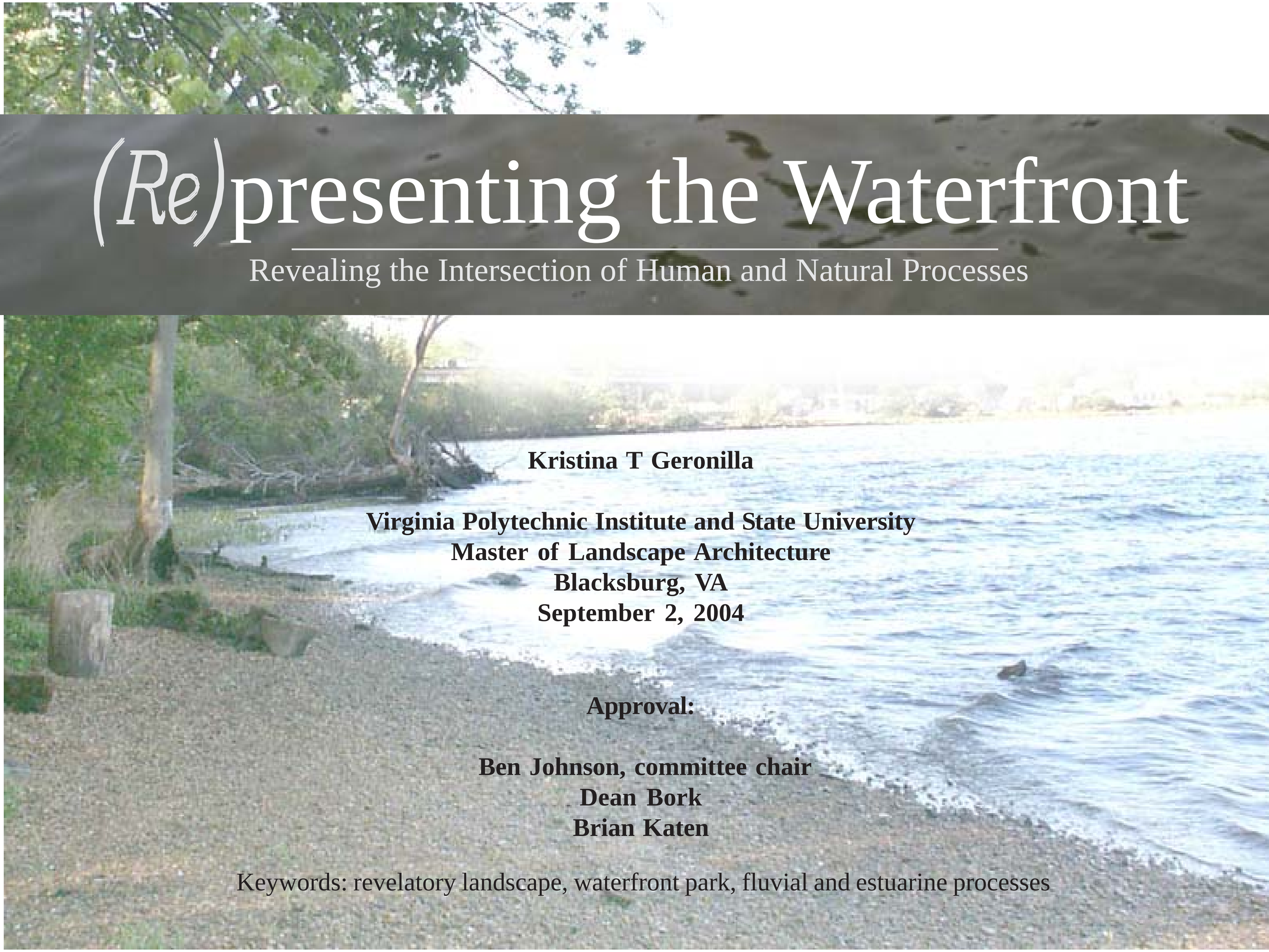

(Re)presenting the Waterfront

Revealing the Intersection of Human and Natural Processes

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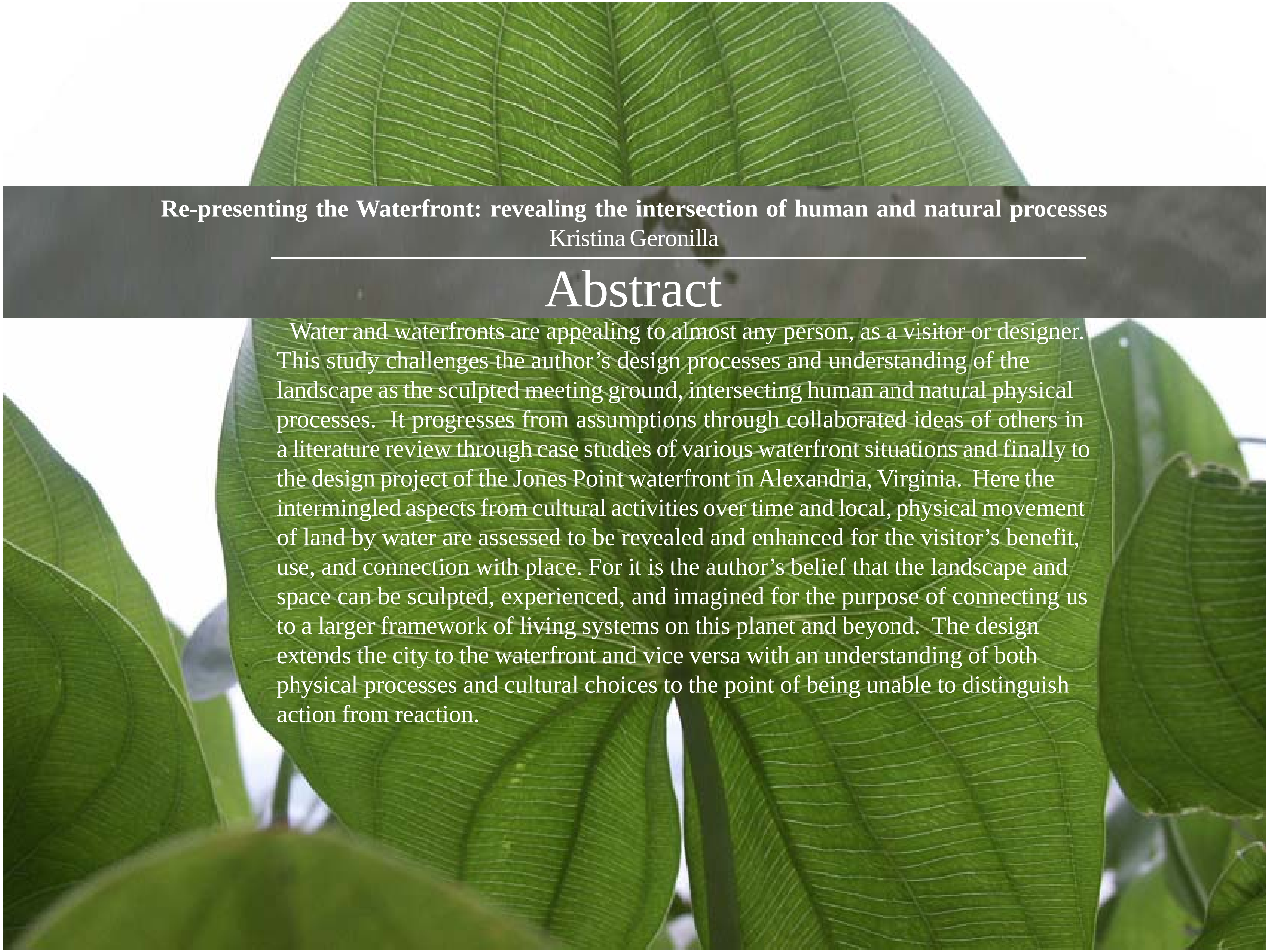


Re-presenting the Waterfront: revealing the intersection of human and natural processes

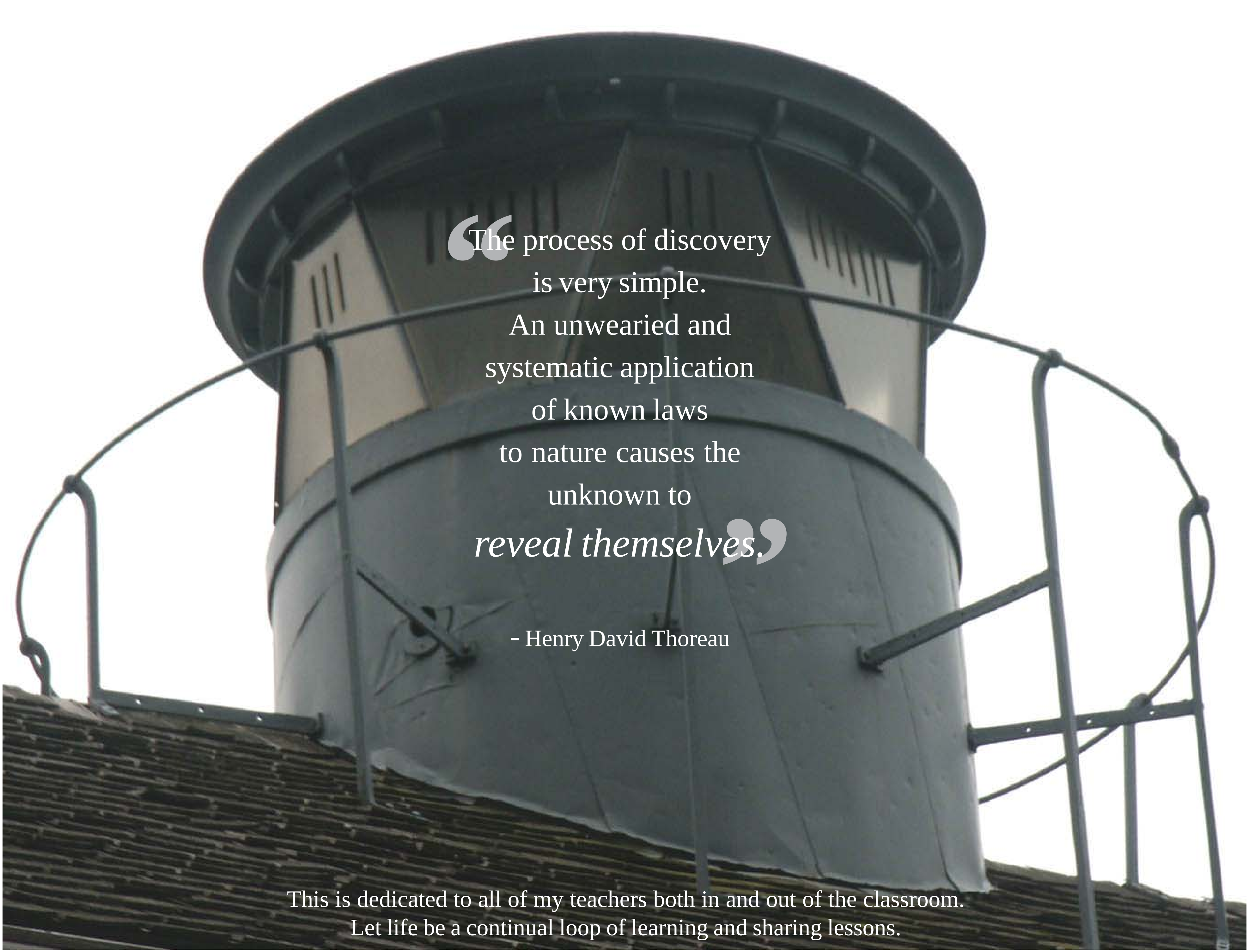
Kristina Geronilla

Abstract

Water and waterfronts are appealing to almost any person, as a visitor or designer. This study challenges the author’s design processes and understanding of the landscape as the sculpted meeting ground, intersecting human and natural physical processes. It progresses from assumptions through collaborated ideas of others in a literature review through case studies of various waterfront situations and finally to the design project of the Jones Point waterfront in Alexandria, Virginia. Here the intermingled aspects from cultural activities over time and local, physical movement of land by water are assessed to be revealed and enhanced for the visitor’s benefit, use, and connection with place. For it is the author’s belief that the landscape and space can be sculpted, experienced, and imagined for the purpose of connecting us to a larger framework of living systems on this planet and beyond. The design extends the city to the waterfront and vice versa with an understanding of both physical processes and cultural choices to the point of being unable to distinguish action from reaction.

Acknowledgements

This project could not have been completed without the efforts and encouragement of so many others. Many thanks to my family, friends, committee members, and those who have touched this project.



“The process of discovery
is very simple.
An unwearied and
systematic application
of known laws
to nature causes the
unknown to
reveal themselves.”

- Henry David Thoreau

This is dedicated to all of my teachers both in and out of the classroom.
Let life be a continual loop of learning and sharing lessons.

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1) Introduction

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Opening:

The personal appeal of landscape architecture results from its divergent nature and collaborative efforts from a range of compartmentalized schools of thought. Pursuit of this endeavor necessitates the general understanding and use of these complementary perspectives, which help build a theoretical base and inform design decisions when creating built and manipulated spaces. These spaces in the landscape receive significant influence from natural processes, cultural values, and progressive technology with each one containing still more concepts and influences.

These spaces in the landscape receive significant influence from natural, or physical, processes, cultural values, and progressive technology with each one containing still more influences and concepts. I have found a certain amount of satisfaction in being able to integrate my preliminary studies in biology with these present ecological concepts and organizational principles of design. While biology explores the forms and functions of our physical world, landscape architecture along with design in general engages the organization, perception, relationships, and interactions of humans with their surroundings and this physical world. So in my mind's eye, I find design to be a further exploration, within the two or three dimensional manifestation, of form and function. It helps me to depict how, why, and if organizational factors of space, dare I say landscape for it can

Jones Point present foot bridge over stream in volunteer forest area be applied to all spaces, exist and are appropriate. It is the contemplation of appropriateness which leads to the presence of intention(s), but more importantly awareness of the manipulation and its many forms.

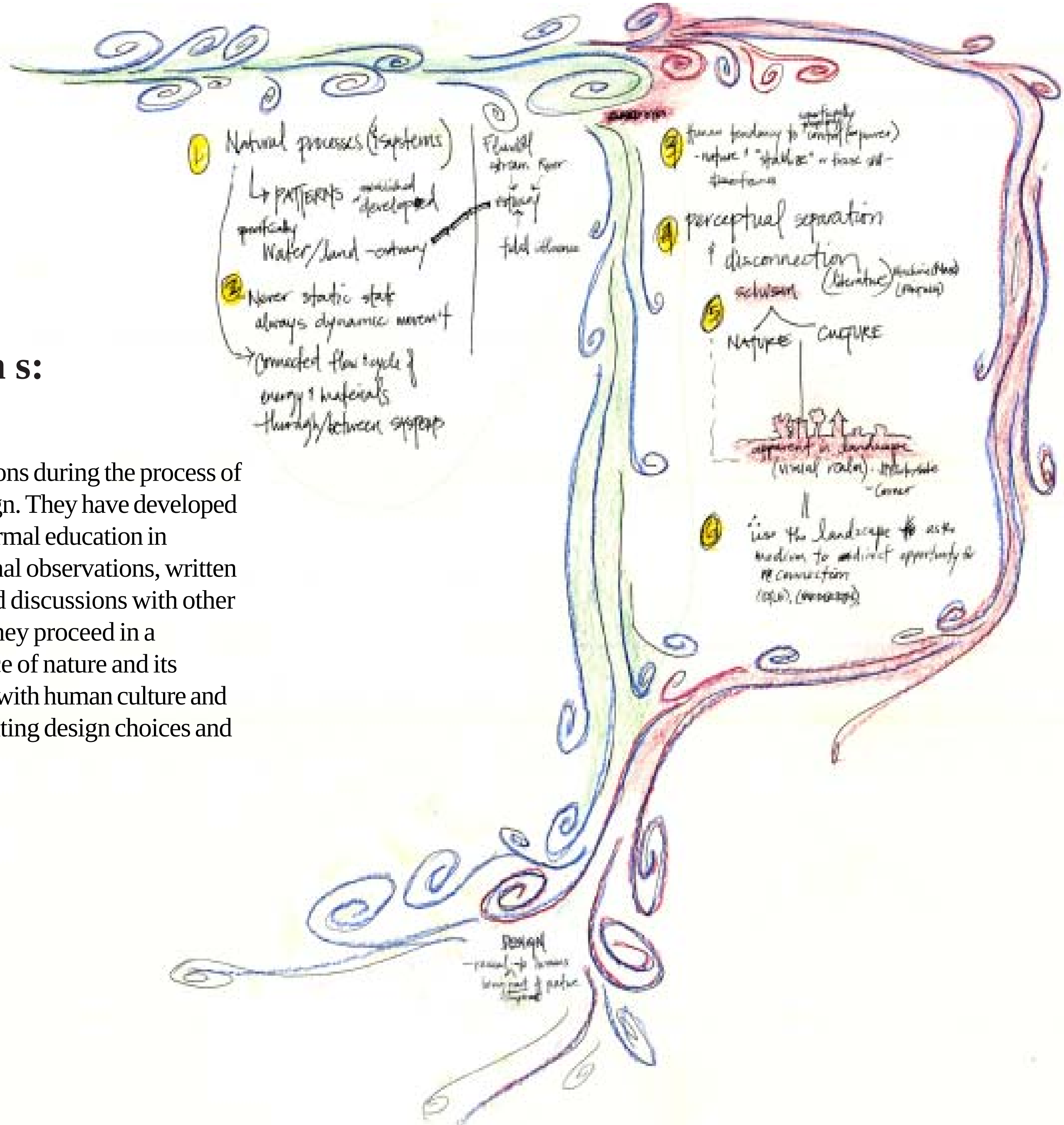
The diversity within the contemporary field of landscape architecture, spanning across a wide scope of design scales and levels of human interactions, and can easily lose sight of its encompassing sense of coherence and shared ideologies. This study does not attempt to provide *the* approach to unifying the profession, rather to exercise the possibility of *a* way to explore and approach design and its reciprocating effects of created spaces.

A growing challenge for present and future designers of the built world involves re-considering the benefits of integrating, revealing, and re-presenting the presence and use of local natural systems and cycles into designs for the purpose of mending the physical and perceptual separations between economically thriving urban cultures and ubiquitous natural systems.

Nature infilling areas of former concrete shipping railways.

Assumptive Truths:

I made the following set of assumptions during the process of exploring environmental and revelatory design. They have developed over the past few years while pursuing my formal education in Landscape Architecture in the form of personal observations, written perspectives, class work, studio projects, and discussions with other colleagues, professors, and professionals. They proceed in a sequential order from the passive, observance of nature and its dynamic tendencies through a disconnection with human culture and built spaces to a more significant role of dictating design choices and built spaces.

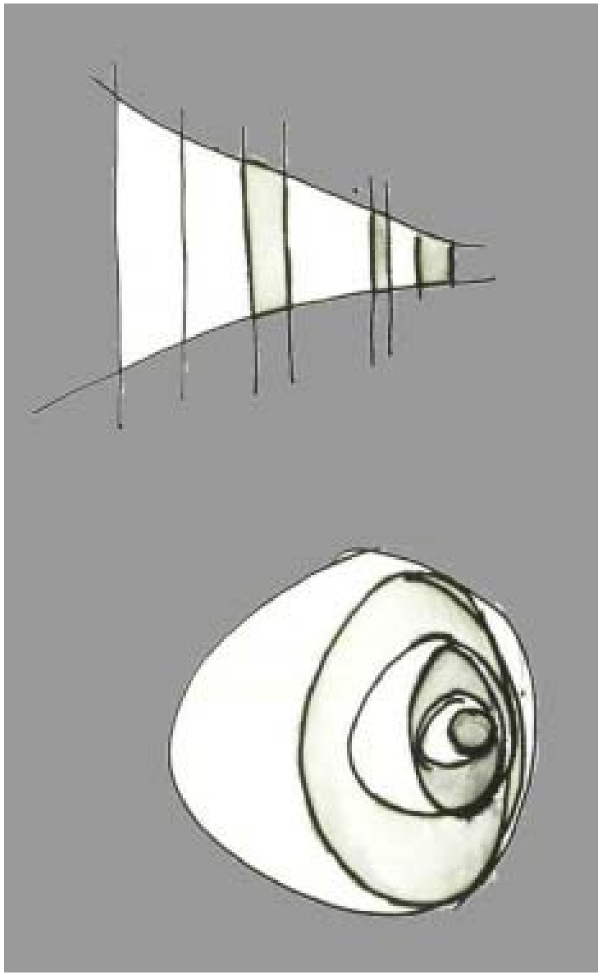


Brainstorm of assumptions involving the separation from nature

1) Natural, or physical, processes produce and reveal discernible, physical and visual patterns in the landscape and result from site specific conditions, which may or may not persist in a constant location. An underlying thread is the movement of materials and energy which results in designated physical characteristics. For instance, the chosen site area is inhabited by two fluvial processes in the upper reaches of the Potomac River tributary to the Chesapeake Bay estuary; namely, the freshwater river and creek and also the saltwater tidal movement. These processes interact with the land and contribute to very different topographic conditions along its shores with some steeply sloping and others are more gradual. In generalized terms, the fluvial freshwater drains the continent while eroding and depositing features along the terrain and mouth openings, and the tidal estuary is the dynamic meeting ground between freshwater and saltwater systems where rivers meet the ocean. These processes and systems are led by driving forces, which can be depicted in geologic terms as gravitational forces between and within planets, thermal radiation emitted from the sun, and geothermal heat radiating from the earth's core. So from these almost larger-than-life driving forces come the more perceptible natural processes occurring under specific circumstances and time frames. These processes are key factors in visualizing nature as cycling matter and flowing energy collective.

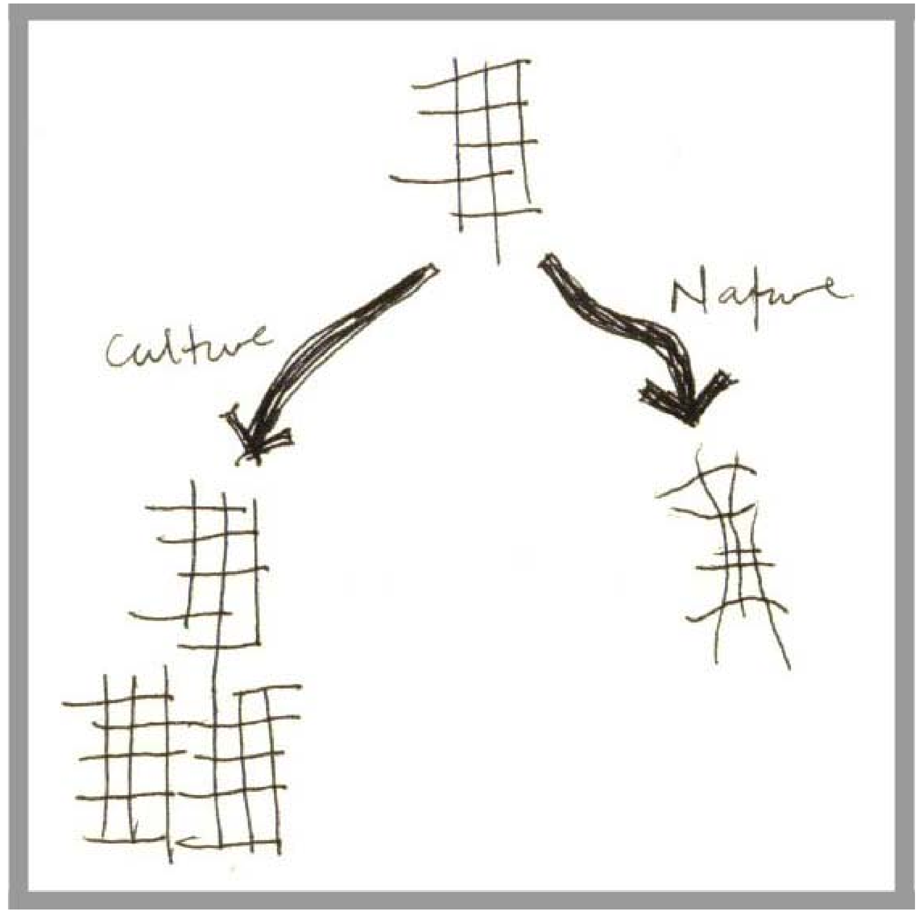
Aerial of Salt Lake City,UT - interacting edges of natural and human processes

2) These physical processes are dynamic systems and therefore are never static regardless of their immediate, perceptual state. They remain in a perpetual state of flux. There may not be just one climax state or condition that exists but only one that is utilizing the path of least resistance and energy consumption. Returning to the concept of perceivable change on the landscape from the influence of natural processes, the time frame for which the human population relates to change are very short term such as minutes, hours, days, seasons, years, and with the longest relatable time span generally about three generations prior to their own, which seems only a glimpse in the earth's overall existence.



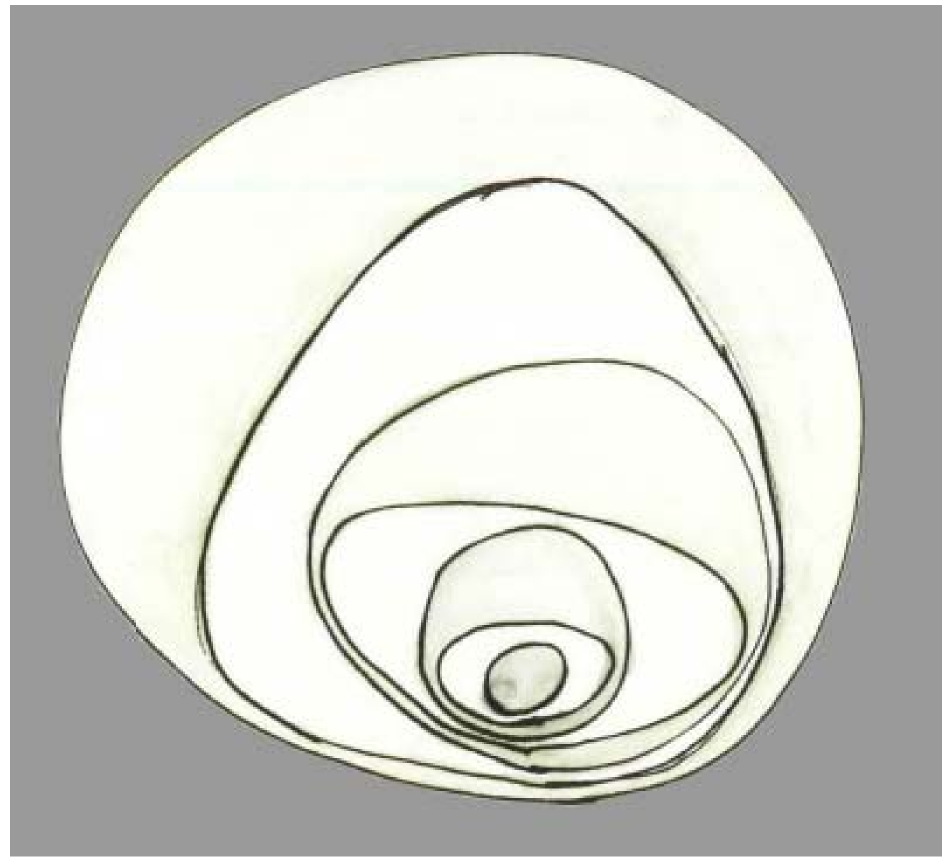
Patterns and observable space forms

3) Humans posses a desire to superficially control their surroundings and built spaces in a prolonged stable, static state. This control allows for the pursuit of power and sense of domination over natural processes, especially when commerce and economic well being are involved. These control mechanisms tend to be short-lived, due to lack of insight of multiple natural processes, and consume a high amount of non-renewable energy to install or maintain, which may lead to unintentionally negative long-term effects. Not to mention, the quantity and toxicity of waste products are almost completely disregarded or minimally considered.
4) Human cultures and societies directly or indirectly reflect their values and opinions of nature through their economic structure, social priorities, and built infrastructure. This separation between nature and human culture can be seen and described in the physical and visual realm of the landscape. The American landscape has been almost completely re-sculpted by the work of human efforts. For example, forest, wetlands, and prairies cleared for settlement, agriculture, transportation routes, and utility lines.



Shaped space expanded or abandoned to natural process where right angles are insignificant.

