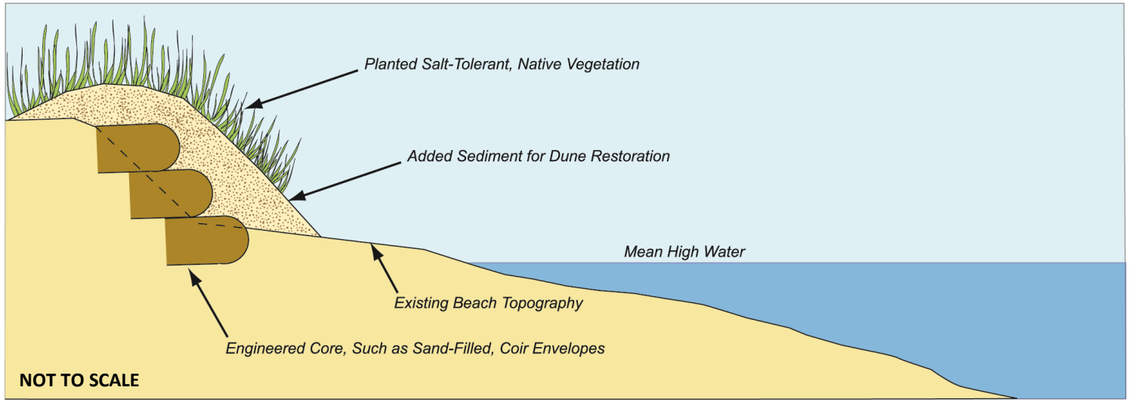
# Dune - Engineered Core

Dune projects involving a core as a central design element covered with compatible sediment. This may be a component of a beach nourishment effort or a standalone project.

*Objectives: erosion control; shoreline protection; dissipate wave energy; enhanced wildlife and shorebird habitat.*

## Design Schematics




## Case Study

### Jerusalem Dune, Narragansett, RI

Homeowners along an eroding shoreline were interested in increased shoreline protection. The houses were located 12 to 25 feet from the dune scarp. This shoreline has an average annual erosion rate (AAER) of just less than 2 feet per year.



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| **Project Proponent** | Three private homeowners with contiguous properties |
| **Status** | Completed in November 2011; Maintained (added sand and plantings) after Sandy in 2012. |
| **Permitting Insights** | Using sand filled coir envelopes as the dune core is considered a non-structural technique in the RI Coastal Resources Management Program because the coir is biodegradable and sand compatible with beach and dune sediment, so allowed where revetments and bulkheads are not. Applicants required to maintain lateral beach access. |
| **Construction Notes** | The project extended 135 linear feet across 3 properties – 45 feet each. Ends of the coir structure were gradually returned to the slope of the feature in order to minimize erosion on adjoining properties. |
| **Maintenance Issues** | Significant repairs were necessary after Hurricane Sandy. |
| **Final Cost** | Permitting :$750 ($250 per property)<br>Construction: $46,650 (2 properties each cost $14,950 and a third property cost $16,750)<br>Maintenance: Costs are storm dependent |
| **Challenges** | The dune and coir core is not likely to withstand a major storm leaving the properties are at risk. |

## Overview of Technique

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| Materials | Sediment is brought in from an offsite source, such as a sand and gravel pit or coastal dredging project.[1] To be considered a living shoreline (or non-structural) project, an engineered core should be constructed using coir envelopes, which are coir fabric filled with sand.[1] Planting the dune with native, salt-tolerant, erosion-control vegetation (i.e. beach grass *Ammophilia breviligulata*) with extensive root systems is highly recommended to help hold the sediments in place.[1,11] Sand fencing can also be installed to trap windblown sand to help maintain and build the volume of a dune.[1,11] |
| Habitat Components | Dunes planted with native beach grass can provide significant wildlife habitat.[9] |
| Durability and Maintenance | The core should be kept covered to increase longevity. Some repairs to the fabric, or replacement of sand, may be necessary after a storm. The core essentially functions as a backup in the event that the rest of the dune fails during a high energy event. The height, length, and width of a dune relative to the size of the predicted storm waves and storm surge determines the level of protection the dune can provide.[1] To maintain an effective dune, sediment may need to be added regularly to keep dune's height, width, and volume at appropriate levels.[1] The seaward slope of the dune should typically be less steep than 3:1 (base:height).[1,9] Dunes with vegetation perform more efficiently, ensuring stability, greater energy dissipation, and resistance to erosion.[10] If plantings were included, plants should be replaced if they are removed by storm or die.[1] |
| Design Life | Dunes typically erode during storm events. In areas with no beach at high tide, dune projects will be short lived as sediments are rapidly eroded and redistributed to the nearshore.[1] Designs should consider techniques that enhance or maintain the dune (e.g. sand fencing and/or vegetation to trap wind blown sand). |
| Ecological Services Provided | The added sediment from dune projects supports the protective capacity of the entire beach system (i.e., dune, beach, and nearshore area). Any sand eroded from the dune during a storm, supplies a reservoir of sand to the fronting beach and nearshore area.[1,9] Dunes dissipate rather than reflect wave energy, as is the case with hard structures.[1] Dunes also act as a barrier to storm surges and flooding, protecting landward coastal resources,[9] and reducing overwash events.[10] Sand dunes provide a unique wildlife habitat.[9] |
| Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps) | Shorter planting and construction window due to shorter growing season. Utilization of irrigation to establish plants quickly. Presence of sensitive species may require design (e.g. slope, plant density) and timing adjustments. |

