Where is the Green in Transit-Oriented Communities? A Geospatial Analysis of MTSA Green Space Access

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Abstract

Are Ontario's Major Transit Station Areas (MTSAs) being planned to provide adequate green space for the populations they are designated to serve? Provincial policy mandates the density of people and jobs in MTSAs in absolute terms, but no equivalent standard governs the provision of green space that is assumed to accompany that density. Using a network-based, population-weighted geospatial accessibility analysis of 50 MTSAs across Richmond Hill, Vaughan, and Markham, this study calculates an accessible green space per capita score for each MTSA and evaluates this score against measures of distributional inequality, transit-mode and density patterns, spatial autocorrelation, and external provision benchmarks. MTSAs planned for higher density and larger populations tend to have less accessible green space per person, not more. Green space access is also far less equal across these MTSA's than it is for existing green space across the City of Toronto. The shortfall is severe for the region's three largest growth centres, Richmond Hill Centre, Vaughan Metropolitan Centre, and Langstaff GO-Bridge. Even at full build-out, Langstaff's own Secondary Plans parkland allocation reaches only 2.9 square metres per person, a fraction of the 24 square metres per person recommended by the Fields in Trust benchmark. A supporting policy review traces this outcome to specific mechanisms, including the absence of a quantitative parkland target in Richmond Hill Centre's Secondary Plan and Bill 23's reduction of the municipal parkland dedication tools available to offset that shortfall. These findings suggest that Ontario's MTSA framework has, to this point, mandated density with considerably more rigour than it has mandated green space. Green space provision therefore should be a binding requirement of MTSA planning, comparable in enforceability to existing density targets.

Keywords: green space, GIS, geospatial accessibility analysis, intensification, Major Transit Station Areas.

Foreword

This Major Research Paper was completed in fulfilment of the requirements for the Master of Environmental Studies (MES) in Planning program at York University. My plan of study has three components: Urban planning, built form and infrastructure, and sustainability. Below is a discussion of my components' learning objectives and the contribution my topic makes toward fulfilling them.

The first component of my plan of study, "urban planning," has four objectives. 1.1 'To obtain the knowledge and skills necessary to meet the program requirements of the Canadian Institute of Planning and Ontario Professional Institute of Planners Candidate Membership.' 1.2 'To gain a strong understanding of the current state of housing policy in Ontario.'. 1.3 'To develop a working knowledge of the various policies and regulatory frameworks that dictate land use.' And 1.4 'To gain strong knowledge of the determinants of housing financialization.' Through my research, I engage heavily with planning policy by studying MTSAs, helping fulfill objective 1.1. MTSAs are a major component of the province's current approach to housing provision, and examining the implementation of this concept alongside green space provision will strengthen my understanding of housing and land use policy, contributing to the fulfillment of objectives 1.2, 1.3, and 1.4.

The second component built form and infrastructure learning strategies are as follows; 2.1 'to develop a comprehensive understanding of Urban Political Ecology and material flows', 2.2 'to examine existing frameworks modelling material and energy flows in Ontario', 2.3 'to develop a working understanding of critical infrastructure planning and procurement in Ontario' and 2.4 'to strengthen my geographic information system (GIS) skills, to work with and quantify spatial data pertaining to infrastructure development'. Central to my research is the recognition of the interconnectedness of nature and the city, which contributes to the fulfillment of objective 2.1. Additionally, the scholarly conversation surrounding MTSAs heavily emphasizes the efficient use of resources and energy, contributing to the fulfillment of objectives 2.2 and 2.3. My research has a significant GIS component that quantifies urban development, helping fulfill strategy 2.4.

The third component is sustainability, and its strategies are 2.1 ‘to forge an in-depth understanding of sustainability and sustainable development to grasp urban development processes in Southern Ontario’, 3.2 ‘to develop a comprehensive understanding of sustainable land use’, and 3.3 ‘to formulate a greater understanding of neoliberalism’s impact on sustainability targets in Ontario’. My research engages with discussions of sustainability on two fronts: examining the integration of nature into population centers, and examining MTSA’s, which have become a normative approach to sustainable development in Ontario, thereby contributing to the fulfillment of these objectives.

