WEAVING AN AESTHETIC OF ECOLOGICAL AND CULTURAL PROCESS:

DESIGNING FOR THE FUTURE OF BOSTON'S SEAPORT

by

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(Under the Direction of Douglas M. Pardue)

ABSTRACT

This thesis explores landscape urbanism theory as a framework for urban design that combines cultural and ecological processes, and culminates in a design for a waterfront park in the Seaport District in Boston, Massachusetts. Investigation of Boston's urban form as the product of ecological and cultural processes acting upon the city and the vital ecological processes of a New England salt marsh yields elements that are incorporated into the park design. Analysis of case studies provides further insight into the challenges of combining these two often divergent elements. The final design creates an urban park that recaptures the history and identity of the area, links the Seaport District to its larger urban context in Boston, embraces ecological process, and provides stormwater infrastructure while contributing the greenspace essential for the health of the adjacent community.

INDEX WORDS: Landscape urbanism, Urban form, Salt marsh ecology, Seaport District, Boston, Massachusetts

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1. INTRODUCTION

The Seaport District in Boston, Massachusetts (Figure 1), was identified several decades ago as the focus of future development for the city's ongoing revitalization efforts. However, due to various obstacles and delays caused by public concern over erasure of the area's history and identity, loss of industry and affordable housing as a result of gentrification, and privatization of the waterfront, much of the area still lies, as it has for the majority of a century, in a state of limbo somewhere between dwindling industrial use and emerging waterfront community. "Somehow, two centuries of producing new waterfronts – each a radical undertaking for its day, each eschewing conventional wisdom or timidity, each producing a quite striking and distinct environment – haven't produced a confidence about doing it well at the Seaport District," (Krieger, 2001, p. 174). Despite the city of Boston's extensive résumé in reconfiguring its waterfront and altering its urban fabric, opposition to proposed plans and reluctance to move forward with development speak of the importance of the Seaport District in the lives of Boston residents and an underlying concern for choosing the future path that will most greatly benefit the city.

Figure 1: Map of Seaport District, Boston, Massachusetts
Source: Adapted from Google Earth version 4.2.198.2451

In an effort to address points of contention and assuage public concern, the Boston Redevelopment Authority compiled the *Seaport District Public Realm Plan* in the mid-1990s. This report prompted subsequent planning initiatives that outline goals for the development of a vibrant mixed-use neighborhood that will:

> • Encourage residential, cultural, civic, retail, restaurant, recreation, and entertainment uses closer to the waterfront.
> • Protect and enhance industrial, manufacturing, warehouse, research and development, and office uses in South Boston, and preserve the economic viability of water-dependent users reliant upon the Harbor and the Channel.
> • Support development of affordable housing throughout the South Boston neighborhood, including artist live-work space in the Fort Point Historic District…
> • Design a compact, walkable environment with intimately-scaled streets, blocks, and neighborhood parks, and local connections to the waterfront…
> • Connect the Seaport to the proposed Urban Ring Transit System.
> (Boston Redevelopment Authority [BRA], 2006, p. 19)

These objectives adequately address cultural aspects of the proposed neighborhood, make provisions for the historic, industrial, gentrification, and privatization concerns raised by the public, and, essentially, lay the groundwork for creating a community that adheres to the requirements of sustainable urbanism.

Sustainable urbanism, a concept proposed by Chicago-based architect, Douglas Farr (2008), is the result of a compilation of smart growth, new urbanism, and green building principles that seeks to create "walkable and transit-served urbanism integrated with high-performance buildings and high-performance infrastructure," (p. 42). While development guidelines for the Seaport District put in place density, connectivity, and neighborhood amenity criteria that are central to sustainable urbanism thought, they lack consideration for the inclusion of two important ideas – *biophilia* and infrastructure – that hold the potential to greatly improve the character of the district and the health of its residents. *Biophilia,* defined as "the human love of nature based on [the] intrinsic interdependence between humans and other living systems" (Farr, p. 48), is an integral piece in the human psyche, and it is vital that nature – whether real or constructed – be better integrated into our urban centers. By omitting any mention of ecology in the development goals, a message is sent that surrounding ecosystems are not valued and not to be considered in the future of the Seaport District.

Development of this area will also stress the already taxed infrastructure that serves the district, specifically wastewater and sewer systems, leading to an increased number of Combined Sewer Overflow (CSO) events where stormwater runoff overwhelms the water conveyance system releasing untreated water and sewage directly into Boston Harbor. Sustainable urbanism and other initiatives propose that stormwater runoff generated by development enter systems that "treat water as a resource, not a waste product….through the incorporation of techniques that effectively cleanse, diffuse, and absorb water where it falls, thus restoring the historical patterns of groundwater-dominated hydrology and water quality," (Farr, 2008, p. 175). Incorporation of these infrastructural objectives into the development goals for the Seaport District can reduce runoff entering the existing stormwater infrastructure limiting the quantity and severity of CSO events and improving water quality in Boston Harbor and adjacent waterways.

As the Seaport District undergoes extensive redevelopment, the need for open space recognized in the planning initiatives will become increasingly important and can provide a place to recapture the history and identity of the area, link the Seaport District to its larger urban context in Boston, embrace ecological process, and provide stormwater infrastructure while providing greenspace essential to the health of the emerging community. Salt marshes that existed in the area prior to extensive land-making initiatives at the turn of the nineteenth century are an example of an ecosystem whose processes and function could be incorporated into a public park that would recall a historical condition and whose potential to filter water could alleviate stress on local stormwater infrastructure. This thesis will explore how cultural factors and ecological processes can come together in a park design for the Seaport District in order to serve the needs of the future community and the adjacent ecosystems.

Building on the motives and rationale of sustainable urbanism, landscape urbanism theory is concerned with combining urban form and ecological process but moves beyond specifications for creating good community, as detailed in sustainable urbanism literature, to address the relationship of forms and processes as they appear in a landscape. Centered on the design goals of "the ability to shift scales, to locate urban fabrics in their regional and biotic contexts, and to design relationships between dynamic environmental processes and urban form" (Corner, 2006, p. 24), as well as to "think of landscape as an infrastructure which underlies other urban systems" (Mossop, 2006, p. 176), these tenets of landscape urbanism provide a framework that allows for a juncture between ecology and culture in order to create cities that respond to contemporary populations and provide, as proponents of this theory see it, for the shortcomings of traditional urban design. Yet several questions remain: how can landscape urbanism theory be applied to the design of a park in the Seaport District that will effectively integrate the existing urban forms in Boston with ecological processes? What urban forms exist in Boston and the Seaport District and what cultural and ecological processes shaped them? What ecological processes should be incorporated into an urban park that can simultaneously fulfill the partial function of stormwater infrastructure? And what is the urban design aesthetic that emerges at the intersection of a cultural and ecological landscape?

Figure 2: Site Outline for Park Design Application
Source: Adapted from BRA, 2006.

This thesis will seek to provide answers to these questions through an investigation of scale and context, dynamic process, ecology, and infrastructure as proscribed in the tenets of landscape urbanism and create a design for a public park that integrates the findings (Figure 2). Chapter 2 of this thesis will further analyze landscape urbanism and discuss related theories that build upon it, such as hierarchy theory of scales, Kevin Lynch's analogy of a city as an ecosystem, and Kristina Hill's criteria for "good" ecological design. Chapter 3 will examine components of urban form, specifically street patterns, permeability, and edge conditions, as influenced by both cultural and ecological factors. Four iconic Boston neighborhoods – the North End, Downtown Financial District, the Back Bay, and South Boston – and the Seaport District will be explored at different scales to distill forms that can be referenced or replicated in a park design to establish contextual connections across the city and strengthen ties to the history and identity of the district. Chapter 4 presents a salt marsh as a viable option for an ecological model in a park. The cultural and ecological processes that shape salt marshes across several scales will be examined to distill forms that can be used to weave aspects of the ecosystem into a park and the urban fabric of the Seaport District. Five case studies – Crissy Field in San Francisco, Allegheny Riverfront Park in Pittsburgh, Oosterschelde Weir in the Netherlands, East River Ferry Landings in New York, and the 12^{th} Avenue Green Street in Portland – are identified in Chapter 5 and analyzed to compare and contrast distinct approaches that combine urban form with ecological process. The conclusions drawn from these chapters will be applied in a design application in Chapter 6 to inform the design aesthetic of an urban park. The design will reference urban forms found in Boston as well as the Seaport District to ground the park in its urban context and strengthen the identity of the Seaport District. Processes and forms characteristic of a salt marsh will integrate the park in its ecological context and alleviate stress on existing infrastructure while improving water quality. Finally, Chapter 7 will evaluate the design for its adherence to the tenets of landscape urbanism theory and draw conclusions about the aesthetic produced at the convergence of cultural and ecological components.

2. TOWARDS A SOCIO-ECOLOGICAL AESTHETIC

> *Sustainability stands on three pillars, we are told: ecology, social equity and economy. The ecological operates in relationship to social justice and capitalist profit, but not aesthetics. Here, I will make a claim for reinserting the aesthetic into discussions of sustainability.*
>
> *-Elizabeth Meyer, 2008*

Cultural and Ecological Process

The quadruple bottom line of sustainable design combines four values: ecology, social equity or culture, economics, and aesthetics. While the economic component is outside the scope of this study, it is an equally important factor in a balanced community. This thesis will investigate the relationship between the remaining three components insofar as cultural and ecological processes pertain to urban and ecological forms and the aesthetic produced at the intersection of these two elements.

In order to identify an urban aesthetic that weaves together cultural and ecological processes, one must begin by defining these two elements. Cultural processes "comprise all procedures through which people transform the world…. Norms and rules, values and ideas, information and knowledge as represented, exchanged, appropriated, altered and created anew in the process of communication" (Research Institute for Austrian and International Literature and Cultural Studies, 1998) determine the changes that occur and the speed at which they happen. Our physical networks, most prevalent in urban landscapes, facilitate the exchanges and interactions between people and organizations. Ecological processes, similarly, are cycles and exchanges specific to each ecosystem that contribute to the system's resilience and survival. Although humans often alter the natural environment through cultural processes, ecological processes also exert influence over cultural decisions. These two categories are inextricably intertwined, even though they are often addressed as separate topics in landscape architecture literature and practice with little connectivity or transparency.

Urban areas present an arena where both types of processes exert influence over each other because of the intensified presence of the cultural processes. Often, due to the overwhelmingly constructed forms, cultural processes are more evident and ecological processes are hidden from view in artificial infrastructure. Although functional, the covert ecological processes do not perform to their maximum potential, diverting beneficial goods from both city and ecosystem. Furthermore, covered processes miss the opportunity to offer a visible or engaging experience for the public with the potential to instill appreciation for natural and built forms.

Through the Lens of Landscape Urbanism

The tenets of landscape urbanism introduced in Chapter 1 of this thesis, offer a framework for developing an aesthetic that combines cultural and ecological processes while balancing the needs of the human communities and ecosystems. First, encompassing multiple scales allows for the creation of complex designs capable of addressing various levels of influence that anchor the site more firmly in their wider contexts, both man-made and natural. Second, designing for dynamic processes considers the needs of both the cultural and ecological systems and facilitates reciprocal exchange between the site and those processes, inserting a design as an integral part of the larger system. Third, "ecology teaches us that all life is bound into dynamic and interrelated processes of codependency" (Corner, 2006, p. 63). Incorporating ecological process into the landscape gives design the ability to raise awareness of ecosystem function and exact positive change in the attitudes and behaviors of the public. Finally, by merging landscape and infrastructure, a space can take on multiple uses and work to improve both the environmental qualities in the city and adjacent ecosystems.

Shifting Scales

The city operates and mixes processes at a number of scales, regional to local, community to individual – all critical to the character and functions of the city's fabric. Architect Linda Pollack (2006) underlines the necessity of designing at multiple scales:

> A site exists at an unlimited number of scales….the potential of a project to operate at different scales relies upon the designer's investment in representing the elements and forces that exist or have existed at those scales, as a precondition for designing ways to foster interdependencies between them. (p. 130)

In urban spaces, the interconnectedness between the site, the adjacent buildings, districts, and ecosystems, and the city as a whole works legibly to relate the meaning of sites to users. References to various scales not only ground the design in its urban and ecological contexts, but also recognize the processes that created the city and molded the site.

In design, inattention to scales in an urban setting can lead to a loss of site identity as well as hinder integration with surrounding urban conditions. Inattention to the multiple scales at which forces act on ecosystems can limit ecological function on the site (Miller, 2008). Hierarchy theory acknowledges the need to investigate three levels of spatial scale.

> The scale just above or broader than the area or object of interest exerts effects on the area. Second, other areas at the same scale as the area of interest exert competitive or collaborative effects. And finally, the scale just below or finer than the area of interest affects the area. (Forman, 2008, p. 19)

While addressing these three levels of scale is important in design, James Miller notes the difficulties of effectively incorporating multiple scales into site design:

> a balanced consideration of broad and fine scales and the processes that link them is not easily achieved…when it comes to integrating nature and culture in cities and suburbs, landscape architects have become too focused on site design, failing to mesh their work with the broader fabric of ecological patterns and processes. (p. 116)

Yet it is possible to create sites that arrive at the delicate balance of scales that Miller describes. Spaces that recognize and react to the contiguous urban forms to provide valuable cultural experiences for human users while maintaining connections with ecological processes occurring at fine, medium, and broad scales are able to bridge the divide that has been established between culture and nature and locate sites in their cultural and biotic contexts.

Designing for Dynamic Process

Landscape urbanism is especially concerned with the dialogue between cultural and ecological forces that act upon cities.

> It marks a dissolution of old dualities such as nature-culture, and it dismantles classical notions of hierarchy, boundary and centre…. landscape urbanism views the emergent metropolis as a thick, living mat of accumulated patches and layered systems, with no single authority or control….The contemporary metropolis is out of control – and this is not a weakness but its strength. (Corner, 2003, p. 59)

Acknowledgment of influences that shape the metropolitan sphere and blurring the line between nature and culture allows for the creation of landscapes that speak directly to and communicate the fluidity and constant flow of the city.

Concurrent with James Corner's assessment of the city as a living, ever-changing system, Kevin Lynch (1987) noted the similarity of urban centers to ecosystems in an exploration of alternative models for urban form, concluding:

> the idea of ecology seems close to an explanation, since an ecosystem is a set of organisms in a habitat, where each organism is in some relation to others or its own kind, as well as to other species and the inorganic setting….and has certain characteristic features of fluctuation and development, of species diversity, of intercommunication, of the cycling of nutrients, and the pass-through of energy. (p. 115)

The likeness of the patterns and flows that occur in urban spaces to those in ecosystems illustrates a common dynamic quality present in each setting, and highlights dynamism as a thread that can serve to bring together these seemingly opposing landscapes in a design for an urban park that highlights the variability both of the city and an ecosystem.

The physical attributes of an urban area produced as a result of the cultural and ecological forces acting upon the land give the city its recognizable character and temporarily capture the instability of urban areas. As Lynch (1960) states, "while [the city] may be stable in general outlines for some time, it is ever changing in detail…there is no final result, only a continuous succession of phases" (p. 2). The city acts as a register of cultural and ecological processes acting together, its forms influenced by possibilities and norms: "the city is a mirror of the complexity of modern life. The result is a city where instability is the only constant…a city pieced together from heterogeneous elements that when combined create a homogeneous aesthetic" (Marshall, 2001, p. 3). Discussed further in Chapter 3, the forms that characterize the city of Boston and the Seaport District are directly traceable to historical events, cultural practices, and ecological constraints, and have created distinct identities for each neighborhood that collectively constitute the personality of the city as a whole and call attention to the cultural and ecological processes at work.

Ecological Design

Prevalent cultural processes in urban environments radically alter the terrain of cities for cultural benefit, yet often these created settings are perceived as devoid of life other than our own. “Despite the many benefits urbanism bestows on the Earth, conventional urbanism obliterates virtually all the systems of nature it comes into contact with” (Farr, 2008, p. 48). This is a drastic view on the urban condition that ultimately promotes a healing or conservationist approach to urban design. Interestingly, as designers attempt to remedy this situation with the goals of improving the quality of the environment and showcasing the health benefits of interaction with nature, the result is often more of the same since Richard Forman (2008) and others have shown that these 'obliterated' terrains are often abundant in ecological diversity. “The most species-impoverished locations are the most intensively designed, built, and managed, whereas several of the richest biodiversity sites are the least designed, least managed, and most overlooked locations in a city” (p. 107). These findings suggest that an unmanaged approach that allows for the evolution of a space over time as unrestricted cultural and ecological processes act upon the land yields a greater diversity of species.

Landscape urbanism suggests that there is a middle ground between the healing-conservationist design method and allowing spaces to go completely unmanaged for the sake of encouraging biodiversity. To improve the condition of biodiversity across the entire city, design must play a role in integrating ecology into the urban fabric with attention to creating spaces with the dual purpose of providing habitat for species and accommodating cultural needs, otherwise our current practices will continue indefinitely, further degrading ecosystem function in and around the city. Many landscape architects and other ecological designers have developed prototypes and explored unique designs for weaving ecology into urban sites. In her essay *Green Good, Better, and Best: Effective Ecological Design in Cities*, Kristina Hill (2008) describes the elements that should be present in good ecological design.

> First, "good" ecological design must enable a biological function important to the ecological health of its regional and local setting. "Better" ecological design would address the functions that are strategically critical to this health in a given bioregion—such as improving water quality, conserving plant or animal species at risk of local or global extinction, increasing soil fertility, or improving air quality. "Best" ecological design would be able to show these benefits in measurable ways and would stay in touch with the latest thinking in the sciences and engineering (and social and environmental ethics) to make sure it makes sense to keep pursuing those benefits. (p. 145)

Opting to design for a critically important ecosystem function creates a more relevant proposal by addressing issues that affect areas outside the site's boundaries. Additionally, a design that responds to the changing needs of the community and environment by emphasizing the benefits and monitoring the necessity of ecological function succeeds in addressing the processes that act on the city, and places the site in relation to its larger ecological context.

However, a designed place does not need to look like a naturally occurring ecosystem to accentuate ecological processes and relate to a larger system. "Landscape architects spend too much time worrying about "real nature" versus "constructed nature" when both are alive and are part of the same ecological essence," (Amidon, 2005, p. 25). In fact most urban sites have limited space, high real estate costs, and multiple users and cannot feasibly devote the entire area to the ecological function in question. Noting that a site "doesn't have the breadth or scale of real nature," Michael Van Valkenburgh Associates' solution to this problem is to build a constructed nature termed *hypernature*: "an exaggerated version of a natural palette," (Amidon, p. 57). By accentuating the elements found in a natural ecosystem – increasing the density of plantings, installing larger boulders, highlighting the contrast between land and water – the ecological function is more readily related to the viewer and still accomplishes the goal of incorporating ecological process into the urban site.

Another idea about the relationship between urbanism and ecology has begun to enter into American landscape architecture theory from Europe. Dutch landscape architect and urban designer Adriaan Geuze sees "nature and landscape as artificial," (Schröder, 2001, p. 176). This is largely true is his home country that has been claimed from the sea by extensive dikes and barriers and where the imprint of human intervention is ubiquitous. A proponent of post-Darwinism theory, Geuze and his firm subscribe to the thinking that nature is capable of adapting to new natural environments, and therefore is capable of evolving to exist in artificial settings (Weilacher, 1999). Although this theory applies to the highly altered landscape in the Netherlands, it is also applicable to urban spaces in the United States. Our urban centers are highly transformed from their original states, yet, as Richard Forman observed, harbor a certain degree of biodiversity. Artificial ecosystems that are created on urban sites will therefore support the flora and fauna that are able to adapt to fit the new forms. The New England salt marsh, discussed further in Chapter 4, with its capacity to filter water, readily visible dynamic processes, as a historic ecosystem in Boston, and as a naturally occurring transition zone between land and sea, offers a reasonable option for a model ecosystem to be incorporated into the urban fabric of the Seaport District.

