Terrestrial Archaeological Resources Predictive Model

CAPE FEAR SKYWAY

New Hanover and Brunswick Counties

STIP No. U-4738

Prepared for:

NORTH CAROLINA Turnpike Authority

Prepared by:

URS

December 2011

Table of Contents

1.0 INTRODUCTION AND PURPOSE 1
1.1 INTRODUCTION 1
1.2 PURPOSE 3
2.0 ARCHAEOLOGICAL PREDICTIVE MODELS BACKGROUND 4
2.1 PREDICTIVE MODELS INTRODUCTION 4
2.2 TYPES OF ARCHAEOLOGICAL PREDICTIVE MODELS 4
2.2.1 Descriptive Models 4
2.2.2 Behavioral Models 4
2.2.3 Statistical Models 5
2.3 PAST ARCHAEOLOGICAL PREDICTIVE MODELS OF THE SOUTHERN COASTAL PLAIN OF NORTH CAROLINA 5
3.0 CAPE FEAR SKYWAY ARCHAEOLOGICAL PREDICTIVE MODEL METHODOLOGY 8
3.1 INTRODUCTION 8
3.2 TYPE OF ARCHAEOLOGICAL PREDICTIVE MODEL FOR CAPE FEAR SKYWAY 8
3.3 VARIABLES USED FOR CAPE FEAR SKYWAY ARCHAEOLOGICAL PREDICTIVE MODEL 10
3.3.1 Soil Drainage 10
3.3.2 Proximity to Water 11
3.3.3 Topographic Setting 12
3.3.4 Proximity to Historic Roads 13
3.3.5 Disturbed/Developed Areas 14
3.4 Geographic Information Systems METHODOLOGY 14
3.4.1 Geographic Information Systems Introduction 14
3.4.2 Data Layer Creation 14
3.4.2.1 Soil Drainage 14
3.4.2.2 Proximity to Water 15
3.4.2.3 Topographic Setting 15
3.4.2.4 Proximity to Historic Roads 16
3.4.2.5 Disturbed/Developed Areas 16
3.4.3 Variable Weighting 16
3.4.4 Archaeological Potential Generation 17
4.0 CAPE FEAR SKYWAY ARCHAEOLOGICAL PREDICTIVE MODEL RESULTS 18
4.1 INTRODUCTION 18
4.2 SEGMENTS, OPTIONS, CONCEPTUAL DESIGNS, AND STUDY CORRIDORS OF THE CAPE FEAR SKYWAY 18
4.3 RESULTS OF INDIVIDUAL VARIABLES FOR ARCHAEOLOGICAL PREDICTIVE MODEL OF CAPE FEAR SKYWAY 23
4.4 RESULTS OF COMPREHENSIVE ARCHAEOLOGICAL PREDICTIVE MODEL FOR CAPE FEAR SKYWAY STUDY AREA 23
4.5 COMPARISON OF PREVIOUSLY RECORDED SITES TO PREDICTIVE MODEL 23
4.6 RESULTS OF COMPREHENSIVE ARCHAEOLOGICAL PREDICTIVE MODEL FOR CAPE FEAR SKYWAY CONCEPTUAL DESIGNS AND STUDY CORRIDORS 32
4.6.1 Conceptual Designs 32
4.6.2 Study Corridors 35
5.0 CONCLUSIONS 40
6.0 REFERENCES 41

List of Tables

Table 1. Soil Types and Drainage Characteristics within Cape Fear Skyway Study Area.....11
Table 2. Historic Roads within Cape Fear Skyway Study Area 13
Table 3. Disturbed/Developed Soil Types in Cape Fear Skyway Study Area.....14
Table 4. Archaeological Probability for Cape Fear Skyway Conceptual Designs.....34
Table 5. Archaeological Probability for Cape Fear Skyway Study Corridors 38

List of Figures

Figure 1. General Location of Cape Fear Skyway Study Area in Brunswick and New Hanover Counties, North Carolina.....2
Figure 2. Map Showing Cape Fear Skyway Study Area and Archaeological Predictive Model Analysis Area 9
Figure 3. Location of Cape Fear Skyway Segments.....19
Figure 4. Location of Cape Fear Skyway Options 20
Figure 5. Location of Cape Fear Skyway Conceptual Designs.....21
Figure 6. Location of Cape Fear Skyway Study Corridors.....22
Figure 7. Soil Drainage Classifications 24
Figure 8. Proximity to Water Classifications 25
Figure 9. Topographic Setting Classifications.....26
Figure 10. Proximity to Historic Road Classifications 27
Figure 11. Disturbed/Developed Areas.....28
Figure 12. Prehistoric Archaeological Sensitivity Results 29
Figure 13. Historic Archaeological Sensitivity Results 30
Figure 14. Archaeological Predictive Model Results.....31
Figure 15. Locations of Previously Recorded Archaeological Sites Compared to Archaeological Probability in Cape Fear Skyway Analysis Area 33
Figure 16. Archaeological Sensitivity for Cape Fear Skyway Conceptual Designs 36
Figure 17. Archaeological Sensitivity for Cape Fear Skyway Study Corridors 39

1.0 INTRODUCTION AND PURPOSE

1.1 INTRODUCTION

In October 2002, legislation was passed authorizing the creation of the North Carolina Turnpike Authority (NCTA) with the purpose to study, design, plan, construct, promote, own, finance, and operate a system of toll roads, bridges, and/or tunnels supplementing the traditional non-toll transportation system serving the citizens of North Carolina (GS §136-89.182).

In August 2005 and August 2006, legislation was passed authorizing the NCTA to study, plan, develop, and undertake preliminary design work on up to nine toll projects. At the conclusion of these activities, the NCTA is authorized to design, establish, purchase, construct, operate, and maintain several projects, one of which is the Cape Fear Skyway. Toll enforcement legislation was passed in July 2008 authorizing the NCTA to require payment of a toll for the use of a NCTA project by the registered owner of a motor vehicle (GS §136-89.212).

The Cape Fear Skyway project is included in the 2009-2015 North Carolina Department of Transportation (NCDOT) State Transportation Improvement Program (STIP) as STIP Project No. U-4738, and listed as new location from US 17 to Independence Boulevard/Carolina Beach Road Intersection – construct a new facility with structure over the Cape Fear River (9.5 miles). Additionally, the Cape Fear Skyway is included in the Wilmington Urban Area Metropolitan Planning Organization's (WMPO) *2030 Long Range Transportation Plan* (2030 LRTP) (March 2005) as a freeway. An update to the current LRTP, titled the *Cape Fear Commutes 2035 Transportation Plan,* was finalized in December 2010.

The NCTA is proposing to improve transportation mobility in the area around the City of Wilmington and between southern Brunswick and southern New Hanover Counties, particularly across the Cape Fear River. According to the *Feasibility Study for the Wilmington Southern Bridge from US 17 Bypass near Bishop to US 421* prepared by the NCDOT in August 2003, the project would serve multiple users, including the Port of Wilmington, the military, commuters, and tourists.

The general study area for the Cape Fear Skyway project consists of a 40,670 acre (16,459 hectares, 63.55 square miles) area that begins near the communities of Bishop and Spring Hill in Brunswick County and ends in the City of Wilmington (pop. 101,350 in 2009) in New Hanover County (**Figure 1**). The size of the study area is based upon the study area developed for the Final Draft of the Purpose and Need Statement (URS 2010), and all spatial calculations utilize Geographic Information Systems (GIS).

In accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, and the North Carolina [State] Environmental Policy Act (SEPA), an Environmental Impact Statement (EIS) is being prepared for the proposed Cape Fear Skyway. The EIS is intended for use as an informational document by the decision-makers and the public.

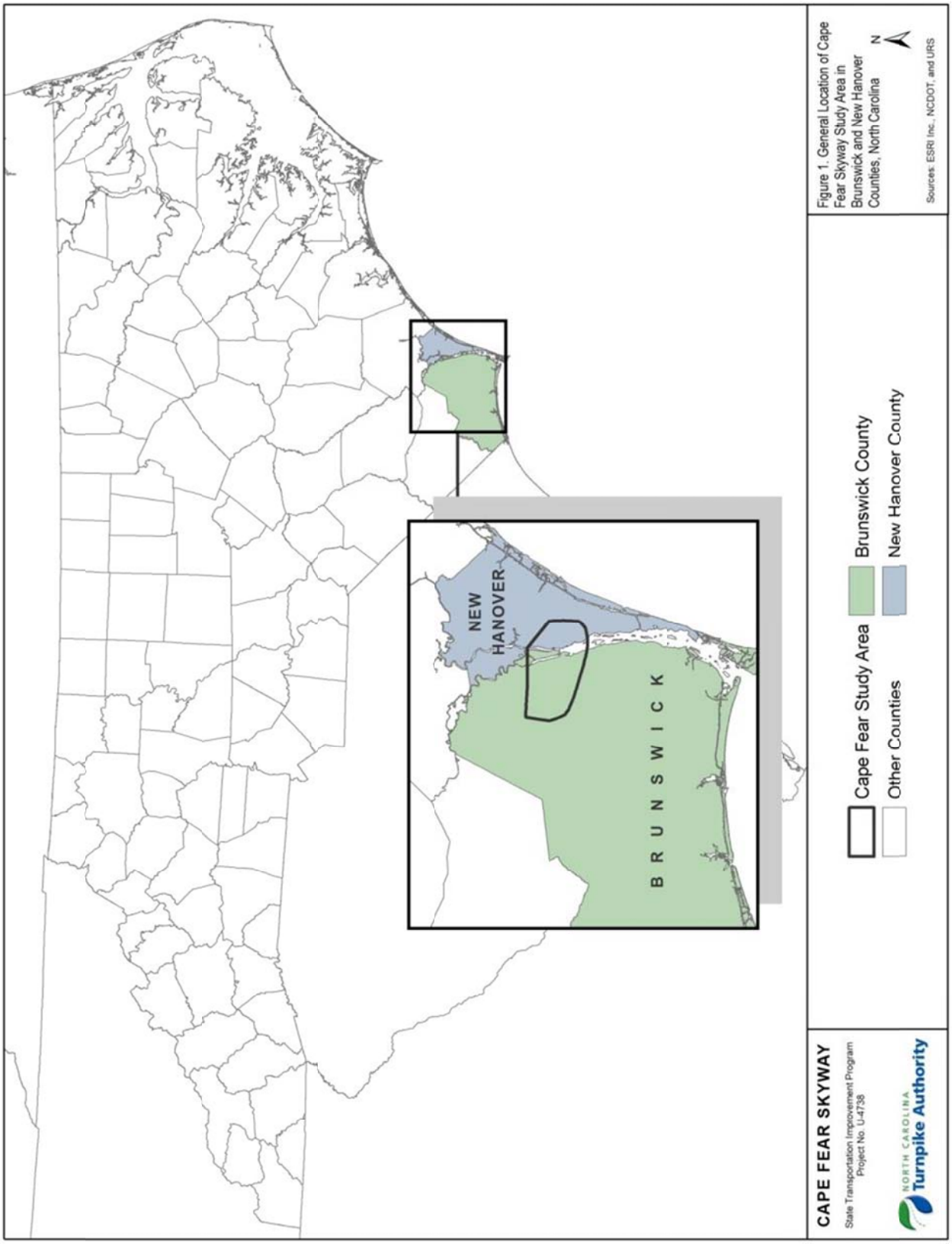

Figure 1. General Location of Cape Fear Skyway Study Area in Brunswick and New Hanover Counties, North Carolina

1.2 PURPOSE

This document presents information regarding predictive modeling efforts to identify archaeological sensitivity within 14 Options currently under consideration for the proposed Cape Fear Skyway. This document is the second planning document related to cultural resources studies for the Cape Fear Skyway project. URS Corporation (URS) previously prepared a comprehensive report detailing prehistoric and historic contexts for the region and summarizing previously recorded archaeological and historic architectural resources within the 35 square-mile Cape Fear Skyway study area (URS 2009). It should be noted the overall study area for the Cape Fear Skyway project has expanded since that time; the discussion of the areal extent of the project given above in Section 1.1 details the current study area.

For this cultural resources study, URS was tasked with creating a predictive model for terrestrial archaeological resources sensitivity within the corridors currently being evaluated for the Cape Fear Skyway project. The goal of this modeling effort is to provide guidance to the alternatives analysis concerning the relative impacts of each corridor option. Additional background research for this task was conducted in early-2011, including research at the North Carolina Office of State Archaeology (OSA) on March 8, 2011.

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 Cape Fear Skyway 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 has 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 summarized in the following sections:

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 ARCHAEOLOGICAL PREDICTIVE MODELS OF THE SOUTHERN COASTAL PLAIN OF NORTH CAROLINA

A number of past efforts have been conducted to formulate predictive models for the southern Coastal Plain region of North Carolina, and in particular, for the Lower Cape Fear region of New Hanover County. Several of these works are summarized here, with particular attention paid to the methods of stratifying fieldwork efforts rather than project results.

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 2002, the NCDOT initiated an archaeological predictive model project 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 CAPE FEAR SKYWAY ARCHAEOLOGICAL PREDICTIVE MODEL METHODOLOGY

3.1 INTRODUCTION

Prior to detailing the model type, variables, and methods used in this analysis, it is necessary to differentiate between the Cape Fear Skyway study area and the archaeological predictive model analysis area (**Figure 2**). The latter differs from the former in two ways. The overall study area for the Cape Fear Skyway was described earlier in **Section 1.1**. However, the most up-to-date aerial photography for the entire study area was not available for the predictive model analysis. Since one of the variables (disturbed/developed) used in this analysis was largely based on modern aerial photographs, lacking that data in the northwestern portion of the study area resulted in a partial predictive model analysis. Second, with the exception of the excluded northwest corner, an additional 1,000 feet beyond the study area was included in the predictive model analysis area.

3.2 TYPE OF ARCHAEOLOGICAL PREDICTIVE MODEL FOR CAPE FEAR SKYWAY

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, URS consulted with archaeologists at NCDOT's Human Environment Unit regarding the best approach for formulating a model for the Cape Fear Skyway project. It was agreed that a descriptive model would meet the needs of the Cape Fear Skyway project. This decision was based on two primary reasons.

