbanization modifies any watershed's natural hydrology by reducing the volume of surface water that can infiltrate the soil and increasing the volume of stormwater runoff. Increased runoff erodes streambanks, washes large quantities of trash, sediments and other pollutants into waterways and damages stream bottoms.

Additional urbanization and development within the Bayou La Batre Watershed will result in additional adverse impacts on water quality. However, these impacts can be minimized by adopting measures to sustain the Watershed's hydrology. Such management measures are referred to Low Impact Development (LID).

Low Impact Development (LID) is an interdisciplinary systematic approach to stormwater management that can result in improved stormwater quality, improved health of local water bodies, reduced flooding, increased groundwater recharge, more attractive landscapes, improved wildlife habitat, and improved quality of life for residents. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. Successful implementation of LID recreates a more natural hydrologic cycle in a developed watershed. Suggested LID techniques for new residential developments with potential pollutant load reductions are presented in **Table 6.1**, and recommended retrofits for existing developed areas are presented in **Table 6.2**.

Table 6. 1Recommended LID practices (ADEM 2014)

Practice	Pollutant Removal			Cost
	Sediment	Nitrogen	Phosphorous	
Bioretention Cells	80 – 85%	40 - 50%	45 - 60%	medium/high
Constructed Stormwater Wetlands	80 – 85%	30 – 40%	40%	medium/high
Permeable Pavement	99%	65 – 80%	42 – 80%	high
Swales	35 – 80%	20 – 50%	20 – 50%	low
Level Spreaders and Grassed Filter Strips	40 – 50%	20 – 30%	20 – 35%	low
Rainwater Harvesting	Reduces flooding and erosion			medium
Green Roofs	Decrease runoff and peak flows			high
Riparian Buffers	60 – 85%	30%	35 – 40%	medium

Table 6. 2 Recommended retrofit LID practices (ADEM 2014)

Practice	Pollutant Removal			Cost
	Sediment	Nitrogen	Phosphorous	
Rain Gardens	Phosphorus and nitrogen removal			low
Curb Cuts	Directs runoff to primary stormwater control measure			medium
Disconnected Downspouts	Directs runoff to primary stormwater control measure			low
Retention Cells (where land is available)	80 – 85%	40 – 50%	45 – 60%	medium/high

Development of one or more demonstration projects in the Watershed could help illustrate for stakeholders that LID practices can provide substantial community benefits while improving water quality and minimizing flooding. Working with an appropriately qualified engineering firm, several types of demonstration projects using The *Alabama LID Handbook* recommendations could be completed. This would encourage, through education and outreach, the use of LID practices that could greatly enhance Watershed protection.

Recommended LID management measures for the Bayou La Batre Watershed include, but are not limited to the following:

- Bioretention swales and cells
- Constructed stormwater wetlands
- Rainwater harvesting

Bioretention Swales and Cells

Bioretention swales are gently sloping drainage ditches filled with vegetation that are designed to remove silt and other pollution from stormwater and surface water runoff (Gibney 2015). Large underutilized parking areas may be suitable for partial pavement removal and replacement with natural vegetation, as well as installation of a bioretention swale as shown in **Figure 6.2. Figure 6.3** displays four different types of swale designs.


Figure 6.2 Example of bioretention swale in a parking area at Auburn Research Park; Auburn, AL (ADEM 2014)

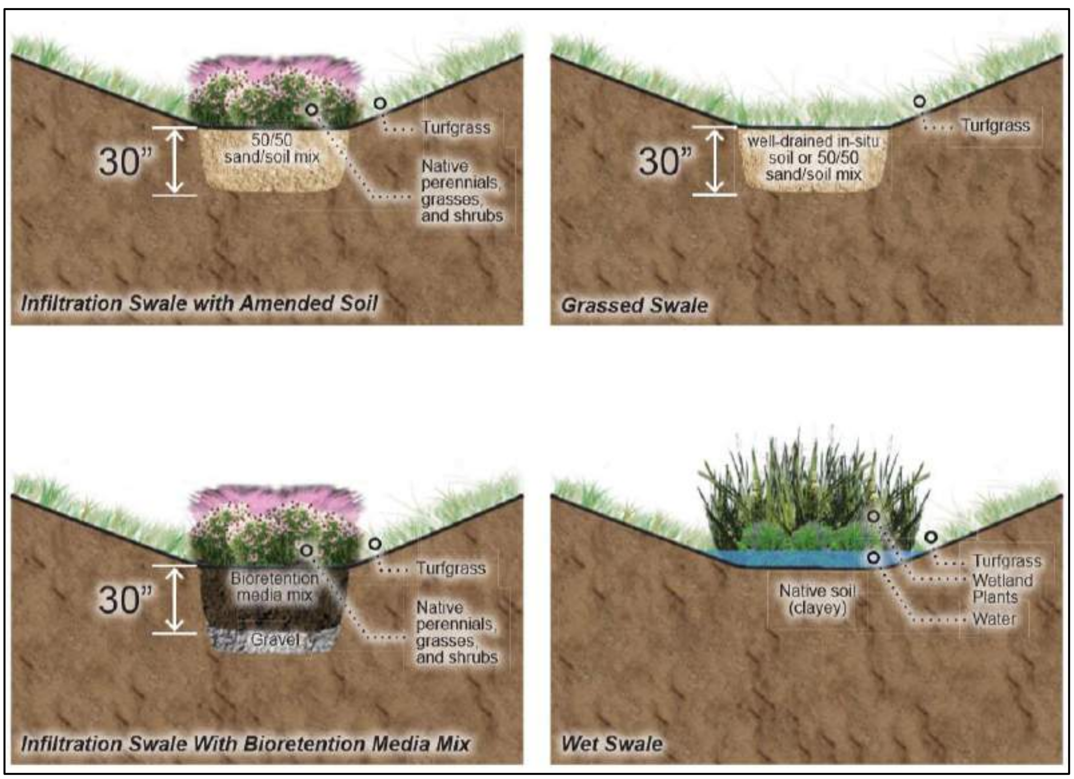


Figure 6.3 Examples of bioretention swales (ADEM 2014)

Bioretention cells (BRCs) are depressions on the surface that capture and store stormwater runoff for a short period. BRCs remove pollutants by the processes of absorption, filtration, sedimentation, volatilization, ion exchange, and biological decomposition and can dually support flood- and drought-tolerant native vegetation habitats (ACES 2016b).
Figure 6.4 provides a profile of a typical BRC, while example applications of BRC's are presented in **Figure 6.5**.

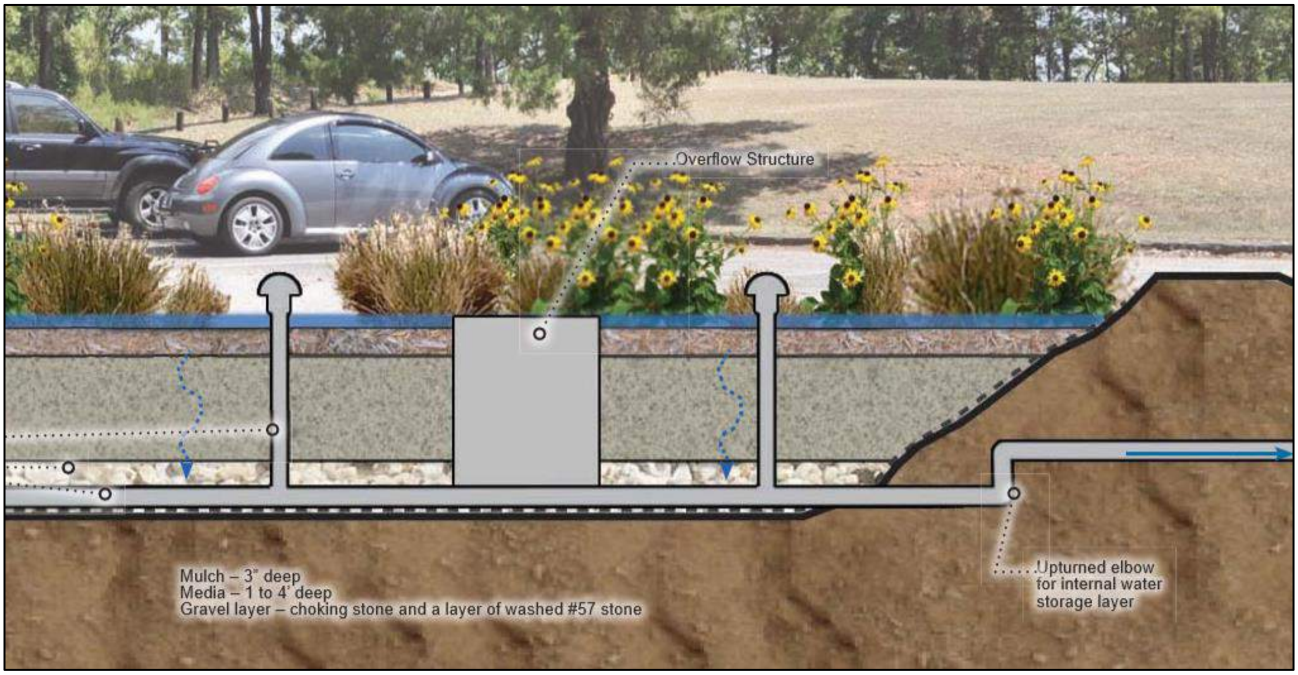


Figure 6.4 Example of typical BRC profile (ADEM 2014)

Constructed Stormwater Wetlands

Constructed stormwater wetlands (CSWs) function like natural wetlands to treat stormwater by using biological, chemical, and physical processes to promote infiltration, cycle nutrients, and filter and decompose pollutants (ACES 2016b). **Figure 6.6** provides a cross section of a CSW, while an example application of a CSW is provided in **Figure 6.7.**

Figure 6.5 Examples of imlemented BRCs adjacent to development in Railroad Park; Birmingham, AL

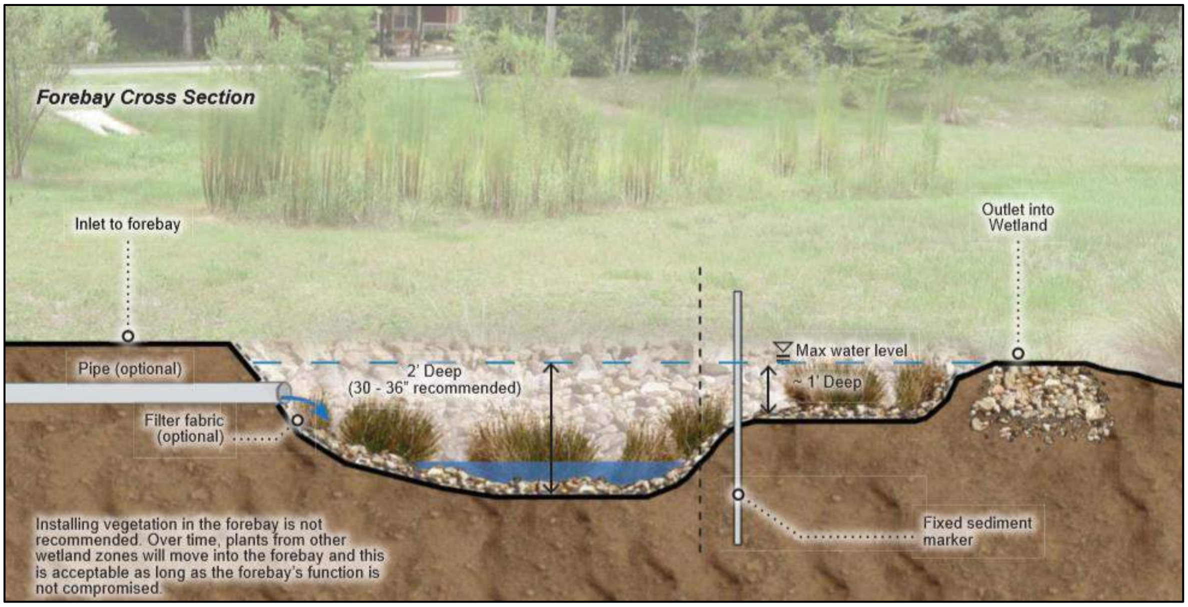


Figure 6.6 Example of CSW cross section (ADEM 2014)


Figure 6.7 Example of CSW at Hank Aaron Stadium; Mobile, AL

Rainwater Harvesting

Rainwater harvesting involves the collection of rainwater for reuse, typically from a rooftop, and can be used as a form of runoff management from impervious surfaces. The City of Bayou La Batre and the entire Bayou La Batre Watershed would both greatly benefit from increased landscaping and streetscaping that incorporate rainwater harvesting. Numerous funding sources are available that assist communities with planning and funding tools that incorporate LID practices such as rain barrels and rain gardens in landscaping and streetscaping, as shown in **Figures 6.8** and Figures **6.9**.

Figure 6.8 Example of rain barrel harvesting residential rainwater

Figure 6.9 Example of rain garden (EPA: Green Infrastructure Guide)

6.2.1.6 Monitoring of Permitted Discharges

As previously described in Section 4, a number of industrial and commercial companies are located within the Bayou La Batre Watershed and a current list of authorized discharges was provided in **Table 4.2**. The development of an interactive map of all permitted discharges within the Watershed is recommended. This would provide a comprehensive review of the types of waste streams and water quality data from these point-source discharges as well as allow Bayou La Batre to identify and enforce violations of permitted discharges.

6.2.1.7 Unpermitted Discharges

In **Chapter 3** it was noted that the Bayou La Batre Watershed has moderately high concentrations of mercury and copper. The presence of mercury may be attributed to atmospheric deposition due to air pollution and is therefore difficult to mitigate. However, the presence of copper may have local origins. The upper Watershed has several mining operations and/or quarries. Minerals and heavy metals are typical in waste streams from these industries. It is recommended that these operations be inspected to ensure that no unpermitted discharges are occurring which could result in accumulations downstream. In addition, education and outreach to local mining industries regarding how to implement BMPs with respect to extraction operations should be implemented.

6.2.2 Agricultural BMPs

Several BMPs can be utilized in agricultural areas to minimize the pollutant load entering tributaries to the Bayou La Batre Watershed through stormwater runoff. Appropriate BMPs for mitigating downstream impacts are relatively simple and do not require significant costs for implementation.

6.2.2.1 Agricultural Best Management Practices for Stormwater Runoff

In the Bayou La Batre Watershed, rural and agricultural areas also comprise a significant portion of the upper Watershed area as described in **Chapter 3**. Practices associated with these areas present the first potential for pollutants to enter the watershed system but they also present a significant opportunity to mitigate and improve overall water quality in the system.

Developing an educational and outreach program to educate landowners and provide incentives for implementation of BMPs into agricultural practices could result in a significant improvement of water quality downstream. Examples of agricultural BMPs that should be encouraged within the Watershed include:

- Livestock exclusion from wetlands/streams and protection of riparian buffers along Streams
- Increased use of cover crops to decrease soil erosion and nutrient leaching, improve infiltration and increase soil organics
- Improved nutrient management through increased use of precision agriculture application of fertilizer and pesticides
- Remediation of areas with high livestock numbers where manure runoff is found to be a source of pathogens associated with water quality issues

There are a number of conservation programs available for both public and private landowners through the NRCS and Farm Service Agency (FSA) including:

- Conservation Stewardship Program
- Environmental Quality Improvement Program (EQIP)
- Emergency Watershed Protection Program (EWP)
- Regional Conservation Partnership Program (RCPP)
- The Watershed and Flood Prevention Operations Program (WFPO)

6.2.2.2 Conservation Buffer Strip

Conservation buffer strips are narrow strips of permanent vegetation left adjacent to streams in order to provide a barrier between fields and surface waters without significantly reducing the usable area for cultivation. Buffer strips slow stormwater runoff, trap sediments, and agricultural chemicals by providing an area for enhanced infiltration prior to runoff entering the upper tributaries and streams. In addition, conservation buffer strips can reduce sedimentation created by wind erosion in adjacent fields. Buffers create a zone of natural habitat, mitigate the temperature of the adjacent streams, stabilize streambanks, minimize erosion, and create a barrier between livestock and surface waters. If properly installed and maintained, buffer strips have the potential to remove up to 50% of nutrients and pesticides, up to 60% of non-human pathogens, and up to 75% of sediments. In addition, conservation buffers can provide shelter for livestock during high winds or extreme temperatures. **Figure 6.10** provides an example of a conservation buffer strip adjacent to a stream. **Tables 6.3 and 6.4** provide a summary of the potential riparian buffer restoration sites in the Bayou La Batre Watershed.

Figure 6.10 Conservation buffer strip adjacent to stream. Source: Chesapeake Bay Program

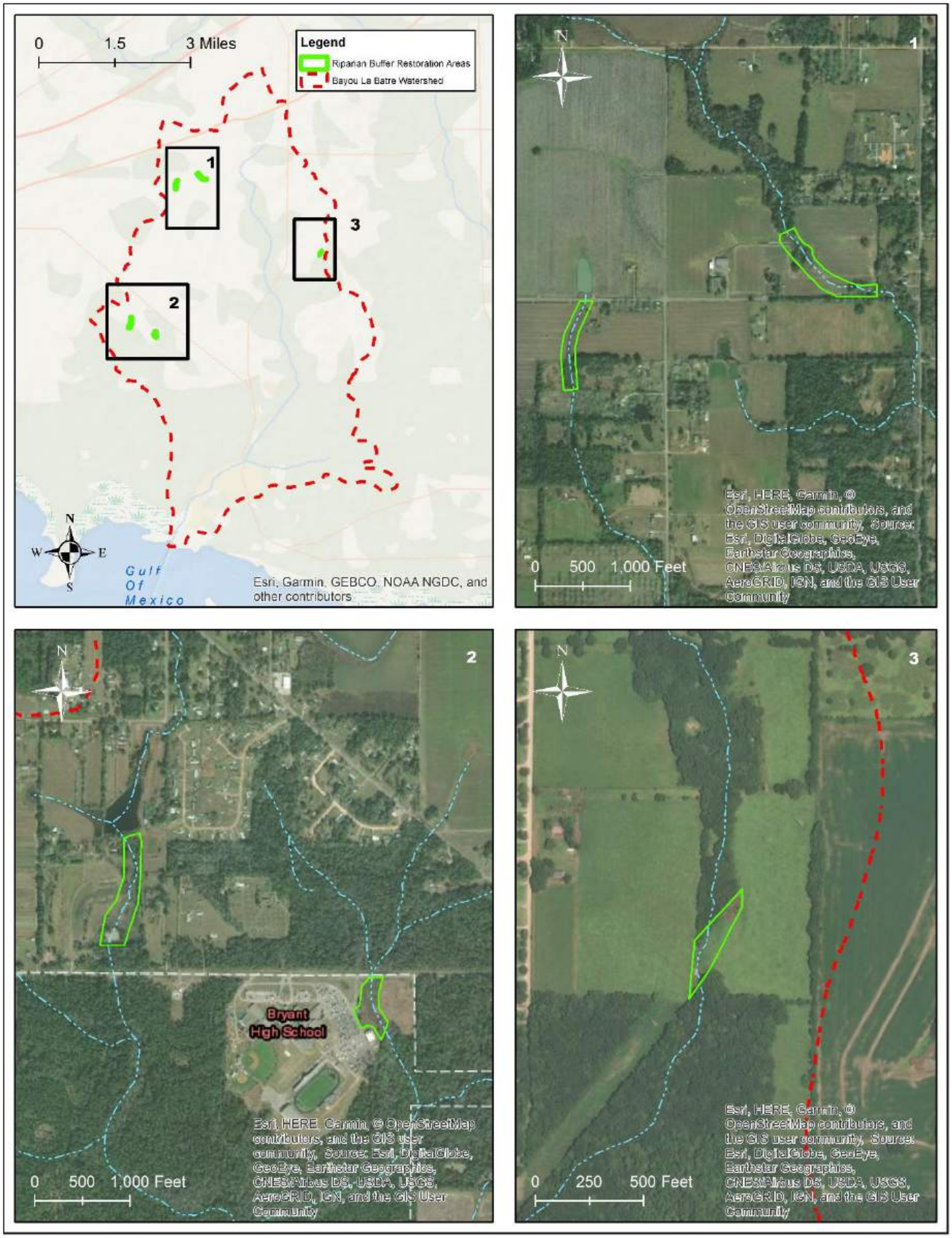


Figure 6. 11 Riparian Buffer Restoration Location Map

Table 6.3 Potential conservation buffer locations in the Bayou La Batre Watershed

Site Name	General Location/Description	Upstream Latitude/Longitude	Downstream Latitude/Longitude	Linear Feet (ft)
CB-1	Unnamed Tributary of Bayou La Batre, N of Hurricane Blvd	30° 26’ 40.811” N 88° 17’ 7.799” W	30° 26’ 39.119” N 88° 17’ 9.96” W	1,300
CB-2	Tributary of Bishop Manor Creek, S of Tom Waller Rd	30° 29’ 12.479” N 88° 16’ 13.439” W	30° 29’ 6.719” N 88° 16’ 15.239” W	635
CB-3	Tributary of Hammar Creek, N of Tom Waller Rd	30° 29’ 19.68” N 88° 15’ 48.599” W	30° 29’ 13.56” N 88° 15’ 38.519” W	900
CB-4	Unnamed tributary of Bayou La Batre, E of Almba Bryant High School, S of Hurricane Blvd	30° 26’ 35.88” N 88° 16’ 37.56” W	30° 26’ 30.48” N 88° 16’ 36.479” W	600
CB-5	Tributary of Hammar Creek, E of Magnolia Road	30° 27’ 59.399” N 88° 13’ 21.359” W	30° 27’ 56.519” N 88° 13’ 22.439” W	300

Table 6.4 Location diagrams of potential conservation buffer locations

Site Name	Location Diagram
CB-1	
CB-2	

CB-3	
CB-4	
CB-5	

6.2.2.3 Livestock Exclusion System

A livestock exclusion system consists of permanent fencing to prevent livestock from grazing and accessing critical areas such as streams, wellheads, and wetlands (see **Figure 6.11**). Excluding livestock from stream banks prevents degradation to vegetation, which is vital to stabilizing banks and preventing erosion. In addition, it prevents livestock from entering surface waters, which has the further benefit of reducing risk of introducing non-human pathogens to the Watershed.

Figure 6.12 Livestock exclusion from wetlands/streams and protection of riparian buffers along streams. Source: Conservation Ontario

6.2.2.4 Alternate Water Sources

Alternative cattle water sources are strategically located freshwater sources for livestock such as upland excavated ponds, wells, or watering troughs that provide adequate drinking water supply located away from critical surface waters (see **Figure 6.12**). Implementation of alternate water sources in conjunction with a livestock exclusion system significantly reduces the risks of sedimentation and non-human pathogens entering the upper tributaries by preventing livestock from accessing streams.

Figure 6.13 Livestock solar well. Source: U.S. Fish and Wildlife Service, Partners for Fish and Wildlife

6.2.2.5 Fertilizer Application

Applying fertilizer to fields is a commonly used practice to enhance the production of crops. However, fertilizers can also add an excess of nutrients to the Watershed system. **Figure 6.13** is an observed example of agricultural runoff in the Bayou La Batre Watershed. Simple practices used in the application of fertilizers can reduce the amount of resulting nitrogen and phosphorus that are conveyed into adjacent streams.

When and where fertilizer is applied can have a significant effect on the risks to surface waters. The following are recommended guidelines regarding the application of fertilizers:

- Apply fertilizers when soils are not saturated and during or immediately following planting allows optimum conditions for absorption by crops and minimizes transport into groundwater and surface water runoff
- Provide a sufficient buffer (i.e. 50 feet) from streams and wetlands to minimize the risk that nutrients enter surface waters
- Apply small quantities of fertilizer at the roots of crops through the use of drip irrigation as it provides the benefits of maximum absorption by the root system and significantly minimizes risk of runoff into surface water conveyances
- Follow appropriate application rates. The application of fertilizers is beneficial only to the point at which crops can adsorb the nutrients; once plants have reached their intake limit, the crops stop responding to sub sequential applications
- Crop rotation can minimize the amount and cost of fertilizers required by allowing the nutrients in a fallow field to replenish naturally through the decay of organic matter.

Figure 6.14 Agricultural stormwater runoff from a row-crop field into an unnamed tributary of Hammar Creek at Tom Waller Road (Cook 2016)

6.2.2.6 Pesticide Application

The application of pesticides is similar to that of fertilizers with regards to risk and the overall health of the Watershed. The following are recommended guidelines regarding the application of pesticides:

- Apply pesticides when soils are not saturated and not immediately prior to a rain event in order to minimize risk
- Many pesticides do not persist for long periods of time in the environment, therefore, if applied during dry conditions, it is possible that the chemicals have time to degrade prior to being collected by runoff and conveyed into surface water conveyances
- Pesticides should be stored in roofed enclosures where they are not exposed to rainwater, and in clearly labeled, closed containers.

6.2.3 Sediment

Suspended sediment is defined as the portion of a water sample that can be separated from the water by filtering. Sediment may be composed of organic and inorganic particles that include algae, industrial and municipal wastes, urban and agricultural runoff, eroded material from geologic formations, or streambed particles that are too large or too dense to be carried in suspension by stream flow. These materials are transported to stream channels by overland flow related to stormwater runoff and cause varying levels of turbidity. Suspended sediment loading within the Bayou La Batre Watershed was identified as a priority issue based on studies by the GSA, data provided by the ADEM and the AWW organization, public perception, and input from the Steering Committee.

6.2.3.1 Unpaved Roads Stabilization

As described in previous sections, unpaved roads located on both private and county right of way are considered to be a major source of sedimentation in the Watershed. **Figure 6.14** is an example of the amount of sediment that could potentially enter a waterway from a single unpaved road. The stabilization of unpaved roads either from paving or other stabilization actions will greatly reduce the likelihood of sediment entering the Watersheds various waterways. **Figure 6.15** and **Table 6.5** identify unpaved roads in the Watershed that are candidates for stabilization practices given their location either bisecting or occurring adjacent to streams and wetlands. The length of each unpaved road recommended for stabilization practices was determined by the potential for sediment to enter a waterway.

Figure 6.15 Unpaved road-stream crossing sedimentation

Table 6.5 Unpaved road candidates for stabilization practices

Road Name	Latitude	Longitude	Waterbody Impacted	Length (ft)
Adams Street	30° 23' 36.91" N	88° 15' 36.63" W	Bayou Cateau	1,900
Marine Laboratory Road	30° 24' 58.41" N	88° 15' 54.01" W	Bayou Du Pont and Spring Bayou	7,500
Cut Off Road	30° 24' 20.10" N	88° 16' 18.65" W	Bayou Du Pont	5,300
Little River Road	30° 24' 6.36" N	88° 16' 1.56" W	Tate Bayou	3,200
Magnolia Road	30° 28' 27.86" N	88° 13' 31.67" W	Hammer Creek tributary	5,300
Hogue Road	30° 27' 29.03" N	88° 13' 52.64" W	Hammer Creek tributary	3,400
Shrimp Lane	30° 28' 01.92" N	88° 13' 37.24" W	Hammer Creek tributary	1,230
South Meadow Lane	30° 28' 00.2" N	88° 14' 16.62" W	Hammer Creek	2,200
2 Mile Road	30° 28' 21.20" N	88° 15' 19.77" W	Bishop Manor Creek tributary	2,600

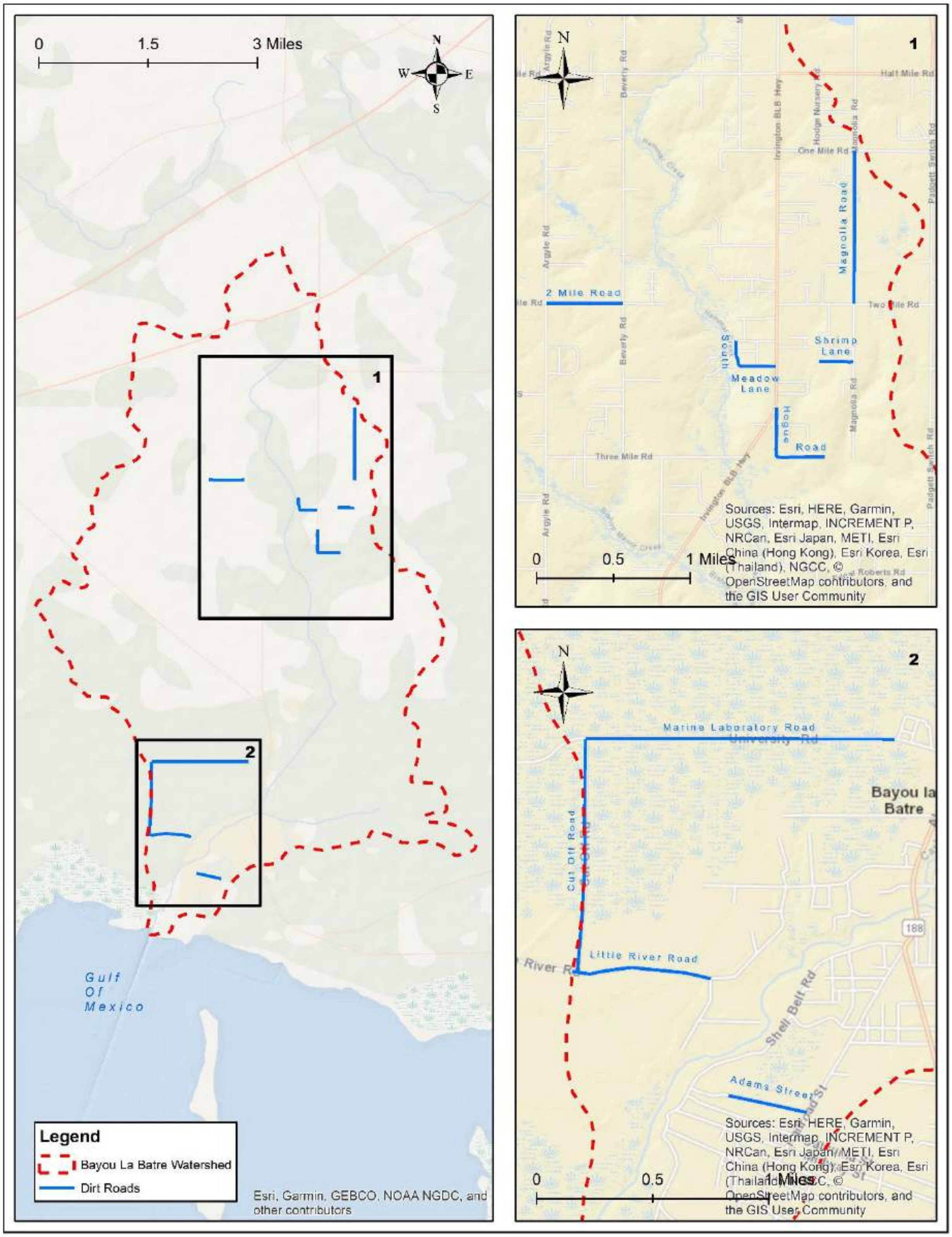


Figure 6.16 Location of unpaved road candidates for stabilization practices

Paving including roadside stormwater treatment is the most expensive unpaved road stabilization technique. There are, however, numerous techniques that may be applied to unpaved roads that reduce and/or eliminate their potential to adversely affect water quality. These efforts include the use of a Driving Surface Aggregate (DSA) or comparable, less erosive aggregate material, road contouring (raising and reshaping the road profile), installing grade breaks, and incorporating additional, properly located drainage outlets (i.e. diversion of material away from stream) (Scheetz 2008).

Driving Surface Aggregate

An aggregated surfaced road is an unpaved road that is primarily surfaced with materials derived from stone such as gravel or crushed rocks and greatly increases the stability, traffic support capability, and resistance of roads to erosion. A typical aggregate road is constructed in three layers (see **Figure 6.16**)(USFWS 2005):

- Surface Course – an 8 inch thick, uniformly graded gravel or crushed stone layer that is placed on top of the aggregate base.
- Base Course – An 18 to 24 inch thick layer comprised of compacted gravel and crushed stone and a minimal amount of fines (clay and silt) that produces a strong, stable matrix and drains freely.
- Subgrade – The bottom layer roadbed made up of the native soil materials found along the road or fill brought in to fill depressions.

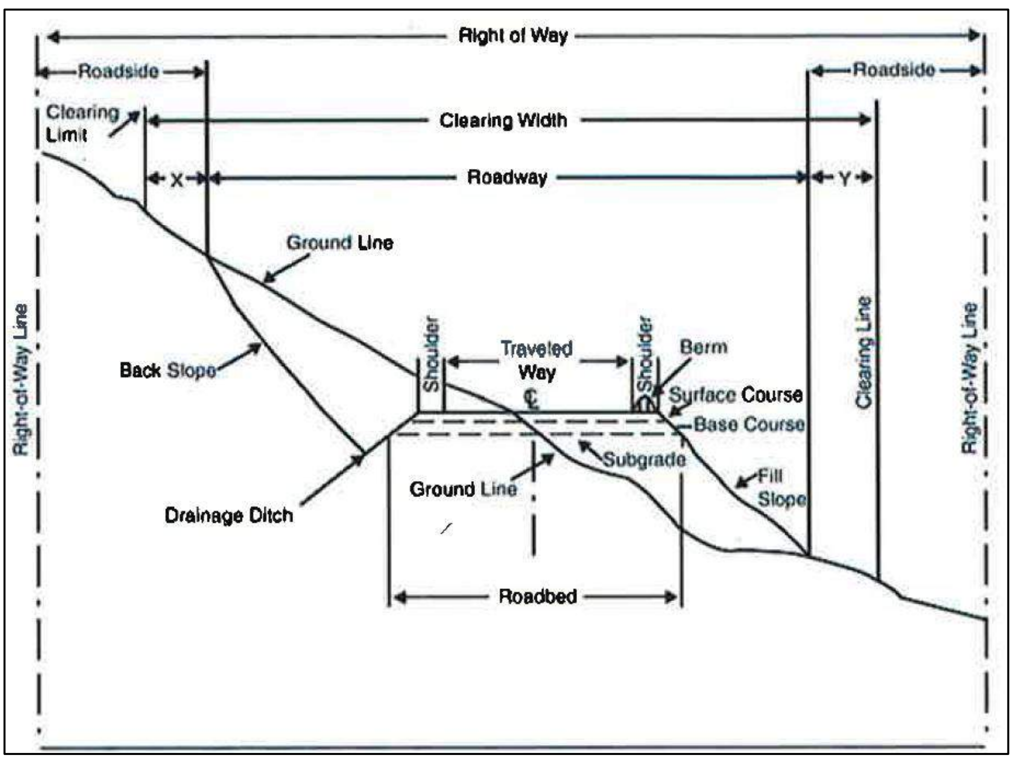


Figure 6.17 Roadway components

Road Contouring

Proper road contouring creates a configuration that facilitates the movement of runoff into established roadside drainage systems (preferably vegetated swales or drainage outlets) and provide a cohesive road surface that will resist erosion and safely support trafficking requirements. To effectively remove water from the roadway, the surface must uniformly slope towards one edge (outsloping) or have a center section that is higher than either edge (crowning).

Outsloped roadways avoid concentrating water flows by draining toward the downhill or shoulder where it may then be dispersed over and adsorbed into the receiving slope area below the road, preferably vegetated slopes and into a natural outlet. The primary advantage of road crowning is that the volume of runoff is split, ideally to a vegetated swale, and thereby reduces the erosive potential to a single roadside area, drain, or outlet. **Figure 6.17** depicts outsloped and crowned road configurations.

