



NC 12 FEASIBILITY STUDY

HATTERAS VILLAGE

DARE COUNTY, NORTH CAROLINA

STATE TRANSPORTATION IMPROVEMENT PROGRAM PROJECT

No. R-3116B



PREPARED FOR:

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
PROJECT DEVELOPMENT AND ENVIRONMENTAL ANALYSIS
UNIT

PREPARED BY:

URS CORPORATION—NORTH CAROLINA

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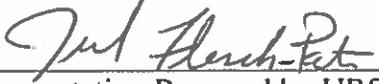
FEASIBILITY STUDY

NC 12 Improvements Hatteras Village Dare County, North Carolina

Division 1
WBS Number 34525.1.5



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List of Acronyms and Abbreviations

AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
AEC	area of environmental concern
CAMA	Coastal Area Management Act
CSE	Coastal Science and Engineering
EFH	essential fish habitat
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FSC	Federal Species of Concern
GIS	geographic information system
HPO	[North Carolina State] Historic Preservation Office
HQW	High Quality Water
LUP	Land Use Plan
mph	miles per hour
NC	North Carolina
NC-CREWS	North Carolina Coastal Region Evaluation of Wetland Significance
NCCRC	North Carolina Coastal Resources Commission
NCDCM	North Carolina Division of Coastal Management
NCDEQ	North Carolina Department of Environmental Quality
NCDOT	North Carolina Department of Transportation
NCDWR	North Carolina Division of Water Resources
NCGS	North Carolina Geological Survey
NCNHP	North Carolina Natural Heritage Program
NCWRC	North Carolina Wildlife Resources Commission
NEPA	National Environmental Policy Act
NHPNA	Natural Heritage Program Natural Area



NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWI	National Wetlands Inventory
ORW	outstanding resource water
PNA	primary nursery area
ROW	right-of-way
SAV	submerged aquatic vegetation
SC	special concern
Seashore	Cape Hatteras National Seashore
SR	secondary road
STI	Strategic Transportation Investments
STIP	State Transportation Improvement Program
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service



1. Project Description

1.1 Purpose of Study

This feasibility study is a preliminary step to the National Environmental Policy Act (NEPA) process to identify potential project scope, a range of estimated costs of completion, and project-specific concerns related to preserving the North Carolina (NC) 12 corridor between Hatteras Village and the unincorporated limits of Frisco, North Carolina (the project) (Figure 1). This is not a funded project. This feasibility study provides information on various possible options to improve the stability of the NC 12 corridor over both a short-term (5-year) and long-term (50-year) timeframe. The short-term solutions will provide the North Carolina Department of Transportation (NCDOT) with potential options for maintaining or restoring the integrity of NC 12 with minimal interruption of traffic should a storm event or coastal processes compromise roadway access. The analysis of long-term solutions considers the costs of different alternatives so that the project can potentially be added to a list of funded projects within NCDOT’s State Transportation Improvement Program (STIP). In some instances the project is referred to as the R-3116B Hot Spot project in this report.

Figure 1: View of a portion of the project study area (Source: URS)



1.2 Funding

As part of implementing the new Strategic Transportation Investments (STI) Law, NCDOT released its 10-year STIP in June 2015, which scheduled the statewide projects proposed for full or partial funding between 2016 and 2025 (NCDOT 2015a). The purpose of the STI Law is to allow NCDOT to maximize North Carolina’s existing transportation funding to enhance the state’s infrastructure and support economic growth, job creation, and high quality of life.

STI established the Strategic Mobility Formula, a new way of allocating available revenues based on data-driven scoring and local input. Proposed transportation projects go through a prioritization process during which they are evaluated through an analysis of the existing and future conditions, the benefits the project is expected to provide, the project’s multi-modal characteristics, and how the project fits in with local priorities. Generally, the projects that increase capacity, safety, connectivity, and economic development score higher under the prioritization formula. The NC 12 R-3116B Hot Spot project was not included in the latest Prioritization 3.0 (P3.0) process, which closed on August 29, 2014. The project is



anticipated to be included for evaluation and prioritization in the Prioritization 4.0 (P4.0) process. New candidate projects for P4.0 will be submitted in fall of 2015.

Depending upon the results of the P4.0 process, it is not certain that the proposed project will be included in the next STIP document.

1.3 Project Study Area

The project is located within Dare County on Hatteras Island, a barrier island on the Outer Banks of North Carolina. The project limits begin near Elizabeth Avenue in Hatteras Village and extend north 1.7 miles into Frisco near Marlin Drive. The Cape Hatteras National Seashore (Seashore) adjoins Hatteras and Frisco. This seashore, administered by the National Park Service (NPS), makes up all lands within the project limits except those that are privately owned in Hatteras Village and Frisco. The topography in the study area is characterized by ocean and beaches, wetlands, overwash areas, and man-made dunes between NC 12 and the Atlantic Ocean (ocean).

The project study area extends beyond the identified project limits to allow consideration of a full range of transportation options, including a bridge option. Figure 2 shows the project study area and the project termini.

Figure 2: Vicinity map





1.4 Roadway Characteristics

NC 12 is functionally classified as a major collector route and is part of the National Highway System. NC 12 carries both local and regional traffic and provides the only roadway access to Hatteras Island. The typical section of the roadway consists of a two-lane road with 11-foot wide lanes plus 4-foot shoulders allowing for bicycle and pedestrian accessibility. Sand dunes of variable width and height are located adjacent to the roadway. This typical section is consistent with other portions of NC 12 on Hatteras Island. The posted speed limit is 55 miles per hour (mph) within the Seashore, and between 35 and 45 mph in Hatteras and Frisco.



2. Need for Improvements

2.1 Background

NC 12 provides the primary transportation link in to and out of Hatteras Village and provides access for residents, visitors, businesses, services, and tourist attractions (Figure 3).

Island residents depend on NC 12 for mainland community services, such as hospitals, emergency response, and waste collection. Local access to schools and other support service areas (e.g., retail stores, community centers, etc.) on Hatteras Island, but beyond the limits of Hatteras Village, is also provided by NC 12. The Buxton community, located several miles northeast of Hatteras Village, houses two schools where the children of Hatteras Village attend; Cape Hatteras Elementary School and Cape Hatteras Secondary School. The only vehicular access to those schools is provided by NC 12. Further, NC 12 provides the only vehicular access to the Seashore for recreational use.



Figure 3: Beaches served by NC 12 in the project study area (Source: URS)

Tourism is the number one industry in Dare County, and it plays an important role in the economic vitality of Hatteras Village. NC 12 is a critical transportation component providing tourist access to Hatteras Island and the Seashore. It facilitates the transport of goods and services to and from the island. According to the *Hatteras Island Economic Impact* report (Lane 2013), Hatteras Village is one of the top three Hatteras Island communities in the number of businesses that support tourism. Consequently, most employment in the area is related to the tourism sector of the local economy.

The *Dare County Emergency Management Operation Plan* has designated NC 12 as the primary evacuation route for all permanent and temporary residents on Hatteras Island when severe weather is approaching (Dare County Government 2007).

Frequent maintenance and operational issues associated with NC 12 within the project limits are due primarily to sand deposits left behind in the aftermath of a hurricane or storm event, particularly 2,000 feet east of Austin Road, where the roadway was breached by Hurricane Isabel in 2003. The island is very narrow in this area, and the dunes are, in some cases, located less than 25 feet from the edge of pavement. Frequent sand deposits on the roadway require corrective action by NCDOT maintenance forces. Storm damage and overwash can completely disrupt vehicle use and at a minimum cause travel time delays.

Normal tidal patterns are slowly eroding the beach on both the Atlantic Ocean and the Sound sides of the project. The sand dunes, which function as a protective barrier for NC 12, have also eroded substantially through time.



2.2 Purpose of Potential Project

The purpose of this project is to provide stability to the transportation corridor between Hatteras Village and Frisco. The project would provide a corridor less vulnerable to overwash and flooding events as well as natural coastal processes. The expected overwash from hurricanes or other storm events threatens the structural integrity of NC 12 and its protective dune barriers in the short-term. Over the long-term, this continued vulnerability coupled with the naturally occurring erosion of shorelines on both the Atlantic Ocean and sound sides of NC 12 threaten the reliability and stability of the roadway. This study examines potential actions to provide increased stability to NC 12 in both the short-term (5 years) and long-term (50 years) time horizons.



3. Design Options

Eight alternatives (four short-term and four long-term alternatives) have been evaluated for this feasibility study. Human and natural environment issues as well as construction costs were evaluated for each of these alternatives.

3.1 Design Criteria

Due to the fact that the land available in which to improve NC 12 is constrained between the Sound and the ocean, the development of study alternatives required consideration of road relocation and bridging scenarios along with beach nourishment and dune replenishment options.

3.1.1 Coastal Conditions and Non-Highway Criteria

Shoreline Forecasts

The estimated shoreline change rate (with a 95 percent confidence interval) due to erosion varies on average from about 5 feet per year to less than 1 foot per year in the project study area. Due to the receding nature of the ocean shoreline, future shoreline limits for the short-term (5 year) and long term (50 year) alternatives were established using historical shoreline position data over a 45 year timespan. Future shoreline limits for each design alternative include the modeled average shoreline position and a more conservative upper bound position that incorporated a 95% confidence level. This upper bound shoreline model, which has been referred to as the high erosion shoreline in other NCDOT NC 12 studies, indicates that there is a 95 percent chance that the shoreline position will be located ocean ward of that position in the specified year. The high erosion shoreline position has been used for planning purposes on other NC 12 transportation projects on Hatteras Island (B-2500, B-2500 A, and B-2500 B). For this feasibility study, the average shoreline position was used for the development of the short-term alternatives, while the high erosion shoreline was used for the long-term alternatives. Use of the high erosion shoreline for long-term solutions allows for the alternatives to be designed to account for erosion as well as dynamic changes in the shoreline due to storm events while minimizing private property or easement impacts.

The forecast shoreline determined the location of the alternative centerlines. NCDOT has utilized a vulnerability criterion of a minimum 230 foot buffer from mean high water (existing shorelines) to the seaward edge of pavement for NC 12 projects; the 230 foot distance was determined through an empirical analysis of roadway maintenance data.

The buffer distance criteria were applied to each alternative. In addition, bridges were developed to span areas where the forecast shoreline was less than 230 feet away from the current edge of roadway pavement.

Dune Construction

Each alternative design includes a dune structure between the roadway and the ocean shoreline except for bridged areas. In some cases, dunes currently located along the existing roadway may require relocation or structural fortification to provide adequate protection for portions of NC 12 in the project study area.



NCDOT recommends placing dunes approximately 25 feet from the edge of NC 12 pavement, with potential variations from this distance in some locations. The proposed dune geometry is recommended to include 3:1 slopes adjacent to NC 12, a 15-foot top width, and 5:1 slopes facing the beach, varying in some locations due to elevation changes. A continuous dune structure in areas void of other barriers will provide some protection to NC 12 during storm events.

As the beach erodes due to long-term erosion, the shoreline moves closer to the dune and the dune is more vulnerable to wave action. NCDOT will maintain existing dunes where possible as opposed to building new dunes. The alternatives developed for this project consider the magnitude of the dune field as documented by NCDOT in 2009. Data documented in 2009 was the most recent information available at the time of this study. The need to reconstruct the dune with the landward relocation of the highway and to maintain the dune in place in combination with beach nourishment was also considered. It is reasonable to expect that the dunes will need to be maintained every ten years.

The build-alternative dune geometry is provided for evaluation of alternatives, but may change in the design process. The dune geometry will be determined by actual elevations and shoreline modeling information, based on further project development (Table 1).

Table 1: Build alternative dune geometry

Category	Measurement
Dune offset from edge of pavement	25 feet
Dune height above centerline of road ^a	10 feet
Dune slope on landward side	3:1
Dune width at crest	15 feet
Dune slope on seaward	5:1

^a This is an estimate. The actual dune height will depend on surrounding elevation.

