REVISED

TERRESTRIAL ARCHAEOLOGICAL RESOURCES PREDICTIVE MODEL

FOR
ADMINISTRATIVE ACTION
STATE ENVIRONMENTAL IMPACT STATEMENT

KINSTON BYPASS
LENOIR, JONES, AND CRAVEN COUNTIES
NORTH CAROLINA

STIP PROJECT R-2553
WBS No. 34460.1.2

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

AUGUST 2013

REVISED DECEMBER 2014
REVISED OCTOBER 2017

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1.0 INTRODUCTION

The North Carolina Department of Transportation (NCDOT) is proposing a four-lane, median-divided freeway with full control of access in Lenoir, Jones and Craven counties in North Carolina. The project extends from US 70 near LaGrange (in Lenoir County) to US 70 near Dover (on the Jones and Craven County line). The proposed action is listed in the 2013-2023 Draft State Transportation Improvement Program (STIP) as Project Number R-2553.

In 2008, the North Carolina Interagency Leadership Team (ILT) established the Kinston Bypass project as a Geographic Information System (GIS) pilot project as a means to streamline the project development process by utilizing GIS data for alternative development, alternative evaluation, and selection of the Least Environmentally Damaging Practicable Alternative (LEDPA).

1.1 PROJECT STUDY AREA

The project study area, shown in **Figure 1**, is located mostly in Lenoir County in eastern North Carolina, with the eastern part of the project study area in Craven and Jones Counties. Lenoir County borders Greene County to the north, Pitt County to the northeast, Craven County to the east, Jones County to the southeast, Duplin County to the southwest, and Wayne County to the west.

The western boundary of the Project Study Area follows the Lenoir/Wayne county boundary, where US 70 includes full control of access. The southern boundary cuts through Lenoir County south of Kinston following the Neuse River for approximately 5 miles, then continuing southeast crossing NC 55, NC 11 (south of Deep Run), US 258, and US 58 in southern Lenoir County. The eastern edge of the Project Study Area is about sixteen miles east of Kinston near the Town of Cove City in Craven County, where US 70 includes full control of access. The northern boundary is common with the county boundary between Greene and Lenoir Counties. The boundary follows Beaver Creek as it crosses into Jones County all the way to NC 41 (north of Trenton).

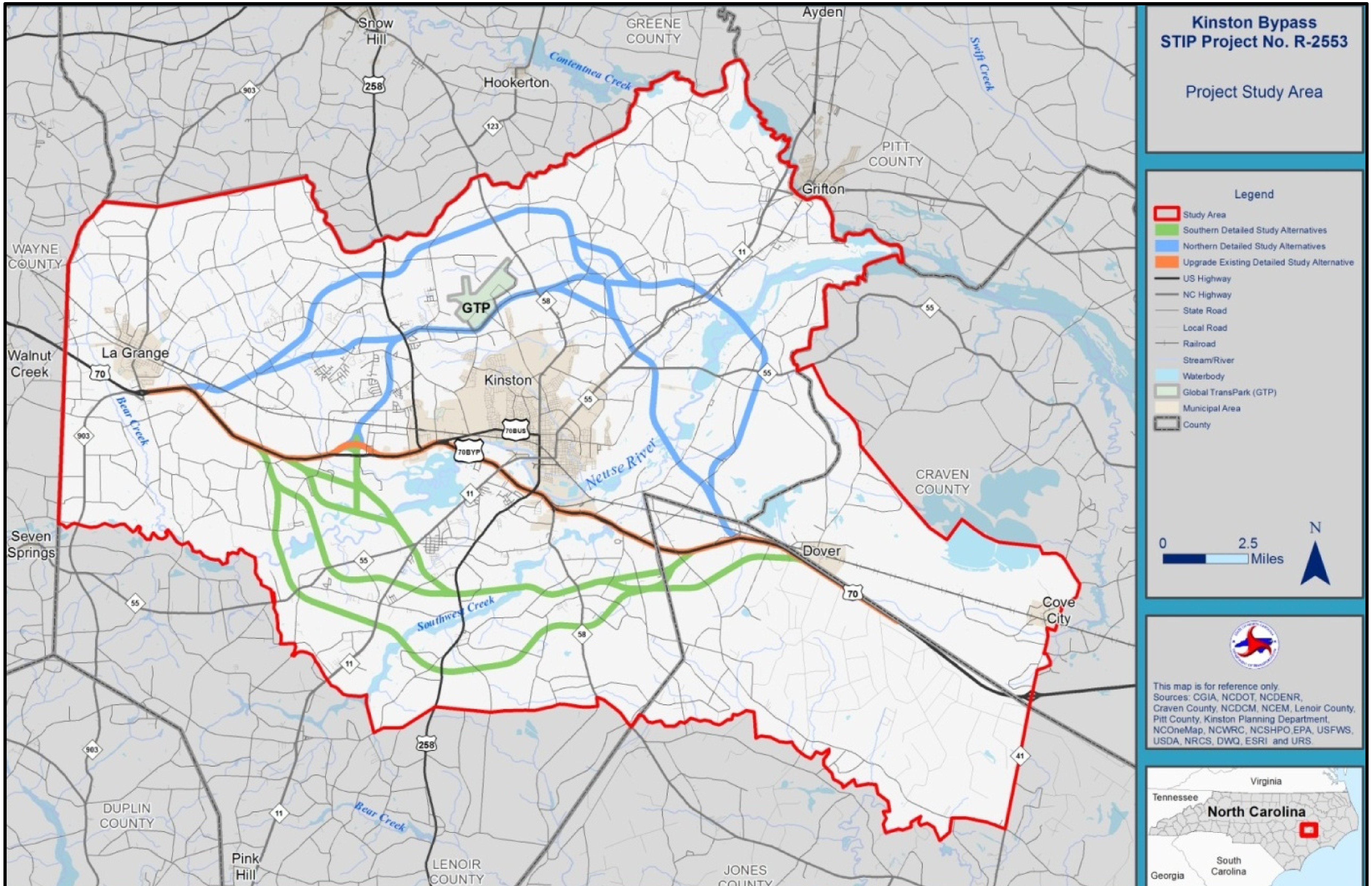

Figure 1. Project Study Area

1.2 PROJECT SETTING

The project study area lies in the Coastal Plain Physiographic Province of North Carolina. The topography of Lenoir County is characterized as mostly level, with gently-rolling areas along interstream divides. Topography within the project study area is relatively flat with elevations ranging from 6 to 130 feet (1.8 to 39.6 meters) above mean sea level (msl). The dominant natural features in the Kinston Urban Area are the Neuse River and its associated floodplains and wetland systems. Tributaries to the Neuse River within the study area include Bear Creek, Falling Creek, Briery Run, Stoneyton Creek, Mosley Creek, and Southwest Creek.

Kinston, the County seat, is the largest city in Lenoir County. The Neuse River flows west-to-east through Kinston, dividing Lenoir County in half. Kinston is located within forty minutes of both Goldsboro to the west and Greenville to the north. North Carolina's State Capital, Raleigh, is located approximately 78 miles to the northwest of Kinston. Morehead City is located approximately 70 miles to the southeast of Kinston and Wilmington is located approximately 89 miles to the south. Kinston is in relatively close proximity to North Carolina's ports, located in Morehead City and Wilmington.

Kinston has a typical mix of urban land uses that includes a central business district (CBD), office/institutional properties, residential neighborhoods, and commercial development. The most prominent land use throughout Lenoir County, excluding downtown Kinston, is agriculture. Other land uses are rural, undeveloped land including pasture, cropland, forest, and wetlands. There are clusters of residential development in and around the municipal areas and large-lot residential development spread throughout the rural areas. Commercial and industrial development areas exist as well, particularly around the area of the Global TransPark and US 70 West of Kinston.

1.3 PURPOSE OF PREDICTIVE MODEL

This document presents information regarding predictive modeling efforts to identify terrestrial archaeological sensitivity associated with the 17 Detailed Study Alternatives (DSA) currently under consideration for the proposed Kinston Bypass. The goal of this modeling effort is to provide guidance to the alternatives analysis concerning the relative impacts of each corridor option. Further, although the goal is to provide archaeological sensitivity data for each current corridor option, the predictive model was generated for the entire study area to allow for any future corridors (i.e., new alignments or alterations to existing ones) to be evaluated easily for archaeological sensitivity.

The remainder of this document is organized as follows. Section 2 discusses archaeological predictive models, focusing on the general types of models utilized as well as detailing several past models created for archaeological resources in North Carolina. Section 3 presents the methodology utilized for this study, including model variables and GIS methods. Section 4 provides the results of the modeling effort as it pertains to the Kinston Bypass DSA corridors. Section 5 summarizes the study, and a list of references cited can be found in Section 6.

2.0 ARCHAEOLOGICAL PREDICTIVE MODELS BACKGROUND

2.1 PREDICTIVE MODELS INTRODUCTION

Predictive models of archaeological site distributions have been conducted all over the world, have focused on a variety of geographic scales, and have utilized a number of different approaches. For transportation planning, the use of archaeological predictive models during initial planning phases provides cost savings throughout the life cycle of the project. A prime example of this is seen in Minnesota where a state-wide GIS-based archaeological predictive model system has been used by the state's Department of Transportation (Mn/DOT) since the late-1990s (Mn/DOT 2005). Mn/DOT saved approximately three million dollars per year over a four year period in the early-2000s after implementation of the system. In addition to direct cost savings, "results have helped Mn/DOT determine where surveys are needed, or not needed. They have also been used to suggest project alignments or modifications that reduce the potential for impacts on cultural resources. These applications of Mn/Model have expedited project clearance, reduced costs, and done a better job of protecting cultural resources" (Mn/DOT 2005). Such benefits to Mn/DOT have included: (a) Mn/DOT cultural resources staff have cleared about 35 percent more projects per year, (b) number of Memoranda of Agreement (MOA) reduced by almost 60 percent, and (c) improved project turnaround time by 30 percent.

The purpose of this section of the report is to familiarize the reader with the types of predictive models available for use in archaeological applications and to provide a number of examples of how such studies have been applied in the North Carolina Coastal Plain.

2.2 TYPES OF ARCHAEOLOGICAL PREDICTIVE MODELS

Three types of archaeological predictive models are generally formulated—descriptive, behavioral, or statistical (Hay et al. 1982:13-15). These models are briefly summarized here.

2.2.1 DESCRIPTIVE MODELS

"*Descriptive predictive models consist of summaries of previously collected archaeological data, and indicate which areas, or kinds of areas, have produced archaeological materials*" (Hay et al. 1982:13). This type of approach can be either qualitative or quantitative, and offers the advantages of both flexibility and simplicity. However, it is not without its drawbacks. Weaknesses may be included in the model depending on the dataset utilized to formulate it. For example, if the locations of sites identified only during surface inspections are utilized to formulate a model, then the model may have a robust ability to predict the locations of other surface sites, but would be lacking in its ability to predict the locations of sites in areas where no surface visibility exists.

2.2.2 BEHAVIORAL MODELS

Behavioral predictive models "*are based on ecological and economic reconstructions of prehistoric lifeways…[to] specify which microenvironmental zones within that environment were exploited, and for what purposes*" (Hay et al. 1982:14). Although this approach has the strength of being based on a general archaeological goal to reconstruct and explain past human behaviors, it has the disadvantage of requiring a large research commitment utilizing high-quality archaeological, ethnographic, and ecological data.

2.2.3 STATISTICAL MODELS

"*Statistical models consist of equations that express relationships among a specified set of variables*" (Hay et al. 1982:14). This method has the benefit of being able to weight certain variables that are deemed more important than other variables. For example, individuals may have chosen a specific location based on its proximity to water with less regard for the elevation of that location; however, these individuals may not have desired to be in low-lying swamps, so elevation was still given *some* preference. Much like the other two types of predictive models summarized above, the statistical approach is not without its drawbacks (Hay et al. 1982:15). Primarily, the formulation of a statistical model must be based on data obtained from all possible localities within the area of interest. Archaeological data generally does not represent a sample of all possible microenvironments. This is because archaeological survey efforts often cannot sample all possible localities due to project limitations (e.g., narrow study corridor or small area of survey), methodological limitations (e.g., relying on surface inspection of exposed ground surfaces), or any other number of potential limitations.

With modern-day computing technology, in particular GIS and statistical program packages, simple descriptive models can weight variables, thus blurring the line between descriptive and statistical models compared to just a few decades ago. The distinction between the two is in where and how statistical calculations are used. In a descriptive model, weighted variables can be used to help identify varying probability levels within the model. However, in statistical models, additional computations are utilized after the production of the model as a means to test and verify its accuracy.

2.3 PAST ARCHAEOLOGOCAL PREDICTIVE MODELS IN NORTH CAROLINA

A number of past efforts have been conducted to formulate archaeological predictive models for the southern Coastal Plain region of North Carolina, and in particular, the Lower Cape Fear region (cf. Hay et al. 1982; Wilde-Ramsing 1980). However, no such studies have been conducted on the northern Coastal Plain region, and only informal definitions of settlement patterns have been proposed, but not tested, for this region (Phelps 1983). Several of these works are summarized here, with particular attention paid to the methods of stratifying fieldwork efforts and/or segregating modeling levels rather than specific project results.

In terms of the immediate project area, in other words, the northern inner Coastal Plain, no formal predictive models for archaeological sensitivity have been formulated. Robert Crawford (1966) conducted a survey of Lenoir county in conjunction with his Master's Thesis. No formal settlement pattern was presented, but Crawford (1966:134-139) did provide some basic commentary on settlement during various prehistoric periods. Specifically, he suggested that peoples during the Early Archaic were nomadic and wide-ranging (Crawford 1966:134). The same was suggested for the "Later Archaic" (Crawford 1966:136). For the Early Woodland, Crawford (1966:137) states, "the distribution of [Early Woodland] sites and cultural debris in some of the localities inhabited by these people suggests the possibility of small groups of houses scattered several hundred feet apart." He goes on to describe the Late Woodland as, "instead of small groups of a few houses, sites were probably characterized by villages of several houses. There is also an indication that instead of being widely scattered along upland streams, populations were now more concentrated along the banks of the Neuse River and its major tributaries" (Crawford 1966:138-139). Given these comments, Crawford (1966) is in essence painting a picture of highly nomadic Archaic groups, followed by scattered hamlets along upland streams in the Early Woodland, which then gives way to nucleated villages in the lower landscape along the Neuse River and its major tributaries.

Some 17 years later, Phelps (1983) provides minor commentary regarding prehistoric settlement patterns that largely reiterates those provided by Crawford (1966). Phelps (1983:32) suggests settlement patterns in the Early Woodland may have been similar to the preceding Late Archaic. In reference to settlement patterns of the Archaic, Phelps (1983:24) states they "are everywhere irrevocably related to stream accessibility." As an example, Phelps (1983:24-25; see also Phelps 1976:320) discusses the results of survey of the Swift Creek watershed in which 53 sites with Archaic occupations were identified. Of those sites, six were interpreted as base camps and the remaining 47 were interpreted as small temporary sites. All of the sites were distributed relatively evenly across all stream classes, but the six base camps were also situated at stream confluences. With the working hypothesis that Archaic and Early Woodland settlement patterns were similar, Phelps (1983:33) notes a change in the Middle Woodland during the Mount Pleasant phase. "There is a noticeable decrease in the number of small sites along the smaller tributary streams in the interior and an increase in sites along the major trunk streams and estuaries and on the coast" (ibid). In the subsequent Late Woodland period, specifically the Cashie phase of the northern inner coastal plain, settlement is not well understood, but appears to be more sedentary than earlier, consisting of seasonal villages along major rivers and tributaries (Phelps 1983:46-47).

Moving southward and eastward to the southeastern portion of North Carolina, we find several formal predictive models and informal settlement patterns for prehistoric sites. Projects from the late-1970s (cf. Hay et al. 1982; Wilde-Ramsing 1978) up to some very recent projects (cf. Green et al. 2007; URS 2011) have evaluated archaeological probability.

In 1977 and 1978, a Comprehensive Employment Training Act (CETA) project was conducted, the purpose of which was to identify archaeological sites throughout New Hanover County "to fill a lack in substantial and comprehensive archaeological site information" (Wilde-Ramsing, 1978:1). Between August 1977 and July 1978, staff of the New Hanover County Archaeological Survey CETA project identified 463 archaeological sites within New Hanover County (Wilde-Ramsing 1978). Although the CETA project was not a predictive model, the data from it was utilized in the late-1970s and early-1980s to generate several predictive models and correlations of archaeological sites and their environmental contexts.

A predictive model of archaeological sites based on the CETA data was produced in 1982 (Hay et al. 1982). The model was produced in a three-step process. The first part was to formulate a descriptive predictive model based on the CETA data. Hay et al. (1982:16) identified four variables for creation of the initial predictive model—elevation, distance to nearest water, type of nearest water, and soil type. These variables were used to define high-, medium-, low-, and no-probability zones. The second part was to conduct field survey as a means to test the model. In the third part, based on the results of the field survey, Hay et al. (1982:56) determined soil suitability for crops and soil drainage characteristics were more appropriate for determining archaeological probability than soil type.

Wilde-Ramsing (1980, 1981a, 1981b) also utilized the CETA data to correlate archaeological sites with environmental zones and soil types. Wilde-Ramsing (1980) discussed the associations of prehistoric archaeological sites with environmental zones. Sites with prehistoric ceramic artifacts were concentrated near sounds, saltwater marsh, and maritime forests; near swamp bottomland hardwood forests and permanent water; and along the borders of swamp bottomland mixed pine and hardwood forests. Conversely, ceramic bearing sites were virtually non-existent in longleaf pine-turkey oak forests, live oak-blue jack oak forests, pocosins, pine savannah, or ocean/dune settings. Archaeological sites that produced only lithic artifacts were virtually identical in associations, the only real difference being lithic-only sites near sounds, saltwater marsh, and maritime forests were moderate density compared to the high density for ceramic sites in the same setting.

Wilde-Ramsing (1981a) then concentrated on a set of sites near the Big Bend Region in the northwestern portion of New Hanover County. For this study, sites located within swamp hardwood forests were compared to sites located along the upland bluffs overlooking swamp hardwood forests. Sites within lowland swamp locales occupied low rises, generally less than five feet above mean sea level (amsl). Sites along upland bluff edges were found at elevations between ten and 20 feet amsl and exhibited a larger areal extent than those in the bottom lands.

Finally, Wilde-Ramsing (1981b) utilized the CETA data to correlate prehistoric archaeological sites with specific soil types. Utilizing 235 of the CETA sites, it was determined the vast majority of sites were located in the Kenansville-Craven-Lakeland soil association (n=81; 34.5 percent) and the Wrightsboro-Onslow-Kenansville soil association (n=76; 32.3 percent). As for specific soil types (not just soil associations), the Kenansville, Baymeade, and Kureb types contained the majority of the sites in the study—80 (34.0 percent), 35 (14.9 percent), and 33 (14.0 percent) respectively. Of the 16 different soil types where prehistoric sites were located, these three accounted for almost two-thirds of the sites (n=148; 62.9 percent).

Beginning in the mid-1990s, a series of projects in conjunction with the proposed Wilmington Bypass corridor utilized studies like the ones discussed above to stratify field efforts. URS (formerly Greiner, Inc. and URS-Greiner) was contracted by the NCDOT to conduct these archaeological studies. Klein et al. (1994:5.1) stratified field efforts for the northern and southern alternatives in the eastern portion of the Wilmington Bypass into high, medium, and low probability areas. A subsequent sample survey identified 13 archaeological sites (11 prehistoric and two historic). All 11 prehistoric sites were in high probability areas in close proximity to the northern alternative's Northeast Cape Fear River crossing.

Subsequent to the archaeological survey of the northern and southern alternatives of the Wilmington Bypass (Klein et al. 1994) a new alternative, termed the Center Alternative, was designed. Consultation between the NCDOT and the North Carolina Historic Preservation Office (NC HPO) initially agreed to perform field studies only on high probability area, which was determined to be the 762 meters (2,500 feet) on either side of the alternative's Northeast Cape Fear River crossing. However, subsequent analysis of project plans indicated a large segment of the proposed right-of-way paralleled an unnamed tributary of the river and thus also constituted high probability area. As such, a total of 2,027 meters (6,650 feet) was subjected to archaeological survey.

In late-2002, URS conducted archaeological survey for the western portion of the Wilmington Bypass (Jorgenson et al. 2003). Much like previous efforts for the Wilmington Bypass, URS' survey of the western section "*concentrated on areas of slightly elevated and drier soils adjacent to waterways or wetland margins*" (Jorgenson et al. 2003:i).

More recently, a 1,300 acre tract in New Hanover County along the Cape Fear River was subjected to Phase I survey in advance of residential development by Newland National Partners IV, LLC (NNP IV) (Green et al. 2007). The northern portion of the NNP IV project area is located within the overall study area for the Cape Fear Skyway project (URS 2009:57). Survey efforts for the project consisted of intensive shovel testing of high probability areas and pedestrian walkover with judgmental shovel testing in the remainder of the project area. High probability was defined as "*areas within 200 m of a permanent water source (i.e., Cape Fear River, Barnard's Creek, and Mott Creek), and 100 m along either side of River Road*" (Green et al. 2007:47). Fifty-four archaeological resources were identified during these efforts, and all but one were identified within high probability areas. Another result of the survey that bears mentioning here pertains to relocating previously-recorded archaeological sites, particularly those recorded several decades ago. Background research for the project indicated that 24 archaeological sites identified during the late-1970s CETA project were recorded within the NNP IV project area. Of the 24 previously recorded sites, only two were relocated during the project.

In 2011 URS completed a GIS-based predictive model to evaluate various alternatives for the Cape Fear Skyway project (STIP U-4738) in New Hanover and Brunswick counties (URS 2011). The Cape Fear Skyway terrestrial archaeological predictive model forms the basis for the current Kinston Bypass effort. For the Cape Fear Skyway model, URS generated a two-tier (i.e., High-Low probability) model on the almost 64 square-mile study area. The variables chosen for the Cape Fear Skyway model included: soil drainage, proximity to water, topographic setting, proximity to historic roads, and disturbed/developed areas (URS 2011:10). Linear elements such as proximity to water and historic roads were evaluated by buffering vector data while areal elements such as soil drainage and disturbed/developed areas were evaluated by creating raster layers that condensed numerous data elements into high/low categories (URS 2011:10-14). Unlike many of the models and settlement patterns described above, the URS effort purposefully included data to model historic archaeological sensitivity (URS 2011:23). Separate models were created for prehistoric and historic archaeological sensitivity and these two models were then combined to generate a single master sensitivity for the study area (URS 2011:Figures 12, 13, 14). Twenty-four alternative routes were then analyzed in terms of both percentage and acreage of high and low probability areas within each option. Further, the options were analyzed using narrower conceptual designs that closely represented the final footprint of the roadway as well as wider study corridors that represented areas that would be subjected to future environmental field studies. The former dataset provided key information to project planners in terms of approximate levels of impacts to sensitive areas. The latter dataset provides key information for future field studies planning, particularly in regards to maximizing cost efficiency for project scoping, level of field effort consultation with the NC HPO, and cost estimates to perform the required field studies. With very little alteration, the methodology for the current project (presented in the following section) mimics the Cape Fear Skyway modeling effort.

