Fringe Benefits

by

David McMurchy

A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirements for the degree of
Master of Architecture

Waterloo, Ontario, Canada, 2018

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any final required revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The Greater Toronto and Hamilton Area (GTHA) is in a state of constant and massive growth in terms of population, development and economic investment. This growth has generated pressures both within and at the peripheries of the cities contained within the Golden Horseshoe as they develop outwards to their legal boundaries. This pressure has taken many forms, including an explosive and unaffordable housing market, transportation infrastructure that is already at or beyond capacity, and corporate development pressures to bulldoze and build over the Greenbelt, the provincially-protected ring of vital ecological systems and agricultural enterprises that surround the GTHA.

While the province has established certain legal frameworks to mitigate the pressures of growth and manage its future manifestations, so long as the interests of powerful developers and corporations are at odds with the strategies contained therein, there remains a risk that these frameworks – and the public interests that they protect – will be undermined or repealed.

This thesis is positioned at the boundary between rampant suburban development and the protected biological, agricultural and economic resources of the Greenbelt and lays out a case study for hybrid large format commercial retail development that addresses the needs of commercial land developers, a growing suburban population, a changing boundary landscape, and the ecological and agricultural interests of the Greenbelt.

Acknowledgements

This thesis would not have been possible without the many people who have given me guidance, support, feedback, discussion, criticism and encouragement over the past three years.

Thank you to Emily for always pushing me to do my best, for always believing in me and for the incredible patience and support that you've given me while I complete this work.

Thank you Maman and Dad for believing in me and always supporting my education no matter how long it took.

Thank you to Mona, Val and Ali for your constant feedback, patience, experience and dedication to my thesis.

Thank you to my friends who've suffered along beside me in the persuit of their own theses.

For Emily

Table of Contents

List of Figures

All figures produced by the author unless otherwise stated below.

1.0

2.0

3.0

This map represents the network of Large Format Retail developments which contain multinational food retailers on site. In this thesis, these points represent potential opportunities for more profitable enterprise due to their formulaic and generic networks.

4.0

Introduction

Between 2005 and 2008, the Ontario provincial government put into effect three major policy initiatives with the purpose of fostering and managing sustainable growth in the Greater Toronto and Hamilton Area (GTHA). These policies – the Greenbelt Act of 2005, the Growth Plan for the Greater Golden Horseshoe of 2006, and the Big Move of 2008 – set into law various requirements for growth management, environmental protection and economic generation in order to ensure that the cities of the Golden Horseshoe are capable of expanding and existing efficiently as an emerging mega-region. The language of these documents focusses on mitigating the long term effects of development and resource management within the developed lands of the GTHA as well as the Greenbelt, but for the most part ignore the expansive boundary condition that the meeting of these two geographies create.

This boundary is a place of great value, desired by developers, businesses and regional residents, but also an area that has the greatest connection to the protected Greenbelt lands without being as directly governed and influenced by the policies set in place to protect it. This territory is one with the possibility of great risk to the existing greenfield conditions while also retaining the possibility of generating great value beyond that of the typical generic suburban landscape development.

This thesis explores this boundary between rapidly developing urban landscapes and the agricultural, ecological and rural conditions that - when placed side-by-side - make up an edge with the potential for new forms of productive boundary programming.

The GTHA is made up of the continuous aggregation of municipalities found within the internal confines of the Greenbelt, from Oshawa and Pickering in the East, Vaughan and Markham in the North, Milton and Halton Hills in the West and Hamilton in the South. The area that is now the GTHA has over the past one hundred and fifty years flourished from a series of agricultural and military settlements of British colonial origins into the mighty hub of commerce, industry and culture that it stands as today. Even the most cursory of inspection of the GTHA today reveals the critical role that it and its component cities play in generating wealth and culture for the region and for the country.

As is evident by the sheer size of the GTHA, the economic and cultural forces that underlay the region are clear to see, especially to the nearly 7.2 million people who call it home and work within it. The GTHA also includes vast territories of agricultural and ecological wealth; systems and areas which provide peace of mind and security for today's and future generations of Canadians. These territories have, for the first time since the inception of the Province of Ontario, become protected by a unified set of laws meant to ensure that the safety and wellbeing of generations of Canadians to come are not eroded for the short term gain of wealthy industrial and land development interests. These laws, however, are fragile and constantly under fire from various interests, the geographic boundaries they control and shape being ephemerally written on political paper with no clear indication to those unversed in the actual location and form of the regional ecological systems and resources. This lack of a visible physical presence creates a danger for these liminal territories, as things not at the direct forefront of peoples' minds tend to be the things that they are the least willing to fight to keep. As well, without the constant nurturing, protection and advocacy for these territories, they become at risk of being removed and their benefits and protections for future generations of Canadians lost for good.

This is the place in which this thesis finds itself, in the space between large development interests with a rapidly growing population of new residents, numerous governments interacting at various levels, and a veritable treasure trove of natural, social and historic resources and landscapes, both with short and long term potential. In this place of forces in tension, it is critical that the in order to make the best use of the area's rapidly diminishing resources, these opposing forces work together to explore new methods of land development.

The first task of this work is to understand the resources and boundaries that make up the GTHA, especially the boundary between the urbanized municipal areas that have already developed in the last decades, and the presently protected agricultural lands and sensitive ecologies, river corridors, forests and open spaces that make up the protected landscapes of the Greenbelt. The boundary between the resources of the Greenbelt and the pressures of the interior developed areas takes on several forms, both material and not. It is an imaginary line drawn in computers and reflected in official plans and surveys, with no physical markers to illustrate the extents of its domain. It is also visible in places as a clear distinction between new tract housing at urban edges facing on to timeless Ontarian agricultural vistas, showing a bizarre meeting of lifestyles from an agrarian past and urban future. This boundary between past and future, agrarian and urban occupies a vast linear territory surrounding numerous cities and stretching 450 kilometers of opportunity when laid out as a straight line, and 1,200 kilometers when including boundaries encompassing critical hydrological features protected by purview of the Greenbelt Act.

By understanding the conditions inherent in these landscapes and their boundaries, an understanding of the vast wealth

– economically, agriculturally and ecologically – can be fostered. This understanding is subsequently useful in determining sites of opportunity for new forms of urban and landscape development and city-making. The form that this new development takes is one which has a great presence in the lives of most people living in 21st century Ontario, that of the ubiquitous large format retail development (LFR), colloquially known as the "big box." The convenience of the LFR cannot be understated, as their size, widespread and regular placements and uniform goods and quality of experience create an environment where most basic needs can reliably be attended to for the typical Ontario resident.

This consistency of experience and form has been refined and improved over the past century by the forces of commercial retail enterprise to serve the most consumers with the least costs, carefully calculated and quantified into tables and formulas where individual variables can be altered and the outcome predicted. Across the expansive network of these LFR developments, certain attributes and values are repeated and reflect both a rapidly globalizing generic culture epitomized by a homogeneous experience, as well as a deep rooted philosophy of consistency and predictability. The widespread and generic nature of LFR sites presents opportunities for small individual changes to have large impacts on the combined network of these like developments. The consistent and formulaic nature of their elements means that the effects of any design changes can be measured off of a very precise baseline, the costs and benefits quantified for boardrooms and shareholders.

In examining opportunities for alterations to the existing formula of the the typical LFR development, it is important to determine the value that any additional programming to be combined with the existing base economic will add. Without a doubt, modifications made to the retail development model will come with increased costs as compared to the existing formula. The addition of rooftop structures, as an example would result in an increase in capital costs, while the overlaying of active night-time programming would result in increased operational expenses. While the addition of new programming to the much-refined LFR formula is certain to increase capital and ongoing costs, additive programming has the potential to provide returns greater than the sum of its parts when said programming makes effective use of the site. The costs associated with adding new and unknown variables to the formula, however, sets a high bar for the amount of economic value that must be generated to be anywhere near feasible.

Several corporate entities have made attempts at merging existing programme types with the unconventional, to varying degrees of success. The Amagerforbrænding Waste Incineration Plant concept in Copenhagen couples industrial waste incineration with artificial alpine recreation, the Meydan Shopping Square in Istanbul combines a generic LFR development with social programme and the Wholefoods green roof project in Lynnfield Massachusetts adds a productive green roof to a grocery store. In all three of these projects, the additive programming provides value beyond merely adding a new layer of useable floor space to the site, with site location and proximity to the primary programme being leveraged to generate additional value found at the interstice between programmes.

This is, however, also a stage for potential development opportunity through the synthesizing of various programmes, resources and land development types, all utilizing the energies and efforts of large multinational organizations to generate shared value beyond simple capitalistic economic gain. The ubiquity of the commercial retail urban typology in the suburban landscape is more consistent in the minds of regional residents than even the housing that people live in, with various forms of commercial retail enterprise having been distilled over the decades into today's massive supercenters at the same time that housing options have multiplied in scale and type. This consistency of architectural form and the enormous role it plays in the day-to-day experiences of nearly all regional residents demonstrates an urban condition with a disproportionate impact upon the common psyche as compared to the physical space that these developments take up. The possibility of hybridizing programmatic types with the ultra-generic LFR development site is an opportunity for all who live, work and make profits in the GTHA.

The case is then to design a proof of concept LFR development to show how a single node of the archetype can be designed in order to generate additional social, ecological, agricultural and economic value. This proof of concept can then be repeated across the network of near identical generic conditions, with variations made on a site-by-site basis depending on local context in order to maximize positive impacts and revenue generation. Several aspects of potential generative value are explored, taking some of their attributes and placing them into the chosen site context in ways that seek to demonstrate a maximized potential value if the site were to focus on them. These aspects are ecology, agriculture, social and power generation. These aspects and their programmatic design charrettes are then investigated in terms of their costs and benefits over the generic LFR development and reduced to a universal unit cost that can be used to calculate these costs and benefits across the wide network of generic commercial sites. Finally, the design concept is developed for the site, chosen at the exterior periphery of the Whitebelt in order to leverage the interstices of agriculture, ecology and urban development for the mutual benefit of local residents, businesses and corporations. The various unit costs and benefits can be roughly quantified for the chosen site, their necessary investment costs and estimated returns taken from the analysis of their component elements.

This thesis is not an attempt at redesigning all aspects of the suburban built environment, nor is it meant to encapsulate all modes of urban development within the Whitebelt of a continuously growing city. Rather, it is an investigation of a particular set of boundary conditions found at the very fringes of urban development in the GTHA where the inexorable march of tract housing, parking lots and industrial parks runs up against the critical ecological public resource that is the Greenbelt.

While there are innumerable avenues for the investigation of the suburban built environment – ranging from novel modes of transit to energy efficient micro-homes – I have focused my efforts on researching and developing a basic arithmetic for quantifying some of the physical costs brought on by the commercial built environment of the past century. The near total homogeneity of the suburban built environment makes for a perfect testing bed to measure the present built commercial conditions against a hypothetical design exercise, and from those conclusions allow for the future extrapolation outwards from a single site to the vast network of interconnected like sites.

The results of these calculations and the end design is a proof of concept that takes the first steps into a possible high-value suburban retail future, generating additional value ecologically, agriculturally, socially and financially. By hybridizing disparate programmes together in one location and taking advantage of the boundary territory that the site occupies, additional productive value is generated on site, serving to enhance the robustness of the local food production network, reduce ecological impacts from the massive scale of the site, increase revenue generation on site and enhance awareness of the Greenbelt as a productive, valuable asset to the region and its residents.

1.0 | A History of Growth in the GTHA

1.1 | Toronto-Centric Development

The Greater Toronto and Hamilton Area (GTHA) is made up of the continuous aggregation of municipalities found within the confines of the Greenbelt, from Oshawa and Pickering in the East, Vaughan and Markham in the North and all the municipalities in between, out to Hamilton in the South West. These municipalities – bordering upon the Greenbelt and Lake Ontario – are some of the fastest growing cities in Canada[1], with a combined population of 6.5 million[2] and expected growth of 1.8 million new residents[4] by 2031.

Toronto, and the cities as its periphery are some of the largest contributors to economic and cultural growth in Canada, having grown from a British colonial settlement in Upper Canada into the economic engine for the country, housing 19% of the Canadian population[5] and producing 300 billion dollars in economic output per year.[6] The city of Toronto is also home to numerous major festivals, parades, charities and public events, increasing the cultural output and presence of the GTHA on the world stage. Furthermore, there is a notable connection to nature within the city planning of the GTHA as Toronto has an extensive public park network and the GTHA as a whole has an extensive ravine and river system with trails and parks along them. It is clear that the GTHA is one of the most vibrant, productive and critical regions in the country.

1.2 | Historic Growth Trends

Growth and settlement patterns in the GTHA have been polycentric in nature and fact for the entirety of the history of the major settlements. In the case of what would become the GTHA, polycentric growth developed with the starting point of Toronto. From there, minor peripheral settlements

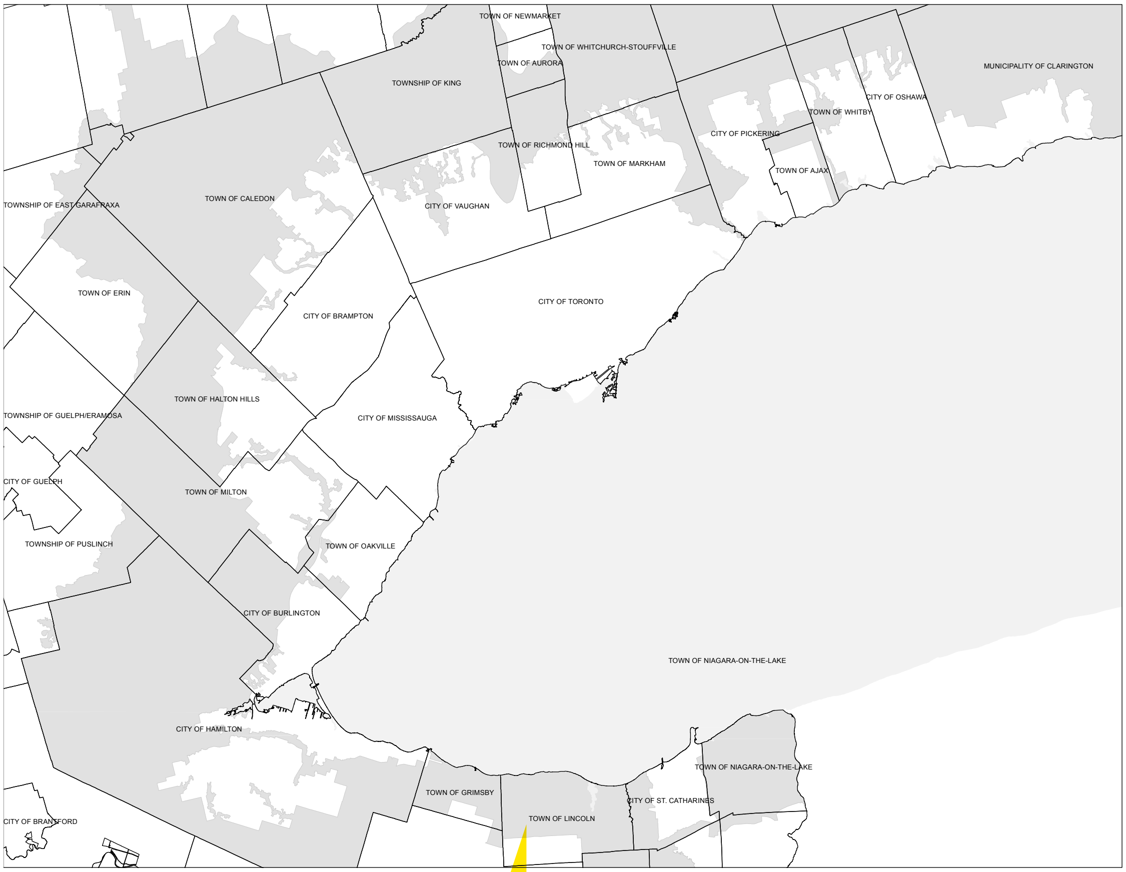


Figure 1.1 - Map showing municipalities making up the GTHA

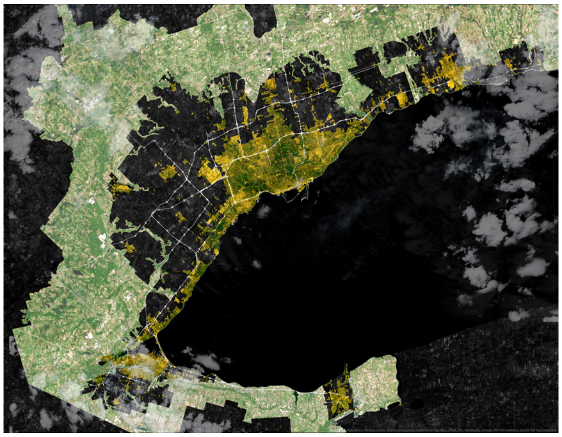


Figure 1.3 - Built Area: 1960

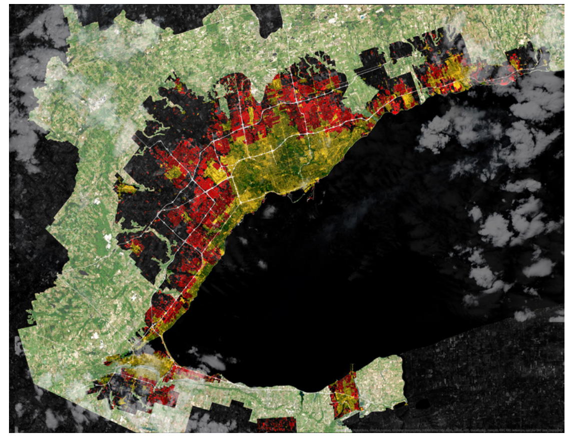


Figure 1.2 - Mapping Growth: 1960 - 1992

These maps show the growth of urbanized areas in the GTHA over the past 50 years. In the approximately 30 years after 1960, an enormous amount of urbanization - roughly 636 square kilometers (71.7% or 5.5% per year on average) - occured in the region. Figure 1.3 - Built Area: 1960 on page 5

In the 21 years between 1992 and 2013, urbanized land development occured in areas measuring 389 square kilometers (25.5% or 6.0% per year on average). Figure 1.5 - Mapping Growth: 1992 - 2013 on page 6

Regional urbanization over the past half century has run at a rampant

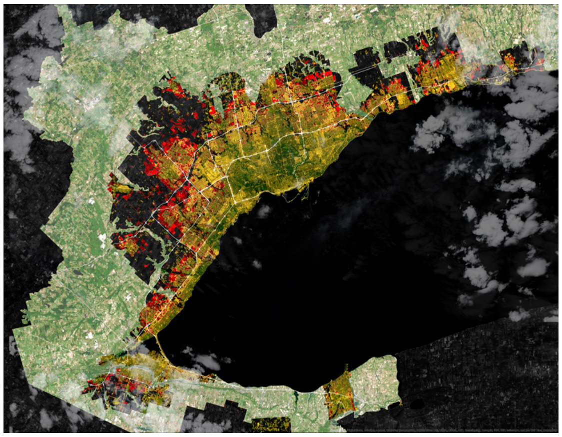


Figure 1.5 - Mapping Growth: 1992 - 2013

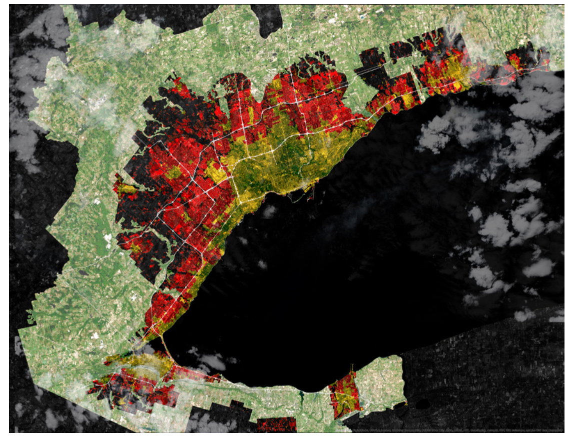
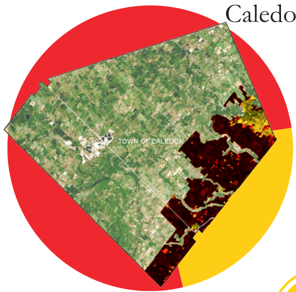


Figure 1.4 - Mapping Growth: 1960 - 2013

pace, rapidly reducing the amount of greenfield land available for future development while simultaneously increasing the burdens on the systems and services that operate in spread out and inneficient suburban landscapes. In total, green field development between 1960 and expanded by 1,025 square kilometers Figure 1.4 - Mapping Growth: 1960 - 2013 on page 6

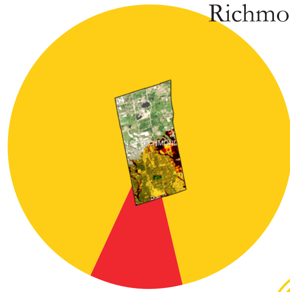
Caledon



Population: 57,050
Area: 687 km2
Greenbelt Area: 529 km2
Built Area: 34 km2
Whitebelt: 110 km2

3.24

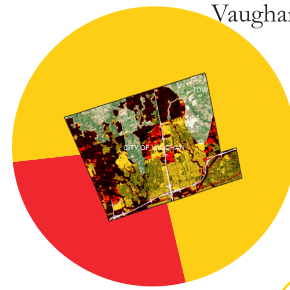
Richmond Hill



Population: 162,704
Area: 101 km2
Greenbelt Area: 39 km2
Built Area: 47 km2
Whitebelt: 9 km2

0.12

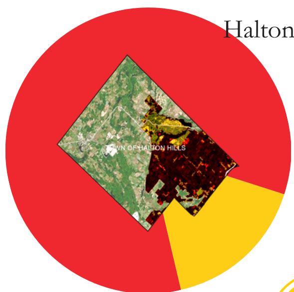
Vaughan



Population: 238,866
Area: 274 km2
Greenbelt Area: 69 km2
Built Area: 90 km2
Whitebelt: 33 km2

0.37

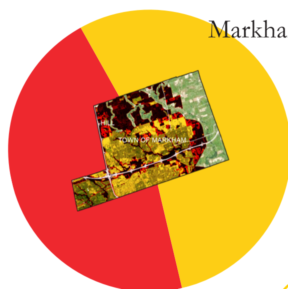
Halton Hills



Population: 55,289
Area: 276 km2
Greenbelt Area: 101 km2
Built Area: 14 km2
Whitebelt: 72 km2

5.14

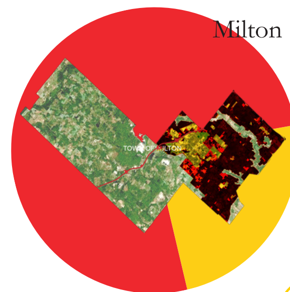
Markham



Population: 261,573
Area: 213 km2
Greenbelt Area: 51 km2
Built Area: 79 km2
Whitebelt: 66 km2

0.84

Milton

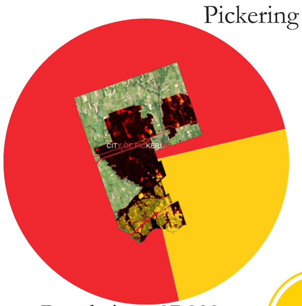


Population: 53,939
Area: 367 km2
Greenbelt Area: 231 km2
Built Area: 29 km2
Whitebelt: 92 km2

3.17

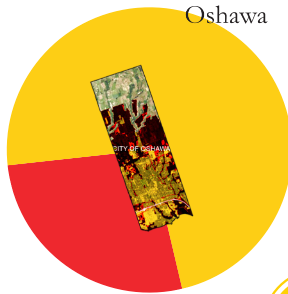
Figure 1.6 - A closer look at the municipalities that make up the GTHA reveals the existing relationship between greyfield and greenfield conditions.

In these circle diagrams, the yellow represents the ratio of total land within municipal boundaries not governed by the Greenbelt Act that is currently developed. The red, conversely, represents the ratio of land within the municipal boundaries that are still available for development according to their municipalilties' settlement boundaries and development plans. Caledon, with a built area of 34 square kilometers and 110 square kilometers of greenfield, has a ratio of 3.24. This means that the city has the potential to grow 324% before running out of lands not within the Greenbelt.



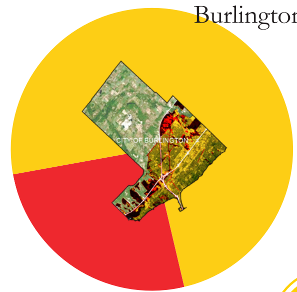
3.0

Population: 87,838
Area: 232 km2
Greenbelt Area: 107 km2
Built Area: 28 km2
Whitebelt: 84 km2



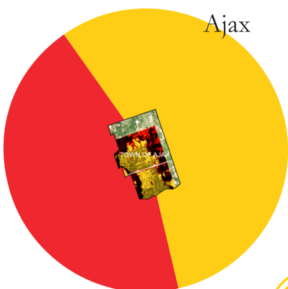
0.37

Population: 238,866
Area: 274 km2
Greenbelt Area: 69 km2
Built Area: 90 km2
Whitebelt: 33 km2



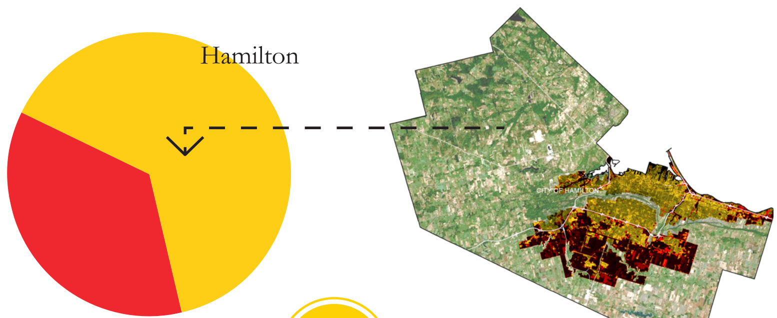
0.35

Population: 164,415
Area: 186 km2
Greenbelt Area: 91 km2
Built Area: 63 km2
Whitebelt: 22 km2



0.79

Population: 90,167
Area: 67 km2
Greenbelt Area: 19 km2
Built Area: 24 km2
Whitebelt: 19 km2



0.56

Population: 504,560
Area: 1,138 km2
Greenbelt Area: 819 km2
Built Area: 182 km2
Whitebelt: 102 km2

A city like Richmond Hill, on the other hand, has a ratio of 0.12 resulting in potential growth and urbanization expansion of only 12%.

were established and run independently of the city, while still taking advantage of their proximity to the major shipping and rail networks found in Toronto. In recent history these settlements have experienced large population booms accompanied by their associated construction frenzies These now-cities have spread out from their initial agriculturally-oriented cores until their edges have blended together, creating a condition where you can often pass from city to city without travelling even through farm land or naturalized areas. Population growth in the GTHA has remained relatively stable for several decades[7] as migrants have entered the region for a variety of reasons, and the cities have responded accordingly by expanding their official settlement boundaries and building infrastructure to accommodate these new residents. Some cities such as Brampton and Milton have historically taken in considerably more migrants as they have both had the geographic space to accommodate them[8] and the local proximity to the City of Toronto either along the highways or along the various regional rail lines such as GO Transit or VIA Rail. Major population growth cities are generally located to the West and to the North of the city of Toronto.

Between the years of 1960 and 2013, the built form of the GTHA has grown by approximately 390 square kilometers[9]. Looking at historic development trends over the past half century in the GTHA and applying them to the remaining 460 square kilometers[10] of lands undeveloped and not covered by the Greenbelt Act establishes a condition in which if regional development patterns do not change, the built up areas of the GTHA will have completely filled the Whitebelt by the end of the current century. These trends were made clear to municipal, provincial and federal elected officials through various studies and have resulted in several pieces of key provincial policy frameworks established in order to mitigate the effects of sprawl and expansive land use for the future.

1.3 | Regional Policies

As a result of the aforementioned ongoing sprawl, as well as its effects of increased congestion and the degradation of important environmental features in the GTHA, the provincial government implemented several pieces of key legislation to support and improve upon the mandate of the Planning Act, the legislation that governs how municipalities may expand their developed boundaries and interpret their official plans.

These regional policies were the Greenbelt Act and Greenbelt Plan, the Places to Grow Act and Growth Plan for the Greater Golden Horseshoe, and the Big Move: Transforming Transportation in the Greater Toronto and Hamilton Area. These acts and their associated implementation plans serve as a provincial mandate on the overall direction of smart growth for the GTHA and are supported and enforced by individual municipal official plans and zoning bylaws

1.3.1 | The Greenbelt Act (2005)

The Greenbelt Act was approved by the Ontario provincial government in 2005 as one of three major components of the provincial government's mandate for the Planning Act. Its purpose was to consolidate and expand upon existing ecological protection laws such as the Oak Ridges Moraine Conservation Plan (ORMCP), the Niagara Escarpment Plan (NEP), the Parkway Belt West Plan and the Rouge North Management Plan using protective policies and regulations described in the Greenbelt Plan, released a year later.

> "The Protected Countryside lands identified in this Greenbelt Plan are intended to enhance the spatial extent of agriculturally and environmentally protected lands currently covered by the NEP and the ORMCP while at the same time improving

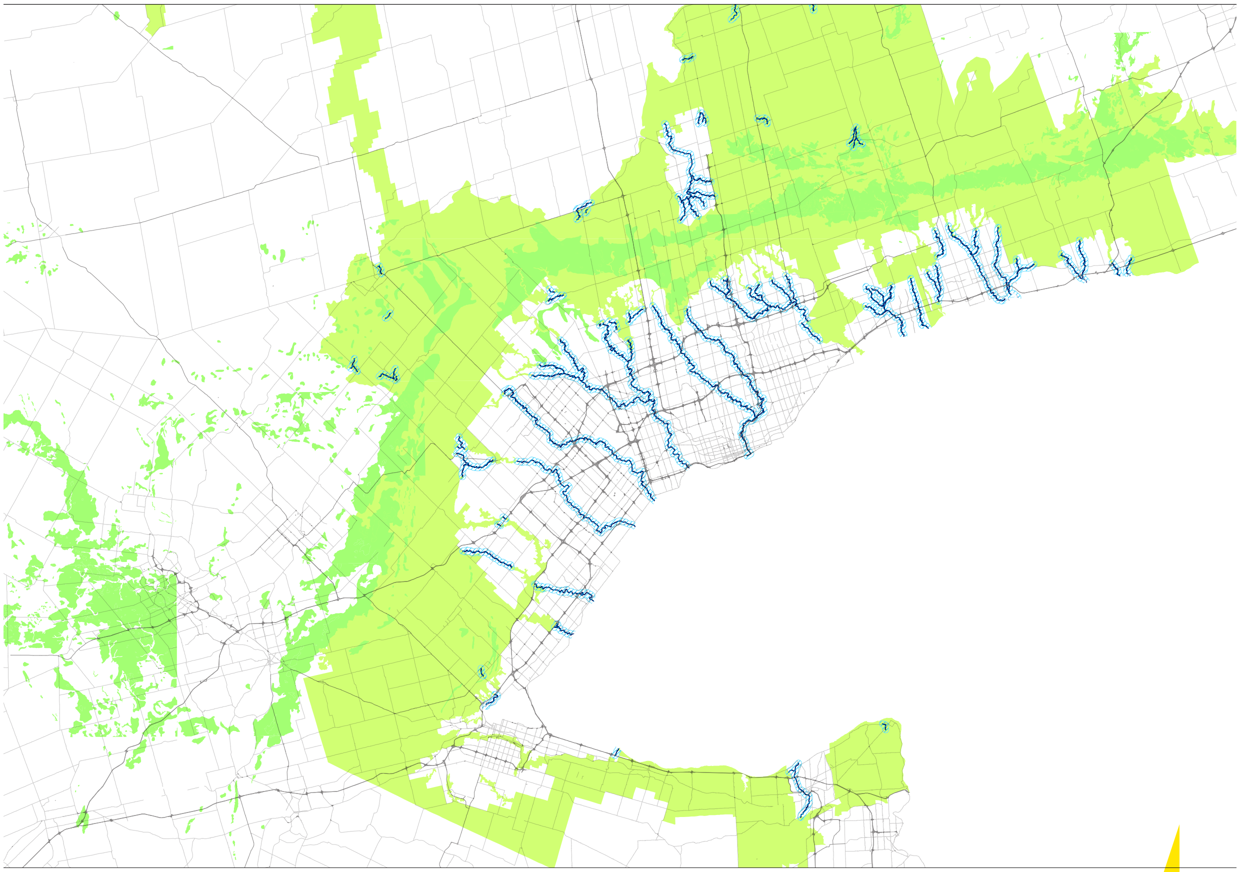


Figure 1.7 - Map showing the Greenbelt, along with the major ecological geographies whos protections were consolidated through the creation of the act.

> linkages between these areas and the surrounding major lake systems and watersheds."

The Greenbelt Plan specifically acts to protect, in this band surrounding the urbanized cities of the GTHA, critical ecological features such as the Oak Ridges Moraine, watersheds and river valleys feeding into Lake Ontario, agricultural assets which provide enormous ecological and economic benefit to the region, as well as minimizing the impacts of existing Greenbelt-situated settlements and proposed infrastructure on the ecology and agriculture of the region.[11]

> "Protects against the loss and fragmentation of the agricultural land base and supports agriculture as the predominant land use",

> "gives permanent protection to the natural heritage and water resource systems that sustain ecological and human health and that form the environmental

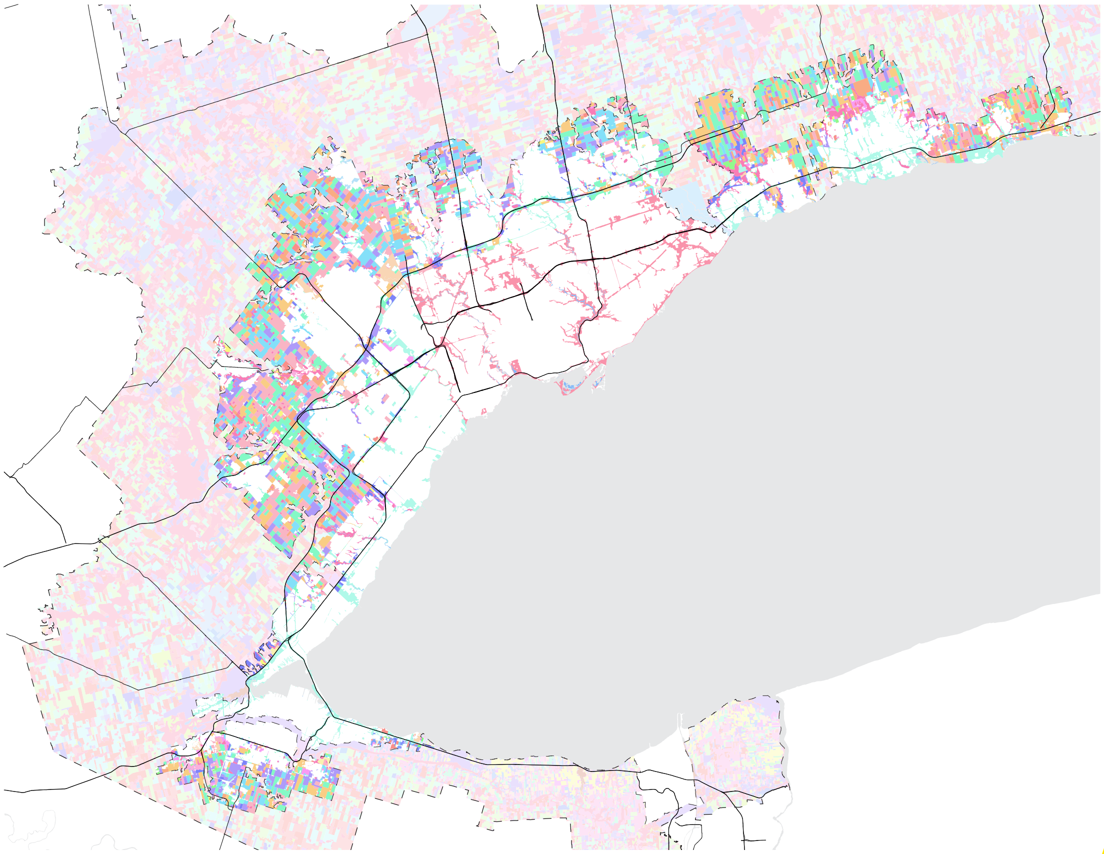
> framework around which major urbanization in south-central Ontario will be organized; and"
>
> "…provides for a diverse range of economic and social activities associated with rural communities, agriculture, tourism, recreation and resource uses."[12]

The two aforementioned features – hydrological and agricultural – are enormously important to the wellbeing of the GTHA in ecological as well as economic terms and their protection through individualized legislation as well as the unified Greenbelt Plan is intended to solidify their continued existence and subsequently the health of the GTHA overall for generations to come.

The Oak Ridges Moraine

The Oak Ridges moraines are essential to maintaining the water table for the GTHA. It is along this natural geological feature that water is accumulated into underground aquifers and then flows down through the GTHA and into Lake Ontario. Without an extensive permeable moraine, the water so necessary to the lakes, cities and greater Toronto agriculture would be unable to flow to these areas. By creating the Greenbelt Act and connecting the protective purview of the Oak Ridges Moraine Conservation Plan with other nearby conservation plans, the consolidated impact of the protection of the Oak Ridges Moraine is increased, therefore increasing the wellbeing of GTHA watersheds.

The protection of the Moraine has not been without opposition, as developers planning suburban developments in municipalities overlapping the Moraine such as Vaughan and Richmond Hill have brought the provincial government to the Ontario Municipal Board to contest the shutting down of their long planned development projects. An early agreement was reached in 2001 between the provincial government and the various Oak Ridges landowners to exchange the highly contested privately-held lands slated for development in the moraine for government owned lands in North Pickering[13] in what is known as the North Pickering Land Exchange.



Agricultural Assets

Since the founding of the settlement York in 1793, agriculture has been an important element of the regional economy. While the GTHA has over the years shifted its dominant economic output from agriculture and industry and towards finances and services, the regional agricultural fabric in the GTHA remains an economically and ecologically valuable asset to the region for several reasons:

Soil Quality: The soil quality in Southern Ontario is of an extremely high grade and is therefore exceedingly productive. The soil conditions in the GTHA where urbanization has not taken place are a mixture of soil class 1 and 2 primarily, indicating conditions extremely suitable for productive crop cultivation[14]

Figure 1.8 - Map showing the variety of agricultural enterprises in the Greenbelt and Whitebelt.

Although this data is old (1983), the more recent agricultural survey does not cover the interior boundaries of the Greenbelt nor the areas contained within the Whitebelt.

This demonstrates a clear prioritization by the provincial overnment to measure and classify agricultural lands with the least chance of being converted into residential suburban development, however it also has created an unfortunate situation where current data does not show exactly what agricultural lands are being lost to development in the Whitebelt in aggregate.

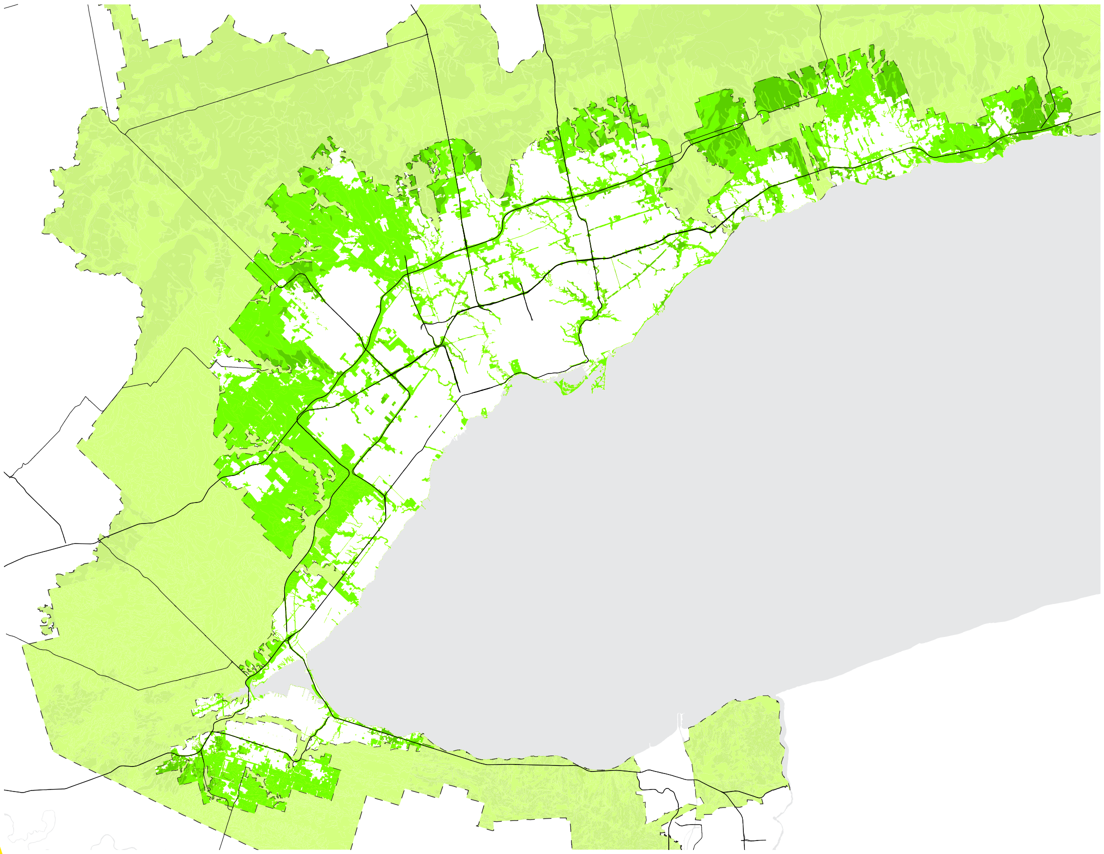


Figure 1.9 - Map showing the quality of soil in the Whitebelt

This map shows the quality of soil in the Whitebelt as categorized by the Canada Land Inventory. The majority of topsoil in the Whitebelt is of class 1 or class 2, no or few limitations to agricultural production.

Agricultural Variety: The excellent quality of soils in South Western Ontario has created a situation where there exists a great variety of farms and crops being cultivated. As a result of this plethora of agricultural businesses and crop types, multiple markets and food distributors can be served locally for more needs rather than sourcing from international suppliers.

Economic Generation: According to the Golden Horseshoe Food and Farming Alliance, the value of direct agricultural production in the Golden Horseshoe as measured in gross farm receipts (GFR's) was $1.7 billion (2011). This organization estimates that the indirect economic impacts from regional agriculture (through associated services such as distribution, retail, processing, canning, etc) to be $6.3 billion (2011).[15]

With such important natural and agricultural features adjacent to several major growing Ontario cities the necessity of the Greenbelt Act to consolidate and expand existing ecological conservation strategies becomes clear as these natural features have far reaching impacts for the ecology and economy of the GTHA beyond their borders. The result of this consolidated Greenbelt Act and Plan is that there now exists an extensive ecological and agro-economical band of productive lands surrounding the sprawling cities of the GTHA, but also within close reach of those same cities. This band includes over six thousand individual farms producing over 200 commodities for local and international markets over just under a million acres of arable land[16], rich ecosystems and valuable hydrological networks, all of which together act to restrict the sprawling development trends exemplified over the past thirty years in the GTHA.

The danger that the Greenbelt faces today comes from the powerful and influential land-developers who have, despite successes such as the North Pickering Land Exchange, continued to contest the boundaries of the established Greenbelt and have lobbied for exceptions in rapidly developing locales such as Vaughan, Richmond Hill and Markham.[17]

1.3.2 | Growth Plan for the Greater Golden Horseshoe(2006)

The Growth Plan for the Greater Golden Horseshoe, more commonly referred to by The Places To Grow Act that preceded it, behaves in a different manner than does the Greenbelt Act. Where the Greenbelt Act indirectly acts as a barrier to contain sprawl immediately and establishes boundaries for growth, the Growth Plan instead uses policy approaches to direct planning and development within the GTHA towards more sustainable ends. The Growth Plan

Figure 1.10 - Map of Urban Growth Centres

This map shows the various urban growth centres proposed by the Growth Plan. These urban centres are municipal areas slated for higher density growth and brownfield development.

establishes that existing development patterns in Ontario are not sustainable and in response demands that certain development requirements are met. These requirements are:

Density:

> "By the year 2015 and for each year thereafter, a minimum of 40 per cent of all residential development occurring annually within each upper-and single-tier municipality will be within the built-up area."[18] This requirement of general intensification addresses the existing condition in the GTHA where "86% of the net new residents added between 2001 and 2011 were housed in new suburban subdivisions built on greenfield sites."[19]

Decrease in Auto-Dependence: The act recognizes that auto-dependence is choking the roadways of the GTHA and costing residents ever-increasing amounts of time in terms of transportation, particularly daily commutes.

In response to this growing problem, the Growth Plan emphasizes the importance of regional mass-transit between urban growth centers and the development of

> "…a balance of transportation choices that reduces reliance upon any single mode and promotes transit, cycling and walking."[20]

Urban Growth Centers: Urban Growth Centers are defined as locations where development is occurring close to various transit networks. These are to be

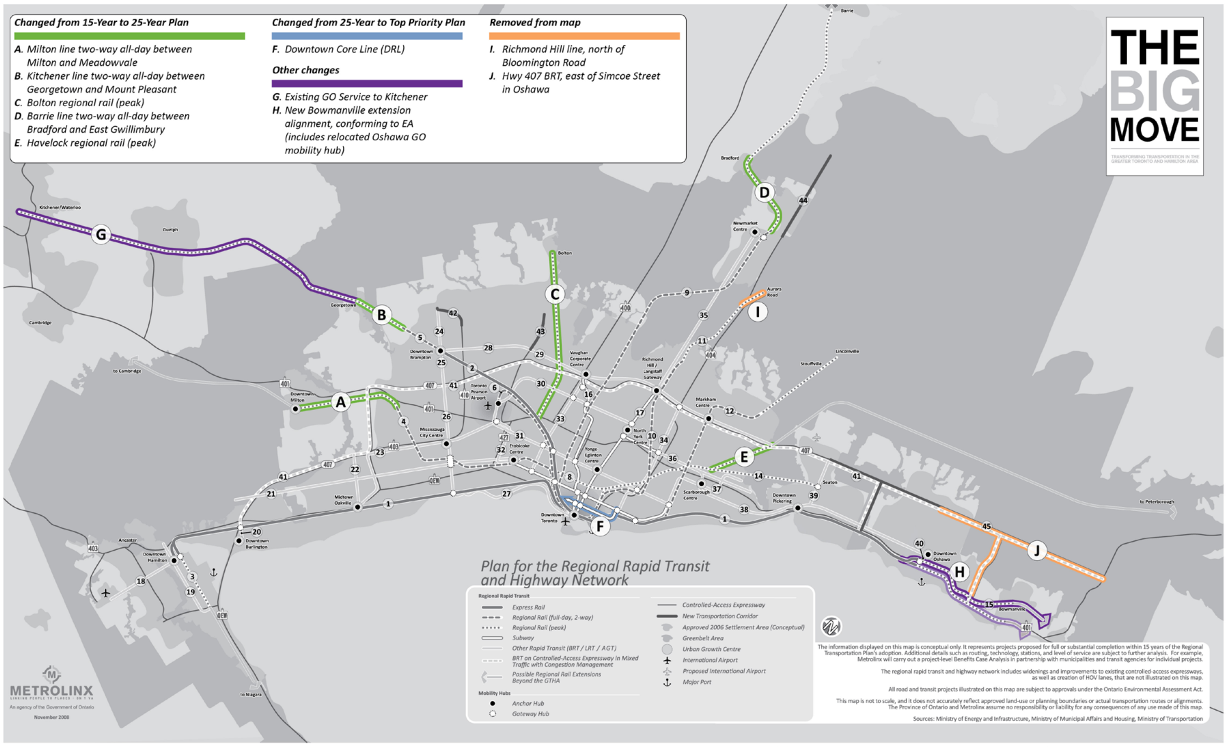
> "…focal areas for investment in institutional and region-wide public services, as well as commercial, recreational and entertainment uses"[21] and "…high density major employment centers that will attract provincially, nationally or internationally significant employment uses." [22]

By creating these 'nodes,' the act hopes to focus higher development where the costs, both economic and infrastructural, can support it. These urban growth centers will also serve as locations from which greater density can spread outwards and ultimately become the new civic centers.

