

**NC COASTAL RESOURCES COMMISSION
TERMINAL GROIN STUDY
RECOMMENDATIONS
APRIL 1, 2010**

The N.C. General Assembly enacted Session Law 2009-479 (House Bill 709) to direct the Coastal Resources Commission (CRC) in consultation with the Division of Coastal Management (DCM), the Division of Land Resources, and the Coastal Resources Advisory Commission (CRAC) to study the feasibility and advisability of the use of a terminal groin as an erosion control device. The Session Law also mandated that the CRC develop recommendations to be presented to the Environmental Review Commission and the General Assembly by April 1, 2010.

Specifically, the CRC was directed to consider six focus areas:

- (1) Scientific data regarding the effectiveness of terminal groins constructed in North Carolina and other states in controlling erosion. Such data will include consideration of the effect of terminal groins on adjacent areas of the coastline.
- (2) Scientific data regarding the impact of terminal groins on the environment and natural wildlife habitats.
- (3) Information regarding the engineering techniques used to construct terminal groins, including technological advances and techniques that minimize the impact on adjacent shorelines.
- (4) Information regarding the current and projected economic impact to the State, local governments, and the private sector from erosion caused by shifting inlets, including loss of property, public infrastructure, and tax base.
- (5) Information regarding the public and private monetary costs of the construction and maintenance of terminal groins.
- (6) Whether the potential use of terminal groins should be limited to navigable, dredged inlet channels.

The DENR has contracted with engineering firm Moffatt & Nichol to complete the study for the CRC at a cost of \$287,420. The project team members were:

- Moffatt & Nichol -Project Lead/ Coastal Engineering Analyses/Construction/Costs/Locations
- Dial Cordy and Associates, Inc.- Environmental Resource Assessment
- Dr. Duncan M. FitzGerald, Boston University - Coastal Geology
- Dr. Chris Dumas, UNC Wilmington - Socio-Economics

STUDY PROCESS

The Project Team was provided guidance by a Terminal Groin Study Steering Subcommittee comprised of CRC/CRAC members:

Bob Emory - CRC	Dara Royal – CRAC
Jim Leutze - CRC	Spencer Rogers - CRAC
Melvin Shepard - CRC	Anne Deaton - CRAC
Veronica Carter - CRC	Tracy Skrabal - CRAC
Charles “Boots” Elam - CRC	Bill Morrison – CRAC

The Commission also utilized the CRC’s Science Panel on Coastal Hazards to provide guidance on the proposed scope of work, the methodologies to be used for the various aspects of the study as well as the selection of study sites.

While House Bill 709 required the CRC to hold only three public hearings on the issues, the Commission held five public hearings including three at meetings of the full Commission. In addition to the public hearings, written comments could be submitted to the executive secretary of the CRC. The five meetings of the Science Panel were also publicized and the public was allowed to attend and hear the discussions, although public comment was not taken at those meetings. All meeting minutes, presentations and public comments have been posted on the Division of Coastal Management website (www.nccoastalmanagement.net/CRC/tgs/terminal%20groin%20study.html).

SELECTION OF INLETS

In consultation with the Science Panel, five sites were selected to be included in the study. These sites were selected based on three main criteria developed by the Science Panel. First, whether the structure at the site fit the definition of a terminal groin; second, whether the site had similarity to potential North Carolina scenarios; and third, whether there was a reasonable expectation that a suitable quality and quantity of data was available for the location. For the purposes of this study, a terminal groin was defined as a structure built with the primary purpose to retain sand and not for navigation (jetty). Therefore, a terminal groin is defined as a narrow, roughly shore-normal structure that generally extends only a short distance offshore.

Additionally, the sites were chosen to reflect a variety of structures, inlet size and characteristics. Most sites contain a single terminal groin, that is, a terminal groin not part of a groin field located adjacent to a tidal inlet. The general consensus and direction given by the Science Panel was to study only terminal groins adjacent to inlets. The House Bill had defined the study to include “the feasibility and advisability of the use of a terminal groin as an erosion control device at the end of a littoral cell or the side of an inlet” and defined a littoral cell as “any section of coastline that has its own sediment sources and is isolated from adjacent coastal reaches in terms of sediment movement.” The decision as to where a littoral cell begins or ends along a barrier island is extremely

difficult to pinpoint and can shift. An inlet provides a clearly defined location and is generally the location of a terminal groin.

The five sites selected for the study are the terminal groins at Oregon Inlet and Beaufort Inlets (Fort Macon) in North Carolina, and at Amelia Island, Captiva Island and John's Pass in Florida.

