

**HURRICANE RECOVERY:
THE CHALLENGE OF IMPLEMENTING AN ECOLOGICALLY SENSITIVE
SOLUTION TO A TRANSPORTATION DISASTER ON THE NORTH CAROLINA
OUTER BANKS**

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ABSTRACT:

This paper discusses how the North Carolina Department of Transportation (NCDOT) responded to Hurricane Irene and the destruction of North Carolina Highway 12 (NC 12) on the Outer Banks. Hurricane Irene breached Hatteras Island, creating a new inlet which severed the highway on the Pea Island National Wildlife Refuge and ripped up a 164 foot (50 meter) section of asphalt on NC 12 north of Rodanthe. This event severed the sole land transportation route for thousands who work, live and play on the scenic Outer Banks. The only way on and off of the island was a ferry now dedicated to emergency services. A rapid response that met the needs of the people depending on that route while protecting the ecologically sensitive habitats and endangered species of the Wildlife Refuge was developed. An important aspect of NCDOT's disaster response model was the collaboration among agency partners responsible for the environmental permits and regulatory requirements needed. Continuing to learn from this model and develop a long-term solution to an area that is continuously exposed to strong storms and marine currents will be crucial if we intend to maintain the area's important economic, touristic and ecological value.

The Setting

One of the unique aspects of North Carolina is the series of barrier islands called the Outer Banks (Figure 1). These barrier islands are made of sand, and they are bordered to the East by the Atlantic Ocean and to the west by the Currituck, Albemarle and Pamlico Sounds. These islands are narrow, and in some places very close to mean sea level. In their natural migration, storms have caused waves to wash over sections of the islands, transporting sand and occasionally opening inlets through the islands allowing the exchange of water between the ocean and the sounds (Riggs et al., 2011). Inlets may open and close again, only to re-open in the same area or a nearby section. In reality, these inlets could be called "outlets" since all of the water flowing out of the major rivers in the coastal plain of North Carolina must flow to the ocean through them. Active exchange of freshwater and seawater have made these sounds an important estuary and nursery area for fish, shellfish and a great diversity of other flora and fauna, including many threatened and endangered species.

Several sections of the Outer Banks have been placed in public trust as National Seashores and National Wildlife Refuges. The focal area of this paper is the Pea Island National Wildlife Refuge and the Cape Hatteras National Seashore. The Cape Hatteras National Seashore was established by an act of Congress in 1937. The Pea Island National Wildlife Refuge was established in 1938 on the north end of Hatteras Island, and was intended to protect migrating snow geese and other birds and wildlife. The National Seashore and Wildlife Refuge are known as destination points for birdwatchers, beachgoers, fishermen, surfers and all manner of outdoor enthusiasts. The tourism industry has thrived as a result of the unique nature of the Outer Banks and the opportunities presented by the refuge and park.



FIGURE 1 NC Outer Banks with red areas indicating sections of the islands prone to ocean overwash. (modified from Outer Banks Task Force <http://www.obtf.org>).

The History

Shifting sands and ocean overwash prohibited the establishment of permanent roads and structures on most of these islands prior to the 1930s (Lee 2008). Between 1934 and 1941 the Work Projects Administration (WPA) and the Civilian Conservation Corps (CCC) implemented dike construction, dune enhancement, water control, dune stabilization plantings, fencing and additional work to stabilize the islands. Paving of NC 12 began in 1948 and the Bonner Bridge connected Bodie Island to Hatteras Island in 1963. This newly developed transportation access facilitated the growth of the Barrier Island communities. In the years since it was first paved, NC 12 and the Bonner Bridge have become the primary travel corridors for residents and business interests on Hatteras Island, where the economy depends heavily on tourism.

When Category 1 Hurricane Irene struck the North Carolina Coast on August 27, 2011, it destroyed parts of NC 12, severing the lifeline to the mainland for thousands who live, work and play on the scenic Outer Banks (Figure 2).