1.3.3 | The Big Move

The Big Move: Transforming Transportation in the Greater Toronto and Hamilton Area is a regional transportation plan (RTP) adopted in November 2008 by Metrolinx, the GTHA regional transit administration. It was designed as a response to the decades of sprawl development in the GTHA supported by a network of highways and roads that were and continue to become ever more congested and overburdened. The annual costs of this congestion has been estimated by a Metrolinx study to be six billion dollars[23]in lost productivity for commuters and general economic slowdowns as of 2006, and if trends continue unchanged, is forecast to balloon to fifteen billion dollars by the year 2031[24]

PLAN FOR THE REGIONAL RAPID TRANSIT NETWORK



THE BIG MOVE | Transforming Transportation in the Greater Toronto and Hamilton Area 92

Figure 1.11 - This map shows the major transportation routes and mobility hubs as described by the Big Move.

The Big Move sets out thirteen goals to achieve by the year 2031, pertaining to transportation issues governing quality of life, environmental protection and strong economic growth,[25] and proposes ten principal strategies necessary to achieve these goals over twenty five years. These goals address the need to create a safe, accessible, integrated network of multi-modal transportation options while maintaining and enhancing existing transportation infrastructures such as highways and rail lines. The Big Move further sets out nine "big moves," priority objectives that if acted upon are expected to have the greatest impact on transportation networks in the GTHA. These moves include the expansion and improvement of regional rapid transit, a rail connection to Pearson Airport and its associated employment district, improvements to Union Station, improved and expanded pedestrian pathways and bike networks, efficient and useable network information access to travelers, an integrated fare system for the GTHA, a network of connected "mobility hubs," a comprehensive strategy for freight and goods distribution and most critically, an "investment strategy to provide immediate, stable and predictable funding."[26]

The Big Move has proved to be an ambitious and much needed planning effort for the GTHA, the necessity of which becomes clearer with each passing year of stifling congestion. What is amazing is the sheer fact that it was established at all, as the political capital and willpower necessary for large infrastructural projects is enormous.

Of course, the politics of development and transit planning can also work strongly against a unified transportation strategy, as demonstrated by the devastating impact that former mayor Rob Ford had on the development of higher order transit in Toronto upon gaining his office in 2010. His words, "Transit City is dead" were explicitly and implicitly legitimized by a council and provincial government afraid of his supposed influence on voters, thereby undoing half a decade of collective efforts, planning, design and even initial construction on a major portion of The Big Move plan. This example is a clear warning to those wishing to rely on top-down legislative planning efforts to improve the cities in which we live, as regional collective efforts are only as strong as the weakest link.

1.4 | Issues With a Top-Down Planning Method

The requirements of the Greenbelt Act (2005), the Growth Plan for the Greater Golden Horseshoe (2006) and the Big Move (2008) and subsequently the changes they've brought to the development of the peripheral cities of the GTHA have been an improvement over the historically sprawling growth of previous decades. The Greenbelt Act has established a protected ecological and agricultural zone surrounding the cities of the GTHA, while the legislation of the Growth Plan has helped to mitigate the fallout of this boundary by providing guidance to municipalities on the mandate of the provincial government's official plan. That being said, it must be acknowledged that these policies have not been 100% effective or without their own problems. Policies, in and of themselves, are slow to implement and require enormous amounts of political will and capital to push through legislature. This is exacerbated by various special interest groups including major land developers who have and continue to lobby against these policies at the municipal level through direct conversations with politicians and planning officials as well as at the provincial level through the Ontario Municipal Board.[27]

In the case of the Growth Plan for the Greater Golden Horseshoe, the time span between its inauguration into provincial and municipal legal framework and its full implementation has been ten years, allowing for a decade of development to continue following pre-existing patterns. Even today, land developers and municipal governments in municipalities with little Whitebelt lands remaining argue that the requirements set forth in the Growth Plan are too stringent.[28]

The Greenbelt Act is also contested by developers and municipalities in which there is easy access to major highway connective infrastructures for commuting to the inner GTHA cities, as this infrastructural access creates residential desirability that is not matched by green field development opportunities in these municipalities due to diminished Whitebelt land areas. In these municipalities with little remaining Whitebelt lands such as Richmond Hill, Markham, Brampton and Vaughan, opposition to the Greenbelt by developer lobbyists and municipal officials continues to be fierce, which is in indicative of the issues faced by top-down planning strategies.

Furthermore, in the case of the GTHA and the three policies acting upon development in the region, industrial zoning typologies are left out of any sort of restriction or change from existing requirements set out in the Official Plans of the various municipalities. While employment districts and mixed-use development requirements are set in place by legislation, the expansive and sprawling industrial building typology is not required to improve in any meaningful way and therefore exists outside of the regional frameworks.

Finally, while these policies call for improvements in terms of density, ecological and agricultural preservation, and the improvement of mass transportation systems, they fail to address issues of quality of life and cultural amenities. Top-down policies are most legible and effective when the requirements are quantitative in nature and as a result the qualitative aspects of land development – factors affecting how these neighborhoods will actually feel to live in such as streetscapes, views and quality of design – are still controlled by the developers. The provincial legislation and unified the top down development approach for the GTHA has proven to be a necessary improvement, but it will require the active support of developers and corporations to ensure that the GTHA cities of the future are built for long-term sustainability.

2.0 | Using Cartography to Determine Site Value

2.1 | Deciphering Homogeneity at the Edge

In investigating the suburban built form, it becomes apparent that suburbia is at its surface an exceedingly generic landscape. Built form typologies are few and repeat in the thousands across bulldozed and paved over greenfield sites. The Whitebelt itself is named after the misguided idea that it is land that is ungoverned by spatial planning legal frameworks and can therefore exist as an extension of this generic topography as a blank slate for development. This generic appearance raises the question of how cartography can help to decipher these homogenous landscapes and reveal hidden patterns and alternative and more profitable site opportunities in the Whitebelt. The cartographic analysis of the Whitebelt and Greenbelt boundary condition serves this thesis in determining some of these opportunities, interpreted through four analytical lenses: agriculture, ecology, social resources and power generation.

2.2 | Identifying Natural Value at the Boundary

In investigating the edge condition between the critical resources of the Greenbelt and the rapidly expanding urbanized fabric of the GTHA, this thesis investigates the relationship between conditions similar to this edge and the cost of land ownership. In other words, properties situated in proximity to naturalized conditions - panoramic vistas and rivers - have a higher inherrent value and desirability. These higher values and desire to live near these conditions result in a need to create better developments rather than the usual.

In this first cartographic exercise, the aim is to isolate the extensive areas of adjacency that is symptomatic of the Greenbelt edge condition in order to visualize the quantity of higher value lands mentioned prior. The ephemeral edge

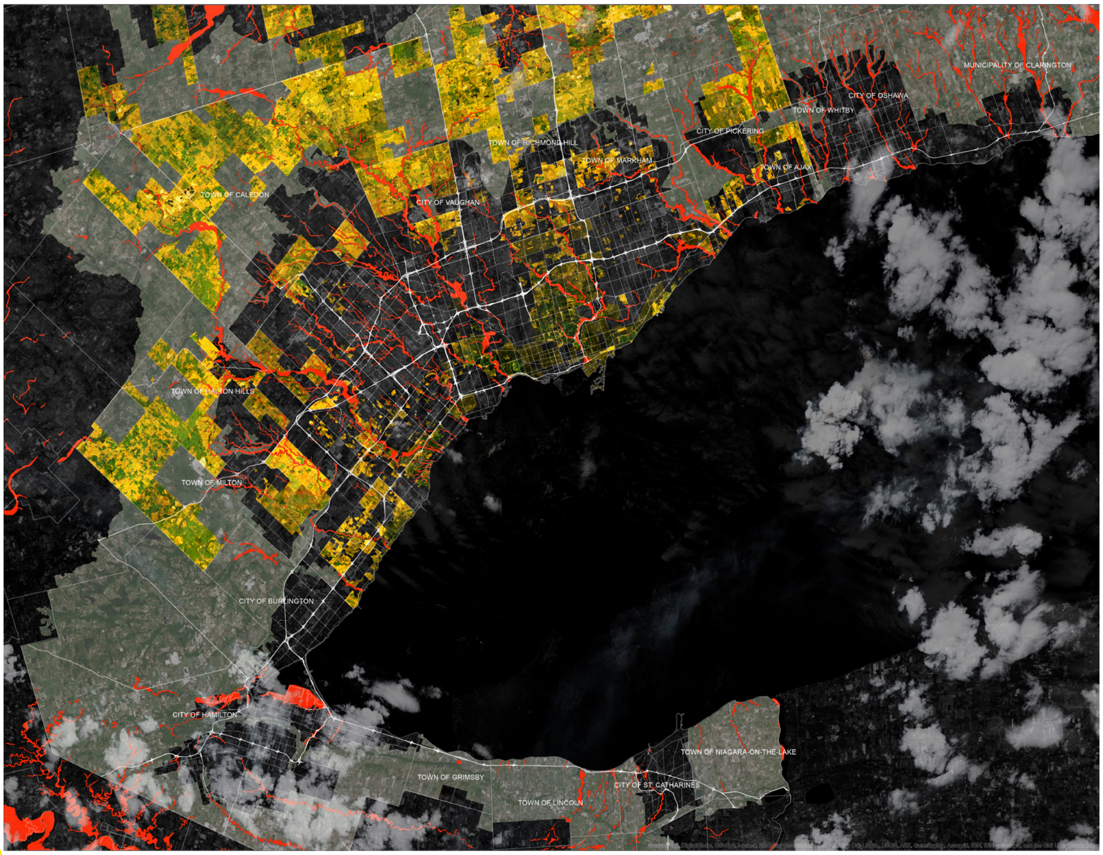


Figure 2.1 - Map showing the relationship between proximity to naturalized areas - forests, rivers, valleys, lakes - and the inherrent desirability of properties.

The hightlighted areas are determined in the metro Toronto footprint via average property prices and in the surrounding municipalities and Greenbelt areas using Statistics Canada data of average household income (datasets isolated to $100,000 +)

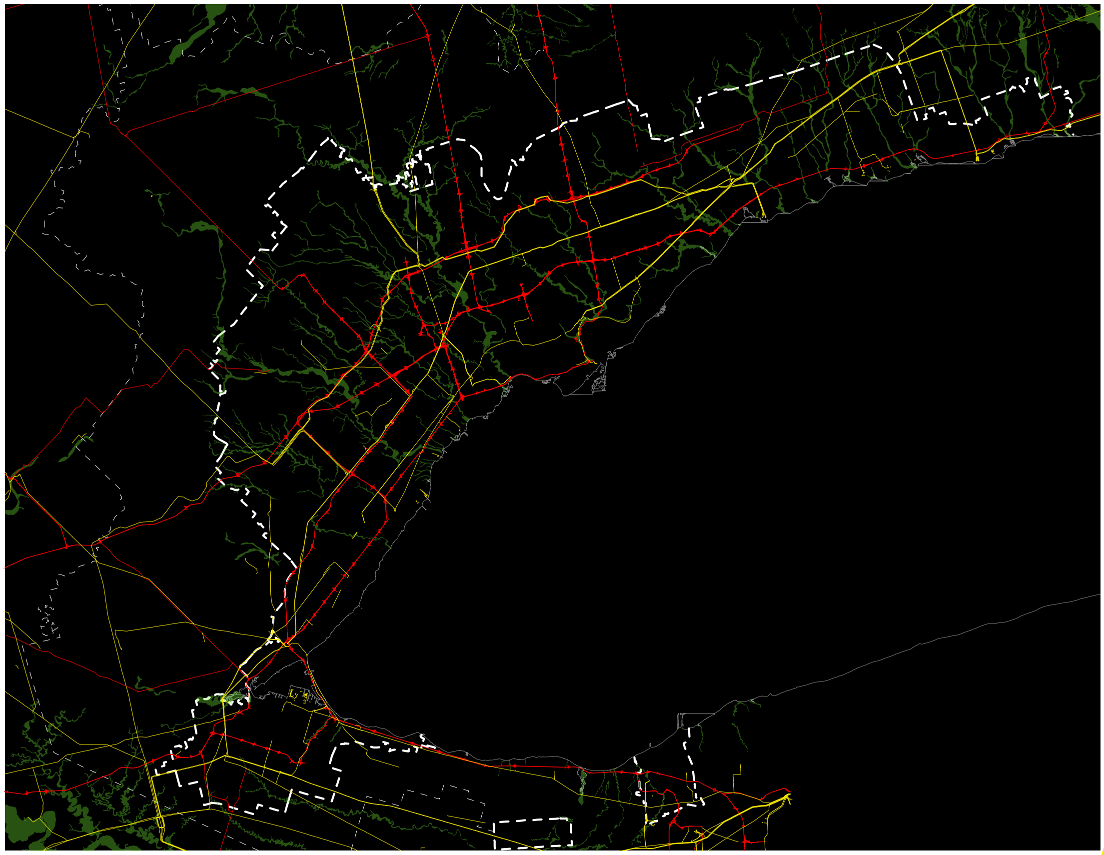


Figure 2.2 - Map Isolating Greenbelt Agricultural Boundaries.

In this map, the simplified form of the agricultural Greenbelt interior boundary is isolated. This simplified outline becomes the primary element of the Greenbelt boundary that the following analysis works around.

Figure 2.3 - Map Isolating and Cataloguing Hydrological Protected Areas of the Greenbelt.

This map isolates the ecological and hydrological features that stretch towards the lake from the interior boundary of the greenbelt. These features will be preserved as objects in the following manipulations.

Figure 2.4 - Map showing how major geometries are drawn around the incursive hydrological features, allowing for larger straight segments to be extrapolated

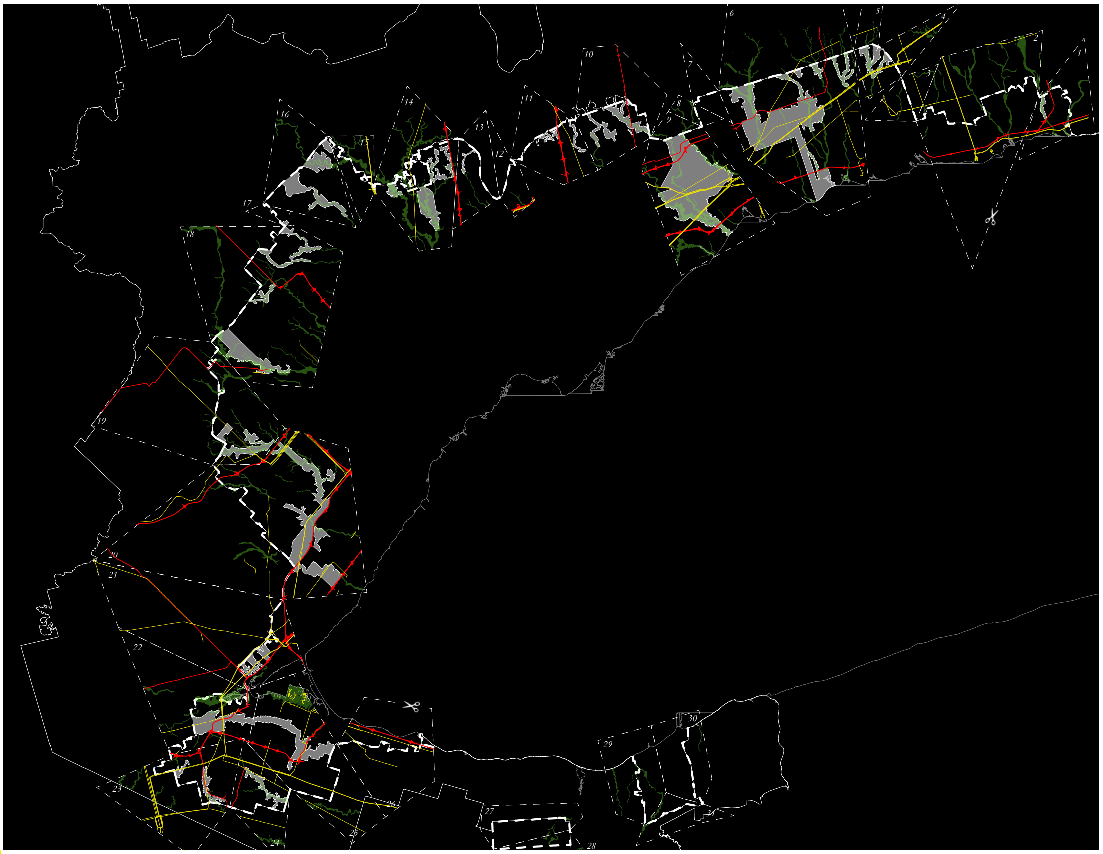
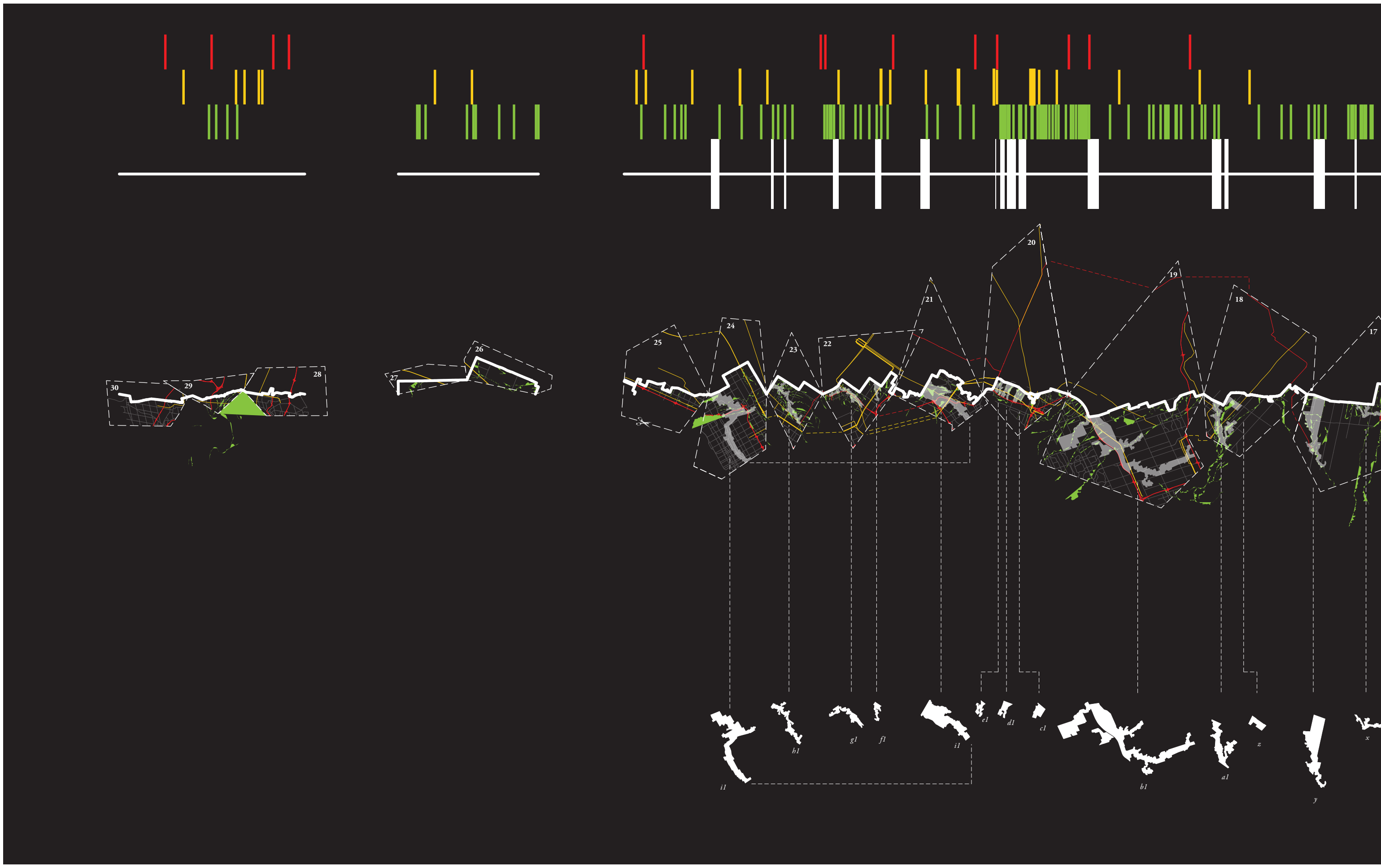


Figure 2.5 - Map showing the prior geometry, along with some of the major networks and features that are contained in the segments.



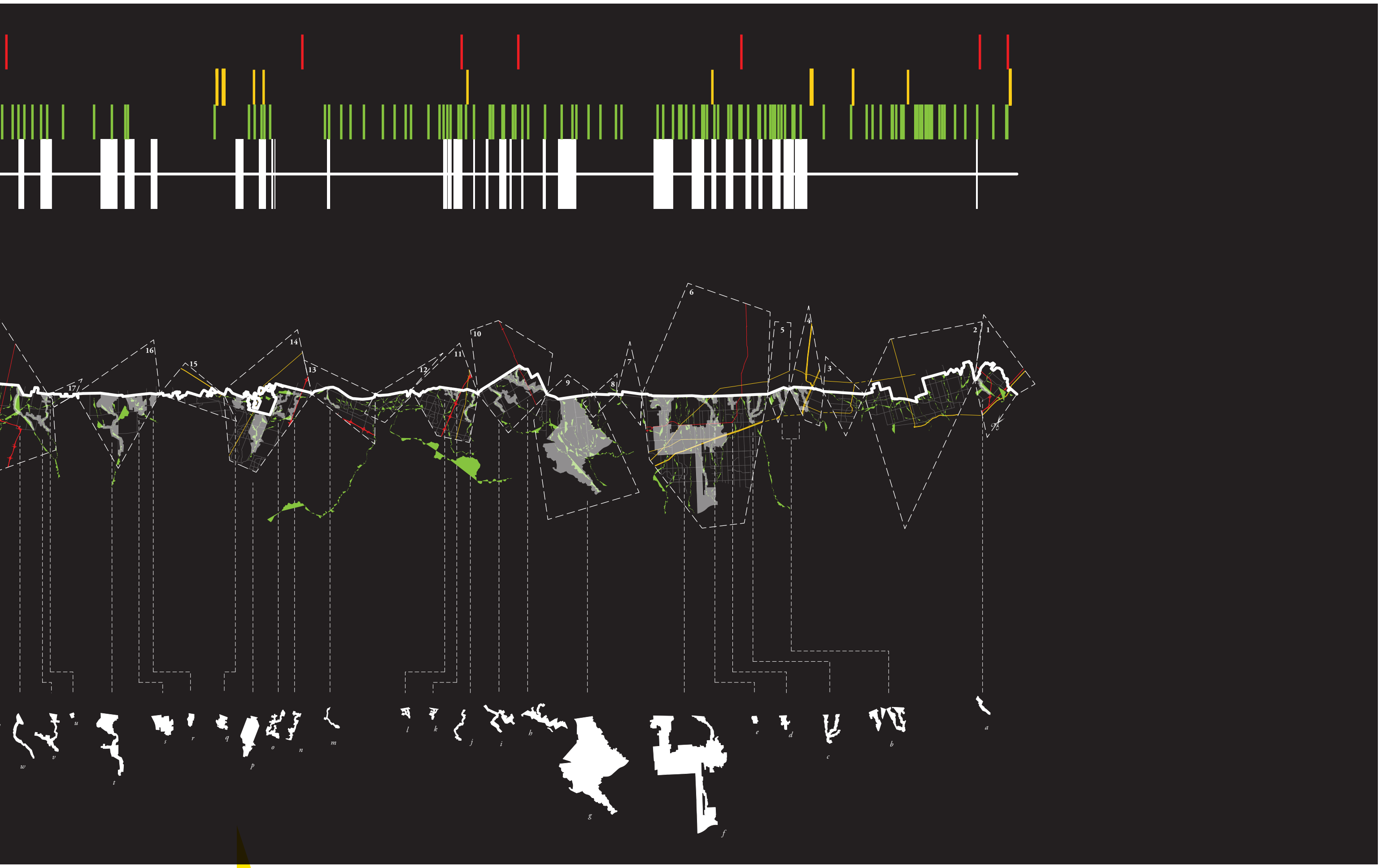
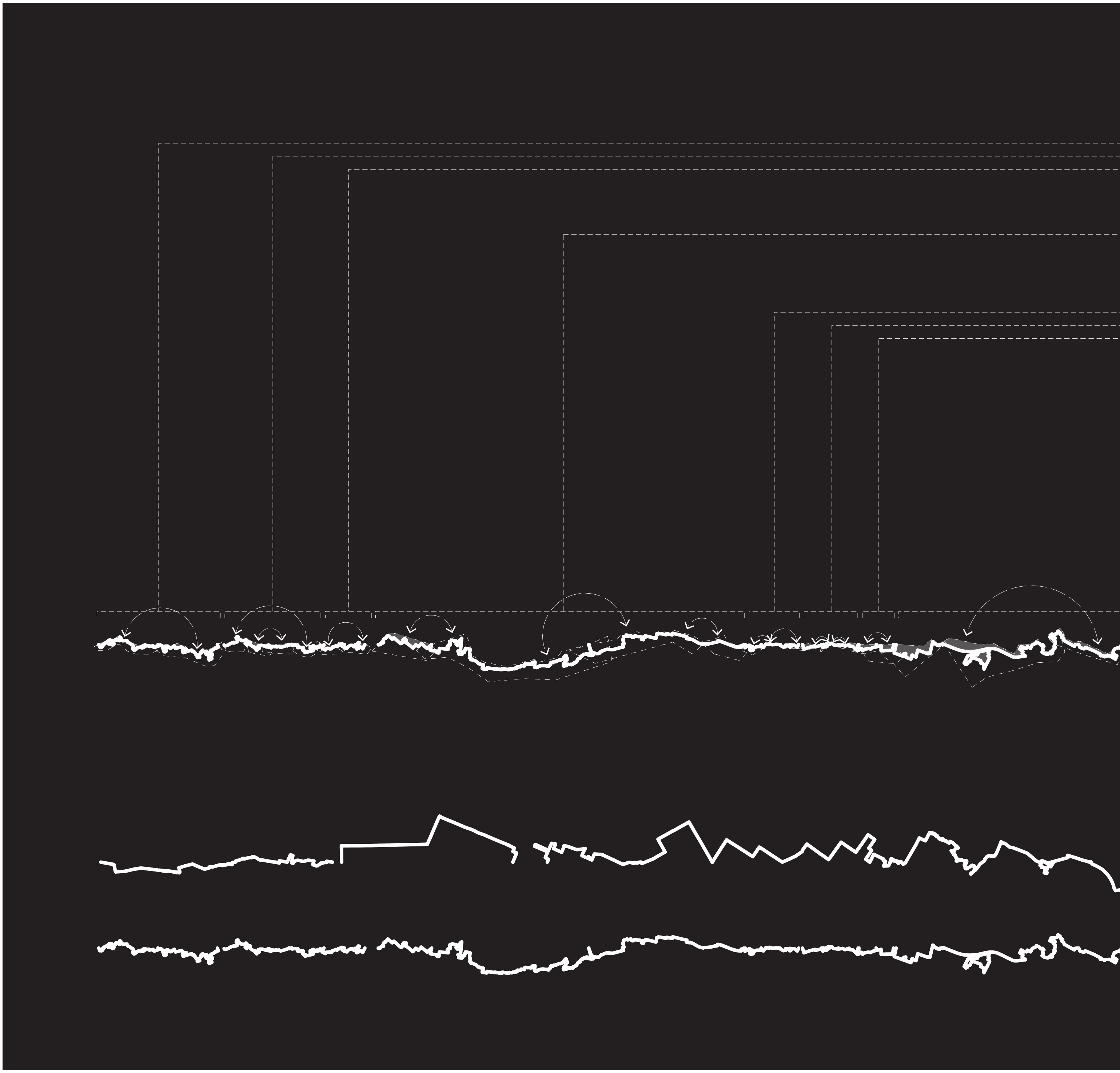
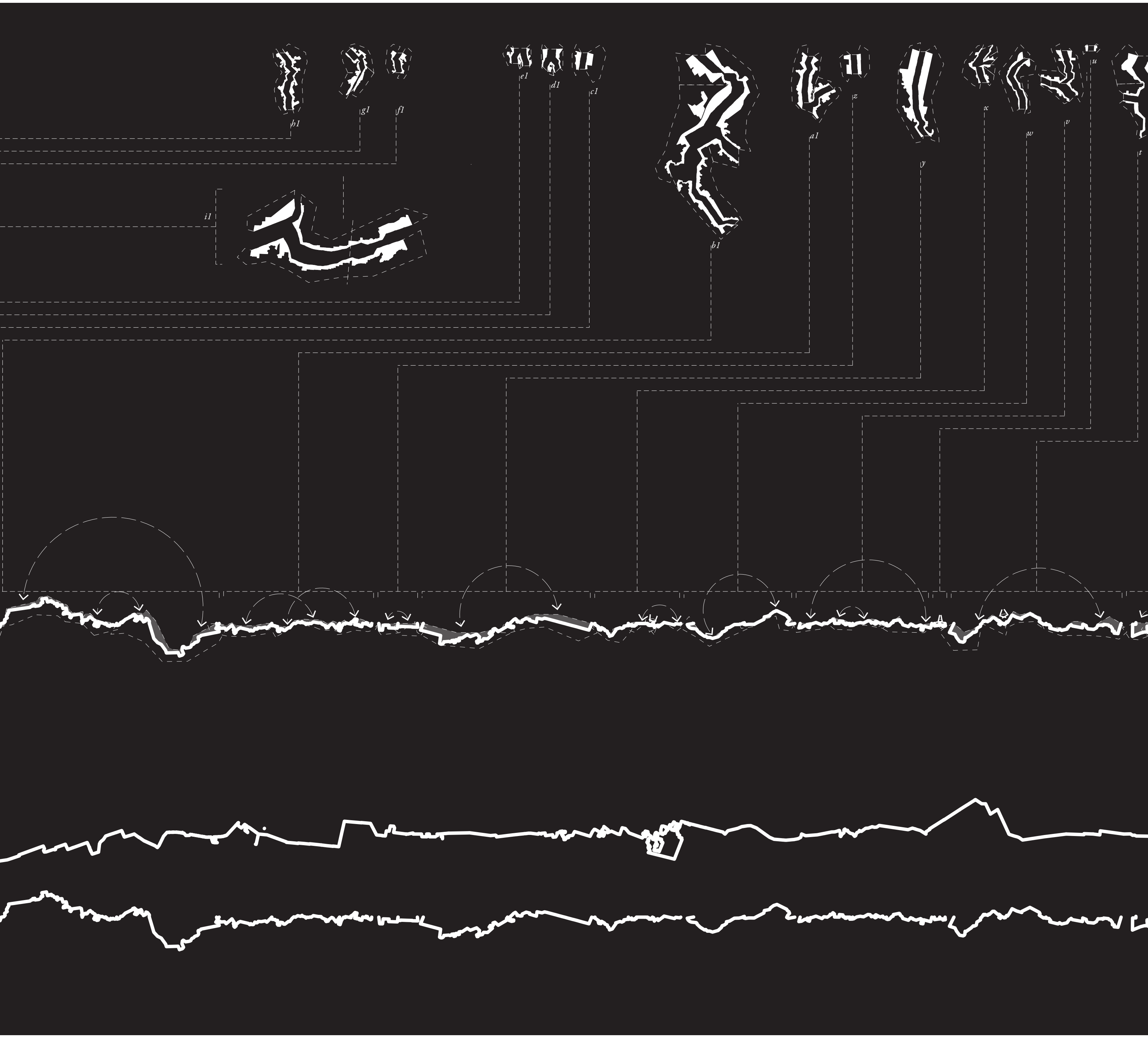


Figure 2.6 - This map shows how the geometry of the previous maps are unfolded around the ecologicaly sensitive river valleys and hydrological corridors to become a simplified linear boundary.

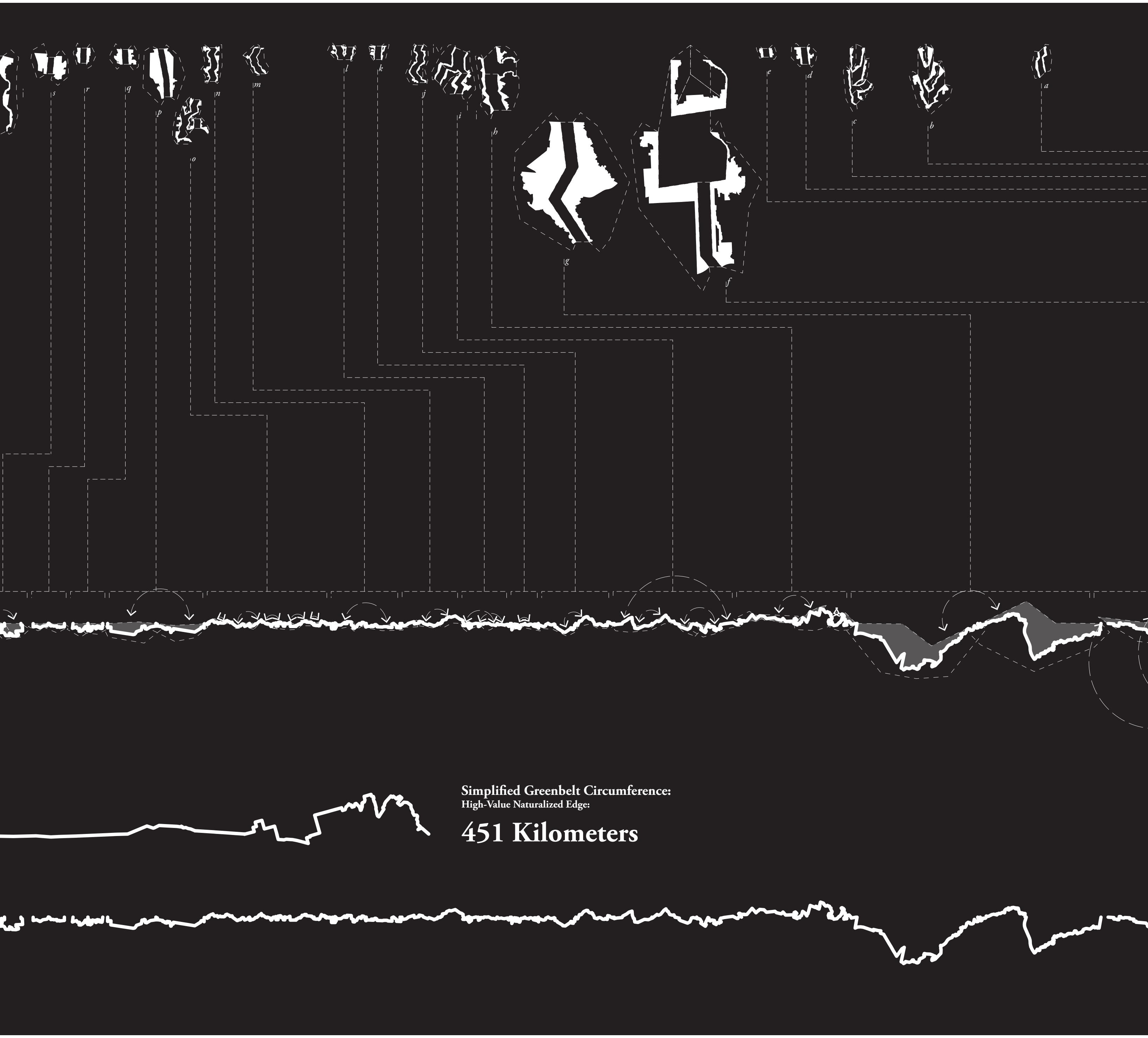
The unfolded interior of the Greenbelt is bridged by various networks both infrastructural and ecological., with ecological/hydrological networks such as rivers and streams being shown in green, hydropower corridors in yellow, and major highways in red.

The hydrologically protected boundaries of the Greenbelt are shown in white at the bottom, and are unfolded seperately in the next diagram.





h1
g1
f1
e1
d1
c1
b1
a1
z
y
x
w
v
u
t
i1


Simplified Greenbelt Circumference:
High-Value Naturalized Edge:
451 Kilometers

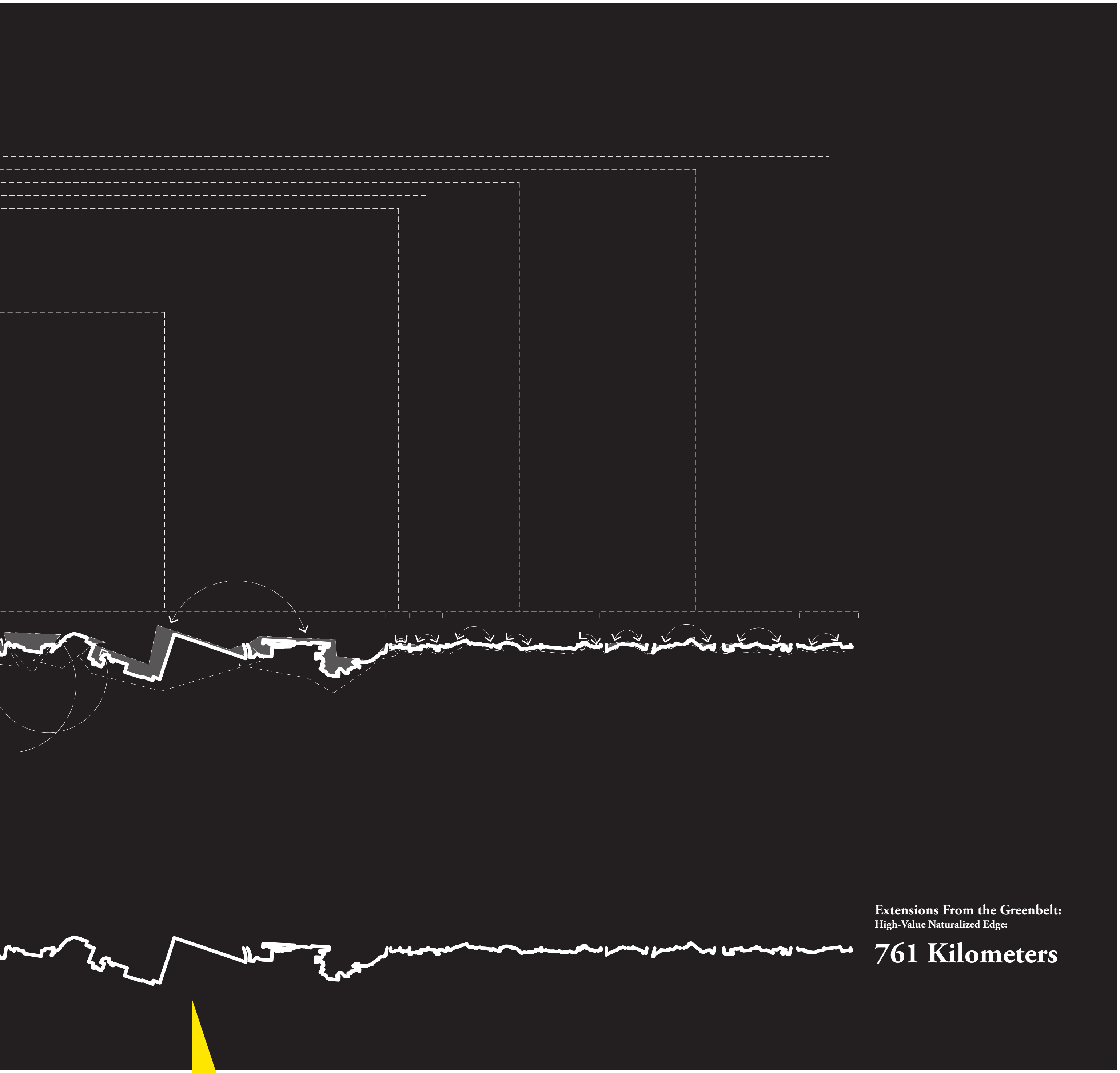
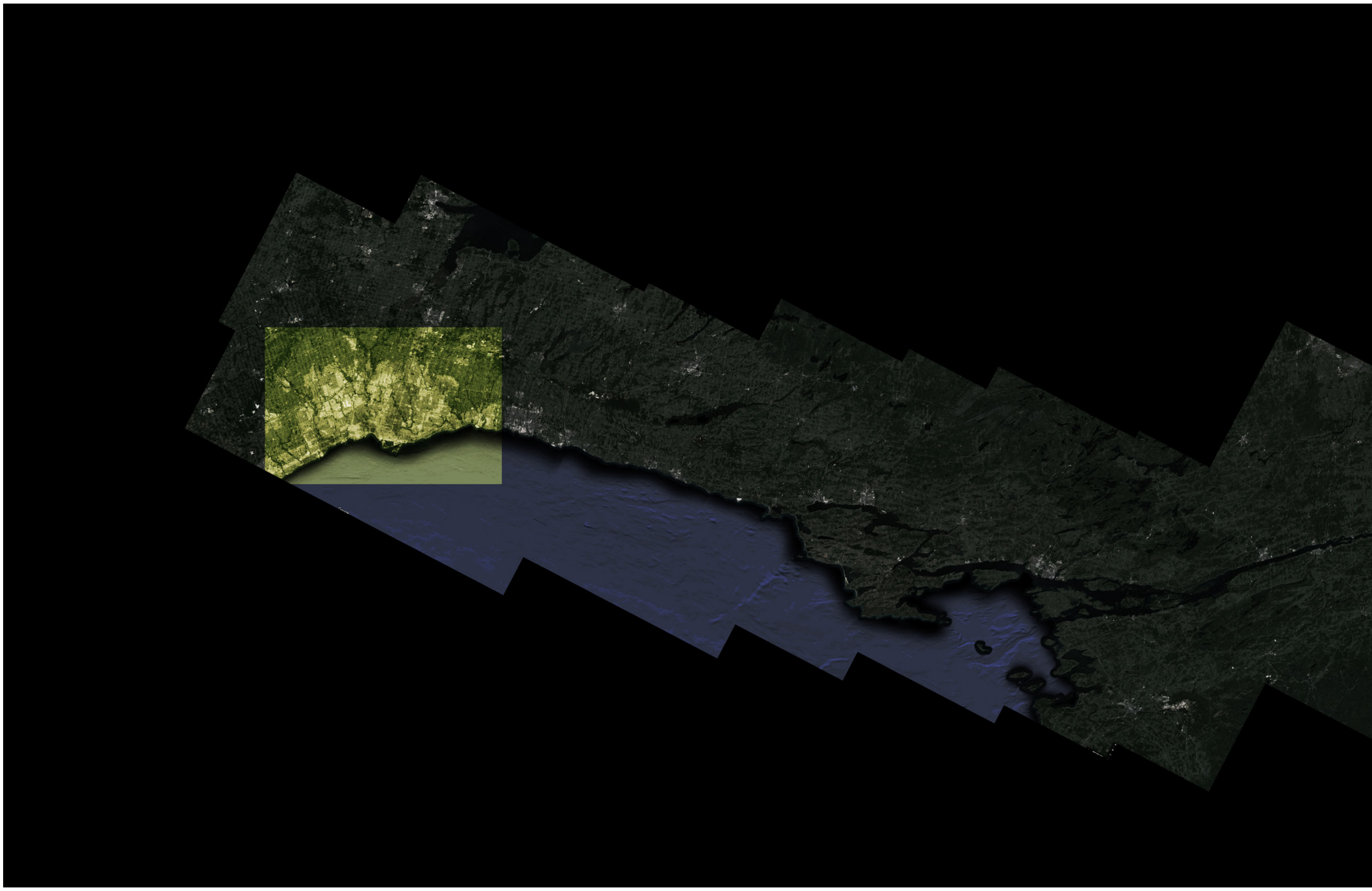


Figure 2.7 - When the network of hydrological features is unfolded, the total length of high-value adjacency lands becomes apparent, with a total of 761 kilometers of naturalized-urban adjacency, and 451 kilometers of agricultural-urban adjacency.



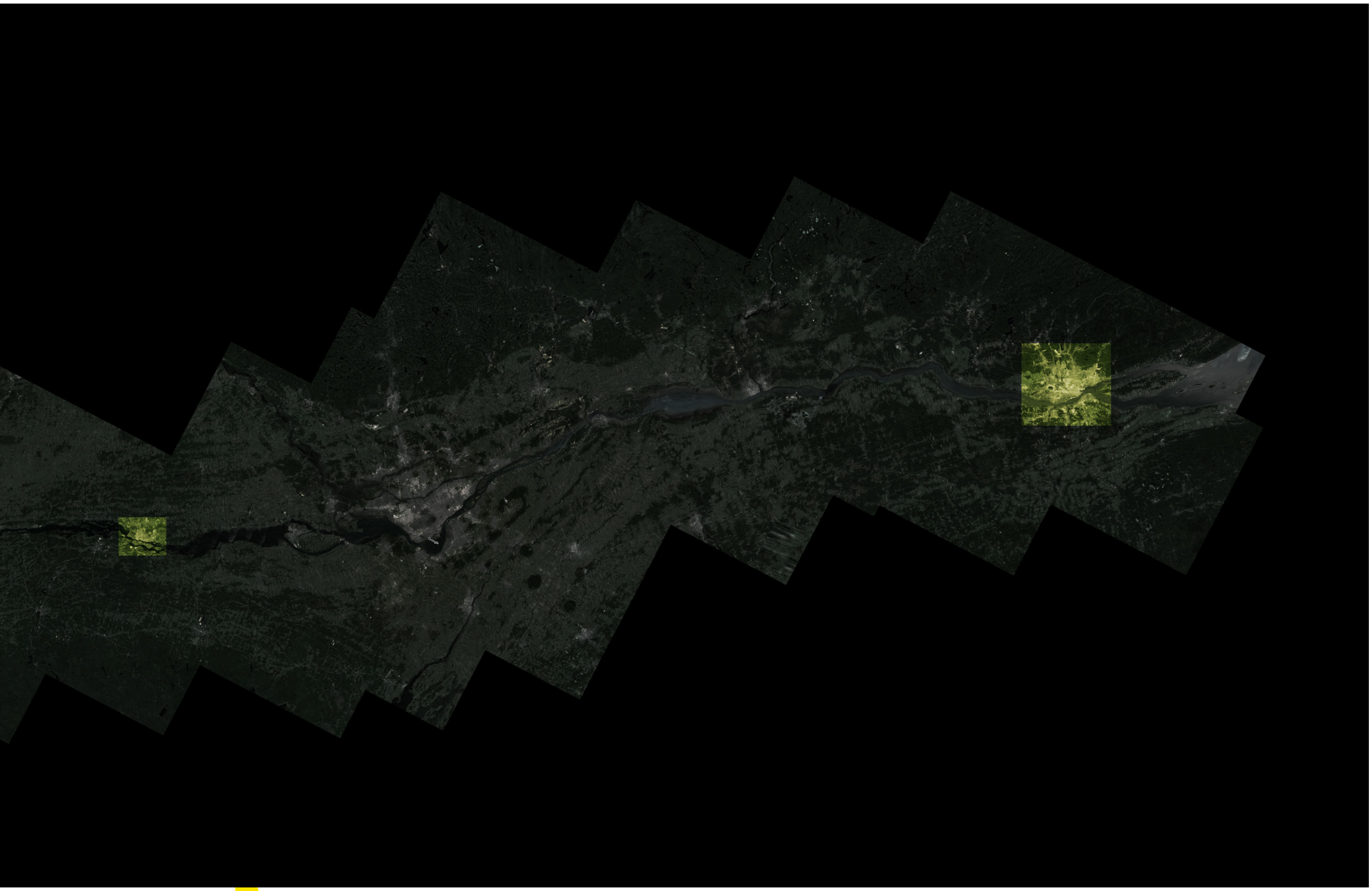


Figure 2.8 - This map demonstrates the sheer volume of high desiribility lands that form the interior boundary of the Greenbelt.

