Site Fingerprinting Utilizing GIS/GPS Technology

1.1 What is Site Fingerprinting?

Site fingerprinting is a planning tool used to design communities where protection of natural resources is the primary focus. This process enables the user to view, identify, and analyze the natural, built, economic, and social aspects of a prospective site.

Site fingerprinting has five key objectives:

- Identify general site features,
- Determine and locate primary and secondary conservation areas,
- Consider the impact of other important factors such as adjacent land uses, accessibility, transportation and infrastructure availability,
- Use collected information to derive the actual buildable area, and
- Synthesize this information to create various development scenarios which incorporate the natural features of the site.

Land planners, community officials, environmental scientists, engineers, and developers can protect natural resources using this ecology-based planning approach. Built on traditional principles, site fingerprinting uses technology Geographic Information Systems (“GIS”) and Global Positioning Systems (“GPS)”] to avoid and minimize environmental impacts as well as facilitate integration of the natural features and existing environmental conditions of the site into the development concept.

1.2 Site Fingerprinting using GIS and GPS

Site fingerprinting is made dramatically more efficient and accurate through use of GIS and GPS. These remarkably versatile mapping tools have great utility in land planning and development. GIS is used to query, analyze, and clearly display information in the form of generated maps and accompanying reports. GPS is used to locate new features or to verify, validate, and update existing information with accurate survey data collected from the site.

The results of site fingerprinting using GIS and GPS can be communicated with maps, reports, or both. A map may display geographic relationships best, while a report may be most appropriate for summarizing tabular data or documenting calculated values.

The virtual desktop application of GIS and real-time application of GPS make site fingerprinting faster, cost-effective and more efficient, especially when considering the time saved in the field identifying and marking natural features already noted through GIS and GPS. While not a replacement for conventional methods, GIS and GPS improve the conventional process with precision and efficiency previously unattainable. Older methods compile this information by hand using expensive photographic enlargements to create a series of overlays by which the site can be read. These time-consuming site reconnaissance and analytical tasks can be performed rapidly using GIS and GPS. (Figure 1.2.a)

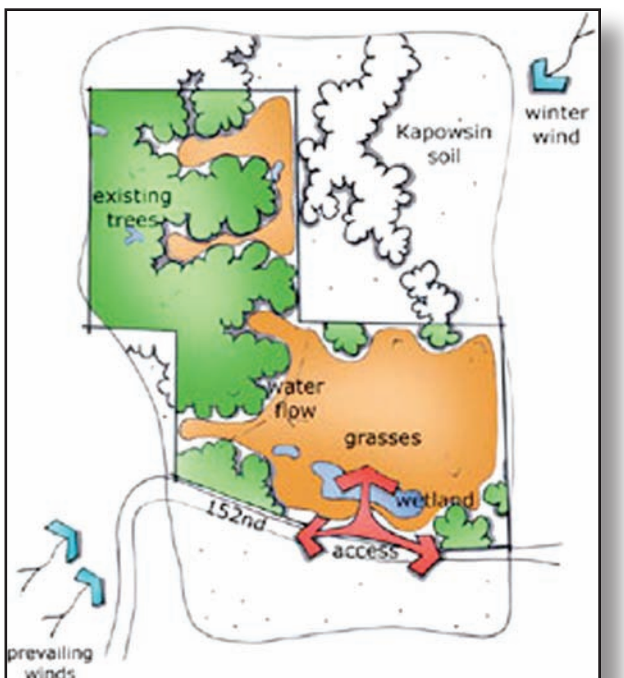

Figure 1.2a Traditional Planners Sketch of Site Inventory Image
Image Courtesy of: Pierce County WA and AHBL, Inc.

1.2.1 What is GIS?

GIS is a digital, *visual* library of information. In this library, *layers* are the books. By simply adding the desired layers of information such as parcels, streets, utilities, floodplain, soils, and streams, a single digital map is produced that simultaneously displays a wealth of information. What previously took weeks to research now takes a matter of hours or even minutes to complete.

Figure 1.2.1a Conventional Soil Map from NRCS
Image Created by: Patrice Cook

For example, soil surveys were previously available only in books of fold out maps. Organized by an index within the county, dated roads as well as other landmarks were the only way to narrow the search for a particular site. With GIS, this information is set to coordinates, digitized, and seamed together to form county soil layers. The soil layer can be rapidly overlain on the selected property for analysis. This map depicts which soils, delineated by series, are located on the project site. These boundaries are then used to locate potential building lots, roads, stormwater, and septic systems. The same information conveyed before in books can now be conveniently accessed and efficiently manipulated from the desktop. (Figures 1.2.1.a and 1.2.1.b)

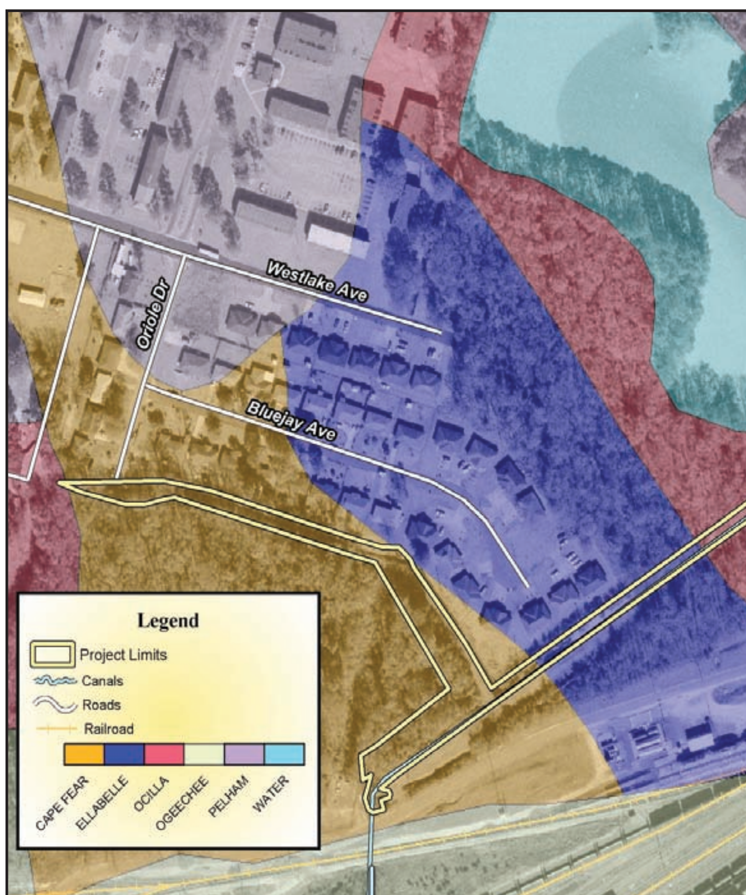

Figure 1.2.1b Soils Layer Using GIS
Image Created by: Patrice Cook

GIS, with its unique capabilities of mapping and modeling, can produce invaluable information for use in:

- Site Selection Studies,
- Site Analysis and Development Suitability,
- Demographic/Market Research,
- Land Use Studies,
- Analysis of Development Plans, and
- Restoration Studies.