Based on the learning components and objectives identified in my Plan of Study, this research paper explores the following research question and sub-questions.

- Are Major Transit Station Areas providing adequate green space for the populations they are being built for?
    - Are we building MTSAs in ways that recognize that cities are a part of nature?
    - How can MTSAs be planned to integrate nature? How is “nature” (or its synonyms) discussed in planning documents (either by the Province, York Region, or the city)? And specifically in relation to MTSAs?

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AI Disclaimer

This research utilized artificial intelligence tools at several stages of the research process. AI assistance was used to support statistical analysis and troubleshooting, to brainstorm and refine ideas during the writing process, and to generate and debug Python code used in the geospatial analysis. Grammarly was used throughout for grammar, clarity, and style editing. The research design, data collection, analysis, interpretation, and conclusions presented in this paper are entirely my own.

Chapter 1. Introduction

1.1 Introduction

Ontario's *Growth Plan for the Greater Golden Horseshoe*, and the Provincial Planning Statement that succeeded it in 2024, direct the province's largest population increases towards Major Transit Station Areas (MTSAs). MTSAs are provincially designated zones surrounding high-order transit stations, mandated to absorb residential and employment growth through binding, numerically specific density targets. This transit-oriented planning framework explicitly promotes the development of complete communities, a planning concept that promises not only compact, transit-supportive development but a full range of environmental, social and economic benefits, including access to green space as well (Advisory Panel, 2015). While MTSA density targets are set in absolute figures, no provincial standard exists for accompanying green space, creating an asymmetry in their planning and implementation.

This study finds that this asymmetry is not just theoretical: across 50 MTSA study sites in Richmond Hill, Vaughan, and Markham, accessible green space per capita is negatively correlated with both planned population ($r = -0.34$) and provincial density targets ($r = -0.26$) and is distributed with a population-weighted Gini coefficient of 0.589, indicating substantial inequality of green space access across MTSAs. This pattern is not accidental it is traceable to specific policy mechanisms. Richmond Hill Centre's Secondary Plan sets no definitive quantitative schedule of green space, and the city's own Draft Parks Plan concedes that its future provision rate is structurally unachievable with current tools. Bill 23, the Build More Homes Faster Act, has since halved both the alternative dedication rate and the cash-in-lieu rate available to municipalities. Even where a Secondary Plan does name a quantitative schedule of green space elements, as at Langstaff GO-Bridge Station, this study finds that full build-out of the plan's own stated parkland still falls short of established benchmarks.

This outcome is not unforeseen: Petersson-Forsberg (2014) wrote that Swedish spatial planning tools were a 'blunt instrument' for protecting outdoor recreation against competing development pressure, Engström and Qviström (2022) observe that recreation and green space

remain a comparative ‘silence’ in the literature on transit-oriented development, and Bolleter and Ramalho (2020) argue that TOD planning, left unchecked, tends to treat green space as incidental to density rather than as a co-equal design objective. Until green space is treated as a binding requirement of MTSA planning rather than an afterthought, Ontario's transit-oriented future risks building density without livability, and communities without the space, air, and contact with nature that make urban life worth living

This research was motivated by the question of whether Major Transit Station Areas are being planned to provide adequate green space for the populations they are designated to serve. It answers this question through a geospatial accessibility analysis of 50 MTSAs, calculating an accessible green space per capita score for each site using a network-based, population-weighted allocation methodology, and compares this against measures of distributional inequality, transit-mode and density patterns, spatial autocorrelation, and external greenspace standards. This regional dataset is supplemented by a focused policy review that traces municipal, provincial, and site-specific policies governing green space provision, examined in depth at Richmond Hill Centre and Langstaff GO Bridge, two sites planned to host a combined population greater than 80,000 people, forming a new regional hub. The study concludes that the region's greenspace problem is not simply one of distribution but one of significant planned undersupply.

1.2 Site Context and Existing Conditions

Before turning to the literature review in Chapter 2, this section situates the reader in the 50 MTSAs examined in this research. This study uses a sample of 50 York Region MTSAs, in Vaughan, Markham, and Richmond Hill. The two MTSA’s examined as case studies in this research are Richmond Hill Centre and Langstaff GO-Bridge; both are located along the Yonge Street corridor in York Region, north of the City of Toronto. The two sites are separated by Ontario Highway 407 and the Highway 7 utility corridor.

