TIDAL WETLANDS GUIDANCE DOCUMENT

Living Shoreline Techniques in the Marine District of New York State

November 22, 2017

Planting marsh grasses *along a "living shoreline" on the Shinnecock Reservation, Southampton NY on Shinnecock Bay in Suffolk County , NY. This rock sill and native vegetation can protect shores from erosion and wave damage and create habitat for wildlife.*

Photo credit: Cornell Cooperative Extension, Suffolk County

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I. Summary

The intent of this document is to provide guidance on the issuance of permits for living shorelines techniques in the Marine and Coastal District Waters of New York (the Marine District) and it answers the recommendations of the NY 2100 Commission report to encourage the use of green or natural infrastructure.

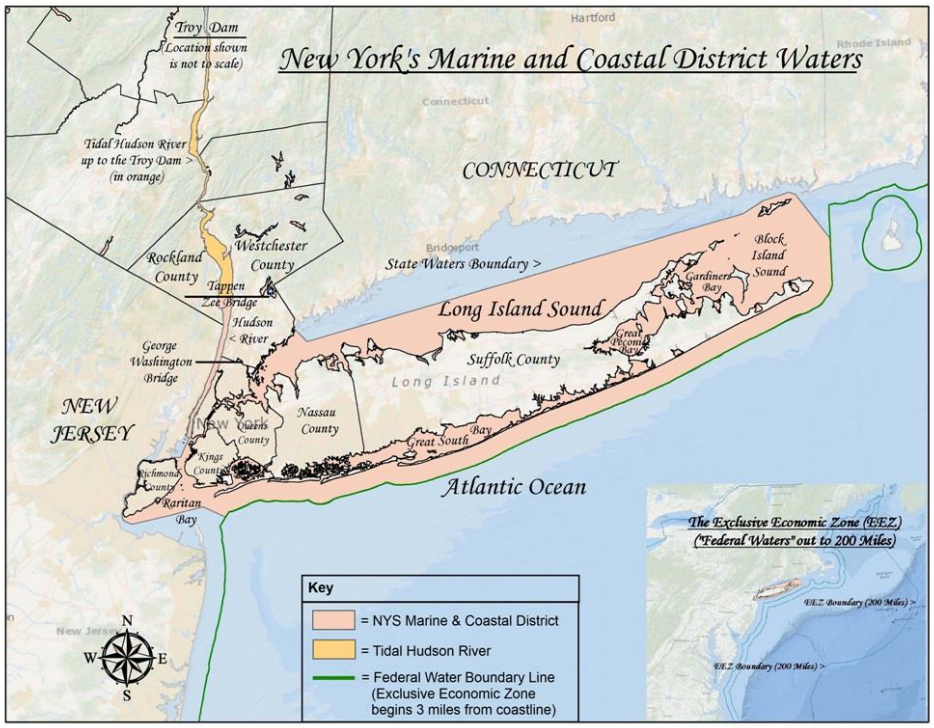

Figure 1. New York Marine and Coastal District from south of the Tappan Zee Bridge on the Hudson to the tip of Long Island. http://www.dec.ny.gov/permits/95483.html.

This guidance applies to permits issued pursuant to:

Environmental Conservation Law (ECL) Article 25, Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (6 NYCRR) Part 661 (Tidal Wetland Land Use Regulations)

ECL Article 15, 6 NYCRR Part 608 (Use and Protection of Waters)

This guidance is **not applicable** to areas subject to:

ECL Article 34, 6 NYCRR Part 505 (Coastal Erosion Hazard Areas)

II. Purpose and Scope

This purpose of this guidance is to: (A) to encourage appropriate use of living shorelines in place of hardened approaches for erosion control, because living shorelines offer greater habitat and ecological value than hardened shorelines and revetments (Figure 2), (B) to encourage, where appropriate, modification of existing shoreline erosion control structures into living shorelines, and (C) to promote a consistent approach for permit application evaluations for living shoreline techniques. This guidance is intended for a wide audience: state permitting staff, design professionals, and property owners. This guidance applies to the following use-categories in the Tidal Wetland Land Use Regulations and similar, or related, activities that are also regulated under ECL Article 15 and 6 NYCRR Part 608 (Use and Protection of Waters, Excavation and Placement of Fill in Navigable Waters):

- Establishing plantings (6 NYCRR § 661.5(b)(9));
- In-kind and in-place replacement of existing functional bulkheads and similar structures (6 NYCRR § 661.5(b)(22));
- Substantial restoration or reconstruction of existing functional structures (6 NYCRR § 661.5(b)(24));
- Expansion or substantial modification of existing functional facilities and structures (6 NYCRR § 661.5(b)(25));
- Construction of groins, bulkheads, and other shoreline stabilization structures (6 NYCRR § 661.5(b)(29)); and,
- Filling (6 NYCRR § 661.5(b)(30)).

The guidance presented here pertains to living shoreline installations that are generally conducive to low-moderate energy, sheltered areas of the Marine District (Figure 3). This guidance does not apply to large habitat restoration projects or CEHA jurisdictional areas (large coastal erosion protection projects).

Figure 2. Sheltered creek (low energy area) DEC GIS 2013 images.

This guidance applies to living shoreline techniques ranging from permit-required, generally compatible activities (GCp) (for example, in-water marsh plantings on an eroded shoreline) through activities that are permit-required, presumptively incompatible (PIp) (for example, in-water filling). Projects may be located on public or private properties. Section IV, Permitting Requirements and Standards, provides guidance to determine how to evaluate your project as per permit standards.

III. Introduction to Living Shoreline Techniques and Benefits

New York acknowledges national and state trends that emphasize the importance of and the value of natural and nature-based features (NNBF) such as living shorelines to reduce risk from flooding and erosion. Living shorelines also provide public benefits including supporting fisheries, improving water quality, and adaptability over time to changing conditions. Appropriate NNBF integrate well with regional ecosystems.

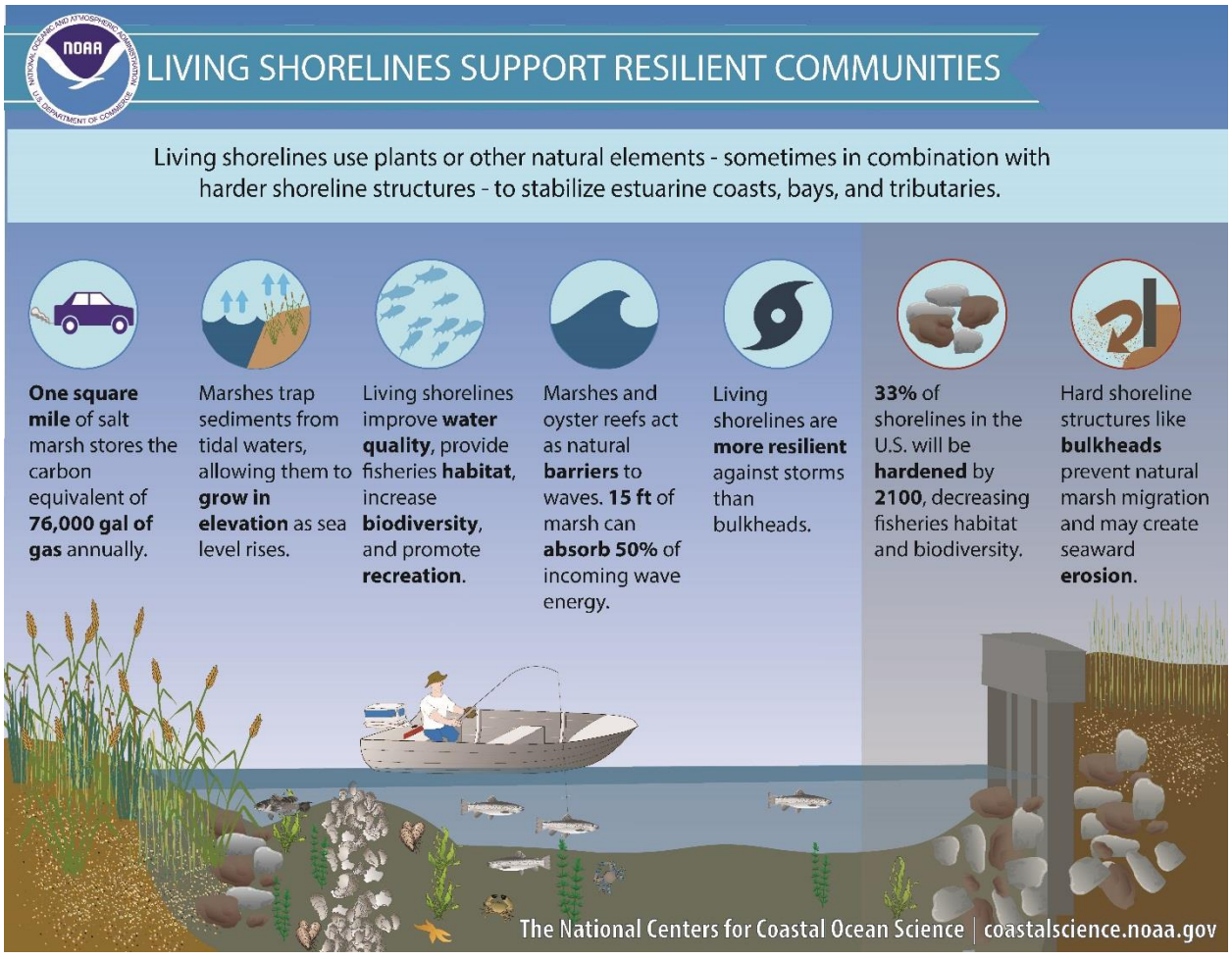

Figure 3. Benefits of Living Shorelines. Image credit: NOAA.

