# Borrow Pits to Regional Detention along Magnolia River

## A Constructed Wetland Feasibility Study Report

Prepared for:

Baldwin County Soil & Water Conservation District
Town of Magnolia Springs
The Friends of Magnolia River Committee

BALDWIN COUNTY CONSERVATION DISTRICT

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February 2021

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# 1.0 INTRODUCTION

This report aims to objectively and rationally assess the feasibility of utilizing constructed wetlands in conjunction with regional detention for mitigation of flooding and improving resilience against future flooding resulting from sea level rise in the Magnolia River sub-watershed (Hydrologic Unit Code (HUC) 031602050203). The report also seeks to identify the strengths, weaknesses, opportunities, and threats present in the natural environment, the resources required to carry the project forward, and ultimately, the prospects for success for future similar sites along Magnolia River.

The Magnolia River sub-watershed is an agricultural-based basin with some urban influence that is encompassed within the overall boundary of the Weeks Bay Watershed, located in south Baldwin County, Alabama (**Figure 1.0**).

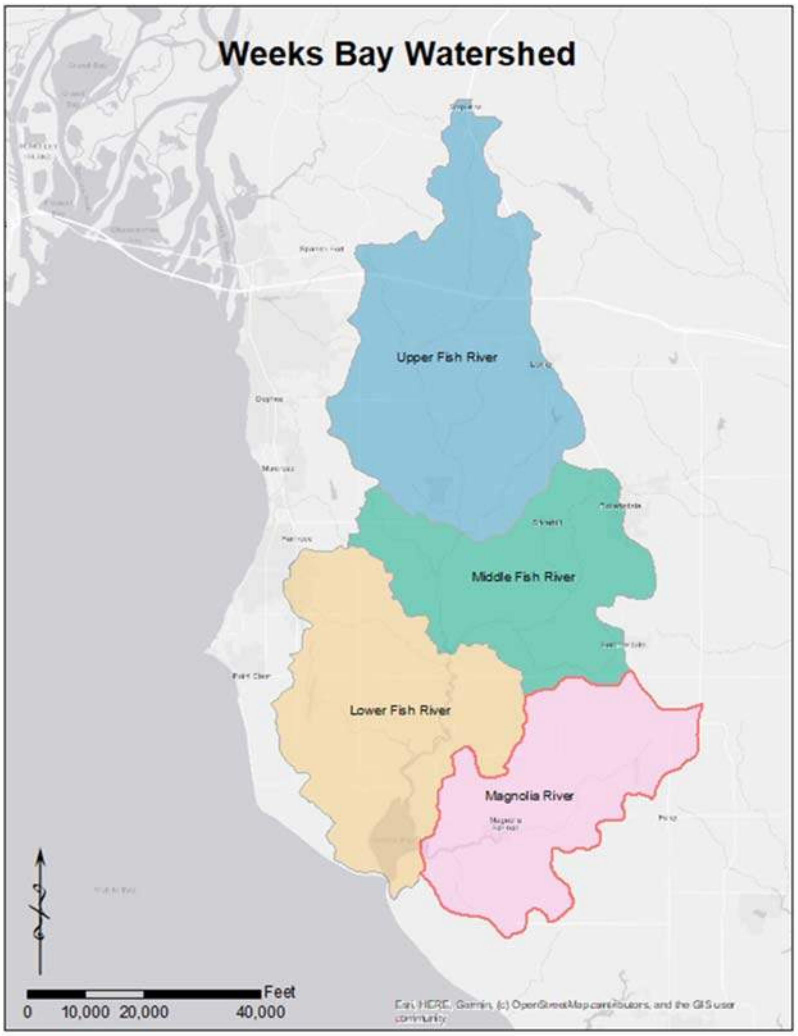



**Figure 1.0: Map of Sub-watersheds within Weeks Bay Watershed**

The need for flood mitigation within the sub-watershed was first recognized after a flood event that occurred on April 29, 2014. Over the course of nine hours, approximately 10-15 inches of rain fell over south Baldwin County (Maniscalo & Barry, 2019) leading to severe damage that permanently altered the characteristics of Magnolia River and surrounding tributaries. Some areas experience 22 inches of rain in a 29-hour period making this storm fall between a 100-year and 200-year frequency (1% and 0.5% chance annual probability, respectively).


**Figure 1.2: Image from April 2014 Flood Event Near Magnolia River**

The desire for flood mitigation was further expressed in the Weeks Bay Watershed Management Plan finalized in November of 2017. Flooding in this region was one of the greatest concerns expressed by citizens during the planning process.

# 2.0 EXISTING WATERSHED CONDITIONS

The Magnolia River sub-watershed encompasses the town of Magnolia Springs in its entirety, as well as portions of Baldwin County, the city of Foley, and the town of Summerdale (**Figure 2.1**). Its drainage area totals approximately 26,000 acres (approximately 41 square miles) and drains from northeast to southwest into Weeks Bay.

## 2.1 Land Use/Land Cover

Land use in the Magnolia River sub-watershed is dominated by the agricultural industry, specifically pastureland and row crops. Following agriculture, forested wetlands and evergreen forest are the next dominant land uses and are primarily found along the Magnolia River and its tributaries. Low intensity development is the most prevalent urban land use and is primarily located in the eastern and central portion of the watershed (**Figure 2.2**).

Development in the sub-watershed has spiked in recent years and is expected to continue as Baldwin County has become the fastest growing county in the state (Specker, 2019). It is reasonable to assume that lands currently used for agricultural purposes have the potential to be converted to residential and commercial use. **Figure 2.3** illustrates the percent impervious cover of the Magnolia Sub-watershed and the surrounding communities. The data used to create Figure 2.3 was gathered from the Multi-Resolution Land Characteristics Consortium (NLCS, 2016).