Landscape as Infrastructure

Acting as interface and support, infrastructure provides a valuable design platform for registering and expressing cultural and ecological processes due to its potential to harness natural processes, the inadequacy of modern systems, and promise of improved health for contiguous ecosystems and the city itself. As landscape architect Richard Weller states, "the landscape itself is a medium through which all ecological transactions must pass: it is *the* infrastructure of the future" (Waldheim, 2006, p. 44). By relocating and exposing infrastructural systems in the landscape the public will become more aware of the networks that allow a city to function, and land dedicated to the single function of delivery or removal of goods can be repurposed for combined cultural and ecological uses.

In Boston's early history, sewage and wastewater were dumped directly into nearby water bodies. Over time, the water quality diminished and foul smells permeated much of the city, prompting a flurry of efforts to fill low lying areas, capping the offensive waterways, and burying the odors. However, in the 1880s, Frederick Law Olmsted was hired by the city of Boston and set a new precedent for infrastructural landscapes with his plan for the Back Bay Fens.

> The plan that Olmsted devised evoked the scenery of nearby salt marshes, but a great deal of engineering underlay the apparent naturalness. His scheme provided ingenious solutions to a series of problems involving sanitary engineering, traffic engineering, recreational facilities, and institutions for scientific education. (Beveridge & Rocheleau, 1995, p. 98)

While the design for this landscape did accomplish its goals of managing sewage effluent and flooding, Olmsted also endeavored to provide users with a picturesque experience – the preferred aesthetic of this time period – by invoking salt marsh scenery at a time when marshes were considered undesirable. In this manner, he combined function with beauty, but as Anne Spirn (1996) observes, "he disguised the artifice, so that ultimately the built landscapes were not recognized and valued as human constructs….it was viewed as decorative, not functional" (p. 111). When Olmsted succeeded in creating a picturesque landscape, the infrastructural processes that he planned to highlight were ultimately disguised along with his design intent.

Current landscape architecture projects that incorporate infrastructure into their designs, such as Field Operations' Fresh Kills Landfill, Hargreaves Associates' Byxbee Park, and Brown, Richardson, & Rowe's Spectacle Island, often take a different approach and set apart large swaths of land to let successional processes run their course in the landscape. While this is one way of illustrating ecological process in an urban location, the forms are often organic in origin and become less well defined with the passing of time. Harvard professor, Michel Desvigne, summarizes the outcome of this style of process design:

> the aesthetic is the aesthetic of transformation: the landscape develops as a product of processes of transformation, which are proposed and organized by the landscape architect. But it is true that these techniques do tend to result in a 'naturalistic' landscape. (Davione, 2003, p. 84)

Over time, these landscapes cease to demonstrate that they are constructed and lull the public into believing in a false sense of nature: a beautiful, scenic park with only faint hints of the infrastructure embodied in the design.

Constructed "naturalistic" landscapes not only have the effect of obscuring intended infrastructural function but also devalue natural ecosystems, especially as they appear in urban spaces, by creating a unrealistic sense of nature. Randy Hester acknowledges this trend and offers insights in how to remedy the situation, noting that "swamps, wetlands, mud flats, mud holes, even ponds, creeks, and forests that are sources of joy become stigmatized and off limits…The two most effective design strategies appear to be transparency and framing" (2006, p. 112). By creating landscapes that are clearly constructed, the false perception of nature produced when 'naturalistic' landscapes lose their design intent is eliminated, leaving sites that function infrastructurally and an intact appreciation of nautral ecosystems. Joan Nassauer (1995) consents noting that "novel landscape designs that improve ecological quality may not be appreciated or maintained if recognizable landscape language that communicates human intention is not part of the landscape," (p. 161). The disconnect between the public and ecological processes has created an inability to appreciate the aesthetic qualities of landscapes that function as infrastructure. Yet designers hold a key to change this perception: framing processes and patterns in the landscape.

Contrary to the objection that imposing form onto ecological processes limits their efficacy or diminishes their ability to be seen by the public, forces and functions highlighted by urban forms become more legible to visitors thereby increasing awareness of the existence of dynamic systems. Nassauer (1995) points out that "when ecological function is framed by cultural language, it is not obliterated or covered up or compromised," (p. 163). In the Seaport District the salt marsh has the ability to fulfill multiple infrastructural and hydrologic needs, while urban forms pulled from the surrounding Boston neighborhoods incorporate references to multi-scaled cultural and ecological processes and provide the necessary frames for an increased appreciation of ecological function.

3. BOSTON'S URBAN FORM AS AN INDICATOR OF CULTURAL AND ECOLOGICAL PROCESS

> *The city is a mirror of the complexity of modern life. The result is a city environment where instability is the only constant. The results of half a century of urban space-making have left us with a diffused urban structure; a city pieced together from heterogeneous elements that when combined create a homogeneous aesthetic.*
>
> – Richard Marshall, 2001

Cities are an amalgamation of physical, social, cultural, and natural components, distinct in their structural and temporal qualities of and the relationships between these elements. Boston's rich tradition of blending these components has helped shape and given rise to its uniquely wonderful urban form. By distilling urban patterns into critical relationships and scales, this chapter will focus on the concrete elements that compose urban form in Boston. As discussed in the previous chapter, the physical character of a city is the result of the cultural and ecological processes at work and can be used as a means of visualizing these intangible processes. "Settlement form, usually referred to by the term 'physical environment,' is normally taken to be the spatial pattern of the large, inert, permanent physical objects in a city: buildings, streets, utilities, hills, rivers, perhaps the trees" (Lynch, 1987, p. 47). Although not the only indicator of urban character, the pattern of streets and blocks largely determines the shape that other networks take and influences a person's perception of the city. "The street plan tends to be the most enduring element. Its stability derives from its being a capital asset not lightly set aside" (Carmona, 2003, p. 61). The layout and size of city blocks establishes the scale of the city and its buildings, the density of the population, and how finely mixed the services and neighborhoods are within the urban fabric.

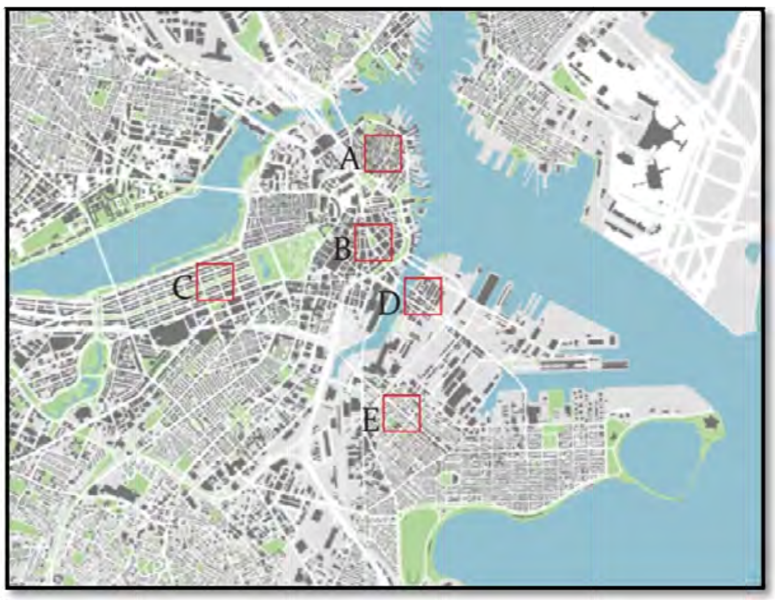

Figure 3: Neighborhoods of Boston Sampled to Explore Urban Form; A: North End, B: Downtown Financial District, C: Back Bay, D: Fort Point Historic District, E: South Boston

Exploration of the street pattern and permeability at distinct scales in five neighborhoods (Figure 3), selected for their unique, definable attributes and vibrant communities, will provide an opportunity to discover Boston's history and the evolution of the urban fabric. As a port city, the water's edge plays an important role in Boston's history and will be examined to distill forms that may aid in the combination of ecology and cultural process in urban design. Finally, a focused investigation into the historical conditions and activities that formed the Seaport District will yield information that can be used to ground a park design in its local context.

Boston's Form at Three Scales

City as a Whole: Coarse Scale

The city of Boston has a distinct history and form that sets it apart from its contemporaries. Built before the advent of the automobile, its streets share the maze-like charm of a medieval European city. However, in some sections, urban planning initiatives, have added a grid system to the irregularly arranged streets in order to facilitate large-scale development and construction. Regularly arranged streets have an effect of creating highly legible and navigable neighborhoods easily distinguished from the earliest parts of Boston. During the 1950s, the nation's interstate system was constructed and highways were carved through the heart of Boston, obliterating less affluent sections of the city and isolating neighborhoods (Jacobs, 1989). Less than half a century later, and true to Boston's spirit of progressive infrastructure, the highways have been rebuilt underground, creating a network of parks and urban space that has the potential to forge new concepts of city, rebuild community connections severed by the divisive, yet necessary, transportation network, and reveal new iconic landscapes.

Built on the narrow Shawmut Peninsula, the Boston of the seventeenth century looked nothing like the city today. The original topography of the city was a product of the glaciers that moved across the land during the last ice age leaving mounds of rocky deposits. The hilly landscape that constitutes Boston's peninsula and protective chain of Harbor Islands as well as its deep, natural channel, was essential to its development into a bustling port but also hindered outward expansion as the city prospered (Lynch, 1987). The natural landscape has influenced the form of the city in many ways, yet the quest for space to support the growing population has led to the unrelenting earth moving projects that have punctuated Boston's history. As a result of various initiatives to create more land for building, the coastline of this port city has changed dramatically over the past several centuries (Figure 4) creating a modern city that is built on thousands of acres of fill (Krieger & Cobb, 1999).

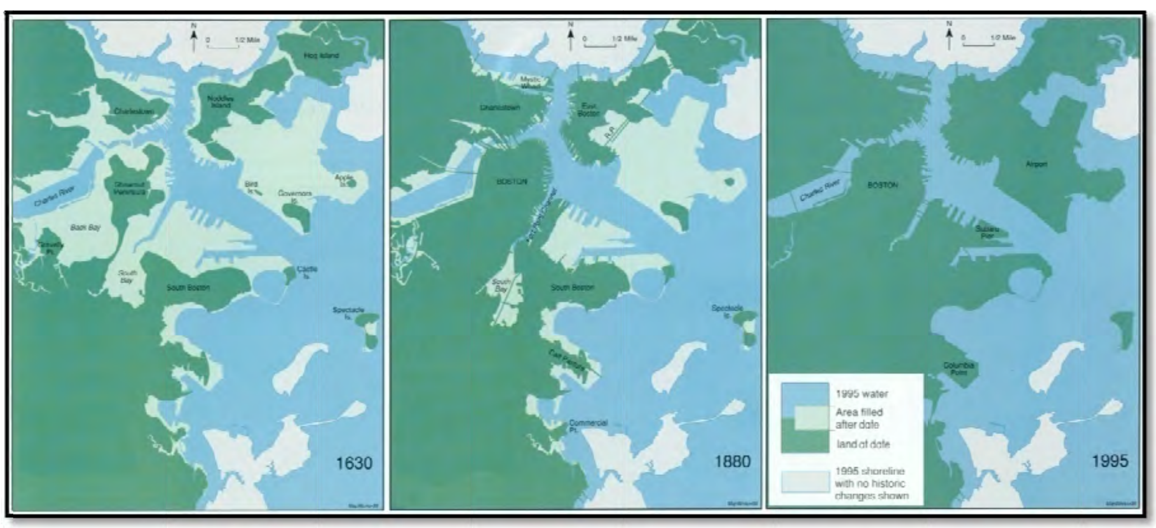

Figure 4: Land Change in Boston – 1630, 1880, and 1995
Source: Adapted from Krieger & Cobb, 1999.

Neighborhoods: Medium Scale

Interaction with the water has been an integral part of the city's history since its establishment and has shaped the layout of the emerging urban center. The first settlers began building wharfs immediately, and the coastline was soon perforated with piers extending out into the harbor. Long Wharf was constructed in 1711 in the middle of the cove on the eastern side of the peninsula, and a road was built as an extension toward the land (Krieger & Cobb, 1999). This street, named State Street, soon became the economic center of the city as Boston advanced its position as the primary port on the Eastern Seaboard (Lynch, 1987). Boston served as a model of growth and prosperity for the majority of the eighteenth and nineteenth century and the city grew outward from the central commercial spine.

In the early 1800s, *wharfing out* – a process where space between adjacent wharves was filled to make usable land – began in earnest (Krieger & Cobb, 1999). As this new land was created, more wharves would be built into the harbor to provide continued access to ships, and the old wharf was incorporated as a street into the urban fabric. Thus the seemingly illogical layout of many streets in older sections of Boston, is a reflection of historic coastlines and their perpendicular wharves.

The irregular pattern of streets in the North End and Downtown Financial District (Figure 5) created by the wharfing out process is characterized by distinctly shaped blocks that cannot easily be defined using geometric descriptors.

These multisided blocks interspersed between numerous intersections increase the permeability of the neighborhoods, – "the extent to which an environment allows a choice of routes both through and within it" (Carmona, 2003, p. 64) – and the organic layout indicates the streets were originally "based on pedestrian movement, and…built as integral parts of the immediate area rather than as through routes" (Carmona, p. 65). Increased permeability and freedom to move around within the city affect the level at which local and regional networks can penetrate the urban fabric. The North End and Financial District have good permeability, for both pedestrians and vehicles, as the irregular layout of the streets and small blocks creates many intersections that allow for multiple options for path selection and give these areas their distinct character.

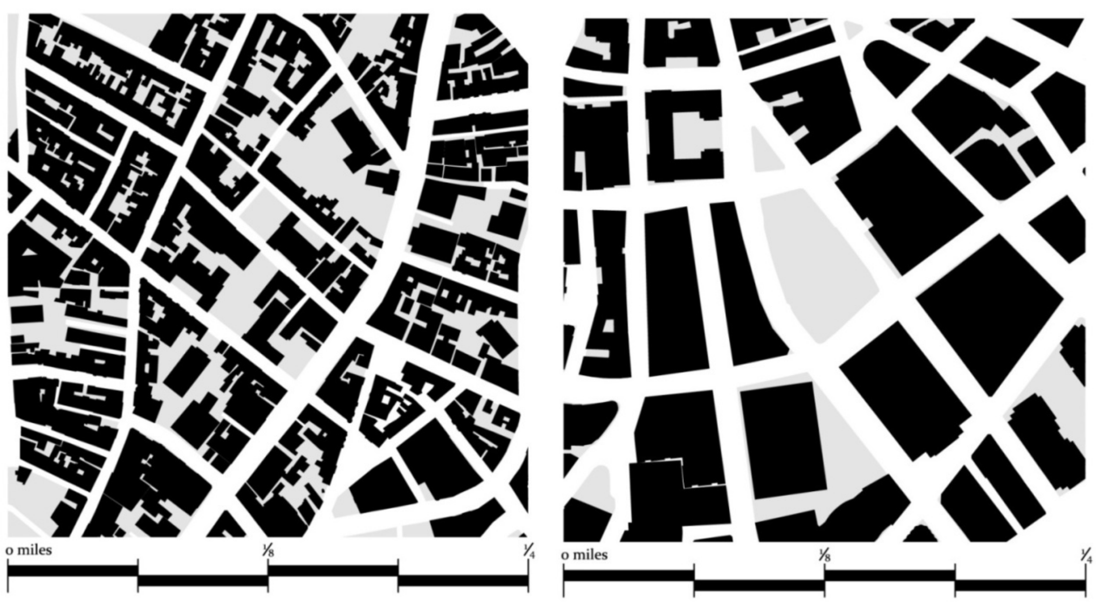

Figure 5: Irregular Street Pattern in Boston's North End (A in Figure 3) and Downtown Financial District (B in Figure 3)

In the mid 1800s, wharfing out was superseded by large scale filling of tidal flats, salt marshes, and riparian systems. The hills, characteristic of Boston's glaciated past, were cut down for fill, but also to create gentler slopes more conducive to the construction of buildings (Krieger, 2001). These large filled sites were essentially blank slates, containing no wharves to determine the location or orientation of streets and buildings, and were often laid out with a regular grid of city blocks, as in the case of the Back Bay and South Boston (Figure 6). The rectangular layout of the blocks in the Back Bay and South Boston neighborhoods impose a regular pattern on the land that is readily legible and easy to negotiate, creating an identity that differentiates these areas from the older, irregularly patterned North End and Downtown areas.

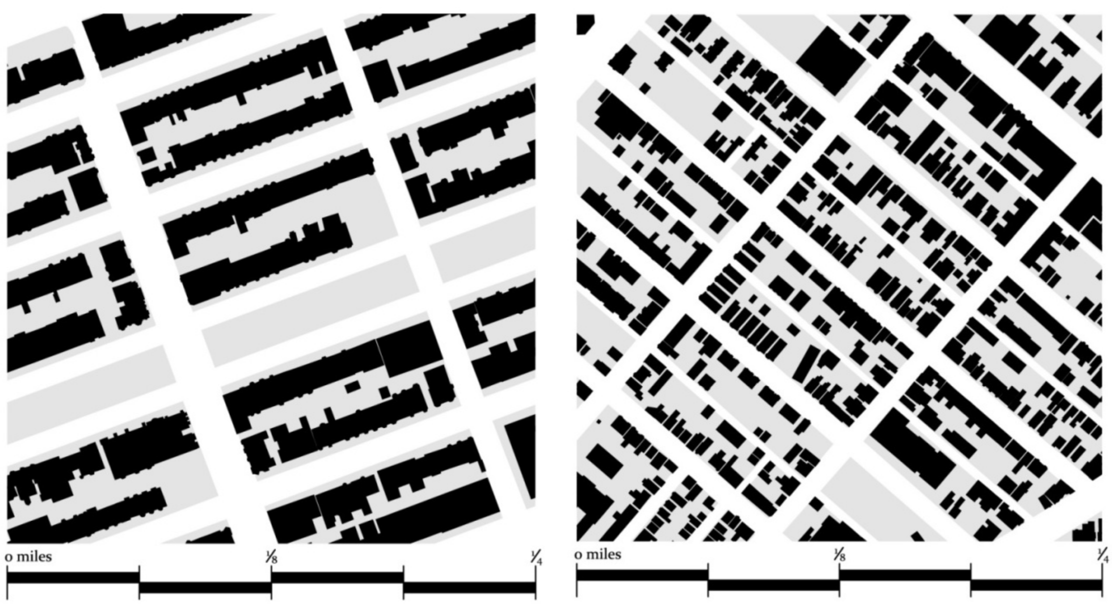

Figure 6: Regular Street Pattern in Boston's Back Bay (C in Figure 3) and South Boston (D in Figure 3)

Individual Blocks: Fine Scale

The extent of pedestrian permeability within a block in these neighborhoods and the unique building style adds to the identity of each area. Both the North End and Financial District have high rates of permeability due to their street layout, but the scale of the buildings evokes significantly different feelings when moving through the areas. Zooming in to look at permeability in a single block, the North End (Figure 7) contains small scale – three to four story – buildings intermingled with alleyways and courtyards, identified by a human-scale experience with pedestrian permeability into the interior of the blocks. The Financial District (Figure 8), which underwent extensive construction in the 1970s as part of Downtown Boston's revitalization effort, on the other hand, has larger buildings, often one per block, which are significantly grander in scale and limit permeability to the street pattern. Both scales of building are appropriate to the use of each area: fine-grained pedestrian permeability in the vibrant mixed-use North End and bustling daytime streetscapes in the office-dominated downtown.