The dunes included as part of the alternative designs represent the proposed final dune location. Dunes that exist would not be removed or restored. As erosion gradually eliminates existing dune structures, new structures would be constructed until the final dune location is achieved.

Beach Nourishment

Beach nourishment involves the placement of a large quantity of beach compatible sand along the shoreline for purposes of elevating the dry beach and advancing the shoreline toward the ocean (i.e., widening the beach), and replenishing the volume of sand lost over some period of time. Over the project’s design life, any beach nourishment component of a design option would be expected to meet the objectives of increasing the storm protection function of the beach.

3.1.2 Highway Design Criteria

Based on existing conditions, NCDOT determined the design speed for the proposed project to be 60 mph. The existing right-of-way width is 100 feet, which will be the design right-of-way in this project. The project-specific design criteria used in developing the alternatives are based on American Association of State Highway and Transportation Officials standards and the *North Carolina Roadway Design Manual* (NCDOT 2014) (Table 2).



Table 2: Build alternative roadway relocation design criteria

Functional Classification	Collector
Terrain	Level
Design speed	60 mph
Posted speed	55 mph
Right-of-way width	100 feet
Shoulder width	8 feet
Lane width	11 feet

3.2 Short-Term Design Options

The short-term design options are designed for the 5-year project life, based on the 5-year average shoreline model unless otherwise noted. These options are designed to be implemented as expeditiously as possible in the event that NC 12 is damaged and before a long-term design option is constructed.

3.2.1 Short-Term Alternative 1: Road Relocation A

Alternative 1 proposed roadway improvements would begin at the western project terminus near Elizabeth Avenue and extend east for 1.5 miles on new alignment, tying into the existing NC 12 roadway approximately three-quarters of a mile south of Osprey Way (Figure 4). This alternative would shift the roadway approximately 100 to 120 feet north of the existing roadway. The majority of new right-of-way for this alternative would be on property managed by the NPS. This alternative would also include new dune construction approximately 25 feet from the new edge of pavement on the ocean side for approximately 7,500 feet as described in Section 3.1.



Figure 4: Short-Term Alternative 1: Road Relocation A





3.2.2 Short-Term Alternative 2: Road Relocation B

Alternative 2 proposed improvements would begin at the western project terminus near Elizabeth Avenue and extend east for 1.8 miles on new alignment, tying into the existing NC 12 roadway approximately three-quarters of a mile south of Osprey Way (Figure 5). This alternative utilized the 95% confidence level which would require the shifting of the roadway approximately 200 feet north of the existing roadway for over 0.5 mile, then extend onto a 2,900-foot bridge structure, returning to over 0.5 mile of roadway before connecting with the existing NC 12 alignment. The bridge would be pre-cast cored concrete slab. The majority of new right-of-way for this alternative would be on property managed by the NPS. This alternative would also include construction of a new dune for approximately 2,700 feet to the specifications described in Section 3.1.



Figure 5: Short-Term Alternative 2: Road Relocation B





3.2.3 Short-Term Alternative 3: Beach Nourishment

This alternative would leave the existing roadway in current location, and implement a beach nourishment program to protect the roadway. Alternative 3 proposed improvements would begin at the western project terminus near Elizabeth Avenue and extend east for 1.5 miles on the existing alignment (Figure 6). The beach nourishment would be provided to create a 230 foot minimum distance between the roadway and mean high water level. This alternative would include dune maintenance (rather than new dune creation) for approximately 7,500 feet. One cycle of beach nourishment and dune maintenance is assumed for this alternative.



Figure 6: Short-Term Alternative 3: Beach Nourishment





3.2.4 Short-Term Alternative 4: Combination of Road Relocation and Beach Nourishment

Alternative 4 proposed improvements would begin at the western project terminus near Elizabeth Avenue with 3,000 feet of beach nourishment, 1,700 feet of which would be located in front of relocated roadway (Figure 7). Approximately 1.3 miles of roadway would be relocated on new alignment. The new alignment would tie into the existing NC 12 roadway approximately three-quarters of a mile south of Osprey Way. The majority of new right-of-way for this alternative would be on property managed by the NPS. This alternative would also include a combination of new dune construction for approximately 4,000 feet and maintenance of the existing dune system for approximately 3,000 feet.



Figure 7: Short-Term Alternative 4: Combination of Road Relocation and Beach Nourishment

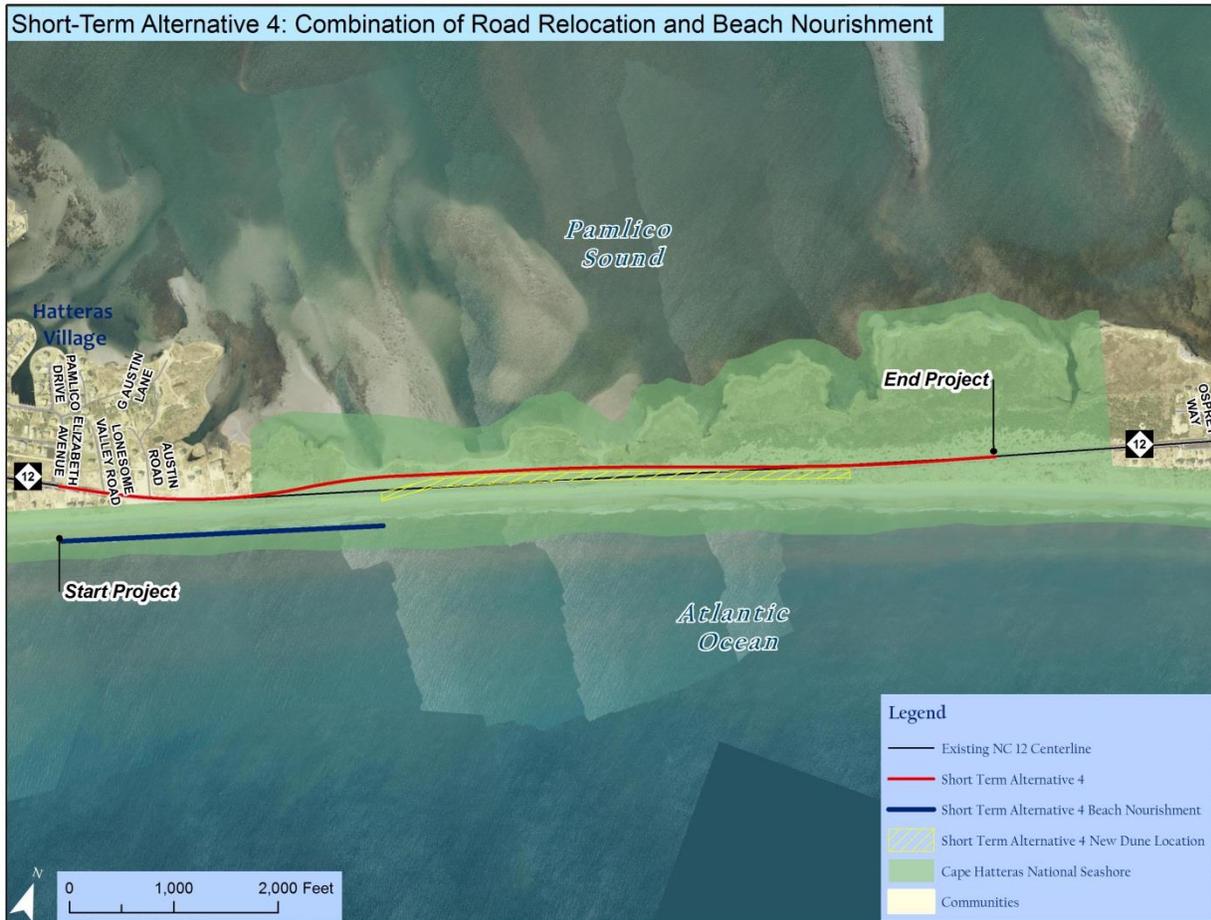


Table 3 provides the anticipated volume of sand required for dune maintenance and construction by short-term alternative.

Table 3: Dune volume requirement for short-term alternatives

Short-Term Alternative	Description of Dune Construction and Maintenance Type	Dune Volume (cubic yards) at Time of Project Construction
Alternative 1: Road Relocation A	Construction	139,722
Alternative 2: Road Relocation B	Construction	161,430
Alternative 3: Beach Nourishment	Maintenance	139,722
Alternative 4: Combination of Road Relocation and Beach Nourishment	Construction and Maintenance	104,148

Source: Overton 2015.



3.3 Long-Term Design Options

The long-term design options are designed for a 50-year project life, based on the 2063 forecast shoreline position. Unless otherwise noted, the high erosion shoreline was used in the development of the alternatives.

3.3.1 Long-Term Alternative 1: Road Relocation with Bridge

The Long-term Alternative 1 proposed improvements used the average shoreline forecast for planning and design purposes and would begin at the western project terminus near Elizabeth Avenue and extend east for over 0.5 mile on new alignment (Figure 8). The reason for using the average shoreline in lieu of the high erosion shoreline was to minimize impacts to privately owned property. The roadway would then extend onto a three-quarter mile pre-stressed concrete bridge. One-half mile of relocated roadway would connect the bridge to the existing roadway approximately 700 feet west of the Frisco Bathhouse parking area. Where there is no bridge structure, this alternative would also include approximately 5,000 feet of new dune construction.



Figure 8: Long-term Alternative 1: Road Relocation with Bridge





3.3.2 Long-term Alternative 2: Road Relocation with Bridge

Long-term Alternative 2 proposed improvements used the high erosion shoreline and would begin at the western project terminus near Elizabeth Avenue and extend east for 0.5 mile on new alignment tying into a 1-mile pre-stressed concrete bridge approximately 450 feet north of the existing roadway (Figure 9). Three-quarters of a mile of roadway on new alignment would tie the bridge into the existing roadway near the Creed Hill Lifesaving Station. The majority of new right-of-way for this alternative would be on property managed by the NPS. Where there is no bridge structure, this alternative would also include approximately 4,000 feet of new dune construction.

Figure 9: Long-term Alternative 2: Road Relocation with Bridge





3.3.3 Long-term Alternative 3: Existing Alignment with Beach Nourishment

Alternative 3 proposed improvements include beach nourishment that would begin at the western project terminus near Elizabeth Avenue and extend over 1.5 miles east (Figure 10). The beach improvements would tie into the existing shoreline approximately 700 feet west of the Frisco Bathhouse parking area. No additional easement from the NPS would be necessary for this alternative, as the NC 12 roadway would remain in its current location. Although no right of way or permanent easement would be needed, beach nourishment would occur over multiple cycles in the near-shore, which is administered by the National Park Service. The beach nourishment would be constructed as described in Section 3.1. This alternative would also include dune maintenance for approximately 8,500 feet in accordance with the stated design objectives in Section 3.1. Beach nourishment and dune maintenance are expected to occur at five-year intervals; however, the actual intervals will be greatly influenced by extreme weather events.

Figure 10: Long-term Alternative 3: Existing Alignment with Beach Nourishment





3.3.4 Long-term Alternative 4: Bridge In Existing Easement and Beach Nourishment

This alternative combines a bridge within the existing NC 12 easement and beach nourishment (Figure 11). Alternative 4 proposed improvements would begin at the western project terminus near Elizabeth Avenue and extend 1,800 feet on new alignment with beach nourishment before tying into a 1.5 mile pre-stressed concrete bridge located next to the existing roadway within the NPS right-of-way. The bridge would tie into 1,150 feet of roadway connecting to existing NC 12 just east of the Creed's Hill Lifesaving Station. This alignment would require minimal new right-of-way from private property owners at the eastern and western termini of the project. This alternative would also include dune maintenance for approximately 2,200 feet.

