Part 2

4. NOURISHMENT CONCEPTS

Simply stated, beach nourishment is the introduction of sediment onto a beach. In most cases, the sediment is sand and the beach is in an eroded condition. The process supplements the diminishing supply of natural sediment. Nourished shorelines provide two primary benefits: increased area for recreation, and greater protection against coastal storms. Other tangible benefits include tourism revenues, restored wildlife habitats, enhanced public health and safety, increased coastal access, and reduced need for hard structures.

Sediment characteristics and sources, sediment placement methods, and maintenance requirements, the key components of nourishment projects, are discussed in the following sections.

4.1 Overview

Whereas structural means of beach retention were common 30 to 50 years ago, beach nourishment has become the preferred method in recent decades. Beach nourishment represents a “soft” method of shoreline stabilization, in contrast to “hard” alternatives such as groins. Hard structures are designed to remain stable and stationary, fully resisting the actions of waves, currents, and sediment transport. Hence, they tend to be large structures and may significantly impact the natural movement of sand. Soft stabilization alternatives, such as sand or cobble beach fills, mimic nature and are intended to be dynamic, responding to changes in wave and current conditions. In the case of beach nourishment with sand, the dry beach may become narrow during winter storms and then recover much or all of its original width under milder summer wave conditions. Ideally, a beach nourishment project is designed so that this range of seasonal shoreline fluctuation remains within acceptable limits during the project design life. Ultimately, however, nourishment material is sacrificial in nature and will require periodic maintenance.

Introducing new sand onto the beach can compensate for a reduced sediment supply delivered by rivers and streams. In this way, beach nourishment represents a means of restoring a more natural system. Wider beaches, in turn, reduce the need for hard structures while simultaneously increasing recreational opportunities.

4.2 Beach Nourishment Material

The characteristics of the available fill material are of utmost importance in the design of beach nourishment projects. At a minimum, the sediment must be uncontaminated and have a small fraction of fine grain sizes (“fines”, such as silt and clay). Most nourishment projects use sand as the fill material, although projects have been implemented using pebbles and cobbles.

In addition to the foregoing properties, the fill material should possess grain sizes that are comparable to or larger than those of the native beach sand. Comparably sized grains will tend to behave in a manner analogous to that of the native material, while larger grain size will tend to be more stable. Smaller grains should be avoided whenever possible, as they are less stable and hence prone to accelerated erosion.

4.3 Sediment Sources

Sources of nourishment material may include offshore deposits, inland areas, sediment accumulations from within the littoral system, and “sand of opportunity” (NRC, 1995). Each of these sources is described in one of the sections that follow.

4.3.1 Sand of Opportunity

The majority of beach nourishment projects conducted in California have utilized “sand of opportunity”, which is derived from projects whose primary motive is not beach replenishment. Common sources of this material have been dredged sediment from harbor construction, harbor maintenance, and lagoon restoration projects (Wiegel, 1994). In these cases, the suitability of the sediment as a beach fill material must be carefully examined both in terms of size fraction and pollutants. The primary advantage of sand of opportunity is the low cost. By placing the sediment on the beach, offshore disposal costs are eliminated and the nourishment project provides a tangible benefit from the dredging operation.

4.3.2 Offshore Sources

During recent decades, offshore sand deposits have served as the most common source of borrow material. Sand from these relict deposits is typically dredged and placed on the dry beach. The primary advantages of this approach include low cost, high placement rates on the receiving beach, and minimal disturbance onshore while the project is underway.

Although the use of offshore sand deposits also has disadvantages, careful planning and coordination with resource and regulatory agencies can minimize the potential drawbacks. One such drawback is the tendency for offshore sediments to contain a higher percentage of silt and clay, necessitating a large overfill volume to account for anticipated losses. Additionally, the offshore borrow areas must be sited well seaward of the active portion of the beach profile so that the nourishment sand is not drained back into the borrow area by waves and currents.

4.3.3 Inland Sources

There are a number of inland sources of beach-quality sand. In southern California, the loss of sediment reaching the coast due to the damming of rivers is a well-documented phenomenon (Chapter 7, this report). The sediment trapped behind the dams represents a significant source of nourishment material. The use of this sediment accomplishes two objectives: re-establishment of the reservoir capacity and nourishment of the beaches. Other inland sources that have been exploited in the past include sand dunes and deserts.

4.3.4 Sources within the Littoral System

Sand bypassing and backpassing operations redistribute sand within the littoral system. Neither method represents a true source of sand because no new material is added to the system. However, both operations have been utilized extensively in California to place sand where it is most needed.

Sand bypassing is the practice of transporting accumulated sand from the upcoast side of a sediment barrier, such as a jetty, to the eroded side. The process attempts to restore the natural downcoast flow of sand. Many harbors in California conduct sand bypassing in conjunction with maintenance dredging operations.