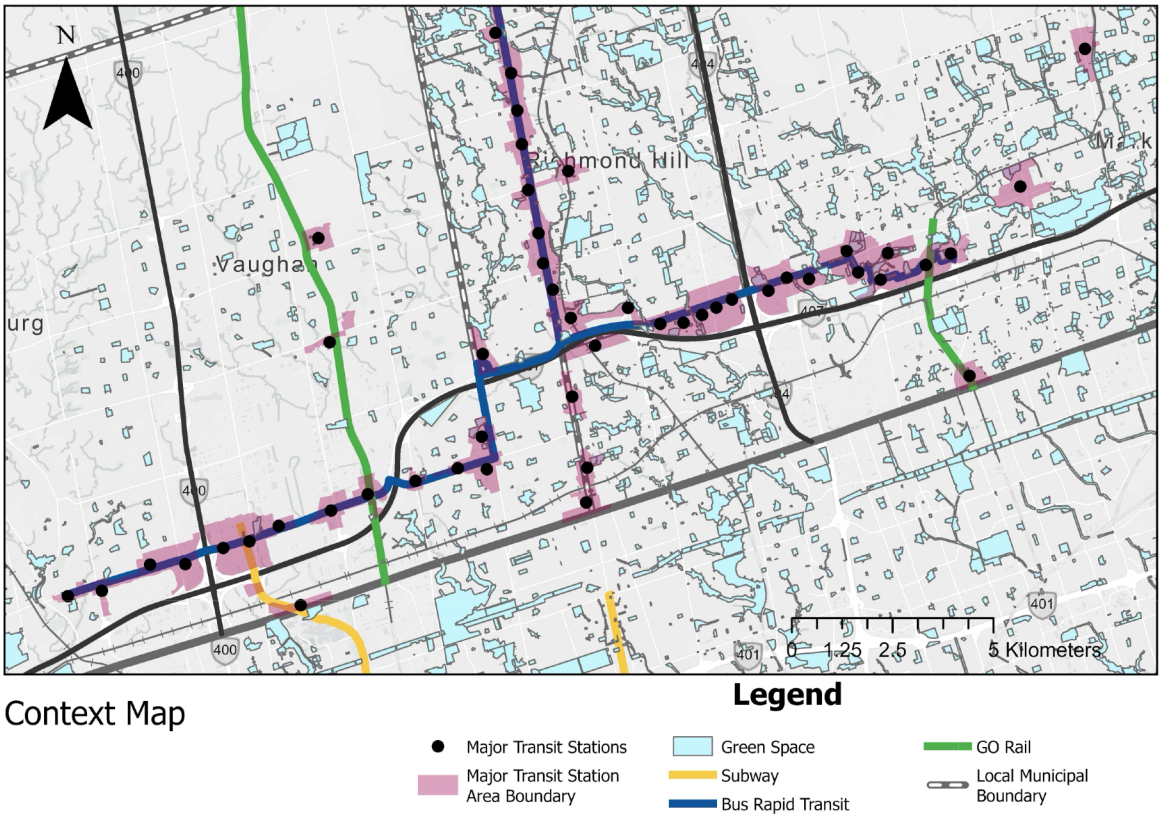


Figure 1: Context Map

Richmond Hill Centre is located at the intersection of Yonge Street and Highway Seven, approximately 4.5 km north of the Toronto city limit. The site is currently characterized by low-density commercial development and large surface parking lots, land uses the City has identified as low density and suited to high-density development (Richmond Hill, 2025a).

Langstaff GO-Bridge spans the Richmond Hill Markham municipal boundary near the Langstaff GO Station, bordered by Highway 407 to the north and Holy Cross Cemetery to the South, spanning from Yonge Street to Bayview Avenue, approximately 4 km north of the Toronto City limit. Langstaff GO-Bridge is the MTSA's official name in the York Region Official Plan; the site is referred to by multiple names, including: Langstaff GO, Bridge Station, and the Langstaff Gateway. Langstaff GO-Bridge is used as the preferred name in this research going forward as it encompasses the entire MTSA. The site is currently composed of a mix of vacant parcels, light industrial uses, and vehicle storage, a legacy of the area's industrial past that

the City of Markham plans to transform into a mixed-use transit-oriented community (Markham, 2011).