If these lands were to be unfolded around the simplified boundary line (Figure 2.7 on page 36), the linear distance that this boundary would cover would be equal to 451 kilometers, roughly the distance from Toronto to Ottawa.

The rivers and hydrological corridors by themselves would stretch 761 kilometers, nearly the entire distance from Toronto to Quebec City.

that is the boundary between the legally protected Greenbelt lands and the current and future urban development of cities in the GTHA is manipulated in the form by unfolding the geometry and flattening it into a simplified line. The interior edge of the Greenbelt, currently an abstracted boundary shaped by pre-existing policies, geological and ecological features is now reimagined as a much simplified linear boundary that allows for a more clarified understanding of the sheer quantity of opportunity at the edge of this critical agri-ecological preserve.

Furthermore, by unfolding the inner edge of the Greenbelt, the map clearly demonstrates the existing panoramic condition that is apparent therein. This panorama opens onto two conditions – agricultural vistas and ecological ravines – which both add value to the lands at their boundaries. In the accompanying maps, the value and desirability of lands is established based upon census tracts combined with incomes over one hundred thousand dollars as a percentage of population[1] and in the metro Toronto area actual property values. If a buffer zone of even a half kilometer is established off of this panoramic boundary, then the cumulative area in the GTHA for high value potential development due to proximity to the Greenbelt panorama is over six hundred square kilometers.[2]

It is clear from these maps that the edge between protected rural and developing urban conditions in the GTHA holds enormous potential value. The idea of continuing development patterns unchanged as GTHA cities reach this boundary is simply unbelievable as desirability for these lands, coupled with decreasing development land areas, will ensure that the boundary lands are developed to allow more people to access the panorama beyond simply increasing density but also in terms of addressing this unique condition in the GTHA.

2.3 | Identifying Sites of Congruent Potential

With a clarified understanding of the increased economic potential value of boundary lands around the GTHA comes an impetus to amplify various traits and conditions which occur in geographies such as the Greenbelt. As the Greenbelt is a critical public resource due to its agricultural, ecological and land planning effects, there is a clear necessity to preserve and protect its value for a healthy and productive future for the region.

In this thesis, four infrastructure and resource networks are analyzed cartographically in order to determine productive congruencies, geospatial areas with the potential to improve upon the provincially mandated development strategies for the GTHA. The networks mapped are agricultural production, ecological preservation and hydrological networks, social programming and public community areas, and solar power generation opportunities for a resilient power grid.

By mapping out the physical locations and overlapping between these networks, sites can be revealed which would benefit from the addition of either programming that takes advantage of the presence of the network, or fulfil a need due to the absence of the network in that area. These sites show greater promise in being financially viable as investment opportunities for both the public and private sectors.

2.3.1 | Agriculture

The hydrological importance of river valleys and ecosystems is clearly stated as an ecological priority for protection in the Greenbelt Plan. In the plan it is stated that the "protection, improvement or restoration of the quality and quantity of ground and surface water and the hydrological integrity of watersheds"[4] are necessary for the enhancement of "… urban and rural areas and overall quality of life…"[3]

For this reason cartographies are generated which isolate the urban river connections protected by the Greenbelt as specific intervention zones, or buffers reaching inwards from the Greenbelt interior edge. These buffers are connected both to the important hydrological resources at the rivers as well as the developing municipalities and infrastructural networks. Design interventions at these sites are ecologically and hydrologically focused.

2.3.2 | Ecology

The network of hydropower corridors that crisscross through the province exist as anomalies compared to other land use developments, not conforming to municipal boundaries, ecological or geographical features, infrastructure networks or other networks apart from that of transformer stations and substations. For this reason, the hydropower corridor network – and the vast areas of generic landscapes contained therein – can perform as a new connective network with extensive reach joining a variety of municipalities and landscapes. Design interventions in these networks are ecological and agricultural and social and act as a connective network for these programes.

2.3.3 | Social

The purpose of this map is to isolate existing large format retail developments along the boundary between the Greenbelt and the interior municipalities in order to locate contemporary large format retail developments to analyze and modify for interventional purposes. These large format retail developments are already built and exist in the Greybelt and their present typology establishes the pattern of development in contemporary large format retail sites. The design portion of this thesis will find areas and qualities to improve upon.

In order to select potential intervention sites from the large format retail network, several geospatial criteria were isolated and examined. These criteria were: proximity to the Greenbelt-urban boundary (one kilometer) and the presence of a food distributor or grocery store on the development site. From these requirements, seven sites were selected that adhered to these criteria, of which two were investigated in greater detail according to specific site related parameters described in Chapter three.

2.3.4 | Solar Power Generation

Solar power generation is a condition that is not overly dependent on any particular geographic or urban features. Photovoltaic arrays can be placed in any number of configurations and locations, whether that be in at-grade solar farm installations, residential rooftop panels or commercial/industrial rooftop arrays.

Solar power generation can, however, be used as both a means to reduce operating costs for the large format retail development as well as a method to generate revenue via selling generated power back into the grid. By generating electrical power on site and storing it in battery arrays, the LFR ensures greater robustness to their operations and potentially the electrical grid itself as power outages become a challenge with at least a temporary solution.

Despite the fact that solar power generation is not site specific, the conditions promote uninterupted power generation - full solar exposure and lack of shade - are only as useful

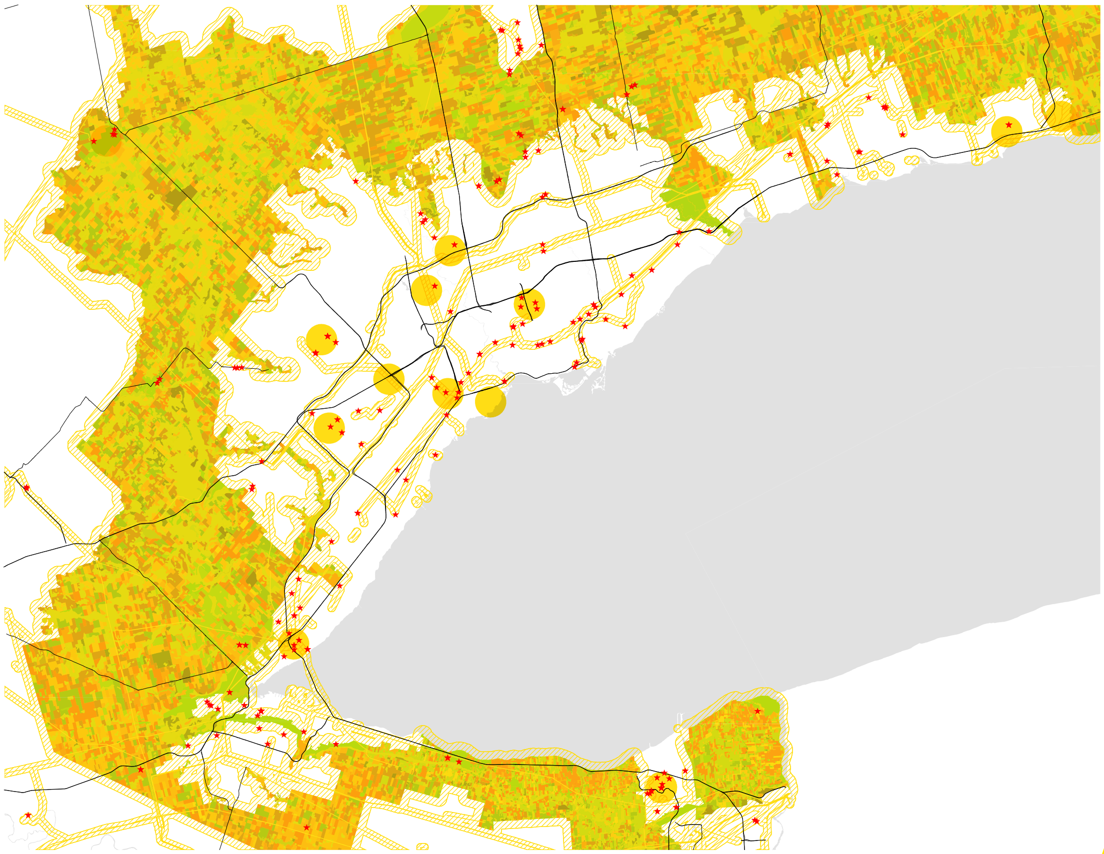


Figure 2.9 - Map establishing agricultural adjacencies

In this map, agricultural buffers are drawn off of the boundaries of the Greenbelt as well as hydro power corridors, generating places for existing and potential future agricultural production and infrastructures in close proximity to existing and future urban developments.

These buffers are 500 meters, well within the range of a comfortable walk for many people.

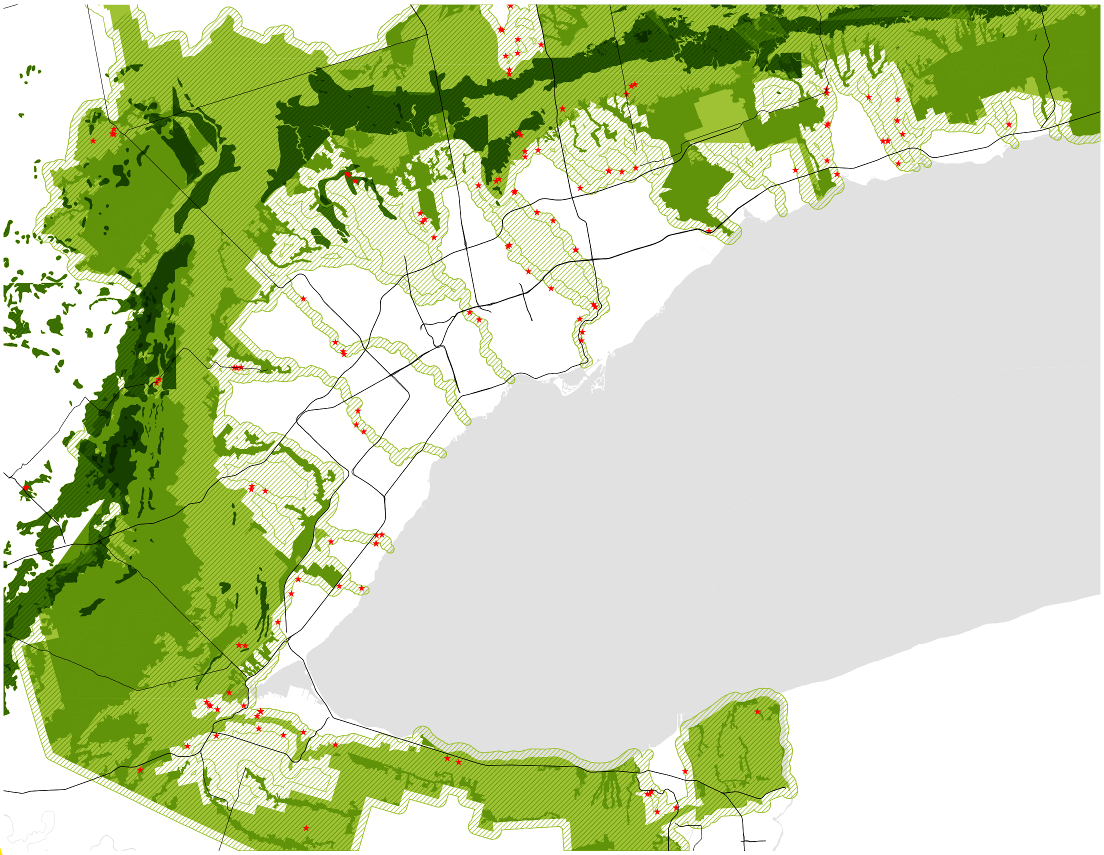


Figure 2.10 - Map establishing ecological adjacencies

In this map, ecological protection zones are expanded upon beyond the simple boundaries of the Greenbelt.

These 500 meter buffers generate places in which the ecological impacts of development may have a higher adverse effect on the hydrologies and ecologies that are so critical to the region's natural health.

These buffers are based on the Greenbelt and expanded river valley networks including the urban river connections to Lake Ontario.

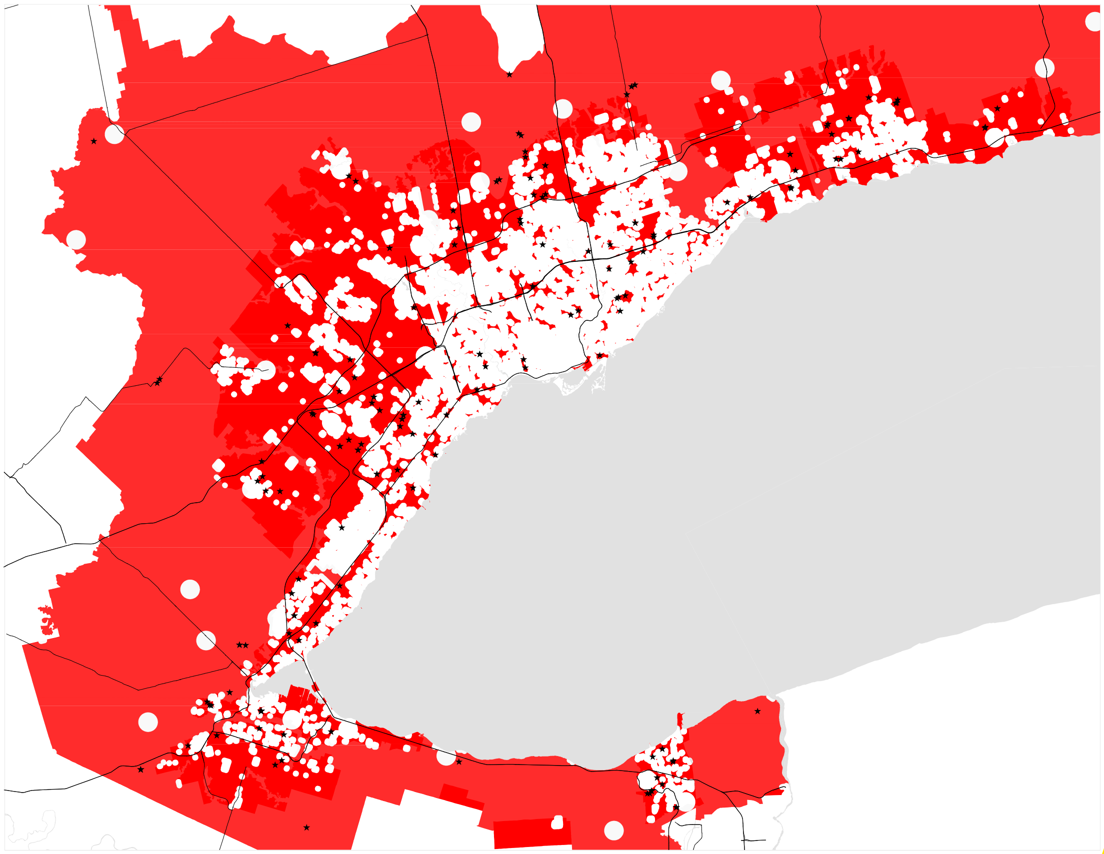


Figure 2.11 - Map establishing social deserts

Existing social and recreational assets are removed from the urban fabric including and between the Greenbelt and Lake Ontario, revealing social deserts where the addition of cultural and recreational programming can have the most impacts.

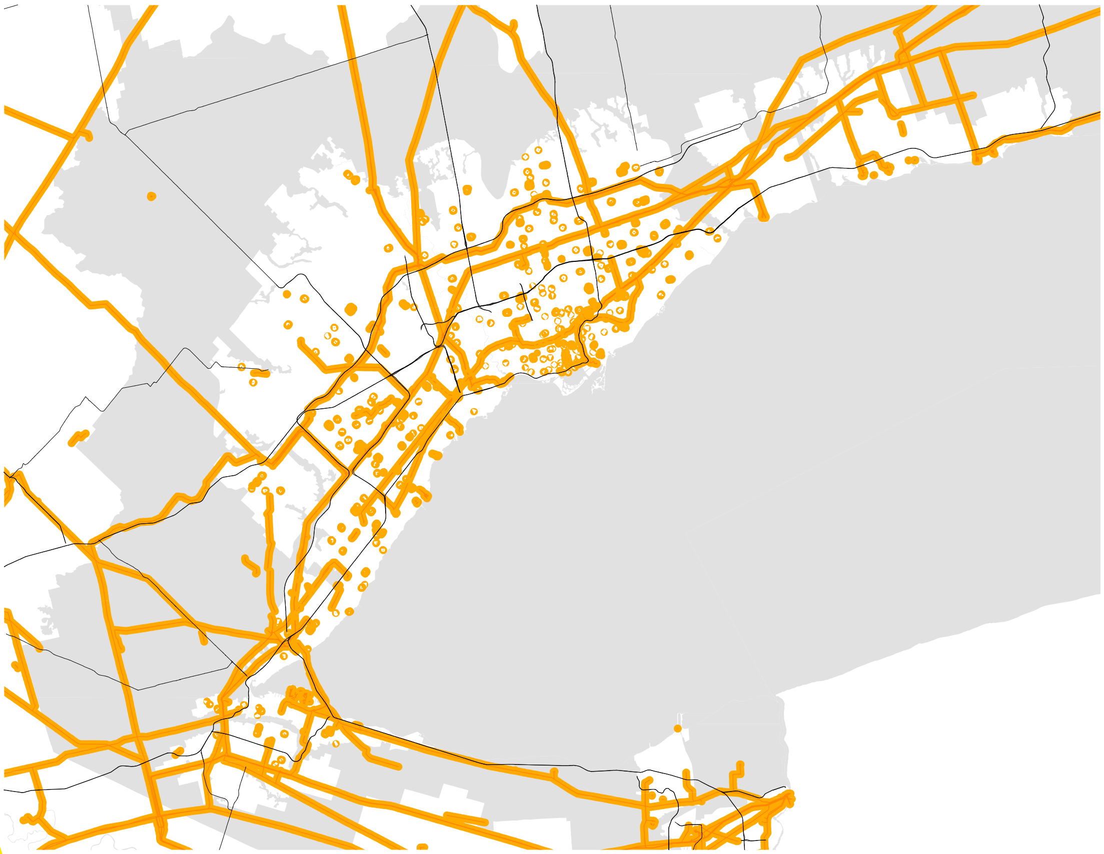


Figure 2.12 - Map establishing photovoltaic production areas and energy grid tie-ins

Solar power generation can take place on any open and sunny site. While the general light infrastructural requirements for solar allow installations in nearly unlimited sites or circumstances, there are economic benefits to larger installations to take advantage of economies of scale, particularly if energy storage infrastructures are to be set up.

This map shows the breadth of underutilized hydro power corridors as well as the larger sites of large format retail development, areas which may be effective in generating, storing and selling solar power energy.

Figure 2.13 - Map establishing convergences of high-value programming

A combination of these various networks of opportunity generate combinations of high density geographies, landscapes in which hybrid programming can take place while fulfilling a need or taking advantage of a naturally occuring opportunity.

Figure 2.14 - Map demonstrating potential sites, based off of total congruencies and existing LFR development locations.

In this map, the overlapping of the various existing networks and buffers reveals certain key development areas which may have the most opportunity for additive programming.

These key development areas are shown with existing LFR developments in red, showing ideal candidates for a specific-site proof of concept design.

in determining sites for such endeavours as the landscape beneath the photovoltaic panels. That is to say, an installation needs to take into account the quantity of solar radiation as well as the fact that the landscape beneath the panel arrays needs to not be negatively affected by a continuous year long shade canopy. For these reasons, solar power generation site selections have been based upon the network of expansive LFR sites as well as the underutilized hydro power corridors.

2.4 | Conclusion

In isolating and manipulating the geospatial edge between the Greenbelt and the Whitebelt, the vast territories that make up this boundary condition can be isolated and more easily understood in terms of opportunity through desirability and conservation. Mapping has shown that there is a demonstratively higher economic value to edge condition development that may be leveraged to offset the added costs of addressing the ecological importance of that edge.

A further investigation of four key networks reveals areas in which new value can be generated due to existing resource congruencies. For the purpose of this thesis, the site chosen as a case study of hybrid development potential is one wherein all four networks are present, although in a different case and at a different site, other combinations of networks can be combined and given weight in order to take into account local contexts.

The use of cartographic analysis of the GTHA is useful in determining pre-existing large format retail developments that show a future typical edge development condition. By isolating LFR developments in near proximity to the conditions represented by the Greenbelt and ripe for high potential development due to the congruence agricultural, ecological and urbanized conditions, a case study design site has been chosen from among many in order to explore the appearance and form of future development that takes into account the unique and valuable conditions found at the boundary.

3.0 | A Regional Corporate Landscape

3.1 | Introduction to the Regional Corporate Landscape

The Greater Toronto and Hamilton Area (GTHA) is the economic engine of the country, driving $300 billion dollars in economic productivity each year1. To say that it is an important region for the wellbeing and economic security of the nation would not be an exaggeration. While the regional economy is split into various industries – service, financial, resource extraction, agricultural, etc. – it is the retail industry with its well-known and well used large format retail store typology, or "big box" store, that this thesis will investigate in greater detail.

These large format retail development typologies are as ubiquitous as they are physically massive and are an active element in the daily lives of millions of Canadian citizens for whom this typology is their primary source for groceries, clothes, entertainment and incidentals. In fact, whichever form of living environment a Canadian lives in – whether house, townhouse, apartment or condo – it is likely that the common factor in their public daily experiences is their reliance on the LFR centre for nearly all of their purchases. In this chapter, the typology of the LFR development is analyzed in terms of site land use as well as the design rationales that drive the interior volumes.

3.2 | Ownership Hierarchies

For the intervention that this thesis proposes at large format retail developments to have a strong impact in the GTHA, the type of retail development needs to adhere to several criteria. Namely, the intervention sites need to have a physically large presence, be owned by few stakeholders so that decisions to alter the typology can be realized efficiently, and be generic so that successful alterations and additions to the test location can be replicated across an extensive and growing network. For these reasons, explained in detail below, the ideal retail environment in which to make these interventions is the large format retail environment that is so ubiquitous in the GTHA.

Retail Size

In terms of reach, the small-scale local business (or the "mom and pop" shop) is generally restricted to the historic main streets of an amalgamated municipality or exist as a complementary element to the anchor store of the retail strip. While their network of locations is collectively expansive, their individual impacts on the surroundings are relatively minor due to their small physical sizes and independent ownerships. The large format retail development is the antithesis of the local business in terms of scale, existing on large parcels of land with expansive paved areas surrounding the decorated shed that is the box. Their physical size is industrial and isolated as opposed to pedestrian and integrated.

Retail Ownership Heirarchies

Unless part of a corporate chain, the ownership of the small-grain retail environment is usually the managers/operators themselves. What this means is that decisions and changes can be made relatively quickly depending on funding availability and that the authority to implement change rests with the people most directly involved with the day-to-day operations of the business.

Large-format retail, on the other hand, is owned and managed by differing sets of people who are not immediately present in the locations of their stores. While local managers and supervisors have an influence on the daily operation of the retail locations, the critical decision making for the physical condition and alterations to the store comes from above. The authority to implement changes to the retail format, distribution of goods or sales formats lies in the hands of a small group of executives and analysts. These high-level administrators and decision makers are much fewer in number than store level managers and carry considerable influence and reach in terms of decisions on the operation and appearance of the business. This has the effect of creating a centralized power structure for the large format retail typology that this thesis proposes partnering with in order to effect large scale improvements to the suburban Whitebelt condition.

3.3 | Large Format Retail as a Generic Canvas

The large format retail typology has been so successful for so long in part because refinements and improvements to any retail location, if successful, can be imitated relatively easily across various near-identical locations. Instead of numerous retail locations needing to learn and make mistakes, the entire network of generic large format retail locations can act as testing grounds for improvements to the typology and learn from each other. Their similarities are exemplary of their generic and formulaic nature, as proven by the fact that regardless of site area or location, these developments are nearly perfectly uniform in their land-use ratios, with 30% of the site being covered in the physical buildings that drive the retail operations, 60% being asphalt paved areas and a superficial 10% of the site being devoted to softscaped elements such as planting beds or lawn.

The absolute homogeneity of the corporate chain typology has allowed several corporations to perform total physical rebranding of their retail networks in the recent past, renovating aged physical storefronts to reflect changing consumer desires, demographics and priorities in cohesive ways that allow for an unbroken corporate image to be projected to all of their consumers. McDonalds, Tim Hortons, and On Route have all made enormous investments in a complete makeover of their physical locations, and the similarities between all of their properties has meant that a single design master plan could be generated and then applied with some modifications due to particular site constraints.

3.4 | Corporate Networked Locations

The GTHA is home to an extensive network of large-format retail nodes, connected via their reliance on other networks, namely the road and highway network and the residential development networks. These retail nodes portray all of the characteristics of the suburban archetype. They are homogeneous in morphology and occupancy, expansive, generic, paved-over, branded and, most critically, possess a near absolute reliance on the use of a private automobile for access. Located along the major auto-oriented transit corridors of highways and arterial roads, these large-format retail nodes are always situated in proximity to residential sheds within close driving range at relative speeds. It is to the advantage of the large-format retail node to be just off of a highway exit because the greater speeds of the highway increase their consumer shed. Specifically, the sites selected for this type of large-format commercial-retail developments are situated to achieve the following goals:

Efficient distribution: The commercial-retail node is situated along major arterial roads not only to take advantage of the volume of customers that can be brought in, but also for the ease of transport trucks to navigate these wide, straight roads directly from the highways. The less turns needed to make the trip the more efficient the distribution process will be.

Maximize customer access: The large-format retail

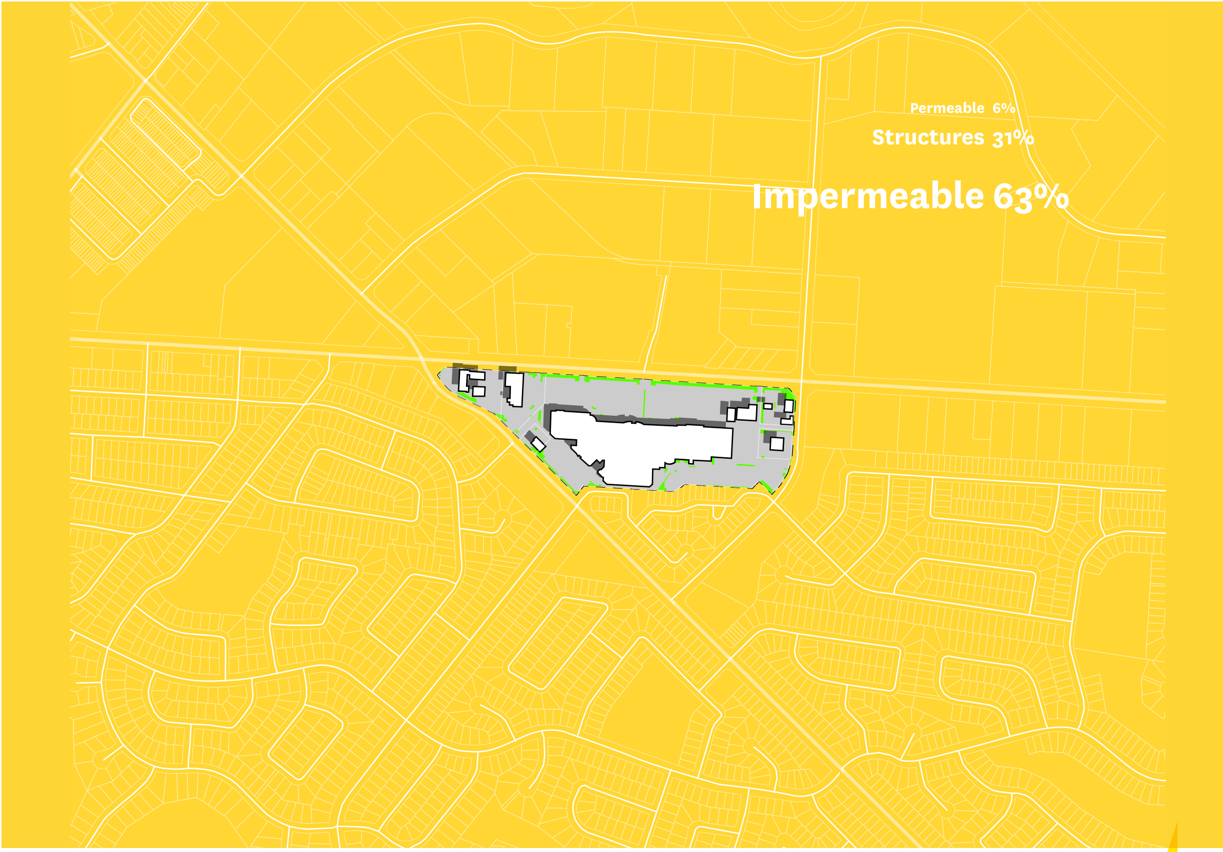


Figure 3.1 - LFR Site Land Use Case Study #1

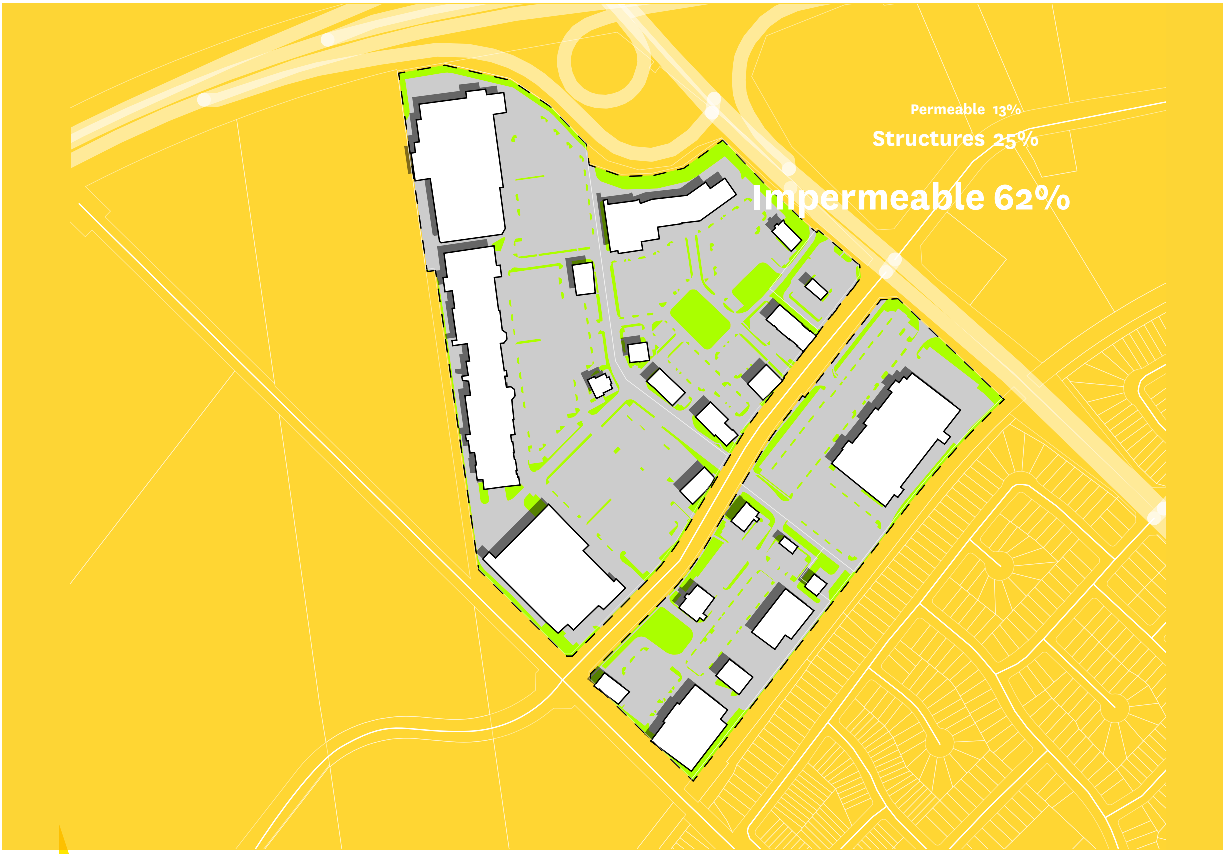


Figure 3.2 - LFR Site Land Use Case Study #2

Figure 3.3 - LFR Site Land Use Case Study #3

Figure 3.4 - LFR Site Land Use Case Study #4

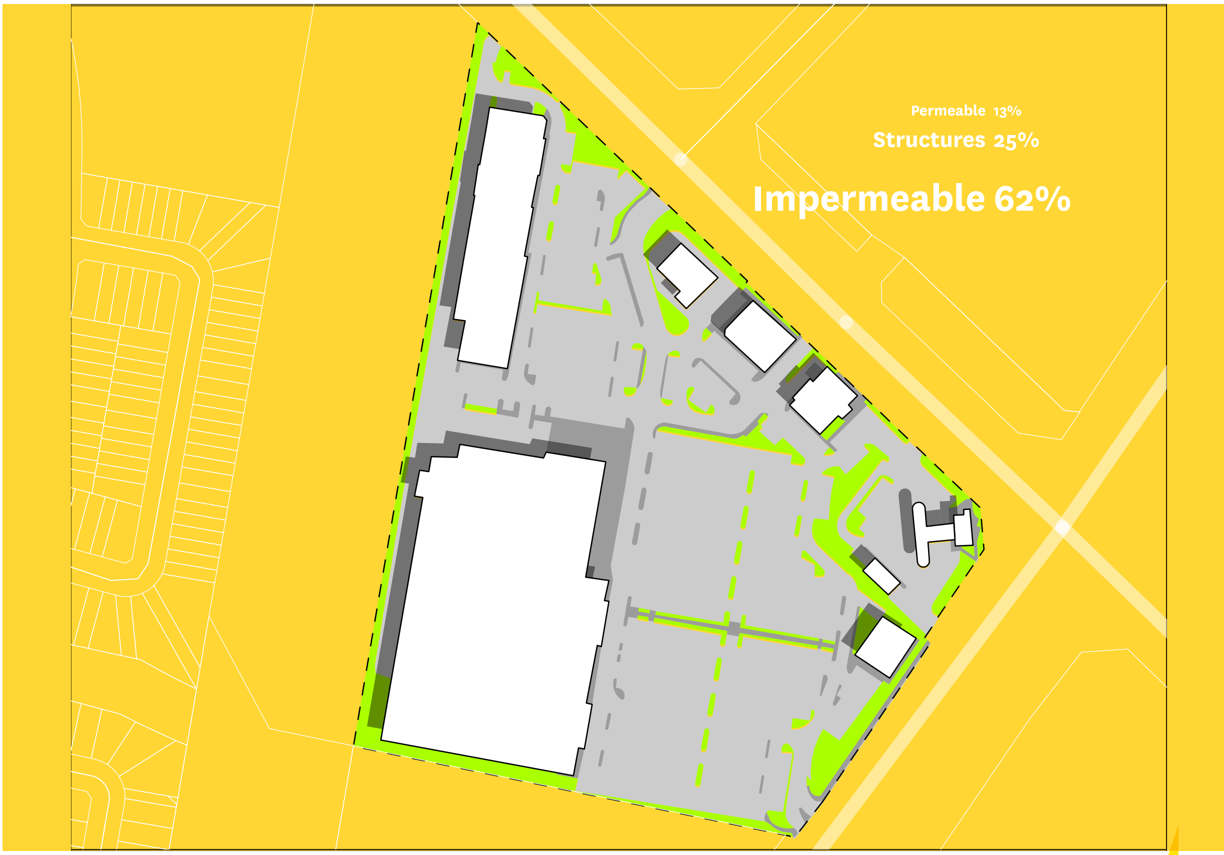


Figure 3.5 - LFR Site Land Use Case Study #5

This is the site chosen for the final hybrid design case study in Chapter 4, and is located at Dundas Street and Appleby Line.

Figure 3.6 - Map showing the network of LFR developments incorporating a large food retailer on site.

In this thesis, these points represent potential opportunities for more profitable enterprise due to their formulaic and generic networks.

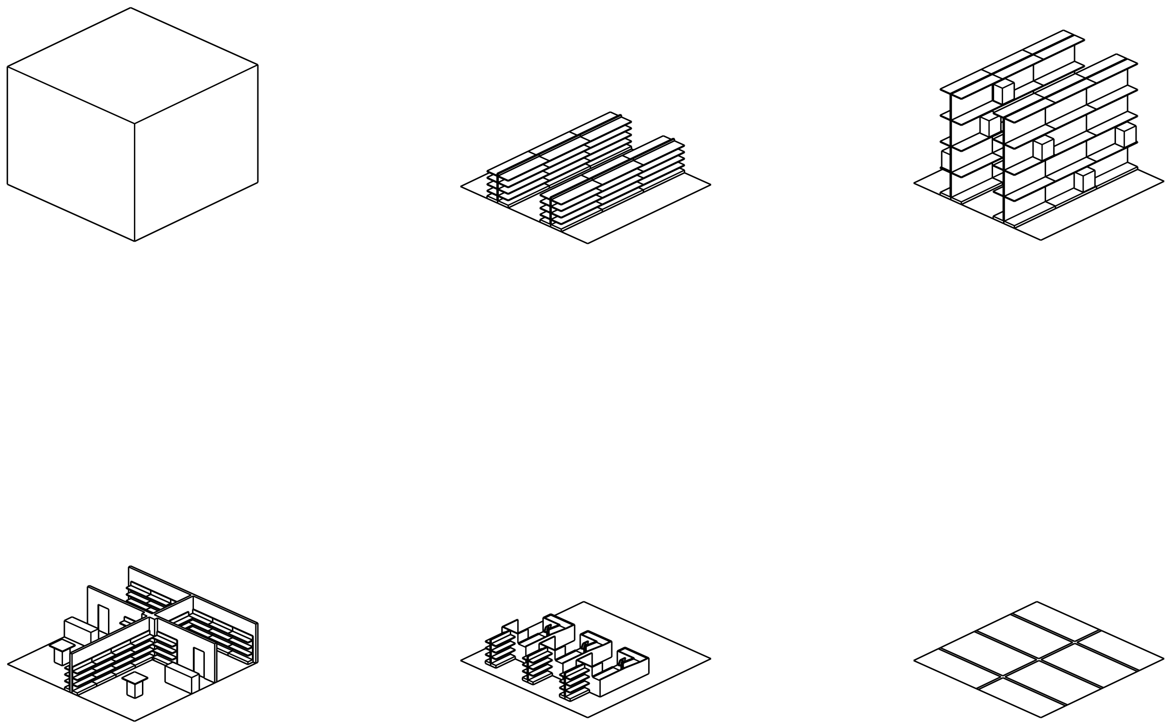


Figure 3.7 - Diagram showing formulaic interior layout design language

Formulaic and repetitive interior and exterior elements define the large format retail tyology. Carefully calculated to optimally utilize the spaces on site and within the building, these elements work around a regularly spaced column grid.

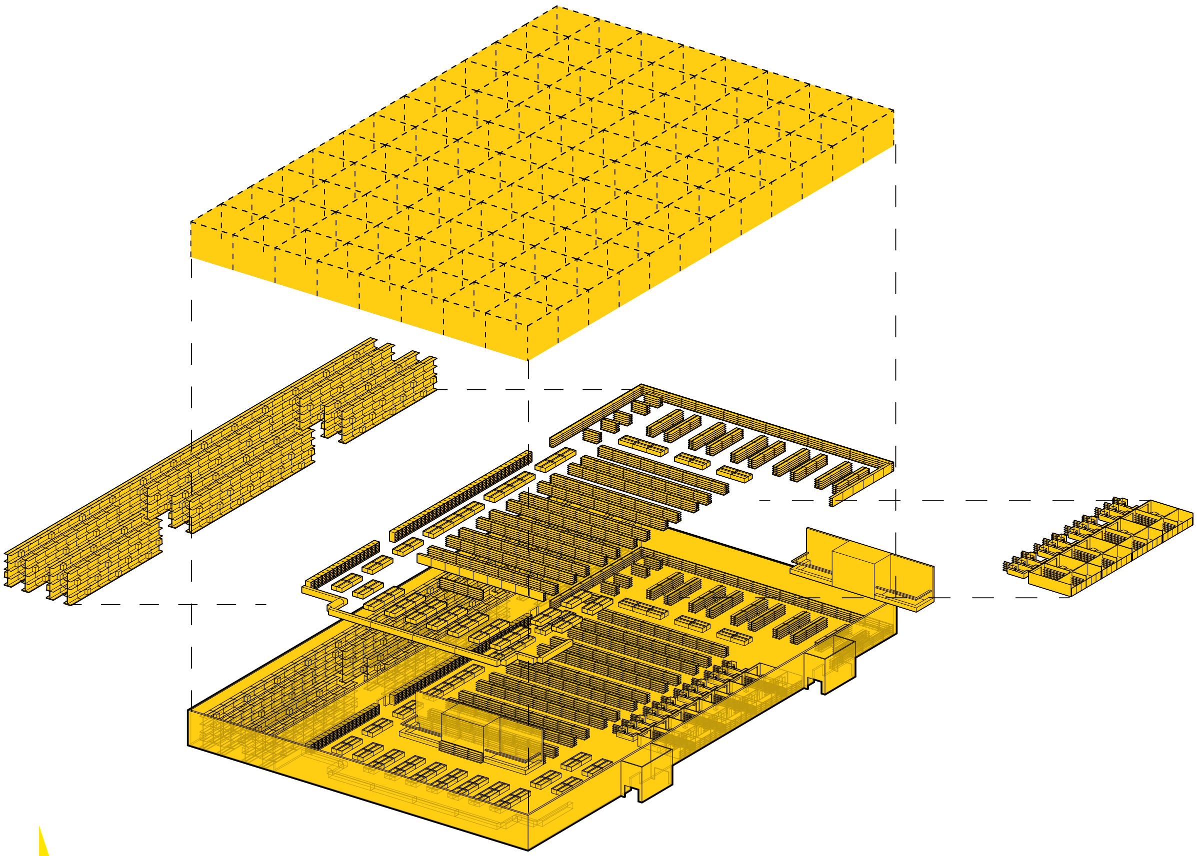


Figure 3.8 - Interior volumes are optimized to a pedestrian level in the public areas (shelving aisles, registers, boutiques) but optimized for vertical height in back of house areas where forklifts and specialized equipments can be operated without danger to customers.

The regular column grid is the organizational element around which the buildig is structured, its dimensions calculated to allow for optimal aisle widths without space lost due to their placement.

node is typically located close to residential developments, with larger 'super' and 'power' centers often being located directly at the intersection of a major highway and an arterial road. The closer to a highway the retail node is, the higher use it gets from regional shoppers.

Minimize costs: Corporations rely on a minimized initial investment of land purchase and development to create a higher return on investment for the property when it becomes operational. In order to minimize the costs of building a commercial-retail node, the developer will opt for the cheapest land that fits their criteria. Environmental site factors such as views, green space and walking path development are all aspects of a site that are typically deemed desirable but in the context of large-format retail development simply add to the cost of the initial investment, and based on their current method of site use and construction do not contribute to any profit.

The result of these site-selection attributes determining the locations of large-format retail developments is that there now exists a network of near-identical site conditions spread around the GTHA, with similar factors affecting each and every one. As such, any morphological changes to the design site can be reproduced throughout the network with only minimal changes to the existing design typology to account for minor variances in the surrounding contexts of each individual site. The economic advantages for the existing typology of the large format retail development can be applied to interventional design.

3.5 | An Introduction to the Corporate Typology

When considering shopping opportunities in the GTHA, the first thought of a typical regional resident will be of the

The diagrams on the left show the approximate existing impacts of the four lenses on the current LFR development site.

The diagrams on the right show the proposed and desired impacts of the four lenses on the site.

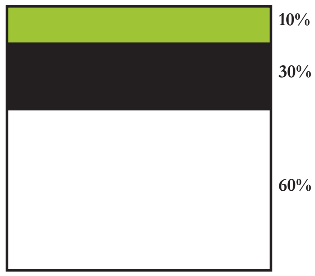


Figure 3.9 - Existing Ecology

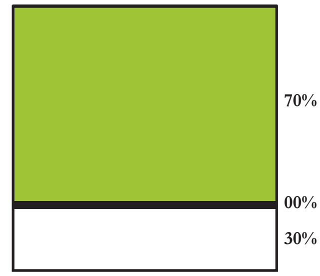


Figure 3.13 - Proposed Ecology

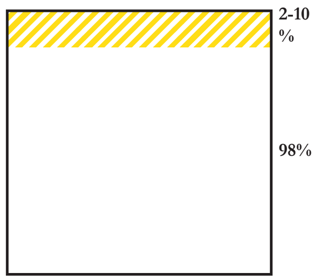


Figure 3.10 - Existing Agriculture

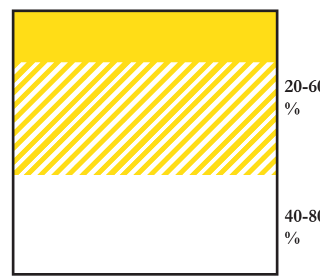


Figure 3.14 - Proposed Agriculture

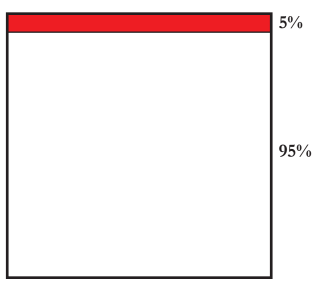


Figure 3.11 - Existing Social

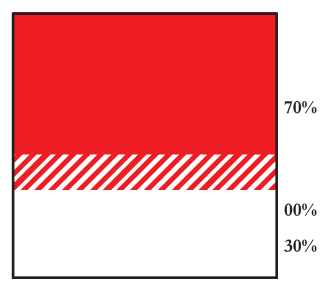


Figure 3.15 - Proposed Social

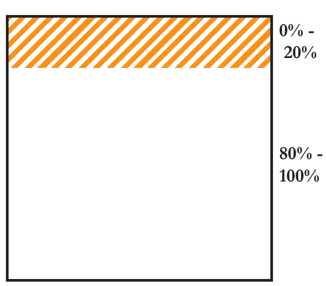


Figure 3.12 - Existing Solar Power Generation

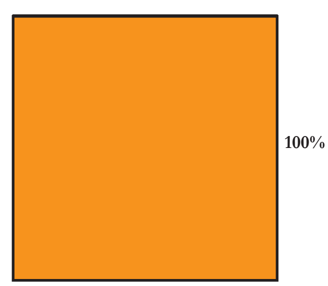


Figure 3.16 - Proposed Solar Power Generation

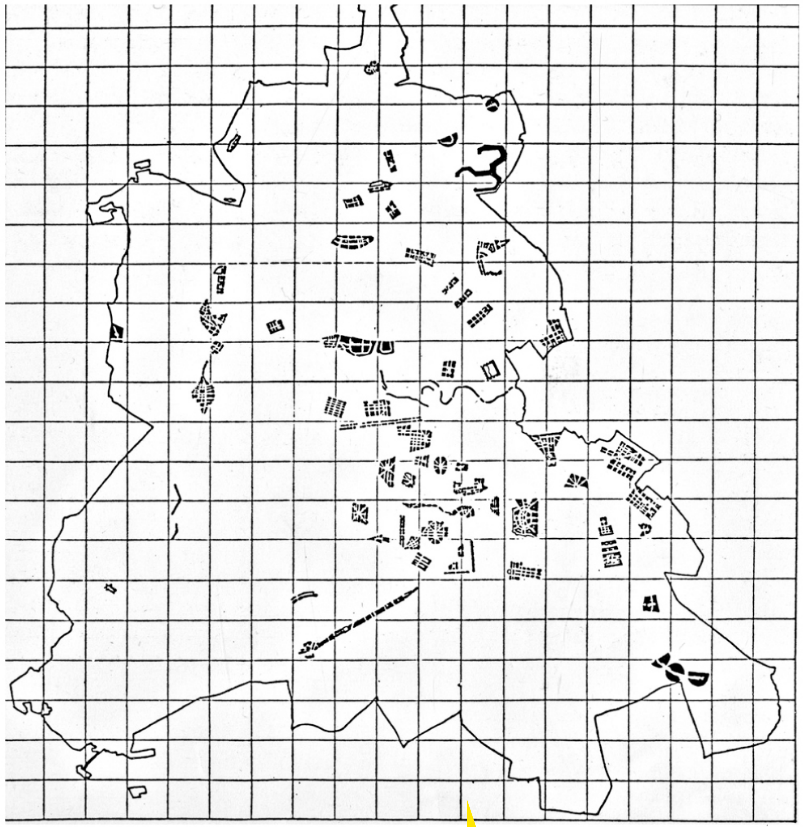


Figure 3.17 - Post war Berlin is re-imagined rebuilt as an archipelago, with nodes of cultural significance acting as loci for redevelopment.

