US ARMY CORPS OF ENGINEERS

US DEPARTMENT OF INTERIOR

NATIONAL PARK SERVICE

CAPE HATTERAS NATIONAL SEASHORE

NORTH CAROLINA

BEACH RESTORATION TO PROTECT NC HIGHWAY 12

CLEAN WATER ACT 404 AND NPS SPECIAL USE PERMITS

AT BUXTON, DARE COUNTY, NORTH CAROLINA

ENVIRONMENTAL ASSESSMENT

15 SEPTEMBER 2015

NPS 603/129663

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

AEC	Area of Environmental Concern
ASCE	American Society of Civil Engineers
BA	Biological Assessment
BAV	Beach Action Value
BC	Berm crest
BEACH	Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000
BO	Biological Opinion
CAMA	Coastal Area Management Act
CBIA	Coastal Barrier Improvement Act
CBRA	Coastal Barrier Resources Act
CEQ	Council on Environmental Quality
CERC	Coastal Engineering Research Center
CFR	Code of Federal Regulations
CHWA	Cape Hatteras Water Association
CSE	Coastal Science & Engineering Inc
CWA	Clean Water Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
CZR	CZR Incorporated
DPS	Designated Population Segment
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
GENESIS	Generalized model for simulating shoreline change
GIBA	Globally Important Bird Area
HAPC	Habitat Areas of Particular Concern
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LEDPA	Least Environmentally Damaging Practicable Alternative
MBTA	Migratory Bird Treaty Act
MMMA	Marine Mammal Protection Act
MLW	Mean low water
MTL	Mean tide level
NAS	National Academy of Sciences
NAVD	North American Vertical Datum
NC 12	North Carolina State Highway 12
NCCRC	North Carolina Coastal Resources Commission
NCDCCPS	North Carolina Department of Crime Control and Public Safety
NCDCM	North Carolina Division of Coastal Management
NCDENR	North Carolina Department of Environment and Natural Resources
NCDMF	North Carolina Division of Marine Fisheries

NCDOT	North Carolina Department of Transportation
NCSG	North Carolina Sea Grant
NCDWR	North Carolina Division of Water Resources
NCNHP	North Carolina Natural Heritage Program
NCWRC	North Carolina Wildlife Resources Commission
NDBC	National Data Wave Buoy
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMNH	National Museum of Natural History
NOAA	National Oceanic & Atmospheric Administration
NOI	Notice of Intent
NOS	National Ocean Service
NPS	National Park Service
NPS	Non-Point Source Pollution
NRC	National Research Council
NRCS	Natural Resources Conservation Service
OCRM	Office of Ocean & Coastal Resource Management
OPA	Otherwise Protected Area
OSHA	Occupational Safety and Health Administration
PEPC	Planning, Environmental and Public Comment
PRD	Protected Resource Division [National Marine Fisheries Service (NOAA)]
SARBO	South Atlantic Regional Biological Opinion
Seashore	Cape Hatteras National Seashore
SERO	Southeast Regional Office (NOAA)
SHPO	State Historic Preservation Office
SOSUS	Sound Surveillance System
STWAVE	Steady-state spectral wave model
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USFWS	US Fish & Wildlife Service
USGS	US Geological Survey
WIS	Wave Information Study

BEACH RESTORATION

AT BUXTON, DARE COUNTY, NORTH CAROLINA

Environmental Assessment

CHAPTER 1 – PURPOSE AND NEED FOR ACTION

INTRODUCTION

This Environmental Assessment (EA) is prepared in connection with an application by Dare County, North Carolina (Applicant), for federal and state permits to place sand along a 3-mile length of Hatteras Island. This 3-mile beach includes ~2.2 miles in the Cape Hatteras National Seashore (Seashore) and ~0.8 mile along the village of Buxton (Fig 1.1), hereafter referred to as the Proposed Action Area or Buxton Action Area. The federal action analyzed in this Environmental Assessment is to decide whether or not, and under what conditions, to issue the permits the Applicant has requested.

This Environmental Assessment is prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (as amended) to address environmental and public safety concerns (Figs. 1.1 and 1.2). If the permits are issued, the project would serve the following purposes according to the Applicant:

1) To provide a wider beach and buffer storm waves along a critically eroding section of Hatteras Island.

2) To reduce the frequency of storm damages to North Carolina Highway 12 (NC 12) and existing community infrastructure.

3) To replace erosion losses and augment the regional supply of beach sand by using a non-littoral borrow source of compatible sediments from an offshore borrow area.

The permitted project would encompass up to 15,500 linear feet of ocean beach (2.94 miles) and would call for up to 2.6 million cubic yards of beach quality sand to be pumped onto the beach via dredge. The Applicant's proposed source of sand for beach nourishment is from an offshore borrow area situated within state waters about 1.7 miles off the former site of the Cape Hatteras Lighthouse (Fig 1.1). The borrow site is an isolated shoal in water depths between ~32 and 45 feet. Sand would be discharged along the beach via hydraulic pipeline and spread by land-based equipment at grades and slopes similar to the natural dry-sand and wet-sand beach. According to the Applicant, no nourishment sand would be placed on existing vegetation, dunes, shore-protection structures, or upland property. If approved, the permits would allow one nourishment event up to the scale and extents outlined herein.

This Environmental Assessment discusses the purpose and need for the Proposed Action (Chapter 1), alternatives considered (Chapter 2), affected environment (Chapter 3), and environmental consequences (Chapter 4). In addition to the Applicant's selected action alternatives, this Environmental Assessment addresses the No-Action Alternative. Supplementary data and analyses pertinent to the Proposed Action are contained in Appendices A-G.

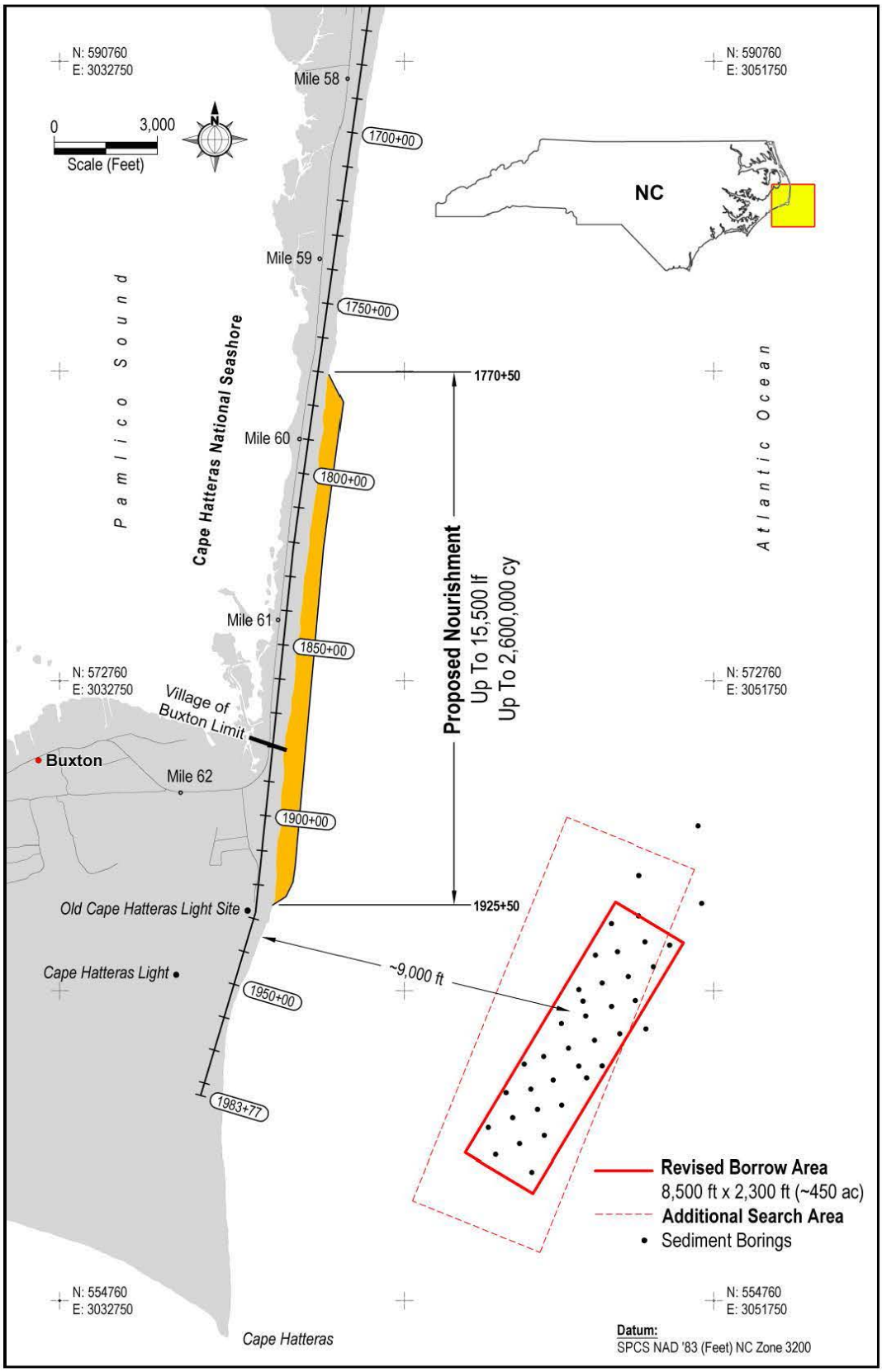

Figure 1.1. Map showing Applicant's Proposed Action illustrating maximum limits of nourishment along the oceanfront in the vicinity of Buxton, NC. The sand source is an offshore borrow area situated about 9,000 feet from the former site of the Cape Hatteras Lighthouse.

Figure 1.2. Oblique aerial photograph of Cape Hatteras National Seashore looking south in the vicinity of Buxton Village on 11 September 2014 showing the approximate limits of the proposed beach nourishment project. The northern project limit is in the vicinity of the Haulover Day Use Area of the Seashore. The southern project limit is in the vicinity of the former site of the Cape Hatteras Lighthouse site. (Image by Coastal Science & Engineering)

The alternatives, identification of the affected environment, and potential environmental consequences have been developed in coordination with the Applicant. The US Army Corps of Engineers (Wilmington District, North Carolina) is the lead agency, and the other principal federal agency is the National Park Service (Cape Hatteras National Seashore, Manteo, North Carolina). Primary corresponding federal resource agencies which have provided detailed guidance include US Fish & Wildlife Service (USFWS, Raleigh, North Carolina) and National Marine Fisheries Service (NMFS, Beaufort, North Carolina). The North Carolina Department of Environment & Natural Resources (NCDENR) and its various corresponding resource divisions have provided input to this National Environmental Policy Act document via pre-application meetings in Washington, North Carolina.

The public may review and comment on the Environmental Assessment via:

Beach Restoration to Protect NC 12 Permits EA
US Army Corps of Engineers–Wilmington District
Washington Regulatory Field Office
2407 West Fifth Street
Washington, NC 27889
Attn: Raleigh W Bland, PWS

In addition, a public forum(s) on the project will be convened prior to issuance of permits with press releases, notices published in local papers, and posted on the project website prior to each event.

PURPOSE AND NEED

The purpose of the federal action is to respond to Dare County's permit applications, considering the purposes and resources of the Cape Hatteras National Seashore as expressed in statute, regulation and policy, and the National Park Service's objectives in taking action, detailed later in this chapter. Federal action is required by the US Army Corps of Engineers (USACE) to determine whether the Proposed Action meets the standards and requirements for issuance of a major permit for construction activities in critical areas and in the coastal zone. State action and a permit for construction in state waters are required under the NC Coastal Zone Management Act (CAMA), which is a prerequisite for the federal permits.

The Applicant's stated purpose for submitting permit applications to federal and state agencies is to secure permission to conduct a beach nourishment project. The permit requests are seeking approval for a one-time event to address the immediate problem of beach erosion along critically eroding sections of Hatteras Island and to protect NC State Highway 12 (NC 12) and community infrastructure. Sand placed along portions of the Seashore would be expected to migrate south (downcoast) and to feed other sections of Hatteras Island, while reducing runup and damage to existing dunes, backshore habitat, and infrastructure in the Buxton area. The Proposed Action would provide a wider beach to serve as a critical buffer for storm waves between the ocean and NC 12, the main highway serving the Seashore.

Need for Action

Federal action is needed by US Army Corps of Engineers for reasons stated above in Purpose and Need. NPS action is needed because Dare County has submitted an application and a plan to expand beach areas under NPS jurisdiction, which includes widening Buxton beach. Before the National Park Service can issue a special use permit allowing beach expansion within the park, it must consider and assess the potential impacts of the action on the natural and human environments pursuant to the National Environmental Policy Act. The NPS permit would be issued in coordination with the USACE permit.

The Applicant has proposed the action because Buxton's beach is narrower than other sections of beach on Hatteras Island. Normal waves are directly impacting developed property, and highway NC 12 is frequently flooded (Fig 1.3). The only road providing access to historic villages and park resources along Hatteras Island, NC 12 accommodates millions of visitors each year and serves as a critical lifeline for the health and safety of Hatteras communities. Dare County holds no jurisdiction over the maintenance of NC 12, as it is the State's responsibility to maintain the highway. While Dare County is involved in meetings addressing the erosion at Buxton, the county is dependent on the NC Department of Transportation (NCDOT) to develop solutions regarding the highway itself and to act on them.

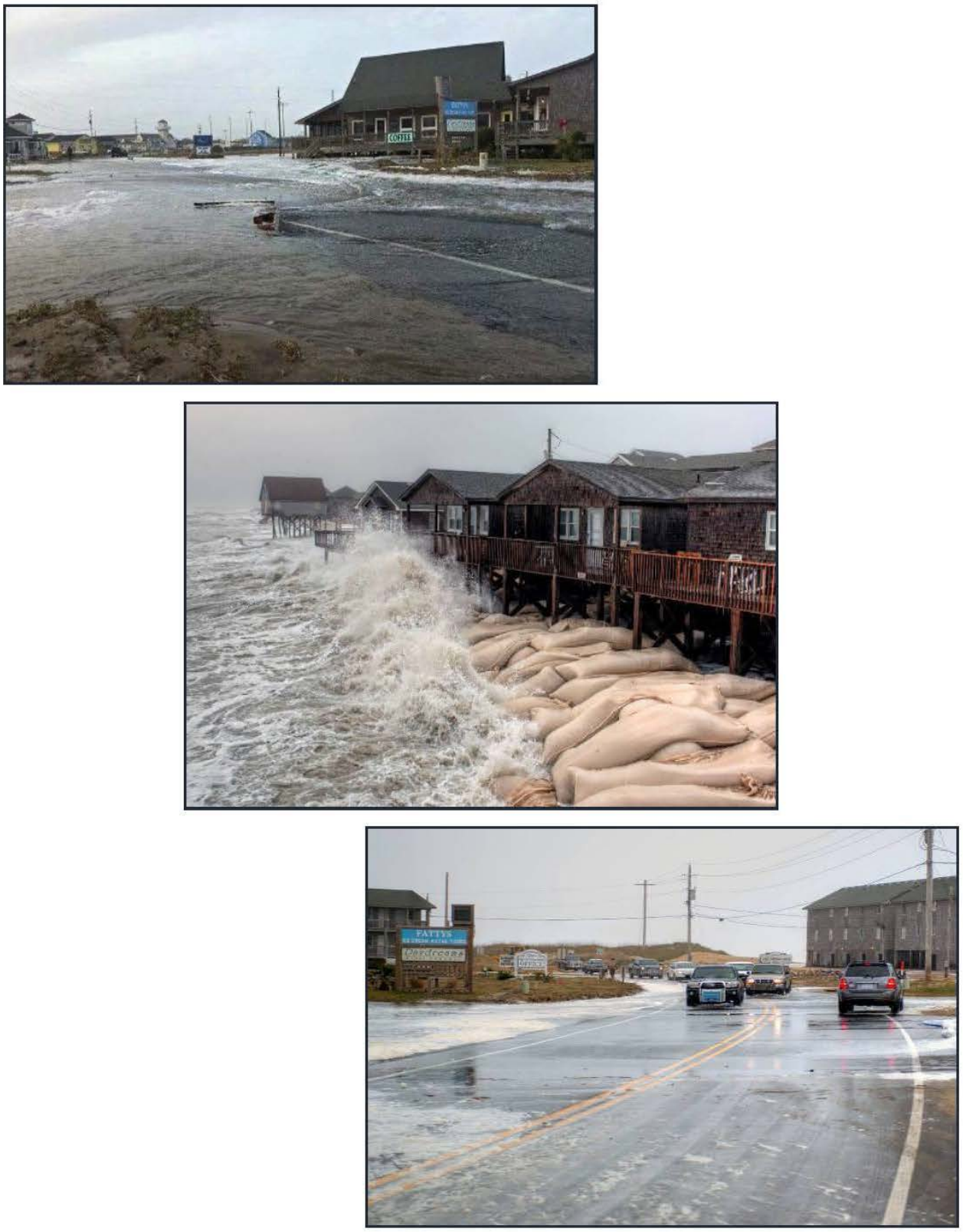

Figure 1.3. Flooding of NC 12 and damaging waves along the Buxton oceanfront during a northeaster on 8 December 2014. (a) NC 12 at the highway curve entering Buxton Village from the Seashore (photo by Brett Burley). (b) Wave breaking on emergency sand bags along a local oceanfront motel (photo by Danny Bowers). (c) Flooding on NC 12 near the Buxton Village-Seashore border looking northeast (photo by Danny Bowers). Erosion has left little sand on the beach along this section of Hatteras Island and, consequently, normal waves impact existing buildings.

A study commissioned by the Applicant has documented an estimated sand deficit that exceeded 900,000 cubic yards along the ocean beach in the Proposed Action Area (CSE 2013b). This deficit (i.e. the volume of sand needed to comprise a stable[1] beach) has developed over several decades. The foredune north of Buxton Village has breached frequently, damaging NC 12, often to the degree it is too dangerous or impossible to drive on. This has caused the NC Department of Transportation to conduct emergency repairs and push the dunes back up to keep NC 12 open (NCDOT, 2015 in prep, *Feasibility Study of Alternatives for NC 12 in the Buxton Area*). While efforts to maintain the protective dune have been successful for limited times between storm events, the condition of the beach has worsened. As beach width and sand volume decline, the vulnerability of NC 12 and infrastructure along the coast increases (NRC 1995). Sand losses due to chronic erosion in the Buxton Action Area have accumulated to the point where the amount of sand in the beach zone[2] is similar to that of Rodanthe in 2011 and is significantly lower than adjacent stable sections of Hatteras Island (see Appendix A - *Littoral Processes*).

Figure 1.4 shows the section of Hatteras Island about 20 miles north of the Buxton Action Area around the communities of the Tri-Villages (Rodanthe, Waves, and Salvo) along with the approximate width of the beach-dune system seaward of existing structures. Each community's vulnerability to storms is directly related to the condition of the littoral profile (ie the width and volume of sand seaward of buildings and infrastructure) as depicted in land cutaway diagrams (profiles) to left of the photo.

As depicted in Figure 1.4, Rodanthe has a narrow beach and negligible dune protection seaward of buildings. The communities of Waves and Salvo have increasingly wider beaches and dunes between buildings and the ocean. The latter two communities sustained Hurricane *Irene* (2011) and *Sandy* (2012) with little damage, whereas at Rodanthe numerous houses were damaged. Present conditions in the Proposed Action Area are similar to conditions in 2011 along parts of Pea Island, at Mirlo Beach, and at Rodanthe when breach inlets formed during Hurricane *Irene* (Fig 1.5) (CSE 2013b, USACE 2013a). The beach is narrow and highly vulnerable to breaching during storms.

The Applicant believes continued beach erosion would impact natural, cultural, and human resources in the Proposed Action Area. The narrow beach would allow waves to wash out the foredune during minor storms, leave steep escarpments, breach the dunes in places, and deposit sand on NC 12. There could be loss of bird and turtle nesting habitat seaward of the dune line and loss of vehicle access to communities at Cape Hatteras. Emergency repairs would be required to restore infrastructure and reopen NC 12; however, the underlying sand deficit along the Proposed Action Area would not change, leaving the area vulnerable to repeated damage.

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[1] *A stable beach is herein defined as a beach with sufficient width and sand volume to withstand normal yearly fluctuations in its profile without damage to the foredune. Beaches with insufficient sand volume in their profile have a deficit, which can be approximated by comparing stable beaches with eroded beaches as discussed in Appendix A.*

[2] *The active beach zone is considered to be the area between the toe of the foredune and some depth offshore where sediments are mobilized and shaped by waves, and the bottom elevation changes measurably at yearly to decadal scales.*

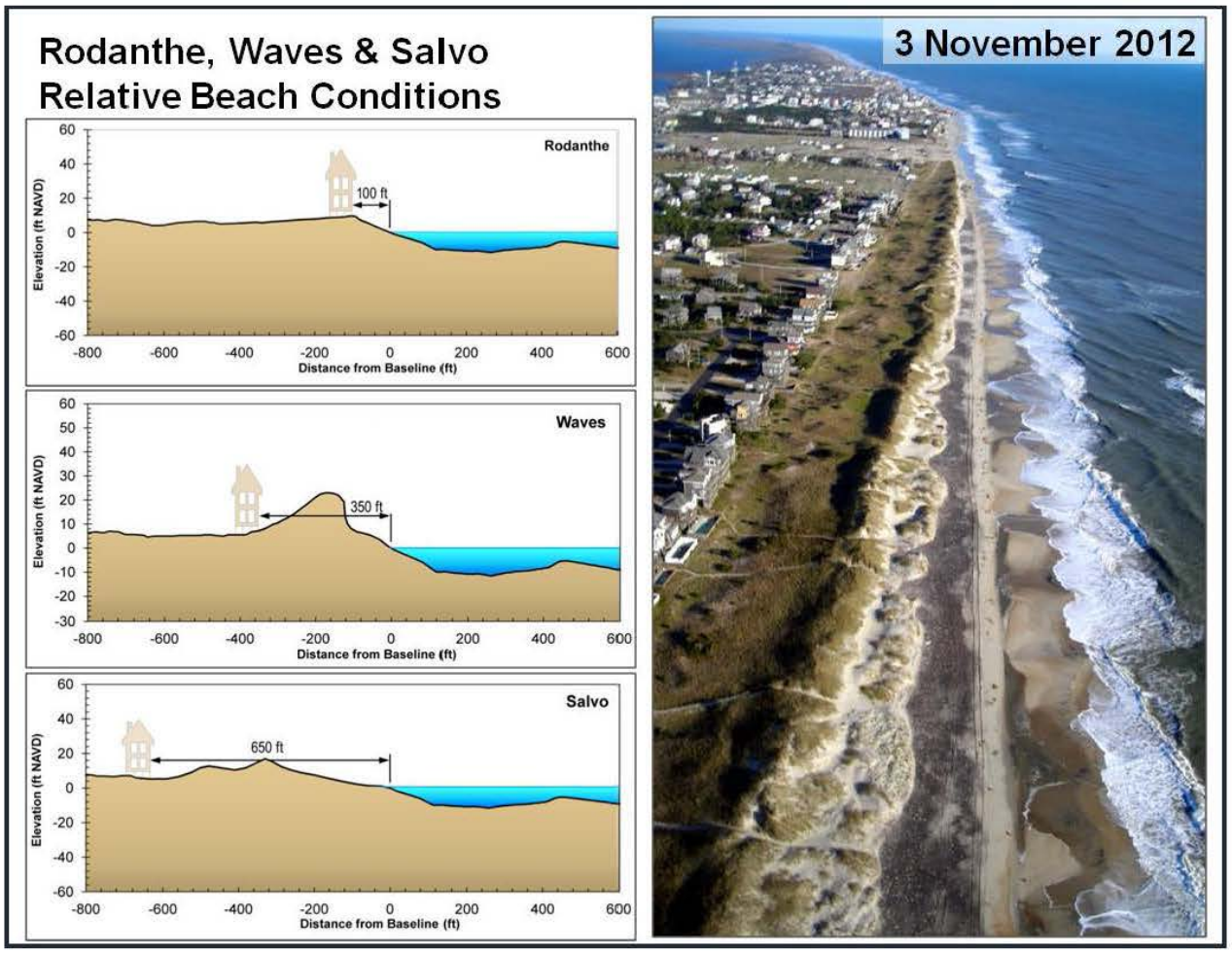

Figure 1.4. The shoreline along the village of Waves (NC) on Hatteras Island ~20 miles north of Buxton. The Village of Rodanthe is at the top of the photo, and the Village of Salvo is out of the picture below the bottom of the image. Photo was taken one week after Hurricane *Sandy* passed offshore (late October 2012). The side panels provide cutaway diagrams across the barrier beach and inshore area based on surveys by Coastal Science & Engineering in 2013. The panels show relative differences in beach and dune width seaward of buildings. Prior to Hurricanes *Irene* (27 August 2011) and *Sandy*, sections of Rodanthe lacked any dry-sand beach, whereas parts of Salvo had an ~400-foot wide dune field and dry beach seaward of development. Damages and overwash were severe along narrow sections of the island but negligible along stable areas of Hatteras Island such as Waves and Salvo. (Image by Coastal Science & Engineering)

Figure 1.5. Map illustrating the path of Hurricane *Irene* (27 August 2011). Dune breaches along low areas where the beach was narrow combined with peak tides in Pamlico Sound caused two inlet breaches:

Breach 1 (upper photo): ~29 miles north of Buxton Village along the Pea Island National Wildlife Refuge.
Breach 2 (middle photo): ~24 miles north of Buxton Village at Mirlo Beach (north end of Rodanthe).
Where the beach and foredune were wide between Waves and Salvo (lower photo), storm damage was negligible.

