Designing With Water

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One of the myriad consequences of climate change is the increased amount of flooding that communities are incurring. This includes not only coastal communities flooding due to sea level rise and the resultant impacts of astronomical high tides, but also severe storm flooding happening along estuaries and even further inland along rivers and tributaries. Our built environment should permit water's presence and, thus, designers must begin to accept a perception of water within the built environment and anticipate new interactions between ecological and human systems. How can the dissection of water and its hydrologic movements become the base for exploring how design interventions may tap into this system thoughtfully? How do we allow water to re-enter our built environment, not as a treacherous element as seen in the past (and current) paradigm, but as an element that enriches?

In 2020, the US Army Corps of Engineers (USACE) released a feasibility report and environmental assessment to address coastal storm risk for the Charleston Peninsula. In 2021 the City asked Clemson University's Master of Resilient Urban Design Program to produce a parallel design study in order to examine counter proposals to the USACE proposition, particularly nature-based design strategies. This paper articulates the process and product behind the counter proposal to offer suggestions for design grounded in social and environmental concerns in addition to physical and fiscal ones.

INTRODUCTION

Life in Charleston, South Carolina is and always has been oriented toward the sea. Science clearly indicates that as the 21st century progresses, the city's prosperity will be tied to its ability to manage risks associated with flooding (surge, tidal, rainfall, storm water, drainage, surface, groundwater inundation) and sea-level rise. A noted in findings from the Dutch Dialogues Charleston, "This is indeed 'the Lowcountry,' with half of all home elevations at less than 10ft above sea level. […] Urbanization-induced landfill has changed the water-land interface, but the region's marshes still want to act like marshes, regardless of use."[1] Charleston's extant buildings and landscapes are among the city's most valuable and vulnerable economic and social resources and any plan for future development and water management must consider a multitude of intersecting needs to include extant material assets, protection of public space, displacement, and social and environmental equity.[2]

In April 2020, the US Army Corps of Engineers (USACE) released a draft feasibility report and environmental assessment to address coastal storm risk for the Charleston Peninsula. This study is the result of the federal planning process referred to as the 3x3x3 process consisting of a $3 million study completed within three years and including three concurrent levels of review. Following eighteen months of data collection, modeling, and analysis the USACE is proposing to construct a nearly eight-mile seawall around the perimeter of the peninsula approximately three feet higher than the current height of the High Battery seawall. Also included in the USACE recommendations is a 4,000-foot-long breakwater located offshore by the Battery. In 2021 the City of Charleston asked the Master of Resilient Urban Design (MRUD) Program (located at the Clemson Design Center.Charleston) to produce a parallel design study in order to examine counter proposals to the USACE seawall proposition, particularly nature-based design strategies. This presentation articulates those counter proposals in the context of the 3x3x3x process (2020-2021) and the Charleston Dutch Dialogues process (2019) to offer suggestions for a design process grounded in social and environmental concerns in addition to physical and fiscal ones.

The background for MRUD's 2021 effort lay in their collaboration with Dutch Dialogues Charleston held at the Clemson Design Center in 2019. Directed by Waggonner & Ball, The Water Institute of the Gulf and the Royal Netherlands Embassy, Dutch Dialogues Charleston was a collective effort that brought together water and landscape experts of national and international repute to work alongside Lowcountry professionals and community members to discuss a new way of thinking about the intersectional relationship between peoples and the water and land they inhabit.[3] Espousing a philosophy of learning to work with water rather than fear it, the Dutch Dialogues Colloquium findings noted that, "Developers are not leading on resilience.

Whether fearful of leadership or of losing market share to lower-priced developments, the recently completed developments underscore how little effort is made toward a resilient future for Charleston."[4] Instead, Dutch Dialogues Charleston asserted, "Designing for the future enables Charleston to project toward 2100 and beyond, with a long-term future imaginable as a new way of living with water."[5]

STUDIO PROCESS: RESEARCH

As co-host of the Dutch Dialogues, the MRUD program brought that knowledge forward when the City of Charleston asked the Program to perform a counter study US Army Corps of Engineers' sea-wall proposition. To do so, MRUD divided the Charleston Peninsula up into 7 segments with varying urban, landscape, and water conditions. To keep the paper succinct and still explain the process undertaken, a single segment of the study (Segment 2) will be explained in detail.