Moving west of the Kinston Bypass study area, the NCDOT formulated an archaeological predictive model for a portion of the Piedmont region of the state (Madry et al. 2006). The project was a pilot program that included seven counties in the Piedmont region—Cabarrus, Chatham, Forsyth, Granville, Guilford, Randolph, and Wake. A wide variety of GIS datasets were either obtained or created for use in developing the predictive model. Eleven variables were chosen as appropriate for the creation of the predictive model. The Piedmont Predictive Model project produced a number of models using the 11 variables; however, the models were variably stratified. Some of the models used simpler three-level probability stratifications (i.e., High, Medium, Low) while others used more complex 10-level probability stratifications (see Madry et al. 2006:Figures 5.4 through 5.7 for examples).

3.0 ARCHAEOLOGICAL PREDICTIVE MODEL METHODOLOGY

3.1 TYPE OF ARCHAEOLOGICAL PREDICTIVE MODEL

As discussed in **Section 2.2** above, there are generally three types of archaeological predictive models. The examples provided in the previous chapter cover the gamut of possibilities from simple descriptive models like those produced by Wilde-Ramsing in the early-1980s (Wilde-Ramsing 1980, 1981a, 1981b) to statistically analyzed efforts like the New Hanover County Archaeological Predictive Model (Hay et al. 1982) and the seven-county Piedmont model generated for the NCDOT (Madry et al. 2006).

Given the wide variety of predictive model types generated for archaeological purposes, through consultation with archaeologists at NCDOT's Human Environment Section, it was agreed that a descriptive model would meet the needs of the Kinston Bypass project, and that the effort from URS' earlier Cape Fear Skyway predictive model would serve as the basis for generating the Kinston Bypass model. These decisions were based on two primary reasons.

First, given the success of past descriptive models, it was determined that the higher costs associated with a statistical approach were not warranted. Although the NCDOT's Piedmont archaeological predictive model was a successful endeavor, it was not a cost-effective approach for the current project given the number of DSA's to evaluate.

Second, given the effort of the Cape Fear Skyway predictive model URS produced in 2011, coupled with a similar set of environmental variables between it and the Kinston Bypass study area (e.g., general lack of steep slope and overall topography changes, sandy well-drained soils, Carolina Bays and other analogous topographic features), it was decided that using the Cape Fear Skyway model as a starting point would further provide a cost-savings, without "cutting corners" in terms of producing robust results from the predictive model.

With the decision to produce a descriptive predictive model based on the Cape Fear Skyway effort made, it was determined that the Kinston Bypass predictive model project would be stratified into high probability and low probability zones. Previous work in the region had shown this two-part division to be effective (e.g., Barse 1997; Green et al. 2007). It should be noted that the use of the term low probability does not indicate the area has no potential for containing archaeological sites, just that the probability for such resources is relatively low. In essence, an archaeological site *can* occur anywhere; therefore, we have refrained from utilizing a "no probability" classification like some earlier projects have (e.g., Hay et al. 1982).

Finally, it should be noted that the predictive model for the Kinston Bypass project was generated for the overall study area, not just for DSA corridors currently under consideration. There are multiple reasons for generating the model this way. First, generating the model on the analysis area is actually easier and quicker in GIS than doing so only for the DSA corridors. Second, producing the predictive model for the analysis area generates a more robust system, since narrow corridors may not cover all possible microenvironments in the region. Third, and most importantly, it allows for DSA alignment modifications or additional alignments to be developed in the future that, with a minimum of time, can also have archaeological sensitivity statistics generated for them.

3.2 VARIABLES USED FOR ARCHAEOLOGICAL PREDICTIVE MODEL

The examples of archaeological predictive models presented in the previous chapter used a wide range of variables. Some of the projects used a larger number of variables, such as the NCDOT's Piedmont archaeological predictive model (Madry et al. 2006). Conversely, most of the models developed for the lower Cape Fear region, such as Hay et al.'s (1982) predictive model of New Hanover County employed a smaller number of variables. Consultation with NCDOT during planning for URS' (2011) Cape Fear Skyway model regarding this element of the project resulted in a decision to include fewer variables than employed in the Piedmont project, primarily because at least half of the variables used for the Piedmont project—elevation, slope (specifically the presence of steep slope), aspect, Indian trading path, and rock shelters—have little to no applicability to the Coastal Plain region. Given the similarity between the study areas for the Cape Fear Skyway and the Kinston Bypass, the current project will also utilize fewer variables compared to Madry et al.'s (2006) Piedmont modeling project.

Hay et al. (1982) initially included four variables—soil type, elevation, distance to nearest water, and type of nearest water. After testing their initial model in the field, it was determined that soil type was not as strong of a variable as soil drainage and soil productivity rating. Therefore, their revised model used the latter rather than the former. Similarly, most of the other predictive models focusing on the lower Cape Fear region discussed previously have relied on soil drainage and proximity to water characteristics. Conversely, given that little topographic relief exists in the project area, the attributes of elevation and slope have played little role in past predictive models. Landform has not been explicitly used in the lower Cape Fear River region prior to URS' 2011 Cape Fear Skyway project; however, past efforts have shown that proximity to certain topographic settings is an important variable (e.g., upland edge overlooking swamp, small rises within swampy bottomlands). Most past predictive model efforts have not taken into account the impacts of extensive urban and suburban development. Finally, most of the predictive models generated in the past were focused on prehistoric resources, with little to no regard for incorporating historic archaeological sensitivity.

Based on the above, the variables chosen for the Kinston Bypass predictive model are: soil drainage, proximity to water, topographic setting, proximity to historic roads, NRHP-listed or NRHP-eligible Civil War resources, and disturbed/developed areas. These variables are discussed below.

3.2.1 SOIL DRAINAGE

Past archaeological predictive modeling projects, particularly in the lower Cape Fear region, have shown a correlation between archaeological sites and well-drained soils (cf. Hay et al. 1982; Wilde-Ramsing 1981b). A few archaeological sites have been identified in areas mapped as poorly-drained soil types. However, closer examination in the field typically reveals these sites are actually situated on a small pocket of well-drained soil that is not depicted on soil survey maps. Typically, these sites are located on slightly elevated locations within large expanses of swampy bottomland, and on ridges around Carolina Bays.

Within the Kinston Bypass study area, a total of 87 soil types (including water categories) have been mapped by the Natural Resources Conservation Service (NRCS). Among these soil types, drainage characteristics consist of: excessively drained, moderately well drained, poorly drained, somewhat excessively drained, somewhat poorly drained, very poorly drained, and well drained. Soils that have excessively drained, moderately well drained, somewhat excessively drained, and well drained drainage characteristics are considered highly sensitive for the presence of archaeological sites. Conversely, soils that have poorly drained, somewhat poorly drained, and very poorly drained drainage characteristics are considered to have a low sensitivity for the presence of archaeological sites. The exceptions to this are waters, udorthents (man-made land), and borrow pit soil types are included in the low sensitive category not because of their drainage characteristic per se, but because they are areas unlikely to contain intact archaeological sites. **Table 1** lists the highly sensitive soil types present in the Kinston Bypass study area; **Table 2** lists the low sensitivity soil types present in the Kinston Bypass study area.

Table 1. Highly Sensitive Soil Types and Drainage for Kinston Bypass Study Area

Soil Code	**Description**	**Drainage**
AnB	Alpin fine sand, 0 to 6 percent slopes	Excessively drained
KuB	Kureb sand, 0 to 6 percent slopes	Excessively drained
La	Lakeland sand, 0 to 6 percent slopes	Excessively drained
La	Leaf silt loam	Excessively drained
Po	Pocalla loamy sand, 0 to 6 percent slopes	Somewhat excessively drained
TaB	Tarboro sand, 0 to 6 percent slopes	Somewhat excessively drained
AaA	Altavista fine sandy loam, 0 to 2 percent slopes	Moderately well drained
Bn	Blanton sand, 0 to 6 percent slopes	Moderately well drained
Cr	Craven fine sandy loam, 1 to 4 percent slopes	Moderately well drained
CrB	Craven silt loam, 1 to 4 percent slopes	Moderately well drained
CrB	Craven very fine sandy loam, 1 to 4 percent slopes	Moderately well drained
CrC	Craven very fine sandy loam, 4 to 8 percent slopes	Moderately well drained
Cv	Craven fine sandy loam, 4 to 8 percent slopes	Moderately well drained
Go	Goldsboro loamy sand, 0 to 2 percent slopes	Moderately well drained
GoA	Goldsboro loamy fine sand, 0 to 2 percent slopes	Moderately well drained
GoA	Goldsboro loamy sand, 0 to 2 percent slopes	Moderately well drained
Jo	Johns fine sandy loam	Moderately well drained
On	Onslow fine sandy loam	Moderately well drained
On	Onslow loamy sand	Moderately well drained
Pa	Pactolus loamy fine sand	Moderately well drained
Pa	Pactolus loamy sand	Moderately well drained
Pa	Pantego fine sandy loam	Moderately well drained
Se	Seabrook loamy sand	Moderately well drained
AuB	Autryville loamy fine sand, 0 to 4 percent slopes	Well drained
Ka	Kalmia loamy sand, 0 to 2 percent slopes	Well drained
KaA	Kalmia loamy sand, 0 to 3 percent slopes	Well drained
Kb	Kalmia loamy sand, 2 to 6 percent slopes	Well drained
Ke	Kenansville loamy sand, 0 to 6 percent slopes	Well drained
KeA	Kenansville loamy fine sand, 0 to 3 percent slopes	Well drained
MaC	Marvyn loamy sand, 6 to 15 percent slopes	Well drained
Na	Norfolk loamy sand, 0 to 2 percent slopes	Well drained
Nb	Norfolk loamy sand, 2 to 6 percent slopes	Well drained
Nc	Norfolk loamy sand, 6 to 10 percent slopes	Well drained
NoA	Norfolk loamy fine sand, 0 to 2 percent slopes	Well drained
NoB	Norfolk loamy fine sand, 2 to 6 percent slopes	Well drained
NoB	Norfolk loamy sand, 1 to 4 percent slopes	Well drained
Wb	Wagram loamy sand, 0 to 6 percent slopes	Well drained
Wc	Wagram loamy sand, 6 to 10 percent slopes	Well drained
Wd	Wagram loamy sand, 10 to 15 percent slopes	Well drained
Wk	Wickham loamy sand, 1 to 6 percent slopes	Well drained

Table 2. Low Sensitivity Soil Types and Drainage for Kinston Bypass Study Area

Soil Code	Description	Drainage
BB	Bibb soils, frequently flooded	Poorly drained
Co	Coxville loam	Poorly drained
Gr	Grifton sandy loam	Poorly drained
Gt	Grifton fine sandy loam	Poorly drained
Kn	Kinston loam, frequently flooded	Poorly drained
Le	Leaf loam	Poorly drained
Le	Lenoir silt loam	Poorly drained
Lo	Leon sand	Poorly drained
Lu	Lumbee sandy loam	Poorly drained
Me	Meggett fine sandy loam	Poorly drained
Me	Meggett loam	Poorly drained
Me	Meggett sandy loam	Poorly drained
Mk	Muckalee loam	Poorly drained
Ra	Rains fine sandy loam	Poorly drained
Ra	Rains sandy loam	Poorly drained
Ro	Roanoke fine sandy loam	Poorly drained
Tm	Tomotley fine sandy loam	Poorly drained
Wn	Woodington loamy sand	Poorly drained
Wo	Woodington fine sandy loam	Poorly drained
Ag	Augusta fine sandy loam	Somewhat poorly drained
Ch	Chewacla loam, frequently flooded	Somewhat poorly drained
Ln	Lenoir loam	Somewhat poorly drained
Ln	Leon sand	Somewhat poorly drained
Ly	Lynchburg fine sandy loam	Somewhat poorly drained
Ly	Lynchburg sandy loam	Somewhat poorly drained
St	Stallings loamy fine sand	Somewhat poorly drained
St	Stallings loamy sand	Somewhat poorly drained
Ap	Arapahoe fine sandy loam	Very poorly drained
Ba	Bayboro mucky loam	Very poorly drained
Ct	Croatan muck	Very poorly drained
De	Deloss fine sandy loam	Very poorly drained
JS	Johnston soils	Very poorly drained
MM	Masontown mucky fine sandy loam and Muckalee sandy loam, frequently flooded	Very poorly drained
Mu	Murville fine sand	Very poorly drained
Mu	Murville mucky loamy sand	Very poorly drained
Pc	Pamlico muck	Very poorly drained
Pe	Pantego loam	Very poorly drained
Pn	Pantego loam	Very poorly drained
Pr	Portsmouth loam	Very poorly drained
Sx	Stockade fine sandy loam	Very poorly drained
To	Torhunta fine sandy loam	Very poorly drained
To	Torhunta loam	Very poorly drained
Uo	Umbric Ochraqualfs	Very poorly drained
Ud	Udorthents, loamy	Well drained
Bp	Borrow pit	NA

3.2.2 PROXIMITY TO WATER

Much like the drainage characteristic of soils, previous predictive models and assessments of settlement patterns have shown that archaeological sites often occur in relatively close proximity to permanent water. In the examples provided in the previous chapter, distances used for defining high probability areas ranged from 200 meters to 762 meters from a water source. For the Kinston Bypass model generation, areas within 100 meters on either side of permanent water (200 meters total) constitute high probability areas for containing archaeological sites. This distance was recently used with good results during survey of the NNP IV Cape Fear Tract (Green et al. 2007).

3.2.3 TOPOGRAPHIC SETTING

Few past predictive modeling efforts have specifically used or defined topographic setting. However, most have employed such a concept by default. Conversely, the Piedmont predictive model utilized several topographic setting variables including slope and aspect, among others (Madry et al. 2006). Based on examination of past reports, the following list of topographic settings was generated. These topographic settings are considered highly sensitive for containing archaeological sites in the Kinston Bypass study area: small rise in floodplain, bluff edge of upland adjacent to Neuse River, edge of pocosins/Carolina Bay. Much like proximity to water, the high probability zone for these topographic settings is defined as 200 meters, with the exception of small rises on the floodplain and edge of pocosins/Carolina Bays.

For small rises on the floodplain, the high probability area is the rise itself, since they are typically less than 200 meters in diameter. Wilde-Ramsing's (1981a:4) analysis of sites in the Big Bend region of New Hanover County noted a prevalence for archaeological sites to be located within swampy bottomlands on slight rises above five feet amsl. Based on analysis of the topography in the Kinston Bypass study area, elevation above the 42-foot contour lines was used to define the limits of small rises in the floodplains. Topographic quad maps and Digital Elevation Model (DEM) data were used to identify small rises in floodplain settings for the Kinston Bypass study area.

In many of the predictive models and settlement pattern discussions of the coastal plain, archaeologists have noted a tendency for archaeological sites to be located along bluff edges overlooking the swampy bottomlands of major river floodplains. For example, Wilde-Ramsing (1980) discussed the associations of prehistoric archaeological sites with environmental zones, finding that sites with prehistoric ceramic artifacts were concentrated along the borders of swamp bottomland mixed pine and hardwood forests (among other locales). Similarly, Wilde-Ramsing (1981a) later discussed a set of sites near the Big Bend Region in the northwestern portion of New Hanover County, where he compared sites located within swamp hardwood forests to sites located along the upland bluffs overlooking swamp hardwood forests. In this analysis, Wilde-Ramsing (ibid) noted sites along upland bluff edges were found at elevations between ten and 20 feet amsl and exhibited a larger areal extent than those in the bottom lands. For the purposes of the Kinston Bypass model, we utilized the 42-foot contour as demarcating the front edge of the bluff. This contour was then buffered out (away from the floodplain) 200-meters to identify the high probability zone associated with bluff edge.

For pocosins and Carolina Bays, the zone is 100 meters on the "outside" edge of the feature. Of particular interest in current archaeological research themes are sites identified along the rims of Carolina Bays. Extensive archaeological research projects focused on Carolina Bays have been conducted in several locales in the Coastal Plain of South Carolina (see Brooks et al. 2010:151-157 for a summary of these various efforts). Less intensive archaeological work on these geological features has also been conducted in North Carolina (cf. Phelps 1989; Pittman and Lipe 1972). The rims of Carolina Bays are built up with sediment deposited by lacustrine (lake) and eolian (wind-blown) processes, therefore "*the potential exists for prehistoric occupations to have been buried and preserved*" (Moore et al. 2010:57). Although prehistoric sites can be found along any part of a Carolina Bay margin, and these sites cover the spectrum of the prehistoric past, most sites are found along the northeast and southeast facing sides, and it appears that use of these locales was much more intensive during the Paleoindian and Archaic periods (Moore et al. 2010; Dr. Christopher Moore 2011, personal communication). Much like the identification of small rises in floodplain settings, pocosins and Carolina Bay edges within the Kinston Bypass study area have been identified through a combination of topographic maps, DEM data, and Light Detection and Ranging (LIDAR) data.

3.2.4 PROXIMITY TO HISTORIC ROADS

A variable for proximity to historic roads was included in the current study to make sure that historic period archaeological sites were more fully included in the model. The Cape Fear Skyway archaeological predictive model included proximity to historic roads (URS 2011:13, 16). Survey of the NNP IV Cape Fear Tract used historic roads (River Road in the case of the NNP IV Cape Fear Tract survey) as a feature likely to have historic archaeological sites in close proximity, defining 100 meters on either side of the road as high probability (Green et al. 2007). The subsequent Cape Fear Skyway predictive model utilized the same definition; for the current study, the 100 meter on both sides of historic roads is utilized again.

For the current study, historic maps online at www.lib.unc.edu/dc/ncmaps/ were consulted in May 2013. Numerous maps from the region are available; however, three specific maps were chosen to georeference and identify the alignment of historic roads. The three Lenoir County maps used for this variable are:

- ca. 1862 “Sketch Map of Parts of Greene and Lenoir Counties” (no cartographer cited, NC Maps 2013) (**Figure 2**)
- 1900 “Soil Map, North Carolina, Kinston Sheet” (Smith 1900) (**Figure 3**)
- 1938 “Lenoir County, North Carolina” (State Highway and Public Works Commission 1938a) (**Figure 4**)

The three Jones County maps used for this variable are:

- 1868 “Map of Jones County” (Kinsey 1868) (**Figure 5**)
- 1903 “Soil Map, North Carolina, Craven Sheet” (Smith 1903) (**Figure 6**)
- 1938 “Jones County, North Carolina” (State Highway and Public Works Commission 1938b) (**Figure 7**)

The use of these six maps, which provide historic “snap shots” of about 38 years apart, provides a good cross-section of the available maps without overly burdening the model with multiple maps from short time intervals (i.e., minimal changes between maps).

For the ca. 1862 map of Lenoir County (NC Maps 2013) and the 1868 map of Jones County (Kinsey 1868), very little is shown in the way of roads. As such, all roads from these maps were digitized into the predictive model. It should be noted that as “sketch maps,” these maps are unlikely to be very accurate. But their use in creating the model is still warranted as a means to approximate the locations of mid-nineteenth century roads in the study area. Analysis of future fieldwork results will need to consider if historic site(s) not near any current roads may be indicators of former road alignments. Likewise, future field studies should try to identify traces of older roads that are no longer extant.

The 1900 and 1903 soil maps (Smith 1900, 1903) provides great detail in terms of roadways, landscape features, and structures. Close inspection of these maps revealed that many of the roadways were not—or only sparsely—populated with structures. Given one aim of the predictive model is to find where historic sites are likely to be located, not all roads from these maps were digitized. Rather, roadways and segments of roadways that depicted higher densities of structures along them were digitized.

Much like the 1900 map, the 1938 roadway map (State Highway and Public Works Commission 1938) provides exacting details on roadways and structures. In fact, so much detail is included on this map that the tactic of choosing more densely populated roadways utilized for the 1900 soil map did not seem warranted for the 1938 map as doing so would mean digitizing the entire map. Instead, roadways depicted as paved (solid dark line) and "surface treated roads" (alternating dark and clear rectangles) as shown in the map's legend, were digitized for the predictive model.

Figure 8 depicts the results of georeferencing the three maps. The roadways from the three different maps are depicted in that image using different colors. The results of applying the 100 meter buffer to them will be presented in the results section of this report.