5) Exerting power and control upon the landscape and built spaces creates a literal and more perilous perceptual separation and disconnection from nature and also reinforces the dependent relationship with technology. Advances in design and material availability contribute to universal implementation of non-regional building skills or methods, which seal-off building interiors from the physical world and discount a great deal of local knowledge and craftsmanship of differing climatic and geographic regions. For instance, the Industrial Revolution boosted technological skills and availability of newer and readily available material which aided this separation of lifestyles from the natural processes.
6) The landscape can be the vehicle of opportunity for promoting reconnections and providing opportunities for visitors to notice and reflect upon their involvement in natural systems, especially in daily life and decision-making moments, in order to remember that they are a part *of* nature and not apart *from* these natural processes. This opens the door of exploring design in another light or with a more conscious purpose in mind. Some of these options affect the experiential, sensory qualities of a place, such as the sequential progression through space, edge treatments within and around waterfront parks, tension resulting from the juxtaposition of design treatments, or introduction of alternative systems responding to human impact. The possibilities are only beginning.



Shifting physical dimensions and sources of power manipulating space

Principle Issues:

When comparing what is to what could be, the present state typically seems flawed mainly because it is the result of circumstances, both predicted and unseen. Understanding these circumstances helps to accept reality, but they involve a wide range of explored and hypothetical concepts and ideas, in which events unfold. Influence can come from physical and social arenas.

The author's thoughts are focused by the contemplation of the following issues as questions. To what end are resources and technology used to maintain various standards of living and support the high numbers of the population with our consumption of fossil fuels and non-renewable resources and pollution of air and water supplies? Where is the application of information acquired from the numerous scientific and observational studies to understand life on and history of the earth? How difficult is it to alter our awareness and lifestyle to the cycles of physical processes? How effective are human efforts to "control" nature? What is appropriate treatment of public waterfront open spaces, if that should be applicable? The intention of these questions is to question my own understanding and awareness of the conscious results of design and manipulation of space.

Views of the water-land transitional area around Jones Point park

More specifically addressing design in the present United States and specifically the Atlantic coastal region, the author is interested in exploring ways of using design to reveal local and physical processes and ecosystems along with human development and daily life. It will be an interesting job of linking scales and the range of interactions for individual visitors to experience. On an estuarine riverfront area with human settlement, it is a question of how to reveal the depositional and erosional features of fluvial freshwater and tidal movement on landforms while dealing with urban watersheds and storm water. At a site specific scale, the author explores transitioning the experience smoothly from an urban setting to the water's edge through the use of a public waterfront park. These are issues at a small scale and veers away from larger scale issues.

An extensive problem that exists among us, humans especially among industrial societies, is a lack of understanding and maintaining a successful balance of necessities, luxuries, and security by using and returning usable resources in nature during our existence on this earth; a balance that involves the demands of human cultures and the ability of ecosystems to withstand their resulting pressures. A fear exists that humans are becoming too content with a daily lifestyle disconnected from the physical processes to which we are most certainly bound and linked.

Water's influence on Jones Point north part of retaining wall (above) and under road (below)

Project Goals:

In this project I absorb and reflect ideas put forth from accomplished minds while developing and conceptually applying my own perspective and uses of design. I intuitively wanted to focus on water in motion as physical cycles across land, as moving bodies all their own – as physical cycles across land, as large bodies in motion, and as forces to move land – because I believe water to be a common denominator of life, both human and not. So in this project I aspire:

- To understand and make visible and apparent these invisible strings and connections between technology/culture and physical processes, esp. with regard to water processes and its conversation/interaction with land along with the context of the waterfront's cultural evolution.
- To heighten awareness of site specific natural processes with revelatory design in an approach to promote the viewer to consider (new) views of nature and how these processes shape and influence space and design form
- To reveal the processes in an exposable and recognizable form in order for individuals to enhance their awareness and connection to place.

Wetland plants struggling for existence in an area where they once thrived

Project Objectives and Process:

In order to move forward with design of a space for the purpose of revealing and connecting humans with the local, physical processes, then the local setting is helpful and almost necessary to understand. With a waterfront setting, the water and land processes should be explored, paying close attention to the specific physical interactions.

- to visualize the culture and its evolutionary context as informed by natural processes
- to explore intervention opportunities with regard to experience and observation of the waterfront's local processes and interactions
- to emphasize the need to transition from a consumptive, linear state of existence to a more balanced, cyclic state with the help of the above efforts
- to understand the significant states and periods of the areas past to better understand how to move forwardwith design

Boundary marker between Virginia and Maryland on Jones Point

2) Literature Review

Dialogue
Waterfront Case Studies in Japan

L i t e r a t u r e   R e v i e w

This literature review is a structured discussion of facts, theories, and observations that mold and influence my position as well as clarify issues from perceived assumptions stated previously. It consists of a dialogue to articulate terms and concepts and then a comparison of case studies developed while a student in Japan.

Physical and invisible connections with nature

D i a l o g u e:

To examine the overlapping relationships between nature, landscape, technology and culture, some pertinent issues and opportunities should be viewed with inputs from various perspectives such as art, ecological theory, economics, planning, engineering, geomorphology, sociology, ethics, or critical theory. Listed are terms elaborated on in this section: Nature, physical processes, landscape, technology, cultural landscape, eco-economy, environmental design, land art, revelatory design.

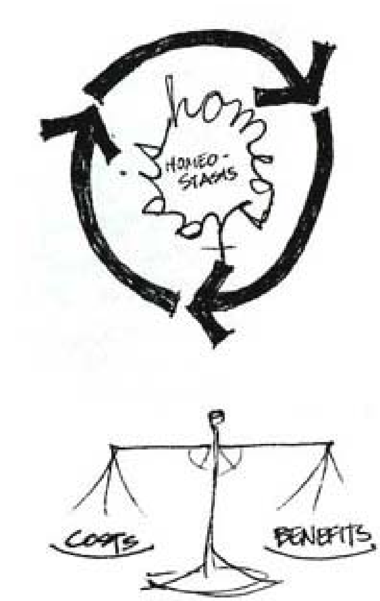
I. How the Earth Works
II. Losing Perspective and Accountability
III. Intersections and New Directions

Jones Point: part of volunteer forest inundated with stream

I. How the Earth Works

The earth, with all of its complexities, is still limited in many ways. The limited quantity of matter used for building blocks and the intolerance with the concept of useless waste are commonalities that link all living organisms. These links will remain and become apparent with time and circumstance regardless of how removed, conceptually and physically, humans may become. Integrating aspects of physical processes are possible with the use of cultural, environmental, and revelatory design aspects. Clive Ponting states in his book, *A Green History of the World*, that human societies exist with a dependency on complex, interrelated physical, chemical, and biological processes such as the energy produced by the sun, the circulation of elements crucial for life, the geophysical processes shifting continental land masses across the face of the globe, and factors regulating climatic change (1991, 8). Without these elements as the foundation for so many plants and animals, including humans, the complex and interdependent communities would not exist in their present states.

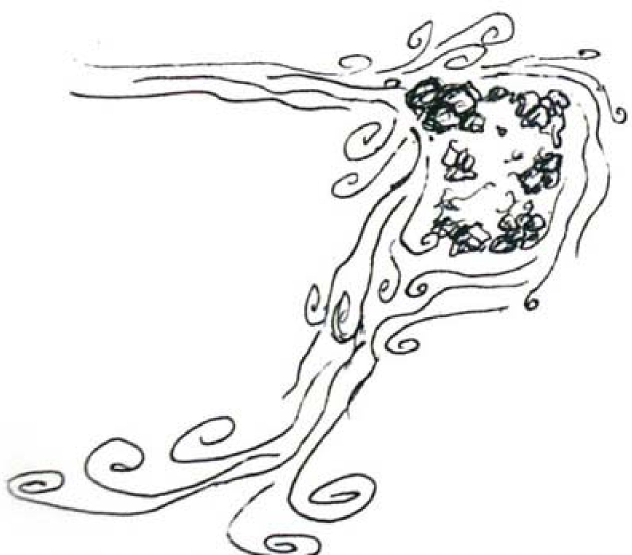
Physical and living elements dynamically play within the Earth's closed system. Matter cycles, taking on many molecular structures and sizes, all the while consuming and producing energy from work. This energy can be stored and then released, but ultimately it flows through and among living organisms and systems through the use of driving forces. One organism's output becomes another's input. At one point in *Biomimicry: innovation inspired by nature*, Janine Benyus compares the similarities between ecosystems and economies with both entailing energy and material to transport them into products, but with the big difference of our economy working linear and nature's cyclic (1997, 242). Un-usable waste and pollution are concepts developed by human societies, us, which are in dire need of reconsideration. Waste is deposited into ecosystems that cannot be recycled by natural systems or not in the concentrations in which they are found (Ponting 1991, 16). In this closed system, resources are finite and nothing gets out, not even waste and pollution. Everything is linked.



Continuous pursuit of a balanced state

The notion of driving forces, which shape the physical elements of the planet, comes to me through the field of geomorphology. The underlying concept to keep in mind is *process*, eliciting continual motion and change to take place at all scales of size and resulting in varying geomorphic features. The three general driving forces of earth are gravity, geothermal heat, and solar radiation. These are the basis for physical processes such as tidal currents, plate tectonic movement such as earthquakes, and weather especially the hydrologic cycle to name a few. These processes distribute resources, material, and energy which support diverse flora and fauna of wide ranging ecosystems.

As components within the earth's closed system, ecosystems are open to influence and regulation by outside factors with material and energy flowing in and out of their reaches along the earth's surface. Defined in many ways, ecology targets the examination of interactions among organisms and the environment (Forman 2002, 89), and therefore ecosystems are a continuously self-organizing composition of both the living and non-living components with a strong emphasis on interactions between them. Sim van der Ryn and Stuart Cowan refer to interactions as global cycles, linking organisms together in a highly effective recycling system which jumps in scale from a ten-billionth of a meter to ten thousand kilometers (van der Ryn & Cowan 1996, 33). Robert Cook stresses the importance of process and its influence on dynamic changes within systems and understanding its dynamics depends on the context in which it is embedded (Cook 1996, 46). Ian McHarg voiced his ecological view in *Design with Nature* saying that all life is linked, in matter and in the act of living (1992, 29). He called the phenomenal world our home and ecology (derived from *oikos*) the science of that home.



Actions and Reactions

Ecosystems have been categorized in many ways. Some by regulating physical processes, geographic features, soil, climate, flora and fauna, and by temperature and level of rainfall, but there are many players in each ecosystem. John Lyle believes the key to understanding and working with ecosystems stems from recognizing the motivating processes that define their essential character (Lyle 1999, 15). Ponting finds it necessary to understand the pieces as part of a larger whole before examining the individual parts:

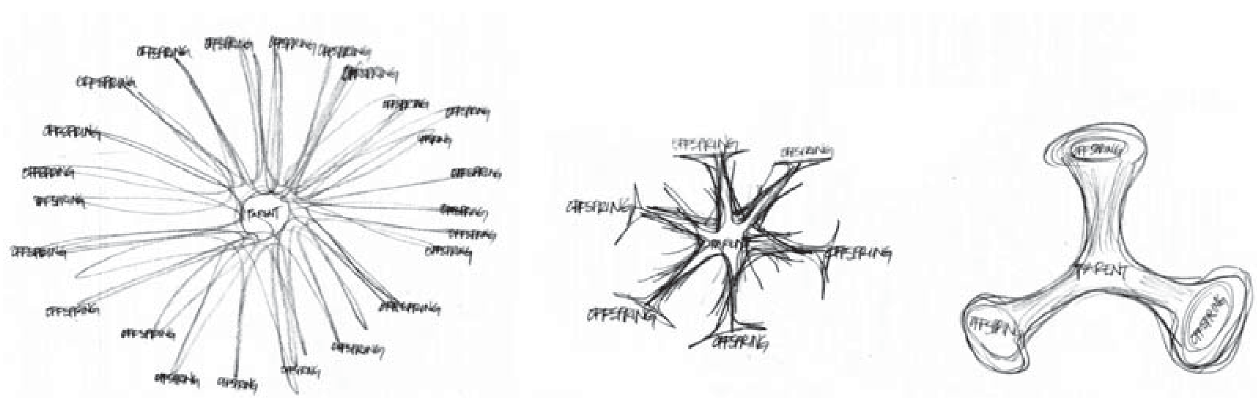
> All the parts of an ecosystem are interconnected through a complex set of self regulating cycles, feedback loops and linkages between different parts of the food chain. …If one part of an ecosystem is removed or disrupted there will be knock-on effects

> elsewhere in the system. The extent of the reverberations will of course vary depending on the nature, scale and duration of the initial disruption; on the relative significance of the part or parts affected; and on the resilience of the ecosystem. (Ponting 1991, 16)

A disruption of one part will lead to a chain reaction among the whole system. This leads to constant changes within ecosystems.

A general knowledge about the successive stages of these dynamic systems exists. The transformations come about in an orderly and predictable series of changes which are the result of modifications of the environment to culminate in a climax system, which supports the maximum number of plants and animals for the available energy input (Ponting 1991, 12-13). Benyus categorized ecosystems into three levels according to their energy use: Type I systems take full advantage of resources present, utilize a rapid growth strategy producing as many offspring as possible, and operates linearly by lacking capacity for decay which decreases living space; Type II systems utilize energy for enduring features which out pace or shade type I systems and also producing less offspring with increased capability of survival; and Type III systems use energy to optimize relationships with other species to do more with less effort, tending to the production and wellbeing of very few offspring, utilizing a "patience" strategy and loyalty to place, and reusing all outputs and materials (Benyus 1997, 249-250).

In essence, an ecosystem changes as well as the organisms it supports. Therefore the history of the earth is layered with climax communities destroyed and subsequently replaced by others of a similar or different manner. Or as Van der Ryn and Cowan put it, "seeing natural history in terms of unpredictable yet patterned narratives that encompass the collected creature-wisdom of the planet (Van der Ryn & Cowan 1996, 141)." Tapping into some of that creature-wisdom may be just what we need to refocus our efforts.



Type I
Use resources completely until none
Multiple offspring
Waste at 100%

Type II
Use 50% of resources
Variable offspring
Waste at 50%

Type III
Cycling of resources and waste
Limited offspring
efficiency of place 100%

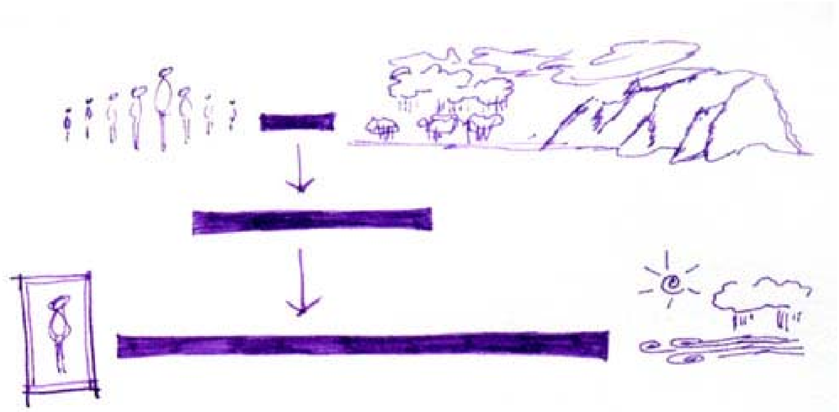
II. Losing Perspective and Accountability

Somewhere along the way to an evolved species, humans lost sight of the connection to place and physical processes. This section explores the role and impact of humans during our brief existence on earth with the hopes to inform a holistic approach to intentional revelatory design. Once dependent on physical processes for survival, humans conquered diversity with skills but lost the appreciation and respect behind the link to the larger network of ecosystems.

Competition and cooperation exists among organisms for survival. Humans, as living organisms, are very much a part of the earth's ecosystems, whether conscious of this fact and its implications or not: "We human beings are integral, interacting components of ecosystems at every level…even at the level of the biosphere, we may be an overriding, controlling component, but we are a component nonetheless (Lyle 1999, 17)." Benyus agrees and urges for acknowledgement since "one hundred years into the Industrial Revolution, we are only now opening our eyes and realizing that our artificially constructed world is not isolated from the real one. It is enmeshed in a larger natural world that cradles and nourishes us, making all of our activities possible. Fouling this nest, a lesson other organisms learned long ago, can be a deadly business (1997, 240)." It is only a matter of time before the physical processes are over loaded with unnecessary waste and pollution.

I believe this loss of perspective stems partially from the changing notion of what nature is. The rhetorical question of – where did "nature" come from? – surfaced as I began examining concepts relating to cultural landscapes. I am referring to the secular use of the term and its implications, especially as they relate to the settlement of the United State over the last four centuries, separate from the contemplative, metaphysical associations with faith or religion. So its use is more about semantics and cultural perception. The term *nature* encompasses a wide range of ambiguous and inclusive terms to very specific definitions. It can refer to physical space and forces, the essence or quality of something, human tendency, or reactive qualities from actions. John Dixon Hunt seems to believe the notion of nature results from the influence of time, place, and cultural priorities:

> The arts and sciences of any given society discover and make accessible to that time and place a particular perspective on the phenomenal world; they "invent" an

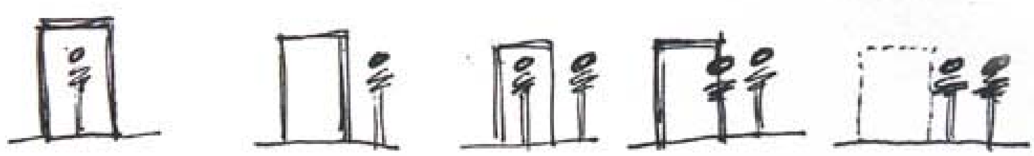


An increased separation between man and nature

> idea of nature that their society can cherish. In these circumstances "nature" is never a normative, stable entity, but a view of the physical world that a particular culture creates to be able to live with… It is among the functions of culture to devise or construct a nature for its contemporaries to live in, believe in, and represent in their arts …abstracting or extrapolating from the vast resources of the natural world a version of that world that is enhancing. (Hunt 1996, 56)

In this light, nature becomes a title and biased perspective, and maybe justifiable so. For it seems that culture, like other components of ecosystems, is dynamic, unique to place and circumstance, becoming a heavy influence on the term nature.

It may have been a change in perception and priorities that aided the separation between humans and ecosystems through time. As humans developed so did their beliefs and priorities. For example: "In the seventeenth century …the Scientific Revolution made reverence for the Earth obsolete, while the Church condemned it as druidic superstition. Once nature was demoted to a dead and soulless assembly of atoms, it became socially acceptable to exert our 'God-given' dominion over her. The path was cleared for world wide exploitation. (Benyus 1997, 241)" Besides the aftermath of the Reformation is the shift in social politics and attitudes of the American people for independence from the British after the Revolutionary war. While exploring influences of social politics on economic development in *The Machine in the Garden,* Leo Marx discusses Thomas Jefferson's pursuit for the pastoral ideal and his description of the true American to be a ploughman "whose values are derived from his relations to the land, not from 'artificial rules.' …the conviction with which Jefferson makes this kind of assertion stems from his belief in the unspoiled American landscape as peculiarly conducive to the nurture of the 'moral sense.' It disseminates germs of virtue. (Marx 1964, 131)" As good as that sounds, the factories and steam engines won-out in the end with their capability for profit and economic wealth, and the separation between humans and ecosystems widens.



Breaking down the barriers between humans and natural processes

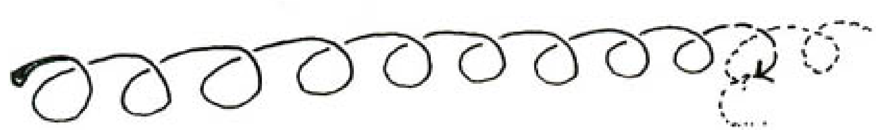
There are other qualities, besides perception which distinguish humans (and direct ancestors) from other organisms. Humans are the only species with the capacity to endanger and even destroy ecosystems, upon which they depend for their existence, and also spread into and dominate every terrestrial

ecosystem with the use of technology (Ponting 1991, 17). Humans developed traits beyond primates with bigger brains, standing upright, speech, but especially technology. The adoption of technological means was fundamental in the human settlement of the world because of its use to overcome difficulties imposed by hostile environments (Ponting 1991, 24). It also encouraged the development of cultural standards and luxuries by allowing the energy, otherwise spent obtaining necessary provisions and assuring survival, to be utilized in less strenuous and idle ways.

Reliance on technology occurred within industrial societies and cultures for the not only survival but also material needs, comfort, and security. The appeal of exerting less effort and enjoying leisure activities grew to the point of developing a dependency upon the technology by these cultures for survival. Culture co-evolved with technology through the ages to a point of dependency so integrated into the daily lives and routines of humans that without it the culture may fail. Technology becomes personified with so much responsibility placed upon it by human cultures to the point of saying it co-evolved with humans. This makes technology a double-edged sword of sorts; where it assures our survival as long as we continue to maintain and use it. Benyus puts it best when she describes the speed and intensity that human culture clung to technology:

> When biceps and back muscles ran the shovels, our rate of destruction more closely matched nature's rate of renewal. It wasn't until the Industrial Revolution put us on the winning side of a very large lever that we began vaulting past nature. Gears, hydraulics, fossil fuels, and the internal combustion engine allowed us to tap deeper, faster, and farther in the Earth. …We began to extract resources as quickly as we could, transforming them into products, waste, and …more people. The farther removed we became from nature in our attitudes, lifestyles, and spirituality, the more dependent we became on the products of this transformation. We became addicted to the spoils of our 'rational mastery.' (Benyus 1997, 242)

We gave it power- a perilous move. Robert Thayer describes the remorse and paradox of technology: "we discovered technology as a means of survival in nature and now it is killing other life forms and threatening us as well. Yet technology is the "nature" of human nature. In spite of a green heart, we have made an ambivalent gray world (Thayer



Breaking away from projected cycles

1994, 307).” So somewhere in the past we became the hunter and no longer the hunted and did not cease at dominating our environment.

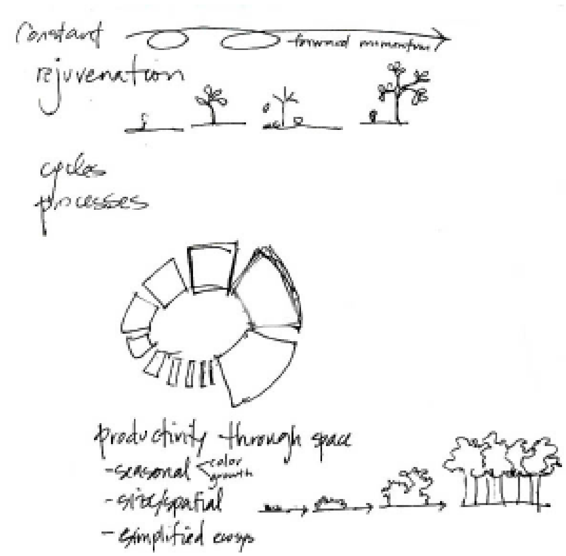
A shift occurred in some human cultures once they were insured of their survival to obtaining power and dominance. Similar to the divergent evolution of species into varieties that arise when separated and left to evolve in different environments, not all cultures obtained the same technology and tools and resulted in unequally advance cultures, putting some at a disadvantage for survival while others thrived. Hence, the struggle for power persists. In *The Machine in the Garden*, Leo Marx depicts the journey of a budding American culture as it chooses its technological tools to obtain power in the forms of social identity and economic independence from threatening, originating cultures. Through the examples of literary works and political essays, Marx points-out the dilemma of choosing a pastoral lifestyle, connected with the land, and one empowered by machines and the constant struggle for power. Upon choosing machines, humans become comfortable with a lifestyle void of direct, physical effort and knowledge of local ecosystems and processes to obtain necessities for survival.

Many revolutions have occurred through the centuries to change the way humans perceive and exist with nature. Starting from the earliest time of hunting and gathering, they are the Agricultural Revolution, the Scientific Revolution, the Industrial Revolution, and the Petrochemical and Genetic Engineering Revolution of today. Although all of these made great strides, two stand out as significant points of transition in human history that increased the loss of perception and accountability within ecosystems. The first is the “adoption of agriculture and rise of settled societies” of the Agricultural Revolution and the second is “the exploitation of the earth’s vast (but limited) stock of fossil fuels” which ranges from the Industrial Revolution through to present day (Ponting 1991, 267). They make me wonder if *progress* is “the increasing ability of human societies to control and modify the environment to meet their needs through sheer ingenuity and a capacity to respond to challenges and to engage in problem solving (Ponting 1991, 396)” or if it is just creating different, larger problems.

Technology and culture now reside among other components of social sciences such as economics, commerce, politics, etc. which spread the acceptance of a lifestyle separate from physical processes and ecosystems and complicate the pursuit of reconciliation with nature. Not claiming to be intimately familiar with this area, I understand their significance through Ponting’s perspective when he discusses the unequal distribution of the world’s wealth and power that has evolved over the last five hundred years and the diverse pressures experienced by different countries and regions, which reinforces the inherent difficulties of developing coherent international strategies: “Past experience suggests that these pressures will continue to be felt in four main areas – growing strains on resources, unequal development and distribution of food and wealth, a growing weight of numbers and the threat from the outputs of industrial society in the

form of pollution. In each of these areas the shadow of the past falls across all modern societies as they try to find solutions. (Ponting 1991, 401-2)" When seen as such a far reaching and complex situation, I do not doubt that we lack the willingness to try and comprehend it, let alone tackle its solutions.

In undermined efforts, similarities between economics and ecology have been made in attempt to reevaluate values and behaviors with hopes of departing from our consumptive and wasteful lifestyles. Living things maintain a dynamic stability of juggling resources and waste within the parameters of their ecosystems (Benyus 1997, 7). So it is not an impossible goal, and success stories exist all around us in nature. She also compares the behaviors of industrial cultures to Type I systems that place a lot of energy in consuming resources with no regard for recycling the waste:



Contemplating cycles and processes in space and time

> Pollution was not the root cause of our environmental crisis; fantasy was. We had begun telling ourselves a dangerous fairy tale… We treated raw materials as if they were essentially free – you paid for access to them and you paid to remove them, but you paid nothing for the leaching slag heaps on the fact that you were depleting another generation's resource stock. Waste was released to oceans, rivers, land, and air, with no recompense for the Earth's free services. (Benyus 1997, 243)

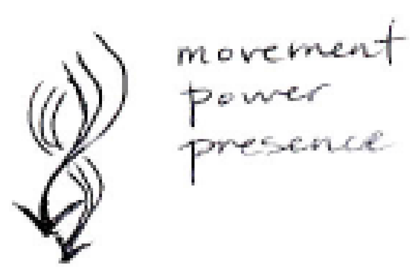
This could be because no price was given for the repercussions of withdrawing or using the resources and "no incentives to extract sustainably, process clearly, or optimize use. As a result… dumb material choices, dumb process choices, and when it came to waste, we blithely elected to emit it and forget it. (Benyus 1997, 243)" So now that effects of the past are being noticed now, the opportunity to change presents itself. Industrial ecology gets its drive from configuring its 'modus operandi' around the possibility of being like closed-loop, sun-driven biology (Benyus 1997, 242). I would like to see how our economy could look and *function* resembling the natural world in which it exists.

The quality of our lives could be linked with a cyclic existence in ecosystems. The skills and opportunity for humans to make a difference has been proved with the examination of our past. The investigation now is how to use our skills of manipulation and design to mend the separation and disconnection from our role in physical processes of local ecosystems, especially in daily life and decision making.

III. Intersections and New Directions

Potential exists for exploring methods of design that can affect the direct personal experience and perception of a place to reemphasize the importance of integrating or emphasizing physical processes of local ecosystems with cultural systems. Plenty of sources acknowledge the ecological crisis that is mounting with our consumptive track of non-renewable resources and wasteful, affluent behaviors. So this section focuses efforts on the landscape as a medium for design to find ways of acknowledging the need to reconnect with global cycles and ecosystems.

The landscape is an obvious choice for its direct exposure to the elements and ecosystems, but is difficult to define. Yi-Fu Tuan sums it up faultlessly by calling the landscape a fusion of two major perspectives – functional and moral aesthetic, and it is an ordering of reality from different angles of both vertical and side views (Tuan 1979, 89-90). This makes the landscape not just a physical, working place but also a construct of the mind and perception. Design with the landscape with the latter cannot dictate what people think but rather provide experiences for direct contact and use of the senses which elicit contemplation and reflection.



Acknowledging intersections and connections

The nature of design involves manipulation, but designing with nature succeeds with the understanding its vocabulary and processes. Anne Spirn and Peirce Lewis focus their writings towards reading the details and complexities of landscapes to understand their forms, functions, and processes. Both discuss the physical elements as much as the cultural features. Spirn reiterates how important it is to understand the language of landscape because it opens eyes and minds to identifying visual clues to invisible processes. So when examined thoroughly, the landscape could almost inform us about proper use and placement of development. Lewis focuses more on repetitive examinations of landscapes to help the participant thoroughly examine and understand the commonly overlooked order within these places. Reading landscapes becomes an exercise in patience and humility from nature.