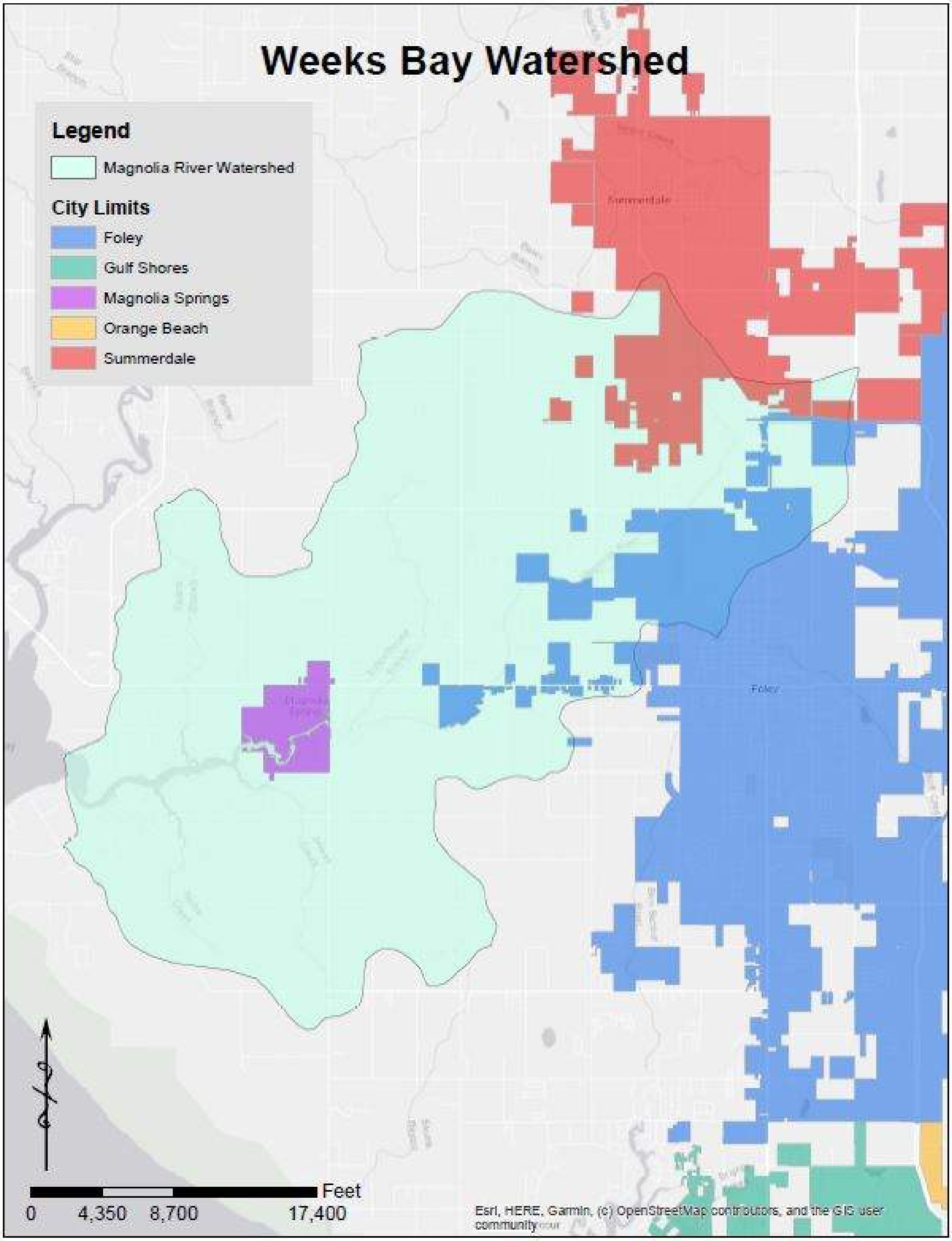



**Figure 2.1: Map Illustrating the Municipalities that are within the Magnolia River Sub-Watershed**

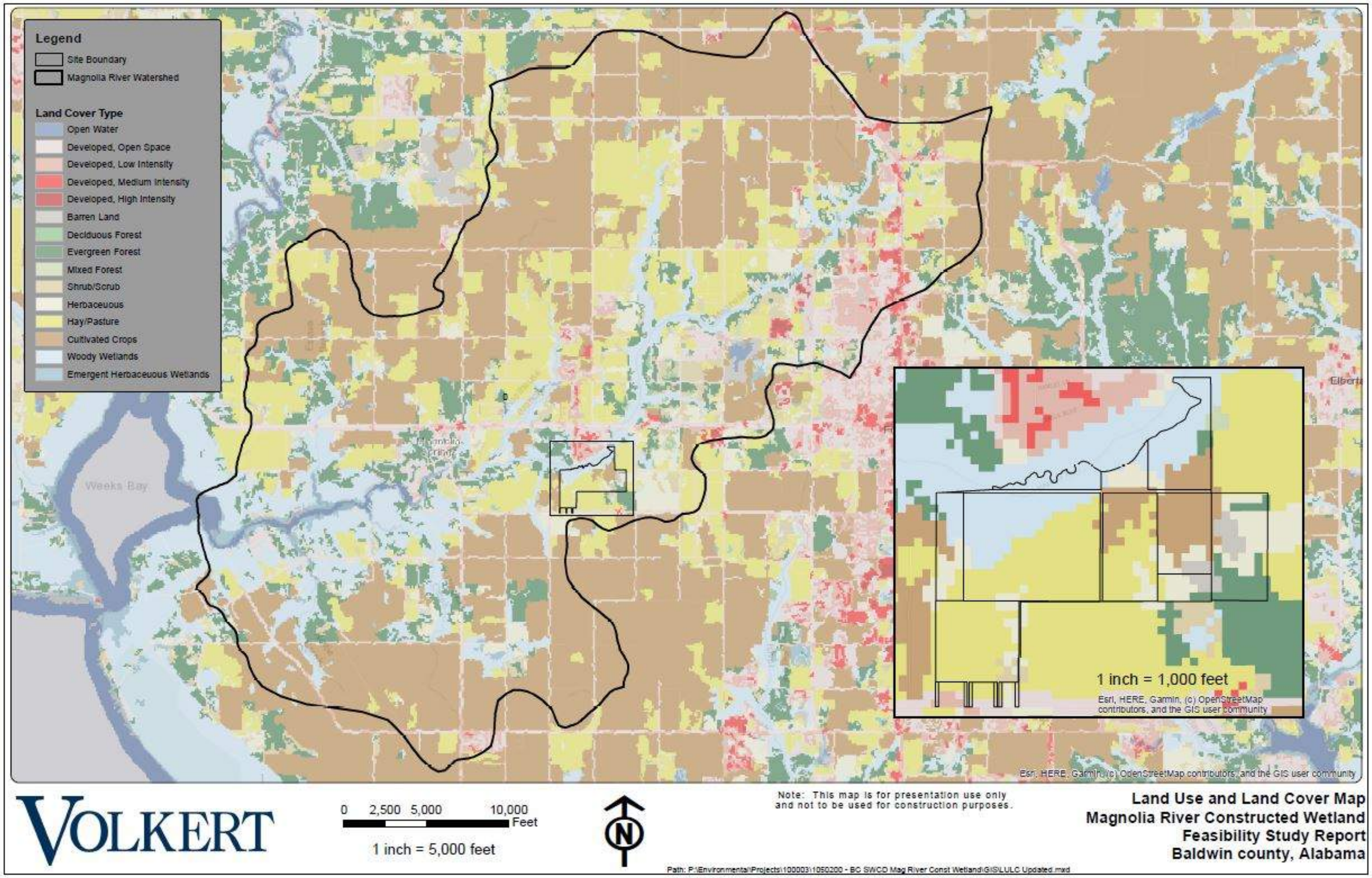



**Figure 2.2: Land Use Map of the Magnolia River Sub-watershed**

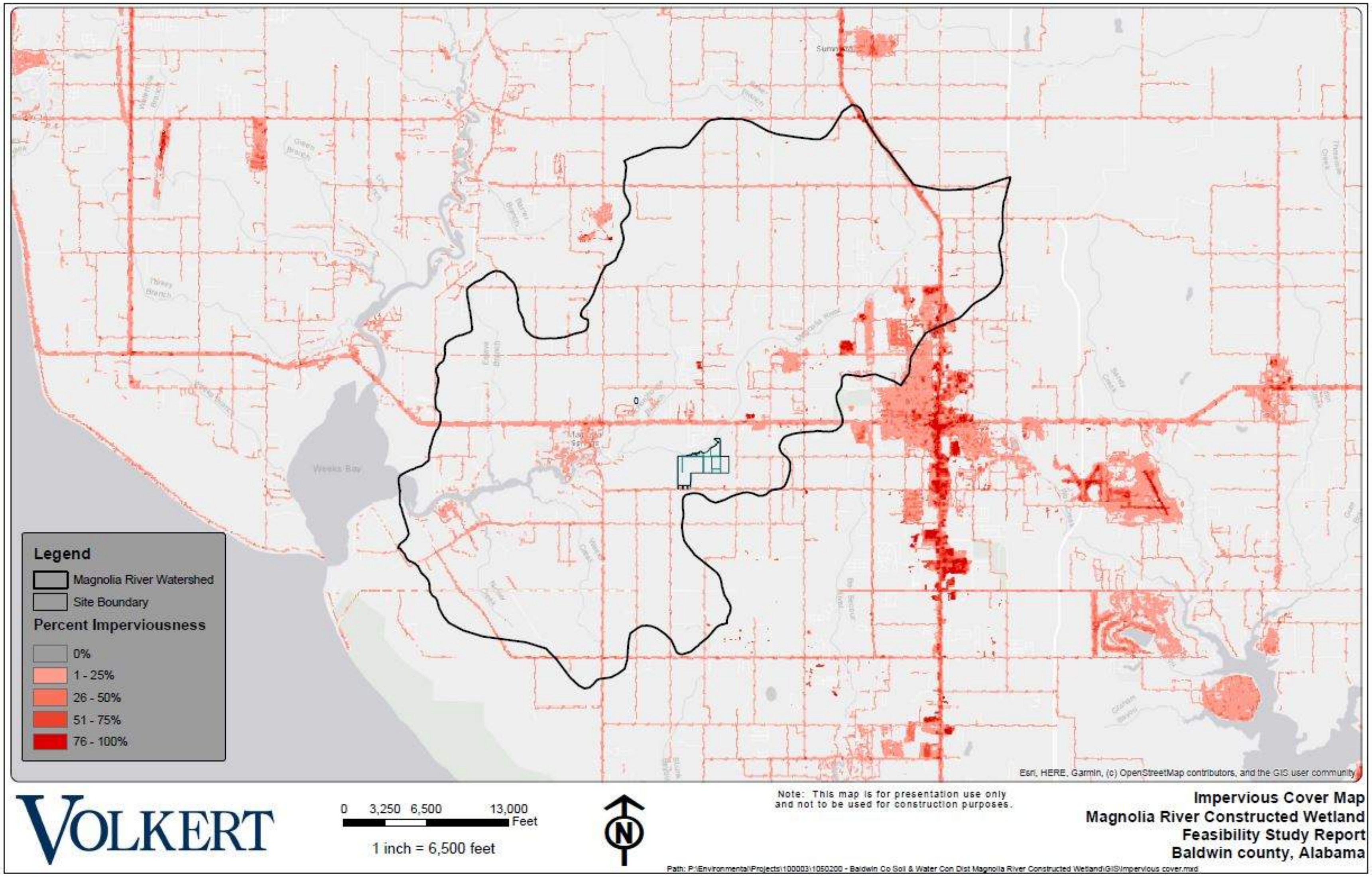



**Figure 2.3: Impervious Cover Map for the Magnolia River Sub-Watershed and Surrounding Communities**

## 2.2 Soils

Seventy-four soil types make up the Magnolia River sub-watershed. The soils are primarily composed of sandy loams and loamy sands. Because this feasibility study is focusing on flood mitigation and coastal resiliency**, Figure 2.4** reflects the hydrologic soil groups within the sub-watershed. Hydrologic soil groups by definition provide an index of the rate in which water infiltrates a soil and are used in hydrologic modeling. This data was obtained from the USDA Natural Resources Conservation Service's Web Soil Survey software.

## 2.3 Topography

The sub-watershed ranges in elevation from approximately five feet above mean sea level MSL at its lowest point to approximately 103 feet above mean sea level MSL at its highest point. The topography consists of gently sloping terrain that drains north, south, and southwest towards Magnolia River (**Figure 2.5**).

## 2.4 Floodplains

Portions of the sub-watershed are located within the Federal Emergency Management Administration's (FEMA) designated flood zone areas. **Figure 2.6** reflects the 500-year, 100-year, and regulated floodway designations for the sub-watershed. Areas located within the 500-year flood zone have a 0.2% annual chance of flooding. Areas within the 100-year flood zone have a 1% annual chance of flooding. Regulated floodways are the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights (FEMA, 2019).

