RESPONSE TO:

RFP #FY26-GRIT1

Guinea Resilience & Innovation for Tidal Wetlands (GRIT) – Phase I Project

COPY

MIDDLE PENINSULA
PLANNING DISTRICT COMMISSION

STRAUGHAN
ENVIRONMENTAL

SUBMITTED:
February 10, 2026

SUBMITTED TO:
Middle Peninsula Planning District Commission (MPPDC)
Attn: Mindy Strevig, Project Manager
4521 Lewis B. Puller Memorial Highway
Mattaponi, VA 23110

SUBMITTED BY:
Straughan Environmental, Inc.
919 E Main Street, Suite 1000
Richmond, VA 23219

POINT OF CONTACT:
Justin Haynes, Vice President
540.421.3775 | jhaynes@straughanenvironmental.com

Page intentionally left blank.

Table of Contents

Boathouse on the Mattaponi River

Table of Contents

Page intentionally left blank.

1.
Cover Sheet

Guinea Marsh, August 2024
Photo by proposed Project Manager, Chris Overcash

February 10, 2026

Middle Peninsula Planning District Commission
Attn: Mindy Strevig, Project Manager
P.O. Box 399
Shacklefords, VA 23156

Re: Proposal for RFP #FY26-GRIT1 - Guinea Resilience & Innovation for Tidal Wetlands (GRIT) - Phase I

Dear Ms. Strevig:

The Straughan Environmental, Inc. (Straughan) Team—comprising prime consultant Straughan and subconsultants AECOM, Marine Solutions Inc. (MSI), and Johns Hopkins Applied Physics Laboratory (JHU APL)—is excited to submit our proposal for the **Guinea Resilience & Innovation for Tidal Wetlands (GRIT) – Phase I Project**. The GRIT initiative represents a unique opportunity to advance nature-based shoreline resilience, marsh migration readiness, and community-supported adaptation across the Guinea Marsh Wildlife Management Area and the broader Mobjack Bay system.

Our team is uniquely positioned to support MPPDC and its partners through our deep, local, and interdisciplinary expertise in coastal engineering using nature-based solutions, ecological restoration, climate resilience, and geospatial analysis. Our capabilities align directly with the requirements outlined in the RFP and with the long-term goals of the GRIT program. To highlight a few of our key strengths:

- **Local Knowledge and Actionable GRIT Phase 1 Plan:** The Virginia offices' and long-standing work throughout Tidewater of all the team members provide deep regional familiarity, responsive support, and strong relationships with local partners and stakeholders. This is highlighted by our Project Manager Chris Overcash's extensive Tidewater experience advancing nature-based solutions initiatives with USACE Engineering With Nature, ERP, DoD, NPS, and City of Hampton. With this knowledge we have already defined, and presented, throughout this proposal our actionable plan to provide resilience to Guinea Marsh.
- **Nature-Based Coastal and Climate Resilience Expertise:** Our team delivers proven nature-based and hybrid shoreline solutions across the Mid-Atlantic, advancing beneficial use of sediment. We also have extensive experience evaluating sea-level rise, marsh migration potential, and delivering adaptable long-term sustainable ecosystem performance.
- **Innovation and Resilience Integration:** Through our wide expertise and our partnership with JHU APL, we apply AI-enabled modeling and advanced analytics to support next-generation coastal resilience planning and valuation.
- **Best-in-Class Data Synthesis, Advanced GIS, and Spatial Analytics:** We integrate LiDAR, bathymetry, biological data, and climate projections into clear, actionable existing-conditions baselines that support adaptable decision-making. We deliver high-resolution habitat maps and parcel-level suitability analyses that guide long-term land management and resilience planning.
- **Strong Stakeholder and Community Engagement Record:** Our team consistently facilitates effective public meetings, workshops, and collaborative sessions to ensure project solutions reflect community and partner priorities.

Beyond these strengths, our coastal engineers and geomorphologists have designed marsh edge stabilization, thin-layer placement, beneficial use of dredged material, and wetland enhancement strategies that balance ecological performance with constructability and cost. For GRIT Phase I, our team will develop up to three conceptual alternatives grounded in site-specific hydrodynamics, geomorphology, and stakeholder priorities. Our climate resilience planners will integrate sea-level rise scenarios, habitat migration potential, and landscape-scale considerations into feasibility assessments—directly supporting the Phase I deliverables related to technical feasibility, project phasing, and long-term performance.

We also bring extensive experience supporting public engagement efforts with project partners, including serving as technical experts during community meetings and collaborative design sessions. We are committed to ensuring that all project deliverables reflect the input and priorities of MPPDC, DWR, Carlexson Consulting, Consociate Media, IEN, and the broader community.

We understand the importance of a clear work plan, robust QA/QC, and a milestone-driven schedule to meet the December 31, 2026 project timeline, while maintaining flexibility for any approved extensions. Our Virginia office will serve as the responsible lead location, ensuring proximity, responsiveness, and dedicated capacity throughout the contract period.

Thank you for the opportunity to submit this proposal. We would be honored to partner with MPPDC on this important effort to safeguard and enhance one of Virginia's most ecologically significant coastal landscapes.

Please contact our **Project Manager, Chris Overcash, PE**, at covercash@straughanenvironmental.com or 443-386-0413, or contact me at jhaynes@straughanenvironmental.com or 540-421-3775 with any questions.

Sincerely,

Justin Haynes
Vice President

Straughan Environmental, Inc.
919 E Main Street, Suite 1000
Richmond, VA 23219

2.
Project Understanding, Approach, and Methodology

PROJECT: Blue Green Infrastructure
OWNER: Metropolitan Washington Council of Governments (MWCOG)

Community engagement at a project outreach event

Introduction

The Straughan Team is excited to respond to the Guinea Resilience & Innovation for Tidal Wetlands (GRIT) Phase I Project, as advancing coastal resilience through nature-based and hybrid solutions is a core strength of our practice. The Straughan Environmental, Inc. (Straughan) Team is led by Straughan as the prime consultant and includes subconsultants AECOM, Marine Solutions Inc. (MSI), and the Johns Hopkins Applied Physics Laboratory (JHU APL). Each team member maintains a physical office presence in Virginia and brings extensive local and regional experience supporting coastal and tidal wetland resilience initiatives.

This proposal has been organized to directly address MPPDC's requirements and evaluation criteria, which are reflected in the structure of the Table of Contents. The alignment with the evaluation categories is summarized below, with corresponding page references:

LOCAL ECONOMIC PARTICIPATION

Each member of the Straughan Team maintains offices within the Commonwealth of Virginia, supporting MPPDC's interest in regional participation. In addition, we are committed to engaging local stakeholders and community members throughout the project through active, inclusive engagement. Our team includes professionals who live and work in the Tidewater region, and we share a strong commitment to delivering meaningful, durable coastal resilience outcomes for Guinea Marsh and the surrounding communities.

FIRM	ROLE ON THE PROJECT TEAM	VALUE TO THE GRIT PHASE 1 EFFORT
STRAUGHAN ENVIRONMENTAL	Prime Consultant, Project Management, and Technical Lead for Coastal and Tidal Wetland Resilience	Provides overall project management and technical leadership for the GRIT Phase I effort. Leads coastal and watershed-scale resilience planning, tidal wetland and shoreline systems analysis, nature-based and hybrid solution development, hydrologic and hydraulic assessment, feasibility evaluation, and permitting and implementation readiness. Coordinates interdisciplinary inputs, manages QA/QC, and ensures delivery of actionable, fundable concepts aligned with long-term resilience objectives.
AECOM	Coastal Resilience and Climate Adaptation Support	Contributes extensive experience in coastal resilience, climate vulnerability assessment, and evaluation of nature-based and hybrid solutions. Supports modeling, technical analysis, and integration of climate projections to strengthen feasibility and long-term resilience considerations.

FIRM	ROLE ON THE PROJECT TEAM	VALUE TO THE GRIT PHASE 1 EFFORT
MARINE SOLUTIONS	Marine Surveying and Existing Conditions Specialist	Provides marine and waterfront expertise including hydrographic surveying, shoreline condition assessment, sonar imaging, and field-based data collection. Supports accurate characterization of tidal and nearshore conditions to inform feasibility, constructability, and design considerations.
APL JOHNS HOPKINS APPLIED PHYSICS LABORATORY	Innovation and Advanced Analytics Partner	Provides applied research and analytical expertise, including AI-enabled modeling and decision-support tools. Supports rapid evaluation and prioritization of nature-based and hybrid interventions, strengthening innovation and data-driven decision-making.

Project Understanding & Goals

The Straughan Team understands that coastal marshes in Mobjack Bay are losing elevation and lateral extent in the face of accelerating sea level rise, more frequent/intense storms, and chronic erosion—threatening natural infrastructure, fish and wildlife habitat, and the resilience of historic working waterfront communities. The Guinea Marsh Wildlife Management Area (GMWMA) and adjacent marsh islands constitute greater than 1,000 acres of tidal wetlands that have long provided wave attenuation, storm surge buffering, water quality benefits, and essential nursery habitat for oysters, blue crabs, SAV, finfish, and other species. In this area, leading-edge marshes and dunes are eroding (up to 5 ft/yr at exposed points), interior marsh platforms and maritime hammocks are succumbing to relative sea-level rise (RSLR) and protective islands and spits/points have disappeared and are no longer safeguarding adjacent shorelines, marshes, and SAV beds in harbored embayments such as Browns Bay. The Straughan Team is committed to advancing coastal resilience by implementing innovative, nature-based and hybrid strategies designed to safeguard and restore the existing 1,000 acres of tidal marshes, dunes, and beaches within the Guinea Marsh system. Our approach incorporates climate-adaptive design principles to strengthen ecological function, reduce shoreline erosion, and ensure long-term habitat resilience in the face of RSLR. By integrating nature-based and hybrid solutions, our team will aim to deliver strategies that not only protect critical coastal resources but also enhance their capacity to adapt to changing hydrologic conditions.

The Straughan Team also understands that multiple partners (VMRC, VDWR, NOAA, VIMS, MP PAA, local aquaculture businesses, and community organizations) are focused on Guinea Marshes as a priority site for largescale nature-based restoration and shoreline protection, with complementary workstreams in oyster structure siting, living shoreline design, marsh migration planning, and stakeholder engagement. These efforts align with NOAA's Middle Peninsula Habitat Focus Area and the Coastal Wetlands Plan for the York, Piankatank, and Mobjack Bay, which specifically recommends projects at GMWMA and Big Island.

As Phase I of the GRIT initiative, our approach described below is designed to not only to deliver the required technical analyses and conceptual designs, advanced to the level for JPA submission, but also to establish a robust framework for subsequent implementation phases. By developing comprehensive baseline data, feasibility assessments, and preliminary design alternatives, we will ensure that future phases can advance seamlessly from planning to ultimate construction with minimized risk and streamlined execution. Our deliverables will serve as actionable, validated solutions that inform permitting, funding strategies, and long-term resilience planning across the Guinea Marsh system.

Advanced and Cost-Effective Modeling Capabilities

Our team brings cutting edge innovative techniques in coastal modeling to make certain that we are presenting the best long term adaptable solutions through our team's knowledge while also integrating artificial intelligence (AI) resources through the Johns Hopkins Applied Physics Laboratory, which has been working on similar resilience assessments for nature-based solutions at locations such as Tyndall Air Force Base in Florida *(Please see Section 3 and our Supporting Documents section of the proposal for more details on this AI research.)* Any use of AI will incorporate standards for data protection/confidentially and thorough quality control reviews.

Approach and Methodology

RESTORATION VISION

The Straughan Team is focused on developing conceptual designs which will combine proven and innovative nature-based solutions to provide adaptability to the constantly changing Guinea Marsh ecosystem impacted by shoreline erosion, RSLR, increasing storm surge and intensity, and compound flooding. Our team includes experts in the field, engineers, scientists, and planners who have worked to achieve these goals at other coastal marsh systems in Tidewater, the mid-Atlantic, and elsewhere, including as a few examples, Farnham, VA, Croppers Island, and Thompson Island, DE, which we describe within our project references.

TECHNICAL APPROACH

We understand that to effectively target three locations it is important to know the full picture of the dynamics now and into the foreseeable future at Guinea Marsh. Below, we provide a ***Description of Nature Based Solution Elements*** which we are considering as solutions in the full context of the Guinea Marsh system. Following this we present our ***Prioritization*** strategy for the entire Guinea Marsh (see page 20 - **GRIT Phase 1 Concept Plan**) along with conceptual cross sections which could be deployed in each priority area (see Section 9. Other Supporting Data - **GRIT Phase 1 Concept Cross Sections**). The Straughan Team understands it is important to address prioritization prior to identification of the three design solutions which are part of this project through site evaluations as well as vetting through stakeholder engagement. Another key overarching element is to understand the role that marsh migration corridors will play in the future of the overall system adaptability due to increasing RSLR impacts. This is a topic that our team has addressed in past projects, such as the Masonville shoreline project for the Maryland Port Administration and at the Stark (Langmaid and Bliss Happens) Properties Salt Marsh restoration.

DESCRIPTION OF NATURE-BASED SOLUTION ELEMENTS

This list provides several, cost-effective nature-based solutions we have designed and implemented at various locations in the mid-Atlantic (described below and within our project reference section) and that we plan to employ to address the issues faced by Guinea Marsh to provide the outcomes sought by MPPDC. These strategies will be screened and configured into up to three conceptual alternatives (in Task 3) using modeling and stakeholder input. Below we describe each:

- **Breakwaters** – Also known as headlands, breakwaters are offshore structures designed to attenuate wave energy, reduce shoreline erosion, and encourage sediment deposition in targeted areas, while minimizing shoaling in locations where it is undesirable. Breakwaters are proposed in high and medium energy shorelines to stop, and in some cases reverse, the high rates of shoreline erosion (up to 5 ft/yr) at these shorelines. Breakwaters provide co-benefits of creating protected coves suitable for sustainable and resilient sea grass bed growth, living shorelines (marsh establishment), and beach and dune habitats. The Straughan Team through design experience knows that several forms of breakwaters can accomplish these outcomes, each with varying effectiveness and tradeoffs which are discussed below:
  - **Living Breakwaters** – Living breakwaters incorporate ecological components that provide habitat and enhance biodiversity, creating a more sustainable and resilient coastal system. The term “living breakwater” encompasses a range of designs, each tailored to specific site conditions and project objectives. These may include oyster-based reefs, rock-based structures, or hybrid systems that combine natural and engineered elements. During project planning, all applicable types of living breakwaters will be evaluated to determine the most effective and regionally appropriate approach for achieving shoreline stabilization, habitat enhancement, and long-term resilience. *One recent example designed by Straughan was completed at Farnham, VA which incorporated a base of rock with vegetative elements to protect adjacent shoreline.*

» **Wave Attenuation Structures (WASs)** – WASs are engineered structures designed to reduce wave energy and protect shorelines from erosion while promoting sediment deposition in targeted areas. These structures typically feature a modular design with a relatively small footprint, making them suitable for a wide range of coastal environments without requiring extensive space or heavy construction. WASs are valued for their ease of installation and adaptability, allowing for rapid deployment and minimal disturbance to existing habitats. In addition to their functional benefits, WASs provide complex habitat structures that support marine life such as oysters, creating opportunities for ecological enhancement alongside shoreline stabilization. Their versatility and ecological benefits make WASs an attractive option for projects seeking both resilience and habitat improvement. *Straughan has completed various breakwater systems including for the Thompson Island project completed for the Delaware Center for Inland Bays depicted below with example design drawing as well.*

» **Log Bundles or Inverted Rootwads** – In medium or low energy environments, coarse wood materials can be used as breakwaters by anchoring or embedding the wood in underlying sediments. Using natural materials maintains the natural appearance and ecological character of the marsh while

***Photo 1** | Wave Attenuation Structures (WASs) are installed offshore of Thompson Island, DE to address high wave energy conditions. Project designed by Straughan Environmental.*

***Photo 2** | Wave Attenuation Structures (WASs) are designed offshore of Thompson Island, DE to address high wave energy conditions and to protect adjacent nature base shoreline project elements.*

minimizing cost. *The Straughan Team has integrated this solution in various project including Croppers Island and Stark Properties Salt Marsh Restoration.*

- **Living shorelines** – Often coupled with breakwaters in high wave energy environments, living shorelines are nature-based solutions designed to protect and enhance coastal environments by using natural elements such as marsh vegetation, oyster reefs, and biodegradable materials. These systems stabilize the toe of existing marshes, reducing erosion and buffering against wave energy, while simultaneously creating or restoring additional marsh habitat that supports biodiversity and improves water quality. Unlike traditional hardened structures, living shorelines adapt over time and provide ecological benefits, such as carbon sequestration and habitat for fish and wildlife. The specific design and materials used—such as native plants, coir logs, or rock sills—are carefully selected based on site conditions, including tidal range, wave exposure, and soil type, as well as the desired outcomes for shoreline protection and habitat enhancement. *Straughan has designed and constructed a variety of living shoreline projects as depicted on the photographs here and within our project descriptions in the Qualifications and Experience section.*

***Photo 3** | Cedar Haven Living Shoreline on the Patuxent River. Designed by Straughan Environmental, this project included installation of a stone sill, sand nourishment, and bank grading to improve coastal resilience and provide habitat for estuarine species.*

***Photo 4** | Beach and Dune Creation as part of a Living Breakwater project on the Tred Avon River in Oxford, MD. The project, designed by team member Keith Binsted, included offshore living breakwaters and marsh, beach, and dune creation to increase coastal resiliency of low-lying roads and homes.*

- **Beach / Dune / Island nourishment** – Beach, dune, and barrier island nourishment is a sediment management strategy that utilizes compatible dredged material to reestablish littoral sediment budgets and restore geomorphic processes critical for coastal stability. By augmenting sediment supply, this technique enhances dynamic shoreline functions that dissipate wave energy and reduce erosion risk. When integrated with offshore breakwaters, nourishment can accelerate sediment accretion and profile equilibration; however, under certain hydrodynamic and morphologic conditions, standalone nourishment can achieve similar resilience objectives without structural interventions. This strategy is proposed to reverse the trend of shoreline loss, particularly in areas that play an outsized role in protection of the GMWMA such as existing barrier islands and protective spits. *Project Manager, Chris Overcash, has extensive beach nourishment experience and is co-author of National Park Services' 2023 Beach Nourishment Guidance document.*

- **Thin Layer Placement (TLP)** – TLP is a restoration technique that involves applying a thin layer of compatible dredged material to the surface of an existing marsh to increase its elevation and enhance resilience. This approach is designed to counteract the effects of subsidence, sea level rise, and erosion, which are compromising marsh health and function over time at GMWMA. By carefully selecting and placing sediment that matches the native substrate, TLP helps restore or sustain critical marsh functions such as nutrient cycling, habitat provision, and storm surge attenuation. The process is typically implemented in a controlled manner to avoid smothering vegetation, allowing plants to grow through the added material and maintain ecological integrity. TLP is considered a cost-effective and adaptive strategy for preserving coastal wetlands and supporting long-term ecosystem stability. *The Straughan Team has designed this technique for projects such at Croppers Island and Four Marshes in Delaware and team members have wide experience with the technique, including assistance in creating the state of Virginia TLP guidance document in 2024.*

***Photo 5** | Thin Layer Placement (TLP) has been successfully implemented in the Chesapeake Bay to enhance tidal marsh elevation and resilience in response to subsidence, sea level rise, and erosion. Projects such as the Blackwater National Wildlife Refuge restoration demonstrate that carefully controlled sediment placement can raise marsh elevations while allowing vegetation to persist and recover, supporting long term marsh function and ecosystem stability.*
Image source: U.S. Army Corps of Engineers, ERDC - https://tlp.el.erdc.dren.mil/

- **Runnels** – Runnels are shallow (just below root mat of marsh plants), narrow drainage channels designed to mimic the natural process of pond capture by tidal creeks. By re-establishing tidal flow and sediment pathways, runnels help prevent marsh drowning and restore natural sediment accretion, enabling GMWMA marshes to keep pace with relative sea level rise (RSLR). This technique improves interior marsh plant community health by restoring hydrologic connectivity, which reduces waterlogging stress on vegetation. Ecologically, runnels enhance habitat quality for fish, invertebrates, and birds by creating microhabitats and improving nutrient exchange. From a coastal resilience perspective, runnels strengthen marsh stability, increase storm surge absorption, and support long-term shoreline protection. *The project team has successfully implemented this strategy in multiple coastal marsh restoration projects, demonstrating its effectiveness in sustaining marsh ecosystems under changing climate conditions. This includes the Langmaid and Bliss Happens Salt Marsh projects that have been constructed, as well as the Croppers Island, Sunset Park and Four Marshes projects that have been designed. In conjunction, high marsh hummocks (see Photo 6) within the marsh areas are often constructed using material generated from excavating the runnels to create habitat at higher elevations for birds including salt marsh sparrow.*

***Photo 6** | Constructed runnel and high marsh hummocks at Langmaid Salt Marsh Restoration, designed by Straughan Environmental*

***Photo 7** | Example salt marsh restoration plan developed by Straughan Environmental and Sovereign Consulting showcasing proposed runnels (channels) and thin layer placement (nourishment).*

- **Legacy berm removal** – Removing legacy berms helps prevent the formation of internal ponds that can lead to marsh drowning – a common issue within bermed systems, including those found within the GMWMA. This technique re-establishes natural hydrology and sediment exchange, allowing marshes to regain their ability to accrete sediment and keep pace with relative sea level rise (RSLR). By restoring these processes, berm removal enhances coastal resilience, reducing vulnerability to flooding and storm surge. Ecologically, it supports healthier marsh vegetation, improves habitat connectivity for fish and wildlife, and promotes biodiversity. These benefits strengthen the overall function of the marsh as a critical buffer against climate impacts while maintaining its role in carbon sequestration and nutrient cycling. *Straughan completed just such as design for the John Heinz NWR project where we developed modeling for breaching a dredge material containment berm.*

- **Seagrass beds** – Seagrass beds, also known as submerged aquatic vegetation (SAV), are protected or enhanced behind structures and within sheltered sections of marshes. Seagrass plays a critical ecological role by stabilizing sediments, improving water quality through nutrient uptake, and providing essential habitat for fish, shellfish, and other marine species. These beds also act as carbon sinks, helping to mitigate climate change by storing significant amounts of carbon in their biomass and sediments. In addition, seagrass beds help reduce wave energy and stabilize shorelines, providing natural protection against erosion and enhancing coastal resilience. Protection and enhancement of

***Photo 8** | Sea grass bed area and density in 2024 around Guinea Marsh. Source: Virginia Institute of Marine Science (VIMS), SAV Work Area Boundary Map (SAVWAB), screenshot from interactive web map, accessed January 9, 2026. https://mobjack.vims.edu/sav/savwabmap/*

sea grass will be a consideration in the final prioritization of projects due to this ecological significance. Reduction of impacts to existing sea grass beds will be a key consideration in any proposed project due to their protected status as a Special Aquatic Site under section 404(b)(1) of the Clean Water Act guidelines. Opportunities to restore SAV will be explored in collaboration with project partners to enhance biodiversity, fisheries productivity, and overall ecosystem resilience.

- **Maritime hammocks** – Maritime hammocks provide critical habitat, including nesting and perching sites for birds, and contribute to overall ecosystem diversity. Beyond habitat benefits, maritime hammocks enhance ecological resilience by buffering against relative sea level rise (RSLR) and reducing the impacts of large storms. Their vegetation helps stabilize soils, absorb storm surge energy, and maintain coastal integrity, making them an important nature-based solution for long-term shoreline protection and climate adaptation.

***Photo 9** | Existing maritime (forested) hammocks within Guinea Marsh. Photo credit: Aileen Devlin | Virginia Sea Grant | Sept. 22, 2021 https://www.flickr.com/photos/virginiaseagrant/51531558432/in/photostream/*

Thin Layer Placement techniques can be used to create localized areas of higher elevation within marsh systems that support maritime hammock vegetation. There are several locations in GMWMA that previously supported maritime hammocks that have been lost or reduced in size due to RSLR and could benefit from this restoration strategy. Comparable Chesapeake Bay projects demonstrate that dredged material can be strategically placed to establish elevated, vegetated landforms that provide critical nesting and perching habitat for birds, enhance ecosystem diversity, and improve resilience to sea level rise and storm impacts.

- **Marsh migration corridors** – These are identified for conservation within and adjacent to the Guinea Marsh area to allow for the natural response of marsh to RSLR.

The best opportunities for marsh migration corridors will be explored by the Straughan Team during the assessment, stakeholder involvement, and design phases to identify and select which option(s) best fit the goals of project partners and applicable regulations at the selected sites.

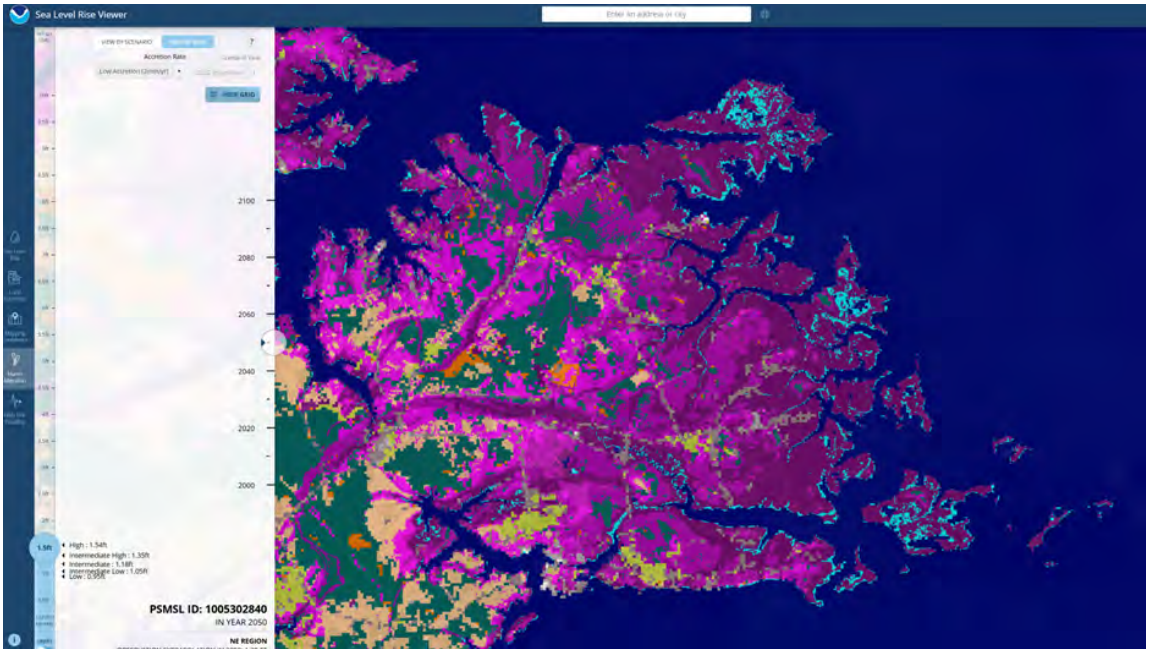
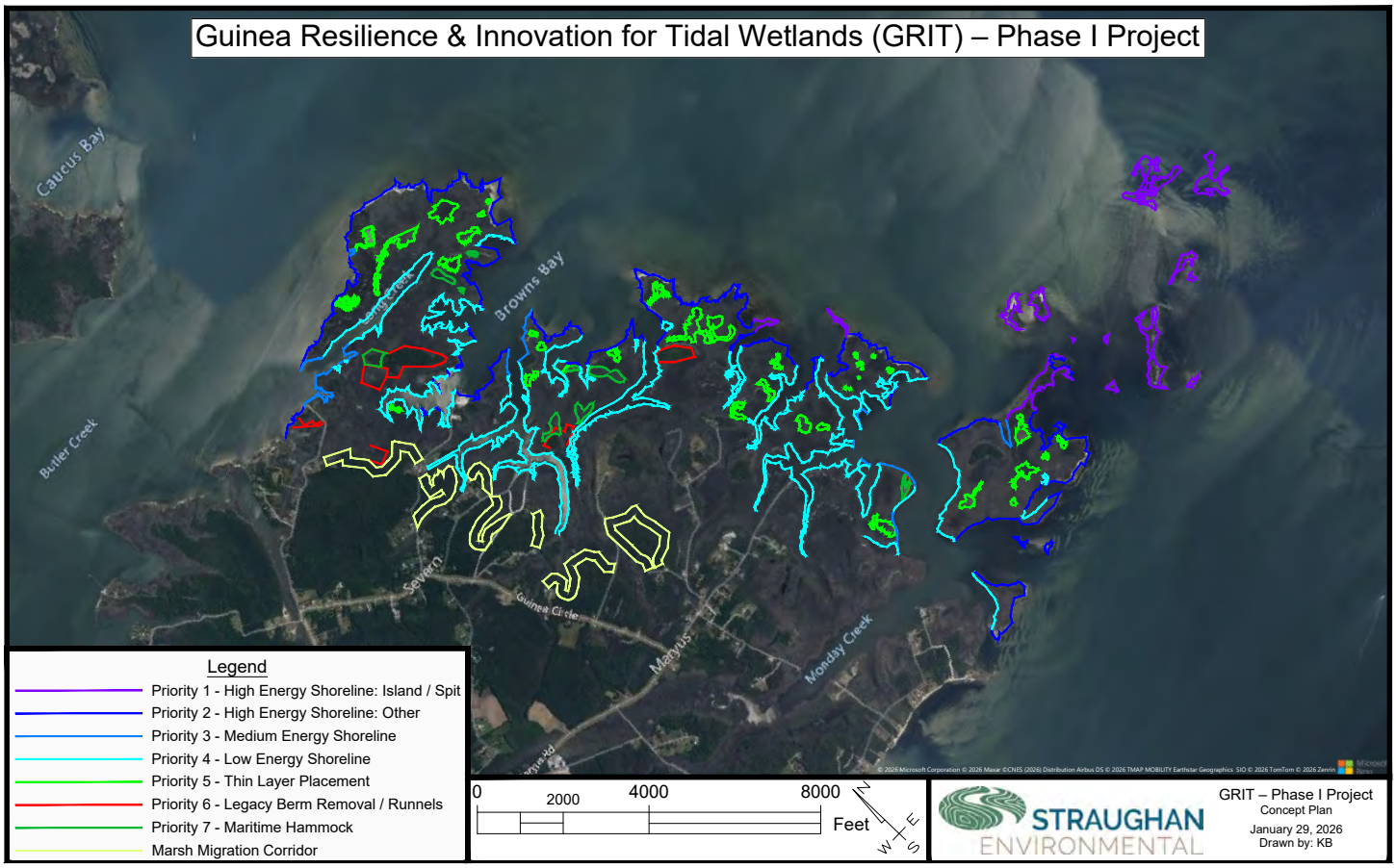


***Photo 10** | Sea level rise modelling for Guinea Marsh, assuming 1.5 ft (high scenario, 2050), preliminarily identifies suitable land for marsh migration.*
Source: National Oceanic and Atmospheric Administration (NOAA). Sea Level Rise Viewer, Office for Coastal Management. Screenshot from interactive web map accessed January 9, 2026. https://coast.noaa.gov/slr/

PRIORITIZATION

To facilitate the possible phasing of this comprehensive project, the Straughan Team has identified a system of prioritization of project areas based upon vulnerability, criticality, and dynamics at Guinea Marsh. The most vulnerable or critical sections of the existing marsh ecosystem have been identified for protection or restoration through a series of areas designated as Priority 1, 2, 3, etc., with the lowest number indicating a higher priority for implementation. This is our team's carefully considered initial assessment, ultimately the full work will be completed during the project through collaboration with project partners, integration with the AI systems that Johns Hopkins has used successfully at other locations, and consideration with all available site data. The preliminary determination of priority is included on the attached concept plan (labeled **GRIT Phase 1 Project Concept Plan**) and associated cross section concept drawings (labeled **GRIT Phase 1 Project Concept Cross Sections**) which are provided below and described in the subsequent text. In addition to the landscape architecturally stylized cross-sections within this section, in **Section 9** we provide engineering based versions, created in CAD as well which provide additional site constraint information.



GRIT Phase I Project Concept Plan

PRIORITY 1 – HIGH ENERGY SHORELINES: ISLANDS AND SPITS

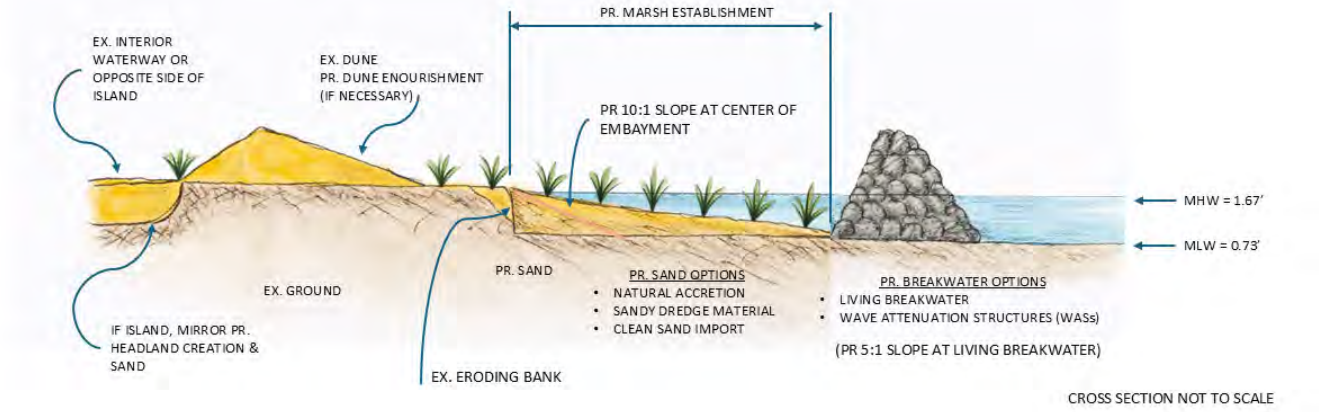
Priority 1 areas, which are our team's highest priority locations to be addressed, include the protection and restoration of the archipelago of islands located at the southeast edge of Guinea Marsh. The largest fetch reaching Guinea Marsh, and thus a primary driver of shoreline erosion, extends southeast from Guinea Marsh into the Atlantic Ocean. These islands shelter the eastern edge of Guinea Marsh from high energy waves from the southeast. If not protected or restored, these islands are certain to continue to erode and eventually disappear – two islands have disappeared since 1937 – and thus leave the majority of Guinea Marsh's exterior edge exposed to more wave energy than it experienced in the past. In addition, it is important to note that islands within the Chesapeake Bay serve as crucial nesting habitat for various bird and turtle species whose nests are susceptible to land predators. Island habitat is declining rapidly across the entire Chesapeake Bay, so protection of this habitat is key for the survival of species that depend on it.

Also included in this priority area are the protection or restoration of existing sand spits or remnant marsh peninsulas at the exterior edge of Guinea Marsh. It is important to protect these features, because they shield longer shorelines in their lee and create protected coves that are critical habitat for sea grass beds and the species dependent on sea grass. These features are under threat from erosion from a large fetch due east.

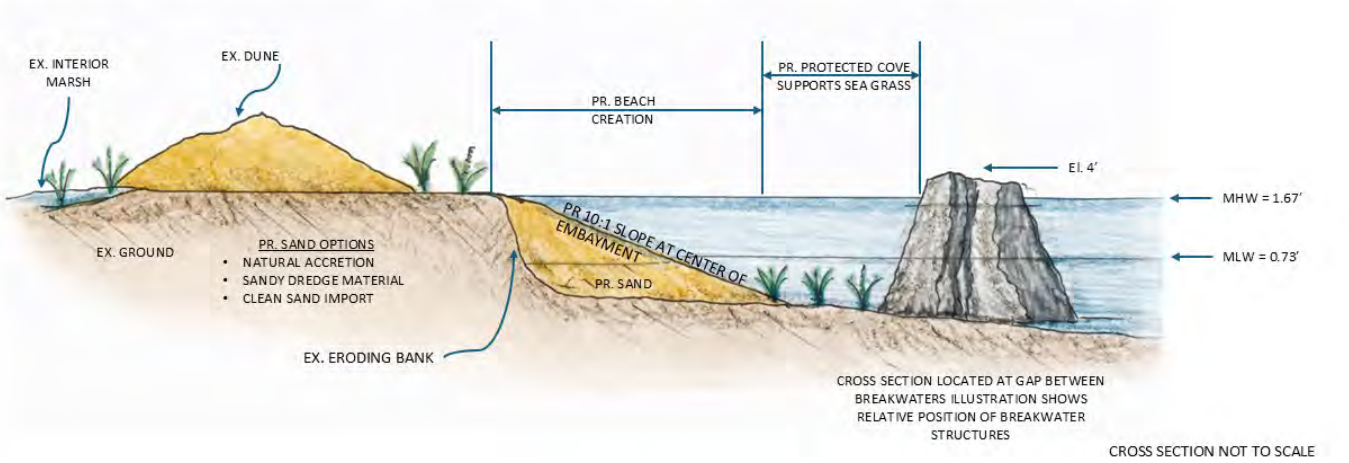
Depicted on the **Concept Plan**, Straughan's preliminary investigation identified 7.3 miles of high energy shorelines associated with islands and spits of the Guinea Marsh ecosystem. The cross sections presented in the **Concept Cross Sections - Priority 1** depicts a general approach to the protection and restoration of an island or spit at Guinea Marsh. One of the options for the breakwater feature, as shown on the right side of the cross section, would be designed to dissipate incoming wave energy. The breakwaters would be designed to create a series of protected coves and depositional zones between the breakwaters and the island or spit. Assuming that there is sufficient sand supply via littoral drift, sand would naturally accrete in this area to create a salient and later a tombolo that connects the land to the breakwater. If desired, this natural process can be expedited by the discharge of sandy dredge material or import of clean sand material. The formed tombolo can then be planted with marsh vegetation, or the marsh vegetation can be allowed to spread naturally to cover the tombolo over a longer timeframe. The **Priority 1 & 2 Cross Section** represents a generic cross section at the midpoint between breakwaters. The breakwaters are positioned so that a sandy beach is formed against the eroding bank. The wave action within the cove is greatest at the center, maintaining open beach and backshore dune habitat to the benefit of turtles and crabs which depend on this habitat for nesting. The protected cove between the breakwater and beach supports sea grass beds. The islands at Guinea Marsh receive significant fetch from the north, east, and south, and so the sequence of breakwaters and coves would be implemented to provide protection from all of these major fetches. The vulnerable spits of Guinea Marsh receive fetch predominately from the east, and so protection is initially only needed on that side.

In summary, the protection or restoration of islands and spits is the highest priority because if these features are lost to erosion, the marsh edge and protected coves behind these features will be exposed to greater energy, thus accelerating the rate of erosion and marsh loss.

Priority 1 – High Energy Shorelines: Islands & Spits



Priority 1 & 2 – High Energy Shoreline (Embayment View)



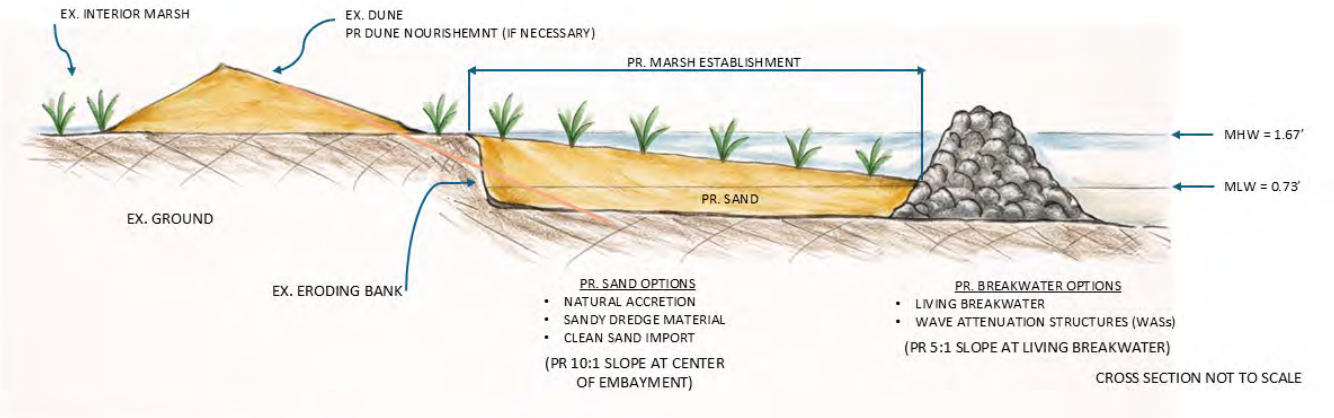
PRIORITY 2 – HIGH ENERGY SHORELINES: OTHER

Priority 2 areas represent the protection of other high energy shorelines around the exterior permitter of Guinea Marsh (see **Priority 2 High Energy Shorelines: Other cross section below**). Straughan's preliminary investigation identified 11.4 miles of high energy shorelines, excluding the shorelines of islands and spits described above. Depending on shoreline orientation, the exterior of Guinea Marsh has eroded on average 3 to 5 ft per year since 1937, resulting in hundreds of acres of exterior marsh lost in this time. Within this priority area, the sections of shoreline that are eroding faster – generally those shorelines facing south or east – are in the highest need of protection or restoration. Another consideration in this zone is the proximity to lower elevations, which are more susceptible to erosion.

The cross sections presented in the **Priority 1 & 2 Cross Section** depicts a general approach to the protection and restoration of a shoreline in a high energy condition. One of the options for the breakwater feature, as shown on the right side of the cross section, would be designed to dissipate incoming wave energy. The breakwaters would be designed to create a series of protected coves and depositional zones between the breakwaters and the island or spit, similar to the strategy for the Priority 1 areas. Assuming that there is sufficient sand supply via littoral drift, sand would naturally accrete in this area to create a salient and later a tombolo that connects the land to the breakwater. If desired, this natural process can be expedited by the discharge of sandy dredge material or import of clean sand material. The formed tombolo can then be planted with marsh vegetation, or the marsh vegetation can be allowed to spread naturally to cover the tombolo over a longer timeframe.

In summary, the protection or restoration of other high energy shorelines is the second priority because of the high rates of erosion these areas are experiencing, resulting in high rates of marsh loss.

Priority 2 – High Energy Shorelines: Other



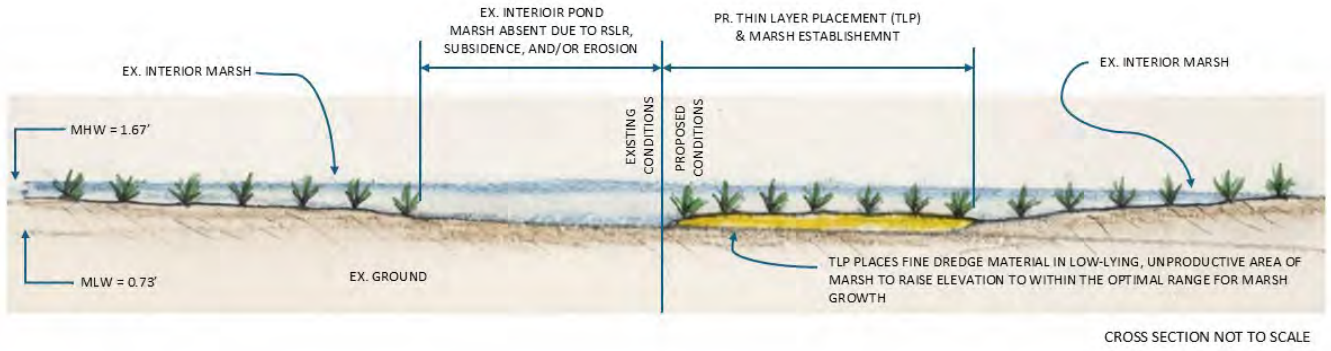
PRIORITY 3 – THIN LAYER PLACEMENT IN INTERIOR MARSH

Priority 3 of the Straughan Team's consideration is the restoration of the interior marsh through TLP. The provided concept plan identifies 37 locations that would be suitable for restoration of marsh interior through TLP totaling 49 acres. This is not exhaustive of all opportunities for TLP but does represent critical areas for implementation due to vulnerability. The highest priority projects within this category are those that are largest and closest in proximity to open water exterior to the marsh. The largest interior ponds may be experiencing runaway expansion due to internal wind-wave erosion. Addressing these areas first limits the future resources needed for restoration. Likewise, internal ponds closest in proximity to the open water exterior to the marsh may soon be breached due to shoreline erosion and subsequently allow for accelerated erosion along the shoreline of the now-exterior connecting pond. If unchecked, internal pond expansion and mergence can expedite the transition of peninsulas into islands, which accelerates loss of marsh area by opening more shoreline length to wave energy.

The **Priority 3 Cross Section** shows the typical existing conditions (left) and proposed conditions (right) for a thin layer placement project. The existing conditions show a shallow interior pond that has formed due to RSLR, subsidence, and/or erosion. The ground elevation is below MLW and these permanently saturated conditions prevent regrowth of marsh. The proposed condition shows elevating the ground surface within the interior pond to within the optimal range for marsh growth via import of fine dredge material. TLP may also be applied in areas where marsh currently exists but is unhealthy and trending downwards. After the ground elevation is raised within the optimal range, the bare soil may be allowed to be colonized by adjacent marsh or may be seeded or planted to expedite recovery of marsh vegetation.

In summary, the restoration of the interior marsh through TLP is the third priority because of the ongoing expansion of internal ponds at accelerating rates, which would result in widespread loss of marsh.

Priority 3 – Thin Layer Placement in Interior Marsh



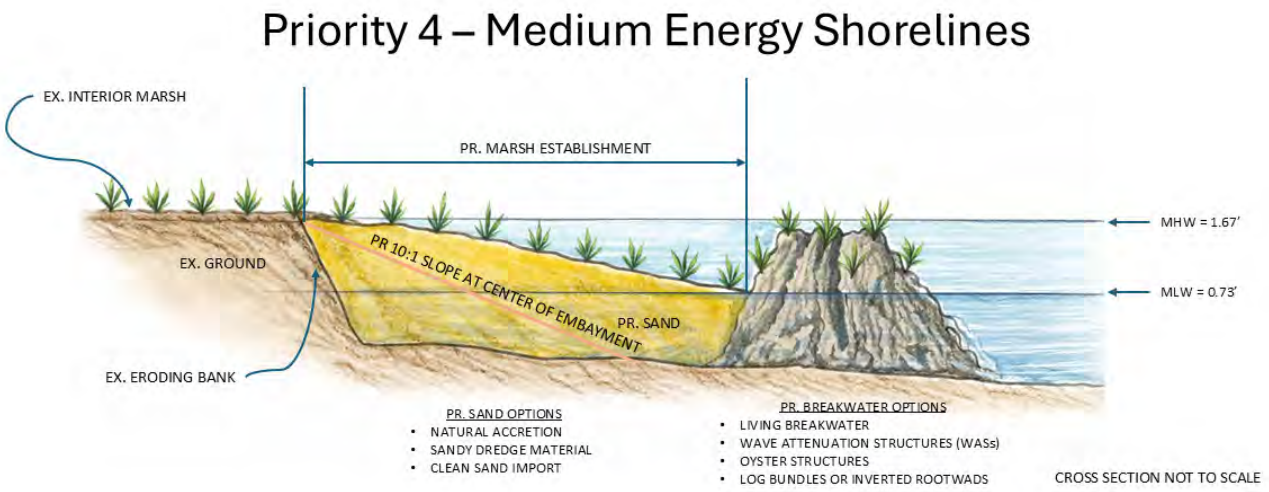
PRIORITY 4 – MEDIUM ENERGY SHORELINES

Priority 4 areas represent the protection or restoration of medium energy shorelines. Due to the location of Guinea Marsh, a minority of shorelines are in areas of medium wave energy. Straughan's preliminary investigation identified 2.1 miles of medium energy shorelines – most are near the mouths of the larger tidal inlets, such as Monday Creek, or are sheltered by the islands, such as north of Big Island. In these areas, the shorelines are dominated by marsh but are still eroding, though at a slower average rate of about 1 foot per year. In these areas, the existing marsh edge is often a near vertical slope, except for the occasional pocket beach, which could impede wildlife access to marsh areas during low tides. Restoration would be focused not only on shoreline stabilization, but also on connectivity and habitat diversity.

The **Priority 4 Cross Section** depicts a generic cross section for a medium energy shoreline. The same principles for breakwaters, tombolos, and protected coves discussed for high energy shorelines above apply to medium energy shorelines and form the basis of the proposal. However, there are unique considerations at medium energy shorelines due to the reduced energy and longshore drift expected. The location of the breakwaters can be closer to shore, the crest height of the breakwaters can be lower in elevation, and there are additional options for breakwater materials. In addition to the WASs and Living Breakwater options discussed above, the use of natural coarse wood material such as log bundles or inverted rootwads and the use of structures designed for oyster establishment are possibilities. Longshore drift is expected to be less prevalent at medium energy shorelines, so discharge of sandy dredge material or import of

clean sand must be more heavily considered if tombolos and beaches are desired. Relative to the total area of sand, more area will be suitable for marsh establishment due to the lower energy climate, and so less open sand habitat is expected.

In summary, protection or restoration of medium energy shorelines is the fourth priority due to the relatively low rates of erosion at these shorelines, corresponding with relatively lower rates of marsh loss.



PRIORITY 5 – RUNNELS OR LEGACY BERM REMOVAL

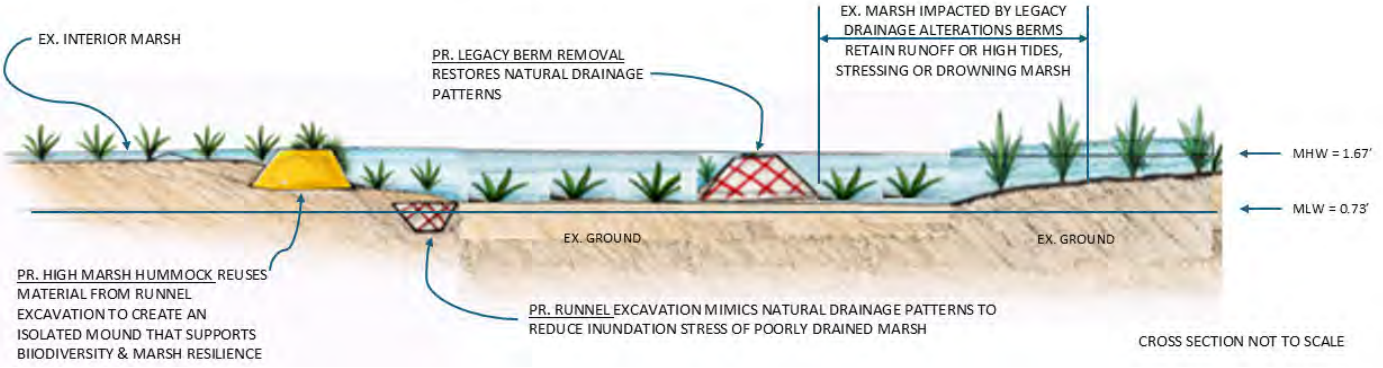
Historic land use within Guinea Marsh ecosystem has left evidence in the form of berms that previously separated marsh from farmland. A preliminary investigation by Straughan found six berm systems on property held by project partners. These berms may be negatively affecting marsh health by hindering drainage after large storms or high-water events. Natural drainage patterns can be returned by removing these berms in their entirety or through strategic runnel design. Both options will be evaluated on a case-by-case basis.

Runnels may also be applicable in situations where natural rings of higher elevation create internal ponds within the marsh that are not connected to any tidal channels. Thus, rising sea levels and ground water levels stress these interior areas due to lack of drainage. These are not represented on the concept plan as specific opportunities could not be identified from the available information and thus require further investigation. These areas could also be candidates for TLP, which may offer greater long-term resilience albeit at a greater project cost.

The **Priority 5 Cross Section** depicts a typical cross section of marsh where a legacy berm is impeding drainage, thus stressing or drowning existing marsh. The removal of this berm is proposed to restore natural drainage patterns, thus removing the inundation stressor from the marsh upslope from the berm. The area of marsh restored by the berm removal can be allowed to naturally revegetate or can be seeded or planting to expedite revegetation. Removal of the berm can likely be limited to a few sections at existing low points in the marsh, but further investigation is necessary to determine appropriate locations and dimensions for these targeted removals.

In summary, the use of runnels or removal of legacy berms is the fifth priority due to the limited extent of applicability and outcomes in protecting or restoring the Guinea Marsh ecosystem. However, due to the relatively low costs associated with these approaches, they remain cost effective solutions to improve Guinea Marsh.

Priority 5 – Runnels or Legacy Berm Removal



PRIORITY 6 – MARITIME HAMMOCK RESTORATION

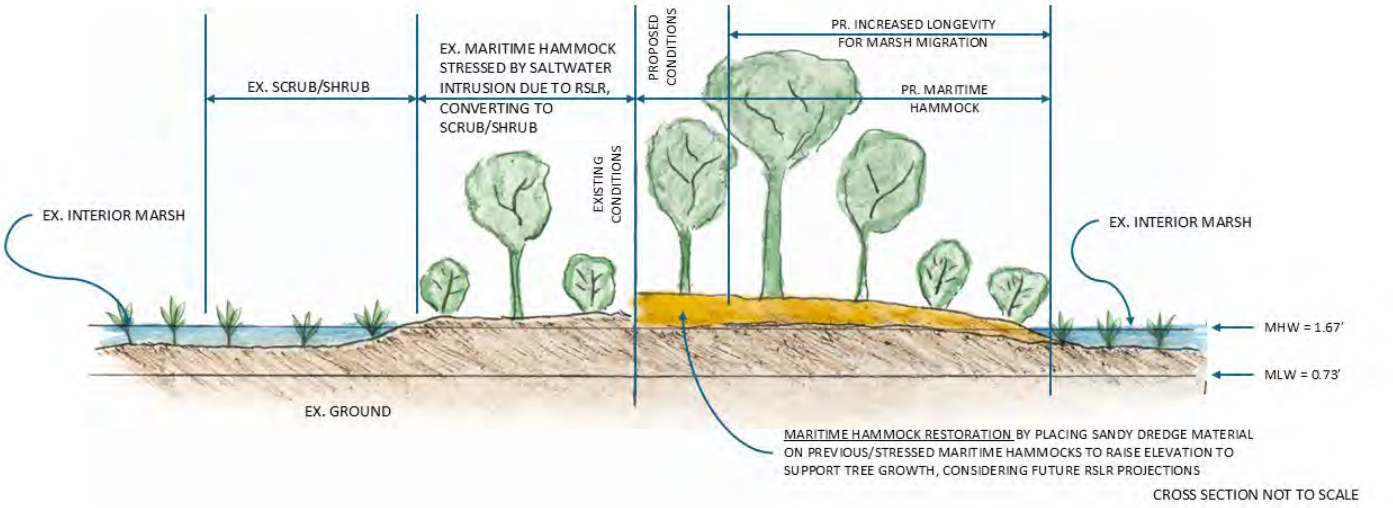
Despite their minimal area relative to total marsh area, maritime hammocks are critical components of the Guinea Marsh ecosystem due to their uniquely high elevation. Hammocks are often zones of high productivity and species interaction; support species not found elsewhere in the marsh such as forest and upland species of plants and animals; serve as nesting or roosting sites for birds that forage in the adjacent marsh; provide refuge for terrestrial fauna and sheltering from wave energy for low-lying marsh in their vicinity during high water events, thus increasing ecosystem resilience; and often align with historic Native American or earlier colonial historical sites.

As sea levels have risen since 1937, the overall size and number of maritime hammocks (also known as marsh islands) have decreased. Straughan's preliminary investigation found approximately 16 acres suitable for hammock restoration, spread across 9 locations – 3 locations are contiguous with existing healthy maritime hammocks. Continued sea level rise will further decrease the size and number of maritime hammocks over time.

The **Priority 6 Cross Section** depicts the existing conditions (left) and proposed conditions (right) for a typical maritime hammock restoration project. In the existing conditions, the maximum elevation of the hammock is about 1 foot above mean higher high water (MHHW). Salt resistant, but not tolerant, vegetation that was established decades ago is stressed by the increasing salinity due to RSLR. The vegetation community is transitioning from maritime forest to scrub shrub wetland, and eventually to marsh. The proposed conditions shows elevating the ground by up to two feet above the existing ground to create suitable conditions for maritime forest establishment that would persist above projected sea levels for several decades. The 2050 MHHW based on VIMS RSLR predictions for Yorktown, VA, are shown for reference.