MRUD began by studying practices around the global and in north America regarding how urban areas are dealing with flooding. The Segment 2 study relied on an examination of water-related design strategies in Bridgeport, South Bay of San Francisco, New Orleans, Tokyo, Hamburg, and Lagos. A part of Rebuild by Design, the Resilient Bridgeport design proposal for Bridgeport, Connecticut looks at reducing the risk of flooding by strengthening the natural habitat through restoring wetland habitats and connecting barrier islands.[6] Perimeter levee, raised roads, and elevated buildings are also considered in addition to wetland restoration. The South Bay Sponge study was also produced by Rebuild by Design as an integrative, nature-based vision for the South Bay of San Francisco to develop natural systems for collecting, filtering, and dispensing excess water.[7] Some design strategies used were to swap developed land for conservation purposes, the introduction of green infrastructure, absorptive landscapes, and a protected shoreline park. Included in the scope of the project was intensive community involvement, regulation and funding paths, a new integrated permitting structure, and the framework for a resiliency district.

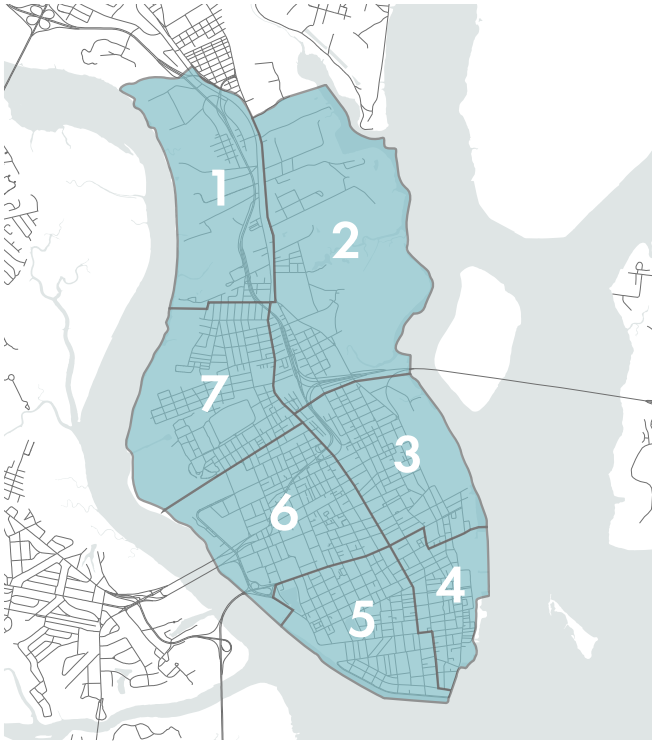

Figure 1: Charleston Peninsula divided into seven segment areas of study. Graphic by Courtney Wolff.

Unlike Bridgeport and South Bay, New Orleans especially faces a problem with subsidence, as the city has been sinking because of the lack of water permeating into the soil.[8] Design strategies used in this case study, based on work proposed following Hurricane Katrina, were the implementation of permeable pavers on pedestrian pathways, adapting transit networks to function in events of flooding, and treating water as an asset rather than a nuisance. This approach has been true in Tokyo, Japan as well with the Super Levees design proposal that treats a significant piece of flooding infrastructure as an interactive space.[9] The Super Levees in Tokyo, Japan, have been designed to withstand strong floods and storm surges. However, these levees are not standalone from the urban environment; the urbanism of the city has been integrated into the levee structure. This means that commercial, residential, and mixed-use buildings are attached to the same structure that helps mitigate flooding impacts. In addition, many of these super levees contain park spaces that improve the riverside environment. Much like the Tokyo Super Levees, HafenCity in Hamburg, Germany provides an example of a flood wall that incorporates other structures into the wall itself.[10] Here, the flood wall and buildings blend together showing how development could improve the overall resiliency of a city. This is opposed to the usual typology where a separate structure is required to protect development. In addition to buildings being incorporated into the flood wall, public parks and a promenade are also included.