There is a preference for the shoreline to remain in its natural state as much as is possible. Living shoreline projects that mimics the natural environment are preferred over hybrid options that utilize structural components. Projects should try and emulate the natural coastal process of the area before options with structural components are considered.

New York State (NYS) Department of Environmental Conservation (DEC) prefers the use of ecologically sustainable techniques over hardening techniques when erosion control projects are necessary in the Marine District. The benefits living shoreline techniques can provide include

- Improving water quality through filtering nutrients and other pollutants;
- Creating habitats for fish, birds and other marine resources;
- Providing attractive and natural appearance and offer public access opportunities;
- Providing for erosion control – reducing wave energy impacts;
- Adaptability and resilience to erosive forces and sea level rise in comparison to hardened shorelines;
- Maintaining natural shoreline dynamics and sand movement and
- Economy, as they often are less costly than traditional shoreline stabilization methods such as bulkheads and revetments.

A. Definition

For the purposes of this guidance, the Division of Marine Resources (the Division), Bureau of Marine Habitat defines living shoreline techniques as follows:

> Shoreline techniques that incorporate natural living features alone or in combination with structural components such as rock, wood, fiber rolls, bagged shell, and concrete shellfish substrate.[1] This combination is also called hybrid. To be considered a living shoreline the techniques shall:
>
> - Control or reduce shoreline erosion while maintaining benefits comparable to the natural shoreline such as, but not limited to, allowing for natural sediment movement;
> - Use the minimum amount of structural components necessary for hybrid techniques to obtain project goals;

[1] Concrete shellfish substrate includes trademarked manufactured products such as reef balls, oyster castles or reef blocks.

- Improve, restore, or maintain the connection between the upland and water habitats; and
- Incorporate habitat enhancement and natural elements, frequently includes native re-vegetation or establishment of new vegetation that is consistent with a natural shoreline typical of the site location.

B. Types of Living Shoreline Techniques

There is a spectrum of shoreline erosion protection techniques, ranging from plantings only to the use of hard material such as rock. All techniques have in common that they can accomplish various shoreline risk reduction goals, such as soil stabilization or wave energy attenuation. At the same time, these techniques have varying impacts on the ecological community and natural processes.

Erosion management techniques can be used appropriately in combination with each other to manage risk, provide diversity, accommodate different uses, and conserve essential natural resources and processes. The features of a living shoreline project should include provisions for maintenance or improvement of connectivity between terrestrial and marine environments; use and maintenance of natural sediment transport pathways and quantities; utilization of shallow slopes while minimizing footprint as much as practicable; diversity in the plan view (i.e., not a straight, homogenous shoreline); encouraging use of native plant communities; allowing for filtration of stormwater and other natural processes; and utilization of the minimal amount of structural materials and minimizing the project footprint.

The following are examples of living shoreline techniques best suited for low to moderate wave energy environments that may be viable in the Marine District (see page 15 for wave energy characteristics). Additional and other available techniques may be considered should they meet the definition and goals of living shorelines. A coastal engineer, coastal geologist, landscape architect, or restoration scientist can provide designs which combine these techniques to accomplish the objectives of the shoreline stabilization project.

- Beach nourishment /sand replenishment to restore coastal processes
- Bank stabilization with vegetation
- Edging or toe protection
- Vegetated slope with additional structural protection
- Low profile sill with vegetation

PLEASE NOTE: This is not an exhaustive list, and the proposal of any of these techniques is not guarantee of a permit approval. An analysis may be necessary to

determine stability of any material, combination of materials or layout at a particular site. Appendix D, Descriptions of Living Shoreline Techniques, provides more information on some of these examples of shoreline stabilization techniques and includes illustrations.

IV. Permitting Requirements and Standards

Shoreline stabilization structures within the Marine District require various state permits. See Table 1 below.

Permit Program	Rules & Regulations	Description
Article 25 – Tidal Wetlands	6 NYCRR § 661	Permit required for certain activities in tidally-influenced wetlands and their regulated adjacent areas. Regulated wetlands are identified on Tidal Wetland Regulatory Maps.
Article 15 – Excavation & Fill in Navigable Waters; and Water Quality Certification“	6 NYCRR §§ 608.5; 608.9	Permit required for excavation and fill below MHW in all lakes, rivers, streams, and other bodies of water in the state that are navigable in fact, including wetlands adjacent and contiguous to navigable waters of the state; construction or operation of facilities that may result in a discharge into navigable waters.
Coastal Zone Consistency	15 CFR Part 930 Subpart D and 19 NYCRR Part 600;	Consistency determination and review conducted by New York State Department of State (DOS) for actions, including permit review, in a coastal area; State agency consistency review (done by all other NYS agencies when undertaking an action in the Coastal Area)
New York State Office of General Services (NYSOGS)	Public land law, Article 6	Title to the bed of numerous bodies of water is held in trust for the people of the State of New York. Structures, including fill, located in, on, or above state-owned lands under water may require authorization from the state.

Other state permits

Stream Disturbance: There are some areas of the marine district where waterbodies are also subject to regulation under Article 15, Title 5, Protection of Waters and 6 NYCRR Part 608.2, Disturbance of protected streams. This applies to streams or

ponds of less than 10 acres in size which have the following classifications or standards: AA, AA(t), A, A(t), B, B(t), or C(t). Jurisdiction extends to both the bed and banks, which can extend as much as 50 feet from the stream.

Wild, Scenic and Recreational Rivers Systems: There are a few areas of the marine district that are also subject to regulation pursuant to Article 15, Title 27 and 6 NYCRR 666 as Wild, Scenic, or Recreational River areas. A list of the designated river areas is available on the DEC website at http://www.dec.ny.gov/permits/32739.html. The regulated river area may extend well landward of the waterbody. If your site is near a designated section, contact your regional DEC office for more information.

DEC strongly urges applicants unfamiliar with DEC permitting procedures to request a pre-application conference, in order to obtain preliminary answers to questions about wetland and adjacent area boundaries, application procedures, standards for permit issuance, and other potential regulations and compliance issues such as historic preservation, endangered species, or hazardous waste disposal sites. For information on the tidal wetland application procedures, visit the DEC website at http://www.dec.ny.gov/permits/6357.html. As discussed below, the procedures for tidal wetlands applications are inclusive of those for Use and Protection of Waters and Water Quality Certification.

If an applicant requires a pre-application conference, a preliminary project plan and a written request for a pre-application conference should be submitted to the appropriate Regional Permit Administrator. A list of regional contacts by county can be found at http://www.dec.ny.gov/about/39381.html.

Please see section VIII. B. 5 for other governmental permit information.

A. Regulatory Standards for Permit Issuance

All projects must meet the standards for permit issuance for each permit required. The standards for permit issuance can be found at:

- Tidal Wetlands, 6 NYCRR § 661.9
- Use & Protection of Waters, 6 NYCRR § 608.8
- Water Quality Certifications, 6 NYCRR § 608.9

Applicants should contact the applicable DEC Regional Division of Environmental Permits office before beginning the application process.

The applicable standards for permit issuance for Parts 608 and 661 overlap and can be summarized by the four points below. Before DEC will issue or modify a permit, it must determine that the proposal is not contrary to public interest and meets the following requirements (the list below has been paraphrased):

- The proposal is compatible with the policy of the Tidal Wetlands Act (Article 25 of the ECL) to preserve and protect tidal wetlands and to prevent their degradation (6 NYCRR § 661.9(b)(1)(i)); that work in the adjacent area will not have an undue adverse impact on the present or potential value of any adjacent or nearby tidal wetland (6 NYCRR § 661.9(c)(3)); and that the project will not cause unreasonable, uncontrolled, or unnecessary damage to the natural resources of the state (6 NYCRR § 608.8(c)).
- The proposal is compatible with and will not endanger the public health, safety, and/or welfare (6 NYCRR §§ 661.9(b)(1)(ii), 661.9(c)(1), and 608.8(b)).
- The proposal for work in tidal wetlands and below mean high water is reasonable and necessary (6 NYCRR §§ 608.8(a) and 661.9(b)(1)(iii)).
- The proposal complies with the use guidelines contained in 6 NYCRR § 661.5. If a proposed regulated activity is a presumptively incompatible use under this section, the applicant must overcome the presumption and demonstrate that the proposed activity will be compatible with the area involved and with the preservation, protection, and enhancement of the present and potential values of tidal wetlands (6 NYCRR §§ 661.9(b)(1)(v) and 661.9(c)(4)).

B. Evaluation of Standards for Permit Issuance

Generally, the decision to grant a permit for a living shoreline project will take into account the suitability of a project for the overall conditions of the site (e.g., fetch, soil type, erosion, adjacent shoreline conditions, and habitat). Living shoreline projects must be designed and constructed to avoid impacts to ecological functions, critical area resources (such as eelgrass beds and finfish habitats, habitats for state and federally listed threatened and endangered species and species of greatest conservation need), processes (such as currents and sediment processes), and recreational or other human use of the area or, if that is not possible, to minimize and mitigate unavoidable impacts. Preferably, living (nature based) shoreline projects should be constructed and designed to provide for necessary erosion control while enhancing the area involved through improvement of water quality, creation of habitat, adaptability to sea level rise and promotion of natural sand movement. Benefits are discussed in Section III above. Guidelines are provided below to assist permit applicants and Department staff in evaluating the compatibility of a proposed project with on-site conditions and to facilitate consistent determinations in the issuance of permits.

