Fishers Island Shoreline Breakwater Project

Proposal for Innovative Shoreline Protection

to Reduce Beach and Dune Erosion

October 18, 2014

Introduction

In the aftermath of Hurricane Sandy, the entire south shore of Fishers Island was adversely impacted by increased erosion as storm surge damaged the public docks, the wastewater treatment plant, the airport, several roads, private residences and beaches.

The intense wave action and storm surge scoured beaches, reducing their width and eroded shorelines precariously close to homes and infrastructure. As predictions for increasing storm intensity appear all too true; 'Super Storms' appear to be a taste of things to come in the 'era of the New Normal'. Hurricane Sandy has increased the vulnerability of the island's shoreline to the next set of major storms as natural shoreline defense features are weakened, damaged or completely destroyed.

The most significant and consistent Post Sandy impact reported throughout the Northeast US coastal region was beach erosion caused by the extreme storm surge and wave action. At the eastern end of Long Island Sound, Great Gull Island was breached in two places and Falkner Island off Connecticut lost nearly 1/3 of its entire land mass. Griswold Point in Old Lyme was hit by the storm surge with such force that it is no longer attached to the mainland[i].

The immense storm surge and dune erosion has lowered elevation of beaches and near shore areas all along the southern coastline of Fishers Island now **more vulnerable** to additional storm impacts and future hurricanes. The general consensus from surveys conducted after the storm was that natural barriers such as intertidal and near shore habitats, sand dunes, salt marshes thus speeding their recovery. The proposed Bio-Rock shoreline living reef will improve shoreline resilience as the Eccosolution – Bio-Rock Technology Team effectively constructs and seeds the development of these natural systems.

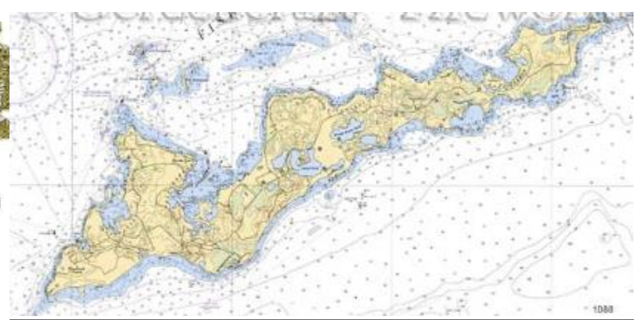

Fig-1. Location of Fishers Island

Fig-2. FI Nautical Chart

Scope of Work

The proposed project is designed in three (3) phases. Phase I will complete the survey, design, and interact with permitting agencies. It will include curriculum development for Fishers Island STEM teachers and students including meetings with school staff. Phase II will model, and permit the system. Phase III will install and monitor the innovative yet tested permeable near shore bio-rock living reef.

Phase I will commence an interactive and iterative process with all relevant resource agencies to both guide and inform updated standards for shoreline protection enabling living reefs of proper design and specifications a clear path to permitting.

Phase II of the project will be to model, permit and prepare bid specifications for the proposed breakwater structure(s).

Phase III will be to actually install and monitor the breakwater living reef. A monitoring program will assess and document effectiveness. Project monitoring will be accomplished by the project team in cooperation with the Fishers Island School (k-12) with special focus on adapting the monitoring process to the Science, Technology, Engineering and Math (STEM) requirements of middle and high school science and math course curriculum and field projects.

The methodology proposed is to (1) research available data, (2) collect wave, oceanographic and bathymetric field data, (3) develop alternative breakwater designs, (4) model alternative approaches with ground truth provided by actual field data and (5) compare relative effectiveness of alternative systems with regards to public safety, system cost and environmental impacts, (6) discuss and present findings with resource agencies.

Once alternative breakwater designs are complete, and the pubic agencies are familiar with the bio rock breakwater design, the modeling process will utilize (1) SWAN (Simulating Waves Near shore) with the capability of modeling impacts in shallow coastal waters. The additional application of (2) SNL-EFDC, a model that is a USEPA approved 3D hydrodynamic model will simulate sediment transport and water flow characteristics in the Great Kills Harbor coastal areas. Each step of the modeling process will engage an interactive process to USACE, NYSDEC, NYC DEP and related local, state and federal agencies to compare alternative design approaches with existing or planned regulatory requirements. Overall findings will focus on the effectiveness of alternative approaches to increase the resiliency of the shoreline based on modeling results. Findings will be explained to solicit comments at a stakeholder meeting along with proposed next steps, timelines for system deployment, cost estimates, and monitoring requirements.

Project phases include (1) Field Data acquisition to include site-specific bathymetry, oceanography, sea bed and near shore geology, wave, wind and water currents data, (2) Design of two alternative Bio-Rock Breakwater Designs, and (3) wave and hydrodynamic modeling to determine shoreline impacts resulting from alternative breakwater designs. (4) Stakeholder presentations will enable a more complete understanding of the proposed design. These will be available on-island and also via the FI Website.



Fig-5. (top left) Conventional shore protection structures on left cost $13M per kilometer. Fig-6 (top right) Biorock structures shown offshore in Indonesia. Fig-7 (bottom) Healthy Bio-Rock oyster reef ecosystem.