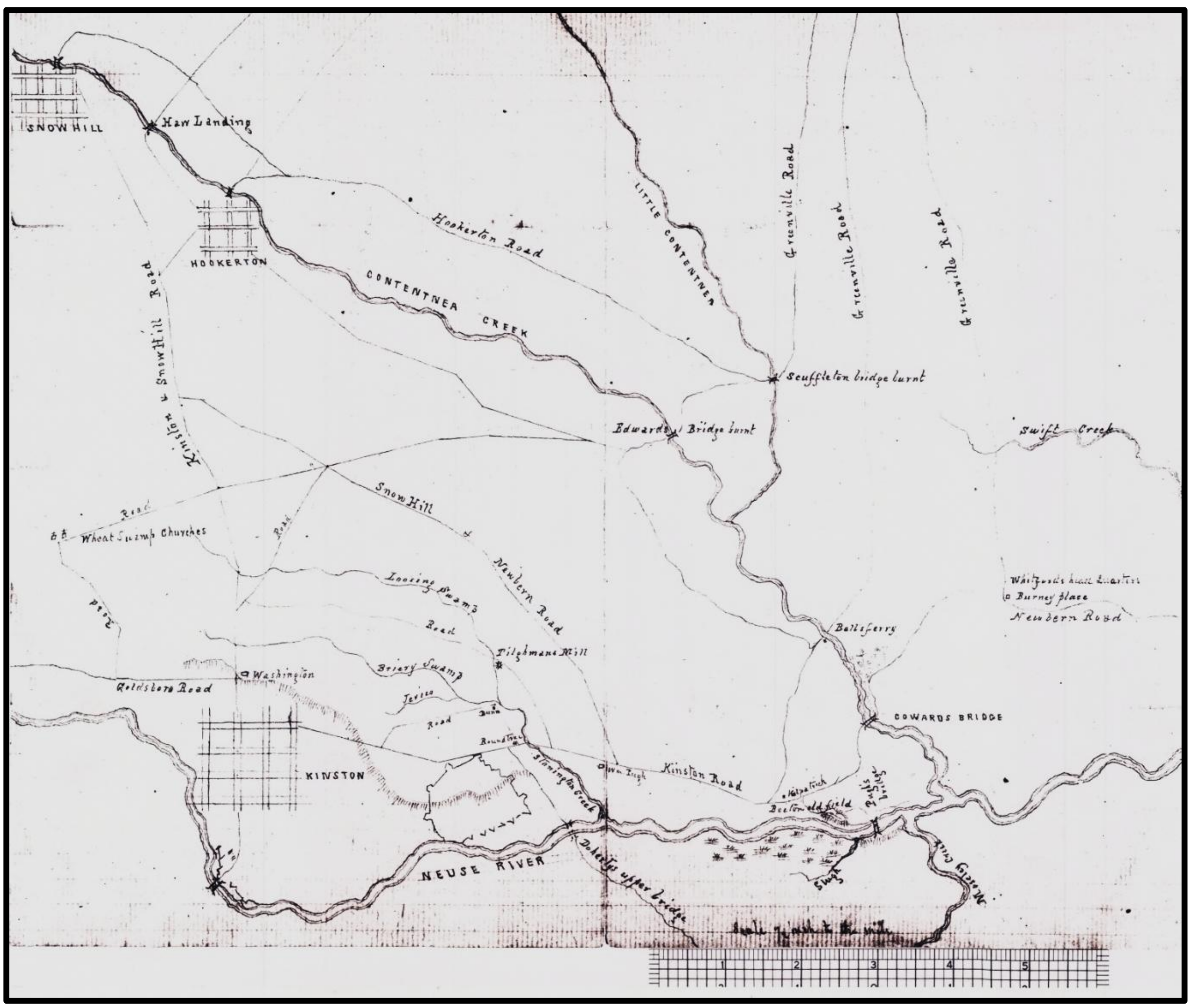

Figure 2. Circa 1862 Sketch Map of Greene and Lenoir Counties

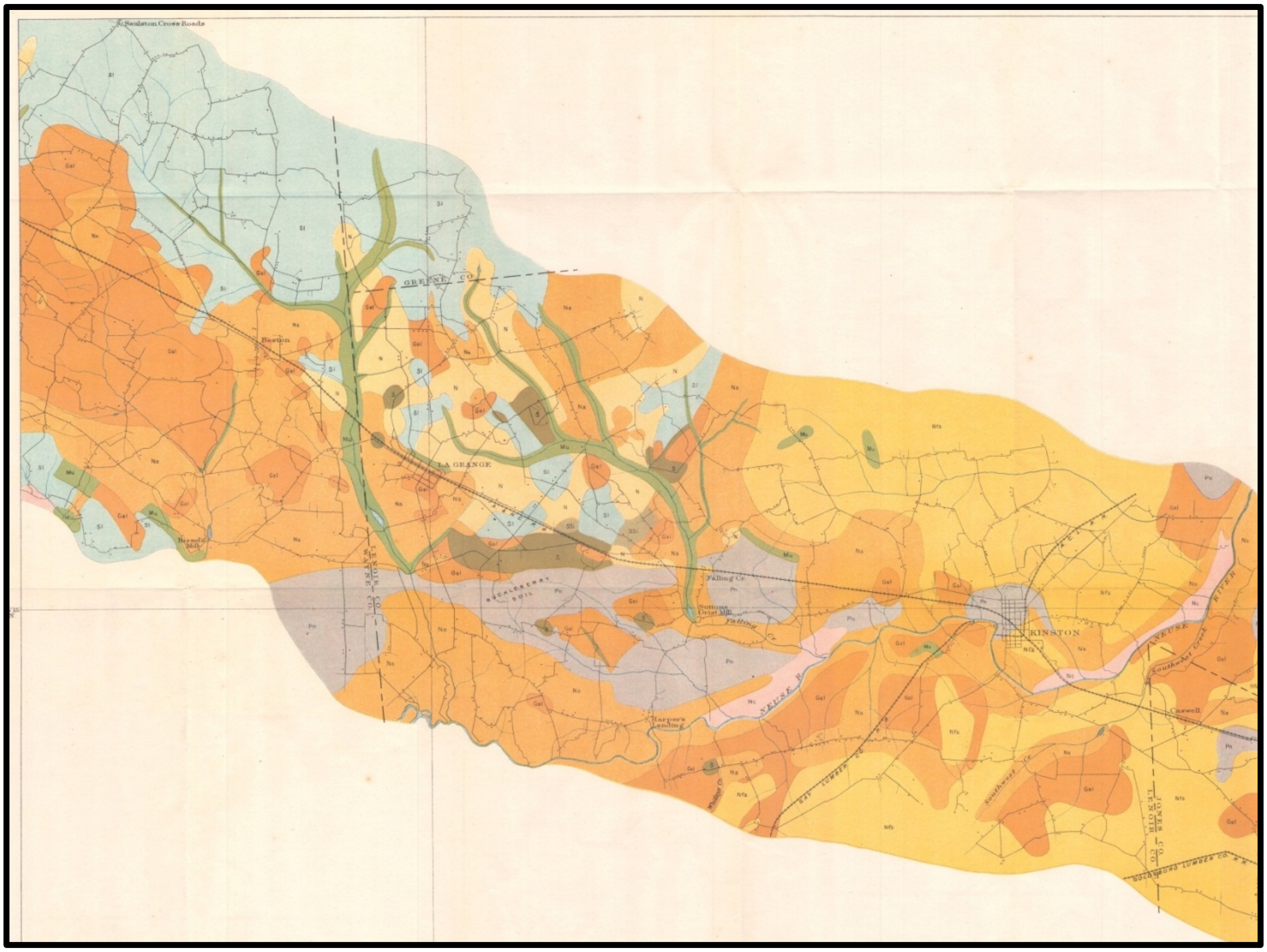

Figure 3. 1900 Soil Map, Lenoir Sheet

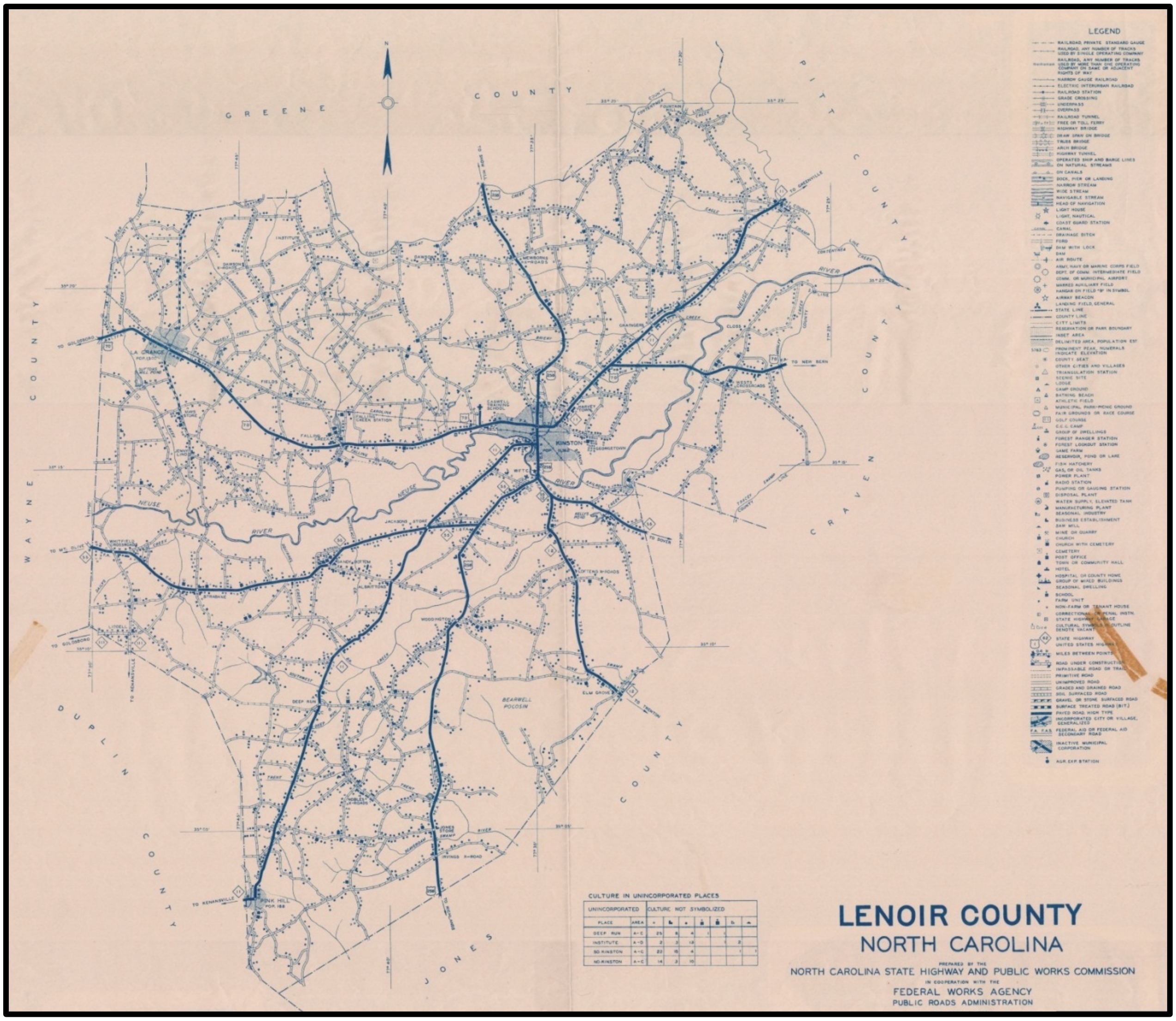

Figure 4. 1938 Lenoir County Road Map

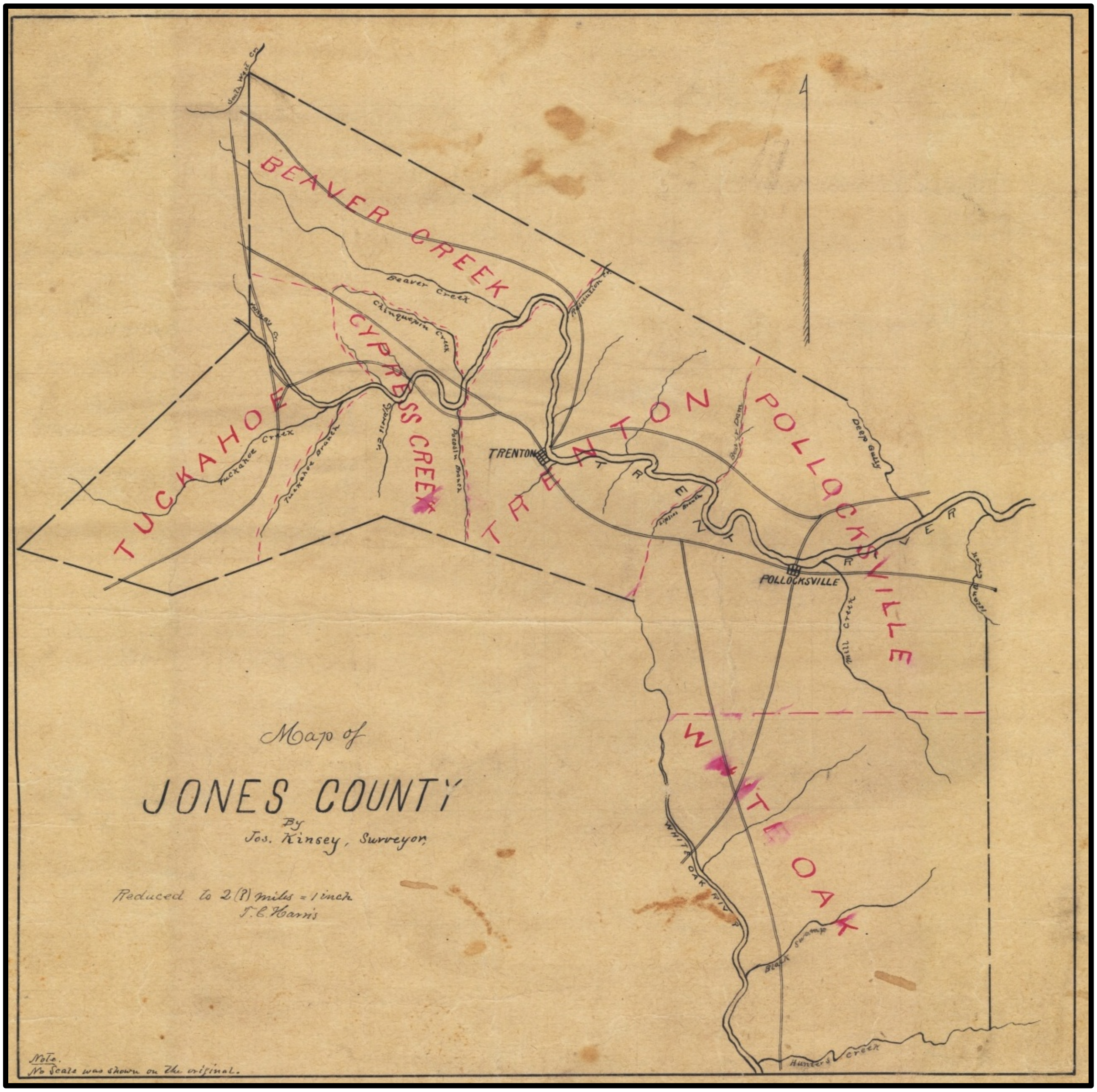

Figure 5. 1868 Map of Jones County

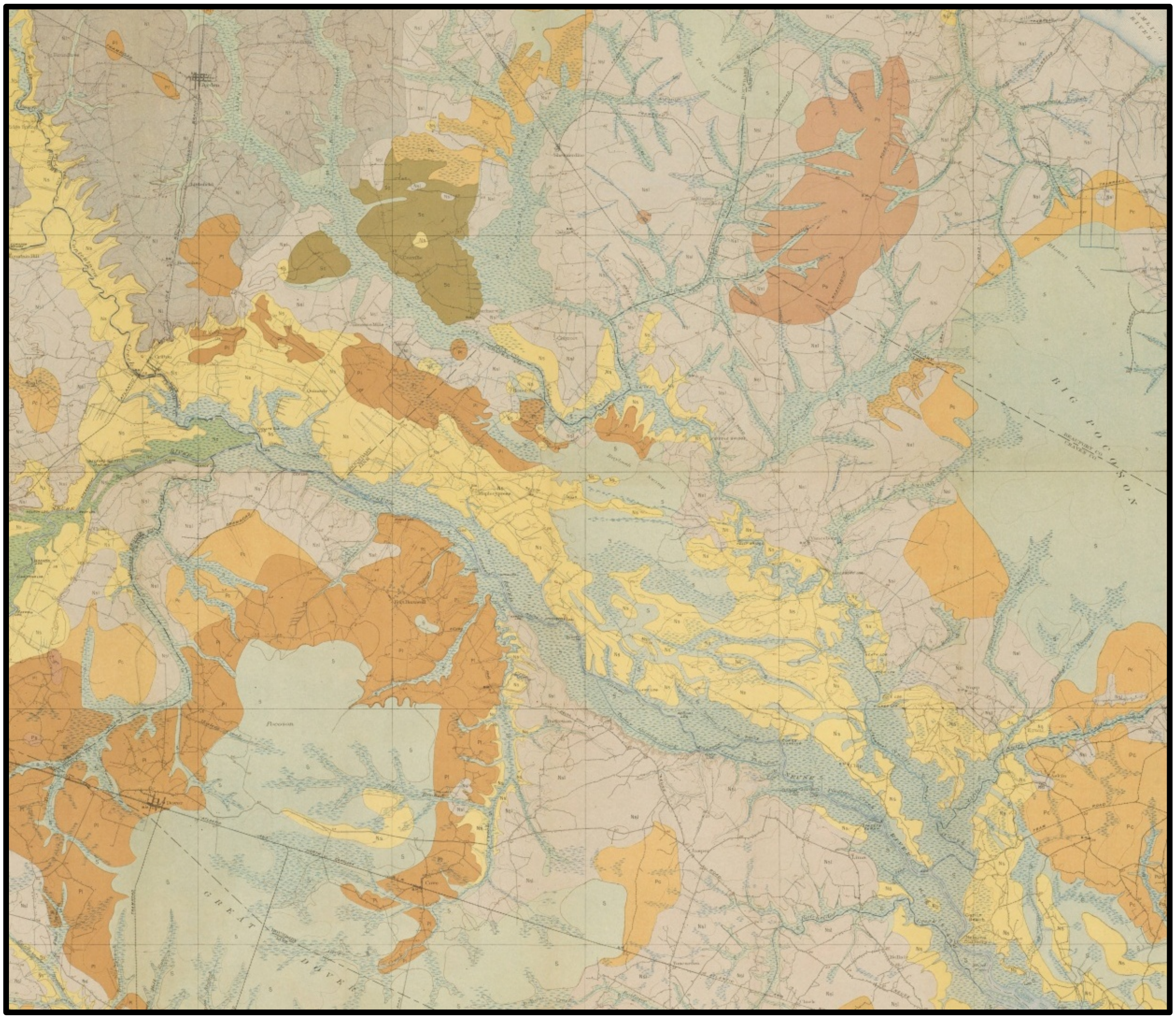

Figure 6. 1903 Soil Map, Craven Sheet

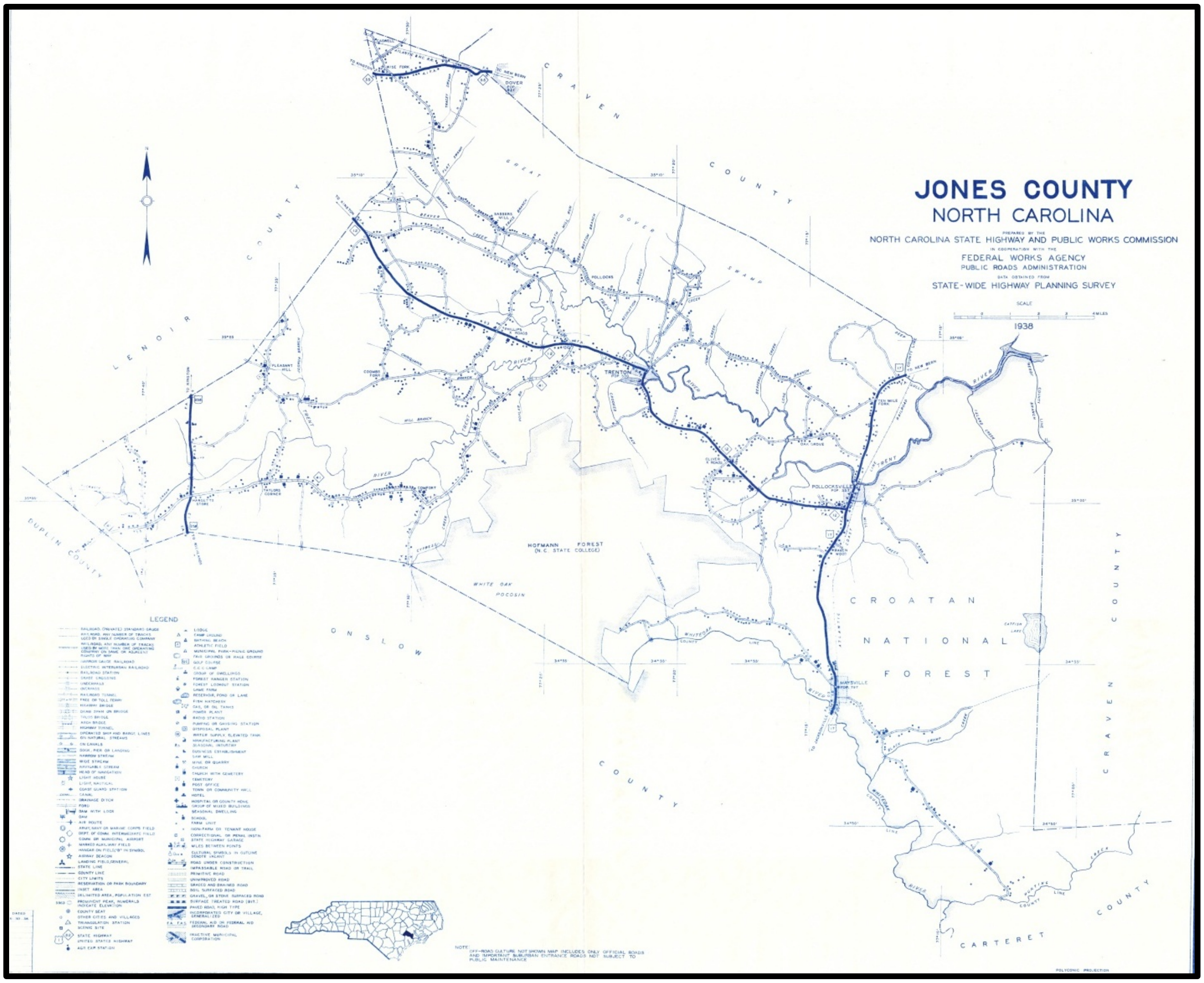

Figure 7. 1938 Jones County Road Map

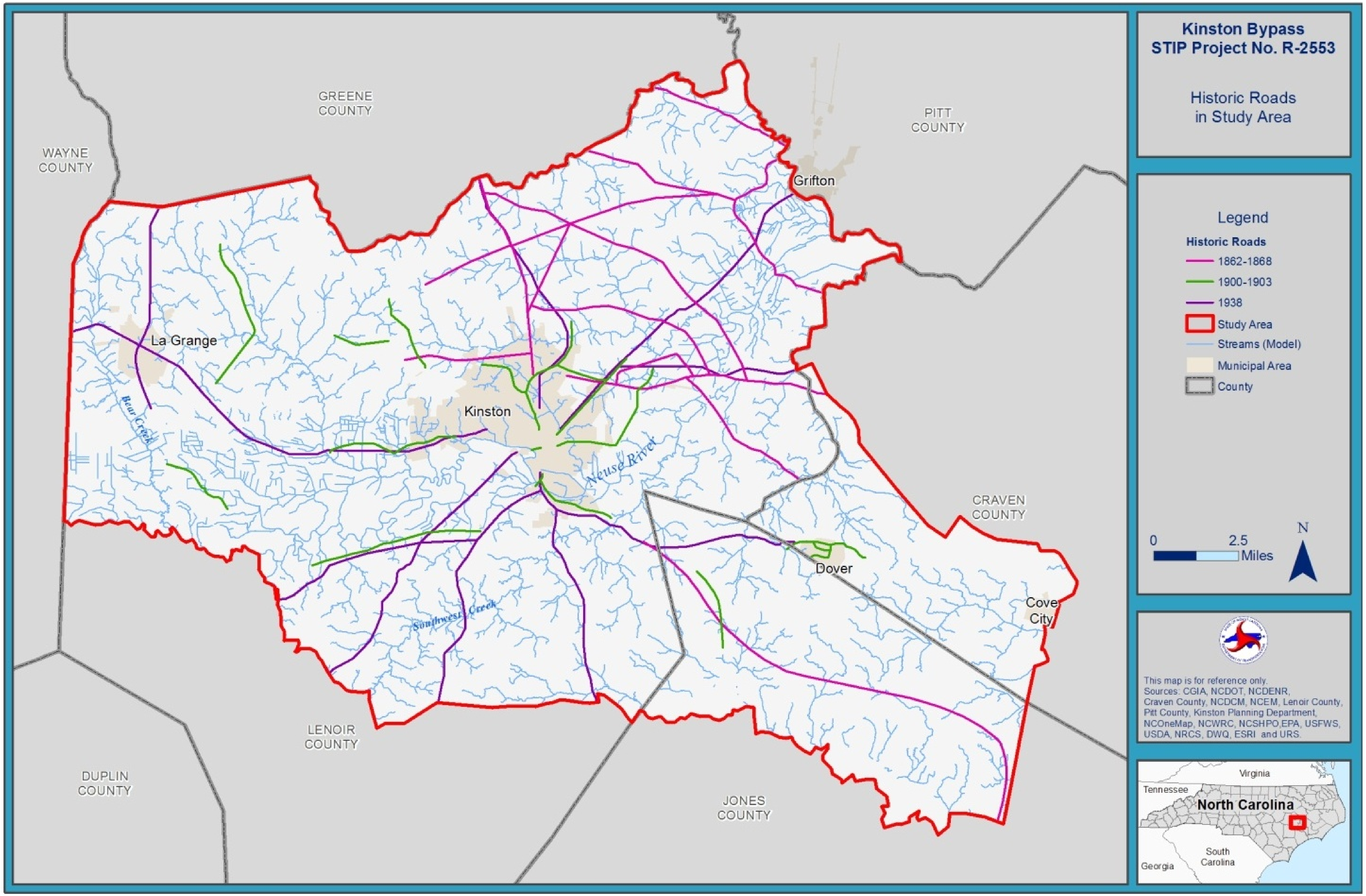

Figure 8. Historic Roads in Study Area

3.2.5 PREVIOUSLY RECORDED CIVIL WAR HISTORIC RESOURCES

A variable not utilized in the Cape Fear Skyway model that is included for the current Kinston Bypass model is the presence of previously recorded historic resources, particularly those associated with Civil War battles fought in the study area—First Battle of Kinston (December 1862) and Battle of Wyse Fork (March 1865).

