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2998 Loggerhead Ct.
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Dear Ms. Faulkner:

I am writing to you as the Public Information Officer regarding my review and critique of The Geological Society of America Special Paper 460, dated 2009, "North Topsail Beach, North Carolina: A model for maximizing coastal hazard vulnerability" by Orrin H. Pilkey and William J. Neal. This letter represents a summary of my entire report and analysis that is published on the Town of North Topsail Beach's Website at www.ntbnc.org.

During the past forty years my research at UNCW's Center for Marine Science has focused on the NC barrier islands, tidal inlets and the inner-continental shelf in the coastal sector between Cape Lookout and Little River, SC. In addition to my academic research, I have acted as a geological consultant for a number of homeowners, coastal towns (North Topsail Beach, Figure Eight Island, Bald Head Island, Oak Island, Holden Beach and Sunset Beach) the NC DCM, the USACE (Wilmington District) and a number of NC, SC and FL engineering firms. The NC Beach and Inlet Management Plan's geological and inlet-related sections are my contributions. I am also an original member of the NC CRC's Science Panel that was convened in 1997, and I continue to serve the Commission. During my tenure, the Panel has dealt with a variety of coastal management issues that confront the coastal communities.

Based on the aforementioned, I believe that I have the expertise to offer another viewpoint on nature of Topsail Island and in particular the shoreline along the Town of North Topsail Beach. At the outset I must mention that the Pilkey and Neal (2009) article is as the authors state, an opinion paper. None of their assertions are supported by data, theirs or otherwise. In contrast, my comments that follow are based on a robust data set.

1) Pilkey and Neal (2009) mention that Topsail Island was composed of three islands in the 19th C. This statement is irrelevant with respect to present situation or for potential opening of new inlets because no inlet has opened along the island during the past 220 years. Furthermore, all the barriers in SE NC were composed of several islands in their recent past. Wrightsville Beach for example was composed of two islands as recent as 1965 when Moore's Inlet was closed artificially. Likewise historic inlets have migrated along the entirety of Wrightsville Beach.

2) With respect to the island's stormy past there is absolutely no photographic evidence to support the claim that Hurricane Hazel (1954) opened *a new and viable inlet just north of the County line, only quickly to be closed by the state*. Aerial photographs (11/9/54, 1" = 800 ft) show no evidence of an inlet scar or other features relating to an inlet. Dune breaches are present, and therefore it is likely if infilling did occur, it was related to one of these features.

3) Pilkey and Neal (2009) state that the formation of new inlets during hurricanes is a certainty for North Topsail Beach, given the fact seven swash channels are present within the community and are repeatedly opened by storms. There are three widely separated zones along the NTB shoreline where the hurricanes of the 1990s cut shallow "channels" across the island. Along the southern portion of the Town's one scour channel extended to the shrub/marsh boundary while the others ended at the road while washover fans extended across the island and into the marsh. All of these scour features closed naturally within several weeks while only one of the four channels reopened during a subsequent storm event. These shallow features could not have evolved into inlets by any stretch of one's imagination. The two swash channels along the northern zone are bridge sites where rising water levels during the hurricanes and related wave swash eroded the dunes and washed over and under the bridges.

> 3a) Hurricane Bertha (7/12/96) was the initial storm to breach the dune line and form small scour channels three years after the low areas were bridged. Washover fans extended into the marsh and the open shallow water near the dredge material islands. The NC DOT placed sheet pile structures on the landward side of the two bridge sites in the aftermath of Hurricane Bertha. When Hurricane Fran (9/6/96) struck, the dune line was non-existent; and consequently, the storm-related rising surge easily overtopped the area and led to further development of the overwash-related topography in the marsh and open water area. By the time Hurricane Bonnie made landfall (8/26/98), the marsh and open water landward of the northernmost swash channel had infilled to such a large extent that little tidal exchange occurred. When Hurricane Floyd struck the NC coast (9/16/99) it did not reactivate the swash channel at the northernmost site, but it did add additional washover material to the landward side of the bridged area. The storm however did reactivate a shallow swash channel to the south that remained open for a short period of time. Contrary to the assertion of Pilkey and Neal (2009), the northernmost swash channel had a very low probability of becoming a viable inlet due to the lack of a connection to open water (sufficient tidal prism) and a deep enough channel.