In look at cautionary examples, Segment 2 studied the Eko Atlantic project located in Lagos, Nigeria which provides important reminders about the relationship between sea level rise and equity.[11] The wall being built in Lagos will create a new, fortified district on fabricated land, but little is being done to protect existing neighborhoods that experience regular flooding. People previously living in slums at the edge of the project area were given a 72-hour evacuation notice before their neighborhood was demolished. Remaining slums and nearby villages are now experiencing increased flooding and storm surges as water is simply pushed around the new, luxury waterfront district of Eko Atlantic. This climate change "solution" is one of many examples of work that benefits the wealthy few and is devastating to the larger numbers of the poor.

Following the case study inquiries, the existing context was studied from the point of view of the cultural, the physical, and the ecological. Historically known as East Neck, Segment 2 became a place of refuge for slaves with lower rent and distance from their owners in the city during the nineteenth century.[12] With the phosphate boom in the 1860's-1890's, the land became industrialized but was still an overlooked residential area for then freed slaves. Up until 1926, there was still only one road through the neck limiting access to the area. Even with the development of Highway 26, the East Neck was seen as somewhere only to pass through as opposed to a destination by the white and wealthier populations of the Peninsula. As the City of Charleston grew, the Upper Neck was gradually incorporated into the city.[13] This expansion has increased land-value and thus reduced the space available for low-income, primarily black, residents, resulting in displacement and gentrification pressure for these at-risk communities.

The built context for the Upper Neck is an area that historically was with lush vegetation. As the city grew, so did its demand for industry. Today, much of this land is contaminated and still occupied by industrial buildings.[14] Where currently possible, a large array of development projects have been completed or are planned.[15]

When looking at sea level rise, a greater percentage of land in this area is at higher elevations than the rest of the peninsula.[16]There are still areas where sea level rise and storm surge pose a risk within the next 50 years, but risk will be greater in the 50–100-year range. The ecological context of this area includes a geology that is mostly artificial fill with some areas of sand and clayey sand.[17] Because of the high level of urban impact, all this area is poorly drained and absorbs little to no water. Artificial fill and tidal-marsh deposits are also "soft soils", meaning there is higher hazard risk in these areas during seismic activity. In Segment 2, both the Cooper River and Shipyard Creek are dredged to support industry in the area as well as Columbus Terminal to the South and Hugh K. Leatherman Terminal to the North.[18] The natural watersheds in this study area were redefined when pumps were implemented to drain water off the peninsula.[19] While this system was mildly successful for some time, it is now failing.

The Lowcountry salt marsh is a diverse and productive ecosystem that provides full-time residence to many species; and the marsh is also a vital stop along bird migration paths.[20] Long-term disregard for the importance of the marsh, paired with the threats of sea level rise and pollution, have put many of these species in danger as endangered, threatened, or on the watchlist.[21]

STUDIO PROCESS: CONCEPTUAL STUDY

The case studies, context studies, and a series of zoom meetings with a variety of community stakeholders led to an initial conceptual design idea for Segment 2 entitled Adaptive Memorials. The conceptual design strategies applied provide a reinterpretation of a wall that incorporates the historic narrative of Charleston as

Figure 2: Conceptual Design Ideas for Segment 2 entitled: Adaptive Memorials. Graphic by Courtney Wolff.

a means for considering how the past influences the future. Time is experienced visually as people pass through different series of spaces. The impacts of climate change are reflected upon, and opportunity is provided for adaptation.

The big idea offered as a conventional sea wall replacement is a continuous boardwalk encompassing the peninsula and transforming the wall into a recreational amenity. Three experiential typologies are situated along the boardwalk: park, preserve, and exhibit.