1. Undue Adverse Impact

To determine whether or not the project will have an "undue adverse impact on the present or potential value of the affected" tidal wetlands, adjacent areas, and/or other resources of the state (6 NYCRR §§ 608.8(c), 661.9(b)(1)(i), and 661.9(c)(3)), the applicant must provide an evaluation of the resources that might be affected by the proposed project as follows:

a. Indicating the amount and location of upland or wetland area affected, including any filling or excavation;

b. Defining the impact to any areas below the apparent high water line or in tidal wetlands and indicating how that impact will be avoided or minimized. In addition, it must be demonstrated in which way(s) the project will enhance the current and potential function as related to tidal wetland values as defined in the regulations (6 NYCRR § 661.2) and in Appendix A;

c. Evaluating how the project may affect wildlife (e.g., birds, fish, invertebrate community, species of greatest conservation need), including the potential for taking of threatened or endangered species requiring a permit pursuant to ECL Article 11, Title 5 and 6

NYCRR Part 182, and or any beneficial effect the project may have on wildlife; and

d. Evaluating how the project may affect the sediment processes, including, but not limited to, sediment transport pathways, sediment supply, and sediment type.

2. Public Health and Welfare

A proposal must not have negative impacts on public health and/or welfare (6 NYCRR §§ 608.8(b), 661.9(b)(1)(ii), and 661.9(c)(1)). An applicant must also include an explanation of how the project will or will not affect adjacent landowners. The explanation should include the following:

a. An assessment of the potential erosion or sediment deposition to the surrounding area resulting from the project. If it is determined that the project has the potential to cause erosion to surrounding areas, the potential impact and ways to minimize and mitigate that erosion must be detailed;

b. Documentation of permission from any affected property owners if the installation will extend beyond property lines (adjacent property owners may include municipalities and the NYSOGS if work is proposed below the apparent high water line);

c. An assessment demonstrating that the living shoreline project does not substantially interfere with navigation (eg. extending too far into waterway), recreational access (eg. blocking usage of a public waterfront, or other existing uses of the area involved; and

d. Other considerations, as outlined in Section VIII, Other Considerations, Part B, Additional Regulations, such as information about utilizing shellfish in a living shoreline project.

3. Reasonable and Necessary

The proponent of a regulated activity in a wetland must demonstrate that the proposal is reasonable and necessary (6 NYCRR §§ 608.8(a) and 661.9(b)(1)(iii)).

Typically, shoreline structures are installed to protect shorelines from erosion and to some extent, for flood protection. Measures to address erosion and flood protection generally will only meet the reasonable and

necessary criteria if there is infrastructure, development, or habitat to protect and no other reasonable option is available.

a. Analysis should consider the degree to which the activity requires water access or is water dependent, consider alternate sites for non water dependent development that are less vulnerable to erosion, and the feasibility of relocating existing development to a site removed from the eroding area.

b. An applicant shall assess the causes and rates of erosion on the site, the jeopardy to existing uses, and demonstrate a need for the proposed treatment, taking into account reasonable alternatives.

   Erosion is a natural process; it is the wearing away of soil by forces such as wind, water, and ice. Natural erosion is necessary to maintain adjacent beaches and landforms, and the biological community is adapted to erosive and storm events. The prevention of erosion can have negative effects on adjacent areas. Erosion along a shore can be caused by animals, currents (downstream or tidal), wind driven waves, vessel wakes, upland runoff, ice, floating debris, construction of vertical structures, or placement of structures such as bulkheads, jetties, and groins. Sea-level rise causes shoreline recession, which is sometimes interpreted as natural erosion.

   Erosion on a shore can also be caused by animals, surface water runoff, wind, ice, and gravity, which causes the sediment to move downslope. Humans can exacerbate erosion by foot and vehicle traffic, through placement of impervious surfaces in the upland and through direct excavation or other disturbance of soil or vegetation. The applicant is encouraged to address upland stormwater runoff as this will reduce impacts to the adjacent wetland.

   It is important to estimate the rate of erosion (amount of sediment lost over time, measured in inches or feet per year). The rate of erosion can be most readily estimated through photographic evidence. Sources of photography include historical aerial or satellite imagery (www.historicaerials.com and Google Earth) as well as dated site photos showing gradual root exposure or loss of land based on the distance to a fixed object.

c. The applicant shall provide an alternatives analysis. Alternatives to consider include:
    - doing nothing, the “no action alternative”;
    - retreating, moving manmade structures landward;
    - proper siting of newly proposed upland structures
    - removing structures entirely and allowing the area to return to natural conditions or restoring a shoreline’s natural features; and
    - evaluating reasonable alternate shoreline treatments.

    Provide a discussion of why the preferred alternative was chosen over others. The alternatives analysis is used to understand the trade-offs: it must provide a sufficient level of technical analysis necessary (i.e., costs, benefits, detriments) to support the preferred alternative. In regards to shoreline treatments options, the appropriateness of the upland use that the proposed erosion control structure would protect should be considered, including whether the upland use will be viable under projected future conditions and storms, see Section V, Sea-Level Rise and Climate Change. DEC prefers the use of ecologically sustainable techniques over hardening techniques when erosion control projects are necessary in the Marine District.

4. Use Categories

A proposed activity must also comply with the use guidelines set forth in 6 NYCRR § 661.5.

Under 6 NYCRR §§ 661.9(b) [tidal wetlands] and (c) [adjacent areas], the designation of an activity as presumptively incompatible places (Plp), the burden on the applicant to demonstrate that the project is, in fact, compatible and the application will need a more developed analysis of potential impacts. The proponent of an activity with this designation will need to show that the project will not have undue adverse impacts on present or potential values of a wetland. The PIp designation assumes that these activities will have some negative effect on natural resources. Therefore, showing that the project will improve a degraded shoreline and provide environmental benefit to the wetland and upland area involved is key to overcoming this presumption. Proposals to enhance existing

wetland benefits can be considered in making a decision whether or not to grant a permit.

Some examples of the benefits provided by tidal wetlands and adjacent areas that can be preserved or enhanced through a living shoreline in comparison to standard structural erosion control techniques are:

a. Providing an enhanced habitat for a variety of native species (including forage, nursery, and refuge areas);
b. Providing for energy dissipation; fostering natural sediment process characteristic of the site;
c. Maintaining the connection between water and upland for fish, wildlife and other natural processes such as nutrient cycling, and water quality protection; and
d. Providing for the potential to create space for wetland expansion.

V. Sea-Level Rise and Climate Change

In 2010, DEC Commissioner's Policy CP-49, "Climate Change and DEC Action" was enacted, which requires that DEC consider Climate Change in all aspects of its activities, including permit approvals. New York State's 2100 Commission Report, *Recommendations to Improve the Strength and Resilience of the Empire State's Infrastructure (2013)*, was written after the devastation of Hurricane Irene, Tropical Storm Lee, and Superstorm Sandy, and recommends using natural resilience measures such as living shorelines as a key strategy to reducing future risk. The "Community Risk and Resiliency Act" (CRRA) of 2014 will advance these recommendations even further. See Appendix C, CRRA and Sea-Level Rise Projections, for additional information on CRRA.

When designing a living shoreline, applicants should consider factors relating to climate change and sea-level rise by recognizing that conditions are likely to change over the life-span of the structure and design accordingly. Living shorelines are typically more adaptable to sea level rise than traditional hardened shorelines (eg. marshes that may accrete in relation to rising seas, or the addition of extra stone to raise the height of a marsh sill). Issues to consider include:

- higher mean and spring tide levels,
- higher storm surges and larger areas of inundation,
- extreme precipitation rates and greater stormwater runoff,

- greater frequency and intensity of storms,
- wetland migration inland,
- changes in salinity and migration of the salt wedge, and
- permanent inundation of coastal properties.

The Department has established science based projections of sea-level rise in three specified geographic regions over various time intervals (6 NYCRR Part 490, Projected Sea-level Rise).

Sea-level rise and flooding must be considered for major projects under the affected UPA permit programs, including Article 25. An applicant can also use municipal or other established sea-level rise projections that may be more cautionary.

See Appendix C, CRRA and Sea-Level Rise Projections.

VI. Proper Siting

An applicant must demonstrate that the proposed living shoreline techniques chosen after the above analysis, is adequate for the area and appropriately designed to consider wave action and other site characteristics. Living shorelines are most appropriate for low to moderate wave energy environments. See Appendix D, Descriptions of Living Shoreline Techniques, for examples of demonstration projects. The characteristics of the location of the potential living shoreline are important to the design and subsequent success of the living shoreline techniques. Factors for the design may include the following:

A. Erosive Forces:

1. **Wave Characteristics** – It is important to understand the wave characteristics affecting the project site, as shorelines are shaped and modified by wave processes. Waves are dependent on shore slope, bottom friction, angle, tides and ultimately on meteorological conditions which control wave formation and interaction. The size of the waves is the result of energy transfer from wind, the fetch or distance over which the wind blows, and the duration of the blowing wind. Waves are also affected by water depth. Below are general characteristics associated with differing wave energy environments:
   a. Low energy: Limited fetch in a sheltered, shallow, or small waterbody (estuary, river, bay) i.e., wave height is less than 2 feet.
   b. Medium energy: A range that combines elements of low and high energy (shallow water with a large fetch or partially sheltered) i.e., wave height ranges from 2 to 5 feet.

c. High energy: Large fetch, deep water (open ocean) i.e., wave height exceeds 5 feet. This wave environment is not appropriate for the living shoreline projects addressed under this guidance.