The worst oceanfront damage along the northern Outer Banks during *Irene* was at Mirlo Beach (middle photo). Storm waves eroded the foredune and washed into low areas along the barrier island, initiating breaches at several places. The lagoon surge and lower ocean tide on the evening of 27 August 2011 likely produced a sufficient head of water to cut the new inlets in the seaward direction at Rodanthe and along Pea Island. Both breaches closed naturally within weeks to a few months of the event with additional restoration work around the Mirlo Beach channel to rebuild the road bed.

(Images by Coastal Science & Engineering, Source: Kana et al. 2012)

Project Background

The location of the Proposed Action is on Hatteras Island in the Village of Buxton in the Outer Banks of North Carolina. Hatteras Island is part of a nearly continuous chain of barrier islands which extend from New York to Florida. As shown in Figure 1.6, the Cape Hatteras National Seashore includes portions of the islands of, Hatteras, Bodie, and Roanoke, which together offer about 70 miles of ocean shoreline. A similar length chain of barrier islands immediately to the south comprise the Cape Lookout National Seashore.

One of the largest preserved parcels of the Outer Banks, the Seashore offers beachcombing, birding, fishing, camping, wind-surfing, and kite-boarding to beachgoers and road trippers each year. The area is known for its abundant recreational, natural, and cultural resources, including such historic locations as the Cape Hatteras Lighthouse, the Chicamacomico Life Saving Station, the Wright Brothers National Memorial, and the Fort Raleigh National Historic Site (Cape Hatteras National Seashore, OuterBanks.com Visitor's Guide. http://www.outerbanks.com/cape-hatteras-national-seashore.html – accessed 17 April 2015).

There is only one highway linking all the Seashore islands and villages along the ocean. Before NC 12 was built, islanders drove on the beach to access homes and businesses. Seven villages—Hatteras, Frisco, Buxton, Avon, Salvo, Waves, and Rodanthe (from south to north)—occupy Hatteras Island, which includes a year-round population of ~ 4,300 people (2010 Census). Buxton is the largest of the villages, known for world-class surf fishing and the Cape Hatteras Lighthouse (Cape Hatteras National Seashore, OuterBanks.com Visitor's Guide. www.outerbanks.com/hatteras-island.html – accessed 14 April 2015). The Hatteras Lighthouse is a registered National Historic Landmark and a National Historic Civil Engineering Landmark, since its relocation inland in 1999 (Booher & Ezell 2001).

Hatteras Island has been positionally stable for over three centuries (Everts et al. 1983, Byrnes et al. 2003). Portions of the island, such as Waves, Salvo, and south Buxton, enjoy wide and stable beaches which have been accumulating sand. Other areas are narrow and have sustained extensive erosion along the oceanfront, notably around Rodanthe and East Buxton (NCDENR 2012).

Shoreline change rates along the Outer Banks oceanfront are variously reported to average 2.6 feet per year (Everts et al. 1983) to 4.5 feet per year (NCDENR 2012). At several localities, including south Nags Head, Pea Island, Mirlo Beach, and the Buxton Canadian Hole just north of the village, erosion rates have exceeded 10 feet per year over the past 50 years (NCDENR 2012). Coincidentally, these sites have experienced chronic dune breaching, over wash onto NC 12, or formation of temporary breach inlets.

Hatteras Island plays a vital economic role in the state and local economy. During peak tourist season, the Island receives up to 50,000 visitors daily which, in recent years, has stimulated notable growth in rental properties and businesses. A study for the Outer Banks Visitors Bureau (Lane 2013) found that Hatteras Island's tourism expenditures totaled $204 million in 2011, with a state tax contribution of $10.3 million and $9.4 million in local taxes. Also in 2011, island real estate generated >$9 million annually in Dare County property taxes and $2.1 million in occupancy tax collections. However, that same year, it was estimated that $2 million was lost in annual occupancy rates (in tourism terms shoulder season September and October), due to a two-month closure of NC 12 for dune rebuilding and road repairs.

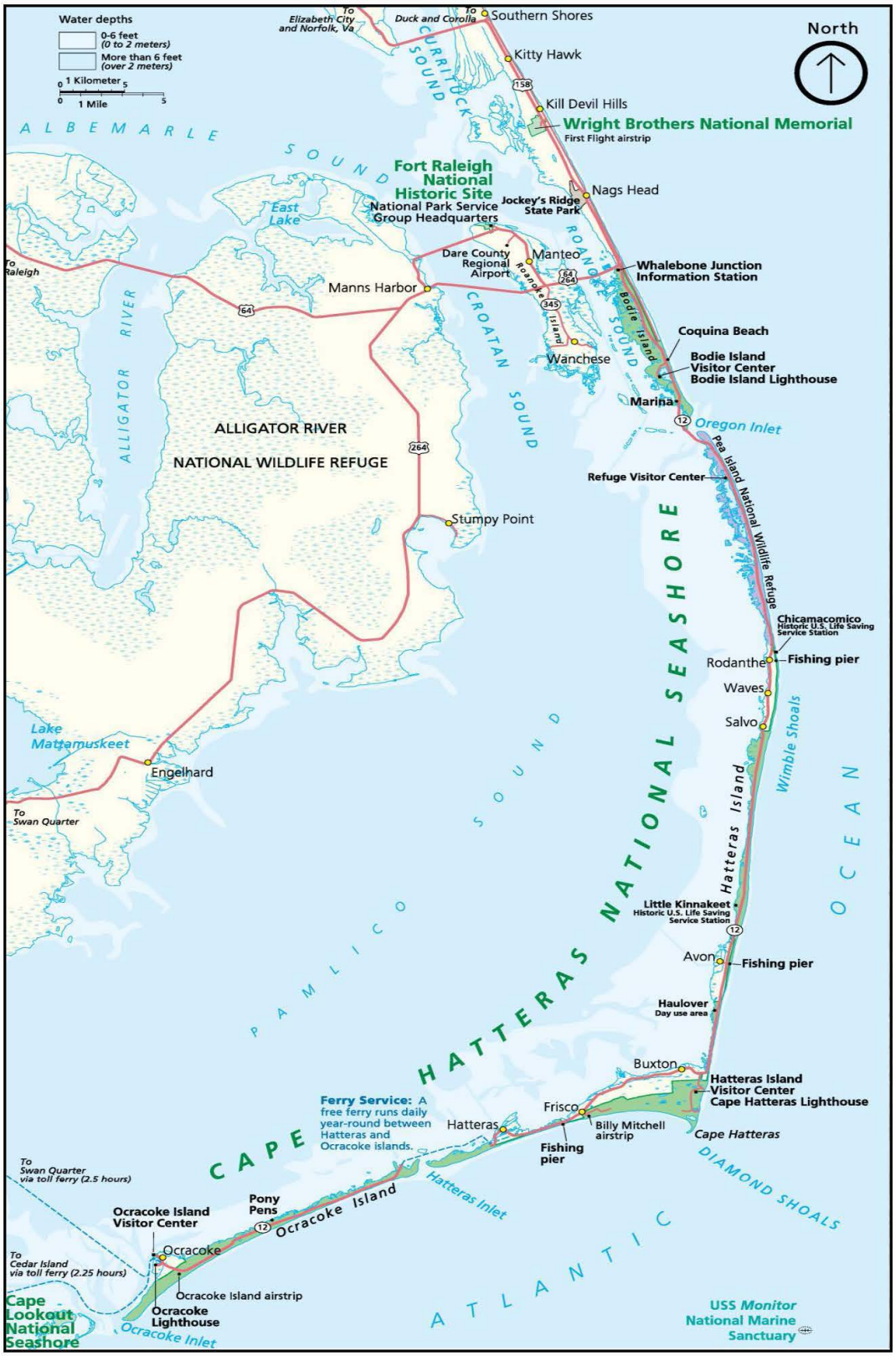

Figure 1.6. Map of Cape Hatteras National Seashore. The Buxton Action Area is situated between the Cape Hatteras Lighthouse and Haulover Day Use Area at the lower right corner of the map (NPS 2011).

In response to erosion, NC 12 has been realigned at some localities, including the Proposed Action Area north of Buxton Village. The highway was washed out by a breach inlet in 1962 (Fig 1.7) and was severely overwashed during other storms between 1962 and 1973 (Fisher 1967, Everts et al. 1983). After the 1960s storms, a realignment of NC 12 shifted the road as close as practicable to Pamlico Sound (NPS 1980). Beach nourishment between 1966 and 1973 reportedly helped mitigate breach events for over 20 years (Lighthouse View Motel, J. Hooper, former Dare County commissioner, pers. comm., April 2014). However, continued loss of sand along the Buxton Canadian Hole has resulted in more frequent road repairs by NCDOT as a result of foredune breaches. The most recent repairs were in response to Hurricane *Irene* (August 2011) and Hurricane *Sandy* (October 2012).

Maintenance of NC 12 has been an issue for decades and remains the subject of intensive study by NCDOT. Presently, NCDOT is developing a feasibility study for NC 12 in the Buxton area to consider alternatives for interim (5-year) protection and longer term (50-year) protection (NCDOT, J. Jennings, Division Director, pers. comm., February 2015). Any improvements or modifications to NC 12 are subject to existing Easements and agreements between the National Park Service and NCDOT. While NCDOT studies are underway, the Applicant has reviewed the options for protection of NC 12, infrastructure, and maintenance of the beach under present coastal zone management (CZM) rules and regulations. The Applicant has determined that a wider beach is needed in the Buxton area to restore the sand deficit, protect the foredune and infrastructure, and maintain access via NC 12 in the Buxton Action Area with minimum disruption to the economy and the environment.

Erosion has also undermined 51 houses and motel units along the Eastern shore of Buxton Village, leading to emergency measures. These include sand-bagging to protect structures along ~1,500 linear feet of oceanfront at the south end of the Proposed Action Area (see Fig 1.3). Sand bags have eliminated a recreational beach and related habitats along ~10% of the beach in the Proposed Action Area.

The County commissioned a feasibility study to evaluate erosion and beach restoration alternatives (CSE 2013b). Detailed surveys into deep water documented that erosion over several decades has left a major sand deficit in the Buxton area relative to adjacent sections of beach (see Appendix A – *Littoral Processes*). Dune-breach events have generally occurred in the areas of Hatteras Island where dunes are low, the beach is narrowest, and there is less sand seaward of buildings and infrastructure compared with a normal stable beach (see Fig 1.5). The breaches at Pea Island and Mirlo Beach during Hurricane *Irene* (2011) are examples.

PURPOSE AND SIGNIFICANCE OF THE PARK

In 1937, Congress authorized the establishment of a national park along the Outer Banks in the state of North Carolina to be administered under the Secretary of the Interior by the National Park Service. This park was designated a national seashore and established as the Cape Hatteras National Seashore 12 January 1953. The Seashore lands comprised ~100 square miles on the islands of Ocracoke, Hatteras, Bodie, Roanoke, and Colington, except those lands within the limits of established villages. Under the enabling legislation and later amendments, certain areas of the Seashore were designated for recreational use, hunting and fishing, primitive wilderness, and as a migratory bird refuge. As defined by the park service in the Seashore's *Foundation Statement*, the purpose of the park is (see Fig 1.6):

> *to permanently preserve the wild and primitive character of the ever- changing barrier islands, protect the diverse plant and animal communities sustained by the coastal island processes, and provide for recreational use and enjoyment that is compatible with preserving the distinctive natural and cultural resources of the nation's first national seashore.* (NPS 2011 pgs 9–11)

Figure 1.7. In March 1962, the mid-Atlantic northeaster of record, Ash Wednesday storm, breached the dunes at Buxton and opened an inlet within the Proposed Action Area. A temporary timber bridge was built over the inlet to restore access. However, a northeaster during the period 25 November to 3 December 1962 destroyed the bridge. The images show the inlet at Buxton (upper left) looking south (5 December 1962). Local interests (non-federal) closed the breach between (upper right) 29 January 1963 and (lower) 21 February 1963. The borrow source was in Pamlico Sound in close proximity to the project site. (From USACE 1963, Appendices 6-19)

Continuing in the *Foundation Statement*, the park service recognized seven areas of major coastal, biological, cultural, and historical significance. These included the preservation of unspoiled barrier islands, their associated flora and fauna, and recreational use; the inherent value as a living laboratory for physiographic, oceanographic and ecological research; the diversity of aquatic and terrestrial habitat which support a variety of marine and land-based wildlife, including protected and endangered species; the tangible archeological links to human survival and adaptation in a coastal environment isolated from the mainland; and historical events of national significance on or near its shores, including shipwrecks, wartime reconnaissance, and development of new technology (NPS 2011, pgs 10–11). The Applicant's Proposed Action could potentially impact each area of significance cited by the park service.

The National Park Service has designated ten national seashores including seven along the US East Coast. The four closest to Cape Hatteras are Fire Island (NY), Assateague Island (MD/VA), Cape Lookout (NC), and Cumberland Island (GA). Fire Island, Cape Lookout, and Cumberland Island are not accessible via road, while Cape Hatteras and Assateague Island are accessible. This difference in accessibility is reflected in the number of annual visitors (Table 1). During the past decade, Cape Hatteras and Assateague Island National Seashores have averaged over two million visitors per year. By comparison, Fire Island and Cape Lookout numbers around 500,000 visitors per year, and Cumberland Island sees less than 100,000 visitors per year.

The infrastructure along Hatteras Island that supports visitors and the long-established communities is far more extensive than that of the other national seashores referenced in Table 1. Roads, power lines, sewage treatment plants, parking areas, marinas, and extensive commercial activities have modified the natural setting. Unlike the Cape Hatteras National Seashore, the other seashores do not have a paved road spanning their lengths and are mainly undeveloped wildlife preserves.

TABLE 1.1 2010–2014 Average Annual National Seashore Attendance – US East Coast (http://irma.nps.gov/stats/)

Location	Ocean Shoreline (Miles)	Accessible by Car?	2010–2014 Avg. Annual Visitation
Cape Hatteras	70	Yes	2,164,792
Cumberland Island	18	No	68,121
Fire Island	32	No	458,825
Assateague Island	38	Yes	2,118,775
Cape Lookout	55	No	473,217

PREVIOUS AND RELATED PLANNING AND RESEARCH

An extensive literature review was conducted in the preparation of this Environmental Assessment, including several dozen articles and reports, EIS's, and EA's on similar projects along the Outer Banks and the Seashore, published between 1943 and 2014. Table 1.2 (next page) lists some of the key plans and studies which informed the development of alternatives for the Proposed Action. Additional background information and references are contained in Appendices A-G of this EA.

TABLE 1.2 Annotated list of plans and studies which informed and contributed to the development of alternatives according to the Applicant. USACE – US Army Corps of Engineers. CRA – Coastal Research Associates (Charlottesville, VA). ECU – East Carolina University (Greenville, NC.) CSE – Coastal Science & Engineering (Columbia, SC). CZR – CZR Incorporated (Wilmington, NC).

Date	Title	Source	Description
1963	**Report on Operation Five High. App 6-19. Closure of Buxton Inlet**	USACE	Documents impacts of March 1962 Ash Wednesday storm, which breached Hatteras north of Buxton Village within the Proposed Action Area (see Fig 1.7).
1974	**Buxton Beach 1973 Nourishment Project: An Annotated Photographic Atlas**	CRA	Prepared for NPS, report documents the 1973 beach nourishment project; ~1,300,000 cy pumped from Cape Point to Buxton Action Area; constructed between April and September.
1983	**Report on Shoreline Movement: Cape Henry (Virginia) to Cape Hatteras (North Carolina), 1849–1980**	USACE	Comprehensive shoreline change data spanning 130 years includes ocean and sound shorelines. Documents erosion of ocean shorelines averaging ~0.8 meter per year and sound shoreline at 0.1 meter per year. Documents 30 inlets opened and closed during the past ~400 years (i.e. ~7.5 inlets per century) with all but three of them (Oregon, Hatteras,) being short-lived.
2000	**FEIS on Hurricane Protection and Beach Erosion Control: Dare County Beaches (North Carolina)**	USACE	Recommends nourishment along ~14 miles of Bodie Island beaches including 10 miles along Nags Head. Addresses many of the environmental impacts that need to be considered for other nourishment projects in Dare County.
2006	**Management Policies – The Guide to Managing the National Park System**	NPS	Report outlines mandate for preserving and protecting America's national parks. For national seashores, the management policies discourage interference of natural barrier-island processes, in response to past modification of parks by development, construction/maintenance of roads, and rebuilding dunes.
2007	**The Creation and Establishment of Cape Hatteras National Seashore: The Great Depression through Mission 66**	NPS	Describes Seashore history, including early beach erosion control and dune restoration measures in the 1930s, the disposition of the Cape Hatteras Light Station, and efforts to improve park access by ferry and road construction.
2008	**North Carolina's Coasts in Crisis: A Vision for the Future**	ECU	Presents a theory that Hatteras Island is evolving toward a string of isolated islands separated by numerous tidal inlets, due principally to sea level rise.
2010	**FEIS: Beach Nourishment Project, Town of Nags Head (North Carolina)**	USACE	FEIS for the 4.6 million cy beach nourishment project completed between May and October 2011 along the Town of Nags Head. The 10-mile-long project used an offshore borrow source and was constructed by dredge with environmental protection measures prescribed under the permits. Project locally funded.
2012	**NPS Beach Nourishment Guide: Natural Resource Technical Report NPS/NRSS/GRD/NRTR-2012/581**	NPS	Provides guidance to better plan and manage beach nourishment projects when beach nourishment determined to be consistent with NPS management policies. Under NPS policies allowing intervention in natural geologic processes (pg 3), the Buxton Proposed Action must satisfy requirements for sediment quality, endangered species protection, and preservation of natural barrier-island processes.
2013	**Inventory of Coastal Engineering Projects in the Cape Hatteras National Seashore**	NPS	Provides information on prior coastal engineering projects identified in or immediately adjacent to the Seashore: 48 coastal structures, 17 beach nourishments, 5 dredging projects, and 2 dune construction projects.
2013	**Shoreline Erosion Assessment & Plan for Beach Restoration: Rodanthe & Buxton Areas, Dare County, North Carolina**	CSE	Evaluates the feasibility and probable costs of beach restoration and maintenance for up to ten years in the Rodanthe and Buxton areas on Hatteras Island. It serves as a primary reference for the Proposed Action and provides the preliminary technical basis for the Applicant's proposed plan.
2014	**Nags Head 2011 Beach Nourishment Project: Post-Year 2 and Final Report**	CZR-CSE	In accordance with benthic monitoring plan of NCDENR/NCDCM Permit 45-10, presents results of (1) pre- and post-nourishment biological sampling, (2) methodology and results from 4 seasonal pre-nourishment benthic sampling events and 8 seasonal post-nourishment benthic sampling events. Compares results of species abundance and diversity in the action area and adjacent unnourished areas.
2014	**Monitoring and Analysis of the 2011 Nags Head Beach Nourishment Project**	CSE	Presents beach-condition survey results covering three years of physical monitoring following construction of the 2011 beach nourishment project. Provides breakdowns of nourishment volumes remaining within four segments of the beach and six cross-shore zones. Data document the longshore and cross-shore adjustment of the nourishment and its response to storm events, including Hurricane *Irene* (27 August 2011) during construction and Hurricane *Sandy* (27 October 2012).

LAWS, REGULATIONS, AND POLICIES

Table 1.3 provides federal and state laws, regulations and policies relevant to this EA.