First, the majority of such efforts previously done for the lower Cape Fear River region had utilized this approach, and these efforts have been very accurate in discerning the types of microenvironments where most archaeological sites will be found in the region.

Second, 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 also came with a large price tag since it took thousands of labor hours to acquire the data necessary for the process (e.g., digitizing archaeological site locations based on 114 hardcopy topographic maps).

With the decision to produce a descriptive predictive model made, it was also determined that the Cape Fear Skyway project area 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).

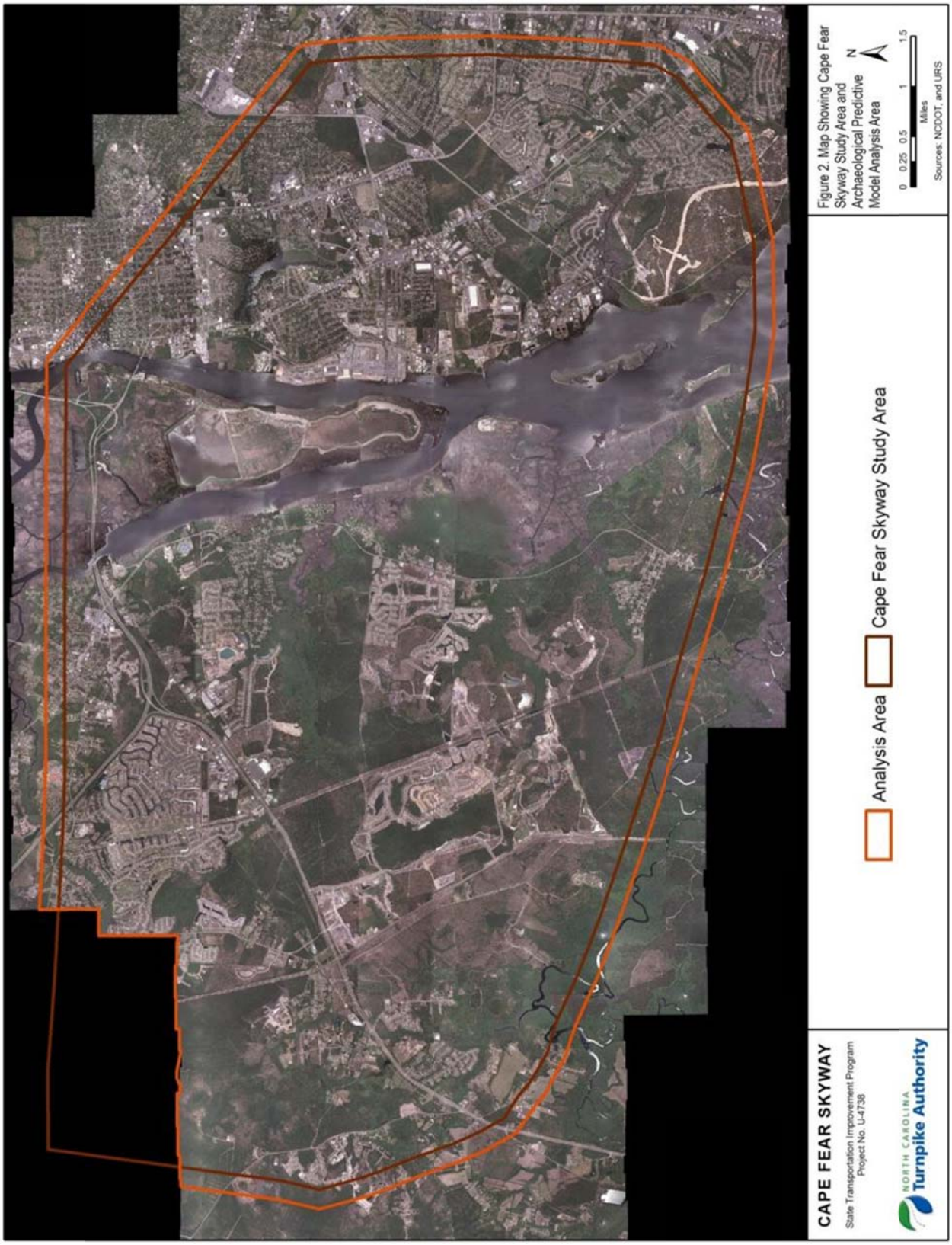

Figure 2. Map Showing Cape Fear Skyway Study Area and Archaeological Predictive Model Analysis Area

Finally, it should be noted that the predictive model for the Cape Fear Skyway project was generated for most of the overall study area, termed the analysis area, not just for alternative corridors. 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 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 additional alignments to be developed in the future that, with a minimum of time, can also have archaeological sensitivity statistics generated for them.

3.3 VARIABLES USED FOR CAPE FEAR SKYWAY 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 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.

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. Finally, landform has not been explicitly used in the lower Cape Fear River region; 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).

The variables chosen for this study are: soil drainage, proximity to water, topographic setting, proximity to historic roads, and disturbed/developed areas. These variables are discussed below.

3.3.1 SOIL DRAINAGE

Past archaeological projects 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 indicates 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 Cape Fear Skyway study area, a total of 53 soil types (plus a water category) 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 low sensitive for the presence of archaeological sites. **Table 1** lists the soil types present in the Cape Fear Skyway study area, their drainage classification, and their flooding frequency. It should be noted that the categories of pits, urban lands, and water do not list a drainage characteristic.

3.3.2 PROXIMITY TO WATER

Much like the drainage characteristic of soils, past archaeological work in the region has shown that archaeological sites most 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. Areas within 200 meters from permanent water 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).

Table 1. Soil Types and Drainage Characteristics within Cape Fear Skyway Study Area

Soil Name	Drainage Class	Flood Freq.
Baymeade and Marvyn soils, 6 to 12 percent slopes	Well drained	None
Baymeade fine sand, 1 to 6 percent slopes	Well drained	None
Baymeade-Urban land complex 1 to 6 percent slopes	Well drained	None
Blanton fine sand, 0 to 5 percent slopes	Moderately well drained	None
Borrow pits	Well drained	None
Bragg fine sandy loam, 2 to 6 percent slopes	Well drained	None
Chowan silt loam	Very poorly drained	Frequent
Craven fine sandy loam, 1 to 4 percent slopes	Moderately well drained	None
Croatan muck	Very poorly drained	None
Dorovan muck	Very poorly drained	Frequent
Dorovan soils	Very poorly drained	Frequent
Foreston loamy fine sand	Moderately well drained	None
Goldsboro fine sandy loam, 0 to 2 percent slopes	Moderately well drained	None
Johnston soils	Very poorly drained	Frequent
Kenansville fine sand, 0 to 3 percent slopes	Well drained	None
Kureb fine sand, 1 to 8 percent slopes	Excessively drained	None
Kureb sand, 1 to 8 percent slopes	Excessively drained	None
Kureb-Urban land complex, 1 to 8 percent slopes	Excessively drained	None
Lakeland sand, 1 to 8 percent slopes	Excessively drained	None
Leon fine sand	Poorly drained	None
Leon sand	Poorly drained	None
Leon-Urban land complex	Poorly drained	None
Longshoal muck	Very poorly drained	Very frequent
Lynchburg fine sandy loam	Somewhat poorly drained	None
Lynn Haven fine sand	Poorly drained	None
Mandarin fine sand	Somewhat poorly drained	None
Muckalee loam	Poorly drained	Frequent
Murville fine sand	Very poorly drained	None
Murville mucky fine sand	Very poorly drained	Rare
Newhan fine sand	Excessively drained	Rare
Newhan fine sand, dredged, 2 to 30 percent slopes	Excessively drained	Rare
Norfolk fine sandy loam, 0 to 4 percent slopes	Well drained	None
Norfolk loamy fine sand, 2 to 6 percent slopes	Well drained	None

Table 1. Soil Types and Drainage Characteristics within Cape Fear Skyway Study Area (continued)

Soil Name	Drainage Class	Flood Freq.
Onslow fine sandy loam	Moderately well drained	None
Onslow loamy fine sand	Moderately well drained	None
Pactolus fine sand, 0 to 2 percent slopes	Moderately well drained	Rare
Pamlico muck	Very poorly drained	Frequent
Pantego loam	Very poorly drained	Rare
Pantego mucky loam	Very poorly drained	None
Pits		None
Rains fine sandy loam	Poorly drained	None
Rimini sand, 1 to 6 percent slopes	Excessively drained	None
Seagate fine sand	Moderately well drained	None
Stallings fine sand	Somewhat poorly drained	None
Tidal marsh	Very poorly drained	Very frequent
Tomahawk loamy fine sand	Moderately well drained	None
Torhunta loamy fine sand	Very poorly drained	None
Torhunta mucky fine sandy loam	Very poorly drained	None
Urban land		None
Wakulla sand, 1 to 8 percent slopes	Somewhat excessively drained	None
Water		None
Woodington fine sandy loam	Poorly drained	None
Wrightsboro fine sandy loam, 0 to 2 percent slopes	Moderately well drained	None
Yaupon silty clay loam, 0 to 3 percent slopes	Somewhat poorly drained	Very rare

Source: USDA-NRCS (2011)

3.3.3 TOPOGRAPHIC SETTING

Few past predictive model efforts from the lower Cape Fear River area have specifically used or defined topographic setting. However, most have employed such a concept by default. 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, generally listed as if moving away from the Cape Fear River: small rise in floodplain, bluff edge of upland, upland flat adjacent to stream, 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. For the purposes of this study, the six-foot contour line was utilized 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 Cape Fear Skyway study area.

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 Cape Fear Skyway study area have been identified through a combination of topographic maps, DEM data, and Light Detection and Ranging (LIDAR) data.

3.3.4 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. 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 (Green et. al. 2007). The area they defined as high probability in relation to the road was 100 meters on either side of the road. The current study for the Cape Fear Skyway used the same definition for proximity to historic roads.

For the current study, historic maps online at www.lib.unc.edu/dc/ncmaps/ were consulted in February 2011. Numerous maps from the region were viewed to identify the age of certain roads within the study area. **Table 2** lists extant roads that are older than 50 years, but are not part of a potentially historic neighborhood (e.g., Sunset Park NRHP district, South Wilmington, Maffit Village—see URS 2009 for details on historic resources in the study area).

Table 2. Historic Roads within Cape Fear Skyway Study Area

Road	Earliest Map Evidence	Current Alignment In	Comments
New Hanover Co.			
US 421	Mid-19th c.	Turn 19th/20th c.	Northern portion along different alignment prior to 1900s
River Road	Mid-19th c.	Mid-20th c.	Alignment pre-1953 along edge of upland; alignment post-1953 is current
Independence Blvd.	1960s	Post 1953	Alignment does not appear on 1953 map but does appear on 1968 map
Shipyard Blvd.	1940s	Post 1944	Alignement does not appear on 1944 map but does appear on 1953 map
Downtown Wilmington	Early/Mid-18th c.	Early/mid-18th c.	Downtown Wilmington established in 1730s
Brunswick Co.			
River Road (NC 133)	Mid/late-19th c.	Late-19th c.	Southern portion changed little since mid-1800s; northern portion changed little since late-1800s
US 17	Mid-19th c.	Mid-19th c.	Alignment of US 17 has changed little since mid-19th century; however, the road has been upgraded to a four-lane divided access-controlled highway
Wire Road	Mid-19th c.	Mid-19th c.	Alignment has not changed since mid-19th century

Source: URS

3.3.5 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.

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, pits, and any soil type with an urban element are considered disturbed/developed. A total of six soil types meet these criteria (**Table 3**). For aerial photography, aerial photographs dated April 16, 2009 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. As discussed above, lack of aerial imagery in the northwestern portion of the study area resulted in running the predictive model analysis on a reduced area termed the analysis area (**Figure 2**).

Table 3. Disturbed/Developed Soil Types in Cape Fear Skyway Study Area

Soil Name	Drainage Class	Flood Freq.
Baymeade-Urban land complex 1 to 6 percent slopes	Well drained	None
Borrow pits	Well drained	None
Kureb-Urban land complex, 1 to 8 percent slopes	Excessively drained	None
Leon-Urban land complex	Poorly drained	None
Pits		None
Urban land		None

Source: USDA-NRCS (2011)

3.4 GEOGRAPHIC INFORMATION SYSTEMS METHODOLOGY

3.4.1 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.

3.4.2 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.

3.4.2.1 Soil Drainage

Soil GIS data for Brunswick and New Hanover 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.

3.4.2.2 Proximity to Water

Water course and water body GIS data for Brunswick and New Hanover counties was downloaded from the NC Department of Environment and Natural Resources (DENR) Division of Water Quality (DWQ) website (http://207.4.252.94/DWQ_Data_Dist/). This data dates to 2006 as the 2007 update was not available at the time of this analysis. This 1:24,000 GIS data contains information about canals, man-made ponds, tidal flats, and wetland areas in addition to more traditional water features. Relevant water features such as streams, rivers, ponds, and water bodies were identified and selected for use in this analysis.

Each relevant water feature 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.

3.4.2.3 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 1:24,000 USGS topographic maps from the NC DOT GIS website (www.ncdot.org/it/gis/DataDistribution/USGSTopographicMaps/default.html). The analysis area covers four quad maps: 172, 173, 177, and 178. Upon inspection, it was determined that the two eastern quad maps (tiles 173 and 178) were improperly georeferenced and could not be used to locate Carolina bays. Therefore, information about Carolina bays in the eastern section of the analysis area was derived from USDA NRCS GIS data. Several Carolina bays were heads-up digitized (i.e., digitized by hand by creating polygons based on another data source) in the western portion of the analysis area.

