Re-interpreting and Re-programming the Edge: Site, Infrastructure and Community

by

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The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance a thesis entitled “Re-interpreting and Re-programming the Edge: Site, Infrastructure and Community” by Alexandra Bogusat in partial fulfilment of the requirements for the degree of Master of Architecture.

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ABSTRACT

Landscapes are formed across space and over time by both natural processes and human artifice. Within urban landscapes, natural processes have been harnessed as the basis for infrastructural systems, which support urban life. However, the relationship between infrastructure and natural processes has become increasingly opaque. This thesis seeks to reveal the interrelationship between natural, infrastructural and human processes by integrating a wastewater treatment facility with a public park, offering recreational and cultural amenities, in the town of Niagara-on-the-Lake, Ontario, Canada. The design entails the addition of a “new landscape,” including built facilities on three sites within the park space. The architecture of these sites engages in multiple and layered flows of nature, infrastructure and community, acknowledging the complex history, ecology and diverse programs existing within the chosen site. The concept of edges is used as a tool for relating diverse programmatic elements and the complexity of site.

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CHAPTER 1: INTRODUCTION

Nature and Culture

> Usually, when we say nature, do we mean to include ourselves?
> (Williams 1980, 67)

In *Keywords,* Raymond Williams explores the lineage and historical meaning of the word 'nature' and finds that western society has tended to define nature in opposition to the human-made realm of 'culture.' This perspective, that sees the human-made and the natural worlds as inherently separate, has served to cloud society's understanding of how humans impact the natural world and of how natural processes, in return, impact human life. To appreciate societies relationship to nature, it is important to contemplate the value ascribed to nature at different times in society's history.

The early use of the word, as discussed by Williams, personifies nature as a goddess wielding an all-powerful creative and 'shaping force' (Williams 1976, 221). This insinuates that nature possesses attributes that clearly separate it from the realm of mortal humans. Similarly, Ian McHarg, in his book *Design with Nature,* emphasizes that early human societies believed that the "elements of life and survival were beyond (mankind's) ken and control: they could not and did not enter (mankind's) value system save imperfectly through religious views" (McHarg 1969, 25). With the development of a monotheism, God became creator; thus, nature was demoted to the subordinate rank of 'minister' or 'deputy.' However, apart from these 'creative forces,' mankind was also ever mindful of the terrible destructive power wrought by nature (Williams 1976, 221). Thus, societal perceptions of nature have always incorporated a substantial element of humankind's deep-seeded fear of nature's unbridled destructive power.

As the great western religions developed, so too did the view of nature. Nature was seen as both "a primitive condition before human society; through the sense of an original innocence from which there has been a fall and a curse, requiring redemption" (222). This paradoxical meaning of nature reveals humans uncertainty and tension towards it, resulting in an attempt to control it (222). Thus, nature is preferred as a pastoral backdrop to human life, where its disorder is controlled. This view of nature, as an enduring 'Garden of Eden,' characterizes the lack of importance attributed to a thorough and systematic understanding of the natural world during the early years of monotheism. Contrarily, in the 17th century, it was widely accepted that to "understand the creation was to praise the creator" (222). Following this new belief, new conceptions of nature were developed; the most prominent among these novel ideas were the laws of nature, which were understood to be 'static' and representing a 'singular goodness.' Nature's laws were the cure to a corrupt and ailing society; the belief in nature as innocent and good reinforced the idea that nature is "the 'countryside', the 'unspoiled places', plants and creatures other than man" (223). However, with the discovery of natural selection and evolution, another meaning of nature emerged, one that spoke of nature not as a set of static laws, but as a process trying to reach a balance. Again these new discoveries of nature were generalized.

While scientific advancements have led to a more complete understanding of nature, it remains true that deeply entrenched cultural views dissuade humans from appreciating the degree to which we all are connected to the natural world. Owing partly to humankind's initial fear of nature, and partly to religion's portrayal of human as separate from nature, we have accepted the exploitation and destruction of the natural world, largely without complaint. Williams concludes in *Ideas of Nature* that, "We need and are perhaps beginning to find different ideas, different feelings, if we are to know nature as varied and variable nature, as the changing conditions of a human world" (Williams 1980, 85). This 'new idea of nature' should reflect the understanding that humans are, in fact, a part of nature. Moreover, in the past few decades nature has begun to be understood in terms of processes, rather than in terms of static laws (Johnson and Hill 2002, 1). Thus, nature is seen as dynamic, interconnected and changing, a process of succession and decay, in which humans, due to our numbers and habitat under our control, play an important part.

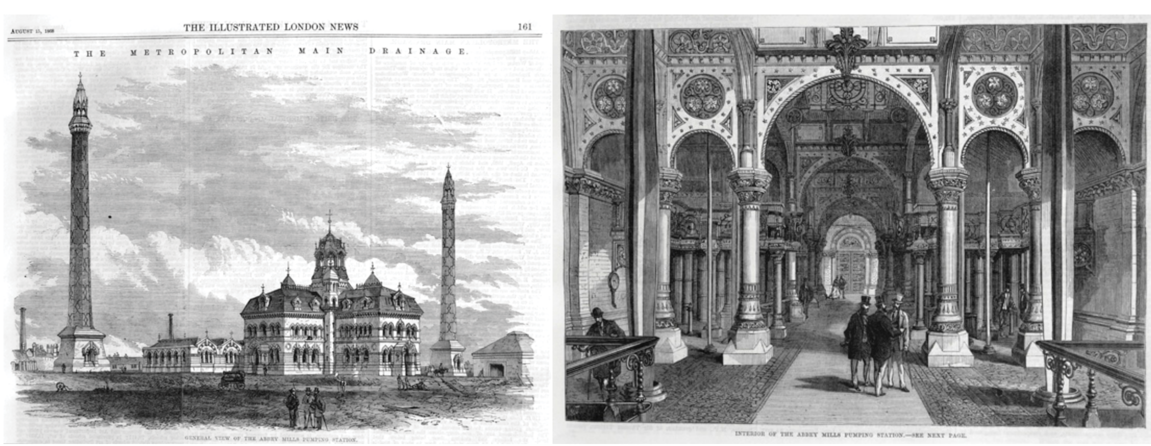
Natural Processes and Infrastructure

> Cities have the 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. (Mumford 1956, 386)

Humans rely on natural processes for survival. Even in modern times, with all the technological advances that are the bases for our cities today, natural systems are the grounds from which infrastructure is created to support urban life (Rosenberg 1996, 89). In particular, water is essential to the growth of cities. Romans were one of the first to “recognize the need for clean water and secured their supplies from distant mountain streams via aqueducts, rather than from the River Tiber” (Hough 2004, 33). By the nineteenth century, more complex forms of water infrastructure were brought into the city, such as sanitary sewers. These systems were imperative, as connections were made between health and water supply and disposal (Kaika and Swyngedouw 2000, 125). At the time it was fully believed that infrastructure and “technological innovation would pave the way for breaking the chains of slavery to nature and to other human beings. Technology in itself would improve living standards and social environments, and held the promise of automatically leading to a better world” (125). These infrastructural innovations were seen as symbols of progress and objects of civic pride, and were so celebrated by the people that “guided tours and spectacles were organized to visit and admire them, to pay homage to the construction that would transforms people’s lives” (129-30). Of course, water supply and sanitation were not yet taken for granted; however, over time, the promise of a better world slowly faded. Between continual inequality, two World Wars and the Great Depression, the failure of technology and infrastructure was strongly felt:

> Urban technology networks and constructions, those witnesses of disillusionment with the patina of time added over them, rusting like the modern urban dream of emancipation and equality, had to be cleared away, literally swept underneath the carpet. They went underground. (132)

As infrastructure was moved underground it rendered the systems and ‘natural’ processes of these infrastructures invisible. Functionality gave the impression of a clean, sleek,



Abbey Mills Pumping Station, London. An example of Gothic industrial architecture, built by Joseph Bazalgette between 1865 and 1868. (Kaika et al. 2000) pure city, with infinite control over it's terrain and nature. The trend continued through the twentieth century as infrastructural problems were solved with technical solutions, which invokes "a logic that can be summarized as 'end pipe, out of sight, out of mind" (Karvonen 2011, 7). Thus, infrastructure has lost its connection to society and to the natural processes it harnesses and controls. This veiling of infrastructure reinforced the idea of cities being a refuge from nature; a place wholly constructed by and for humans, the antithesis of nature (1). Consequently, since infrastructure has been planned and placed to be out-of-sight and out-of-mind, it has been cast as a nuisance in the public imagination (Singer, Cruz and Bregman 2007). Hence infrastructural projects are often disruptive, hazardous and unsightly, with the public often opposing these projects, especially when they are near established urban areas.

Re-examining Infrastructure

Displacing infrastructure far from cities overlooks the important functions these facilities provide to urban areas. Thus, a re-examination of the role of infrastructure is required in its planning and design. Contemporary landscape scholars and designers, such as Elizabeth Mossop and Michael Hough, call for a re-visioning and 'unveiling' of infrastructure. Mossop sees the re-visioning driving from a re-examination of spaces themselves, stating "all types of space are valuable, not just the privileged spaces of more traditional parks and squares. This requires the rethinking of the mono-functional realm of infrastructure... to recognize its role as a part of the formal inhabited city" (Mossop 2005, 171). This would entail developing infrastructural landscapes as beyond utilitarian spaces. Hough re-examines infrastructure from an environmental perspective, in which visibility of infrastructure is "crucial to environmentally responsible behaviour" (Hough 2004, 37). He also agrees with Mossop that infrastructure should not be mono-functional; rather, planning for infrastructure should be based in "a design language whose inspiration derives from making the most of available opportunities; one that re-establishes the concept of multifunctional productive and working landscapes that integrate ecology, people and economy" (25). In other words, the focus ought to be on creating beneficial relationships between infrastructure and its surrounding community and landscape.

Hough also suggests infrastructure should be more ecological by making use of natural technologies. William Wenke, in his essay "Toward an Inclusive Concept of Infrastructure," describes how natural technologies make use of natural flows and processes, which have the benefit of being more energy efficient (Wenke 2002, 174). Moreover, using natural technologies can create a “cultivated ecological landscape that provides high-quality human habitat, while minimizing impacts on natural ecosystems” (174). For instance, biologists have known for many years that wetlands can be used as a natural technology to treat wastewater. The natural processes that occur within wetlands are capable of removing nutrients and toxins found in wastewater, while offering other benefits to the surrounding landscape and community (Campbell and Ogden 1999, 3). These potential benefits include habitat development for wildlife and integrating constructed wetlands into a park system. *Arcata Marsh and Wildlife Sanctuary* in California is an example of integrating constructed wetlands designed to treat wastewater with a public park system. Arcata Marsh is a multifunctional infrastructural landscape that combines wastewater treatment facilities, wildlife habitat, educational and interpretative features and public recreational trails. The site receives 150,000 visitors a year for recreational and educational purposes (241-42). The educational and interpretive features have been recognized “as having contributed greatly to public awareness of the multiple benefits of the system” (242). Overall, the community of Arcata has become more connected to the process of treating wastewater through the use of ecological wastewater treatment. Such landscapes would encourage awareness of the relationship between nature, infrastructure and humans.

Aerial view of Arcata Marsh and Wildlife Sanctuary, California. The site features extensive wetlands used for treating municipal wastewater. (Google Earth 2012)

Ecology as a Framework

Ecology provides a framework to understand the complex relationships between infrastructural, natural and human processes. During the 1960s as "led by the late Robert MacArthur, ecologists developed a view of the world that encapsulated the notion of the 'balance of nature'" (Pulliam and Johnson 2002, 52). This worldview challenged the traditional notion of nature as static, as it began to explain nature's dynamic qualities. Since then, ecologists have found that nature is not striving to reach a balance; rather it is in a constant state of flux and change, growth and decay, affected by processes that occur in other places and throughout time (70). Thus, ecologists have provided a new understanding of the natural landscape based in a relational perspective of the world, which emphasizes processes and flows over objects. Furthermore, "ecology itself becomes an extremely useful lens through which to analyze and project alternative urban futures. The lessons of ecology have aimed to show how all life on the planet is deeply bound into dynamic relationships" (Corner 2006, 29). Applying ecology to cities means considering the urban "landscape not only in terms of its natural processes, but also in terms of the reciprocal relationship between people and the landscape. The important word here is relationships" (Karvonen 2011, 26). Design should be a process of relation building – a perspective that challenges the technological practices of designing infrastructure and the false dichotomy of nature and city.

Parks Re-examined

The design of city parks has been deeply embedded in the false dichotomy of city and nature. The creation of the municipal park movement in Europe occurred along with the process of urbanization, as public parks evolved to become the antidote to the dirty industrial cities of the 19th century (Czerniak 2007, 23). Parks were developed based on "the conviction that nature should be brought to the city to improve the health of the people, by providing space for exercise and relaxation," (Hough 2004, 12) and were designed in marked contrast to the city itself. However, traditional park design has been based on an idealized version of nature, the picturesque pastoral landscape, which is largely devoid of natural processes (Rosenberg 1996, 89). Furthermore, as an idealized piece of nature transplanted in the city, the design of these parks often neglected their defining 'urban' quality.

However, with the re-conceptualization of ecology, the role of the traditional park is being re-examined. A relational perspective highlights the interconnectedness of parks to the surrounding city. Parks should be considered as integrated into the larger urban system and should help to address city problems such as infrastructure, reclamation of derelict lands, and health and social well-being (Cranz and Boland 2004, 106-11). Lastly, contemporary parks should find new modes of aesthetic expression by challenging the traditional notion of the pastoral landscape and by rooting design in the new understanding of landscapes as the products of both human and natural processes and formed overtime.

Recent competitions for large parks articulate the changing views of landscape. The winning competition entry for Fresh Kills Park, in 2003, by James Corner/Field Operations is based on a design that acknowledges the ecological and human processes occurring within and acting on the site. The design, called *Lifescape*, establishes “connections at nested scales, from the local site to the region, providing for flows of people, water and wildlife, as well as recreation and educational opportunities... Aesthetically, the scheme reveals the unique character of a site that performs as a land-regeneration project” (Czerniak 2007, 223). The park reflects a new understanding of nature and landscape, as

Lifescape: layers of landscape use. (New York City: Department of City Planning 2012) the design “makes use of the logics of natural systems and the dynamics of ecological feedback without the romantic attachment to a pastoral idea of nature”(224). The intention is to not control nature but, rather, to consider humans, wildlife and plants as part of the same system, based in relational perspective of landscape. The new landscape supports,

> the integration of physical design with geological, hydrological and biological processes at multiple scales. The proposal’s spatial framework ... can be understood as the agent of a fluid set of ecological systems, allowing the interaction of programmatic, cultural and natural elements to create the complex, synthetic environment. (Pollak 2007, 107)

Fresh Kills represents the sustainable park as a hybrid space, where ecological functions and human activity can both be supported. These new types of parks challenge the conventional notion of parks as a place designed only for human activity within ‘nature’. Parks are now being seen as places that support essential and multiple functions, including the functions of nature, which are necessary to support human settlements.

Thesis Statement

This thesis is situated in the re-evaluation of landscapes. It questions what a relationship between the natural world and us, in our time, might be. Moreover it questions, how these landscapes, such as parks and infrastructure, should function, how we interact with them and how they relate to the surrounding community and the local ecology.

How can architecture engage in and mediate between the edges and zones of intersecting layers of natural, human and infrastructural flows, so that an understanding of their interconnectedness emerges?

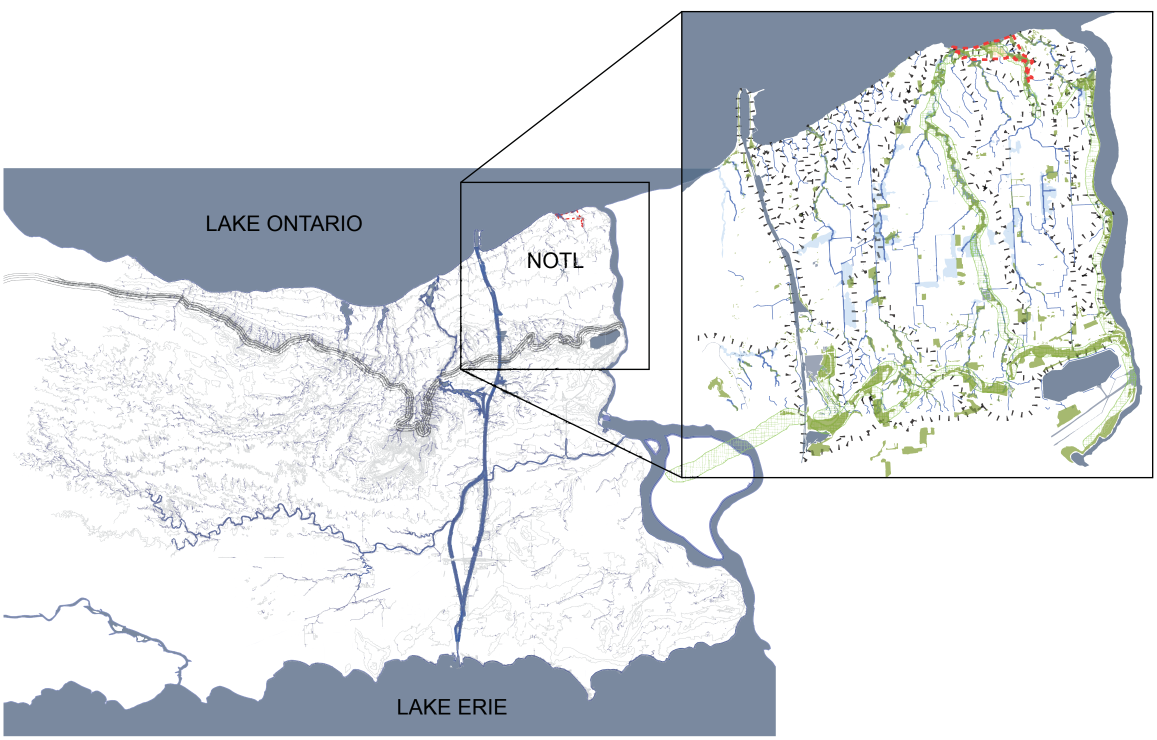
CHAPTER 2: REGIONAL LANDSCAPE

> Whether wild or clipped, composed of curved lines or straight, living plants or plastic, every garden and every region is a product of natural phenomena and human artifice. (Spirn 2002, 29)

The site is located in the town of Niagara-on-the-Lake (NOTL), Ontario, in the Region of Niagara. The Region is considered a peninsula as it is defined by three bodies of water, Lake Ontario, Lake Erie and the Niagara River; thus, it is often referred to as the Niagara Peninsula. This chapter describes the essential characteristics of the region and its natural, human and infrastructural landscapes it is composed of.

Natural Landscape

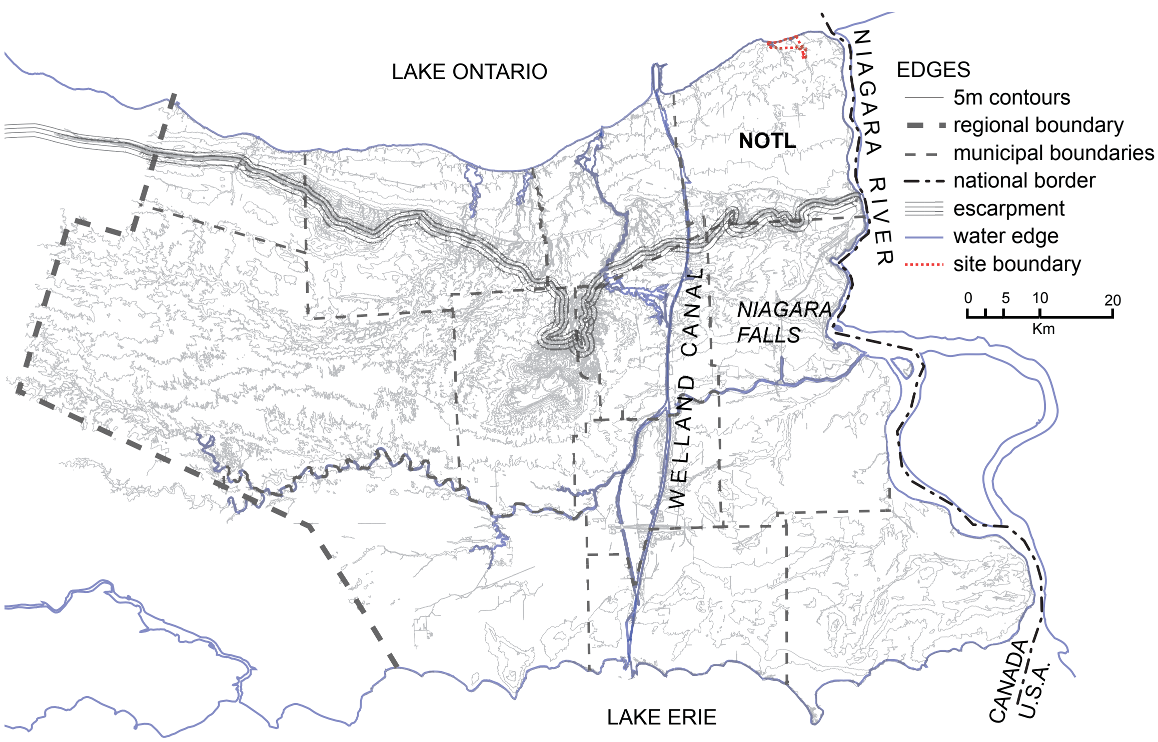
In this section the significant aspects of the natural landscape of NOTL and the Region of Niagara are considered. It is broken into Topography, Hydrology, Climate, and Ecology.



The natural landscape of the Region of Niagara and NOTL. Data from Ontario, Ministry of Natural Resources, Niagara Region and GeoSmart Niagara.

Topography

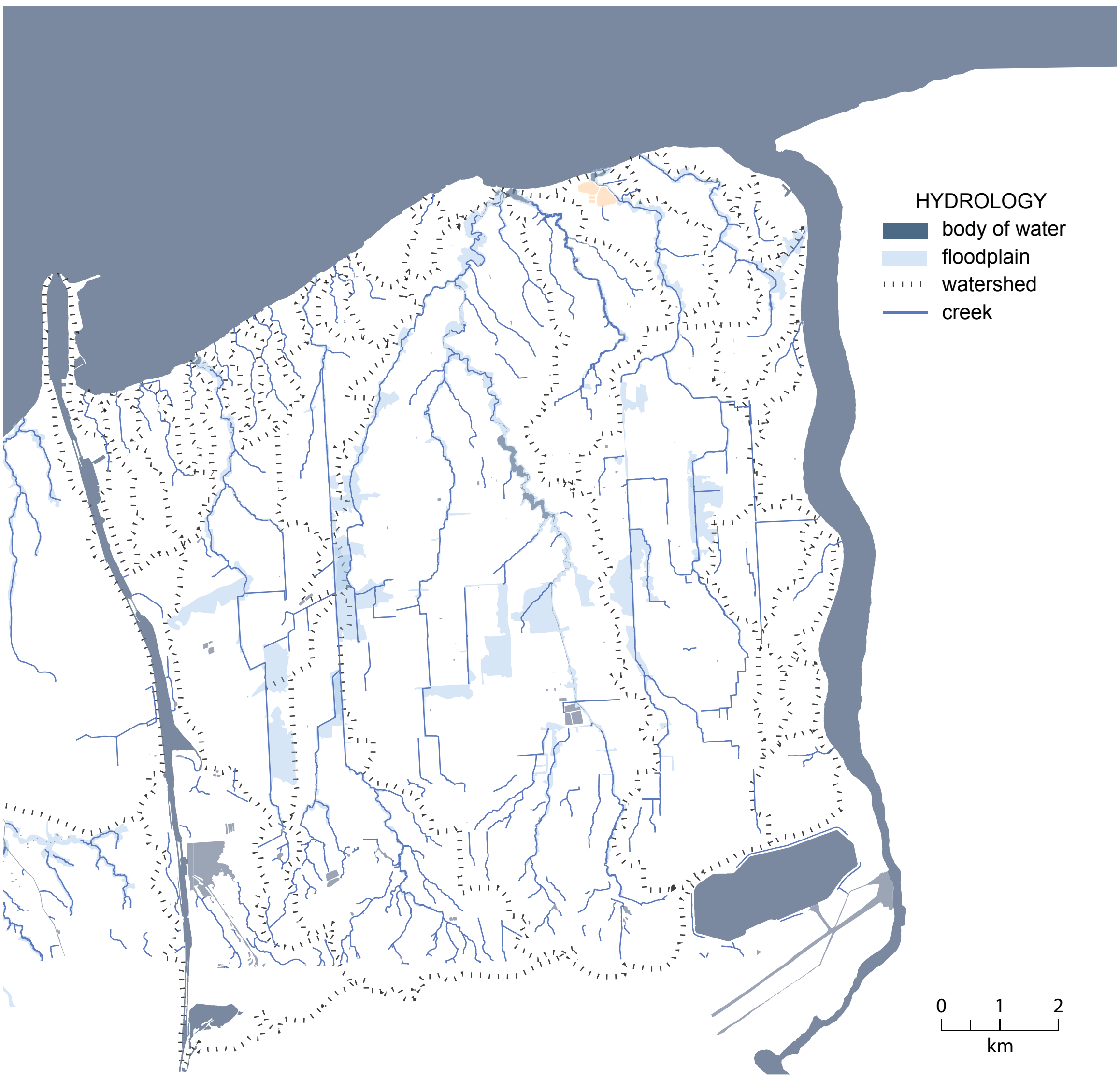
The Town of Niagara-on-the-Lake is defined by four major landscape features: the Niagara Escarpment to the South, Niagara River to the East, Lake Ontario to the north, and the Welland Canal to the West. These landscape features, aside from the Welland Canal, were formed over hundreds of thousands of years as a series of glacial periods covered the country under a mass of ice. The escarpment was first to form, from an unequal erosion of bedrock that left behind the hard rock of the escarpment, and formed a depression below. As the last phase of glaciation waned, the depression filled with water, thereby forming the post glacial Lake Iroquois (Feenstra, 1981). The streams and rivers crossing over the Niagara Escarpment, the largest being the Niagara River, provided the lake with a continuous supply of water and formed waterfalls, such as Niagara Falls. When the Laurentide ice sheet finally cleared the St. Lawrence valley, Lake Iroquois drained, and eventually, partially refilled to form Lake Ontario (Tinkler 1994, 25). As the water's edge retreated from Lake Iroquois's original shoreline, the sediments of its lake bed remained behind. Thus, the glacial lake endowed the region with a legacy of fertile sand and clay till, creating the Iroquois Plain, now referred to as the Fruit Belt of Canada (Murphy 2010, 17).



Regional edges map highlights the topographical features that define the Region of Niagara and NOTL. Data from Ontario, Ministry of Natural Resources.

Hydrology

The streams and rivers have continued to flow down the escarpment and carve into the Iroquois Plain; two of these waterways run through the proposed site: Two Mile Creek and Four Mile Creek. Many of these creeks form baymouth bars when they reach the new lower level of the lake, which create ponds and beaches at these sites (19). These creeks running across the flat plain are part of a vast watershed characterized as 'flashy' and dominated by runoff processes. The majority of the subwatersheds in the town begin at the base of the Niagara Escarpment and flow north, passing en route through vast agricultural lands and urban areas, and eventually discharging into Lake Ontario (Campbell et al. 2010, 5).



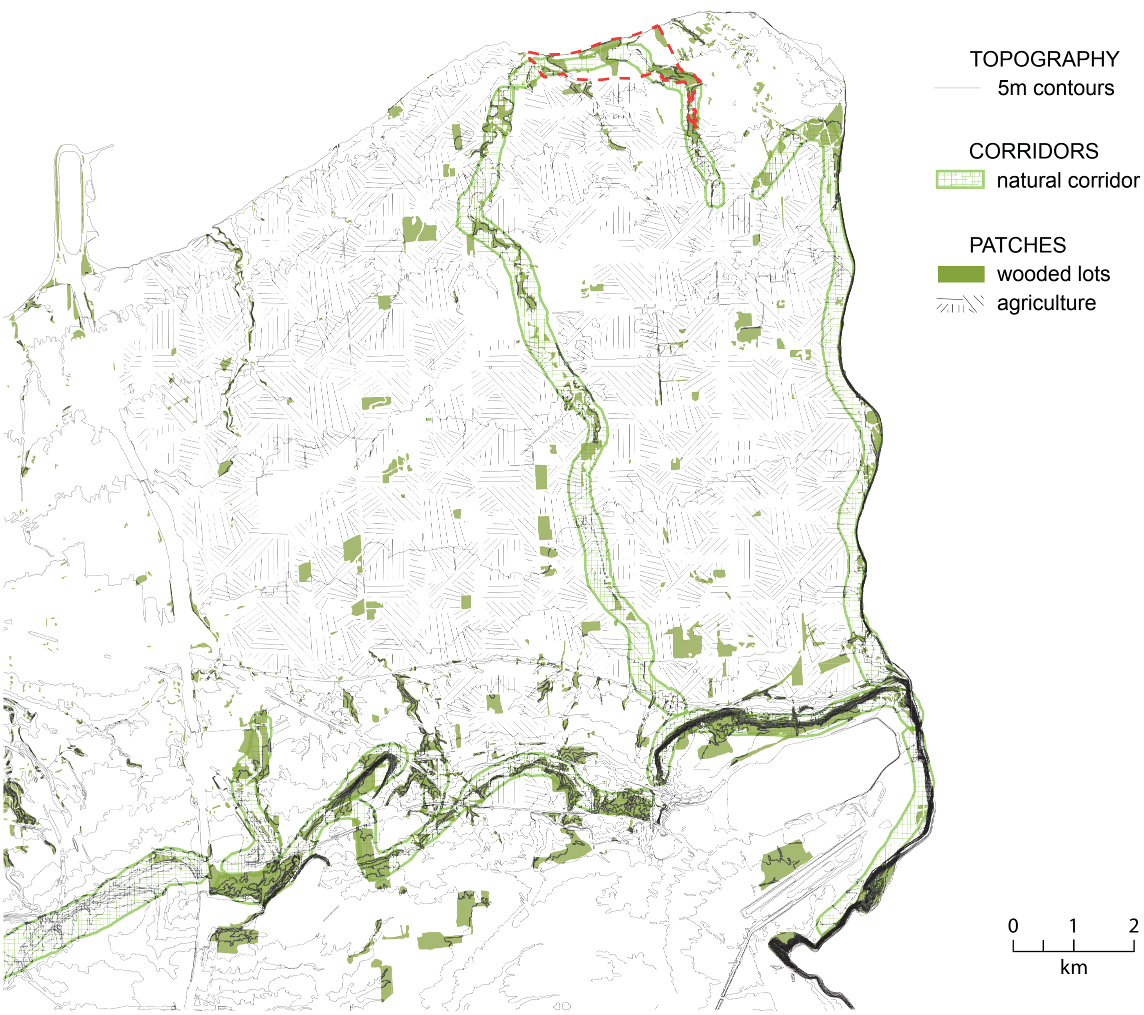
Hydrology of NOTL. Map illustrates the extent of the watershed and creeks. Data from Ministry of Natural Resources, Niagara Region and GeoSmart Niagara.

