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September 7, 2021

VIA E-MAIL

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Re: Charleston Peninsula Coastal Flood Risk Management Study, Charleston, South Carolina

Dear Mr. Wilson:

On June 19, 2020, we submitted comments on the Draft Feasibility Report / Environmental Assessment ("EA") and Proposed Draft Finding of No Significant Impact for the Charleston Peninsula Coastal Flood Risk Management Study. In that letter, we expressed our concerns about the unduly narrow focus of the U.S. Army Corps of Engineers ("Corps") study and alternatives analysis. We recommended that the Corps prepare an Environmental Impact Statement ("EIS") for the project and consider a wider range of alternatives, including nature-based solutions in combination with structural designs.

We are pleased that the Corps has since decided to prepare an EIS given the significance of this proposal to the City of Charleston and its residents, and we look forward to reviewing and commenting on the draft EIS upon its release to the public. In the meantime, and in partnership with the Coastal Conservation League, we have commissioned the attached report, *Beyond the Wall*, from Sherwood Design Engineers, an engineering company with experience designing resilient solutions to address flooding problems for communities around the country. This report provides a range of nature-based alternatives that address storm surge, as well as other sources of flooding, and also deliver additional benefits, such as recreational amenities. These alternatives are more in keeping with the character of the city than the proposed seawall, which would sever residents' connection to the water.

To put this report in its proper perspective, we offer the following additional points:

First, the alternatives in *Beyond the Wall* are not final engineering plans. These are proposed alternative solutions to storm surge that meet the purpose and need of the proposed project and that the Corps should carry forward and evaluate as part of the NEPA process. In addition, it is our hope that these recommendations will help to spur an ongoing dialogue among residents and city leaders for how this project could better accomplish the Corps' and the city's goals in a way that equitably provides flood protection and recreational amenities throughout the peninsula.

Second, as we have said previously, we agree that there may be specific locations on the Charleston peninsula where a traditional concrete seawall is the best option to address storm surge. However, there are clearly opportunities to take different approaches along other sections of the peninsula's shoreline by incorporating natural, layered strategies to address flooding. The recommendations from our report are in keeping with the Corps' assertion in the EA that "[r]esiliency increases when there are multiple layers incorporated in any risk management project," including "structural, nonstructural, and natural and nature-based" measures. EA at 51. In addition, it should be noted that we have not attempted to redesign the entire seawall project. Instead, we have selected three specific locations on the Charleston peninsula where the Corps should embrace a different approach. To that end, the *Beyond the Wall* report provides more tailored designs for the Battery, the Lockwood Corridor, and Rosemont. The approaches taken for these three areas can be applied to similar locations within the Corps' study area.

Third, one fundamental problem with the Corps' current recommendation is that it does not address the city's most pervasive flooding problems. While storm surge is an obvious and major concern that we must prepare for, it is unknown when the peninsula will experience the next 100-year storm surge event.[1] Although we cannot predict when the next 100-year storm event will occur, Charleston is already experiencing the negative effects of numerous ongoing, flood threats that interact with and reinforce storm surge, including chronic tidal flooding and intensifying rain events combined with a low-lying, aging stormwater drainage system. The near-term risk of inland flooding is already a significant threat to the peninsula's economy and daily operations. The Corps' monolithic, expensive approach, requiring a match of local dollars, would take resources away from other, present day needs. In short, a concrete

[1] Notably, the Corps' proposal would not defend against major storm surges, such as the peak surge experienced north of Charleston during Hurricane Hugo. *See* https://www.weather.gov/chs/HurricaneHugo-Sep1989.

seawall intended to solve only one flooding problem may not be the best place to start to address Charleston's flood exposure. At a minimum, if this process continues to move forward, it is imperative that we examine alternatives, like those included in *Beyond the Wall*, that are multi-functional and designed to tackle storm surge in addition to other flooding threats.

Fourth, instead of building a single-purpose, uniform wall, the Corps should carefully evaluate solutions that are customized to the unique needs of different areas of the peninsula. The Charleston peninsula includes distinct neighborhoods and districts with varying levels of exposure to flooding and coastal storm events. The current plan treats the entire peninsula as one cohesive unit, rather than acknowledging the different challenges and adaptation needs throughout the city. By breaking down the study area into smaller blocks along the perimeter of the peninsula, the Corps should develop plans for the distinct needs of each neighborhood and shoreline area.

Fifth, we understand that the Corps believes it is wedded to a narrow interpretation of its economic analysis and the calculation of National Economic Development benefits, and, as a result, it has not accounted for the benefits of greener solutions and has prematurely and wrongly eliminated these types of alternatives in the EA. This is contrary to Congress's express directive to the Corps "to consider the use of both traditional and natural infrastructure alternatives, alone *or in conjunction with* each other, if those alternatives are practicable." Section 1149 of Pub.L. 115-270, 33 U.S.C. § 2282 note (Oct. 23, 2018) (emphasis added). In fact, as we have said previously, the Corps has accepted a more flexible and inclusive approach for projects such as the Living Breakwaters project in New York.[2] *See Beyond the Wall* at 23. Moreover, the Corps has led on the design and implementation of nature-based projects in other areas of the country.[3] To date, the Corps' proposal here considers non-structural and nature-based measures only in isolation rather than as integrated components of a broader solution. The Corps must now rigorously study nature-based alternatives, such as the ones set forward in *Beyond the Wall*, in the EIS process, calculating not only their direct flood reduction benefits but also the many other resilience, ecological, and community benefits these systems can provide. As stated in our previous letter, "[t]he 'existence of a viable but unexamined alternative renders an environmental impact statement inadequate.'" *Resources Ltd. v. Robinson*, 35 35 F.3d 1300, 1307 (9th Cir. 1994).

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[2] SCAPE, *Rebuild by Design: Living Breakwaters Project Benefit Cost Analysis*, New York Governor's Office of Storm Recovery, 2017, stormrecovery.ny.gov/sites/default/files/crp/community/documents/Living%20Breakwaters%20BCA%20for%20website.pdf.

[3] *See* Engineering with Nature, *Proving Grounds,* https://ewn.erdc.dren.mil/?page_id=49.

Sixth, not only does the Corps' economic analysis fail to account for the benefits and services of nature-based solutions, but the cost-benefit analysis employed by the Corps to justify its preferred alternative is skewed in favor of affluent communities. As a general matter, the way the Corps values the impacts on affected structures assigns greater value to structures in wealthier neighborhoods than in lower-income areas. Additionally, areas with a wide range of community assets, such as hospitals or tourist attractions, receive a higher valuation in the impact analysis than areas lacking non-residential structures that contribute to economic activity. In its economic analysis for this project, the Corps does not provide sufficient information to determine why neighborhoods like Rosemont and Bridgeview Village were excluded from the proposed perimeter protection. Further, the Corps must disclose its separate valuations of the Modeled Areas, including the Wagener Terrace and Newmarket Unprotected Modeled Areas, under all scenarios to provide transparency about the storm surge damages estimated for the areas not afforded protection by the proposed wall. *See* EA, Appendix C. As this process moves forward, the Corps must include this type of information and explain its analysis more fully so the public can understand how its economic study shaped its recommendations.

As it stands now, the Corps' proposal in the EA for neighborhoods, such as Rosemont, are lacking. The inequitable treatment of these Charleston neighborhoods must be resolved through greater transparency, but also through meaningful community engagement centered on community-driven solutions. *See Beyond the Wall* at 52. Although the Corps has recommended raising houses in Rosemont, this would not be enough to provide protection from storm surge and flooding, as residents with elevated houses in the neighborhood still struggle with the effects of flooding on neighborhood roads and on the foundations of their homes. In the attached report, Sherwood recommends community resilience planning for Rosemont and sets forth a suite of options residents could evaluate to determine how to best address storm surge and other sources of flooding in their neighborhood. *Beyond the Wall* at 53. The Corps cannot allow a flawed economic analysis to unfairly leave this neighborhood and others like it exposed to the increasing threat of storm surge and flooding.

In sum, the proposed Charleston seawall could amount to one of the most important engineering projects in the city's history; and therefore, it is critical that the Corps, the city, and other agencies take the time to get it right. We appreciate the Corps' decision to prepare an EIS because it should provide the city and its residents with a robust opportunity to examine a broader range of alternatives than what has been studied to date and to carefully consider locations on the peninsula where greener strategies would improve the overall project. These nature-based alternatives could help mitigate other types of flooding in addition to storm surge, provide recreational

opportunities, and fit in better with the character of the city and its neighborhoods. We recognize that there is no silver bullet for solving Charleston's flooding woes, but with a price tag this massive, the Corps must take a more holistic approach and develop an inclusive plan that creates greater benefits for the peninsula and all of its residents.

We appreciate the opportunity for continued engagement on this proposal. Should you have any questions about our comments or the accompanying report, please do not hesitate to contact the undersigned.

Sincerely,

Christopher K. DeScherer
South Carolina Office Director
Southern Environmental Law Center

CC (via email only):

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BEYOND THE WALL

AN EXPLORATION OF ALTERNATIVE STRATEGIES TO THE CORPS SEAWALL PROPOSAL FOR CHARLESTON, SOUTH CAROLINA

September 2021

SHERWOOD
DESIGN ENGINEERS


LOCKWOOD CORRIDOR

BEYOND THE WALL

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THE LOW BATTERY

1 INTRODUCTION

Charleston, South Carolina, is one of the country's great urban jewels—steeped in history, beautifully scaled, walkable, and replete with amenities for its citizens and visitors. The city is an economic driver for the region and an international tourist attraction, and owes much of its prominence and success, past and present, to its connection with water. Proximity to Charleston Harbor and the Atlantic Ocean was essential to Charleston's founding and growth and continues to draw tourists, businesses, and new residents to the city.

Charleston's connection with water also puts the city at great risk from climate change, and solutions are urgently needed to improve its resilience. Rising seas and stronger storms more frequently bring flooding to the peninsula, including routine nuisance flooding that causes property damage, interrupts business, discourages tourism, and diminishes quality of life.

BICYCLISTS AT COLONIAL LAKE

In light of the city's precarious condition, the U.S. Army Corps of Engineers (Corps) has committed to designing and implementing a coastal protection system for a significant portion of the peninsula (Corps Project or Project), recommending construction of a nearly eight-mile-long concrete seawall to defend against future storm surge. While we agree that a solution is needed, we do not believe that the Corps' proposal is the right approach for Charleston. By focusing narrowly on the threat of storm surge, the proposed seawall falls short of tackling other climate change threats confronting Charleston, including strengthening rain events and routine tidal flooding, and its scale and appearance would impair the city's character and residents' quality of life. The proposed seawall would not even protect against major storm surges, and water from any overtopping waves could be trapped within the wall. If the Corps would instead consider the diverse, interrelated flooding risks to Charleston and recognize the city's economic and livability needs, we are convinced that the agency could arrive at a more layered, adaptive solution — one which would lead to a more resilient local economy, better integrate into the physical and historical context of the city, and build consensus among local stakeholders.

INTRODUCTION

At the heart of our approach is the recognition that a one-size-fits-all strategy to Charleston's flooding problems will continue to leave the city vulnerable. While the Corps' recommended intervention currently addresses only storm surge flooding, this investment *must* take into account the full array of resilience threats to Charleston, so that current and future investments in flood management and prevention can be integrated with the Corps Project. This strategy is known as layered protection, and in the case of Charleston, it would enable the community to design and build flood-control infrastructure over time that mitigates localized flooding, reduces erosion and subsidence, and incorporates site-specific ecology and nature-based solutions, while also creating a connected coastal edge that respects the character of Charleston's neighborhoods. The current Corps plan does not accomplish these goals: the proposed seawall would, at best, solve coastal flooding from certain future storm events (but not all), and would do nothing to improve the more prevalent, near-term threat of localized inland flooding. In fact, the wall could trap stormwater runoff and worsen inland flooding. The seawall would also impair visual and physical access to the water.

This Corps Project offers a prime opportunity to design flood protection that will secure public safety and the economy, enhance existing ecological functions, and preserve local character and connectivity to the water. We can — and must — build a protection system that mitigates not only flooding from the rare hurricane, but also the chronic tidal and pluvial flooding that more routinely disrupts Charleston businesses and residents. The protection system must also be capable of adapting to future conditions — to be extended, expanded, improved, or raised in response to sea level rise and other climate change effects. Put simply, this multi-billion-dollar, generational project can and should result in more than a one-dimensional, concrete seawall.

If we get it right in Charleston, this process of adaptive layered resilience could be applied to cities throughout the country in need of effective, creative solutions to adapt to climate change.

This report presents potential resilience solutions that have been specifically tailored to the needs and contexts of three areas of the Charleston peninsula — the Battery, the Lockwood Corridor/Medical District, and the Rosemont community. The planning methods and design concepts proposed in this report could also be expanded to other areas of Charleston in need of resilience solutions. Over the course of our research and stakeholder conversations, several priorities emerged for the Corps Project:

- The protection system should be designed as an interconnected network that unifies, rather than separates, communities and the water.
- Communities, like Rosemont, that are outside the proposed seawall must be treated equitably and engaged to find solutions to reduce flood risk.
- City and state capital improvement projects should be leveraged and integrated with the Corps Project to more efficiently address both coastal protection and inland flooding.
- Protection strategies should be adaptable to future conditions and responsive to the unique contexts of Charleston's neighborhoods.
- Existing and future ecosystem values should be preserved and strengthened to provide natural edge protection and other resilience benefits.

With these goals in mind, our team identified a number of nature-based structural and nonstructural solutions that merit further evaluation and consideration in Charleston, including some which the Corps has implemented on resilience projects in other parts of the country.

This report was prepared with input from Robert Young, Director of the Program for the Study of Developed Shorelines; Kate Orff, Founder and Director of SCAPE Studio; and Keith Bowers, President of Biohabitats.

WHITE POINT GARDENS

GICLEE PAINTING OF CHARLESTON (1872)

2

OVERVIEW

2.1 THE CORPS' PREFERRED ALTERNATIVE

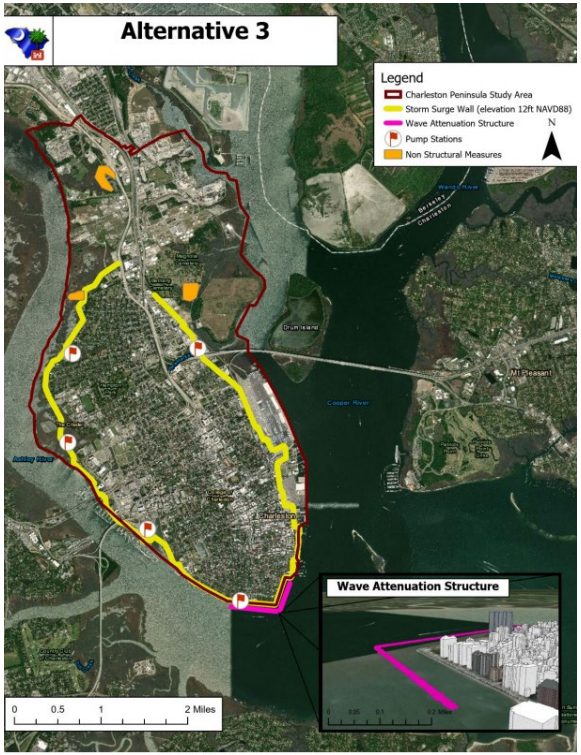
The Corps has engaged in a number of Coastal Storm Risk Management (CSRM) studies in select areas along the eastern seaboard, including the Florida Keys, Collier County, Miami-Dade County, New Jersey's back bays, New York and New Jersey Harbor and tributaries, and now the Charleston peninsula. These three-year studies evaluate a mix of engineered solutions to address coastal storm surge flooding; the local community sponsor ultimately decides whether to move forward with the recommended alternative. If the local community agrees to the proposal and the 35% local match of the total cost, the project enters a queue to await congressional funding.

The Charleston peninsula was selected for CSRM study due to its economic importance in the region and vulnerability to coastal storms. Charleston is also increasingly under threat from flooding associated with sea level rise: in 2020, although Charleston was not directly impacted by any hurricanes, it experienced 68 minor tidal flooding events (tides higher than 7 feet), the second-most ever recorded. Perhaps more alarming, 2020 saw the most major tidal flooding events (tides higher than 8 feet) in the city's history (Johnson 2021). Flood frequency and intensity is expected to increase dramatically before the end of the century as a result of climate change.

The Corps has assessed seven alternative protection strategies as part of the Charleston peninsula CSRM study. Alternatives were weighed on their effectiveness to reduce loss of life, increase safety, and minimize economic damages from a projected future coastal storm event. The Corps advanced two alternatives for further consideration and then selected Alternative 3 as the preferred alternative on the basis that it most closely aligned with the study's stated objectives and offered the highest return on investment per the agency's Benefit-Cost Analysis (BCA).

Alternative 3 recommends a 7.8-mile-long concrete seawall surrounding a significant portion of the Charleston peninsula at an elevation of 12-foot NAVD-88, comparable to 12 feet above Mean Sea Level in the Charleston area. A few neighborhoods on the peninsula totaling 100 structures were excluded from the proposed seawall boundary (U.S. Army Corps 2020, p. 19). For these areas, the Corps has broadly identified potential nonstructural measures such as relocations, buyouts, elevations, and flood-proofing but with no concrete proposals.

When the preferred alternative was introduced in the Corps' April 2020 Feasibility Study, it included a 16.2-foot-high (NAVD-88) wave attenuating breakwater composed of granite rock to add protection to the tip of the peninsula. The breakwater was meant to reduce the effect of wave overtopping and wave attack at the Battery, thus reducing long-term maintenance needs and costs. Since the initial publication of the Feasibility Study, however, the Corps has announced that the breakwater will be removed from the next iteration of the recommended alternative due to insufficient modeled benefits compared to expected construction costs. We have chosen to revisit the decision to eliminate the breakwater in our analysis.



PROPOSED CORPS SEAWALL MAP (THE CORPS 2020)

OVERVIEW

2.2 CONCERNS WITH THE CORPS' PREFERRED ALTERNATIVE

Alternative 3, the Corps' preferred alternative, fails to adequately address the climate change risks facing the Charleston region, and would leave the city unacceptably exposed to flooding threats in the near and long-term. Charleston needs a more dynamic approach to flood resilience than a concrete seawall — one that will respond to immediate risks while providing adaptive protection for the future. Below is a summary of our key concerns with the Corps' preferred alternative.

