

# GREEN GROWTH GUIDELINES

*A Framework for Sustainable Development for Coastal Georgia*



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# What is Green Infrastructure?



An interconnected network of undisturbed natural areas and open space that helps preserve the values and functions of our watersheds and provides a wide array of benefits to both people and wildlife

An ecological framework for environmental, social, and economic health... our natural life support system

(Benedict and McMahon 2006)

**Green Infrastructure Tools:** practices and strategies that incorporate fundamental GI principles to improve water quality, air quality and habitats, protect human health and restore naturally functioning ecosystems.

# Green Infrastructure Stormwater

<b>Better Site Planning</b>	<b>Better Site Design</b>	<b>Low Impact Development</b>
<ul style="list-style-type: none"><li>• Preserve Primary Conservation Areas</li><li>• Preserve Secondary Conservation Areas</li></ul>	<ul style="list-style-type: none"><li>• Reduce Clearing and Grading Limits</li><li>• Reduce Roadway Lengths and Widths</li><li>• Fewer or Alternative Cul-de-Sacs</li><li>• Reduce Parking Lot Footprints</li><li>• Landscaping Areas in Parking Lots</li><li>• Reduce Sidewalk Lengths and Widths</li><li>• Reduce Building Footprints</li><li>• Reduce Setbacks and Frontages</li></ul>	<ul style="list-style-type: none"><li>• Soil Restoration</li><li>• Site Reforestation</li><li>• Conservation Areas</li><li>• Vegetated Filter Strips</li><li>• Grass Channels</li><li>• Simple Disconnection</li><li>• Rain Gardens</li><li>• Stormwater Planters</li><li>• Dry Wells</li><li>• Rainwater Harvesting</li><li>• Green Roofs</li><li>• Permeable Pavement</li><li>• Bioretention Areas</li><li>• Infiltration Practices</li><li>• Dry Swales</li></ul>

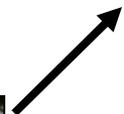
# The recommended approach looks like this.....



Better Site Planning



Better Site Design



Low Impact  
Development  
Practices



Stormwater  
Management Practices



Receiving Waters



# rather than this.....



Development Project



Stormwater Management Practices



Receiving Waters



# GI Goals

## **Protect the Environment & Human Health**

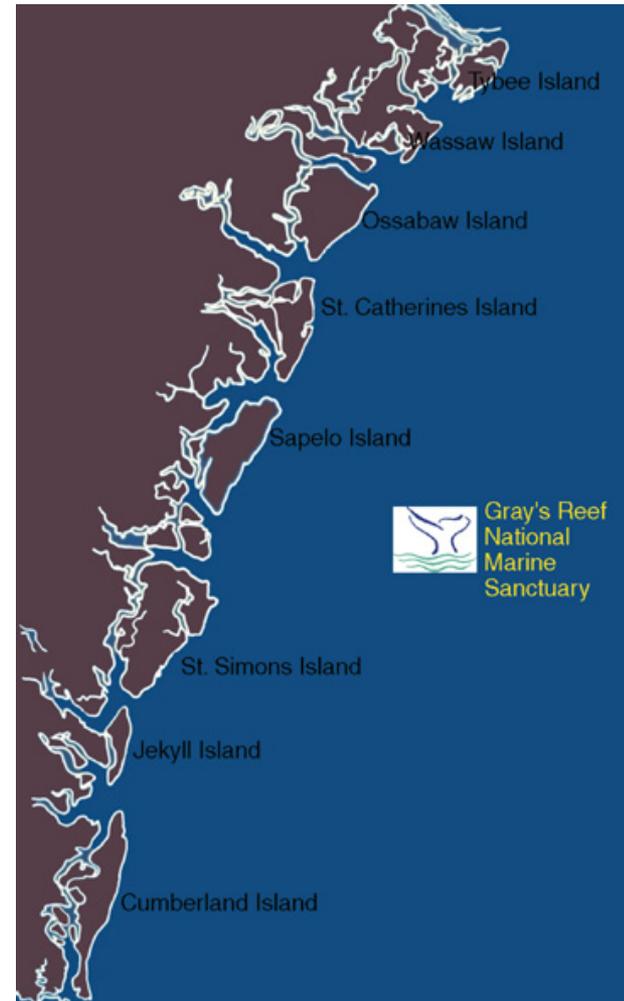
- ✓ Reduce runoff rates, volumes and pollutant loads
- ✓ Protect of the integrity of streams, wetlands, riparian areas
- ✓ Preserve connectivity of areas that provide valuable habitat for aquatic and terrestrial organisms

## **Save Money and Time**

- ✓ Reduce or eliminate need for larger, more expensive practices
- ✓ Reduce maintenance
- ✓ Reduce overall cost of development while maintaining or increasing overall value of project
- ✓ Streamline or eliminate expensive, time consuming federal permitting



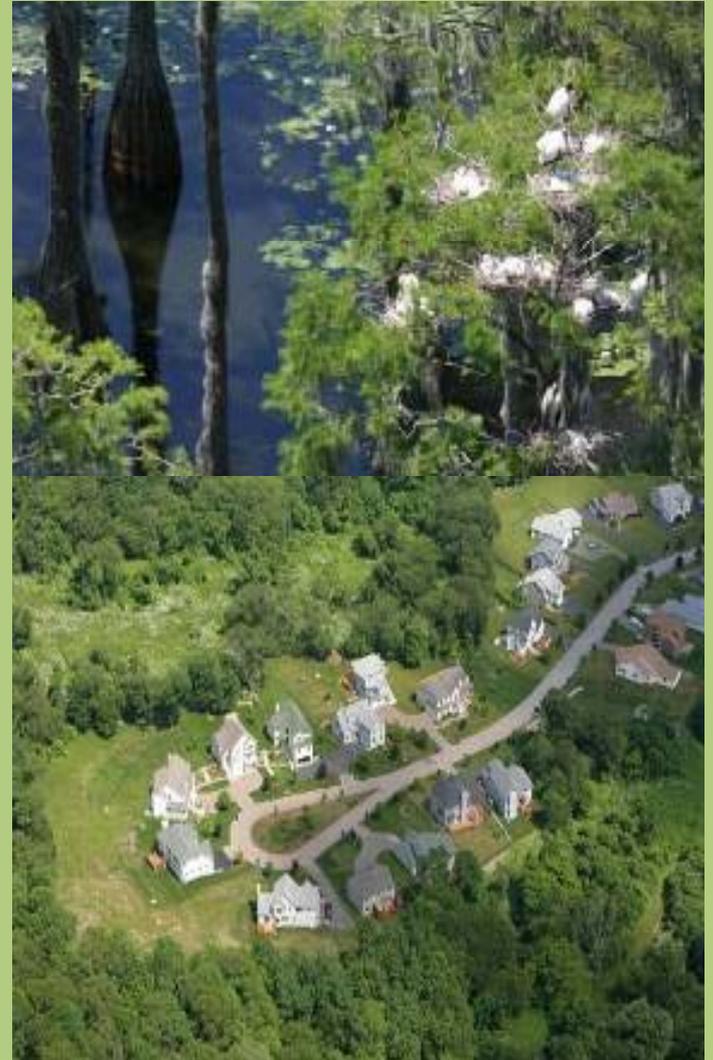
# Healthy systems require a network of vital connections



# Ecosystem Services

Using our “**Natural Capital**” (intact natural environment) and designing with the land to **provide important ecosystem services**:

- Flood Control
- Pollutant Removal
- Recreation
- Water and Air Quality Protection
- Energy Efficiency
- Carbon Sequestration
- Groundwater Recharge



# Green Infrastructure Toolbox

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- ◉ Green Growth Guidelines (G3)
- ◉ GA SW Mgmt Manual Coastal Stormwater Supplement (CSS)
- ◉ Coastscapes Communities Program
- ◉ Coastal Model Ordinances
- ◉ GA Statewide Water Plan
- ◉ Governor's Coastal Comprehensive Plan
- ◉ Georgia State Wildlife Action Plan and Coastal Biological Assessment

# Green Growth Guidelines - G3

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- ◉ Development tool geared for the coast
- ◉ Site-scale approach
- ◉ Intended for broad audience
- ◉ Environmental, economic, social benefits



# Contents of G3

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- ◉ Comprehensive Planning Methods
- ◉ Conservation Design Principles
- ◉ Low Impact Construction Practices



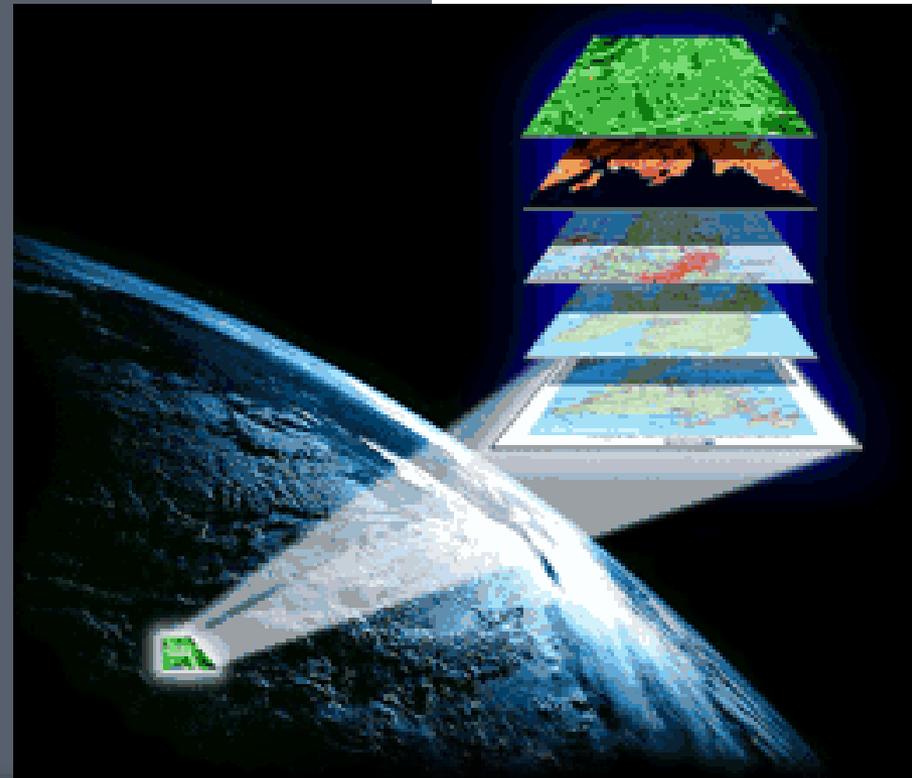
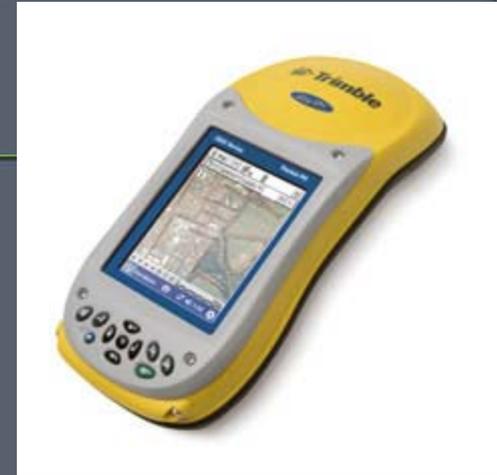
# G3 Overview

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- ◎ Site Fingerprinting Using GIS & GPS
- ◎ Designing with the Landform
- ◎ Low Impact Stormwater Management
- ◎ Streambank Stabilization
- ◎ Recreational Facilities (Marinas, Golf Courses)

# CH. I Site Fingerprinting

- Utilize GIS/GPS Technology
- Identify Existing Conditions
- Consider Constraints & Opportunities
- Analyze Alternatives
- Predict Results

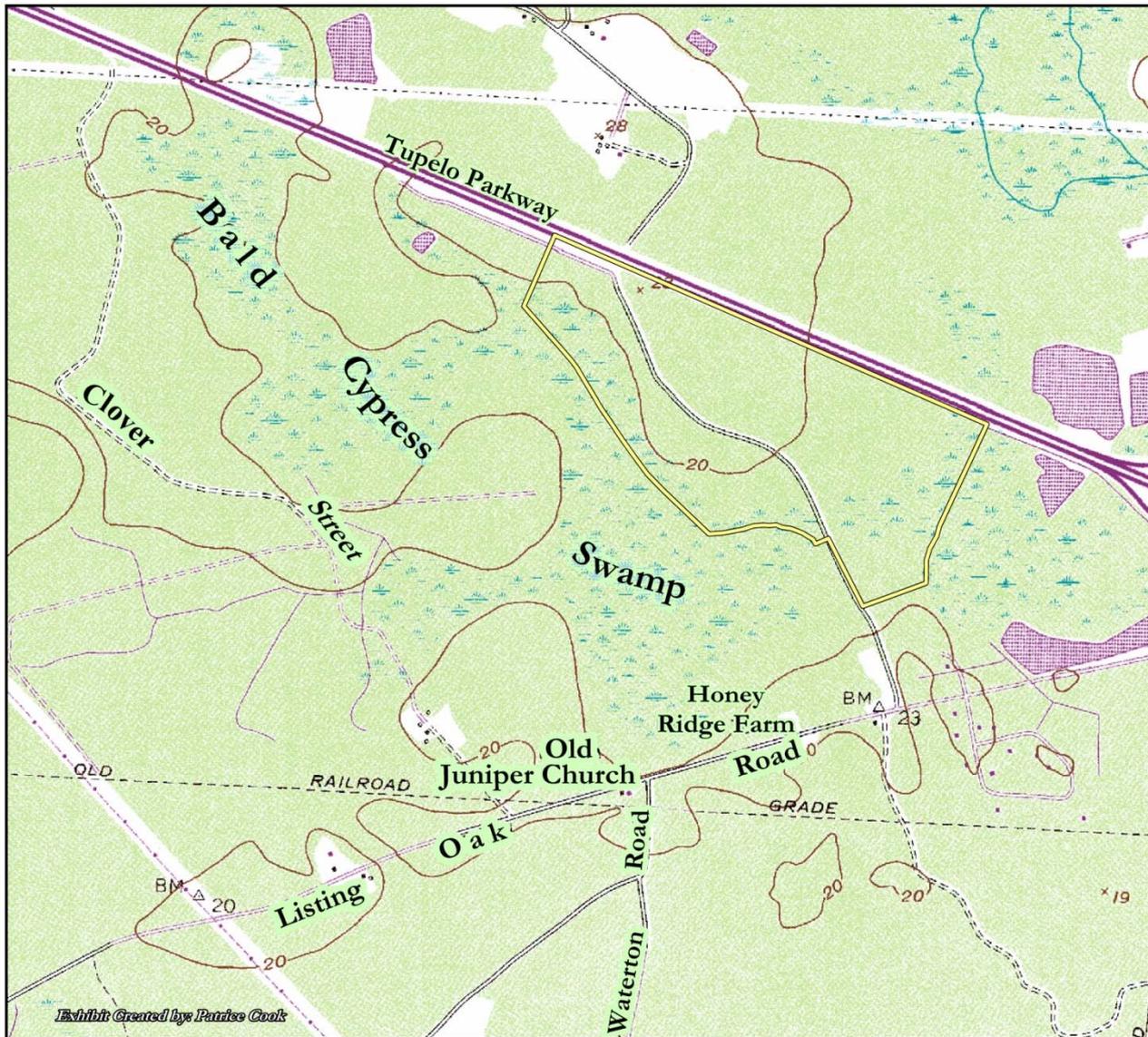


# Mapping the Site

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- Topography
- Hydrology
- Infrastructure
- Land use
- Zoning
- Significant landmarks
- Wetlands & waterways
- Groundwater recharge areas
- Floodplain
- Tree Cover
- Soils
- Wildlife Habitat
- Historic & Archeo Resources
- Setbacks & Buffers
- Essential Fish Habitat
- Shellfish Harvesting Areas