The proposed nourishment is suggested to protect the western approach to the bridge, since the high erosion shoreline in fifty years is projected to be landward of the existing NC 12 right-of-way and within the marsh on the estuarine side. Given the likelihood that an inlet would form under these conditions, it should be acknowledged that nourishment is not recommended adjacent to an inlet unless there is a structure in place to stabilize the inlet shoulder. However, if nourishment is placed as designed every five years in this location, it is likely to spread laterally along the shoreline and mitigate the impact of erosion both west and east of the designed location. This may prevent the inlet throat from locating next to the bridge approach on the western extent of the project area if long-term erosion is the mechanism for inlet opening and may reduce the need for a structure during the design period.



Figure 11: Long-term Alternative 4: Bridge in Existing Easement and Beach Nourishment





Table 4 provides the anticipated volume of sand required for dune maintenance and construction by long-term alternatives.

Table 4: Dune volume requirement for long-term alternatives

Long-Term Alternative	Description of Dune Maintenance Type	Dune Volume (cubic yards) at Time of Project Construction
Alternative 1: Road Relocation With Bridge (average erosion shoreline)	Construction	65,093
Alternative 2: Road Relocation With Bridge (high erosion shoreline)	Construction	78,111
Alternative 3: Existing Alignment with Beach Nourishment	Maintenance	158,352
Alternative 4: Bridge in Existing Easement and Beach Nourishment	Maintenance	40,985

Source: Overton 2015.

Four of the proposed alternatives in the R-3116B study area (two short-term alternatives and two long-term alternatives) utilize beach nourishment. The alternatives are described in Table 5 below. It is noteworthy that the alongshore length of necessary dune is anticipated to be shorter in the long term than the short term.

Table 5: R-3116B study area design alternatives using beach nourishment

	Alternative	Description
Short-Term Design (5 years)	Alternative 3: Beach Nourishment	Beach nourishment only
	Alternative 4: Combination of Road relocation and Beach Nourishment	Road relocation and beach nourishment
Long-Term Design (50 years)	Alternative 3: Existing Alignment with Beach Nourishment	Beach Nourishment only
	Alternative 4: Bridge in Existing Easement and Beach Nourishment	Road relocation with bridge and beach nourishment

Source: Overton 2015.

The length and location of the beach nourishment for short-term Alternatives 3 and 4 and long-term Alternatives 3 and 4 is also dependent on shoreline position and change.

The volume of sand estimated for the nourishment options consists of two parts. The first is to determine if there is an existing deficit in sand volume relative to the 230 foot highway vulnerability criteria, and the second is to determine the amount of fill needed to maintain a minimum of 230 feet between the edge of pavement and the active shoreline for the length of time of the project. The volume of sand required is a function of the height of the berm, the length and width of beach required to meet the design needs, and the depth of closure which is defined as the most landward depth at



which there is no notable change in bottom elevation and no notable sediment transport. Within the project study area, the height of the berm is measured at 6 feet, and the depth of closure is 24 feet. The length of the beach nourishment project is determined from an analysis of shoreline position and shoreline change rate is used to compute volumes. In addition, the volume needed in the last 500 foot section of the shoreline is doubled to allow for a transition length of 1,000 feet on both ends of the project.

The nourishment placement cycle is assumed to be five years. For the short term design there is one placement with a volume required to offset both the deficit volume and the five year erosion volume. For the long term design, the deficit volume is added to the first five year cycle, but is not included in the subsequent nine placements.

The volume of sand required for the four proposed alternatives requiring nourishment is presented in Table 6. The volumes provided below do not include additional sand volumes needed for the construction of proposed dunes. That information is provided in Table 3 and Table 4.

Table 6: Nourishment sand volume requirements

Project Design Period	Project Alternative	Project Distance (miles)	Deficit (cubic yards)	Expected Eroded Volume (cubic yards)	20% Assumed Losses (cubic yards)	Total Volume Required (cubic yards)
Short Term (5 years)	Existing Alignment	1.4	360,566	260,062	124,124	744,741
	Road Relocation	0.6	91,461	140,506	46,393	278,360
Long Term (50 years)	Existing Alignment (Total)	1.6	361,000	2,758,641	623,839	3,743,036
	Road Relocation with Bridge (Total)	0.4	93,178	1,086,768	235,989	1,415,935

Source: Overton 2015.



4. Constructability Issues

Coastal conditions in the project area present constructability issues that would vary in severity for each potential long-term and short-term alternative. Construction issues are generally attributed to the coastal conditions coupled with the loss of beach width.

The integrity of NC 12 and/or its protective dune barriers is threatened by the possibility of overwash resulting from hurricanes or other storm events in the short term. Over the long term, this continued vulnerability coupled with the naturally-occurring erosion of shorelines on both the Atlantic Ocean and Pamlico Sound sides of NC 12 also have the potential to threaten the reliability and stability of the roadway.

Alternatives that would require sand for beach nourishment or dune construction may face limitations of available fill sand that is suitable for both existing wildlife habitat and project construction. The grain size and geologic characteristics should be similar to the native beach sand. Sand within the project study area serves as habitat for federally-protected sea turtles and birds, as well as other wildlife species (NPS 2013a). It is possible that suitable fill sands could be transported from the mainland or offshore locations, but that would substantially add to the cost of project construction. A report prepared for the Outer Banks Task Force and NCDOT by the North Carolina Geological Survey (NCGS 2009) identified two sites suitable for nourishment that are located offshore just south of the project limits in the ocean. The identified sites have the potential to yield cumulatively more than 120 million cubic yards of sand, although further testing is needed to definitively identify the amount and suitability of sand at those sites and the potential effect of sand extraction.

Alternatives requiring beach nourishment sand should consider the sand source and sediment size as further design is pursued. The sediment size needs to approximate the native beach sediment size. If sand size differs, then the projected cost of the alternative could vary. Environmental considerations also encourage sediment characteristics of nourishment sand to be closely approximated to the native beach. In addition, the losses in the alongshore direction due to shoreline reconfiguration of the nourished beach relative to the adjacent beach can be notable and should be considered in the final design.

Two primary cost components of nourishment projects are mobilization/demobilization costs and pumping costs. Since pumping costs are a function of volume required, the re-nourishment interval should be evaluated through time to ensure the most economical intervals that still achieve protection of NC 12. Locations with low erosion rates (and thus lower expected eroded volumes for the same period of time) are candidates for long replacement cycles, which can lower project cost.

Since nourishment volume estimates are based on long-term erosion, any individual sequence of storms can impact the apparent success of the project. Storm events may erode the beach and the dune face, depositing sand in the nearshore. The sand in the nearshore may take several seasons to be transported back to the beach and affect beach width. Dunes provide additional protection during storm events and can be a source of sediment feeding either the beach or the landward extent of the barrier island as dune erosion occurs. Maintenance of the dune field can be effective in managing the impact of storm events and should be repaired to design standards post storm. Further, dunes can be a factor in preventing island breaching due to soundside storm surges by acting as a barrier to cross-island flow.



The application of geotextile containers for the purpose of beach stabilization was not considered as part of this feasibility study. However, they could be considered in future studies of temporary shoreline protection measures. The use of geotextile containers for shoreline protection is regulated by the North Carolina Administrative Code on Ocean Hazards. The Code prohibits construction of breakwaters on the oceanfront but allows the use of sandbags or soft structures in temporary installations with restrictions; therefore, under the Code as it is currently written, the use of geotextile containers would likely be restricted to use as a dune core when reconstructing a dune field or other temporary installation landward of the high water line. In addition, the stability of geotextile container installations during storm events remains a concern, due to the potential failure of these installations from scour, rotation, or displacement that has been documented following storms. The potential failure of these installations would need to be addressed in order to consider them a viable temporary protection measure.

Each build alternative has the potential to encroach upon jurisdictional wetlands. Special care will be taken during planning and design to avoid or minimize impacts to wetlands. If impacts to wetlands are unavoidable, mitigation opportunities will be coordinated with the United States Army Corps of Engineers (USACE) and NPS. It is noteworthy that in the context of other NCDOT projects NPS has stated during project coordination activities that any wetland mitigation needed as a result of a transportation project impacting NPS lands must be within the Seashore.

Construction-related activities would be coordinated with the United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) Fisheries, and the NPS to minimize potential harm to protected sea turtles, plants, fish and bird species. Due to the potential to disturb sensitive wildlife nesting, spawning and hatching habitat, NPS has requested consideration of a seasonal construction moratorium for construction-related activities.

Construction of the proposed project could involve the use of temporary cored slab bridge structures for the 5-year options. Cored slab bridges can be constructed in a much shorter time span compared to a more permanent structure, but are intended to sustain use for a much shorter span of time than what would be expected from a permanent structure. Additionally, cored slab bridges would be constructed at lower elevations than permanent bridging structures; therefore, smaller storm events may damage these structures. Maintenance needs would be expected to be greater for a cored slab bridge, although the use of cored slab bridge pieces may alleviate much of the expected additional maintenance due to the ease of simply replacing damaged slab with new slab pieces.

Construction staging could be a concern considering the limited area available for such use regardless of which build alternative is carried forward in the project development process.

Due to the presence of Submerged Aquatic Vegetation (SAV) within the Sound, dredging to accommodate barges would likely require coordination with NOAA Fisheries, North Carolina Division of Coastal Management (NCCDM), and other resource agencies.

In recent years the NPS has directed the NCDOT to minimize noise and traffic impacts during peak tourist season. This directive could add considerable time to the project construction schedule. Additionally, construction-related activities such as pile jetting may be restricted to daylight hours in peak tourist season if located near designated camping or recreational areas.



5. Project Cost

5.1 Estimated Cost – Short and Long-Term Alternatives

Table 7 and **Table 8** provide estimates for the total construction costs (including maintenance cycles) for both the short-term and long-term alternatives, respectively. The cost of dune construction is not included in the estimated cost totals provided below in Tables 7 and 8. The cost of dune construction is not included in the estimated cost total provided in Tables 7 and 8 due to the dynamic effects that storm events have on the dune sand volumes at any given snapshot in time. Estimated dune volumes in Tables 3 and 4 are likely to be different by the time either a short-term or long-term option is developed and recommended for construction. Assessing the condition of the dunes closer to project construction is recommended and will add some cost to the estimates provided in Tables 7 and 8 for options that benefit from dune maintenance.

Table 7: Project costs for short-term alternatives

Alternative	Construction (millions of dollars)	Beach Nourishment (millions of dollars)	Total (millions of dollars)
Alternative 1: Road Relocation A	\$5.4	N/A	\$5.4
Alternative 2: Road Relocation B	\$35.1	N/A	\$35.1
Alternative 3: Beach Nourishment	N/A	\$12.3	\$12.3
Alternative 4: Combination of Road Relocation and Beach Nourishment	\$4.9	\$7.5	\$12.4

Source: NCDOT.2014c, Overton 2015.

Table 8: Project costs for long-term alternatives

Alternative	Construction (millions of dollars)	Beach Nourishment (millions of dollars)	Total (millions of dollars)
Alternative 1: Road Relocation With Bridge (average erosion shoreline)	\$45.8	N/A	\$45.8
Alternative 2: Road Relocation With Bridge (high erosion shoreline)	\$67.4	N/A	\$67.4
Alternative 3: Existing Alignment with Beach Nourishment	N/A	\$84.7	\$84.7
Alternative 4: Bridge in Existing Easement and Beach Nourishment	\$77.6	\$60.7	\$138.3

Source: NCDOT.2014c, Overton 2015.



5.2 Beach Nourishment Costs Breakout – Short and Long-Term Alternatives

The total cost of beach nourishment is a function of the following components:

- Mobilization and demobilization costs
- Sand pumping costs
- Administrative costs (design, surveys, engineering and construction)
- Regulatory permitting and state and federal environmental analysis
- Contingency costs

The approach taken to separate out the costs associated with beach nourishment is consistent with that provided to the Dare County Board of Commissioners by Coastal Science and Engineering (CSE 2013). The costs are based on the 2011 project at Nags Head, North Carolina. For long term Alternatives 3 and 4, costs are broken out by beach nourishment cycle increments (Table 9).