Ecological Concerns

- **Excluded Nature-Based Benefits:** The calculated benefits from the Corps' BCA do not account for benefits that would accrue from natural and nature-based solutions — either alone or in conjunction with structural projects. This hinders the Corps' ability to adequately compare natural infrastructure solutions with grey infrastructure (U.S. Government Accountability Office 2019, p. 2). If benefits such as wildlife habitat, wetland creation, and economic development opportunities were incorporated into the BCA, an alternative with nature-based components could prove more cost-effective than structural solutions alone.
- **Overreliance on Grey Infrastructure:** The concrete seawall proposed by the Corps would rely solely on grey infrastructure, or traditional, man-made structures used to manage water such as pipes, dams, and water treatment plants. Grey infrastructure generally degrades ecosystems, as opposed to "green" or nature-based infrastructure, which leverages vegetation and other natural features to capture, filter, and reduce the volume of water and, consequently, enhances ecosystem services such as water purification and wildlife habitat.
- **Ecosystem Loss:** As originally proposed, the seawall would degrade or eliminate up to 111 acres of ecologically valuable salt marsh surrounding the Charleston peninsula due to construction and future operation (U.S. Army Corps 2020, p. 173). It would also lead to the elimination of salt marsh adjacent to the seawall, an impact which the Corps' Feasibility Study did not assess. Since publication of the Feasibility Study, the Corps has announced changes to its original alignment, moving the seawall inland to reduce salt marsh impacts to approximately 45 acres (Johnson 2021). While this new proposal is a step in the right direction, the agency should consider alternative protection strategies that could either preserve existing, create new, or adapt current marshes and other coastal ecosystems to preserve long-term ecological function.
- **Coastal Interactions:** The seawall would constrain or block the openings of inland tributaries on the peninsula during rain events and tidal changes. This would reduce the time for water infiltration during a rain event, potentially producing scour and higher peak discharges, and limit stormwater sheet flow into the marsh, thus trapping more water inland of the wall.

Economic and Community Concerns

- **Inequitable Benefit-Cost Analysis:** The Corps' BCA methodology is skewed in favor of investing in protection strategies for affluent neighborhoods as opposed to lower-income neighborhoods. This hinders the Corps' ability to propose solutions that are equitable.
- **Adaptability:** The Corps has established a protection height for the seawall that is designed to prepare for a future potential 100-year catastrophic event, based on the low-end 1.15 foot sea level rise the Corps included in the Feasibility Study. However, if current projections underestimate the magnitude or rate of sea level rise, then the seawall will not be large enough to protect against a cataclysmic event.

Mid-range NOAA scenarios predict approximately 2.5 to 4 feet of sea level rise by the end of the Corps' study period (2026-2075), and upwards of 6 feet by the end of the century (NOAA 2020). The seawall, as proposed, is not capable of adapting to accelerated changes in future conditions because it cannot be raised due to structural constraints.

- **Unduly Narrow Focus:** The Corps' current review is limited to flooding caused by storm surge; however, there are other sources of flooding that are disruptive to the daily operations of the city. Building now to protect against a single future event ignores many of the significant climate change impacts that the community is facing on a much more regular basis that more readily impact economic conditions and quality of life.
- **Equitable Protection:** The Corps' preferred alternative excludes neighborhoods such as Rosemont and Bridgeview Village, which are predominantly Black, from the protection of the seawall, and the agency has offered only vague references to potential non-structural measures for these areas, but no concrete proposals or strategies for decision-makers to follow. This is likely due, at least in part, to the Corps' community engagement efforts in these communities, which have fallen well short of understanding and incorporating the needs and desires of residents into this Project. Communities that have been disproportionately affected by industry and infrastructure, often leading to physical isolation, require robust engagement and effective solutions to address flooding.
- **Project Cost and Life Cycle:** The Corps' BCA runs until the end of the seawall's expected life cycle in 2075 but does not account for the significant end-of-life costs associated with the Project (U.S. Army Corps 2020, p. C-41). If projections hold true, in 2075, Charleston will be left with an obsolete seawall likely in its worst condition, requiring increased maintenance due to material degradation and scouring and potentially even removal. The Corps should consider these additional expenses to the city in its analysis of alternatives.
- **Construction and Operations:** Given that the Corps has not yet finalized design details for Alternative 3, there is a high probability that the Feasibility Study underestimated the true construction and operation and maintenance (O&M) costs of the Project. To date, the Corps has provided no breakdown of the investment or O&M costs and no explanation for assumptions underlying its cost estimates. Historically, the actual price tag of Corps projects to taxpayers and non-federal sponsors has dramatically exceeded estimates: at least two-thirds of the 87 Corps flood control projects budgeted for construction between Fiscal Year (FY) 2004 and FY2012 experienced cost overruns (U.S. Government Accountability Office 2014).
- **Character Impacts:** The height of the seawall, and its proximity to the shoreline, would sever the Lockwood Corridor's viewshed of, and connectivity to, the Ashley River and Charleston Harbor, with potentially significant implications for local culture, residents' quality of life, and tourism.
- **False Sense of Security:** There is a risk that the seawall will instill a false sense of safety for those neighborhoods within its perimeter, encouraging further development in flood- and disaster-prone areas. Should development in these vulnerable areas increase, more people and structures would be at risk from storm waves overtopping the wall or rainfall flooding within the wall's perimeter. Development pressure will continue to reduce open space, increase the amount of impervious area, and degrade natural habitats and storm defenses on the peninsula.

OVERVIEW

2.3 RESILIENT ALTERNATIVES FOR CONSIDERATION

The issues that Charleston faces today and into the future are complex. While no single project will solve all of the city's flooding and climate change challenges, the Corps' process — in particular, its singular focus on storm surge flooding — has been unnecessarily and dangerously narrow. Charleston, of course, experiences more than just storm surge flooding, as both coastal and inland flooding are on the rise with climate change. These multiple flooding threats should not be solved through mutually exclusive, separately undertaken infrastructure programs, as the Corps proposes here, but through a holistic strategy that responds to all or several climate change risks and efficiently deploys capital to projects with multiple resilience benefits.

An emphasis on layered, nature-based protection would more effectively address coastal and inland flooding and would provide greater capacity for Charleston to adapt to an unpredictable climate future. Layered protection involves multiple components that can be added to a base level of strategic protection through time to increase resilience or take advantage of additional opportunities — for example, after more funding becomes available or when higher seas necessitate greater protection.

As we formulated a layered protection strategy for Charleston, six key design criteria emerged:

- **System flexibility and adaptation:** Providing phased resilience over time in response to future scenarios
- **Holistic resilience:** Addressing physical, economic, and character considerations
- **Shoreline stabilization:** Preventing erosion and scour and preserving natural coastal assets
- **Sensitivity and restoration of ecosystems:** Identifying and prioritizing the preservation and growth of critical ecology
- **Integration of inland and coastal conditions:** Developing comprehensive protection strategies
- **Comparative advantage:** Providing a commensurate level of protection from storm surge and flooding compared to the Corps' proposal

To illustrate how these goals can be achieved within the Corps Project, our effort focused on three distinct locations along the western shore of the peninsula:

- The Battery at the tip of the peninsula
- The Lockwood Corridor between the Medical District and the U.S. Coast Guard Station
- The Rosemont community in the Neck area of the peninsula

We selected the peninsula's western shoreline because of its diverse physical, economic, and social conditions, which help to demonstrate the customization possible with a layered resilience approach.[1] It features a highly varied edge, high- and low-density development, marsh habitat, major infrastructure corridors, historic districts, major employment centers, and long-established communities with diverse racial and economic demographics.[2] The protection strategies developed for each location are replicable in similar neighborhoods throughout the peninsula and the region, would improve resilience over time compared to a uniform seawall, and would deliver greater payback for surrounding communities.

1 While we did not have the resources to study additional areas within the Corps Project, the planning concepts presented in this report should be applied throughout the peninsula to provide creative, nature-based alternatives to a seawall.

2 Historically, the Charleston shoreline benefited from coastal salt marsh ecosystems and the natural coastal protection that had existed for millennia. The erosion of these ecosystems in the past several decades has had a detrimental effect on the physical character and resilience of the adjacent communities.

MARSHLAND ALONGSIDE LOCKWOOD CORRIDOR

3 DESIGN CONSIDERATIONS

3.1 HISTORY AND CONTEXT

Over its more than 350-year history, Charleston has played a central role in the country's most pivotal periods and events. The city's built environment continues to tell that history today, ranging from its central role in the Atlantic slave trade, to its contributions to American democracy, and later leading the way in historic preservation. The equity issues that derive from this history continue to resonate in Charleston, including patterns of environmental injustice which will be discussed later in this report. As noted in the Corps' Feasibility Study, the Project area contains a remarkable 197 historic and cultural resources that have been listed on the National Register of Historic Places (NRHP), determined eligible for listing on the NRHP, or require additional investigation to determine NRHP eligibility (U.S. Army Corps 2020, p. 107). The Charleston Old and Historic District, which the proposed seawall would encircle, is a National Historic Landmark (NHL) and contains 30 structures that are individually NHLs (U.S. Army Corps 2020, p. 108). NHLs receive the highest level of protection under federal law. Pursuant to Section 110(f) of the National Historic Preservation Act, whenever a federal action such as the Corps Project may affect an NHL, the responsible agency must "undertake such planning and actions as may be necessary to minimize harm" to the landmark. 54 U.S.C. § 306107.

The Charleston peninsula is formed at the convergence of the Ashley and Cooper Rivers into Charleston Harbor, a natural tidal estuary sheltered by barrier islands. Within its roughly 8 square miles, the peninsula houses the historic core and urban center of Charleston, including 40,000 people and a multitude of critical assets—fire and police stations, colleges and universities, public schools, hospitals,

HALSEY MAP OF CHARLESTON (1946)

DESIGN CONSIDERATIONS

military installations, and port terminals. In total, the structures located on the peninsula and their contents are valued at approximately $14 billion dollars, as estimated by the Corps in Fiscal Year 2020 dollars (U.S. Army Corps 2020, pg. C-33). The boundaries of the city extend far beyond the peninsula and encompass 120 square miles, excluding waterways, and 137,500 residents (US Department of Commerce).

Tourism is the single largest economic sector in the region, attracting 7 million visitors to greater Charleston each year and accounting for nearly 25% of all consumer transactions on the peninsula. This $8-billion industry supports more than 47,000 local jobs annually (Palkowski 2018).

3.2 DRIVERS OF FLOODING

Charleston has been vulnerable to flooding throughout its history, not only from strong storms and hurricanes but also increasingly from tidal events and an elevated groundwater table. Development practices, such as building in the floodplain and filling waterways, have exacerbated these flood risks. In particular, much of the intertidal zone along the edge of the peninsula, including marshes and tidal creeks, was filled over time to create developable land; historic maps reveal that more than one-third of present-day land was "reclaimed" from the intertidal zone. This type of landfill is especially prevalent on the southern and western sides of the peninsula, areas which are now dealing with land subsidence and where the floodplain and stormwater pooling still follow historic marshes and tidal creeks.

Today, the Charleston peninsula experiences three main types of flooding — tidal, rainfall/pluvial, and groundwater. Tidal flooding occurs when the tide, made higher by sea level rise, pushes onto land, blocks stormwater outfalls, and causes ponding and street flooding in low-lying neighborhoods. This type of flooding is particularly problematic along the shoreline where the historic marsh edge was filled for development. Charleston has seen a marked increase in exceptionally high tides, referred to as King Tides, in recent years. Indeed, 8 of the area's top 15 tides ever recorded have occurred in just the last four years (EPA 2020), and the frequency and severity of King Tides and tidal flooding are only expected to rise with sea levels.

Turning to pluvial flooding, the wettest months in Charleston occur each year between June and September. There has been an increase in significant rainfall events, often referred to as rain bombs, as a result of climate change (Bartelme et al. 2021). These super soaker events can inundate local stormwater systems, causing them to overflow into city streets, especially when they coincide with significant high tides.

Finally, groundwater flooding is a significant, though sometimes overlooked, threat to Charleston because the peninsula is characterized by a high water table, which will rise going forward with sea levels. Over time, the elevated water table will reduce the effectiveness and availability of underground excavated stormwater detention, decrease the ground's capacity to absorb rainwater, and result in increased water ponding above-ground. This would increase the volume of inland flooding contained by a seawall structure.

Each of these types of flooding will become more frequent and intense as sea levels rise, and will exacerbate damage to the peninsula as they interact and compound on one another. Storms can generate both tidal and pluvial flooding, placing an even greater burden on already stressed infrastructure within the peninsula. US-17, a major transportation corridor through the peninsula, currently floods more than 10 times per year and is expected to experience up to 180 flood events annually by 2045 (U.S. Army Corps 2020, p. 47). The Corps' 2013 intermediate sea level rise scenario projects just over 1 foot of sea level rise by 2075. This would inundate 50% of police stations, 42% of healthcare facilities, and 29% of fire

DESIGN CONSIDERATIONS

LOCATION OF CAPITAL IMPROVEMENT PROJECTS (DEPT OF STORMWATER PROJECTS, 2020)

RENDERING OF RAISED LOW BATTERY SEAWALL AFTER COMPLETION

stations on the peninsula during a 25-year storm (U.S. Army Corps 2020, p. 42).[3] The Corps' 2013 high sea level rise scenario, which is just under the more updated NOAA 2017 intermediate-high scenario used in the 4th National Climate Assessment, projects over 3 feet of sea level rise by 2075. Under this scenario, the peninsula would face even more significant damage; however, the Corps has inexplicably declined to consider this scenario in its analysis of the Project thus far.[4]

City officials recognize that the peninsula is in a particularly vulnerable position and have commissioned a series of capital improvement projects to address coastal resilience and inland flooding. These projects, including the elevation of the Low Battery, the Market Street Drainage Improvement Project, US-17/Fishburne Drainage Improvement Project, and Calhoun West Drainage Improvement Project, are in various stages of design and construction.[5] Most of these projects address vulnerabilities through retrofits to existing infrastructure, rather than creating new and additional infrastructure.

Assuming that the city's planned capital improvement projects are finalized but no recommendations from the Feasibility Study are constructed, the Corps' models predict storm damages of $11.2 billion, an average of $416 million annually between 2026 and 2075 (U.S. Army Corps 2020, p. C-45). The Corps also estimates that by 2075, without the seawall, approximately

3 In a storm with 4% annual exceedance probability (i.e., 25-year) storm event, the listed critical infrastructure would be flooded to elevation 9 feet (NAVD88).

4 The Corps has developed the Project based on misinformed sea level rise projections. Consideration of higher risk aversion projections correlated to the most up-to-date scientific data should inform the Project.

5 In addition to the edge protection structures discussed, the City has installed 22 one-way check valves on stormwater discharge piping throughout the peninsula to prevent tidal backflow, with plans to install more. While check valves have helped reduce the frequency of inland flooding during sunny day (high tide and King Tide) events, they do not solve flooding during storm events when inland rain is heavy and tides are high. For more information, visit the Projects page on the Charleston City website: https://www.charleston-sc.gov/586/Projects.

DESIGN CONSIDERATIONS

54% of historic structures will be at risk from inundation during a 25-year storm event. Conversely, if the Corps were to ignore inland flooding in its Project — as it currently is poised to do — then Charleston would miss out on potential alignments between the Corps' coastal protection system and the city's internal drainage improvements. The proposed seawall could even exacerbate some inland flooding issues by trapping stormwater inside the city. It is therefore clear that an effective storm surge protection solution must also consider inland flooding issues and capital improvements targeted at these problems (Porter 2020).

3.3 SHORELINE EDGE CONDITIONS

Over time the city's built environment expanded into areas that were once marsh, the new shoreline was armored with structures such as the High and Low Batteries. The High Battery was constructed in the early nineteenth century and is approximately 1400-feet long and 9-feet high (NAVD88) (U.S. Army Corps 2020, p. 108). It connects to the roughly 6-foot high (NAVD88) Low Battery at its western end, which extends along the Ashley River for a little less than a mile (U.S. Army Corps 2020, p. 56). These seawalls are Charleston's most significant storm surge flood prevention structures. Due to their age and construction method, however, both require ongoing maintenance and stabilization, and neither is high enough to meet future storm surge projections. The city is funding the restoration and elevation of the Low Battery to match the 9-foot height of the High Battery.[6] As proposed, the Corps' seawall would be built seaward of these existing seawalls.

Moving northwest from the Battery, much of the peninsula's edge has been modified to accommodate vehicular circulation and residential and commercial development with little regard to the value of the adjacent salt marsh. The Lockwood Drive corridor and the Medical District flood regularly. As a result, the infrastructure in the area is often closed due to inundation and requires costly maintenance.

Further northwest, the edge retains more of its established salt marsh ecosystems and communities are set back further from the water's edge. The prevalence of natural systems has helped protect communities in this area from tidal and major storm flooding, although climate change and rising seas will require these communities to develop strategies for future resilience.

3.4 PROPOSALS INFLUENCING OUR DESIGNS

3.4.1 Dutch Dialogues

Dutch Dialogues Charleston proposes a series of layered resilience solutions designed to allow the city to live harmoniously with water. Importantly, this vision does not include a 12-foot high (NAVD88) concrete seawall but instead balances grey and green infrastructure to manage flooding and emphasizes design-solutions that solve for more than one problem. The report was a collaborative effort among local representatives and experts in stormwater management, resiliency, and urban planning (Waggoner & Ball et al. 2019).

To address resilience needs on the peninsula, Dutch Dialogues recommends a multi-faceted Peninsula Water Management System, to include:

- An integrated stormwater drainage system that manages runoff and groundwater;
- Construction of a separate, secondary stormwater drainage system to alleviate capacity of the primary stormwater drainage system;
- A comprehensive stormwater storage plan in public spaces and on commercial and residential properties; and
- Increased requirements to store stormwater in public spaces and residential property to provide infrastructure with multiple functions.

The report also recommends elevating critical low spots, providing temporary stormwater storage for times when the

6 The Low Battery project also includes retrofitting the stormwater drainage system, landings, and wall with stronger protective materials. Construction is expected to be completed in November 2021.

