New Jersey Atlantic Coastline Regional Sediment Management Framework

COMMUNITY RESILIENCE WHITE PAPER

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1.0 Purpose

This white paper will provide an overview of the possible relationship between beneficial use of dredged materials and community resilience. It will briefly document the impacts of climate change on the coastal communities and the most vulnerable populations and provide details describing how dredged resources can be used to reduce the impacts of climate change to these communities as well as considerations when planning a beneficial use project. The white paper was developed by the New Jersey Department of Environmental Protection (DEP) to inform and complement *A Framework for Managing Sediment in the Back Bays of New Jersey* (Framework). DEP is committed to providing support to communities by supplying the most up-to-date scientific information, strategies, resources, and tools for decision-makers to make the best choices to increase resilience in their own communities and this white paper and the Framework serve as two of those resources.

2.0 Background

Climate change is the greatest long-term threat that humanity faces. Across the globe, we are seeing increasing temperatures, more frequent and intense storms, extreme flooding, and rising sea levels – all of which are posing a threat to our natural resources, economy, and human and wildlife health and wellbeing (NJDEP, 2020b). The rate of global sea-level rise is estimated to be 1.1 to 1.9 millimeters per year, though there are additional factors that impact the rate of sea-level rise on a more regional and local level, such as land subsidence and geologic influences. Along the coast of New Jersey, sea-level rise has occurred at a rate of about four millimeters per year since the early 1900s – this is double the historic rate of two millimeters per year prior to any human-related contributions (NJDEP, 2021). Under moderate greenhouse gas emissions, it is likely that there will be approximately a two-feet increase in sea level by 2050, and five feet by 2100 (NJDEP, 2020b). This increase in sea-level rise will also increase the vulnerability of New Jersey coastal communities, putting the residents at further risk from storm surges and tidal nuisance flooding.

New Jersey boasts 1,800 miles of tidal coastline, including 126 miles along the Atlantic Coast from Sandy Hook to Cape May, and more than 300,000 acres of tidal wetlands that span most of the Delaware River and Bay, the Atlantic

Coast and back bays of the barrier islands, along the Raritan River, and up into the Meadowlands near New York City (NJDEP2020b). There are 239 municipalities located in the state's coastal zone, where more than half of New Jersey's population resides (NJDEP, 2020a). The tidal marshes, wetlands, beaches, dunes, and maritime forests that comprise the coastal zone shape the economic vitality of the state, provide critical habitat for many species, and serve as storm buffers for inland communities.

Counties in the coastal zone are estimated to contribute $400 billion in annual economic output, which includes $200 billion of cargo movement through the Port of New York and New Jersey, $22 billion from tourism, $50 billion from the maritime industry, and $50 billion from leisure and hospitality (NJOEM, 2019). Studies have found that tidal wetlands provide more than $1.24 billion per year in ecosystem services which also helps drive the tourism industry (Liu et al., 2010). As a critical stopover for migratory shorebirds, Cape May County alone accounts for $313 million in consumer spending, contributing to the larger annual tourism economic output (Schuster, 2014).

Coastal ecosystems are among the most diverse and productive bionetworks on earth (Barbier et al., 2011). They are home to numerous species of flora and fauna that support various wildlife populations. These ecosystems also contribute to local and regional economies in a variety of ways, including tourism, fishing, and recreation. Natural resources such as beaches, dunes, wetlands, and marshes play a critical role in supporting fisheries, nutrient cycling, sustaining local economies, and protecting coastal communities from storm surge and flooding (NJDEP, 2020b). These natural systems act as the first line of defense for coastal and upland communities and provide protection from erosion and storm surge for the coastal areas. Wetlands also store flood waters, improve water quality, and sequester carbon (NJDEP, 2020b). Climate change has dramatically impacted the ability of these natural systems to continue to adapt and thrive. Due to sea-level rise, marshes become susceptible to edge slumping, tidal channel widening, and general landscape fragmentation (Hartig et al., 2002). The potential loss to coastal wetlands areas by increased flooding, sea-level rise, and salinity are striking – an estimated 92% of brackish marshes in the Delaware Estuary are projected to be lost to the effects of sea-level rise by 2100 (Glick et al., 2008).