TIMELINE OF HARDENED STRUCTURES BAN IN NC

- June 1, 1979 – CRC limits the use of permanent erosion control methods to protect structures existing as of this date.
- 1984 - Outer Banks Erosion Task Force recommends prohibiting hardened structures unless strict criteria can be met.
- January 1985 - CRC bans hardened structures regardless of construction date.
- December 1989 - CRC amends rule to allow for the protection of the Bonner Bridge.
- August 1992 – Amendments to allow for the protection of nationally significant historic sites and existing commercial navigation channels.
- March 1995 – CRC grants a variance to allow a sand filled tube groin field on Bald Head Island.
- July 2003 – CAMA amended to prohibit permanent erosion control structures with limited exceptions.

DISCUSSION OF FINDINGS

As with any study of this nature that has schedule and budgetary constraints, there are limitations that should be noted with respect to the quantity and quality of available data and analysis procedures. No new data collection efforts were undertaken for this study. Rather, available data (shoreline changes, nourishment and dredging activities, natural resources, etc.) were collected from as many sources as possible. Additionally, most of the data originally were collected for purposes other than determining the potential impact of a terminal groin.

In the CRC's discussion of the findings of the study, specific issues stand out in considering the siting of terminal groins in NC. Some of the issues are clear, such as it being expensive to remove one of these structures. Other issues, including the most relevant ones regarding the effects of such structures are less clear, making it difficult to draw definitive conclusions. The Commission has concluded that the general impacts of the groins, as reported in this study, tend to be lost in the "noise" of other inlet management activities. The most substantial (longer, higher and/or less permeable) terminal groins were typically found in areas where the greatest amount of dredging activity occurs. It was found that the more significant the dredging activities, the potentially greater the impacts on adjacent shorelines. The impacts from these dredging activities may greatly overshadow any potential long-term shoreline changes resulting from the construction of a terminal groin. It is worth noting that at the majority of sites studied there were other stabilization structures present such multiple groins, and breakwaters.

While the groins do appear to hold the tip of the island in place, stabilizing the terminal groin side of the inlet, there can be other resultant impacts such as changes to the inlet cross-section – a general narrowing and deepening over time which may cause the channel to shift and potentially undermine the groin. The study also found that, in some cases, there were increases in beach volume on the terminal groin side of the inlet. In other cases there were decreases in beach volume on the terminal groin side after subtracting all beach nourishment volumes. The response of the beach did vary by distance from the groin. The permeability of the structure was found to have a significant impact on adjacent shorelines. The Amelia Island structure has allowed some material to bypass, limiting the effects on downdrift shorelines and volumes. However, the structure has also had a limited impact on the updrift shoreline (mainly within the first 0.5 miles). The other structures studied have impermeable cores and appear to hold more sand for a greater distance on their updrift shorelines.

In looking for commonalities between the sites studied, the CRC found that the structure side of the inlets were eroding prior to construction of the terminal groins; and after construction, the shorelines on the structure side were generally accreting. However the data for the shorelines on the opposite side of the inlets did not display a clear trend. Some were accreting and some were eroding. Generally, there is a reduction of erosion or increased accretion over the first mile of shoreline (except for Amelia Island as noted above). For the shorelines opposite of the terminal groin, a minor to moderate increase in erosion or decrease in accretion occurs over the first half to three-quarters of a mile. However, it is not possible to definitively conclude if this is the effect of terminal groin construction or other impacts such as increased dredging or migrating inlets. Making an assessment of the general effects on adjacent shorelines requires caveats and assumptions. As with nourishment, the influence of dredging material from the inlet system must be accounted for when attempting to assess the impact of the terminal groins.

Again the “noise” of other inlet management activities make identification of structure impacts on adjacent shorelines difficult to discern if they exist at all if located adjacent to a highly managed, deeper-draft navigable inlet. The relative impact of these structures on adjacent areas is likely increased when sited next to natural or minimally managed shallow-draft inlets. Should a structure be considered in these locations, additional care and study (geologic setting, sediment budgets, etc.) is warranted to be sure that the terminal groin’s impacts are acceptable or can be mitigated through minimal human activities (dredging and nourishment).

Dredging and nourishment were common and necessary activities associated with these structures. Terminal groins are typically constructed as part of a broader beach management plan and may make nourishment adjacent to inlets feasible, but they do not eliminate the need for ongoing beach nourishment. Initial project costs including construction of the terminal groin, initial beach nourishment and permitting and design fees may range from about \$3.5 million for a shorter groin to over \$10 million for a larger one. Annual project costs including structure maintenance/repair, annual beach

nourishment, and monitoring could be in the range of \$0.7 million to over \$2 million. While sea level rise is included in the above estimates, it is prudent to assume that these costs may increase over the life span of an individual project.