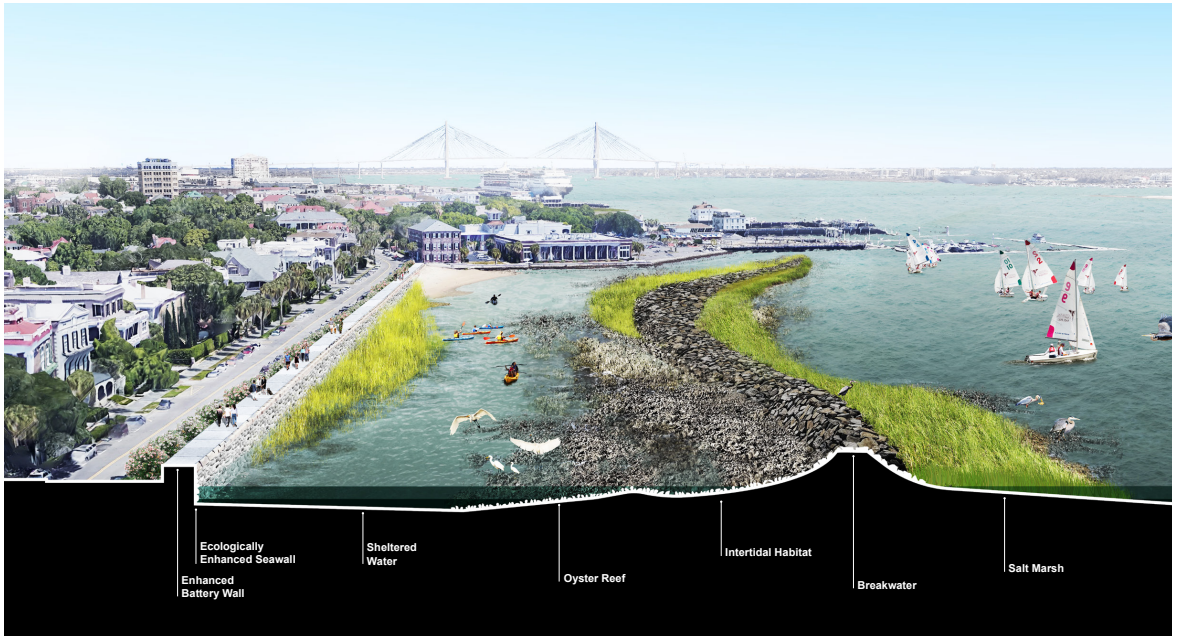
system cannot function properly, and conducting a groundwater study.
For the Lockwood Corridor and associated Medical District, Dutch Dialogues offered a specific set of recommendations, including two alternative primary coastal protections and additional flood mitigation techniques. The two primary coastal protections were:

- Raising Lockwood Drive to be part of the seawall, similar to the High Battery; and
- Pushing perimeter protection into the Ashley River and restoring the marsh in the corridor

3.4.2 Imagine the Wall

In response to the Corps' Feasibility Study, two private consulting firms collaborated on a publication titled "Imagine the Wall," to encourage conversation about alternative edge protection designs to the proposed seawall. The report aligns with Dutch Dialogues by presenting layered, nature-based solutions that provide multiple benefits and address resilience issues traditionally solved with grey infrastructure. The report also identifies measures to capitalize on existing infrastructure by increasing stormwater storage capacity (Biohabitats et al. 2020).

Imagine the Wall's high-level perimeter strategy recommends replacing the traditional seawall as the primary coastal protection with horizontal levees, living shorelines, and raised promenades similar to the Battery. The proposal redesigned the Corps' proposed breakwater at the tip of the peninsula to create a living breakwater archipelago, which would reduce wave heights, offer recreational and scenic enhancement, and provide shallow coastal habitat. The design team argues that this type of structure could provide the same level of wave protection at a lower elevation than a traditionally engineered breakwater. The document also recommends mitigating inland stormwater issues by constructing green infrastructure and installing a greenway along East Bay Street behind the State Ports Authority's Columbus Street Terminal, implementing district-wide green roofs and stormwater corridors, and strategically placing pump stations throughout the peninsula.



BIOHABITATS' "IMAGINE THE WALL" CONCEPT DESIGN FOR THE LIVING BREAKWATERS ARCHIPELAGO

THE BATTERY

4 PROPOSED SOLUTIONS

MAP OF CHARLESTON PENINSULA HIGHLIGHTING THE THREE STUDY AREAS

THE EXISTING BATTERY WALL

4.1 BREAKWATER

BACKGROUND

Both the High and Low Batteries were designed to fortify the city while contributing to its scenic beauty.[7] Today, more than a century after the Battery's construction, the tip of the peninsula is renowned for its scenery, historic significance, and rows of antebellum homes that are among the most iconic in the city. However, the Battery that has provided protection for so many years is now up against its gravest threat yet — climate change. Stronger, more frequent storms and rising sea levels inevitably will necessitate improvements and repairs to the seawall and require additional forms of protection.

More than a century ago, the tip of the peninsula featured wetlands that extended from the mainland to the approximate location of the Battery. This natural ecosystem provided coastal habitat as well as wave energy dissipation during storm events but was never restored since the Battery's construction.

PEDESTRIANS AT THE BATTERY

ELEVATION MAP SHOWING THE BATTERY

7 The High Battery is 1,400 feet long and was built in the early nineteenth century. The construction of the High Battery facilitated the creation of East Battery and White Point Gardens. The original High Battery consisted of a seaward stone wall, backed by two masonry walls approximately 10 feet apart, and backfilled with soil between the walls with a stone slab and promenade on top (City of Charleston 2020). An addition to the High Battery, called the "Turn," connects the High Battery and Low Battery at the meeting of Murray Boulevard and East Battery. The "Turn" was repaired in 2015 as the first phase of the overall seawall repair project.

The Low Battery was built adjacent to the High Battery in the early twentieth century and is nearly 5,000 feet long. Extending from Tradd Street to the "Turn," the Low Battery facilitated construction of Murray Boulevard. Unlike the dual seawall configuration of the High Battery, the Low Battery was constructed as a single seawall reinforced with concrete. The concrete seawall is supported on timber piles, which are protected by a continuous array of concrete slabs on the seaward side of the wall (Butler 2019).

BREAKWATER

BACKGROUND

LOW BATTERY RECONSTRUCTION

HIGH BATTERY

HIGH BATTERY CIRCA 1890
(Charleston Pilots 2014)

HIGH BATTERY CIRCA 19TH CENTURY

The Corps' Feasibility Study conducted a BCA to determine the relative benefits and costs of incorporating a wave attenuator into the Battery protection strategy. The wave attenuator structure as described in the Feasibility Study is assumed to be a breakwater consisting of granite stone or a rubble mound that would stretch parallel to the existing seawall. Traditional breakwaters are barriers built out into a body of water that are meant to slow and weaken incoming waves. The Benefit-Cost Ratios (BCR) for the seawall with and without the wave attenuator are presented in Table 15 as Alternative 3 and Alternative 2, respectively.

The difference in benefits between the two alternatives is approximately $15 million. Although the alternative without the attenuator yielded a higher BCR, the Corps originally stated that there were many associated benefits that the BCA did not account for, and therefore overrode the calculations by selecting Alternative 3 with the wave attenuator. Since publication of the Feasibility Study, the Corps has removed the wave attenuator from its proposal due to uncertainties in modeling and the BCA (US Army Corps 2021).

Table 15: Risk Analysis
Probability that Average Annual Benefits Exceed Annual Costs

Cost/Benefit Item	Alternative 2	Alternative 3
Average Annual Benefits	$153,858,000	$174,639,000
Standard Deviation	$ 14,938,000	$ 9,744,000
Minimum Average Annual Benefits	$ 91,775,000	$121,692,000
Maximum Average Annual Benefits	$175,004,000	$191,094,000
Average Annual Costs	$65,889,000	$80,221,000
Average Annual Net Benefits	$87,968,000	$94,417,000
Average Annual BCR	2.3	2.2
Probability Benefits Exceed Costs And BCR is greater than 1.0	100%	100%

RISK ANALYSIS FOR WAVE ATTENUATOR (U.S. ARMY CORPS 2020, p. C-65)

VIEW OVERLOOKING THE BATTERY

BREAKWATER

POTENTIAL DESIGN APPROACHES

The Living Breakwaters project in Raritan Bay, New York, is an excellent example of the diverse values that a breakwater system could provide in Charleston.[8] A living breakwater integrates nature-based features, including oyster habitat and constructed marsh, into the rock barrier elements of a traditional breakwater. These elements act as an evolving system which replicate and strengthen over time, providing additional protection, ecological and O&M benefits. The Raritan Bay Living Breakwaters project demonstrates how a proper BCA methodology — one which considers the environmental and social values of green infrastructure — would strengthen the rationale for naturalizing the tip of the peninsula.

The Living Breakwaters is a series of offshore breakwaters designed to reduce wave action and shoreline erosion while also providing habitat enhancements, oyster cultivation, and educational stewardship programming. The BCA was prepared by a private consultant following guidance from the U.S. Department of Housing and Urban Development (HUD), and was approved by the Corps, the regulatory agency with jurisdiction over the project (SCAPE 2017).[9] The more comprehensive scope of the Living Breakwaters BCA quantifies benefits beyond just an expected reduction in damages, including resilience, environmental, and social values. These values were not considered in the Corps' BCA for the proposed Charleston seawall.

The following table summarizes the final BCA for the Living Breakwaters project (SCAPE 2017).

Table ES1: Living Breakwaters Project - Benefit Cost Analysis Summary
Constant 2016 US Dollars

	Cumulative Present Values (2016-2066) At Discount Rates of:	
	7%	**3%**
LIFECYCLE COSTS		
Project Investment Costs \a	$54,909,955	$61,150,787
Operations & Maintenance (O&M)		
Maintenance	$7,080,207	$14,507,755
Monitoring	$453,411	$829,867
Total O&M	$7,533,618	$15,337,622
Total Costs	**$62,443,573**	**$76,488,409**
BENEFITS		
Resiliency Values		
Avoided Property Damages	$4,888,646	$12,645,701
Avoided Casualties (Mortality & Injuries)	$2,859,166	$5,858,597
Avoided Mental Health Treatment Costs	$506,972	$965,226
Avoided Lost Productivity Costs	$1,128,405	$2,148,374
Avoided shoreline erosion/dune reconstruction costs	$41,858,316	$56,815,891
Avoided displacement/disruption costs	$526,326	$1,376,525
Avoided Road Closure/Travel Disruption costs	$315,901	$647,300
Avoided Cost of Power Outages	$1,050,543	$2,152,587
Avoided Vehicle Damages	$63,787	$189,399
Total Resiliency Values	$53,198,061	$82,799,601
Environmental Values		
Total Gross Ecosystem Annual Service Gains (+)	$11,860,749	$24,625,205
Total Ecosystem Annual Services Displaced (-)	$264,537	$509,059
Net Ecosystem Annual Service Gains	$11,596,212	$24,116,146
Social Values		
Educational/Environmental Stewardship	$1,253,995	$2,569,509
Recreation	$7,095,681	$14,539,461
Total Social Values	$8,349,676	$17,108,970
Economic Revitalization Benefits		
Property Value Impacts (∫[Distance and Beach Width])	$2,953,868	$6,052,646
Total Benefits	$76,097,817	$130,077,363
Benefits less Costs (Net Present Value)	**$13,654,244**	**$53,588,954**
Benefit Cost Ratio (BCR)	**1.22**	**1.70**

Notes:
Includes adjustment over time for 30 inch Sea Level Rise (SLR)
\a Note that because Project construction is anticipated to occur over 2018, 2019 and the first quarter of 2020, the present value calculation of costs (as of 2016) will appear to be lower than the nominal project investment costs shown in the Opinion of Probable Cost Document due to the application of the 7% HUD recommended discount rate

SUMMARY OF LIVING BREAKWATERS BCA (SCAPE 2017)

8 The Living Breakwaters project was developed by SCAPE/LANDSCAPE ARCHITECTURE with Parsons Brinckerhoff, Dr. Philip Orton / Stevens Institute of Technology, Ocean & Coastal Consultants, SeArc Ecological Consulting, LOT-EK, MTWTF, and the Harbor School and Paul Greenberg, to reduce risk, revive ecologies, and connect residents and educators to Staten Island's southeast shoreline while working in concert with other ongoing resilience initiatives in the area.

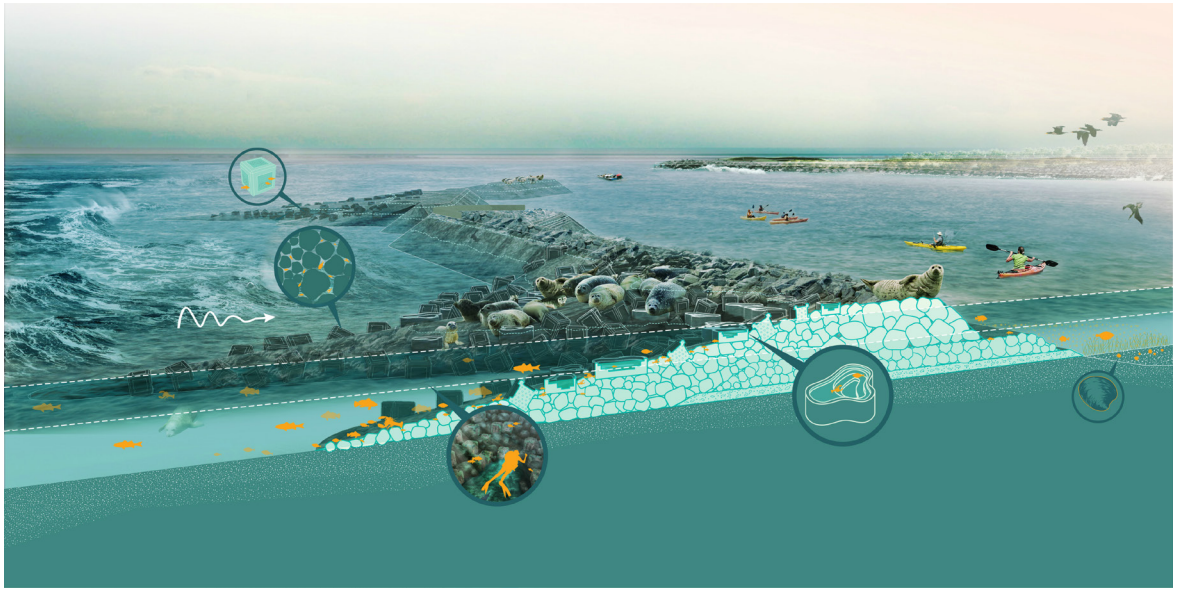
9 In reviewing this project as a precedent, we had conversations with the lead design team of the Living Breakwater (SCAPE) to further understand the design constraints and methodology of the project.

RESILIENCE VALUES

The Living Breakwaters BCA accounts for non-traditional benefits such as avoidance of mortality, injuries, mental health treatment costs, and lost productivity costs (SCAPE 2017).[10] Avoided damages, which is one of the metrics included in the Corps' BCA for the Charleston seawall, would fall into the overall Resilience Values category.

ENVIRONMENTAL VALUES

The Living Breakwaters BCA calculated annual gains in ecosystem services — specifically, habitat/reef sustainability, commercial finfish, water quality, habitat, and recreation—as well as displaced ecosystem services, since the 12.7-acre breakwaters would displace existing subtidal small- and large-grained bottom habitat (SCAPE 2017).[11]



SCAPE'S LIVING BREAKWATER CONCEPT DESIGN FOR THE U.S. HUD'S REBUILD BY DESIGN INITIATIVE (SCAPE 2014)

SOCIAL VALUES

The Living Breakwaters BCA estimated social values, including recreational and educational opportunities, by using the "benefits transfer" method to compare usages at similar educational facilities and parks (SCAPE 2017).[12]

For this Project in Charleston, it is imperative that the Corps incorporate these additional resilience, environmental, and social values, both direct and indirect, into its BCA for the breakwater. This would align with the evolving practices of other federal agencies, such as the Federal Emergency Management Agency (FEMA), which have begun to consider a broader set of benefits, like ecosystem services, in their BCAs. If the Corps were to use a more comprehensive BCA, the analysis would be more accurate and reliable and would document substantially more benefits for a breakwater than the Project's most recent BCA.

10 To calculate avoided mortalities and injuries, mortality and injury estimates were developed for a historical 100-year storm using recorded deaths and injuries from Hurricane Sandy. Injury and fatality rates were calculated based on those values as percentages of the impacted population, and then valuations for those rates were calculated based on individual valuations published in FEMA and HUD guidance documents. Avoided costs of mental health treatment and lost productivity costs for the same cohort were calculated in a similar manner, also using percentages of the impacted population from Hurricane Sandy.

11 The ecosystem services gained and displaced were monetarily valued using the outside publication "The Value of New Jersey's Ecosystem Services and Natural Capital" by Robert Constanza et al.

12 Benefits transfer is the process of adapting an existing value estimate, like the amount of money earned from ticket sales for one amenity, to a different (but reasonably comparable) facility elsewhere. Social values for the Living Breakwaters were estimated by applying a benefits transfer to the unit values applied, that represent the willingness to pay for recreational and specific types of environmental education among potential users.

BREAKWATER

RECOMMENDATIONS

Our analysis concludes that a living breakwater would create multiple primary resilience and secondary ecological and social benefits for the Corps Project and offer an adaptable solution that works within the design constraints and criteria of the Corps' Feasibility Study. Therefore, we recommend that the breakwater concept remain in the seawall protection strategy, but that it be designed specifically as a *living* breakwater.

The key design constraints include impending sea level rise (which will alter the intertidal zone in the future), the alignment of the Battery, and federally-delineated navigation channels in the harbor. The living breakwater alternative will benefit the Battery by reducing erosion and long-term maintenance, while also delivering ecological benefits in the form of wildlife habitat and ecosystem services for the area.

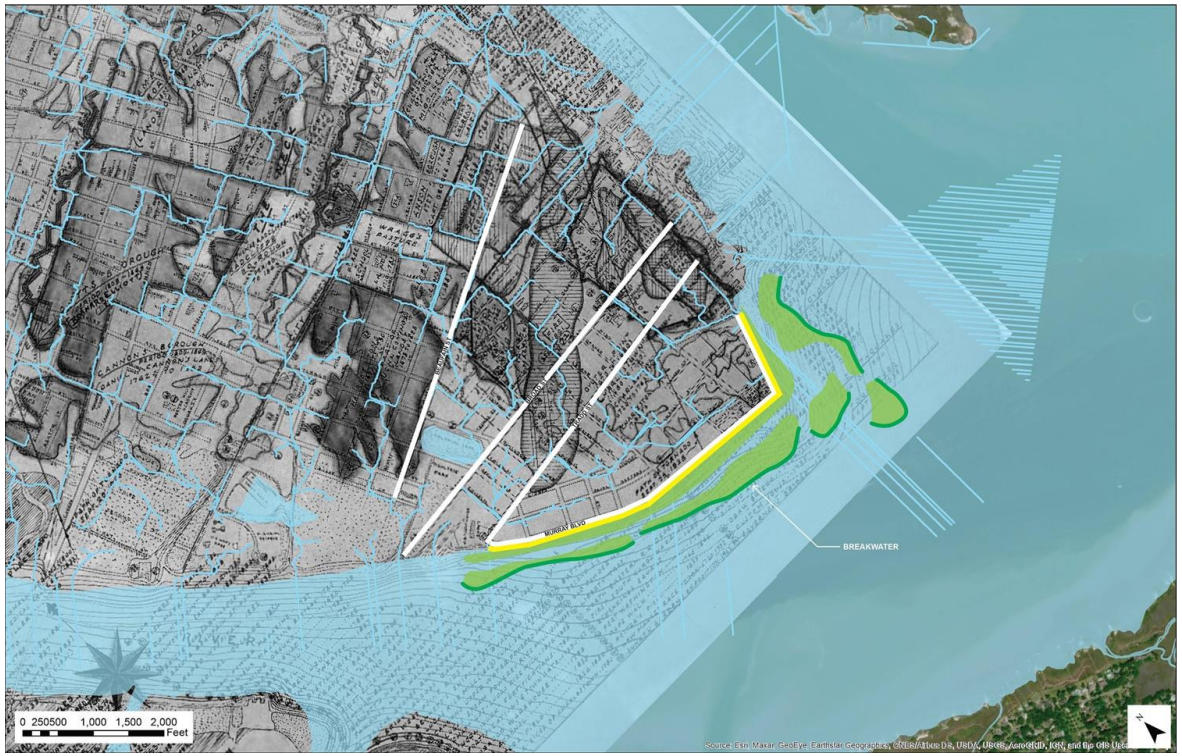
This design offers the ability to:

- Address existing/future storm surge and sea level impacts;
- Maintain the cultural and scenic role of the Battery and minimize hindrances to the viewshed;
- Reduce the cost of maintaining the Battery seawall;
- Protect the southern tip of the peninsula from flooding and repetitive damage;
- Restore native marsh habitat;
- Provide both primary (protection) and secondary (ecological services) benefits; and
- Adapt to sea level rise and other changing conditions.