The continued ripple effect could not only displace or nearly decimate entire species of animals, but this loss will also pose a threat to the human health and wellbeing of those that live in coastal communities. Continuing to recognize the significance of these natural systems positions New Jersey to be more responsive and proactive.

As a response to sea-level rise, coastal marshes migrate landward as a mechanism to adapt to the inundation and salinity change (Osland et al., 2022). However, in New Jersey nearly one-third of the possible migration areas are hindered by roads and other development (Lathrop & Love 2007). Being the most densely populated state, New Jersey faces a complex interplay between these natural areas and development, leaving nowhere for the marshes to migrate and ultimately putting coastal communities at further risk. There are solutions that can be implemented to alleviate or mitigate some of the potential impacts of sea-level rise and loss of coastal wetlands. One such solution involves the beneficial use of dredged material to elevate, restore, and enhance marsh platforms and edges.

2.1 Historic Shoreline Management

Historically, many barrier island communities have installed sea walls, revetments, jetties, groins, and bulkheads to alleviate the persistence of coastal waters. In 2014, a study was conducted by the University of North Carolina at Chapel Hill on the growth and development of shorelines in the United States. It was reported that 14% of the shoreline across the country's shoreline has been hardened (Gittman et al., 2016). In more recent years, there is evidence that shows these types of hard structures are more detrimental to the coast than they are helpful. Hard structures, like sea walls, can interfere with the natural water currents and littoral drift, disrupting the way water and sediment move along the shore, and can cause the shoreline to erode at a quicker rate. Hard structures that armor the shoreline may protect against significant storm events, but they do not protect against the pervasive daily flooding that is and will continue to be caused by sea-level rise; they are also costly to implement and maintain. Additionally, such structural measures often have negative impacts on natural ecosystems and further sever the connection between land and water for humans and wildlife alike, reduce the available habitat for marine species, and can interfere with plant growth and upland transgression. In contrast to natural shorelines, seawalls have been reported to support 23% lower biodiversity and 45% fewer organisms (Gittman et al., 2016).

3.0 Vulnerability to Sea-level rise and the Need for Community Resilience

3.1 Overview of New Jersey Coastal Communities and Flooding Risks

New Jersey is comprised of twenty-one (21) counties, seventeen (17) of which include tidally influenced waterways and are located completely or partially in the state's coastal zone. Of those counties, five (5) contain frontage along the Atlantic Ocean and the Atlantic back bays. The state's coastal communities are home to over 4.6 million people, which is more than half the population of New Jersey (NJDEP, 2020a).

During the summer, the population along the Atlantic back bays and ocean front increases dramatically as tourists visit the area. For example, the population in Monmouth County can swell by over 300,000 people on an average summer day and by over 440,000 on a peak day (Monmouth, 2008).

In addition to having an impact on tourism, the main economic driver of the coastal area, flooding also puts critical community infrastructure at risk – evacuation routes, military bases, schools, and hospitals can become inaccessible to the community. Of the 95,805 year-round residents of Cape May County, more than half live in the county floodplain (NJOEM, 2019). Those within proximity to coastal areas and major rivers experience flooding on a regular basis and with greater frequency due to rising sea levels. "Sunny day flooding" or, inundation from the twice-daily high tide without a rain or storm event, is a common occurrence in these areas and will only become exacerbated due to sea-level rise. The Science and Technical Advisory Panel convened by Rutgers University projected that even in a moderate-emissions scenario, Atlantic City could likely experience 45 sunny day flooding events by 2050, with a fifty percent chance of 355 sunny day flooding events by 2100 (Kopp et al., 2019).

