REVEALING WASTEWATER ECOLOGIES

A Combined Sewer Overflow Strategy and Treatment Facility Design for Seattle's Georgetown Neighborhood

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Abstract:
The 21st century infrastructure used to convey and treat sanitary waste and stormwater runoff is largely screened, hidden or buried from public view. In much of Seattle, as in many older cities, stormwater is conveyed in the same pipe as sewage to distant wastewater treatment plants, leading to frequent combined sewer overflows of contaminated water into rivers, streams and the Puget Sound during storm events.

This thesis proposes a new strategy for addressing combined sewer overflows occurring on one stretch of the Duwamish River. Specifically, this thesis will investigate how the design of a combined sewer overflow treatment facility and site, conveyance route and discharge in Seattle's Georgetown neighborhood can become a community amenity, increase ecological function and raise awareness of urban runoff and water quality issues in the built environment and the high costs of conveying water to distant and energy-intensive treatment plants.

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I was fortunate to have the opportunity to meet with officials from King County's Wastewater Treatment Division who generously spoke with me about several innovative wastewater projects underway in our region and Seattle's ongoing efforts to reclaim wastewater for beneficial uses, as well as Seattle's plan to further reduce overflow events into Puget Sound. My meetings with Michael Popiwny and John Phillips at King County Wastewater were particularly informative and helped shape my understanding of many of the complex social, environmental and infrastructural issues involved with wastewater treatment. In addition, thanks to Michael Shiosaki at Seattle Parks and Recreation for meeting with me to discuss this project.

I also would like to thank Mary Roderick for sharing her expertise on stormwater management during my early investigations into this topic. I'd like to thank Jenny Kempson, Lesley Bain and Mackenzie Waller for inspiring me to take on this topic. Lastly, thank you to my family and friends who have supported me during this journey.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

PREFACE

My decision to investigate wastewater treatment processes was driven by an interest in revealing natural and infrastructural systems in the city that we often take for granted, a curiosity about how Seattle is managing combined sewer overflows and an interest in wastewater as a potential untapped resource. While over the last several decades, many landscape architects have played a major role in stormwater projects that 'daylight', celebrate and cleanse stormwater, there are far fewer examples that explore the potentials of wastewater renovation.

As I began researching this topic, I became interested in thinking about how the design of a wastewater treatment facility can express and make legible its important function to the wider community. While wastewater treatment plants are often located in peripheral locations outside of the city, how could a major infrastructural project fit into an urban context? While the conventional approach to wastewater treatment tends to result in single purpose infrastructure, how could the treatment process become a neighborhood amenity, providing open space and habitat enhancement, and engage Seattle residents with the water cycles in the city?

As I began researching the Duwamish River, which is currently experiencing the largest share of combined sewage overflows in our region, it became apparent that the river has undergone massive physical changes in the 20^{th} century; its seasonal flows have been controlled, its meandering course has been straightened, and its ecologically rich mudflats have been paved over and erased to make room for the industrial growth of Seattle. Since the river cannot be brought back to its predevelopment condition, how can the historic presence of the river be made legible in the present day landscape, and how can its diverse ecological and social functions could be regenerated within this dynamic context?

INTRODUCTION

While wastewater infrastructure plays a critical role in the health of our built environment, the infrastructure used to convey and treat sanitary waste and stormwater runoff in cities is largely screened, hidden or buried from public view. The conventional approach towards dealing with urban runoff in the U.S. has primarily focused on conveying water away from urban areas as quickly as possible without addressing increasing water runoff volumes in cities and water quality issues. In much of Seattle, as in many older cities, stormwater is conveyed in the same pipe as sewage. During rain events, many of Seattle's aging sewers overflow, contaminating rivers, streams and the Puget Sound.

This thesis proposes a new strategy for addressing combined sewer overflows occurring on one stretch of the Duwamish River. More specifically, it will explore how the design of a 'satellite' wastewater treatment facility in Seattle's Georgetown neighborhood—programmed to activate during combined sewer overflows—can illuminate the Seattle's overburdened infrastructure, wastewater renovation and connect residents to the treatment process. In addition, this thesis will investigate how the design of a community facility, a conveyance route and discharge site for cleansed effluent can become neighborhood amenity that enhances ecological and social function along a historically degraded river.

Chapter 1 provides an overview of the sewage infrastructure that has developed in response to health epidemics and unsanitary conditions in the city, focusing on the development of Seattle's combined sewer system. In this chapter, I discuss how early decisions about Seattle's sewer infrastructure and drainage have resulted in many unforeseen and 'end of pipe' problems that we continue to grapple with today. I will also discuss how growing environmental concerns led to the development of a regional centralized wastewater treatment system.

In chapter 2, I argue that the 20th century approach, which focused on efficient water conveyance, attempted to control and compartmentalize nature from the city. These attempts to separate an unpredictable nature from the urban environment have impaired our connection to the local watershed and its dynamic processes. Infrastructure elements have neutralized and substituted an unpredictable nature in the city for a predictable and controlled one. Furthermore, while these infrastructural systems are interdependent with natural systems, the constant flow of water in our city, irrespective of rainfall and seasons, has increasingly led us to take water for granted. By revealing and 'daylighting' combined sewer overflows and treatment processes in the built environment, we can form a closer connection to the cycles of water and its relation to urban infrastructural systems.

Chapter 3 presents three design precedents that demonstrate innovative approaches, which illuminate water treatment in the city, provide additional benefits such as habitat enhancement, and also showcase different approaches to community engagement. These examples contrast with the conventional engineered approach that viewed wastewater treatment and stormwater as a nuisance in the city to be hidden from view.

In chapter 4, I discuss the spatial, temporal and infrastructural context for the selected site and building intervention in Seattle's Georgetown neighborhood located along the Duwamish River. In this chapter I discuss the current open space opportunities in Georgetown as well as the history of the Duwamish River in relation to the selected site.

In chapter 5, I describe the design response I took to address these issues, demonstrating how wastewater infrastructure can serve as a community amenity, engage residents with the water treatment process and fit within the fabric of a neighborhood. In addition, I explore how reclaimed water can be used to enhance ecological function on the Duwamish River and engage residents and visitors to the past, present and future health of the river.

1 SEATTLE'S AGING AND OVERBURDENED WASTEWATER INFASTRUCTURE

The Metabolic City

Over the last century Seattle's sewer infrastructure has evolved from an assemblage of privies, pipes and cesspools to become a massive underground network of nearly 1000 miles of sewer lines, catch basins, storage vaults and pumps conveying effluent to a centralized municipal treatment plant[1]. Together with water supply, drainage and sanitary sewage, this system comprises the metabolic workings of the modern city, collecting and circulating hundreds of millions of gallons of both fresh water supply and wastewater to and from homes and businesses (See Figure 1.1).

Seattle's sewer system utilizes a water carriage system to convey wastewater to a centralized treatment facility where it is cleansed through biological, chemical and UV treatment processes prior to being discharged into deep outfalls in the Puget Sound. While this regional network of infrastructure provides a convenient system for collecting, conveying and treating both stormwater runoff and sanitary waste from homes and businesses, this process is highly energy intensive. Wastewater plants are among the largest consumer of energy within Seattle.[2]

Today much of Seattle's wastewater infrastructure is over 100 years old and failing to meet the demands of the 21st century. Urban sprawl, population growth and an increase in impermeable surfaces have overburdened Seattle's sewer lines, resulting in frequent overflows of wastewater that threaten the health of lakes, rivers and the Puget Sound as well as nearby communities.

Figure 1.1 Conventional Wastewater Treatment Plant, Source: http://www.businessgreen.com/bg/feature/2332837/innovators-tap-the-value-of-wastewater

1 King County, Regional Wastewater Service Plan (1999), http://www.kingcounty.gov/environment/wtd/Construction/planning/rwsp.aspx.

2 ibid.

Early Decisions and Downstream Impacts

For Seattle's early pioneers, privies, pits and cesspools were used to dispose of sewage. As the population grew in Seattle in the late 1800s, pits and cesspools frequently became overwhelmed, and foul odors would often create a public nuisance, prompting government officials to undertake the construction of Seattle's first sewers. Seattle's early sewer system consisted of wood troughs that would convey wastewater to the nearest receiving waterbody. By 1883, more durable materials, such as brick, were used in construction of these first sewer lines.[3]

While early Seattle residents were drawing their drinking water supply from Lake Washington and Lake Union, they were also using these lakes as a repository for sewage. By the end of the 19th Century, the contamination of Lake Union and Lake Washington had become a major public health risk, prompting the City to plan a new system to direct wastewater away from freshwater sources. The City originally hired Colonel George Waring Jr. to plan a new sewer system. Waring proposed separating the sewers, but his plan was ultimately rejected due to the higher upfront costs of building this system. The city then hired Chicago engineer Benzette Williams, who recommended a combined system that would convey both stormwater and sewage in a larger pipe to outfalls in the Puget Sound, in anticipation of Seattle's future growth. The City began construction of the combined system in 1890. While unforeseen at the time, this decision to combine sewage and stormwater would end up being a costly mistake due to future treatment requirements and increasing run-off volumes that would overwhelm the system's capacity.[4]

In 1889, a fire destroyed much of Seattle's central business district. The 1889 fire not only provided an impetus for new building codes, but also led to a systematic planning of Seattle's water supply and sewage networks. While Seattle's water supply had relied on pumping water from Lake Washington, the pumping capacity was seen as inhibiting growth and providing an inadequate supply for fire protection.[5] The City's chief engineer, Renigald H. Thomson, convinced the city to tap into the Cedar River for Seattle's water supply. The original gravity-fed pipe ran twenty-two miles and opened in 1901 (see Figure 1.2). Incidents of typhoid and waterborne illnesses were greatly reduced following the construction of this system. This consistent water supply boosted Seattle's economic position in the region. Furthermore, the Cedar River would soon support the massive regrading of Seattle's downtown hills, which were seen as an obstacle for economic growth and transportation.[6]

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3 King County, "Wastewater Treatment: The early days of sewage treatment and disposal," accessed Nov. 16, 2014, http://www.kingcounty.gov/environment/wtd/About/History/EarlyDays.aspx

4 Source: King County, "Wastewater Treatment: Metropolitan Seattle Sewerage and Drainage Survey, March 1958," accessed Nov. 16, 2014, http://www.kingcounty.gov/environment/wtd/About/History/PlanningSystem/1958Plan.aspx.

5 Karvonen, Andrew, Politics of Urban Runoff Nature, Technology, and the Sustainable City (Cambridge, Mass.: MIT Press, 2011), 100

6 Karvonen, Andrew, 101

The first more permanent sewer projects that would divert sewage away from Lake Union and Lake Washington were completed in the 1920s. While the Lake Union Tunnel, the North Trunk Sewer and the Beacon Hill tunnel marked important first steps in efficiently conveying a large portion of Seattle's sewage away from freshwater lakes, the increased sewage volumes entering tidal waters created a new problem in Puget Sound.

Unforeseen End of Pipe Problems

While the development of Seattle's early sewer system improved the sanitary conditions and public health in the city, as the population grew in Seattle the increase in sewage resulted in unforeseen end-of-pipe pollution problems.[7] While early sewer systems were built to transport stormwater and wastewater away from populated areas, treatment of sewage was dependent entirely on its dilution into larger bodies of water. Early 20th century engineers had argued that large waterbodies could adequately treat sanitary waste through dilution[8]. However, by the mid 1940s, sewage volumes had increased significantly.

7 Karvonen, Andrew, Politics of Urban Runoff Nature, Technology, and the Sustainable City (Cambridge, Mass.: MIT Press, 2011), 7
8 ibid.

Figure 1.2 Constructing the Cedar River Pipeline, c.1900.
Source: Seattle Municipal Archives

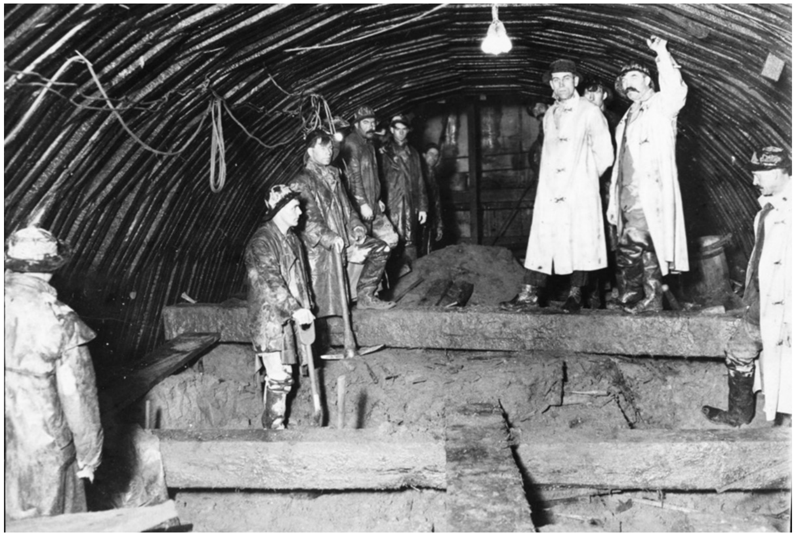


Figure 1.3 The North Trunk Sewer under Construction
Figure 1.4 Sewage Backwash at West Point in Magnolia, Seattle Municipal Archives

The North Truck Sewer, near West Point, was discharging around forty million gallons of untreated sewage per day, contaminating and forcing the closure of nearby beaches (see Figure 1.3 and 1.4). Similarly, large discharges from the Denny Way/Lake Union Tunnel were degrading Elliot Bay. In South Seattle, the Rainier Sewer System also was causing high levels of contamination along the Duwamish River. By the 1950 Seattle's sewer system had grown to encompass nearly 1000 miles of pipes (see Figure 1.4).

The Formation of Metro

Although major sewer lines diverted sewage to Puget Sound, over 30 outfalls still directed sewage into Lake Washington from outlying suburban communities (Karvoven, 116). With increasing urban sprawl, water quality on Lake Washington was seen to be visibly deteriorating. The decrease in visibility and large oxygen-depleting algae blooms prompted residents and scientists to voice concerns over the health of the lake.

A citizen group led by Jim Ellis lobbied to create the Municipality of Metropolitan Seattle, also known as Metro. Proponents of Metro sought to develop a strong regional-scale governance to address pollution issues that required coordination between multiple municipalities and sewage districts. In 1961, a majority of voters of Seattle and surrounding communities approved the formation of Metro (see Figure 1.5). In the months that followed, Metro developed a ten-year sewer system plan encompassing 231 acres.[9] In order to address Lake Washington's

9 King County, "Wastewater Treatment: The early days of sewage treatment and disposal," accessed Nov. 16, 2014, http://www.kingcounty.gov/environment/wtd/About/History/EarlyDays.aspx

pollution, an interceptor sewer was built around the entire perimeter of the lake to divert wastewater to the centralized treatment plants. Lake Washington sewers diverted effluent primarily to the Elliot Bay Sewer that runs parallel to the Duwamish River.