What is BioRock?

Bio-Rock is the process of creating natural coral or oyster reefs and other near shore marine ecological zones (Sea Grass, Salt Marsh) through the use of electro-deposition of carbonate minerals on specially designed steel structures. A micro trickle-charge of electric current through the steel structure promotes deposition of carbonates from seawater. Expert marine biologists then seed the structures with corals or oysters that rapidly propagate creating a highly successful bio-remediation strategy and effective, ever-growing breakwater. Bio-Rock shore protection structures are designed and engineered in a site-specific way to withstand maximum wave energies and reduce storm surge impacts. They are faster and cheaper to build than concrete or rock structures of the same size. Bio-Rock breakwaters are designed and constructed as open frameworks that allow waves to pass through them, slowing them by refraction, diffraction, and energy dissipation due to reef structure or vegetative bottom friction. They operate under completely different physical principles than conventional breakwaters, essentially using refraction instead of reflection. Waves passing through the structures reach the shore with less energy, so they deposit sand on beaches instead of eroding them. Bio-Rock breakwaters avoid increased scour and erosion caused by solid breakwaters, that wash away all the sand in front, and then underneath them, accelerating undermining, cracking, settlement, and collapse. Another Bio-Rock approach enables rock and concrete module breakwaters to be armored over and cemented together with limestone, forming massive units that prevent rocks and concrete modules from moving apart in heavy storms, and having to be reset with cranes at great cost. Bio-Rock breakwaters gain strength with age, becoming more effective over time as surface area increases and corals, oysters, and mussels proliferate. Bio-Rock structures in shallow water, sitting unattached on sand, un-welded and held together only with binding wire, withstood some of the strongest hurricanes ever recorded in the Caribbean with only minor damage because waves were able to pass through them, while massive structures were overturned or ripped apart.

Sea Grass, Salt Marsh Restoration – Bio-Rock methods increase sea grass growth and salt marsh survival, even promoting growth and proliferation of roots on hard rock bottom where they are normally unable to survive. Sea grasses provide critical juvenile fish and shellfish habitat. They also provide crucial shore protection services by stabilizing sand. Sea grasses are rapidly being destroyed worldwide, and Bio-Rock technology provides the fastest restoration. Shoreline areas will be surveyed by the Design Team during the field site assessment stage to determine the opportunity for Sea Grass and Salt Marsh Restoration.

Fisheries Restoration: Bio-Rock methods create ideal habitat to restore damaged fisheries, especially on barren sand, mud or rock, where there are no reefs or sea-grass to provide nursery habitat for baby fishes to hide in. Populations of fish, oysters, mussels, lobsters, crabs, and giant clams rapidly increase around Bio-Rock projects, generating enormous fish schools. Indonesian fishermen report increased numbers, sizes, and diversity of fish in areas near Bio-Rock projects. Each species needs habitat with different size and shaped spaces to attach to or hide in. Bio-Rock habitat can be made in shapes that certain desired species prefer. Bio-Rock reefs can be restocked with baby fishes collected in the open sea, turning >95% mortality into >95% survival, and is the fastest possible way to restore coastal fisheries, reducing limitations caused by lack of juvenile recruitment, habitat, and food.

Reversing the Effects of Ocean Acidification: The Bio-Rock process reverses ocean acidification by creating alkaline high pH local conditions. It is the best way to create habitats to grow acid-vulnerable species at accelerated rates. Acidification is killing oyster larvae in the northeast Pacific, severely damaging the oyster industry on the west coast of North America. In a recent study in New York City, 93% of control oysters died over winter, and the few survivors shrank because cold acidic water dissolved their shells. Bio-Rock oysters nearby had 100% survival, grew over the winter when they would have otherwise been dormant, and their shells were shiny with no signs of dissolution. Bio-Rock technology can be powered by energy from the sun, winds, waves, and ocean currents generated directly at the site or from onshore power that is rectified from AC to low voltage DC

Field Data Acquisition and Project Overview: Three teams cooperate to deliver an optimally accurate and timely modeling of alternative breakwater systems. These include a (1) Field Data Team, (2) Bio-Rock Design Team and (3) Breakwater Modeling Team. The (1) Field Data Team compiles site specific physical characteristics using research from oceanographic databases, and is experienced in the oceanographic field data acquisition for primary data on water currents (ADCP), wave characteristics (Nortek), bathymetry, sampling seafloor geology and site mapping using underwater video to characterize the seafloor boundary layer. The (2) Bio-Rock Design Team participates in the on site assessments of both the offshore breakwater project area and near shore marine ecology. Based on these observations and 24-years experience in Bio-Rock construction, two alternative Bio-Rock breakwater designs are completed. The (3) Breakwater Modeling Team utilizes the input of primary and secondary site data to complete the modeling of alternative impacts of hard rock and Bio-Rock breakwater structures.

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[i] American Littoral Society. *Final Report Assessing Impacts of Hurricane Sandy on Coastal Habitats.* 2013.