It is important to design nature-based features in such a way that they will establish and/or re-establish natural processes and become as self-sustaining as possible. It is up to the applicant to make sure the living shoreline option chosen will work in the environment on site.

2. **Boat Traffic** – A boat travelling through the water generates a wake or waves that can cause erosion. It is beneficial to understand the amount of boat traffic and wake-generating wave characteristics in the area of a project. Boat wakes are common in many water bodies.

3. **Ice** – In bodies of water that freeze, ice can cause scouring to river edges, the inshore shallows, and surfaces it contacts. Tidal currents break solid ice into large floes, which slowly move downstream. The ice itself can push sediment in response to wind and water forces. It is beneficial to understand average thickness, duration, areal coverage, and how these factors impact affect a site.

4. **Surface Water Runoff** – When rain or snow falls to the ground, it starts moving and some seeps into the ground where it may replenish groundwater. Most flows downhill as runoff. Runoff is extremely important; not only does it keep rivers and lakes full of water, but it also can change the landscape if the runoff is strong enough and the surface material unstable enough to cause erosion. It is beneficial to understand how surface water may affect a site for any proposal and how runoff and groundwater seepage should to be treated so as not to exacerbate erosion of the site.

5. **Erosion Rate** – Distance of shoreline, area, or volume of sediment lost and deposited, and sediment transport patterns over time. Understanding the rate of erosion and sediment movement is essential for designing a solution. For example, the use of temporary protection until plants are established, or choosing plantings alone versus a hybrid stabilization solution will depend on erosion rate as well as other factors.

B. Habitat

1. **Habitat** – Type of plant and animal life occurring on or near the site that may be affected by the proposal.

2. **Water Condition** – Certain living shoreline components depend upon water quality, including, dissolved oxygen concentrations, water temperature, salinity, and turbidity. These conditions may be important to survival of certain aspects of a chosen living shoreline.

3. **Sunlight Exposure** – The direction and the duration of time at which sunlight falls on the landscape. Sunlight exposure over both land and water is important for plant selection, to aid in determining the use of sun-or shade-loving plants.

C. Other Physical Shoreline information

1. **Tidal Range** – The vertical difference between high tide and low tide. This is important for grading, determining height of sills or other preferred living shoreline types, and selection of plants and/or shellfish.
    a. Mean Lower Low Water - the average of the lower low water height of each tidal day.
    b. Mean Low Water - the average of all the low water heights;
    c. Mean High Water - the average of all the high water heights;
    d. Mean Tide Level - the arithmetic mean of mean high water and mean low water;
    e. Mean Higher High Water - the average of the higher high water height of each tidal day.

2. **Tidal Datums** – Tidal datums are used as references to measure local water levels observed over the National Tidal Datum Epoch. These designations are important for grading, determining height of sills or other preferred living shoreline types, and selection of plants and/or shellfish.

3. **Sea-Level Rise Projections** – Scientists project sea levels along New York's coastlines and estuaries will be 18 to 50 inches higher by the year 2100 than they are today, though a rise as much as 75 inches could occur. As per Section V above, the design of a living shoreline technique should consider sea-level rise because the rise of the sea will change the conditions of the shoreline. In Figure 3, (p.6), projected sea-level rise water levels are incorporated into the project's upper

slope. As well as appropriate plant species adaptive to impacts of sea level rise.

4. **Any Existing Shoreline Stabilization and its Condition** – The types of shoreline stabilization and conditions of neighboring properties are necessary to understand sediment deposition and erosion patterns/rates and how they affect any project proposal and vice versa.

5. **Shoreline Slope** – The level at which the ground at the project site tends downward towards the water, expressed as the horizontal distance divided by the vertical distance, for example 3 divided by 1, 3/1, or 3:1. This is also important for grading, determining height of sills or other preferred living shoreline types, and selection of plants and shellfish. Sharp breaks in slope should be noted. The land area from approximately the upland area to mean lower low water. Often the shoreline is broken into sections categorized as upland slope (above MHW), shoreline slope (between MHW and MLW) and offshore slope (below MLW).

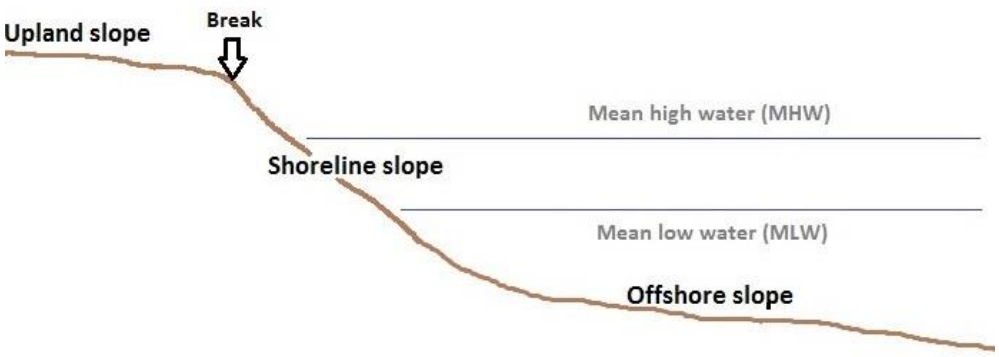

Figure 4. Shoreline Slope. Image credit: K. Giuliano.

6. **Soil Bearing Capacity** – The ability of soils to hold up to the weight of overlying structural elements such as stone or concrete without settling.
7. **Soil and Sediment Types** – The different types and sizes of particles of soil/sediment in a particular site location. This is important for understanding sediment mobilization potential and choosing vegetation, as soil/sediment type will influence stability, rate of growth and root penetration. Matching appropriate soil and sediment grain

size with proposed measures is important for successful living shoreline types.

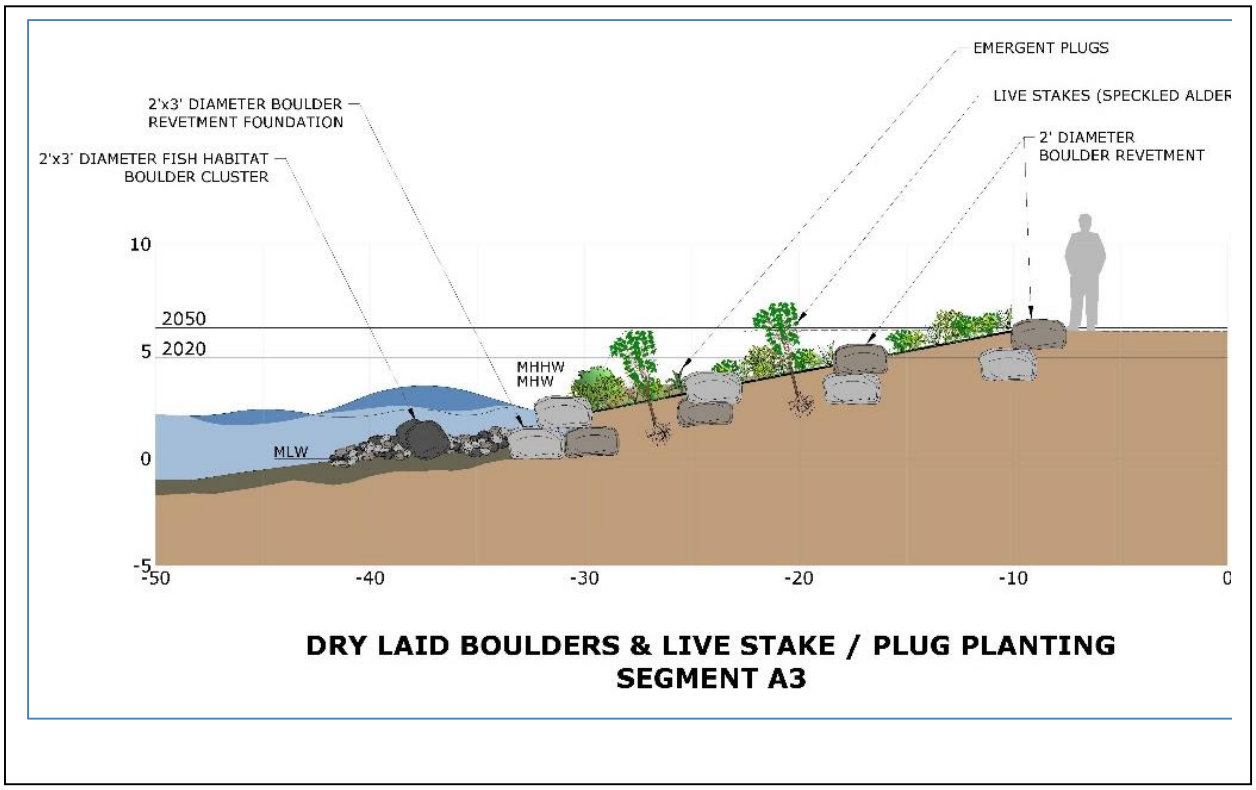

Figure 5. Example of incorporating sea-level rise projections for 2020 and 2050 into design. From Milone and MacBroom et al. (2014).