Table 9: R-3116B Estimated costs for nourishment

Activity	Short-Term Alternative 3 (millions of dollars)	Short-Term Alternative 4 (millions of dollars)	Long-Term Alternative 3 (millions of dollars)	Long-Term Alternative 4 (millions of dollars)
			(Cycles 1-10)	(Cycles 1-10)
1. Mob/Demob	\$4.0	\$4.0	\$40.0	\$40.0
2. Pumping	\$6.7	\$2.5	\$33.7	\$12.7
3. Administration	\$0.9	\$0.5	\$5.9	\$4.2
4. Reports & Permitting	\$0.2	\$0.1	\$1.5	\$1.1
5. Contingency	\$0.5	\$0.3	\$3.7	\$2.6
Total	\$12.3	\$7.5	\$84.7	\$60.7

Source: Overton 2015.



6. Traffic Forecast

A Traffic Forecast Report (URS 2014) was prepared for this feasibility study. This report used a base year of 2013 and a future year of 2040. The 2013 base year traffic forecast includes a No-Build Scenario for summer weekdays and summer weekends daily traffic with the existing Herbert C. Bonner Bridge in use. The base year does not include a Build Scenario. The 2040 future year traffic forecast includes a Build Scenario for summer weekdays and summer weekends daily traffic with a new Herbert C. Bonner Bridge in place. Since the new Herbert C. Bonner Bridge is expected to have the same number of lanes as the existing one, there was no change in roadway capacity and therefore no need to differentiate between Future Build and Future No-Build forecast scenarios.

The methodology for determining a reasonable growth rate to use for the purposes of this study involved the consideration of data from different sources to arrive at a reasonable growth rate for both population and traffic in Avon, Buxton, Frisco and Hatteras Village. Information from the NC Office of State Budget and Management, United States Census Bureau, the *2009 Dare County Land Use Plan Update* (Dare County 2012), and NCDOT's Ferry Division and Traffic Survey Group was collected and analyzed.

Building permits information from the *2009 Dare County Land Use Plan Update* was used to estimate a growth rate for the permanent residents on Hatteras Island. The study area was expanded to include the unincorporated areas of Rodanthe, Waves, and Salvo. Permanent population on the island was divided by residents who own and live in their homes and residents renting the homes they live in. This was done to account for the fact that the two groups revealed different occupancy rates. Another important factor in the calculations was the fact that only part of the homes on Hatteras Island are occupied year-round, and most homes are vacation or seasonal rental properties. This was later utilized to assign the proper number of occupants to the homes expected to be constructed in the future.

According to the *NC 12 Hatteras Village Hot Spot Improvements Traffic Forecast* (URS 2014), the Dare County planning department established that not all building permits were issued exclusively for new home construction. It was assumed that about a third of the permits will be used to renovate and expand existing properties.

Using the number of homes expected to be built in the future and available vacant acres, it was determined that land suitable for development will still be available even after year 2040. Thus, buildout will not occur until after the forecast future year. It was assumed that the current ratio of visitors per permanent residents of 6:1 taken from the *2009 Dare County Land Use Plan* will remain the same.

Based on the anticipated 2040 forecast traffic volume, a two-lane facility is still considered appropriate for this project. A more detailed traffic forecast will be needed if the project proceeds to the NEPA phase. The resulting traffic forecasts for 2013 are shown in Table 10.



Table 10: 2013 Base year no-build traffic forecast

Forecast Location	AADT Extrapolated to 2013	Base Year 2013 No-Build Forecast Volume	
		Summer Weekday	Summer Weekend
NC 12 south of SR 1246 (Austin Road)	3,700	5,900	8,500
NC 12 east of SR 1483 (Traacher Lane). <i>Outside of the project study area. Used for informational purposes.</i>	7,400	11,600	16,800

Data from the *Dare County Comprehensive Transportation Plan* (NCDOT 20115b), the North Carolina Office of State Budget and Management, and the United States Census Bureau were collected and analyzed to assist with the determination of the 1.15 percent traffic growth rate for the project. Correspondence with Dare County’s planning staff was also beneficial to confirm that the growth rate was reasonable and appropriate for the purposes of this study. To estimate traffic volumes for the base year it was assumed that the new Herbert C. Bonner Bridge would function at full capacity. The resulting 2040 forecast traffic volume is presented in Table 11.

Table 11: Future year 2040 forecast traffic volume

Forecast Location	AADT Extrapolated to 2013	Future Year 2040 Build Forecast Volume	
		Summer Weekday	Summer Weekend
NC 12 south of SR 1246 (Austin Road)	3,700	8,100	11,600
NC 12 east of SR 1483 (Traacher Lane). <i>Outside of the project study area. Used for informational purposes.</i>	7,400	15,800	22,900



7. Environmental Considerations

This section considers the general environmental characteristics of both the naturally occurring and constructed environments within the project study limits.

7.1 Cultural Environment

Historically, Hatteras Island communities, including Hatteras and Frisco, have relied on each other to maintain economic self-sufficiency and a distinctive way of life, which was deeply rooted in both maritime and agricultural cultures. These cohesive characteristics are still present today in the remnant dialect of many who are native to the Outer Banks, often referring to themselves as “bankers.”

The cultural landscape of Hatteras Island and its communities within began to change with the establishment of the Cape Hatteras National Seashore in the 1950s and the paving of NC 12 to better access the seashore communities. Improving access to Hatteras Island helped to establish these communities as destination points, which in turn influenced the emergence of the tourism sector and cleared the way for those desiring to retire to a coastal community or to purchase a vacation home.

Hatteras and Frisco maintain strong year-round residential communities, yet there is a distinct tourism season. During the summer season the population peaks due to an influx of tourists. During the winter season the population within both of these communities notably decreases.

Indicators of community cohesiveness among permanent residents in the project study area include the use of local place or family names for streets, places of worship, and fishing and beach areas. Community features in and near the project study area include Hatteras Harbor Marina, Hatteras Civic Center, and Frisco Pier. Billy Mitchell Airport is approximately 0.5 mile east of the project study area (Figure 12).

7.2 Land Use

Land use adjacent to NC 12 in the project study area consists of residential and commercial development. Notable resources include Hatteras Estates residential community, Hatteras Cabanas (a rental community), Beach Pharmacy, various real estate offices, and other various businesses. Medium to low density commercial and residential development exists mostly along the north side of NC 12 in this area.

The Frisco community is at the northern end of the project study area. While Frisco has a diverse mix of commercial, residential, and cultural properties, the portion within the project study area is mostly residential.

Most community services, such as law enforcement and fire departments, are located outside of the project study area in both communities.

The Cape Hatteras National Seashore, a publicly-owned park and recreational area, makes up approximately 50 percent of the project study area.



Figure 12: Community features map





7.3 Existing Plans and Policies

The project study area includes properties under the influence of federal, state, and local plans and policies. The following NPS laws, policies, management plans, and guides are applicable:

- 16 United States Code 1 2 3, and 4, National Park Service Organic Act of 1916
- National Park Service Management Policies (NPS 1988) (Chapter 4:20)
- Cape Hatteras National Seashore Enabling Legislation (1937), as amended
- Foundation Statement, Cape Hatteras National Seashore (NPS 2011)
- Natural Resources Management Reference Manual #77 (NPS 1991)

Other applicable plans and policies include the following:

- **2009 Dare County Land Use Plan Update (Dare County 2010)** - The Dare County Land Use Plan (LUP), adopted on December 6, 2010, notes that NC 12 on Hatteras Island is routinely inundated by storm tide from ocean overwash and/or sound-side flooding. During these events, NC 12 is impassable and closed to traffic or traffic is restricted to four wheel drive vehicles due to sand and water on the roadway. The LUP identifies the long-term protection and maintenance of NC 12 as essential for Hatteras Island. The need for continual maintenance and long-term solutions for NC 12 was noted during the plan update process and is reflected in the LUP policies.
- **Dare County Shoreline Management Commission** - Established in 2005 to oversee and advocate for the preservation and restoration of the shorelines of Dare County, the Shoreline Advisory Commission serves as an advisory board to the Dare County Board of Commissioners.
- **Coastal Area Management Act** - The North Carolina General Assembly approved the Coastal Area Management Act (CAMA) in 1974. This legislation is applicable to all 20 coastal counties, including Dare County. CAMA requires each of the 20 coastal counties in North Carolina to have a local LUP that meets guidelines established by the North Carolina Coastal Resources Commission (NCCRC). To comply with CAMA regulations, Dare County adopted its Coastal Area Management Plan, titled 2009 Dare County Land Use Plan Update, in December 2010 and it was then certified by the NCCRC in February 2011.
- **Dare County Comprehensive Transportation Plan (NCDOT 2015)** - The NCDOT Board of Transportation adopted the *Dare County Comprehensive Transportation Plan* on March 4, 2015. This long-range planning document will assist the county in making transportation decisions over the next 25 to 30 years. The proposed project was included in the report as needing roadway improvements. The plan also recommends bicycle and pedestrian accommodations along NC 12, within the study area.
- **North Carolina State Transportation Improvement Program** - The proposed action (or proposed project) is designated in the NCDOT Current STIP, December 2014, as STIP Number R-3116B and described as “NC 12 Improvements.” This project is funded for planning and environmental studies only.



7.4 Economic Conditions

The primary driver of the economy in the project study area is tourism and the services associated with the tourism industry. This includes retail businesses, restaurants, hotels, and short-term rental of private homes (Figure 13). Boat building and commercial fishing are also common in Dare County (Dare County 2010). Businesses within the project study area would potentially see a positive economic benefit over the long term, as the proposed project would maintain connectivity and improve the local transportation system. The long-term improvements could also enhance the efficiency of transporting goods and services throughout the regional area.



Figure 13: Businesses within the project study area (Source: URS)

7.5 Tourism

On Hatteras Island, which includes the project study area, 25 percent of the businesses are directly involved in the tourism industry (Lane 2013). Estimates place tourism spending on Hatteras Island in 2011 at \$204 million, responsible for 2,618 jobs. Occupancy receipts in 2011 were \$106 million, with a tax collection of \$2.1 million. It is estimated that the tourism industry on Hatteras Island contributed \$10.3 million in North Carolina state taxes and \$9.4 million in local taxes.

7.6 Recreational Resources

There are both publicly-owned and privately-managed recreational resources within the project study area that support the emerging tourism section of the local economy. Privately-owned resources include art galleries, museums, fun parks, and water activity outfitters. The Cape Hatteras National Seashore is a national tourism destination and as such is considered to be a primary source of recreational resources and activities.

The NPS provides beach access in the project study area. There are two NPS facilities in the project study area, as shown on Figure 14. These include the Frisco Bathhouse, near the eastern project terminus, and Sandy Bay Beach Access, approximately 1 mile from the western project terminus. No new NPS facilities are anticipated for the project study area. Alternatives that protect the roadway in the current location will also provide protection for NPS infrastructure through beach nourishment and dune construction.



Figure 14: NPS facilities in the project study area





7.6.1 Recreational Activities

Assessing the effects of the project on recreational resources within the project study area requires consideration of not only the activity associated with the resources but also its setting and the overall recreational experience of the user.

The visual effect associated with a roadway improvement project is often subjectively based on the viewer's experience to change in the project setting. For this project, each alternative has the potential to change the existing setting within the project study area but not to a magnitude that would be considered notable. It is likely that the beach nourishment options would represent the least degree of visual change. Road relocation and, in some cases, introduction of bridge structures would be expected to represent greater degrees of change within the existing setting of the project study area.

The following sections address some of the most popular recreational activities afforded to locals and tourists within the project study area, as well as potential project related effects.

Windsurfing

Windsurfing is a popular activity on the sound side of the project study area. This sport requires open areas, wind, tide, and a suitable contour of the ocean floor that is conducive to the sport. The Canadian Hole is a popular windsurfing spot north of the project study area located midway between Buxton and Avon in Pamlico Sound. The warm, shallow water of Pamlico Sound combined with the steady Outer Banks winds create unparalleled conditions for windsurfing and kite boarding. This site, Buxton/Canadian Hole, was originally named in the 1980s due to the large influx of tourists from Canada that frequented this area for windsurfing. The Buxton/Canadian Hole has been the focal point of exceptional East Coast windsurfing for decades. The proposed project is not anticipated to impact windsurfing activities within the Sound or to notably change the project setting from the Sound. Areas frequented by windsurfers may require further analysis as the project moves into the NEPA phase to assess potential effects to viewsheds from the Sound.