In summary, maritime hammock restoration is the sixth of seven priorities due to their ecological significance but relatively low level of immediate threat to their existence within Guinea Marsh.

Priority 6 – Maritime Hammock Restoration

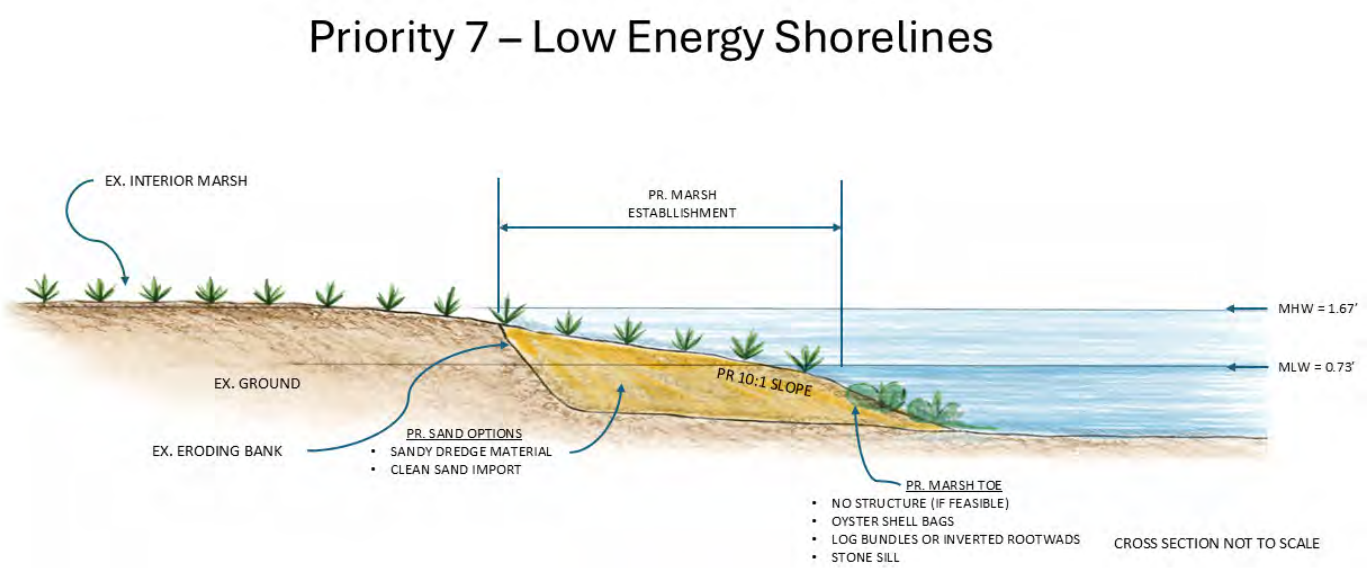


PRIORITY 7 – LOW ENERGY SHORELINES

Straughan's preliminary investigation found approximately 20.4 miles of low energy shorelines within the Guinea Marsh ecosystem on properties held by project partners. These shorelines are retreating, but at a relatively low rates – 0.1 to 0.5 feet per year. This retreat is likely driven predominately by RSLR. In low energy environments, tidal channels expand in response to the greater daily tidal discharge volume and velocity rather than wind-wave erosion. Efforts to reduce tidal channel expansion could include encouraging additional channel formation, thereby distributing energy over a wider area. However, the hydrology of the marsh is highly sensitive to minute changes in elevation, resulting in a complex system that is difficult to predict, making such projects prone to result in unintended consequences.

The **Priority 7 Cross Section** shows a representative cross section for the protection or restoration of a low energy shoreline. This living shoreline design includes placement of sandy dredge material or imported clean sand to create a marsh-vegetation stabilized slope at the existing marsh edge. Longshore drift is not typically present at low energy shorelines deep within the marsh ecosystem, so natural accretion of sand should not be expected. If feasible based on site conditions, sand fill can be placed without additional containment structures. If that is not feasible, suitable options to contain the sand fill include oyster structures, log bundles or inverted rootwards, or a stone sill – with their maximum elevations set to be submerged at mean low tide (MLW).

In summary, the restoration or protection of low energy shorelines is the lowest priority due to the minimal threat to total marsh area and overall complexity of the projects.



MARSH MIGRATION CORRIDORS

Straughan's preliminary investigation also identified 7 different areas totaling 77 acres that may be appropriate for the establishment of marsh migration corridors. These areas are located predominantly on private land, where existing forest and scrub/shrub habitats border existing marsh. These areas specifically exclude any areas containing infrastructure or otherwise managed land (see **Concept Plan on page 21**). A simple distance buffer of 200 feet was applied to this preliminary investigation. Future investigations will consider existing elevations, expected RSLR projections, and other relevant information.

Framework

The Straughan Team framework to accomplish this project is clarified further in this section. The Straughan Team understands the objective of the project is to deliver a comprehensive, science-based design and planning framework to enhance shoreline and marsh resilience within the Guinea Marsh system. Key objectives include developing a **Comprehensive Existing Conditions Report (ECR)** that integrates desktop analyses, LiDAR and bathymetric surveys, and biological data to establish a robust baseline of physical, hydrologic, and ecological conditions. Building on this foundation, the team will create **conceptual and preliminary design alternatives** for nature-based shoreline stabilization and marsh restoration features, informed by stakeholder input and ecological data and advanced to the level that draft JPA permit applications can be completed.

The team will then prepare a **Basis of Design Report (BOD)** detailing engineering assumptions, performance goals, and cost estimates, and complete a **Resilience Feasibility Assessment** evaluating technical, environmental, and economic viability of interventions such as thin-layer placement and beneficial use of dredged material. Additional objectives include conducting a **Land Conservation Suitability Assessment** to identify parcels and corridors that support marsh migration and long-term habitat protection, and preparing **draft environmental and permitting documentation** (Environmental Review Summary and Joint Permit Application). Throughout the process, the Straughan Team will coordinate closely with project partners, maintain rigorous QA/QC standards, and deliver quality-controlled data, reports, and design materials suitable for final permitting and implementation.

Our approach to accomplishing these objectives is linked to the tasks as listed in the RFP and is presented below:

TASK 1 – PROJECT INITIATION, WORK PLAN, COORDINATION, QA/QC, AND REPORTING

Straughan will begin with a kickoff meeting alongside MPPDC, Carlexson Consulting, DWR, and project partners to confirm objectives, roles, and communication protocols. We will establish a detailed work plan and schedule using Microsoft Project, outlining milestones for design submittals, review checkpoints, and stakeholder engagement events. Monthly coordination meetings and quarterly progress briefings will be supported by status dashboards in Teams for real-time updates.

QA/QC protocols will follow Straughan's internal procedures, including metadata standards (FGDC) and version control in ArcGIS Pro. All datasets - LiDAR, bathymetry, biological surveys - will undergo validation checks before integration. This task includes in person attendance of at least two (no more than three) community or stakeholder engagement events to support in a technical expert role. Deliverables will include the detailed work plan, monthly progress reports, and a Final Technical Data Package consolidating all outputs.

TASK 2 – COMPREHENSIVE EXISTING CONDITIONS REPORT (ECR)

We will compile and synthesize existing datasets during the desktop assessment phase such as VIMS shoreline change data, NOAA bathymetric charts, SAV mapping layers, aerial imagery, hydrologic models, and climate projections from NOAA Sea Level Rise Viewer. The team will also review existing data sets provided by MPPDC. Further, the Straughan Team is also working with Natrx, Inc. as a data source vendor. Through this agreement we have access to all the information which was produced as part of the data accumulation which supported the NFWF NCRF grant submission in 2024. Natrx will be updating this information to the most current data for next steps in analysis for GRIT. This information will be key to streamline the initial assessment of the site and includes:

- A Unified Data Repository
- GIS layers, field data, documents, environmental sampling, and media.
- Integration with existing Guinea Marsh baseline studies and analysis (See **Figure 1**).

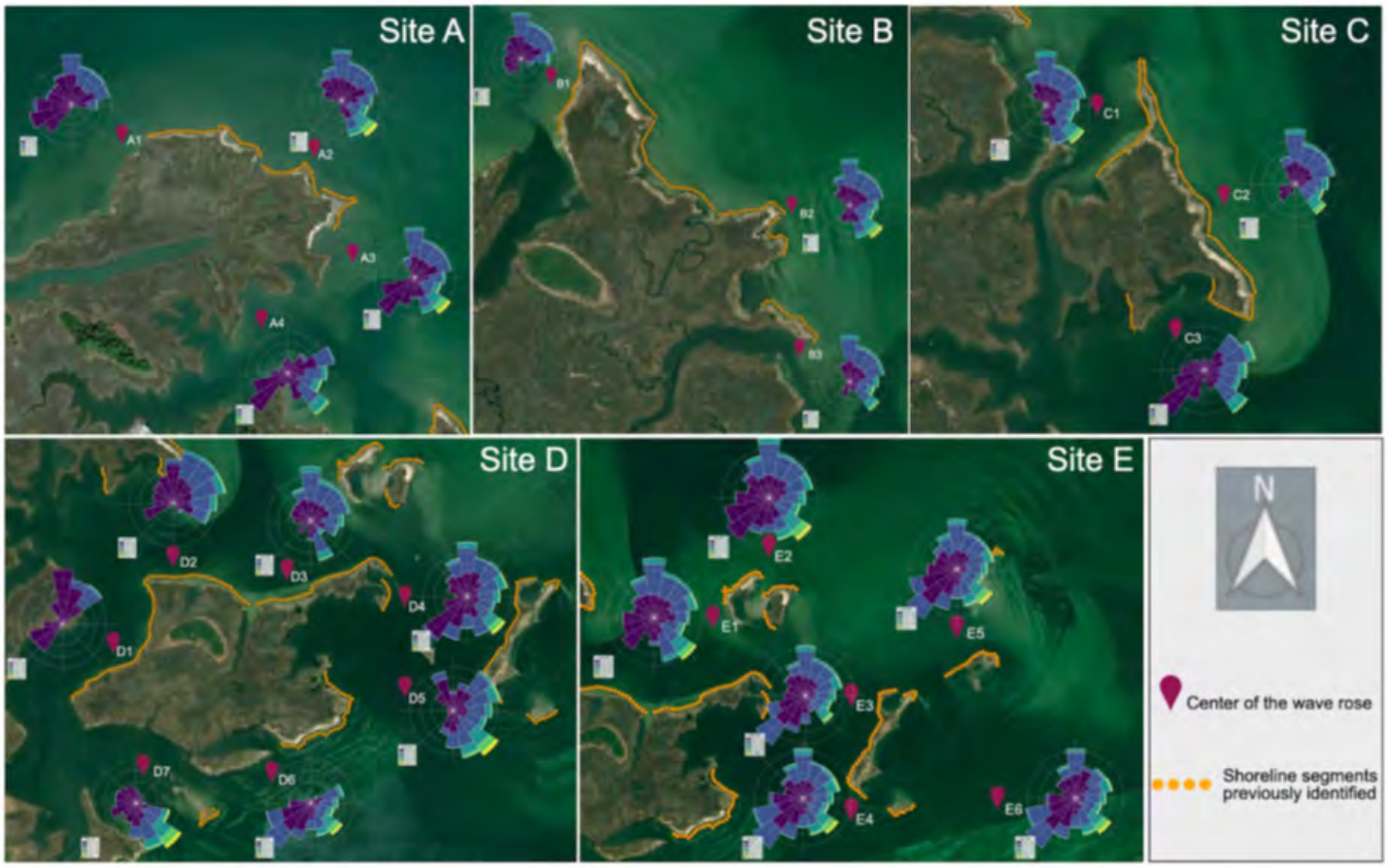


***Figure 1** | Resilience information, land-water classification, baseline erosion and marsh migration trends are available for all of Guinea Marsh and Mobjack Bay within the Natrx provided information.*

Following a full review of existing information, data gaps will be identified by the team and a plan will be established to collect additional information as part of Optional Task 8, if needed. This information may include LiDAR surveys, single-beam or multi-beam bathymetry, and biological assessments (vegetation transects, oyster reef mapping, eDNA sampling). The Straughan Team will also evaluate the need of any onsite validation checks during the project of elevation data. If found to be necessary due to data gaps, this will be critical for the JPA submission at this point in the project as well. The Straughan Team will allocate resources to complete validation of elevation data as needed during the project.

Data processing will leverage ArcGIS Pro for DEM generationand habitat mapping, while hydrologic and wave data will be processed in MATLAB or Python for statistical validation. The ECR will integrate geomorphology, hydrodynamics, and habitat vulnerability analysis, supported by GIS deliverables with full metadata.

Findings from this task will be integrated into a comprehensive Existing Conditions Report (ECR), to include a summary of site characteristics, geomorphology, habitat types, vulnerabilities, and restoration opportunities. The report will be shared with the Project Team at four review check points - (1) Outline and Table of Contents, (2) draft data figures and maps, (3) draft report, and (4) final ECR - incorporating feedback from each review.

Deliverables include the draft ECR at the checkpoints identified above and the final ECR, each with supporting GIS and data files.

TASK 3 – CONCEPTUAL DESIGN DEVELOPMENT

Straughan will develop three conceptual alternatives combining a range of NBS as noted in detail previously. Concept layouts will be drafted in AutoCAD Civil 3D and visualized in ArcGIS StoryMaps for stakeholder review.

Performance screening will use SWAN/STWAVE for wave attenuation modeling and XBeach for storm surge and sediment transport simulations. Ecological uplift will be assessed using Habitat Suitability Index (HSI) models and SAV sensitivity layers. Alternatives will be evaluated for constructability, cost, and resilience benefits, then presented during a Design Review Workshop.

Wave transformation and shoreline response modeling using SWAN or STWAVE will help characterize the wave climate across different fetch directions, which is critical for understanding energy exposure at Guinea Marsh. By simulating storm conditions with XBeach or CMS Wave, planners can assess overtopping risks and shoreline vulnerability, informing the placement and design of living shorelines or low-crested structures that reduce erosion while maintaining ecological function.

For morphodynamics and stability, sediment transport modeling can estimate cross-shore and longshore fluxes, guiding decisions on sill crest elevations and breakwater spacing. These analyses ensure that structures attenuate wave energy without disrupting sediment bypassing or water exchange, which is essential for sustaining marsh accretion and resilience. Optimizing these parameters supports hybrid solutions that stabilize the shoreline while promoting natural sediment delivery to marsh interiors.

Finally, hydrologic connectivity modeling using 1D/2D shallow flow tools can evaluate interventions like runnels or selective berm removal to restore tidal exchange. By simulating inundation patterns, residence times, and sediment routing, these models help identify strategies that reconnect interior marsh cells to estuarine processes, enhancing habitat quality and long-term resilience. Together, these systems provide a comprehensive framework for designing nature-based solutions that balance physical stability with ecological restoration.

Task 3 will include the following elements:

- **Portfolio assembly:** Compilation of the conceptual design elements linked to our strategy of prioritization outlined earlier.
- **Stakeholder engagement:** Facilitation of one formal Design Review Workshop, working sessions with watermen/ aquaculture operators, heritage organizations, and public landowners; codevelop siting to avoid user conflicts and enhance community benefits.
- **Data integration & iterative design:** Combine survey/model outputs with existing regional tools (shoreline change, oyster siting, marsh health/lifespan, marsh migration corridors) to refine alignments and phasing.
- **Wave transformation & shoreline response:** Use SWAN/STWAVE for wave climate transformation across fetch directions; apply XBeach or CMS Wave for storm response and overtopping risk where applicable.
- **Morphodynamics & stability:** Cross-shore /longshore sediment transport estimates; sill crest optimization; breakwater spacing/gap analysis to balance wave attenuation with sediment bypassing or accretion and water exchange.
- **Hydrologic connectivity:** 1 D/2D shallow flow modeling to test runnels and selective berm removal options that restore natural tidal inundation, residence time, and sediment routing to interior marsh cells.
- **Artificial Intelligence Design Optimization for Marsh Resilience:** We will engage an AI- and physics-driven framework that will identify interventions (e.g., living breakwaters, marsh elevation, etc.) that optimize coastal marsh resilience outcomes. The framework will rapidly predict flood and wave mitigation benefits from potential interventions and then suggest configurations that satisfy constructability constraints and maximize outcomes under scenario and model uncertainty. (see Section 3 of the proposal for more details).
- **Beneficial use/TLP design envelopes:** Elevation enhancement targets derived from site specific accretion/relative SLR; lift thickness, placement methods, and expected vegetation recovery trajectories.

Deliverables for task 3 are the conceptual design drawings, alternatives analysis summary, and Design Review Workshop notes. Designs will be advanced to a level sufficient to complete draft JPA permits.

TASK 4 – BASIS OF DESIGN REPORT (BOD)

The BOD will document selected design criteria, including design year/lifespan, sill crest elevations, breakwater spacing, and thin-layer placement specifications. Engineering assumptions will be supported by hydrodynamic modeling outputs from SWAN/STWAVE and sediment transport analyses in CMS-Wave. Cost estimates will be developed using USACE, RS Means and historical bid data, while phasing recommendations will be visualized in Gantt charts. Draft and final BOD reports will include annotated drawings, model results, and QA/QC summaries. Straughan will provide the draft BOD report and participate in a draft BOD review meeting with the full Project Team and incorporate comments into the final report.

Deliverables for Task 4 are the draft and final BOD reports with sufficient level of detail to complete draft JPA packages for at least one of the three designs.

TASK 5 – RESILIENCE FEASIBILITY ASSESSMENT

We will evaluate the conceptual design elements including thin-layer placement (TLP) and beneficial dredged material use through sediment compatibility analysis (grain size, chemistry) and elevation enhancement modeling under various NOAA SLR scenarios, including intermediate and intermediate-high based upon the Intergovernmental Report, Sweet et al. 2022.

Resilience benefits will be quantified using SLAMM (Sea Level Affecting Marshes Model) and InVEST Coastal Vulnerability Tool, integrated with hydrodynamic outputs to predict marsh persistence and habitat gains. Findings will be summarized in a feasibility matrix and incorporated into the draft and final reports.

As part of Task 5 the team will also execute the following:

- **Multi Criteria Decision Analysis (MCDA):** Multi criteria screening (performance, cost, access, permitting risk, habitat tradeoffs) confirms a constructible sequence with near-term shoreline protection and long term marsh sustainability.
- **Constructability Review:** Shallow draft equipment plans, seasonal work windows (SAV, fisheries), turbidity controls, and logistics for material delivery and staging will be considered along with other elements which may affect construction implementation.

Straughan will provide the draft Feasibility Assessment Report and participate in a draft report review meeting with MPPDC and Carlexson and incorporate comments into the final report.

Deliverables for Task 5 include the draft and final Feasibility Assessment Report, including supporting information.

TASK 6 – LAND CONSERVATION SUITABILITY ASSESSMENT

Our team will implement a comprehensive GIS-based Land Conservation Suitability Assessment tailored to the Guinea Marsh and adjacent Mobjack Bay marsh islands. We will begin by compiling and analyzing spatial datasets to identify parcels and corridors that support future marsh migration and long-term habitat protection. This analysis will integrate multiple criteria - land use, ownership patterns, elevation profiles, projected inundation under sea-level rise scenarios, and ecological value - to ensure prioritization aligns with resilience objectives. Using advanced geospatial modeling, we will generate detailed maps and parcel prioritization tables, supported by metadata for transparency and reproducibility. Prior to finalization, we will convene a mapping review and ranking workshop with the Project Team to validate assumptions and incorporate stakeholder input. The outcome will be a Draft and Final Land Conservation Suitability Assessment Report, accompanied by a complete GIS package, providing actionable insights for conservation easements and strategic protection measures that enhance ecological connectivity and climate resilience.

The Straughan Team is well suited to execute this important task. We have extensive experience developing custom GIS-based suitability and prioritization models that are purpose-built to support client-specific, regulatory, planning, and funding objectives. Our modeling work spans sea level rise resilience, stormwater management, green and blue-green infrastructure, flood mitigation, aquatic organism passage, and nature-based solutions for local, state, and regional clients. Each model we build is tailored to the decision context at hand, whether identifying implementable sites, prioritizing capital investments, supporting grant competitiveness, or demonstrating regulatory compliance, ensuring the analytical framework directly aligns with how the client must act on the results. Our frameworks are built using four core themes:

1. **Robust data integration and scalable geospatial architecture.**

   Our approach begins with the integration of diverse datasets from local, state, federal, and partner sources into well-structured, defensible geodatabases designed for long-term use. Significant data gathering has already taken place as part of the NFWF grant application process, which identifies data layers that are part of the Tidal Marsh Adaptation Mapper. Those sources will be validated, and any expired/invalid datasets will be replaced with a suitable data resource that is available. We develop scalable data schemas that support asset tracking, maintenance workflows, regulatory reporting, and future expansion as new data becomes available. To ensure consistency, transparency, and efficiency, we implement automation through Python scripting, Model Builder workflows, and embedded quality-control processes, enabling repeatable analyses that can be updated as conditions, priorities, or datasets change.

2. **Multi-criteria decision analysis (MCDA) for suitability and prioritization methodologies**

   We apply rigorous multi-criteria suitability and prioritization methodologies that clearly separate feasibility screening, design- and practice-specific constraints, and final prioritization logic. Our frameworks commonly use tiered or MCDA-based approaches that evaluate physical constraints and existing conditions, best-practice design

requirements, environmental and social benefits, and implementation feasibility. Scoring and weighting structures are intentionally designed to be consistent and transparent, allowing multiple interventions or scenarios to be evaluated simultaneously while remaining flexible enough to reflect evolving client priorities. Our models sometimes begin with frameworks that have been built for similar purposes, and then we integrate them with our model to meet specific client needs.

3. **Integration of technical analysis with professional judgement and local knowledge**

   A defining feature of our work is the integration of advanced spatial analysis with professional engineering, resiliency, and planning judgment. We combine quantitative GIS modeling with stakeholder engagement, community input, and field verification to ground-truth results and ensure practical applicability. This hybrid approach strengthens the defensibility of model outputs, avoids artificial score inflation, and produces prioritization results that are both technically sound and contextually informed, giving clients confidence that recommended sites and projects are realistic, equitable, and actionable.

4. **Decision ready outputs**

   Our suitability and prioritization models are designed to produce decision-ready outputs that directly support planning, funding, and implementation. We translate complex analyses into ranked site lists, suitability maps, and defined focus areas that inform capital programming, project phasing, and grant applications. Deliverables are tailored to both technical and non-technical audiences and often include map books, dashboards, and web-based visualization tools that support leadership briefings and public engagement. Final datasets are delivered with complete metadata, documentation, and training to ensure clients can confidently maintain, update, and reuse the results over time. For this project, in addition to GIS data and metadata, we will deliver parcel prioritization tables and suitability maps.

Tier 1 Data Layers Identified in NFWF Grant Application

- Existing Marsh Area
- Marsh Characteristics
  - » Health (UVVR)
  - » Lifespan
  - » Tidal Range
  - » Elevation
- Adaptive Capacity
  - » Marsh migration corridors
- Vulnerability
  - » Sea level rise
- Coastal Protection
  - » Shoreline inventory
  - » Shoreline change
- Habitat
  - » Land use
  - » Hardened shorelines
  - » SAV
  - » ACFHP Mid-Atlantic Estuarine Analysis, Diadromous Analysis
  - » Projected habitat transitions
  - » Projected marsh change
  - » Natures Network
- Underserved Communities
  - » VA EJ Screen: poverty level, communities of color
  - » FEMA Risk Index (census tracts)
- Water Quality
  - » VIMS layer
- State Targeted Priorities
  - » Conserve Virginia priority areas
- Partner Engagement Active Projects and Areas of Interest
  - » Middle Peninsula Coastal Wetland Sites
- Protected lands (public and private land under easement)

We have a proven track record delivering suitability and prioritization modeling efforts for complex projects involving multiple agencies, jurisdictions, and stakeholder groups. Our team is experienced in managing large study areas, extensive asset inventories, and varied data standards while adapting to evolving project goals and data availability. Through disciplined project management, clear communication, and efficient modeling workflows, we consistently deliver high-quality products on schedule and within budget. These efficiencies often allow us to provide value-added enhancements that further strengthen client outcomes without increasing project costs.

The GIS-based analysis for this project will include identifying and ranking parcels and corridors suitable for future protection or easement by assessing land use, ownership, elevation, projected inundation, and ecological value, among others. Straughan will provide draft maps, parcel prioritization tables, and metadata and participate in a mapping review

and ranking discussion with the Project Team prior to finalization and incorporate comments into the draft report. The draft Land Conservation Suitability Assessment Report will be provided for comment, and comments will be incorporated into the final report.

Deliverables for Task 6 include the draft and final Land Conservation Suitability Assessment Report and GIS data package.

TASK 7 – ENVIRONMENTAL AND REGULATORY DOCUMENTATION

We will prepare an Environmental Evaluation Summary outlining anticipated effects, mitigation needs and measures, and compliance/regulatory pathways under VMRC, VIMS, DWR, USACE, and CZMA requirements. Draft Joint Permit Application (JPA) materials will be developed using AutoCAD for plan sheets and integrated with environmental narratives. For the JPA the team will prepare at least one draft package that has been field verified regarding elevation information to increase the likelihood of permit issuance. We understand that formal submittal of the JPA is not required, however the team will be in communication through pre-application dialogue with regulators to guarantee future permit issuance.

All documentation will undergo internal QA/QC and review by MPPDC, DWR, and the Project Team prior to submission.

The deliverables for Task 7 are the draft Environmental Evaluation Summary and draft JPA package.

TASK 8 – OPTIONAL FIELD SERVICES

Based upon the existing information review conducted during the Task 2 Desktop Assessment and the data gaps assessment, the following field work may be needed to fill data gaps. The Straughan Team understands that these services are likely to be deployed for future design, however we stand ready to execute these items as needed for GRIT Phase 1 if called for:

- **Topographic & marsh platform elevations:** As needed we will collect topographic data using RTK GNSS/terrestrial LiDAR to define cross-shore profiles, toe elevations, and vegetation zones. Should a larger comprehensive survey be needed, this will begin with UAV-based flown topography to capture land and marsh elevations. RTK photogrammetry will be the primary method, using high-overlap flight plans and ground control points for accuracy, with PPK as a backup. In areas with dense vegetation or low-texture surfaces, LiDAR will be deployed to complement photogrammetry, providing classified point clouds and hydro-flattened water features.
- **Bathymetry & access corridors:** Bathymetry if needed will be completed by our team member Marine Solutions Inc.(MSI) using an EdgeTech sidescan or echosounder for shallow areas and an R2 Sonic multibeam system for deeper sections. These operations will include sound velocity profiling, real-time motion corrections, and calibration procedures such as patch tests and beam angle adjustments. Shoreline features will be surveyed with GNSS rovers and supplemented by total station measurements where necessary, ensuring seamless integration with bathymetric data. Finally, all datasets will be merged into a unified DEM/DTM, with contours and QA/QC documentation to validate accuracy and compliance.
- **Hydrographic measurements:** Water level, waves (pressure sensors), and currents (ADCP) for model calibration/validation.
- **Sediment characterization:** Grain size, bulk density, organic content, contaminants—used to screen and match dredged material for thin-layer placement (TLP).
- **Living resources baseline:** Vegetation mapping; oyster structure condition surveys; fish use (including eDNA/eRNA as feasible); SAV coverage/health in affected embayments.

Straughan will consult with the Project Team for confirmation before proceeding with any data collection beyond the scope of Tasks 1 through 7.

Page intentionally left blank.

3.
Innovation and Resilience Integration

PROJECT: Croppers Island and Stark Properties Salt Marsh Restoration
OWNER: U.S. Fish & Wildlife Service

Constructed runnel and high marsh hummocks at Langmaid Salt Marsh Restoration, designed by Straughan Environmental

The Straughan Team is committed to identifying the most effective pathways for delivering regional resilience solutions rooted in nature-based, climate-adaptive strategies. As outlined in Section 2, our approach is firmly centered on these objectives. Leveraging extensive experience and technical expertise, we design solutions that prioritize long-term adaptability, ensuring current systems can evolve seamlessly to address future challenges such as RSLR and ongoing coastal erosion. Our confidence in this approach is grounded in proven success—we have implemented these strategies before and delivered measurable results. Additionally, as noted previously our team includes cutting edge AI resources which are able to vet the most optimum nature-based solutions for deployment throughout GMWMA. This section outlines some the key elements the Straughan Team is engaging to make sure our deliverable fully provides for resilience through innovative concepts.

Artificial Intelligence Design Optimization for Marsh Resilience

Straughan Team member Johns Hopkins Applied Physics Laboratory (APL) will engage an AI- and physics-driven framework that will identify interventions (e.g., living breakwaters, marsh elevation, etc.) that optimize coastal marsh resilience outcomes. The framework will rapidly predict flood and wave mitigation benefits from potential interventions and then suggest configurations that satisfy constructability constraints and maximize outcomes under scenario and model uncertainty.

The approach is an extension of JHU APL prior work in discovering strategies to mitigate hurricane flooding damage. Previously, the team demonstrated this framework's effectiveness for a set of storms incident on a specific geographical region (the Gulf Coast portion of Florida). We were able to model how oyster reefs attenuate flooding and then utilized our optimization approach to identify a set of sea walls and oyster reefs projected to minimize expected future damage from flooding, offering billions of dollars of potential future savings.

Physics-based simulations will initially be used to sample from a space of possible interventions, and then the AI surrogate models will be trained on these simulations and used to fill out trajectories for novel interventions. Specifically, we will generate training data for our AI surrogate models using the COAWST modeling system; which combines WRF, including WRF-Hydro; ROMS; a wave model; and a sediment transport model. Data generation throughput will be enhanced with our super-resolution strategy, in which we generate low-resolution data and then use AI models to map it into higher and more usable resolutions. We will leverage our past work in modeling interventions like oyster reefs within COAWST. The effects of interventions on inundation patterns are simulated using the physics-based wave over topping (WOT) model, which includes a set of equations that describe water going onto land based on land height plus any constructed intervention, the still water level, and the significant wave height. Training data and model predictions will be validated against collected geographic information system (GIS) data and other relevant data modalities.

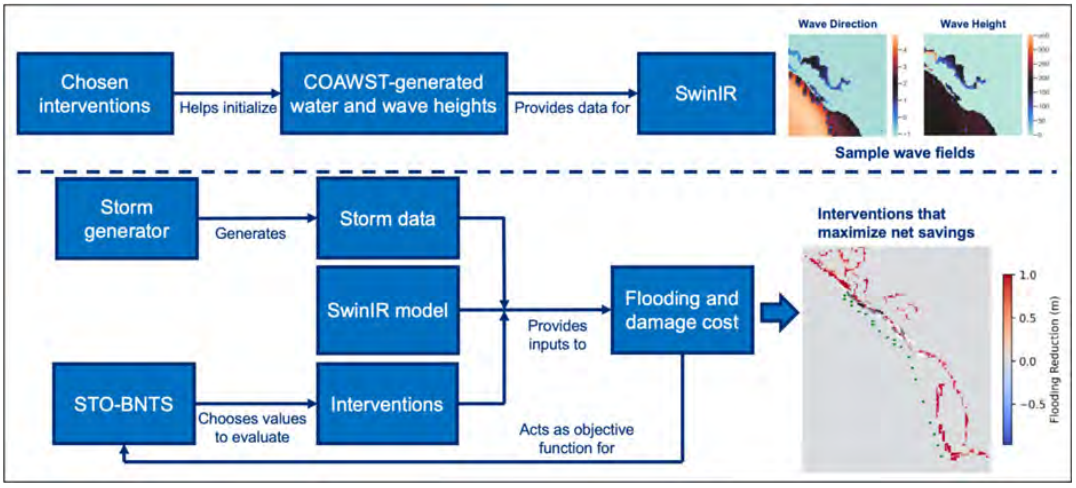


***Photo 11** | APL framework combines numerical and AI-based storm data generation, shifted window image restoration transformers for predicting intervention effect, and Sample-Then-Optimize Batch Neural Thompson Sampling for optimizing interventions (Source: JHU APL)*

Given these data, we will train an AI surrogate that forecasts the water and wave fields for the testbed when provided with an intervention (e.g., living breakwater, TLP, etc.) configuration and initial condition. Specifically, we will use the Shifted Window Image Restoration (SwinIR) transformer used in our previous work, which is effective at accurately predicting spatiotemporal fields with multi-scale features. We will adopt an ensemble approach in which we train multiple models and then use their distribution of predictions to obtain prediction intervals associated with intervention impact estimates, thus providing uncertainty quantification for the surrogate.

Given the surrogate model, we will search for intervention configurations that maximize our objective functions. For this, we will use Sample-Then-Optimize Batch Neural Thompson Sampling (STO-BNTS) to traverse the design-space and identify optimal intervention sets. This black-box optimization approach uses a set of neural networks to predict the score of an intervention set, while incorporating uncertainty from both the environment (i.e., the surrogate's predictions) and the predicted objective function values. We will follow our strategy and augment the STO-BNTS baseline through intelligent sampling of initial candidate actions in the action optimization stage of each round of the multi-armed bandit problem. By balancing exploration with exploitation of solutions previously identified to be strong, we are able to more efficiently search the high-dimensional space of potential interventions. After optimization iterations, we will conduct sensitivity analyses to determine which interventions most influence outcomes.

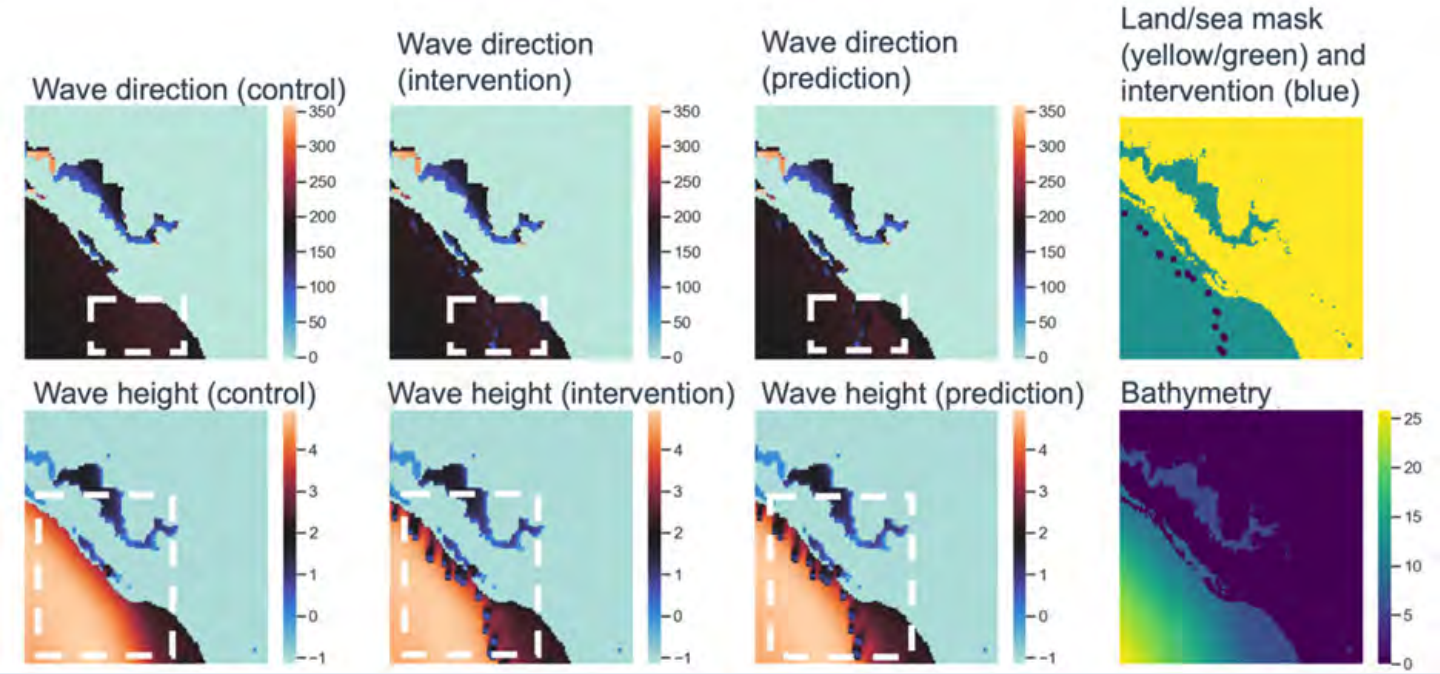


***Photo 12** | For a given intervention setup and time from our validation set, we show the intervention-less wave variables (far left); COAWST-predicted variables (middle left); SwinIR-predicted variables (middle right); and land-sea mask, intervention locations and bathymetry (far right). For both wave direction and height, SwimIR captures how the oyster reef changes the waves. (Source: JHU APL)*

Concurrently, we will work with data generated by the full Straughan Team for Guinea Marsh and train additional AI models. Specifically, we will use Gaussian process regression (GPR) to learn the relationship between Straughan Team hydrodynamic model inputs and outputs. The uncertainties associated with GPR model predictions will be fed into active learning and optimization algorithms that select inputs at which the hydrodynamic model will be queried. Here, the AI model will help to efficiently explore the variety of outputs that can be calculated by the hydrodynamic model while also estimating the sensitivity given input parameters have on the model outputs.

Nature-Based & Climate Resilient Solutions

The designs concepts proposed within Section 2 as noted previously, are focused upon gaining a full understanding of the dynamics in Guinea Marsh and the most likely prioritization to provide resilience to the system. These will, to the greatest extent feasible, rely on natural materials and natural processes to maximize ecological benefits and project resilience. Basing designs around natural processes allows the implemented solutions to adapt to changing conditions, increasing project resilience and lifespan. Examples from Section 2 which link to these objectives include:

- **Living Shorelines & Living Breakwaters:** Pair rock/oyster structures with native plantings and graded banks to deliver wave attenuation, shoreline stability, and multispecies habitat. Gapped breakwaters maintain water exchange and sediment accretion to minimize unintended deficits. Conversely these breakwaters can also be designed to provide protection again shoaling in channel areas.
- **Thin Layer Placement (TLP):** Use compatible dredged sediments in thin lifts to raise marsh elevations to offset relative sea level rise. This strategy is an adaptive, repeatable intervention that preserves vegetation communities and hydroperiods.
- **Hydrologic Reconnection (Runnels/Berm Removal):** Restore tidal inundation and drainage pathways to interior marshes, thereby reducing extended ponding/drowning to improve marsh health, improving sediment delivery to support vertical accretion in concert with RSLR, and enhancing ecosystem resilience to storms.

ADAPTIVE DESIGN & MONITORING

Achieving resilience objectives requires a clear framework for evaluating whether design elements and implemented solutions are performing as intended. Equally important is the ability to identify when design modifications or adaptive measures are necessary to maintain system functionality over time. This approach relies on designing for adaptability, guided by predefined performance thresholds. Regular monitoring is essential to determine whether these thresholds are met, using parameters tailored to each design type.

Key strategies include:

- **Adaptive thresholds:** Establish explicit performance metrics (e.g., elevation change, vegetation recovery, wave attenuation, SAV coverage) and trigger maintenance actions - such as supplemental TLP lifts, targeted replanting, or module adjustments - when thresholds are not achieved.
- **Pilot-to-scale pathway:** Deploy pilot cells (e.g., selected TLP panels and oyster module arrays), monitor responses across seasonal cycles and storm events, and scale up based on demonstrated performance and stakeholder feedback.
- **Data-driven iteration:** Conduct annual analyses of physical, biological, and socio-ecological monitoring datasets to inform incremental design refinements and maintenance cycles.

INTEGRATION WITH REGIONAL RESILIENCE & DREDGING PROGRAMS

Project success depends on developing solutions that align with broader regional resilience objectives rather than functioning as isolated interventions. The Straughan Team brings extensive experience with living shoreline projects across the region, including work for VDOT in the Middle Peninsula and other Tidewater areas. Our team has engaged with dredging operations ranging from the Chesapeake Bay deepwater channel to recreational waterways and marina maintenance programs. A critical component is identifying opportunities for beneficial use of dredged sediment and ensuring alignment with regional resilience plans and priorities. We have the contacts with USACE and VPA and others and are able to assess availability of sediment for any projects to be advanced for Guinea Marsh. Equally important is understanding community and stakeholder perspectives - because even the most technically sound design will fail if it does not reflect local objectives.

Key strategies include:

- **Beneficial Use Pipeline:** Coordinate with navigation and maintenance dredging schedules to secure sediment sources, match material characteristics to marsh cell requirements, and minimize transport costs. Where possible, leverage programmatic or regional general permits to streamline implementation.
- **Regional Planning Alignment:** Integrate design siting with marsh migration corridors, shoreline change projections, oyster restoration tools, and coastal wetland planning priorities to deliver co-benefits such as erosion reduction, habitat enhancement, and water quality improvement.
- **Stakeholder & Workforce Integration:** Collaborate with aquaculture businesses, watermen's associations, heritage groups, and public landowners to avoid user conflicts, incorporate local knowledge into siting and construction windows, and expand stewardship capacity.

COST EFFICIENCY & IMPLEMENTATION READINESS

Innovation and resilience are essential, but project success ultimately depends on delivering solutions that are both cost-effective and practical to implement. The Straughan Team has a proven track record of designing adaptable coastal systems that meet these criteria. Several strategies support these objectives:

- **Adaptable Design:** Develop designs that anticipate future adaptive management needs, such as adding material to breakwater crests in response to relative sea-level rise (RSLR).
- **Modular, Phased Construction:** Sequence living breakwaters and shoreline elements to provide early wave attenuation and shoaling reduction, while implementing TLP and hydrologic reconnection in staged cells - spreading cost and reducing risk.
- **Constructability in Shallow Settings:** Utilize shallow-draft equipment and near-site material staging; design for maintenance practicality with replaceable oyster modules and accessible monitoring arrays.
- **Permitting Strategy:** Engage regulators early to align monitoring plans, seasonal work windows, and beneficial use documentation - minimizing permitting uncertainty and accelerating delivery.
- **Co-Benefits:** Design nature-based solutions to achieve multiple objectives, such as habitat enhancement and water quality improvement, opening diverse funding pathways.

4.
Schedule and Deliverables

PROJECT: Thompson Island Shoreline Stabilization
OWNER: Delaware Center for Inland Bays

Wave Attenuation Structures (WASs) are installed offshore of Thompson Island, DE to address high wave energy conditions. Project designed by Straughan Environmental.

A detailed schedule outlining key tasks, interim deliverables, review periods, and final deliverables is provided below. We have focused on ensuring the project will meet the current grant-imposed deadline of December 31, 2026. However, we understand that an extension has been requested to add an additional year, with an end date of December 31, 2027. We have compiled a schedule to meet the current project completion timeline and we will be engaging the large staff resources of the Straughan Team, which includes AECOM, one of the largest consulting firms in the world. Assuming a notice-to-proceed of March 1, 2026, this schedule results in project completion by December 30, 2026. Should the extension be granted, it would allow for more review time by MPPDC and a more refined final deliverables within the same budgetary constraints.

Page intentionally left blank.

TASK	TASK NAME	Jan 2026	Feb 2026	Mar 2026	Apr 2026	May 2026	Jun 2026	Jul 2026	Aug 2026	Sep 2026	Oct 2026	Nov 2026	Dec 2026
NTP	**Assumed Notice to Proceed**			**3/1/2026**									
1	**Project Initiation, Work Plan, Coordination, QA/QC, and Reporting**												
1.1	Kickoff and coordination meetings with MPPDC, Carlexson Consulting, DWR, and project team												
1.2	Monthly coordination meetings and quarterly progress briefings				Monthly	Monthly	Monthly & Quarterly	Monthly	Monthly	Monthly & Quarterly	Monthly	Monthly	Monthly & Quarterly
1.3	Review existing data, reports, and surveys (LiDAR, bathymetry, biological assessments, existing conditions)												
1.4	Maintain QA/QC documentation for all datasets and analyses			On-going									
1.5	Develop detailed work plan and schedule with milestones, submittals, and review check points												
1.5 D	**Deliverable: Approved Project Work Plan and schedule**												
1.6	Attend and support at least two community/stakeholder engagement events in a technical expert role					Inform ECR				Inform CDD			
1 D1	**Deliverable: Monthly progress reports (accomplishments, issues, schedule updates)**												
1 D2	**Deliverable: Final Report & Technical Data Package (contains all deliverables from all tasks)**												
2	**Comprehensive Existing Conditions Report (ECR)**												
2.1	Desktop Assessment: compile and synthesize datasets (shoreline studies, bathymetry, SAV mapping, aerial imagery, hydrologic models, climate projections, etc)												
2.2	Field Data Assessment: inform/review collection of LiDAR, bathymetric, biological surveys, and other field services to identify/fill data gaps and verify existing information												
2.3	Data Processing & Mapping: deliver processed datasets (DEM, bathymetric surface, habitat maps) in GIS with metadata												
2.4	Report Development: integrate findings on geomorphology, habitat types, vulnerabilities, restoration opportunities into ECR report												
2.4 D1	**Deliverable - Checkpoint 1: Outline and table of contents**												
2.4 R2	*Review - Checkpoint 1: Outline and table of contents – team review/approval*												
2.4 D2	**Deliverable - Checkpoint 2: Draft data figures and maps**												
2.4 R4	*Review - Checkpoint 2: Draft data figures and maps – technical review by MPPDC, Carlexson, DWR*												
2.4 D3	**Deliverable - Checkpoint 3: Draft report**												
2.4 R2	*Review - Checkpoint 3: Draft report – partner review by MPPDC, IEN, Consociate Media*												
2.4 D4	**Deliverable - Checkpoint 4: Final ECR – incorporate consolidated feedback**												
2.4 R4	*Review - Checkpoint 4: Final ECR – incorporate consolidated feedback*												
2.D	**Deliverable: Final ECR with supporting GIS and data files**												
3	**Conceptual Design Development (CDD)**												
3.1	Develop up to three conceptual design alternatives (marsh edge stabilization, dune/beach & wetland restoration, hybrid nature-based structures, etc)												
3.1 D	**Deliverable: Conceptual Design Drawings**												
3.2	Evaluate alternatives for constructability, cost, performance, ecological enhancement, resilience benefits												
3.2 D	**Deliverable: Alternatives Analysis Summary**												
3.3 R	*Design Review Workshop: present alternatives to project team*												
3.3 D	**Deliverable: Workshop Notes**												
4	**Basis of Design Report (BOD)**												
4.1	Prepare BOD, documenting selected design approach, design criteria, phased implementation recommendations, supporting analyses, model results, cost estimates												
4.1 D	**Deliverable: Draft BOD Reports**												
4.1 R	*Review: Participate in draft BOD review meeting with full project team*												
4 D	**Deliverable: Final BOD Reports**												
5	**Resilience Feasibility Assessment**												
5.1	Evaluate technical/economic feasibility of interventions (thin-layer placement, beneficial dredged material use)												
5.2	Assess resilience benefits under sea-level rise scenarios												
5.3	Coordinate findings with engineering and ecological assessments												
5.4	Develop Draft Feasibility Assessment Report												
5.4 D	**Deliverable: Draft Feasibility Assessment Report**												
5.4 R	*Review: Draft Feasibility Report review with MPPDC and Carlexson prior to finalization, receive and address comments*												
5 D	**Deliverable: Draft and Final Feasibility Assessment Report**												
6	**Land Conservation Suitability Assessment**												
6.1	GIS analysis: identify parcels & corridors suitable for future protection or easement. Assess land use, ownership, elevation, projected inundation, ecological value												
6.1 D	**Deliverable: Draft maps, parcel prioritization tables, and metadata**												
6.1 R	*Review: Mapping review and ranking discussion with Project Team*												
6.2	Develop Draft Land Conservation Suitability Assessment Report												
6.2 D	**Deliverable: Draft Land Conservation Suitability Assessment Report**												
6.2 R	*Review: Draft Land Conservation Suitability Assessment Report with Project Team, receive and address comments*												
6 D	**Deliverable: Final Report and GIS package**												
7	**Environmental and Regulatory Documentation**												
7.1	Prepare environmental evaluation summary (anticipated effects, mitigation needs, compliance pathways, applicable regulatory requirements and pathways)												
7.1 R	*Draft materials reviewed by MPPDC, DWR, and Project Team prior to submission*												
7 D	**Deliverable: Draft Environmental Review and Draft JPA package**												
8 (Optional)	**Field Services**												
8.1	Field Data Collection: collect LiDAR, bathymetric, biological surveys, and other field services to fill data gaps				As needed								
END	**Project Completion**												
-													**12/30/2026**

Page intentionally left blank.

This aggressive schedule could face a variety of challenges – typical challenges and the planned responses proposed in this schedule are described below.

In addition, as noted previously, we are in support of the requested grant extension and the Straughan Team would work with the project team to help acquire this as necessary. The extension would help to facilitate a complete, high quality work product.

Challenge	Response
DATA AVAILABILITY AND QUALITY Delays may arise from incomplete, inconsistent, or late delivery of required data, surveys, or background documentation.	One month is allocated for thorough data review at the start of the project.
STAKEHOLDER COORDINATION Multiple review agencies, decision-makers, or public stakeholders can introduce review and approval bottlenecks if timelines are not clearly defined.	Up to a month is allocated for most review checkpoints. Monthly coordination meetings and quarterly progress meetings are meant to keep all project partners on track, and these meetings will be supported by status dashboards delivered through Teams for real-time updates.
THIRD-PARTY DEPENDENCIES Reliance on subconsultants, permitting authorities, utility owners, or vendors may impact schedules outside the Offeror's direct control.	Early involvement and frequent recurring coordination with relevant third-parties will be the intent throughout the project duration.
SCOPE EVOLUTION OR CLARIFICATIONS Refinements to scope during early phases can create downstream impacts if not promptly addressed.	Our project management team will be monitoring the scope closely and will notify project partners of potential impacts to schedule as soon as they arise.
EXTERNAL FACTORS Weather events, regulatory changes, or unforeseen site conditions may affect fieldwork or modeling-related tasks.	If needed, field work is scheduled for early in the project, leaving time within the project schedule for adjustments, if necessary, before the target end date.

Page intentionally left blank.

5.
Qualifications and Experience of the Firm and the Project Team

Guinea Marsh, August 2024
Photo by proposed Project Manager, Chris Overcash

Our Team

The Straughan-led team brings directly relevant experience supporting coastal resilience planning efforts that integrate nature-based and hybrid solutions, field-informed existing conditions analysis, feasibility evaluation, stakeholder coordination, and implementation readiness. The personnel and projects presented in this section reflect capabilities that closely align with the objectives of the Guinea Resilience & Innovation for Tidal Wetlands (GRIT) Phase I effort, including advancing tidal wetland resilience, supporting adaptive shoreline strategies, and laying the technical groundwork for future design, permitting, and funding. All of our team members have a robust local presence in the Virginia tidewater area and have executed work in the region, including some projects within the Middle Peninsula region. Our team members have also worked together on a variety of projects for many years.

STRAUGHAN serves as the prime consultant and provides leadership in coastal and watershed-scale resilience planning, flood risk mitigation, blue-green infrastructure, and nature-based and hybrid solution development. Our key staff bring hands-on experience delivering GRIT-adjacent work across the Mid-Atlantic, with a focus on comprehensive existing conditions assessments, climate-informed vulnerability analysis, concept-level design, feasibility evaluation, and collaborative engagement with agencies and stakeholders. This includes hands on expertise from 40+ coastal resiliency projects in the Tidewater and Chesapeake Bay region, including:

- Farnham, VA
- Joint Base Langley- Eustis, VA
- Hampton, VA
- Norfolk, VA
- St. Georges Island, MD
- Thompson Island, DE

AECOM contributes nationally recognized expertise in coastal resilience, climate vulnerability assessment, nature-based and hybrid infrastructure planning, and large-scale resilience programs delivered for federal, state, and local agencies. AECOM is a fully integrated professional and technical services firm with comprehensive capabilities to plan, design, and implement infrastructure solutions, supported by more than 500 collective years of water-resources expertise. AECOM's Virginia and Maryland offices include over 890 professionals, with the Virginia Beach office serving as the primary location supporting this effort. This depth of regional presence, technical capacity, and institutional experience strengthens the team's ability to support GRIT's emphasis on innovation, technical rigor, and implementation-ready outcomes.

MARINE SOLUTIONS, INC. (MSI) provides specialized capabilities in waterfront and marine infrastructure inspection, hydrographic surveying, sonar imaging, and condition assessment. MSI's experience supporting coastal and waterfront projects for transportation agencies, port authorities, and federal clients enhances the team's ability to evaluate existing conditions, characterize physical constraints, and inform resilience planning and design in dynamic tidal environments.

JOHNS HOPKINS APPLIED PHYSICS LABORATORY (APL) is the Nation's largest University-Affiliated Research Center. As such, APL functions as an independent, nonprofit organization that conducts essential research,

development, and systems engineering to serve strategic national priorities, free from conflicts of interest or competition with commercial industry. APL employs roughly 9,000 permanent full-time staff. Approximately 75% are professional staff, which includes: physicists, engineers, mathematicians, chemists, and other technical specialists, of which 72% hold advanced degrees. APL researchers are focused on solving a wide range of challenges, including developing nature-based coastal resilience strategies using cutting-edge technology for vegetation re-establishment, as well as artificial intelligence systems for engineering and siting concerns.

Key Personnel

We have assembled our team for the GRIT project from experts who have been working in the Tidewater area, including the Middle Peninsula, on resilience and nature based applications for a long time. Our team is structured to succeed through integration of skills, knowledge, and proximity to the project location as depicted in the organizational chart below. The following key team members are committed to this project and will be available throughout the duration of the work.

CHRIS OVERCASH, PE, ENV SP, Straughan's Director of Resilience will be our Project Manager. Chris is a renowned national expert in the use of NBS for coastal resilience with 29 years of experience in consulting and academia. He is co-author of the National Park Services' 2023 Beach Nourishment Guidance. In the Tidewater area in recent years', he has worked to help develop the Beneficial Use of Dredge Material and Thin Layer Placement (TLP) Guidance Document for VIMS and pilot TLP projects for the Elizabeth River Project, he has worked closely with Joint-Base Langley Eustic and the City of Hampton to develop NBS coastal solutions for the surrounding areas and helped the City of Hampton acquire NFWF NCRF funding to advance 30% design concepts for coastal NBS. Chris has also worked closely with NPS to advance concepts for NBS on Colonial Parkway at College Creek and Jamestown. He is a member of the Network for Engineering with Nature that is working closely with USACE to advance NBS for coastal and upland environments. Chris has also worked on research projects with the USACE Engineering with Nature program at locations in the Tidewater Area as well as nationally. He has worked with NPS to develop NBS coastal solutions at over 30 locations nationally. At Johns Hopkins University, Chris co-leads the Coastal Climate Resilience Research Initiative and is an associate member of the Johns Hopkins Institute for Planetary Health.

NOELLE CROWLEY will act as Deputy Project Manager for the project. Noelle has deep ties to coastal Virginia, with her parents living on a tidal creek in Jamesville. Noelle has over 24 years of water resource, flood mitigation, and resiliency project experience. She lives in the Hampton Roads area and has supported numerous Virginia clients with CFPF grant applications and Resilience Plan development, and is currently supporting the City of Norfolk with implementation of the Coastal Storm Risk Management project. She has been managing multi-disciplinary teams on water resource planning and flood mitigation projects along the Virginia Coast for the last 20 years.

Our Key Staff:

The resumes that follow highlight the qualifications, technical expertise, and project experience of the individuals who will be responsible for managing and executing the GRIT Phase I effort. These team members bring direct experience in coastal resilience planning, nature-based and hybrid solution development, geospatial analysis, and stakeholder coordination, ensuring strong leadership and continuity throughout the project.

