

## APPENDIX C: LIVING SHORELINE TREATMENT TYPES AND DEFINITIONS

**Living Shoreline Treatment:** A type of nature-based shoreline protection. “Living shoreline” means a shoreline management practice that provides erosion control and water quality benefits; protects, restores or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural and organic materials. When practicable, a living shoreline may enhance coastal resilience and attenuation of wave energy and storm surge (Virginia Definition, <https://law.lis.virginia.gov/vacode/title28.2/chapter1/section28.2-104.1/>).

### **Living Shoreline Treatment Types**

**Beach with Breakwater:** Nourished or existing beach with offshore breakwater.

**Marsh:** Planted or enhanced marsh with no fronting structure.

**Marsh with Coir Log:** Planted or existing marsh with fronting coir log structure that absorbs or deflects wave energy to allow the marsh to establish.

**Marsh with Mixed Treatments:** Planted or existing marsh with multiple fronting structures (e.g., coir logs and bagged oyster shell) that absorbs or deflects wave energy to allow the marsh to establish and persist.

**Marsh with Oyster Structure:** Planted or existing marsh with fronting oyster reef structure (e.g., bagged oyster shell, oyster castles, reef balls) that absorbs or deflects wave energy to allow the marsh to establish and persist.

**Marsh with Rock Sill:** Planted or existing marsh with fronting rock sill structure that absorbs or deflects wave energy to allow the marsh to establish and persist.

### **Living Shoreline Treatment Structure Types**

**Rock Sill:** A nearshore, free-standing, shore-parallel structure that creates an area of low hydrodynamic energy in the intertidal between the sill and the bank that encourages sediment accumulation and saltmarsh establishment and persistence. Sills are typically constructed to a height at about mean high water level from quarried rock, tend to be pyramids in cross-section, and have tidal openings at both ends.



**Breakwater:** Offshore shore-parallel structure that reduces the wave energy reaching the beach and supports sediment accretion landward of the structures. Commonly used in combination with sand nourishment to create or enhance an existing beach. Breakwaters are distinguished from rock sills by the size of the structures, distance offshore, and presence of a sand beach instead of a tidal marsh landward from the structures.



**Coir Logs:** Interwoven coconut or other natural fibers that are bound together with biodegradable netting. Used as a porous media that can temporarily protect shorelines from wave energy or reduce sediment run off while vegetation establishes itself.



**Loose Shell:** Mounds of uncontained shell placed nearshore to reduce wave energy.

**Oyster reef structures:** shore-parallel reef substratum (e.g., oyster castles, bagged oyster shell, reef balls) designed for the recruitment of oysters and wave attenuation.

### Oyster reef structure types (examples below)

**Bagged Oyster Shell:** oyster shells contained in a netting that bundles the shells together to reduce settling, scattering, and siltation of the shell reef. These are often placed or stacked along the leading marsh edge. Bagged oyster shells promote recruitment by serving as substrate for larval attachment and growth.



**Oyster Castles:** precast interlocking concrete blocks in the shape of a castle that are stacked on top of each other and can be arranged in different ways to serve as a living breakwater that attracts oysters. Oyster castles are not embedded with any biogenic material and the concrete structure itself is what serves as a hard substrate for oyster recruitment.



**ExoForms (NatrX):** custom, 3D printed, concrete, interlocking modules





**Oyster Catcher (SANDBAR):** reef substrates that are a composite derived from cement infusion of plant-based cloths. They can be molded into different shapes such as tables, pretzels and pillows that can be stacked and tiered to increase settlement surface area. Textured surfaces encourage oyster settlement and seeding is possible.

**Quick Reef (Native Shorelines):** Comprised primarily of native coastal materials such as limestone marl and oyster shells that are cemented together. The units have protected interstitial spacing to encourage oyster recruitment. They are stacked in a pyramidal fashion.

**Reef Balls:** pre-cast, spherical, hollow, free-standing structures made from a mixture of sand, concrete, and pea gravel. The design includes numerous nooks and crannies, which encourage oyster larvae to attach to both the external and internal surfaces.

**Pyramids (e.g., Ready Reef):** prism-shaped, free standing, precast concrete structures that generally include embedded and incorporated oyster shells within the structure. These are sometimes made of concrete or hollow metallic material that is often placed in a staggered line fashion in front of existing or planted marshes.



## APPENDIX D: GLOSSARY

**Adult Oyster:** *Crassostrea virginica* with a shell height that measures greater than or equal to 25 mm (~1 in).

**As-Built Monitoring:** A monitoring event to assess whether a living shoreline was installed as planned or permitted and is becoming established.

**Attached Algae:** Algae that is clinging to a structure and has not simply floated there.

**Bank:** The interface between the shoreline and the upland; may be gradual or steep.

**Channelward:** Towards the water.

**Delineate:** To outline or mark the boundary of a particular area.

**Dominant Species:** A species that dominates >50% of the marsh.

**Ebb Tide:** The period between high tide and low tide; water flows toward the ocean.

**Flood Tide:** The period between low and high tide; water flows away from the ocean.

**High Tide:** The state of the tide when at its highest daily level.

**High-Water Mark:** The vertical distance between the high-water line and the top of the structure (i.e., the height of the lighter-colored portion of the top of the structure).

**Landward:** Towards the land.

**Live Oyster Density:** The number of live oysters, including recruits, per m<sup>2</sup>.

**Living Shoreline Treatment:** A type of nature-based shoreline protection. Multiple treatments may be applied along a long reach of shoreline. For example, Treatment 1: Marsh with Rock Sill; Treatment 2: Marsh with Oyster Structure.

**Long-Term Monitoring:** Routine monitoring events of a completed living shoreline project. This may be done once or multiple times a year. Optimal annual monitoring timeframes are between June and September.

**Low Marsh:** The area of marsh that is flooded daily during high tides. This marsh zone traps sediment and provides important aquatic habitat for small fishes and crabs while it is flooded. During low tides, the low marsh zone is exposed, which provides access to food and cover for wetland and terrestrial animals.

**Low Tide:** The state of the tide when at its lowest daily level.

**Monitoring Site:** The spatial extent within which monitoring will occur. Represented by a polygon in the ShoreWatch App delineated by a user.

**Oyster Recruit:** *Crassostrea virginica* with a shell height that measures greater than or equal to 10 mm (~0.4 in) but less than 25 mm (~1 in). These oysters are considered to have survived to annual census (typically at the end of the growing season).

**Percent Cover:** The portion of the ground surface that is covered by the aerial portions (leaves and stems) of a plant species when viewed from above.

**Plot:** A defined sample area to collect data.

**Polygon:** A feature created in the ShoreWatch App by delineating an area of interest.

**Post-Storm Monitoring:** A monitoring event of a completed living shoreline project following a significant storm event during any time of the year.

**Project Footprint:** Areal extent of the reef. Achieved by collecting structure length and widths.

**Recruitment:** Includes settlement and some period of post-settlement survival.

**Riparian Zone:** An upland zone or area along the water that interacts cross-shore with the lands waterward and landward

**Settlement:** Occurs once the larva has become permanently attached to the substrate or has metamorphosed into its final benthic form.

**Structure:** Engineered component placed channelward and parallel to the shoreline to reduce wave energy and protect existing or planted marsh vegetation (e.g., rock sill, bagged oyster shell).

**Total Height:** The vertical distance from the seafloor to the top of the structure or oyster growth

**Transect:** A line that bisects the site from the water or nearshore structure through the riparian zone to capture the intertidal and different vegetation zones (e.g., the low marsh and high marsh).

**Wrack Line:** A band of accumulated herbaceous dead plants, large woody debris, trash, or other material.