Table 1.3. US laws and regulations covering the coastal zone (presented in order of year passed)

Name	Administered by	Purpose
1968 National Flood Insurance Program (NFIP) (Created under the National Flood Insurance Act)	Federal Emergency Management Agency (FEMA)	- To reduce the loss of life and damage caused by flooding. - To help victims recover from floods. - To promote an equitable distribution of costs among those who are protecte by flood insurance and the general public. (NFIP Coastal Regulations–1968 to Present. (2011). NC Cooperating Tech. State. www.ncfloodmaps.com/pubdocs/fact_sheets/coastal_regs.pdf. Accessed 10 April 2015).
1969 National Environmental Policy Act (NEPA)	Council on Environmental Quality (CEQ)	- Prescribes requirements of federal agencies for reviews of proposed actions involving work in federal lands or where there is a federal interest.
1972 Clean Water Act (CWA)	Environmental Protection Agency (EPA)	- Establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface water Enacted in 1948 as the Federal Water Pollution Control Act, the CWA was reorganized and expanded in 1972.
1972 Coastal Zone Management Act (CZMA)	Office of Ocean & Coastal Resource Management (OCRM) / National Oceanic and Atmospheric Administration NOAA	- To manage the nation's coastal resources, including the Great Lakes. - To balance economic development with environmental conservation. - To preserve, protect, develop, and where possible, to restore/ enhance the resources of the nation's coastal zone. The CZMA also established: - National Coastal Zone Management Program to balance competing land and water issues in the coastal zone, and - National Estuarine Research Reserve System to identify field laboratories for research to arrive at a greater understanding of estuaries and how humans impact them. (NFIP Coastal Regulations–1968 to Present (2011). NC Cooperating Tech. State. www.ncfloodmaps.com/pubdocs/fact_sheets/coastal_regs.pdf. Accessed 10 April 2015)
1972 Marine Mammal Protection Act (MMPA)	National Marine Fisheries Service (NMFS)/ National Oceanic and Atmospheric Administration (NOAA)/ US Commerce Department	- To protect whales, dolphins, porpoises, seals, and sea lions by establishing a national policy: - To prevent marine mammal species and population stocks from declining to the degree they are no longer a significant part of their ecosystem. - To manage populations to maintain the health and stability of the marine ecosystem. - To set requirements for animal population management that places the benefit of the animal before commercial exploitation. - To prohibit the taking (harassment, injury, killing) of marine mammals unless exempted or specifically permitted or authorized as described in Section 101(a) (5) (A) and (D). - To require ESA Sect. 7 consultation for the issuance of incidental take authorizations under the MMPA. (www.nmfs.noaa.gov/pr/pdfs/mmpa_factsheet.pdf.; www.nmfs.noaa.gov/pr/. Accessed 13 August 2015.)
1973 Endangered Species Act (ESA)	US Fish and Wildlife Service (USFWS) / US Department of the Interior / National Marine Fisheries Service (NMFS) / US Commerce Department	- To designate/ conserve species that are endangered or threatened throughout all or a significant part of their range. - To conserve the ecosystems on which they depend. - To replace the Endangered Species Conservation Act of 1969. (Endangered Species Act (ESA). No pub date. NOAA Fisheries. www.nmfs.noaa.gov/pr/laws/esa/. Accessed 10 April 2015)
1982 Coastal Barrier Resources Act (CBRA)	USFWS / US Department of the Interior	- To designate relatively undeveloped coastal barrier areas along the Atlantic and Gulf Coast as part of the John H. Chafee CBRS. - To outline how to identify, map, and maintain CBRS areas. - To minimize the loss of human life, wasteful expenditure of Federal revenues and damage to fish, wildlife, and other natural resources. - To restrict future federal expenditures and financial assistance which have th effect of encouraging development in these sensitive areas. (NFIP Coastal Regulations–1968 to Present. (2010). NC Cooperating Tech. State. www.ncfloodmaps.com/pubdocs/fact_sheets/coastal_regs.pdf. Accessed 10 April 2015)

NC Laws and Regulations for Activities in the Coastal Zone (Table 1.3 continued)		
Name	**Administering Agency**	**Purpose**
1990 Coastal Barrier Improvement Act (CBIA) (Reauthorized the CBRA)	USFWS / US Department of the Interior	- To add new areas to the CBRS in Puerto Rico, the U.S. Virgin Islands, and the Great Lakes. - To expand the existing CBRS along the Atlantic and Gulf coasts. - To designate a new category called otherwise protected areas (OPAs),areas established under federal, state, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes. (NFIP Coastal Regulations–1968 to Present. (2010). NC Cooperating Tech. State. www.ncfloodmaps.com/pubdocs/fact_sheets/coastal_regs.pdf. Accessed 10 April 2015).
Coastal Area Management Act (CAMA) (1974)	NC Division of Coastal Management (NCDCM) NC Department of Environment & Natural Resources (NCDENR)	- To establish a cooperative program of coastal area management between the state of North Carolina and local governments. o The state establishes Areas of Environmental Concern (AEC's), such as wetlands, estuarine waters, renewable resource areas, fragile or historic areas, waterways to which the public may have rights of access, natural hazard areas, and Primary Nursery Areas. o Local government takes initiative for planning. State government shall act primarily in a supportive standard-setting and review capacity, except where local governments do not exercise their initiative. - To apply to all 20 coastal counties and all municipalities located within them. - To develop a program of permit review and coordination within areas of environmental concern. (NFIP Coastal Regulations -1968 to Present. (2010). NC Cooperating Technical State. www.ncfloodmaps.com/pubdocs/fact_sheets/coastal_regs.pdf. Accessed 10 April 2015).
Specific coastal management provisions under CAMA are:		
Dredge and Fill Regulations	NCDCM / NCDENR	NC Admin. Code tit. 15A, r. 7H.1500. A general permit allowing excavation within existing canals, channels, basins and ditches in estuarine/ public trust waters to maintain previous water depths.
		NC Admin. Code tit. 15A, r. 7K.0401. Exempting the USACE from permit require-ments regarding maintenance of federal navigation channels, including dredging and disposal of dredged materials in Areas of Environmental Concern (AECs).
		NC Admin. Code tit. 15A, r. 7M.1100. Under General Policy Guide-lines (Coastal Area): Providing that excavation/ maintenance material from navigation channels be used in a beneficial way.
Dune Creation/ Restoration Regulations	NCDCM / NCDENR	NC Admin. Code tit. 15A, r. 7M.0202. Under General Policy Guide-lines (Coastal Area): Allowing dune creation as a temporary measure to counteract erosion, but only to the extent necessary to protect property for a short period of time until threatened structures may be relocated or until the effects of short-term erosion event are reversed.
Near Shore Sand Mining Regulations	NC Division of Marine Fisheries (NCDMF) NCDENR	NC Admin. Code tit. 15A, r. 7H.0106, 7H.0208. Submerged lands mining rules for estuarine and public trust waters.
		NC Admin. Code tit. 15A, r. 7M.1201-1202. General Policy Guidelines (Coastal Area): Ocean Mining Policies for federal and state waters (applicable for federal consistency).
Public Access Regulations	NCDCM / NCDENR	NC Admin. Code tit. 15A, r. 7M.0201-0202. Shoreline Erosion Policies. The following are required with state involvement (funding or sponsorship) in beach restoration or sand nourishment projects: (a) the entire restored portion of the beach shall be in permanent public ownership, and (b) it shall be a local government responsibility to provide adequate parking, public access and services for public recreational use of the restored bEAch.* *Exception: The National Park Service manages parking and public access within the Cape Hatteras National Seashore.
Sand Scraping/ Dune Reshaping Regulations	NCDCM/ NCDENR	NC Admin. Code tit. 15A, r. 7H.1800. N.C. A General permit allowing beach bulldozing needed to reconstruct or repair frontal and/or primary dune systems.

OBJECTIVES IN TAKING ACTION

Based on the needs for the Proposed Action listed previously, the following objectives have been identified for evaluating alternatives. The project should:

- Build a wider beach predicted to last up to ten years, addressing the sand deficit along a critically eroding section of Hatteras Island.
- Provide a more effective buffer during storms to reduce damages to NC 12, property, and infrastructure, which considers the natural flow of sand from north to south.
- Reduce the need and cost of providing repeated emergency repairs of the dune around Buxton Village and of providing repeated repairs of the physical damage caused by major storms to NC 12, water and power lines, and related infrastructure.
- Minimize the impact on marine and wildlife species and protect natural, cultural, and historical resources during construction within the regulations and guidelines of NEPA and other federal and state laws.
- Provide secure, reliable access for residents, workers, and visitors to Hatteras Island and the Seashore that is compatible with local land and water uses, including coastal and wildlife areas, year-round and vacation residences, businesses and commercial areas, and natural, cultural, and historic resources.
- Expand coastal habitat during and after project completion to provide improved nesting opportunities for threatened or endangered sea turtles and expanded nesting or roosting areas for piping plover, other threatened or endangered shorebirds, and other colonial water birds.

SCOPING PROCESS AND PUBLIC PARTICIPATION

Summary of Scoping

Scoping is an early and open process to determine the breadth of environmental issues and alternatives to be addressed in a National Environmental Policy Act document. Scoping is used to identify which issues need to be analyzed in detail and which can be eliminated from in-depth analysis. For this project, the interdisciplinary team used scoping to:

- allocate assignments among the NPS interdisciplinary team members, USACE officials, and/or other participating agencies;
- identify related projects and associated documents;
- identify permits, surveys, consultation, and other requirements; and
- create a schedule that allows adequate time to prepare and distribute the EA for public review and comment before a final decision is made.

Scoping activity may include any public, staff-interested agency, or any agency with jurisdiction by law or expertise (e.g. USFWS, NCDENR, and NCDCM).

The Proposed Action alternatives have been developed following a series of public discussions and community forums convened by Dare County (2012–2014), internal and interagency scoping meetings, and formal federal public scoping in January and February 2015. Dare County officials have met frequently (in person and via regular teleconference) with park service officials throughout 2014 and 2015 to discuss the purpose and need for the project and solicit input from NPS staff and the US Fish and Wildlife Service about issues of concern.

Internal and Agency Scoping

Three pre-application meetings were convened (22 October 2014, 8 January and 29 July 2015) at the offices of the NC Department of Environment & Natural Resources in Washington, North Carolina to solicit input from state and federal resource agencies and the principal permit-issuing agencies for projects of this type: US Army Corps of Engineers, National Park Service, and NC Department of Environment & Natural Resources (NCDENR)/Division of Coastal Management. In addition to the permit-issuing agencies, resource agencies in attendance included the US Fish & Wildlife Service, National Oceanic Atmospheric Administration/National Marine Fisheries Service, and NCDENR's Wildlife Resources Commission, Division of Marine Fisheries, and Division of Water Resources. The pre-application meetings provided opportunities for park service resource personnel, state resource agencies, and the principal permitting agencies to outline issues of concern and to identify environmental impacts to be addressed in project documents under the NEPA process.

Public Scoping

Dare County convened public forums in Manteo (county seat) and Buxton on 18-19 August 2014, and the park service convened public forums at the same localities on 27–28 January 2015. Public comments were solicited during a public scoping period between 12 January and 27 February 2015. These were invited under formal NPS public scoping in response to a Notice of Intent (NOI) published in the Federal Register on 29 December 2014, pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969. The Notice of Intent to prepare an Environmental Impact Statement (EIS) notified the public of a request from Dare County, North Carolina for a Special Use Permit from the National Park Service for activities related to beach widening in the Buxton area within and adjacent to Cape Hatteras National Seashore. The public comment period extended to 27 February 2015, and written comments were collected through the Planning, Environment, and Public Comment (PEPC) website (http://parkplanning.nps.gov/caha).

Following receipt of public comments in response to the Notice of Intent, the National Park Service met with the US Army Corps of Engineers officials and determined that the Proposed Action should be evaluated under one joint Environmental Assessment (EA) by the USACE and the National Park Service. Accordingly, the National Park Service issued a Public Notice of Termination (dated 17 June 2015) of the EIS and its intent to prepare the present EA (FR Vol 80, No 116, pg 34691).

Over 260 comments on the Proposed Action were received. The majority of comments were concerns about not implementing the project soon enough because of the situation's urgency. The public was alerted to watch for updates and information on the Cape Hatteras National Seashore website, at local media outlets, and on the PEPC website. A summary of comments received follows.

Socioeconomic Concerns

Most concerns were about the socioeconomic impacts caused by the loss of beach area due to the ongoing erosion and threat of increased erosion during storm events. These concerns were focused on the need to protect NC 12 and infrastructure in the Buxton area and to maintain the transportation corridor for residents and visitors to Hatteras Island. Ocean storm-caused flooding, overwash, and sand deposition are becoming more frequent and severe, which has further heightened concerns about the potential threats to public safety and to the island economy if a breach inlet occurs.

The main concerns cited were chronic erosion damages associated with the narrow beach, impassable conditions on NC 12 and other roads during storms, road closure and damage creating safety issues (such as risky travel conditions and limited access for emergency vehicles, hospitals, emergency

services, and supplies), and impeded access to schools, churches, jobs, businesses, and ferry service to Ocracoke Island. Other concerns expressed included cost of repeated road closures and repairs, unstable water and electricity supply, and total loss of water and electricity caused by storms damaging utility lines along NC 12. Also, concerns were expressed regarding loss of revenue for tourist-dependent businesses, county and state tax revenues, and jobs–particularly because visitors may be discouraged by storm damages causing limited access, smaller beach areas, and closed accommodations. Severe erosion is causing ongoing property damage to houses and business in Buxton and forcing emergency measures, such as sand-bagging, which blocks access along the beach.

Another concern stated that nourishing an erosional beach was a losing battle, and that a beach renourishment project to widen Buxton beach would be a short-term, expensive, and ineffectual solution. Others noted the favorable impact of the 1973 Buxton beach nourishment project and the more recent experience of the 2011 beach nourishment project at Nags Head, North Carolina. Generally, respondents expressed strong support of restoring the beach through nourishment for up to a predicted 10 years, while the NC Department of Transportation sought a more permanent solution.

Natural Resources Concerns

Concerns regarding impacts on natural resources were also expressed. These included the following: impacts on sensitive beach-nesting birds and sea turtle species during the breeding season through noise and physical disruption, increased sand compaction and hardness, and changes in moisture content and beach slope; impacts on fisheries from dredging during the seasonal moratorium (1 April – 30 September) by increases in turbidity and pollution at the site, and by physical harm caused by the operation of the dredge itself. One commenter stated that the summer season is considered critical to growth and reproduction of fish, shellfish, and their habitats, and the project would produce irrevocable, long-term impacts to the beach's biotic community through changes in sand characteristics, substrate composition, slope, or profile of the beach.

One commenter expressed concern that the project would increase erosion rates due to increased wave energy and prevent wave overwash of the narrow barrier island. Continuing, the commenter noted that this precludes accretion on the sound side of the island, causes the island to narrow, and diminishes the overwash fans that provide wildlife habitat on a barrier island. Other concerns expressed included potential loss of wildlife habitat for species that use the beach and nearshore waters and impacts of dredging at the borrow area offshore of Buxton Village, a high-relief sand shoal that could possibly be classified as Essential Fish Habitat (EFH). One commenter stated that dredging of Oregon Inlet and associated dune building has caused erosion of beaches. There is concern that the project is not a one-time beach nourishment project and that it would set a precedent for future beach nourishment.

A number of commenters stated that adding more dune and beach area would provide more breeding area for sea turtles and birds by creating a larger habitat for nesting.

Visitor Experience Concerns

Among the comments during public scoping were questions concerning why millions of dollars were spent to move the Cape Hatteras Lighthouse, if there was no intention of maintaining access via NC 12 in Buxton so that people can see it. One commenter stated the borrow area off Buxton is used by recreational and commercial anglers during the summer months, and user conflicts could be high during the proposed summer timeframe for construction. The habitat near shoals, such as the borrow area, was cited as a reason fishermen flock to this area. Another visitor-experience concern was beach closure during the high-use summer timeframe.

Alternatives and Mitigation

Many commenters recommended a declaration of a state of emergency so the project can be implemented in 2015 because delaying the project until 2016 would increase the risk of more storm-related damages. A few comments also recommended special-use permits be issued for other erosion hotspots, including within Hatteras Village and along Roanoke Island. Some commenters requested that in addition to beach nourishment, the project should include stabilization methods, such as groins, to stop beach erosion. Other comments included that the special-use permit for beach nourishment should be a one-time event and be designed to ensure that it would accomplish its stated purpose. Also stated was that the beach nourishment should take place between November and March, utilizing protective buffers to exclude beach nourishment activities from the areas around any unfledged shorebird broods and any unhatched sea turtle nests.

One commenter suggested that relief to the construction moratorium window might be considered in the beginning or in the end of the moratorium period if efforts are made to avoid working during the moratorium. Another commenter wants to limit the duration of the dredging and nourishment activities over the course of each day and limit the total number of days that the dredging and nourishment activities last, while reducing the overall scope of the project to the smallest scale possible. It was suggested by one commenter that other borrow areas offshore which are not essential fish habitat be considered.

Another commenter recommended that the design incorporate unnourished spans within the Proposed Action Area to foster the recovery of the biotic community on the beach. It was suggested by one commenter that negative effects from the dredge and fill operations could be minimized by taking shallower cuts from the borrow area to reduce negative impacts to benthic fauna while leaving some habitat relief. One commenter recommended biological monitoring to measure impacts of the project as well as habitat recovery and to contact US Fish & Wildlife Service and nearby municipalities that have completed recent nourishment projects within Pea Island National Wildlife Refuge and on Bodie Island.

Many issues of concern mentioned in the comment letters during the public scoping period were brought to the attention of the Applicant by the park service and the resource agencies at pre-application meetings. The next section identifies the issues and impact topics retained for detailed analysis in this document.

PLANNING ISSUES AND CONCERNS

Specific considerations and concerns were identified through public discussions and open forums convened by the Applicant, pre-application meetings with the US Army Corps of Engineers, other federal and state regulatory and resource agencies previously named, and the NPS scoping process. Those identified were considered critical to incorporate, while planning how to best manage erosion in the Buxton Action Area over a reasonable time period. The following were identified as most important to the design and planning process:

- Address the primary threat of erosion, which is loss of sand along the oceanfront and restore a viable, wide beach.
- Quantify the degree of erosion in an objective manner such that realistic projections of future changes with or without action can be made.
- Seek a solution which mimics natural processes while protecting natural and cultural resources to the extent possible, including anticipated downcoast movement of sand over time.

- Provide a solution which has significant longevity within a budget that considers the limited resources of the community and does not depend on subsidy support by the state or federal government.
- Anticipate that natural processes associated with a wider beach would potentially enhance the back beach and dune area, thereby reducing damages to existing infrastructure.

In addition to these primary planning considerations, the Applicant has considered logistics and site access, quality of materials, existing land use, recreation, natural features, and indigenous wildlife of the area. Along with the purpose and need for the Proposed Action, these topics guided the development of alternatives and contributed to selection of impact topics, as identified in this section.

Anticipated Sea-Level Rise

Drawing from tide gauge data from the National Oceanic & Atmospheric Administration (NOAA), the North Carolina Coastal Resources Commission (NCCRC) has determined that sea level in the Oregon Inlet area (~35 miles north of the Buxton Action Area) rose 3.65 millimeters (mm) per year (±1.36 mm) between 1977 and 2013 (NCCRC 2015). This equates to a 30-year rise of 4.3 inches (range 2.7–5.9 inches). Using that measurement rate and certain scenarios developed by the Intergovernmental Panel on Climate Change (IPCC 2013a, 2013b), the NC Coastal Resources Commission projects that by 2045 sea level will rise between 6.3 inches (range 3.9–8.7 inches) and 7.3 inches (range 4.7–9.9 inches). The IPCC scenarios consider a range of greenhouse gas emissions (Church et al. 2013). The resulting range in the NCCRC 30-year projections for the Oregon Inlet area represents the lowest and highest greenhouse–gas-emission scenarios adopted by IPCC (2013a).

As previously illustrated (see Fig 1.4), some segments of Hatteras Island have wider beaches and wider dunes which are building seaward, whereas other segments are narrow and highly erosional. Some studies (Leatherman et al. 1999, Riggs et al. 2008) suggest that sea-level rise is an important factor in explaining coastal erosion. Other studies (e.g. Hayes 1994, NRC 1995) suggest that erosion is site-specific and a function of many factors of which sea-level rise may be a minor one, compared with other factors such as sand trapping by jetties (Dean & Dalrymple 2002) or inlet sediment bypassing (Bruun & Gerritsen 1959, Kana et al. 1984). Due to broad concerns over the impact of sea-level rise on coastal areas and the varying scientific opinions specifically regarding its impact on the Proposed Action Area itself, sea-level rise has been considered in the planning process and would continue to be over the expected design life of the project.

The Proposed Action at Buxton is expected to have a limited design life of the order ten years in accordance with the Applicant's available funds and preliminary projections of design life for certain alternatives (CSE 2013b). Using the most current projections of sea-level rise and pro-rating them for a ten-year project design life, sea-level rise rates are expected in the range of 1.3 inch to 3.3 inches (range of means from 2.10 inches to 2.43 inches). It can be shown that a sea-level rise within these ranges equates to beach recession via inundation of the order ~1.6 feet to 4.1 feet over a ten-year period, assuming beach slopes of ~1 on 15, typical of Hatteras Island (Bruun 1962, Hands 1981, CSE 2013b).

Regulatory Role and Proposed Action Alternatives

The Applicant recognizes that the National Park Service administers the lands on which any proposed action along the oceanfront may occur in the Buxton area. NPS Management Policies (2006) provide guidance regarding protection and preservation of park resources. It is likely that the Proposed Action

alternatives would involve unavoidable temporary impacts associated with construction activities but would also potentially produce some beneficial impacts in the form of a wider beach.

Existing federal and state rules for activities in the coastal zone place a high burden on the Applicant to demonstrate that adverse impacts would be minimized to the extent practicable and that appropriate mitigation may be required in connection with execution of the Applicant's Proposed Action. The Proposed Action alternative must comply with NPS mandates for protection of park lands, preservation of habitats for threatened and endangered species, and the continued enjoyment of park visitors.

Site Constraints and Construction Logistics

Placement of sand in the beach zone is constrained by site conditions including continual exposure to waves, tides and currents. The Buxton Action Area is highly exposed to storm waves and does not offer a nearby safe harbor for dredging operations or convenient access for a trucking operation. The lack of nearby upland areas for sand mining is likely to make a trucking operation from far away sand pits prohibitively expensive. Other sand sources, such as Pamlico Sound deposits (see Fig 1.7) may produce greater environmental impacts or result in deposits of incompatible material on the beach. The Applicant's overarching goal is to execute the Proposed Action in the shortest time possible at a scale that provides significant longevity so that the action area can return to normal upon completion. This would lessen the need for frequent beach maintenance activities and reduce or eliminate frequent post-storm emergency measures, such as dune rebuilding and repairs to NC 12.

Existing Uses of the Area

Existing uses within the action area include nesting, foraging, and/or roosting activities for threatened and endangered species, fishing, beach recreation, surfing, picnicking, sightseeing, research, overnight visits, and permanent residence along the oceanfront. The Proposed Action and construction approach should be designed to avoid or minimize interference with these ongoing uses. Similarly, the Proposed Action should seek to preserve the general character of the setting or produce conditions which lead to a more natural character. For example, previous repairs after storms have restored the dune, pushed up asphalt and debris into its core, trucked in small quantities of sand, and left a relatively uniform, artificial dune along the critically eroding Buxton Action Area. Within the Village of Buxton, homes and businesses have required emergency sand bags to prevent major damage to buildings (see Fig 1.3). The Proposed Action alternatives should do nothing to exacerbate these conditions, and if possible, should provide improvements which ultimately yield a more natural character to the beach-dune system in the action area.

REGULATORY ISSUES AND MANAGEMENT CONCERNS

Based on discussions with federal and state regulatory agencies and the National Park Service, the beach construction activities described in this Environmental Assessment would not require any changes to existing legislation or management policies in order to be implemented. Prior to construction, the Applicant must follow all necessary procedures to apply for required permits and receive approvals from the US Army Corps of Engineers, National Park Service, and state authorizing agencies. These include the following:

- A USACE Individual Permit for impacts to navigable waters and wetlands of the United States pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act.

- A federal water quality permit pursuant to Section 401 of the Clean Water Act issued by the NCDENR Division of Water Resources (NCDWR).
- A North Carolina Individual Permit for impacts to critical areas pursuant to the Coastal Area Management Act (CAMA) issued by NCDENR Division of Coastal Management (NCDCM).
- A special use permit for activities within NPS lands pursuant to the National Environmental Protection Act (NEPA) issued by the National Park Service.

The USACE permit is conditioned on issuance of a Biological Opinion (BO) by US Fish & Wildlife Service on construction activities which are proposed to occur when protected species may be present. The permit is also subject to existing BOs issued by the National Marine Fisheries Service, if the Proposed Action alternative involves any offshore dredging during specified moratorium windows. In addition, project managers would coordinate activities and consult with NMFS as required regarding Critical Habitat dates for migrating loggerhead sea turtles.