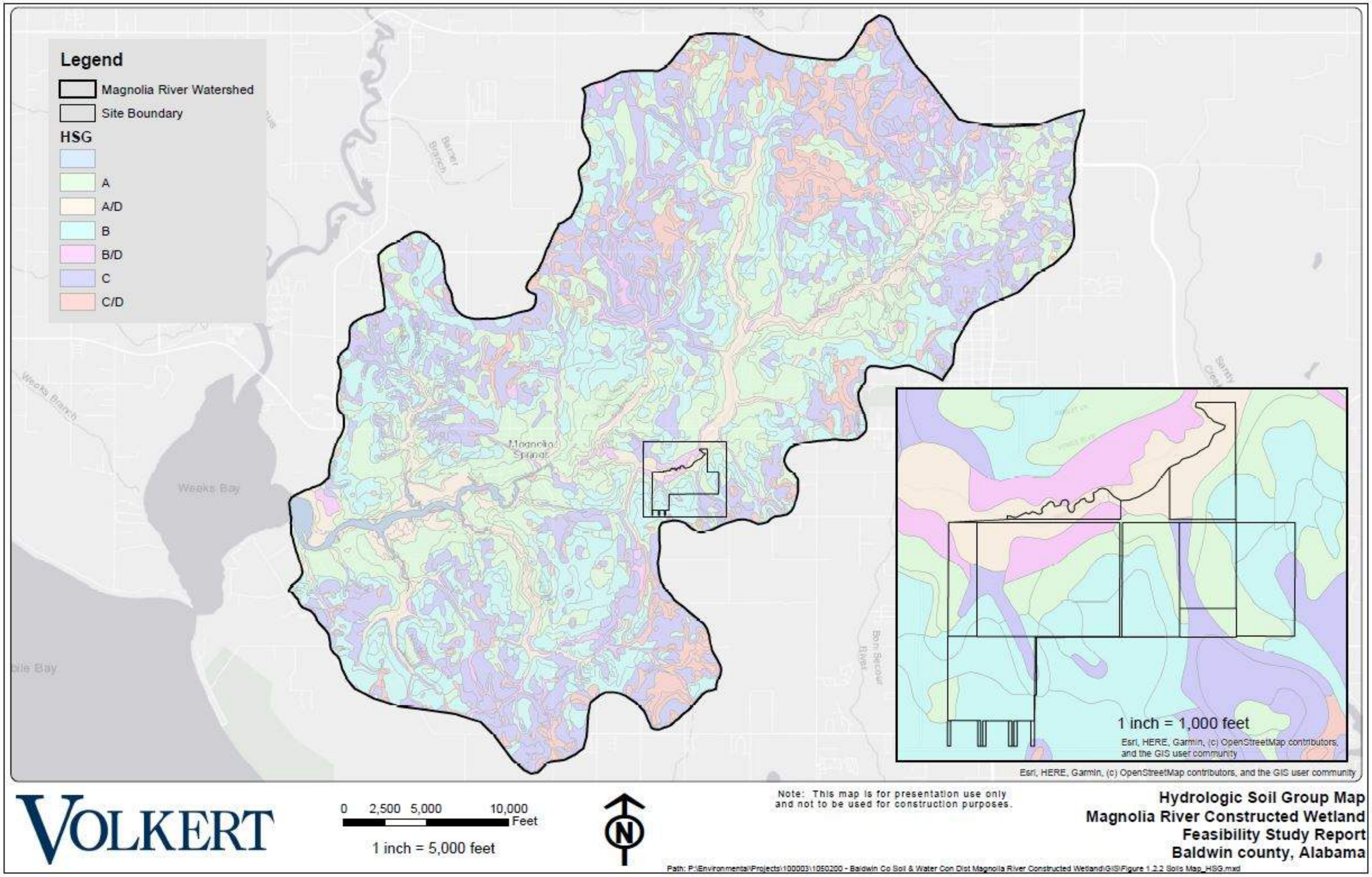



**Figure 2.4: Soils Map of Magnolia River Sub-watershed and (inset) the Proposed Project Site**

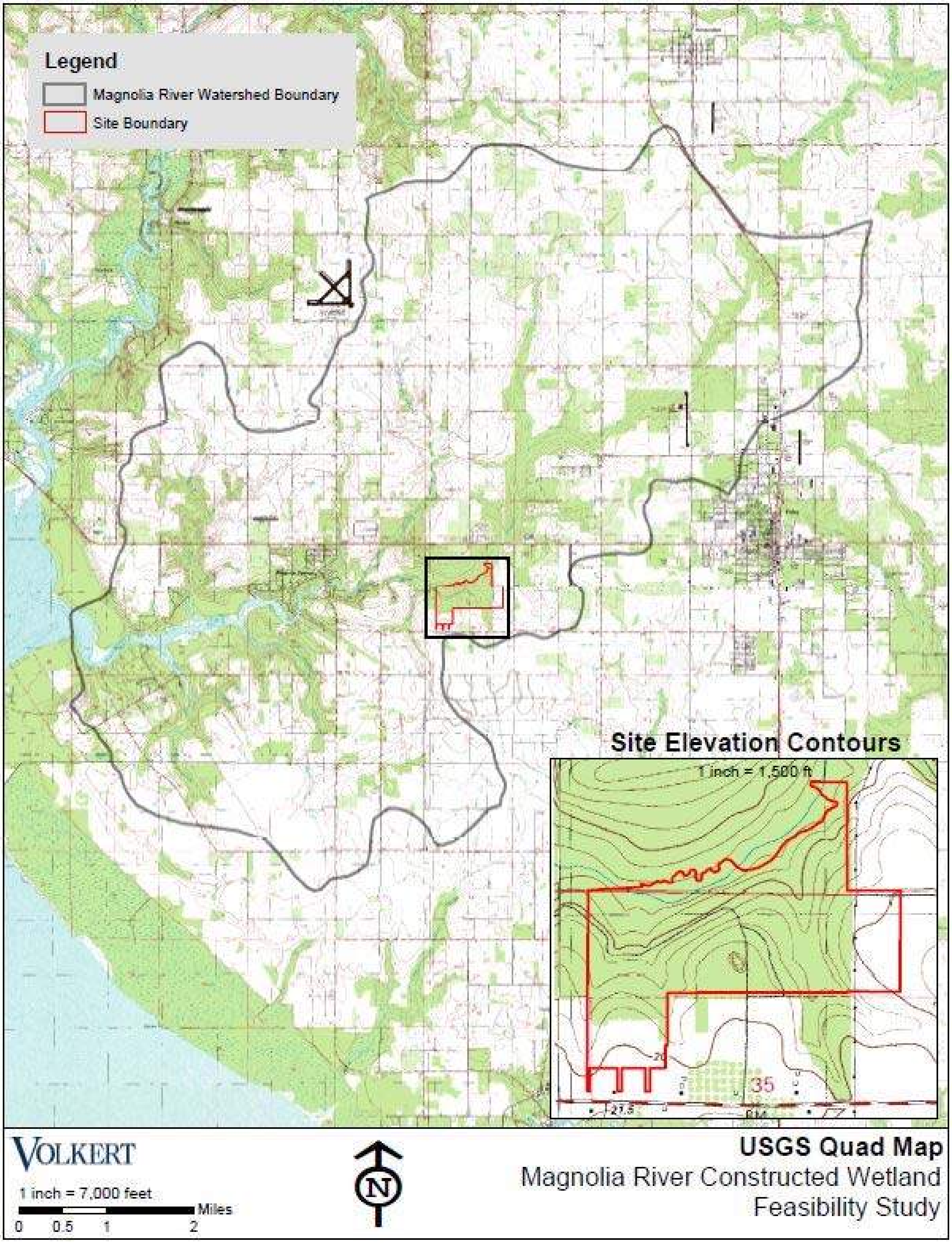



**Figure 2.5: USGS Quad Map for the Magnolia River Sub-Watershed and (inset) Project site**

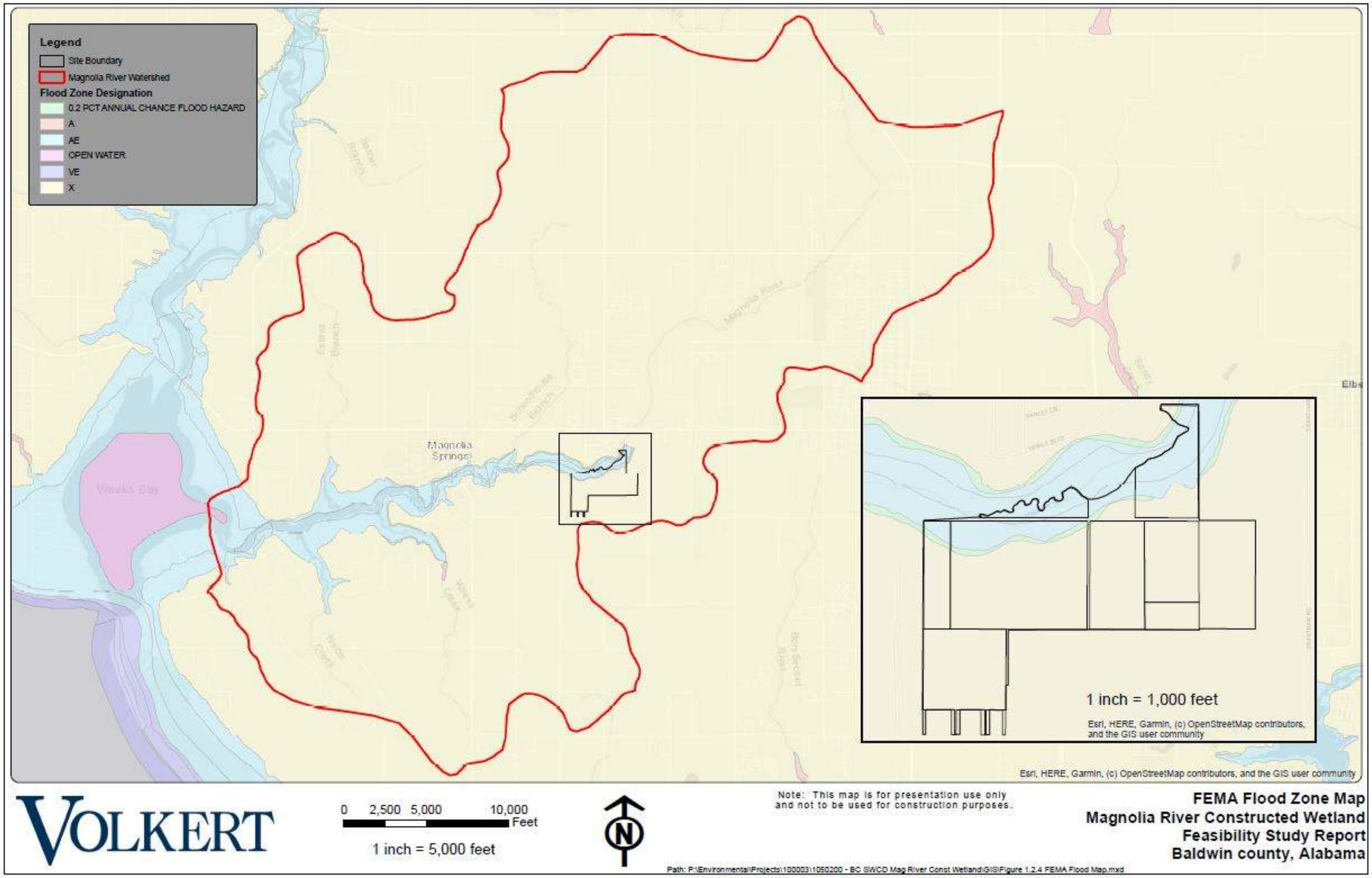



**Figure 2.6: FEMA Flood Zone Map of the Magnolia River Sub-Watershed and (inset) Project Site**

# 3.0 METHODS FOR STUDYING FEASIBILITY

## 3.1 Multi-Criteria Decision Analysis

A multi-decision criteria analysis (MCDA) is used to explicitly evaluate multiple conflicting solutions to a given problem. This practice is often used in business settings to predict the most profittable actions in a highly variable market. The criteria used in a decision-making process are usually conflicting and need to be prioritized according to the factors that will most affect the bottom line.

