

**ENGAGING ECOLOGY THROUGH ARCHITECTURE:
RECONNECTING BEDFORD TO ITS BAY**

by

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ABSTRACT

This thesis studies the relationship between the urban environment and ecosystem and the intersection between ecosystem and architectural project. While urban sites are commonly understood as separate and unique from their natural settings, this proposal for a hybrid urban ecology defines them as one and the same. The architecture in this proposal acknowledges the natural systems of Bedford Bay, Nova Scotia and facilitates a public interface with this provisional landscape. Local coastal building strategies are reimagined in this three-phased proposal and represented schematically at the regional scale of the bay and in detail at the Mill River estuary and DeWolf Park. The architecture is reconceived as landscape, infrastructure, and built-form and serves as a scaffold for the succession of an interdependent urban ecology that supports a public program centered around outdoor recreation.

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I dedicate this thesis to my parents, Randy and Debi Jones for their enduring encouragement and support and to my brother Josh who always remained in my corner. Also, to my grandmother, Violet Jones, who helped me discover this project and continued to inspire me from its beginning to its end.

CHAPTER 1: INTRODUCTION

Thesis Question

Can architecture redefine the relationship of the urban environment and existing ecosystem in Bedford Bay, Nova Scotia as a means to foster a renewed public presence on the coast?

How nature and the urban environment are perceived and how they intersect is the question at the core of this exploration. This thesis moves between various scales of analysis to situate the urban fabric and natural landscape of Bedford Bay, NS in its regional and spatial context. Systems theory is implemented as a means to challenge the presently privatized condition of urban development along the Bedford Bay shoreline as the bay is examined at the larger regional scale and then design using local test sites is applied. Design serves to acknowledge the existing natural functions of Bedford Bay by altering coastal landscape so that it responds to, diverts and magnifies these underlying natural systems. Architecture in the form of landscape, infrastructure, and built-form re-interprets past and present coastal development practices to incrementally build new urban habitat.

The parameters of the proposed conditions are devised to embody an earlier operational state in the bay, but do not set out to replicate the past. Rather, program is designed as a response to the current intersection of public interaction with the water. Past and present use is challenged so as to attempt to optimize the proposed hybrid ecology's future outcomes, where architecture actively engages the natural systems to foster the succession of a new urban ecosystem. Legacies of human occupation at this site and the landscape interventions that have shaped its current condition are identified by mapping locations of current public ocean frontage. These areas are mapped against environments nested within the bay, such as estuaries, salt marshes and intertidal zones, to localize sites along the shore primed for new architecture.

Through visibly acknowledging this landscape and activating it with new architecture a re-invigorated public dedication to the site is developed. The human component of this hybrid ecosystem is understood as integral and represented with programmatic considerations based on previous recreational use in the Bay. This project thus proposes an architectural

intervention that will incrementally build new habitats, engage with existing operant ecologies, mediate development induced environmental degradation and reconnect the public to the water through the design of architecture that is integrated with site.

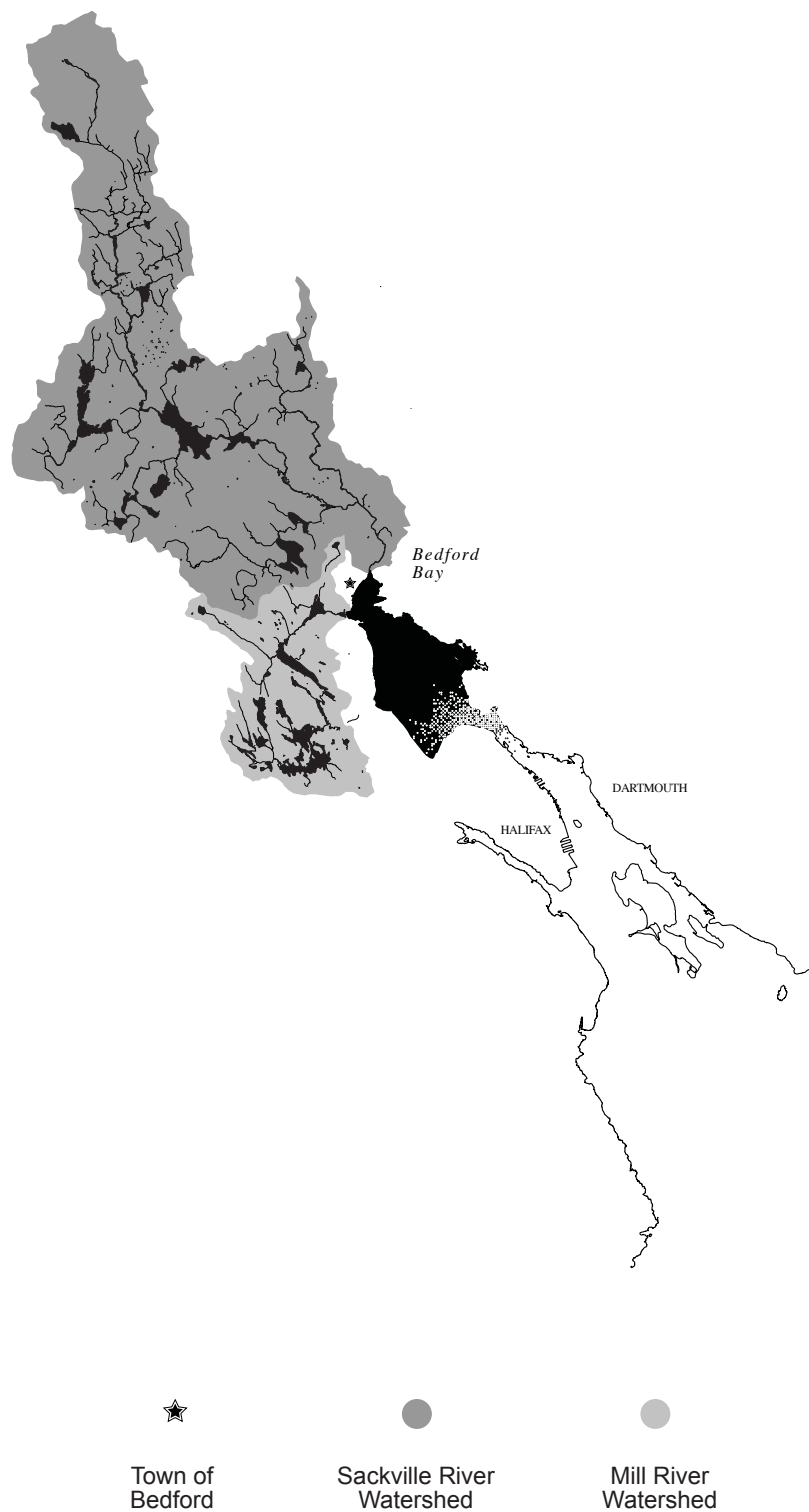
Localized environmental conditions are considered when redesigning the existing landscape so that the introduction of architecture acts as a scaffold for the succession from the present independent state of the urban and natural populations in and around Bedford Bay to a interdependent urban ecosystem. Resiliency of this hybrid urban ecology is afforded by phasing where responsive design parameters can result in multiple possible futures.

[H]abitat cultivation and diversification become the engine of project evolution and phasing; linear trajectories of time and process and history expand the issues and inputs considered germane; and ecological-infrastructure-productive sequences are choreographed to suggest multiple possible futures (Reed and Lister 2014, 135).

Situating Bedford Bay

The Human Connection with Bedford Bay

For thousands of years before the arrival of European settlers to the shores of what is now referred to as Bedford Bay, the indigenous Mi'kmaq people summered around this region. The plentiful fishery at the mouth of the Sackville River and the picturesque beauty of the sheltered bay provided the ideal setting for their Spring Feast (Tolson 1979, 9). In 1749, at the same time the future Governor of Nova Scotia, Lieutenant General Edward Cornwallis established a fort on the Halifax Peninsula, so too was Fort Sackville established in Bedford, which marked the end of the Mi'kmaq tradition and the seed of a new, permanent settlement along the coast of the Bedford Bay (Tolson 1979, 9). The human presence in and around Bedford would only increase over time with the establishment of industries reliant on the natural qualities provided by the site, and then, eventually a shift to a primarily residential community (Edwards 2007, 5). The human influence on Bedford Bay culminates in the current state of the site today, a coastline that is nearly entirely privatized, with few points of public access and a marked decrease in the productivity of the basin ecosystem that the early Mi'kmaq would have enjoyed.



Map showing location of Bedford relative to the city of Halifax and the two major contributing watersheds to Bedford Bay: the Sackville River watershed in dark gray and the Mill River Watershed in light gray (from HRM Geodatabase 2012)

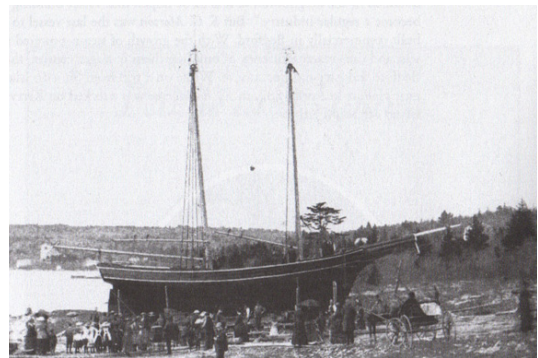
Coastal Industry: Exploiting the Bay's Ecologies

Not long after European settlement of Bedford Bay did industry arrive to its shores. The presence of more than one river discharging into the bay meant that mills were built to exploit this raw energy for the production of goods. The first large scale commercial mill was built by John Henry Mixner in 1813 on Mill River on what was then referred to as Winter Cove and operated until 1836 (Edwards 2007, 61). Mills were also present at the mouth of the Sackville River for many years (Edwards 2007, 63). Ownership changed hands many times over the years and various goods were produced, including blankets, grain, paper and even chocolate. In Edward's account of historic Bedford she writes that "while the mills were turning raw goods, at other spots on the shore of the Bedford Basin vessels were being built" (Edwards 2007, 74). Ship building was the other principle industry that operated on the shores of the Bay for many years where everyday life in this self-sufficient community was regulated by "the sounding of the noon whistle at Moir's Mill" (Edwards 2007, iv).

The commercial ship building industry in Bedford lasted until the turn of the century when the last commercial vessel was built in Bedford (Edwards 2007, 80). Mills continued to operate for many years after this until 1963 when "the last vestige of a major name in maritime industry disappeared" with the closing of Moir's Mill (Edwards 2007, 73). The closure of these mills would mark a fundamental shift in the identity of Bedford from that of a self supporting coastal community to a residential satellite of the larger city of Halifax (Edwards 2007, 73).



Millview Grain Elevator, 1883 (Edwards 2007)



Launch of S.G. Morton, 1884 (Edwards 2007)

Residential Bedford

The Town of Bedford existed as an independent town until 1996 when it joined the larger Halifax Regional Municipality. Today Bedford's urban fabric consists primarily of subdivisions containing single family detached homes. Commercial buildings and other businesses are concentrated around the main road that wraps around the bay, the Bedford Highway. Waterfront development, as previously discussed, consists of mostly private residential buildings, with detached houses wrapping around the North East edge of coastline and mid-rise condominium buildings concentrated along the South-West. In 2011, the population of Bedford was 23,019 with the largest majority of citizens being between 35 and 54 years old.

The Bay as Playground: Recreation on Bedford Bay

As the years rolled on and the population increased, the Basin was used for recreation, too. It was a popular spot for skating in the winter and swimming in the summer. (Edwards 2007, 149)

There is a rich precedence of human engagement with the water along the shores of Bedford Bay. Both residents and visitors would flock to the shores of the bay in summer months, much like the Mi'kmaq once did, to enjoy its tepid waters and to play along its shores. "In summer the Basin is incomparable for sailing, canoeing, even yet for swimming. In winter there is skating, iceboating and hiking" (Tolson 1979, 255). Indeed, recreation did not cease in the winter as the Bay's waters would freeze all the way to the narrows which made it a popular skating destination.



Swimmers at Admiral's Rock, 1954 (Edwards 2007)



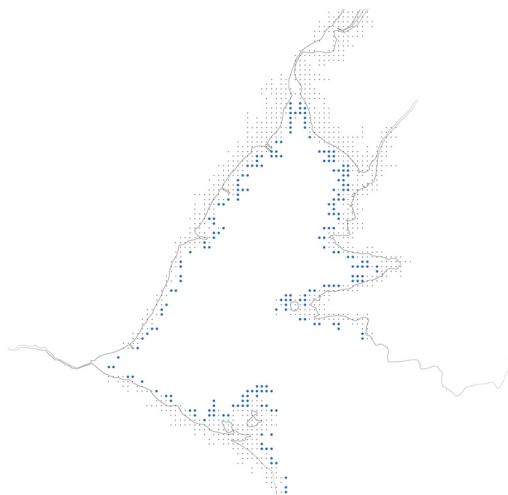
Map of historic Bedford for the period between 1930 and 1955 highlighting popular swimming areas, the threshold of consistent freezing during the winter and coastal morphology (composite image created with data from Critchley 2011, Edwards 2007, GeoNova Data Locator 1964, GeoNova Data Locator 1974, HRM Geodatabase 2012, Tolson 1979 and Woolford 1817)



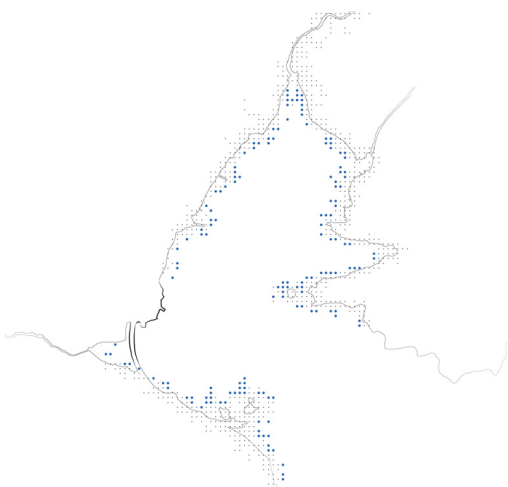
Hockey on the Basin, 1909 (Tolson 1979)

Where citizens of Bedford were once able to swim in the bay during the summer and skate on it in the winter today these activities no longer exist. Expansive residential growth in the 1970's resulted in a degradation of the bay environment and privatization of the waterfront compounded this by fostering an attitude of apathy and a devaluing of the bay ecology. Where the Bay would once freeze over for the whole of winter this no longer occurs. A paper published in 1975 investigating factors preventing freezing of Halifax Harbour states that the "...most significant [factor affecting freezing is] industrial waste that increases the water's temperature" (Tolson 1979, 256).