(Figures 1.2.1.c and 1.2.1.d)

Figure 1.2.1c Desktop Site Selection Using GIS

Image Created by: Patrice Cook

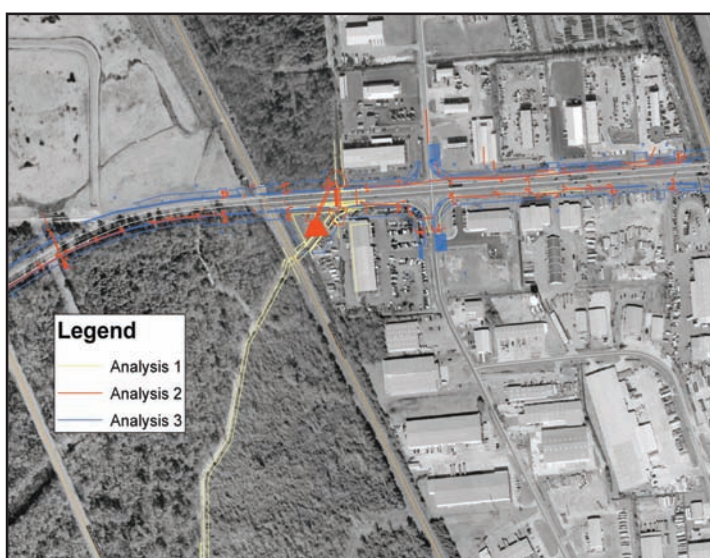

Figure 1.2.1d Alternative Analysis of Proposed Waterline Using GIS

Image Created by: Patrice Cook

1.2.2 What is GPS?

GPS is often used in combination with GIS to field verify existing site conditions and locate physical features not yet mapped. GPS is a universal utility comprised of a radio-navigation system formed from a constellation of satellites and their ground stations. This technology uses these "man-made stars" as reference points to calculate one's relative position on the ground, often to a level of sub-meter accuracy. Using hand-held and backpack GPS units, real-time coordinates of certain physical features of a site can be recorded and then imported into GIS to form new layers of information from which maps and models can be produced.

For example, an environmental scientist can use GIS/GPS technology to perform a wetland survey faster and more efficiently. In the past, scientists would de-archive paper maps of the subject site before performing the wetland delineation. Since wetlands are based on three criteria (soils, vegetation, and hydrology), three separate maps with three different scales would have to be de-archived and photocopied for field use. Then, once the wetland delineation was complete, a survey team would locate the flagged wetland boundary using conventional survey equipment. Conventional surveying uses a control monument or benchmark to assign coordinates to the flagged boundary. This entails clearing trees and vegetation in the "line of site" between the monument and the flagged point, which is often time-consuming and expensive. (Figure 1.2.2.a)

Preliminary site reconnaissance can now be done from the desktop using a GIS database. GIS can generate one scaled map that shows the general location of soils, wetlands, streams, and vegetation types on the subject tract. The scientist can then take this map to the site to verify actual field conditions. Having one scaled map is much easier to use in the field compared to three maps of different scales. In addition, GIS maps can now be uploaded into the GPS hand-held unit itself, and viewed on the unit's screen during fieldwork eliminating the need for a paper map altogether. This way, the scientist knows their position on the ground relative to the parcel, soils, wetlands, and vegetation boundaries supplied by GIS. Once the

Figure 1.2.2a Trimble GPS Pack in Use

Image Courtesy of: Tara Merrill

scientist conducts the necessary field work (i.e. soil borings, vegetation classification, and local hydrology studies), a wetland boundary can be marked (usually by flagging trees) and located using GPS. Each flag on the wetland boundary can be collected and assigned a relative position (coordinate) using the hand-held GPS.

The GPS communicates with satellites that give the coordinate assignment, alleviating the need to clear a “line of site” as with conventional surveys. Then, these points can be downloaded from the GPS and migrated into the GIS to create a new layer of information on the original map. This new line represents the actual wetland boundary within the subject property boundary, as flagged in the field by the wetland delineator. (Figure 1.2.2.b) The compatibility and versatility of GIS and GPS enables the user to perform pre-planning and field tasks more efficiently, and in some cases, at a lower cost compared to conventional methods.

The value of using GIS and GPS as a planning tool is significant. However, regulatory agencies may need to approve the use of GPS to formally delineate wetland boundaries.

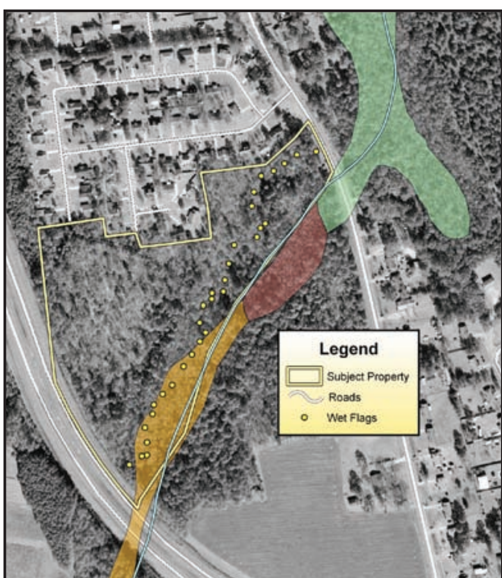

Figure 1.2.2b Wetland Line Surveyed with GPS and Imported to GIS

Image Created by: Patrice Cook

1.3 Synthesize Site Context

Once a thorough analysis of existing conditions and surrounding features is performed using GIS and GPS, the site’s physical opportunities and constraints become apparent. (See Exhibits 1-11) These individual geographic, built, economical, and environmental attributes are then overlaid to form a composite map, which is used to synthesize the overall context of the site. This map shows all primary and secondary conservation areas combined, essentially defining the actual buildable area on the site. (Figure 1.3.a)