In the decade that followed, water quality and visibility increased to over 20 feet on Lake Washington. The formation of Metro is heralded as a successful example of a major lake cleanup through the creation of regional governance. While Lake Washington benefited, in The Politics of Urban Runoff, Andrew Karvoven explains that the "replumbing of the region... came at the expense of the waterbody receiving the diverting sewage, the battered Duwamish River".[10] Karvoven writes:

"Already burdened by dredging and straightening activities to accommodate industrial development in the early twentieth century, the fishermen and Native Americans who relied on the Duwamish for recreation and sustenance were further affected by the metro interceptor sewers and treatment plants that defined the Duwamish as the ultimate drain of the region."[11]

The cleanup of Lake Washington had shifted sewage issues to low-lying communities that lacked political sway to protest it.[12]

10 Karvonen, Andrew, Politics of Urban Runoff Nature, Technology, and the Sustain able City (Cambridge, Mass.: MIT Press, 2011), 119

11 Karvonen, Andrew, 120

12 ibid.

Year	*Miles of Sewer*	*Population*
1891	14.9	2,837
1900	60.45	80,761
1908	212.32	237,000
1924	628.3	330,000
1930	802	365,583
1940	863.15	368,302
1950	988.09	467,591

Figure 1.4, Sewer Miles and Population Growth. Source: Metro Report (Sewer Miles) and US Census Data (Population Data)

Figure 1.5 1958 Metro Campaign Poster, Source: http://www.kingcounty.gov/environment/wtd/About/History/BirthOfMetro.aspx

Sewer Infrastructure and Population Growth in Seattle

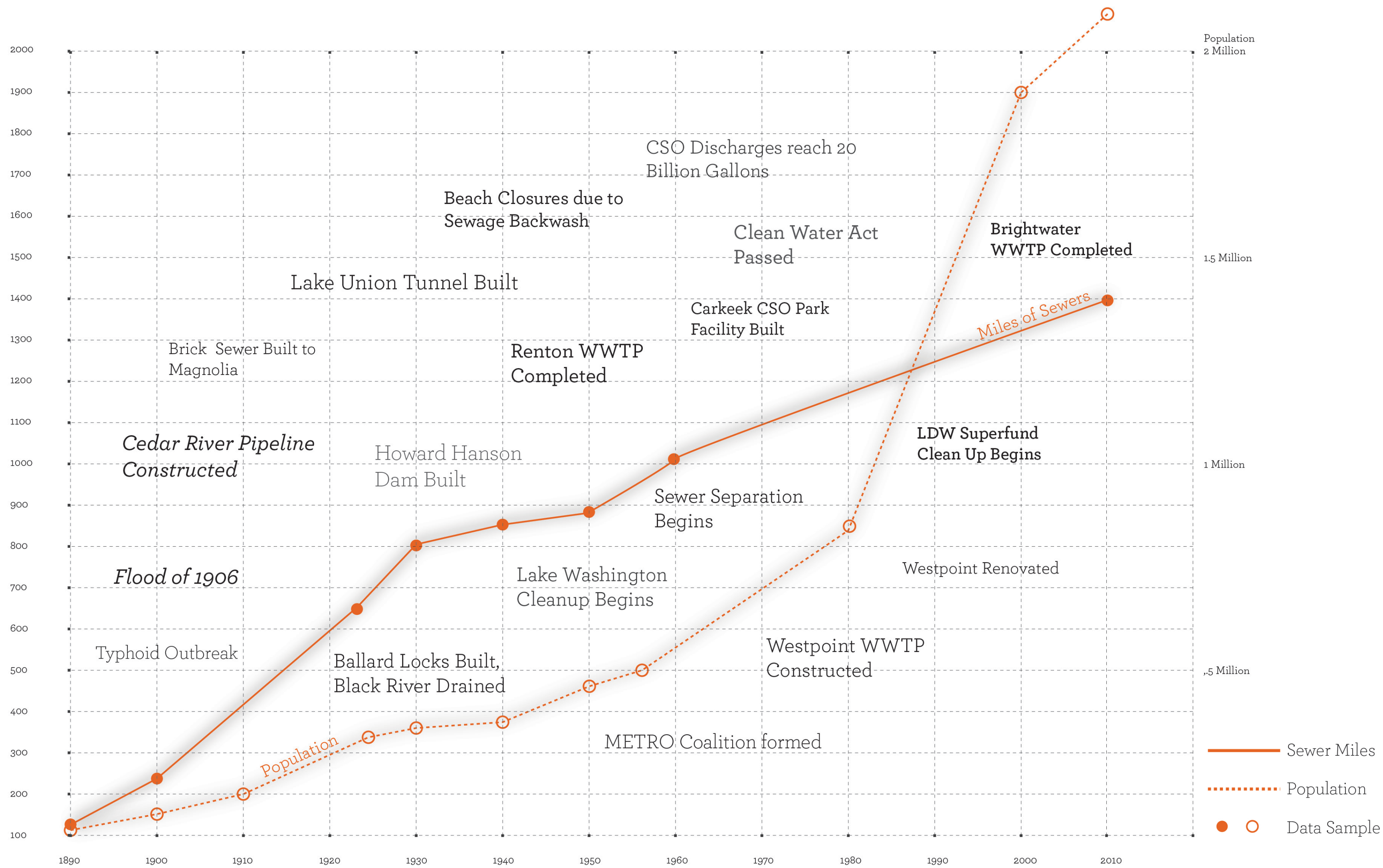


Figure 1. 6 Sewer Infrastructure and Population Data Source: SPU Website and US Census Data

Combined Sewer Overflows Today

Although Seattle's treatment plants have been extremely effective at reducing pollution from entering into Puget Sound, approximately one third of Seattle relies on Seattle's original combined sewer system. During rain events these older sewers frequently overflow large quantities of wastewater into the lakes, rivers and the Puget Sound (See Figure 1.7). Combined Sewer Overflows (CSOs) contain many harmful pollutants that can be potentially dangerous to human health. The typical contaminants in a CSO overflow are shown in Figure 1.8.

While Seattle has been successful in reducing approximately 90 percent of its CSOs in the last 40 years, currently around one billion gallons of contaminated water still overflows Seattle's combined sewer each year. Under federal law, King County and the City of Seattle are required to control their Combined Sewer Overflows (CSOs) to meet EPA's Clean Water Act by 2030. "Control" is defined by Washington State standards as reducing the number of untreated wastewater overflows to an average of once per year at each CSO location.

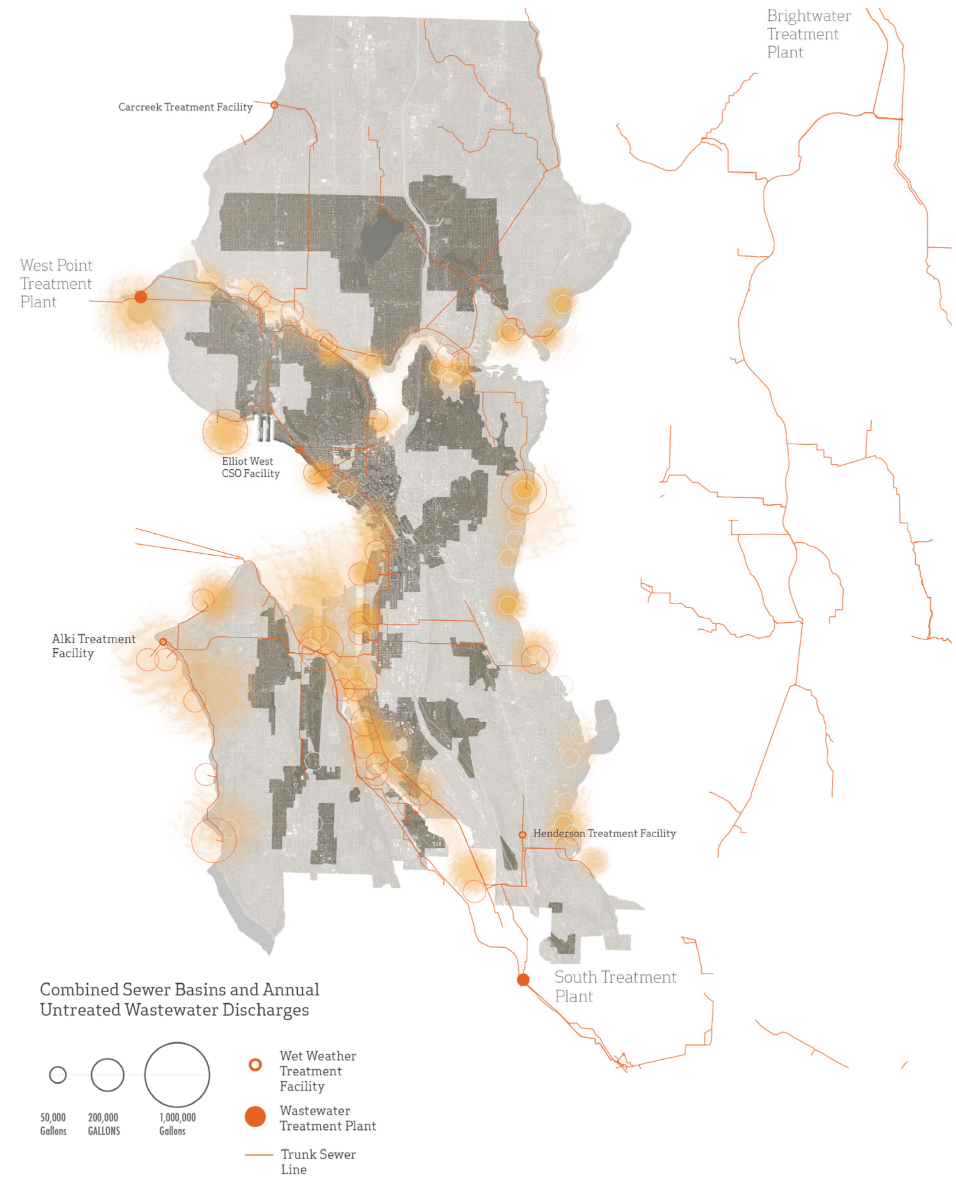


Fig 1.7 Combined Sewer Basins and CSOs in King County, WA. About 60 of the Seattle's CSOs are uncontrolled

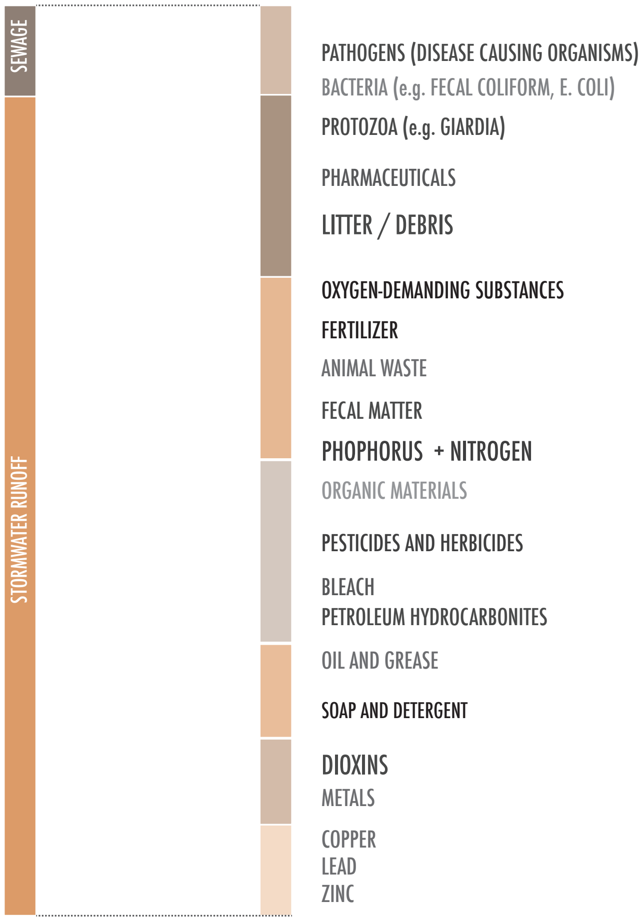


Figure 1.8 CSOs discharge a variety of contaminants to the Duwamish River, including heavy metals, PCBs, pthalates, exessive nutrients and petroleum hydrocarbons

In 2012 The City and County updated their long-term control plan to reach the goal of controlling the remaining 60 uncontrolled CSOs. The County has allocated approximately one billion dollars towards a multitude of infrastructure projects in order to meet this goal. Strategies in the 2030 plan to reduce overflows have included building additional storage, CSO treatment facilities, increasing conveyance, sewer separation and building green stormwater infrastructure to reduce and slow down stormwater run-off into combined sewers.[13]

Duwamish River and Combined Sewer Overflows

King County and Seattle's stormwater and combined sewer system drain a total of 32 square miles into the Duwamish River. In addition there are many other polluters contributing to a degradation of water quality on the Duwamish. The Lower Duwamish River is the receiving waterbody for over 100 public and private stormwater outfalls, CSOs and as well as industrial pollution.[14]

The Department of Health advises against consumption of resident Duwamish fish, crab or shellfish due to elevated contamination found in these species that can be attributed to toxins in the Duwamish. Excessive nutrients in wastewater can also lead to algae blooms, which can deplete oxygen levels in water and be detrimental to fish and aquatic invertebrates.

13 King County, King County Executive's Recommended CSO Control Plan (2012), http://www.kingcounty.gov/environment/wastewater/CSO/Library/PlanUpdates/2012Plan.aspx.

14 Duwamish River Cleanup Coalition, Duwamish Valley Vision Map and Report (2009), http://duwamishcleanup.org/wp-content/uploads/2012/02/Duwamish-Val ley-Vision-Report-2009.pdf.