Focusing on the physical and functional qualities of landscape, some descriptions stem from the natural sciences. Like ecosystems, landscapes can be of any size and are open to the movement of material and energy through them. Upon relating landscape to the earth, McHarg infers landscape to be the setting for all processes. Lyle reminds us of Eugene Odum's compartmentalization of the total landscape according to basic ecological roles:

> productive, where succession is continually retarded by human controls to maintain high levels of productivity; protective or natural, where succession is allowed or encouraged to proceed into the mature, and thus stable if not highly productive stages; compromise, which is a combination of the previously listed that Lyle classifies as human ecosystems; and urban industrial, which are biologically nonvital areas. (Lyle 1999, 15)

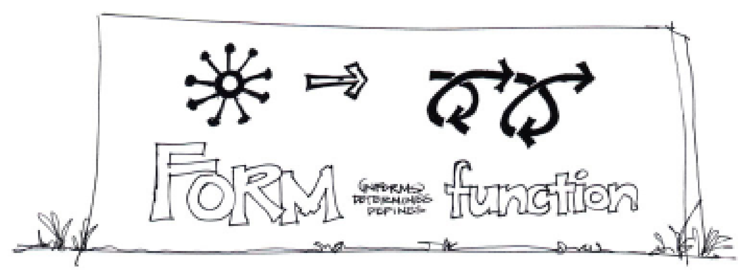
A mixture of communities of different ecological ages is good to have together in an area for the sake of productivity and protection. Lyle does this to reiterate the invisible links between form and function- of the visible and invisible.

Taking a look at the culturally produced landscape and aesthetics, influence comes more from the social sciences and art. In *Taking Measure across the American Landscape,* James Corner acknowledges how a particular people view, value, and act upon the land is structured highly through their codes, convention, and schemata of representation – their cultural images (Corner 1996, xi). This relates to the concepts of cultural and vernacular landscapes where lifestyles sculpt the physical land on a daily basis. Lyle adds that its not just about looks and scenery, even though those are significant to cultural heritage. A dual change in our attitudes and practices of manipulating the landscape will take patience and time. It may take “generations of environmental education to create a general public understanding of the fact that the importance of nature and its processes goes far beyond scenery (Lyle 1999, 3).” These perspectives are built on the foundation of earlier pioneers like John Brinckerhoff Jackson, who thoroughly investigated the vernacular qualities and etymology of landscape as it changed over time through cultural differentiation into various societies worldwide. Other conceptualist are summarized by Paul Groth and Chris Wilson by calling cultural landscapes product of cultural groups, in which culture is the agent and the natural area is the medium (Wilson & Groth 2003, 5). With this, I would add culture as a motivation or driving force to the list with gravity, solar radiation, and geothermal heat for its ability to elicit changes of the earth’s features and mechanics and by such a significant amount in only the brief period its existence. So by existing, humans affect the way the earth works and looks.

Aesthetics contributes to human behaviors and actions. Richard Schein describes an anti-modernist viewpoint of saying aesthetics develop with each individual and from the social influence of cultural constructs: “A contemporary landscape aesthetic is reliant upon vision and, often shared notions of spatial order, which in turn constitute an epistemology; and that epistemology, like other seemingly ‘commonsense’ approaches to social life, is a product of its place and time.(Schein 2003, 201)” This perspective recognizes that aesthetics of landscape transcend individual interpretation. They are unavoidably embedded in various social contexts and not universally understood or agreed upon. As complicated as grasping the general concepts of

aesthetics may be, they must be recognized by anyone manipulating landscapes and ecosystems. Arnold Berleant studies environmental aesthetics and insists on recognizing the inseparability of humans and nature to the point that aesthetic value, generally speaking, be a necessary part of environmental understanding and actions, especially with intended proposals of environmental change (Berleant 1992, 178). This complements concepts regarding environmental design.

Over time, I have come to understand environmental design to involve the exploration of various design elements with intentional awareness of integrating site-specific, natural processes and materials. Mixed with what I have encountered thus far in design and impending changes needed, I am in agreement with the potential advantages of environmental design to humbly work with nature. It can be a tool to help stretch the range of our ability to predict and respond to long-term dangers, which ecologist Paul Ehrlich admits humans are not "genetically hardwired to do (Benyus 1997, 244)." It is time to fix our near-sightedness. Lyle and Ponting both discuss the importance of staying within the limits of an areas carrying capacity, which is based on the quantity and rate of cycling limited natural resources. Lyle seeks to use site analysis and observation in his design projects for the purpose of effective programming alternatives.



Unbreakable and complex connections between form and function in the natural world

McHarg successfully used layers of analysis overlaid to form a composite from which to inform design. In *Ecological Design*, Van der Ryn and Cowan put together five principles to consider while implementing ecological design process: solutions grow from place, ecological accounting informs design, design with nature, everyone is a designer, and make nature visible. They intend for these to be guidelines, which inspire creativity and serve as a departure point for design, rather than strict rules. Benyus' book, *Biomimicry*, is another source of inspiration and examples of design application at all scales, integrating various academic fields together with commercial businesses. Design becomes a collaborative effort.

Land art is also a collaboration of sorts between the artists and materials. They are usually installation projects in the landscape of mostly, if not entirely, naturally found materials. The name originated from an art movement that emerged in the US in the late sixties that produced works of art in and with the landscape. Emphasis of the pieces generally focuses on discovery and process, which exposes some level of perceived tension. Andy Goldsworthy says he places emphasis on revealing the process to engage viewers to question their assumptions about nature. He says the appeal of land art is its ability to explore new views of the earth with the use of all

his senses (Terra Luna Films 1991). In the book edited by Udo Weilacher, *Between Landscape Architecture and Land Art*, John Dixon Hunt writes in the forward: "In short, Land Art seems to restore to landscape architecture its old and largely lost concern for the intricate melding of site, sight, and insight (Weilacher 1999, 6)." The book introduced me to examples of processes revealed in a physical form but not practical functions. Like all art, land art is meant to be contemplative and experienced by as many senses as possible.

Revelatory landscapes are composed of built spaces, which have been implemented with a goal of increasing the awareness of processes and features while contemplating present conditions or assumptions of the visitor. These landscapes combine qualities from land art, culture, physical processes specific to place, and technology in order to reconnect human perceptions with ecosystems and nature. The designer can reveal structure that exist only in the act of interpretation and making, and these structures become fictions of the real, telling a story of where we are and how we might understand our place in the physical world, by digging, marking, and otherwise removing rather than adding (Betsky, Levy & MacCannell 2001, 8-9). What I find intriguing is the meanings that come from the idea of differentiation which "takes the form of edges, boundaries, paths, or groupings of plants of different color, size, and texture (Betsky, Levy & MacCannell 2001, 21)." I think of opposing elements such as light and dark, sky and water or earth, past and present, nature and culture, object and representation and wonder what makes them fundamentally different.

Taking revelatory landscapes one step further, eco-revelatory designs and landscapes reveal and interpret ecological phenomena, processes, and relationships. The two goals of the special issue from *Landscape Journal*, which compiles exhibit projects with the theme of eco-revelatory design, are to stimulate creative and critical investigation and discussion as well as produce an exhibit of examples of these concerns. This adds another dimension to the art and theory of landscape architecture. Eco-revelatory design is a way to reevaluate cultural perceptions and behaviors with local processes and ecosystems, using the medium of landscape.

IV. Waterfronts as Intersections

Waterfronts are fascinating intersections between land and water. They serve as edges or terminations of fluvial processes. Water can be a powerful force to move sediment, chisel rock, shape banks and channels, and eventually deposit sediment. Douglas Way and William Marsh describe types and characteristics of water dominant processes. In *Terrain Analysis,* Way focuses on examining landforms and the importance of knowing processes to visually understand a place. Fluvial landforms are ceaseless: "These erosive and transporting processes are dynamic, modifying and creating waterlaid landforms and utilizing the weathered and eroded materials of other landforms (Way 1978, 287." So they are integrally connected to other systems and processes. Way groups fluvial landforms into four major categories based on their depositional process and topographic form. They include river fluvial formations such as flood plains, terraces, and deltas; alluvial landforms of sand, clay, etc from mountain and rock formations. including alluvial fans, valley fills, and continental alluvium; lacustrine formations produced by lakes or ponds including lake beds (playas) and organic deposits; and marine landforms such as coastal plains, beach ridges, and tidal flats (Way 1978, 290). In *Landscape Planning: environmental applications,* Marsh discusses topics affecting areas with human development like stormwater mitigation in urban watersheds; valley and floodplain sizes and shapes; water quality management and effects on land value of waterfront property; channel forms and the riparian landscape with its progressive movement and slope of bank; and sun angles and microclimates of urban environments. Lyle also integrates principles of design with human ecosystems on waterfront boundaries that depict methods of analysis of their particular fluvial processes.

One specific water intersection that intrigues me most is estuaries. Not only does water meet land, but it is where river fluvial systems meet tidal marine processes. Estuaries contain very productive and abundant ecosystems and vary from place to place across the globe. I studied the Chesapeake estuary system, and have included information in the Appendix. It is the result of mostly geologic time and ecological adaptation.

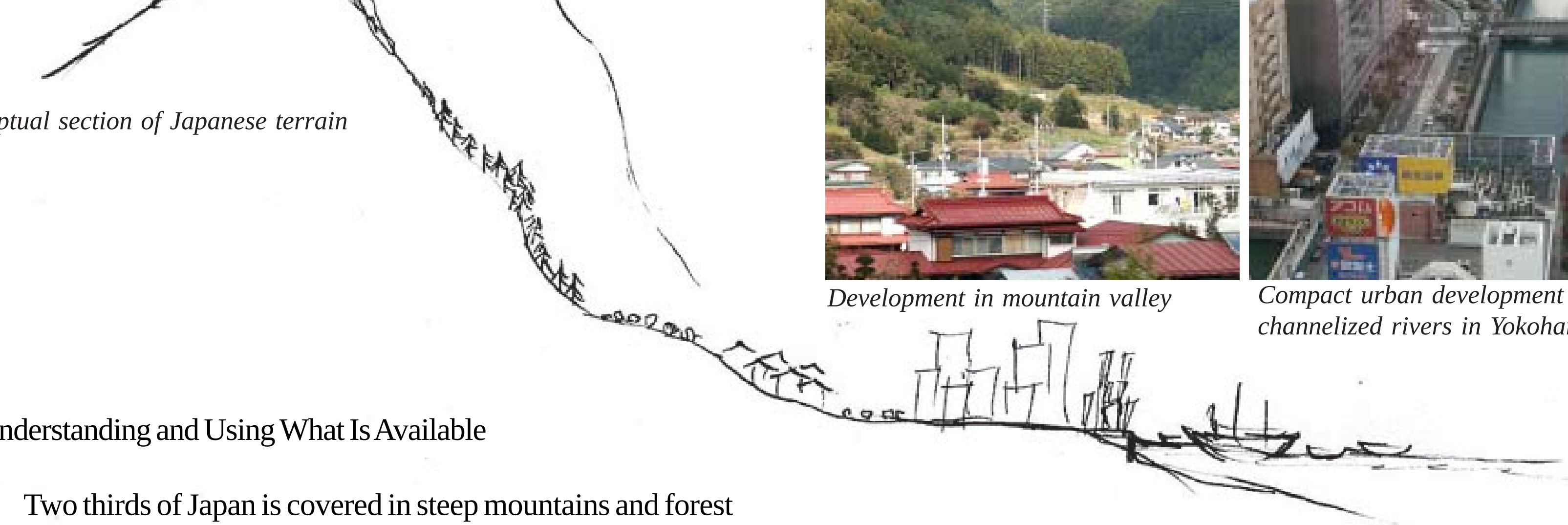
In areas where there is a desire or need to increase waterfront, or land-edge, places, land reclamation usually is involved and stems from understanding fluvial processes. Spirn relays stories of repeated structural failures when the fluvial processes of the flood plain areas are ignored or minimized, and human development is blindly constructed. Audrey Lambert tells of how the Dutch landscape underwent major land reclamation efforts with the meticulous use of dykes after understanding how tidal marsh systems interacted along there coast line. Their efforts took advantage of these systems and work with the natural processes in order to increase the land mass of the country. In a dominantly mountainous country like Japan, flat land is at a minimum, but every bit of it is used to its highest efficiency. The industrial waterfront is now being regenerated to integrate public parks and commercial businesses. Examples of some waterfront parks are presented in the following case study section.

Waterfront Case Studies from Japan:

Interaction with water is a very universal experience but each location and instance is very personal and unique. I would like to review some specific instances that I have encountered. While studying for a semester at Yokohama National University in Yokohama, Japan, I observed how the culture, geography , and physical processes in the area shaped the treatment of the bay and river boundaries.

View of Yokohama Bay, Japan (March 2003)

Downspout chain in Nikko, Japan (February 2003)



Conceptual section of Japanese terrain

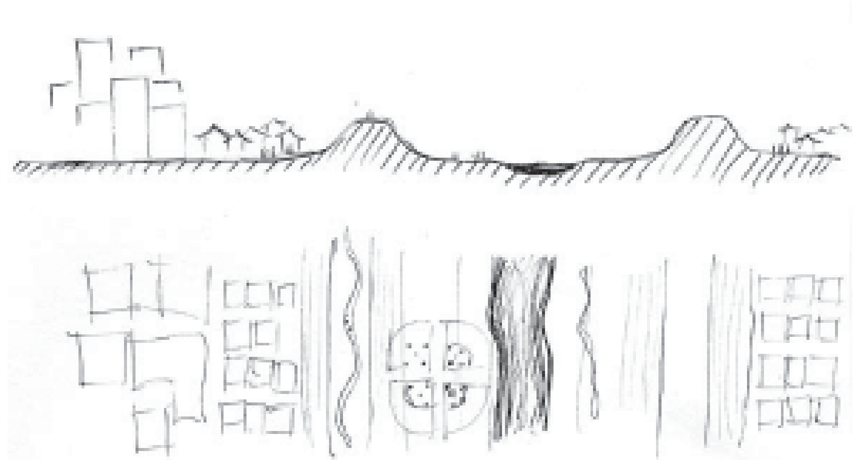
Development in mountain valley

Compact urban development and channelized rivers in Yokohama

Understanding and Using What Is Available

- Two thirds of Japan is covered in steep mountains and forest or timber farms
- Flat land is very limited
- Most flat areas are located along the coasts
- Land reclamation along waterfronts use extended retaining walls and engineering
- All “usable” land is precious and zoned for various purposes, vs. single zoning

Full utilization of flat land typical in coastal areas such as Kamakura.



Conceptual section and plan of urban rivers and utilized floodplain area

Nippon (Japanese) riverfronts: Whenever possible, the lower portion of channeled or engineered river throughout Japan's southeast Honshu region addressed seasonal and annual water level and velocity increases while maintaining safety of immediate neighborhoods and businesses. There was usually a grade change in the form of a berm on both sides of the river and complemented with a lower ground plane, varying in width to become inundated with increased water levels. The use of these strips varied. I saw walking paths, playing fields, naturalized areas and engineered slopes.

Section on sign of bermed river banks to allow for development near rivers

A mix of pedestrian and bicycle paths along the engineered river banks

Playing fields and pathways contained within floodplain area of raised bermed river banks

Engineered river bank edges typical through urban areas

Sumida Riverfront, Asakusa area of Tokyo, Japan:
Through the denser, commercialized portions of the city, there is channelization of rivers, allowing little to no interaction between people and the water except visually. There are both upper and lower walking paths running parallel with the river. The lower paths are reinforced with concrete walls dropping immediately down into the river's water. No vegetated bank would tolerate the fast water and constant dredging. Some of the lower areas are left to be flooded as part of the design detail but with a width of no more than 2 meters. There is lots of seating and design details, which are referring to the cherry blossom observing traditions popular in the spring.

Terraced use of Sumida River with the top area lined with cherry trees popular for viewing in the spring and lower area for strolling or being partially submerged with rising waters of river

View of terraced river bank with stairs and upper recreational facilities

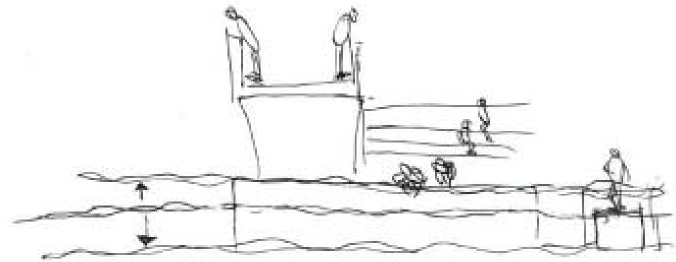
Rising waters along lower area

Cherry blossoms in paving

Cherry blossom references in railings

Open space used for passive recreation and picnicing with view to bay

Submergable water crossing in circular amphitheater area



Section along interactive amphitheater in north area of park

Rinko (Seaside) Park, Yokohama Bay, Japan: The water meets hardscape materials mostly concrete and stone on this commercial bay-front park. But the interaction with water is not just left at the borders of the park; it is allowed to penetrate the eastern portion. The shifting character of the tidal water is expressed in the circular amphitheater area, where it may weave around stepping stones and then flow over them as the water level rises.

Square bench seating

Picture of park map

View into amphitheater area with submergable areas

Interactive water edge

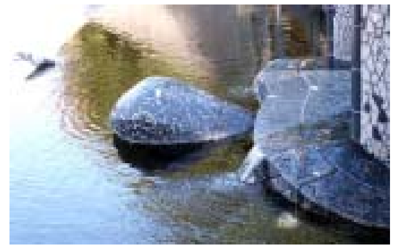
View along terraced bay front

Vertical water's edge of previous port use

View from rose garden to boat docks

Seagulls line up along boat docks and overhead

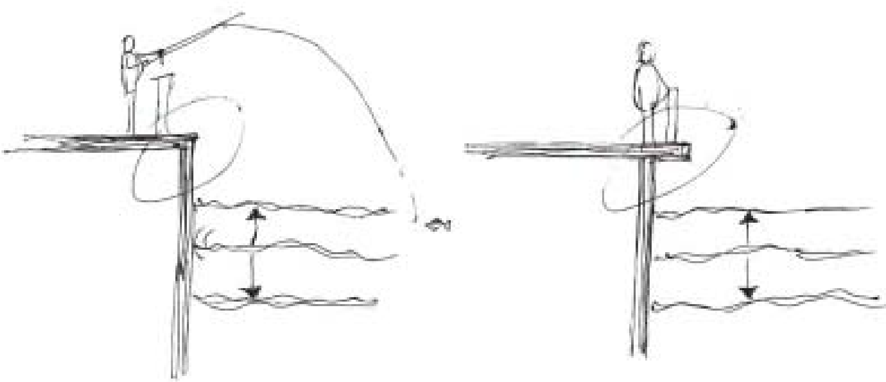
Yamashita Park, Yokohama Bay, Japan: The design seems to emphasize the importance of Yokohama's port history with its linear elements and orientation along the bay. There are seagulls and pigeons galore as well as statues and rose garden – the official flower of Yokohama. Park elements include long, linear areas of grass terminated with a stepped, mosaic serpentine fountain.



Bottom pool of serpentine fountain

People gather as performers entertain crowds alond the water

View from top of fountain down to rose garden



Vertical edge along park where land has been reclaimed from the bay

View of lawn axis through rose garden

View over rose garden from waterfront

View from elevated boardwalk area towards protective island

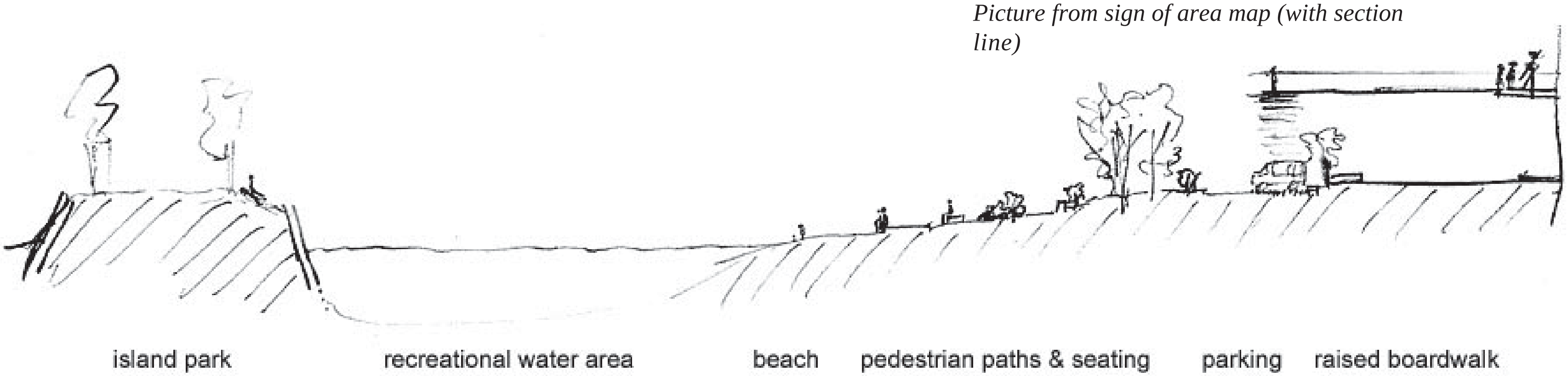
Seating benches along paths

View overview of beach area

Elevated boardwalk commercial area

Odaiba Bay beach area, Tokyo Bay, Japan: One of the few beaches to exist among so much land reclamation in the Tokyo area. The beach is limited and strategically placed in the setting of a boardwalk commercial area, targetting tourism. The bay seems protected from wave erosion by an artificial island.

Picture from sign of area map (with section line)



Conceptual section through bay area relating to map above

Nippon (Japanese) Waterfront Case Studies

Waterfront Types	Physical Processes	Visible Patterns and Traits	Design Response and Use	Revelatory Aspects
lower reaches of bermed rivers (around Tokyo and Yokohama)	fluvial freshwater and seasonal flooding	low water flow channel with adjacent flood plain area	engineered slopes of significantly high berms on banks to protect adjacent buildings and neighborhoods from seasonal flooding	height of berms show extreme water level rise and immensity of development up-river and reference of watershed or topography
channelized portions of rivers through cities	fluvial freshwater and/or tidal influence	vertical banks of artificial hardscape following rectilinear grid through city layout and pedestrian access on either side	engineered slopes of hardscape reinforced concrete material keeping water daylighted instead of covered and culverted	relation of low water table and lower plain of city topography
bay front view areas	fluvial estuarine	rectilinear surfaces of city development extended as far as possible into and over water as possible with present signs of industrial use	very vertical and engineered edges, leaving little to no direct physical contact with water	city's port and shipping significance and development and land reclamation efforts
bay front used areas	tidal action with estuarine influence	less vertical edges with more sloping and horizontal edges of mixed hardscape and plantings	more curvilinear and broken edges instead of straight edges as opportunity for visitors connection and interaction with water	tidal range and frequency revealed through time with changing horizontal movement and depth of water along water's edge
beach areas	tidal and wave action	gradually sloping, sandy shores and curvilinear edges	stepped vertical, hardscape elements and retaining elements	littoral area exposed between high and low tides and sloping angle relate to wave energy and local, coastal geomorphology

In conclusion, a visual relationship exists between the human habitation and use of selected areas and the cyclic water processes, which can be seen in revealing aspects of the design and space in the landscape. One aspect acts upon the other which reacts back, and a cycle of reactions occurs. Natural processes will continue without regard for human understanding or consideration. So it is in the best interest of human existence to understand and build in cooperation with these processes to minimize our energy-consumptive and futile efforts to block or hold-back the elements. Humans are members of the larger network of living systems and can live symbiotically by reintegrating physical processes back into the design of our physical world.

Pathway adjacent to pond at the Kinkakuji in Kyoto, Japan

Sunset over Yokohama Bay near slopes bordering Sankeien gardens

3) Design Project

- Design Position
- Project Site
- Analysis
- Design Concepts
- Design Master Plan

Design Position:

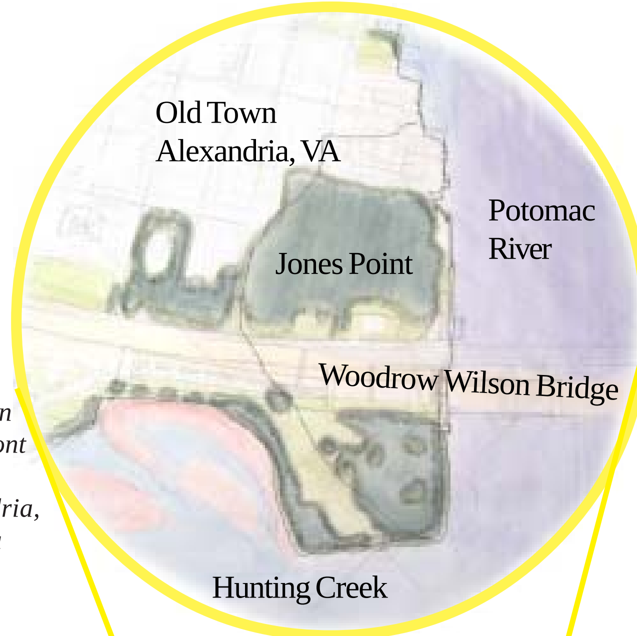
There exists an unbreakable connection between natural processes and cultural activities via technology, especially in urban settings, to the point that distinguishing between the two becomes the unraveling of a finely woven tapestry. Their intersection becomes apparent in the visual landscape and a reciprocating reflection of the people existing within it at a particular time and place.

Design provides the opportunity and vehicle to invite participants to engage and connect to their place in the landscape, localized natural processes, and larger global driving forces with the purpose of revealing their contribution and involvement in these contexts. This is accomplished with experiential and process-revealing design, in which the resulting experience of a place is enhanced by the visitor's contemplation of the processes by which the space was shaped.

Spot under bridge construction periodically filled with water which reveals connections between human and natural processes

Project Site:

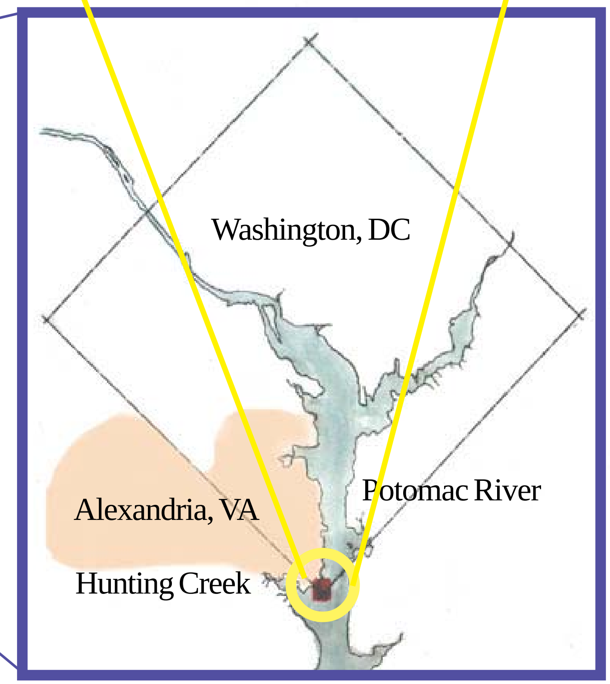
The site chosen for hypothetically testing physical design ideas grounded in the discussed theory and concepts is the result of both physical and human processes. Jones Point Park presently is composed of about 70 acres of developing park land located on southern waterfront of the City of Alexandria, Virginia, which is in the upper reaches of the Potomac River just south of Washington, D.C.