Once the outline of these bays was drawn, a 200 meter buffer outside the bay was generated. Next, the buffer adjoining the northern and western portions of each bay was removed, leaving a 200 meter buffer for areas south and east of each Carolina bay. 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, providing a well drained soil location atypical of the surrounding soil type. Topographic contour GIS data used to derive this variable was downloaded from the NCDOT GIS website (www.ncdot.org/it/gis/DataDistribution/ContourElevationData/default.html) and was derived from

LiDAR imagery in 2007. It was decided that any closed location above the floodplain would be included. An elevation of six feet was sufficient enough to indicate a small rise or hill in swampy areas. Each enclosed area of six feet elevation was examined for inclusion in this variable. Once these areas were identified, they were traced, and 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 ten feet represented the edge of the bluff between the floodplain and the uplands. Topographic lines representing ten 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.

3.4.2.4 Proximity to Historic Roads

Using historic map resources as discussed above in **Section 3.3.4**, historic roads were identified. Using current road information from NCDOT GIS, contemporary roads following historic alignments were selected (www.ncdot.org/it/gis/DataDistribution/DOTData/default.html). Next, a 100 meter buffer was applied to both sides of each road. Because several of these roads either cross, or are located near, water bodies, the buffer was modified to exclude areas which are considered water bodies. 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.

3.4.2.5 Disturbed/Developed Areas

The disturbed and developed area variable was generated using a 2009 aerial photo of the analysis area which was flown for this project. Areas such as sub-divisions, golf courses, city blocks, large man-made ponds, 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.

3.4.3 VARIABLE WEIGHTING

Based on previous research in the Cape Fear area, each variable was ranked based on its perceived level of influence on historic and prehistoric settlement. Weighting of the variables was arbitrarily performed 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 area. 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 recovered. Regardless of the probability calculated based on soils, TSP, and PW, areas within DD areas 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.

3.4.4 ARCHAEOLOGICAL POTENTIAL GENERATION

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

Prehistoric probability = (2TSP + (1PW + 1WDr)*0.5 PDr)*0.5DD

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 by half.

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

Historic probability = (2TSH + (1PR + 1PW + 1 WDr)*0.5PDr)*0.5DD

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 broken 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 CAPE FEAR SKYWAY ARCHAEOLOGICAL PREDICTIVE MODEL RESULTS

4.1 INTRODUCTION

Determining the location of high and low probability areas was conducted on the entire Cape Fear Skyway study area; however, the focus of the current study addresses the corridor Options and Conceptual Designs that are currently under consideration. Should a future need to consider additional or altered Options or Designs arise, analysis of those can be conducted with the GIS and reported in an addendum memorandum.

4.2 SEGMENTS, OPTIONS, CONCEPTUAL DESIGNS, AND STUDY CORRIDORS OF THE CAPE FEAR SKYWAY

To date, planning for the Cape Fear Skyway has focused efforts on decreasing the unit of study from the initial broad study area, through possible portions of alignments (termed segments), to full alignments (termed options), and finally, to conceptual designs for alignments. Moving forward, studies will focus on the conceptual designs. However, studies will focus on both the actual conceptual designs (ca. 350 feet R/W) as well as a broader study corridor (ca. 1,000 feet wide).

Initially, 29 segments were developed for the Cape Fear Skyway as approximate centerlines. Preliminary study of these 29 segments led to the removal of eight from further consideration (Segments 11, 16, 17, 18, 19, 23, 24, 25). Further, segments 12 and 15 were combined into one (Segment 15). Thus, a total of 20 segments were retained for consideration for the Cape Fear Skyway project. **Figure 3** depicts the locations of these 20 segments.

In early-2011, complete *options*, which represented potential full-length alignments, were devised. In total, 14 options were developed and assigned a letter designation from “A” to “N” (**Figure 4**). In general, 12 of the options (A-D, G-N) were wholly or largely along new alignment while two of the options (E-F) were wholly or largely an upgrade to existing US 17 (Brunswick County) and US 421 (New Hanover County).

Once the options were chosen, *conceptual designs* were created to more specifically identify where a final roadway may be located. Conceptual designs include a horizontal alignment for the roadway, basic design of the interchanges, and assumed right of way limits (approximately 350 feet right-of-way). At this step of the design process, a total of 24 conceptual designs were created within the 14 Options (**Figure 5**). It should be noted that the number of conceptual designs is higher than the number of options for two reasons. First, six of the options (E-J) had both arterial widening (i.e., widen existing) and freeway options created for them. Second, four of the conceptual designs (K-N) were altered after their initial development to avoid residential development. As such, a total of 24 conceptual designs are currently under consideration—eight options, six options as arterial widening, six options as freeway, and four avoidance designs.

Finally, with conceptual designs created, broader study corridors were developed for environmental studies to target (**Figure 6**). These study corridors are 1,000 feet wide and are generally centered on the conceptual designs. Focusing analyses on study corridors will allow for minor shifts during creation of the final designs based on the results of field studies (i.e., minor alignment shifts can be done within the study corridors without the need for additional field studies and reporting).