Figure 7: Human-Scaled Experience and Permeability to Interior of Block in the North End
Source: Photograph from www.city-data.com/picfilesc/picc22766.php

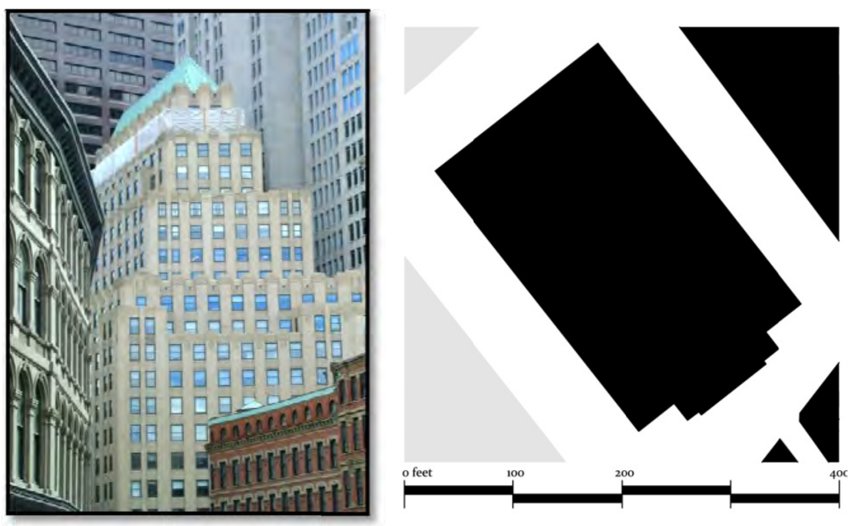

Figure 8: Large-Scale Buildings in Downtown Boston with No Pedestrian Permeability to Interior of Block
Source: Photograph from www.freefoto.com

South Boston and the Back Bay are both primarily residential neighborhoods with some commercial space and have small scaled buildings. However, South Boston (Figure 9), a vibrant working-class neighborhood with strong Irish roots, remains significantly more permeable, at least visually, due to the alleyways and detached buildings. The long sides of the blocks in the Back Bay (Figure 10), which was developed as an upscale neighborhood in the 1880s, are fronted with continuous rows of houses that maintain an urban street edge but are more visually imposing and limit pedestrian permeability to the interior of the blocks.

Figure 9: South Boston Neighborhood Architecture and Permeability to Interior of Block

Source: Photograph from picasaweb.google.com/liana.elyse/BostonLocations

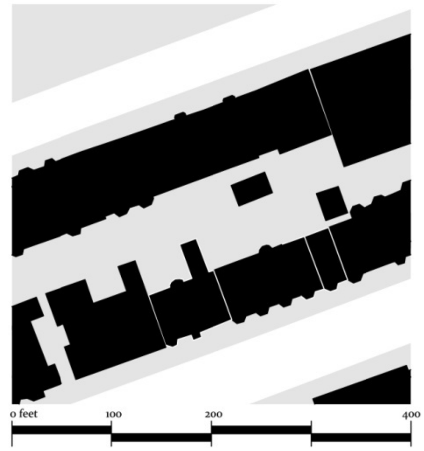

Figure 10: Back Bay Architecture and Blocks with Limited Pedestrian Permeability
Source: Photograph from www.bostoncondoloft.com

Through the examination of these four neighborhoods and the ecological and cultural processes that created them, several recognizable patterns and forms have emerged that can be employed in a park design in the Seaport District to tie the new park to its urban context in the city of Boston. The radial pattern of piers that have been absorbed into the urban framework, lend the city its characteristic irregular street layout and create highly permeable neighborhoods. Meanwhile, large swaths of land are dominated by rectilinear grids as evidence of planning and development endeavors that provide legible neighborhoods with distinct character. The multiple factors that influenced the formation of Boston have left their mark on the city, each adding a layer to the identity and pattern of the urban center and visibly inscribing the effects of cultural and ecological process in the urban fabric.

Edge Conditions

Edges of districts play a key role in facilitating exchange across borders. The shape, complexity, and three-dimensionality of edges all determine the ease with which movement occurs across a boundary. In *Landscape Ecology Principles in Landscape Architecture and Land-Use Planning* (1996), Wenche Dramstad, James Olson, and Richard Forman distill the most important characteristics of edges and further describe the effects that edge character has on movement between districts. Although their conclusions are oriented toward ecological transactions, the principles of cross-boundary movement are easily applied and readily applicable to cultural exchanges in urban contexts.

The shape that an edge takes – whether straight or curvilinear – affects the type of movement that occurs nearby (Figure 11). "A straight boundary tends to have more species movement along it, whereas a convoluted boundary is more likely to have movement across it" (Dramstad et al., 1996, p. 30). Similarly, a convoluted boundary provides a greater diversity of spaces, and can host more variety of activity, whereas a straight boundary provides an abrupt transition between spaces and may preclude transactions across it. Furthermore, the three-dimensional qualities of a boundary influence the ease of movement and "edges with high structural diversity, vertically and horizontally, are richer" (Dramstad et al., p. 28) as the graduated structure provides a smoother transition between spaces (Figure 12). Finally, Dramstad et al. contrast natural and man-made edges, noting that "most natural edges are curvilinear, complex, and soft, whereas humans tend to make straight, simple, and hard edges" (p. 29). However, convoluted edges can be comprised of straight lines and still function as permeable boundaries for humans and other species. The determining factor is the scale of the permutation. Large-scale straight edges will act as a barrier to small organisms while fine-grained edges, even when comprised of linear components, should promote a high level of permeability.

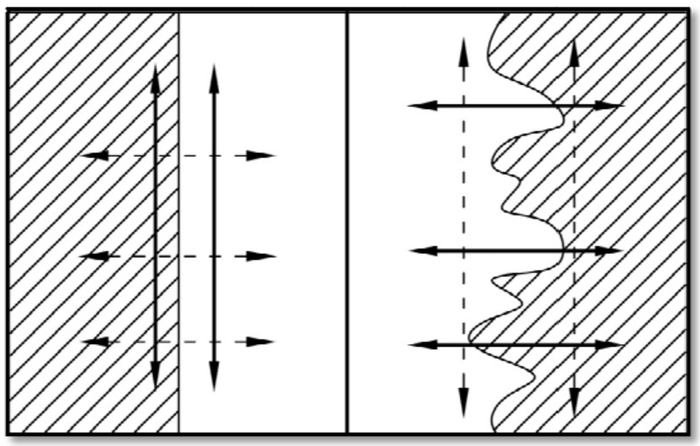

Figure 11: Movement across Straight and Convoluted Boundaries
Source: Adapted from Dramstad et al., 1996.

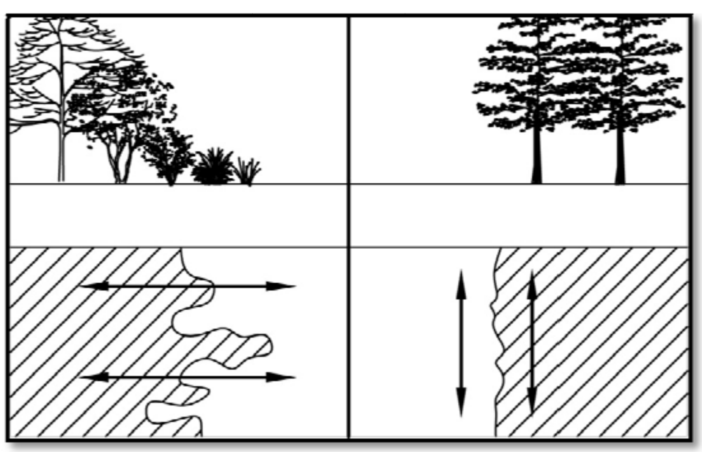

Figure 12: Structural Diversity Promotes Movement across Boundaries
Source: Adapted from Dramstad et al., 1996.

In Boston, there are two types of edges that are of particular interest in the study of cultural and ecological processes: boundaries between districts and the line between land and sea. Neighborhoods and districts in Boston have unique defining characteristics and equally well-defined boundaries. "The dialectical relationship between neighborhood lines and the wariness of one neighborhood toward an adjoining one seems part of the physical fabric itself" (Krieger & Cobb, 1999, p. 154). The sharp edges that demarcate districts serve to contain local cultural processes within neighborhood boundaries. The scale of these processes and the resistance in crossing such linear, abrupt edges intensifies the effects of cultural forces within each area, indelibly etching the process into the physical urban form of each district and helping to reinforce each district's identity within these edges.

Conversely, the coastline is a complex, undulating edge conducive to vibrant activity and, when bounded by appropriate three-dimensional structural diversity, readily crossed by many species. Dramstad et al. (1996) stress the importance of aligning ecological boundaries with artificial – political or administrative – edges to ease the interaction between constructed and natural worlds. Boston's waterfront is just that: a convergence of the edge of the city and a natural transition zone between land and water. In its original state, the coastline exhibited the convoluted, curvilinear forms and graduated vegetation zones that encouraged movement across the land-water gradient for coastal species. Due to the integral role of the ocean in the cultural history of Boston, early settlers instituted the practice of building wharves into the water, making a rectilinear edge (Figure 13) that maintained the complexity of the natural coastline and provided a transition between the vertical buildings of the city. This highly permeable constructed coastline, still present today, encourages transactions between land and water and provides the ideal location for integrating cultural and ecological processes in an urban setting.

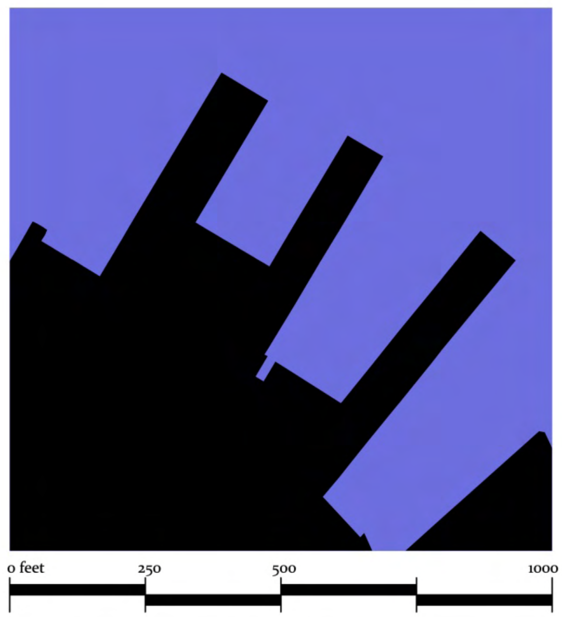

Figure 13: Convoluted Rectilinear Edge Formed by Wharves

The Seaport District

Originally the site of salt marsh and mud flats projecting into Boston Harbor off of the Dorchester Peninsula, the Seaport District has experienced dramatic alteration since the city's establishment. The ecological processes that occurred in the marsh and shaped the early landscape will be discussed more fully in the following chapter. As industry was pushed out of the expanding downtown area in the mid-1800s, the shallow waters covering Commonwealth Flats, as the area was known, offered an ideal location to create new land and still enjoy proximity to the city's commercial center.

Initial filling efforts that proceeded via wharfing out produced the narrow strip of land seen in the 1880 map in Figure 4, and the streets in existence today along the Fort Point Channel are mostly the product of old wharf patterns (Tyrrell, 2004). The remainder of the Commonwealth Flats was filled between the 1850s and 1916 as a result of reports by the U.S. Commissioners of Boston Harbor that determined filling of the flats would improve water flow through shipping channels, keeping them free of sediment (Krieger & Cobb, 1999). "And so the South Boston, or Commonwealth, Flats project, which eventually became one of the largest land-making projects ever conducted in the city, began not as a commercial development but as a harbor improvement" (Krieger & Cobb, p. 131). This large-scale project solidified the Seaport District's place in Boston's history of unprecedented and innovative earth-moving endeavors, but cast the area into a century-long cycle of renovation that has yet to settle into a stable, defining aesthetic.

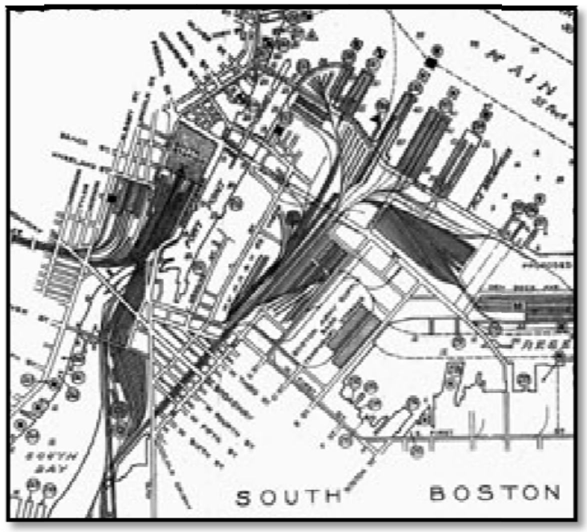

Figure 14: Pattern of Linear Railways Connecting Port with Inland Areas
Source: Boston Public Library

The Seaport District has been reworked time again by the industrial enterprises that characterized the area and connected Boston's port to the railways that distributed goods to inland regions. The railways along with the bridges that connected to downtown Boston were both essential to the success of this district and until the 1950s rail lines created a distinctive linear array (Figure 14) across the land, perpendicular to the water. Bridges that crossed the Fort Point Channel were usually extensions of streets on the Boston side and subsequently break the grid that runs parallel and perpendicular to the channel in the Seaport District.

One section, known as the Fort Point District (Figure 15) was developed as residential and commercial space by the Boston Wharf Company in the 1880s following a collapse in the sugar market and has survived the shifting mosaic of uses. The street grid in this area runs parallel to the edge of the Fort Point

Channel, but is skewed as it responds to the connector streets that bridge the channel from Downtown Boston.

Figure 15: Skewed Street Grid and Building Pattern in Fort Point District

The buildings in the Fort Point District have an industrial aesthetic (Figure 16) indicative of the history of the district, and have space between each building to allow for loading and unloading from warehouses and for the utmost level of permeability to meet the demands of the hustle and bustle of the once vibrant port. Also, the buildings directly abut the street which creates a more densely settled, vertical edge like that of the North End or Financial District rather than the row houses of South Boston and the Back Bay that are set back from the street and add to the residential feel of those neighborhoods.

Figure 16: Fort Point District Warehouse Converted to Mixed-Use
Source: Photograph taken by the author, January 5, 2009.

By the time the Seaport District had been created, the heyday of maritime industry was winding down and land that had seemed so necessary half a century earlier lay as a flat, underutilized expanse. "The area has essentially served as a land bank for years, awaiting better regional access and, more importantly, demand for the expansion of the nearby downtown" (Krieger, 2001, p. 174). The time has arrived for the Seaport to be repurposed to meet the needs of a mixed-use community, and the area's history offers many forms and patterns that can be incorporated into the new urban design aesthetic that will call attention to the unique past and identity of the district.

Implications for Urban Park Design

The city of Boston is a product of natural topography – the topography created by the Laurentian glacier, the convergence of the Charles and Mystic Rivers, and the force of the Atlantic Ocean – as well as the early cultural forces that shaped its development. Landscape urbanism recognizes the importance of stitching a new park into a wider urban context by referencing urban forms and thereby acknowledging the processes that created the city. This chapter identifies several forms in Boston that can be incorporated into an urban park. Irregular street pattern, a response to the historic coastline and hilly terrain of the city facilitate high rates of permeability and could be applied to the circulation routes in a park to increase accessibility of all portions of the park. On the other hand, rectilinear street layouts, a completely cultural construct, were imposed on top of large filled areas as there was no natural topography to work around. A regular pattern is appropriate for the Seaport District as it shares the historic aspect of filled land with other Boston neighborhoods. Highly permeable interior block areas in the North End and South Boston coincide with vibrant, closely knit communities, while larger buildings with limited pedestrian permeability into the interior of blocks create lively streetscapes in the Back Bay and Downtown Financial District. Perhaps a hybrid model could be applied for a park in the Seaport District that would have some edges that were more impermeable to pedestrians, reinforcing the urban street pattern, while other portions of the park could exhibit perforated edges to allow for unimpeded pedestrian entry.

The role of Boston as a port city fostered a relationship of interdependence with the water, and created the economic engine for the city and a vibrant waterfront whose wharves blur the edge between land and sea. The convoluted pattern of wharves along the water could be applied in the park to smudge and simultaneously encourage movement across the urban-marsh divide. In the Seaport District, industrial buildings line a grid of streets bisected by skewed cross streets that bridge the Fort Point Channel to downtown Boston. Linear rail lines once marched toward the water, and the flat expanse of the filled land contrasts the hilly landscape of the Harbor Islands and surrounding landscape. As the park will be adjacent to the Fort Point District, pieces of the industrial past and present should be incorporated into the design to tie the site to its immediate context.

4. ECOLOGICAL PROCESS IN A NEW ENGLAND SALT MARSH

> *The ribbon of green marshes, part solid land, part mobile water, has a definite but elusive border, now hidden, now exposed, as the tides of the Atlantic fluctuate.*
>
> – John & Mildred Teal, 1969

As the historic ecosystem that existed in the Seaport District upon European settlement, and as a naturally occurring transition from land to ocean, the New England salt marsh has the potential to serve as a model ecosystem from which to distill patterns and pull forms to incorporate into the design of an urban waterfront park in Boston. Examination of the historic and current extents of marsh systems in the Boston area provides perspective on the impact that establishing a patch of constructed salt marsh within the Seaport District will have on the larger marsh system. A look at processes which define a salt marsh and physical forms produced by those processes will reveal elements that can be applied to a park design. And further investigation into marsh properties that replicate the function of traditional stormwater infrastructure will yield ecological processes that can potentially be used in park design to ameliorate inadequacies in current infrastructural systems in the Seaport District and contribute to the enhancement of water quality on and off the site. The elements distilled from salt marsh function in this chapter will be used in combination with Boston's urban forms identified in the previous chapter, to create a park design that responds to the scale, process, ecology, and infrastructure ingredients of landscape urbanism theory.

A Network of Marshes

Salt marshes establish themselves along protected shorelines and in tidal estuaries and can range in size from a few acres to vast tracts, stretching for miles. In the late 1700s, significant portions of the coastline near Boston were covered in marsh (Figure 17) and comprised part of a continuous system of salt marsh that extended from Georgia to Newfoundland. Today, however, much of the salt marsh along the Atlantic coast has been lost to development and only remnant patches remain.

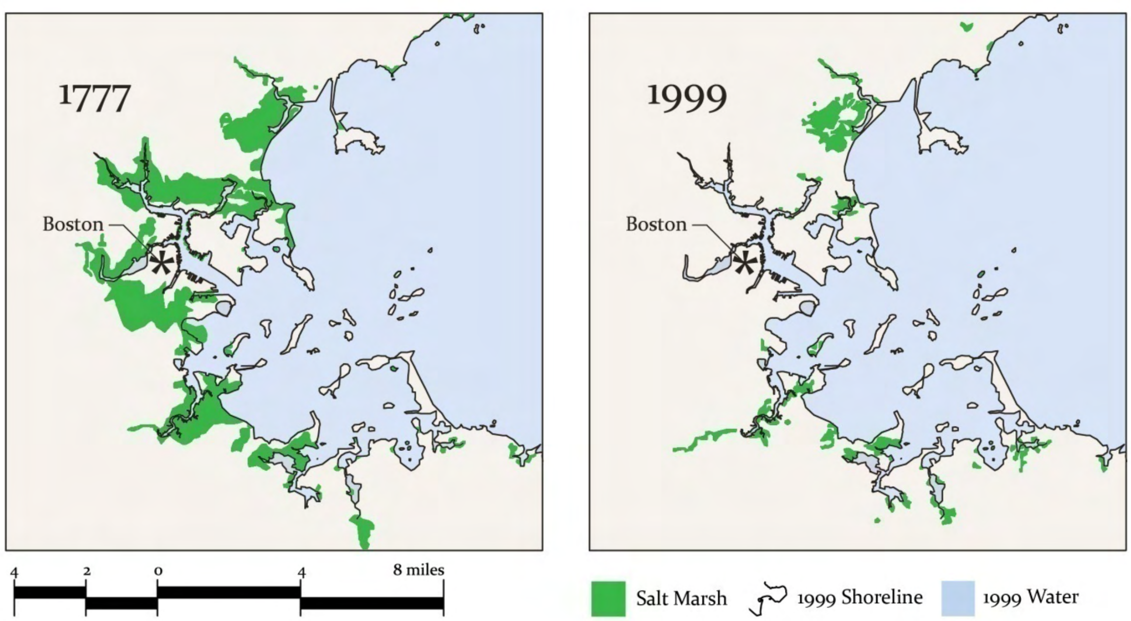

Figure 17: Distribution of Salt Marsh in Boston Area, 1777 and 1999
Source: Adapted from Bromberg & Bertness, 2005.

