

Carbon-Removing Shoreline Protection

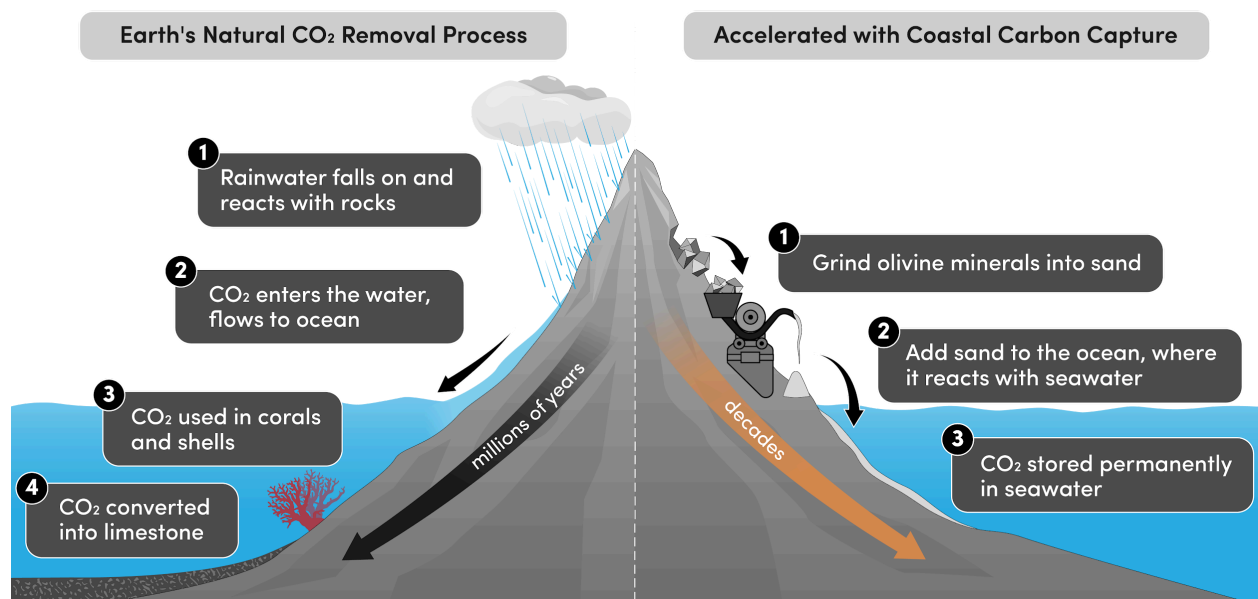
COASTAL CARBON CAPTURE AT NORTH SEA BEACH

Coastal Carbon Capture™ is a method for carbon dioxide (CO₂) removal inspired by Coastal Enhanced Weathering which accelerates the Earth's natural process for removing atmospheric CO₂ (See Figure below). Coastal Carbon Capture involves the placement of sand made from the naturally occurring mineral olivine in coastal areas (Read more about the mineral olivine [here!](#))

North Sea Beach Colony (NSBC) is a community located on Little Peconic Bay on Long Island, NY. Like many coastal areas, NSBC is experiencing shoreline erosion. Over the last decade, New York alone has deployed more than 25 million cubic yards of sand to restore eroding coastlines in the state through a method called beach nourishment: a shoreline protection approach used in the USA and worldwide for over a century to replenish eroding beaches with sand.

In an effort to restore a section of North Sea Beach, the Southampton Town Board formed the NSBC Beach Erosion Control District (NSBC-BECD). In 2020, NSBC-BECD executed phase 1 of this beach nourishment project which placed sand from North Sea Harbor Inlet onto a portion of North Sea Beach. In June, 2022, NSBC executed Phase 2 of the beach renourishment and placed 10,000 cu yd of sand from North Sea Harbor Inlet.

In July 2022, the North Sea Beach Colony (NSBC) in Southampton, NY became home to the world's first field pilot of Coastal Carbon Capture when they incorporated olivine sand into Phase 2 of their beach restoration project. The Town of Southampton, in collaboration with the NSBC, Vesta, and [First Coastal](#), deployed 500 cu yd of olivine sand such that it comprised ~5% of the total sand volume that was placed.



OBJECTIVES OF THE PROJECT

The pilot project at NSBC has two main goals: 1) quantify the rate at which olivine sand dissolves and the efficiency of carbon removal in a natural setting, and 2) document any environmental impacts, positive or negative. Vesta is meeting these goals through a comprehensive, multi-year science monitoring program with collaborators at Stony Brook University and the Cornell Cooperative Extension, which includes frequent sampling and testing of water, sediment, and marine organisms.

Assessing environmental safety is at the forefront of Vesta's mission. Vesta has been continuously monitoring water quality through the deployment of a **sonde**. Sonde measurements include seawater pH, dissolved oxygen concentrations, turbidity, and chlorophyll A (an indicator for algae). After our first year of data collection, we have observed no **statistically** significant impacts to these parameters.