The "park" typology encourages physical interaction with the water and creates a new recreational amenity currently missing from the peninsula as tiered parks are introduced on the exterior of the flood walls with access to water. It should be implemented where there is currently no marsh and long stretches of shallows where exposed breakwaters can slow water and reduce wave action

Utilized in places such as the aquarium, the "exhibit" typology encourages an educational experience and submerges people

below the surface of the water for. The typology keeps tight shipping channels clear without compromising sea floor depth

In places along the peninsula where there is still healthy marsh, the "preserve" typology highlights this natural resource with a passive park experience as dredged material maintains

marsh and reef habitat. Protection provided by flood wall keeps the area safe for recreation

STUDIO PROCESS: DESIGN DEVELOPMENT

After community and professional feedback, further research studies in nature-based design solutions and urban typologies were performed leading to a further developed project proposal. In Segment 2's vision for resilient growth, new development is implemented in

tandem with nature-based systems and policy reform instead of building a wall. While a wall may seem like a permanent solution, the life span of a sea wall is only approximately fifty years. In this time, there is a 40 percent chance that a wall would fail.[22] Conditions creating the need for a protection system, such as sea level rise and the increased severity and frequency of storms, are not disappearing at the end of that wall's life span. This project aims to alter an antiquated view of land and urban design by proposing a life-cycle approach which can adapt over time.

Resiliency is built into the new urban fabric, mirroring the surrounding, changing landscape. The design goals for this proposal are to:

- Address multiple flooding issues, not just storm surge
- Leverage the unique transitional period in this area and plan for future development
- Make time, change, and adaptation tangible and visible to the community
- Tie together past, present, and future

Some of the primary strategies for achieving this include:

- Investing in two-way community outreach, both to receive feedback and to educate about best practices
- A full zoning restructuring that revolves around a new ecological based code
- All new development is implemented in tandem with resiliency and landscape strategies

Figure 3: Segment 2 Nature-Based and Community-Based Master Plan. Graphic by Courtney Wolff.

DESIGN DEVELOPMENT: COMMUNITY OUTREACH

As noted in the cultural context research, pressure has been put on this former refuge for slaved and freed peoples as the city has grown.[23] Today, the Neck is home to a large percentage of Charleston's most vulnerable communities: people of color, people experiencing poverty, and single mothers.[24] Implications of this demographic data include the necessity of diverse community outreach and the implementation of equitable finance and development mechanisms.

As contemporary development occurs in this area, it is important to honor all stories of this place and the meaning it holds for different people. Traditional methods of community engagement such as online surveys or public meetings are not always an option for everybody, especially for vulnerable communities. Car ownership, childcare, and access to internet can all be barriers to these commonly used methods of community outreach. To better support the community, this project embeds tangible moments of education, outreach, and support into the urban fabric. These include: a Disaster Relief Community Center, a Craftsman Hall, a Recreation Facility, a Marine Industry Discovery Center, an Ecological Research Hub, and Saltmarsh Discovery Boardwalk.

Community engagement is often utilized to gain input and feedback about a specific topic but creating tools for community-wide education is equally important. This project proposes that engagement, education, and feedback became a part of everyday life through tools that have tangible benefits and uses. The creation of the app normalizes two-way communication that is not only helpful to both the citizen and the city but is also fun for the user.

In addition to community outreach, mechanisms to prevent displacement include the use of community land trusts (CLT). Community land trusts are an equitable finance mechanism where a nonprofit ensures long-term ownership of land.[25] The CLT purchases, or is granted, land and then sells the building to an eligible buyer. In this proposal, eligibility restrictions include: (1) Limits on income to no greater than 80% AMI; (2) Preference given to families who work in the community; and (3) Preference given to first time homebuyers. The implementation of CLTs prior to new development is crucial. By doing this, gentrification can be preemptively combated by reserving this space in perpetuity for affordable and workforce housing.

Promoting economic diversity is a key component of this proposal. By encouraging mixed-income development, social stigmas of low-income communities can be resisted, and acceptance of affordable housing can increase. Residents of mixed-income developments also gain access to higher quality services and amenities, engage in a wider range of social interactions, and have a closer proximity to a wider range of job opportunities.