For the purpose of this feasibility study, an MCDA matrix was used twice---once to select the most appropriate site for this project and again to decide which project approach would be the most effective at meeting the project objectives. **Figure 3.1** is a combination of the two MCDA matrices used for this study. Matrices were created to provide a means for visualizing the options' effectiveness in achieving each goal. The MCDA matrix was used to analyze the available project sites according to the following criteria:

**A. Resilience to Flooding**

1. Mitigate Flooding Risk to Residential Homes
2. Mitigate Flooding Risk to Existing Infrastructure (Utilities and Road Crossings)
3. Decrease Peak Flow Rates

**B. Water Quality**

1. Reduce, Minimize and/or Eliminate Sources of Excessive Turbidity & Sediment Loading
2. Decrease Nutrient Loading (Nitrogen and Phosphorus)
3. Increase Dissolved Oxygen (D.O.) Levels (Bacterial Cultures/Pathogens)

**C. Native Habitat**

1. Improve In-Stream Habitat in Downstream Receiving Waters
2. Increase Overall Habitat Diversity
3. Control Invasive And Exotic Species

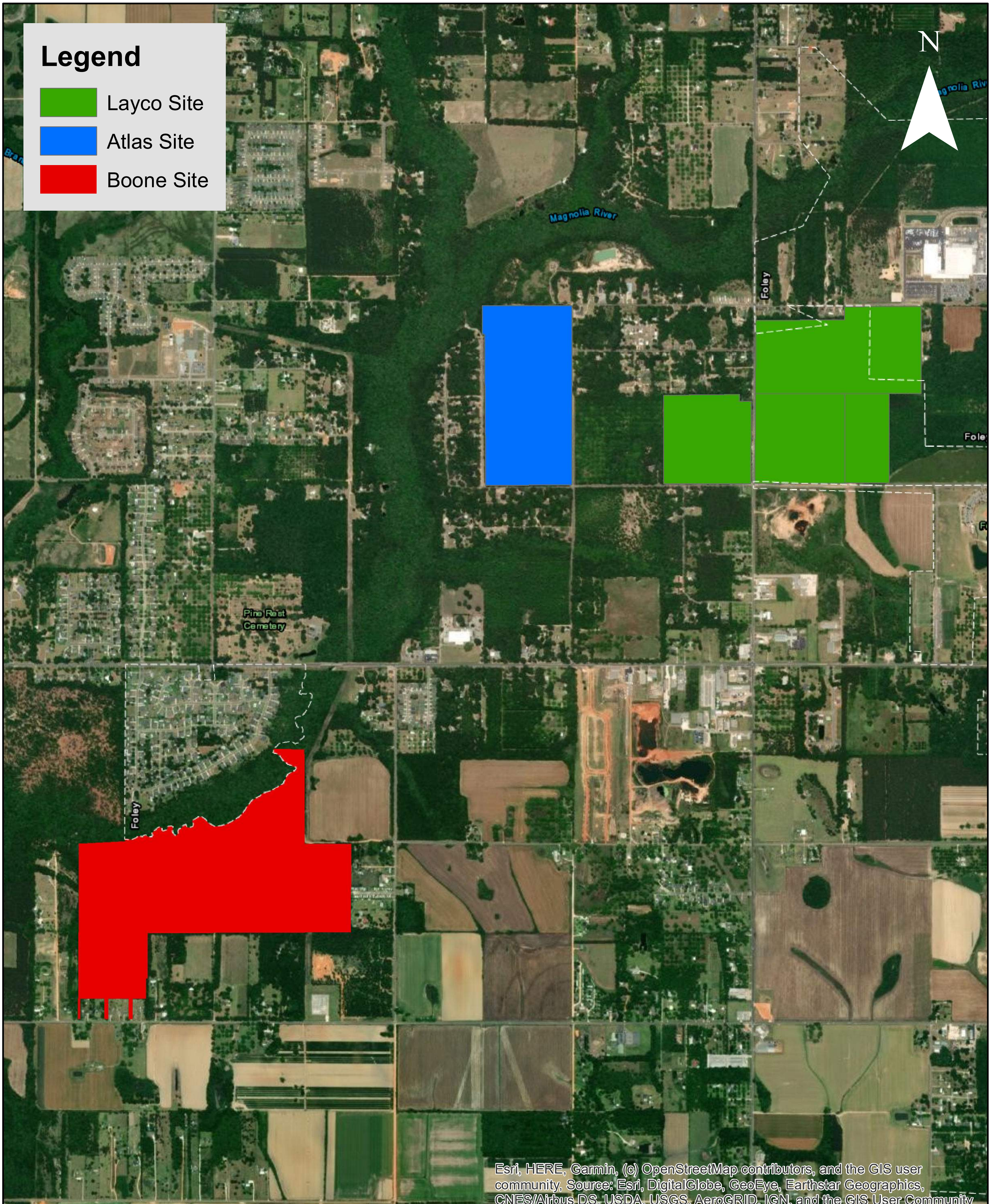
**D. Long Term Resiliency**

1. Reduce Frequency, Duration, and/or Severity of Flooding within the Watershed and SLR Impacts
2. Minimize Required Future Maintenance to Infrastructure
3. Improve Overall Habitat for Native Species

Three project design options were also evaluated for the selected site using the same criteria listed above. Each sub-category (A1-D3) was given a multiplier based on its priority. For each option (1a-3), a ranking was assigned that indicated the level of success that the site/option would have for every sub-category. The rankings were given in the numerical form of 1-5 with 1 meaning the site/option would be ideal and 5 meaning that the site/option is not feasible for the given sub-category. The individual rankings (per each option) were multiplied by the sub-category multiplier and then summed to calculate a matrix score. The option with the lowest matrix score, best addresses the criteria.

| MCDA matrices provide a rapid comparative analysis of design options utilizing a weighted ranking for each project objective. The option with the lowest cumulative score best addresses the project objectives. | | Resilience to Flooding GOAL | | | Water Quality GOAL | | | Native Habitat GOAL | | | Long Term Resiliency GOAL | | | RANKING | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | A3 | B1 | B2 | B3 | C1 | C2 | C3 | D1 | D2 | D3 | | |
| | | Mitigate Flooding Risk to Residential Homes | Mitigate Flooding Risk to Existing Ifrastructure (UTILITIES AND ROAD CROSSINGS) | Decrease Peak Flow Rates | Reduce, Minimize and/or Eliminate Sources of Excessive Turbidity & Sediment Loading | Decrease Nutrient Loading (Nitrogen and Phosphorus) | Increase Dissolved Oxygen (DO) Levels (BACTERIA CULTURE/PATHOGENS) | Improve In-Stream Habitat in Downstream Receiving Waters | Increase Overall Habitat Diversity | Control Invasive And Exotic Species | Reduce Frequency, Duration, and/or Severity of Flooding within the Watershed and SLR Impacts | Minimize Required Future Maintenance to Infrastructure | Improve Overall Habitat for Native Species | MCDA Matrix Score | MCDA RANKING |
| **Concept No.** | **Concept Option Description** | **5** | **5** | **3** | **4** | **3** | **5** | **2** | **4** | **3** | **5** | **2** | **3** | | |
| 1a | Boone Pit Site<br>Max Storage | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | **98** | **3** |
| 1b | Boone Pit Site<br>Swamp Floodplain Enhancement | 2 | 2 | 2 | 4 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | **93** | **2** |
| 1c | Boone Pit Site<br>Oxbow Braid | 3 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 1 | 1 | **88** | **1** |
| 2 | Atlas Pit Site | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 2 | 5 | 4 | 4 | **115** | **4** |
| 3 | Layco Pit Site | 1 | 1 | 1 | 5 | 5 | 5 | 4 | 5 | 2 | 1 | 5 | 5 | **124** | **5** |

**Figure 3.1: MCDA Matrix for the Magnolia River Sonstructed Wetland**

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1 inch = 1,800 feet

0 900 1,800 3,600 Feet

**Figure 3.2 Possible Project Sites**

Magnolia River Constructed Wetland

Feasibility Study

## 3.2 Site Selection

Three possible site locations were evaluated for this project. Each location reviewed is currently permitted for and used as a borrow pit for sand and gravel. **Figure 3.2** presents the location of each site. An MCDA Matrix, as explained in **Section 3.1**, was utilized as a tool to evaluate the site that would best accommodate the Magnolia River Constructed Wetland Project based on the listed criteria.

With respect to flood abatement, the Layco site offered the most storage, the largest reduction in flood risk to residential homes and the most dramatic decrease in peak flow rates; however, the cost associated with routing stormwater to and from this site outweighed the flood mitigation benefits. The Atlas site exhibited costs that were not as high as the Layco site but did not offer sufficient volume needed to improve the long-term resilience of the Magnolia River sub-watershed.