4) Pilkey and Neal (2009) assert that the formation of new inlets during hurricanes is a certainty for North Topsail Beach, given the fact seven swash channels are present within the community and are repeatedly opened by storms. The four swash channels in the southern portion of North Topsail Beach were small scour features and closed quickly. The remaining two major swash channels to the north would not have evolved into tidal inlets even if the placement of sheet piles on the landward side of the bridged areas had not occurred. Furthermore, elevated washover-fans now occupy the areas of marsh and open water that once backed the bridged low areas where the swash channels formed. Additionally, the cumulative effect of the four hurricanes in the 1990s substantially increased the elevation of the area either directly via washover fan development or indirectly through "outwash" of fine grained material. As well, a part of the modern barrier is now attached to the large dredge material islands via a large washover terrace that has in effect widened the barrier.

> 4a) The point germane to the discussion of the potential for future tidal inlets is that the back barrier area is now elevated, and the once small area of open water is now an elevated grassland. Also, the sheet piles are still in place although buried. If scour channels did form in the northern breach zone again, they would close quickly as there is a lack of a large potential tidal prism to maintain the breach.

5) Pilkey and Neal further state that inlets formed along North Topsail Beach during modern hurricanes have been closed artificially before significant flood-tidal deltas formed. The implication here is that if the modern "inlets" were allowed to remain open, large flood deltas

would have been produced, which eventually would have been colonized by tidal marsh when the inlet closed naturally, thereby effectively widening the barrier. Likewise, Pilkey and Neal (2009), made reference to an inlet that opened during Hurricane Hazel in vicinity of the Onslow/Pender County line and was quickly closed by artificial means. No proof of such an inlet opening is evidenced in any of the post-Hurricane Hazel aerial photographs. Additionally, it is interesting to note that no inlets have opened along the North Topsail Beach shoreline since 1794 when Barren Inlet opened. Map data substantiate this assertion as well the occurrence of extensive peat exposures along the majority of Town's oceanfront.

6) It was stated by Pilkey and Neal (2009) that *the continued migration of New River Inlet and the potential for new inlet formation prompted the state to propose increasing the size of the designated inlet hazard zone.* This statement is totally misleading for a number of reasons. Firstly, potential inlet formation is not considered in the designation of an IHA. The IHA refers to those segments of the adjacent barriers that are influenced by inlet-related processes. As a founding member of the NC Science Panel (1996), the Panel began working toward updating the Inlet Hazard Areas (IHAs) as early as 1997. The rationale was that the basis for the delineation of the IHA was outdated and was based simply upon historic inlet migration trends.

> 6a) Furthermore, New River Inlet was an unstable feature between 1856 and 1932 when it was an unmodified system. It is important to understand the history of modification of the inlet when considering inlet migration. Information derived from historic charts (1852-1932) indicated the presence of a very small outer bar and clogged interior channels that indicated the tidal prism was very small. A series of modifications occurred between 1930 and 1962 related to the dredging of the AIWW and the feeder channels. By 1962, the inlet had adjusted to the modifications, and as a result the outer bar had enlarged significantly due to the increased tidal prism. Since 1962, the migration rates have varied and generally decreased from ~41 ft/yr (1962-1974) to 17 ft/yr (1974-1990) and most recently to ~9 ft/yr (1990-2013). The latter rate is likely the slowest migration rate of any shallow-dradft inlet in NC.

7) According to Pilkey and Neal (2009) *The least environmentally damaging source of sand for North Carolina beaches is the continental shelf. Finding such sand deposits, however, requires extensive and costly seismic surveying and vibracoring. The continental shelf off Topsail Island is rock, and sand deposits are presumed to be spotty and small, requiring extensive seismic surveying and vibracoring to find sand for beach replenishment.* The inferences derived from the above assertions made by Pilkey and Neal (2009) suggests that no data existed regarding the availability of sand resources offshore North Topsail Beach when their paper was submitted for publication. In reality, several island-wide investigations of the inner-shelf had been completed by 2003 and by 2005 significant advances in the identification of borrow sources had occurred. Pilkey and Neal (2009 have neglected to mention the existence of these data.