HISTORIC MARSHLAND EDGE PRIOR TO COASTAL INFILL

A living breakwater would provide an equivalent level of protection as the Corps' proposed seawall but with important advantages. First, because it would mimic the natural geometry of coastline,[13] a living breakwater would restore historic marsh habitat at the tip of the peninsula for the first time since landfill whittled

13 The function of a coastline exists horizontally and vertically. Horizontally, the tidal footprint is a critical area available for waves to crash, vegetation to exist, habitat to thrive, and sediment transport to begin (i.e., erosion). These functions naturally exist in geomorphic and tidal balance that changes and evolves over time. Stability is driven by sediment size/deposition, wave energy, and edge structures (natural and anthropogenic). The footprint available for this horizontal edge condition is driven by the vertical profile/coastal grade of the shoreline. For example, a 4.3 foot tide has an 8-foot horizontal footprint in a 2:1 coastal slope while a 4-foot tide has a 40-foot horizontal footprint in a 10:1 coastal slope.



POTENTIAL MARSHLAND FORMATION WITH THE IMPLEMENTATION OF A BREAKWATER

away the marsh for development. This habitat could support a number of plant and animal species which are increasingly threatened by the disappearance of marsh throughout Charleston, including many fish and shorebird species. Second, this living shoreline approach also provides the kind of flexibility that a monolithic concrete wall cannot since structural constraints would prevent raising the seawall over time in response to sea level rise. A breakwater also would not obstruct views from, and thus diminish, the Battery, but would instead beautify the tip of the peninsula with a potential recreational and commercial asset. In short, a living breakwater works immediately to reduce wave energy, while also building resilient ecology, continually strengthening and adapting via sediment accretion, and enhancing the Battery's landmark status.

The larger the vertical and horizontal footprint of the living breakwater, the more area and flexibility there is for:

- Wave energy dissipation;
- Storm surge and wave height reductions;
- Erosion mitigation;
- Natural sedimentation and water quality improvement;
- Habitat creation for existing ecological communities;
- Habitat creation for sea level rise displacement/resettlement; and
- Ecosystem services and economic development.

As sea levels rise and stronger hurricanes more frequently batter the coast, the elevation of the Battery and of the living breakwater will need to be reevaluated and adjusted. Mid-range NOAA scenarios predict approximately 2.5 to 4 feet of sea level rise by the end of the Corps' Feasibility Study period (2026-2075), and upwards of 6 feet by the end of the century (NOAA 2017). With higher seas, waves and storm surge will also reach higher on the landscape.

At the same time, the living breakwater, if constructed, would continually strengthen through sediment accumulation, helping reduce storm surge impact on the Battery and, consequently, maintenance needs. As seas rise, the breakwater would have less surface area for energy dissipation and habitat but could be built up to adapt to

BREAKWATER
RECOMMENDATIONS

the rising tides. The height of the existing Battery will also likely need to adapt.

There are several methods that would keep this asset as active and iconic as it is today. Glass panel floodwalls or removable flood panels have the opportunity to blend closely with the area's historic nature and limit viewshed disturbance. These flood barrier inserts could be affixed into the Battery walls or fit over the existing rails to provide additional levels of protection and prevent overtopping. This would allow the Battery to achieve the necessary level of protection, while also maintaining one of Charleston's most prized landmarks without the need to construct an additional seawall in the area as proposed by the Corps.

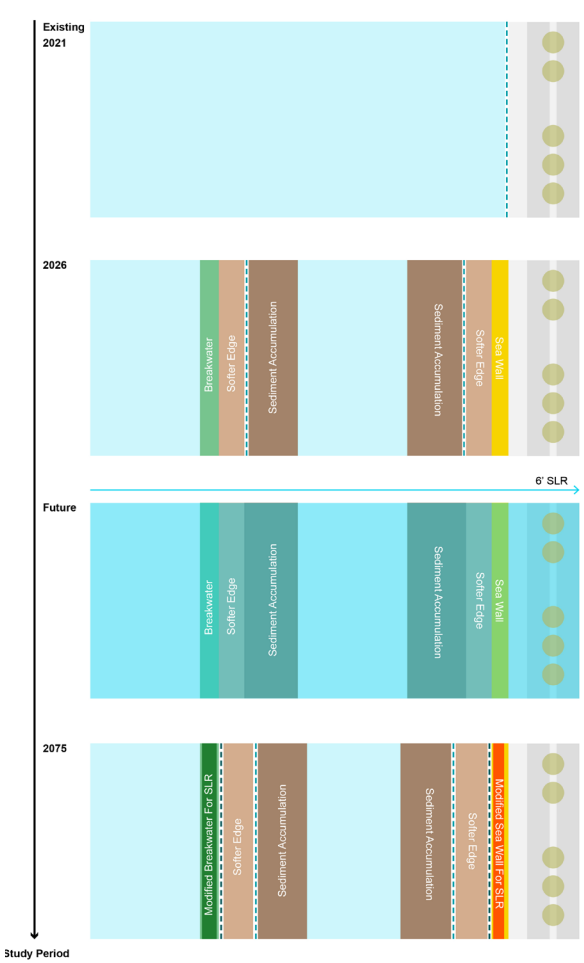
GLASS FLOODWALL (BBC 2016)

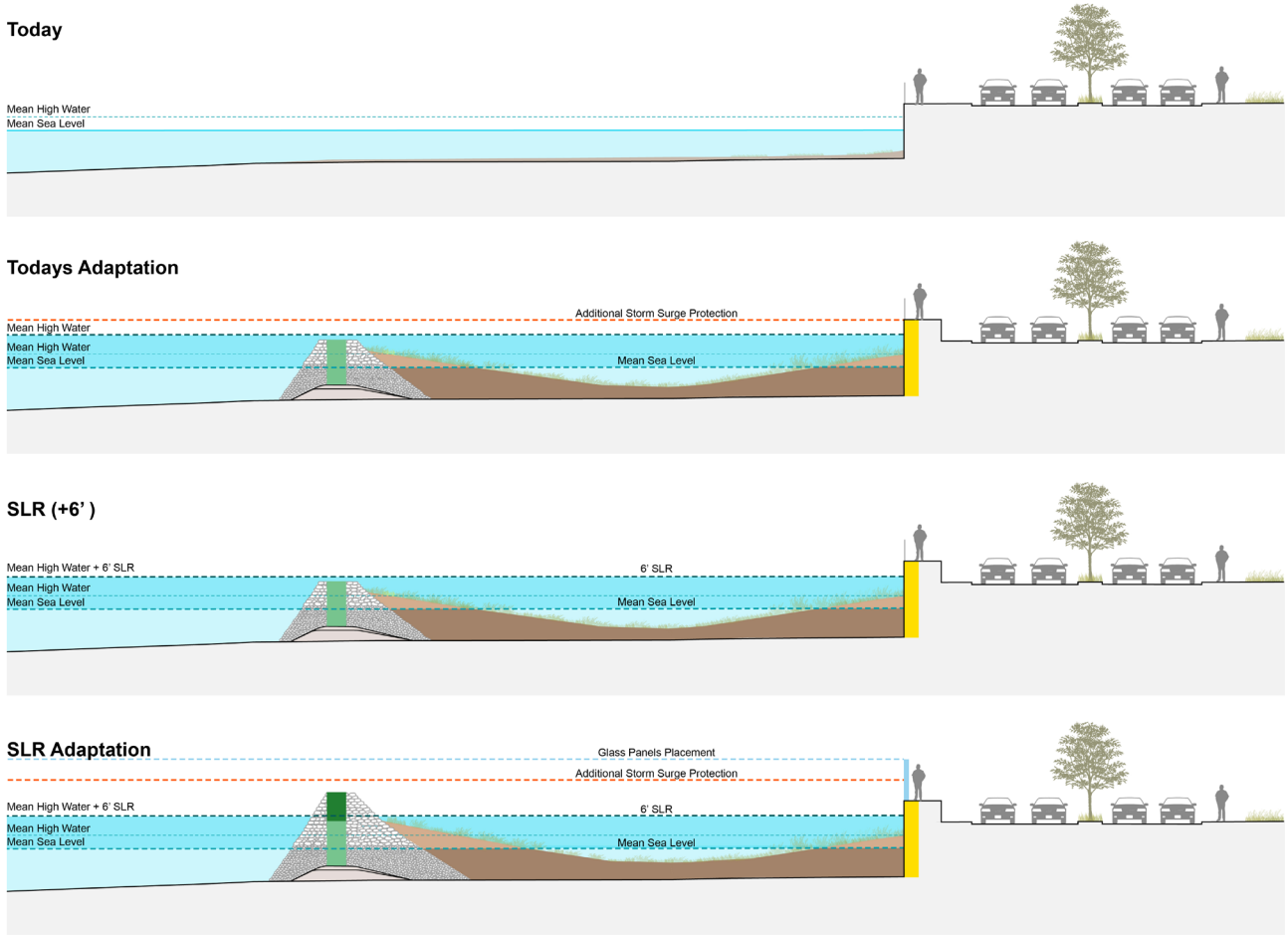
It is paramount that the Corps reevaluate the components of its BCA and its decision to eliminate the breakwater from the Project. The agency must calculate the numerous, valuable benefits of a natural wave attenuator and include these factors in the BCA to more accurately quantify its value. While there would be costs associated with maintaining a living breakwater, it would allow for adaptation, and create environmental benefits that also improve residents' well-being through better air and water quality. Living breakwater systems can also incorporate features such as:

- Oyster reefs to help dampen wave energy, filter water, and provide local jobs and food supply;
- Tidal wetlands to shelter crabs, shrimp larvae, and marsh birds;
- Shell mounds and mudflats for shorebird habitat; and
- Recreational opportunities for birding, fishing, education, and kayaking.

In addition to evaluating all potential benefits, the Corps should study the best location for the breakwater, taking into account scour and sediment accretion. Finally, we recommend that the Corps form an agreement with the city to define funding obligations—specifically, that the Corps will use federal money to build all aspects of the breakwater within their jurisdiction, and that the city will fund any additional features designed for habitat or recreation.

BREAKWATER
RECOMMENDATIONS





RECOMMENDED BREAKWATER ALTERNATIVES UNDER VARYING CONDITIONS

EXISTING BATTERY AND COASTLINE

BREAKWATER
RECOMMENDATIONS

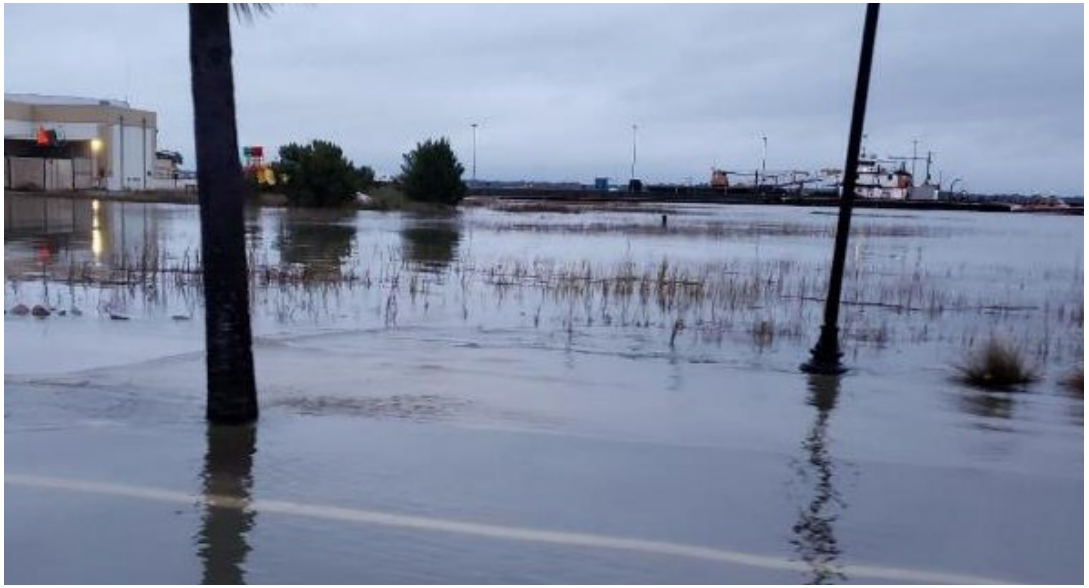
EXISTING LOCKWOOD CORRIDOR

4.2 LOCKWOOD CORRIDOR

BACKGROUND

Located in the southwest area of the Charleston peninsula, Lockwood Drive extends along the Ashley River from Fishburne Street on the north to Broad Street on the south. The Charleston Police Department, two marinas, a residential neighborhood, and the Medical District are all located on this corridor. The Medical District contains the largest concentration of healthcare infrastructure on the peninsula, including the Medical University of South Carolina (MUSC) and two other hospitals (Roper Hospital and Ralph H. Johnson Veterans Affairs Medical Center). For purposes of this report, the Lockwood Corridor comprises the zone between the south end of the Medical District and the north end of the U.S. Coast Guard Station.

Due to Lockwood Drive's elevation and proximity to the Ashley River, the corridor is especially susceptible to storm surge and tidal flooding. It is important to note that the elevation of Lockwood Drive changes along its alignment, and therefore, the road's vulnerability changes by location. An elevation analysis indicates that the northern portion of the road is higher and slightly less vulnerable than the southern end. Sunny day tidal flooding frequently occurs along the roadway, resulting in ponded water that may last for several days due to the topography's inability to drain, which in turn deteriorates roads, sidewalks, and utility infrastructure.



PERIMETER SALT MARSH BETWEEN LOCKWOOD DRIVE AND U.S. COAST GUARD, 2019 HIGH TIDE STORM (THE CORPS 2020)

LOCKWOOD DRIVE AND THE COASTAL EDGE

LOCKWOOD CORRIDOR

BACKGROUND

Lockwood Corridor and the Medical District are particularly vulnerable to severe tidal and stormwater flooding, particularly on King Tides. This flooding has impaired operation of critical facilities and created a need for frequent maintenance of area roadways — an issue which will only be exacerbated in the future as water levels rise, producing more frequent and severe tropical storms and, consequently, storm surge.

The shoreline edge of Lockwood Drive contains some remnants of the historic salt marsh, between the Charleston City Marina and Broad Street. This salt marsh, while not enough to combat future flooding on its own, is a vital asset to the community and the ecosystem. However, the marsh is at grave risk, as sea level rise threatens to inundate and further deteriorate it. In normal conditions, a salt marsh would migrate inland in response to an increase in water surface elevations, but this marsh is restricted from migration by Lockwood Drive and will instead shrink over time. Wave damage in this section of the corridor is thus likely to increase as this natural buffer recedes.

Our analysis also considered two lakes inland of the Lockwood Corridor — Long Lake and Colonial Lake — both of which provide the neighborhood with some stormwater detention but could be modified to increase floodwater storage.

LOCKWOOD CORRIDOR AND COASTAL MARSHLAND

LONG LAKE

LOCKWOOD CORRIDOR

BACKGROUND

LOCKWOOD CORRIDOR EXISTING CONDITIONS

The Lockwood Corridor has many important stakeholders that should have a role in determining the preferred strategies to address storm surge protection and inland flooding. The U.S. Coast Guard recently announced that it will move its Charleston operations to a larger superbase elsewhere in the area and sell the current base, which lies between the southern end of Lockwood Drive and the start of the Low Battery (Wren 2020). This property offers a significant opportunity for the Lockwood Drive Corridor, and the city as a whole, to add recreational space, improve bicycle and pedestrian connectivity, and increase coastal resilience. Additionally, in 2015, the Medical University of South Carolina (MUSC) created a campus-wide master plan to envision the future for the Medical District and how it will adapt to a changing world and address its current storm and tidal flooding issues.

LOCKWOOD CORRIDOR

BACKGROUND

In meetings with the MUSC internal Master Plan team, our project team learned that the Medical District is actively trying to mitigate flooding conditions, even studying raising Courtenay Drive and Doughty Street and increasing the stormwater storage capacity of Long Lake. Alignments between the Medical District's and the Corps' recommended solutions could include raising Courtenay Drive, increasing the capacity of Long Lake, and improving pedestrian connectivity throughout the Lockwood Corridor and the Medical District. There is also the possibility of integrating potential stormwater tunnel construction projects with new edge protection solutions to best optimize construction costs and maximize the efficiency of long-term protection, maintenance, and performance.