VII. Maintenance and Monitoring

Maintenance and monitoring are crucial to the successful establishment of a living shoreline. All shoreline erosion control projects require maintenance and monitoring, but the timing is different (sooner) for living shorelines versus more traditional approaches. Rella and Miller (2012 b) calculated the combined life time costs of traditional and more nature based approaches on the Hudson River over 70 years and found that nature-based approaches compare favorably. Initial costs of living shoreline installations are generally less expensive than more traditional shoreline erosion control methods (Allen and Leech 1997). Maintenance and monitoring costs should be factored into any living shoreline project under consideration.

The types of maintenance and monitoring are specific to the elements and goals of the project and may include: measuring plant survival; protecting the plants from animals (herbivory); providing temporary wave attenuation until root/plants are established;

removal of invasive species and debris; replacing or removing sediment; measuring shellfish productivity for certain projects; measuring erosion and accretion patterns; and assuring that the organic and structural materials stay in place (e.g., replacing stakes, moving fiber rolls, or loose rock). Ordinary maintenance and repair (not involving expansion or substantial restoration and reconstruction or modification of existing and functional structures) does not require a tidal wetland permit. Examples include removing trash/wrack, replacing a few plants, fixing a few loose stones. Official permit modifications will be necessary for any significant mechanized alteration or modification of a living shoreline. Contact the regional DEC Division of Environmental Permits office for related questions.

Maintenance and Monitoring Reports

Some living shoreline permits issued by DEC will include requirements that both maintenance and monitoring be conducted and reported for five (5) years post-construction. Additional monitoring beyond the scope of the 5 years is encouraged and will contribute to the overall understanding of living shoreline design and performance. Additionally, DEC recommends additional monitoring immediately following large storms.

If permit conditions require an annual report, the report, discussing the status of the project, shall be submitted for the duration of the permit. The report will generally include the following, as appropriate for the individual project:

- representative photographs of the treatment areas taken from a fixed point and a site plan or sketch that indicates the location and direction from which each picture was taken;
- assessment of any plants established (species and number of plants, percent of plant survival and number of dead plants (coverage success), number of plants replaced, evidence of herbivory);
- any action taken with respect to invasive species removal;
- monitoring of any sediment erosion or deposition in vicinity of project;
- what, if any, structural maintenance has occurred;
- other site conditions necessary to assess effectiveness of the project (storm damage, adjacent site activities etc.); and
- tracking response of target species, if appropriate (piping plover or salt marsh sparrow as an example) for a larger municipal project.

VIII. Other Considerations

A. Short Term Construction Impact Mitigation

Generally, all projects will have to be undertaken so as to minimize impacts from construction activities and use best management practices, including such measures as appropriate storage of material and equipment in the upland area or on barges, avoiding/minimizing impacts to wetland areas, installing and maintaining temporary erosion controls, and proper disposal of excess material.

B. Additional Regulations

1. **State Environmental Quality Review Act (SEQRA):** New or modified shoreline treatments requiring permits from state or local agencies are subject to review pursuant to and completion of the SEQR process by the involved agencies. For information on the SEQR process, see the DEC website at http://www.dec.ny.gov/permits/357.html.

2. **Historic Preservation:** All state and local agencies are subject to the State Historic Preservation Act and must consider the potential impacts of projects on historic and cultural resources. This includes both archeological resources and historic sites. To determine if your project site is near protected resources, see the online resources of the State Historic Preservation Office (SHPO) at http://www.nysparks.com/shpo/online-tools/.

3. **Shellfish Concerns: Shellfish Concerns:** If the installation utilizes shellfish, additional permits may be required by the local municipality and DEC (e.g. license to collect and possess, shellfish importation permit if using an out-of-state source of shellfish, etc.). Generally, it is the policy of the DEC to not allow the utilization of commercially important species, such as oysters, in waters of the state that are classified as “uncertified” and thus closed to any shellfish harvest unless such areas are designated sanctuaries that are marked and adequately enforced to prevent illegal harvest. Shellfish of any type is restricted to native species only. It is preferred that these installations are done in certified areas or in designated sanctuaries. Use of alternative species such as ribbed mussels is recommended in areas that are closed to shellfish harvesting. To determine the sanitary classification of your site and check to see if your project site is located in an area closed to shellfish harvest

(uncertified), see the DEC website at www.dec.ny.gov/outdoor/103483.html
Please contact your regional DEC office to discuss your project or the Shellfisheries office for questions on classification of shellfish lands for harvest and acceptable origin of shellfish for placement in marine waters.

4. **Endangered & Threatened Species Incidental Take Permit:** If impacts to an endangered or threatened animal species cannot be avoided and a taking will occur, a permit pursuant to Article 11, Title 5 of the ECL, and 6 NYCRR Part 182 will be required. You can check for the presence of endangered and threatened species with the DEC's Environmental Resource Mapper. If the mapper indicates that your site includes "Rare Animals and/or Rare Plants", contact your regional DEC office for specific species information.

5. **Other Government Permits:** Local municipal permits may be needed. NYSOGS authorization may be needed for installations that extend below the apparent high water line. Federal Permits from the Army Corps of Engineers, pursuant to the Rivers and Harbors Act and/or the Clean Water Act may be required if a structure or fill is placed below the plane of Mean High Water or Spring High Water, respectively. In addition, should a federal permit be required, a federal coastal consistency review may be required from the DOS to ensure compliance with the NYS Coastal Management Program. Should an action be deemed SEQRA Type I or unlisted, certain additional requirements may need to be undertaken by state permitting agencies pursuant to 19 NYCRR Part 600, a process commonly known as "State Coastal Consistency."

6. **Invasive Species Concerns:** Under no circumstances may an invasive species be used in a living (or other) shoreline. See 6 NYCRR §§ 575.3 and 575.4 for a list of prohibited and regulated species.

C. Clean Fill Only

Any and all fill material utilized for a project shall consist of clean, uncontaminated earthen materials or untreated vegetative matter only. Acceptable fill materials include sand, gravel, rock, overburden, unadulterated topsoil, and similar natural mineral resources or coir logs, timber stakes, and other wood or natural fiber products. Asphalt, slag, fly ash, broken concrete, recycled concrete aggregate (RCA), and demolition debris are not acceptable and will likely result in the denial of a permit.

See 6 NYCRR § 360.2(b)(284) [draft] for the definition of uncontaminated and General Fill Table 2 in 360.13 [draft]. The use of engineered, pre-cast concrete structures may be considered on an individual basis; it is recommended that DEC be contacted early in the design process when using such structures. For projects involving shell, local shell from shellfish native to New York is preferred. Shell may be subject to land-based air curing and testing prior to use in or adjacent to tidal wetlands. All shell, regardless of origin, must be devoid of any tissue material, sediment, fouling organisms, or any other material on the shell prior to introduction. The shell may be subject to inspection by the Department. Contact the Shellfisheries office for further information on acceptable origin of shell.

D. Contiguous Property Owners

A group of contiguous property owners can also join together and apply for a single permit to install a living shoreline project on multiple several adjoining (or nearby) properties. This would likely allow the property owners to realize cost savings and increase the effectiveness of the installation and the likeliness of project survival and success in addition to improved aesthtics. Contiguous living shorelines decrease the amount of hardened shorelines along a waterbody and therefore decreased the negative effects such as down drift erosion as well as deflecting wave energy onto nearby properties.

E. Hazardous Material Remediation

Contaminated sites may not be suitable for living shorelines because of necessary containment (e.g. bulkheads), restrictions on excavation or fill in these areas, or the need for more substantial erosion protection. Coordination with the DEC Division of Environmental Remediation will be required for any shoreline work at a remediation site.

F. Timing Restrictions

Restrictions on the timeframes allowed for work may be imposed. Different timeframes may be required depending on the resource at risk – various fish species, shellfish, shorebirds, etc. Work below the apparent high water line may be restricted to the time of low tide when the area is dry.

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Appendix A. Glossary

See also: Section V, Proper Siting, and Section VIII, Examples of Living Shoreline Techniques. Additional terminology can be found in 6 NYCRR § 661.4.

A. Common Terms Defined in this Guidance

Accretion – The gradual build up or enlargement of an area of land through the natural accumulation of sediment transported by water. Tidal currents carry sediment into a wetland and provides the soil base for wetlands.

Adjacent Area – The land immediately adjacent to a tidal wetland bounded by the limits described in the tidal wetland regulations 6 NYCRR § 661.4(b). A request for jurisdiction determination to establish the limits of the adjacent area on a specific site can be submitted to the regional DEC office.

Apparent high water – The high water line determined during a site inspection. This high water line can be determined by field conditions such as water or algae stained soils, rocks or other structures, wrack lines, and information provided by published tide charts.

Apparent low water – The low water line observed during a site visit timed during published tide chart low water.

Coast – Within this document, this term refers to New York State's marine shoreline only, not to the Great Lakes or other inland shorelines (see definition of "marine district" below).

Coastal Erosion Hazard Areas – Areas mapped by NYSDEC pursuant to Article 34 of the ECL. http://www.dec.ny.gov/lands/86541.html.