> 7a) Subsequently, detailed mapping of hardbottom areas adjacent to all the borrow sites and extensive sediment analyses of the compatibility of the material in the borrow areas resulted in a proven sand resource total volume of ~24.5 M cy, a volume sufficient for over 30 years of nourishment. An additional source of sand not mentioned by Pilkey and Neal (2009) is the material derived from maintenance operations within the New River Inlet system that includes the outer bar channel and the navigation channel within the Cedar Bush Marsh area that can be used for nourishment purposes.

8) Pilkey and Neal (2009) *maintain that navigation channel realignment is something of a misnomer because the former channel was not filled in; so at least initially, the inlet has two*

channels and an increased cross-sectional area. Channel realignment occurred at New River Inlet in early January 2013. Inspection of post-channel realignment satellite images shows that the former ebb channel has shoaled, and its remnant extends only a short distance inside the mouth of the inlet while the outer segment is recognizable, its presence had no influence on increasing the cross-sectional area of the inlet. However, the portion of the ebb channel that has a bearing on the cross-sectional area is located much farther landward in the throat where the inlet is at its minimum width. This region where constriction is greatest is where one measures the Ac. It is this region of the throat that is paramount in the retardation of tidal flow and hence the tidal prism, not the region near or seaward of the mouth of the inlet as suggested by Pilkey and Neal (2009).

9) Pilkey and Neal (2009) further state that the supposed increase in the cross-sectional area would cause deposition on the tidal deltas. They also believed that sand transport across the inlet is reduced or even halted because the outer bar is not in equilibrium, and this condition will lead to erosion on the adjacent barriers. As mentioned, channel realignment occurred at New River Inlet in early January 2013. The satellite images clearly show that significant reconfiguration of the ebb-tidal delta had occurred by April 2013. Analyses show that an average of 565 ft of landward retreat of the periphery of outer bar had occurred by since January 2013, clear evidence of sand transport along the periphery of the outer bar.

10) Pilkey and Neal (2009) oppose the use of terminal groins as a management tool. Terminal groins are constructed at the end of sediment cells for the purpose of mitigating erosion and conserving sand along the terminus of a barrier. They are usually constructed on the downdrift end of a barrier (updrift margin of an inlet). However, because sand enters the inlet along both inlet margins due to wave refraction, they can be placed on the downdrift margin of the inlet as well. In the case of Figure Eight Island, the terminal groin will be constructed on the downdrift margin of the inlet or the updrift end of the island. The groin will extend seaward of the HTL several hundred feet and upon completion, beach fill will be added, so that the groin does not impound sand. When the fillet is full to its capacity, sand is transported around or over the terminal groin into the inlet usually leading to the development of a beach.

> 10a) Although a terminal groin has the capability to impound sand they are very dissimilar to a jetty. A jetty or jetties are constructed as part of a navigation project at an inlet with the intention of preventing sand from entering an inlet and thereby helping to maintain navigation depths in the ebb channel. The jetties at Masonboro Inlet, NC are ~3,100 ft long. In almost all cases jetties lead to erosion along the adjacent barriers. Jetties confine the ebb flow within the deepened inlet throat and eventually lead to an enlarged, steepened and elongated ebb-tidal delta that extends well into deep water.
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> 10b). Currently in NC there are two inlets where terminal groins are in place: Beaufort Inlet and Oregon Inlet. Shoreline erosion has occurred along Atlantic Beach (Beaufort Inlet) and Pea Island (Oregon Inlet), but it is unrelated to the terminal groins. In both areas the adjacent inlets have been modified extensively through long-term channel maintenance (dredging and disposal). In addition, Pea Island is a storm-dominated barrier where shoreline change is rapid and ever changing due to storm impacts.

11) Pilkey and Neal (2009) have alluded to the high persistent wave energy that impacts North Topsail Beach and Topsail Island in general. Wave height is used as a proxy or as an indicator of wave energy and this is important because it drives the longshore transport. As wave heights increase the wave energy increases as the square of the wave height and hence the ability to erode

and transport beach material also increases. Therefore, slight changes in wave height are important in both the long- and short-term.