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*Dune projects are appropriate for almost any area with dry beach at high tide and sufficient space to maintain some dry beach even after the new dune sediments are added to the site, and can be done independently, or in conjunction with a beach nourishment project.*

**Dune with an engineered core, South Kingstown, RI**
*Photo courtesy of Janet Freedman*

## Regulatory and Review Agencies

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| In general, coastal dunes with an engineered core are more difficult to permit than natural dunes. | |
| Maine | Municipal Shoreland Zoning, Municipal Floodplain, ME Dept. of Environmental Protection, ME Land Use Planning Commission, ME Coastal Program, ME Dept. of Marine Resources, ME Dept. of Inland Fisheries and Wildlife, and ME Geological Survey. |
| New Hampshire | Local Conservation Commission, NH Natural Heritage Bureau, NH Department of Environmental Services (Wetlands Bureau, Shoreland Program, and Coastal Program), and NH Fish & Game Department. |
| Massachusetts | Local Conservation Commission, MA Division of Fisheries and Wildlife (Natural Heritage and Endangered Species Program), MA Environmental Policy Act, and MA Office of Coastal Zone Management. |
| Rhode Island | Coastal Resources Management Program. |
| Connecticut | Local Planning and Zoning Commission, and CT Department of Energy and Environmental Protection. |
| Federal (for all states) | U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service. |

## Siting Characteristics and Design Considerations

| Selection Characteristics | Detail |
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| ES Energy State | Only applicable in moderate to high energy environments. Natural dune projects are preferred whenever possible. |
| EE Existing Environmental Resources | Coastal beach; coastal dune; coastal bank |
| SR Nearby Sensitive Resources | All. Dune projects can be successfully designed even in the presence of sensitive resource areas. However, special consideration is needed near salt marsh, horseshoe crab spawning grounds, and other sensitive habitats. Sediment can smother plants and animals if it is eroded quickly and carried to these areas. Impacts can be minimized by placing dunes as far landward as possible and using compatible grain size.[1] In addition, plantings may need to be thinned for dune projects in nesting habitat for protected shorebird and turtle species.[1,9] |
| TR Tidal Range | Low to high |
| EL Elevation | Above MHW. Dune projects require a dry high tide beach to be successful. |
| IS Intertidal Slope | Flat to steep |
| BS Bathymetric Slope | Flat to steep |
| ER Erosion | Moderate to high |
| **Other Characteristics** | **Detail** |
| Grain Size | It is important to utilize sediment with a grain size and shape compatible to the site.[5] The percentage of sand-, gravel-, and cobble-sized sediment should match, or be slightly coarser than, the existing dune sediments.[1] Mixed sediment dunes may be appropriate and necessary for some locations.[5] The shape of the material is also important, especially for larger sediment, and should be rounded rather than angular. [1] |
| Impairment Level | Consideration should be given to invasive species, level of existing armoring, and extent of public use. |
| Climate Vulnerability | Dunes with an engineered core provide more stability and protection to landward areas in the short term, but do not allow the dune to migrate naturally, which may be necessary given increased storms and sea level rise in the future. |
| Surrounding Land Use | Shoreline armoring changes the lateral movement of sediment, thereby affecting sediment flows to nearby dunes. Therefore, any armoring adjacent to a dune restoration site needs to be taken into consideration during the planning process.[5] Dune restoration will be most successful if it is located where the natural dune line should be and, if possible, tied into existing dunes.[11] Dunes are not well suited for major urban centers or large port/harbor facilities because of space requirements and the level of risk reduction required.[10] |