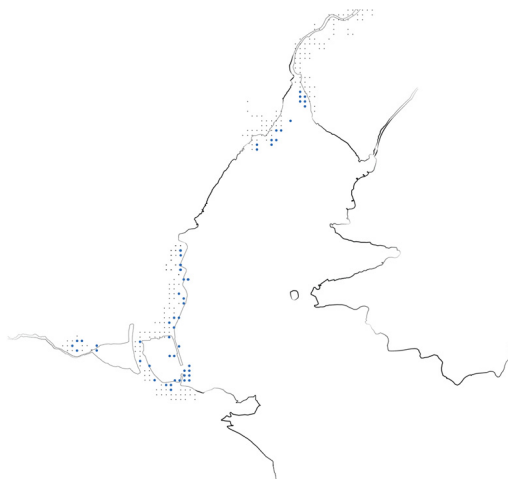
Water quality testing around this time restricted swimming in the bay due to high levels of coliform fecal units, or CFU's resulting from sewage outflow into its waters. Residential expansion and an increase in population contributed to these higher levels of pollution and a public pool was opened on the shore at Lion's Park to coincide with this great reduction in swimming in the bay (Tolson 1979, 247). Today, thanks to secondary sewage treatment facilities in Bedford and, more recently, an advanced primary sewage treatment strategy for neighbouring Halifax and Dartmouth the water quality has greatly increased (Williams 2010, 29). Recent testing shows that CFU's are being maintained at a level safe for swimming however consistent freezing safe for skating still does not occur.



Map of Bedford Bay coastline in 1850 showing unrestricted public water access (composite image created with data from Edwards 2007, HRM Geodatabase 2012 and Tolson 1979)



Map of Bedford Bay coastline in 1950 showing progressive privatization of coastline (composite image created with data from Edwards 2007, GeoNova Data Locator 1964, HRM Geodatabase 2012 and Tolson 1979)



Map of Bedford Bay coastline in 2015 showing presently restricted public water access (composite image created with data from Edwards 2007, GeoNova Data Locator 1992, HRM Geodatabase 2012 and Tolson 1979)

Tracing the Human Impact on Bedford Bay's Landscape

Prior to the settlement of Bedford in 1749 by the British there is evidence of seasonal Mi'kmaq habitation of the site. However, the resulting anthropogenic effects were likely minimal (Williams 2010, 29). Conversely, after the establishment of a permanent settlement along the shores of Bedford Bay evidence of the human presence on the landscape begins to become more easily traced. The first major human intervention, and one that remains today, was the building of a causeway across what was previously referred to as Winter Cove in 1853 (Edwards 2007, 64). This causeway was built for the new railway and this railroad still wraps around the shoreline of Bedford today.

For many years, the causeway was one of the most recognizable landscape interventions on the shores of the bay. Although coastal architecture was always present in the form of large piers sitting on piles it wasn't until the 1970's when intense dredging of the bay floor would noticeably intervene in the previously unaltered environment again.

Dredging in the harbour continues to be used as a way to ensure that waters are sufficiently deep to allow ships to easily pass through. The dredged material is also used as a source of fill for construction. Several areas of Halifax Harbour have also been infilled to allow for shipping, industrial construction and residential construction along the shoreline: this practice continues today. (Williams 2010, 31-2)

Dredging in Bedford Bay occurred to allow for sufficient depth for pleasure boats. The ocean floor at the mouth of the Sackville River was extensively dredged because of its proximity to Bedford's private yacht club (Roze 2000). Dredged materials were used to build out shoreline along the bay's coast - a practice that persisted and continues today in Bedford where a large-scale in-fill initiative on the South-West quadrant of the bay is on-going. The in-fill consists primarily of pyritic slate and previously in-filled areas now serve as sites for medium sized residential towers and the largest public water-frontage in Bedford, DeWolf Park. These in-fill operations have greatly altered the morphology of the Bedford Bay coastline.

The composition of coastal fill that is used in Nova Scotia today can vary but primarily consists of excavated stone and earth from ongoing construction projects. Historically, the coastline in Halifax Harbour was built out with a wide array of fill, including rock, soil and even garbage (Legge 2012). Dredging operations, as previously stated, have also been used to build up coastline with material collected from the sea floor. Today, the practice



Map of Bedford Bay showing coastal morphology in 1749, before European settlement (composite image created with data from Critchley 2011, Edwards 2007, HRM Geodatabase 2012, Tolson 1979 and Woolford 1817)



Map of Bedford Bay showing coastal morphology in 1865, after first coastal in-fill initiative to build a causeway for the railway (composite image created with data from Critchley 2011, Edwards 2007, HRM Geodatabase 2012, Tolson 1979 and Woolford 1817)



Map of Bedford Bay showing coastal morphology in 1945 (composite image created with data from Critchley 2011, Edwards 2007, HRM Geodatabase 2012 and Tolson 1979)



Map of Bedford Bay showing coastal morphology in 2015, with coastal in-fill drawn in black (composite image created with data from Critchley 2011, Edwards 2007, GeoNova Data Locator 1992, HRM Geodatabase 2012 and Tolson 1979)



Map of present day Bedford showing areas of the coastal in-fill, sea floor that has been dredged and relative organization of private residential, private commercial and public buildings (composite image created with data from Critchley 2011, Edwards 2007, GeoNova Data Locator 1992, HRM Geodatabase 2012, Rozee 2000 and Tolson 1979)

of dumping pyritic slate into the ocean is regularly practiced as can be seen in Bedford Bay where the large area of coastal infill previously mentioned consists mostly of this material (Legge 2012). This stone is habitually unearthed during local construction and when exposed to oxygen produces acid run-off which can be harmful to the environment it is dumped in.

However, Fisheries and Oceans Canada and Environment Canada have both determined that this material can be safely dumped underwater because of the lack of oxygen in this environment (Legge 2012).

The Living Bay: Bedford's Operant Ecologies

The Halifax Harbour as a whole is described as an estuarine system where salt and fresh water mix (Mann 2000, 9-10). It is in the Bedford Bay where this mixing process truly occurs, at the mouth of the Sackville River, the primary freshwater tributary into the Bedford Basin, and by adjunct the Halifax Harbour (Mann 2000, 9-10). The estuarine system is rich in nutrients and attracts a high level of biodiversity because of this. While estuarine mixing is objectively one of the most influential operations of the Bedford Bay it is not the only one considered. For the purpose of this thesis research, the contributing watersheds have also been mapped, in addition to the biodiversity composition of both primary producers and secondary consumers of the bay ecosystem, intertidal zonation along the coast, bathymetry and the presences of a small reef and existing salt marsh. Although many ecological operations intersect in Bedford Bay the ecosystem functions of the bay have been modified by man, "so that the harbour has lost much of its biological diversity and is much less productive of fish and shellfish than it was 250 years ago" (Mann 2000, 13).

The Bedford Bay Estuary

Harry Thurston describes estuaries as places where fresh and salt waters meet and mix wherever a river drains into the sea (Thurston 2011, 16). Sackville River, the major source of freshwater into the harbour system is found in Bedford Bay and has an average inflow rate of 5.3 m³/s (Williams 2010, 29). In addition to the Sackville River freshwater enters the Halifax Harbour through numerous streams and rainfall (Williams 2010, 29).

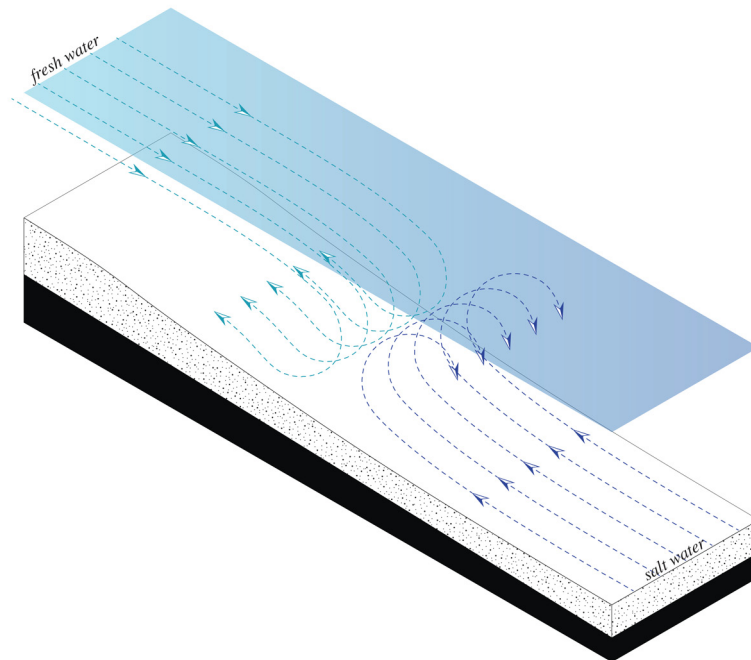


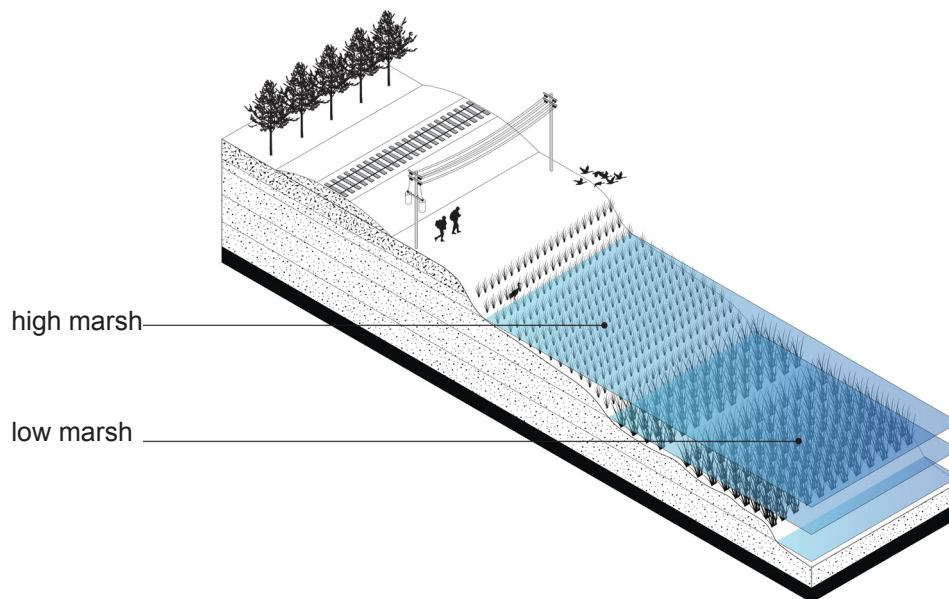
Diagram showing the mixing of fresh and salt water in an estuary, as seen in Bedford Bay at the mouths of the Sackville and Mill Rivers.

The Bedford Bay is home to three of these additional streams that contribute notable levels of freshwater. The Mill River in particular also has a high annual flow rate, despite the fact that it is dammed upstream from the coast. Where it was once a much larger tributary historic damming for mills that operated on its banks contribute to its diminished input. Presently, the cove where it enters the bay is also bisected by the causeway previously discussed.

In *The Atlantic Coast: A Natural History*, the author explains that “...most estuaries are highly productive. The turbulent clash of fresh and salt waters underpins this productivity by keeping nutrients in suspension and available to the host of plants and animals that make up the estuarine food web” (Thurston 2011, 16). Estuarine shorelines are where this productivity is at its highest as the zones allowing sun light penetration provide habitat for a variety of large plants (Mann 2000, 12). Two estuary shoreline conditions occur here: shallow estuaries which provide habitat for salt marsh grass and steep-sided coastlines that are home to different seaweeds (Mann 2000, 12).

Salt Marsh

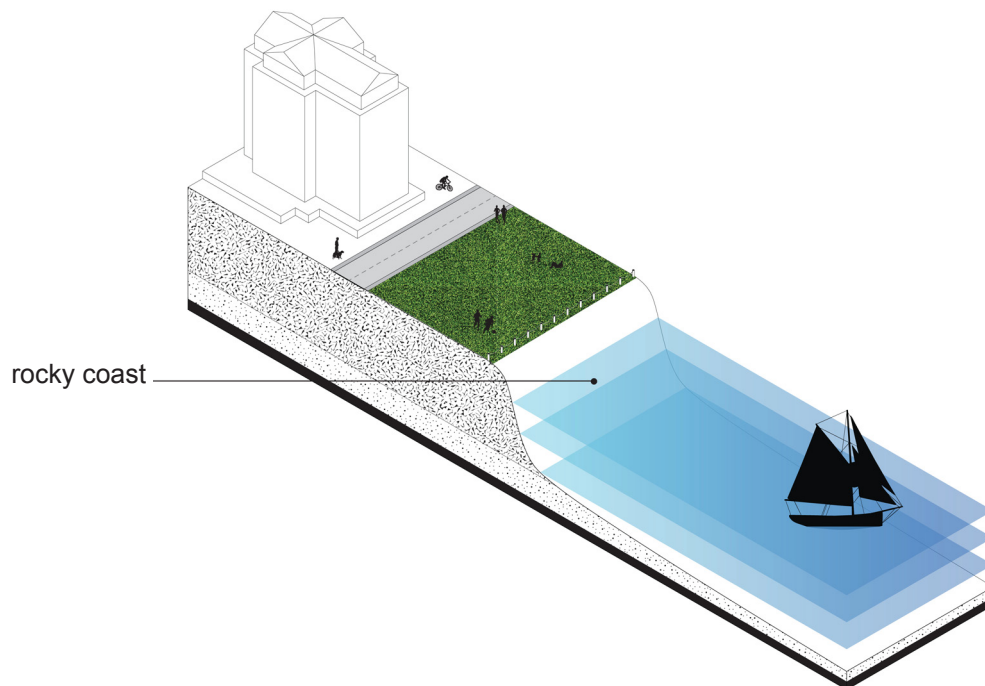
Harry Thurston describes the salt marsh as “among the richest habitats on land or sea” (Thurston 2011, 17). The salt marsh is flooded daily by the tides which produces a delineation between a high marsh and a low marsh. Salt-tolerant cordgrass is the most prevalent primary producer present in this system with *Spartina alterniflora* growing on the low marsh and *Spartina patens* growing on the high marsh, which is not touched by the tide as often (Thurston 2011, 17). Presently, a small salt marsh exists in Bedford Bay near the Mill River estuary. The composition of the shallow salt marsh provides ideal habitat for juvenile fish and other marine invertebrates, such as herring, smelt and flounder (Thurston 2011, 17). In turn, secondary consumers are attracted to this site such as cormorants, herons and other sea birds that capitalize on the high level of productivity found here.