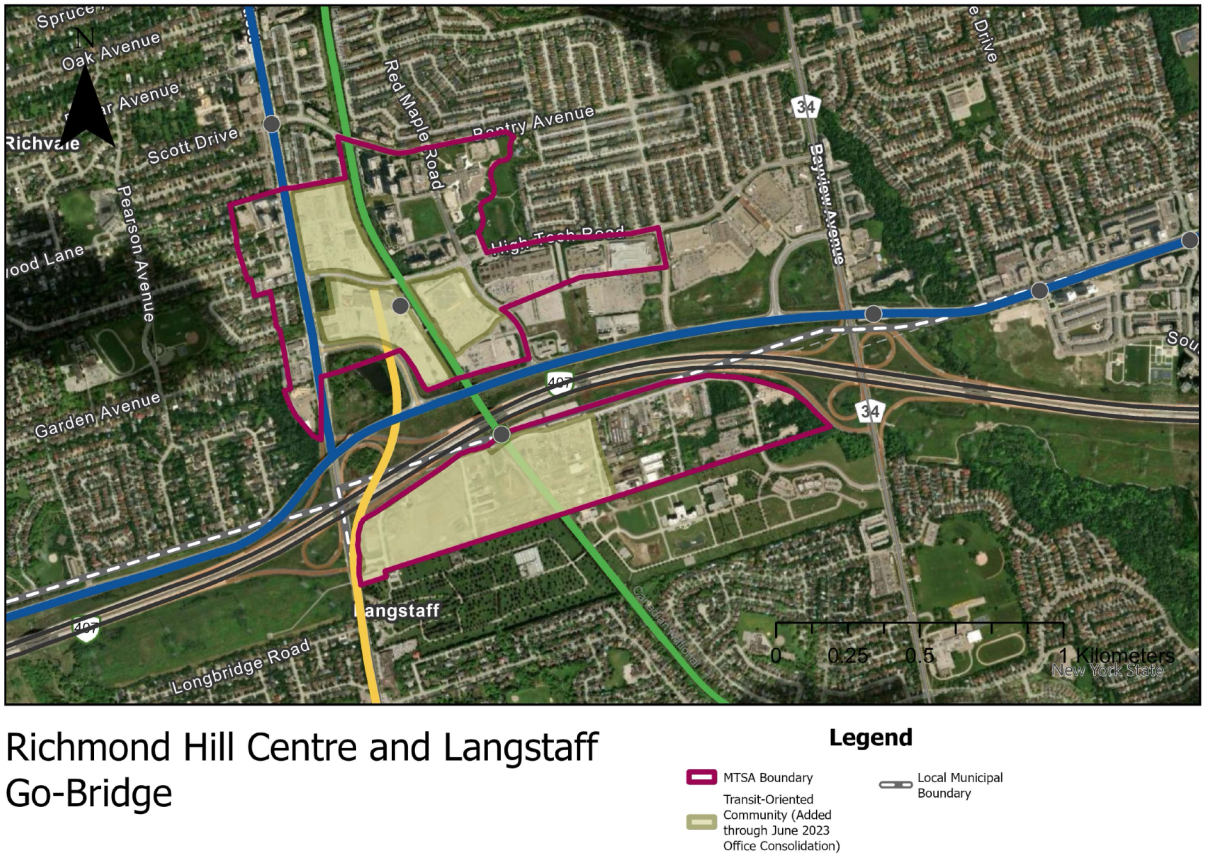


Figure 2: Richmond Hill Centre (top) & Langstaff GO-Bridge (bottom) satellite imagery

1.3 Roadmap

The remainder of this paper proceeds as follows. Section 1 reviews the literature on transit-oriented development, ecosystem services, and green space planning under intensification. Section 3 examines the policy framework, from the Provincial Planning Act and Bill 23 through municipal Official Plans to the Secondary Plans governing Richmond Hill Centre and Langstaff GO-Bridge. The Methodology section then details the geospatial approach used to calculate green space accessibility, typology, and inequality. Section 4 reports the findings, Section 5 discusses them in light of the literature and policy review, and Section 6 concludes with this study's implications for MTSA planning going forward. What follows is not simply a shortfall in numbers: it is evidence that Ontario is mandating exactly how many people and jobs

belong in its highest-priority growth areas, while leaving the question of whether those people will have anywhere to walk, play, or simply be outside almost entirely up to chance.