Southern waterfront area of Alexandria, Virginia

contiguous United States of America

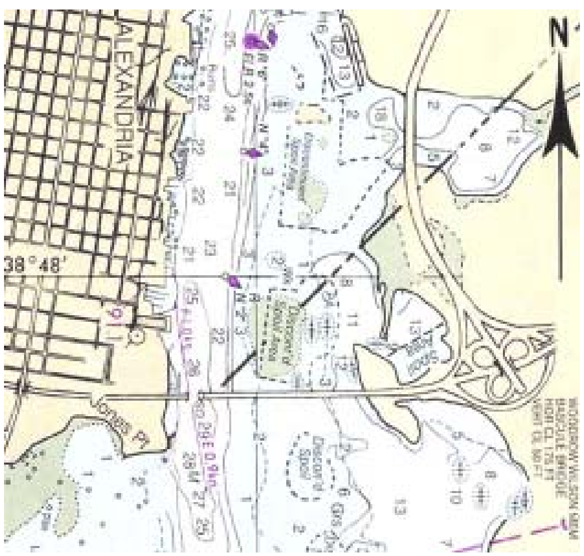
Chesapeake Bay region on Atlantic side



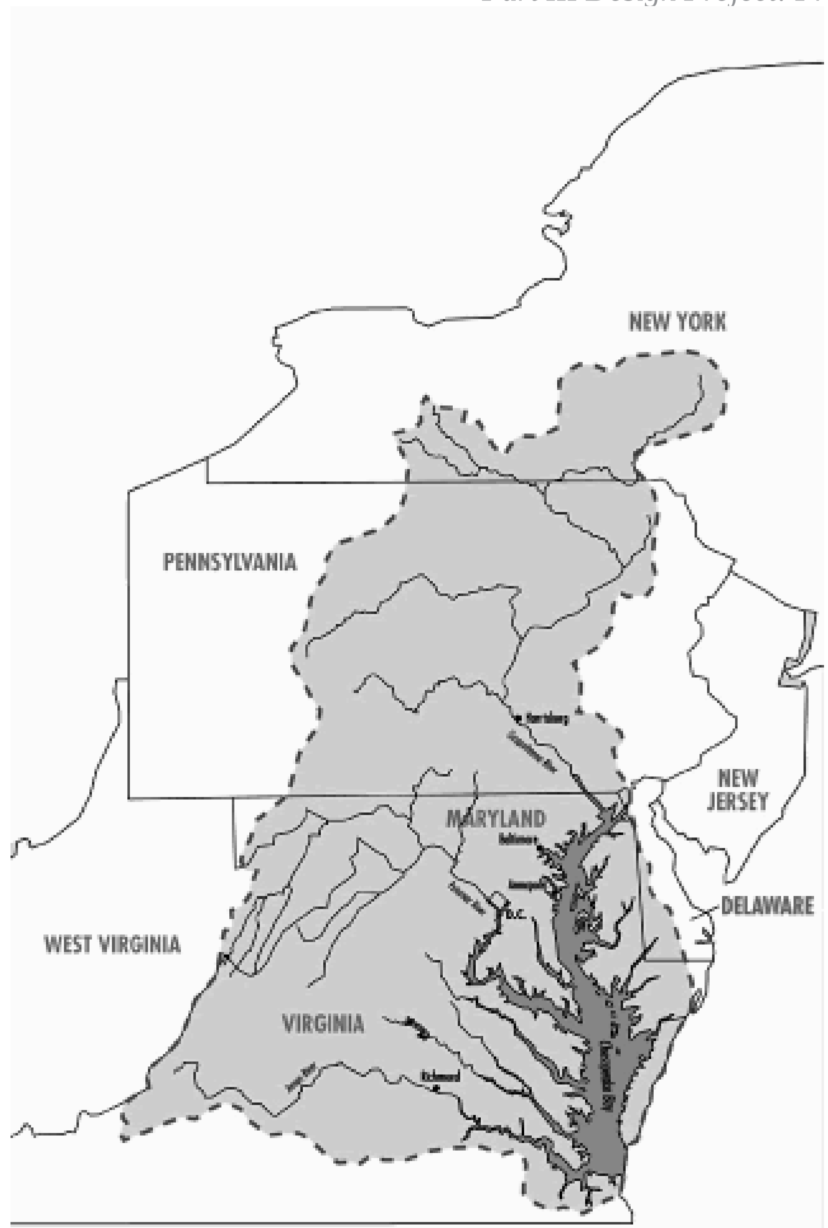
Upper Potomac River area of Alexandria and DC

Jones Point, Virginia

- Geographic setting: Mid-Atlantic plate, coastal plain, upper reaches of Potomac River (tidal influence and tributary to Chesapeake Bay estuary), and mouth of Hunting Creek
- Southern most waterfront of Alexandria, forming corner between west bank of Potomac and north bank of Hunting Creek
- Adjacent to urban development and bisected by Woodrow Wilson Bridge overpass (to be replaced by New Potomac Bridge in general location scheduled for completion in 2008)
- Significant Periods (trading post, Battery Cove, rope walk, cornerstone of Federal City, Light house, sea wall and river spoils deposited, Virginia Shipbuilding Co., Army training facilities, National Park Services training facilities and recreational use)



water chart map of Potomac River with Alexandria, Virginia on the west



Chesapeake Bay watershed area crossing six states

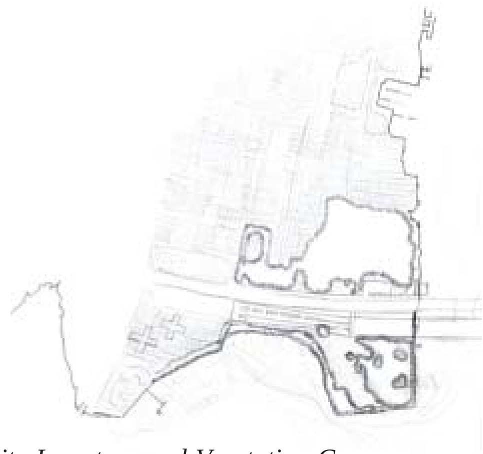
A n a l y s i s:

This section explores the analysis of human and natural systems and processes related to Jones Point. Human and natural systems are difficult to describe separately since they are two titles for physical systems which entail actions and reactions of one playing off of the other. So the areas used in analysis are:

- Settlement
- Site Grading and Drainage
- Ecosystems
- Water Movement and Edges
- Current Uses

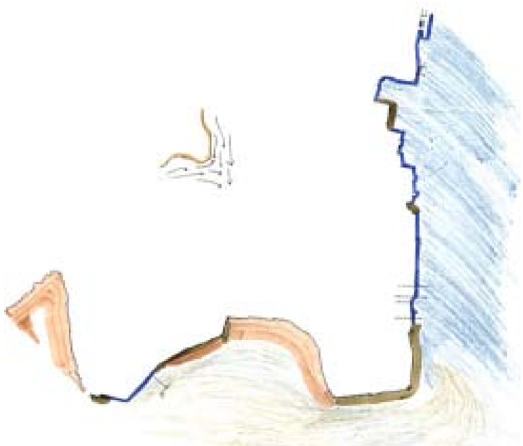
Project Process:

- Understand location of prominent physical processes and relationship to adjacent areas of Jones Point, watershed, and Alexandria development
- Delineate areas of change/intervention and to remain
- Develop master plan for Jones Point Park implementing eco-revelatory design …and sequential periods of installation
- Further develop specific opportunities and predicted change over time



Site Inventory and Vegetation Cover large areas of volunteer forest bisected by the construction of the 8+ lane bridge

Last formed natural shoreline of 1910 with footprint of buildings and shipways used since in-filled

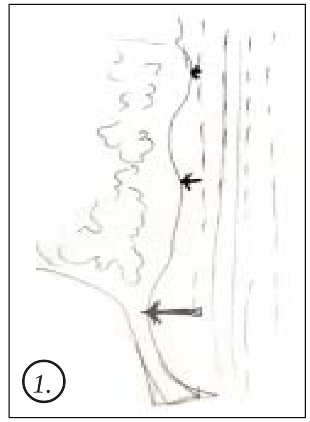


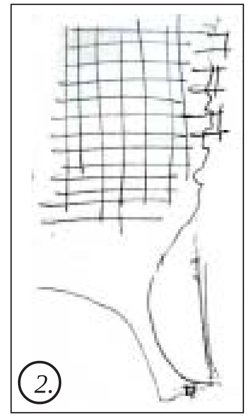
Steeper banks and faster water of the Potomac to the east and slow shallow water to the south of Hunting Creek

Settlement

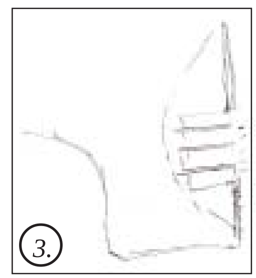
Learning about how the area was changed over time was a good exercise in realizing the interrelatedness of humans and natural systems. Significant points are covered here. For a more in-depth timeline see the timeline in Appendix A.

- Alexandria settled along the deeper, bank-cutting side of the Potomac River, which allowed for more boats and ship access
- Rectilinear grid layout of city aligns with Potomac River bank
- Cornerstone laid of Federal City, which encompasses a defendable portion of the peninsula where the Potomac and Anacostia Rivers merge
- Port-industry economic basis for city's existence and complemented with railroad amenities on land
- Increased technology pushed the use and transition to automobiles, leading to major road and bridge construction
- Development and settlement continued to edge of city as far as the 8' contour along waterfront to be mindful of tidal river changes, estuarine systems (see Appendix B), and major storm/flood events until recent use of retaining walls and elevated housing developments in areas just north of Jones Point
- 64 acres of Potomac River dredged and cove filled to be used by various occupants from a contracted shipbuilding company, army facilities, and national park services

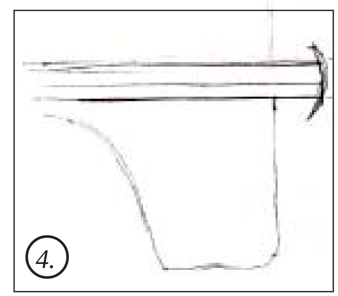




Alexandria's changing waterfront

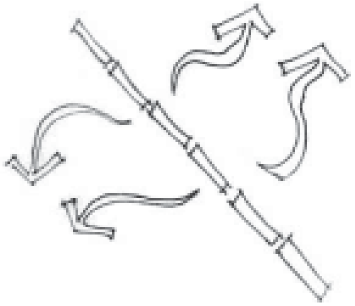


The figures illustrate some of the changes to Jones Point in conjunction with the settlement of Alexandria. The earliest part of port development was in the northern area where the deeper part of the channel was nearest the shore (1), leaving the area near Jones Point undeveloped (2.). Later when the cove is filled with spoils dredged from the Potomac (3.) was it sporadically occupied and then bisected by the construction of the Woodrow Wilson Bridege

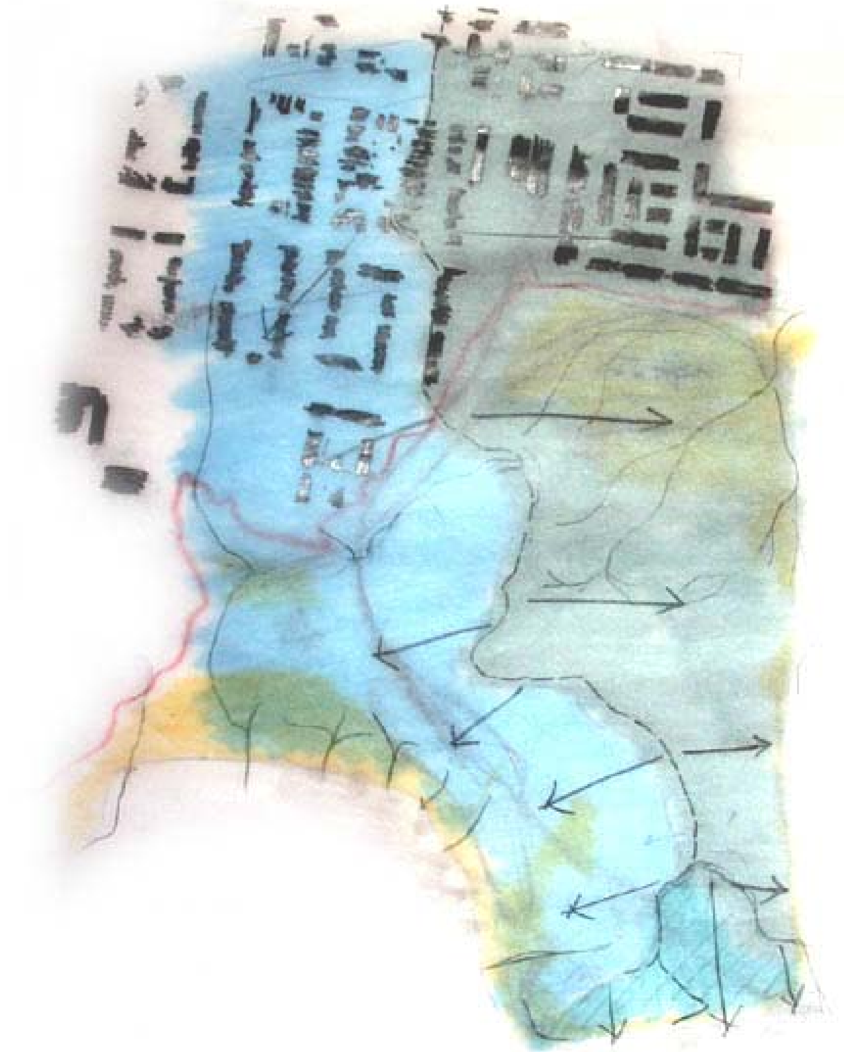


Site Grading and Drainage

Jones Point is within the floodplain of the City of Alexandria and has very little grade change. Areas adjacent to the site are greater than 4% and then are no more than 4-2%. A very slight ridge line runs diagonally through the Jones Point site, dividing the runoff to either the Potomac River to the east or Hunting Creek to the south. This ridge aligns with the former peninsula strip before the cove was filled in the early 1900s.



Diagonal drainage of water on Jones Point

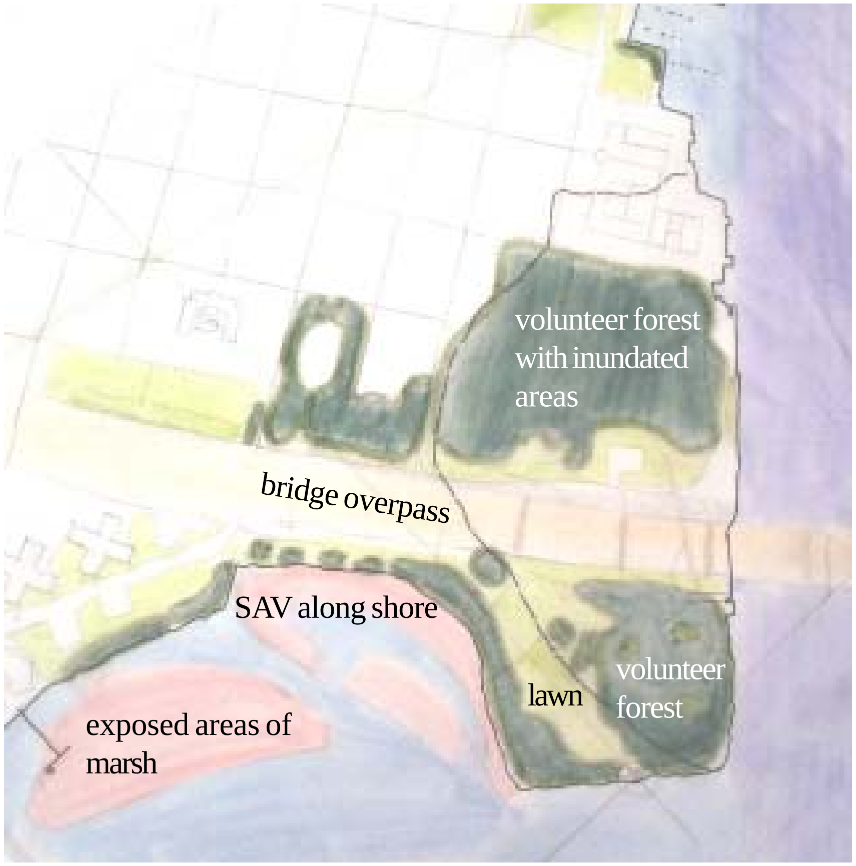


Analysis of drainage of Jones Point and area north to see direction of runoff and lower elevation areas of shoreline affected by estuarine tidal changes and raised water levels

Ecosystems

In a very broad sense are these listed below but change is expected as well as the geomorphology of the shoreline.

- volunteer forest areas dominate with inundated patches by fresh and slightly brine water
- gradual slopes have areas of tidal marsh and submerged aquatic vegetation (SAV)
- managed areas of lawn and community gardens for "park" use
- micro-climates of shade tolerant communities under bridge, wind tolerant areas along breezy riverfront



Analysis of ground coverings and massed vegetation which shows most of the volunteer forest to exist in the filled cove area east of the former shoreline indicated by dashed line.

Shallow waters and submerged aquatic vegetation along Hunting Creek

Shaded areas under bridge and forest canopy

Rocky shores along south side of Jones Point adjacent to the lighthouse

Managed playing fields and view to bridge construction

Water Movement

Three interactive types of water shape and affect Jones Point: tidal estuarine, fluvial river, and storm water runoff.

See appendix B for more information on esturarine movement. There is a diurnal, twice a day, change in the average water level influenced from tidal conditions and seasons that fluctuates an average of three and a half feet. This change is more apparent in the shallow waters of Hunting Creek and not so much on the steeper, reinforced banks along the Potomac. There is more description on the next page. Fluvial movement of the Potomac River dominates with its massive volume, depth, and velocity compared to Hunting Creek, which should be considered when making changes to the eastern edge of the site design. Urban runoff contributes to sediment and nonpoint source pollution to the marsh area as well as fluctuating water quantities.

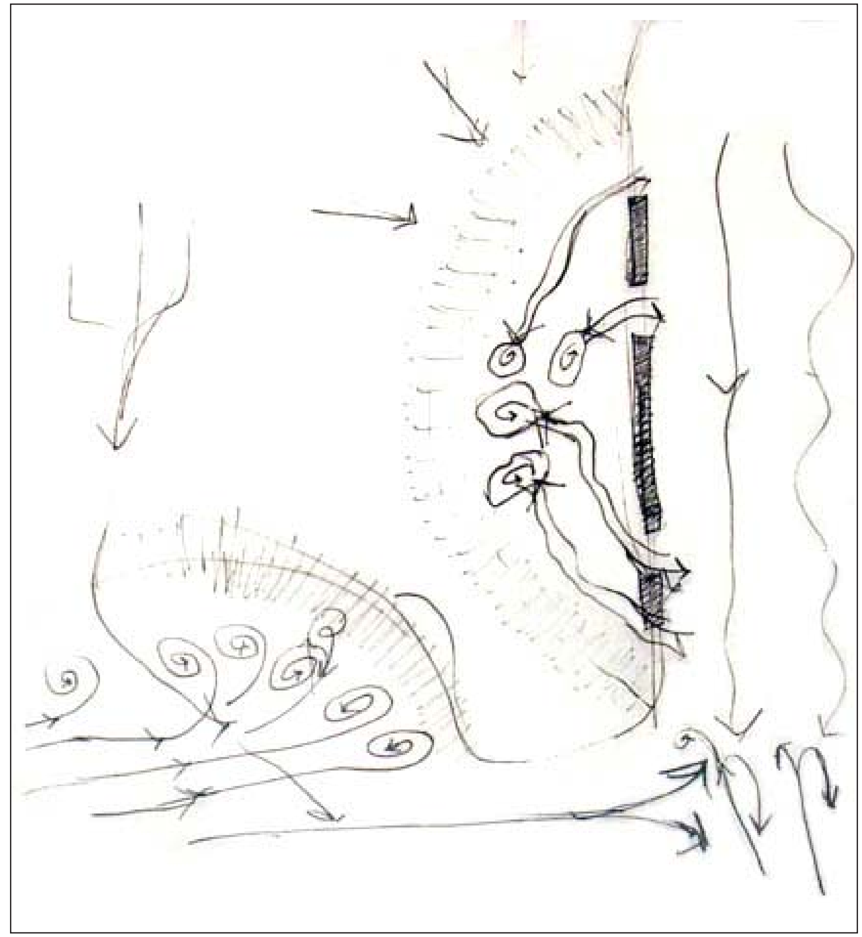
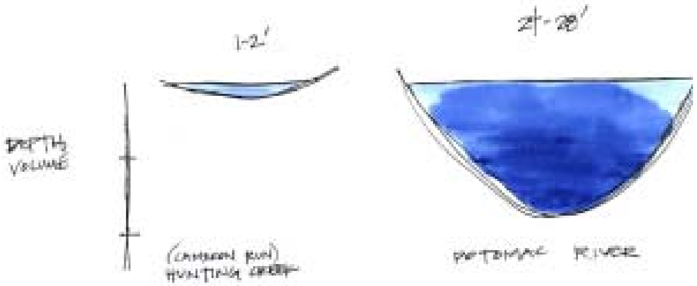
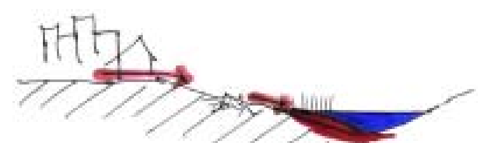


Figure exploring the influence of the different water movement during the past, present, and possible future of Jones Point



Conceptually comparing adjacent, merging waterbodies

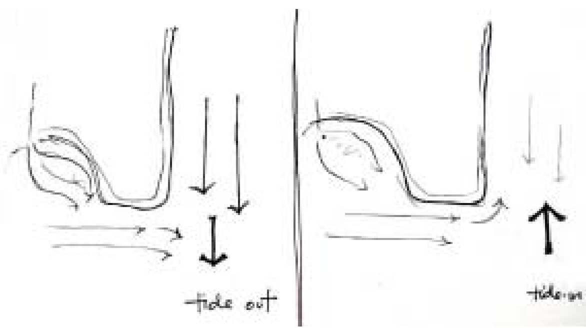
Comparison of fluvial water movement



Increased sedimentation and speed of urban runoff

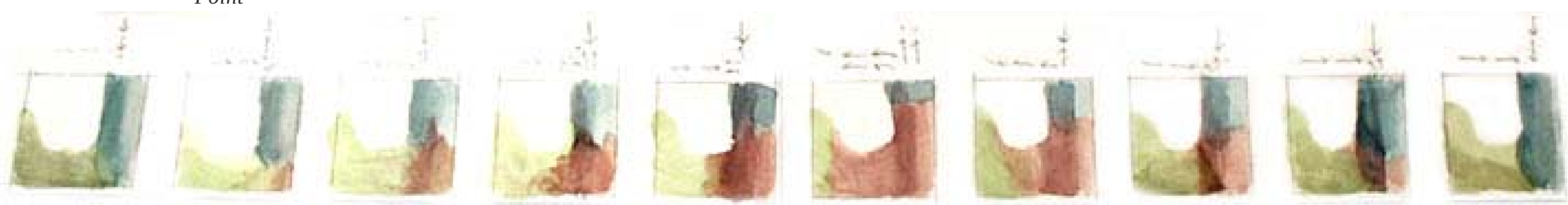
Water Movement

Estuarine influence on water movement. In estuaries, two opposing forces merge together, trading-off periods of domination. They are the fluvial freshwater bodies and the tidal marine waters. The bottom sequence of fingures diagrams the merging fluvial freshwater movement being opposed by the rising tidal water movement as it happens twice a day. Appendix B describes more specific detail on the Chesapeake Bay estuary system.



Varying movement of estuarine waters at Jones Point

Watercolor of methodical horizontal movement and gravitational vertical movement

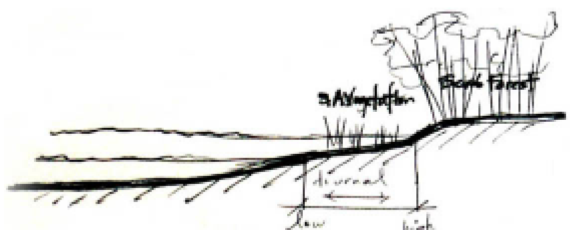


Conceptual depiction of tidal waters flowing against fluvial freshwater in diurnal periods, twice a day

Sketch of transitional edge of urban development of naturalized area

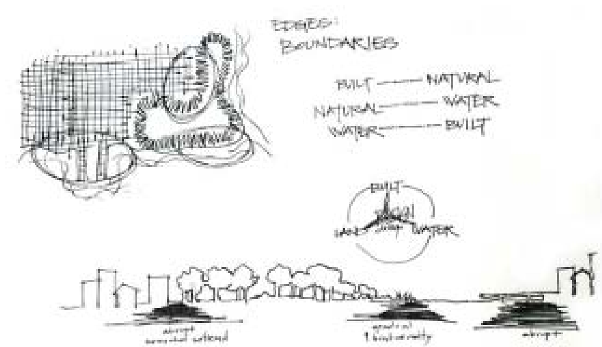
E d g e s

Edges are perceived in physical and conceptual forms. They are similar to boundaries but with less exactness. Some of the edge situations explored were the urban development met the naturalized area, where land met the water, where the rectilinear grid met the meandering streams, where asphalt and concrete meet mulch and gravel paths, where enclosed canopies opened into views and clearings, where forests canopies transitioned to bridge overpass shading, where dry land transitioned into soft wet areas.



Conceptual section of water-land edge changing twice daily

Sketches of canopy edges and vertical sloping

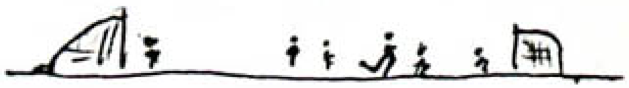


Sketches of physical boundaries

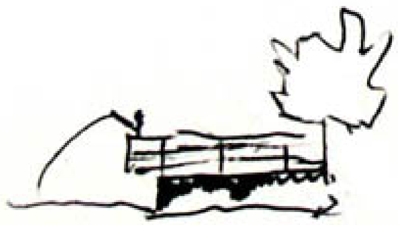
C u r r e n t   U s e s

Current uses include:
- pedestrian and bike circulation paths
- fishing areas
- playing fields
- community garden plots
- gravel parking lots and access road
- bridge construction and administration trailers
- historic lighthouse, markers, and plaques

Natural vegetation and wildlife look-outs



Maintained lawn of playing fields

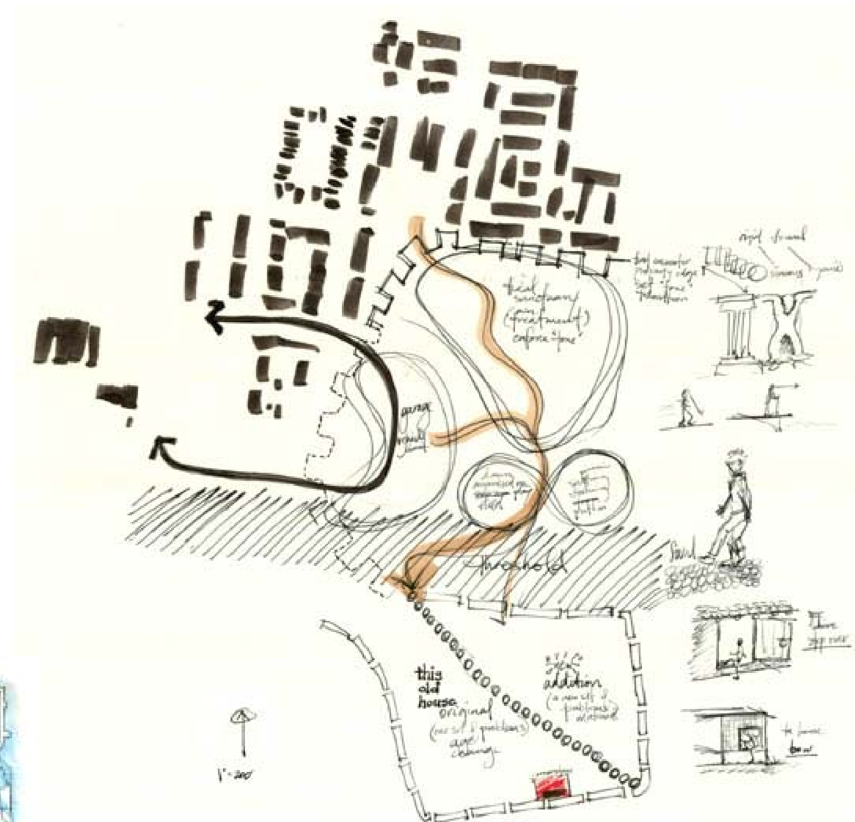


Stabilized docks or banks for fishing

Design Concepts:

This section contains the building blocks of ideas used to reach the final design and divided into sections:

- Zoned Areas and Uses
- Program
- Emphasis of Shoreline
- Design Concept Sketches

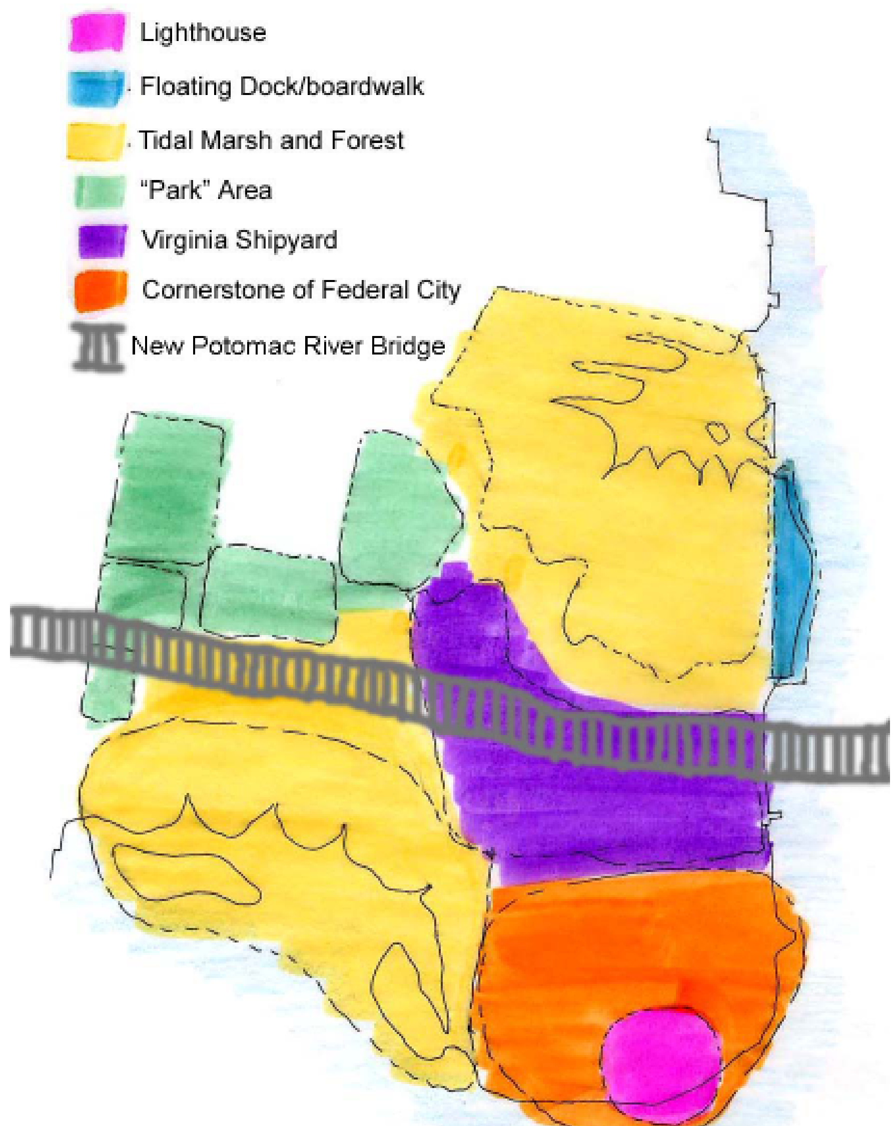


One example from the conceptual phase when contemplating the age and physical characteristics of natural processes

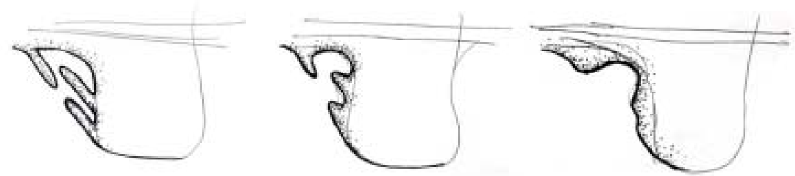
Conceptual grading plan, on left, and proposed grading plan are a couple of the products from the conceptual process

Zoned Areas and Uses

Zoned areas used to emphasize program and experiences which are significant to cultural history or physical process. Proximity to urban area or waterfront helped to associate different uses and programmatic desires. There are interconnected circuits of paths for passive recreation and bike trails that transect the park's various settings using conceptual areas and transitioning through space and views and visible changes in landscape (daily or longer-term).