The idea is that architecture of cultural significance can influence the reconstruction and urban layout of a post-war wasteland, their cultural and social weight filling the vacuum left by total destruction and ensuring that the city that is built out of the rubble is reflective of the values of these iconic assets.

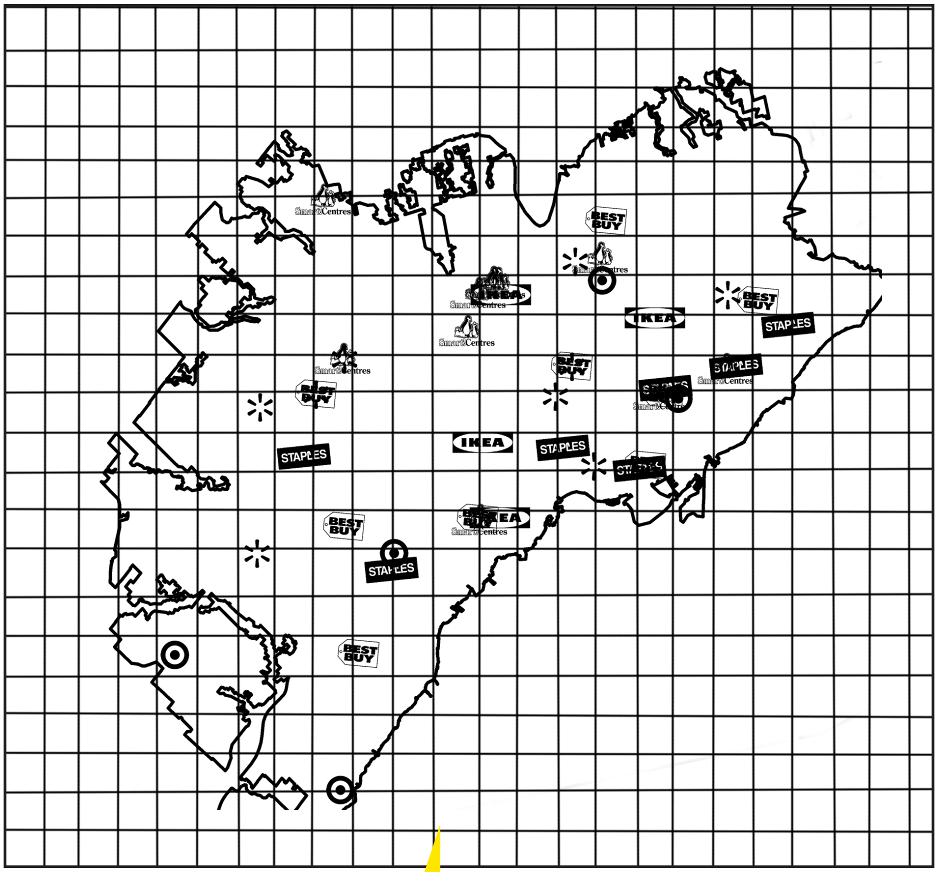


Figure 3.18 - The GTHA is re-imagined as a corporate archipelago, utilizing the expansive network of large format retail developments as loci for civic and ecological improvement.

Similarly to the green archipelago concept, the nodes that comprise the network have high cultural significance, albeit not due to their unique social value but due to their complete ubiquity and presence in the lives of those who occupy the suburban wasteland.

This network takes advantage of the inherrent homogeneity of the nodes to effect change on a large and regional scale, repeating modifications to the nodes across the system to ensure that the change has a controlled and far reaching impact.

local large format retail development. This may take the form of a local plaza with a single food retailer as the anchor or it may take the form of the regional supercenter with five or even more anchor stores and a dozen complementary retailers. While the overall development scale may differ between locations based on the desired consumer shed and sales type, the typology of the large format retail building is generic in the extreme and the architecture reflects the desire for corporate, economic and formula driven design. The following analysis will describe the architectural qualities of the large format retail development in order to establish a baseline for the design of the design intervention.

3.6 | Architectural Basis for the Big Box Store Typology

The design of the contemporary large format retail building is governed by economies. The interior and exterior spaces, the spans, ceiling heights, floor areas and volumes are all strategically chosen in order to maximize useable space while minimizing construction and maintenance costs. The primary architectural feature of the big box store is obviously its expansive nature. The floor areas, roof areas and parking areas are all vast and two thirds of them – the rood and parking – are extremely underutilized for the inherent potential of the expansive space that they occupy. The column-grid layout for the large-format retail store is predicated on the number of shelving units that can fit between the columns while allowing the minimum reasonable amount of clear space for a standard forklift to operate in the aisles.

Ceiling heights are determined by the vertical height requirements to fit the most levels of pallet shelving accessible by forklift. Typically this amounts to around 30 feet for warehousing purposes. Although this tall ceiling height is only a requirement in the stocking area at the rear of the building, the sales floor maintains this height in order to simplify construction thereby minimizing the associated costs. The result of this particular aspect of the architecture of the big-box does is to create enormous volumetric voids over the sales floor which in the present typology house hanging light fixtures, utilities, signage and banners. In some larger food-retail stores – specifically Zehr's – the front of the store has a second story walkway with access to washrooms, seminar space for cooking, etc. While this is a positive evolution within the big-box typology, it only puts to use a very small minority of the unused volume of the sales floor while leaving the unproductive void above. These voids and large surfaces are a major component of the current large-format retail typology that can be altered to promote the ideals of a more productive big-box store.

3.7 | Four Systems in the Large Format Retail Development

The method for analyzing the large format retail development sites that were selected in Chapter two is through a fourfold investigation of overlapping systems which make up the bulk of existing and potential impacts of development on the surrounding urban and rural contexts.

These four systems are:

Ecological: The analysis looks at the impact that the site has on local ecology in terms of storm water management and remediation, salt and toxin runoffs, greenhouse gas emissions resulting from the use of the site, and urban heat island impact.

Agricultural: The analysis investigates the impacts of agriculture and agribusiness related products on the site. These include distribution distances, site presence, and cultural awareness.

Social: The analysis of the social areas of the LFR development includes movie theatres, sports arenas, public libraries, public squares, pools and parks. This particular use of space is rare in a corporate commercial development, outside of food service establishments and movie theatres.

Power Generation: Solar power energy generation has in more recent years become the clear next step in establishing a robust and cost effective system for the powering of cities and corporate buildings. The implementation of large scale rooftop photovoltaic arrays by such retailers as Amazon at their fulfillment centres makes a very strong case for their effectiveness in reducing operating costs and dependence on municipal system blackouts.

By analyzing multiple large format retail development sites in various locations around the GTHA, this thesis establishes prevailing trends in terms of large format retail development priorities, which in turn generate a frame of reference for the existing LFR typology. The ratios of land cover determined through this analysis show that the average large format retail development is comprised of roughly sixty percent impermeable land (circulation pathways, delivery, parking), thirty percent retail building (anchor stores, secondary stores, restaurants), and ten percent permeable grounds (landscaping, trees, storm water retention ponds). The information immediately extrapolated from these ratios is that the large format retail development in its contemporary incarnation utilizes roughly ninety percent of its total site area for the exclusive use of the economic system layer, whether in actual sales floor area, shipping and receiving, or parking lot and site accessibility. This efficacy is born from decades of research, design and testing over thousands of large format retail sites worldwide but occurs at the expense of the ecological and agricultural systems that operate alongside the economic system.

On the other hand, the remaining systems of analysis receive nearly no physical space on the site as they are clearly of much lower priority. The ecological systems that operate on site are in most cases entirely aesthetic elements that happen to work minimally towards reducing storm water runoff, as the primary storm water management strategy is through storm drain systems dispersed throughout the parking lots. Contemporary agricultural system that operates on the large format retail development is contained entirely within the food retailer building and service lanes and more distantly through the expansive distribution network from across North America. The social systems incorporated into LFR sites are nearly exclusively food service establishments, comprised of generic large chain restaurants with incorporated bars or the occasional Chuck E Cheese, Playdium or laser tag. Solar power generation is now being included in LFR developments, albeit usually only on the rooftops of the largest anchor stores.

The design portion of the thesis as it relates to the large format retail development will demonstrate how enhancing the ecological and agricultural systems of site development can improve the site for the benefit of the community, environment and Greenbelt access, all the while increasing the economic productive value of the site.

3.8 | Conclusion

The large-format corporate-retail typology has existed for decades because it is incredibly cost effective. Every iteration of its development as a typology over the years has been designed with the goal of minimizing costs – both capital and ongoing – and maximizing profits. It could be said that the large format retail store is the architectural personification of the corporate ideal, using its architectural design in order to perpetually increase profits for the corporate shareholders.

Economies of scale, site location, simple design and construction, access to civic infrastructure and effective distribution networks are all elements that serve the purpose of creating the most efficient method of creating profit through the sale of physical goods. This aggressive efficiency creates a dilemma for this thesis that is situated in the large format retail landscape of the suburban Greater Toronto and Hamilton Area, as any architectural interventions to the large format retail development needs to be financially viable for corporate stakeholders. It is imperative that any changes to this meticulously-planned, re-iterated and refined archetype be beneficial to the ecological and agricultural systems in addition to improving the economic system that lies at the heart of the large format retail development. If this profitability can be established, however, then the generic architecture and site design, top-down ownership and design hierarchy, and expansiveness of the large format retail network can be harnessed to implement much greater change through the replication of the intervention. Thus, the network of reprogrammed large format retail developments becomes a productive corporate archipelago, influencing surrounding context through architectural interventions.

4.0 | Case Study: Hybridizing the Big-Box Retail Model

4.1 | Establishing the Value of Hybrid Design

Existing large format retail typologies are effective at their primary purpose of maximizing retail and commercial exchange for profit, within the municipal frameworks in which they reside. Their homogeneous local contexts that of the generic suburban landscape, means that they need not modify their programmes or much alter their designs and layouts in order to remain effective in their primary purposes. The formula, so refined over the decades, works effectively due to the generic nature of the landscapes that these developments reside in, requiring little to no changes.

Sites situated in proximity to the Greenbelt, however have less of a generic site context than do the majority of large format retail sites within the GTHA due to the enormous agricultural and ecological importance of this adjacent region and the existing large format retail formula isn't' refined to take advantage of these opportunities.

In order to address the Greenbelt and create conditions improving upon the adjacencies between Greenbelt and urbanized areas, additional programmatic requirements need to be put into place on site, making use of the various underutilized canvases of the large format retail development such as their expansive surface parking areas, large roofscapes, and surface material designs.

Combining dissimilar programmes addressing different contexts beyond that of a generic suburban car-oriented condition, however, requires greater initial financial cost due to the architectural and structural requirements for stacking programmes and specialized construction techniques, as well as greater cost due to the increased areas and volumes to supervise and secure as well as logistics and personnel for these additional programmes.

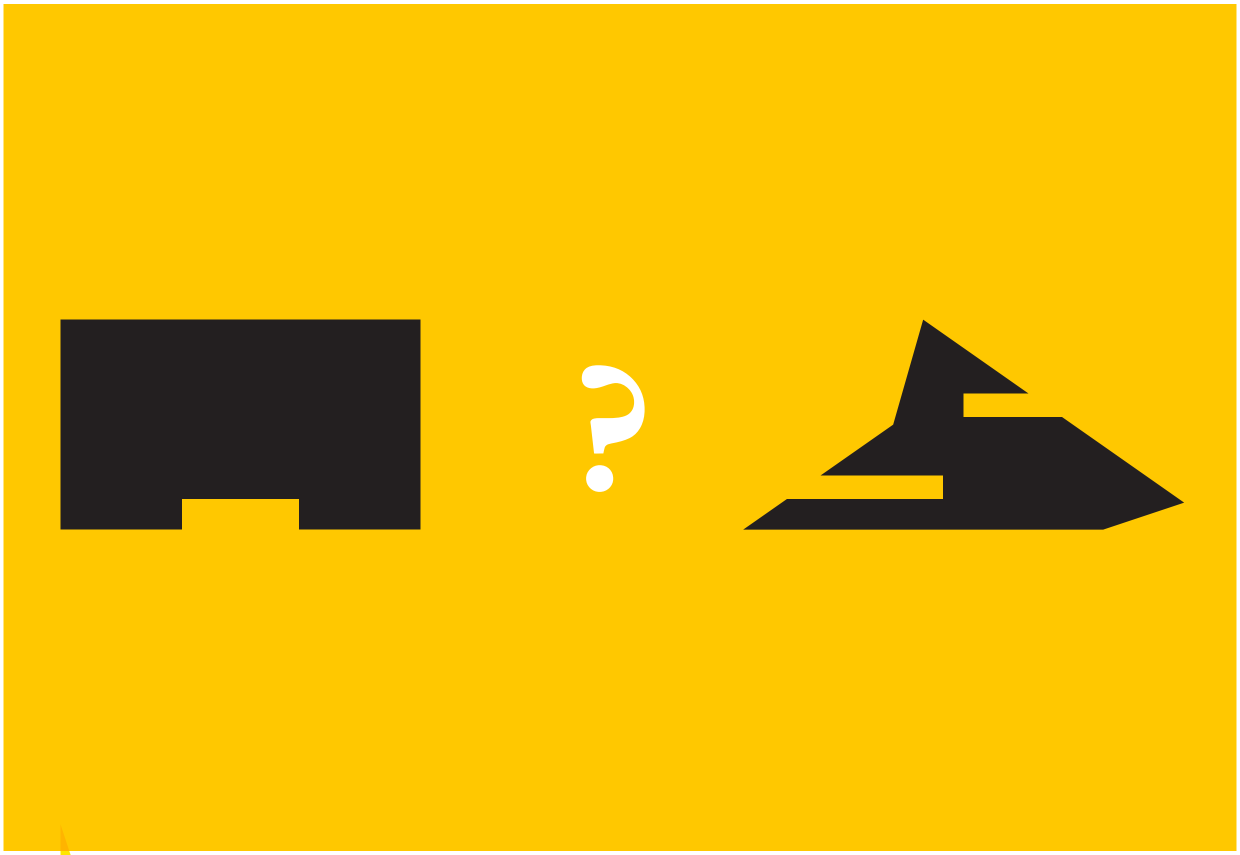


Figure 4.1 - What value is there in hybrid design?

While the social, moral and environmental benefits of adding additional programmes and useage density (or FAR) may justify to some the increased financial burdens of constructing and maintaining these hybridized sites, the developer and/or owner of the site may see no benefit outside of financially returning upon their investments and satisfying their shareholders.

For these reasons, the additional programmes must add significant financial value to the owner/operator of the development to be even worth investigating.

This chapter investigates three precedent case studies of projects wherein hybrid additional programme has been added to a conventional commercial, retail or industrial site in manners which demonstrate a clear financial additional value beyond the simple sum of their parts. These sites – the

Amagerforbraending waste incineration plant in Copenhagen, the Meydan Shopping Square in Istanbul and the Whole Foods green roof initiative in Lynnfield Massachusetts – demonstrate the potential value of combining disparate programmes on one generic footprint, and prepare a framework of logic to which hybridizing can be applied to the context of large format retail sites in the GTHA.

[For this reason it is critical when investigating hybrid design proposals to investigate how the hybridization of the various programmes and typologies together will result in a net economic benefit to the various stakeholders. If a benefit for the stakeholders cannot be found, then the added cost of designing, building and owning hybrid projects cannot be justified by the return gains.]

Figure 4.2 - Amagerforbraending Waste Incineration Facility, Copenhagen

Render

4.1.1 | Amagerforbraending Waste Incineration Facility

Denmark is one of the world's leaders in the use of waste-to-energy facilities and the Amagerforbraending Waste Incineration Facility is to be the largest of its kind on the globe. Designed not only to be the largest waste-to-energy facility, the Amagerforbraending plant is also intended to be one of Copenhagen's largest public leisure facilities and a destination for public recreation near the center of the historic downtown core. It is situated on a point of industrial land 3 kilometers from the historic city centre, meaning that it is within a fifteen-minute bike ride for thousands of residents and within a half hour walk from several residential neighbourhoods.

The project tries to distance itself from other attempts to modernize industrial and waste treatment facilities that have simply re-skinned their facades (fig – Spittelau waste incineration plant in Vienna) by creating a deliberate integration with the public both in terms of actual usage and in terms of visual accessibility from the surrounding city.

The two principal strategies to create this close-knit civic presence are the expansive sloped roof –an all season artificial ski-slope with three levels of difficulty – and the steam exhaust system (fig – steam rings) which expels 25 meter-wide smoke rings for every quarter-ton of CO_2 produced during energy production.

The smoke ring exhaust creates a visual connection to the plant from around the city, while nurturing a public awareness of the primary function of the building.

Figure 4.3 - Meydan Shopping Square, Istanbul

Plaza view

The ski-slope roof system turns what would otherwise be an unproductive and extensive roofing area into a center for recreation and entertainment while mitigating the deleterious effects of the urban heat island.

Visually, the extraordinary vertical dimension of the plant – driven by the requirement for a ski slope – brings the impression of mountains to a city that is devoid of this sort of natural form.

What is important to recognize with this project in terms of its abilities to improve the public realm is that the additive programmes that have been integrated into the building are of a high-value nature for the city. Downhill skiing is a pastime that is difficult to access while in Copenhagen due to the extreme flatness of the landscape. By bringing in programme that is regionally rare, the owners/operators can more easily make a case for building a hybrid programme for the sake of communal improvement.

The addition of the high-value programme means that the site can make additional revenue while the rarity of the programme means that if desired, the operator could charge a premium for the use of the recreational facility.

4.1.2 | Meydan Shopping Square

The Meydan Shopping Square is a large open air shopping centre located in Istanbul. Surrounded by residential neighbourhoods, the shopping square acts as a focal point for local shopping and congregation, and its adjacency to a large wilderness park allows it to act a gateway between the countryside and adjacent neighbourhoods. (fig – site plan

Figure 4.4 - Whole Foods Green Roof Initiative, Lynnfield

Rooftop garden view

with surrounding dense residential context)

The shopping square is comprised of a series of overlapping layers of retail programming topped with a sculpted structural green roof that creates a shallow bowl, blocking out the visual and audible cacophony of the surrounding city.

The green roof spans some of the spaces between the retail buildings and acts as a large shade structure for the square. In addition, certain accessible portions of the green roof become useful as public park and casual meeting space in the dense urban environment, although it should be noted that much of the roof is fenced off and exists as an aesthetic, rather than inhabitable, environment. (fig – green roof)

By sinking much of the large-scale program, and layering and intertwining smaller-scale and secondary programs on top, the Meydan Shopping Square creates a public town square for the local surroundings while concurrently embracing the large-scale retail opportunities afforded by the site.

This use of building-as-landscape serves a very clear purpose in terms of additive or productive programme. In the case of the Meydan Shopping Square, the surrounding context is extremely dense, fine-grained urban fabric. Before the construction of this project there were no other large public congregation areas nearby, creating a neighbourhood public void that is well serviced by this development.

The programme of park and leisure space that has been added on top of the primary grocery store is clearly beneficial to the community at large, but it is also economically viable for the owner/operator, in theory, as customers stay for longer periods of time in the landscaped public areas which leads spending money in the other shops that make up the retail environment.

This is a similar condition to the typical big box development in North America wherein one large anchor store acts as the attractive force to drive customers to the shared parking space where, once there, they may see other shops they need to stop at. In the case of Meydan, the communal space is an attractive anchor complimentary to the large-format food retail anchor of the lower floor, which also serves the social needs of the surrounding community.

4.1.3 | Whole Foods Productive Green Roof

In 2013, Whole Foods Market completed work on an expansive, semi-intensive green roof project at their Lynnfield Massachusetts retail location. The project brief called for the construction of 17,000 square feet of agricultural green roof, taking up a sizeable fraction of the total roof area, to be

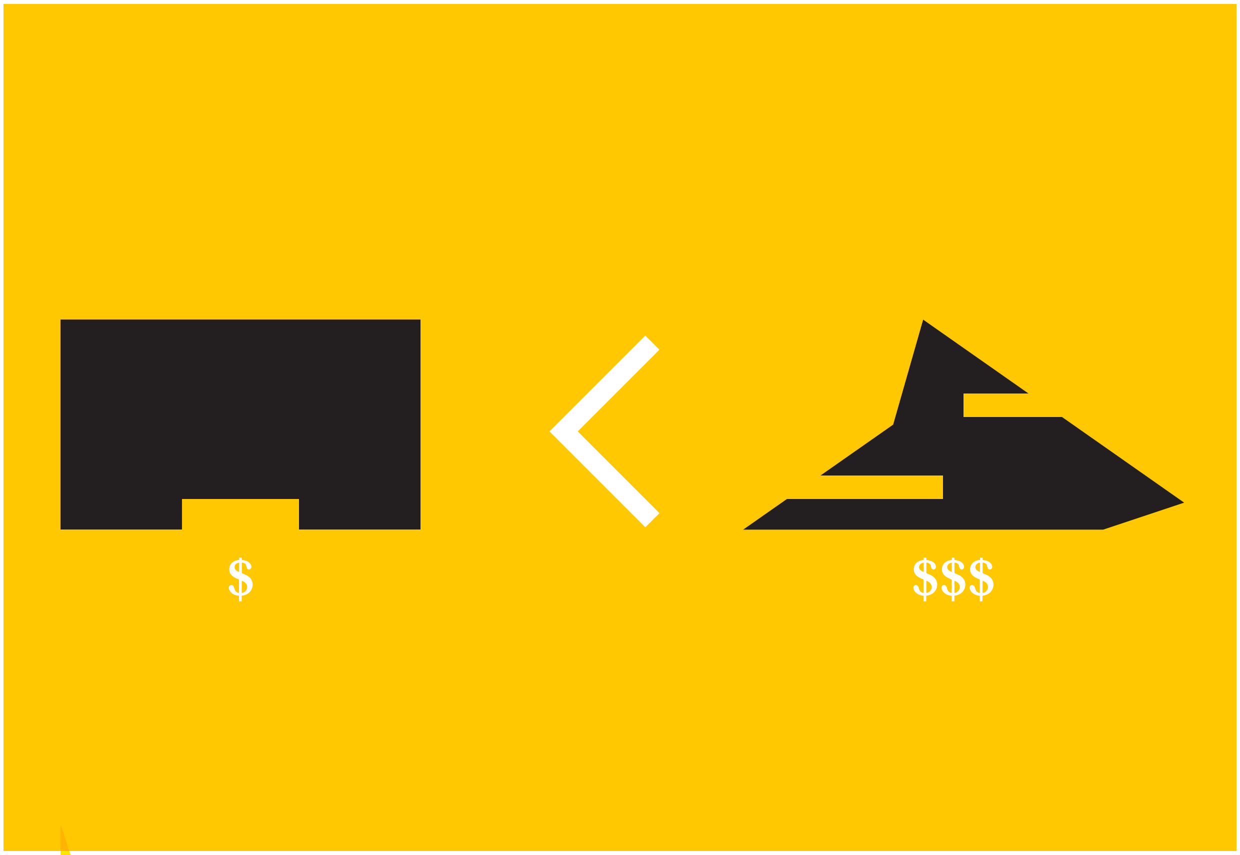


Figure 4.5 - There is a guaranteed additional cost of designing, building and operating hybrid programme buildings

managed by an outside green roof agricultural contractor.

The project, designed and constructed by Recover Green Roofs, made use of traditional agricultural technologies and methods, and Whole Foods partnered with Green City Growers to maintain and harvest the farm.

This rooftop farm, despite providing 11,000lbs of produce per year to be sold in the store below, represents only a fraction of the produce that this and similar large format food retailers sell annually.

While this project has shown itself to be successful as a means of selling agricultural produce, the nature of open-air ground-based farming means that the project sits unused for a portion of the year, the same as traditional farms.

To mitigate this, the project has over several years expanded to include hoop farming which extends growing season, although there are no current plans to expand the square footage of the growing medium.

The true value of this food-retail and agriculture project is in its power as a marketing device, showcasing the Whole Foods brand's commitment to their stated dedication to healthy, high quality produce and enhancing their reputation. This value is further reflected in the store's large internal signage showcasing the produce taken from the green roof as well as the live video feed of the farm being streamed to displays in store, making a viscerally clear connection to shoppers between the freshness of the food they are looking to buy and the store that they are shopping in.

When it is taken into account that the funding for development of this project came from the marketing budget at Whole Foods rather than from research, development or facilities, it becomes clear that this project was seen as a means to promoting the Whole Foods brand rather than a profitable agricultural venture, no matter how profitable the farm may be.

There is no clearer indication that a brand is committed to the sale of healthy, local and organic foodstuffs than when the produce is being farmed organically on the very roof of the store itself, and the value added to the owner of this large format retail location is greater than the sum of its architectural parts.

4.1.4 | The Value of Hybrid Landscapes

It is clear that hybrid programmatic design requires additional expense in order to construct and maintain the facilities and grounds that house it. For these additional costs to make financial sense to the owners and operators, additional value needs to be added to the site in greater numbers than the cost

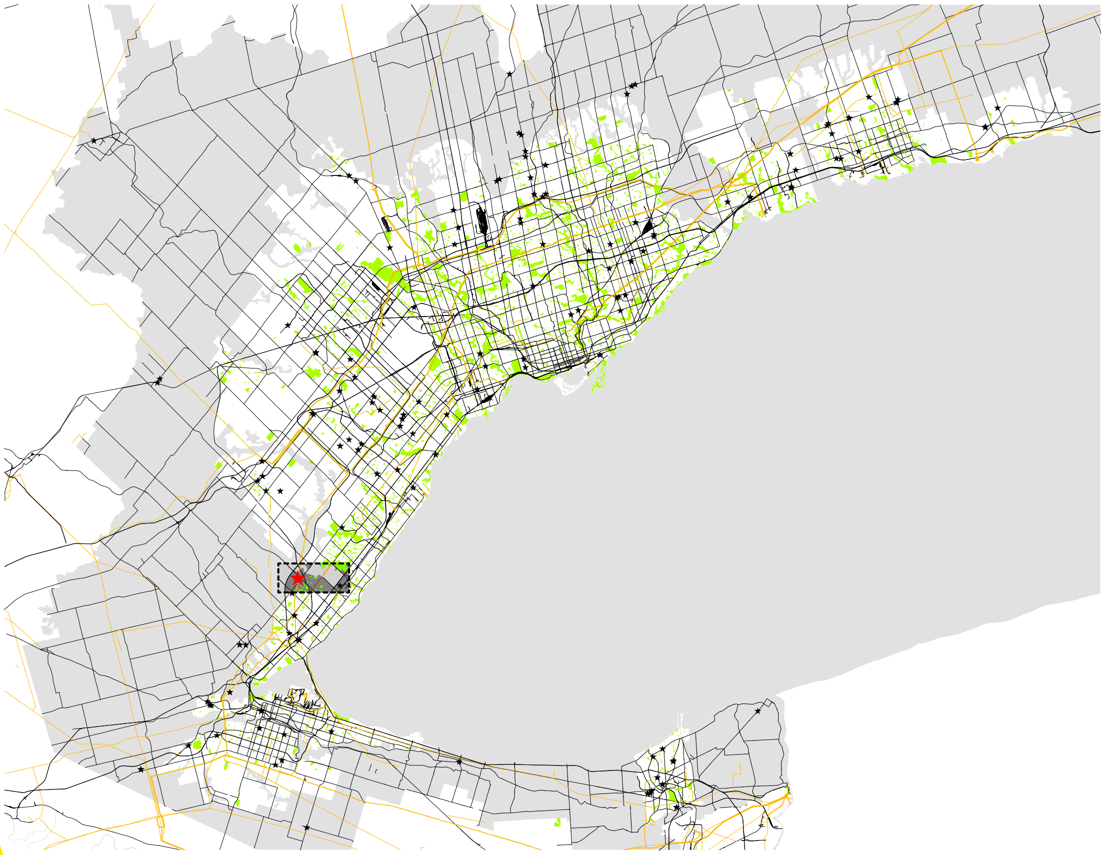


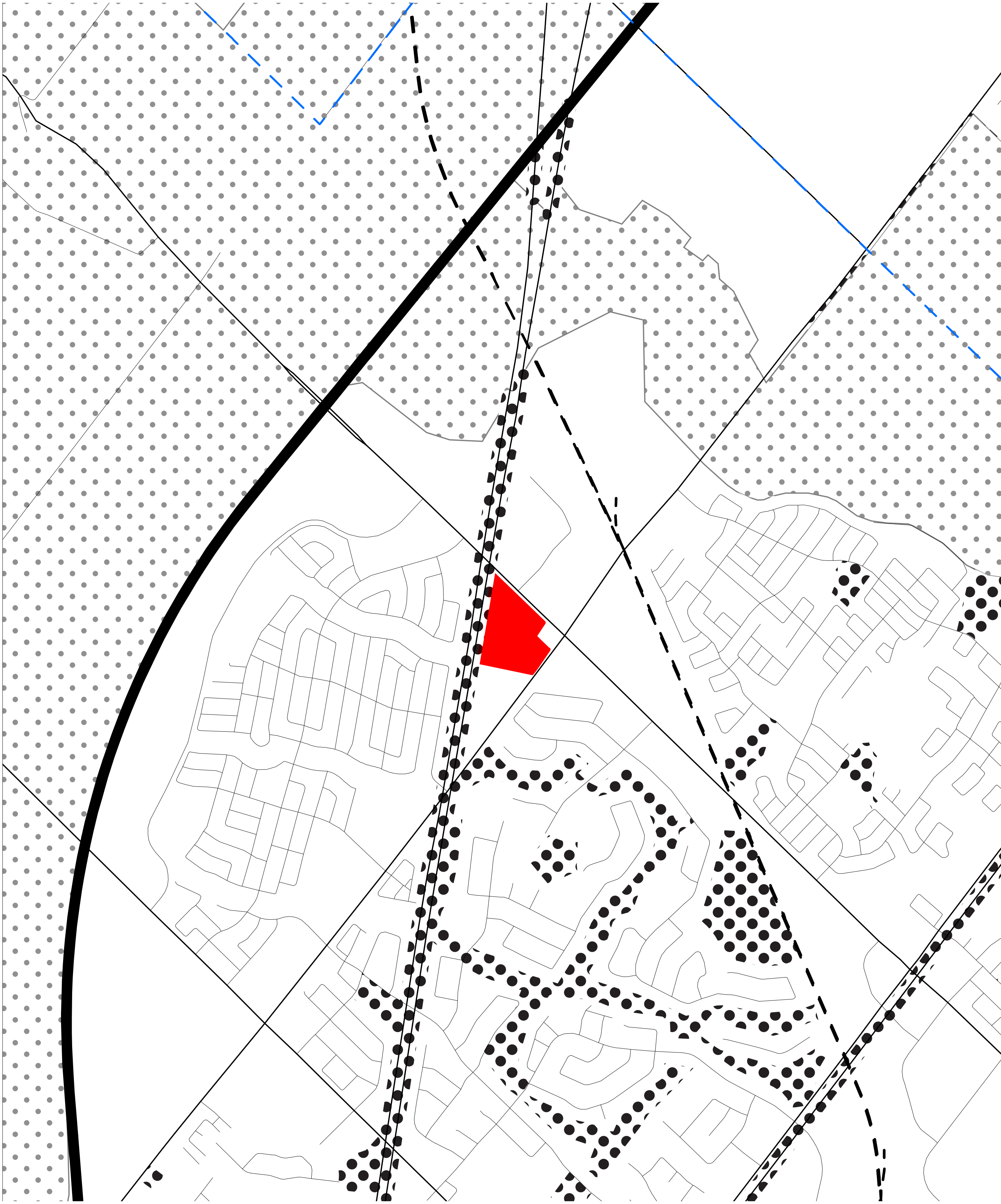
Figure 4.6 - The network of LFR developments in the GTHA are merged with the calculated boundary of overlapping high value programming from Chapter 2.

A site is selected in North Burlington as a suitable generic location to test out the ideas of hybrid additive programming.

of implementation.

These three precedent projects demonstrate that hybrid programmatic design can provide this financial value beyond the additional construction and maintenance costs.

In all three projects, the additional programme that converted a typical use-case into a hybrid programmed site was chosen based upon its very high potential value. In the case of the Meydan Shopping Square, the lack of local public squares and spaces created additional value to this programme when it was added on top of and around the primary retail environments. The availability of this privately-owned public space created an environment more attractive to shoppers from a greater retail shed to travel further and spend more time – therefore money – on site.



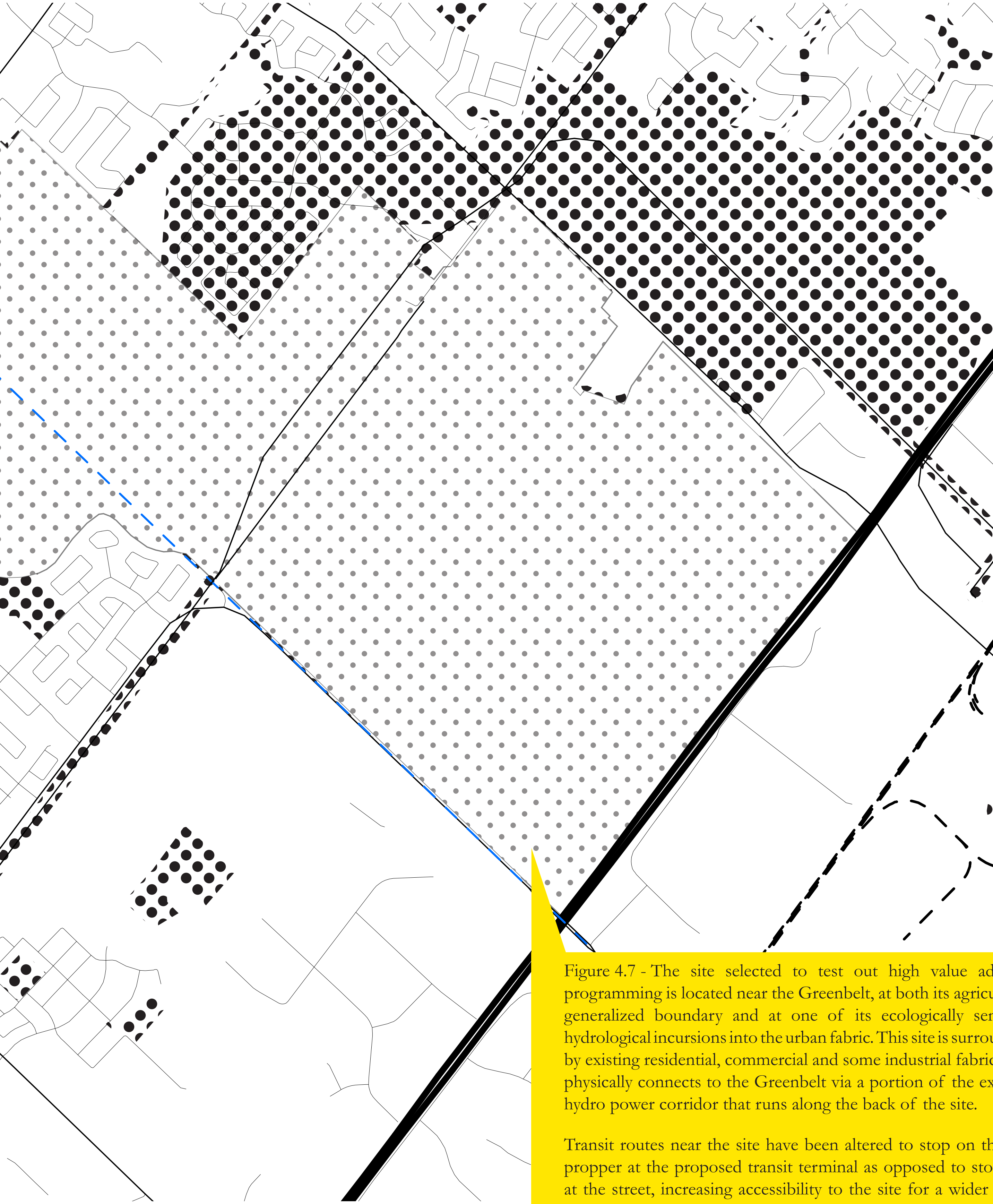


Figure 4.7 - The site selected to test out high value additive programming is located near the Greenbelt, at both its agricultural generalized boundary and at one of its ecologically sensitive hydrological incursions into the urban fabric. This site is surrounded by existing residential, commercial and some industrial fabrics and physically connects to the Greenbelt via a portion of the existing hydro power corridor that runs along the back of the site.

Transit routes near the site have been altered to stop on the site propper at the proposed transit terminal as opposed to stopping at the street, increasing accessibility to the site for a wider range of possible visitors.

In the case of the Amagerforbraending waste incineration facility, the local extremely flat geography and small country footprint meant that the added slope-based programmes were unique to the area and therefore provided an athletic and leisure condition to the public that would otherwise be entirely unavailable. The elevated programme, furthermore, meant that this prime waterfront land was not simply developed in favour of industrial and infrastructural ends but remains available to the public with vistas of the ocean, city and country.

The Lynnfield Massachusetts Whole Foods green roof, finally, took a corporate mission statement and embedded it into the very architecture of the building, creating a physical and visceral connection between the consumer and the brand whenever they visit the store – the ultimate product placement!

4.2 | Design Introduction/Goals of Design

This design exercise is an architectural response to the suburban issues of sprawl and inefficient land-use in the GTHA presented in chapter 1. The goal of this design exercise is to improve the development patterns of the Whitebelt beyond what is required by the Planning Act and its trifecta of supporting legislative documentation and the official plans of municipalities. The goal is also to increase popular accessibility to the Greenbelt and ensure that it has a prominent position at the forefront of the local cultural psyche, safeguarding it as a valuable, productive resource to the GTHA.

4.3 | Four Design Lenses

In order to determine the positive benefits to the addition of secondary programming to generic large format retail sites, this thesis has isolated the five lenses of site analysis investigated in chapter 3 and implemented each in a quick study showing the additional value that can be gained from each lens when it is prioritized to an extreme degree.

This is meant to create a generic condition for each lens that can be reconfigured to specific sites in and around the GTHA and allowing for each site's specific local context to direct which lenses are most influential in the design of additional programming.

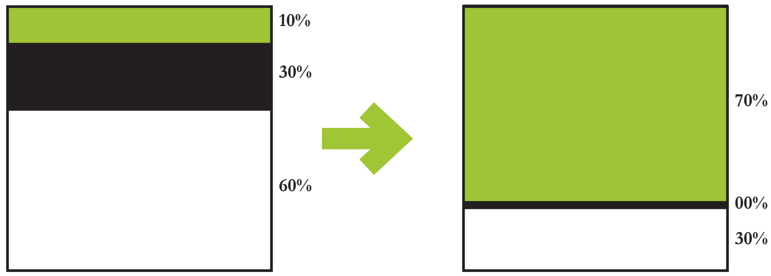
In order to create a large format retail development that – in addition to having a productive economic system in place – also have additional productive value on any of the five programme types, there needs to be corporate impetus and desire to enact these changes as well as the legal and political support to allow their implementation.

This thesis, having analyzed the generic site through five lenses, then proposes a concept design addressing the local site context through the agricultural and ecological lenses primarily, as it sits near the border between Burlington and the Greenbelt.

4.3.1 | Ecology

The principal issues with the contemporary large format retail development in terms of ecology are greenhouse gas emissions due to car-oriented access, storm water and pollutant runoff due to paved areas, and the urban heat island effect.

The following architectural interventions of the large format retail development typology address these issues in order to enhance the ecological system and minimize the damaging ecological impacts of the large format retail development on



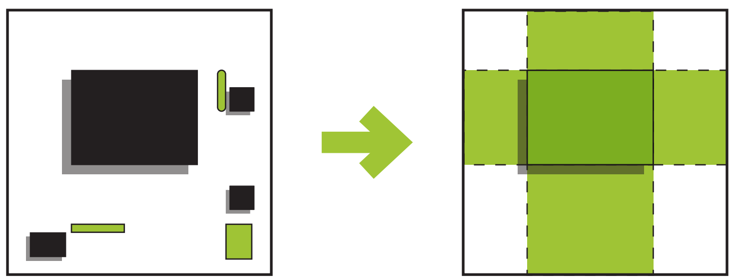


Figure 4.8 - Existing ecological coverage compared to proposed ecological coverage.

These diagrams indicate the desired changes to the site in terms of ecological impact improvements. The aim is to turn what is currently an ecologically inneficient and damaging site condition into one that has minimal impact on the local and regional ecology.

Figure 4.9Permeable surfaces - at grade and at roof level - are increased to 90% site coverage, reducing stormwater impacts and urban heat island effects.

Figure 4.10The use of high albedo materials, shade structures and tree canopy improvements result in reductions to the urban heat island effect.

Figure 4.11The improvement of higher order transit access to the site results in decreases in carbon emissions due to access to the site.

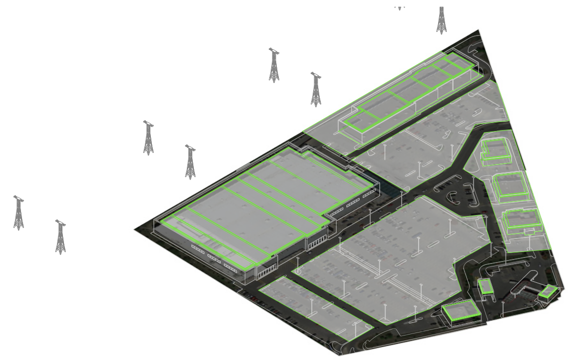


Figure 4.9 - Permeable Surfaces

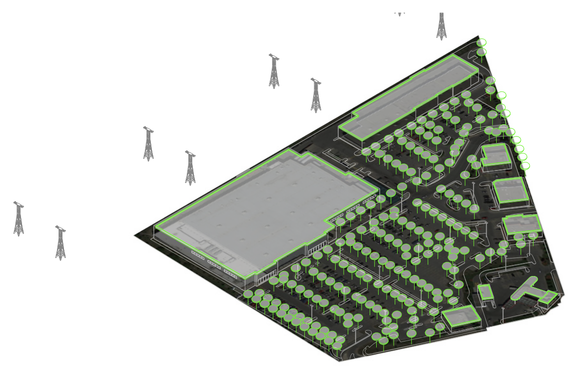


Figure 4.10 - Reduce urban heat island effects

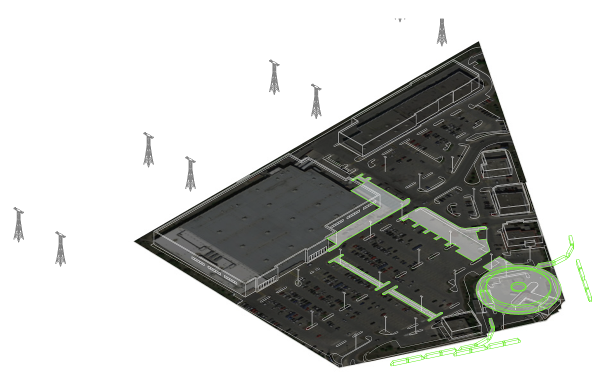
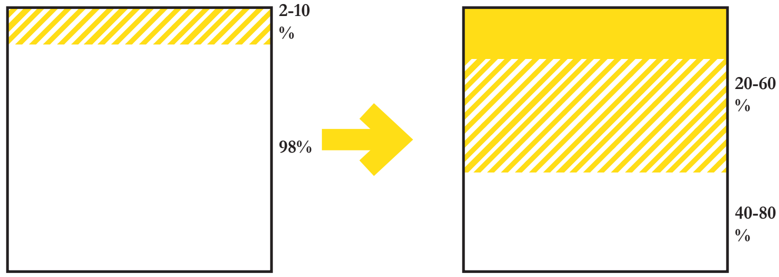


Figure 4.11 - Reduction in greenhouse gasses



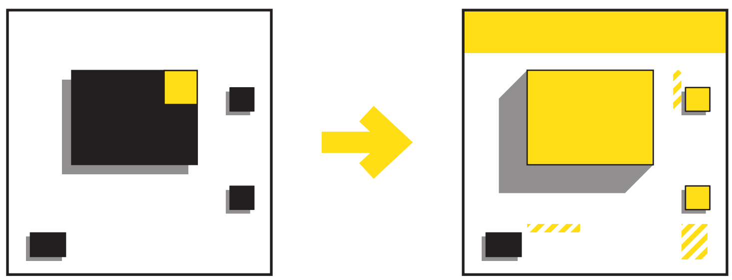


Figure 4.12 - Existing agricultural coverage compared to proposed agricultural coverage.

These diagrams indicate the desired changes to the site in terms of agricultural programmatic additions. The aim is to make the site a productive part of the food infrastructural network.

Figure 4.13High efficiency hydroponic greenhouses on major rooftop surfaces and in adjacent underutilized lands such as hydro corridors can generate ample amounts of produce.

Figure 4.14Traditional agricultural farming methods can be used in the same locations, to lesser effect but also lesser capital costs.

Figure 4.15Underutilized parking spaces can be used as temporary and semi-permanent farmers' markets, maximizing the food retail impact of the site.

Figure 4.16Food service providers make use of adjacent agricultural landscapes and vistas to highlight the connection between their food and local, organic and healthy eating.