With regard to the effects of a terminal groin on wildlife and the environment, the study found that the environmental effects of a terminal groin structure alone could not be isolated from the effects of the associated beach nourishment activity. The potential effects of terminal groins in conjunction with shoreline management (i.e. beach nourishment) on natural resources, such as sea turtles and shorebirds, vary according to the type of construction equipment used, the nature and location of sediment discharges, the time period of construction and maintenance in relation to life cycles of organisms that could be potentially affected, and the nature of the interaction of a particular species.

The study indicated that the construction of a terminal groin, along with beach nourishment and dune construction prevents natural overwash and inlet migration from occurring. The interruption of these natural processes contributes to a loss of habitat for breeding and non-breeding shorebirds, including the endangered piping plover. The study also notes that groins are typically used in combination with a long-term shoreline protection program (beach fill), in areas where pre-project shoreline conditions are generally degraded and offer only limited potential for sea turtle nesting activity.

With respect to fish and bottom dwelling species, the placement of rock to construct a terminal groin would result in a temporary and footprint-specific loss of the existing benthic community. The placement of rock may also result in the permanent loss of intertidal and nearshore subtidal habitat, but this loss may be negligible when compared to the total amount of intertidal habitat within a specific project area. The loss of these habitats could also be replaced by rocky, "hardbottom" material that would add diversity to the bottom habitat, providing a new habitat type that can be utilized by certain groups of invertebrates, juvenile/larval fish, and birds. According to NC Division of Marine Fisheries, rocky habitat adjacent to an inlet is not natural to NC and therefore is not needed by the native fish or bird community. The addition of rocky habitat within a sandy intertidal area is not necessarily a positive benefit, but rather a habitat trade-off. It has also been suggested that creating rocky habitat has led to the introduction of non-native invasive species within the vicinity of the structure.

Due to a lack of historic natural resource data, it is difficult to draw conclusions on the effects of the construction and operation of the terminal groin on natural resources. Based upon the historical nature of the terminal groins at Beaufort Inlet (Fort Macon), John's Pass (northern groin), and Redfish Pass, discernible trends of the effects of these terminal groins on the natural resources are somewhat limited. The lack of preconstruction data makes an empirical determination of post-construction effects at these sites difficult if not impossible. Additionally, there were no pre-construction or post-construction data available for fish or benthic organisms.

In order to define an area considered for the economic values at risk, the study utilized a 30-year risk area developed by the Science Panel in their deliberations of Inlet Hazard Areas. The purpose was to provide a designation of risk that is approximately equal to the level of risk indicated by the setbacks in the adjacent oceanfront areas. The study found that the economic values within the 30 year risk areas for developed shorelines varies from about \$27 million at Ocean Isle to over \$320 million at Bald Head Island. The study further refined the economic value at current or imminent risk (as defined by the presence of sandbags for temporary protection) for developed shorelines from just under \$3 million at North Topsail Beach to about \$26 million at the north end of Figure Eight Island. It must be noted that a single terminal groin could not protect all properties identified as being “at risk” near any given inlet; a terminal groin on one side of an inlet will only stabilize the shoreline on that side of the inlet.

It is difficult to draw conclusions on the effects associated with a terminal groin on an unmanaged inlet since all of the structures considered for this study were located at inlets adjacent to navigable, dredged channels. It can be said that the structure will alter the natural inlet processes of a specific inlet. In what manner and to what degree can only be determined through specific study of the geologic setting, sediment budgets and hydrodynamics of the individual inlet.

RECOMMENDATIONS

Under Article 14, Section 5 of the North Carolina Constitution, it is the policy of the State to conserve and protect its lands and waters for the benefit of all its citizenry, and to preserve as a part of the common heritage of this State its forests, wetlands, estuaries, beaches, historical sites, open lands, and places of beauty. In G.S. 113A-102(b), the General Assembly identified one of the goals of the Coastal Area Management Act as follows:

- (1) To provide a management system capable of preserving and managing the natural ecological conditions of the estuarine system, the barrier dune system, and the beaches, so as to safeguard and perpetuate their natural productivity and their biological, economic and esthetic values.

CAMA also specifically directed the Commission to develop standards capable of protecting the natural resources of the coastal area, including fish and wildlife, and maintaining public trust rights. CAMA recognized that the Commission would also need to consider economic development and impacts to private property.

As permanent erosion control structures may cause significant adverse impacts on the value and enjoyment of adjacent properties, the Commission has relied on nonstructural approaches to coastal hazard mitigation. Those methods include:

- development standards for the ocean and inlet hazard areas, including building setbacks;
- land use planning and land classification ;

- relocation of threatened structures;
- subdivision regulations;
- management of vegetation to stabilize dunes;
- beach nourishment;
- use of sandbags for short-term stabilization; and
- inlet relocation.