Proposed areas of design plan



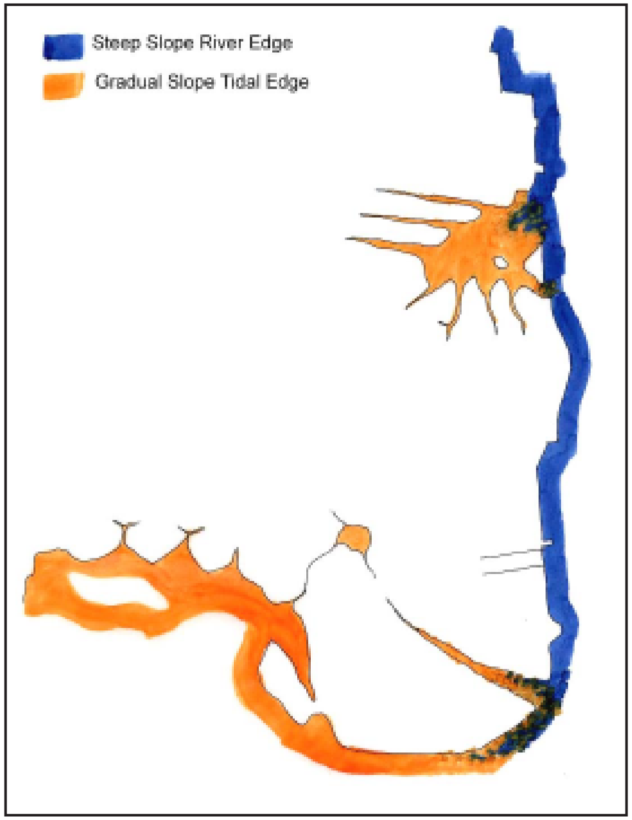
Anticipated change of shoreline over time and through physical processes

Program

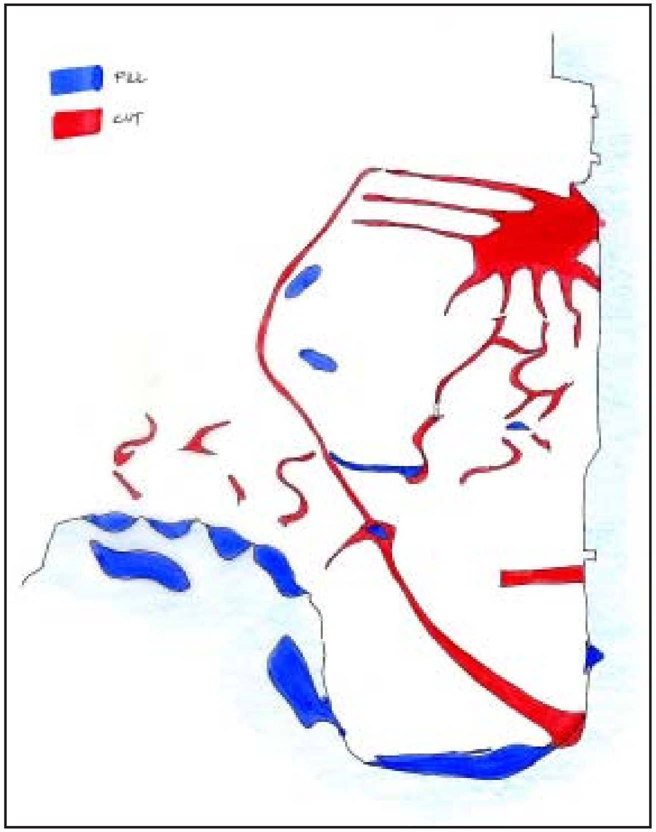
The design uses passive recreation in the form of paths and (non-motor) boat docks informed by significant periods of the sites human and natural history. There is an underlying emphasis on revealing and utilizing fluvial and tidal systems within human systems. Physical change is expected over time and through physical processes, especially in the appearance of the shoreline and water movement through the site. This is encouraged with grading changes over time.

Water-Land boundaries of proposed design

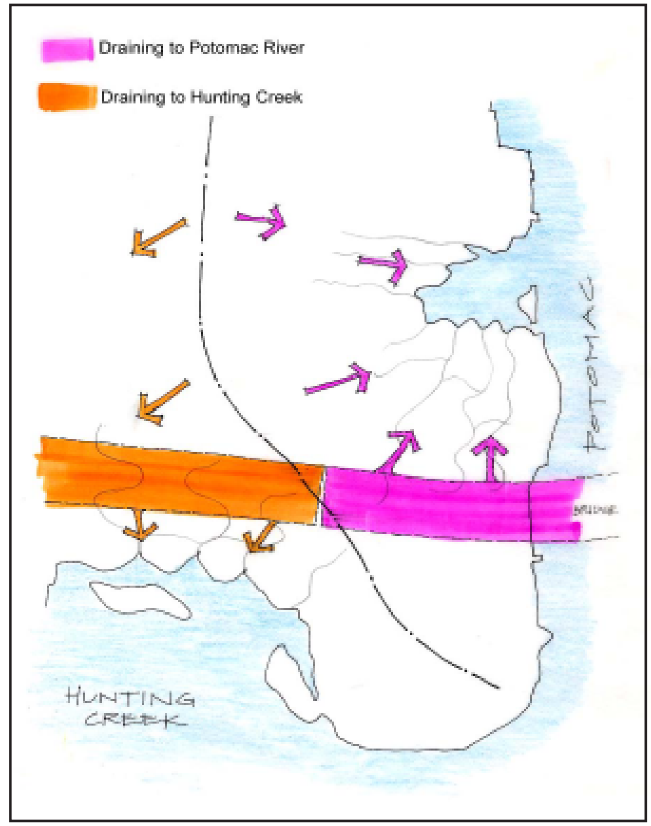
Network of pathways and boardwalks of proposed design



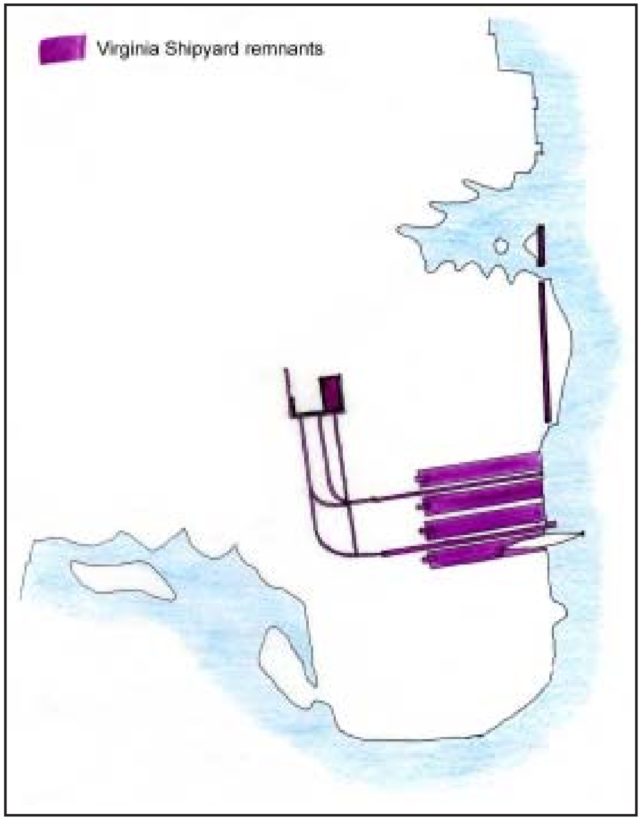
Proposed shoreline angle and edges of Jones Point in which the shallower portions are predominantly shaped by tidal movements and the steeper banks by fluvial river movements



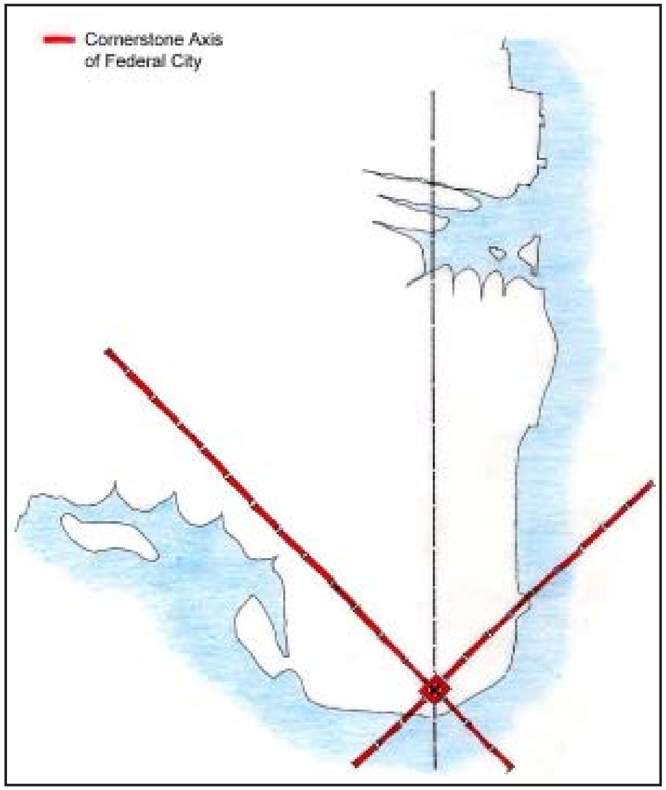
Proposed grading of Jones Point with areas of cut and fill



Proposed drainage of Jones Point and new bridge overpass which remains consistent with original, diagonal flow of stormwater runoff



Proposed design enhancing significant occupation of site by Virginia Shipping Company with front facade of main assembly building, four shipways with two craneways between them, connecting railroad tracks, and reinforced retaining wall

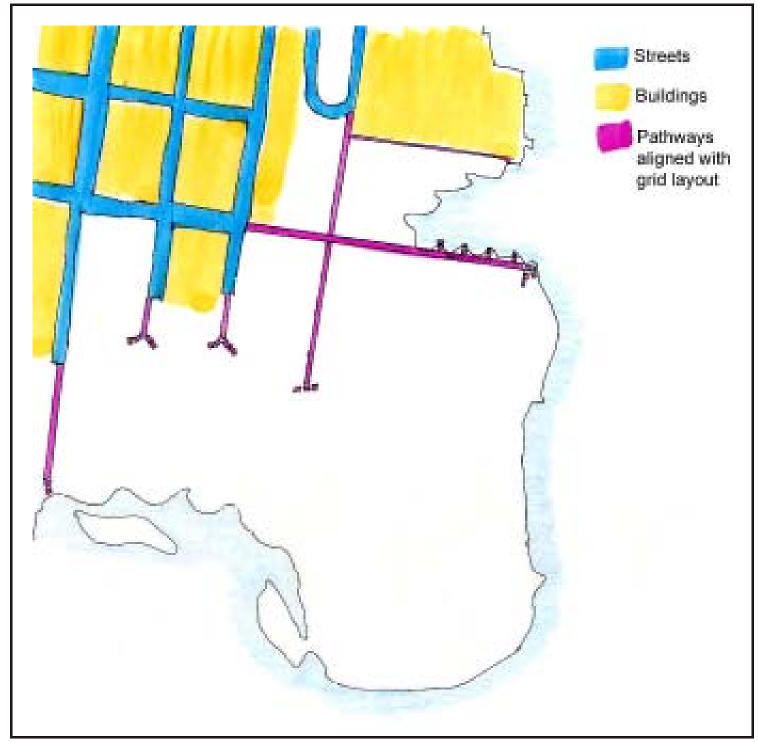


Proposed design to enhance cornerstone and axis of Federal City to Jones Point with the use of aligned views and markers

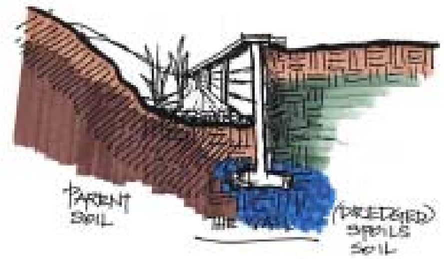
Proposed design revealing the last naturally existing shoreline of the former Battery Cove through the use of a short, wood retaining wall on one side (to the east) allowing the natural slope on the other (west) side

Proposed placement of "park" uses, such as playing field, parking, community gardens, basketball courts, picnic area, and restrooms, to be adjacent to urban grid to maximize use and transition space

Proposed pathways and boardwalks as seen with adjacent grid system



Proposed pathways which align and extend from the existing urban grid of Alexandria's streets, transitioning into the more naturalized area of Jones Point

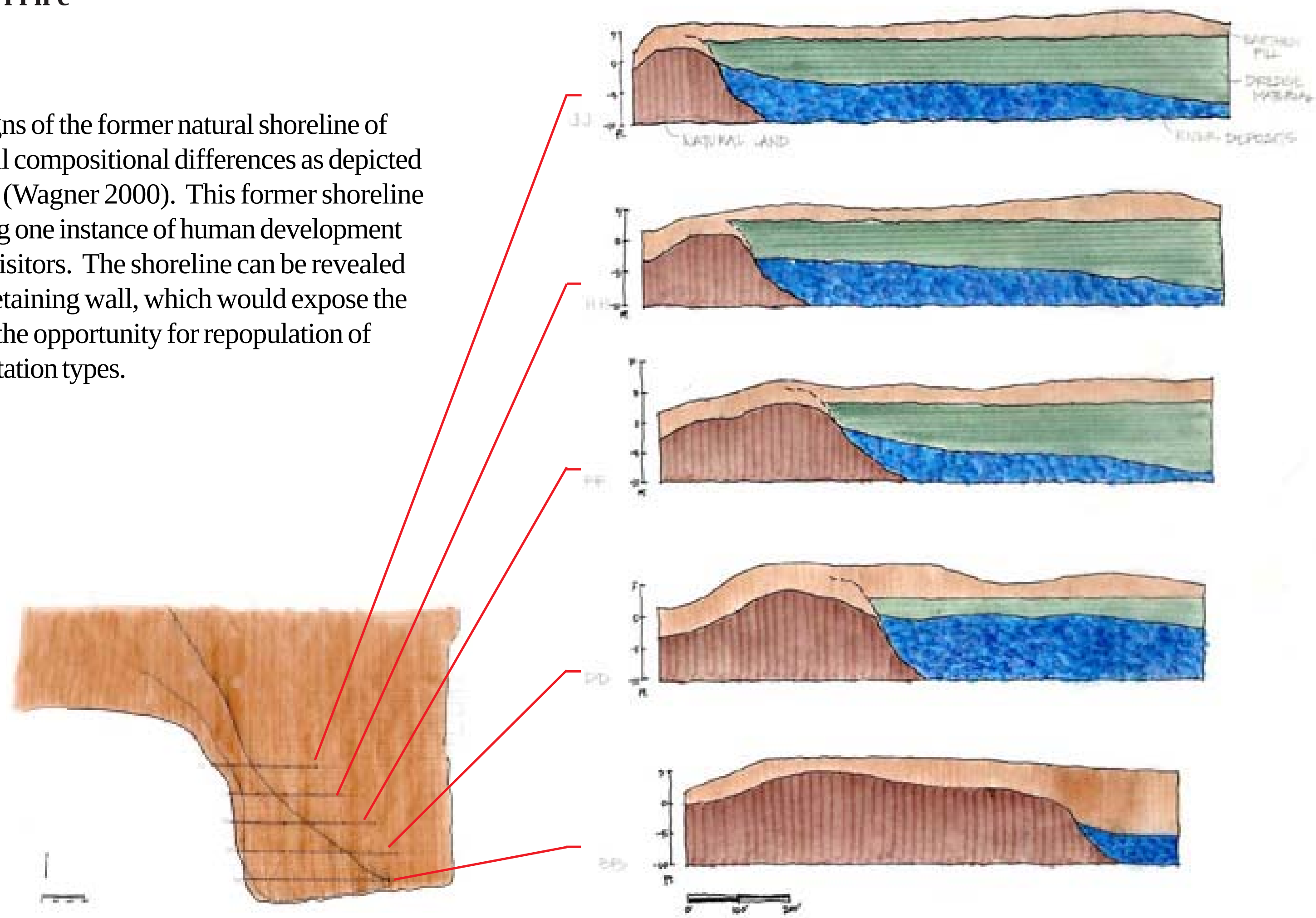


Conceptual sketch of proposed retaining wall to reveal shoreline

Emphasis of Shoreline

A century later, there are still signs of the former natural shoreline of Battery Cove and significant soil compositional differences as depicted in the soil borings done in 2000 (Wagner 2000). This former shoreline holds high potential for revealing one instance of human development in natural systems to potential visitors. The shoreline can be revealed with the use of a simple wood retaining wall, which would expose the shoreline once again and allow the opportunity for repopulation of willing submerged aquatic vegetation types.

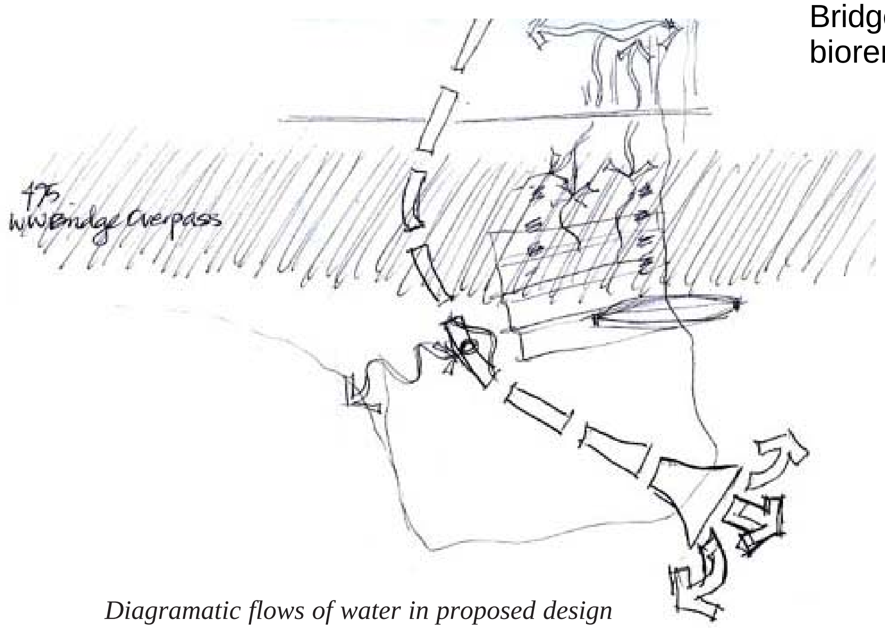
Proposed shoreline emphasized in design



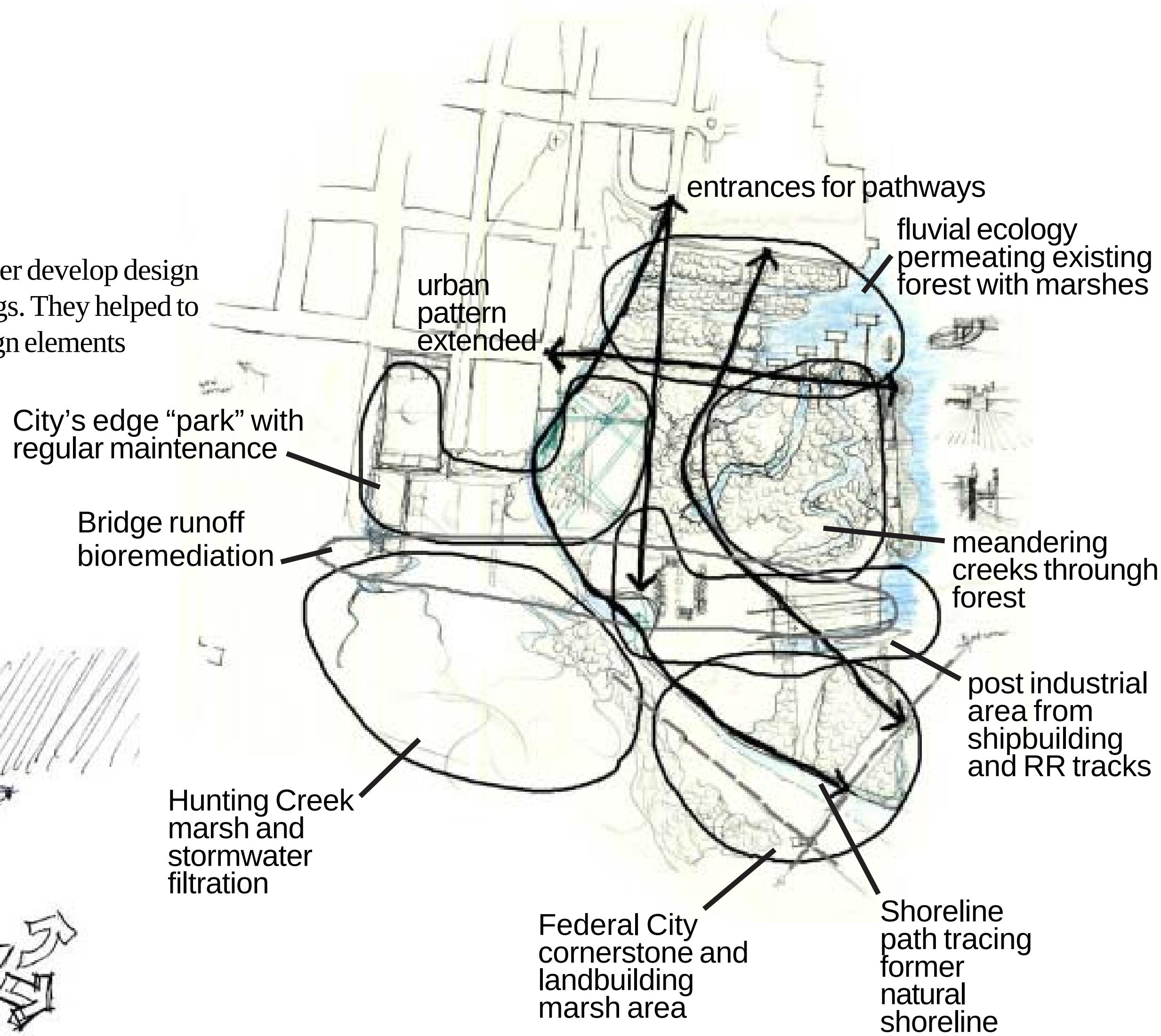
Soil cores extracted from Jones Point to reveal former shoreline with portions of natural land (dark brown), river deposits (blue), deposited dredged material (green), and earthen fill (light brown)

Design Concept Sketches

These sketches are visual explorations used to further develop design issues with plans, sections, and diagramatic drawings. They helped to clarify circulation and exact form and layout of design elements throughout Jones Point.