ISSUES AND IMPACT TOPICS RETAINED FOR DETAILED ANALYSIS

Issues are potential environmental problems that may result from a proposed action. Issues were identified during scoping by specialists with USACE, NPS, USFWS, NMFS, NCDENR, academic institutions, and the public. Once issues were identified, they were used to help formulate the Proposed Action alternatives and mitigation measures. Impact topics were then selected for detailed analysis based on substantive issues, environmental statutes, regulations, and executive orders; and NPS (2006) management policies. A summary of specifics and rationale for their selection is given below.

Impact topics analyzed in this Environmental Assessment are listed below along with a brief rationale for the selection of each impact topic. They include coastal resources, sand resources, water quality, essential fish habitat, biological resources, cultural resources, socioeconomics, visitor use and experience, public safety, sustainability, and long-term management. In addition, cumulative impacts of the Proposed Action alternatives are addressed. Each topic is further discussed in detail in this document in Chapter 3: Affected Environment and Chapter 4: Environmental Consequences.

Coastal Resources (including Littoral Processes)

NPS Management Policies (NPS 2006) state that the National Park Service is charged with protecting barrier islands such as the Cape Hatteras National Seashore and allowing natural processes to proceed unimpeded to the greatest extent possible. Natural processes applicable in this case include barrier-island evolution, erosion, accretion, and longshore sediment transport in the littoral zone. Under certain circumstances, natural processes may be impacted for purposes of protecting important cultural resources or when existing development must be protected in the short-term to achieve park management objectives including high density visitor use (NPS 2006, Section 4.8.1.1).

Other interventions may be used when needed to protect other park resources, human health and safety, or facilities (NPS 2006, Section 4.1). In summary, impacts to park resources should be minimized to the greatest extent possible. The potential impact of the Proposed Action on littoral processes is addressed with supplemental information in Appendix A – *Littoral Processes*. Beach nourishment has been implemented on other NPS lands, including Assateague Island (Maryland), in response to erosion that is attributed to other man-induced changes to coastal resources (e.g. www.edi/nrs/classes/NRSS555/assets/rEAdings_08/schupp/Schupp_et_al_2007.pdf, accessed July 2015).

Sand Resources

The national seashores of the US East Coast are founded on unstable sandy soils which are subject to movement by winds, waves, and currents. The Proposed Action alternatives require identification of a suitable sand source(s) which may augment the natural beach system while not significantly changing the character of the beach or creating adverse impacts elsewhere. USACE and NPS guidelines for beach nourishment (USACE 2008, NPS 2012a) require that any sand considered for use as nourishment material must be similar in size, texture and quality to the existing (native) beach. In some settings where chronic erosion and shore protection structures have altered the normal distribution of sand size, it may be necessary or beneficial to re-introduce sands that match adjacent, undisturbed beaches. Potential sand sources for nourishment in the action area are evaluated in this EA and in Appendix C - *Geotechnical Data*.

Water Quality

NPS Management Policies (2006) and the Clean Water Act require that any action in the coastal zone shall safeguard and maintain or restore the quality of surface waters and ground waters and comply with all other applicable federal, state and local laws and regulations. The Proposed Action would involve dredging and placement of sediment in near shore waters of the beach zone. As such, construction operations have potential to introduce turbidity. Therefore, the impact topic of water quality is addressed.

Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires that federal agencies consult with the National Marine Fisheries Service to determine potential impacts on essential fish habitat (EFH) and what measures to avoid, minimize, mitigate and otherwise offset adverse effects on essential fish habitat. If an offshore borrow area is used for the Proposed Action (see Fig 1.1), potentially upward of 450 acres of ocean bottom may be altered. The dredging would impact benthic species living in surficial sediments upon which certain fish populations depend. An EFH assessment, in compliance with the Magnuson-Stevens Act, has been prepared and is included as Appendix D - *Essential Fish Habitat* in this Environmental Assessment. Because of its relevance to the Proposed Action, a biological monitoring report (CZR/CSE 2014) on the impacts of dredging and beach nourishment for the 2011 Nags Head beach nourishment project is included as Appendix E - *Biological Monitoring*.

Biological Resources

The Proposed Action would impact the beach and inshore zone where certain threatened and endangered species may be present during part of their life cycles. Because of the potential adverse impacts if construction occurs when certain species are present, the Applicant has identified and evaluated biological resources at risk under a *Biological Assessment* (*BA*) (Appendix B of this EA). Formal consultation with USFWS under Section 7 of the Endangered Species Act is required for projects of this type. The *Biological Assessment* (Appendix B) is required to assist federal resource agencies in evaluating the impacts of the project and to enable a biological opinion (BO) regarding whether the project would or would not jeopardize the continued existence of a threatened or endangered species. The BO is a prerequisite for a decision by the US Army Corps of Engineers to issue a permit for construction. Biological resources addressed in the BA and present Environmental Assessment include terrestrial, intertidal and subtidal species, along with identification and special attention to threatened and

endangered species, particularly nesting shorebirds and sea turtles. The BA addresses the habitats on which biological resources of the action area depend.

Cultural Resources

Cultural resources encompass archaeological and historic objects which may exist within the action area, including offshore waters where dredging operations may occur. The Applicant has consulted with the NC Historic Preservation Office regarding the Proposed Action in the action area and in the offshore borrow area. To supplement, the Applicant contracted for a cultural resources survey of the proposed borrow area and an inventory of historical buildings and shipwrecks that may be present in the Proposed Action Area (Appendix F – *Cultural Resources*). Per state requirements for borrow area confirmation (15A NCAC 07H.0312 Technical Standards for Beach Fill Projects, effective 1 February 2007, amended effective 1 August 2014), the survey included magnetometer, shallow seismic and side scan sonar geophysical data collection and identification of any targets which may represent debris, fishing gear, undersea cables or shipwreck remains. The survey provides specific recommendations for buffer zones (i.e. no-work areas) to avoid excavation and placement of non-compatible material on the beach. The only known historic landmark in the vicinity of the action area is the Cape Hatteras Lighthouse, which was moved from its historic position to a site ~1600 feet inland in 1999 (NRC 1988, Booher & Ezell 2001). Other structures of note are an abandoned and removed US Naval Facility adjacent to the old lighthouse site, which may have installed undersea cables and a sonar detection system for monitoring submarines after World War II (Appendix F – *Cultural Resources*).

Socioeconomics

NPS Management Policies (NPS 2006) require the National Park Service to identify impacts to socioeconomic resources when determining the feasibility of a proposed action. The purpose of the Proposed Action is to widen the beach and restore the sand deficit, which in turn would reduce potential storm damages to NC 12 and infrastructure on which the economy of Dare County depends. The project would not involve direct expenditures of state or federal funds, but may reduce or eliminate potential outlays by state and federal agencies following storm emergencies. Therefore, the cost of the proposed action is evaluated in relation to the economy at risk in this EA.

Visitor Use and Experience

Enjoyment of park resources and upholding the values of the people of the United States are part of the fundamental purpose of all parks (NPS 2006). The NPS mandate is to provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the natural and cultural resources found in parks. The visitor experience encompasses interpretation, understanding, enjoyment, safety, circulation, and accessibility. While the Proposed Action may result in temporary impacts to these elements during the construction phase, the No-Action alternative may result in longer term and more adverse impacts to visitor use and experience. Therefore, this impact topic is addressed in this EA.

Public Safety

NPS Management Policies (NPS 2006) instructs the National Park Service to consider public safety in all proposed actions. NC 12 is used heavily by permanent residents, park visitors, vacationers renting homes and hotel rooms, suppliers, public safety personnel and motorists who seek to experience the iconic drive along the Outer Banks. Beach nourishment operations necessarily involve work under potentially dangerous conditions along exposed ocean beaches. The USACE must weigh potential

hazards to construction personnel when issuing permits, drawing on prior experience with accidents. USACE must also ensure that work is performed according to federal Occupational Safety and Health Administration (OSHA) laws and regulations. Because of its importance, Public Safety is retained for analysis in this EA.

Sustainability and Long-Term Management

Public scoping identified a common concern regarding beach nourishment—specifically, that project construction may last a long time and may have to be repeated every few years. The Applicant is aware of these concerns based on previous comments at public forums and articles in the popular press. Alternatives should address duration of construction as well as longevity in accordance with beach fill design guidance by the USACE (2008) and other guidance for beach nourishment (e.g. NRC 1995, Dean 2002). Long-term management of NC 12 is being investigated by NCDOT (NCDOT 2015, in preparation), has been taken into consideration by the Applicant, and is addressed in this EA.

IMPACT TOPICS DISMISSED FROM FURTHER ANALYSIS

Geologic Resources

The National Park System encompasses lands with significant geologic features, land forms and landscapes characteristic of the United States. The principal land form associated with Cape Hatteras National Seashore is the barrier island and its associated beaches, capes, inlets, sounds and related habitats. The Proposed Action Area does not represent any unique barrier island features that are only found within the ~3-mile-long Buxton segment of the Outer Banks. Further, the Buxton segment has been modified by sand scraping, dune re-construction after storms, installed vegetation and emergency shore protection devices, such as sand bags, to protect developed property. Any proposed action by the Applicant should seek to maintain or improve upon this altered landscape for the general benefit of park users and indigenous wildlife. No mineral resources, gas or oil reserves, or unique geologic features would be impacted by the project. Therefore, the impact topic of geologic resources is dismissed from further analysis. The impact of the project on the form and profile of the barrier island, beach, and borrow area is addressed under coastal resources.

Soils and Upland Topography

The Proposed Action would involve placement of beach quality sand in the active beach zone. It would not involve any direct sand placement on existing vegetation or modify the existing dune topography during construction. The sand placement would seek to match the natural elevation and slope of the dry sand beach while widening this zone without change in topography. The resulting intertidal area is expected to remain nearly equal to pre-project conditions as discussed under Coastal Resources impacts. Because the Proposed Action would not alter the basic topography of the action area or modify soils where vegetation exists, the issue of soils and upland topography are dismissed from further analysis.

Floodplains

All federal agencies are required by Executive Order 11988 (Floodplain Management) to evaluate the likely impacts of their actions in floodplains. The objectives of the EO 11988 are to avoid, as much as possible, the short- and long-term adverse impacts associated with occupancy, modification, or destruction of floodplains and to avoid indirect support of development and new construction in such

areas where there is a practicable alternative. NPS Director's Order #77-2 (Floodplain Management) provides NPS procedures for complying with EO 11988.

The barrier-island floodplains help to reduce the impact of hurricanes and other storms on the shorelines that they shelter. These floodplains provide storm-water holding capacity, reducing runoff that could otherwise flood developed areas. They also provide habitat for species adapted to the coastal barrier island environment. Storm events such as hurricanes and nor'easters (winter storms along the mid-Atlantic coast) and associated wave action and high precipitation are the prime sources of flooding in the Seashore. Additionally some areas are known to be susceptible to minor flooding without wave involvement when large amounts of rainfall occur.

North Carolina's barrier islands have historically been and continue to be affected by coastal forces and flooding events. The barrier islands of the Seashore are predominantly flat and narrow and lie adjacent to the shallow and wide Pamlico Sound. The widest part of the Seashore is near Cape Point, between the villages of Buxton and Frisco (Pendleton et al. 2005). According to Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps for Dare County (www.darenc.com/planning/floodmaps.asp, accessed May 2015), most of the Seashore is within the 100-year floodplain with the exception of some areas that are located at the Navy tower site on Bodie Island and a larger area on Hatteras Island near Buxton Village, which are within the 500-year floodplain (shaded X Zone). The Proposed Action Area itself lies completely within the 100-year floodplain (fris.nc.gov/fris/index.aspx?FIPS=055&ST=NC&user=General%20Public, accessed May 2015).

Generally, lands along the ocean beaches and adjacent to the sound (at wide points) are in flood zone VE, which is the flood insurance rate zone that corresponds to 100-year coastal floodplains that have additional hazards associated with storm waves, high water tables, and periodic flooding. Zone VE is also referred to as the Coastal High Hazard Area. Lands within the 100-year floodplain and not directly adjacent to the ocean or sound lie within the AE zone, which is subject to waves less than 3 feet high (NCDCCPS 2008); only zone VE is found within the Proposed Action Area.

None of the alternatives presented by the Applicant would elevate the action area above the floodplain or reduce the capacity and function of the affected floodplain. The Proposed Action can only occur within the floodplain, but it would not reduce the amount of floodplain. It would likely widen the recreational beach and potentially increase the capacity and function of the shoreface floodplain. The Proposed Action would not pose a risk to humans, a risk to investment, or impact floodplain processes and values. Therefore, the project is deemed exempt from the need to prepare a Floodplain Statement of Findings per NPS Director's Order #77-2 *Floodplain Procedures Manual* V. B Exemptions (National Park Service, Denver Service Center, Steven Culver, Natural Resource Specialist, pers. comm., 4 May 2015). The impact of floodplains is dismissed from further analysis.

Wetlands

Executive Order (EO) 11990 – *Protection of Wetlands*, directs all federal agencies to avoid, to the maximum extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. In the absence of such alternatives, parks must modify actions to preserve and enhance wetland values and minimize degradation. Consistent with EO 11990 and NPS Director's Order #77-1: *Wetland Protection*, the National Park Service adopted a goal of no net loss of wetlands. Director's Order #77-1 states that for new actions where impacts to wetlands cannot be avoided, proposals must include plans for compensatory mitigation that restores wetlands on NPS lands, at a minimum acreage ratio of 1:1.

For the purpose of implementing EO 11990 on NPS-managed lands, any area that is classified as a *wetland* according to the USFWS Classification of Wetlands and Deepwater Habitats of the United States (Report FWS/OBS-79/31 – Cowardin et al. 1979) is subject to NPS Director's Order #77-1 and its implementation procedures. Under the Cowardin definition, a wetland must have one or more of the following three attributes:

1) At least periodically, the land supports predominantly hydrophytes (wetland vegetation);
2) The substrate is predominantly undrained hydric soil; or
3) The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The Cowardin wetland definition encompasses more aquatic habitat types than the definition and delineation manual used by the Corps of Engineers for identification of wetlands under Section 404 of the Clean Water Act. Federal regulations define wetlands as:

> *Those areas that are inundated or saturated by surface or ground water (hydrology) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation (hydrophytes) typically adapted for life in saturated soil conditions (hydric soils). Wetlands generally include swamps, marshes, bogs, and similar areas.* (40 CFR 232.2 (r)

Wetlands can be identified by the presence of those plants (hydrophytes) that are adapted to life in the soils that form under flooded or saturated conditions (hydric soils). The Proposed Action Area is a high-energy, active beach zone where mobile sandy sediments preclude the establishment of vegetation. The 1987 Corps of Engineers Wetlands Delineation Manual and its regional supplements require that *all three* of the parameters listed above (hydrophytic vegetation, hydric soil, wetland hydrology) be present in order for an area to be considered a wetland.

Under the Cowardin wetland definition, the intertidal beach is classified as a marine wetland. Marine wetlands are found along the entire length of ocean shoreline between extreme high tide and extreme low tide and are subject to high wind and wave energy. The intertidal beach zone (Cowardin marine wetland) continually adjusts to wave energy and sand supply, maintaining a profile under conditions of erosion or accretion. The intertidal zone in the Proposed Action Area is degraded (see Fig 1.3) by the presence of sand bags. Any activity that increases the sand supply within the action area is likely to maintain or incrementally increase the area of marine wetlands, provided the introduced sediments are similar in size and texture as the native beach.

Because the Proposed Action is water dependent (can only occur in proximity to an aquatic environment) and there is likely to be no change or an incremental increase in wetland habitat, the Proposed Action is an exception under the Restoration Exception in Section 4.2.1 (h) of NPS Procedural Manual #77-1: *Wetland Protection.* Therefore, under the restoration excepted action a Wetland Statement of Findings does not need to be prepared, and the impact of wetlands is dismissed from further analysis.

The following best-management practices would be observed:

- Nourished shoreline would have similar slopes as the existing shoreline.
- Use of heavy equipment to shape the pumped sand would leave no trace of disturbance when restoration efforts are complete.

Water Resources

The Proposed Action would not alter surface water and ground water, or the exchange of these water resources. Because the profile topography and elevation of the beach would be designed to match the natural (existing) profile, drainage would be similar to existing conditions. Impacts on water resources under the Proposed Action was considered, but dismissed from further analysis in this EA.

Energy Resources

There are no known fossil energy resources in the Proposed Action Area. Waves and winds are considered an energy resource with potential to augment local power supplies along the coast. The Proposed Action would not alter wave power or winds and would only impact a small area of ocean bottom for a few months during construction. Impacts on energy resources under the Proposed Action were considered, but dismissed from further analysis in this Environmental Assessment.

Visual Resources

The Proposed Action would create temporary, short-term impacts to the vistas characteristic of an undeveloped barrier island. Heavy equipment and a dredge pipeline would be placed on the beach and would be visible to beachgoers in the vicinity of the active construction area. These impacts are unavoidable and are associated with all earthmoving projects. However, upon project completion after a few months of local impacts, all equipment would be removed and the action area left to evolve naturally. The vistas after project completion are expected to remain the same as pre-project conditions or to improve along areas where emergency sand bags have been placed due to severe erosion. Extra sand added to the beach system is expected to eventually build up along the backshore and toe of the foredunes. If the sand placed on the beach closely matches the native sand in terms of color, texture, and grain size distribution, there would be no long-term adverse impacts on vistas or user experience. Visual resources of the action area were considered, but dismissed from further analysis in this EA.

Navigation

Dredging projects involving US waters are subject to navigation rules administered by the US Coast Guard. Notices to Mariners would be issued according to existing rules and regulations alerting recreational boaters, commercial fishermen, and merchant mariners of the temporary presence of dredging equipment, floating and submerged pipelines, and associated support equipment in the action area. Because work would take place in a limited area of open ocean waters and would not involve excavation in confined channels, impacts on navigation are expected to be minimal. Recreational use of the offshore borrow area during construction would be possible around the same time as dredging operations, subject to existing rules for right of way and mariner safety in the vicinity of operating dredges. Notices of the effects of the Proposed Action on navigation during construction are mandated under law and would be incorporated into project plans and construction documents to ensure compliance. However, upon completion and removal of dredge equipment, the offshore area would return to approximate pre-project conditions. Navigation impacts of the Proposed Action were considered but dismissed from further analysis in this EA.

Historic Structures

No historic structures are present in the Proposed Action Area. The closest historic structure, the Cape Hatteras Lighthouse, was moved away from the shoreline in 1999 (NRC 1988, Booher and Ezell 2001). Remaining buildings close to the beach are non-designated hotels and houses, some of which are

protected by emergency sand bags. Under state CZM regulations, no beach nourishment sand can be placed on private upland property or shore-protection structures. All work would be performed seaward of existing structures, buildings, and NC 12. Impacts to historic structures in the Action Area were considered but dismissed from further analysis in this Environmental Assessment.

Ethnographic Resources

An ethnographic resource is defined as any site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it (NPS 2002). There are no known ethnographic resources within the action area. Therefore, the impact topic of ethnographic resources is dismissed from further analysis in this EA. In the unlikely event that human remains, funerary objects, sacred objects, or objects of cultural patrimony (or matrimony) are discovered during construction, provisions outlined in the Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001) would be followed.

Indian Trust Resources

Secretarial Order 3175 requires that any anticipated impacts on Indian Trust resources from a proposed project or action by US Department of the Interior agencies be explicitly addressed in environmental documents. The federal Indian Trust responsibility is a legally enforceable obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights. It represents a duty to carry out the mandates of federal laws with respect to Native American tribes. No known Indian Trust resources are present in the Proposed Action Area, and the lands comprising the park are not held in trust by the Secretary of the Interior for the benefit of Indians due to their status as Indians. Therefore, the impact topic of Indian Trust resources is dismissed from further analysis.

Museum Collections

A museum collection is an assemblage of objects, works of art, historic documents, and/or natural history specimens collected according to a rational scheme and maintained so that they can be preserved, studied, and interpreted for public benefit (NPS 2002). No museum collections are present within the action area and none of the park's existing museum collections would be impacted by the Proposed Action. Therefore, the impact topic of museum collections is dismissed from further analysis.

Prime or Unique Farmland

In 1980, the Council on Environmental Quality (CEQ) directed federal agencies to assess the effects of their action on farmland soils classified as prime or unique by the US Department of Agriculture, Natural Resources Conservation Service. Prime or unique farmland is defined as soil that particularly produces general crops such as common foods, forage, fiber, and oil seed; unique farmland produces general crops such as fruits, vegetables, and nuts. No prime or unique farmlands are associated with the action area; therefore, prime or unique farmland was dismissed as an impact topic in this EA.

Air Quality

Currently, Cape Hatteras National Seashore is located in an area classified by the US Environmental Protection Agency (EPA) as being in attainment for all six criteria air pollutants. Activities associated with dredging and beach nourishment produce localized, temporary increases in pollutant levels associated with operation of heavy machinery mainly through the combustion of diesel fuel. Highest levels would occur at the dredge offshore and at the active work zone along the beach. Pollutant

concentrates are expected to diminish exponentially with distance from construction and return to ambient levels in close proximity to the work areas. Upon completion of the work, no additional discharges or sustained impacts would be associated with the Proposed Action. Windy conditions along the Outer Banks are expected to disperse pollutants rapidly from the area. Emissions are not expected to be at a level that would contribute measurably to greenhouse gases on a wider scale and are not expected to produce conditions that would alter the EPA classification of Dare County for being in attainment for all six criteria air pollutants. Impacts of the Proposed Action on air quality were considered but dismissed from further consideration in this EA.

Climate Change

Climate change refers to any significant changes in average climatic conditions (such as mean temperature, precipitation, or wind) or variability (such as seasonality, storm frequency, etc.) lasting for an extended period (decades or longer). Recent reports by the U.S. Climate Change Science Program, the National Academy of Sciences, and the United Nations Intergovernmental Panel on Climate Change (IPCC) provide evidence that climate change is occurring and may accelerate in the coming decades. There is strong evidence showing that global climate change is being driven by human activities worldwide, primarily the burning of fossil fuels and tropical deforestation. These activities release carbon dioxide and other heat-trapping gases, commonly called greenhouse gases, into the atmosphere (IPCC 2007).

Two aspects of climate change must be considered in an environmental impact analysis and is recommended for consideration in an Environmental Assessment:

- Human impact on climate change (i.e. through our actions, the potential to increase or decrease emissions of greenhouse gases that contribute to climate change).
- The impact of climate change on humans (i.e. how are the resources that we manage likely to change in response to changing climate conditions, and how does that change or otherwise affect our management actions and the impacts of those actions on the resource?).

The Proposed Action would neither result in the construction of any permanent carbon-emitting infrastructure, nor would it result in any enhancement of vehicular use or create any new recreational attraction that would increase vehicular carbon emissions. During the construction process, the Proposed Action could result in a temporary increase in emissions of greenhouse gases from the operation of construction equipment. However, because temporary construction impacts would cease on completion, the Proposed Action would have no affect on climate change. The Applicant has considered the impact of the Proposed Action on climate change, but dismissed it as an impact topic for further analysis.

