
# Sand Resources for Shore Protection Projects in New Jersey

*New Jersey's active and successful shore protection program requires large and readily available offshore sources of sand for beach nourishment projects. Through cooperation of the New Jersey Geological Survey and other State and Federal agencies, potential sources of sand are located for these projects. This work helps to ensure long range plans that protect the safety and property of New Jersey's citizens.*

## Introduction

A beach is a flexible and effective coastal structure offering storm wave and flood protection. When erosion of New Jersey's shore necessitates action, beach nourishment projects have become the primary method to develop a protective beach. Identifying sand sources is a critical part of these projects.

A beach's profile is a cross-section of the surface of a beach from land to ocean. Its shape varies with the changing seasons. During summer months, the beach profile is broad and flat. In winter, the profile steepens in response to increased wave energy. During storms, strong winds drive steep waves toward the shore that may exceed the seasonal equilibrium of the beach. In a prolonged, severe storm, winds push the sea to higher levels along the coast, causing inland flooding, particularly during high tide.

The sand on a beach acts to absorb wave energy through the movement of countless grains of sand. In so doing the beach and its dunes become the first line of defense against storm-driven coastal flooding. The cost of that protection is measured as beach erosion. A season of strong winter storms, a northeaster, or hurricane, may erode a beach and its dunes to an extent that it can not recover to a suitable profile within an acceptable time frame (fig. 1). The goal of beach nourishment is to add sand to the system so that the beach will have the quantity of sand needed at that location to absorb wave energy, and reduce coastal flooding. The most effective protective beaches include dunes, vegetation, habitat-protection areas, and a beach profile that is appropriate for wave conditions at that location.

**Figure 1**. View of a beach profile after a winter storm event.

Coastal engineers from the State's Department of Environmental Protection's (NJDEP) Engineering and Construction Section and the US Army Corps of Engineers collect data, evaluate impacts, and create computer-generated beach profile models to determine an appropriate beach shape for a particular location. Scientists from the US Minerals Management Service gather economic mineral resource and biologic data in federal waters. In this way, engineers and scientists determine the method and scope of a beach nourishment project.

The most efficient way to deliver large amounts of sand is to dredge and pump a sand-water slurry onto the beach (fig. 2) through a pipeline. This method of shore protection requires large quantities of sand. A rule of thumb is that for every foot of protective beach, one cubic yard of sand is required. For example, if the State needs to extend 1,000 feet of shoreline 200 feet farther offshore, it will require 200,000 cubic yards of sand -- nearly 20,000 truckloads! An offshore sand source pumped directly onto the beach is more efficient and less costly than trucks. When smaller volumes of sand are needed, Hopper or Dustpan dredges can be used to pick up material from a source and deliver it to the beach in need of nourishment.

## Geologic Mapping of Beach Sand Resources

Geologists from the New Jersey Geological Survey (NJGS) study the ocean bottom sediments off the coast of New Jersey to locate potential sources of suitable beach sand. This would be an easy job if the entire ocean bottom were covered with sand, but fine-grained silts and clays are also common bottom sediments.

Sand is not all the same. Grain size variation within the sediment is a critical factor in designing a stable beach. The energy and direction of waves along a beach is what actually controls the range of grain size along the shore. These factors vary with every mile of coastline, and must be modeled for every beach. The beaches of Cape May, for example, are composed of finer-grained sand than the beaches located farther north at Sandy Hook. If Cape May sand were placed on a Sandy Hook beach, it would be unsuitable for local wave conditions. The beach would be

**Figure 2**. Bulldozer building a protective beach using sands pumped from an offshore sand source. The hydraulic dredge is on the horizon.

less stable and erode more quickly. As a result, more frequent nourishment would be required.

Geologists map areas offshore where coastal engineers project a need for sources of nourishment sand. The geologic maps produced are the most efficient way to predict, locate and estimate the quality and size of a beach sand resource. The area of investigation generally extends approximately seven miles offshore, the economically feasible distance for obtaining beach replenishment sand.

## Beach Sand and the Ice Age

The sediments offshore New Jersey are largely composed of sand, silt, clay and organic material that has been deposited, eroded and reworked over the past 125,000 years. The most influential geologic event in New Jersey during this period was the lowering and subsequent rise of sea level during the last glacial period beginning about 25,000 years ago. At the time of the last glacial maximum when an enormous volume of Earth's water was stored as ice, sea level dropped more than 300 feet below what it is now, and the New Jersey shoreline was located tens of miles beyond the present coastline. As sea level rose at the end of the last ice age, the same dynamic coastal features that we see today (barrier islands, spits, inlets, back bays, and marshes) moved landward. The remnants of these features serve as the sand resources now used for beach nourishment.