LEGEND:
- [S] Straughan
- [A] AECOM
- [M] Marine Solutions
- [J] JHU APL
- * Resume included

Project Manager
Chris Overcash, PE *[S]

Deputy Project Manager
Noelle Crowley *[A]

Principal Quality Manager
Michael Blose, PE [S]

SUBJECT MATTER EXPERTS:

Coastal Resilience Planning
Chris Levitz, PE, CFM *[A]

Nature Based Soutions
Chris Overcash, PE *[S]

Barrier Island Restoration / Protection
Taylor Squires, PE *[A]

Coastal Engineering / Resilience

COASTAL ENGINEERING
Larry Trout, Jr., PE *[S]
Joe Arrowsmith, PE *[S]
Serena Stafford, PE *[S]
Justin Vandever, PE *[A]
Taylor Squires, PE *[A]

NATURE-BASED SOLUTIONS
Drew Altland, PE *[S]
Keith Binsted [S]
Chris Levitz, PE, CFM *[A]

HYDRODYNAMIC MODELING
Justin Vandever, PE *[A]
Luisa Torres [A]
Hanieh Moghadam [A]

CLIMATE CHANGE
Jen Molnar, ENV SP *[A]

COST ESTIMATING
Drew Altland, PE *[S]

CONSTRUCTABILITY
Larry Trout, Jr., PE *[S]
Keith Binsted [S]

Regulatory

PERMITTING
Kate Traut, PWS *[S]
Lauren Wirth [S]
Maria Hackey *[S]
Isha McKnight, PWS [S]

RESILIENCE POLICY
Phetmano Phannavong, JD, PE, PMP, CFM *[A]

Resilience Feasibility

VULNERABILITY & RISK ASSESSMENT
Chris Overcash, PE *[S]
Chris Levitz, PE, CFM *[A]
Andrea Sweigart [A]

ECONOMIC EVALUATION / SUSTAINABILITY
Sabrina Bachman [S]
Jennifer Martin, CEP, ENV SP *[S]
Anne DeBoer [A]

ARTIFICIAL INTELLIGENCE TECHNICAL EVALUATION
Alex New, PhD *[J]
Jenny Boothby PhD *[J]
Jay Brett PhD [J]

FUNDING / GRANTS
Chris Overcash, PE *[S]

COMMUNITY OUTREACH / SOCIOECONOMIC ANALYSIS
Sabrina Bachman [S]
Jennifer Martin, CEP, ENV SP *[S]
Claire Still, ENV SP [A]
Brooke Grow [A]

Land Conservation Suitability Analysis / GIS

GIS
Julie Spangler, GISP [S]
Liz O'Keefe Markham, GISP *[S]
Jay Sullivan, GISP [S]

GRAPHIC DESIGN
Mindy Barnowski, CPSM *[S]
Kay Weekes [S]
Hiroko Koike [A]

Survey / Topographic / LiDAR / Bathymetric

John Loftus, III, PE *[M]
Keenan Lautner, PLS *[M]
Matt Owings [M]
Amanda Schindhelm [M]

Natural Resources / Environmental

Kate Traut, PWS *[S]
Lauren Wirth [S]
Maria Hackey *[S]
Isha McKnight, PWS [S]
Michael Greenberg [S]
Melissa Bernardo Hess, PE, CFM, ENV SP *[A]

Page intentionally left blank.

Christopher L. Overcash, PE, BCEE, ENV SP, LEED AP

Project Manager

Summary

Mr. Overcash has 28 years of progressive experience in the management, business development, planning, execution, design, and evaluation of projects in climate and coastal resilience for infrastructure and natural resources, environmental and civil engineering and systems planning. He has led and coordinated grant opportunity pursuits and coordinated stakeholder engagement and public outreach. He is a registered professional engineer in 11 states; and a Board-Certified Environmental Engineer and an ENV SP and LEED AP. His background has included projects involving resilience, marine design, dredging, water and wastewater systems and resource management as well as hazardous materials investigations.

He is also Program Manager and Adjunct Professor of the Environmental Engineering, Science, Management and Sustainability Programs, Johns Hopkins Engineering for Professionals. At Johns Hopkins he also co-leads the Coastal Climate Resilience Initiative.

Experience

Beneficial Use of Dredge Material Guidance Document | Virginia Marine Resources Commission | Virginia | Principal Engineer

Led development of the first guidance document for the beneficial use of dredged material in Virginia. The task included convening a stakeholder workgroup and facilitation of workshops as well as interviews with a wide range of entities. The focus of the document centered around the coastal resilience opportunities of using dredged material to meet the needs of preserving wetlands, natural resources and infrastructure in the face of rising sea levels. Including development of nature based coastal resilience using the dredged material.

Coastal Resilience Planning and Design for Nature Based Solutions | USACE Engineering With Nature | Joint Base Langley – Eustis (JBLE) | Project Manager

Led project evaluation and concept designs for climate and coastal impacts and nature based solutions at a number of locations nationwide including JBLE. The JBLE project delivered coastal resilience through use of coastal nature-based solutions including thin layer placement of sediment for tidal marsh resilience, living shorelines, breakwaters and other NBS. The concept design developed including stakeholder engagement and on-stie workshops. Working with the City of Hampton VA, the concepts led to follow on funding through a NFWF NCRF grant being executed presently.

Coastal Resilience Capacity Building for Nine Coastal Communities - National Coastal Resilience Fund - Technical Team Services| University of Maryland | Statewide, Maryland | Project Director

Partnered with the University of Maryland Environmental Finance Center through a National Fish and Wildlife, National Coastal Resilience Fund grant. This project is guiding a cohort of eight coastal Maryland communities

YEARS OF EXPERIENCE

28 years

YEARS WITH STRAUGHAN

<1 year

EDUCATION

MS, 2002, Environmental Engineering, Johns Hopkins University

BS, 1995, Environmental Science and Engineering, University of Maryland Baltimore County

REGISTRATIONS/CERTIFICATIONS

Professional Engineer, Virginia - 2004 (0402040537, Exp. 10/31/26)

Professional Engineer: DC, DE, KY, MD, MI, NC, OH, SC, TX

Envision Sustainability Professional Credential (ENV SP)

Leadership In Energy and Environmental Design (LEED AP)

Board Certified Environmental Engineer (BCEE)

AFFILIATIONS

Baltimore County Commission on Env. Quality (Commissioner)

American Council on Engineering Companies (Member)

American Society of Civil Engineers (Member)

Water Environment Federation (Member)

American Academy of Environmental Engineers (Volunteer)

Sail Baltimore (Board Member)

through a resilience planning process to (1) evaluate the local government's capacity and readiness to adapt; (2) assess each jurisdiction's vulnerability to climate-related coastal hazards; (3) identify and prioritize a set of nature-based solutions (NBS) that will improve resilience to coastal hazards and protect or enhance fish and wildlife habitat; and (4) connect each community to partners that can expand capacity or support implementation. Straughan is leading the technical team to develop a climate vulnerability assessment and a list of nature-based and hybrid solution project options to provide coastal resilience to these communities. Straughan is also assisting in community outreach and tracking of future funding for implementation of the concepts being developed.

Coastal Engineering and Hazards Support for National Park Service; | National Park Service | Colonial Parkway, VA and National | Senior Coastal Engineer

Provided technical leadership for response to National Park Service coastal units inquiries regarding a wide variety of coastal and hazard associated impacts. Through a 3-year open-end contract, assisted on review and project direction for coastal impacts, climate and sea level rise changes, and emergency response planning at a wide range of the 88 National Park Service coastal park units. Provides program level services in support of assessing vulnerabilities, risk, and adaption options related to coastal resilience in support of National Park Coastal Units. Specifically, he addresses issues related to climate change and promotes more resilient protection and adaptation options such as the use of hard engineering or natural and nature-based features. Working with scientists and planners, has lead the development of resilience related efforts assessing impacts at locations including Sitka National Historic Park in Alaska, Golden Gate National Recreation Area in California, Padre Island National Seashore in Texas, Gateway National Recreation Area in New Jersey, George Washington Birthplace in Virginia, Colonial Parkway in Virginia, Fort Pulaski National Monument in Georgia, Sleeping Bear Dunes National Lakeshore in Michigan, Dry Tortugas National Park in Florida, The National Mall in Washington, D.C., Salt River National Historical Park and Ecological Preserve on Saint Croix, USVI, and Acadia National Park in Maine.

Blue Green Stormwater Infrastructure (BGI) Flood Mitigation Study | Metropolitan Washington Council of Governments (MWCOG) | Prince George's County, MD and Washington, DC | Senior Technical Reviewer

Provided review and input to the technical approach for a FEMA-funded, cross-jurisdictional flood resilience planning study spanning Prince George's County and Washington, DC. Completed in June 2025, the study represents an innovative effort to align flood goals across jurisdictions while investing in public space and community wellbeing. The project focused on three shared watersheds—Oxon Run, Watts Branch, and Arundel Canal—and advanced a coordinated strategy to reduce risk through Blue Green Infrastructure (BGI) that also improves parks, trails, and amenities. The project developed the prioritization framework, held stakeholder workshops, and developed the methodology and demonstration concept.

Integrated Assessment of Climate Change Impacts to Groundwater, Stormwater, and Wastewater Infrastructure at Coastal Military Facilities | University of Delaware | Joint Base Langley Eustis, Naval Station Norfolk and National | Project Director

For the University of Delaware to the Environmental Security Technology Certification Program (ESTCP) Phase 1 project which will demonstrate the application of an integrated suite of models (EPA SWMM and USGS MODFLOW) to holistically analyze the impacts of climate change and extreme weather on groundwater, stormwater, and wastewater infrastructure at US military installations in coastal settings including Joint Base Langley Eustis (JBLE), Naval Station Norfolk (NSN). This modeling toolbox will allow users to identify and prioritize investment in interventions to increase water security and reduce the overall cost to the Department of Defense (DoD) for sustaining water infrastructure systems.

Guidance for Enhancing Climate Resilience of Waterway Crossings within Coastal and Near-Coastal Environments | Massachusetts Division of Ecological Restoration | Massachusetts | Project Manager

With projected impacts of climate change, including updated estimates of sea level rise for Massachusetts, it is anticipated that culvert and bridge crossings seated at the transition between non-tidal, estuarine, and tidal habitats will be directly impacted by changing conditions. The team developed guidance, definitions and criteria for the near-coastal transitional zone and building a Transitional Crossing Identification Tool in ArcGIS Pro Model Builder to prioritize and quantify the severity of the crossings within the zone. Detailed field reconnaissance was performed to better understand the existing and projected conditions of crossings. Finally, the team assisted in compilation of draft guidance to increase the resiliency of Massachusetts' near-coastal transitional stream crossings to (i) outline a general climate change adaptation framework and objectives for the transitional crossings, (ii) recommend assessment, feasibility, design, and permitting guidance, and (iii) provide a suggested framework to prioritize investments and other interventions at locations at risk.

Noelle Crowley

Deputy Project Manager

AECOM

Summary

Noelle Crowley has over 24 years of experience in resilence planning and nature based solutions, stormwater management, environmental compliance, MS4 permit compliance, TMDL Action Planning, stormwater master planning, flood mitigation and project management. She has extensive experience assisting municipal and federal clients throughout Virginia with stormwater and floodplain planning, Virginia Stormwater Management Program (VSMP) compliance, MS4 program implementation, TMDL Action Plan development and stormwater conveyance and treatment design.

Experience

Norfolk Coastal Storm Risk Management Project | City of Norfolk, VA | Task Manager

Task Manager for Environmental and Cultural activities related to the Norfolk CSRM project. Supporting the City of Norfolk with non-federal sponsor responsibilities including overseeing performance of environmental studies, cultural and archeological studies, Phase I and II environmental site assessments, navigation of Hazardous, Toxic and Radioactive Waste (HTRW) policy with USACE, environmental permitting and planning, and coordination with Norfolk District USACE.

VSMP MS4 Stormwater Program Support Services | City of Virginia Beach | Contract Manager

Contract Manager for annual services contract since 2021. Roles include technical support, project management, scope and schedule development and monthly progress updates with City project managers. Work orders under this contract have included:

- **17th Street Regional Stormwater Management Facility.** Currently serving as the City's project manager for the design of this large SWMF and drainage project that will provide water quality and quantity control for proposed development in the drainage area.
- **Salem and Bellamy Woods Water Quality Improvement Projects.** Providing technical support for the design of two manufactured treatment devices in the Southern Rivers Watershed.
- **SWMF Asset Management.** Providing technical and project management support for this project which includes research and database updates for over 3,500 public and private SWMFs in the City.

Resilience Planning Public Outreach Support | Virginia Department of Conservation and Recreation| Deputy Project Manager

Deputy Project Manager for two task orders with Virginia DCR to support public outreach campaigns and public information meetings for the Coastal Resilience Master Plan Phase II and the Virginia Flood Protection Master Plan.

Drainage Study and Flood Resilience Plan | Covington, VA| Project Manager

Project Manager for the development of a stormwater drainage study of flood-prone areas of the City to determine drainage improvements to

YEARS OF EXPERIENCE

24 years

YEARS WITH AECOM

5 years

EDUCATION

BS, 1999, Environmental Engineering, Syracuse University

AFFILIATIONS

Water Environment Federation

VWEA Stormwater Committee, Member

SAME Hampton Roads Post, Programs Chair

alleviate recurrent flooding issues and the development of a Flood Resilience Plan meeting the requirements of the Virginia DCR Community Flood Preparedness Fund (CFPF) grant program.

Stormwater Master Plan | U.S. Coast Guard Base Portsmouth | Portsmouth, VA| Project Manager
Project Manager for Storm Sewer Repair project at the Coast Guard Base in Portsmouth, Virginia. Project involved field data collection and update of Base storm sewer system mapping and condition assessment completed by a previous consultant, development of a Stormwater Master Plan for the Base which accounted for sea level rise and increasing storm intensities and complete design and bid support for designed upgrades to the facility to mitigate recurrent flooding.

Stormwater Pond and Infrastructure Design | U.S. Coast Guard Base Portsmouth | Portsmouth, VA | Task Lead
Task Lead for the design of a Level 2 Wet Pond and infrastructure modifications to reroute stormwater runoff from 19 acres of the Base to the new pond. Pond was designed to meet the Virginia BMP Clearinghouse criteria to provide Chesapeake Bay TMDL nutrient and sediment reduction credits, VSMP TP credits for planned redevelopment on Base and provide flood control for up to the 100-year storm event using the recently adopted Virginia Beach NOAA Atlas 14 + 20% storm event. Developed methodology to internally track TP credits for both TMDL and VSMP compliance.

Floodplain Management Support Services | Town of Blacksburg, VA | Blacksburg, VA | Project Manager
Project Manager for floodplain management support task orders with the town, which has included developer floodplain model and site plan reviews for two projects (801 N Main Street and Tech Terrace). Also performed evaluation of drainage alternatives to reduce recurrent flooding along Webb Street to reduce flood hazard to people, cars and buildings.

Comprehensive Stormwater Program Management | Chesterfield County, VA | Chesterfield County, VA | Task Lead
Management of multiple year stormwater contract with Chesterfield County that has included separate task orders for compliance planning, stream restoration, preliminary engineering report for large scale reservoir restoration, stormwater BMP retrofit design, stormwater utility fee development, Chesapeake Bay TMDL Action Plan development, and stormwater management plan review support. Developed a compliance plan that included recommendations for stormwater BMP retrofits that will be implemented to achieve the nutrient and sediment reduction goals required in the first permit term for the Chesapeake Bay TMDL.

Riverfront Park Stormwater Assessment | City of Lynchburg, VA | Lynchburg, VA | Technical Lead
Technical Lead for the evaluation of existing stormwater management facilities in the Riverfront Park redevelopment area to assess current condition, flood mitigation options and improvement recommendations to alleviate flooding in the area. Assessed floodplain development requirements for new amphitheater and associated facilities.

Stormwater Design and MS4 Compliance Support Services | City of Newport News, VA | Newport News, VA | Project Manager
Project Manager responsible for design improvements to pond outlet structure and prepared permit applications for living shoreline project near Mariners Museum in Newport News to alleviate flooding concerns in residential neighborhood. Developed Stormwater Pollution Prevention Plan (SWPPP) template and site-specific SWPPPs for all of the City's High Priority Municipal Facilities.

Cobbs Creek Reservoir Modeling and Withdrawal Permit Support | Henrico County, VA | Henrico County, VA | Technical Lead
Technical Lead for the development of safe yield model for Cobbs Creek Reservoir to determine river withdrawal and release rules required to meet ecological requirements and water supply demands of downstream partners. Negotiated terms with VDEQ for surface water withdrawal permit.

Larry Trout, Jr., PE

Lead Coastal Engineer

STRAUGHAN ENVIRONMENTAL

Summary

Larry is a coastal and ecological restoration designer with many years of practical experience in the areas of nature-based solutions, shoreline stabilization, tidal marsh restoration, and stream/wetland restoration. He has worked on multiple coastal restoration projects which has enabled him to understand the challenges of working in a dynamic coastal environment. Provided services have included economic/ vulnerability assessments as well as design, permitting and construction of living shorelines. Mr. Trout has worked for state and local governments on the evaluation and implementation of coastal restoration opportunities in which infrastructure protection and/or MS4 crediting were challenges, some of which involved grant funding assistance.

Experience

Natural and Nature-Based Solutions (NNBS) Pilot Site | Virginia Department of Transportation (VDOT) | Farnham, VA | Project Manager

Responsible for developing pilot study site maintenance measures design and installation support, 30% design and monitoring for this VDOT Natural and Nature-Based Solutions (NNBS) Pilot Study conceptual design project. The project included developing a conceptual and 30% design as well as design of maintenance measures for the previously selected Pilot Study site. The pilot site is an approximate 1,000 linear foot length of shoreline located adjacent to Simonson Road along Morattico Creek in Farnham, VA. Tasks included performing a biological resource assessment, vegetation reference site characterization, water level monitoring and development of 30% plans in VDOT plan and CADD standards.

Hilton Beach Shoreline Restoration | City of Newport News | Newport News, VA| Task Manager

Responsible for performing site evaluation as well as beach creation/shoreline management strategies for Hilton Beach park for the City of Newport News. Plans were prepared for the construction of the proposed shoreline improvements which includes creation of beach profile as well as access path improvements. The shoreline improvements were performed in construction with upgrade and extension of two storm drain outfalls.

Alternatives Analysis for the Regulatory Building Line Along Delaware's Coast | Delaware Department of Natural Resources and Environmental Control (DNREC) | Kent and Sussex Counties, DE| Water Resources Engineering Task Manager

responsible for supporting The Division of Watershed Stewardship's Shoreline and Waterway Management Section's study to evaluate alternatives for updating the Building Line, a setback line used in regulating coastal construction on the Delaware Coast under the provisions for the Beach Preservation Act of 1972. The Building Line is currently based on a delineated topographic feature meant to represent the landward toe of the dune, but

YEARS OF EXPERIENCE

31 years

YEARS WITH STRAUGHAN

5 years

EDUCATION

MS, 1995, Civil Engineering, Bucknell University

BS, 1994, Civil Engineering, Bucknell University

REGISTRATIONS/CERTIFICATIONS

Professional Engineer: DE, MD

Rosgen Levels I-IV

AFFILIATIONS

Past Vice President, Delaware Chapter of the American Water Resources Association

Past Regional Coordinator, AASHTO TRAC Program

the mapping of this feature has not reoccurred since the Building Line's establishment in 1981. In the State's 2021 Climate Action Plan (CAP), the state is called upon to "Periodically update the regulations for the Beach Preservation Act, incorporating current best science and management practices to account for rising sea levels and storm surge." The study investigated the alternatives available for updating the Building Line using the best available science, management practices and datasets, as prescribed by the CAP. Tasks included summary and review of existing coastal construction setback line methodologies including conducting interviews with regulators in other states; data collection; alternatives analysis; and recommendations for re-establishing the Building Line.

Shoreline Stabilization & Flood Protection for St. George's Island along MD 249 Piney Point Road | Maryland State Highway Administration | St. Mary's County, MD | Project Manager

Responsible for assessment and preparation of conceptual design of living shoreline, revetment and wave attenuation device (WAD) techniques for stabilization and flood protection of three targeted shoreline areas along the Potomac River. St. George's Island is located at the confluence of the St. Mary's River and Potomac River in St. Mary's County, Maryland. MD 249 is the only access point for the island and serves as an emergency route, making the road vital to the island community of approximately 200 homes. Shoreline erosion (93 feet since 1993 and an average of approximately 4 feet per year since 1858) has accelerated due to rising sea levels, increased precipitation, subsequent stream flow, wind and wave action, and loss of wetland vegetation. At the project sites the shoreline has eroded to less than 7ft from the edge of road. The frequency of nuisance flooding is increasing (MD 249 was estimated to have inundated 52 times last year, despite the twice monthly ditch cleaning, and frequent road maintenance) due to sea level rise. Proposed methods to address and meet these goals include development of three tiers of protection to address tidal fluctuations as well as storm surges and wave energy.

Croppers Island and Two Stark Properties Salt Marsh Restoration, U.S. Fish & Wildlife Service, Worcester County, MD | Project Manager

Responsible for final design of salt marsh restoration at three (3) private properties along the Maryland Coastal Bays of Newport and Sinepuxent Bays, as a subconsultant to Sovereign Consulting, Inc. The salt marshes have been impacted by ditching for mosquito control as well as effects of sea level rising causing creation of open waters in a portion of the marsh cells. Proposed improvements include addition of runnels to improve marsh drainage as well as fill placement where needed to raise the marsh platform. Tasks include: desktop data collection and review and use of the provided USFWS data; site visit to all sites to perform assessment and document current conditions; preparation of 30%, 60%, 90% and final design plans; and permitting support services including development of impact plates, narratives and meeting attendance.

Coastal Resilience Capacity Building for Eight Coastal Communities -National Coastal Resilience Fund - Technical Team Services | University of Maryland| Maryland | Project Manager

Project Manager for the University of Maryland Environmental Finance Center through a National Fish and Wildlife, National Coastal Resilience Fund grant. This project is guiding a cohort of eight coastal Maryland communities through a resilience planning process to (1) evaluate the local government's capacity and readiness to adapt; (2) assess each jurisdiction's vulnerability to climate-related coastal hazards; (3) identify and prioritize a set of nature-based solutions (NBS) that will improve resilience to coastal hazards and protect or enhance fish and wildlife habitat; and (4) connect each community to partners that can expand capacity or support implementation. Straughan is leading the technical team to develop a climate vulnerability assessment and a list of nature-based and hybrid solutions to advance to provide coastal resilience to these communities. Straughan is also assisting in community outreach and tracking of future funding for implementation of the concepts being developed.

Perry Point Medical Center (VAMC) Shoreline Stabilization Study | U.S. Department of Veterans Affairs | Perryville, MD | Project Manager

Leading a team that is currently evaluating the feasibility of stabilizing the entirety of the VAMC shoreline in the currently non-stabilized areas, a length of approximately 7,000 feet. The VA hopes to maintain and improve the shoreline, not only to obtain MS4 regulation credits, but to ensure erosion can be controlled to maintain the Chesapeake Bay Critical Area buffer and prevent the property shoreline from eroding into the Susquehanna River, especially in sensitive areas. Our work involves data collection and document review, onsite surveys of existing shoreline conditions, identification of stabilization design parameters including for storm drain outfalls, coordination with state, local, and federal regulatory agencies, development of conceptual drawings and details, cost estimates, and we are further aiding the VA in identifying potential sources of future funding sources and partnerships.

Joe Arrowsmith, PE

Ecological & Coastal Engineer

STRAUGHAN ENVIRONMENTAL

Summary

Joe Arrowsmith is a civil and water resources engineer with 17 years of experience advancing nature-based restoration throughout the Chesapeake Bay watershed and coastal bays. His portfolio ranges from tidal wetland creation and living shoreline design to large-scale ecosystem rehabilitation integrated within complex urban and industrial landscapes. Joe recently completed the natural resources design and oversaw construction for the 68th Street Landfill Superfund site, including tidal wetland systems and tidal stream channels built to perform under highly constrained site conditions. He has developed nature-based shoreline projects using a range of approaches including offshore breakwaters, regenerative headland and tombolo features, and improved marsh channel circulation, and has supported alternatives analyses for organizations such as the U.S. Fish and Wildlife service, the Maryland Port Administration and the Maryland Department of Natural Resources. Joe is experienced in coastal flood modeling, wave setup and runup analysis, and AD-CIRC tidal circulation applications, and served as a subject matter expert and quality reviewer for Straughan's engineering support to the Hampton Roads Bridge Tunnel Project. His work has been recognized with both local and national Awards from ACEC. In addition to coastal work, Joe has led multiple upland restoration projects and authored technical guidance and trainings on integrating modern infrastructure, land use constraints, and community priorities into resilient ecological design.

Experience

John Heinz Wetland Restoration Two-Dimensional Modeling | U.S. Fish and Wildlife Service | Philadelphia, PA | Project Manager

For the U.S. Fish and Wildlife Service, Joe led a two-dimensional hydraulic modeling effort to inform tidal wetland restoration at the Henderson Dike Marsh, a dredged spoil site within the John Heinz National Wildlife Refuge. The project supported a larger design initiative aimed at improving tidal connectivity and ecosystem resilience across a 160-acre site at the confluence of riverine and tidal hydrology. Joe managed the development of SRH-2D models using SMS mesh generation tools to characterize flow direction, velocity, and shear stress under both existing and proposed conditions. The modeling incorporated field-validated data and was used to evaluate two alternative channel reconfiguration designs, supporting the selection of a restoration approach that maximized tidal exchange and long-term hydrologic function. Joe provided technical leadership in model selection, parameterization, mesh development, and team oversight throughout delivery.

I-64 Hampton Roads Bridge-Tunnel Expansion Project | Virginia Department of Transportation (VDOT) | Hampton, Virginia | Subject Matter Expert

Responsible for overseeing quality and providing review for a Stormwater Pollution Prevention Plan (SWPPP) for the HRBT I-64 expansion project. Mr. Arrowsmith provided review and guidance on erosion and sediment control

YEARS OF EXPERIENCE

17 years

YEARS WITH STRAUGHAN

9 years

EDUCATION

MS, 2015, Environmental Engineering and Science, Johns Hopkins University

BS, 2009, Civil & Environmental Engineering, Virginia Tech

REGISTRATIONS/CERTIFICATIONS

Professional Engineer, Virginia - 2024 (067941, Exp. 2/28/29)

Professional Engineer: DC, MD

Rosgen Levels I-IV

PUBLICATIONS

Design Guidelines for Step Pool Stormwater Conveyance Systems (SPSC), Anne Arundel County, 2022 (primary author)

Uncovering the History of the District's Buried Streams, District Department of Energy and Environment, 2021 (co-author)

Regenerative Stream Conveyance Construction Guidance, Maryland Department of Natural Resources, 2018 (technical reviewer)

AWARDS

ACEC-MW Young Professional of the Year (2022)

design, sequencing of construction, pollution prevention planning, and SWPPP report generation for South Island and Willoughby Spit. The overall project spans approximately 9.5 miles across tidal waters between Hampton and Norfolk, Virginia. The proposed conditions included addition of two travel lanes on the landside portions of I-64 and four additional lanes created by two new tunnel bores and bridges on the waterside portions of I-64.

Hart-Miller Island Shoreline Stabilization Alternatives | MDOT Maryland Port Administration | Baltimore County, MD | Project Manager

For the MDOT Maryland Port Administration, Mr. Arrowsmith led the development of an alternatives analysis and conceptual design report to stabilize 2,700 linear feet of shoreline at the Hart-Miller Island Dredged Material Containment Facility, an asset slated for future transfer to the Maryland Department of Natural Resources. The project was initiated to ensure DNR receives a resilient and sustainable site upon closure. Joe managed all aspects of the effort, including client coordination, subcontractor oversight, and technical direction. He led a VIMS shoreline stability evaluation, reviewed 27 years of historical records and mapping, and oversaw the development of wind and wave analysis across a 32-mile fetch. Five stabilization alternatives were developed, ranging from offshore breakwaters and hybrid sill/marsh configurations to beach nourishment and innovative, lower-cost solutions such as Atlantic Reefmaker. Each alternative included construction cost estimates and projections for potential TMDL/MS4 credit generation.

68th Street Landfill Restoration Plan | 68th Street Working Group | Baltimore County, MD Project Manager and Lead Designer

Mr. Arrowsmith led the Natural Resources Damages Scope of Work for stream and tidal wetland restoration activities at the 68th Street Landfill Superfund site in Rosedale, MD. He provided design services for stream stabilization, floodplain reconnection, invasive species management, tidal wetland creation, and native landscaping. He developed a 2D hydraulic model of the site to identify flow patterns within tidally influenced interconnected streams and floodplains. He also led O&M and trash capture strategy. The restoration project completed final design in June 2022 and completed construction in 2024. He is overseeing supporting post-construction monitoring.

Identifying Non-Point Source Nutrient and Sediment Reduction Opportunities in the Sinepuxent, Newport and Chincoteague Bay Sub-Watersheds, Maryland Coastal Bays Program | Worcester County, MD | Technical Specialist

Responsible for assisting with search criteria and site prioritization for non-point source nutrient and sediment reduction projects in the Sinepuxent, Newport, and Chincoteague Bay sub-watersheds in the Maryland Coastal Bays. Mr. Arrowsmith provided technical direction on GIS desktop search parameters, review of individual sites, and independent peer review of field data following on-site visits.

Cedar Haven Living Shoreline | Prince George's County Department of the Environment | Prince George's County, MD | Project Manager / Technical Advisor

For Prince George's County Department of the Environment, this project restored 800 linear feet of shoreline along the Patuxent River using an offshore sill and marsh backfill system on public parkland. The project contributed to the County's TMDL and MS4 restoration goals while enhancing resilience and ecosystem function. Joe served as Project Manager and technical advisor, leading quality assurance and technical review of the living shoreline design. He also supported agency coordination with MDE, USACE, and the Critical Area Commission throughout the permitting process. Following permit approvals, he assisted the County with procurement, coordinated time-of-year waiver requests, and provided technical support during construction, including review of contractor RFIs and field questions.

Magruder's Ferry Living Shoreline | Prince George's County Department of the Environment | Prince George's County, MD | Project Manager / Technical Advisor

For Prince George's County Department of the Environment, this project restored 1,000 linear feet of shoreline along the Patuxent River using an offshore sill and marsh backfill system on public parkland. The project was a first of it's kind collaboration on private land which contributed to the County's TMDL and MS4 restoration goals. Joe served multiple roles on this project including Project Manager and technical advisor, leading quality assurance and technical review of the living shoreline design. Following permit approvals, he assisted the County with construction oversight, including review of contractor RFIs and field questions.

Drew Altland, PE

Nature Based Solutions & Ecological Restoration Engineer

STRAUGHAN ENVIRONMENTAL

Summary

Drew Altland has over 30 years of experience providing assessment, design, monitoring, peer review, legal support, and construction supervision for water resources projects. His expertise in fluvial geomorphology, sediment transport, eco-system assessment and hydraulic modeling has allowed him to lead many successful projects in watershed, stream, floodplain, wetland and shoreline restoration. He has specialized experience in developing methods to achieve MS4/TMDL and stormwater credits for restoring streams, floodplains, and wetlands. He is adept in 1D and 2D hydraulic river modeling, dam removal, aquatic life passage, flood impact studies, infrastructure protection in the river setting, stormwater practices and compensatory mitigation. He is skilled at preparing construction documents, including drawings, specifications, cost estimates, and bid documents. He routinely utilizes computer software, including, but not limited to: MicroStation, In-Roads, SMS/TUFLOW, HEC-RAS, TR-55/TR-20 and HY-8.

Experience

Shenandoah River Watershed Stream Restoration TMDL Credit Analysis and Restoration Design | Private Client for VA Department of Environmental Quality (DEQ) | Rockingham and Clarke Counties, VA | Senior Engineer

Led on-site evaluations for two separate streams within the Shenandoah watershed, spanning approximately 8,400 linear feet, to assess stream characteristics including Rosgen stream classification, construction access, extent of tree/forest cover, utility conflicts, fish passage blockages, and other constraints. Oversaw a streambank erosion study using Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) methodology. Led the design effort which included hydrologic studies, hydraulic analysis, plan development, construction quantity estimates, and an evaluation natural resource impacts. To maximize TMDL reduction credits the designs utilized integrated stream/wetland approach that removes legacy sediment from the restored floodplain zone to tie into the historic wetland soil layer and groundwater aquifer. TMDL reduction credits were computed for sediment, nitrogen and phosphorus by the elimination of sources of sediment and nutrients stored in erosive stream banks (Protocol 1), creating an expansive floodplain wetland system tied into the historic groundwater aquifer, and incorporating woody material to improve hyporheic exchange (Protocol 2), and attaching flood flows, base flows, and/or groundwater to a highly-attached riparian floodplain that serves to trap and filter sediment and nutrients (Protocol 3).

Gramies Run Assessment and Restoration | MDOT SHA | Cecil County, MD | Project Manager

Responsible for watershed assessment and stream corridor studies supporting MDOT SHA's TMDL initiatives. Watershed assessment included anthropogenic impact investigation using historic site data and maps and evaluation of modern infrastructure impacts, watershed-scale hydrologic

YEARS OF EXPERIENCE

33 years

YEARS WITH STRAUGHAN

2 years

EDUCATION

BS, Civil Engineering (Concentration: Water Resources), 1993, Pennsylvania State University

REGISTRATIONS/CERTIFICATIONS

Professional Engineer, Virginia - 2022 (0402065495, Exp. 8/31/2026)

Professional Engineer: DC, GA, KY, MD, NC, PA, TN, TX

EXPERT PANEL & TECHNICAL SUPPORT

PA Department of the Environment (DEP), Waterways and Wetlands Restoration Stakeholder Workgroup Steering Committee, 2024-ongoing

DEP, Pennsylvania Post-Construction Stormwater Management Manual (PCSM), 2023-2024

Scientific and Technical Advisory Committee (STAC) Workshop on the State of Science and Practice of Stream Restoration in the Chesapeake Bay: Lessons Learned to Inform Better Implementation of Assessment and Outcomes, Invited Contributor, 2023

Chesapeake Bay Trust Pooled Monitoring Initiative Expert Panel, 2021-2023

EPA/CSN Stream Restoration Expert Panels to develop sediment and nutrient reduction protocols, 2018-ongoing

study, existing conditions hydraulics analysis using HEC-RAS and HY-8, and water quality pollutant load modeling. Field efforts for geomorphic assessment spanned 28,600 feet of Gramies Run and three tributaries, channel stability assessment using BANCS, establishment of monumented cross section, monitoring of bank pins, bulk density sampling/testing, and bankfull flow and sediment transport analysis. From these studies approximately 12,500 feet of stream length was targeted for restoration within seven reaches of Gramies Run and unnamed tributaries. TMDL stream credit computations were performed following Protocol 1, 2 and 3 guidance. Preliminary stream and floodplain restoration plans were developed for approximately 12,500 feet of existing channel length that included three separated restoration alternatives. Drew developed a design report that included an advantages/disadvantages discussion of three design alternatives, cost vs. benefit analysis included TMDL crediting, and function uplift assessments.

Regional Blue Green Infrastructure (BGI) Flood Mitigation Study | Metropolitan Washington Council of Governments (MWCOG) | Prince George's County, MD and Washington, DC | Senior Engineer

Supported the study to provide watershed assessments within Oxon Run, Watts Branch and Arundel Canal watersheds to identify actionable alternatives for blue, green, and gray infrastructure improvements. Identified improvements in each watershed included green streets, impervious area reduction, reforestation and street tree plantings, pond retrofits, stream/floodplain restoration, floodable public spaces, storm drainage outfall retrofits, stream daylighting, and undersized bridge/culvert modifications. Evaluation of these opportunity improvements included hydrologic studies, hydraulic analysis, alternatives evaluation, and production of concept drawings and renderings for priority opportunities. Performed a research effort to identify Federal, State and local government grant opportunities to help fund flood improvement and relief projects and aided in the development of a grant comparison matrix to help prioritize most suitable funding tracks.

Woodfield Wetland Mitigation Bank Study | MDOT-SHA-OED | Montgomery County, MD | Project Director

Led the efforts to perform a review of the SC-19 Wetland Mitigation Project documents that was constructed in 2013, the Woodfield Wetland Mitigation Bank Semi-Final Design documents developed in 2019, and other pertinent information related to these projects to develop recommendations based on today's site conditions. These findings and recommendations have been informed by on-site investigations, digital elevation model (DEM) differencing analysis using available Light Detection and Ranging (LiDAR) data and digital terrain models (DTMs) from multiple field survey efforts including an updated field survey of the Great Seneca Creek active channels in June 2024. The DEM differencing efforts have been performed to help track areas of erosion and deposition in the channels and floodplain since 2011. Developed a findings and recommendations report to document today's conditions, stability of the 2013 mitigated wetlands, appropriateness of the past 2019 design to protect the wetland constructed in 2013, and recommendations to achieve long-term stability based on the data that was available in 2024.

Marley Creek Watershed Study, Stream Restoration, Outfall Stabilizations, and Stormwater BMP Retrofits | Anne Arundel County DPW | Anne Arundel County, MD | Project Manager

Led the restoration of Marley Creek and multiple tributaries to meet TMDL programmatic needs, which spans approximately 18,308 feet with approximately 19 stormwater/culvert outfall stabilizations and two SWM retrofit practices of piped/closed stream segments. Services included performing a watershed study to assess sediment/large woody debris sources/supply, base level controls and stream corridor impairments, HQ-LiDAR, topographic and bathometric surveys, environmental due diligence assessments, NRIs, geomorphic surveys, BANCS assessments, hydrologic studies, hydraulic modeling using HEC-RAS, FEMA floodplain modeling integration and flood impact analysis, stream restoration design, stormwater retrofit design, stormwater outfall stabilization, TMDL credit computations, construction document development, and preparation of all permits.

Serena Stafford, PE

Coastal Engineer

STRAUGHAN ENVIRONMENTAL

Summary

Ms. Stafford is a Professional Engineer experienced in management and design of civil, roadway, and water resource engineering for Federal, State, and local construction projects. She has been involved in transportation projects for the past 17 years. Her experience includes: stormwater management (SWM); erosion and sediment control (ESC); roadway and site drainage; shoreline restoration; cost estimating; NPDES compliance; permitting; roadway design, and preparation of construction documents. She has experience using WIN TR-20, TR-55, HY-8, ICPR, Projectwise, MicroStation and GeoPak.

Experience

I-64 Hampton Road Bridge Tunnel Expansion Project| Virginia Department of Transportation | Hampton, VA | Water Resources Engineer

Responsible for preparation of the Construction General Permit and Stormwater Pollution Prevention Plan (CGP/SWPPP) for the North and South Island that will be utilized for the tunnel boring operations for the expansion of the I-64 bridge tunnel and the overall landside roadway expansion. The expansion project will take the road from two - 2 lane segments to four - 2 lane tunnel segments, taking the total number of lanes from four to eight. The CGP/SWPPP includes preparing erosion and sediment control design for the two islands using VDOT standards. Straughan also prepared the stormwater nutrient credit determination using the Performance based water quality spreadsheet from Virginia DEQ.

Living Shorelines | Prince George's County Department of Environment (PG DoE) | Cedar Haven, MD and Magruders Ferry | Task Manager

Responsible for hybrid living shoreline project and Erosion and Sediment Control. The project includes providing field assessments and design solutions for shoreline stabilization and erosion control in Prince George's County to help Prince George's County Department of the Environment (PG DoE) meet the mandate for the counties Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) permit. Project tasks included coordination for a Maryland Agricultural trust (MALPF) easement on the property that will have the shoreline improvements, coordination with Prince George's County planning commission, and development of special provisions. Ms. Stafford is currently providing construction phase services for Cedar Haven Fishing Area design by reviewing contractor requests for information, making site visits, and providing technical support to PG County.

Shoreline Stabilization & Flood Protection for St. George's Island along MD 249 Piney Point Road | Maryland State Highway Administration | St. Mary's County, MD | Water Resources Task Manager

Responsible for leading design that proposes living shoreline, revetment and wave attenuation device (WAD) techniques for stabilization and flood protection of three targeted shoreline areas along the Potomac River. The

YEARS OF EXPERIENCE

17 years

YEARS WITH STRAUGHAN

7 years

EDUCATION

ME, 2015, Civil Engineering, University of Maryland

BS, 2005, Civil Engineering, University of Central Florida

REGISTRATIONS/CERTIFICATIONS

Professional Engineer, Virginia - 2014 (#0402053215, Exp. 6/30/26)

Professional Engineer: MD

Virginia DEQ Plan Reviewer for SWM, 2019

Virginia DEQ Plan Reviewer for ESC, 2019

AFFILIATIONS

American Society of Highway Engineers

Women's Transportation Seminar

frequency of nuisance flooding is increasing (MD 249 was estimated to have been inundated 52 times last year, despite the twice monthly ditch cleaning, and frequent road maintenance) due to sea level rise. Proposed methods to address and meet these goals include development of three tiers of protection to address tidal fluctuations as well as storm surges and wave energy.

Oak Road Park Shoreline Erosion Control and Enhancement Services | Baltimore County DEP | Baltimore County, MD | Water Resources Engineer

Responsible for reviewing and providing input on the design of living shorelines at the Oak Road Park. Project objectives include improving water quality by stabilizing eroding banks and reducing the nutrient loading (nitrogen and phosphorous) into to the Chesapeake. Providing ecological uplift by improving tidal habitat through use of nature-based shoreline stabilization, protecting and enhancing the riparian buffer. Straughan is also assisting in meeting the County's Watershed Implementation Plan as required by its NPDES MS4 permit and the Clean Water Act. Straughan has provided design alternatives that include timber toe protection, ECO-WAD, oyster castles, and more traditional living shoreline design with stone breakwaters.

Hart Miller Island – Shoreline Alternatives | Baltimore County, MD | Independent Technical Reviewer and Quality Manager

Independent Technical Reviewer and Quality Manager for the assessment and design of shoreline restoration alternatives approximately 2,700 linear feet of the western boundary of the Hart Miller Island dredge material containment site. Ms. Stafford was responsible for reviewing concept alternatives and offshore wave and wind calculations, stone sizing, and cost estimates. Ms. Stafford served as a technical consultant and participated in the development design alternatives and ensured the results were in agreement with owner objectives. These alternatives included living shoreline, breakwaters, revetments, stone sills, and beach replenishment. Ms. Stafford also reviewed calculations for TMDL/MS4 impervious acre credit to ensure compliance with current guidelines from MDE and the Chesapeake Bay program.

Jennifer Martin, ENV SP, CEP

Environmental Planner

STRAUGHAN ENVIRONMENTAL

Summary

Jennifer has many years of national experience in environmental planning efforts for various federal, state, and local government clients. Her experience includes a diverse range of projects and programs relating to environmental regulatory compliance, sustainability, and climate resiliency program implementation. Her combined technical and environmental experience serves as a foundation for developing effective stakeholder coordination and equitable public outreach for the clients she serves.

Experience

Clean Ports Program-wide Outreach & Engagement Services | Maryland Port Administration (MPA)/Maryland Environmental Service (MES) | Statewide, MD | Project Manager

Project Manager for the Maryland Port Administration's Clean Ports Program initiative, responsible for leading strategic planning and coordination efforts to support the deployment of zero-emission equipment, development of an Air Quality Improvement Strategy, and creation of a Comprehensive Community Engagement Plan. This role includes stakeholder collaboration, project communications, and alignment with US EPA grant requirements to ensure measurable reductions in criteria air pollutants and greenhouse gas emissions. Manages the development of outreach materials that communicate project goals, environmental benefits, and community opportunities, ensuring content is accessible, engaging, and aligned with the Clean Ports Program's mission. Also responsible for the integration of workforce development and energy resiliency components, helping shape a forward-looking blueprint for sustainable port operations.

Technical Support Needs Assessment | Maryland Port Administration | Statewide, MD | Technical Specialist

Supporting the Maryland Port Administration's Digital Transformation Strategic Assessment, contributing to the modernization of MPA operational workflows across Outreach, Administration, Innovative Reuse, and Permitting functions. Responsibilities include evaluating existing systems, identifying opportunities for data integration and automation, and recommending technology-based improvements aligned with MPA's strategic goals. Also supported stakeholder engagement, facilitated needs assessments, and helped define digital solutions such as centralized databases, GIS-enabled dashboards, and automated compliance tools.

Natural Resource Management Plan (NRMP) | Columbia Association | Columbia, MD| Project Manager

Responsible for leading the development of a comprehensive strategy to assess, protect, and enhance natural resources within the communities of Columbia and across Columbia Association (CA) assets. Responsibilities include overseeing stakeholder engagement, coordinating with subcontractors, and guiding the inventory and analysis of quantitative data, visuals, policies, and best management practices. Facilitated the

YEARS OF EXPERIENCE

23 years

YEARS WITH STRAUGHAN

1 year

EDUCATION

MS, 2005, Environmental Sciences and Policy, Johns Hopkins University

BS, 2001, Environmental Analysis & Planning, Frostburg State University

REGISTRATIONS/CERTIFICATIONS

Envision Sustainability Professional, Institute for Sustainable Infrastructure

Certified Instructor, National Highway Institute (NHI)/FHWA

Certified Environmental Professional, Academy of Board-Certified Environmental Professionals

integration of existing reports, regulations, and community input to inform actionable recommendations and future policy development. She oversees outreach activities including public and stakeholder meetings, surveys, and targeted communications to gather input from residents, CA staff, and local organizations and is responsible for synthesizing qualitative feedback with technical data to inform plan recommendations and ensure alignment with community values. This work supports long-term ecological resilience, regulatory alignment, and strategic planning for sustainable land management.

MTA Climate Resilient Transportation Program | Maryland Transit Administration (MTA) | Statewide, MD| Project Manager

Provided staff augmentation services on behalf of the Maryland Transit Administration (MTA), serving in the role of Resilient Transportation Program Manager and working in tandem with the agency's Sustainable Transportation Program to combine performance metrics, reporting, etc., on behalf of the agency. She ensured alignment of both programs with the agency's strategic plan, confirms all efforts are carried forward with an equitable lens, sets program goals/performance measures, and oversaw baselines/performance targets. In addition to identifying components of the program, her responsibility included prioritizing equity in resilience and sustainability initiatives, conducting transportation agency interviews of best practices throughout the country, performing legislative/literature reviews, and assisting with the development of a climate equity index and ranking criteria for project prioritization. Ms. Martin represented MTA internally and externally for efforts relating to changing the organizational culture of MTA and the consideration of climate resiliency for the agency's assets, programs, as well as transit riders throughout the state of Maryland. Ms. Martin was also the primary architect and developer of an Adaptation and Resiliency Toolbox (ARToolbox), which provides a hands-on analytical planning tool for transportation assets and incorporating equity into resiliency planning. Ms. Martin also spearheaded efforts to update the agency-wide vulnerability assessment, which included reviews environmental data layers relating to climatic hazards, asset vulnerability determinations, and consideration of social vulnerability of underserved and underrepresented populations. She also assisted with climate-resiliency grant application and management, which included FEMA-funded grant vehicles (HMGP, BRIC, etc.) including preparation of grant benefit-cost analyses in support of grant applications. Ms. Martin led efforts for resiliency-specific projects and pilot studies and developed standard operating procedures for incorporating resiliency into MTA's project planning process. Ms. Martin represented MTA on MDOT's Resiliency Task Force, often leading presentations of efforts being employed at the agency. Ms. Martin also continuously coordinated with internal stakeholders, modes/divisions, and Asset Management to determine appropriate methods for incorporating resiliency into the asset management and project development process.

WMATA Resiliency System-Wide Program Development | WMATA | VA, MD, Washington, DC | Subject Matter Expert

Subject Matter Expert on a multi-disciplinary team for the development of a system-wide resiliency program for the Washington Metropolitan Area Transit Authority (WMATA) for agency assets located in Virginia, Washington, DC and Maryland. In this role, Ms. Martin provided technical assistance related to: reviewing and researching industry standards/guidance, federal regulations, and regional policies; identification and analyses of existing agency resilience policy gaps; development of draft resiliency policy design guidelines/standards; support of stress tests and site-specific risk assessments; external agency research and review of resiliency programs/projects; development draft resilience program structure approach, and resiliency program implementation support.

Inaugural Sustainability Plan Outreach & Engagement Services | City of Laurel | Laurel, MD | Public Involvement Lead Designer

Responsible for all outreach and engagement materials prepared in support of both a sustainable community implementation framework and sustainable organization implementation plan. Ms. Martin was responsible for the overall management and content development supporting outreach efforts to engage a diverse base of community members such as: elected officials, residents, business owners, youth/students, civic organizations, environmental groups, social service organizations, and organizations serving and/or representing underrepresented populations. Responsibilities include the development of program "branding" and design/publication of various mailers, poster boards, explainer animated videos, surveys, etc. Jennifer also served as a subject matter expert for public engagement meetings and facilitated several small focus groups with stakeholders and special interest groups with vested interest in program development. Strategies to engage community members pair broad scale and grassroot outreach efforts to culturally diverse populations.

Elizabeth O'Keefe Markham, GISP

GIS Analyst

STRAUGHAN ENVIRONMENTAL

Summary

Elizabeth O'Keefe Markham has nine years' experience with the manipulation and analysis of both spatial and non-spatial data. Ms. O'Keefe Markham is responsible for project management, spatial database management, GIS mapping, and spatial analysis. She is an expert with Esri products including ArcGIS Pro, Python, SQL, Spatial Analyst, model-builder, ArcGIS Online, Field Maps for ArcGIS, Survey 123 for ArcGIS, WebApp Builder and Experience Builder, as well as Esri Story Maps, Sites, and Dashboards. She has extensive experience supporting data collection and analysis, map creation, as well as developing suitability and prioritization models and impact analyses. She has experience with environmental planning in technical report writing for projects following the NEPA documentation process at EIS, EA, and CE levels.

Experience

Regional Blue Green Infrastructure (BGI) Flood Mitigation Study | Metropolitan Washington Council of Governments (MWCOG) | Prince George's County, MD and Washington, DC | Senior GIS Analyst

Managed the GIS team and associated GIS tasks to support an interdisciplinary team of engineers and planners developing a groundbreaking approach to regional flood management by studying three watersheds (Oxon Run, Watts Branch, Arundel Canal) that cross jurisdictional boundaries. Developed a framework and a methodology for processing topic area spatial data within the focus areas for the prioritization analysis. Ranked and prioritized the processed data based on criteria and weighting factors in line with project focus and goals, highlighting focus areas which met criteria to be suitable candidates for BMP development. Designed a series of maps and a custom printing script to show potential opportunities within the current project area as well as the existing features and conditions of the watersheds that make up the project area. Developed mapping and displays for use in the report and in public outreach with accessibility considerations in mind.

Integrated Assessment of Climate Change Impacts to Groundwater, Stormwater, and Wastewater Infrastructure at Coastal Military Facilities | University of Delaware | Dover, DE, Hampton VA, and Norfolk VA, Dover DE, and Nationwide | Senior GIS Analyst

Senior GIS Analyst for project with the University of Delaware to the Environmental Security Technology Certification Program (ESTCP) Phase 1 which will demonstrate the application of an integrated suite of models (EPA SWMM and USGS MODFLOW) to holistically analyze the impacts of climate change and extreme weather on groundwater, stormwater, and wastewater infrastructure at US military installations in coastal settings. This modeling toolbox will allow users to identify and prioritize investment in interventions to increase water security and reduce the overall cost to the Department of Defense (DoD) for sustaining water infrastructure systems. Straughan is providing expertise in modeling stormwater generation, stormwater conveyance networks, i.e., piping and pump networks, and wastewater

YEARS OF EXPERIENCE

9 years

YEARS WITH STRAUGHAN

5 years

EDUCATION

BS, 2017, Environmental Science & Technology, University of Maryland - College Park

REGISTRATIONS/CERTIFICATIONS

Geographic Information Systems Professional – 16714

AFFILIATIONS

American Ecological Engineering Society (AEES)

Maryland Stream Restoration Association (MSRA)

Maryland State Geographic Information Committee (MSGIC)

College of Agriculture and Natural Resources Alumni Network Board of Governors – Past President

University of Maryland Alumni Association Board of Governors – Board Member, Representative of the College of Agriculture and Natural Resources

treatment plant performance in response to changes in inflow and salinity. Finally, because of our expertise in providing cost-effective designs of water and wastewater infrastructure, we are responsible for delivering all estimates of cost and construction timelines for the project. Liz is responsible for supporting the University's efforts to launch a research project and providing occasional GIS guidance and technical support. Georeferenced and digitized drainage area maps and delivered geodatabase to the University of Delaware project team.

DNREC Building Line Alternative Analysis | Delaware Department of Natural Resources and Environmental Control (DNREC) | Kent and Sussex Counties, DE | GIS Analyst

Responsible for supporting The Division of Watershed Stewardship's Shoreline and Waterway Management Section's study to evaluate alternatives for updating the Building Line, a setback line used in regulating coastal construction on the Delaware Coast under the provisions for the Beach Preservation Act of 1972. The Building Line is currently based on a delineated topographic feature meant to represent the landward toe of the dune, but the mapping of this feature has not reoccurred since the Building Line's establishment in 1981. In the State's 2021 Climate Action Plan (CAP), the state is called upon to "Periodically update the regulations for the Beach Preservation Act, incorporating current best science and management practices to account for rising sea levels and storm surge." The study investigated the alternatives available for updating the Building Line using the best available science, management practices and datasets, as prescribed by the CAP. Tasks included; summary and review of existing coastal construction setback line methodologies including conducting interviews with regulators in other states; data collection; alternatives analysis; and recommendations for re-establishing the Building Line on Delaware's Coast. Liz was responsible for integrating coastal setback research with available geospatial data to generate five alternative coastal building lines along Delaware's coast. Analyzed LiDAR-derived elevation contours, transect data, erosion rates, orthoimagery, Federal Emergency Management Agency (FEMA)'s Limit of Moderate Wave Action (LiMWA), and Delaware's Mean High Water Line data to create the alternative lines. She performed detailed geoprocessing tasks on the alternative lines for an economic impact analysis, and supported the creation of study areas for each alternative and processed parcel, land use/land cover, and zoning geospatial data to include in the analysis. Liz packaged the data into a comprehensive geodatabase with accompanying metadata and delivered it to the client. She also helped with some of the initial data compilation and map making, and prepared online mapping layers for publication.

Parkland Forest Management Plans and Natural Resource Inventories | Department of Recreation and Parks | Baltimore, MD | GIS Analyst

Responsible for creating, managing, processing, and performing Quality Control of collected data utilized throughout this project, spanning 10 parks. Liz built customized Survey123 forms with schema designed for data incorporation into USDA Forest Service's NED-3 decision support system. She created forms that supported the field collection efforts and enabled precise and efficient data collection across 680 plots and 124 transects, integrating over 230 field parameters across two collection seasons. Results were processed, quality controlled (QC'd), then converted with a custom scripted process into compatible formatting for loading into NED-3's analysis system. NED-3 was then used to evaluate existing and proposed conditions within forested areas, providing a basis for targeted management goals related to ecology, forest health, water resources, and wildlife. This data integration facilitated streamlined analysis and reduced manual data handling within the NED-3 system. Liz developed a comprehensive geodatabase to house all collected data and facilitate analysis of data for reporting. She provided mapping sets to display the collected data within each of the 10 parks, with formatting and symbology to allow for as many resources to be present and legible as possible to analyze the trends and patterns of urban forest conditions.

Category R – Stormwater Management and Green Infrastructure Design | District Department of Transportation (DDOT) | Washington, DC | GIS Analyst

Responsible for the coordination and management of the new assets and the implementation of the data associated with updating their asset inventory with new features based on recorded as-built information on existing Green Infrastructure (GI) BMP features. Additional responsibilities included peer review of the facilities and their attributes populated by other team members, revising the accompanying Geodatabase User Manual, and assisting with the development of Python scripting tools for streamlining geodatabase attribute population. She developed and built a comprehensive model to identify potentially suitable locations for 20 different types of GI within the DDOT public right of way (PROW) across the entirety of the District. The model quantitatively processed weighted values based on the GIS design parameters and incorporated qualitative values based on additional factors provided by the client and engineering team. The result of the model provided generalized footprints for the top 1000 most potentially suitable locations for engineers to develop solutions utilizing co-benefits.

Kate Traut, PWS

Regulatory Specialist

STRAUGHAN ENVIRONMENTAL

Summary

Ms. Traut is a Professional Wetland Scientist and a Certified Arborist with 25 years of combined technical and project management experience. She has extensive experience providing services on a variety of projects including wetland delineations and natural resources inventories; Federal, state, and local environmental regulation compliance, including Section 404/401 permit facilitation; Critical Area coordination; landscape design; wetland and forest mitigation design and monitoring; stream stabilization and remediation design; environmental compliance management and construction oversight; GIS analysis; critical habitat and species surveys; invasive species management plans; regulatory agency and stakeholder coordination; and public outreach and education.

Experience

Potomac Yard WQIA | Washington Metropolitan Area Transit Authority (WMATA) | Alexandria, VA | Project Manager

Responsible for developing a Major Water Quality Impact Assessment (WQIA) in support of the proposed Potomac Yard Metrorail Station. This design-build project proposes impacts to designated Resource Protection Areas, triggering the requirement to prepare a Major WQIA, pursuant to City of Alexandria Article XIII Section 13-117. Responsibilities also included reviewing sediment and erosion control plans, wetland mitigation design plans, and providing regulatory guidance to design-builder.