PROJECT PARTNERS AND COLLABORATORS



FIRST
Coastal



VESTA



Stony Brook
University



Cornell University

CARBON REMOVAL MONITORING PROGRAM

The Vesta Monitoring Program includes a suite of survey and sensor-based measurements to demonstrate both the ecological safety and efficiency of Coastal Carbon Capture through rigorous, multidisciplinary scientific study. Vesta personnel and collaborators have been on site performing surveys periodically throughout the project life cycle.

Low-profile, continuous monitoring sensors were installed at several locations within the project site. An Aqualink Smart Buoy has been deployed in the Little Peconic Bay, providing real time wave, wind, and temperature data that can be accessed at <https://aqualink.org/sites/3336>.

Vesta has been trailing multiple approaches to measure carbon removal. Some of our methods are outlined below:

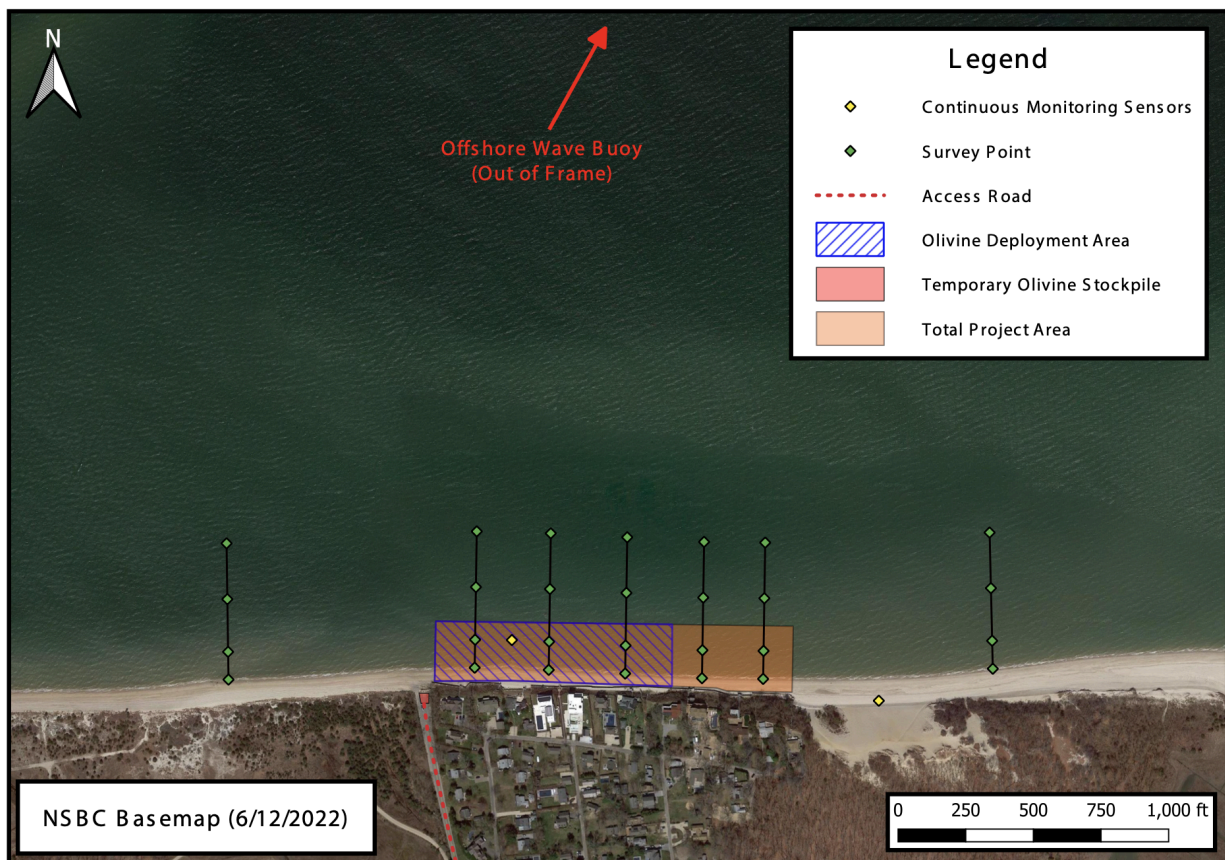
Sippers extract water samples from between grains of sand (porewater) at various depths in the sediment. Due to their close proximity to the olivine sand, these water samples have concentrated dissolved carbon.

Microprofiling is an approach where small, thin electrodes that measure parameters such as pH, are inserted directly into the sediment to measure the porewater chemistry in the field.

Benthic Flux Chambers capture a volume of seawater directly at the sediment-seawater boundary. They are left in the ocean for a few days, allowing dissolved carbon to accumulate without being diluted by seawater circulation.

Sediment Cores are also essential for documenting carbon removal. Our team pushes rigid cylinders into the ground capturing the sediment inside. This style of sampling preserves the layers that are formed in the beach profile. We can then test the sand for change in solid carbon and mineral reservoirs, such as organic matter and carbonate (e.g. shell content).