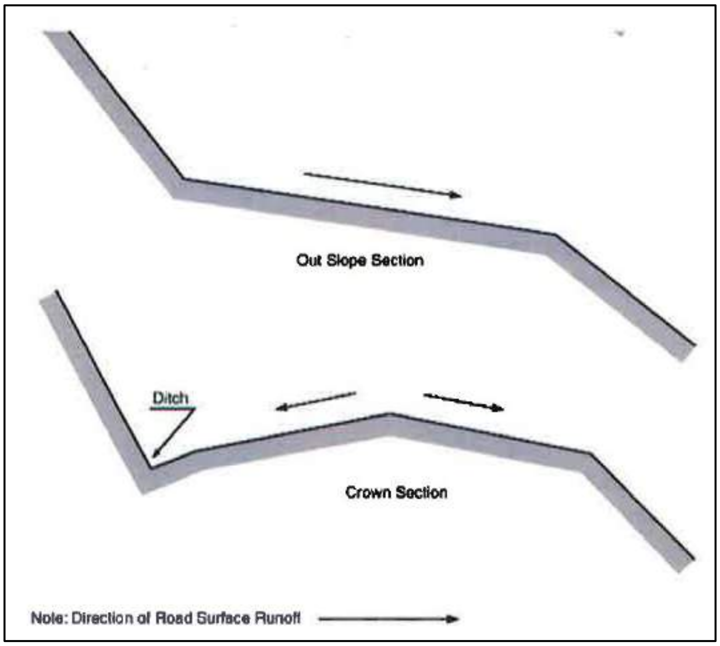
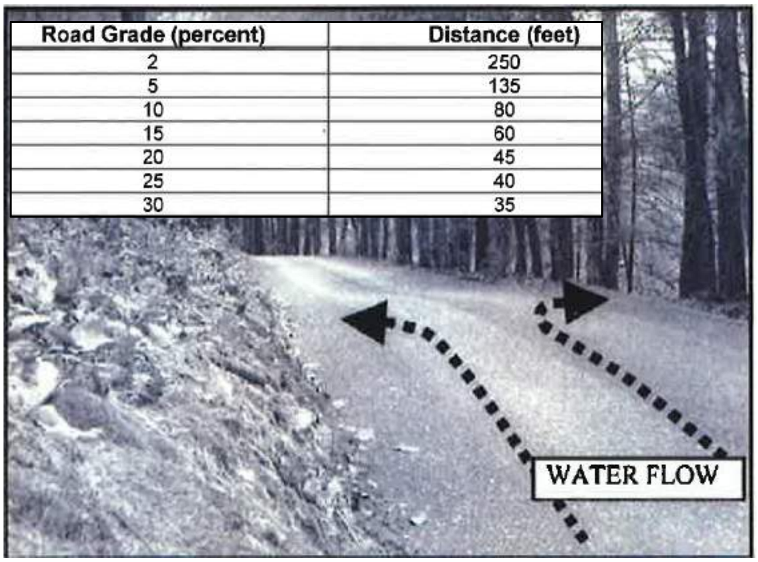


Figure 6.18 Outsloped and crowned road configurations (USFWS 2005)

Grade Break

A grade break is a small intentional increase in road elevation on a downhill slope, causing water to flow off the roadway surface and into road drainage features or natural drainage areas, thereby preventing road material erosion. Multiple grade breaks placed in succession are highly effective on long sloped roads to remove water from the road surface and prevent buildup of erosive water volume and velocity. **Figure 6.18** depicts a grade break as well as recommended distances between grade breaks.



Road Grade (percent)	Distance (feet)
2	250
5	135
10	80
15	60
20	45
25	40
30	35

Figure 6.19 Slope grade break (Center for Dirt and Gravel Road Studies) and recommended distance between grade breaks (Kochenderfer 1970)

Drainage Outlets

The best type of roadside drainage system is one that directly moves stormwater off the road and into natural, vegetated roadside drainways (areas of standing grasses, forbs, shrubs, trees, and over ground litter layers that effectively function as infiltration sinks and filtering buffers). In addition to vegetated roadside drainways, turnouts, a transitional excavated depression that intercepts and conveys roadside runoff to a stable discharge outlet, and sediment basins, an excavated holding pond that is used to capture and detain runoff, are effective in converting a concentrated flow of runoff to non-erosive sheet flow. Areas subject to a high volume and velocity of runoff may utilize energy dissipators (i.e. riprap or geosynthetic structure) to control erosion at the outlet (USFWS 2005).

6.2.3.2 Gully Restoration

Due to the types of soils and topography of the upper Watershed, these areas are prone to gully formation. Proper land management, including the agricultural BMPs described previously can prevent gully formation. However, additional measures are recommended to address erosional gullies where they have already formed. Low flow gully areas can be stabilized by shaping and filling with dirt to establish more gentle slopes, promoting the establishment of vegetation. Slopes no greater than 3:1 are recommended for best results in establishing vegetation. In addition to filling and shaping, installation of properly spaced check dams can reduce water velocity and subsequent erosion in high flow gullies (see **Figure 6.19**).

Figure 6.20 Agricultural gully stabilized with rip-rap check dams

6.2.3.3 Enforcement of NPDES Permits

Erosion and sedimentation from construction sites contribute to watershed degradation nationwide. Despite the relatively small area of disturbance compared to the overall watershed area, construction sites act as major contributor to sedimentation because the erosion potential on bare or disturbed land is typically 100 times greater than the erosion potential of agricultural lands. The National Pollutant Discharge Elimination System (NPDES) regulates erosion and sedimentation from construction sites in which greater than one acre of land is disturbed or construction sites, which are part of a larger plan of development, which totals more than one acre. Compliance is a performance-based regulatory system. This means that the Permittee has the ability to choose what (if any) erosion control measures are utilized during construction. However, compliance requires elimination of any non-point source discharge of sediment from the construction site.

ADEM NPDES CONSTRUCTION STORMWATER INSPECTION REPORT AND BMP CERTIFICATION

RESPOND WITH "N/A" AS APPROPRIATE. FORMS WITH INCOMPLETE OR INCORRECT ANSWERS, OR MISSING SIGNATURES WILL BE RETURNED AND MAY RESULT IN APPROPRIATE COMPLIANCE ACTION BY THE DEPARTMENT. IF SPACE IS INSUFFICIENT, CONTINUE ON AN ATTACHED SHEET(S) AS NECESSARY. PLEASE TYPE OR PRINT IN INK.

Item I.

Permittee Name:	Facility/Site Name:
Permit Number:	County:
Facility Entrance Latitude & Longitude:	Phone Number:
Facility Street Address or Location Description:	

Item II.

List name of current ultimate receiving water(s) (indicate if through MS4) and the number of disturbed acres which drains through each treatment system or BMP: Add additional sheet(s) if necessary.

Receiving Water	Disturbed Acres	Discharge Point #	Representative Outfall
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

Item III.

1. ☐ YES ☐ NO Did discharges of sediment or other pollutants occur from the site? If "Yes", please list a description of the discharge(s) and their location(s):
2. ☐ YES ☐ NO Were BMPs properly implemented and maintained at the time of inspection? If "No", please provide location(s) and descriptions of BMPs that need maintenance:
3. ☐ YES ☐ NO Are BMPs needed in addition to those already present onsite at the time of inspection? If "Yes" please provide a description and location of additional BMPs that are needed:
4. ☐ YES ☐ NO Have any BMPs failed to operate as designed? If "Yes", please provide location(s) and description of BMP(s) that failed:
5. ☐ YES ☐ NO Were there BMPs required by the CBMPP that were not installed or installed in a manner not consistent with the CBMPP? If "Yes", please provide a description and location where the BMPs were not installed or installed incorrectly:

Item IV.

The Permittee shall conduct turbidity monitoring in accordance with Part V of the permit:

1. ☐ YES ☐ NO Is this facility a Priority Construction Site?
2. ☐ YES ☐ NO Has the facility disturbed greater than 10 acres?
3. ☐ YES ☐ NO Was the site discharging at the time of inspection?
4. ☐ YES ☐ NO Samples collected, if "Yes", sampling data must be attached.

ADEM CSW Inspection Report Form 23 11/11 1 of 2

Figure 6.21 ADEM Form 023: Construction Stormwater Inspection Report and BMP Certification (ADEM 2018)

Issuance and enforcement of NPDES permits is typically managed by states. In Alabama, the Alabama Department of Environmental Management (ADEM) manages NPDES permits. It is the responsibility of the Permittee to perform periodic inspections of the erosion control BMPs throughout duration of construction. However, the City of Bayou La Batre as the local regulatory agency can assist the state in enforcement of the NPDES requirements by reporting violations and discharges to ADEM for action. In addition, the City could include regulatory requirements regarding erosion control for new construction into the City's Zoning Ordinance and require that these measures be included in local regulatory review prior to issuance of local development permits. **Figure 6.20** provides an example of the State's stormwater inspection report and BMP certification that could be adopted and utilized by the City.

6.2.4 Management Measures for Human Sources of Degradation Factors

6.2.4.1 Pathogens

Pathogens were detected at low levels in surface waters of the Bayou La Batre Watershed. Agricultural BMPs to reduce the risk of pathogens from livestock in the Bayou's headwaters have been presented in previous sections. However, the presence of human markers as sources for bacteria within surface waters likely originate from three sources: sanitary sewer overflows within the urban wastewater system, vessel discharges, and unpermitted discharges from rural septic systems.

6.2.4.2 Sanitary Sewer Overflows

Sanitary sewer overflows during extreme rain events (due to the effects of inflow and infiltration of stormwater and/or groundwater into leaking sewage collection systems) is a typical occurrence in the City's aging wastewater infrastructure. The Mobile Baykeeper organization has tracked SSOs in the greater Mobile Bay area for over a decade. **Figures 6.21** and **Figures 6.22** show the location and relative magnitude in terms of volumes released from SSOs in the Bayou La Batre Watershed in 2016 and in 2017, respectively (Mobile Baykeeper 2017). In order to address this issue, an inflow and infiltration analysis is recommended, including smoke testing, to detect the areas within the collection system where leaks are occurring. Prioritizing and planning for replacement of this infrastructure can greatly reduce the frequency of sanitary sewer overflows and consistently reduce levels of pathogens present in surface waters throughout the Watershed.

In addition to rehabilitation or replacement of collection lines, rehabilitation of sewer manholes may also be necessary. An analysis of the overall wastewater system to include projected growth and future demands is recommended. Upgrading existing lift stations to accommodate greater pumping capacities will reduce the risk of sanitary sewer overflows both in the current conditions and as well as meet the requirements of future pumping demands.

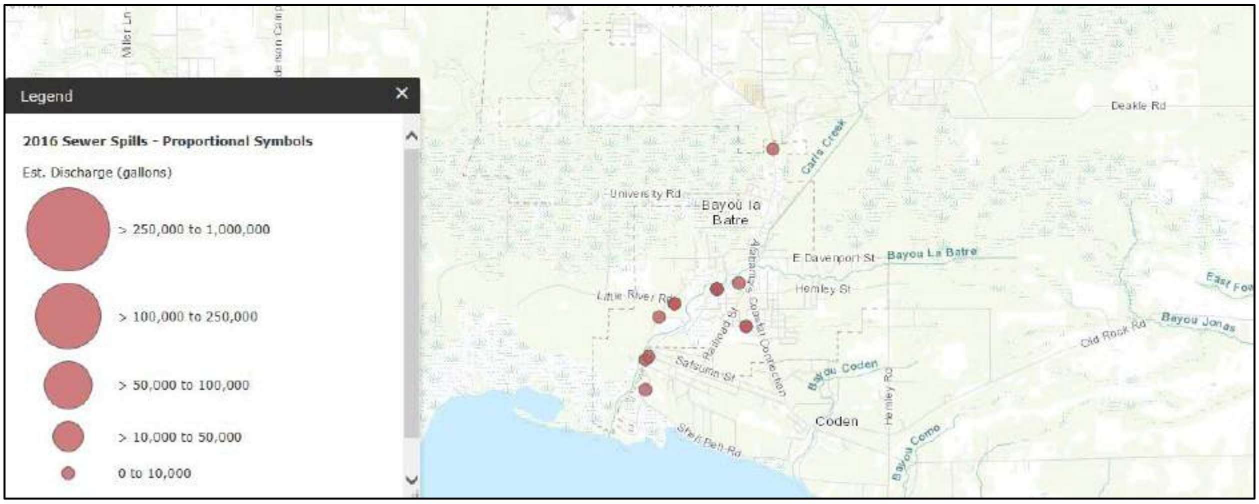


Figure 6.22 Location and relative magnitude of SSOs occurring in 2016 (Mobile Baykeeper 2017)

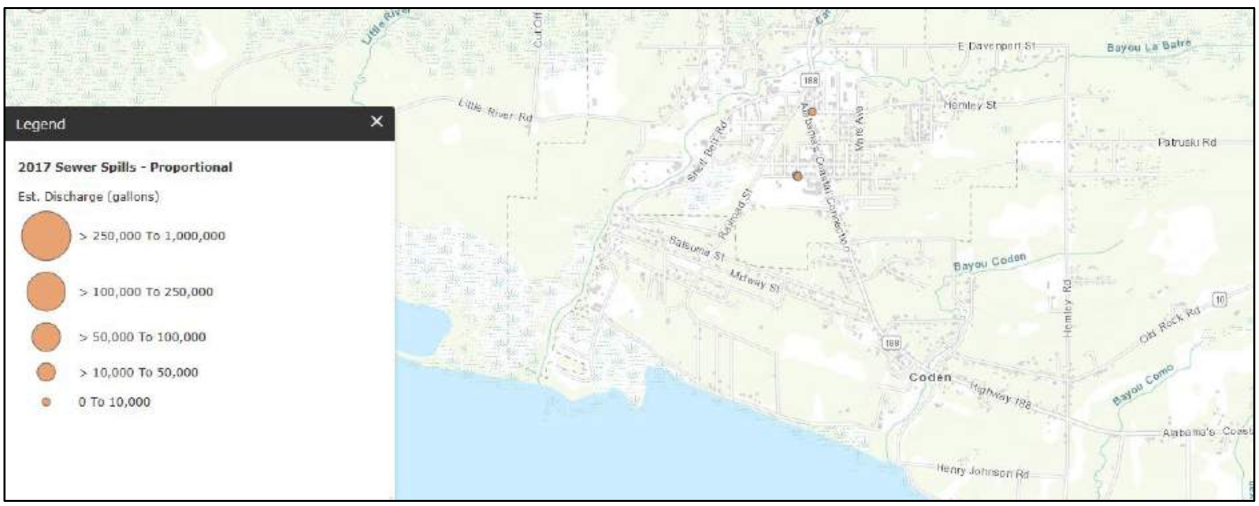


Figure 6.23 Location and relative magnitude of SSOs occurring in 2017 (Mobile Baykeeper 2017)

6.2.4.3 Vessel Discharges

The lower Watershed has an abundance of boat traffic, primarily associated with industry, that may directly contribute illicit discharges to surface waters. Currently there are no pump out stations within Bayou La Batre. Therefore, it is recommended that a vessel pump out station be installed at the City Docks to provide boaters an alternative to discharging into Portersville Bay or Bayou La Batre. **Figure 6.23** is an example of a boat pump out station located at a marina.

Figure 6.24 Boat pump out station. Source: FDEP Clean Marina Program

6.2.4.4 Unpermitted Discharges from Septic Systems

Many septic systems within the Bayou La Batre Watershed system have already been connected to wastewater collection systems through the CIAP program. However, there are rural portions of the Watershed that do not have access to a wastewater collection system. Therefore, these areas continue to rely on septic systems for wastewater disposal. Aging septic systems or improperly installed and maintained systems are prone to leaking and contribute to the presence of pathogens in surface waters within the Watershed. An extension to the sanitary sewer collection system to allow more residents to abandon septic systems and connect to the City's system is recommended. However, there are areas within the Watershed where this is not feasible. For areas where sanitary sewer collection system connections are not feasible, education and outreach for proper installation and maintenance of septic systems is recommended.

6.2.4.5 Trash

Chapter 4 identified trash as an endemic problem throughout the Watershed. Whether intentional or accidental, improperly disposed trash is likely to end up in surface waters of the Watershed. This not only negatively affects water quality and aquatic habitats, but also has a negative impact on recreational activity within the Watershed. Combating litter will take a multi-faceted approach that includes the expansion of existing programs, increased regulatory control and enforcement, and a relentless education and outreach campaign in order to treat the problem at its source. In addition to public outreach, active trash collection and removal efforts should be supported and enhanced as much as possible.

6.2.4.5.1 Acquisition of a Trash Boat

Acquisition of a trash boat to allow collection of trash and debris from the Bayou would enable the City to maintain surface waters and further enforce violations. **Figure 6.24** is a photograph of the City of Mobile's litter boat actively patrolling a waterway.

Figure 6.25 City of Mobile litter boat. Source DRCR (2016)

6.2.4.5.2 Enforcement

Improved enforcement, including increased monitoring and fines for intentional violations for trash disposal is recommended in order to discourage improper waste disposal.

6.2.4.5.3 Zoning Restrictions for Waste/Debris Storage

Adoption of zoning restrictions which require waste and debris storage be located a minimum distance away from surface waters is recommended. Restrictions should also require that trash storage and debris areas be enclosed by a fence and/or be stored inside a container with a lid to prevent litter from blowing away and to prevent scavenging by animals.

6.2.4.5.4 Installation of Waste Transfer Stations

Installation of waste transfer stations provides an affordable and environmentally sound solution for communities to handle collected waste without convenient access to a landfill. Transfer stations provide a hub to manage community waste and to accept large waste items until trash can be sorted and transported for permanent disposal. Because the City of Bayou La Batre does not have a municipal landfill, a coordinated effort between the City and Mobile County for the installation of waste transfer stations throughout the Watershed is a recommended measure for trash/debris management.

6.2.5 Education and Outreach

Litter and pollution reduction methods mentioned previously are only part of the long-term solution of improving water quality. Citizen education and increased awareness is the best management measure to treat impairments to water quality at its direct source.

6.2.5.1 Education Programs for Agricultural Activities in the Watershed

Development of an effective outreach and education program should be the first step in pursuing changes in the headwaters of the Watershed to incorporate Agricultural BMPs. An effective program would engage landowners, provide compelling evidence of the benefits for watershed management to the agricultural industry, provide technical assistance for identifying appropriate BMPs and implementation, and potentially provide financial incentives and assistance to cover the costs of implementation of structural BMPs. This educational endeavor should be conducted in conjunction with organizations and agencies currently working with the farming communities to assure maximum "buy in."

6.2.5.2 Education Programs Related to Trash Issues

Educational programs should be designed and implemented to help adult and youth stakeholders understand the importance of preventing trash in the waterway and to understand how they can be instrumental in the process. Programs should be designed for English-speaking stakeholders as well as those whose native tongue is not English (i.e. Cambodian, Spanish, Laotian, and Vietnamese). Litter and trash programs should include opportunities for stakeholders to participate in active coastal cleanup programs.

The MBNEP through their "Clean Water Future" campaign, "Keep Mobile Beautiful", and many others local organizations have worked tirelessly to educate the public about the environmental harm created by trash. As part of "Keep Mobile Beautiful", recycling drop-off centers were implemented to promote a cleaner environment. These organizations inform the public so people are aware that littering upstream negatively affects downstream systems. Supporting those efforts and encouraging the formation of similar campaigns will be an effective measure to combat trash throughout the Bayou La Batre Watershed.

6.2.5.3 Education Programs for Shipyards (Boatbuilders) and Commercial Seafood Operators

Educational endeavors should be implemented with boat builders and the owners of commercial seafood boats to encourage environmental awareness of their operations and illustrate ways in which each can help reduce litter, eliminate oil, chemical and other discharges.

6.2.5.4 Education Opportunities for City of Bayou La Batre Officials

Effective implementation of the Bayou La Batre Watershed Management Plan will require the full support and intimate participation of key City officials, including the Code Inspector. A priority should be placed on helping the City secure appropriate resources to assure that the Code Inspector is knowledgeable of current methodologies related to protecting the Watershed.

6.3 Fish/ Habitat

Improving water quality in degraded streams, wetlands, and coastal salt marshes was identified in Chapter 4 as a priority in order to improve the overall health of the Watershed from its headwaters to Portersville Bay. Many conditions and factors affecting water quality have been discussed in previous sections. This section will focus on the importance of habitat restoration and the positive impact that natural species have on supporting ecosystem function and health.

6.3.1 Invasive Species

6.3.1.1 Field Survey of Invasive Species

The presence of invasive species within the Watershed disrupts natural processes and functions and often threatens native species by overtaking habitat. Identifying and mapping invasive species present within the Watershed is a necessary step in establishing an invasive species eradication program in order to restore habitat for native species.

6.3.1.2 Develop Invasive Species Eradication Program

Currently, there is no comprehensive program for (1) detecting infestations of invasive flora and fauna in the Watershed and (2) managing or eradicating them once they have been identified. Ongoing inventories of invasive species would be valuable in determining to what extent non-native species have impacted the Watershed and how best to manage eradication, maintenance of biodiversity, and management of threatened natural resources. A public-private collaboration program for the inventory, management, and monitoring of invasive species in the Watershed is recommended.

6.3.2 Channel Restoration

Alternations to the natural dimension, pattern, profile of waterbodies as well as their connectivity to the floodplain can cause a variety of impairments to water quality, channel morphology, and quality of aquatic habitat. Specific impacts to waterbodies observed in the Watershed include floodplain fill from dredging and straightening (i.e. channelizing) of the stream channel. Both activities create an incised channel that are characterized as having high bank erosion rates, lateral channel migration, and an increased sediment supply (i.e. bed aggradation and bar deposition) that often results in a loss of aquatic habitat.

Channel restoration involves a multifaceted approach that includes careful research, design, and engineering. Restoration efforts may include the re-connection and/or expansion of a floodplain, bank stabilization, reestablishing channel sinuosity, and installing energy dissipating structures to decrease water velocity and erosion.

Natural Channel Design

The process of channel restoration through natural channel design involves a multiplestep approach including data collection, engineering and scientific assessment, design, construction, monitoring, and maintenance. The success of channel restoration is contingent upon sound design methodology and implementation. The restoration approach follows specific published guidelines and methods endorsed by numerous institutions and regulatory agencies including the EPA, U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS), and the North Carolina Stream Restoration Institute.

Identification and Assessment of Impaired Channels

The identification and thorough assessment of an impaired channel is the first step in the restoration and design process. Visual observations, coupled with the initial analysis of maps and aerial photos, will help identify priority problem areas and develop a broad understanding of the general conditions within the system.

Site specific data is necessary for documenting the baseline condition of the channel as well as providing sufficient information to classify the channel through the Rosgen Classification of Natural Rivers (Rosgen 1994). This classification methodology will provide a basis for analyzing and interpreting data on channel form (cross-section, profile, and meander geometry), existing condition (lateral and vertical stability and sediment supply), and factors that may influence channel morphology (bank erosion potential, streambank and riparian vegetation, debris and channel obstructions/amoring). Additionally, this information will provide insight as to how the system might respond to direct channel or floodplain alterations and/ or indirect changes to the hydrologic and sediment regime.

Identification and Assessment of Reference Channels

Following evaluation of an impaired channel, stable channels in close proximity to and within the same watershed as the impacted channel should be identified and assessed with regard to their quality and value to the restoration project. These stable channels are referred to as a reference reach.

The existing conditions data from the impaired channel can be compared to data collected from stable reference reaches of the same Rosgen stream type functioning at full potential. A reach functioning at full potential will exhibit its best morphologic condition. This morphologic condition includes a set of desired or preferred characteristics that can be quantitatively described relative to channel size (moderate-low width/depth ratio) and shape (symmetric in crossover reaches, asymmetric in meander bends), channel bed stability (neither aggrading or degrading), bank stability (low bank erosion potential and low lateral migration rates), and sediment supply (comparatively low rates). This comparison will provide the degree to which the existing conditions in the impaired channel differ from those morphological values exhibited by the stable reference reach.

Channel Design

Once data describing existing conditions of the impaired channel and reference data from reference channels has been collected and analyzed, a detailed restoration design of the impaired channel may begin. The design should involve a multidimensional approach based on empirical, analytical, and natural channel principles. The empirical approach incorporates equations derived from regional data sets of various channel characteristics of dynamically stable systems. The analytical approach makes use of hydraulic equations and sediment transport functions to derive equilibrium conditions, and the principles of natural channel design focuses on the morphologic structure and fluvial function of a dynamically stable, natural channel as the model for efforts to improve channel structure and function. Utilizing this approach allows for the proper design of a stable dimension, pattern and profile of the channel that is based on reference reach data, incorporates restoration goals, and allows for flexibility to work within existing site constraints.

One crucial parameter of design is bankfull discharge. Bankfull discharge is calculated based on the anticipated one- to two-year rainfall event, drainage area for the project reach, land use within the drainage area, and substrate characteristics. The data are entered into a hydrologic model providing a bankfull flow rate target. Regional trend data collected from the reference reach should be used to corroborate the hydrology model. Utilizing the calculated flow rate, anticipated channel slope for the restored channel and projected channel "roughness," the size of the channel can be calculated to ensure overbank flow on an approximate annual frequency. Regional curves generated from recorded data are used to validate certain design criteria

The layout of the channel design is then prepared using available topographical data and data obtained from the reference and/or regional curve. Considering the characteristics of the land and potential constraints in the surrounding area, the layout design can follow four different approaches. The four priorities for restoration of impaired and incised channels were developed by Rosgen (1994) and include the following:

- **Priority 1:** Establish bankfull stage at the historical floodplain elevation.
- **Priority 2:** Create a new floodplain and channel pattern with the channel bed remaining at the present elevation.
- **Priority 3:** Widen the floodplain at the existing bankfull elevation.
- **Priority 4:** Stabilize existing banks in place.

Priority 1 Restoration: Establish bankfull stage at the historical floodplain elevation

For a Priority 1 restoration, the incised channel is re-established on the historical floodplain using the relic channel or by way of construction of a new morphologically stable channel. The channel is "lifted" to a higher elevation to connect with the historical floodplain, as illustrated in **Figure 6.25**. The new channel has the dimension, pattern, and profile characteristic of a stable form, and its floodplain is on the existing ground surface. The existing incised channel is either completely filled or partially filled to create discontinuous oxbow lakes and offline wetlands level with new floodplain elevation.

The surrounding land use may prohibit this restoration approach. Priority 1 restorations typically result in higher flood elevations and require sufficient land for meandering, posing a problem where flooding and land use issues exist. Constraints such as permanent culverts upstream and downstream of the restoration reach can also render this approach infeasible.

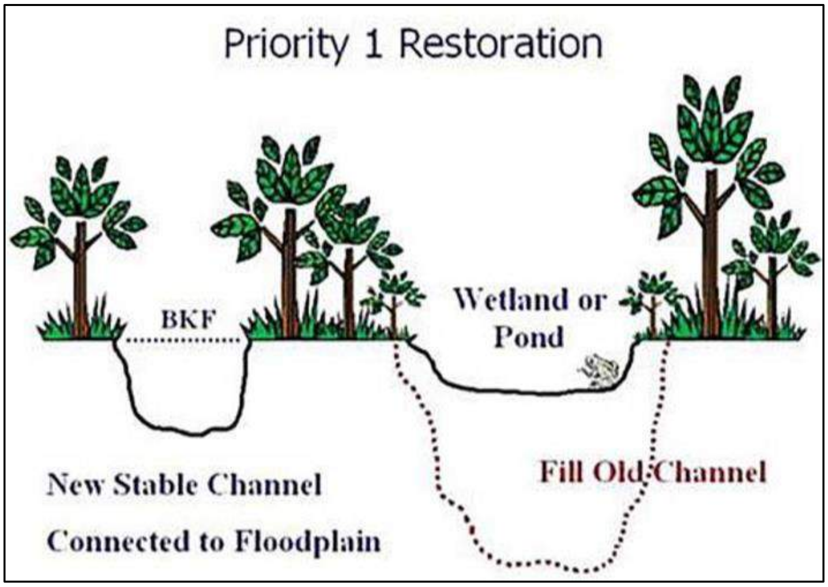


Figure 6.26 Conceptual cross section of Priority 1 restoration (BKF = bankfull) (Doll *et al.* 2003)

Priority 2 Restoration: Create a new floodplain and channel pattern with the channel bed at the present elevation

In a Priority 2 restoration, a new stable channel with the appropriate dimension, pattern, and profile is constructed at the elevation of the existing channel. A new floodplain is established, typically at a lower elevation than the historical floodplain, as depicted in **Figure 6.26**. The new channel is typically a meandering channel with bankfull at the elevation of the new floodplain. This type of project can be constructed in dry conditions while channel flow continues in its original channel or is diverted around the construction site.

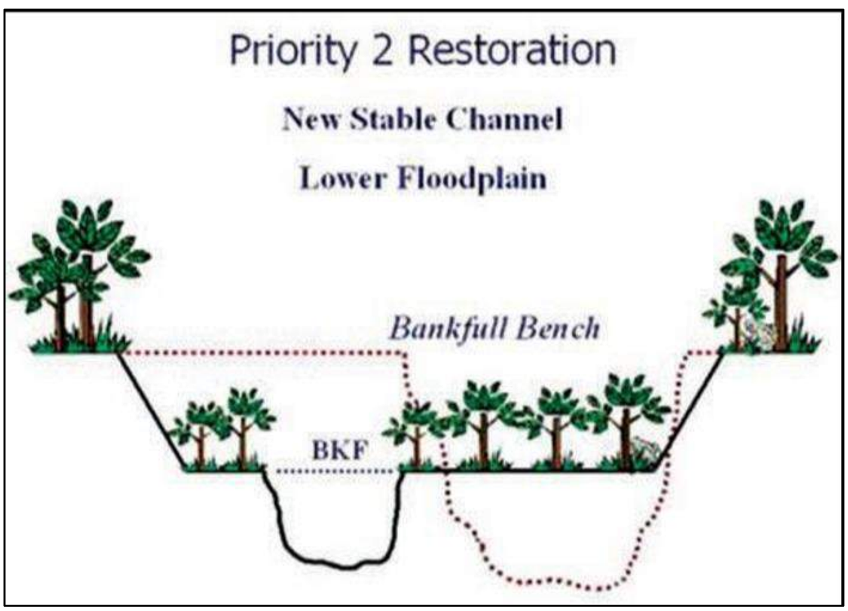


Figure 6.27 Conceptual cross section of Priority 2 restoration (Doll *et al.* 2003)

A major advantage of the Priority 2 approach is that flooding does not increase and may, in some cases, decrease as the floodplain is excavated at a lower elevation. Riparian wetlands in the channel corridor created by the excavation may be enhanced with this approach. Priority 2 projects typically produce more cut material than is needed to fill the old channel. This means that designers should consider the expense and logistics of managing extra soil material excavated from the floodplain. Surrounding land uses can limit the use of this approach if there are concerns about widening the channel corridor.

Priority 3 Restoration: Widen the floodplain at the existing bankfull elevation

Priority 3 restorations entail converting the existing unstable channel to a more stable channel at the existing elevation and with the existing pattern of the channel but without an active floodplain, as illustrated in **Figure 6.27** . This approach involves establishing proper dimension and profile by excavating the existing channel to modify the Rosgen stream classification. This restoration concept is implemented where channels are confined (laterally contained) and physical constraints limit the use of Priorities 1 and 2 restorations. A Priority 3 restoration can produce a moderately stable channel system, but may require structural measures and maintenance. For these reasons, it may be more expensive and complex to construct, depending on valley conditions and structure requirements.

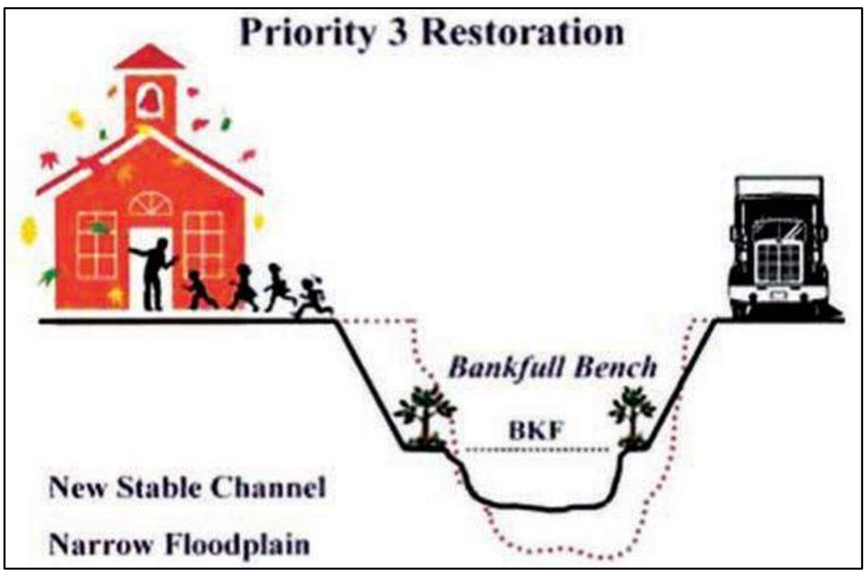


Figure 6.28 Conceptual cross section of Priority 3 restoration (Doll *et al.* 2003)

Priority 4 Restoration: Stabilize existing channel banks in place

In a Priority 4 restoration approach, the existing channel is stabilized in place utilizing stabilization materials and methods that have been used to decrease channel bed and bank erosion, including riprap, gabions, and bioengineering methods. Because this method does not address existing excessive shear stress and velocity that may have caused the impaired channel, it is considered high risk. This approach also limits aquatic habitat and is the least desirable option from a biological and aesthetic standpoint. **Table 6.6** summarizes the advantages and disadvantages of the four priorities for restoration of impaired and incised channels.

Table 6.6 Advantages and disadvantages of incised channel restoration options (Doll et al. 2003)

Priority	Advantages	Disadvantages
1	• Results in long-term stable channels • Restores optimal habitat values • Enhances wetlands by raising water table • Minimal excavation required	• Increases flooding potential • Requires wide channel corridor • Cost associated with excess soil disposal • May disturb existing vegetation
2	• Results in long-term stable channel • Improves habitat values • Enhances wetlands in channel corridor • May decrease flooding potential	• Requires wide channel corridor to implement • Requires extensive excavation • May disturb existing vegetation
3	• Results in moderately stable channel • Improves habitat values • May decrease flooding potential • Maintains narrow channel corridor	• May disturb existing vegetation • Does not enhance riparian wetlands • Requires structural stabilization measures
4	• May stabilize channel banks • Maintanis narrow channel corridor • May not disturb existing vegetation	• Does not reduce shear stress • May not improve habitat values • May require costly structural measures • May require maintenance

Several channel segments were identified as potential restoration areas within the Bayou La Batre Watershed. **Table 6.7** describes potential sites, type of possible restoration as well as their respective location. **Figures 6.28 – 6.34** provide general views of the potential sites recommended for channel restoration.

Table 6.7 Potential channel restoration sites

Location	Linear Feet (ft)	Priority Type	Location Diagram	Description
(1) Unnamed Tributary to Bayou La Batre 30° 24’ 25.52” N 88° 14’ 9.66” W	750	2 or 4		Channel appears to be channelized and incised resulting in lack of floodplain connectivity and eroding streambanks; extensive erosion at road crossing
(2) Unnamed Tributary to Bayou La Batre 30° 24’ 25.54” N 88° 14’ 00.26” W	1,400	2 or 4		Channel appears to be channelized and incised resulting in lack of floodplain connectivity and eroding streambanks; extensive erosion at road crossing
(3) Unnamed Tributary to Bayou La Batre 30° 24’ 25.54” N 88° 13’ 38.92” W	1,250	2,3, or 4		Channel appears to be channelized and incised resulting in lack of floodplain connectivity and eroding streambanks; extensive erosion at road crossing and threatening to undermine adjacent driveway

Channel Restoration Site (1)

Figure 6.29 (1) Channel downstream of road crossing

Figure 6.30 (1) Channel upstream of road crossing

Figure 6.31 (1) Channel culvert crossing

Channel Restoration Site (2)

Figure 6.32 (2) Channel downstream of road crossing

Figure 6.33 (2) Channel upstream of road crossing

Figure 6.34 (2) Channel culvert crossing

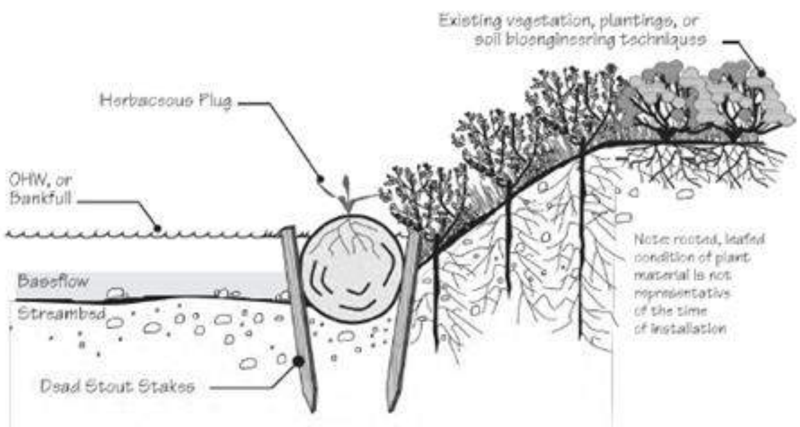
Channel Restoration Site (3)

Figure 6.35 (3) Channel downstream of road crossing

Figure 6.36 (3) Channel upstream of road crossing

6.3.2.1 Channel Bank Restoration and Stabilization

Long-term bank stability can be improved by increasing root density and rooting depth, decreasing the bank angle thereby eliminating undercutting, and maximizing surface protection. Eroding banks can be reshaped to reduce the bank angle allowing for a grade that best supports selected species for revegetation. Typically, this is a 1:4 ratio or better, though grading to the existing terrestrial slope can be a target. Typically this would consist of using an excavator to grade the banks so that the bank angle is reduced in order to minimize future bank failure and maximize vegetation colonization and persistence. Associated stabilization techniques using standard methods and natural materials should be used when reshaping the banks following these general guidelines and specified once a formal plan is developed. Once the bank is reshaped and stabilized, surface soils should be amended, planted, and landscaped as appropriate with the overall goal of maximizing root depth, density, and surface protection.