Old Cameron Run Trail | City of Alexandria | Alexandria, VA | Project Oversight

Project Oversight for natural resources investigations and Section 404/401 permit facilitation for the City's proposed recreational trail along Hooff's Run near Four Mile Creek. Responsibilities include conducting wetland delineations and tree surveys and supporting preparation of existing conditions documentation, wetland impact plates, permit applications, and RTE coordination letters.

Baltimore City Forest Management Plan | Baltimore City Forestry | Baltimore, MD | Natural Resources Senior Consultant, Quality Assurance Lead

Responsible for oversight of and coordination with Natural Resources Task Manager and Contract Manager in support of the development of multi-faceted resource management plan for three major City parks and Natural Resources Inventories (NRIs) for seven smaller City parks. Ms. Traut co-authored the proposal and technical approach, performs ongoing oversight and coordination of the subconsultant, manages project staffing, and provides ongoing subject matter expertise and technical guidance related to the development of the GIS database, field data collection and analysis effort, and development of management recommendations. The forest management plans for the three major parks address forest health issue/threats, species composition, invasive species management, soils improvement, reforestation

YEARS OF EXPERIENCE

25 years

YEARS WITH STRAUGHAN

19 years

EDUCATION

BS, 2005, Environmental Science, Towson University

BA, 1996, Psychology, James Madison University

REGISTRATIONS/CERTIFICATIONS

Professional Wetland Scientist (#2681)

AFFILIATIONS

Society of Wetland Scientists

Association of State Wetland Managers

Maryland Native Plant Society

Society for Ecological Restoration

opportunities, ephemeral plant distribution, and characteristics related to park visitor usage and wildlife presence.

Whitemarsh Run Mitigation Site | Maryland Transportation Authority (MDOT MDTA) | Baltimore County, MD | Environmental Scientist

Responsible for coordinating, leading, and documenting all physical and biological monitoring aspects of constructed and enhanced wetland and 36 vernal pool sites, including invasive species surveying (for monitoring years 0-3). This mitigation site includes the Straughan designed stream restoration site. Post-construction preliminary monitoring and annual data collection in accordance with MDE/USACE approved long term monitoring plan include hydric soils and hydrology assessments using IRIS tubes; wetland and invasive plant species identification; anuran call surveys; salamander and benthic macroinvertebrate sampling; interpretation of data and evaluation of results against performance standards. For monitoring years 4-5, responsibilities included oversight of monitoring coordination, technical support, remedial action assessment and coordination, and QA/QC of data and deliverables.

MD 4 from Forestville to MD 485, Invasive Species Management Plan | Maryland State Highway Administration (MDOT SHA) | Prince George's County, MD | Environmental Specialist

Responsible for developing an invasive species management plan for approximately 4.5 miles of roadway edge vegetation and forested areas. Responsibilities included clarifying project's management goals, tailoring an appropriate field survey methodology and treatment to these goals, leading field surveys, identifying problem species and evaluating infestation densities, using GPS to map field data and prepare infestation location maps, prepare plan documents, including data analysis, species-specific treatment guidelines, and short-term and long-term timelines for treatment. Field surveys resulted in identification of 40 invasive plant species, including one state-listed noxious weed.

Intersection Improvements and Woodland Conservation Bank Establishment | Prince George's County Department of Public Works & Transportation (DPW&T) | Prince George's County, MD | Project Manager/Environmental Scientist

Project Manager/Environmental Scientist responsible for guiding DPW&T through successful establishment of a 54-acre off-site woodland conservation bank site to mitigate for forest impacts, in accordance with M-NCPPC guidance and approval. Efforts included leading forest, wetland, and invasive species investigations; preparation and review of forest conservation documentation; field assessment and reporting of woody stem density and diversity; GPS survey and GIS mapping of invasive species infestations; and preparation of compliance documentation. Designed and implemented a three-year invasive species management strategy (including biological, manual, and chemical treatment methods) and inspected and documented treatment efforts. Cost-saving and multi-pronged approach to site management resulted in two state awards (CEAM and MdQI) and press coverage.

Long Bridge | Virginia Passenger Rail Authority (VPRA) | Washington, DC and Arlington County, VA | Environmental Manager

Overseeing, facilitating, and tracking compliance with environmental/NEPA commitments, Programmatic Agreements, and regulatory approvals, including quality assurance of compliance documents, meeting minutes, and agency agreements.

Soapstone Valley Stream Restoration, Sewer Rehabilitation, and Environmental Compliance and Permitting | DC Water | Washington, DC | Environmental Scientist/Task Manager

Responsible for leading wetland and tree investigations in support of Section 404/401 permitting and NPS Executive Orders; coordinating with NPS, regulatory agencies, and engineers regarding design impacts and avoidance and mitigation; preparing and reviewing NEPA documentation, including EA sections and technical reports; and facilitating agency site visits. She was responsible for substantial revisions to the Wetland/Floodplain Statement of Findings, involving NPS/DC Water coordination and preparation of functional uplift assessment. Efforts supported MS4 outfall repairs and stream stabilization associated with exposed sewer assets.

Maple Dell Farm Cattail Creek Stream Restoration Water Quality Monitoring | WSSC Water | Howard County, MD | Environmental Scientist and Field Support

Responsible for stream restoration monitoring at Cattail Creek, a Patuxent River tributary impacted by agricultural inputs. Project objective is to collect data (chemical, biological, and physical habitat) to characterize the condition of the stream channel, instream habitat and water quality conditions prior to planned restoration activities. Specific tasks included collecting ISCO sampler water collection and sample delivery to WSSC Water lab.

Maria Hackey

Regulatory Specialist

STRAUGHAN ENVIRONMENTAL

Summary

Ms. Hackey is an Environmental Scientist with 27 years' experience with a focus experience CWA Sections 401, 404, and 406 permitting, NEPA documentation, Virginia EIRs, USFWS Section 7 Consultation, SHPO Section 106 Consultation, and natural resources management. A well-rounded early career provides a broad base of experience in brownfields, environmental due diligence and ASTM E1527, industrial hygiene, CERCLA, RCRA, and VPDES compliance.

Experience

Long Bridge Project | Virginia Passenger Rail Authority (VPRA) |Washington, DC and Arlington, VA | Environmental Deputy Manager

Responsible for supporting the Environmental Manager in overseeing, facilitating, and tracking compliance with environmental permit conditions, NEPA commitments, Programmatic Agreements, and regulatory approvals for VPRA's expansion of railway capacity over the Potomac River and Washington Channel. The project includes development of procurement packages, preparation of permit packages (USACE, DOEE, NPS, DDOT, USCG, DCSHPO, etc.), facilitation of permitting processes, resource agency/stakeholder coordination, design review, construction oversight, and compliance documentation.

Falling Creek Reservoir Restoration Permitting | Chesterfield County Environmental Engineering | Chesterfield County, VA | Permitting Manager

Dredge project to re-purpose Falling Creek Reservoir as a Level 1 wet pond as part of the owner's MS4 Implementation Plan. Obtained environmental permits compliant with Clean Water Act (CWA) Section and 401 and 404. Prepared certification for compliance with the Coastal Zone Management Act. Conducted agency consultations in compliance with the National Historic Preservation Act (NHPA) and Endangered Species Act (ESA). Coordinated field activities, was primary contact for regulators and client for permit related tasks, prepared permit application and supporting documentation for regulatory review. Oversaw permit monitoring during construction activities.

Michaux Creek Stream Restoration Project| Chesterfield County Environmental Engineering |Chesterfield County, VA | Permitting Manager

Project included natural stream design and stormwater structures, requiring multiple Nationwide Permits and Virginia Water Protection Permit. Project required environmental permitting compliance with Sections 401 and 404 of the Clean Water Act (CWA) and agency consultation in compliance with the National Historic Preservation Act (NHPA) and Endangered Species Act (ESA). Guided the client through a difficult permitting process due to recent regulatory changes and changes in Navigable Water Rule (NWR).

YEARS OF EXPERIENCE

27 years

YEARS WITH STRAUGHAN

2 years

EDUCATION

BS, Biology, 1995, Le Moyne College

REGISTRATIONS/CERTIFICATIONS

HAZWOPER Certified

AFFILIATIONS

Virginia Association of Wetland Professionals

Addison Evans Water Treatment Plan Flood Wall Environmental Assessment |Chesterfield County Department of Utilities | Chesterfield County, VA | NEPA Task Manager

Conducted an Environmental Assessment under the National Environmental Policy ACT (NEPA) for a proposed floodwall to protect a water treatment plant located entirely within the FEMA 100-year floodplain. EA was prepared to support a grant application and receive Federal pre-disaster mitigation grant funding. Received a Finding of No Significant Impact (FONSI). Assisted FEMA in conducting agency consultation in compliance with the National Historic Preservation Act (NHPA) and Endangered Species Act (ESA).

NEPA Documentation for USCG Exchange | US Coast Guard | Virginia | Senior Scientist

Prepared documentation for Categorical Exclusion determinations by the USCG. Completed a due diligence audit of three potential facilities, environmental impact data collection, consultations with federal and state natural resources and cultural resources agencies in compliance with Section 106 of the NHPA and Section 7 of the ESA.

CSX Railroad Yards NPDES Stormwater Compliance| CSX | Various Locations in Virginia | Senior Scientist

Conducted stormwater sampling in compliance with the NPDES/VPDES permit requirements at railroad yards in Richmond, Newport News, and Portsmouth Virginia. As part of a multi-year contract with renewals, started as field staff collecting samples and transitioned to overseeing field technicians, coordinating sampling events, and ensuring staff received proper railyard safety training.

Master Services Agreement | Virginia Port Authority (VPA) | Various Locations in Virginia | Senior Scientist

Provided Virginia Environmental Impact Reviews for capital improvement projects under a Master Services Agreement. Conducted environmental assessments for expanding railroad spurs to Norfolk Port, including wetland delineations and Phase I ESA along existing and proposed railroad lines.

Multi-Location Vegetation Management Projects | Confidential Gas and Electrical Utilities Client | California | Senior Planner

Multi-year program supporting utility provider in their vegetation management program. Provided biological and cultural resources reviews, agency notifications, and Environmental Release to Construction Reports consistent with federal and state agency programmatic agreements. Worked closely with client's land planners and subject matter experts to meet aggressive timelines on a high-volume portfolio.

Multi-Location Bridge and Culvert Replacement Projects | Confidential Class I Railroad Client | Various Locations | Permitting Scientist

Obtained federal, state, and local permits for multiple bridge replacement projects in California and Arizona, including complex permitting for projects near federal levees. Supported environmental permitting processes including Section 401 and 404 of the CWA, coordinated with state regulatory agencies and Local Levee Maintaining Agencies, and prepared Central Valley Flood Permit Encroachment Applications. Provided documentation to demonstrate project compliance with the NHPA and ESA.

EA for Station Tybee Rebuild | US Coast Guard | Georgia | Senior Scientist

An Environmental Assessment for the US Coast Guard project to rebuild Station Tybee which suffered substantial hurricane damage. Project proposed construction of a new 26,000 square foot structure, repairs to the existing shoreline, parking and roads reconfiguration, and all utility work within the compound to support existing and new infrastructure. Analyzed impacts for two project alternatives to existing natural, cultural, historical, resources including historical National Park Service assets. The EA received a Finding of No Significant Impact (FONSI) from the USCG and the National Park Services.

Mindy Barnowski, CPSM, CF APMP

Graphic Designer & Communications Specialist

STRAUGHAN ENVIRONMENTAL

Summary

Ms. Barnowski is a Graphic Designer and Communications Specialist with extensive experience supporting environmental, infrastructure, and resilience programs through strategic communications, public outreach, and stakeholder engagement. She specializes in translating complex technical information into clear, accessible messaging and visual materials that inform decision-making and encourage participation across diverse audiences. Her experience includes development of educational and outreach materials, coordination with subject matter experts, brand and campaign development, event and meeting support, technical editing, and communications strategy for public-sector clients. Ms. Barnowski has supported public outreach and engagement efforts for a wide range of environmental and infrastructure initiatives, helping agencies communicate program goals, project impacts, and planning concepts effectively and transparently.

Experience

Clean Ports Program-wide Outreach & Engagement Services | Maryland Port Administration (MPA) / Maryland Environmental Service (MES) | Statewide, MD | Design Lead and Senior Graphic Designer

Responsible for developing a comprehensive suite of branded communication tools to support program-wide stakeholder engagement and community outreach for the Clean Ports Program. Leads the creation of a 40-page report template, custom icon set, multiple infographics, and standardized templates for PowerPoint presentations, letterhead, and formal reports. Collaborates closely with technical staff to translate complex environmental and programmatic information into clear, accessible, public-facing materials that communicate program purpose, benefits, and outcomes to diverse audiences. Oversees the work of a junior graphic designer and provides quality control across all deliverables to ensure consistency, clarity, and alignment with program goals. Supports preparation of large-format posters delivered to the client for use in outreach and stakeholder engagement activities.

Natural Resource Management Plan (NRMP) | Columbia Association | Columbia, MD | Senior Graphic Designer

Responsible for producing visual communication tools to support community engagement and project communications for a Natural Resource Management Plan. Creates custom graphic elements used in outreach materials and project explanation tools to convey project goals, environmental considerations, and planning concepts to the public. Participates in community outreach events to engage stakeholders, respond to public questions, and gather feedback on project needs and priorities, supporting an inclusive and transparent planning process. Design support contributes to improved public understanding of project objectives and strengthens the client's stakeholder engagement efforts.

YEARS OF EXPERIENCE

23 years

YEARS WITH STRAUGHAN

11 years

EDUCATION

Graduate Studies, Masters in Marketing, Johns Hopkins University

BS, Business Administration - Marketing & Management, 2002, Elizabethtown College

REGISTRATIONS/CERTIFICATIONS

Certified Professional Services Marketer (CPSM)

Foundation Certification, Association of Proposal Management Professionals (CF APMP)

AFFILIATIONS

Society for the Marketing of Professional Services (SMPS)

Association of Proposal Management Professionals (APMP)

SCMaglev Environmental Studies & Documentation | Maryland Transit Administration (MTA) | Statewide, MD | Graphic Designer

Responsible for designing and producing five standardized report templates to support clear, consistent communication of environmental study findings. Templates were developed in Adobe Illustrator and delivered in Acrobat PDF format for client use. The templates enhanced the readability and visual clarity of technical documentation intended for agency review and public-facing distribution, supporting effective communication of complex environmental information.

Straughan Environmental Brand Refresh | Columbia, MD | Senior Graphic Designer

Responsible for leading a comprehensive brand refresh, including creation of a new company logo and color palette, development of a brand guidelines document, and design and rollout of all branded promotional materials. Deliverables included letterhead, memos, invoices, report templates, business cards, brochures, service overview one-pagers, branding of internal SaaS platforms, conference display banners, labels, company vehicle graphics, presentation templates, email signatures, and updates to the company website. Conducted internal training on proper use of brand materials. The brand refresh received the SMPS Maryland Key Award for Brand Identity in 2020.

I-95 Belvidere Road Public Outreach | Maryland Transportation Authority (MDTA) | Cecil County, MD | Graphic Designer and Voice Over Artist

Responsible for creating animated graphics and multimedia content for a virtual public project status update. Developed animated visuals using Adobe After Effects and Adobe Animate and provided voice-over narration for a twelve-minute video presentation. The virtual presentation replaced an in-person public meeting during the COVID-19 pandemic and was designed to meet public outreach requirements by providing project updates in an accessible format. The effort supported regulatory outreach and stakeholder engagement and represented MDTA's first fully virtual public meeting of its kind.

Compliance-Focused Environmental Management System (CFEMS) | AREAS USA | Statewide, MD | Graphic Designer

Responsible for creating digital graphics focused on sustainability and compliance-driven environmental messaging for the Compliance-Focused Environmental Management System (CFEMS). Designed "e-pages" displayed on electronic message boards at AREAS USA's Maryland House and Chesapeake House travel plazas along I-95. Graphics addressed topics including sustainability facts, LEED certification, sustainable site features, and recent accomplishments, supporting integration of environmental sustainability into operations and compliance with regulatory and contract requirements.

Student Education Initiatives | Howard County Public School System and Montgomery County Public Schools | Howard and Montgomery Counties, MD | Graphic Designer

Prepared age-appropriate educational presentations for students in grades K–12 focused on the construction process and the built environment. The elementary-level presentation emphasized safety and teamwork, the middle-school presentation addressed construction techniques, materials, and tools, and the high-school presentation highlighted career opportunities and environmentally responsible design and construction practices. Materials supported STEM education objectives and workforce awareness.

Federal Complex Renovations and Additions | Confidential Client | Washington, DC | Graphic Designer

Responsible for preparing sustainability-focused graphics for presentation to the project Owner in support of federal facility renovation and addition projects. Developed more than two dozen graphics designed to convey complex sustainability concepts in a clear, concise, and visually accessible format. Deliverables were used across presentations, poster boards, and reports to support decision-making and stakeholder communication.

Crisis Communications | BP Solar | Nationwide | Advertising and Marketing Communications Manager

Responsible for analyzing research findings related to public perception of the BP Solar brand following the Deepwater Horizon Oil Spill. Developed and implemented print and digital media campaigns for the North American market aimed at reversing negative trends in web traffic and lead generation. Campaigns incorporated pilot studies and data-driven messaging strategies to support reputation recovery and stakeholder trust.

Chris Levitz, PE, CFM

Coastal Resilience & NBS Subject Matter Expert

AECOM

Summary

Mr. Levitz specializes in resilience planning and design, with a strong focus on coastal and flood risk. Through these efforts, he has prioritized building consensus within communities, working to align community development goals with ecological and long-term climate change needs. His focus is on developing approaches to integrate green and gray infrastructure for a more resilient and adaptable community future, incorporating these elements into planning and design. He serves as AECOM's lead for nature-based solutions in hazard mitigation and oversees AECOM's partnership with the Network for Engineering With Nature. These efforts have led to multiple award-winning projects, including living shoreline projects at Sylvan Beach and Virginia Point, as well as large-scale master planning with the Texas Coastal Resiliency Master Plan.

Experience

Texas Coastal Resiliency Master Plan | Texas General Land Office | Texas Coast | Project Manager

AECOM serves as the engineer for the Texas Coastal Resiliency Master Plan, with Chris serving as the Project Manager. Responsibilities include developing coastal strategies for all regions of the coast, including structural, nature-based and non-structural solutions. Efforts include technical analysis (cost, economics, physical, risk, environmental, and feasibility), planning, outreach, and management. These efforts were being done in cooperation with client team members, as well as academic and outreach entities. Chris is working with the GLO to further refine coastal resiliency outlooks through modeling of marsh retreat and storm surge scenarios, expand economic analyses for both traditional and non-traditional benefits, complete conceptual engineering design and analyses for key projects, and enhanced coordination with Federal and local entities.

Reefense Project | U.S. Department of Defense (DoD) Defense Advanced Research Projects Agency (DARPA) | Technical Advisor

As part of a research team led by the University of Miami, AECOM is helping design and construct reef-mimicking structures as a mitigation solution to coastal erosion. The reef structures are designed to be self-healing, wave attenuating structures that promote coral settlement and growth, allowing the structures to adapt to sea level rise over time. The solutions AECOM helped develop will be deployed as a 50m pilot structure in the Florida Keys, and the Reefense project will help similar structures of this kind be designed and constructed across the Atlantic Seaboard. AECOM's role on the project will include permitting, coordinating with concrete casting contractors for complex structural components, developing construction drawings and documents, and coordinating deployment with the construction contractor and dive team. Chris serves as the technical advisor to develop construction drawings and technical specifications and oversee deployment.

YEARS OF EXPERIENCE

20 years

YEARS WITH AECOM

20 years

EDUCATION

Coastal Engineering Certification, Old Dominion University

BS, 2005, Civil Engineering, University of Texas at Austin

REGISTRATIONS/CERTIFICATIONS

Professional Engineer: FL, LA, MS, TX

Certified Floodplain Manager (CFM)

1,000 Mile Living Shoreline | BCarbon | Texas Coastwide | Project Manager

BCarbon is developing a 1,000-mile living shoreline to protect valuable carbon storing marsh habitats along the Texas coast. AECOM is performing an alternatives analysis to consider the impact that key shoreline characteristics will have on the living shoreline engineering design in different location along the coast to mitigate the long-term impacts of sea level rise while maximizing sediment accumulation in existing estuarine marsh complexes. The relative significance of each key shoreline characteristic will be considered, and an assessment of location specific characteristics will be performed. Chris serves as the project manager, leading development of an alternatives framework and the resulting alternatives analysis and engineering.

Natural and Nature-Based Solutions (NNBS) Job Aids and Workshop | FEMA | Puerto Rico | Project Manager

FEMA contracted AECOM, led by Chris as project manager, to conduct an in-person workshop in Puerto Rico for the promotion of nature-based solutions, specifically related to hazard mitigation. The AECOM team was tasked with communicating the opportunities available for the implementation of these types of projects using FEMA hazard mitigation assistance funding streams (HMGP and BRIC). This effort was conducted in partnership with The Nature Conservancy. As a follow-up to the workshop, AECOM led the development of practitioner-focused job aids specific to shoreline, streambank, and stormwater needs in Puerto Rico. Chris serves as the project manager and technical, leading the organization of the workshop presentation team, job aid development, and stakeholder engagement.

Virginia Point Breakwater Final Design, Permitting, Construction Oversight, and Monitoring | Texas General Land Office & Scenic Galveston | Galveston, TX | Project Manager

Approximately 11,000 feet of clay bluff shoreline at the Virginia Beach Preserve in Galveston Bay experiences rapid erosion and as a result the project site received multiple grants to complete design and construction efforts to mitigate these issues. In order to stabilize the shoreline, permitting, design and construction have been completed for segmented limestone breakwater structures that were built using shallow water techniques that avoid disturbing existing site conditions, including multiple existing oyster reef sites along the shoreline. The breakwater design is intended to enhance sedimentation behind the breakwater structures to create up to 40 acres of new tidal marshes. The resulting construction covers nearly two miles of living shoreline that combines bird nesting and oyster habitat along the breakwaters, marsh habitat between the breakwaters and bluff shoreline, and a stable upland prairie. Upon construction completion, a monitoring and adaptive management plan was developed as part of a three year effort. Responsibilities include leading USACE permitting, final design, construction oversight and monitoring efforts for shoreline protection and marsh restoration project in Galveston Bay. The project was awarded the inaugural American Shore and Beach Preservation Association Best Restored Shoreline in 2019.

Laguna Vista Spoil Island Shoreline Protection Phase I | Texas General Land Office | Laguna Vista, TX | Technical Advisor

AECOM is designing shoreline protection measures for an 11-acre island in the Laguna Madre near Laguna Vista, Texas. The island is an active bird rookery and supports migratory and colonial birds, including great blue herons, brown pelicans, and neotropical cormorants. Portions of the shoreline have been eroding at a rate of 5 to 10 feet per year since the early 2010s; as a result, the shoreline is experiencing severe scarping of up to 4 feet in height. The project is expected to provide up to 2,250 linear feet of shoreline protection in the form of nearshore, segmented limestone breakwaters and an optional revetment for areas of less extensive erosion. Portions of the island may be filled to provide additional upland areas for ground nesters. Special aquatic site plantings are being considered to improve the overall biodiversity and productivity of the site. Chris serves as a technical advisor for alternatives development and preliminary design.

Jen Molnar, ENV SP

Climate Change & Resilience Expert

AECOM

Summary

Ms. Molnar, ENV-SP serves as the Climate Resilience and Nature-Based Solutions Lead for the US East Water at AECOM, where she partners with public and private sector clients to embed nature-based solutions, biodiversity enhancement, and climate adaptation strategies into resilient infrastructure portfolios. With more than 25 years of experience, Jen brings a multidisciplinary approach that bridges environmental science and engineering, policy innovation, economic valuation, and stakeholder alignment to help clients advance resilience, sustainability performance, and long-term asset value. Prior to joining AECOM in 2024, Jen spent 20 years at The Nature Conservancy (TNC), where she led interdisciplinary global research teams focused on developing scalable solutions for nature and climate – building the evidence base for nature-based solutions and enabling implementation through collaboration across disciplines and sectors. Jen provided technical and strategic leadership for science-based collaborations with companies to invest in nature-based solutions and shift to sustainable practices and business models. She has previous engineering consulting experience in remediation and hydrology.

Experience

Biodiversity & Ecosystem in Business Decision-Making | The Nature Conservancy and Dow Collaboration | Arlington, VA and Midland, MI | Technical Lead

The TNC-Dow collaboration (initially $10M/6 year, extended with additional funding) demonstrated how to incorporate biodiversity and ecosystem services and the value they provide into business decision-making. Led pilots to assess nature in business decisions in Freeport, TX and Santa Vitoria, Brazil – including coastal resilience, water supply, forests for air quality, and sustainable agriculture. Contributed to the development of Dow's ground-breaking 10-year Valuing Nature Goal, a commitment to consider nature in all of the company's capital, R&D, and real estate decisions by 2020, while aiming to generate $1B in business value by 2025. Partnered on developing business tools to implement, including the Ecosystem Service Identification and Inventory Tool (ESII Tool), recently relaunched as the Ecosystem Intelligence platform. More than a dozen papers and articles were published by collaboration in peer review and industry publications.

Policy & Markets Analytics | The Nature Conservancy | Arlington, VA | Managing Director and Lead Scientist

Delivered analysis to increase investment in solutions for climate and nature; influenced policy and markets by making the economic case for conservation and enabled equitable, durable results - including for 30x30 protection, natural climate solutions, and fisheries; led and strategically expanded TNC's engagement in voluntary corporate climate standards (Science Based Targets Initiative (SBTi) and GHG Protocol) to integrate natural climate solutions credibly and practically; and integrated biodiversity in corporate science-

YEARS OF EXPERIENCE

26 years

YEARS WITH AECOM

25 years

EDUCATION

MEM, 2004, Water Science Policy and Management, Yale University

BS, 1998, Environment Engineering, Harvard University

REGISTRATIONS/CERTIFICATIONS

Envision Sustainability Professional

based solutions, including in corporate engagements, sharing TNC data with investors, and led development of TNC's approach to biodiversity credits.

River Basin Flood Study | Texas General Land Office (GLO) | Western Region Basins, TX | Technical Advisor
AECOM is leading a team focused in Western Region, Texas basins to evaluate flood risks to communities, identify flood projects that strengthen the resilience of communities, and identify possible funding sources for community flood projects. To support the inclusion of nature-based solutions in flood mitigation alternatives, Ms. Molnar reviewed trainings that informed development of alternatives and provided expert review in workshops to assess potential high-impact flood mitigation projects in study areas.

Biodiversity Impact Reduction Pilot | Confidential Technology and Logistics Client | United States | Project Director and Technical Lead
AECOM is piloting a new approach to design and construction that reduces the negative impact a project's development has on biodiversity and ultimately integrates biodiversity net gain elements into infrastructure development in a measurable and cost-effective way. The approach includes integrating biodiversity uplift and nature-based solutions alternatives, and then testing biodiversity metrics and ROI analysis on-site real-time during site design and construction. The broader aim is to support the development of a vetted, repeatable biodiversity framework that can be employed across design and construction projects that can benefit biodiversity, as well as other potential returns where applicable, and show the ROI.

Green Infrastructure Project Benefit Cost Analysis | Texas A&M AgriLife | Statewide, TX | Technical Advisor
Green infrastructure (GI) and nature-based solutions (NBS) projects provide a wide range of benefits as part of long-term cost-effective resilience solutions, but have historically been under-prioritized. Ms. Molnar advised on the development of guidance and recommendations on ecosystem services valuation in benefit-cost analysis for GI and NBS projects, including with more locally specific valuations of Texas' unique ecosystems.

Tunnel Resilience Benefit Cost Analysis (BCA) | Massachusetts Bay Transportation Authority (MBTA) | Boston, MA | Technical Reviewer
AECOM conducted a BCA in support of the MBTA BRIC application to fund the Silver Line Flood Mitigation Project in the Seaport District of Boston, Massachusetts. As part of broader services supporting resilience planning with the MBTA, the analysis evaluated the cost-effectiveness of the proposed project improvements to mitigate the impacts of coastal flooding on the tunnel structures, portals and stations on the Silver Line Transitway Tunnel.

Flood Risk Framework Plan Development | District Department of Energy and Environment (DOEE) | Washington, DC | Technical Advisor
The Flood Risk Framework Plan is DC's road map for reducing flood risk with neighborhood scale infrastructure, as part of the Integrated Flood Model (IFM) project, led by AECOM. The Framework Plan draws on results from the IFM to identify priority neighborhoods that are susceptible to coastal, riverine, and/or inland flooding, and lays out an approach for identifying and assessing flood mitigation and adaptation measures. Ms Molnar developed a menu of nature-based solutions that could be assessed with the IFM for effectiveness in reducing flood risk, while also providing additional benefits to ecosystems and the communities.

Ecological and Social Values of Restoration in Remediation Closure | Private Client | New Jersey | Technical Advisor
Development of metrics of ecological and social value to assess the outcomes of ecological restoration and nature-based solutions in remediation of Super Fund site.

OpenHazus Future of Flood Risk Data Task Order, FEMA Risk MAP Production and Technical Services Contract | FEMA | Washington, DC | Technical Delivery Leader
FEMA awarded Risk MAP Production and Technical Services (PTS) Contracts to provide a wide range of services related to floodplain analysis, mapping, and management both regionally and nationally. Ms. Molnar has supported several task orders related to climate change, nature-based solutions, and risk assessment. Ms. Molnar was a technical delivery leader for tasks related to how climate uncertainty may be handled by future flood risk data, including due to sea level rise and future conditions, and identifying sources of variance in the modeling processes.

Nature Climate Solutions Assessment | National Audubon Society | Washington, DC | Strategic Consultant
To support refinement of natural climate solutions strategy, Ms. Molnar conducted a rigorous review of Audubon's strategies and theory of change to identify credible areas for investment in market and policy opportunities to increase outcomes for carbon, as well as conservation and communities.

Phetmano Phannavong, JD, PE, PMP, CFM

Resilience Policy Expert

AECOM

Summary

Phetmano is a well-respected public-sector partner and program management with over 20 years of federal, state, and local climate resilience and policy, program and project management experience involving floodplain and stormwater management, building science, and Artificial Intelligence (AI) governance. He established a comprehensive flood risk management program in the District of Columbia to enhance its implementation of the National Flood Insurance Program. He is the founder and a co-leader of the DC inter-agency flood risk management team, DC Silver Jackets, under the US Army Corps of Engineers National Silver Jackets program. His accomplishments include building climate resilience through integrated planning and strong partnerships among public and private stakeholders and all levels of government. He is a resilience and artificial intelligence (AI) policy advisor well regarded by many stakeholders nationally and internationally. He is a co-founder and co-chair of the ASFPM AI Subcommittee to explore evolving AI technology and transform technical and policy solutions for natural disaster management during the 21st century.

Experience

Norfolk Coastal Storm Risk Management (CSRM) Project | City of Norfolk | Virginia | Nonstructural Program Management Lead

Nonstructural Program Management Lead as part of the Norfolk Resilience Partners team to assist the City of Norfolk to implement the $2.6B Norfolk CSRM Project. The Norfolk CSRM Project is a decade-long collaboration between the US Army Corps of Engineers (USACE) and the City of Norfolk to address coastal flood risk. The City of Norfolk is increasingly at risk from flooding and damage from coastal storms. Norfolk has one of the highest rates of relative sea level rise in the country, putting the City at risk for coastal flooding and damage from hurricanes, nor'easters, and other significant storms. The Project features storm surge barriers, nearly 8 miles of floodwalls, nearly 1 mile of levees, 11 tide gates, and 10 pump stations, along with a series of nonstructural projects that include home elevations, basement fills, and commercial floodproofing. Much more than just a floodwall project, the Project is rooted in social and environmental equity, bringing multiple agencies together with a holistic approach benefitting the entire City—prioritizing layers of defense for the most socially vulnerable areas. Conducted legal and policy research and analyses on federal, state, and local laws including USACE authority, regulations, and guidance, Code of Virginia on coastal resilience and flood protection, and the City of Norfolk' floodplain management. Provide a roadmap with specific recommendations to implement the Nonstructural Program that meets federal, state, and local authorities from the pre- to post-construction phases of the Project. The policy recommendations include drafting the program implementation plan, the review plan setting a peer review process of each project element, and the operation and management plan to monitor the project after

YEARS OF EXPERIENCE

23 years

YEARS WITH AECOM

2 years

EDUCATION

JD, 2017, Law, University of the District of Columbia

MSCE, 2002, Geotechnical Engineering, George Washington University

BEng, 1998, Civil Engineering, Kasetsart University (Thailand)

REGISTRATIONS/CERTIFICATIONS

Professional Engineer: Virginia (0402041348)

Professional Engineer: DC

Bar Admission in District of Columbia, DC Court of Appeals

Bar Admission in Minnesota, Minnesota Supreme Court

Artificial Intelligence Governance Professional (AIGP), International Association of Privacy Professionals

Project Management Professional (PMP), Project Management Institute

Certified Floodplain Manager (CFM), Association of State Floodplain Managers

AFFILIATIONS

International Association of Privacy Professionals (IAPP)

Flood Hazard Committee of the DC Construction Codes Coordinating Board

Artificial Intelligence (AI) Subcommittee Co-chair, Association of State Floodplain Managers (ASFPM)

construction; and establishing a steering committee to oversee the project implementation.

FEMA Building Science Support Under the Production and Technical Services (PTS) Contract | FEMA | Washington, DC | Team Leader

Provided program and policy analyses and recommendations to the FEMA Building Science team to develop code proposals on behalf of FEMA to the International Code Council (ICC) as part of the 2017 International Codes Series adoption. Since 2019 FEMA has been embarking on integrating policies and programs to align with building code requirements and promoting the adoption, application, and enforcement of the latest editions of building codes at the state and local government levels. The FEMA Building Codes Strategy was released in March 2022. Responsibilities for this engagement included leading a team to facilitate FEMA and subject matter expert work group members and providing expertise in drafting code proposals along with justification on how FEMA would promote strong codes and standards that meet FEMA's vision and overall agency strategy, including addressing climate change impacts equitably.

DC Flood Risk Management Program | District Department of Energy and Environment (DOEE) | Washington, DC | Program Manager

Oversaw the program's day-to-day operations, including regulating floodplain development and providing long-term strategic plans and financial management. Introduced a DC flood risk management program to the DC Department of Energy and Environment (DOEE) in 2008. Activated and fully implemented NFIP to ensure that DC residents had access to federally backed flood insurance policies and became more resilient to flood hazards. Took initiatives to begin this important task by building relationships with responsible DC agencies and seeking funding from FEMA, other federal, and DC to build and maintain the program. Worked closely with the DC Department of Consumer and Regulatory Affairs (DCRA) to clearly define roles and responsibilities between the building code official (i.e., DCRA) and the floodplain administrator (i.e., DOEE) and streamline floodplain development permit review and approval. Appointed chairperson of the Flood Hazard Special Committee to the DC Construction Codes Coordinating Board (building code board) to ensure continuing coordination between DCRA and DOEE and to successfully adopt flood provisions in the 2015 International Codes series, including the Appendix G of the International Building Code, in compliance with minimum NFIP requirements.

Innovation Under Production and Technical Services Support | FEMA | Washington, DC | Senoir Project Manager

Led a team of hydrologic and hydraulic modeling engineers to conduct research and provide policy and technical recommendations to FEMA to take actions related to urban flooding, and future-conditions flood hazard mapping in the US. Climate changes impact rainfall intensity, durations, and frequencies, causing riverine systems to flood. There is no standardized and consistent approach to assess climate-informed inland riverine flood hazards to create regulatory or non-regulatory products. To begin implementing recommendations of the Technical Mapping Advisory Council (TMAC), Government Accountability Office, and Office of Management and Budget and working with other federal agencies to deliver climate-informed coastal and non-coastal riverine products, a better understanding of the current landscape of relevant scientific methods and applied science approaches were used by other partners to enable FEMA to provide comprehensive flood hazard and risk information to the Nation. The objectives of this project involved understanding the current state of scientific research, tools, and techniques that represent the state-of-the-art for actionable hydrologic analyses accounting for the potential effects of climate change and identifying promising scientific methods and applied approaches to produce climate-informed hazard information in different regions and land use conditions in the US.

Technical Mapping Advisory Council (TMAC) support | FEMA \ Washington, DC | Technical Advisor

Provided program and technical support, meeting planning, facilitation, and documentation services to the TMAC. In 2012, Congress authorized FEMA to establish the TMAC, a federal advisory committee consisting of Secretaries of multiple federal agencies and representatives from federal, state, and local governments, including USACE, non-profit organizations, and the private sector. FEMA tasks the TMAC annually to review and provide recommendations to improve the preparation of flood maps and flood hazard information, including assessing projected future conditions related to flooding. Congress mandated that FEMA submit the TMAC annual reports. Provided technical and subject matter expertise support to TMAC since 2019 by working closely with subcommittees' co-chairs to set agenda, discussion topics, work plans, and deliverables under FEMA's Production and Technical Services contract. Facilitated the subcommittee meetings, drafted recommendations and reports, and reviewed and finalized the TMAC annual reports. Provided support in 2020 and 2021 to TMAC to explore nationwide stakeholder engagement in the future of the national flood mapping program.

Justin Vandever, PE

Coastal Engineer

AECOM

Summary

Mr. Vandever is a coastal engineer, climate adaptation specialist, and restoration practitioner with nineteen years of consulting experience in coastal and marine science, wetland restoration, coastal engineering, and climate change adaptation.

Prior to starting his consulting career, Justin grew up in Virginia and completed graduate studies at the Virginia Institute of Marine Science on Chesapeake Bay. Justin's masters research focused on field observations and numerical modeling of waves in the York River Estuary of Chesapeake Bay, where he also supported water quality monitoring efforts for the Chesapeake Bay National Estuarine Research Reserve. Justin maintains ties to the Chesapeake Bay through volunteering as an annual grant application reviewer for the Chesapeake Bay Trust's Pooled Monitoring Initiative's Restoration Research Award Program (since 2019).

Justin is a Regional Service Lead for Strengthening Climate Resilience at AECOM and serves as the Water Resources lead for AECOM's Resilience and Climate Change Technical Practice Group. His project experience includes coastal hazard analysis, climate change vulnerability and risk assessments, sea level rise inundation mapping, coastal processes and flooding, and response of coastal and estuarine environments to sea level rise. Mr. Vandever has served as a quality reviewer and technical advisor on numerous coastal flooding and climate change-related projects across the country. He has co-authored technical articles related to climate change vulnerability, including sea level rise impacts in San Francisco Bay, effects of coastal erosion on the California coast, coastal flood response to sea level rise, and mitigating climate change through coastal wetland restoration and has presented at regional, nationwide, and international coastal conferences.

Experience

Eden Landing Phase 2 Salt Marsh Restoration Design | Ducks Unlimited | San Francisco Bay, CA | Coastal Technical Lead

AECOM is supporting final design of 1300 acres of tidal wetland in south San Francisco Bay. Justin led the hydrodynamic and wave modeling at the site using the MIKE21 model to inform breach and channel sizing and evaluate the impact of waves on the geomorphic evolution of the site. AECOM also conducted an analysis of wind wave generation within the site to evaluate potential risks of wave runup and overtopping on adjacent flood protection levees.

Stinson Beach Living Shoreline Pre-Feasibility Study | Greater Farallones Association (GFA) | Project Manager

AECOM worked with GFA to identify opportunities for shoreline enhancement in Bolinas Lagoon along Calle Del Arroyo and Dipsea Road in the Stinson Beach-Seadrift neighborhoods. Mr. Vandever developed a conceptual shoreline enhancement plan, draft alternative evaluation criteria for the

YEARS OF EXPERIENCE

19 years

YEARS WITH AECOM

15 years

EDUCATION

MS, 2007, Marine Science (Physical Oceanography), Virginia Institute of Marine Science, College of William and Mary

BS, 2004, Civil and Environmental Engineering, Cornell University

Coastal Engineering Certificate, 2012, Old Dominion University

REGISTRATIONS/CERTIFICATIONS

Professional Engineer: CA

AFFILIATIONS

American Society of Civil Engineers

American Shore and Beach Preservation Association

project, and next steps for further evaluation. The proposed project would implement a living shoreline concept and provide habitat connectivity along the shoreline while creating transitional habitat for SLR adaptation.

Living Shoreline Design | US Army Corps of Engineers, Military Ocean Terminal Concord | Concord, CA | Coastal Technical Lead

AECOM is supporting conceptual, preliminary, and final design of flood protection and living shorelines at the project site. Justin led an assessment of site conditions and suitability for living shoreline alternatives, including evaluation of water levels, waves, currents, salinity, and compatibility with existing habitats. Alternatives evaluated included nearshore rock sill, oyster reef, marsh mounds, microgroins, and ecotone slope. AECOM prepared conceptual and preliminary design plans, estimated quantities, and prepared cost estimates for the preferred design alternative.

Newark Slough Mitigation Bank Modeling and Habitat Evolution Studies | Wildlands and RES | Newark, CA | Project Manager

AECOM provided technical assistance to Wildlands and RES in support of a wetland mitigation bank in south San Francisco Bay. Mr. Vandever led the evaluation of the hydrodynamic response of the restored wetland site using the MIKE21 model, including evaluation of downstream impacts to water levels, flows, and existing habitat. As a follow-up study, AECOM conducted habitat evolution modeling in response to estuarine sedimentation and future sea level rise.

Mad River Slough Wetland Mitigation Bank | California Department of Transportation | Humboldt Bay, CA | Hydrology Technical Lead

AECOM assisted Caltrans in the development of a conceptual design/feasibility analysis of restoration alternatives at a mitigation site on Mad River Slough in Humboldt Bay. The proposed project would restore tidal wetlands to a 40-acre site as mitigation for transportation projects in the region. AECOM conducted topographic and hydrologic surveys of the site, hydraulic modeling using HEC-RAS, site evolution in response to sea level rise, and conceptual design and cost estimates for the project.

North End Wetland Enhancement Project | Marin County Parks and Open Space District | Bolinas, CA | Sea Level Rise Technical Advisor

AECOM assisted Marin County Parks to develop conceptual design solutions to restore riparian and shoreline habitat and adapt Highway 1 and surrounding local roads to accommodate future sea level rise. Mr. Vandever provided input on the sea level rise analysis, shoreline enhancements, opportunities and constraints, and quantity and cost estimating.

Palo Alto Baylands Comprehensive Conservation Plan | City of Palo Alto, CA | Palo Alto, CA | Climate Change Technical Lead

AECOM assisted the City of Palo Alto to develop a Comprehensive Conservation Plan to articulate guiding principles for holistic management of the Baylands in the future. As part of this effort, Mr. Vandever led a sea level rise assessment of the Baylands habitats and adjacent public access and infrastructure assets.

Sea Level Rise Vulnerability Assessments and Adaptation Pathways | California State Parks | San Diego Coast District, CA | Technical Lead.

AECOM is assisting California State Parks, under contract with Coastal Quest, to conduct SLR vulnerability assessments and develop adaptation pathways for nine coastal and estuarine state parks within the San Diego Coast District.

Sacramento-San Joaquin Delta Climate Change Vulnerability Assessment and Adaptation Strategy | Delta Stewardship Council | California | Project Manager and Technical Lead

AECOM is developing a climate change vulnerability assessment and adaptation strategy (CCVA & AS) for the Delta Stewardship Council to meet the co-equal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The CCVA evaluated the effects of climate change stressors, including temperature, sea level rise, changes in watershed hydrology, and changes in the frequency and magnitude of extreme events. The impact of hazards including flooding, extreme heat, wildfire, and drought on Delta assets and resources is also being assessed. The AS will identify a suite of adaptation strategies to address climate related vulnerabilities within the Delta.

Matilija Dam Removal Ecosystem Restoration Project, Estuary and Coastal Modeling Support | Ventura County Watershed Protection District | California | Coastal Engineer

AECOM provided coastal analysis support to Integral Consulting to perform coastal analysis of wave conditions, sediment transport, and shoreline evolution in response to the Matilija Dam removal on the Ventura River.

Melissa Bernardo Hess, PE, CFM, ENV SP

Natural Resource & Resilience Engineer

AECOM

Summary

Melissa has 29 years of experience and has managed projects focused on resilience and green infrastructure, stream and coastal restoration, water quality stormwater management, and permitting. Melissa has led several on-call stormwater service contracts in recent years and is currently the contract manager for our City of Alexandria Comprehensive Environmental Services contract.

Experience

Comprehensive Environmental Services On-Call Contract | City of Alexandria | Alexandria, VA | Contract Manager

Assisting the City with more than 65 task orders to date, which include stormwater designs, flood mitigation, stream restoration, storm drain capacity analysis, BMP inspections and public outreach.

Further Investigations for Neighborhood Flooding | City of Alexandria | Alexandria, VA | Quality Manager

for the task orders related to investigating flooding in various neighborhoods throughout the City. She reviewed the submittals and supervised the quality of the modeling, alternative analyses and documents.

On-Call Contract for Stormwater and Watershed Management Evaluation and Design Services | Howard County, MD | Contract Manager

Manages this on-call contract for Howard County. To date, the team has performed stream restoration design, pond retrofits, outfall design, stream construction management, and dam repair projects. She oversees the work on all task orders.

On-Call Contract for Water Resources Design and Assessment | Harford County | Harford County, MD | Contract Manager

Contract Manager for this on-call contract performing stream restoration design and BMP inspection services. Also selected staff for two staff augmentation task orders for design plan reviews.

Green Sidewalks Manual | City of Alexandria | Alexandria, VA | Project Manager

Assisted the City with updating their Green Sidewalks BMP Design Guidelines. Recommended additional BMPs for inclusion in the Guidelines, let the workgroup meetings, and her team developed design standard and specifications.

Ben Brenman Pond Journey to Cleaner Water | City of Alexandria | Alexandria, VA | Project Manager

Worked with the City to create content and design five interpretive signs that illustrate the Journey to Cleaner Water as you walk around the Ben Brenman pond. These signs educate the community on the SW pond and how the City protects our local waterways.

YEARS OF EXPERIENCE

29 years

YEARS WITH AECOM

29 years

EDUCATION

BS, 1995, Civil Engineering, Bucknell University

REGISTRATIONS/CERTIFICATIONS

Professional Engineer, Virginia - 2021 (0402063898, Exp. 8/31/2027)

Professional Engineer: MD

Certified Floodplain Manager

Envision Sustainability Professional

Little Creek Watershed Evaluation and Flood Mitigation Study | Prince William County | Prince William County, VA | Project Manager

REPI-funded effort to reduce flooding and protect infrastructure near the Main Gate of MCB Quantico. Oversaw the concept design work, facilitated the stakeholder meetings, and performed quality reviews.

Military Installation Resiliency Review (MIRR) 2.0 | Northern Virginia Regional Commission | Various Locations, VA | Discipline Lead

Lead the Stormwater and Flood Mitigation task during MIRR 2.0. A series of proposed guidelines and operating procedures were identified to support more effective stormwater and floodplain mitigation and management.

Green Infrastructure Design and TMDL Compliance Study | US Army Corps of Engineers | Pentagon, Arlington, VA | Task Manager

Evaluated green infrastructure scenarios and developing concept designs for the Pentagon to support NPDES MS4 Permit and TMDL goals for pollutant reductions of sediment, nitrogen and phosphorus. Tasks include an evaluation of the existing BMPs, identification of potential new BMPs, and assessment of pollutant removal for various scenarios.

Taylor Squires, PE

Coastal Engineer

AECOM

Summary

Taylor has 11 years of experience working on coastal restoration, coastal/maritime planning, and climate resilience projects. Her relevant experience includes restoration design (nature-based solutions, erosion control structures, living shorelines, wetland restoration, beneficial use of dredged material), resilience assessments (climate resilience, mitigation, site development), dredged material management, construction oversight, site monitoring (wetlands, oyster reefs), large-scale planning for state agencies (coastal master planning, ports master planning), and outreach (technical advisory committee meetings, stakeholder outreach).

Experience

Brown Ranch Shoreline Protection Project | Galveston Bay Foundation | East Galveston Bay, Texas | Project Engineer

AECOM provided engineering services to the Galveston Bay Foundation (GBF) for the design and implementation of the Brown Ranch Living Shoreline Project along East Galveston Bay's north shoreline near Lake Surprise, Texas. The project included design for approximately 20,000 linear feet of shoreline protection nearshore breakwaters to enhance coastal resilience, reduce erosion, and restore marsh habitat. The breakwaters will provide long-term protection against wind-wave erosion while supporting ecological functions critical to the bay system. AECOM's scope included site assessment, site surveys, permitting support, and preliminary through final design. Taylor served as the technical lead and project manager.

Wetland Action Mapping | The Nature Conservancy | Coastal Texas | Project Advisor

As part of The Nature Conservancy's (TNC) Texas Wetland Action Mapping (WAM) initiative, AECOM provided strategic planning support to help advance tidal wetland restoration and conservation efforts across the Texas coast. The planning process included two stakeholder meetings per action area—initial and review—held virtually. These meetings refined action area boundaries, identified potential projects, and documented local priorities, threats, and opportunities. AECOM also participated in three in-person WAM workshops across Houston, Corpus Christi, and Brownsville to introduce the planning framework and engage the broader WAM working group. Following stakeholder input, AECOM conducted desktop GIS analyses to quantify potential implementable acreage for restoration and protection, identify co-benefits (e.g., flood risk reduction, blue carbon), and visualize potential project opportunities. Deliverables included stylized maps for each action area, one-page fact sheets summarizing key findings, and technical memos detailing stakeholder input, project concepts, ecological context, and recommended next steps. Taylor provided advisory support and stakeholder engagement leadership.

YEARS OF EXPERIENCE

11 years

YEARS WITH AECOM

11 years

EDUCATION

BS, 2014, Civil Engineering, University of Texas at Austin

Coastal Engineering Certificate, 2019, Old Dominion University

REGISTRATIONS/CERTIFICATIONS

Professional Engineer - FL, TX

AECOM Certified Project Manager

Adult First Aid/AED/CPR

Texas A&M Dredging Short Course, January 2022

PROFESSIONAL AFFILIATIONS

American Shore and Beach Preservation Association

Coasts, Oceans, Ports, and Rivers Institute of ASCE

Pickwick Lake and W.H. Turner Living Shoreline. | Southwest Florida Water Management District (SFWMD) | Coastal Engineering Lead

As part of a FEMA Building Resilient Infrastructure and Communities (BRIC) grant, SFWMD sought to improve its water control infrastructure while providing nature-based solutions for the Pickwick Lake and W.H. Turner conveyance canal shorelines. AECOM served as the engineering lead to perform 30% and 60% design and initiate environmental permitting. Taylor served as the coastal engineering lead to develop living shoreline alternatives, including a wetland terrace and living seawalls to maintain conveyance capacities in the drainage canals while protecting against shoreline erosion. Design included a water levels assessment to predict ambient and storm-related water levels based on SFWMD records. The project was discontinued when FEMA discontinued the BRIC program in early 2025 and withdrew grant funding.

Military Ocean Terminal Concord (MOTCO) Flood Risk Management | Concord, CA | USACE Sacramento District | Coastal Engineering Co-Lead

AECOM is providing Design-Bid-Build engineering services for a flood control levee and floodwall project to protect military installations at the MOTCO terminal in Concord, CA. As part of the design process, AECOM is providing 10%, 35%, 65%, 95% and 100% plans, technical specifications, and probable cost estimates. In addition to the flood control levee/floodwall, the project will include Resilience Measures stated in USACE's 2021 Installation Climate Resilience Plan; roads, pavements; vehicle bridges; and wetlands remediation/reclamation. Taylor is serving as a co-lead of the coastal engineering discipline to lead the production team developing living shoreline concepts and designs along the MOTCO shoreline to protect existing wetlands in present-day conditions and with future sea level rise over a 50-year design life.

1,000 Mile Living Shoreline | BCarbon | Texas Coastwide | Engineering Lead

BCarbon is developing a 1,000-mile living shoreline to protect valuable carbon storing marsh habitats along the Texas coast. AECOM is performing an alternatives analysis to consider the impact that key shoreline characteristics (shoreline type, fetch distance, slope, sedimentation rates, salinity, etc.) will have on the living shoreline engineering design in different location along the coast to mitigate the long-term impacts of sea level rise while maximizing sediment accumulation in existing estuarine marsh complexes. The relative significance of each key shoreline characteristic was considered, and an assessment of location specific characteristics was performed, to propose implementation alternatives tailored to Texas's varied shoreline types. Taylor serves as the engineering lead, leading development of typical section designs for the living shoreline alternatives and the technical supporting documentation.

NASA Shoreline Study | NASA Kennedy Space Center | Brevard County, Florida | Deputy Technical Lead

The Kennedy Space Center is located within a vulnerable coastal area that is exposed to Atlantic and bay-based wave forces. AECOM provided NASA with services to assess and develop resilience solutions for Atlantic and estuarine shorelines to protect critical transportation and space exploration infrastructure. AECOM's work involves sediment transport modeling, long-term shoreline change analysis that considers impacts from relative sea level rise, and development of shoreline mitigation alternatives. Taylor served as the deputy technical lead of the effort, assisting the project manager and overall technical lead overseeing teams focused on developing the alternatives for the Atlantic and estuarine studies. She provided technical oversight for design tasks, including making sand source recommendations and drafting preliminary engineering drawings, and wrote significant portions of both reports to recommend shoreline stabilization alternatives for Atlantic and estuarine shorelines on Cape Canaveral.

Laguna Vista Spoil Island Shoreline Protection Ph. I-II | Texas General Land Office | Laguna Vista, TX | Project Manager

AECOM is designing shoreline protection measures for an 11-acre island in the Laguna Madre near Laguna Vista, Texas. The island is an active bird rookery and supports migratory and colonial birds, including great blue herons, brown pelicans, and neotropical cormorants. Portions of the shoreline have been eroding at a rate of 5 to 10 feet per year since the early 2010s; as a result, the shoreline is experiencing severe scarping of up to 4 feet in height. The project is expected to provide up to 2,250 linear feet of shoreline protection in the form of nearshore, segmented limestone breakwaters and an optional revetment for areas of less extensive erosion. Portions of the island may be filled to provide additional upland areas for ground nesters. Special aquatic site plantings are being considered to improve the overall biodiversity and productivity of the site. Responsibilities included serving as the Project Manager and overseeing all aspects of planning, site surveys, wind/wave assessment, alternatives development, permitting, and preliminary design.

John Loftus, III, PE

Hydrographic Surveyor

MARINE SOLUTIONS

Summary

Mr. John Loftus, III, PE, is a licensed engineer, certified commercial diver and NBIS team leader who has focused his career on the inspection, assessment, rehabilitation and hydrographic surveys of bridges and waterfront structures. Mr. Loftus has performed both above and underwater structural inspections throughout the U.S. on a wide variety of structures in many different environments. He has extensive experience in underwater 2D and 3D sonar imaging on a variety of marine and bridge structures. Many of the structures he has imaged have been published in a variety of papers and an FHWA study.

Experience

Naval Station Norfolk Waterfront Facilities Inspection | Naval Facilities (NAVFAC) Engineering and Expeditionary Warfare Center | Norfolk, VA | Underwater Inspection Team Leader/Supervisor

Responsible for assisting with planning and execution of the project, on-site safety, staff supervision, and coordination with client. The project consisted of above and below water inspection of 70 facilities across two Navy installations.

Waterfront Facilities Inspection | Naval Facilities Engineering Command | Norfolk Naval Shipyard, Norfolk, VA | Project Manager

Responsible for developing the scope of work, overall project and safety management, scheduling, quality control, and primary client. Inspection of all facilities at the Norfolk Naval Shipyard.

Waterfront Facilities Inspection | Naval Facilities Engineering Command | Joint Expeditionary Base Little Creek-Fort Story, VA | Project Manager

Responsible for developing the scope of work, overall project and safety management, scheduling, quality control, and primary contact with the client. The project consisted of the inspection of 107 Facilities.