Coastal areas usually have some of the highest population densities, and as a result, marshes in and around urban centers are highly impacted by cultural activities and processes. Historically, as coastal populations swelled, community demand on the marshes increased and the ecosystems declined primarily due to disturbance of the hydrologic regimes and increased pollution loads. Channels were cut or straightened to provide improved shipping access to towns at the heads of marshes (Teal & Teal, 1969), and the marshes were drained to improve grazing land for cattle and to combat the mosquito populations that thrived in the waterlogged environment (Figure 18). Interestingly, Mark Bertness (2007) hypothesizes that "widespread draining of New England salt marshes has likely contributed to their simple plant communities consisting of only a handful of plant and animal species" (p. 370), indicating that marshes as they currently exist are the product, at least in part, of cultural processes. Further disruption of hydraulic processes occurred with the construction of railways across the flat, treeless expanses of the marshes and later continued with the advent of the automobile and construction of our modern road network (New Hampshire Department of Environmental Services [NHDES], 2004a). The deleterious and highly visible effect that severing and altering hydrologic flows across the salt marsh causes indicates that intact hydrologic flows are the most important component of a salt marsh, without which the marsh will cease to exist.

Figure 18: Partially Drained Salt Marsh with Linear Mosquito Ditches and Centralized Channel
Source: Photograph from saltmarshlife.com/salt-marsh/aerial.htm

The second most prominent impact that settlement of coastal communities has had on salt marshes, short of outright filling of the marshes, is elevated pollution levels. Concentrations of nitrogen and phosphorous from stormwater runoff, sewage effluent, and heavy metals from industry have increased dramatically since colonial times, particularly near urban centers (Forman, 2008). While *Spartina* grasses in the marsh initially seem to thrive on increased nitrogen loading in the water, ultimately the surplus of nutrients leads to a change in the distribution of marsh plants and animals, thereby altering the ecosystem with undetermined consequences (Deegan et al., 2007). High nitrogen concentrations also produce algal blooms which cloud the water and reduce light penetration which is detrimental to phytoplankton and bottom-dwelling plants (Massachusetts Water Resources Authority [MWRA], 2002). Additionally, salt marshes receive and filter large amounts of runoff from surrounding urban centers, acting as sponges for heavy metals and other contaminants that are accumulated in the peat substrate, absorbed by plants, or ingested by animals (NHDES, 2004a). The inherent resilience of a salt marsh, coupled with its ability to remove and store pollutants, enable these ecosystems to survive in the presence of contaminants, but as toxins accrue and reach high levels, marshes, too, succumb to the effects of urbanization.

Despite the negative impacts that development has had on many of the marshes near Boston, the remaining areas still function as a system made up of patches and corridors within a larger matrix. The ecological principles of metapopulation dynamics, "a population subdivided into spatially separate groups, with some movement of individuals among groups" (Forman, 2008, p. 39), account for the existence of species in fragmented ecosystems. Large tracts of salt marsh have remained intact to the north and south of Boston and act as "source" patches where species breed and expand their population (Opdam & Steingröver, 2008). The smaller patches closer to the city, are not large or diverse enough to support viable populations of some animals and are referred to as "sinks" because they do not add to the overall population (Opdam & Steingröver). However, these small patches are essential to the existence of the metapopulation as they are large enough to be sources for species that require less space, and act as "stepping stones" that connect larger patches and provide food and shelter along the way (Forman).

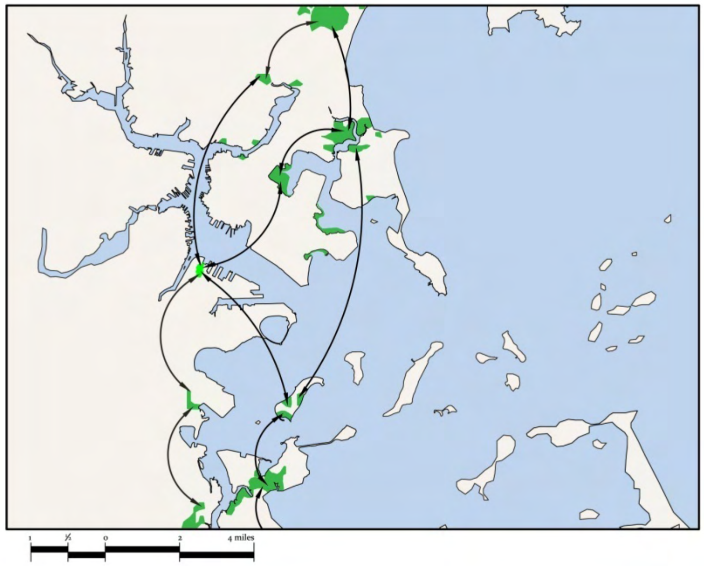

Figure 19: Potential Movement of Metapopulations between Existing Salt Marsh Patches and Proposed Park

The addition of salt marsh habitat in the Seaport District, even as a constructed entity, could add a stepping stone to the existing system of marshes that would enhance connectivity between source patches (Figure 19). Even though the highly urbanized location would be undesirable to some species, others would be able to establish viable populations and highly mobile species would benefit from an added refuge. The proposed park is centrally located in the network of salt marshes in the immediate vicinity of Boston, and could serve as an important connector between the Harbor Islands and marshes to the south and the Mystic River and other marshes to the north, while affording a break from the highly urbanized edge of the Inner Harbor.

Salt Marsh Process and Form

The driving force behind the formation and function of a salt marsh is the ebb and flow of the tide. This constant, powerful, dynamic input shapes, delivers nutrients, and allows for all interaction within the marsh ecosystem. Anne Spirn (1988) emphasizes the need to create public urban space that "celebrates motion and change, that encompasses dynamic processes" (p. 108) in order to compose a richer experience for the visitor. The tide provides a continuously changing, readily available source of dynamic process that is vital to the salt marsh and can be easily emphasized in a park setting.

Like urban centers, the physical form of a salt marsh can be used to visualize the processes at work in the ecosystem. As a result of their location in a highly variable environment, salt marshes are characterized by visible zones of vegetation and topography (Figure 20) that are created and maintained by daily tidal flux but also by sedimentation and growth regimes that marshes rely upon for regeneration. From the seaward edge, waves are first slowed by a sand bar at the mouth of the estuary. The seawater then passes over tidal flats briefly exposed at low tide, and as it encounters the edge of the marsh, stands of smooth cordgrass (*Spartina alterniflora*) slow the water even more, teasing heavier sediments out of the water column and reducing erosion by binding soil with their roots (Teal & Teal, 1969). Over time, the marsh accumulates a layer of peat comprised of sediment, algae, diatoms, and decomposed cordgrass that grows continually upward with the passage of the seasons and provides shelter and habitat for animals (Bertness, 2007). When portions of the smooth cordgrass beds, found in the low marsh, reach a point where they are only inundated by spring tides (the highest tides occurring twice monthly at the new and full moons) high marsh plants begin to colonize the area – particularly marsh hay (*Spartina patens*), black needle rush (*Juncus gerardi*), and glasswort (*Salicornia europaea*) (Teal & Teal).

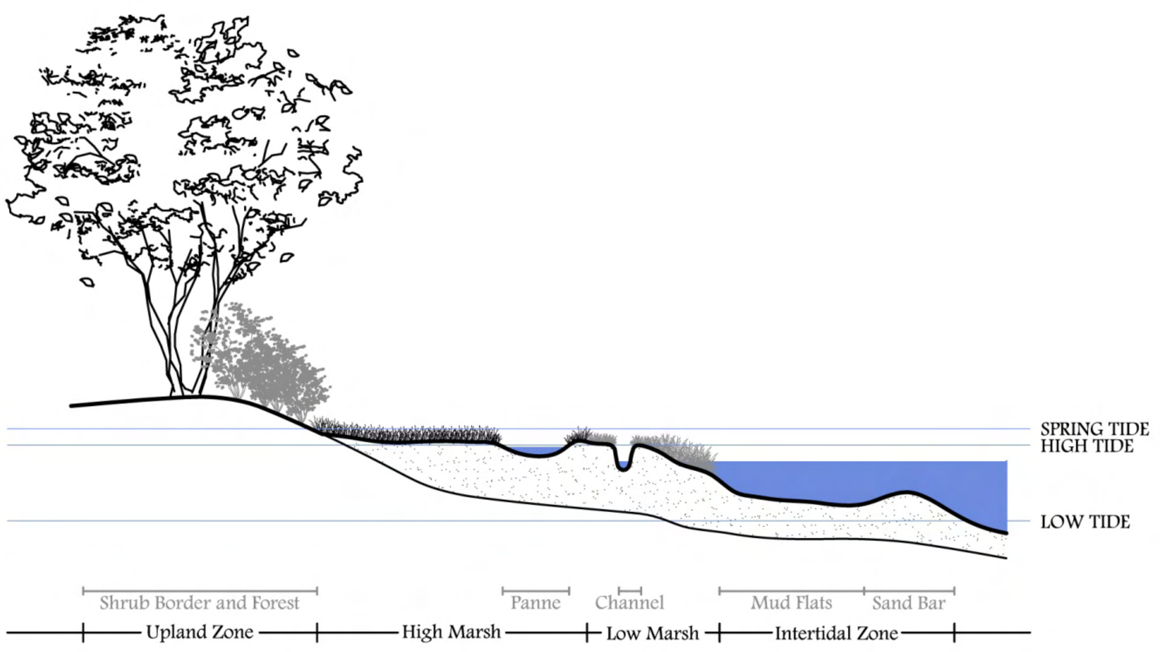

Figure 20: Salt Marsh Zones Section Diagram
Source: Adapted from Merrimack Valley Planning Commission, 2007.

As the marsh builds upon itself, it does not always do so uniformly and depressions form that retain water through low tide. In the low marsh, the depressions, referred to as pools, are flushed daily by the incoming tide and support abundant animal life (NHDES, 2004b). In the high marsh, however, the depressions, called pannes, are not often irrigated with seawater and increase in salinity to toxic levels through evaporation (Bertness, 2007).

The most distinctive and highly visible characteristic of the marsh is the pattern of channels that allow for the inundation of seawater (Figure 21). Following the path of least resistance, water makes its way up winding, mud-bottomed channels carved through the marsh grasses by the tide and drainage patterns (Bertness, 2007). Similar to the street system in a city, the channels act as the basis for networks of exchange and exhibit a hierarchy, seen as they become narrower, shallower, and more finely-grained in a landward progression. Above the marsh, the shrub boundary, protected from flooding, transitions into upland forest.

Figure 21: Plan View of Typical Salt Marsh Zones

Another highly visible temporal scale in the New England salt marsh is the change of season. Unlike their southern counterparts, northern marshes exhibit dramatic seasonal transformation (Figure 22). Winter brings a period of slowed metabolism, where mobile species migrate away, others hibernate in the mud, and grasses die back to the ground to reduce the destructive forces of ice as it rises and falls with the tide (Teal & Teal, 1969). In spring, the grasses regenerate, migratory birds return to nest in the high marsh, and fish return to the channels. Summer marks the peak of marsh activity, and in autumn, animals begin their annual migration out of the marsh and grasses go to seed in preparation for the cycle to begin anew in the spring (Teal & Teal).

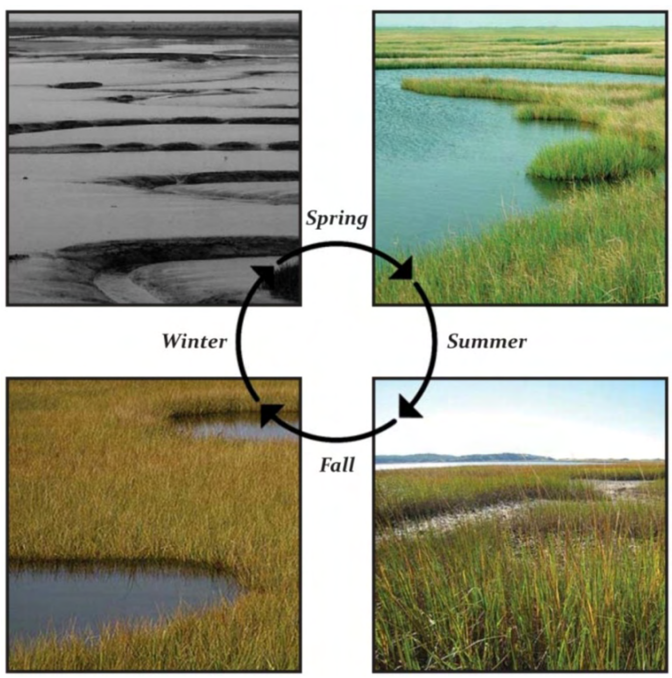

Figure 22: Seasonal Variation in Salt Marsh Vegetation
Sources: (clockwise from upper left) www.flickr.com/photos/bobdavis; pro.corbis.com/; www.flickr.com/photos/wnprimages; www.immelphoto.com/2008/07/salt-marsh.html

The processes and patterns described above are the most highly visible and some of the most important to salt marsh existence. The ebb and flow of the tide is the organizing force behind the salt marsh: shaping, sculpting channels and ponds, and stratifying it into its characteristic zones inhabited by specific flora and fauna. Seasonality, also a perceptible cycle, dictates periods of growth and decay further emphasizing the dynamic qualities of the salt marsh.

Salt Marsh as Infrastructure

As one of the Earth's most productive environments, shoreline marshes can produce up to 10 tons of organic matter per acre per year (Teal & Teal, 1969) – more than a tropical rainforest and many times the production rate of conventional agricultural fields (Bertness, 2007). Abundant nutrients in coastal waters enable this high primary production rate and are ushered into the salt marsh on the incoming tide or swept from upstream locations by rivers for uptake by the *Spartina* grasses and algae (Forman, 2008). The aggressive consumption of nutrients creates an environment that has the potential to contribute many beneficial functions to neighboring human settlements. The dense grasses filter out nitrogen and toxins that have polluted water bodies, and a study by Linda A. Deegan et al. (2007) suggests that salt marshes can absorb 30-40% of the nitrogen added to water flooding a salt marsh on an incoming tide, while other findings document the ability of marshes to store heavy metals and act as natural sewage treatment facilities (Bertness, 2007). This indicates that salt marshes have the ability to provide functions similar to a wastewater treatment plant that removes harmful substances from a wastewater stream prior to its release into the nearest body of water.

Over the past twenty years, Massachusetts has made marked progress toward the clean-up of once heavily polluted Boston Harbor through the efforts of federally mandated programs and independent environmental initiatives. Closing antiquated treatment plants, enacting more stringent water treatment regulations, and investing in an overhaul of sewer system pipes greatly reduced the amount of untreated sewage entering the Harbor with measurable effects. Figure 23 shows the drop in *Enterococcus* bacteria as a result of clean-up efforts, and Figure 24 illustrates a reduction of chlorophyll concentration in the Harbor indicating fewer algal blooms due to the decrease in nitrogen concentrations from effluent (MWRA, 2002). While these images show promise for the future of water clarity in Boston Harbor, much work still needs to be done. In many parts of the city, sewage and stormwater are carried in the same pipes. During especially heavy rains, stormwater can overwhelm the system and a Combined Sewer Overflow (CSO) event occurs, spilling raw, untreated sewage into the Harbor. Despite efforts to reduce these occurrences, CSOs still discharge over 400 million gallons of untreated sewage per year (MWRA).

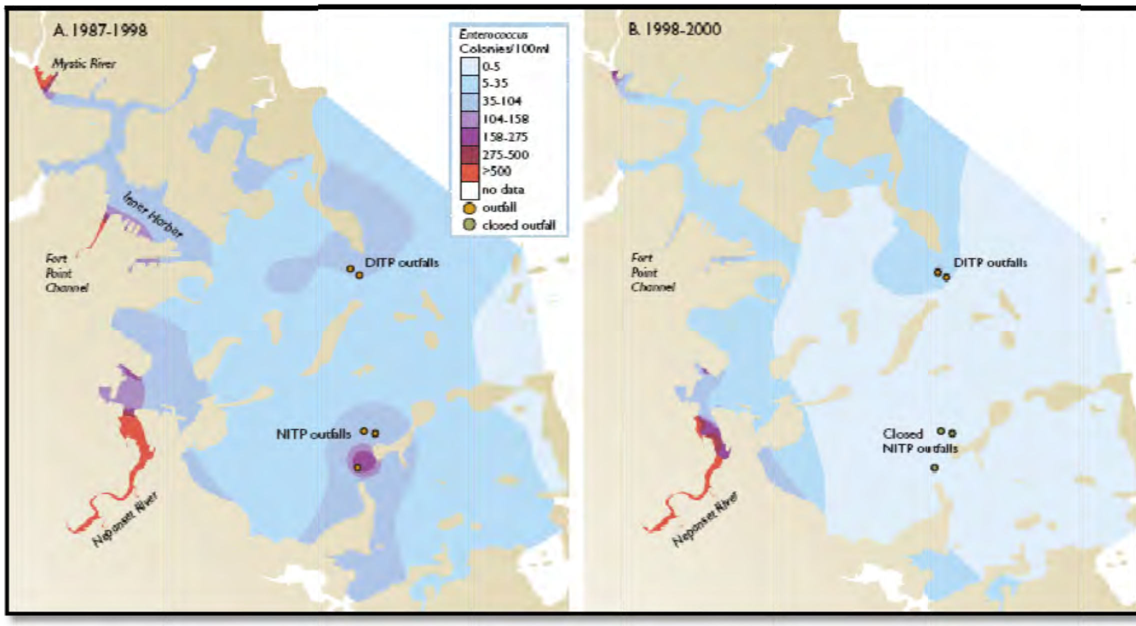

Figure 23: Reduction in *Enterococcus* Counts between 1987 and 2000
Source: MWRA, 2002.