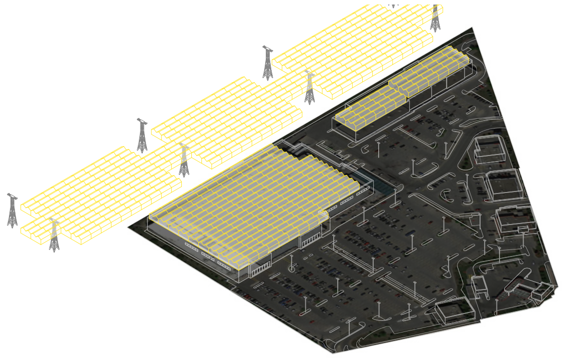


Figure 4.13 - High efficiency hydroponic greenhouses

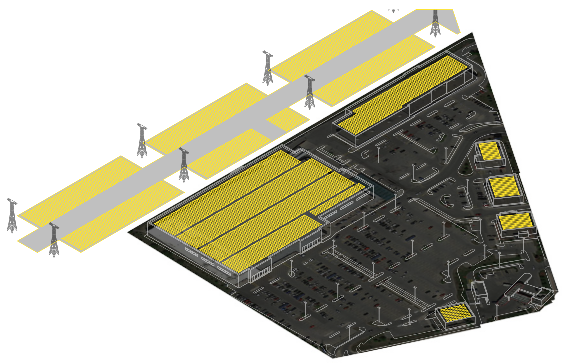


Figure 4.14 - Traditional agricultural methods

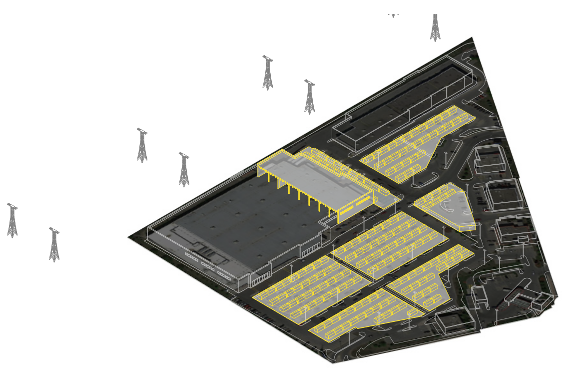


Figure 4.15 - Food retail areas

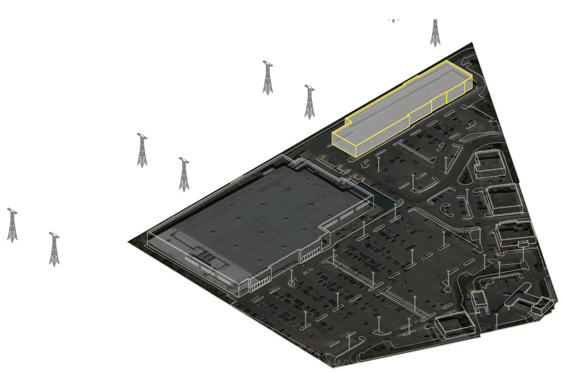


Figure 4.16 - Food service areas

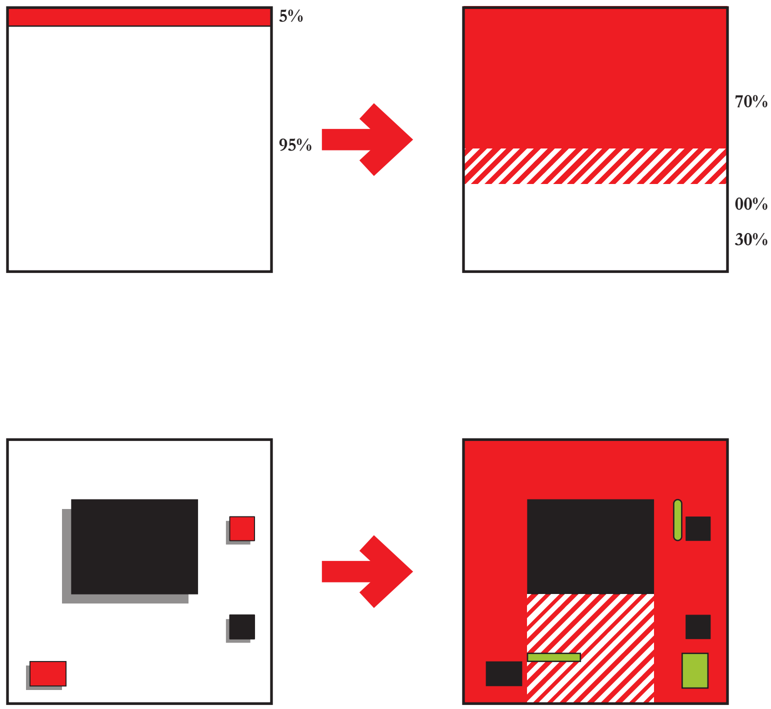


Figure 4.17 - Existing social overage compared to proposed social coverage

These diagrams indicate the desired changes to the site in terms of social landscape improvements. The purpose is to generate social programmes on the site and improve accessibility to those programmes to a greater audience.

Figure 4.18Formal sports fields and recreation spaces cover major roofscapes. Open underutilized parking areas at grade make way for temporary sports fields and courts during off peak hours/days.

Figure 4.19Informal recreation and social spaces such as parks, walkways and trails cover the site, with programmatic nodes such as pavillions or pop ups scattered throughout the parking areas.

Figure 4.20Interior social programming is added to the unused void spaces in major volumes.

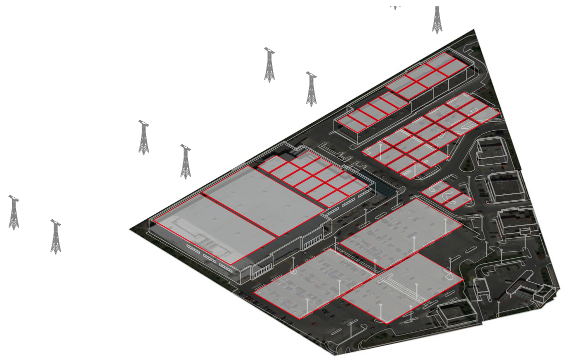


Figure 4.18 - Formal sports fields

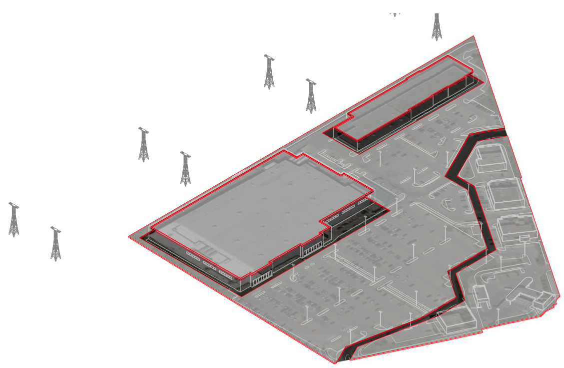


Figure 4.19 - Casual recreation space

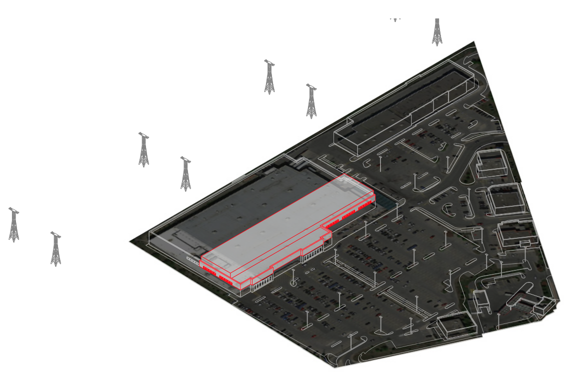
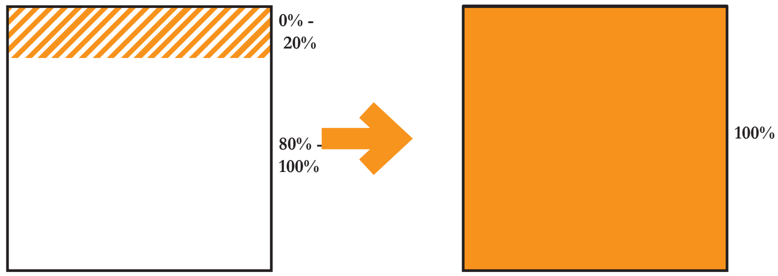


Figure 4.20 - Indoor community facilities



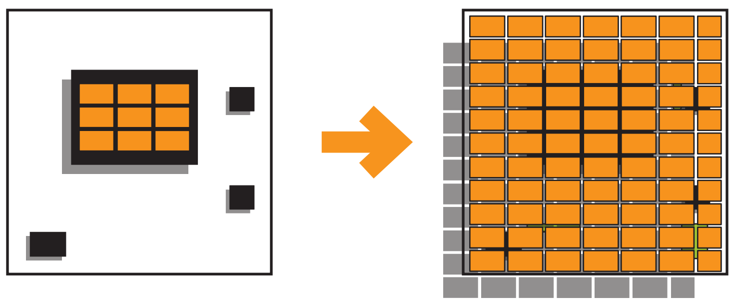


Figure 4.21 - Existing solar power generation coverage compared to proposed solar power generation coverage

These diagrams indicate the desired changes to the site in terms of power generation improvements. The aim is to increase the amount of power generated on site in order to reduce operating and ecological costs.

Figure 4.22100% rooftop coverage is an easy way to generate greater energy savings and is reflective of current corporate trends in large format retailers.

Figure 4.23100% site coverage using a mix of rooftop arrays and at grade array cannopys generates enough electricity to sell back to the grid and on site battery storage allows for emergency power backup during blackouts.

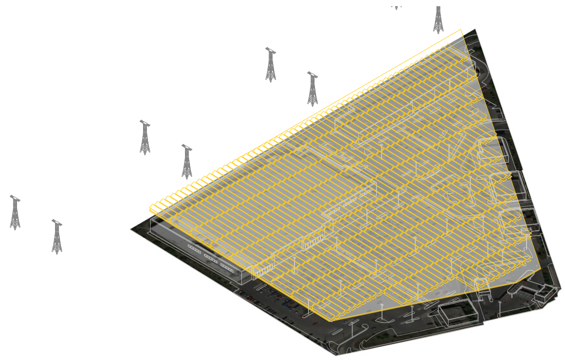


Figure 4.22 - Solar power generation: roof canopy

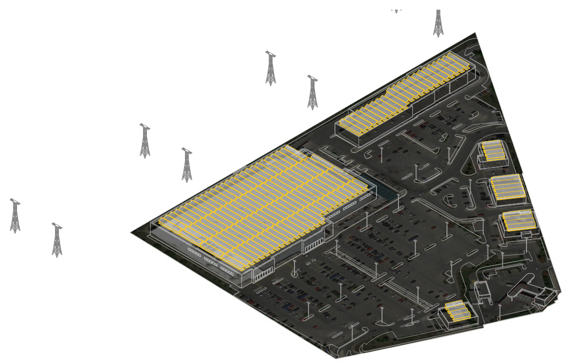


Figure 4.23 - Solar power generation: building coverage

its surroundings.

Greenhouse Gas Emissions: Greenhouse gas emissions due to the primacy of personal auto use as access to the large format retail development are addressed using a mixture of technologies and infrastructural processes. In terms of infrastructure, the design advocates for higher order transit availability leading to the large format retail development. Using higher order transit, from busses to LRT routes, creates opportunities for shoppers to leave their cars at home. Grade-separated transit such as bus rapid transit routes or LRT, furthermore, create permanence and reliability for transit to and from the site, making transit more appealing to a greater number of potential shoppers.

As a network of sites at the agricultural periphery of the GTHA, the design proposes a ring of connective higher order transit between municipalities as they expand to meet the border of the Greenbelt as well as higher order transit lines radiating inwards from the Greenbelt and the large format retail development center.

The design also proposes alliances with ride and car sharing co-ops and companies such as Uber and Lyft in order to create on demand grocery trip assistance to and from the large format retail development. This technical intervention will not reduce greenhouse gas emissions from trips taken by consumers to the large format retail development on a daily basis, but will instead allow those consumers to use alternative modes of transportation at other times such as when visiting clothing retailers, when there is no need to carry multiple heavy grocery bags.

Water Management: Several design interventions are used to reduce the effects of the large scale retail development on local and regional hydrological systems. These interventions focus on reducing the amount of impermeable surfaces to remove rainfall from entering the storm water system in a deluge, as well as the filtration and treatment of grey water.

Reducing the amount of impermeable surfaces is critical to the reduction of storm runoff and is accomplished by using various permeable paving solutions for major parking, pedestrian and driving areas as well as increasing the area of landscaped areas and the use of green roof systems overtop of retail environments.

Water filtration and rehabilitation is managed by the use of bio swales, natural grey water treatment systems, rooftop rainfall capture, recycling, and reuse.

Urban Heat Island Effect: In order to reduce the uncomfortable temperatures and environments experienced due to the urban heat island effect, three primary strategies have been employed. The first is to increase the amounts of shaded areas via shade structures and creating a healthy tree canopy, thereby reducing the quantity of captured radiant heat in hard surfaces. The second is by decreasing the areas of impermeable materials, allowing for rainfall and moisture to be captured by the ground. This allows for the ground to 'sweat' out radiant energy through evaporation as opposed to capturing and storing it in hard surfaces. The third is by using lighter materials with higher albedo values throughout the site. This includes replacing black asphalt with light concrete in the utilitarian and service/delivery areas, light paving materials elsewhere and light high reflectivity commercial roofing membranes where green roofs are not present. Green roofing is to be applied site wide where possible as well as solar panels, both of which capture high percentages of solar radiant energy to be released by productive means rather than heat energy.

4.3.2 | Agriculture

This design focus increases the presence and productivity of the agricultural system at the large format retail development, beyond simply providing a food retail outlet.

In a recently released provincial report Planning for Health, Prosperity and Growth in the Greater Golden Horseshoe, the advisory panel makes the recommendation that the government

"Provide policy direction and guidelines to improve compatibility and reduce conflicts between farms and adjacent non-agricultural uses, for example through requirements for edge planning such as buffers on urban development adjacent to farmland."

While not all LFR sites within the Whitebelt are situated adjacent to the Greenbelt, the recommendation to blur the line between rural and urban can go beyond simply reducing conflict and go towards actively fostering agricultural understanding.

Commercial roof top agriculture: Making available all major rooftop surface areas for high density greenhouse commercial agriculture will allow for greatly increased local food production outside of the Greenbelt. Adjacent hydro corridor areas can also be made available for these endeavors and accessed through the large format retail site.

Community agricultural opportunities: Communal agriculture projects have proven to be highly successful in urban areas in terms of fostering community bonds as well as making available organic and fresh produce to areas underserved by food retail distributors and educating communities on agriculture and farming practices. These can happen in adjacent hydro corridor lands with outbuildings, processing and storage on site.

Farmers' Markets: Farmers markets are an effective way to bring fresh produce and products into the hands of as many people as possible while also introducing ordinary citizens to the farmers and food producers responsible for the food

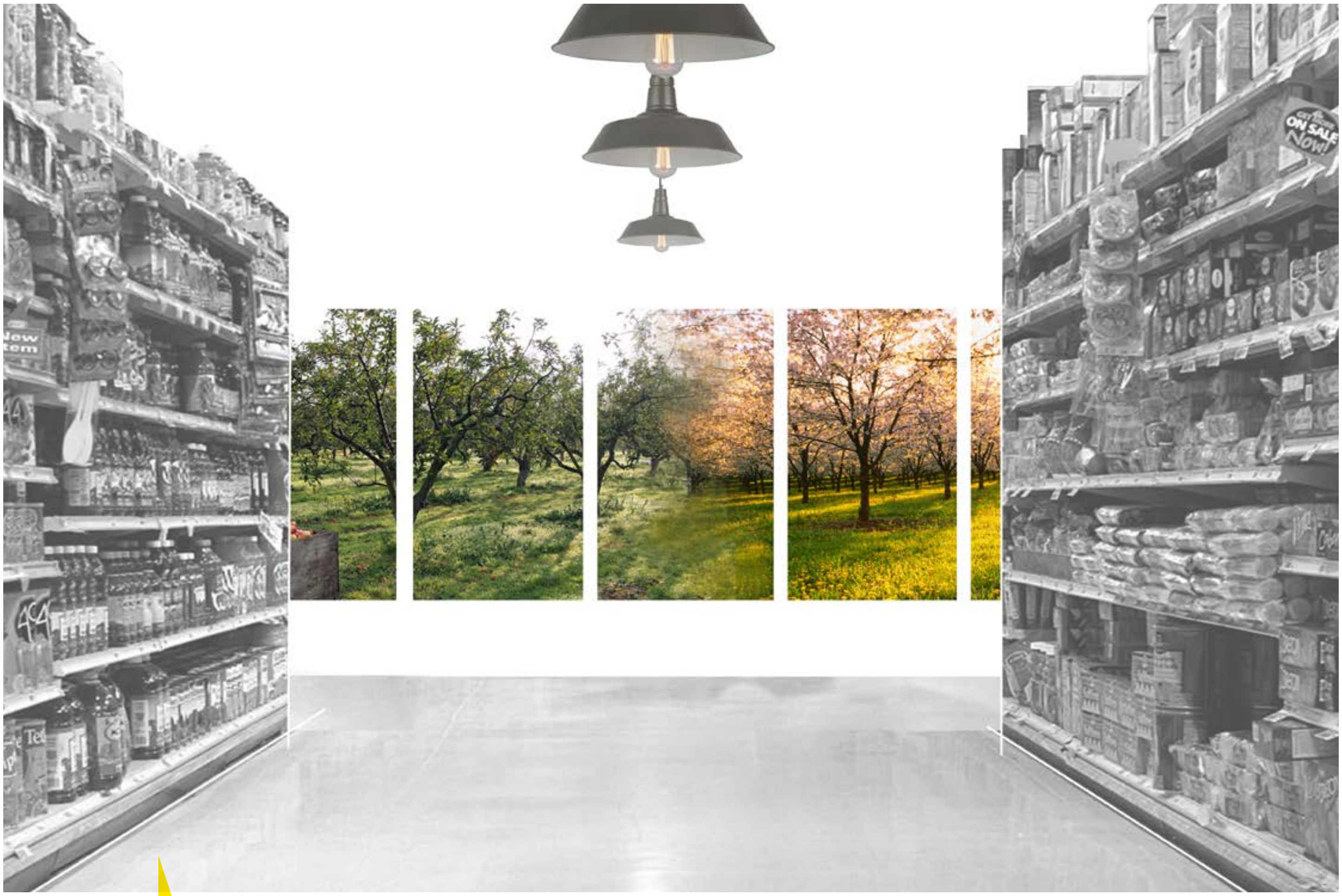


Figure 4.24 - Harnessing adjacencies between corporate image and experience and natrualized and agricultural areas

BENEFITS COSTS

Permeable Surfacing

-207,000 lbs of sodium runoff annually
Reduction of lead in runoff annually
Reduced ambient local ground temperature
Increased appeal to additive programming

Site capital cost permeable paving: $3.7 million (+100%)
Site capital cost green roof: $4.5 million (+46%)

$ ♥ $ $

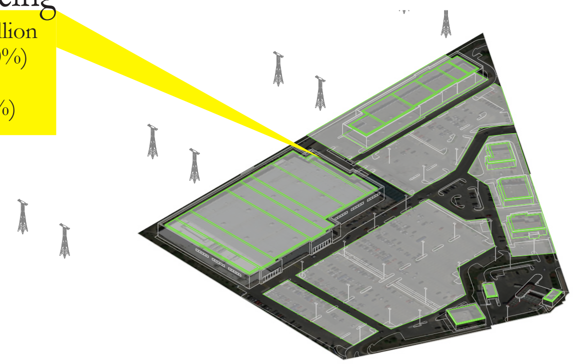


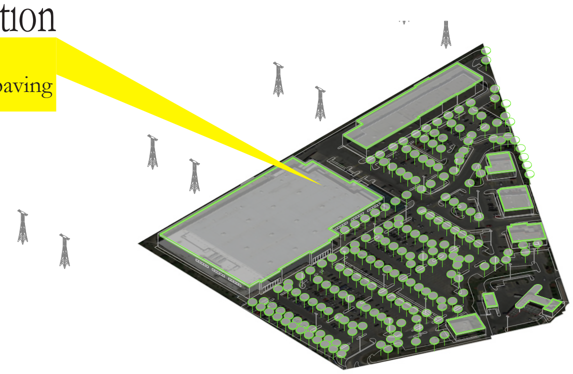
Figure 4.25 - Increased Site Permeable Surface Materials

Urban Heat Island Reduction

Reduced ambient local ground temperature
Increased appeal to additive programming

Site tree capital costs: $190,000
Low albedo concrete: +67% over asphalt paving

$ ♥ $

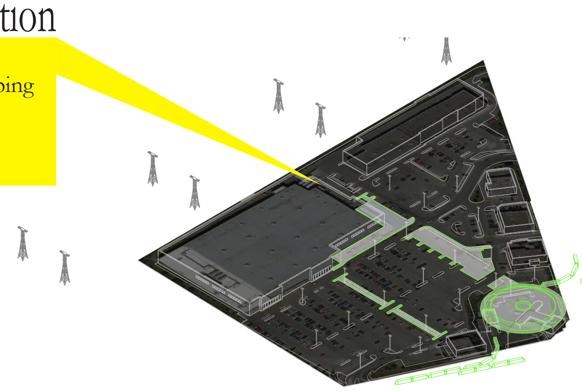


Autodependency Reduction

Autodependency Reductions
Parking area savings: 10,725 m^2
Parking revenue: $321,750/month
Greenhouse gas reductions 26 tonnes/year
Increased site accessibility

Loss of rental revenue at corner site
Loss of parking spaces during heavy shopping events (Christmas, etc.)

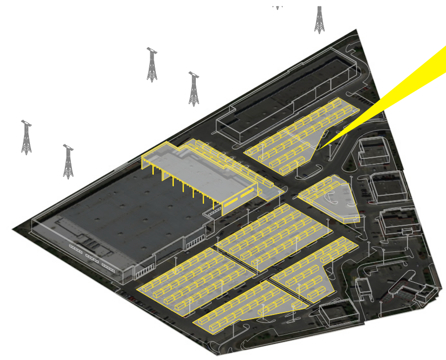
$ $ $



ECOLOGY

BENEFITS COSTS

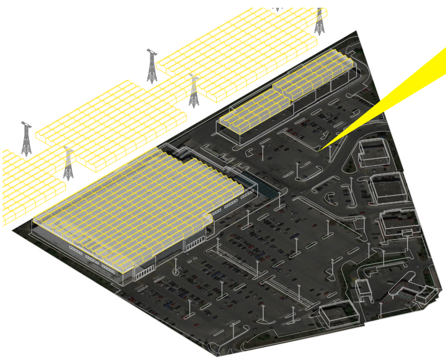
Food Retail



Benefits:
Clear visual connection between product, agricultural environment and brand
Site rental revenue from farmers' markets

Costs:
Loss of permanent parking for temporary markets
Potential competition with anchor store
Interior layout alterations for external visibility
Post-market cleanup and site maintenance

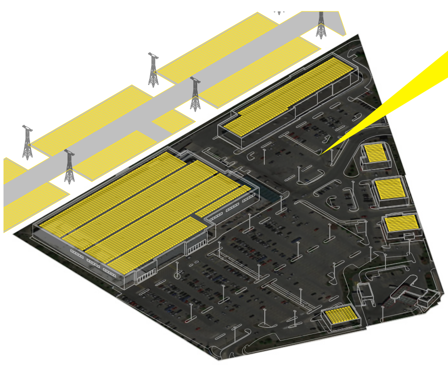
Agricultural Production - Hydroponic



Benefits:
Site net revenue cucumbers: $486,000
Direct emotional connection between brand image and healthy local grown produce
Decreased carbon generation from shipping

Costs:
Site capital costs: $18.9 million
Site production costs tomatoes: $8.1 million

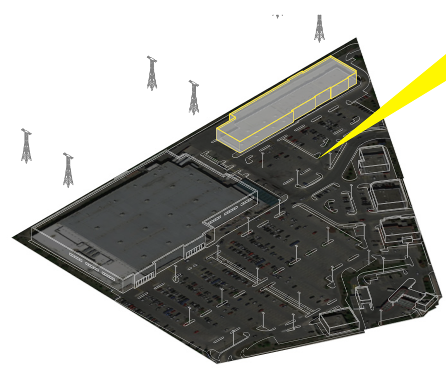
Agricultural Production - Traditional



Benefits:
Site net revenue tomatoes: $456,000
Direct emotional connection between brand image and healthy local grown produce
Decreased carbon generation from shipping

Costs:
Site production costs tomatoes: $344,000
Green roof capital costs: $4.5 million

Food Service



Benefits:
Direct emotional connection between brand image and healthy local grown produce

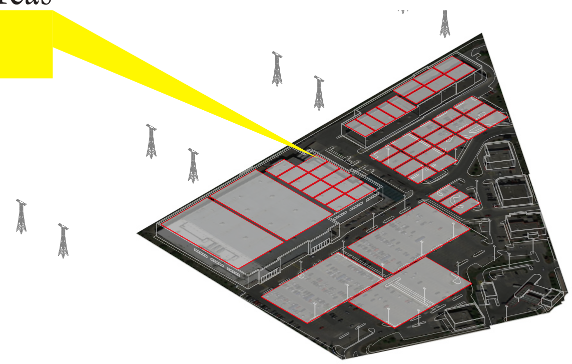
Costs:
Higher risk tenancy unless large chain restaurant

AGRICULTURE

BENEFITS COSTS

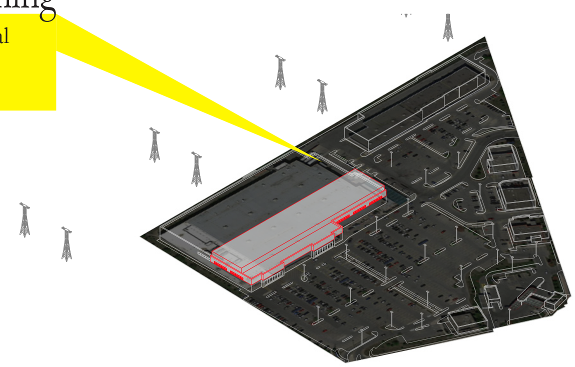
Formal Sports Areas

BENEFITS	COSTS
Potential 10 large sports fields Potential 150 small sports fields	Increased capital and maintenance costs Loss of parking during sport events



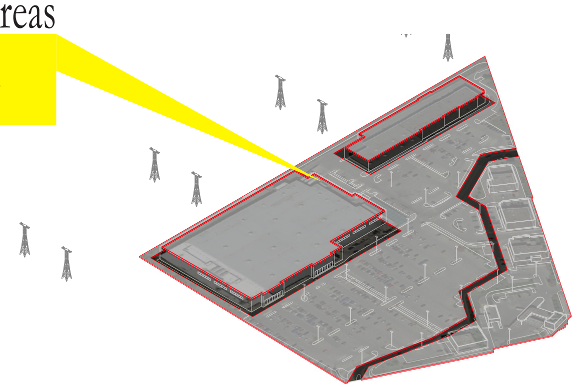
Interior Public Programming

BENEFITS	COSTS
Use of built "void" spaces Annual commercial rental income: $72,000 Additional interior programming: 9,600 m^2	Increased structural, capital and operational expenses.



Informal Social Areas

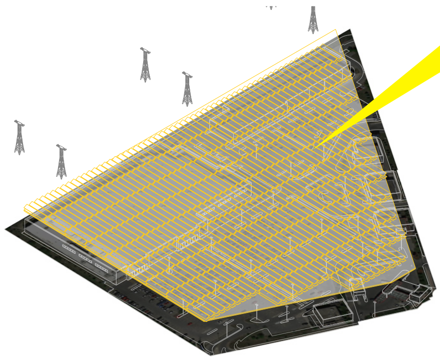
BENEFITS	COSTS
Potential 23,000 m^2 parks and social area	Loss of parking areas Increased capital and maintenance costs vs standard paved parking areas



SOCIAL

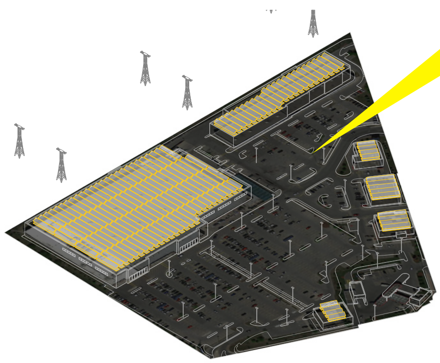
BENEFITS COSTS

Site Total Coverage



BENEFITS	COSTS
117 million kWh / year Power for 3,300 homes / year Sold energy worth: $11.5 million / year	Capital costs: $13 million

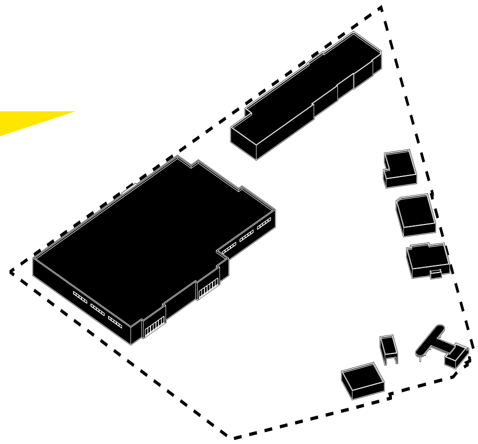
Rooftop Total Coverage



BENEFITS	COSTS
35 million kWh / year Power for 990 homes / year Sold energy worth: $3.8 million / year	Capital costs: $4.3 million

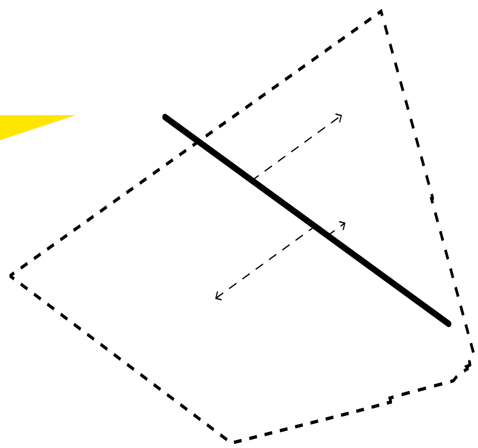
POWER GENERATION

THE PRESERVATION OF EXISTING ECONOMIC FORMULAS. This means not altering too drastically the existing large format retail fabric condition, as its designs and characteristics have been finely honed over long periods of time to be effective means of generating revenue.



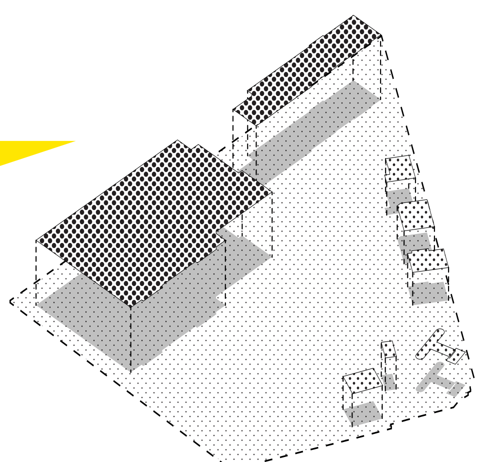
Preservation of existing economic formulas

THE CREATION OF AN ACTIVE PEDESTRIAN CORRIDOR between the intersection (as well as its transit access point) and the hydro corridor behind the site. This corridor creates a pedestrian friendly environment with offshoots of programming, connecting the various site elements to a greater audience than before.



Creation of an active pedestrian corridor

THE RE-ANIMATION OF MAJOR SURFICIAL PROGRAMMES. This is reflected in the resurfacing of major parking and roofing elements, aspects of the generic site which presently exist in a wholy functional and non-productive capacity.



Reanimation of major surficial areas

on their tables. Bringing in regular farmers' markets to the often vacant parking areas of large format retail development would leverage existing infrastructure and consumer habits to improve access to fresh local produce.

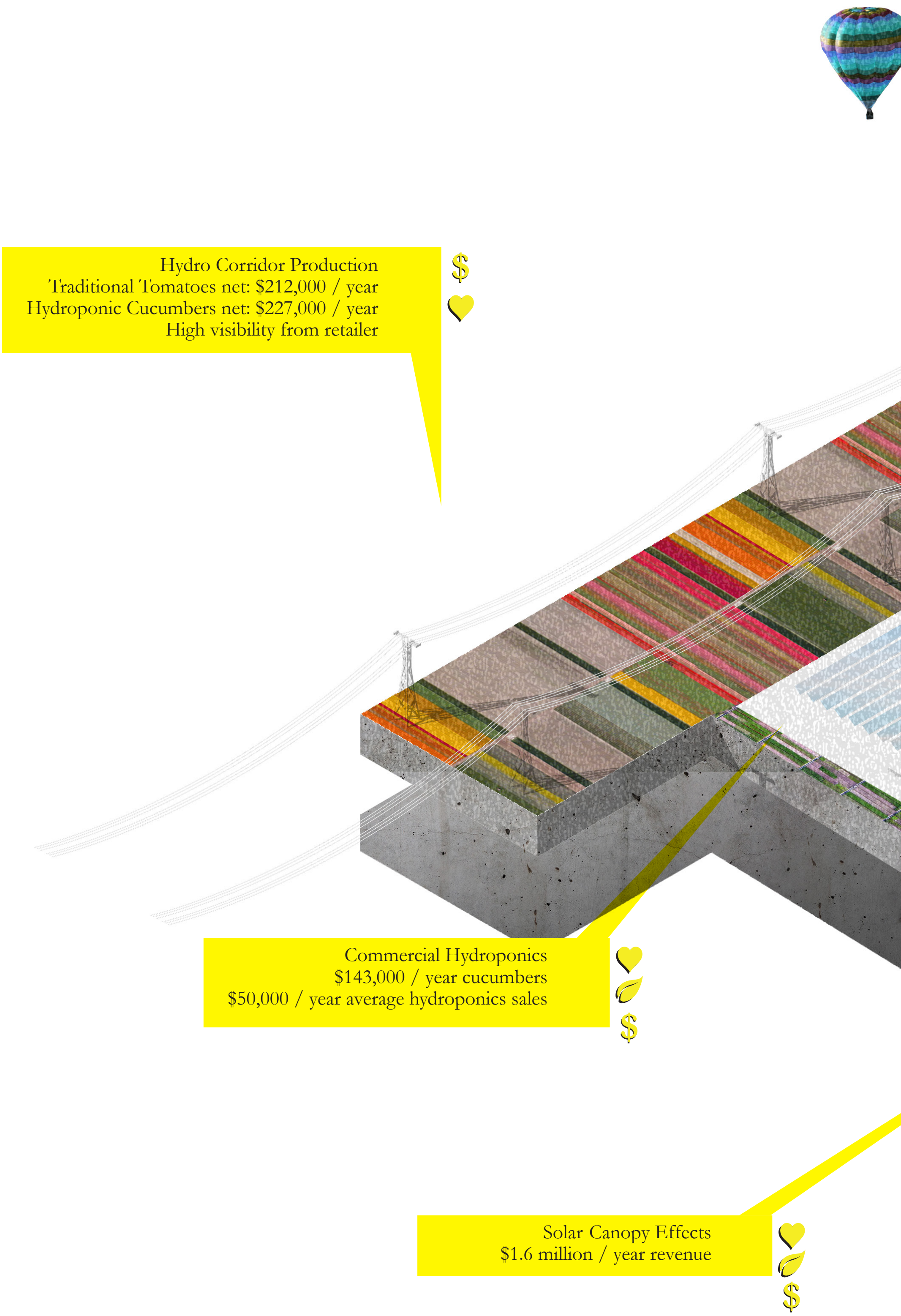
While farmers' markets may create some financial competition between a tenant food retailer whose interests are to have a site local monopoly and local farmers selling within eyesight of their front doors, the quantities, differences in convenience and seasonal nature of the markets are designed not to compete directly with the primary food retailer.

4.3.3 | Social Improvement

The vast areas subdivided in the typical GTHA suburban development means that there are often wide gaps between public spaces available for social gathering, sports, exercise and play. This creates an opportunity ripe for enhancing large format retail developments with social areas and programmes, filling in the voids of social programming and reducing the distances required and improving the availability of choices for residents of the suburbs.

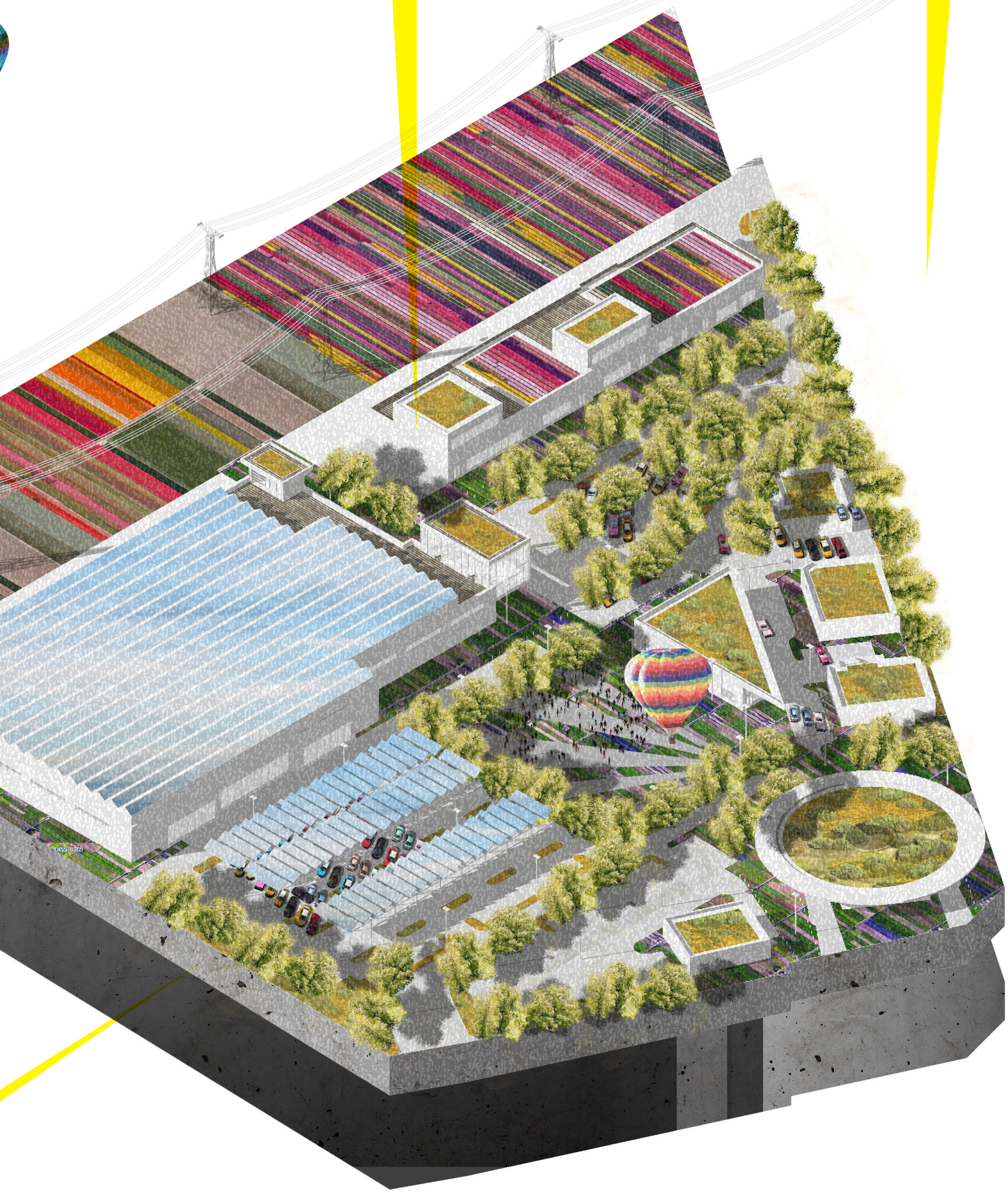
Sports Areas: Due to the generally flat topography of the large format retail development, a multitude of formal sports fields and courts can be added to the various roofscapes and ground level hardscapes.

General Recreation and Park Lands: Once again filling in the gaps between traditional formalized parks and ravines, landscaping and hardscaping can make the vast areas of the large format retail development inviting to pedestrians and available for use.

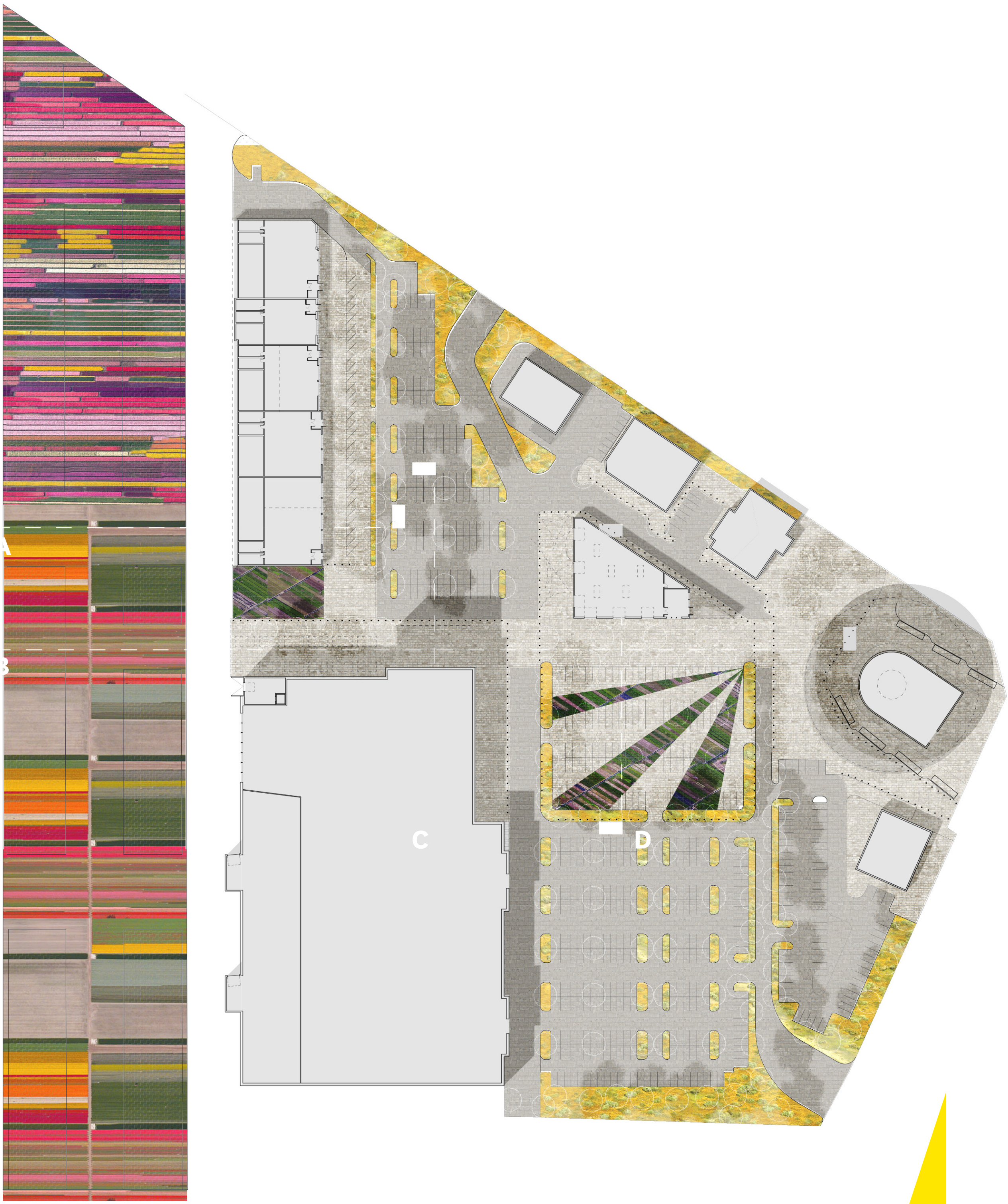

Hydro Corridor Production
Traditional Tomatoes net: $212,000 / year
Hydroponic Cucumbers net: $227,000 / year
High visibility from retailer
Commercial Hydroponics
$143,000 / year cucumbers
$50,000 / year average hydroponics sales
Solar Canopy Effects
$1.6 million / year revenue

Permeable Paving Effects
Decreased local temperatures
Inviting pedestrian realm
Stormwater reductions

Tree Canopy Effects
Decreased local temperature
Inviting environment
Promotes longer visits

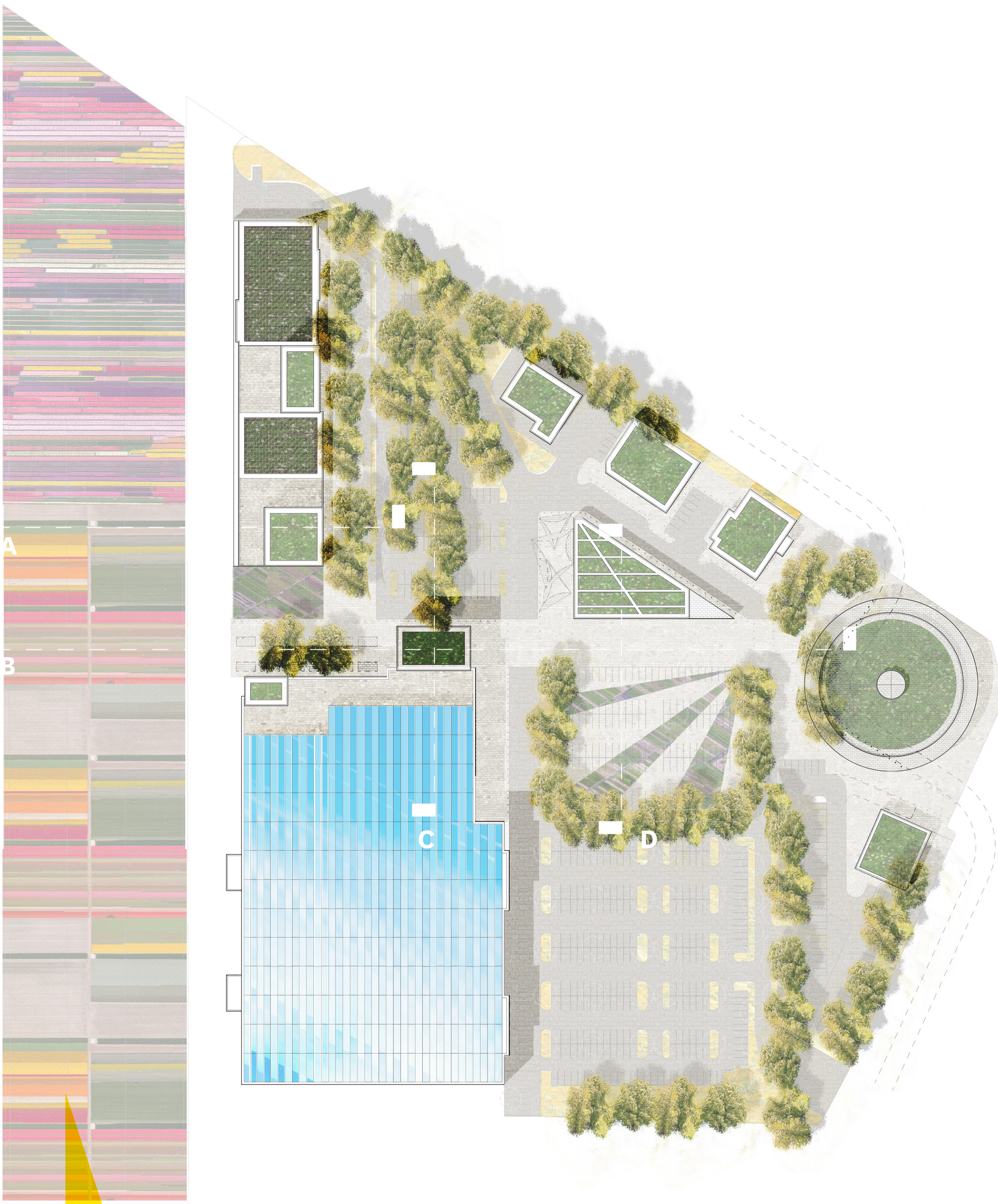


Public Transit Hub
Decreased greenhouse gas production
$72,000 / year additional rental revenue
Long-term densification and development potential



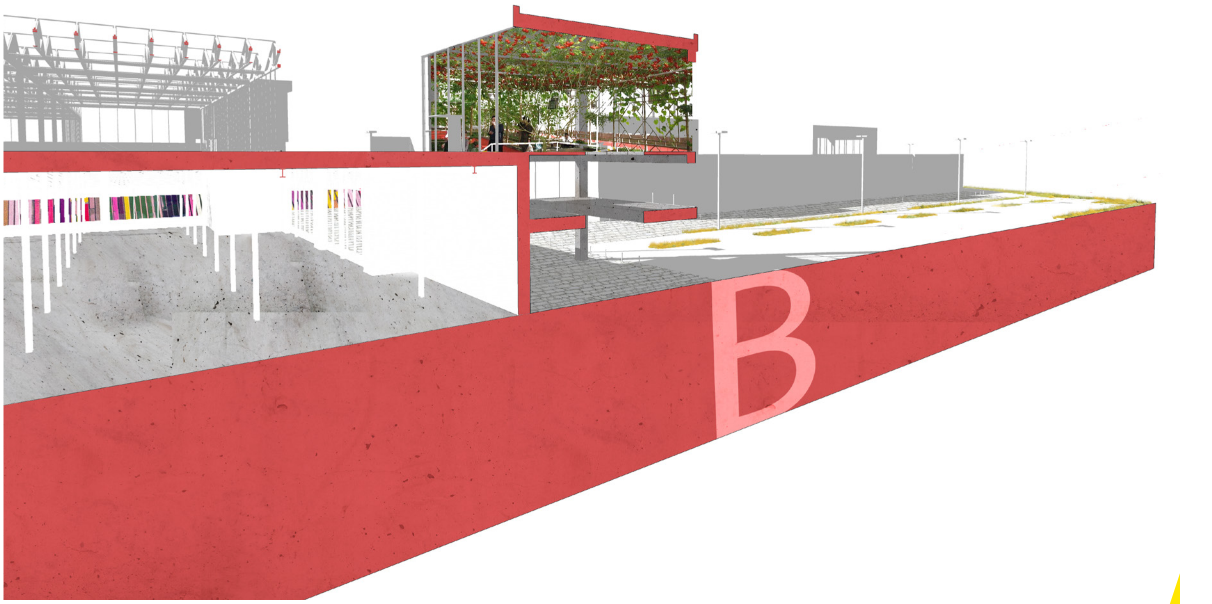
The at-grade landscape has transformed from a barren expanse of paved parking into a programmatically diversified and ecolocigally productive landscape.