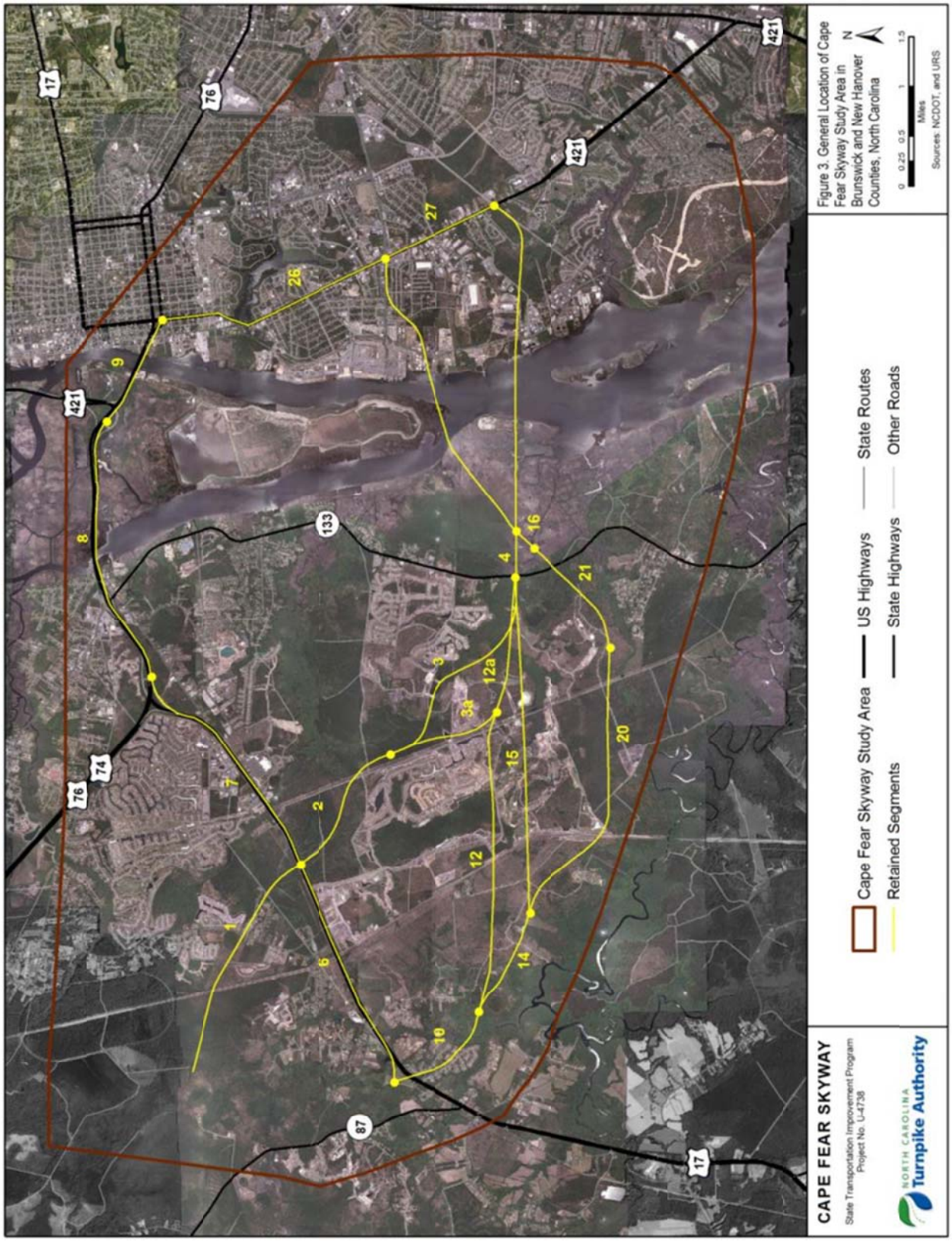

Figure 3. Location of Cape Fear Skyway Segments

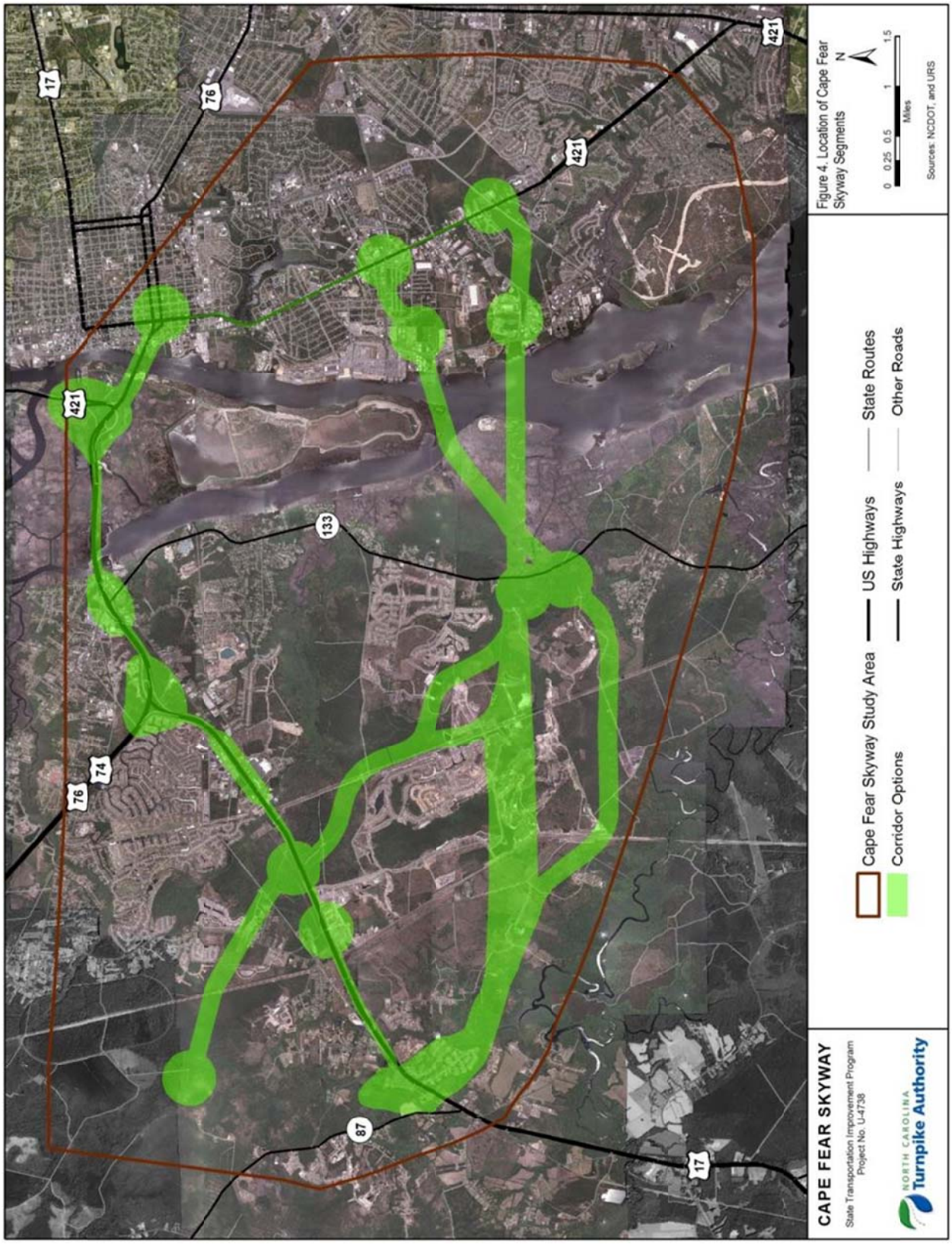

Figure 4. Location of Cape Fear Skyway Options

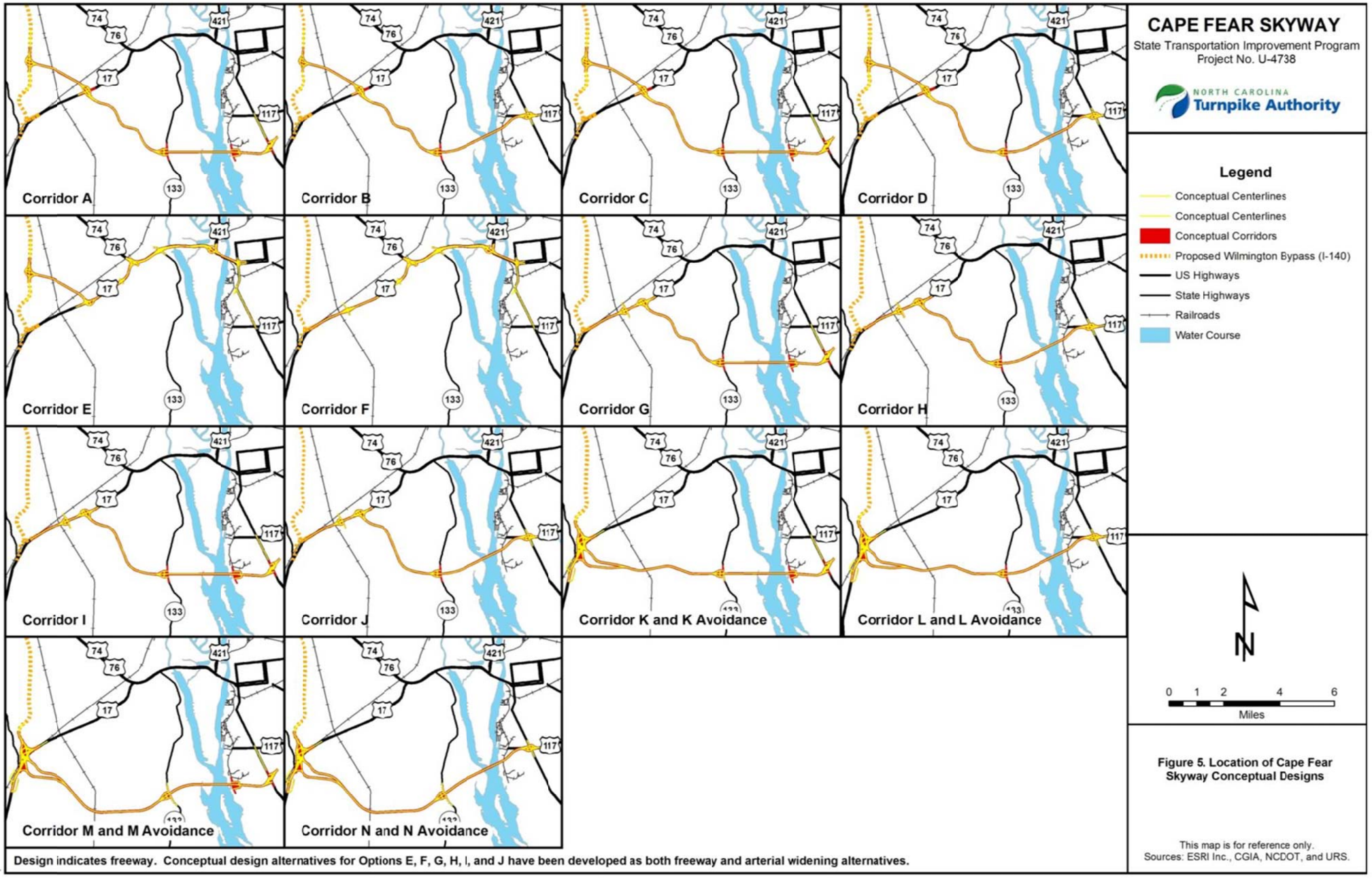

Figure 5. Location of Cape Fear Skyway Conceptual Designs

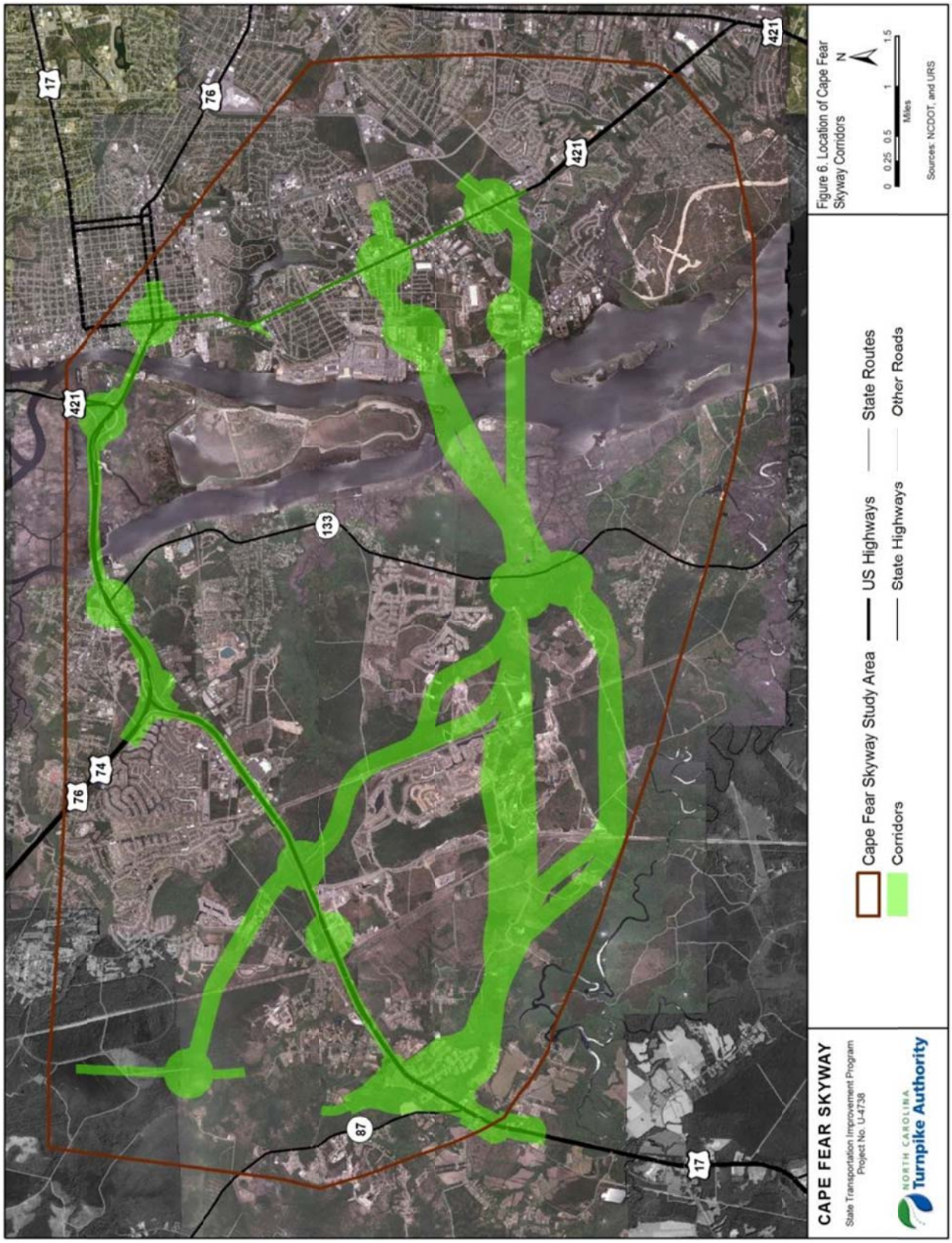

Figure 6. Location of Cape Fear Skyway Study Corridors

4.3 RESULTS OF INDIVIDUAL VARIABLES FOR ARCHAEOLOGICAL PREDICTIVE MODEL OF CAPE FEAR SKYWAY

The purpose of this section is to provide a graphical summary of results for each of the variables used to create the Cape Fear Skyway 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 7** (Soil Drainage Classifications), **Figure 8** (Proximity to Water Classifications), **Figure 9** (Topographic Setting Classifications), **Figure 10** (Proximity to Historic Road Classifications), and **Figure 11** (Disturbed/Developed Areas).

4.4 RESULTS OF COMPREHENSIVE ARCHAEOLOGICAL PREDICTIVE MODEL FOR CAPE FEAR SKYWAY STUDY AREA

Although 24 conceptual designs and study corridors 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 12**, **Figure 13**, and **Figure 14** graphically depict the high and low probability for prehistoric, historic, and a composite of both (respectively) for the entire analysis area of the Cape Fear Skyway. 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 (part of the topographic setting variable) was not considered, while proximity to historic roads was considered.

In terms of the composite sensitivity for any type of archaeological site (**Figure 14**), the entire analysis area, excluding water, contains 42,189.7 acres. Of this, 16,264.5 acres (6,582.0 hectares, 38.6 percent) are high probability area and 25,925.2 acres (10,491.6 hectares, 61.4 percent) are low probability area.

4.5 COMPARISON OF PREVIOUSLY RECORDED SITES TO PREDICTIVE MODEL

The purpose of this section is to compare known archaeological resources in the Cape Fear Skyway study area to the results of the archaeological predictive model generated above. Doing so provides a means to evaluate the results of the generated model, since their specific locations were not used to generate the model itself.

On March 8, 2011, maps depicting archaeological site locations on file at the OSA were checked to see if any additional archaeological sites had been recorded in the Cape Fear Skyway study area since URS produced an archaeological and historical context report for the project (URS 2009). Within the study area, no additional sites have been recorded since the April 2009 check. However, expansion of the overall study area since that time has increased the site count by one; site 31BW375 in Brunswick County is now included in the overall study area. As such, 102 archaeological resources—25 in Brunswick County and 77 in New Hanover County—are located within the Cape Fear Skyway study area.