Coconut Fiber Roll

A coconut fiber roll (Coir™ log) is used to protect a bank's toe and to define an edge. It is a cylindrical structure composed of coconut husk fibers bound together with twine woven from coconut fiber. This product is most commonly manufactured in 12 in. diameters and lengths of 20 ft. However, purchases of prefabricated rolls can be expensive. Use stakes or duckbills to anchor it in place at the toe of the slope, generally at the ordinary high-water mark or bankfull level.

Applications and Effectiveness

- Protects slopes from shallow slides or undermining.
- Molds to existing curvature of the streambank.
- Traps sediment in and behind the roll.
- Produces a well-reinforced toe without much site disturbance.
- Lasts an estimated 6 to 10 years, according to manufacturer's claims.

Construction Guidelines

Inert materials

- Coconut logs (Coir™).
- Untreated twine.
- Cable and duckbill anchors.
- 5/16 in cable and cable clips.
- Dead stout stakes. Make dead stout stakes from 2.5- to 4-ft. long, sound, untreated 2- by 4-in. lumber. Cut each length diagonally across the 4-in. face to make two stakes. Use only sound lumber. Discard any stakes that shatter upon installation.

Figure 6.37 Coconut/coir fiber roll specifications for stabilizing eroding banks

Erosion control fabric made from biodegradable, natural materials such as coconut fibers should be installed as needed and held in place using wood stakes or similar biodegradable materials (see **Figure 6.36**). It is preferable to use erosion control fabric in all areas impacted by construction, though other landscaping measures reducing erosion pressure can be employed.

Care must be taken in selecting vegetation that will tolerate local soil and water conditions while still achieving project objectives. For example, vegetation can be selected to incorporate a variety of plants with robust rooting structures and different seasonal flowering schedules to maximize flowering throughout the year. **Figure 6.37** is a general example of a bank along Bayou La Batre that would be a candidate for bank stabilization and **Table 6.8** provides cost estimates for channel restoration and bank stabilization techniques.

Figure 6.38 General example of bank along Bayou la Batre ideal for bank stabilization

Table 6.8 Channel restoration cost estimates

Item	Unit	Unit Cost
16" natural fiber roll	Per foot	$20
18" natural fiber roll	Per foot	$22
Balled and burlapped trees	Per acre	$5,000
Bare root trees	Per acre	$1,000
Brush layering	Square yard	$150
Channel excavation	Cubic yard	$35
Clear & Grub- heavy	Per acre	$10,000
Clear & grub- light	Per acre	$8,000
Clear & Grub-medium	Per acre	$9.000

Item	Unit	Unit Cost
Coir Fiber Matting	Per foot	$5
Conservation plans	Per acre	$350
Container trees	Per acre	$2,000
Cover crops	Per acre	$25
Cover crop & straw mulching	Square yard	$1
Dozer	Per day	$850
Erosion control matting	Square yard	$3
Evergreen trees- 6 feet tall	Each	$175
Excavator	Per day	$600
Excavator	Per week	$1,400
Filler fiber	Square yard	$5
Grade controls	Per foot	$1,800
Hard bank stabilization	Per foot	$100
Herbaceous plants (1 gallon)	Each	$7
Hydraulic Dredging	Cubic yard	$5-$15
Invasive plant removal/control	Per acre	$250-$1,000
Labor crew	Per day	$200-$600
Live facine	Square yard	$30
Live stake	Each	$5
Log haul	Per log	$115
Mobilization	In & out	$8,000
Native deciduous tree (2.5" diam)	Each	$300
Natural channel design	Per foot	$5-$20
Planting	Per acre	$110
Rig	Per month	$200
Riparian thinning	Per acre	$900
Rootwad	Each	$500
Rubble removal	Per acre	$500
Shrubs (2-3 gallon container)	Each	$35

Item	Unit	Unit Cost
Silt fence	Per foot	$4
Sodding	Square yard	$50
Soft bank stabilization	Per foot	$50
Soil amendments	Per acre	$1,500
Stone toe protection	Per foot	$55
Stream cleanup	Per reach	$100
Stream diversion (pump)	Per day	$500
Wetland plants	Each	$10
Wetland restoration	Per acre	$1,000
Wetland seed mix	Per pound	$200
Project management	5%-10% of total budget	
Design and contingency	20%-30% of construction cost	

6.3.3 Preservation of Ecologically Significant Habitats

Over many decades, historical forests, wetlands, streams, floodplains, and other ecologically significant habitats have been lost to increases in development. Additional loss of critical habitats has occurred as a result of erosion caused by high flow events, boat wakes, and sea level rise. Although the loss and conversion of habitat is challenging and expensive to reverse, it is critical to protect and preserve remaining areas of ecological significance such as wetlands, streams and floodplains, which provide a natural filter for pollutants, pathogens, sediment, etc. Failure to protect these areas will exacerbate negative impacts described throughout this WMP. Examples of potential preservation areas in the Bayou La Batre Watershed are provided in **Figure 6.38** and **Table 6.9.**

Potential wetland preservation areas in the Bayou La Batre Watershed are shown in **Figure 6.39** and further described in **Table 6.9**. These areas were identified as priority sites primarily due to their size as well as connectivity to other significant habitats. It should be noted that **Table 6.9** is not an exhaustive list for priority wetland preservation sites, and other wetland tracts that become available in the future for long-term preservation and protection should be pursued aggressively. The protection of these natural wetland areas will help to ensure that water quality and habitat conditions do not continue to degrade and the benefits currently provided by these areas are not lost.

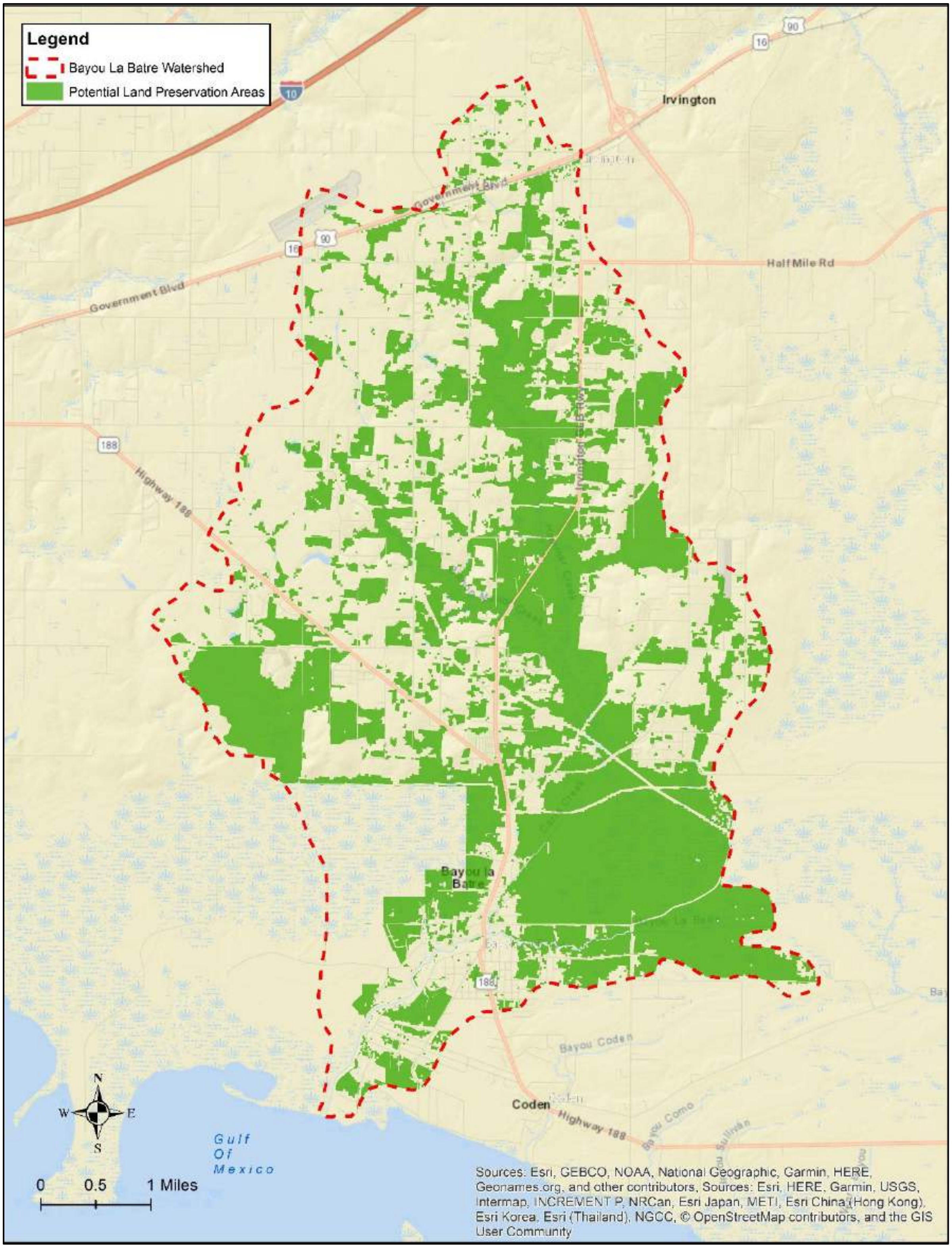


Figure 6.39 Potential areas for habitat preservation (FEMA 2015; MCRC 2016; USFWS 2010)

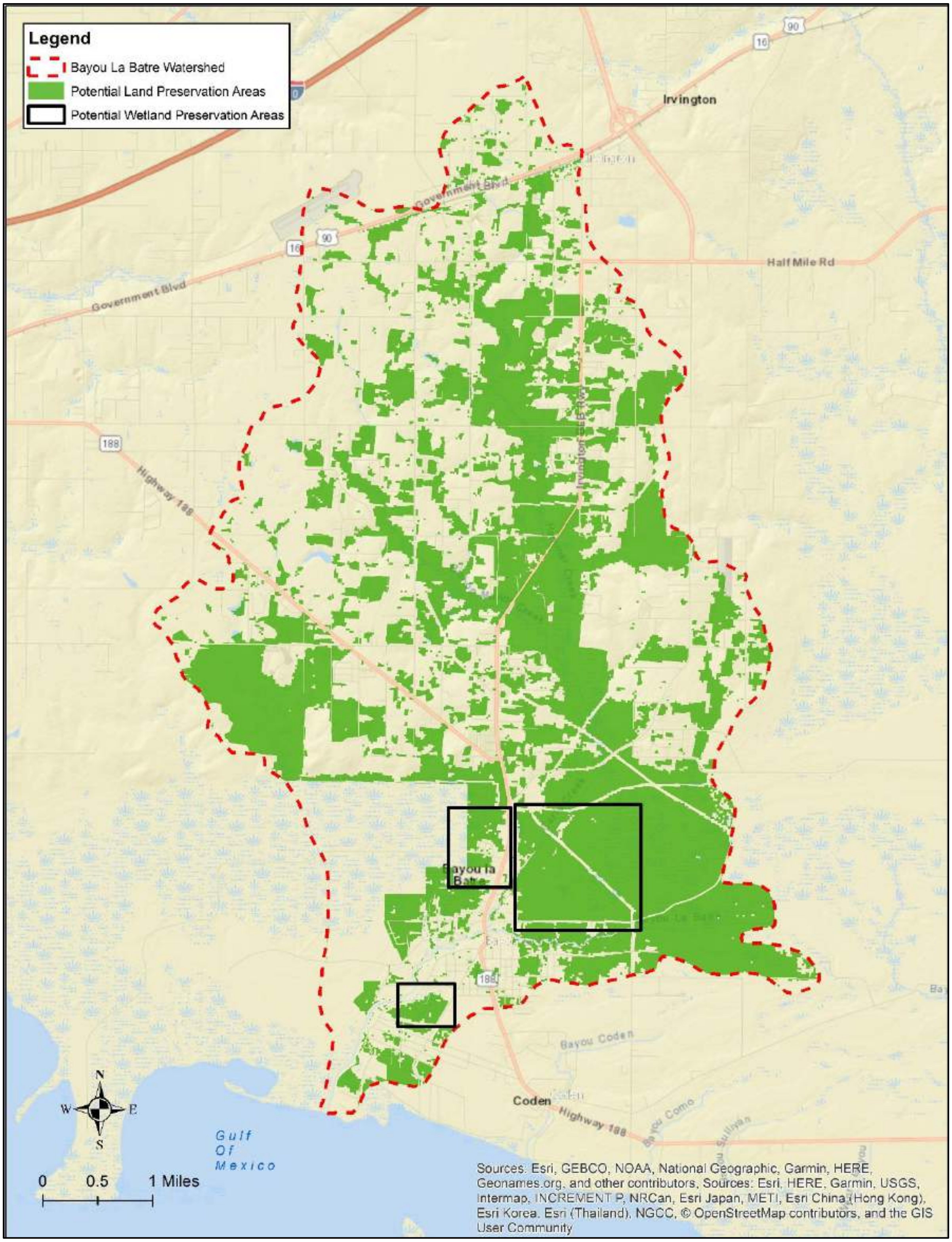


Figure 6.40 Potential areas for wetland preservation

Table 6.9 Potential areas for wetland preservation

Name	Location Map	Description
Upper Bayou Spring Bayou Properties		These parcels are some of the last privately held wetland areas contiguous to the State and City held lands in this area. The wetlands systems are characterized as Freshwater Forested wetlands dominated by needle-leaved evergreen wetland species with shrubs and persistent emergent wetland vegetation. The soils are seasonally saturated to at or near the soils surface for extended periods during the growing season. This area consist of approximately 92.85 acres.
Bayou Cateau Properties		These parcels are some of the last privately held tidal wetland areas immediately adjacent to Bayou Cateau. The wetlands are characterized as an Estuarine deepwater tidal habitat with an adjacent Freshwater Forested/ Shrub wetland system. The forested wetlands system temporarily floods for brief periods during the growing season and where the emergent system is irregularly flooded during periodic tidal events. This area consists of approximately 48 acres.
Carls Creek / Bayou de Duce Properties		These parcels are large predominately-undisturbed privately held wetland areas contiguous to Carls Creek and Bayou de Duce. The wetlands systems are characterized as freshwater forested wetlands dominated by needle-leaved evergreen wetland species with shrubs, persistent emergent wetland vegetation. The soils are seasonally saturated to at or near the soils surface for extended periods during the growing season These parcels do also consist of some interspersed forested hardwood systems with soils that are seasonally flooded for extended periods of time especially early in the growing season. This area consist of approximately 694 acres.

6.3.4 Bird Watching

Bird watching was identified in previous Chapters as a popular recreational activity within the Bayou La Batre Watershed. Channel restoration, property acquisition and habitat restoration will ensure that native birds within the Watershed continue to thrive and enhance the area for bird watching. Establishment of birding trails provide an opportunity to educate recreational users about the importance of the Watershed as habitat for native species and to the community's coastal industries. There are several large tracts of public lands located along the western portion of the Watershed, part of the Grand Bay Savanna Tract of Forever Wild, that hold opportunities for birding. Recreation planning could include trails that connect the urban center to these preservation tracts for birding and for other wildlife observation. These western public tracts are part of the Alabama Coastal Birding Trail and habitat in the area is noted to be a premier location for sighting specific species. Connecting the urban center of Bayou La Batre to these western tracts would also mean connecting visitors on the Alabama Coastal Birding Trail to Bayou La Batre and has the potential for bringing ecotourism to the area.

6.4 Access

There is currently only limited access for recreational activities, both passive and active, in Bayou La Batre. Public access is limited to only a few locations along the Bayou, namely Lightning Point, St. Margaret's Church, and a few locations where kayaks and small boats can be put in. The need for more green space including parks, trails, nature observation stations, fishing piers, and small boat launches for kayaks and canoes has been identified as a management priority.

6.4.1 Master Recreational Use Plan

Development of a Master Recreational Use Plan would engage stakeholders in a review of existing recreational conditions and facilities throughout the watershed, analyze the needs and preferences of residents and visitors, and develop a prioritized plan for implementation. A Master Recreational Use Plan would also allow coordination of property acquisition of areas identified as critical habitat restoration/preservation areas as well as recreational opportunities.

This effort should also incorporate many of the previously identified natural areas/refuges and access points that are located outside of the Watershed which include:

- Point aux Pins to the west
- Bellingrath Gardens to the east
- Dauphin Island to the south
- Grand Bay National Wildlife Refuge and Grand Bay Savanna (further to the west of the Forever Wild tract along the state line)
- Coffee Island and Cat Island habitat recovery project to the south
- Helen Wood Park Oyster restoration south of Mobile
- The Mississippi Sand Hill Crane National Wildlife Refuge
- The Nature Conservancy has a few areas in southern Alabama, including Dennis Cove, north and west of Mobile, Rabbit Island Preserve (near Perdido Key), and Splinter Hill Bog, north east of Mobile, and west of Bayou la Batre in Mississippi the TNC also has the Red Creek Mitigation Area and the Old Fort Bayou Mitigation Bank.

6.4.2 Public Access to Coastal Resources

Public access to coastal resources is important to the people who live near the coast. Increasing and improving public access to the natural resource is a goal of the MBNEP CCMP. Public access to the ecosystems people value most also exposes them to their surroundings and is critical to establishing a connection between people and the environment. Recommended accesses include water front parks, fishing piers, and boat launches for kayaks and canoes. In addition, the installation of pedestrian accesses, bike lanes, and walking trails that connect residential neighborhoods to the waterways are another important recommended measure to provide public access.

Currently, public access to coastal resources is limited because much of the waterfront in the Bayou La Batre Watershed is privately owned. However, several locations have been identified along the main channel that are currently owned by the City (i.e. the south end of Powell Avenue, the north end of Mars Avenue and the east end of Tram Avenue). These locations could be enhanced with amenities to include restrooms, park equipment, picnic areas, fishing access, and kayak launches/canoe launches.

6.4.3 Joint Recreational and Educational Opportunities

Creating access and recreational facilities along waterways also provides an opportunity for outreach and education for visitors who use these facilities. Signage, informational kiosks, visitor centers, guided tours, scenic trails, historical City landmarks, or tours by boat are all platforms for informing recreational users about the community and its history, the Watershed, habitat, and local wildlife. This opportunity also has the potential of promoting the Bayou area and making the City a destination for tourists.

6.4.4 Scenic Byway Loop to Lightning Point

Creating a scenic byway loop through the City of Bayou La Batre and connecting the Scenic Byway Route 188 to Lightning Point is recommended for establishing a working waterfront. A scenic loop designated with signage would blend tourism with commercial activity and allow visitors to observe and experience the waterfront industries. This effort would dually highlight many of the City's historic landmarks as well as promote the concept of a downtown area. The working waterfront would include both the City of Bayou La Batre's traditional industries while also accommodating an emerging tourism-based economy. Enhancing the facilities at Lightning Point in order to make the City Docks a destination for visitors and attracting tourism-based businesses such as restaurants, boat rentals, shops, etc. would be an important element in establishing the Scenic Byway Loop and in creating a downtown area.

6.5 Heritage

The culture, heritage, and history of the people of the City of Bayou La Batre, Coden, Dixon Corner, Irvington and similar communities has revolved around the resources provided by the Bayou La Batre Watershed. There is little doubt that the future of the communities that make up the Bayou La Batre Watershed is in doubt in many ways. The challenges are immense but are outweighed by the opportunities if one will only step back and envision what the future can hold. With a little planning and visionary leadership, the Bayou La Batre Watershed can continue to provide the basis for a vibrant local economy – but perhaps an economy that looks slightly different from that of today.

The following recommendations would preserve the existing rich culture and heritage of Bayou La Batre and its natural resources while also creating new opportunities for outside visitors to experience and enjoy the uniqueness of the Bayou La Batre community.

- Implement a Clean Marina Program. This program is a voluntary certification program consisting of a partnership of private marina owners, local government facilities, and yacht clubs that provides guidance in BMPs for the boating community in order to protect state coastal and inland waters.

- Implement a Clean Water Future Program. This is another program that provides resources and assistance to communities for promoting BMPs to protect waterways.
- Designate a Historical and Heritage Trail. This trail would expand from the Scenic Byway Loop to Lighting Point trail and would take visitors and residents to areas and landmarks of historical and cultural significance. Promoting tourism based on the community's culture and heritage is a simple and inexpensive way to bring visitors to the area and help preserve history.
- Develop an Alabama Coastal Maritime Heritage and Education Center. This Center could highlight the culture and heritage of Bayou La Batre with displays of seafood harvesting vessels, pictorial displays of historical significance, and environmental displays highlighting the importance of environmental stewardship in the Watershed. This facility could host significant events during the year to attract visitors to the City of Bayou La Batre and promote the local economy.
- Develop a Cultural Entertainment District south of Wintzell Bridge. This District would complement the recommended enhancements of Lightning Point, the scenic byway loop, and the heritage trail. A Cultural Entertainment District could transform the area to minimize infrastructure and include community gardens, community shows/festivals, farmers markets, and seafood markets that would cater to both residents and visitors of the City of Bayou La Batre.
- Develop a Working Waterfront. As mentioned in previous sections, creating a working waterfront would provide an opportunity for a combination of commercial and industrial activity as well as tourism-based businesses along the waterfront. This would allow the City to maximize the economic opportunities provided by the downtown area and the cultural significance of the coastal shorelines.
- Develop a Seafood Research Center. This research laboratory could focus on the exploration of other sources of commercially viable products that can be derived from the marine environment.

The following properties were identified as possible locations that could dually serve as access points to the Watershed as well as sites for cultural enrichment opportunities. **Figure 6.40** is a location map of each property in the Watershed.

Property #1

General Description:	Commercial lot with extensive old growth oak trees located along the Bayou La Batre waterway.
General Location:	End of Tram Avenue on the west side of the waterway
Property Size:	App. 5 acres; App. 425 ft. along the waterway
City of Mobile Tax Key/ ID:	01335576 / R024407263002015. 01335610 / R024407263002018. 01335638 / R024407263002020.
Significance of Property:	Habitat conservation and an excellent citizen access to the waterway for fishing, kayaking and family-oriented recreation

Property #2

General Description:	Large commercial lot currently used for boat building
General Location:	West side of Bayou La Batre
Property Size:	App. 18 acres
City of Mobile Tax Key/ ID:	01522524 / R024407263003007. 01335790 / R024407263003008.

	01522533 / R024407263003009. 01348919 / R024408390001024.
Significance of Property:	Potential location for support facilities for the ecotourism industry including docking for tour boats and charter vessels.

Property #3

General Description:	Commercial lot
General Location:	Intersection of Little River Road and Snake Bayou in Bayou La Batre
Property Size:	App. 1.65 acres
City of Mobile Tax Key/ ID:	01335709 / R024407263002026.
Significance of Property:	Habitat conservation, habitat enhancement, and public access (canoe and kayak) to Snake Bayou, a tributary of the Bayou La Batre waterway.

Property #4

General Description:	Large commercial property on the east side of the Bayou La Batre waterway.
General Location:	State Docks Road at Lightening Point
Property Size:	App. 12.1 acres; App 825 ft. of waterfront
City of Mobile Tax Key/ ID:	01422446 / R024407380004001. 01423383 / R024407380005097.
Significance of Property:	Site for ecotourism, public access and educational/outreach programs.

Property #5

General Description:	Undeveloped lot
General Location:	State Docks Road in Bayou la Batre, immediately south of the Gulf City Seafood property identified above.
Property Size:	App. 5 acres; App. 250 ft of waterfront.
City of Mobile Tax Key/ ID:	01345066 / R024407380004002. 01365463 / R024701380004001.
Significance of Property:	Site for ecotourism, public access and educational/outreach programs

Property #6

General Description:	Commercial lot currently used as a small shipyard
General Location:	State Docks Road in Bayou la Batre, immediately south of the Dauphin Island Sea Lab property identified above
Property Size:	App. 5 acres; App. 250 ft. of waterfront
City of Mobile Tax Key/ ID:	01523104 / R024407380004003. 01523300 / R024701380004002.
Significance of Property:	Site for ecotourism, public access and educational/outreach programs

Property #7

General Description:	Marsh land at Lightning Point in the City of Bayou La Batre
General Location:	West side of State Docks Road, across from Buddyland Shipyard
Property Size:	App. 5 acres
City of Mobile Tax Key/ ID:	01523293 / R024701380003006.

Significance of Property:	Habitat conservation, habitat enhancement and ideal site educational boardwalks and teaching tours.

Property #8

General Description:	Nine properties abutting Cateau Bayou in Bayou La Batre
General Location:	East side of Shell Belt Roade in the City of Bayou La Batre
Property Size:	App. 23 acres; App. 1,700 ft. on Cateau Bayou.
City of Mobile Tax Key/ ID:	01343816 / R024407380002083. 01343825 / R024407380002084. 01343834 / R024407380002085. 01343843 / R024407380002086. 01343264 / R024407380002028. 01343273 / R024407380002029. 01343282 / R024407380002030. 01343291 / R024407380002031. 01343308 / R024407380002032.
Significance of Property:	Habitat conservation and site for education and outreach programs as well as ecotourism

Property #9

General Description:	Vacant property
General Location:	Located along the east side of the Bayou La Batre waterway behind St. Margaret's Church immediately south of the Wintzell drawbridge
Property Size:	App. 3.75 acres
City of Mobile Tax Key/ ID:	01337075 / R024407264002009.
Importance of the Property:	Access to the Bayou La Batre waterway.

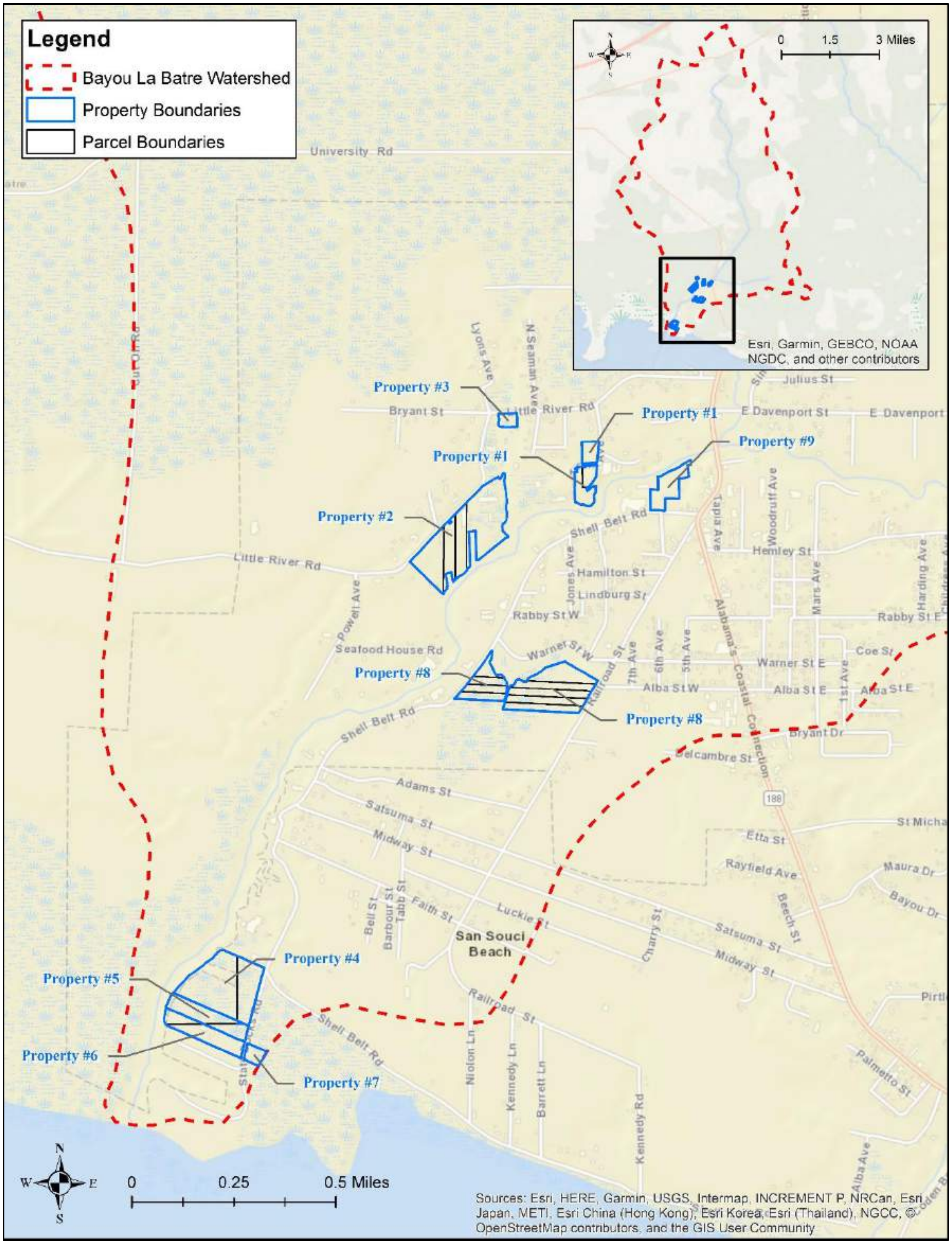


Figure 6.41 Potential locations to improve cultural and environmental enrichment

6.6 Coastlines

Approximately 40% of the Watershed's shorelines are classified as natural. However, the majority of these natural shorelines are limited to the upper Watershed. Nearly the entire lower Watershed has hard armoring in place with the exception of the western bank at the mouth of the Bayou La Batre extending approximately 1 mile upstream. In the lower Watershed, the mouth of Bayou La Batre has been identified as a critical location for shoreline restoration due its susceptibility to natural wave action and boat traffic.

6.6.1 Shoreline Restoration and Preservation

There is evidence that shorelines having intact natural habitat (e.g., wetlands, dunes, oyster reefs, beaches, etc.) experience less damage from severe storms and are more resilient than hardened shorelines (NOAA 2015a). However, as discussed in Chapter 4, natural shoreline habitats in the Bayou La Batre Watershed have experienced losses and degradation. Therefore, management measures should focus on protecting, conserving, preserving, or restoring shorelines and natural shoreline habitats in the Watershed.

In 2016, The Nature Conservancy was awarded funds from the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund to acquire approximately 100 acres of coastal habitat, restore approximately 28 acres of salt marsh, and create nearly 1.5 miles of nearshore breakwaters along the mouth of Bayou La Batre at Lightning Point (see **Figure 6.41**). This project will restore critical coastline areas to their historic positions and more effectively manage the effects of coastal wave action. Projects that involve the nature based restoration of coastal resources similar to that of the acquisition and restoration of Lightning Point are recommend for the Watershed.

6.6.1.1 Implement Living Shorelines

Vertical bulkheads degrade habitat at their toes and reflect boat wake energy to nearby unprotected shorelines, causing erosion. Much better alternatives involve the use of living shorelines technologies. Living shorelines combine engineered erosion control using living plant material, oyster shells, earthen material or a combination of natural structures with riprap, offshore or headland breakwaters to protect property from erosion (Boyd 2007). Living shorelines are designed to absorb and dissipate energy, rather than reflect it, and also seek to provide habitat for aquatic life.

Stabilization solutions for shorelines range from green (soft) or natural and nature based measures to gray (hard) or structural types, shown in **Figure 6.42** (NOAA 2015a). The term "living shoreline" refers to the management of shorelines through natural means such as the placement of structural organic materials and plants native to the local environment, with limited or strategic use of structures. The implementation of a living shoreline method, as opposed to armoring techniques, seek to maintain the sustenance and improve biodiversity of the ecosystem.

NFWF | Gulf Environmental Benefit Fund

RECIPIENTS
The Nature Conservancy

AWARD AMOUNT
$5,903,100

PARTNERS
Alabama Department of Conservation and Natural Resources

Mobile County

City of Bayou la Batre

Dauphin Island Sea Lab

LOCATION
Bayou la Batre, Alabama

AWARD DATE
November 2016

PROGRESS UPDATE
Five of the eight target parcels have been acquired. Two contracts for restoration and monitoring have been executed, and development of management strategy for Forever Wild parcel is underway. (February 2018)

The Gulf Environmental Benefit Fund, administered by the National Fish and Wildlife Foundation (NFWF), supports projects to remedy harm and eliminate or reduce the risk of harm to Gulf Coast natural resources affected by the 2010 Deepwater Horizon oil spill. To learn more about NFWF, go to **www.nfwf.org.**

ALABAMA

Lightning Point Acquisition and Restoration Project – Phase I

This project will protect and restore a key stretch of coastal shoreline at the mouth of Bayou La Batre River. Specifically, the project includes the acquisition of more than 100 acres of coastal habitat and the engineering and design for restoring approximately 28 acres of marsh and 1.5 miles of intertidal nearshore breakwater. The acquisition targets represent more than 2 miles of nearly contiguous undeveloped waterfront adjacent to existing protected lands owned by the state, Mobile County, and the City of Bayou La Batre.

The restoration element will enhance and restore coastal marsh and employ living shoreline techniques along an eroding shoreline. This work extends an existing living shoreline installed immediately to the west and a future living shoreline funded under Early Restoration that will be installed directly to the east. Funding of the restoration elements is anticipated once engineering and design has been completed.

The acquisition and improvement of target coastal parcels will expand existing protected lands and restoration projects. The proposed breakwater will help stabilize a key stretch of eroding shoreline.