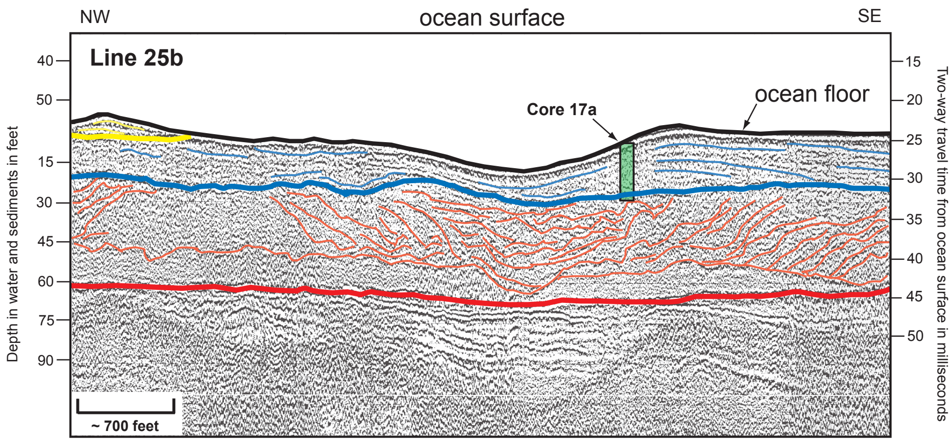


**Figure 3**. Seismic profile of ocean bottom sediments. Colored lines have been added to enhance the readability of the figure. Thick-colored lines are drawn at the boundary between geologic units and thin-colored lines highlight layering within the different units. Vibracore data is used to determine the composition of the ocean bottom sediments.

## Sea Floor Mapping and Sampling

Geologists use both direct and indirect sampling methods to collect information about deposits offshore. Direct sampling of the actual sea floor sediments is accomplished by drilling or vibracoring. Indirect methods measure the differences in the physical properties of sea floor sediments by using acoustic (sound) or electrical instruments.

Geophysical acoustic methods, including bathymetric sonar, sidescan sonar, and seismic profiling, are highly effective for marine subsurface mapping. A significant advantage of these systems is that data is collected from a moving boat that yields a two- or three-dimensional representation.

Seismic profiling uses a pulse of sound that is transmitted through the seawater and into the bottom sediments. The energy of this signal reflects (echoes) off sediment layers, and is recorded when it returns to the surface. A seismic cross-section of the sediment layers about 150 feet thick is generated for analysis (fig. 3). In each area of investigation, a grid with tens to hundreds of miles of seismic data is collected.

NJGS geologists use the seismic data to determine the shape and location of offshore deposits and pinpoint the best places to sample the ocean bottom. At these locations a core sample, used to determine the composition of the sediment layers, is taken using a vibracore drill rig.

Vibracore equipment is lowered from an anchored boat, and a core barrel is vibrated nearly 20 feet into the sea floor sediments (fig. 4). The extracted core preserves relatively undisturbed sediment layers for study in the laboratory (fig. 5). The size distribution of the sand grains is determined by using a group of stacked sieves that sort them and organic material is radiometrically dated. By correlating the vibracore information with the seismic data, geologists develop an understanding of the offshore sand deposits. During this process geologists also determine if the grain size of the sand deposit and the beach to be nourished is a suitable match.

Once geologists map and evaluate a suitable sand resource, the volume of sand is calculated. This information is passed on to State and Federal coastal engineers and scientists who investigate the potential physical and biological impact of extracting the undersea resource. After a sand source is chosen, the engineers design and implement a comprehensive plan for the new protective beach. The entire beach nourishment process, from mapping the resource to nourishing a beach, can take several years.

**Figure 5**. Geologist noting geologic characteristics of an extracted Vibracore (split and placed in black tray). After completing a geologic description of the core it is photographed and sampled for laboratory analysis.

**Figure 4**. Vibracore rig being deployed off the side of a boat. The four-legged base (foreground) is rotated to sit on the ocean bottom. The core barrel is vibrated up to 20 feet into the sediments.

## Conclusion

Geologic mapping of the New Jersey offshore is an essential part of a science-based, cost-effective effort to locate sand resources for shore protection. Coordination between the New Jersey Geological Survey, other agencies within the State's Department of Environmental Protection, U.S. Army Corps of Engineers, and U.S. Minerals Management Service is valued for efficient sharing of expertise and funding, and allows for long-term planning. This coordinated effort is a successful strategy that protects people, property, and coastal wildlife habitat while preserving the beauty of New Jersey's scenic coastline.

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