Climate

Located, as it is, on the south shore of Lake Ontario and below the Niagara Escarpment, the town's local climate is well moderated, and is characterized as having warm, moderately humid summers and mild winters (1). However, the combination of topography and air flow patterns give rise to several linear micro-climatic zones parallel to the lake and escarpment; both the lake and escarpment have effects on temperatures, winds and precipitation. As a large body of water, and with its capacity to store heat energy, Lake Ontario moderates the temperature of the zone closest to the lake. Winds in this zone are also highly influenced by the lake, as it creates circular airflow patterns by way of lake effect breezes. The site is located in the lakeshore effect zone. The escarpment also affects winds and precipitation by acting as a shelter belt from prevailing southwest winds; thus creating a rainshadow effect on the whole of the Iroquois Plain (Shaw 1994, 118). However, when winds switch from the prevailing southwesterlies to cold northeast winds, the town can experience lake effect precipitation as the winds move across Lake Ontario. Throughout the year, precipitation is fairly uniformly distributed, principally in the form of rain and light to moderate snow (129).

Ecology

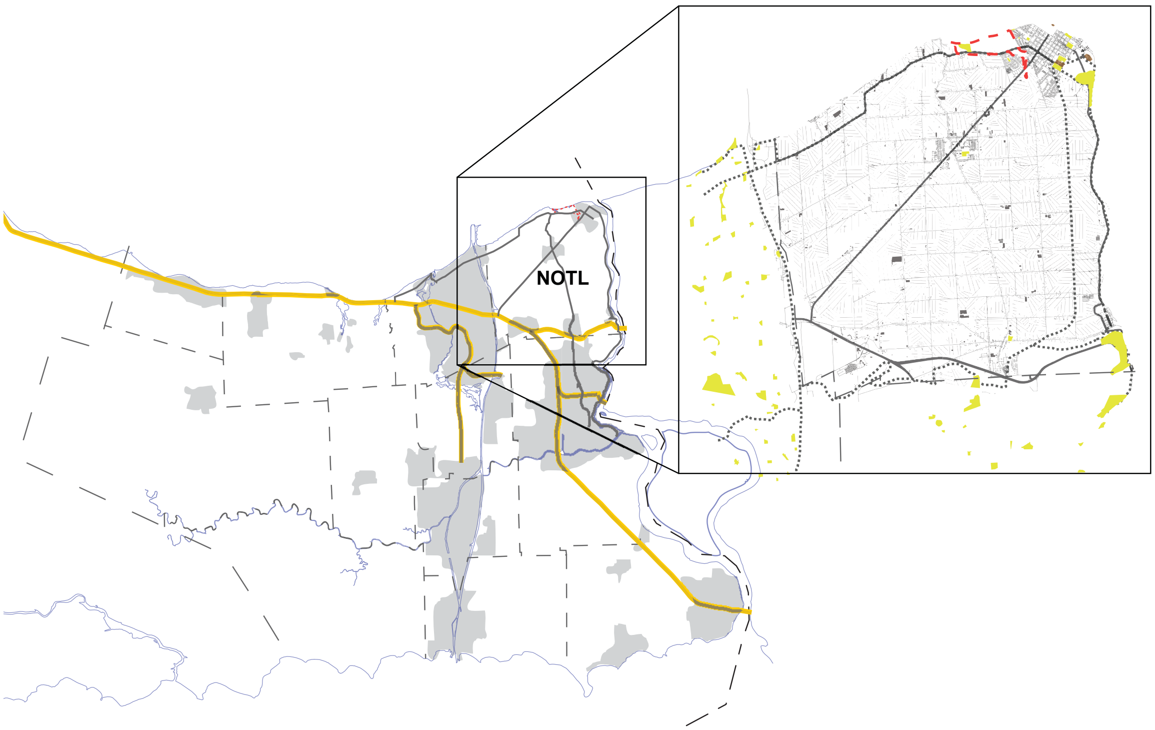
Following the last glacial period, the area gradually became vegetated and forested; the vegetation has changed and continues to evolve, responding to lake levels, hydrological balance, climatic variability, landforms, soil development and, since settlement, human processes. Thus, little evidence survives of the early forests in the area. Studies have found an early dominance of spruce over 12000 years ago, followed by a subsequent dominance of pines up to 7500 years ago. Since then, there has been the eventual establishment of typical deciduous and mixed deciduous-coniferous communities (Moss 1994, 140). Ecological components in the area consist of unique Carolinian elements, which comprise part of the Carolinian Life zone – an ecological zone that extends as far as the Gulf States and northern Florida. The zone's northernmost limits extend across southern Ontario, meeting the more southerly limits of Conifer-Hardwood forests. Carolinian Canada is considered significant as it is one of the smaller life zones in Canada, and yet it has more diversity of species than any other ecosystem in Canada. Moreover, it exists in Canada's most urbanized area (Jalava et al. 2010, 2). In the town of Niagara-on-the-Lake, the natural forest cover has been reduced to patch sizes, which has greatly compromised essential ecological processes and functions. To mitigate the damage to these ecological processes, efforts have been made to establish natural corridors in the area, one of which runs through the proposed site and connects the escarpment, the Niagara River and Lake Ontario. Although forest cover has been drastically reduced, trees and woodlots still remain as an obvious and striking component of the natural landscape (Moss 1994, 172).



Natural patches and corridors of NOTL. Data from Ministry of Natural Resources, Niagara Region and GeoSmart Niagara.

Human Landscape

The Niagara Region is located within the most populated area of Canada. This section considers key aspects of human's occupation of the region: Early Settlement, Urban Development, Demographics, Land Use and Industry



Human landscape of the Region and Town. Data from Ministry of Natural Resources, Niagara Region and GeoSmart Niagara.

Early Settlement

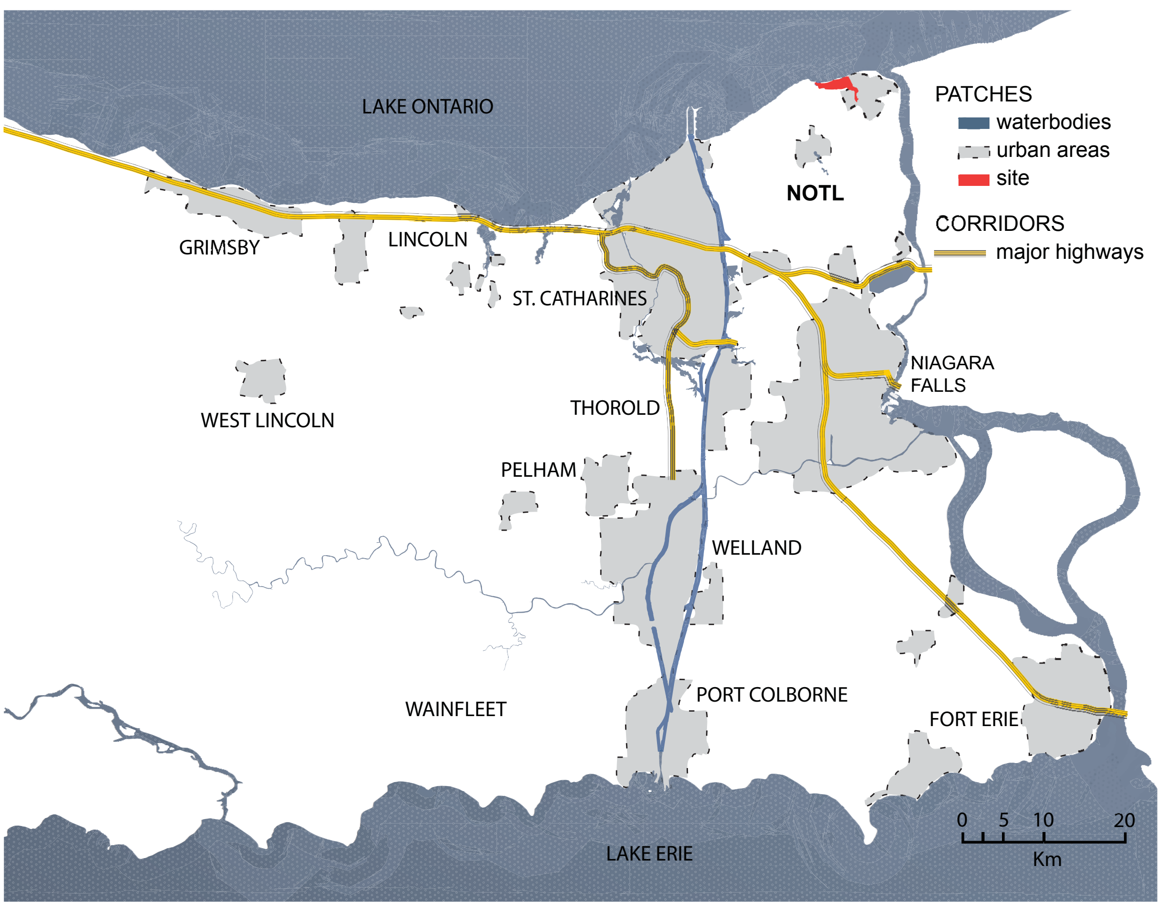
The natural landscape greatly figured in early human settlement of the Niagara Region and town of NOTL. The lakes and rivers made the area easily accessible, while the Niagara Escarpment and the Falls restricted early human movement. Despite the obstacles, "the geographical conditions were highly favourable to settlement as well as to trade by both aboriginals and European-American newcomers" (Turner 1994, 204). Its position between two great lakes and along the Niagara River established the region as a crossroads for trade and communication, north-south by water and east-west by land. Moreover, fertile soils, favourable climate and an abundance of fish, birds and game also fostered human settlement. Aboriginals and French fur traders took advantage of the geographical features, simply taking what they needed and made little impression on the landscape. The most significant legacy they left behind was an extensive network of trails for trade, many of which are now the location of modern roads (182). These characteristics that made the area significant for trade also made it vulnerable for warfare, first between the aboriginal groups, then between the French and the British and lastly between the British and the Americans. Thus, when the British gained control of the area in the late eighteenth century they began to make significant changes to the landscape for defensive purposes. The British were focused on military control rather than settling the land. However, permanent settlement began as a by- product of warfare, as the American Revolution forced Loyalists to flee north to British North America. Along with permanent settlement began even greater changes to the natural landscape, as land was cleared for farming and for urban areas (187). Small villages were established along major route-ways as service centres. The most important of which, at the time, was Newark (now Old Town NOTL) as for a

Historical human settlement of NOTL. Settlement initially followed native trading trails; the trails have become locations of modern roads, except for the road along the lake, as it has eroded away.

short time it functioned as the Capital of Upper Canada (Gayler 1994, 1). The population of the town continued to grow until the War of 1812, when the Americans invaded Upper and Lower Canada. The American's gained temporary control of the area and as they retreated they burned the town to the ground, leaving five hundred residents homeless (Parks Canada 1998). Following the war, the Niagara River was confirmed as the national border, and a race began between the two nations to dominate the Great Lakes (Gayler 1994, 1). Thus, in the 1820s the Welland Canal was built to by-pass the Niagara Falls and connect Lake Ontario to Lake Erie. This marked a new era, one of human domination over the physical landscape.

Urban Development and Demographics

Soon to follow the construction of the canal were other major structures, such as railways, highways and bridges. Trends of settlement continued to follow these major route-ways.



Regional patches and corridors, human landscape. The map illustrates the lower density of NOTL in respects to its surroundings. Data from Ministry of Natural Resources and GeoSmart Niagara.

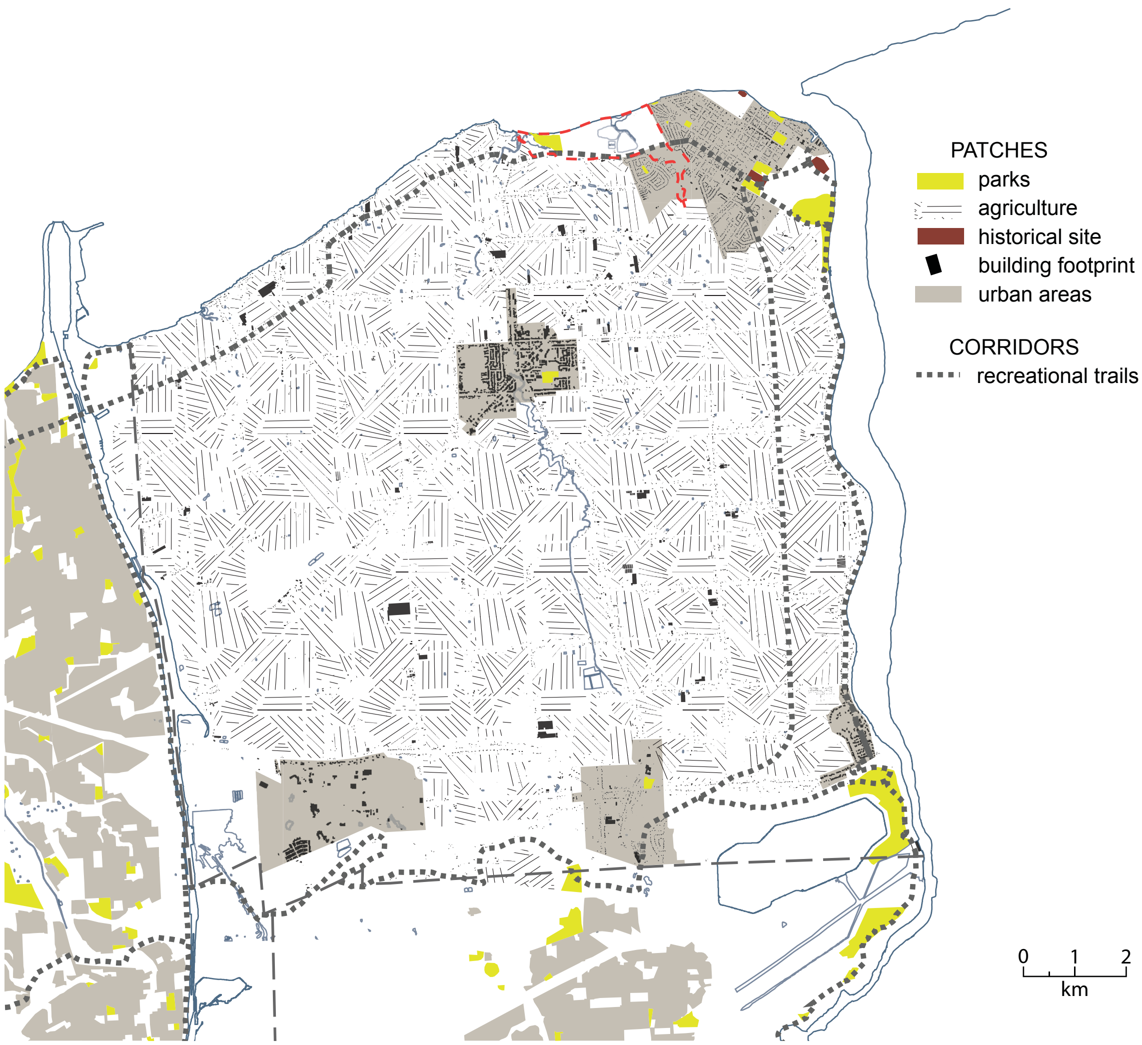
Thus:

> Population densities were altered with an increase in densities towards the new canals and away from the town of NOTL, now no longer as important for boat traffic and at the ends of the roads. The trend of low density in respect to surrounding areas in NOTL has continued throughout time as major transportation routes such as important railways and highways were placed outside the town boundaries. (Turner 1994, 204)

NOTL has maintained its rural character to this day, consisting of vast agricultural land with small urban centres: Old Town, Virgil, Queenston, St. Davids and Glendale. Due to its rural nature and favourable climate NOTL has become a popular retirement area (Gayler 1994, 5). Thus, the town is becoming one of the oldest populations in Ontario with an extremely low population growth rate.

Land Use and Industry

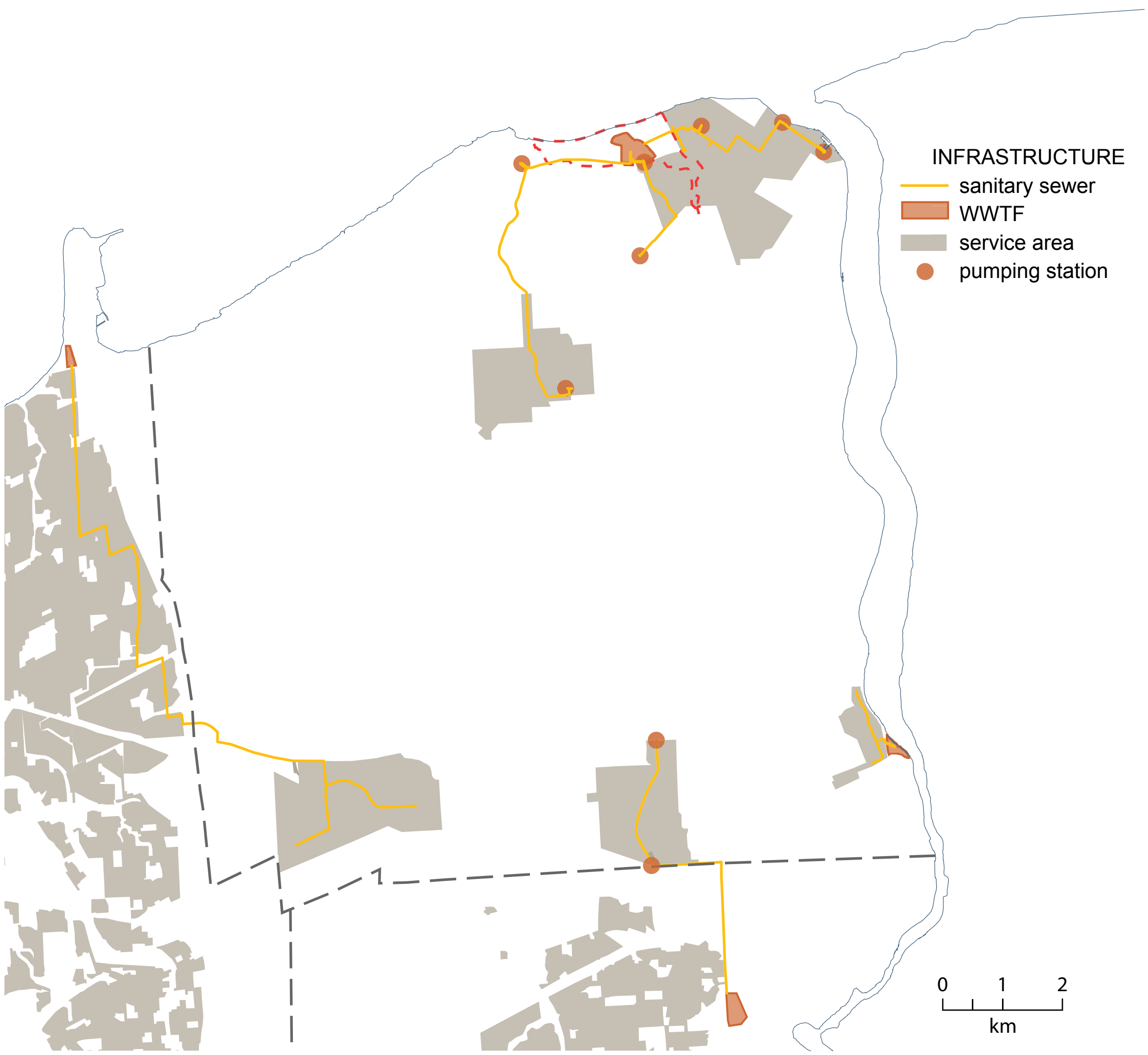
Due to its strategic position, Niagara-on-the-Lake was first established as a military and governmental centre. It continued to be used by the military for training through the World Wars. The proposed site is in fact an abandoned military reserve created for mortar and tank training. However, following the World Wars, other industries have played a significant role in the development of the town, particularly the recreation and tourism industry. Tourism in the Region was first fostered by the legendary Niagara Falls; once discovered by the Europeans, the Falls quickly became a tourist destination (Thomson 1994, 301). The town of NOTL has taken advantage of its proximity to the Falls by establishing a tourist industry based in its natural beauty and historical significance. The history of the town remains “visually available to visitors who, indeed, come in large numbers to visit historic sites and view historically based events” (Turner 1994, 180). Moreover, the establishment of the Shaw Festival Theatre in 1962 also contributed to the growth of the tourist industry, as “the gift shops, boutiques, hotels and restaurants that originally opened to serve the theatre patrons, have in fact served to attract a much wider clientele” (Thomson 1994, 315). Most recently the region has become a destination for its wine: “New grape varieties, changing consumer tastes, new cottage wineries, award-winning quality wines and aggressive marketing have helped put Niagara and Canadian wine on the map” (Gayler 1994, 5). Wine routes have been developed connecting wineries throughout the region, many in the town of NOTL. While the tourist industry is the largest employer, agriculture remains the largest land user of the town. Aboriginals were first to recognize the potential for farming in the region clearing small patches of land using the slash and burn technique (Turner 1994, 142). More extensive agricultural practices occurred “when settlers cleared the land in the eighteenth century. As settlements grew, grain and livestock farming predominated. There was some fruit and grape farming, but it was of limited extent and served individual and local needs. Not until the 1870s did fruit and grapes begin to increase in importance” (Chapman 1994, 282). Currently, fruit and grape farming is the predominate and most significant agricultural practice in the region, as there are only a few areas in Canada were fruit and grape farming are possible.



Town Patches: map illustrates land use, designating agricultural land from urban areas. It also highlights parks and their connection to trails. Data from Ministry of Natural Resources, Niagara Region and GeoSmart Niagara.

Infrastructural Landscape: Wastewater

In NOTL the treatment of wastewater is dealt with differently between the urban and rural areas. In the rural areas, buildings are on independent septic tank systems, thus are not connected to a larger wastewater system. The urban areas are connected to a sanitary system, however they are not all connected to the same wastewater treatment facility (WWTF). The small village of Queenston located in the south-east corner of NOTL has its own WWTF, while St. Davids and Glendale direct their wastewater to larger facilities in Niagara Falls and St. Catharines, respectively. Wastewater from Virgil and Old Town NOTL are treated at the same facility, located on the proposed site. Currently, the decision of whether to relocate this existing wastewater treatment facility has been the subject of public discourse. Consisting of sewage lagoons, residents nearby have complained of odours coming from the WWTF during the hot summer months. Furthermore, the facility is due to reach capacity by 2013-2014. Proposals to upgrade the system have been presented to the public. Three basic options exist: one option is to upgrade the plant at the existing location; the second option is to pump sewage to another facility ten kilometres away; and the last option is to relocate the facility within the Niagara Urban Service Area (Niagara Region 2008). Throughout the public consultation process, residents have unanimously supported relocating the existing facilities further from residential areas (Niagara Region: Public Comments 2008). This thesis, while considering the publics needs, agrees with the first option; keeping the facility at its current location is a testament to the important role this WWTF has for the town of NOTL.



Wastewater system of NOTL. Data from Niagara Region and GeoSmart Niagara.

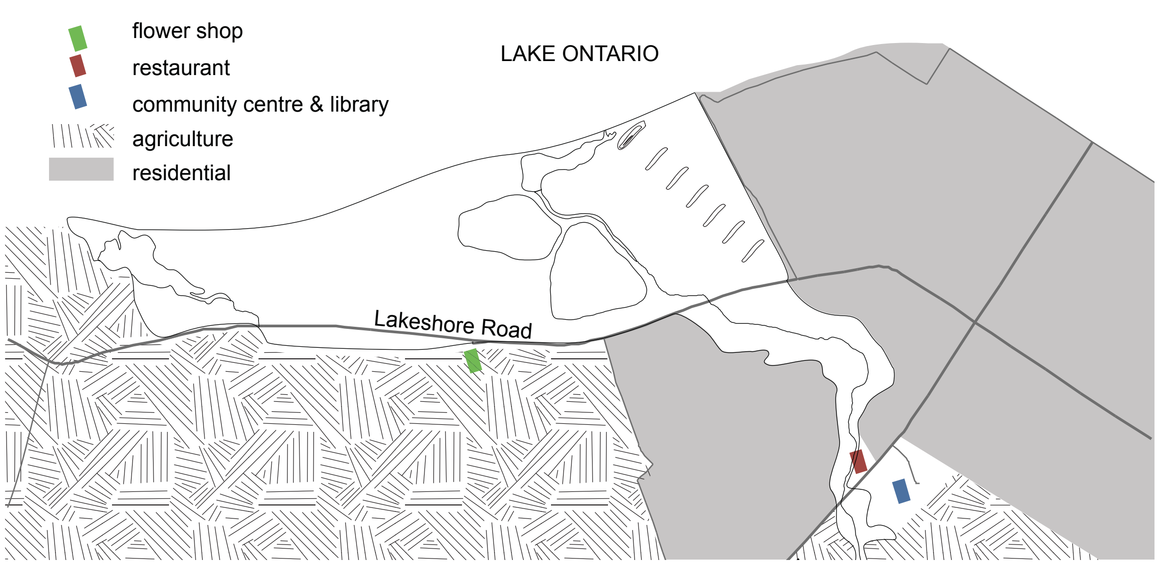
CHAPTER 3: SITE ANALYSIS AND METHODOLOGY

Layers as a Framework

The working method of layering, in all means of representation (mapping, drawing and models) was developed to understand the fluid and interconnected networks of the region town and site, and the relationships that the various programmatic elements play. As Berrizbeitia suggests, “Layering multiple forms of organization on the site is a strategy that acknowledges complexity, history and the often contradictory programs that must be accommodated in large parks” (Berrizbeitia 2007, 179). The design developed through understanding and interpreting the relationship between the various layers of the site and the added program.

Existing Site Layers

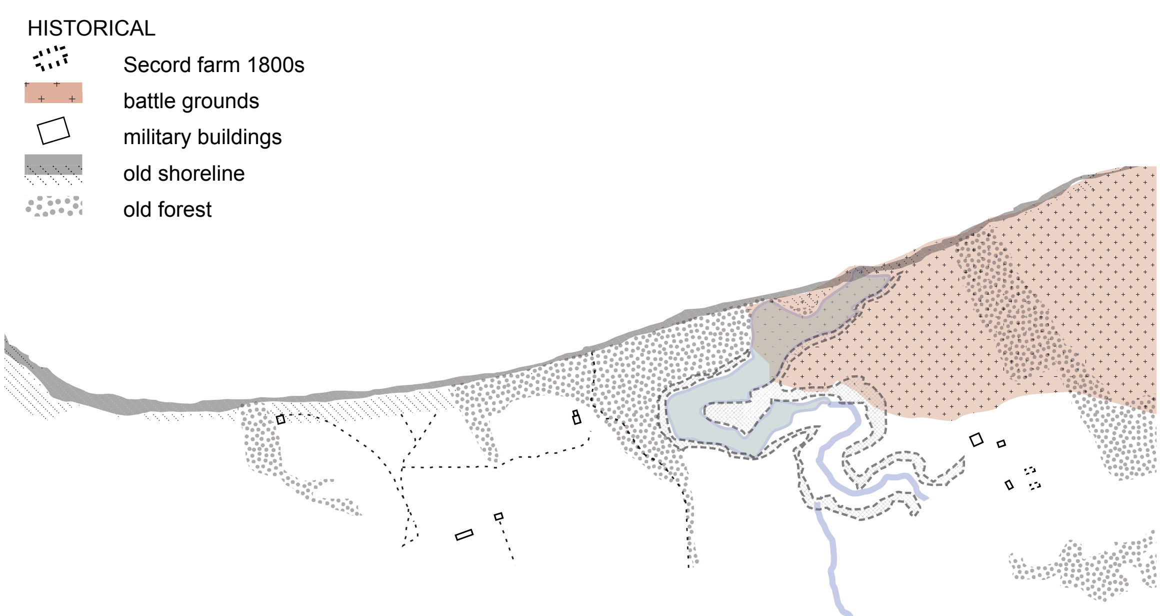
The site is located on the South shore of Lake Ontario and bordered by residential neighbourhoods, as well as agricultural land. The site, as mosaic, has a complex history, multiple uses (including wastewater treatment and park space) and it is of significant ecological importance. Mapping the layers of history and the ecological elements, both natural and human, will establish a dialogue for which new layers can be added. This ‘new landscape’ includes, a proposed park and recreational plan with a market, greenhouse, community and learning spaces and a wastewater treatment facility.



Site adjacencies.