Axonometric diagram of an example of the coastal condition where salt marsh habitat presently occurs in Bedford Bay.

Intertidal Zone: The Atlantic Coast's Rocky Shore

In opposition to the shallow salt marsh, the vast majority of the Halifax Harbour coastline consists of the steep, rocky shore that represents a large part of the Atlantic shore composition (Thurston 2011, 18). Whereas the salt marsh experiences the tides as a graded delineation into two zones the rocky shore has “a clearly visible vertical zonation of organisms” (Thurston 2011, 19). Although divided by the high-water mark, the intertidal rocky shore is sub-divided into five recognizable zones in which each provide specific habitat for plant and animal. At the extreme high water/splash zone one can find lichens, below this zone at the high tide/black zone blue green algae and rough periwinkles. Then, in descending order from the high-water mark: the barnacle zone, the brown algae zone and finally the low intertidal zone home to red algae (Thurston 2011, 19).



Axonometric diagram of an example of the coastal condition where intertidal zone habitat presently occurs in Bedford Bay.

Tracing the Human Impact on Bedford Bay's Ecology

Despite the inherent productivity offered by the estuarine mixing that occurs in Bedford Bay the human presence in this ecosystem has modified its basic functions causing a loss in biodiversity (Mann 2000, 13). In B.D. Thompson's paper, "Halifax Harbour - Fisheries Act Implications," it is explained that considerable fish habitat loss has occurred in the Bedford Basin since the town's founding in 1749 (Thompson 2000, 77). He states that "these losses generally have anthropogenic causes, such as dredging, in-filling, the discharge of wastewater and contaminated surface runoff" (Thompson 2000, 77).

Until the 1950's and 1960's there was a popular recreational fishery in Bedford that targeted Atlantic Salmon, pollock, smelt, gaspereau, sea trout, shark and mackerel. Due to lost habitat, reduction in fish populations and a reduction in water access this practice has since declined (Thompson 2000, 77). Direct evidence of the decline in fish populations in Bedford is recorded by the decrease of salmon trapping at the mouth of the Sackville River which in 1959 dropped from 500 to 600 each year to only 130. The following year only six breeding salmon returned to the river (Tolson 1979, 191).

Ken Mann's paper, "The Living Estuary," explains that "when an area of shoreline is in-filled for development, the highly productive shallow areas are smothered and only limited productivity occurs" (Mann 2000, 12). Extensive residential development and dredging of the ocean floor also contributes to the degradation of aquatic habitat in Bedford. Additionally, land disturbance resulting from development has contributed to the degradation or loss of freshwater lakes, streams and brooks, as seen in the case of Mill River which is currently dammed and cut off from the bay by the causeway.

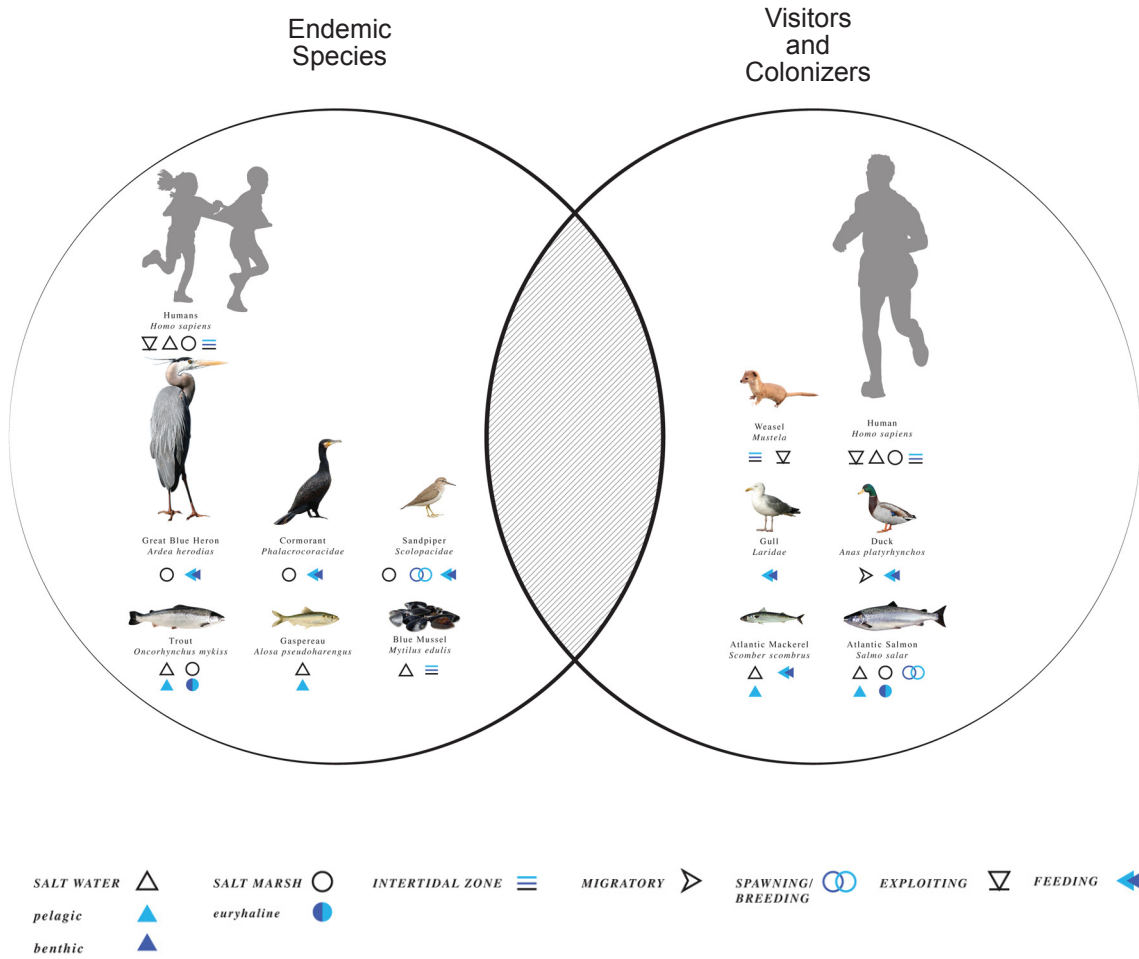


Diagram representing the intended integration of native and non-native fauna that occur in Bedford Bay.

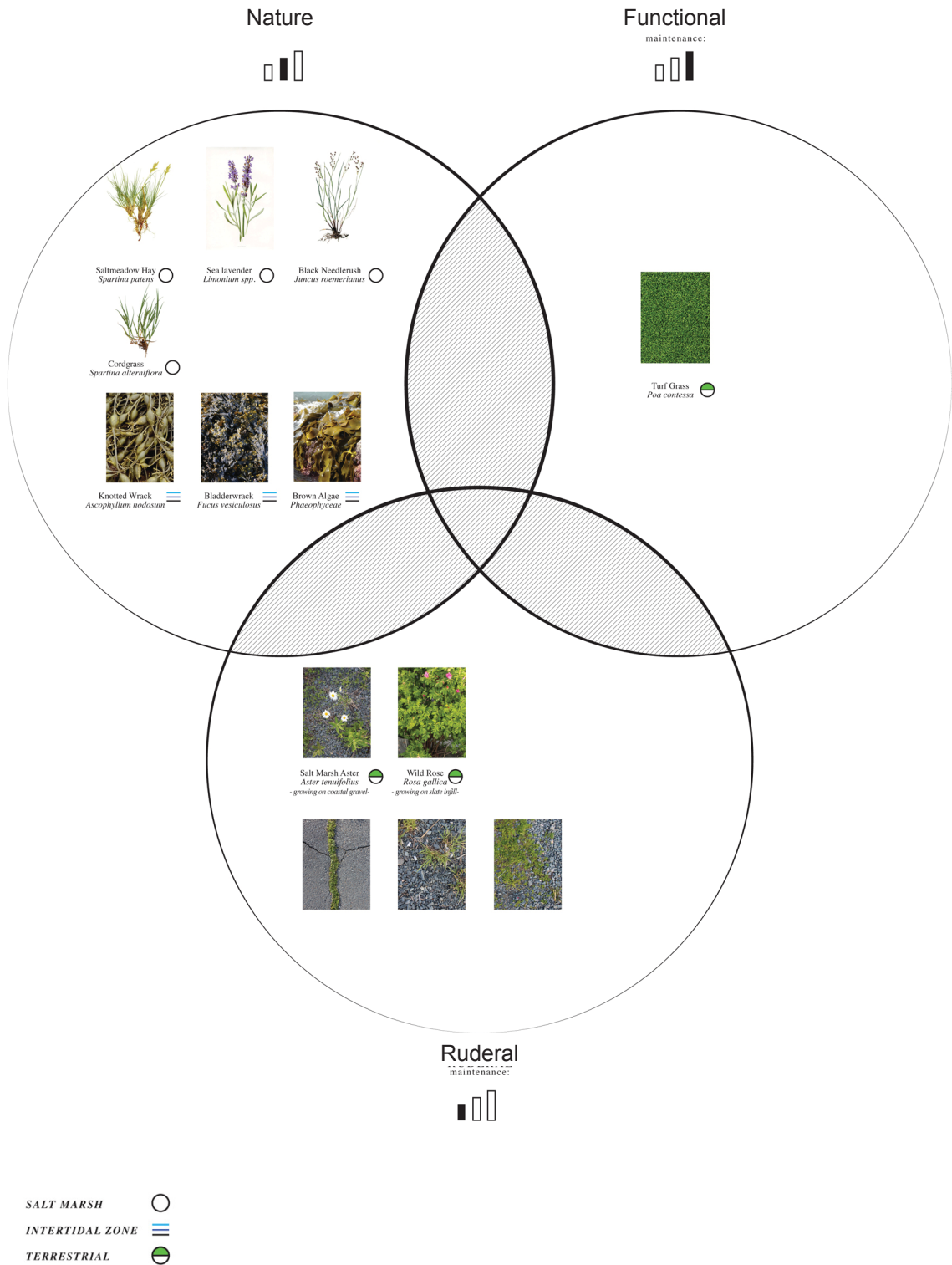


Diagram representing the intended integration of native and non-native flora that occur in Bedford Bay.

Major Theoretical Writings

Defining an Urban Ecology

The investigation of the intersection of ecology and architecture has been ongoing since the 1970s when Ian McHarg laid the foundation for this research in his seminal work, *Design with Nature*. McHarg, a landscape architect and academic, presents a design approach that responds to an attitude of development of the time he describes as “dominate and destroy” (McHarg 1969, 8). He counters this attitude by drawing on an ecological sensibility that considers the human and natural worlds as a necessarily integrated entity, that is home to dynamic relationships at various scales that must be acknowledged (McHarg 1969, 8). It was a pioneering work for ecological planning and architecture and proposed that this planning should consider conditions of setting and environment carefully and not disregard them.

In *The Organic Machine*, Richard White’s history of the relationship between man and nature on the Columbia River, this discussion of the intersection of the human and natural worlds is continued. He explains this relationship as oft misrepresented. When discussing the state of the Columbia River, White explains that there are claims that the river has been killed or raped by extensive human intervention but asserts that neither are true. “Nature still exists on the Columbia. It is not dead, only altered by our labour” (White 1995, 59). Where the human-nature relationship is often described as the effect of humans on nature he argues that this is a reciprocal and mutually experienced relationship. White does not defame or celebrate human intervention with natural systems but instead explains the Columbia in the context of an organic machine, “as an energy system which, although modified by human intervention, maintains its natural, its ‘unmade’ qualities” (White 1995, ix).

The idea of a hybridized urban ecology thus emerges where nature and city are no longer considered as different and in opposition. Indeed, James Corner states in his essay, *Terra Fluxus*, that “landscape actually drives the process of city formation” (Corner 2006, 24). Building upon McHarg’s consideration of ecology, additional research reinforces how all life on the planet, both human and non-human, is profoundly engaged in dynamic relationships. (Corner 2006, 24). Nina-Marie Lister explains that “[i]f our collective analy-

ses of site and context shift beyond the ground plane and embrace the social-cultural and political-economic dynamics of landscape, new typologies of infrastructure necessarily emerge” (Lister 2010, 538). This idea of the urban landscape is thus engaged in “designing relationships between dynamic environmental processes and urban form,” while carefully considering the human-induced social, political and economic conditions specific to site (Corner 2006, 24). As observed by Richard White, “nature...is salmon swimming, the river flowing, and I would add, humans fishing” (White 1995, 59).

The User’s Role in a New Ecology

Marked urban growth in 1970s and 1980s resulted in a change in the user interface with Bedford Bay. The coastline became highly privatized, and dredging and in-fill initiatives influenced the natural operant ecological systems in Bedford (Roze 2000, 166). Today, recreation contingent on the bay is almost entirely non-existent save for the recreational boating that still exists. With the great urban growth that occurred in the ‘70s and ‘80s was coupled an environmental degradation of the basin’s waters (Tolson 1979, 66). Expansive residential development radiated from around the bay and the environment felt these effects in the form of construction run-off and increased septic and sewage loads. This degradation was compounded by the reduced public access to the waters of the bay. The resultant reduction in user devotion to the site contributed to a collective apathy toward the stewardship of this recreational resource, which for sometime allowed continuing human-induced ruin of the once uninfluenced ecosystem.

The human is thus conceived as inherently related and part of any urban nature and not as a separate component within the system. In Martha Schwartz’s essay, *Ecological Urbanism and Landscape*, she asserts “[that] if we are to deliver a sustainable built environment, we must create places that people will value and to which they can connect emotionally” (Schwartz 2010, 525). As a direct result of the reduced public access to the water, and in turn a reduced visibility of the degradation of the natural environment it is argued that the emotional connection Schwartz describes as being integral in fostering a user devotion was lost. In his article, “Ecosystem Health and ecological engineering” ecologist Robert Costanza explains that truly sustainable ecosystems must “integrate human society with its natural environment for the benefit of both” (Costanza 2012, 24-9). Therefore, it is argued that any strategy for designing, or re-designing, a healthy urban ecosystem will be

explicitly linked to the human user of that system. This approach promotes user devotion because of the visible benefits to the human user and in-turn ensures additional sustainability because of the inherent stewardship produced by this relationship.

