

SHORELINES – November 2007

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Beach Nourishment Geometries

With 8 large-scale beach nourishment projects under our belts since 2001 and the delivery of roughly 10 million cubic yards (mcy) of sand in the process, most Bogue Banks locals rightfully consider themselves as nourishment connoisseurs. That 10 mcy worth of sand could extend a 94' x 50' regulation-sized basketball court 10 miles into the air or fill roughly 700,000 dump trucks. This mental image aside, our projects have also essentially been constructed in the same general manner – pump the sand to the dry beach and extend the width towards the sea. Go along the beach as far you can until we run out of sand. However, there are other nourishment configurations in the books that might be considered in the future and is the subject of this edition of *Shorelines*.

Let's remember the goal of beach nourishment is to place sand onto the beach from a source outside the eroding area. Figure 1 depicts some of the common and even rarer cross-sectional configurations that can be used to achieve this purpose and include; (1) dune nourishment, (2) subaerial beach nourishment, (3) profile nourishment, and (4) bar nourishment.

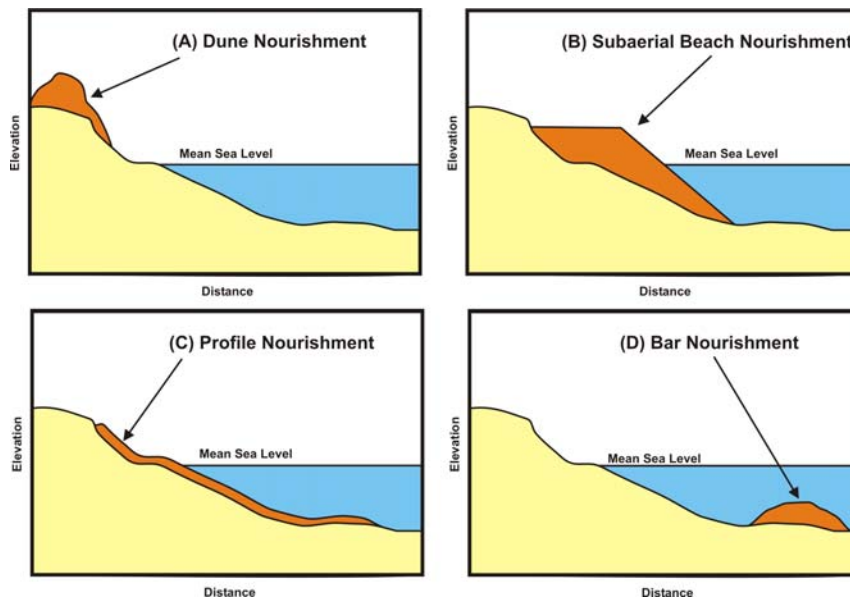


Fig. 1 – Common beach nourishment construction geometries depicted in the “z-axis”, or in cross-section including (A) dune nourishment, (B) subaerial beach nourishment, (C) profile nourishment, and (D) bar nourishment.

(A) Dune nourishment, the placement of sand as a dune landward of the active beach, is predominantly utilized as storm surge or other high-water episode mitigation measure aimed to protect upland structures (i.e., human-made dikes).

The delivery method for the sand can be by means of hydraulic slurry or mechanical (i.e., dump truck, etc.) processes.

(B) Subaerial beach nourishment is by far the most common “soft approach” utilized along the Atlantic coast of the United States, including Bogue Banks. Construction of large-scale nourishment projects often incorporates a combination of dune and subaerial beach nourishment. The design protocol for subaerial nourishment usually includes the hydraulic placement (pumping and grading) of a wide elevated berm with a slope extending offshore. The slope is usually not contoured by heavy equipment but is rather allowed to assume its natural gradient based predominantly upon the grain-size of the borrow source. The initial berm placement (construction profile) usually artificially steepens the beach, resulting in the offshore movement of sand as it is reworked by wave energy and redistributed along the beach profile. This equilibrated profile is referred to as the design profile. However, this equilibration process can take months or years to transpire.

(C) Profile nourishment entails the placement of sand from the toe of the dune, or highest point of the berm, towards the offshore direction including the bulk of the existing berm and most of the shoreface. Because the sand is placed in approximately the same configuration as the existing profile, the equilibration adjustments are less pronounced and therefore is a key benefit of this approach. However, the practical application of profile nourishment is problematic as the delivery of sand across the entire profile is time consuming, and contractors have little control over the contouring of sand once the material penetrates the water and settles to the bottom.