> 11a) A comparison of the significant wave height from offshore North Topsail Beach and Wrightsville Beach shows that the Hs data are similar, and, in fact, the Hs is slightly lower for North Topsail Beach. Data also show that slightly longer period waves, and hence slightly more energetic waves, approach Wrightsville Beach more than they do North Topsail Beach. Furthermore, the significant difference in the shoreline orientation of North Topsail Beach (N61^{o}E) and nearby Wrightsville Beach (N32^{o}E) indicate that due to the combined effect of the slightly higher Hs and the shoreline orientation, erosion and sand transport would be greater for Wrightsville Beach. The buoy wave data do not support the assertions of Pilkey and Neal (2009).

> 11b) Furthermore, the USGS's risk ranking related to the mean wave height and future sea-level change shows that North Topsail Beach has a moderate risk ranking compared to a high designated ranking for the adjacent shoreline reaches in Carteret County, portions of Pender County, and a significant portion of New Hanover County located to the southwest**.**

12). It is extremely misleading for Pilkey and Neal to infer that all of the hurricanes and nor'easters listed in their appendix and mentioned in their narrative (as supposedly having impacted Topsail Island) did not also impact all the islands in Pender and New Hanover Counties located farther to the southwest, as well as those barriers located to the northeast in Carteret County. NOAA hurricane strike data for selected SE NC counties indicated North Topsail Beach (Onslow County) received nine direct hits between 1900 and 2005, the least number compared to the other southeastern NC counties that received between a total of 10 to 11 direct hits. The data also show that Brunswick, New Hanover and Pender Counties all received a direct hit by one category 4 hurricane. It is interesting to note that according to the NOAA data, Carteret County had the greatest number of indirect hits (21), while Onslow County received the second-most indirect hits (16). This latter high value is related to the fact that adjacent Carteret County had more direct hits, and hence according to NOAA's subjective designation, those counties (ie. Onslow Co.) located on either side of a direct hit by default were often assigned an indirect hit designation. The NOAA county strike data do not support the opinions expressed by Pilkey and Neal (2009).

13) The recently updated NC DCM erosion rates for North Topsail Beach indicates that erosion is occurring along a total of 9.8 miles (88.6 %) of the Town's oceanfront while accretion is occurring along 1.2 miles (11.4 %) of the shoreline. Four erosion rate categories were indentified: 2ft/yr or less, 2-5 ft/yr, 5-8 ft/yr and > 8ft/yr. The most important point germane to the discussion of the Pilkey and Neal (2009) paper is that 8.4 miles (75.2%) of the 11.1 miles of shoreline analyzed is eroding at rates <u>less than</u> 2ft/yr. An additional 1.2 miles (10.9%) of shoreline is eroding at rates between 2-5 ft/yr, and the great majority of shoreline segments that fall with in this designation are eroding at rates < 3 ft/yr. These data clearly are in direct opposition to the contention made by Pilkey and Neal (2009) that persistent high erosion rates are the norm for North Topsail Beach.

14) The USGS' CVI is also pertinent to this discussion of North Topsail Beach's vulnerability as opined by Pilkey and Neal (2009). The USGS' classification index is based upon an analysis of six physical variables, which include mean wave height and the short- and long-term shoreline change rates. A USGS map of Topsail Island shows the short-term shoreline change rates (1973-

1997) generally ranged between -1m/yr and +1 m/yr. The highest erosion rates (-2m/yr to -1m/yr) occur along the oceanfront adjacent to the inlet and near the bend in the AIWW and southward, where major dune breaches occurred during the hurricanes of the1990s. Similarly, a map that depicts the long-term shoreline change rates (1856 -1997) ranged between -1m/yr to +1m/yr for North Topsail Beach and the remainder of Topsail Island. A map of the CVI ranking shows that the majority of the coastline segments in Southeastern North Carolina have the lowest CVI risk ranking (moderate) in comparison to other coastal reaches along the coast of North Carolina. The moderate risk designation assigned to North Topsail Beach clearly does not support nor validate the opinion of Pilkey and Neal (2009).

My assertions and comments mentioned above are derived from existing data and ongoing research that deal with a variety of points pertinent to the validity of the assertions and opinions made by Pilkey and Neal in their 2009 article.

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