Impacts of climate change on the project are likely to be of a subtle, gradual nature. A rise in sea level would modify the beach profile and may cause wave attack to occur at higher elevations and/or be translated farther inland. Changes in climate such as general warming, changes in water availability, and storm frequency, intensity, or duration could cause changes in the rate of sand loss within the park over decades. While most people visiting or passing through the park would be unaware of the changes, changes in shoreline position may occur as a result of sea-level rise. Sea level rise is addressed under Anticipated Sea Level Rise in this Environmental Assessment as one of the primary planning considerations for the Proposed Action. Because sea-level rise operates at long time scales and the

Proposed Action is anticipated to last over one decade, or so, the impact of sea level rise on the Proposed Action over one decade has been analyzed in relation to the scale and scope of the Action.

Soundscapes

The National Park Service strives to maintain or reduce existing noise impacts within its parks to preserve, to the greatest extent practicable, the natural park sounds. The Proposed Action Area is adjacent to NC 12 and is, therefore, subject to regular noise emissions from vehicles. During construction activities, a temporary, localized increase in noise generation would occur due to the use of heavy equipment; however, the soundscape of the project overall would not be noticeably altered. Therefore, the impact topic of soundscapes was considered, but dismissed from further analysis in this Environmental Assessment.

Noise

Noise associated with dredging operations may trigger avoidance reactions in marine mammals which rely on sound for purposes of navigation and communication. Reine et al. (2014) found that the frequency and peak pressure of noise generated during dredging varies depending on the type of dredge. Because sound plays an important role in the marine environment for certain species, potential impacts of elevated sound levels are addressed for a number of species that may be present in the action area including whales, birds, and sea turtles.

Lightscapes

In accordance with NPS Management Policies (NPS 2006), the National Park Service strives to preserve natural ambient lightscapes and other values that exist in the absence of manmade light. The Proposed Action would not change lightscapes within the action area upon completion, and therefore the impact topic of lightscapes is dismissed from further analysis in this EA.

Construction activities would temporarily impact lightscapes in the active work area as a result of the likely need to work 24/7 during a limited period of time when offshore dredging is feasible in the Buxton setting. Construction lighting at night is subject to OSHA regulations (CFR 1926.56). Because of potential impacts of construction lighting on threatened and endangered species, the US Fish & Wildlife Service has prescribed certain measures if these species are present in the action area. These include the prescribed use of certain types of lighting on the beach and instructions for directing lights in particular ways to minimize impacts. More detail on light minimization is provided in the threatened and endangered species impact topic analysis in Chapter 4 of this Environmental Assessment.

Land-Use Planning and Design

There are no identified conflicts between the Proposed Action and land use plans, policies, or controls for the action area. The design of the built environment would remain relatively constant throughout the action area, with most of the oceanfront remaining in trust under NPS jurisdiction. The remainder of the action area within the village of Buxton is built out. Existing CZM rules prohibit any new development on restored beaches. In accordance with North Carolina coastal zone management rules (portal.ncdenr.org/web/cm/coastal-area-mangemt-act1, accessed May 2015), a mean-high-water survey would be performed along the Proposed Action Area to record its location prior to placement of any sand. Accreted lands seaward of mean high water due to the project would accrue to the state or federal government (as applicable) and would not become part of an existing private property. Therefore, the impact topic of land use planning and design was considered but dismissed from further analysis.

Energy Requirements and Conservation Potential

The Council on Environmental Quality guidelines for implementation of the National Environmental Policy Act require an examination of energy requirements and conservation potential as a possible impact topic in environmental documents [40 CFR 1502.16(e)]. NPS staff strives to incorporate the principles of sustainable design and development into all Seashore facilities and operations. The objectives of sustainability are to design structures to minimize adverse impacts on natural and cultural values, to reflect their environmental setting, to maintain and encourage biodiversity, to construct and retrofit facilities using energy efficient materials and building techniques, to operate and maintain facilities to promote their sustainability, and to illustrate and promote conservation principles and practices through sustainable design and ecologically sensitive use. Essentially, sustainability is living within the environment with the least impact on the environment. The Proposed Action could potentially result in reduced use of energy and conservation over the design life of the project, if it reduces the frequency of storm repairs needed. Each emergency repair of NC 12 and infrastructure requires use of heavy equipment and importing of construction materials from distant sources. However, the Proposed Action would not result in noticeable changes to energy requirements or the ability to conserve energy resources during normal, daily activities common to the action area.Therefore, the topic of energy requirements and conservation potential was considered, but dismissed from further analysis in this Environmental Assessment.

Environmental Justice

Executive Order 12898, General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing the disproportionately high and/or adverse human health or environmental effects of their programs and policies on minorities and low income populations and communities. According to the Environmental Protection Agency, environmental justice is the ...*fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations and policies. Fair treatment means that no group of people, including a racial, ethnic, or socio-economic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.*

The goal of fair treatment is not to shift risks among populations, but to identify potentially disproportionately high and adverse effects and identify alternatives that may mitigate these impacts. Environmental Justice is dismissed from further analysis for the following reasons:

- The park staff and planning team solicited public participation as part of the planning process and gave equal consideration to all input from persons regardless of age, race, income status, or other socioeconomic or demographic factors.
- Implementation of the Proposed Action would not result in any identifiable adverse human health effects. Therefore, there would be no direct or indirect adverse impacts on any minority or low-income population.
- The impacts associated with implementation of the Proposed Action would not disproportionately affect any minority or low-income population or community.
- Implementation of the Proposed Action would not result in any identified effects that would be specific to any minority or low-income community.

Infrastructure and Park Operations

No Seashore infrastructure is located within the immediate boundaries of the Proposed Action Area. Therefore, infrastructure is dismissed from further analysis. Park operations include certain monitoring and managing of threatened and endangered species, including patrols along the beach to locate and mark nests. These activities are expected to continue during and after the Proposed Action and to be a key means of minimizing impacts of the project by establishing no-work buffers and providing additional monitoring beyond that which is proposed by the Applicant. Following completion of construction, park operations, with respect to endangered species monitoring, are expected to remain the same, albeit along a wider beach with potentially more habitat area to consider. (See Chapter 4 for complete discussion of monitoring shorebird and sea turtle nests and relocating sea turtle nests.) The potential impact of the Proposed Action on park operations was considered but dismissed from further analysis.

CHAPTER 2 – ALTERNATIVES

This chapter describes the No-Action alternative and two action alternatives. The two action alternatives are for beach restoration along the Cape Hatteras National Seashore (Seashore) and the village of Buxton. The action alternatives were designed to augment the natural supply of sand along the ocean beach and reduce the frequency of dune breaches and storm damages to NC 12 and community infrastructure. The Environmental Assessment examines three alternatives:

- Alternative 1–No-Action
- Alternative 2–Winter Construction
- Alternative 3 (Preferred Alternative)–Summer Construction

Additional alternatives were considered during the early stages of planning, but were dismissed from further analysis for the reasons documented below.

DEVELOPMENT OF ALTERNATIVES

Guiding Principles

The Council on Environmental Quality regulations for implementation of the National Environmental Policy Act call for alternatives in a document to include a no-action alternative (i.e. Alternative 1). The description and evaluation of the No-Action Alternative provides a baseline against which the action alternatives can be compared.

Alternative 2–Winter Construction and Alternative 3–Summer Construction were developed based on the objective of Dare County (Applicant) to implement a project which mitigates erosion, restores the Buxton beach, reduces the frequency of dune breaches and storm damage to NC 12, and provides effective beach widening and storm-damage reduction for a period of up to ten years. The project would be funded by Dare County without imposing additional costs on the state of North Carolina or the US Government. It would be consistent with federal and state regulations for construction activities in the coastal zone, specifically the beach area, and seek to minimize the impact on marine and wildlife species during construction.

An objective of the Applicant is to implement a project which is indistinguishable from a natural beach while providing a wider buffer and expanded habitat areas between the ocean and threatened structures. Under current North Carolina CZM regulations, only three alternatives are allowed to deal with severe beach erosion: No Action (ie abandonment), Retreat and Relocation, and Beach Nourishment. Under the same state regulations, hard erosion-control structures are not allowed.

In addition to these guiding principles, NPS Management Policies (NPS 2006) were also considered. Specific and applicable policies are described below.

Protection of Geologic Processes

Geologic resources (both features and processes) are integral components of park natural systems. The National Park Service prefers natural geologic processes to proceed unimpeded except under certain circumstances (NPS 2006, Section 4.8.1). With respect to this project, *three* such exceptions are applicable:

- The project is necessary to respond to emergencies that threaten human life and property.

- The natural area has been previously modified or manipulated.
- No other feasible way exists to protect natural resources, park facilities, or historic properties.

Shoreline and Barrier Islands

Natural shoreline processes should be allowed to continue without interference where possible (NPS 2006). Manipulation of the shoreline may be approved only after an analysis of the degree to which such measures would impact natural resources and processes, so that an informed decision can be made through an assessment of alternatives. This Environmental Assessment represents such an assessment. NPS guidelines also require minimization of impacts outside the action area.

Barrier islands are formed and shaped by waves, tidal currents, and winds. At geological time scales (>1000s of years), they are ephemeral, temporary landforms dependent on the available sediment supply and specific position of sea level. At decadal to century time scales (time scales relevant for community planning), barrier islands exhibit a continuum of shoreline changes ranging from high erosion to high accretion. The majority of US East Coast barrier islands are changing at <1 meter per year at century time scales (Dolan et al. 1990).

Permanent infrastructure is not possible at geological time scales on barrier islands or over much of the coastal plain, but has been essential for some coastal islands at century time scales. Barrier island development has been a critical driver of the tourism economy in the US (Houston 1995, 2002, 2013). Fortunately, not all barrier islands are developed and large percentages (>50%) of the ocean coasts of Virginia, North Carolina, and South Carolina remain undeveloped.

The development of alternatives took into account the fact that relocation of NC 12, existing development and community infrastructure is not possible by the Applicant for a number of reasons:

- Dare County has no authority over private property, utility lines, and NC 12, a state road maintained by the NC Department of Transportation.
- Community infrastructure including NC 12 were previously relocated in the Buxton Action Area and are presently situated as far landward as practicable, without encroaching on USACE jurisdictional wetlands (salt marsh) along Pamlico Sound.
- There is a limited right-of-way corridor established through Easement agreements for location of infrastructure.

The NPS Management Policies (NPS 2006) recognize instances where resource management practices may influence alternatives available for decisions. In developing potential nourishment approaches for coastal areas, the Management Policies provide:

> *Where human activities or structures have altered the nature or rate of natural shoreline processes, the Service will, in consultation with appropriate state and federal agencies, investigate alternatives for mitigating the effects of such activities or structures and for restoring natural conditions. The Service will comply with the provisions of Executive Order 11988 (Floodplain Management) and state coastal zone management plans prepared under the Coastal Zone Management Act of 1972. Any shoreline manipulation measures proposed to protect cultural resources may be approved only after an analysis of the degree to which such measures would impact natural resources and processes, so that an informed decision can be made through an assessment of alternatives. Where erosion control is required by law, or where present developments must be protected in the short run to achieve park management objectives, including high-density visitor use, the Service will use the most effective method feasible to achieve the natural resource management objectives while minimizing impacts outside the target area. (4.8.1.1)*

The action alternatives selected for analysis are expected to mimic natural processes and have negligible effects on coastal processes, while restoring the beach and reducing the frequency of such emergency actions as road closures, dune reconstruction, and emergency sand bagging.

Beach Nourishment Implementation Options

Beach nourishment—the addition of beach quality sand to the littoral zone from non-littoral sources (NRC 1995)—can be accomplished by a number of methods including truck hauling and dredging via suction-cutter head dredge or trailing-arm hopper dredge. Cost is generally a function of the distance between the borrow source and the placement area and the means of conveyance. Therefore, nearby sources are favored for economic reasons. The Applicant considered alternate borrow sources, construction methods, and placement configurations. This EA addresses methods and sources deemed feasible and most advantageous with respect to project longevity and environmental protection given a fixed construction budget established by the Applicant. Beach nourishment performance and longevity is highly dependent on sediment quality and project length (NRC 1995, Dean 2002). Accordingly, certain construction methods and sand sources were eliminated from further consideration as discussed later in this chapter.

ALTERNATIVE 1–NO-ACTION

Under the No-Action Alternative, the US Army Corps of Engineers and National Park Service would not issue permits to Dare County for beach nourishment along the shoreline in Cape Hatteras National Seashore and the Village of Buxton Beach.

The No-Action Alternative provides a basis for comparing management direction and environmental consequences of the action alternatives. Should the No-Action Alternative be selected, Dare County, the State of North Carolina, and local entities would respond to future maintenance needs associated with the current natural conditions of unabated erosion in the Buxton Action Area. Current responses to that erosion by the NC Department of Transportation would continue, including sand scraping and road repairs. As erosion progresses and sufficient room to maintain a protective dune no longer exists, the state and individual property owners are likely to implement short-term emergency measures such as sand-bagging. This alternative assumes that a high potential exists for NC 12 to be closed due to major storm damage and that NCDOT would carry out repairs as needed to reopen the road. Possible emergency repair options to reopen the road would include a temporary bridge or emergency beach nourishment, as were completed in 2012 at the Pea Island breach and in 2014 north of Rodanthe.

If a breach occurred as feared during a major storm(s), Hatteras communities, as in the past, could be isolated from the mainland until the road was reopened. Emergency services would have to seek alternative ways of transporting sick or injured people off the island until repairs could be made. The normal transport of food and goods for families and materials to repair damaged houses and businesses would be interrupted. Other than helicopter lifts and boat traffic, travel would cease and transporting of goods and services would likely occur by ferry or small plane.

ALTERNATIVE 2–WINTER CONSTRUCTION

Alternative 2–Winter Construction consists of beach nourishment in the winter time via dredge using an offshore borrow area and placement of up to 1.3 million cubic yards of sand along ~15,500 linear feet of shoreline along Cape Hatteras National Seashore and the Village of Buxton; ie the Buxton Action Area (see Fig 1.1). Alternative 2–Winter Construction requires contracting with a professional dredging company experienced and equipped to conduct a project of this type and scale. The specific design, plans, and specifications of the nourishment project on which dredging companies would provide bids for construction would be prepared by the Applicant's consultant, a registered engineering firm with

demonstrated experience in these types of projects. If permitted, the Applicant, its consulting engineer, and the dredging company would coordinate the work closely with representatives of the US Army Corps of Engineers and the National Park Service to ensure the project complies with federal and state permits for construction.

Beach nourishment by dredge involves hydraulic excavations of a borrow area, pumping via pipeline, and discharge of a sediment-water slurry along the beach. Water drains, leaving the sediment in place to be shaped by land-based equipment such as bulldozers. A nourished beach is typically constructed in sections, adding sand to the active beach zone working parallel to shore. Bulldozers distribute the sand from the pumpout point to elevations and slopes typical of a natural beach (Dean 2002). Surveys before and after sand placement are used to confirm how much sand has been added in each section and whether the elevation and slope of the new beach conform with the plans and specifications for the project which reflect the approved profiles in the permits.

Alternative 2–Winter Construction would involve excavation of sand by ocean-certified dredges from a borrow area ~1.7 miles seaward of the Cape Hatteras Lighthouse (see Fig 1.1). The dredges would be either cutter head dredges or self-propelled hopper dredges. If traditional suction cutter head dredges are used, excavations would be limited to ~7 feet below the substrate and would be pumped directly onto the beach via submerged pipeline. Sections of pipe (typically 40 feet long) would be added as construction progressed along the beach. Approximately 200–300 feet of beach would be nourished over a 24-hour period, working from one of two landing points for the submerged pipeline. The landward limit of sand placement would be seaward of the foredune along the existing dry-beach area. Initially, the material would be shaped to form a gently sloping berg at or below the normal dry-beach level in the action area. The seaward edge of the nourishment would be sloped by dozers to match a typical beach slope in the swash zone, the area over which waves break and run up the shore. After project completion, the nourished profile would generally adjust to waves as illustrated in Figure 2.1.

If hopper dredges are used, excavation depths would be shallower, but would not exceed ~7 feet in the aggregate (after multiple passes) within the designated borrow Area. Hopper dredges tend to leave some undisturbed Areas. Hopper dredges are self-propelled vessels which pump sand into the hopper of the ship then motor to a pumpout point where a length of submerged pipe extends ~1,500 feet offshore from the beach. Sand in the hopper is pumped to shore and distributed by the same methods used for cutter head dredge discharges. The environmental impacts of such cutter head and hopper dredges are essentially the same on the beach, but vary at the borrow Area as discussed later.

Using either type of dredge, excavations would be restricted to the approved offshore borrow Area and would avoid cultural resources, shipwreck debris, or obstructions that may be present. Further, the borrow Area would be chosen based on having sand that closely matches the existing sand in the action area. Along the beach, no sand would be placed on the foredune or private property. Upon completion, the nourished beach would be left to equilibrate under wave action—that is, even out and develop a profile and slopes typical of a natural beach.

Work under Alternative 2–Winter Construction would be completed during winter months within particular environmental windows for construction prescribed by USFWS and NMFS. The assumed window is December 1 through March 31, based on the 1997 South Atlantic Regional Biological Opinion (NMFS 1997). The location of the action area is about 110 miles from the nearest safe harbor that can accommodate large ocean-certified dredges. Oregon Inlet (~36 miles from the Proposed Action Area) is too shallow for entry by large hopper dredges (typical draft unloaded is ~15 feet). The Bonner Bridge (fixed-span) at Oregon Inlet further precludes entry into sheltered waters by large vessels.

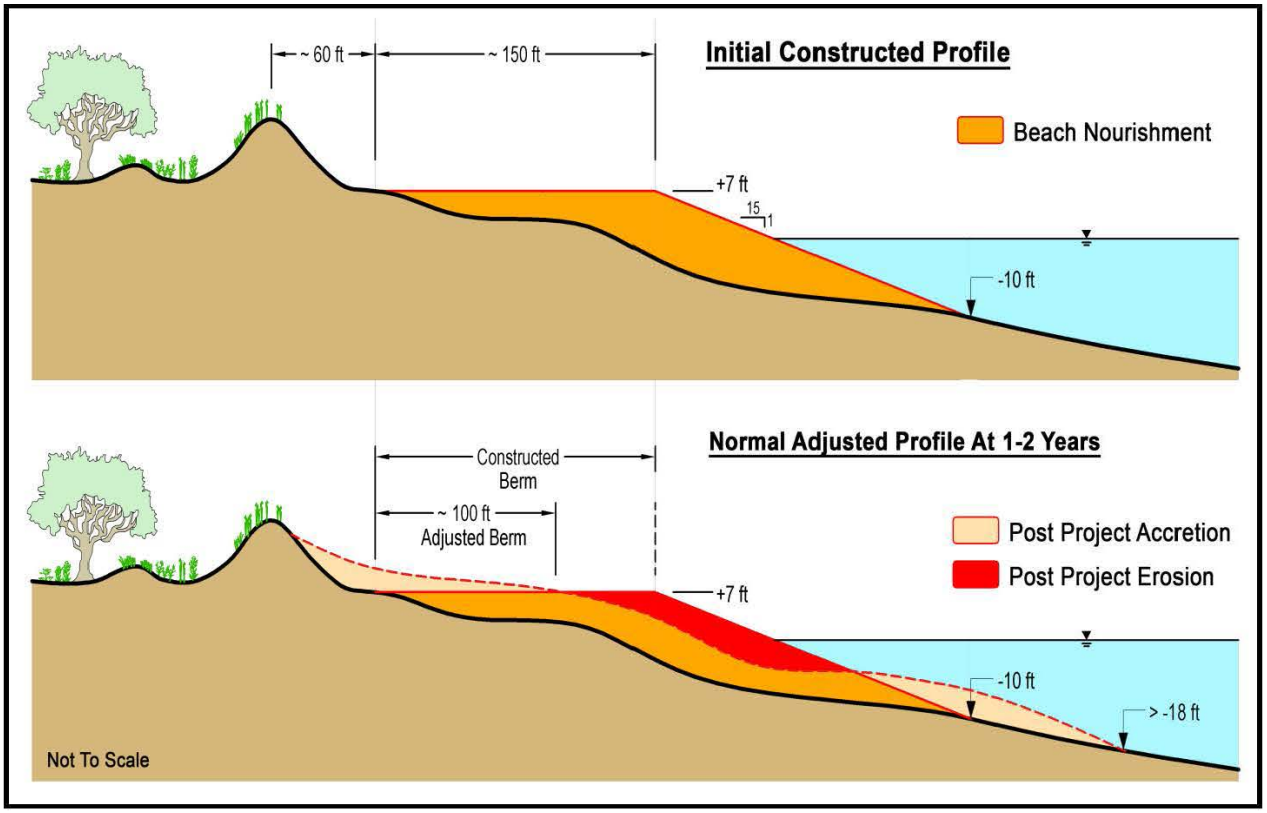

Figure 2.1. Idealized initial nourishment profile for sand placement seaward of the foredune and upper beach. Upon project completion, storm waves and winds would quickly shift some nourishment sand toward the dune, as well as into deeper water. The resulting "equilibrated" profile would exhibit a narrower berm (i.e. "dry sand beach") as illustrated. Note the initial constructed profile (berm width) would vary between ~150 feet and 350 feet according to the specific sand deficit and erosion rate at a particular segment of beach. The area of intertidal wet sand is expected to remain constant but be displaced seaward after initial equilibration of the nourishment sand.

Normal safe operations require dredging equipment and personnel to move to a safe harbor before a storm event occurs. Operations can only resume after seas return to operational conditions.

Due to the sailing time from the Proposed Action Area to the nearest safe harbor in the Norfolk, Virginia, area, each northeast storm event is likely to suspend dredging operations for a minimum of three days. Based on average storm frequencies of 1 per 6 days during winter months in the action area, dredging efficiency is expected to be <50% for either hopper or suction cutter head dredges. When common winter storms pass through the Buxton area, pipe on the beach may have to be removed temporarily and stored on high ground.

The scale and scope of Alternative 2–Winter Construction would be dependent on the number of operational days that are possible in the action area within the assumed four-month window for construction. Winter construction would be limited to those days when waves are less than the threshold for safe operating conditions (Fig 2.2). Factors to consider are the average frequency of northeasters and tropical storm (1per 6 days) (USACE 2010), projections of efficiencies for winter dredging in the northern Outer Banks (USACE 2000, 2010), and experience within similar settings (CSE 2012, 2014). Under Alternative 2–Winter Construction, construction would involve 2–3 days per week of 24-hour operations pumping sand, interrupted by moving the dredge(s) to a safe harbor during storm forecasts. The scale, scope, and construction duration for Alternative 2–Winter Construction is based on a fixed budget established by the Applicant. Based on preliminary planning and design, and the

assumptions of dredging efficiency, Alternative 2–Winter Construction would involve excavation and placement of up to 1.3 million cubic yards in the Buxton Action Area. This equates to a maximum average fill density of ~84 cubic yards per foot along 15,500 linear feet. It can be shown that a fill density of this magnitude equates to a maximum average beach width increase of ~70 feet in this setting (Overton & Fisher 2005, Kana et al. 2015). It would take 65 dredging days averaging 20,000 cubic yards per dredge per day to accomplish the work. At <50% production efficiency, more than a four-month construction duration would be required if only a single, ocean-certified dredge is used. To accomplish up to 1.3 million cubic yards, more than one ocean-certified dredge would likely be required part of the time. The proposed borrow area is large enough to accommodate two dredges operating at the same time.