Permeable paving, enhanced tree canopy and shaded areas, lighter materials and pedestrian friendly areas create an environment that promotes social activity and lengthened site visits.



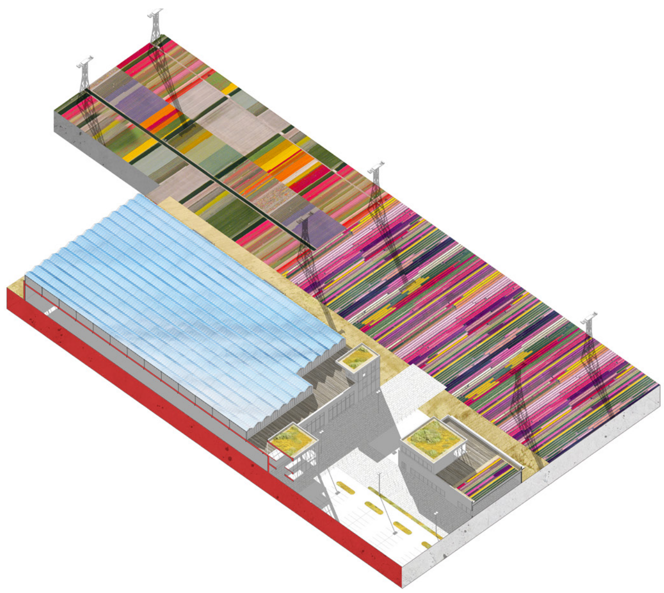
Roof level plans show the new mix of programme added to the previously under-used roof areas.

High density hydroponics, ecological green roofs, accessible food service patios with vistas and low density food retail agricultural operations replace gravel and asphalt.

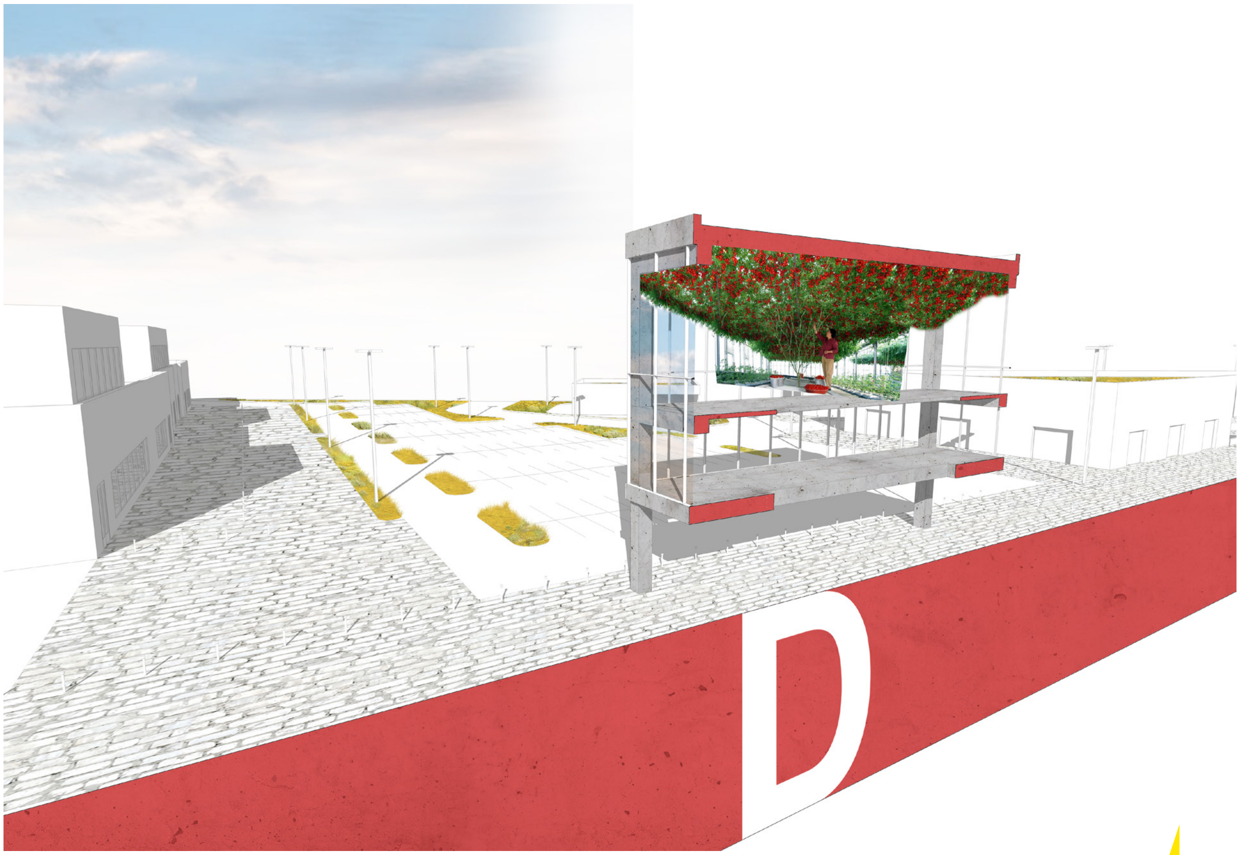


Section B

This section demonstrates the visual permeability of agricultural site additions, and the way in which creating openings in walls can create emotional subliminal connections between organic and local agriculture, and the commercial retail space that operates in its vicinity.



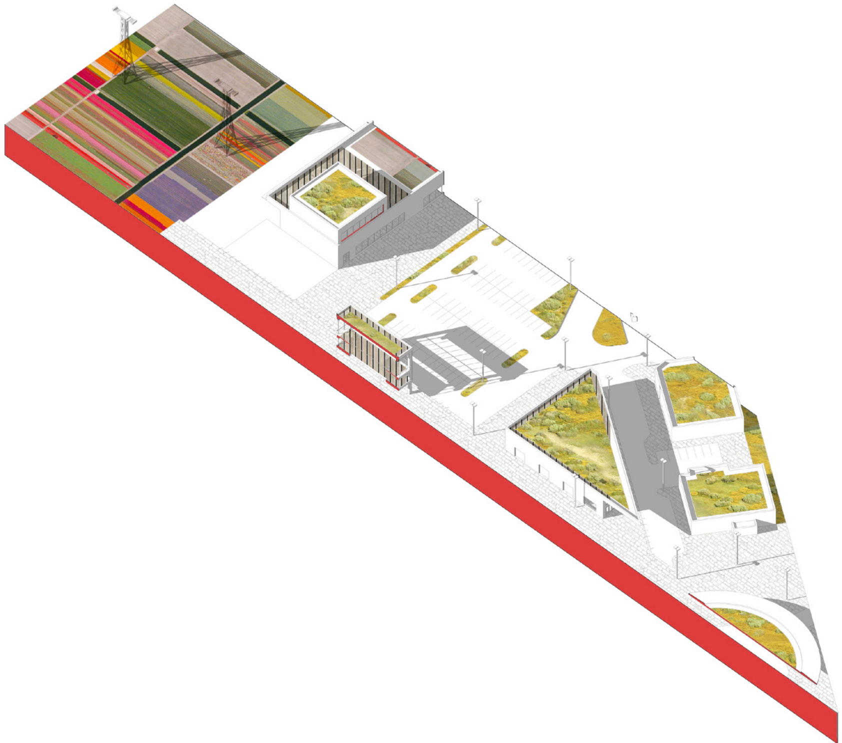
Section B - Axonometric



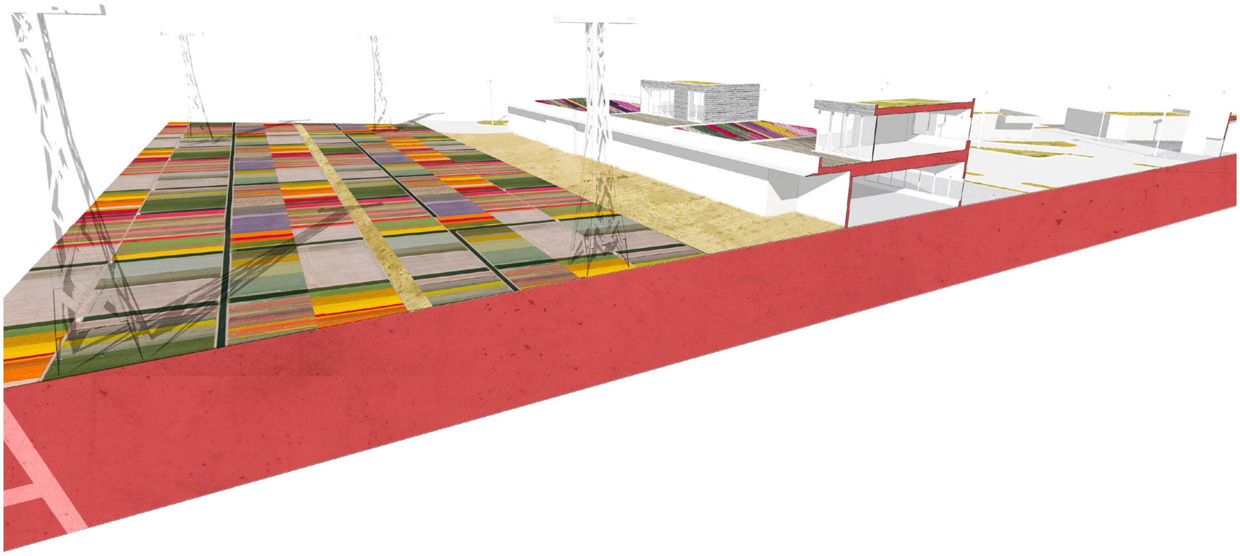
Section D

This section shows the pedestrian axis, along with the public agricultural information building addition.

The addition acts as a visual focus along the axis, drawing visitors to the site from the transit hub and parking areas and directs them to look out from this point towards the boulevard, the agricultural hydro corridor, the community building and spillway, and the commercial rooftop agriculture beside it.

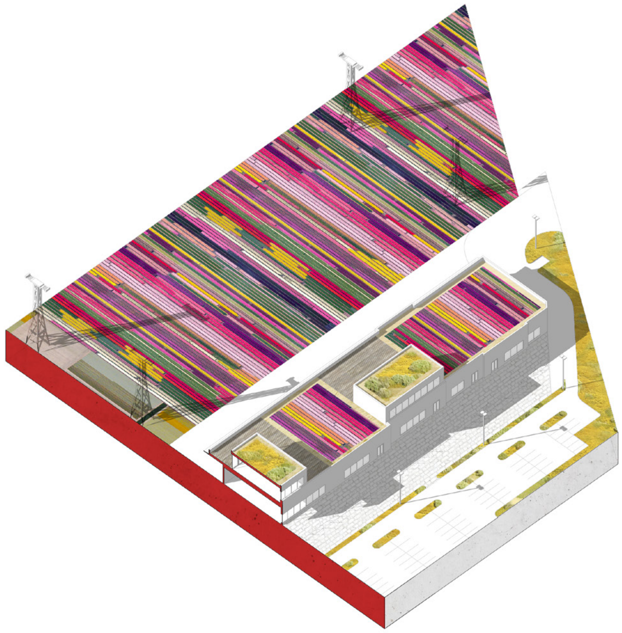


Section D - Axonometric

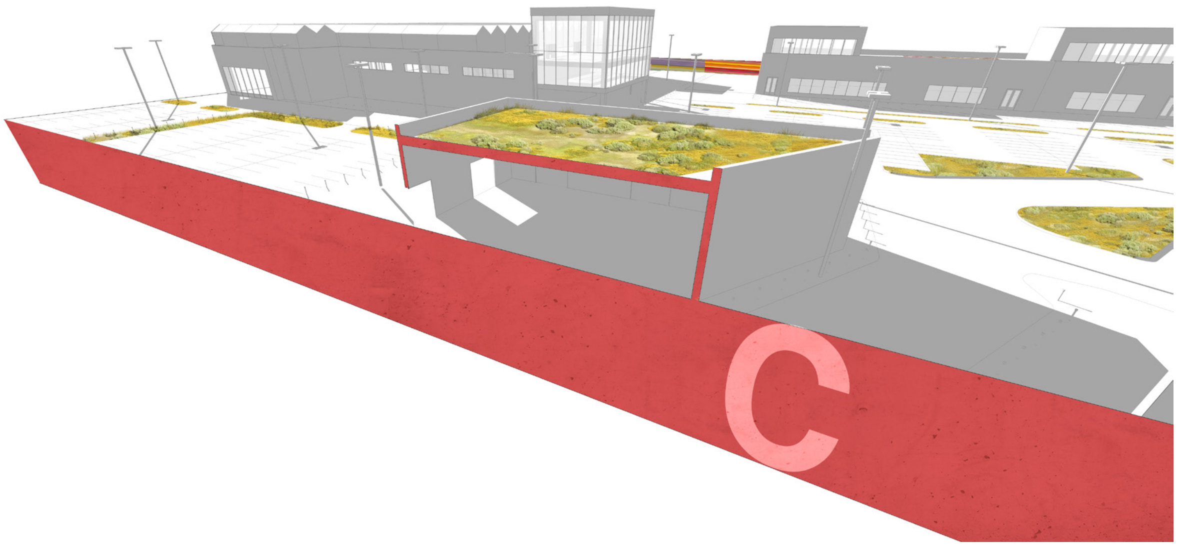


Section A

In this section, the connection between traditional agricultural landscapes and the food retail environment adjacent to it is highlighted. This adjacency of similar programmes creates both a unique pastoral vista for diners but also creates a clear visual connection between their meals and the local organic produce being grown next door.



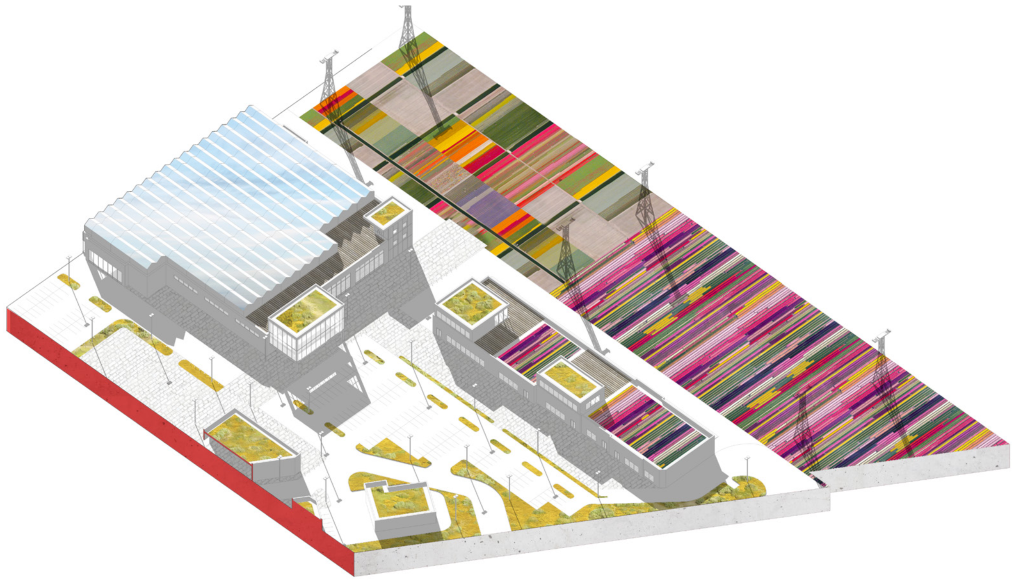
Section A - Axonometrix



Section C

This section showcases the community building and event space, its connection to the pedestrian corridor and its ability to be expanded into the spillway for larger events, sports and community activities.

This building acts as a central hub for pedestrian activity on the site, drawing from automotive visitors and public transit users alike, and is the framework around which public site use can be generated.



Section C - Axonometric

4.3.4 | Power Generation

The large size and open air of the large format retail development invites the establishment of near total coverage for power generation endeavours.

Solar Power: Entire roofscapes can be covered with general ease, creating a 30% site coverage devoted to solar power generation. Additional solar power canopies and infrastructure can cover the remaining site area if so desired. This solution has already begun to see widespread adoption by major commercial building owners such as Amazon(fn amazon article) and Walmart and their forward momentum with such projects is likely to drive adoption in the greater market.

Agricultural vistas are integrated with the generic suburban LFR fabric by establishing relevant food production and retail programming at the border as well as establishing clear views between those programmes and the vistas that complement them.

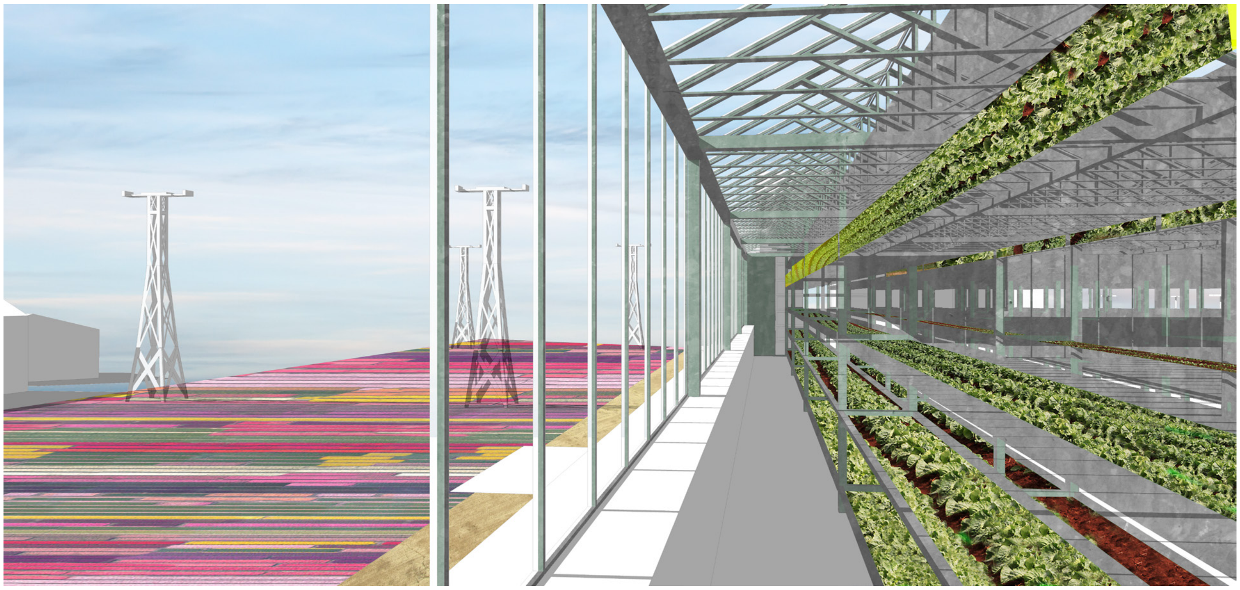
The pedestrian corridor that aligns with the transit hub acts as a catchment basin for transit users and drivers alike, and the public agriculture addition draws eyes to the additive programming from around the site.

Agriculture has a presence in the generic suburban landscape, with community and commercial plots available for rental. the connection between the commercial sale and production of food and the city that it feeds is firmly established.

4.4 | Economy

The contemporary large-format commercial-retail development exists in its current form due to decades of minor modifications and experiments with the goal of creating the ideal corporate site for efficiency and economic gain. To this end, every aspect of their design, maintenance, construction and distribution are governed by principles of minimizing cost and maximizing profit.

Without any increase in economic gain, any change to the large-format retail development through enhancements to the ecological, social, electrical generating and agricultural systems will result in a decrease in the amount of profit per dollar spent due to an increase in dollars spent. Therefore, any altering of the design of these developments needs to make a convincing case for the financial profit of the owner/

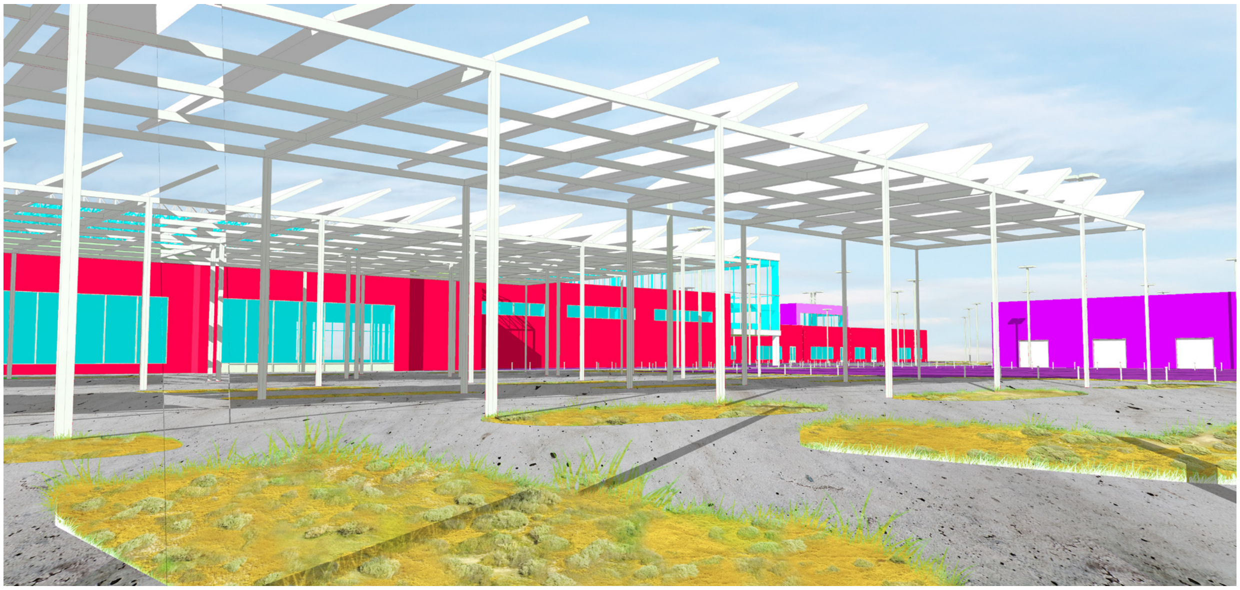


operator to balance out their increased capital investment, and ideally increase their economic gain overall. Some economic factors will be clearly quantifiable whereas some are more experiential, the results of which may be more difficult to prove directly.

The productive use of generic suburban landscapes - both at grade and on the expansive rooftops - is nurtured in order to add both productive economic value to the sites as well as generate social awareness and involvement in the provenance of food.

Brand Image and Association: One way to recuperate the additional costs of construction and maintenance of a hybrid building is by interpreting these modifications as a part of the marketing strategy for the corporation. By siting the building – and, by extension, the brand – in a location where it can directly, visually and viscerally address the positive attributes of the Greenbelt, the brand can create a direct emotional connection between itself and these attributes.

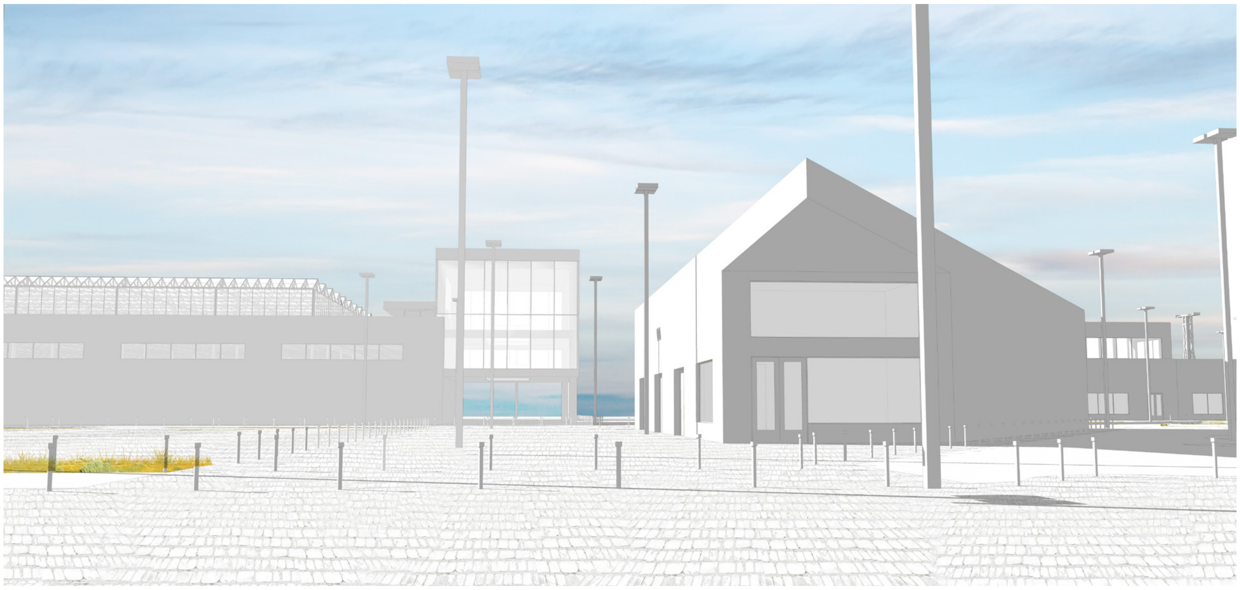
This cannot be accomplished by simply putting corporate



Elevated photovoltaic arrays create shade structures for the hot summer months while also generating power for use on site, reducing the site's environmental impact and operating costs.`

brand imagery on top of natural areas (fig – brand advertising in fields. Think Tobermory highway) but must be achieved by placing productive corporate architecture within the influence of the Greenbelt.

In the case of the Whole Foods green roof initiative in Lynnfield, Massachusetts (fn)(fig – image) the entire cost of constructing and maintaining the green roof – not an inconsequential cost by any stretch – was covered by the marketing department and not by their land-acquisition or construction departments (fn). This is an ingenious way to create the brand image of healthy, local produce for Whole Foods, despite the fact that the green roof – with its low-to-medium density growth medium and low production quantities – has a minimal presence within the store itself (fn). This financing scheme is a $______ (fn) validation of



the value of association between healthy produce and a food retail brand.

In this thesis design, the goal is not to create a new Whole Foods green roof, wherein the object is to create a veneer of health and freshness while not being an actually productive project. The goal is to utilize the economic benefits of this connection between the Greenbelt and large corporations to promote the idea of a multi-use hybrid large-format retail development.

Dense Nodes Cause Cross-Pollination: By mixing various programmes together on the site and within the building, a condition is created wherein more people with various overlapping desires and requirements will be in closer proximity, as opposed to the traditional suburban model wherein every programme and land-use is separated

The flexible pedestrian corridor that spans the site acts as a conduit for all varieties of site visitors, whether they arrive by public transit or by private car.

The community facilities on the axis act as a programmatic focal point to the site, with adjacent parking areas being easily converted to temporary event spillover areas.

In the distance, the hydroponic greenhouse and agricultural education addition draws eyes towards the various forms of agricultural production on and off the site.

As the generic LFR site gains a wider variety of programmes economically and socially, it becomes important to ensure that access to the site is not reserved only to those with the means to afford a car.

A public transit hub at the corner gives visitors a place to wait for their transportation in relative comfort, and helps to make up for the loss of parking spaces due to landscaping and new construction.

by great distance. This would allow for people to come for their anchor store or business and be exposed to various other uses that they otherwise would not encounter. The proximity of these uses reduces the barriers that are created by the process of navigating multiple parking lots and streets, and the cross pollination of consumers is intended to result in greater sales.

Decreased Distribution Costs: In the case of the food retail establishment, the adjacency to the Greenbelt will result in reduced distribution costs, as the farms are located within local trucking distance from the final retail store destinations (fig – buffered inner 2km distribution map, tally land area served). Obviously not all food products will be locally sourced, but a large portion of the seasonal produce, meat products and other specialty products may be sourced from farms much closer than is the usual. This proximity could encourage local eating and consumption of foods with less preservatives and additives.

In another scenario, the food retailer could establish a partnership with local farm operators adjacent to their store (fig – edge map with store, farms under their partnership) and source from these farms directly for the bulk of their seasonal produce. In the winter, rooftop commercial greenhouses can substantially reduce the need for internationally sourced products via high-density greenhouses with hydroponics. (fn – lufa farms)(fig - lufa farms bio page)

In either of these two scenarios, the costs of distribution are decreased for the food retailer, strengthening the case for a hybrid edge food programme.

4.5 | Hybrid Case Study

Ultimately, the design of the Whitebelt and the edge as it exists is one that is wholly inefficient on a variety of levels, including land-use, density and transit, and one that isolates marginalized groups such as those who cannot afford cars or the time needed for long commutes due to the vastness of the landscapes and the reliance on the personal car for reasonable and timely transportation.

This thesis design, then, is a response to this existing suburban typology as it has evolved over the years for corporate financial efficiency without regard to its long-term viability. This response is formed around four Whitebelt conditions that are ripe for productive intervention. These conditions – agricultural, economic, social, power generation – have been reimagined as generic conceptual site designs to determine the effects of maximizing an LFR's area and volumes under these conditions. A more detailed design now takes into account a specific site with site specific contexts under non-generic site conditions.

Edge Commercial infrastructure as Agricultural Communities: Future large format retail development lands, if developed continuing trends of increased size and spatial impact on the urban environment, will have large impacts on communities growing in the Whitebelt. These familiar development types are separated by land-use in vast homogeneous blocks – residential, large-format retail and economic districts – of which the large format retail typology plays an enormous role. Specifically, these retail developments are typically the only places to shop for most people living in the suburbs and so they exist as quasi-community centers of public aggregation, without facilitating any actual communing and interaction. Large format retail developments at the boundary between the urbanizing areas of the Whitebelt and the rural qualities of the Greenbelt can take on additional roles, namely through the addressing of the Greenbelt as a productive, beneficial force for the cities of the GTHA. There exists extensive value in the Greenbelt, a value that has until now not effectively been addressed by the cities within its boundaries as most are not yet exerting great development pressure against the boundary. The value lies in its agricultural and economic potential as well as in its proximity to ever-growing cities, allowing for fresh and local produce to be accessible to more people. By altering the large-format retail typology at the GTHA periphery, architecture can be used to address this value and introduce the wider public to the qualities, characteristics and importance of the surrounding landscape. Boundary-located hybrid agricultural/retail architecture can harness the inherent tensions between the rural and urban landscapes – that will be put under increasing pressure as the cities expand their settlement boundaries – in order to protect the Greenbelt and enhance the public realm. Further benefits can be made to local farming co-ops and businesses as The Greenbelt Act has created great difficulties in expanding agricultural operations due to restrictions on construction in the regulated lands (fn – article about farmers) (fn – agriculture GGH report). As the cities expand to the boundaries, expansion projects and additional infrastructure – such as warehousing, production, storage, maintenance garages, etc. – can be set up outside of Greenbelt jurisdiction in otherwise-inefficiently used lands – such as large-format parking lots – in partnership with corporate retail centers. Finally, by producing architecture that reflects the desires and needs of the population while also addressing the importance and proximity of food production in the Greater Toronto Area, farming is brought to greater public attention. This would have the effect of giving farmers increased public recognition as well as increasing their bargaining power in discussions that affect them.

4.6 | Conclusion

The generic large format retail development site so demonstrative of GTHA suburbia in the grey belt need not remain as it has for so long as cities struggle towards more efficient land use and higher density. While the form of LFR development over the past half century has been continuously improved and refined towards today's state of economic and commercial efficiency, there is still room for it to develop further without hindering the effectiveness of the existing system to the development's major stakeholders.

High value additive programming can be added to the site, creating additional income opportunities while also enhancing the public realm. Commercial agriculture has the potential to drive additional revenue on site while also creating a clear connection between the large format food retailer and the idea of local, organic and healthy produce and foods, whether or not the produce farmed on site is sold on site or shipped to more lucrative markets. Enhancing ecologically protective elements on site do not simply result in feelings of moral responsibility and civic mindedness to the developer and site owner, but also act to create a more comfortable and inviting environment for the traditional consumer as well as site visitors to enjoy additive programming. Social programming on the traditionally underutilized areas of the site drive site visitation from a wider demographic and creates opportunity shopping moments through cross pollination of programmes. Finally, adding power generation on site is an effective method to ensure that operational costs are lowered for the LFR site owner/operator while also enhancing the robustness of site operations for power outage situations.

All of these design interventions and additive programming create improvements to the public realm while also partially or completely offsetting the cost of their implementation. Some of these interventions are more easily quantifiable in their economic effectiveness (such as power generation or agricultural endeavours) than some of the more experiential interventions (such as the use of high albedo paving and shade structures), but the sum of their parts is an experience in which site visitors may be inclined to spend more time on site.

The large format retail development has been in state of constant flux for a very long time, continuously being altered and improved towards the new commercial ideal. The ideal of the next 30 years need not be one simply of economic concern, but also one that works to safeguard one of the most important natural and economic resources of the GTHA while maintaining or adding to the economic performance of major stakeholders.

5.0 | Conclusion

Conclusion

Between 2005 and 2008, the Ontario provincial government put into effect three major policy initiatives with the purpose of fostering and managing sustainable growth in the Greater Toronto and Hamilton Area. These policies – the Greenbelt Act of 2005, the Growth Plan for the Greater Golden Horseshoe of 2006 and the Big Move of 2008 – set into law various requirements for growth management, environmental protection and economic generation in order to ensure that the cities of the Golden Horseshoe are capable of expanding efficiently and effectively as an emerging mega-region. The language of these documents focus on mitigating the long term effects of development and resource management within the developed lands of the GTHA as well as the Greenbelt, but for the most part have ignored the expansive boundary condition that exists at the meeting of Greenbelt and Whitebelt.

This boundary has been shown to be a place of great value, desired by developers, businesses and regional residents for its inherent economic value as well as its qualities of landscape, ecology and aesthetic. Its presence as the interior edge between Greenbelt and Whitebelt also makes it the last frontier of development before said development must leap across the protected lands, increasing travelling distances to the economic engine that is Toronto. The boundary has been shown to be an area with immediate connections to the protected Greenbelt lands while avoiding being as forcefully governed and constrained by the policies enshrined into law in the early 2000's. This edge territory is one with the possibility of great risk to the existing greenfield conditions due to the lack of distance, while being a territory with the potential of generating great value beyond that of the typical generic suburban landscape development due to the confluence of forces – economic, ecological and spatial – that occupy the edge.

The large format retail development typology – most commonly known as the big-box store, the SmartCentre™, or the super centre – has evolved over the past century under the careful study and direction of the corporate entities that make up the soul to their brick and mortar bodies. As the LFR has grown in physical scale, so too it has developed an unrepentant homogeneity that in its earlier iterations mirrored the generic suburban residential development model's cookie cutter nature, but that now surpasses it as the true heart of the generic developing landscape.

This sameness that suffuses every aspect of the LFR development is the result of corporate ideals and megacorporate scales of operation, and the physical attributes of such consistency coupled with their ever-expanding physical presences generates enormous sterile landscapes of opportunity. These landscapes have been shown to be designed following principles of programme, placement and proportion that remain constant regardless of either the local placement of the site within the regional land fabric or the physical size of the site itself. The consistent formulaic nature of these developments demonstrates careful planning and consideration, as well as a very top-heavy approach to the design of places in which the vast majority of all people living in the modern GTHA will experience on at least a weekly basis. This does mean, however, that the corporate entities that control these crucial places have a perfect networked control group against which to test modifications and improvements to the present iteration of their ongoing design formula.

The idea that large corporate-controlled buildings and developments can be altered to become something more valuable while also continuing to fulfil their primary operational requirements has been explored and tested around the world at various scales and with various programmes. The analysis of several of these projects reveals that additions to the existing carefully-organized programming needs to be of a type that generates high-value activity on site, or fills a void that the local surrounding context is incapable of filling on its own. This requirement for high-value additions is crucial, as any modifications to a generic corporate development will be a detraction from the microscopically-refined formula that places economic efficiency at its core, and thus will incur greater design, construction and operational costs, the antithesis of the corporate development model.

In the case of the Amagerforbraendig Waste Incineration Facility and the Meydan Shopping Square, the hybrid interventions proposed by their architects fill a void of physical conditions that the local geography and urban fabric were incapable of addressing. These programmatic interventions generate enormous recreational and social value to the sites, filling a void left by the ultra-dense urban fabric of Istanbul and the geologically level condition of Copenhagen. In the case of the Whole Foods retail location in Lynnfield, the addition of organic rooftop agriculture creates branding opportunities of which the value goes well beyond the additional costs of construction and operation of the small-scale organic green roof.

The LFR development typology has a cultural and social presence in equal proportion to its physical size in the suburban and urban landscape, being visited regularly by millions of people around the GTHA, province and continent. For most of these people, the LFR is the location they most frequently visit outside of their own homes and workplaces.

This thesis has explored the design elements that makes up the generic built form of these developments, from the simple availability of expansive open space at grade and above, to the material choices that have environmental and experiential impacts that can be mitigated against and improved. These explorations have revealed interventional opportunities and some of their associated potential costs and benefits if applied at a site scale, as well as an early attempt to reduce these impacts to a generic numeric value that may be applied and calculated across any number of similar generic sites. These numbers create a new set of variables and values which may be used in conjunction with the long-established and deeply proprietary development formulas which dictate the designs of these enormously impactful sites.

These values were then used to modify an existing LFR development in Burlington in an attempt to demonstrate what an intervention may look like on such a site. Alterations in materials at grade along with the intensive planting of trees reduce localized temperatures due to the urban heat island effect, making the site less hostile to pedestrian access and therefore allowing for a wider variety of site programme opportunities such as farmers' markets, festivals, performances and formal/informal recreation. The wider variety of activity on the site, along with the improved pedestrian realm transforms the site from one of fleeting and insulated visits into one which nurtures extended visits, retail cross-pollination and positive brand image.

The present-day LFR development is the culmination of decades of study, market research, calculation and bookkeeping working in sync in order to most effectively facilitate the seperation of consumers and their money. Every design decision - from auto circulation and site access, to signage and marketing - is based upon this principle and then continues to be influenced upon each new iteration of the formula that has been attempted. What this thesis has attempted to do is show how the formulas and design drivers can be altered in order to maintain the LFR as an effective economic productivity machine for its owners, while also embracing a role of greater social responsibility more in proportion with the LFR typology's physical and social presence in the GTHA and North America.

The design that I have investigated as a methodological case study has been an exercise of compartmentalization and introspection. It has been necessary to my process to isolate the site as an island in order to be able to have a more effective control group; in effect, by analyzing the site independently of external forces and influences, the impacts of the various present and proposed design elements can be distilled with greater clarity. This, however, requires a certain degree of imagination and hypothesis, as in reality there are innumerable separate forces and influences on the site that could be measured that act upon the site. Any attempt made to incorporate them into the equations so early in the investigative process would serve no purpose but to cloud the waters and would generate two questions for each answer rendered.

There are numerous alternative development strategies and typologies that could take place on such expansive and generic canvases as the typical LFR development site, as evidenced by their existing homogeneity and the recent hybrid development projects investigated. My thesis has, however, eschewed investigating the totality of disparate opportunities in order to focus on developing an initial methodology of site analysis and interpretation that can be used to better understand existing and future site impacts. The development of these formulae, however preliminary, is necessary to establish a basis for future experimentation in development typologies on the LFR site, and further research and modifications to the formulae and methods are likely to yield even greater accuracy of prediction and interpretation.

The continuation of my thesis would – in addition to further developing the basic equations and logics that determine the impacts of the retail development site – take the results of these calculations and apply them at the scale of local and regional networks of like sites. While the information learned from these investigations has great use in weighing the costs of our present development methodologies, it does not gauge the combined effect that the utter reliance on this development and commercial strategy has on the local and regional environments. It is these networks and their collective impacts that deserve more intensive public scrutiny, as the march towards global economies and scales often results in great pressures and forces, both beneficial and detrimental to different parties.

There is no reason to assume that the big box retail development that North Americans are so accustomed to is incapable of change and there are numerous reasons as to why alterations to the LFR formula going forward can both act to preserve and enhance the local ecological, agricultural and social fabrics while also generating new revenue streams in order to ensure its viability.

6.1 | Endnotes

Chapter 1

1. Growth Plan for the Greater Golden Horseshoe
2. Statistics Canada
3. Statistics Canada
4. Growth Plan for the Greater Golden Horseshoe
5. Statscan catalogue no.98-310-x2011001
6. $600b/year Ontario x 50.1% population in GTHA. CANSIM table 379-0030).
7. Growth Plan for the Greater Golden Horseshoe
8. Statistics Canada
9. Cartography by Author
10. Neptis Foundation. A Note About the Whitebelt report p.72. Table 3.13
11. Greenbelt Plan p.4 (1.2.1)
12. Greenbelt Plan p.4 (1.2.1)
13. North Pickering Land Exchange. www.mah.gov.on.ca/page326.aspx
14. Overview of Classification Methodology for Determining Land Capability for Agriculture. Sis.agr.gc.ca/cansis/nsdb/cli/classdesc.html
15. Agriculture and Agri-Food Economic Profile for the Golden Horseshoe. Oct. 2014
16. Agriculture and Agri-Food Economic Profile for the Golden Horseshoe. Oct. 2014
17. "Despite the Greenbelt, Suburban Sprawl Presses On" Toronto Star, November 30, 2015

18. Growth Plan for the Greater Golden Horseshoe p.14 (2.2.3.1)

19. Growing Pains: Understanding the New Reality of Population and Dwelling Patterns in the Toronto and Vancouver Regions p.11

20. Growth Plan for the Greater Golden Horseshoe p.24 (3.2.2.1.b)

21. Growth Plan for the Greater Golden Horseshoe p.16 (2.2.4.4.a)

22. Growth Plan for the Greater Golden Horseshoe p.16 (2.2.4.4.c)

23. The Big Move – 1.3 Challenges: Congestion. Find report from here

24. The Big Move – 1.3 Challenges: Congestion. Find report from here

25. The Big Move – 2.0: A Vision for the Future

26. The Big Move – 2.0, table 3: Nine Big Moves

27. North Pickering Land Exchange. www.mah.gov.on.ca/page326.aspx

28. "Despite the Greenbelt, Suburban Sprawl Presses On" Toronto Star, November 30, 2015

Chapter 2

1. Statistics Canada

2. Cartography by Author

3. The Greenbelt Plan p.5, 1.2.2.2.c

4. The Greenbelt Plan p.5, 1.2.2 Goals

Chapter 3

1. Growth Plan for the Greater Golden Horseshoe

6.2 | Bibliography

Big. 2012. A + U: Architecture and Urbanism(10(505)) (Oct 2012): 22-37.

Meydan: A shopping center with a green meadow on the roof. in Zinco USA, Inc. [database online]. 2011 [cited October 1 2014]. Available from http://www.zinco-usa.com/news/press_releases/press_release_details.php?id=60.

Table 4-1average household energy use, by household and dwelling characteristics, 2011 — household size. 2011. Statistics Canada, Environment Accounts and Statistics Division., 11-526-S.

Safeway georgetown — now open. in www.pavilions.com [database online]. 2010 [cited June 25, 2015 2015]. Available from http://www.pavilions.com/ShopStores/Georgetown-Safeway-About-Us.

Fiat works (lingotto), turin, italy. in www.architectural-world.com [database online]. 2008 [cited September 28 2014]. Available from http://www.architectural-world.com/2008/05/fiat-works-lingotto-turin-italy.html.

Meydan – umraniye retail complex & multiplex / FOA. in ArchDaily [database online]. 2008 [cited September 30 2014]. Available from http://www.archdaily.com/3338/meydan-umraniye-retail-complex-multiplex-foa/.

Architecture of modern italy volume II : Visions of utopia, 1900-present2005. , ed. Terry Kirk. New York, NY, USA: Princeton Architectural Press.

Story - lingotto factory conversion. in www.fondazionerenzopiano.org [database online]. 1999 [cited September 28 2014]. Available from http://www.fondazionerenzopiano.org/project/92/lingotto-factory-conversion/genesis/.

Industrial property markets : In western europe. 1992. , ed. B. Wood. London, GBR: Spon Press.

Lingotto factory conversion torino, italy. in www.rpbw.com [database online]. [cited September 20 2014]. Available from http://rpbw.com/project/62/lingotto-factory-conversion/.

A rooftop racetrack: The fiat lingotto factory in turin, italy (1923). in www.thecharnelhouse.org [database online]. [cited September 27 2014]. Available from http://thecharnelhouse.org/2013/05/01/a-rooftop-racetrack-the-fiat-lingotto-factory-in-turin-italy-1923/.

Urban megaprojects: A worldwide view. In . Vol. 13, iEmerald Group Publishing Limited.

Comparing costs: Concrete vs. asphalt paving. in Onsite Contracting Inc. [database online]. 2013 [cited February 27 2017]. Available from http://www.oscinc.ca/comparing-costs-concrete-vs-asphalt-paving/.

Belen Brick and Supply. Unilock stock products. in Unilock [database online]. 2014 [cited January 27 2017]. Available from http://www.beldenbrickandsupply.com/files/Unilock_Stock_Products_2014.pdf.

Berman, Ila, and Ed Mitchell. 2012. ACSA 101: New constellations new ecologies. San Fransisco, CA.

Bodnar, Judit, and Judit Veres. Chapter 4 the petty politics of a megaproject in budapest. In . Vol. 13, 83-106Emerald Group Publishing Limited.

Bogart, William T. 2006. Don't call it sprawl : Metropolitan structure in the 21st century. West Nyack, NY, USA: Cambridge University Press.