Dissolved Oxygen (D.O.) – The amount of oxygen dissolved in a body of water.

NYSDEC (DEC) – The New York State Department of Environmental Conservation, the State's environmental regulatory agency. It has broad statutory authority to implement the State's environmental policies and it oversees numerous state programs designed to protect and enhance the environment. More information can be found at: http://www.dec.ny.gov/24.html .

NYSDOS (DOS)- New York State Department of State, the state's planning agency. The Coastal Zone Management Act provides the authority through the DOS coastal management program over decision making in the coastal area. https://www.dos.ny.gov/opd/programs/consistency/index.html

Division – The Division of Marine Resources, lead for this document.

Erosion – The natural process of shoreline change by which sediment is transported from one location to another, and leads to retreat of the shoreline landward. The loss of sediment from the shoreline due to the action of water, ice or wind that carries sediment grains from the land to the water column away from the source. From http://sagecoast.org/info/glossary.html

Hardened Shoreline – A shoreline with engineered erosion protection that does not involve living components; typical examples are bulkheads, seawalls, cribbing, revetments and breakwaters.

Living Shorelines – Shoreline techniques that incorporate natural living features alone or in combination with structural components such as rock, fiber rolls, bagged shell, and concrete shellfish substrate.[2] This combination is also called hybrid. To be considered a living shoreline the techniques shall:

- Control or reduce shoreline erosion while maintaining benefits comparable to the natural shoreline such as, but not limited to, allowing for natural sediment movement;
- Use the minimum amount of structural components necessary to obtain project goals;
- Improve, restore, or maintain the connection between the upland and water habitats; and
- Incorporate habitat enhancement and natural elements, including native re-vegetation or establishment of new vegetation that is consistent with a natural shoreline typical of the site location.

Marine District – ECL 13-0103. The Marine and Coastal District Waters of New York State; it refers to all ocean waters that are within three nautical miles from the state's coastline, including the Atlantic Ocean, Long Island Sound and embayments, as well as the tidal Hudson River waters running south of the Tappan Zee Bridge. Marine and coastal district waters are governed by both state and town municipal regulation and authority. See http://www.dec.ny.gov/permits/95483.html for more information.

Major Project – Any action requiring a permit identified in section 6 CRR-NY 621.1, which is specifically defined as major or which is not specifically defined as minor in section 621.4.

[2] Concrete shellfish substrate includes trademarked manufactured products such as reef balls, oyster castles or reef blocks.

Natural (as in Shoreline) – The unaltered (as in human intervention through construction or other means) condition of a specific area; within this document, this usually refers to the shoreline.

NYS – New York State.

Salinity – The saltiness or dissolved salt content of the body of water at the project site is important to understand what types of plants are suitable at that location.

Stabilization – The artificial control of erosion through hardened, hybrid, or nature-based techniques.

Tidal wetland – Any area delineated as tidal wetlands on an inventory map pursuant to Article 25 of the ECL, more specifically all areas defined as tidal wetlands pursuant to ECL § 25-0103(1) and 6 NYCRR § 661.4(hh).

Turbidity- The measure of relative clarity of a liquid.

Value of a tidal wetland – The combination of benefits provided by tidal wetlands. Tidal wetlands constitute one of the most vital and productive areas of the natural world and collectively have many values. These values include, but are not limited to, marine food production, wildlife habitat, flood and storm and hurricane control, recreation, cleansing ecosystems, sedimentation control, education and research, and open space and aesthetic appreciation, as set forth in the legislative findings contained in section 1 of chapter 790 of the Laws of 1973.

Uniform Procedures – 6 NYCRR Part 621.

B. Terms Defined in Other Sources

Brush mattresses – Live cuttings with branches on the slope with butt ends keyed into toe protection. The branches are layered in a criss-cross overlapping pattern and secured with wire and dead stout stakes. A rock toe or fascine is used for toe protection. (Allen, et al. 2006, modified from USDA NRCS, 1996)

Bulkhead – A common shoreline protection technique comprising a vertical wall that prevents the loss of soil and the further erosion of the shore. They can be made of a variety of materials including rock, steel, concrete, and wood (Hauser 2012).

Fetch – The unobstructed distance of water over which the wind can blow. Fetch, along with water depth and wind duration, leads to wave generation (Fagherazzi and Wiberg, 2009).

Fiber Roll – A fiber roll is a coconut fiber, straw, or excelsior woven roll encased in netting of jute, nylon, or burlap used to dissipate energy along bodies of water and provide a good medium for the introduction of herbaceous vegetation. The roll is anchored into the bank and, after suitable backfill is placed behind the roll, herbaceous or woody vegetation can be planted. (NYSDEC 2005)

Hybrid approach – A hybrid shoreline is the combination of hardened structures with natural materials (NJDEP 2014; Smith 2006; VaCZM 2012).

National Tidal Datum Epoch – To account for various tidal fluctuations, a 19-year period of water level averaging, the National Tidal Datum Epoch (NTDE) has been established by NOAA/NOS in the United States. NTDEs have included the years 1924-1942, 1941-1959, 1960-1978, and most recently, 1983-2001. http://www.ngs.noaa.gov/datums/vertical/

Protection, shoreline – A range of engineering responses that focus on protecting land or landward infrastructure from erosion, inundation, or storm-induced flooding (Hauser 2012).

Revetments – A common shoreline protection technique constructed of large rocks or concrete armor units that slope toward shore. Rock revetments go through a more rigorous engineering analysis and provide a higher degree of protection than does rip-rap (Hauser 2012).

Rip-rap – A shoreline protection technique to armor a sloping shore by using small rocks or, cobble, to protect the finer sized sediments from eroding. Rip-rap can also refer to the material itself (Hauser 2012).

Shoreline – The term shoreline is used in many ways, including defining either a line or an area. Therefore, several definitions are included here:

- An “infinitesimally thin line that separates the water from the land” (Strayer and Findlay 2010);
- In New York State, the intersection of the mean high water line with the beach profile; below mean high water may be privately or publicly owned;
- The fringe area along the edge of a water body, which connects the shallow aquatic portion of the water body with adjacent upland;
- The zone of contact of a body of water’s surface and the land; or
- The land along the edge of a body of water.

Related terms: *shore zone, riverfront, coast, shore, waterfront, coastline* (Hauser 2012).

Sills – Low profile, continuous structures placed parallel to the shore at mean low water. Sills can be made of broken rock, cobbles or other hard material and typically have a trapezoidal cross-section. Sills reduce shoreline erosion by dissipating wave energy, which may cause sediment to build up between the sill and the shoreline. This sediment may provide substrate for marsh growth (Hauser 2012).

Taking of Threatened or Endangered Species – A taking includes not only the death of individuals, but also any adverse modification of a species' habitat, and any interference with or impairment of an essential behavior of the species. See 6 NYCRR Part 182 for more detail.

Vegetated geogrid – A vegetated geogrid is a system of successive soil lifts wrapped in a synthetic or natural fiber material with live branch cuttings placed between layers (Allen, et al. 2006, modified from USDA NRCS, 1996)

Appendix B. Permit Application Checklist

- ☐ Signed Joint Application Form
- ☐ Signed Permission to Inspect Property
- ☐ SEQR Short Environmental Assessment Form (EAF) – Part 1 completed & signed. http://www.dec.ny.gov/permits/6191.html. DEC recommends the use of the EAF mapper which allows you to select your site and will then generate a partially filled-in form.
- ☐ Required Additional Materials
  - Location Map
  - Project Plans (instructions on-line)
  - At least three (3) recent color photographs of the site labeled with date taken and orientation of photo
  - Application Fee – refer to http://www.dec.ny.gov/permits/65153.html
- ☐ Identification of adjacent landowners.
- ☐ Project drawings showing all existing and proposed structures, the tidal wetland boundary, apparent high water line, and existing & proposed elevation contours in 2-foot intervals for the work area. The wetland boundary must be recently (within 5 years) delineated by a qualified person. The apparent high water line may also have to be delineated by a qualified person. Contact your regional office.
- ☐ USGS Quadrangle Map (or equivalent) showing the project location
  - Map showing roads and proposed machinery access route
- ☐ Letter signed by landowner; or, if application is not signed by landowner, letter designating an authorized agent if application is not signed by landowner and, if additional landowners are involved, signed letter(s) of permission for each.

Basic Drawing Requirements

Site Plans:

- ☐ Scale (i.e. 1" = 50', 1" = 40') and north arrow.
- ☐ Name of preparer and dated prepared and name of property owner.
- ☐ Property lines and names of all adjacent landowners.
- ☐ County tax map numbers.

- ☐ Address of project location (street and number); if vacant land, give utility pole number or other landmark.
- ☐ Apparent high water line (AHW) and apparent low water line (ALW) *tidal wetlands only.
- ☐ Vegetated wetlands boundary, indicate name of individual delineating boundary and date of delineation.
- ☐ Outline and identify existing and proposed structures.
- ☐ Dimensions of proposed structures/work areas, grade changes, excavation, filling, and/or clearing.
- ☐ Elevations referenced to NGVD 1929 or NAVD 1988 when applicable.