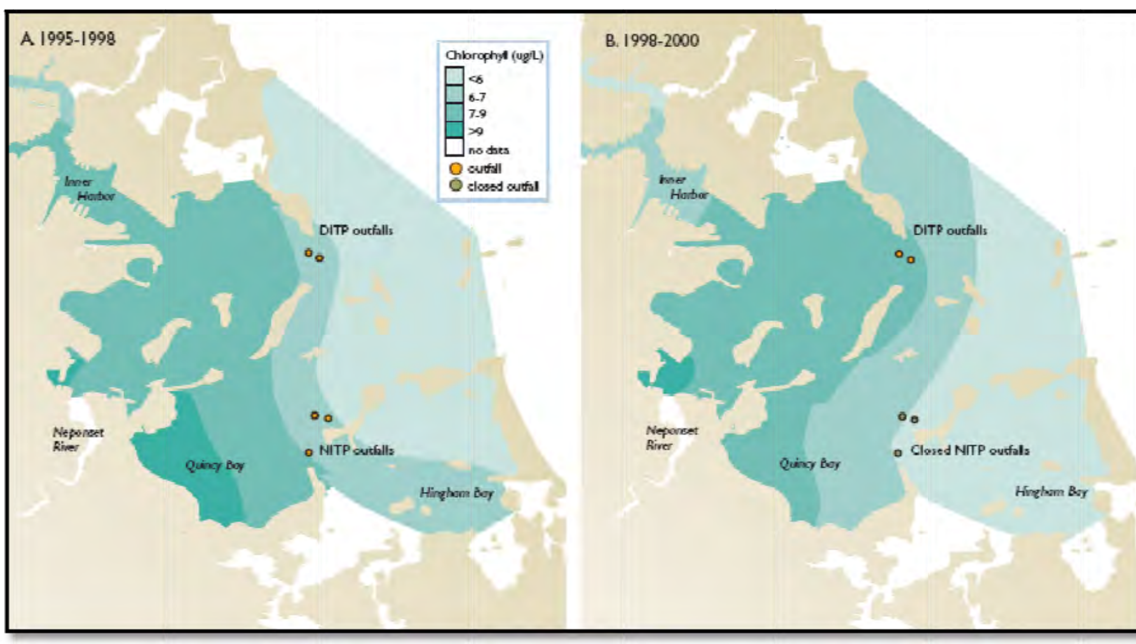

Figure 24: Reduction in Chlorophyll Concentrations between 1995 and 2000
Source: MWRA, 2002.

Although water quality has improved dramatically in Boston Harbor over the past two decades, current pollution levels still indicate coastal ecosystems in distress. A salt marsh's ability to filter nutrients out of the water column, specifically nitrogen, indicates that reestablishing marshes could help improve water quality in coastal areas. Coastal marshes constructed in and around urban centers could be employed to filter nitrogen and other toxins from stormwater before it reaches the ocean, and would also cleanse volumes of seawater during each tidal cycle. Although some marsh species are susceptible to high levels of pollution, other species that are able to withstand the presence of contaminants could be employed to filter stormwater. As water clarity improves over time, through the function of the marshes and ongoing efforts to reduce runoff from urban areas, plants and animals unable to withstand poor water quality could be reestablished. A constructed marsh in the Seaport District would be designed to capture stormwater runoff from the surrounding streets and buildings, diverting large volumes of water from existing sewer infrastructure, aiding in the prevention of CSO events, and improving the quality of water discharged into Boston Harbor.

Implications for Urban Park Design

Incorporation of a salt marsh into an urban park, speaks to all four tenets of landscape urbanism explored in this thesis. Attention to the location of the park as a crucial connection between remnant marshes in the Boston area references the park's ecological context at a regional scale and indicates that the park will impact nearby metapopulation dynamics. Acknowledgement of the effects that urbanization has on hydrologic flows and pollution levels in marshes and adjacent water bodies indicates the strength of local and regional cultural influences. Patterns identified and distilled from dynamic processes occurring in a salt marsh can be combined with the urban forms from the previous chapter to serve as a foundation for the park's aesthetic. Daily tidal inundation as the driving force behind the marsh is integral to the success of a constructed marsh. Hierarchical channels that branch and become more diminutive towards the landward edge of a marsh act as dispersal networks for water and species. The high and low marsh zones created and maintained by the tide and channels, give the marsh its characteristic appearance reinforced by the species that inhabit each level. Finally, changes that occur with the seasons allow for a visually discernable passage of time. Integrating these processes into park design speaks to landscape urbanism as it seeks to incorporate dynamic ecological process into urban sites.

On an even finer scale, nitrogen cycling and pollution removal by salt marsh plants and animals, place a constructed marsh as an ideal model of a landscape that can double as stormwater infrastructure. A park that employs a marsh as stormwater treatment can simultaneously function as a space that meets the openspace needs of the human community, highlights ecological process to create public awareness of the importance of ecosystems, and improves water quality for the benefit of both human and salt marsh communities.

5. CASE STUDIES

Investigation into approaches that other designers have taken in precedent projects can be employed when tackling a new design challenge to discern useful techniques that can be of aid during the design process. The works explored in this thesis were selected because they undertake partial or extensive re-creation or manipulation of a coastal or riparian habitat in an urban location. In an attempt to better understand the relationships between ecological process and urban form and the goals of landscape urbanism as addressed in the design of these spaces, the projects were examined for the answers to the following questions:

- How are the form and design of the case study influenced by its urban context?
- How is the case study project accessed by its users and how does access affect pedestrian permeability?
- How are the case study's form and aesthetics influenced by ecological processes?
- How was infrastructure integrated into the design and how does the project benefit the ecosystems it is designed for?

Although it may not be possible to discern absolutely between the ecological and urban influence on form in these case studies, for the purposes of this thesis, an attempt will be made to trace the forms to their origin in order to draw conclusions that can be applied in design. Through the examination of the designer's intent and evaluative literature on the success of these projects, patterns, obstacles, strategies, and insights will emerge that can influence the design application for meshing the ecological processes of a New England salt marsh with the urban form of Boston in the Seaport District to create a design that responds to the needs of both ecological and human communities.

Reconstruction: Crissy Field, San Francisco

Crissy Field is the waterfront portion of San Francisco's Presidio, an air force base decommissioned in the 1990s and put under the control of the National Park Service. Hargreaves Associates was hired to design a public park that highlighted the cultural history of the site as well as returned a portion of the shoreline to its historic condition as a functioning salt marsh (Rieder, 2001). The landscape architect was able to weave together the interests of many groups, including windsurfers who used the beach as their launch point and neighborhood residents who wanted the beach preserved for off-leash dog walking, to arrive at a design (Figures 25 & 26) that met each constituent's needs.

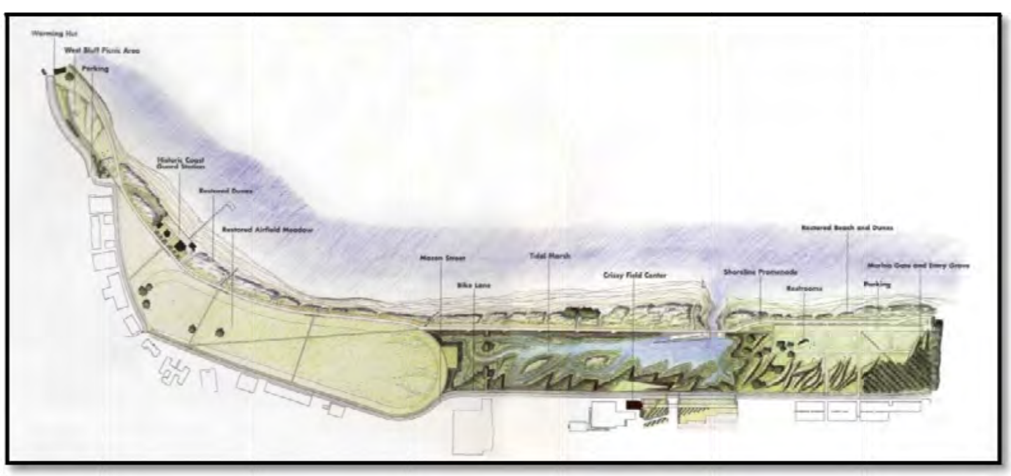

Figure 25: Plan View of Crissy Field
Source: Boland, 2003.

Figure 26: Aerial View of Crissy Field
Source: www.presidio.gov/trust/projects/doyle.htm

The airfield was returned to the historic grass strip of the 1910s and 1920s when many aviation records were set on the site (Rieder, 2001). Access was provided to the East Beach area for windsurfers and dog walkers, and a visitor's center and walking paths were constructed to provide recreation and information to users. Twenty acres were allotted for the restoration of a salt marsh as hydrologists working with the Hargreaves Associates determined that this size "was the minimum amount of area necessary for the marsh to be self-sustaining" (Krinke, 2001, p. 135).

Urban Form

Although Crissy Field abuts an urban neighborhood and frames views to Downtown San Francisco, the forms in the park are not directly resulting from its urban surroundings but rather from the cultural history of the site. The airfield's curving edge, and straight pathways originate from its historic form and juxtapose the organic patterns at the border of the marsh (Rieder, 2001). The act of building up the land to reshape the airfield and the landforms surrounding the naturalistic marsh, evoke the site's past of continuous alteration over time. "The park's design restores the airfield in its original location, in its exact size and shape, although it too is configured as a landform, underscoring its remade nature" (Krinke, 2001, p. 134). Other elements, often the product of dynamic natural process, have instead been fixed on the site. The tidal channel that allows for the inundation and drainage of the salt marsh and would naturally shift up and down the coast, has been cast in place between two seawalls and reinforced with rock revetments (Boland, 2003). The entire site is a balance between culture and nature that incorporates forms indicative of each and those that are a product of the combination of the two.

Access and Permeability

As the salt marsh is a fragile ecosystem that cannot handle direct foot traffic, several strategies have been employed at Crissy Field to allow maximum pedestrian access and ample visual access. The shoreline promenade brings visitors along the seawall and a boardwalk winds its way through the marsh (Figure 27) to create vantage points to observe wildlife and water movement within the ecos2ystem. The main channel can be accessed along the beach, but the muddy bottom further into the marsh discourages access. In order to protect birds and other wildlife, fences hidden in vegetation prevent dogs from entering the marsh.

Figure 27: Pedestrian Traffic Limited to Constructed Paths to Protect Marsh
Source: http://www.hargreaves.com/firm/Principals-Staff/rieder/

Ecological Processes

In many ways, ecological processes have shaped the form of this park. Although the designers selected the space for the marsh based on constraints posed by the airfield, cultural demands, and the physical edge of the adjacent urban neighborhood, the biological needs of the ecosystem ultimately determined its size. Unsure that a constructed marsh would function optimally, the design team decided to excavate the land and allow the seawater to form its own channels – "the design was deliberately open and evolutionary" (Boland, 2003, p. 42). The location of the tidal channel was carefully selected to reduce the possibility of being blocked by shifting sand along the coast, but was designed to look "natural" – as opposed to a concrete culvert – due to pressure from the interest groups (Rieder, 2001).

The dunes on the site also derive their form from ecological processes – "instead of building sand dunes, rubble was removed from the shore to free up blowing sand, which was then allowed to accrete naturally around newly planted beach sandwort and sand verbena" (Boland, 2003, p. 42). Other landforms, like the grassy landforms near the windsurfer's parking lot, take their overall form from windswept coastal dunes (Figure 28), but are decidedly man-made.

Figure 28: Grass Landforms at Crissy Field
Source: http://www.davidsanger.com

Environmental Benefits

Finally, the environmental benefits afforded by the redesign of this site have been numerous. The wildlife habitat that has been established is a boon to local flora and fauna, helping to reestablish breeding and hunting grounds that are dwindling throughout urban areas. The water filtration properties of a salt marsh act to clean pollutants from the water (Cranz & Boland, 2004). Furthermore, great care was taken to remove contaminants from the site during construction, and recycled materials were used throughout the construction of Crissy Field. Soil removed from the salt marsh was used to build up the air strip and other high ground portions of the site and asphalt and concrete removed from the military complexes were ground and reused on site as structural fill (Boland, 2003).

Inundation: Allegheny Riverfront Park, Pittsburgh

The Allegheny Riverfront Park sits on two long, thin strips of land between the city of Pittsburgh, two expressways, and the Allegheny River. Michael Van Valkenburgh Associates was hired in the mid-1990s to activate the river's edge for pedestrian users and to engage the city with the river. The small amount of space available for the park combined with 17 feet of grade change and a massive concrete seawall that separated the two park areas from one another, as well as the large volumes of traffic on the adjacent streets provided challenges for the designers in addition to dealing with the various bureaucratic agencies that owned portions of the land allocated for the park. Yet the designers were able to formulate a plan (Figure 29) that would create two unique and enjoyable experiences for visitors.

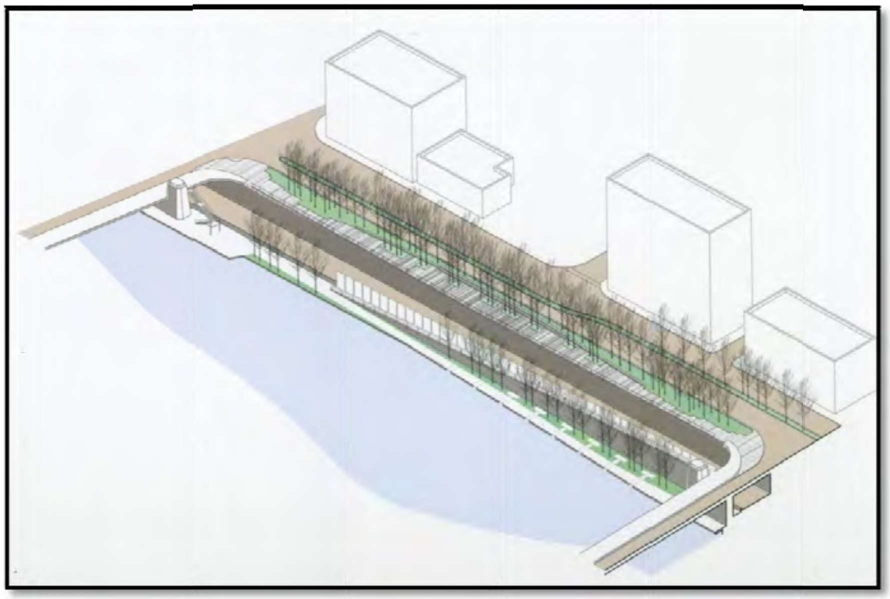

Figure 29: Axon of Western Half of Allegheny Riverfront Park
Source: Amidon, 2005.

The lower park (Figure 30), subject to the seasonal flooding and intended to be influenced by nature is tied to the street by two long, gently sloping ramps lined with chain link screens covered with Virginia creeper, and a sculptural railing that guides the visitor up or down the slope (Amidon, 2005). A concrete walkway, flanked by native riparian trees emerging from a field of boulders, steers users along the riverbank and cantilevers out over the water to skirt the bridge abutment (Moffat, 2002). Meanwhile, the upper park (Figure 31), more closely aligned with the city, lies across the expressway from the lower park and is the result of reclaiming a 50-foot wide strip of median from a surface street. A wide, curving walkway extends through the park shaded by London Plane trees and protected from traffic by an ivy-covered embankment (Amidon).

Figure 30: Lower Park, Allegheny Riverfront
Source: Michael Van Valkenburgh Associates, 2009.

Figure 31: Upper Park, Allegheny Riverfront
Source: Michael Van Valkenburgh Associates, 2009.

Urban Form

Urban influences, including the linearity of the expressway, are largely responsible for the forms in the Allegheny Riverfront Park. The park itself has been reclaimed from the roadways, and it sits atop a high seawall that protects the city from the annual floods that inundate the lower park. Native bluestone, typical of many buildings in Pittsburgh, was used for the paving and benches in the park because of its role as the predominant historic construction material (Krinke, 2006). The rectilinear pavers were also laid perpendicular to the river to reflect the urban patterns extending away from the city toward the waterfront.

In the lower park, the walkway angles outward from the bank in order to bypass the bridge abutment, yielding to massive urban infrastructure and requiring cantilevered supports and substantial counterweights (Amidon, 2005). Rather than hide the structural elements, the designers decided to make them a visible, urban form in the park. The grill, made from galvanized, rectangular scrim, used to screen the ramps from the expressway that "references the highway" and "almost looks like the back of a highway sign" (Amidon, p. 98) are another expression of the urban aesthetic in the park (Figure 32).

Figure 32: Urban Form Manifested in Rectilinear Noise-Attenuators
Source: Krinke, 2006.

Access and Permeability

The ADA compliant ramps provide pedestrian access to the lower park, while the upper park is at street level and is easily reached from the city. The industrial scrim of the noise dampening grills line the urban side of the ramps, while a stylized bronze railing reminiscent of a tree branch line the side towards the river, referencing the ecological influence of the lower park. Visual access to the lower park and river in achieved from the upper park and highlighted by the linear pavers and seating areas that direct the visitor's attention toward the shoreline.

Ecological Process

Much of the lower park is directly affected by the flood regime of the river and the forms of Allegheny Riverfront Park are dictated in part by the linearity of the river. The trees were selected for their ability to withstand flooding, and were installed in an irregular pattern "to allow enough chaos and randomness that if forty or so trees get crushed, some perfect geometric order is not wrecked" (Amidon, 2005, p. 60). The boulders that are interspersed among the trees are more that an aesthetic flourish, they keep the trees in place during floods and encourage the deposition of silt (Moffat, 2002). Reed patterns (Figure 33) pressed into the concrete walkway were made by pressed native riverside vegetation, and give way to smooth concrete over the water, indicating whether a visitor is on solid ground or a cantilevered portion of the walkway (Krinke, 2006).

Figure 33: Reed Patterns Pressed into Concrete Walkway
Source: Amidon, 2005.

The change in seasons was another natural cycle that was enhanced in the design and is visible in the designers' attempts to instill the quality of hypernature, – in this case, "intensifying the density of the planting, creating an exaggeration" (Amidon, 2005, p. 60). The upper park, on the other hand, represents the less wild, more formal urban aspect but has muted seasonal change (Amidon).

Environmental Benefits

The Allegheny Riverfront Park benefits the environment by adding vegetation to an area of Pittsburgh previously defined by its expanses of concrete and asphalt. Access to the river provides recreational opportunities for urbanites without further control of the waterway's natural flood regime. The native trees and shrubs planted in the park not only afford aesthetic appreciation of the site but add to the ecological function of the river. Riparian plants that are severed during flood events have the unique ability to sprout downstream thereby serving to stabilize the riverbank and contribute to the distribution of native vegetation (Amidon, 2005).

Evolution: Oosterschelde Weir, Zeeland, Netherlands

Oosterscheldekering, an eight kilometer long storm barrier in Zeeland (Figures 34 & 35) built in the mid-1980s to protect the low-lying landscape from catastrophic flooding, is a testament to the on-going battle for dry land between the Dutch people and the sea. After construction of the massive structure, islands built for staging along its length were turned over to landscape architecture firm, West 8, for "clearing up" (Weilacher, 1999, p. 236). Instead of delivering a design for a naturalistic landscape as expected, the designers created level plateaus out of the left over sand piles, and topped them with alternating stripes of black mussel shells and white cockle shells from near-by shellfishing operations (Schröder, 2001).

Figure 34: Context Map and Plan View of Oosterscheldekering and Islands
Source: www.picturesofholland.nl/Deltaworks/Deltaworkstext.htm

Figure 35: Aerial View of Oosterschelde Weir and Image during Storm Event
Source: www.trekearth.com/gallery/Europe/Netherlands/;
www.nedwater.eu/Delta%20Technology.htm

Urban Form and Ecological Process

The forms on this site are derived from the man-made elements present. The linearity of the storm barrier and the highway running across it are mirrored in the striped pattern of shells; and the raised, flattened plateaus mimic the nearby uniform landscape as it has been shaped by man for centuries. However, West 8 did consider the natural process of evolution, believing that "nature is to a certain extent successful in developing evolutionary strategies to adapt to areas inhabited by man" (Weilacher, 1999, p. 230). The plateaus and the stripes of contrasting shells still function as breeding grounds for shorebirds – gulls seek flat places and other birds nest exclusively on white ground (Schröder, 2001). The pattern of the ground does not preclude nesting: nature is able to adapt to man-made forms and continue the processes necessary to survival.

Access and Permeability

This site is accessed primarily by vehicles passing quickly on the highway (Figure 36). The scale of the stripes and landforms were designed with this in mind, and the pattern was created to be best experienced from a speeding car, and the plateaus constructed not to obscure the view of the sea (Weilacher, 1999).

Figure 36: Striped Plateau at Northern End of Oosterscheldekering
Source: West 8, 2009.