Ultimately, the Boone site was chosen because of its proximity and orientation to Magnolia River. Other sites offered access to the river, but only at a single point. Therefore, flood water could be diverted to the site for storage but could not be reintroduced to the main channel without impacting adjacent homes or infrastructure. The Boone site is located where water can be diverted from the river on the eastern portion of the site, stored and treated on the site, and then reintroduced to the river by exiting on the western portion of the site.  This approach reduces the cost of routing stormwater while providing the best orientation for water quality improvement.

## 3.3 Option Analysis

Because flood abatement is a high priority for stakeholders in the Magnolia River sub-watershed, the three options that were evaluated for this project are similar in that that they all provide increased storage for flood water. Renderings of each option are presented in **Appendix A**.

As seen in the MCDA Matrix in Figure 3.1, the Oxbow Braid Option was selected as the option that would render the highest benefit to cost ratio. See **Section 4.0** for more information about the benefits and costs associated with each option.

### *3.3.1 Extended Floodplain Option*

Illustrated in **Appendix A: Figure 1**, Option 1 utilizes expands the existing floodplain to act as a forested wetland. Wetlands function as environmental “sponges” to store floodwaters that overflow riverbanks and surface water accumulated from stormwater runoff (EPA, 2006). The shaded area presented in the rendering represents existing land on site that would be graded to expand the existing floodplain. The basin would start at existing floodplain elevation, approximately 19 ft above MSL, and gradually increase at a 1-2% slope. Three flood storage ponds have been included within the extended wetland. These ponds will have vegetated emergent wetland benches, provide increased flood storage to the floodplain extension, will act as a sink to decrease the velocity of flood water, and filter sediment and pollutants from Magnolia River. The water will divert from the main channel at the northeast corner of the site. After being stored and treated by the extended floodplain and storage ponds, the water will be returned to the main channel on the northwest corner of the site. Three stormwater ponds containing freshwater emergent wetlands are also included in Option 1. These ponds will intercept the stormwater runoff generated from agricultural, residential and commercial regions located to the south and east of the site. Much larger, deeper and at higher elevations, these ponds are not meant to discharge to Magnolia River. Instead, the water stored in these ponds will percolate and recharge the groundwater in aquifers below the site.

#### *3.3.2 Oxbow Braid Option*

A rendering of the Oxbow Braid Option is presented in **Appendix A: Figure 2**. This option is similar to Option 1 in that they both use flood storage ponds with emergent wetland benches within the floodplain to maximize flood water retention. Option 2, however, includes a constructed stream braid to divert water from the main channel into the floodplain, and then back into the main channel. The water that overflows the banks of the constructed braid will be controlled by five flood storage ponds. The storage ponds will act as “micropools” to capture sediment and pollutants, temporarily store flood water and slow the velocity of the water moving through the site. Water at a high velocity has the potential to scour and erode which will lead to downstream sedimentation and pollutant loading. The goal for Option two was to maximize flood water retention and minimize the velocity of the water while also simulating a natural braided system.

Also similar to Option 1, three storm water ponds with freshwater emergent wetlands were included in this design. These ponds are meant to capture the stormwater that would normally runoff from agricultural, residential and commercial regions to the south and east of the site. These ponds will not discharge to the Magnolia River but will percolate and recharge the groundwater aquifers below the site. Because the water stored in these ponds will not be discharged into the extended floodplain, more diverted flood water can be stored instead.

#### *3.3.3 Maximum Storage Option*

Because flood abatement was the stakeholder priority that was ranked the highest, Option 3 puts the emphasis on storing as much water as possible. In doing so, this option does not offer the same level of habitat enhancement and improved biodiversity that the previous two options provide.

Presented in **Appendix A: Figure 3**, Option 3 consists of two 26-acre flood storage ponds with wetland benches. Water is directed from Magnolia River via diversion berm where it is then stored and filtered by the first pond. The first pond is connected to the second by a constructed stream. The same type of constructed stream will carry the water out of the second pond and back to the main channel. The constructed streams are also used to connect three stormwater ponds to the flood plain.

### 3.4 Storage Potential of Wetlands

The potential of wetland storage for reducing peak flood flows is recognized as one of the most poorly understood functions of wetlands (Interagency Floodplain Management Review Committee, 1994). Nevertheless, several studies and commentary have noted that historical wetland drainage has magnified the impact of recent large (low frequency) flood events (Hey and Philippi, 1995).

A critical factor influencing the ability of a wetland to reduce peak flood stages during extreme weather events is its available storage potential which is often referred to as ‘bounce’ and is a function of wetland volume and depth, as well as antecedent soil moisture and precipitation.

All of the options presented in this feasibility report offer two types of wet extended detention ponds---one of which is for flood storage with wetland benches. The other type of pond is designed to capture and hold stormwater over a long period of time. All three of the options propose storage for flood waters, as well as stormwater runoff that may occur during extreme weather events.

# 4.0 ECONOMIC FEASIBILITY

Because the Magnolia River Constructed Wetland project is considered a public project, the entire community, especially those immediately downstream, are considered stakeholders. It is necessary to demonstrate that the net benefit of this project outweighs the net cost. The economic portion of this feasibility study was calculated using a combination of cost-benefit ratios and the MCDA Matrix. In order to justify the expenditures needed to successfully meet all four project goals, it is necessary to evaluate the actual and abstract costs, as well as benefits.

## 4.1 Defining Costs

### *4.1.1 Property Acquisition*

There are 13 parcels that need to be acquired in order to pursue any of the options suggested in this feasibility study. Those parcels, and their estimated purchase prices, can be seen in **Figure 4.1**. The total cost for land acquisition is approximately $843,100. The costs of acquiring these parcels was estimated using the current value of each parcel according to the Baldwin County Revenue Commission's Parcel Viewer. Actual market values may vary depending on use and available material remaining in the borrow pits. The Boone pit is an active site and as material is removed, the cost of the land and subsequent cost of construction will decrease.

### *4.1.2 Earthwork and Construction*

The most obvious costs for this project are the earth work and restoration construction. General earthwork estimates were calculated using AutoCAD based on preliminary drawings of each of the options. **Table 4.1** presents the earthwork estimated for each option and the cost associated with it. **Appendix B** identifies other restoration costs associated with each option.

**Table 4.1: Earthwork Cost Estimate for Each Option**

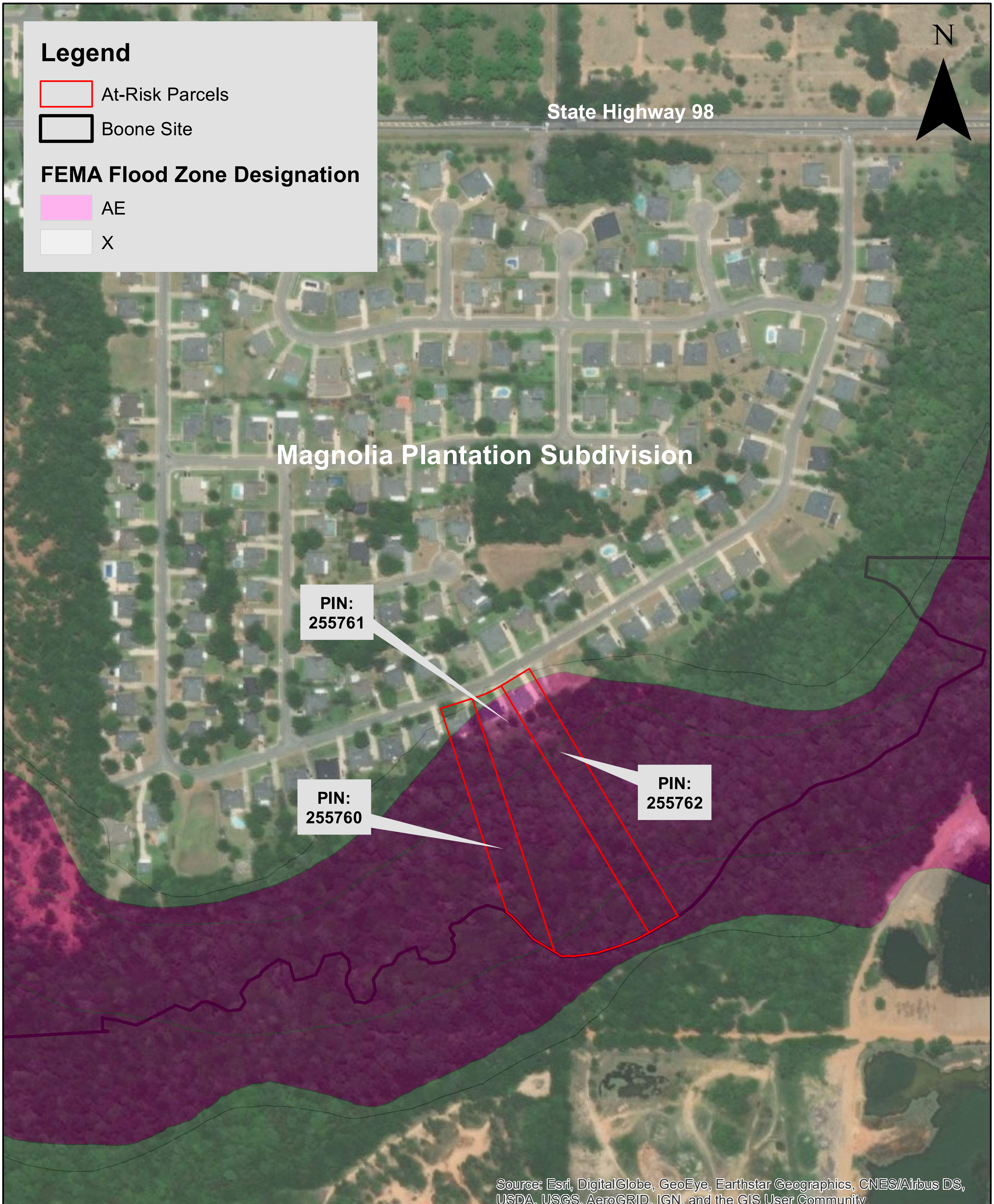
| Option | Net Volume (CUYD) | Cut/Fill | Cost per CUYD | Total Cost |
|---|---|---|---|---|
| Extended Floodplain | 1,000,000 | CUT | $ 8.00 | $ 8,000,000 |
| OxBow | 500,000 | CUT | $ 8.00 | $ 4,000,000 |
| Max Storage | 800,000 | CUT | $ 8.00 | $ 6,400,000 |


**Figure 4.1: Parcel Acquisition Map with Estimated Costs per Parcel**

## 4.2 Defining Benefits

### *4.2.1 Avoided Flood Damage*

Because a major goal of this project is to mitigate flooding, it is important to estimate the amount of money that would be saved from future flood insurance claims if nearby residences were safe from flooding. According to the Insurance Information Institute, the national average residential flood insurance claim in 2018 was $42,580. There are 3 properties that lie within the 100-year floodplain for this site, as seen in **Figure 4.2**. It has been concluded that for all three options, the floodplain will be altered in a way that removes these residences from the 100-year floodplain. The likelihood of any one of those home being affected by a 100-year storm within the next 20 years is 18.2%. A long-term monetary savings of $127,740 would be expected if any of the options were selected. Reduced flooding also decreases the risk of damage to existing utilities and infrastructure.