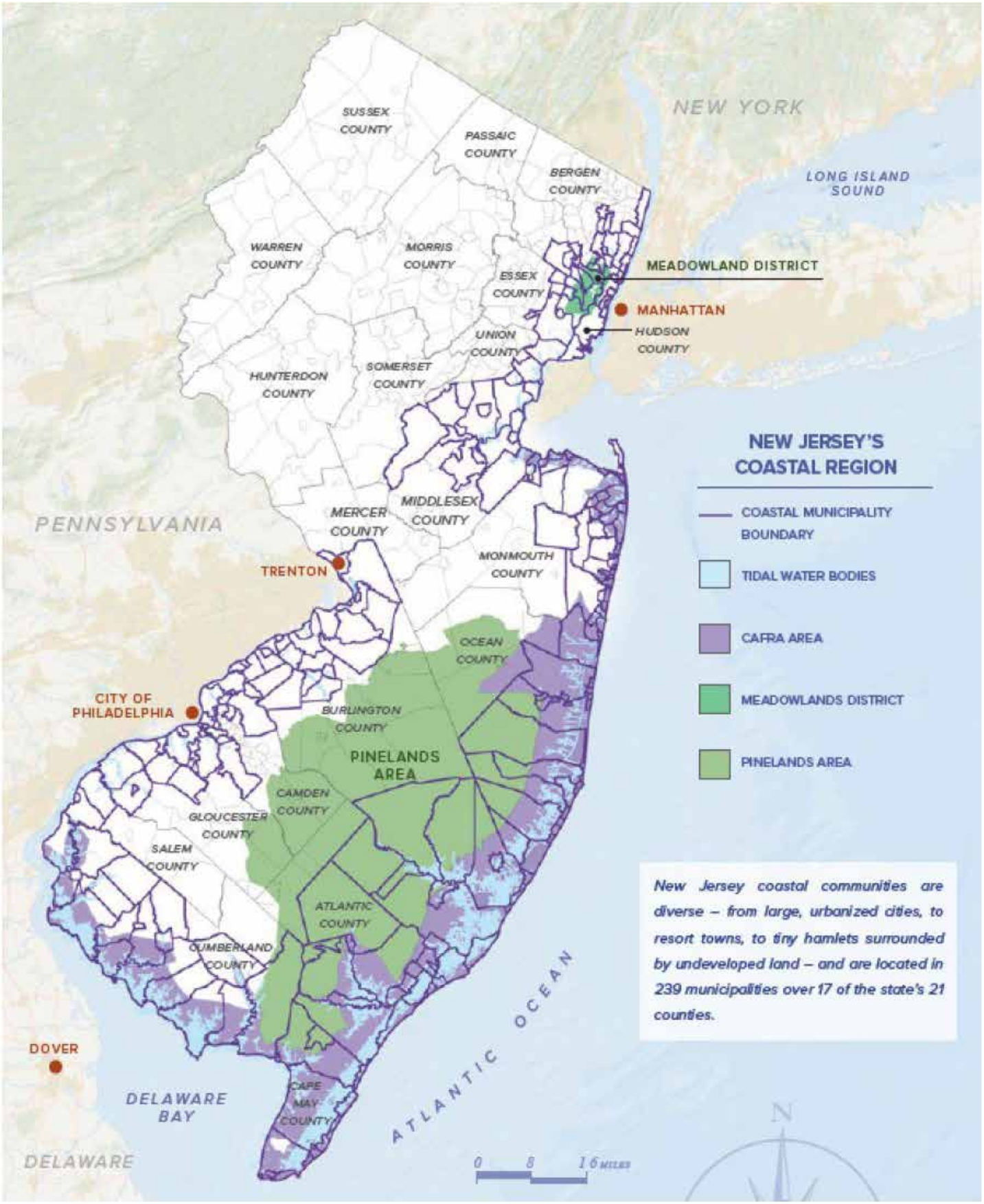

Figure 1. New Jersey's Coastal Region. Source: NJ Climate Resilience Strategy, 2020.

3.2 Socially Vulnerable and Overburdened Communities

Climate change and the associated effects like sea-level rise and nuisance flooding will continue to place a unique burden on socially vulnerable and overburdened communities, reducing their ability to be resilient in the face of these threats. Socially vulnerable communities are characterized by socioeconomic status, age, gender, race and ethnicity, English language proficiency, and disability. Overburdened communities are defined as being socially vulnerable, low-income, communities of color that have experienced historic and systemic impacts and disinvestment and are disproportionately burdened by environmental hazards and less able to prevent, respond, and recover from those adverse environmental impacts (NJDEP OEJ, 2024).

New Jersey's Environmental Justic Law defines overburdened communities as those that contain census block groups with one (1) or more of the following (NJDEP, 2022):

- At least thirty-five percent (35%) percent low-income households.
- At least forty percent (40%) of the residents identify as minority or as members of a State recognized tribal community.
- At least forty percent (40%) of the households have limited English proficiency.