Historical

The history of the site reflects much of the history of the region and town itself. Surveys from the 1780s show the land was settled by British loyalists, John Secord and Colonel John Butler. However, these homes, along with most of the town were destroyed during the War of 1812. The site played a pivotal role during the war as it was the landing site for the American soldiers in May 1813, during the Battle of Fort George. It is considered to be "where the fighting was most fierce, and where to a considerable degree the eventual outcome of the battle was determined" (Parks Canada 2006). However, there is no commemoration on the site for this battle, as it has been closed to the public for over a century. The land was purchased by the Department of National Defence (DND) in 1906. It functioned as an extension of the existing military reserve on the other side of town and was used for tank and mortar training, as well as target practice on a rifle range. The reserve was used to train soldiers for both World Wars, and the rifle range was used until the late twentieth century by both Canadian and American soldiers. In 1947 the DND transferred the land to Parks Canada, who opened up a small portion of the site on the west end for public use, now maintained by the town (Parks Canada 2006). The rest of the site remains inaccessible due to contamination from military use and for the WWTF.



Historical layer. The map shows significant aspects of the history of the site including the original form of Two Mile Creek.

Topography

Topography refers to the three-dimensional quality of the surface and identifies specific landforms that define the site (Forman 1995, 302). The largest change in topography occurs along the shoreline of Lake Ontario, where bluffs drop seven to five metres to the waters edge and establishes the northern edge of the site. This edge is unstable due to erosion, thus, requires a setback. Humans often interfere with this edge by placing retaining walls to prevent erosion, causing more problems further along the shoreline. The rest of the site is relatively flat, aside from where Two Mile and Four Mile Creek have carved into the flat plain forming ravines and ponds. Unstable slopes occur along the ravines in areas steeper than a 3:1 slope. Humans have altered the topography of the site in several areas: the lagoons, which redirected Two Mile Creek; the stabilization ponds; and the earth mounds for training in the rifle range.

Topography layer. Data from Niagara Region and GeoSmart Niagara.

Patches

Patches are areas differing in appearance from its surroundings (Forman 1986, 83). The site is composed of several types of patches, natural to human. Buildings have been defined as patches as they are distinctly different than their surroundings. Several building patches exists on or adjacent to the site, which are defined by type of use: residential, commercial, infrastructural and community. The natural patches on the site also vary, each type containing their own plant and animal communities. The treed patches are of significant interest as they are examples of rare Carolinian Forest, "with such species as shagbark hickory, black walnut, beech, and red oak; the trees average 90 to 120 years old. Furthermore, part of the site, in the vicinity of Four Mile Pond, has been designated as a Provincial Area of Scientific and Natural Interest, primarily in recognition of the rare plant species found there." (Parks Canada 2006) The extent of the forest on the site is rare in this highly urban and agricultural region.

Patches layer. Data from Niagara Region and GeoSmart Niagara.

Edges

Edges occur as an outer band to the patches in the landscape and are significantly different from the interior of the patch (Forman and Godron 1986, 108). They are differentiated between hard edges and soft edges, and land edges and water edges. Hard edges occur primarily near human affected areas, such as along the road or where a forest meets a maintained field. Hard edges typically exhibit less interaction of fauna and flora between the patches. Soft edges occur within the more natural landscape and exhibit high interaction between patches. Soft edges dominate the interior portion of the site and can be particularity observed in the area of forest regrowth, where the military has stopped maintaining the land for several decades.

Edges layer.

Corridors

Corridors have four functions: habitat for certain species, conduits of movement, barriers or filters separating areas and a source of environmental and biotic effects on the surrounding landscape Its function as a conduit is perhaps the most obvious to observe. Human corridors can be a road or pedestrian path. Two main roads bisect the site, Lakeshore Road and HWY 55. Both these roads are main access-ways to NOTL from the City of St.

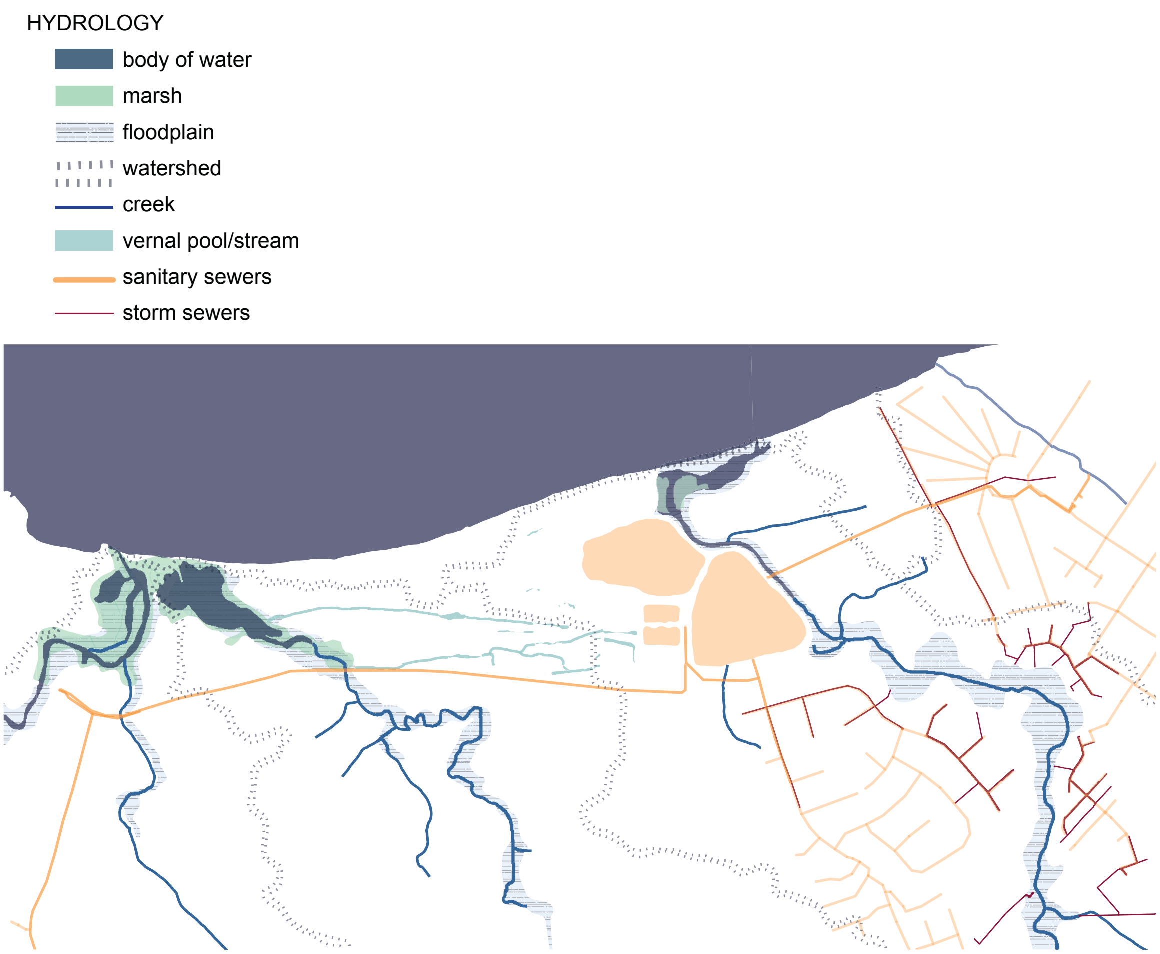
Catharines. Both Roads are also important bicycle routes, used commonly by tourists. Several pedestrian paths run through the site, one of which bisects Two Mile Creek, connecting the residential neighbourhoods on either side. Natural corridors are also vary in use and size. Often in nature, corridors follow streams, such as Two Mile and Four Mile Creek. Animals often move along streams, as long as there are wide edges along the banks (Forman and Godron 1986, 398). Two Mile Creek and Four Mile Creek are part of an important natural corridor for the region.

Corridor layer. Data from Niagara Region and GeoSmart Niagara.

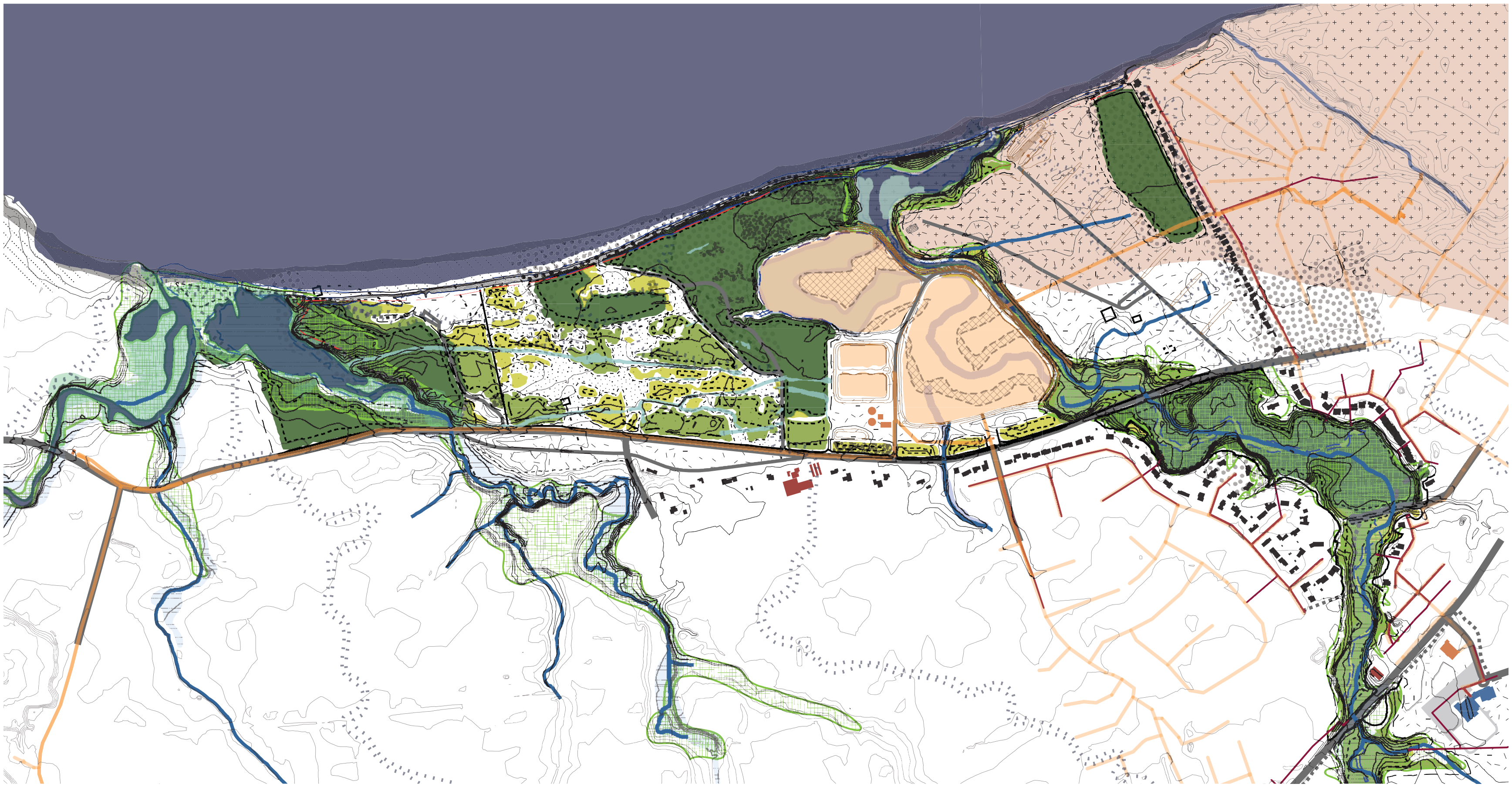
Hydrology

Hydrology is also considered in terms of human-made and natural; however, they are not as separate as we image. Lake Ontario is the northern boundary to the site and is one of the Great Lakes. It receives runoff from a large area of land by way of creeks and rivers. It also receives effluent from the WWTF. In operation since 1950s, the WWTF on site consists of two large lagoons, operating in series, two stabilization ponds, also operating in series and a disinfection facility. It services a population of 6500 people and is functioning at 84% capacity (see Appendix A). The wastewater system for the town is considered partially separated; there are separate sanitary and storm sewers but groundwater infiltration and runoff enter the sanity system. Thus, the WWTF receives peak wet weather flows.

The problem is exacerbated as residents illegally connect downspouts and foundation drains to the sanity sewers (Niagara Region 2008). The separated storm sewers release the water collected from urban areas into the nearby creeks, thus the creeks also receive peak wet weather flows. Some creeks have been culverted to function as storm sewers themselves, such as a small branch of Two Mile Creek near the community centre and library. Also significant on the site, in terms of the natural hydrology are vernal pools. Vernal pools exists only seasonally; however, they are breeding habitats for many amphibious species. These vernal pools, along with their watersheds, should be protected as they are critical for the ecology of the site.



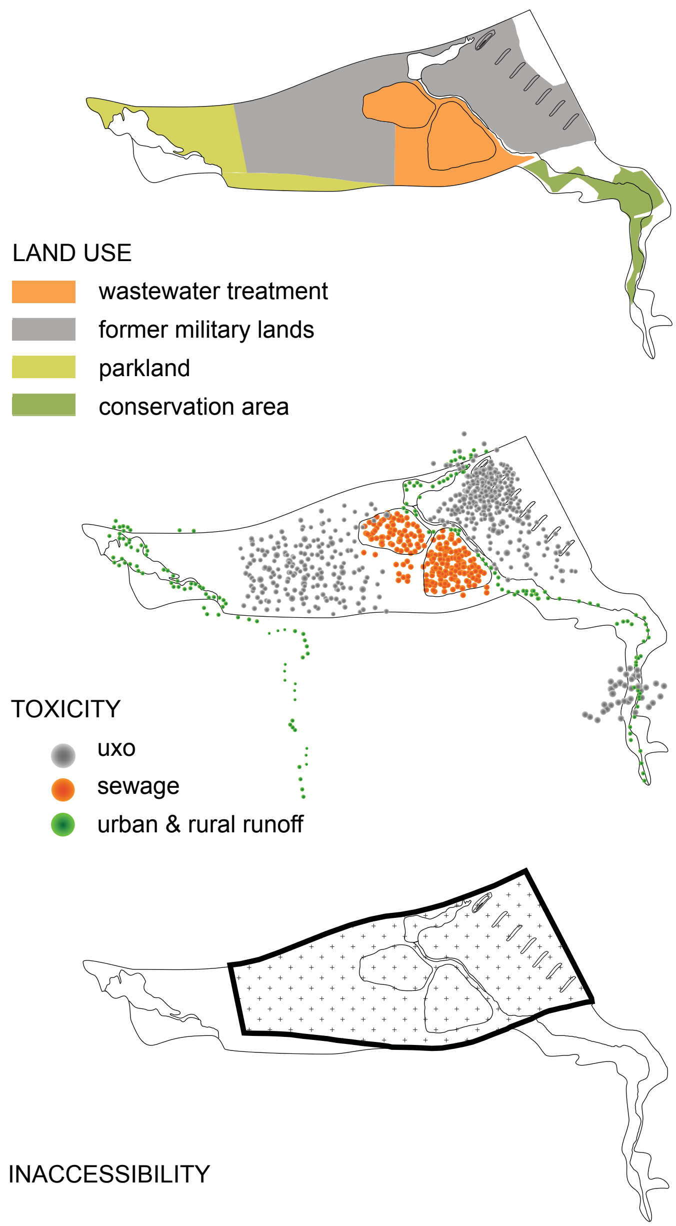
Hydrology layer. Data from Niagara Region and GeoSmart Niagara.



All site layers.

Merged Layers: Ecological Zones and Edges

Overlaying the layers allows for a complete understanding of the site, the result of which begins to define zones of the site. These zones have been defined in terms of ecological landscapes, where important flora and fauna, who dominate the zones, have been identified. The edges of the zones have also been identified to illustrate the relationship between them.



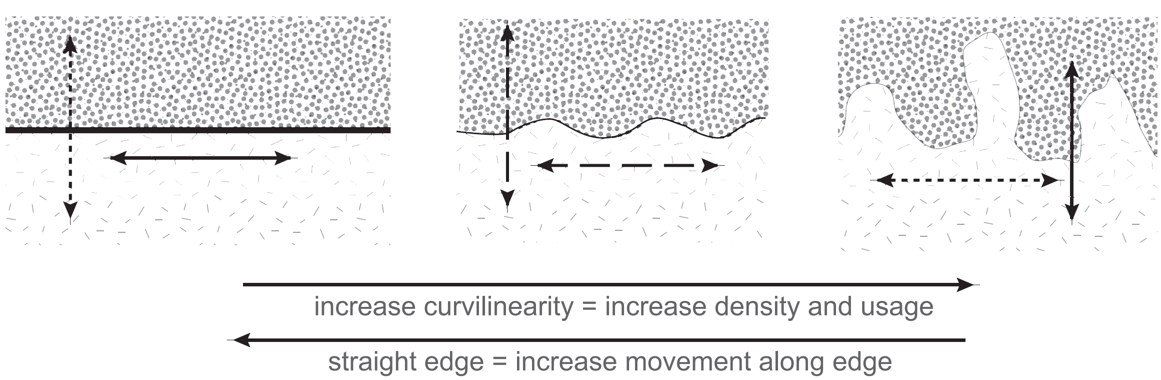
Existing site condition diagrams.

Ecological zones and edges of the existing site.

Edges as a Framework for Design

Edges are places of movement and flow between separate elements. Across different disciplines edges have strong functional characteristics. In biology, edges are permeable cellular membranes, which filter material in and out of the cell. Politically, edges are geographical borders between countries, states and towns; highly controlled at specific sites, borders differentiate insiders from outsiders. Aesthetically, views are often dominated by edges in the landscape; edges either frame or control one's perspective of what lies beyond the edge itself. In the environment, edges separate ecosystems or land uses in the landscape and filter flows or movements of plant material, wind, sun, water and animals that physically encounter the edge (Forman 1995, 81).

In the landscape, edges are created by "three mechanisms: (1) a patchy physical environment, such as mosaic of soil types or landforms; (2) natural disturbances, including wildfire and tornado 3) human activities such as clear cutting and development for housing." (85) Within an edge there are three main characteristics to define it: the length, which often describes the curvilinearity; the width between the border and interior of a patch; and the height, including stratification (86). These characteristics indicate in what manner flows and movements would navigate through an edge and, thus, how diverse landscapes would interact with one another. Applied to designed landscapes, the edge becomes a tool for relating diverse programmatic spaces to each other and to the site.



Edge flow diagram based on the characteristic of curvilinearity.

Existing Site Edges

As there are many ecological zones within the existing site, the edges of these zones become particularly important to consider. The edges describe the relationships between the various zones in terms of its ecological, infrastructural and/or human movements and flows. The most significant edges are those where humans interact with a natural edge, as human activity disturbs or changes the natural networks, connections and flows. Thus, these edges are where there is the most potential for design. The edge conditions on the site that exhibit the highest human interaction are: the bluff, the ravine and the road. These specific sites were analyzed through a series of layered models, which considered the characteristics and functions of each edge.

Bluff Edge

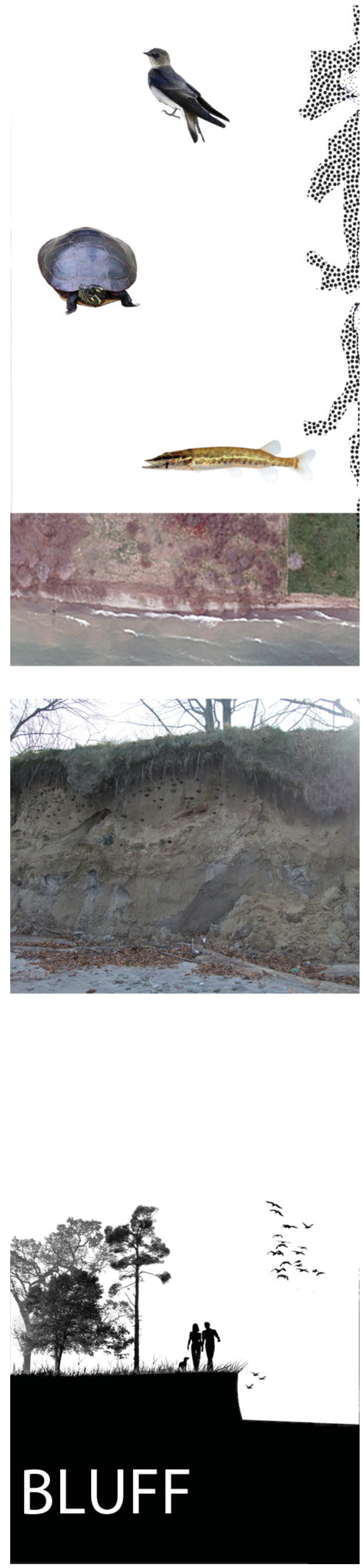
The characteristics of the bluff edge change along the shoreline of the site. The area chosen for study is where the existing public park meets the shoreline as humans have impacted the natural bluff edge through their interaction with it. However, human intervention at this specific site is still minimal, thus the edge is relatively natural with minimal human activity. The characteristics of the edge are described in terms of natural and human processes.

Natural Processes

The bluffs were essentially created by “isostatic rebound in the Lake Ontario Basin and St. Lawrence River. When Lake Iroquois drained away with the opening of the St. Lawrence about 11,800 years ago the continent had been depressed by the mass of the ice which once reached a thickness . . . of up to two kilometers” (Murphy 2010, 18). As the ice cleared the land began to rebound, causing the eastern end of the lake to rise and the western end to sink, a process still slowly occurring. Moreover, as the lake bed began to be refilled, the lake bed deposits began to be eroded by wave action, forming bluffs. The bluffs continue to be eroded by waves: “The rate at which these bluffs are being destroyed varies from year to year. When lake levels are low the small beach that is formed is enough to protect the bluffs. During periods of high water the erosion is much greater” (Murphy 2010, 18).

Human Processes

The shoreline of the existing site is mainly a bluff condition, rising as high as seven metres from the water's edge. Along the northern edge of the rifle range, boulders have been placed along the bluff to protect it from erosion, which is commonly done along the shoreline of Lake Ontario in areas of human habitation. The rest of the bluff along the site remains open to the elements, particularly in the existing public park as trees and bushes have been removed from the edge to allow for an open view to the lake. This has greatly increased the erosion of the bluff in this section. Moreover, humans continue to climb the bluff edge, which also increases the rate of erosion.



Ecological zone enlargement: The Bluff.

Bluff edge model. The layers of mesh are supported by the ‘trees’ and their roots. The trees are setback from the edge demonstrating the lack of stability along the bluff edge. The blue thread represents the waterflows and wave action causing erosion.

Ravine Edge

While the ravines existing on the site are highly natural elements composed of natural processes, both human and infrastructural flows also encounter the ravine edge.

Natural Processes

The ravine is a natural corridor, its components are: a stream, the edges of the stream, the flood plain, the banks above the flood plain and even part of the upland above the banks. The width of the stream corridor has functional implications. The main function of a stream is controlling water and mineral nutrient flows it receives from the surrounding landscape by way of surface runoff and ground water infiltration. Wide stream corridors are also conduits for animals to move between forest patches (Forman 1986, 146). Two Mile and Four Mile Creek and are part of a large natural corridor connecting the escarpment to the lake. Moreover both creeks are significant fish and mussel habitats, particularly for breeding as they connect to Lake Ontario.

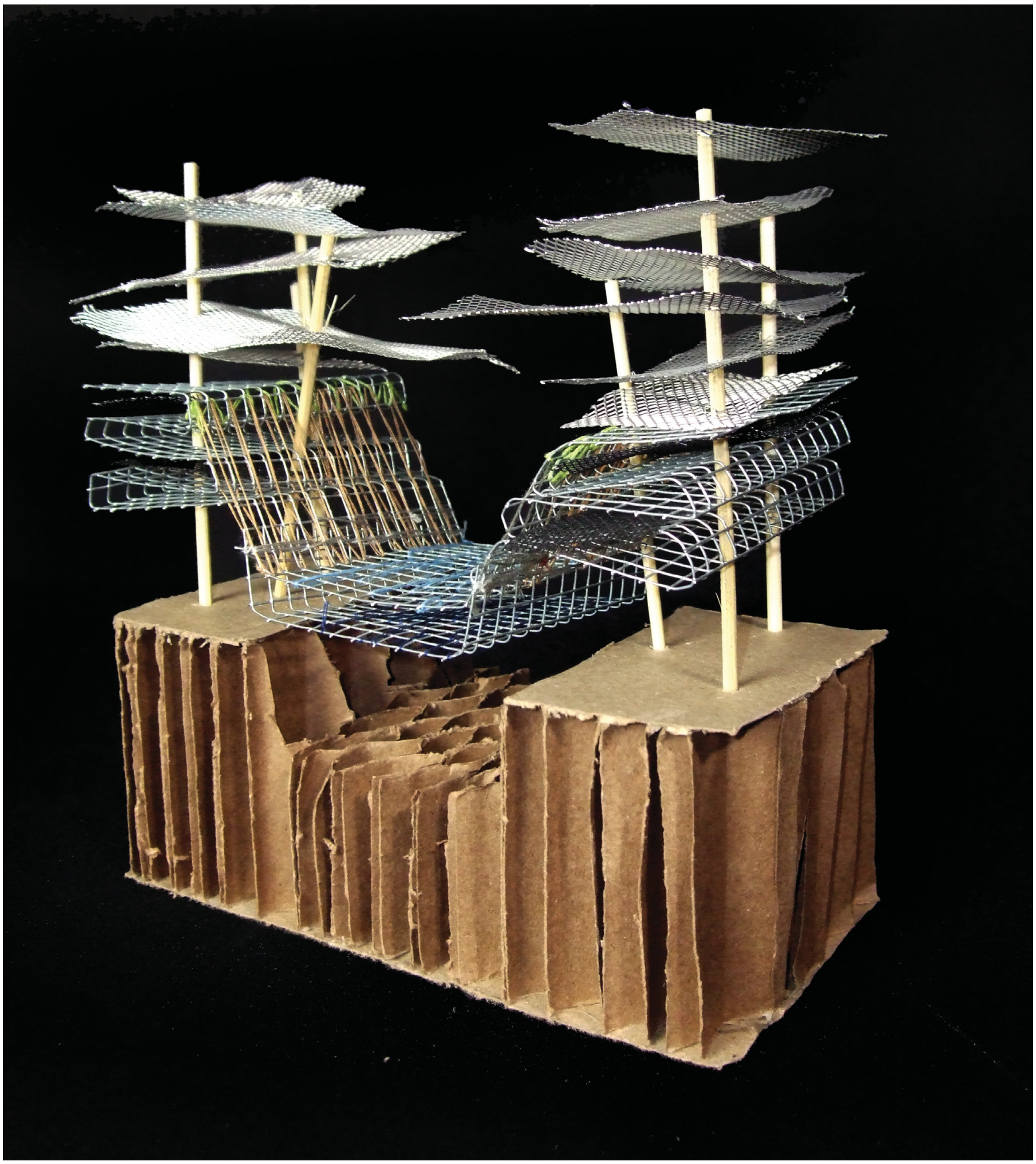
Human Processes

Humans direct interaction with the ravines is minimal, however a path bisects two mile creek and residential neighbourhoods back onto the creek. Some residences who back onto the ravine use the zone for collecting firewood and dumping leaves. At times children use these areas to play in nature and build forts. Aside from the path and some residences, the ravine is largely inaccessible.

Infrastructural Processes

However, humans greatly affect the ravines by way of runoff processes. Both Two Mile and Four Mile creek have extensive watersheds crossing urban and agricultural land. The ravines also function as storm water management for adjacent urban areas. Storm sewers release water collected from urban areas into the ravines, thus increasing the speed water enters the ravines during storm conditions. Thus the watershed of the creeks are partially natural and partially human-made/altered. Moreover, some creeks have even been culverted to function as storm sewers.

Ecological zone enlargement: The Ravine.



Ravine edge model. The base of the model is carved away to illustrate how the creeks have carved into the Iroquois Plain. The trees and their roots support the banks of the ravine and have formed a naturally protected corridor for animal movement.

Road Edge

The Road is a human-made element; however, natural, human and infrastructural flows intersect with the road edge.

Human Processes

A road is a corridor. It includes the surface for vehicle movement and the roadside. The road surface and roadside are continuously maintained, and thus are repeatedly disturbed. The disturbance is concentrated in a strip within the corridor, however, the road is also a source of oil, salt, dust, heavy metals and debris that enter the surrounding landscape (Forman 1995, 159). Two roads bisect the existing site, Lakeshore Road and HWY 55, which are both significant roads for NOTL as they are two of three main entries into the town. These roads experience high volume of traffic and are also used as bicycle routes. Road kills are commonly found along both roads. The roadsides are usually vegetated strips in the form ditches, sometimes bordered by fences.