According to the EPA, CSO overflows are one of the five major contributors to the degradation of the Duwamish and its current listing as Federal Superfund Site. The EPA has identified 42 chemicals that are above environmental and health standards in the Duwamish. According to the EPA's findings, these chemicals are byproducts of industrial activities, and residential and industrial waste overflowing from overburdened sewage pipes.[15] Millions of gallons of untreated sewage and run-off continue to contaminate the river annually, counteracting early cleanup actions and posing threats to the health of the river system and nearby communities (See Figure 1.10).[16]

Figure 1.9, A CSO Outfall on the Duwamish River, Photography by Katie Campbell, source: http://www.opb.org/news/article/a-clean-water-act-primer/

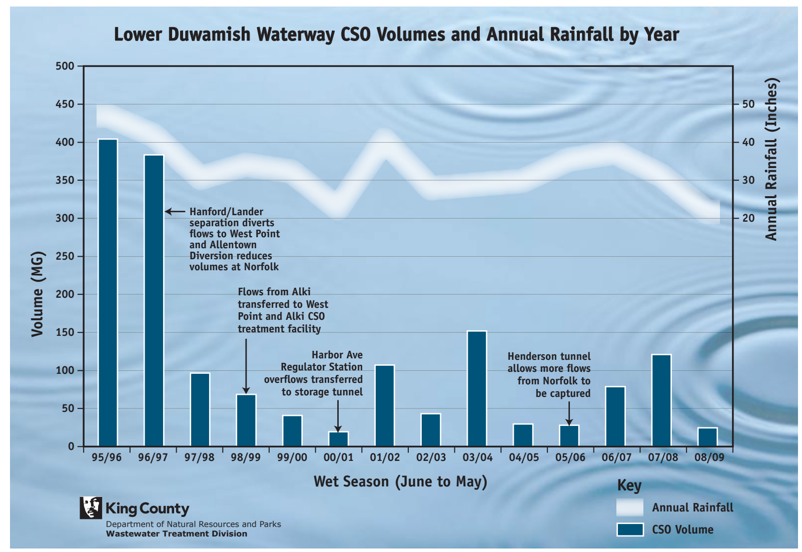


Figure 1.10, Annual Rainfall and CSO Discharges on the Duwamish. King County will invest $550 million by 2030 to control the remaining uncontrolled CSOs on the Duwamish. Source: http://www.kingcounty.gov/services/environment/watersheds/green-river/OurDuwamish/Cleanup/ControlCSOs.aspx

15 US Environmental Protection Agency, "The Lower Duwamish Waterway Superfund Site," accessed Nov. 16, 2014, http://yosemite.epa.gov/r10/cleanup.nsf/sites/lduwamish.

16 Lower Duwamish Waterway Group, "Cleanup Progress: Early actions moving cleanup forward," accessed March 27, 2014, http://www.ldwg.org/follow.html.

2 OUT OF SIGHT, OUT OF MIND: OUR IMPAIRED RELATIONSHIP TO THE URBAN WATERSHED

Out of Sight, Out of Mind

"Our lives are diminished if we cannot establish a rich and abiding contact with water... But of course, in most cities we cannot...We take the water for granted… as marvelous as the high technology of water treatment and distribution has become, it does not satisfy the emotional need to make contact with the local reservoirs, and to understand the cycle of water: its limits and its mystery."

--Christopher Alexander, et. al. *A Pattern Language*, 1977:64

The early 20th century approach to managing wastewater and stormwater runoff has been largely based on the logic of 'efficient conveyance'.[17] Engineers and bureaucrats have operated under the premise that stormwater runoff is a 'nuisance' and should be conveyed away from the city as quickly as possible.[18] Under this approach, rainwater has been channelized from gutters into sewers and underground storm drains; reservoirs are covered up, and urban rivers are transformed into immense drainage canals. These attempts to control water through an underground infrastructural network of pipes have loosened our connection to the cycle of water in the city.[19] As Christopher Alexander notes in A Pattern Language, we have become out of touch with water within the contemporary city[20].

17 Karvonen, Andrew, Politics of Urban Runoff Nature, Technology, and the Sustainable City (Cambridge, Mass.: MIT Press, 2011)., 8
18 ibid.
19 Mumford, Lewis, The City in History (New York: Harcourt, Brace and World, Inc., 1961),.
20 Alexander, Christopher, and Sara Ishikawa, A Pattern Language: Towns, Buildings, Construction (New York: Oxford University Press, 1977),

Similarly, Gary Strang observes in his essay "Infrastructure as Landscape," that the hydrology of a place has often been ignored in contemporary cities "…that operate independent of rainfall and gravity".[21] Strang notes that some of the most deeply moving landscapes of pre-industrial cities "…were nothing more than the irrigation, domestic water supply, sanitary sewer and flood control systems of the time. These landscapes allowed the workings of nature to be revealed in an urban setting" (223). For instance, Inca mountain settlements express and make legible the logic of the watershed in the design of the city.

Compartmentalizing Nature and the City

The conventional approach to water infrastructure in the city has largely been based on a compartmentalized view of nature and the city – a social construct advanced during the industrial age. According to Karvonen (2011), as cities developed in the early 20th Century, we attempted to dominate and replace natural systems with infrastructural systems, in order to support the illusion of man's independence from the natural world.[22] As Karvonen points out, one of the most extreme examples of this effort to separate a wild and unpredictable nature from the city is the formerly expansive Los Angeles River, which has been largely reduced to an encased concrete drainage culvert.[23]

21 Gary Strang, "Infrastructure as Landscape," Places (3)1:223
22 Karvonen, Andrew, Politics of Urban Runoff Nature, Technology, and the Sustainable City (Cambridge, Mass.: MIT Press, 2011)., 8
23 ibid,.

Similarly, in the "Natural History of Urbanization," Lewis Mumford observes that the 20th century infrastructure we have built distances us from the natural world and conceals our dependence on natural systems. He writes:

"[Urban settlements have]…a tendency to loosen the bonds that connect its inhabitants with nature and to transform, eliminate or replace its earth-bound aspects, covering the natural site with an artificial environment that enhances the dominance of man and encourages an illusion of complete independence from nature."

--Lewis Mumford, The City in History[24]

As Lewis Mumford and Andrew Karvonen point out, our modern infrastructural system have not only advanced a myth of dominance over nature, but have also impaired our connection to natural environment and the cycles of water in the city. While urban hydrological systems are interdependent with natural water cycles, the constant flows of water in our city, irrespective of rainfall and seasons, has increasingly led us to take water for granted. Furthermore, since wastewater in the city is conveyed into through underground network that is mostly out of sight, we are largely unaware of our collective impact and dependence on these interconnected systems.

Wastewater Treatment: Hidden from View

As discussed in the previous chapter, the conventional wisdom for wastewater treatment throughout the U.S. has been to collect wastewater from large distributed areas and pipe it to centralized treatment plants. While the infrastructure is highly energy-intensive and provides a significant environmental and societal function, treatment plants are typically located in suburban locations and are generally masked or screen from view.

Due to the relatively recent development of wastewater treatment technology, there is not a long-standing architectural tradition behind wastewater treatment plants. In addition, the unglamorous function of wastewater treatment has also resulted in architecture that is equally bland (with some notable exceptions in recent years). Typically, major public utilities are fenced off and not accessible to the public due in part to their unattractive appearance and single-purpose function. Furthermore, designers have traditionally had a diminutive role in major public work projects which have been regarded as technical and engineering problems.[25]

Gary Strang writes, "[Architects and Landscape Architects] are most often charged with hiding, concealing and cosmetically screening infrastructure, in order to maintain the image of the untouched surrounding of an earlier era. They are rarely asked to consider infrastructure as an opportunity, as a fundamental component of urban and regional form". [26]

Wastewater Treatment Process

While there are many different technologies utilized to treating municipal wastewater, the the conventional process is outlined in the following section. The inputs and outputs are diagrammed in Figure 2.1.

24 Mumford, Lewis, The City in History (New York: Harcourt, Brace and World, Inc., 1961), Quote also referenced in Karvonen, 7.

25 Chris Reed, Public Works Practice in Landscape Urbanism Reader, 275,

26 Gary Strang, "Infrastructure as Landscape," Places (3)1:231

- Preliminary treatment: In the first stage influent is typically stored in an equalization basin that diverts flows to the treatment facility. The first step of treatment is screening, where bar screens and pre-aeration basins screen out grit and trash, which is sent to the landfill for disposal.

- In Primary treatment, organics and grease are removed in large settling tanks while grease floats to the surface and is collected by skimmers. Collected solids and grease are then sent to solids treatment to be turned into nutrient-rich fertilizer called biosolids.

- Secondary treatment (biological and/or chemical): Secondary treatment further removes organic matter than escapes primary treatment. In secondary treatment, microorganisms (occurring naturally in wastewater) consume and breakdown the organic materials, which settle out and are recycled, leaving the water 85-95 percent clean.

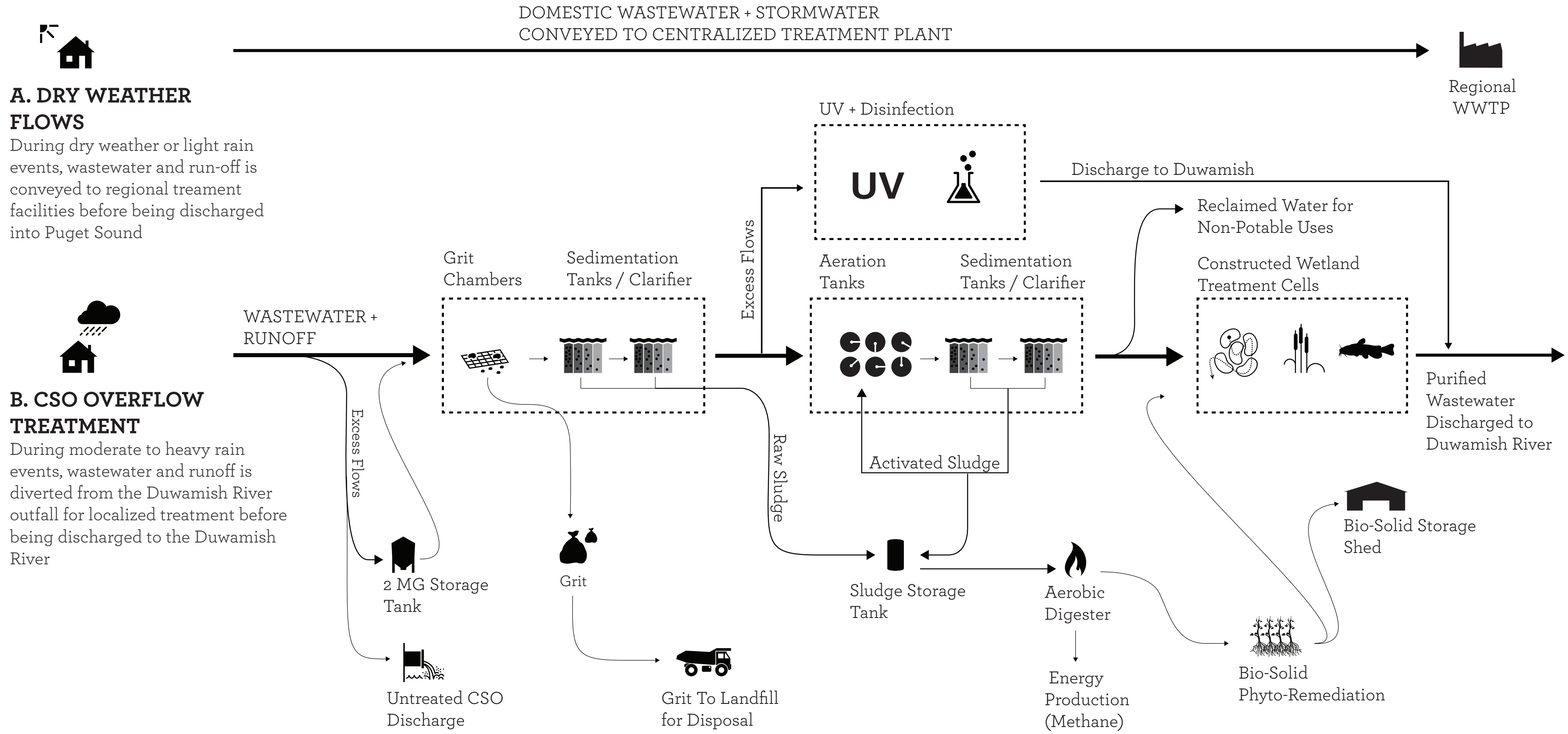
- Tertiary Treatment: Tertiary treatment is the final step to cleanse the water to a higher quality, and can remove up to 99% of impurities within wastewater. Water is disinfected with ultraviolet lights, chlorine or hypochlorite to kill remaining harmful microorganisms. Some innovative treatment systems are able to cleanse the water to a drinking water standard. After the water receives treatment, the purified effluent is discharged to a receiving waterbody or may be reclaimed for landscape irrigation purposes.

- Bio-Solid Production: Solids, which are separated from the water early on in the process, are broken down in anaerobic digester tanks under high heat for approximately 30 days, producing nutrient-rich fertilizer. In Seattle, 300 tons of nutrient rich bio-solids are produced each year from Seattle's three major treatment plants and are used for agricultural and landscape uses (King County). Anaerobic digesters also produce methane gas, which can be utilized to produce energy.

Constructed Wetlands for Treatment

While the conventional treatment process utilizes a mechanical system, constructed wetlands are increasingly being recognized as sustainable alternative to conventional wastewater treatment systems and have been implemented in some smaller cities in the U.S.[27] Plants and soils can be used to absorb contaminants in wastewater and stormwater through phytoremediation. In addition to water treatment, wetlands can provide additional benefits such as habitat enhancement and open space. While wetland systems are used for treating wastewater in some rural areas, the amount of land required often prevents their usage as a primary treatment system in more densely populated areas.

27 Campbell, Craig S., and Michael Ogden, Constructed Wetlands in the Sustainable Landscape (New York: Wiley, 1999),



① Primary Treatment

In this stage, grit is screened and removed from the influent. After screening water is then seperated from solids via sedimentation. Skimmers are then used to removed oil and greese from the water.

② Secondary Treatment

In this stage, microorganisms digest organic matter and reduce the amount of organic waste. In addition, disinfection using chemicals or UV treatment futher removes pathogens from the wastewater.

③ Tertiary Treatment

Tertiary treatment can remove more containments from wastewater than is typically achieved through primary and secondary treatment. Nitrogen, phosphorus and heavy metals can be removed to meet specific discharge criteria such as water re-use for irrigation.

Figure 2.1 Sewage Treatment Process

Moving Beyond the 20th Century Approach: Revealing Wastewater Infrastructure in The City

While the conventional approach to wastewater treatment has been to hide it and screen it from view, this thesis posits that revealing this critical infrastructure in the city and the processes used to treat wastewater can increase our awareness of the built and natural systems we rely upon in the city. When infrastructural sites are made accessible to the community, residents will experience and be more likely to understand the built and natural systems upon which they depend. By engaging the community up-close to infrastructural systems used to treat wastewater, this thesis posits, Seattle residents will be less likely to take water for granted and can form a stronger connection to the cycles of water in the city.

Given the ubiquity of water infrastructure in the city there are multiple opportunities for design to engage community to these systems. Storage sites, treatment sites, conveyance routes and discharge sites can be made legible and can become public amenities. Gary Strang writes, "Infrastructure systems...can be designed with a formal clarity that expresses their importance to society, at the same time creating new layers of urban landmarks, spaces and connections".[28] By overlaying additional functions onto these typically fenced off utilitarian elements we can establish a more nuanced and integrated approach towards the built and natural environment in the 21st century.

Figure 2.2 Conventional Treatment Plant in Syracuse, New York. Source: Unknown
Figure 2.3 Municipal Wastewater Treatment Lagoon in Arcata, California Source: http://www.redwoods.info/photos%5C1729PArcata%20marsh6.jpg

28 Gary Strang, "Infastructure As Landscape" Places (3)1:1996, 220.

3 DESIGN PRECEDENTS

In this chapter I will briefly discuss three selected projects that show the potential to integrate water renovation with art, interpretive trails, education centers and resilient and evocative landscapes. These projects challenge the conventional notion that wastewater should be obscured from public view. While the projects share similarities in terms of positioning landscape as infrastructure, each project is unique in terms of how it engages site visitors to the water treatment process through artistic, scientific and technological approaches.