# Topography



## Exhibit 1: Topographic & Hydrologic Features

This exhibit displays a topographic map compiled in 1975 by the U.S. Geological Survey (USGS). This map shows the general topography and hydrology of the site and the surrounding area. Topographic maps illustrate a three-dimensional configuration of the Earth's surface (the actual ground elevation) using contour lines. Broadly spaced contours represent gentle slopes while close contour intervals indicate steep slopes. These maps show major geographic features including mountains, hills, rivers, valleys, and depressional wetlands. Also represented on the topographic are man-made features such as roads, churches, railroads, land boundaries, and buildings. Topographic maps are bounded by rectangular-shaped areas defined by latitudes and longitudes separated at 30', 15' or 7.5' intervals. These "quadrangles" are named by the most prominent geologic feature or the largest town. The 124-acre project site known as the Tupelo Tract is located on the Waterton Quadrangle.

On this map, the low-lying Bald Cypress Swamp is graphically illustrated by its defining boundary identified by the twenty-foot contour line. Also depicted is the presence of an intermittent stream flowing through the tract. This stream flows beneath the Tupelo Parkway and eventually discharges into Bald Cypress Swamp. Several borrow pits and cleared areas located around the site are instantly recognizable, as well as a dated rail bed to the south of the subject parcel. Distances and the location of significant landmarks are also ascertained from the topographic map. Approximately 4,800 linear feet of the Tupelo Tract extends east-west along the Tupelo Parkway. Bisecting the southernmost ridge defining Bald Cypress Swamp is Listing Oak Road, where Old Juniper Church and Honey Ridge Farm are located. Further east on Listing Oak Road, approximately 300 feet from Benchmark 23, is County Road 13 which runs north from Tupelo Parkway, south to Listing Oak Road through the heart of the uplands portion of the tract. This access road location, the site's proximity to main thoroughfares (Tupelo Parkway and Listing Oak Road) and the concentration of uplands as a contiguous body on the northern portion of the property make this tract ideal for residential development.

 Tupelo Tract: 124 Acres

1 inch equals 1,000 feet

0 1,000 2,000 Feet



Exhibit Created by Patrice Cook

# Infrastructure

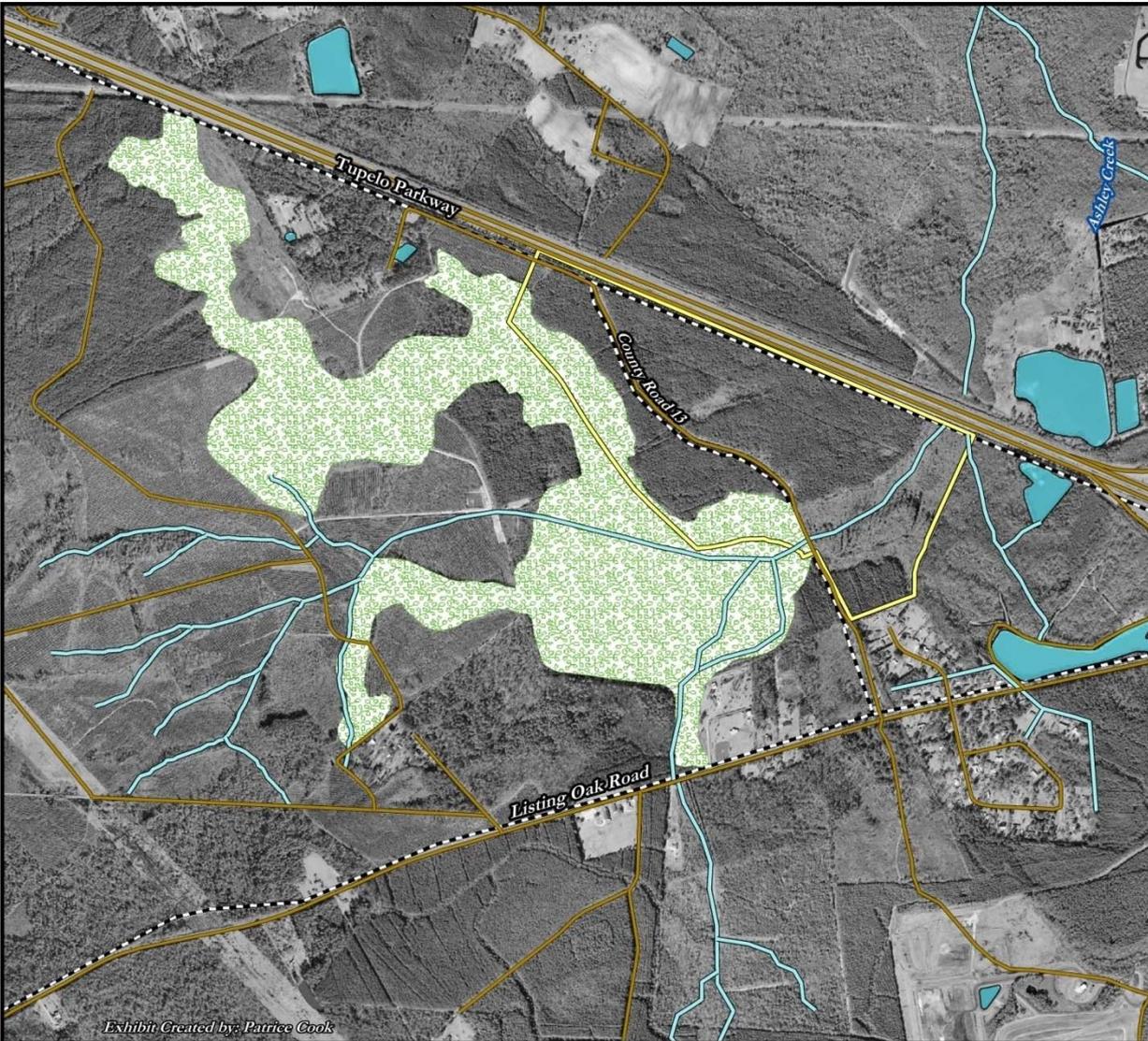


Exhibit Created by: Patrice Cook

## Exhibit 2: Available Infrastructure

This exhibit is derived from the layering of 2002 transportation and 2003 utility information maintained and updated by Caleb County and the Georgia Department of Transportation (GDOT) with black and white aerial photography distributed by Earthdata International, Inc. This map shows the location of roads and existing utility easements in the immediate area. This exhibit was designed to reveal the available connections of the Tupelo Tract to existing gas and power easements.

Note the existing utility easement maintained by Caleb County running alongside the Tupelo Parkway and the property access road, County Road 13 which offers connection to municipal utilities such as electricity, gas, water, sewer, and transmission lines. With this infrastructure already in place, the monetary costs associated with the project decrease dramatically, as does the disturbance required to install them. Furthermore, the existing road crossing and utility easement also reduces the need for further environmental impacts to the wetland system, benefiting both the natural area and the developer by eliminating engineering, construction, and permitting costs associated with such impacts. In addition, County Road 13 provides connection to a main thoroughfare that runs up and down the entire Georgia coast. An interchange for the Tupelo Parkway is located within a 1/4 mile of the property; an indication the site is accessible yet somewhat secluded by adjacent natural areas.

-  Tupelo Tract
-  Lakes
-  Roads
-  Streams
-  Bald Cypress Swamp
-  Existing Utility Easement



1 inch equals 1,004 feet



# Surrounding Land Uses

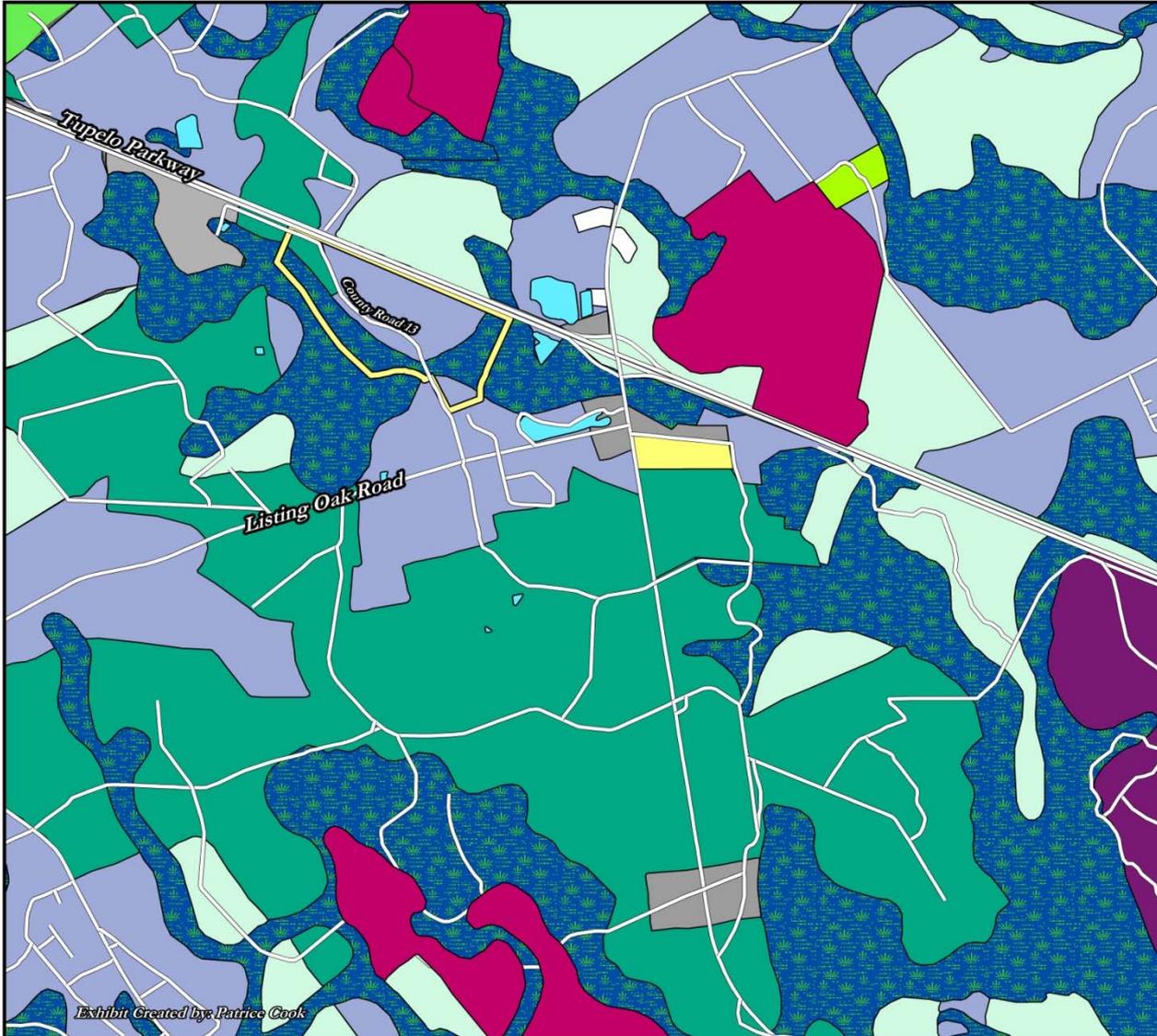


Exhibit Created by Patrice Cook

### Exhibit 3: Surrounding Land Uses

Figure 3 is a map of land uses compiled by the Caleb County Planning Commission and Waterton Building and Zoning Commission. Examining surrounding land uses is an important factor in determining the placement of future development. Land use maps offer insight to amenities available to serve residential communities such as grocery stores, shopping centers, and recreational areas. Benefits to a commercial development could be analysis of current commercial districts, proximity to competitors, and accessibility to major thoroughfares. A commercial development could benefit from an analysis of existing commercial districts, proximity to competitors, and accessibility to major thoroughfares. Understanding the surrounding land uses helps define the market conditions.