Establishing User Devotion

Public space in the city must surely be more than mere token compensation or vessels for this generic activity called 'recreation.' Public spaces are firstly the containers for collective memory and desire, and secondly they are places for geographic and social imagination to extend new relationships and sets of possibility. (Corner 2006, 32)

Public access to the Bedford Bay along the coastline of Bedford is minimal, and the existing public infrastructure along this coast manifests as a homogenous, raised boardwalk in a small section of the South West edge at DeWolf Park. With the current condition of access and the legacy of reduced ecological productivity, present user devotion, as previously asserted, is low. If Martha Schwartz's statement that "[w]ithout human connection to a site or a city, even [the] best efforts at creating sustainable environments will not succeed" is used to guide this design than it is also decidedly necessary to engineer a strategy for increasing user devotion as an additional guarantee that the proposed design is evaluated as sustainable (Schwartz 2010, 525).

The heritage of a rich and active public engagement with the water in Bedford informs the proposal for new public waterfront infrastructure that will act as a vessel to strengthen user devotion to the coastal ecosystem. Additionally, the long tradition of Bedford as a recreational destination instructs the program of the proposed architectural interventions. Program that fosters a human connection to the environment is at the root of this project and is developed around the importance of the intersection of Bedford's urban environment and the natural ecosystems present in the bay. Architecture designed therefore addresses, and equally considers these two realities. This intersection is examined to determine where design interventions should occur and to what magnitude. Areas of present public water access are thus mapped against areas where existing operant ecologies converge .

Design Strategy

Tendencies and Capacities of Bedford Bay: Designing for Multiple Futures

The dynamic systems of Bedford Bay, both human and natural have been observed and described. To this point these systems have been presented in their historical and present day contexts only, however, an element that is paramount in an integrated and sensitive proposal for a networked ecology is also the third measure of time, that of the unknown - of the future. In James Corner's essay, *Terra Fluxus*, this is clearly stated when he argues that " [the] complexity of interaction between elements within ecological systems is such that linear, mechanistic models prove to be markedly inadequate to describe them" (Corner 2006, 29). Indeed, the nature of ecological systems is that of many dynamic relationships, at various scales that produce incremental and cumulative effects "that continually evolve the shape of an environment over time"(Corner 2006, 30).

Therefore, in addition to understanding the relationships between the operant ecologies of Bedford Bay and the built environment and it's human occupants at any one point in time, to propose a design strategy that truly engages these different factors one must consider a built-in latency. For this thesis project, the design proposal thus exists as a plan for phasing that engages in this provisional operation, where the design evolves with the landscape rather than existing separately from those spatially and temporally unique qualities of the natural world. This provides a necessary resiliency to the design proposal in the form of the capacity for adaptation and evolution.

One of the characteristics of systems that are trying to work with natural processes is the idea of their development over time, and the formal outcomes of the projects that rely on these process are difficult to predict...(Mossop 2010, 171)

Nina-Marie Lister describes this reality of evolving and changing natures over time as normal, albeit difficult to predict and thus to control (Lister 2010, 537-542). Where the properties of a system can be easily established, tendencies and capacities prove more challenging to define (Koltick 2013). Where ecological systems were once characterized as closed and self-regulating Robert E.Cook explains in his essay, "Do Landscapes Learn? 'New Paradigm' and Design in Landscape Architecture," that a new paradigm has emerged in the field of ecology where the natural world is understood as " a setting of dynamic change and uncertainty."

This challenge is met with designing an urban ecosystem that considers, and incorporates, a certain level of resiliency. In the practice of ecology resiliency is described as the “ability of a system to maintain its structure and pattern of behavior in the presence of external stress” (Costanza 2012, 24-29). Because of the inherent difficulty in predicting how a system will behave in the presence of these stressors resiliency manifests most successfully as a multi-layered approach through the application of a range of behaviours and performances embedded in the landscape that are adaptable to change and stress in the form of weather events, manifestations of climate change, and the human factors linked to the environment (Koltick 2013).

A Systems Approach to Site Selection

If our collective analyses of site and context shift beyond the ground plane and embrace the social-cultural and political-economic dynamics of landscape, new typologies of infrastructure necessarily emerge. Indeed, contemporary urbanism requires a multi-focal perspective, one that encompasses the notions of form, function, field, and flows across and between the dynamic layers. (Lister 2010, 538)

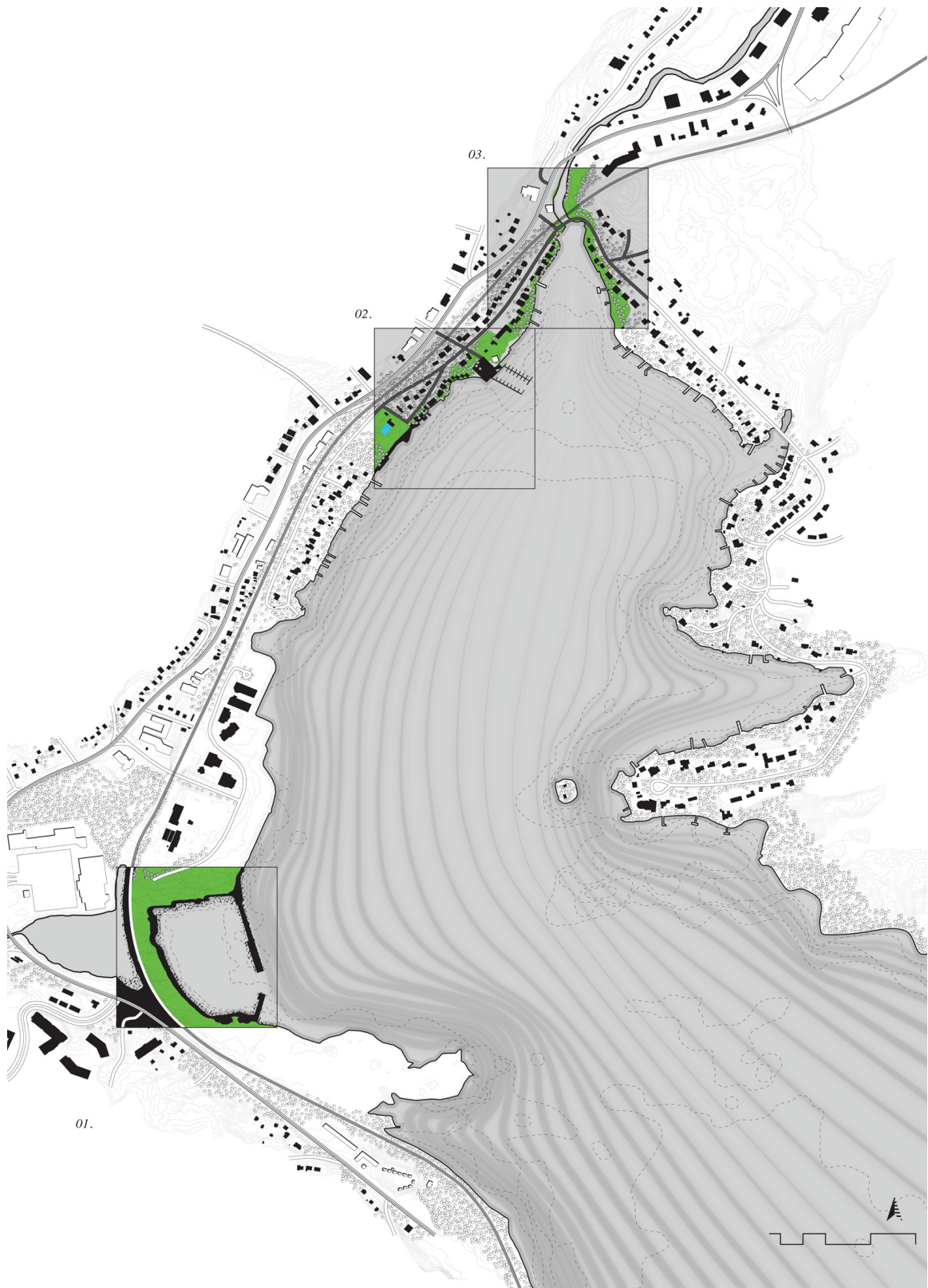
It has been established that this project addresses the ideas of designing user devotion and incorporating the necessary consideration of time whilst designing for ecosystem health. These principal guiding concepts are unified by the primary design approach of an active architectural engagement with the operant ecologies of Bedford Bay. This design proposal argues that although opposing conditions are intrinsic in the relationship between urbanism and ecology, the relationship between city and ecosystem can be re-framed by applying variations of public architectural designs that respond to, adapt with, divert and magnify the underlying natural systems that exist in and around Bedford Bay.

This approach can be best described by drawing from Nicole Koltick’s description of homeostasis as it relates to architecture, and in this case an ecologically integrated design for Bedford Bay. In Koltick’s presentation, “Tomorrow’s Ecologies: A Synthetic Approach”, at the *ACSA Annual Meeting* in March, 2013 she explains homeostasis as “an ideal state that is the opposite of stasis. It is in constant flux but in very subtle and nuanced ways and tied to the feedback received and given from parts of the system or sub-systems to other parts as well as integrating external information” (Koltick 2013). Borrowed from the operation used to describe the natural state of cellular regulation, homeostasis is valuable in conceptualizing the desired condition this thesis project will achieve. It is argued that the

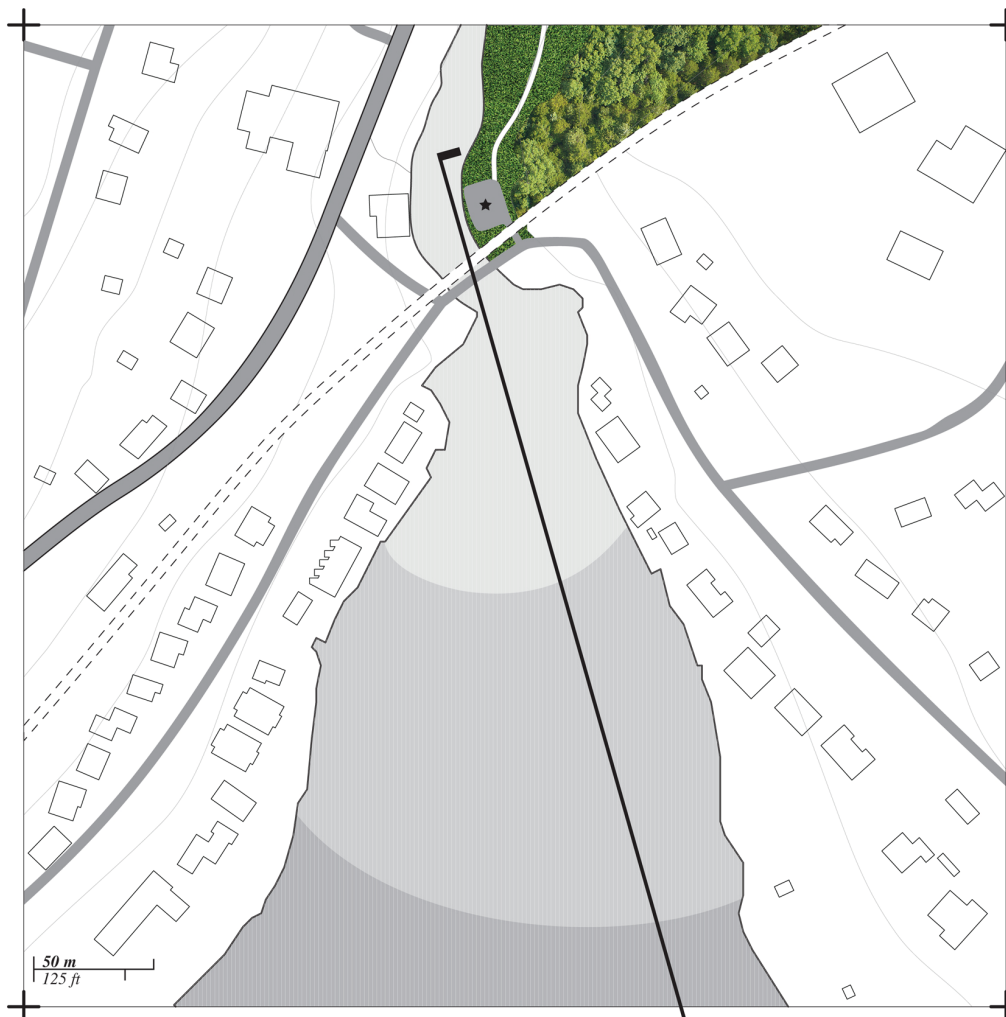
coastal condition of the Bedford Bay today is in the opposite of this state- a closed system that is fixed both spatially and temporally. The architecture presented in this proposal addresses this condition by way of a design that acts as a scaffold for habitat formation and links the urban condition around Bedford Bay to the natural operant ecologies that exist on its edge to act as mediator of a new 'homeostasis' for the bay.

This 'homeostasis' is achieved by first systematically selecting sites along the coastline of Bedford Bay primed for intervention where there is both a measurable ecological presence and often underperforming public space. As particular architectural responses for intervention are developed for these localized sites guiding principles of the design response to each site are followed. These include re-establishing a devotion by various user groups through acknowledging existing natural operations and the application of a phasing strategy that produces incremental and cumulative effects over time. These sites act as point locations for the application of a regional design strategy but are also unique in that they are designed as a response to localized environmental conditions.

These sites are: 1) The Mill River estuary and its neighbouring DeWolf Park, which is built primarily on coastal in-fill, 2) Lion's Park, the site of the only public beach along Bedford Bay and 3) Fish Hatchery Park at the North end of Bedford Bay, which sits on the banks of the largest fresh water tributary to the bay, the Sackville River.



Map of Bedford Bay highlighting location of three test sites where public water frontage and observable ecological operations intersect: 1) Mill River and DeWolf Park. 2) Lion's Park and 3) Fish Hatchery Park (composite image created with data from HRM Geodatabase 2012, HRM 2015, and Google Maps 2015)



03

--- railroad

◆ streets

★ parking lot

Fish Hatchery Park is so named for the Dominion Fish Hatchery that operated on its location for nearly 100 years. It is located at the mouth of the Sackville River, the primary tributary of the Bedford Basin and Halifax Harbour. Once the location of a thriving spawning fish population, today these numbers have greatly declined due to development, and extensive dredging of both the bay floor and the riverbed.



Sackville River



Fish Hatchery Park

Test site 3, Fish Hatchery Park (composite image created with data from HRM Geodatabase 2012, HRM 2015, and Google Maps 2015)



- ◆ private beach
- ◆ public beach

Lion's Park is a small park built on the Bedford shore in the 1950's. At one time it was an active beach and swimming destination for many people. Today it is one of the few locations along the coast with public beach access, although no one is swimming there.