In 2020, it was reported that 4.5 million individuals were living in areas classified as overburdened communities (NJDEP, 2020b). Historic inequities, such as discriminatory housing, environmental and investment policies, and exclusion from planning processes, make it challenging for socially vulnerable and overburdened communities to adapt to climate change. Furthermore, New Jersey's overburdened communities often lack green and open spaces or sufficient stormwater management, putting the population at greater risk for impacts of climate change, including nuisance flooding and sea-level rise. These underlying societal inequities and discrimination create significant hurdles to achieving resilience.

4.0 Building Community Resilience in New Jersey

Coastal wetlands protect vast areas of New Jersey's coastline from exposure to coastal hazards by storing and filtering floodwaters, attenuating waves, and absorbing some of the destructive impacts of storm surges before they reach homes and infrastructure. Without a marsh or forest buffer, back bay communities would be impacted by daily wave energy and increasingly battered by storm surge. This activity is incessant and increasing with the intensity of storm events, hastening the demise of the edges of this ecosystem. One study found that communities located behind intact marshes had twenty percent less flood damage than those communities in which the marsh buffer had been lost (Narayan et al., 2016). A 2017 study by Narayan and others showed that coastal wetlands in New York and New Jersey prevented $625 million in direct flood damages during Hurricane Sandy and reduced damages by more than twenty-two percent (22%) in half of the affected areas. Properties in Barnegat Bay, New Jersey that were fronted by salt marshes experienced sixteen percent (16%) lower annual flood losses from storms than those without adjoining marshes (Narayan et al., 2017).

The loss of these valuable resources will dramatically alter New Jersey and raise questions about the long-term safety implications of so many people living in high-risk coastal areas. As the most densely populated state, existing communities, planners, and coastal managers will need to address and mitigate increasing impacts from climate change and sea-level rise.

To protect natural resources and increase resilience for inland communities, dredged material can be used to elevate coastal marshes to keep pace with sea-level rise (Weis et al., 2021). Placement of dredged material on

marshes up to thirty centimeters, commonly referred to as thin layer placement, can provide the elevation needed to slow the loss of marshes and allow for vegetation regrowth. Since the 1980s, studies have shown that marshes respond consistently and positively to placement of dredged material on marshes (Ray, 2007). Beneficial use of dredged material is critical to increase the resilience of coastal communities at risk of sea-level rise and climate change related disasters. To understand how beneficial use of dredged material fits into community resilience strategies, state and local governments, and landowners, need to understand the risks and impacts of climate change on communities and critical ecosystems. Changing the way we assess and plan for these risks will lead to a more resilient future.

4.1 Types of Community Resilience Projects that Require Sediment Deposits

Dredging of channels, inlets, and waterways is a common practice in coastal areas, including New Jersey. Regular maintenance of these water bodies is typically required to prevent siltation and allow for navigation by recreational and commercial marine vessels. Dredge resources from this process can be utilized in a manner that can help mitigate community impacts from coastal flooding. Specific types of such projects include beach nourishment and replenishment, marsh platform elevation, marsh edge stabilization, and bay island restoration/creation. As a coastal state, New Jersey marshes and shores would benefit greatly by the re-use of dredged material. The sediment characteristics and distance between the dredged location and deposit area will determine the appropriate resilience project.

Beach nourishment and replenishment.

Beaches and dunes are an integral part of the coastal ecosystem – they provide habitat for wildlife, protection to the upland communities from storm surge and flooding, and provide recreational opportunities for anglers, tourists, and beach enthusiasts. Coastal storms and Nor'easters can wreak havoc on beaches and dune areas. To ensure the beaches and dunes provide these benefits, many New Jersey coastal communities spend hundreds of thousands of dollars annually to restore beaches and dunes to reverse the effects of erosion. Dredged materials consisting of primarily fine sandy particulate is utilized for and placed on beaches to restore dunes and add surface to beach areas.

Marsh platform enhancement and stabilization of marsh edges.

A marsh platform is the fundamental surface of a salt marsh, connecting the water to the land. Marsh platforms accumulate sediment brought in by rising tides, which is deposited as the tide retreats. This ecosystem provides an established surface for water tolerant plant material to thrive (Stark et al., 2015). As sea-level rises, the marsh platforms become inundated with water and the plants eventually die off due to a lack of oxygen. Sea-level rise also has an effect on marsh edges –without the support of plant roots, edges of the marsh slump off into the water.