Five areas where various skirmishes took place during the First Battle of Kinston of 1862 have been demarcated. These locations were listed on the National Register of Historic Places (NRHP) in 2006. An additional two areas on either side of the Neuse River where studies have identified 19th century bridge pilings (site 31LR381**) have also been included in the First Battle of Kinston resource. Although not listed on the NRHP with the other five areas, the bridge "might be considered contributing elements to [the] Battle of Kinston district" (31LR381** site form). Likewise, a large area where the Battle of Wyse Fork of 1865 took place has been demarcated. Lea Abbott of the OSA, with the help of local Civil War enthusiasts, is currently in the process of developing a NRHP nomination form for this large cultural resource (Lea Abbott 2009, 2013, personal communications).

In both cases, the larger areas of the battles encompass numerous distinct elements of these battles including skirmish areas, earthworks, structures utilized during the battles, and other associated battle-related resources. Many of these resources have painstakingly been identified by local Civil War enthusiasts through a combination of historic documentary research and in-field verifications. However, none of these areas has been subjected to systematic archaeological investigation. Given the fluid nature of troop movements and activities within battles, coupled with the lack of systematic cultural resources fieldwork within these areas, the current model will utilize the NRHP boundaries (or proposed boundary in the case of Wyse Fork) and demarcate these areas as highly sensitive regardless of other variables.

3.2.6 DISTURBED/DEVELOPED AREAS

Areas that have been subjected to commercial, industrial, and residential development will also be considered in this predictive model. The clear-cutting, grading, cutting, and/or filling activities associated with intensively developed areas typically destroy the integrity of archaeological resources that may have existed. Therefore, the current study will demarcate these areas and classify them in the predictive model as low-probability regardless of other variables, with the exception of Civil War sites. In cases where both disturbed/developed areas and previously recorded NRHP-listed or NRHP-eligible Civil War resources overlap, they will be classified as high probability.

It is acknowledged that archaeological sites can be preserved within portions of urban landscapes. However, the goal of this modeling program is to assess the overall sensitivity of alternative corridors, not to predict the exact location of all possible archaeological sites. Future field studies will need to closely examine the background data to determine the need for survey in any given area.

Two methods were used to demarcate disturbed/developed areas—soils data and aerial photography. For soils data, borrow pits and any soil type with an urban and/or udorthents element(s) are considered disturbed/developed. A total of two soil types within the study area meet these criteria—Udorthents (loamy), and Borrow pit.

For aerial photography, aerial photographs dated 2010 were visually inspected for developments including, but not limited to, residential neighborhoods, golf courses, industrial complexes, and commercial complexes. These areas were then digitized in the GIS as disturbed/developed areas.

3.2.7 IN-RIVER ARCHAEOLOGICAL RESOURCES

The purpose of this predictive model is terrestrial in nature. We recognize that resources are also present within the Neuse River in the study area. However, as resources within an aquatic environment, they are not formally considered as part of this terrestrial model. Given the expense of underwater archaeological studies, identifying and evaluating these types of resources is most cost effective when done on a specifically defined preferred river crossing location (or at least a limited number of preferred alternative crossings).

3.3 GEOGRAPHIC INFORMATION SYSTEMS METHODOLOGY

3.3.1 GEOGRAPHIC INFORMATION SYSTEMS INTRODUCTION

The following subsection will detail the GIS methodology used for creation of the archaeological predictive model. Details are provided pertaining to how data layers were generated, how the variables were weighted for the analysis, and how the final predictive model was created.

3.3.2 DATA LAYER CREATION

This section discusses how each of the data layers for the five variables was created. Each of the variables was created from relevant data and analyzed so that the end result stratified the data into areas of high probability and low probability for that one variable.

3.3.2.1 Soil Drainage

Soil GIS data for Lenoir, Craven and Jones counties was downloaded from the United States Department of Agriculture (USDA) NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/). Tabular and spatial information were joined to provide soil types and drainage classifications to the soil polygons. Next, all soils with drainage characteristics of excessively drained, moderately well drained, and well drained were reclassified as well drained. Soils with drainage characteristics of poorly drained, somewhat poorly drained, and very poorly drained were re-classified as poorly drained. Water bodies, mines, and pits were also included in the poorly drained category.

Once the two classifications of well drained and poorly drained soils were established, the GIS data was clipped to the analysis area and serves as a variable in the model.

3.3.2.2 Proximity to Water

Stream lines for the Kinston Bypass project were modeled and field verified by the North Carolina Department of Water Quality (NCDWQ).

Each stream line was buffered by 200 meters on both sides to define the high probability zone. Next, the areas outside the buffer zone were included in the data layer to represent low probability areas. The resulting classifications were then clipped to the analysis area.

3.3.2.3 Topographic Setting

The topographic setting (TSP) variable has three components: Carolina Bays, upland bluffs, and small rises in the swamps. It was decided that each of these three topographic characteristics would have influenced prehistoric settlement. However, it is likely that historic populations would have only been influenced by the uplands bluffs, not the Carolina Bays or small rises in the swamp. Therefore, separate prehistoric and historic topographic setting variables were created for use in this project.

Carolina Bays were derived from USA topo maps provided as ESRI ArcGIS Basemaps along with LiDAR. All Carolina Bays were heads-up digitized, by creating lines on the south and eastern portions of each Carolina Bay. A 200 meter buffer was created from the south and eastern lines on all of the Carolina Bays. These small strips of buffered area provide a component of the prehistoric topographic setting variable.

The second component of the prehistoric topographic setting variable is small rises in low/swampy areas; these small areas stand a few feet above the surrounding floodplain. Topographic contour GIS data used to derive this variable was downloaded from the NCDOT GIS website (https://connect.ncdot.gov/resources/gis/Pages/Cont-Elev_v2.aspx) and was derived from LiDAR imagery in 2007. It was decided that any closed location above the floodplain would be included. An elevation greater than 42 feet above sea level was used to indicate a small rise or hill in swampy areas. Once these areas were identified, a polygon GIS layer was created.

The third component of the prehistoric topographic setting variable is proximity to upland bluffs. This component also serves as the only topographic setting variable for the historic model. Topographic contour GIS data was used to derive this variable. It was decided that an elevation of 42 feet represented the edge of the bluff between the floodplain and the uplands. Topographic lines representing 42 feet of elevation were buffered for 200 meters on the inland side of the bluff.

The upland bluff component serves as the historic topographic setting variable. To derive the prehistoric topographic setting variable, all three topographic setting components were compiled into a single GIS layer. As a last step, areas outside these zones were included in the data layer to represent areas not included in the topographic setting variable.

3.3.2.4 Proximity to Historic Roads

Using historic map resources as discussed above in **Section 3.2.4**, historic roads were identified (http://www.lib.unc.edu/dc/ncmaps/). Once identified, the historic maps were georeferenced in the GIS system and then digitized into vector data.

Next, a 100 meter buffer was applied to both sides of each road. The resulting buffer zones were clipped to the analysis area. As a last step, areas outside the historic road buffers were added to the data layer to represent areas which are not close to historic roads.

3.3.2.5 Previously Recorded Civil War Historic Resources

The polygons used to demarcate areas associated with the First Battle of Kinston and the Battle of Wyse Fork were based on NRHP boundaries. For the First Battle of Kinston, the multiple areas have already been listed on the NRHP. It should be noted that other locations related to this battle exist within the study area; however, for the purposes of this predictive model, only the NRHP-listed areas were utilized. The First Battle of Kinston polygons were provided from the State Historic Preservation Office in May 2011. For the Battle of Wyse Fork, the boundary utilized is the one being proposed in its NRHP nomination form, which is currently in preparation by Lea Abbott of the OSA (personal communications 2009, 2013).

3.3.2.6 Disturbed/Developed Areas

The disturbed and developed area variable was generated using a 2010 aerial photo of the analysis area which was flown for this project. Areas such as sub-divisions, commercial development, and other disturbed areas were heads up digitized at a scale no less than 1:3,600. Also, any area classified as a mine, pit, or urban area in the USDA NRCS soil data was included as disturbed. The resulting disturbed areas were clipped to the analysis area.

As a last step, undeveloped areas were added to the data layer to represent areas which are not significantly disturbed or developed.

3.3.3 VARIABLE WEIGHTING

Based on previous research, each variable was ranked based on its perceived level of influence on historic and prehistoric settlement. Weighting of the variables was defined by URS archaeologists based on the general results of previous work (see **Section 2.3**). For example, several past efforts have shown a correlation between archaeological sites and proximity to water and soil drainage classification. As such, these types of variables were given stronger weight towards the definition of high probability areas. Conversely, few past efforts have taken into account the impact of modern development. In this case, we had to make our own judgment about this variable's weight. The primary goal of this project is to predict where intact archaeological sites are likely to occur, therefore, disturbed/developed areas were assigned a strong weight towards the identification of low probability areas.

For the prehistoric model, the TSP variable was weighted the highest, such that bluff edges, Carolina Bays, and rises in the swamp would always have a high probability. The TSP variable was followed in rank by proximity to water (PW), and well drained soils (WDr). Poorly drained soils (PDr) would have been avoided by prehistoric populations. Therefore, this variable decreases overall probability. The final variable, disturbed/developed areas (DD), decreases the likelihood that intact archaeological remains will be encountered. Regardless of the probability based on soils, TSP, and PW, areas within DD automatically have a low probability.

It was decided that historic probability would exclude Carolina Bays and rises in the swamp but include proximity to historic roads. Again, the TSP in the form of bluff edges weighted the highest (TSH). Proximity to historic roads (PR) was ranked below topographic setting and the same as PW and WDr. The presence of PDr decreases the overall historic probability. Similar to the prehistoric model, DD areas decrease the likelihood that historic remnants will be recovered. Regardless of the probability calculated based on other variables, areas within DD areas automatically have a low probability.

3.3.4 ARCHAEOLOGICAL POTENTIAL GENERATION

Based on the weight of each variable discussed previously, the following equation was used to compute the prehistoric probability model:

$$\text{Prehistoric probability} = ((\text{TSP} + \text{PW} + \text{WDr}) - \text{PDr}) - \text{DD}$$

This equation takes into account the effect of DD areas on prehistoric probability. Regardless of probability based on TSP, soil drainage, and distance to water, the presence of DD areas decreases prehistoric probability.

The following equation was used to compute the historic probability model:

$$\text{Historic probability} = ((TSH + PR + PW + WDr) - PDr) - DD$$

Like the prehistoric probability equation, the presence of DD areas decreases historic probability by half. This model also takes into account the influence of historically known roads. Once each model was created, the probability across the analysis area was divided into two categories, low and high. A final comprehensive model was created using the high categories from both the prehistoric and the historic models. Any raster cell that was deemed high probability in either of the models was coded as high probability in the combined model; for a raster cell to be coded as low probability in the combined model, both the prehistoric and historic models had to have that cell coded as low probability.

4.0 TERRESTRIAL ARCHAEOLOGICAL PREDICTIVE MODEL RESULTS

Determination of the location of high and low probability terrestrial archaeological areas was compiled for the entire Kinston Bypass study area; however, the focus of the current study addresses 17 DSAs that are currently under consideration. Should a future need to consider additional or altered DSAs arise, analysis of those can be conducted with the GIS and reported in an addendum memorandum.

4.1 SEGMENTS, DRAFT PRELIMINARY CORRIDORS, AND DETAILED STUDY ALTERNATIVES

Project planning for the Kinston Bypass project began in earnest in 2009. To date, planning for the Kinston Bypass has focused efforts on decreasing the unit of study from the initial broad study area, through possible portions of alignments (termed segments), to DSAs. Moving forward, studies will focus on the DSAs, and this is the unit of analysis this predictive model will ultimately evaluate.

Initially, many segments were developed for the Kinston Bypass, which resulted in over 3,000 possible overall alignments. Segments were further refined and reduced to 89 segments which, when combined, provided 95 possible complete corridors.

Further analysis, coupled with public input from Citizen Informational Workshops (CIWs) held in 2010 and 2011, increased the number of segments for consideration, but also reduced the overall number of potential full routes to 62 Draft Preliminary Corridors (DPCs). In November 2011 and March 2012, these DPCs were further reduced by the Interagency Merger Team, ultimately resulting in the 17 DSAs currently under consideration.

4.2 RESULTS OF INDIVIDUAL VARIABLES FOR ARCHAEOLOGICAL PREDICTIVE MODEL

The purpose of this section is to provide a graphical summary of results for each of the variables used to create the Kinston Bypass archaeological predictive model. The intent is to show the results of analysis of each variable prior to their combination to produce comprehensive results. Since the focus of the study is the results of the final model, each of the variables is graphically depicted in **Figure 9** (Soil Drainage Classifications), **Figure 10** (Proximity to Water Classifications), **Figure 11** (Topographic Setting Classifications), **Figure 12** (Proximity to Historic Road Classifications), **Figure 13** (Previously-recorded Historic Resources), and **Figure 14** (Disturbed/Developed Areas).