Vesta has observed geochemical evidence for olivine dissolution and carbon removal at the site using these techniques. Initial observations from the 2022 monitoring program thus far can be found in the 2022 annual report.



These methods help us monitor a variety of parameters:
WATER CHEMISTRY

- pH, Temperature, Salinity
- Trace metals
- Alkalinity, $p\text{CO}_2$
- Dissolved inorganic carbon (DIC)
- Nutrients
- Dissolved organic carbon (DOC)
- Dissolved oxygen
- Iron, Sulfur
- Turbidity

SEDIMENTOLOGY

- Grain size
- Olivine content

- Carbonate content

- Secondary minerals

- Organic content

GEOMORPHOLOGY

- Lateral sediment transport

- Vertical sediment sorting

- Bathymetry

- Wave dynamics

ECOLOGY PROGRAM

In collaboration with the Cornell Cooperative Extension, Vesta conducted a baseline survey of benthic organisms at NSBC before and post-placement. Samples for benthic community structure were collected five times throughout 2022 and the results show no effect of olivine placement on abundances and species richness. Samples for ecotoxicological study on benthic organisms were collected three times in 2022 and the post-placement results show lack of elevated concentrations of trace metals (Ni, Cr and Co) in organisms tissue at the NSBC. Over the coming months these samples will be assessed for species abundance and health. Vesta and the Cornell Cooperative Extension also conducted two experiments assessing the impact of olivine sand on horseshoe crab eggs and oysters. Oysters are a sensitive species often used in ecotoxicological studies and horseshoe crab eggs, although not naturally nesting at the NSBC, spawn along the entire US East Coast. Thus, NSBC provides a great opportunity to study olivine effects on nesting habitats without risk of affecting the natural nests. Bags of horseshoe crab eggs and oysters were manually placed in the sand and sampled throughout the summer. Sand properties such as temperature, which can impact horseshoe crab nesting success, were

measured concurrently. Oysters grew in size over summer 2022 and our analyses shows no evidence of trace metals accumulation in their tissue (Ni, Cr and Co). The measurement will be conducted again in 2023 to confirm those results. The team is currently processing the horseshoe crab eggs samples from 2022 and are repeating the experiments in the summer of 2023.

OLIVINE SAND

Olivine is a common, naturally occurring silicate mineral (Mg_2SiO_4) similar to quartz sand (SiO_2). Like all sand, olivine dissolves over decades in a natural process called mineral weathering.

Olivine is found all over the world, including New York! The Palisades Sill, for example, contains a 30 ft section called the "olivine rich zone" (OZR) where olivine is abundantly found.

Unlike other sand, olivine removes atmospheric carbon dioxide (CO_2) as it dissolves in water and permanently stores it in the ocean as alkalinity.

For billions of years, olivine has been naturally and slowly removing CO_2 from the atmosphere. Coastal Carbon Capture speeds up the process.

Olivine is an abundant natural mineral with the capacity to help coastal communities meet the challenges of climate change.

A CARBON-REMOVING SHORELINE PROTECTION PROJECT

A carbon-removing project removes more CO₂ than it emits, meaning it will have an overall beneficial effect on the climate.

There are CO₂ emissions associated with the project, for example from dredging the sand and deploying the olivine.

We anticipate that the olivine will remove more CO₂ from the atmosphere than the emissions from the project. The specific amount will be determined through our science program.

<https://carbonherald.com/vesta-launches-its-southampton-demonstration-site-the-first-carbon-capture-beach/>

For further reading, check out the following articles featuring the project:

- [27 East](#)
- [Carbon Herald](#)

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FAQ

HAS OLIVINE SAND BEEN APPROVED FOR BEACH NOURISHMENT?

Olivine sand has been carefully tested to look for any risks, and all relevant regulatory agencies have issued permits for the project.

CAN I STILL USE THE BEACH?

Yes. Olivine has no effect on beach use.

WILL THIS CHANGE HOW THE BEACH LOOKS?

Initially you may see changes in beach coloration, but once the olivine mixes in with existing sand it will look the same.



Natural Beach Sand



Natural Beach Sand + 10% Olivine



100% Olivine

HOW MUCH CLIMATE IMPACT WILL THE PROJECT HAVE?

This pilot project is projected to remove the CO₂ emissions of 1 car per household in NSBC for 1-2 years.

HOW DOES THIS HELP THE STATE OF NEW YORK

Both Southampton and the state of NY have set sustainability goals to achieve reduced and net zero greenhouse gas emissions outlined in the Town Southampton 400+ and NY State Climate Leadership and Community Protection Act of 2019, respectively.

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PROJECT TIMELINE

2021

- Project Scoping & Outreach

2022

- Baseline Ecosystem Surveying
- Channel-Dredged Sand Deployment
- Olivine Sand Deployment
- Sensor and Wave Buoy Installation
- Scientific Surveys

2023-24

- Reporting & Stakeholder Engagement
- Quantify CO₂ Removal
- Project Closeout