Lesner Bridges Underwater Inspection and Imaging | City of Virginia Beach, VA | Virginia Beach, VA | QA/QC Manager

Responsible for ensuring accuracy and consistency of project deliverables. This project involves the base line (initial) underwater inspection of the Lesner Bridges in Virginia Beach, VA. The two bridges span east-to-west over Lynnhaven Inlet, and area with potentially excessive current. The bridges are newly constructed and consist of pier footings constructed on 4' diameter drilled shafts. Approximately five footings will be inspected per bridge (10 total). The client has also requested an underwater inspection of the newly constructed steel H-pile fender system at the channel. Lastly, the client has requested 2D sonar imaging be performed of all the underwater portions of the bridges.

Underwater Inspection and Hydrographic Survey at Yatesville Lake Marina | Kentucky Department of Parks | Louisa, KY | Engineer Diver

Responsible for performing underwater inspections, assisting with field operations, recording field notes, and report preparation. The project

YEARS OF EXPERIENCE

22 years

YEARS WITH MSI

13 years

EDUCATION

BS, 2003, Civil Engineering, Marquette University

Commercial Diver, Minnesota Commercial Diver Training Center, 2009

REGISTRATIONS/CERTIFICATIONS

ADCI Surface-Supplied Air Diving Supervisor (#44118), 2011

Professional Engineer: AK, AR, ID, IN, KY, LA, MD, MO, NJ, NV, NY, OH, TN, TX, UT, WI

Remote Pilot Certification No. 4347882

TRAINING

Kongsberg Sonar Inspection Techniques

QPS Software

R2Sonic

CodaOctopus Training

ADCI Surface-Supplied Air Diving Supervisor

consisted of the above and underwater inspection of a state park marina, along with a hydrographic survey of the channel bottom in and around the marina.

Naval Base Kitsap (NBK)-Bangor Delta Pier Underwater Inspection | NAVFAC | Poulsbo, WA | Engineer
Responsible for engineering evaluations, analyses, and development of project submittals. The project included a design-level visual and tactile underwater inspection of portions of Delta Pier at Naval Base Kitsap-Bangor. The purpose of the inspection was to determine which steel pile wraps needed to be repaired or replaced, record the condition of the steel piles, assist in the analysis of the cathodic protection system, and note the conditions of the Security Floating Dock and Fragmentation Barrier Wall.

Panama Canal Underwater Inspection | Panama Canal Authority | Panama | Supervisor
Responsible for assisting with planning and execution of the project, on-site safety, staff supervision, and coordination with the client. This project included the "rapid" visual underwater inspection of 6 critical structures on the Panama Canal as part of the field investigation for the prime contractor's seismic analysis. The purpose of performing the field investigation and accompanying seismic analysis is that canal structures are over 100 years old and were designed at time when seismic data and design considerations were limited. The underwater inspection was primarily accomplished by using volumetric sonar imaging, but a few supplemental diving inspections were performed to clarify details found by the sonar imaging.

Pennyrile and Greenbo Dam Inspections | Kentucky Department of Parks | Dawson Springs, KY | Engineer Diver
Responsible for assisting with planning and execution of the project. This project included comprehensive underwater inspections for both the Pennyrile and Greenbo Lake Dams. For the Pennyrile Dam, detailed underwater inspections of the dam structure, drawdown valves, piping, and imaging of the dam face were conducted. The team utilized Remotely Operated Vehicles (ROVs) and crawlers to inspect the drawdown line and performed a thorough hydrographic survey to map underwater features. At Greenbo Lake Dam, underwater inspections were performed using ROVs for all accessible drawdown and anti-vortexing devices. The team employed ROVs and crawlers to examine the low-level drawdown line and completed a hydrographic survey to ensure accurate mapping of underwater elements.

Hydrographic Survey | Louisville Gas & Electric | Ghent, KY | Senior Surveyor

Responsible for leading and conducting hydrographic and topographic surveys. The scope included a multibeam hydrographic survey which included collecting bottom surface sounding data and sonar imaging of the bottom. Post-processing of the collected data was performed for accuracy and time and space corrections. Deliverables included printable and digital output files in ASCII, SBET, PDF, CAD, and digital scene formats.

Rough River State Park Marina Design Support Services | Kentucky Department of Parks | Nicholasville, KY | Engineer Diver
Responsible for performing underwater inspections, assisting with field operations, recording field notes, and report preparation. The project consisted of the inspection, survey, assessment, and design support for repair or replacement of the marina docks, boat ramp, and floating marina store.

NAS Patuxent River Waterfront Facilities Inspection | NAVFAC | Patuxent River, MD | Project Manager, Engineer Diver
Responsible for developing the scope of work, performing underwater inspections, recording field notes, report preparation, overall project and safety management, scheduling, quality control, and primary contact with the client. The project consisted of the inspection of 37 waterfront facilities, including bulkheads, piers, ramps, revetments and mooring dolphins. The services also include a LiDAR survey of the shoreline.

Dredging Analysis | Marathon Petroleum Corporation | Midland, PA | Surveyor
Responsible for directing and performing surveys and post-processing field data to be used to generate survey deliverables. The project consisted of performing a hydrographic survey and dredging analysis. Dredging quantities and limits were calculated based on field surveys to aid with budgetary planning and permit applications.

Dredging Consulting & Hydrographic Surveying | East Kentucky Power Cooperative | Maysville, KY | Supervisor
Responsible for assisting with planning and execution of the project, on-site safety, staff supervision, and coordination with the client. The project consisted of a hydrographic survey and follow-up consulting to support the procurement of dredging services for key fleeting areas. The services also included limited dredging consultation including scope preparation, quantity estimates, and oversight along with pre and post dredging surveying of dredging target areas.

Keenan Lautner, PLS

Professional Surveyor/Hydrographer

MARINE SOLUTIONS

Summary

Keenan is a highly motivated engineer and licensed Professional Land Surveyor with 6 years of experience in the surveying, inspection, design, and rehabilitation of marine and waterfront structures. His expertise lies in planning and executing site data gathering missions through heavy marine construction projects for federal, state, and local governments as well as private interests for ports and harbors in both coastal and inland settings.

Mr. Lautner has a proven track record in leading rehabilitation projects. He has successfully led projects that require bathymetric and topographic surveys, waterfront infrastructure structural assessments, and intricate design considerations. He has also been integral in the planning, bidding, and execution of major marine construction projects both as an owner's agent and as the contractor's engineering support. This broad range of experience has provided a wealth of marine infrastructure knowledge to aid any client with sound and wise project development.

Experience

Yatesville Marina Improvements, Kentucky Department of Parks, Yatesville, KY | Project Surveyor

Responsible for directing and performing a bathymetric survey and a RTK Drone Photogrammetry mission. These datasets were combined to create a 3D surface utilized in the design of the improvements of the Marina.

Shoreline Monitoring Services, NAVFAC, NAS Oceana, Oceana, VA| Project Surveyor

Responsible for directing surveys to monitor erosion of the shorelines. The acquired data was processed and analyzed to be utilized in reports submitted to NAVFAC.

Earthen Dam Rehabilitation, NRCS, Marshall County, KY| Project Manager

Responsible for directing, management and execution of all surveying work for the rehabilitation of an earthen dam. A RTK drone survey was performed of the entire dam structure and combined with supplemental survey work collected with GPS system. The survey findings were processed into a 3D model of the dam to be utilized in the rehabilitation process.

City of Shelbyville Sewer Separation, City of Shelbyville, IL| Project Surveyor

Responsible for all site data collection of the entire city of Shelbyville. As the project surveyor a 550 Acre RTK drone flight was completed as well as supplemental Topographic survey utilizing GPS and Total station technology was completed. These datasets were combined and utilized for design purposes of the proposed sewer system for the city of Shelbyville.

Dock 2 Demolition and Shoreline Restoration Design | Ports of Indiana | Jeffersonville, IN | Project Surveyor/Engineer

Responsible for completing RTK Drone Photogrammetry mission to establish horizontal and vertical coordinates of 45 acres of the project site surrounding

YEARS OF EXPERIENCE

6 years

YEARS WITH MSI

2 years

EDUCATION

BS, 2021, Civil Sustainable Engineering, Murray State University

BS, 2020, Civil/Surveying Engineering Technology, Murray State University

REGISTRATIONS/CERTIFICATIONS

Professional Land Surveyor: KY, #4725, 2025

FAA Part 107 Remote Pilot

the demolition and replacement of a failed earthen slope and retaining wall structure. The acquired data was utilized for analysis and design to provide the port with an demolition and shoreline restoration design package. Mr. Lautner was responsible for the preparation of construction drawing and specification bid documents along with serving in project administration roles supporting the owner in the procurement, bidding, and bid evaluation process. Mr. Lautner also served as the construction engineer responsible for management of construction inspection, submittal reviews, responding to requests for information, and administering routine construction review meetings.

Duke Energy Gallagher Demolition Project, New Albany | Duke Energy | Statewide, IN | Project Surveyor/Engineer
Responsible for directing and performing bathymetric surveys and post-processing field data to be used to generate survey deliverables. The project consisted of performing a bathymetric survey and assistance in combining the collected data with Drone Lidar data. Survey reports were created to document the demolition process and confirm all intended structures had been properly removed.

Jacobsen Reservoir | Lexington, KY | Project Surveyor/Engineer
Responsible for direction of bathymetric surveys and post-processing field data to be used to generate survey deliverables. The project consisted of performing a bathymetric survey and assistance in combining the collected data with Drone Lidar data. Survey reports were created to document the capacity of the reservoir.

Sewer Installation | City of Westfield, IL | Project Surveyor
Responsible for all site data collection of the entire city of Westfield. As the project surveyor a 625 Acre RTK drone flight was completed as well as supplemental Topographic survey utilizing GPS and Total station technology was completed. These datasets were combined and utilized for design purposes of the proposed sewer system for the city of Westfield.

Manufacturing/Office Facility Site Development | Stor-Mor Portable Buildings | Hickory, KY | Project Surveyor/ Engineer
Responsible for all site data collection of the proposed location for a 10,000 Square foot manufacturing facility. As the project surveyor a 30 Acre RTK drone flight was completed and a boundary survey of the proposed site. These datasets were then utilized and constructed by Mr. Lautner into full site development drawing set encompassing hydraulics studies, roadway design, and utilities layout. During the construction phase construction layout was performed of all proposed improvements utilizing GPS and Total station technology.

Farm Development | Purdue University | Lafayette, IN | Project Surveyor/Engineer
Responsible for all site data collection of the Purdue East and West Farms. As the project surveyor, a 300 Acre RTK drone survey was performed and analyzed to provide better drainage opportunities for the farm. As the project surveyor, responsible for data collection, client coordination, processing of datasets and design of proposed improvements to the site.

Plant Expansion | Caterpillar Inc. | Lafayette, IN | Project Surveyor/Engineer
Responsible for all site data collection of the Caterpillar Plant. As the project surveyor, a 250 Acre RTK drone survey was performed to be utilized in the expansion of the existing manufacturing plant. As the project surveyor, responsible for data collection, client coordination, and processing of datasets.

Jennifer Boothby, PhD

Research Coordinator

Johns Hopkins Applied Physics Laboratory

Summary

Dr. Jennifer Boothby is a Senior Biomaterials Engineer at Johns Hopkins University Applied Physics Laboratory with expertise in smart materials, nature-based coastal protection, and interdisciplinary resilience research. Her work spans biopolymers, biohybrid systems, and materials characterization in support of a wide range of projects, including coastal erosion mitigation and hybrid reef systems. She has contributed to several projects integrating laboratory testing, modeling, and field-relevant design for coastal and environmental applications.

Funding Awards

Co-PI – DARPA BTO, *GELER (Genomics, Encapsulating Larvae, and Enhancing Reefs)*, POP: June 2024 - November 2025

Co-PI/Subcontract – DARPA Reefense Program, *REEFS (Reef Engineering to Enhance Future Structures)*, subcontract to Andrew Baker (University of Miami), POP: June 2022 – November 2023

Task Lead – NRO DII Proposal, *ADAPT (Adaptable and Deployable Aperture Polymer Technology)*, POP: January 2024 – May 2026

PI – JHU Discovery Award *Developing Innovative Implementation Methods: Coastal Resilience Solutions for the Baltimore Area*, POP: September 2024 – August 2025

Select Publications

Boothby, J.M. & Brett, J., Beechert, J., Sleeman, J. A reduced model of coral reefs to examine decadal-scale dynamics. Submitted to *Journal of Coastal Research* on November 13, 2025.

Brett, J., Samuell, M., Augstein, B., Parra, S., Hancock, E., Saunders, C., Wunsch, S., Winstead, N., **Boothby, J. M.** (2024) Nature-based Coastal Protection: Measuring and Modeling Flow Reduction by Oysters. *Journal of Coastal Research*, 40 (4): 647-660.

Bunton, C. M., Bassampour, Z. M., **Boothby, J. M.**, Smith, A. N., Rose, J. V., Nguyen, D. M., ... & Son, D. Y. (2020). Degradable Silyl Ether–Containing Networks from Trifunctional Thiols and Acrylates. *Macromolecules*, 53(22), 9890-9900.

Select Presentations

J.M. Boothby, M. Kesavan, D. Trigg, S. Mehta (2025) Utilizing biopolymers for improving outcomes for nature-based solutions and mitigating coastal erosion. Materials Research Society Spring Meeting.

J.M. Boothby, M. Bartlett (2024) Biomaterials for Hybrid Reef Engineering. Atlantic Coastal Resilience Workshop, Invited Talk. Laurel, MD.

J.M. Boothby (2024) Defending the Coastline: Coastal Resilience at APL. Johns

YEARS OF EXPERIENCE

10 years

YEARS WITH JHU APL

6 years

EDUCATION

PhD, 2019, Biomedical Engineering, University of Texas at Dallas

MS, 2019, Biomedical Engineering, University of Texas at Dallas

BS, 2014, Biomedical Engineering (minor in Biology), Georgia Institute of Technology

AFFILIATIONS

Materials Research Society – Member, 2015-Present

Applied Biomedical Engineering Department, Engineering for Professionals Program, Johns Hopkins University – Advisor & Lecturer, 2019-Present

Hopkins University Sustainability Symposium. Baltimore, MD.

J. M. Boothby (2023) Bioinspired Smart Material Applications. Korea-US Advanced Industry and Technology Cooperation Forum 2023, Invited Talk. Seoul, South Korea.

J. M. Boothby, M. Harman, R. Hegab, M. Hughes (2022) Do Materials Matter? Finding Materials Solution to Coral Restoration. Reef Futures, Key Largo, FL.

J. M. Boothby, Z. Xia (2020) Degradable Hydrogels for Ocean Sensing. Materials Research Society Fall 2020 Conference, Virtual.

Alexander New, PhD

Artificial Intelligence Research Lead

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

Summary

Mr. New seeks to develop techniques that maximize the ability of machine learning (ML) and artificial intelligence (AI) methods to ingest and create scientific and mathematical knowledge. This has included work in different scientific and engineering domains, including coastal resilience materials science, chemistry, protein design, fluid dynamics, and population health. In a JHU/APL internal research effort, the team for which he was the ML lead demonstrated the first-known AI-enabled of a novel superconductor. Core technical efforts have focused on methods designed to leverage information contained in domain-specific scientific data types. This includes physics-informed machine learning for predicting solutions to systems governed by differential equations and other complex physical systems, geometric machine learning and for modeling molecular and material structures, and Bayesian optimization for data-efficient discovery.

Recent Publications

J. Markowitz*, **A. New***, J. Sleeman*, et al., "Discovering strategies for coastal resilience with AI-based prediction and optimization", arXiv 2025 https://arxiv.org/abs/2509.19263

A. New, M. Villafañe-Delgado, C. Shugert, "Equation identification for fluid flows via physics-informed neural networks", ICML 2024 AI4Science, https://openreview.net/forum?id=XsvCLEYH3O

V. J. Leon, N. Ford, H. Mrema, J. Gilbert, **A. New**, "Ensemble models outperform single model uncertainties and predictions for operator-learning of hypersonic flows" NeurIPS 2023 MLPS, https://arxiv.org/abs/2311.00060

G. L. Collins*, **A. New***, R. A. Darragh, B. E. Damit, C. D. Stiles, "Rapid prediction of two-dimensional airflow in an operating room using scientific machine learning", NeurIPS2023 AI4Science, https://openreview.net/forum?id=mUQrw0rIZN

B. Wilfong, **A. New**, G. Bassen, et al., "Ternary materials discovery using human-in-the-loop generative machine learning", *RSC Adv.* 2025, https://pubs.rsc.org/en/content/articlehtml/2025/ra/d5ra00427f

M. Pekala, E. A. Pogue, K. McElroy, **A. New**, et al., "Evaluating AI-guided design for scientific discovery" NeurIPS2023 AI4Mat, https://openreview.net/forum?id=SfEsK3O2KT

E. A. Pogue*, **A. New***, K. McElroy et al., "Closed-loop superconducting materials discovery". *npj Computational Materials* 2023, https://doi.org/10.1038/s41524-023-01131-3

M. M. Baker, **A. New**, M. Aguilar-Simon, et al., "A domain-agnostic approach for characterization of lifelong learning systems" *Neural Networks* 2023, https://doi.org/10.1016/j.neunet.2023.01.007

YEARS OF EXPERIENCE

10 years in research

5 years in AI surrogate modeling

YEARS WITH JHU APL

6 years

EDUCATION

PhD, 2019, Mathematics, Rensselaer Polytechnic Institute

BA, 2014, Physics and Mathematics, Kenyon College

Page intentionally left blank.

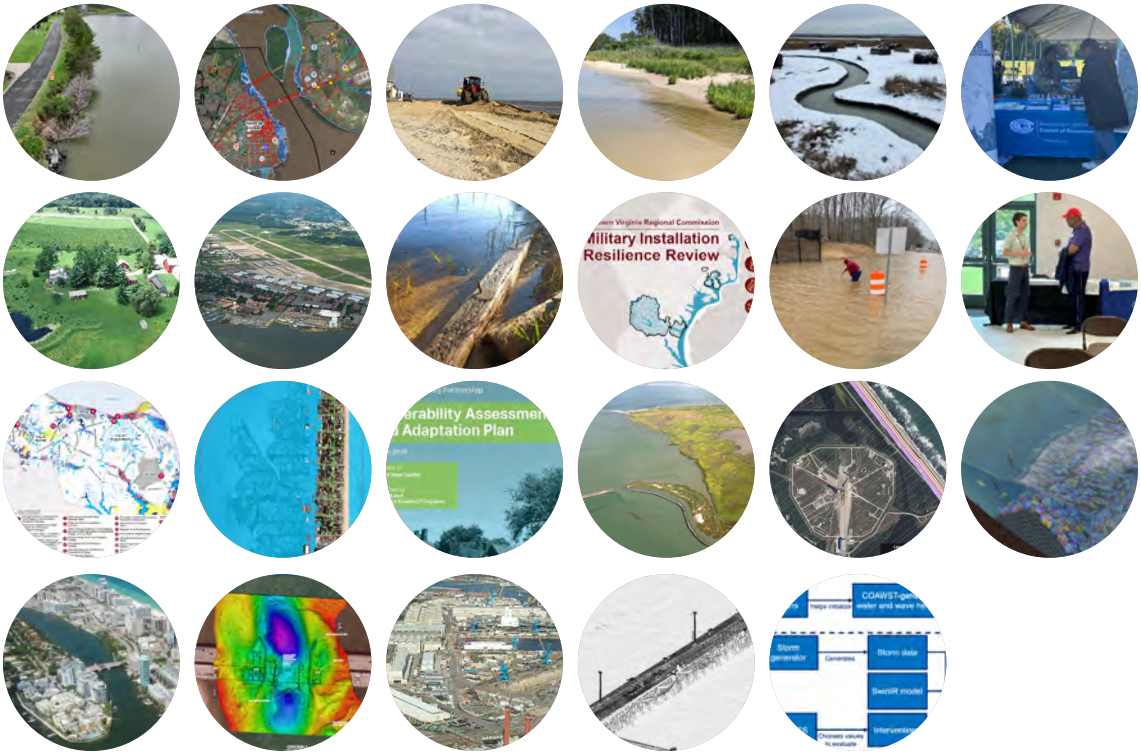
Project Experience

The following matrix summarizes representative projects completed by the Straughan-led team and illustrates how each aligns with the technical and programmatic priorities of the GRIT Phase I effort. These priorities include advancing tidal wetland resilience, evaluating nature-based and hybrid solutions, conducting field-informed existing conditions and feasibility analyses, supporting stakeholder coordination, and laying the groundwork for future design, permitting, and funding.

The subsequent project descriptions expand on these examples and demonstrate the team's ability to support GRIT Phase I from baseline assessment through feasibility and concept development, with a clear focus on collaboration, constructability, and implementation readiness.

Collectively, these projects demonstrate a depth of experience that closely mirrors the intent and technical demands of the GRIT Phase I effort, positioning the team to deliver informed, innovative, and implementation-focused outcomes from the outset.

Our Key Projects:



Page intentionally left blank.

	Marsh Resilience, Restoration & Field Assessments	Nature-Based Solutions & Innovation	Resilience Feasibility, Land Conservation Suitability & GIS Analysis	Stakeholder Engagement	Environmental and Regulatory Documentation
Statewide Sustainability Consulting – Nature-Based Solutions & Climate Visualization Pilot Virginia Department of Transportation (VDOT)	✓	✓	✓		✓
Resilience Capacity Building for Nine Maryland Communities University of Maryland Environmental Finance Center, NFWF NCRF	✓	✓	✓	✓	✓
MD 249 Saint Georges Island Shoreline Assessment and Living Shoreline Design Maryland State Highway Administration (SHA)	✓	✓	✓		✓
Building Line Alternative Analysis Delaware Department of Natural Resources and Environmental Control (DNREC)			✓	✓	
Thompson Island Shoreline Stabilization Delaware Center for Inland Bays	✓	✓	✓	✓	✓
Croppers Island and Stark Properties Salt Marsh Restoration U.S. Fish & Wildlife Service	✓	✓	✓	✓	✓
Regional Blue-Green Infrastructure Resilience Planning Community Engagement Metropolitan Washington Council of Governments (MWCOG)	✓	✓	✓	✓	✓
Environmental Engineering Services, 518803 Maryland Port Administration	✓	✓	✓	✓	✓
Integrated Assessment of Climate Change Impacts to Groundwater, Stormwater, and Wastewater Infrastructure at Military Facilities University of Delaware, DARPA ESTCP	✓		✓	✓	
Environmental Engineering Services, 522803 Maryland Port Administration	✓	✓	✓	✓	✓
Military Installation Resilience Review 1.0/2.0 Northern Virginia Regional Commission (NVRC)	✓	✓	✓	✓	✓

	Marsh Resilience, Restoration & Field Assessments	Nature-Based Solutions & Innovation	Resilience Feasibility, Land Conservation Suitability & GIS Analysis	Stakeholder Engagement	Environmental and Regulatory Documentation
Little Creek Watershed Evaluation and Concept Design Plans Northern Virginia Regional Commission	✓	✓	✓	✓	✓
Resilience Planning Public Outreach Support Virginia Department of Conservation and Recreation		✓	✓	✓	✓
Norfolk and Virginia Beach Joint Land Use Study Hampton Roads Planning District Commission	✓	✓	✓	✓	✓
Sea Level Rise Vulnerability Study Town of Fenwick Island, DE		✓	✓	✓	
Vulnerability Assessment and Adaptation Plan City of New Castle, DE	✓	✓	✓	✓	✓
Texas Coastal Resiliency Master Plan Texas General Land Office	✓	✓	✓	✓	✓
NASA Kennedy Space Center Coastal Sustainability Study NASA Kennedy Space Center	✓	✓	✓		
Defense Advanced Research Projects Agency, Reefense University of Miami	✓	✓	✓		
Sea Level Rise Vulnerability Assessment and Adaptation Plan City of Miami Beach, FL	✓	✓	✓	✓	
Lesner Bridge Underwater Inspection and Imaging City of Virginia Beach, VA	✓				
Waterfront Inspections Norfolk Naval Shipyard Naval Facilities Engineering Systems Command Expeditionary Warfare Center (NAVFAC EXWC)	✓				
Waterfront Facilities Inspection NAVFAC EXWC	✓				
AI-Driven Coastal Resilience Optimization US Air Force, Tyndall AFB	✓	✓	✓		

Statewide Sustainability Consulting – Nature-Based Solutions & Climate Visualization Pilot

Virginia Department of Transportation (VDOT)

STRAUGHAN ENVIRONMENTAL

Straughan provided key technical support to the ICF team as a lead consultant for the Virginia Department of Transportation (VDOT), focusing on sustainability, resilience, greenhouse gas reduction, land management, and stewardship. Our comprehensive approach encompasses two main projects: a Natural and Nature-Based Solutions (NBS) pilot project and the development of a climate risk visualization tool.

NATURAL AND NATURE-BASED SOLUTIONS (NBS) PILOT PROJECT. In the NNBS pilot study, Straughan developed interim maintenance measures, conceptual designs, and monitoring strategies for a selected coastal site adjacent to Simonson Road along Morattico Creek in Farnham on the Middle Peninsula in Virginia. Key components include:

- Site Assessment and Design: Collaborating with VDOT to establish project goals, our team conducted a comprehensive pre-engineering assessment, inclusive of topographic and biological condition evaluations. This effort informed the identification of appropriate NNBS design elements.
- Preliminary Design Solutions: We produced three distinct conceptual designs that integrate green and gray infrastructure components. The designs aim to enhance climate resilience while providing infrastructure improvements to benefit both community and ecosystem needs.
- Technical Documentation: Straughan prepared detailed plans and cross-sectional drawings for each design alternative, with assessments of effectiveness (risk levels, maintenance requirements, costs, climate resilience, and regulatory compliance) documented in a technical memorandum.
- Biological Resource Assessment: Conducted assessments of terrestrial and aquatic ecosystems, identifying special-status species, keystone resources, and potential coastal erosion issues. UAV imaging facilitated the development of a GIS-based biological resources map.
- Water Level Monitoring: Installed a continuous water level monitoring instrument to collect vital data for the design process. This included site calibration and data validation through systematic monitoring over a 60-day period.
- 30% Plans Development: Progressed the conceptual plans to a 30% completion level using VDOT standards and MicroStation format, coordinating with the survey team to incorporate topographic and bathymetric data.

CLIMATE RISK VISUALIZATION TOOL. Straughan is developing a climate risk visualization and decision-support tool to assist VDOT in integrating climate resilience into daily operations. This project entails:

- Vulnerability Assessment: A thorough analysis of climate-related impacts, such as flooding, monetizes risks to transportation infrastructure and evaluates the community impacts of damaged road segments under various hazard scenarios.
- Data Integration: Utilizing advanced geospatial data processing and GIS analysis to identify critical assets needing adaptation investments. The

RESPONSIBLE OFFICE

Straughan | Columbia, MD

PROJECT LOCATION

Statewide, VA

CLIENT REFERENCE

Maria Mutuc, Resilience Program Manager, VDOT

Phone: 804.729.6689

Email: maria.mutoc@vdot.virginia.gov

BUDGETED COST

$109,055.60

COMPLETED COST

$109,055.60

SCHEDULED COMPLETION DATE

December 31, 2025

ACTUAL COMPLETION DATE

December 31, 2025

PROJECT HIGHLIGHTS

- GIS-based vulnerability assessment
- Climate risk decision support
- Asset prioritization analysis
- Nature-based solutions design
- Hybrid green-gray concepts
- Feasibility-informed alternatives

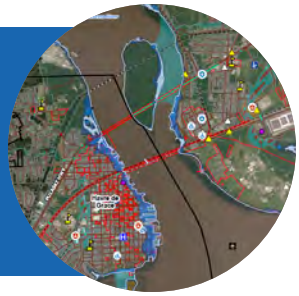
tool amalgamates vulnerability metrics with risk data to portray cumulative risks to the transportation system clearly.

- Collaboration: Our team works closely with VDOT stakeholders to gather necessary datasets and institutional knowledge, ensuring the visualization tool is based on high-quality, actionable data.
- Technical Processing: Significant effort was devoted to acquiring and preparing geospatial data, including raster file organization, processing, quality control, and packaging datasets for model inclusion. Continuous communication ensured data accuracy and responsiveness to evolving needs.

Straughan's expertise in geospatial analysis, environmental assessment, and nature-based solution design positioned us effectively to support VDOT's goals for sustainable and resilient transportation systems. Our collaborative, data-driven approach ensures that projects are grounded in the best available science while addressing both current and future climatic challenges. The integration of innovative tools and nature-based solutions is enhancing VDOT resilience against climate impacts, ensuring long-term benefits for communities and ecosystems alike.

Resilience Capacity Building for Nine Maryland Communities

University of Maryland Environmental Finance Center



Straughan in on the team with the University of Maryland Environmental Finance Center through a National Fish and Wildlife Foundation, National Coastal Resilience Fund grant. This project is focused on guiding a cohort of nine coastal Maryland communities through a resilience planning process to (1) evaluate the local government's capacity and readiness to adapt; (2) assess each jurisdiction's vulnerability to climate-related hazards; (3) identify and prioritize a set of hybrid or nature-based solutions (NBS) that will improve resilience to climate-related hazards and protect or enhance fish and wildlife habitat; and (4) connect each community to partners that can expand capacity or support implementation. For this project Straughan is leading the technical team to develop a climate vulnerability assessment as well as adaptation projects of nature-based and hybrid solution options to provide climate resilience to these communities. Straughan is also assisting with community outreach, stakeholder identification, and tracking of future funding for implementation of the concepts being developed.

NATURE BASED AND HYBRID CLIMATE SOLUTIONS. To develop community resilience Straughan in contributing to thought leadership in the region by developing a menu of potential NBS that communities can use to adapt to climate change impacts. Straughan is also providing expertise related to improving ecological/ wildlife habitat with a broad range of project concepts from reducing flooding to improving water quality based upon living shorelines, wetland restoration and expansion, blue-green infrastructure, and vegetated berms linked to structural solutions where appropriate to create resilience hybrid solutions.

Straughan is also developing the vulnerability assessment for each community to climate impacts including increased duration and intensity precipitation, storm surge, sea level rise and the combination of these. The team is using published information/data to assess existing habitat vulnerability for each community including NWI and MD DNR wetland inventories, MDE surface waters, MD DNR Merlin Environmental Mapper, County Soil Survey data, Critical Area mapping, FEMA Floodplain mapping, aerial photographs, topographic surveys and others. The team is also presenting the results of these studies to the communities to gather input and feedback based on residents' local experience with ongoing climate impacts.

RESILIENCE WORKPLAN. Based upon this information the team is developing a community resilience workplan with UMD EFC including the following elements:

- A list of NBS and hybrid opportunities to address both coastal and upland flooding for each community to address problems identified in vulnerability assessment and prioritized by community.
- Preparation of preliminary concept plans for the top 3 NBS projects chosen by each community though a Multicriteria Decision Assessment (MCDA) which will include wildlife habitat restoration/ enhancement components

RESPONSIBLE OFFICE

Straughan | Columbia, MD

PROJECT LOCATION

Statewide, MD

CLIENT REFERENCE

Stephanie P. Dalke, Project Director, UMD-EFC

Phone: 301.405.5036

Email: spdalke@umd.edu

BUDGETED COST

$151,000

COMPLETED COST

$151,000

SCHEDULED COMPLETION DATE

May 2026

ACTUAL COMPLETION DATE

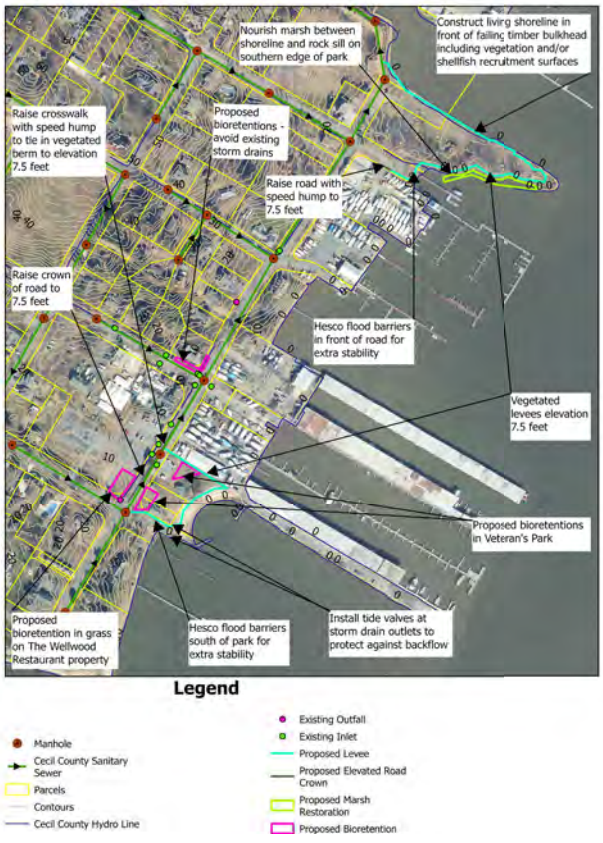
On schedule

PROJECT HIGHLIGHTS

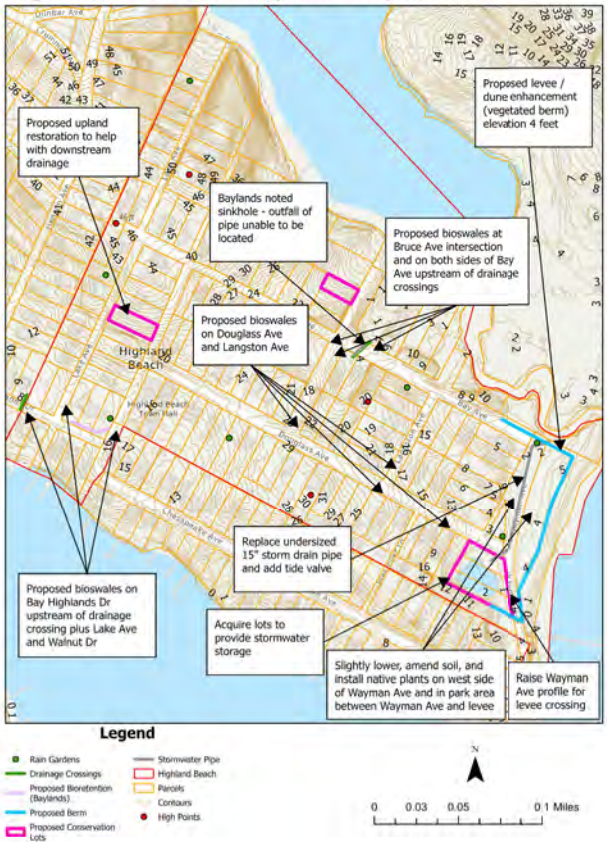
- Climate vulnerability assessment
- Nature-based solutions planning
- Hybrid resilience concepts
- Ecological habitat enhancement
- Community-driven prioritization
- Feasibility and funding support

- Completion of a draft cost-benefit analysis for potential NBS projects to provide support for pursuit of funding for implementation.
- Development of further workplan content including a description of steps that will help communities pursue funding for final design, and implementation of NBS projects to support long term community and habitat resilience.

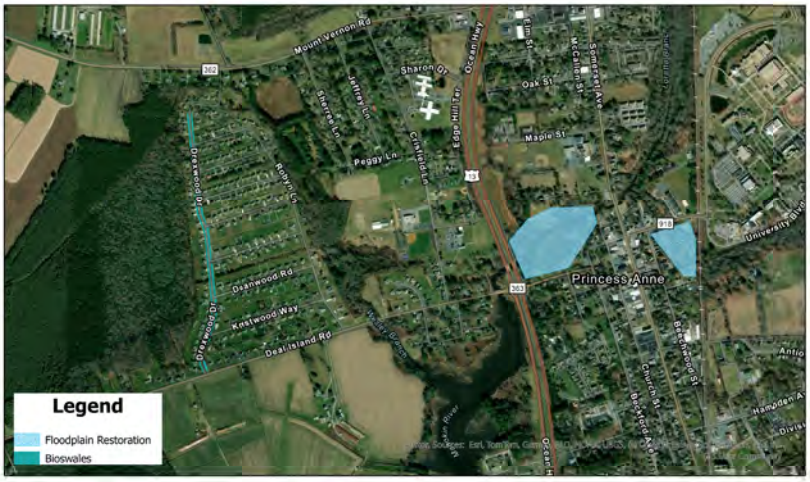
Proposed Shoreline Protection



Highland Beach Existing and Proposed BMPs



Princess Anne GI Concept Solutions



STRAUGHAN ENVIRONMENTAL
9175 Guilford Road, Suite 100 | Columbia, MD 21045
301.362.9200 | www.straughanenvironmental.com

ENVIRONMENTAL FINANCE CENTER

MD 249 Saint Georges Island Shoreline Assessment and Living Shoreline Design

Maryland State Highway Administration (SHA)

OBJECTIVE. Straughan is committed to providing resilience against ongoing sea-level rise and coastal erosion through the development of hybrid and nature-based solutions for critical infrastructure. Our experience in addressing these challenges in various communities, including St. Mary's County along the Potomac River, underscores our capability to effectively support coastal adaptation and resilience planning.

BACKGROUND. MD 249 Piney Point Road serves as the sole access point to Saint George Island, with approximately 180 homes relying on this critical roadway. An average of 1,500 vehicles daily traverses this route, which has faced severe flooding challenges—experiencing approximately 50 flood events in 2019 alone. Evaluations by the Maryland Department of Transportation State Highway Administration (SHA) revealed that several road segments are only 2 feet above mean sea level, making them extremely vulnerable during high tides and storm surges. Projections indicate that by 2045, flooding events will occur at least 226 times annually at the most affected sites.

PROJECT GOALS AND OBJECTIVES. The overarching goal is to ensure the operational integrity of the roadway while enhancing community resilience. The project objectives include:

- Maintenance of Fixed Assets: Ensure roadway shoulders are improved for durability through the 2045 design year, minimizing frequent maintenance needs.
- Effective Drainage Solutions: Upgrade existing drainage systems to effectively manage stormwater runoff while accounting for projected sea level rise and sediment accumulation.
- Safe Access for Residents: Implement geometric improvements to reduce the anticipated yearly roadway inundations to below 52 by 2045, and provide adequate erosion protection for lost marshland and dune areas.

PROACTIVE MEASURES. To meet these goals, Straughan has undertaken a comprehensive approach involving roadway improvements, drainage enhancements, and living shoreline designs. Our actions include:

- Shoreline Assessment: Detailed assessments of shoreline erosion at three identified sites, along with the addition of a fourth site based on observed flooding and erosion concerns.
- Design Development: Creation of living shoreline and shoreline stabilization design elements, ensuring solutions are both cost-effective and permit-friendly for construction contractors.
- Preliminary and Final Designs: Development of 65% designs, reports, specifications, and estimates, culminating in the preparation of final design documentation for all targeted sites.

CURRENT ACTIVITIES. Straughan is actively delivering the following services:

- Final Design Services for Sites 1, 2, and 3: Completing detailed design plans that align with SHA standards.
- Wetland Permitting Preparation: Facilitating the acquisition of necessary permits for environmental compliance.

RESPONSIBLE OFFICE

Straughan | Columbia, MD

PROJECT LOCATION

Piney Point, MD

CLIENT REFERENCE

Anthony Verdicchio, Transportation Engineer III Maryland State Highway Administration

Phone: 410.545.8876

Email: averdiccio@mdot.maryland.gov

BUDGETED COST

$326,652.06

COMPLETED COST

On budget

SCHEDULED COMPLETION DATE

12/31/2026

ACTUAL COMPLETION DATE

On schedule

PROJECT HIGHLIGHTS

- Nature-based shoreline design
- Hybrid resilience solutions
- Flood risk mitigation
- Existing conditions assessment
- Concept to final design
- Permitting-ready deliverables

- Erosion Control and Stabilization: Designing erosion and sediment control measures, including grading, planting details, and calculating Total Maximum Daily Load (TMDL) credits.
- Stormwater Management: Incorporating wind and wave assessments for the design of infrastructure resilient to a 25-year design storm.

This project has allowed Straughan to leverage our extensive experience in flood risk mitigation, shoreline stabilization, and adaptive infrastructure design. Our holistic strategies and community-focused solutions will ensure enhanced resilience against the impacts of climate change and protect both existing infrastructure and local ecosystems at the project site.

Site 1

Site 2

Site 3

Building Line Alternative Analysis

Delaware Department of Natural Resources and Environmental Control (DNREC)

PROJECT OVERVIEW. Straughan successfully completed the significant coastal adaptation project for Delaware's Department of Natural Resources and Environmental Control (DNREC). Our work integrated comprehensive coastal setback research and advanced geospatial data to produce five alternative coastal building lines designed to protect shorelines from flooding and erosion while accommodating projections for sea level rise.

OBJECTIVE. Our dedicated analysis aimed to develop adaptive coastal regulations that safeguard communities and ecosystems along Delaware's coastal communities. The need for updated building lines is underscored by ongoing climate risks, necessitating a responsive framework to manage coastal development effectively. For the project 36 miles of coastline were reviewed which could effect up to 7,551 parcels.

METHODOLOGY. We approached the building line analysis through five meticulously defined alternatives:

1. **No Action Alternative (Baseline):** Utilized the existing 1981 building line as the standard for comparison, creating an updated version for clarity and replicability in subsequent analyses.
2. **Re-delineation Using Updated Topography:** Leveraged advanced LiDAR data to reassess building lines along the Delaware coast, providing mixed results in terms of land shifts in regulatory positions.
3. **Erosion Rate Analysis:** Developed building lines based on varying erosion rates, using updated transect data and beach nourishment plans to project sustainable distances from established baselines.
4. **FEMA Limit of Moderate Wave Action (LiMWA):** This approach employed FEMA's flood maps to establish a robust reference for building lines, ensuring they remain landward of existing structures while accounting for potential wave impacts.
5. **Mean High Water Line (MHWL) Based Offset:** Defined building lines in relation to the MHWL, utilizing location-specific offsets to adapt to diverse coastal conditions, ensuring ongoing relevance to regulatory frameworks.

KEY FINDINGS AND RECOMMENDATIONS. After extensive analysis, Straughan determined that Alternative 4, based on the LiMWA, offers the most effective approach for managing future sea level rise and storm surges. This alternative provides:

- Adaptability: Updates easily alongside FEMA's evolving models, ensuring resilience against climate impacts.
- Credibility: Utilizes federal data recognized for its reliability, thereby increasing stakeholder confidence.
- Sustainability: Projects a reasonable balance of regulatory progression while minimizing drastic shifts from the established building line.

CONCLUSIONS. This project underscores Straughan's experience and commitment to data-driven solutions for developing coastal adaptation and resilience plans. By integrating advanced methodologies and responsive constructs for building lines, we aimed to enhance community safety and

RESPONSIBLE OFFICE

Straughan | Columbia, MD

CLIENT REFERENCE

Jamie Genevie, Climate Resilience Senior Managing Consultant, ICF

Phone: (267) 571-6684

Email: jamie.genevie@icf.com

BUDGETED COST

$98,420

COMPLETED COST

$98,420

SCHEDULED COMPLETION DATE

June 30, 2024

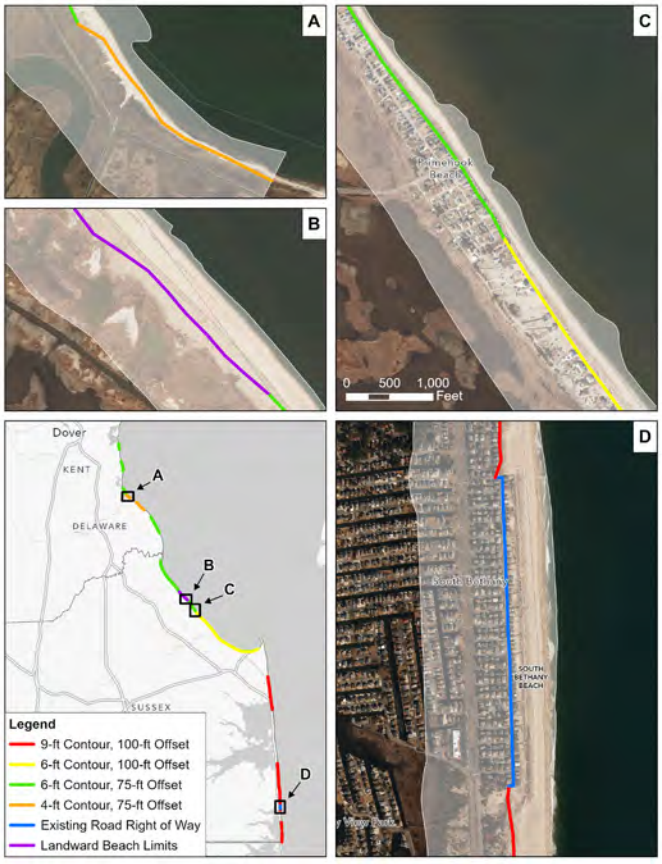
ACTUAL COMPLETION DATE

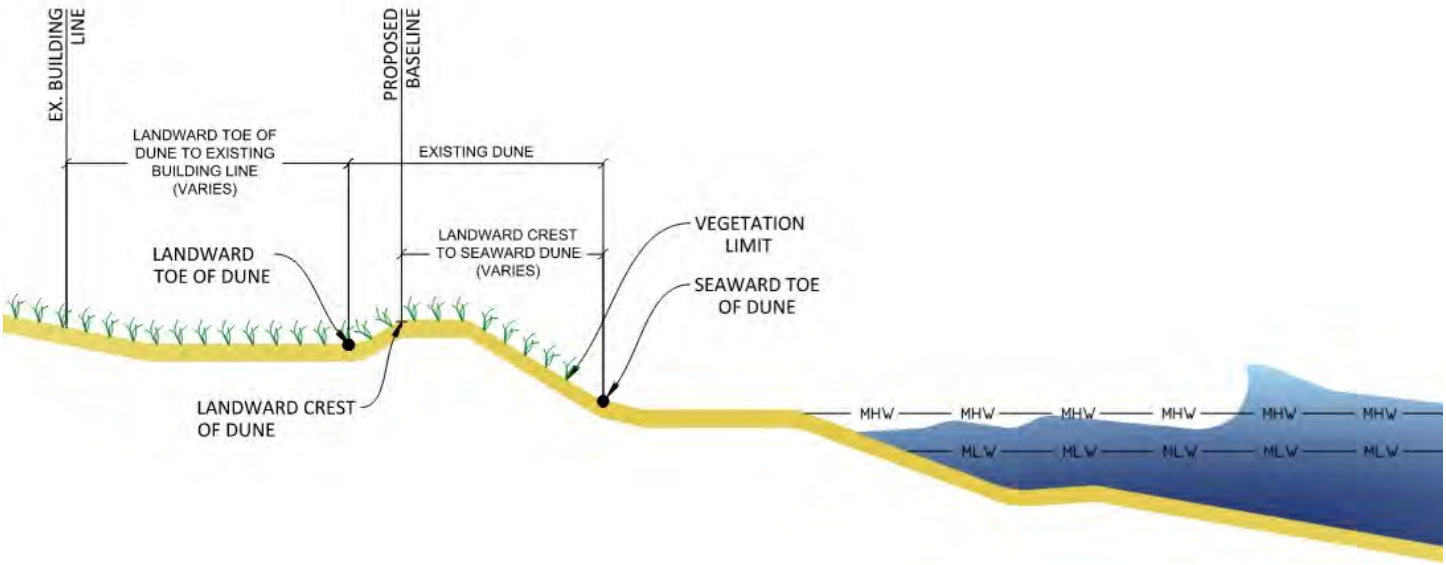
June 30, 2024

PROJECT HIGHLIGHTS

- Coastal adaptation planning
- Sea level rise analysis
- GIS-based alternatives evaluation
- Flood and erosion risk mapping
- Regulatory feasibility assessment
- Implementation-ready datasets

environmental integrity while adhering to adaptive regulations that prioritize future resilience against climate change. Upon project completion, we provided a comprehensive report and geodatabase to ensure that stakeholders could easily access, understand, and utilize the developed strategies.





Thompson Island Shoreline Stabilization

Delaware Center for Inland Bays

Thompson Island (TI) is an island in Rehoboth Bay, Delaware comprised of 4,400 linear feet of unarmored shoreline along its western, southern, and eastern shorelines. Thompson Island is located on state-owned property in Sussex County, Delaware on the north end of Rehoboth Bay (Bay), a bar-built inlet estuary. Thompson Island is designated as a nature preserve, the highest level of land protection in Delaware, and is protected by the Department of Natural Resources and Environmental Control (DNREC) Division of Parks and Recreation. Thompson Island historically has cultural significance to the Nanticoke Indian Tribe (Nanticoke), and the state park is owned and managed by the state of Delaware but is accessible to the Nanticoke for various ceremonies. Otherwise, public access onto the island is generally prohibited (Wilson, 2021). Straughan Environmental, Inc. (Straughan), under contract with Sovereign Consulting, Inc. (Sovereign), assessed the area to inform the shoreline stabilization design and prepared design plans, permitting documents, specifications and construction cost estimates, and provided construction phase services for the Delaware Center for Inland Bays (CIB). The primary goals for the project are:

- Protection of significant archeologic resources located on the island;
- Reduction of public access by water to the island for the purposes of protecting the above noted resources;
- Long-term, resilient, nature-based stabilization for the shoreline;
- Protection of an existing State S1.1 plant (to date, only a single extant occurrence or population of this species is known to exist in the state);
- Enhancement of shoreline and nearshore habitat and associated ecological functions; and
- Water quality benefits.

Thompson Island is separated from mainland by Stockley Creek on the north side and the Lewes & Rehoboth Canal on the west side. The eastern and southern exposures of the island are bordered by the Rehoboth Bay. The island is approximately 120 acres comprised of 5,675 feet of shoreline along Thompson Island. This project will address the west, south, and east shorelines. The northern shoreline and interior of the island are not part of the project footprint.

Straughan provided data collection, desktop shoreline assessments, field data collection, data analysis and development of concept design solutions for shoreline stabilization. Field data collection included aerial photography using drone. We have also prepared 30%, 60%, and 100% design plans, specifications and construction cost estimates. As an accepted Total Maximum Daily Load (TMDL) implementation strategy for both nutrient and sediment load reduction, State and local jurisdictions are increasingly turning to nature-based shorelines as a stabilization technique along tidal waters. Nature-based shorelines projects protect shorelines from erosion while maintaining natural shorelines processes that increase water quality and sustain living resources.

Straughan performed desktop and field assessments to determine site characteristics and determine stabilization measures that would provide

RESPONSIBLE OFFICE

Straughan | Columbia, MD

CLIENT REFERENCE

Meghan Noe Fellows, Science Director, Delaware Center for Inland Bays

Phone: 302.226.8105

Email: mnoefellows@inlandbays.org

BUDGETED COST

$122,000

COMPLETED COST

$122,000

SCHEDULED COMPLETION DATE

November 30, 2025

ACTUAL COMPLETION DATE

November 30, 2025

PROJECT HIGHLIGHTS

- Nature-based shoreline stabilization
- Hybrid energy-based design
- Ecological habitat enhancement
- Cultural resource protection
- Sea level rise adaptation
- Permitting-to-construction delivery

maximum benefits in line with the primary project goals listed above. Based on the varying degrees of energy encountered at each of the shorelines, Straughan is using low-, medium- and high-energy tactics at each of the shorelines. Low-energy tactics in the form of a shell bag sill/toe marsh protection are proposed along the western shoreline where encountered energy is primarily a result of vessel wake from the canal. Medium-energy tactics in the form of a nearshore array of concrete oyster castles are proposed along the eastern shoreline where the primary cause of erosion is from waves occurring during normal tidal conditions and low to moderate storm events. High energy tactics, in the form of a nearshore array of 3.5 to 5 ft high prefabricated concrete artificial reefs are proposed along the southern shoreline where the erosion from waves is highest and the bluff requires protection. They will be deployed in a manner that will interact and dampen the larger wave vectors. These structures will also provide a secondary benefit of accreting particulates being carried in the water column. Structure heights are proposed to address projected future sea level rise to 2050.

Design, permitting and bid phase have been completed for all the proposed improvements. Straughan has completed construction phase services for the project. Permitting included approval through DNREC's DFM process which also included preparation of the project manual according to DFM requirements. Also included permit support for US Coast Guard, USACE and DNREC Subaqueous Lands.

Croppers Island and Stark Properties Salt Marsh Restoration

U.S. Fish & Wildlife Service

For this project, Straughan was part of a team tasked with designing restoration practices for salt marshes in the Maryland's Coastal Bays. The salt marshes have been impacted by ditching for mosquito control as well as effects of sea level rising causing creation of open waters in a portion of the marsh cells. These impacts have led to decreased habitat for species including the saltmarsh sparrow. The project aimed to alleviate pooling and deterioration of the marsh environment and improve the flow of water through the marsh to maintain healthy tidal levels. Straughan was responsible for providing the design of salt marsh restoration at three (3) private properties along the Maryland Coastal Bays of Newport and Sinepuxent Bays, as a subconsultant to Sovereign. Tasks included desktop data collection and review and use of the provide USFWS data; site visit to all sites to perform assessment and document current conditions; preparation of 30%, 60%, 90% and final design plans; and permitting support services including development of impact plates, narratives and meeting attendance.

The saltmarsh sparrow habitat is found in the high marsh area of the salt marsh, an elevated portion of land that does not flood expect during spring tides or storm surges. Sea level rise and human-made impacts are increasingly reducing this habitat, flooding the high marsh too often and creating pockets of standing water. Prolonged inundation to certain marsh plant species can "drown" them, decreasing plant density which has negative consequences to the vegetation-sediment interaction of the marsh, reducing sedimentation and pioneer growth. Straughan participated in conducting site visits to assess the conditions at the three marsh sites and then worked with our project partner to create a design approach. This assessment took into consideration factors such as tidal water surface data, survey elevations, and acreage of waterlogged marsh cells for resiliency. Due to the size of the marshes, topographic surveying was limited to transects at various locations in the project area. While this data was important for determining critical elevation ranges in areas with poor vs stable marsh conditions, it did not provide a full survey for the site. To overcome this challenge, Straughan supplemented the survey with local LiDAR data and aerial imagery analysis, identifying marsh features that would help to estimate the location and elevation of pools and channels throughout the marsh project area.

Straughan subdivided each site into smaller marsh cells which enabled us to thoroughly evaluate the complex topography of the sites and select design practices in each sub-area catered to specific conditions within that cell. Some of the problems faced were areas of pooled standing water, deteriorating channels through the marsh, and reduced flow distribution across the marsh. To address these issues, the overall design goal was to create a marsh environment resilient to sea-level changes that can support plant growth, improve fish habitats and maintain healthy water levels by way of effective channelization throughout the marsh. Ultimately, multiple design practices were needed to meet these goals which varied practice based on the individual cells.

RESPONSIBLE OFFICE

Straughan | Columbia, MD

CLIENT REFERENCE

Rich Mason, Project Manager, U.S. Fish & Wildlife Service

Phone: 410.573.4584

Email: rich_mason@fws.gov

BUDGETED COST

$33,557

COMPLETED COST

On budget

SCHEDULED COMPLETION DATE

June 30, 2026

ACTUAL COMPLETION DATE

On schedule

PROJECT HIGHLIGHTS

- Tidal marsh restoration
- Nature-based resilience design
- Sea level rise adaptation
- Habitat-focused solutions
- Field-informed existing conditions
- Permitting-ready design delivery

The final design practices proposed included creating borrow ponds to source fill material on site, filling of failing/ abandoned ditches, and cleaning out of ditches needed for tidal exchange. The main practices consist of either proposing high marsh nourishment or secondary platform channels to target areas of failing marsh within each marsh cell. The areas of high marsh nourishment create an area of fill material where permanent pooling exists, consisting of a central berm, or spine to create the elevated land needed for high marsh habitat with positive drainage. Within this nourishment, high marsh plantings such as salt meadow hay and seagrass will promote longevity and help restore the marsh.

The areas of secondary drainage channels will create runnels to alleviate pooling and direct flow of water towards existing ditches to promote a healthy marsh environment. The goal of these runnels is to reintroduce proper tidal flush in the low marsh areas and promote access of wildlife through the marsh, therefore improving the function of the marsh habitat. Overall, across the three sites, Straughan and the design team are proposing to restore over 112 acres of saltmarsh. These proposed practices will aim to support local watershed goals of restoring the hydrology and habitat of these marsh environments.