Island restoration and creation.

An additional method to utilize beneficial dredged resources involves the restoration or creation of bay islands. Bay islands that dot the back bays between the Mantaloking and Beach Haven Inlets protect inland communities from some impacts of coastal storms – though as sea level continues to rise, the islands are starting to disappear. Dredged material from navigation channels can be utilized to enhance the bay islands.

4.2 Beneficial Use of Dredged Material Project Locations

Coastal waterways are subject to the forces of nature, resulting in accretion and sedimentation of waterways and navigation channels. If no maintenance is conducted, active vessel channels can eventually be reduced to the point where the depth prevents use by various marine vessels. Material collected from channel maintenance dredging is often placed in Confine Disposal Facilities (CDF) or other inland disposal area. However, this material can also be used as a resource to restore the ecological function of an area and address the resilience needs of a nearby community.

From 2014 through 2017 three (3) thin layer placement of dredge spoil material pilot projects were constructed in New Jersey: Ring Island (Avalon), Cape May Wetlands Wildlife Management Area, and Fortescue Wildlife Management Area. These projects were monitored and evaluated for success. Each of the projects utilized thin layer placement of dredge materials in documented areas where marsh lands had declined or suffered erosion. In August 2021 in a report entitled ***"The Nature Conservancy and New Jersey Department of Environmental Protection (2021). Beneficial use of dredged material to enhance salt marsh habitat in New Jersey: Project summary and lessons learned"*** documented these projects and can guide the process of future beneficial use projects in New Jersey (TNC & NJDEP, 2021).

Well-planned projects, like the examples provided above, become successfully implemented projects as a result of a thorough comprehensive planning process that considers municipal, county, regional, and state assets, the vulnerability of those assets to climate change, and identifies the most appropriate and implementable actions that can be taken to reduce the identified vulnerabilities. Engagement with stakeholders and community members, as well as community input, during all phases of the project is also critical. A list of plans and other resources that may identify projects that are in need of sediment include, but is not limited to:

Regional and Municipal Resilience Action Plans.
Through the NJDEP Resilient NJ program, action plans are developed that identify priority areas and potential projects. A complete list of action plans developed through Resilient NJ can be found on the program website. Other municipal, county, and regional plans may exist that identify potential project locations.

Coastal Ecological Restoration and Adaptation Planning (CERAP) Explorer.
CERAP is a web-based DEP tool, hosted by Rutgers University Center for Remote Sensing and Spatial Analysis, that offers baseline desktop analysis to identify areas for ecological projects that increase community resilience, ecosystem health, and/or carbon sequestration.

State Hazard Mitigation Plan.
New Jersey's Federal Emergency Management Agency (FEMA)-approved hazard mitigation plan identifies natural and human-caused risks and outlines a strategy to reduce those hazards.

Marsh Explorer.
The Nature Conservancy's web-based tool analyzes potential restoration areas along New Jersey's Atlantic Coast back-bay marshes and ranks the feasibility of beneficial use of dredged material projects.

4.3 Considerations to Inform Beneficial Use of Dredged Material for Community Resilience

The beneficial use of dredged material (BUDM) can be a viable alternative to the traditional method of dredging and disposing of material in a confined disposal facility if there is a viable beneficial use placement site for the dredged material.

The use of dredged material has gained momentum during the last few decades and although there are several successful projects in New Jersey and throughout the country, there is still much that can be learned. During the planning phase of a beneficial use project, there are several considerations that must be identified and analyzed for each proposed project in regard to increasing community resilience and the potential gaps in knowledge. These considerations are listed below.

Community-led visioning efforts.
BUDM can be utilized in many ways to enhance community resilience. Projects should reflect the specific vision that is unique to each community or region that the project will serve. This vision and uses of the project areas should inform project selection to ensure community support and buy-in for the project.

Knowledge gap: Communities frequently do not think of dredged sediment as a source of material for restoration projects to increase community resilience.

The communities that do consider dredged materials as a solution to their sediment needs are often unsure how to start and align their dredging and restoration needs.