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1 inch = 350 feet

0 175 350 700 Feet

**Figure 4.2 At-Risk Parcel Map**

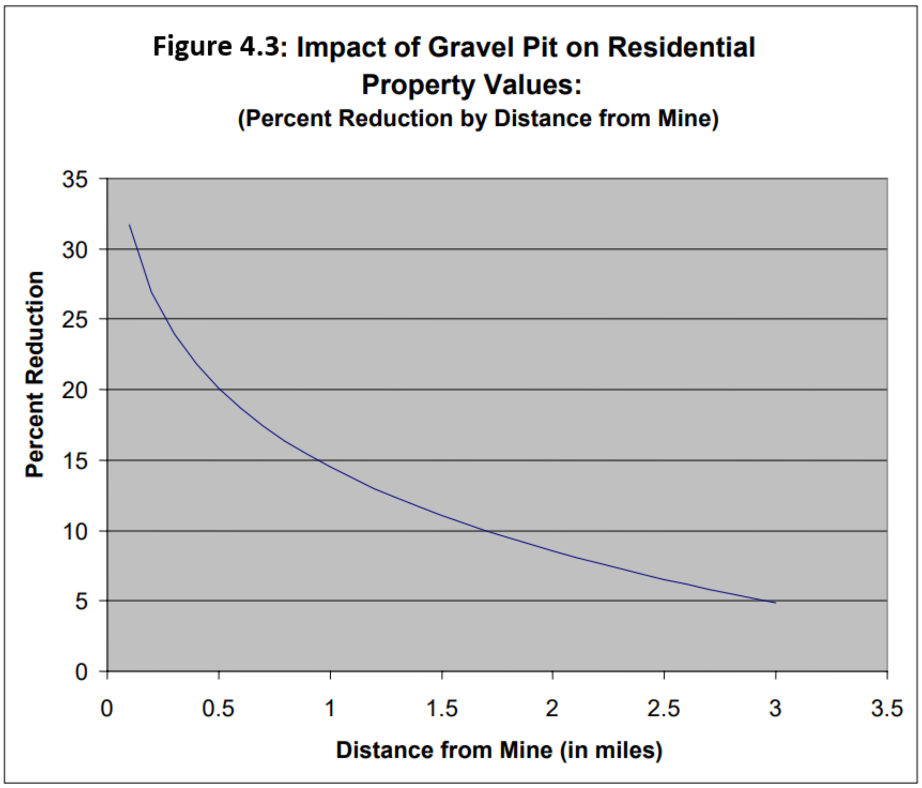
Magnolia River Constructed Wetland

Feasibiliy Study

### *4.2.2 Increased Property Value*

A study done in 2006 determined that there is a definite statistical correlation between property distance from a spoils pit and that property's sale price (Erickcek, 2006). With the conversion of the spoils pits to protected habitats, the value of surrounding properties is expected to increase. The exact amount of increase depends on the size of the surrounding property, land use and proximity to Magnolia River.

For example, there are multiple 0.70-acre lots located directly to the south of the site. The land for each parcel is currently valued at $33,700. A parcel of the same size and land use located near a protected area (Weeks Bay Preserve) is valued at $50,000. Property value is affected by many factors and can vary across neighborhoods, let alone zip codes. However, it is important to note that property located near protected areas are seen as desirable because there is no foreseeable threat of commercialization of the area.




**(Source: Erickcek, 2006)**

Because there is statistical evidence that the value of property will decrease relative to proximity to borrow pits, it is reasonable to assume that property values will also increase with proximity to protected restoration sites.

**Figure 4.3** was created from property value data provided by the Baldwin County Revenue Commission parcel viewer web portal. Buffers were created that extend 0.25, 0.5, 0.75, 1, 2 and 1 mile from the site boundary. **Table 4.2** presents the average increase in property value (per acre) for each buffer after restoration. The percentages used to generate an estimated increase in property value were gathered from the results of the same 2006 Study by Erickcek.

**Table 4.2: Estimated Increases in Property Value According to Buffer**

| Buffer Range | Total Value of Buffer | Estimated Increase After Restoration | |
|---|---|---|---|
| Miles | $ | % | $ |
| 0-0.25 | $44,918,900 | 25.5 | $11,229,725 |
| 0.25-0.5 | $35,074,726 | 20 | $7,014,945 |
| 0.5-0.75 | $38,519,000 | 17 | $6,548,230 |
| 0.75-1 | $60,506,300 | 14.5 | $8,773,414 |
| 1-2 | $179,018,926 | 8.9 | $15,932,684 |
| | Total Added Value After Restoration | | $49,498,998 |

A more recent study suggests that properties near a completed restoration project are approximately 8% more valuable than they were before the site was restored. This percentage was the result of a hedonic pricing model using a 2-mile buffer around three separate sites in Northern Colorado (Steketee, 2020). If the same method is applied to the Magnolia River Constructed Wetland site, an 8% increase in property value over a 1-mile buffer would result in an overall property value increase of $14,449,254. A one-mile buffer was used, instead of two, because there is another borrow pit site located within two miles of the site that would skew the property values in the 1-2-mile range.

#### *4.2.3 Downstream Water Quality*

Magnolia River is used for a variety of commercial and recreational aspects. The well-known "Cold Hole", a relatively deep bend of the river located to the East of County Road 49, is frequented by boaters and kayakers. Jesse's, a local staple restaurant, is accessed by both boaters and kayakers from Magnolia River. Recreational fishing, paddle boarding, bird and wildlife watching are also activities stakeholders are interested in protecting. In the 2019-2020 Fiscal Planning Document, the town of Magnolia Springs expected to receive approximately $300,000 in revenue tax associated with the use of Magnolia River and the commodities that it provides. Another long-term benefit of this project is increased, or at least sustained, revenue as opposed to the lack of use that would be associated with a future flood.

### 4.3 Cost-Benefit Ratio

A cost-benefit ratio is used to summarize the overall relationship between the relative costs and benefits of a project. If a project has a cost-benefit ratio of greater than 1.0, the project is expected to deliver a positive net present value. On the other hand, if a project has a cost-benefit ratio of less than 1.0, the costs outweigh the benefits and an alternative solution should be considered. The ratio is calculated by dividing the proposed total benefit of a project by the proposed total cost of the same project.

**Table 4.3** presents the cost-benefit ratios for each option. The ratios done for this feasibility study only included the monetary values gathered from researching impacts as a direct result of this project. The ratios do not include values for indirect (ecological or social) impacts.

**Table 4.3: Cost-Benefit Ratios**

| Option | Cost-Benefit Ratio |
|---|---|
| Extended Floodplain | 1.263 |
| Oxbow | 1.785 |
| Max Storage | 1.487 |

# 5.0 ECOLOGICAL FEASIBILITY

## 5.1 Ecological Costs

Just as some benefits cannot be estimated with a monetary value, there are some impacts that are detrimental to the environment or community but are not directly financially measurable. Magnolia River is currently classified as an Outstanding Alabama Water (OAW) by the Alabama Department of Environmental Management. Magnolia River is one of just five rivers with this distinction in Alabama. To maintain OAW status, physical and chemical characteristics of Magnolia River are monitored, and must be maintained at appropriate levels.

There are significant monetary costs associated with constructing any of the project options described in **Section 3.3**; however, the ecological cost of doing nothing could also be substantial. Allowing the river channel to continue to degrade with each future flood event could potentially cause Magnolia River to lose OAW status.

## 5.2 Ecological Benefits

Wetlands are perceived as providing valuable services to society including water purification, groundwater recharge, fish and wildlife habitat, recreational and amenity services, and flood control. However, because many of the services that wetlands provide cannot be actively traded in the market, determining their economic value is difficult.

The functional values of a wetland can be especially difficult to assess. For example, there is no monetary equivalent that could be assigned to the water quality (sediment trapping, pollution removal, biochemical processes), hydrologic (velocity reduction, atmospheric processes, groundwater recharge) or habitat (wildlife biodiversity, nutrient accumulation, soils formation) benefits that are produced by a wetland. There are, however, some external values that are available because of the presence of the wetland that can be monetarily valued. Those include commercial harvesting (of timber, shellfish, peat and nutrients), recreation (sport fishing and hunting), agriculture incentives (livestock watering and foraging) and protection of property (peak flow reduction, water quality improvement, erosion control, sediment removal). Furthermore, this project will create wetland habitat that is known for filtering sediment and pollution that contribute to water body degradation.