Recreational Fishing

Cape Hatteras National Seashore offers recreational fishing opportunities in a variety of ways. Many different types of fish can be taken from the surf, piers, and freshwater ponds as well as from boats in the inlets, the sound, and offshore in the Gulf Stream. Fishing is a year-round sport at Cape Hatteras. The proposed project is not anticipated to affect recreational fishing opportunities from the surf, piers, and freshwater pond. Access to these facilities would be maintained.

Water Activities

Water activities that occur within the project study area include kayaking and canoeing, snorkeling, swimming, surfing, and crabbing. Kayaking and canoeing occur on both the sound and ocean side. Many residents and tourists choose Pamlico Sound for snorkeling and swimming due to the shallow waters. Cape Hatteras boasts some of the best surfing on the Atlantic Coast. Construction activities in beach areas would be expected to temporarily interrupt water activities in the areas of construction.

Hiking

Impacts to the NPS shoreline and access areas would affect the hiking areas available in the project study area. Relocating the roadway onto NPS lands would potentially remove areas currently used for hiking. This would require further analysis as the project moves into the NEPA phase.



Bird Watching

Birding is a popular year-round activity within the NPS due to the presence of native shorebirds, as well as migrating birds. Designated birding trails are located within Buxton Woods near the Cape Hatteras Lighthouse. Areas frequented by bird watchers may require further analysis as the project moves into the NEPA phase to assess potential effects such as changes in noise and vibration levels.

7.7 Natural Environment

A cursory evaluation of the natural resources was completed in the project study area.

7.7.1 Biotic Resources

The project study area encompasses communities that are largely dependent on topography, soils, hydrology, disturbance, and distance from tidal waters. Barrier island plant communities, in particular, are interrelated but separated into distinct zones based on proximity to the ocean or sound, elevation above sea level, and degree of shelter from wind-borne salt spray.

Six major terrestrial plant communities typical of the Outer Banks could be expected within the project study area. These include brackish marsh, salt shrub, maritime dry grassland, dune grass, upper beach, and maintained/disturbed land. The project study area also contains open water on both the sound and ocean side of the island.

7.7.2 Terrestrial Wildlife

Wildlife populations within the project study area, and along the entirety of the Outer Banks, are hindered by a species' ability to tolerate harsh salt environments and limited freshwater sources. While the Outer Banks are known for providing ideal bird nesting, foraging, and flyover habitat, other species groups are challenged by the environment.

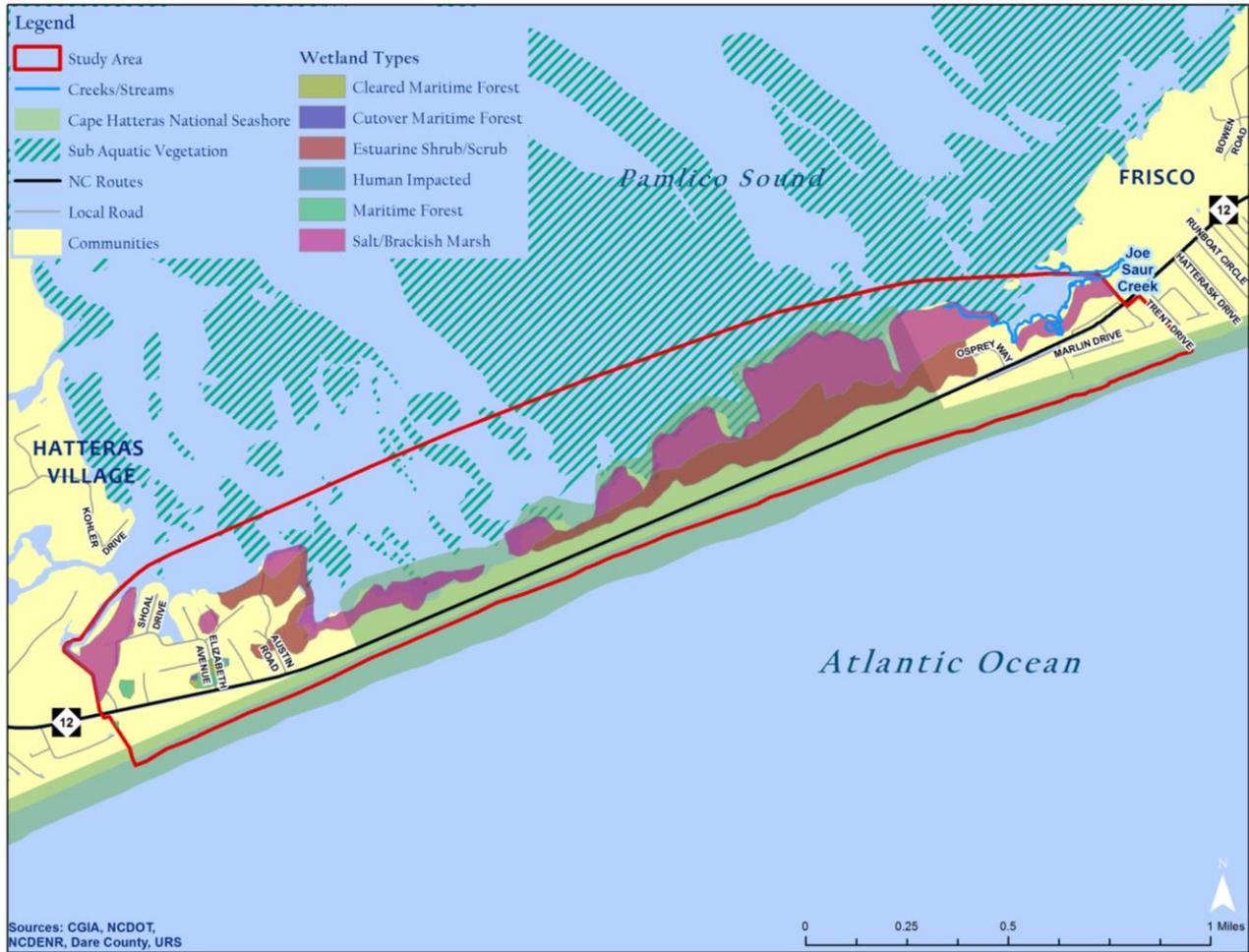
Specific species surveys have not been performed for the project.

7.7.3 Water Resources

Water resources within the project study area are part of the Pasquotank River Basin (USGS Hydrologic Unit 03020105). The project study area includes portions of the Sound and Joe Saur Creek, as well as a number of sound-side unnamed tributaries to Joe Saur Creek, Sandy Bay, and the Sound (Figure 15). Water resources within the project study area are estuarine. The best usage classification of both Joe Saur Creek and the Sound is SA; HQW (North Carolina Division of Water Resources [NCDWR] 2013). The SA designation identifies tidal salt waters that are used for commercial shellfishing or marketing purposes and are also protected for all Class SC and Class SB uses. The High Quality Waters (HQW) supplemental designation identifies HQW that are rated as excellent based on biological and physical/chemical characteristics through monitoring or special studies, primary nursery areas, critical habitat areas, water supply watersheds, and all Class SA waters.



Figure 15: Natural resources map





No water supply watersheds or Outstanding Resource Waters (ORW) are present within the project study area.

Both Joe Saur Creek and the Sound are present on the 2014 Draft 303(d) list of impaired waters (NCDWR 2014) as prohibited shellfish areas (Fecal, SH, SA). All waters within the project study area are closed to shellfish harvesting.

Primary Nursery Areas

Primary Nursery Areas (PNA) are located in the upper portions of creeks and bays. These are usually shallow with soft, muddy bottoms and surrounded by marshes and wetlands. Low salinity and an abundance of food in these areas create an ideal habitat for young fish and shellfish. The entirety of the Sound and its associated tributaries on the north side of NC 12 are considered PNA.

Submerged Aquatic Vegetation

SAV is a fish habitat dominated by one or more species of underwater vascular plants. These vegetation beds occur in both subtidal and intertidal zones and may occur in isolated patches or cover extensive areas. Freshwater vegetation may also grow in SAV beds. In North Carolina, SAV usually occurs in water less than 6 feet deep due to light limitations at depths greater than 6 feet. In addition to its role as critical habitat for many aquatic fauna species, SAV is an important bio-indicator of environmental health because of its sensitivity to aquatic stressors. There are approximately 156 acres of SAV mapped within the Sound and Joe Saur Creek in the project study area (North Carolina Department of Environment and Natural Resources [NCDENR] 2008).

1996 amendments to the Magnuson-Stevens Fishery Management and Conservation Act (Public Law 94-265, as amended through October 11, 1996) require federal action agencies that fund, permit, or carry out activities that may adversely impact Essential Fish Habitat (EFH) to consult with the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service regarding the potential effects of their actions on Essential Fish Habitat. An EFH assessment has not been conducted for the project study area; however, SAV areas and the ocean surf zone are considered EFH.

The SAV present within the project study area is used by a wide range of aquatic species during some or all phases of their life cycle. These nursery areas are generally found in shallow, mid- to high-salinity waters that lie over muddy or grassy bottoms, such as those found in tributary creeks, and embayments and along the western edge of barrier islands.

7.7.4 Jurisdictional Issues

Sections 401 and 404 of the Clean Water Act require regulation of discharges into Waters of the United States. No formal stream or wetland delineations have been performed within the project study area; however, topographic mapping and existing geographic information system (GIS) data are used to provide likely occurrences for purposes of this feasibility study.

Surface Waters

Pamlico Sound, Joe Saur Creek, and a number of unnamed tributaries are present on the north side of the project study area, north of NC 12.



Wetlands

The NPS utilizes a broader definition of wetland and adheres to the "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin 1979), which defines wetland as lands that are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year. Wetlands have not been delineated within the project study area, but can be estimated through the use of NCDENR, Division of Coastal Management (NCDCM) wetlands mapping (NCDCM 2003). NCDCM wetlands are generated through analysis of National Wetlands Inventory mapping, county soils mapping, and classified land use/land cover from satellite imagery. NCDCM's classification scheme is based on both vegetative cover and hydrogeomorphic character.

There are 163.5 acres of NCDCM wetlands within the project study area (Table 12). All the wetlands within the project study area occur on the north side of NC 12. The largest wetland component is salt/brackish marsh, occurring along the edges of the Sound. The salt/brackish marsh grades back into estuarine shrub/scrub to the south.

Table 12: NCDCM wetlands within the project study area

NCDCM Wetland Type	Acres
Cleared maritime forest	0.8
Cutover maritime forest	0.2
Estuarine shrub/scrub	57.0
Human impacted	0.4
Maritime forest	9.4
Salt/brackish marsh	95.7
Total	163.5

NCDCM has created a watershed-based GIS wetland functional assessment model to assist in the classification and quality assessment of NCDCM-mapped wetlands. North Carolina Coastal Region Evaluation of Wetland Significance (NC-CREWS) is the procedure that NCDCM uses to assess the functions of its wetlands (NCDCM 1999). NC-CREWS evaluate three main wetland functions: water quality, wildlife habitat, and hydraulic. The overall wetland rating is based on each wetland's ability and opportunity to provide each of the three main functions. There are three relative ORW scores (in order from low to high): Beneficial Significance, Substantial Significance, and Exceptional Significance.

Of the 163.5 acres of wetlands within the project study area, 161.3 acres are rated Exceptional Significance. The remaining wetlands are rated Substantial Significance.

Coastal Area Management Act Areas of Environmental Concern

The CAMA requires permits for development in areas of environmental concern (AEC). An AEC is an area of natural importance. It may be easily destroyed by erosion or flooding, or it may have environmental, social, economic, or aesthetic values that make it valuable to the state.