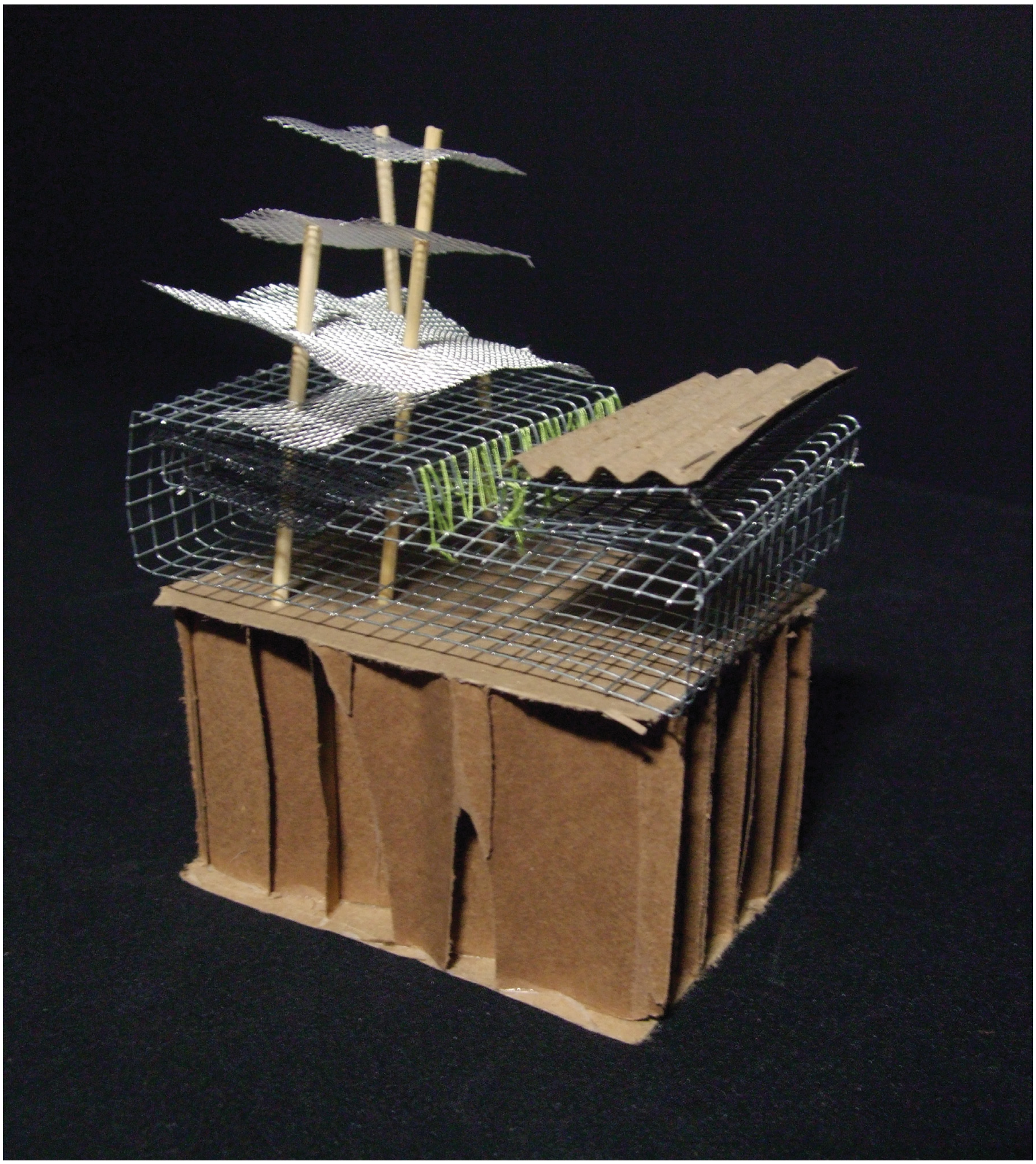
Infrastructural Processes

Other urban infrastructures follow roads, such as power lines (either buried or overhead) gas lines, and storm and sanitary sewers. These services also require maintenance causing further distance to the road and roadside. Storm and sanitary sewers also need access, thus manholes are created in the road way.

Natural Processes

Smaller roads, such as those found in the interior of the site, would act as a conduit for animals. However larger roads, such as Lakeshore Road and HWY 55, would be barriers or filters separating areas and reducing the movement of small animals; however “two-lane paved roads are not barriers to relatively large animals (e.g., fox, grouse)” (Forman and Godron 1986, 380). While roads are inhabitable, roadside banks and ditches are habitats for specific species, primarily edge species. Roads are also a conduit for seeds moved by vehicles. Moreover, while a natural ravine has a canopy of trees a road is an open trough, meaning that the sun and wind can penetrate from above (Forman 1995, 159-160).

Ecological zone enlargement: The Road.



Road edge model. The road surface is solid to represent its impermeability. It is sloped towards its sides to direct runoff to the ditch.

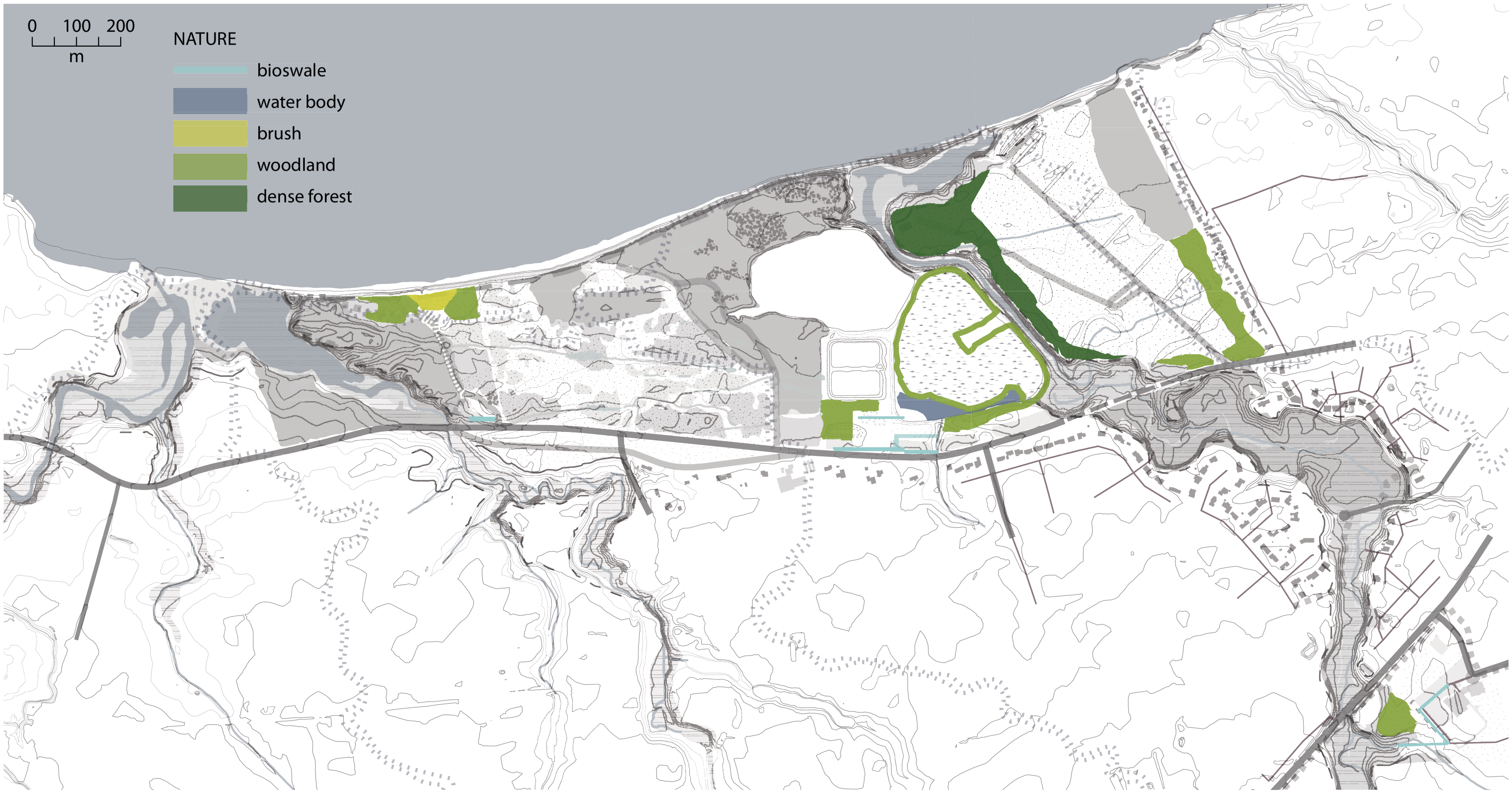
CHAPTER 4: DESIGN

Proposed Site Layers: New Landscape and Architecture

The overall scheme of the park is considered as layers of natural, human and infrastructural landscapes, which are superimposed onto the existing site. The 'new landscape' responds to multiple scales from regional to site specifics; it makes use of available opportunities already present by enhancing their functions for humans, infrastructure and nature. The design creates a beneficial relationship between the new landscape and architecture, existing landscape and the surrounding area. Thus, the new landscape integrates the WWTF, the park amenities and the natural landscape into a multifunctional productive and working landscape, which responds to human, infrastructural and natural processes.

Natural Landscape

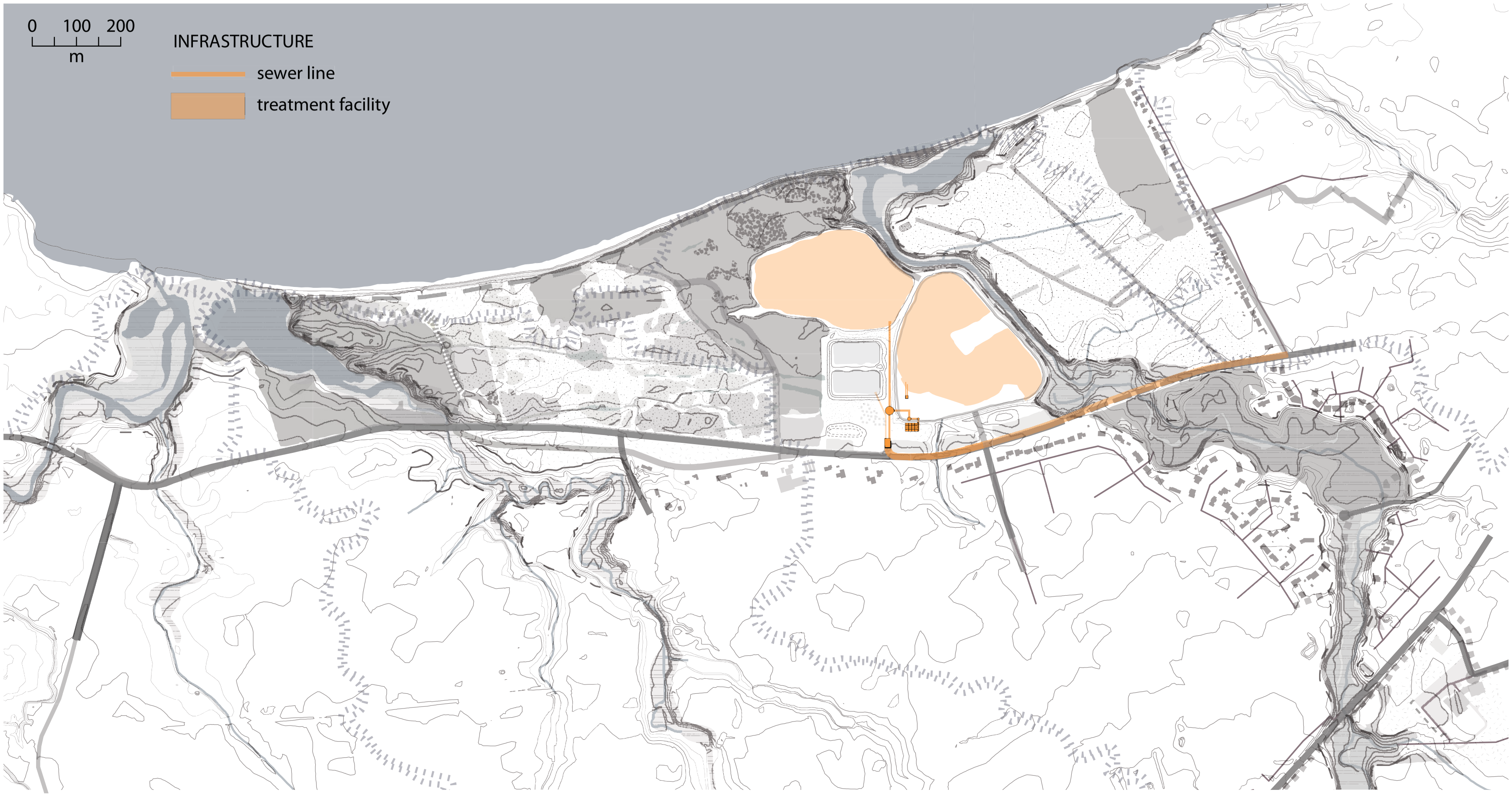
To enhance the function of the natural landscape, the new landscape includes strategies such as habitat creation and water management. Habitat creation includes the constructed wetlands and forest regrowth. The wetlands and forest regrowth widen the ravine of Two Mile Creek, increasing its function as a natural corridor. Furthermore new forest connects existing isolated patches to the natural corridor. For storm water management and to treat urban run-off, bioswales are used and placed along roads and parking. Lastly to minimize disturbances, the land is left largely unaltered. The earth mounds in the rifle range field remain to acknowledge the sites previous use, while only one of the existing sewage lagoons is replaced by wetlands, taking shape of the historical Two Mile Creek.



Proposed natural landscape superimposed onto the existing site.

Infrastructural Landscape

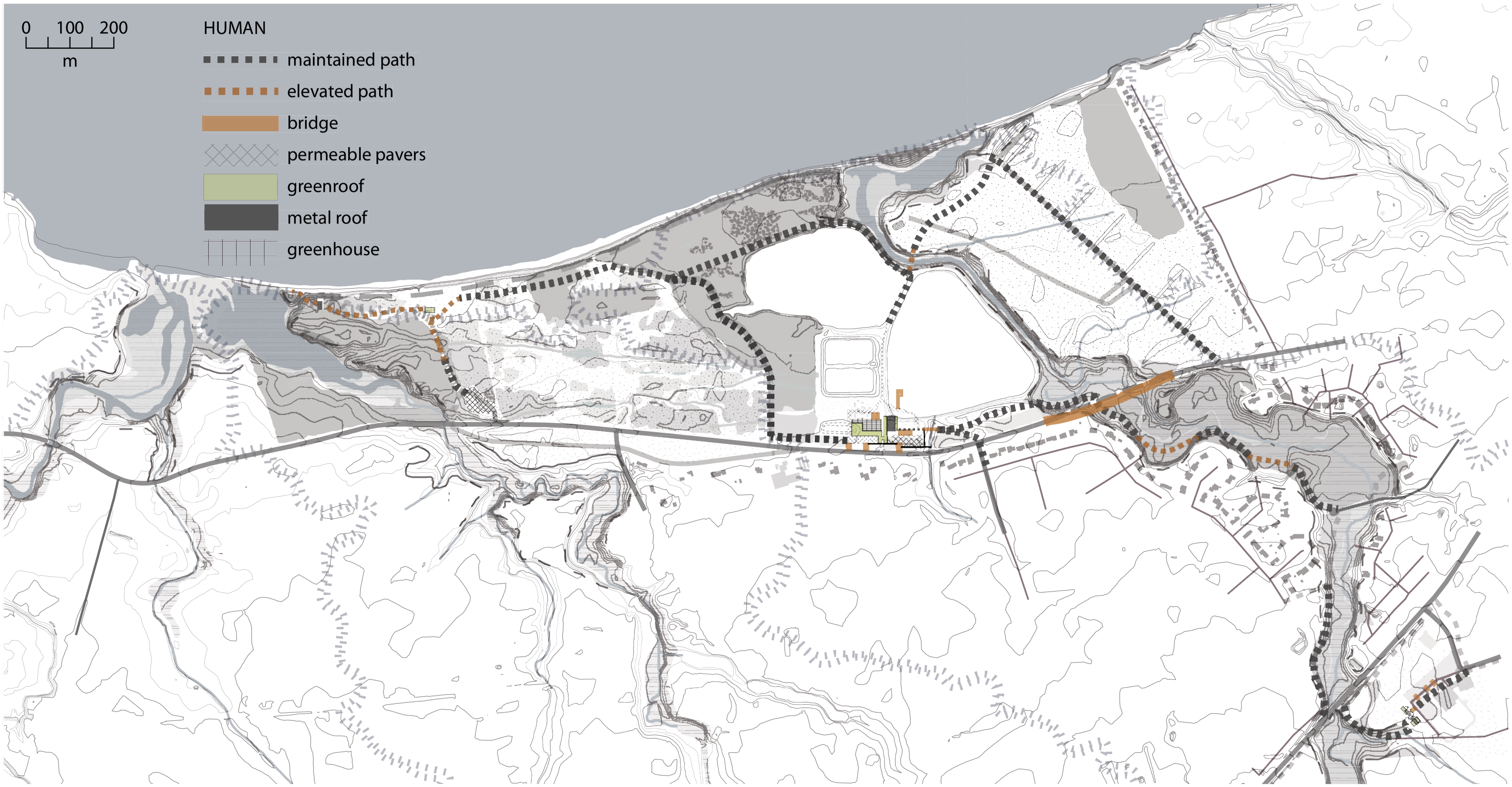
While the existing lagoon and wetlands are natural elements, they are also part of the infrastructural landscape as they are used for the secondary treatment of wastewater. Primary treatment, sludge treatment and disinfection are also part of the infrastructural landscape, however, they are built structures. The built structures, existing lagoon and wetlands are connected by underground sewer lines. The existing sewer lines connected to the site are altered to direct all the sewage influent to the same point of entry onto the site. Thus, the sewer line crossing the rifle range will be decommission, and a new sanitary sewer will follow Lakeshore Road.



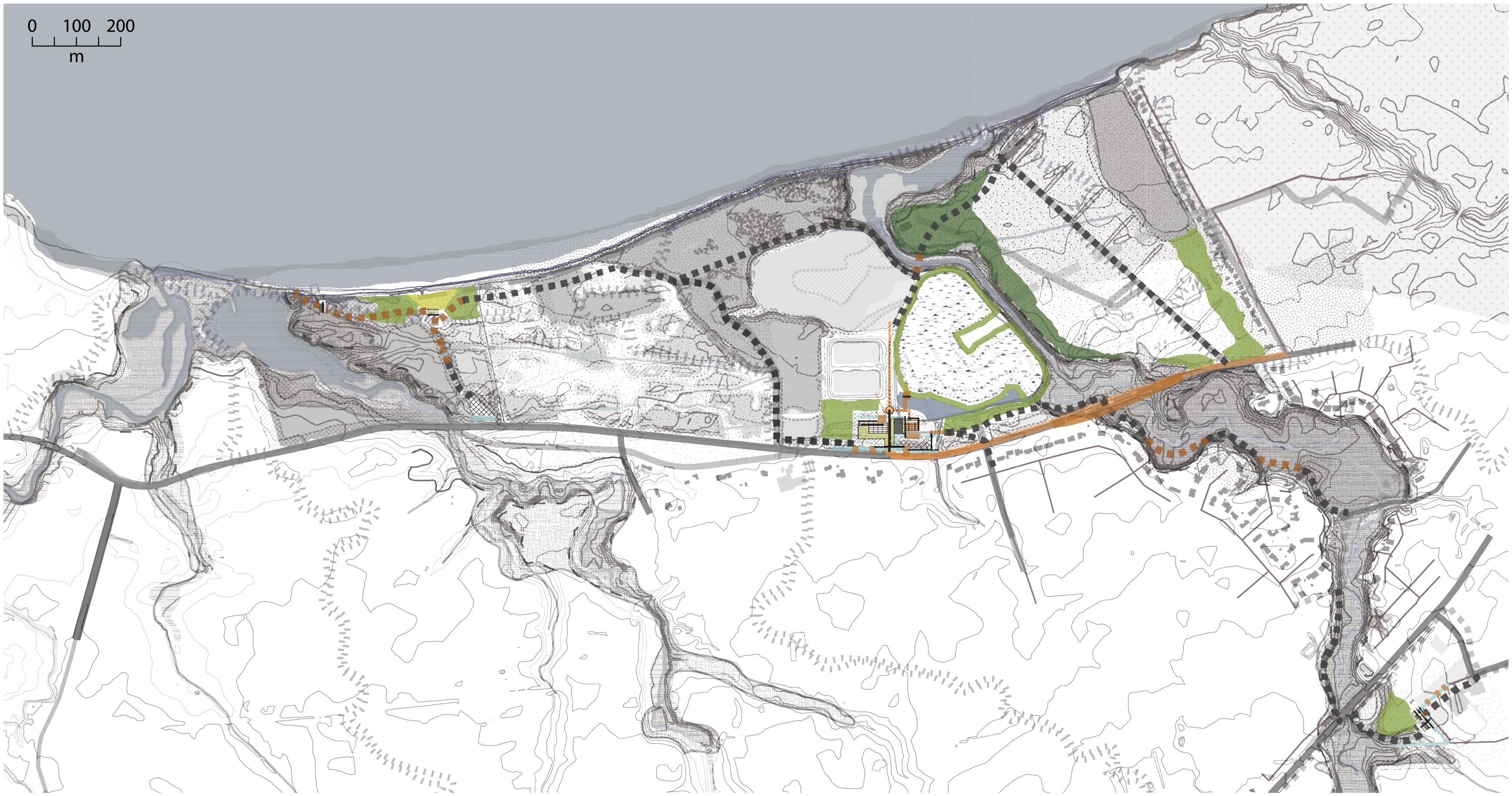
Proposed infrastructural landscape superimposed onto the existing site.

Human Landscape

The first strategy for the human landscape is lifting and curving Lakeshore Road as it crosses Two Mile Creek to avoid disrupting the natural corridor and to slow traffic as they reach the residential area. The most far reaching element of the human landscape are the recreational paths. The paths connect the site to the surrounding neighbourhood and connects the facilities within the new landscape. The new facilities are at three locations marking main entries into the site and providing recreational and cultural amenities; these are the three design sites.



Proposed human landscape.



'New Landscape' superimposed onto the existing site.

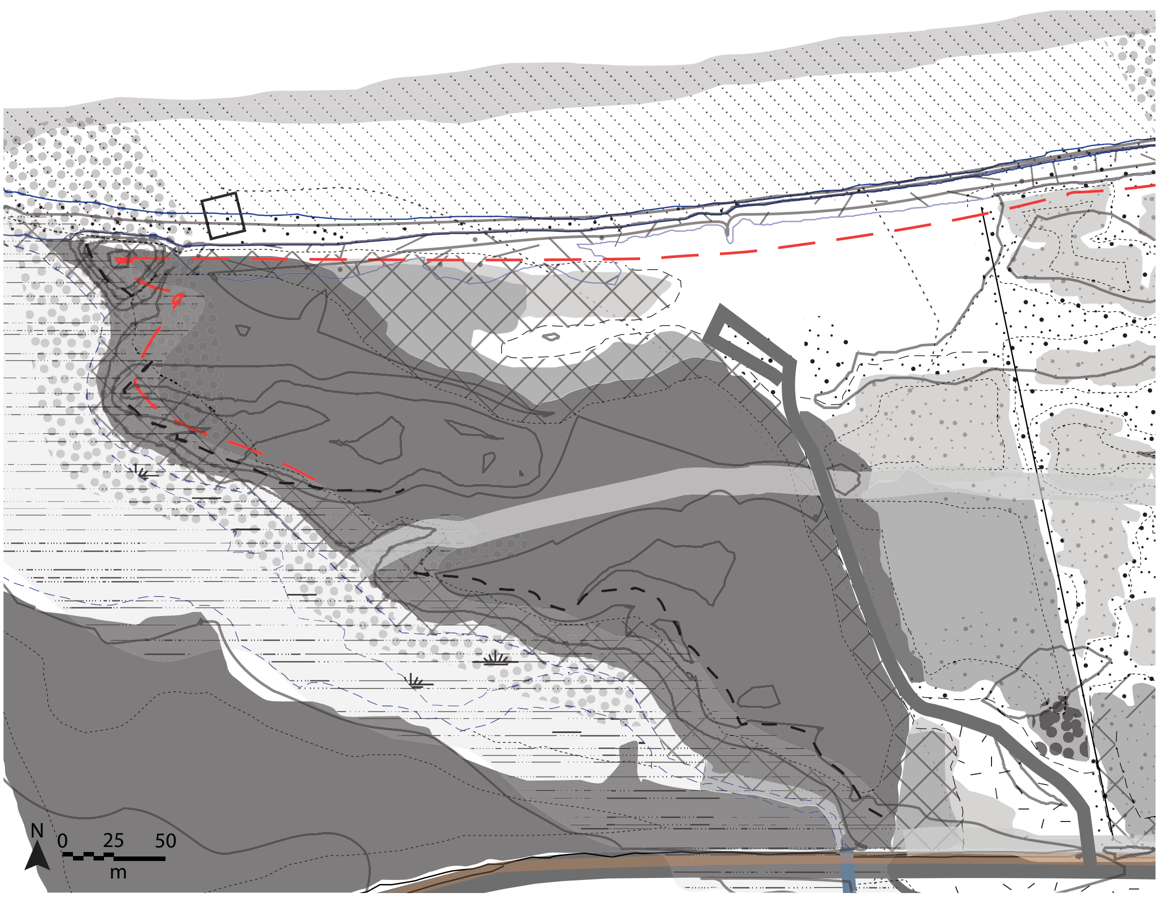
Proposed Edge Sites

The edges of the site are important as it is the edge of the park zone that interacts with the surrounding community and natural landscape. Thus, the design focuses on three edge conditions of the site: an entrance from the water's edge (the bluff), a pedestrian entrance at the community centre and library (the ravine) and a primary entrance at the wastewater treatment facility (the road). Each of the three sites reflects a different means of mediation, whether between the layers of natural and human or natural, human and infrastructural flows.

The Bluff

Existing Condition

The bluff site is located within the existing park space, at the north-west corner of the site. As described previously the bluff edge is relatively natural, however human activity is causing further damage to the edge. Currently, access to the site is from the road, where

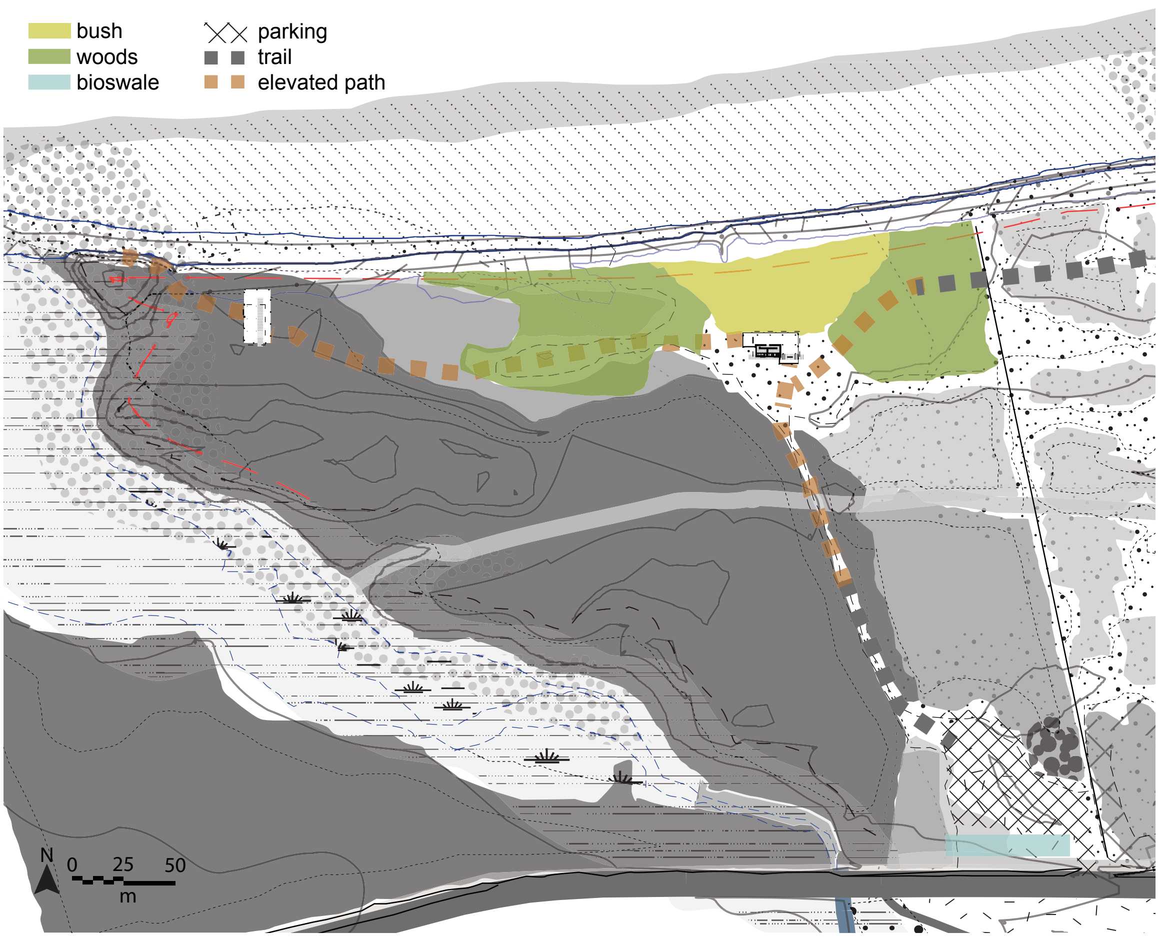


The Bluff Edge: existing site plan.

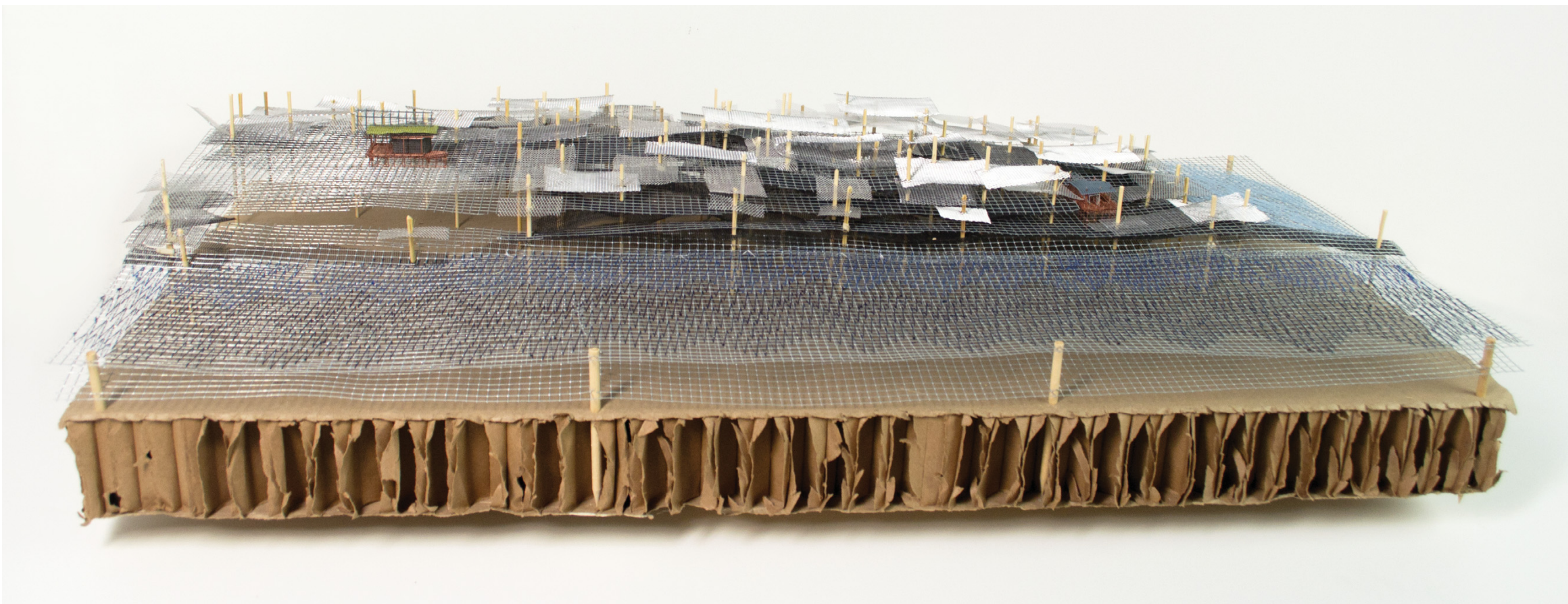
cars are able to drive through the forest to a cleared field for parking. The paths on site are dirt, maintained by vehicles and foot traffic. Access to the water is not well defined; people may follow the dirt path or climb the steep bluff edge.