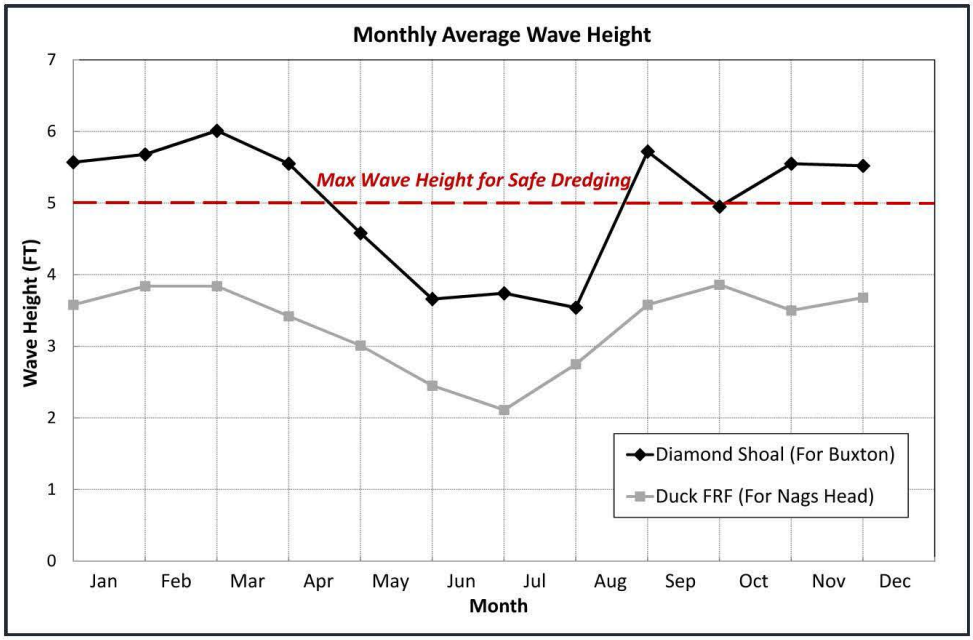

Figure 2.2. Graph showing the monthly average wave climate from 2003–2013 at NDBC Wave Buoy Station 41025 at Diamond Shoals (NC) near Buxton compared with the wave climate at the USACE Field Research Facility at Duck (NC). The criteria for safe dredging apply to hopper-dredge operations using ocean-certified equipment per informal guidance by dredging contractors. Suction-cutter head dredges generally cannot operate safely in waves >3 feet (USACE 2010). The graph shows that average monthly wave height exceeds 5 feet from September to April in the Proposed Action area. Calmest conditions occur in June and July when average wave heights are ~3.7 feet. The bars at the bottom of the graph show approximate range of dates when certain protected species may be present in or near the Action area. (Source: NDBC)

The total nourishment volume that would be accomplished under Alternative 2–Winter Construction would be about 40% greater than the existing sand deficit estimated by CSE (2013b) (ie ~900,000 cubic yards). The difference provides advance nourishment (USACE 2008) to accommodate average annual beach losses in the range 115,000–130,000 cubic yards per year (CSE 2013b). Thus, Alternative 2–Winter Construction would provide ~3 years of erosion relief, offsetting average annual losses before the beach reverts back to a deficit volume.

Alternative 2–Winter Construction would require a staging area for mobilization of equipment and temporary storage of shore pipe, which are typically 40-foot lengths of 30-inch-diameter steel pipe. As beach building occurs, the equipment and pipe would be stored on the newly constructed beach and would move with the active work area. For the Buxton Action Area, two landing points are likely to be

used. One would be ~4,000 feet south of the Haulover Day Use Area on Seashore property, which marks the approximate north limit of the Proposed Action. The other would be positioned near the north boundary of the village of Buxton. Pumping onto the beach would begin at these landing points and proceed northerly or southerly for up to ~4,000 feet, adding shore pipe as the beach is built. Upon completion of an ~4,000-foot section of the project, pipe would be removed and shifted to the next work area, proceeding in the other direction from the landing point. At any point in time, there would be between ~100 feet and 4,000 feet of beach impacted by the presence of the pipeline.

The active beach pumping area would extend ~500 feet alongshore on a given day. Pipe-loading equipmint, support vehicles, fuel barge, and a portable office and shelter for workers would move with the active work zone and would be cordoned off from the public. The active work area would be marked by flagging ribbon and would be limited to hard-hat personnel who have completed safety briefings. Dredge safety personnel would be stationed at the safety fence to prevent unauthorized entry and safeguard the public from areas where heavy equipment is operating. Upon completion of construction, all equipment and supplies would be removed from the site. The beach would be graded to eliminate tire tracks, depressions, and mounds. The staging area(s) would be restored to pre-project conditions. If compaction measurements show values above USFWS thresholds after project completion, the Applicant would seek guidance whether tilling of the beach should be performed and implement tilling at the direction of state and federal resource agencies.

PREFERRED ALTERNATIVE 3 – SUMMER CONSTRUCTION

Alternative 3 – Summer Construction consists of beach nourishment during summer months via dredge using an offshore borrow area and placement along up to 15,500 linear feet of shoreline along Cape Hatteras National Seashore and the Village of Buxton (ie, the Buxton Action Area) (see Fig 1.1). It differs from Alternative 2–Winter Construction in terms of the amount of sand placed and the season of construction. Sand excavation and placement would be as described under Alternative 2–Winter Construction. However, the project would be constructed during fair-weather months in summer when dredging efficiency can be maximized in the action area.

Under a fixed budget established by the Applicant, Alternative 3 – Summer Construction would provide up to ~2.6 million cubic yards of sand, which is equivalent to a maximum average fill density of ~168 cubic yards per foot. This quantity of nourishment sand would widen the beach by ~140 feet after normal adjustment of the profile (see Fig 2.1). The higher volume (approximately twice that of Alternative 2–Winter Construction) would be nearly three times the present sand deficit estimated by CSE (2013b). The additional sand would increase project longevity to ~10 years before the beach returned to a deficit condition. Factoring out the deficit volume (~900,000 cubic yards), Alternative 3 provides up to ~1.7 million cubic yards to erode under normal yearly processes (annual loss rates in the range 115,000–130,000 cubic yards per year, CSE 2013b) before the Proposed Action Area returns to a deficit condition. Given the uncertainty in the erosion rates after the project, this additional volume may last somewhat more or less than ten years.

Because beach nourishment has not been conducted in the Proposed Action Area since the 1970s (Dolan et al. 1974), experience from prior projects is limited. As a result, dredging costs for such a project are uncertain, and no comparative volumetric erosion data spanning years to decades exists. Thus, the final scale of Alternative 3 – Summer Construction is uncertain. The Applicant has considered this and has determined the project may be reduced by up to 25%, which would yield a total volume of ~1.9 million cubic yards. The higher volume (2.6 million cubic yards) is referenced with respect to the permitted quantity desired by the Applicant. Because the Proposed Action is

intended to replace sand losses and provide benefits for a minimum of five years, any volume within the range of 1.9–2.6 million cubic yards is considered viable to meet the project goals. The volume of 2.6 million cubic yards is used as a basis to evaluate project impacts. [Note: References to 2.6 million cubic yards in other sections of this EA reflect the maximum possible volume that may be applied under a fixed budget.]

Alternative 3 – Summer Construction would be performed by trailing arm suction hopper dredges or traditional hydraulic cutter head dredges with booster pumps. The dredges would reach from the borrow area to the furthest segment of project beach, a distance of ~18,000 linear feet. (The two dredge types were generally described under Alternative 2–Winter Construction.) The Applicant desires permits which allow both hopper and hydraulic dredges to be used at the discretion of the dredging contractor. Allowing both types provides the most flexibility to accomplish the work in the shortest time. It also allows the contractor to use the resources he determines to be the most advantageous to minimize the environmental risks and maximize dredging efficiency. One or more hopper dredges and a hydraulic dredge may work on the project at the same time. The objective is to complete the project in one season and in the shortest time possible.

As a result of prior correspondence from the Dredging Contractors of America (USACE 2010) and discussions with qualified dredging contractors, the Applicant has concluded that the Proposed Action could not be accomplished safely or cost-effectively during fall or winter in the Buxton Area by either cutter head or hopper dredges. In the summer, cutter head dredges are less preferred, because offshore mean wave heights exceed threshold conditions for that type of dredge (Fig 2.2, also Appendix A - *Littoral Processes*). The use of hopper dredges in the summer, with the cutter head as an option during calmer seas, is the Applicant's preferred approach to ensure the Proposed Action is achievable.

The Proposed Action involves dredging and placement of up to 2.6 million cubic yards on the target beach. The average production per day varies according to sailing distance from the borrow area to the beach, as well as weather and environmental restrictions placed on the project. Based on project experience at Nags Head (CSE 2012), one hopper dredge can excavate and place from 15,000 to 30,000 cubic yards per day (24-hour period). Under ideal conditions, a hydraulic dredge can excavate up to 60,000 cubic yards per day. That volume would go down with increased wave heights and work stoppages as well as relocation due to severe weather. Therefore, project duration is dependent on average daily production.

A single hopper dredge operating at an efficiency of 80% and a daily production of 25,000 cubic yards per day would require 130 calendar days (~4 months) to complete the project. Efficiency is measured as the actual dredging time divided by the total time available. Giving the contractor flexibility to use both hopper and hydraulic dredges, with an average (net) production of 40,000 cubic yards per day, the project would require 65 days (~2 months) to complete. Net production at Nags Head was ~42,000 cubic yards per day with two dredges, one hopper dredge and one suction cutter head dredge, operating May 27 to August 27. Net production dropped to ~13,000 cubic yards per day between August 27 and October 27 with two smaller hopper dredges operating (CSE 2012). The downtime associated with shutdown and redeployment of the dredges during weather events is the main factor contributing to efficiency and construction duration of the Proposed Action.

May to August is a period of relative calm compared to fall and winter months (October to March) in the Proposed Action Area. Permitting the dredges to work over the warm and calm weather months (May to August), along with allowing both hopper and hydraulic dredges, would mitigate some of the risks to man and machine and would provide conditions where the work could be completed in a much shorter time period, thus reducing the duration of environmental impacts. The production efficiencies

for Nags Head (2011) was close to 80% from June through August, a rate that incorporates downtime due to Hurricane Irene and other weather events (CSE 2012). Projections of dredging efficiency under Alternative 3 take into account the possibility of hurricanes and other high wave events during summer in the action area. Equipment requirements and operations under Alternative 3–Summer Construction would be the same as Alternative 2–Winter Construction. However, work during summer months, when threatened or endangered species may be present, would require modification of operations as follows:

- Endangered species observers would be stationed on dredges to alert dredging personnel and record encounters. This would include authority to suspend operations while wildlife resources officials are contacted in the event of a take as defined under the Biological Opinion applicable for the Proposed Action.
- Certified trawlers would be retained to trawl for sea turtles ahead of operating hopper dredges and relocate turtles if encountered, or operate as non-capture trawling per final recommendations of NMFS.
- Continuous nightly beach patrols would be performed by certified monitors to locate any turtles that are stranded behind the dredge pipe on the beach and relocate them to the waters' edge or deal with them according to directives by and in consultation with USFWS and North Carolina Wildlife Resources Commission (NCWRC).
- Vehicle ingress and egress at night would be with escorts by certified, endangered species observers.
- Lighting at the Action Work Area on the beach would be minimized in conformance with USFWS requirements for beach lighting.
- Use of bulldozers at night would be reduced to the minimum required for safe operations as sand is being discharged.
- The order of work (sections to be filled) would be accomplished in close coordination with NPS officials so that there would be the least practicable disruption to bird-nesting activities along Seashore lands.
- No-work buffers along the beach would be established around the turtle or bird nests in coordination with USFWS, NCWRC, and NPS officials.
- Other operations modifications as may be recommended by federal and state resource agencies.

Placement Options — Beach nourishment may be placed in a number of configurations, depending on the goals and objectives of the project, as well as various environmental protection requirements (NRC 1995, Dean 2002). In some instances, particularly after major storms, emphasis may be to restore a protective dune and place a majority of the fill above the high watermark. Other projects have emphasized placement in the active beach zone seaward of the dune. In a few projects (Douglass 1997), nourishment sediment was placed in the near shore with the hope of eventual onshore migration of material. Each type of placement has advantages and disadvantages from an operational standpoint. Intermittent nourishment alongshore has also been suggested under the assumption that undisturbed areas between fill sections would help accelerate recruitment of benthic organisms into impacted areas (Peterson and Bishop 2005). Each of these placement options has been evaluated and ranked by the Applicant in terms of how well each meets the goals and objectives of the Proposed Action and with consideration of environmental protection requirements for projects within the Seashore boundary. Alternative 3 would involve two of the placement options (Fig 2.3).

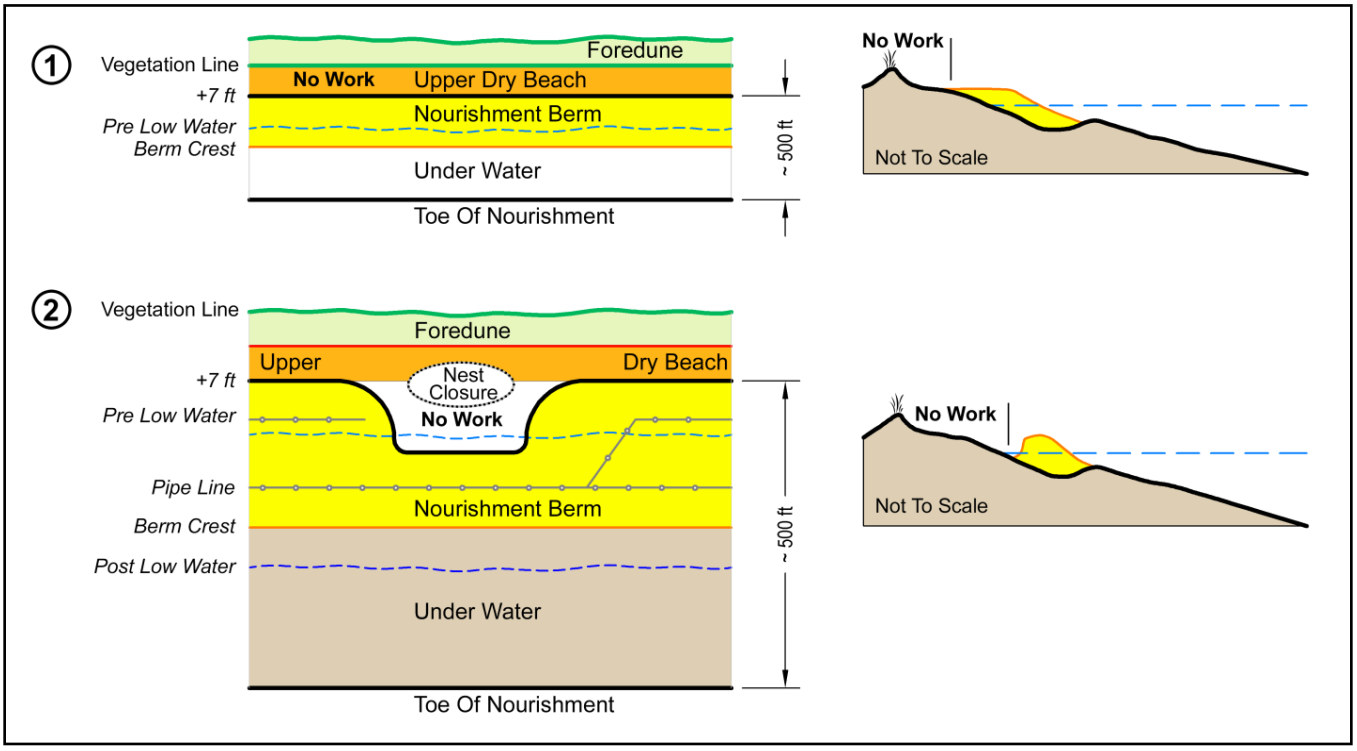

Figure 2.3. Diagram showing two beach-nourishment placement options in plan view (left) and section view (right) considered for the Buxton nourishment project under Alternative 3 – Summer Construction. The dashed blue line references mean low water (MLW). Option 1 (Continuous Placement) would leave a no-work area along the upper beach between the foredune and the (~)+7-foot NAVD contour. Option 2 (Modified Continuous Placement) is the preferred option if there are unavoidable, shorebird nest closure areas delineated by park biologists during project implementation. Option 2 would leave buffer areas along the dry-sand beach and place material seaward of low water for limited distances along the project area. This would leave a small pond between the existing beach and nourishment berm in the area labeled no work in the lower left-hand diagram. Over time, upon project completion, the low swales left along no-work areas would infill naturally by wave swash and washover deposits.

1) *Continuous placement* along the active beach zone at or below the +7 ft NAVD contour at grades and slopes matching the existing dry-sand and wet-sand beach.
2) *Modified continuous placement* along the active beach zone at or below the +7 ft NAVD contour extending across the inner surf zone (ie inside the outer bar), leaving isolated undisturbed areas landward of the approximate low watermark.

Placement Option 1 is a typical method of beach construction. It produces a berg at the normal dry-sand beach level over which the equipment can proceed down the beach without impact to existing dunes or vegetation. The +7-foot NAVD contour is chosen as an optimal berg elevation for the Proposed Action Area—berms vary in elevation from (~)+5 feet to (~)+9 feet NAVD (CSE 2013b). By limiting the fill to the 7-foot contour, a narrow no-work area would be maintained between the foredune and the active work area. This would allow public ingress and egress as the project proceeds. While it is not possible to control the underwater slope at placement, the final design would assume slopes typical of hydraulic placement using medium-coarse sand in this setting (~1 on 15) following the experience at Nags Head (CSE 2012). Placement of elevations close to the natural elevation of the native beach increases the likelihood and frequency of wave overtopping and runup across the dry-sand beach. This allows the nourished beach to take on a more natural character soon after construction, particularly if a project is completed in summer and then exposed to the high waves of fall and winter.

Placement Option 2 is proposed by the Applicant to provide limited no-work buffers around critical habitat areas at the time of construction yet maintain efficient operation and complete the project in the shortest time possible. *Modified continuous placement* would entail the same placement configuration as described under Option 1 for the majority of the Proposed Action Area. If NPS biologists identify active nesting areas for migratory birds, the Applicant proposes to postpone fill placement near that area(s) as long as practicable.

If nesting activity remains as construction progresses near the area (provided no areas remain where operations can be shifted), the Applicant proposes to place nourishment seaward of mean low water over the length of the nest closure area to keep equipment as far as possible from species of concern. This concept is illustrated in Figure 2.3. The resulting fill configuration would be continuous along the outer beach, but would leave a swale between the nourished berm and existing beach. This swale would become a temporary pond until the seaward nourishment berg overwashes and infills the area. A similar fill configuration was used for a short segment of the 2011 Nags Head project (Fig 2.4). Fall 2011 storms overtopped the completed berm and filled in the pond with sand within several months of nourishment along that section of beach.

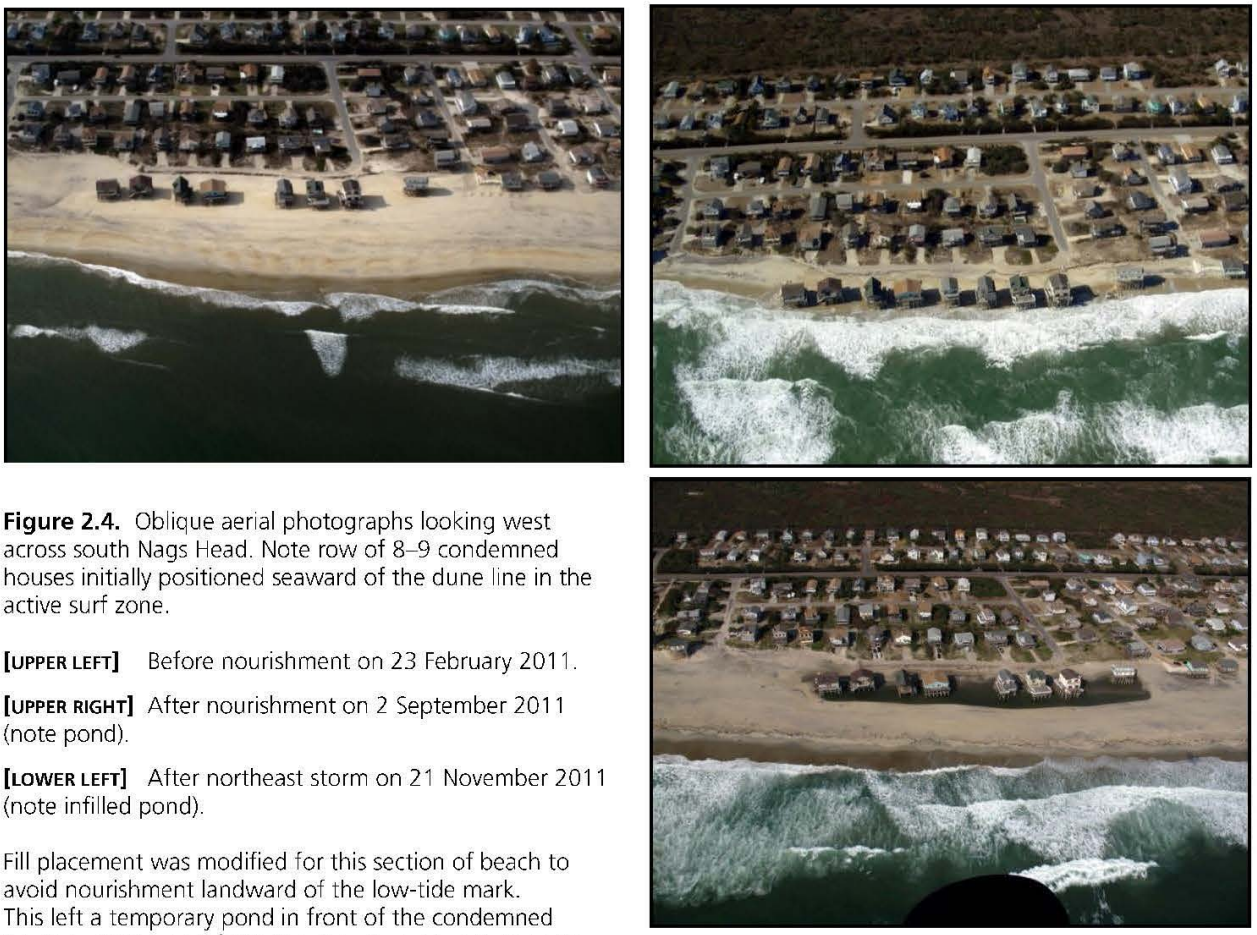

Figure 2.4. Oblique aerial photographs looking west across south Nags Head. Note row of 8–9 condemned houses initially positioned seaward of the dune line in the active surf zone.

[UPPER LEFT] Before nourishment on 23 February 2011.

[UPPER RIGHT] After nourishment on 2 September 2011 (note pond).

[LOWER LEFT] After northeast storm on 21 November 2011 (note infilled pond).

Fill placement was modified for this section of beach to avoid nourishment landward of the low-tide mark. This left a temporary pond in front of the condemned houses which was infilled naturally by overwash deposits. Fill placement Option 2 for the Buxton proposed project would be similar to sand placement illustrated here.

For a project of the scale of Buxton, it is likely the contractor would elect to use a minimum of two submerged, pipe-landing points from which sand pumping would proceed in both directions. This means work would likely be divided into four beach segments 3,000 feet long to ~4,000 feet long with nearly all activities occurring within one segment for about 2–3 weeks before shifting equipment to the next segment. This sequencing provides opportunities to avoid nest closure areas for a significant portion of the project duration. Based on production rates at Nags Head, the assumed duration of construction impacts under Alternative 3 is 2.5 months.