Sand backpassing involves the mechanical transport of material from a wide stable beach to an upcoast sediment-starved beach. This method often is utilized in locations where the sand from an eroding reach moves alongshore and is deposited in a more sheltered area. Backpassing essentially “recycles” the sand back to the eroding beach. If the sand volumes are moderate and the haul distances are short, the practice can provide a cost-effective scheme for beach maintenance. Similar to sand bypassing, the process must be conducted on a regular basis.

4.4 Beach Fill Placement

Once sand is placed on the beach, waves and currents redistribute the material offshore and alongshore until a stable configuration is achieved. Depending on local conditions, a nourished beach may take several months or years to reach the equilibrium condition.

The fill may be placed well above the shoreline as dune nourishment, on the dry beach and near the waterline, across an extended portion of the profile that stretches from the dry beach to well offshore, or completely offshore as a sand bar (NRC, 1995). In some cases, hard structures may prolong the life of the nourishment material. The various placement strategies are discussed below.

4.4.1 Dune Nourishment

Dune nourishment (Figure 4.1) is particularly effective in protecting upland development against storm waves. The placement of material high above the waterline does not expand the width of the dry beach, however, and therefore is not appropriate when the enhancement of recreational opportunities is an important project objective.

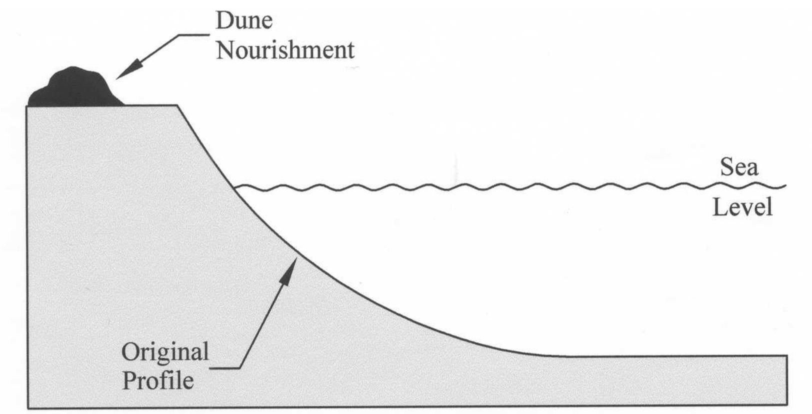

Figure 4.1 Dune nourishment

4.4.2 Dry Beach Nourishment

Nourishment of the dry beach is a very common approach. In this scheme, sand is placed on the dry portion of the beach and near the waterline, and results in an immediate increase in beach width available for recreation (Figure 4.2). However, because no sand is placed on the submerged portion of the beach, sand will be redistributed offshore across the entire profile until a stable configuration is established. The equilibrating process results in a substantial narrowing of the initial dry beach width.

The loss of sand from the beach face, sometimes rather quickly, has been a major source of criticism of beach nourishment projects in the past. This misunderstanding about the redistribution of the fill sand could be eliminated by better public education on the part of coastal engineers, scientists, and planners. It should be made clear that the sand will adjust to a more stable configuration resulting in a substantial narrowing of the initial beach width. However, the project is designed so that the desired beach width is provided after the sand has been re-worked by waves and currents, and this narrower design width should be the public expectation.

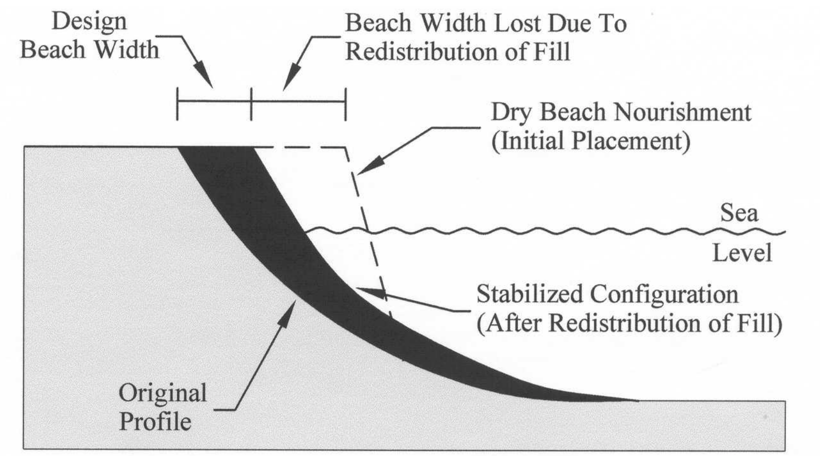

Figure 4.2 Dry beach nourishment

4.4.3 Profile Nourishment

Profile nourishment involves placing the sand across the entire beach cross-section, both above and below water (Figure 4.3). The placement method attempts to build the beach in an already-stable configuration. Because the equilibrium condition develops immediately, there is little offshore redistribution of sand and changes in the dry beach width are minimal. However, this placement scheme is more difficult and also provides less storm protection because there is no extra reserve of sand on the beach as there is with the dune and dry beach nourishment schemes.