Proposed Bluff Edge Design

Thus the design for the bluff edge responds to the natural processes, while allowing for human interaction. To stabilize the bluff edge, zones of vegetation have been defined. These zones also respond to the needs of human activity, as a zone designated for low bushes allows for views of the lake. The built structures on the site are raised to also grant views. Moreover, the elevated structures allow the natural processes to function below the buildings unimpeded. To minimize the disturbance from cars, the parking is moved directly off the road, defined by permeable pavers. A bioswale runs along the road and parking area to treat runoff before it enters the nearby creek. Off of the parking area is a path which slowly rises creating an elevated boardwalk that connects to the facilities on this site.

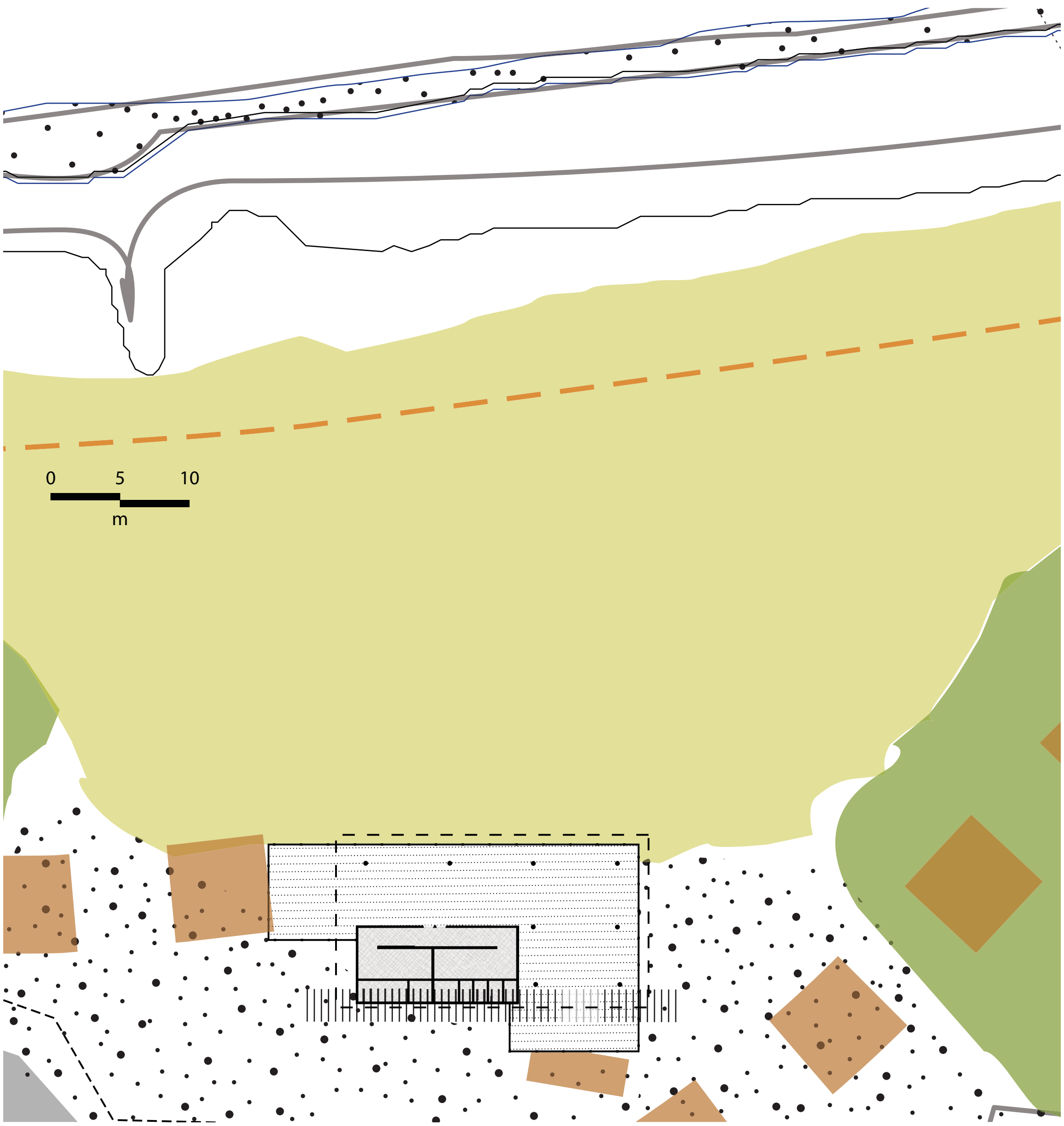


The Bluff Edge: proposed site plan.



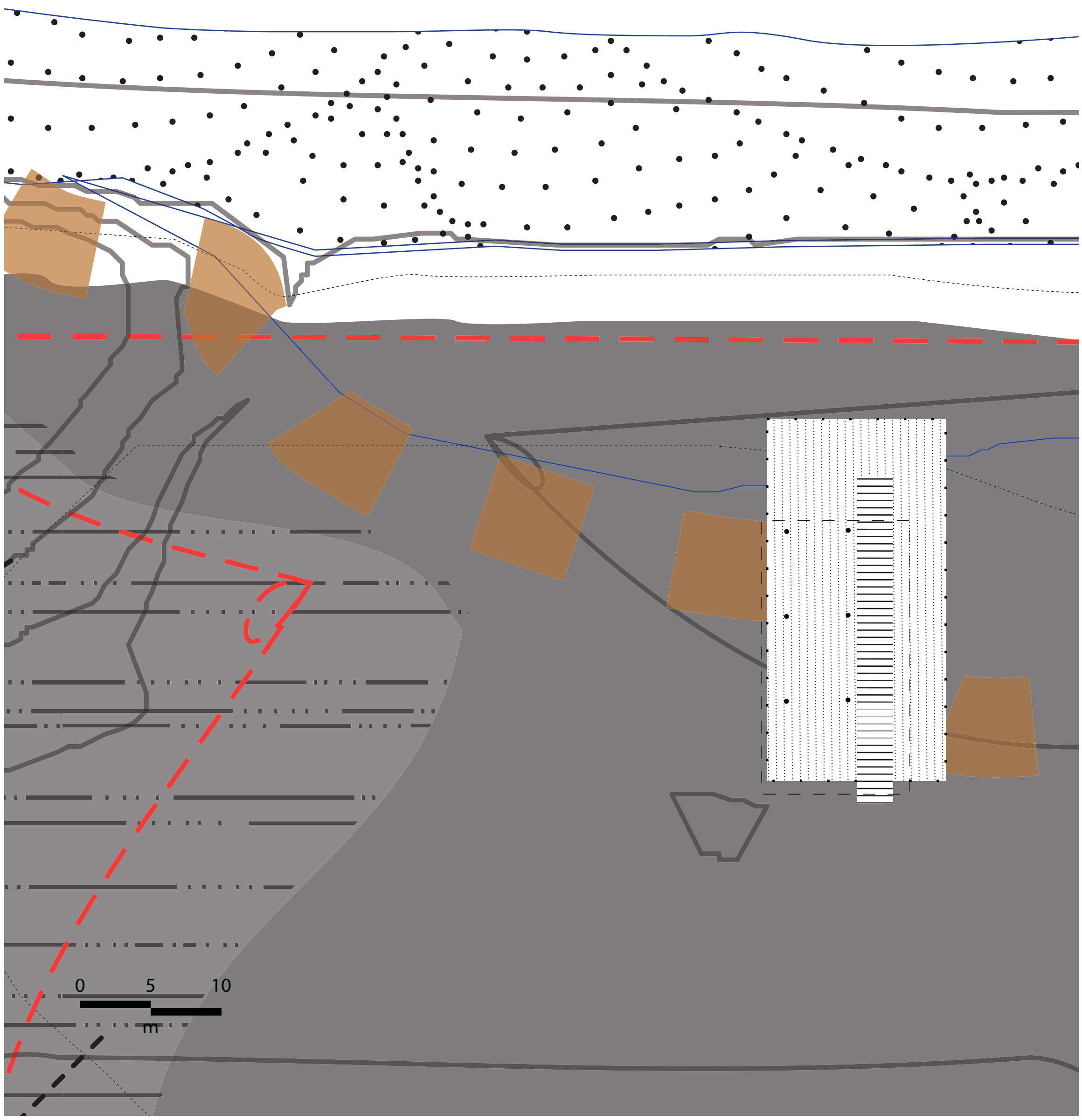
The Bluff Edge: site model, looking south from the lake.

The facilities include a trailhead with park information and solar compost toilets, as well as a viewing platform. As a visitor reaches the platform he/she passes through a defined edge, which also functions as a solar chimney to power the compost toilets. The orientation of the edge is south to allow for maximum sun exposure, while a wood platform faces North to Lake Ontario, where views of sunsets and the Toronto skyline are enjoyed. The washroom areas are defined by stacked stone for privacy and to provide thermal mass to increase the function of the solar chimney. At this location the trail splits; one trail connects to the eastern end of the site and another heads to the water's edge. The path



The Bluff Edge: trailhead with viewing platform and compost toilets.

towards the water remains elevated and connects to a boathouse. Again visitors pass through an edge as they reach the facility. This edge is a storage rack for kayak and canoe rentals. Users can carry the boats along the path to access the water by way of beaches below the bluff. The disturbance to the eroding bluff edge is minimized by directing people along a controlled boardwalk that navigates through the woods along gentle terrain and by setting back the built structures away from the edge. The strategy for the site recognizes the ecological importance, while allowing for human activity.

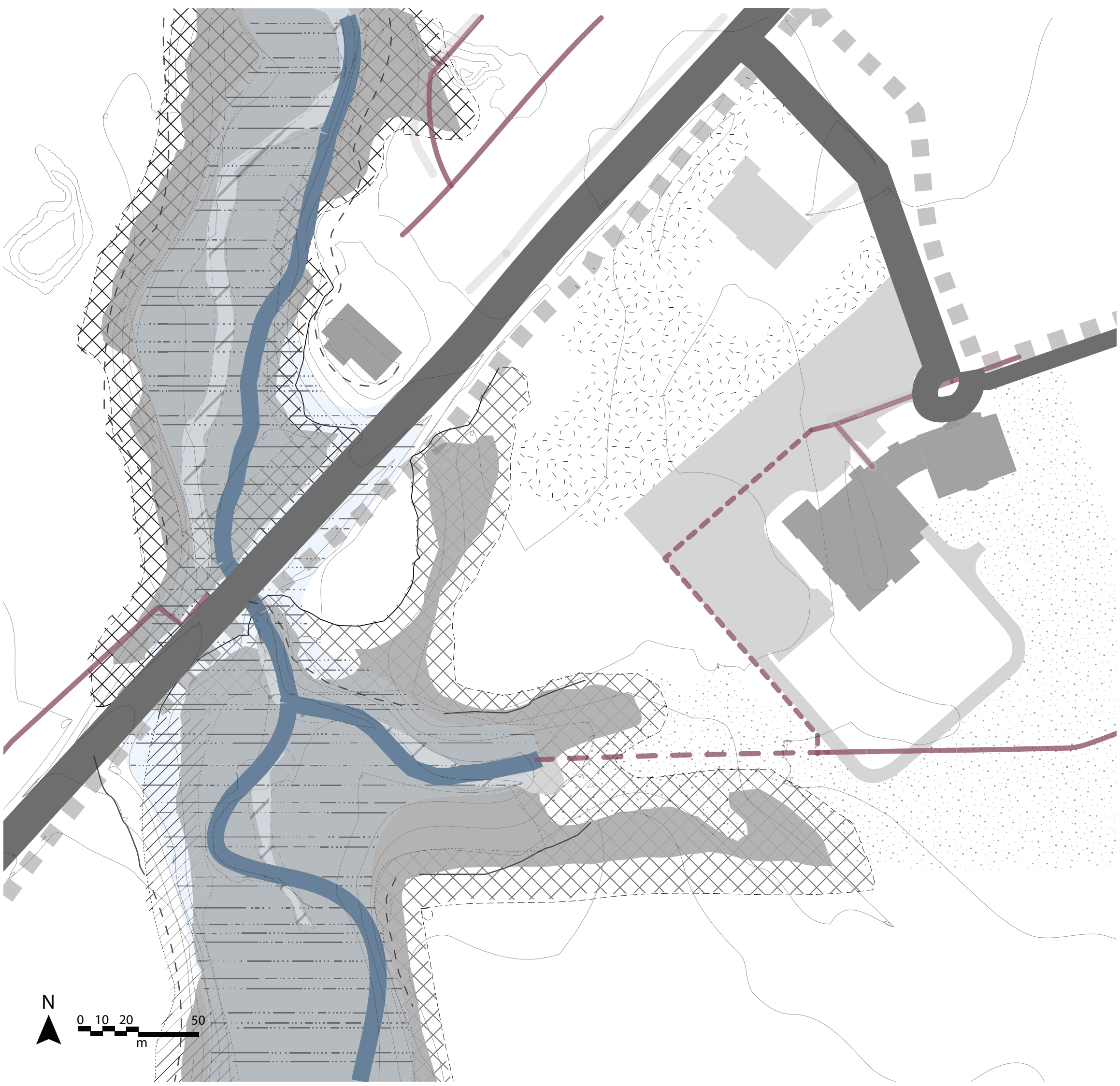


The Bluff Edge: kayak and canoe rental facility.

The Ravine

Existing Condition

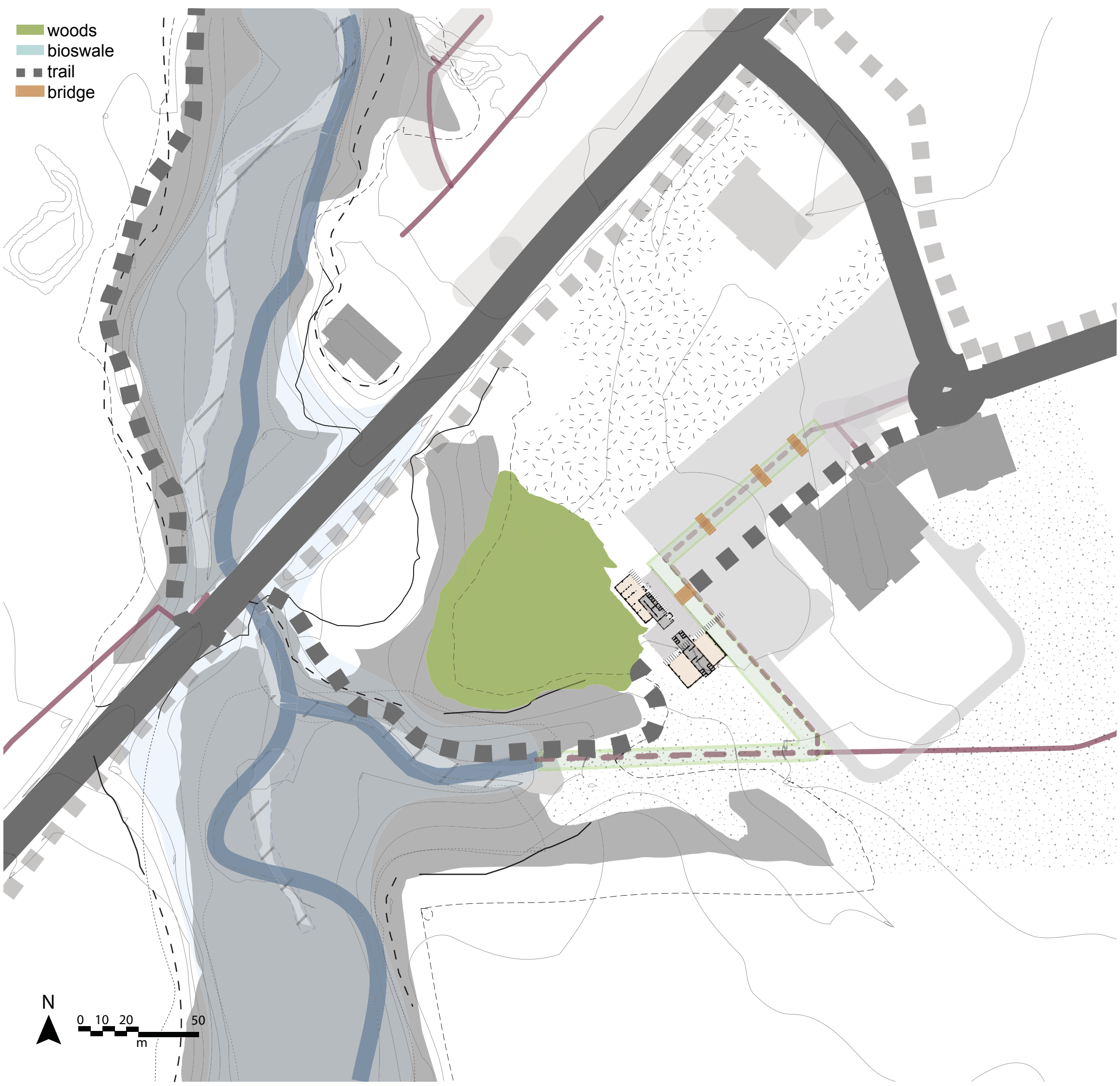
At the southwest corner of the site is an existing community centre and library adjacent to Two Mile Creek. The landscape is dominated by a parking lot, which is disconnected from the nearby ravine. The ravine receives urban runoff via storm sewers, one running beneath the parking lot and another runs from the nearby neighbourhood, which is in fact a culverted branch of Two Mile Creek. Currently, the site has been treated as an urban area, not reorganizing its inherent natural components.



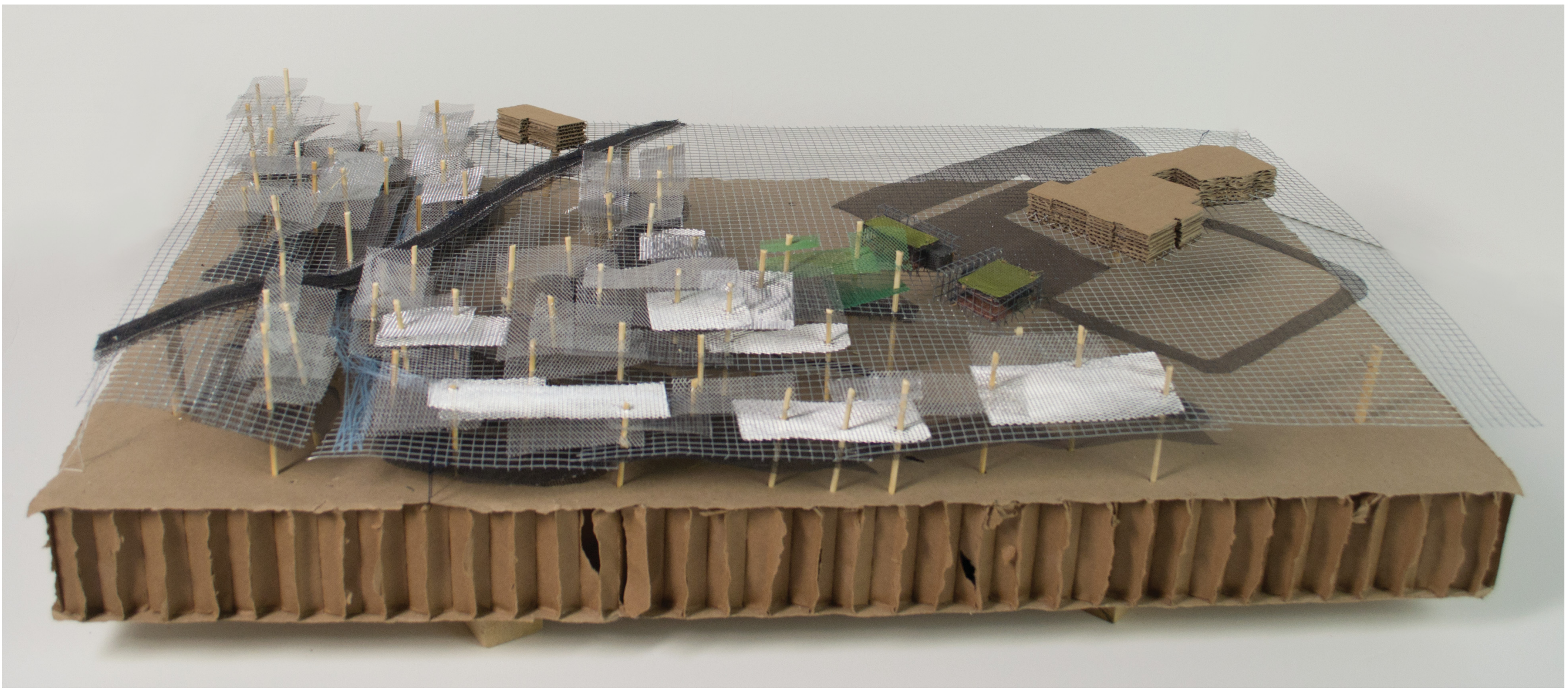
The Ravine Edge: existing site plan.

Proposed Ravine Edge Design

The design for the ravine edge brings natural elements into the urban space, while connecting humans to the natural ravine edge. To naturalize the parking lot, the storm sewers are replaced by bioswales that treat urban runoff before being released into the creek. The forested edge is allowed to expand into the area around the parking lot to create a closer connection to the natural ravine. The built structure bridges the bioswale, connecting the parking lot and path to the ravine. The outdoor space is the trailhead offering information about the park and its amenities and providing bicycle rentals. The larger indoor spaces



The Ravine Edge: proposed site plan.



The Ravine Edge: site model, looking north.

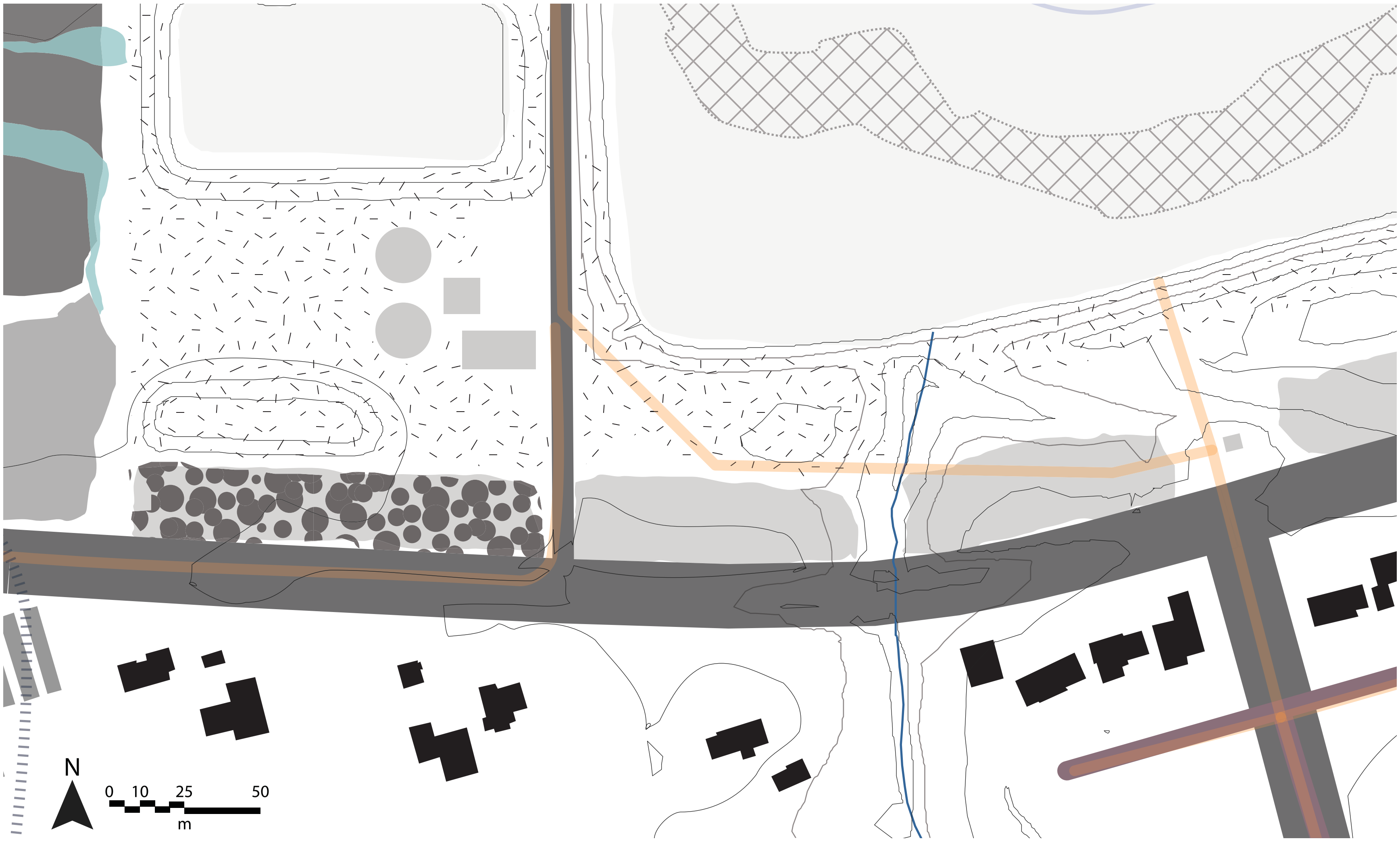
are expansions of the existing programs on the site. To expand upon the use of the library, the space adjacent to the woods are reading rooms. People using the space can enjoy an unobstructed view to nature, in a quiet and well lit space. The rooms to the south are breakout spaces for the community centre's physical fitness facilities. The rooms offer well lit and ventilated spaces for yoga or other exercises with views to the woods and agricultural fields beyond. The 'edges' for both spaces are again solar chimneys offering daylight and natural ventilation. The edges also mark the entries into each space. Services on site include washrooms for the reading rooms and change rooms for the yoga studios. This strategy, again, responds to the human needs, while reintroducing natural elements and mediates between the urban landscape and natural landscape for recreational users.

The Ravine Edge: A. Reading room; B. Yoga Studios; C. Bicycle rentals.

The Road

Existing Conditions

The road edge site is located at the existing WWTF. The site was chosen as it is easily accessible from the road and has direct access to the towns sewer lines. Furthermore, it is the prime location, as it is between the residential areas and agricultural land, which is essential as the amenities on the site are for both rural and urban users. Currently the lagoons occupy the majority of the space, and are surrounded by mowed fields, with a forested edge along the road to obstruct views to the WWTF. The site is currently inaccessible to the public; used for infrastructural purposes, it is off limits to the residents of the town even though it is surrounded by significant natural landscape.



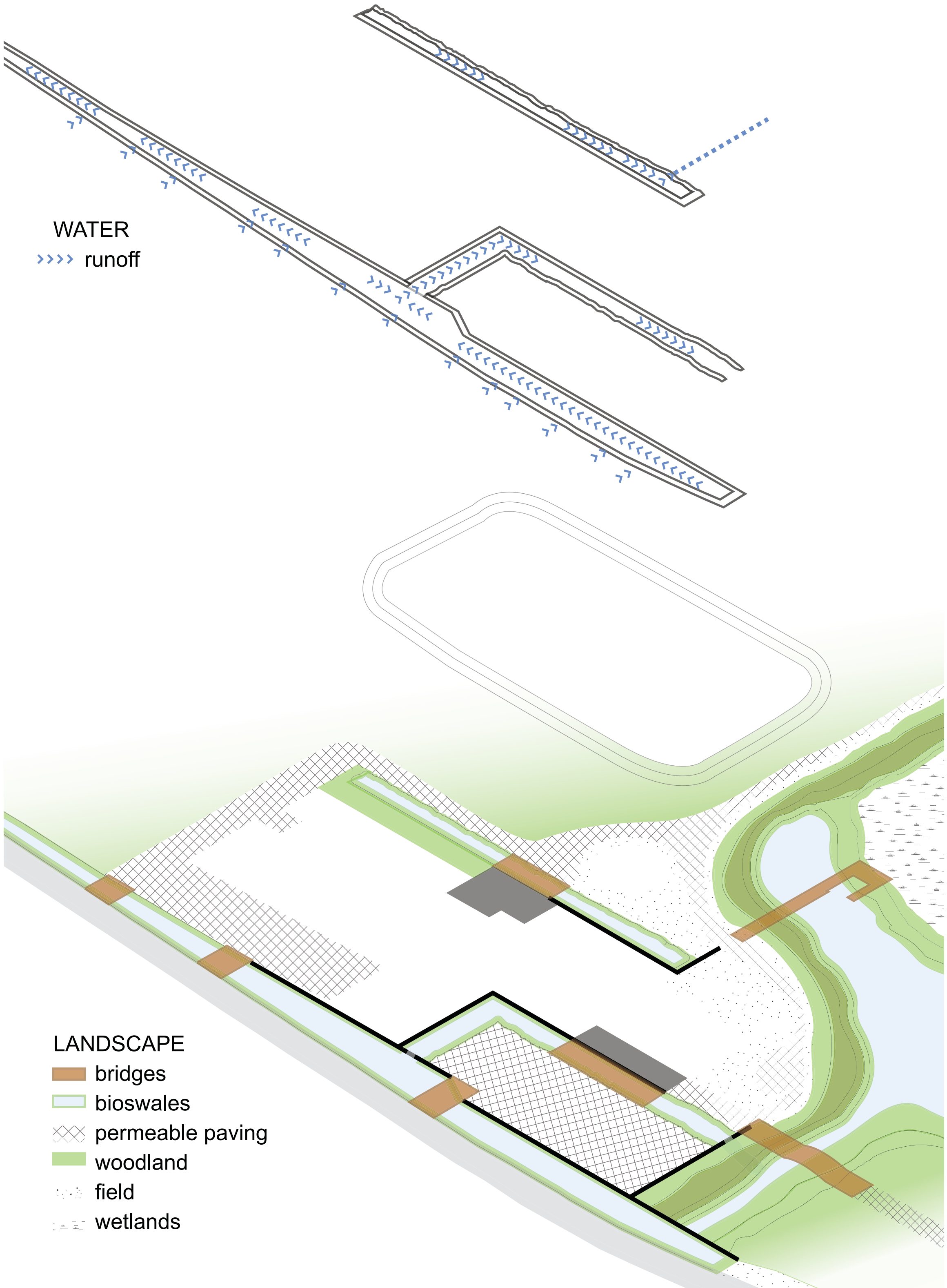
The Road Edge: existing site plan.