Bos, Caroline, and Ben van Berkel. 2011. Typological instruments: Connecting architecture and urbanism. Architectural Design 81 (1) (Jan 2011): 66-77.

Carr, James H., and Lisa J. Servon. 2008. Vernacular culture and urban economic development: Thinking outside the (big) box. Journal of the American Planning Association 75 (1) (12/31; 2014/10): 28-40.

Cesarz, Michael, Manina Ferreira-Erlenbach, Murat Pulat, and Cornelia Tomerius. 2007. Meydan shopping square : Ein neuer prototyp von foa = A new prototype by foa : A metro group project in istanbul. Berlin: Berlin : Jovis.

Christensen, Julia. 2008. Big box reuse. Cambridge, Mass.: Cambridge, Mass. : MIT Press.

Ciuffi, Valentina. 2012. In bici, in auto o sugli sci? il ministro dell'ambiente e l'amagerforbrænding = by bike, by car or on skis? the minister for the environment and the amagerforbrænding. Abitare(528) (Dec 2012): 140-5.

Cowen, Deborah. 2014. Inner suburbs at stake : Investing in social infrastructure in scarborough, eds. Vanessa Parlette, Neighbourhood Change Community University Research Alliance and University of Toronto. Cities Centre,creator. Beaconsfield, Quebec: Toronto, Canada : Cities Centre, University of Toronto.

Davis, Diane E., and Flores Dewey Onesimo. Chapter 12 how to defeat an urban megaproject: Lessons from mexico city?s airport controversy. In . Vol. 13, 287-315Emerald Group Publishing Limited.

De Jong, Judith. 2014. New suburbanisms. First edition. ed. Abingdon, Oxon ; New York, NY: Abingdon, Oxon ; New York, NY : Routledge.

Dey, Dennis, Jim Calpas, Dr M. Mirza, Betty Vladicka, and Nabi Chaudhary. 2001. Commercial greenhouse vegetable production. Alberta Agriculture and Forestry, Agdex 250/830-2.

Dezeen.com. Meydan shopping square by foreign office architects. in Dezeen [database online]. 2007 [cited September 11 2014]. Available from http://www.dezeen.

com/2007/12/12/meydan-shopping-square-by-foreign-office-architects/.

Dunham-Jones, Ellen. 2011. Retrofitting suburbia : Urban design solutions for redesigning suburbs, ed. June Williamson. Updated ed. ed. Hoboken, N.J.: Hoboken, N.J. : Wiley.

Dunn, Sarah, and Martin Felsen. 2012. Too big to fail. Architectural Design 82 (5): 114-9.

Ferré, Albert, and Tihamér Hazarja Salij. 2010. Total housing : Alternatives to urban sprawl. Barcelona ; New York: Barcelona ; New York : Actar.

FieldTurf. Cost analysis. in FieldTurf [database online]. 2016 [cited February 27 2017]. Available from http://www.fieldturf.com/en/fieldturf-difference/cost-analysis.

Florida, Richard. 2013. The fading differentiation between city and suburb. Urban Land Magazine (January 31).

Fraker, Harrison. 2013. The hidden potential of sustainable neighborhoods : Lessons from low-carbon communities. Washington: Washington : Island Press.

Gerardo del, Cerro Santamar. Chapter 2 the alleged bilbao miracle and its discontents. In . Vol. 13, 27-59Emerald Group Publishing Limited.

Goodno, James B. 2004. Rethinking retail. Planning 70 (10) (11): 10-5.

greenerenergy.ca. Tilt and angle orientation of solar panels. in greenerenergy.ca [database online]. [cited August 8 2016]. Available from http://www.greenerenergy.ca/PDFs/Tilt%20and%20Angle%20Orientation%20of%20Solar%20Panels.pdf.

Hahn, Barbara. 2000. Power centres: A new retail format in the united states of america. Journal of Retailing and

Consumer Services 7 (4) (10): 223-31.

Haltiwanger, John, Ron Jarmin, and C. J. Krizan. 2010. Mom-and-pop meet big-box: Complements or substitutes? Journal of Urban Economics 67 (1) (1): 116-34.

Harris, Thomas R. 2006. The economic and social impact of big box retailers: Discussion. American Journal of Agricultural Economics 88 (5) (12/01): 1311-2.

Ingels, Bjarke, and Michele Stramezzi. 2011. BIG: Window to the future [interview]. C3 Korea(321) (May 2011): 178-209.

Jones, Ken, and Michael Doucet. 2000. Big-box retailing and the urban retail structure: The case of the toronto area. Journal of Retailing and Consumer Services 7 (4) (10): 233-47.

Kedron, Amy. 2013. Main street revisited: How local proprietor relationships drive sustainable community economic development. Ph.D., State University of New York at Buffalo.

Keil, Roger. 2013. Suburban constellations : Governance, land and infrastructure in the 21st century. Berlin: Berlin : Jovis Verlag.

Kelly, Garrett. How much does it cost to install a basketball court?. in angieslist.com [database online]. 2016 [cited February 27 2017]. Available from https://www.angieslist.com/articles/how-much-does-it-cost-install-basketball-court.htm.

Kim, Erica. in www.designboom.com [database online]. 2011 [cited September 19 2014]. Available from http://www.designboom.com/architecture/big-architects-amagerforbraending-waste-treatment-plant-and-ski-run/.

Kuak, David. 2012. Maximizing hydroponic crop production. Greenhouse Product News (December).

Kuitenbrouwer, Peter. 2014. Despite $120M in tax breaks, the billion dollar woodbine live project fell apart. at least they still have soybeans. The National Post. 2014, sec Toronto.

Lukez, Paul. 2007. Suburban transformations. 1st ed. ed. New York: New York : Princeton Architectural Press.

MaCaulay, Tyson. 2008. Critical Infrastructure: understanding its component parts, vulnerabilities, operating risks, and interdependencies. CRC Press, .

McRae, Rod. 2015. Dollars & sense : Opportunities to strengthen southern ontario's food system. Toronto, Ontario: Metcalf Foundation,Canadian Electronic Library, .

Merrilees, Bill, and Dale Miller. 1997. The superstore format in australia: Opportunities and limitations. Long Range Planning 30 (6) (12): 899-905.

Min-Young Lee, Kelly Green Atkins, Youn-Kyung Kim, and Soo-Hee Park. 2006. Competitive analyses between regional malls and big-box retailers: A correspondence analysis for segmentation and positioning. Journal of Shopping Center Research 13 (1) (04): 81-98.

Munro, Steve. RER, UP(X), (D)RL, SmartTrack, W(W/E) LRT: The frustration of competing plans. in www.stevemunro.ca [database online]. 2014 [cited September 15 2014]. Available from http://stevemunro.ca/?p=10174.

Natural Resources, Ministry o. Lassifying prime and marginal agricultural soils and landscapes: Guidelines for application of the canada land inventory in ontario. in Queen's Printer for Ontario [database online]. Ontario, 2013 [cited November/21 2014]. Available from http://www.omafra.gov.on.ca/english/landuse/classify.htm#references.

organicpricetracker.ca. The requested price information. in Canadian Organic Growers [database online]. 2017 [cited February 28 2017]. Available from http://organicpricetracker.ca/index.php/getprice/toronto/240%2C109%2C37%2C47%2C72.

O'Rourke, T. D. 2007. Critical infrastructure, interdependencies, and resilience. The Bridge 37 (1): 22.

P. Galinato, Suzette, Carol A. Miles, and Srinivasa S. Ponnaluru. 2012.

2011 cost of producing fresh market field-grown tomatoes in western washington Washington State University, FS080E.

Pena, Dr Jose. 1985. Greenhouse vegetable production economic considerations, marketing, and financing. Paper presented at Hydroponics Worldwide: State Of The Art In Soilless Crop Production, Hawaii.

Poirier, Gabrielle. 2012. Monumental waste. Journal of Architectural Education 65 (2) (Mar 2012): 118-24.

Rutledge, kevan foster. 2006. Beyond the (re) decorated shed: exploring alternative methods for big box reuse. University of cincinnati.

Saunders, William S. 2005. Sprawl and suburbia : A harvard design magazine reader. Minneapolis: Minneapolis : University of Minnesota Press.

Sewell, John. 2009. The shape of the suburbs understanding toronto's sprawl. Toronto ; Buffalo; Toronto Ont.]: Toronto Ont. : University of Toronto Press.

Sklair, Leslie. Chapter 7 the role of iconic architecture in globalizing urban megaprojects. In . Vol. 13, 161-183Emerald Group Publishing Limited.

Smith, Veronica Rose. 2014. Future relics: The rise and fall of the big box store. M.A., The University of Iowa.

Spencer, Robert, and Barkley, Shelley. Starting A commercial greenhouse business in alberta. in Alberta Agriculture and Forestry [database online]. 2009 [cited November 6 2016]. Available from http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp11207.

sportsknowhow.com. High school-college basketball court dimensions diagram. in sportsknowhow.com [database online]. [cited August 8 2016]. Available from http://www.sportsknowhow.com/basketball/dimensions/high-school-basketball-court-dimensions.html.

Sportsknowhow.com. Soccer field dimensions diagram. in sportsknowhow.com [database online]. [cited August 8 2016]. Available from http://www.sportsknowhow.com/soccer/dimensions/soccer-dimensions.html%23enlarge.

Sportsknowhow.com. Tennis court dimensions diagram. in sportsknowhow.com [database online]. [cited August 8 2015]. Available from http://www.sportsknowhow.com/tennis/dimensions/tennis-court-dimensions.html%23enlarge.

Sutton, Tori. Plan pitched for sobeys development. in www.southwesternontario.ca [database online]. 2012 [cited June 25, 2015 2015]. Available from http://www.southwesternontario.ca/news/plan-pitched-for-sobeys-development/.

Thompson, David. 2014. Suburban sprawl : Exposing hidden costs, identifying innovations, ed. University of Ottawa. Sustainable Prosperity,issuing body. Beaconsfield, Quebec: Ottawa, Ontario : Sustainable Prosperity University of Ottawa.

Toronto and Region Conservation. An economic analysis of green roofs: evaluating the costs and savings to building owners in toronto and surrounding regions in Toronto and Region Conservation [database online]. 2007 [cited January 18 2017]. Available from http://www.sustainabletechnologies.ca/wp/wp-content/uploads/2013/03/GR_Econ.pdf.

Toronto Region Board of Trade. 2014. Discussion paper: Build regional transportation now. www.bot.com, .

Trienekens, Jacques. 2010. Towards effective food chains : Models and applications. Wageningen, The Netherlands: Wageningen, The Netherlands : Wageningen Academic Publishers.

Webb, Michael. 2008. Made in china. Vol. 224.

Zahle, David, and Matteo Poli. 2012. Amagerforbrænding, copenhagen: Termovalorizzatore da sci = waste-to-energy to ski. Abitare(528) (Dec 2012): 146-9.

6.3 | Glossary

Glossary

Large Format Retail (LFR):

Colloquially known as "big box" stores and including such developments as supercentres, 'Smartcentres' and other expansive generic retail developments

Greenbelt:

The consolidated boundary containing several pieces of pre-existing legislation in one large and protected boundary, for which unified laws and regulations are developed.

Whitebelt:

Colloquial term describing the unsettled greenfield lands between developed suburbia and the protected Greenbelt boundary.

Greenfield Development:

Term describing the urban development of virgin lands, including farms, forests, fields, etc.

Greyfield Development:

Term describing the redevelopment and infill of the empty spatial infrastructure that surrounds large suburban development typologies such as parking lots.

Brownfield Development:

Term describing the redevelopment of lands that were previously built up. Such sites are often contaminated by prior industrial uses.

6.4 | Appendix 1: Site Calculations

6.1.1 | Quantitative Site Calculations
A1 | Agriculture Yields

Traditional Agricultural Methods

Tomato Yields

average yield = 30,360 lbs / acre in lbs / m^2 => 7.5 lbs/m^2

> Tomatoes are harvested 3 times a week for 8 weeks, which yields approximately 5.52 lbs per plant per season. Another study calculated roughly 30,000 lbs of yield per acre, which equates to 7.5 lbs of yield per square meter per season.

Hydroponic Agricultural Methods

Cucumbers

plant density = 1.25 plants / m^2

average yield = 120 cucumbers / m^2

potential yield = 150 cucumbers / m^2

harvest = 3 / year

Tomatos

plant density = 2.5 plants / m^2

average yield = 60 kg / m^2 in lbs / m^2 => 132.28 lbs/m^2

harvest = 1 / year

Peppers

plant density = 4.5 plants / m^2

average yield = 26 kg / m^2 in lbs / m^2 => 57.32 lbs/m^2 harvest = 1 / year

Lettuce

gross revenue potential = $86 / m^2

harvest = 12 / year

Flowers

gross revenue potential = $110 / m^2

Economic Impacts Agriculture

Known Values

site area = 94,471 m^2

area roofs = site area * 30% => 28,341.3 m^2

adjacent hydro land area = 33,000 m^2 * 75% => 24,750 m^2

useable area = area roofs + adjacent hydro land area => 53,091.3 m^2

value lettuce hydroponic = $86 / m^2

value flowers hydroponic = $110 / m^2

Hydroponic Agriculture Methods

Cost Hydroponic

capital cost hydroponic = $200 / m^2

production cost tomato = $86.33 / m^2

production cost cucumber = $70.50 / m^2

site capital cost hydroponic = capital cost hydroponic * site area => $18,894,200

site production cost tomato = production cost tomato * site area => $8,155,681.43

site production cost cucumber = production cost cucumber * site area => $6,660,205.5

Benefits Hydroponic

ontario greenhouse sales = $103 / m^2

average gross revenue = $90.20 / m^2

average net revenue = $3.88 / m^2

gross revenue cucumber = $79.65 / m^2

net revenue cucumber = $9.15 / m^2

site average sales = ontario greenhouse sales * useable area => $5,468,403.9

site average gross revenue = average gross revenue * useable area => $4,788,835.26

site average net revenue = average net revenue * useable area => $205,994.24

site gross revenue cucumber = gross revenue cucumber * useable area => $4,228,722.05

site net revenue cucumber = net revenue cucumber * useable area => $485,785.4

Cost Traditional

production cost tomato = $25,982.92 / acre in $/m^2 => $6.42/m^2 site production cost tomato = production cost tomato * useable area => $340,873.72

Benefits Traditional

gross revenue tomato = $60,720 / acre in $/m^2 => $15/m^2

net revenue tomato = $34,737.08 / acre in $/m^2 => $8.58/m^2

site gross revenue tomato = gross revenue tomato * useable area => $796,594.54

site net revenue tomato = net revenue tomato * useable area => $455,720.82

E1 | Reduce Storm Water Impacts

These calculations are to determine the volume of annual precipitation that falls upon the generic site, determined to the square meter.

Millimiters to Liters Conversion (Per Square Meter)

200 mm * 1m^2 in L => 200 L

10 mm * 1 m^2 in L => 10 L

Therefore every 1mm of precipitation over 1 square meter is equivalent to 1 L in volume.

Volume Calculation for Site

site area = 94,471 m^2

average annual precipitation = 200 mm / m^2

annual site precipitation = average annual precipitation * site area => 18,894,200 mm

annual site precipitation volume = annual site precipitation *

1 m^2 in L => 18,894,200 L

Therefore, for a site with an area of 94,471 square meters, there is a total average annual precipitation equivalent to 18 million liters, whose effects in terms of pollutant and stormwater runnoff as well as thermal accumulation can be calculated.

The formula is, simply: "site area (m^2)" * "precipitation (mm / year)" = "Precipitation Volume (L / year)"

Effects Sodium Chloride

Known Values

annual site precipitation volume => 18,894,200 L

peak chloride runnoff concentration = 11,000 mg / L

chronic water quality limit = 230 mg / L

acute water quality limit = 860 mg / L

We determine the total volume of chloride impacting the site and its surroundings due to stormwater runnoff and winter melt, "precipitation chloride impact" in Kg. The modifier (0.5 * 0.75) represents the 6 months of winter salt application as well as a 75% peak sodium density to be conservative with the estimate.

precipitation chloride impact = peak chloride runnoff concentration * annual site precipitation volume in kg * (0.5 * 0.75) => 207,836.2 kg

This calculation shows that the annual sodium chloride impact of the site due to winter melt and runnoff is roughly 208,000 kg, or 554,000 lbs.

Effects Lead

Known Values

lead runnoff concentration = 5.5 mg / L

field runnoff concentration = 0.09 mg / L precipitation lead impact = lead runnoff concentration * annual site precipitation volume in kg => 103.9181 kg

rural lead impact comparitor = field runnoff concentration * annual site precipitation volume in kg => 1.7005 kg

This figure compares poorly with the concentration of lead in a similarly sized field, with a concentration of just 0.09 mg/L. A rural or agriculturally conditioned field of the same size as the site would have a total surficial lead volume of just 1.7 kg compared to the LFR's 104 kg. The impact of heavy automobile traffic cannot be understated.

This calculation shows that simply by existing, the site may drain around 100 kilograms of lead into the local hydrology, impacting the health of the local ecosystem, fish, plants and frogs

E2 | Urban Heat Island Effects

Known Values

site area = 94,471 m^2

The higher the albedo value, the more reflective the material is. The lower the albedo, the more solar radiant energy is absorbed by the material to later be radiated as thermal energy.

An increased local temperature, or "urban heat island" has two principal effects towards the local environment. The first is that if the low albedo paved areas are expansive enough, the local microclimates and climate can be affected. The second, and more critical effect is that with an urban heat island in place on a site, additional programming will have difficulty being attractive to site visitors, consumers, etc. If the temperature at grade is 8 degrees celsius hotter than a grassy field in the same place, the quality of enjoyment (or even just tolerance) of the site goes down dramatically for visitors or consumers.

Albedo:

burlington mean daily global insolation = 4.22 kWh / m^2 albedo asphalt = 8%

albedo gravel roofing = 31%

albedo white gravel roofing = 72%

albedo white membrane roofing = 84%

gravel roofing temperature = 68 degrees

white gravel roofing temperature = 59 degrees

We can calculate the differences between the albedos of high reflectivity gravel and traditional gravel, as well as the differences between their respective albedos, to determine a value that represents the degree change per albedo percentage point.

Units in temperature degrees / albedo (percentage point)

difference gravels = gravel roofing temperature - white gravel roofing temperature => 9 degrees

difference albedos = albedo white gravel roofing - albedo gravel roofing => 0.41

difference gravel-white gravel / difference albedo gravel-albedo white gravel

albedo effect = difference gravels / difference albedos / 100 => 0.2195 degrees

This shows roughly that for every degree increase in albedo, the unshaded roof temperature goes down by 0.22 degrees celsius. It is important to note that even with a high-albedo white gravel roofing material, the unshaded surface temperature in the study was still 59 degrees celsius, showing that additional means of cooling the area is recommended. Such means include the increase in semi permeable or fully permeable surfaces which retain rainwater and allow the site to "sweat," releasing energy as steam instead of as directly through radiant heat energy, as well as increase in shaded areas through a planted tree canopy or structures.

It is clearly a benefit to increase the total albedo of the site in order to make it more attractive to consumers, opening up greater value for the site owner and/or operator.

E3 | Effects of Enhanced Public Transit Access on Site

Known Values

site area = 94,471 m^2

Daily Access Total = 1,300

Percentage Access Car = 90%

Percentage Access HOT = 100% - Percentage Access Car in % => 10%

Consumer Access Method Car = Daily Access Total * Percentage Access Car => 1,170

Consumer Access Method HOT = Daily Access Total * Percentage Access HOT => 130

> For each Higher Order Transit trip to the site, as opposed to taking a personal automobile, greenhouse gas emissions are reduced by 0.24 lbs.

GHG Car = 0.25 lbs / day

GHG HOT = 0.01 lbs / day

Effect Access HOT = (Consumer Access Method HOT * GHG HOT) + (-Consumer Access Method HOT * GHG Car)=> -31.2 lbs/day

Effect Access Car = Consumer Access Method Car * GHG Car => 292.5 lbs/day

> Therefore, "Effect Access HOT" defines the total reduction for the site as calculated from all of the trips taken by higher order transit as opposed to a personal automobile, calculated by multiplying the total number of daily trips using HOT by the mass of greenhouse gas emissions for the default car, offset by the same number of trips by higher order

transit multiplied by the mass of greenhouse gas emissions for HOT use.

Parking Area Effects

By multiplying the number of consumers accessing the site per day using higher order transit as opposed to personal automobiles by the standard area of a parking stall, we can determine a roughly calculated parking area savings which, if the move to other transit methods is more permanent than say a one time trial by the consumer, can be used by the development site owner and/or operator as retail area, creating revenues and driving more consumers to the site.

Stall Length = 6 m

Stall Width = 2.75 m

Parking Stall Area = Stall Length * Stall Width => 16.5 m^2

Revenue Standard Retail = $30 / m^2 / month

Parking Area Savings = Consumer Access Method HOT * Parking Stall Area => 2,145 m^2

Potential Revenue PAS = Parking Area Savings * Revenue Standard Retail => $64,350/month

This initial calculation of the Potential Revenue using a 10% multiplier of all consumer access to the site in a given day, shows a total of 130 consumers using higher order transit instead of a personal car, resulting in a total of 2,340 square meters of parking stall area that is no longer necessary in that capacity. The greater number of shoppers visiting the site using alternative means of transportation in more permanent numbers, the greater the number of traditional parking stalls unneeded resulting in greater areas of space that can be used for alternative uses such as retail, service or infrastructures.

This is, of course, tempered by the local municipalities' requirements for parking spaces for total site and programme areas, so any realistic application of this concept would need to go through municipal and most likely provincial approval.

Concept: 50% Higher Order Transit Site Access

To explore the effects of these calculations, an assumed change from 10% HOT site access to 50% is applied.

Percentage Access Car = 50%

Percentage Access HOT => 50%

Effect Access HOT => -156 lbs/day

Effect Access Car => 162.5 lbs/day

Parking Area Savings => 10,725 m^2

Potential Revenue PAS => $321,750/month

This shows that if the site's design can alter the access patterns for 50% of the consumers permanently, a total new available volume due to unused parking spaces is 9,360 square meters, which can be used in a more productive capacity. Using a standard rental cost for retail of $30 per square meter per month, a total of $351,000 of retail revenue can be generated monthly for the site owner and operator. This value will vary by area and local standard rental costs.

Furthermore, the effect of converting 50% of trips to the LFR site from personal car to higher order transit reduces the total greenhouse gas emissions by site visitors by 156 lbs per day, or 26 metric tonnes per year.

S1 | Sports and Formal Recreation

Known Values

site area = 94,471 m^2

roof area large = site area * 30% * 60% => 17,004.78 m^2 roof area small = site area * 30% * 40% => 11,336.52 m^2

parking area = site area * 50% => 47,235.5 m^2

> "roof area large" denotes roof areas that can be used for larger programme, such as soccer/football fields.
>
> "roof area small" denotes roof areas that can be used for smaller scale programme, such as basketball courts or tennis courts.
>
> These areas are tabulated by multiplying the generic formula of 30% total site coverage being built structures, with an additional qualifier of 60% being the anchor store and subsequently 40% being the remaining retail programming.
>
> "parking area" is tabulated by taking the 60% of the site that is impermeable paving, such as parking lots, circulation and sidewalks, and multiplying that against a 50% qualifier. This qualifier represents a reduction of the total area down to only the largest continuous areas, while incorporating a further reduction due to necessary circulation pathways.

area soccer field = 60 yards * 100 yards in m^2 => 5,016.76 m^2

area basketball court = 42 ft * 74 ft in m^2 => 288.74 m^2

area tennis court = 36 ft * 78 ft in m^2 => 260.87 m^2

area average small = (area basketball court + area tennis court) / 2 => 274.81 m^2

quantity large = (roof area large + parking area) / area soccer field => 12.81

quantity small = (roof area small + roof area large + parking area) / area average small => 275.02

> These figures show that with the existing areas of space on the typical generic large format retail site, an additional 8 small formal recreation courts can be added on the roofs and at grade. Larger formal recreation programming such as soccer or football fields have a harder time at finding placement due to their vast sizes. However, if a half size recreational

soccer/football field is used, not only does it increase the number of games that can be played simultaneously but it also increases the potential users through a more accessible playing size.

If the entire site is covered in a structural recreational canopy, then the flexibility of arrangements to formal programming becomes much greater and the total amount of such programming expands in tandem.

canopy area total = site area * 90% => 85,023.9 m^2

canopy infrastructure = canopy area total * 10% => 8,502.39 m^2

canopy sports area = canopy area total - canopy infrastructure => 76,521.51 m^2

quantity large canopy = canopy sports area / area soccer field => 15.25

quantity small canopy = canopy sports area / area average small => 278.46

These calculations show a scenario with a structural recreational canopy covering 90% of the site, with 10% of the total area being infrastructural, operational spaces and access/circulation spaces.

S2 | Parks and Informal Recreation

Known Values

site area = 94,471 m^2

at grade parking infrastructure = (site area * 60%) - (site area * 10%) => 47,235.5 m^2

at grade parks = at grade parking infrastructure * 50% => 23,617.75 m^2

canopy structure parks = site area * 90% => 85,023.9 m^2

This simple calculation demonstrates the effect of converting 50% of at grade parking infrastructure into informal recreation spaces such as parks, walkways or gardens.

A more intensive layout would see a structural canopy over 90% of the site hosting those programmes above grade. This canopy increases the total area of available space for said programming but creates difficulty in easy access to the site for the visitor (or alternatively, increases control, management and safety capabilities to the site owner and/or operator).

S3 | Indoor Community Facilities

This design focus puts into use the cavernous spaces of the large format retail building, in particular the upper storeys of unoccupied volume, for community or private social and recreational purposes. This includes such programming as educational workshops, clubrooms, athletic, performance, art and culture, etc. This figure is calculated as 50% of the at grade floor area of the anchor store(s) on site and adds programmatic density to the site.

Known Values

site area = 94,471 m^2

building area anchor = site area * 30% * 60% => 17,004.78 m^2

building area secondary = site area * 30% * 40% => 11,336.52 m^2

circulation area = site area * 60% * 10% => 5,668.26 m^2

parking area = site area * 60% - circulation area => 51,014.34 m^2

additional built programme = building area secondary * 10% => 1,133.65 m^2 indoor community facilities = (building area anchor * 50%) + additional built programme => 9,636.04 m^2

E1 | Solar Power Generation

These calculations determine the total potential solar power generation values for a given site, based on the area and local daily global insolation.

Known Values

daily global insolation (DGI) : The total daily amount of average solar radiant energy that is received in a given location, measured in kWh/m^2

DGI Burlington = 4.22 kWh / m^2

latitude burlington = 43

site area = 94,471 m^2

roof area = site area * 30% => 28,341.3 m^2

solar panel coverage = 80%

yearly household energy = 127 GJ in kWh => 35,277.78 kWh

Option 1 - Total Roof Coverage

yearly total potential energy = DGI Burlington * roof area * solar panel coverage * 365 => 34,923,283.51 kWh

household equivalent = yearly total potential energy / yearly household energy => 989.95

This shows that if all rooftops on site were to be covered with solar panels at 80% coverage, then the site would be able to generate 1.3 million kWh of energy on average per year.

This equates to the total average energy consumption of 38 households.

Option 2 - Total Site Coverage

yearly total potential energy = DGI Burlington * site area * solar panel coverage * 365 => 116,410,945.04 kWh

household equivalent = yearly total potential energy / yearly household energy => 3,299.84

> This shows that if the site were to be covered with a solar cell canopy at 80% of the total site area, the site would generate 4.3 million kWh of energy on average per year.
>
> This equates to the total annual energy consumption of 126 households.

6.1.2 | Economic Site Calculations

Economic Impacts | Ecology

site area = 94,471 m^2 in foot^2 => 1,016,877.38 foot^2

area roofs = site area * 30% => 305,063.21 foot^2

adjacent hydro land area = 33,000 m^2 * 75% => 24,750 m^2

useable area = area roofs + adjacent hydro land area => 305,063.21 foot^2 + 24,750 m^2

Permeable Surfacing

unilock turfstone = $6.78 / foot^2

unilock courtstone = $8.63 / foot^2

unilock hollandstone = $2.36 / foot^2

green roof unit cost = $15.00 / foot^2

Note that green roofs can carry a capital cost of between $6.00 and $21.00 per square foot on top of the base cost of the roof. For the purposes of these calculations, a unit cost of $15.00 per square foot has been chosen.

Note that the estimated capital costs for a standard commercial flat roofing installation is roughly $15.00 per square foot, resulting in a 100% increase of roofing cost for a 100% coverage of green roofing.

green roof site cost = area roofs * green roof unit cost => $4,575,948.21

turfstone site cost = site area * 60% * 70% * unilock turfstone => $2,895,660.03

hollandstone site cost = site area * 60% * 20% * unilock hollandstone => $287,979.67

courtstone site cost = site area * 60% * 10% * unilock courtstone => $526,539.11

total cost permeable +=

green roof site cost = $4,575,948.21

turfstone site cost = $2,895,660.03

hollandstone site cost = $287,979.67

courtstone site cost = $526,539.11

total cost permeable => $8,286,127.02

The cost of installing permeable paving throughout the site including roofs can be estimated to be around $8.3 million.

Impermeable Surfacing Reference

asphalt = $3.00 / foot^2

commercial roofing = $8.00 / foot^2

asphalt site cost = asphalt * site area * 60% => $1,830,379.29

commercial roofing site cost = commercial roofing * site area * 30% => $2,440,505.71

total cost impermeable +=

asphalt site cost = $1,830,379.29

commercial roofing site cost = $2,440,505.71

total cost impermeable => $4,270,885

The cost of a typical surface and roof installation using impermeable materials can be estimated to be around $4.3 million.

Using permeable materials throughout the site results in a 100% installation cost increase.

Urban Heat Island Effect Reductions

site area = 94,471 m^2

tree unit cost = $250

planting number = (site area * 60% * 80% * 25%) / 15 m^2 => 755.77

tree site cost = tree unit cost * planting number in $ => $188,942

At a typical cost of roughly $250 for the purchase and installation of a medium sized tree, the total cost of the planting of 755 trees on site for shade and temperature control will cost roughly $190,000.

This planting number is calculated by assuming a desired tree canopy of 25% of total surface coverage of parking areas on site and dividing that area by a mature tree canopy area of 15 square meters per tree.

concrete unit cost = $5.00 / foot^2

concrete site cost = concrete unit cost * site area in $/m^2 *

60% => $5,084,386.9

concrete cost increase = concrete site cost / asphalt site cost => 2.78

> Using a higher cost, higher albedo concrete as the typical site paving material increases the installation cost by 67%.

Effects of Enhanced Public Transit Access on Site

site area = 94,471 m^2

Stall Length = 6 m

Stall Width = 2.75 m

Parking Stall Area = Stall Length * Stall Width => 16.5 m^2

total parking area = site area * 60% * 75% => 42,511.95 m^2

Daily Access Total = total parking area / Parking Stall Area * 30% => 772.94

Percentage Access Car = 90%

Percentage Access HOT = 100% - Percentage Access Car in % => 10%

Consumer Access Method Car = Daily Access Total * Percentage Access Car => 695.65

Consumer Access Method HOT = Daily Access Total * Percentage Access HOT => 77.29

> Daily Access Total represents the total number of parking stalls that might be in active use for the sole purpose of temporary visitor parking. It is calculated by applying a typical 30% modifier to the total parking area to denote an approximate normal usage. Consumer-oriented holidays such as Christmas would not adhere to such a conservative multiplier.

For each Higher Order Transit trip to the site, as opposed to taking a personal automobile, greenhouse gas emissions are reduced by 0.24 lbs.

GHG Car = 0.25 lbs / day

GHG HOT = 0.01 lbs / day

Effect Access HOT = (Consumer Access Method HOT * GHG HOT) + (-Consumer Access Method HOT * GHG Car)=> -18.55 lbs/day

Effect Access Car = Consumer Access Method Car * GHG Car => 173.91 lbs/day

Therefore, "Effect Access HOT" defines the total reduction for the site as calculated from all of the trips taken by higher order transit as opposed to a personal automobile, calculated by multiplying the total number of daily trips using HOT by the mass of greenhouse gas emissions for the default car, offset by the same number of trips by higher order transit multiplied by the mass of greenhouse gas emissions for HOT use.

Parking Area Effects

By multiplying the number of consumers accessing the site per day using higher order transit as opposed to personal automobiles by the standard area of a parking stall, we can determine a roughly calculated parking area savings which, if the move to other transit methods is more permanent than say a one time trial by the consumer, can be used by the development site owner and/or operator as retail area, creating revenues and driving more consumers to the site.

Revenue Standard Retail = $30 / m^2 / month

Parking Area Savings = Consumer Access Method HOT * Parking Stall Area => 1,275.36 m^2

Potential Revenue PAS = Parking Area Savings * Revenue Standard Retail => $38,260.76/month

This initial calculation of the Potential Revenue using a 10% multiplier of all consumer access to the site in a given day, shows a total of 130 consumers using higher order transit instead of a personal car, resulting in a total of 2,340 square meters of parking stall area that is no longer necessary in that capacity. The greater number of shoppers visiting the site using alternative means of transportation in more permanent numbers, the greater the number of traditional parking stalls unneeded resulting in greater areas of space that can be used for alternative uses such as retail, service or infrastructures.

This is, of course, tempered by the local municipalities' requirements for parking spaces for total site and programme areas, so any realistic application of this concept would need to go through municipal and most likely provincial approval.

Concept: 50% Higher Order Transit Site Access

To explore the effects of these calculations, an assumed change from 10% HOT site access to 50% is applied.

Percentage Access Car = 50%

Percentage Access HOT => 50%

Effect Access HOT => -92.75 lbs/day

Effect Access Car => 96.62 lbs/day

Parking Area Savings => 6,376.79 m^2

Potential Revenue PAS => $191,303.78/month

This shows that if the site's design can alter the access patterns for 50% of the consumers permanently, a total new available volume due to unused parking spaces is 9,360 square meters, which can be used in a more productive capacity. Using a standard rental cost for retail of $30 per square meter per month, a total of $351,000 of retail revenue can be generated monthly for the site owner and operator. This value will vary by area and local standard rental costs.

Furthermore, the effect of converting 50% of trips to the LFR site from personal car to higher order transit reduces the total greenhouse gas emissions by site visitors by 156 lbs per day, or 26 metric tonnes per year.

Economic Impacts | Agriculture

site area = 94,471 m^2

area roofs = site area * 30% => 28,341.3 m^2

adjacent hydro land area = 33,000 m^2 * 75% => 24,750 m^2

useable area = area roofs + adjacent hydro land area => 53,091.3 m^2

value tomato traditional = $1.63 / lbs

value cucumber hydroponic = $1.92 / lbs

value tomato hydroponic = $1.63 / lbs

value peppers hydroponic = $1.98 / bunch

value lettuce hydroponic = $86 / m^2

value flowers hydroponic = $110 / m^2

Cost Hydroponic

capital cost hydroponic = $200 / m^2

production cost tomato = $86.33 / m^2

production cost cucumber = $70.50 / m^2

site capital cost hydroponic = capital cost hydroponic * useable area => $10,618,260

site production cost tomato = production cost tomato * useable area => $4,583,371.93

site production cost cucumber = production cost cucumber * useable area => $3,742,936.65

Benefits Hydroponic

ontario greenhouse sales = $103 / m^2

average gross revenue = $90.20 / m^2

average net revenue = $3.88 / m^2

gross revenue cucumber = $79.65 / m^2

net revenue cucumber = $9.15 / m^2

site average sales = ontario greenhouse sales * useable area => $5,468,403.9

site average gross revenue = average gross revenue * useable area => $4,788,835.26

site average net revenue = average net revenue * useable area => $205,994.24

site gross revenue cucumber = gross revenue cucumber * useable area => $4,228,722.05

site net revenue cucumber = net revenue cucumber * useable area => $485,785.4

Cost Traditional

production cost tomato = $25,982.92 / acre in $/m^2 => $6.42/m^2

site production cost tomato = production cost tomato * useable area => $340,873.72

Benefits Traditional

gross revenue tomato = $60,720 / acre in $/m^2 => $15/m^2

net revenue tomato = $34,737.08 / acre in $/m^2 => $8.58/m^2

site gross revenue tomato = gross revenue tomato * useable area => $796,594.54

site net revenue tomato = net revenue tomato * useable area

=> $455,720.82

Economics | Social

additional commercial rent = additional built programme * $30/m^2/month => 30 additional built programme*$/(m^2*month)

By including and charging rent for interior volume additive community facilities within the anchor store volume, as well as replacing 10% of site parking facilities with built facilities, an additional $153,000 can be generated per month, assuming 100% rented areas and current commercial rates.

Solar Power Generation

These calculations determine the total potential solar power generation values for a given site, based on the area and local daily global insolation.

daily global insolation (DGI) : The total daily amount of average solar radiant energy that is received in a given location, measured in kWh/m^2

DGI Burlington = 4.22 kWh / m^2 / day

latitude burlington = 43

site area = 94,471 m^2

roof area = site area * 30% => 28,341.3 m^2

solar panel coverage = 80%

site coverage area = site area * solar panel coverage => 75,576.8 m^2

yearly household energy = 127 GJ in kWh => 35,277.78 kWh

Option 1 - Roof Coverage

total potential energy = DGI Burlington * roof area * solar panel coverage => 95,680.23 kWh/day

roof yearly total potential energy = total potential energy *

365 day => 34,923,283.51 kWh

yearly household equivalent = roof yearly total potential energy / yearly household energy => 989.95

> This shows that if all rooftops on site were to be covered with solar panels at 80% coverage, then the site would be able to generate 34 million kWh of energy on average per year.
>
> This equates to the total average energy consumption of 1,000 households.

Option 2 - Site Canopy Coverage

roof area => 28,341.3 m^2

grade canopy area = site area * 60% * 80% => 45,346.08 m^2

total canopy area = (roof area * 80%) + (grade canopy area) => 68,019.12 m^2

canopy yearly total potential energy = DGI Burlington * total canopy area *365 day => 104,769,850.54 kWh

household equivalent = canopy yearly total potential energy / yearly household energy => 2,969.85

> This shows that if the site were to be covered with a solar cell canopy at 80% of the total site area, the site would generate 105 million kWh of energy on average per year.
>
> This equates to the total average energy consumption of 3,000 households.

Economics | Power Generation

Rooftop Solar Costs: Reference

rooftop wattage = 1,000kW

rooftop area = 71,000 foot^2 in m^2 => 6,596.12 m^2

rooftop cost = $1,000,000

rooftop area unit production = rooftop wattage / rooftop area => 0.15 kW/m^2

rooftop area unit cost = rooftop cost / rooftop area => $151.6/m^2

rooftop watt unit cost = rooftop cost / rooftop wattage => $1,000/kW

($1.00 / W)

Structural Canopy Costs: Reference

canopy wattage = 1,000kW

canopy area = 68,000 foot^2 in m^2 => 6,317.41 m^2

canopy area unit production = canopy wattage / canopy area => 0.16 kW/m^2

canopy cost = $1,200,000

canopy area unit cost = canopy cost / canopy area in $/m^2=> $189.95/m^2

canopy watt unit cost = canopy cost / canopy wattage in $/W=> $1.2/W

Rooftop Solar Costs: Site

roof area => 28,341.3 m^2

rooftop area unit cost => $151.6/m^2

rooftop site cost = roof area * rooftop area unit cost => $4,296,664.99

Total Structural Canopy Costs: Site

roof area => 28,341.3 m^2

grade canopy area = site area * 60% * 80% => 45,346.08 m^2

grade canopy site cost = grade canopy area * canopy area unit cost => $8,613,549.58

site canopy cost = grade canopy site cost + rooftop site cost => $12,910,214.57

The total cost of an 80% photovoltaic installation coverage for the entire site would be roughly $13 million.

Economics | Power Generation | Benefits

ontario hydro blended rates = $0.11 / kWh

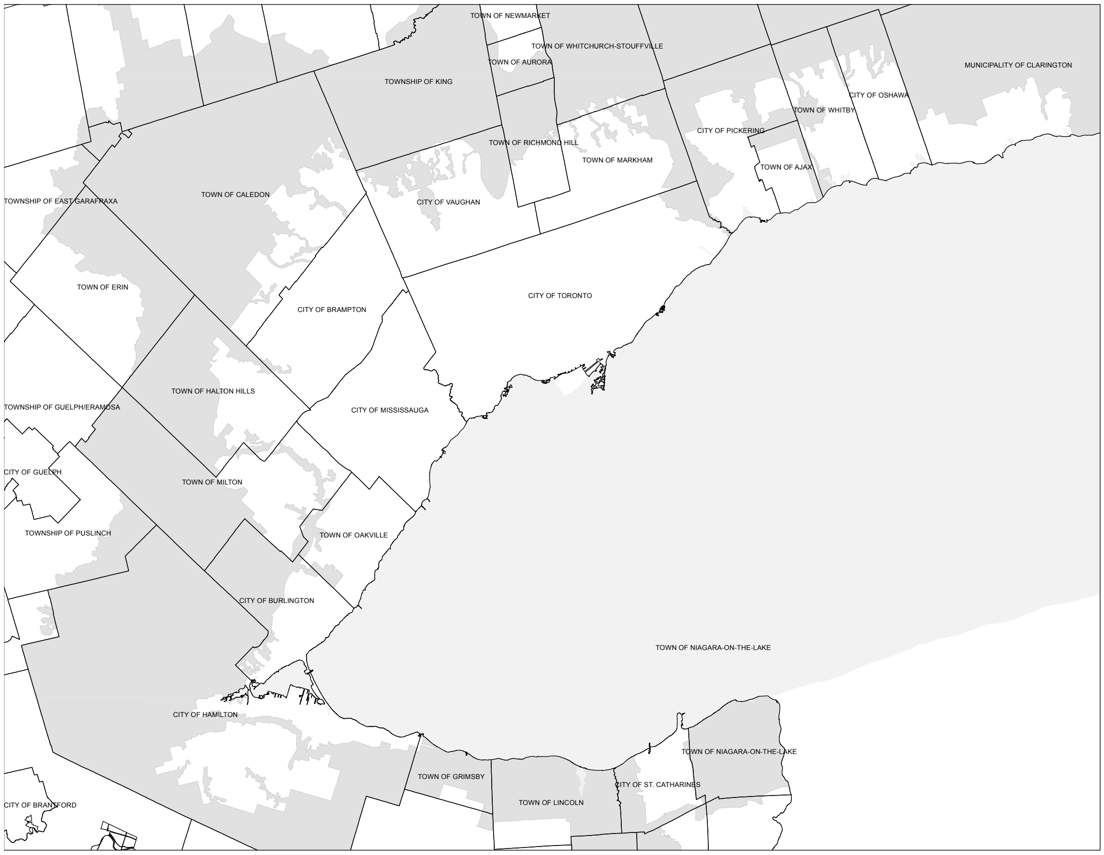
Total Roof coverage: Benefits

canopy yearly total potential energy => 104,769,850.54 kWh

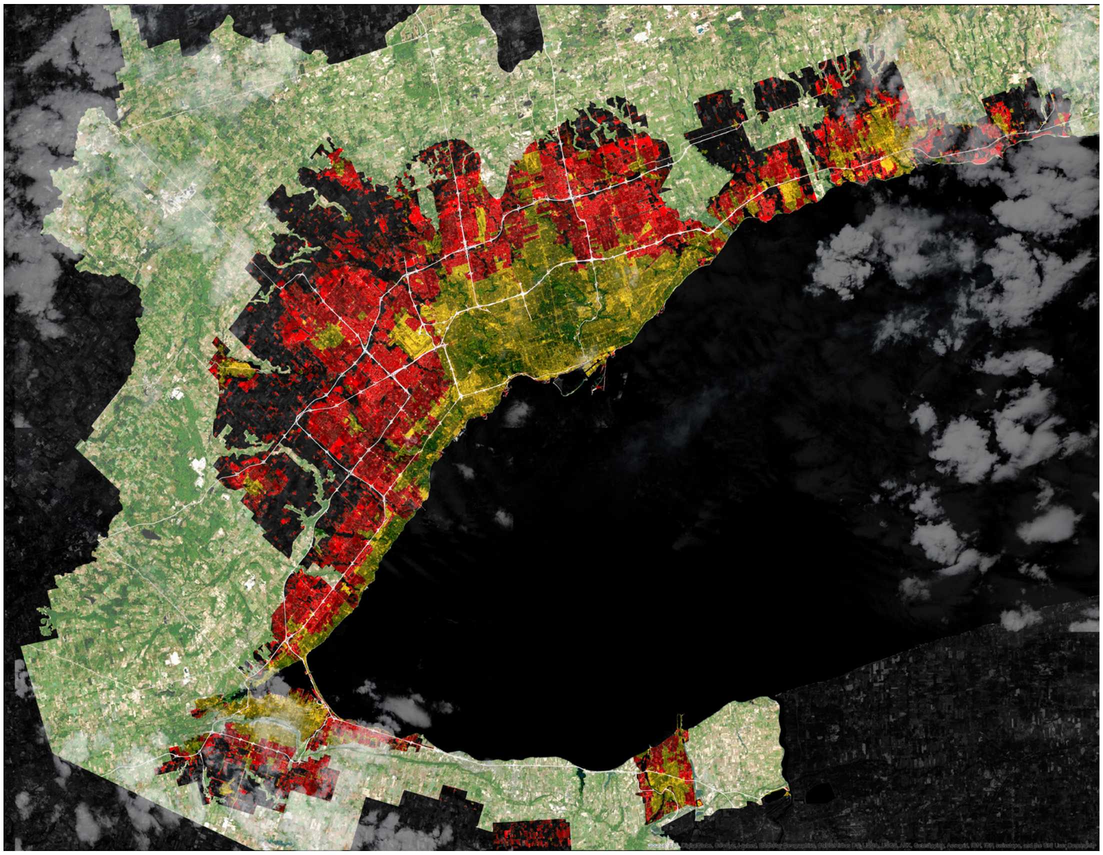
energy sale roof = canopy yearly total potential energy * ontario hydro blended rates => $11,524,683.56

Using current blended hydro rates, the annual sale of energy from roof and at grade photovoltaic canopy structures can be estimated to be roughly $11.5 million