Figure 6. 42 National FIsh and Wildlife Foundation's Gulf Environmental Benefit Fund, Lightning Point Project. Source: NFWF (2016)

Many of the Watershed's shorelines may perform quite well with soft structures. Examples of areas suited for living shorelines are presented in **Figures 6.43** through **6.45.**

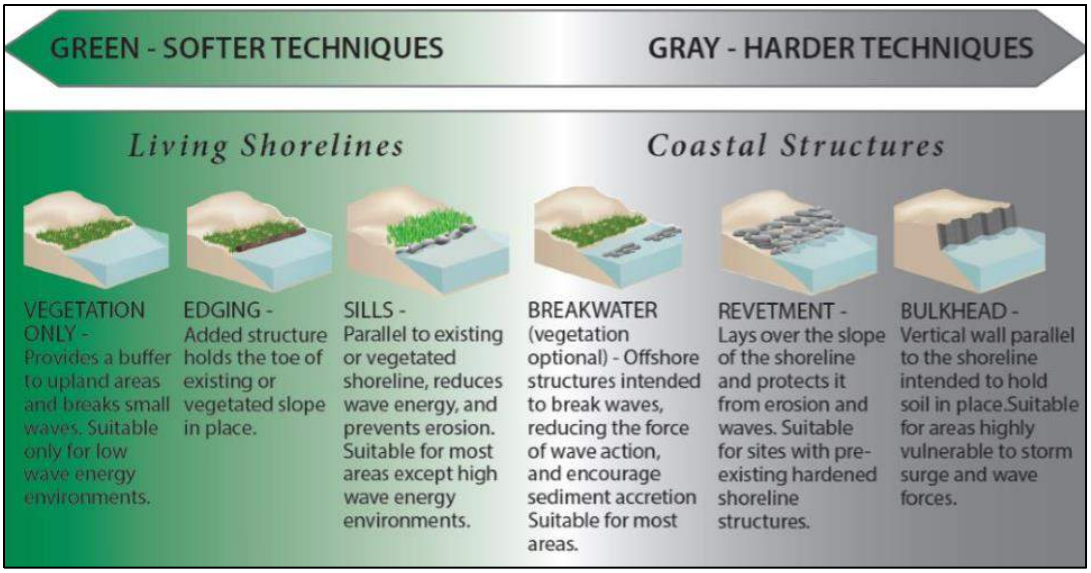


Figure 6.43 Green (soft) to gray (hard) shoreline stabilization techniques (NOAA 2015a)

Figure 6.44 General example of an area along Bayou La Batre suitable for a living shoreline

Figure 6.45 General example of an area along Bayou La Batre suitable for a living shoreline

Figure 6.46 Example of residential logs along Bayou la Batre suitable for a living shoreline

6.6.2 Sea Level Rise

Results of the SLR models described in Section 4 provide some indication of the Watershed's vulnerabilities as they relate to SLR, storm surge, and resiliency. The SLOSH results indicate that many of the City of Bayou La Batre's buildings will be impacted by Category 3 storm surge, and even more will be impacted by a Category 3 storm surge when incorporating the most conservative SLR projections (IPCC 2013 intermediate level). Essentially all of the built environment within the floodplain is vulnerable to impacts from major storms and localized flooding events.

6.6.2.1 Planning for Sea Level Rise

Development of an adaptation planning strategy provides local governments and vested stakeholders a guide to better determine vulnerable areas and develop strategies to mitigate the effects caused by SLR and flooding. The following summary was adapted from the Florida Department of Economic Opportunity accessed at (http://www.floridajobs.org/docs/defaultsource/2015-community-development/communityplanning/crdp/adaptationplann inginflorida.pdf?sfvrsn=2). The adaptation strategy was developed recognizing that SLR will increase coastal vulnerability to a variety of problems, including:

- Increased flooding and drainage problems;
- Destruction of natural resource habitats;
- Higher storm surge, increased evacuation areas and evacuation time frames;
- Increased shoreline erosion;
- Saltwater intrusion; and
- Loss of infrastructure and existing development.

The adaptation strategy prescribes a series of steps that a community may take to become more resilient to the impacts of storm surge, flash floods, stormwater runoff and SLR. The three main strategies a community may use to protect infrastructure and developed areas are:

I. Protection

Protection strategies involve "hard" and "soft" structural defensive measures to mitigate the impacts of rising seas and increased flooding. These include shoreline armoring or beach nourishment. This decreases vulnerability yet allows structures and infrastructure in the area to remain unaltered. Protection strategies may be targeted for areas of a community that are location-dependent and cannot be significantly changed structurally (i.e. downtown centers, areas of historical significance, water-dependent uses, etc.).

II. Accommodation

"The accommodation strategy mitigates the risk of sea level rise through changes in human behavior or infrastructure while maintaining existing uses of coastal areas. For example, it might involve modifying existing infrastructure for adaptive land uses, raising the ground level or improving drainage facilities, encouraging salt resistant crops, restoring sand beaches, and improving flood warning systems" (Lee, 2014).

III. Retreat

Retreat involves the actual removal of existing development, possible relocation to other areas, and the prevention of future development in these high-risk areas. Retreat options usually involve the acquisition of vulnerable land for public ownership, but may also include other strategies such as: transfer of development rights, purchase of development rights, rolling easements, conservation easements, etc. Additional information related to habitat migration and managed retreat is found in Section 6.7

6.6.2.2 Property Acquisition

In order to implement shoreline restoration and return Bayou La Batre's waterfront to natural stabilization, the City will need to acquire additional properties within and adjacent to the mouth of Bayou La Batre. Coordination with the Nature Conservancy in identifying additional properties that may provide opportunities for additional shoreline restoration and preservation is recommended. Many properties previously identified for access and cultural enrichment opportunities could also serve as sites for habitat restoration or preservation activities.

6.7 Resiliency

As described in previous sections, much of Bayou La Batre's developed areas also lie within areas most prone to coastal storm surge and flooding. In fact, the majority of the City of Bayou La Batre lies within the FEMA designated flood zones. Models suggest that a significant portion of the City's infrastructure would be impacted by a Category 3 hurricane, which when compounded with SLR, would put critical infrastructure like the City Hall, the Police Station, and Fire Station at risk.

6.7.1 Land Use Planning and Zoning

The City of Bayou La Batre is prone to hurricanes and flooding, and these weather events present the highest risk to residents and infrastructure within the City. The City could minimize these risks by implementing building restrictions and development requirements that address flood hazards and focus on protecting residents and infrastructure prior to a natural disaster.

Planning that a) limits land use within flood zones to specific types of infrastructure and b) keeps critical structures and the most vulnerable residents out of the flood zone provides a significant form of risk reduction. In addition, zoning regulations that require infrastructure within the flood zone be designed and built to withstand flooding further minimizes risk to structures during a disaster.

6.7.1.1 Existing Land Use Analysis

The first step in implementing land use designation and zoning regulations is to analyze how existing development and infrastructure is organized and where it is located. Performing this task will allow the City of Bayou La Batre to identify areas within the Watershed that are at highest risk and identify alternatives locations to minimize risk.

6.7.1.2 Create Future Land Use Map

After identifying areas of vulnerability, a Future Land Use Map, that is consistent with the City's Comprehensive Plan, should be developed. The Future Land Use Map should addresses risk minimization as well as follow the City's overall vision for how and where development should occur within the Watershed. For instance, the City should explore alternative locations for critical infrastructure including City Hall, the Police Station, and Fire Station, which are currently located within the floodplain. Land use and accompanying zoning is a tool the City can use to ensure that development within the most vulnerable and flood prone areas is restricted. By doing so, it will encourage the development of new residential and commercial endeavors by limiting the uncertainty developers might encounter.

6.7.1.3 Implement Floodplain Management

Implementation of restrictions for development within flood zones limits the risk of exposure and ensures that structures are built to minimum standards. This effort could qualify the City of Bayou La Batre for participation in the Community Rating System (CRS), which provides reduced flood insurance rates for policyholders when communities practice floodplain management activities that exceed the minimum NFIP standards. Additionally, FEMA provides several funding opportunities for technical assistance and Hazard Mitigation Assistance to help communities fund projects to reduce flood impacts.

6.7.1.4 City Districts

In order to implement the risk mitigation measures described above, the City of Bayou La Batre must re-organize its urban area and create new City Districts. It is recommended that a new Civic District be developed north of the City and out of the floodplain. This District would consolidate critical infrastructure into a new location that would not be at risk for flooding during a natural disaster, and thereby ensuring that associated services remain undisrupted during an event. Another recommendation is to develop a new Residential District outside of the floodplain in order to accommodate relocation of the highest risk neighborhoods as well as future development. Finally, as described in Section 6.5, the current downtown area could be transformed into a Cultural Entertainment District. This would provide economic potential for development of tourism-based businesses and provide significant risk mitigation benefits to the City as it would limit permanent infrastructure within flood prone areas. The Cultural Entertainment District would accommodate temporary structures associated with community events, farmers markets, etc. as well as mobile structures.

6.7.2 Risk Management

6.7.2.1 Harbor of Refuge

A Harbor of Refuge refers to a port, inlet, or other body of water normally sheltered from heavy seas by land and in which a vessel can navigate and safely moor (C.F.R. 175.400). While the shrimping fleet based in the Bayou La Batre Waterway has been substantially reduced over the last fifteen years, it remains a key element of the local economy. Without the vessels, the contributions of the shrimping industry would cease to exist. Working in conjunction with The Nature Conservancy's acquisition and restoration project at Lightning Point, a Harbor of Refuge at Lightning Point should also be created. This Harbor would meet the needs of the coastal residents and industries that rely on boating for recreation and livelihoods and provide an area of refuge during strong weather events.

6.7.2.2 Diversification of the Local Economy

As stated in previous sections, the City of Bayou La Batre's economy has been centered around coastal resources, specifically, seafood harvesting and most recently ship building. However, diverse economies, which depend on multiple types of industries, are more stable and resilient. Therefore, diversifying the City's economy to include tourism and ecotourism provides an opportunity to make the overall Watershed more economically resilient while protecting the local culture and history. The management measures provided for the creation of a working waterfront, development of a Cultural Entertainment District, creation of new parks and recreational-protect water quality will be key factors in promoting the development of a tourism/ecotourism sector to support the local economy.

An expanded economy in the southern part of the watershed might include some or all the following elements:

- Ecotourism
    - Charter Fishing
    - Charter Shrimping
    - Educational Tours
    - Working waterfront
    - Excursions to local islands and habitats
    - Elevated Boardwalks for wildlife stations/viewing
    - An Environmental Education Center
    - Biking/hiking/nature trails
    - Birding Sites
    - Eco-explore cruises
    - Canoeing and Kayaking

- Ecotourism Support Elements
    - Tourism Research and Marketing Center
    - Floating House Communities
    - Redeveloped of Lightening Point Wharf
    - Marinas
    - Fisherman's Markets
    - Maritime Museum
    - Waterfront Dining
    - Town Center shopping areas

6.7.2.3 Participate in the Coastal Resiliency Index Program

The Coastal Resilience Index is a self-assessment tool developed by the Mississippi-Alabama Sea Grant Consortium and NOAA's Coastal Storms Program. The index is a tool to guide discussion about a community' resilience to coastal hazards and weaknesses that need to addressed prior to the next hazard event. It consists of an eight-page guiding document, and includes six sections (critical facilities and infrastructure, transportation issues, community plans and agreements, mitigation measures, business plans, and social systems).

6.7.2.4 Promote a Resilience Action Award for Individual/ Groups

A Resilience Action Award could be developed by the City of Bayou La Batre that acknowledges and promotes those individuals (adults and youth) and businesses within the Watershed that proactively incorporate resiliency and environmental stewardship practices into their design or practices. Creating and promoting such annual awards would create substantial visibility for the need to protect the Waterway and encourage personal and corporate stewardship.

7 The Bayou La Batre Watershed Management Plan Implementation Program

In **Chapter 6** a number of management measures were provided to address the critical areas and issues over a short and long-term time frame. For successful implementation of each of the management measures, a clearly defined strategic approach is needed to address the threats previously identified as affecting the Bayou La Batre Watershed. The actions and strategies identified within this chapter are recommended to successfully implement the management measures in this Watershed Management Plan (WMP).

The Bayou La Batre WMP is centered on these six values and addresses the following:

Water

Identifies actions to reduce point and non-point source pollution and remediate past effects of environmental degradation, thereby reducing outgoing pollutant loads into Portersville Bay, Mississippi Sound, and the Gulf of Mexico.

Coastlines

Assesses shoreline conditions and identifies strategic areas for shoreline stabilization and fishery enhancements.

Access

Characterizes existing opportunities for public access, recreation, and ecotourism and identifies potential sites to expand access to open spaces and waters within the watershed.

Fish

Identifies actions to reduce the incidence and impacts of invasive flora and fauna and improve habitats necessary to support healthy populations of fish and shellfish. Provides a strategy for conserving and restoring coastal habitat types; providing critical ecosystem services; and identified by the MBNEP's Science Advisory Committee (SAC) as most threatened by anthropogenic stressors. These habitat types: freshwater wetlands; streams, rivers and riparian buffers; and intertidal marshes and flats, were classified as most stressed from dredging and filling, fragmentation, and sedimentation, all related to land use change.

Heritage

Characterizes customary uses of biological resources and identifies actions to preserve culture, heritage, and traditional ecological knowledge of the watershed.

Resiliency

Identifies vulnerabilities in the watershed from accelerated sea level rise, storm surge, temperature increases, and precipitation and improves watershed resiliency through adaptation strategies.

7.1 Implementation Strategies

7.1.1 Establish a Watershed Plan Implementation Team (WPIT)

Implementation of the Bayou La Batre WMP will require leadership and substantial funding. A Bayou La Batre Watershed Plan Implementation Team (WPIT) must be created to implement the work necessary to prioritize specific projects, develop project budgets, collaborate with all appropriate entities and agencies, and locate the necessary funding. The initial leadership needed to enact the creation of the WPIT will be provided and led by the South Mobile County Community Development Corporation (SMCCDC).

Membership of the Implementation Team must illustrate the diversity of entities that guided development of the WMP including local citizens and business interests, Mobile County, the City of Bayou La Batre, engineering firms (as needed), regional planners (SARPC), agricultural interests, seafood interests, boat building interests, Mobile County Public School System, utilities and others. Implementation of the Bayou La Batre WMP should be coordinated by an individual or organization with fundamental knowledge of the watershed and the uniqueness of its stakeholders, such as the SMCCDC.

Members of the Implementation Team should be open to interdisciplinary discussions on how to establish and achieve consistent management goals, devise appropriate regulatory requirements, share critical information, and seek program and funding objectives.

The WPIT should also provide an avenue for public engagement and membership, and foster community outreach and education to promote the goals of the WMP. Moving forward, it is critical for the WPIT to focus on the following principles:

- Involve
- Engage
- Educate
- Own

Involve

Momentum has been building over the years to transform the Bayou and its watershed into a healthy and vibrant community that supports robust habitat; provides increased public access; serves as an economic engine supporting the seafood and shipbuilding industry and ecotourism; and celebrates and preserves the rich culture and heritage of the area. With the development of this WMP and the activities involved (i.e. public meetings, committee meetings), the timing is right to build upon the involvement of current audiences and invite more to participate in this work. The WPIT must develop a working coalition with local residents and organizations, city, county, state, and federal agencies, as well as private industry.

Engage

The WPIT should build upon existing as well as create new opportunities for public involvement and membership, host meetings with community groups and local associations to equip them with knowledge and materials to advocate and promote the goals and objectives of this WMP, and provide education and outreach events that promote wise stewardship of the Watershed.

Educate

Successful implementation of the recommended management measures and achievement of the goals and objectives identified in this WMP may not be possible without public education and outreach. Education extends beyond school curriculum opportunities and involvement of academia in research and teaching. It involves educating all stakeholders (i.e. local officials and leaders, private industry, and local citizens) to increase awareness about the present and future threats to the Watershed, and to foster new attitudes, motivations, and stakeholder commitments.

Own

In order to achieve the desired vision for the Watershed, this WMP must become an initiative rooted within the community. The MBNEP has led by initiating and driving the development of the WMP, however, local officials, leaders, and citizens must take ownership of this WMP for the vision of the Watershed to become a reality.

7.1.2 Develop Appropriate Monitoring and Adaptive Management Mechanisms

To achieve maximum effectiveness, the Bayou La Batre Watershed Management Plan implementation effort should monitor a variety of management measures and indicators, including but not limited to the following.

- acres of wetlands preserved
- acres of wetlands restored
- miles or acres of riparian buffer restored
- acres treated for invasive plant removal
- number of septic tanks inspected and serviced and/or taken out of service
- number of alternative on-site sewage disposal systems installed
- miles of livestock exclusion fencing installed
- number and type of agricultural Best Management Practices (BMPs) implemented,
- miles of waterway restored

In addition, a comprehensive watershed water monitoring system should be designed and implemented that will be consistent enough to accurately monitor trends in Watershed conditions and parameters. All monitoring activities should be conducted in accordance with ADEM or Alabama Water Watch (AWW) protocols. A vital element of the Watershed Monitoring Program will be volunteer citizen participation to enable successful implementation and establish a sense of community ownership within the Watershed. Efforts should be made to recruit as many volunteer monitors as possible.

7.1.3 Establish and Implement a Range of Educational Outreach Efforts within the Watershed

Educational programs on priority Bayou La Batre Watershed issues (wetlands, water quality, stormwater management, sea level rise, etc.) should be developed and targeted toward municipal officials, business interests, homeowners and youth. Outreach and education efforts must target different messages to different audiences on issues relating to implementation of the WMP. The primary goal should be to increase the sensitivity and understanding of the target audiences to the necessity of implementing the management measures outlined in the WMP.

7.1.4 Short-Term Strategies

The short-term strategies listed in **Table 7.1** have been identified to facilitate realistic short-term successes that will assist the WPIT in building early momentum within the stakeholder communities. These early successes will provide the WPIT with the building blocks of environmental stewardship by instilling confidence and involvement from the stakeholders, which is necessary to achieve the overall vision of the WMP. These short-term strategies are identified along the lines of the MBNEP Comprehensive Conservation and Management Plan's values with management measures relating to water quality, coastlines, heritage, access, and resiliency. Within each of these management measures, potential action items have been identified as well as prospective partnering with other institutions/ agencies to meet their respective published plans and goals. These include, but are not limited to, the Alabama Department of Conservation and Natural Resources, State Lands Division, Coastal Section; *Alabama Coastal Area Management Program Strategic Plan 2013-2018* (ACAMP), Alabama Gulf Coast Recovery Council project's list (AGCRC), US Fish and Wildlife Service; *Vision for a Healthy Gulf of Mexico Watershed; Next Steps for a Healthy Gulf of Mexico Watershed* (FWS Next Steps); Mobile Bay National Estuary Program; *Comprehensive Conservation & Management Plan 2013-2018* (CCMP) and Deepwater Horizon Natural Resource Damage Assessment Trustees (DHNRDAT) funded projects.

Table 7. 1 Short-term strategies (0-3 years)

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Resiliency Water Fish Coastlines	Reduce the amount of trash in and entering the bayou and tributaries	1. Develop a public educational program to address litter control 2. Develop educational and outreach to waterfront property owners and businesses; Fishing vessel owners and operators to properly manage waste 3. Organize waterways and coastline clean-up events (Two per year) (CCMP TAC-2.1) 4. Champion the enhancement and enforcement of littering and solid waste ordinances 5. Assist in the development and advocate enforcement of derelict vessel ordinances 6. Coordinate efforts between City and County officials to establish a solid waste / recycling stations throughout the watershed 7. Coordinate an "Adopt a Stream/Area/Mile" program with PALS	Alabama PALS; Alabama Coastal Clean Up Inc.; Alabama Clean Water Partnership; Local businesses; City of Bayou La Batre; Bayou La Batre Area Chamber of Commerce, Bayou La Batre Beautification Committee; Mobile County; GOMA Marine Debris Cross-Team Initiative; NRCS;

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Resiliency Water	Reduce sediments in stormwater runoff and address nuisance flooding in yards and streets	8. Develop GIS based inventory of stormwater conveyances and outfalls within the City (ACAMP Goal 2 A iii) 9. Identify BMP opportunities and assist in the implementation on public accessible areas. 10. Coordinate with the County to address rural road stormwater runoff. (implement BMPs/ pave dirt roads)(ACAMP Goal 2 A ii)	City of Bayou La Batre; Mobile County; CIAP; ADCNR; Weeks Bay CTP; ARWA
Resiliency Water Coastlines	Reduce nutrients and sediments from stormwater runoff	11. Coordinate a BMP standards educational campaign for farmers in the upper watershed 12. Implement outreach for compliance with NPDES stormwater construction activities (CCMP TAC-2.3)	Mobile County Soil & Conservation District; Alabama Extension Alabama A&M and Auburn Univ.; ARWA;ACES; ADEM; ADCNR; NRCS;Weeks Bay CTP; Bayou La Batre Area Chamber of Commerce

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Fish Resiliency Water	Remove Sanitary System Leaks, SSO, and illicit discharges into Bayou La Batre	13. Identify and promote the remove of sanitary system leakage/overflows into groundwater, creeks and tributaries 14. Conduct/ coordinate outreach for compliance with the NPDES activities (MS4, Industrial and Vessel sectors) (CCMP TAC-2.3) 15. Preform outreach for compliance with the Marine Sanitation Act 2003-59 16. Explore implementation of Clean Marina Program 17. Participate in the Coastal Alabama Clean Water Partnership 18. Coordinate water quality sampling volunteers with the MBNEP's program, Coastal Volunteer Environmental Monitoring Initiative (DHNRDAT project)	ADEM; ADCNR; ARWA; City of Bayou La Batre; Mississippi-Alabama Sea Grant Consortium; Bayou La Batre Area Chamber of Commerce; Mobile Baykeepers; ALEA Marine Police Div.; MBNEP

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Coastlines Fish Resiliency	Reduce the occurrence of nuisance and/or exotic species with focus on the bayou	19. Coordinate a field survey of invasive/ exotic flora and fauna 20. Initiate and develop an invasive/ exotic eradication program (FWS Next Steps) 21. Initiate and develop educational programs for large landowners in the upper watershed about land management practices (Prescribed burns, Longleaf Pine, etc.) (FWS Next Steps)	Alabama Extension Alabama A&M and Auburn Univ.; ADCNR; City of Bayou La Batre; NRCS- LLPI & WLFW, Farm Restoration program; Alabama Forestry Commission; Alabama Treasure Forest Foundation; USFWS; USDA-FS
Coastlines Fish Resiliency	Promote coastal habitat protection and conservation	22. Identity and prioritize parcel acquisition for areas (DHNRDAT project): a. along the east and west shore of the bayou (CCMP ERP-3.2) b. flood prone to turn into public green spaces design for stormwater attenuation 23. Identify and remove derelict vessels 24. Develop a "Adopt a Watershed/ Stream" program 25. Develop Outreach/ Educational program about the importance of wetland systems 26. Coordinate with local recreational department to install habitat and natural resource interpretive signage in new and existing parks to educate visitors	NOAA Marine Debris Program; EPA; ADEM; MBNEP; City of Bayou La Batre; Alabama Rivers Alliance; Southern Regional Water Program; Alabama PALS; Alabama Water Watch; Auburn University Water Resources Center; The Nature Conservancy; USFWS

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Access Heritage Resiliency	Citizen access	27. Assist in the re-development of the City Docks (AGCRC Prj # 218) (ACAMP Goal 3 Bi) (DHNRDAT project) 28. Champion Waterfront Park upgrades (Lightning Point, Rolston Park)(ACAMP Goal 3 Bi) (DHNRDAT project)	Alabama Working Waterfront Coalition. Mississippi-Alabama Sea Grant Consortium; ADCNR; NPRA
Access Heritage Resiliency	Ecotourism	29. Champion the creation of a local Alabama Coastal Bird Stewardship Program 30. Coordinate the creation of nature trails with wildlife observation points within local public lands(ACAMP Goal 3 Bi) 31. Explore the creation of a multi- user trail along Shell Belt Road (ACAMP Goal 3 Bi) 32. Establish a Bluewater tail in conjunction with the Mobile County Blueway Trail (AGCRC prj#228) (ACAMP Goal 3 Bi)	NFWF; ADECA. NPRA; Bayou La Batre Chamber of Commerce, the South Mobile County Community Development Corporation and the South Mobile County Tourism Authority (SMCTA); ADCNR
Access Heritage Fish Water	Increase private sector support for protecting bayou water quality/ habitat	33. Conduct Maritime and historic inventory 34. Identify and connect stakeholders for partnerships in celebrating the rich cultural heritage of the bayou(CCMP TAC-2.2)	ACAMP; Bayou La Batre Chamber of Commerce, the South Mobile County Community Development Corporation and the South Mobile County Tourism Authority (SMCTA)

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Access Heritage Water	Educational outreach for Create a Cleanwater Future (CCWF)	35. Conduct outreach to private sector (seafood/ shipbuilding industries, large landholders, etc.) (CCMP TAC-1.2)	BLB Chamber, Seafood Industry, Shipbuilding Industry, Farmers
Access Heritage	Heritage/ Cultural trails	36. Encourage eco-heritage tourism around the bayou by the creation of walking/ biking/ paddling trails (CCMP ERP-3.3) 37. Create coastal resource protection guidelines for eco-tourism	Alabama Gulf Coast Convention and Visitor Bureau; Bayou La Batre - Coden Historical Foundation; ADCNR
Access Heritage	Preserve cultural heritage	38. Promote Seafood Industry (AGCRC prj. # 241) (DHNRDAT project, Eat Alabama Wild Seafood) 39. Promote the Shipbuilding Industry	Alabama Gulf Coast Convention and Visitor Bureau; Bayou La Batre - Coden Historical Foundation
Coastlines Fish Resiliency Water	Implement living shoreline projects	40. Develop an action plan to increase "natural" shorelines within the bayou to reduce shoreline erosion (ACAMP Goal 1 Aiii) 41. Education campaign to waterfront property owners about natural shoreline stabilization. (ACAMP Goal 1 Aiii) 42. Coordinate efforts to replace harden structures with " natural" shorelines (CCMP ERP-2.1)	Alabama Working Waterfront Coalition. Mississippi-Alabama Sea Grant Consortium; ADCNR; MBNEP; Alabama Coastal Foundation; NOAA; The Nature Conservancy ; USFWS

Table 7.1 Short-Term Strategies (0-3 years)

Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
		43. Promote acquisition of parcels on the east and west side an upper part of the bayou (ACAMP Goal 4 vi)	
Coastlines Water Fish Resiliency	Shoreline sustainability	44. Develop an plan to identify beneficial dredge spoil usage projects to support shoreline sustainability (ACAMP Goal 1 J) 45. Develop public outreach/ education for currently funded shoreline restoration projects at Lightning Point, Shell Belt Road and Point aux Pins 46. Develop a long-term plan for management and protection of shoreline sites that have been acquired (ACAMP Goal 1 Aiii)	City of Bayou La Batre; ADCNR; Weeks Bay CTP; CIAP; GOMA HCRT; The Nature Conservancy; USFWS
Coastlines Water Fish Resiliency Access	City comprehensive planning and development	47. Develop a plan to relocate critical infrastructure and facilities out of the 100-year floodplain. (ACAMP Goal 4 Aii) 48. Advocate for local updating of the Building Code and adopt the most current International Building Code (ACAMP Goal 4 iv & v) 49. Expand Safe Harbor neighborhood (DHNRDAT project) 50. Implement programs that will lower homeowner's insurance premiums. (ACAMP Goal 4 Aiii)	Mississippi-Alabama Sea Grant Consortium; ADCNR; GOMA; FEMA; City of Bayou La Batre; ACAMP; Weeks Bay CTP; ARWA; CLECP; Mississippi-Alabama Sea Grant Consortium; ADCNR; GOMA; FEMA; City of Bayou La Batre; ACAMP; Weeks Bay CTP; ARWA; CLECP

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Heritage		51. Re-organize layout of city by relocating city parks and other uses to areas that can absorb flooding (ACAMP Goal 4 Aii) 52. Develop policies to promote relocation of new housing areas to upland areas that are out of the floodplain (ACAMP Goal 4 Aii) 53. Identify greenspace and conservation lands within city limits (ACAMP Goal 4vi) 54. Advocate for the removal of molded and dilapidated structures that present a safety hazard 55. Promote a Resiliency Action Award recognition for local Individuals/ Industry/ Group that encourages/ implements environmentally sound management practices 56. Adopt/ institute a Wellhead/ groundwater protection plan 57. Participate in the Coastal Resilience Index Program (ACAMP Goal 4 Aiii)	

Table 7.1 Short-Term Strategies (0-3 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action Items	Prospective Partnerships
Coastlines Water Resiliency Heritage	Port Resiliency Clean & Resilient Marinas Initiative	58. Encourage the Bayou La Batre Port Authority to Participate in the Ports Resiliency Self-Assessment 59. Encourage local and City marinas to participate in an initiative to explore possible best management implementation	City of Bayou La Batre; GOMA; ADCNR; Mississippi-Alabama Sea Grant Consortium;

7.1.5 Long-Term Implementation Strategies

The long-term strategies listed in **Table 7.2** have been identified to perpetuate the successes gained from the short-term strategies by continued sustainability of the WPIT's charge to improve the overall quality of the Watershed for its stakeholders. These strategies will focus on the long-term "big picture" projects that will enhance the Watershed's condition. One of these enduring goals is to establish a Watershed Management Authority under the 1991 Alabama State Law, Act No. 91-602, authorizing the establishment of Watershed Management Authorities with the intent of protecting and managing Watersheds by developing and executing plans and programs related to water conservation, water usage, flood control and prevention, wildlife habitat protection, agriculture and timberland protection, erosion control and prevention and floodwater and sediment damages. This authority could be sought in conjunction with WPIT from adjacent Watersheds.

Table 7. 2 Long-term strategies (4-10 years)

Table 7.2 Long-Term Strategies (4-10 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action items	Prospective Partnerships
Resiliency Water	Reduce the amount of trash in and entering the bayou and tributaries	1. Champion the acquisition of a trash boat to maintain the bayous 2. Organize water ways and coastline clean-up events (Two per year)(CCMP TAC-2.1)	Alabama PALS; Alabama Coastal Clean Up Inc.; Alabama Clean Water Partnership; City of Bayou La Batre; Bayou La Batre Area Chamber of Commerce; Alabama Coastal Conservation Corps; GOMA
Resiliency Water Fish	Reduce sediments in stormwater runoff and address nuisance flooding in yards and streets	3. Develop a watershed wide study to ID drainage and water quality improvements. 4. Map existing ROW and drainage easements. ID required easement acquisition to provide future maintenance for the drainage system	City of Bayou La Batre; ADCNR; Weeks Bay CTP; USFWS
Resiliency Water Coastlines	Reduce nutrients and sediments from stormwater runoff	5. Work with local agricultural land owners to implement agricultural BMPs (i.e. vegetated buffers or perimeter swales)	Alabama Extension Alabama A&M and Auburn Univ.; ARWA; ACNPCP; NRCS; NWTF; USDA-FS

Table 7.2 Long-Term Strategies (4-10 years)

Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action items	Prospective Partnerships
Fish Resiliency Water	Remove Sanitary System Leaks, SSO, and illicit discharges into Bayou La Batre	6. Advocate for the construction of sewage pump out stations for working vessels 7. Assist the local utility in GIS locating the sewer collection system 8. Conduct an I/I study of the collection system 9. Organize the mapping of all active NDPES MSGP discharges within the watershed to include abandoned mines. Evaluate runoff controls and ID problem areas 10. Implement a sanitary sewer and manhole realignment and replacement program(AGCRC project #261) 11. Address the location of the wastewater treatment plant surface water discharge pipe. (AGCRC project #255) 12. Advocate for the construction of lift station along the bayou (AGCRC project #261)	Mississippi-Alabama Sea Grant Consortium; ARWA; ADEM

Table 7.2 Long-Term Strategies (4-10 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action items	Prospective Partnerships
Coastlines Fish Resiliency	Reduce the occurrence of nuisance and/or exotic species with focus on the bayou	13. Partner with large land owners in the upper watershed to implement land management practices	Alabama Extension Alabama A&M and Auburn Univ.; ACAMP; City of Bayou La Batre; NRSC-LLPI & WLFW, Farm Restoration program; USFWS
Coastlines Fish Resiliency	Upper Watershed restoration	14. Implement a program to protect natural shorelines from erosive environments (ACAMP Goal 1 Aiii) 15. Explore restoration of the natural streambed within the Watershed (CCMP ERP-2.1)	ADCNR, MBNEP ,EPA, ADEM; The Nature Conservancy; USFWS
Coastlines Fish Resiliency	Promote coastal habitat protection and conservation	16. Identity and prioritize parcel acquisition for areas: a. along the east and west shore of the bayou (CCMP ERP-3.2) b. flood prone to turn into public green spaces design for stormwater attenuation 17. Develop an "Adopt a Watershed" program	City of Bayou La Batre; ADCNR; Weeks Bay CTP; CIAP; GOMA HCRT; The Nature Conservancy
Access Heritage	Create access points	18. Create educational access points that includes an area of shoreline/ habitat	Alabama Working Waterfront Coalition. Mississippi-Alabama Sea

Table 7.2 Long-Term Strategies (4-10 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action items	Prospective Partnerships
		restoration (CCMP ERP-3.1) (ACAMP Goal 3 Bi) 19. Establish a Bluewater tail in conjunction with the Mobile County Blueway Trail (AGCRC prj#228) (ACAMP Goal 3 Bi)	Grant Consortium; ADCNR
Access Fish Heritage Water	Environmental outreach/ education	20. Create an Environmental Center (AGCRC prj #333)	ADEM, ADCNR; AGCRC, GOMA, ACAMP; The Nature Conservancy; USFWS; NWTF
Access Heritage Water	Working Waterfront	21. Coordinate and increase awareness of working waterfront issues and eco-friendly BMPs.	Alabama Working Waterfront Coalition; Mississippi-Alabama Sea Grant Consortium; ADCNR; National Working Waterfront Network, US Economic Development Administration; City of Bayou La Batre; Mobile County

Table 7.2 Long-Term Strategies (4-10 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action items	Prospective Partnerships
Access Heritage Resiliency Water	Long-Term Watershed Management	22. Explore the creation of a Watershed Management Authority under Alabama Code Title 9 Chapter 10A. May look at combining other watersheds such as West Fowl River, and Dauphin Island	City of Bayou La Batre; ADCNR; Weeks Bay CTP; MBNEP
Coastlines Water Resiliency	Outreach/ education	23. Coordinate an educational curriculum and teaching tools that can support local schools in teaching the values and the importance of natural resources (SAVs, Wetlands, Watersheds) (ACAMP Goal 1 Ei)	Alabama Working Waterfront Coalition. Mississippi-Alabama Sea Grant Consortium; ACAMP; GOMA
Coastlines Fish Water Resiliency	Implement living shoreline projects	24. Coordinate efforts to replace harden structures with " natural" shorelines (CCMP ERP-2.1) 25. Promote acquisition of parcels on the east and west side an upper part of the bayou (ACAMP Goal 4 vi)	City of Bayou La Batre; ADCNR; Weeks Bay CTP; ACAMP; The Nature Conservancy; USFWS; NWTF
Heritage Coastlines Resiliency	Preserve coastal Alabama heritage	26. Explore the creation of an Oyster Farm Enterprise Zone (CCMP TAC-3.1) (ACAMP Goal 3 Bi) 27. Develop a Safe Harbor in the bayou AGCRC prj. #237; CCMP TAC-3.2)	Alabama Working Waterfront Coalition. Mississippi-Alabama Sea Grant Consortium; ADCNR

Table 7.2 Long-Term Strategies (4-10 years)			
Bayou la Batre Watershed Challenge to be Addressed and CCMP Value	Management Measures	Potential Action items	Prospective Partnerships
 Coastlines Resiliency Fish Water	Coastal habitat protection	28. Look for opportunities to acquire properties in the floodplain and restore to natural habitat (ACAMP Goal 4 Aii) 29. Create outreach events to educated elected officials, citizens and business and industry leaders of the importance of resiliency strategies for long term sustainability (ACAMP Goal 1 Di, Goal 4 Aii)	City of Bayou La Batre; ADCNR; Weeks Bay CTP; CELCP; ACAMP; The Nature Conservancy; USFWS

7.1.6 Implementation Milestones

Interim milestones should be established to support detailed scheduling and task tracking. The interim milestones should identify specific goals, and the time frame within which those milestones should be accomplished. Milestones can be loosely organized into short-term (one to three years), mid-term (five years), and long-term (five to ten years) categories.

Short-Term Milestones

- Designate the SMCCDC as the leader of the WPIT
- Get WMP adopted by the City of Bayou La Batre
- Apply for and receive funding for projects identified in **Table 7.3**
- Develop Education and Outreach Programs
- Coordinate with Mobile Baykeeper and Alabama Water Watch to develop a formal Monitoring Program.

Mid-Term Milestones

- Initiate a formal Monitoring Program
- Implement projects identified in **Table 7.3**
- Encourage and implement necessary legislative and regulatory actions
- Continue to identify opportunities and apply for funding

Long-Term Milestones

- Reduce the volume of trash deposited in the Bayou La Batre Watershed
- Improve watershed drainage systems and stormwater treatment
- Reduce SSO's and unpermitted discharges
- Diversify local economy
- Improve access to coastal resources
- Implement community resiliency actions
- Complete projects prescribed in the WMP
- Continue to identify opportunities and apply for funding.