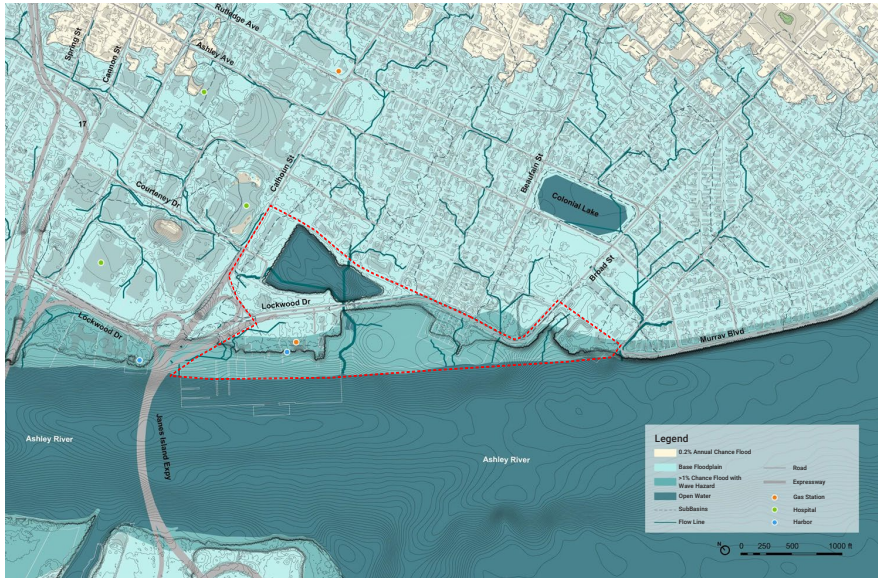
Lastly, it is important to note that this particular zone of study will also affect a residential neighborhood, whose residents expressed a desire to enhance the local ecosystem in any protection and stormwater mitigation solutions. We virtually engaged with a focus group of residents living in the Harleston Village neighborhood to discuss the Corps' proposal. During these conversations, it became clear that any solution must also align with the character of the neighborhood and address more than just storm surge risk. A concrete wall inhibiting views of the river and degrading the ecosystem was not a favored solution, rather the residents would prefer a solution more reflective of both the needs and character of the area.

MEDICAL DISTRICT PERSONNEL

MEDICAL DISTRICT PERSONNEL

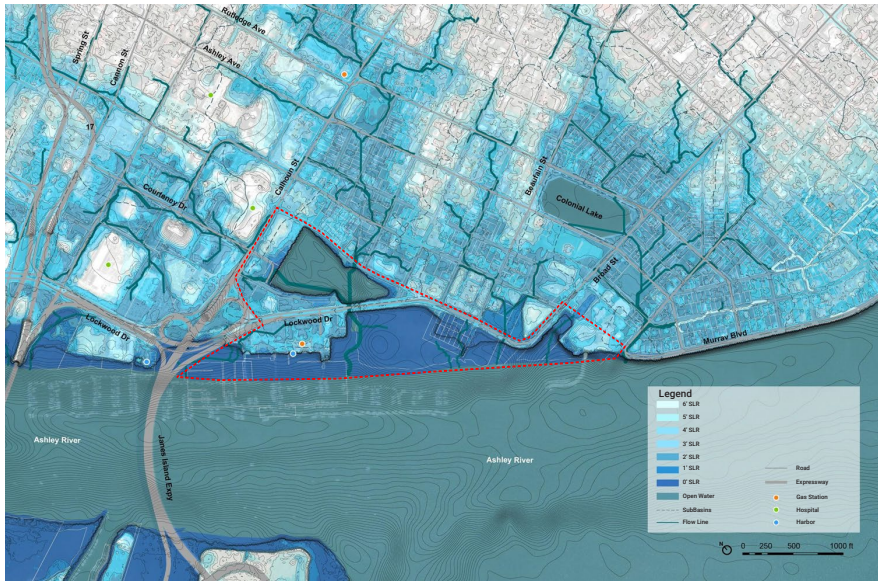
LOCKWOOD CORRIDOR

BACKGROUND

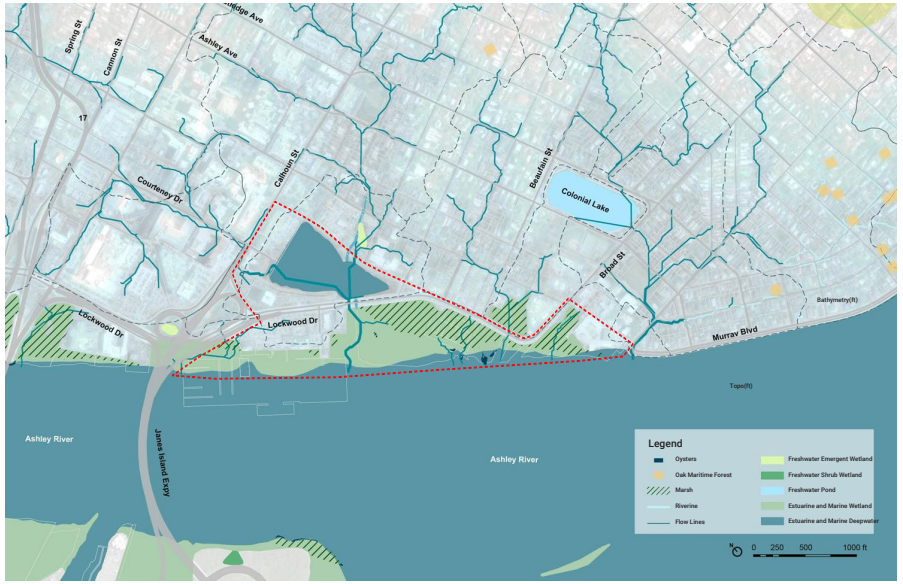


LOCKWOOD CORRIDOR FLOODPLAIN

LOCKWOOD CORRIDOR ELEVATION



LOCKWOOD CORRIDOR SEA LEVEL RISE



LOCKWOOD CORRIDOR NATURAL RESOURCES

LOCKWOOD CORRIDOR

POTENTIAL DESIGN APPROACHES

The alternatives we present for the Lockwood Corridor are substantially different from the Corps' proposed seawall. The Corps' design achieves some level of surge protection but at great expense to the local ecosystem, neighborhood character, and maintenance costs; our alternative solutions would provide commensurate levels of protection while avoiding the negative consequences. These alternatives are by no means the first of their kind but are based on precedential projects and concepts embraced elsewhere in the United States, including by the Corps.

NATURAL & NATURE-BASED FEATURES

In 2016, Congress specifically included natural and nature-based features (NNBFs) as a planning requirement in Corps flood risk reduction projects. Since then, the Corps has begun to more frequently incorporate these types of designs through its Engineering with Nature division. The Corps considers NNBFs to include wetlands, such as salt marshes, and certain submerged aquatic vegetation, such as oyster and coral reefs (Carter et al. 2020).

The Corps recognizes that NNBFs can support risk reduction and provide ecosystem services, such as habitat and nesting grounds for fisheries, that ultimately contribute to coastal resilience.

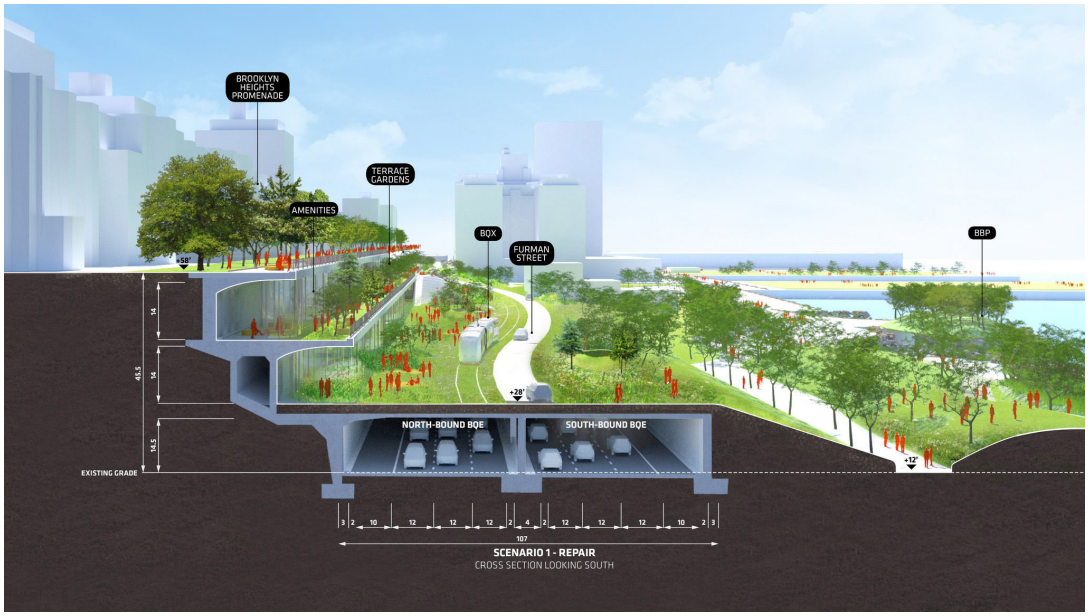
MARSHLAND FRONTING LOCKWOOD DRIVE

Many NNBFs are also lower in cost than traditional grey infrastructure solutions, as NNBFs often require minimal maintenance and rarely have life cycles where functionality diminishes (Carter et al. 2020). Indeed, functionality of the design often evolves naturally with the site ecology.

Enhanced wetlands as a coastal protection strategy are a favorite among NNBFs because their dense vegetation and shallow water depths can slow the advance of storm surge. Relatedly, wetlands help to dissipate wave energy, potentially reducing the destructiveness of storm surge. In addition to risk and damage reductions, wetlands provide other critical, valuable ecosystem services, from supporting commercial seafood harvests, to absorbing water and air pollutants, to serving as a habitat for wildlife. For these reasons, the Corps has been increasingly incorporating living shorelines with

enhanced wetlands in its coastal resilience projects, especially in the Gulf of Mexico (Carter et al. 2020).

In the Corps' Virginia's Norfolk Coastal Storm Risk Management Project, the agency recommended living shorelines as a tool to increase resilience, citing that NNBFs were "economically justified by their ability to reduce maintenance costs associated with structural features of the [recommended plan]" (U.S. Army Corps 2018, p. 331) . The Corps also applied similar measures to New York's East Rockaway Inlet to Rockaway Inlet and Jamaica Bay in another reformulation project, where large boulders and enhanced vegetation were added to a coastline to mitigate wave action and reduce erosion. For the latter project, the Corps determined that NNBFs were the best solution because they would cost less per linear feet of seawall (U.S. Army Corps 2019, p. 135).



BQP SECTION, COURTESY OF BIG ARCHITECTS (WORLD ARCHITECTURE CONTENTS 2019)

ENCAPSULATED ROADS

Built in the 1950s, the Brooklyn Queens Expressway (BQE) is an iconic piece of New York City infrastructure that has accommodated car and truck traffic for more than 60 years. Due to the road's deteriorating condition, renovations were commissioned for the expressway, and after multiple design iterations, the final proposed project includes an at-grade roadway along Brooklyn Bridge Park (BQP) with a covered simple deck structure. The deck provides a platform for adding significant new parkland above an underused corridor, while connecting Brooklyn Heights to Brooklyn Bridge Park with a preserved or re-constructed cliffside—crisscrossed by rampways, greenery, and park amenities. The result is a condition more reminiscent of Brooklyn Heights' historic conditions, where city and river interlaced seamlessly prior to construction of the expressway (World Architecture Contents 2019). Like our vision for Lockwood Drive, this new BQE is intended to become a connector not only for cars and trucks, but for people — to integrate neighborhoods with greenspace after decades beside a major highway.

LOCKWOOD CORRIDOR

RECOMMENDATIONS

The goals of our modified alternative include:

- Integration with the city's and the Medical District's capital improvement plans;
- Meeting design criteria within relevant constraints;
- Increasing pedestrian connectivity and promoting passive and active recreation;
- Promoting ecological preservation and restoration;
- Supporting economic development;
- Minimizing grey infrastructure; and
- Enhancing the character and history of the coastal edge.

The design criteria are adapted from the Corps' stated goals, including to:

- Protect Lockwood Corridor from storm surge;
- Improve connectivity between the two anchors (Medical District and U.S. Coast Guard Station) and throughout the area;
- Preserve critical transportation networks and evacuation routes; and
- Re-establish enhanced ecology for long-term benefits

Design constraints associated with the area include:

- Minimal coastal edge elevation change;
- The highest concentration of marsh soils on the peninsula;
- A high water table; and
- Land subsidence.

These factors make it impossible for the city to build large enough pipes to fully drain the Lockwood Corridor to the Ashley River, leaving the area continuously vulnerable to a bathtub effect during sunny-day and storm flooding. There are currently no structural protections for the area, and the elevation of the Ashley River Bridge (US 17) constrains the height of any proposed structural measures.

After identifying these design criteria and constraints, our design process evaluated ideas that have already been presented for the Lockwood Corridor, as well as potential project precedents, and determined what portions of each idea fit the design constraints and criteria. Each idea was evaluated in detail for feasibility, performance, and adequacy. We followed this iterative process to reach final recommendations.

The recommended solution is separated into two phases: a first phase (Phase 1), with two alternative phases for future protection (Phases 2A and 2B). These recommendations are presented in this order to show the potential to adapt to evolving conditions.

Phase 1

Through our feedback, research, and analysis, we conclude that the proposed seawall does not properly accommodate the Lockwood Corridor's character or ecosystem: in particular, this area of Charleston is unique in that a seawall does not yet exist, and we believe this more natural character should be preserved by avoiding new traditional grey infrastructure. Instead, the Corps should pursue a solution that leverages existing salt marsh conditions to provide natural protection, with possibilities for future adaptation and resilience. A nature-based solution in this segment of Lockwood Corridor could:

- Allow for salt marsh replenishment and natural edge protection;
- Integrate neighborhood stormwater capital improvement projects for dual performance and more dynamic protection;
- Provide an edge protection design that also doubles as a community amenity and place-making opportunity;
- Re-consider existing vehicular circulation; and
- Link Charleston's Medical District to the U.S. Coast Guard Station.

LOCKWOOD CORRIDOR

RECOMMENDATIONS

PROPOSED ALTERNATIVE STRATEGIES

As Phase 1 for the Lockwood Corridor, we recommend constructing a horizontal levee in the same general alignment of the Corps' proposed seawall. A horizontal levee is a form of levee that blends a traditional earthen levee with the restoration of tidal marshes, which are excellent natural barriers to slow storm surge. The horizontal levee would consist of a standard levee (impermeable core, fill, side slopes, etc.), but with a gentler slope on the river side to encourage salt marsh establishment and growth over time. The horizontal levee would be constructed along the southern portion of Lockwood Drive and extend north to the City Marina. From here, an earthen berm would wrap the outer edge of the City Marina and connect to the Corps' proposed seawall at the intersection of Lockwood Drive and the James Island Expressway.

LOCKWOOD CORRIDOR

RECOMMENDATIONS

Lastly, to provide the opportunity for further wave attenuation and habitat restoration, this phase also includes a series of breakwaters that stretch from south to north in alignment with the existing marina slips.

Along the portion of Lockwood Drive protected by the horizontal levee, we recommend reducing the road width and number of lanes to one lane of travel in each direction. This would minimize disturbance to the existing salt marsh since the levee could occupy land formerly taken up by the road, and reduce costs associated with in-water work, construction access, and road re-paving.[14] In addition, the reduction in lanes would eliminate existing lane redundancies at Lockwood Drive's connection with Broad Street, calm traffic in this more residential area, and improve bicycle and pedestrian safety.

This alternative would offer at least as much protection as the Corps' proposed seawall, but with minimal grey infrastructure and a more natural edge on already disturbed land. This layered approach of vertical protection with embedded ecosystem services would protect residents and infrastructure, preserve the area's natural beauty, and improve the ecology. The horizontal levee would also enhance the aesthetic value of the harbor viewshed from the Lockwood Corridor, likely maintaining or increasing property values in the area.

Phase 2A

Phase 2A proposes to expand on the horizontal levee and berm constructed in Phase 1: specifically, the berm would remain, while the top of the levee would be extended inland to encapsulate Lockwood Drive, either by tunnel or cantilever. The levee elevation would be raised to fit overtop Lockwood Drive, which would be designed to accommodate a 14-foot clearance for each of the two lanes, thus offering even more protection against storm surge and tidal flooding than Phase 1. Above Lockwood Drive, on top of the levee, a promenade would create linear park space for active and passive recreation with expansive vistas of the Charleston Harbor.

This solution creates an opportunity for economic development along the promenade, which could be transformed into a tourist destination similar to the High Line in New York City or the BeltLine in Atlanta. Additionally, this promenade would embed pedestrian circulation into a car-dominated corridor and connect two major anchors, the Medical District and the U.S. Coast Guard Station, with an option to link to the High Battery. This would essentially re-invent the western edge of Charleston as a forward-thinking, interconnected ecosystem that is capable of responding and adapting to climate change over time.

In addition to supporting economic development and recreational opportunities, this alternative prioritizes safe access to critical infrastructure in a changing climate and offers safe ingress and egress in all conditions. The tidal and storm surge flooding that exists along the corridor today threatens the functionality of critical infrastructure and, consequently, the safety of the entire peninsula. By redesigning Lockwood Drive, critical infrastructure such as emergency services could continue to operate on this road and access the peninsula even after a natural disaster.

Phase 2B

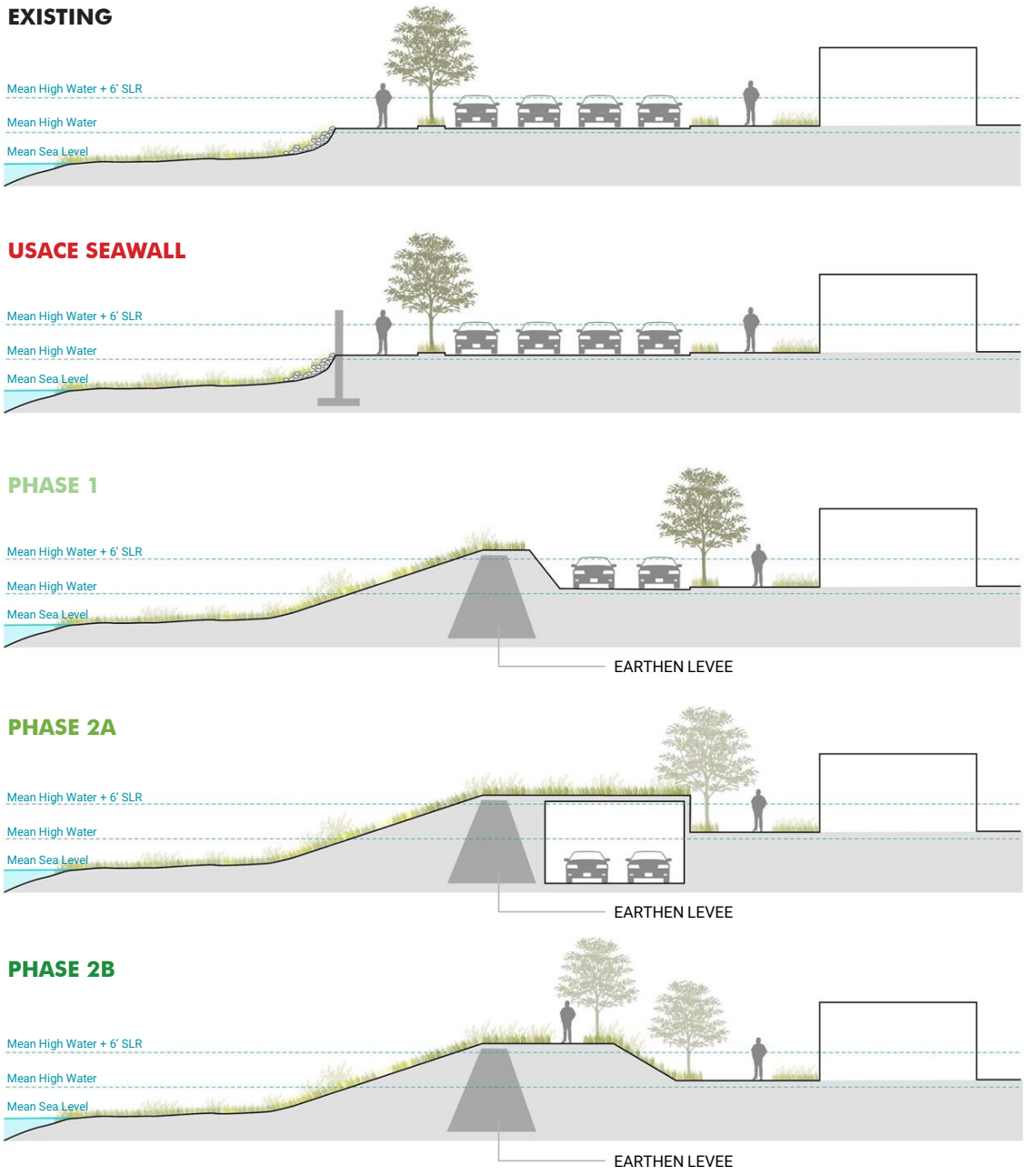
Phase 2B further challenges the status quo and asks the question: What could we accomplish if we completely re-envision Lockwood Drive? Could we shift this segment of the Lockwood Corridor away from vehicular traffic to pedestrian circulation, resilience, and recreation instead? Under Phase 2B, the horizontal levee would remain, but Lockwood Drive would be removed altogether, transforming

14 By contrast, our assumption is that construction of the Corps' seawall would need a minimum of one lane of traffic for laydown, setup, and installation, and would likely disrupt the salt marsh habitat along Lockwood Drive's edge.