Crossviews:

- ☐ Name of preparer and date prepared.
- ☐ Water depths at low tide, apparent high water line (AHW) and low water line (ALW).
- ☐ Existing and proposed structures and grades.
- ☐ Dimensions of all materials to be used or affected areas in inches or feet.
- ☐ Distances between structures and components (i.e. distance between seaward toe of proposed living shoreline structure and an existing fixed structure on property such as a building or parking lot; vertical / horizontal distances between seaward toe of proposed living shoreline structure and top or landward edge of proposed structure).
- ☐ Type of material(s) proposed.

Additional Drawing Details Required for Specific Activities:

For filling, dredge material deposition, excavating, clearing, grading, bluff or dune restoration, or beach nourishment.

Site Plans:

- ☐ Outline of area(s) to be affected by these activities.
- ☐ Top and bottom of bluff or dune, if applicable.
- ☐ If grade changes exceed 2 feet, contour lines showing existing and proposed contours at 2-foot intervals.
- ☐ Volume of material to be placed/removed in cubic yards.
- ☐ Source and type of material involved (sand, silt, loam, rock).
- ☐ Method of placing and removing material and location of disposal.

Crossviews:

- ☐ Existing and proposed angle of surfaces.
- ☐ Source and type of material proposed.
- ☐ Volume of material, in cubic yards, to be placed.

Living Shoreline Treatments or Other Erosion Protection Structures

Site Plans:

- ☐ Distances from existing substantial structures (i.e. dwelling or telephone pole) to ends of proposed structure.
- ☐ Source, type and volume (cubic yards) of material proposed for backfill.
- ☐ Limits of backfill.
- ☐ Direction of littoral drift.

Cross views:

- ☐ Distances from existing structures.
- ☐ Distances below grade of structural components.
- ☐ Distances below apparent low water of project components.
- ☐ If rock structures are proposed, minimum weights of all grades of stone used.
- ☐ Backfill area.

DEC staff may require additional information to adequately review and evaluate the application.

Appendix C. CRRA and Proposed Sea-Level Rise Projections

On September 22, 2014, Governor Cuomo signed into law the Community Risk and Resiliency Act, Chapter 355 of the Laws of 2014 (CRRA). CRRA is intended to ensure that certain state monies, facility siting regulations and permits include consideration of the effects of climate risk and extreme weather events. The act has several provisions. It calls for:

- DEC to adopt official projections for sea level rise by January 1, 2016 and update the projections every five years. DEC has established a new 6 NYCRR Part 490, Projected Sea-level Rise. Part 490 establishes projections of sea-level rise in three specified geographic regions over various time intervals but will not impose any requirements on any entity at this time. Projections are below.
- DEC, in specific facility and siting regulations, and applicants to several permit and funding programs to consider sea-level rise, storm surge, and flooding. Affected programs including major projects under Protection of Waters (Article 15, Title 5) and Tidal Wetlands (Article 25).
- The State to add mitigation of sea-level rise, storm surge, and flooding to the list of criteria under the Smart Growth Public Infrastructure Policy Act.
- NYSDOS and DEC to prepare model local laws to manage physical climate risks.
- DEC and NYSDOS to provide guidance on the implementation of the Act, including the use of resiliency measures that utilize natural resources and natural processes to reduce risk.

In response to CRRA, DEC and NYSDOS are drafting guidance on resiliency measures that utilize natural resources and natural processes to reduce risk in addition to guidance on considering sea level rise, storm surge and flooding.

Sea-Level Rise Projections

New York City/Lower Hudson Region -The main stem of the Hudson River, south from the mouth of Rondout Creek at Kingston, New York, and the marine coast of the five boroughs of New York City and the Long Island Sound in Westchester County.

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches

2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

Long Island Region -The marine coast of Nassau and Suffolk counties.

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	21 inches	34 inches	47 inches	72 inches

For definitions of the range projections (low to high) see http://www.dec.ny.gov/regulations/103877.html. For example, high projection is the amount of sea-level rise that is very unlikely (the 90th percentile of ClimAID model outputs) to be exceeded by the specified time interval.

Values represent inches of rise over baseline level, which is defined as the average level of the surface of marine or tidal water over the years 2000 through 2004.

Appendix D. Descriptions of Living Shoreline Techniques

Beach nourishment /sand replenishment – The process of replacing the sand on the beach naturally by longshore transport or mechanically by placing sand on a beach to secure the beach against shore erosion and damages to inland areas. This project purpose was to establish a feeder beach/erosional head to restore the sediment budget disruption due to an adjacent bulkhead. (Nordstrom, K. F., N. L. Jackson, and E.J. Farrell. 2016.)

Figure 6. Placement of sand, before and after feeder beach sand placement at Sailor's Haven on Long Island. Large volume of sand added from outside source to an eroding beach to widen the beach and move the shoreline seaward. Photo credit: NYSDEC GIS images.

Vegetated Slope / Bank Restoration

Vegetated slopes are created using wetland or upland vegetation to control or prevent further erosion by absorbing wave energy and stabilizing the slope. Existing native plants can be preserved or new native species restored. When selecting species, look for plants with substantial root systems, to hold the soil. Shorelines in low energy creeks and coves are locations where vegetation alone can be used to protect from erosion. See Figures 7 and 8.

Figure 7. Marsh planting along slope of Occahannock Creek, Northampton County, VA, at time of planting and one and ten years later. Image credit: C.S. Hardaway, VIMS from (Hardaway & Byrne 1999).

Figure 8. Slope planted with native vegetation. Photo credit: New England Environmental, Inc.

Edging or Toe Protection

Figure 9. Fiber roll and bagged shell edging.
Photo credit: Dave Bushek.

The use of material at the edge of a wetland or vegetated slope to control or prevent further erosion. Material choices can include staked bio logs as planting medium, bagged shells, reef balls, rip-rap, or other structure to absorb wave energy in order to protect existing or newly planted vegetation. See Figures 9, 10, and 11.

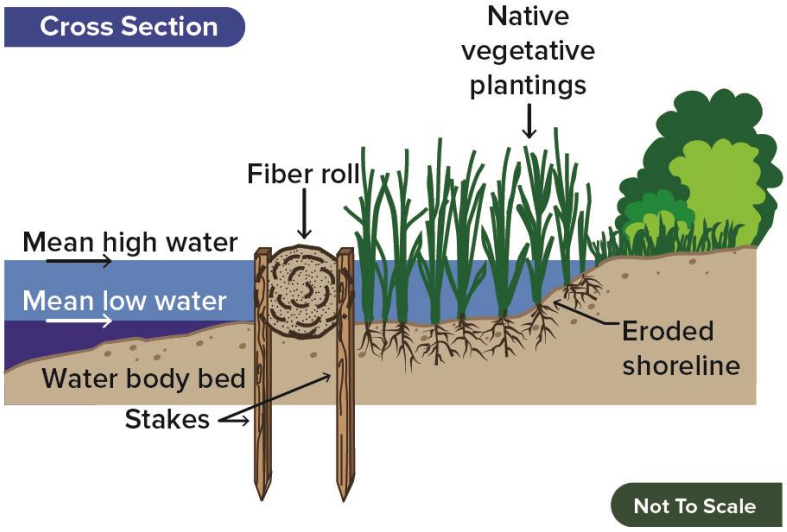

Figure 10. Fiber roll edge protection. Adapted from USDA NRCS (1996.)

Figure 11. Example of stone toe protection with a vegetated slope using bio-degradable geotextile and shrubs, upper left and right. Photo at left shows established shrubs and stone (toe at high tide), six years after installation at Esopus Meadows, NY. Photos courtesy of Creative Habitat Inc.

See Hudson River Sustainable Shorelines Case Study: Esopus Meadows Preserve https://www.hrnerr.org/doc/?doc=240260694.

Vegetated slope with additional structural protection

The use of structure to stabilize the slope or to serve as a planting medium. Material choices can include staked fiber rolls, boulders and cobbles wooden timber or logs. (Figure 12.) Specific techniques include joint planted revetments, vegetated geogrids with stone toe protection (Figure 13) and branch mattresses with stone toe protection (Figure14). Those ecologically enhanced engineered structures that use more hard armoring (structural) components in conjunction with vegetation to stabilize the slope are more appropriate in areas subject to stronger erosive forces like boat wake and ice scour as well as those with steeper slopes. These can replace or enhance existing vertical structures. These types of structures can disrupt sediment transport, erode the seaward bed or shoreline and inhibit land water access. These effects should be carefully considered in any evaluation of alternatives.