The current land use of the subject tract is predominately single-family (low to medium density) residential with clearly designated areas of wetlands, marsh, and recreational uses. The property to the north of the tract across the Tupelo Parkway is largely undeveloped. The properties along the Tupelo Parkway interchange are predominately retail, office, and commercial businesses which are conveniently located near the proposed development. In addition, adjacent public and institutional uses provide recreational opportunities. The context of the subject tract indicates an ideal location for a residential development.

**Landuse Classifications**

Retail, Office & Commercial	Agriculture & Forestry
Single Family Residential	Public & Institutional
Recreation	Recreation
Wetlands & Marsh	Industrial
Mobile Homes	Undeveloped

Tupelo Tract      Roads

Lakes

1 inch equals 2,000 feet

0      0.25      0.5      1  
Miles

# Sites of Interest

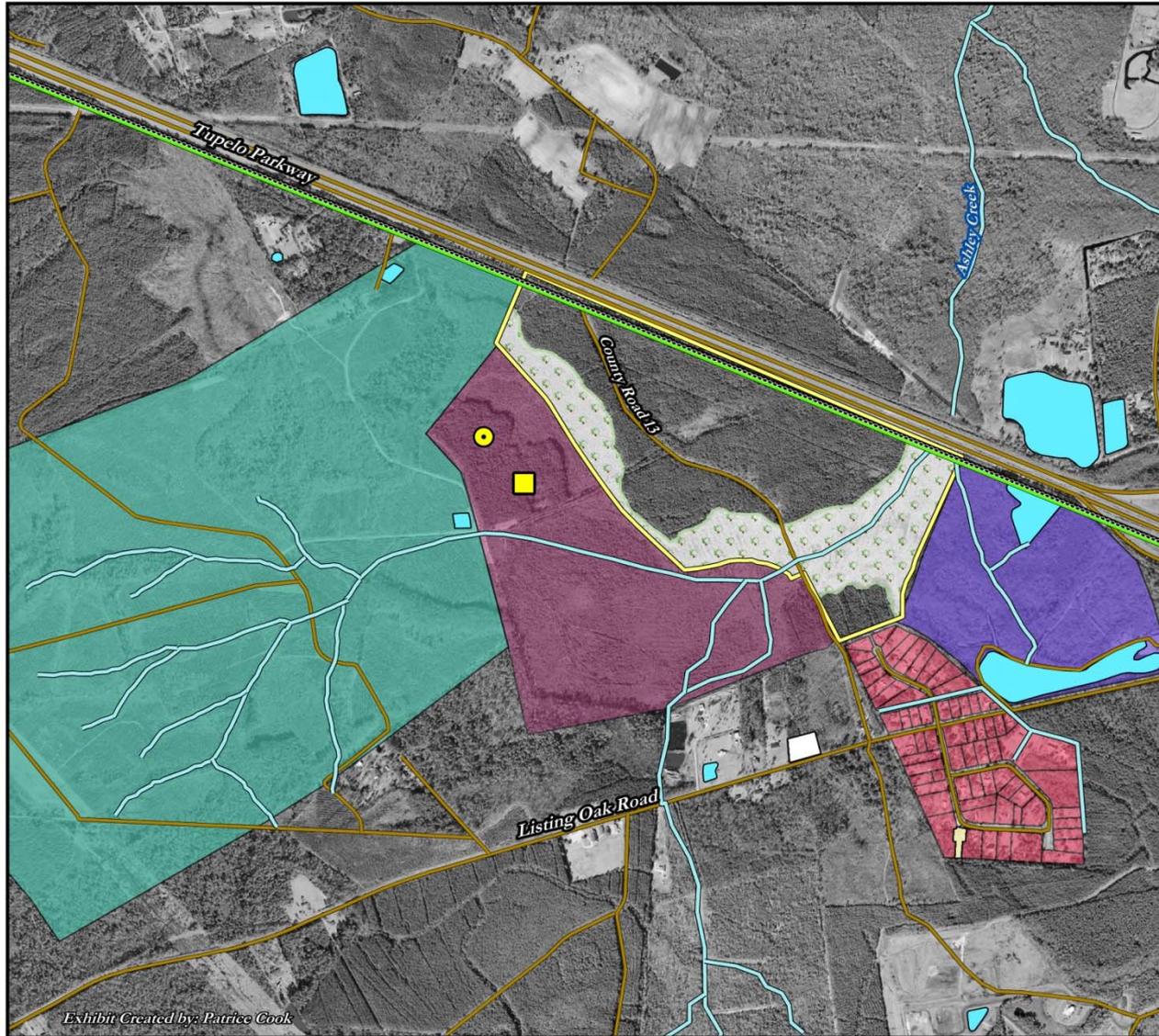


Exhibit Created by: Patrice Cook

## Exhibit 4: Significant Landmarks & Other Sites of Interest

Parcel information compiled by Caleb County and data from the U.S. National Park Service was utilized to build this map. This exhibit reveals some sites of interest located in close proximity to the Tupelo Tract including nearby churches, cemeteries, historic sites, recreational areas, wildlife preserves and adjacent residential developments. Most features recorded on a plat are listed within the parcel layer and are available to the viewer instantly as a particular parcel is selected. Information within the parcel database was queried to determine the value of the subject properties and adjacent tracts, the owner information, zoning designation, deeded acreage, and significant landmarks in the immediate project vicinity. Historic sites and structures were located by querying the National Register of Historic Places (NRIS) database. In addition, archeological sites were identified using report data from the Georgia Archeological Site Files (GASF) database.

This map shows the Tupelo Tract is bordered on the west by the Ashley Creek Wildlife Preserve and to the southwest by McDonough Plantation, a national historic site where a historic 18th century tabby home and rice mill are located. Juniper Crossing, a residential community is located southeast of the tract and Waterton Park, a county recreational area located east of the Tupelo Tract. This map also assisted in planning for future green space areas and trail connections.

### Sites of Interest

- |   |   |
|---|---|
|  McDonough Plantation National Historic Site |  Tabby Home Site         |
|  Juniper Crossing Residential Community      |  Rice Mill              |
|  Waterton Park Recreational Area           |  Regional Trail System |
|  Ashley Creek Wildlife Preserve            |  Juniper Church        |
|  Additional Green Space Sited              |  Lakes                 |
|  Juniper Creek Cemetery                    |  Streams               |
|  Tupelo Tract                              |  Roads                 |

1 inch equals 1,000 feet

0 500 1,000 2,000 Feet



# Wetlands

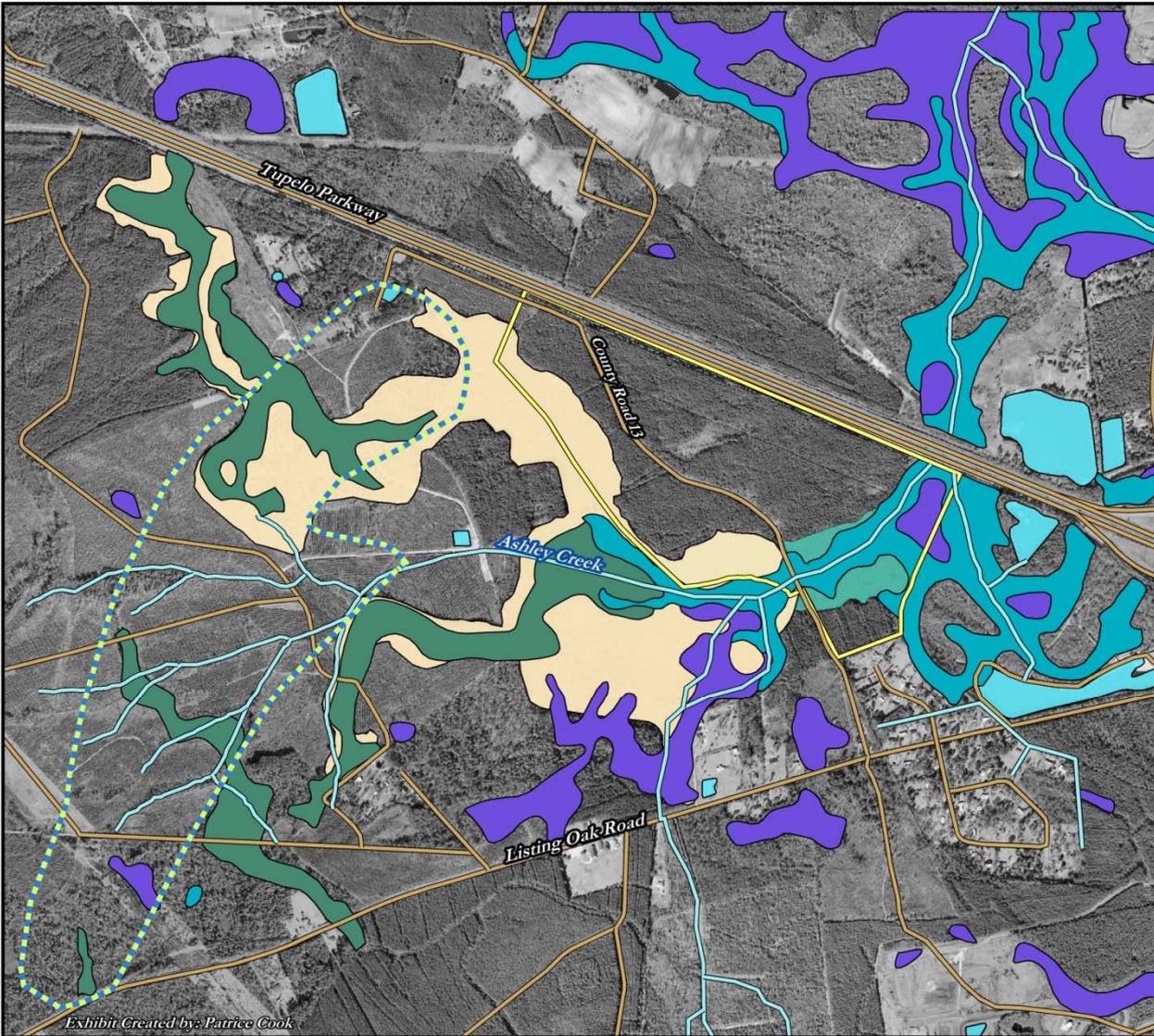


Exhibit Created by: Patrice Cook

## Exhibit 5: Wetlands, Streams, & Groundwater Recharge Areas

Figure 5 depicts the wetlands, marshes, ponds, lakes, streams, riparian forests, and significant groundwater recharge areas located within the tract and the immediate area. This map was used to locate the approximate wetland and stream boundaries so to avoid and minimize impacts to these areas to the greatest extent possible. These data layers were supplied by the U.S. Geological Survey (USGS) and the U.S. Fish & Wildlife Service (USFWS). In the mid 1970's, using aerial photography combined with information from NRCS soil surveys, the US FWS initiated the National Wetlands Inventory (NWI) program. The program was implemented to map the Nation's wetlands and report on their status. Each wetland is defined by type of vegetation and the areas' proclivity toward inundation (i.e. broad-leaved deciduous, seasonally flooded or needle-leaved, semi-permanently flooded). The presence and extent of the Ashley Creek and its large contiguous swath of riparian wetlands known as the Bald Cypress Swamp is apparent within the Tupelo Tract. A large portion of the Tupelo Tract is highland, while its southern, eastern and western borders are composed of deciduous semi-permanently flooded and semi-flooded wetlands.

Wetland systems are essential to flood control and provide habitat for a diverse palette of plants and animals, some of which are endangered or threatened. The NWI enables the planner to design a layout which avoids and minimizes impacts to the system. In addition, this map can be used to locate future development, specifically stormwater drainage systems and septic systems, away from major groundwater recharge areas and wetlands. Locating aquatic resources can also identify necessary buffers and conservation areas.

### NWI Codes

-  Broad-Leaved Deciduous Seasonally Flooded
-  Needle-Leaved Deciduous Seasonally Flooded
-  Deciduous Semi-flooded
-  Deciduous Semi-permanently Flooded
-  Needle-Leaved Evergreen Seasonally Flooded
-  Groundwater Recharge Area
-  Tupelo Tract
-  Roads
-  Streams
-  Lakes