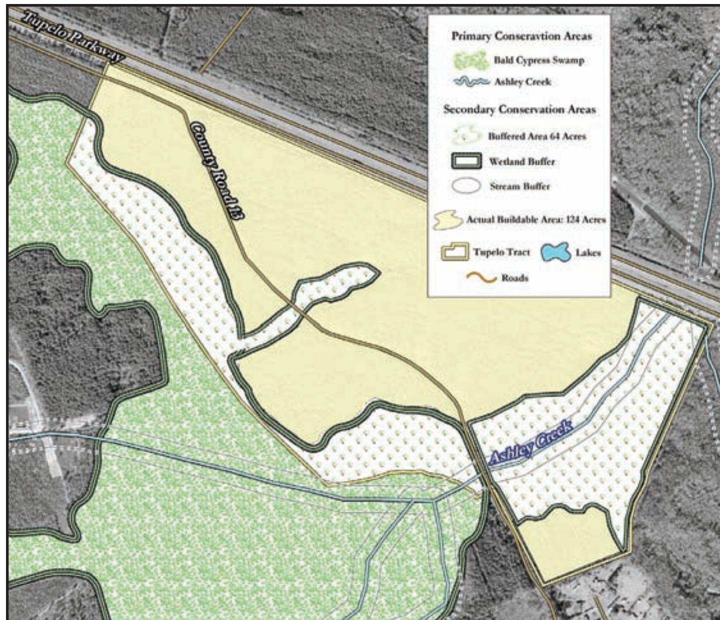

Figure 1.3a Geographic Information Systems Site Inventory Map

Image Created by: Patrice Cook

The overall composite becomes the base map that is used by the site designer to create a sketch level plan of the proposed development. The process of refining the land plan has historically been done using traditional survey methods. Today, we can refine the land plan using GIS and GPS technology. Instead of developing the land plan to a detailed level before site stakeout, a sketch plan can be taken into the field for adjustment (located by GPS), compared to the actual conditions on the site (mapped by GIS), and adjusted to avoid impacts before significant resources are dedicated to detailed planning, surveying, and engineering services. This process repeats until a concept plan that fits the actual character of the site is produced.

1.4 Tupelo Tract, A Model Site in Coastal Georgia

In the same way a developer might seek to find a parcel or tract of land for acquisition and development, GIS data was utilized to identify several prospective development sites within coastal Georgia. The Tupelo Tract was chosen by the authors from several existing land tracts to serve as the example site. The actual name and names of features of the site and the immediate area were changed, as the exact location of the tract, outside its existence in coastal Georgia, is not relevant to the purposes of this manual, which is to demonstrate how one can plan and design low impact residential developments. In addition, the GIS data layers were manipulated to introduce environmental issues typical of this region, particularly wetlands, streams, buffers, and the species that depend on these areas for their existence.

The Tupelo Tract is characteristic of many coastal sites in Georgia with its relatively flat terrain, thick native vegetation, and proximity to freshwater and tidal wetlands rich with a diverse population of plant and animal species that inhabit these areas. This site, like many tracts in coastal Georgia, is located along a main thoroughfare that provides quick and easy access to these natural resources. For these reasons, the Tupelo Tract is a candidate site for a low impact residential neighborhood where effective land planning and innovative design is critical to preserving the natural character and beauty of the land beyond development.

Exhibits 1-11 demonstrate the use of GIS mapping to identify and analyze certain notable features and characteristics of the Tupelo Tract. The following key features were mapped using GIS and considered during the site fingerprinting process:

- Natural topography and hydrology.
- Available infrastructure including roads, rails, and utilities.
- Land use patterns and current zoning designations.
- Significant landmarks and nearby sites of interest.
- Location of wetlands, streams, and groundwater recharge areas.
- 100-year floodplain, major drainage ways, and contour elevations.
- Type and extent of tree cover.
- Soil series and approximate boundaries.
- Wildlife habitat and species of concern.
- Historic and archeological resources.
- Areas of special concern with protective setbacks and buffers.
- Downstream coastal resources bordering essential fish habitat and shellfish harvest areas including tidal marshlands, creeks, estuaries, beaches, and hammocks.
- Composite overlay of primary/secondary conservation areas and actual buildable area.

1.5 GIS Data Sources

Site data can either be gathered by conventional or GPS survey methods or can be accessed by on-line databases and clearinghouses. There are many digital data sets available from national, regional, state, and local sources that can be purchased and downloaded or obtained on CD-ROM. A list of commonly used date libraries is provided in Appendix B.