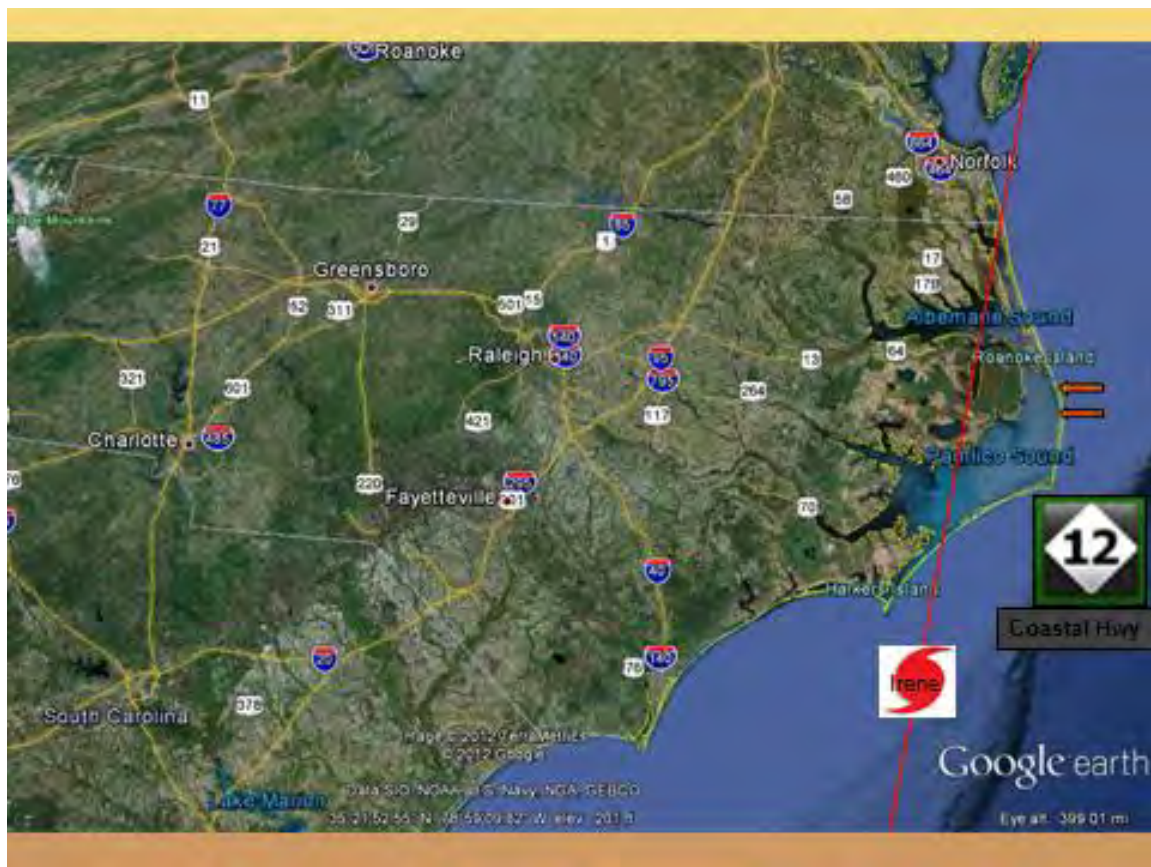


FIGURE 2 Path of Hurricane Irene.

The storm breached the highway on the Pea Island National Wildlife Refuge six miles south of Oregon Inlet and the Bonner Bridge at the site of the historical New Inlet, which was known to have opened several times in recent history. The hurricane left a gap approximately 200 feet (61 meters) wide where the road was previously located. This gap has since become known as “Pea Island Inlet” (Figure 3).



FIGURE 3 Aerial photo of Pea Island Inlet taken August 28, 2011: one day after Hurricane Irene. The breach in NC 12 can be seen in the middle.

Irene also breached NC 12 north of Rodanthe at an area called the “S Curves.” Here the storm ripped out a 164 foot (50 meter) section of asphalt, sending water swirling into nearby beach homes. This gap eventually grew to 220 feet (67 meters) wide (Figure 4). As a result of this damage, the only way on and off the island was a ferry dedicated to emergency services.



FIGURE 4 Ariel photo of the breach at Rodanthe "S Curves" taken August 28, 2011.