Environmental Benefits

Despite the decidedly artificial form of the islands and lines of shells, Oosterscheldekering provides environmental good. Not only does the design serve as nesting areas for birds, but the shells used utilize a local waste material from the shellfish industry. Furthermore, the noticeably man-made forms contrast with the natural shoreline, instilling an appreciation for the natural landscape and designed nature and raising sensitivity to man's power to alter our surroundings.

Decoration: East River Ferry Landings, New York

East River Ferry Landings consists of a pedestrian bridge and promenade that connects pedestrians to the waterfront and allows them to experience the river more intimately. Along the promenade Ken Smith Landscape Architect and his firm have designed raised, steel planters of salt marsh grasses to enhance the visitors experience and create an awareness of the historic edge condition along the river (Figure 37). The planters protect the grasses from wave activity generated by the wakes of passing boats and allow for a freshwater irrigation scheme that promotes plant growth combined with a once weekly flushing of brackish water from the river to maintain the salt tolerant marsh grasses and preclude the growth of unwanted freshwater weed species (Margolis & Robinson, 2007).

Figure 37: East River Ferry Landings Rendering
Source: Amidon, 2006.

Urban Form

Although certain components of the design are of ecological origin, the folding, "warped rectangular" form of the planters is a reflection of the architecture of the roofs and buildings adjacent to the site (Amidon, 2006). The idea of the planters is also influenced by the high level of wave activity and the urban seawalls that deflect the waves, doing little to diminish their power. The structures respond to the urban condition by protecting the grasses and enabling their survival.

Ecological Process

The forms of the planters are partially informed by the ecological processes of a salt marsh and riparian systems. Each planter is higher on one side than the other. This creates a gentle incline that is reminiscent of the natural slope of the riverbanks where salt marshes would have naturally occurred in the region (Margolis & Robinson, 2007). The slope of the planters also allows for the creation of the distinct zones that would occur in a salt marsh.

> An irrigation system pumps river water into the planted boxes, a kind of artificial tide, which results in a differentiation of plant selection sorting itself out within the planters. Necessarily, the lower areas, where the moisture gathers, have a greater population of mussels and things like that. (Amidon, 2006, p. 75)

The slope of the planters references the variation created through elevation change and tidal patterns in the landscape and fosters a more diverse assembly of plants and animals than would be possible if the planter were uniformly submerged.

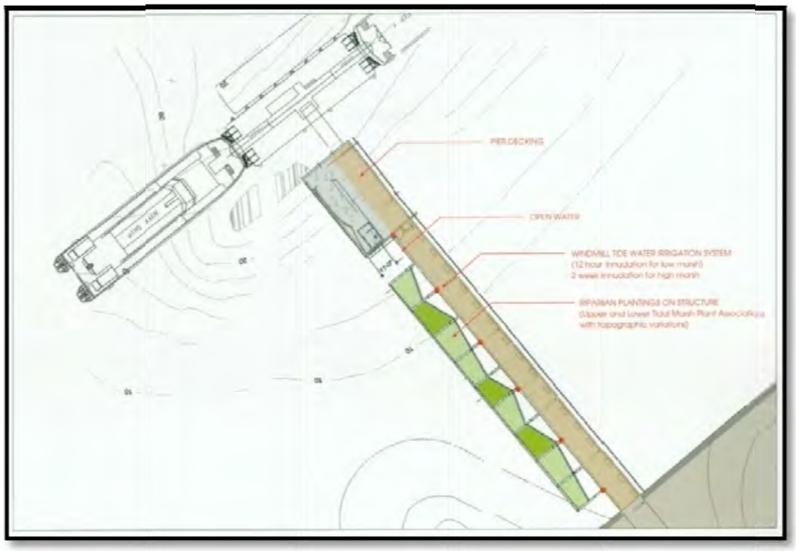

Figure 38: Plan View of East River Ferry Landings Planters
Source: Amidon, 2006

Access and Ecological Benefits

The salt marsh plants are only visually accessible at the East River Ferry Landings. They flank the promenade and present an artificial band of vegetation between the user and the water (Figure 38), reminiscent of the condition present in a natural situation (Amidon, 2006). While they may filter a small amount of river water and provide mediocre slivers of habitat for flora and fauna, the greatest benefit of this design is that is builds awareness of loss of the riparian edge (Amidon).

Infiltration: SW 12th Avenue, Portland

As one of the most ecologically progressive cities in the country, Portland, Oregon, launched its Green Streets Program to improve the water quality of stormwater runoff released into the Willamette River and to create more aesthetically pleasing streetscapes. In 2005, the City of Portland hired Kevin Robert Perry to design stormwater infrastructure on SW 12th Avenue as a prototype that would respond to the city's goal of promoting "a more natural approach to urban stormwater management" (American Society of Landscape Architects [ASLA], 2006). The design consists of four off-line stormwater planters embedded in the sidewalk that capture rainwater to a depth of six inches and infiltrate it into the ground (Figure 39). Grasses in the planters filter the water and only when rainfall exceeds the infiltration rate of the planters does water enter the sewer system. These basins have been so successful that alternative designs have been developed and are currently being installed throughout the city.

Figure 39: SW 12th Street Stormwater Planters
Source: ASLA, 2006

Urban Form

Since the planters are located along urban streets, the forms are heavily influenced by the cityscape. The rectilinear forms respond to the urban street grid and linearity of the adjacent sidewalk and roadway. The concrete curbs that ring each planter reinforce the urban setting, and the grid of grasses allows for maintenance regimes and simultaneously mimics the organizational grid that dominates Portland's street layout.

Access and Permeability

Carving such large areas out of the sidewalk did pose a challenge for designers in maintaining pedestrian connections between the sidewalk and on-street parking. The solution reached was to provide a 3-foot walkway next to the curb to allow for egress from vehicles and a pedestrian cut-through between each planter (ALSA, 2006). These secondary circulation areas are paved with cobbles to differentiate between the main sidewalks (Figure 40). Finally, ADA grates cover the water channels where they cross the sidewalk.

Figure 40: Paving Differentiation between Pedestrian Zones
Source: ASLA, 2006

Ecological Process

The layout of the planters and the proscribed path of the water in this design is influenced by riparian and wetland ecology. The winding course that the water takes as it progresses from planter to street and back to planter (Figure 41) was inspired by the meanders in rivers that serve to slow the water, thereby encouraging deposition of sediments. The selection of plants is based on areas that are seasonally flooded and can withstand wet and dry periods.

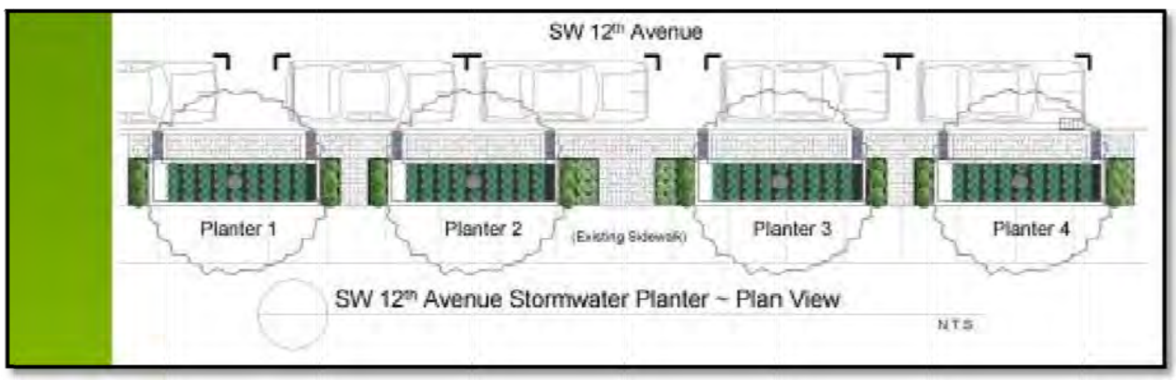

Figure 41: Plan View of Green Street Planters
Source: ASLA, 2006.

Environmental Benefits

These planters provide substantial ecological benefits by filtering and infiltrating water that would otherwise need to be processed by wastewater treatment plants. Toxins and sediments are dropped out of the water by the reeds, and reduced volumes of water entering the storm sewers reduces overflow events where untreated water and sewage are released into the Willamette River. Furthermore, significant amounts of water – up to 70% of the 25-year storm

(ALSA, 2006) – are infiltrated into the ground on-site which helps replenish depleted urban aquifers.

Implications of the Case Studies

These case studies span the spectrum of park design that integrates ecological process and urban form. Each example exhibits a distinct level of influence from the ecosystem it seeks to engage, the adjacent urban context, and the design intent. As a result, each site has incorporated different means of access to the park that matches the design intent and durability of the design and each establishes a unique relationship between ecology and culture and a distinctive aesthetic.

Crissy Field employs a naturalistic aesthetic in its salt marsh and dunes, but other areas reflect the mechanistic forms of the site's long military history. Although the salt marsh provides beneficial water cleansing services and wildlife habitat, due to its fragility, the decision to re-create a self-sustaining, fully ecologically functional marsh, resulted in the need to control pedestrian access into the area. Thus the only paths are constructed walkways high above the marsh that reinforce the divide between humans and the natural environment. This example exposes the difficulty of reestablishing a salt marsh that allows for active human interaction: the natural forms are simply too delicate. While the psychological benefits of visual access to greenspace should not be overlooked, inability to actively experience the ecological processes diminishes their legibility in the landscape. In the design application, access to the marsh should bring visitors into the marsh to more closely observe the environment, but must protect the fragile salt marsh from damage.

At the other end of the spectrum, Oosterschelde Weir is a completely man-made landscape that incorporates the essential characteristics for seabird nesting habitat. The design was justified on the premise that nature has the ability to adapt, including evolving to make use of built forms. Continuing the thought of urban inspiration, this site is designed to be experienced travelling in an automobile – the ultimate symbol of human progress. This example weaves together urban form and one, specific ecological process. Although this would be considered "good" ecological design by Kristina Hill, it fails to meet her criteria for "better" or "best" ecological design because the ecological process addressed in the design is not critical to the endurance of the ecosystem. However, the success of the nesting birds provides evidence that ecological processes can indeed occur in artificial landscapes, and suggests that salt marsh flora and fauna may indeed be able to adapt to a constructed environment.

East River Ferry Landings is another project that only allows visual access to the ecologically functional pieces of the design. The form of the marsh grass planters are a blend of both ecological process and urban structure, but are primarily an artistic statement rather than a functional ecosystem or accessible public park. The pumps and other technology needed to enable the functioning of the system merely imitate natural processes but do not allow the participation of tidal action, river flooding, or other ecological processes that occur on the site despite the presence of urban forms. The ability of ecological processes to act on the site is an integral part to designing for the balance of ecology and urban form in a public space, without it, the design becomes entirely about cultural process. However, organisms like mussels and *Spartina* grasses are thriving in these semi-enclosed ecosystems, indicating that certain species will be able to survive in a larger artificial marsh in the Seaport District park design.

Allegheny Riverfront Park is an excellent example of the intersection of urban form and ecological process. The aesthetic of the park predominately reflects its urban context, but at the same time is responsive to the periodic flooding of the river. The ecological processes ultimately control access to the site, clearly illustrating the reciprocal relationship between ecosystems and urban spaces and a functional interaction between the two. A similar approach could be taken in the Seaport District to reinforce the twice daily tidal inundation.

The Green Street Program on SW 12th Avenue although not a park, uses urban-inspired planters to bring stormwater infrastructure to the surface and enhance its performance based on ecological principles. The scale of the planters is easily grasped by visitors and the integration of ecological and cultural process is complete, providing benefits to natural systems – cleaner water and recharged aquifers – and to human populations – aesthetically pleasing streets and reduced stress on and need for water treatment infrastructure and facilities. This design provides an elegant example of the ease with which hydrologic cycles can be effectively integrated into design using urban forms and the impressive benefits that can be achieved with small installations.

Fulfilling the Goals of Landscape Urbanism

The overarching goal of landscape urbanism is to create spaces that address their urban and natural contexts and integrate dynamic ecological process into urban centers at several scales while using the landscape to supplement the services of traditional infrastructure. The result is a site specific design that is firmly rooted in its cultural and ecological surroundings and facilitates beneficial exchange between people and the environment. These case studies were examined for the designers' success at combining urban form with ecological process, which most did effectively. However, out of all five projects only the Portland Green Street met all four goals of landscape urbanism: scale, context, process, and infrastructure.

By attempting to infiltrate water on-site, the Green Street design references not just the water on one street but the hydrologic cycle that affects the entire city and region, calling attention to the connection between the two scales and acknowledging the effect that the site has on surrounding watersheds. Allegheny Riverfront Park is also successful at referencing the city outside of the site through material selection and the adjacent riparian system through selecting plants that can sprout downstream to aid in riverbank stabilization. Crissy Field identifies only with the site itself, creating a park that floats in its urban setting with no real foundation. Attention to large, medium, and fine scales will be essential in the design of a park in the Seaport District to avoid making a space that ignores its position in Boston's urban fabric and the larger system of salt marshes.

Crissy Field and Allegheny Riverfront Park both fully incorporate the historical, urban, and ecological contexts into the design, giving the parks relevance and appeal. Oosterschelde Weir plays off of the modified nature of the Dutch countryside to create a highly constructed landscape that speaks to its surroundings, but twists the perception of its immediate context. East River Ferry Landings makes a loose, unconvincing attempt to respond to its urban or ecological surroundings. Emphasizing elements of historical importance, like railways and industry, well as identifying factors of urban and ecological significance that relate to the Seaport District will help weave the proposed park design into its urban and biotic contexts.

Dynamic process is highlighted in several of these case studies to create engaging design. The Green Street uses runoff to underline the importance of local infiltration to the larger hydrologic cycle, Oosterschelde Weir captures the evolutionary and adaptive capabilities of species, and Allegheny Riverfront Park engages the flood cycles and process of urbanization. Crissy Field incorporates salt marsh processes, but they are not emphasized through design moves, and East River Ferry Landings merely imitates tidal inundation. These projects shed light on the need to not just incorporate Boston's cultural and a salt marsh's ecological processes into the Seaport District site, but to call attention to their presence within the park using design decisions.

The final component of landscape urbanism, infrastructure, must be intentionally incorporated into landscape design if it is to escape its traditional confines. The design for Oosterschelde Weir celebrates the massive structure that protects low-lying areas from storm surges, while the Green Street takes much of the burden from the traditional stormwater infrastructure and handles it more efficiently with environmental and aesthetic benefits. East River Ferry Landings professes an attempt to cleanse and filter river water, but as this was not the underlying project intent, the scale and design make its attempts ineffectual. By inserting the goal of incorporating stormwater filtration into the design criteria for a park in the Seaport District, the park will be able to reduce strain on traditional stormwater infrastructure and add to the slowly improving water quality of Boston Harbor.

6. SEAPORT DISTRICT PARK DESIGN APPLICATION

Intent

The goal of this design is to create an urban waterfront park in the Seaport District in Boston that will weave together the cultural and ecological processes that have shaped the site and the city. The aesthetic will integrate the park with the surrounding urban fabric and will be informed by the conclusions drawn from the research of this thesis. Urban forms distilled from the analysis of street patterns and levels of permeability in other Boston neighborhoods as well as the historic treatment of edge conditions provide physical forms that are a result of cultural and ecological process and will serve as the foundation for the design and ground the site in its historic, contemporary, and environmental contexts. The ecological processes of the salt marsh will inform the design and highlight the dynamic qualities of the ebb and flow of the tide and change of seasons to promote user understanding of the marsh and harness water purification services to aid in the on-going clean-up efforts of Boston Harbor. Issues raised in the examination of the case studies will be taken into account and, where appropriate, applied to this design.

Current Site Conditions

The Seaport District is a large area that is currently being carved up for development by private and public entities (Figure 42). The plans proposed and installed by each organization are distinct in design and intention but each is generally guided by the goals set out by the Boston Redevelopment Authority for creating a mixed-use neighborhood that engages the waterfront, incorporates the commercial fishing industry, accommodates the existing artist community, preserves the historic industrial aesthetic, provides open space and mixed-income housing for residents, and enhances pedestrian connections to Boston's park systems. Site selection for the park in this application will be influenced by existing conditions and proposed plans and will adhere to the Boston Redevelopment Authority's guidelines.

Figure 42: Existing Conditions and Proposed Development, Seaport District

The entire site is currently occupied by asphalt expanses that serve as remote parking for downtown offices (Figure 43), and is transected by Northern Avenue and Seaport Boulevard, running northwest to southeast, and bounded by Boston Wharf Road, Congress Street, East Service Road, and proposed streets in the adjacent Fan Pier development. A small church occupies the eastern corner of the site between Northern Avenue and Seaport Boulevard.

Figure 43: View of Proposed Park Site Facing South
Source: Photograph taken by Jeffery Cronin, March 17, 2009

Construction of the proposed development for Fan Pier is underway and will include eight mid-rise, LEED certified buildings that will house office and residential space as well as retail, restaurants, and a hotel. A waterfront park will serve as an extension of the existing park in front of the courthouse, and a second space has been designated as a public open space fronting the future marina. The park in this application will use the proposed public green as its connection to the water and embrace the rectilinear street grid shown in the developer's plans.

The Fort Point Historic District abuts the site to the west, lending an industrial aesthetic provided by the warehouse buildings converted into residential units, interspersed with office and retail space and house a thriving artist community. The Boston Redevelopment Authority has also worked on the 100 Acres Master Plan to bridge the gap between this mixed-use area and the Gillette factory located further down the Fort Point Channel. The plan suggests extending the grid of streets and creating blocks and buildings that mimic the style and scale of the existing warehouses. A proposed park extends away from the Fort Point Channel toward the Boston Convention Center.

The recently constructed, iconic Institute of Contemporary Art building (Figure 44) sits at the water's edge and is part of the city of Boston's push to bring cultural activities to the Seaport along with the Boston Children's Museum. Beyond the Institute of Contemporary Art, the World Trade Center, Seaport Hotel, mid-rise office buildings, and Fish Pier form an energized waterfront enclave and are a potential source for future visitors to the park. The World Trade Center also doubles as an active ferry and water taxi terminal and Fish Pier acts as the hub of Boston's fishing industry.

Figure 44: Institute of Contemporary Art
Source: www.museumsofboston.org/museums/ica.html

Another relatively recent addition, the enormous Boston Convention Center (Figure 45) located in the middle of the Seaport District is grossly out of scale with the surrounding buildings, but again, promises to be a source of park users in need of fresh air after day-long meetings. Interstate-90 runs underneath the Seaport District with an access point just north of the Convention Center.

Figure 45: Boston Convention Center
Source: www.bostonconventioncenter.com

Connections and access to the site are provided by several linkages. The Harborwalk, a promenade that follows the coastline of Boston for 47 miles, runs through the proposed site near the Fan Pier development. This, along with the Northern Avenue bridge will provide pedestrian connection from the site to other open space including the newly constructed Rose Kennedy Greenway, a product of burying the expressway during the Big Dig. Additionally, two stops on the Silver Line transit are within a quarter-mile and South Station train and bus terminal is within a ten minute walk, ensuring easy public transportation access to the site.

Urban vs. Ecological Emphasis

Many urban parks tout the inclusion of ecological processes in their programming. However, most parks generally have a bias either toward urban form or toward ecology. Landscape urbanism hopes to bridge the gap between these two models to create a balance of cultural and ecological uses. By looking at a culturally-inclined and an ecologically-inclined design for this site, the gap between the two will illustrate the importance of meshing ecology and culture and the models can be combined to create a stronger overall design.