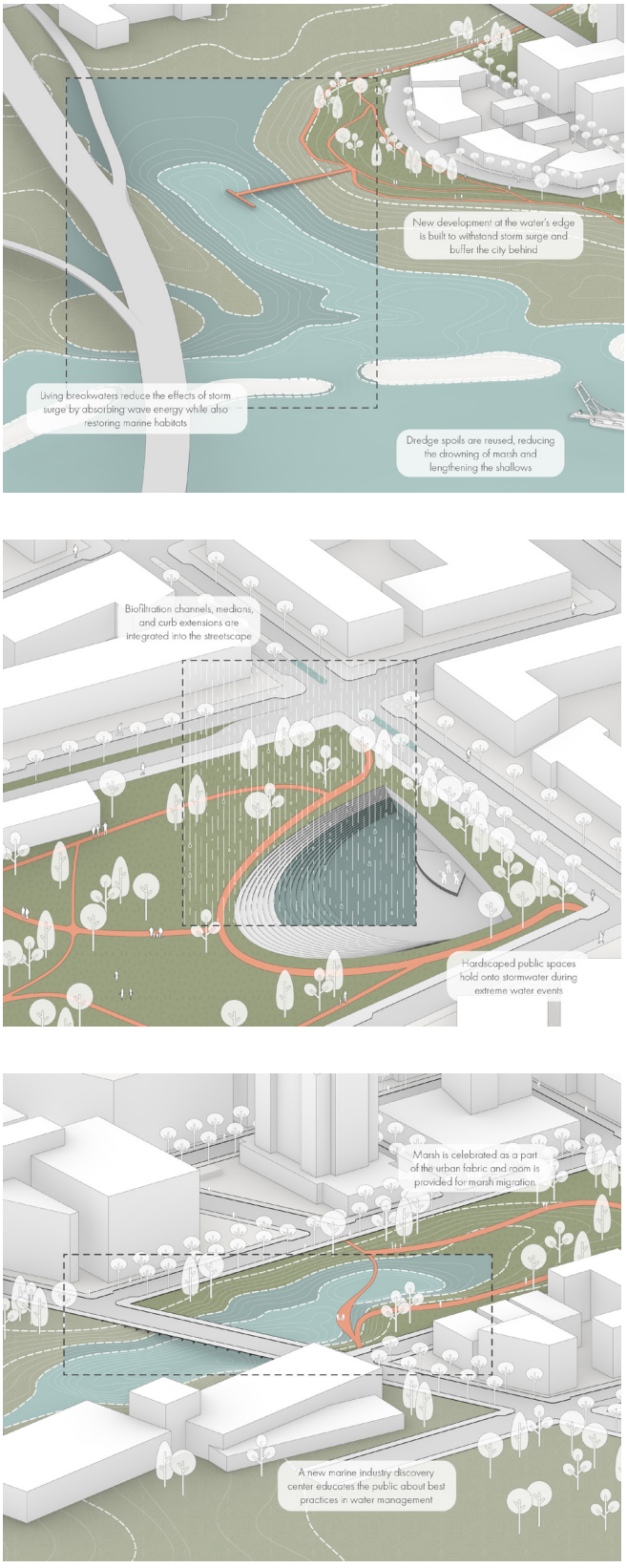

Figure 4: Urban design examples of slow, filter, and store within Segment 2. Graphic by Courtney Wolff.

DESIGN DEVELOPMENT: ECOLOGICAL-BASED CODE

The City of Charleston currently uses Euclidean base zoning districts with overlapping overlay zones.[26] This segment area currently consists of large amounts of heavy industrial as well as Charleston's new Upper Peninsula zoning district. This Euclidean zoning system, created and established in the 1920s, is a template based on the upcoming land use.[27] By only focusing on the upcoming land use, it is impossible to fully consider the future impacts of development.