# 6.0 SOCIAL FEASIBILITY

Throughout the development of the Weeks Bay Watershed Management Plan, stakeholders from the community were asked to prioritize issues within the watershed. For the Magnolia River sub-watershed, those priorities were the same as the four goals that govern this feasibility study:

1. Mitigate flooding
2. Improve water quality
3. Enhance native habitat
4. Promote long term watershed resilience

Projects such as this were recommended in the Weeks Bay Watershed Management Plan and have been supported by the Friends of Magnolia River Committee (FRMC).

## 7.0 FINANCING ALTERNATIVES

Both state and local governments have allocated funding for improvements to coastal ecosystem resiliency after the Deep-Water Horizon oil spill that devastated the Gulf Coast in 2010 (Ivey, 2018). Other funding resources, specifically for flood mitigation or coastal resiliency projects, include the following:

**Table 7.0: Project Financing Alternatives**

| Program Name | Agency | Type | Description |
|---|---|---|---|
| Flood Mitigation Assistance Program | Federal Emergency Management Agency | Federal | FY 2019: $50 Million in grants allocated for reducing or eliminating claims for States, Tribal, Territories and Local governments |
| Coastal Resilience Grants Program | National Oceanic and Atmospheric Administration | Federal | The program funds projects that are helping coastal communities and ecosystems prepare for and recover from extreme weather events, climate hazards and changing ocean conditions. |
| National Coastal Resilience Fund | National Fish and Wildlife Foundation | Federal | The NRCF restores, increases and strengthens natural infrastructure to protect coastal communities while also enhancing habitats. |
| Alabama Coastal Area Management Program | Alabama Department of Conservation and Natural Resources | State | ACAMP promotes wise management of cultural and natural resources of the State's coastal areas and fosters efforts to ensure the long-term ecological and economic productivity of coastal Alabama. |
| Non-point Source Pollution Program | Alabama Department of Environmental Management | State | Section 319 (Clean Water Act) funding is available to fund targeted, on-the-ground, implementation practices to restore impaired waterbodies in Alabama. |
| Conservation Alabama Foundation | | Private-Public Partnership | As a coalition of environmental organizations, individuals and businesses, CAF is funding projects that restore the Alabama Gulf Coast's environment, economy and communities from legal settlements and penalties regarding the Deepwater Horizon Oil Spill. |

## 8.0 SUMMARY AND CONCLUSION

The purpose of this feasibility study was to evaluate the practicality of the three solutions that have been proposed for the Magnolia River Constructed Wetlands Project, to compare the costs and benefits associated with each solution, and to identify possible short- and long-term environmental impacts.

The overall feasibility of each option was evaluated using a MCDA matrix. A tool used to analyze multi-criteria decisions; the matrix ranks the options according to priorities set by stakeholders. Cost-benefit ratios were used to understand the financial impacts of this project, as well as each option's viability compared to the others.

While all the options presented high cost-benefit ratios in a monetary sense, most of the benefits expected from this project are not monetary. For example, it is difficult to estimate the financial value of increased biodiversity, enhanced habitat and improved water quality.

The results from this feasibility study suggest that the Oxbow Braid Option (#2) is the most feasible solution for this project.

It is the recommendation of Volkert, Inc. that a holistic approach is used for this project. The option that offers strictly the most flood abatement does not address habitat enhancement or biodiversity. The ideal solution is one that addresses all the major goals while still exhibiting a practical cost-benefit ratio. The solution recommended by Volkert, Inc. is the Oxbow Braid Option for the Boone Pit site.

# 9.0 REFERENCES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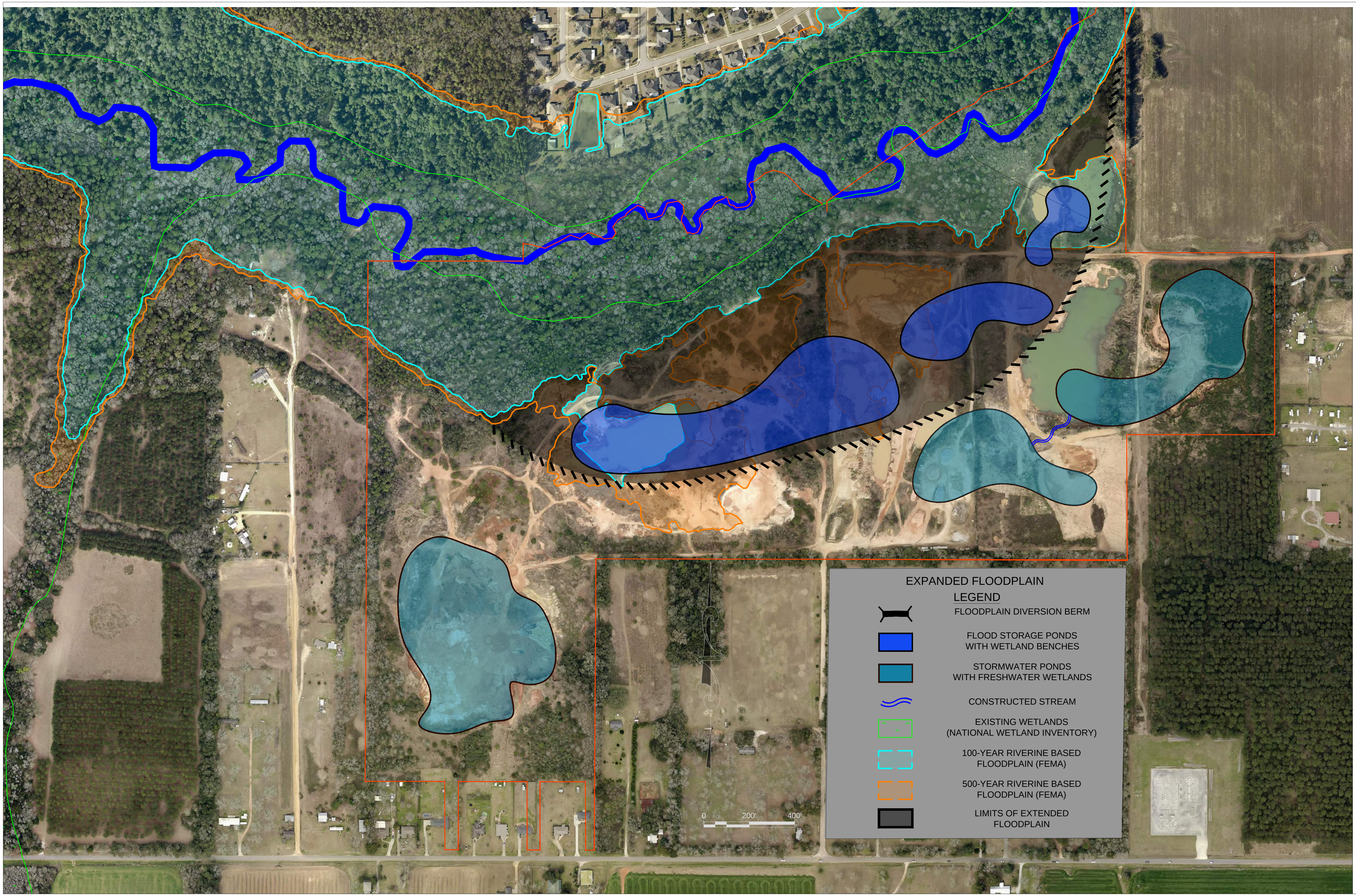
# 10.0 APPENDICES

**Appendix A: Figure 1**

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| CHECKED BY: A.E.J. | DATE 3/2/20 | | |
| APPROVED BY: | DATE 3/2/20 | | |
| SCALE | SHEET 4 | | |

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
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VOLKERT

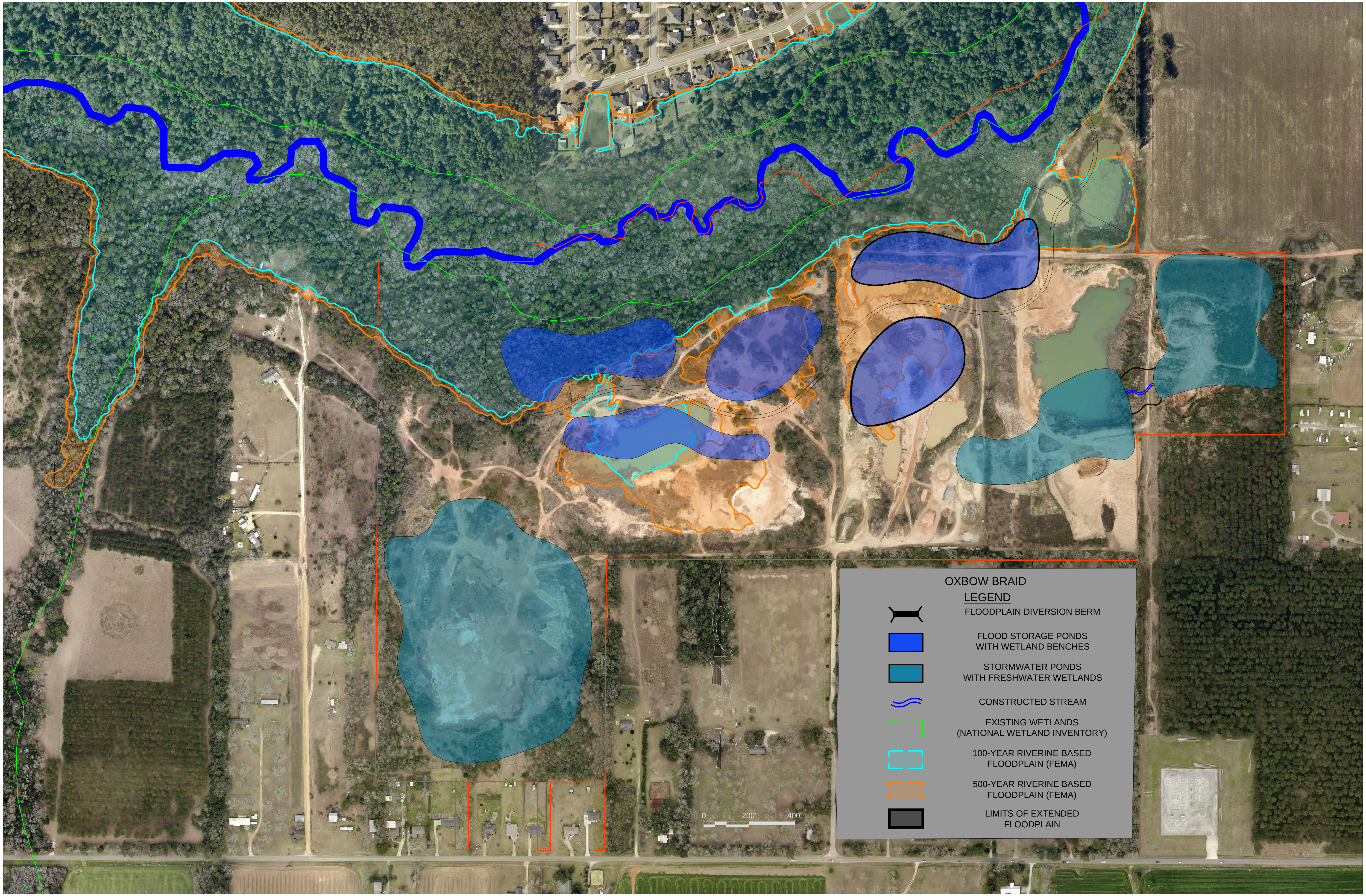
1680B West 2nd Street, Gulf Shores, AL 36542

