



# Nature-Based Solutions

## Installation and Maintenance Costs

Many coastal communities are considering nature-based solutions, or green infrastructure, to reduce the impacts of coastal hazards and provide other benefits, such as recreation and wildlife habitat. To make informed decisions, local officials need information on the costs of implementing and maintaining those solutions.

The table below provides this information, including the best available figures from a variety of sources, most of which can be found in NOAA's **Green Infrastructure Effectiveness Database** ([coast.noaa.gov/digitalcoast/training/gi-database.html](https://coast.noaa.gov/digitalcoast/training/gi-database.html)). These figures can vary by location.

The value of the many benefits provided by each practice are not included in this table but are critical in decision-making. Many times, the benefits gained by implementing green infrastructure can offset or justify the cost of implementation. See **Nature-Based Solutions: Practices and Benefits** ([coast.noaa.gov/digitalcoast/training/gi-practices-and-benefits.html](https://coast.noaa.gov/digitalcoast/training/gi-practices-and-benefits.html)) for more information. To understand the qualitative and quantitative economic analyses available to determine costs and benefits, see **Assessing the Costs and Benefits of Nature-Based Solutions** ([coast.noaa.gov/data/digitalcoast/pdf/nature-based-solutions-costs-benefits.pdf](https://coast.noaa.gov/data/digitalcoast/pdf/nature-based-solutions-costs-benefits.pdf)).

Nature-Based Solution	Average Cost	Maintenance Cost	Cost Considerations
<b>Land Preservation or Restoration</b>	Varies based on land value and method of preservation	Varies based on land value and method of preservation	Ecological baseline assessment, land acquisition, removal of existing structures, design, engineering, permitting, and maintenance including controlling pollution, invasives, erosion, and visitation.
<b>Forestry:</b> Forest Preservation	Varies based on land value and method of preservation	Varies based on land value and method of preservation	Plant materials, installation (watering, backhoe, shovels, mulch, seedlings), maintenance materials (bucket truck, chipper, chainsaws), and maintenance including, pruning (especially near power lines), watering, pest control, removal and disposal of hazardous trees, and fringe landscaping.

Nature-Based Solution	Average Cost	Maintenance Cost	Cost Considerations
Tree Box Filters	\$70-\$600 per sq. foot	\$3-\$14 per sq. foot	Plant materials, installation (watering, backhoe, shovels, mulch, seedlings), maintenance materials (bucket truck, chipper, chainsaws), and maintenance including, pruning (especially near power lines), watering, pest control, removal and disposal of hazardous trees, and fringe landscaping.
Tree Planting	\$13-\$288 per tree	\$15-\$81 per tree	Plant materials, installation (watering, backhoe, shovels, mulch, seedlings), maintenance materials (bucket truck, chipper, chainsaws), and maintenance including, pruning (especially near power lines), watering, pest control, removal and disposal of hazardous trees, and fringe landscaping.
<b>Green Streets</b>	Varies based on the combination of practices used	Varies based on the combination of practices used	Considerations are based on a combination of practices used but may include removing sediment, leaves, or trash that can impede water flow, replacing plants, and watering. Costs are reduced if projects are part of an existing street improvement program.
<b>Bioretention:</b> Rain Garden	\$5-\$16 per sq. foot	\$.31-\$.61 per sq. foot	Design, engineering, permitting, materials (e.g., rocks, plants mulch), installation, and maintenance including watering, pruning, weeding, controlling invasive species, raking mulch, removing litter, and clearing flow pathways at least twice per year and after major storm events.
Bioswales	\$5.50-\$24 per sq. foot	\$.06-\$.21 per sq. foot	Design, engineering, permitting, materials (e.g., rocks, plants mulch), installation, and maintenance including watering, pruning, weeding, controlling invasive species, raking mulch, removing litter, and clearing flow pathways at least twice per year and after major storm events.
Vegetated Filter Strips	\$.03-\$3 per sq. foot	\$.07 per sq. foot	Design, engineering, permitting, materials (e.g., rocks, plants mulch), installation, and maintenance including watering, pruning, weeding, controlling invasive species, raking mulch, removing litter, and clearing flow pathways at least twice per year and after major storm events.
<b>Green and Blue Roofs:</b> Blue Roofs	\$1-\$5 per sq. foot	N/A	Design, engineering, permitting, structural reinforcement, waterproofing (40 year life expectancy), installation, plants, soil, and maintenance including watering, controlling invasive species, and yearly inspections removing problematic shrubs and reducing the potential for leaks to develop.