A sample park design that derives the bulk of its form from urban influences (Figure 46) is highly responsive to its built surroundings and the needs of the community. In this design, the grid pattern of blocks established in the proposed Fan Pier development is extended southward to Seaport Boulevard. Similar to street layouts found on filled land in the Back Bay and South Boston neighborhoods, the regular pattern is indicative of the artificiality of the land in the Seaport District. Additionally, mid-rise buildings that occupy a full block extend to Seaport Boulevard and create a transition between the high-rises of Downtown and the lower buildings near the World Trade Center and the Fort Point Historic District.

The pattern of warehouses that characterize the Fort Point Historic District is extended westward through the southern portion of the site, stitching new to old. Alleys, similar to those found in South Boston break up the large block at the southern end of the park and increase vehicle and pedestrian permeability within the site. The alleys that interrupt the rectilinear grid of the northern portion of the park repeat the angle that Congress Street creates as it slices through the Seaport District from Downtown Boston. Towards the interior of the block, the pattern of buildings opens up, forming courtyard-like spaces evocative of block interiors in the North End, facilitating pedestrian permeability and activating the spaces.

Two axes running through the site are preserved in the design through the location of buildings and alleys and reinforce the connection with the water. A channel, deriving its rectilinear form from the pattern of wharves that define the water's edge in Boston, winds through the site flanked by narrow planters containing salt marsh vegetation. However, the small scale of the constructed marsh system and inattention to its broader ecological needs limit the efficacy of the marsh's function.

Figure 46: Park Design with Emphasis on Urban Form

In a second sample design that emphasizes ecology (Figure 47), a salt marsh is reconstructed on the site with great care taken to adequately reproduce hydrologic function, species interaction, and other essential aspects of the ecosystem. This salt marsh has the potential to provide wildlife habitat and restore hydrologic cycles on the site whose flows have been funneled into underground pipes. Cultural uses occur at the fringes of the park and the fragile nature of the marsh limits pedestrian circulation to the edges and few elevated walkways that span the marsh. Several buildings occupy the southern end of the park, extending the industrial aesthetic of the Fort Point Historic District, but the absence of buildings over the remainder of the site creates inactive edges that limit the appeal of the park to users.

Although each of these designs considers both cultural and ecological factors for the site, neither is able to adequately address both. The first, heavily influenced by urban forms, focuses on weaving the site into the surrounding urban fabric and includes the ecology of a salt marsh as an afterthought that raises public awareness of the importance of a marsh, but does nothing to benefit surrounding ecosystems. The ecologically based design takes on a naturalistic aesthetic and concentrates entirely on reconstructing a marsh with great benefit to the environment, but characteristics of a salt marsh that limit pedestrian permeability and community uses throughout the park fall short of meeting the needs of visitors. Designing to meet both cultural and ecological needs will not only create a stronger design that merges urban form and ecological function into a new aesthetic, but will produce a space that greatly benefits community, the urban center, and surrounding ecosystems.

Figure 47: Park Design with Ecological Emphasis

Weaving an Aesthetic of Cultural and Ecological Process

The design for this park (Figure 48 & 49) combines forms distilled from cultural and ecological processes and techniques and ideas that emerged from case studies. These ideas are merged using a framework provided by landscape urbanism theory that seeks to bridge the gap between culture and nature, the importance of which is illustrated in the previous exercise of urban versus ecological design.

The Seaport District is a large tract of land that can be divided into smaller districts (Figure 50): the large scale active industrial and institutional area containing the Gillette Factory, Convention Center, and World Trade Center area; the mid-rise newly constructed mixed-use waterfront on Fan Pier that includes the northern portion of the park; and the converted warehouses of the Fort Point District and 100 Acres Plan including the southern portion of the park. Like most of the neighborhoods in Boston that have abrupt, perceivable borders, Seaport Boulevard marks the distinction between Fan Pier and the Fort Point District and I-90 separates the Convention Center from the Fort Point District and the park. Since the site for this park spans the Fan Pier area and Fort Point District, it will seek to integrate these two areas, but, true to Bostonian tradition of strong, inwardly-focused, neighborhood identity, will not address the Convention Center that lies to the south.

Figure 48: Master Plan of Proposed Park

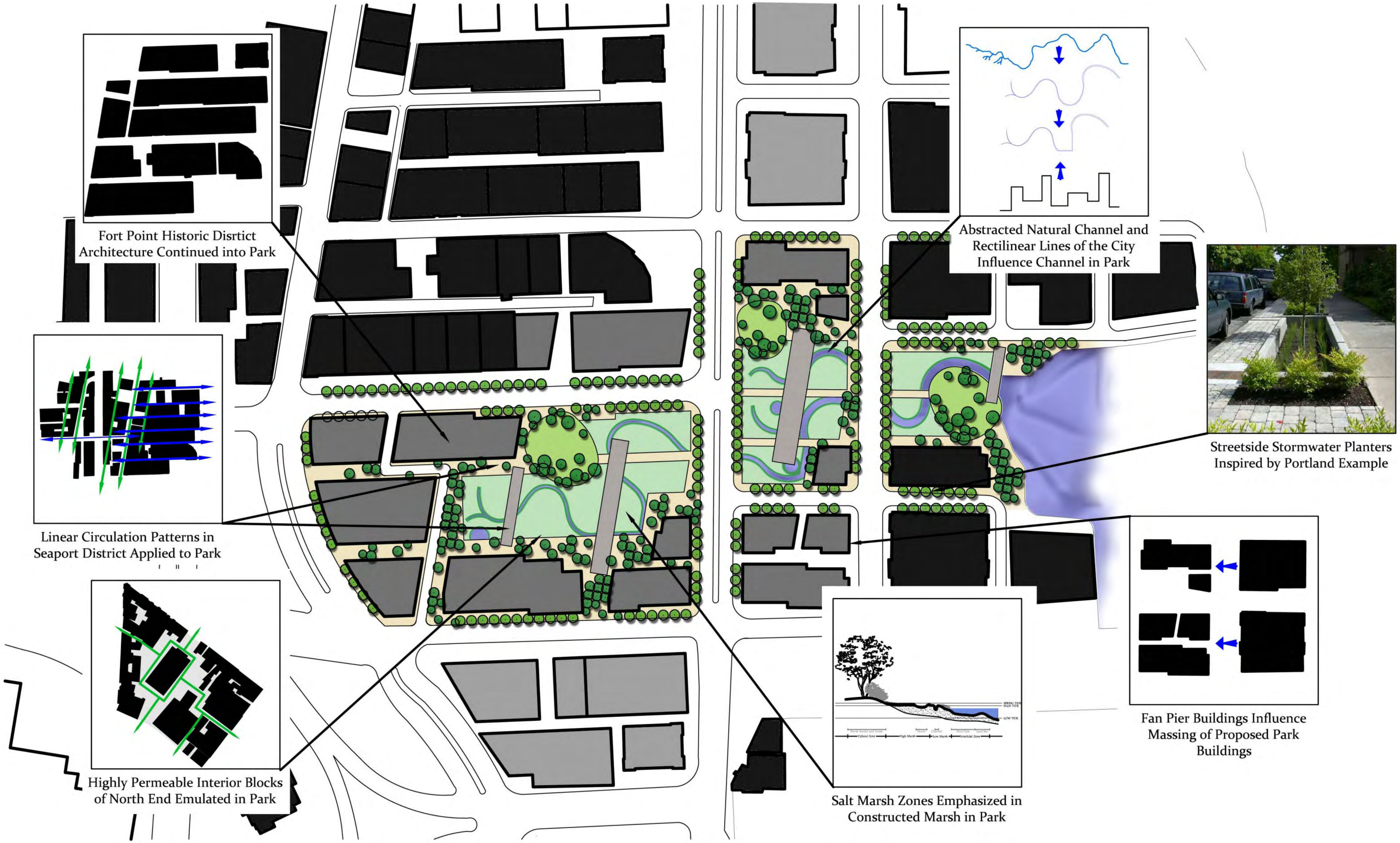

Figure 49: Cultural and Ecological Influences as Applied in Design

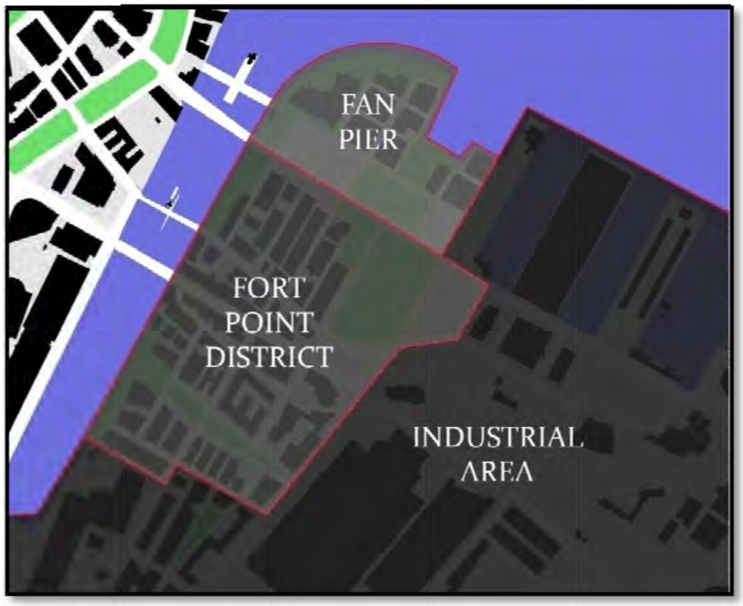

Figure 50: Sub-Districts within the Seaport District

Mixed-use buildings throughout the park provide an active edge where retail and commercial space on the ground floor provide a draw for visitors as well as residents and office workers that occupy the upper floors. These buildings will have a double front to engage the park and the street and avoid the feeling that the park is ringed with secondary rear entrances. Cafés, shops, and seating areas with views to the marsh spill out into the park creating a transition from public to private space.

The layout of these buildings is a compromise between the heavily built urban park and the less dense ecological park discussed in the previous section and retains references to urban forms within the Seaport District and other neighborhoods of Boston. A pattern of long, narrow warehouses indicative of the site's industrial history is continued into the park from the Fort Point Historic

District and dictates the pattern of pedestrian circulation that runs throughout the site in long axes that terminate at the water's edge (Figure 51). The buildings are spaced to encourage pedestrian permeability to the interior of the block in a similar manner to the North End neighborhood (Figure 52). The southern portion of the park will carry the industrial aesthetic and six to seven story height of the Fort Point District, while the buildings north of Seaport Boulevard will be clustered to approximate the massing of the larger, contemporary architecture of the Fan Pier area (Figure 53). The scale of the buildings in the park is consistent with the size of the salt marsh areas which balances the two elements and serves to more fully integrate the marsh and the urban fabric.

Figure 51: Pedestrian Circulation in Seaport and Park Dictated by Buildings

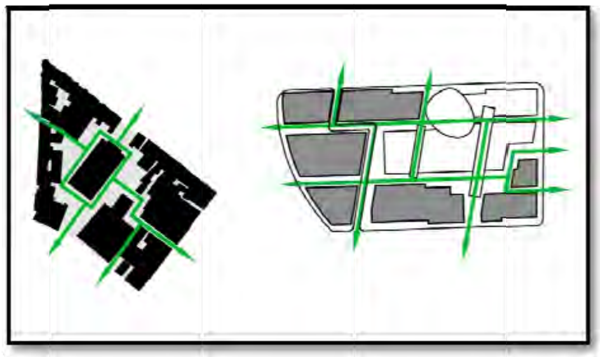

Figure 52: Pedestrian Circulation within Block in North End (left) and Site

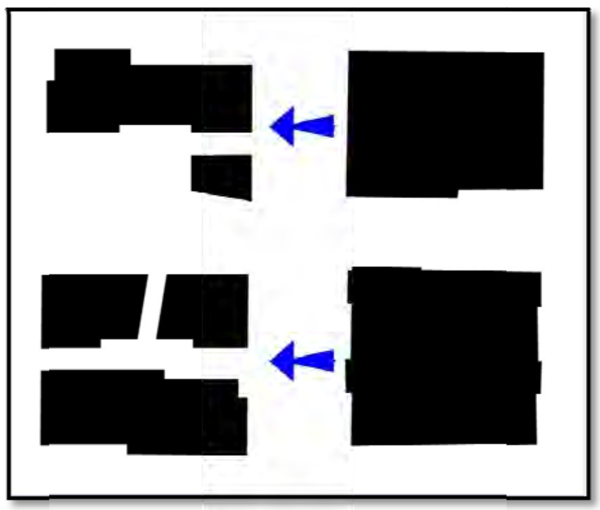

Figure 53: Massing of Buildings within Park Relates to Buildings in Fan Pier

A second organizing feature of the park is the diagonal pattern derived from the orientation of Congress Street as it connects to Downtown Boston (Figure 54). This diagonal is manifested in the alleyway that cuts through the southern portion of the park providing limited vehicular access, as well as the footprints of proposed buildings. Wide bridges allow for pedestrian circulation throughout the park above the salt marsh and provide open gathering space that can be adapted to different activities within the park such as concerts or fairs (Figures 55 & 56).

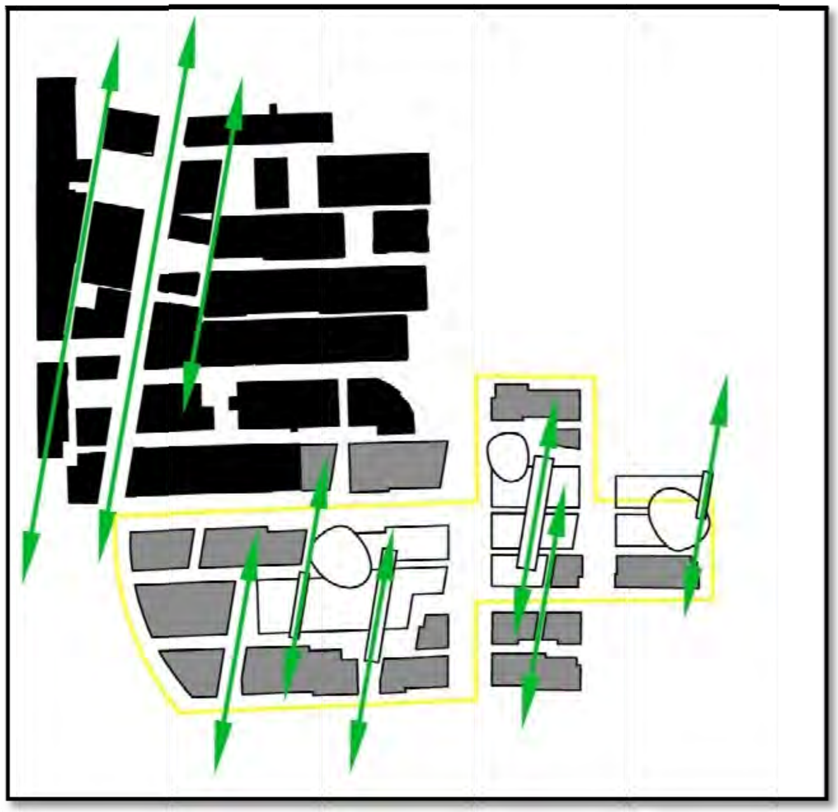

Figure 54: Diagonal Axis from Congress Street Carried into Park

The pattern of trees in the park also responds to the surrounding urban forms while meeting the needs of the salt marsh. The trees are laid out on a grid that is tighter in open areas of hardscape to reflect the rectilinear qualities of the city, but the pattern breaks apart on the lawn and toward the edges of the park. The trees that merge into the street trees along the edges of the park are smaller understory specimens and the plant palette on the lawn is a mix of a few varieties commonly found in the upland forest surrounding New England salt marshes. The trees also act as a transition zone between buildings and marsh and create structural diversity along to edge of the marsh that will help to blur the edge between marsh and city and facilitate movement across this boundary.

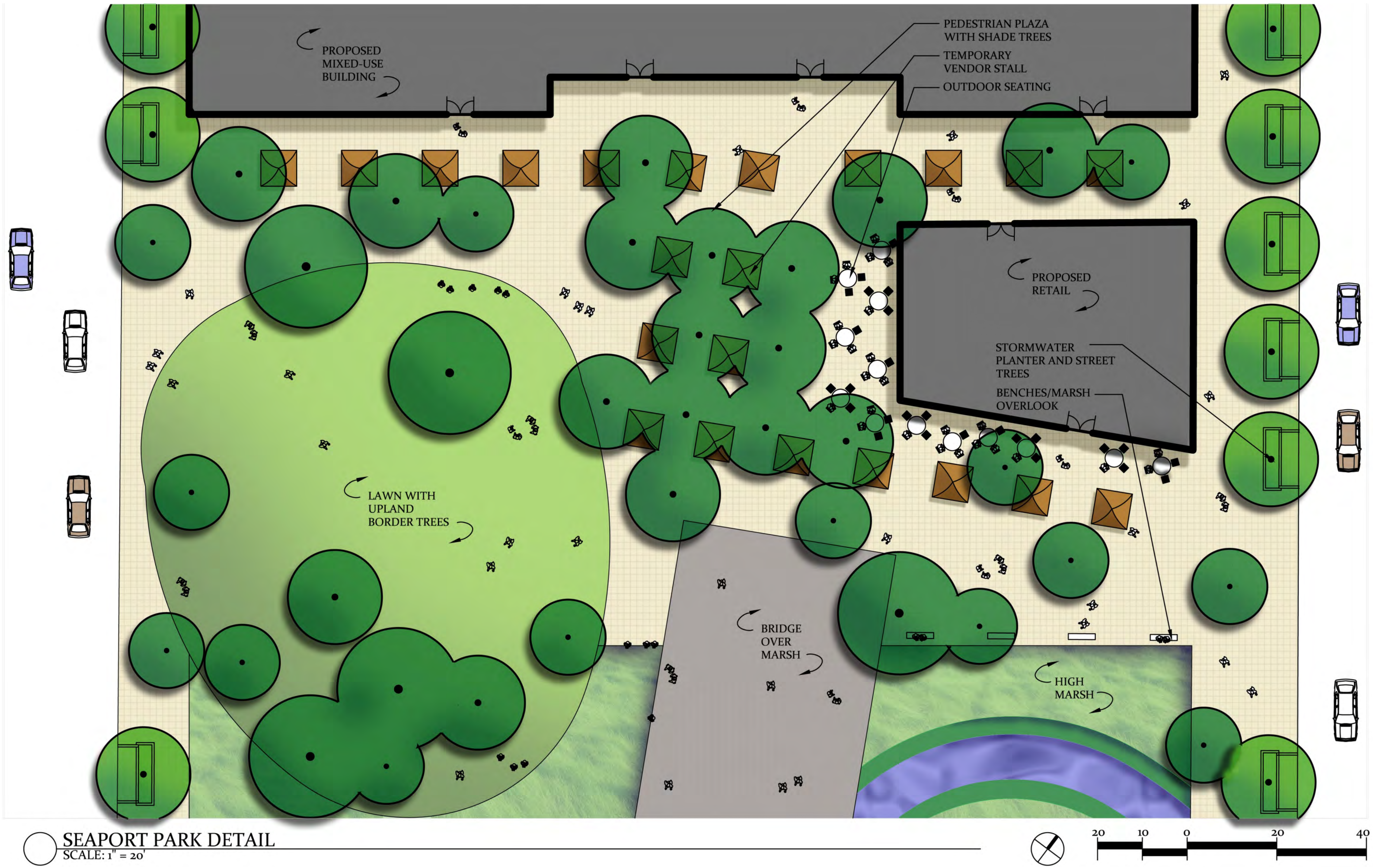

Figure 55: Detail of Park Retail Edge Configured for a Farmer's Market or Fair

Figure 56: Detail of Bridge and Walkways

In a restoration effort for a salt marsh, an approach similar to the one employed in Crissy Field, where the entire site was excavated to allow the tide to establish channels and a hydrologic regime, would be ideal. But in a highly urbanized setting where visibility and human interaction are also important and a naturalistic aesthetic has the potential to instill a false sense of nature, another approach is required. In this park, the channel derives its form from a channel in a mature salt marsh. The shape has been abstracted through the application of intentional curves but adopts the straight lines of the city in certain areas (Figure 57), reinforcing the integration of culture and nature and the fact that this is a constructed marsh.