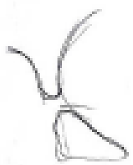


Diagramatic flows of water in proposed design

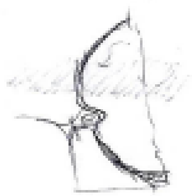


Sketch of water elements throughout design for Jones Point

Design Concept Sketches

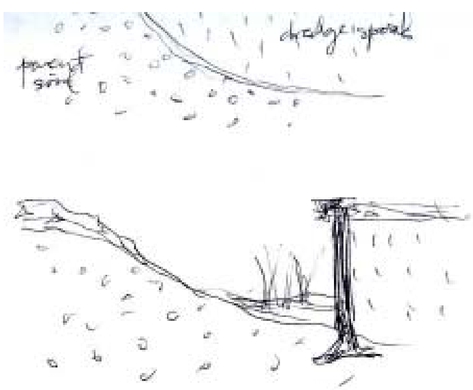


historic shore with high water

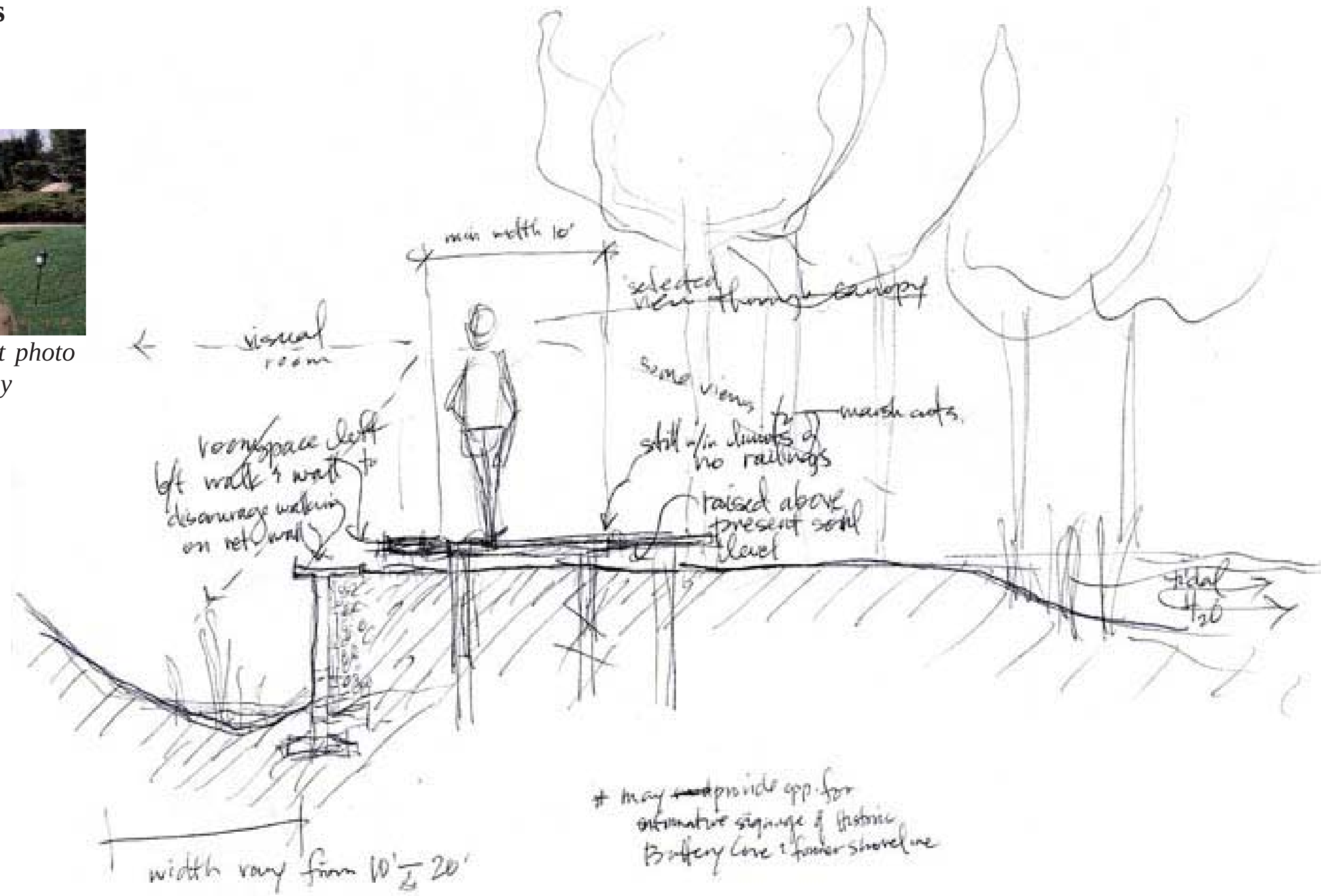


proposed design with interpretive shore walk

Company product photo of sample pathway

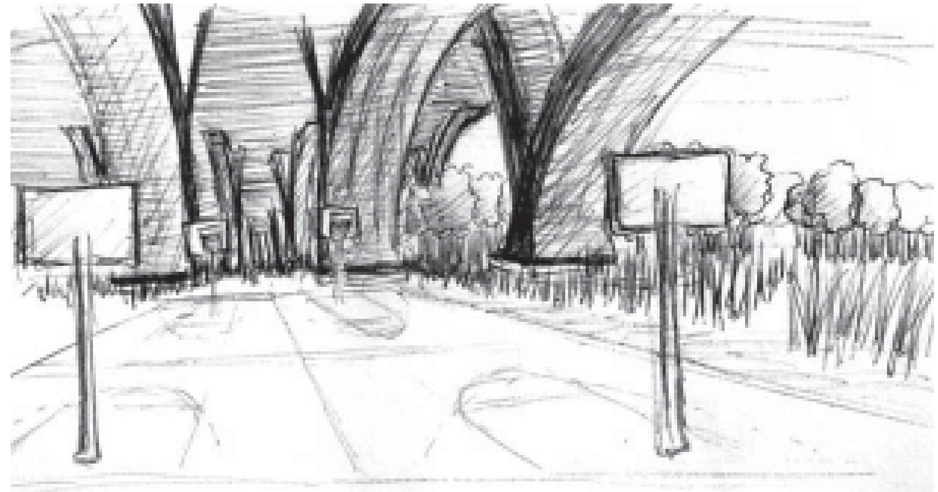


Beginning stages of developing a retaining wall to reveal shoreline

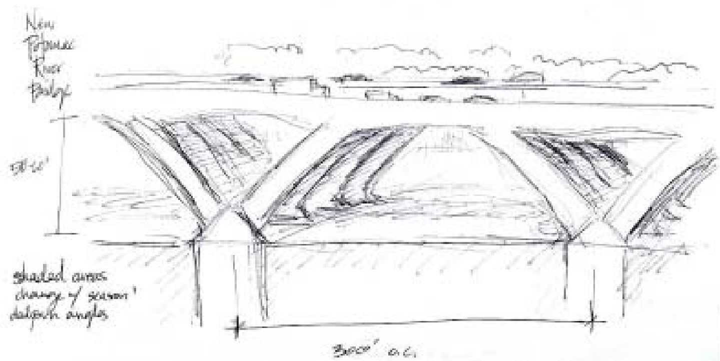


Conceptual section of retaining wall and pathway along wall to test widths, views, materials, assembly, and surrounding vegetation

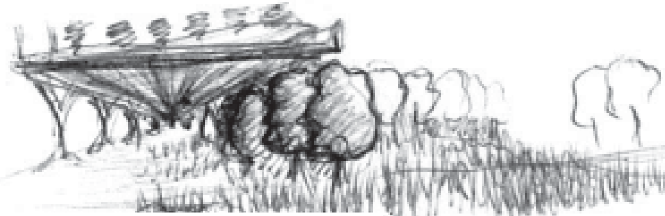
Design Concept Sketches



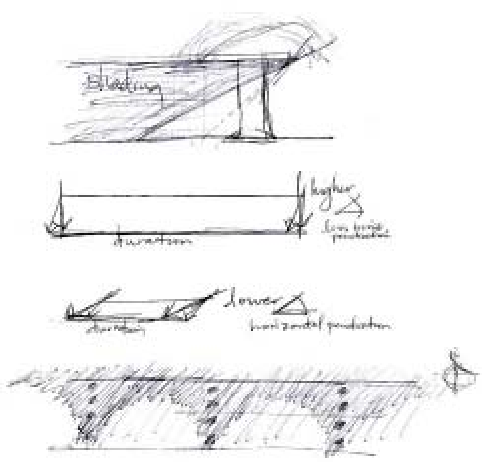
View under bridge with basketball courts and vegetation to combine recreation and water filtration of bridge runoff using the marsh area



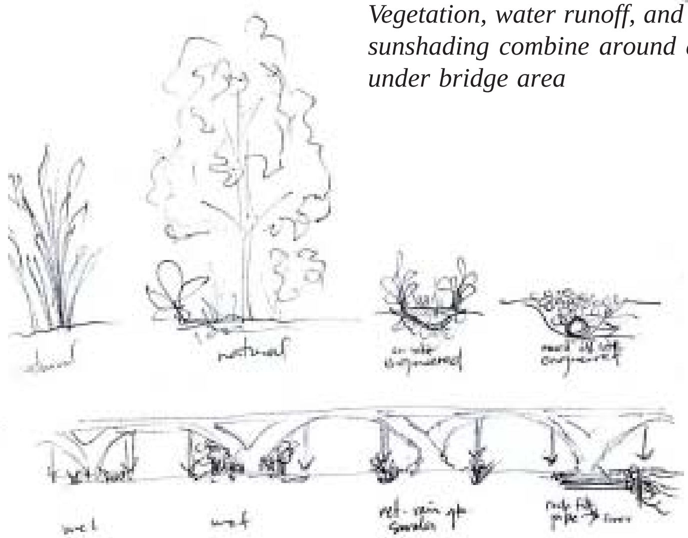
Sketch of dimensions of New Potomac River Bridge overpass to help understand its physical presence through Jones Point



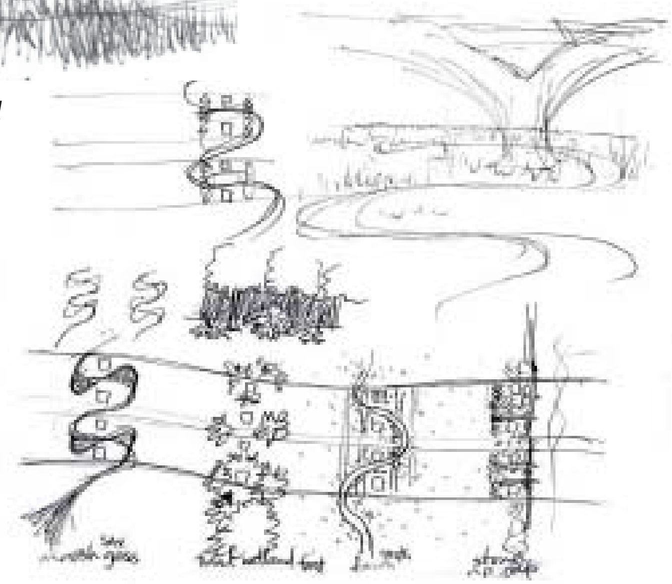
Vegetation, water runoff, and sunshading combine around and under bridge area



Sketches to consider the sun-shade impact of the New Potomac River Bridge overpass bisecting Jones Point



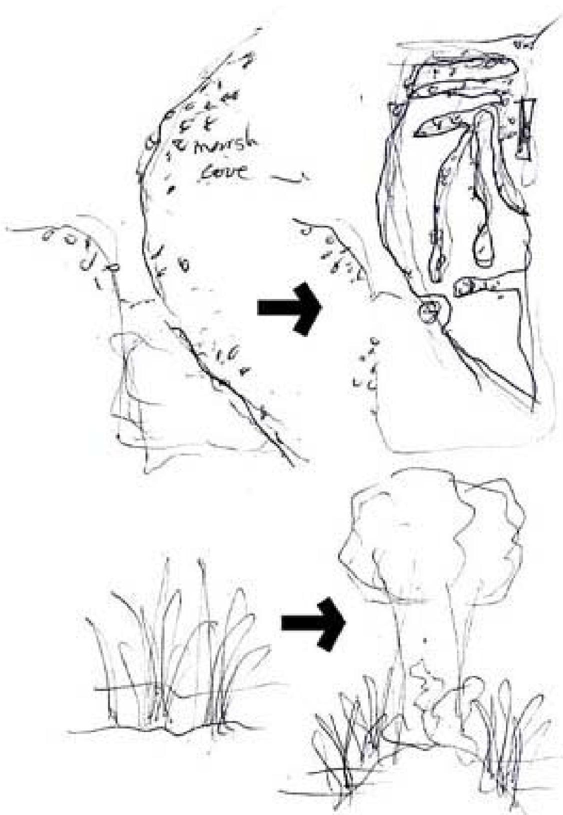
Considering directing the bridge runoff over different areas of vegetation in proposed design



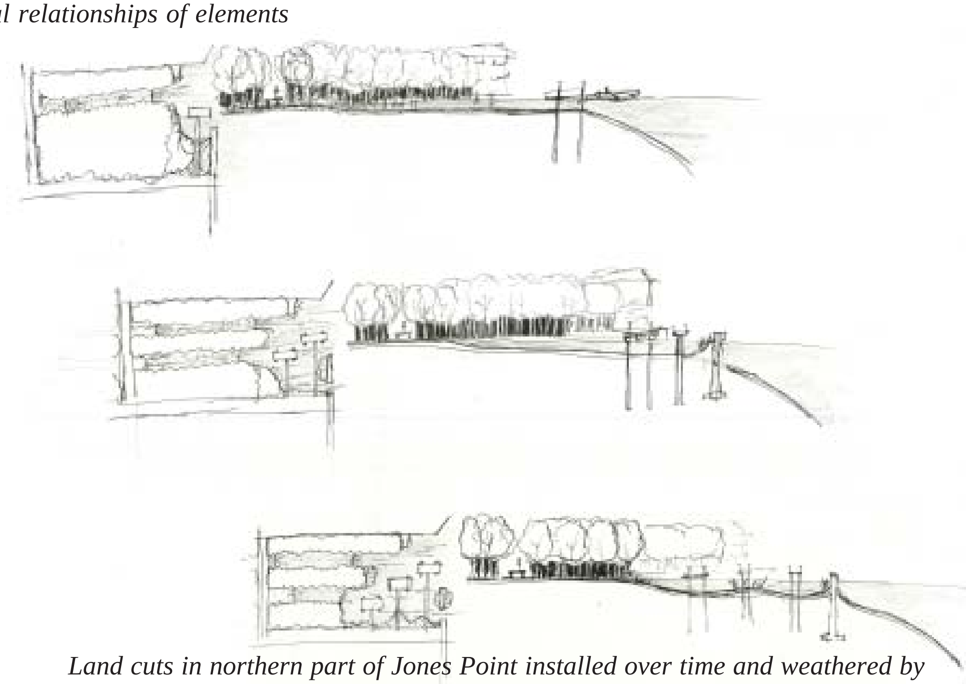
Proposing bridge runoff to descend by bridge footings and interact with different physical processes and vegetation in proposed design

Design Concept Sketches

Sketch of pathway through tidal marsh area towards floating pier working on material, dimensions, and physical relationships of elements



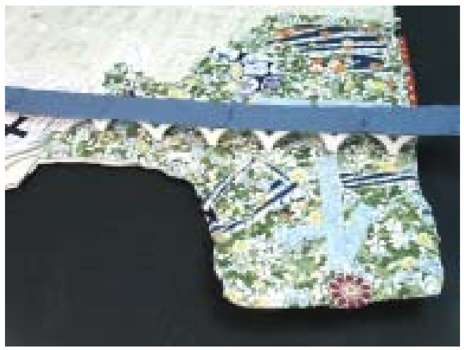
Exploring the relationship of the historic, natural state of Jones Point and the proposed re-introduction of tidal areas in the man-made land mass



Land cuts in northern part of Jones Point installed over time and weathered by dynamic water processes

Design Concept Model

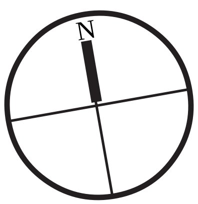
Concept model of Jones Point in relation to urban fabric of Alexandria, Virginia and the bridge overpass

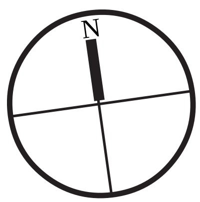


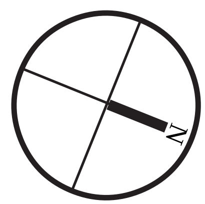
Southern part of Jones Point with lighthouse and cornerstone of Federal City and view to bridge

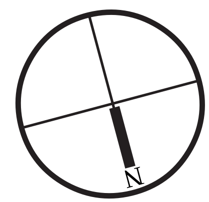
View of Jones Point fron northeast and physical impact of bridge overpass bisecting the area

View from north area of Jones Point looking down the Potomac River waterfront and under the bridge overpass









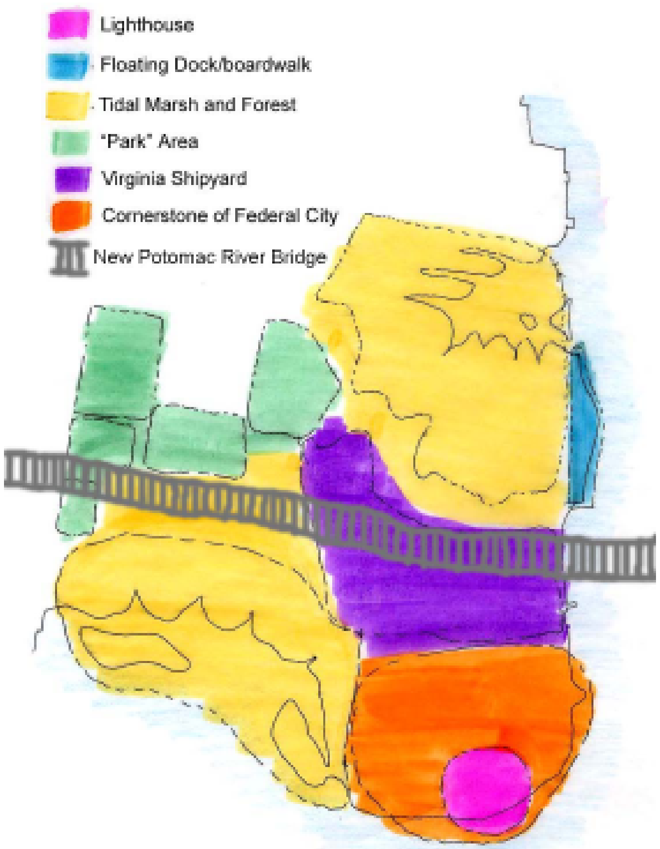
Design Master Plan:

The final design focuses on revealing the connected interactions of human and natural processes as they exist on Jones Point. Some of the main design elements include the circuit of pathways, of which reflect the boundary of the former Battery Cove shoreline along with revealed remnants from other human uses on the area,the increased presence of tidal marsh areas and water courses, the enhancement of the cornerstone and lighthouse area to emphasize its placement and alignment with the former Federal City, and the integration of the New Potomac River Bridge overpass with its physical surroundings and processes.

Some of the relationships addressed with proposed design are to improve the transition and placement of specific park areas and entrances related to adjacent residential grid layout and also of the dynamic water types attributed to the shaping of Jones Point - shoreline, river, tidal, and storm water runoff.

Historic map of Alexandria and Potomac River with the Federal City boundaries marked and JonesPoint in red

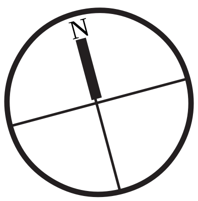
Comparison of present bridge (left) to a omposite picture of perspective view of New Potomac River Bridge (right) from Jones Point

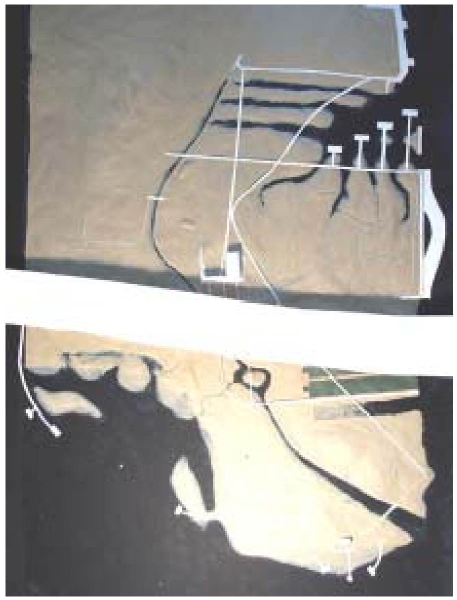


The proposed design extends the city of Alexandria to the water's edge and reveals its local, natural processes in connection with human systems and development. Periods of significance are emphasized with land sculpting, built structures, and pathways which reflect both natural and human influence. The daily and seasonal movement of water is expected to shift the shoreline's dynamic edge over time with erosional forces dominating in the northern area and depositional forces in the southwest, in accordance with its previous, natural formation.

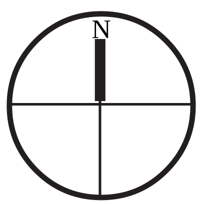
Jones Point Master Plan

Model of Jones Point area topography with highest point northwest of site. Most of site below 8’ contour and <4% slope

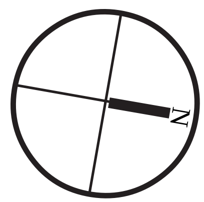




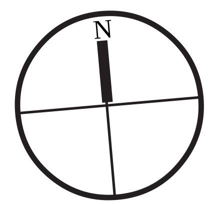
Afternoon sun in spring & fall casting shadow of bridge overpass and allowing sun under bridge on south side

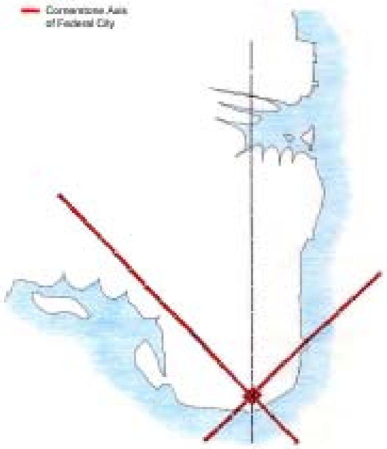


Bridge footings bisecting Jones Point and to serve as downspouts for bridge stormwater runoff

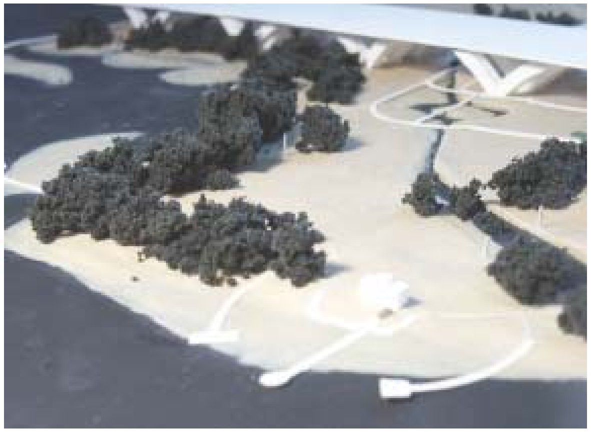


Proposed design of landforms, pathways, docks, and planted shipway areas under bridge footings





Southern cornerstone site and relation to west, north, and east markers



View from cornerstone to west marker

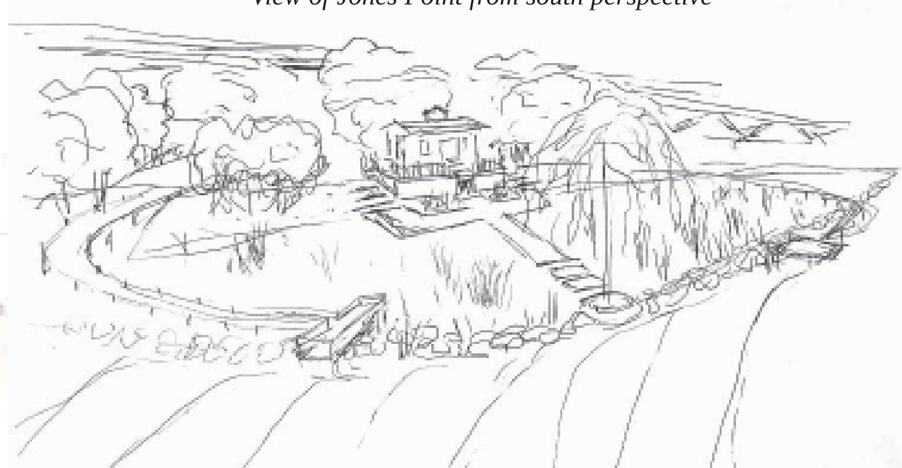
View from cornerstone to north marker

View from cornerstone to east marker

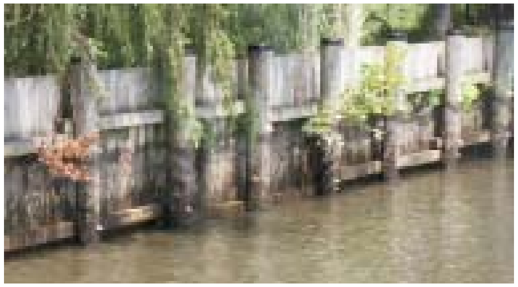
Present view of lighthouse and cornerstone encased in retaining wall and behind iron bars

View of Jones Point from south perspective

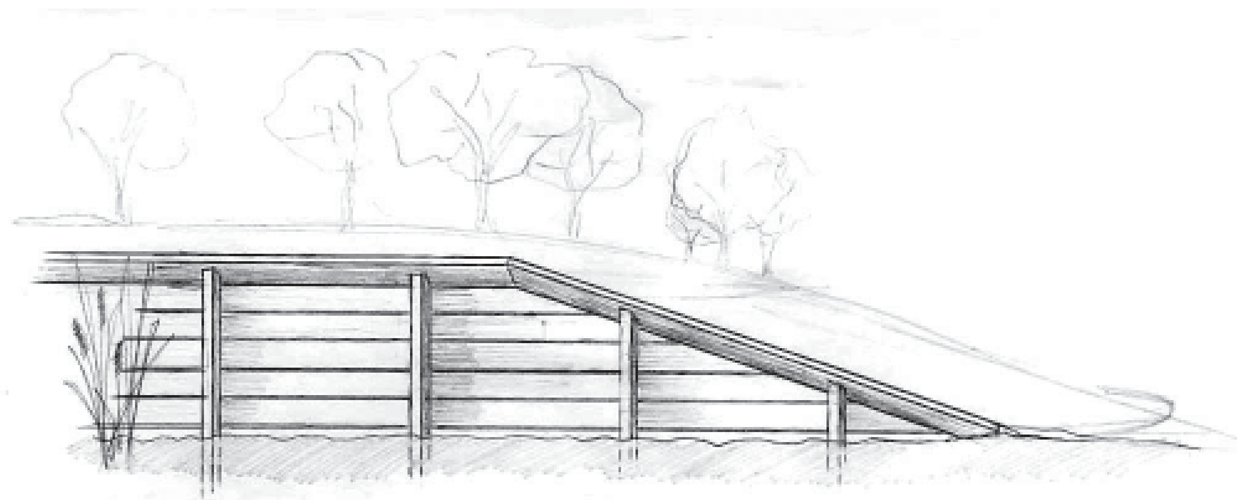
Perspective from southwest side of lighthouse and raised walkways over tidal plantings



South-southwest perspective of lighthouse and cornerstone walkways in tidal area

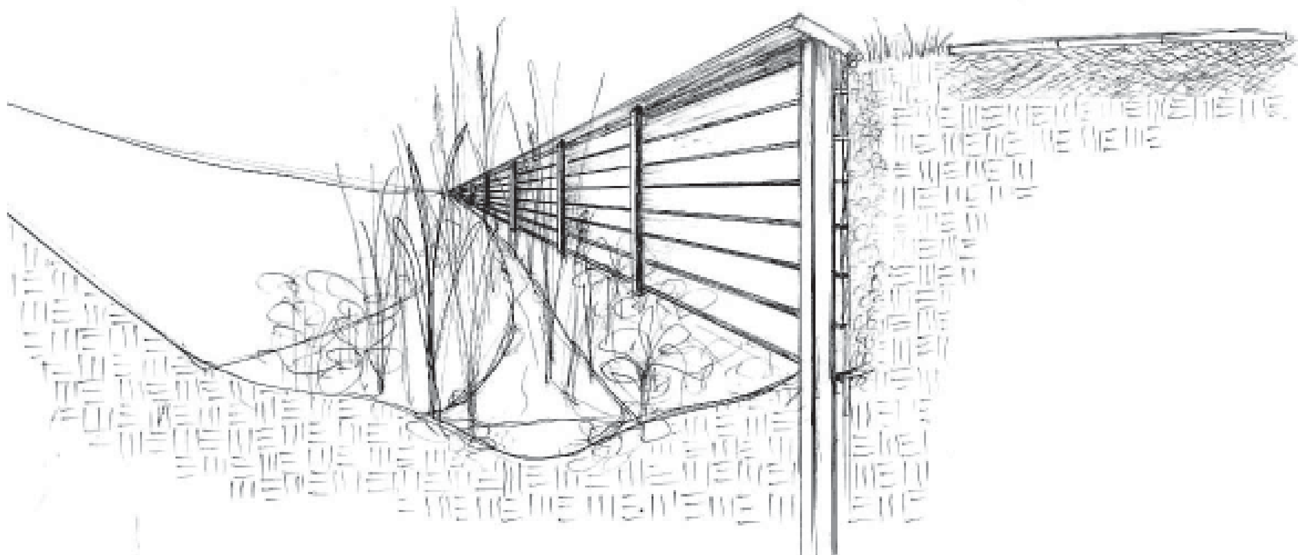


Example structures demonstrating similar characteristics in adjacent area of Jones Point

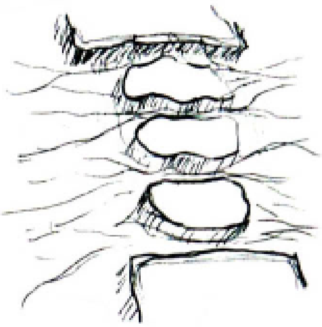


Front view of retaining wall as it terminates in the southern area of Jones Point

Proposed design to reveal and emphasize former, natural shoreline of Battery Cove with dredging and retaining wall



Section of retaining wall to allow for tidal water and aquatic vegetation as well as upper pathway