Waterworks Garden, King County Treatment Plant, Renton, WA (Lorna Jordan, Concept Lead; Jones & Jones, Landscape Architects; Brown and Caldwell, Consulting Engineers).

Waterworks Gardens is an eight-acre stormwater park located next to the South King County Treatment Facility in Renton, Washington. While the original plans for the 85-acre wastewater treatment plant sought to disguise the treatment facility within its suburban context, environmental artist Lorna Jordan proposed providing public access to the site, which would highlight the natural treatment process of water as it is cleansed and moves through a series of constructed wetlands. Jordan's plan for the site integrated stormwater enhancement, wetlands and environmental artwork (see Figure 4.1). While engineers had originally planned a series of large rectilinear stormwater distention ponds to manage run-off from 50 acres of impervious surfaces within the treatment site, Jordan's design used sculptural landforms in order to engage the community to the process of stormwater treatment. (see Figure 4.2).

The site is designed to put visitors in touch with the water cycle and the

Figure 3.1 Waterworks Garden, 1997, Image Credit: 4Culture.

poetic and mysterious qualities of water. The main pathway follows the course of the water being cleansed and leads to five different 'garden rooms'. The site slope drops nearly 70 feet, and water cascades through a series of 11 ponds that settle out contaminants; water is eventually released into a larger wetland. [29] The pathway also links up to a nearby trail along an existing creek. The site design is innovative not only in terms of its artistic approach towards stormwater, but also in terms of its implementation. While Waterworks garden was not part of the original scope of the project, the expansion of the treatment plant provided the majority of the funding for the 1.3 million dollar project.[30]

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29 Valenta, Carol, "Cycles of Water: Stormwater Treatment and Wetland Enhancement Become Public Art," in On the Ground: The Multimedia Journal on Community, Design & Environment (Berkeley, Calif.: 1000 Words, 1995), 13-15.

30 Campbell, Craig S., and Michael Ogden, Constructed Wetlands in the Sustainable Landscape (New York: Wiley, 1999), p.219.

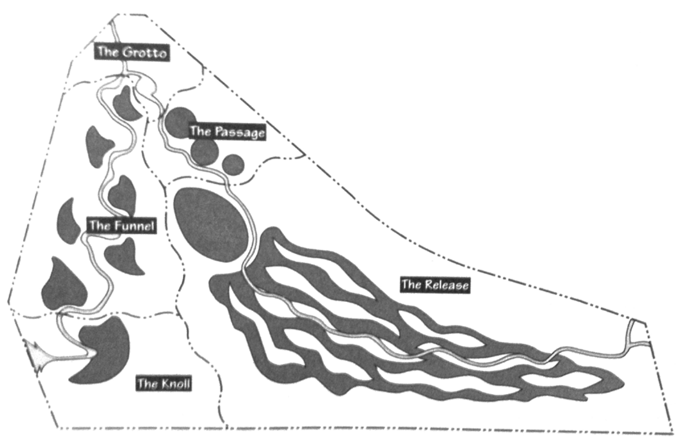

Figure 3.2, Water Works Garden Site Plan, design by Lorna Jordan, Source: Campbell, Craig S., and Michael Ogden, Constructed Wetlands in the Sustainable Landscape (New York: Wiley, 1999), p.219.

Water Pollution Control Lab Portland, Oregon (Miller | Hull, Architect; Murase Associates, Landscape Architect).

The Water Pollution Control Laboratory in Portland conducts research on how contaminants affect water quality. The site design extends the function of the laboratory into the surrounding landscape by providing wetlands to test how stormwater runoff may be treated in the urban environment.

Two overlapping wetland cells are designed to retain and filter out pollutants from a 50-acre neighborhood uphill of the site before the water reaches the Willamette River. A large stone-lined concrete flume dissipates the energy of the water being released into the wetlands, allowing solids to settle out. Water enters the upper cell through several weepholes in the side of the concrete flume. In the lower pond, a wall constructed of basalt marks changes in water level due to large rain event (See Figure 4.3).[31]

The project also celebrates stormwater management techniques as a site amenity. For instance, the building expresses stormwater through its expressive scuppers, which extend out from the roof and shoot water into a series of bioswales, which also capture run-off from the parking lot (see Figure 4.4). While the wetland cells were not intended for habitat, the ponds have attracted birds to the site. The site serves as a demonstration of sustainable stormwater management within an urban context and also integrates with the existing trails along the Willamette River.



Figure 3.3 Flume and Pond Image Credit: Murase Associates
Figure 3.4 Rainwater Scuppers, Image Credit: Murase Associates + Miller | Hull Architects

31 Thompson, William, "The Poetics of Stormwater," in Landscape Architecture (1999): 58-91.

Brightwater Treatment Plant, Woodinville, WA (Mithun, Architect; Hargreaves Associates, Landscape Architect; CH2M HILL / Brown and Caldwell / Streeter & Associates, Consulting Team).
Brightwater is a newly constructed wastewater treatment plant that will respond to the increasing growth in the King County region. The 130 million gallon per day capacity treatment plant uses state-of-the-art technology that will recycle sewage to high quality water standards. In addition, the facility utilizes an anaerobic digester will process solids into nutrient-rich fertilizer and provide methane to power the plant.

The treatment plant design includes forty acres of publicly accessible open space; a community and environmental learning center; walking and jogging trails; and a wetland that integrates reclaimed wastewater (see Figure 3.5 and 3.6). The site design includes many permanent art installations relating to the water treatment and reclamation process.[32] For example, a large pipeline used to convey treated water is treated as a sculptural element on the site. The Brightwater community center provides a gathering space for community events and educational programs geared towards urban environmental education.

32 King County "Brightwater Treatment Plant," accessed Feb 2, 2015, http://www.kingcounty.gov/environment/wtd/Construction/North/Brightwater.aspx

Figure 3.5 & 3.6 Brightwater Community Center and WWTP, Mithun Architects, Photo Credit: Benjamin Benschneider

4 SITE SELECTION AND ANALYSIS

This chapter reviews the spatial, temporal and infrastructural context for the selected site and building intervention. In this chapter I discuss sewage overflows in relation to the Georgetown, a proposed strategy to control these overflows and the proposed site based on this strategy.

CSOs on the Duwamish:

Figure 4.1 shows the average volume and frequency of combined sewage overflows occurring at the Brandon and Michigan Outfalls during rainstorms. These overflows are caused not only by the Georgetown's combined system, but also from the combined sewage system in the uphill Beacon Hill neighborhood, which also flows into the Elliot Bay Interceptor.

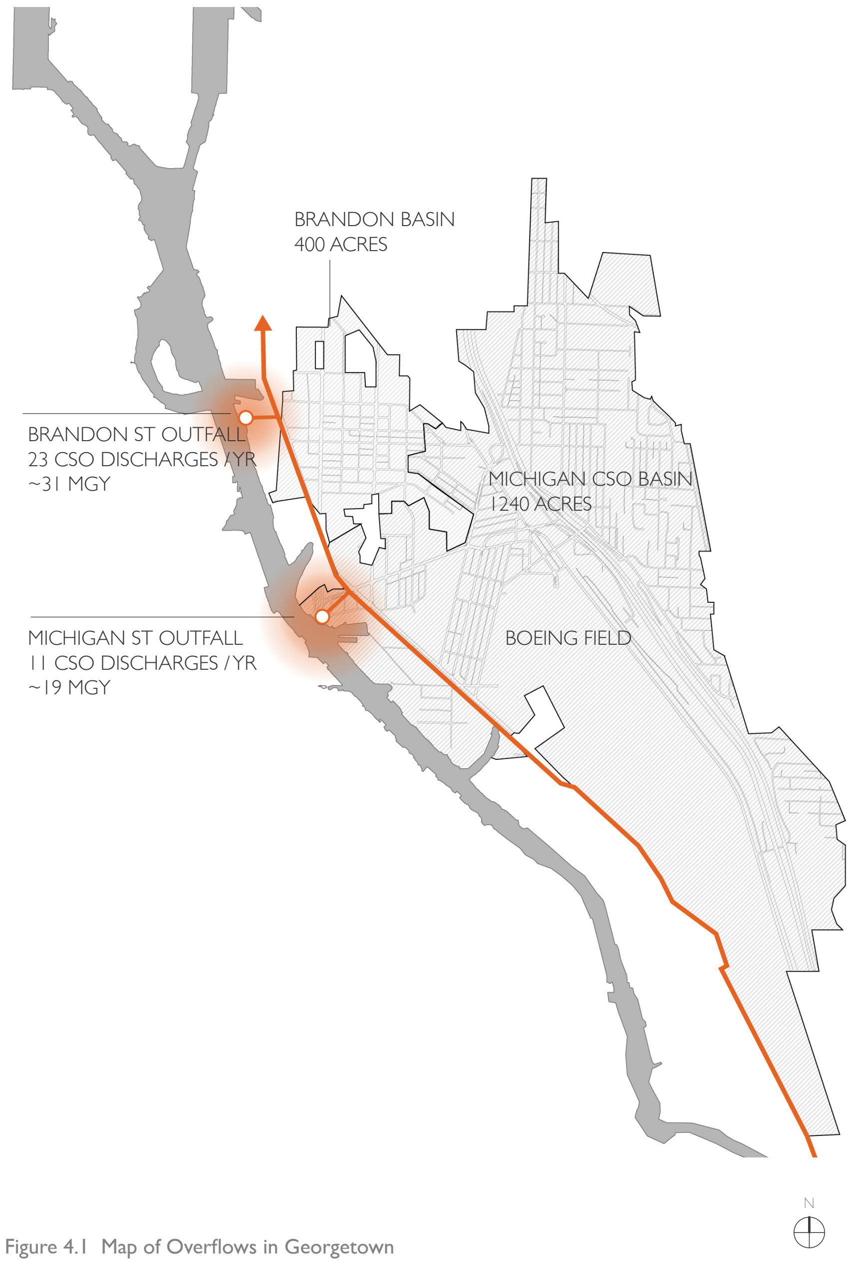

Figure 4.1 Map of Overflows in Georgetown

King County's Strategy:

In order to control these outfalls, the County recommends diverting these overflows to a 66 million-gallon/day capacity wet-weather treatment facility located on a 4-acre site before discharging the treated effluent to the Duwamish River. The County would also construct a regulator station, new conveyance to this facility and a new outfall on the Duwamish River (see Figure 4.2). The county estimates the total project cost for controlling these two outfalls will be 139.7 million dollars.[33]

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33 King County

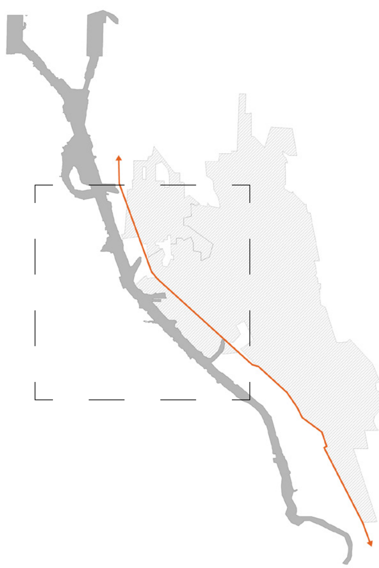


Figure 4.2 King County's Proposed Strategy

Proposed Strategy and Site

This thesis proposes that wastewater overflows be conveyed instead to a nearby 12-acre site currently owned by WSDOT in the Georgetown neighborhood (see Figure 4.3). While the proposed strategy would maintain a similar sized wet-weather facility, this proposal deviates in terms of the larger parcel size, in order to provide multiple benefits to the Georgetown neighborhood.

The site offers many advantages as a potential park and water treatment site due to its connectivity to the surrounding neighborhood, and its larger land area that would be suitable for reclaiming treated water and habitat enhancement. In addition to moving the location of the treatment site, this thesis also proposes that the discharge point be located at 'slip 4' —a turning basin for barges— in order to provide habitat enhancement and better access and recreational opportunities on the Duwamish River.

Figure 4.3 Proposed Strategy

Site Context

The proposed intervention is located within Seattle's Georgetown neighborhood, which is situated along the Duwamish River, approximately three miles south of downtown Seattle. While alternative neighborhoods were explored during the early stages of this thesis, King County's 2030 Regional Wastewater Services Plan specifies that a 'wet weather' treatment facility is needed within an approximately half mile radius of the Michigan Street or Brandon Street outfalls in the Georgetown neighborhood in order to control combined sewer overflows on the Duwamish. In a separate study, the county determined that collecting and treating the combined sewage overflow was more efficient and less costly than separating the combined sewer in the two basin areas.[34]

The proposed treatment site and discharge site are shown in Figure 4.4. The location of this site was driven by its proximity to the Brandon Street and Michigan Outfalls, which are frequently discharging into the Duwamish River during rain events. Due to the hefty cost of modifying existing infrastructure, King County also provided a boundary area for where a wet-weather treatment facility should be located. The selected treatment site is located upstream of these two 'uncontrolled' outfalls and meets the location criteria specified by King County.

34 King County, "Protecting Our Waters: Brandon St & South Michigan Project," accessed Feb 2, 2015, http://www.kingcounty.gov/environment/wastewater/CSO/Library/PlanUpdates/2012Plan/9Projects/BranSMich.aspx.