The project study area for the proposed project is considered an AEC, containing Estuarine and Ocean System, Ocean Hazard System, and Natural and Cultural Resource Areas. NCDOT has established coastal resource setback criteria for oceanfront construction based on the rate of shoreline change. The potential effects to AEC have not been fully assessed in this feasibility study and would require further investigation should this project be carried forward in the NEPA/SEPA process. NCDOT will be required to adhere to Rule 15A NCAC7H .0304 (Area of Environmental Concern within Ocean Hazard Areas).

7.7.5 Rare and Protected Species

Federally-Protected Species

As of April 20, 2015, the United States Fish and Wildlife Service (USFWS) lists 16 federally-protected species for Dare County (USFWS 2014). These species are shown in Table 13. Habitat requirements for each species are based on the current best available information from referenced literature and/or USFWS.

Table 13: Federally-protected species listed for Dare County

Scientific Name	Common Name	Federal Status	Habitat Present
<i>Alligator mississippiensis</i>	American alligator	T(S/A)	Yes
<i>Acipenser oxyrinchus oxyrinchus</i>	Atlantic sturgeon	E	No
<i>Haliaeetus leucocephalus</i>	Bald eagle	BGPA	Yes
<i>Chelonia mydas</i>	Green sea turtle	T	Yes
<i>Eretmochelys imbricata</i>	Hawksbill sea turtle	E	Yes
<i>Lepidochelys kempii</i>	Kemp’s ridley sea turtle	E	Yes
<i>Dermochelys coriacea</i>	Leatherback sea turtle	E	Yes
<i>Caretta caretta</i>	Loggerhead sea turtle	T	Yes
<i>Charadrius melodus</i>	Piping plover	T	Yes
<i>Calidris canutus rufa</i>	Red knot	T	Yes
<i>Canis rufus</i>	Red wolf	EXP	No
<i>Picoides borealis</i>	Red-cockaded woodpecker	E	No
<i>Sterna dougallii dougallii</i>	Roseate tern	T	Yes
<i>Acipenser brevirostrum</i>	Shortnose sturgeon	E	No
<i>Trichechus manatus</i>	West Indian manatee	E	Yes
<i>Amaranthus pumilus</i>	Seabeach amaranth	T	Yes

BGPA = Bald Eagle and Golden Eagle Protection Act

E = Endangered

EXP = Experimental Population

P = Proposed

T = Threatened

T(S/A) = Threatened Due to Similarity in Appearance

Endangered Species Act Critical Habitat Designations

Critical habitat for piping plover, which can be found within the project study area along sandy beaches and dunes, is listed for Dare County (October 21, 2008, Federal Register, 73:62816-62841).



Construction Moratoria

Due to the number of protected species known to occupy the project study area and their nesting, flowering, and migration patterns, construction moratoria would likely be applicable for activities on the ocean beach. The need for moratoria will be coordinated with resource agencies during project development and prior to construction. This is a typical moratorium, but alternatives could be developed to minimize impact so that work can be allowed during these times. Roseate tern and piping plover are present in late March/early April (NPS 2013b). Sea turtles begin to nest in May. Seabeach amaranth is present from May to September, and the roseate tern returns for August through October (NPS 2013c).

Federal Species of Concern

Federal Species of Concern (FSC) are not legally protected under the Endangered Species Act (ESA) of 1973 and are not subject to any of its provisions, including Section 7, until they are formally proposed or listed as threatened or endangered. The ESA does not formally protect federal-candidate or state-listed species. An FSC is defined as a species that is under consideration for endangered species listing for which there is insufficient information to support this listing. Organisms listed as threatened, endangered, or special concern (SC) on the NCNHP list of rare plant and animal species are afforded state protection under the ESA and the North Carolina Plant Protection and Conservation Act of 1979. The North Carolina Wildlife Resource Commission and the North Carolina Department of Agriculture are responsible for enforcing and administering species protection.

As of April 20, 2015, the USFWS lists seven FSC species for Dare County (Table 14).

Table 14: Federal species of concern for Dare County

Scientific Name	Common Name
<i>Anguilla rostrata</i>	American eel
<i>Laterallus jamaicensis</i>	Black rail
<i>Dendroica virens waynei</i>	Black-throated green warbler
<i>Peromyscus leucopus ssp. 1</i>	Buxton Woods white-footed mouse
<i>Malaclemys terrapin terrapin</i>	Northern diamondback terrapin
<i>Corynorhinus rafinesquii</i>	Rafinesque’s big-eared bat
<i>Trichostema sp. 1</i>	Dune blue curls

Bald Eagle and Golden Eagle Protection Act

In the July 9, 2007 Federal Register (72:37346-37372), the bald eagle was declared recovered, and removed (delisted) from the federal list of threatened and endangered wildlife. This delisting took effect August 8, 2007. After delisting, the Bald and Golden Eagle Protection Act (Eagle Act) (16 USC 668-668d) became the primary law protecting bald eagles.

Habitat for the bald eagle consists primarily of mature forests in proximity to large bodies of open water for foraging. Large, dominant trees are utilized for nesting sites, typically within 1 mile of open water. Ideal habitat for the bald eagle is not present within the project study area. However, eagles are known as year-round transient species along the Outer Banks. A review of April 2014 NCNHP records indicates known occurrences of bald eagles within 1 mile of the project study area.



7.8 Bicycle and Pedestrian Facilities

NC 12 has 3- to 6-foot roadway shoulders to support bicycle traffic throughout the project study area.

The Outer Banks Scenic Byway includes NC 12 on Hatteras Island. STIP S-5104 is under construction and consists of providing 7.9 miles of concrete pathways in Rodanthe, Waves, Salvo, and Avon on Hatteras Island.

Figure 16 shows the one pedestrian crossing in the project study area at the Sandy Bay parking area. Over the past several years bikeways and walkways have been constructed in many portions of Dare County. These improvements provide a safe alternative means of access for residents and visitors.



Figure 16: Sandy Bay pedestrian crossing (Source: URS)

7.9 Historic Resources and Landmarks

A preliminary investigation of the historic resources and landmark resources has identified the following resources. As the project moves forward into the NEPA review process, this information will be updated.

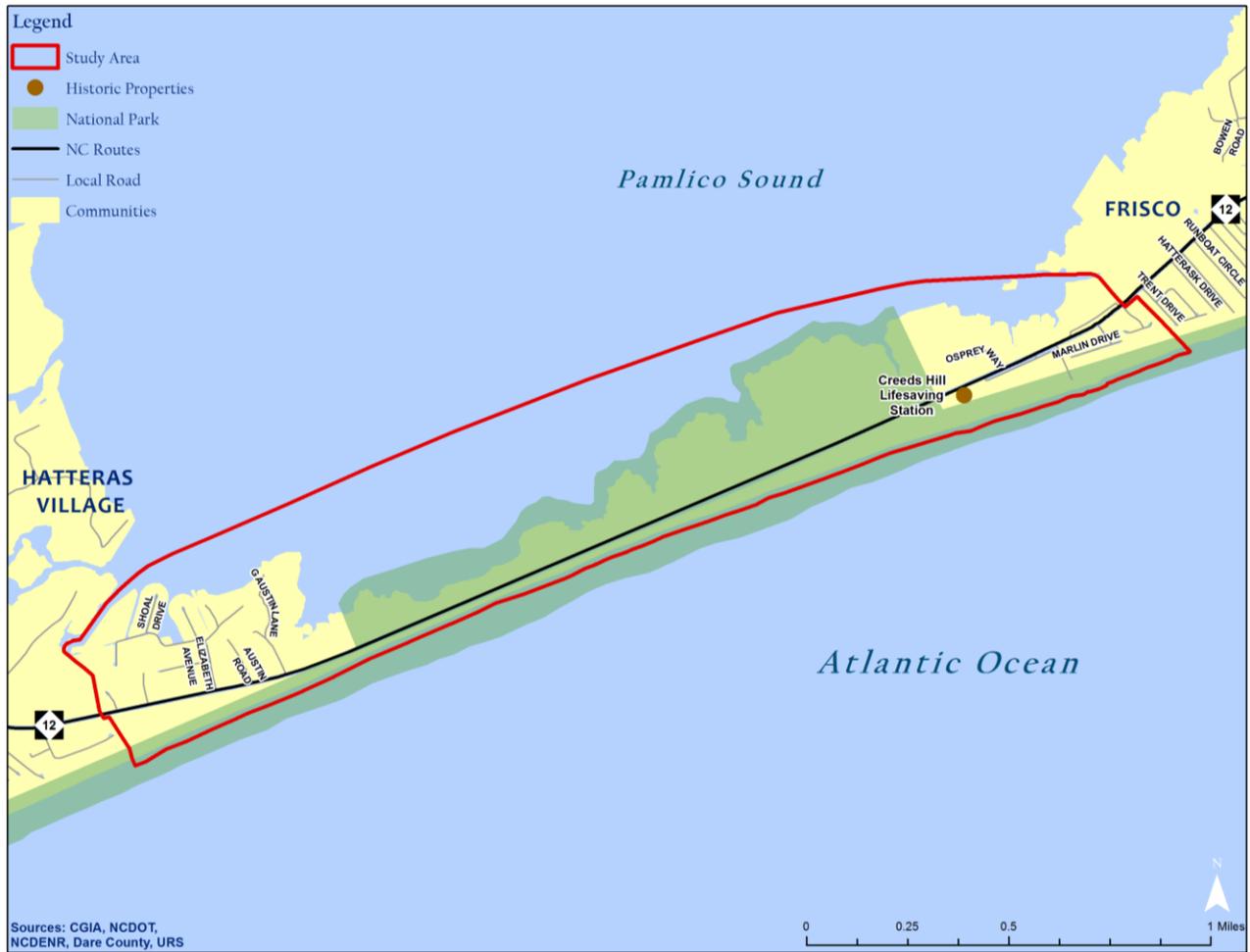
7.9.1 Historic Resources

There is one known historic resource in the area, as shown on Figure 17. Creeds Hill Lifesaving Station was established in 1878 as one of ten lifesaving stations originally built on Hatteras Island. The facility was abandoned in 1947 but is still standing less than 0.5 mile from the eastern project limits.

Because so much time has passed since the last thorough historic investigation of the area, there may be more properties eligible for National Register listing. As the project moves forward in the NEPA process a new investigation will be conducted to identify any new historic properties.



Figure 17: Historic resources map







7.9.2 Landmarks

The Cape Hatteras National Seashore (Figure 18) is a publicly-owned park and recreational area that is owned by the federal government and administered by the NPS. The Cape Hatteras National Seashore boundary follows the mean low watermark along the Atlantic Ocean side of the project study area. On the Sound side the boundary extends 150 feet from the shoreline. Outdoor recreational activities at the Seashore and the Sound include fishing, surf fishing, windboarding, walking, running, cycling, and bird watching.

As the project moves forward in the NEPA process, further review of the impacts to the Seashore will be necessary.



Figure 18: Cape Hatteras National Seashore (Source: URS)



8. Summary of Agency Coordination

A series of meetings have been conducted to engage cooperating agencies and local officials.

8.1 National Park Service

A meeting was held on April 22, 2014, between the NCDOT project team and NPS to discuss the initiation of the feasibility study. Representatives from NPS were briefed on the project and asked for input that would be valuable for the feasibility study.

Project study area details discussed at this meeting included the following:

- Dare County has submitted a proposal for beach nourishment in Buxton and northern Rodanthe to NPS. Generally, beach nourishment activities go against NPS management policy, but this policy is under review.
- NPS expressed interest in a high speed ferry service option because of extensive beach erosion in the project study area.
- All NPS properties in the project study area are a habitat for sea turtles, sensitive to construction activities from mid-May through November.
- Recreational activities in the project study area include kite boarding, hiking, windsurfing, recreational fishing, and swimming.