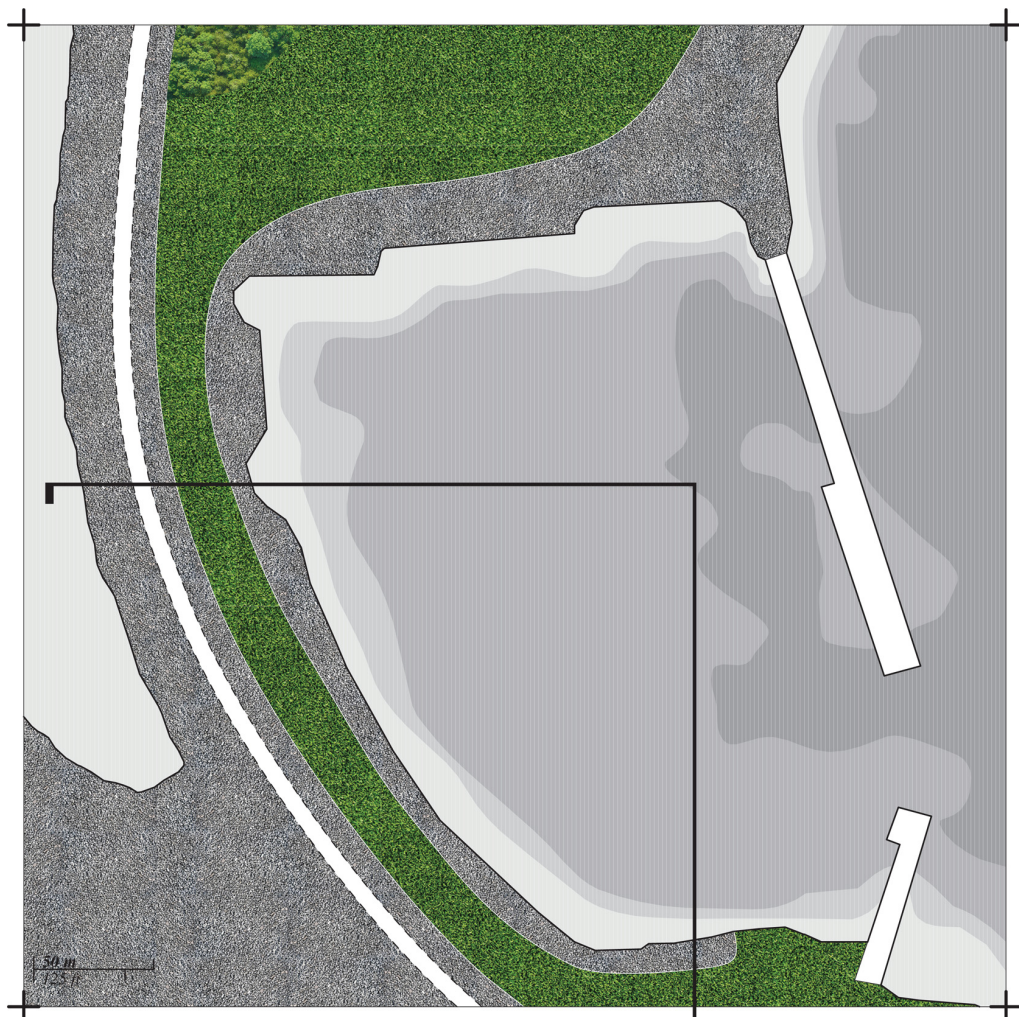


Lion's Pool



Lion's Park

Test site 2, Lion's Park (composite image created with data from HRM Geodatabase 2012, HRM 2015, and Google Maps 2015)



01

||| railroad



causeway

DeWolf Park is the largest area of public coastal frontage in Bedford. It sits on nearly entirely infilled land between the bay and the railroad. The park extends at its southern point along a causeway, originally built for the railroad, that cuts off the Mill River estuary from the rest of Bedford Bay.



causeway railbed

Test site 1, DeWolf Park (composite image created with data from HRM Geodatabase 2012, HRM 2015, and Google Maps 2015)

CHAPTER 2: DESIGN

Evidence of Intervention: Tracing Human Impact by Design

As previously stated, the environment of Bedford Bay has been changed by the human occupation of land and sea. The impact of these operations, both natural and man-made, becomes evident when examined through mapping. The topography of the site reflects the flow of fresh water tributaries that scar their path into the land and flattened, low-lying areas suggest once present, now absent flood plains. By comparing the ecological operations that are unique to this region and mapping them against existing urban form further analysis of the diversity of flows is offered: the intersection of the flow of water, the flow of land and the flow of people. While nature's flows are reflected in topography and the coastal edge as a result of riverbed erosion, ocean currents and tidal flow, the impact of man on this site is not always as easily traced. Aided by historical maps and photographs a comprehensive understanding of the human effect on the morphology of Bedford's landscape is established. As previously presented, this manifests primarily in the form of different coastal in-fill operations and extensive dredging of the bay floor (Rozee 2000).

This understanding of the flow of water, land and then people (in the form of traceable intervention) informs the proposed re-calibration of landscape in this project. This design strategy is described as re-calibration because the proposed intervention will employ additive and subtractive landscape strategies at the coastal edge of the present landscape that will activate it in a way in which engagement with these existing operant ecologies is achieved. Boundaries of this landscape design are established by topography, the high water mark (50 year storm), and the flow of fresh and salt water in and out of the bay as well as existing transportation infrastructure and the surrounding built environment. Subtraction of existing infill serves to uncover flood plain and open an unacknowledged estuary to the sea and the relocation of this fill functions to strategically divert ocean currents. While historic anthropogenic interventions were indiscriminate and did not consider the natural flows of this area those proposed in this project are directly influenced by them.

Although boundaries of subtraction and addition are directly linked to the existing natural flows of the system the proposed landscape intervention is designed to be uniquely recognizable as man-made. Underlying topographic and hydrologic mapping and existing

infrastructure is averaged into formal geometries in order for the public to easily trace the presence of human intervention. By differentiating between unaltered natural landscape and intentionally augmented landscape visitors to the site are able to witness how human intervention effects the operant ecologies of the bay. This strategy is necessary in establishing the desired user devotion. Program that fosters a human connection to the environment is at the core of this project and is developed around the importance of the intersection of Bedford's urban environment and the natural ecosystems present in its bay. To strengthen the emotional connection of the user to the environment, that Martha Schwartz defines as necessary, the user bears witness to the natural operations of this environment by way of public architecture that acts as an interface with these operant ecologies.

A Scaffold for Succession: Design in Three Phases

The future composition of any ecosystem is indeterminate because of the dynamic, evolving quality of the natural world. In establishing design parameters for a new urban ecosystem in Bedford Bay a phasing strategy is thus employed to address this added consideration of time. Although impossible to predict the exact result of initial land-shaping moves, understanding the tendencies and capacities of the operant ecologies found in Bedford Bay provides a framework to guide these initial moves so that new landscape engages these systems by design. In opposition to historic coastal in-fill activity, in-fill in this project is organized to respond to and engage with these existing environmental processes. For each phase, schematic designs are proposed for the bay system as a whole and the Mill River estuary is studied in detail.

Coastal Building Strategies Reinterpreted: Pile Fields and In-fill

The built-environment on the coast of Bedford Bay today is primarily relegated to private homes and mid-rise residential towers built on coastal in-fill. As previously presented, there are also three landscaped park spaces which provide the only present public water access. Historically, the coast-scape of Bedford Bay included large piers built at various locations along its length where ship-builders would launch their commercial vessels and visitors from Halifax and beyond would dock their row boats and canoes. Today, only small docks persist to provide home owners with private water access. In addition to this

built heritage, human occupation of this coastal edge is also traced by the extensive and on-going in-fill which has altered the coastal morphology and continues to do so.

These two observable building strategies for bridging land and sea in Bedford Bay, the former which has a historical presence and has left minimal relics of its application, and the latter which is a continuing practice and has changed the flow of land forever, are reimagined in a large-scale implementation in Bedford Bay. Pile construction and rock in-fill are employed together in the redesign of the present landscape to modify the coastal edge and act as a scaffold for the incremental succession of new habitat through an active engagement with existing ecosystems. As previously outlined, additive and subtractive land-forming is devised of as a way to redesign the coastal edge in order to provide the groundwork for new, public architecture that engages the natural systems of the bay. This re-calibration magnifies and diverts the environment of this landscape and its integrated architecture reimagines historic and existing building techniques to achieve this.

The first phase acts to re-calibrate the existing coast-scape by excavating and relocating coastal in-fill to divert current and establishing marine pile fields designed to encourage sedimentation. The additive and subtractive processes of in-fill and dredging that have been implemented in Bedford Bay for generations are reinterpreted here so they establish a scaffold for new habitat formation driven by the ecological operations present in the bay.

New buildings are introduced in the second phase and serve to further reinforce the emergence of a hybrid ecosystem and provide an interface for the public to experience it. Public program is designed for visitors to engage with this emerging hybrid environment and supports skating, swimming, kayaking, fishing and educational initiatives.

Phase three presents a possible future for Bedford Bay, where interventions in phase one and phase two have contributed to the emergence of a new coast-scape and the maturation of new salt marsh environment which fosters a high level of bio-diversity and recreational potential for visitors to the site.

Phase 1: Landscape Re-Calibration

The initial interventions in and around the bay are the most intrusive. Although these moves may be perceived as severe they are necessary in the initial recalibration of the bay system. Additive and subtractive landscape strategies are applied that are designed to respond to the flow of water in the bay by diverting and magnifying ocean currents. These interventions are centralized at the zones previously identified where nested ecosystems and undervalued public water-frontage intersect. These initial zones of intervention act as point locations that will produce ripple effects that are felt throughout the entire bay system.



Map of Phase 1-A, the Mill River estuary and DeWolf Park as it is today (composite image created with data from HRM Geodatabase 2012 and Google Maps 2015)

First, at the Mill River estuary, the causeway is excavated and the estuary is reconnected to Bedford Bay. Existing parking lot is cut away to reveal the once present flood plain at the mouth of Mill River and the excavated in-fill is relocated and built-up along the southern edge of Dewolf Park. Additional in-fill is deposited at the north end of DeWolf Park and built in to a breakwater. At the mouth of the newly revealed Mill River a field of piles is established designed to encourage sediment build-up for the eventual development of new salt marsh environment.

The redesign of the coastline at this site diverts current strategically to encourage the development of beach frontage at the northern end of Dewolf Park and to shelter the newly



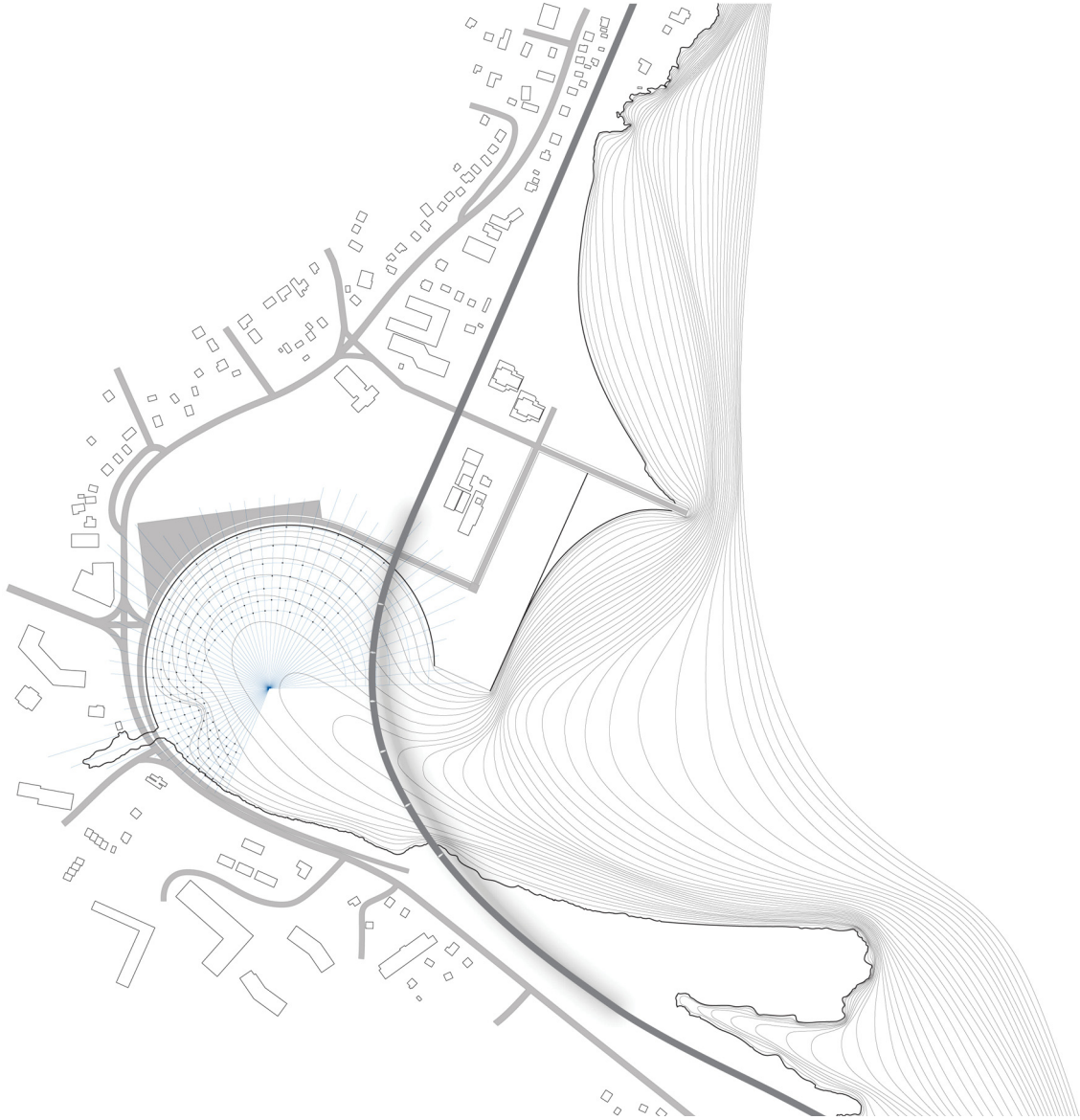
Map of Phase 1-B, where the causeway is removed and replaced with a bridge for the railroad and the previous flood plain is revealed by excavating the existing parking lot (composite image created with data from HRM Geodatabase 2012 and Google Maps 2015)

revealed Mill Cove estuary from storm events. Over time, this recalibration of the coastline will help in the development of new coastal environment. By acknowledging these existing operations within the bay coastal building strategies can be employed to respond to and engage with them.

At the bay scale, landscape interventions applied at Mill Cove are adapted for the Sackville River estuary where a pile field is again established. Here, sedimentation will also occur over time providing new salt marsh habitat by replacing areas of dredged ocean floor.