Proposed Road Edge Design

Instead of considering the site as a mono-functional landscape for infrastructural purposes, the design creates a multifunctional landscape composed of layers of infrastructural, natural and human flows. This design exhibits the most complex intersection of zones, edges, and flows, in which it engages in and/or mediates. Due to the complexity of the site and program, this section describes the design in terms of its natural, infrastructural and human landscape.

Natural Landscape

A driving influence for the design of the natural landscape was a nearby stream, offering a destination for waterflows. Bioswales collect runoff from the road and parking areas, filtering the water before it is discharged into the stream, while also managing peak storm flows. The stream is released into a human-made pond, which also receives treated effluent from the new disinfection facility. Surrounding the stream and pond are vegetated zones composed of local species found within the site, forming important habitat. Similarly, the bioswales are composed of local plant species that have the ability to thrive in waterlogged conditions. The new habitats would become incorporated into the existing ecology of the site. Even the parking spaces are considerate of natural processes; made of permeable pavers, the parking lots are able to manage runoff better than paved surfaces. Moreover, lines of trees throughout the parking lots also provides stormwater management, as well as shade for parked cars.



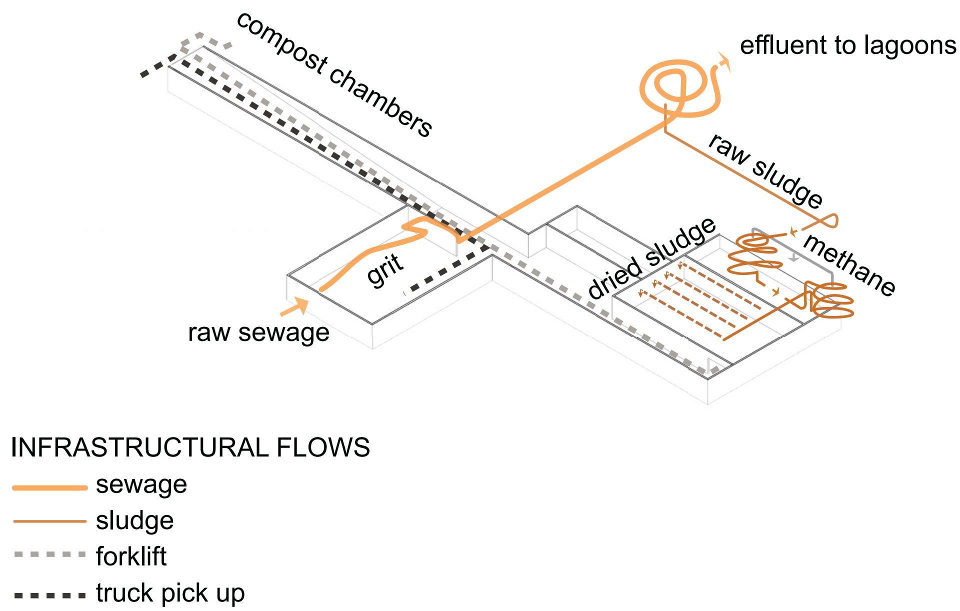
The Road Edge: axonometric drawing of the natural landscape showing zones and flows.

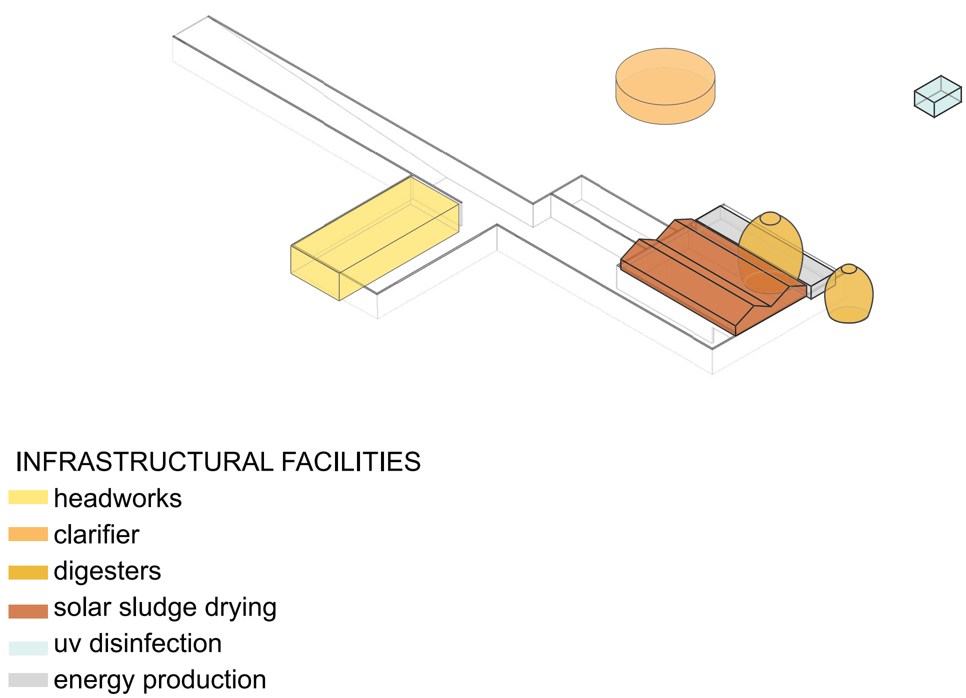
Infrastructural Landscape

The wastewater treatment begins at the ‘headworks,’ were raw sewage from Old Town NOTL and Virgil are pumped from the sewer lines into the facilities. The headworks is responsible for removing debris. Large debris is removed by utilizing mechanical bar screens. Next the wastewater goes through a grit chamber where smaller debris, such as sand and pebbles, are removed. The grit and debris are ground up, and held in a glass container above the headworks for visitors to view. Once full it is emptied into a garbage truck below, for disposal. Thus adjacent to the headworks is an area for truck pick up, which is accessed by a large ramp from ground level.

The next stage of wastewater treatment is the clarifier. The clarifier removes the sludge from the wastewater. The solids are then pumped into digesters, while the effluent is pumped to the farthest existing sewage lagoon. From the existing lagoon, wastewater is then released into the constructed wetlands for final treatment. The treated effluent is then disinfected by ultraviolet light at the disinfection facility adjacent to the wetlands.

The sludge is treated separately from the wastewater; it first is goes through two digesters to be thickened, stabilized and then de-watered. The digesters use anaerobic bacteria to breakdown the organic matter and during this process methane is produced. This methane is collected and used for combined heat and power, by way of a heat engine, turbine and generator. The heat is used for the facilities on site and the energy is used on site or sold to the grid. The stabilized sludge is then pumped onto two sludge drying beds. These drying beds are held within a greenhouse to increase the rate of drying and reduce public exposure. To also increase the rate of drying, the sludge is rotated by large mechanical screws. Once dried, the screws dump the dried sludge onto conveyor belts that transport the dried sludge into containers. These containers are manoeuvred by forklifts and placed into a compost chamber wall, where the sludge continues to dry to create usable compost. The compost is used at the facility or sold at the market.



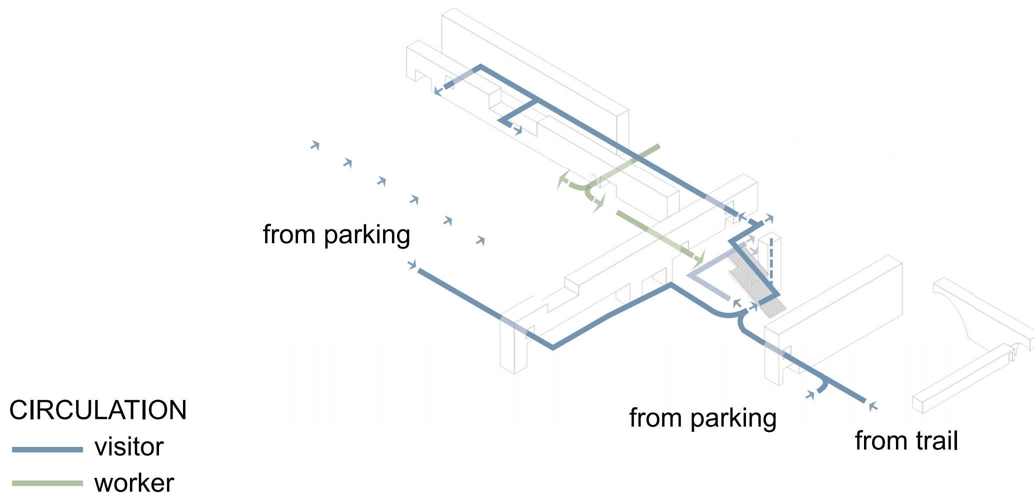


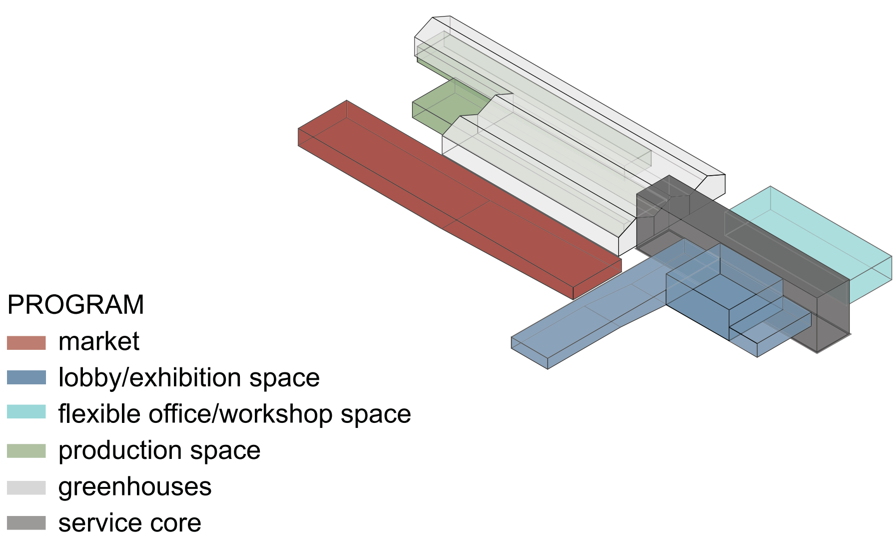
The Road Edge: axonometric drawing of the infrastructural landscape showing facilities and flows.

Human Landscape

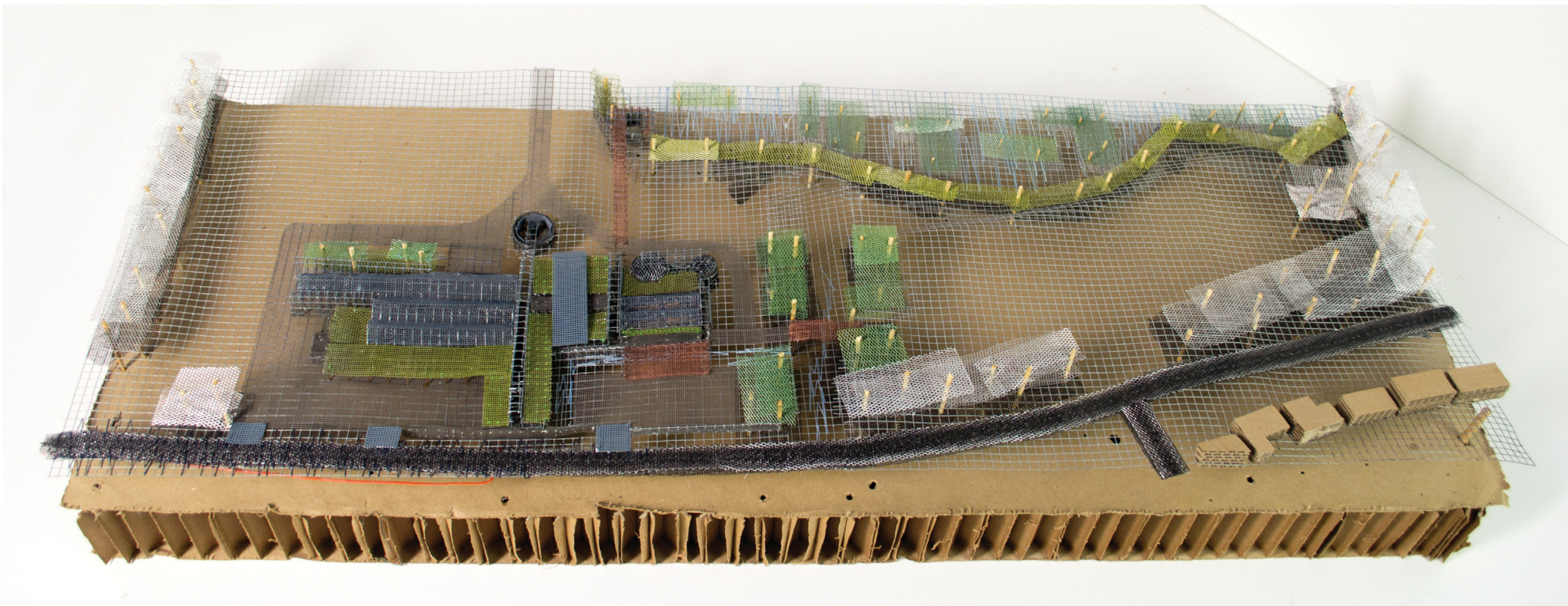
The program is based on the resources recovered from the wastewater treatment process, as well as on educational opportunities and providing amenities for the public. The space adjacent to the compost chambers is the production space, where the finished compost is bagged and packaged to be sold or used for potting plants. The plants are also potted in the production space and then grown in greenhouses above. The greenhouses grow native plants to encourage the idea of ecological friendly gardening. Furthermore, a large section would be devoted to growing wetland species to encourage the creation of wetlands for wastewater treatment throughout the region. The plants and the packaged compost are sold in the market space. This market space is also for local farmers and crafts people to sell their goods and produce, as currently in NOTL there is no such facility.

The other program spaces offer educational opportunities and community involvement. The main visitor space on the south side of the building is where visitors first enter the building, and thus, it is a lobby space with a welcome desk and exhibition space. The exhibitions provide visitors with information about the wastewater treatment or specifics about the site, such as its history or ecology. These exhibitions are curated by the program directors who work on site, doing research and running workshops for the community. The office space and workshops are located in the back half the building facing north, on the first and second floor. These spaces are large and flexible, making use of partitions to create small individual offices or larger spaces for school groups or community meetings. Both the exhibition space and flexible workshop/office space can be rented out for community events. These spaces are divided by a service core, containing washrooms, an elevator, the stairs and a kitchen for catering events.

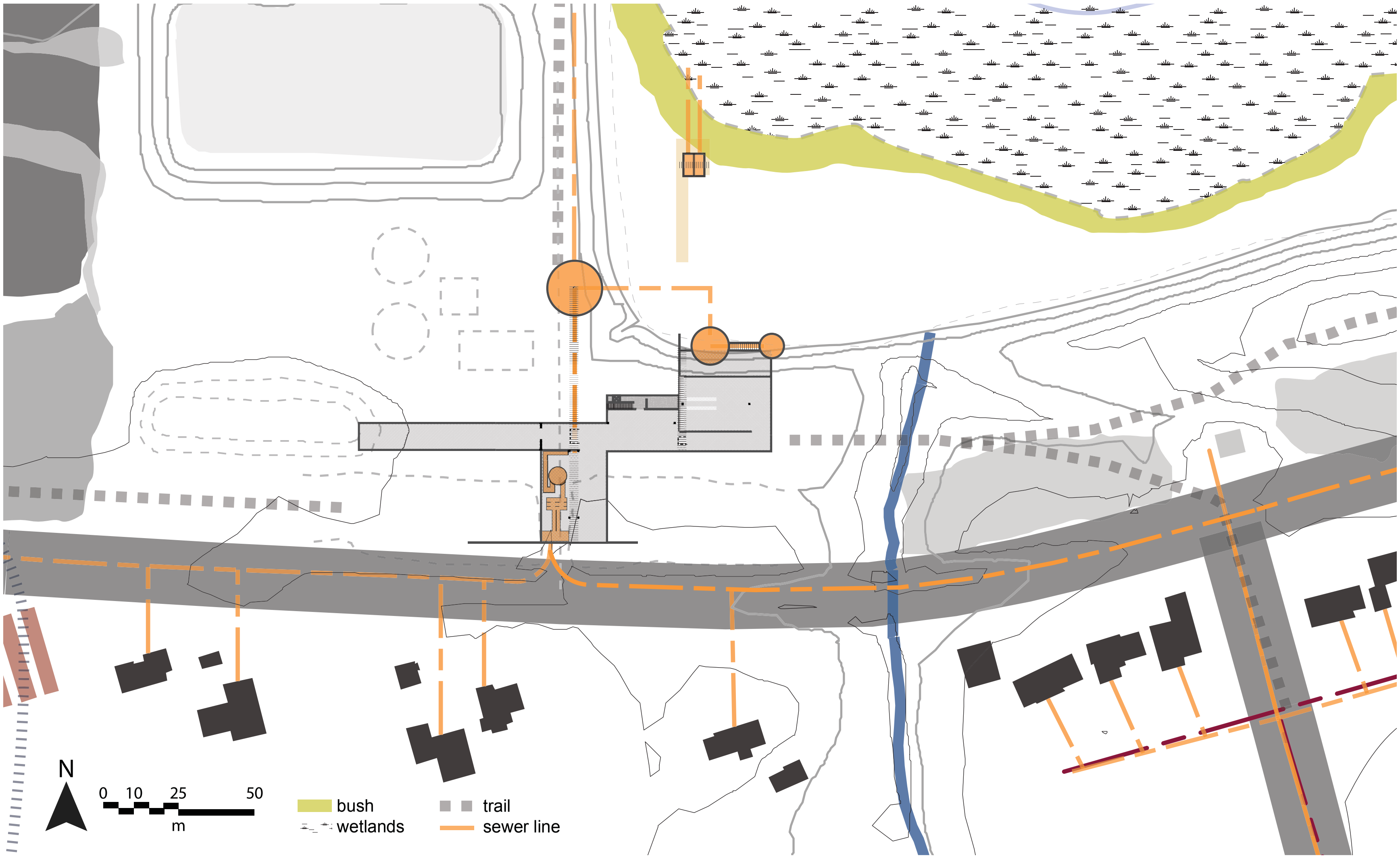




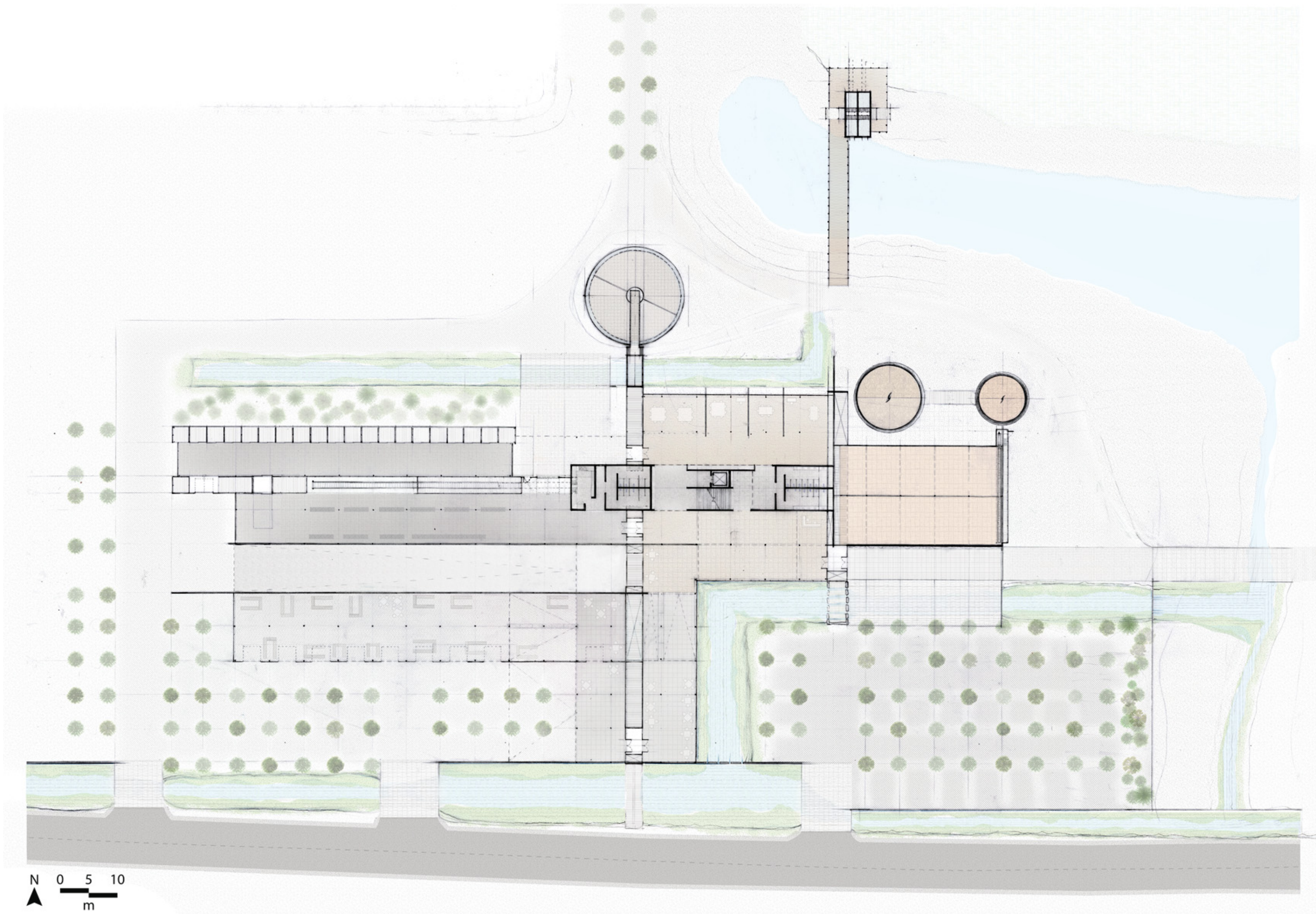
The Road Edge: axonometric drawing of the human landscape showing facilities and circulation.



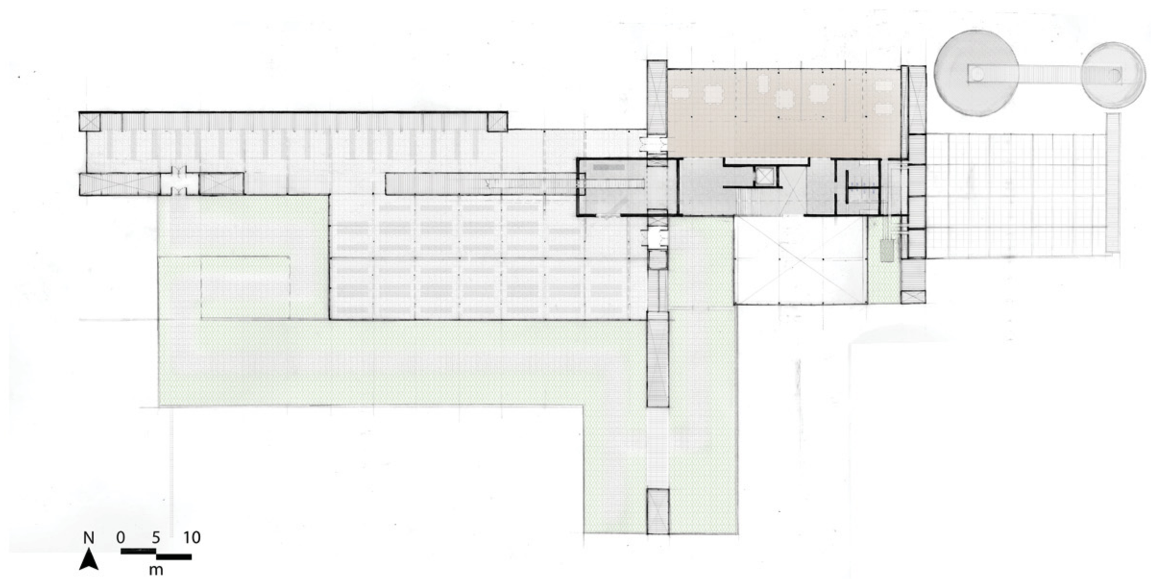
The Road Edge: site model.



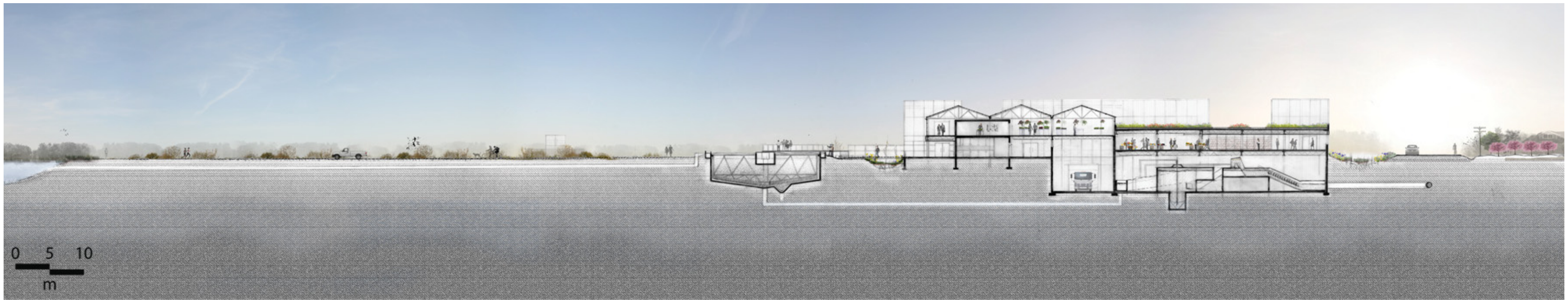
The Road Edge: basement/site plan..



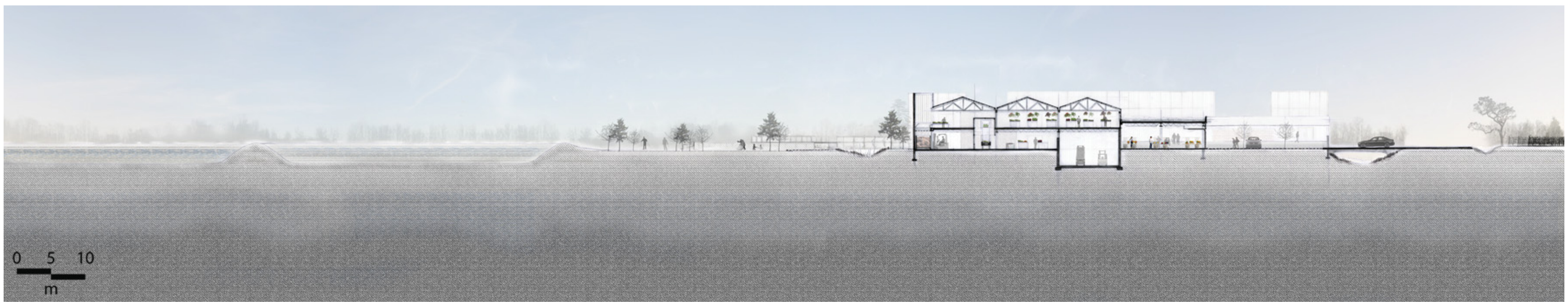
The Road Edge: ground floor plan.



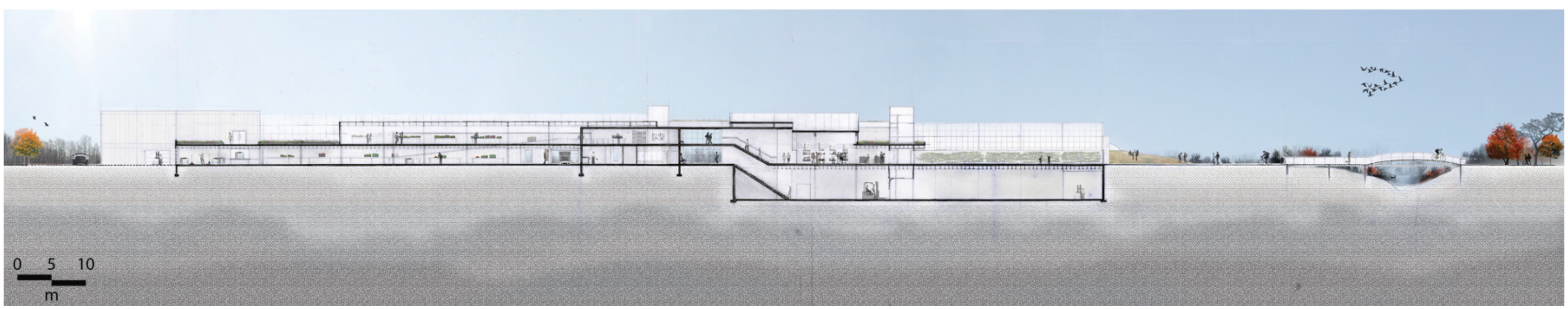
The Road Edge: second floor plan.