7.1.7 Implementation Schedule

The implementation schedule for the WMP should be organized and executed by the WPIT under the leadership of the SMCCDC. The time frames for implementation may be subject to change, depending on the availability of funds, success of management measures, and watershed response. The implementation schedule will serve as an important tool to assess the status of the WMP and to identify where corrective actions are needed to address problems encountered in the implementation of the WMP. As part of the recommended adaptive management approach, a review of the WMP implementation program should be performed every year, with an in-depth assessment every three to five years. This review should consider the results of performance monitoring as discussed in **Chapter 11** to assess the results from implemented action items and whether changes are warranted to the action items, scope, or management measures to achieve the stated goals and objectives of the WMP. Additionally, the WPIT should develop standards for determining implementation success with the input from the stakeholders and the general public. On an annual basis, a Watershed Progress Report should be prepared and made public on the accomplishments, success stories, and overall condition of the Watershed.

7.1.8 Evaluation Framework

The evaluation framework for this WMP, its implementation, and its success can be divided into three primary areas: inputs, outputs, and outcomes. Inputs include human resources of time and technical expertise, organizational structure, management, and stakeholder participation. Outputs include implementation of management measures, public outreach and education, and the monitoring program. Outcomes include increased public awareness, improved watershed conditions, and improved water quality.

An effective evaluation framework allows the WMP and implementation strategy to be modified as necessary to maximize efficiency and achieve stated goals. The evaluation framework for the Bayou La Batre WMP should focus on answering these questions during the indicated time frames. If the answer to any of these questions is negative, the implementation strategy should be reevaluated and revised.

Short-Term Milestone Period (0-4 Years)

- Has SMCCDC established WPIT members along with assigned duties and responsibilities?
- Has WMP been adopted by the City of Bayou La Batre?
- Has the necessary funding been quantified, sources identified, and received?

- Has the Public Education and Outreach Program been organized and implemented?
- Has the Monitoring Program been established and a qualified entity identified to carry out the program?

Mid-Term Milestone Period (5 Years)

- Has the Monitoring Program been successfully implemented?
- Have any management measures been implemented?
- Did the level of public interest and participation rise to the level of helping to achieve the WMP goals?
- Have any legislative or regulatory actions been implemented or adopted?
- Has additional funding been identified and secured?

Long-Term Milestone Period (5-10 Years)

- Have specific projects and management measures proposed in the WMP been fully implemented and completed?
- Have there been reductions in trash and pollution in the Watershed?
- Have water quality conditions improved?
- Has the local economy diversified and/or expanded?
- Has access to the Watershed been improved?
- Has the City initiated any recommended resiliency actions?

7.1.9 Estimation of Costs

The costs to implement the proposed management measures and to monitor the results will be significant. Cost estimates to implement the WMP over 10 years will be between $22,054,355.00 and $39,934,630.00; estimated costs are listed in **Table 7.3**. The WPIT under leadership of the SMCCDC will require the assistance of numerous government agencies and private organizations.

Table 7.3 Estimation of costs

Chapter/Section	Activity Description	Quantity	Unit Cost ($)	Total Cost ($)
Water Quality				
6.2.1.2	Stormwater Master Plan	Study only; estimate 4 sq. mi.	$5,000 - $15,000/sq.mi	$20,000 - $60,000
6.2.1.2	Develop GIS based inventory of stormwater	Study only;	$3,000 - $5,000/sq.mi.	$12,000 - $20,000

	infrastructure within the City	estimate 4 sq. mi.		
6.2.1.4	Implement stormwater structural BMPs	Assume 12	$500,000 – $1,000,000	$6,000,000 - $12,000,000
6.2.1.5	Install LID practices	Assume 12	$35,000 – $125,000	$420,000 - $1,500,000
6.2.1.6, 6.2.1.7, 6.2.3.3, 6.2.5.5.3	Field observation/identification of permitted and unpermitted discharges, GIS inventory of discharges, and code enforcement/fines	10 years	$30,000/yr allocation	$300,000
6.2.2	Partner with private land owners to install agricultural BMPs; provide grants/incentives	Assume 50 projects	$5,000 - $20,000/project @ 50% cost share	$250,000 - $1,000,000
6.2.2.2	Conservation Buffer Strips: CB-1	1	$2,500/ac	$3,750
6.2.2.2	Conservation Buffer Strips: CB-2	1	$2,500/ac	$1,800
6.2.2.2	Conservation Buffer Strips: CB-3	1	$2,500/ac	$2,575
6.2.2.2	Conservation Buffer Strips: CB-4	1	$2,500/ac	$1,725
6.2.2.2	Conservation Buffer Strips: CB-5	1	$2,500/ac	$850
6.2.3.1	Paving Unpaved Roads including roadside treatment – Adams	1	$100/LF labor and materials 8% Engineering 15% General Conditions	$248,900

	Street; excludes crossing replacement		8% CEI	
6.2.3.1	Paving Unpaved Roads including roadside treatment – Marine Laboratory Road; excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$982,500
6.2.3.1	Paving Unpaved Roads including roadside treatment – Cut Off Road; excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$694,300
6.2.3.1	Paving Unpaved Roads including roadside treatment – Little River Road; excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$419,200
6.2.3.1	Paving Unpaved Roads including roadside treatment – Magnolia Road; excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$694,300
6.2.3.1	Paving Unpaved Roads including roadside treatment – Hogue Road; excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$445,400
6.2.3.1	Paving Unpaved Roads including roadside treatment – Shrimp Lane excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$161,130

6.2.3.1	Paving Unpaved Roads including roadside treatment – South Meadow Lane; excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$288,200
6.2.3.1	Paving Unpaved Roads including roadside treatment – 2 Mile Road; excludes crossing replacement	1	$100/LF labor and materials 8% Engineering 15% General Conditions 8% CEI	$340,600
6.2.3.1	Unpaved Road BMP's (aggregate and/or grading)	9 roads for 10 years	$100,000/yr	$900,000
6.2.4.2	Field studies and inspection; GIS based sewer system inspection and inventory of main conveyance system and conduct inflow/infiltration study of collection system	Study only; estimate 5 miles along the main sewer system	$10,000 - $50,000/mi	$50,000 - $250,000
6.2.5.3	Install sewage pump out station for working vessels	1	$75,000	$75,000
6.2.5.4, 6.2.5.5.5,	Partner with County and private hauler to establish solid waste and recyclcling transfer stations throughout the Watershed (coordinate with education and enforcement measures); assume 25% shared capital cost	4 ea	$100,000 - $150,000	$400,000 - $600,000
6.2.5.5	Trash Boat	1 @ operation	$50,000	$150,000

		for 10 years		
6.2.6.1, 6.2.6.2, 6.2.6.3, 6.2.6.4,	Develop multi-topic education and outreach program; partner with schools, churches and community groups. Pollution prevention topics include litter control, erosion control, proper sewage disposal and pathogen control, fertilizer and pesticide control	10 years	$20,000/yr allocation	$200,000
6.4.4.5.2	Water Quality Monitoring and Sampling Program including Enforcement	10 years	$100,000 - $150,000/yr	$1,000,000 - $1,500,000
Fish/Habitat				
6.3.1.1 and 6.3.1.2	Field survey of invasive species, GIS inventory, and eradication program	10 years	$50,000/yr	$500,000
6.3.2	Channel Restoration – assessment, engineering, construction, monitoring, and maintenance - Site 1	750 LF	$400/LF	$300,000
6.3.2	Channel Restoration – assessment, engineering, construction, monitoring, and maintenance - Site 2	750 LF	$400/LF	$560,000
6.3.2	Channel Restoration – assessment, engineering, construction, monitoring, and maintenance - Site 3	750 LF	$400/LF	$500,000
6.3.3	Preservation – Upper Spring Bayou Properties	92.85 acres	$2,500 - $4,000/acre	$232,125 - $371,400

6.3.3	Preservation – Bayou Cateau Properties	48 acres	$2,500 - $4,000/acre	$120,000 - $192,000
6.3.3	Preservation – Carls Creek/Bayou de Duce Properties	694 acres	$2,500 - $4,000/acre	$1,735,000 - $2,776,000
Access and Heritage				
6.4.1	Master Recreational Use Plan	1	$50,000	$50,000
6.5	Property Acquisition – Property #1	App. 5 acres	$50,000 - $150,000/acre	$250,000 - $750,000
6.5	Property Acquisition – Property #2	App. 18 acres	$50,000 - $150,000/acre	$900,000 - $2,700,000
6.5	Property Acquisition – Property #3	App. 1.65 acres	$50,000 - $150,000/acre	$82,500 - $247,500
6.5	Property Acquisition – Property #4	App. 12.1 acres	$50,000 - $150,000/acre	$605,000 - $1,815, 000
6.5	Property Acquisition – Property #5	App. 5 acres	$50,000 - $150,000/acre	$250,000 - $750,000
6.5	Property Acquisition – Property #6	App. 5 acres	$50,000 - $150,000/acre	$250,000 - $750,000
6.5	Property Acquisition – Property #7	App. 5 acres	$50,000 - $150,000/acre	$250,000 - $750,000
6.5	Property Acquisition – Property #8	App. 23 acres	$50,000 - $150,000/acre	$1,150,000 - $3,450,000
6.5	Property Acquisition – Property #9	App. 3.75 acres	$50,000 - $150,000/acre	$187,500 - $562,500

Resiliency				
6.7.1	Land Use Planning and Zoning including Future Land Use Map and new City Districts	1	$70,000	$70,000

7.1.10 Initial Implementation of Management Measures

Implementation of recommended management measures should begin immediately following the approval of the Bayou La Batre WMP, under the guidance of the SMCCDC and WPIT. Initial implementation should focus on the most critical issues and the prioritized management measures identified in this WMP.

1. **Develop a GIS based sewer system inspection and inventory including Inflow/Infiltration study of collection system**. Create a GIS model of the existing collection system including condition inspection. Include an Inflow/Infiltration study to determine where leaks are occurring, and develop a plan that prioritizes the rehabilitation or replacement of collection lines and sewer manholes as necessary.

2. **Develop a Stormwater Master Plan.** This plan will provide the framework for implementing structural BMPs and planning to accommodate future development.

3. **Develop a long-term water quality monitoring and sampling plan.** Establish a long-term monitoring program to collect water quality data at permanent sample locations to assure consistency over an approximate 10-year time period. This will allow for better analyses (identification of trends, significant changes to data output, etc.) and determine the success of implemented management measures within the Watershed and indicate where additional measures are needed.

4. **Secure funding to acquire a Trash Boat.** Trash is an endemic problem throughout the Watershed. It not only negatively affects water quality and aquatic habitats, but also has a negative impact on recreational activity within the Watershed.

5. **Implement stormwater management improvements to target identified critical issues.** Install structural BMPs for treatment of stormwater runoff and encourage LID projects (bioretention swales and cells, constructed stormwater wetlands, and rainwater harvesting.

6. **Restore critical habitats** to provide ecological benefits and improve water quality and flooding (infiltration, flood control, treatment, decrease sedimentation, etc.). Restoration efforts include stream, streambank, and conservation buffer restoration, living shorelines, and invasive species management.

7. **Improve public access to the water** by purchasing properties identified for access and cultural enrichment and pursue funding for recreational amenities.

8. **Stabilize unpaved roads** to reduce the risk of sediment entering waterways.

9. **Expand and diversify the local economy** with the acquisition of critical parcels and support for expanding the tourism and ecotourism industry.

10. **Develop a Migration and Relocation Plan** focusing initially on critical infrastructure and expanding to critical habitats, residential areas, and future development.

8 Regulatory Framework

In conjunction with of the development of this Watershed Management Plan (WMP) for the Bayou La Batre Watershed, a review of existing regulations at the federal, state, and local levels were conducted. The regulatory framework reviewed in this WMP focuses on the Federal, State, County and City of Bayou La Batre's laws, regulations, and ordinances that pertained to water quality, stormwater management, erosion and sediment control, coastal zone issues, wetlands and other surface waters, and land disturbance activities. Federal, state, and local regulations are periodically reviewed and updated. Normally, permitted activities within the Watershed are regularly updated (typically every five years) and usually require some changes from the previously issued permits to become compliant with any regulatory updates. Recently, the City of Bayou La Batre has drafted a new ordinance to address activities related to subdivision development and this draft is currently out for public comments.

8.1 Federal Authorities

8.1.1 Federal Water Pollution Control Act

The Federal Water Pollution Control Act was enacted in 1948, and was significantly reorganized and expanded in 1977. The Clean Water Act (CWA) became the Act's common name with the amendments in 1972. The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating water quality standards for surface waters. The CWA and its amendments provide the basis for the primary federal regulatory and permitting procedures relating to stormwater management in the Bayou La Batre Watershed. The most applicable sections of the CWA related to controlling stormwater runoff and erosion and sedimentation within the Watershed are listed below.

- CWA §303 (33 USC §1313) – Water quality standards and TMDL program
- CWA §319 (33 USC §1329) – Non-point source pollution program
- CWA §401 (33 USC §1341) and CWA §401(a) – State Water Quality Certification
- CWA §402 (33 USC §1342) – NPDES permitting program
- CWA §404 (33 USC § 1344) – dredged/fill material discharged to waters of the US

8.1.1.1 CWA § 303(D) (33 USC §1313)

Under Section 303(d) of the 1972 CWA, states, territories, and authorized tribes are required to develop lists of impaired waters. These impaired waters do not meet water quality standards that states, territories, and authorized tribes have set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop total maximum daily loads (TMDLs) for these waters. The TMDLs are used to establish limits for the amount and type of pollutant discharges that the receiving streams can handle without experiencing further degradation. Within the greater Dog River Watershed, Halls Mill Creek is listed on the Alabama § 303(d) list for siltation because of its sediment load concentrations. The TMDL is currently ending for Halls Mill Creek. Once a TMDL is established, additional research may be warranted to determine additional measures that can be implemented to meet the required TMDL. Additionally, TMDLs have been approved for several other pollutants and named surface water systems in the Bayou La Batre Watershed and are further described in Chapter 3.

8.1.1.2 CWA § 404 (33 USC §1344)

This section establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. CWA Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States, unless the activity is exempt from Section 404 regulation (e.g., certain farming and forestry activities). The USACE is the primary permitting authority for impacts to waters of the United States, including wetlands. Permit applications are reviewed and evaluated based on the environmental criteria set forth in the CWA Section 404(b)(1) guidelines and regulations promulgated by the U.S. Environmental Protection Agency (EPA). The permits must also meet State water quality standards and coastal area requirements and must be consistent with each program.

8.1.1.3 CWA § 402 (33 USC §1342)

This section authorizes permitting under the NPDES program with EPA having primary permitting authority. The NPDES program requires dischargers to obtain permits prior to discharging pollutants into waters of the United States. The NPDES program covers point source discharges from industrial facilities; municipal separate storm sewer systems (MS4s); concentrated animal feeding operations (CAFO); publicly-owned treatment works (POTW); combined sewer overflows (CSO) and sanitary sewer overflows (SSO); and construction, non-coal/non-metallic mining and dry processing less than five acres, other land disturbance activities, and areas associated with these activities.

Through delegation from the EPA, ADEM has the authority to administer the NPDES program. Through ADEM Administrative Code Reg. 335-6-6 the Department regulates and permits certain point source discharges. Through ADEM Admin Code Reg. 335-6-6, ADEM regulates discharges from construction, non-coal/non-metallic mining and dry processing less than five acres, other land disturbance activities, and areas associated with these activities. This regulation also imposes requirements for controlling erosion, sedimentation, and other potential sources of pollution from these activities through the use of best management practices. This regulation also outlines requirements for inspections, reporting, and enforcement actions.

The EPA promulgated the *Effluent Limitations Guidelines and Standards for the Construction and Development Point Source Category* in December 2009. The rule requires owners and operators of permitted construction activities to adopt certain requirements including the implementation of erosion and sediment controls, stabilization of soils, management of dewatering activities, implementation of pollution prevention measures, provision and maintenance of a buffer around surface waters, prohibition of certain discharges, and utilization of surface outlets for discharges from basins and impoundments. The 2009 rule also included the establishment of numeric limitations on the allowable level of turbidity in discharges from certain construction sites. In 2014, the EPA made several revisions to the 2009 rule requirements including defining “infeasible” and removing the numeric turbidity effluent limitation and monitoring requirements.

In addition to the activities listed above, ADEM is also the delegated authority from the EPA to regulate discharges from MS4s. ADEM requires municipalities and other large operators of MS4s, such as the Alabama Department of Transportation (ALDOT), to obtain and comply with terms of an NPDES permit to control the discharges from such systems.

8.1.2 Coastal Zone Management Act (16 USC§1451)

The U.S Congress authorized the Coastal Zone Management Act after it recognized the challenges the coastal areas faced with continuing growth. The Act is administered by the National Oceanic and Atmospheric Administration (NOAA) and encourages coastal states to develop and implement a coastal zone management plan to manage, preserve, protect, develop, and where possible restore or enhance coastal resources.

8.2 State Authorities

8.2.1 Alabama Water Pollution Control Act (Code of Alabama 1975 § 22-22-1)

The Alabama Water Pollution Control Act, like its federal counterpart (CWA), prohibits the discharge of pollutants to waters of the State without a permit and provides the foundation for the State’s delegated authority to implement various federal water quality programs, including the §402 NPDES permitting program, §303 water quality standards and Total Maximum Daily Load (TMDL), and §319 Non-Point Source programs. Water quality programs are generally implemented through various sections of ADEM Administrative Code Rs. 335-6 and NPDES permits.

8.2.2 Water Quality Criteria (Code of Alabama 1991 § 335-6-10)

As previously mentioned, CWA §404 permit applications, pursuant to CWA §401(a), State Water Quality Certification, must be submitted to ADEM for review of the proposal’s consistency with the State’s water quality program. ADEM reviews applications to ensure the proposed discharge of dredged or fill material will not cause or contribute to a violation of State water quality standards as set forth in ADEM Administrative Code Rs. 335-6-10.

8.2.3 Construction Site Stormwater & State MS4 NPDES Program (Code of Alabama 1977 § 335-6-6)

Section 402 of the CWA, NPDES Permitting Program, sets forth the national permitting program for discharges of pollutants to waters of the United States. Alabama is an NPDES delegated state and ADEM is authorized to implement the NPDES permitting program. ADEM administers the program through its Water Quality Program, ADEM Administrative Code Rs. 335-6-6. Facilities discharging pollutants are divided by ADEM into a number of categories based on the type and/or size of the facility (e.g. major industrial, major municipal, minor industrial, mining, etc.) and level of treatment required. Discharge limitations are generally similar within the classifications but may vary where the water quality of the waterbody receiving the discharge is a limiting factor. The larger facilities, such as sewage treatment plants and heavy industrial facilities usually are authorized to discharge under stricter "Individual" NPDES permits. Smaller facilities of a similar nature (*i.e.* concrete plants, construction sites, etc.) are usually grouped under a "General Permit" developed to cover the specific industrial sector. The primary ADEM NPDES permit relevant to this project is ALR1000000 addressing construction stormwater discharges. A copy of the current version of the permit is available on the ADEM website at:

http://adem.alabama.gov/programs/water/waterforms/ALR16CGP.pdf

Construction site operators and/or owners seeking coverage under this general permit must submit a Notice of Intent (NOI) in accordance with the permit requirements. Operators and/or owners of all regulated construction sites must implement and maintain effective erosion and sediment controls in accordance with a Construction Best Management Practices Plan (CBMPP) prepared and certified by a Qualified Credentialed Professional (QCP). For priority construction sites, which include any sites that discharge to (1) a waterbody listed on the most recently EPA approved 303(d) list of impaired waters for turbidity, siltation, or sedimentation; (2) any waterbody for which a TMDL has been finalized or approved by EPA for turbidity, siltation, or sedimentation; (3) any waterbody assigned the Outstanding Alabama Water use classification in accordance with ADEM Admin. Code Reg. 335-6-10-.09; and (4) any waterbody assigned a special designation in accordance with ADEM Admin. Code Reg. 335-6-10-.10, the CBMPP must be submitted to ADEM for review along with the NOI. A Qualified Credentialed Inspector (QCI) or QCP must conduct regular inspections of regulated construction activities to ensure effective erosion and sediment controls are being maintained.

This program also includes the NPDES Municipal Separate Storm Sewer System (MS4) permitting covering large municipalities and urban areas with more than 50,000 people. The MS4 permitting program sets requirements for the covered entity to develop and implement a local stormwater management program to reduce the contamination of stormwater runoff and prohibit illicit discharges. The general requirements of MS4 permits are to develop, implement, and enforce a Storm Water Management Program Plan (SWMPP) that addresses the following minimum control measures:

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

The MS4 permits also may set forth requirements for actual stormwater or stream monitoring or assessment where stormwater discharges are to a 303(d)-listed stream or to a stream with an approved TMDL, and encourages the implementation of Low Impact Development/Green Infrastructure (LID/GI) practices. The MS4 permits also require that an annual report of activities and accomplishments related to the six control measures be submitted to ADEM. With few exceptions, the local jurisdictions with the more stringent stormwater management requirements are those with MS4 permit coverage.

8.2.4 CWA § 303 (D) (33 USC §1313)

ADEM is required by the EPA to designate waters for which technology-based limits alone do not ensure attainment of applicable water quality standards. This list is to be submitted to the EPA on the 1st of April for each even-numbered year. Impairments include things such as nutrients, pesticides, pathogens, metals, organic enrichment, and siltation, among other things, and can be caused by point sources or non-point sources. The impaired waters must then be sampled and a TMDL amount or limit must be calculated. Bayou La Batre was placed on Alabama's 303(d) list of impaired waters for pathogens; and pathogens were detected during water quality sampling undertaken as part of this watershed study. Results from four of five microbial source tracking samples collected indicated presence of human bacteria (see **Section 3.1.3**).

8.2.5 Alabama Coastal Zone Management Act (Code of Alabama 1975 § 9-7-10)

The Alabama Coastal Zone Management Act establishes the statutory basis for the Alabama Coastal Area Management Program and was first enacted in 1976 with the stated purpose "to promote, improve and safeguard the lands and waters located in the coastal areas of this 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 this state." Currently, the coastal program's implementation is split between ADEM (regulatory portions) and the Alabama Department of Conservation and Natural Resources (planning and administration portions) and only applies to lands and waters seaward of the continuous 10-foot contour. Within the coastal area, a separate coastal management permit or coastal consistency certification is required pursuant to ADEM Administrative Code Rs. 335-8. This requirement applies to projects impacting wetlands (dredge or fill), developments greater than five acres, shoreline stabilization, docks and piers, construction on beaches and dunes, and other similar activities impacting coastal resources.

Alabama Coastal Area Management Program Strategic Plan 2013-2018 (ACAMP), Alabama Code § 9-7-1 et seq., requires approval by ADEM for most construction and development activities within the coastal area through regulations established in ADEM Admin. Code Reg. 335-8. The inland boundary of the coastal area in Alabama is the continuous 10-foot contour where the land surface elevation reaches 10 feet above sea level. The coastal area includes all land lying seaward of the 10-foot contour. ACAMP is a joint effort of the Alabama Department of Conservation and Natural Resources -State Lands Division (ADCNRSLD) and the ADEM Coastal Program. The ADCNRSLD is responsible for planning and policy development, while the ADEM is responsible for permitting, monitoring, and enforcement activities. A significant portion of ADEM's permitting, monitoring, and enforcement activities in the coastal area are related to determining federal consistency for projects and activities that require federal permits, such as Section 404 permits issued by the USACE.

8.2.6 Alabama Watershed Management Authority Act (Code of Alabama 1991 § 91-602)

The State of Alabama passed Legislature Act No. 91-602 that provides for the creation of a watershed management authority having the statutory authority to develop and execute plans and programs related to water conservation, water usage, flood control and prevention, wildlife habitat protection, agriculture and timberland protection, erosion control and prevention and floodwater and sediment damages with the intent of protecting and managing Watersheds.

This body is non-regulatory; however, the law provides numerous powers and authorities to the Board of Directors of a watershed management authority, including the power to:

- Acquire lands or rights-of-way by purchase, gift, grant, bequest, or through condemnation proceedings;
- Construct, improve, operate, and maintain such structures and projects as may be necessary for the exercise of any authorized function of the Authority;
- Borrow money as is necessary for the performance of its functions;
- Make and execute contracts and other instruments necessary to the exercise of its powers;
- Act as agent for the State of Alabama or any of its agencies, the United States or any of its agencies, or any county or municipality in connection with the acquisition, construction, operation, or administration of any project within the boundaries of the Authority;
- Issue, negotiate, and sell bonds upon approval of the State Finance Director; and Accept money, services, or materials from national, state, or local governments.

8.3 Mobile County Authorities

The county government's statutory authority is somewhat more limited. The county requirements are implemented countywide in areas not subject to a municipality's planning jurisdiction. *Code of Alabama 1975* §11-19-1 through 24 provides general authority for counties to adopt zoning ordinances in flood prone areas.

Mobile County also cites *Code of Alabama 1975* §11-24-1. *et. seq.* as the authority for its subdivision regulations. Although Mobile County states in its stormwater management plan that it does not have authority to require or enforce the use of BMPs during construction, with the exception of implementing local zoning districts.

8.3.1 Mobile County Flood Damage Prevention Ordinance (March 2010)

The Mobile County Flood Damage Prevention Ordinance applies to all areas of special flood hazard within the jurisdiction of Mobile County. Although the primary focus of the Ordinance is to regulate activities within designated flood hazard zones, the Ordinance does include regulations that also help protect water quality. The Ordinance includes measures to control the alteration of natural floodplains, stream channels, and natural protective barriers that are involved in the accommodation of floodwaters. The protection of these areas is important to the overall water quality of the Bayou La Batre Watershed.

8.3.2 Mobile County Subdivision Regulations (Amended April 2005)

The Mobile County subdivision regulations are administered by the Mobile County Commission. These regulations apply to every subdivision of land in all unincorporated areas of Mobile County that do not lie within the planning jurisdiction of any municipal planning commission. The primary purpose of the regulations is to establish procedures and guidelines for the development of subdivision or proposed additions to existing subdivisions related to minimum size of lots; the planning and construction of streets, roads, and drainage features; and the installation of water and sewer facilities. Portions of the Regulation, Sections 4, 7, and 8, include provisions related to water quality. Section 4.12 of the regulation requires the design of subdivisions to implement measures to protect streams and other water bodies. This section also requires a written statement that all applicable federal and state permits have been required prior to the approval of construction plans. In Section 7.5, it requires that good engineering practices, judgement, and criteria be employed to control stormwater runoff, and water detention shall be employed where required by such good engineering practices, judgement, and criteria. This section also requires that best management practices be used during construction. Stormwater detention requirements are outlined in Section 8.1 for any watershed that contains a public drinking water source. The detention requirements include a maximum release rate equivalent to the 10-year storm pre-development rate, and a minimum detention capacity for the volume of a 50-year post development storm.

8.3.3 Mobile County MS4 Phase II Permit (September 2016)

The Phase II MS4 General Permit was issued September 6, 2016. Coverage under this permit was granted to the Mobile County Commission and became effective October 1, 2016 (Permit #ALR040043) and expires September 30, 2021. The MS4 permit for Mobile County requires:

- Identify major sources of stormwater pollution (mapping and tracking)
- Reduce pollutants in runoff from industrial, commercial and residential areas
- Control stormwater discharges from new development and redevelopment areas
- Implement a water quality monitoring program

The implementation of these requirement has the intent to reduce the discharge of pollutants to and from the MS4 to the maximum extent practical, thus protecting water quality. The MS4 permit is coordinated and managed by the mobile County Environmental Services Department.

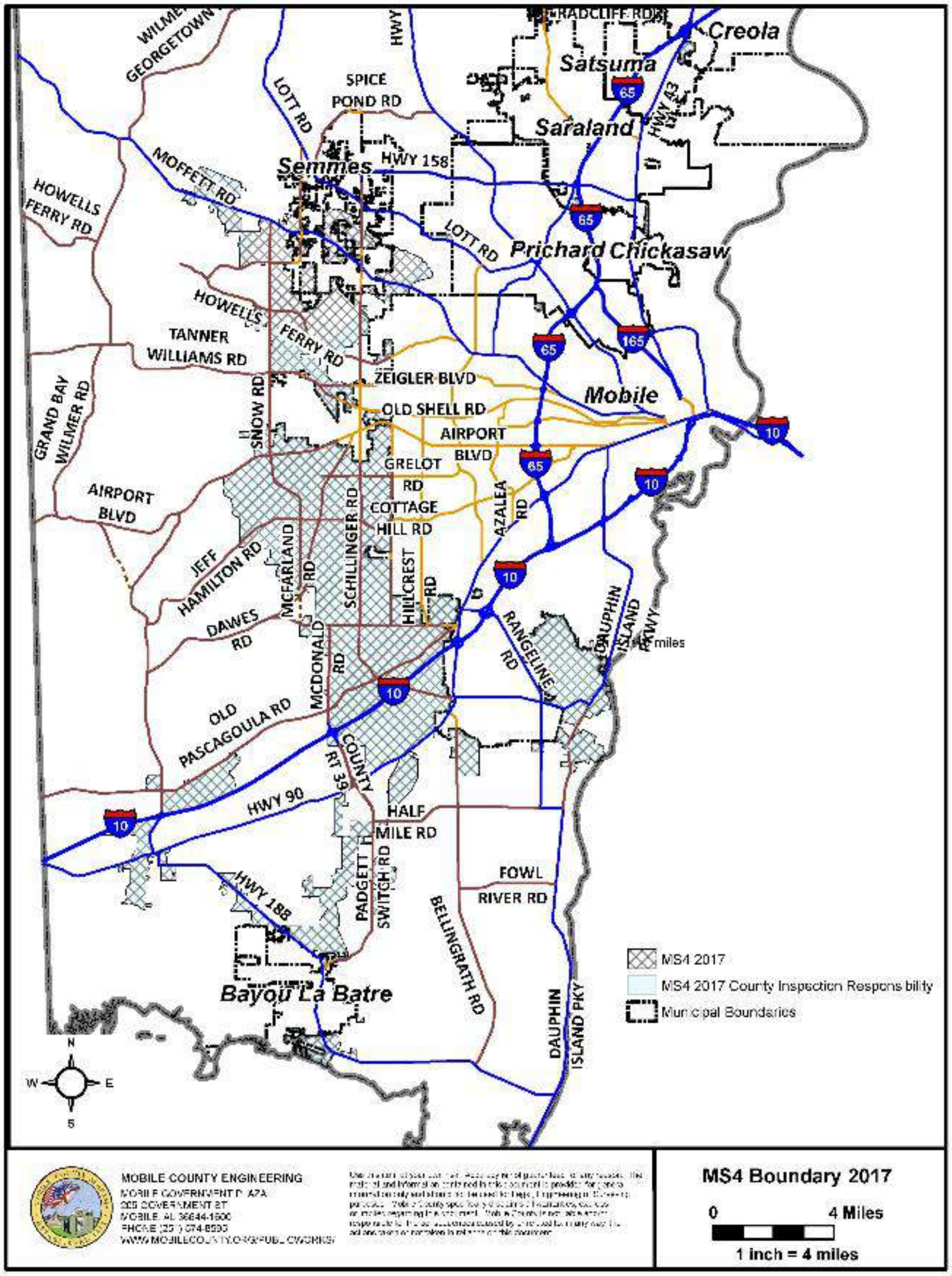


Figure 8. 1 Mobile County MS4 Boundary. Source: Mobile County MS4 SWMPP 2017)

8.3.4 Mobile County Stormwater Management Program Plan (October 2013)

The Mobile County Commission prepared the Mobile County Stormwater Management Program Plan (SWMPP) as part of the requirements of the County's NPDES MS4 Permit. The plan was created to protect water quality by reducing, to the maximum extent practicable, the discharge of pollutants in stormwater. The SWMPP provides regulatory purview for areas located within twenty-two 12—digit Hydrologic Unit Code (HUC 12) including an area approximately 3,281 acres within the Bayou La Batre watershed.

8.4 Local Authorities

8.4.1 Jurisdiction Regulations and Ordinances

Information originally gathered and provided by the Mississippi-Alabama Sea Grant Legal Program indicates that Alabama is a "Dillon's Rule" state. According to uslegal.com, under Dillon's Rule, a municipal government has authority to act only when:

> (1) the power is granted in the express words of the statute, private act, or charter creating the municipal corporation;
>
> (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 corporation.

The local cities and towns, as municipal corporations under Alabama law, have the authority to implement zoning, regulate new development, and manage stormwater. The legal basis for this authority can be found in the *Code of Alabama 1975*:

- §11-40-1: Defines municipal corporations/municipalities as cities and towns
- §11-40-6: Municipalities with 2,000 or more residents constitute cities, and those with less than 2,000 residents constitute towns
- §11-45-1: Gives power to municipal corporations to create ordinances generally
- §11-52-2: Gives municipalities authority generally for creation of a municipal plan and planning commission
- §11-52-6: Defines powers of municipal planning commissions generally
- §11-52-7: Gives specific zoning authority for municipal planning commissions
- §11-52-70: Gives municipal corporations authority to divide municipality into commercial, industrial, and residential zones

Some municipalities exercise their authority to issue permits within their police jurisdiction or "extraterritorial jurisdiction" (ETJ) while others confine permitting to the city limits.

8.4.2 City of Bayou La Batre MS4 Phase II Permit

A Phase II MS4 General Permit was issued the City of Bayou La Batre and coverage under that permit requires the City of Bayou La Batre to:

- Identify major sources of stormwater pollution (mapping and tracking)
- Reduce pollutants in runoff from industrial, commercial and residential areas
- Control stormwater discharges from new development and redevelopment areas

- Implement a water quality monitoring program

The implementation of these requirement has the intent to reduce the discharge of pollutants to and from the MS4 to the maximum extent practical, thus protecting water quality.

8.4.3 City of Bayou La Batre Ordinance 2000-435

This ordinance adopted by the City of Bayou La Batre in 2000, requires all shipyards, marine or other repair facilities, including but not limited to, ship building, shipyards repairs, mechanical repairs, sandblasting and/or painting operations that operate on or adjacent to any waterway within the City of Bayou La Batre to have a valid ADEM and /or EPA permit that are required to by the NPDES program prior to the City of Bayou La Batre's issuance of an annual business license.

8.4.4 City of Bayou La Batre Ordinance 2005-495

The Zoning Ordinance was adopted by the City of Bayou La Batre on March 22, 2005. This ordinance requires homes to connect to municipal water and sewer if available It also, regulates the surface run-off from developments to not exceed background levels by more than 10%, and that the development's compliance review may require information about surface drainage, erosion and sediment controls, water and sewer connections, and coastal protection.

8.4.5 City of Bayou La Batre Ordinance 2005-504

City of Bayou La Batre adopted a Stormwater Management and Flood Control ordinance on October 11, 2005, to address activities related to land disturbance and stormwater drainage facilities in compliance with the Federal Clean Water Act, the National Pollution Discharge Elimination System (NPDES) program and the requirements under the Alabama Coastal Consistency program and the Federal Emergency Management Agency to reduce flooding. Portions of this ordinance include provisions related to water quality. Section 1-12 of the ordinance requires site grading and drainage plans to implement measures to protect streams and other water bodies through the implementation of Best Management Practices (BMPs). Section 1-8 delegated the duties of the City Engineer to include verification that all applicable federal and state permits have been required prior to the approval of construction plans. Section 1-8 and 1-12 of the ordinance requires that good engineering practices, judgement, and criteria be employed to control stormwater runoff, and water detention shall be employed where required by such good engineering practices, judgement, and criteria. Section 1-12 requirements include a maximum release rate equivalent to the 10-year storm pre-development rate. Division 2 of the ordinance identifies regulations for activities located within the floodplain and Special Flood Hazard Areas.

8.4.6 Additional Local Regulations

In addition to the regulatory drivers noted above, subdivision restrictive covenants can also play an important role in stormwater management. Usually, within a residential subdivision, property owners' associations are incorporated, and for most, there exist various subdivision restrictions that have been recorded and are imposed to regulate the activities within the subdivision. By nature, these restrictions look inward without consideration of neighboring property and, until recently, most do not address stormwater management.