8.2 Merger Team

On May 8, 2014, NCDOT conducted a NEPA/Section 404 Merger Team meeting to discuss this feasibility study. Representatives were in attendance from NPS, US Environmental Protection Agency (EPA), National Marine Fisheries Service, USFWS, United States Army Corps of Engineers (USACE), Federal Highway Administration, North Carolina Wildlife Resources Commission, NCDOT, North Carolina State Historic Preservation Office (SHPO), the Albemarle Rural Planning Organization, and NCDWR.

Project study area details discussed at this meeting included the following:

- There is a concern that suitable sand for NCDOT's proposed improvements may not be available in close proximity of the project. Importing sand may be problematic from a biological suitability standpoint, as well as in terms of cost feasibility.
- The Outer Banks Task Force has a NC Geological Survey report that addresses areas that may be a viable sand borrowing area for sand.
- The NPS representative indicated that mitigation for wetland impacts may be problematic in that any wetland mitigation should occur within the management boundaries of NPS.
- There has been some discussion among locals of the possibility of relocating the ferry operations farther south of the existing location, but NPS doubts the feasibility of this option due to the shallowness of waters at locations farther south and due to the extent of the extra travel times required to reach the locations south.
- NPS indicated that they have several proposals for projects from various entities that are causing them to review and reconsider the viability of their policies regarding the barrier islands. Proposals include a project to protect portions of the Oregon Inlet (a new jetty on the north side



of the inlet to reduce migration of sand) and the proposal from Dare County for beach nourishment to protect county resources.

- NPS remarked that a 5-year beach nourishment option looks much different than a 50-year option, which may require several iterations of activity similar to a one time 5-year option. NPS doubts that there would be enough sand for a 5-year beach nourishment option, let alone a 50-year option. A 404 permit has been needed in the past for dredging activities, and NPS has a positive relationship with USACE for these efforts.
- Utility poles on the sound side of existing NC 12 are at risk of washing away; therefore, nourishment activities may help with the preservation of these utilities.
- Coastal resource setback criteria would need to be adhered to.

8.3 Local Officials

Dare County officials attended an information session on June 11, 2014, in which they were introduced to the study. NCDOT indicated that the estimated project costs generated as part of this feasibility study and others would be used to program and schedule projects in the upcoming STIP. This project is already included in the current STIP, but is funded for planning and environmental studies only. One local official voiced his position regarding the need for the project as not a matter of “if,” but “when.” NCDOT representatives went on to state that the feasibility study would consider both the short-term and long-term option to provide reliable access along NC 12 and to maintain the integrity and viability of the transportation network. The intent of the short-term feasibility options is to be able to act quickly if a storm event requires emergency repairs on any of the hot spots. The long-term options are intended to meet the needs of the project throughout its design life.



9. Summary of Project-Related Effects

Table 15: Short-term alternative analysis

Alternative	Construction				Human Environment			Natural Environment			
	Cost (Millions)(Excludes the cost of dune construction)	Length of project (feet)	Length of proposed bridges (feet)	Constructability Concerns	Right-of-Way	Recreational Resources	Tourism	Encroachment on NPS	New Stream Crossings	Jurisdictional Wetlands ^a (acres)	Submerged Aquatic Vegetation in Sound (potential for encroachment)
Alternative 1 (Road Relocation A)	5.4	7,700	0	<p>Potential shortage of fill sand. Approximate dune in feet: 7,520 total.</p> <p>Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns.</p> <p>Construction staging is likely a concern considering the limited area available for such use.</p>	Easement within NPS will be needed for beach nourishment within seashore. Private property acquisition would be needed. Fifteen properties are anticipated to be impacted by dune construction. It is estimated that six relocations could occur due to dune construction.	Access to recreational resources would be maintained, but may contribute to traffic congestion if construction was to occur during the tourism season. Construction-related impacts on the sound side are possible and may temporarily alter usage of the national seashore in construction areas.	Potential residential property relocations may represent a decrease in rental property during the tourism season and a loss of rental income for property owners.	Encroachment of 10.35 acres of National Seashore	1 crossing (existing location)	Low	Not Likely
Alternative 2 (Road Relocation B)	35.1	9,650	2,900	<p>Potential shortage of fill sand. Approximate dune in feet: 5,200 total</p> <p>Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns.</p> <p>Construction staging is likely a concern considering the limited area available for such use.</p>	Easement within NPS will be needed for beach nourishment within seashore. Private property acquisition would be needed. Nineteen properties are anticipated to be impacted by dune construction. It is estimated that six relocations could occur due to dune construction.	Access to recreational resources would be maintained but may contribute to traffic congestion if construction was to occur during the tourism season. Construction-related impacts on the sound side are possible and may temporarily alter usage of the national seashore in construction areas.	Potential residential property relocations may represent a decrease in rental property during the tourism season and a loss of rental income for property owners.	Encroachment of 13.6 acres of National Seashore	1 existing (existing location)	Low	Not Likely



Alternative	Construction				Human Environment			Natural Environment			
	Cost (Millions)(Excludes the cost of dune construction)	Length of project (feet)	Length of proposed bridges (feet)	Constructability Concerns	Right-of-Way	Recreational Resources	Tourism	Encroachment on NPS	New Stream Crossings	Jurisdictional Wetlands ^a (acres)	Submerged Aquatic Vegetation in Sound (potential for encroachment)
Alternative 3 (Beach Nourishment)	12.3	7,392	0	<p>Potential shortage of borrow sand for the purpose of beach nourishment may prevent consideration of this option.</p> <p>NPS policy on beach nourishment proposals is under internal agency review.</p> <p>Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns.</p> <p>Construction staging is likely a concern considering the limited area available for such use.</p>	ROW (or at least an easement agreement) may be needed on private properties if beach nourishment extends upland of MHW line. Easement within NPS will be needed for beach nourishment within Seashore.	<p>Access to recreational resources would be maintained.</p> <p>Beach nourishment associated with this alternative is likely to expand beachfront on the Atlantic Ocean side of NC 12.</p>	Construction activities in beach areas would be expected to temporarily interrupt beach related activities in the area of construction such as swimming, fishing, or surfing,	Encroachment on the ocean beach within the National Seashore. Beach nourishment would temporarily alter the naturally occurring wildlife habitat and hydrological regime.	None	High, assuming beach nourishment to occur in areas meeting the criteria of NPS and USACE wetlands	Not Likely



Alternative	Construction				Human Environment			Natural Environment			
	Cost (Millions)(Excludes the cost of dune construction)	Length of project (feet)	Length of proposed bridges (feet)	Constructability Concerns	Right-of-Way	Recreational Resources	Tourism	Encroachment on NPS	New Stream Crossings	Jurisdictional Wetlands ^a (acres)	Submerged Aquatic Vegetation in Sound (potential for encroachment)
Alternative 4 (Road Relocation with Beach Nourishment)	12.4	6,800	0	<p>Approximate dune in feet: 4,500 total.</p> <p>Potential shortage of borrow sand for the purpose of beach nourishment may prevent consideration of this option.</p> <p>NPS policy on beach nourishment proposals is under internal agency review.</p> <p>Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns.</p> <p>Construction staging is likely a concern considering the limited area available for such use.</p>	Easement within NPS will be needed for beach nourishment within Seashore. Private property acquisition would be needed. ROW (or at least an easement agreement) may be needed on private properties if beach nourishment extends upland of MHW line. Easement within NPS will be needed for beach nourishment within Seashore.	Access to recreational resources would be maintained. Construction-related impacts on the sound side are possible and may temporarily alter usage of the national seashore in construction areas. Beach nourishment associated with this alternative is likely to encroach upon beach areas used for swimming and fishing.	Construction activities in beach areas would be expected to interrupt beach related activities in the area of construction such as swimming, fishing, or surfing,	Encroachment of 7.9 acres of National Seashore	1 crossing (existing)	High, assuming beach nourishment to occur in areas meeting the criteria of NPS and USACE wetlands	Not Likely

^a Scale of severity: <1 acre= low, > 1 acre=high



Table 16: Long-term alternative analysis

Alternative	Construction			Human Environment			Natural Environment				
	Cost	Length of project (feet)	Length of proposed bridges (feet)	Constructability Issues	Right-of-Way	Recreational Resources	Tourism	Encroachment on NPS	New Stream Crossings	Jurisdictional Wetlands ^a (acres)	Submerged Aquatic Vegetation in Sound (potential for encroachment)
Alternative 1 (Road Relocation with Bridge)	45.8	9,700	3,750	Roadway construction possibly in unstable soils. Approximate dune in feet: 2,985 total. Borrow sands may be difficult to find and transport to project site. Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns. Construction staging is likely a concern considering the limited area available for such use.	Easement within NPS will be needed for dune construction within Seashore. Private property acquisition would be needed. Seventeen properties are anticipated to be impacted by dune construction. It is estimated that seven relocations of single family residences and one seven unit townhome could occur due to dune construction.	Access to recreational resources would be maintained. Construction-related impacts on the sound side are possible and may temporarily alter usage of the national seashore in construction areas.	Moderate potential for residential relocation near eastern terminus. Residential property relocations may represent a decrease in rental property during the tourism season and a loss of rental income for property owners. Construction activities in beach areas would be expected to interrupt beach related activities in the area of construction such as swimming, fishing, or surfing,	Encroachment of 11.14 acres of National Seashore	1 crossing (existing)	Low	Not likely
Alternative 2 (Road Relocation with Bridge)	67.4	11,950	5,200	Roadway construction possibly in unstable soils. Approximate dune in feet: 1,050 total. Borrow sands may be difficult to find and transport to project site. Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns. Construction staging is likely a concern considering the limited area available for such use.	Easement within NPS will be needed for dune construction? within Seashore. Private property acquisition would be needed. Twelve properties are anticipated to be impacted by dune construction. It is estimated that eight residential relocations and one business relocation could occur due to dune construction.	Access to recreational resources would be maintained. Construction-related impacts on the sound side are possible and may temporarily alter usage of the national seashore in construction areas.	Residential property relocations may cause a decrease in rental property during the tourism season and a loss of rental income for property owners.	Encroachment of 13.50 acres of National Seashore	1 crossing (existing)	Low	Not Likely



Alternative	Construction				Human Environment			Natural Environment			
	Cost	Length of project (feet)	Length of proposed bridges (feet)	Constructability Issues	Right-of-Way	Recreational Resources	Tourism	Encroachment on NPS	New Stream Crossings	Jurisdictional Wetlands ^a (acres)	Submerged Aquatic Vegetation in Sound (potential for encroachment)
Alternative 3 (Existing Alignment with Beach Nourishment)	84.7	8,448	None	<p>Likely shortage of borrow sand for long-term beach nourishment may render this option infeasible.</p> <p>NPS policy on beach nourishment proposals is under internal agency review.</p> <p>Beach nourishment would require fortification on a scheduled basis (e.g., 5 year intervals).</p> <p>Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns.</p> <p>Construction staging is likely a concern considering the limited area available for such use.</p>	<p>ROW (or at least an easement agreement) may be needed on private properties if beach nourishment extends upland of MHW line. Easement within NPS will be needed for beach nourishment within Seashore.</p>	<p>Access to recreational resources would be maintained.</p> <p>Beach nourishment associated with this alternative is likely to expand beachfront on the Atlantic Ocean side of NC 12.</p>	<p>Temporary impacts to tourists during beach nourishment construction.</p> <p>Construction activities in beach areas would be expected to interrupt beach related activities in the area of construction such as swimming, fishing, or surfing,</p>	<p>Beach nourishment would temporarily alter the naturally occurring wildlife habitat and hydrological regime.</p>	None	High	Not Likely