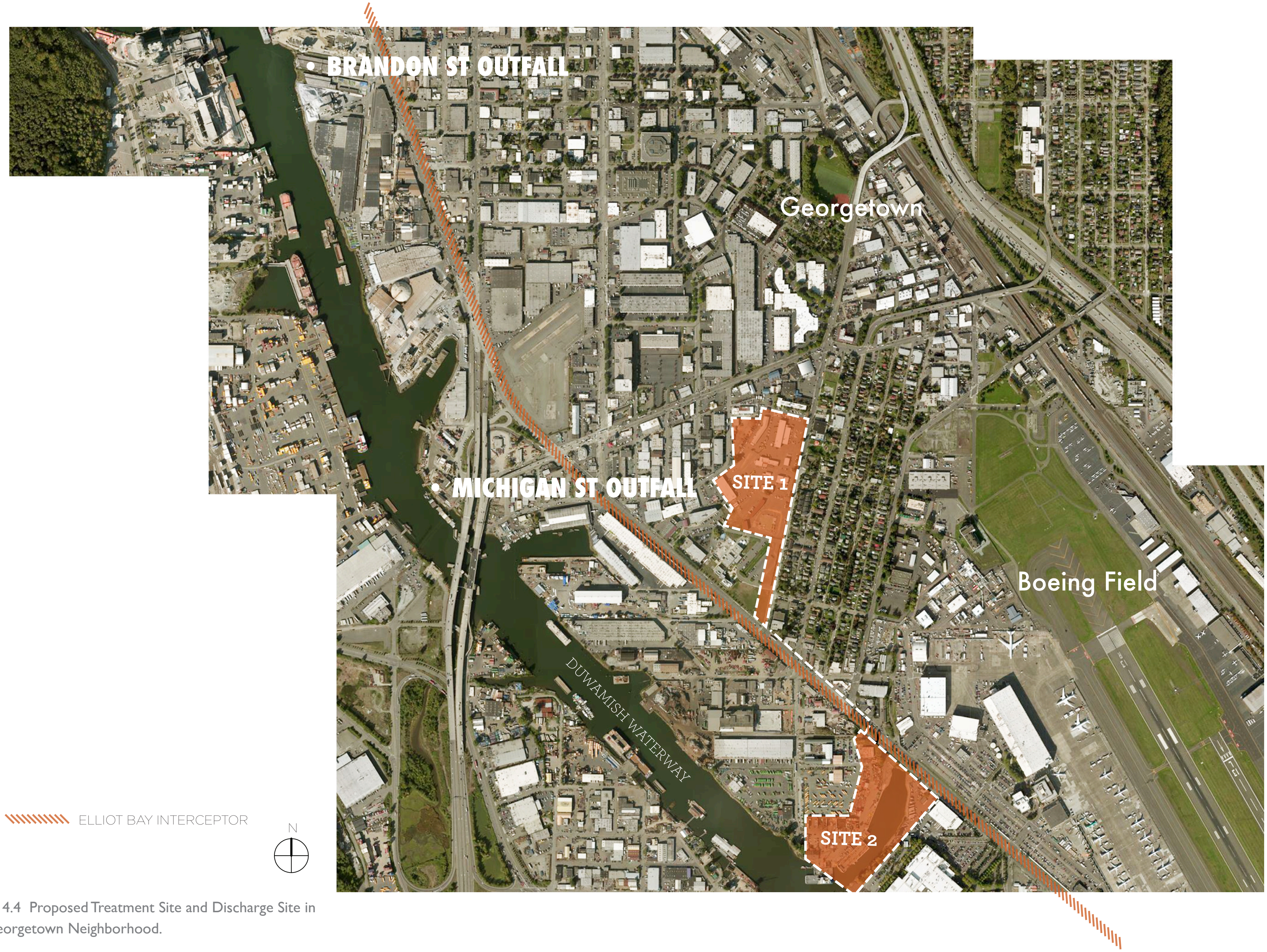


Figure 4.4 Proposed Treatment Site and Discharge Site in the Georgetown Neighborhood.

A Dynamic River

While the Duwamish River historically supported the Duwamish Tribe as an important cultural resource for thousands of years, the encroachment of white settlers in the late 1800s and the subsequent transformations to the river in the early 1900s displaced Native American villages from the banks of the River[35].

The transformation of the river from a wild, messy and unpredictable hydrological system to an industrial waterway is depicted in Figure 4.5. The river was tamed, channelized and armored in for economic and shipping development that supported the growth of Seattle as a major port city.[36] The river's original ecological character and dynamic processes have been largely erased by patterns of development which have filled in tidal marshes, straightened the river and restricted the dynamic and seasonal hydrological cycles (see Figure 4.5 and 4.6). A report released by the Port of Seattle notes the major loss of habitat that has coincided with the industrial development along the river.

35 Source: http://allaboutsouthpark.com/live/history/duwamish-tribe-history/.

36 Sato, Mike. The Price of Taming a River: The Decline of Puget Sound's Duwamish/Green Waterway. Seattle, Wash.: The Mountaineers, 1997.

The report states:

"The historic estuary included approximately 1450 acres of intertidal sand and mud substrate, nearly 1300 acres of intertidal marsh, and approximately 1450 acres of tidal swamp (or forested wetland). In addition, the meandering river channel included approximately 17 miles of riparian environment and estuarine floodplain. The combined intertidal and estuarine floodplain habitat area was approximately 5300 acres".[37]

In addition to these physical transformations, a legacy of toxic waste from industrial sources, runoff and sewage discharges continue to degrade the health of the urban river system and hamper ongoing cleanup efforts.[38] In 2001, the Lower Duwamish Waterway was declared an EPA federal Superfund site and is the focus of ongoing clean up efforts (see Figure 4.7).[39]

37 Port of Seattle, Duwamish History Report, https://www.portseattle.org/Environ mental/Water-Wetlands-Wildlife/Documents/Duwamishtour.pdf

38 Duwamish River Cleanup Coalition, Duwamish Valley Vision Map and Report (2009), http://duwamishcleanup.org/wp-content/uploads/2012/02/Duwamish-Valley-Vision-Report-2009.pdf.

39 EPA Superfund Site

Duwamish River, 1854

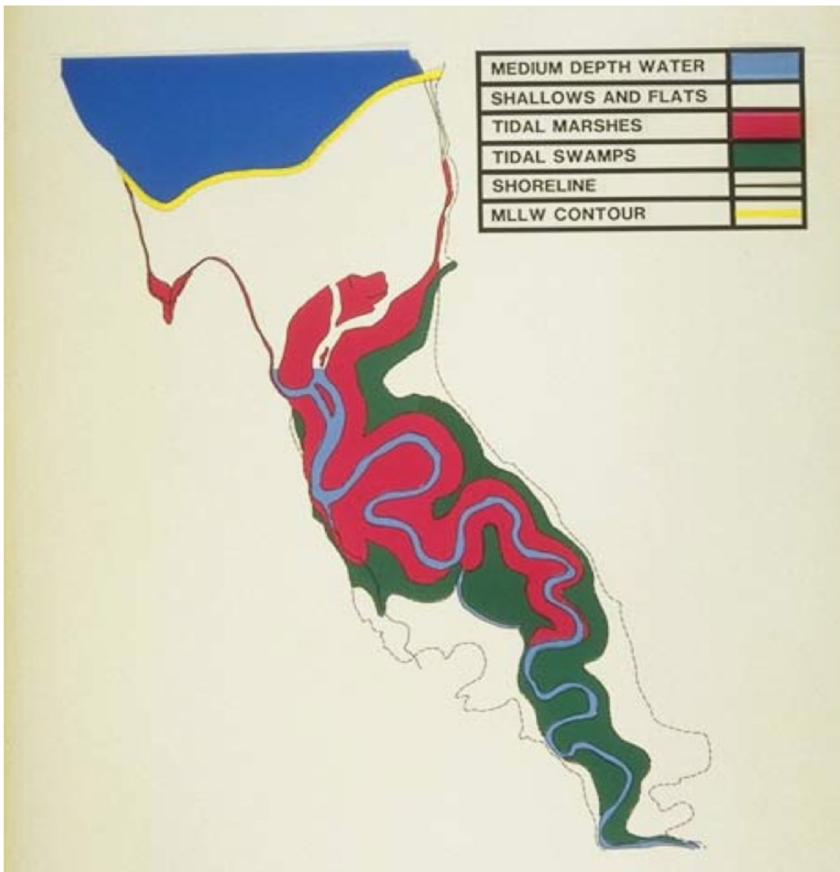
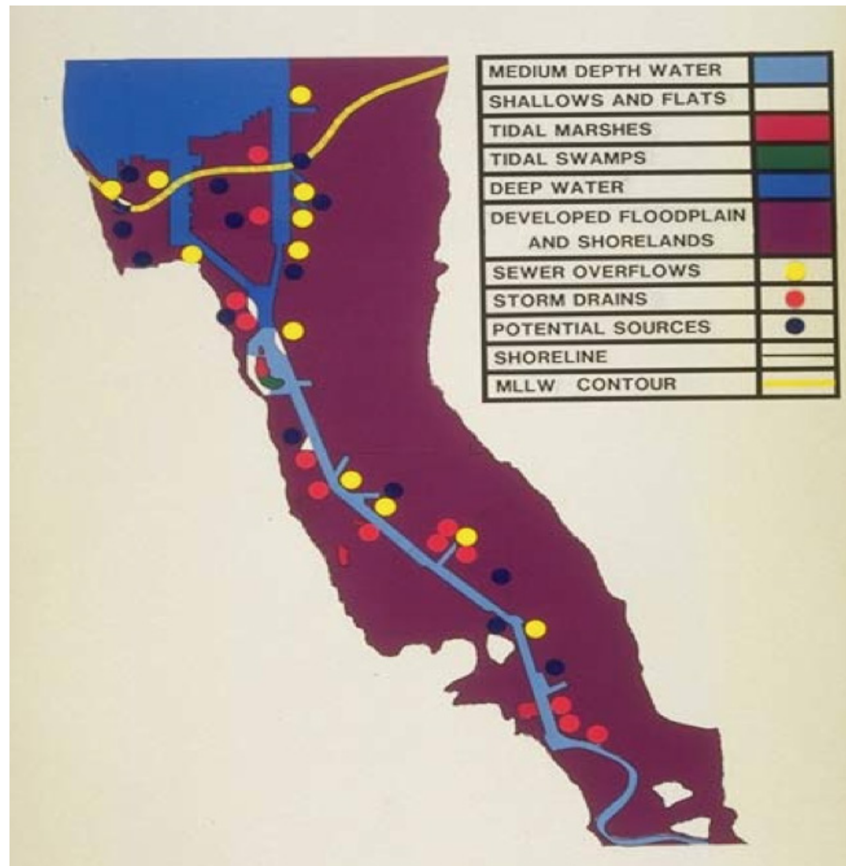


Figure 4.5 a Duwamish River Habitat, 1854, Source: Port of Seattle Restoration Plan

Duwamish Waterway, 1984



4.5 b Duwamish River Habitat, 1984, Source: Port of Seattle Restoration plan

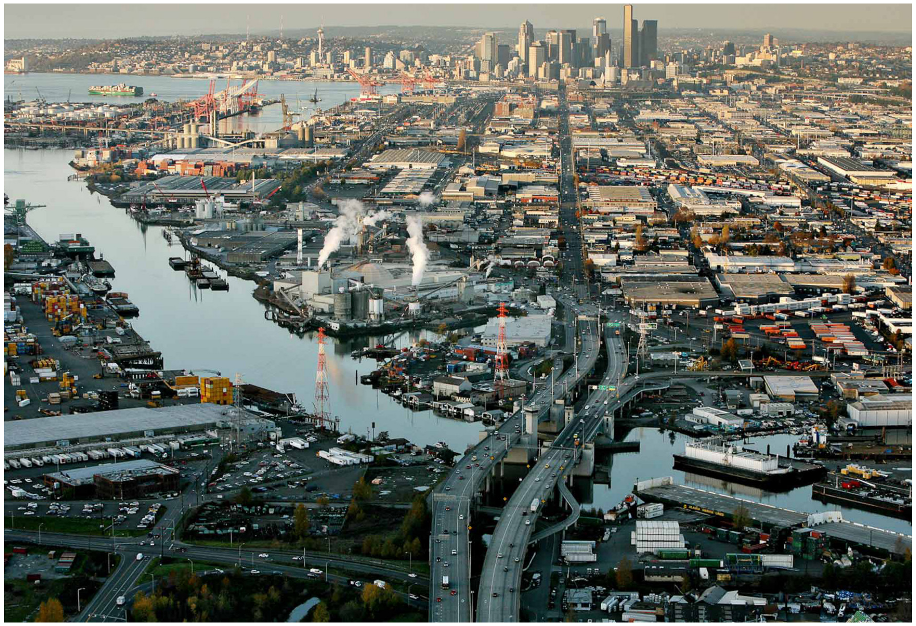


Figure 4. 6 Dredging of the Duwamish Begins, Photo Credit: Seattle Times Archive, c. 1914
Figure 4. 7 Duwamish Industrial Activities, Photo by Paul Joseph Brown/Ecosystemphoto.com, 2001

River Overlay

The proposed treatment site and the discharge site are also located on the historic route of the Duwamish River, before the Army Corps channelized it in 1913. Figure 4.8 depicts the route of the river in 1854 prior to it being filled and straightened to make way for industrial uses.

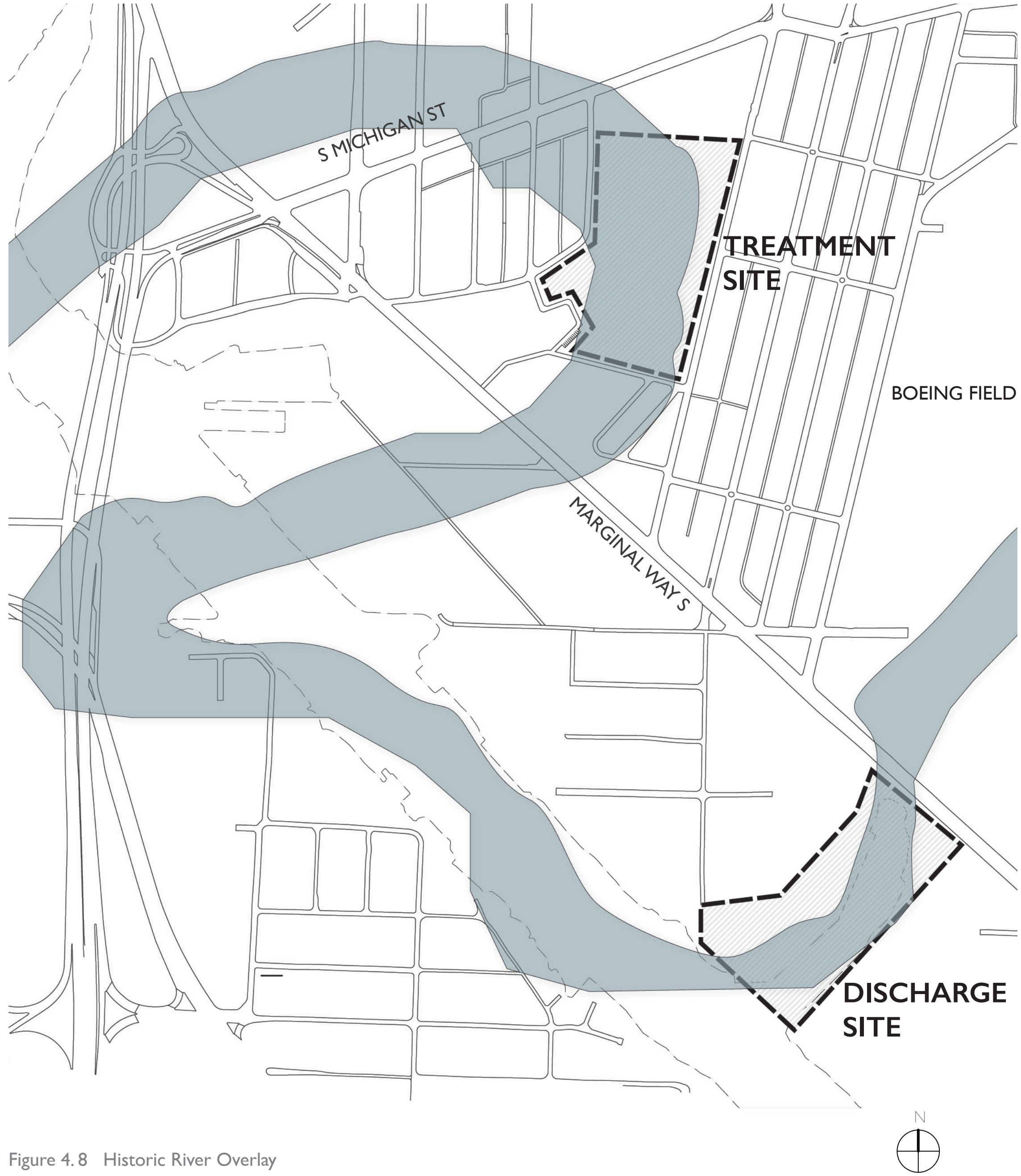


Figure 4. 8 Historic River Overlay

Image 4.9 characterizes the predominant relationship between the river and its surrounding land uses. Large-scale warehouses and industrial shipping yards appear to have a tenuous and single-purpose relationship to the river. The name of the river "the Duwamish Industrial Waterway" also reflects its transformation in the 20th century from a tidal estuary to an infrastructural waterway. Arguably, the river is understood as an infrastructural element and may not be valued as a natural asset within Seattle, due to its toxic legacy and current lack of diverse uses.