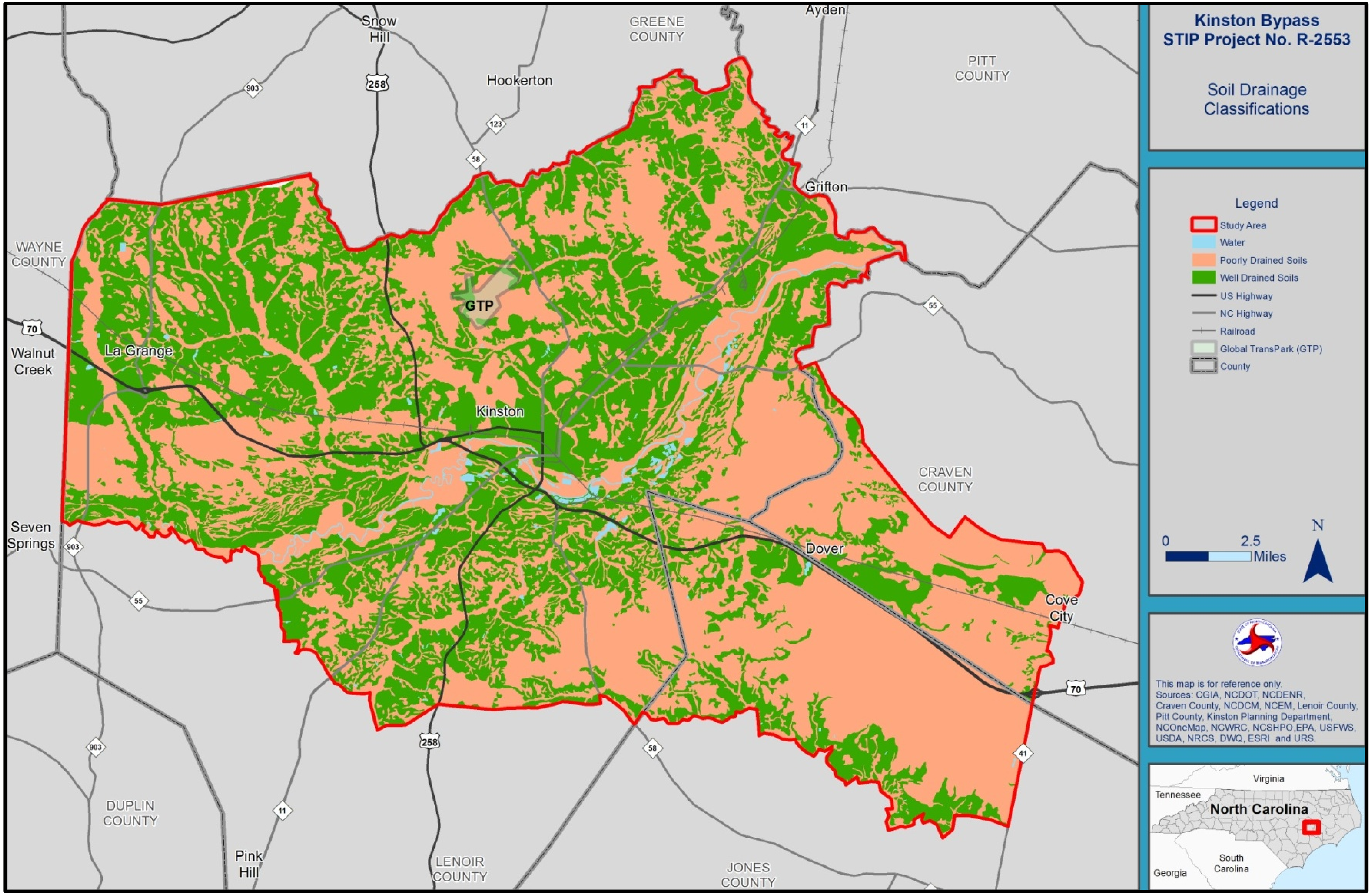

Figure 9. Soil Drainage Classifications

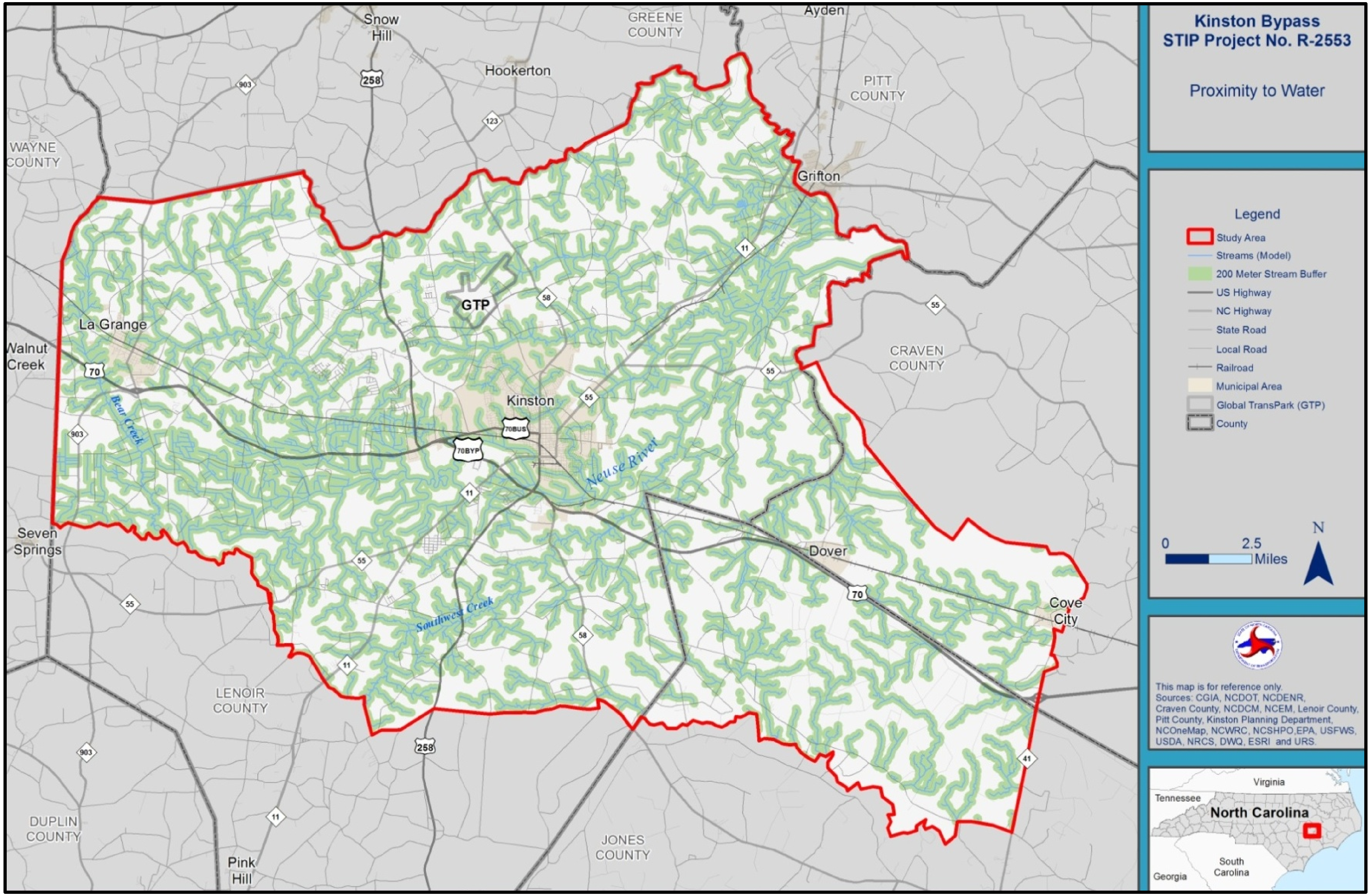

Figure 10. Proximity to Water Classifications

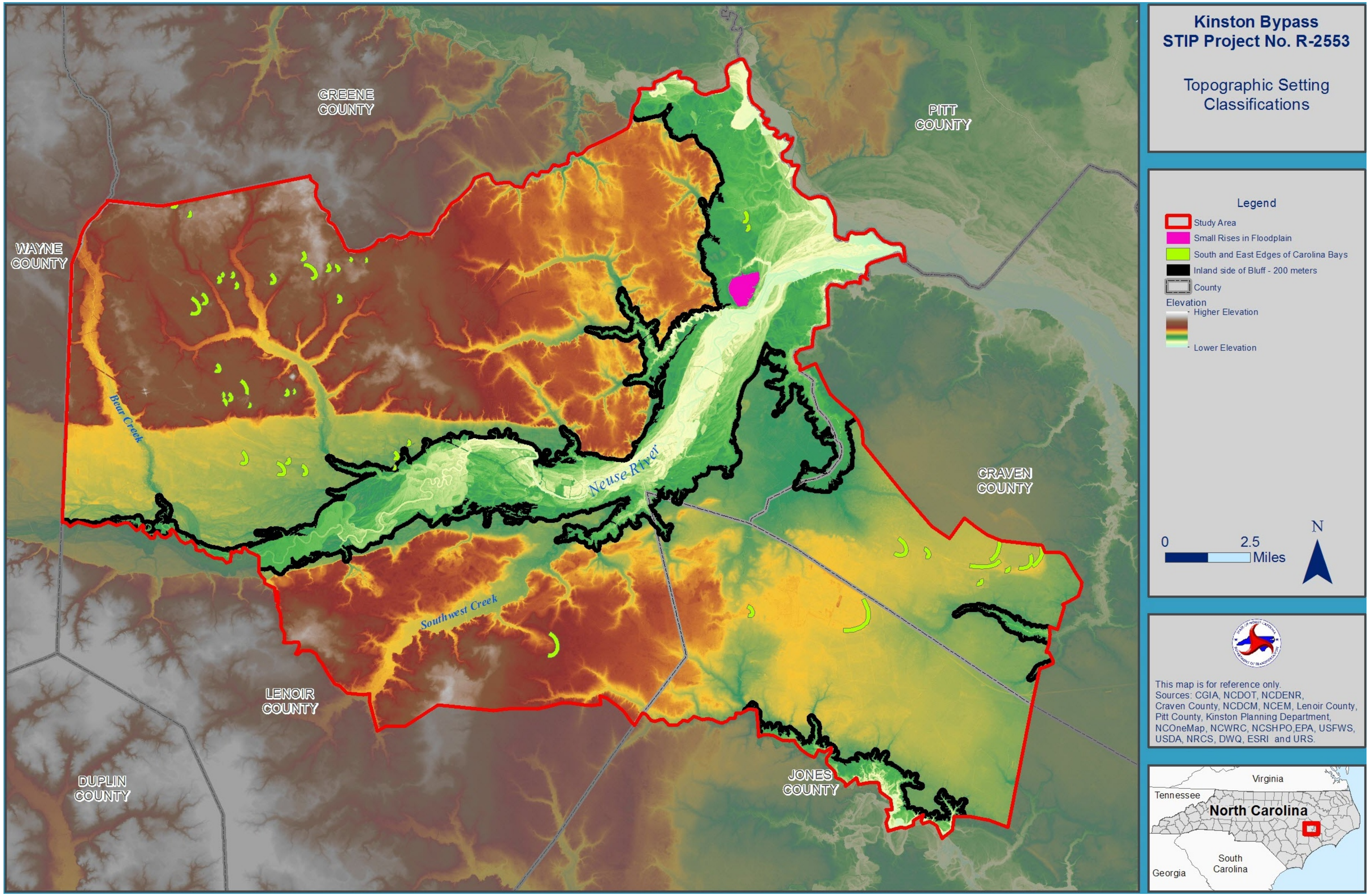

Figure 11. Topographic Setting Classifications

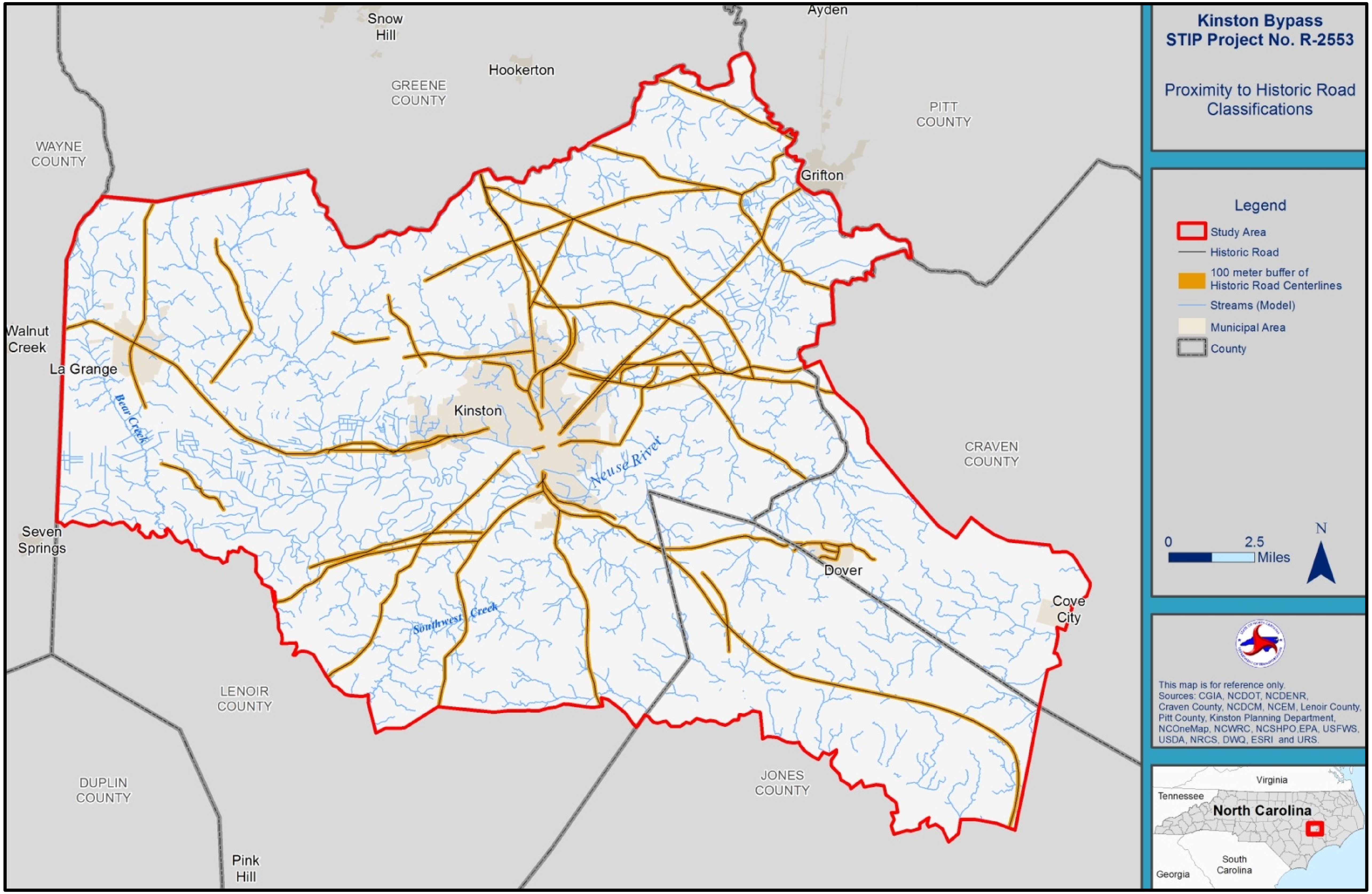

Figure 12. Proximity to Historic Road Classifications

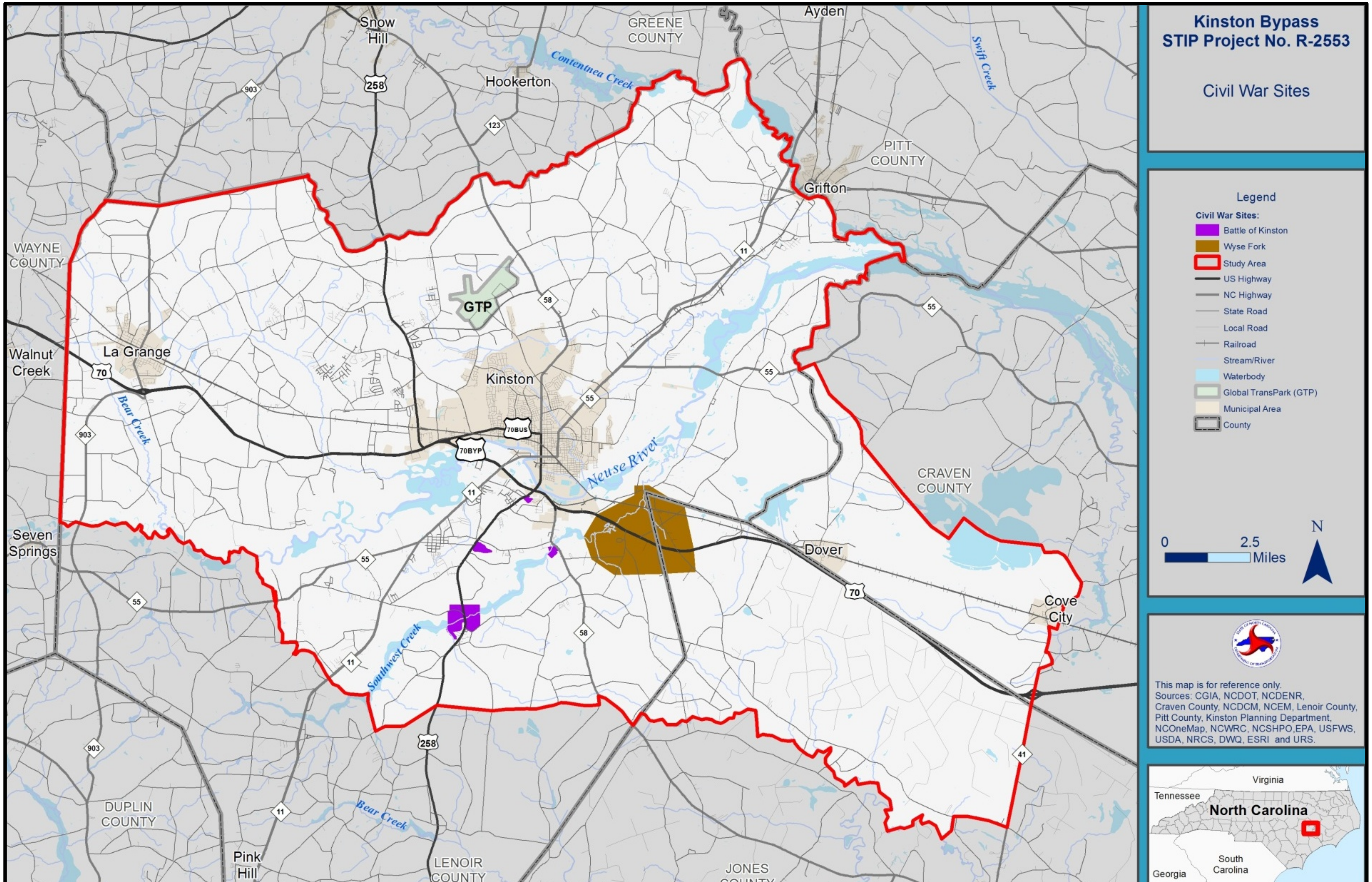

Figure 13. Civil War Sites

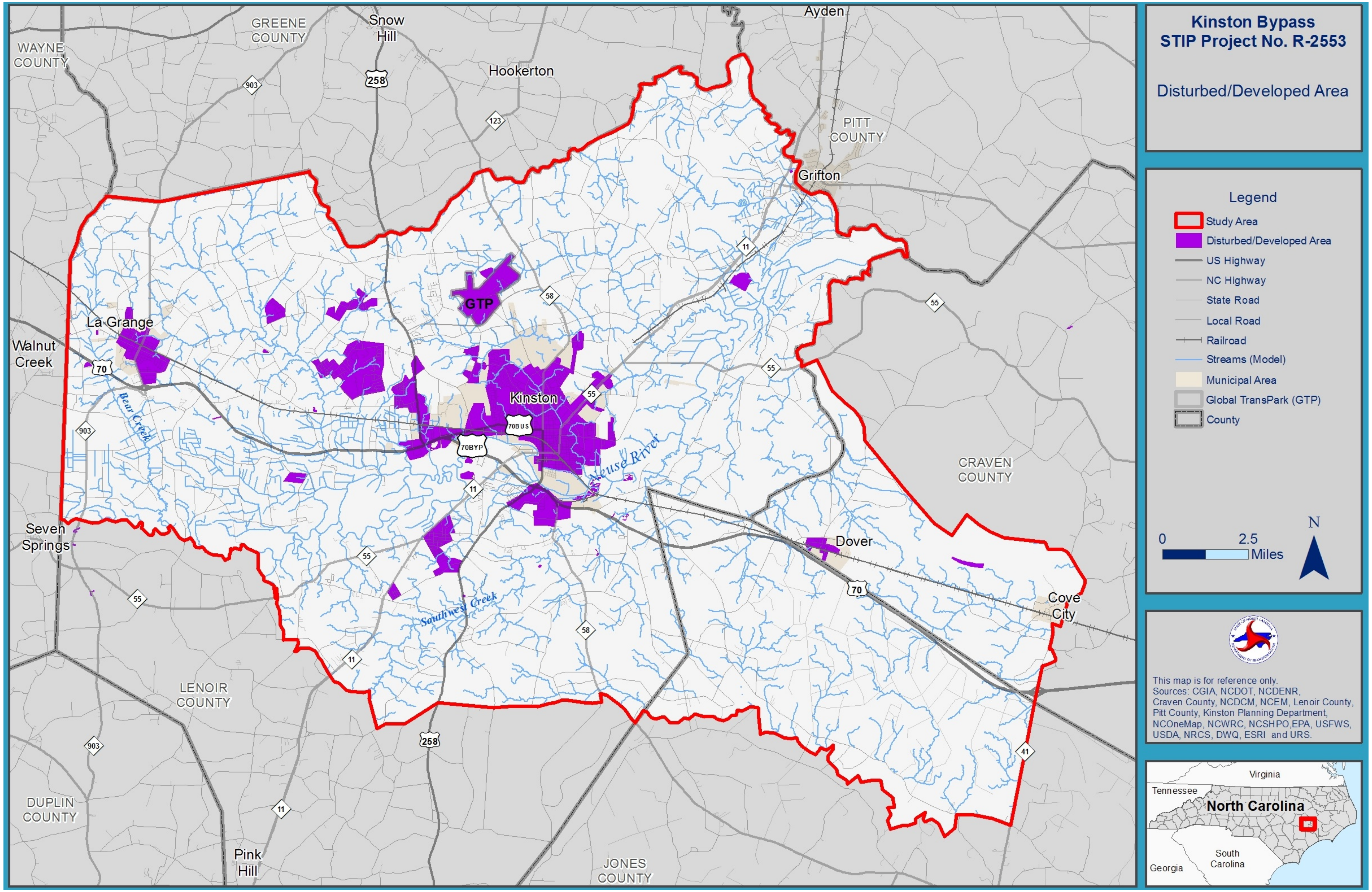

Figure 14. Disturbed/Developed Areas

4.3 RESULTS OF COMPREHENSIVE ARCHAEOLOGICAL PREDICTIVE MODEL FOR PROJECT STUDY AREA

Although 17 DSAs are the main focus of this study, a summary of the entire study area is also provided so that specific alignments can be compared to the generalized results of the archaeological predictive model. **Figure 15**, **Figure 16**, and **Figure 17** graphically depict the high and low probability for prehistoric, historic, and a composite of both (respectively) for the entire study area for the Kinston Bypass. As noted in the methods section above, the historic sensitivity was developed in a similar fashion to the prehistoric model. However, proximity to Carolina Bays and small rises in the floodplain (part of the topographic setting variable) was not considered, while proximity to historic roads and NRHP-listed or NRHP-eligible Civil War sites were considered.

In terms of the composite sensitivity for any type of archaeological site (**Figure 17**), the entire analysis area contains 242,317.8 acres (98,062.9 hectares). Of this, 75,134.1 acres (30,405.7 hectares, 31.0 percent) are classified as high probability areas and 167,183.7 acres (67,657.2 hectares, 69.0 percent) are classified as low probability areas.

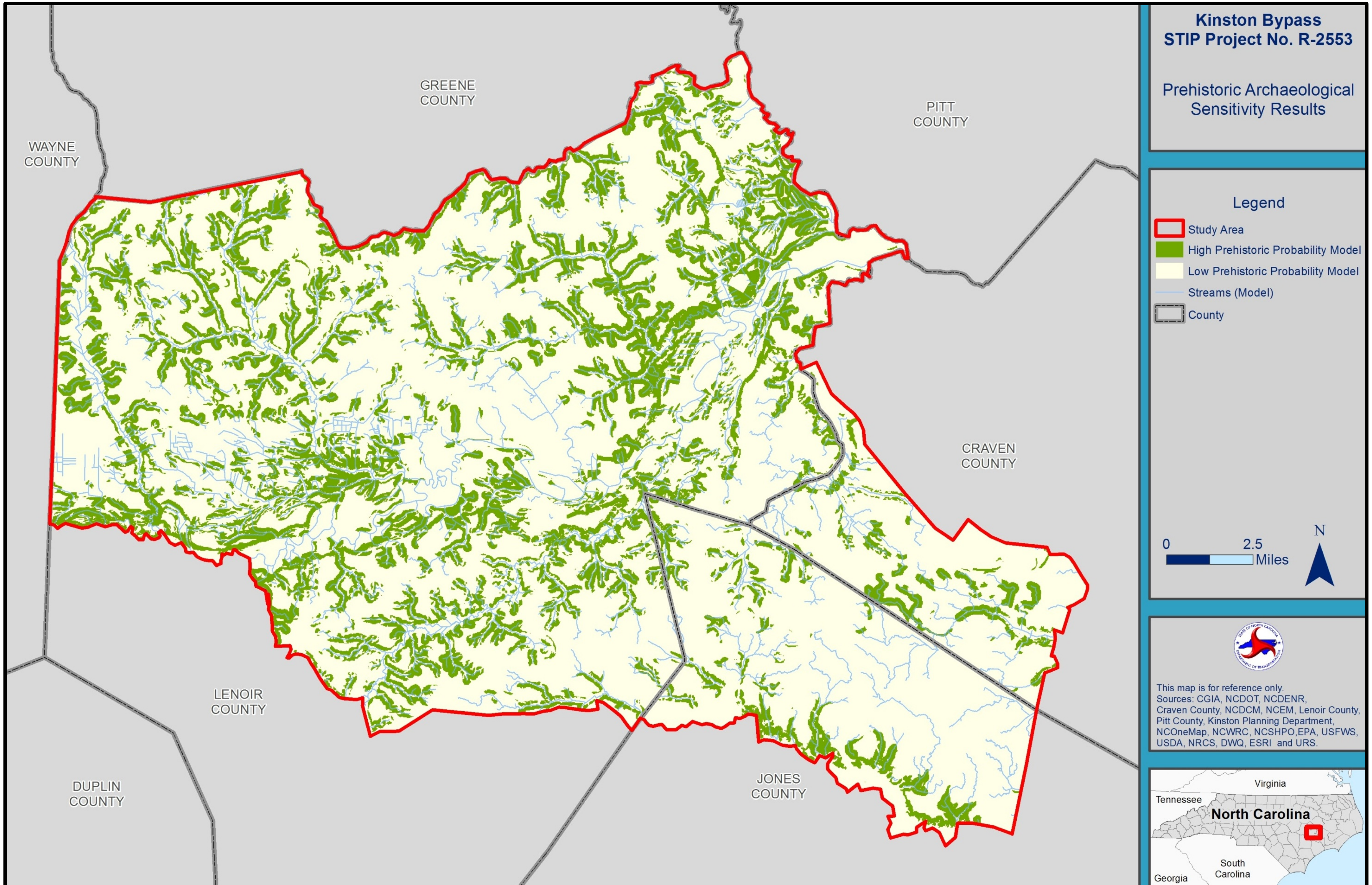

Figure 15. Prehistoric Archaeological Sensitivity Results

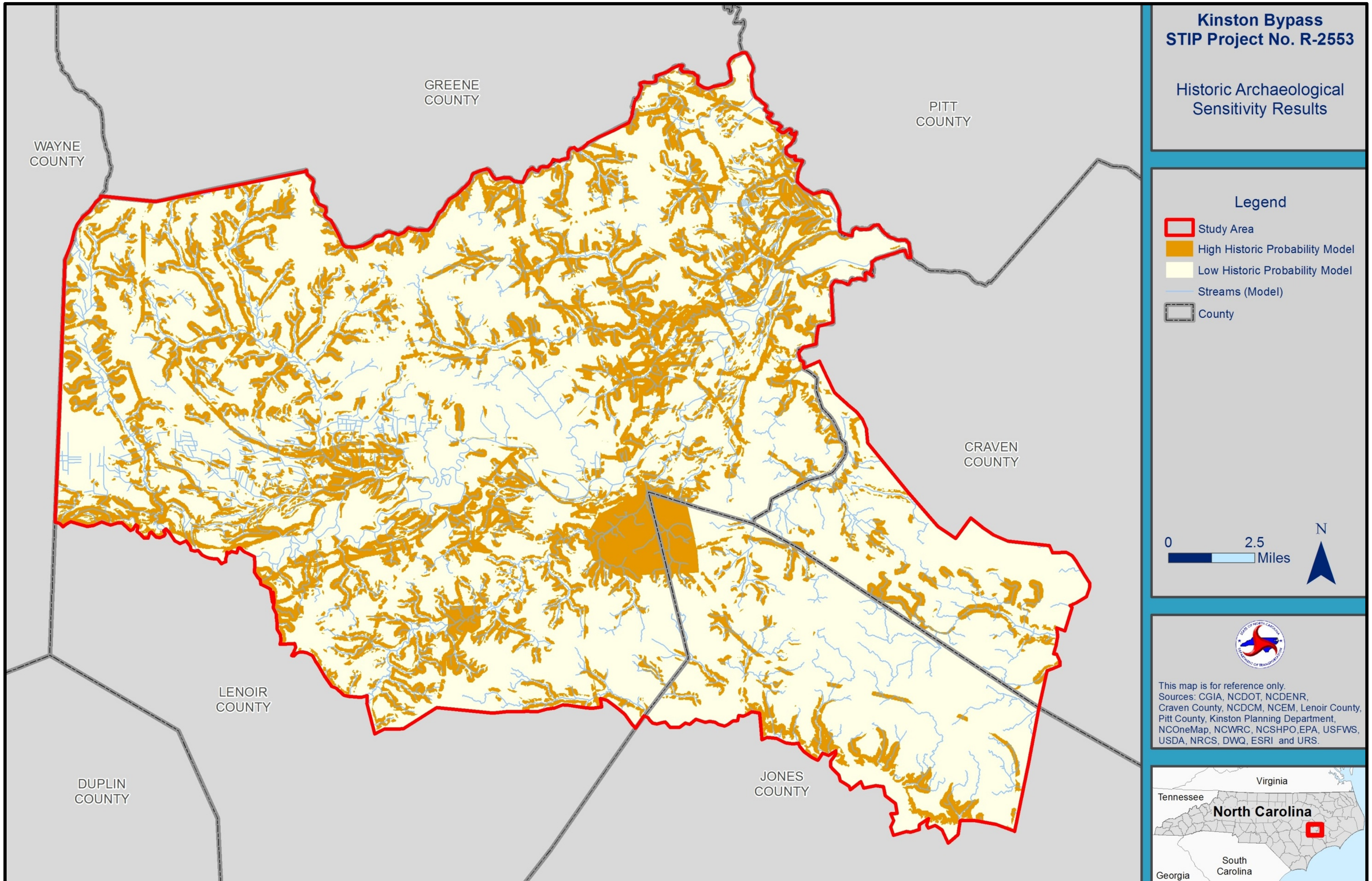

Figure 16. Historic Archaeological Sensitivity Results

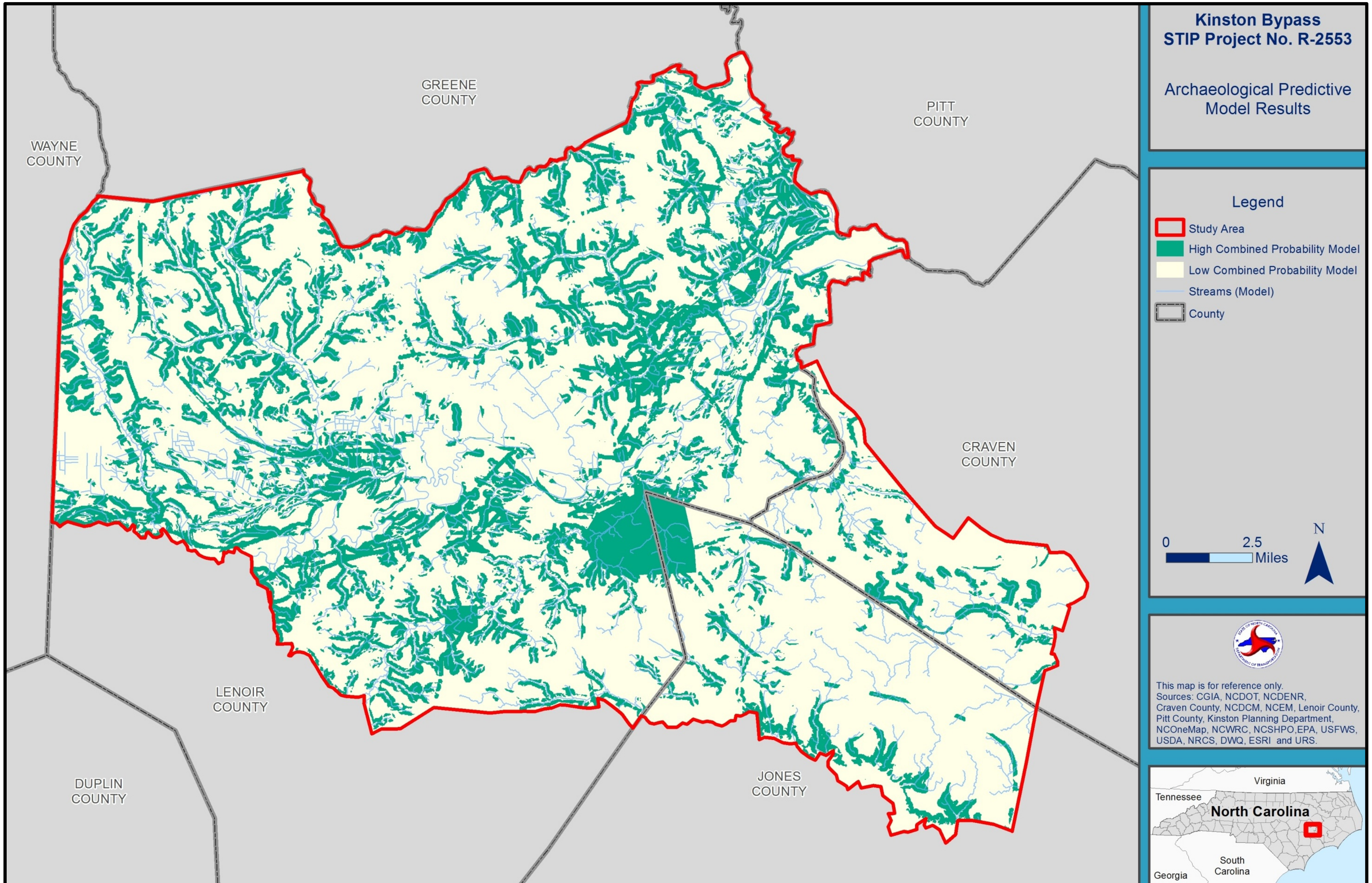

Figure 17. Composite of Archaeological Predictive Model Results

4.4 RESULTS OF COMPREHENSIVE ARCHAEOLOGICAL PREDICTIVE MODEL FOR DSA CORRIDORS

Acreage and percentage of high and low probability for the 17 DSA Corridors were calculated (based on a 500-foot wide corridor) (**Table 3**). A composite of the DSA Corridors depicting this information graphically is provided in **Figure 18**.