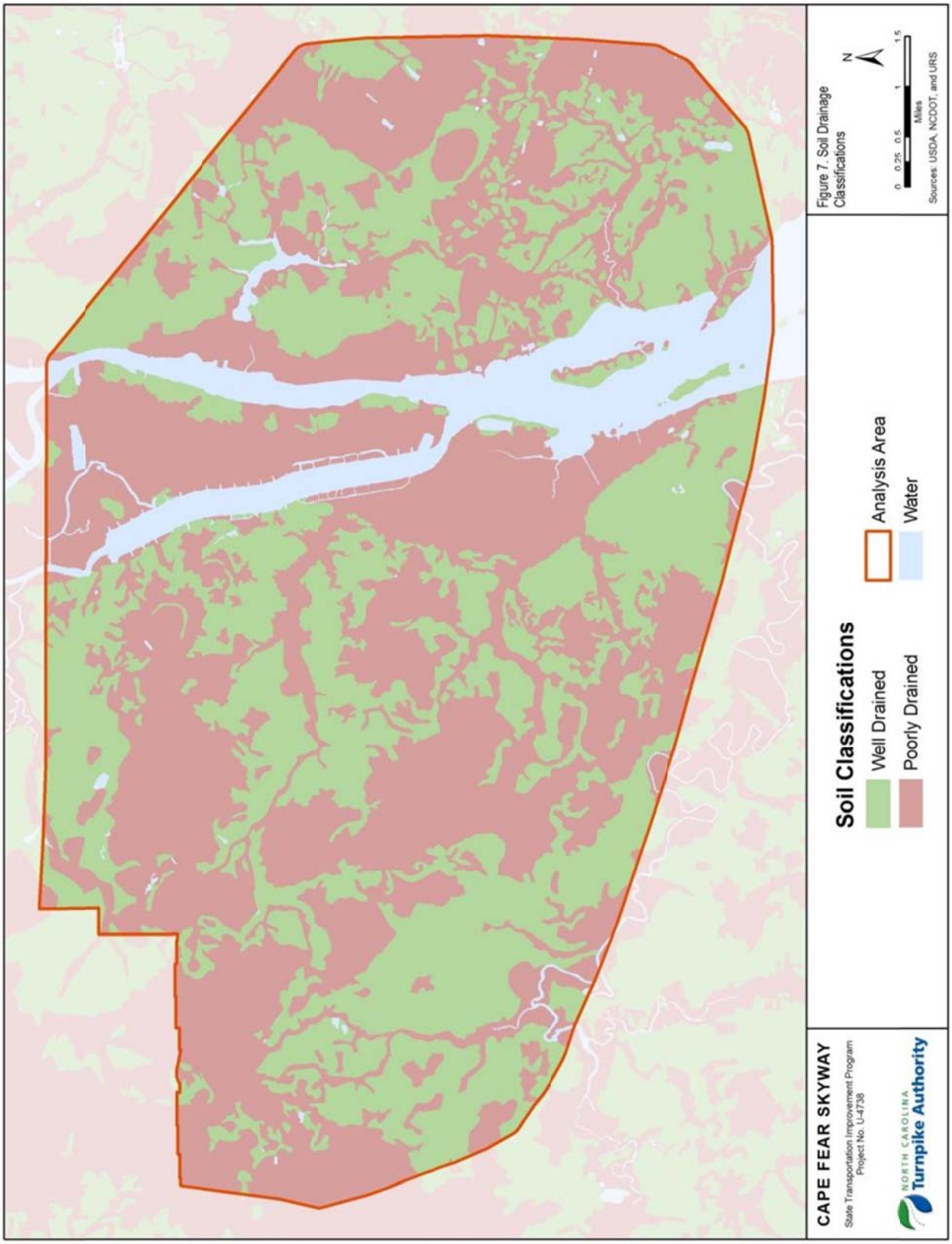

Figure 7. Soil Drainage Classifications

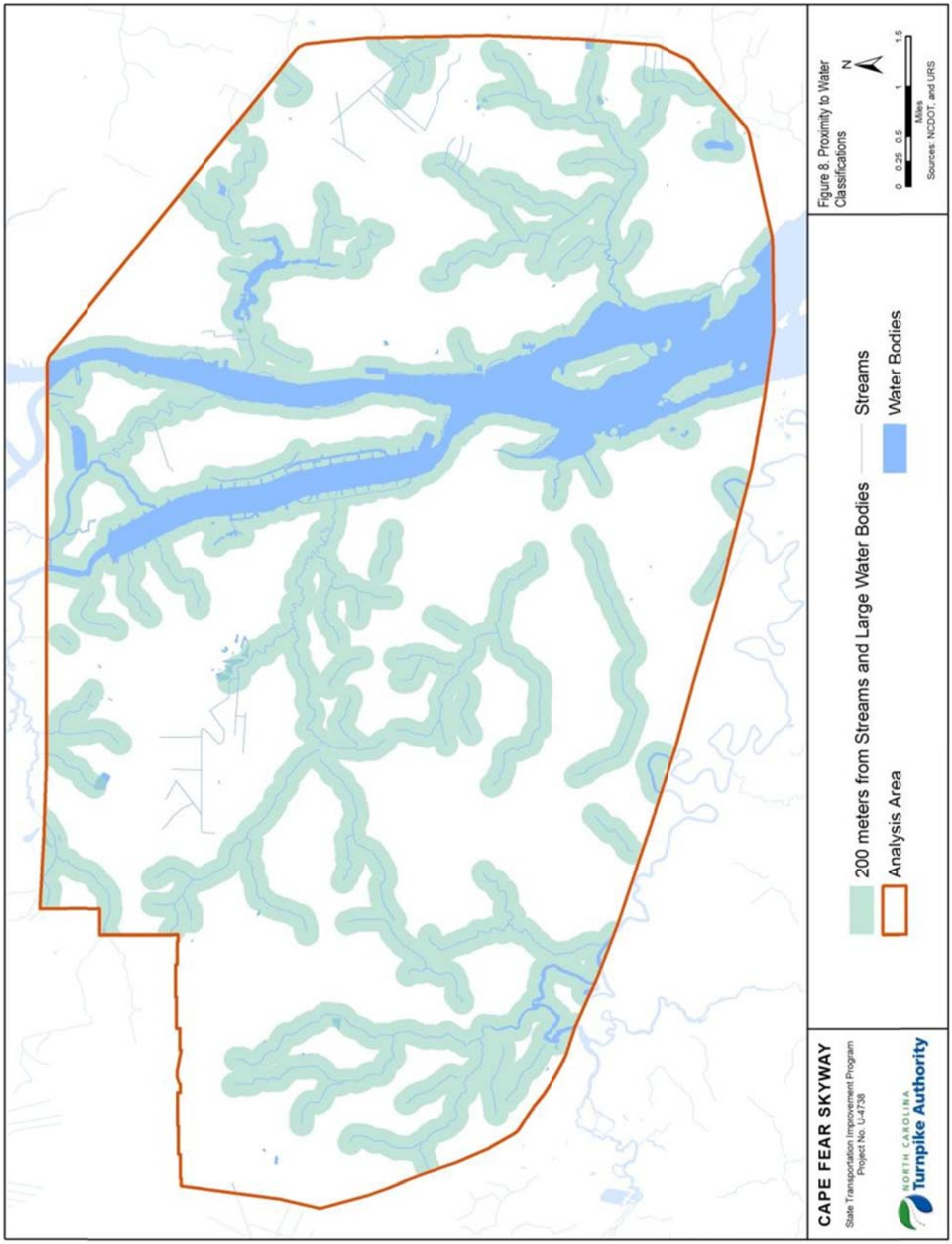

Figure 8. Proximity to Water Classifications

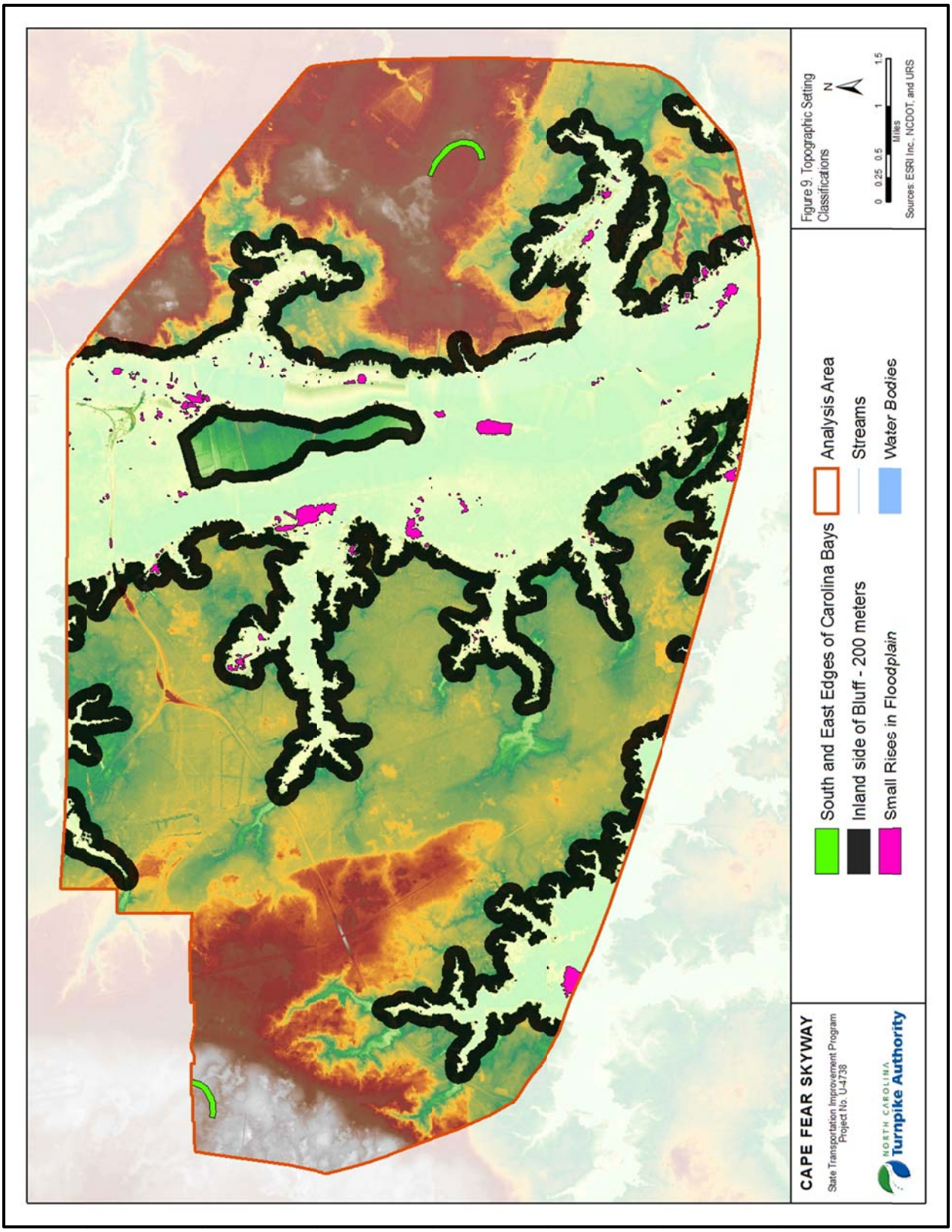

Figure 9. Topographic Setting Classifications

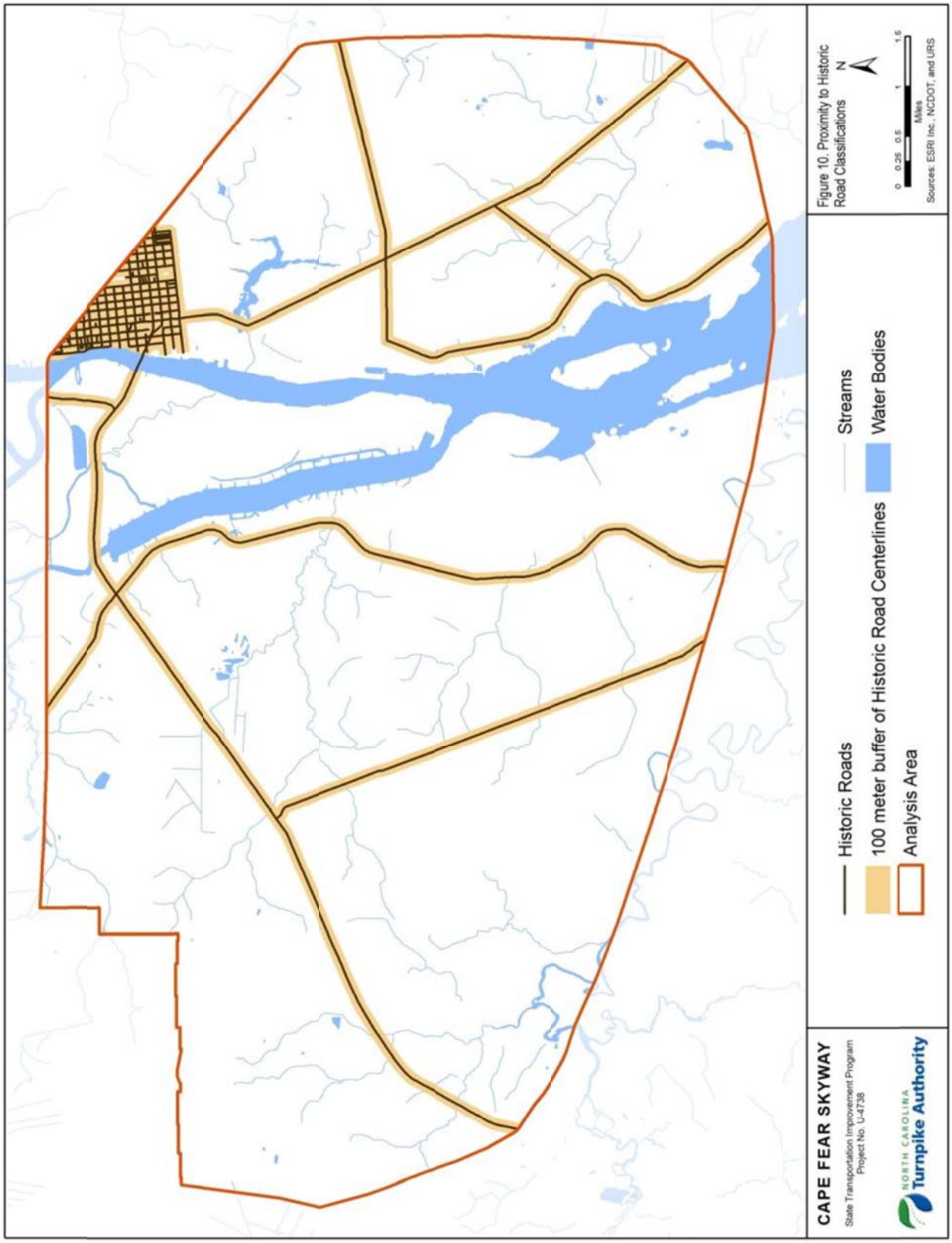

Figure 10. Proximity to Historic Road Classifications

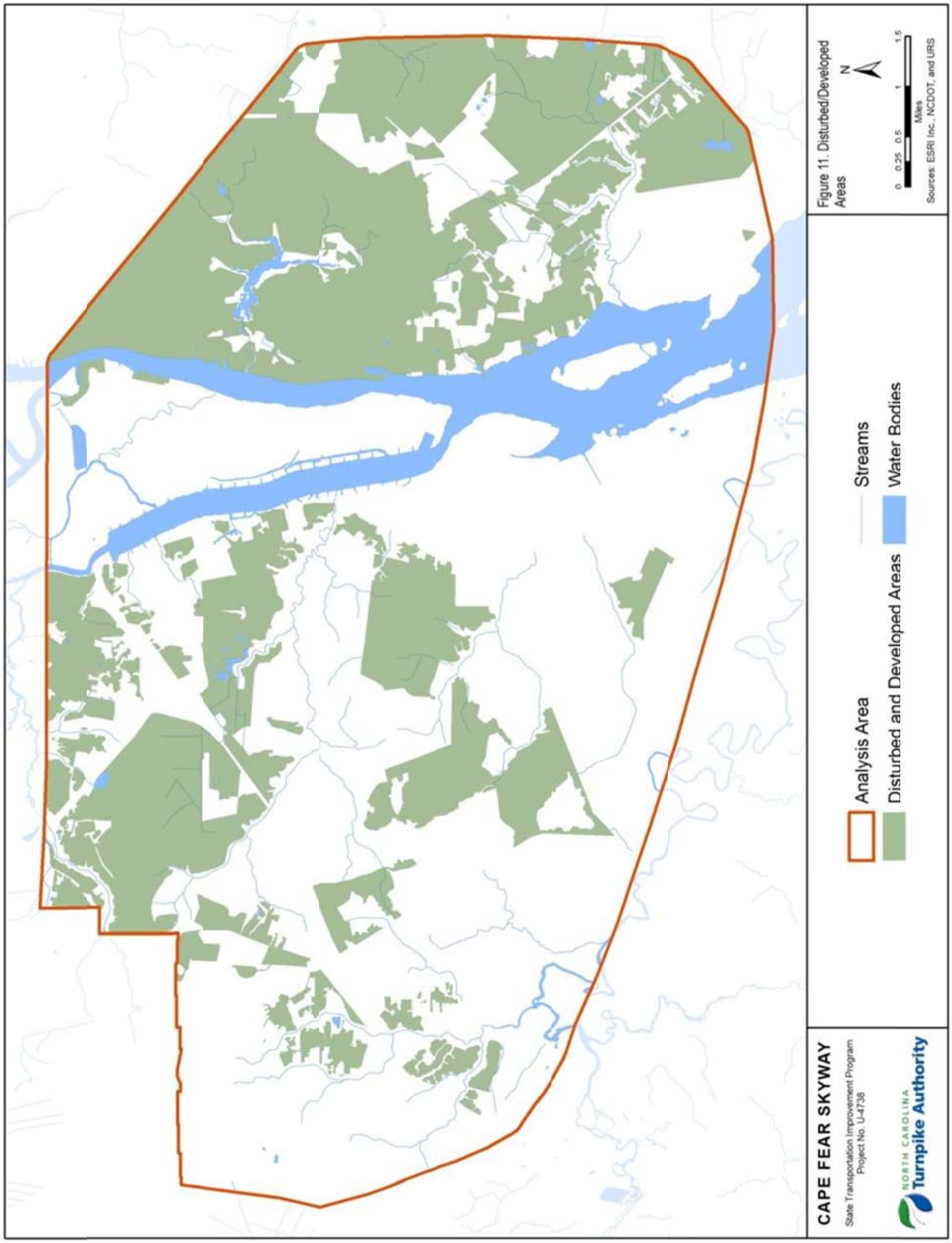

Figure 11. Disturbed/Developed Areas

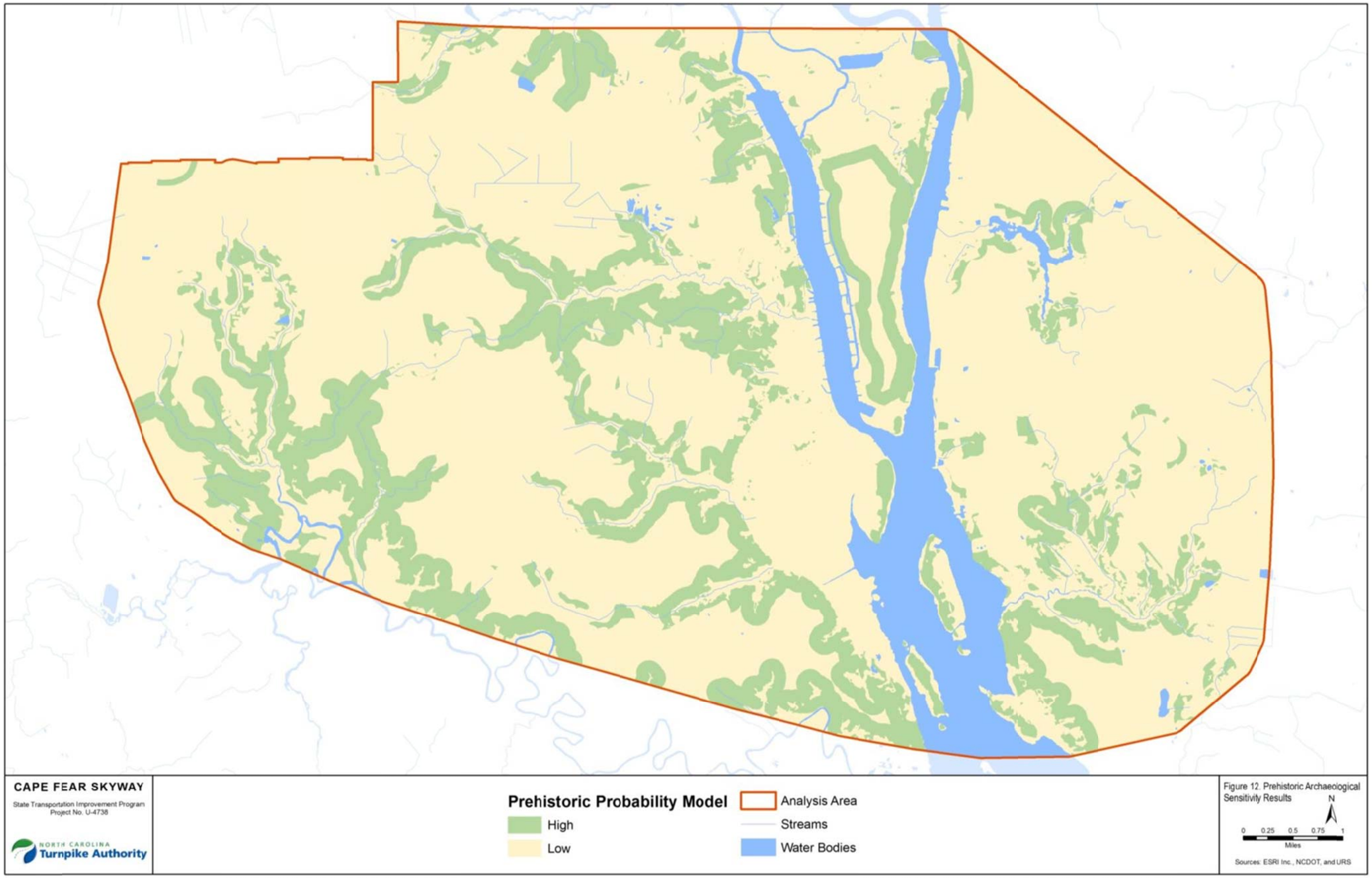

Figure 12. Prehistoric Archaeological Sensitivity Results

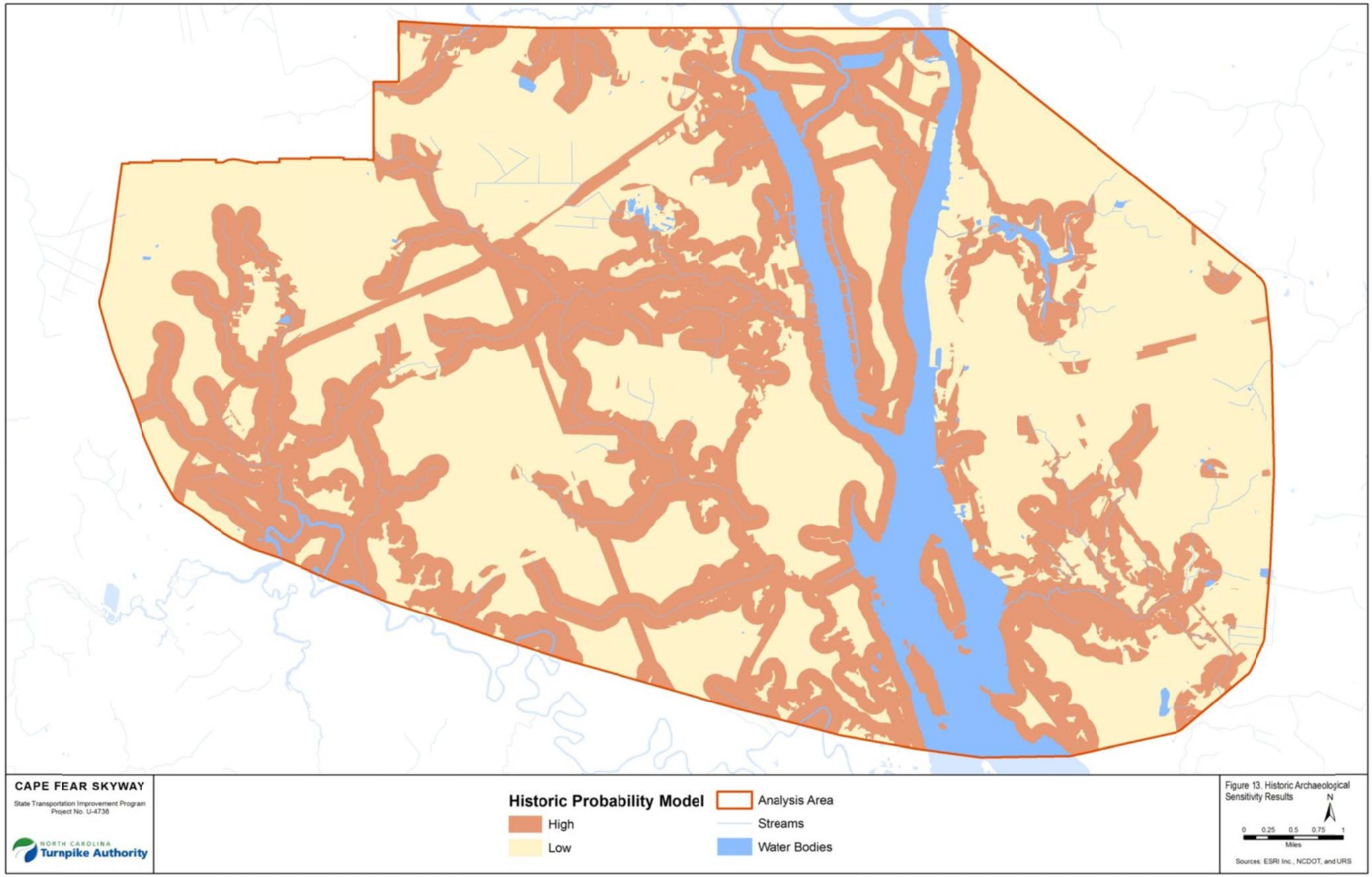

Figure 13. Historic Archaeological Sensitivity Results

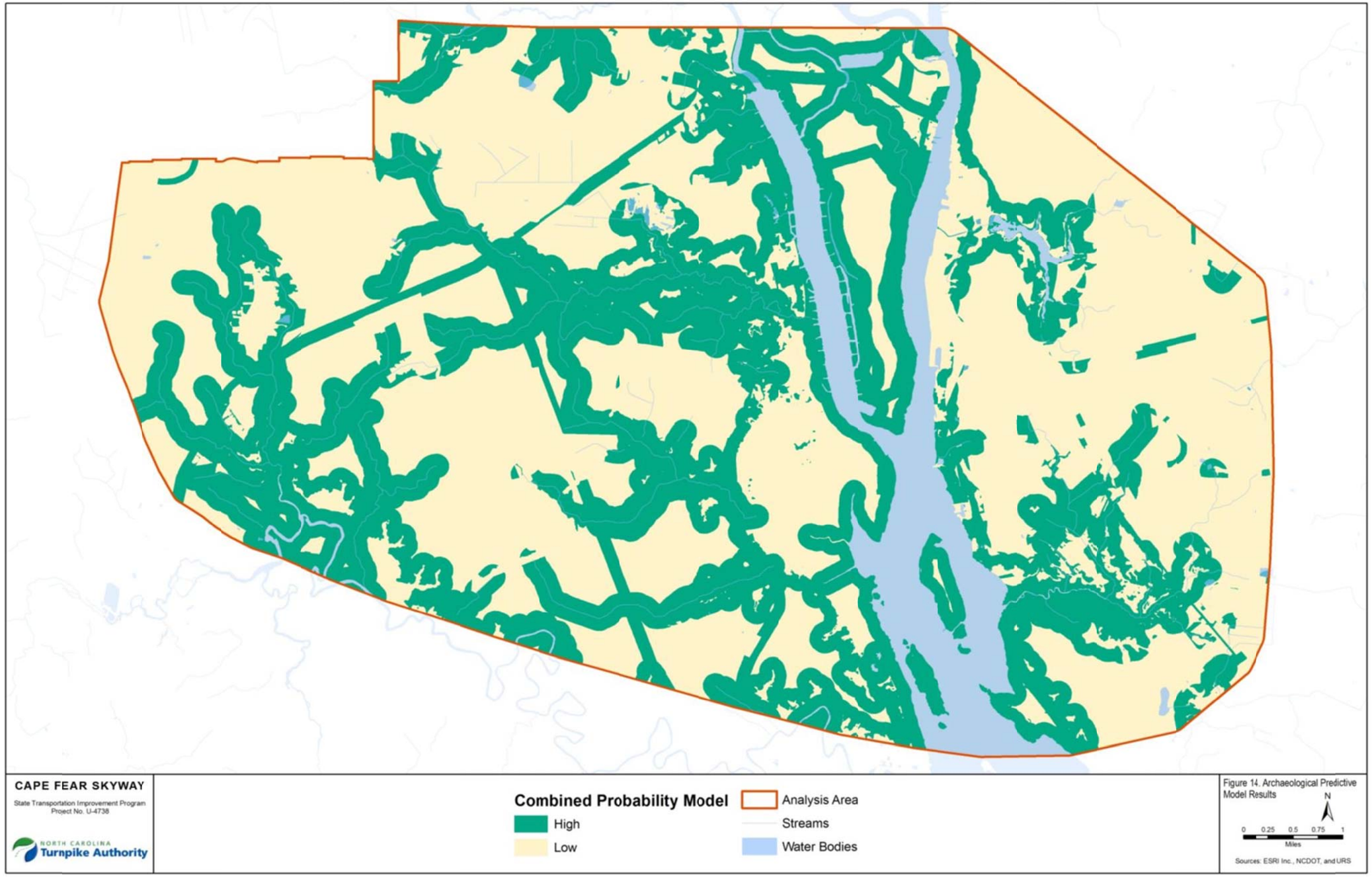

Figure 14. Archaeological Predictive Model Results

Further, conducting the predictive model on an extra 1,000 feet outside most of the study area captured several other previously-recorded sites. Therefore, the number of previously recorded sites in the predictive model analysis area is 116. Of the 116 previously recorded sites, 90 are located in high probability areas (**Figure 15**). It is likely that several of the 26 sites in low probability areas are in that zone due to identification of the site prior to disturbance or development that has rendered the location low probability in more recent times. Similarly, many of the 26 sites located in low probability areas are in very close proximity to high probability areas. This is likely a result of site locations being digitized in the GIS system as point features rather than polygons. It is unlikely that all 26 sites in low probability areas fall into these situations, though, so it is important to reiterate that low probability does not equate to *no probability*, just that the chances of identifying sites in low probability areas is much less compared to areas of high probability.

In summary, over 75 percent of the previously-recorded sites are situated in locations designated as high probability by the current model. This demonstrates the utility of the model created for the Cape Fear Skyway project.

4.6 RESULTS OF COMPREHENSIVE ARCHAEOLOGICAL PREDICTIVE MODEL FOR CAPE FEAR SKYWAY CONCEPTUAL DESIGNS AND STUDY CORRIDORS

4.6.1 CONCEPTUAL DESIGNS

Acreage and percentage of high and low probability for the 24 conceptual designs were calculated (**Table 4**). A composite of the conceptual designs depicting this information graphically is provided in **Figure 16**.