To exacerbate this issue, 12 miles (19 kilometers) of the transportation corridor pass through sensitive ecological habitat on the Pea Island National Wildlife Refuge, home to 11 federally listed threatened and endangered species, including the piping plover (*Charadrius melodus*), Atlantic sturgeon (*Acipenser oxyrinchus*), and loggerhead sea turtle (*Caretta caretta*). This situation presented some unique ecological, design, and engineering challenges to be faced in such an environmentally sensitive and physically dynamic area.

The Response

In continuing its designated mission, the NCDOT instantly put a disaster response plan into action. After two days of damage assessment from land and air, NCDOT organized a meeting with state and federal environmental partners; more than 80 people in all, to coordinate the environmental permits needed to repair NC 12 and re-open the transportation corridor. In order to achieve this, it was necessary to have standing relationships of trust and good communication with multiple agencies that are responsible for making decisions about the area and issuing permits for repairs. These relationships were fostered through the Merger process. This process "merges" key steps of the National Environmental Policy Act (NEPA) and section 4 of the Clean Water Act document development process with engineering pre-construction and design. The process gathers regulatory and commenting stakeholder agencies to discuss and "concur" at

different key steps of the process. This involves the stakeholders from project inception through project construction. Principle agencies include the Federal Highways Administration, U.S. Army Corps of Engineers, North Carolina Division of Coastal Management, North Carolina Department of Natural Resources, U.S. Fish and Wildlife Service and National Park Service.

In the case of NC 12, stakeholder agencies had been meeting prior to Hurricane Irene to work on an agreement for the replacement of Bonner Bridge, which spans Oregon Inlet, as well as a long term solution to vulnerable portions of NC 12. In response to Hurricane Irene, all agencies were able to come together quickly to discuss concerns, issues and regulatory requirements.

The environmental permits included commitments that required monitoring the federally endangered piping plover and data gathering at the Pea Island Inlet as well as the S Curves during repair. The breaches and inlet created on Pea Island National Wildlife Refuge opened some new habitat for the piping plover, which is known to use wide, flat, open beaches with very little grass or other vegetation (USFWS). The piping plover's use of this newly created habitat was confirmed by NCDOT biologists during the time following Hurricane Irene.

One of the biggest challenges was the requirement that all construction activities occur within the existing Right-of-Way, keeping all construction personnel – contractors, inspectors, and others aware of the environmental issues and special protocol that had to be followed due to working on federally protected land. For example, it was necessary to keep the construction crews from washing their concrete buckets out in the inlet. Special Use Permits were worked out with the agencies on site and the conditions of those permits put in place immediately.

Once all of the required permits were obtained, a temporary bridge was purchased from Mabey Bridge & Shoring of Maryland and constructed by Carolina Bridge Company across the largest breach in the middle of Pea Island. This bridge provides a 2-lane, 650 foot (200 meter) span across Pea Island Inlet (Figure 5). The modular design of the bridge allowed for quick construction and placement. In Rodanthe, the NCDOT found a suitable source of sand and began filling in the breach. NC 12 was re-opened on October 10th, 2011; exactly forty four days after Hurricane Irene caused the damage, at a cost of 10 million dollars U.S. currency



Figure 5 Bridge over Pea Island Inlet

Constant collaboration on the ground with NCDOT and all stakeholders involved allowed NCDOT to succeed and build a model for future disaster response. This also provided a positive outcome for both parties – NCDOT was able to restore access for the public, and also provide valuable biological and geological data of this dynamic system to the resource agencies on Pea Island National Wildlife Refuge. Some of the benefits of this collaboration are data involving the utilization of this newly formed inlet by ecologically sensitive shorebirds and tracking migration of the new inlet since its formation. Data continues to be gathered and will help us understand the value of balancing the needs of residents, business and tourists of Hatteras Island with the dynamics of the natural environment.

Current status of the inlet and protected species

The barrier island system is an extremely dynamic one. At the time of this writing, Pea Island Inlet has naturally filled in with sand. The existing temporary bridge is still in use. The expanse of sand continues to be used by shorebirds for foraging and loafing.

The continuing challenge

On Oct 27, 2012, Hurricane Sandy caused extensive damage to NC 12 in multiple areas again. In the recent past, other hurricanes, including Isabel in 2003, have severed the NC 12 travel corridor. Additional storms, nor-easters and the potential of sea-level rise associated flooding increase the challenge of reaching a long term solution that meets the needs of local businesses and residents. The section of Hatteras Island north of Rodanthe known as the “S Curves” has a high erosion rate which threatens houses, business and NC 12.