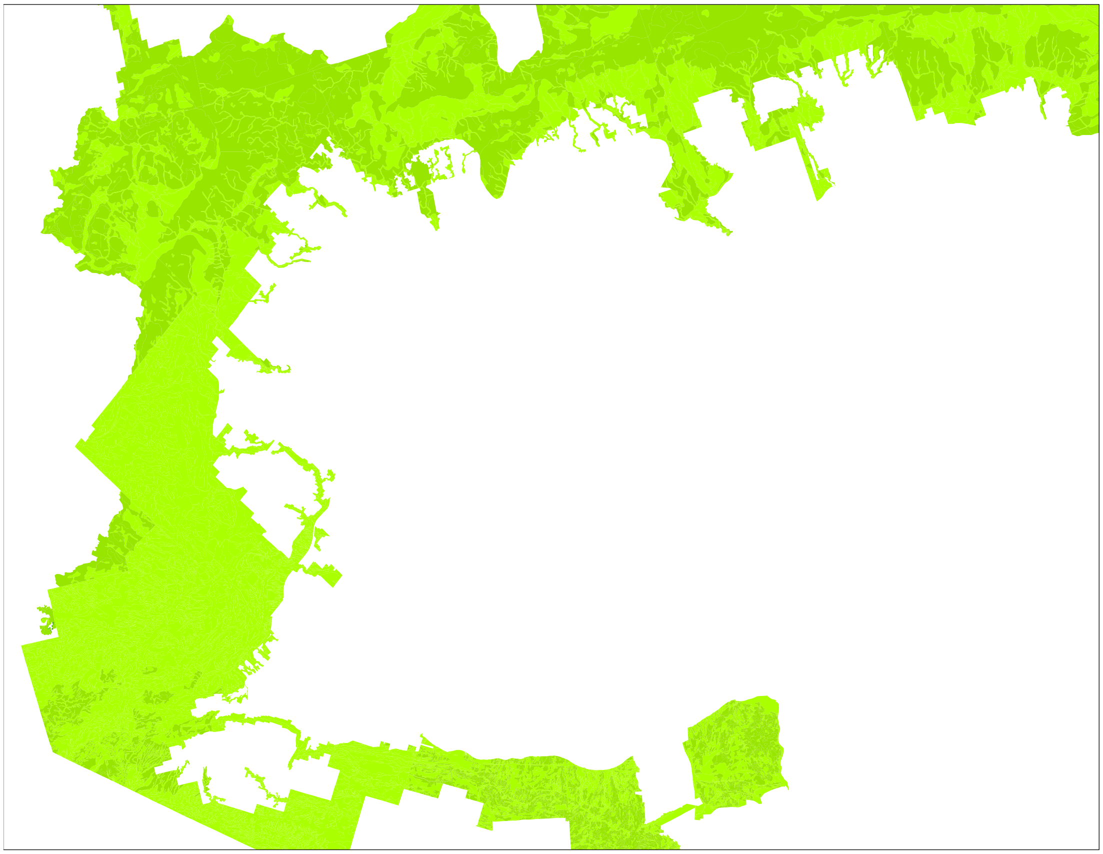
6.5 | Appendix 2: Further Mapping



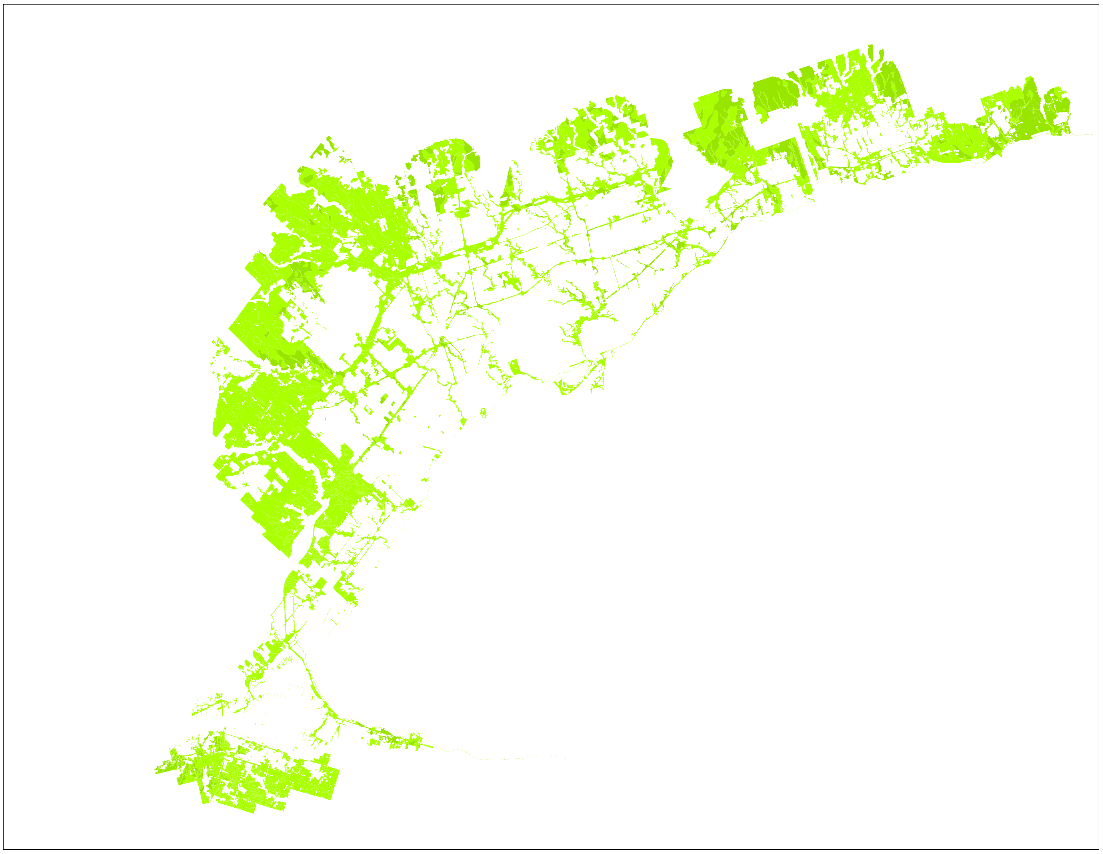
Municipal Boundaries Throughout the GTHA



Built Area Expansion - 1966 - 2014

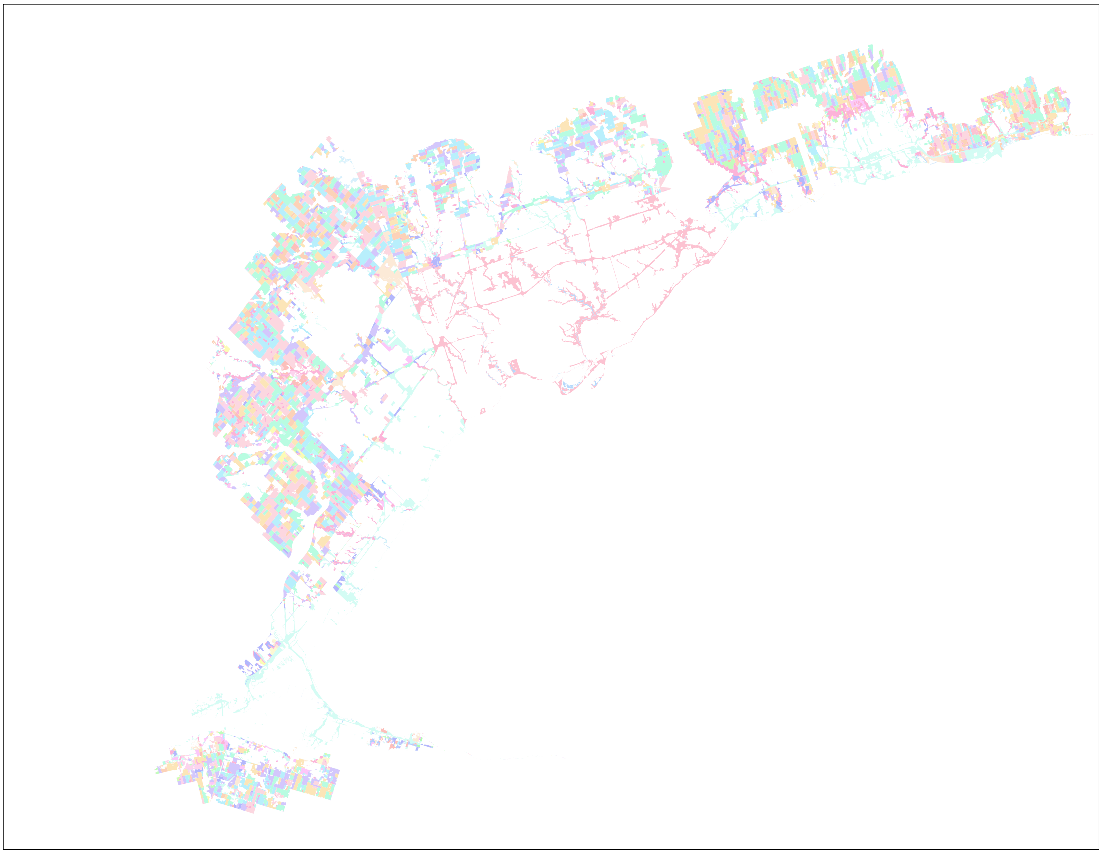


Greenbelt Soil Quality Survey

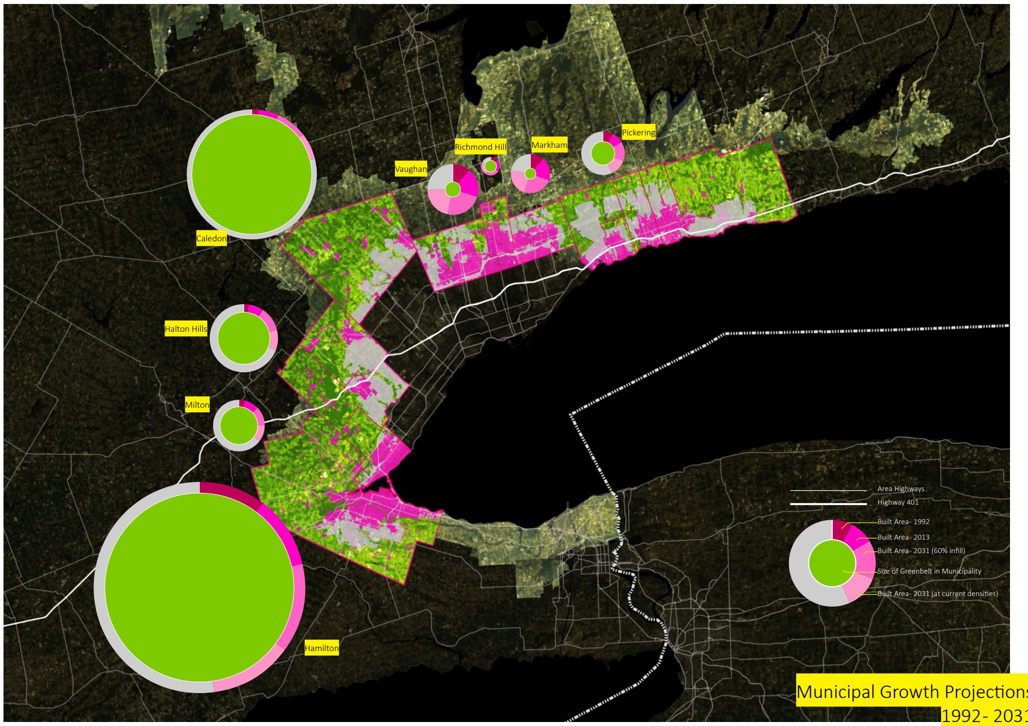


Whitebelt Soil Quality Survey

Greenbelt Agricultural Inventory



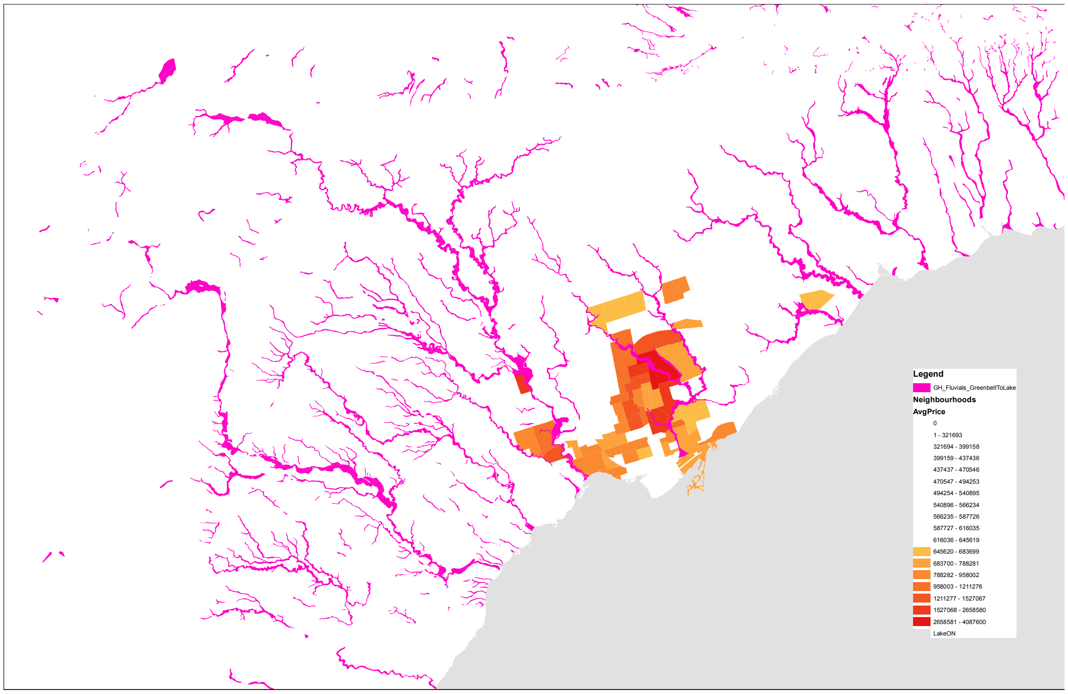
Whitebelt Agricultural Inventory



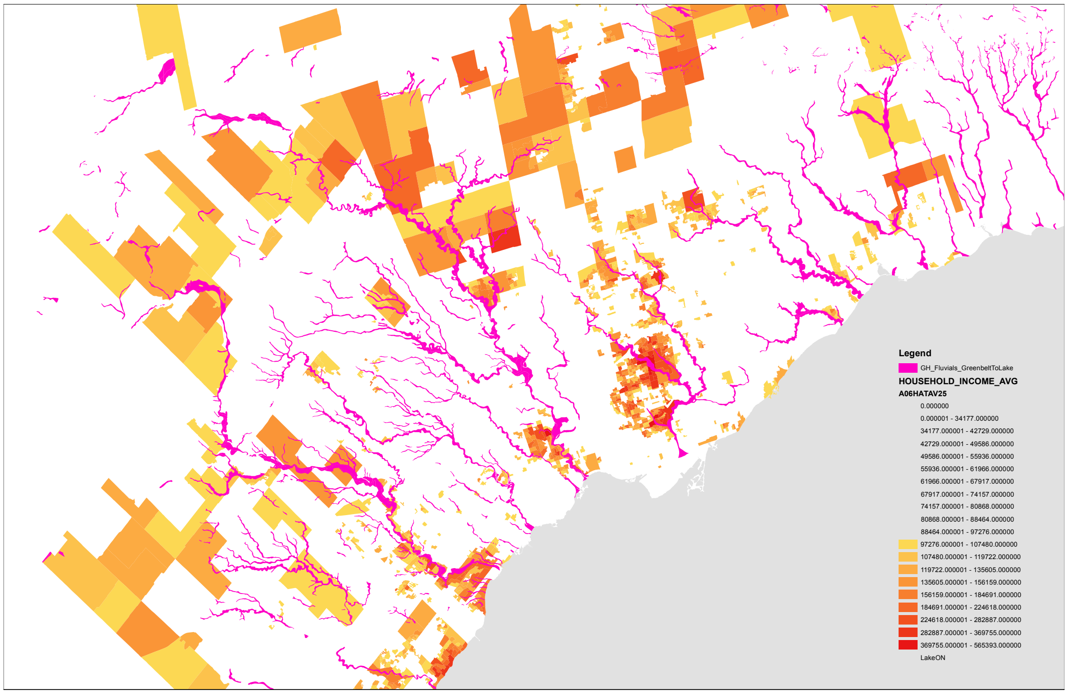
Municipal Growth Projections Map

Created for presentation in 2015 Polycentric Cities in Transformation conference in Essen, Germany.

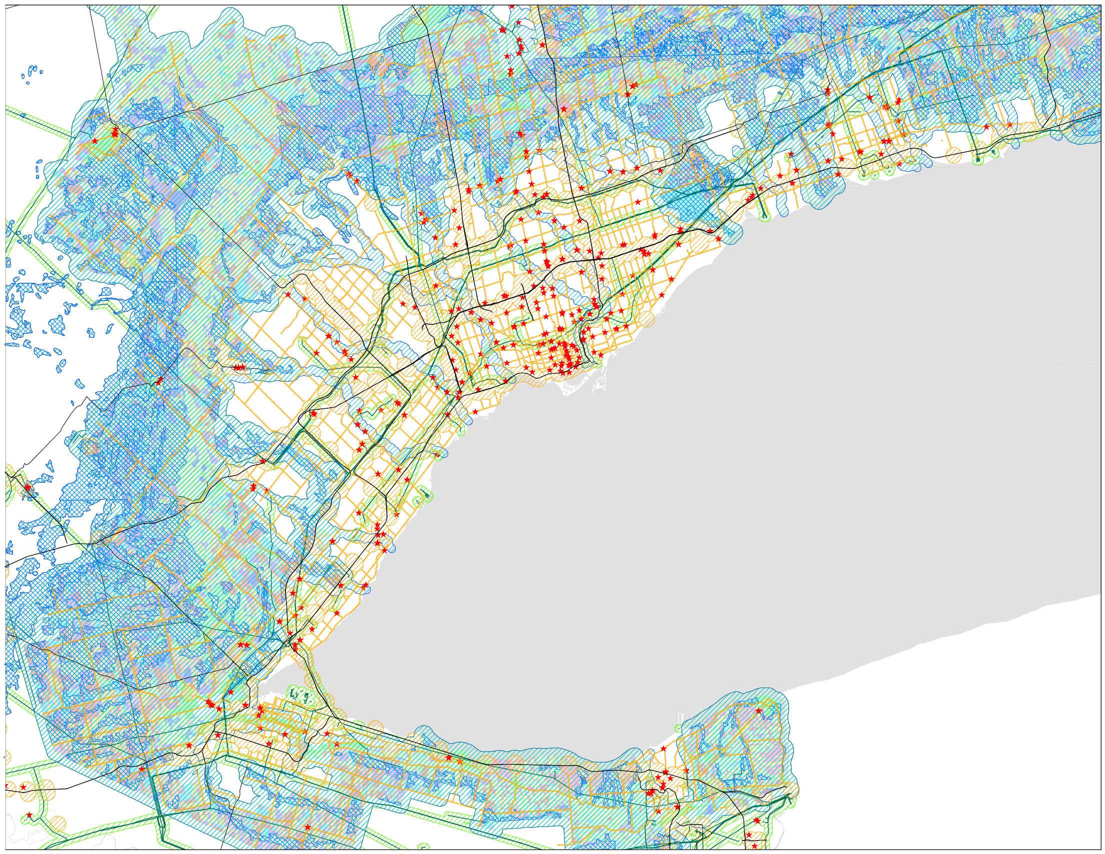
Greenbelt Extents



Average residential property values in the City of Toronto, isolated to those valued above $600,000

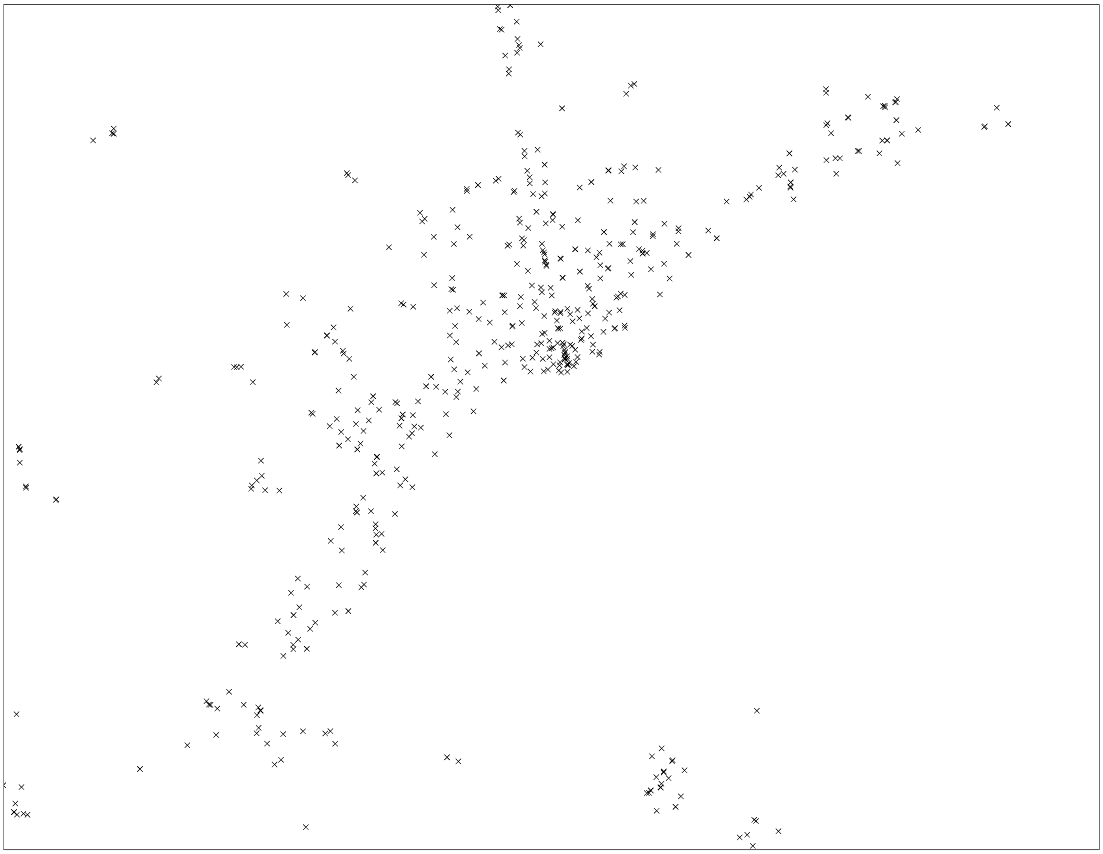


Average household income, isolated to households with an income of over $100,000.

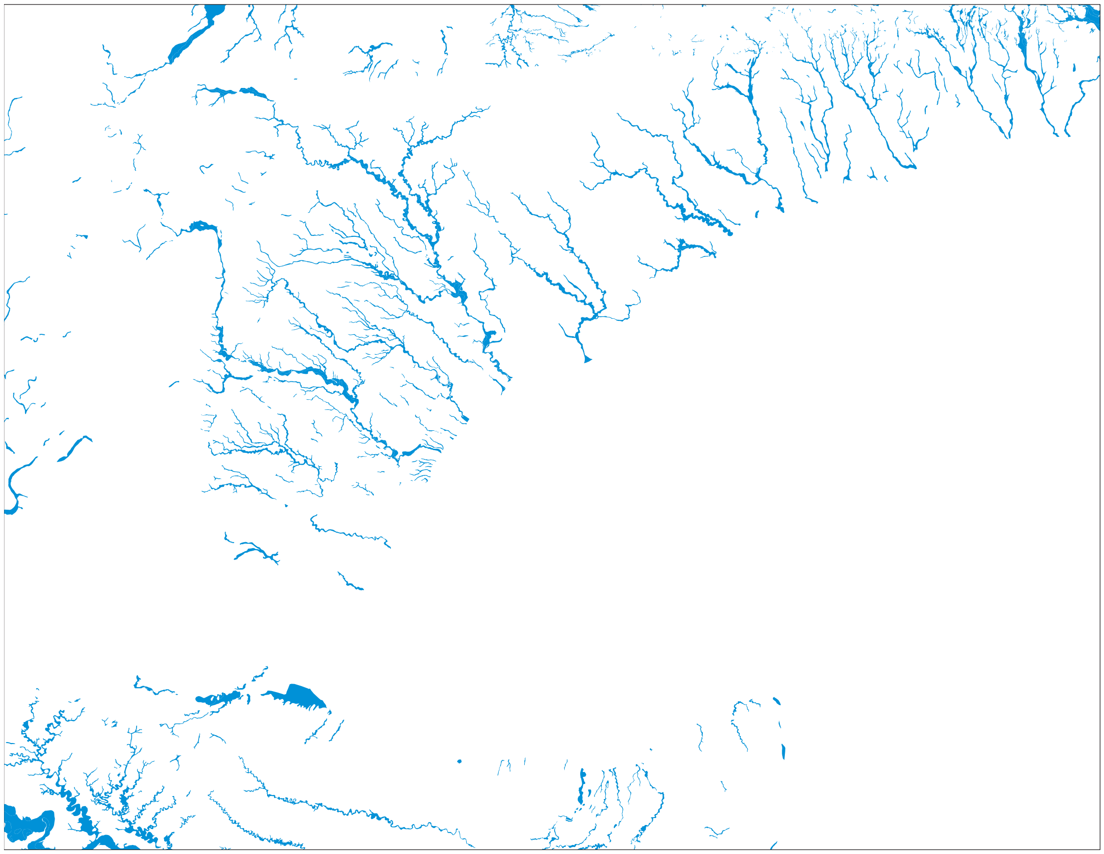


Combined Networks of Interpretation

Overlaid networks including agricultural, ecological/hydrological, movement grids and highways, buffers and the food retail locations that intersect or are contained by any of these network conditions.



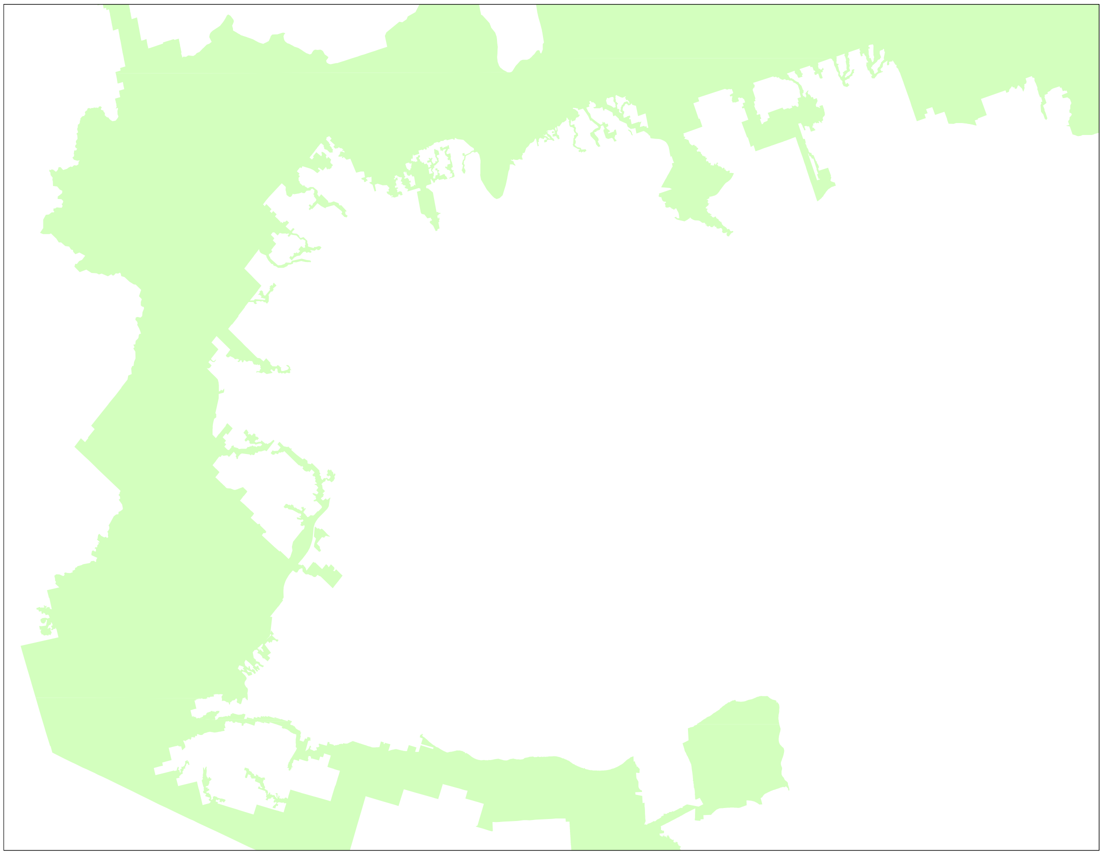
Food Retail Locations in Ontario - GTHA



Fluvial Soil Conditions, Isolated

Urban River Connections

Rivers and waterways which connect the Greenbelt to Lake Ontario, typically protected.

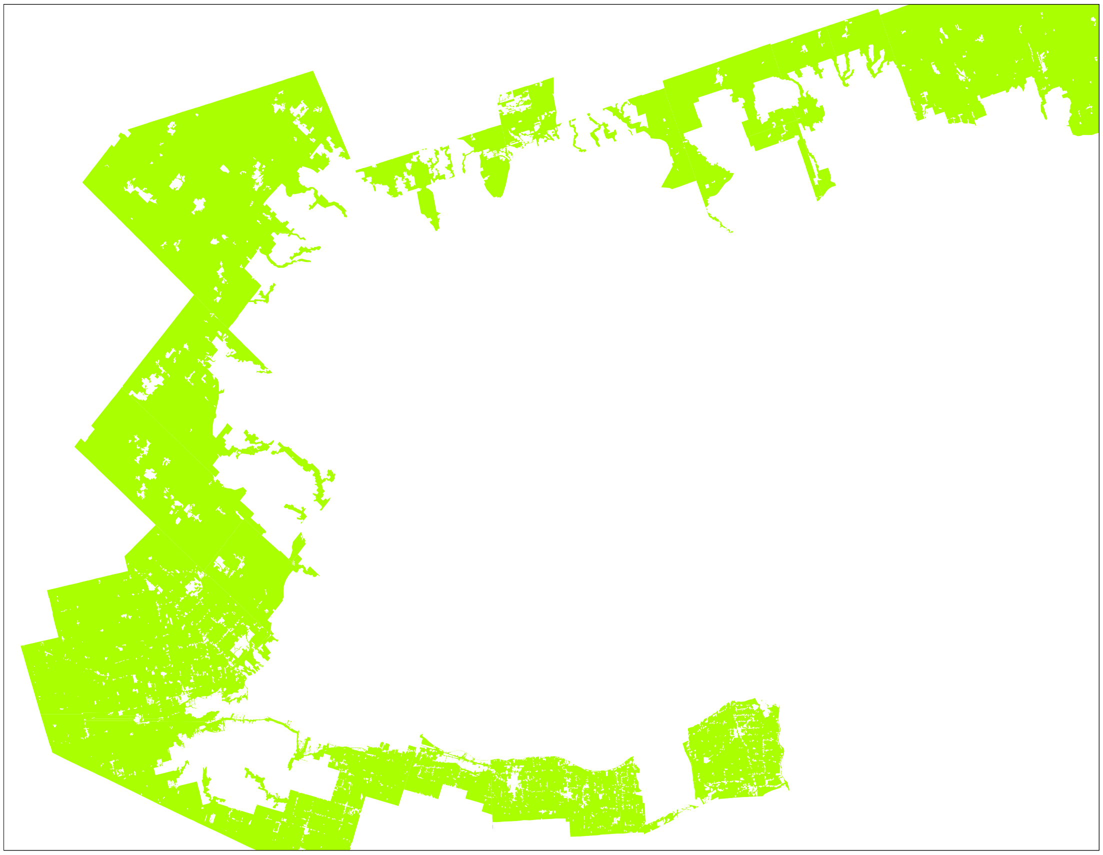


Greenbelt Boundary

Line Indicating the Interior Boundary of
the Greenbelt

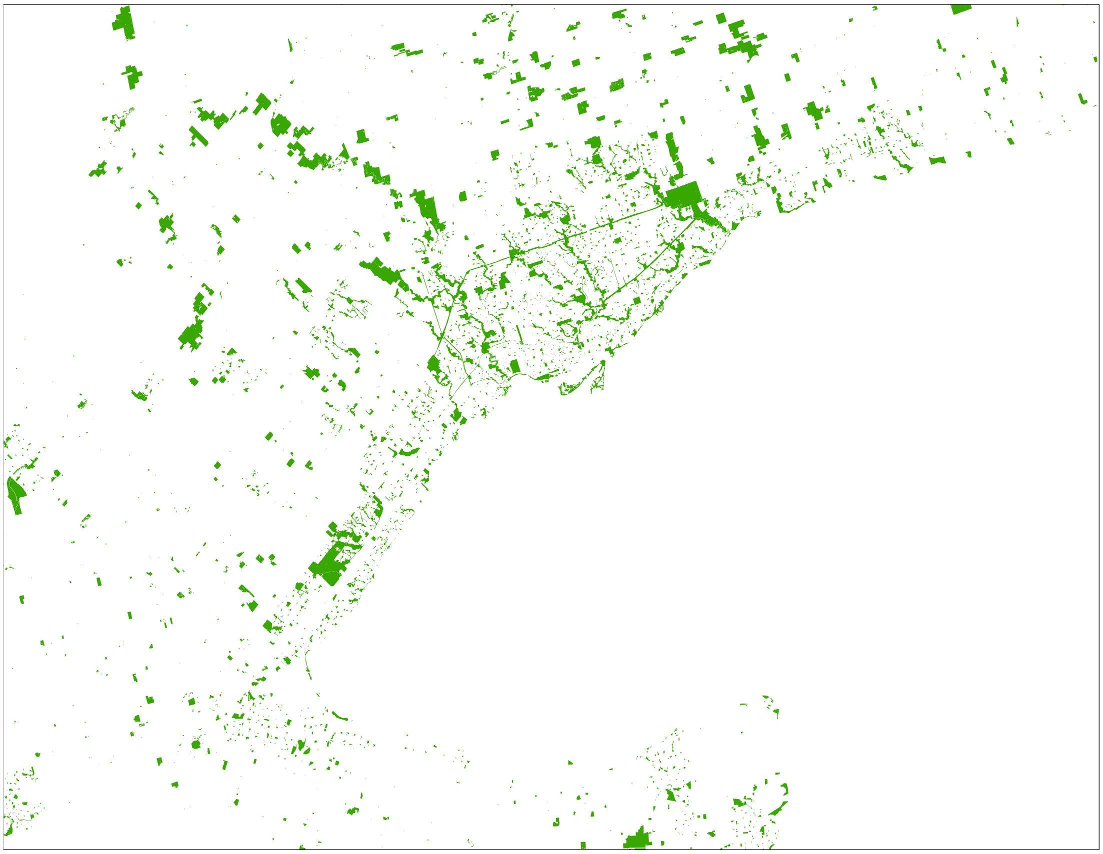
Municipalities Which Contain Both Whitebelt and Greenbelt Areas

Built Areas Within Municipalities Containing Greenbelt Areas



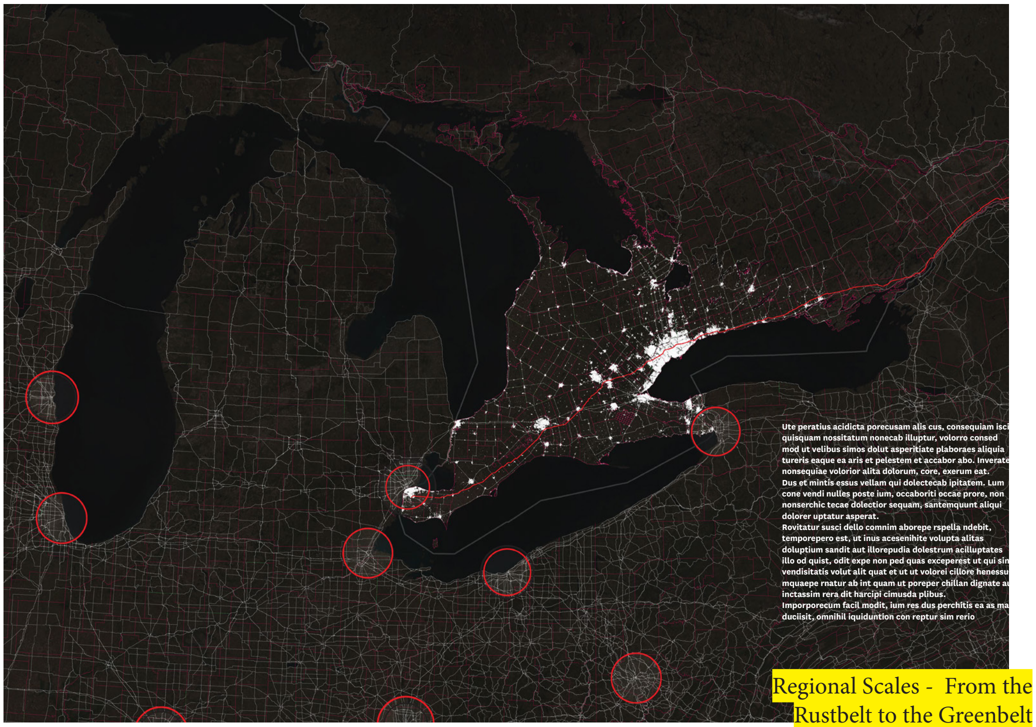
Greenbelt Areas Within Municipalities Containing Greenbelt Areas

Whitebelt Areas Within Municipalities Containing Greenbelt Areas



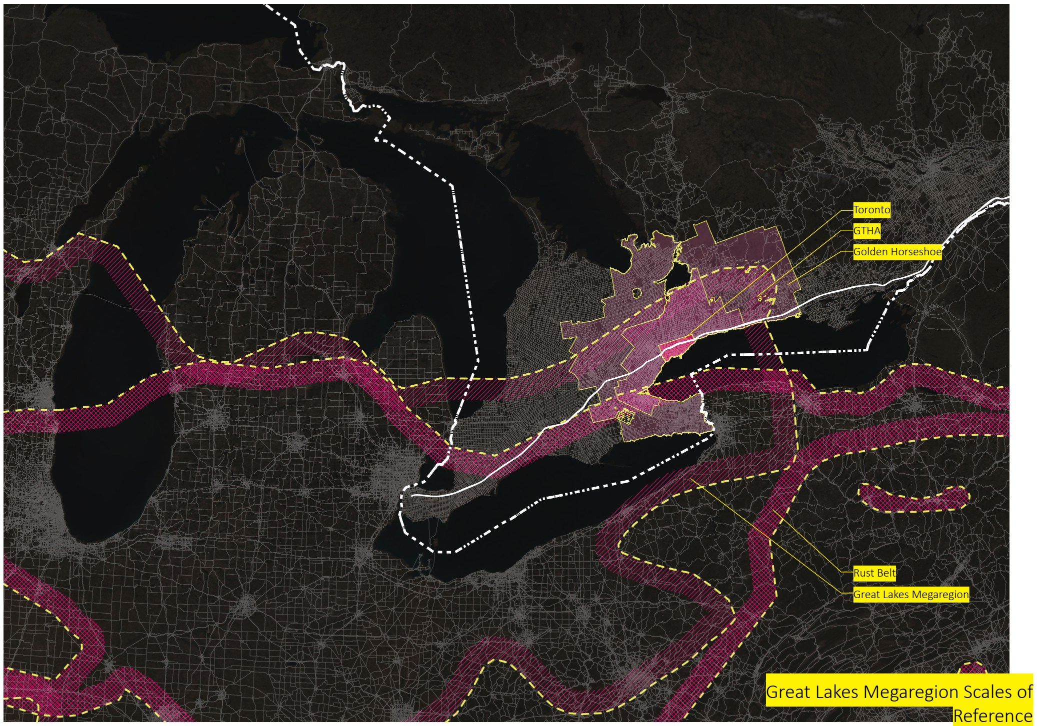
Parks and Public Spaces Within the GTHA

Rail Corridors and Nodes Within the GTHA



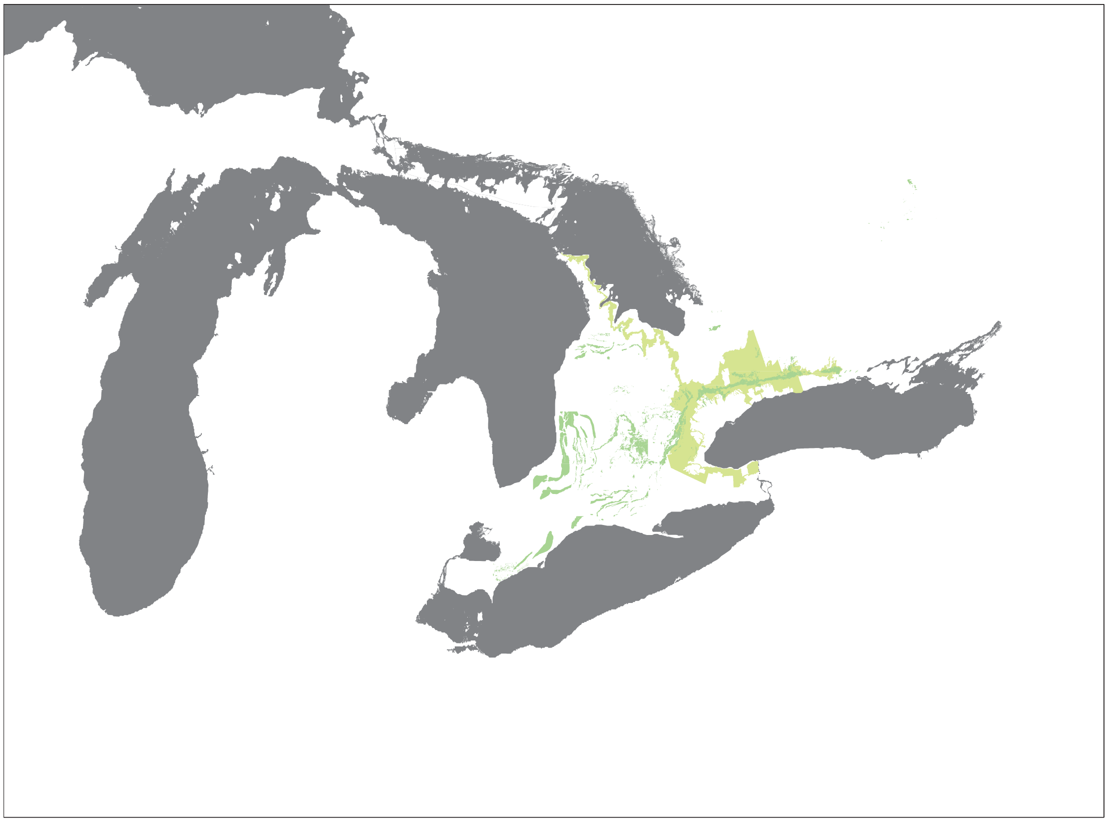
Major Urban Centres of the Rustbelt

Created for presentation in 2015 Polycentric Cities in Transformation conference in Essen, Germany.

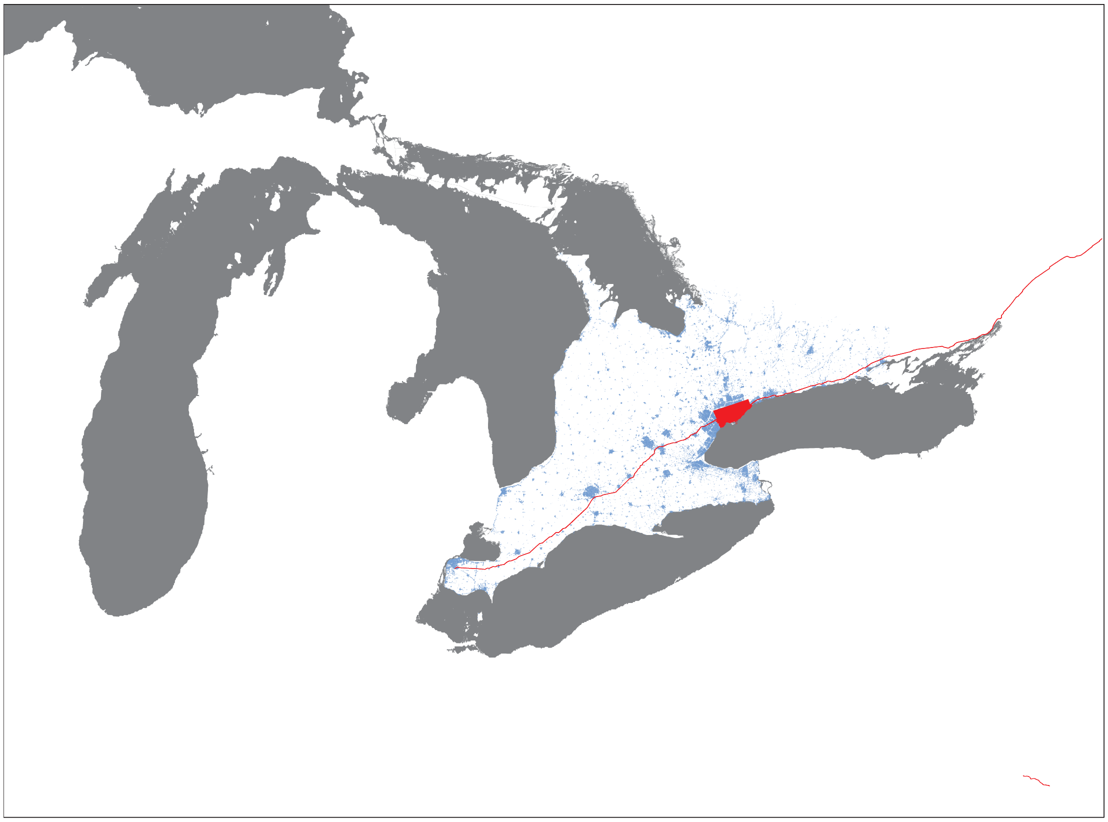


Great Lakes Megaregion Scales of Reference

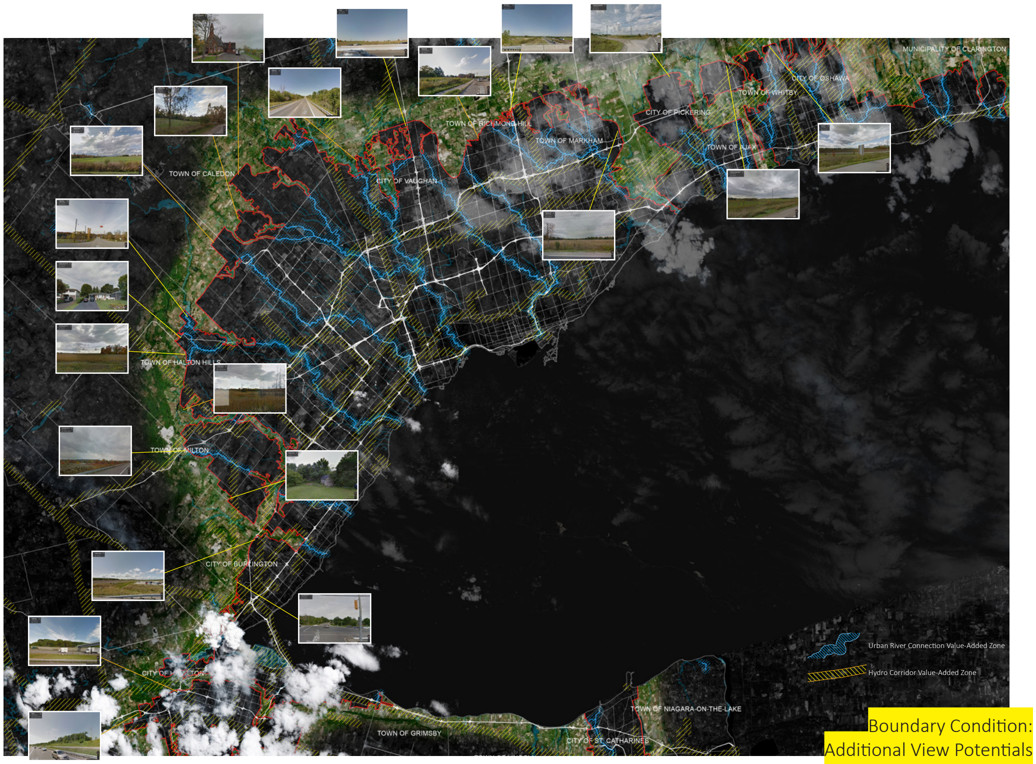
Created for presentation in 2015 Polycentric Cities in Transformation conference in Essen, Germany.



The Greenbelt is shown at its full extent, combined with the boundaries and areas of the Oak Ridges Morraines.



The built areas of Southern Ontario are shown along with the focal node that is metro Toronto. Also shown is highway 401.



An early look at the boundary conditions experienced at the interior edge of the Greenbelt. Imagery taken from Google Streetview and show views along the boundary, facing outwards into the Greenbelt.