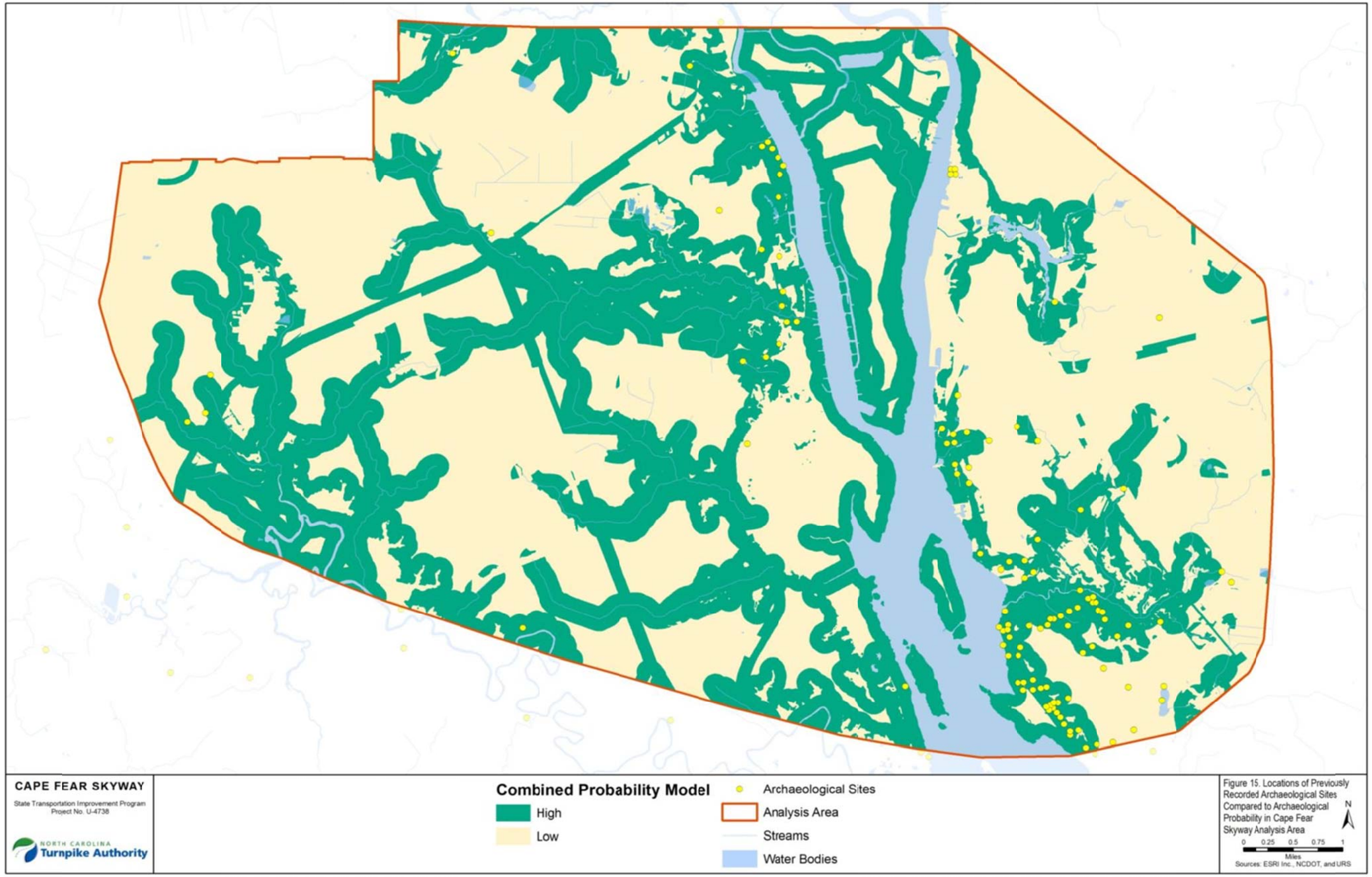

Figure 15. Locations of Previously Recorded Archaeological Sites Compared to Archaeological Probability in Cape Fear Skyway Analysis Area

Table 4. Archaeological Probability for Cape Fear Skyway Conceptual Designs

Corridor	High (acres)	High (%)	Low (acres)	Low (%)	Total (acres)
Sorted by High Probability Percentage					
Q	384.3	61.4	242.1	38.6	626.4
K Avoidance	500.4	61.1	319.2	38.9	819.6
G	411.7	60.6	268.1	39.4	679.8
P	319.8	59.6	216.8	40.4	536.6
F	372.5	58.8	261.3	41.2	633.8
M Avoidance	497.8	58.6	352.0	41.4	849.7
K	405.7	57.3	302.0	42.7	707.7
S	351.8	56.3	273.7	43.8	625.5
I	379.8	55.8	300.8	44.2	680.6
M	411.8	55.7	327.7	44.3	739.4
L Avoidance	398.8	52.0	367.6	48.0	766.4
N Avoidance	395.4	49.5	403.0	50.5	798.4
H	310.3	49.5	316.7	50.5	627.0
R	282.5	49.4	289.1	50.6	571.6
L	304.2	47.3	339.1	52.7	643.3
N	310.7	45.9	366.8	54.1	677.5
A	324.6	45.5	389.0	54.5	713.6
J	276.2	44.1	349.5	55.9	625.6
T	251.6	43.7	323.6	56.3	575.2
O	289.7	43.7	373.4	56.3	663.1
E	307.5	43.4	400.8	56.6	708.3
C	294.1	41.1	421.5	58.9	715.6
B	224.0	33.8	439.2	66.2	663.2
D	189.9	28.6	473.2	71.4	663.1
Sorted by High Probability Acres					
K Avoidance	500.4	61.1	319.2	38.9	819.6
M Avoidance	497.8	58.6	352.0	41.4	849.7
M	411.8	55.7	327.7	44.3	739.4
G	411.7	60.6	268.1	39.4	679.8
K	405.7	57.3	302.0	42.7	707.7
L Avoidance	398.8	52.0	367.6	48.0	766.4
N Avoidance	395.4	49.5	403.0	50.5	798.4
Q	384.3	61.4	242.1	38.6	626.4
I	379.8	55.8	300.8	44.2	680.6
F	372.5	58.8	261.3	41.2	633.8
S	351.8	56.3	273.7	43.8	625.5
A	324.6	45.5	389.0	54.5	713.6
P	319.8	59.6	216.8	40.4	536.6
N	310.7	45.9	366.8	54.1	677.5
H	310.3	49.5	316.7	50.5	627.0
E	307.5	43.4	400.8	56.6	708.3
L	304.2	47.3	339.1	52.7	643.3
C	294.1	41.1	421.5	58.9	715.6
O	289.7	43.7	373.4	56.3	663.1
R	282.5	49.4	289.1	50.6	571.6
J	276.2	44.1	349.5	55.9	625.6
T	251.6	43.7	323.6	56.3	575.2
B	224.0	33.8	439.2	66.2	663.2
D	189.9	28.6	473.2	71.4	663.1

Three conceptual designs consist of over 60 percent high probability area—Q, K Avoidance, and G. Conversely, two conceptual designs contain less than 40 percent high probability areas—B and D. The bulk of the conceptual designs consist of between 40 and 60 percent high

probability with 11 between 40 and 50 percent (N Avoidance, H, R, L, N, A, J, T, O, E, and C) and eight between 50 and 60 percent (P, F, M Avoidance, K, S, I, M, and L Avoidance).

Compared to the overall analysis area (**Section 4.4**), which contained 38.6 percent high probability and 61 percent low probability, conceptual designs E, C, and B are within five percent of the analysis area results with 43 percent, 41 percent, and 34 percent high probability respectively. Combined with conceptual design D (29 percent high probability), these four conceptual designs represent the ones that exhibit similar or lesser amounts of high probability area; the remaining 20 conceptual designs exhibit greater than five percent more high probability area in comparison to the overall analysis area.

In terms of acreage, five conceptual designs contain 400 or more acres of high-probability area—K Avoidance, M Avoidance, M, G, and K. Only one conceptual design, D, contains less than 200 acres of high probability area. The vast majority of the conceptual designs contain between 200 and 400 acres of high probability with 12 containing between 300 and 400 acres (L Avoidance, N Avoidance, Q, I, F, S, A, P, N, H, E, and L) and six containing between 200 and 300 acres (C, O, R, J, T, and B).

In summary, conceptual designs G and K Avoidance contain both a high percentage of high probability area as well as comparatively high acreage of high probability. Conversely, conceptual design D contains both a low percentage and comparative acreage of high probability area.

4.6.2 STUDY CORRIDORS

Acreage and percentage of high and low probability for the 24 study corridors were calculated (Error! Reference source not found.). **Figure 17** presents a composite of this information graphically.

No study corridors consist of over 60 percent high probability area. Nine of the study corridors exhibit between 50 and 60 percent high probability area (K Avoidance, M Avoidance, G, Q, F, P, K, I, and S) and another nine study corridors exhibit between 40 and 50 percent (M, L Avoidance, N Avoidance, A, L, H, R, N, and C). The remaining six study corridors have less than 40 percent high probability area (J, T, E, O, and B between 30 and 40 percent; D with less than 30 percent).

Compared to the overall analysis area (see Section 4.4 above), which contained 38.6 percent high probability and 61 percent low probability, nine study corridors are approximately within five percent of the analysis area results with between 34 and 44 percent high probability area (H, R, N, C, J, T, E, O, and B). Combined with study corridor D (30 percent high probability), these ten conceptual designs represent the ones that exhibit similar or lesser amounts of high probability area compared to the overall analysis area; the remaining 14 conceptual designs exhibit greater than five percent more high probability area in comparison.

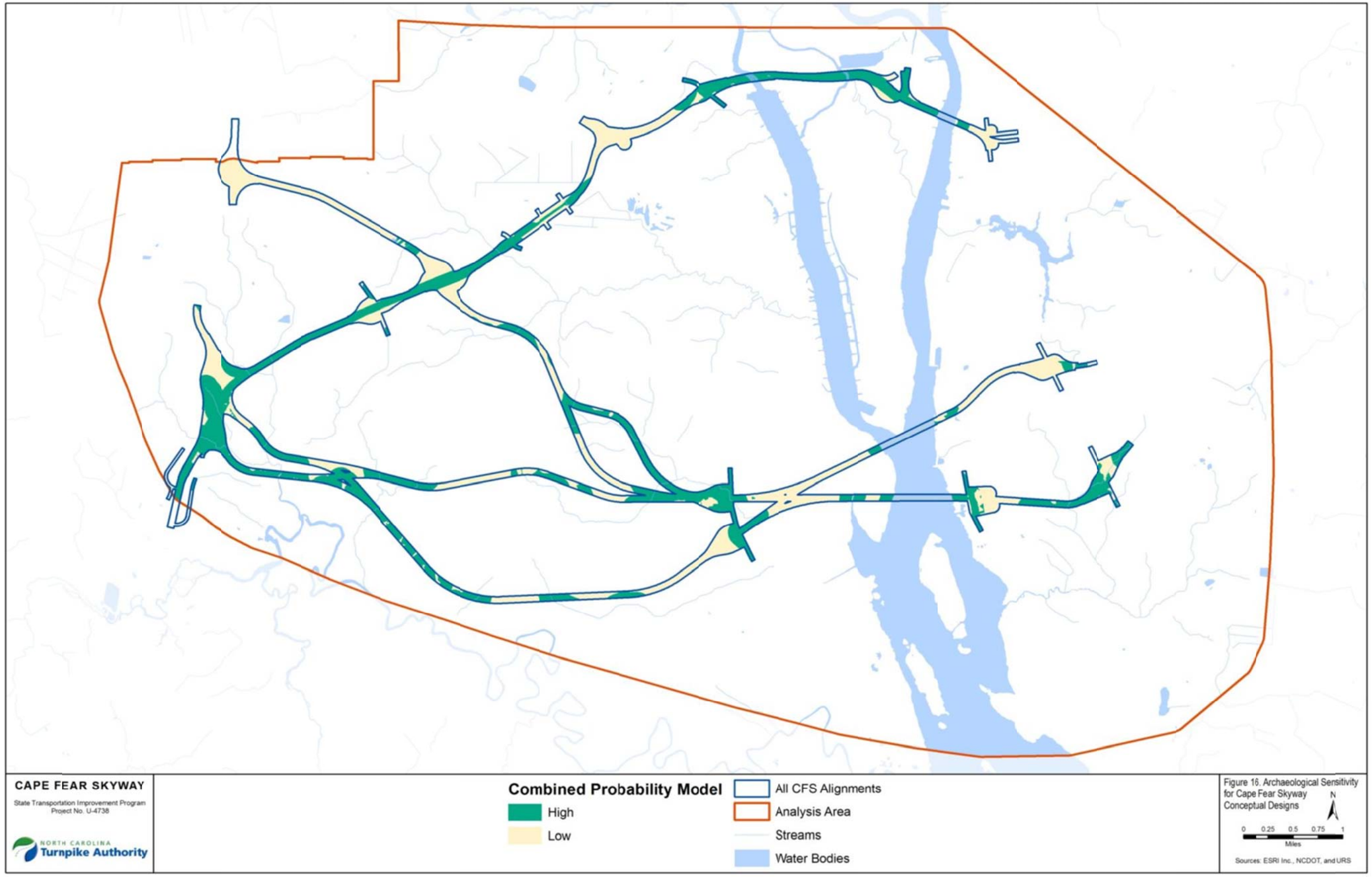

Figure 16. Archaeological Sensitivity for Cape Fear Skyway Conceptual Designs

In terms of acreage, three study corridors contain 1,000 or more acres of high-probability area—K, K Avoidance, and M Avoidance. Only one study corridor, D, contains less than 500 acres of high probability area. The vast majority of the study corridors contain between 500 and 1,000 acres of high probability area as follows:

- 900 to 1,000 acres (*n*=2): L, M
- 800 to 900 acres (*n*=4): N Avoidance, G, Q, L Avoidance
- 700 to 800 acres (*n*=4): I, S, N, A
- 600 to 700 acres (*n*=5): C, H, R, F, P
- 500 to 600 acres (*n*=5): J, T, B, E, O

In summary, study corridors K, M Avoidance, and K Avoidance contain both a high percentage of high probability area and a comparatively high acreage of high probability area. Conversely, study corridor D contains both a low percentage and comparative acreage of high probability area.