8.5 Regulatory Overlap

Understandably, there is overlap among federal, state, and local requirements and the Bayou La Batre Watershed Management Plan (2018) provides an excellent example, using the permitting of a proposal to fill jurisdictional wetlands, which would require:

- A proper CWA §404 permit – either an individual permit with review by all agencies and the public, or a Nationwide Permit (NWP);
- Appropriate ADEM §401 water quality certification;
- Consideration of CWA §303(d) impacts (for listed stream segments);
- ADEM coastal program consistency determination (if in the coastal area);
- A CWA §402 NPDES construction stormwater permit (if greater than one acre will be disturbed);
- City and/or county land disturbance permits;
- City and/or county development permits and plat approvals; and
- City and/or county building permits.

This overlap is unavoidable; however, the degree of regulatory overlap has been lessened by delegation of certain programmatic or regulatory authority by EPA to ADEM and for certain coastal program requirements from ADEM to the local authorities.

Table 8.1 Current regulations within the Bayou La Batre Watershed

Current regulations within the Bayou La Batre Watershed			
	ADEM	Mobile County	City of Bayou La Batre
Construction Phase Stormwater Management	Yes	Yes	Yes
Design Standards	Yes	Yes	Yes
Design Storm Event	Yes	N/A	Yes
Site Size	Yes	N/A	Yes
Inspection Requirement	Yes	N/A	N/A
Stabilization Times	Yes	N/A	N/A
BMP Maintenance/ Repair Schedule	Yes	N/A	Yes
Non-Compliance Reporting	Yes	N/A	N/A

Current regulations within the Bayou La Batre Watershed			
	ADEM	Mobile County	City of Bayou La Batre
Turbidity Monitoring	No	N/A	N/A
Buffer Requirement	Yes	N/A	N/A
Post-Construction Phase Stormwater Management	No	Yes	Yes
Stormwater Quality	N/A	No	N/A
Stormwater Quantity	N/A	Yes	Yes
Design Storm	N/A	Yes	Yes
Site Size	N/A	Yes	Yes
Inspection Requirements	N/A	Yes	Yes
Maintenance Requirements	N/A	Yes	Yes
Reporting	N/A	Yes	Yes
Calculation Method	N/A	N/A	Yes
Protection for Waters of the U.S. (Wetlands and other surface waters)			
Permit Requirement	Yes in coastal Areas	ADEM/USACE	USACE/ADEM/ City of Bayou La Batre
Setback Requirement	No	No	N/A
Buffer Requirement	No	Yes	N/A
Coastal Area Protections	Yes	No	Yes

8.6 Regulatory Deficiencies

8.6.1 Regulatory Gaps

States often rely on federal regulatory requirements, and in turn local governments rely on state requirements, to provide a measure of consistency and some level of "minimum standards." The federal and state environmental and stormwater requirements are necessarily designed to be applied at a national or statewide level and, while appropriate at their respective levels, may not be meaningful or provide the level of protection needed for a particular local resource and should be considered only as "minimum standards". The federal and state requirements are also more difficult to modify because of their broader application and implications, which becomes a problem when regulations do not address critical issues or have become antiquated. A prime example of a lack of federal or state standards is with regard to post-construction stormwater management. If it were not for the Federal Emergency Management Agency (FEMA) flood requirements, which only address volume, there would be no consideration of post-construction stormwater runoff. Neither EPA nor ADEM have any promulgated standards to set a consistent baseline for stormwater quality or treatment, so this endeavor falls solely to local units of government. Outdated regulations are often less effective than they could be, because they do not consider advancements in science, technology, or resource protection alternatives. ADEM's coastal program regulations relating to resource protection (ADEM Administrative Code Rs. 335-8-2) have not been updated in over 20 years. Recent studies funded by Baldwin County (HydroEngineering Solutions, 2010) found that consideration should be given to the timing of stormwater releases as well as discharge rates.

Local governments often assume that the maze of federal and state permitting requirements will be sufficient to protect the natural function of these systems. Unfortunately, this is rarely the case.

- The State of Alabama currently has no codified buffer or setback requirements (other than the setback requirements in the construction general permit).
- There are no federal of State requirements for post-construction stormwater management.
- Federal and state permits are routinely issued that allow wetlands to be impacted either directly or indirectly and, although mitigation for stream and wetland impacts may be required by the permit, mitigation often takes place outside of the watershed in which the impacts actually occur.

Therefore, local governments must fill the gaps in order to protect these vital resources from both direct and indirect impacts associated with development.

In a 2018 report, S*outh Alabama Stormwater Regulatory Review,* for the Mobile Bay National Estuary Program, it identified that 23 of 27 local jurisdictions (~85%) have their own construction-phase BMP requirements, but within Mobile County, the rate is only ~67%. Most of the jurisdictions that do not have specific requirements refer to the ADEM requirements. Post construction stormwater management requirements follow the same trend, primarily due to FEMA flood control requirements. However only 10 local jurisdictions (~37%) address post-construction stormwater quality. Coastal resource protection requirements are only evident in ~44% of the local jurisdictions, although all jurisdictions mention the State and/or federal permitting requirements. LID and shoreline protection requirements are only evident in about 30% and 15%, respectively (although shoreline protection is less critical in more inland communities without traditionally navigable waterways). Ten of the 27 jurisdictions are currently covered under the NPDES MS4 program permit.

8.6.2 Regulatory Inconsistencies

Regulatory inconsistencies between federal, state, and local units of government are inevitable and can contribute to ineffective watershed management, serve as impediments to restoration efforts, and cause confusion in the regulated community. Addressing regulatory inconsistency was a high priority item identified by both the development community and local government representatives during the public planning workshop held as part of the Weeks Bay Watershed

Management Planning process. Development entities frequently gravitate to, or seek incorporation into, jurisdictions with "less regulation". However, the long-term costs to the broader community and its citizens will be realized as flooding increases; flood zones expand, increasing insurance rates; and waterbodies become polluted, prompting additional regulatory oversight, expensive restoration projects, and increased stormwater treatment costs; and stormwater conveyance, maintenance, and dredging costs manifest and increase.

Regulatory inconsistencies have even precipitated legal action between jurisdictions (Baldwin County *v* Bay Minette, *et. al.*, 854 So. 2d 42[Ala. 2003]) whereby the County was attempting to prevent municipalities from issuing permits outside of their respective city limits because of potential differences in regulatory standards between the County and the various municipalities. The fact that creeks and rivers do not respect political boundaries, and what happens relative to stormwater runoff in an upstream community has impacts on all communities downstream, highlights the need for consistent stormwater management policies and practices. By example, stormwater runoff from the southeast corner of Semmes, Alabama, enters a watercourse tributary to Eight-Mile Creek, and flows through Mobile County, the City of Mobile, the City of Prichard, the City of Chickasaw, joins Chickasaw Creek and borders the City of Saraland, and flows back into the City of Mobile. Conversely, stormwater runoff from various portions of the City of Mobile affects about a dozen different major (HUC 12) watersheds.

In that 2018 report, S*outh Alabama Stormwater Regulatory Review,* the most notable inconsistencies between-jurisdictions are the requirements for stabilization timeframes, which is the most critical element in erosion control. Other obvious inconsistencies are in design standards and storms; site size to which the requirements apply; and buffers and setbacks. The following list has been paraphrased from the *Weeks Bay Watershed Management Plan* (2017) and provides a good example of where (and why) regulatory consistency is of most benefit:

- Design standards for construction-phase BMP implementation. The current recommendations by EPA, the *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas (2014),* and the ADEM stormwater general permit all reference the two-year 24-hour frequency event. This is generally the physical limitation of most all of the temporary construction phase BMPs currently available, and designing for a larger event is impracticable. Having requirements for construction phase BMP plan preparation and BMP design and selection that are compatible with the ADEM guidance and requirements also reduces the potential for applicants having to prepare multiple plans under differing guidelines.
- Stabilization Time. Erosion and sedimentation issues are directly related to the "extent and duration" of the area exposed, *i.e.,* how much denuded area is exposed to rainfall and how long it is exposed before being stabilized. ADEM's construction stormwater general permit requires that areas that have been disturbed and will not have activity for 13 days or more be temporarily stabilized immediately (emphasis added). Based on guidance from EPA, the ALDOT limits exposure to 17.5 acres, unless waived by the project engineer, to help control the extent of an area exposed.
- Maintenance. The effectiveness of construction-phase BMPs is directly related to maintenance of the individual control measures. The ADEM permits allow five days (from the date of discovery) to repair, maintain, or replace ineffective BMPs. Three municipalities within the two counties use a 48-hour repair or maintenance timeframe,

which is consistent with recommendations in the D'Olive Creek WMP (2010) and other areas of the state.

- Post-construction design standards. The effectiveness of post-construction stormwater management is directly related to adequate design and installation and routine inspection and maintenance. There are no federal or State requirements, so having consistent local requirements that meet both flood mitigation goals and watershed protection goals are critical.
- Long term maintenance of post-construction stormwater facilities. Developing a consistent set of maintenance and repair requirements for permanent stormwater management facilities will ensure that watershed protection goals can be sustained. This could also facilitate the compilation of an inventory of systems that can be used to systematically inspect and prioritize the repair, maintenance, or retrofitting of systems throughout the two-county area.

To add to the above list, having a consistent site size, where the construction-phase and post-construction-phase requirements apply, consistent design criteria (storm size/frequency, calculation methods, etc.) and consistent setbacks/buffers and LID requirements would be helpful to those working in multiple jurisdictions. Having a degree of consistency on erosion and sediment control plan submission, what credentials are necessary to prepare plans and perform inspections, as well as consistent nomenclature relative to stormwater management, would also be beneficial. Resolving the majority of the inconsistencies identified in the matrix to achieve common watershed protection goals would be beneficial to both local governments and the development community (developers, builders, consultants, etc.) and will foster wise stewardship of the resources within the watersheds.

8.7 Regulatory Enforcement

The Bayou La Batre Watershed falls within authority of two local governmental entities, Mobile County and the City of Bayou La Batre. For Mobile County, the Inspection Services Department administers compliance with plan review components of subdivision regulations and commercial site plan requirements. It also administers compliance with building construction, permitting, inspections, and enforcement of construction regulations, flood damage prevention ordinance, and Land Disturbance Permitting. The county's SWMPP states "Failure to maintain storm water controls results in an escalating enforcement strategy including verbal and/or written warnings, failed inspections, Stop Work Orders, and fees if work continues without remedying deficient items. ADEM is notified once it is determined that the County's enforcement methods are considered unsuccessful. ADEM is also notified if a qualifying inspected construction site does not have an NPDES permit." The City of Bayou La Batre has enforcement responsibilities under their MS4 permit and the Stormwater Management and Flood Control Ordinance 2005-504. The majority of the compliance oversite responsibility falls to the City Engineer and the Building Inspection Department. Section 1-16 identifies legal responsibilities for maintaining drainage systems and fines associated with not complying with these responsibilities. It includes a one hundred dollar fine for each non-compliance occurrence. For a system out of compliance for multiple days, an occurrence may be considered for each day out of compliance. These local governmental entities are instrumental in providing additional support to the federal and state agencies with enforcement rights to identify and regulate water quality concerns within the watershed.

9 Financing

Often the most challenging and intricate phase of a watershed management plan is financing the implementation program. In these post-watershed management activities, funding must be secured to carry out the recommendations in **Chapter 6 and 7** in order to fulfill the goals and objectives outlined in **Chapter 5**. Because watershed management goals and objectives can vary widely, especially across different geographic and economic regions, sources of funding for watershed projects can also vary widely. The following section describes the suggested framework for financing watershed projects in the Bayou La Batre Watershed followed by specific descriptions of the most viable funding sources.

9.1 Framework

In previous sections, we have addressed the challenges facing the Bayou la Batre Watershed, identified the goals and objectives for restoring the Watershed, and explored the range of management measures and implementation strategies for consideration in restoring the Watershed. This section discusses the proposed framework for financing projects discussed in **Chapters 6 and 7**. The basic project financing framework consists of the following steps:

1. Identify project need and goal(s)
2. Develop scope and budget to meet project goal(s)
3. Identify individual project schedules (in total months) with a breakdown of activities that can be used for easy phasing of project. For example:

Activity	Date
Phase I – Planning	Months 1 - 3
Phase II – Engineering, Design, Permitting, and Bidding	Months 4 - 16
Phase III – Construction	Months 17-19
Phase IV – Construction Inspections	Month 20
Phase V – Monitoring	Months 21-24

4. Identify all potential funding sources for each phase of the project using key words and phrases from the project scope.
5. Analyze the funding sources for each project to create individual project schedules which align with funding schedules:
6. Project schedules are very important as they can allow for flexibility in sensitive timing of funding sources.
7. Project schedules should include:
    - Funding source(s) application open date
    - Funding source(s) award notification date
    - Funding source(s) effective start date
8. Use the information above to create proposed project start and end dates by phase. Different funding sources can be used to leverage one another in order to fund the full project budget. See **Figure 9.1**.

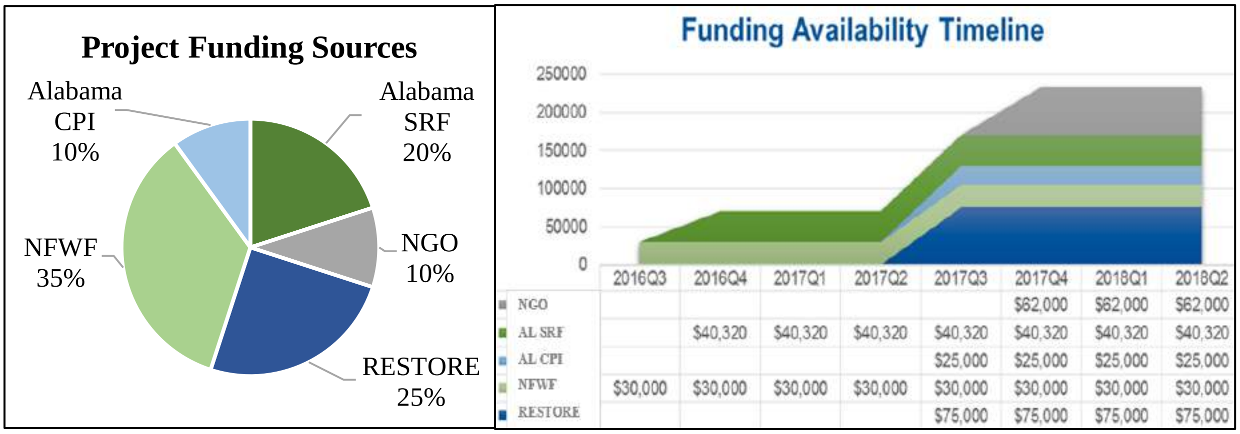


Figure 9. 1 Example of leveraging project funding sources

9.1.1 Funding Analyses

Step 4 in the financing framework is to analyze the funding sources for each project to create individual projects schedules. Developing project funding schedules will allow project planning milestones to be easily tracked. Most importantly, they identify time frames for which funding should be pursued and secured. Most funding sources discussed in this WMP are recurring annually; however, are only open to apply for a limited timeframe each year. Reviewing current and archived funding opportunity announcements will provide information on the application open date, application deadline, award notification date, and effective start date.

9.2 Funding Sources – Public and Private

Restoration and management priorities were identified in **Chapter 6** to include water quality, fish/ habitat, access, heritage, coastlines, resiliency. These management priorities have identified various strategies and goals for each management priority, which will have the greatest potential to provide significant early benefits to reaching the WMP goals and objectives. Step 4 of the framework is to identify potential funding sources for each project. The public and private funding sources, as identified in Appendix E, are described in detail as prospective funding matches for management priorities identified in **Chapter 6**.

9.2.1 NRDA

On April 20, 2010, the offshore oil drilling platform, Deepwater Horizon (DWH), exploded in the Gulf of Mexico near Louisiana releasing approximately 134 million gallons of crude oil and four million pounds of natural and methane gas into Gulf waters before it was capped on July 15, 2010. The Oil Pollution Act authorizes certain state and federal agencies to evaluate the impacts of the DWH oil spill. This legal process, known as Natural Resource Damage Assessment (NRDA), determines the type and amount of restoration needed to compensate the public for damages caused by the oil spill. In April 2011, BP committed to $1 billion in early restoration projects in an agreement with the NRDA trustees. To date there are five phases of early restoration planning. Figure 9.2 shows the NRDA restoration funding allocated for each restoration goal identified for Alabama.

No projects within the Watershed were selected for Phases I through III Early Restoration funding. However, in late 2015, the Shell Belt and Coden Belt Roads Living Shoreline project was selected for Phase IV Early Restoration funding for a total estimated cost of $8.05M. This project will employ shoreline restoration techniques to increase benthic productivity and enhance the growth of planted native marsh vegetation. Specifically, shoreline breakwaters will be constructed to dampen wave energy and protect newly planted emergent vegetation while also providing habitat and increasing benthic secondary productivity. Over time, the breakwaters are expected to develop into reefs that support benthic secondary productivity, including, but not limited to, bivalve mollusks, annelid worms, shrimp, and crabs. Marsh vegetation is expected to become established further enhancing both primary and secondary productivity adjacent to the breakwaters.

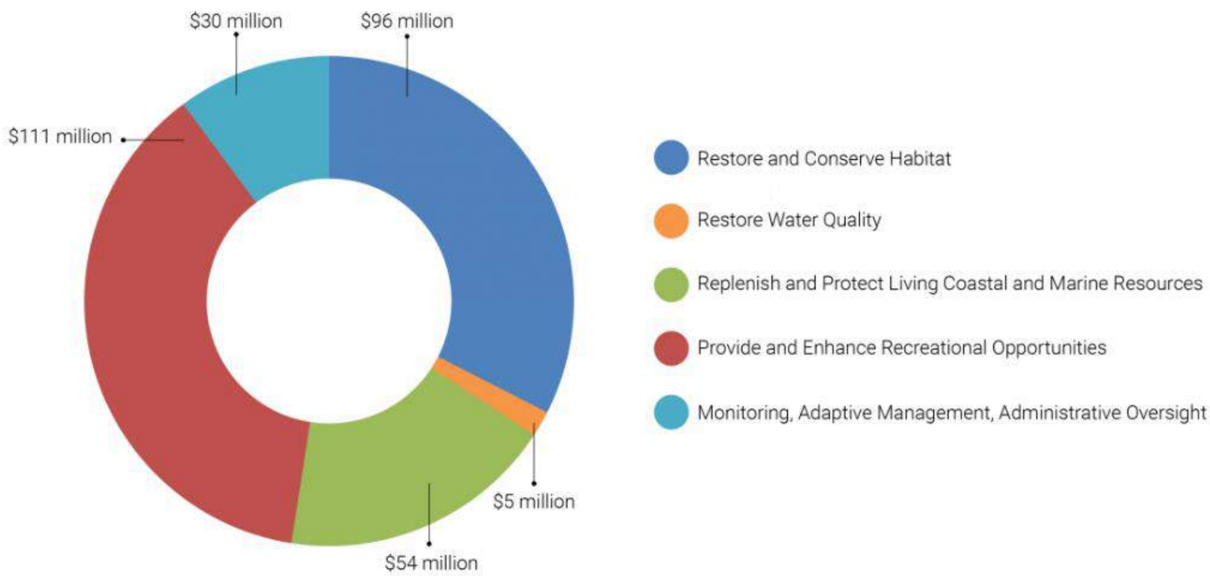


Figure 9.2 Allocation of NRDA restoration funds in Alabama for each restoration goal

On July 2, 2015 an agreement in principle was announced in which BP Exploration & Production Inc. (BP) will pay $8.1 billion in natural resource damages, including the $1 billion BP previously committed to pay for early restoration projects.

9.2.2 GEBF

The National Fish and Wildlife Foundation's (NFWF) Gulf Environmental Benefit Fund (GEBF) was established in early 2013 as a result of two plea agreements resolving the criminal cases against BP and Transocean after the 2010 Deepwater Horizon oil spill. The agreements direct a total of $2.544 billion to NFWF over a five-year period. The funds are to be used to support projects that remedy harm to natural resources where there has been injury to, or destruction of, loss of, or loss of use of those resources resulting from the oil spill. Projects are expected to occur within reasonable proximity to where the impacts occurred, as appropriate. Under the allocation formula and other provisions contained in the plea agreements, $356 million of the total amount to be deposited into the Gulf Environmental Benefit Fund will be for project expenditures in the state of Alabama (funded over a five-year period).

In 2016, GEBF awarded The Nature Conservancy $5,903,100 for the Lightning Point Acquisition and Restoration Project (Phase I). This project will protect and restore a key stretch of coastal shoreline at the mouth of the Bayou La Batre River. Specifically, the project includes the acquisition of more than 100 acres of coastal habitat and the engineering and design for restoring approximately 28 acres of marsh and 1.5 miles of intertidal nearshore breakwater. The acquisition targets represent more than 2 miles of nearly contiguous undeveloped waterfront adjacent to existing protected lands owned by the state, Mobile County, and the City of Bayou La Batre.

Other regional cooperative projects funded by GEBF that benefit the Mississippi Sound Complex include:

- Enhanced Fisheries Monitoring in Alabama's Marine Waters (Phase I – III) - $1,800,000
- Fowl River Watershed Restoration: Coastal Spits and Wetlands Project (Phase I) - $1,127,000
- Dauphin Island Conservation Acquisition - $3,568,600
- Alabama Coastal Bird Stewardship Program -$1,462,000
- Grand Bay Acquisition - $1,777,500
- Alabama Artificial Reef and Habitat Enhancement - $12,525,400
- Alabama Barrier island Restoration Assessment - $4,277,600
- Alabama Marine Mammal Conservation and Recovery Program - $1,281,600
- Restoration and Enhancement of Oyster Reefs in Alabama - $3,750,000
- Fowl River Watershed Restoration - $3,244,150

9.2.3 RESTORE

The federal RESTORE Act was signed into law on July 6th, 2012, as part of the Moving Ahead for Progress in the 21st Century Act (Public Law 112-141). The legislation established a mechanism for providing funding to the Gulf region to restore ecosystems and rebuild local economies damaged by the Deepwater Horizon oil spill. The RESTORE Act established in the Treasury of the United States the Gulf Coast Restoration Trust Fund (Trust Fund) consisting of 80% of an amount equal to any administrative and civil penalties paid after the date of the RESTORE Act by the responsible parties in connection with the Deepwater Horizon oil spill to the United States pursuant to a court order, negotiated settlement, or other instrument in accordance with section 311 of the Federal Water Pollution Control Act (FWPCA, 33 U.S.C. 1321).

As shown in **Figure 9.3**, the RESTORE Act divides the funds into five separate allocations and sets the parameters for how the funds are to be spent in each:

- 35% of the funds are divided equally among the five Gulf Coast states for ecological and economic restoration. Eligible activities include: restoration and protection of natural resources; mitigation of damage to natural resources; work force development and job creation; improvements to state parks; infrastructure projects, including ports; coastal flood protection; and promotion of tourism and Gulf seafood.

- 30% of the funds will be administered for restoration and protection according to the Comprehensive Plan developed by the Gulf Coast Ecosystem Restoration Council.

- 30% of the funds are dedicated to the Gulf Coast states based on a formula. This formula will be based on the number of miles of shoreline that experienced oiling, the distance from the Deepwater Horizon mobile drilling unit at the time of the explosion, and the average population as of the 2010 Census. Each state is required to have a Council-approved plan in place for use of these funds.

- Two and a half percent of the funds are dedicated to the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring and Technology Program, which will be established by NOAA for marine and estuarine research, ecosystem monitoring and ocean observation, data collection and stock assessments, and cooperative research.

- Two and a half percent of the funds are dedicated to the Centers of Excellence Research Grants Program. The funding is distributed through the states to nongovernmental entities to establish Centers of Excellence that will focus on the following disciplines: coastal and deltaic sustainability; restoration and protection; fisheries and wildlife ecosystem research and monitoring; offshore energy development; sustainable and resilient growth; and comprehensive observation, monitoring, and mapping in the Gulf.

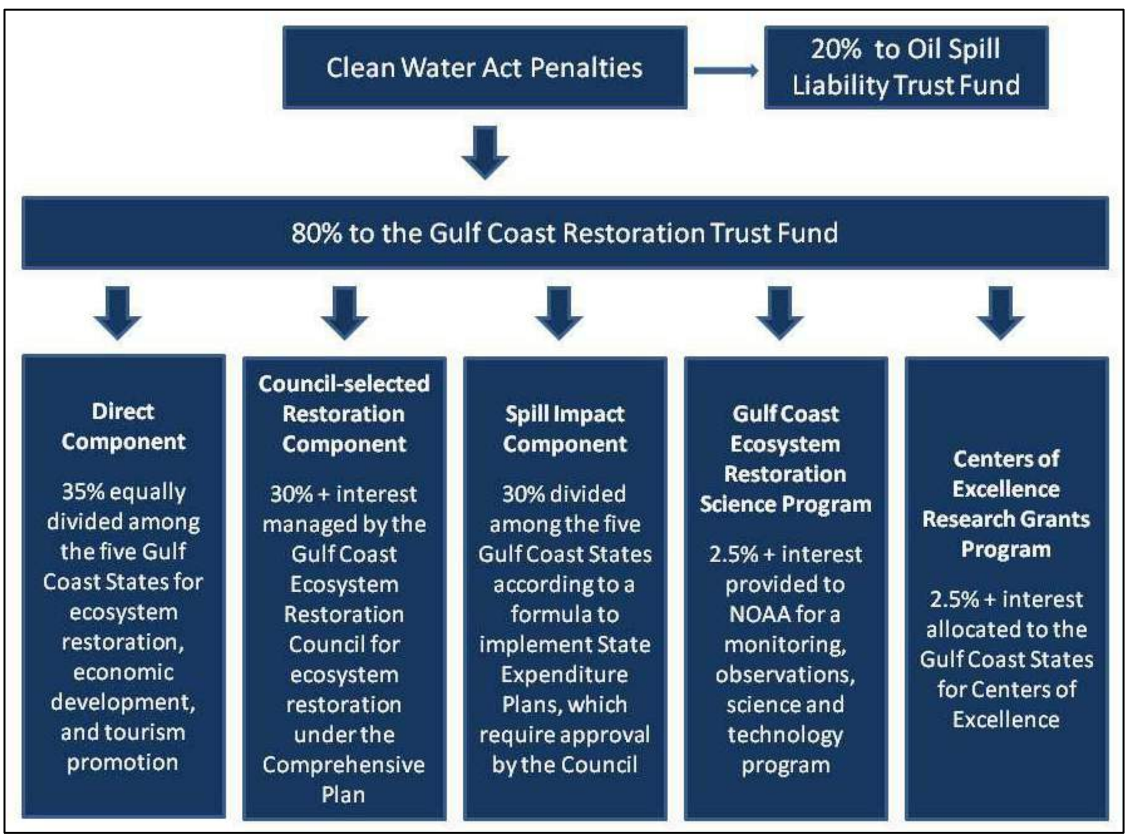


Figure 9.3 RESTORE Act allocation structure

9.2.4 Gulf of Mexico Energy Security Act of 2006 (GOMESA)

On December 20, 2006, the President signed into law the Gulf of Mexico Energy Security Act of 2006 (Pub. Law 109-432). The Act significantly enhances outer continental shelf (OCS) oil and gas leasing activities and revenue sharing in the Gulf of Mexico (GOM). The Act shares leasing revenues with Gulf oil and gas-producing states and the Land & Water Conservation Fund for coastal restoration projects; bans oil and gas leasing within 125 miles of the Florida coastline in the Eastern Planning Area, and a portion of the Central Planning Area, until 2022; and, allows companies to exchange certain existing leases in moratorium areas for bonus and royalty credits to be used on other GOM leases.

The Act created revenue-sharing provisions for the four Gulf oil- and gas- producing states of Alabama, Louisiana, Mississippi, and Texas, and their coastal political subdivisions (CPSs). GOMESA funds are to be used for coastal conservation, restoration, and hurricane protection. There are two phases of GOMESA revenue sharing:

- **Phase I:** Beginning in Fiscal Year 2007 (FY07), 37.5% of all qualified OCS revenues, including bonus bids, rentals, and production royalties, were shared among the four states and their coastal political subdivisions from those new leases issued in the 181 Area in the Eastern planning area (also known as the 224 Sale Area) and the 181 South Area. Additionally, 12.5% of revenues are allocated to the Land and Water Conservation Fund (LWCF).
- **Phase II:** The second phase of GOMESA revenue sharing begins in Fiscal Year 2017 (FY17). It expands the definition of qualified OCS revenues to include receipts from GOM leases issued either after December 20, 2006, in the 181 Call Area, or, in 2002–2007, GOM Planning Areas subject to withdrawal or moratoria restrictions. A revenue-sharing cap of $500 million per year for the four Gulf oil- and gas-producing states, their CPSs, and the LWCF applies from Fiscal Years 2016 through 2055. The $500 million cap does not apply to qualified revenues generated in those areas associated with Phase I of the GOMESA program. The Bureau will address the second phase of GOMESA revenue sharing in a subsequent rulemaking.

9.2.5 Non-Governmental Organizations and Other Private Funding

Numerous private foundations and non-governmental organizations (NGOs) are either headquartered or operate within or around the Watershed. These organizations include a wide range of environmental, academic, social, educational, religious, medical, and philanthropic institutions focused on achieving continued improvement in the quality of life for the residents of the Watershed. While not all of these organizations have either the focus or capacity of watershed recovery in their missions, we believe that many of these organizations would actively participate and contribute if simply given the opportunity. The following is a list of foundations and organizations that could participate and contribute in achieving the many goals and objectives identified in this WMP:

- Alabama Coastal Foundation
- Bishop State Community College
- Coalition of Alabama Students for the Environment
- Discovering Alabama
- Hands on Mobile
- J.L. Bedsole Foundation
- Keep Mobile Beautiful
- Mobile Baykeeper
- Mobile Bay Sierra Club
- Mobile United
- National Audubon Society
- The Nature Conservancy
- Partners for Environmental Progress
- Restoration Keepers
- University of South Alabama
- Kodak American Greenways Program
- RBC Bank Blue Water
- Surdna Foundation

9.2.6 Funding of Management Measures

The extensive and varied group of flexible financing-support structures identified in this WMP illustrates that there are readily available mechanisms to help support the Bayou La Batre WMP implementation at whatever implementation schedule the supporting governance and community are prepared and committed to undertake to conserve this invaluable resource. In anticipation that this WMP will be adopted for implementation, an initial assessment of which of these entities might offer the best initial underwriting assistance for the identified management measures. The results of that assessment are provided as a "jump- start" blueprint in **Table 9.1**.

In summary, there are significant financial support options available to help support and ensure the Bayou La Batre WMP's success in conserving and revitalizing this resource. Establishment of a WMTF would clearly demonstrate to the grant markets the communities' active resolve to serve as vested and committed partners in the Bayou La Batre watershed improvement and protection process. This endeavor would significantly enhance the WMTF's attractiveness and position as it pursues available federal, state, local, and private grant assistance needed for implementation. With a supported WMTF, coupled with aggressive, deliberate implementation of the initial Short-Term Strategies over the next three years, will help secure long-term local commitment. These efforts will also establish the knowledge and experience needed to apply for the full range of funding sources needed for complete and successful implementation of this WMP.

Table 9.1 Recommended funding sources for Priority Management Measures, Short-Term Strategies (0-3years)

Priority Management Measures	Recommended Support Targets / Authorities		
	Federal / State Grants (65%)	Local Cost Share (15%)	Private Partnership Support (20%)
Reduce trash in and entering waterways	EPA NOAA USDA(GOMI) ADEM RESTORE	General Fund Commitments (County & Municipal) Municipal Bonds Clean Water SRF Stormwater Utility Fee Program Implementation (w/TMC Set-aside) AL RESTORE ADCNR ADECA	Private Contributions and Grants Portfolio Development and Management NFWF
Reduces sediments and nutrients from runoff	ACOE NOAA FEMA (HMGP) ADEM ACAMP RESTORE		
Remove illicit discharges	EPA ADEM		
Reduce nuisance and/ or exotic species	NOAA USFWS EPA ACOE NRCS USDA RESTORE		
Blueway & Greenway trails	ALDOT HUD/ CDBG USDA RESTORE NOAA ACAMP DOI GOMA		
Tourism	ACAMP SMCTA		
Education and outreach	ADEM ACAMP GOMA AGCRC	General Fund Commitments (County & Municipal) Municipal Bonds Clean Water SRF Stormwater Utility Fee Program Implementation (w/TMC Set-aside) AL RESTORE ADCNR ADECA	Private Contributions and Grants Portfolio Development and Management NFWF
Heritage	AGCCVB GOMA		
Shoreline protection and Restoration	RETORE EPA NOAA USFWS ACOE GOMA		
Coastal Resiliency	EPA NOAA RESOTRE GOMA ACAMP		

10 Community Participation and Stakeholder Engagement

10.1 Introduction, Purpose and Goals

The Bayou La Batre Watershed (Watershed) has a population of approximately 10,500 people, including approximately 2,300 who are residents of the City of Bayou La Batre. For over 120 years, the economy of much of the watershed was heavily supported by the harvesting of seafood. Bayou La Batre (BLB) still identifies itself as the "Seafood Capital of Alabama." More recently, shipbuilding has also become an economic engine for the area.

Many families living in the Watershed proudly trace their heritage back to the original 18th century settlers and maintain an intense pride in their French and Spanish lineages and family relationships. However, the social and cultural mix of the Watershed was forever changed in the 1970's with the immigration of substantial families from Southeast Asia. Much of this citizenry is underprivileged and economically disadvantaged, and the Asian communities tend to be marginalized due to language and cultural biases. Although the Asian community represents approximately 35% of the population of the municipality of Bayou La Batre, many do not speak English.

It was recognized that challenges of engaging citizens in a watershed study is always complex and is made even more daunting by the socioeconomic structures and language barriers. In addition, there is a substantial local perception of socioeconomic disparity between those who have been successful in the seafood and shipbuilding industries and those who have simply maintained a day-to-day living from those same industries.

The WMP Team recognized all of these factors and designed a public awareness and outreach program that connected with each community segment in order to maximize trust, participation, and effectiveness. Throughout the course of the project, the entire Watershed community was kept informed of milestones and accomplishments and was continuously encouraged to participate in community meetings, surveys, and engagement activities. Figure 9.1 provides a visual representation of the number of stakeholders that were reached through the public outreach and engagement program.

In addition to group and one-on-one meetings, the WMP Team provided watershed materials and presentations at a number of community events. The following sections highlight those activities and events.