Figure 4. 9 Monofunctional Uses along the River

River Access

Georgetown has only one publicly accessible access point to the river, despite having been a riverfront community prior to the straightening of the river.[40] The Duwamish Valley River Vision report states:

"Public access to the Duwamish River is highly restricted by an industrially-zoned barrier between the neighborhoods and major arterials along most of the river... Increasing opportunities for public access to the river was identified as a high priority throughout the Duwamish Valley visioning process."[41]

Several new focus areas for public river access are recommended in the Vision. In particular, 8th Avenue South presents a major opportunity to improve access to the river due to its proximity to the residential neighborhood. There is a small street end park currently located on 8th Ave South. While the site is in need of physical improvements, it offers sweeping views to the river and to Mount Rainier. River access also could be improved by having boat launches for kayaks and rowing shells (there is an active rowing club in the neighboring South Park neighborhood).

40 http://duwamishcleanup.org/wp-content/uploads/2012/02/Duwamish-Valley-Vision-Report-2009.pdf, P. 34

41 Duwamish River Cleanup Coalition, Duwamish Valley Vision Map and Report (2009), http://duwamishcleanup.org/wp-content/uploads/2012/02/Duwamish-Valley-Vision-Report-2009.pdf.

Open Space and Parks in Georgetown

Figure 4.8 shows the existing open spaces close to the main residential neighborhood. These two nearby parks comprise approximately 1.2 acres of open space and provide only a limited range of activities for the neighborhood. Compared to Seattle's average of 8.9 acres of public open space per 1000 residents, Georgetown has a significant deficiency of parkland.[42] If the proposed WSDOT site were to be acquired for use as a treatment park, this would increase public open space in Georgetown substantially, providing the neighborhood with a ratio of parkland similar to other areas in the city. The discharge site located along the Duwamish River would also provide increased recreational opportunities, as well as habitat and shoreline enhancements that would benefit fish and wildlife on the Duwamish.

Community Facilities

The Georgetown Neighborhood Plan (2004) recommends that community facilities and programs should be implemented as funding becomes available. Currently there is a lack of public community gathering spaces in the neighborhood. Specifically, the plan specifies that a community center or multi-purpose facility would benefit Georgetown residents. The community facility could support ESL classes, art workshops, community events and many other uses.[43]

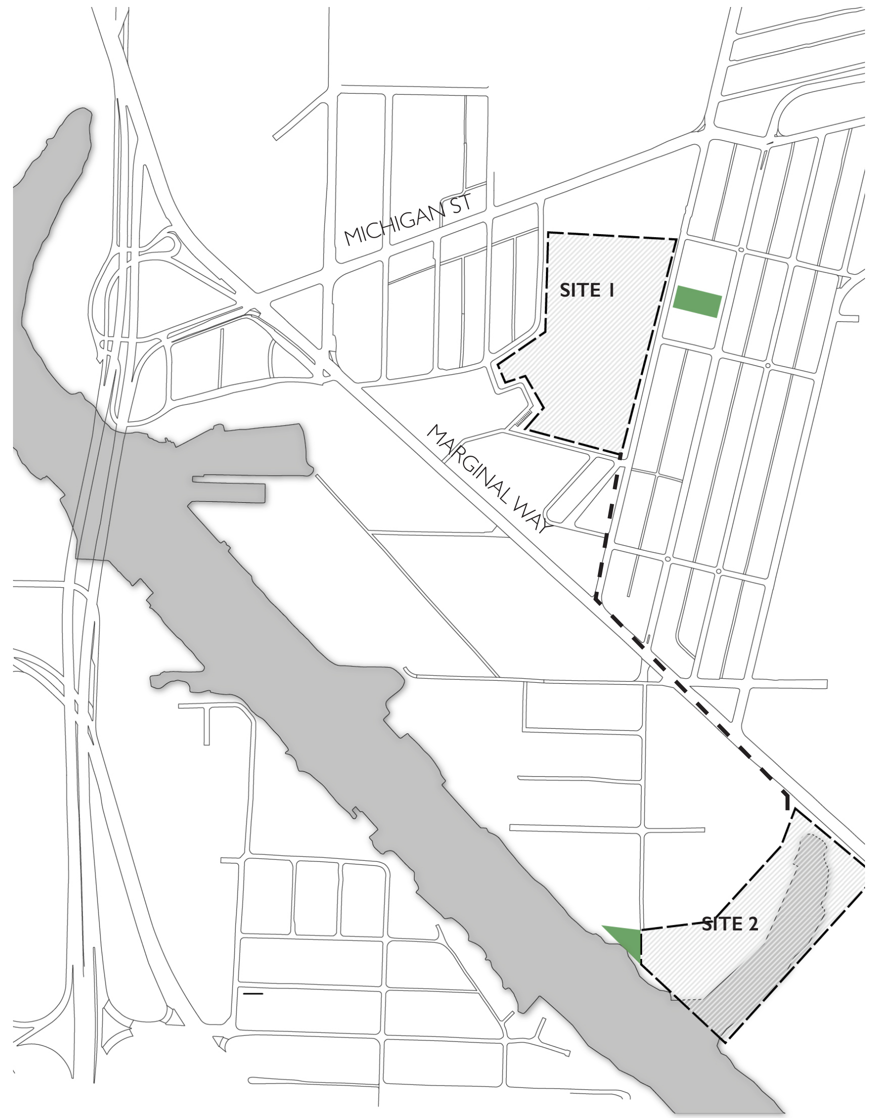


Figure 4. 10 Open Spaces in Georgetown

42 City of Seattle, "Seattle Land Use Quick Statistics," accessed March 29, 2015, http://www.seattle.gov/dpd/cityplanning/populationdemographics/aboutseattle/landuse/default.htm.
43 City of Seattle, "Georgetown Neighborhood Plan, 2005,"

Land Use

The treatment site is currently owned by WSDOT and used for commercial vehicle licensing. The thirteen-acre site includes an administrative building, several sheds, storage containers and several acres of underutilized parking. The site has many different edge conditions due to different land uses, which are shown in Figure 4.11. It also should be noted that the industrial grid runs North-South with the residential grid running Northeast–Southwest. The WSDOT site is a critical point within the neighborhood due to the diverse uses that surround it, and it has the potential to become a focal point or heart for the community. It is also located adjacent to South Seattle Community College, which offers workforce training, mainly in the construction and manufacturing industries.

Along the river, industrial and shipping land uses prevail and a lack of diverse uses hampers other activities from taking place on the river. The proposed discharge site, referred by the Port of Seattle as 'Slip 4', is currently used for sand storage. The 6.4-acre slip was recently cleaned up under the EPA's 'early action' plan for the Lower Duwamish River. Cleanup activities removed approximately 14,000 tons of contaminated sediments from the slip bottom, and improved habitat for juvenile salmon.

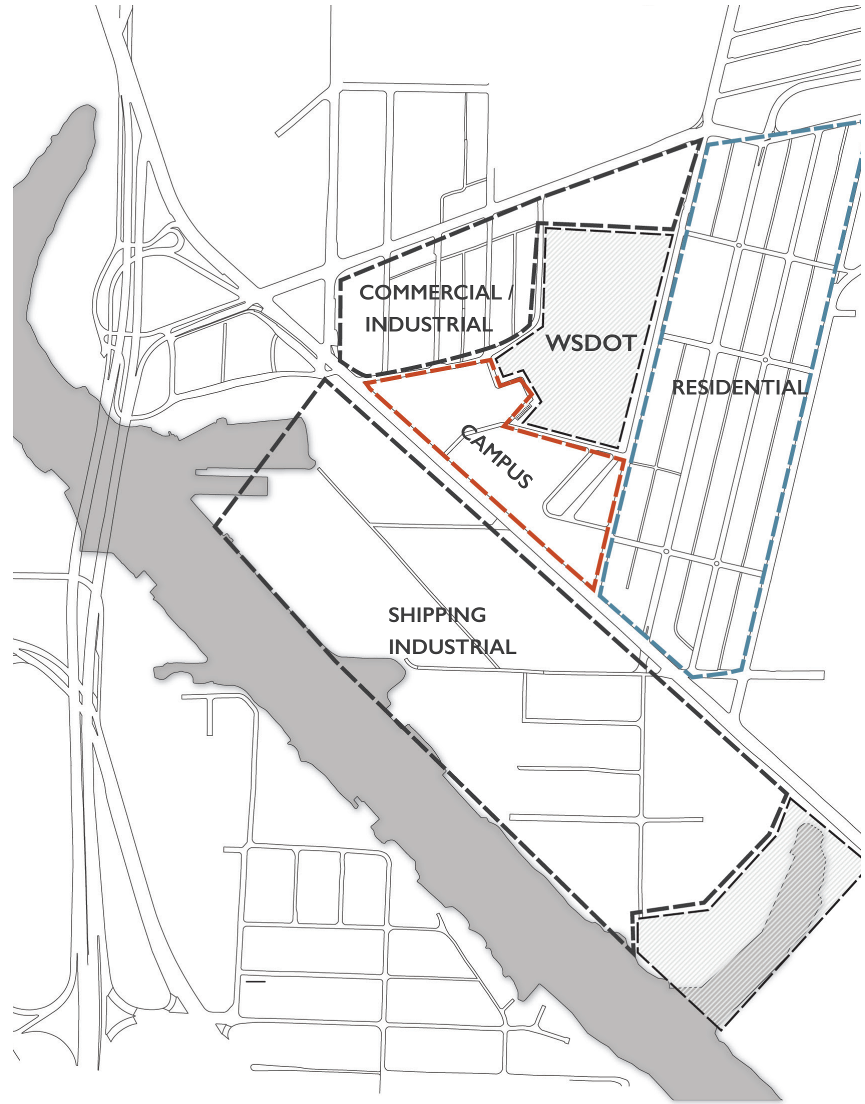


Figure 4.11 Land Use Map

Figure 4.12 shows a figure-ground diagram of the site and proposed building removal on both sites. The current building stock located on the treatment site includes a WSDOT administrative office building, a warehouse and several storage sheds. The scale of the surrounding industrial buildings and blocks are very large and imposing and often obstruct visual and physical access to the river.

Existing Site Conditions

The proposed treatment site is surrounded by a chain-link fence and is currently inaccessible to the public (see Figure 4.13). The majority of the site is paved over for parking and storage, and there is little natural vegetation or trees within the underutilized parcel. The site is also relatively flat and has only minor topographical changes. While the soil in Georgetown is generally has a high infiltration potential, soil and groundwater contamination would likely need to be assessed.

During my site visits, it became clear upon that while the river has been erased and paved over by industry, the site is still very wet and water is naturally pooling on roadways and in slight depressions found there (see Figure 4.14). While the majority of the WSDOT parcel consists of a parking lot and storage facilities, a small birch grove has established itself on the edge of the site, adjacent to River Street.

Since the treatment of sewage overflows plays a major role in the future health of the Duwamish River, I felt it was important to establish a strong

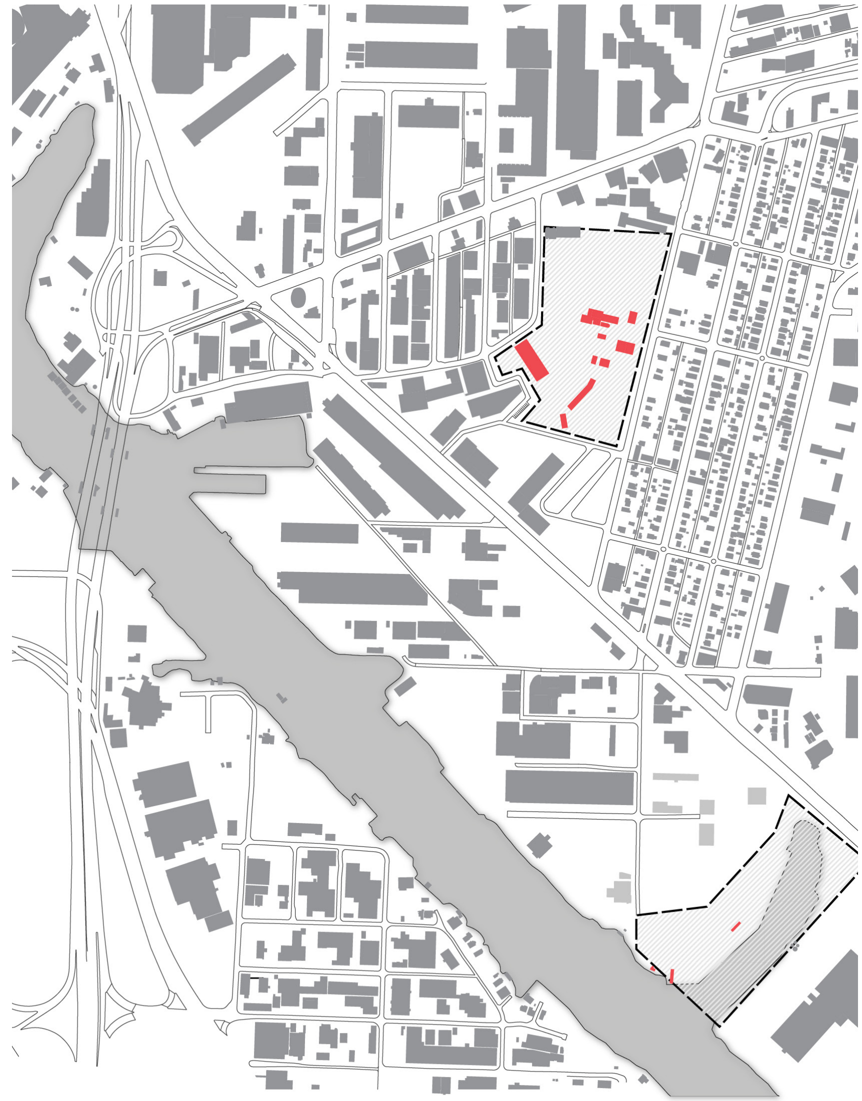


Figure 4. 12 Figure Ground Map and Proposed Building Removal

connection between the treatment site, which is linked within the fabric of the community, and effluent discharge site at the river. While both the treatment site and the discharge site are envisioned as autonomous public open spaces in their own right, with their own social and ecological functions, it was also important to show how these sites are part of an interconnected infrastructural system.