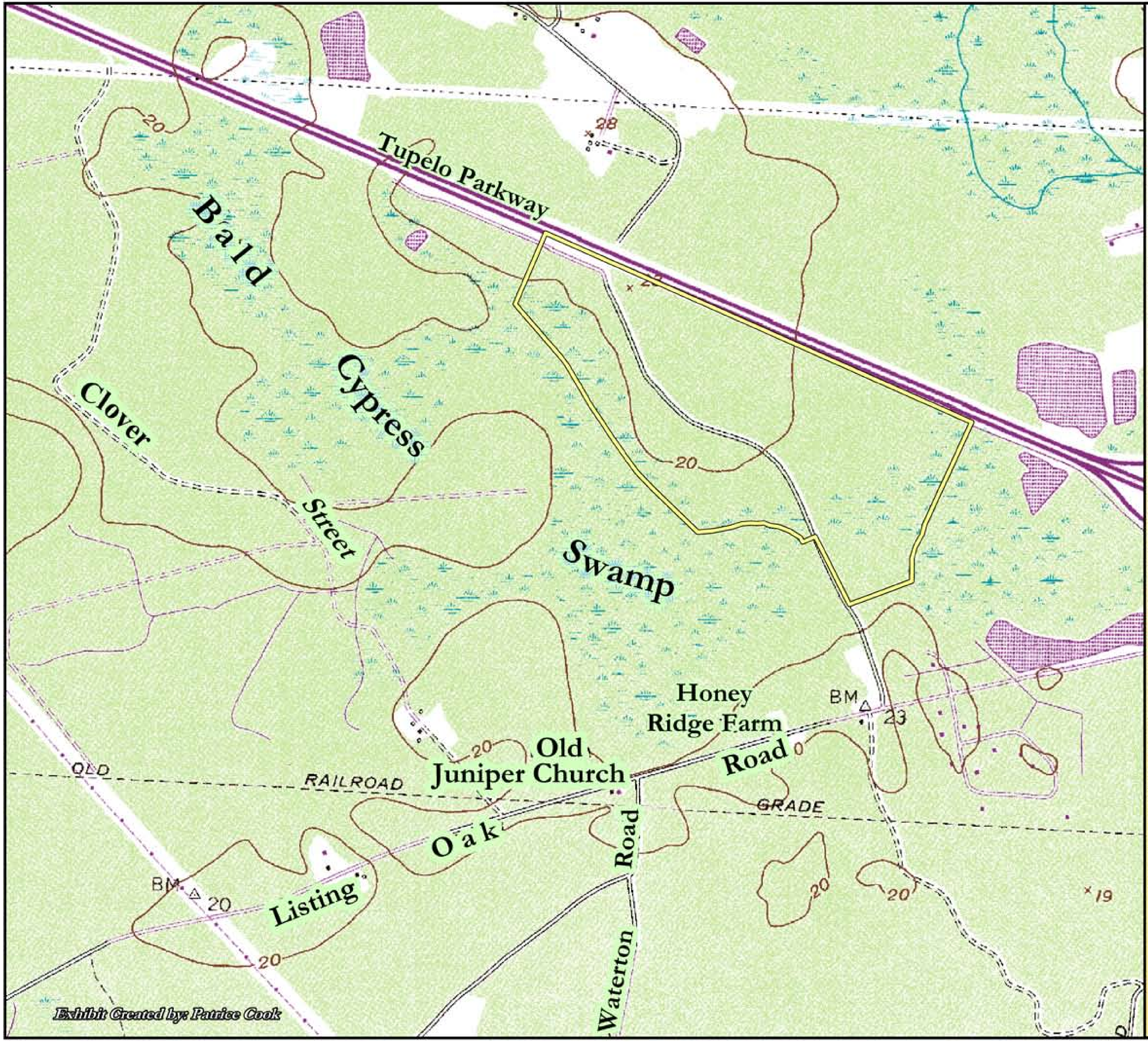

Exhibit 1: Topographic & Hydrologic Features

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

N W E S

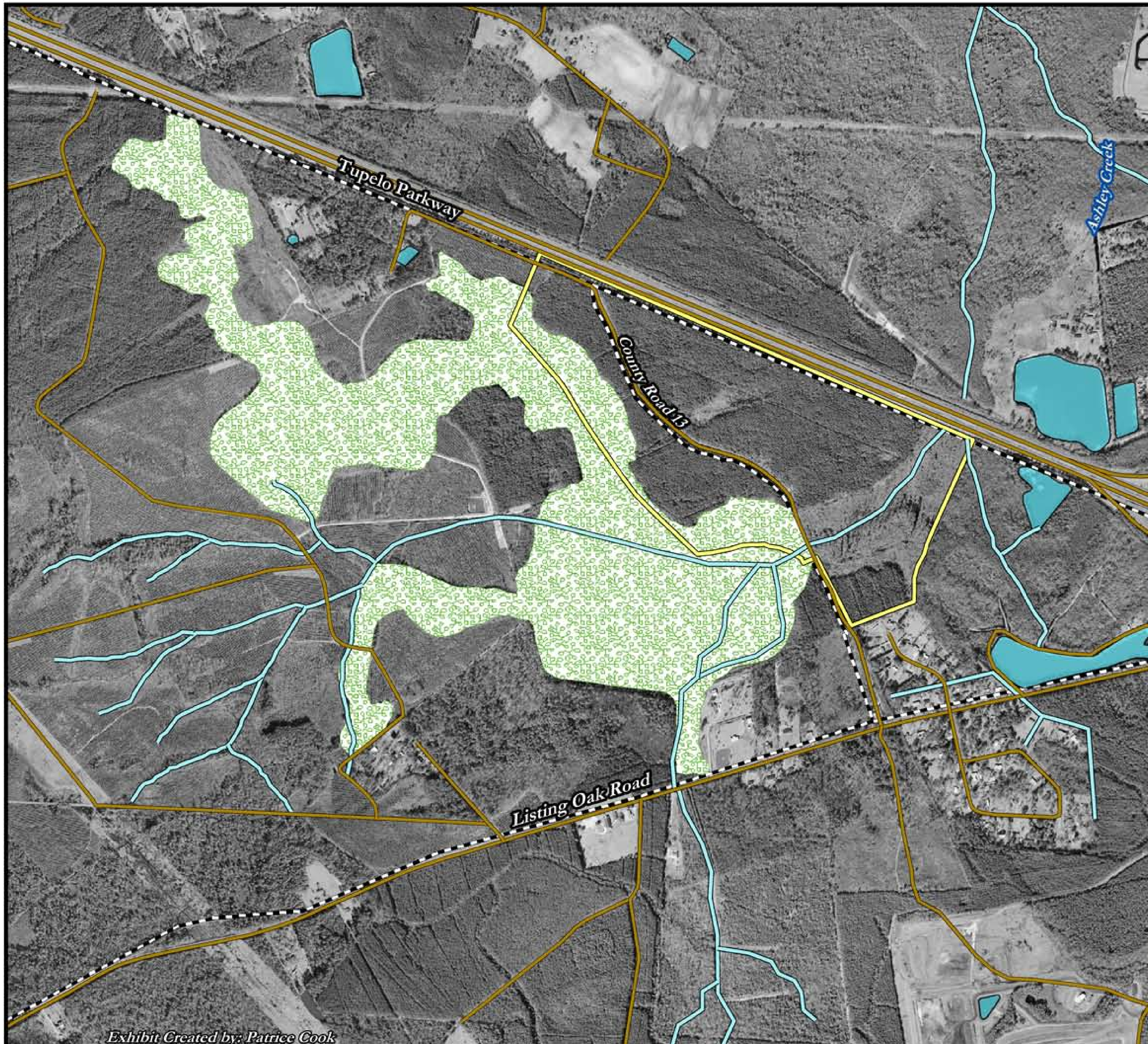

Exhibit 2: Available Infrastructure

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 ¼ 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

N
W E
S

1 inch equals 1,004 feet

0 500 1,000 2,000
Feet

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
- Single Family Residential
- Recreation
- Agriculture & Forestry
- Wetlands & Marsh
- Public & Institutional
- Recreation
- Industrial
- Mobile Homes
- Undeveloped
- Tupelo Tract
- Roads
- Lakes