1 inch equals 1,000 feet



# Floodplain and Elevations

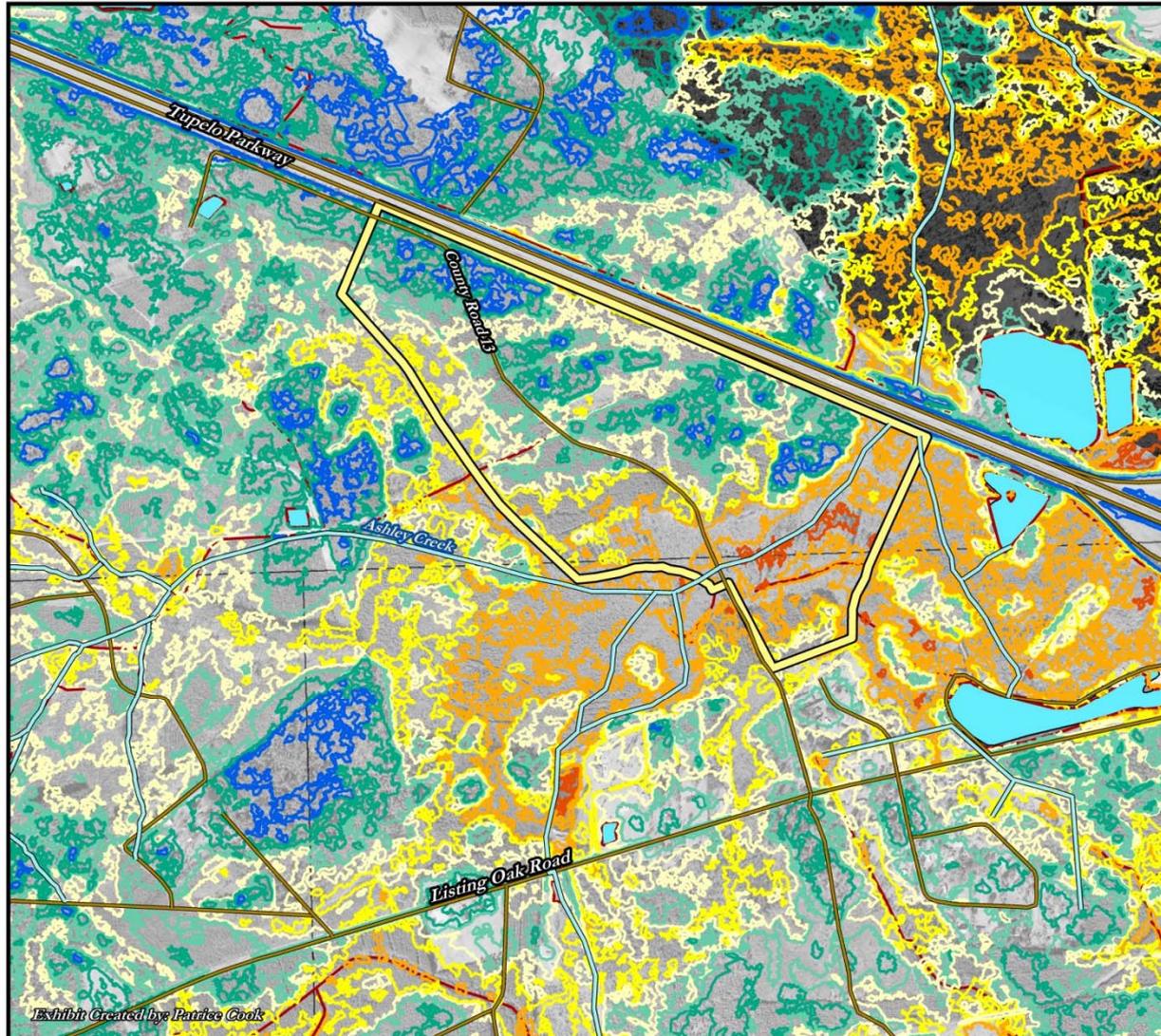
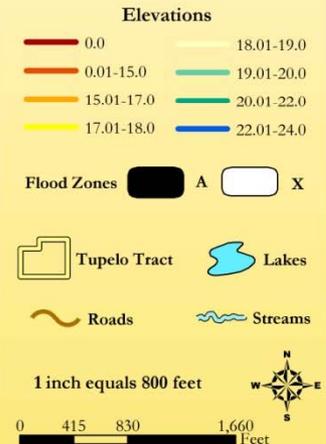


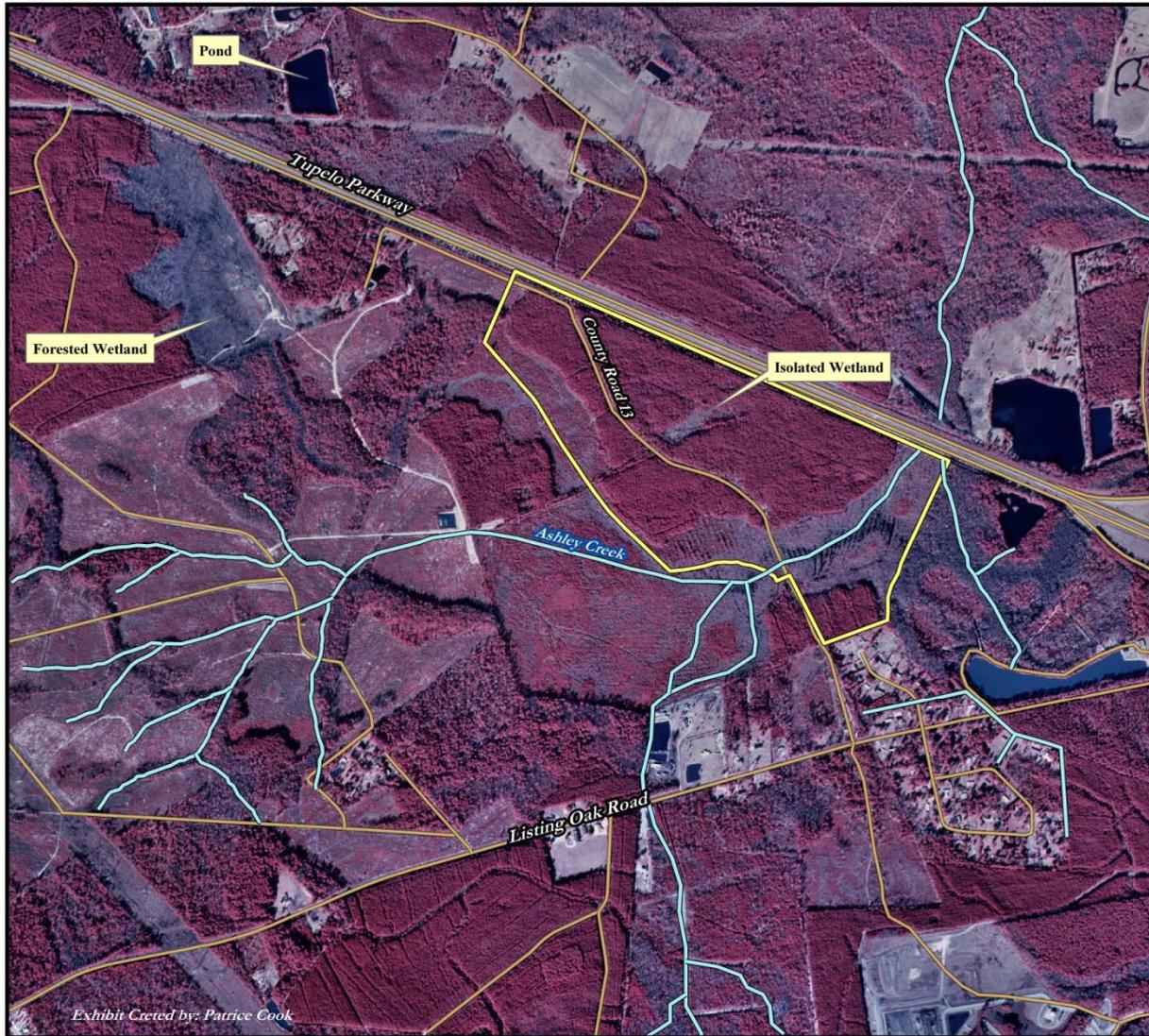
Exhibit Created by Patrice Cook

**Exhibit 6:  
Floodplain and Elevations**

Figure 6 layers elevation contours produced from Airborne Laser Terrain Mapping (ALTM) by Earthdata International with National Flood Insurance Rate Maps (FIRM) from the Federal Emergency Management Agency (FEMA) for a more accurate depiction of elevation and proximity to the floodplain. The Federal Emergency Management Agency produces maps of flood prone areas. Because FEMA subsidizes flood insurance claims, these maps encourage development outside of the floodplain. Flood zone "A" is located within the 100-year flood boundary while zone "X" is located outside of the 100-year flood zone. This map shows the project site is located outside the 100-year floodplain, while most of the surrounding area northeast of the site is located within an area of flood concern. The map clearly indicates the area within the Tupelo Tract north of County Road 13 is 18 to 24 feet above mean sea level, while the area south, northeast and southwest of County Road 13 has a peak elevation of 20 feet and averages somewhere around 18 feet above mean sea level. These dimensions reflect natural drainage toward the lower, southern portions of the property, specifically toward the Ashley Creek. This information was utilized to determine the location of roads, stormwater treatment practices, and the general layout of the residential home sites.



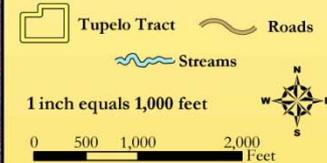
# Vegetation Type/Extent



## Exhibit 7: Vegetation Types & Extent of Coverage

The U.S. Geological Survey supplies Color Infrared (CIR) of most of the United States. Each CIR is bound by the same coordinates as used to define the quadrangles of USGS topographic maps. This is the CIR of the Waterton Quadrangle taken in 1999. The aerial photograph was used to determine potentially wet areas within and adjacent to the site. This photography displays heat signatures emitted from the terrain as a range of colors from red to black. Wetlands, streams, marshes, lakes, and ponds display generally as black, indicating deep water; lighter shades of blue represent seasonally flooded forested wetlands; greenish blue indicates emergent wetlands and marshlands. Uplands typically show as a range of deep burgundy red to pink depending on the density of vegetation coverage. The denser the vegetation the more intense the red hue becomes. Acreage of tree cover can be quickly calculated when assessing site suitability. The type of indigenous trees and vegetation types within and around the subject tract can be identified and quantified on this coverage by recognizing its characteristic signature. The physical condition, growth pattern, and approximate age of the vegetation can also be inferred. Stressed vegetation, old growth forests, and past forestry and agricultural practices can be determined by viewing this type of imagery.

The uplands within the Tupelo Tract appear to be covered by mostly pine forest mixed with some tupelo and sweetgum. The viewer can infer from the light blue signature of this area and its proximity to the creek that it is most likely bottomland hardwood forest comprised of pines, maple, and cypress. The wetlands appear to have been timbered in the past and re-planted with pines evident by linear features (rows) and their associated bright red tones (upland species) intermingled among the deep blue hues indicative of wetlands. Also note a faint blue signature north of County Road 13 and centrally located within the uplands of the Tupelo Tract. This is a low-lying area (See Figure 6: Floodplain and Elevations), and is most likely an isolated wetland due to its proximity to the Bald Cypress Swamp and Ashley Creek. CIR photography makes these systems immediately apparent to the viewer and can be used by site designers to avoid and minimize impact to these areas during the planning phase of development. In addition, this imagery greatly aids in the planning of tree save areas, timber harvest areas, buffers and hiking trails.

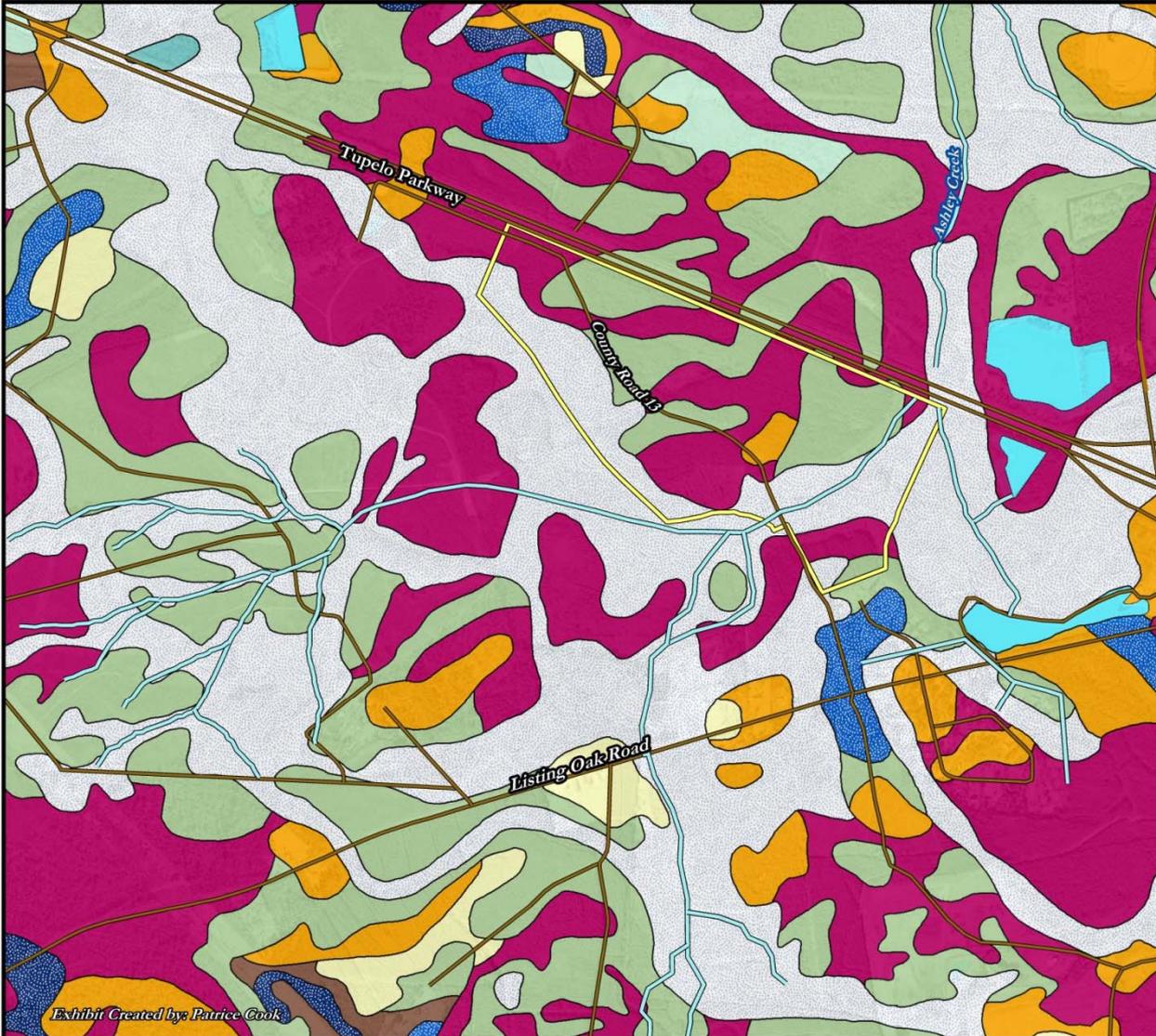


# Soils

## Exhibit 8: Soils Analysis

This soil map was taken from the Soil Survey of Caleb County generated in 1977 by the Natural Resources Conservation Service (NRCS). Soils are important for many reasons; they sustain plant and animal life; they regulate the flow and filtration of contaminants in runoff; and they are critical for locating septic systems and when engineering foundations for roads and buildings. A soil survey depicts soil boundaries by series with supporting tables of information on soil properties. The plasticity, drainage capacity, stability, permeability, and shrink-swell potential of each soil series are described in detail within the database. Building lots and supporting infrastructure can be located based on the suitability of certain soils and their intended use.