Map of Phase 1-C, where excavated coastal in-fill is relocated and the southern tip of DeWolf Park built up (composite image created with data from HRM Geodatabase 2012 and Google Maps 2015)



Map of Phase 1-D, where a pile field is established at the mouth of Mill River (composite image created with data from HRM Geodatabase 2012 and Google Maps 2015)

Phase 2: Buildings as Landscape Interface

After the initial landscape interventions have been executed and the seed for a new urban ecosystem in Bedford Bay established new public buildings are introduced. These buildings act to further acknowledge the ecology of Bedford Bay and serve to reconnect the public to the water by behaving as an interface for people to experience this new urban ecosystem. Program is determined by past recreational activities in and around the bay as well as being informed by new opportunities created by the emerging coastal habitat.

First, a tidal pool is excavated in the southern section of the newly built-up DeWolf Park. This pool acts as a public destination at the site where visitors engage with the new urban habitat in different ways and around which new buildings are organized. In the summer months, this tidal pool is a space for education where the public can experience the flora and fauna found at this site in a focused location, guided by interpreters employed there. In the winter months the sheltered tidal pool freezes and provides a surface for skating. Program that supports these activities is housed in a pavilion at the north end of the tidal pool which contains an interpretive centre, a small cafe, public washrooms and skate rental.

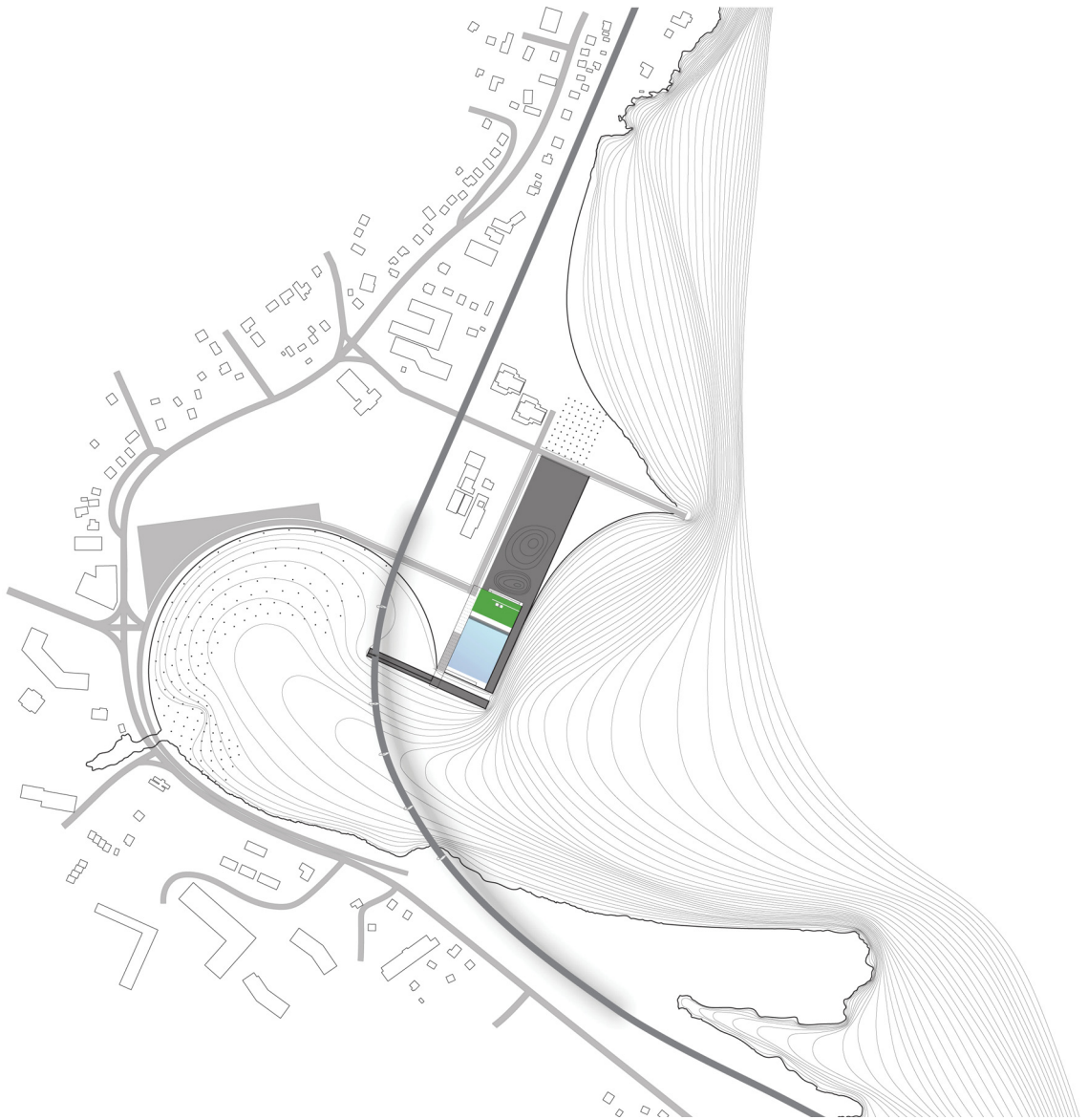


Map of Phase 2-A, where a tidal pool is excavated in the newly built-up fill in DeWolf Park (composite image created with data from HRM Geodatabase 2012 and Google Maps 2015)

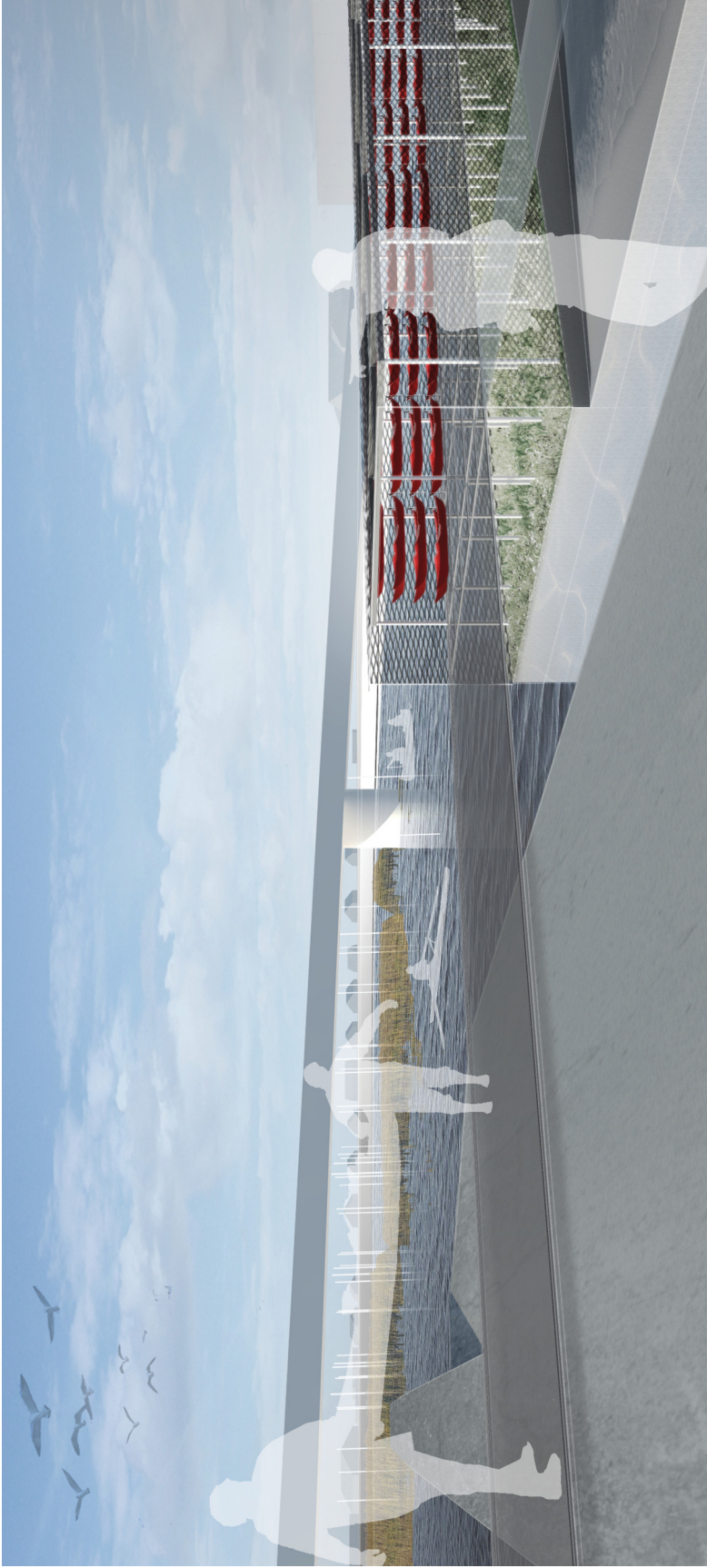


Rendered perspective showing public skating on the tidal pool in the winter with the North Pavilion in the background.

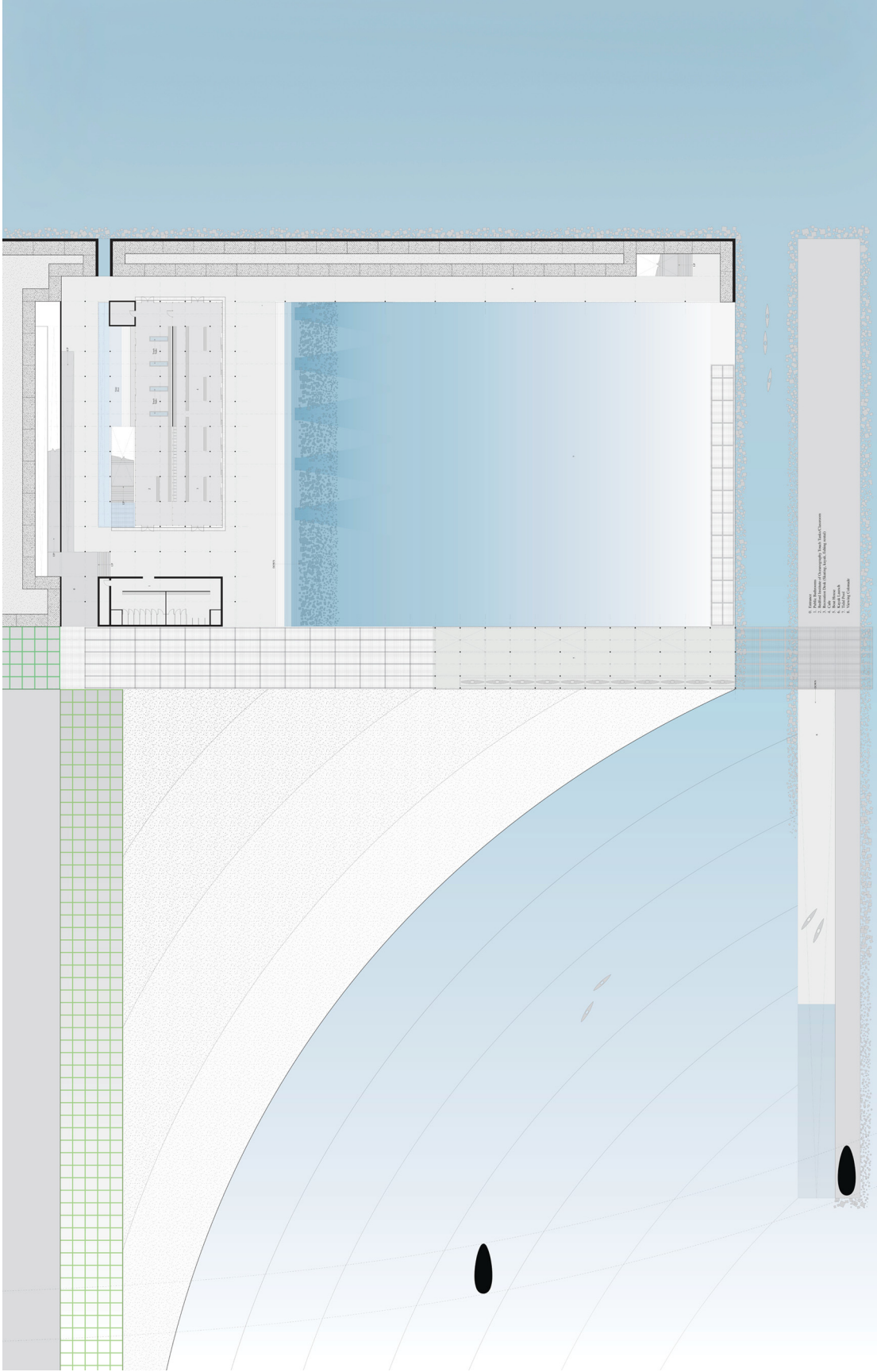
Additionally, as salt marsh habitat begins to form amongst the adjacent pile field visitors are able to rent kayaks and canoes to explore the emerging habitat. A boat house at the south end of the tidal pool serves as kayak storage and as the rental point for visitors.



Map of Phase 2-B, where buildings are introduced at either end of the tidal pool to house supplementary program, such as kayak rental, skate rental and an interpretive centre (composite image created with data from HRM Geodatabase 2012 and Google Maps 2015)

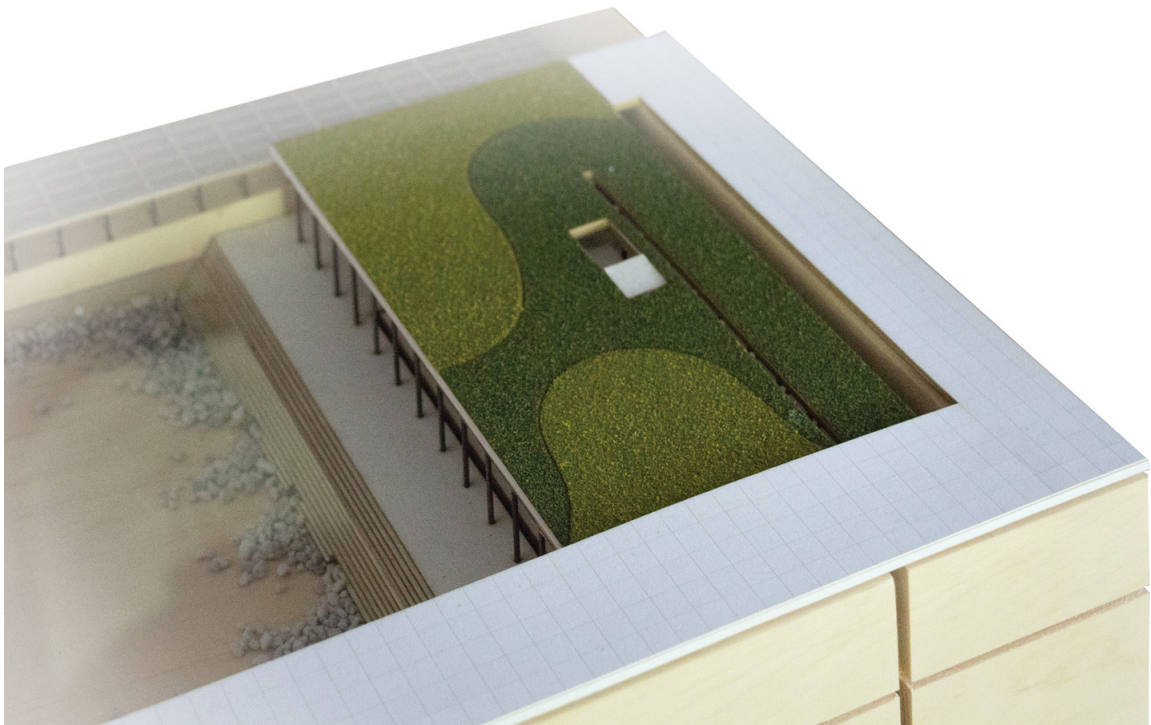


Rendered perspective showing visitors launching a kayak from the South Pavilion, with the developing salt marsh in the background.