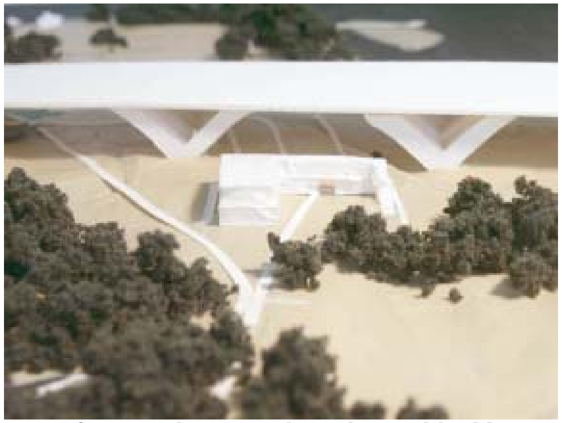


stepping stone path set in water to interact with changing levels

Model viewed from south-southeast

View from south of open space and pathways crossing water by bridge

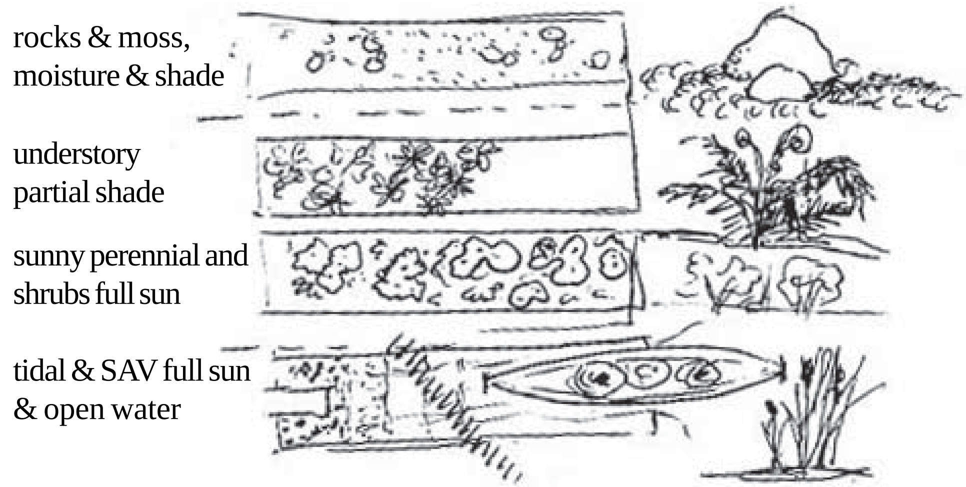
Perspective and plan of shipyard building facade and structure for restrooms and storage



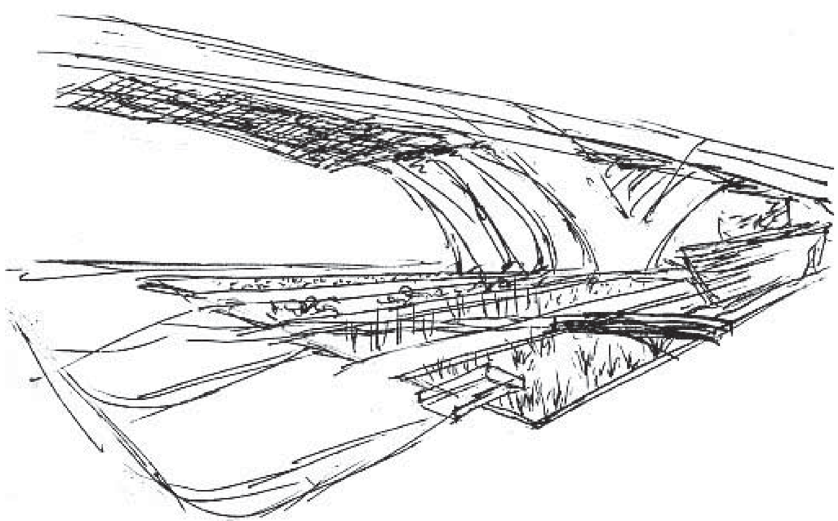
View from north approach to shipyard building

Southern view to shipyard building and picnic area

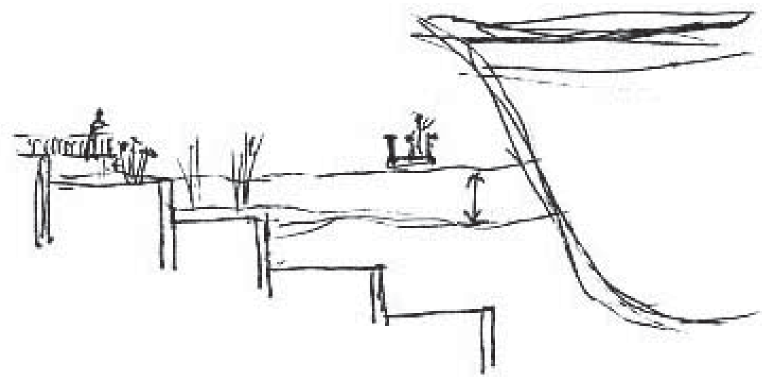
Planted shipway areas intersecting with bridge overpass



Varying planting beds based on microclimates and to service bridge stormwater runoff



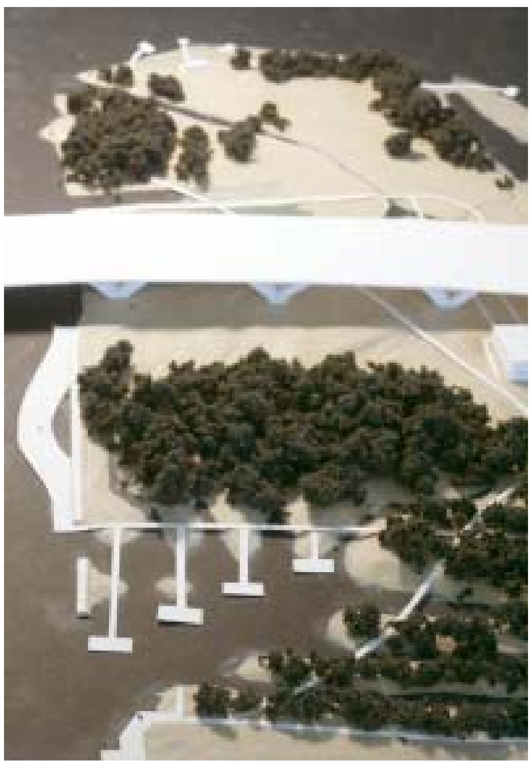
Perspective of planted areas under bridge



Section of southern shipway terraced into Potomac River

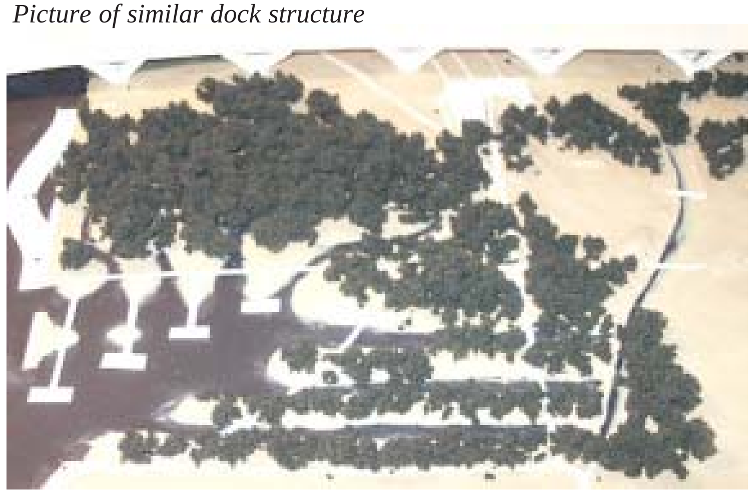
Composite view from walkway by tidal area toward docks and Potomac River

Perspective looking south at ground level of docks and New Potomac River Bridge



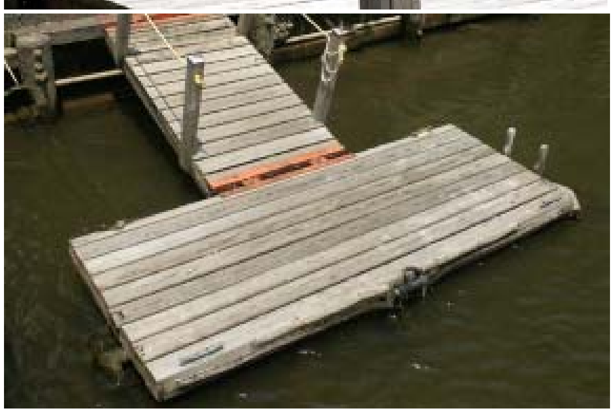
Picture of similar dock structure

View from north of docks and tidal marsh area



View of model from north to area north of bridge overpass

View from northeast into tidal dock area



Drawing from southwestern part of proposed design for Jones Point which enhances the landbuilding activity of the tidal marsh and terminus of Hunting Creek at the Potomac River

Example walkway to be used in tidal marsh areas

Examples of walkways and docks in tidal marsh area with SAV (submerged aquatic vegetation)

Perspective of proposed design on north entrance at Union Street

Perspective of proposed design from northwest towards playing field of Jones Point

Present view of north entrance

Present view of corner in west area of Jones Point

View of north entrance looking south along retaining wall to west entrance

Perspective of west entrance to Jones Point as seen from Green Street

View from northwest towards east entrances into picnic area

View from west towards west entrance in-line with Green Street

Design Conclusion

This project challenged the use of the landscape as the medium for revealing and reconnecting human and physical processes. The interweaving of cultural and natural influences became the driving forces of the design to better utilize Jones Point as an extension of Alexandria by embracing the significant contributions from cultural activities and natural forces. The design blends the border between the urban development and the natural setting of Jones Point with efficient placement of "park" areas adjacent to the city's grid development and opening up views into the site. The bridge is seen as an amenity to the site and not just a large impeding structure although there will be a great deal of shade produced by the overpass. The network of pathways aids passive recreation and circulation throughout the park. The paths reveal the shape and placement of the former, natural shoreline as well as extensions of the city's grid layout. The meandering water channels were enhanced to further the present state and provide the opportunity for the area to be populated and serve as a tidal marsh as well as filter stormwater runoff from the bridge. Change of the landforms and shoreline is expected and anticipated with erosive forces on the east near the Potomac River and depositional features on the south by Hunting Creek. So many elements of the design are from the blended efforts of human and natural processes.

Present state of Jones Point with mostly scrub forest bordering the urban development of Alexandria

Proposed design extending and connecting the urban setting and human systems of Alexandria with the natural setting and local processes of Jones Point

Some areas which could not be addressed in this study were with issues much larger than the scope of the site and field of landscape architecture. The author has limited qualifications to address large, global implications of economics, politics, terrorist mitigation under bridge, etc. which are underlying driving forces of cultural choices. Also the exact projection of what the area will look like in the future could not be assessed due to the dynamic nature of this estuary and lack of practice with geomorphology and fluvial systems. What can be said is that change takes time, most often over generations or decades, and does not cease. Water is a building block to all things on this planet.

4) Conclusions

Project Conclusions
References
Appendices
Vita

Project Conclusions:

This study supports the use of design to reconnect human with natural systems and challenges the notion of what makes a waterfront park, which typically only borders or exists adjacent to water. This waterfront shifts and permeates through Jones Point engaging the visitors, revealing its fluvial and cultural influences. Water continually cycles, flows, and moves land along its path. As a result waterfronts do not always constitute a single, straight edge or completely separate from the water, and design can embrace and assist in revealing how a waterfront was and is shaped.

A dialogue exists between land, water, and cultural decisions. A constant exchange of actions and reactions exists. This project weaves together aspects of cultural activity with fluvial processes such as the Potomac River, Chesapeake Bay estuary, and local storm water runoff. Together the culture and physical processes indistinguishably have shifted and shaped the landform and development of Jones Point over time and informed the proposed design by extending the city to the water for the residents of and visitors to the City of Alexandria. Chosen historic structures and markers are enhanced with the integration of physical space and natural systems. Tidal waters had once dominated and sculpted the former Battery Cove of Jones Point and are showing signs of return despite the previously installed retaining wall to contain the 64 acres of dredged river spoils from the Potomac River filling the Cove in the early 1900s. The cleansing features of the marsh plantings and planted shipways aid the cycling of water runoff from both the urban streets of Alexandria and the overpass of the New Potomac River Bridge.

Understanding the fluvial processes, especially estuaries, and how they interact with cultural activities was essential for developing the proposed design. They helped to see the shallow land-building areas off of Hunting Creek and the eroding effects at the north end of retaining wall by the Potomac River. The design layout integrates these lessons and anticipates change after installation is complete, which will complement further the design, minimizing maintenance and unnecessary energy.

This study embraces the idea of developing and revealing places where energy and material efficiently cycle while also allowing visitors to use the spaces for recreation and reconnection to the larger framework of living systems. Jones Point is a waterfront that teaches visitors about a place where physical systems symbiotically work together with human development. The proposed result is mainly due to the understanding, respect, and appreciation of these systems in which we exist.

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Appendices:

A. Jones Point Alexandria, VA Timeline
B. Chesapeake Bay estuary paper and images

Appendix A:

General Timeline for Jones Point
Alexandria, Virginia

Timeline for Jones Point Alexandria, Virginia

Pre 1600	light use by Native Americans for fishing, hunting, and trading
1608	Smith's description of setting and exploration up the Potomac River appeals to explorers
1654	Mistress Margaret Brent (St. Mary's City, MD) first private owner of land in soon-to-be Alexandria area through land patent of 700 acres
1669	Charles II allocates land grants to private owners/uses, including 6,000 acres to Robert Housing who sold it to John Alexander in exchange for 6,000 pounds of tobacco. Alexander also reimbursed M. Brent's heirs for their 700 acres with 10,500 pounds of tobacco
1699	Cadwalder Jones, and English trader and map maker, builds cabin at Jones Point
1749	Part of Belhaven area declared Alexandria (owner-Alexander family)
1780's	Keith's Warf built by merchants to increase commerce
1790	George Washington requested by Congress to delineate boundaries for Federal District
1793	Washington declares 10 $mile^2$ diamond-shape as Federal City, starting with cornerstone at Jones Point
1801	Federal City delineated with Alexandria within Capital boundaries
1830s-50s	rope and ship cordage production facilities on Jones Point
1846	Alexandria re-cedes back to northern Virginia by Congress
1850s	Congress appoints $5,000 to build light house for inner coastal waterway and in use for 70 years until 1926
1863	Civil War defenses put in place to guard S. Potomac & Accontink River approaches to the Capital and Battery Cove gets its name
1889	Large storm sinks a barge in Potomac which diverts flow and sediment accumulates along Alexandria waterfront
1897	commercial fisheries and processing plants are largest among east coast (development and reduced water quality decreased fisheries)
1910-11	Army Corp of Eng. dredge Potomac River and infill Battery Cove with ownership to the Department of the Interior, NPS
1917	VA Shipbuilding produces 12 steel ships for WWII on site with four shipways and two craneways
1926	steel lighthouse built 100' from original one by Dept of Commerce
1930s	steel light house torn down and site used by Army
1961	Woodrow Wilson Bridge completed, connecting VA & MD (I-95)
1980s-90s	increased automobile traffic exceeds bridge carrying capacity
2000	concepts for new bridge to replace Wilson Bridge presented
2002	Construction of New Potomac Bridge begins with new footings to be placed in Jones Point 300' o.c.

Appendix B:

Chesapeake Bay Estuary

Shifting the Scenery:
Exploring the Estuarine Processes of the Chesapeake Bay

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Spring 2004

Abstract

The Chesapeake Bay estuary is one of largest estuaries in the world, which makes a complex natural system. It lies on a tectonically stable coastal plain and operates under the command of oceanic and freshwater systems. Primary processes at work in the Chesapeake Bay are dictated by the interaction of these merging water systems. Circulation within the estuary is driven primarily by the different mixing conditions at the interfaces of varying water salinity levels and secondarily by gravity, tides, wind, waves, and temperature. Circulation also separates the classification of estuaries into three general categories of highly stratified (or salt wedges), partially mixed (or stratified), and well mixed systems. The Chesapeake Bay contains areas of all three categories but is generally referred to as a partially mixed estuary. Positioned at the terminus of an encompassing drainage area, large quantities of sediment enter the estuary each year. The Chesapeake Bay is primarily a depositional feature but progressively shows signs of rise in sea level and erosion of shorelines along coastal areas.

Introduction to Estuaries

This paper introduces general concepts of an estuary system and focuses more specifically on the physical inner-workings of the Chesapeake Bay estuary. The substantial mixing of varying water bodies characterizes the estuary's circulation and morphology. Topics explored include characteristics of water sources, various water mixing classifications, influences of salinity and tidal currents on circulation, physical morphology, and sediment quantities and movement. The authors who contributed to this paper are: Pritchard (1952, 1978, 1988 with Carter), who built a foundation of information on estuaries and particularly the Chesapeake Bay's estuarine processes; Dyer (1977), for his compiled facts and explanations into revised text books; Woodroffe (2002), who offered the latest fusion of a wide-spanning body of work in coastal geomorphology; Stevenson and Kearney (1996), who embraced what could be related to in the physical terrain and also offered explanations for sedimentation and possibilities down the road; and Lippson et al.(1979) for the descriptive explanations and illustrative pictures and diagrams that speak better than words.

The estuary functions as the sculpted meeting ground between freshwater and saltwater bodies and their influential properties and processes. It is always under the influence of multiple variables interacting at any one point whether physical, chemical, or biological. An estuary is described by D. W. Pritchard as "*a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water from land drainage* (Schubel, 1971, I-9)." So the two main sources of water are using both fluvial and tidal influences.

Estuaries may be classified by both their geomorphological characteristics and also their fluctuating salinity distributions, both of which are discussed later in this paper regarding the Chesapeake Bay estuary. Geomorphologically an estuary can be the result of a drowned river valley, ria, fjord, bar-built or the result of tectonic process to name a few. Estuaries mainly are "valleys incised into sedimentary sequences rather than into bedrock (Woodroffe, 2002, 359)." Estuaries have some general characteristics to consider:

> All estuaries contain chemical gradients between their saline and fresh sources of water input. Frequently, there are other gradients found in estuaries – temperature, sediment burden, and dissolved materials. Most estuaries are subject to relatively violent environmental changes with fluctuations in riverine inflow, seasonal temperatures, and influences of

> meteorological events. All estuaries are recipients of the composite chemical burden of the waters from land – waters from urban centers and from all other parts of the contributing watershed. Most estuaries are or have been extraordinarily productive of biological crops, many of which are useful to man. Each estuary is subject to effects of changes in water quality in those adjacent ocean waters that provide about half of the water in the average estuary. (Studies in Geophysics, 1983, 4)

An interconnectedness exists among the physical, chemical, and biological aspects within an estuary's reach to the point that when one aspect is acted upon it will affect directly or indirectly the others.

Finding the Chesapeake Bay (Regional Setting)

To understand the Chesapeake Bay estuary, it is best to comprehend it from the creation of the embayment. With sea level 125 meters lower at the end of the Wisconsin glaciation over 18,000 years ago (White, 1989, 9), the Susquehanna River meandered through the eastern part of what is now the United States and drained into the central area of the trailing-edge coast of the Atlantic Coastal Plain (Carter and Pritchard, 1988, 2). "When the great glaciers melted, uncountable billions of gallons of water poured back into the world's oceans (Chesapeake Bay Study, 1984, 7)." With all of this water, a rise in sea level persisted, and the area where the ancient Susquehanna had drained directly in to the Atlantic Ocean was now submerged, moving the mouth of the river landward and displacing over a third of its length (White, 1989, 10) and giving the Bay its geomorphological classification as a *drowned river valley*. This was all about 10,000 years ago so from a geologic perspective the estuary is quite young.

Being on an Amero-trailing edge coastline, the Chesapeake Bay estuary is part of the long continental shelf and well developed drainage area. The shallowness of the coastal plain lends itself to generally low energy waves and development of depositional features such as sand bars and barrier islands. The numbers alone help to emphasize its immense size:

> The estuarine system has a water surface area of approximately 11,400 km^2, a shoreline length of some 11,700 km, and varies in width from 6 to 50 km. The bay receives freshwater inflow from a drainage area of approximately 166,000 sq km (about 64,000 $miles^2$) through over 50 rivers of varying hydraulic and geochemical properties. The Susquehanna River alone supplies over half of the freshwater contributed to the bay, exerting profound hydraulic and ecological effects on the system. Salinities range from 33 parts per thousand (ppt) inside the mouth of the bay to near zero at the head of tide. Average maximum tidal currents in the mid channel of the bay range between one and 3.5 kilometers per hour. (McKay, 1976, 405)

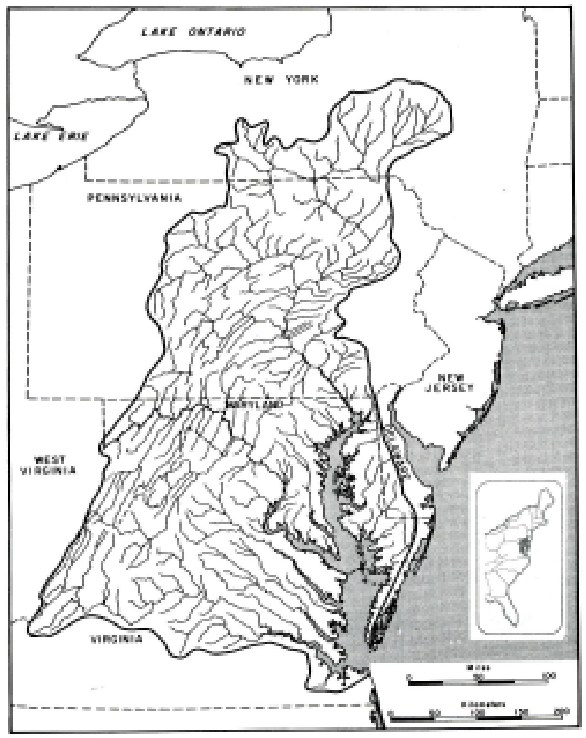

Figure 1 Chesapeake Bay watershed of 64,000 $miles^2$, draining six states (Schubel, 1986)

Figure 1 depicts the geographic boundaries of the Bay's watershed, spanning six states. The watershed is delineated by the topography, and the estuary is a composite of various forces, especially those of water.

Chesapeake Bay Estuary (Location Details)

Within the estuary, constant movement and energy flow occur, and the marine influences merge, circulate, and form the physical properties of the Chesapeake Bay estuary. Table 1 briefly lists the main driving forces, processes and example geomorphic features.

Driving Forces	Processes	Geomorphic Features
Gravity	Fluvial movement- erosion	River valleys and channels
	Tidal Processes	Wide embayment opening
		Island formation
		Meandering Channels
Density	Water gradient	Brackish marshes along banks
Solar Radiation (wind & heat)	Waves	Steep western banks
	Currents	Headlands
	Glaciation & De-glaciation	Semi-enclosed embayment

Table 1 Driving forces leading to example geomorphic features of the Chesapeake Bay estuary

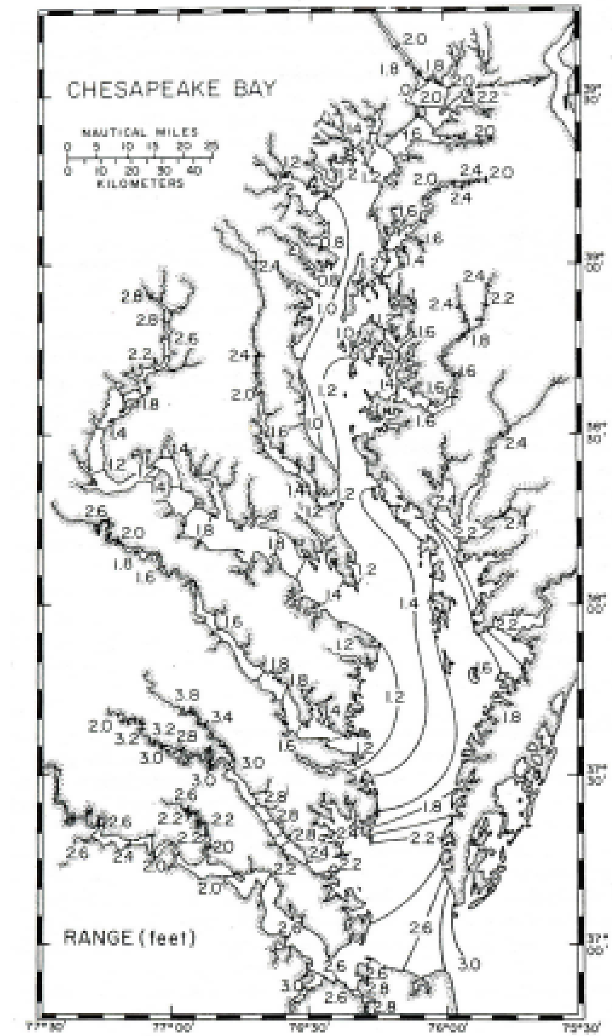

Figure 2. Tidal change in the Chesapeake Bay in feet[3] (Carter and Pritchard, 1988)

Physical Processes:

The elements under this heading refer to tidal processes, minimal waves and wind, currents, and the interaction of two different bodies of water. All of these involve the movement of energy and how it affects the estuary. The Bay's estuary is a process driven formation, and emphasis is focused towards the understanding of what those processes are.

Some of the general characteristics about the Chesapeake Bay are its semi-diurnal classification with a tidal period of 12.5 hours (Lippson et al., 1979, 33), a mean tidal range of up to 1 meter (Figure 2), waves average a height of 0.3m (Stevenson and Kearney, 1996, 243), and an estimated 6.9 million tons of sediment entering in the Bay's system annually. Tidal currents move large amounts of water through the estuary, changing the channel depths and flood-storage capabilities of the edges (Studies in Geophysics, 1983, 7). Currents also affect longshore sediment transport of sediment away from eroding headlands term reversal of surface flows (Pritchard, 1978, 4).

Fresh and salt water have different sources and input amounts affording them different capabilities. For instance, the ocean-supplied salt water fluctuates mainly with each tidal period, whereas the fresh water has seasonal variations and additional localized events like the melting of winter snows, spring precipitation within the watershed, and large storm events (Bowden, 1978, 15). These two types of water act as transport vehicles to circulate sediment, nutrients, and organisms.

The chemical density of freshwater is lighter and able to flow over the heavier saltwater. Therefore, surface salinity levels will be lower than at varying depths. At the interface of the two water densities, a variable amount of friction stirs the water, suspended material and organisms, referred to as turbidity (Figure 3). Salinity characteristically varies longitudinally up the length of the estuary from the mouth to its upper tidal reaches. The Venice System lists the names and ratios in Table 2. The minimum salinity levels occur in spring and maximum salinities occur in autumn within the main extension up the Susquehanna River portion of the estuary.

Estuaries are classified by vertical saline stratification and circulation. Pritchard (1952) delineated three general categories (Figure 4) which are the highly stratified (or salt wedge), the partially stratified

Type of System	Zones	Salinity
Riverine	Nontidal Fresh	0 ppt
Estuarine	Tidal Fresh	0 - 0.5 ppt
	Oligohaline	0.5 - 5.0 ppt
	Mesohaline	5.0 - 18.0 ppt
	Polyhaline	18.0 - 30.0 ppt
Marine	Euhaline	>30.0 ppt

Table 2. The Venice System of characterizing salinity zones, covering salinity ranges from riverine regions to the ocean (Lippson et al., 1979)

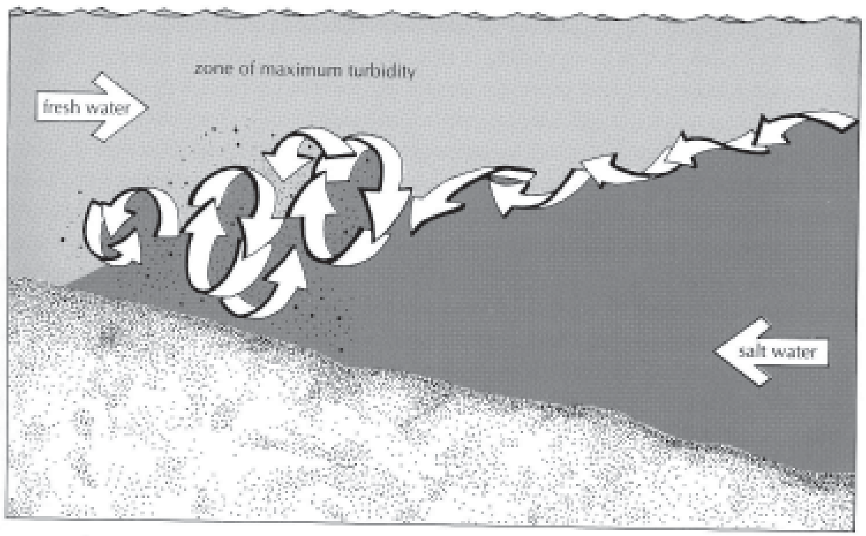

Figure 3. Turbidity from mixing densities of fresh and saltwater sources typically near the head of the Bay and its major tributaries – nutrients, as well as sediments, are mixed and resuspended (White, 1989)

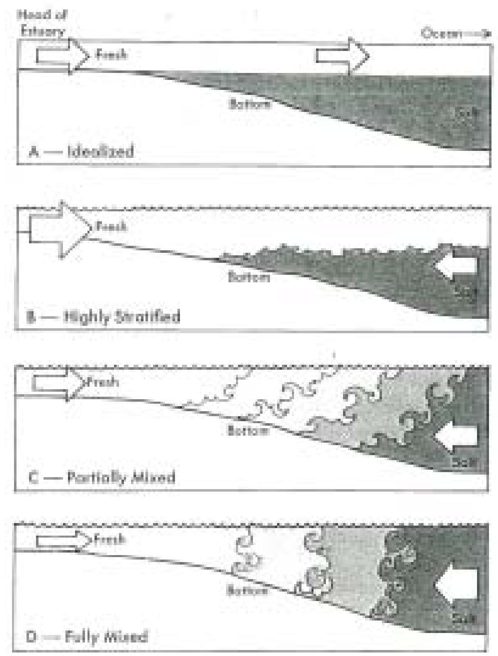

Figure 4. Estuary classification based on salinity distribution, indicating the direction and degree of mixing. (Lippson et al. 1979)

and the well-mixed estuaries. These classifications can refer to either entire lengths or segments of estuaries. One tributary estuary to the Chesapeake Bay estuary, the Potomac River estuary, shows characteristics of all three (Figure 5). Variation can also be observed in the vertical and lateral distribution:

> The vertical distribution of salinity is characterized by an upper layer of very slow increase with depth, an intermediate layer of more rapid increase (the halocline), and a deep layer in which the salinity increase with depth is again small. The salinity also varies laterally across the Bay with lower salinities on the western side of the Bay. Although the greater runoff of freshwater from the western shore contributes to this difference, the major cause is the rotation of the earth (Coriolis Effect). (Carter and Pritchard, 1988, 10)

Salinity influences circulation but is also affected by physical processes as well: "the Coriolis force due to the earth's rotation and centrifugal force due to the curves of the estuary affect the lateral distribution. The Coriolis force is important near the surface in broader portions of the estuary, whereas the centrifugal force may become more important in the bends (Lippson, 1979, 37)." All of this sets the stage to describe the estuarine circulation.