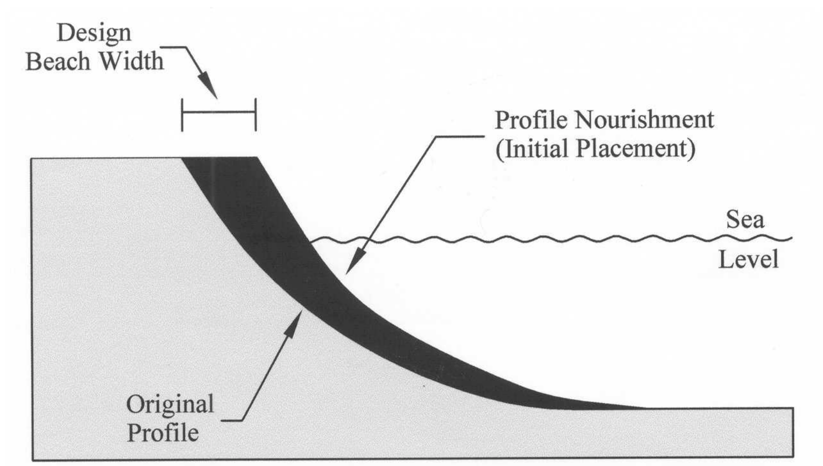

Figure 4.3 Profile nourishment

4.4.4 Nearshore Bar Nourishment

This method involves the placement of beach fill material in a sand bar just offshore of the surf zone (Figure 4.4). To be successful, the placement must be within the active portion of the beach profile. The sand will gradually move onshore under the influence of waves and currents, increasing the beach width. The period of time required for the sediment to be moved up onto the beach varies with wave conditions. Although the nearshore bar placement scheme is the most technically challenging, it may be the most cost-effective alternative.

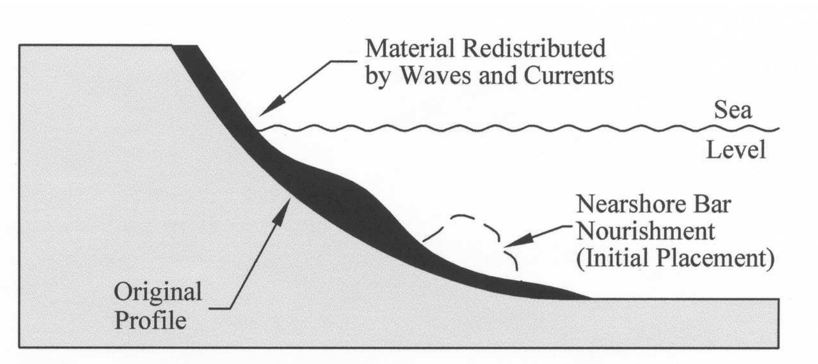

Figure 4.4 Nearshore bar nourishment

4.4.5 Beach Nourishment with Sand Retention Devices

Sand retention devices are often used to prolong the effectiveness of a beach nourishment program (USACE, 1995). These devices are designed to reduce the amount of fill lost alongshore or offshore. Examples of natural sand containment are common in California. Many naturally-wide beaches exist where sand is retained by sediment-blocking features such as headlands, reefs, rocky stream deltas, and other irregular bottom contours (Everts, 2000). In concept, the use of sand retention devices with nourishment is appealing; however, it should be considered cautiously. Undesirable effects, including accelerated erosion at adjacent downcoast beaches and loss of nearshore recreational opportunities, may result if these devices are not utilized properly.

4.5 Maintenance

As indicated at the outset of this chapter, nourished beaches typically require periodic replenishment. Waves and currents will redistribute the beach fill sand in the alongshore and cross-shore directions, background erosion may persist, and extreme storm events may cause large losses of sediment from the dry beach. As a result, maintenance should be scheduled in the original project plan and monitoring should be performed to insure that the maintenance schedule is appropriate. Typical re-nourishment intervals range between two and ten years.

Depending on local site conditions and sediment availability, it may be more economical to place a smaller fill initially and perform frequent re-nourishment. Conversely, if the beach fill project is dependent on a single large dredge project in a nearby navigation channel, then a larger initial fill will be placed and the interval between maintenance operations will be greater.

4.6 References

Everts, C. H., and C. Eldon, 2000. "Beach Retention Structures and Wide Sandy Beaches in Southern California", *Shore & Beach*, Vol.68, No. 3, pp. 11-22.

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