Table 3. Archaeological Probability for Kinston Bypass DSA Corridors

DSA Corridor	High (acres)	High (%)	Low (acres)	Low (%)	Total (acres)
Sorted (descending) by High Probability Percentage					
1	740	49.63	751	50.37	1491
12	735	46.02	862	53.98	1597
32	705	43.23	926	56.77	1631
63	662	39.31	1022	60.69	1684
52	590	37.06	994	62.94	1584
11	577	36.34	1011	63.66	1588
2	655	34.21	1251	65.79	1906
31	546	33.66	1076	66.34	1622
61	574	30.47	1300	69.53	1874
5	637	30.08	1481	69.92	2118
65	503	30.03	1172	69.97	1675
35	518	29.70	1226	70.30	1744
53	484	28.66	1205	71.34	1689
51	428	27.17	1147	72.83	1575
57	540	26.59	1491	73.41	2031
56	469	24.68	1431	75.32	1900
36	391	22.76	1327	77.24	1718
Sorted (descending) by High Probability Acres					
1	740	49.63	751	50.37	1491
12	735	46.02	862	53.98	1597
32	705	43.23	926	56.77	1631
63	662	39.31	1022	60.69	1684
2	655	34.21	1251	65.79	1906
5	637	30.08	1481	69.92	2118
52	590	37.06	994	62.94	1584
11	577	36.34	1011	63.66	1588
61	574	30.47	1300	69.53	1874
31	546	33.66	1076	66.34	1622
57	540	26.59	1491	73.41	2031
35	518	29.70	1226	70.30	1744
65	503	30.03	1172	69.97	1675
53	484	28.66	1205	71.34	1689
56	469	24.68	1431	75.32	1900
51	428	27.17	1147	72.83	1575
36	391	22.76	1327	77.24	1718

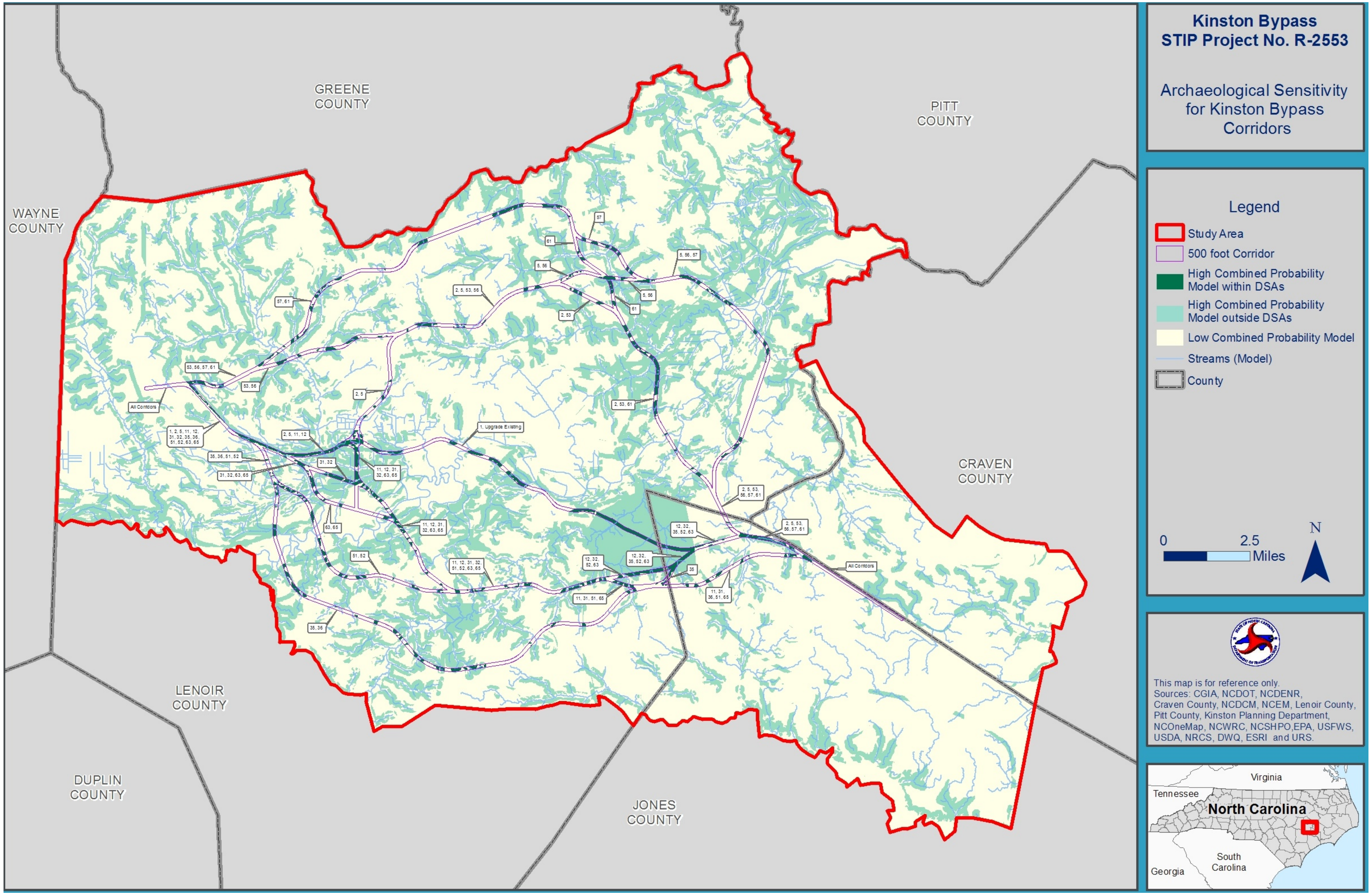

Figure 18. Archaeological Sensitivity for Kinston Bypass DSA Corridors

In terms of high probability percentage, three DSA Corridors consist of over 40 percent high probability area—1, 12, and 32. Eight DSA Corridors contain between 30 and 39.99 percent high probability—63, 52, 11, 2, 31, 61, 5, and 65. The remaining six DSA Corridors contain less than 29.99 percent high probability (to a low of 22.76 percent)—35, 53, 51, 57, 56, and 36.

In terms of acreage, three DSA Corridors contain over 700 acres of high probability area—1, 12, and 32. Three DSA Corridors contain 600 to 699 acres of high probability area—2, 5, and 63. Seven DSA Corridors contain between 500 and 599 acres of high probability area—11, 31, 35, 52, 57, 61, and 65. Three DSA Corridors (51, 53, and 56) contain between 400 and 499 acres, and one DSA Corridor (36) contains less than 400 acres of high probability area (391 acres).

Compared to the overall analysis area (**Section 4.4**), which contained 27.7 percent high probability and 72.3 percent low probability, the following DSA Corridors were within five percent of the average high probability: DSA Corridor 36 (22.76 percent), DSA Corridor 56 (24.68 percent), DSA Corridor 57 (26.59 percent), DSA Corridor 51 (27.17 percent), DSA Corridor 53 (28.66 percent), DSA Corridor 35 (29.7 percent), DSA Corridor 65 (30.03 percent), DSA Corridor 5 (30.08 percent) and DSA Corridor 61 (30.47 percent). These nine DSA Corridors represent the ones that exhibit similar or lesser amounts of high probability area; the remaining eight DSA Corridors exhibit greater than five percent more high probability area in comparison to the overall analysis area.

In summary, DSA Corridors 1, 12, and 32 contain both a high percentage and comparatively high acreage of high probability areas. Conversely, DSA Corridor 36 contains the lowest percentage and comparative acreage of high probability area.

5.0 SUMMARY OF RECOMMENDATIONS

A GIS-based predictive model has been created for the entire Kinston Bypass study area. This model included the variables of soil drainage, proximity to water, topographic setting, proximity to historic roads, NRHP-listed or NRHP-eligible Civil War resources, and disturbed/developed areas. These data layers were created and then analyzed to produce a two-tier probability—high and low. Once all the variables had been analyzed in this manner, separate prehistoric and historic sensitivity maps were created. Finally, these two sensitivity maps were combined into a composite/final sensitivity map depicting high and low probability for any type of archaeological resource.

Seventeen DSAs are currently under consideration within the Kinston Bypass study area. These DSAs have not been fully developed into functional designs which closely depict the footprint of the alignment, but rather, exist at this time as approximate centerlines with a 250-foot buffer on either side (for a total of 500-foot wide corridor). The primary reason for creating the predictive model on the entire study area was to allow for easy recalculation of potential impacts as project planning progresses and DSAs are further developed into more realistic corridor alignments. The 17 DSA Corridors were individually analyzed in their current form to determine the amount of high and low probability area each DSA Corridor contained (these results will be updated later based upon the functional designs).

Of the 17 DSA Corridors, three contain both the highest percentage and highest acreage of high probability area, and thus potential impacts to archaeological resources—1, 12, and 32. These three DSA Corridors contain between 43 and 50 percent high probability area as well as 705 to 740 acres of high probability area. Conversely, DSA Corridor 36 contains the lowest percentage (23 percent) and lowest acreage (391 acres) of high probability area.

Given the early stage of planning for the Kinston Bypass, future changes to the DSA alignments will occur. Further, as DSAs are removed from consideration and a Least Environmentally Damaging Practicable Alternative (LEDPA)/Preferred Alternative is chosen, terrestrial archaeological fieldwork will need to be performed for the LEDPA/Preferred Alternative. As future changes to the alignments are made, reanalysis of potential impacts can be accomplished with little effort. If and when such future re-analyses are performed, results can be reported in memorandum or formal report format(s) as the NCDOT wishes.

6.0 NOVEMBER 2014 UPDATE

6.1 INTRODUCTION

The preceding document was produced in August 2013 based on project data at that time. Subsequent to the August 2013 version, several project milestones have been reached, and updated information regarding archaeological sensitivity can be generated with regards to the project as currently under consideration. The three primary changes of the Kinston Bypass project since August 2013 are: (1) removal of all alternatives north of existing US 70 from further consideration; (2) addition of the Upgrade Existing US 70 with a Shallow Southern Bypass (referred to as Detailed Study Alternative 1UESB), which when combined with (1) above, results in a total of 12 DSAs under current consideration; and (3) production of preliminary functional designs with slope stake limits with a 40-foot buffer limits reflecting a much more realistic build corridor compared to the general 500-foot-wide corridors utilized during the earlier study.

6.2 RESULTS OF 2014 FUNCTIONAL DESIGN ANALYSIS

The 12 DSAs currently under consideration are: 1UE (previously referred to as Detailed Study Alternative 1), 1UESB, 11, 12, 31, 32, 35, 36, 51, 52, 63, and 65. Table 4 presents data regarding archaeological probability for the 12 DSAs, and is sorted to show area by both percentage and acreage. Figure 19 through Figure 24 depicts these results graphically.

In terms of percentage as well as acreage, DSAs 1UESB, 32, and 12 have the largest amount of high probability within their corridors. Conversely, DSAs 65, 51, and 36 contain the least percentage and acreage of high probability area.

Table 4. Archaeological Probability for Kinston Bypass DSA Corridors as of November 2014

DSA	High (acres)	High (%)	Low (acres)	Low (%)	Total (acres)
Sorted (descending) by High Probability Percentage					
1UESB	884	60.05%	588	39.95%	1,472
32	793	52.51%	717	47.49%	1,510
12	769	50.66%	749	49.34%	1,518
1UE	751	50.56%	735	49.44%	1,486
63	746	48.20%	802	51.80%	1,548
52	707	47.66%	777	52.34%	1,484
31	666	44.60%	827	55.40%	1,493
11	669	44.57%	832	55.43%	1,501
35	702	42.39%	954	57.61%	1,656
65	619	40.44%	912	59.56%	1,532
51	580	39.56%	887	60.44%	1,467
36	597	36.73%	1029	63.27%	1,626
Sorted (descending) by High Probability Acreage					
1UESB	884	60.05%	588	39.95%	1,472
32	793	52.51%	717	47.49%	1,510
12	769	50.66%	749	49.34%	1,518
1UE	751	50.56%	735	49.44%	1,486
63	746	48.20%	802	51.80%	1,548
52	707	47.66%	777	52.34%	1,484
35	702	42.39%	954	57.61%	1,656
11	669	44.57%	832	55.43%	1,501
31	666	44.60%	827	55.40%	1,493
65	619	40.44%	912	59.56%	1,532
36	597	36.73%	1029	63.27%	1,626
51	580	39.56%	887	60.44%	1,467

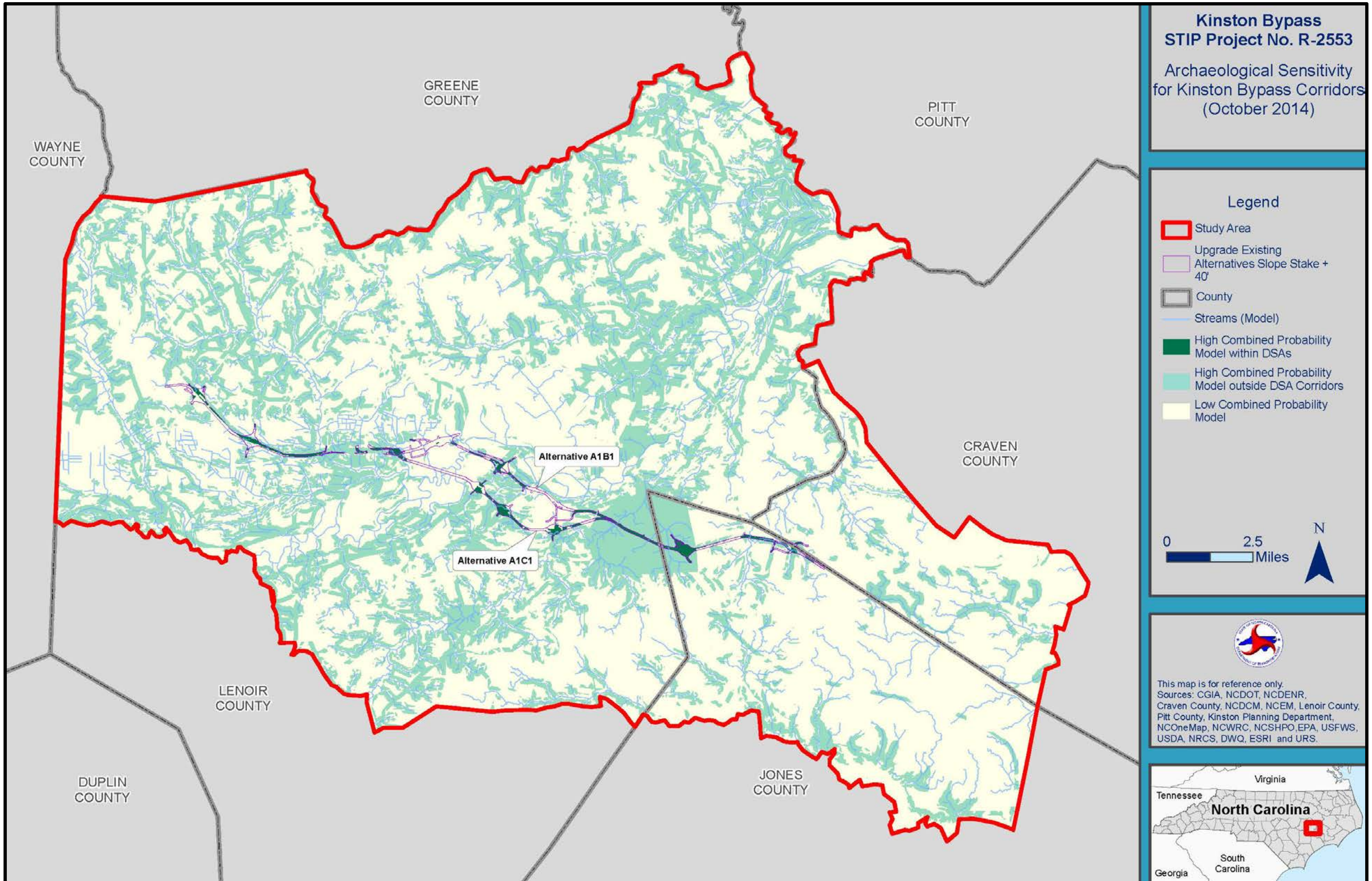

Figure 19. Archaeological Sensitivity for Kinston Bypass DSA Corridors 1UE and 1UESB