The Road Edge: Headworks/clarifier section.



The Road Edge: Market/greenhouse section.



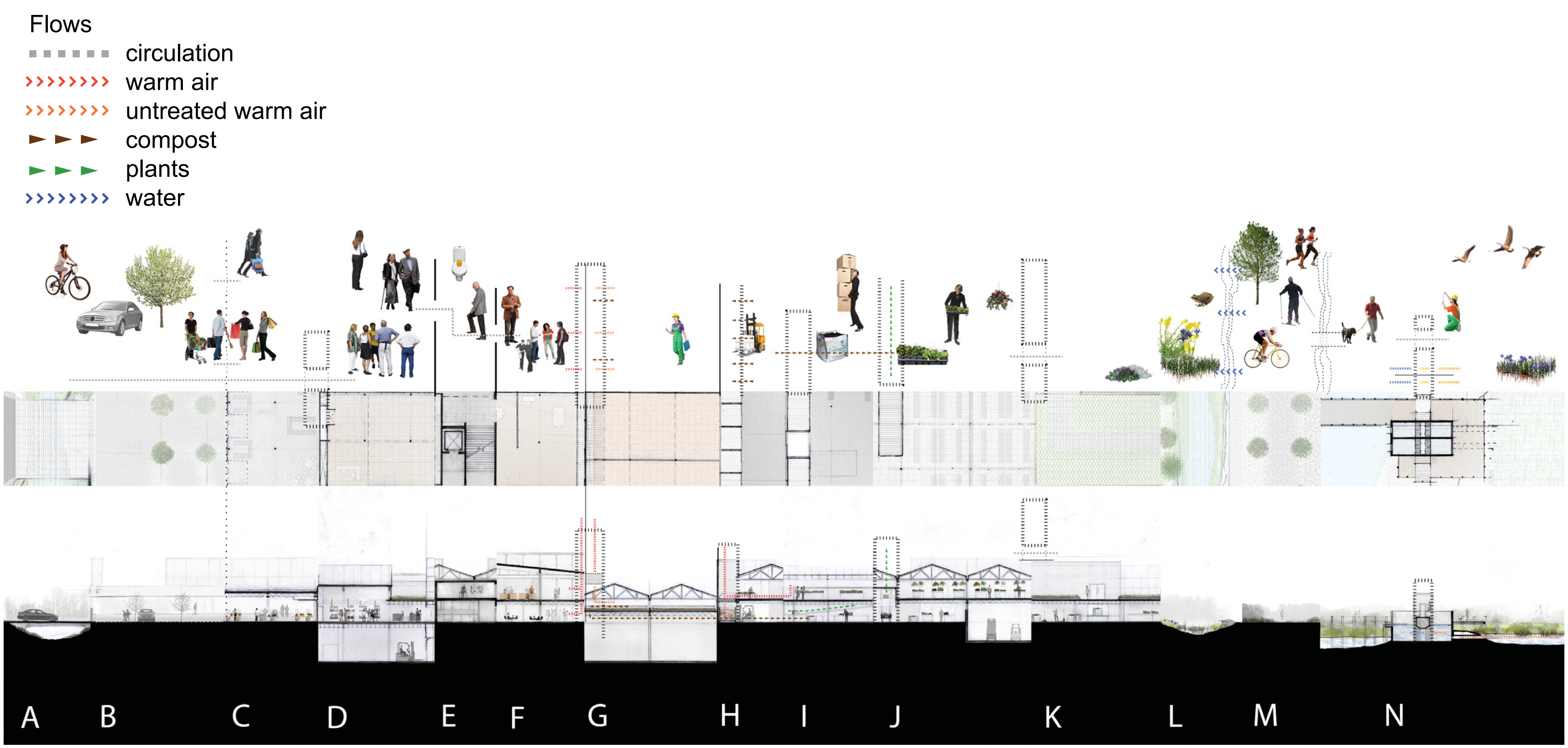
The Road Edge: East/west section.

Zones

Assembling the layers results is a dynamic facility, responding to the flows of the natural, infrastructural and human landscapes. The spaces or zones of the design facilitate in the human activities, wastewater treatment and ecological processes. Much like the ecological zones of the existing site, the various zones of the building and new landscape each function as their own ‘habitat,’ allowing for specific purposes to be carried out within the spaces. However, just as in the existing landscape, these zones also relate to each other and there are many varied interactions between the zones. The design responds to, and builds upon, the relationships between the zones, which begins to define a series of edges.

Edges

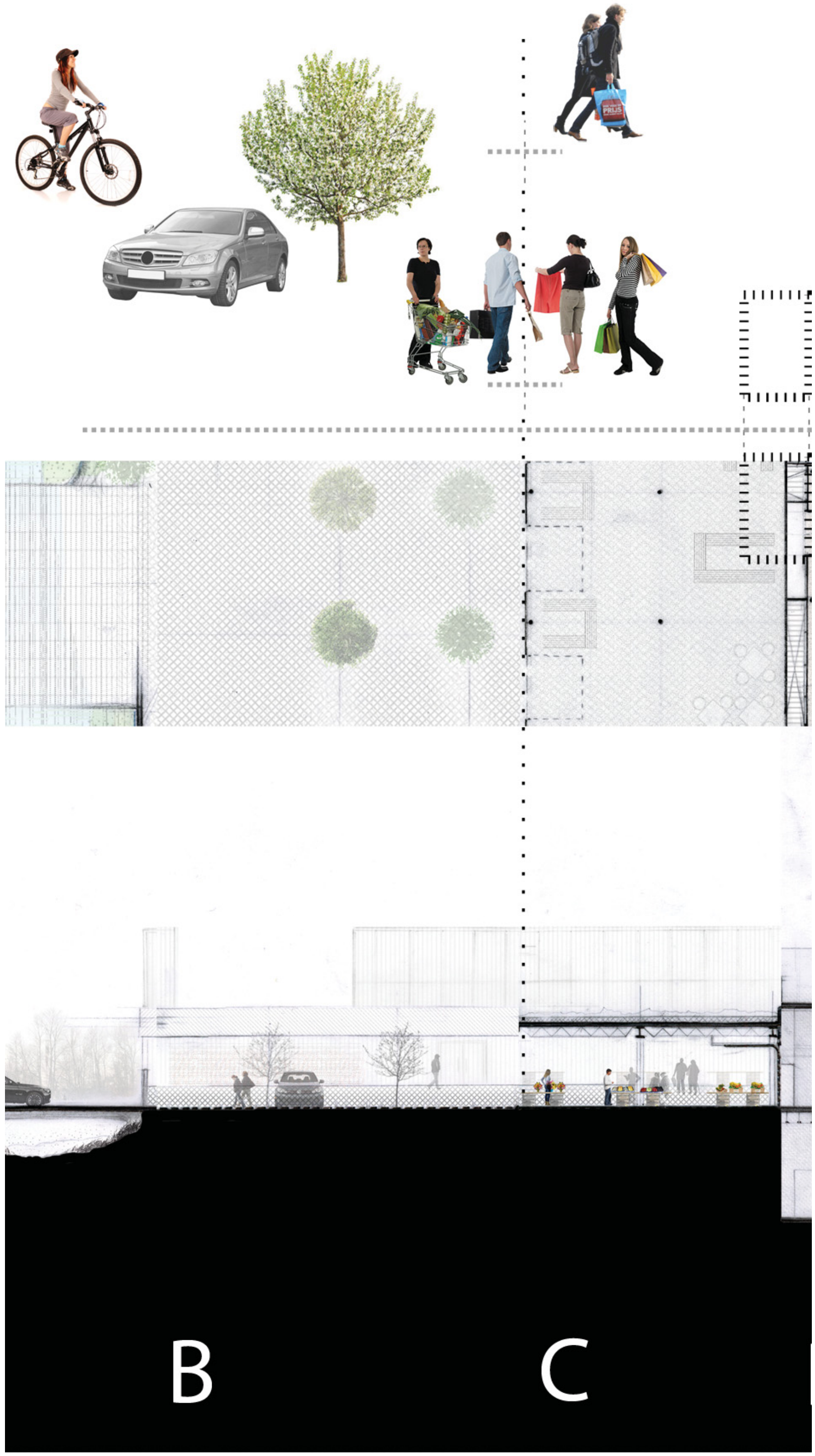
The characteristics of an edge varies depending on the relationship between the zones and the function required of the edge. An edge may be a curtain wall to allow for a visual connection, while protecting against the elements. An interior partition is also an edge, allowing for spatial segregation, perhaps for visual purposes, noise control or controlling human access. Each edge engages in a variety of different flows and its influence expands into the bordering zones. Most significant edges are were multiple flows converge. This next section describes several important edges of the design: market edge, compost chamber edge, production/greenhouse edge, disinfection edge and sludge bed edge.



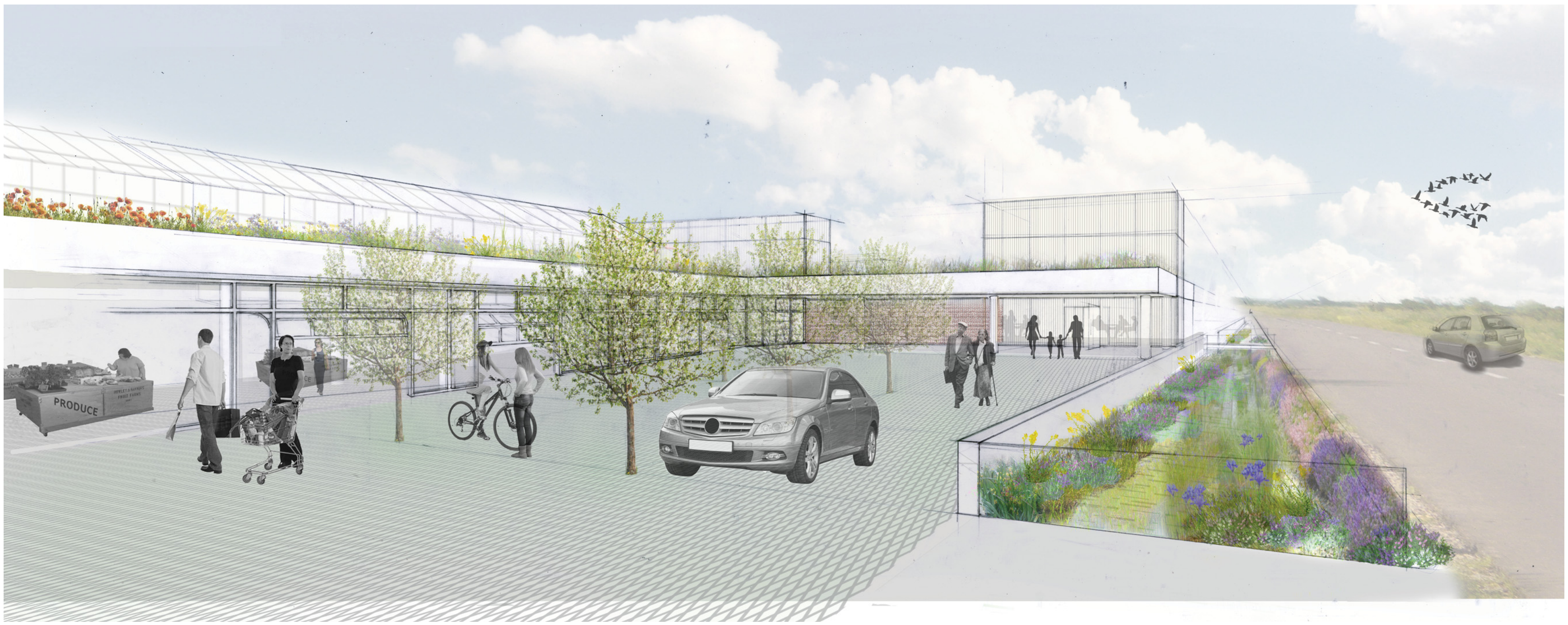
Zones and Edges: A. Bridge, B. Parking Lots, C. Market Space, D. Exhibition Space, E. Service Core, F. Flexible Workshop/office Space, G. Sludge Drying Beds, H. Compost Chambers, I. Production space, J. Greenhouse, K. Greenroof, L. Bioswales, M. Paths and N. Disinfection Facility.

Market Edge

The market edge functions horizontally and is an expansive, transformative edge. While the market edge is relatively simple, in terms of its form, it greatly facilitates the function of the market space. Along the south wall large openings are created by garage doors, allowing for easy loading and unloading for the vendors, and in the warmer months enables the market to expand into the parking area. This creates a lively street atmosphere, attracting more customers who are travelling along Lakeshore Road. Thus, the 'edge' or the line of the interior to the exterior, can transform, becoming less defined, almost seamless between the parking space and market space, weather permitting. To enable the expansive quality of this edge, the pattern of preamble pavers of the parking space continues into the market, only distinguished by becoming a solid floor made of the same pavers but interlocked. Also to indicate the separate space of the market and to provide shelter from the weather, a greenroof encloses the market space. The roof is supported by a series of columns, which are also used to delineate the smaller spaces within the market; they follow the same rhythm as the trees in the parking space. Again, this creates a visual connection between the two spaces, and adds to the horizontal and expansive quality of the market edge.



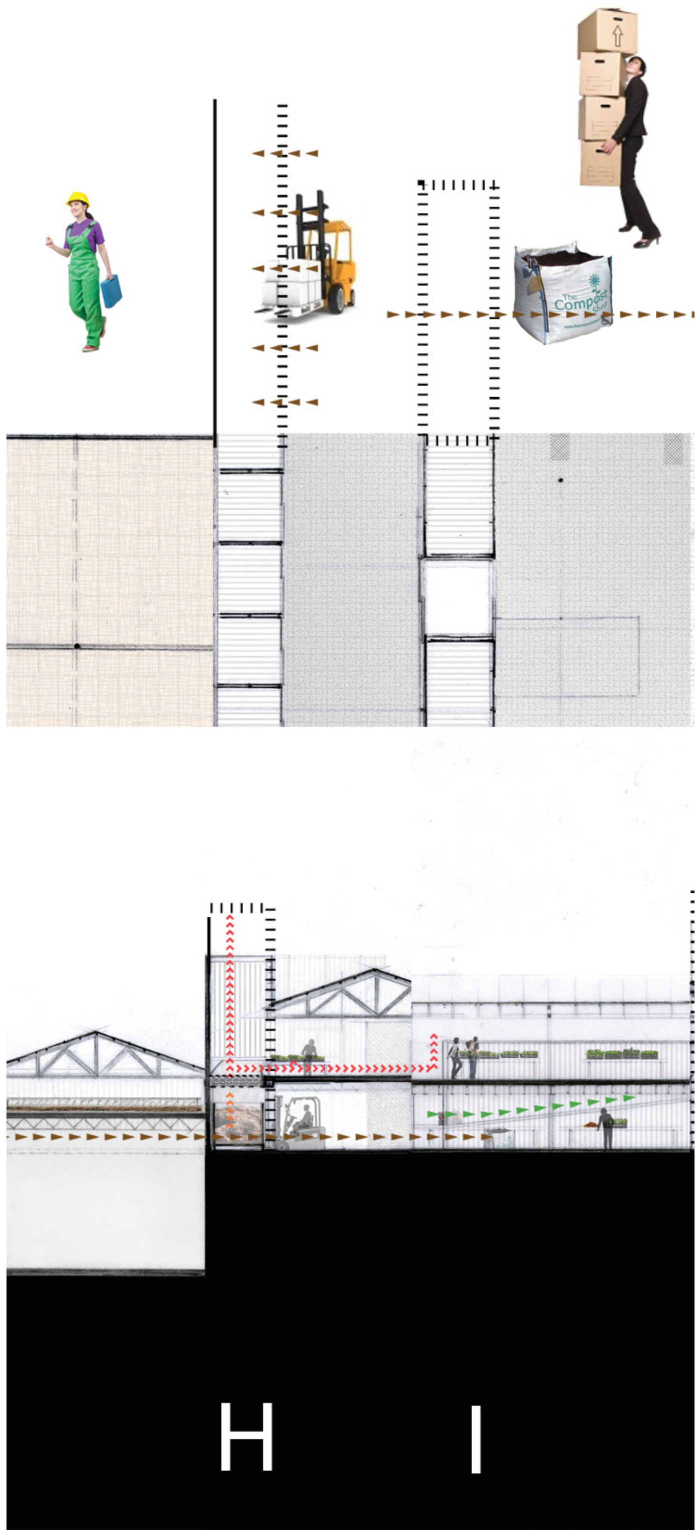
Market space and edge.



View of market, parking space and entry above the headworks. The market opens up into the parking space to allow it to expand, and engage with the activity of the road. Visitors can also enter the main part of the building from this parking lot through an edge. As they do so, visitors can view the grit and debris container, which shows what ends up in the wastewater system. This edge teaches people to be more responsible with what they flush down the drain.

Compost Chamber Edge

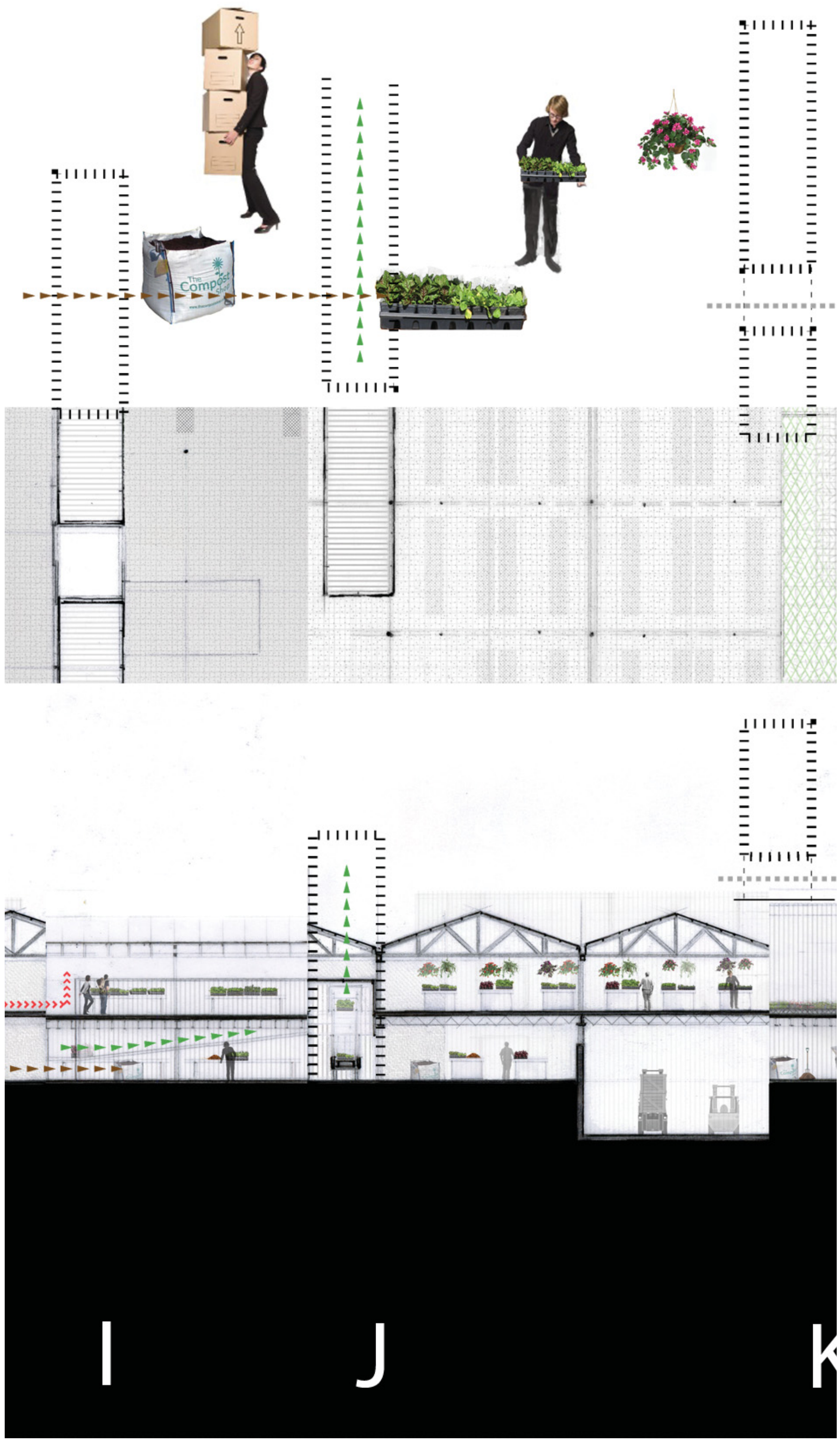
The compost chamber edge is a more defined edge and functions primarily vertically. It houses the compost in containers throughout the various stages of the drying process. This edge also facilitates recovering various resources from the production of compost, such as heat and carbon dioxide. Both of these, along with the compost, are supplied to the greenhouse. The warm air from the compost is drawn up within this edge, creating a transition area where the 'edge' functions as a solar chimney. As the warm air moves up it passes through biofilters, which are responsible for treating the air and mitigating the smell of the drying compost. This warm air is also rich in carbon dioxide, which is an important factor for the growth of plants. Thus, the waste of the drying compost becomes an asset for the greenhouse. In the hot summer months, this edge, acts as a solar chimney passively ventilating the greenhouse space.



Compost chamber zone and edge.

Production/greenhouse Edge

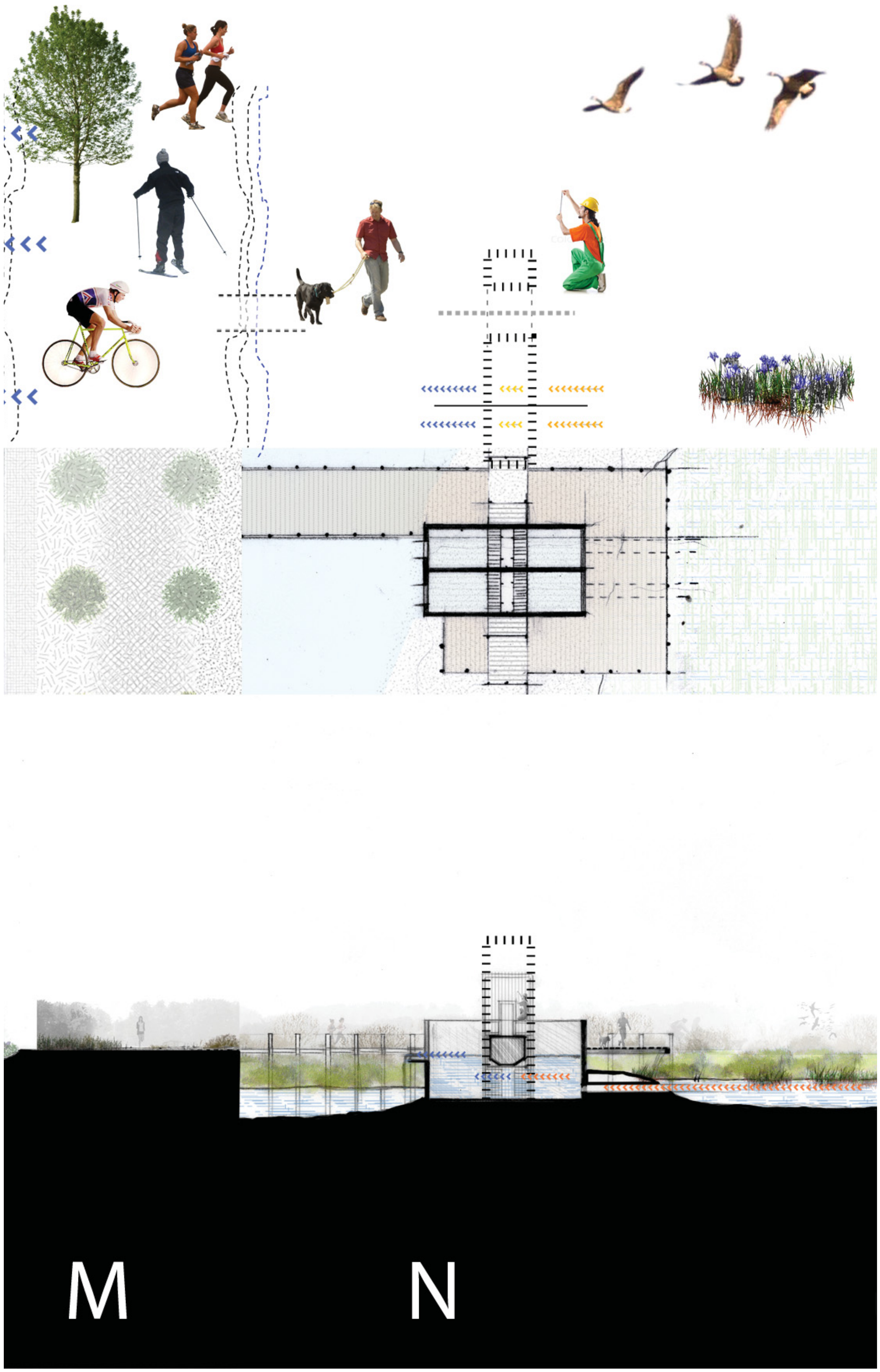
The edge between the planting/packaging production space and the greenhouses functions primarily in a vertical manor. It facilities the movement of the plants by a conveyor belt, from potting and then up into the greenhouse. This same edge also contains a loading dock and intersects with the packaging and distribution of dried compost. At certain locations this edge also functions as a solar chimney to passively ventilate the production space and as a light well for daylighting. This edge is also a point of overlap between the infrastructure, the workers and the visitors as they engage in the resources recovered from the wastewater treatment process.



Production space and greenhouses.

Disinfection Edge

Out in the landscape, at the edge of the wetlands is the disinfection facility. This edge, horizontally, divides the effluent of the wetlands from the final stage of treated water. Within this edge are ultraviolet lights, which are used to disinfect the effluent by killing bacteria. The treated water can be seen falling from the facility into a human-made pond. Visitors can walk an elevated path leading to the disinfection facility and cross through the edge onto a viewing platform. This edge also separates the visitors from the equipment, while providing working space for the facility operators.

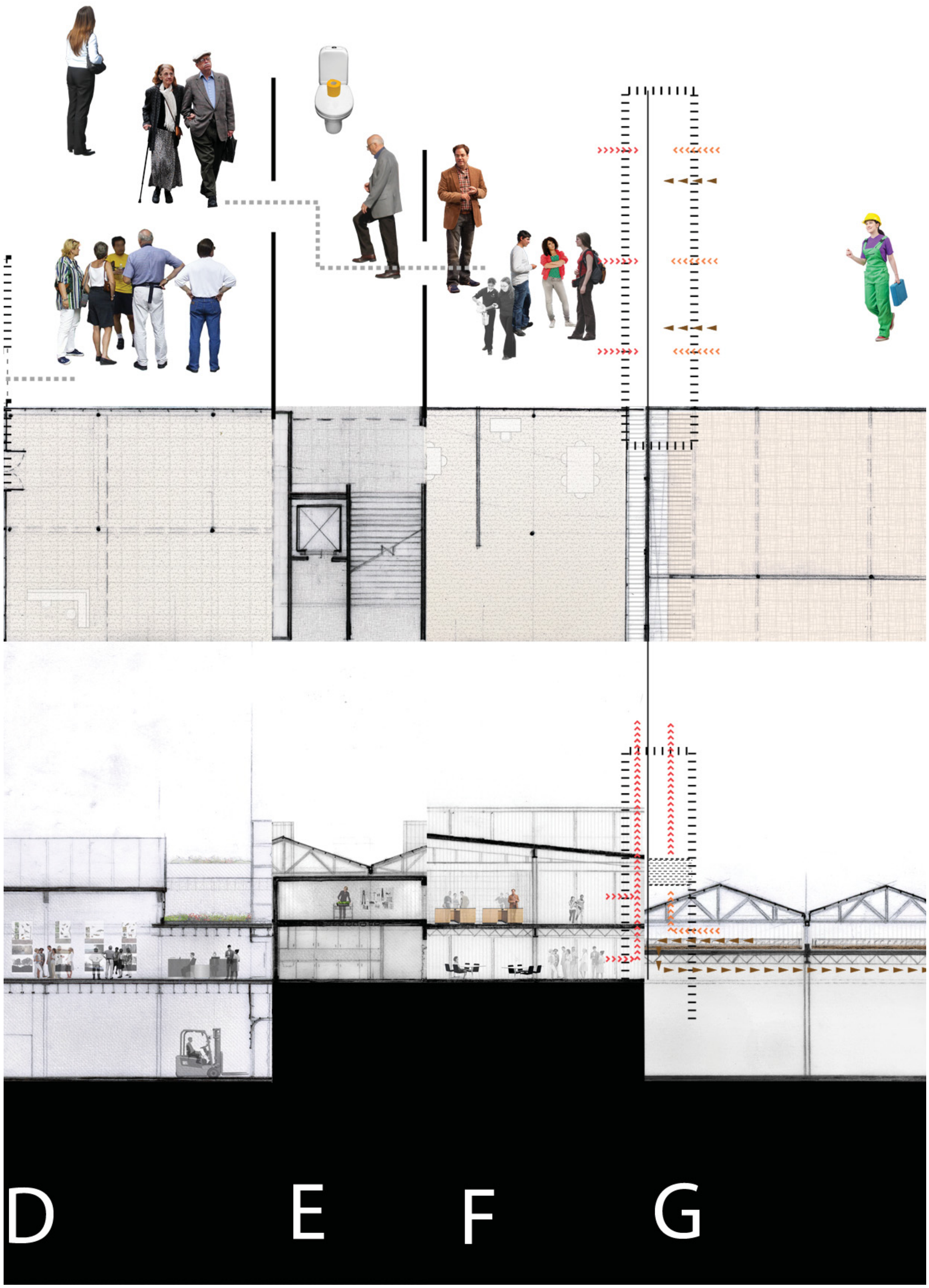


Disinfection facility and edge.