Figure 4.13a Site from Corson Ave


Figure 4.13b Site from South Seattle Community College (Georgetown Campus)


Figure 4.13c Proposed Discharge Site

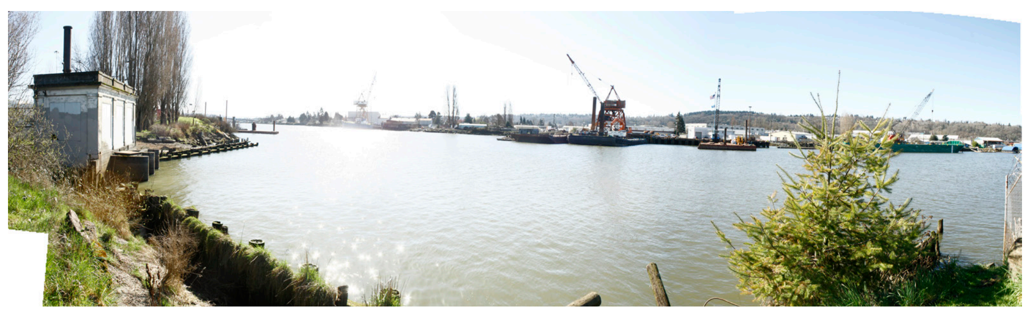


Figure 4.13d Street end park with a derelict steam plant structure (discharge site in the background).

Figure 4.14 The character of the treatment site. Note the water pooling on the site.

5 DESIGN RESPONSE

Site Vision

Figure 5.1 shows the overall vision for the treatment site, the conveyance route and discharge site as a connected network of open spaces. During storm events, combined overflows wastewater will be diverted and piped from the Elliot Bay Sewer Interceptor located on Marginal Way to a 'satellite' CSO treatment facility located adjacent to River Street, sized to handle flows up to 66 million gallons per day. The treatment facility will cleanse the combined overflow and discharge purified effluent to a constructed wetland system for further polishing.

During peak storm events, the lowest pond will flood and discharge treated water to a constructed tidal estuary (the discharge site) through a new conveyance pipe along Marginal Way. The tidal estuary will provide habitat enhancement along the Duwamish as well as recreational opportunities on the river. Lastly, a network of green streets with stormwater features is envisioned as stitching together these sites, while also reducing the volume and of combined sewer overflows. At the neighborhood scale, a visitor could trace the flow of water from the treatment facility through the wetlands and finally arrive at the discharge site where the purified effluent is slowly discharged to the Duwamish River.

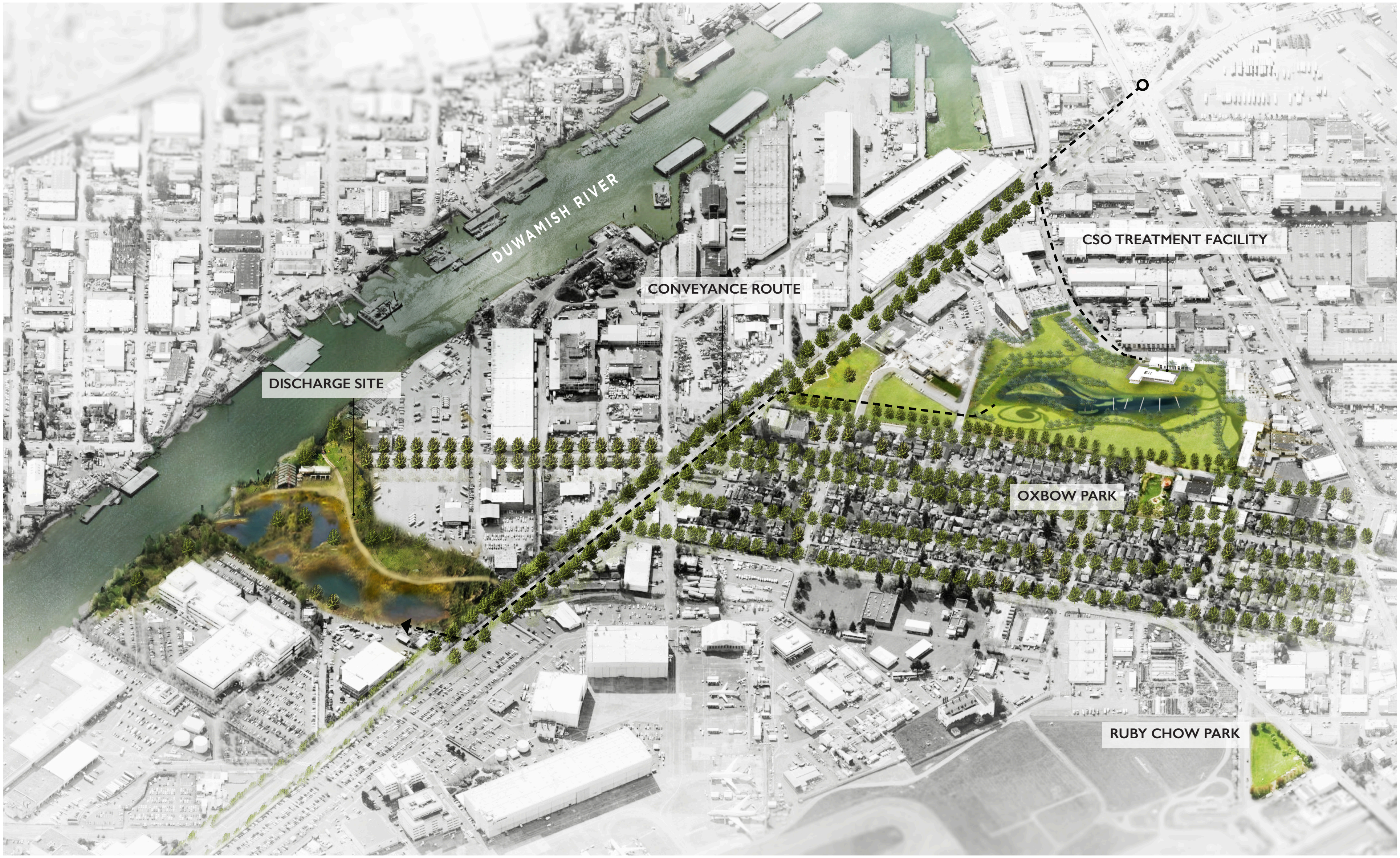


Figure 5.1 Neighborhood Scale Site Vision for the Treatment Site, Conveyance Route, and Discharge Site

Diversification of Program Over Time

Figure 5.2 shows the incremental development of the social program over time, in response to the improving water quality and new programmatic uses of the treatment and discharge site. Over the long term, these sites are envisioned as adapting to new programmatic uses as the water quality improves. For instance, fishing and recreational uses such as kayaking are seen as contingent on the access to the river, supportive infrastructure and the health of the river. The sites are not static, but may evolve over time to meet community uses and priorities.

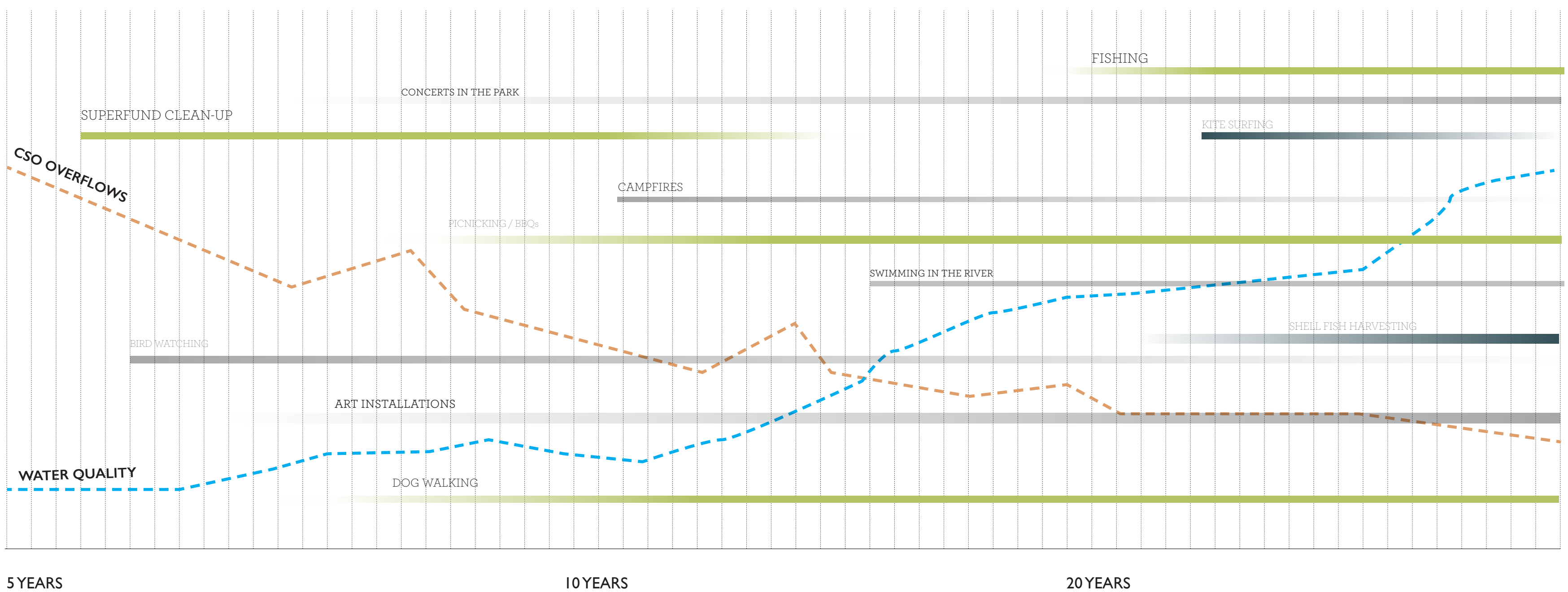


Figure 5.2 Diversification of Activities

Treatment Facility and Community Facility Program

The program for the treatment site includes 2 buildings: a 66 MG CSO treatment facility and a multipurpose community center. Since the treatment facility will only activate during CSO overflows it will require minimal staffing. The community facility will include an exhibit space for art installations, meeting rooms, classrooms and a microscope learning lab. The sizes of each programmatic component are tabulated to the right.

Treatment Facility	*Size (SF)*
Screening Room / Grit Removal	2400 SF
Ballasted Sedimentation Tanks	2800 SF
UV Treatment	2800 SF
Staff / Administrative Spaces / Restrooms	1200 SF
Chemical and Sand Storage	800 SF
Odor Control Rooms	2000 SF
Mechanical / Electrical Rooms	1000 SF
Truck Loading and Unloading	2000 SF
Total Square Feet	**15000 SF**

Community Facility	*Size (SF)*
Lobby / Entry	600 SF
Community Room with Deck	2800 SF
Community Exhibit Space	1600 SF
Classroom	1450 SF
Learning Labs	1450 SF
Staff / Administrative Spaces / Labs	1200 SF
Conference Room	600 SF
Bathrooms	320 SF
Mechanical Room	400 SF
Total Square Feet	**10420 SF**

Treatment Site and Building Design

The cleansing process and flow of water from infrastructural systems to its eventual discharge on the Duwamish River formed the foundation for the site plan (see Figure 5.3). The design aims to illuminate the treatment process to the public while also providing community amenities. On an experiential level, the design traces the historic route of the river before it was channelized and straightened, serving as a mnemonic device to recall and regenerate a river whose presence has been largely erased and tamed for industry and commerce. A loop traces the increasing purification water from the facility to the lower wetland pond. During heavy rainstorms the lower pond will flood, inundating the path at the Southen end of the site and water will be conveyed to the Discharge site on the Duwamish.

The treatment facility is located adjacent to the industrial edge of the site and is aligned to the grid of the industrial neighborhood (South River Street) while the adjacent community center is oriented to match the grid of the residential neighborhood (Corson Ave South) with views predominately to the wetland system. While the community facility is open to the public, the interior of the treatment facility is generally not publicly accessible, with the exception of tours led by facility staff.

The design of the treatment building expresses the linear diagram of the treatment process described in chapter 2 with three distinct volumes, expressing each stage of the cleansing process (see Figure 5.4). Since the building would only be activated during storm events (approximately 40 times a year), it is conceived of as an 'industrial machine' that responds to changing urban hydrological cycles and seasons, and provides a support role to Seattle's centralized treatment plants. By exposing the treatment process that occurs during combined sewer overflows, the design intends to reveal the interconnectedness of our built and natural systems.

The treatment facility is constructed of steel and concrete and is utilitarian in keeping with its industrial function, yet 'cuts' in the concrete walls allow visitors to peak into the various stages of water cleansing, while also providing daylight to filter into the facility. As water becomes more purified through each stage, the walls increasingly break down, expressing the cleansing and filtering process that is taking place within the facility. At the end of the treatment process the building is the most transparent, symbolizing the purification of the wastewater and allowing park visitors to see the water before it is discharged into the landscape.

After water is treated with ultraviolet light, it is discharged into the site itself for further cleansing through phytoremediation, whereby plants and soils will absorb and uptake remaining pollutants. The planting palette will consist of mainly wetland plants, trees and vegetation that will provide phytoremediation to residual contaminants in the water.

Water will flow through five wetland cells separated by concrete weirs before reaching a larger pond with several small habitat islands. While the pond would retain a base level of water year-round, the cells would fill up with water and overflow weirs only during storm events, in order to signify storms that previously would have resulted in combined sewer overflows. During major storm events, the lower pond and islands would partially flood, and water would inundate the gravel pathway on the lower portion of the site.

Concrete weirs are utilized to slow water and call attention to the infrastructural modifications to natural water cycles. As water moves through the wetlands, the landforms break down and form habitat islands while also slowing down water as it moves through the constructed wetland system. The seasonal and changing water volumes on the site will further engage and connect residents with their local watershed.