This proposal aims to implement a life-cycle approach to zoning which can adapt over time. By understanding that Charleston is within a changing landscape, zoning can enable responsible stewardship of the land. Instead of zones based solely on upcoming land use, Sectors are proposed that relate to ground elevation, level of urbanization, future land use, and upcoming land use. The Sectors as defined in this rethinking of zoning with an ecological-based code include:

- Preserve open space: Existing parks, cemeteries, marsh, and undeveloped land will either stay as is or transfer to another open space use.
- Reserve open space: While not currently open space, this is land that will be returned back to natural uses. Much of the land in this sector is low-lying, marsh-adjacent, and currently zoned as Heavy Industrial. By reserving this land as open space within the zoning code, there is room for marsh migration as the sea level rises.
- Protected growth: This sector is intended to enable smart development at elevations that are not currently at the water's edge but will be within 50 years. All development within the protected growth sector must have the structural ability to buffer storm surge with incentives for orienting buildings to provide even greater protection to the rest of the urban fabric.
- Intended growth: All new development areas at elevations over 12' NAVD88 fall within the intended growth sector. This sector is further divided into 4 categories: General urban, Urban center, Urban core, and Civic space. These categories ensure public realm standards that put people and water at the forefront of design.
- Retrofit: Much of the existing urban fabric is at an at-risk elevation (below 12' NAVD88), some of which already suffers from flooding. In this sector, incentives exist to bring all buildings and infrastructure to meet new resiliency standards. All new construction must meet the same standards as the protected growth sector.
- Infill: Land over 12' NAVDD88 will have updated resiliency standards but without the same restrictions on new construction as the retrofit sector.

Due to the time-based nature of this code, reevaluation will occur every ten years. This will ensure appropriate elevation requirements to reflect sea level rise and enable the incorporation of the most up-to-date water management strategies.

Figure 5: Community support diagram of Segment 2. Graphic by Courtney Wolff.

Revaluation is also intended to ensure public realm standards that put people and water at the forefront of design.

DESIGN DEVELOPMENT: RESILIENCY AND NATURE-BASED STRATEGIES

This project aims to address the needs of the community and the environment using a resilient-based complete street network.[28] Key existing roads will be retrofitted, and all new streets give equal importance to people, water, and transportation. Today, Charleston is difficult to navigate without a car, creating barriers to opportunity. Links to the rest of the city have been created that prioritize cyclists, bus transit, and pedestrians. This proposal's definition of complete streets includes acknowledging the simultaneously need of every street to be streets for people, streets for mobility, and streets for water.

In considering streets for people, a network of multi-use paths weave through the focus area which encourages a walkable lifestyle. The new street network has a minimum sidewalk width of eight feet but expands on commercial streets for outdoor shopping and dining. The streets also carry on the Charleston tradition of maintaining view corridors to the water. Other features to enhance pedestrian safety and experience are:

- Curb extensions at crosswalks
- Pedestrian islands
- Road tables at midblock crossings
- Public plazas and parks

In considering streets for mobility, within the new street network there are both streets with protected bike lanes as well as sharrows (bike-oriented streets). All the major multi-use paths also have cyclist tracks, including the new pedestrian overpass connecting to the Lowcountry Rapid Transit stop at Milford Street. King Street, Meeting Street, and East Bay Street also include bike lanes in their retrofits. Roads with bus routes have stops and shelters located at expanded curb extensions for convenience and safety.

In considering streets for water, every new street incorporates water storage and filtration through planted channels, stormwater medians, or biofiltration curb extensions.[29] Safety and accessibility during extreme water conditions have also been at the forefront of design; streets are at a minimum elevation of 12' NAVD88. This has been achieved through raising elevations, elevating roads, and incorporating bridges and pedestrian dock systems.

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In this project, natural systems are layered with projected development to create a long-term water management for the area. Three main approaches to water are being proposed: slow, filter, and store.[30] Each of these approaches are implemented through multiple design strategies at a variety of scales.

For Slow, both velocity and peak flood levels are reduced by using natural and artificial forms to buffer incoming water. Living breakwaters reduce the effects of storm surge by absorbing wave energy while also restoring marine habitats. Dredge spoils are reused, reducing the drowning of marsh, and lengthening the shallows. New development at the water's edge is built to withstand storm surge and buffer the city behind.