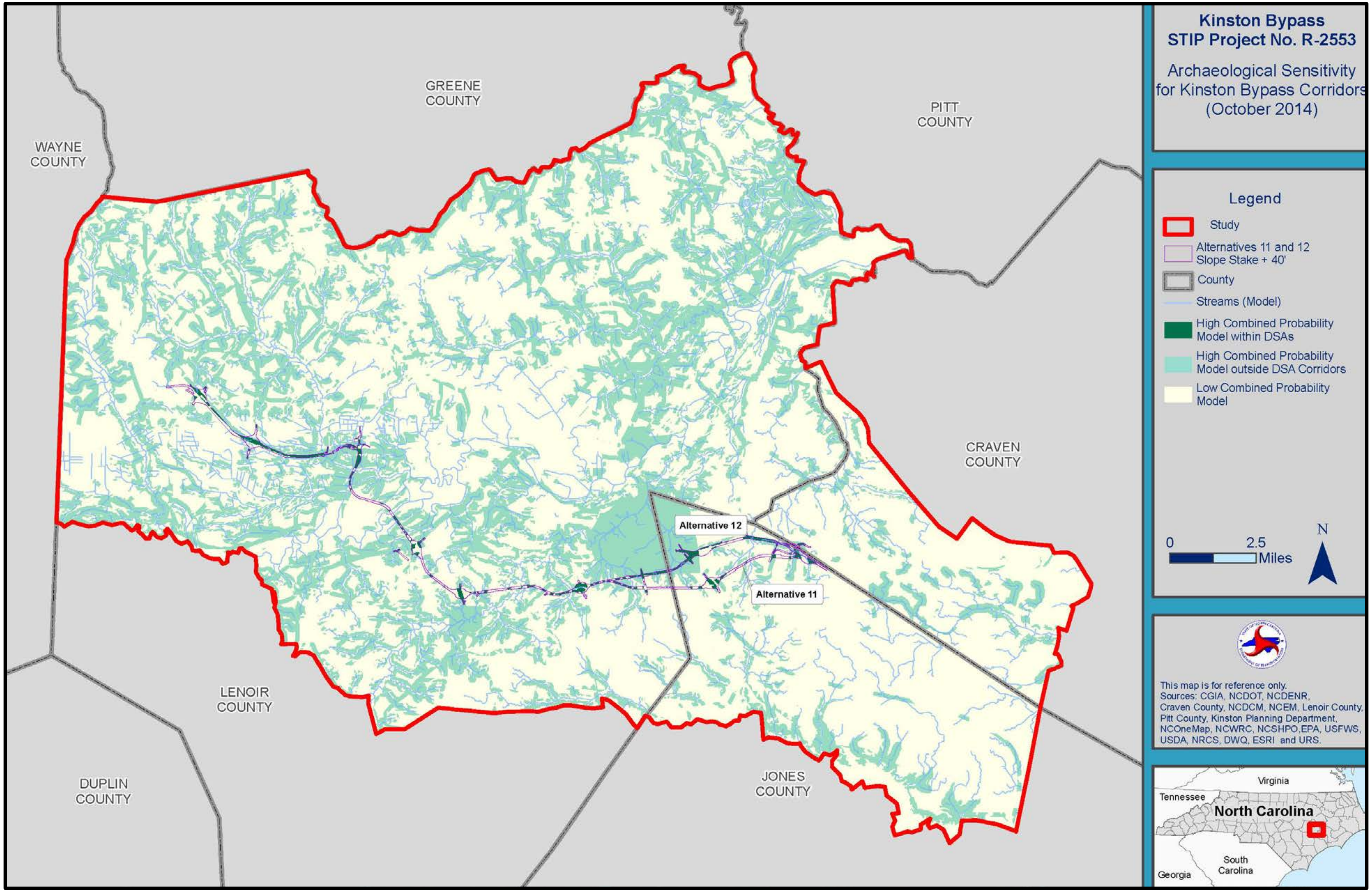

Figure 20. Archaeological Sensitivity for Kinston Bypass DSA Corridors 11 and 12

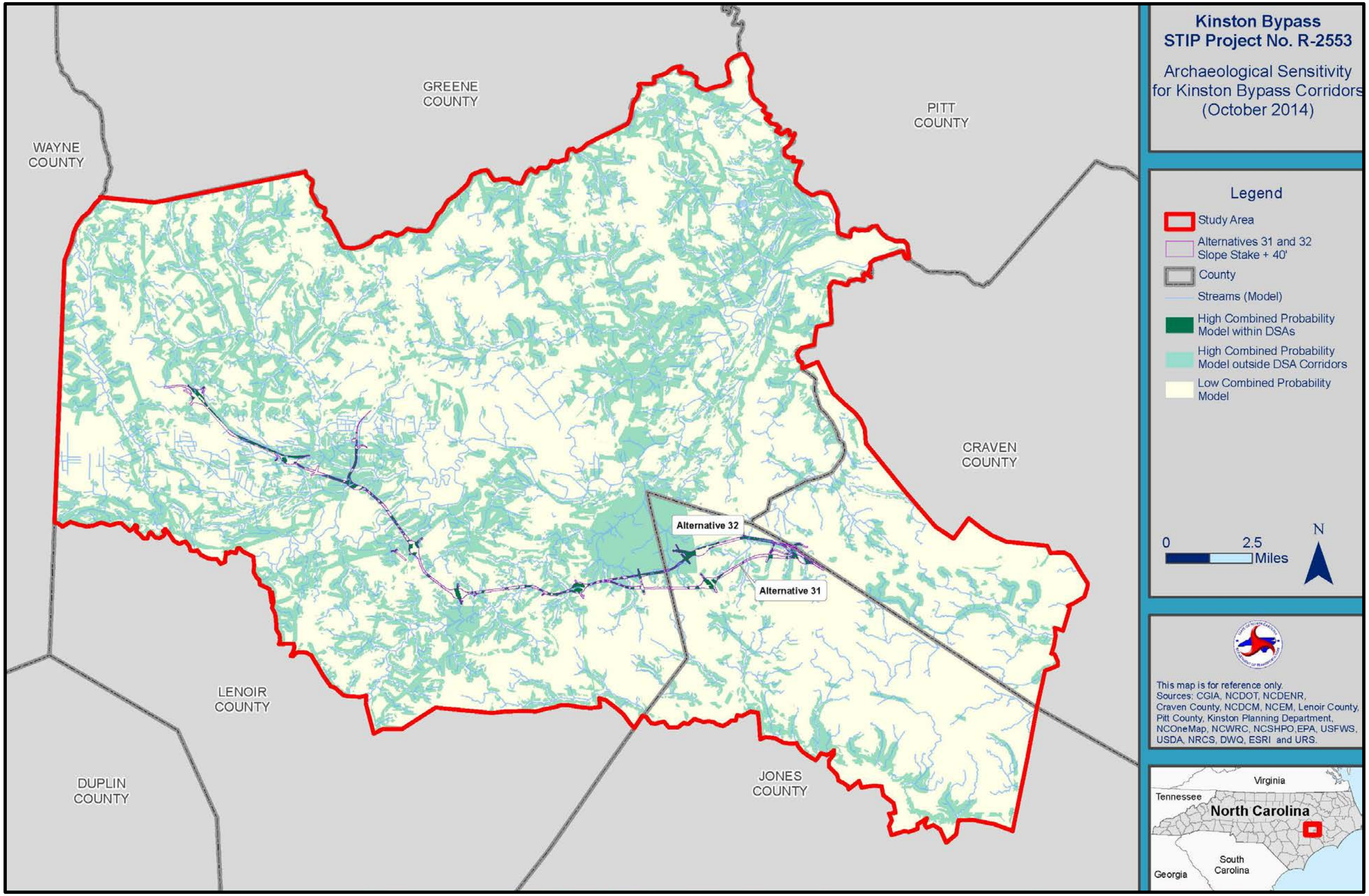

Figure 21. Archaeological Sensitivity for Kinston Bypass DSA Corridors 31 and 32

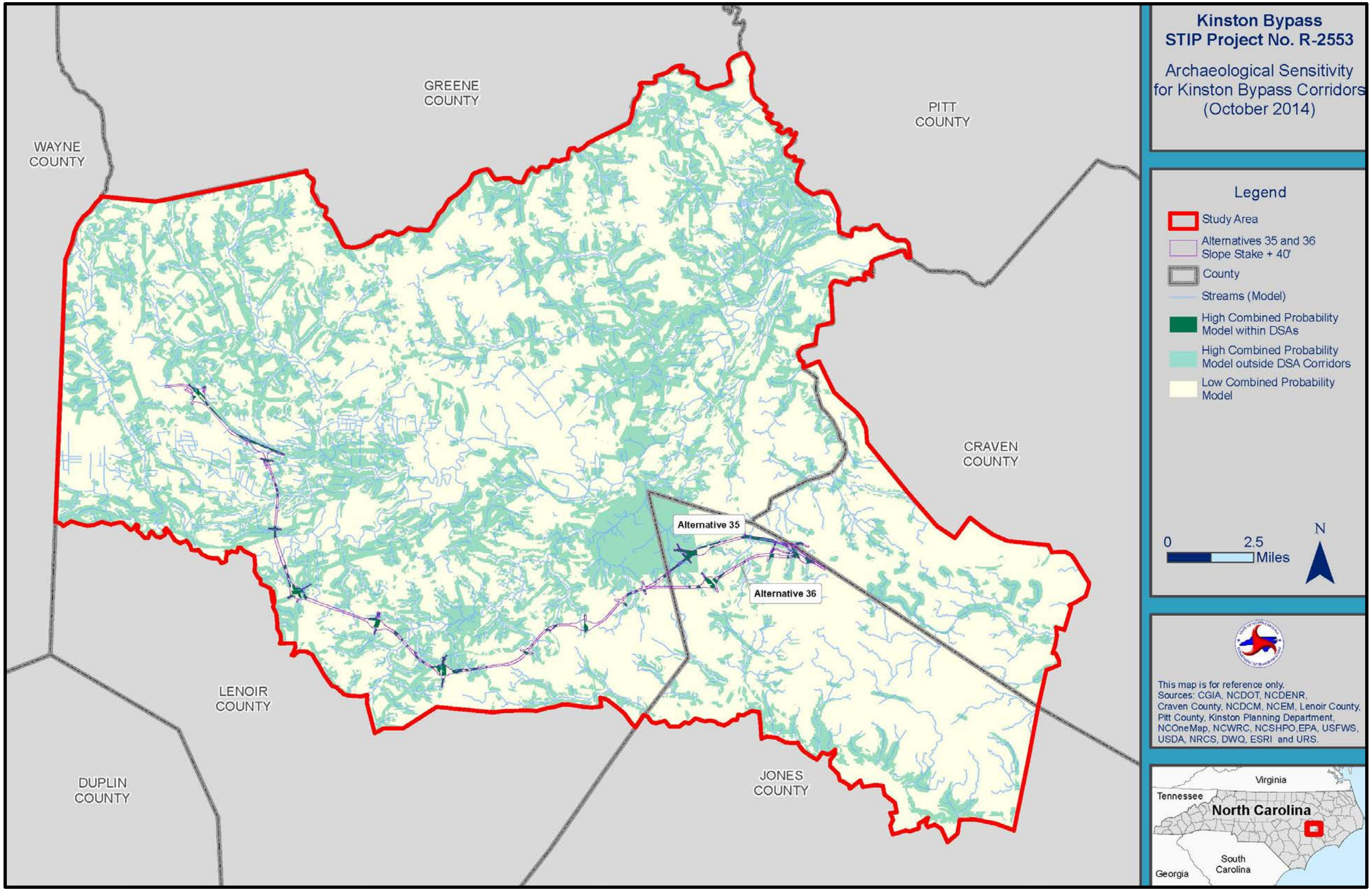

Figure 22. Archaeological Sensitivity for Kinston Bypass DSA Corridors 35 and 36

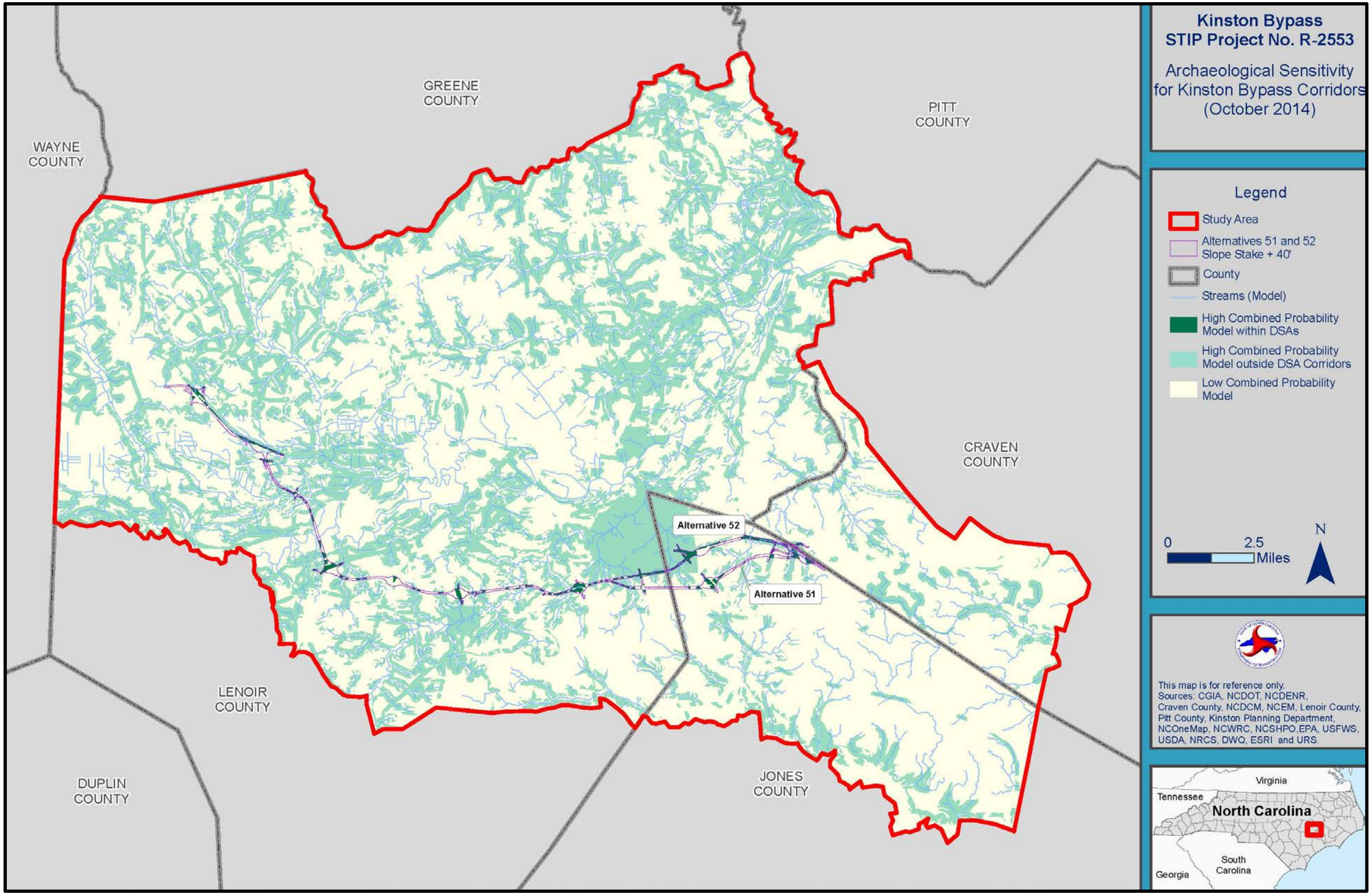

Figure 23. Archaeological Sensitivity for Kinston Bypass DSA Corridors 51 and 52

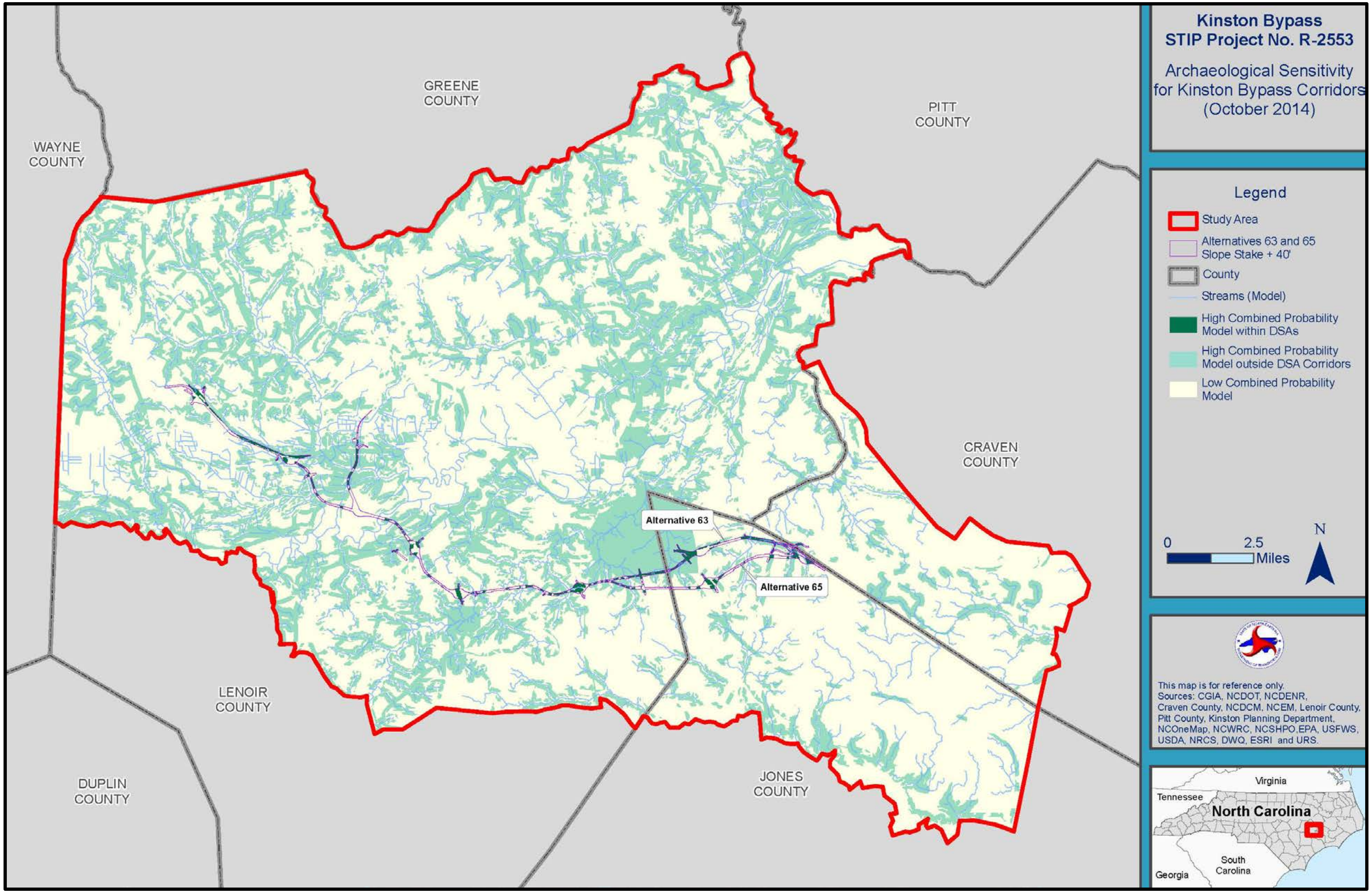

Figure 24. Archaeological Sensitivity for Kinston Bypass DSA Corridors 63 and 65

7.0 OCTOBER 2017 UPDATE

7.1 INTRODUCTION

The preceding analyses were produced in November 2014 based on the project configuration at that time. Subsequent to the November 2014 version, design alterations have occurred, and the extent of right-of-way has been determined (Figure 25). Design alterations include some minor alignment shifts, but primarily consist of alterations to many of the interchanges that move all ramps to one side of a cross road. The right-of-way has now been determined based on the new designs, and includes areas not previously included in the 2014 update. Right-of-way provides a more realistic estimate of potential area of impacts from the project, so is utilized in this analysis to evaluate archaeological sensitivity for the 12 current DSAs.

7.2 RESULTS OF 2017 FUNCTIONAL DESIGN ANALYSIS

The 12 DSAs currently under consideration are: 1UESB, 1UE, 11, 12, 31, 32, 35, 36, 51, 52, 63, and 65. Table 5 presents data regarding archaeological probability for the 12 DSAs, and is sorted to tabulate probability zones by both percentage and acreage. Figure 26 through Figure 31 depict these results graphically.

DSA 1UESB ranks at the top of the list both by percentage as well as by acreage; DSAs 1UE, 12, 32, and 63 also rank high in terms of both percentage and acreage of high probability. In terms of percentage, DSA 1UESB consists of over 60 percent high probability area (64.47%). Four additional DSAs (12, 32, 1UE, 63) contain between 50 and 60 percent high probability. By way of acreage, DSA 1UESB contains over 1,100 acres (1,132 acres). DSAs 1UE, 12, 32, and 63 all contain over 700 acres of high probability area.

Conversely, DSAs 35, 36, and 51 contain less than 40 percent high probability area, and DSAs 36, 51, and 65 contain less than 600 acres of high probability area.

7.3 COMPARISON OF 2014 AND 2017 RESULTS

A comparison of Table 4 and Table 5 is provided in Table 6. In general, most of the DSAs have seen an overall reduction in the total acreage, with the exceptions of DSAs 1UE and 1UESB. These two DSAs actually increased in overall acreage due to incorporation of new areas not included in the 2014 analysis, particularly at the intersection of US 70 and NC 148 (C.F. Harvey Parkway) as well as at the intersection of US 70 and Neuse Road (see Figure 25). The 10 other DSAs all reduced overall acreage by 63 to 183 acres.

Conversely, most DSAs have seen slight increases in the percentage of high probability area, despite the reduction in overall acreage in most cases. This is largely the result of two factors. First, the newly incorporated additional acreage at the intersection of US 70 and NC 148 noted above affects eight of the 12 DSAs (1UE, 1UESB, 11, 12, 31, 32, 63, and 65). Second, much of the lost overall acreage is low probability area, thus increasing the relative percentage of high probability by comparison.

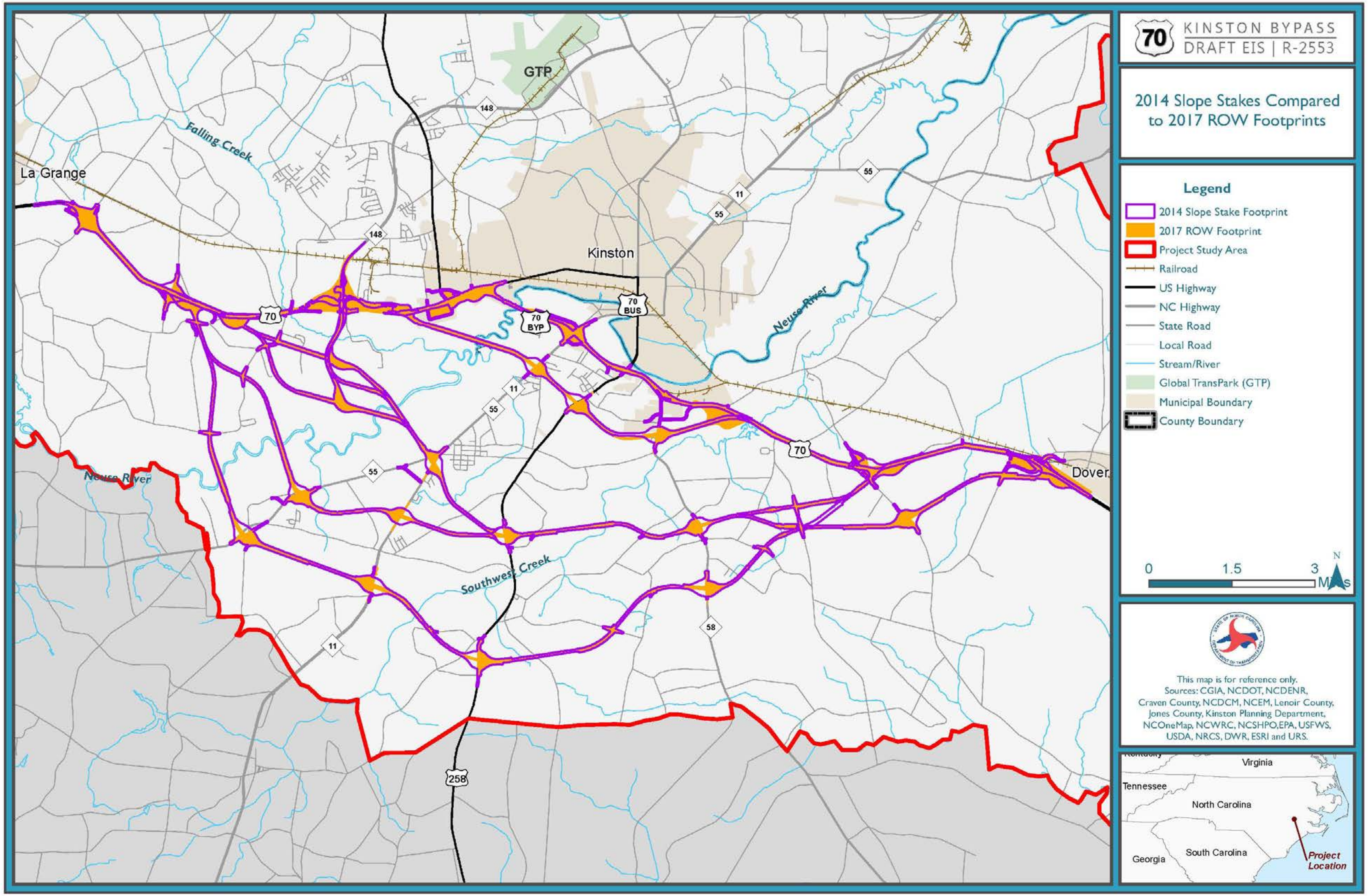

Figure 25. Comparison of 2014 Design and 2017 Right of Way for Kinston Bypass

Table 5. Archaeological Probability for Kinston Bypass DSA Corridors as of October 2017

DSA	High (acres)	High (%)	Low (acres)	Low (%)	Total (acres)
Sorted (descending) by High Probability Percentage					
1UESB	1132	64.47	624	35.53	1756
Alternative 12	771	55.35	622	44.65	1393
Alternative 32	736	54.71	610	45.29	1346
1UE	842	53.18	742	46.82	1584
Alternative 63	703	50.52	688	49.48	1391
Alternative 52	687	49.86	691	50.14	1378
Alternative 11	654	47.74	716	52.26	1369
Alternative 31	606	46.17	707	53.83	1313
Alternative 65	558	41.36	791	58.64	1349
Alternative 51	513	39.90	773	60.10	1286
Alternative 35	635	39.89	957	60.11	1593
Alternative 36	563	37.74	929	62.26	1491
Sorted (descending) by High Probability Acres					
1UESB	1132	64.47	624	35.53	1756
1UE	842	53.18	742	46.82	1584
Alternative 12	771	55.35	622	44.65	1393
Alternative 32	736	54.71	610	45.29	1346
Alternative 63	703	50.52	688	49.48	1391
Alternative 52	687	49.86	691	50.14	1378
Alternative 11	654	47.74	716	52.26	1369
Alternative 35	635	39.89	957	60.11	1593
Alternative 31	606	46.17	707	53.83	1313
Alternative 36	563	37.74	929	62.26	1491
Alternative 65	558	41.36	791	58.64	1349
Alternative 51	513	39.90	773	60.10	1286