Most of the upland soils contained within the Tupelo Tract belong to the Lakeland, Wahee, and Ocilla Series. These series are generally sandy, well-drained soils adequate for most road and building foundations, as well as for stormwater detention facilities. The Ashley Creek and surrounding areas contain Ellabelle soils. Ellabelle is a poorly-suited wetland soil that should be avoided with structural foundations, especially sites supported by septic tanks.



### Soil Types

	Lakeland		Albany
	Wahee		Craven
	Ocilla		Ellabelle
	Olustee		Mascotte
			Ogeechee

Hydric Soils Shown Stippled in Blue  
May Indicate the Presence of Wetlands

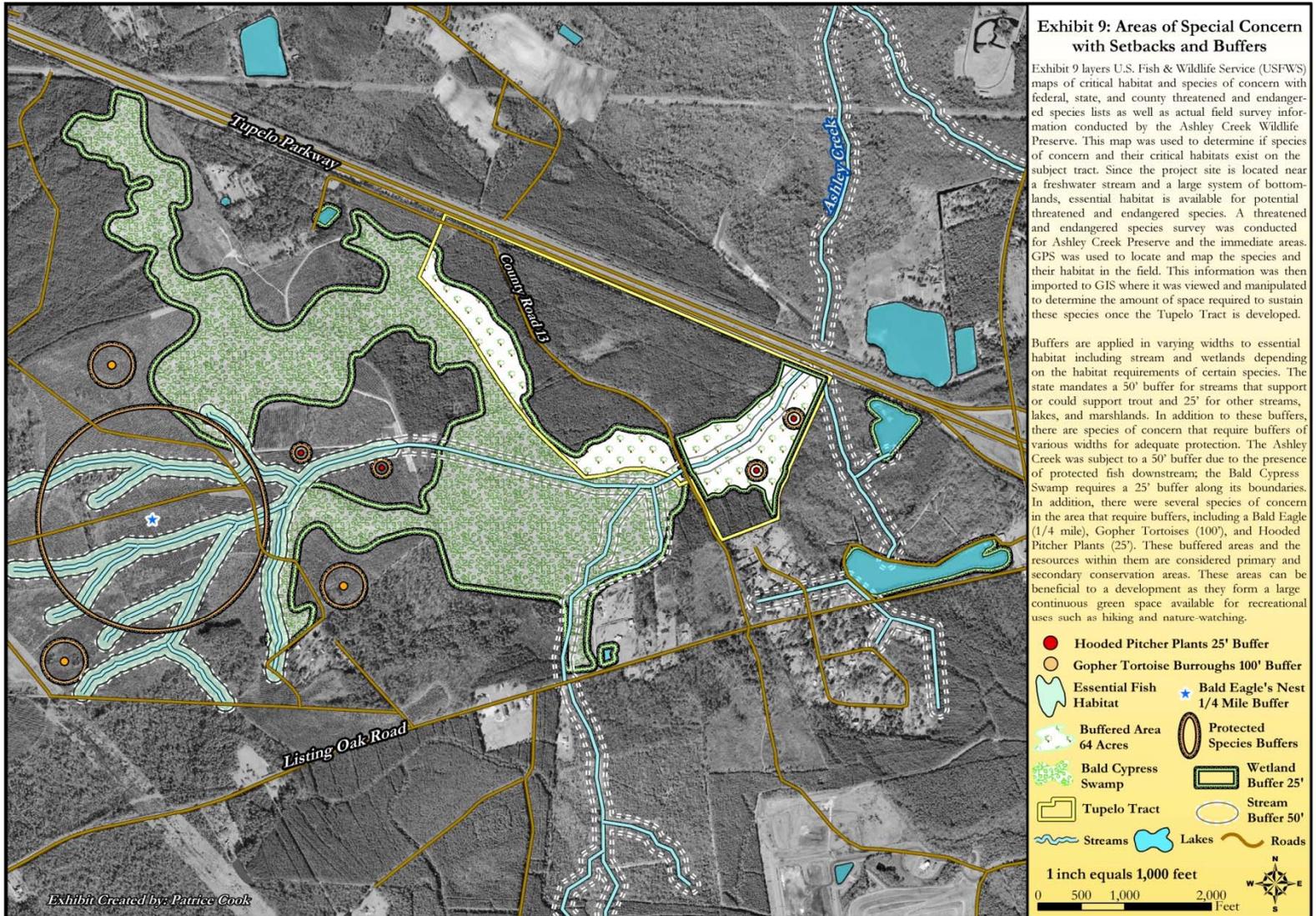
	Tupelo Tract		Streams
	Lakes		Roads

1 inch equals 1,000 feet



Exhibit Created by Patrice Cook

# Setbacks and Buffers



# Coastal Resources



Exhibit Created by: Patrice Cook

## Exhibit 10: Downstream Coastal Resources of Concern

This map was assembled from USGS color infrared photography and coastal data sets compiled by the Georgia Department of Natural Resources (GDNR). Figure 10 reveals the coastal resources located within a 1/2 mile downstream of the Tupelo Tract. The Ashley Creek eventually discharges into the Ogeechee River, which outfalls into a system of marshlands, hammocks, and beaches all of which are areas vital to the existence of fish, crab, shellfish, and migratory birds that inhabit these areas. This information can be used to avoid impacts to the nearby marsh ecosystem by implementing measures that improve downstream water quality and protect resident and transient animal populations simultaneously. For example, upstream developments with detention ponds, bio-swales, and forested stream buffers capture and clean stormwater runoff before it enters creeks and marshes lessening the impact to these downstream species and their habitats. In addition to upstream improvements, waterfront development must give special consideration to siting septic tanks, parking lots, and turf lawns since pollutants from these areas can cause serious degradation to coastal ecosystems. Shellfish and harvest areas have strict water quality standards imposed by the U.S. Department of Agriculture (USDA) regarding nutrient loadings, turbidity, dissolved oxygen and especially fecal chloroform bacteria (most often related to septic tanks). Waterfront development setbacks must be greater near these areas to assure that septic system effluent does not reach these harvest areas via shallow groundwater. Community waste treatment systems, whether sewer or on-site systems with a common drainfield set back as far as possible from the water would be an ideal design for these areas.

This photography can also be used for river and beach erosion studies. Accreted sand beaches and dunes as well as areas of bank scour and channel shoaling are evident from an aerial view.

Coastal estuaries, marshlands, rivers, and creeks play a vital role in the proliferation of fish, crab, and shellfish populations. For this reason, these areas deserve special planning and design measures that serve to protect these resources in perpetuity. The sustained health of these resources can provide endless commercial and recreational opportunities to residents and visitors including fishing, boating, kayaking and swimming.

	Essential Fish Habitat		Shellfish Harvest Area
	Crab Harvest Area		Public Beach
	Coastal Hammock		

1 inch equals 0.75 miles

0 0.25 0.5 1 1.5 Miles



# Buildable & Conservation Areas

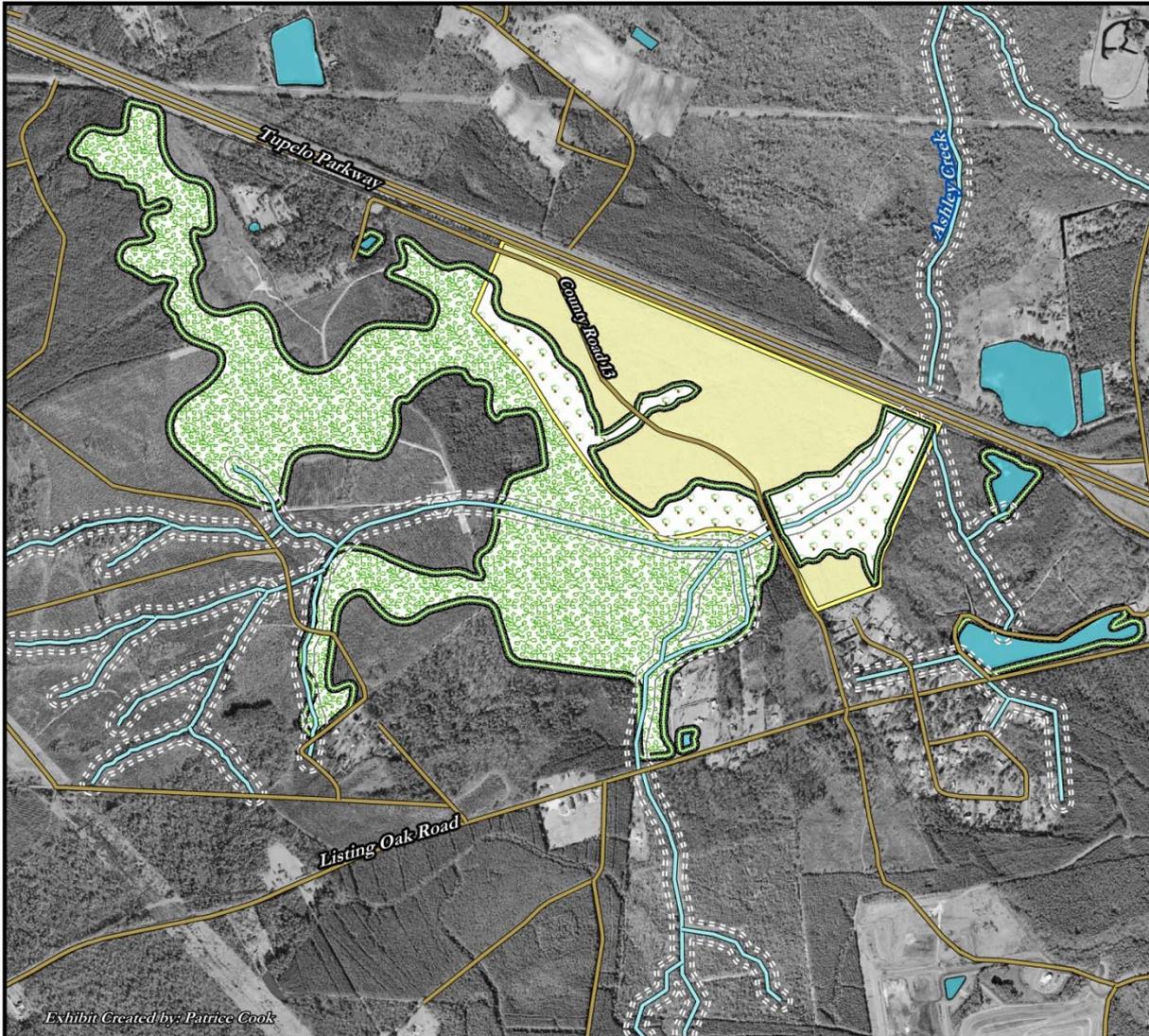


Exhibit Created by: Patrice Cook

## Exhibit 11: Overall Composite: Buildable, Primary, & Secondary Conservation Areas

Figure 11 is a compilation of previously analyzed individual site characteristics. These features are classified into three main areas: Primary Conservation, Secondary Conservation, and Actual Buildable Area. Primary conservation areas include the Ashley Creek and the Bald Cypress Swamp. These areas are considered essential fish and plant habitat and should be preserved to the greatest extent possible. Secondary conservation areas denote areas to be considered during site design for additional protection such as poor soils, groundwater recharge areas, and downstream resources. By viewing an overlay of these conservation areas, a viable buildable area for the Tupelo Tract was determined and quantified. The "development envelope" consists of 124 acres, including standard setbacks and buffers, mostly located on the uplands, north of the Bald Cypress Swamp. The remaining portion of the property composes a preserved area of approximately 64 acres, almost all within Bald Cypress Swamp and Ashley Creek.