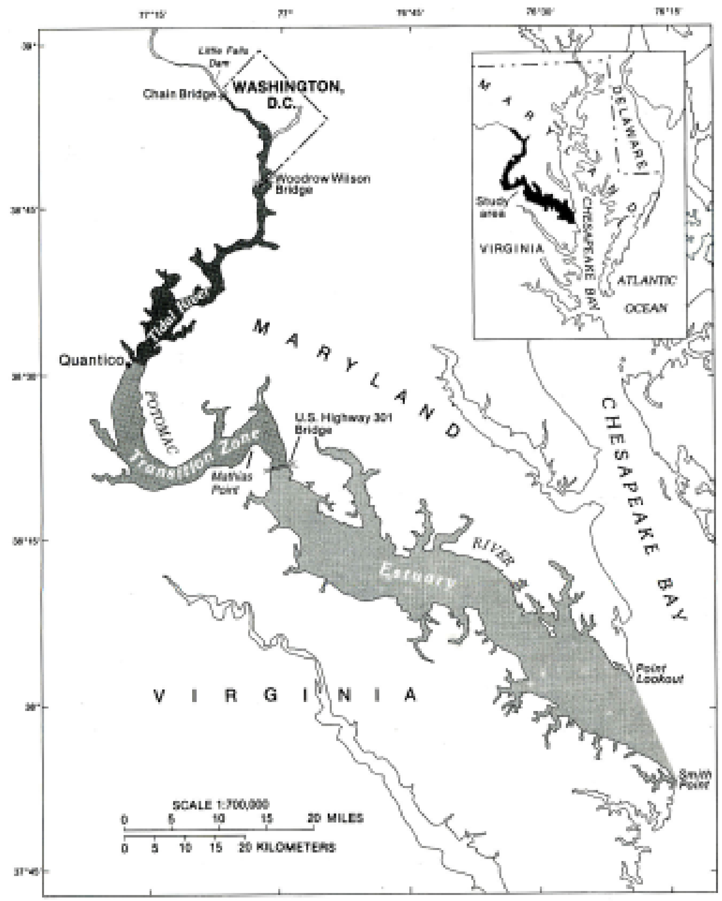

Figure 5. The Potomac River Estuary subdivided into generalized salinity zones (Schultz, 1982)

<u>Estuarine Circulation</u>:

Circulation requires movement and energy inputs with the interaction of freshwater and saltwater of varying salinities. This energy can be from predictable daily changes and also localized storm events. This section will focus on the former. From tidal processes, a decent amount of energy is offered up for use:

> The tidal currents… introduce a considerable amount of kinetic energy, some of which is used in mixing the river water and sea water and modifying the circulation. Thus an interaction exists between the river flow and tidal currents which gives rise to a range of circulation types, depending mainly on the ratio of river flow to tidal flow and the topography of the estuary. (Bowden, 1978, 12)

The three general types of salinity mixing also correspond to the estuarine circulation classifications: highly stratified (salt wedge), partially stratified (mixed), and well mixed estuaries (Figure 6).

Highly stratified estuaries, referred to as salt wedge estuaries, maintain an almost horizontal boundary where the

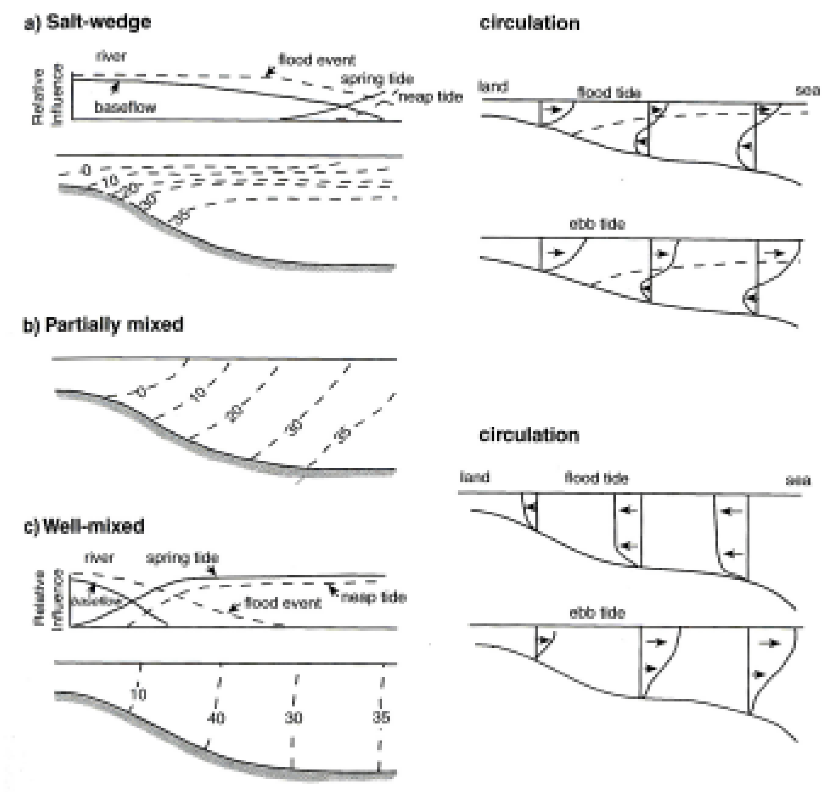

Figure 6. Estuary circulation classifications and isohaline distribution shown as a schematic indication of the influence of river and tidal processes along salt-wedge and well-mixed estuaries, for which the pattern of circulation and flow velocity on flood and ebb tide is shown (Woodroffe, 2002)

fresh water moves above without reaching the bay floor. Two layers of movement appear where "the influx river discharge drives the seaward movement of fresh water, and the salt water is moved landwards by a process of residual flow (Woodroffe, 2002, 332)." Some saltwater is picked up by the upper freshwater layer but still remains horizontally layered. This stratification usually occurs where the tidal prism (volume) is small and tidal currents are too slow to mix with the inflow and receiving water bodies (Woodroffe, 2002, 332).

On the other extreme, well mixed estuaries have almost no vertical stratification and almost vertical isohalines, which are lines of equal salinity. This usually occurs in estuaries with large tidal ranges and where tidal volumes are considerably greater than freshwater river discharge so that most of the water is moved through the estuary by tidal rise and fall (Woodroffe, 2002, 332).

This leaves the partially mixed or stratified estuaries to describe all the variation in between these previous two, where salinity increases steadily down the estuary with equally spaced and sloping isohalines. This partial mixing occurs in (more mesotidal) areas where the bulk of the volume is moved with tidal fluxes. The movement pattern of water particles under this situation is shown in Figure 7.

The boundaries of these classifications are not permanent, but fluctuate according to the water source variation. In other words, "the salinity distribution and stratification may change considerably during a tidal period in response to the changing velocity of the tidal currents and

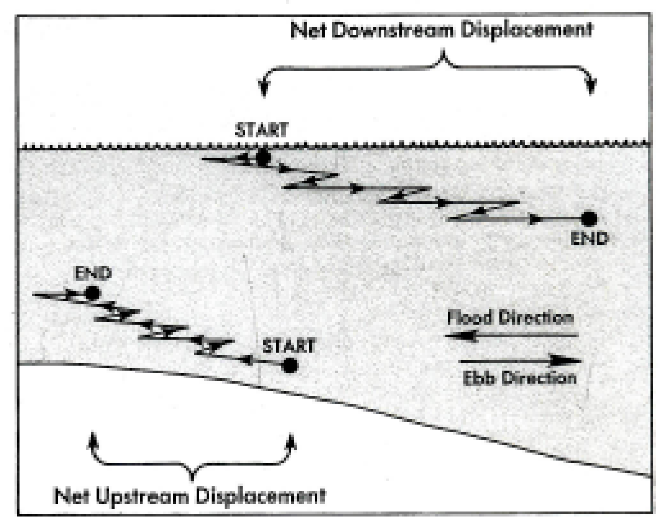

Figure 7. Net movement of a particle in each layer (Lippson et al. 1979)

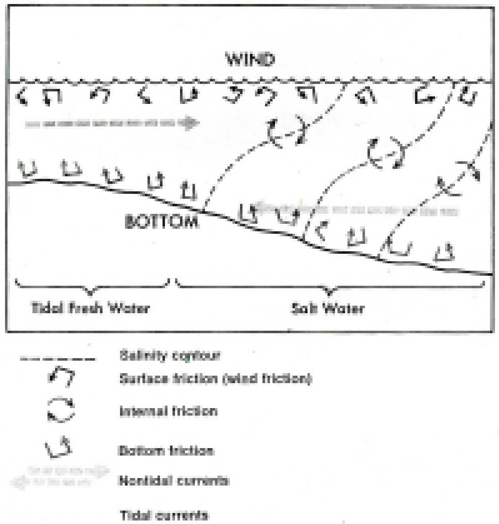

Figure 8 Mixing forces and flows in the estuary (Lippson et al., 1979)

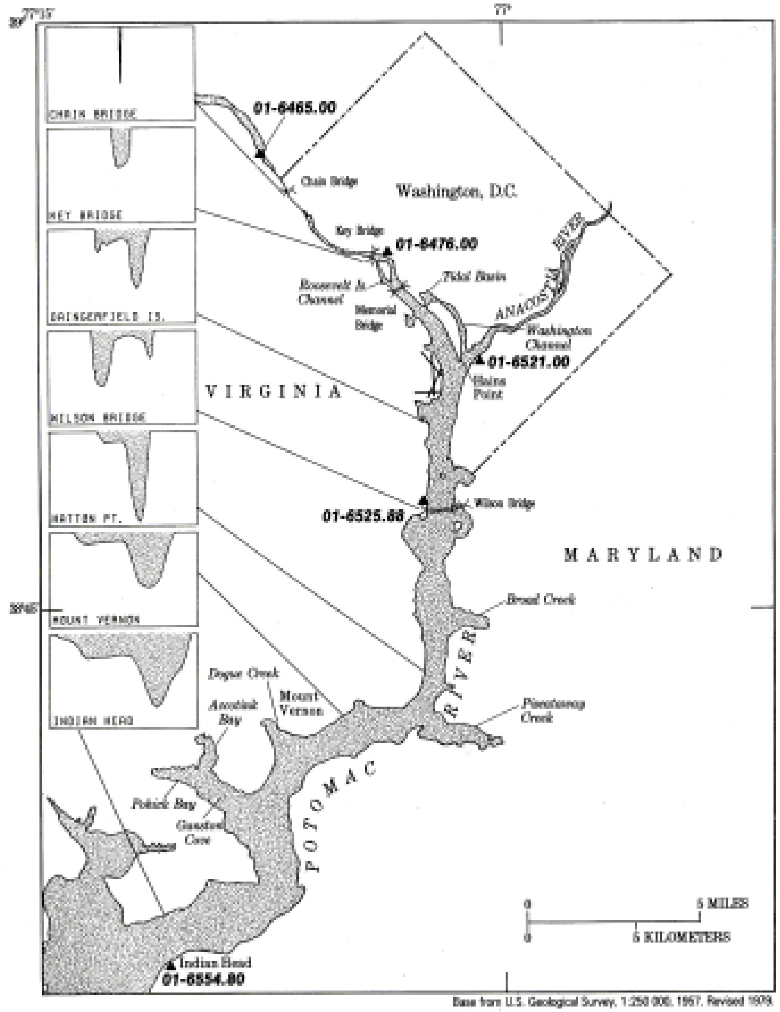

Figure 9 Cross sections through the Potomac River to show channel topography (Schaffranek, 1987)

corresponding changes in the intensity of turbulence (Bowden, 1978, 15)." The Chesapeake Bay estuary's complexity involves all three of these classifications but essentially is characterized as a partially mixed estuary. Along with salinity stratification, other contributing mixing forces influence circulation. Figure 8 diagrams these mixing forces and flows.

Some non-tidal influences on circulation are topography, wind and temperature. They give provide character to distinguish one coastal plain estuary from another (Lippson, 1979, 6). Topography may affect fluvial processes but also tidal circulation: "when the depth varies across the estuary cross-section, the upstream flow tends to be concentrated in the deeper part of the section while in the shallow parts the flow is seaward at all depths (Bowden, 1978, 19)." This can be interpolated in the cross-sections of Figure 9 along the Potomac River. Wind can also affect circulation both longitudinally and laterally through the estuary; the latter is especially prominent in the wider areas. The surface winds will cause internal waves and may even reverse the net flow (Carter and Pritchard, 1988, 8). It has also been noted to affect subtidal water levels (Thompson Bosley and Hess, 2001, 16,869). Wind played a major role in the classical Two Flow method (Pritchard, 1978,

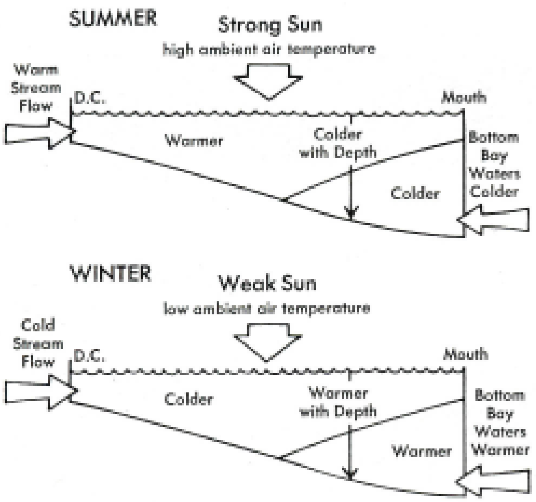

Figure 10 Schematic diagrams of seasonal temperature differences (Lippson et al., 1979)

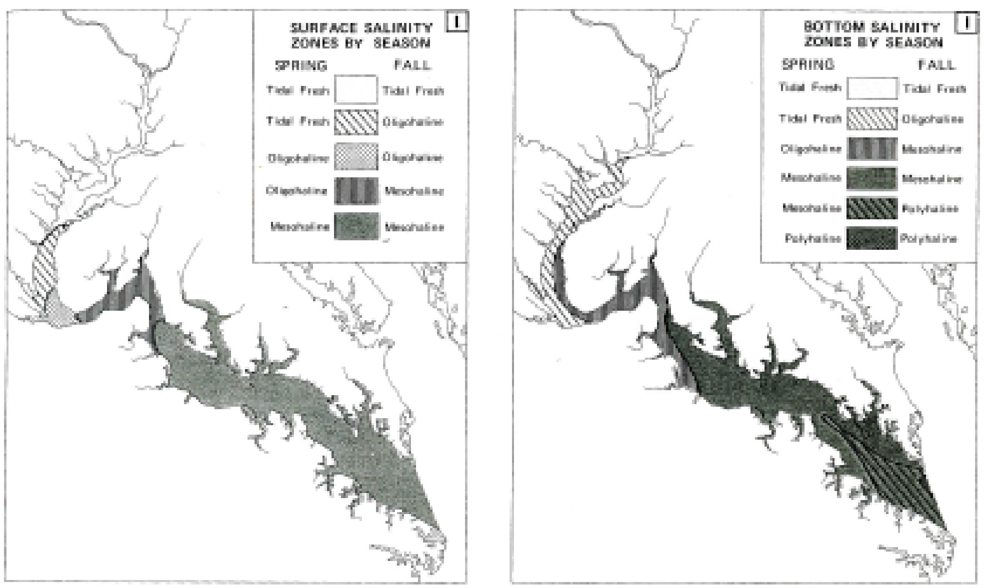

Figure 11 General locations of salinity zones at surface and bottom in the Potomac estuary during spring and fall (Lippson et al., 1979)

1-2) of water flowing in and out in horizontal layers of the estuary. And finally, temperature is a subtle player in circulation: "temperature has a secondary effect on the stratification of estuarine waters, as it does in the Potomac estuary (Figures 10 & 11). In the summer, denser saline waters are cooler and warmed by ambient air temperatures, and in winter surface temperatures drop, causing inverted temperature stratification (Lippson et al. 1979, 10)." Affects from temperature are not so pronounced in the physical process but relay its' importance to nutrient mixing for organisms and ecological systems.

Morphology and Sediment:

Influenced and linked with circulation, sediment movement affects the morphology and shoreline of the estuary. The estuarine system is built upon the deposition and circulation of sediment at the terminus of a continental drainage system and the active ocean. Figure 12 plots the cyclic stages of sediment, in which particle size and velocity are influential factors. Sediment can be either stationary or in motion:

> The bottoms of estuaries are covered with sedimentary deposits composed of unconsolidated particles originally eroded from terrestrial rocks and soil. …Suspended particles are continually carried into estuaries from the upper riverine systems and from shore erosion. Sediments are also transported into estuaries from offshore sources; however, the greatest amount of sediment is contributed by river transport from upstream sources. (Lippson, 1979, 11)

Estuarine sources of sediment derive from offshore, like the continental shelf, or the atmosphere, fluvial erosion, bio-waste of estuarine organisms, or shoreline erosion (Marcus and Kearney, 1991, 405).

The Potomac River estuary is one of the largest tributaries to the Chesapeake Bay estuary and therefore contributes a large quantity of sediment. Looking at its geography (Figure 13), it

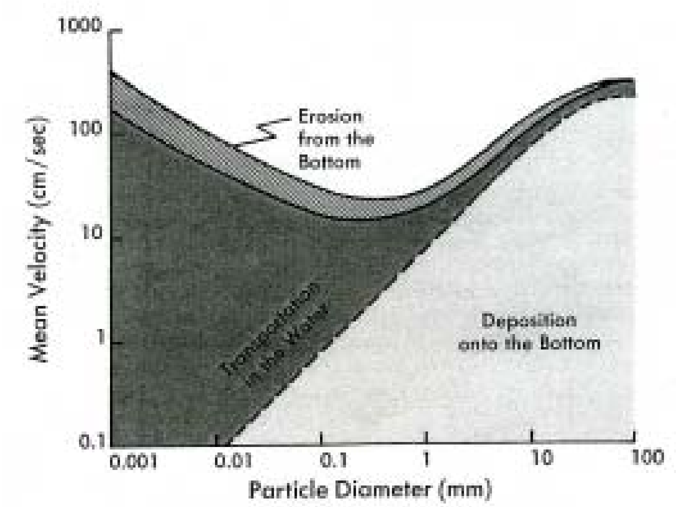

Figure 12 Sediment erosion, deposition, and transport of unconsolidated sediments with various particle diameters (Lippson et al., 1979)

flows through three physiographic provinces labeled as mountains, piedmont, and coastal provinces, where the estuary exists on a depositional sedimentary wedge. Around 3.0 million tons of sediment enters the Potomac River basin each year (Lippson, 1979, 57), and an estimated 6.9 million tons of sediment enter the larger Chesapeake system annually (Stevenson and Kearney, 1996, 234). Regardless of all this input there still seems to be shoreline erosion and a rise (measured in millimeters over decades) in apparent seal level, leading to changes in the estuarine morphology.

Three distinct zones (Figure 14) appear in the Chesapeake Bay estuary. They are an upstream river-dominated zone, a central mixed-energy zone, and a seaward marine-dominated zone, in which the shape of the upstream zone is relatively straight and driven by fluvial processes. The central zone of converging sediment is often very sinuous and influenced by both river and marine and tidal processes. And finally, the seaward zone is relatively straight and wider as sediment moves in a net landward direction. (Woodroffe, 2002, 330) In the marine dominated zone, where wave action and currents are minimal, mudflats of finer particles are created (Lippson, 1979, 12).

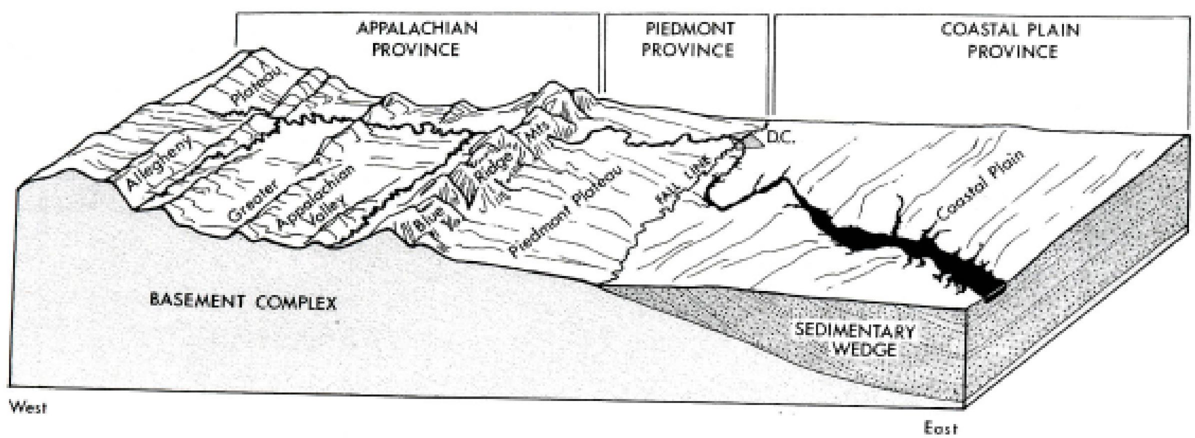

Figure 13 Physical characteristics and provinces with the Appalachian Province divided into three subdivisions (Lippson et al., 1979)

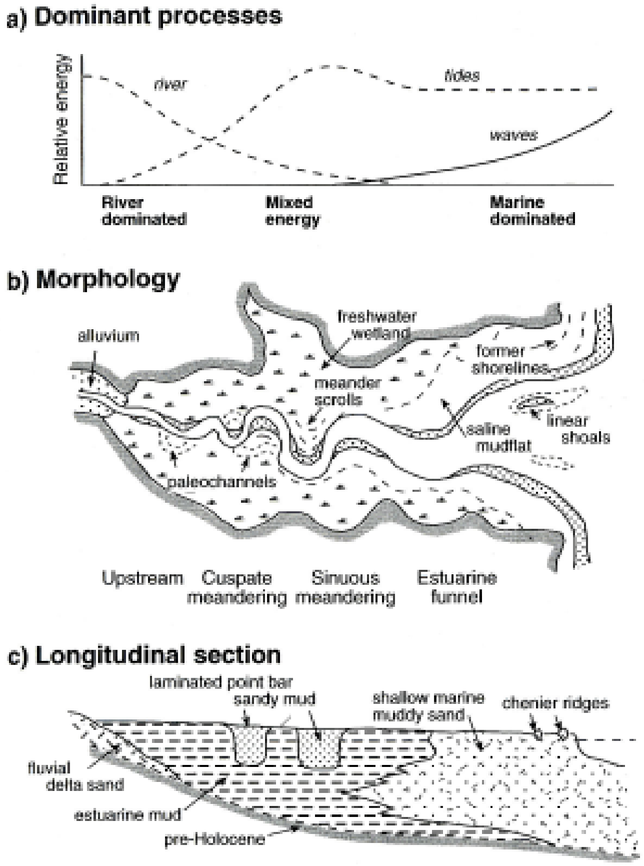

Figure 14 Estuary morphology influenced by river and marine processes (Woodroffe, 2002)

Even the topography plays an influential role. The more pronounced western terrain of the Bay shows more signs of erosion. All of the above coupled with human development and various land uses produces even higher supplies of sediment and small-scale filling of tidal creeks versus the flat terrain of the Eastern Shore (Stevenson and Kearney, 1996, 235).

In contrast to the historical depiction of a “geologically – aging” Chesapeake Bay, which would fill-in over time, more shoreline loss and rise in sea level are actually occurring. Both the sea level rise and shoreline transgression are recent phenomena:

> Analysis of historical records and maps reveal that rates of land loss among Bay islands were slow in the middle Bay prior to the mid -19th century. Since then, land loss rates have jumped dramatically, and formerly stable populated islands have either disappeared or shrunk beyond the point of being inhabitable. Such changes mirror the general trend in sea level rise in this period, and it is clear that the rising tidal prism underlies the increasing transgression of Bay shorelines. (Stevenson and Kearney, 1996, 243-244)

Figure 15 points out the major shoreline retreat areas. Even island formation is more commonly the result of an eroding peninsula (Stevenson and Kearney, 1996, 248) than the deposition of sediment. A good deal of this erosion and sediment load can be connected to the changing land users adjacent to the estuary and within the drained watershed (Lippson, 1979, 57). Human impacts become apparent in these physical, geomorphic features of the Bay estuary.

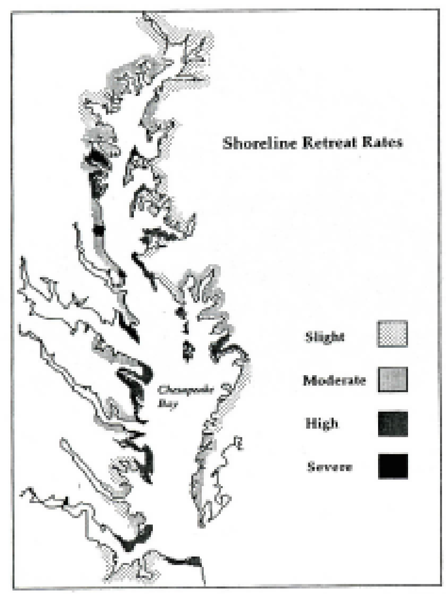

Figure 15. Shoreline retreat areas and rates of Chesapeake Bay. For Virginia, slight=0-0.3maÉ^1; moderate=0.3-1maÉ^1; high=1-2maÉ^1; severe=2maÉ^1. For Maryland, slight=0-0.6maÉ^1; moderate=0.6->1maÉ^1; high=>1->2.5maÉ^1. (Stevenson and Kearney, 1996)

Conclusions:

The Chesapeake Bay estuary is the product of multiple layers and interactions. No linear explanation depicts the estuarine process, but it is rather a matrix of processes and characteristics all linked and connected. The drowned river valley of the Chesapeake Bay is under the influence of both the draining watershed and the semi-diurnal tidal processes. The movement of freshwater, saltwater, and sediment circulate within the Bay under the influence of gravity, densities, wind, tides, and fluctuating temperatures throughout the year.

The immense size of the Chesapeake Bay estuary with its tributary estuaries makes it difficult to categorize its circulation and morphology under single headings. The Chesapeake Bay estuary is typically referred to as a partially mixed system even though upper, river-dominated areas are more stratified, or salt-wedges, and the lower, marine-influenced areas are more of a well mixed type. Also the Chesapeake Bay estuary is regarded as a depositional feature being at the end of a large drainage basin and watershed, but there is developing evidence of erosion along coastal shoreline areas and rises in sea level within the Bay.

Overall the Chesapeake Bay estuary is a sculpted meeting ground between merging fresh and salt water bodies, resulting in various actions such as transporting, mixing, cycling, deposition, and erosion. Difficulty comes with exploring each contributing feature or process separately because they all interact and affect others in minimal or immense ways. Only the major physical processes and morphology of the estuary are explored here, but they help to set the foundation for further exploration and understanding of other contributing factors to the formation, stabilization, and manipulation of the Chesapeake Bay.

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V i t a:

K r i s t i n a G e r o n i l l a

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