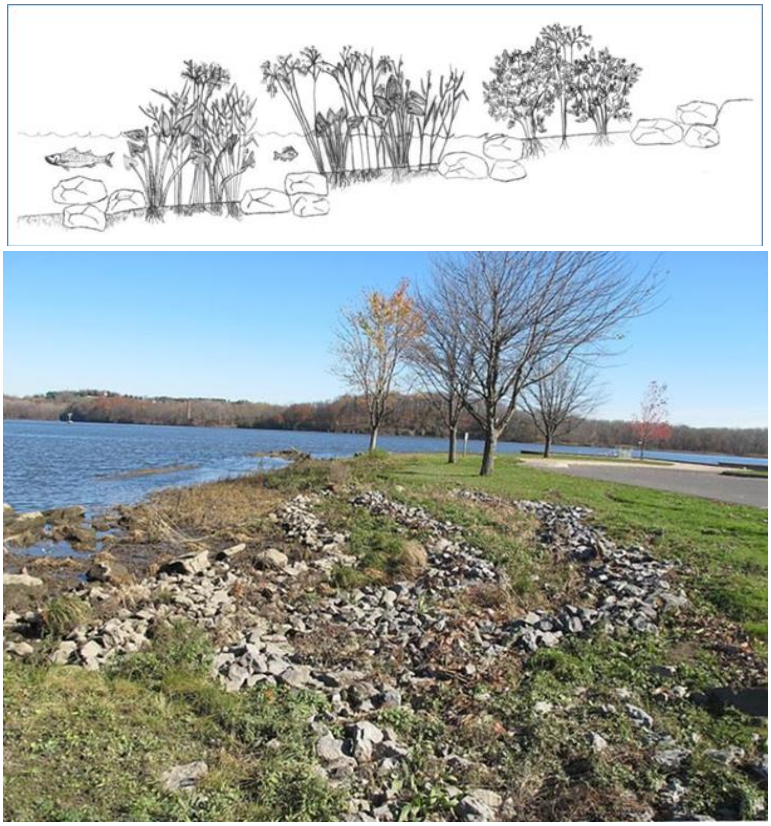

Figure 12. Schematic drawing and in field photo of Coxsackie, NY sloped bank with tiered rock rip-rap with vegetation, Image by Ben Ganon and photo by Casey Holzworth.

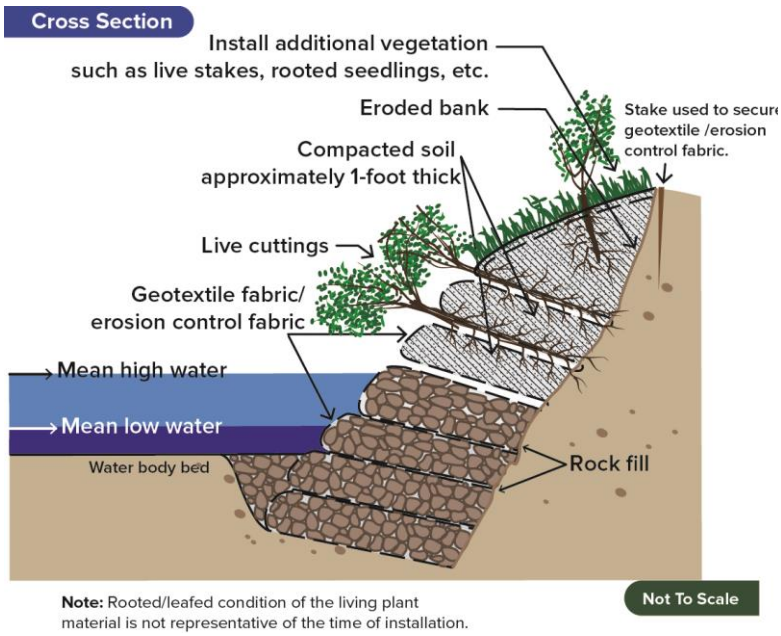

Figure 13. Vegetated geogrid to protect slope with stone toe protection. Adapted from USDS NRCS (1996).

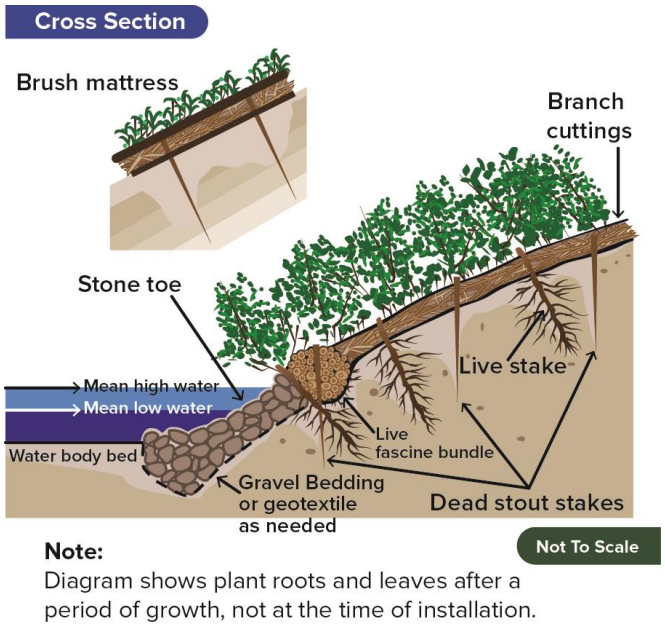

Figure 14. Brush mattress to protect slope with stone toe protection. Adapted from USDS NRCS (1996).

Low profile sill for wave attenuation Sills are typically low profile, continuous or intermittent structures placed parallel to the shore at mean low water, see Figure 15. Sills can be made of broken rock, cobbles, bagged oyster shells or reef balls. Sills typically have a trapezoidal cross-section. Sills reduce shoreline erosion by dissipating wave energy, which may cause sediment to build up between it the sill and the shoreline. This sediment can provide substrate for marsh growth. In some cases, the area between the sill and the shoreline is prefilled and planted to accelerate the marsh creation process; this approach is sometimes called a marsh sill. A sill is placed offshore of existing marsh to help reduce the erosion of the waterward edge (escarpment) where marsh would or could grow and is planted or placed to protect the eroding edge of an existing marsh. These structures can effect sediment transport, so design should consider those potential effects.

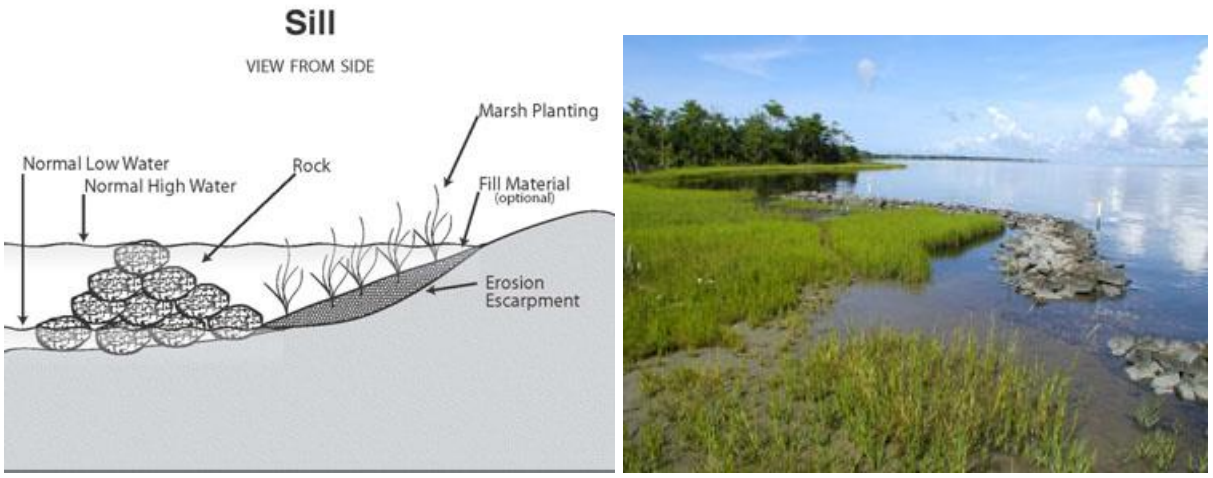

Figure 15. Schematic drawing and in field photo of marsh sill. Sill is composed of rock and has openings for aquatic fauna passage. Image and photo courtesy of: North Carolina Division of Coastal Management.

Appendix E. Information on Demonstration Projects

DEC's Hudson River National Estuarine Research Reserve conducted a survey of stakeholders in sheltered waters of New York, New Jersey, and Delaware. One finding of the survey was that stakeholders expressed a need for information on project costs, site conditions, design techniques, and successes and failures of living shorelines (Tobitsch et al. 2014). At the time of writing this guidance document, there are several on-line databases and websites with information that include some living shorelines that have already been installed and other useful information. DEC is providing these internet resources as an informational tools.

- Hudson River Sustainable Shoreline Project Demonstration Site Network (https://www.hrnerr.org/hudson-river-sustainable-shorelines/demonstration-site-network/)
- Hudson River Sustainable Shoreline Project Forensic Analysis of Shoreline Structures on the Hudson River https://www.hrnerr.org/shorelinesforensicanalysis/
- Rella, A. & Miller, J. (2012b). A Comparative Cost Analysis of Ten Shore Protection Approaches at Three Sites Under Two Sea Level Rise Scenarios. In association with and published by the Hudson River Sustainable Shorelines Project, Staatsburg, NY 12580, https://www.hrnerr.org/doc/?doc=240186100
- NYS DOS Office of Planning and Development
  Story map on living shorelines through the Geographic Information Gateway. It includes a map of living shoreline projects in various stages throughout the state as well as other reports/studies related to living shorelines in New York. http://opdgig.dos.ny.gov/#/storyTemplate/11/1/1
- Partnership for the Delaware Estuary (http://delawareestuary.org/Living_Shorelines)
- American Society of Civil Engineers - Coasts, Oceans, Ports, and Rivers Institute (http://mycopri.org/)
- Systems Approach to Geomorphic Engineering (SAGE) http://sagecoast.org
- NOAA Habitat Conservation Restoration Center, Living Shorelines http://www.habitat.noaa.gov/restoration/techniques/lsimplementation.html
- VIMS Center for Coastal Management http://ccrm.vims.edu/livingshorelines/demonstration_area_map.html