For reasons of safety, construction efficiency, project longevity, and duration of construction impacts, Alternative 3 - Summer Construction (Nourishment with Offshore Sand Source) is the Preferred Alternative.

Alternatives 1, 2, and 3 are retained for further analysis in this Environmental Assessment.

ALTERNATIVES ELIMINATED FROM FURTHER STUDY

Several alternatives were identified during the planning process and internal and public scoping. Some of these alternatives were determined to have unacceptable impacts or to be technically or economically infeasible. Other alternatives identified during initial scoping were determined to be outside the project purpose, not allowed under existing North Carolina laws, or beyond the means of the Applicant.

The following alternatives eliminated from further study are presented in several categories:

1) Alternate nourishment borrow sources,
2) Erosion control methods designed to retain sand, and
3) Shore-protection methods involving hard structures.

Rationale for Dismissing Nourishment Using Non-Offshore Sand Sources

Based on previous practice along the US East Coast, the following classes of borrow sources have been used for beach nourishment (CERC 1984):

– Lagoon sediments	– Offshore deposits	– Inland deposits
– Inlet shoals	– Recycled spoil sediments	– Freshwater pond deposits
– Near shore bars	– Accreting spits/beach deposits	– Imported material

In general, economics favor the borrow source(s) that matches the native beach quality, involves the shortest transportation distance, and minimizes environmental impacts. Large-scale projects, such as the Buxton nourishment project, require large volumes of material which may not be available in only one offshore deposit.

The following sediment sources are considered unacceptable for the Proposed Action.

Lagoon Deposits in Pamlico Sound – Generally, sand in the sound is much finer than sand on the beach and contains levels of mud and silt unacceptable for beach nourishment. Additionally, the environmental impacts of a large-scale dredging project (up to 2.6 million cubic yards) in Pamlico Sound would be high because of the greater diversity of estuarine organisms and submerged vegetation present. In a US Geological Survey (USGS) paper written in cooperation with the National Park Service, Dolan and Lins (1986) discussed the use of beach nourishment for shoreline stabilization, stating:

> *. . . artificial beach nourishment . . . has long been considered the most desirable method of protection because (1) placement of sand on a beach does not alter the suitability of the system for recreation, (2)*

> *nourishment cannot adversely affect areas beyond the problem area, and (3) if the design fails, the effects . . . are soon dissipated.*
>
> *Perhaps the greatest disadvantage of artificial nourishment is that great quantities of sand of suitable quality (type and size) are not readily available. In the past, sand was dredged from sounds and bays immediately inland from the beach or transported from inland sources. Because of recent concern about estuarine ecology, however, and because materials dredged from sounds and bays are generally too fine to be effective in beach nourishment, estuarine and bay sources have been less desirable and are no longer readily available. The only future source of large quantities of sand for nourishment of the Outer Banks appears to be offshore areas, such as Diamond Shoals and coastal inlets* [Dolan and Lins (1986), pg 34].

Inlet Shoals (Inshore) — Significant accumulations of sand occur in the ebb- and flood-tidal delta shoals of Oregon Inlet ~36 miles north of the project site. The mean grain size of these deposits tends to be much finer than native beach sand. The flood shoals are located inshore of the Oregon Inlet bridge and would have to be pumped either directly to the project site with the aid of many booster pumps or pumped offshore to hopper dredges which could transfer and pump out the material after sailing nearly 80 miles (roundtrip) to the project site. Additionally, these ephemeral flood-tidal delta shoals are habitat for a number of protected shorebird species. The environmental consequences, level of coordination required, the potential for disapproval by conservation groups and regulatory agencies, the cost implications due to pumping distances, and the unsuitable sediment size make this source of sand infeasible when compared to the offshore borrow sources.

Significant deposits of sand are available from the ebb-tidal delta shoals of Oregon Inlet. The navigation channel across the outer bar is dredged frequently by the USACE. Typically, the dredged material is disposed of on the beaches at the northern tip of Pea Island adjacent to Oregon Inlet. CSE (2011) determined the location of the placement of the dredge spoil, sampled the material, and analyzed the sand samples for texture and suitability for beach nourishment. The material is generally fine-grained sand (<0.25 millimeter mean diameter) and was determined to be much finer than native beach sand along Nags Head. The Buxton beach sand is slightly coarser than Nags Head (CSE 2013a) (Appendix C - *Geotechnical Data*). It can be shown that placement of finer sand on a beach typically leads to rapid dispersal into the underwater part of the beach zone (Dean 2002). This lessens the benefit of nourishment (narrower dry-sand beach) and reduces wave attenuation relative to sediment sizes that match the visible beach.

Nearshore Bar(s) Along the Project Area — Sand stored in nearshore bars (water depths <20 ft) is part of the active beach profile and is an important component in the beach system that provides wave dissipation. Access to the material would be difficult by deep-draft hopper dredges. Additionally, the material in longshore bars is generally too fine for retention on the dry beach and is inappropriate for beach nourishment. Grain size data for samples in the Buxton Action Area support this finding (see Appendix C – *Geotechnical Data*).

Accreting Spits/Beach Deposits — Major deposits of beach sand are accumulating on Cape Point within Seashore jurisdiction (Fig 2.5). Excavation of these deposits would involve significantly more environmental consequences than offshore deposits because Cape Point is designated as critical habitat for the piping plover.

Figure 2.5. Oblique aerial photos of Cape Point, a highly accretional cuspate foreland which accumulates sediment eroded from the east and south Buxton oceanfront's. Cape Point is an important habitat for endangered and threatened species, such as the piping plover. The left image is looking north with Cape Point in the foreground and the Village of Buxton along the top. The right image is looking west across the Cape Point foreland with the east-facing beach along the lower edge of the picture and the broad south-facing beach arcing toward the top left corner of the picture. [Images by CSE on 10 September 2014]

Inland Deposits — Material imported from sand mines in Currituck County (~75 miles from Buxton) was used for building dunes in Nags Head and Kitty Hawk after Hurricane *Isabel*. No known sand mines are available in the Buxton Action Area which could provide sufficient quantities to complete the proposed nourishment project. Use of distant sand mines would be cost-prohibitive, based on trucking costs for much shorter haul distances between Currituck spit and Kitty Hawk (~16 miles). Dune-building projects at Nags Head and Kitty Hawk were $16.00 per cubic yard and $15.15 per cubic yard (respectively) in 2005 following Hurricane *Isabel* (CSE 2005a). This represents nearly twice the unit costs of nearby offshore borrow areas (including pumping and mobilization and demobilization costs). Under a fixed budget established by the Applicant, a doubling of transportation costs would result in a major reduction in the total project volume, which would reduce the project longevity and would not accomplish the goals and objectives of the Applicant.

Freshwater Pond Deposits — No known freshwater ponds are nearby that require maintenance excavations or that could provide the quantities of beach-compatible sediment required for the Proposed Action.

Recycled Spoil Sediments — No feasible sources of dredge spoils are available to be pumped to the beaches of Buxton.

Primarily for reasons of sediment quality, environmental impacts, economics, or unavailability within economic transportation distances, the alternative borrow sources discussed herein are not deemed

acceptable for the Buxton beach nourishment project. **The alternative of nourishment using non-offshore sand sources is not considered for further analysis in this EA.**

Rationale for Dismissing Sand-Retaining Structures and Techniques

A number of erosion-control methods can be used to intercept mobile sands in the beach zone. These include three general types of sand-retaining structures—jetties, groins, and breakwaters—and one technique—beach dewatering systems. Jetties and groins are shore-perpendicular barriers extending from the upper beach/toe of dune to some distance offshore. They may be constructed of timber, steel sheet piles, quarry stone, pre-cast concrete units, or sand bags. In the presence of a predominant transport direction (north to south along the beach in the action area), sand tends to accumulate along the upcoast (north) side of the structure, producing a salient (bulge) in the shoreline related in size to the length of the structure. When the groin is filled to capacity, excess sand would be transported by waves around or over the structure to the downcoast (south) shoreline, leaving a salient in place. The beach along the upcoast side of the groin or jetty would generally be wider than the beach downcoast for some distance in either direction, which is also a function of groin length (ASCE 1994). Commonly, observable modification of the shoreline due to the presence of groins or jetties can be detected 10–20 times the groin length depending on numerous factors (CERC 1984).

Groins, jetties, and breakwaters are a proven method for reducing sand losses along beaches on the upcoast side of a structure and have been used previously in the Buxton Action Area to protect the US Navy Facility and Cape Hatteras Lighthouse (Machemehl 1979, NPS 1980, USACE 1996, NPS 2013). Intermittent breakwaters and nourishment have been incorporated into a shore-protection plan for Colonial National Historical Park in Virginia (NPS 2012b). Figure 2.6 shows existing groins at the south end of the proposed Buxton project and their impact on the shoreline near Cape Hatteras Lighthouse. The groins were constructed in 1969 (Machemehl 1979) and have produced a salient (bulge) in the shoreline along Buxton Village. The salient results from the groins holding a segment of beach in place while the beaches north and south of the groins continue to erode.

While groins, jetties, and breakwaters combined with nourishment may reduce sand losses and improve project longevity, they are not permissible under existing North Carolina CZM rules and regulations.

Groins and jetties are not evaluated further in this EA because they are not allowed along the northern Outer Banks under present state CZM rules and regulations.

Breakwaters are shore-parallel structures placed close to the beach to modify and reduce wave energy and sand transport along the coast. In the sheltered lee of breakwaters, sediment falls out of suspension and accumulates in the form of a salient. In extreme cases, sand would build out to the breakwater, forming a tombolo spit of high ground between the beach and the structures.

Breakwaters are not evaluated further in this EA because they are not allowed along the North Carolina coast under present state CZM rules and regulations.

Beach dewatering is a technique for sand retention whereby wave swash is withdrawn by suction through a system of pipes and vacuum pumps. The water is discharged offshore or in holding ponds for gradual percolation into the ground. By drawing off part of the swash before it runs back down the sloping part of the beach, less sand moves in the return flow. The result is accumulation and retention of sand in the dry beach zone in the area where pipe is in place. Results are mixed and depend on many factors (Turner & Leatherman 1997). Such a system is not considered viable for the project at Buxton for several reasons:

FIGURE 2.6. **[UPPER]** Oblique aerial photograph looking north along the Buxton Action Area with the moved Cape Hatteras Lighthouse at the lower left side of the image and the Village of Avon at the top right corner of the image. White foam lines of breaking waves over the near shore bar parallel the beach. The east-facing shoreline bulges seaward in the middle of the image. This bulge marks the location of three groins fronting the former US Naval Facility and former location of the Cape Hatteras Lighthouse. The salient (bulge) visible to the north (upper right) is Rodanthe and Salvo. [Image courtesy of USACE–Wilmington District taken 9 September 2000]

[LOWER] Ground photo looking south of two of the groins at former location of the Cape Hatteras Lighthouse. The structures extend into the ocean from right to left and are constructed of pre-cast concrete sheet piles linked by timber whalers. Some sheets have collapsed or washed out as indicated by the gaps in the structure along the top edge of the image. [Image taken 4 November 2013 by Coastal Science & Engineering]

1) Beach dewatering requires an extensive network of perforated pipe to be buried close to the surface of the beach—a permanent installation (which would potentially interfere with turtle nesting activities).
2) The system requires pumps, infrastructure, and discharge points which are not available.
3) The sand deficit along the action area greatly exceeds the scale of the existing beach where such a system would be installed.
4) Dare County and the Park Service do not wish to install permanent infrastructure (piping) along high-energy beaches subject to significant seasonal fluctuations in width and elevation.
5) Beach dewatering does not augment the sand supply in the beach zone, but rather captures some fraction of sand moving downcoast at the expense of adjacent areas.

Beach dewatering systems are not evaluated further in this EA because they are not likely to meet the purpose of the project or they are not allowed under present state CZM rules and regulations.

Rationale for Dismissing Other Potential Alternatives

Other potential alternatives considered and dismissed include:

- Structural shore protection—including seawalls, revetments, and bulkheads.
- Structure relocation—including NC 12 realignment.
- Structure abandonment.
- Alternative transportation system.
- Nourishment along other erosion hotspots such as the Hatteras Village reach west of Buxton, which is narrow and vulnerable to another breach.

As previously described, hard erosion-control structures are prohibited under North Carolina CZM rules and regulations. Installation of a protective seawall along the most vulnerable sections of NC 12 would also not meet the purpose and needs of the project.

The Applicant (Dare County) has no authority to move, elevate, or abandon NC 12. The road alignment is as far landward as practicable without encroaching on existing tidal wetlands at the margin of Pamlico Sound. Such alternatives would not meet the purpose and needs of the project. NCDOT is preparing a feasibility report (in preparation – NCDOT, J. Jennings, Regional Director, pers. comm., July 2015) to evaluate 5-year and 50-year alternatives for NC 12 in the Buxton Canadian Hole area. That report is expected to contain additional information of relevance to the present project. However, implementation of NCDOT plans is likely to require several years before final design can be approved. The Applicant desires to proceed with the Proposed Action, Alternative 3 – Summer Construction, given the urgency of the erosion problem and need to widen the beach to reduce storm damages.

Relocation or abandonment of existing buildings, infrastructure, and sand-trapping structures would not meet the purpose and needs of the project. Dare County has no jurisdiction over existing private structures and cannot remove them under present state law even if they are condemned by the State. The County does not own the existing groins which are functioning to maintain the shoreline salient at Buxton to some unquantified degree. Removal of the groins, emergency sand bags, and several rows of houses would be exceedingly costly as a result of (1) the high value of beach resort property, (2) the cost of litigation necessary to force property owners to abandon homes and businesses if they do not agree

to buyouts at market prices, (3) loss of tax revenue, and (4) loss of rental income and its ripple effect on the local economy.

Property abandonment and relocation associated with ongoing beach erosion is encouraged under existing state CZM regulations. Considering present property values, the economic costs of property abandonment are exceedingly high and generally involve extensive litigation, as demonstrated by a recent case at Nags Head (Sansotta vs Town of Nags Head, US District Court–Eastern District of North Carolina 2:10-CV-29-D). The Town of Nags Head recently settled with a property owner and agreed to pay the owner $1.5 million for six houses that had been sitting in the surf zone for nearly ten years and were rendered uninhabitable.

Along the Buxton Action Area, abandonment and removal of existing groins would lead to rapid erosion of the salient. Figure 2.7 illustrates the likely eventual adjustment of the shoreline if the groins and developed properties were removed. A new shoreline would equilibrate between the Canadian Hole (middle right side of image) and Cape Point (upper part of image). Such abandonment or removal of groins would ultimately lead to shoreline recession of hundreds of feet, taking out a length of NC 12 in the approach to Buxton Village and multiple rows of houses, hotels, and businesses. The aggregate value of properties lost would be at least an order of magnitude greater than the Applicant's budget for the proposed project (ie >$250 million). Associated with abandonment would be even greater economic impacts of the road closure, loss to tax base, loss of business revenues, and other disruptions to the life and well-being of the communities at the Cape.

For reasons stated above and other practical considerations, structural alternatives, structure relocation, and structure abandonment are eliminated from further study because they do not meet the purpose and needs of the project, or Dare County has no authority to impose them, or they are not allowed under state law.

Figure 2.7.

Oblique aerial photograph on 10 September 2014 looking south along the Proposed Action Area with the Canadian Whole area of the Seashore in the middle and Cape Point at the top of the image. The Village of Buxton is marked by the pronounced salient (bulge) in the shoreline.

A dashed line extending landward along the shoreline marks the projected alignment of the dune line if the groins were removed. The equilibrated shoreline would be straighter, but at the cost of losing a long segment of NC 12 and several rows of houses and businesses in Buxton.

The predicted shoreline (dashed line) represents the anticipated impact after several decades of erosion. As the salient along Buxton erodes, the east shore of Cape Point would accrete as implied by the dashed line positioned seaward of the existing dune line at the top of the image.

[Image by Coastal Science & Engineering 2014.]

Nourishment Construction Alternatives Eliminated from Consideration

In addition to the two nourishment placement alternatives retained for further analysis (previous section of EA), four alternative placement methods were considered (Fig 2.8).

Placement Option 3 entails intermittent placement, leaving some gaps along the shoreline. Sometimes this is done to concentrate the nourishment volume where it is needed most for shore protection or recreation as in the case of Hunting Island, South Carolina, in 1991 (Kana & Mohan 1998). However, it has also been recommended under the assumption that it is a way to maintain a benthic community in close proximity to nourished areas from which organisms can rapidly colonize the new beach (Peterson & Bishop 2005, Peterson et al. 2006, NPS 2012a). No documented cases of intermittent nourishments are known to exist whereby this theory can be evaluated using quantitative measurements of the benthic community structure. If this alternative were implemented at Buxton, a number of effects would have to be considered. First, the no-work gaps would require fill sections to be much wider along work areas to accommodate the design volume. The total project length is relatively short at ~3 miles. If two 0.5-mile gaps were added to the project, the average fill density of nourished sections would increase by 50%. At initial placement, the project sections would have to be over 500 feet wide, tapering rapidly to no added beach width. If gradual tapers on the order of 1,500 feet were provided, little space would be left for full sections. This would produce a highly scalloped shoreline and lead to erosional end effects (Dean 2002). It would also increase the vulnerability of the foredune along the unnourished segment until sand spread into the gap. The process of sand spreading into the gaps occurred over several years after the 1991 Hunting Island project (Kana & Mohan 1998).

Nags Head (2011) was a continuous nourishment, using offshore borrow areas along 10 miles without gaps. Within the first three months after completion, pre- and post-project benthic monitoring documented rapid recovery of the benthic community to comparable levels as the adjacent unnourished areas (CZR-CSE 2014, Appendix E- *Biological Monitoring*). Other projects have similarly documented rapid recovery of benthic communities within weeks to months after large-scale continuous beach fills (Van Dolah et al. 1994, Burlas et al. 2001, Jutte et al. 2002).

For the reasons outlined above, Placement Option 3 is no longer considered for the Buxton nourishment project.

Placement Option 4 has been used after storms in many localities because it incorporates dune nourishment with berm nourishment. Many federal projects incorporate some form of protective dune or storm berm above the normal dry beach level. This alternative necessarily requires placement on the face of existing dunes leaving no undisturbed area seaward of the vegetation line as construction proceeds. The Buxton project is situated in a part of the coast subject to strong winds. As the Nags Head (2011) project demonstrated, a significant volume of sand shifted landward by natural processes after project completion. Post-construction measurements documented upwards of 800,000 cubic yards (~17% of the total nourishment volume) shifted into the foredune and upper beach area within three years of project completion (CSE 2014). The average post nourishment dune accretion rate at Nags Head was ~4.2 cubic yards per feet per year for the first three years of the project (CSE 2014). Dune growth was aided by strategic placement of sand fencing in many areas. Where existing dunes were relatively high, foredune vegetation served as a barrier to trap wind-blown sand, mimicking the natural process of dune growth along stable barrier beaches. Sand fencing is not part of the Preferred Alternative, but it may be considered by individual property owners at a later date after construction. The rapidity of dune growth along Nags Head provides a realistic measure of likely dune growth rates at Buxton after nourishment, given the proximity and similar exposure to winds at both sites.

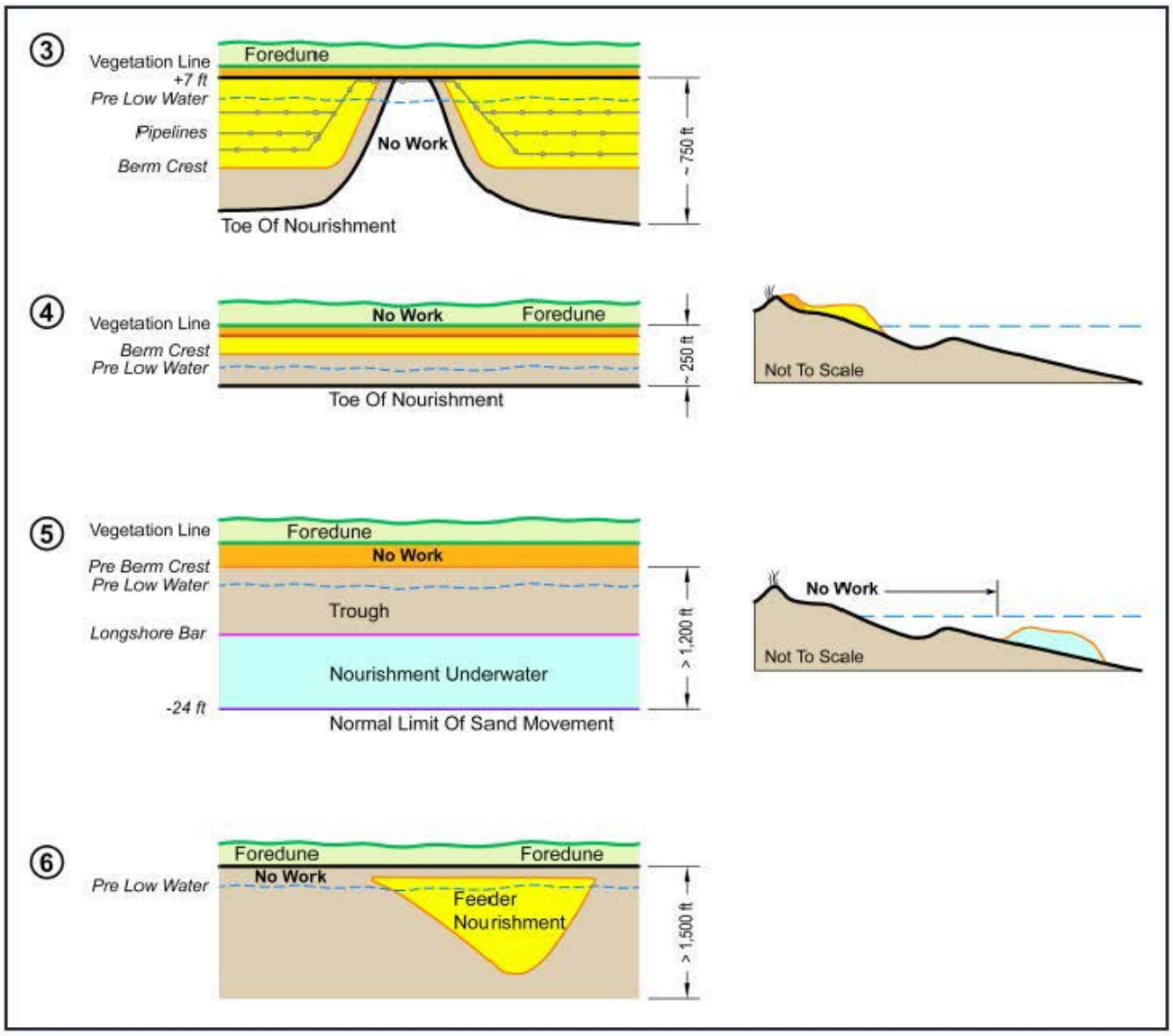

FIGURE 2.8. Diagram showing four beach-nourishment placement options which are rejected from further analysis for the proposed project at Buxton.

[UPPER] Labeled 3 – This diagram illustrates the concept of intermittent fill whereby no-work gaps are left between nourished sections. As discussed in the text, this placement option is not feasible for the relatively short length and high volume of nourishment needed at Buxton.