Nature-Based Solution	Average Cost	Maintenance Cost	Cost Considerations
Green Roofs	\$9-\$31 per sq. foot	\$.02-\$.41 per sq. foot	Design, engineering, permitting, structural reinforcement, waterproofing (40 year life expectancy), installation, plants, soil, and maintenance including watering, controlling invasive species, and yearly inspections removing problematic shrubs and reducing the potential for leaks to develop.
<b>Permeable Pavement:</b> Pavers	\$5-\$12 per sq. foot	\$.01-\$.23 per sq. foot	Design, engineering, permitting, materials, installation, and maintenance including sweeping or vacuuming, reducing sand and salt usage in cold climates, and maintaining soil under pavers to allow for infiltration.
Porous Asphalt	\$5.50-\$8 per sq. foot	\$.09-\$.23 per sq. foot	Design, engineering, permitting, materials, installation, and maintenance including sweeping or vacuuming, reducing sand and salt usage in cold climates, and maintaining soil under pavers to allow for infiltration.
Porous Concrete	\$5.50-\$12 per sq. foot	\$.09-\$.23 per sq. foot	Design, engineering, permitting, materials, installation, and maintenance including sweeping or vacuuming, reducing sand and salt usage in cold climates, and maintaining soil under pavers to allow for infiltration.
Gravel	\$1.70-\$6 per sq. foot	\$.02-\$.05 per sq. foot	Design, engineering, permitting, materials, installation, and maintenance including sweeping or vacuuming, reducing sand and salt usage in cold climates, and maintaining soil under pavers to allow for infiltration.
<b>Dunes and Beaches:</b> Beach Nourishment	\$1.1 million per mile (construction and maintenance)	\$1.1 million per mile (construction and maintenance)	Ecological baseline assessment, design, engineering, permitting, materials (e.g., dune plants), equipment purchase or lease (e.g., for grading, creation of natural contours), monitoring, and maintenance including continual sand resources for renourishment, removal of invasive dune plants, and protection of dune plants.
Dune Restoration	\$2,000-\$5,000 per linear foot	\$100-\$500 per linear foot	Ecological baseline assessment, design, engineering, permitting, materials (e.g., dune plants), equipment purchase or lease (e.g., for grading, creation of natural contours), monitoring, and maintenance including continual sand resources for renourishment, removal of invasive dune plants, and protection of dune plants.

Nature-Based Solution	Average Cost	Maintenance Cost	Cost Considerations
<b>Salt Marsh and Coastal Wetlands:</b> Salt Marsh Restoration	\$78-\$286 per linear foot/\$16,000-\$60,000 per acre	N/A	Ecological baseline assessment, design, engineering, permitting, restoration materials, equipment, labor, monitoring, and maintenance including controlling pollution and invasive species, maintaining sediment supply and hydrology, managing potential stressors, and encouraging wetland migration and adjacent land preservation.
Conserved Wetlands	\$15,500 per acre	N/A	Ecological baseline assessment, design, engineering, permitting, restoration materials, equipment, labor, monitoring, and maintenance including controlling pollution and invasive species, maintaining sediment supply and hydrology, managing potential stressors, and encouraging wetland migration and adjacent land preservation.
Submerged Aquatic Vegetation	\$38,000-\$2.8 million per acre	N/A	Ecological baseline assessment, design, engineering, permitting, restoration materials, equipment, labor, monitoring, and maintenance including controlling pollution and invasive species, maintaining sediment supply and hydrology, managing potential stressors, and encouraging wetland migration and adjacent land preservation.
Mangroves	\$12,500 per acre to restore hydrologic flow	N/A	Ecological baseline assessment, design, engineering, permitting, restoration materials, equipment, labor, monitoring, and maintenance including controlling pollution and invasive species, maintaining sediment supply and hydrology, managing potential stressors, and encouraging wetland migration and adjacent land preservation.
<b>Oyster and Coral Reefs:</b> Oyster Reef Restoration	\$203-\$386 per linear foot/\$1.3 million per mile	N/A	Ecological baseline assessment, design, permitting, restoration materials such as coral plugs or substrates for oyster recruitment, labor, monitoring, and maintenance including reducing stressors such as overfishing, land-based pollution, and habitat destruction.
Coral Reef Restoration	\$0-\$25 million per acre	N/A	Ecological baseline assessment, design, permitting, restoration materials such as coral plugs or substrates for oyster recruitment, labor, monitoring, and maintenance including reducing stressors such as overfishing, land-based pollution, and habitat destruction.

Nature-Based Solution	Average Cost	Maintenance Cost	Cost Considerations
<b>Hybrid Shorelines:</b> Vegetation Only	\$68-\$113 per linear foot	Less than \$100 per linear foot annually	Ecological baseline assessment, design, engineering, permitting, installation, monitoring, and maintenance including controlling invasive plants, repairs and replanting periodically following a major storm or flood event if plant root systems are not fully developed. Costs vary greatly depending on the type of shoreline used.
Natural plus Structural	\$117-\$603 per linear foot (vegetation, structure, fill, and average costs of hybrid options from \$56 for coir logs to \$336 marsh plus sill or breakwater per linear foot)	Less than \$100 per linear foot annually	Ecological baseline assessment, design, engineering, permitting, installation, monitoring, and maintenance including controlling invasive plants, repairs and replanting periodically following a major storm or flood event if plant root systems are not fully developed. Costs vary greatly depending on the type of shoreline used.
<b>Hardened Shorelines</b>	\$457-\$966 per linear foot (\$125 per linear foot for vinyl bulkhead to \$1,952 per linear foot for a seawall)	\$100 to over \$500 per linear foot	Repair or complete replacement of the hardened shoreline when damaged by a storm event or erosion.