Regional Blue-Green Infrastructure Resilience Planning Community Engagement

Metropolitan Washington Council of Governments (MWCOG)

STRAUGHAN ENVIRONMENTAL

PROJECT OVERVIEW. Straughan served as the water resource engineering lead for a pioneering multi-jurisdictional flood mitigation planning study along the borders of Prince George's County, MD, and Washington, D.C. This initiative, part of the Blue-Green Infrastructure (BGI) planning framework, combined water-related elements and vegetation-based systems to enhance community resilience against flooding and climate change impacts. Our collaboration included partnerships with the Metropolitan Washington Council of Governments (MWCOG), the District Homeland Security and Emergency Management Agency (DCHSEMA), and a multi-jurisdictional team focused on vulnerable communities.

OBJECTIVES. The primary goal of the BGI Plan was to mitigate flood risks to properties and infrastructure in high-risk areas exacerbated by climate change. Key objectives included:

- Implementation of Blue-Green Infrastructure: Developed actionable solutions that enhanced the natural and built environment, supporting environmental justice in underserved areas.
- Roadmap to Resilience: Provided a structured plan that outlines mitigation opportunities and educational practices to safeguard lives and property through improved public spaces.

COMMUNITY ENGAGEMENT AND FRAMEWORK DEVELOPMENT. Our approach prioritized community engagement, ensuring that vulnerable populations have a voice in the planning process. The BGI Plan created a replicable framework for future initiatives, including a comprehensive educational outreach strategy that connects internal and external stakeholders.

KEY COMPONENTS AND ACTIVITIES.

- Watershed Suitability Analysis: Straughan conducted a thorough analysis of existing community spaces to identify opportunities for implementing BGI solutions. This hybrid process combined GIS data processing with local knowledge, focusing on community needs. Potential projects included reforestation, reduction of impervious surfaces, green streets, floodable parks, and floodplain restorations.
- Flood Planning and Modeling: We developed prioritization methods to identify effective watershed interventions that balance community benefits with flood risk reduction. By collaborating with modeling groups, Straughan leveraged existing hydrologic and hydraulic models (HEC-HMS, HEC-RAS, InfoWorks ICM) to inform our strategies.

PROJECT MANAGEMENT AND EXECUTION. Straughan ensured project success through diligent project management. We provided regular updates and adapted schedules to align with grant reporting timelines and data acquisition challenges. Maintaining a cloud-based timeline allowed all partners to access updates in real time, enhancing transparency and communication.

RESPONSIBLE OFFICE

Straughan | Columbia, MD

PROJECT LOCATION

Prince George's County, MD and Washington, DC

CLIENT REFERENCE

Katie Dyer, Environmental Planner, MWCOG

Phone: 202.962.3324

Email: kdyer@mwcog.org

BUDGETED COST

$1,299,891

COMPLETED COST

$1,299,891

SCHEDULED COMPLETION DATE

June 30, 2025

ACTUAL COMPLETION DATE

June 30, 2025

PROJECT HIGHLIGHTS

- Watershed-scale resilience planning
- Blue-green infrastructure analysis
- GIS-based suitability assessment
- Flood modeling and prioritization
- Hybrid mitigation alternatives
- Community-centered engagement

TIMELINESS AND BUDGET MANAGEMENT. We prioritized timely project completion within budget constraints. By closely monitoring changes to the work plan and maintaining clear communication among project partners, we successfully navigated the complexities of grant-funded projects. Monthly updates and adaptability strategies ensured that we kept on track, emphasizing our commitment to delivering results efficiently.

Environmental Engineering Services, 518803

Maryland Port Administration

Straughan is currently supporting Maryland Port Administration (MPA) toward meeting the dredged material management needs of the Port of Baltimore. Contract services include planning and environmental studies; engineering, design, and construction support; evaluation of beneficial reuse options for dredged material; and other technical and regulatory assistance. Tasks to date include monitoring the performance of existing dredged material containment facilities, evaluating potential new sites for dredged material placement, and developing plans for environmental remediation of sites within Baltimore Harbor. The Straughan Team conducted work on 20 different tasks. Representative tasks include:

GENERAL DREDGE MATERIAL MANAGEMENT PROGRAM (DMMP) SUPPORT. Straughan provided support to MPA for needs not included in other contracted tasks. The tasks included, but is not limited to: Providing support in completing the DMMP reports and legislative reports; Development of position papers and other technical documents; Development of technical approaches and scopes of work for various MPA initiatives that may not be associated with a particular site or project; and/or Assistance with a variety of support services for the State DMMP process and related tasks, as requested.

COX CREEK MITIGATION AT GENESEE VALLEY PROPOSED RESTORATION RENDERINGS. Straughan prepared concept renderings of the proposed Cox Creek Mitigation at Genesee Valley in Parkton, MD. We gathered existing GIS data, landscape photographs, and drone photographs of the site, prepared a proposed model of the mitigation plan, completed three renderings of proposed conditions, and provided two proposed renderings as printed display boards.

GRANT ASSISTANCE. Straughan provided support to MPA in the identification of grant opportunities and assisting in the development of grant applications. Straughan provided consulting support for grant assistance related to proposed and/or existing MPA projects within the context of the Dredged Material Management Program. This support included, but not limited to, conducting research into potential grant opportunities, meeting with MDOT MPA staff, and providing grant application assistance.

MODIFICATION STUDY-AIR CONFORMITY ASSESSMENT. A general conformity evaluation is required as part of the Baltimore Harbor Anchorages and Channels (BHAC) modification feasibility study conducted by the USACE and MDOT MPA. Straughan evaluated the BHAC modification project to determine the applicability of the requirements of the general conformity rule and prepared a report detailing the results of the general conformity evaluation. To meet the goals of the study, Straughan conducted emissions calculations, general conformity applicability analysis, and developed a report.

RESPONSIBLE OFFICE

Straughan | Columbia, MD

CLIENT REFERENCE

Amanda Peñafiel, Senior Project Manager Maryland Port Administration

Phone: 410.385.4470

Email: apenafiel@marylandports.com

BUDGETED COST

$557,719.85

COMPLETED COST

$557,719.85

SCHEDULED COMPLETION DATE

July 31, 2024

ACTUAL COMPLETION DATE

July 31, 2024

PROJECT HIGHLIGHTS

- Sediment management for resilience
- Beneficial reuse planning
- Tidal wetland mitigation support
- Nature-based restoration planning
- Regulatory and permitting navigation
- Implementation-ready documentation

MASONVILLE COVE WETLAND PLANTING PLANS. Straughan provided plan preparation services including CAD drawings consisting of planting zones, quantity tables and details for replacement of emergent and nontidal forested wetland as well as critical area mitigation upland trees at the Masonville Cove Wetland Mitigation site.

PERMITTING SUPPORT. Straughan provided permitting support services to MPA. This support included; Forest Conservation Act (FCA) and Critical Area (CA) Regulations – Applicability Review & Summary and MPA Harbor-Wide Dredging Permit – Data Consolidation and Volume Computations. MPA facilities are unique in that a majority of property area falls within the Chesapeake Bay Critical Area, and many development activities require Critical Area Commission (CAC) approval. Marine terminal facilities are industrial waterfront areas, consisting of mostly impervious pavement edged by bulkhead or piers, some of which is constructed land in areas that were previously tidal waters. Dredged material containment facilities (DMCFs) consist of constructed containment dikes to hold dredged material, and similar to marine terminals, are often constructed in areas that were previously tidal waters. The impacts to tidal waters for constructing these land areas has already been mitigated for. Existing forested area and tree clearing is not typically encountered on these sites. Clarity was needed on how FCA requirements apply for projects on MPA marine terminals and dredged material containment facility (DMCF) sites, where traditional existing land conditions often do not exist. The purpose of this subtask was to summarize FCA regulations and requirements, to investigate their applicability to MPA development/redevelopment projects on marine terminals and DMCFs, and to prepare a concise overview document. MPA performs regular maintenance dredging of the Baltimore Harbor access channels. To streamline the permitting and authorization process for maintenance dredging at different MPA facilities, MPA has consolidated the access channel dredging into one comprehensive ("Harbor-Wide") maintenance dredging permit that encompassing all of the Harbor facilities. The joint state/federal Harbor-Wide Dredging permit (i.e. State Tidal Wetlands License and U.S. Army Corps Permit) required renewal in 2023. A new application was required to be submitted that included updated existing bathymetric conditions, proposed dredging footprints that consolidate all previous permit modifications, and updated proposed dredging quantities. Prior to preparing the permit application, the existing data had to be compiled and evaluated. The purpose of this subtask was to compile existing bathymetric data and proposed dredging footprints and depths into an organized format and to compute updated proposed dredging quantities in preparation for MPA's application for a new Harbor-Wide Dredging permit.

MASONVILLE COVE WETLANDS AND HAWKINS POINT SOUTH CELL CLOSURE PROJECT – INSPECTION SERVICES. Straughan provided inspection services for the proposed construction for this project. Our subcontractor, AB Consultants, provided on-site services including daily construction logs and E&SC permit required logs, tracking and recording delivery of material/equipment and associated delivery tickets, interpreting design drawings and information provided by MES engineers/surveyors to guide on-site crew, ensuring all construction activities are performed per the approved E&SC permit, performing routine inspections on a weekly basis and within 24 hours of a major precipitation event to ensure that all control measures are in-place and comply per approved E&SC permit and complete and fill out E&SC inspection reports after each inspection.

Genesee Valley rendering

Integrated Assessment of Climate Change Impacts to Groundwater, Stormwater, and Wastewater Infrastructure at Military Facilities

University of Delaware

Straughan is supporting the University of Delaware through Department of Defense research as part of the Environmental Security Technology Certification Program (ESTCP) Phase 1 project which will demonstrate the application of an integrated suite of models (EPA SWMM and USGS MODFLOW) to holistically analyze the impacts of climate change and extreme weather on groundwater, stormwater, and wastewater infrastructure at US military installations in coastal settings. This modeling toolbox will allow users to identify and prioritize investment in interventions to increase water security and reduce the overall cost to the Department of Defense (DoD) for sustaining water infrastructure systems. Straughan is providing expertise in modeling stormwater generation, stormwater conveyance networks, i.e., piping and pump networks, and wastewater treatment plant performance in response to changes in inflow and salinity. Finally, because of Straughan's expertise in providing cost-effective designs of water and wastewater infrastructure, we are responsible for delivering all estimates of cost and construction timelines for the project.

INFRASTRUCTURE RESILIENCE. The project is focused on development of the modeling assessment initially for Dover Air Force Base which is exposed to groundwater, stormwater and fluvial flooding. Its location near the Atlantic coast also exposes the location to coastal threats as well. The Straughan Team is providing technical input for model development as well as devising potential adaptation options to keep critical infrastructure resilient to present day and future threats.

NATIONWIDE ASSESSMENT. Besides the project work at Dover AFB, the Straughan Team is leading assessment at 8 other DoD Installations nationwide. This assessment is first identifying vulnerabilities of infrastructure at these bases and then identifying the specific applicability of the modeling suite to the challenges identified at each location including:

- Naval Station Norfolk
- Marine Corp Base Quantico
- Joint Base Langley Eustis
- Tyndall Air Force Base
- Reagan Test Site
- Hamilton Army Airfield
- Fort Leonard Wood
- Scott Air Force Base

Once the development of the model is complete it will provide DoD a tool to assess resilience to the impacts from climate to critical infrastructure to guarantee mission readiness now and into the future.

RESPONSIBLE OFFICE

Straughan | Columbia, MD

PROJECT LOCATION

Joint Base Langley-Eustis, Naval Station Norfolk, and 6 other locations nationally

CLIENT REFERENCE

Carolyn B. Voter, PhD, Assistant Professor, University of Delaware, Delaware Environmental Institute

Phone: 609.902.5920

Email: cvoter@udel.edu

BUDGETED COST

$145,000

COMPLETED COST

On budget

SCHEDULED COMPLETION DATE

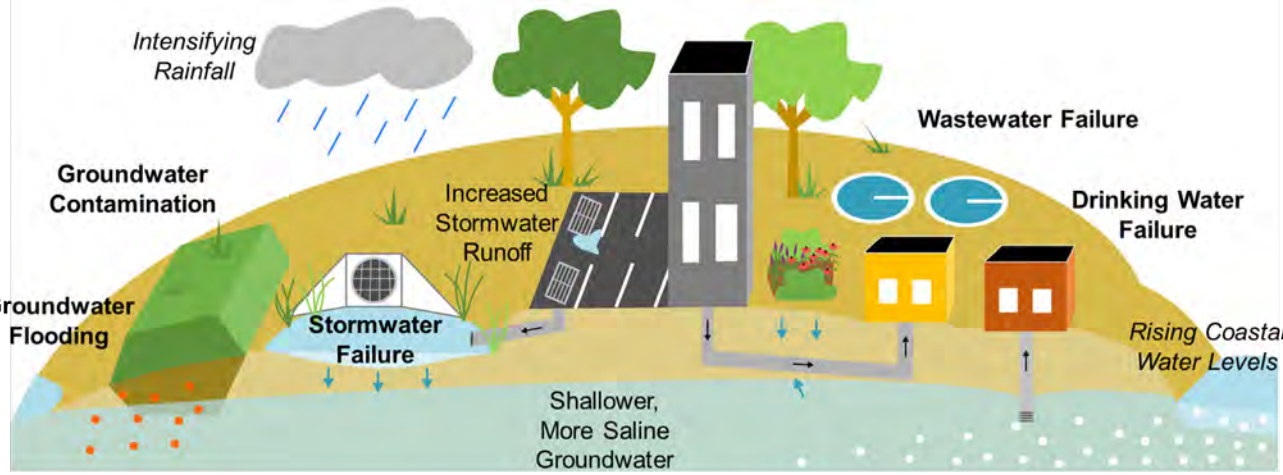
March 2027

ACTUAL COMPLETION DATE

On schedule

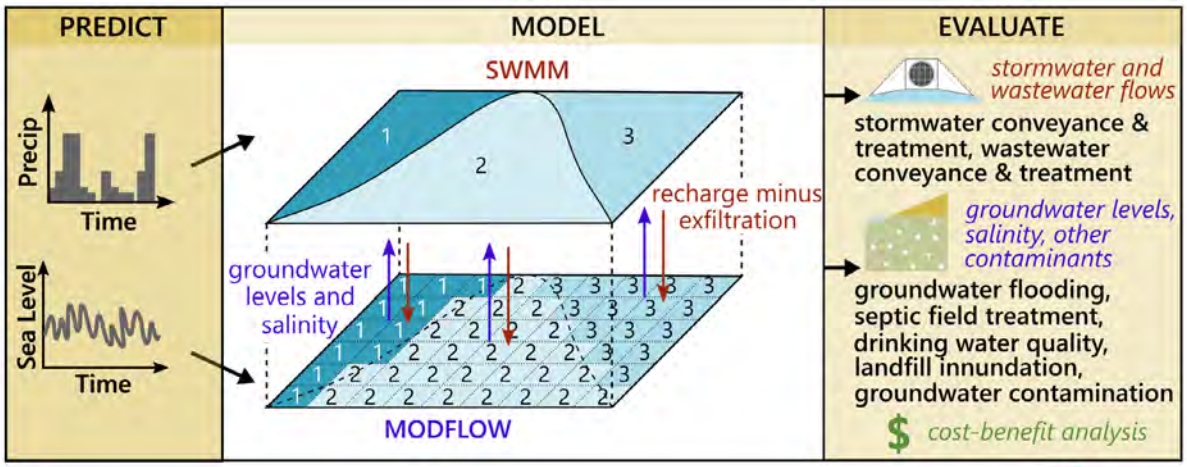
PROJECT HIGHLIGHTS

- Integrated hydrologic modeling
- Climate vulnerability assessment
- Infrastructure resilience planning
- Adaptation options evaluation
- Cost and schedule feasibility
- Multi-site prioritization



Climate change in coastal regions - impacts to water infrastructure.

Source: "Integrated Assessment of Climate Change Impacts to Groundwater, Stormwater, and Wastewater Infrastructure at Coastal Military Facilities" presented by Carolyn Voter, University of Delaware



Source: "Integrated Assessment of Climate Change Impacts to Groundwater, Stormwater, and Wastewater Infrastructure at Coastal Military Facilities" presented by Carolyn Voter, University of Delaware

Existing conditions
8/15/2024 site visit

Environmental Engineering Services, 522803

Maryland Port Administration

STRAUGHAN ENVIRONMENTAL

Straughan is currently supporting Maryland Port Administration (MPA) toward meeting the dredged material management needs of the Port of Baltimore. Contract services include planning and environmental studies; engineering, design, and construction support; evaluation of beneficial reuse options for dredged material; and other technical and regulatory assistance. Tasks to date include sediment management plan development, sediment analysis, assessment of Dredge Management Containment Facility (DMCF) effluent treatment alternatives, database and technology needs assessment, grant support services and shoreline protection assessment. The Straughan Team has conducted or continues to work on 8 different tasks to date. Representative tasks include:

MASONVILLE COVE SHORELINE PROTECTION. Straughan is providing support to MPA in an investigation of shoreline protection/coastal resilience options for the tidal wetland west of the Fishing Pier, up to where it meets the Tidal Wetland at Masonville Cove. Straughan is performing this investigation to develop adaptable solutions for this project. The purpose of this task is to investigate the existing conditions at the tidal wetland location to determine how coastal erosive forces and tidal increases have impacted and may impact further wetland plantings at the site and to provide adaptable solutions for the site including development of design alternatives and corresponding construction cost estimates. Upon selection of the preferred alternative, Straughan will prepare conceptual level design plans, report and construction cost estimate of the selected alternative.

GENERAL DREDGE MATERIAL MANAGEMENT PROGRAM (DMMP) SUPPORT. Straughan is providing support to MPA for needs not included in other contracted tasks. The tasks include, but is not limited to: Providing support in completing the DMMP reports and legislative reports; Development of position papers and other technical documents; Development of technical approaches and scopes of work for various MPA initiatives that may not be associated with a particular site or project; and/or Assistance with a variety of support services for the State DMMP process and related tasks, as requested.

GRANT ASSISTANCE. Straughan is providing support to MPA in the identification of grant opportunities and assisting in the development of grant applications. Straughan is providing consulting support for grant assistance related to proposed and/or existing MPA projects within the context of the Dredged Material Management Program. This support includes, but not limited to, conducting research into potential grant opportunities, meeting with MDOT MPA staff, and providing grant application assistance.

BARREN ISLAND BORROW AREA TECHNICAL SUPPORT. The Straughan Team provided support to MPA by preparing a final sediment quality data report that included conclusions with respect to use of dredged material for construction of Barren Island. Straughan reviewed and provided comments for development of the final report.

RESPONSIBLE OFFICE

Straughan | Columbia, MD

CLIENT REFERENCE

Amanda Peñafiel, Senior Project Manager Maryland Port Administration

Phone: 410.385.4470

Email: apenafiel@marylandports.com

BUDGETED COST

$666,287.24

COMPLETED COST

On budget

SCHEDULED COMPLETION DATE

December 21, 2028

ACTUAL COMPLETION DATE

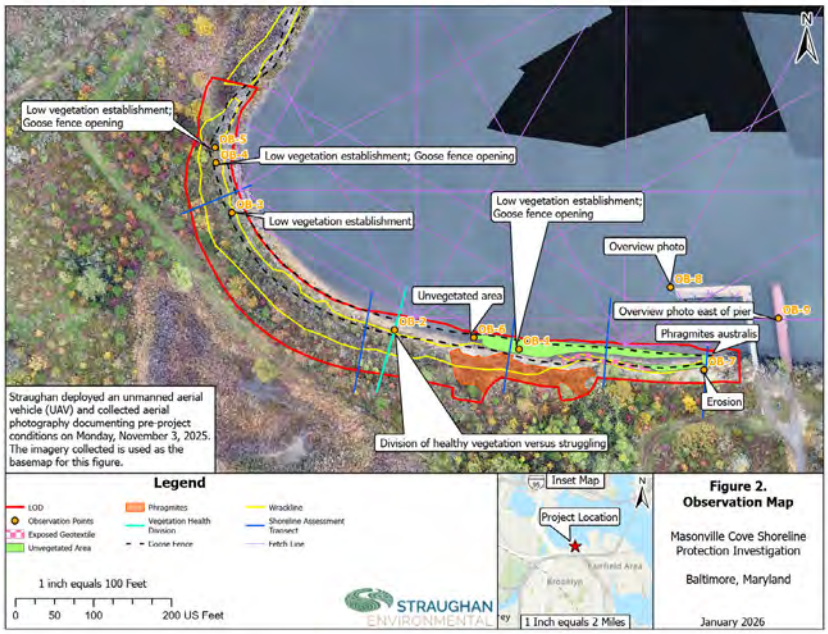
On schedule

PROJECT HIGHLIGHTS

- Sediment management planning
- Beneficial reuse evaluation
- Tidal wetland resilience support
- Shoreline protection assessment
- Nature-based solution feasibility
- Water quality innovation
- Regulatory and permitting support
- Grant and funding assistance
- Data and GIS modernization
- Implementation-ready documentation

DMCF BIOCHAR PILOT PROJECT. The Straughan Team is providing support to MPA in an investigation of biochar's potential for improving water quality at the MPA DMCF facilities. The purpose of this task is to investigate biochar's potential for improving water quality at the MPA's Cox Creek DMCF. The key objectives are: (1) conducting a literature review to assess biochar's application in water quality treatment within the context of effluent discharge, especially focusing on discharge permit requirements monitored by MPA; (2) perform a gravity media filter column study to identify biochar blends best suited to mitigate specific contaminants present in Cox Creek DMCF discharge water; and (3) producing a comprehensive summary memorandum that encapsulates key findings, challenges, recommendations for a treatment train demonstration prior to full scale implementation. This study aims to identify the most effective biochar media blends and other potential amendments to serve as a viable and sustainable solution for pollutant reduction in the MPA's water treatment strategy, aligning with MDE NPDES permit compliance.

DATABASE AND TECHNOLOGY NEEDS ASSESSMENT. Straughan is providing support to MPA for development of a technical needs assessment related to GIS, technology, and database management to support the mission of the Office of Navigation, Innovation, and Stewardship (ONIS). The purpose of this task is to develop a technical assessment report that identifies and makes recommendations to prioritize business process improvements that can be made using GIS, related technologies, and database management with ONIS. The goal of the report is to identify and plan for technology-based projects to streamline workflows, support strong data governance, and promote data transparency. The report will outline the ideas and opportunities identified through stakeholder meetings and will make recommendations based on several factors including project need, level of effort, project impact, project priorities, and which projects have the most support to move forward. It will make recommendations, identify overarching goals, and present order of magnitude budgets, timelines, and costs.



COLGATE CREEK PHASE II SEDIMENT MANAGEMENT PLAN, SAMPLING AND TESTING. The Straughan Team is providing support to MPA by preparing a Sampling and Analysis Plan for in-place sediment sampling within Colgate Creek. Additionally, the Straughan Team is performing sediment sampling and testing and preparing a report. Colgate Creek is a Baltimore Harbor tributary located between the Dundalk and Seagirt Marine Terminals and efforts are ongoing to expand access for larger vessels through dredging of approximately 1.5 miles of the creek. The dewatered dredged material requires characterization and categorization prior to reuse at offsite hauling sites currently identified as Baltimore Peninsula Development, BGE Riverside and/or Masonville Cove DMCF Dike Raising projects. Straughan is reviewing and providing comments for development of the sampling and analysis plan as well as the sediment sampling and testing report.

Military Installation Resilience Review 1.0/2.0

Northern Virginia Regional Commission (NVRC)

AECOM

AECOM completed a regional resiliency study to assess the impacts that current and future climate hazards could have on four counties (Fairfax, Arlington, Prince William, Fairfax) and three military installations in Northern Virginia (Fort Belvoir, Joint Base Myer-Henderson Hall, Marine Corps Base Quantico). The project responds to the increasing threats that climate change has on shared infrastructure and services.

Using hazard data in mapping form, AECOM performed a geospatial vulnerability assessment on over 100,000 different assets that included buildings, utility networks, and transportation systems, many of which provide essential services to both the community and DoD. Next, sensitivity, adaptive capacity, and consequence ratings were assigned to exposed assets to identify areas of focus for strategy development. A series of technical review committee meetings and policy committee meetings guided the process over the 21-month timeframe.

The list of recommended strategies goes beyond high priority hazards of flood and heat to address issues related to emergency management, regional connectivity, and access that emerged during the process. Strategies are either regional, and apply to all installations and counties, or apply only to a specific installation and county and a list of funding sources was defined as a resource for study partners. NVRC is already actively working to advance MIRR strategies based on plan outcomes.

AECOM was awarded a contract with the Northern Virginia Regional Commission (NVRC) to conduct a Military Installation Resilience Review (MIRR) for three military installations in northern Virginia (Joint Base Myer-Henderson Hall, Fort Belvoir, and Marine Corps Base Quantico). The MIRR is a community stakeholder planning process, established by the U.S. Department of Defense (DOD) Office of Defense Local Community Cooperation, with the core purpose to develop a plan that identifies current and future risks, hazards, and vulnerabilities of concern as they relate to DOD's ability to fulfill installation requirements.

These analyses have leveraged a wide range of asset and hazard sources, including local asset data, DOD asset and hazard-specific data, Virginia Sea Level Rise mapping, and FEMA floodplain mapping and multi-hazard data from the National Risk Index.

AECOM assessed the impacts that current and future climate hazards could have on four counties and three military installations. We focused on climate change hazards and impacts on shared infrastructure and services including inland and coastal flooding, extreme heat, and energy demand. The team assessed vulnerability of over 100,000 assets across 11 categories (e.g., buildings, water and wastewater systems, electrical, transportation, stormwater, communications, etc.). We developed strategies to mitigate impacts including order of magnitude costs, timeframes, and lead/partner roles. Our work included regional considerations and topics related to climate hazards such as emergency management and regional connectivity.

RESPONSIBLE OFFICE

AECOM | Arlington, VA

PROJECT LOCATION

Northern VA

CLIENT REFERENCE

Vonzell Mattocks, Director of Community and Military Partnerships, Northern Virginia Regional Commission

Phone: 703.929.6101

Email: vmattocks@novaregion.org

BUDGETED COST

$1,050,466

COMPLETED COST

$1,077,466 ($27k increase to include 508 compliance)

SCHEDULED COMPLETION DATE

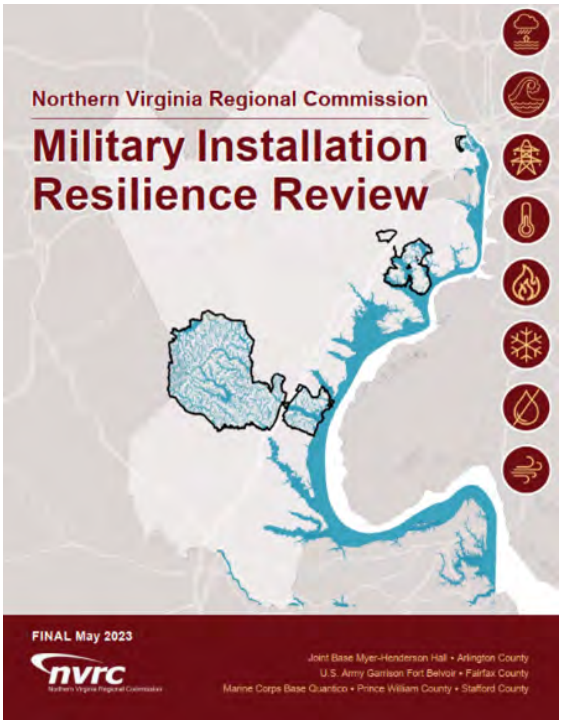
March 2023

ACTUAL COMPLETION DATE

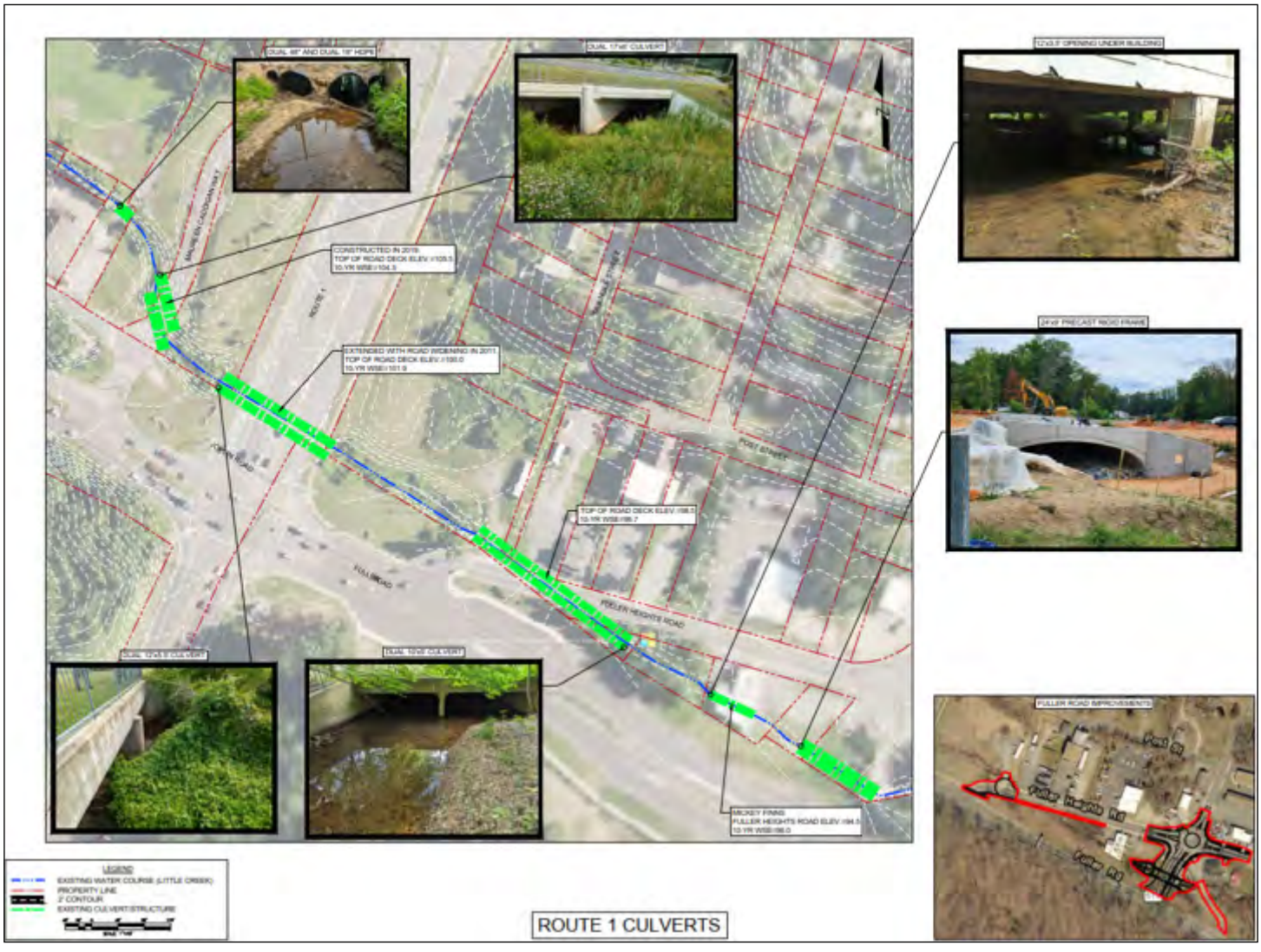
May 2023

PROJECT HIGHLIGHTS

- Regional vulnerability assessment
- GIS-based asset mapping
- Climate hazard analysis
- Infrastructure risk prioritization
- Resilience strategy development
- Multi-stakeholder coordination



Breakdown of MIRR Strategies by Hazard or Topic



Little Creek Watershed Evaluation and Concept Design Plans

Northern Virginia Regional Commission

AECOM

The Northern Virginia Regional Commission (NVRC) recently completed a Military Installation Resiliency Review (MIRR) for the Marine Corps Air Facility Quantico and Marine Corps Base Quantico (MCBQ) in Prince William County. This review identified significant flooding issues at the Fuller Road entry gate, caused by increased stormwater runoff from Little Creek. To address this, the project evaluated various solutions and developed concept designs aimed at mitigating the flooding at Fuller Gate. The comprehensive watershed survey assessed the sources of flooding from north of U.S. Route 1 down to MCBQ and Fuller Gate.

AECOM conducted a thorough review and evaluation of existing data provided by the Northern Virginia Regional Commission (NVRC), Prince William County (PWC), Marine Corps Base Quantico (MCBQ), and the Virginia Department of Transportation (VDOT). Additionally, AECOM obtained and analyzed records of existing flooding incidents. To support the modeling efforts, we utilized the existing FEMA HEC-RAS model and associated topographic data and reviewed online sources for updated topographic information.

AECOM used the existing FEMA HEC-RAS model as a baseline to determine potential improvements and proposed conditions. For flood mitigation alternatives, AECOM conducted a desktop analysis of existing stormwater retention and detention structures within the target drainage area, identified potential locations for new offline storage or detention, identified potential retrofit sites to enhance both runoff quantity and quality control AECOM reviewed the existing stormwater network records to identify possible bottlenecks causing flooding issues. An alternatives analysis was conducted with three levels of stream restoration/stabilization options to mitigate scour along the project reaches and protect existing infrastructure. The proposed stream restoration/stabilization alternatives included high, medium, and low intervention designs. Sites were evaluated based on specific parameters and goals. AECOM collaborated with NVRC and stakeholders to develop a ranking process to prioritize areas for inclusion in the overall design.

Following discussions during the Alternatives Analysis Meeting, AECOM developed concept designs for the selected combination of improvements. These concept designs included over 8,000 linear feet of stream restoration within the Little Creek Watershed in Prince William County, one stormwater pond retrofit, and one new stormwater pond. The concept designs also proposed increasing culvert capacity at the dual 10 by 15-foot culverts under Fuller Heights Road.

RESPONSIBLE OFFICE

AECOM | Arlington, VA

CLIENT REFERENCE

Vonzell Mattocks, Director of Community and Military Partnerships, Northern Virginia Regional Commission

Phone: 703.929.6101

Email: vmattocks@novaregion.org

BUDGETED COST

$960,000

COMPLETED COST

On budget

SCHEDULED COMPLETION DATE

March 2026

ACTUAL COMPLETION DATE

On schedule

PROJECT HIGHLIGHTS

- Watershed-scale flood assessment
- Existing conditions evaluation
- Hydrologic and hydraulic modeling
- Flood mitigation alternatives
- Concept-level design development
- Project prioritization framework

Resilience Planning Public Outreach Support

Virginia Department of Conservation and Recreation

AECOM

AECOM provided communications, public outreach, and engagement support to the Virginia Department of Conservation and Recreation (DCR) in preparation for the rollout of Phase II of the Virginia Coastal Resilience Master Plan (CRMP). The CRMP charts a comprehensive path toward long-term resilience to protect people, homes, businesses, infrastructure, and ecosystems from the impacts of coastal flooding. Phase II of the CRMP builds upon the Phase I plan and will incorporate all major flood hazards, including precipitation-driven flooding; an update the project inventory; and an update to the impacts of exposure.

AECOM, with small business partner West Gary Group, was responsible for developing and implementing the engagement strategy, and developing content for educational materials to prepared stakeholders and the public for the release of CRMP Phase II. The AECOM team developed the following materials:

- Press releases
- Talking points
- Social media campaign content and graphics
- Web content and graphics
- Educational blog articles
- Meeting advertisements
- Presentation materials
- Distribution lists
- A package for Community-based Organizations to use in driving traffic to public meetings

As part of the overall promotion of the CRMP at the local level, AECOM provided meeting planning and facilitation support for a series of in-person and virtual meetings in various communities in Virginia in 2024 and 2025. AECOM worked with DCR to identify venues, publicize the meetings, and ensure the engagements were mutually beneficial for DCR and participants.

RESPONSIBLE OFFICE

AECOM | Virginia Beach, VA

CLIENT REFERENCE

Carolyn Heaps-Pecaro, Senior Resilience Planner, Virginia Department of Conservation and Recreation

Phone: (804) 929-0268

Email: carolyn.heaps-pecaro@dcr.virginia.gov

BUDGETED COST

$547,500

COMPLETED COST

Approximately $350,000 to date

SCHEDULED COMPLETION DATE

June 2027

ACTUAL COMPLETION DATE

On schedule

PROJECT HIGHLIGHTS

- Stakeholder engagement strategy
- Public outreach facilitation
- Resilience communications support
- Community meeting coordination
- Educational material development

Norfolk and Virginia Beach Joint Land Use Study

Hampton Roads Planning District Commission

AECOM

AECOM recently completed the Norfolk and Virginia Beach Joint Land Use Study (JLUS) for the Hampton Roads Planning District Commission (HRPDC), with support from Moffatt and Nichol and the Miles Agency. The JLUS spans two localities in the Hampton Roads Planning District and four Navy bases, including the largest facility in the Navy - Naval Station Norfolk. The JLUS focused in part on evaluating current and future impacts of flooding on the facilities and infrastructure that directly support the Navy and developing actions that the Cities could take to reduce or eliminate both short- and long-term risks for the military. Ultimately, the JLUS helps shape local, regional and state priorities with an emphasis on resilience for the localities and Department of Defense installations.

AECOM utilized best available geographic information systems (GIS) data to perform spatial analyses to inform an overall vulnerability analysis. Moffatt and Nichol collected and evaluated various federal, state and local data sets to define appropriate inundation scenarios for Norfolk and Virginian Beach that were used to evaluate current and future flood and sea level rise risk to important roadway corridors, utility infrastructure, and community assets relied upon by the DOD. Specifically, the team defined appropriate dataset(s) for tidal water levels and sea level change and evaluated community assets, transportation infrastructure, and services like utilities under the scenarios to understand impacts. Over 1200 community assets were assessed for exposure to flooding and over 200 miles of roadway were identified as having some degree of impact under the flood scenarios. AECOM completed a network analysis to further highlight the importance of transportation infrastructure and access as a function of military readiness. The analysis led to the emergence of four geographic areas that became target areas for strategy development.

To aid decision-making across federal, regional and local interests, AECOM developed evaluation criteria that emphasized military readiness factors and undertook concept designs on select strategies to test ideas, costs, and steps that would be necessary for coordinated implementation. For each of the 22 priority actions, the AECOM team defined benefits, implementation steps, responsible parties and partners, and other details to aid the JLUS partners in moving forward. Beyond the 22 actions, the JLUS includes regional coordination strategies focused on advocacy, policy and development regulations, coordination and outreach, and technology and data.

For both studies, the AECOM team designed public meeting programs and materials including fact sheets, surveys, and presentations for public meetings and worked closely with the HRPDC to regularly brief established Policy and Technical Committees on a regular basis. The AECOM team met with over 125 local stakeholders and the public to help define issues and opportunities that informed the analysis.

RESPONSIBLE OFFICE

AECOM | Virginia Beach, VA

CLIENT REFERENCE

Ben McFarlane, Chief Resilience Officer, Hampton Roads Planning District Commission

Phone: (757) 420-8300

Email: bmcfarlane@hrpdcva.gov

BUDGETED COST

$523,000

COMPLETED COST

$523,000

SCHEDULED COMPLETION DATE

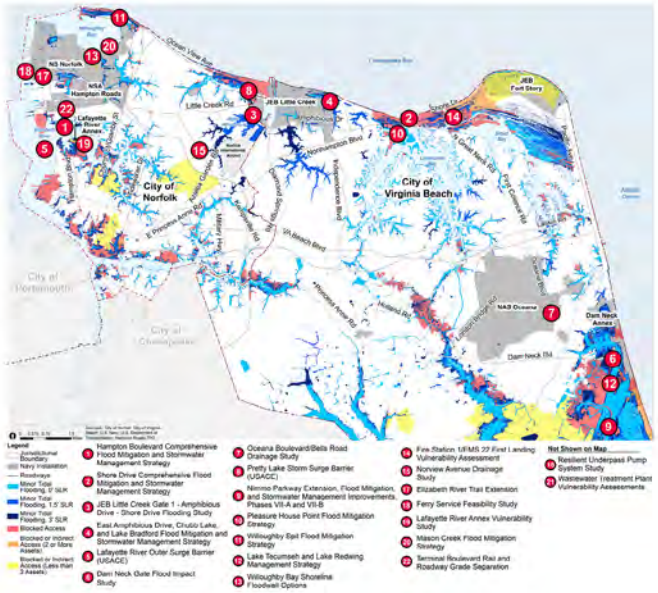
August 2019

ACTUAL COMPLETION DATE

August 2019

PROJECT HIGHLIGHTS

- GIS-based vulnerability analysis
- Flood and inundation scenarios
- Sea level rise assessment
- Infrastructure risk prioritization
- Resilience strategy development
- Stakeholder coordination support



Sea Level Rise Vulnerability Study

Town of Fenwick Island, DE

AECOM

Delaware's coastal communities, including the Town of Fenwick Island, has seen the impacts due to major weather events. Fenwick Island saw the most extensive damage compared to any other Delaware coastal town after Hurricane Sandy. Deciding to be proactive and plan for the future the Town applied for and received grant assistance to complete a sea level rise vulnerability assessment through Delaware's Coastal Management Assistance Grant program.

The overall goal of the Study was for the Town to better understand risks they may face in the future as sea level rise continues and major coastal storms increase. The Study also looked into possible solutions to mitigate those potential risks. There were three parts to the Study. The first part documented the extent of all possible sea level rise effects which included impacts to structures, roads and utilities. This was done through research and mapping. The second part was raising awareness among the Town's residents and business owners. It was important to educate the community on general information about sea level rise as well as the Town's specific vulnerabilities. The last part was researching all possible flood mitigation tools and identifying the best solutions for the Town.

RESPONSIBLE OFFICE

AECOM | New Castle, DE

CLIENT REFERENCE

Terry Tieman, Town Manager (former), Town of Fenwick Island

Phone: (302) 539-3011

Email: townmgr@fenwickisland.org

BUDGETED COST

$39,000

COMPLETED COST

$39,000

SCHEDULED COMPLETION DATE

June 2015

ACTUAL COMPLETION DATE

June 2015

PROJECT HIGHLIGHTS

- Sea level rise mapping
- Coastal vulnerability assessment
- Infrastructure risk evaluation
- Flood mitigation planning
- Community engagement support

Vulnerability Assessment and Adaptation Plan

City of New Castle, DE

AECOM

The City of New Castle was the first city founded along the Delaware River. Its location puts it at risk due to upstream flooding, downstream tidal surges, and combinations of the two. These risks may be compounded by potential sea level rise. DNREC has estimate that water surface elevations along Delaware's coast could rise by as much as two feet by 2050 and five feet by 2100.

As City Engineer and City Planner, AECOM submitted an application to the DCP to establish a Resilient Community Partnership through a program that leverages federal funding provided by the NOAA to help Delaware communities improve their planning and preparation capabilities for responding to coastal hazards. AECOM and DCP partnered to assess current and future conditions, held public meetings, and develop mitigation strategies. The final Vulnerability Assessment and Adaptation Plan includes adaptation strategies for future analysis or implementation. AECOM's tasks included:

DOCUMENT REVIEW. Existing resiliency studies, plans, and policies including the All-Hazards Mitigation Plan Update for New Castle County, and the Emergency Operations Plan and the Comprehensive Plan City of New Castle were reviewed and summarized for consistency between approaches.

DATA COLLECTION AND COMPILATION, Elevation contours, FEMA floodplains, DNREC sea level rise inundation areas, and flood elevation layers have been compiled within a GIS platform.

INVENTORYING OF CURRENT MITIGATION MEASURES. We met with City staff and reviewed available documentation to identify mitigation measures, which have already been implemented.

VULNERABILITY MAPPING OF VULNERABILITIES TO NATURAL HAZARDS AND CLIMATE CHANGE. This was accomplished by overlaying floodplains and sea level rise inundation areas with socioeconomic, facility and infrastructure, and natural resource data layers. We assessed various mapping options such as sea level rise scenarios, FEMA mapping, SLOSH model output, wave actions, etc.

IDENTIFICATION AND PRIORITIZATION OF VULNERABILITIES. Using the vulnerabilities determined during the mapping phase along with current mitigation measures, AECOM developed a matrix of critical structures including public administration and safety buildings, utilities, places of assembly, and buildings on the historic register. Each was assessed for its sensitivity to flooding and adaptive capacity should flooding occur. Various factors were weighted such that priority structures were identified. The Excel-based spreadsheet provided information in an easy-to-understand format. Supporting public outreach efforts: DCP led this effort with AECOM's assistance. The City formed a task force that met monthly to help guide the public outreach efforts and provide critical feedback. Two public meetings were also held. We have supported the outreach efforts with mapping, presentations, and technical guidance.

RESPONSIBLE OFFICE

AECOM | Millsboro, DE

CLIENT REFERENCE

Bill Barthel, City Administrator (former), City of New Castle

Phone: (302) 322-9812

Email: bbarthel@newcastlecity.delaware.gov

BUDGETED COST

$50,000

COMPLETED COST

$50,000

SCHEDULED COMPLETION DATE

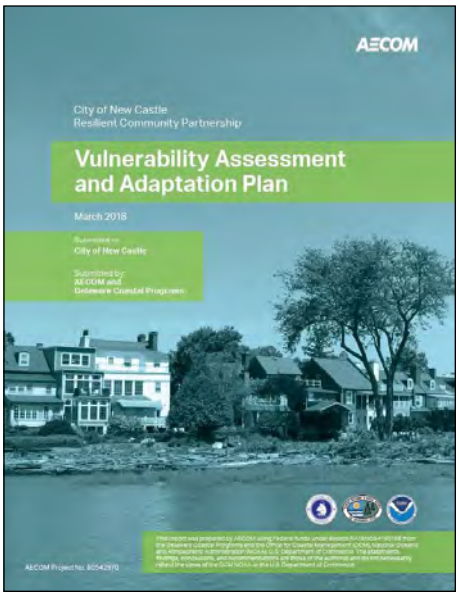
March 2018

ACTUAL COMPLETION DATE

March 2018

PROJECT HIGHLIGHTS

- Existing conditions synthesis
- GIS-based vulnerability mapping
- Sea level rise scenarios
- Flood risk prioritization
- Adaptation strategy development
- Stakeholder engagement support



PREPARATION OF VULNERABILITY ASSESSMENT AND ADAPTATION PLAN. AECOM developed actions or activities which were reviewed by DCP and City staff. These actions or activities were categorized as Planning, Community Engagement, Information Gathering, Ecosystem, Regulatory, Economic, and Spending. We developed order-of-magnitude costs, technical constraints, and/or barriers for to 31 adaptation strategies for inclusion in the Plan.

Texas Coastal Resiliency Master Plan

Texas General Land Office

AECOM

In February 2023, the Texas General Land Office (GLO) released the third Texas Coastal Resiliency Master Plan (Resiliency Plan or Plan), an ambitious coastal planning effort to restore, enhance and protect more than 367 miles of coast and 3,300 miles of bays and estuaries for the State of Texas. The 2019 iteration of the Resiliency Plan was selected by the Climate Change Business Journal for a project merit award in 2019 under the climate change adaptation and resilience category. The Resiliency Plan emphasizes shoring up the coast by using nature- and infrastructure-based projects that are reviewed by and coordinated with a Technical Advisory Committee of over 200 coastal experts and stakeholders, including members of federal, public, and private entities. The recommendations made in the Resiliency Plan are backed by current findings on Texas coastal environments, storm surge and relative sea level rise predictions, economic benefits, and ecosystem services, among others. By championing a statewide Resiliency Plan to guide coastal management, the GLO will assure that Texas works to restore, enhance, and protect its coastlines and communities now and in the future.

AECOM has been the sole engineering contractor working with the GLO to develop the Texas Coastal Resiliency Master Plan since the first iteration in 2017. AECOM's role has been multi-faceted, including both planning and technical tasks. AECOM's planning tasks included facilitating stakeholder engagement and collaboration, identifying opportunities for innovative restoration methodologies for marine habitats (living shorelines, sediment management planning, sea level rise adaptation measures), and writing/producing the final Resiliency Plans. The technical tasks undertaken by AECOM include project reviews, economic analyses, coastal resiliency project design guides, coastal modeling, and initiating a Technical Working Group (TWG) working to value ecosystem services.

The TWG, which began meeting in early 2020, is comprised of subject matter experts on ecosystem service economic valuations and hazard mitigation funding. To improve the future project selection process, the GLO is interested in gaining a better understanding of the costs and the value of the benefits provided by green and hybrid green-gray infrastructure solutions for coastal resiliency. This interest is part of a greater goal to evolve the project evaluation process by modifying the metrics used to better capture the important values that the nature-based components provide, so that green-gray hybrid infrastructure projects may score higher in evaluation tools, gain greater access to funding sources, and ultimately provide greater project solutions than traditional gray infrastructure alone. The aim is that through the course of this project, GLO and AECOM can work collaboratively with the TWG to advance this field and work toward better tools, data, and best practices for integrating green and hybrid infrastructure into Texas coastal resiliency planning for a stronger and more resilient Texas coastline.

RESPONSIBLE OFFICE

AECOM | Houston, TX

CLIENT REFERENCE

Joshua Oyer, Coastal Resiliency Program Manager, Texas General Land Office

Phone: (512) 475-5130

Email: joshua.oyer@glo.texas.gov

BUDGETED COST

Total $6.8M (Phases 1 & 2: $2,000,000; Phase 3: $638,789; Phase 4: $1,281,938; Phase 5: $2,000,000; and Phase 6: $900,000)

COMPLETED COST

Total $6.8M (Phases 1 & 2: $2,000,000; Phase 3: $638,789; Phase 4: $1,281,938; Phase 5: $2,000,000; and Phase 6: $900,000)

SCHEDULED COMPLETION DATE

Phases 1-5 scheduled completion: May 2025

Phase 6: ongoing; on schedule

ACTUAL COMPLETION DATE

Phases 1-5 completion: May 2025

Phase 6: ongoing; on schedule

PROJECT HIGHLIGHTS

- Nature-based resilience planning
- Hybrid green-gray solutions
- Coastal resilience master planning
- Ecosystem services valuation
- Sea level rise analysis
- Stakeholder-driven coordination

Through the Resiliency Plan, AECOM is working to communicate that the Texas Gulf Coast is a dynamic and changing environment. The multitude of investigations conducted by the world's top coastal researchers point to a future Texas coast that has already been and will continue to be susceptible to sea level rise, subsidence, and erosion. In order to plan for changing future scenarios, AECOM continues to look to understand probable changes to the coastal environment that can be addressed by ecological planning, monitoring, and adaptive management. In addition, AECOM will continue to assess gaps in resiliency and recovery needs within Texas to open the door for new solutions to help Texas's coastal communities develop as responsible stewards of their coastal assets

NASA Kennedy Space Center Coastal Sustainability Study

NASA Kennedy Space Center

AECOM

The National Aeronautics and Space Administration (NASA) determined that erosion along the Merritt Island Atlantic shoreline at the John F. Kennedy Space Center (KSC) in Brevard County, Florida, is putting critical infrastructure at risk, particularly during hurricanes and other extreme storm events. The effects of the increased erosion are expected to worsen as future sea level rise (SLR) along the Atlantic shoreline exposes upland facility, launch, and operations infrastructure to higher water levels during storm conditions. NASA has completed several shoreline protection projects to improve its dune system in recent years in a first attempt to protect its infrastructure; however, these projects have been very expensive and ultimately unsuccessful at fully mitigating the KSC's erosion problems. AECOM undertook two studies for NASA, an Atlantic Coastal Sustainability Study and an Estuarine Shoreline Sustainment Study, to evaluate multiple shoreline protection strategies that could be used to protect critical assets at the KSC over a 50-year planning period.

For each of the studies, AECOM evaluated hard shoreline armoring, nature-based infrastructure, and hybrid green/gray shoreline protection alternatives that could potentially be implemented in the KSC and developed criteria-based screening methods to determine which alternatives would be the most beneficial to mitigate erosion. AECOM further evaluated these alternatives based on their costs, feasibility to permit, feasibility to source sufficient material, expected levels of constructability, impacts to the natural ecosystem, and expected future effectiveness. As part of assessing the economic feasibility of the preferred alternatives, AECOM also evaluated potential nearshore and offshore sand source locations to determine source viability and any associated cost savings gained by extracting sediment resources in closer proximity to the KSC than had been achievable for NASA's past dune reconstruction projects. AECOM also put forward a permitting procedure for the proposed alternatives, including tentative permitting schedules, required supporting studies and surveys, and recommendations to protect threatened and endangered species and sensitive habitats.

AECOM completed several technical assessments to inform the shoreline management recommendations presented in each study. For the Atlantic shoreline study, the technical assessments included long-term sediment transport modeling to look at beach and dune shoreline responses for with- and without-project scenarios, considering waves, SLR impacts over the 50-year planning period, and extreme storm events. The analysis also included life cycle cost evaluations to assist NASA with decision making for future design and construction of the preferred project alternative, for which AECOM made a final recommendation. For the Estuarine shoreline study, AECOM's technical assessments included developing the present-day estuarine shoreline using orthophotography, establishing shoreline change rates, assessing wave climates of inland water bodies to identify areas of higher wave risk using 2D ADCIRC+SWAN modeling, classifying shorelines by level of risk based on wave exposure and shoreline change, evaluating

RESPONSIBLE OFFICE

AECOM | Houston, TX

CLIENT REFERENCE

Mick Barth, Senior Project Manager, NASA KSC

Phone: 605.490.2484

Email: michael.t.barth@nasa.gov

BUDGETED COST

$450,000

COMPLETED COST

$450,000

SCHEDULED COMPLETION DATE

November 2021

ACTUAL COMPLETION DATE

November 2021

PROJECT HIGHLIGHTS

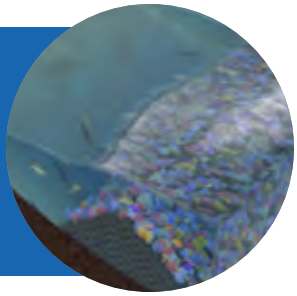
- Shoreline resilience planning
- Nature-based and hybrid solutions
- Sea level rise adaptation
- Sediment transport modeling
- Tidal and estuarine risk assessment
- Feasibility and constructability analysis
- Life-cycle cost evaluation
- Permitting pathway development

the effects of SLR to wetland migration and low-frequency storm-induced flooding at the KSC, and determining critical upland infrastructure at risk due to flooding. AECOM developed several typical sections for future estuarine shoreline projects that can be completed incrementally at the KSC based on prioritized levels of estuarine shoreline risk.

Illustration of Atlantic Shoreline Near Launch Infrastructure Showing Increased Level of Erosion Risk as SLR Increases for 2029 (Yellow), 2059 (Red), and 2089 (Purple).

DARPA Reefense

University of Miami



AECOM is serving as the engineer for the University of Miami (UM)'s Department of Defense (DoD) Defense Advanced Research Projects Agency (DARPA) Reefense project in which Johns Hopkins University, part of the Straughan Team for GRIT, is also engaged. As part of the Reefense project, DARPA is aiming to address coastal threats that are targeting DoD and civilian infrastructure and personnel. DARPA is looking to implement natural solutions in the form of hybrid biological and engineered reefs. These reefs will attenuate waves and dissipate their energy before reaching shore to lessen coastal erosion, flooding, and storm damage. Due to their biological components, the bioengineered reef system will support many fish, corals, and crustaceans, strengthening the local ecosystem and allowing the reef structure to be self-healing and promote natural coral growth. This provides a more resilient shoreline protection solution, as the structure can respond and adapt to changing environmental conditions, including sea level rise. AECOM is providing program management/integration, engineering design, permitting services, and construction coordination for UM in their efforts in completing the DARPA Reefense project.

The University of Miami is leading one of three DARPA-selected design teams customizing highly complex hybrid biological and engineered reefs. The project designed by the UM-led team, known as XREEFS, will be implemented on Boca Chica Key, Florida. AECOM is working within the XREEFS team to ensure successful implementation and installation of the reef designs. The XREEFS team is comprised of research and industry experts to perform other tasks, such as Johns Hopkins University (ecological enhancement for coral recruitment), Penn State University (structural design and fabrication), Florida International University (adaptive biology), University of California at Santa Cruz (coastal resilience), SECORE (reef engineering), and others. AECOM's role will be to coordinate collaboration between the various team members to ensure that biological, ecological, and design needs are met. AECOM will also develop the project permit application in coordination with federal and state regulatory and resources agencies. Finally, AECOM will provide engineering drawings and technical specifications for bidding and construction of the project, along with oversight during implementation.

The XREEFS team expects to implement this project along the south end of the Naval Air Station Key West. The installed reef units will be comprised of multiple modular concrete components including SEAHIVE base units, gyroid lattice structures, and coral mimics. The project team is investigating using 3D architectural concrete printing technology to fabricate the complex concrete units. Numerous reef units will be deployed in shallow water along the Boca Chica Key shoreline to protect DoD infrastructure, provide habitat, and improve the local ecosystem. The project will be a pilot to promote future bioengineered reef construction using novel concrete mixes and construction methods.