LOCKWOOD CORRIDOR
RECOMMENDATIONS

the former road into a linear park linking the Medical District and Harleston Village to the Low Battery. This would convert the western edge of the peninsula into a multi-functioning asset that prioritizes green space and returns the land to as close to natural conditions as possible. Removal of Lockwood Drive would permit the city to integrate stormwater capital improvements into the new open space and enhance the stormwater detention capacity of Long Lake by raising its edges. Phase 2B would also align with the master plan for the Medical District, which prioritizes more park space and better pedestrian access as key elements of its flood-control efforts.

For a proposal of this magnitude, the city would need to re-think vehicular circulation in this area of Charleston. At present, the city is regularly required to close Lockwood Drive and divert traffic due to recurrent tidal flooding. Permanently redirecting traffic away from this low-lying area would conserve city services and maintenance costs required to continually repair flood damage to the road. Still, the city is best positioned to evaluate and optimize vehicular circulation in the Lockwood Corridor and the broader peninsula, so other combinations of pedestrian and vehicular space should be considered to balance open space, resilience, and traffic.



LOCKWOOD CORRIDOR

RECOMMENDATIONS

LOCKWOOD CORRIDOR VISION

Each of the alternatives for the Lockwood Corridor assume completion of and alignment with the Calhoun West stormwater improvement plans for the Medical District watershed. We propose to integrate Long Lake into this design and raise its edges to add even more water detention capacity for the neighborhood. Ultimately, creating an ecological corridor that protects against storm surge and also collects and stores runoff is the best possible alignment for the Lockwood Corridor. By integrating these performance factors and focusing on nature-based strategies, we believe that the Lockwood Corridor could become one of the city's most dynamic, "green," and connected zones.

LOCKWOOD CORRIDOR

RECOMMENDATIONS

ROSEMONT COMMUNITY AND ADJACENT MARSH EDGE

4.3 ROSEMONT

ROSEMONT

BACKGROUND

Located just outside the boundary of the Corps' proposed seawall, Rosemont is a predominantly Black neighborhood on the upper-peninsula that has been disproportionately impacted by infrastructure development and industrial pollution in its history. While the Feasibility Study identified Rosemont as a community at risk from future coastal storm flooding, the Corps recommended only general, non-structural solutions, including home elevations, floodproofing, and buy-outs. The Corps' proposal leaves Rosemont without a clear resilience plan or tangible resilience measures beyond a vague commitment to apply non-structural solutions to 100 structures. In preparation for this report, the Southern Environmental Law Center (SELC) and the South Carolina Coastal Conservation League (Conservation League) conducted outreach with Rosemont residents; their feedback highlighted the need for the Corps and the city to work with residents to incorporate their experiences and needs into any flood management plan.

NORTHERN EDGE OF THE ROSEMONT COMMUNITY, INTERSTATE 26 AND SOUNDWALL

Our mission is to encourage the Corps to develop a resilience plan and implement community-sensitive strategies for Rosemont and other environmental justice communities at risk from flooding. Through engagement, residents and expert agencies can jointly develop an action plan to resolve critical shocks and stresses to the community, prioritize near-term resilience improvements, and set a path toward long-term resilience.

Local Context - Infrastructure & Industry

Rosemont has experienced effects from a disproportionate share of government-funded infrastructure projects over the last several decades, taking a permanent toll on the physical fabric and the quality of life of the community. Rosemont was once a much larger, connected community that stretched across the width of the upper-peninsula in an area referred to as the "Neck." The construction of Interstate 26 (I-26) in the 1960s severed the community and hastened the conversion of many residential buildings to commercial and industrial use. More recently, construction of the Leatherman Port Terminal access roads has placed highway ramps in the community, removing wetlands and marsh and necessitating noise barriers along its eastern edge.

ROSEMONT

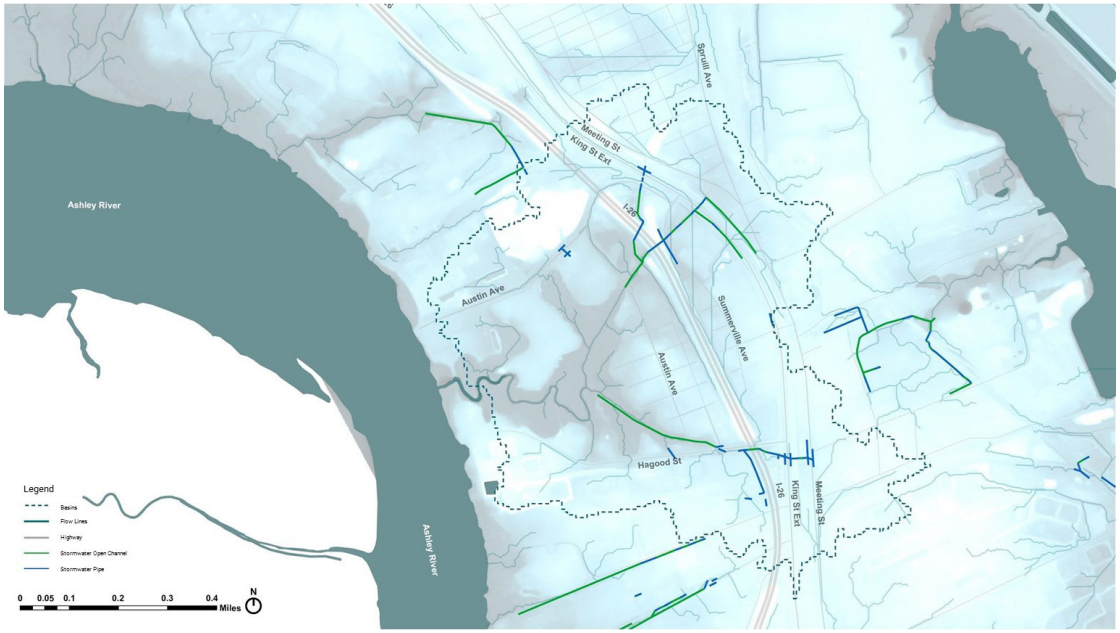
BACKGROUND

Rosemont is surrounded by industrial uses that compound its physical isolation from I-26. These industrial uses carry a history of environmental contamination, including decades of clean-up operations to remediate the pollution and associated health risks (Emmerson 2019). These conditions have impaired the quality of life of Rosemont residents and significantly weakened property values in the neighborhood.

Local Ecologic Conditions

Rosemont is connected to the larger coastal marsh ecosystem that runs along both sides of the Ashley River. This coastal ecosystem provides critical wildlife habitat, filters and cleans the local water system, provides erosion protection, stores carbon, and enhances natural beauty. Rosemont historically supported commercial and recreational fishing, but legacy pollution from nearby industrial operations have degraded the water quality such that fishing is seemingly no longer viable. Although at risk from polluted runoff and sea level rise, the largely intact coastal marsh bordering Rosemont should play a role in a community resilience strategy. Today, the community is largely disconnected from this marsh. Unlike nearby waterfront communities like Harleston Village, which has a series of paths to and along the marsh, Rosemont's connection to its waterfront has been mostly severed since the former community dock washed away during Hurricane Hugo in 1989.

MARSHLAND AND NATURAL RESOURCES



STORMWATER INFRASTRUCTURE NETWORK

Flood Risk

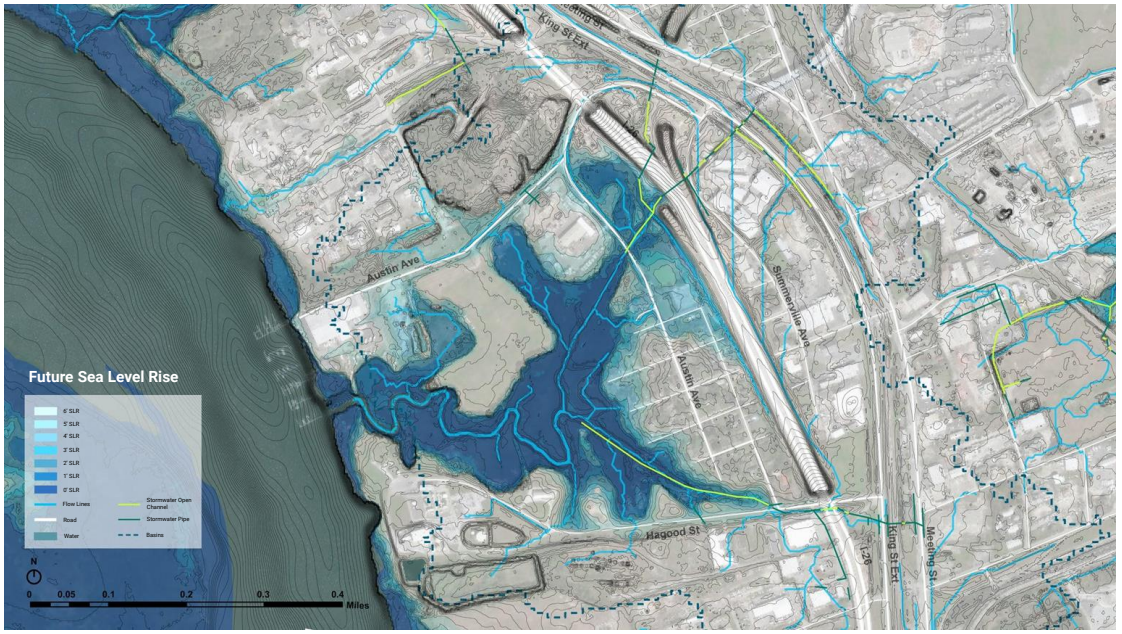
Rosemont faces future flooding threats from tides, rainfall, storm surge, and poor inland drainage. The marsh edge of the community sits approximately at sea level, so any sea level rise and increase in storm severity will increase, perhaps catastrophically, the coastal flooding risk.

While coastal flooding is a significant concern, the community also faces inland flooding issues because there is no roadway drainage in Rosemont and the new highway sound barriers restrict surface water flow. As sea levels rise, storage capacity of the marsh will be reduced, which could further exacerbate localized flooding conditions.

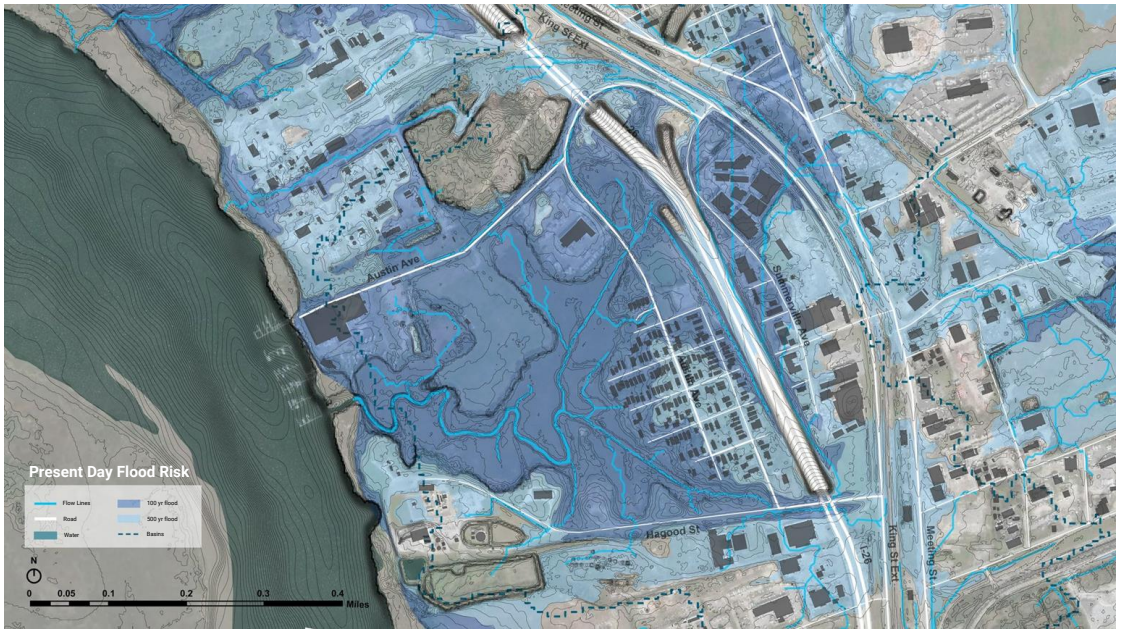
Additional Resilience Considerations

Rosemont is physically isolated from the greater peninsula with only two means of egress past I-26, threatening to cut off access to and from the community during storms. We are uncertain what proportion of Rosemont residents have flood insurance, or have the legal title to apply for insurance or federal funding in case of damage.

Coastal flood risk, inland flood risk, industrial contamination, access limitations, insufficient water management infrastructure, and a pattern of environmental injustice have put Rosemont in a precarious physical and economic position.



FUTURE PROJECTED SEA LEVEL RISE



PRESENT DAY FLOOD RISK

ROSEMONT

POTENTIAL DESIGN APPROACHES

We looked to resilience plans developed by other communities for inspiration and guidance in this report. Many communities across the country have taken an iterative approach to designing small- and large-scale projects to manage climate change impacts while maintaining community character. One example is the New York Rising Community Reconstruction Plan—specifically, the community of Broad Channel, which bears similarities to Rosemont.

The New York Rising Community Reconstruction Plan in Broad Channel included a series of strategies designed and driven by the local community to address inundation during high tides and storms, while developing resilient edge conditions and creating community gathering places. Residents were steadfast about staying in place amid chronic flooding, and therefore focused their efforts on short-term, innovative, and sustainable projects to protect critical infrastructure, natural and cultural amenities, and social centers (Governor's Office of Storm Recovery 2014). The community leveraged technical expertise through partnerships with the state Departments of Transportation and Environmental Conservation, secured funding through the Community Development Block Grant (CDBG) program, and formed resident-driven planning committees to evaluate and design the resilience plans. Design solutions for Broad Channel included raising streets and removing curbs to accommodate vehicle, bicycle, and pedestrian traffic, strategically constructing bulkheads to prevent tidal surges, and installing new stormwater drainage systems, water mains, and sewage infrastructure. Through the support of the State of New York, the City of New York, and outside technical assistance and funding sources, the end result was a truly community-led plan that addressed the most pressing challenges with multi-benefit solutions.

ROSEMONT RESIDENTS

RECOMMENDATIONS

The Corps' current approach to Rosemont—recommending only general, non-structural strategies with no specific implementation plan or timeline—is unacceptable. Not only does the proposed seawall omit Rosemont from its boundary, it may even have the harmful effect of deflecting wave activity into the marsh around Rosemont. Given the substantial future threats facing this community, we recommend that the Corps meaningfully engage with residents to design and implement place-based and community-sensitive measures to avoid catastrophic loss, slow erosion of natural resources, and protect quality of life in Rosemont.

A holistic, resilient solution starts with focused community dialogue that elevates the voices of Rosemont residents to target positive change. As part of this Project, the Corps can—and should—incorporate and fund a resilience plan that serves Rosemont now and into the future, as well as lay the physical and financial foundation for a series of proposed structural resilience measures.

Engagement

SELC and the Conservation League have begun the process of connecting with community members to understand their immediate and long-term resilience risks. Through several walking sessions in Rosemont, SELC and the Conservation League gathered insights into residents' most urgent concerns, knowledge of the proposed seawall, flood exposure, and desires for the future of the community. This engagement was limited due to the ongoing COVID-19 pandemic and highlighted the need for the Corps and the city to share information and elicit feedback in a more coordinated, widespread manner.

SELC and the Conservation League posed the above questions to Rosemont residents in an effort to spark dialogue within the community about the Corps Project.

COMMUNITY SURVEY QUESTIONS

Are you aware of the current Corps plan to build a seawall around the Charleston Peninsula?

What are your biggest concerns in the community?

What would you like to see improved in your community?

Who do you turn to when you need help?

Do you experience flooding? If so, what kind and where?

As you think about flood protection, what would benefit you and your community?

What is your relationship with and connection to the adjacent marsh?

ROSEMONT
RECOMMENDATIONS

Community members shared that neighborhood cohesion is beginning to erode due to infrequent, inadequate opportunities for group interactions and activities. Residents expressed a need for more public amenities, such as outdoor park space, and revealed that there is no shared connection to the marsh and waterfront, though some individuals have their own docks or access points. The community also conveyed frustration at a lack of government support, particularly on critical infrastructure. For example, residents have struggled to get the city to address recurrent septic flooding issues; indeed, the fact that many homes in Rosemont are not connected to the sewer system poses an additional risk to residents during a flood.

This outreach is intended to help the community initiate conversations around resilience planning and build a constituency to participate in the Corps Project and future resilience endeavors.