The use of sand trapping devices, such as terminal groins, has not been allowed on ocean and inlet shorelines except in extraordinary circumstances (i.e., protection of important public infrastructure). The CRC has allowed exceptions for an erosion control structure that is necessary to:

1. protect a bridge that provides the only existing road access on a barrier island and is vital to public safety;
2. protect a state or federally registered historic site; or
3. maintain an existing commercial navigation channel of regional significance within federally authorized limits.

Current rules also allow renewal of a permit for a structure that was constructed pursuant to a variance granted by the Commission prior to 1 July 1995. In each case, the rules require measures to minimize adverse impacts on adjoining properties and on public access to and use of the beach.

It is imperative that activities in the coastal area reflect an awareness of the natural dynamics of the oceanfront. Government policies should not only address existing erosion problems, but should aim toward mitigating the public cost of erosion response. Actions required to deal with erosion problems are expensive and the direct costs of erosion abatement measures and other costs such as maintenance of projects, disaster relief and infrastructure repair will be borne by the public sector. Responses to erosion should be designed to limit these public costs.

The findings of the terminal groin study are inconclusive due to the individual nature of inlets. It also was not possible to entirely separate the effect of an individual terminal groin from the effects of other inlet management activities taking place at or near the site. Based on the results, the Commission can not make a determination that terminal groins would or would not cause adverse impacts on the environment or adjacent properties. The individuality of inlets necessitates case specific study and even then it may be difficult to accurately predict the impacts of a terminal groin in a particular location, the cost of maintaining the structure, and the effectiveness of measures necessary to minimize its impacts. It is within this context that the following recommendations are made.

The Commission has adopted rules that give preference to non-structural responses to erosion including relocation of threatened structures, beach nourishment, inlet relocation and the temporary use of sandbags for short-term shoreline stabilization. The Commission has recently amended its rules on the use of sandbags in Inlet Hazard

Areas to allow the extended use of these structures as well as the repetitive use of sandbags in conjunction with channel realignment projects.

Terminal groins have been shown to be able to anchor the ends of barrier islands adjacent to inlets if associated with long-term beach maintenance. They can likely protect some property at risk but not all properties. The construction and maintenance of terminal groins is very expensive and removing them, if necessary, would be both expensive and disruptive to natural resources. Inlets provide sediment to build up the backside of barrier islands, a vital function in the natural maintenance of these islands.

The General Assembly directed the CRC to conduct a study on the feasibility and advisability of the use of terminal groins as an erosion control device. The study determined that terminal groins, in combination with beach nourishment, can be effective at controlling erosion at the end of barrier islands. The individuality of inlets necessitates site-specific analysis. The study findings were mixed regarding the effects of terminal groins on wildlife habitat and marine resources. If it is the desire of the General Assembly to lift some of the limitations specific to terminal groins, due to the individual nature of inlets, the following factors must be effectively met:

- 1. In light of the current policy favoring a non-structural approach to erosion control, the use of a terminal groin, should be allowed only after all other non-structural erosion control responses, including relocation of threatened structures, are found to be impracticable.**
- 2. The effects of a terminal groin on adjacent beaches are variable and a primary concern. Any use of such a structure should include siting and construction that avoid interruption of the natural sand movement to downdrift beaches.**
- 3. The nature of terminal groins and the potential effects on coastal resources adjacent properties necessitate a full environmental review. Any proposal for the construction of a terminal groin should be accompanied by an environmental impact statement that meets the requirements of the NC Environmental Policy Act (NC G.S. 113-4).**
- 4. To ensure the adequacy of compliance with SEPA and the protection of the public interest, third-party review of all environmental documents should be required. The cost of third-party review should be borne by those responsible for the project. This third-party review should include all design, construction, maintenance and removal criteria.**
- 5. Since a terminal groin may impact properties well beyond those adjacent to the structure, notification of property owners in areas with the potential to be affected by the terminal groin should be required. This notification should include all aspects of the project likely to affect the adjacent**

shoreline, including construction, maintenance and mitigation activities as well as post-construction effects.

- 6. As the post-construction effects of a terminal groin on coastal resources and adjacent properties are difficult to predict, financial assurance in the form of a bond, insurance policy, escrow account or other financial instrument should be required to cover the cost of removing the terminal groin and any restoration of adjacent beaches. Financial assurance should also be required for the long-term maintenance of the structure including beach nourishment activities. (Legislative authorization for requiring financial assurance would be necessary).**
- 7. The use of a terminal groin would need an adequate monitoring program to ensure that the effects on coastal resources and adjacent properties do not exceed what would be anticipated in the environmental documents. All monitoring of impacts of a terminal groin on coastal resources and adjoining properties should be accomplished by a third-party with all cost borne by those responsible for the project.**
- 8. As terminal groins are typically used in combination with a long-term shoreline management program, any proposal for use of a terminal groin in NC should be part of a large-scale beach fill project, including subsequent maintenance necessary to achieve a design life of no less than 25 years.**