RESPONSIBLE OFFICE

AECOM | Coral Gables, FL

CLIENT REFERENCE

Andrew Baker, Professor and Director of Coral Reef Futures Lab at the University of Miami's Rosenstiel School of Marine Atmospheric, and Earth Science, University of Miami

Phone: 305.421.4642

Email: abaker@rsmas.miami.edu

BUDGETED COST

$20M

COMPLETED COST

$420,000

SCHEDULED COMPLETION DATE

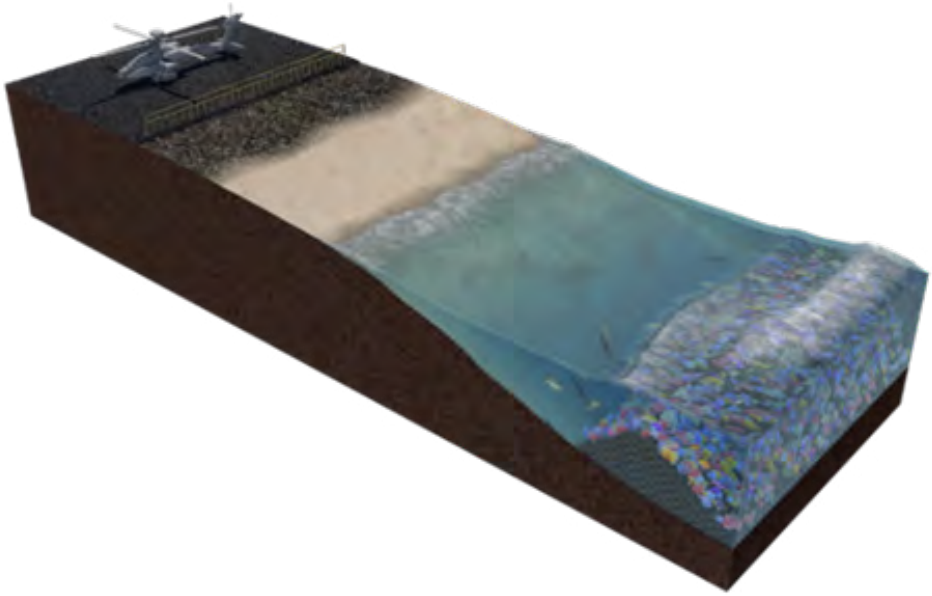
December 2024

ACTUAL COMPLETION DATE

December 2024

PROJECT HIGHLIGHTS

- Hybrid nature-based shoreline protection
- Wave attenuation and erosion reduction
- Bioengineered reef systems
- Sea level rise adaptation
- Habitat and ecosystem enhancement
- Innovative construction methods
- Permitting and implementation support



Section of a hybrid reef protecting DoD infrastructure (Source: DARPA)

Sea Level Rise Vulnerability Assessment and Adaptation Plan

City of Miami Beach, FL

AECOM

AECOM is supporting the City of Miami Beach in developing a Sea Level Rise Vulnerability Assessment and Adaptation Plan to increase the long-term flood resilience of City and community assets. The Vulnerability Assessment is designed to be compliant with requirements outlined in the Resilient Florida grant program.

In addition to assessing physical asset impacts, the Vulnerability Assessment looks at flood risk through a community sensitivity lens to examine the range of sea level rise hazard vulnerabilities experienced across the City. This involves a combination of facilitated focus group interviews with residents and local businesses to understand community perspectives on flooding and identifying infrastructure that serves socially vulnerable neighborhoods to inform the prioritization of equitable adaptation strategies.

Findings of the vulnerability assessment are being used to inform the City's Sea Level Rise Adaptation Plan, which outlines a comprehensive, forward-thinking, and flexible framework to safeguard the City's infrastructure, protect its residents, and maintain its position as a global destination for visitors. The Adaptation Plan integrates ongoing City plans and initiatives to align adaptation efforts with existing flood management, land use, and neighborhood improvement projects, considering updates that may need to occur for the plans to provide flood protection through the end of the century. The goal of the Adaptation Plan is to develop a holistic, coordinated path to flood resilience that addresses the complex, interconnected nature of sea level rise hazards, which often require a flexible and phased approach to adapt in the face of inherent uncertainty.

Promoting a plan that reflects community priorities, the project relies on a range of stakeholder and community engagement to inform the process. Our approach to engagement includes pop-up style community outreach that coincided with ongoing City events to have informal public conversations about the City's vulnerability to sea level rise hazards, workshops with City Department leads to discuss and prioritize solutions, development of online content related to sea level rise hazards for the City's website, and an informal salon gathering panel discussion about adaptation options for the City hosted by a local university.

RESPONSIBLE OFFICE

AECOM | Miami Beach, FL

CLIENT REFERENCE

Amy Knowles, Chief Resilience Officer, City of Miami Beach

Phone: 305.673.7084

Email: amyknowles@miamibeachfl.gov

BUDGETED COST

$285,000

COMPLETED COST

$750,000 (task order included options to expand scope based on findings. Schedule and scope extended to 24 months based on key findings)

SCHEDULED COMPLETION DATE

April 2025

ACTUAL COMPLETION DATE

April 2025

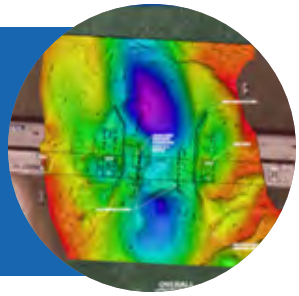
PROJECT HIGHLIGHTS

- Sea level rise vulnerability assessment
- Coastal flood resilience planning
- Community-informed risk analysis
- Equitable adaptation strategies
- Asset and infrastructure prioritization
- Implementation-ready adaptation framework

Lesner Bridge Underwater Inspection and Imaging

City of Virginia Beach, VA

MARINE SOLUTIONS



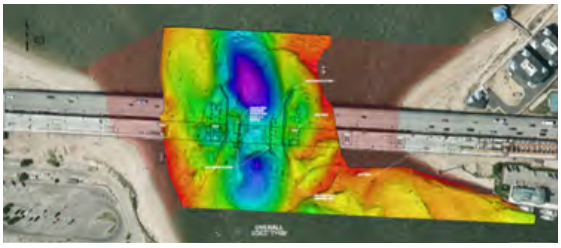
BACKGROUND. The Lesner Bridge carries US 60 / Shore Drive over the Lynnhaven Inlet of the Chesapeake Bay in the City of Virginia Beach. The signature bridge was completed in 2018 to provide additional clearance for vessel traffic.

SITE DESCRIPTION. This 1,575-ft-long bridge includes a 45-ft vertical clearance above mean high water and a 225-ft horizontal clearance at the navigational channel. The two travel lanes on each of the twin structures are 12 ft wide with 10-ft outside and 6-ft inside shoulders, and a 10-ft multiuse pathway for pedestrians and cyclists. The multimodal connector is a concrete segmental bridge consisting of pier footings constructed on 4-ft diameter drilled shafts.

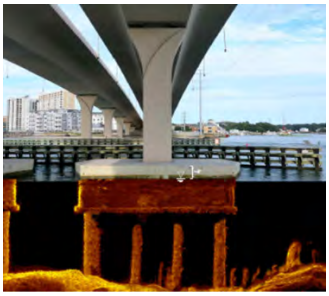
ROLE. Marine Solutions was contracted to provide two cycles of underwater inspection of the bridge including the baseline (initial) inspection. Six footings were inspected per bridge (12 total). Marine Solutions performed the underwater inspection of the bridge foundations including the concrete drilled shafts and steel H-pile fender system. 2D acoustic sonar was used to image the underwater components of the supports and channel bottom. In addition, a multibeam hydrographic survey was performed to map the channel bottom around the structure, extending 200 ft upstream and downstream of the bridges

CREW. The crew worked in challenging conditions including excessive tidal currents and heavy vessel traffic of the Lynnhaven Inlet.

RESULTS. Marine Solutions performed an underwater inspection utilizing surface-supplied air diving equipment, 2D sonar imaging using Kongsberg MS-1000 Mesotech software, and a bathymetric survey of the channel using a R2Sonic multibeam. Aerial photography was also taken using a drone and photos were given to the city. There were no significant findings with the inspection. An abandoned concrete foundation from the old bridge was found within channel limits using multibeam equipment, which was recommended for removal. A high-pressure dredging line from nearby dredge work was also identified so the client would be aware of the location/proximity to channel limits.



Multibeam hydrographic survey color map of Lesner Bridge



Acoustic sonar imaging of a bridge pier

Typical 10-pile channel pier elevation shown at Pier 4

RESPONSIBLE OFFICE

Marine Solutions | Nicholasville, KY

CLIENT REFERENCE

Jimmy Evans, PE, Project Manager, City of Virginia Beach

Phone: (757) 385-4438

Email: jrevans@vbgov.com

BUDGETED COST

$51,565

COMPLETED COST

$51,565

SCHEDULED COMPLETION DATE

Phase 1: January 1, 2020

Phase 2: August 31, 2024

ACTUAL COMPLETION DATE

Phase 1: September 11, 2019

Phase 2: November 11, 2024

PROJECT HIGHLIGHTS

- Underwater existing conditions
- Bathymetric survey mapping
- 2D acoustic sonar imaging
- Multibeam hydrographic survey
- Navigation risk identification
- Challenging marine conditions

Waterfront Inspections Norfolk Naval Shipyard

Naval Facilities Engineering Systems Command Expeditionary Warfare Center (NAVFAC EXWC)

MARINE SOLUTIONS

BACKGROUND. Norfolk Naval Shipyard (NNSY) is one of the largest shipyards in the world specializing in repairing, overhauling, and modernizing ships and submarines. It is also the oldest and largest industrial facility that belongs to the U.S. Navy. The inspections and subsequent report for NNSY were a part of the Waterfront Facilities Inspection Program administered by the Ocean Facilities Division of the Naval Facilities Engineering Systems Command Expeditionary Warfare Center. The program provides inspection, structural analysis, repair recommendations, and repair cost estimates for waterfront facilities. Marine Solutions was responsible for providing the engineering services necessary to perform the inspections and condition assessments of structural components. Norfolk Naval Shipyard consists of three areas designated as Main Site, Southgate Annex, and St. Julien's Creek Annex.

ROLE. As part of the NAVFAC waterfront facility inspections and assessments program, we performed above and below water inspections of 37 facilities. The facilities consisted of piers, wharves, mooring dolphins, floating structures, bulkheads, and seawalls. Inspections included above and below water structural, mooring, berthing, mechanical, and electrical system inspection and reporting on nearly 30,000 linear feet of bulkheads, piers, wharves and over 4,000 piles. The inspection of the below water structural components included Level I (visual-tactile), Level II (in-depth visual), and Level III (testing) inspections. The Level III inspection of steel components included ultrasonic thickness measurements to provide information on the extent of corrosion.

In addition to traditional inspection techniques, sonars, including volumetric multibeam sonars, in conjunction with LiDAR scanners mounted to a survey vessel were used for rapid assessment and inspections at select prier structures and surrounding channel bottom. The collection process consists of the following: establishing survey control, collecting traditional multibeam sonar data, collecting volumetric multibeam sonar data, and collecting the LiDAR data with a 360-degree camera. The results were used and compared to traditional inspection methods and combined to create 2D inspection drawings and 3D digital models.

RESULTS. The teams completed the inspections on schedule without disrupting the busy operations of the base. Following the inspections, Marine Solutions provided interim reports, briefs, and assessment reports which included critical findings, comprehensive asset inventories, defect inventories, mooring fitting ratings, condition indexes, operational capability ratings, prioritized recommendations for repairs, assessment of impacts to mission, repair cost estimates, and form.

Due to the severe condition of the steel H-piles and steel sheet pile bulkhead at Berths 40 and 41, immediate recommendations were provided to limit vertical loading to the structures and conduct additional investigations to further assess, analyze, and facilitate the design of repairs.

RESPONSIBLE OFFICE

Marine Solutions | Nicholasville, KY

CLIENT REFERENCE

Gregor Bo, PE, Waterfront Inspection Program Manager, NAVFAC EXWC

Phone: (202) 433-5150

Email: gregor.s.bo1@navy.mil

BUDGETED COST

$362,476

COMPLETED COST

$ 1,035,389

SCHEDULED COMPLETION DATE

July 2, 2022

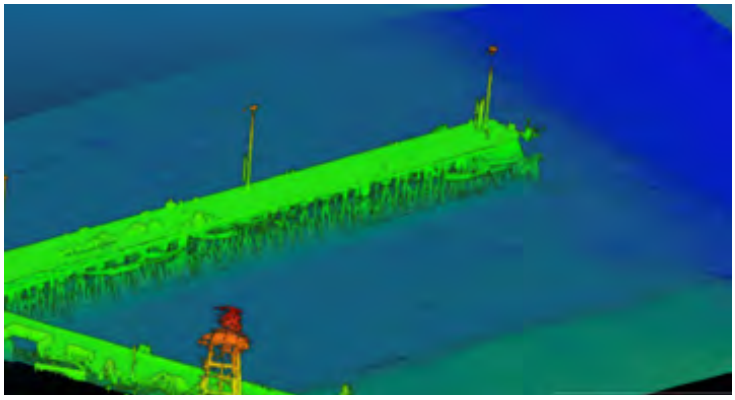
ACTUAL COMPLETION DATE

June 14, 2022

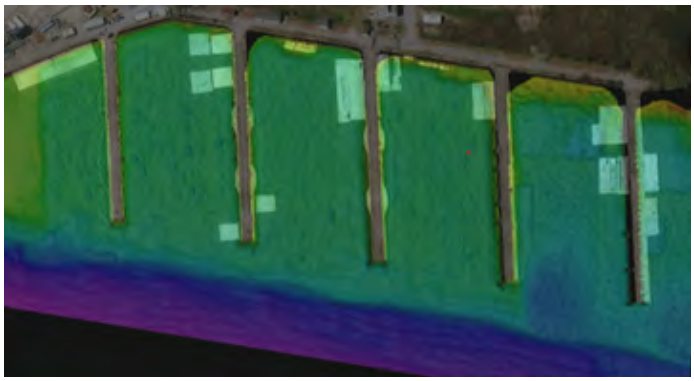
PROJECT HIGHLIGHTS

- Comprehensive conditions assessment
- Above and below-water inspections
- Multibeam sonar surveys
- LiDAR-enabled asset mapping
- Structural feasibility evaluation
- Repair prioritization analysis

Aerial view of Norfolk Naval Shipyard (NNSY)



Combination of LiDAR and Sonar Data

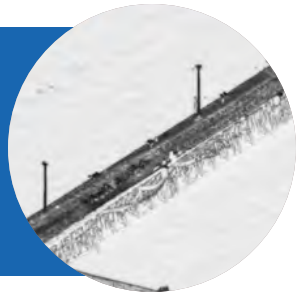


Typical Multibeam Data

Waterfront Facilities Inspection

NAVFAC EXWC

MARINE SOLUTIONS



BACKGROUND. As part of a regional contract by the Naval Facilities Engineering Command Engineering and Expeditionary Warfare Center (NAVFAC EXWC), Marine Solutions was tasked with providing inspections and engineering assessments at 124 waterfront facilities located at the Joint Expeditionary Base (JEB) Little Creek-Fort Story in Virginia.

SITE DESCRIPTION. JEB Little Creek-Fort Story is tasked with training our nation's expeditionary forces. The joint base sits on approximately 2,120 acres of land in the northwest corner of Virginia Beach and portions of Norfolk, VA. The base serves large and small vessels, from military cargo ships to amphibious craft, and supports a wide variety of waterfront activities with over 10 miles of piers, bulkhead, wharves, and coastal structures supported by over 9,000 in-water piles.

ROLE. Marine Solutions provided waterfront facilities inspections and assessments of the entire waterfront, including the structural, mooring, fender, and utility components of all 124 facilities. The purpose of the inspection was to assess the overall condition of each facility, identify operational restrictions, and provide recommendations for repairs and associated budgetary cost estimates.

Marine Solutions provided inspection teams led by licensed professional engineer-divers to complete the above and below water inspections. All diving was conducted in accordance with federal diving requirements and NAVFAC engineering criteria. The project included above and below water inspections, non-destructive testing, underwater sonar imaging, laser (LiDAR) surveying, asset inventory, digital data collection, engineering analysis, repair recommendations, construction cost estimating, condition assessments, complete report documentation. Specifically, sonar data was collected using a traditional multibeam sonar and a volumetric multibeam sonar used in conjunction with LiDAR scanners mounted to survey vessels.

RESULTS. Multiple inspection teams, providing up to 12 inspectors simultaneously, were provided to accelerate the project schedule and complete all inspections ahead of schedule with minimal impact to base operations. The latest in above and below water survey technology was utilized to efficiently assess coastal structures and localized scour concerns. Several critical deficiencies were identified during the inspections, including unknown localized scour that had jeopardized pier foundations and rapidly advancing chemical deterioration that had affected and addressed that greatly reduced operational risks. Detailed guidance was then provided to remain operational until repairs could be made. Additionally, updated assessments assisted in prioritizing and focusing funding by identifying conditions for which repairs could be deferred while calling attention to conditions that warranted higher priority.

RESPONSIBLE OFFICE

Marine Solutions | Nicholasville, KY

CLIENT REFERENCE

Gregor Bo, PE, Waterfront Inspection Program Manager, NAVFAC EXWC

Phone: (202) 433-5150

Email: gregor.s.bo1@navy.mil

BUDGETED COST

$1,658,714

COMPLETED COST

$1,658,714

SCHEDULED COMPLETION DATE

July 2, 2022

ACTUAL COMPLETION DATE

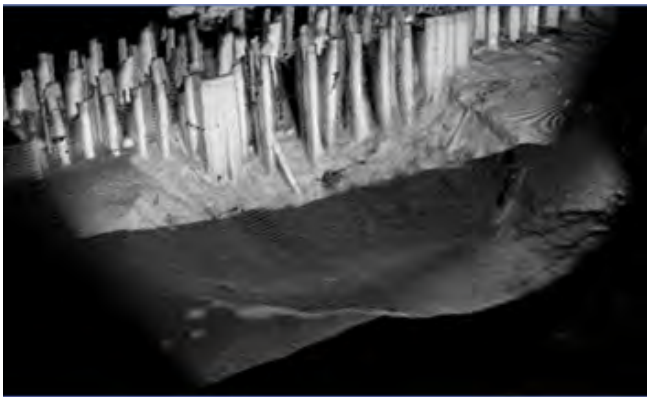
February 22, 2022

PROJECT HIGHLIGHTS

- Large-scale existing conditions
- Above/below-water inspections
- Multibeam sonar surveys
- LiDAR coastal mapping
- Asset inventory development
- Repair feasibility analysis

Aerial view of the JEB Little Creek-Fort Story waterfront

Combined 3D acoustical imaging, LiDAR, and bathymetry data at pier

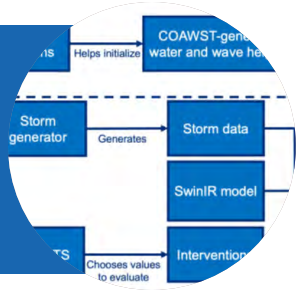


Underwater sonar image of scour hole affecting pier foundations

AI-Driven Coastal Resilience Optimization at Tyndall AFB

Air Force Civil Engineer Center

JOHNS HOPKINS APPLIED PHYSICS LABORATORY



OVERVIEW. The Johns Hopkins Applied Physics Laboratory successfully completed a project to enhance coastal resilience at Tyndall Air Force Base (AFB), Florida, an area severely impacted by Hurricane Michael in 2018. The project applied an AI-driven optimization framework to identify cost-effective combinations of engineered and nature-based interventions—specifically seawalls and oyster reefs—to reduce storm surge and flooding damage.

TECHNICAL APPROACH. The team combined physics-based modeling with advanced machine learning to accelerate and improve intervention planning:

- Storm Simulation – Using the COAWST modeling system, historical Gulf storms were recreated to capture ocean-atmosphere-wave dynamics. To overcome computational bottlenecks, an AI encoder-decoder model (U-Net inspired) generated high-resolution storm surge fields from low-resolution data, reducing simulation time from weeks to hours.
- Intervention Impact Prediction – Transformer-based surrogate models (SwinIR) were trained to predict how oyster reefs and seawalls alter wave height and direction. These models achieved high accuracy with only a fraction of the computational cost of traditional simulations.
- Optimization – A continuum-armed bandit approach (Sample-Then-Optimize Batch Neural Thompson Sampling) was used to select optimal intervention configurations—locations, sizes, and types—minimizing expected flooding damage while accounting for installation and maintenance costs.

RESULTS AND IMPACT

- Optimized interventions for Hurricane Michael alone could have delivered $6 billion in net savings, far outperforming random or greedy strategies.
- When optimized across a representative set of Gulf storms, projected savings over a 50-year intervention lifespan reached tens of billions of dollars.
- The solution demonstrated that hybrid strategies—offshore oyster reefs combined with targeted seawalls—can significantly reduce flooding risk while supporting ecological resilience.

CONCLUSION. This completed project provides a scalable, data-driven decision-support framework for coastal planners and military installations. By integrating AI-driven prediction and optimization, the approach accelerates planning timelines, reduces uncertainty, and enables proactive resilience strategies that protect critical infrastructure and communities from future storm impacts.

RESPONSIBLE OFFICE

JHU APL | Columbia, MD

CLIENT REFERENCE

Garey Payne, Natural Disaster Recovery Acquisition Program Manager, Air Force Civil Engineer Center

Phone: 800.525.0102

Email: garey.payne@tyndal.af.mil

BUDGETED COST

$300,000

COMPLETED COST

$300,000

SCHEDULED COMPLETION DATE

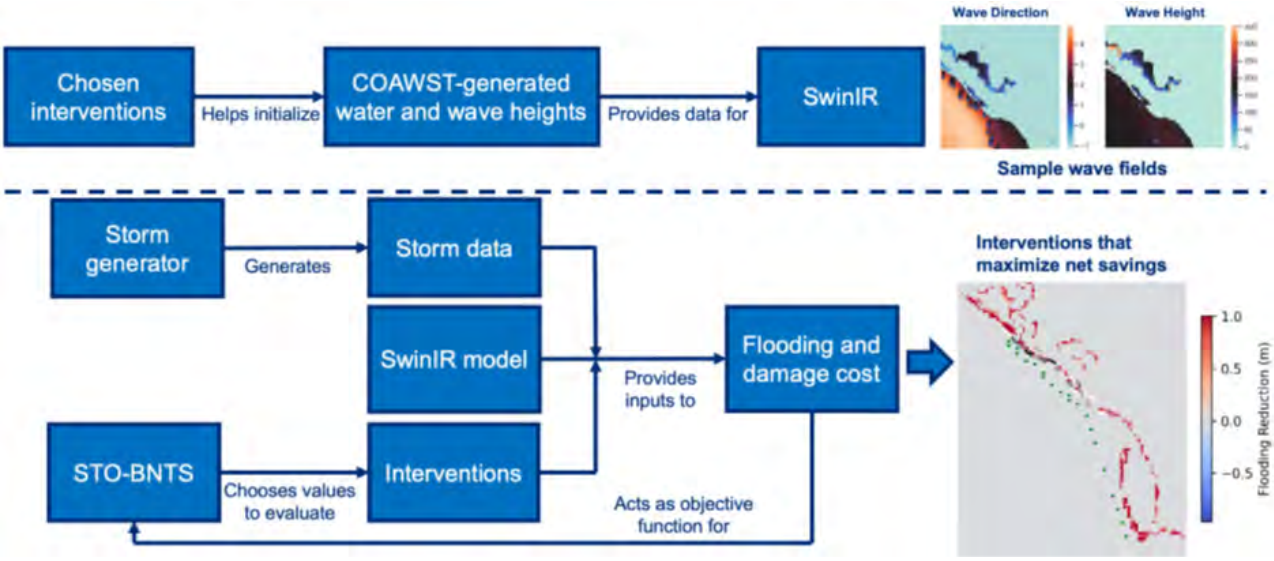
2023

ACTUAL COMPLETION DATE

2023

PROJECT HIGHLIGHTS

- Climate risk decision support
- Asset prioritization analysis
- Nature-based solutions analysis and feasibility
- Feasibility-informed alternatives



APL framework combines numerical and AI-based storm data generation, shifted window image restoration transformers for predicting intervention effect, and Sample-Than-Optimize Batch Neural Thompson Sampling for optimizing interventions (Source: JHU APL)

6.
Response Capability

Statewide Sustainability Consulting – Nature-Based Solutions & Climate Visualization Pilot

Virginia Department of Transportation (VDOT)

The Straughan Team is fully prepared to **dedicate the staff, resources, and management structure** required to successfully deliver all GRIT Phase I tasks within the project timeline. Our Virginia office will lead this effort, structured as depicted in our orgranization chart and through our staff qualifications presented in Section 5 - Qualifications and Experience of the Firm and the Project Team. The team will also be supported by a strong bench of coastal engineers, ecologists, GIS analysts, and resilience planners who maintain balanced workloads that allow for immediate and sustained engagement throughout the contract period.

The Straughan Team has **prioritized the GRIT project** within our active portfolio and has assigned a Project Manager and discipline leads with direct experience in shoreline design, tidal marsh systems, ecological assessment, and climate resilience. Each key staff member has confirmed availability that aligns with the proposed schedule, including capacity to participate in monthly coordination meetings, quarterly briefings, design review workshops, and the two required in-person stakeholder events identified in the RFP. Our internal staffing model also includes pre-identified alternates who can support specific tasks if additional capacity is required, ensuring uninterrupted progress at all phases of the project.

Our firm is structured to provide **responsive, reliable, and consistent communication** to MPPDC and project partners. Straughan uses a disciplined project management system that includes weekly internal coordination, milestone tracking, and structured QA and QC procedures for all technical deliverables. These systems allow us to manage complex, multi-disciplinary efforts while maintaining clarity, schedule adherence, and quality control across all work products. They also support rapid turnaround of comments and timely responses to data requests, a priority we recognize due to the number of review checkpoints outlined for this project.

Straughan is known for being highly responsive to client needs. Our team routinely supports projects with frequent **partner coordination, multi-agency review cycles, and evolving technical inputs**. We understand the importance of timely communication and will maintain open, proactive dialogue with MPPDC and other team members throughout the project. This includes regular progress summaries, early identification of emerging risks, and collaborative problem-solving that keeps the project moving forward.

From a geographic perspective, Straughan's Virginia office provides close proximity to the project area and allows staff to travel to meetings, field locations, and engagement events with minimal delay. This local presence supports MPPDC's interest in regional participation and contributes to efficient coordination throughout the project period. In addition, team member AECOM maintains multiple offices in Virginia, including in the Tidewater area, and both Marine Solutions Inc. and Johns Hopkins APL have established regional presences that further support **timely coordination and engagement**.

The Straughan Team has sufficient **staffing depth and technical capacity** to complete all work within the anticipated project schedule, currently identified as ending on December 31, 2026, with flexibility to accommodate any approved extension. Our track record of delivering coastal resilience, ecological, and engineering projects on schedule demonstrates our ability to manage workload, maintain high-quality deliverables, and meet all required milestones. With dedicated personnel, a structured project management framework, and a commitment to clear and timely communication, the Straughan Team is well-positioned to meet the needs of the GRIT Phase I effort and provide strong support across all phases of the project.

Page intentionally left blank.

7.
Insurance

Shoreline of the Severn River, north of Guinea Marsh, August 2024
Photo by proposed Project Manager, Chris Overcash

Straughan has reviewed the insurance requirements set forth in the Standard Terms and Conditions and will maintain all required insurance for the full duration of the Contract. Upon award and prior to contract execution, Straughan will provide a Certificate of Insurance in compliance with those requirements.

Page intentionally left blank.

8.
References

MD 249 Saint Georges Island Shoreline Assessment and Living Shoreline Design
Maryland State Highway Administration (SHA)

Reference 1

Straughan Environmental

Katie Dyer, Environmental Planner, MWCOG
777 N. Capitol Street NE, Suite 300
Washington, DC 20002
Phone: (202) 962-3324

Regional Blue-Green Infrastructure Resilience Planning Community Engagement

Straughan is serving as the water resources engineering lead for a multi-jurisdictional flood mitigation and blue-green infrastructure (BGI) planning study spanning three watersheds along the border of Prince George's County and Washington, D.C. Led by MWCOG and regional partners, the study focuses on reducing flood risk in vulnerable communities while improving resilience through integrated blue, green, and gray infrastructure solutions. Straughan is leading watershed-scale suitability analysis, flood modeling, and prioritization of mitigation strategies using GIS-based analysis and existing hydrologic and hydraulic models. The resulting BGI Plan will provide an actionable Roadmap to Resilience that aligns community priorities, environmental justice considerations, and state and federal funding criteria, including FEMA BRIC.

Reference 2

Straughan Environmental

Anthony Verdicchio, Transportation Engineer III Maryland State Highway Administration
707 North Calvert Street, Baltimore, MD 21202
Phone: (410) 545-8876

MD 249 Saint Georges Island Shoreline Assessment and Living Shoreline Design

Straughan is leading the design of hybrid and nature-based resilience solutions for MD 249 Piney Point Road, the sole access route to Saint George Island, which experiences frequent flooding from sea level rise, tides, and storm surge. The project focuses on maintaining safe and reliable access while reducing roadway inundation through integrated roadway improvements, drainage enhancements, and living shoreline stabilization. Straughan conducted shoreline erosion assessments and advanced living shoreline concepts through preliminary and final design, including permitting support and erosion and sediment control measures. This work demonstrates Straughan's ability to deliver implementation-ready, permit-friendly coastal resilience solutions that protect critical infrastructure while enhancing adjacent marsh and shoreline systems.

Reference 3

Straughan Environmental

Stephanie Dalke, Project Director, UMD-EFC
1 Physics Ellipse Drive
Second Floor, Anacostia Building
College Park, MD 20740
Phone: (301) 405-5036

Resilience Capacity Building for Nine Maryland Communities

Straughan in on the team with the University of Maryland Environmental Finance Center through a National Fish and Wildlife Foundation, National Coastal Resilience Fund grant. For this project Straughan is leading the technical team to develop a climate vulnerability assessment as well as adaptation projects of nature-based and hybrid solution options to provide climate resilience to these communities. Straughan is also assisting with community outreach, stakeholder identification, and tracking of future funding for implementation of the concepts being developed.

Reference 4

AECOM

Ben McFarlane, Chief Resilience Officer, Hampton Roads Planning District Commission (HRPDC)
723 Woodlake Drive
Chesapeake, VA 23320
Phone: (757) 420-8300

Norfolk and Virginia Beach Joint Land Use Study (JLUS)

AECOM recently completed the Norfolk and Virginia Beach Joint Land Use Study (JLUS) for the Hampton Roads Planning District Commission (HRPDC), with support from Moffatt and Nichol and the Miles Agency. The JLUS spans two localities in the Hampton Roads Planning District and four Navy bases, including the largest facility in the Navy - Naval Station Norfolk. The JLUS focused in part on evaluating current and future impacts of flooding on the facilities and infrastructure that directly support the Navy and developing actions that the Cities could take to reduce or eliminate both short- and long-term risks for the military. Ultimately, the JLUS helps shape local, regional and state priorities with an emphasis on resilience for the localities and Department of Defense installations.

Reference 5

Marine Solutions

Gregor Bo, PE, Waterfront Inspection Program Manager, NAVFAC EXWC
One Liberty Plaza
New York, New York 10006
Phone: (202) 433-5150

Waterfront Inspections Norfolk Naval Shipyard

Marine Solutions supported the U.S. Navy's Waterfront Facilities Inspection Program by conducting comprehensive above- and below-water inspections of 37 waterfront structures at the Norfolk Naval Shipyard. Using a combination of traditional inspection methods and advanced technologies such as multibeam sonar and LiDAR, the team assessed nearly 30,000 linear feet of infrastructure and more than 4,000 piles without disrupting shipyard operations. The resulting reports provided condition ratings, repair priorities, and cost estimates, with critical findings at select berths leading to immediate operational recommendations.

9.
Other Supporting Data

Guinea Marsh, August 2024
Photo by proposed Project Manager, Chris Overcash

Within this section we are including two items of support data described briefly below and then included: The research paper produced by Straughan Team member Johns Hopkins Applied Physics Laboratory in 2025 and the conceptual engineering CAD drawings which are the basis for the landscape architecture stylized profiles presented in Section 2 of the proposal.

The research paper produced by Straughan Team member Johns Hopkins Applied Physics Laboratory in 2025 which describes the method in detail of utilizing AI to predict coastal solution intervention optimization titled Discovering strategies for coastal resilience with AI-based prediction and optimization. As described within this document, this optimization potentially stands to save millions or billions of dollars (depending upon the scale of the area reviewed) in conditions where natural hazards (such as hurricanes) damage coastal natural and built infrastructure. As noted in Section 2 and 3 of our proposal, this is the technology we intend to employ for GRIT Phase 1.

Page intentionally left blank.

Discovering strategies for coastal resilience with AI-based prediction and optimization

Jared Markowitz*, **Alexander New***, **Jennifer Sleeman***
* equal contribution
Research and Exploratory Development Department
Johns Hopkins Applied Physics Laboratory
{jared.markowitz, alex.new, jennifer.sleeman}@jhuapl.edu

Chace Ashcraft, Jay Brett, Gary Collins, Stella In, Nathaniel Winstead
Johns Hopkins Applied Physics Laboratory

Abstract

Tropical storms cause extensive property damage and loss of life, making them one of the most destructive types of natural hazards. The development of predictive models that identify interventions effective at mitigating storm impacts has considerable potential to reduce these adverse outcomes. In this study, we use an artificial intelligence (AI)-driven approach for optimizing intervention schemes that improve resilience to coastal flooding. We combine three different AI models to optimize the selection of intervention types, sites, and scales in order to minimize the expected cost of flooding damage in a given region, including the cost of installing and maintaining the interventions. Our approach combines data-driven generation of storm surge fields, surrogate modeling of intervention impacts, and the solution of a continuum-armed bandit problem. We applied this methodology to optimize the selection of sea wall and oyster reef interventions near Tyndall Air Force Base (AFB) in Florida, an area that was catastrophically impacted by Hurricane Michael. Our analysis predicts that intervention optimization could potentially be used to save billions of dollars in storm damage, far outpacing greedy or non-optimal solutions.

1 Introduction

As climate change intensifies, coastal regions will become increasingly vulnerable to extreme weather [1, 2, 3, 4]. Nascent computational and experimental results have demonstrated how targeted placement of interventions can attenuate flooding and reduce damage [4, 5, 6, 7, 8, 9]. However, the relative impacts of different intervention types (e.g., nature-based solutions like oyster reefs and marshes, grey solutions like sea walls) is not fully understood. Furthermore, the limited representation of interventions in large weather datasets like ERA5 [10] makes it difficult to robustly assess their effectiveness.

We have developed an artificial intelligence (AI)-driven framework (Figure 1) to predict optimized intervention schemes for improved resilience to coastal flooding, given storm properties and the estimated costs of damage and interventions. We evaluated our methodology on a specific use case: optimizing the placement and height of a sea wall and the placement of oyster reefs near Tyndall Air Force Base (AFB) in Florida, an area that was catastrophically impacted by Hurricane Michael [11]. Damage from Hurricane Michael was responsible for 16 direct deaths and 43 indirect deaths in the United States, as well as approximately $30 billion in damages [11]. While our models suggest that

Preprint.

optimized interventions may reduce flooding costs by billions of dollars per storm, we also find that naïve choices may direct water more toward populated areas and thus increase damage and costs.

Our approach uses physics-based modeling of the impact of oyster reefs on wave height and a sea wall on inland flooding (Section C.3 and Section 2.1), AI models for additional storm data generation (Section 2.2), AI-based surrogate models (SMs) to rapidly predict how oyster reefs change wave height and direction, and identification of optimal interventions with black-box optimization (Section 2.4). The framework allows one to decide which interventions to deploy, where they should go, and how large they should be. Selected interventions minimize the cost of expected flooding damage in the affected region, incorporating installation and maintenance costs.

Our key findings are that:

- The computational challenge of producing at-scale storm training data may be overcome by training a model (inspired by the U-Net [12] architecture) to produce storm surge fields based on atmospheric and wave conditions.
- A surrogate model with transformer architecture [13] may be used to accurately predict the effect of oyster reefs on wave heights (Section 3.2) while requiring only a fraction of the computational time of physics-based modeling.
- The combination of offshore (oyster reef) and onshore (sea wall) interventions may be optimized [14] to potentially save billions of dollars per storm and to increase savings over a projected 50-year intervention lifetime by as many as tens of billions of dollars.

While the specific numerical results presented are particular to the region surrounding Tyndall AFB, we expect the approach to be applicable to many different sites and intervention types.

1.1 Related work

Recent weather and earth systems SMs [15, 16, 17, 18, 19] have demonstrated effective short and medium-term forecasts on global and regional scales. However, they are trained on coarse geospatial meshes and their predictions neither resolve the effects of small-scale interventions nor support the inclusion of interventions. Thus, being able to accurately and effectively model interventions requires the generation of a training dataset with different off-shore storms and interventions.

SMs that rely less on large datasets have also been applied to this problem. For example, [20] used Gaussian processs (GPs) to predict wave attenuation coefficients given the presence of rigid vegetation, while [21] used Bayesian optimization (BO) to identify wave conditions that optimize specified criteria. Similarly, [22] optimize for coastal protection based on outputs of physics-based calculations. These approaches and others have shown promise; however, they rely on defining a bespoke problem and then generating data specific to that problem. There is still a need for a general approach that can optimize intervention effects across geographies, storms, and intervention types.

2 Technical approach

2.1 Physics-based storm data simulation

Coupled Ocean–Atmospheric–Wave–Sediment Transport (COAWST) [23, 24] is a United States Geological Services (USGS) modeling framework built to simulate the interactions between ocean, atmosphere, waves, and sediment transport processes. Using COAWST, we recreated Hurricane Michael. It took approximately one week using a high performance computing environment to generate 48 hours of storm data. More details on our use of COAWST are in Section A.1.

For our Michael data, we additionally simulated wind and wave fields for different oyster reef configurations. Specifically, we adopted the approach of [8] and used the vegetation dynamics module included with COAWST to treat oysters as a region of stiff plants located in a user-defined area. Figure 2 shows some of the oyster reef configurations for which we generated wave fields.

Unfortunately, storm data generation using traditional numerical models does not scale to the data needs of modern AI. The COAWST three-way coupled system tends to be prone to numerical instability and is difficult to configure in a high-performance computing environment. For a single storm (using a fully coupled model), it could take a week of compute to simulate a two-day storm.

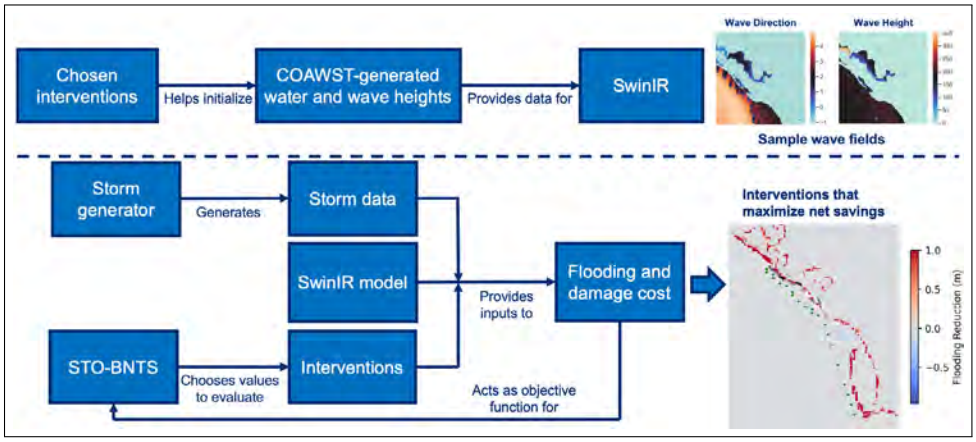


Figure 1: Our framework combines numerical and AI-based storm data generation, shifted window image restoration transformers [13] for predicting intervention effects, and Sample-Then-Optimize Batch Neural Thompson Sampling [14] for optimizing interventions.

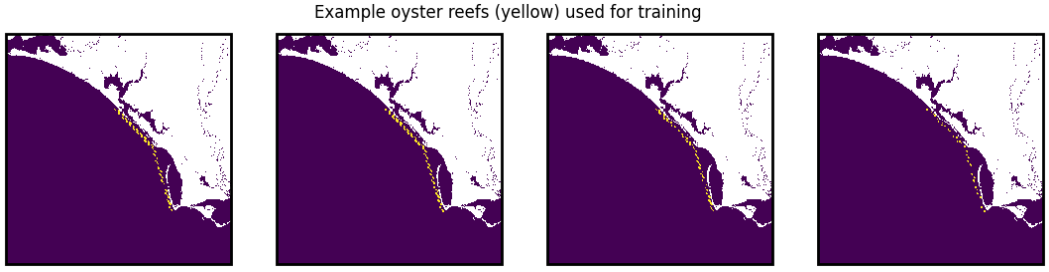


Figure 2: Four of the oyster reef configurations (yellow) for which we generated wave fields using COAWST to use as training and validation data.

For this reason, we explored the use of AI models to decrease the needed COAWST computation time. By reducing the coupling to a two-way coupling of atmospheric and wave models, we were able to reduce the storm simulation time by a factor of five. The model generates the storm surge instead of using the coupled ocean model with the atmospheric and wave models.

2.2 Quickly predicting high-resolution storm surge data from low-resolution data

To overcome the computational bottleneck of running the fully coupled COAWST, we built a domain- and resolution-agnostic AI model (Figure 3) inspired by the U-Net [12] architecture. The model is an encoder-decoder architecture, with skip connections and fully-connected blocks. It avoids assumptions about spatial topology or sampling resolution, allowing us to ingest input originating from heterogeneous grids. This approach provides a flexible global mapping between fixed-size input windows and targets. We mitigate overfitting using normalization and dropout.

The encoder-decoder model is trained by minimizing the errors of an ℓ^1 loss function: $\mathcal{L} = \frac{1}{n}\sum_{i=1}^{n} ||z_i - \hat{z}_i||_1$, where z_i is a high resolution ground-truth storm snapshot and $\hat{z}_i$ is the model prediction.

2.3 Predicting the environmental effect of interventions with surrogate modeling

A key challenge in coastal resilience modeling is the lack of data describing how the placement of interventions affect weather impacts in coastal regions. Here we describe how AI SMs can be used to predict the effect of interventions, given weather data without interventions.

Let $\mathbf{u}(\mathbf{x}, t)$ be a field describing the evolution of one more state variables (e.g., water height, wave direction) on a spatial domain. The field starts with an initial condition $\mathbf{u}(\mathbf{x}, t = 0)$ that is obtained

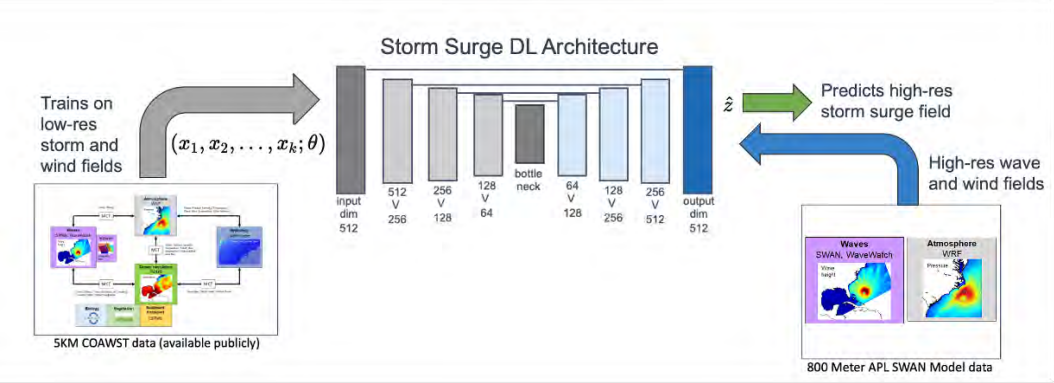


Figure 3: The Storm Surge Encoder Decoder Skip Connection model (Section 2.2). It is trained on 5 km COAWST data and used to predict storm surge at higher resolutions.

elsewhere (Section 2.1). We can modify the spatial domain by adding in an intervention I (e.g., a layer of oyster reefs near the coast line). Intervention-modified state variables are denoted by $\mathbf{u}_I(\mathbf{x}, t)$, the spatiotemporal field that evolves given the presence of the intervention I.

Thus, the effect of an intervention I can be predicted given a method G_θ for mapping $\mathbf{u}$ to $\mathbf{u}_I$. For a rectangular spatial domain, each $\mathbf{u}(t)$ and $\mathbf{u}_I(t)$ is an image, with each channel giving one of the state variables. Thus, we formulate this task as an image-to-image translation problem, where the AI model learns a G_I given a set of input data tuples $(\mathbf{u}(t), \mathbf{u}_I(t), I)$, yielding $\mathbf{u}(t), I \mapsto G_I(\mathbf{u})(t)$. Interventions I are also represented as spatial arrays, and so are added as further channels. We also add in the bathymetry and a binary land-sea mask. Thus, the model input has a number of channels equal to $n_{vars} + n_{interventions} + 2$, and its outputs have n_{vars} channels.

The SM, given data with n_t time points and n_θ different interventions, is trained by minimizing

$$\mathcal{L} = \frac{1}{n_t\, n_I} \sum_{t,I} ||\mathrm{Crop}(G_I(\mathbf{u})(t) - \mathbf{u}_I(t))||_F^2, \tag{1}$$

where Crop is a random crop. Our work uses only a single domain, but the inclusion of bathymetry and the land-sea mask as model inputs enables the model to learn to generalize across geographies.

Because the spatiotemporal fields are driven by multiple physical scales, we use the shifted window image restoration (SwinIR) [13] transformer as the base AI model for G_θ. Hyperparameters are given in Table 1 in Section A.3. The SwinIR model we train from our COAWST data has $\sim$900k parameters. However, to speed up inference time during the optimization (Section 2.4), we use model distillation [25] and train a smaller model with $\sim$100k parameters (Section B).

We randomly sample from the space of oyster interventions (Section 2.1) and use the resulting simulations for model training and validation. Both SwinIR models are trained with Adam [26].

2.4 Intervention optimization

Given models of the storm surge and waves impacting a target region, as well as a model of the impact of different intervention configurations, we train an agent to *optimize* the choice of interventions. The goal is to choose a set of interventions that minimize the sum of projected flooding costs, while also considering the costs of implementation and maintenance. For Tyndall AFB, we derive solutions both specifically for Hurricane Michael and across the set of storms described in Section 3.1.

2.4.1 Intervention Parameterization

We consider oyster reef (offshore) and sea wall (onshore) interventions. The reefs attenuate waves before they hit the coast, while the sea wall may attenuate waves or redirect water (both storm surge and waves) upon landfall. The agent's action space (Figure 8) is parameterized as a 63-dimensional vector with continuous and binary values between 0 and 1; the first 23 correspond to normalized heights of sea wall segments (up to 5m) while the last 40 are binary decisions on oyster reef sites.

2.4.2 Evaluating Flooding Costs

To evaluate flooding cost (Appendix C.2), we use the combination of a wave over topping (WOT) model [27, 28] and gridded cost estimates dependent on the combination of flooding depth and occupancy [29]. At a high level, we track the flow of water onto land for each hour during a storm, allow its height to equilibrate over the affected gridded area (including bathymetry), and use monetary cost estimates based on insurance claims to compute the overall cost of a storm. The optimization objective / reward $r(I)$ for a set of interventions I over a set of storms $\{j\}$ is the sum of three terms:

$$r(I) = -CI_I + \sum_j f(j) \left(CS_{0,j} - CS_{I,j}\right), \tag{2}$$

where CI_I is the cost of installing and maintaining I, CS_0 refers to the cost of a storm given no interventions, CS_I is the cost of a storm given interventions I, and $f(j)$ refers to the expected frequency of storms of the same category (intensity) as j over the lifetime of the interventions. The frequency f was set to 1 for our analysis of Hurricane Michael, given the rarity of such an event. Further details of the estimation of rewards are given in Appendices C.1, C.3, and C.4.

2.4.3 Continuum-Armed Bandit Problem

Our intervention selection problem is a one-step decision that is computationally expensive to evaluate and that has a high-dimensional, continuous action space. While our simulation environment is deterministic, it necessarily represents an uncertain future. We therefore frame the problem as a continuum-armed bandit [30] to (1) naturally leverage function approximation to efficiently search our solution space and (2) explicitly incorporate uncertainty, originating both from the environment we model and from the reward estimate in our bandit approach. To solve the problem, we used Sample-Then-Optimize Batch Neural Thompson Sampling (STO-BNTS) [14]. At each iteration, STO-BNTS trains a neural network (NN) so that choosing inputs (actions) that maximize its output is equivalent to sampling from a GP posterior for reward, with the neural tangent kernel (NTK) [31] as the kernel function. To accommodate the high dimensionality of our search space and the high computational expense of obtaining individual samples, we implemented scheduled, prioritized sampling of initial points when optimizing actions [32] based on the computed reward posterior. Further details are provided in Section D.

3 Results

We evaluated our framework by optimizing the placement and height of sea walls and oyster reefs near Tyndall AFB in Florida, which was catastrophically impacted by Hurricane Michael [11].

3.1 Storm Surge Results

The encoder-decoder skip connection model (Figure 3) was trained on low-resolution 5 km COAWST data to learn the relationship between wind and wave fields. It was built to provide a prediction on a single time-step at a time. Our study sought to understand whether the model could be trained to learn this relationship on 5 km data but used on higher resolution data, such as 1 km and 8 m data.

We first collected storm data from USGS[1], with an hourly temporal resolution and a 5 km horizontal resolution. The data include storms from 2010-2022, over the Gulf, while focusing on dates consistent with periods when storm activity was most significant. Our balanced dataset included an equal number of hurricanes and non-hurricane storms. Data were masked to focus only on points over water and near landfall. Wind fields, wave fields, and time are the input variables used, and surge (zeta) is used as the target variable. With a total of 600,000 samples, 400,000 were used for training, of which 80,000 were used for validation, and 200,000 were held out for testing. The model was trained for 60 epochs with early stopping, and used an Adam [26] optimizer and a ReduceLROnPlateau scheduler.

The model was evaluated on the test set to predict the surge using wind, wave, and time. For normalized predictions, the model's mean squared error (MSE) was 0.008, and the mean absolute error (MAE) was 0.073; unnormalized (meters), the MSE was 0.098, and the MAE was 0.234. Figure 11 (Section B) shows reasonable distributional agreement between predicted and true surge.

[1] https://www.sciencebase.gov/catalog/item/610acd4fd34ef8d7056893da

Next, we evaluated the encoder-decoder skip connection model on Hurricane Michael at an 800 meter horizontal resolution and hourly time resolution. Here, the overall unnormalized MSE of the predicted storm surge was 0.03. The storm surges generated by the numerical model and the predicted storm surge by the encoder-decoder skip connection model are shown in Figure 4. The magnitude of zeta values is slightly exaggerated, but the values were judged to still be physically consistent.

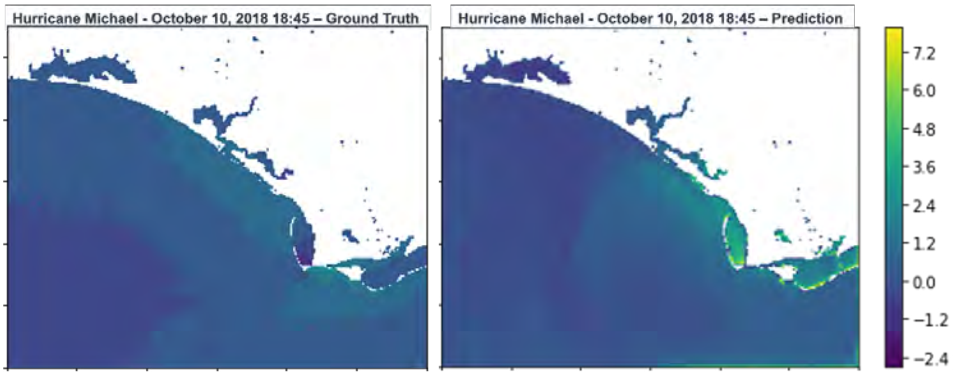


Figure 4: Hurricane Michael Comparing Ground Truth Surge and Predicted Surge.

We generated twelve storms using COAWST: Barry, Delta, Helene, Ian, Ida, Idalia, Irma, Laura, Michael, Nate, Sally, and Zeta. The dates and intensities of the hurricanes are in Figure 9 (Section A.2). The simulations were run without storm surge to reduce the time complexity of running the three-way coupled COAWST model. These storms were created with a horizontal resolution of 1.5 km and an hourly time resolution while covering a broader domain of the entire Gulf.

We use a subset of storms in the optimization intervention framework to provide a greater diversity of storms. By reducing to two-way coupling, the time to generate storms that took on the order of weeks using the three-way coupled model takes now on the order of hours to one day. This includes using the trained encoder-decoder skip connection model to generate surge for two-way coupled storms. For a single storm, a 24-hour output from the encoder-decoder skip connection model takes on the order of minutes calling it on a modest CPU and seconds on a A100/H100 GPU.

3.2 Intervention prediction results

From the COAWST data, we sample ten oyster reefs to use for training and eight for validation. We train SwinIR to predict wave direction and wave height and assess with the mean relative error:

$$\frac{1}{n_t\, n_I} \sum_{t,I} \frac{||G_I(\mathbf{u})(t) - \mathbf{u}_I(t)||_F}{||\mathbf{u}_I(t)||_F}. \tag{3}$$

Interventions primarily change the fields in localized regions, rather than producing significant differences across the entire domain. As such, global metrics like eq. 3 can fail to fully characterize accuracy. Thus, we compare SwinIR to a baseline that assumes that interventions have no effect:

$$G_I(\mathbf{u})(t) = \mathbf{u}(t). \tag{4}$$

In Figure 5, we show that the SwinIR model can attain a relative error of $\sim 2\%$ for predicting wave direction and $\sim 1\%$ for predicting wave height. For both state variables, this is approximately half the error as predicted by our baseline. In Figure 6, we further visualize SwinIR performance and show how the model accurately predicts how a given oyster reef reduces wave height.

3.3 Intervention Optimization results

Optimized interventions were derived for two cases: Hurricane Michael only and for the combination of Hurricanes Barry, Ian, Idalia, Laura, Michael, Nate, and Sally. Estimated savings of selected interventions are displayed in Figure 7.

For Hurricane Michael, we found that randomized interventions would have amounted to little savings- on average, the savings provided by such choices are roughly balanced by the costs of the

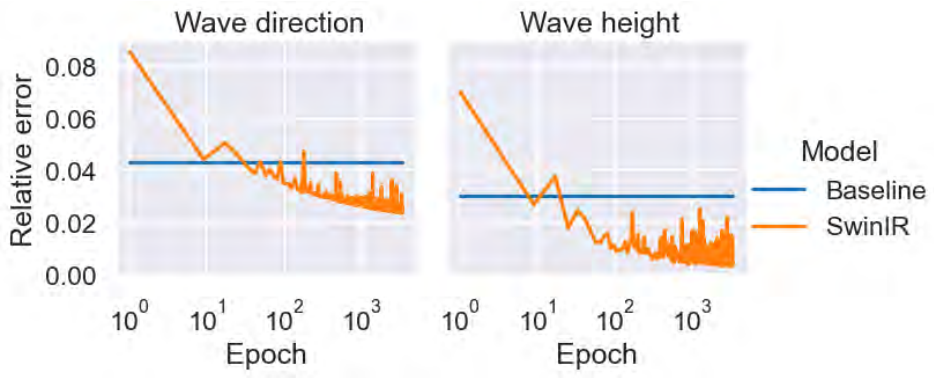


Figure 5: As measured by relative error (eq. 3), our SwinIR model surpasses the baseline (eq. 4) in predicting wave fields on our validation cases.