1 inch equals 2,000 feet

0 0.25 0.5 1

Miles

N W E S

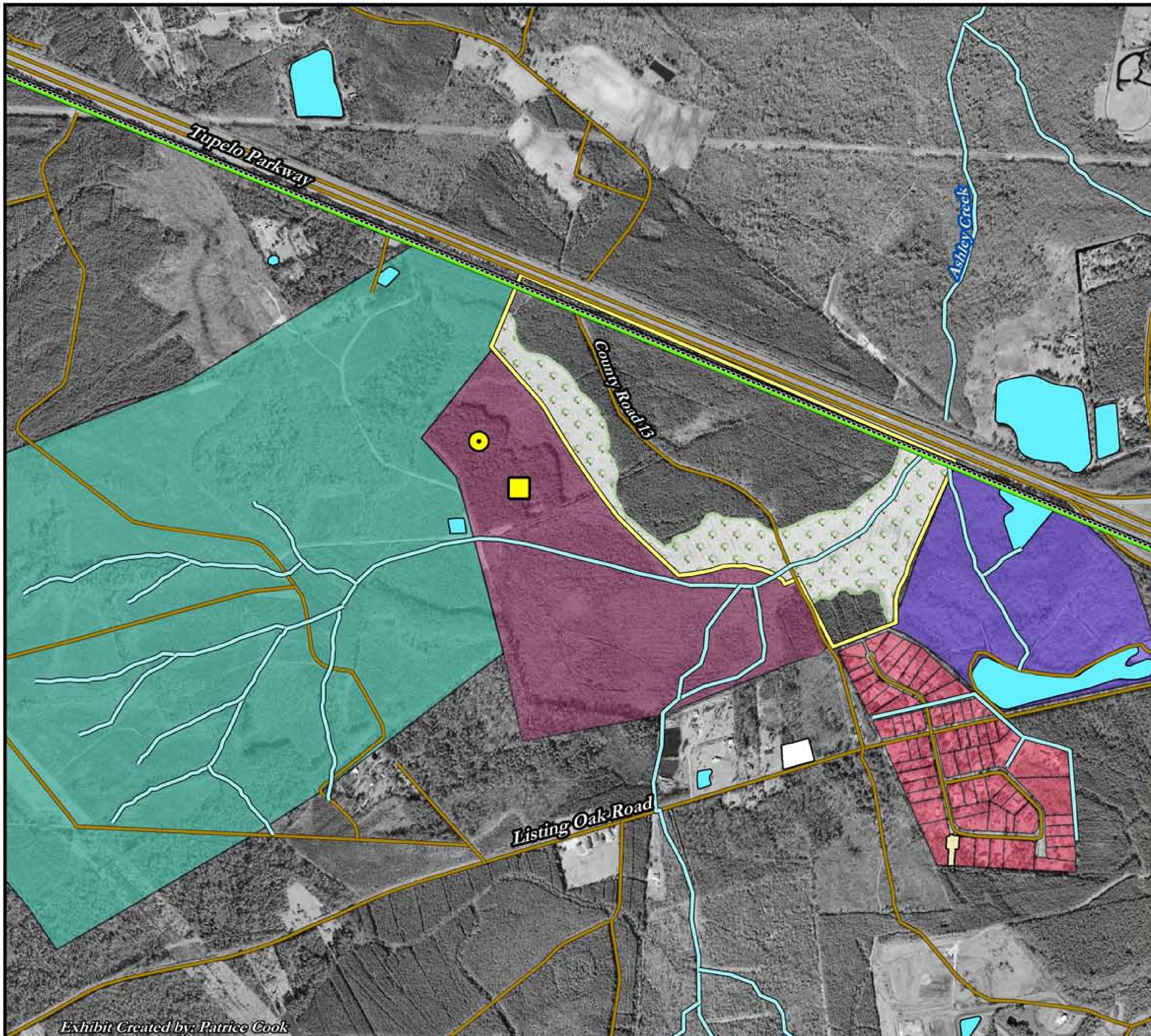

Exhibit 4: Significant Landmarks & Other Sites of Interest

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

1 inch equals 1,000 feet

0 500 1,000 2,000 Feet

N W E S

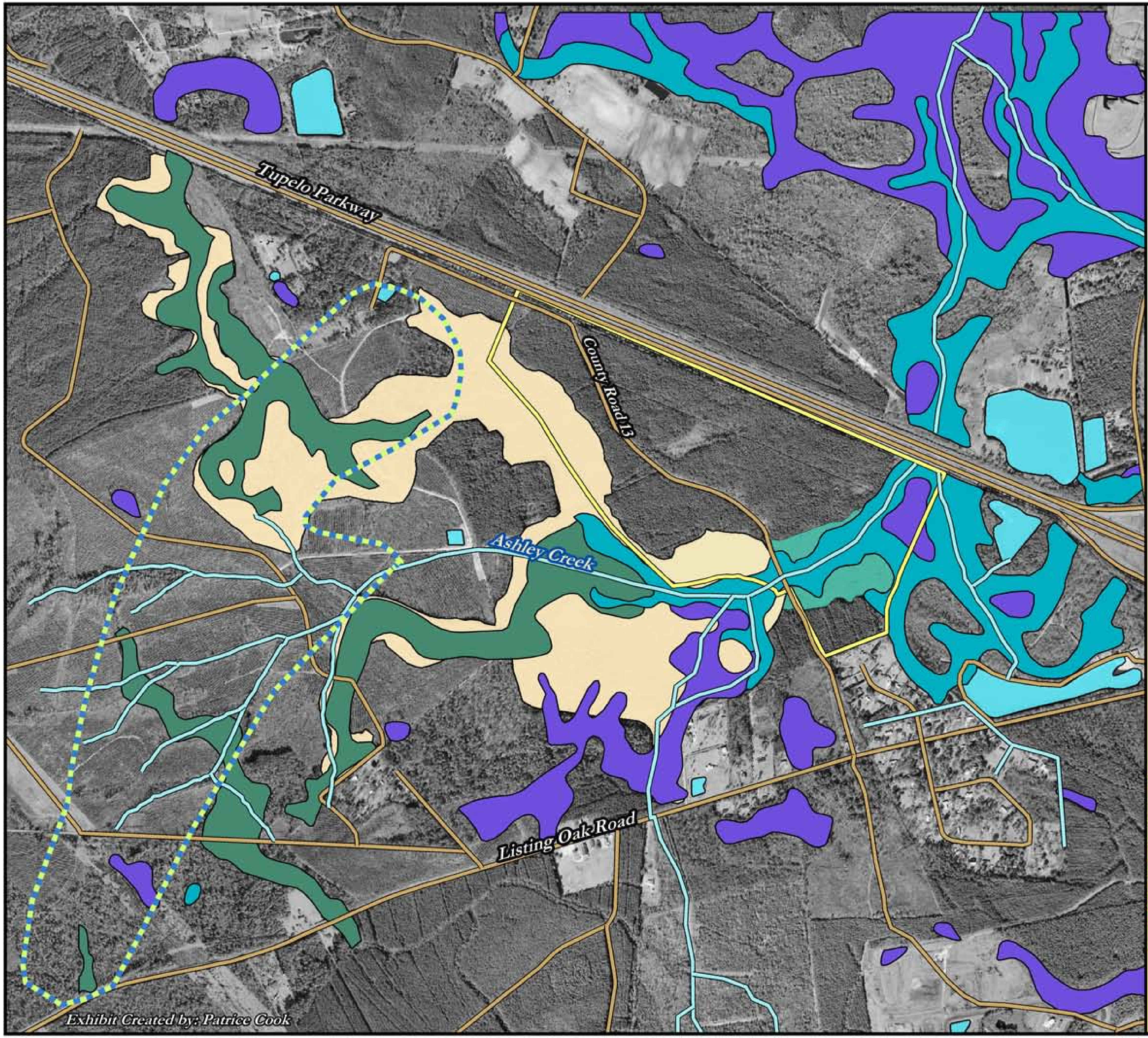

Exhibit 5: Wetlands, Streams, & Groundwater Recharge Areas

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

0 500 1,000 2,000 Feet

N E S W

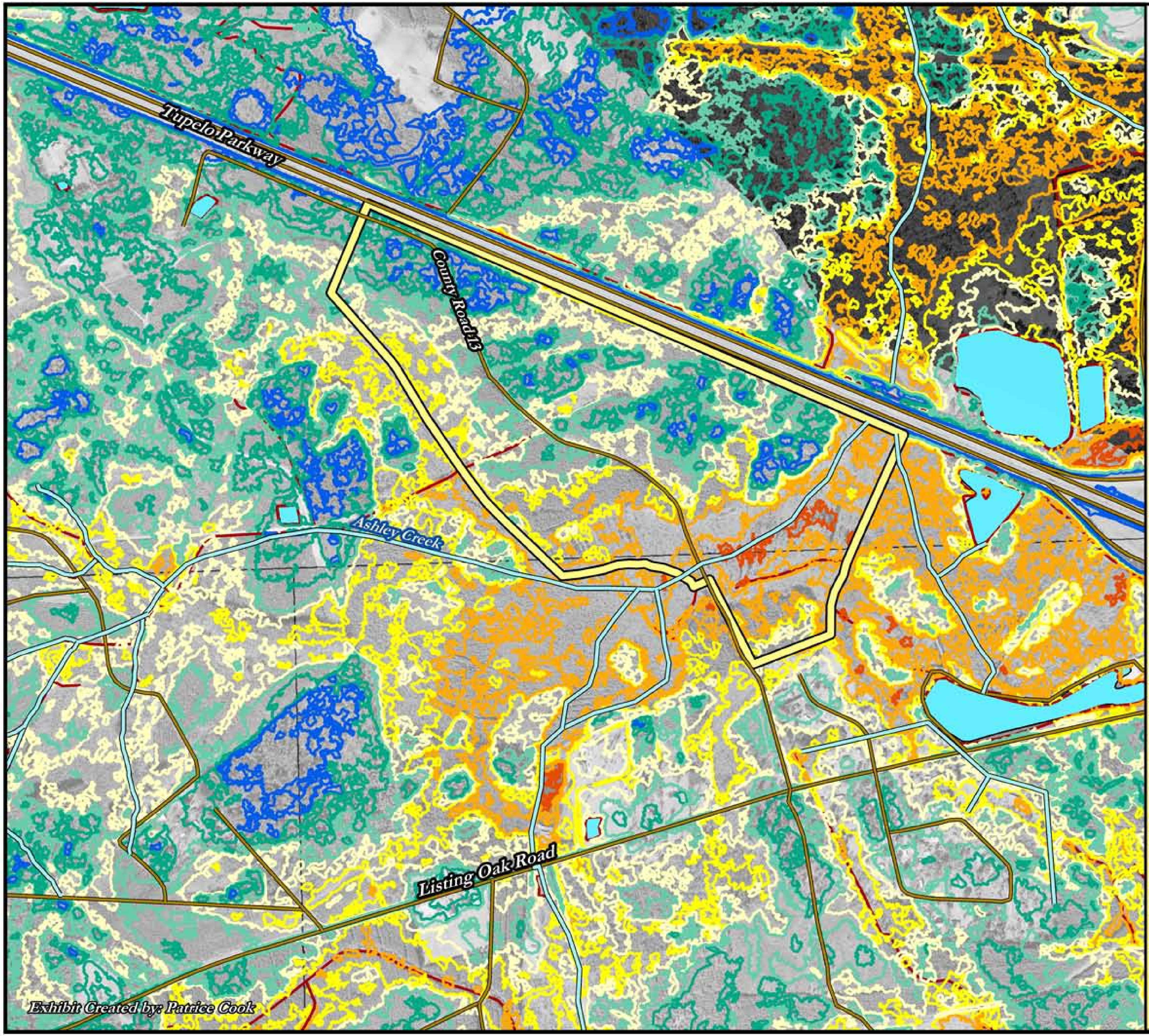

Exhibit 6:
Floodplain and Elevations

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.