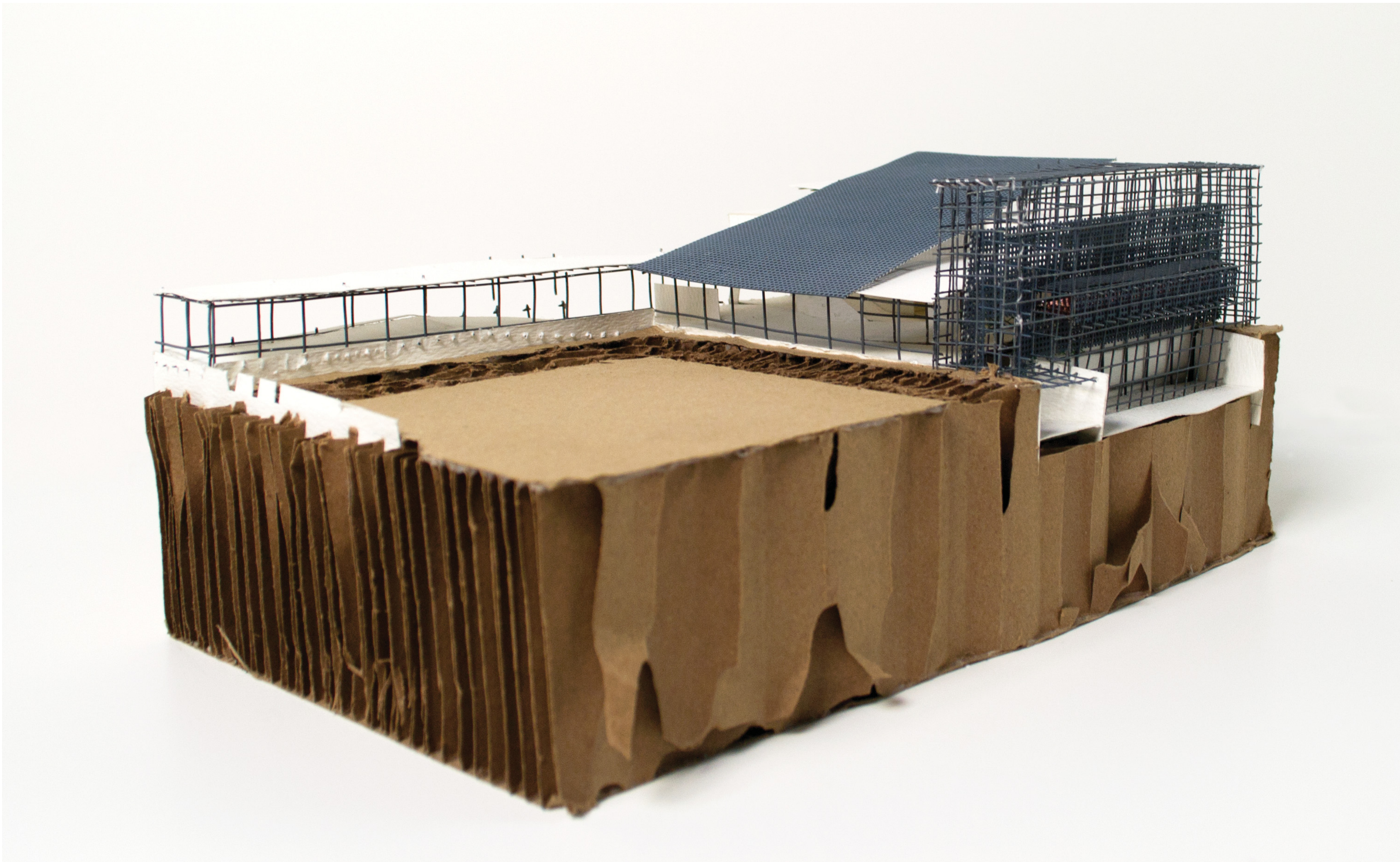
View of landscape from the second floor workshop space. The space is used for workshops or can be further divided up to become office space. The workshops are educational opportunities for the public to learn about environmentally responsible yard care, gardening and water management. The space could also be used by other community groups, such as day cares and art classes. The view is of the constructed wetlands and park space, as well as the disinfection facility. Visitors can see the clean water falling from the disinfection facility into a human-made pond.

Sludge Bed Edge

Similar to some of the other edges, this edge, bordering the sludge beds functions as a solar chimney. Thus, it too functions primarily as a vertical edge. Hot air from the sludge beds is drawn into the solar chimney and passes through biofilters, which treat the air. This edge is also a buffer between the sludge beds and public spaces, including exhibition space, washrooms and workshop/office space. For cooling the solar chimney also draws stale air from these spaces, providing passive ventilation. For heating, the hot air from the sludge bed passes through the edge into a heat exchange unit to preheat incoming fresh air, which is then directed to the greenhouse and other spaces in need of heat. Due to the humidity of the sludge beds, water also condenses within the edge on condensing rods. The water is collect and used to irrigate a wall of apple trees and the plants in the greenhouses. Also within this edge, the dried sludge is placed onto conveyor belts to be transported to compost containers. The main entry into the building passes through this edge, and visitors can stop and observe these processes.



Sludge bed edge: D. Exhibition Space, E. Service Core, F. Flexible Workshop/office space, G. Sludge Drying Beds.



Sectional model: shows the ‘edge’ at the sludge bed and part of the exhibition space, service core and flexible workshop/office space, The main public spaces are under a shed style metal roof, slanted towards the south to allow for solar collection and to direct rain into the bioswale below.

View from within the sludge bed edge at the main entry. Visitors may simply pass through the edge or stop to view the sludge bed. Within the edge, is a framed view of the processes occurring. Visitors can see the sludge drying and being placed on conveyor belts, as well as water condensing and being collected to irrigate a wall of apple trees. Visitors also get a sense of the vertical quality of the edge on the other side, where it cuts through all the floors, from the roof to the basement, this allows the edge to function as a solar chimney and a light well.

CHAPTER 5: CONCLUSION

Whether natural, human or infrastructural, landscapes are formed by processes. By using the ideas of landscapes and ecological principles, as a framework for built structures, architecture can be considered as formed by processes as well. Design needs to not only consider the function of the spaces or zones within, but also the relationship between the spaces and between the spaces and the site, in terms of human movement and natural flows. The result is a responsive and dynamic design that is capable of relating diverse programs to each other and to the site. With infrastructure, these relationships become even more complex as there are hazards to consider. Yet, pairing infrastructure with other uses creates a symbiotic relationship, where the resources of the infrastructure are harnessed to support other uses, such as heating a greenhouse or creating compost.

By recovering the resources from the infrastructural system, other benefits of infrastructure are highlighted. This challenges the conventional notion of infrastructure as strictly utilitarian and meant to be kept out-of-sight. Instead infrastructure can be seen as an asset to a community. Furthermore, exposing the infrastructure to the public creates other educational benefits:

> These projects can become public places of cultural understanding and symbols of the evolving relationship among natural landscapes, industrial expansion and engaged society. (Singer, Cruz and Bregman 2007)

Thus, placing these facilities in-sight and making visible the positive aspects they provide can generate enthusiasm within a community, rather than opposition to infrastructural projects, which is the scenario currently occurring in the town of Niagara-on-the-Lake.

The current proposal by the town of NOTL for the WWTF is to place it further from the residential neighbourhoods and segregate the facility from the rest of the site (See Appendix A). This thesis has provided another alternative, one that considers the WWTF of NOTL as an essential element in the landscape, not only in terms of the service it provides, but also as a facility that responds to the needs of the community and is used as a educational tool. By incorporating the WWTF within a larger parkland, residents can appreciate the larger role it plays within the site and the town.

All together, the orchestration and relationships of flows, between the various zones and across edges, comprises the essence of this new landscape, and how the ‘new landscape’ and architecture relates to the existing site. Each design site responds to a different set of flows, movements and interactions ranging from human-natural, infrastructural-human and infrastructural-natural. Thus, each site offers a different understanding of the relationship between the layers of zones, flows and processes. The design was a process of relation building between the layers, in which the edge becomes an important tool. It is the edges that define the relationship between site, infrastructure and community.

The next step is to apply numerical data to the infrastructural system to highlight its potential and viability. This would give an understanding to the extent of influence this project would have on the community. The data would also provide a sense of the capacity of the wastewater treatment facility. However, this thesis considers this WWTF as the first step in upgrading the wastewater treatment of the town. It will provide the amenities to decentralize the wastewater treatment system by growing wetland plants for future constructed wetlands. As the town grows it should be mandatory that each new development treat its own wastewater by way of wetlands, which are integrated into a similar park system and respond to the specific site and the surrounding community. A series of these ‘new landscapes’ throughout the town would certainly begin to make visible the inherent interconnectedness of humans, nature and infrastructure.

APPENDIX A: NOTL WASTEWATER SYSTEM

Facility Description

A report published in 2008 by the Niagara Region outlines the existing plant in Niagara-on-the-Lake and its current operation. It services a population of 6500, over approximately 478 ha, in the north east are of the town, including Old Town, Garrison Village and Virgil. The facility receives direct flows from forcemains from three pumping stations within the town. The wastewater is pumped into two aerated lagoons, in series and then two stabilization ponds, in series. Effluent is polished and phosphorous removed by utilizing alum in a solids contact clarifier. Effluent is then disinfected using hydrochloride and dechlorinated using sodium bisulphite before being discharged into Lake Ontario (Niagara Region, 2008).

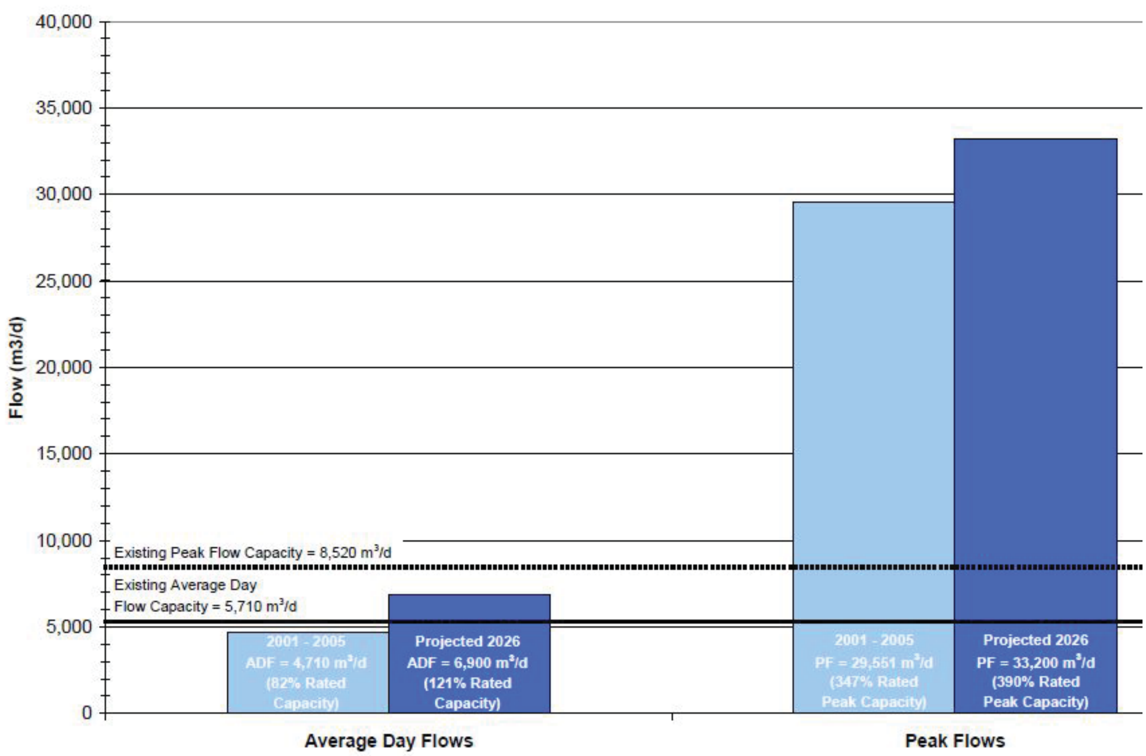
Current Operation

The facility is operating at 84% of its rated capacity of 5710 cu.m/d. However, it receives a high ratio of peak flows to the average day flow, due to wet weather flows. The peak flow capacity is 8520 cu.m/d, and if exceeded the stabilization ponds are used to buffer peak flows, minimizing the need to bypass into Lake Ontario. While the facility is considered adequate, the adjacent residential neighbourhood complain of odours from the lagoons during hot summer months (Niagara Region, 2008).

Aerial view of NOTL WWTF. (Google Earth 2012)

Projected Operation

The population for the service area is forecast to increase by 40% (4200 people) by 2026. The projected capacity must then be 6900 cu.m/d. Thus, the rated capacity will be exceeded by 2013-2014. Several options for upgrading the facilities exist, the town has chosen to either use the existing location for the new facility or find another site on the Lakeshore Road property, owned by Parks Canada (Niagara Region, 2008).



Current and projected flows for wastewater service area of NOTL WWTF. (Niagara Region 2008)

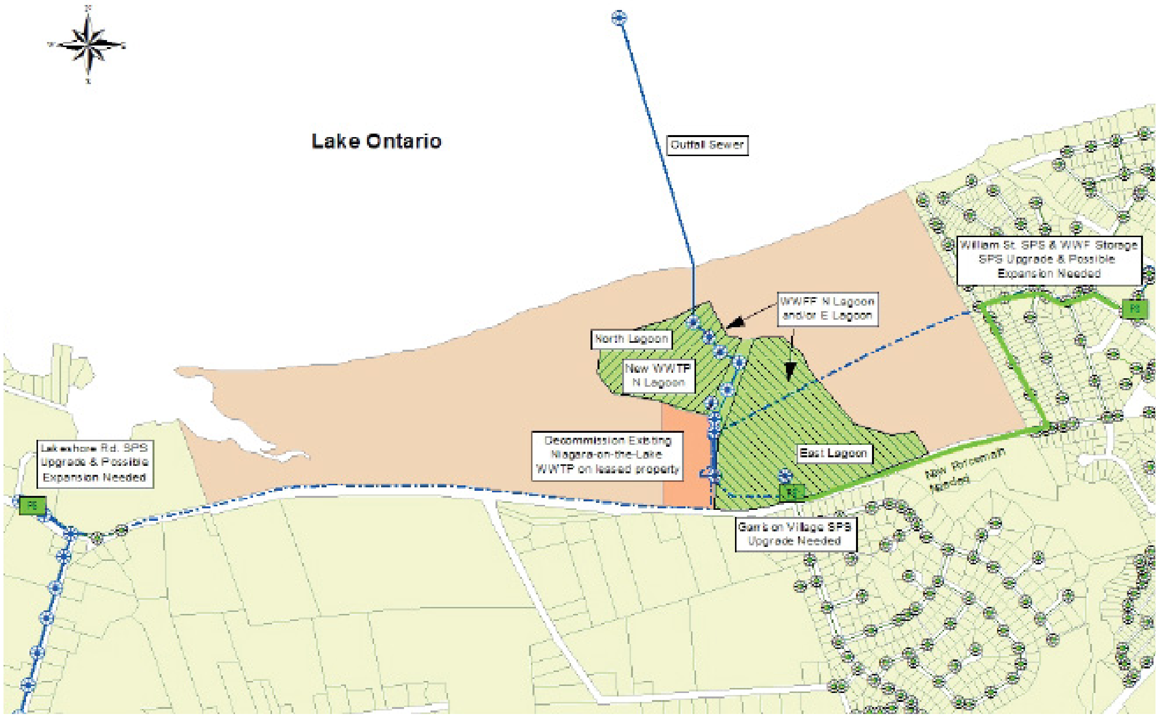
Proposed NOTL WWTF

Currently a study by the Niagara Region (2012) is being done to decide on the best option. The study was first a Schedule ‘C’ Municipal Class Environmental Assessment and is now a Harmonized Federal/ Provincial Environmental Assessment. The target operating capacity for the new facility is 8000 cu.m/d, to provide service up to at least 2031. The criteria of the study were:

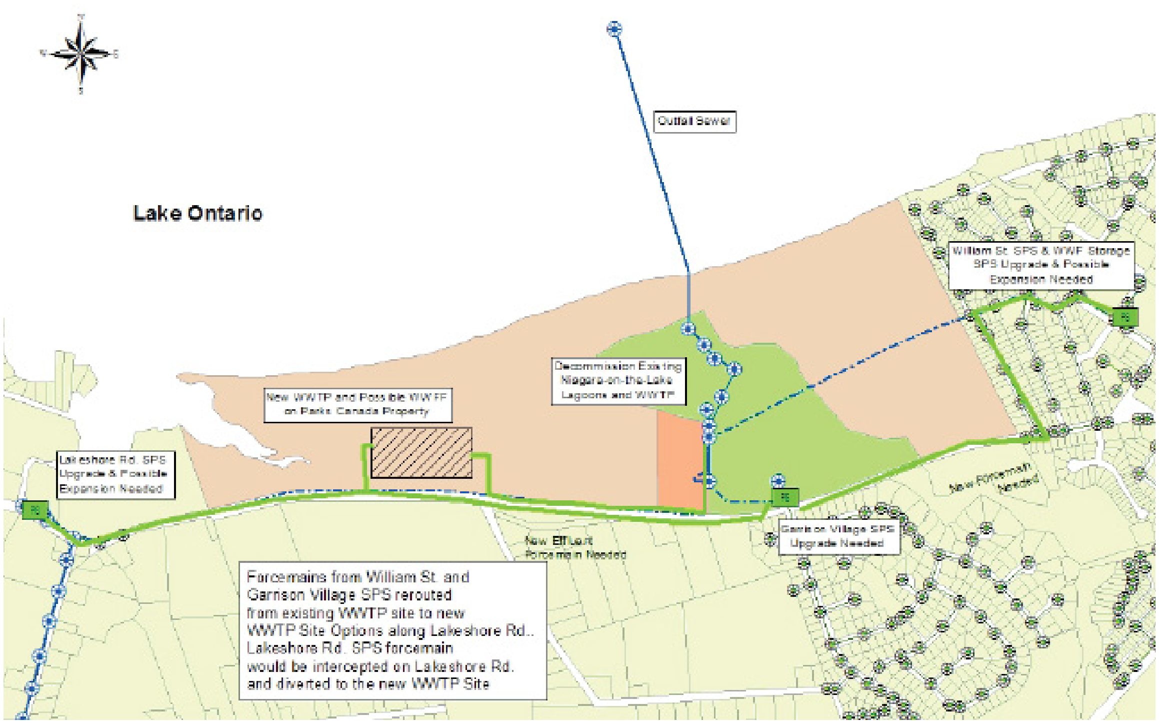
- socio-economic investigation
- natural environmental investigation

- archeological and build heritage investigation
- effluent outfall inspection and aquatic habitats assessment
- Engineering Investigations of Existing Conditions including Flows and Loadings, Effluent Requirements, Geotechnical Investigations, Environmental Site Assessments
- Screening of Long-List of Alternative Solutions, Selection of Two Short-Listed Solutions, Evaluation of Short-Listed Solutions, Selection of Preferred Solution

The study focused on two sites, alternate 2a(location of existing lagoons) and alternate 3a. The study concluded that site 2a is less desirable as it is closer to the residential areas and would impact the future use of the site as a parkland. Moreover, the placement of this site is close to areas containing species-at-risk. However, it is the least costly option. The preferred site is 3a, as it is further from the residential areas and allows for a buffer between potential parkland and the new WWTF (Niagara Region, 2012). However, within the site selection are Provincially Significant Wetlands, which are important breeding zones for chorus frogs. There are plans to mitigate the impact on the wetlands, however the option clearly favours the needs for humans.



Alternate 2a NOTL WWTF. (Niagara Region 2012)



Alternate 3a NOTL WWTF. (Niagara Region 2012)

Proposed 10 Acre site for Alternate 3a. (Niagara Region 2012)

Limits of the Study

The options provided by the study limit the possibilities for creating a WWTF that mitigates impacts on the natural environment. The study considers the WWTF as a blight on the community, as oppose to considering it as an integrated element on the site and within the town. Placing the plant in the area of forest regrowth and on Provincial Significant Wetlands does affect species-at-risk and will disrupt a very fragile ecosystem. Moreover, the forest should be allowed to regrow. Large built structures should be limited to areas already altered and occupied by humans. While this would require placing the facilities closer to the residences, steps can be taken to ensure residences see the infrastructure as a positive element on the site.

APPENDIX B: ARCATA MARSH AND WILDLIFE SANCTUARY

Project Description

Arcata Marsh and Wildlife Sanctuary is an integral part of the wastewater treatment process for the town of Arcata, California (population roughly 17 300). Arcata's wastewater treatment facilities have become an international model for appropriate and successful wastewater treatment utilizing wetland enhancement technologies. Moreover, it is an example of a community initiative for large-scale infrastructure.

The community and city of Arcata had a vision of how infrastructure could make use of the natural processes occurring in wetlands to treat wastewater. Their exploration began in 1969 with wastewater aquaculture projects, which were successful in raising Pacific Salmon and Trout in mixtures of partially treated wastewater and seawater (United States 1993). This initial project "demonstrated that wastewater was a "resource" that could be reused and not simply to be viewed as a disposal problem" (United States 1993). Moreover, the city proved that a constructed wetland system can be a cost efficient solution for treating wastewater. Due to the need to change their wastewater treatment methods, the wetland systems were completed in 1986. Today the system includes built facilities for primary treatment, sludge treatment and disinfection. However, the treatment process continues to evolve as the city continues to search for the best methods for wastewater treatment, which are cost effective and energy efficient. Moreover, the site receives over 150 000 visitors for recreational and educational purposes (United States 1993).

Aerial view of the marsh with wastewater treatment plant near the far upper right corner of image. (Arcata Marsh Overview 2008)

Wastewater Treatment

Considering the small size of city of Arcata and the success of the wastewater treatment facilities, Arcata provides insight for a viable option for wastewater treatment for other small cities. The steps for wastewater treatment can be adapted to suit any municipality's needs and the specifics of a site. The treatment process is described step-by step on the Arcata's Wastewater Treatment Plant and the Arcata Marsh and Wildlife Sanctuary website created by Prof. Dustin Poppendieck, as part of a class from Humboldt State University in 2008.

Primary Treatment

The first step for modern wastewater treatment is primary treatment, which removes solids that are suspended in the wastewater.

Headworks: The headworks is where the raw sewage from the town enters the facilities. Arcata uses screw pumps to lift the sewage from the sewer lines into the headworks. Next the raw sewage passes through bar screens to remove large debris. Smaller debris such as sand and pebbles are removed at the next stage by a grit separator. The debris and grit are collected and taken to the landfill.

Clarifier: The next stage of primary treatment is the clarifier. At this stage suspended material that remains in the wastewater is settled out. Heavier solids settle to the bottom of the tank and are removed, while scum and floating solids are skimmed off the top. Two clarifiers are used; the second and smaller clarifier is for backup during peak wet weather flows.

Sludge Treatment

Sludge is treated separately to reduce the amount of organic matter and the number of disease-causing microorganisms present in solids, and to de-water the sludge into a usable form, compost.

Digesters: Solids removed from the clarifier are sent to the digesters that utilize anaerobic bacteria to break down the solid waste. During this process methane is produced and harnessed to heat the primary digester. Two digesters are used at Arcata to decompose the solids into sludge.

Sludge Beds: Sludge is pumped into two sludge beds, where it sits for six months to dry. These beds are outdoor, covered rectangular boxes, which are four feet deep at the centre. The floors slope to the centre to allow water to drain as the sludge dries. The sludge is dried for easy transportation and for making compost.

Compost Piles: Once the sludge is dried it is placed in compost piles and mixed with other organic matter. The compost is used for fertilizer in city parks and considered Class-A exceptional quality biosolids.

Secondary Treatment

Secondary treatment is designed to degrade the biological content of sewage and further remove solids, toxins and nutrients found in wastewater.

Oxidation Ponds: Following the clarifiers the wastewater, is pumped into a series of oxidation ponds. The ponds reduce the biological oxygen demand (BOD) and further settle out solids. They are designed to allow for algal growth, which introduces oxygen into the water. The oxygen allows aerobic bacteria at the surface to breakdown the organic matter in the wastewater; while anaerobic bacteria, toward the bottom of the ponds, break down the settling solids. Flora also help to extract nitrogen and phosphorus.

Treatment Wetlands: The treatment wetlands remove the remaining pollutants found in the wastewater. The biological processes occurring in wetlands remove some levels of nitrogen, phosphorus and heavy metals without the need for chemicals or machines. At Arcata, water from the oxidation ponds is then slowly moved through the wetlands, which are completely covered in aquatic plants, such as Cattail and Hardstem Bulrushes. The plants assist in the absorption of nutrients, metals and organic compounds. The aquatic environment and roots serve four functions: one is to provide a surface area for micro-organisms to grow, which convert chemical compounds and uptake nutrients such as phosphorus and nitrogen; second function occurs on the roots in the water where anaerobic micro-organisms convert nitrogen to ammonia and ammonium; third function is to allow aerobic micro-organisms to convert ammonia to nitrate, which is taken up by the plants; lastly, the fourth function is for phosphorus extraction, as phosphorous is taken up by the plants and bound to the soil.

Disinfection

The final stage of wastewater treatment is disinfection, which kills any bacteria found in the treated wastewater before being released into the marshes and nearby Humboldt Bay. Arcata uses chlorine for disinfection, however they are conducting a study to determine if UV disinfection, which kills bacteria using ultraviolet light, is more appropriate for their facility.

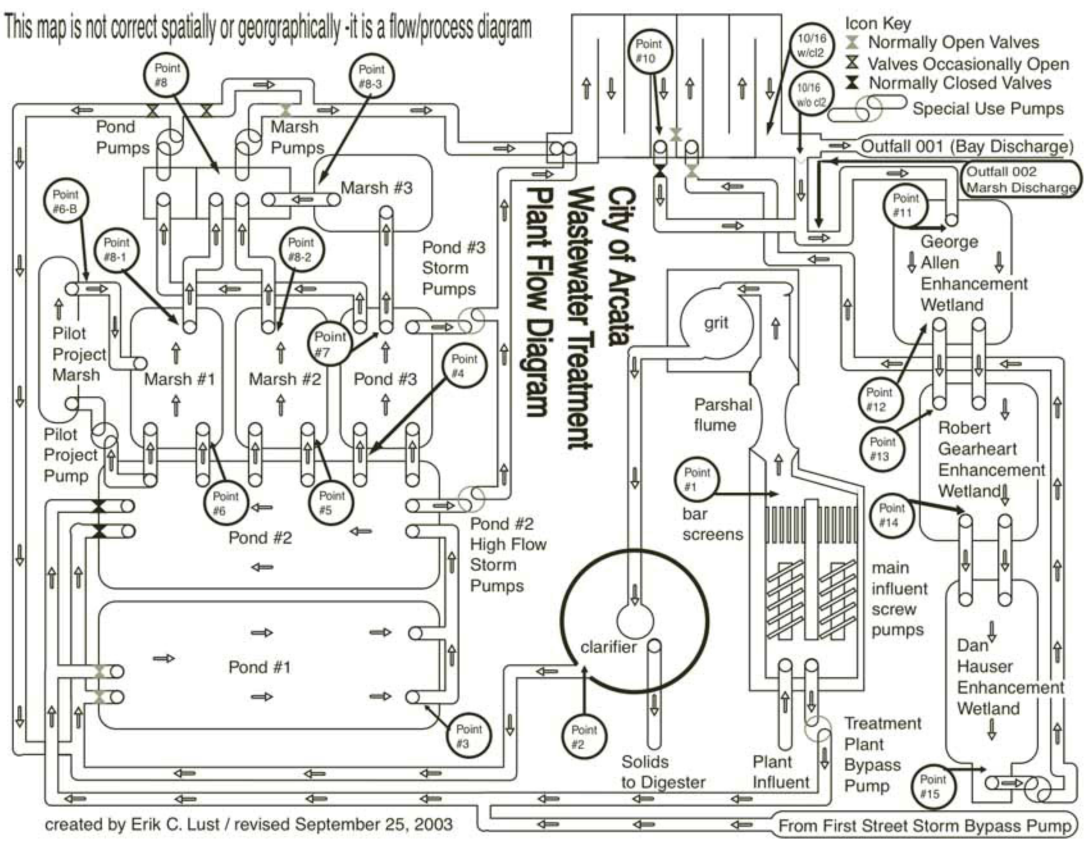


Diagram of wastewater treatment flows. (Arcata Marsh Overview 2008)

Specifications (United States 1993)

Design Population..19,056
Average Annual Flow....................................2.3 mgd
Maximum Monthly Flow................................5.9 mgd
Peak Flow..16.5 mgd
BOD's Load...4100 lbs/day
TSS Load..3400 lbs/day

Headworks

Mechanically Cleaned bar Scree .....2 at 5 mgd each
Gravity Grit Removal 144 ft.2

Clarifiers

2 Primary clarifiers ....26 ft. diam./60 ft. diam
Retention time at design flow ....3.8 hrs.
Retention time at max. monthly flow ....1.4 hrs.

Treatment Marshes

Total area .... 7.5 acres
Ave. Depth .... 2 ft.
Total detention time at design flow .... 1.9 days

Chlorination/Dechlorination

Volume ....185,400 gallons
Retention time at design flow ....58 min.
Retention time at max. monthly flow ....30 min.

3 Enhancement Marshes

Total area .... 31 acres
Ave. Depth ....1.5 ft.
Retention time at ave. Flow ....9 days

APPENDIX C: THESIS PRESENTATION

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