Non-Structural Intervention Opportunities: A Community Resilience Plan

The Corps should fund a community resilience plan as part of the Project. The development of a consensus-driven plan would arm the community with data to understand its vulnerabilities, present the risks and challenges it faces, and identify resources to mitigate these risks. In short, it would provide a blueprint for Rosemont to gain support and empower the neighborhood to champion its needs.

True resilience encompasses environmental, social, and economic values. To that end, a successful resilience plan should consider risks, needs, and opportunities in the categories of community planning and capacity building, economic development, health and social services, housing, infrastructure, and natural and cultural services. The plan should be specific enough to position the community to obtain funding for implementation. Through the planning process, Rosemont residents would assess the community's vulnerabilities to future disasters and identify worthwhile, desirable resilience measures. By understanding and managing the risk to their own community, Rosemont can steer future decisions to ensure their needs are prioritized.

The framework for a community-based plan begins by selecting appropriate community participants and outside partnerships, establishing the scope and goals of the plan, conducting public outreach, and identifying areas of risk. These organizational elements are followed by an assets inventory and risk assessment; based on the risk assessment, a steering committee can determine the community's needs and opportunities in

the face of these risks and engage in a larger regional planning process. The final step is to map out implementation strategies for the plan, including a schedule with funding sources. The development of resilience solutions spearheaded and supported by Rosemont residents should generate a sense of community ownership and pride, encouraging long-term stewardship and sustainability of the plan.

Not only should the Corps facilitate development of the Rosemont resilience plan, but the agency should also fund and implement its recommendations as part of the Project. The structural interventions discussed below, such as marsh restoration, stormwater management retrofits to streets, and horizontal levees, would serve the core mission of the Corps Project—to protect against storm surge by blocking, storing, and conveying floodwaters. For any elements the Corps does not construct, the community plan should clearly identify potential funding sources and provide a timeline for implementation. There is a wealth of financial resources available to take the Rosemont plan from paper to reality, including grants from FEMA, HUD, the U.S. Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), and other state and federal agencies. Some grants require cost-share requirements, speaking to the need for financial partnerships at various levels in addition to technical assistance. A summary of funding sources and strategies to support resilient planning initiatives are further discussed in the Appendix.

RECENTLY CONSTRUCTED SOUNDWALL ADJACENT TO THE ROSEMONT COMMUNITY

Since Rosemont is part of the larger resilience story in Charleston, the community engagement and planning initiatives developed for Rosemont should be integrated into other aspects of the Corps Project and future resilience efforts. For example, marsh conservation and restoration efforts developed for Rosemont can act as a pilot ground and pathway to broader scale implementation of these important strategies in similar areas across Charleston. Further, partnerships and coordination with nearby communities and organizations can support the development of replicable strategies. For example, the Lowcountry Alliance for Model Communities (LAMC) is undertaking a similar effort of engagement and resilience planning in North Charleston, immediately north of Rosemont, funded through an Environmental Justice Grant (Dennis 2020).

ROSEMONT
RECOMMENDATIONS

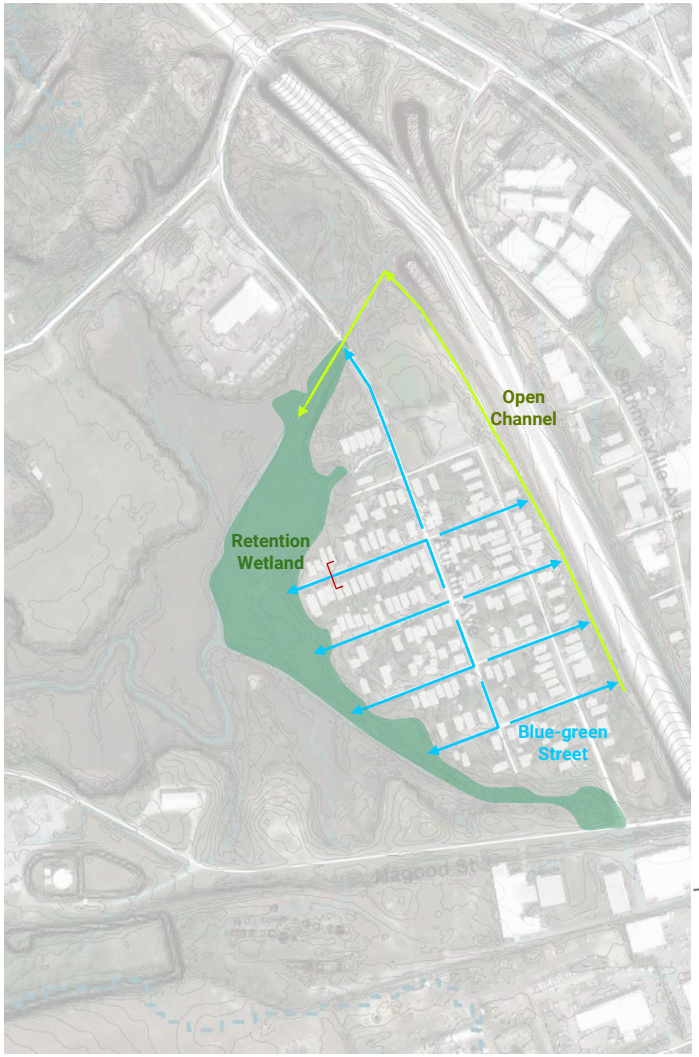
Structural Intervention Opportunities
In addition to a community resilience plan, the Corps should consider and implement structural protection measures to protect Rosemont against sea level rise and future storm surge. The nature of protection should take into account the local context, the ecological value of the marsh, the currently severed connection between the community and water, and the community resilience plan.

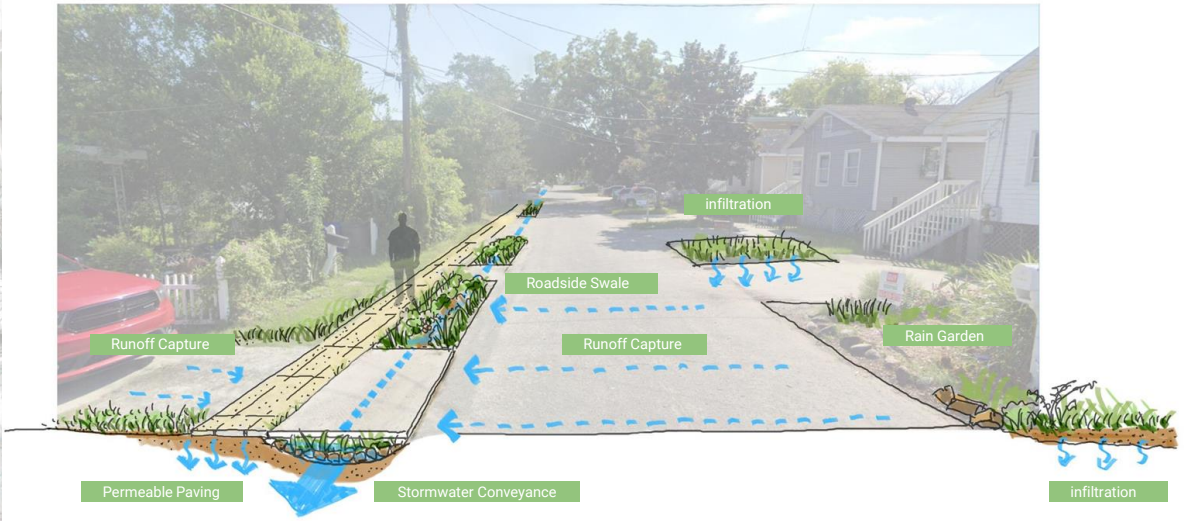
The structural recommendations presented below should be viewed as a toolkit of potential resilience solutions—a jumping-off point to spur further investigation and engagement in line with the Rosemont community's priorities. They are envisioned as a series of integrated protection measures that support community cohesion and ecological resilience in the face of changing conditions. Flood management solutions should enhance ecological functions, as the integration of natural systems has the potential to provide adaptive protection and larger-scale ecosystem services. Opportunities within the community, such as the integration of blue and green streets, can connect to the larger watershed network while bridging the gap between intermediate- and long-term solutions. Specific structural measures directly target coastal impacts and storm surge and should be prioritized and implemented as part of the Corps Project.

ROSEMONT RESIDENTS

Inland Strategies
An effective strategy to resolve inland flooding is development of a blue-green street network. Blue-green infrastructure is a water management approach that incorporates both natural areas and engineered systems, such as permeable pavement, roadside swales, and rain gardens, to slow, capture, cleanse, and store water runoff. This multifunctional strategy reduces localized flooding, recharges groundwater resources, and filters stormwater pollutants prior to infiltration and conveyance to the marsh, which serves as a local and regional resource for storing water. A blue-green street network in Rosemont would integrate into existing stormwater channels to enhance the movement of water into the marsh; as water moves through the street network, there is an opportunity to slow and filter upland stormwater to reduce erosion, contamination, and sediment pollution in the marsh. This strategy would solve a primary flooding concern expressed by Rosemont residents to canvassers—inland ponding due to interstate noise barriers—and would also support community greening, gardens, and pedestrian accessibility.

BLUE GREEN STREET
STORMWATER CAPTURE, CONVEYANCE AND INFILTRATION





ROSEMONT
RECOMMENDATIONS

Edge Strategies
The marsh neighboring Rosemont should serve as a key coastal flood protection asset to the community—with an aim to defend the community from future flood events and sustain the ecological function of the marsh.

Rosemont resembles many other Charleston communities, with fragile marsh forming a regional ecosystem that can be leveraged for coastal protection, mitigation, and adaptation. However, this marsh faces a number of existential pressures due to climate change and human development, and a concerted effort is needed to maintain its size and ecological function.

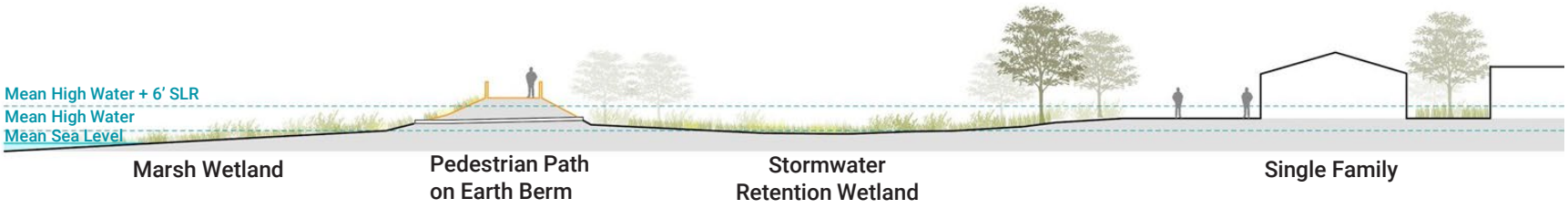
Enhanced vegetation and horizontal levees could be used to create additional wetland and stormwater retention areas, improving the marsh's stormwater retention and natural functioning. The marsh could also be activated for community recreation through the construction of protection berms that extend into the marsh. Over time, as mean sea levels and mean high water levels rise, elements such as an inland tidal gate, horizontal levees, and a riverfront deployable barrier could be incorporated into the resilient marsh design to further protect the community from extreme storm and flood events.

ROSEMONT MARSH NETWORK

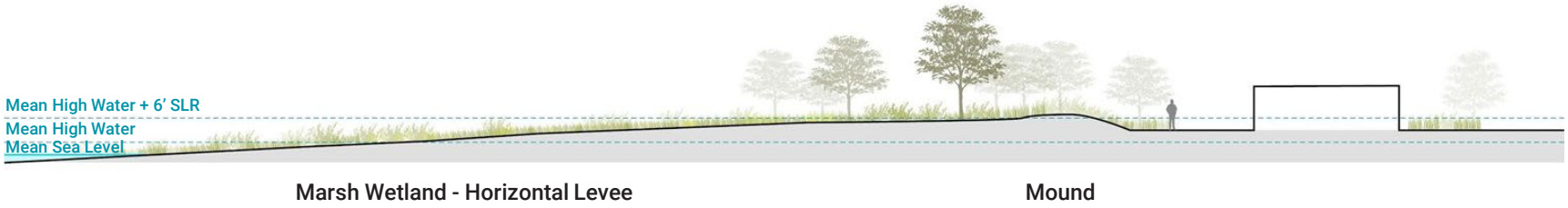
With the support of the city and community partners, as well as federal funding and planning assistance, Rosemont could prioritize resilience strategies that will ensure long-term marsh preservation, which will protect residents against sea level rise and storm surge. This multi-benefit approach expands upon the community's existing natural protection resources and serves broader community goals beyond storm surge protection, including access to natural recreational amenities and internal drainage. Increasing the health and storage capacity of the marsh to serve as an ecological buffer will contribute significantly to the community's long-term resilience. As part of the Corps Project, immediate resilience planning and structural measures should be undertaken in Rosemont to achieve these goals.

ROSEMONT MARSH EDGE

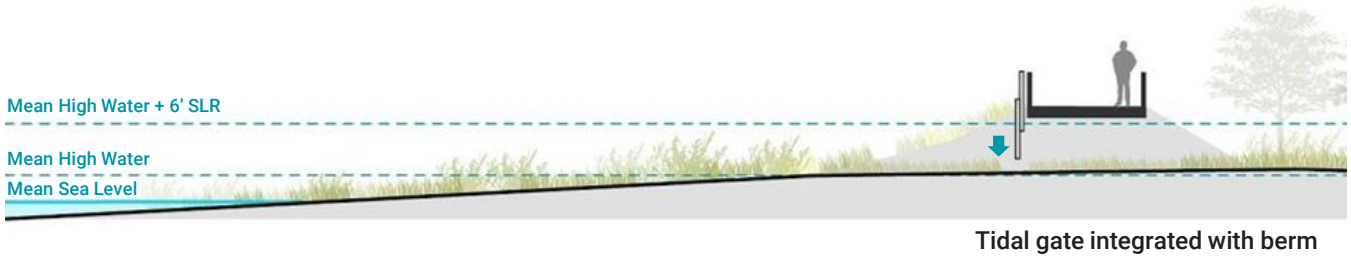
1. INTEGRATED EARTH BERM AND HORIZONTAL LEVEE



Section A



Section B

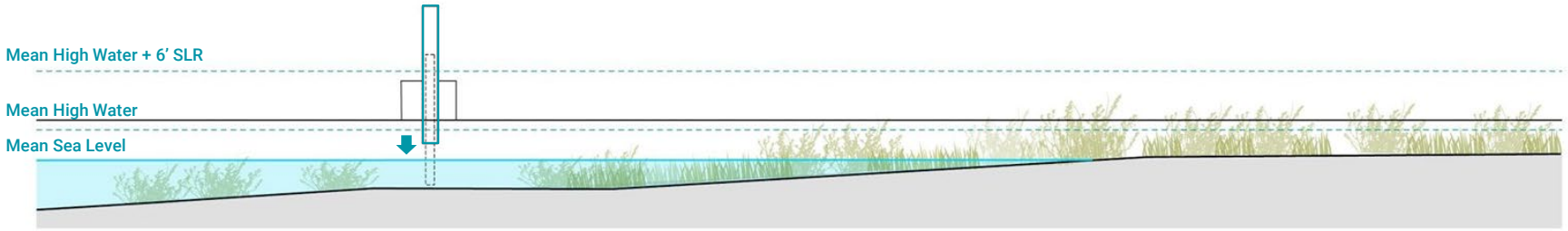


Section C

Tidal Gate
Source: Golden Harvest

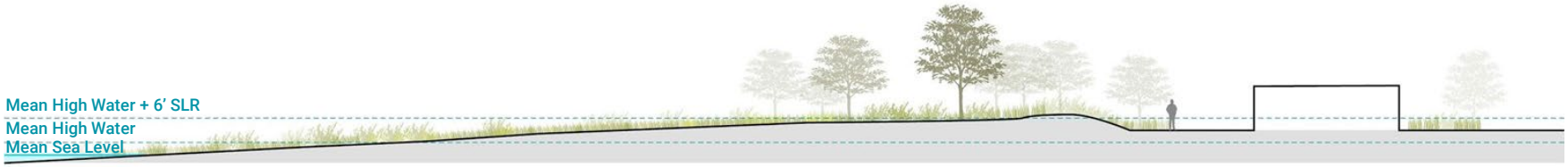
STORM SURGE MITIGATION AND SLR ADAPTATION

2. DEPLOYABLE BARRIER AND HORIZONTAL LEVEE



Deployable Barrier/Gate

Section A



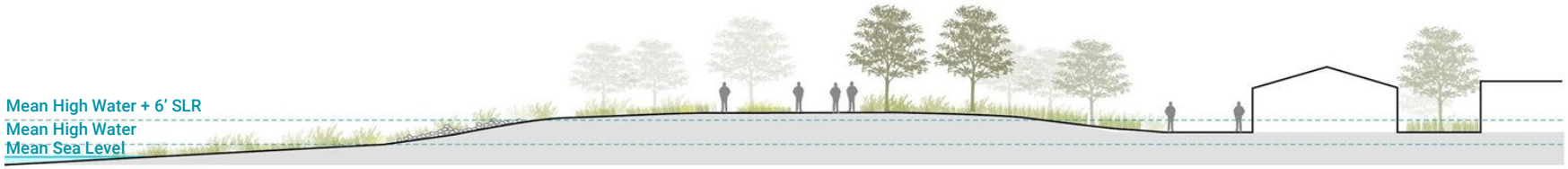
Marsh Wetland - Horizontal Levee

Mound

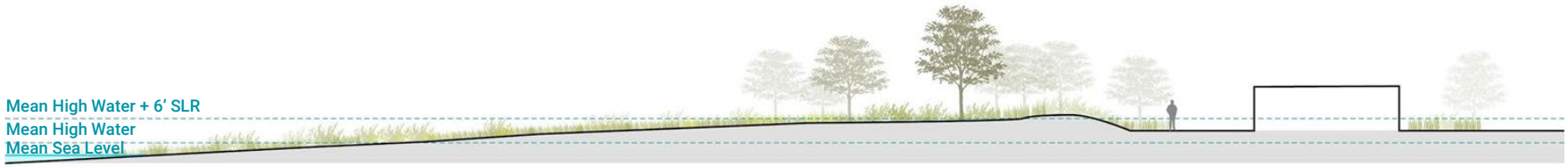
Section B

STORM SURGE MITIGATION AND SLR ADAPTATION

3. HORIZONTAL LEVEE AND INTEGRATED BERM PARK



Section A



Section B

STORM SURGE MITIGATION AND SLR ADAPTATION

CONCLUSION

Charleston can prepare for its future without sacrificing what makes the city so special. As proposed, the Corps' seawall falls short of that promise. This one-size-fits-all approach does not align with the context, goals, and needs of the communities it endeavors to protect and runs the risk of under-protecting against a major storm surge event. A seawall would disrupt views of Charleston Harbor and the Ashley and Cooper Rivers, destroy dozens of acres of ecologically valuable marsh habitat, and cut off the community from the water. The proposed seawall would not even protect against major storm surges, and water from any overtopping waves could be trapped within the wall. The Corps' singular focus on storm surge is also misguided because it ignores more immediate sources of inland flooding that disrupt the day-to-day lives of peninsula residents and businesses.