Recommended action: Incorporating the community in the planning phase of the project is just one way to build community buy-in and project momentum. Communicating regularly with the public on the benefits of BUDM projects, project success, and lessons learned, will be key to the community's understanding of these projects and their increased support for future projects.

Cost of implementation and maintenance compared to benefits generated.

Often the final or bottom line of a project is dependent on two (2) factors: 1) the cost of construction and maintenance associated with the project and, 2) the benefits that accrue from each project. The costs for each project can vary greatly, as can the benefits. Costs include community engagement, planning and design of engineering plans, permitting, project construction, monitoring, as well as adaptive management and maintenance activities necessary to ensure the long-term success of the project. For the three (3) New Jersey BUDM pilot projects (Ring Island, Cape May, Fortescue), these costs were evaluated per acre. Project costs ranged were $56,000 per acre at Ring Island,$342,200 per acre at Avalon, and $467,365 per acre at Fortescue. In 2017 U.S. dollars, for other projects throughout the nation, the median cost per acre was $69,581 per acre with an average cost of $479,800 per acre. These costs do not include maintenance of the projects (TNC & NJDEP, 2021).

Knowledge gap: Project costs need to be weighed against the benefits that a municipality, county, region, and/or state will receive from the project. Calculating these benefits is difficult since it is not as simple as identifying a number of structures to be protected by the project, but also considering the long-term potential of nature's innate ability to compensate and adapt and the ecosystem services the project will provide. Existing resources do not easily allow a dollar amount to be calculated for these benefits.

Recommended action: Develop a method to measure and estimate the benefits achieved for restored marsh areas that is not just limited to the acres of land created, but also the acres of upland that are protected from storm surge and flooding. Quantifying the full economic, community resilience, and habitat restoration values of the beneficial use of dredged material will aid in public understanding for critical need of marsh restoration.

Adaptive management and maintenance. Practitioners should expect that unplanned events may occur during and after construction that can impact the success of a project. To support the long-term success of the project and the community resilience benefits it provides, additional funding should be set aside to address conditions that may need to be addressed during the planning, construction, and post-construction maintenance phases of the project. Having an adaptive management plan in place will provide a framework of recommendation in the event that unexpected changes occur that would hinder the success of the project and potentially put communities at greater risk.

Knowledge gap: How long will the project provide resilience and how long will it need to be maintained are common questions when planning a resilience project. The length of time that a project will provide a measure of resilience for a community or region will vary depending on the type of project. For marsh restoration and platforms, if proper maintenance and monitoring or enacted, these benefits can last for several decades. However, the long-term implications of climate change on the ability of coastal habitats to adapt is largely unknown.

Recommended action: Identifying roles and responsibilities of all involved entities both during and after construction

can aid in this gap. Clearly defining project goals and success metrics will also aid in determining when adaptive management measures may need to be implemented and how the project site should be maintained, with the ultimate goal of a long-term successful project. Being transparent with the public on the realistic lifespan of the project, lessons learned, and project success will build trust within the community and help gain support for future restoration efforts. As this field develops, these benefits will continue to be analyzed, documented, and shared with the public.

Material size.
The sediment size (extra-fine, fine, or medium grain) and composition of the dredged resources will determine where they be most beneficial to increase resilience. Understanding the sediment characteristics when planning the project will determine where the sediment can be placed. Flexibility and ability to quickly pivot are the keys to working with beneficial dredge materials.

Contamination.
The potential for contamination of dredged material is of particular concern when considering its use in community resilience projects. For projects involving direct human contact, all materials must meet all public health criteria. For projects involving thin layer placement and marsh elevation, there are also contamination concerns for wildlife. This is due to the fragile balance of the ecosystem, the large amount of animal and aquatic life forms that are reliant on marshes, and general concerns with the amounts of contaminants that may be present in the environment. For this reason, all material that is to be dredged, whether placed upland or used beneficially, is thoroughly sampled and tested.

5.0 Conclusion

Although here remain outstanding questions and considerations that will impact the success of BUDM methods and the long-term resilience of New Jersey's coast, the challenges and recommended actions that are presented in the Framework and the supporting white papers will help foster discussion around a path forward using dredged material to restore ecological function and increase resilience in New Jersey's Back Bay communities and coastal ecosystems.

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