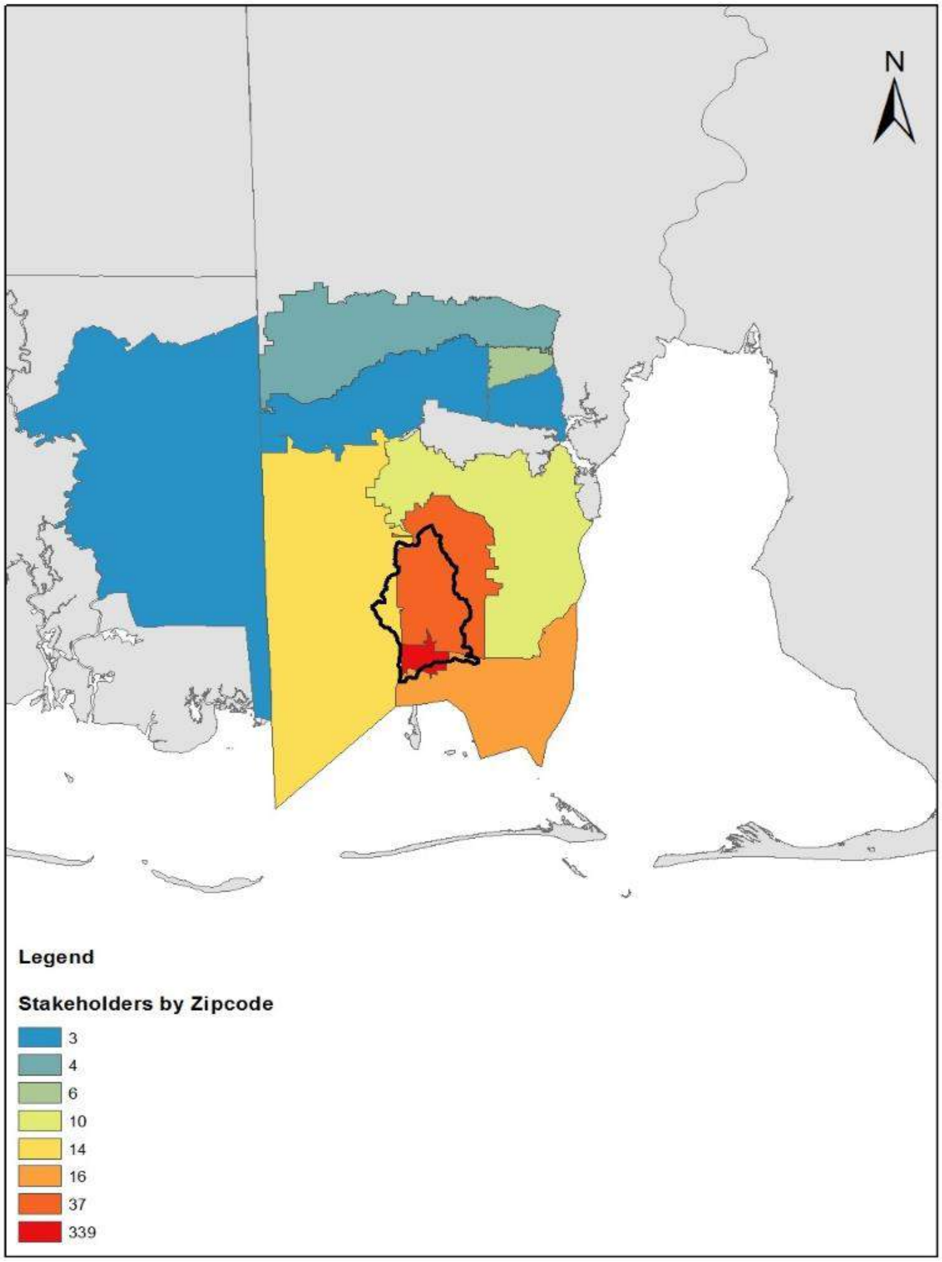


Figure 10.1 Number of Stakeholders (by Zip code) Reached through Public Outreach Program

10.2 Audiences

The following subsets of stakeholders were identified, and specific outreach programs were designed for each stakeholder subset.

- **General Public:** To reach the various ethnic groups within the Watershed, materials were developed and printed in all four languages (English, Cambodian, Laotian, and Vietnamese). Individuals within each community were solicited to serve as "centers of influence" and as interpreters for materials and events. An individual in each of the three communities served as an interpreter for the printed materials as well as an interpreter for the public meetings.

Figure 10.2 Small Group Community Meeting

- **Business Community:** The Watershed is a small community of people, so consideration was given that senior business owners/managers may be uncomfortable participating in public sessions with others from the community who could be their employees. This group was reached effectively through one-on-one sessions. These sessions were time consuming but very effective in establishing these individuals as centers of influence and support. Business groups included:
    - Chamber of Commerce
    - Seafood Related Businesses (Processors, Boat Owners, Retailers)
    - Boat/Shipbuilding Businesses
    - Other Businesses
- **Traditional Farmers:** These are small farmers for whom farming is a supplement to a salaried and more dependable income. Since traditional group meetings and/or one-on-one meetings were less effective for this audience, the WMP Team worked with the MCSWCD and NRCS to reach these stakeholders.
- **Elected Officials (local):** The WMP Team met with the Mayor of BLB and individual BLB City Council members on several occasions to brief them on the progress of the watershed study. In addition, each was invited to all of the public watershed meetings and provided with copies of all correspondence that was distributed to the Steering Committee or the general public. Presentations or progress reports were delivered at several BLB City Council planning sessions and regularly scheduled meetings. These meetings were very effective because they provided a public forum for educational purposes.

Figure 10.3 Bayou La Batre City Hall

- **Students:** Initial plans to involve school age children in water monitoring and sample collection proved challenging due to the lack of available public access points along the waterway and liability issues related to the use of boats for student collection purposes. The WMP Team re-evaluated their outreach approach for this group and collaborated with the City of Bayou La Batre to facilitate the delivery of marine debris and water quality education programs in Grand Bay Middle School, Alba Middle School, and Alma Bryant High School. The City received a marine debris community-based removal grant to remove 21 abandoned and derelict vessels from the waters of BLB, which supported an education and outreach program. During the month of March 2016, eight 848 students and 13 teachers participated in these educational endeavors, which were led by Kim Albins (NOAA) and Caitlin Wessel (DISL). Presentations included opportunities for hands-on student participation.

Figure 10.4 Students participate in Watershed cleanup.

10.2.1 Steering Committee

A BLB Watershed Steering Committee was created and quickly became the engine behind the watershed study. Great care was provided in selecting Steering Committee members from all major community subsets, as well as from key resource agencies. The Steering Committee met several times during the course of the study and helped disseminate information and educational resources to their respective communities.

Figure 10.5 BLB Steering Committee Meeting

Table 10.1 Bayou La Batre Waterway Steering Committee Members

Committee Member	Organization
Reang Ly Ang	Vietnamese Community
Kieu Lien Atwell	Vietnamese Community
Reverend Dennis Bennet	Freewater Baptist Church
Lori Bosarge	Coastal Response Center
Bountrath Bouasanouvong	Laotian Community
Ken Buck	Buck Farms
Sharon Castelin	Citizen Stakeholder
Ida Mae Coleman	BLB City Commission
Chris Collier	Business Owner
Bobby Dixon	Citizen Stakeholder
Bret Dungan	BLB Mayor (2013-2015)
David Esfeller	Esfeller Farms
Judy Haner	The Nature Conservancy
Reverend Joseph Hayes	Sweet Bethel Baptist Church
Philip Hinesley	Alabama Department of Conservation and Natural Resources (ADCNR)

Committee Member	Organization
Lynn Huynh	Vietnamese Community
Annette Johnson	BLB Mayor (2015-2016)
Cristie Keovoravong	Laotian Community
Col. Roosevelt Lewis	BLB Planning Commission
Nancy McCall	Citizen Stakeholder
Shannon McGlynn	Alabama Department of Environmental Management (ADEM)
Christian Miller	MBNEP
Roger Milne	Citizen Stakeholder
Joyce Nicholas	Natural Resources Conservation Service (NRCS)
Randy Nicholas	MCSWCD
Thi Nguyen	Vietnamese Community
Andy Overstreet	Businessman
Wanda Overstreet	Citizen
Dena Pigg	BLB Chamber of Commerce
Jeremy Sessions	Citizen Stakeholder
Randy Shaneyfelt	ADEM
Terry Sue Smith	Citizen Stakeholder
Velma Jean Steel	Citizen Stakeholder
Julian Stewart	Alma Bryant High School
Roberta Swann	MBNEP

10.3 Messaging

The following section presents the overall messaging for Public Outreach component of the WMP.

10.3.1 Content

All stakeholder meetings, whether group sessions or one-on-one discussions, were designed to accomplish the following:

- Introduce the concept of watersheds and why protecting the local watershed is critical to the economy and quality of life in the BLB area for future generations.
- Explain why the watershed management study was being undertaken and why the study was important to each of them, their livelihoods, and their recreational activities.
- Introduce specific elements of the watershed study, including scientific analyses, opportunities for community input, time lines, and anticipated products.
- Emphasize the critical nature of individual responsibility in protecting the quality and heritage of the local watershed.
- Obtain feedback from stakeholders on their perceptions of watershed issues and how improvements and changes could be implemented.
- Provide an opportunity for the Steering Committee and the general public to receive interim and final information concerning the findings of each of the various teams that worked on the study.

10.3.2 Format

Meeting formats were adapted to meet the interests and educational levels of the primary audiences. In general, an agenda was prepared and distributed; information was shared with the audience, open discussion was encouraged, questions were addressed, and stakeholder surveys were completed and collected. Most public meetings lasted one hour to an hour and a half. Every effort was made to engage the audiences and encourage feedback. Asian audiences tended to be a little reticent to participate in the discussions until they realized that an interpreter who spoke their native language was present.

Figure 10.6 Small Group Community Meeting with Interpreter

10.3.3 Public Announcements

Public participation in watershed meetings was encouraged using a variety of methods including:

- Announcements in English, Cambodian, Vietnamese and Laotian posted at the BLB City Hall, the BLB Community Center, the BLB Utility Board, and the BLB office of Alabama Power Company
- An electronic billboard at the BLB Community Center
- Large commercial signs posted at strategic intersections in the area
- Electronic notices
- Phone calls

Figure 10.7 Community Meeting Announcement

10.3.4 Materials

A variety of materials were prepared for use during the various meetings, including but not limited to:

- BLB Watershed Project Description
- BLB Stakeholder Survey Instrument
- BLB Watershed PowerPoint
- BLB Watershed Map
- BLB Slosh Model Results
- Frequently Asked Questions
- "We're Listening" Cards and Handouts
- List of BLB Stakeholder Outreach and Engagement Steering Committee Members

10.4 Public Engagement Opportunities

A variety of different outreach methods were employed to engage the diverse subsets of stakeholders. Schedules of these outreach opportunities are provided below.

10.4.1 Community Stakeholder Workshop Programs

Numerous community outreach meetings were held to engage the public in the watershed planning process. **Table 10.2** provides a detailed list of those meetings.

Table 10.2 Community Stakeholder Workshop Programs

Date	Meeting Type	Location	People in Attendance	Highlights
May 20, 2015	Steering Committee Meeting	Steering Committee Member Home	35	
Jun. 11, 2015	Community Stakeholder Meeting	Coastal Response Center, Coden, AL.	18	Included students and teachers from Alma Bryant High School Academy of Coastal Studies
Jul. 14, 2015	Cambodian Community Meeting	BLB Community Center	33	• All materials distributed in Cambodian including the survey instrument • Oral presentation was translated into Cambodian
Jul. 16, 2015	Vietnamese Community Meeting	BLB Community Center	32	• All materials distributed in Vietnamese including the survey instrument • Oral presentation was translated into Vietnamese

Date	Meeting Type	Location	People in Attendance	Highlights
Jul. 23, 2015	Laotian Community Meeting	BLB Community Center	22	• All materials were distributed in Laotian including the survey instrument • Oral presentation was translated into Laotian
Jul. 29, 2015	Community Stakeholder Meeting	Freewater Baptist Church, Dixon Corner Community	27	
Aug. 20, 2015	Stakeholder Public Information Meeting	BLB Community Center	32	
Oct.13, 2015	Steering Committee Meeting	BLB Community Center	17	
Nov. 17, 2015	Large Vessel Owners Public Meeting	BLB Community Center	14	Meeting of large vessel commercial fishermen to obtain community feedback relative the concept of a local safe harbor facility for use during storm events
Dec. 17, 2015	Presentation to Bayou La Batre Area Chamber of Commerce	BLB Community Center	19	
Jan.20, 2016	Meeting with BLB Utilities Board	BLB Utilities Board	6	Presentation related to the watershed study including issues of importance to WWTP
Mar. 22, 2016	Steering Committee Meeting	BLB Community Center	30	

Figure 10.8 Community Stakeholder Meeting Announcement

10.4.2 Meetings with Elected Officials (Bayou La Batre City Council)

Several presentations were delivered to the BLB City Council and general public at regularly scheduled City of Bayou La Batre City Council meetings and planning meetings, to update the Council and general public on the progress of the watershed plan and engage them in the process. **Table 10.3** provides a detailed list of those meetings.

Table 10.3 Presentations to Elected Officials and Public

Date	Meeting Type	Location	People in Attendance	Highlights
Jul. 6, 2015	Presentation to the BLB City Council and Public	BLB City Hall	31	Regularly scheduled City Council planning meeting
Jul. 9, 2015	Presentation to the BLB City Council and Public	BLB City Hall	43	Regularly scheduled bi-monthly City Council meeting
Sep. 15, 2016	Presentation to the BLB City Council and Public	BLB City Hall	27	Regularly scheduled City Council planning meeting

Jan.11, 2016	Presentation to the BLB City Council and Public	BLB City Hall	37	Regularly scheduled bi-monthly City Council meeting

10.4.3 One-on-One Informational Sessions

A total of sixty-five (65) one-on-one sessions were conducted with watershed stakeholders who represented the following subsets:

- General Citizenry
- Asian Communities (Vietnamese, Cambodia, Laotian)
- Stakeholder Agency Representatives
- Watershed Business Owners/Operators
- Ministry
- Higher Education
- Public Education (k-12)
- Legal Community
- Community Activists
- Healthcare Professionals and Advocates
- Elected Officials
- Municipal Employees
- Farmers

10.4.4 Other Engagement and Informational Opportunities

Throughout the watershed study, numerous informal opportunities were employed to inform community stakeholders about the watershed study and especially the importance of individual responsibility to the health of the waterway.

Table 10.4 Additional Public Outreach Activities

Date	Activity
May 2015	Distributed first summary of stakeholder survey responses to the Steering Committee and other stakeholders with explanations and interpretations
Jun. 23, 2015	Provided a display of watershed materials for the Annual Mobile County Agricultural Fair in BLB
Jul. 23, 2015	BLB Steering Committee watershed canoe tour with approximately 22 key stakeholders from 10 different organizations
Jul. 23, 2015	Conducted planning session for involving Bryant High School Students in watershed activities
Aug. 1, 2016	WMP Team representation at the Bayou La Batre 2^{nd} Annual Kayak Tournament

Date	Activity
Aug.8, 2015	Meeting with the BLB Utility Board Superintendent of Operations to discuss integration of the watershed plan and Utility Board goals and objectives
Aug. 2015	Distributed the second summary of stakeholder survey responses to the Steering Committee and other stakeholders with explanations and interpretations
Sep. – Oct. 2015	WMP Team worked with MCSWCD, NRCS, and Mobile County Farmers Federation to design an outreach effort for the traditional farmers in south Mobile County
Sep. 13, 2016	WMP Team represented at Sea Level Rise workshop at the Weeks Bay Educational Center
Sep. 19, 2015	Distributed the third summary of stakeholder survey responses to the Steering Committee and other stakeholders with explanations and interpretations
Sep.26, 2015	WMP Team represented at Taste of the Bayou
Oct.10, 2015	WMP Team represented at the Annual "Paddle the Bayou" event sponsored by BLB-Coden Historical Foundation
Nov.4, 2015	WMP Team coordinated with BLB Derelict Vessel Project for BLB boat tour with agency stakeholders including NOAA, ADCNR, USACE, City of BLB, and U.S. Coast Guard
Nov. 17	Conducted a planning session at Alma Bryant High with teachers
Dec. 17, 2015	WMP Team coordinated on second boat tour of the BLB waterway to obtain information concerning trash issues along the Bayou and begin the process of identifying the primary sources
Jan.15, 2016	WMP Team coordinated with MCSWCD and NRCS to provide a display of information concerning the watershed study at the Gulf Coast Resource Conservation and Development Conference in Bay Minette, AL. Approximately one hundred and twenty (120) people in attendance.
Mar. 29, 2016	WMP Team convened a visioning session in BLB to begin identifying a process for the migration of City services out of the current flood plain. Fifteen people participated, including elected officials, business leaders, agency leads and community planners/engineers.
Jan.11, 2016	Met with senior members of the Mobile Chamber of Commerce and provided an update of the BLB WMP process and findings
Mar.3, 2016	Conducted a strategy meeting with the City of BLB Mayor Annette Johnson concerning migration plans for moving City services out of the flood plain.
Nov.– Mar., 2016	Conducted five (5) meetings with Col. Roosevelt Lewis and the South Alabama Regional Planning Commission concerning details of the BLB Long Range Plan in relation to the BLB WMP study and final report.

Figure 10.9 Community Envisioning Session

10.5 Summary of Stakeholder Responses

Survey responses obtained from stakeholders, whether in large group sessions or one-on-one, were collated and graphed to illustrate the perceived importance of each element. The results reflect the depth of understanding among stakeholders that protecting the quality of the Watershed is intrinsically tied to protecting the local culture and economy. A combination of responses to (a) Improved water quality, (b) Protecting wetland habitats and (c) Preservation of natural sites represents 46% of all stakeholder primary concerns. The identification of specific policies or procedures for implementing the primary areas of concern was addressed but typically avoided by stakeholders, due to limited experience or knowledge of how implementation could or should occur. This should not belie their passion for the health and viability of the waterway and watershed.

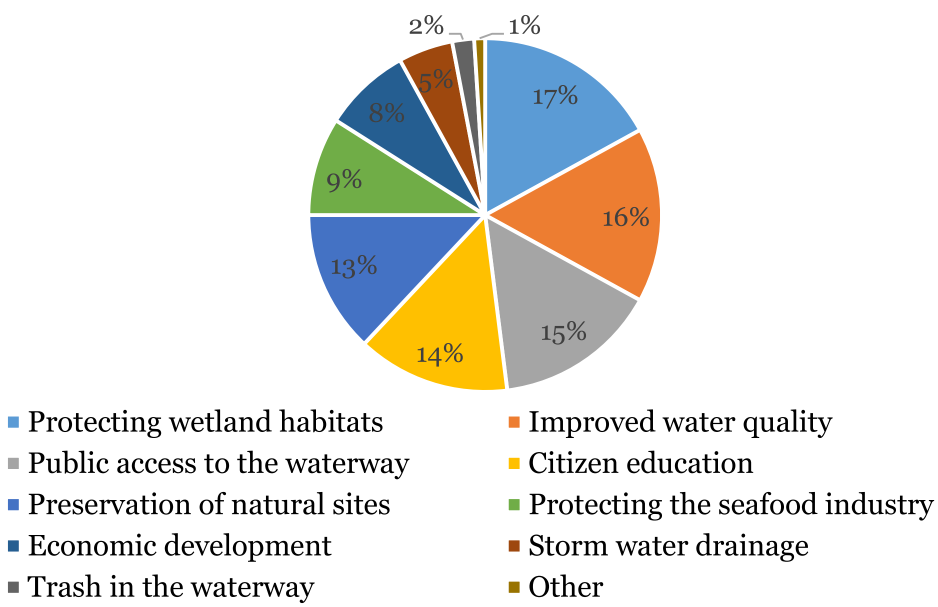


Figure 10.10 Areas of Primary Concern to Stakeholders

10.6 Outreach Recommendations

10.6.1 Introduction and Purpose

This WMP provides additional outreach recommendations to be considered during implementation of the plan. Successful implementation of the WMP will be achieved through a partnership between the MBNEP, members of the BLB Steering Committee, and the public. Consistent input from public stakeholders during the planning process identified ideas for addressing the environmental challenges facing the Watershed. Through public meetings, messaging, and other events, local residents have become invested in the restoration of the Watershed. With input from the MBNEP, the WMP Team presents the following Public Outreach Plan to establish a healthy dialogue between stakeholders in the Watershed and create and encourage investment in the restoration of this valuable natural resource.

10.6.2 Goals

The goals of the Public Outreach Plan are to:

- Inform, educate, and engage key stakeholders in an effort to increase public awareness of the benefits provided by the Watershed.
- Develop the public's sense of ownership of the Watershed, along with an understanding of the value of watershed resources to the community.
- Provide avenues for the public to contribute to the watershed restoration process, such as offering their visions for the watershed that involve aesthetic enhancement, recreational access, and improved water quality.
- Reduce the volume of trash in Bayou La Batre through a cultural shift – where the community increasingly values Bayou La Batre as a natural resource that deserves protection and actively prevents trash from entering the bayou and its tributaries.
- Explore additional techniques and opportunities for public involvement.

10.6.3 General Messaging

To achieve the goals outlined in **Section 10.6.2**, the following statements were developed to use as cohesive messages for all types of stakeholders. For instance, project handouts or talking points include the project vision statement, the definition of success, or the tag line. The benefit of this approach is delivery of a consistent message to the public. The information below will equip the WMP Team, MBNEP, and members of the Steering Committee with common messages for dissemination.

- **Vision**: *To transform the Bayou and its watershed into a healthy and vibrant community amenity that supports a robust habitat; provides increased public access; serves as an economic engine supporting the seafood and shipbuilding industries and ecotourism; and celebrates and preserves the rich culture and heritage of the area.*

- **Success**: The definition of success would be a transformed Bayou and watershed that preserves habitat and open space, has improved water quality, provides more recreational opportunities, and is more resilient to storms and sea level rise.

Challenges to BLB Restoration

- Negative effects of stormwater runoff – including abundance of trash
- Negative impacts to water quality, particularly from pathogens
- Abundance of invasive species
- Community and emergency services in floodplain
- Limited public access
- Property acquisition needs
- Lack of an independent organization to lead and manage restoration efforts

Beneficial Impacts of BLB Restoration

- Monetary:
    - Increased residential and commercial property values
    - Restoration of a cultural destination that celebrates a unique history, attracts visitors, and increases economic opportunities
    - Improved habitats for sustainable fisheries to support local economy
- Health:
    - Improved water quality with less trash
    - Improved fish and wildlife health, resulting in improved community health and increased civic pride
    - Greenway and blueway trails for recreation
    - More open space and access for recreation
- Security:
    - Less exposure and risk to storm events and sea level rise
    - City services and emergency services in more secure areas
    - Safe harbor for vessels
    - A more resilient community!

10.6.4 Partnering Together During Implementation

Engagement is an essential component of ongoing restoration activities and should not end after the publication of the WMP. This planning effort represents an opportunity for intertwining environmental protection with community development. Moving forward, BLB Watershed restoration engagement should center on the following principles:

- Involve
- Engage
- Educate
- Own

Involve

As a result of the efforts developing the WMP (i.e., public meetings, outreach efforts, etc.), momentum has built for restoration of Bayou La Batre. The existing Steering Committee structure provides an array of local leaders who have been actively involved throughout this planning process, and their continued involvement will be extremely beneficial in implementing this WMP. New organizations and businesses should also be identified and recruited to share in the Watershed restoration activities.

Engage

The WMP provides ideas and opportunities for stakeholders to become more actively engaged in restoration efforts and allows stakeholders to see where they might fit in with restoration. The WMP Team has strived to get stakeholders engaged in the planning process, and that momentum should be maintained so there is continued excitement for what the Watershed offers and can become.

Educate

Education is critical to continue building the current momentum towards Watershed restoration. Education extends beyond school curriculum opportunities; it involves educating all stakeholders (i.e., local officials, private industry, grassroots organizations, and citizens) to increase awareness about Watershed challenges and solutions and foster new attitudes, motivations, and stakeholder commitments.

Evaluating outreach efforts, particularly education, provides a feedback mechanism for continuous improvement. As part of any future education endeavors, building in an evaluation component from the beginning will ensure some feedback on the impact of the outreach program.

Own

To achieve success, Watershed restoration must become an initiative rooted within the community. The MBNEP has led by initiating and driving the development of the BLB WMP, engaging a wide variety of stakeholders, and working to make the community vision of the Bayou a reality. The MBNEP must pass the BLB Watershed restoration “torch” to an independent organization solely focused on this effort.

10.6.4.1 Target Audiences During WMP Implementation

The MBNEP and the WMP Team have targeted specific community stakeholders to become leaders in Bayou La Batre restoration. This section identifies these target audiences, describes how WMP implementation will address different values important to each, and identifies appropriate initiatives for each target audience to lead.

The targeted primary audience includes those stakeholders who have the ability to make changes, whether through regulation or policy, participation in restoration activities, management of stormwater runoff, or communication of the Bayou La Batre Watershed restoration message. This audience includes:

- Local government officials (e.g., Mobile County Commissioners, City of Bayou La Batre Mayor, City of Bayou La Batre City Council members, and other regional administrators)
- Private industry
- Academia
- Local resource managers (e.g., utilities, BLB Utility Board, etc.)
- Media (newspaper, radio, TV, and online)
- Community leaders

10.6.4.2 Targeted Audiences - Messaging & Tailored Implementation Initiatives

This section includes particular messages to communicate to important audiences within the Watershed and suggested initiatives to encourage action by these targeted audiences:

➢ **Local Government Officials** - Local elected officials and their staffs are responsible for establishing priorities for local programs, developing policy, and setting annual budgets. These roles can influence the scale and direction of BLB Watershed restoration. The targeted value message for this stakeholder group is:

The WMP will provide local government officials with a vision to unify the communities in the BLB Watershed around a concept – restoring the Bayou La Batre Watershed will revitalize the local community and provide access to a historical and productive waterway. The WMP also provides the necessary information to guide wise decisions related to recreational access and economic development, while ensuring protection of environmental resources.

<u>Local Government Officials can</u>*:*

- Review and adopt the Bayou La Batre Watershed Management Plan (BLB City Council).
- Make implementation of WMP recommendations priorities for City planning.
- Ensure stricter enforcement of regulations related to littering and policing of frontage areas.
- Implement short-term and log-term strategies as suggested in Section 7.
- Facilitate the review and approval of permits associated with the proposed WMP BMPs in a timely manner.
- Consider the establishment of an overlay district within the Watershed area to channel a portion of taxes generated by local industry to Watershed restoration.
- Work with state and federal agencies to align projects and priorities.
- Explore a local disposable bag fee. This would entail passing legislation requiring all businesses selling food and/or alcohol to charge customers five cents for each disposable plastic bag. The businesses would retain one cent per bag and the remaining four cents would be put in a fund for BLB restoration and maintenance, implementation of watershed education programs, trash collection, and retention projects, and distribution of reusable bags. Several cities have implemented this policy (e.g., Washington, DC's Anacostia River Cleanup and Protection Act initiative - "Skip a Bag, Save the Creek"). The initiative would incentivize the use of reusable bags and aid in litter removal and education.
- Investigate opportunities to foster watershed community pride.
- Examine funding watershed signage:

    - Historical and cultural signage – post signs documenting specific moments in history and the role the Bayou played (i.e., Historic activities, biographies of local historical figures, or other uses).
    - "Positive" ownership signs – positively connect residents with the BLB watershed (e.g., "Keep Our Bayou Clean" or "Create a Clean Water Future") rather than "Don't Litter."
    - Visual ways to explain the benefits of the Bayou and share the biological richness of the Bayou with people.
  - Host events (e.g., 5k races, public health fairs) at locations in the Watershed to celebrate the venue while promoting fitness, health, and community among area residents.
- **Private Industry –** Success is more likely with a broad range of financial supporters. Thinking innovatively and demonstrating support from an active and diverse group of private stakeholders will attract and match sources of federal, state, and local funding.

Major institutions along the Bayou should be motivated to support its restoration because:

- All businesses near the Bayou will benefit from its restoration.
- More foot traffic will benefit small businesses.
- Business owners, employees, and citizens will enjoy improved surroundings that will create a better living environment and increase satisfaction and pride in their community.
- Businesses can enhance their public image by demonstrating support for restoring a local resource.

The targeted value message for this stakeholder group is:

The WMP recommends engagement opportunities for private industry in the implementation of projects to support their surrounding community, local workforce, and economy, while promoting their company image and goodwill.

<u>Private industry can</u>:

- Seize opportunities to become involved in recommended action items (see **Section 7**) near their businesses. For example, businesses along Shell Belt Road can work with the City to beautify the roadway near their facilities and encourage the development of a multi-user trail. Parts of commercial property that are not used for operations can be landscaped with native habitat to help soften commercial areas with landscaping pockets. This benefits not only habitat and water quality, but attracts ecotourism to bolster the economy.
- Fund components of other recommended BMPs throughout the Watershed.
- Highlight sponsorship information on signs or plaques.
- Donate materials for trail development (e.g., local nurseries, landscapers, boat launches, and landscape architects donating materials and planting native plants along the trail).
- Provide construction services and equipment for project implementation.
- Build partnerships with the MBNEP and non-government organizations to become more engaged and learn about other ways they can participate in Watershed restoration.

- **Academia** – Local schools and regional institutions of higher education provide opportunities to inform students about issues in their own backyards. Teachers and instructors can introduce their students to WMP concepts (e.g., dynamics and impacts of littering, stormwater management benefits, and water quality impairments). The targeted value message for this stakeholder group is:

The WMP presents extensive scientific and technical data about the current status of the BLB Watershed and measures to improve conditions that can be utilized as educational tools for all levels of curriculum. The WMP also identifies data gaps that can provide opportunities for academic fieldwork that benefits local resources.

Academic institutions can:

- Develop multiple curriculums for grades K-12 and beyond.
- Create grade school field trip opportunities to the Bayou and its tributaries.
- Identify research and implementation opportunities, including fieldwork and data collection with relevant departments at local colleges and universities. Include restoration initiatives in their curricula when possible.

- **Area Resource Managers** – Area resource managers provide services to the Mobile County and City of BLB residents, including water supply and wastewater treatment. These managers can assist in guiding water quantity and quality management within the Watershed. The targeted value message for this stakeholder group is:

The WMP recommends actions that can be taken to improve water quantity and quality for the BLB Watershed, such as reducing stormwater pollutants, eliminating sanitary sewer overflows, reducing the amount of trash in waterways, and increasing the public's understanding of human impacts on water resources.

Local resource managers can:

- Continue efforts to eliminate illicit wastewater connections and sanitary sewer overflows into groundwater, creeks, and tributaries within the Watershed.
- Maintain their involvement in Watershed restoration efforts.

- **Media** – Newspapers, television news programs, online news sources, and radio stations are significant sources of information for the public. The targeted value message for this stakeholder group is:

The WMP provides the background to a story of possibility for the communities in the BLB Watershed and a vision supported by the public to revitalize the area and provide access for all residents to a beautiful natural resource within the City of BLB and Mobile County.

Local media can:

- Publish stories that highlight the WMP and its recommended actions.
- Create a news series describing developments of BLB Watershed restoration post-WMP.
- Advertise any cleanup or anti-littering events and/or campaigns.

- Highlight involvement of local leaders in BLB Watershed restoration.

Community Leaders (neighborhood associations, community action groups, faith-based organizations, residents, etc.) – Community leaders play a vital role in improving Watershed conditions through actions such as litter reduction campaigns, sharing restoration ideas, and demanding that elected officials prioritize Watershed restoration. The targeted value message for this stakeholder group is:

The WMP represents a community-based approach to protect water quality, habitat, and living resources of the BLB watershed with the goals of improving recreational opportunities, beautifying the area, and highlighting historical and cultural aspects of the watershed.

Community leaders can:

- Host/co-host cleanup events.
- Work to create and launch neighborhood anti-littering campaigns.
- Promote the Bayou as a neighborhood location for recreational activities (e.g., walks/runs for charity, kayak/canoe clean-up events).
- Educate residents on the benefits of restoration to their properties.
- Demand that elected officials prioritize Watershed restoration.

10.6.4.3 Future Leadership Structure – Bayou La Batre Watershed Partnership

The MBNEP and the WMP Team have already identified and involved many key community leaders in this project; therefore, the concept is not to identify additional leaders to engage, but rather, how to structure the existing group moving forward. While the MBNEP has led the effort to initiate the restoration of the Watershed, future efforts and project implementation must be rooted within the community.

The mission of the MBNEP is to promote wise stewardship of water quality and living resources of the Mobile Bay area. The BLB Watershed is a part of this area. In order to support its mission and its role in the community, the MBNEP chooses to promote watershed planning, hence the development of this WMP. The MBNEP recognizes the critical importance of restoring the Watershed, but an independent leadership organization is needed to coordinate WMP implementation in close collaboration with the MBNEP.

Suggestions for BLB Watershed Partnership initiatives:

- Develop a vision, mission, bylaws, and leadership structure based on current Watershed restoration involvement.
- Work with local governmental officials and regulators to implement the recommended WMP projects.
- Provide opportunities for public involvement (i.e. cleanup events) and membership.
- Organize and coordinate the training of volunteer Estuary Coordinators on a wide variety of environmental topics (e.g., water quality monitoring and data collection training) and utilize their skills for various watershed efforts.

- Host meetings with community groups and other neighborhood associations to equip them with knowledge and materials for creating anti-littering campaigns and for hosting their own cleanup events. The MBNEP should advertise itself as a resource for planning purposes and materials.
- Collaborate with citizen groups like Alabama Water Watch, to promote stewardship efforts in restoring the Watershed. This citizen volunteer water quality-monitoring program addresses water quality issues for both urban and rural watersheds throughout Alabama through citizen-based action enabling people to gather their own environmental data to address local issues.
- Promote the Watershed as a location for recreational activities (e.g., walks/runs for charity, kayak/canoe cleanup events).
- Hold recurring meetings with area media professionals (e.g., The Mobile Press-Register, Lagniappe, other publications, and local television news programs) to educate them about watershed management; provide information on events, pictures, and other descriptive materials; and update them on new developments and opportunities for public engagement.
- Generate media releases once a month on Watershed activity.

11 Monitoring Program

The monitoring program is designed to assess and document the overall health of the Bayou La Batre Watershed, while providing a quantitative method that helps to establish trends intended to identify successes and failures of the implemented management program. The monitoring program is designed to assess the entirety of the study area in a time and cost efficient manner, while also providing sufficient and concise data, which is necessary to identify possible sources and localities contributing to current and future water quality degradation within the Watershed.

The monitoring program should incorporate the outlined framework identified in the *Mobile Bay Subwatershed Restoration Monitoring Framework* (**Appendix F**) as recommended by the MBNEP's Science Advisory Committee: Monitoring Working Group, 2015. This document identifies sampling protocols for sedimentation and flow, water quality, habitats and biological communities. It also makes recommendations on desired outcomes, efficiencies, and data utilization and storage.

11.1 Monitoring

Following approval of the Watershed Management Plan, the SMCCDC should implement a monitoring program that should be performed by qualified professionals in accordance with the *Mobile Bay Subwatershed Restoration Monitoring Framework* , and state and federal Standard Operation Procedures (SOPs). The monitoring events will include quantitative measures and collection for chemical analysis of analytes (**Section 11.1.0**) contributing to the identified and to unidentified water quality issues. Monitoring events should be conducted during similar time periods and environmental conditions each quarter to promote consistency of collected data. Permanent monitoring stations should be established and identified (**Section 11.3**) to further assure consistency over the life of the monitoring and management program.

A biological assessment should be conducted concurrently (**Section 11.2.1**) with the water quality monitoring program to further assess the overall health of the Bayou La Batre Watershed. The biological assessment component should provide an additional tool in identifying the successes and failures of the management program.

A shoreline assessment within the watershed monitoring program study area should be conducted to observe and document the successes and failures of the living shoreline restoration programs designed to reduce coastal erosion and increase coastal marsh communities.

Data collected during the monitoring program will be compiled, analyzed, and presented to all local, state, and federal agencies involved in the management program. The Annual Report will include a discussion, analysis and presentation of all data gathered in conjunction with the quarterly monitoring program. All data and reports will be provided annually to all involved agencies as paper and electronic copies. An interactive Geographic Information Systems (GIS) dataset should be compiled and developed to facilitate electronic mapping and data query.

11.2 Watershed Conditions and Analytical Parameters

The conditions of the Watershed can be assessed through the quarterly monitoring program. Quarterly monitoring will involve the collection and analysis of the following water quality parameters: Sediment loading and turbidity (**Section 11.2.2**), total nitrogen (**Section 11.2.3**), dissolved inorganic nitrogen (**Section 10.2.4**), total phosphorus (**Section 11.2.5**), dissolved inorganic phosphorus (**Section 11.2.6**), chlorophyll-a (**Section 11.2.7**), bacteria (**Section 11.2.9**), total organic carbon (**Section 11.2.11**), and metals (**Section 11.2.12**). Additionally, standard field parameters (**Section 11.2.1**) will be measured at each monitoring station, including dissolved oxygen, pH, conductivity, and temperature. At locations where there is sufficient water depth, data collection of dissolved oxygen, salinity and temperature should occur at varying water levels to produce a depth profile of existing conditions (**Section 11.2.8**). Observation of coastal shoreline conditions should also be conducted during monitoring (**Section 11.2.13**) and include comparative photographs and aerial photointerpretation of Digital Orthographic Quarter Quadrangles (DOQQs) as available to assess erosion and sedimentation.