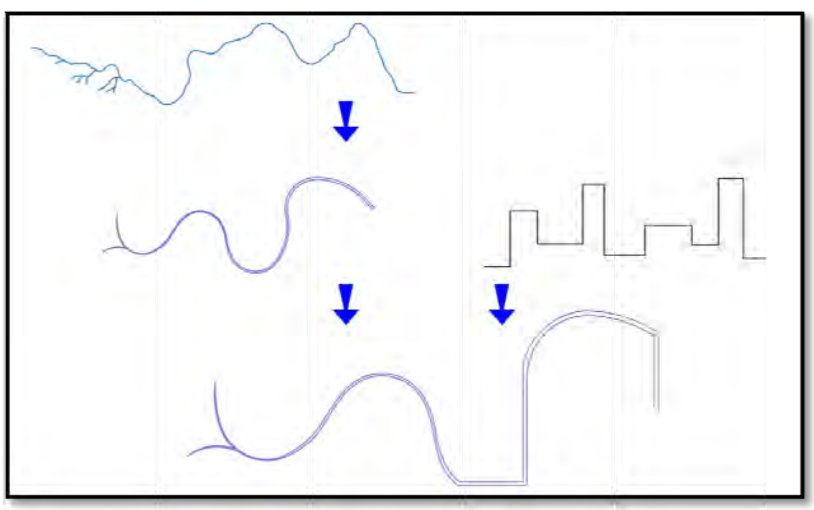

Figure 57: Evolution of Hybrid Channel Form in Park

Outward and upward from the channel, terraced levels demarcate low marsh, high marsh, and shrub border zones (Figure 58) and allow for inundation regimes that characterize each area. Vertical edges made of permeable material to facilitate the necessary water flow between these levels make the distinction more visible to visitors than sloped ground with differentiated plantings. Pools in the low marsh in the central portion of the park highlight another feature of salt marshes, and retain water during low tide. Raised pathways, seen in Figure 56, made of metal scrim to allow light penetration to the marsh and supported by helical anchors, provide the necessary pedestrian circulation throughout the park. These pathways bring people down into the marsh where they can more closely observe the water, plants, and animals that inhabit the ecosystem.

The presence of the tide in this park is unmistakable. For a period of four hours toward low tide, all water is gone from the marsh, with the exception of the pools, and all levels of the marsh and the mud bottom of the channel are exposed. When the water returns, it fills the channel within an hour and a half and then creeps up through the low marsh (Figure 59). As the water rises, pathways in the low marsh are submerged, limiting circulation options and accentuating the presence of the tide on the site in a manner similar to the seasonal flooding in the Allegheny Riverfront Park.

Three large lawn areas provide open space for passive recreation. The hill-like forms of these areas and the trees that cover emulate the topography of uplands surrounding a marsh and provide perches and nest sites for birds. The constructed form of the hills (Figure 60) calls attention to the artificial land and contrasts the flat expanse of the Seaport District while referencing the original topography of Boston that was cut down for fill.

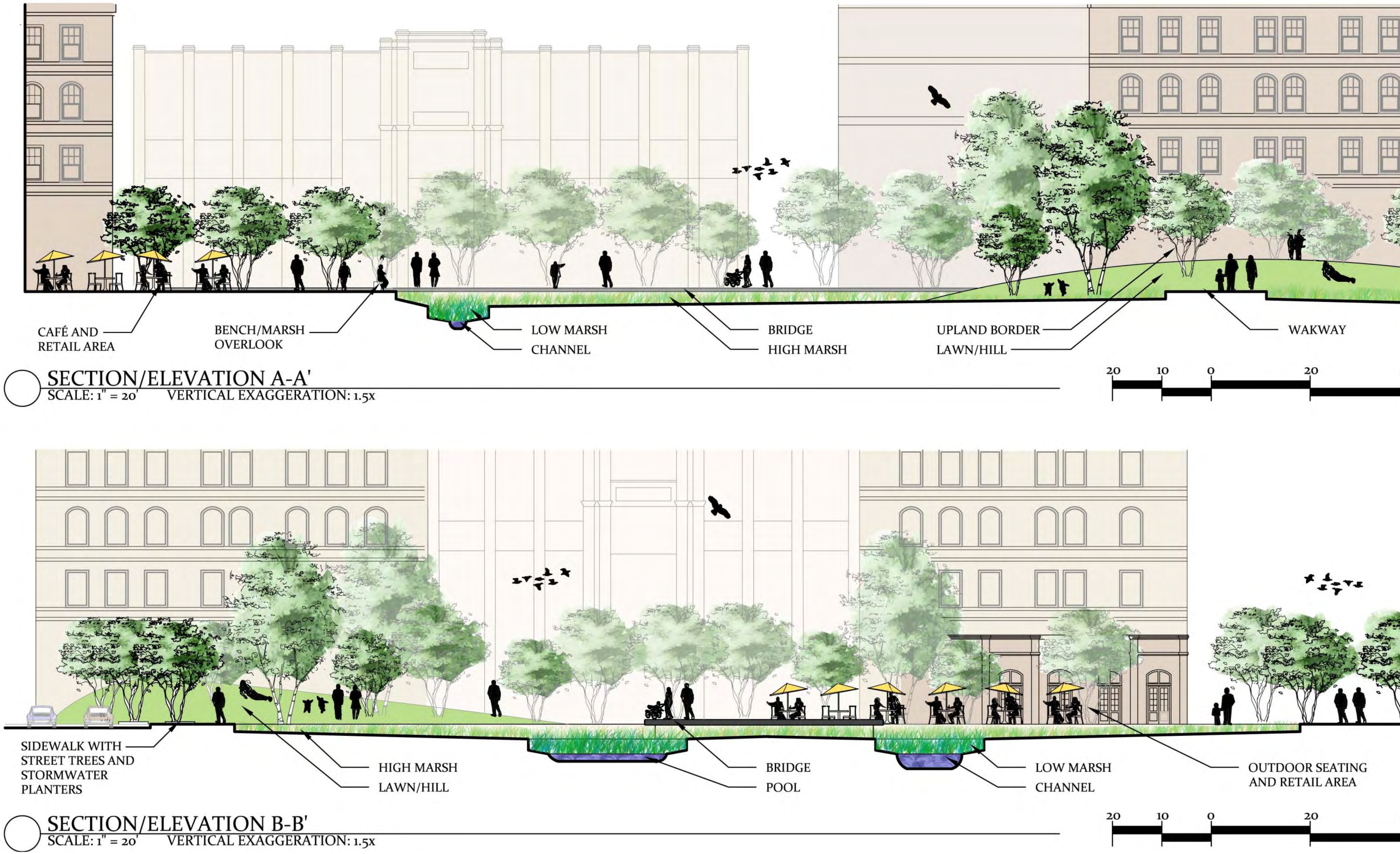

Figure 58: Section/Elevations of Proposed Park

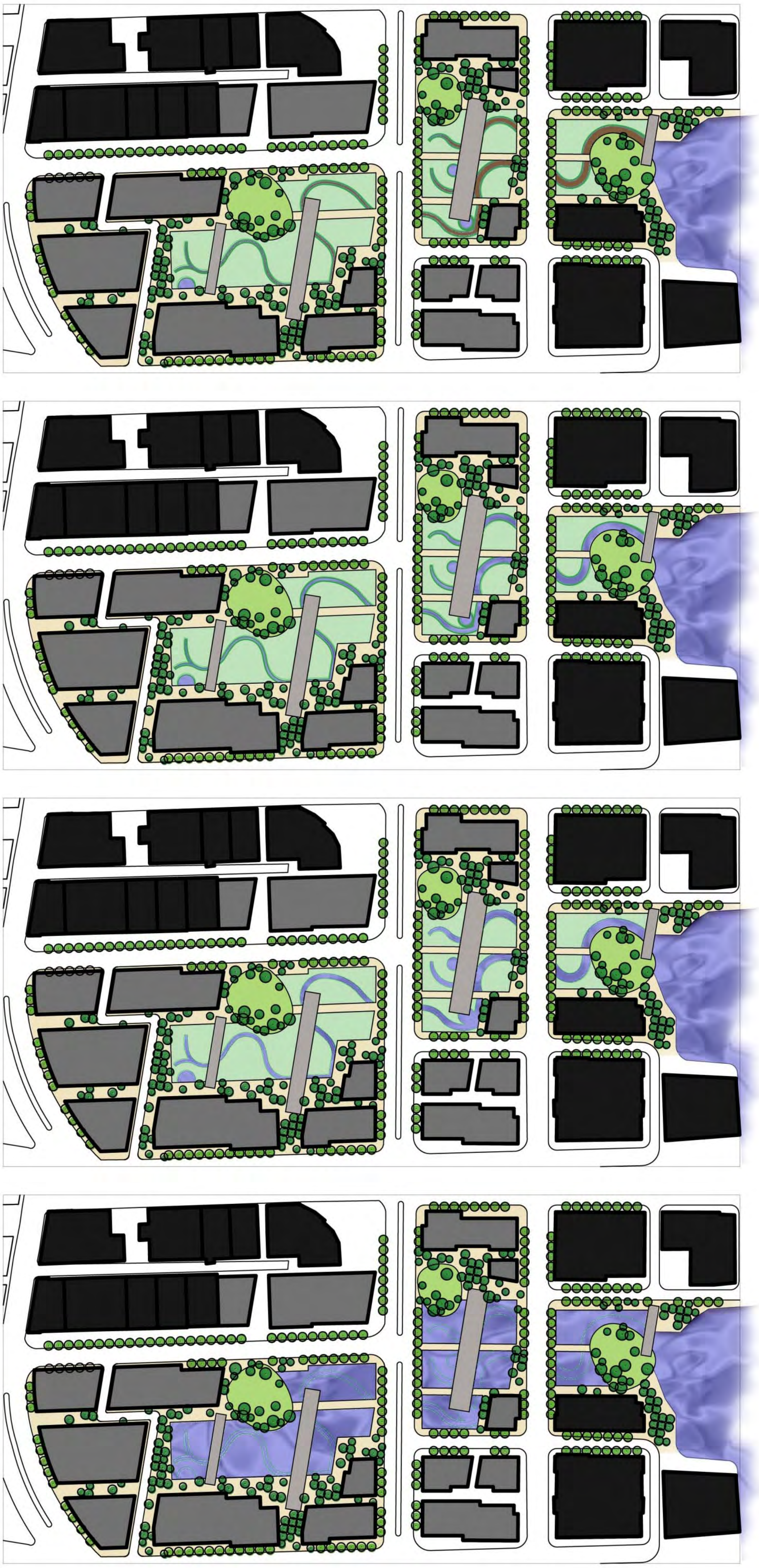

Figure 59: Stages of Flooding in Park at Low, Mid, High, and Spring Tides

Figure 60: View of Bridge, Marsh, and Constructed Hill

In an effort to relieve stress on the combined sewer system that serves much of the Seaport District and discharges into Boston Harbor when overloaded, a system similar to the Green Streets in Portland, Oregon, is constructed along the streets in the Seaport District. Planters, seen in Figures 55 & 56 collect and filter stormwater throughout the area, and runnels channel any overflow not infiltrated in the planters to the marsh for a final cleansing (Figure 61). Not only will stormwater be cleaned without the use of chemicals or energy input, but the reduction in stormwater volume entering the combined sewer will reduce overflow events, allowing a higher percentage of sewage to be cleaned at the treatment plant before discharge into the Harbor. The runnels maintain the axes perpendicular to the water and spill into the marsh over a crenulated lip evocative of the pattern of wharves that mark the transition between city and water.

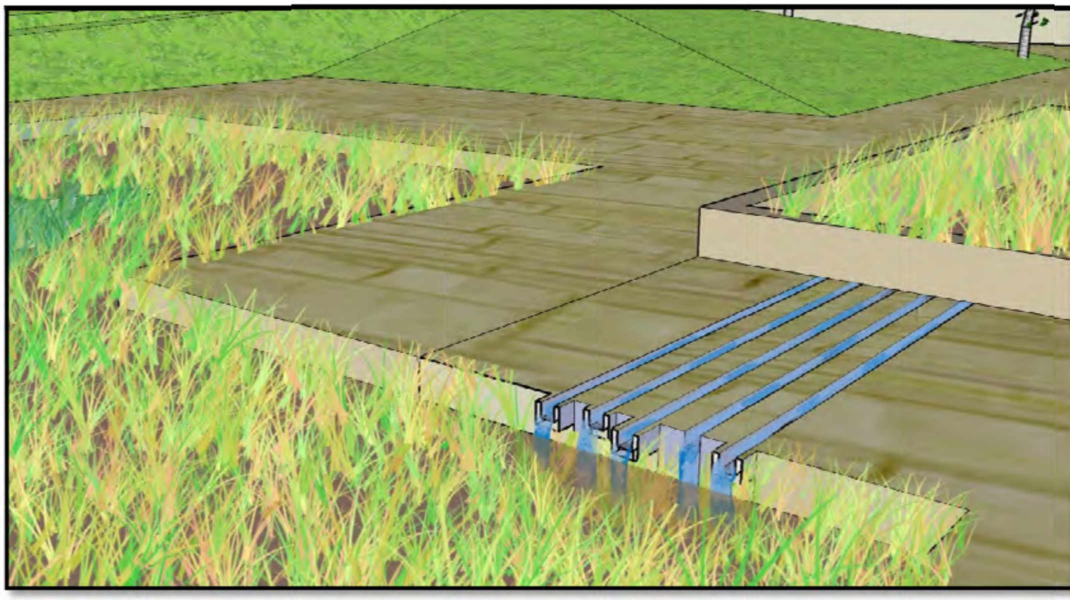

Figure 61: Detail View of Runnel from Stormwater Planter

Insights gained from examining urban form and ecological process through the lens of landscape urbanism have been synthesized into the design of a park in the Seaport District. The aesthetic of the park is a blend of the forms that are the product of dynamic cultural process, ecological process, and the collaboration of the two. By integrating urban form and ecological process in balanced proportions, a space is formed that meets the needs of the human community as well as the needs of the ecological communities and produces benefits for both. This design addresses all users of the space and the integrated approach creates a usable space for the future of the Seaport District.

7. CONCLUSION

Landscape urbanism provides a framework that can inform landscape design through the balanced inclusion of urban form and ecological process. By forcing the designer to pay attention to locating a design in its larger context and harnessing the infrastructural potential of a site, the design acknowledges, reacts to, and positively affects surrounding built and natural environments. The design for a proposed park in the Seaport District employs landscape urbanism theory in the design process to produce a space that responds to the emerging community's cultural needs as well as the ecological requirements of nearby ecosystems. The result is a fusion of Boston's urban forms with the ecological processes of a salt marsh and the aesthetic revealed at their intersection. The design produced at the culmination of this application, although not constructed and therefore unable to be quantifiably measured for its cultural and ecological success, can be evaluated for its integration of the landscape urbanism tenets explored in this thesis.

Examining multiple scales of influence on the site played an integral part in the design process for this park. For example, the larger system of salt marshes was considered for its role in species distribution in the area, zones characteristic of individual salt marshes dictated the topography in the park, and nutrient exchange that takes place at the microscopic level was explored for pollution removal properties, although each of these components has effects that are discernable at multiple scales (i.e. nutrient cycling can also be described at a systems level). Elements of urban form and ecological process that occur at a site scale or smaller were easily incorporated into the design because they are spatially compatible with the site. However, larger scale processes are more difficult to reference. Although present on the site, explored in the design process, and potentially perceptible through the arrival and departure of birds and other highly mobile animals, species exchange between neighboring salt marshes and the park is not clear to the visitor, largely due to the lack of visual connection to other marshes. Nevertheless, introduction and understanding of multiple scales in the design process addresses various levels of influence that locate the site within and integrate its constructed and natural contexts.

Urban forms, as the product of dynamic instability that characterizes the city are shaped by multi-scalar cultural and ecological processes and provide physical manifestations of these forces that are able to be incorporated into a design. References to the distinctive North End, Financial District, Back Bay, and South Boston neighborhoods are scattered throughout the park, linking the design to other periods in Boston's history, solidifying contextual connections between the park and the city, and capitalizing on successful models of vibrant neighborhood design that meet a community's cultural needs. These, among other urban patterns like the industrial architecture extended into the site from the Fort Point District, facilitate cultural activities within the park that intermingle with and overlook the salt marsh that weaves through the space accomplishing landscape urbanism's ultimate goal of blurring the line between culture and ecology (Corner, 2003).

Emphasizing ecology in a landscape underlines the fact that ecological process affects all areas, both constructed and natural. Ecological processes of a salt marsh brought into the design of this site assume forms abstracted from natural marshes and strongly influenced by Boston's urban context. Although not aesthetically identical to a natural marsh, processes, like the tide, still act upon the site, are made highly visible to visitors through the design, and facilitate necessary salt marsh functions. Vertically separated low and high marsh zones, circulation routes and favorite sitting places that disappear under water, and planters not obviously contiguous with the marsh emphasize the importance of the rise and fall of the tide in this ecosystem. Legible ecosystem function in this park instills understanding and appreciation in the public mind for the more subtle interactions that occur in a natural marsh.

Finally, incorporating infrastructure into the landscape diverts some of the inputs and reduces the need to expand conventional systems. The proposed park in the Seaport District seeks to integrate stormwater management into its design through the use of stormwater basins in the sidewalks of adjacent streets and by exploiting the ability of salt marshes to uptake nutrients and toxins. Yet the greatest benefit to incorporating stormwater management into the park is the potential to decrease the number of CSO events that spill raw sewage into Boston

Harbor thereby improving health of proximal water bodies and the plant, animal, and human communities that depend on them.

While not the focus of this thesis, consideration of economic factors is an integral part of design. This park design calls for a large parcel of prime real estate in the Seaport District to be converted to usable open space. Although the cost of constructing the park would be great and the real estate investment would most likely not have as high of a return rate as conventional development, the potential benefits offered to the community and ecosystems could be seen as valuable enough to support the implementation of this park. As a result of the design goals, mixed-use buildings within the park have the potential to create revenue and draw people to the retail spaces. The park itself fulfills the *biophilia* requirement for people who live and work in the area and can act as an amenity that will create a desirable neighborhood that will be a vibrant community for year to come. Additionally, the water cleansing and stormwater management services provided by the park have the ability to save the city of Boston considerable amounts of money by reducing the need for added stormwater infrastructure. These economic incentives, coupled with the cultural and ecological aspects of this design and the consideration of the aesthetic created when these elements are combined come together in the quadruple bottom line of sustainable design to create a park that responds to the contemporary needs of the human community and the surrounding ecosystems.

This thesis has investigated the relationship between cultural and ecological processes and the aesthetic produced by weaving these elements together in an urban park in the Seaport District in Boston. Landscape urbanism theory, used as a guide and method for leading the investigation, resulted in a design that captures the history and identity of the area, responds to its urban and biotic contexts, embraces ecological processes of a salt marsh, incorporates stormwater infrastructure in a space that meets the needs of the community. The artificiality of the site that stems from the filling process used to make the land combined with the 'blank slate' appearance of much of the Seaport District, Boston's history of reinventing its waterfronts in unprecedented ways, and plans for large scale development, make the Seaport District a good candidate to accept innovative design. While the aesthetic that emerges using this framework will be different for each site, the merits of addressing wider contexts and dynamic process in urban locations are invaluable to the creation of spaces that mesh with the urban fabric and benefit communities and their surrounding environments.

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