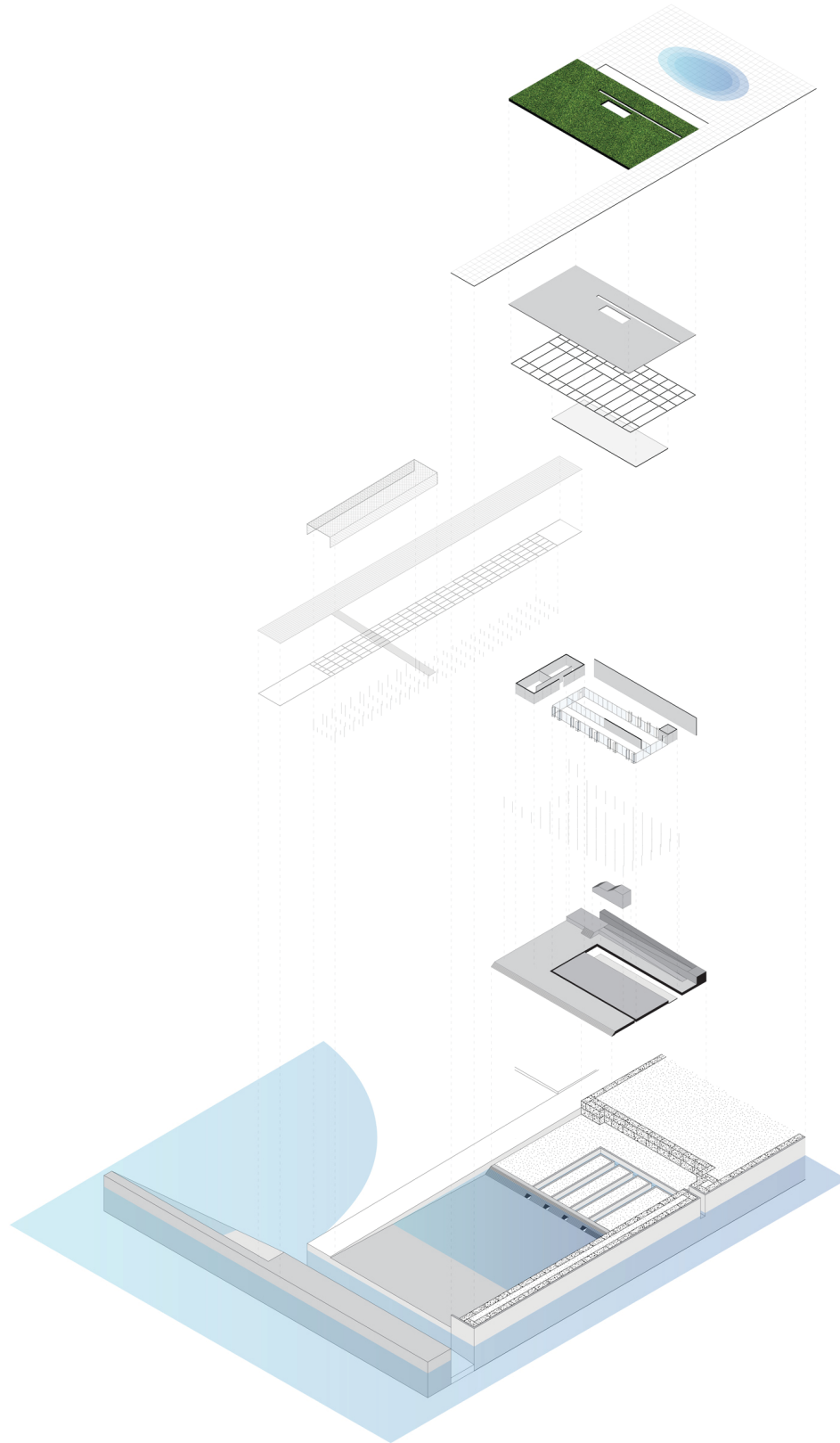


Plan of proposed tidal pool and the two pavilions established around it.

Material and form of the proposed pavilions is inspired by local coastal building strategies that have already been reinterpreted in the design phase 1, with the strategic relocation of coastal in-fill and the application of piles as a tool to increase sedimentation. As previously discussed, formal geometries are employed at the landscape scale as a means to make evident the human intervention in the landscape. At the building scale this is achieved by integrating coastal in-fill in the construction of the pavilions by using gabions filled with excavated rock. Additionally, to further connect building and landscape, columns in the north and south pavilions are designed to formally reference the adjacent pile field.



Model of the North Pavilion highlighting the use of columns that reference the pile field in the Mill River estuary, the presence of in-fill in the tidal pool and the green roof and paved plaza from which you enter into the building below.



Exploded axonometric of the tidal pool and the North and South Pavilions highlighting how water enters the tidal pool, the in-filled foundation and gabion construction, and the ground level green roof and plaza.



Rendered perspective showing a view of the tidal pool from the North Pavilion.

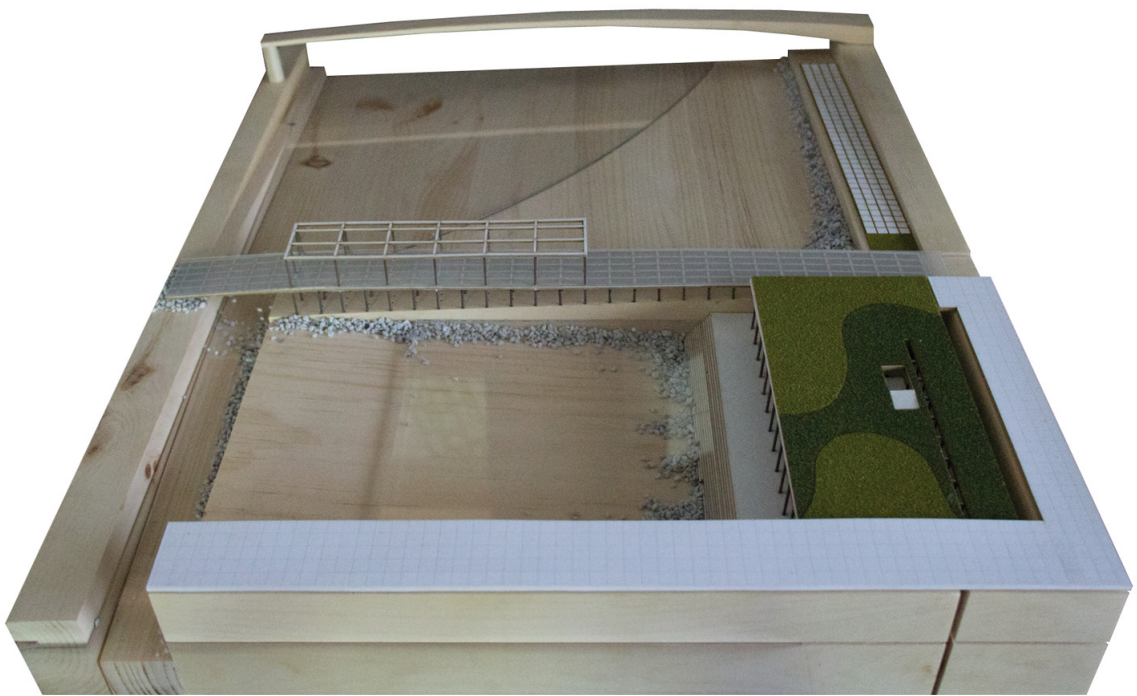
Educating public on the form and consequences of human intervention at this site is integrated in the construction of these pavilions. To further emphasize the immediate site as one that consists primarily of coastal in-fill, the North Pavilion is set into the earth, with visitors entering into the building from above. The North Pavilion has a green roof that is designed to showcase native and non-native species of plant. It connects to a paved plaza which juxtaposes the flora on the roof and wraps around the coastal edge of the tidal pool, providing a different vantage point of the pool below and a vista of the bay system and provisional salt marsh habitat in the Mill River estuary. The green roof is designed to absorb rain water in opposition to the adjacent paved plaza, which is designed with integral depressions where rain water collects. This way, visitors to the site are further educated on how the built environment interacts with natural systems at this location while also being provided with a space for play.

The South Pavilion is located at the end of a catwalk floating above the planted west wall of the tidal pool. It is clad in chain-link fence in reference to fencing existing at the site while also providing security for the boats stored within it.

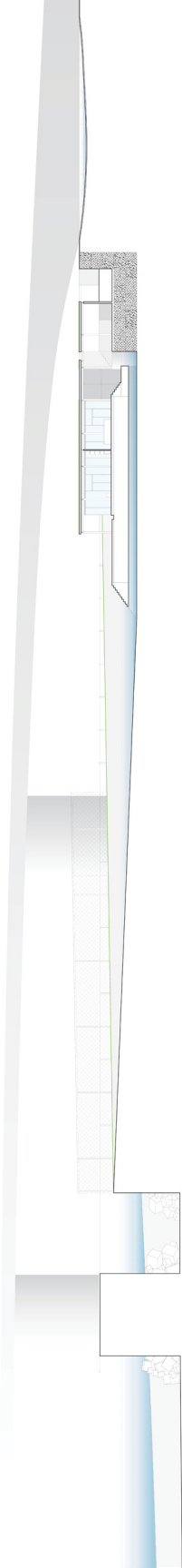


Rendered perspective from the entrance of the North Pavilion which shows the use of gabion construction along the back wall which integrates rock in-fill into the building and steel columns that reference the pile field established in the estuary.

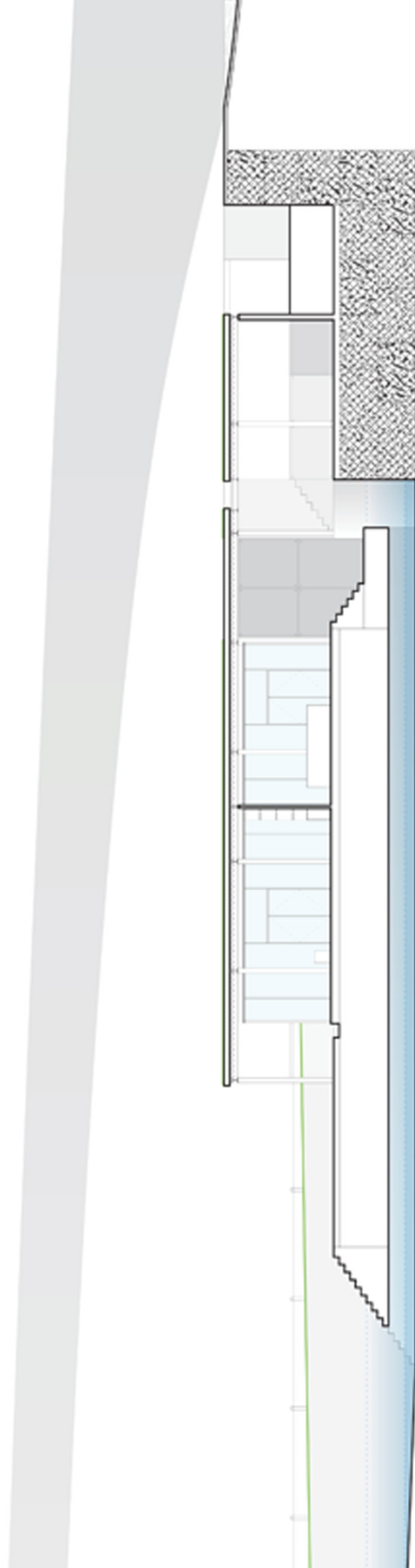
The tidal pool is designed to reference the two main coastal conditions found at this site, salt marsh and intertidal/rocky coast. At its north end stairs lead from the north pavilion's plaza into the deepest end of the pool, referencing the steep sided rocky coast found in much of the bay. This deepest part of the pool gradually inclines towards its south end in reference to the salt marsh condition also present in the bay. These opposing edge conditions provide different ways for the public to engage with the pool and witness the rising and lowering tide. Sea water enters the tidal pool beneath the stairs at the north end through channels in the foundation of the pavilion. Although visible, these channels are not obvious. This is an intentional design strategy that helps emphasize tidal flow within the pool.



Model of the North and South Pavilions and the tidal pool that includes a portion of the MII River estuary and the rail bridge that replaces the existing causeway.