### Primary Conservation Areas

-  Bald Cypress Swamp
-  Ashley Creek

### Secondary Conservation Areas

-  Buffered Area 64 Acres
-  Wetland Buffer
-  Stream Buffer
-  Actual Buildable Area: 124 Acres
-  Tupelo Tract
-  Lakes
-  Roads

1 inch equals 1,000 feet

0 500 1,000 2,000 Feet

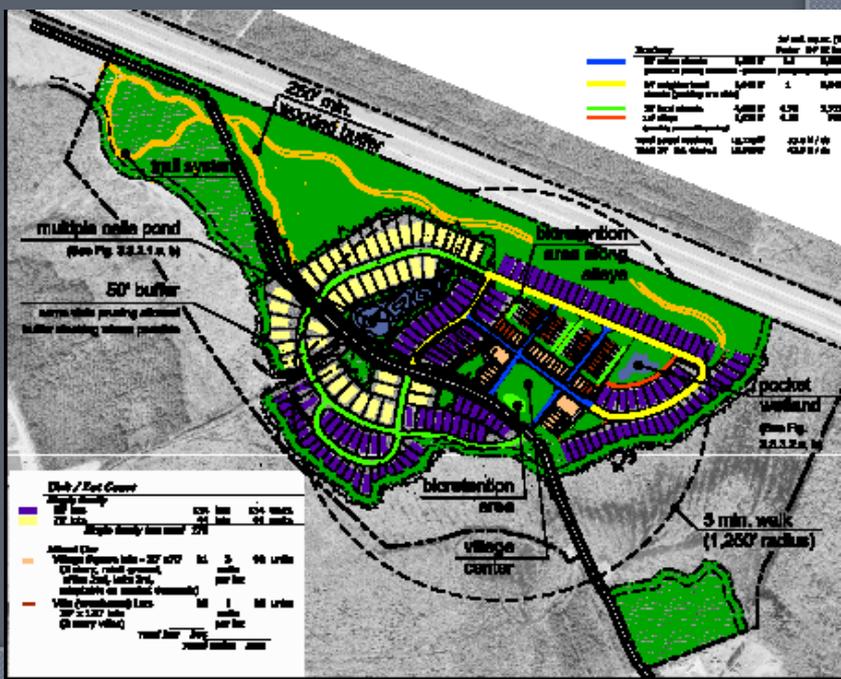
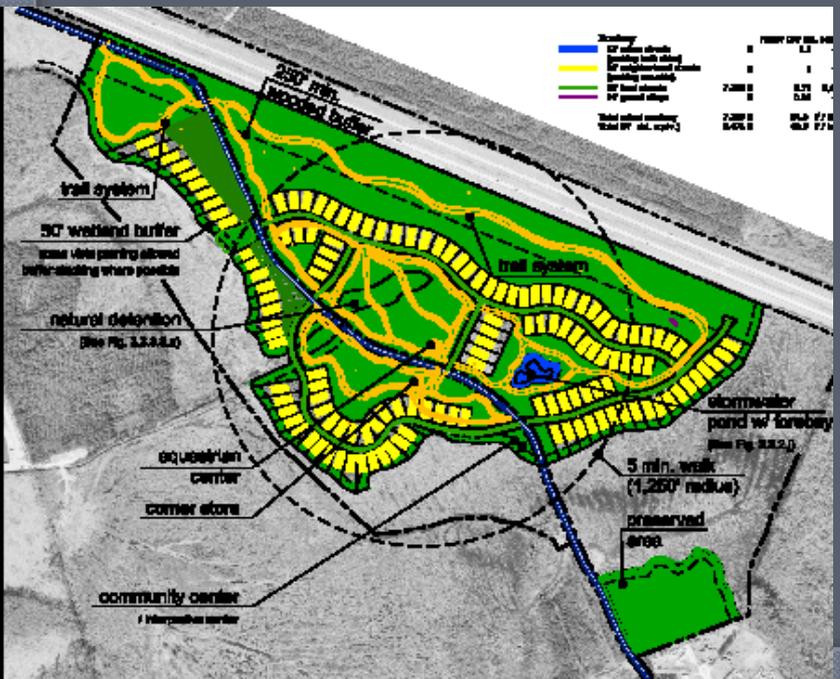
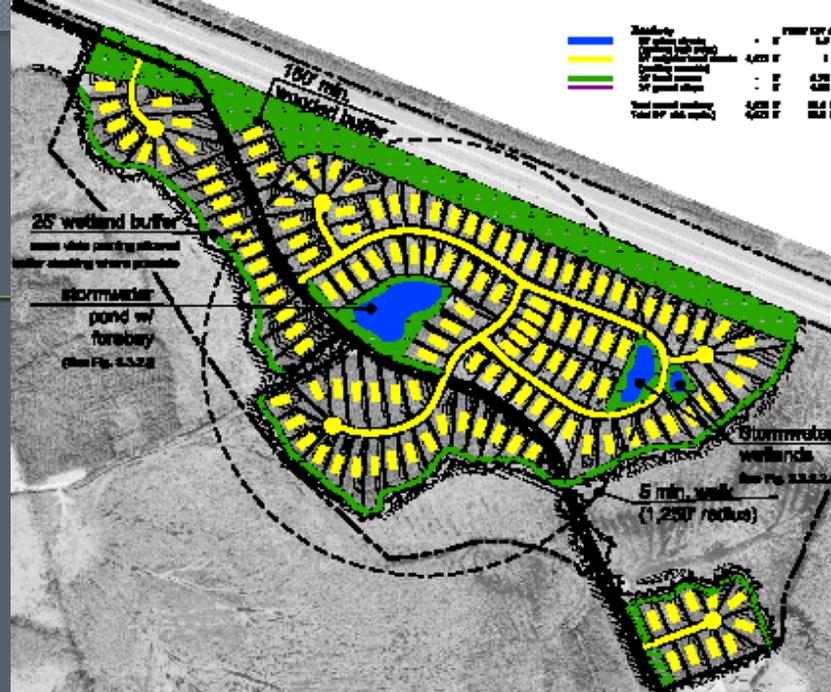


# CH. II

## Designing with the Landform

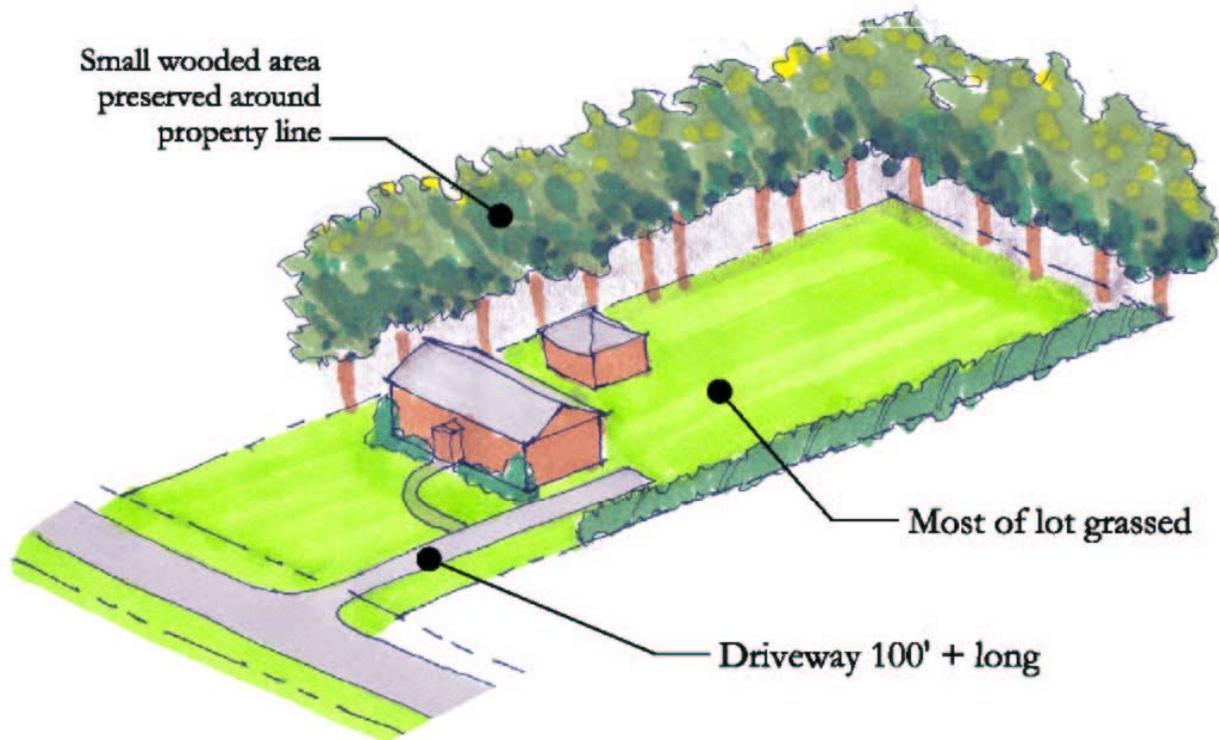
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- ◎ Simple, intelligent design
- ◎ Design with nature
- ◎ Increased value, cost-savings