Elevations

0.0
0.01-15.0
15.01-17.0
17.01-18.0
18.01-19.0
19.01-20.0
20.01-22.0
22.01-24.0

Flood Zones A X

Tupelo Tract
Lakes
Roads
Streams

1 inch equals 800 feet

N W E S

0 415 830 1,660 Feet

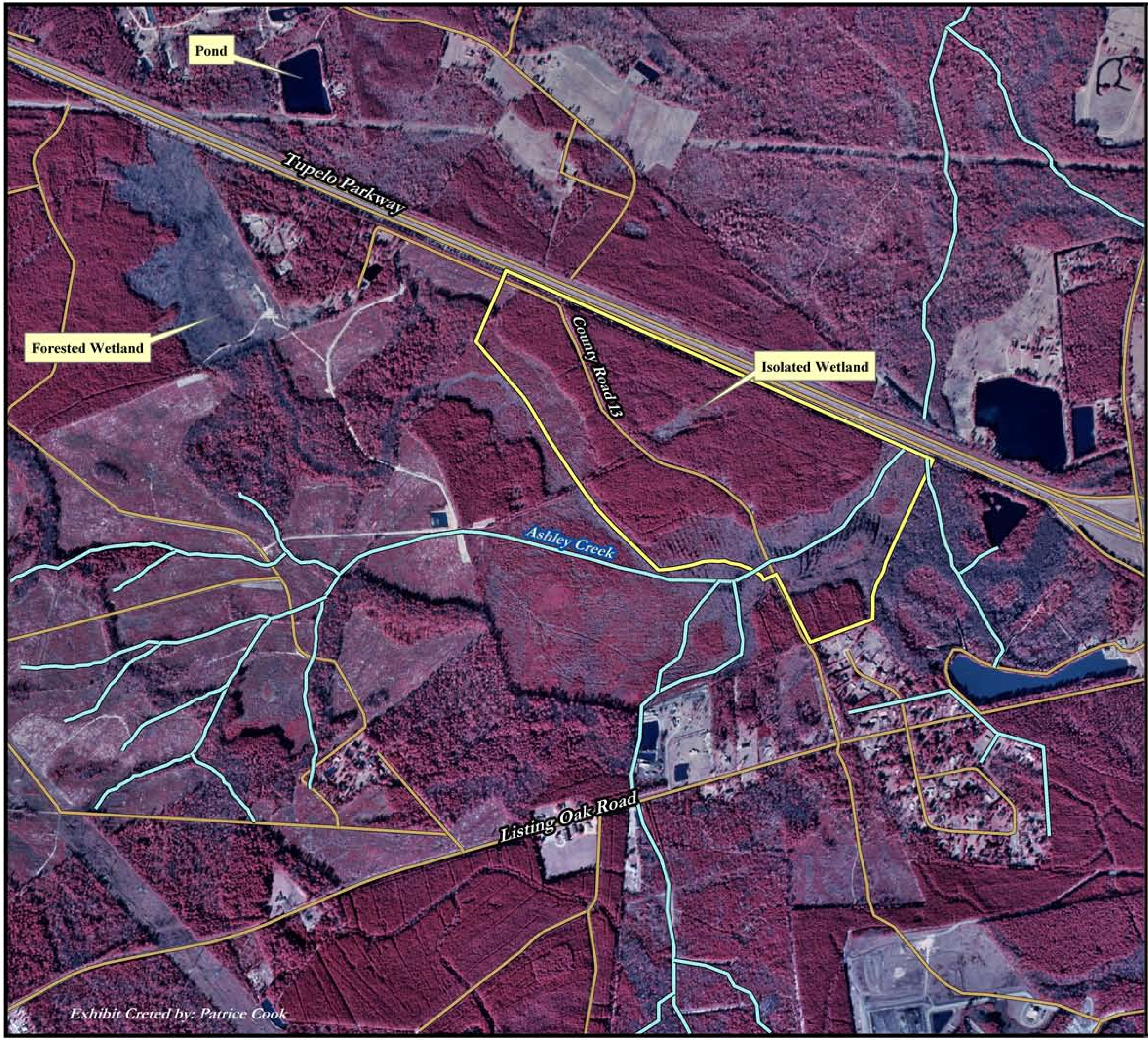

Exhibit 7: Vegetation Types & Extent of Coverage

The U.S. Geological Survey supplies Color Infrared Aerial Photography (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 bluerepresent 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 aides in the planning of tree save areas timber harvest areas, buffers and hiking trails.