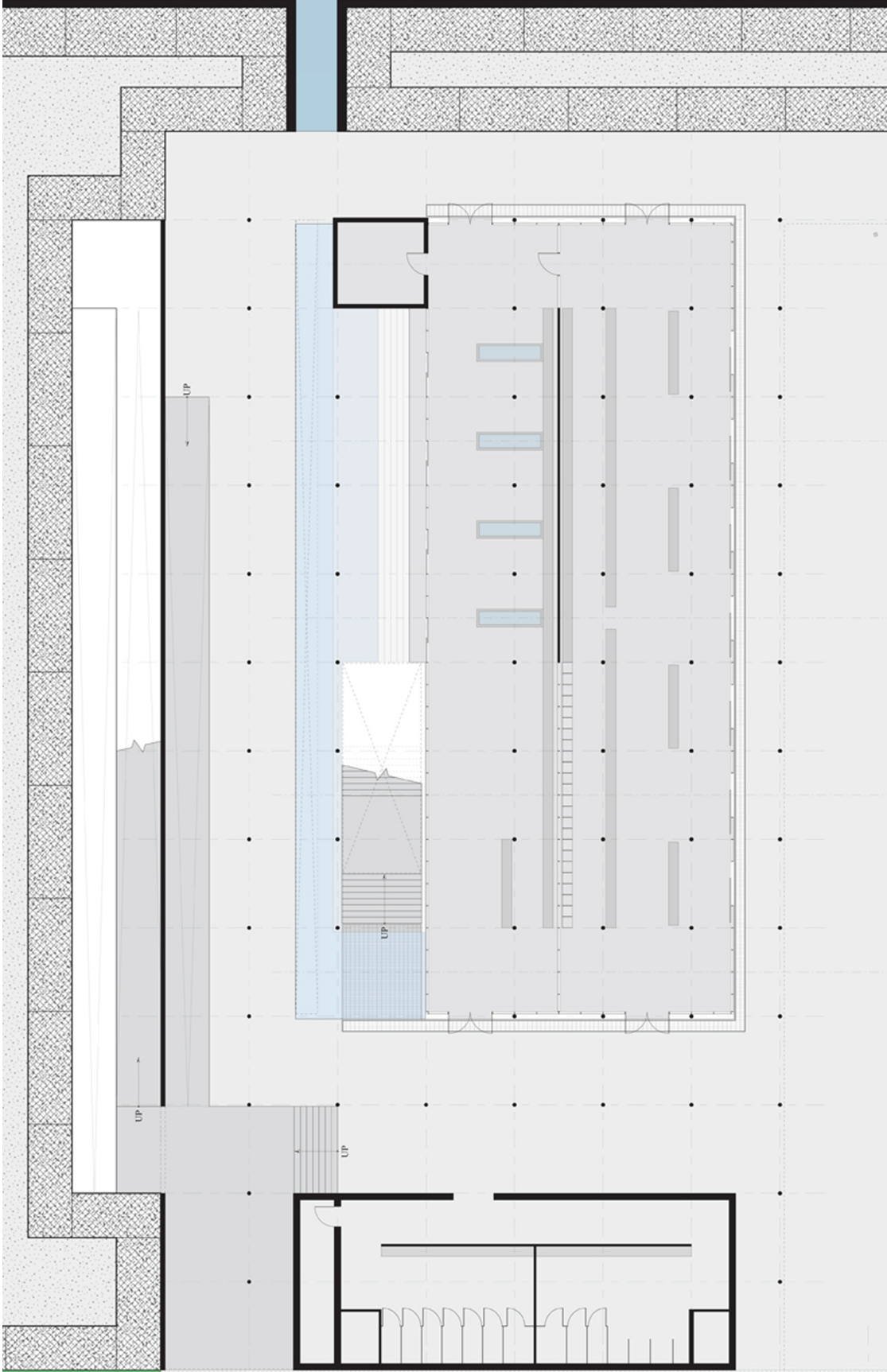
Longitudinal section of the tidal pool and the North and South Pavilions.



Longitudinal section of the North Pavilion.

Program contained within the North Pavilion consists of an interpretive centre and skate rental/cafe surrounded by open circulation. The nested program is enclosed and can be inhabited throughout the year. Circulation around these enclosed spaces is open and provides access to the tidal pool at all times, whether the interpretive center and skate rental/cafe are open or not. Additionally, access to public bathrooms is also provided by the perimeter circulation and these can thus serve the entirety of the site regardless of the hours of operation of the other spaces.

The interpretive centre backs on to a smaller tidal pool contained within the pavilion. This is in fact an opening onto the channel below, delivering water into the larger tidal pool. Here, visitors to the pavilion are able to interact with this environment in smaller, guided groups. The interpretive center also houses touch tanks where visitors have further opportunity to learn about flora and fauna nurtured at this site. Fronting onto the tidal pool is the skate rental and cafe. Here, visitors can observe the tidal pool from one of the built-in benches or spill out onto the plaza in front of the space.



Floor plan of the North Pavilion, which houses program for an interpretive centre and skate rental as well as public washrooms and a cafe.

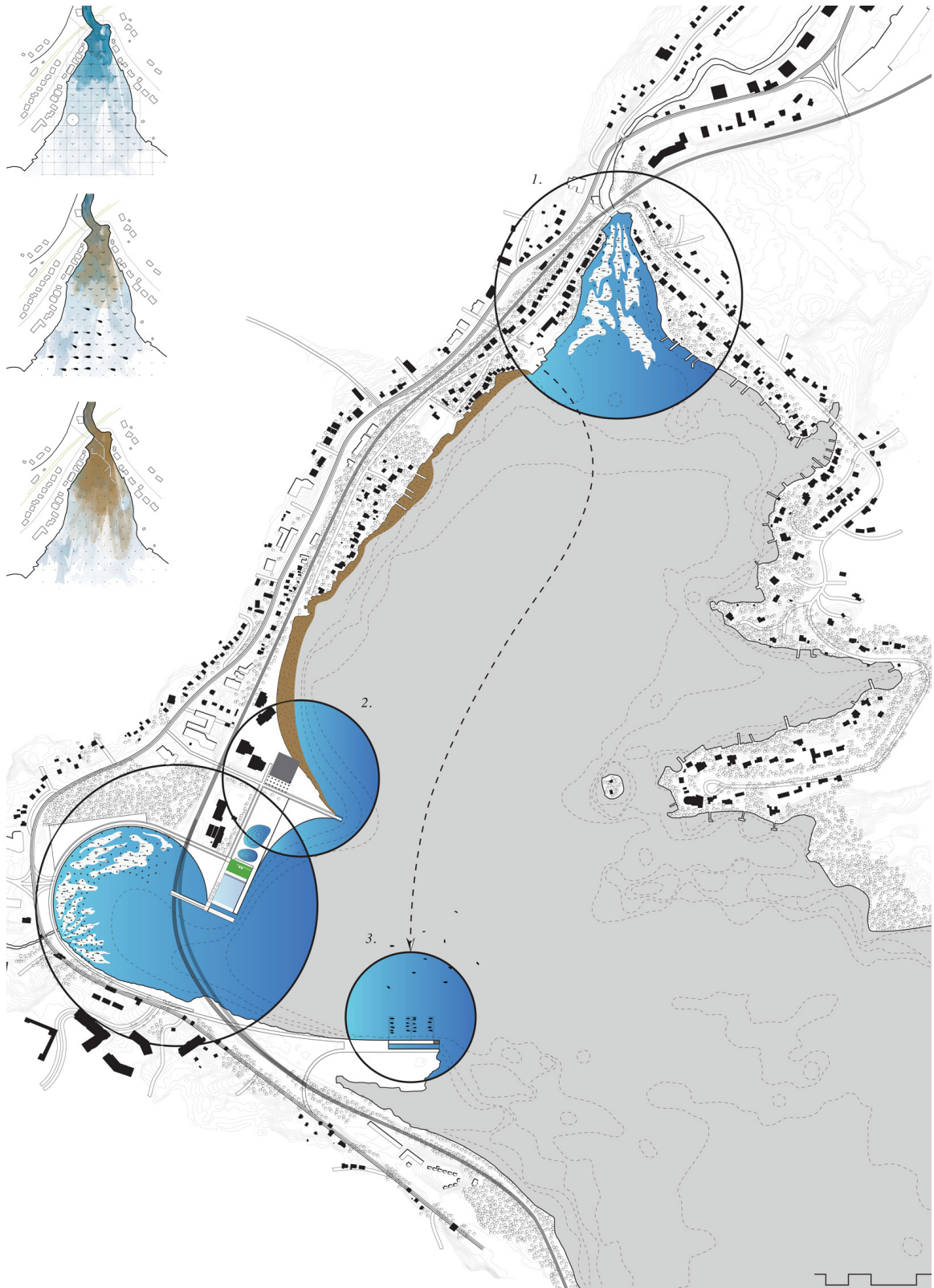
Phase 3: A Possible Future

As the new coast-scape matures and the proposed hybrid ecosystem has established itself the project enters phase three. Here, although the exact morphology of the landscape cannot be precisely predicted, a possible future is presented based on predictions of how the natural and urban ecosystems will intersect and overlap. Notably, conditions for the formation of new salt marsh at the mouths of both the Sackville and Mill Rivers will be optimal and new beach frontage between DeWolf and Lion's Parks will be established.



Map of Phase 3, where the salt marsh habitat has matured and beach frontage North of DeWolf Park has been established (composite image created with data from HRM Geodatabase 2012 and Google Maps 2015)

The maturation of salt marsh habitat at the mouth of the Sackville River means that mooring in front of the Bedford Yacht Club is no longer possible. In phase three the yacht club is relocated to the mouth of the bay where the ocean is sufficiently deep and will not need to be dredged. As coastal environment matures in this proposal, new forms of public engagement are also created, fostering a return to recreation on the bay.



Map of Phase 3 at the scale of the entire bay, showing the establishment of salt marsh environment at the mouths of both major tributaries, the presence of new beach frontage and the relocation of the Bedford Yacht Club (composite image created with data from HRM Geodatabase 2012 , HRM 2015 and Google Maps 2015)

CHAPTER 3: CONCLUSION

How the urban environment relates to the natural world that surrounds it, and exists within it, is the question that guided this thesis. Whereas 'nature' and 'urbanity' are often described as separate and unique, this project reconceived this relationship by defining these systems as interconnected and inextricably linked. Therefore, rather than making a distinction between urban form and ecological operations, the proposed project considers these conditions as part of one dynamic system in the design for a hybrid urban ecology. To further define this approach, built form, landscape and ecology are thought of synonymously as architecture. Natural ecological systems are actively engaged with by the proposed design and included in this proposal for what has been termed a new urban ecology.

In considering architecture as inclusive of landscape and ecology this thesis must also consider project consequences at not only the immediate scale but regionally and into the future. The interconnectedness of any ecosystem means that local interventions can be felt at a regional scale. This can be seen in reference to the proposed beach frontage at the north end of DeWolf Park which is designed to continue to accrue and expand over time. However, in an urban ecosystem, not only ecological effects are considered. Social-cultural and political-economic dynamics of this new landscape also emerge. In addition, when defining this project as an urban ecology it must also be understood that any ecological system is inherently indeterminate. Therefore, the proposed design, although strategically developed to behave in a desired way, is subject to the uncertainty of the natural world. In this case, design parameters help to propose one possible future for Bedford Bay, however it cannot be considered as finite.

Bedford Bay, Nova Scotia was selected as test site for this thesis because of the intersection of underutilized coastal public space and unacknowledged natural systems occurring there. The Mill River estuary and DeWolf Park sites were studied in detail with the design of new architecture in the form of landscape, infrastructure and built form which together act as a scaffold for new habitat formation. At this site, ocean current could be diverted and sedimentation magnified through a recalibration of the coastline achieved by excavation and relocation of coastal in-fill and the establishment of a pile field. These landscape

moves actively acknowledge the existing natural systems of the site, such as the mixing of fresh and salt water and ocean currents, and engage with them. This engagement activates this landscape for the benefit of the public and other members of the existing ecosystem, including plants, animals and marine life. For example, salt marsh formation provides new habitat for fish and birds, increasing biodiversity, and also a new public landscape for recreation and education.

These design strategies are also affected regionally at a schematic level, where a pile field is established at the mouth of the Sackville River and effects of the redesign of the DeWolf park coast-scape are felt further along the coast. Not only observable changes to the ecological operations are considered when studying consequences of this design intervention, but also effects on the social-cultural and political-economic qualities of this urban ecosystem. Presently, the urban morphology of Bedford Bay is one of a primarily residential, highly privatized coastline. This thesis proposes architecture that improves public water access and alters the coastal morphology in a way where the presently homogeneous private edge becomes more dynamic; containing within it nested ecosystems in the form of salt marsh and beach front, providing the potential for a more continuous public edge. While the impetus for this design was to reconnect the public in Bedford Bay to the water, by creating new public space that fosters recreational program at this scale this design also contributes to a change in the socio-cultural perception of Bedford Bay.

First, for inhabitants of Bedford, a new user devotion is intended. With increased access to the water and program that facilitates this access a stewardship of this urban ecology is fostered. Decreased access born of development and environmental degradation coupled with this led to severing the emotional relationship citizens of Bedford once had with their bay. If recreational opportunities that directly benefit these inhabitants are dependent on a high-functioning ecosystem then a continued management of this urban ecology can be established.

Secondly, by creating a new urban morphology for Bedford, the demographic of visitors to this region can also be expanded. Reframing Bedford as a more publicly inclusive region and providing a destination for coastal recreation can draw larger groups of visitors from outside of the area and also appeal to different members of the public. If this is the case,

economic effects may be felt in the form of a higher level of tourist driven revenue. If the region is afforded an economic robustness by its evolving identity as a public, urban ecosystem then policy changes may also be felt regarding coastal development which would also value the stewardship of this new urban ecosystem.

The urban ecology proposed in this thesis is designed as a response to present conditions and inspired by past use. Bedford was once celebrated as a recreation destination and supported this with relatively unobstructed public water access. However, this Bedford no longer exists. The design for a new urban ecosystem is proposed where past use and existing and threatened ecosystems guide a redesign of the existing coast-scape. This redesign is not intended to return Bedford Bay to a previous state and it is understood that any outcome of this project will be invariably different from past or present Bedford. Although potential socio-cultural and political-economic consequences of this redesign are introduced, these subjects were not studied in detail. The resolution of this proposal would benefit from further research into how these architectural changes proposed for Bedford Bay would affect social, cultural, economic and political dynamics and contribute to its new possible future.

This thesis studied how urban and natural systems are perceived in detail and defining an approach to a design where these systems are not considered separate was challenging. As this project evolved it became clear that a large focus of this thesis was relegated to developing a language of design that treated built form, landscape and ecology equally as architecture. This resulted in a design strategy where architecture is designed to actively acknowledge natural operations and integrate them with built form in a plan for a new urban ecology. The outcome of this thesis is a design approach where ecology becomes an essential part of the architect's design considerations. Having outlined a basis for a responsive design future proposals have the possibility to be more clearly resolved. Although invaluable in establishing a base line for this thesis, furthering this research would mean beginning with this new perception of architecture as it relates to an urban ecology and then designing with a deeper, more integrated scalar and temporal understanding of the interconnectivity of these systems.

As urban environments continue to expand worldwide considerations of 'nature's' place in the city becomes more and more pressing. Within this discussion, the architect can play a leading role in defining new relationships between man and nature, and built-form and ecology. As presented in this thesis, this can start by first reconceiving of these relationships as integrated and reciprocal and then proposing designs for new architecture where this new perception is expressed. In this way, the architect's role necessarily expands and the designer must also become landscape architect and ecologist.

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