[SECOND] Labeled 4 – This diagram and an associated cross-section to the right show nourishment incorporating a dune and berm with most of the material placed above the low water contour. The preferred alternative is to minimize sand placement on the dune or back beach area so as to avoid turtle-nesting areas of the beach.

[THIRD] Labeled 5 – This diagram and an associated cross-section to the right show nourishment placed underwater seaward of the outer bar. In theory, such placement would eventually result in sand shifting landward toward the beach. However, it is difficult to control underwater placement, and an unacceptable delay occurs before the added sand provides direct benefits in the form of a wider beach.

[LOWER] Labeled 6 – This diagram illustrates the concept of feeder nourishment whereby all the fill is placed near the upcoast end of the project. Over time, the material is expected to migrate downcoast, replacing lost sand. This option is rejected because the feeder beach would extend so far offshore that it would modify wave patterns and potentially cause erosion at the flanks of the feeder beach before sand spread downcoast (Dean 2002).

A disadvantage of Placement Option 4 is that the majority of nourishment volume is initially perched on the existing beach above low water. This configuration is unstable and subject to large-scale erosion (profile adjustment) until sufficient volume shifts underwater to form a stable base for the fill. Erosional escarpments in the berm tend to persist, particularly where the berm elevation is set well above the normal wave uprush limit. A small federal project at Hunting Island, South Carolina, designed to provide emergency dune protection, set the berm elevation at (~)+11 feet NAVD. This was roughly 4 feet higher than the normal dry-sand beach in the area (USACE–Charleston District, C. Mack, coastal engineer, pers. comm., December 2003) (CSE 2005b). As this highly eroding section of beach receded, escarpments 4–5 feet high persisted for months, inhibiting turtle nesting activities, which were severely limited before nourishment due to the highly eroded condition of the beach.

For the reasons outlined above, Placement Option 4 is rejected for the Buxton nourishment project.

Placement Option 5 involves nourishment along the lower foreshore well beyond the inner surf zone. Ideally, the sediment would be deposited in water shallow enough to eventually migrate onshore and add to the beach volume. If material is placed too far offshore, it would likely not move into the active beach zone, as was the case for a project off the barrier beaches flanking Mobile Bay, Alabama (Douglass 1997). Placement control is difficult under this alternative because it is analogous to emptying a dump truck without spreading the material evenly along the action area. In the case of the Mobile project, near shore disposal was constrained by water depths needed for loaded hopper dredges. Placement was, by necessity, in water exceeding 25 feet deep, the approximate operational depth of the loaded vessel. This placed the material beyond the active littoral zone with little associated nourishment benefit (Douglass 1997). The risks of such fill placement being able to meet the goals and objectives of the project are considered unacceptably high by the Applicant.

For reasons outlined above, Placement Option 5 is rejected for the Buxton nourishment project.

Placement Option 6 involves nourishment along one short segment of beach at the upcoast (i.e. north) end of the project. All fill would be concentrated in that area, with the expectation of gradually feeding the downcoast action area. Feeder beaches have been used adjacent to inlets and navigation projects (CERC 1984) for reasons of economy and size of dredge. Small harbor dredges working channels may only be able to pump a distance of 2,000–4,000 feet. Therefore, the dredge spoil is placed as far away from the inlet as practical, but not extended over long distances downcoast to other areas that may need sand. Oregon Inlet disposal along Pea Island is an example of a feeder beach repeatedly nourished to provide sand gradually to downcoast areas (Dolan & Lins 1986).

This concept is problematic for the Buxton project for two reasons. First, the scale of the Buxton project (~2.6 million cubic yards) greatly exceeds the volumes typically removed from inlet and harbor entrances where feeder beaches have been used. A Buxton feeder beach would produce a very large salient (bulge) in the shoreline extending over 1,000 feet offshore for a limited length of beach. This would alter wave patterns and lead to focused erosion at the ends of the feeder, with the degree of erosion related to the scale of the feeder beach. This interruption of normal transport would increase the likelihood of a dune breach associated with end effects of the nourishment (NRC 1995, Dean 2002). A breach of the foredune would damage NC 12 and infrastructure.

A variation on the feeder beach concept would stockpile a large portion of the sand somewhere along the action area for later distribution by mechanical means after the turtle or bird nesting period or storm emergencies. The primary issue with stockpiles is the lack of room along the existing dry-sand beach or backshore area within the action area for a large stockpile. For example, if 50%, or ~1,300,000 cubic yards, of the project volume were retained in a stockpile, ~800 acre-feet of storage capacity would

be required. Such a stockpile would average 40 feet high and require over 20 acres of land, which would not be practical for the Proposed Action. Also, such a stockpile for later placement along the beach would significantly increase the project costs (or reduce project volume) due to the need for double handling of the nourishment sand.

For reasons outlined above, Placement Option 6 is rejected for the Buxton nourishment project.

MITIGATION MEASURES

To prevent and minimize potential adverse impacts associated with the Proposed Action, certain management and mitigation measures would be implemented during construction. Upon project completion, the action area would be left to adjust naturally and no further maintenance or manipulation of the beach would be involved. Additional monitoring activities before, during, and after construction are anticipated in conformance with the Biological Opinion for the project (to be issued at a later date). The Applicant should anticipate that state and federal permits required before this Proposed Action proceeds with construction would include a variety of conditions specifically related to the protection of water quality and natural resources from construction-related impacts. If the National Park Service decides to permit this Proposed Action, then the following mitigation would be incorporated into the terms and conditions of the NPS Special Use Permit.

Coastal Resources and Soils/Wetland Resources/Wildlife and Wildlife Habitats

- A pre-construction environmental meeting would be convened with resource and regulatory agencies, the National Park Service, the contractor, and the engineer to review protocols and environmental protection measures mandated under the permits.
- Equipment mobilization and use would be via designated beach accesses and along the constructed berm so as to avoid impacts to vegetated areas.
- Pipe and material along the beach would be moved under escort by NPS biologists so as to avoid any nesting activity or sensitive habitat designated by the National Park Service.
- Appropriate measures would be employed to prevent or control spills of fuels, lubricants or other contaminants from entering waterways or sensitive areas. Actions would be consistent with state water quality standards and the Clean Water Act Section 401 certificate requirements. A hazardous spill plan would be approved by the National Park Service and appropriate resource agencies prior to construction. This plan would state what actions would be taken in the case of a spill, notification measures and prevention measures to be implemented, such as the placement of refueling facilities, storage and handling of hazardous materials.
- Equipment on the beach would be moved to a safe location within the vicinity of the action area upon a weather forecast of high wave and water conditions.
- The contractor would not leave vehicles idling for excessive periods when parked or not in use.
- Sea turtle nests lay immediately prior to or during construction within the project Area would be relocated by trained observers under the guidance of USFWS, NPS and NCWRC officials.
- Wildlife collisions would be reported to federal and state resource personnel.
- Injury or death of wildlife would be reported to USACE, NPS personnel and other applicable agencies, such as the USFWS and NCWRC.

Vegetation

- No construction activities or equipment storage would occur on vegetated areas.
- Post-project dune planting or sand fencing are not included in project plans. Such activities would be possible at the discretion of the National Park Service or individual property owners in Buxton Village. The Applicant believes the appropriate time to implement dune planting or sand fencing is after the nourished beach undergoes natural equilibration (months to year timeframe).

Threatened and Endangered/Special Status Species

- The Applicant would coordinate with the National Park Service and resource agencies (USFWS, NCWRC) regarding the need to restrict construction in the vicinity of active nest building by sea turtles, shorebirds, or nesting water birds. (For more detailed discussion regarding mitigation procedures to protect these species, see Chapter 4.)
- The Applicant would coordinate during dredging operations with NMFS and the National Park Service regarding specific restrictions, operations procedures, and protection of turtles, Atlantic sturgeon, whales, and other marine mammals.
- The Applicant would comply with no-work buffers established by the National Park Service around active nests or other designated habitat requiring protection.

Cultural Resources

- Construction would be stopped if cultural resources are encountered, and the contractor would coordinate protective measures to minimize disturbance with the State Historic Preservation Office (SHPO).
- Potential cultural resources detected in the offshore borrow area (see Appendix F- *Cultural Resources*) would be avoided during dredging operations by establishing no-work buffers around the objects. Planning is being conducted for additional Phase 2 surveys to identify a possible abandoned cable running across the borrow area.

SUMMARY COMPARISON OF ALTERNATIVES

Table 2.1 provides a summary comparison of the alternatives presented in this chapter.

Table 2.1 Summary of Alternatives

Topic	Alternative 1: No-Action	Alternative 2: Winter Construction	Preferred Alternative 3: Summer Construction
NPS Beach – Reach 1	The ~11,500 feet of seashore beach north of the Village of Buxton (Reach 1) would continue to erode at historical rates of up to 10 feet/year. The beach would narrow and the dune would erode during storms. Dune breaches would occur with increasing frequency as the beach degrades. Emergency measures to repair the dune or place emergency sand bags to protect infrastructure would be implemented. Transportation and infrastructure would be adversely impacted by major storms. The chance of a breach inlet during storms would increase as the beach continues to narrow.	Reach 1 along the Seashore would be nourished by a sand volume that is about half the amount of the Preferred Alternative during a four-month construction window. The volume of sand would replace the estimated deficit volume of sand (ie minimum volume that must be added to bring the beach profile to a stable condition). This would only provide a few years' worth of extra sand to accommodate annual erosion. Project longevity would be relatively short (several years) before the beach volume is again in deficit.	Reach 1 would be nourished at the maximum sand volume allowable under the Applicant's fixed budget. Summer dredging and nourishment would result in much greater efficiencies and production, shorten-in the duration of construction to ~2.5 months while doubling the volume. The increased volume would provide a much wider beach and increase longevity to ~10 years. This would provide protective benefits for a much longer period and reduce the frequency and magnitude of damages to dunes, NC 12 and infrastructure during storms.
Village of Buxton Beach – Reach 2	The ~4,000-foot length of seashore beach fronting the Village of Buxton would continue to erode at historical rates of up to ~12 feet per year. Beach width would continue to decline and normal waves would impact existing homes and businesses. Property owners would use more emergency sand bags to protect property. Wave runup would be higher at the sand bags without a beach to dissipate waves gradually. High runup and overwash would flood property and NC12 with increasing frequency, cutting off transportation to surrounding communities.	Reach 2 along the village shoreline would be nourished by sand volume that is about half the amount of the Preferred Alternative. Winter construction would be halted numerous times, leaving incomplete sections vulnerable to end losses before construction resumes. The nourishment volume would offset the deficit volume, but only provide for a few years of extra sand to accommodate annual erosion. Project longevity would be short (a few years) before the beach volume is in deficit.	Reach 2 would be nourished at the maximum sand volume allowable under the Applicant's fixed budget. Summer dredging and nourishment would result in much greater efficiencies and production, shortening the duration of construction impacts while doubling the volume. End losses due to temporary construction stoppages would be reduced. The increased volume would provide a much wider beach and increase longevity to ~10 years. This would provide protection benefits for a much longer period and reduce the frequency and magnitude of damages to existing property and infrastructure.
Meets Purpose & Need	No. Present conditions along the action area have deteriorated to the point that minor storms directly impact developed property and cut back the toe of the artificial dune. Future dune breaches are expected at increasing frequency. This would lead to repeated property damage and road closures and would necessitate emergency actions to restore the area.	Yes. Nourishment at about half the amount of the Preferred Alternative would provide improved storm-damage reduction and protection of infrastructure and existing development. A wider beach would reduce wave runup and erosion of the dune, lessening the frequency of breach events. Project longevity would be limited to ~3 years before the action area returns to a deficit volume condition.	Yes. Nourishment at the maximum quantity allowable within the Applicant's budget would provide protection to infrastructure and existing development for up to ten years. Dune-breaching frequency would be reduced, and the wider beach would feed sand to the dune allowing for natural dune growth. Storm damages would be reduced and the probability of a breach inlet forming would diminish.

Table 2.1 (continued) Summary of Alternatives

Topic	Alternative 1: No-Action	Alternative 2: Winter Construction	Preferred Alternative 3: Summer Construction
Anticipated Sea Level Rise	Beaches respond to sea level rise by profile adjustment under waves and changing water levels. The adjustment is rapid and imperceptible. An associated net recession of the shoreline occurs with sea level rise, which in the case of the Buxton action area is dwarfed by other underlying causes of erosion. Sea-level rise in the range 3–6 millimeters per year (recent scenarios) equates to beach recession of ~2–4 inches per year in the Buxton area. The average natural recession rate in the area is ~10–12 feet per year.	The nourished beach would adjust rapidly to sea level rise just as a natural beach. The volume of nourishment and seaward displacement of the shoreline would greatly exceed the recession due to sea level rise at decadal scales. The shoreline advance due to nourishment would be 20–40 times the potential recession due to sea level rise over a 3–5 year period.	Greater nourishment volumes under the Preferred Alternative would provide longer term benefits, more than offset recession due to sea level rise and reduce runup levels which are a function of beach width and steepness of the profile. The shoreline advance due to nourishment would be 40–80 times the potential recession due to sea level rise over an ~10-year period.
Regulatory Implications	Continued erosion, breaches of the dune, damages to buildings, and emergency repairs to NC12 result in repeated need for emergency permits and such remedial measures as sand bagging that are generally discouraged under North Carolina CZM rules and regulations.	Nourishment is a soft-engineering solution to erosion generally approved or preferred by regulatory agencies compared with emergency sand bags or hard structures. Construction in winter months is generally preferred by resource agencies, so as to avoid disturbing sea turtles and other species.	Nourishment during summer months is discouraged or opposed by resource agencies, to avoid times of construction when threatened or endangered species may be present.
Site Constraints & Construction Logistics	The action area is generally considered to be a difficult place to work because of its remoteness and high wave energy. The nearest safe harbor for oceangoing dredges is >100 miles away.	Under Alternative 2, winter conditions pose high risks to contractors working offshore and along the beach. Potential exists for loss of equipment or human life. Production would be greatly diminished because of the number of days in which wave heights exceed operational conditions.	Under Alternative 3, summer conditions significantly reduce risk and improve safety for offshore work. Average wave heights are to operational limits of hopper dredges in the action area in June through August.
Existing Uses	Alternative 1 has no impact on existing uses, which include recreation, bird nesting, turtle nesting, surf fishing, surfing and observing nature. However, ongoing erosion is likely to lead to reduced walkable beach, more dune damages, and temporary highway closures while emergency repairs are performed.	Under Alternative 2, temporary and localized disruption of existing uses would occur during construction. Upon project completion, existing uses would resume with little change. Construction in winter would be less disruptive to threatened and endangered species, recreational users, and other activities.	Under Alternative 3, temporary and localized disruption of existing uses would occur during construction, with greater impacts than Alternative 2. The duration of construction impacts would potentially be shorter due to efficiencies of work during low-wave summer months and the relatively small beach area affected by active construction.

SUMMARY COMPARISON IMPACTS OF ALTERNATIVES

Table 2.2 provides a summary of the impacts related to each alternative. A more detailed explanation of the impacts is presented in Chapter 4 – Environmental Consequences.

Table 2.2 Summary of Impacts of Alternatives

Topic	Alternative 1: No-Action	Alternative 2: Winter Construction	Preferred Alternative 3: Summer Construction
Coastal Resources	Under Alternative 1, erosion and sand loss from the action area would continue to be the dominant process. With continued erosion, the foredune would breach, leading to a further reduction in sand supply along the beach. Because NC12 is a fixed structure and lifeline to the communities of Hatteras Island, emergency highway maintenance would likely continue. Emergency measures would further manipulate the beach/dune system, introduce more emergency sandbags, modify the profile and narrow the recreational beach. The available sand supply to downcoast areas would be reduced. **Project Impact:** Minor to moderate, long-term adverse impacts. **Cumulative Impact:** Contributes a noticeable, adverse increment to a long-term, regional, cumulative adverse impact.	Alternative 2 would augment the sand supply and have negligible impact on littoral processes. A wider beach would reduce runup levels and help promote natural dune growth which depends primarily on wind speed and the width of the dry sand beach. The adjusted profile after construction is expected to retain similar slopes and morphology as other stable beaches in the vicinity of the action area. Excavations in the borrow area would produce short-term local adverse impacts. Alternative 2 benefits would last for several years. **Project Impact:** Long-term (several years) beneficial impacts. **Cumulative Impact:** Contributes a noticeable beneficial increment to a long-term, regional, cumulative adverse impact associated with erosion and dune manipulation along the coast.	Alternative 3 would augment the sand supply by at least twice the amounts under Alternative 2. This would provide similar impacts for dune building without significant modification of littoral processes. The wider beach would allow natural processes of erosion and accretion to occur without frequent adverse impacts to the dune system. Alternative 3 benefits would extend up to one decade. **Project Impact:** Long-term (decade) beneficial impacts. **Cumulative Impact:** Contributes a noticeable, beneficial increment to long-term, regional, cumulative, adverse impact associated with erosion and dune manipulation along the coast.
Sand Resources	Alternative 1 would impact sand resources by continuing to remove sand from the action area. As erosion continues and emergency shore protection is implemented, beach and dune sediments tend to become coarser than normal. Scraping of washovers across NC12 introduces coarser sands and chunks of asphalt into the repaired dune. The narrower and coarser-grained beach tends to steepen, thus modifying the characteristics of the surf. Steep beach faces produce a plunging wave form at the shore, dangerous for surfers and swimmers. **Project Impact:** Minor long-term adverse impacts. **Cumulative Impact:** Contributes a noticeable adverse increment to long-term, beneficial, cumulative impacts of sand additions along other Dare County beaches.	Alternative 2 would augment sand resources on the beach, while reducing sand resources in the offshore borrow area. The impacts would be the same, but lower in magnitude compared with Alternative 3. **Project Impact:** Long-term (several years) beneficial impacts on beach; moderate adverse impacts in borrow area. **Cumulative Impact:** Contributes a minor, adverse increment to long-term, minor, regional, adverse cumulative impacts of offshore sand excavations. Contributes a noticeable, beneficial increment to long-term, beneficial, cumulative impacts of sand additions along other Dare County beaches.	Alternative 3 would provide the largest addition of new sand to the beach under a fixed budget. Sand quality is expected to closely match other native beaches in the area and be incrementally finer than some sections in the action area, which are coarse for the reasons given under Alternative 1. By augmenting the littoral sand supply, the normal processes of erosion and accretion would occur with less direct impacts to the dune, NC 12, and existing structures. Breach events would be less frequent and dune building would occur via natural aeolian processes for the life of the project, rather than via artificial manipulation after storms. The offshore borrow area is an isolated shoal, which would be reduced in height by several feet upon excavation. Data indicate the underlying sediments match the borrow sediments. Thus, little change in substrate conditions should occur upon project completion. **Project Impact:** Long-term (decade), beneficial impacts on beach; moderate, adverse impacts in borrow area. **Cumulative Impact:** Contributes a minor, adverse increment to long-term, minor, regional, adverse cumulative impacts of offshore sand excavation.Contributes a noticeable, beneficial increment to long-term, beneficial, cumulative impacts on the beach.

Topic	Alternative 1: No-Action	Alternative 2: Winter Construction	Preferred Alternative 3: Summer Construction
Water Quality	Continued erosion would increase the frequency of dune breaches, property damage, and overwash onto NC12. Emergency repairs would introduce incompatible materials, such as asphalt, oil and grease, into the reconstructed dune with possible minor adverse impacts to water quality. Turbidity in the littoral zone would be unchanged. **Project Impact:** Negligible to minor, long-term adverse impacts. **Cumulative Impact:** Contributes an imperceptible adverse increment to long-term, negligible adverse cumulative impacts.	Dredging operations would produce localized, short-term increases in turbidity at the borrow area and the slurry discharge area along the beach. The proposed borrow area consists of medium to coarse sand (mean grain size), with trace amounts of mud. Nearly all the sediment would settle rapidly (order of seconds to minutes) based on the fall velocity of sandy materials. Turbidity impacts would be limited temporally and spatially due to the texture of the sediments. **Project Impact:** Transient, short-term, adverse impacts during construction. **Cumulative Impact:** Contributes an imperceptible adverse increment to long-term, negligible adverse cumulative impacts.	Same as Alternative 2, but of incrementally greater magnitude in relation to the higher volume of nourishment that may be accomplished. **Project Impact:** Transient, short-term adverse impacts during construction. **Cumulative Impact:** Contributes an imperceptible adverse increment to long-term, negligible adverse cumulative impacts.
Essential Fish Habitat (EFH)	Under the No-Action Alternative, continued erosion would likely increase the amount of shoreline that is armored with emergency sand bags. This would modify the profile and reduce the area of unconsolidated/shallow subtidal bottom EFH for certain benthic organisms which serve as prey for the surf fishery. There would be no impact in offshore shoal areas. If a breach occurs, it offers transient, potential beneficial impacts of additional estuarine emergent wetlands EFH and estuarine intertidal flats EFH on back barrier due to overwash deposits. Length of benefit would depend on whether and how fast the breach closed and whether or not the breach was bridged. **Project Impact:** Site-specific to local, long-term, minor to moderate adverse impacts to nearshore EFH. Site-specific short-to long-term potential beneficial impacts. **Cumulative Impact:** Contributes imperceptible to noticeable increment to adverse cumulative impacts associated with ongoing erosion processes.	Dredging operations offshore would produce localized, short-term, adverse impacts to the existing population of benthic organisms, removing biomass and prey from the surficial layer of sediment in the Cape Hatteras sandy shoal HAPC and temporarily increase turbidity in marine water column EFH. Dredge operations may impact *Sargassam* habitat HAPC by entrainment. Excavations would leave undisturbed area and some irregular topography which may be attractive to some fish species and foster rapid recruitment of benthic organisms. Beach filling operations would bury sessile benthic organisms in the unconsolidated/ shallow subtidal bottom EFH, temporarily increase turbidity to marine high-salinity surf zone EFH, and/or bury sargassum EFH that may be floating in the area. The borrow area is expected to undergo rapid (order of months) recolonization by similar species because of the similarity between surficial sediments and under-lying sediments. The nourished beach area is expected to undergo rapid (order of weeks to months) recolonization by similar species because of the textural similarity between native and borrow sediments. See Appendix E (*Biological Monitoring*) for related project data from a nearby similar setting. **Project Impact:** Site-specific, short-term, minor to moderate, adverse impacts during construction to nearshore and offshore EFH/HAPC. **Cumulative Impact:** Contributes imperceptible to noticeable, adverse increment during construction to long-term, minor, adverse cumulative impacts of offshore sand borrow excavations and beach placement of excavated materials. It would contribute imperceptible increment to noticeable, long-term, beneficial, cumulative impacts associated with stable beaches.	Same as Alternative 2 but of incrementally greater magnitude in relation to the higher volume of nourishment that may be accomplished. Upon project completion, the greater longevity of Alternative 3 would allow the benthic communities to evolve unobstructed for a longer period of time before erosion returns the area to conditions where the profile is frequently manipulated and hatitat area diminishes for the reasons given under Alternative 1. **Project Impact:** Site-specific, short-term, minor to moderate, adverse impacts to nearshore and offshore EFH/HAPC. **Cumulative Impact:** Contributes imperceptible to noticeable, adverse increment during construction to long-term, minor, regional, adverse cumulative impacts of offshore sand borrow excavations and beach placement of excavated materials. It would contribute an imperceptible increment to noticeable long-term beneficial cumulative impacts associated with stable beaches.