Tupelo Tract
Roads
Streams

1 inch equals 1,000 feet

N W E S

0 500 1,000 2,000 Feet

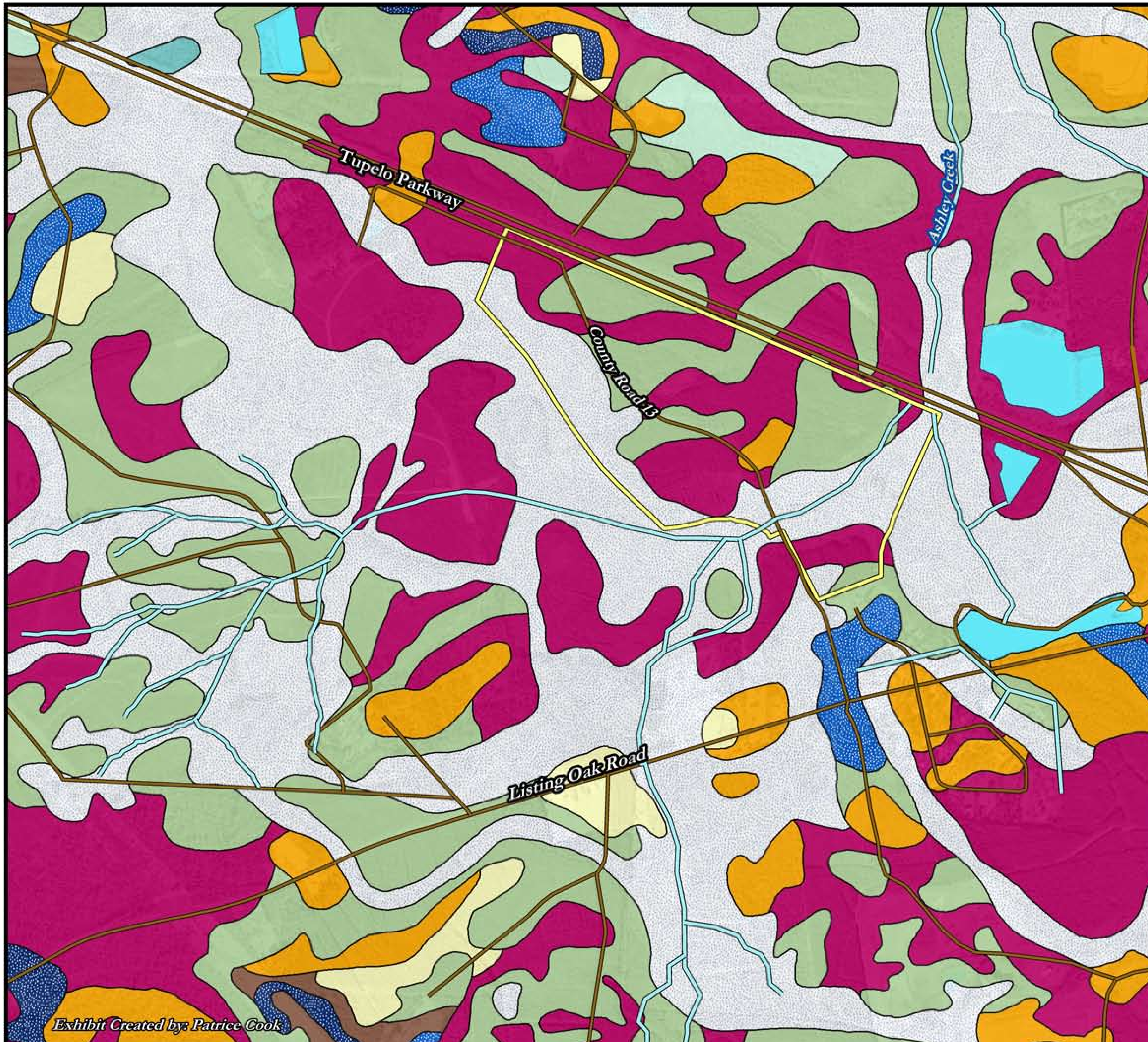

Exhibit 8: Soils Analysis

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
- Wahee
- Ocilla
- Olustee
- Albany
- Craven
- Ellabelle
- 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