Another challenge to the process is the fact that the missions of the stakeholder agencies do not always align perfectly. NCDOT is a commerce agency committed to “Connecting people and places safely and efficiently, with accountability and environmental sensitivity to enhance the economy, health and well-being of North Carolina”. The mission of the U.S. Fish and Wildlife Service is “working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.” Other stakeholder agencies have their own missions, which may or may not be perfectly compatible with NCDOT. Given each agencies mission, we must work together to achieve the best possible outcome for each unique situation.

NCDOT’s Proposed Solutions

The long term plan for protecting NC 12 and maintaining the transportation corridor is scheduled to occur in phases. Phase one involves replacing the 2.7-mile (4.3 kilometer) long Bonner Bridge adjacent to the existing bridge over Oregon Inlet. NCDOT continues to work extensively with stakeholder agencies to ensure that all environmental concerns are addressed. The design-build team has developed creative solutions to reduce both temporary and permanent environmental impacts to the human and natural environment at the site. For example, “top down” construction methods on the main span and extensive use of precast concrete elements will minimize construction activity at the site and impacts to the inlet floor. The contractor will use innovative LED construction lighting to minimize disturbance to sea turtles.

Phase two involves the implementation of a long-term solution for the two breaches on NC 12 caused by Hurricane Irene and subsequent storms. An approximately 2.1 mile (3.4 Kilometer) bridge is proposed to be constructed within the existing NC 12 easement to replace the existing surface road and the temporary bridge over the Pea Island Inlet. The project will be designed to account for the potential re-opening, expansion and migration of the current inlet in the future, as well as to bridge the entire area considered to be susceptible to breaches in the Pea Island Inlet area. In Rodanthe, the department is considering two options. The first one includes elevating

NC 12 onto a bridge within the existing easement, which would end just north of the community center and not require beach nourishment. The second option is constructing an approximately 2.5 mile (4 kilometer) bridge that would extend into the Pamlico Sound and connect back to Rodanthe just north of the community center. NCDOT plans to award a contract for construction at the Rodanthe breach in the Fall of 2013. Both of the phase two bridges are under final environmental review.

Conclusion

Natural processes and disasters have been and will continue to be disruptive to transportation systems in North Carolina, the United States and throughout the world. Preparing for and responding to those disruptions rapidly and efficiently is crucial when the disaster causes hardship to the local economy, health and well-being of those affected. Developing sound relationships with agency partners responsible for the environmental permits and regulatory requirements through the Merger process greatly helped the NCDOT deal with the transportation crisis caused by Hurricane Irene.

Acknowledgments and Photo Credits

Cover page photo courtesy of Pablo Hernandez, NCDOT

Figure 3 aerial photo of Pea Island Inlet courtesy of NCDOT Photogrammetry Unit

Figure 4 aerial photo of Rodanthe “S Curves” courtesy of NCDOT Photogrammetry Unit

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References

- Lee, G.F. 2008. Construction of the Outer Banks: Land Use, Management, and Meaning in the Creation of an American Place. Unpubl. thesis, North Carolina State University, Raleigh, NC. 248p.
- Pilkey, O.H., T.M. Rice, and W.J. Neal. 2004. *How to Read a North Carolina Beach: bubble holes, barking sands, and ripped runnels*. The Univ. North Carolina Press, Chapel Hill. 162 p.
- Riggs, S.R., D.V. Ames, S.J. Culver, and D.J. Mallinson. 2011. *The Battle for North Carolina's Coast: evolutionary history, present crisis, and vision for the future*. The Univ. North Carolina Press, Chapel Hill. 142 p.

Online Resources

<http://www.fws.gov/peaisland/>

http://www.fws.gov/raleigh/species/es_pipl.html Accessed June, 2013

<http://www.ncdot.gov/projects/bonnerbridgephase2/> Accessed May, 2013

<http://www.ncdot.gov/projects/bonnerbridgereplace/> Accessed May, 2013

<http://www.obtf.org/> Accessed June, 2013

<http://www.ncdot.gov/travel/nc12recovery/> Accessed May, 2013