Figure 5.3 Site Plan

LEVEL 1 PLAN

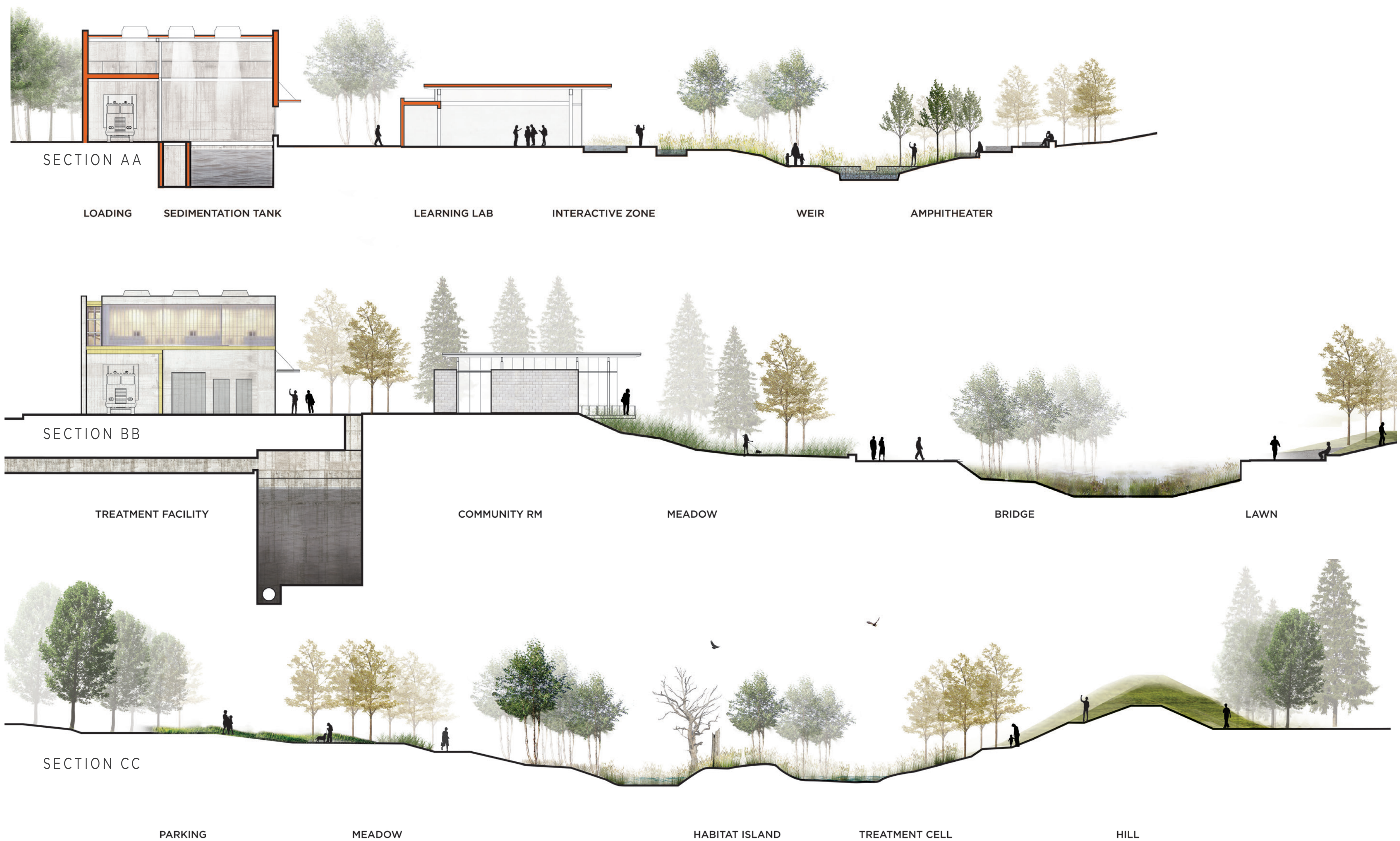
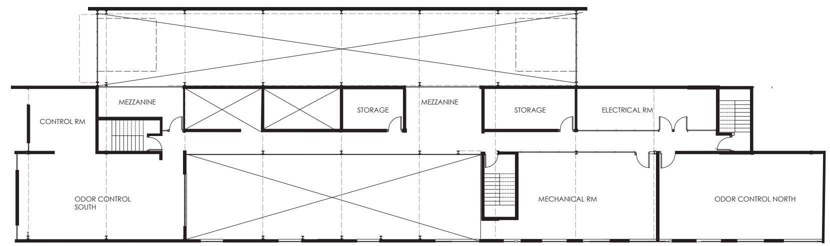


Figure 5.4 Site Sections



LEVEL 2 PLAN

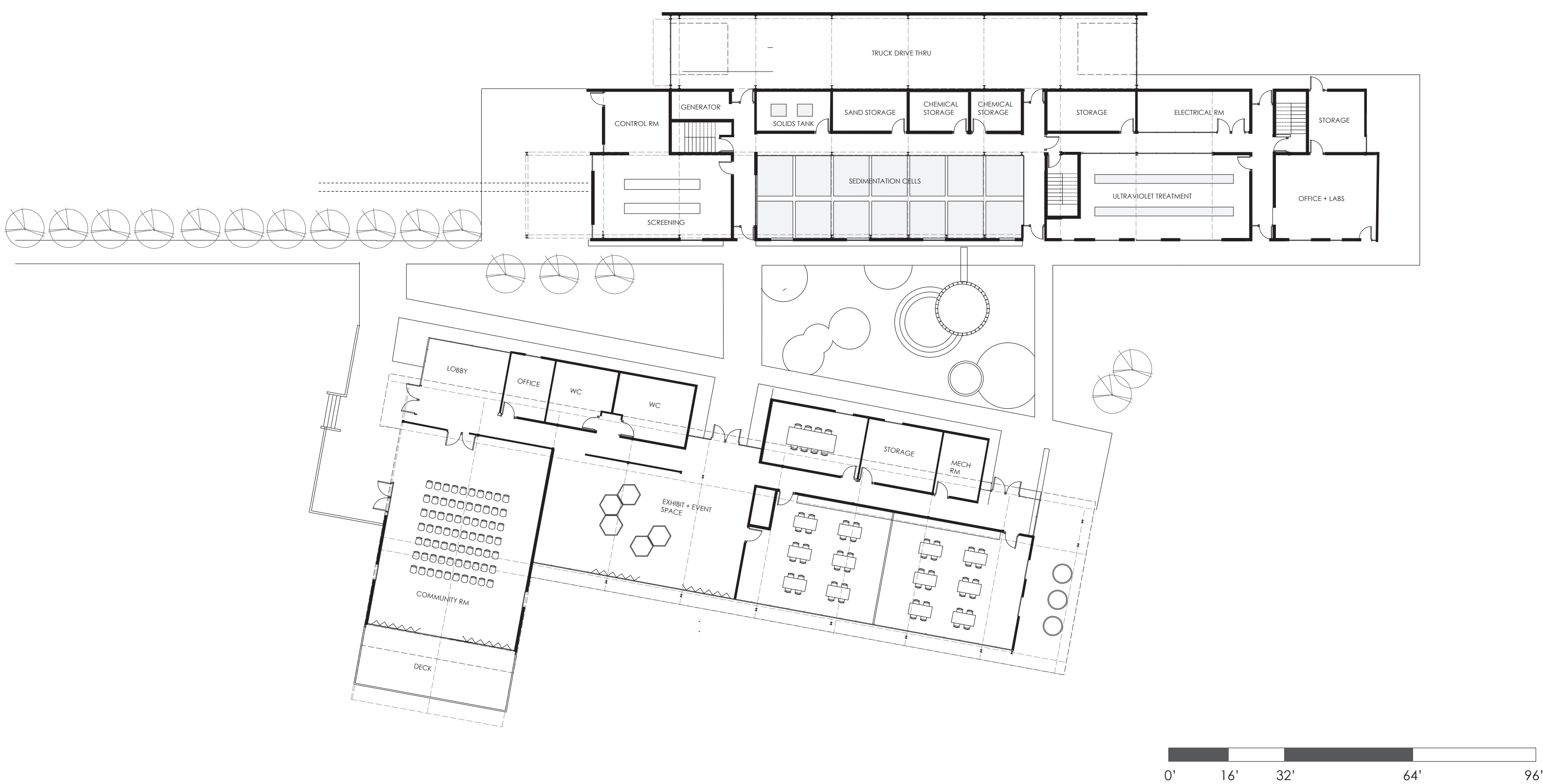


Figure 5.5 Building Plans

The community center is located next to the treatment building and faces outward to the wetlands. The community facility design provides a gathering space that may be used for local art installations and community events and meetings. In addition the facility includes a microscope lab, exhibit space and classroom used for educational programs related to urban water conservation and treatment. The facility would also be a meeting point for organized tours of the treatment facility and wetlands.

A courtyard stitches the two buildings together, creating opportunities for visitors to look into the processes of the treatment facility. In addition the courtyard will provide interactive rainwater features and gardens that encourage visitors to interact with water and learn about how building run-off can be managed on site (see Figure 5.8).

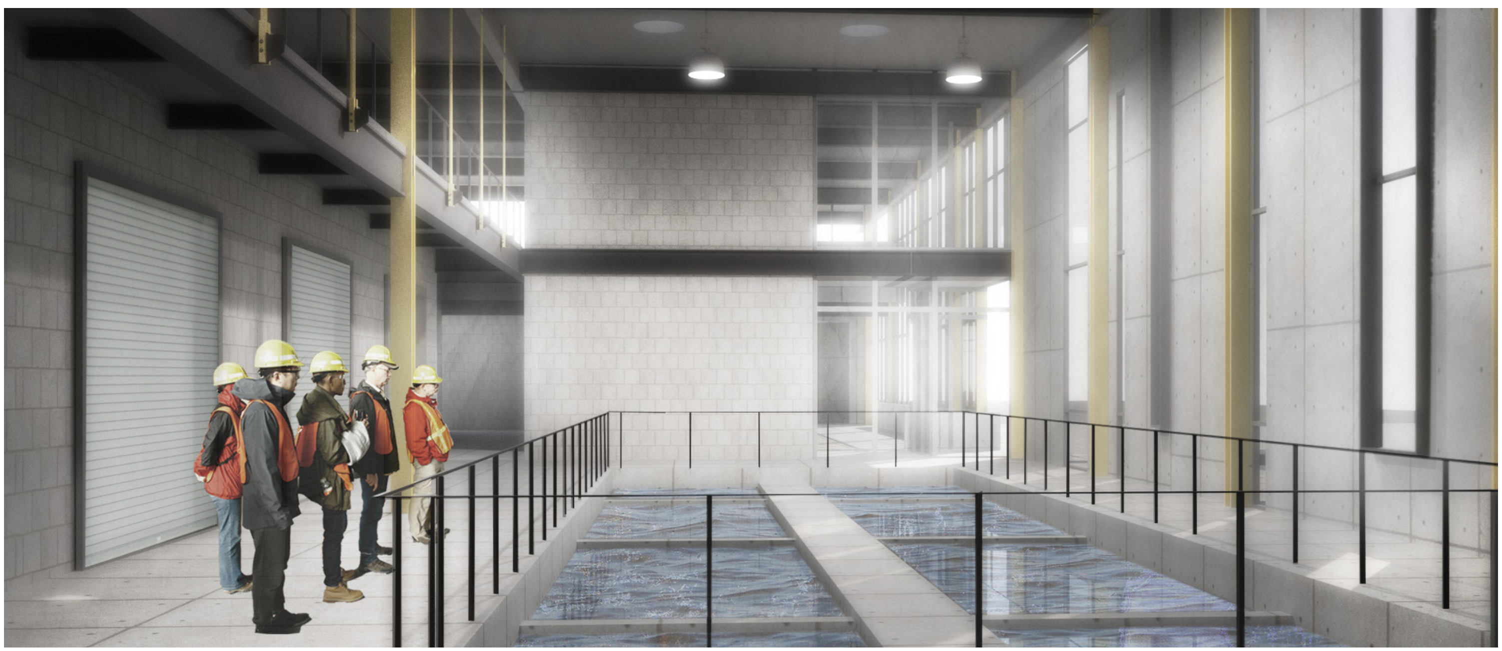


Figure 5.6 Perspective view of entry courtyard. The community center is shown in the foreground.
Figure 5.7 Perspective view of sedimentation tanks in treatment facility

Figure 5.8 Perspective view facing South. Rain garden filter runoff from the building and encourage interaction with the elements.

Figure 5.9 Perspective of the wetland system and community center in the background.

Conveyance Route and Discharge Site

A conveyance route is envisioned as forming a physical connection between the treatment and discharge site, as well as providing a better pedestrian connection for South Seattle residents to access the Duwamish River. Conceptually, the design would make legible the path of the submerged pipe discharging treated effluent to the river, and provide wayfinding. Street trees and roadside swales could be utilized to extend the neighborhood park into the neighborhood while also reducing and treating stormwater impacts on the Duwamish, and could present opportunities for community involvement. In addition, 8th Avenue South presents a major opportunity to form a stronger pedestrian linkage to the Duwamish River, one which could also be retrofitted with additional stormwater features (A demonstration rain stormwater project is already underway).

Discharge Site

A conceptual view of the discharge site is shown in Figure 5.10.The discharge site would present an opportunity to regenerate critical habitat for salmon along the Duwamish River as well as increase recreational opportunities for South Seattle residents. A constructed esturary is proposed in the turning basin ('slip 4'), would provide additional water quality treatment and habitat enhancement on the Duwamish.

The newly formed esturary would also connect to an existing street end park at the end of 8th street that offers sweeping views of the Duwamish River and Mount Rainier. This site could also perform treatment of stormwater from nearby industrial facilities that currently divert their stormwater directly to the river. A community rowing pavilion and kayak launch could be located at this site in order to increase water access and recreational opportunities on the river.

Figure 5.10 Bird's Eye View of Discharge Site

5 CONCLUSION

This thesis has aimed to demonstrate that the 20th century paradigm to separate, control and neutralize natural processes in the urban environment has largely disconnected us from experiencing nature within the city. By increasing our understanding of natural processes, revealing and daylighting hydrological cycles in the city, we will be more likely to act in concert with nature in the 21st century, rather than attempt to subdue or control it.

I also hoped to show that many wastewater treatment plants are hidden from view despite their important societal and environmental function. Due to the ubiquity and scale of our contemporary wastewater systems, there are many opportunities for architects and landscape architects to make this system legible and accessible to the public as signifiant spaces within our built environment. Storage tanks, discharge points and conveyance routes can become markers in our urban landscape, and form a regional network of spaces that perform multiple functions. Buildings can also be designed to be embedded with infrastructure that alleviates the pressures on our wastewater treatment system. For instance, large storage tanks for sewage treatment may pair well with the scale of stadiums.

In addition, this thesis suggests that recycled wastewater is a largely untapped resource. With the impacts of climate change, as exemplified by severe droughts in California, the conservation of water and recycling of wastewater will likely become an increasingly important priority for many cities. While technological and engineering solutions may provide a temporary fix for some of these impending crises, they address the symptom rather than fixing the source of the problem. Decentralized and flexible approaches to water conservation and stormwater management are needed to solve these issues in a holistic manner.

Effectively solving the problem of CSOs will require interdisciplinary collaboration — between engineers, architects, landscape architects, biologists, policy makers, artists and community members — to address these issues on many levels. Infrastructure projects that blur the boundaries between traditional modes of practices can provide multiple benefits to people and the natural environment and will hopefully emerge as the new model for public work projects in the 21st century.

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