PROJECT: MAGNOLIA RIVER CONSTRUCTED WETLANDS

DESCRIPTION: EXPANDED FLOODPLAIN

CLIENT: SOIL & WATER CONSERVATION DISTRICT

**Appendix A: Figure 2**

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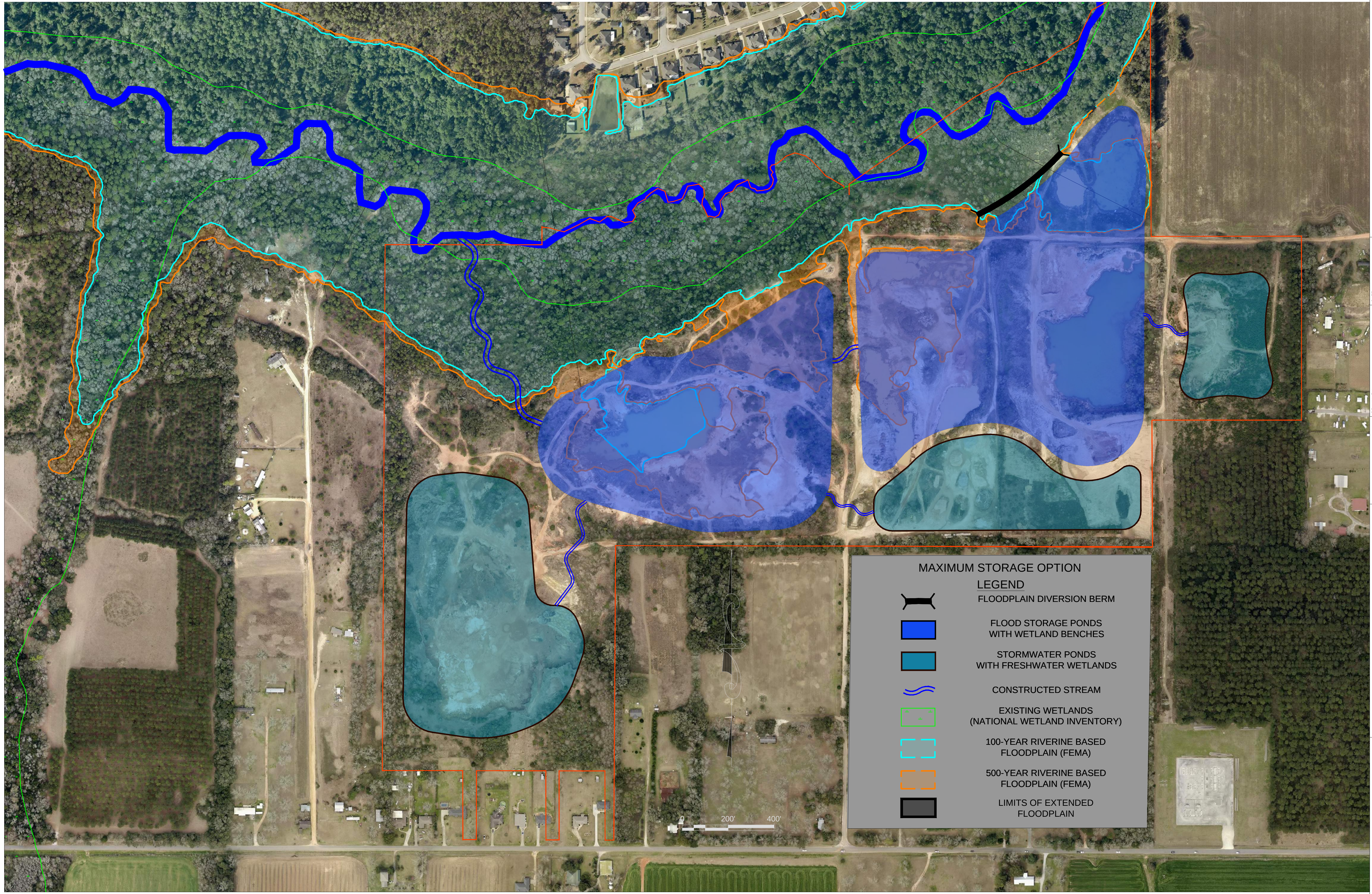
VOLKERT
1680B West 2nd Street, Gulf Shores, AL 36542

PROJECT: MAGNOLIA RIVER CONSTRUCTED WETLANDS
DESCRIPTION: OXBOW BRAID
CLIENT: SOIL & WATER CONSERVATION DISTRICT

**Appendix A: Figure 3**

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APPROVED BY: DATE 3/2/20

SCALE SHEET 4

LICENSED No. 30053 PROFESSIONAL ENGINEER 4/15/19

VOLKERT

1680B West 2nd Street, Gulf Shores, AL 36542

PROJECT: MAGNOLIA RIVER CONSTRUCTED WETLANDS

DESCRIPTION: MAXIMUM STORAGE

CLIENT: SOIL & WATER CONSERVATION DISTRICT

**Appendix B: Cost-Benefit Tables**

| Oxbow Option | | | |
|---|---|---|---|
| **Costs** | **Quantity** | **Unit Cost** | **Estimated Cost** |
| Constructed Wetlands (ac) | 48.725 | $150,000 | $7,308,750 |
| Property Acquisition (ac) | 175 | $4,500 | $787,500 |
| **Total Estimated Cost of Option:** | | | **$8,096,250** |
| **Benefits** | | | **Estimated Benefit** |
| Avoided Insurance Claim (18.2% over 20 years) | | | $127,740 |
| Increased Property Value (8% for 1-mile buffer) | | | $14,321,514 |
| **Total Estimated Benefit of Option:** | | | **$14,449,254** |
| | | | |
| **Cost-Benefit Ratio:** | | | **1.784684771** |

| Extended Floodplain Option | | | |
|---|---|---|---|
| **Costs** | **Quantity** | **Unit Cost** | **Estimated Cost** |
| Constructed Wetlands (ac) | 70.99 | $150,000 | $10,648,500 |
| Property Acquisition (ac) | 175 | $4,500 | $787,500 |
| **Total Estimated Cost of Option:** | | | **$11,436,000** |
| **Benefits** | | | **Estimated Benefit** |
| Avoided Insurance Claim (18.2% over 20 years) | | | $127,740 |
| Increased Property Value (8% for 1-mile buffer) | | | $14,321,514 |
| **Total Estimated Benefit of Option:** | | | **$14,449,254** |
| | | | |
| **Cost-Benefit Ratio:** | | | **1.263488464** |

| Max Storage Option | | | |
|---|---|---|---|
| **Costs** | **Quantity** | **Unit Cost** | **Estimated Cost** |
| Constructed Wetlands (ac) | 59.525 | $150,000 | $8,928,750 |
| Property Acquisition (ac) | 175 | $4,500 | $787,500 |
| **Total Estimated Cost of Option:** | | | **$9,716,250** |
| **Benefits** | | | **Estimated Benefit** |
| Avoided Insurance Claim (18.2% over 20 years) | | | $127,740 |
| Increased Property Value (8% for 1-mile buffer) | | | $14,321,514 |
| **Total Estimated Benefit of Option:** | | | **$14,449,254** |
| | | | |
| **Cost-Benefit Ratio:** | | | **1.487122509** |

*The **Constructed Wetland** cost includes earthwork, vegetation, matting and other expenses related to restoration.


Photo Credit: (Cover, 2 & 3) Casey Fulford, (1 & 4) Andrew James


This endeavor was made possible by the Resilience to Future Flooding project, which was supported through a cooperative agreement with the US Department of Commerce, NOAA Regional Coastal Resilience Grant NA17NOS4730140. Additional funding was provided by the Gulf of Mexico Alliance, Louisiana Sea Grant, UF/IFAS Extension, and YSI. The Resilience to Future Flooding project is led by the Northern Gulf of Mexico Sentinel Site Cooperative, Dauphin Island Sea Lab, Mississippi -Alabama Sea Grant Consortium, Gulf of Mexico Alliance, NOAA, Gulf of Mexico Climate and Resilience Community of Practice, UF/IFAS Extension, Mississippi Department of Marine Resources, Mississippi State University, and Louisiana Sea Grant. The contents of this document do not necessarily reflect the views and policies of these organizations or their partners.

Matching monetary and in-kind funds for this project were provided by Baldwin County Soil & Water Conservation District, Town of Magnolia Springs, and Friends of Magnolia River Committee.



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Completed May 2020

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