For Filter, fostering the marsh ecosystem is the most widespread strategy, smaller scale interventions such as biofiltration systems in the streetscape should be incorporated into design. Community education about proper use of our water systems is also critical. The marsh is celebrated as a part of the urban fabric and room is provided for marsh migration.

For Store, water is prevented from entering the stormwater system through detention, retention, and infiltration. To determine which strategy to employ, special consideration should be given to soil type and water table height. Biofiltration channels, medians, and curb extensions are integrated into the streetscape. Hardscaped public spaces hold onto stormwater during extreme water events.

Landscape strategies supporting the Slow, Filter, and Store approaches include:[31]

- Living Breakwaters: Living breakwaters reduce the velocity of storm surge and can help reduce peak flood levels as well as creating marine habitat.
- Land Swap: Land is moved to create strategic low and high ground prior to new development.
- Buildings as Buffers: Buildings at the water's edge protect the urban fabric behind them by being placed strategically and built to withstand storm surge.
- Dredge Spoils: Dredge spoils are reused in areas where sea level rise has killed off the marsh to promote regrowth with appropriate elevations.
- Wet Floodproofing: Buildings that are wet floodproofed are designed to safely flood with minimal damage.
- Elevated Buildings: Buildings may be built in areas susceptible to sea level rise if they are elevated to 12' NADV88 and have the ability to be elevated higher in the future.
- Floodable Plazas: Hardscaped floodable plazas are best utilized were soil conditions or low elevations restrict water infiltration.

- Rain Gardens: Rain gardens can range in size from whole blocks to small plots but are best utilized where there is optimal water infiltration.
- Green Roofs: Both green roofs and green walls help to slow and filter rainwater as well as reducing temperatures and increasing biodiversity.
- Bioretention Curb Extensions: Bioretention curb extensions are best utilized on streets where large curb extensions are appropriate and street trees are preferred along the sidewalk.
- Planted Channels: An alternative to traditional street tree pits, channels have greater capacity for stormwater with additional filtering capabilities.
- Stormwater Medians: Stormwater medians can vary in size, but 10' is optimal for converting to a turn lane at intersections and are best utilized on streets with longer blocks.

While all the proposed design strategies play a significant role in water management, there are also numerous additional benefits of these strategies. In general, nature-based solutions such as the ones being implemented also:

- Restore damaged ecosystems and create new habitat for at-risk species
- Provide recreation opportunities such as hiking, paddling, and birdwatching
- Capture carbon dioxide from the atmosphere, helping to slow global warming
- Filters out dangerous pollutants from both soil and water
- Reduce the urban heat island effect which results in lower energy costs, air pollution levels, and heat-related illness

REFLECTIONS

The water cycle describes the pilgrimage of water through its phase changes.[32] This cycle is responsible for all forms of life. Our built environment should permit water's presence and, thus, designers must begin to accept a perception of water within the built environment and anticipate new interactions between ecological and human systems. This study of the Charleston Peninsula starts with the premise, how do we allow water to re-enter our built environment, not as a treacherous element, but as an element that enriches? If resilience is understood as a way to manage change, then water is the design tool with which the change manifests in the discussions herein. In doing so, this discussion has sought to assert methods that address risk mitigation and still promote placemaking, sustainable design and socio-environmental justice. This studio investigation asserts that we can learn to live with water, we can adapt our environments to deal with both emergent and non-emergent climate change related situations and we can reveal the invisible processes and phenomenon of water to enrich and enhance human life and reciprocate water's value in the built environment.

ENDNOTES

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32. The cycle includes: ocean storage, evaporation, condensation, cloud storage, advection, deposition, precipitation, accumulation, sublimation, snow melt, surface runoff, plant uptake, transpiration, infiltration, percolation, subsurface flow, lake reservoirs, ground water storage, river discharge, volcanic steam. For a design-based discussion of water, see: Sasaki, "Designing with Water. Creative Solutions from Around the Globe," Preparing for the Rising Tide Series, Vol. (August 2014).