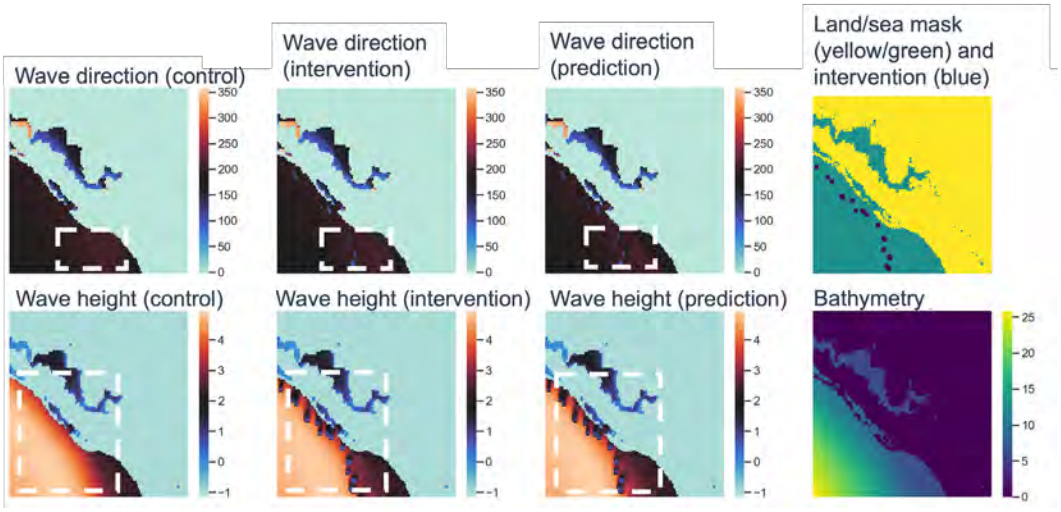


Figure 6: For a given intervention setup and time point from our validation set, we show the intervention-less wave variables (far left); COAWST-predicted variables (middle left); SwinIR-predicted variables (middle right); and land-sea mask, intervention locations, and bathymetry (far right). For both wave direction and height, SwinIR captures how the oyster reefs change the waves.

interventions. The greedy solution is an improvement, but does not nearly match the roughly $6B in net savings that interventions optimized for that particular storm could have allowed.

When optimizing against the distribution of storms, we consider the problem more practically. We seek interventions that protect high-value areas from flooding as effectively as possible, given a set of storms designed to be representative of possible future occurrences. To properly weigh costs, we multiply each storm by its relative frequency (eq. 2) and (roughly) cover the different relevant categories of storms- from consequential but small storms (less than Category 1) to a direct hit from a Category 5 hurricane. We sum over the occurrences of all types over the nominal 50-year [2] lifespan of interventions to arrive at the large numbers in the right panel of Figure 7. Here, even randomized interventions from our set of options lead to big savings (note that the cost of interventions is counted only once). However, we find that large gains are still available through intervention optimization.

Figure 8 provides a visualization of flooding reduction based on optimized interventions, both for the Michael-only optimization (left) and for Hurricane Idalia (center) in the full optimization. The cost grid that guides the optimization is shown on the right. We may observe that the Michael-only optimization concentrates resources near the center of the image, consistent with the storm track (Figure 4). The full optimization concentrates resources more toward the area with high cost density.

[2]This is conservative: properly maintained sea walls and oyster reefs may last significantly longer.

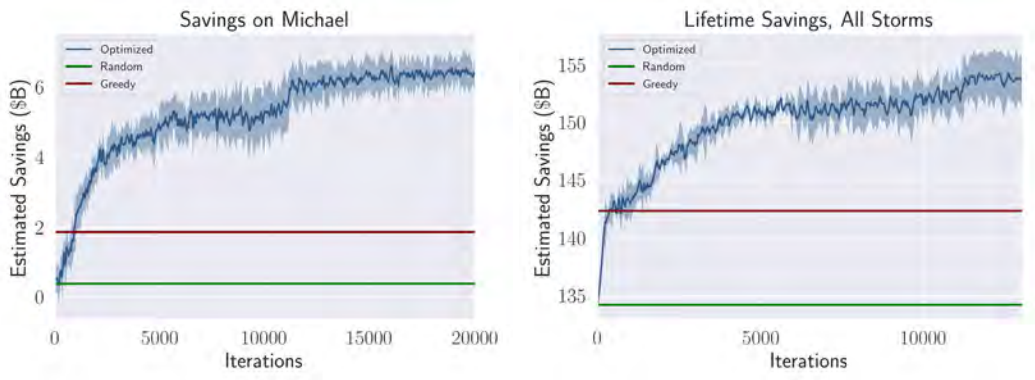


Figure 7: Progression of rewards (Eq. 2) in intervention optimization with STO-BNTS compared with randomly chosen and greedy intervention choices. Greedy lines deploy all possible interventions up to their maximum height, while random lines use randomized actions with an untrained network. Each "optimized" iteration refers to the training of an NN reward posterior and action selection based on its maximization. Left: Training for Hurricane Michael only. Shading for the optimized curve reflects 5 random seeds. Right: Training for our distribution of storms and integrating over the planned 50-year lifespan of the interventions. Shading reflects 4 random seeds.

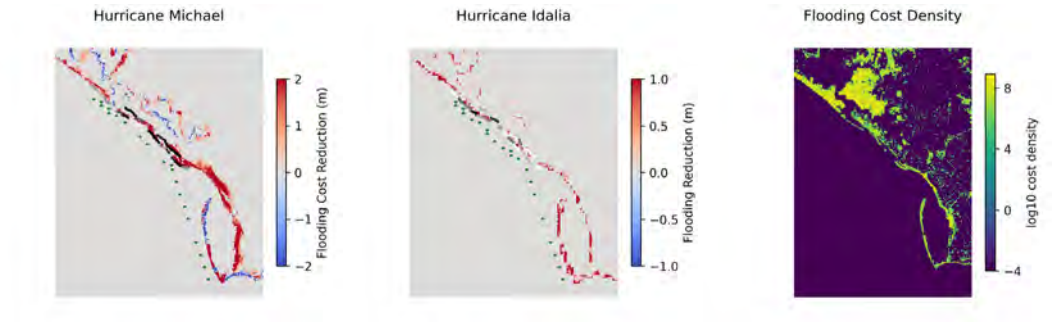


Figure 8: Optimized interventions. Green dots represent prescribed oyster reef sites; white, grey, and black dots refer to the height of sea wall deployed at a potential site (dark is higher, up to 5m). Red/blue shows where interventions reduce/increase flooding relative to no interventions. The flooding reduction is clipped for visualization purposes. Left: Training only on Hurricane Michael. Center: Interventions on Hurricane Idalia, based on training over all storms. Right: Cost mask.

Both optimizations deploy oyster reefs to protect the peninsula in the bottom right of the images, where a sea wall would be impractical. Additional flooding reduction maps are given in Appendix E.

4 Discussion

We have developed a framework (Figure 1) that characterizes and optimizes current coastal resilience capabilities. Our approach combines fast storm data generation, effect prediction, and optimization over potential interventions. When used to choose oyster reefs and seawalls near Tyndall AFB, our models suggest that optimization could potentially save tens of billions of dollars in flooding damage.

Our results consider the area surrounding Tyndall AFB; however, we see our framework as being extensible to a wide range of geographies, storms, and intervention types. The accuracy and data efficiency of our models could be enhanced by the inclusion of other architecture components, such as spatiotemporal convolutions (e.g., [33]), diffusion-based forecast refinement [34], or physics-based regularization [35]. More generally, future work could explore the integration of other data sources, including remote sensing, into our pipeline. The impact of different assumptions on future storms – including their frequency, intensity, and trajectory– on intervention optimization could additionally be explored, perhaps through consideration of a sequential decision-making process, as in [36].

Acknowledgments

This work was supported by internal research and development funding from the Research and Exploratory Development Mission Area of the Johns Hopkins Applied Physics Laboratory. Thanks to Jennifer Boothby, Sarah Herman, Marisa Hughes, Heather Hunter, Christine Piatko, Elizabeth Reilly, and Kristen Ryan for help refining the concept of our framework.

References

[1] Agustín Sánchez-Arcilla, Manuel García-León, Vicente Gracia, Robert Devoy, Adrian Stanica, and Jeremy Gault. Managing coastal environments under climate change: Pathways to adaptation. *Science of The Total Environment*, 572:1336–1352, 2016.

[2] Judy Lawrence, Rob Bell, Paula Blackett, Scott Stephens, and Sylvia Allan. National guidance for adapting to coastal hazards and sea-level rise: Anticipating change, when and how to change pathway. *Environmental Science & Policy*, 82:100–107, 2018.

[3] Carmela Gargiulo, Rosaria Battarra, and Maria Rosa Tremiterra. Coastal areas and climate change: A decision support tool for implementing adaptation measures. *Land Use Policy*, 91:104413, 2020.

[4] Curt D. Storlazzi, Borja G. Reguero, Kristen C. Alkins, James B. Shope, Camila Gaido-Lassarre, T. Shay Viehman, and Michael W. Beck. Hybrid coral reef restoration can be a cost-effective nature-based solution to provide protection to vulnerable coastal populations. *Science Advances*, 11(3):eadn4004, 2025.

[5] Ariana E. Sutton-Grier, Kateryna Wowk, and Holly Bamford. Future of our coasts: The potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems. *Environmental Science & Policy*, 51:137–148, 2015.

[6] Carolyn A. Currin. Chapter 30 - living shorelines for coastal resilience. In Gerardo M.E. Perillo, Eric Wolanski, Donald R. Cahoon, and Charles S. Hopkinson, editors, *Coastal Wetlands (Second Edition)*, pages 1023–1053. Elsevier, second edition edition, 2019.

[7] Philipp Jordan and Peter Fröhle. Bridging the gap between coastal engineering and nature conservation? a review of coastal ecosystems as nature-based solutions for coastal protection. *Journal of coastal conservation*, 26(2):4, 2022.

[8] Jay Brett, Maddie Samuell, Bryan Augstein, Sabrina Parra, Eric Hancock, Curtis Saunders, Scott Wunsch, Nathaniel Winstead, and Jennifer Boothby. Nature-Based Coastal Protection: Measuring and Modeling Flow Reduction by Oysters. *Journal of Coastal Research*, 02 2024.

[9] Robert L. Ceres, Chris E. Forest, and Klaus Keller. Optimization of multiple storm surge risk mitigation strategies for an island city on a wedge. *Environmental Modelling & Software*, 119:341–353, 2019.

[10] Hans Hersbach, Bill Bell, Paul Berrisford, Shoji Hirahara, András Horányi, Joaquín Muñoz-Sabater, Julien Nicolas, Carole Peubey, Raluca Radu, Dinand Schepers, Adrian Simmons, Cornel Soci, Saleh Abdalla, Xavier Abellan, Gianpaolo Balsamo, Peter Bechtold, Gionata Biavati, Jean Bidlot, Massimo Bonavita, Giovanna De Chiara, Per Dahlgren, Dick Dee, Michail Diamantakis, Rossana Dragani, Johannes Flemming, Richard Forbes, Manuel Fuentes, Alan Geer, Leo Haimberger, Sean Healy, Robin J. Hogan, Elías Hólm, Marta Janisková, Sarah Keeley, Patrick Laloyaux, Philippe Lopez, Cristina Lupu, Gabor Radnoti, Patricia de Rosnay, Iryna Rozum, Freja Vamborg, Sebastien Villaume, and Jean-Noël Thépaut. The ERA5 global reanalysis. *Quarterly Journal of the Royal Meteorological Society*, 146(730):1999–2049, 2020.

[11] John Beven II, Robbie Berg, and Andrew Hagen. Tropical cyclone report: Hurricane Michael (AL142018) 7–11 October 2018. Technical Report AL142018, National Hurricane Center, National Oceanic and Atmospheric Administration, May 2019. Accessed: 2025-08-05.

[12] Olaf Ronneberger, Philipp Fischer, and Thomas Brox. U-Net: Convolutional networks for biomedical image segmentation. In Nassir Navab, Joachim Hornegger, William M. Wells, and Alejandro F. Frangi, editors, *Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015*, pages 234–241, Cham, 2015. Springer International Publishing.

[13] Jingyun Liang, Jiezhang Cao, Guolei Sun, Kai Zhang, Luc Van Gool, and Radu Timofte. SwinIR: Image restoration using Swin transformer, 2021.

[14] Zhongxiang Dai, Yao Shu, Bryan Kian Hsiang Low, and Patrick Jaillet. Sample-then-optimize batch neural Thompson sampling. In S. Koyejo, S. Mohamed, A. Agarwal, D. Belgrave, K. Cho, and A. Oh, editors, *Advances in Neural Information Processing Systems*, volume 35, pages 23331–23344. Curran Associates, Inc., 2022.

[15] Remi Lam, Alvaro Sanchez-Gonzalez, Matthew Willson, Peter Wirnsberger, Meire Fortunato, Ferran Alet, Suman Ravuri, Timo Ewalds, Zach Eaton-Rosen, Weihua Hu, Alexander Merose, Stephan Hoyer, George Holland, Oriol Vinyals, Jacklynn Stott, Alexander Pritzel, Shakir Mohamed, and Peter Battaglia. Learning skillful medium-range global weather forecasting. *Science*, 382(6677):1416–1421, 2023.

[16] Jaideep Pathak, Shashank Subramanian, Peter Harrington, Sanjeev Raja, Ashesh Chattopadhyay, Morteza Mardani, Thorsten Kurth, David Hall, Zongyi Li, Kamyar Azizzadenesheli, Pedram Hassanzadeh, Karthik Kashinath, and Animashree Anandkumar. FourCastNet: A global data-driven high-resolution weather model using adaptive Fourier neural operators, 2022.

[17] Tung Nguyen, Johannes Brandstetter, Ashish Kapoor, Jayesh K Gupta, and Aditya Grover. ClimaX: A foundation model for weather and climate. In Andreas Krause, Emma Brunskill, Kyunghyun Cho, Barbara Engelhardt, Sivan Sabato, and Jonathan Scarlett, editors, *Proceedings of the 40th International Conference on Machine Learning*, volume 202 of *Proceedings of Machine Learning Research*, pages 25904–25938. PMLR, 23–29 Jul 2023.

[18] Cristian Bodnar, Wessel P. Bruinsma, Ana Lucic, Megan Stanley, Anna Allen, Johannes Brandstetter, Patrick Garvan, Maik Riechert, Jonathan A. Weyn, Haiyu Dong, Jayesh K. Gupta, Kit Thambiratnam, Alexander T. Archibald, Chun-Chieh Wu, Elizabeth Heider, Max Welling, Richard E. Turner, and Paris Perdikaris. A foundation model for the earth system. *Nature*, 641(8065):1180–1187, May 2025.

[19] Meghana Nagaraj, Alejandra Rodriguez, and Thomas Wahl. Regional modeling of storm surges using localized features and transfer learning. *Journal of Geophysical Research: Machine Learning and Computation*, 2(3):e2025JH000650, 2025. e2025JH000650 2025JH000650.

[20] Kristian Ions, Alma Rahat, Dominic E. Reeve, and Harshinie Karunarathna. Gaussian process regression approach for predicting wave attenuation through rigid vegetation. *Applied Ocean Research*, 145:103935, 2024.

[21] Dripta Mj and Denys Dutykh. Learning extreme wave run-up conditions. *Applied Ocean Research*, 105:102400, 2020.

[22] Yuki Miura, Philip C. Dinenis, Kyle T. Mandli, George Deodatis, and Daniel Bienstock. Optimization of coastal protections in the presence of climate change. *Frontiers in Climate*, 3:613293, 2021.

[23] John C. Warner, Christopher R. Sherwood, Richard P. Signell, Courtney K. Harris, and Hernan G. Arango. Development of a three-dimensional, regional, coupled wave, current, and sediment-transport model. *Computers & Geosciences*, 34(10):1284–1306, 2008. Predictive Modeling in Sediment Transport and Stratigraphy.

[24] John C Warner, Brandy Armstrong, Ruoying He, and Joseph B Zambon. Development of a coupled ocean–atmosphere–wave–sediment transport (COAWST) modeling system. *Ocean modelling*, 35(3):230–244, 2010.

[25] Geoffrey Hinton, Oriol Vinyals, and Jeff Dean. Distilling the knowledge in a neural network, 2015.

[26] Diederik P. Kingma and Jimmy Ba. Adam: A method for stochastic optimization, 2017.

[27] T. Pullen, William Allsop, Tom Bruce, Andreas Kortenhaus, Holger Schüttrumpf, and Jentsje van der Meer. EurOtop wave overtopping of sea defences and related structures: Assessment manual, January 2007. Available online.

[28] J. W. Van der Meer, N. W. H. Allsop, T. Bruce, J. De Rouck, A. Kortenhaus, T. Pullen, H. Schüttrumpf, P. Troch, and B. Zanuttigh. Eurotop, 2018.

[29] United States Army Corps of Engineers. Depth-damage relationships for structures, contents, and vehicles and content-to-structure value ratios (CSVR) in support of the Donaldsonville to the Gulf, Louisiana, feasibility study, 2006.

[30] Robert D. Kleinberg. Nearly tight bounds for the continuum-armed bandit problem. In *Advances in Neural Information Processing Systems 17 (NeurIPS 2004)*, pages 697–704, 2004. Defines the continuum-armed bandit model and provides the first near-optimal regret bounds.

[31] Arthur Jacot, Franck Gabriel, and Clément Hongler. Neural tangent kernel: convergence and generalization in neural networks. In *Proceedings of the 32nd International Conference on Neural Information Processing Systems*, NIPS'18, page 8580–8589, Red Hook, NY, USA, 2018. Curran Associates Inc.

[32] Rafael Martí, Mauricio G. C. Resende, and Celso C. Ribeiro. Multi-start methods for combinatorial optimization. *European Journal of Operational Research*, 226(1):1–8, 2013.

[33] Zongyi Li, Nikola Borislavov Kovachki, Kamyar Azizzadenesheli, Burigede liu, Kaushik Bhattacharya, Andrew Stuart, and Anima Anandkumar. Fourier neural operator for parametric partial differential equations. In *International Conference on Learning Representations*, 2021.

[34] Phillip Lippe, Bas Veeling, Paris Perdikaris, Richard Turner, and Johannes Brandstetter. PDE-Refiner: Achieving accurate long rollouts with neural PDE solvers. In A. Oh, T. Naumann, A. Globerson, K. Saenko, M. Hardt, and S. Levine, editors, *Advances in Neural Information Processing Systems*, volume 36, pages 67398–67433. Curran Associates, Inc., 2023.

[35] Gary Collins, Alexander New, Ryan A. Darragh, Brian E. Damit, and Christopher D. Stiles. Rapid prediction of two-dimensional airflow in an operating room using scientific machine learning. In *NeurIPS 2023 AI for Science Workshop*, 2023.

[36] Ashmita Bhattacharya, Konstantinos G. Papakonstantinou, Gordon P. Warn, Lauren McPhillips, Melissa M. Bilec, Chris E. Forest, Rahaf Hasan, and Digant Chavda. Optimal life-cycle adaptation of coastal infrastructure under climate change. *Nature Communications*, 16(1):1076, Jan 2025.

[37] Alexander F. Shchepetkin and James C. McWilliams. The regional oceanic modeling system (ROMS): a split-explicit, free-surface, topography-following-coordinate oceanic model. *Ocean Modelling*, 9(4):347–404, 2005.

[38] W. Skamarock, J. Klemp, J. Dudhia, D. O. Gill, Z. Liu, J. Berner, W. Wang, J. G. Powers, M. G. Duda, D. Barker, and X.-Y. Huang. A description of the advanced research WRF model version 4.1. Technical report, National Center for Atmospheric Research, 2019.

[39] Nils Booij, Ron C. Ris, and Leo H. Holthuijsen. A spectral wave model for the coastal zone. In *Proceedings of the 8th International Conference on Wave Processes and Coastal and Ocean Engineering (WAB/WAVES '99)*, pages 13–22, 1999.

[40] The SWAN Team. *SWAN User Manual, Cycle III Version 41.31A*. Delft, The Netherlands, 2020. Available online.

[41] Jingyun Liang, Jiezhang Cao, Guolei Sun, Kai Zhang, Luc Van Gool, and Radu Timofte. SwinIR: Image Restoration Using Swin Transformer (pytorch implementation). `https://github.com/JingyunLiang/SwinIR`, 2021.

[42] NOAA Hurricane Research Division. Continental united states hurricane impacts/landfalls 1851–2023, 2024. Revised in May 2024 to include the 2023 season. Accessed 27 Aug 2025.

[43] Seung-Won Suh and Myeong-Hee Lee. Analysis of typhoon-induced wave overtopping vulnerability due to sea level rise using a coastal–seawall–terrestrial seamless grid system. *Journal of Marine Science and Engineering*, 11(11), 2023.

[44] M. Persaresi and P. Politis. GHS-BUILT-V R2023A - GHS built-up volume grids derived from joint assessment of Sentinel2, Landsat, and global DEM data, multitemporal (1975-2030)., 2023.

[45] M. Persaresi and P. Politis. GHS-BUILT-S R2023A - GHS built-up surface grid, derived from Sentinel2 composite and Landsat, multitemporal (1975-2030), 2023.

[46] Coldwell Banker Richard Ellis Group Incorporation. United States construction market trends 2024. Technical report, CBRE Group, 2024.

[47] U.S. Army Corps of Engineers. Levee improvements to the Chalmette Loop Levee, Bayou Bienvenue to Bayou Dupre, Reach LPV 145, St. Bernard Parish, LA: Presolicitation notice w912p8–09–r–0030. `https://www.fbodaily.com/archive/2009/02-February/05-Feb-2009/FBO-01742746.htm`, 2009. FedBizOpps solicitation notice, FBO #2628, issued 5 Feb 2009. Accessed 19 Aug 2025.

[48] Coastal Protection and Restoration Authority of Louisiana. Lafitte tidal protection program Presentation to the CPRA board, 21 August 2024. `https://coastal.la.gov/wp-content/uploads/2024/08/Lafitte-Tidal-CPRA-Board-2024.08.21_FINAL.pdf`, August 2024. PowerPoint slide deck, accessed 19 Aug 2025.

[49] Louisiana Coastal Protection and Restoration Authority. La. begins Rosethorne tidal protection project. `https://www.stormwater.com/stormwater-management/press-release/21258487/la-begins-rosethorne-tidal-protection-project`, February 2022. Press release, accessed 19 Aug 2025.

[50] Louisiana Coastal Protection and Restoration Authority. Gov. Edwards cuts ribbon on first tidal protection system for greater Lafitte area. `https://coastal.la.gov/wp-content/uploads/2020/08/Jean-Lafitte.pdf`, August 2020. Press release, accessed 19 Aug 2025.

[51] Maryland and Virginia Oyster Restoration Interagency Workgroups of the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team. 2024 Chesapeake Bay oyster restoration update: Progress toward the Chesapeake bay watershed agreement's 'ten tributaries by 2025' oyster outcome. `https://www.chesapeakebay.net/files/2024-Annual-Update-final-v3-5-29-2025.pptx.pdf`, 2024. Accessed 19 Aug 2025.

A Additional technical details

A.1 Generating data with COAWST

Coupled Ocean–Atmospheric–Wave–Sediment Transport (COAWST) [23, 24] couples a set of models in order to capture the complex dynamics of coastal and marine environments. It includes 1.) an ocean model (Regional Ocean Modeling System (ROMS) [37]) that simulates the physical state of the ocean, including temperature, salinity, currents, and sea level, 2.) an atmospheric model (Weather Research and Forecast (WRF) [38]) that represents atmospheric processes, including wind, temperature, pressure and humidity, 3.) a wave model (Simulating WAves Nearshore (SWAN) [39, 40]) that simulates the propagation and transformation of ocean waves, and 4.) a sediment model (United States Geological Services (USGS) Community Sediment Modeling System) that simulates the movement of sediment within the water column and across the seabed, influenced by currents and waves.

When we recreated Hurricane Michael in COAWST, we did so at an 800 m resolution in the WRF domain and used a horizontal grid resolution of approximately 300 m for the SWAN and ROMS domain.

A.2 Hurricanes of interest

Figure 9 lists the storms used in our study by name, time of landfall, and category.

Storm	Dates	Category
Barry	7/11/19-7/15/19	1
Delta	10/4/20-10/10/20	4
Helene	9/24/24-9/29/24	4
Ian	9/23/22-9/30/22	5
Ida	8/26/21-9/1/21	4
Idalia	8/26/23-8/31/23	4
Irma	8/30/17-9/12/17	5
Laura	8/20/20-8/29/20	4
Michael	10/7/18-10/11/18	5
Nate	10/4/17-10/8/17	1
Sally	9/11/20-9/17/20	2
Zeta	10/24/20-10/29/20	3

Figure 9: Gulf Storms Listed By Name, Time of Landfall, and Category. These storms were generated using a two-way coupled model and surge (zeta) was generated for a subset of storms using the Encoder Decoder Skip Connection model.

A.3 Hyperparameters

Table 1 gives hyperparameters used to train the shifted window image restoration (SwinIR) models (Section 2.3, Section 3.2).

Hyperparameter	Value
Learning rate	10^{-3}
Number of training epochs	2000
Batch size	16
Crop size	128×128
Window size	8
Depths (Full model)	6, 6, 6, 6
Depths (Distilled model)	6
Embedding dimension (Full model)	60
Embedding dimension (Distilled model)	36
Number of heads (Full model)	6, 6, 6, 6
Number of heads (Distilled model)	6
MLP ratio	2

Table 1: Hyperparameters used to set up and train the SwinIR model. We adapted the official implementation [41]; the documentation explains each variable's meaning. See Section 2.3 for explanations of the full vs. distilled model.

B Additional technical results

The SwinIR model we train from our COAWST data has ∼900k parameters. However, to speed up inference time during the optimization (Section 2.4), we use model distillation [25] and train a smaller model with ∼100k parameters (Section B), using the predictions of the larger model as targets:

$$\mathcal{L}_{distillation} = \frac{1}{n_t\, n_I} \sum_{t,I} ||(\text{Crop}(G_{I,large}(\mathbf{u})(t) - G_{I,small}(\mathbf{u})(t))||_F^2. \tag{5}$$

In Figure 10, we additionally show that the model distillation procedure [25] we use to obtain a faster-to-evaluate SwinIR model retains accuracy and still surpasses the baseline.

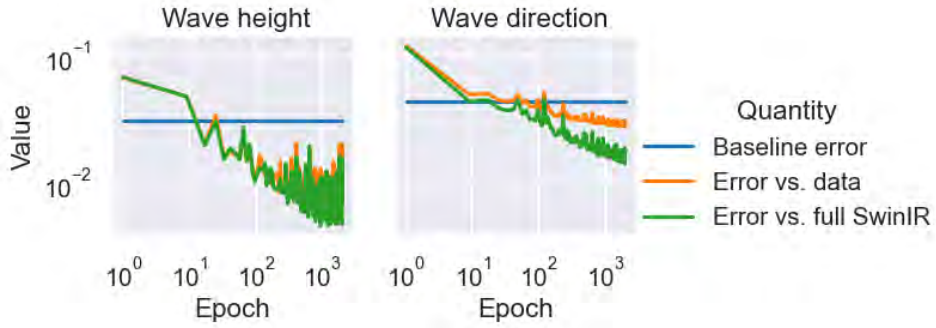


Figure 10: As measured by relative error (eq. 3), model distillation lets a more lightweight SwinIR model retain accuracy in predicting wave height while degrading only somewhat in predicting wave direction. "Baseline error" is the error of the prediction baseline (eq. 4), "Error vs. data" is the error of the smaller SwinIR model vs. the COAWST data, and "Error vs. full SwinIR" is the error of the smaller SwinIR model vs. the full SwinIR model.

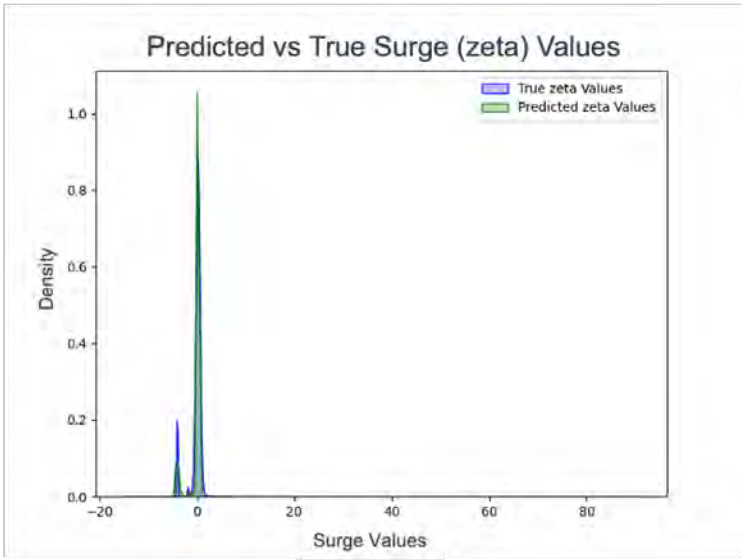


Figure 11: Density Plot Showing Distributional Agreement between AI-Generated Surge (zeta) and Ground Truth Surge (zeta) for the 5 KM COAWST test data set.

In Figure 11, we visualize the performance of the surge prediction model (Figure 3), showing that the distribution of true and predicted surge values are comparable.

C Further details on interventions, flooding, and damage cost assessments

C.1 Storms and Frequencies

For intervention optimization, we considered two scenarios: optimization for Hurricane Michael specifically and optimization against a set of storms. This included AI-generated surge estimates for Hurricanes Barry, Ian, Idalia, Laura, Michael, Nate, and Sally. Note that, while Ian was a Category 5 Hurricane, it did not impact Tyndall AFB as significantly as the other storms considered and therefore is taken as a < 1 Category storm here. The relative frequencies f of these storms in Equation 2 were $[3, 5, 2, 2, 1, 3, 3]$, respectively. These numbers represent approximate recurrences over a projected 50-year lifetime of the interventions. Given the spread in the categories of the storms, we project their summation to approximately reflect the total expected storm occurrences in the region while the interventions in question would be deployed. That is, we estimate roughly one Category 5 hurricane (represented by Michael), four Category 3-4 hurricanes (represented by Idalia and Laura),

six Category 2 hurricanes, and eight significant Category 1 and under storms. These numbers are necessarily imprecise, but reflect historical trends [42]. It should also be noted that the impact of climate change and the unknown lifetime of interventions (which may well exceed 50 years) will introduce uncertainty into these estimates.

C.2 Computing flooding and flooding damage

A (pre-existing) wave over topping (WOT) model [27, 28] was used to quantify flooding over the affected region. This set of equations computes the volume of water flowing onto land based on the land bathmetry (height) plus any seawall barrier, the still water level (SWL), and the significant wave height (H_{sig}). The WOT model is documented in the EurOtop Wave Overtopping Manual [27]; an example of its use is given by Suh & Lee [43]. A key assumption of this analysis is that any absorption of water during the storm is balanced by additional rainfall.

The principal formula used for WOT is

$$\frac{q}{\sqrt{gH_{m0}^3}} = a\exp(-(bR_c/H_{m0})^c), \tag{6}$$

where q is volume of water in m^2/s, g is acceleration due to gravity, H_{m0} is the significant wave height (the spectral moment of wave height), a is the scale parameter, b is the shape parameter, and R_c is the freeboard (the difference between the land and wall height and the still water level). The breaker parameter ξ is introduced for more specific use cases of this equation [28]. For this demonstration, we chose $a = 1, b = 0.75, c = 1$, and $\xi = 1$, which fall within the ranges described in [27] and [28]. Rearranging the above equation to solve for water volume q gives

$$q = \sqrt{gH_{m0}^3} \cdot a\exp\left(-(bR_c/H_{m0})^c\right) \tag{7}$$

This formula works for positive and zero freeboard. For negative freeboard,

$$q = 0.6 \cdot \sqrt{g \cdot |R_c^3|} + 0.0537 \cdot \xi \cdot \sqrt{gH_{m0}^3} \tag{8}$$

In addition to water flowing from ocean to land, we account for the possibility that water flows back to the ocean from saturated grid cells along the coast. For a given cell on the land-sea boundary, we define $R_{c,out}$ as the difference between the maximum of its bathymetry plus the seawall height (if present) and the local water level and the sum of its bathymetry and the local flooding. If $R_{c,out} < 0$, water flows back into the ocean according to

$$q = 0.6 \cdot \sqrt{g \cdot |R_{c,out}^3|}. \tag{9}$$

In this WOT method, as water comes onto land during a storm, that volume of water is spread out to low-lying adjacent areas. Our solver ensures that water flows 'downhill', such that the height in one gridcell is reduced by a flux into the adjacent cell until the water heights equalize when accounting for the topographic heights. The water volume flowing onto land and spread of all water is updated every hour for the duration of the storm.

C.3 Estimating Flooding Damage

Flooding estimates are translated to monetary costs using a grid-based strategy. At each timestep, the estimated depth of flooding d for a given land cell is used to estimate a percentage of damage inflicted on all structures in that cell. The product of this damage percentage D and the total value of structures in a cell v is taken as the estimated cost of flooding in that cell. The storm cost CS that contributes to the optimization objective 2 is the negative summation of these estimates across all land cells i, defined by

$$CS(t) = -\sum_i d_i(D_i(t)) \cdot v_i. \tag{10}$$

Long-term flooding depth to percent damage tables from the US Army Corps of Engineers for residential and commercial structures are averaged and splined to provide a continuous function mapping the amount of flooding in a given cell to the percentage of damage caused to all structures in

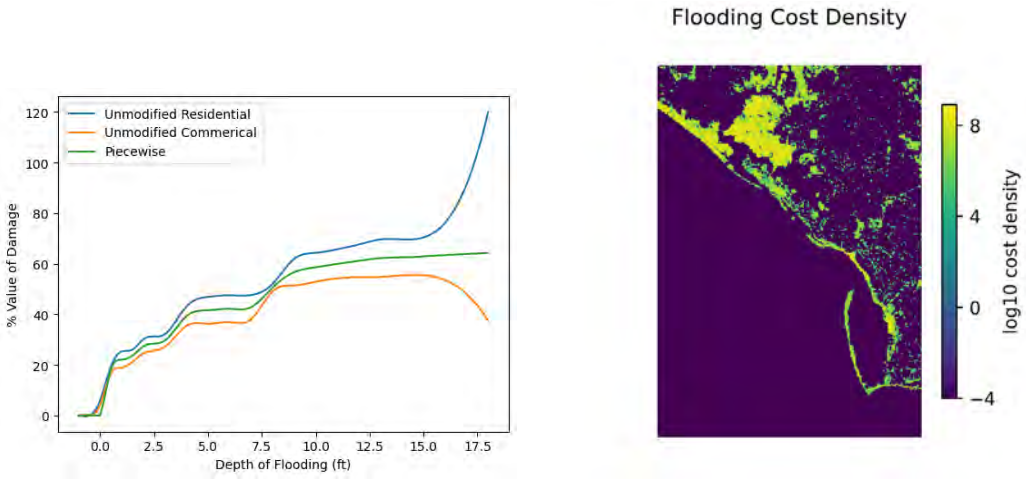


Figure 12: Left: splines of the depth to damage estimates in [29]. Right: cost map used to compute the total cost of flood damage; colors reflect $\log 10$ scale of cost density.

that cell [29]. The splined values are shown in Table 2. In these estimates, some damage to residential structures is assumed even with 0 feet of flooding, due to their basements. Although accurate, this implies that even with perfect intervention, the agent will receive some negative reward. In addition, the cubic growth of the splines can lead to extreme swings near the boundaries. To mitigate these issues, the percent damaged by 0 ft of flooding is set to zero and the following C0-continuous, piecewise depth to damage function is used:

$$d(D) = \begin{cases} 0 & D < 0 \\ S(D) & 0 \leq D < 15 \\ 100 \cdot [S(15) - S(14.99)] \cdot (D - 15) + S(15) & D \geq 15. \end{cases} \tag{11}$$

Here S is the spline of Table 2 and the third portion of the piecewise function is a finite difference approximation of a linear mapping of d to D at the end of the spline. Figure 12 (left) displays eq. 11, as well as the splines for the unmodified residential and commercial depth-to-damage estimates.

Per-cell monetary value estimates v are obtained by using built-up surface data from the Global Human Settlement Layer (GHSL) project [44, 45] as well as cost of construction estimates from the Coldwell Banker Richard Ellis Group [46], a real estate investment firm that conducts research into real estate trends. GHSL data is composed of 100 m grid cells specifying the gross building height GBV and gross building surface area GBA. The average building height ABH in a given cell j is defined by $ABH_j = \frac{GBV_j}{GBA_j}$. An average floor height of 3.5 meters is used to translate these heights to floors per the total area of buildings in that cell ANF_j. Finally, the total value of buildings including multiple floors TV_j is computed as

$$TV_j = ANF_j \cdot GBA_j \cdot \$3552.09, \tag{12}$$

where $\$3552.09$ is the cost of construction per square meter. This cost grid is resampled to the larger land grid by using accumulating costs at nearest land cell centroids which provides v_i in Equation (10), which is shown in Figure 12.

C.4 Estimating the Cost of Interventions

While additional interventions are possible, this study considers concrete seawalls and oyster reefs. Seawall installation was priced as a function of length and height, with a maximum height of 5m being considered. The particular function used was

$$C_{\text{seawall}}(l) = \$2050 l H^{1.3}, \tag{13}$$

where l is seawall length in meters and H is the height of the segment in question. This expression was derived from a log-log fit of recent sea wall installation data in Louisiana [47, 48, 49, 50].

Depth (ft)	Damage (%)
-1.0	0.00
-0.5	0.00
0.0	0.00*
0.5	17.85
1.0	22.10
1.5	23.60
2.0	27.30
3.0	29.60
4.0	39.20
5.0	41.60
6.0	42.20
7.0	42.80
8.0	50.55
9.0	56.65
10.0	58.60
11.0	59.95
12.0	61.15
13.0	62.20
14.0	62.50
15.0	62.95

Table 2: Depth-to-damage values used for splining. These values were obtained from [29] by averaging the commerical and residential damage estimates. In addition, the damage at 0ft of flooding is enforced to be zero.

Maintenance was priced at 1% of the upfront cost annually for the 50-year expected lifetime of the wall (that is, it multiplied the above estimate by 1.5. The maximum total cost of all sea wall options was $\$1.75$B.

Oyster reef installations on the scale of that proposed here are thus far rare. Our cost estimates are based on a recent restoration project in the Chesapeake Bay [51], which cost roughly $\$65k$ per acre. Engineering, permitting, and maintenance were lumped into an extra 20% fee. The total cost of all oyster reef installations considered was $\$494$M.

D Intervention Optimization Strategy

As mentioned in Section 2.4.3, we chose to frame our optimization problem as a continuum-armed bandit [30]. We applied Sample-Then-Optimize Batch Neural Thompson Sampling (STO-BNTS) to solve the problem, modifying the neural-network-based approach in [14] slightly. In particular, we implemented scheduled, prioritized sampling of initial points in action selection, allowing the optimizer to then optimize these initial choices using the Adam optimizer [26]. Each action taken by the agent (after initial data collection) was the best result of optimization of 100 initial actions, with some of those starting points being taken from an "elite" population stored in the replay buffer. These elites represent the top $5 - 10\%$ of evaluated actions up to the time in question. The frequency of elite starting point selection ranged from 10% early in training to 90% late in training, allowing the agent to explore more early and then increasingly focus on advantageous actions. Note that this prioritization did not apply to fitting the neural network, nor did it force the agent to repeat elite actions from the replay buffer.

The full algorithm employed is given in Algorithm 1 and the hyperparameters used are given in Table 3.

Algorithm 1 Sample-Then-Optimize Batch Neural Thompson Sampling [14] with Prioritization

for $t = 1, 2, \ldots, T$ **do**
  Construct NN $f(x; \theta)$ and multiply its output by β_t
  for $i = 1, 2, \ldots, B$ **do**
    Sample $\theta_0 \sim \text{init}(\cdot)$
    Sample $\theta_0' \sim \text{init}(\cdot)$ and set the parameters of θ_0' in the last layer to 0
    Set $f_t^i(x; \theta) = f(x; \theta_0) + \langle \nabla_\theta f(x; \theta_0), \theta_0' \rangle$
    Use observation history $\mathcal{D}_{t-1}$ to train $f_t^i(x; \theta)$ with the loss

$$\mathcal{L}_t(\theta, \mathcal{D}_{t-1}) = \sum_{\tau=1}^{t-1} \sum_{j=1}^{B} \left(y_\tau^j - f_t^i(\mathbf{x}_\tau^j; \theta)\right)^2 + \beta_t^2 \sigma^2 \|\theta - \theta_0\|_2^2$$

    (initialize with θ_0 and run gradient descent with minibatch size M)
    $\theta_t^i \leftarrow \arg\min_\theta \mathcal{L}_t(\theta, \mathcal{D}_{t-1})$
    Choose $\mathbf{x}_t^i \leftarrow \arg\max_{x \in \mathcal{X}} f_t^i(x; \theta_t^i)$, where arg max is found via Adam with restarts, initial points are sampled according to prioritization schedule
  end for
  Query the batch $\{\mathbf{x}_t^i\}_{i=1,\ldots,B}$ to obtain $\{y_t^i\}_{i=1,\ldots,B}$ and add them to $\mathcal{D}_{t-1}$
end for

Hyperparameter	Value
Initial points sampled	1,000
Number of iterations, T	20,000
Batch size, B	1
Prediction weight β_t	1
Observation noise variance σ^2	10^{-2}
Reward network hidden layer widths	[128, 128]
Reward network activation	ReLU
Reward network weight std	$1.5/\sqrt{128}$
Reward network bias std	0.05
Reward Learning rate	10^{-3}
Minibatch size, M	128
Epochs per reward training	20
Max reward training steps	1000
Elite fraction	0.05 (Michael), 0.1, (All storms)
Prioritization Schedule	$\min(0.00008 * t, 0.9)$
Action learning rate	10^{-3}
Action learning steps	50

Table 3: Hyperparameters used for Sample-Then-Optimize Batch Neural Thompson Sampling.

E Additional Optimized Interventions

Here (Figure 13) we include images of optimized intervention choices using the full ensemble of storms in the optimization. We observe that resources are concentrated near the most populated area of Tyndall AFB, but are chosen to be generally effective at reducing flooding everywhere. Note that the flooding reduction on all plots is clipped for visualization purposes.

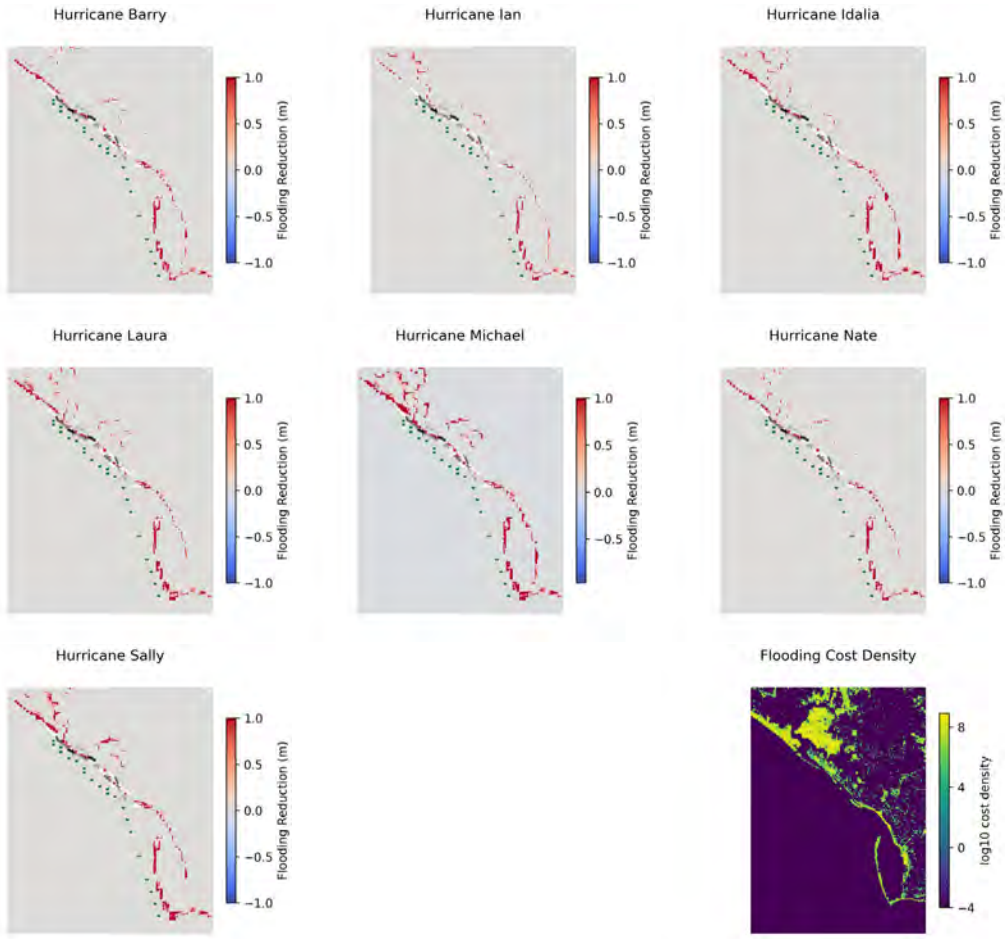
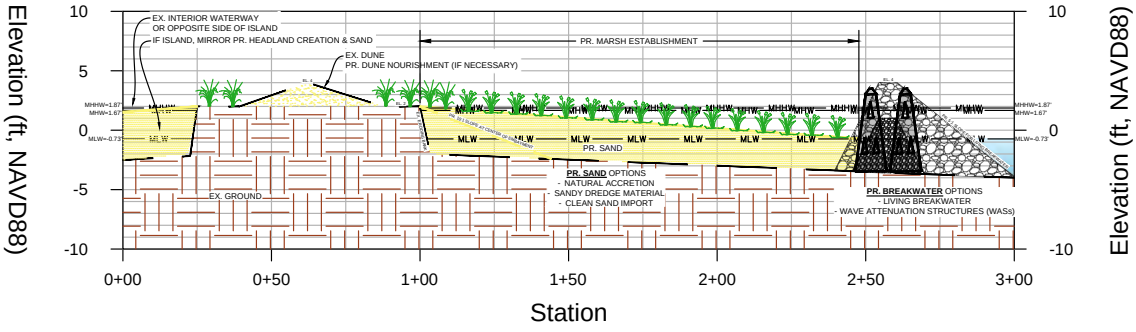


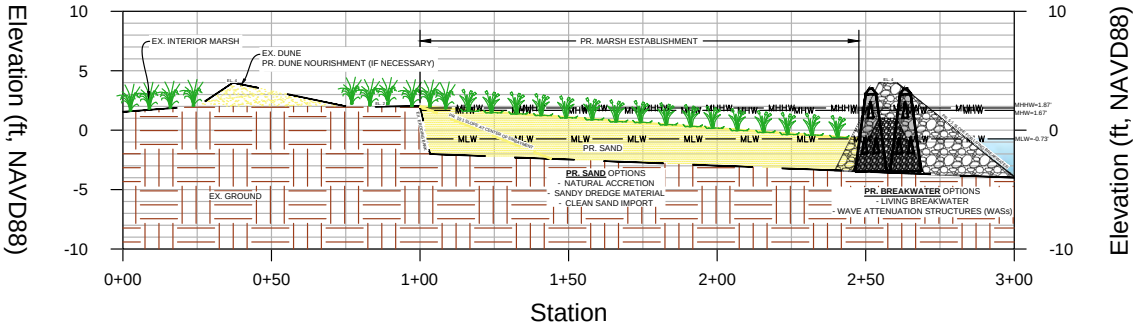
Figure 13: Optimized interventions. The green dots represent prescribed oyster reef sites and the white, grey, and black dots refer to the height of sea wall deployed at a potential site (dark is higher, up to 5m). Red regions are where the interventions reduce flooding relative to no interventions; blue are where flooding is increased. Bottom right: cost mask of region, with colors reflecting costs on a logarithmic scale.

Page intentionally left blank.

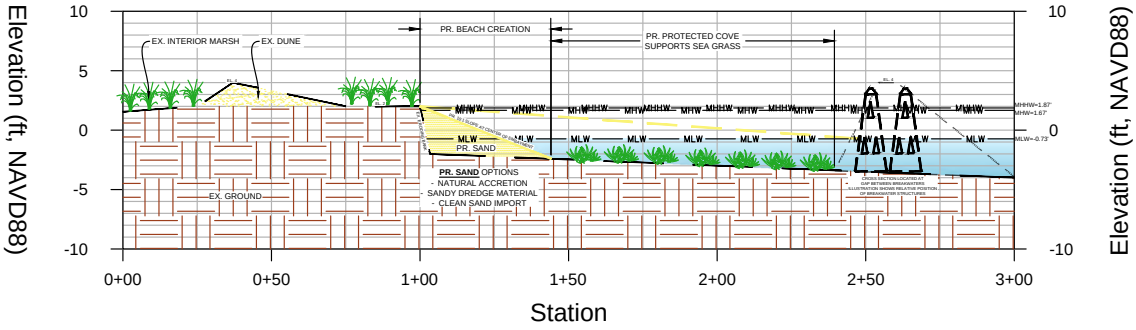
Priority 1 - High Energy Shorelines: Islands & Spits



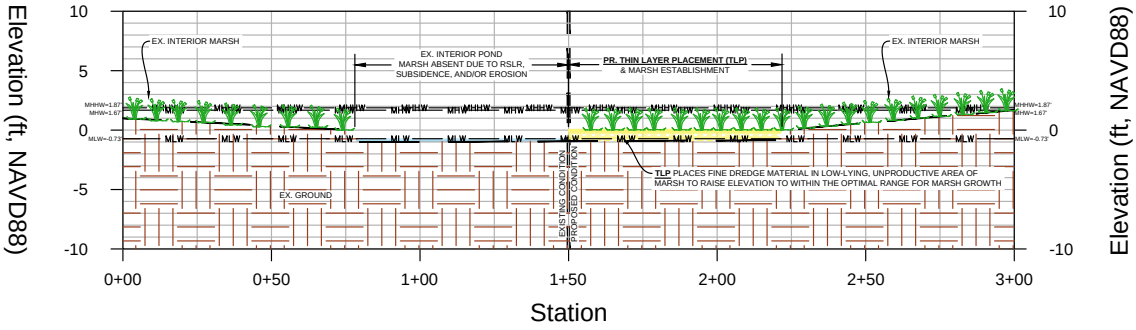
Priority 2 - High Energy Shorelines: Other



Priority 1 & 2 - High Energy Shoreline (Embayment View)



Priority 3 - Thin Layer Placement in Interior Marsh

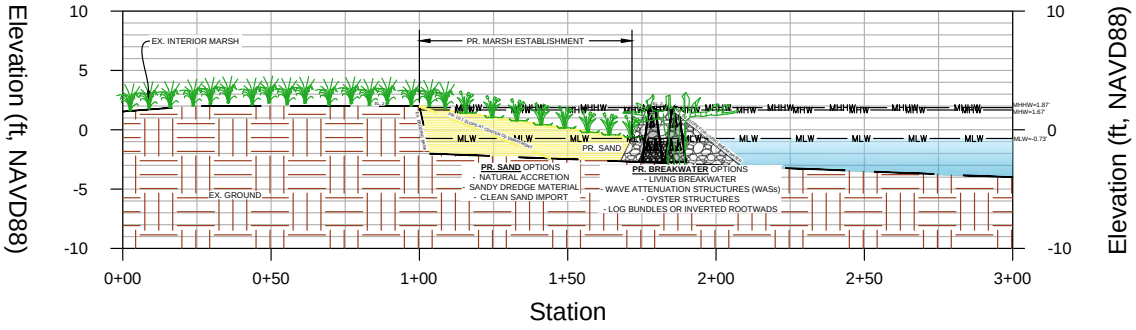


REPRESENTATIVE CROSS SECTIONS ONLY
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 10'

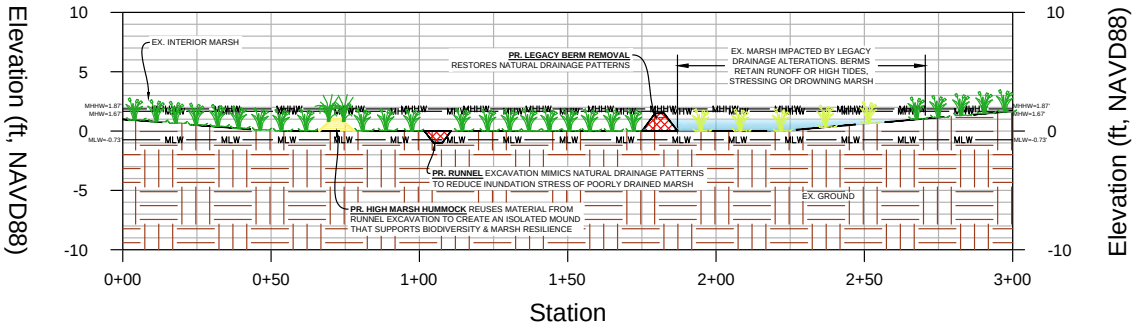
STRAUGHAN ENVIRONMENTAL

GRIT – Phase I Project
Concept Cross Sections
January 13, 2026
Drawn by: KB
Page 1 of 2

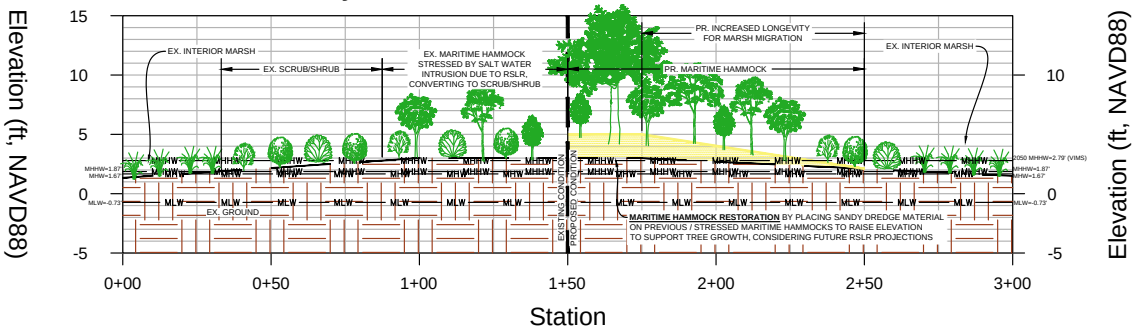
Priority 4 - Medium Energy Shorelines



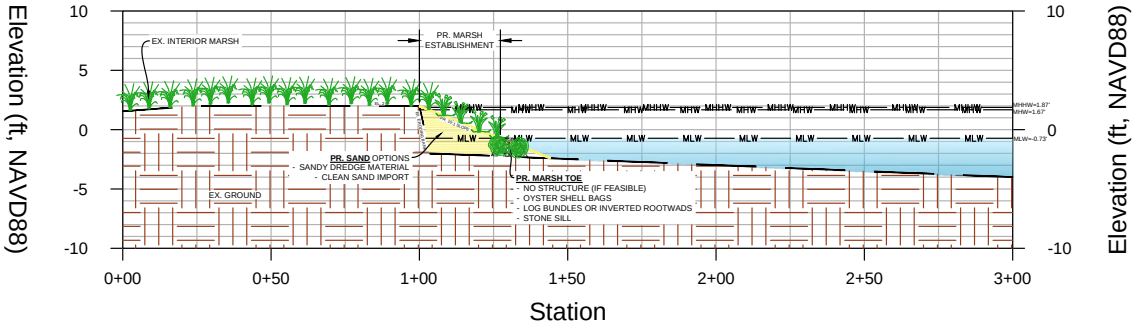
Priority 5 - Runnels or Legacy Berm Removal



Priority 6 - Maritime Hammock Restoration



Priority 7 - Low Energy Shorelines



REPRESENTATIVE CROSS SECTIONS ONLY
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 10'

STRAUGHAN ENVIRONMENTAL

GRIT – Phase I Project
Concept Cross Sections
January 13, 2026
Drawn by: KB
Page 2 of 2

10.
Submission of Proprietary Information

PROJECT: Croppers Island and Stark Properties Salt Marsh Restoration
OWNER: U.S. Fish & Wildlife Service

Straughan is not submitting any trade secrets, proprietary information, or copyrighted material in connection with this proposal. Accordingly, no materials have been submitted under separate cover pursuant to the Virginia Public Procurement Act (Va. Code § 2.2-4342).

STRAUGHAN ENVIRONMENTAL

Straughan Environmental, Inc.
919 E Main Street, Suite 1000 | Richmond, VA 23219
www.straughanenvironmental.com