# Conventional Lot

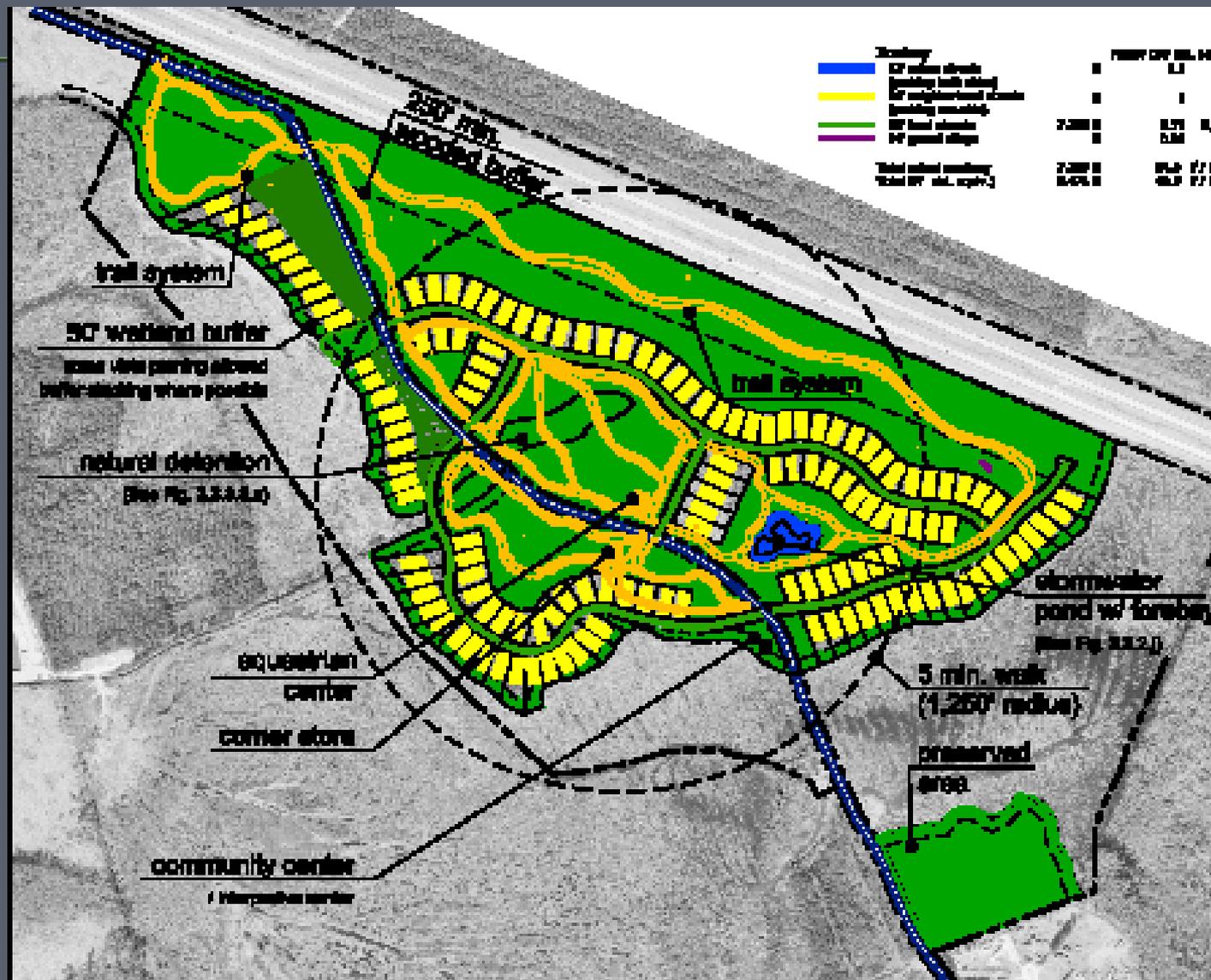


## **Typical Lot Development - Conventional**

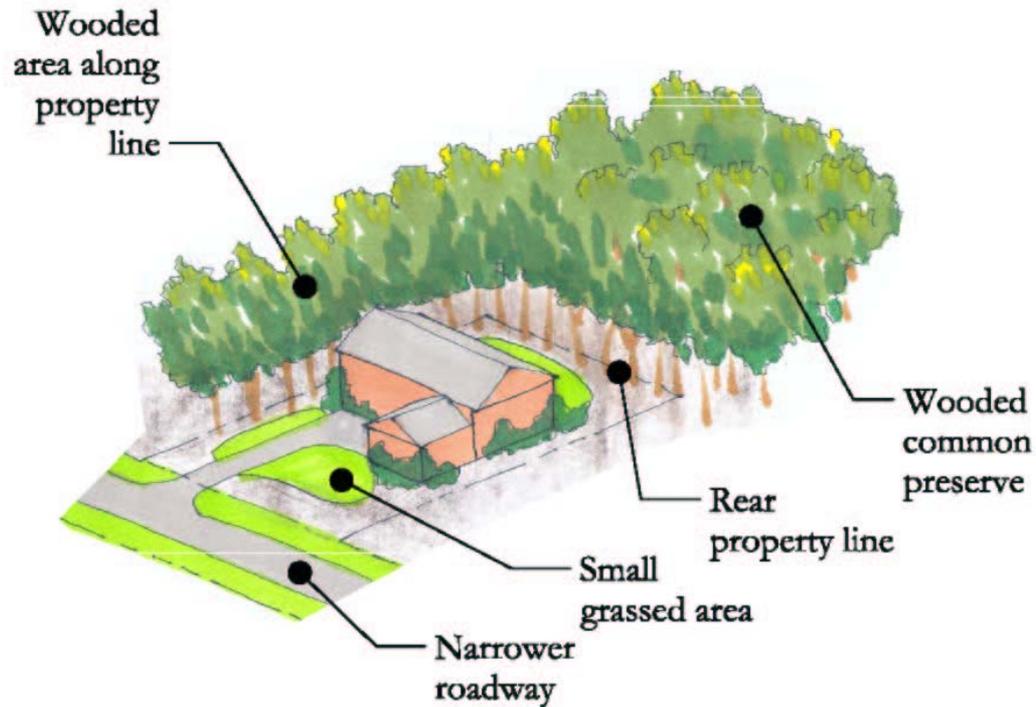
Figure 2.6.2.1.a - nts

Matthew R. Baker, ASLA

# Community Preserve Site Plan



# Community Preserve Lot



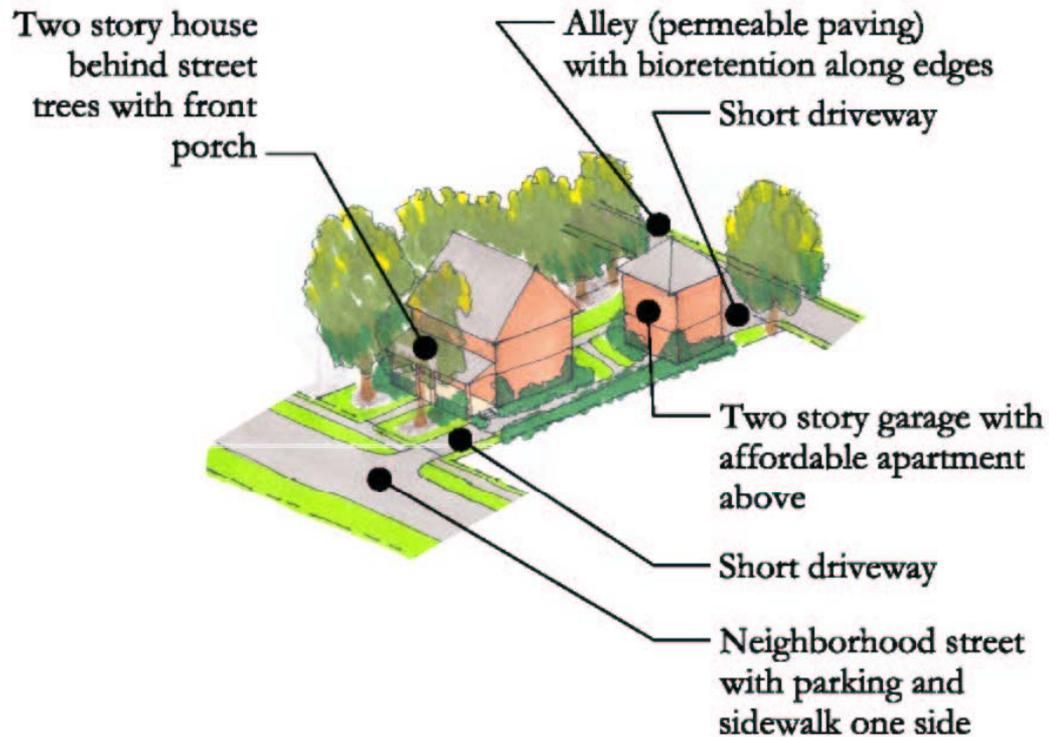
## Typical Lot Development - Community Preserve

Figure 2.6.2.2.a - nts

Matthew R. Baker, ASLA



# Village Lot



## Typical Lot Development - Village

Figure 2.6.2.3.a - nts

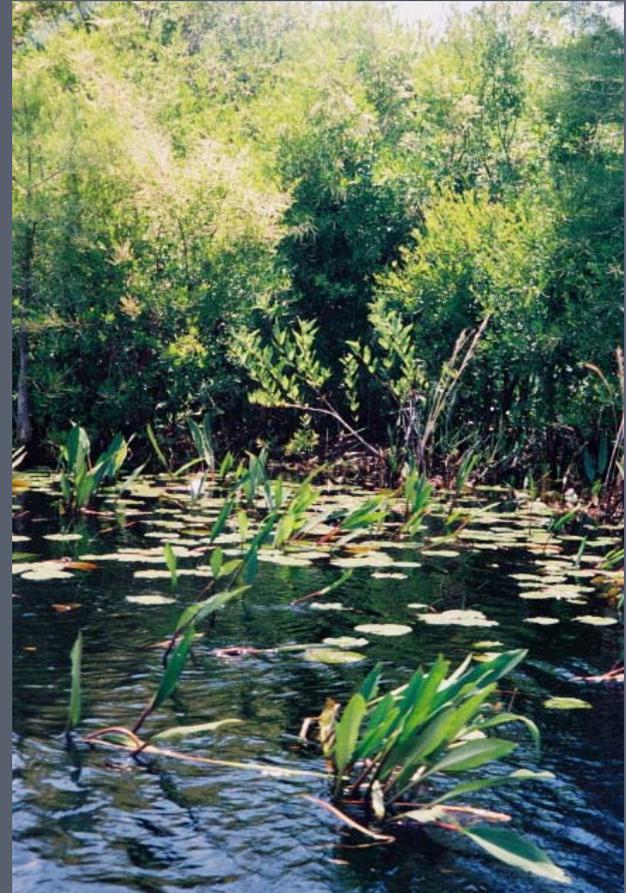
Matthew R. Baker, ASLA

	Conventional	Community Preserve	Village
Total Site Area	188.6	188.6	188.6
Total Uplands	123.9	123.9	123.9
Disturbed Footprint	54%	26%	34%
Total Gray Space	12%	11%	17%
Upland Greenspace	18%	61%	48%
Greenspace (w/wetlands)	46%	74%	66%
Greenspace (w/on lot)	61%	79%	71%
Lot Yield (Net of Upland)	1.1 dua	1.1 dua	2.0 dua
Total Impervious (per lot)	4869 sf	4125 sf	3118 sf
Stormwater Runoff (per lot)	2.1 cfs	1.4 cfs	1.0 cfs
Total Cost (w/ impact fees)	\$1.4 M	\$1 M	\$2.6 M
Total Cost (w/o fees)	\$1 M	\$680k	\$1.8 M
Gross Profit Margin (w/fees)	36%	47%	51%
Gross Profit (w/o fees)	41%	52%	56%

# Water Quality

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- ◉ Interaction Vegetation-Soils
- ◉ Infiltration-Filtration
- ◉ Microbial Activities
- ◉ Immobilizes-Removes Pollutants
- ◉ Erosion-Sedimentation



# CH. III

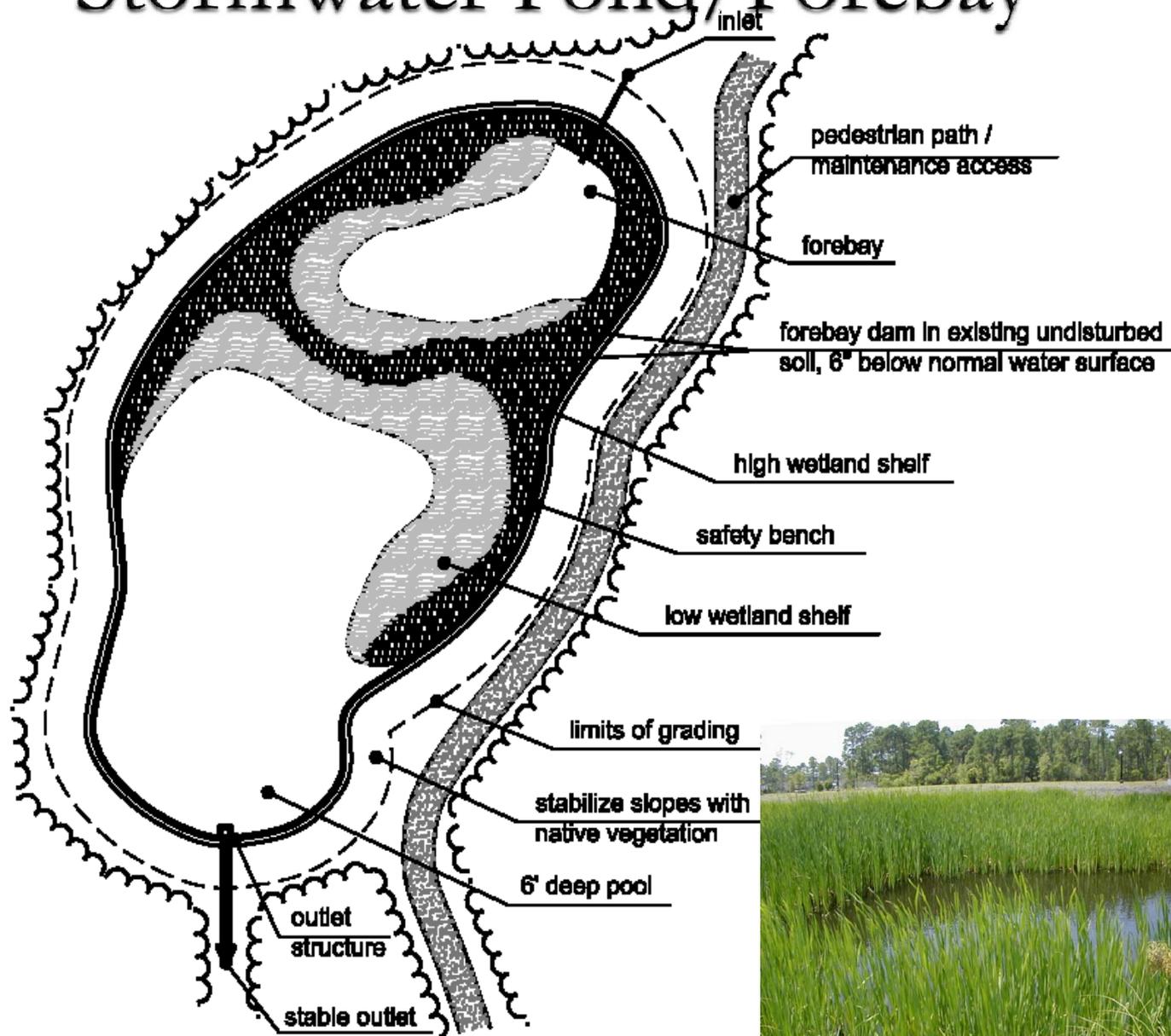
## Stormwater Management

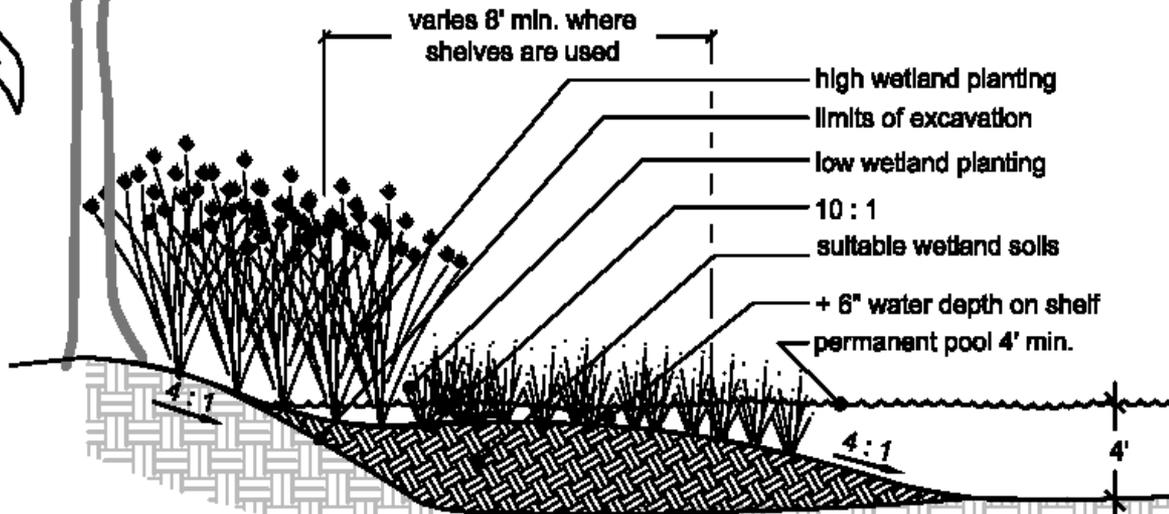
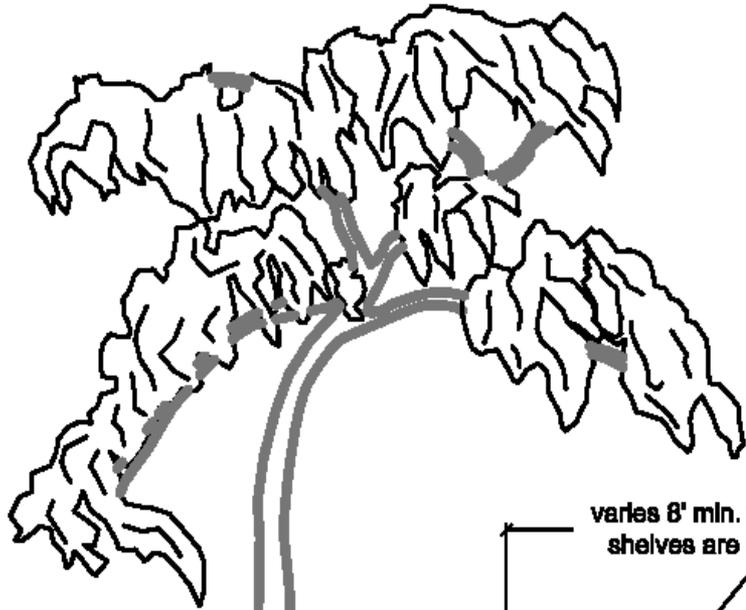
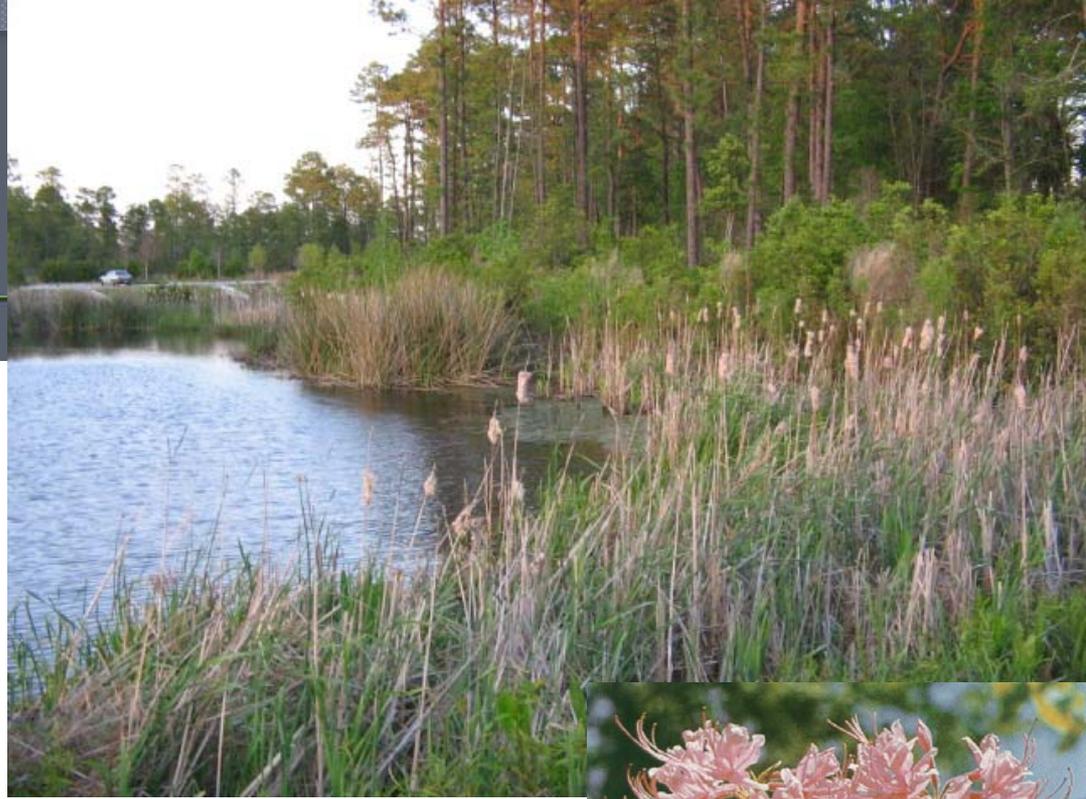
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- ◉ Multi-purpose
- ◉ Flood Relief
- ◉ Control NPS
- ◉ Wildlife Habitat
- ◉ Enhanced Appearance