Alternative	Construction			Human Environment			Natural Environment				
	Cost	Length of project (feet)	Length of proposed bridges (feet)	Constructability Issues	Right-of-Way	Recreational Resources	Tourism	Encroachment on NPS	New Stream Crossings	Jurisdictional Wetlands ^a (acres)	Submerged Aquatic Vegetation in Sound (potential for encroachment)
Alternative 4 (Bridge in Existing Easement and Beach Nourishment)	138.3	10,450	7,500	<p>Roadway construction possibly in unstable soils.</p> <p>Likely shortage of borrow sand for long-term beach nourishment may render this option infeasible.</p> <p>NPS policy on beach nourishment proposals is under internal agency review.</p> <p>Likely construction moratorium for construction activities occurring in areas managed by NPS due to protected species life concerns.</p> <p>Construction staging is likely a concern considering the limited area available for such use.</p>	<p>Residential and commercial property acquisitions needed. Additional right-of-way necessary</p> <p>NPS permits would be needed for any temporary construction easement within Seashore. ROW (or at least an easement agreement) may be needed on private properties if beach nourishment extends upland of MHW line. Easement within NPS will be needed for beach nourishment within Seashore.</p>	<p>Access to recreational resources would be maintained.</p> <p>Construction-related impacts on the sound side are possible and may temporarily alter usage of the national seashore in construction areas.</p> <p>Beach nourishment associated with this alternative is likely to expand beach areas used for swimming and fishing.</p>	<p>Direct access to recreational areas within the Seashore within the bridged section would be lost due to presence of bridge.</p> <p>Construction activities in beach areas would be expected to interrupt beach related activities in the area of construction such as swimming, fishing, or surfing,</p>	<p>Beach nourishment would temporarily alter the naturally occurring wildlife habitat and hydrological regime.</p>	<p>1 crossing (new location)</p>	<p>High</p>	<p>Not Likely</p>

^a Scale of severity: <1 acre= low, > 1 acre=high



10. Summary of Assessments and Recommendations

The reliability of NC 12 within the project limits will continue to decline without the project. This feasibility study consists of the identification and preliminary assessment of a suite of alternatives, each of which, if constructed, would maintain or improve NC 12 within the project study area. It is important to recognize that the occurrences of storm events is likely to result in some measure of storm surge, and erosion on both the sound and ocean sides of the island is expected to continue. The chronic effect of beach erosion and roadway damage caused by storm events, including hurricanes, will continue to increase the frequency of emergency repair efforts on NC 12 in order to maintain uninterrupted access. Routine maintenance costs will also continue to increase as the road becomes more vulnerable to overwash.

This feasibility study considered various 2-lane alternatives to address the established project purpose and need. Based on the anticipated 2040 forecast traffic volume, a two-lane facility is still considered appropriate for this project.

The short-term alternatives were developed to be implemented as expeditiously as possible in the event of a roadway washout before a long-term design option is carried forward for environmental review and construction. The long-term alternatives address the need of the project in a way that is more sustainable, over the life of the project, given what is known about future coastal morphology changes. All alternatives (both short-term and long-term) would need further analysis through the federal NEPA and/or state SEPA review processes and coordination with local, state, and federal resource agencies to assess each alternative's consistency with their agency's mission and current policies.

Alternative development for the purposes of this study considered two estimated limits of shoreline erosion, average shoreline limits, and the high-erosion limits. The difference between these two limits is discussed in section 3.1 of this report. The reasoning behind the utilization of the average shoreline limit was to minimize property impacts to NPS and to private properties such as the commercial hotel located at the northern tip of Buxton adjacent to the existing roadway.

Identifying a source of sand suitable for construction fill and mitigation activities, such as nourishment and dune restoration, is paramount to the construction of both the short and long-term alternatives. As mentioned earlier in this study, a report prepared for the Outer Banks Task Force and NCDOT by the North Carolina Geological Survey (NCGS 2009) estimated that up to 120 million cubic yards of sand suitable for nourishment is located offshore just south of the project limits, which could fulfill project needs if deemed suitable. The finding of this report will need further vetting by resource agencies including the NCDOT, US EPA, and the USACE. A detailed sediment analysis of potential borrow areas may be needed to fully address the question as to whether or not these borrow areas are sources of sand for this project. Additionally, a 404 permit has been required in the past on similar transportation projects prior to dredging for beach nourishment construction.

In the near term it is recommended that NCDOT coordinate with local governments and the NPS to address any concern of competing nourishment proposals, some of which may be more comprehensive than this project and intended to protect homes and other infrastructure within the project study area. In the event that this project obtains future funding for project development and construction, there would be a distinct possibility that no additional funding mechanism would be in place for recurring beach nourishment needs along NC 12.



Coordination with the NPS has indicated that they have been requested to review a proposal that would include construction of double jetties and sand dunes ocean side in Dare County. Competing proposals may further limit the quantity of suitable sand for NCDOT's proposed improvement. It is noteworthy that NCDOT's proposed stabilization measures, such as nourishment and restoration of dunes, are limited to what is needed to protect the transportation infrastructure only.

The tourism sector makes up a substantial portion of the local economy. Coordination with local officials, business owners and the NPS will be needed to minimize any disruption of access to areas that cater to seasonal tourist or to recreational facilities or the beaches on the ocean side or sound side

The need and benefit derived from the use of special construction techniques and/or temporary bridge components should be given further consideration. A cored slab bridge is a more likely option for short-term alternatives on this project, but Mabey bridge components could potentially be stockpiled in or near the project areas for rapid utilization in response to the occurrence of an inlet.

Interim steps that NCDOT should consider to be prepared in the event that a short-term option needs to be implemented to maintain access includes addressing project staging area concerns. Limited space within the project limits for potential staging areas indicated that other options should be considered including the potential utilization of Hatteras Inlet ferry dock, the identification of suitable staging areas located outside of the Seashore or the extension of work bridges into Pamlico Sound.

Maintaining up-to-date inventories of historic, cultural and natural resources to quickly identify the potential impacts of proposed designs is recommended. Additional coordination with the NPS regarding their existing beach nourishment policies, wetland mitigation policies, construction moratoriums, and potential construction staging areas is needed as recent meetings with NPS has suggested that a change in the current policy is being considered.

Coordination with the project's interagency merger team is recommended to address the protection of aquatic ecosystems and wildlife habitat as well as permitting requirements that must be adhered to.



11. Literature Cited

Cowardin, Lewis M. 1979. Classification of Wetlands and Deepwater Habitats of the United States. US Department of Interior, Wildlife Service, Office of Biological Services. Accessed on 8/22/2014. <http://www.fws.gov/wetlands/Documents/Classification-of-Wetlands-and-Deepwater-Habitats-of-the-United-States.pdf>.

CSE. 2013. Shoreline Erosion Assessment and Plan for Beach Restoration, Rodanthe & Buxton Areas, Dare County, North Carolina. Prepared for Dare County Board of Commissioners.

Dare County Emergency Management Operations Plan. <http://www.darenc.com/EmgyMgmt/>.

Dare County. 2010. 2009 Dare County Land Use Plan Update. Dare County, North Carolina. <http://www.darenc.com/Forms/LUSE/LUP.pdf>.

Federal Highway Administration. http://www.environment.fhwa.dot.gov/projdev/bridge_casestudy.asp

Lane, Brent. 2013. Hatteras Island Economic Impact. 2013. Presented to Outer Banks Visitors Bureau. July 2013.

Magnuson-Stevens. 1996. Magnuson-Stevens Fishery Conservation and Management Act, as amended through October 11, 1996. <http://www.nmfs.noaa.gov/sfa/magact/>.

NCDCM. 1999. NC-CREWS: North Carolina Coastal Region Evaluation of Wetland Significance. A Report of the Strategic Plan for Improving Coastal Management in North Carolina. Division of Coastal Management, NOAA, EPA. May 1999.

NCDCM. 2003. DCM Wetland Data and Documents. NCDENR, NCDCM. Shapefile. Published 12/30/03.

NCDEQ. 2008. Submerged Aquatic Vegetation – SAV. NCDENR, Albemarle-Pamlico National Estuary Partnership (APNEP). Vector digital data.

NCDOT. 2013a. NC 12 Community Characteristics Report, NCDOT, January 2013.

NCDOT. 2014a. Feasibility Study, Hatteras Village-Natural Resources Technical Report. NCDOT. July 2014.

NCDOT. 2014b. North Carolina Roadway Design Manual. <https://connect.ncdot.gov/projects/roadway/pages/roadway-design-manual.aspx>.

NCDOT. 2015a. 2016-2025 State Transportation Improvement Program. June 2015.

NCDOT. 2015b. Dare County Comprehensive Transportation Plan. July 2015.

NCDWR. 2013. NC Water Quality Classifications by NC River Basin, Pasquotank River Basin. Surface Water Classifications, Division of Water Resources. Updated December 9, 2013.

NCDWR. 2014. 2014 Draft Category 5 Water Quality Assessments – 303(d) List. Water Quality Data Assessment, Division of Water Resources. Updated February 21, 2014.



NCGS. 2000. Final Report, Sand Resources of the North Carolina Outer Banks. Outer Banks Task Force and the North Carolina Department of Transportation. Revised 20140411. <http://www.obtf.org/NC12/REPORTS/NC12PDF/COMP.pdf>.

NCGS. 2009. Offshore Sand Resource Investigation, North Carolina Outer Banks: Ocracoke Inlet to Oregon Inlet. North Carolina Department of Transportation. Revised August 04, 2009. NCNHP. 2014a. Significant Natural Heritage Areas (April 2014). North Carolina Natural Heritage Program, Department of Environment and Natural Resources. Vector digital data, publication date 20140401.

NCNHP. 2014b. Element Occurrence Shapefile (April 2014). North Carolina Natural Heritage Program, Department of Environment and Natural Resources. Vector digital data, publication date 20140401.

NPS. 1988. Management Policies. U.S. Department of the Interior, National Park Service.

NPS. 1991. NPS #77: The Natural Resource Management Guideline.

NPS. 2011. Foundation Statement, Cape Hatteras National Seashore. US Department of the Interior, National Park Service, Cape Hatteras National Seashore, North Carolina. September 2011.

NPS. 2013a. Cape Hatteras National Seashore Sea Turtle Monitoring 2013 Annual Report. US Department of the Interior, National Park Service, Cape Hatteras National Seashore, North Carolina.

NPS. 2013b. Cape Hatteras National Seashore Piping Plover (*Charadrius melodus*) Monitoring 2013 Annual Report. US Department of the Interior, National Park Service, Cape Hatteras National Seashore, North Carolina.

NPS. 2013c. Cape Hatteras National Seashore Seabeach Amaranth (*Amaranthus pumilus*) Surveys 2013 Annual Report. US Department of the Interior, National Park Service, Cape Hatteras National Seashore, North Carolina.

NPS. 2013d. Proposal to Facilitate Additional Public Beach Access Environmental Assessment. National Park Service. U.S. Department of the Interior. Cape Hatteras National Seashore, North Carolina. June 2013.

Outer Banks Task Force. 2000a. Draft Information to Assist Decision-Makers, Responding to Inlet Formation and Closure Within The Outer Banks Task Force Study Area From Whalebone Junction to Ocracoke Inlet, NC.

Outer Banks Task Force. 2000b. <http://www.obtf.org/nc12hotspots/hot/buxton/buximg4.html>.

Overton, M.F. and J.S. Fisher. 2007. Rodanthe Hotspot – Interim Solution Shoreline Change and Stabilization Analysis. FDH Engineering. Prepared for URS Corporation – North Carolina. 15 pp.

Overton. 2015. Coastal Conditions Update, NCDOT, February 2015.

URS. 2014. NC 12—R-3116B NC 12 Traffic Forecast. Dare County, North Carolina. State Transportation Improvement Program Project No. R-3116B. June 2014.



URS. 2014. NC 12—Hatteras Village Hot Spot Improvements Traffic Forecast. Dare County, North Carolina. State Transportation Improvement Program Project No. R-3116B. June 2014.

URS. 2013. Camacho, C. (photographer), URS Corporation-North Carolina

USFWS. 2014. Endangered Species, Threatened Species, Federal Species of Concern, and Candidate Species, Dare County, North Carolina. Updated January 24, 2014. US Department of the Interior, US Fish and Wildlife Service, Washington, DC.

Wamsley, T.V., K.K Hathaway, and M. Wutkowski. 2010. Hatteras Breach, North Carolina. ERDC/CHL CHETN-VI-43. 23 pp.