While the Corps should be commended for its commitment to protecting Charleston, the agency must refocus its efforts on a holistic, layered approach as described in this report—one which accounts for all climate change effects, enhances natural flood defenses, tailors solutions to the varied conditions of the peninsula, and promotes adaptation over time. Indeed, the Corps can look to its own precedents in other parts of the country, such as the Living Breakwaters, where innovative, nature-based solutions are the centerpiece of coastal resilience projects. This approach should also engage as many people who live and work on the peninsula as possible to solicit their ideas and earn their buy-in. Coastal protection must not only keep those people (and future generations) safe, but also improve their quality of life and enhance the character of their surroundings.

To illustrate a layered resilience approach, this report recommended customized, place-based solutions. Our three case studies demonstrate the advantages of a holistic, layered strategy compared to a one-size-fits all approach, including:

- A more unified, connected coastal edge for people and ecosystems;
- Solutions to both inland and coastal flooding threats;
- Adaptability to sea level rise and future climate change conditions;
- Inclusion of all peninsula communities; and
- Preservation of neighborhood character.

The Battery and the Breakwater
Our design proposal for the Battery retains the breakwater that was originally proposed but later removed from the Corps' Feasibility Study. The breakwater, if enhanced with nature-based solutions as a living breakwater, adds critical benefits that have not been measured in the Corps' BCA process, including adaptation to future storm surge elevation and sea levels, energy dissipation, natural sedimentation, wildlife habitat, community cohesion, and economic development opportunities. The living breakwater would extend the edge of the Battery seawall and provide a naturalized condition that mimics historic marsh geometry, stabilizes sediment transport, and protects the seawall from erosion. Our design would also better preserve the Battery seawall as a signature landmark connecting Charleston to the water and nature.

Lockwood Corridor/Medical District
Our proposals for the Lockwood Corridor would transform Lockwood Drive itself into a coastal protection device, as opposed to constructing a separate seawall in the existing marsh. This strategy carries a number of advantages: the resulting natural edge would better preserve and replenish threatened salt marsh; stormwater retention projects could be integrated to absorb inland floodwaters; reimagined pedestrian routes would link the Medical District to the Lockwood Corridor; and residents would benefit from enhanced park spaces with direct access to the coastal edge.

A Resilience Plan for Rosemont
Our plan for Rosemont provides a path to resilience for a community that is currently left out of the Corps' seawall solution. Rosemont is in need of a long-term resilience plan—one which is designed and

CONCLUSION

supported by the community. As part of the Corps Project, the agency should engage with Rosemont to craft a context-sensitive resilience plan that will be integrated into the capital improvement strategy for Charleston. The plan must provide the community with a clear direction to move forward, including specific actions, a timeline for implementation, and identification of funding resources. Implementation of specific structural measures as identified in this report and further refined in a resilience plan should be the end result of the Corps Project.

These three case studies illustrate the effectiveness and advantages of a comprehensive, place-based design approach. This effort illustrates that a one-size-fits-all seawall would not adequately prepare Charleston for future climate change impacts and would inflict a host of immediate impacts on the people and places it seeks to protect. Charleston must instead seize this opportunity to design a multi-benefit project — capable of protecting the city from future storm surge, reducing disruptive inland flooding, restoring and preserving natural resources and wildlife habitat, and enhancing the historic character and beauty of the city. The Corps Project is a once-in-a-generation opportunity to capture federal funding paired with the Corps' construction competence. It is critical for Charleston's future we get this right.

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APPENDIX

FUNDING SOURCES TO SUPPORT RESILIENT PLANNING INITIATIVES

FEMA's Building Resilient Infrastructure and Communities (BRIC) grant provides support for local communities as they undertake hazard mitigation projects to reduce the risks they face from disasters and natural hazards, and includes activities such as capability and capacity building activities, mitigation projects and management costs. In addition, FEMA's Hazard Mitigation Grant Program provides funds to rebuild in ways that reduce or mitigate future disaster losses, and is available after presidentially declared disasters. Applicable activities include developing and adopting hazard mitigation plans required to receive funding for hazard mitigation projects, floodplain and stream restoration, and green infrastructure to reduce flooding impacts.

HUD's Community Development Block Grant - Disaster Recovery (CDBG-DR) funding provides seed money after a presidential declared disaster to address long-term recovery and restoration of infrastructure, housing and economic activity, including mitigation and mitigation planning intended to reduce or eliminate damage from future disasters. Applicable activities include open space acquisition and improvements such as dams and levees, among others. CDBG's Section 108 Loan Guarantee Program additionally allows local governments to transform a portion of their CDBG funds into low-cost federally funded loans through the assistance of the state. Similarly, CDBG Mitigation funds managed by the South Carolina Disaster Recovery Office are intended to increase resilience and reduce or eliminate long-term risk.

The United States Department of Agriculture (USDA) Watershed and Flood Prevention Program helps communities protect and restore watersheds through federal-state-local cooperative efforts to mitigate erosion, floodwater and sediment damage, as well as to further watershed conservation. Small municipalities can use this program to receive financial and technical assistance for watershed protection, flood prevention, and water management efforts, including water quality improvements, and fish and wildlife habitat improvements. Another grant targeting community-led natural resource conservation is the National Park Service (NPS) Rivers, Trails and Conservation Assistance Program, supporting natural-based flood control measures with the project planning process, community outreach, and fundraising support. These funding examples show a breadth of technical and financial assistance opportunities targeting both planning and implementation. A list of additional potential grant opportunities are included herein.

APPENDIX
GRANT OPPORTUNITIES

Grant Name	Agency/Org	Summary	Applicable Activities
Building Resilient Infrastructure & Communities (BRIC)	FEMA	Support for states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards.	Capability- and Capacity-Building (C&CB) Activities, Mitigation Projects, Management Costs
Hazard Mitigation Grant Program	FEMA	FEMA's Hazard Mitigation Grant Program provides funding to state, local, tribal and territorial governments so they can rebuild in a way that reduces, or mitigates, future disaster losses in their communities. This grant funding is available after a presidentially declared disaster.	Protecting or purchasing public or private property that experienced, or is in danger of experiencing, repetitive damage, Purchasing and removing a flood-prone property from an individual, Developing and adopting hazard mitigation plans, which are required for state, local, tribal and territorial governments to receive funding for their hazard mitigation projects, Using aquifer storage and recovery, floodplain and stream restoration, flood diversion and storage, or green infrastructure methods that may reduce the impacts of flood and drought, Protecting a home with barriers to prevent floodwater from entering, Raising a home so that potential floodwaters flow under it, Constructing a new, raised home to replace a demolished one, Making a home more resistant to floods and earthquakes, Building a safe room inside or nearby to provide safety from strong winds, such as during a tornado or hurricane, Using fire-resistant materials on the outside of a home and clearing trees and brush around it, Strengthening the roof, walls, doors and windows of a home to minimize high wind damage
Flood Mitigation Assistance (FMA) Grant	FEMA	The Flood Mitigation Assistance Program is a competitive grant program that provides funding to states, local communities, federally recognized tribes and territories. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program.	1. Project Scoping (previously Advance Assistance): Project Scoping to develop community flood mitigation projects and/or individual flood mitigation projects that will subsequently reduce flood claims against the NFIP. FEMA will select up to $4 million of Project Scoping subapplications. 2. Community Flood Mitigation Projects: FEMA will select up to $70 million of projects that address community flood risk for the purpose of reducing NFIP flood claim payments. 3. Technical Assistance: Technical Assistance to maintain a viable FMA program over time. To be eligible to apply for Technical Assistance, the Applicant must have received an FY 19 FMA Award of at least $1 million federal share. 4. Flood Hazard Mitigation Planning: Planning subapplications for the flood hazard component of State, Local, Territory, and Tribal (SLTT) Hazard Mitigation Plans and plan updates. 5. Individual Flood Mitigation Projects: Projects that mitigate the risk of flooding to individual NFIP insured structures.
Community Development Block Grant - Disaster Recovery (CDBG-DR)	HUD	CDBG-DR funding is particularly useful for small municipalities because of its broad list of eligible projects. Small municipalities needing funds to recover from a debilitating disaster may benefit from HUD Disaster Recovery grants. A subset of the Community Development Block Grant Program, these grants provide crucial seed money and address the long-term recovery and restoration of infrastructure, housing, and economic activity, including mitigation and mitigation planning activities intended to reduce or eliminate damage from future disasters.	There are 27 eligible activities. Flood-related activities include open space acquisition; construction, repair, replacement, or relocation of public facilities; and improvements, such as dams or levees
CDBG Section 108 Loan Guarantee Program	HUD	HUD's CDBG Section 108 Loan Guarantee Program allows local governments to transform a portion of their CDBG funds into low-cost, federally-guaranteed loans for economic development, housing rehabilitation, public facilities, and other physical infrastructure projects, including those to increase resilience to natural disasters. While these funds are focused on entitlement communities (larger cities), small municipalities can apply for financing with the assistance of their state.	Guaranteed loan funds may be used for many of the CDBG-eligible activities, including open-space acquisition; construction, repair, replacement, or relocation of public facilities; and improvements such as dams and levees. Funded activities must be part of a large-scale economic development, housing, or public facilities project.
Clean Water State Revolving Fund	EPA	Small municipalities should consider leveraging the Environmental Protection Agency's (EPA) Clean Water State Revolving Fund (CWSRF) if they require a source of low-cost financing to address stormwater concerns or create a green infrastructure project, including those that provide flood resilience and risk reduction. This is a program supported by EPA and administered by states. Some states may have customized loan terms to meet the needs of small and disadvantaged communities.	Construction and technical assistance for publicly owned treatment works; nonpoint source pollution management systems; projects that support comprehensive management plans within National Estuary Program study areas; decentralized wastewater treatment systems; stormwater management; water conservation; watershed pilot projects; and water reuse. For example, the city of New Smyrna Beach, Florida improved its stormwater management systems and built swales using four loans totaling over $3 million that the city received through the program.
FY21 Effects of Sea Level Rise (ESLR)	NOAA	The purpose of this document is to advise the public that NOAA/NOS/National Centers for Coastal Ocean Science (NCCOS)/Competitive Research Program (CRP) [formerly Center for Sponsored Coastal Ocean Research (CSCOR)/Coastal Ocean Program (COP)], is soliciting proposals for the Effects of Sea Level Rise Program (ESLR). The program name was shortened in 2020, and was formerly known as the Ecological Effects of Sea Level Rise Program (EESLR). This solicitation is to improve adaptation and planning in response to regional and local effects of sea level rise and coastal inundation through targeted research on key technologies, natural and nature-based infrastructure, physical and biological processes, and model evaluation. The overall goal of the ESLR Program is to facilitate informed adaptation planning and coastal management decisions through a multidisciplinary research program that results in integrated models of dynamic physical and biological processes capable of evaluating vulnerability and resilience under multiple SLR, inundation, and management scenarios. Funding is contingent upon the availability of Fiscal Year 2021 Federal appropriations. It is anticipated that projects funded under this announcement will have a September 1, 2021 or September 1, 2022 start date.	There are two distinct focal areas for this solicitation that will compete separately, 1) Coastal Resilience and 2) Surface Transportation Resilience. It is anticipated that approximately $1,200,000 may be available in Fiscal Year 2021 for the first year for some projects in each focus area, while an additional $1,200,000 could be available in Fiscal Year 2022 for the first year for additional projects selected from this opportunity.Approximately 2-4 projects of 2-4 years in duration are expected to be funded under the Coastal Resilience focus area at a level of approximately $200,000 to $400,000 per year per proposal, with a total budget (across all years) that is less than $1,600,000 for the Coastal Resilience focus area.Approximately 2-4 projects of 2-4 years in duration are expected to be funded under the Surface Transportation Resilience focus area at a level of approximately $200,000 to $500,000 per year per proposal with a total budget (across all years) that is less than $2,000,000 for the Surface Transportation Resilience focus area.Electronic Access: Background information about the ESLR Program, including additional information on this Announcement, details on the timing of an informational webinar, and eventually a recording of the webinar can be found at https://coastalscience.noaa.gov/research/coastal-change/ecological-effects-sea-level-rise-program.The required LOI should be sent by e-mail to nccos.grant.awards@noaa.gov. Full proposals will not be considered if a LOI was not submitted.Full proposals should be submitted through Grants.gov, http://www.grants.gov.
Five Star Urban Waters Restoration Grant Program	NFWF	The National Fish and Wildlife Foundation's (NFWF) Five Star and Urban Waters Restoration Program is a great fit for municipalities in need of smaller amounts of funding for projects that support community stewardship of local natural resources and enhancing habitats for local wildlife. Funding is available to make linkages to municipal flood mitigation and stormwater programs in developed watersheds, improve urban water quality, restore riparian habitat and community forests, and increase public access to urban waterways.	Education and community outreach activities that address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. In order to address concerns of pollution from runoff and flood events through natural water filtration, Eufaula, Oklahoma (population 2,900) utilized this grant program to create four acres of new wetland habitat.

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GRANT OPPORTUNITIES

Grant Name	Agency/Org	Summary	Applicable Activities
Interagency Nonstructural Flood Risk Management Projects	USACE	The U.S. Army Corps of Engineers Floodplain Management Services (USACE FPMS) Program provides a portion of its funding for Interagency Nonstructural Flood Risk Management projects. This interagency work promotes participation by USACE staff in small efforts undertaken in collaboration with other partners, both public and private, in order to achieve flood risk management benefits. This is not a federal grant program, but is instead an opportunity to enable USACE involvement, such as providing technical engineering or planning services to local, county, state, Tribal, or other partners. USACE labor is a typical use of funds. All projects must leverage resources invested by multiple partners (monetary or in-kind) and should seek to reduce flood risk through nonstructural means, with a focus on reducing human exposure or vulnerability to a flood hazard. Structural approaches (like the design or construction of a levee, berm, or floodwall) are not eligible. Some examples of nonstructural approaches are floodplain mapping, evacuation planning, relocation or buyout/acquisition strategies, floodproofing or elevation of buildings, risk communication, public engagement, and local land management activities.	Proposals may address flood risk preparation, response, recovery, or mitigation and may focus on both coastal and riverine areas. Proposals should include at least two governmental partners in addition to USACE and should be executable in 12-18 months. Proposals utilizing USACE funds for construction or intended to culminate in Corpsfunded construction will not be considered
Rivers, Trails, and Conservation Assistance Program	NPS	The National Park Service's Rivers, Trails, and Conservation Assistance program provides free, on-location planning and technical assistance expertise that small municipalities can use to support community-led natural resource conservation and outdoor recreation projects, including natural-based flood control measures, such as riverbank restoration. National Park Service staff can help communities with the project planning process, community outreach, and fundraising support.	The National Park Service's Rivers, Trails, and Conservation Assistance program provides free, on-location planning and technical assistance expertise that small municipalities can use to support community-led natural resource conservation and outdoor recreation projects, including natural-based flood control measures, such as riverbank restoration. National Park Service staff can help communities with the project planning process, community outreach, and fundraising support.
The Coastal Program	FWS	The Coastal Program is a voluntary, community-based program that provides technical and financial assistance through cooperative agreements to coastal communities, conservation partners, and landowners to restore and protect fish and wildlife habitat on public and private lands. The Coastal Program staff coordinates with partners, stakeholders and other Service programs to identify geographic focus areas and develop habitat conservation goals and priorities within these focus areas. Geographic focus areas are where the Coastal Program directs resources to conserve habitat for Federal trust species. Projects are developed in collaboration with partners, and with substantial involvement from Service field staff. Coastal Program projects must support the missions of the U.S. Department of the Interior (DOI), U.S. Fish and Wildlife Service (Service), and the Coastal Program, and be based on sound scientific biological principles.	varies
Water Infrastructure Finance and Innovation Act	EPA	Small municipalities can use the long-term, low-cost supplemental loans provided by the Environmental Protection Agency's (EPA) Water Infrastructure Finance and Innovation Act (WIFIA) Program to upgrade aging water infrastructure and manage stormwater to enhance resilience to flooding	Construction of measures to manage, reduce, treat, or capture stormwater, including those that provide flood resilience and risk reduction; brackish or seawater desalination, aquifer recharge, alternative water supply, and water recycling projects; drought prevention, reduction, or mitigation projects; and property acquisition
Watershed and Flood Prevention Program	USDA	The US Department of Agriculture's Watershed Protection and Flood Prevention Program helps communities protect and restore watersheds of up to 250,000 acres through federal-state-local cooperative efforts to mitigate erosion, floodwater, and sediment damage, as well as to further watershed conservation. Small municipalities can use this program to receive financial and technical assistance for watershed protection, flood prevention, and water management efforts.	Financial and technical assistance for erosion and sediment control; watershed protection; flood prevention; water quality improvements; water management; fish and wildlife habitat enhancement; hydropower sources; and efforts related to rural, municipal, and industrial water supplies.
Community Development Block Grant - Mitigation	HUD	The Community Development Block Grant – Mitigation is a Federal HUD grant that is managed by the South Carolina Disaster Recovery Office (SCDRO). Its purpose is to increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, and suffering and hardship, by lessening the impact of future disasters.	Mitigation Projects, Property Acquisition and Demolition, Localized Flood Risk Reduction Projects, Non-Localized Flood Risk Reduction Projects, Structural Retrofitting of Existing Buildings, Infrastructure Retrofit, Soil Stabilization, hazard mitigation planning, miscellaneous
Disaster Relief and Resilience Reserve Fund	State of SC	The Disaster Relief and Resilience Reserve Fund can provide aid to communities with "significant unmet needs" after a federally declared disaster event. Funds may be used for immediate disaster relief and resilient rebuilding efforts. Further, the act requires that any actions funded account for future flood risks and hazard exposure to ensure that post-disaster rebuilding mitigates exposure to future hazards and potential losses.	Floodplain buyouts, resident relocation, and buyout assistance for single- and multi-family units not eligible under the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program; Supplemental funding for buyouts to relocate residents outside of the floodplain and restore a floodplain's flood-mitigation functions; Support for low- and moderate-income households for projects to lower flood risk; Loans and grants to local governments to support hazard mitigation efforts; and Mitigation projects included in local governments' post-disaster recovery plans.
South Carolina Resilience Revolving Fund	State of SC	Floodplain buyouts and restoration projects	Floodplain buyouts and restoration projects

ASHLEY RIVER