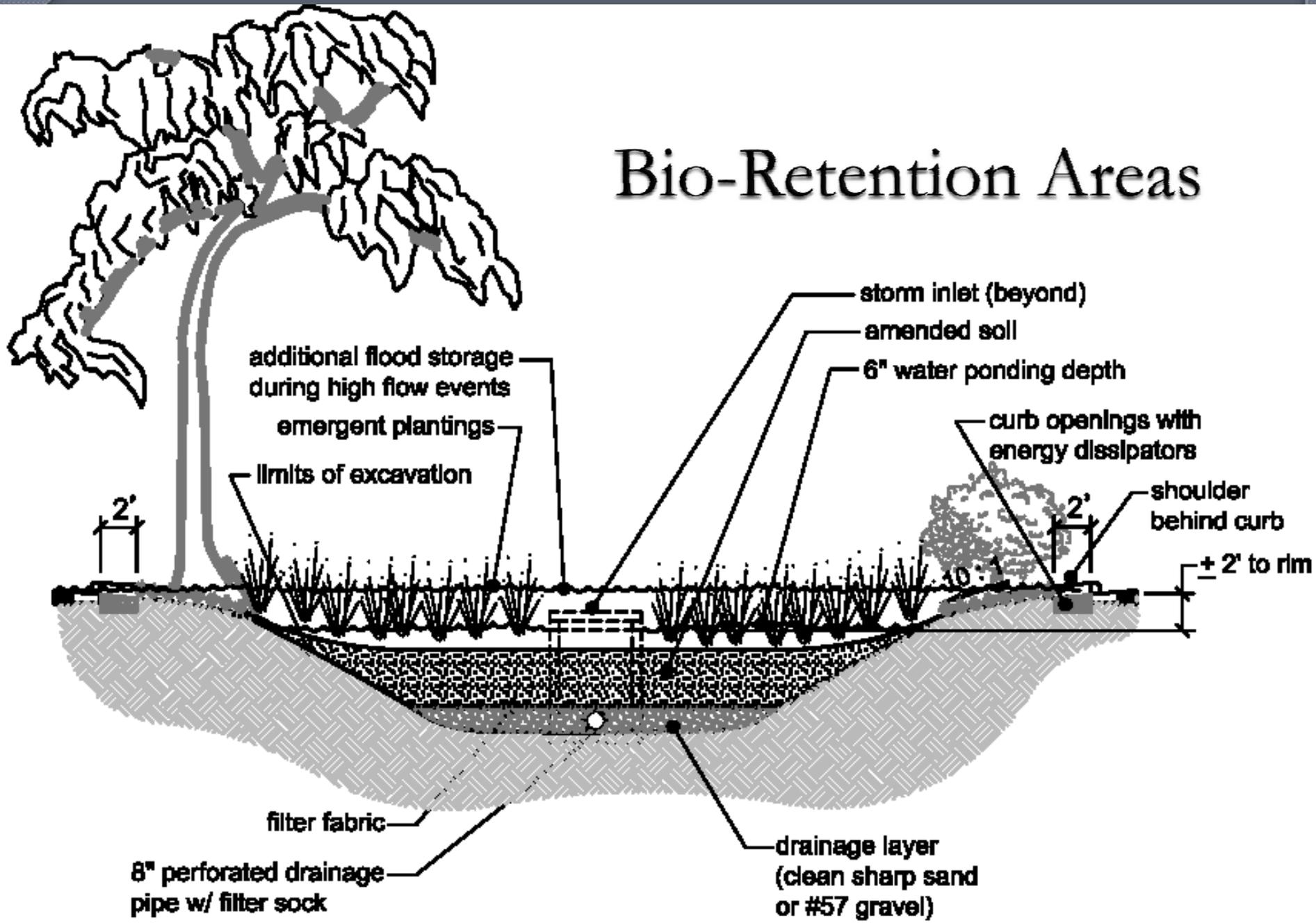


# Stormwater Pond/Forebay





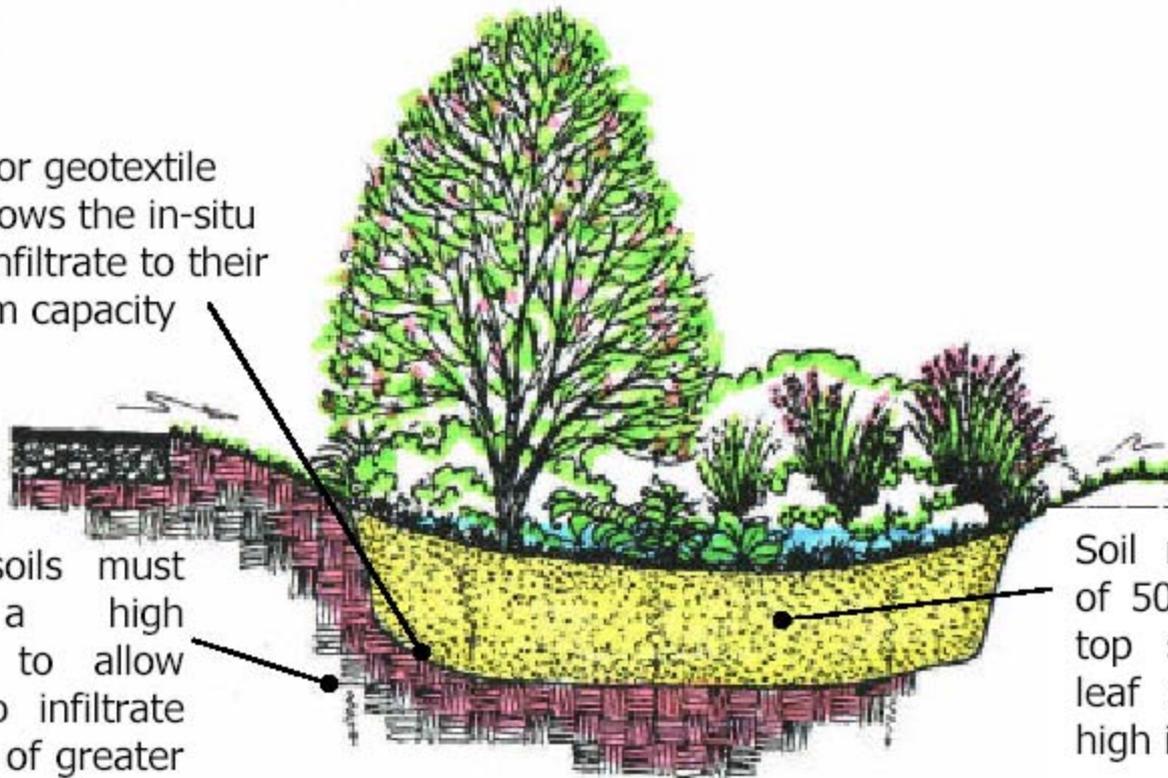
# Bio-Retention Areas



# Rain Gardens

No liner or geotextile fabric allows the in-situ soils to infiltrate to their maximum capacity

In-situ soils must have a high porosity to allow runoff to infiltrate at a rate of greater than 1"/hr



Soil medium consisting of 50-60% sand, 20-30% top soil, and 20-30% leaf compost allows a high infiltration capacity



# Residential Application





- Commercial
- Industrial
- Transportation

# Green Roofs



- Versatile Application



# Permeable Paving



# CH. IV

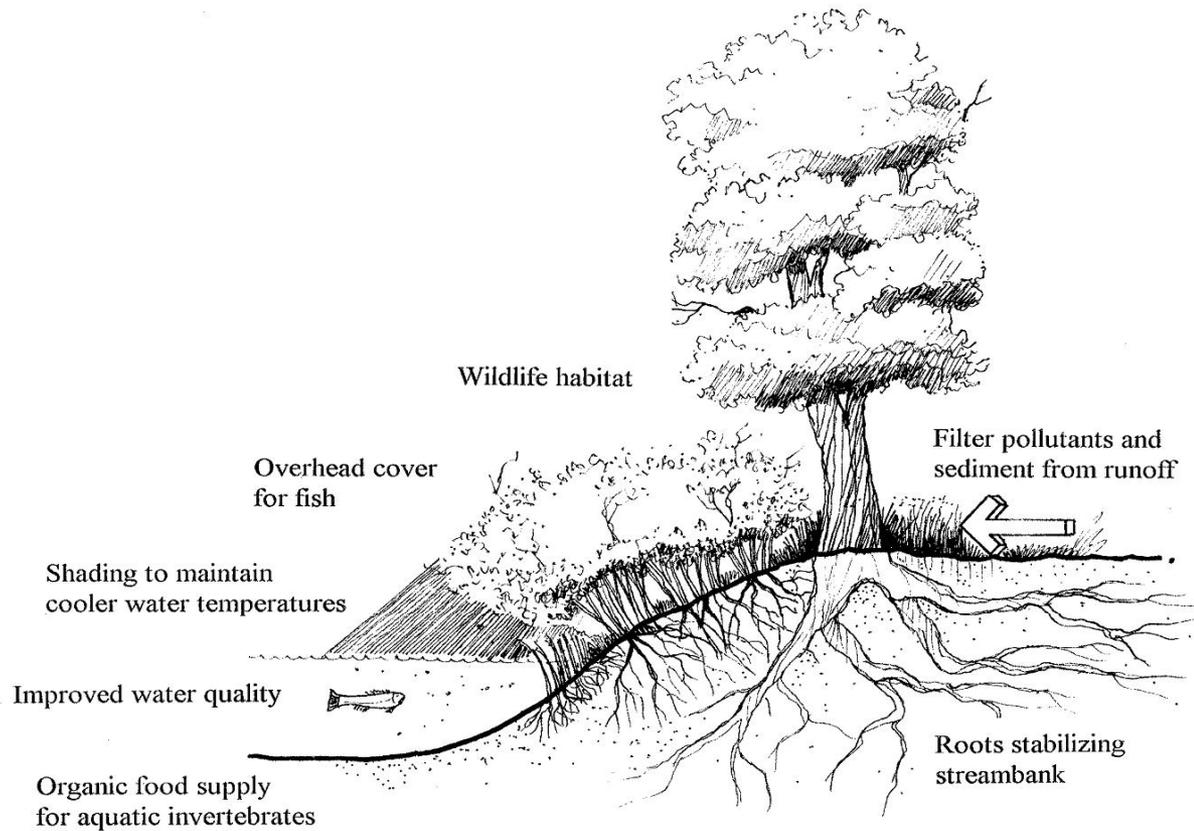
## Streambank Stabilization

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- ◎ Natural & Effective Solutions
- ◎ Native Trees & Plants
- ◎ Habitat

# Mimic Natural System



# Bio-Engineering

- Slope & Grade Banks



- Plant Native Vegetation

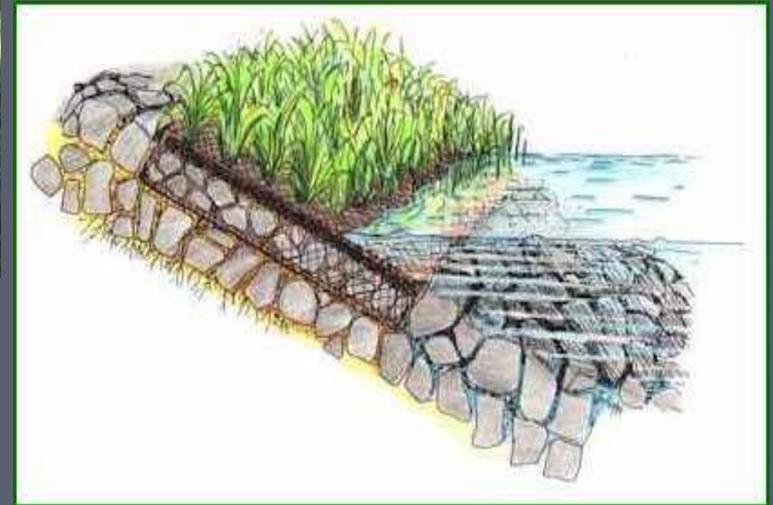
# Temporary Solutions

## Fiber Rolls, Geo-grids



# Permanent Reinforcement

## Gabions, Cribwalls, Revetments



G3 is available on the web

[www.gadnr.org](http://www.gadnr.org)

Coastal Resources-Coastal Management Program



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