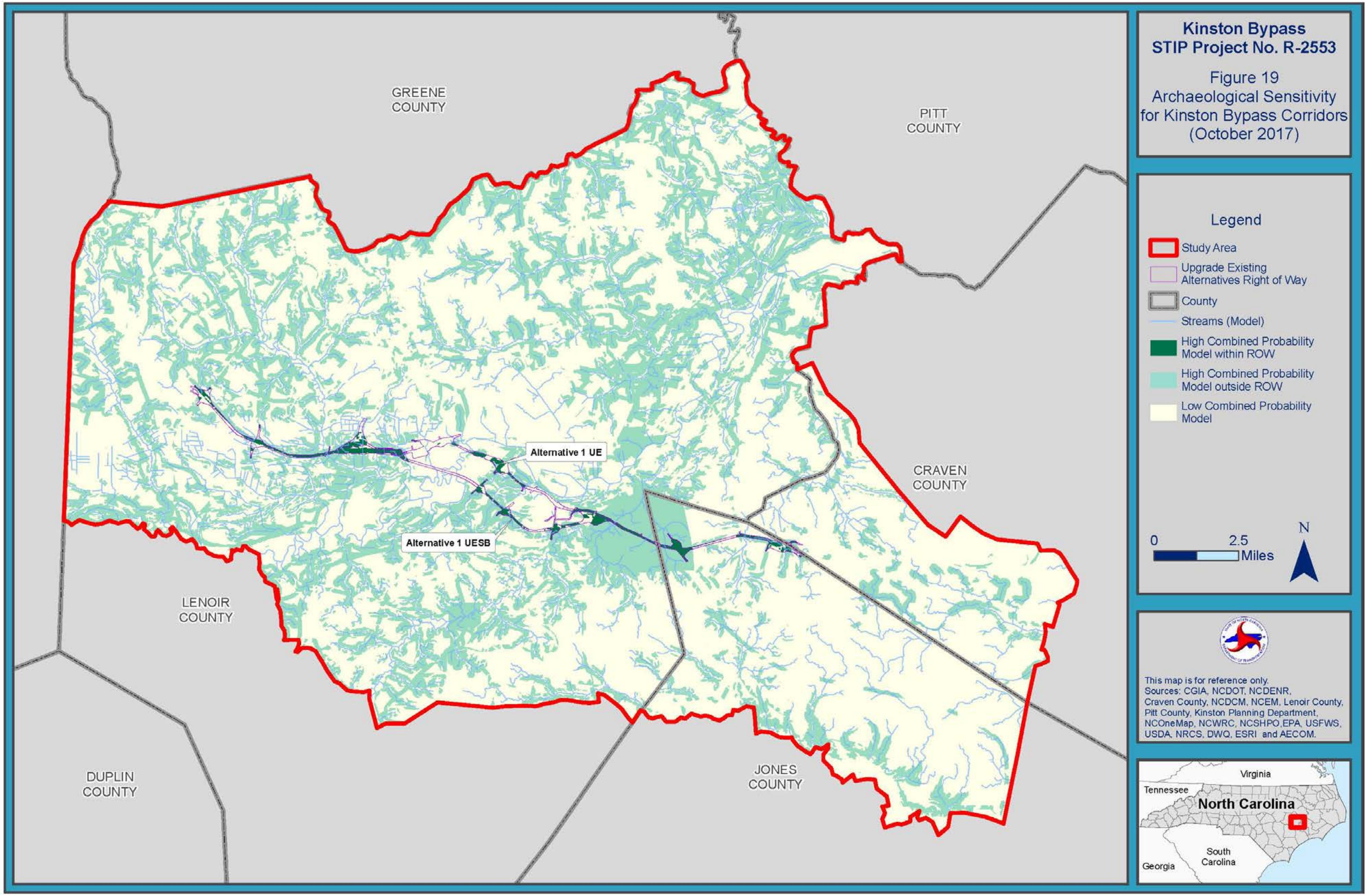

Figure 26. Archaeological Sensitivity for Kinston Bypass DSA Corridors 1UE and 1UESB (October 2017 design)

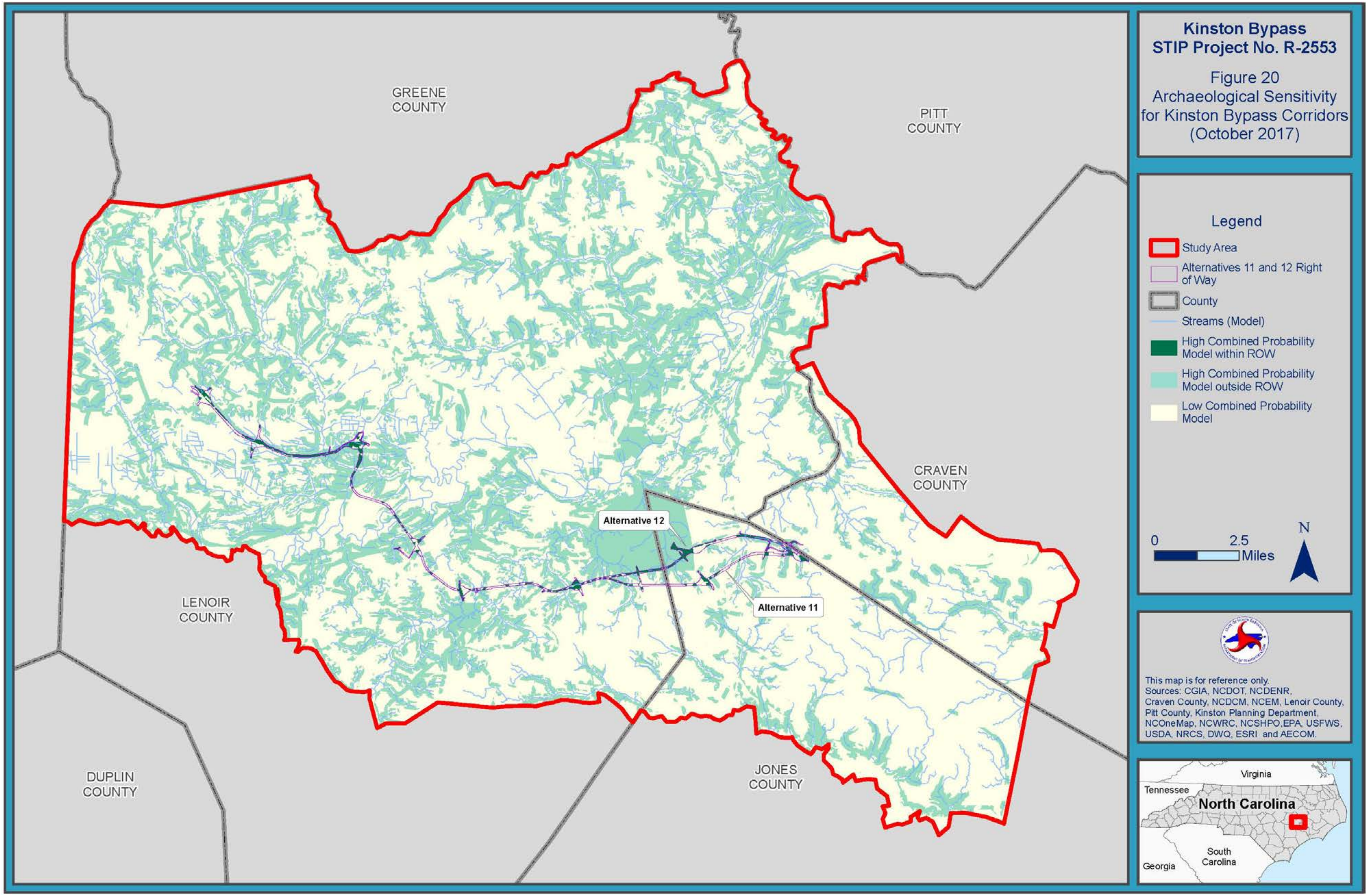

Figure 27. Archaeological Sensitivity for Kinston Bypass DSA Corridors 11 and 12 (October 2017 design)

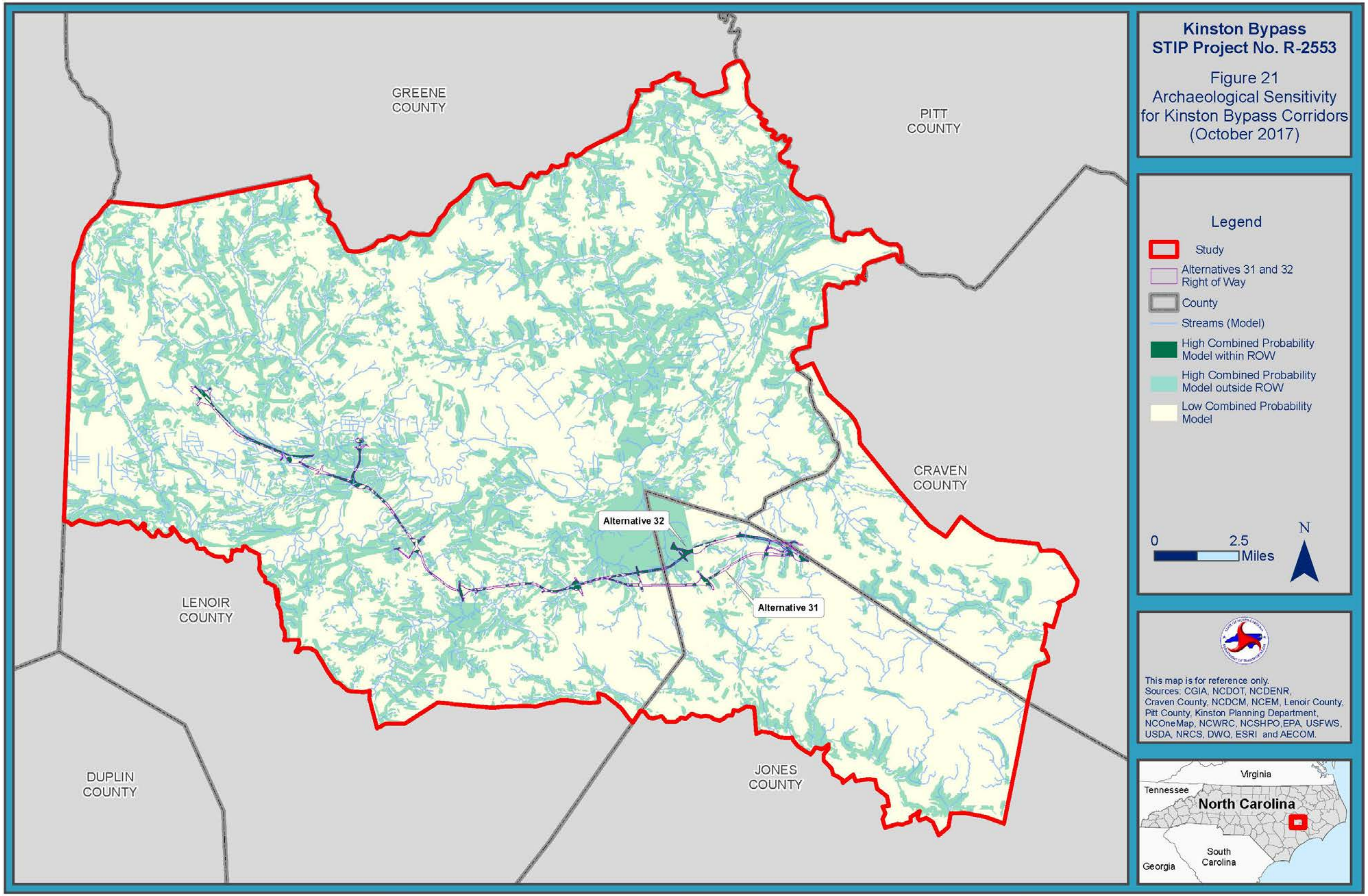

Figure 28. Archaeological Sensitivity for Kinston Bypass DSA Corridors 31 and 32 (October 2017 design)

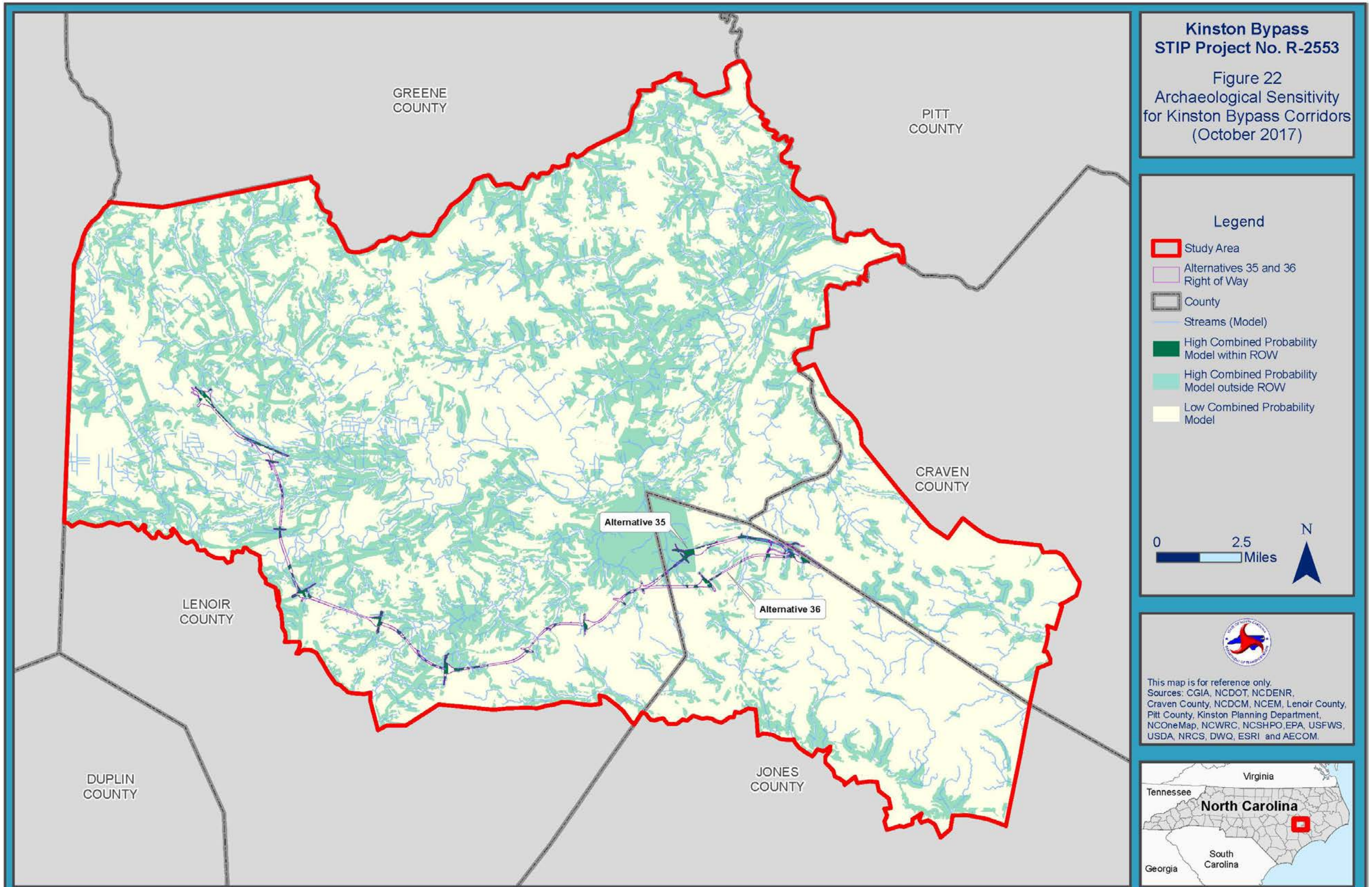

Figure 29. Archaeological Sensitivity for Kinston Bypass DSA Corridors 35 and 36 (October 2017 design)

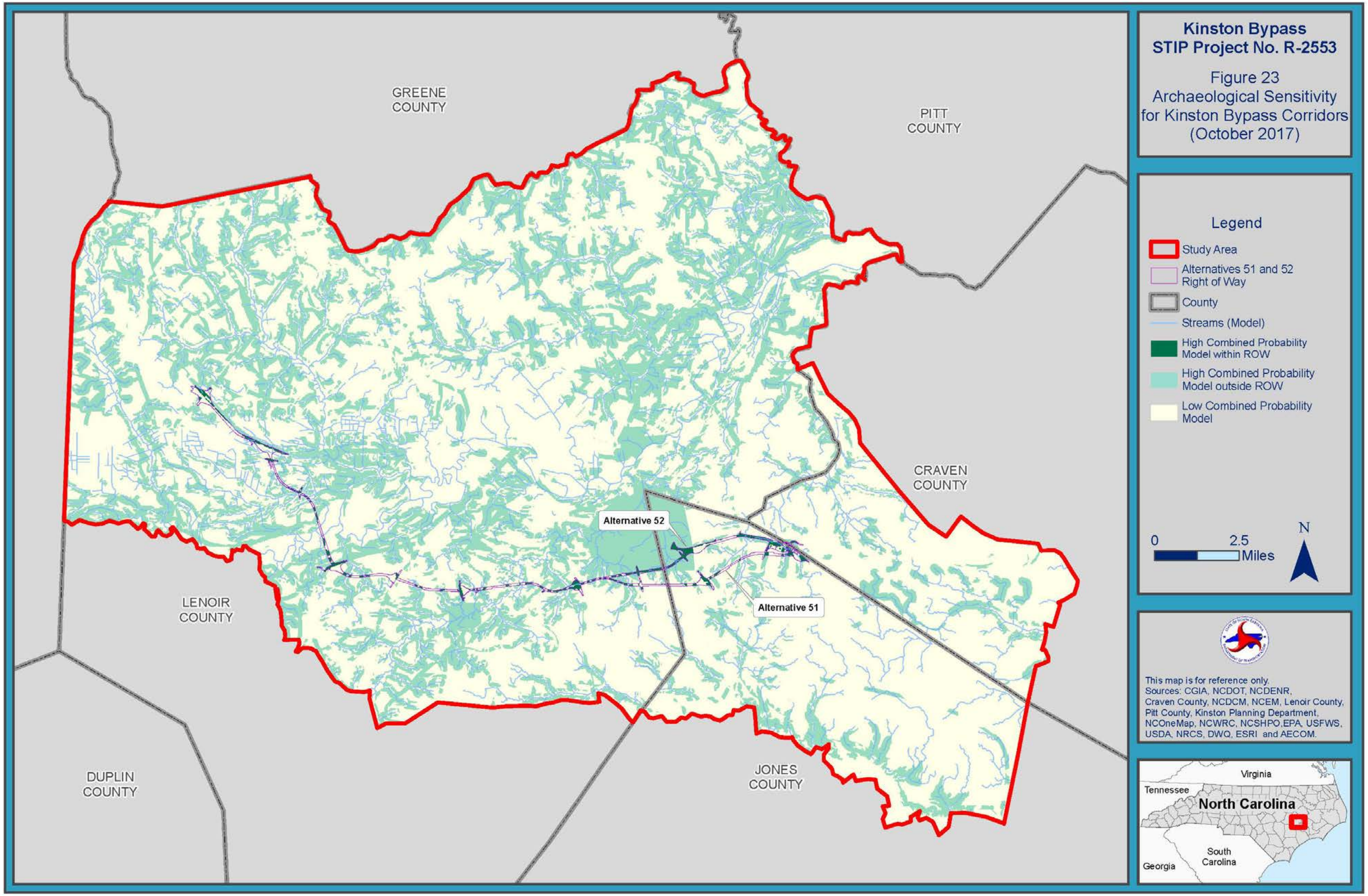

Figure 30. Archaeological Sensitivity for Kinston Bypass DSA Corridors 51 and 52 (October 2017 design)

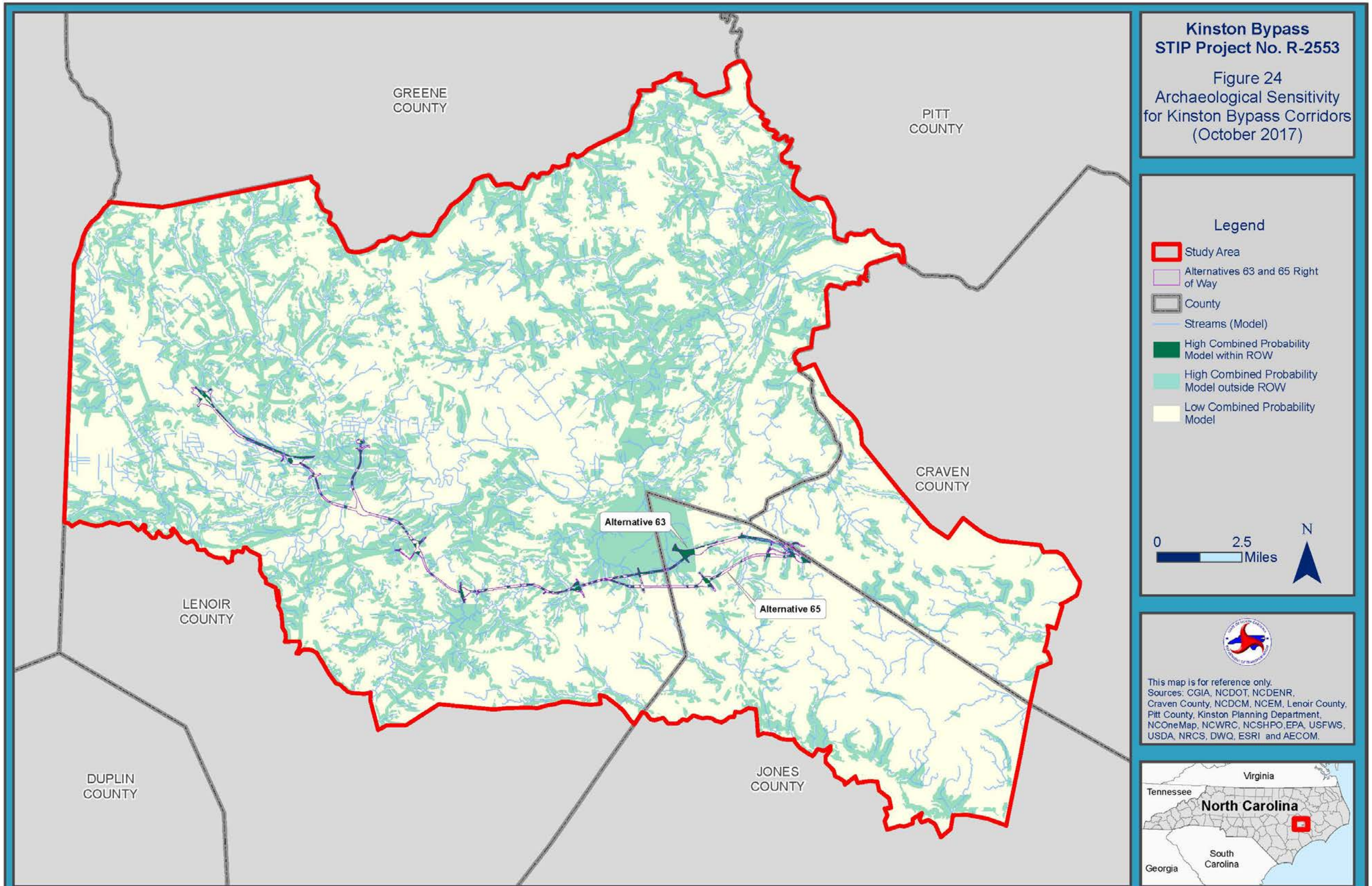

Figure 31. Archaeological Sensitivity for Kinston Bypass DSA Corridors 63 and 65 (October 2017 design)

Table 6. Comparative Calculations for 2014 to 2017 Changes.

DSA	Change in Total Acreage	Change in High Probability Acreage	Change in % of High probability	Change in Low Probability Acreage	Change in % of Low Probability Acreage
1UE	98	91	2.62%	7	-2.62%
1UESB	284	248	4.41%	36	-4.41%
11	-132	-15	3.20%	-116	-3.13%
12	-125	2	4.69%	-127	-4.69%
31	-180	-60	1.55%	-120	-1.55%
32	-164	-57	2.16%	-107	-2.16%
35	-63	-67	-2.53%	3	2.47%
36	-135	-34	1.04%	-100	-0.98%
51	-181	-67	0.35%	-114	-0.35%
52	-106	-20	2.21%	-86	-2.21%
63	-157	-43	2.35%	-114	-2.35%
65	-183	-61	0.96%	-121	-0.89%

7.4 SUMMARY

Of the 12 DSAs currently under consideration, 1UESB, 1UE, 12, 32, and 63 have the most potential to encounter and affect archaeological resources. Conversely, DSAs 35, 36, 51, and 65 have the least potential to affect archaeological resources.

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