Table 5. Archaeological Probability for Cape Fear Skyway Study Corridors

Corridor	High (acres)	High (%)	Low (acres)	Low (%)	Total (acres)
Sorted by High Probability Percentage					
K Avoidance	1020.2	55.9	803.8	44.1	1824.0
M Avoidance	1057.8	55.6	846.1	44.4	1903.9
G	856.5	55.4	690.7	44.6	1547.3
Q	856.5	55.4	690.7	44.6	1547.3
F	604.7	51.7	565.1	48.3	1169.9
P	604.7	51.7	565.1	48.3	1169.9
K	1155.8	51.1	1106.8	48.9	2262.5
I	783.0	50.2	776.7	49.8	1559.7
S	783.0	50.2	776.7	49.8	1559.7
M	935.8	49.4	959.2	50.6	1895.1
L Avoidance	821.0	46.1	959.5	53.9	1780.6
N Avoidance	863.9	46.1	1012.0	53.9	1875.9
A	764.1	45.4	917.7	54.6	1681.8
L	998.5	45.3	1205.1	54.7	2203.7
H	655.3	43.7	845.3	56.3	1500.6
R	655.3	43.7	845.3	56.3	1500.6
N	776.7	42.3	1057.9	57.7	1834.5
C	690.6	40.8	1003.8	59.2	1694.4
J	582.6	38.5	931.3	61.5	1513.9
T	582.6	38.5	931.3	61.5	1513.9
E	528.6	37.5	880.8	62.5	1409.4
O	528.6	37.5	880.8	62.5	1409.4
B	563.6	34.3	1078.1	65.7	1641.6
D	490.9	29.7	1164.7	70.3	1655.6
Sorted by High Probability Acres					
K	1155.8	51.1	1106.8	48.9	2262.5
M Avoidance	1057.8	55.6	846.1	44.4	1903.9
K Avoidance	1020.2	55.9	803.8	44.1	1824.0
L	998.5	45.3	1205.1	54.7	2203.7
M	935.8	49.4	959.2	50.6	1895.1
N Avoidance	863.9	46.1	1012.0	53.9	1875.9
G	856.5	55.4	690.7	44.6	1547.3
Q	856.5	55.4	690.7	44.6	1547.3
L Avoidance	821.0	46.1	959.5	53.9	1780.6
I	783.0	50.2	776.7	49.8	1559.7
S	783.0	50.2	776.7	49.8	1559.7
N	776.7	42.3	1057.9	57.7	1834.5
A	764.1	45.4	917.7	54.6	1681.8
C	690.6	40.8	1003.8	59.2	1694.4
H	655.3	43.7	845.3	56.3	1500.6
R	655.3	43.7	845.3	56.3	1500.6
F	604.7	51.7	565.1	48.3	1169.9
P	604.7	51.7	565.1	48.3	1169.9
J	582.6	38.5	931.3	61.5	1513.9
T	582.6	38.5	931.3	61.5	1513.9
B	563.6	34.3	1078.1	65.7	1641.6
E	528.6	37.5	880.8	62.5	1409.4
O	528.6	37.5	880.8	62.5	1409.4
D	490.9	29.7	1164.7	70.3	1655.6

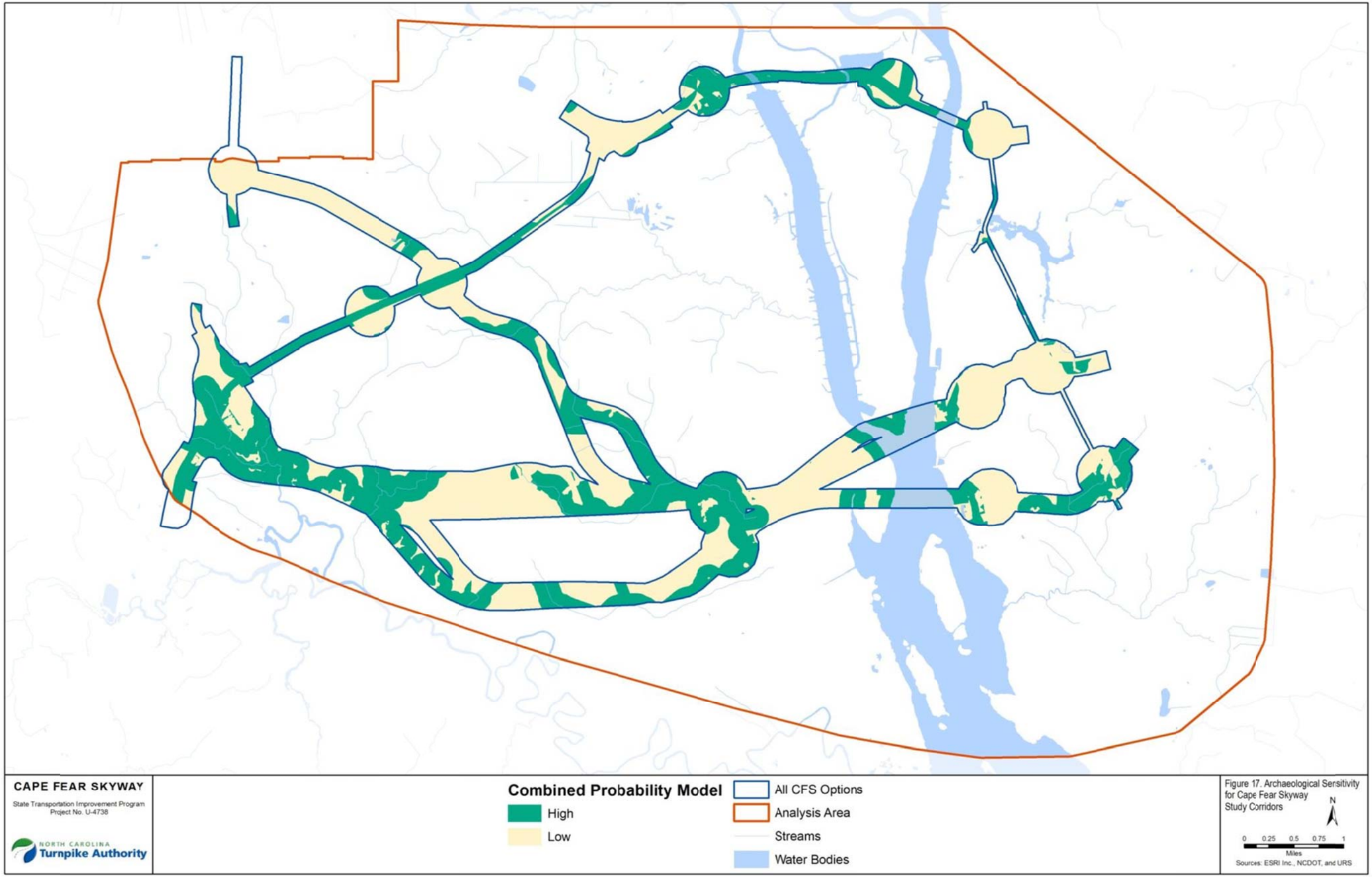

Figure 17. Archaeological Sensitivity for Cape Fear Skyway Study Corridors

5.0 CONCLUSIONS

Of the 24 conceptual designs, three contained over 60 percent high probability area (Q, K Avoidance, G), and two contained less than 40 percent high probability area (B, D). Of these, K Avoidance and G also exhibited comparatively larger amounts of high probability acreage, while D also exhibited comparatively low amounts of high probability acreage.

Of the 24 study corridors, none exhibited over 60 percent high probability area; however, nine did contain between 50 and 60 percent high probability area (K Avoidance, M Avoidance, G, Q, F, P, K, I, and S). Conversely, study corridor D exhibits less than 30 percent high probability area. Of these, K, K Avoidance, and M Avoidance also exhibit comparatively larger amounts of high probability acreage, while study corridor D also exhibits comparatively low amounts of high probability acreage.

A letter from the NC HPO, dated December 8, 2011, states concurrence with this report and is appended to the document.

6.0 REFERENCES

Barse, W.P.
1997 *Addendum: Phase I Archaeological Survey, Wilmington Bypass, Center Alternative, New Hanover County, North Carolina, TIP No. R-2633-C*. URS Greiner, Raleigh. Prepared for North Carolina Department of Transportation, Raleigh.

Barse, W.P., J. Marston, and M.A. Brown
2001 *Phase III Archaeological Investigations at Site 31NH707 for the Center Alternative of the Proposed Wilmington Bypass, New Hanover County, North Carolina*. URS Corporation, Florence, New Jersey. Prepared for North Carolina Department of Transportation, Raleigh.

Brooks, M.J., B.E. Taylor, and A.H. Ivester
2010 Carolina Bays: Time Capsules of Culture and Climate Change. *Southeastern Archaeology* 29(1):146-163.

Green, W., J.D. Moser, H. Jones, and R. Roden
2007 *Phase I and II Archaeological Investigations of the NNP IV Cape Fear Tract, New Hanover County, North Carolina*. S&ME, Inc., Columbia, South Carolina. Prepared for Newland Communities, Columbia, South Carolina.

Hay, C.A., C.E. Bollinger, A.N. Snavely, T.E. Scheitlin, and T.O. Maher
1982 *Archaeological Predictive Models, A New Hanover County Test Case*. North Carolina Archaeological Council Publication Number 18, Raleigh, North Carolina.

Jorgenson, M.
2010 *Woodland Period Ceramics and Architecture in the Southern Coastal Plain of North Carolina: A View from Site 31NH707 (Addendum to: Phase III Archaeological Investigations at Site 31NH707 for the Center Alternative of the Proposed Wilmington Bypass, New Hanover County, North Carolina, STIP R-2633C)*. URS Corporation, Morrisville, North Carolina. Prepared for North Carolina Department of Transportation, Raleigh.

Jorgenson, M., D.F. Cassedy, and M.A. Brown
2003 *Archaeological Survey and Evaluation for the Western Portion of the Wilmington Bypass, New Hanover and Brunswick Counties, North Carolina, TIP R-2633-A/B*. URS Corporation, Morrisville, North Carolina. Prepared for North Carolina Department of Transportation, Raleigh.

Klein, T.H., M.A. Brown, S.S. Pickens, and J.M. Herbert
1996 *Archaeological Background Report, Wilmington Bypass, New Hanover and Brunswick Counties, North Carolina*. Greiner, Inc., Raleigh. Prepared for North Carolina Department of Transportation, Raleigh.

Klein, T.H., J.M. Herbert, and S.S. Pickens
1994 *Phase I Archaeological Survey, Wilmington Bypass, New Hanover and Brunswick Counties, State Project No. 8.U250901, RIP No. R-2633*. Greiner, Inc., Raleigh. Prepared for North Carolina Department of Transportation, Raleigh.

Madry, S., M. Cole, K. Kvamme, S. Seibel, S. Gould, and J. Broush
2006 *North Carolina Archaeological Predictive Modeling Project: Results of Task 2; Cabarrus, Chatham, Forsyth, Granville, Guilford, Randolph, and Wake Counties*. Environmental Services, Inc. Raleigh. Prepared for North Carolina Department of Transportation, Raleigh.

Minnesota Department of Transportation (Mn/DOT)
2005 *Mn/Model Statewide Archaeological Predictive Model*. Minnesota Department of Transportation, St. Paul. Electronic document available at http://www.mnmodel.dot.state.mn.us/index.html, first accessed 14 February 2011.

Moore, C.R., M.J. Brooks, A.H. Ivester, and T.A. Ferguson
2010 Geoarchaeological and Paleoenvironmental Research, 2010. In *Annual Review of Cultural Resource Investigations by the Savannah River Archaeological Research Program: Fiscal Year 2010*, prepared by the staff of the Savannah River Archaeological Research Program, pp. 57-85. Electronic resource available at www.sarp.org/anrpt/fy10.pdf, first accessed 28 February 2011.

Novick, L.
1997 *Archaeological and Historical Background Report: Improvements to NC 311 from High Point East Belt to US 220 (R-2606) Study Area, Randolph County, North Carolina*. North Carolina Department of Transportation, Raleigh.

Phelps, D.S.
1989 *Ancient Pots and Dugout Canoes: Indian Life as Revealed by Archaeology at Lake Phelps*. Department of Anthropology, East Carolina University, Greenville, North Carolina.

Pittman, R.H., and W.D. Lipe
1972 A Prehistoric Dugout Canoe from Southeastern North Carolina. *Florida Anthropologist* 25(1):42-44.

Scheitlin, T.E.
1978 Developing Predictive Models. In *A Report on the New Hanover County Archaeological Survey, a CETA Project*, edited by Mark Wilde-Ramsing, pp. 114-121. Manuscript on file, North Carolina Office of State Archaeology, Raleigh.

Seibel, S., K. Anderson, M. Postlewaite, and T. Russ
2006 *Intensive Archaeological Survey and Evaluation of Asheboro Southern Bypass, Randolph County, North Carolina*. Environmental Services, Inc., Raleigh. Prepared for North Carolina Department of Transportation, Raleigh.

URS Corporation (URS)
2009 *Terrestrial Cultural Resources Background Report, Cape Fear Skyway, New Hanover and Brunswick Counties, STIP No. U-4738*. URS Corporation, Morrisville, North Carolina. Prepared for North Carolina Turnpike Authority, Raleigh.

2010 *Final Draft Purpose and Need Statement, Cape Fear Skyway, New Hanover and Brunswick Counties, STIP No. U-4738*. URS Corporation, Morrisville, North Carolina. Prepared for North Carolina Turnpike Authority, Raleigh.

United States Department of Agriculture-National Soil Conservation Service (USDA-NRCS)

2011 Soil drainage data. Electronic resource available at http://soildatamart.nrcs.usda.gov/ first accessed February 15, 2011.

Wilde-Ramsing, M.

1978 *A Report on the New Hanover County Archaeological Survey, A C.E.T.A. Project*. Manuscript on file, North Carolina Office of State Archaeology, Raleigh.

1980 *Prehistoric Site Distributions and Environmental Zones in New Hanover County*. Department of Anthropology, Catholic University, Washington, D.C. Manuscript on file, North Carolina Office of State Archaeology, Raleigh.

1981a *Prehistoric Utilization of the Big Bend Region, New Hanover County, North Carolina*, 1981a. Department of Anthropology, Catholic University, Washington, D.C. Manuscript on file, North Carolina Office of State Archaeology, Raleigh.

1981b *A Study of New Hanover County Soils and Associated Prehistoric Remains*, 1981b. Department of Anthropology, Catholic University, Washington, D.C. Manuscript on file, North Carolina Office of State Archaeology, Raleigh.

LETTER FROM STATE HISTORIC PRESERVATION OFFICE

DECEMBER 8, 2011

North Carolina Department of Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

December 8, 2011

MEMORANDUM

TO: Matt Wilkerson
Office of Human Environment
NCDOT Division of Highways

FROM: Ramona M. Bartos RSL for Ramona M. Bartos

SUBJECT: Draft: Terrestrial Archaeological Resources Predictive Model, Cape Fear Skyway, U-4738, New Hanover and Brunswick Counties, CH 05-2935

Thank you for the opportunity to review the above referenced report. It is well written and does a good job of describing the rational behind using a descriptive approach to the predictive model formation. The variables seem adequately inclusive and well tailored to the specific environs utilized by previous inhabitants of the lower Cape Fear River drainage.

As the report indicates, this model is not meant to replace the good judgment of the archaeologist on the ground, but will potentially provide planners a better idea of the obstacles likely to be encountered during the permitting and compliance process. We look forward to the validity of the predictive model being tested during the archaeological survey of the chosen corridor.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment please contact Renee Gledhill-Earley, environmental review coordinator, at 919/807-6579. In all future communication concerning this project, please cite the above referenced tracking number.