11.2.1 Standard Field Parameters

Standard field parameters are basic *in situ* measurements of parameters that should be conducted concurrently with sampling of all other laboratory analytical parameters described in **Section 11.2**. These parameters should, at a minimum, include measurements of temperature, dissolved oxygen, pH, specific conductance, salinity, and turbidity.

11.2.2 Sediment Loading and Turbidity

Sedimentation is a natural part of aquatic ecosystems, but the quantity and composition of the sediment can have a variety of effects on the integrity of the ecosystem. Excessive suspended sediment can create turbid plumes of discolored water, as well as significant deposition in downgradient locations from the source. The suspended sediment can have a variety of biological effects on fish, invertebrates, and aquatic vegetation. Anthropogenic sources of sediment and turbidity include agriculture, livestock, channels, eroded embankments, logging, construction, landslides, prescribed burning and overburden spoil cells. Locations of potential sources should be identified and proper management activities should be initiated to prevent excessive sedimentation in aquatic ecosystems. Quarterly monitoring should provide a means to identify contributing sources.

11.2.3 Total Nitrogen

Total nitrogen includes important compounds and elements for living organisms. Nutrients are considered elements that are essential to plant growth. Many anthropogenic and natural processes can produce various forms of nitrogen compounds. These processes can contribute to excess concentrations of nitrogen compounds in waterbodies and waterways. Excess amounts of nitrogen compounds can lead to depleted dissolved oxygen levels, which may have varying degrees of stress on the impacted ecosystem. Total nitrogen is the sum of total Kjeldahl nitrogen and nitrate-nitrite. Total nitrogen can be calculated by measuring organic nitrogen, free-ammonia, and nitrate-nitrite individually, and adding the components together. Quarterly monitoring should provide a means to identify contributing sources.

11.2.4 Dissolved Inorganic Nitrogen

Nutrients are considered elements that are essential to plant growth. Nitrogen is considered a limiting nutrient in aquatic ecosystems. Dissolved inorganic nitrogen is commonly reported as the sum of nitrite, nitrate and ammonia. Nitrite, nitrate and ammonia can have adverse effects on water quality and in certain concentrations, can be toxic to aquatic organisms. Primary production can be affected by the access presence of dissolved inorganic nitrogen and can drive the accumulation of algal and plant biomass. An anthropogenic source of nitrogen includes water treatment effluents, industrial effluents, municipalities, agriculture, pasture and rangeland, septic systems and residential lots. Locations of potential sources should be identified and proper management activities should be initiated to prevent the introduction of excess dissolved inorganic nitrogen into aquatic ecosystems. Quarterly monitoring should provide a means to identify contributing sources.

11.2.5 Total Phosphorus

Like nitrogen, phosphorus is considered a limiting nutrient in aquatic ecosystems. Many anthropogenic and natural processes can produce various forms of phosphorus compounds. These processes can contribute to excess concentrations of phosphorus compounds in waterbodies and waterways. Excess amounts of phosphorus compounds can lead to depleted dissolved oxygen levels, which may have varying degrees of stress on the impacted ecosystem. Total phosphorus is calculated using a series of laboratory techniques. Quarterly monitoring should provide a means to identify contributing sources.

11.2.6 Dissolved Inorganic Phosphorus

Nutrients are considered elements that are essential to plant growth. Phosphorus is considered a limiting nutrient in aquatic ecosystems. Dissolved Inorganic Phosphorus is a form of phosphorus that is necessary for plant growth. Sources of inorganic phosphorus include soil, rocks, fertilizers, and disturbed lands. Anthropogenic sources are primarily agricultural. Locations of potential sources should be identified and proper management activities should be initiated to prevent the introduction of excess DIP into aquatic ecosystems. Quarterly monitoring should provide a means to identify contributing sources.

11.2.7 Chlorophyll-a

Chlorophyll-a is a plant pigment produced by algae. Chlorophyll-a is an indirect measure of the ability for vegetation to utilize available nutrients. Quantitative analysis for the presence of Chlorophyll-a is a common method for quantifying algal biomass. Tracking the concertation of chlorophyll-a within the Watershed should provide insight into whether management techniques are adequately limiting the amount of nutrients entering the Watershed. Quarterly monitoring should provide a means to identify contributing sources.

11.2.8 Dissolved Oxygen, Salinity, and Temperature Profiling

Dissolved oxygen, salinity, and temperature are considered standard field parameters and have already been discussed in **Section 11.2.1**. In situ measurements of these parameters should be conducted at specific depth intervals at select monitoring locations concurrently with all other quarterly monitoring activities. Conducting depth interval monitoring will provide a water quality profile and allow for analysis of stratification layers within aquatic ecosystems in the Bayou La Batre Watershed. Water quality profiling will provide an additional tool for further evaluation of the health of the entire Watershed.

11.2.9 Bacteria

Bacteria are naturally present in healthy aquatic ecosystems and are a crucial contributor to the nitrogen cycle that is vital to the life of organisms. The type of bacteria species and concentration of bacteria present in an aquatic ecosystem vary and are dependent on limiting factors, such as nutrient concentration. Anthropogenic sources of bacteria can include birds, cattle and various other wildlife that are utilizing resources within the watershed area of a particular aquatic ecosystem. Excessive levels of bacteria can indicate elevated nutrient concentrations while diminished bacteria levels can indicate an unhealthy ecosystem. Locations of potential sources should be identified and proper management activities should be initiated to prevent the introduction of unhealthy bacteria species and excessive or diminished bacteria concentration into aquatic ecosystems. Quarterly monitoring should provide a means to identify contributing sources.

11.2.10 Biological Assessments

Biological assessments assist in evaluating the health of aquatic ecosystems by observing stressors that may contribute to short term and long term effects that cannot be assessed strictly by water quality monitoring. Biological assessments should be conducted using state or federally approved standards for assessing aquatic organisms, such as the EPA approved Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Biological assessments should be conducted at the water quality sampling locations (**Figure 11.3**) established by the Alabama Department of Environmental Management (ADEM). The biological assessment will be a critical component in determining whether the goals of the WMP are being successfully met through the management activities established in the WMP.

11.2.11 Total Organic Carbon

Organic carbon consists of compounds that are naturally present in typical aquatic ecosystems. Sources of organic carbon originate from natural organic matter and from anthropogenic sources. Organic carbon originating from anthropogenic sources can create conditions where concentrations can be present at levels exceeding typical background values. Sources of organic carbons include petroleum based chemicals and pesticides. Elevated organic carbon may promote excessive algae growth and reduced dissolved oxygen concentrations. Locations of potential sources should be identified and proper management activities should be initiated to prevent the introduction of excess organic carbon into aquatic ecosystems. Quarterly monitoring of total organic carbon should provide a means to identify contributing sources.

11.2.12 Metals

Metals in the environment can derive from both natural and anthropogenic sources. Some metals are common and can be essential nutrients to aquatic organisms. While some metals are necessary for survival, all metals have the ability to be toxic at particular concentrations. Metals present in toxic concentrations can have adverse effects on the survival, reproduction, and behavior of aquatic organisms. Metals commonly present in water bodies that may cause adverse effects include arsenic, cadmium, chromium, lead, inorganic mercury, nickel, selenium and zinc. Anthropogenic sources of metals can include mines, firing ranges, waste treatment facility outfalls, various industrial activities, urban runoff, landfills, and junkyards. Locations of potential sources should be identified and proper management activities should be initiated to prevent the introduction of unnatural sources of metal into aquatic ecosystems. Quarterly monitoring should provide a means to identify contributing sources.

11.2.13 Coastline Assessment

Coastline habitats serve as nursery habitat for coastal finfish and shellfish (such as speckled seatrout, redfish, Atlantic croaker, shrimp, and blue crabs). Proposed restoration programs discussed in **Chapter 6** are designed to restore the growth of coastal marsh by employing living shoreline techniques that utilize natural and/or artificial breakwater material to dampen wave energy to protect shorelines, while also providing habitat and increasing benthic secondary productivity. Construction activities for the proposed ecosystem restoration will involve living shoreline projects that include placement of intertidal breakwater materials. Assessment of these programs should be included within the monitoring program to assure that management techniques are achieving their intended goals and objectives. Additional erosional areas of shoreline should be observed and documented for future consideration in restoration programs. Assessments can be conducted by establishing permeant photo stations. Photographs should be taken periodically in the same orientation as those taken during previous monitoring events. Historical, current, and future DOQQ imagery can also be used to analyze erosional and depositional areas along the shoreline.

11.3 Sample Collections Locations

The monitoring program is designed to assess the entirety of the Bayou La Batre Watershed in an efficient manner and therefore, sampling locations were strategically identified and selected to provide a detailed analysis of the integrity of the entire Watershed. Twelve (12) monitoring stations were established by Alabama Department of Environmental Management (ADEM) and will continue to be monitored as part of the monitoring program. Six (6) additional monitoring stations have been established as part of the volunteer monitoring program discussed in **Section 11.6**. All 18 monitoring locations are presented in **Table 11.1** and include the Sample ID and the Geographic Position (Latitude/Longitude) of each sampling location. A location map depicting the location of the sample collection locations are included as **Figure 11.1** ADEM Monitoring Stations and **Figure 11.2** Volunteer Monitoring Stations.

Table 11.1 Sample Collection Locations

	Geographic Position	
Sample ID	Latitude	Longitude
ADEM Station BBM-1	30.383	-88.272
ADEM Station BLBM-1	30.387	-88.270
ADEM Station BBM-3	30.396	-88.265
ADEM Station BLBM-2	30.397	-88.260
ADEM Station BBM-5	30.399	-88.258
ADEM Station BBM-6	30.404	-88.256
ADEM Station BLB-1	30.406	-88.248
ADEM Station BLBM-3	30.407	-88.247
ADEM Station BBM-9	30.405	-88.241
ADEM Station BLBM-4	30.406	-88.225
ADEM Station HMC-1	30.428	-88.231
ADEM Station HMC-2	30.458	-88.240
Volunteer Station #1	30.411	-88.255
Volunteer Station #2	30.416	-88.264
Volunteer Station #3	30.448	-88.244
Volunteer Station #4	30.455	-88.258
Volunteer Station #5	30.472	-88.266
Volunteer Station #6	30.476	-88.250

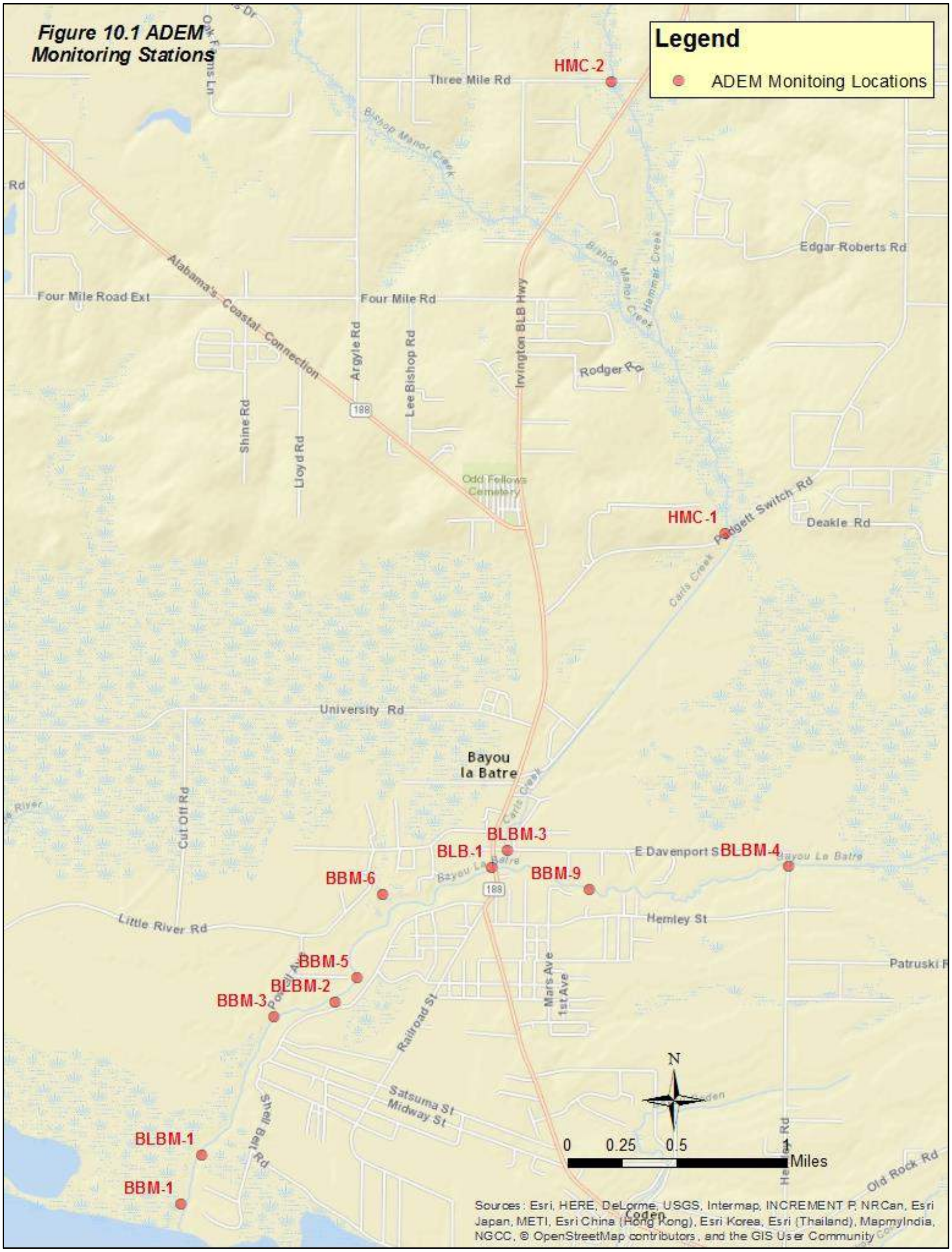


Figure 11.1 Monitoring Stations

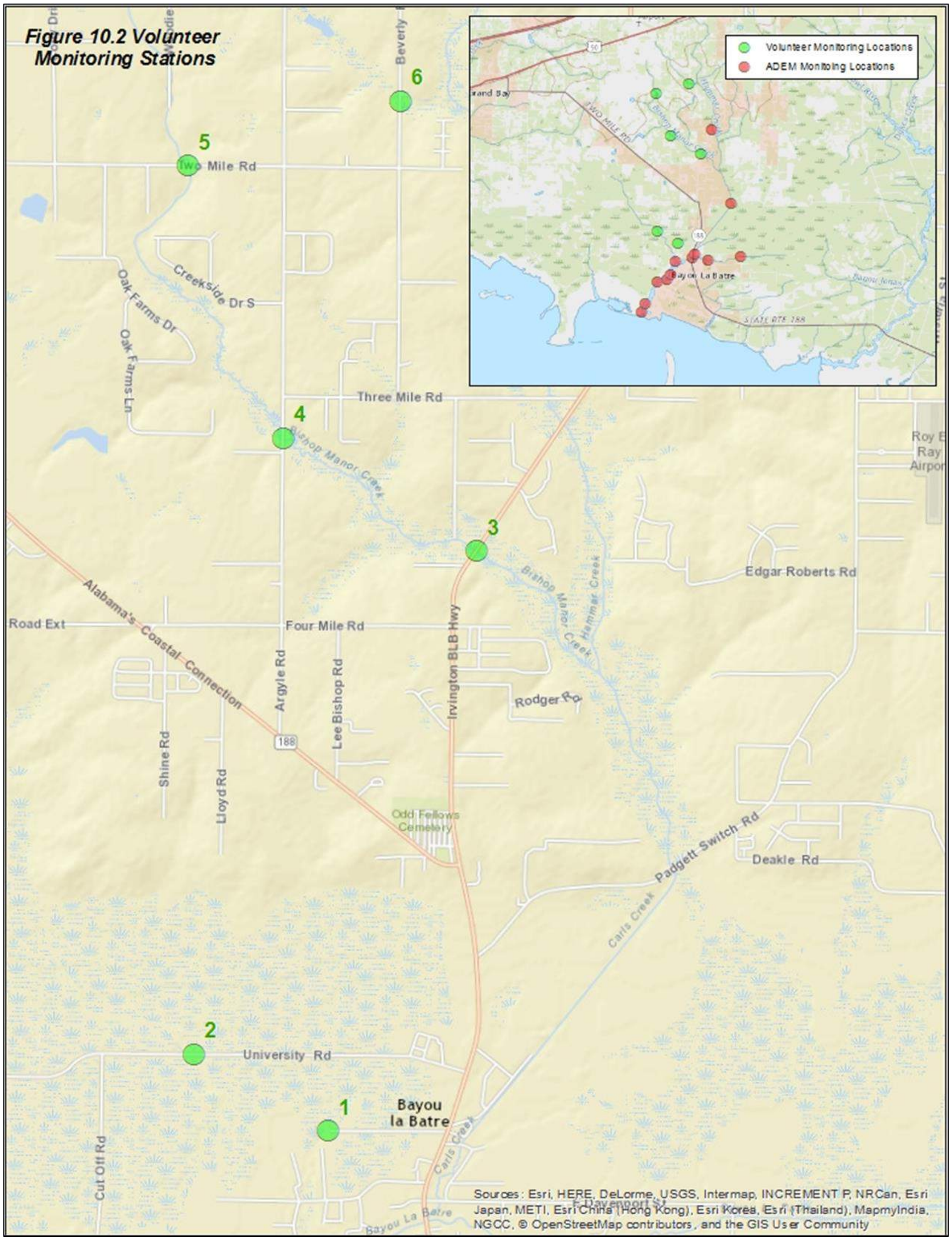


Figure 11.2 Volunteer Monitoring Stations

11.4 Implementation Schedule

The implementation schedule for the WMP should be prepared and maintained by the SMCCDC and WPIT. The schedule should provide a detailed breakdown of the scope of work addressing every major and minor component of the watershed-monitoring program. The schedule should provide a clear timeline for completion of each program measurement. The schedule should include projected initiation and completion dates for each measure, and the personnel responsible for delivery of the task. Direction and timeline for submittal of data should be included. The implementation schedule should be reviewed annually and adjusted as necessary. The schedule will serve as an important resource in assessing the status and success of the monitoring program.

11.5 Stakeholder Volunteer Monitoring Program

Two important components of WMP implementation are monitoring and citizen engagement. Monitoring is recommended to continue to document the condition of the Watershed and track the success or failure of implemented planning strategies. Stakeholder participation is important as engaged citizens can assist and support WMP implementation. One way to combine these two important components is to create a volunteer monitoring program. The goal(s) of the monitoring program should be defined based on potential or known threats to water quality identified in this WMP. Benefits of a volunteer monitoring plan include:

- Empowering stakeholders to use monitoring data for education, restoration and protection and advocacy.
- Fun and meaningful volunteerism that fosters stewardship and a sense of community ownership within the Watershed.
- A well-planned monitoring program may uncover previously unknown water quality problems and help answer important questions to shape solutions.

In order for citizen data to be credible and respected, it needs to be accepted by federal and state agencies. Fortunately, Alabama has a statewide volunteer water quality organization with an Environmental Protection Agency approved Quality Assurance Plan: Alabama Water Watch. The WMTF should create or partner with an existing watershed organization to form a volunteer monitoring program. To ease the process of establishing a volunteer monitoring program, Mobile Bay National Estuary Program staff has created a "how-to" guide for coastal Alabama. Volunteer members should reference **Section 11.3** to obtain the geographic locations of the volunteer monitoring locations.

11.6 Adaptive Management

The monitoring program is designed to assess and document the overall health of the Bayou La Batre Watershed. The program is designed to assess the entirety of the Watershed area in a time and cost efficient manner, while also providing sufficient and concise data, which is necessary to identify possible sources and localities contributing to current and future water quality degradation within the Watershed. The approved monitoring program may encounter instances where data analysis is not correlating with physical observations and biological assessments of the Watershed. In such a case, the monitoring program should be reevaluated and adaptive management implemented to assess if and where data-gaps may be occurring. Additionally, reevaluation of the management plan and management techniques may be necessary to achieve the goals established in the WMP and monitoring program.

11.6.1 Introduction and Purpose

Watersheds are dynamic ecological and physical systems that are impacted by natural and anthropogenic events. Effectively managing them involves making decisions based on multiple, frequently-competing objectives that may be constrained by regulations, implementation capabilities, available resources, and uncertain responses to management actions.
Adaptive management is a systematic approach to improving management decisions by gathering information and learning from outcomes to guide future management decisions. This approach focuses on partnerships of stakeholders who together learn how to create and maintain sustainable resource systems.

11.6.2 The Role of Stakeholders

Stakeholder engagement and input are essential to success in virtually every stage of the adaptive management process; methods to encourage this continued involvement are detailed in Section 8. These stakeholders include the previously identified Steering, Engagement and Technical Committees, as well as interested members of the public, who should continue to serve in collaborative and advisory roles during implementation. The adaptive management process proposed for the Bayou La Batre Watershed promotes stakeholder and project implementation team collaboration by:

- Bolstering the level of stakeholder knowledge and science in the watershed,
- Setting programmatic goals and resource management objectives,
- Guiding the selection and development of the management actions that will be incorporated in individual projects,
- Tracking the implementation of management actions in the watershed,
- Guiding the development of adjustments to the implemented management actions to improve watershed outcomes,
- Assisting in the management and supervision of long-term O&M activities, and
- Garnering stakeholder support for the goals, strategies and objectives throughout the implementation process if adaptive management strategies are to work in practice.

Adaptive management requires the commitment of time and resources and the active engagement of stakeholders working to produce balanced, resilient and sustainable outcomes in the watershed. All phases of the adaptive management process must be open and transparent to stakeholders.

11.6.3 Adaptive Management Process

To implement the adaptive management process for the Bayou La Batre Watershed certain elements must be put in place, and then used in a cycle arriving at decisions by repeating rounds of discovery analyses to achieve the most desired result (See **Figure 11.3**). This section discusses each step in this process and the key activities to be undertaken.

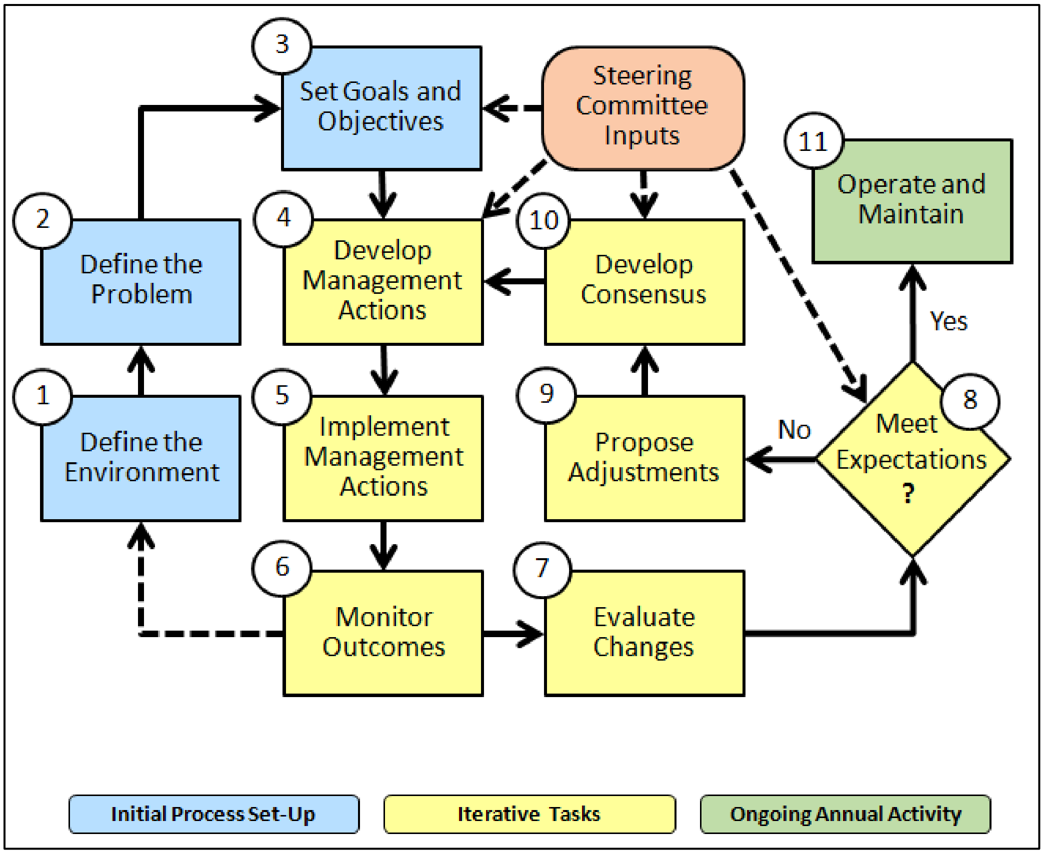


Figure 11.3 The adaptive management process being proposed by the Dewberry Team consists of 11 steps with linked interactions.

11.6.3.1 Step 1: Define the Environment

The multiple aspects of a natural system include its physical, environmental, regulatory, community, financial, cultural and political environments. These environments can be represented as temporal and spatial datasets that are frequently organized in GIS data platforms to facilitate data use and reduce analytical costs. Taken collectively, they provide the basis for identifying and solving problems and developing management solutions. Existing watershed data collected for the development of this WMP includes a GIS database (see Appendix A and Sections 2 and 3 of this document).

Key activities in the initial implementation cycle include:

- Acquire available and relevant information to provide a sound basis for managing the watershed, and
- Identify any data adjustments needed to effectively use the acquired data.

Key activities in successive iteration cycles include:

- Continuously update the environment with new data, and
- Maintain data to ensure that acquired data is readily accessible.

11.6.3.2 Step 2: Define the Problem

This plan identifies the problems and associated consequences in the watershed and prioritizes the problems to be addressed in management actions (see **Section 6**). Implementation of this plan will require initiation of measures, projects and further studies. In each case, a more in-depth evaluation of the specific problems being addressed will be necessary.

Key activities in the initial implementation cycle include:

- Collaborate with stakeholders to develop a consensus regarding the significance of the identified problems; identify additional problems that should be addressed and decide which problems can be potentially eliminated from consideration, and
- Identify additional data gaps that adversely impact the knowledge basis for the management effort.

Key activities in successive iteration cycles include:

- Revise the problem definition(s) as appropriate based on new data resulting from implemented management activities.

11.6.3.3 Step 3: Set Goals and Objectives

Adaptive management requires clear and agreed-upon goals and objectives that are specific, measurable, achievable, results oriented and time-fixed. These goals and objectives will be used to inform and guide decision-making for taking actions, developing assumptions, formulating expected outcomes, modifying implemented actions, ensuring overall value being received and success.

Objectives should not be “broad-brush” statements. Adaptive management itself is not designed to resolve conflicts about objectives. If the objectives are not clear and measurable, the adaptive framework is undermined.

Key activities in the initial implementation cycle include:

- Define goals and objectives in detail, using clear language, so that they are useful as guides for decision making and evaluation;
- Confirm that regulatory requirements, standards and design criteria are being addressed in the new restoration projects;
- Recognize that multiple objectives often exist and work to balance stakeholder interests in the selection of strategies and actions;
- Identify and prioritize critical uncertainties;
- Define the collective vision of stakeholders for the watershed after the identified problems have been addressed;
- Incorporate the social, economic and/or ecological values of stakeholders in the framing of objectives;
- Reach agreement on the definition of and criteria for a successful restoration;
- Ensure that objectives are measurable with appropriate field data, achievable, results-oriented and applicable over the timeframe of the project; and
- Modify goals, objectives and desired endpoints based on input from the stakeholders.

Key activities in successive iteration cycles include:

- Review the initial stakeholder vision to better reflect the insights derived from the implemented management practices,
- Adjust and/or further refine goals and objectives where necessary based on new data and information derived from the monitoring of outcomes, and
- Consider the current criteria being used to identify successful restoration outcomes and make adjustments where required.

11.6.3.4 Step 4: Develop Management Actions

Decision-making in adaptive management involves the selection of appropriate actions for each point in time guided by evolving knowledge and science. Managers have the responsibility of identifying the set of potential management actions from which strategies and implementation plans are developed. If these actions fail to produce intended results, adaptive management will be unable to produce informative strategies. It is often beneficial to consider and include alternatives that will produce different system responses that can be measured and evaluated.

There are many ways to design the process for selecting alternatives. Formal methods can be used to select options that best account for current and future consequences. Stakeholders and managers can sometimes rely on less-structured approaches or common sense to identify acceptable strategies. Decision making should be driven by the objectives and informed by resource status and process uncertainties.

Key activities in the implementation cycle of initial resource management strategies include:

- Determine alternative restoration strategies and approaches that meet goals and objectives,
- Develop appropriate performance measures,
- Bring stakeholders together during the development of management strategies, and encourage long-term collaboration,
- Compare and rank projected outcomes for management alternatives in selection of actions, and
- Predict expected outcomes based on the current state of knowledge.

Key activities in successive iteration cycles for project alternatives include:

- Define alternative strategies for new projects based on initial project outcomes measured relative to goals and objectives,
- Continue to bring stakeholders together during the development of management strategies and decision making practices, and
- Review predicted performance characteristics from prior iteration, and revise as appropriate.

11.6.3.5 Step 5: Implement Management Actions

When all relevant factors have been considered and a strategy developed to consensus, one or more alternatives can be implemented. Each management activity needs to be defined in terms of what will be done, when it will be done, capital investment needed, anticipated annual operation and management costs, and predicted outcomes/benefits.

Key activities in the initial implementation cycle include:

- Develop consensus with stakeholders early on regarding who will be responsible for the different aspects of implementing the selected management activities;
- Secure funding for initial construction and annual operating activities;
- Solicit proposals for implementing the selected management actions, select contractors and award contracts; and
- Adjust project plans as needed.

Key activities in successive iteration cycles, in addition to the work required in the initial iteration, include:

- Confirm that regulatory requirements, standards and design criteria are being addressed in the new restoration projects;
- Update the WMP to reflect successes and conclusion of the initial projects, and add any new implementation plans; and
- Adjust project plans as needed.

11.6.3.6 Step 6: Monitor Outcomes

Adaptive management is not possible without effective monitoring. Monitoring assesses watershed responses to management actions to inform better decisions and increase likelihood of success. By tracking implementation of management measures, monitoring programs enable project evaluation in adaptive management. Outcomes of management programs need to be measured for two distinct purposes:

- To establish performance points (baseline conditions) that can be used to measure progress and establish trends.
- To trigger change in management direction if performance does not meet objectives.

Monitoring provides the data from which to test alternatives and measure progress towards accomplishing objectives. Improved decision making justifies the cost of monitoring and assessment in adaptive management.

Key activities in the initial implementation cycle include:

- Develop and implement monitoring plans to assess progress toward goals and objectives,
- Align monitoring activities with any current stakeholder monitoring programs to the maximum extent possible, and
- Establish current baseline reference conditions in the watershed to compare to responses after project implementation.

Key activities in successive iteration cycles include:

- Continue targeted monitoring activities from the prior iterative cycle with approved adjustments, and
- Review and modify the implemented monitoring plans as necessary.

11.6.3.7 Step 7: Evaluate Changes

Evaluation of system changes improves understanding of resource dynamics. Assessing desired outcomes against actual outcomes can be used to evaluate the effectiveness of decisions and to measure success in attaining objectives. Ideally, the response to previous management actions can be assessed before a decision about the next management action is made. For example, the response of water quality to implementation of water quality BMPs in one year can be assessed in time to inform the selection of the next cycle of BMPs.

Key activities in the initial implementation cycle include:

- Review monitoring data and compare expected outcomes against actual outcomes,
- Evaluate progress of improvements related to the implemented management actions,
- Identify approaches for reducing uncertainty and improving choices of management activities through time, and
- Develop processes for evaluating alternative management approaches.

Key activities in successive iteration cycles include:

- Continue assessment activities from the prior iterative cycle with approved adjustments,
- Identify which management practices had unrealistic or unobtainable initial performance predictions, and
- Evaluate the BMP priorities in future management projects going forward.

11.6.3.8 Step 8: Determine if Meeting Expectations

Adaptive management allows managers to determine systematically whether implemented projects are succeeding or failing to achieve objectives. Consequently, it is important to determine how the actual outcomes measured in the field compare to predicted outcomes. Metrics and the criteria for success in meeting implemented resource management objectives are commonly established by one of two methods:

- Compliance with regulatory criteria and standards
- Consensus of the stakeholders participating in and/or funding the process.

If performance meets or exceeds expectations:

- Determine the management practice to be a success.
- Document the final configuration of components and practices for use in upcoming opportunities.
- Transition the practice status from “adjustment and testing” to “operating and maintaining.”

If performance fails to meet expectations:

- Make adjustments based on assessments and best available data.
- Continue monitoring performance/outcomes.
- Re-evaluate changes in performance/outcomes.

Key activities in the initial implementation cycle include:

- Determine if data is sufficient to decide whether success was achieved;
- If inadequate information exists, examine the data and estimate how much more is needed to decide if success can be achieved; and
- If adequate information exists, share the information with the Steering Committee, schedule a meeting, and collectively decide whether success has been achieved.

11.6.3.9 Step 9: Propose Adjustments

Management decisions can be revisited and adjusted over time. Decision making needs to be fact-based; otherwise, understanding of systems' behaviors cannot advance and learning cannot be applied to other opportunities.

At each decision point during implementation, actions can be adjusted. Appropriate actions are likely to change through time, as understanding evolves and the resource system responds to environmental conditions and management actions. It is the influence of reduced uncertainty on decision making that makes the decision process adaptive.

Key activities in the initial implementation cycle include:

- Use the monitoring results to identify which aspect(s) of the action is causing it to not meet its objective(s),
- Determine which aspect(s) of the action can be adjusted to best improve its performance during the next iterative cycle,
- Recommend one or more potential adjustments expected to improve the future performance of the action, and
- Develop consensus for the recommended adjustments and proceed with implementing those adjustments.

Key work activities in successive iteration cycles include:

- Evaluate the cost effectiveness of the action in terms of the cost per unit of benefit (e.g., $/pound of annual pollutant removal, $/acre of new public creek access, etc.) based on the use of monitoring data, and
- Adjust management actions over time as resource conditions change and understanding of the processes driving the system's responses increases.

11.6.3.10 Step 10: Develop Consensus

Although technical information and scientific understanding are required to assess tradeoffs and levels of risk associated with different management actions, the selection of an appropriate strategy requires building consensus. Stakeholder support of the programmatic goals and objectives helps to ensure that a management strategy works in practice. Consensus on goals and objectives at the beginning of an adaptive management project sets the stage for iterative, adaptive management cycles. However, consensus should continue through the life of the project.

Consensus is sustained by ongoing collaboration, through which any potential conflicts can be resolved. Consensus is promoted by collaboration and relationship building.

Key activities in the initial implementation cycle include:

- Develop a document that carefully defines the proposed changes in the management practice, and provide it to the
  Steering Committee so that all decision makers will be working from the same information;
- Conduct a collaborative workshop to develop consensus on the adjustments and timing of management activities based on resource status and ongoing information gathering.

Key activities in successive iteration cycles include:

- Strengthen working relationships with stakeholders to facilitate the best outcomes for the Bayou La Batre Watershed and receiving water bodies, and
- Continue to encourage stakeholders to commit time and energy to adaptively manage the resource.

11.6.3.11 Step 11: Operate and Maintain

The last step in successful adaptive management processes is the conversion from the experimental "what if we…" phase to the sustained operations phase. In some cases, particularly where water quality treatment infrastructure has continued operations, maintenance activities are required to maintain permitting compliance.

Key activities include:

- Continue operating the management practice under the "success" conditions,
- Provide ongoing maintenance as required to sustain performance levels,
- Continue to measure and document performance,
- Look for ways to reduce annual O&M costs (e.g., labor, electricity, fuels, chemicals), and
- Update the cost per unit benefit estimates.

11.7 Indications of Programmatic Success in Adaptive Management Process

Although "success" means different things to different people, indications of programmatic success in using the adaptive management process are likely to include:

- Stakeholders are actively involved and committed to the process.
- Progress is made toward achieving resource management objectives.
- Results from monitoring and assessment are used to adjust and improve management decisions.
- Implementation is consistent with applicable laws.

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