N W E S

0 500 1,000 2,000 Feet

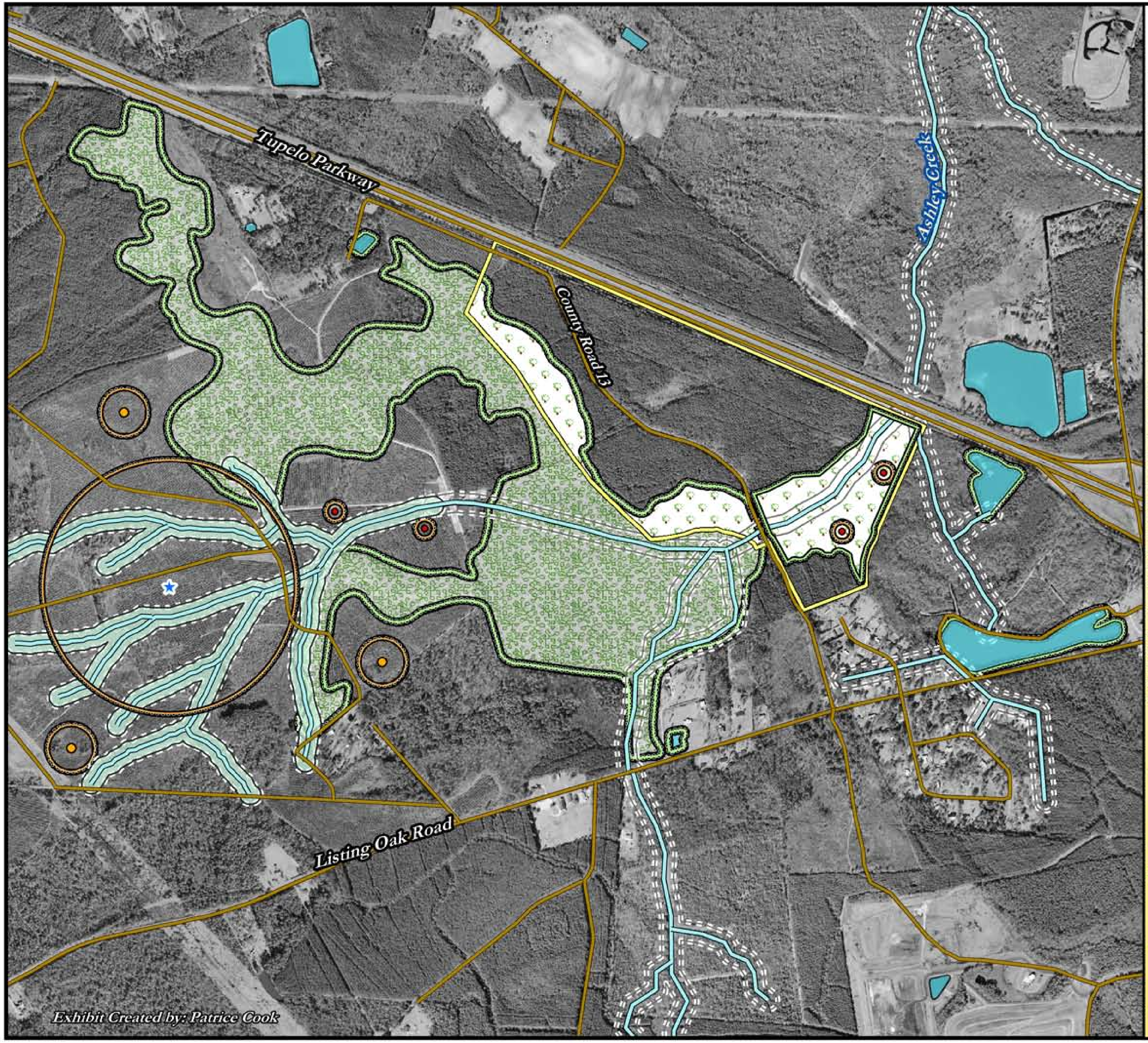

Exhibit 9: Areas of Special Concern with Setbacks and Buffers

Exhibit 9 layers U.S. Fish & Wildlife Service (USFWS) maps of critical habitat and species of concern with federal, state, and county threatened and endangered species lists as well as actual field survey information conducted by the Ashley Creek Wildlife Preserve. This map was used to determine if species of concern and their critical habitats exist on the subject tract. Since the project site is located near a freshwater stream and a large system of bottomlands, essential habitat is available for potential threatened and endangered species. A threatened and endangered species survey was conducted for Ashley Creek Preserve and the immediate areas. GPS was used to locate and map the species and their habitat in the field. This information was then imported to GIS where it was viewed and manipulated to determine the amount of space required to sustain these species once the Tupelo Tract is developed.

Buffers are applied in varying widths to essential habitat including stream and wetlands depending on the habitat requirements of certain species. The state mandates a 50' buffer for streams that support or could support trout and 25' for other streams, lakes, and marshlands. In addition to these buffers, there are species of concern that require buffers of various widths for adequate protection. The Ashley Creek was subject to a 50' buffer due to the presence of protected fish downstream; the Bald Cypress Swamp requires a 25' buffer along its boundaries. In addition, there were several species of concern in the area that require buffers, including a Bald Eagle (1/4 mile), Gopher Tortoises (100'), and Hooded Pitcher Plants (25'). These buffered areas and the resources within them are considered primary and secondary conservation areas. These areas can be beneficial to a development as they form a large continuous green space available for recreational uses such as hiking and nature-watching.

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 ½ 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

N W E S

1 inch equals 0.75 miles

0 0.25 0.5 1 1.5 Miles

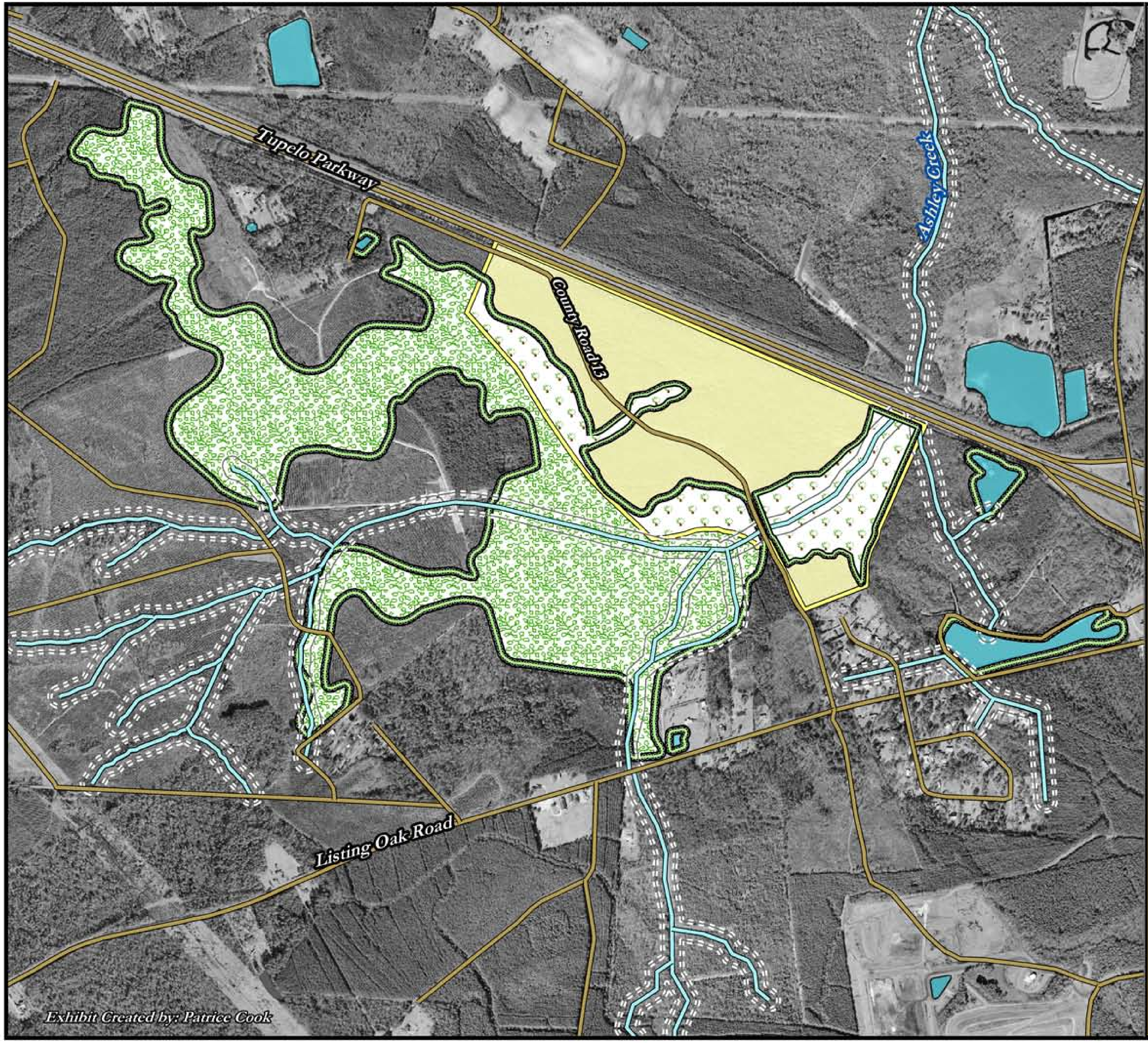

Exhibit 11: Overall Composite: Buildable, Primary, & Secondary Conservation Areas

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 Conseravtion 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

N W E S

0 500 1,000 2,000 Feet