(D) Bar nourishment involves the placement of sand offshore with the expectation that the sand mound or bar will progressively migrate onshore and weld to the beach. The offshore sand may also act as a reef during the intermediate stages of onshore movement, causing storm waves to break farther offshore and thereby reducing the energy actually expended upon the beach. Although not commonly utilized in the United States, dredged material is deposited in shallow water by utilizing tug-assisted split-hull scows (barges) that essentially dump the borrow source material into place, or can be pumped to a target site, or even sprayed into the air and allowed to settle on the seafloor bottom. Research has also shown the placement depth of the material utilized for bar nourishment must be relatively shallow to be effective and permit the material to migrate onshore. Sand placement to this effect (shallow depth) immediately introduces sand into the active shoreface where it can be incorporated into the overall beach profile. Conversely if bar nourishment sand is placed to far seaward, then sand most often remains “stable” and does not become incorporated into the beach profile.

While the aforementioned nourishment geometries are presented as viable options in the vertical (“z”) axis, other aspects of the nourishment geometry lie along horizontal (“x and y”) axes, i.e., how far along the shore (shore parallel) and how far out to sea (shore normal) the fill is placed. This is particularly relevant to subaerial beach nourishment, and when augmented with groins, jetties, and other hard structures (or vice-versa), the number of geometries are almost endless (Fig. 2). Ultimately, nourishment design is predicated upon site conditions, erosion rates, wave climate, suitable sources of sand, volume of sand required, cost, funding sources, environmental concerns, and yes, even politics among other variables. In North Carolina there is statutory ban of hard structures, which takes many of these

configurations, complete with their benefits and negative aspects, off the table for consideration.

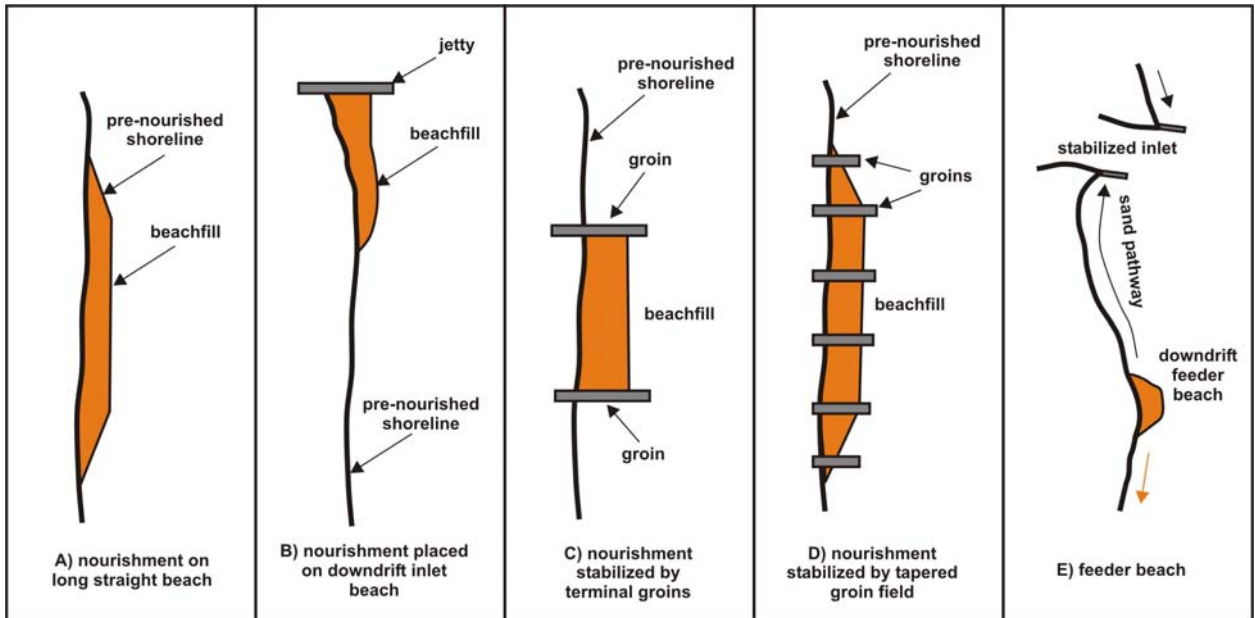


Fig. 2 – Five possible subaerial nourishment geometries in the “x – y” plane, or the alongshore and cross shore directions. The possible types of geometries are almost endless depending upon erosion rates, wave climate, sources of sand, volume of sand, cost, funding sources, and environmental concerns among others.

Note: Much of the information contained in this article was gleaned from the book *Beach Nourishment and Protection* by the National Research Council, 1995.