Chapter 2. Literature Review

This chapter situates this study within scholarship on transit-oriented development (TOD) and urban greenspace. It begins by tracing the origins and core principles of TOD, before turning to a growing body of research showing that green space and recreation have been persistently overlooked in TOD literature and practice, despite TODs' stated commitment to complete, livable communities. The chapter then turns to urban green space literature more broadly, establishing why urban green space matters, and how unevenly those benefits can be distributed. It introduces the ecosystem services framework used throughout this study, before reviewing research on the specific tension between compact city development and green space provision. The chapter closes by examining a methodological precedent for measuring green space accessibility and inequality, which this study's own approach builds upon.

2.1 Transit-oriented Development

Transit-oriented development (TOD), coined by Peter Calthorpe in *The Next American Metropolis: Ecology, Community, and the American Dream, is* defined as compact, mixed-use, pedestrian-oriented development within walking distance of a transit station, framing it as an alternative to low-density, autocentric sprawl, grounded in ecological and community-based principles (Calthorpe, 1993). While Peter Calthorpe coined the term "transit-oriented development" in his 1993 publication, the underlying concept is significantly older: Renne and Appleyard (2019) trace its roots to nineteenth-century streetcar suburbs, Ebenezer Howard's Garden Cities movement, and mid-twentieth-century New Town planning in Scandinavia and Japan, well predating Calthorpe's work. Cervero and Kockelman's (1997) work on the "3Ds" (density, diversity, and design) has become foundational to the study of TOD's built environment, demonstrating that these variables measurably reduce trip generation and encourage a departure from autocentric lifestyles (Cervero & Kockelman, 1997). Ontario's Major Transit Station Area framework implements this model through provincially designated density targets and station area boundaries, translating Calthorpe's design-based concept into a regulatory instrument.

Major Transit Station Areas (MTSAs) are provincially designated areas, each within a 500–800-metre radius of a high-order transit station. MTSAs are a key land-use planning policy for compact urban form and transit-oriented growth, grounded in the principles of complete communities and sustainable development. Complete communities aim to provide a range of environmental, social, health and economic benefits to residents and regions, through compact, mixed-use and transit-supportive development (Advisory Panel, 2015). Rather than focusing solely on density, complete communities foreground functional accessibility, emphasizing the public realm, green space, and connectivity (Advisory Panel, 2015). MTSAs have come to fruition through several iterations of provincial policy, formally beginning with policies such as the *Places to Grow Act* 2005, which enabled the province to issue regional growth plans, and the *Growth Plan for the Greater Golden Horseshoe* 2006, which instituted policy such as urban growth boundaries, settlement area expansion, and transit-supportive density targets (Ontario 2006). In 2020, the Growth Plan was consolidated into the Provincial Planning Statement, with many of the document's core principles, including strategic growth areas and MTSA's, integrated into the PPS and now applicable province-wide, expanding their scope of application. The Provincial Planning Statement defines MTSAs and their application. It requires municipalities to delineate MTSA boundaries in their official plans and to define an approximately 500–800-metre radius around stations (Ontario, 2024). MTSAs must be planned to achieve minimum job and resident densities, as defined by the province (Ontario, 2024). The Provincial Planning Statement also promotes development and intensification within MTSAs, through interventions in land use and built form, and the redevelopment of underutilized surface parking lots (Ontario, 2024).

Despite the importance of recreation and green spaces to sustainable urban development, they remain relatively neglected facets of TOD literature. Engström and Qviström (2022) systematically reviewed academic TOD literature and found that only a small number of studies address recreation at all (Engström and Qviström, 2022). They trace this gap to the modest planning assumptions of TOD; their Swedish case study demonstrates how this theoretical silence permeates into planning practice, with local recreational resources being overlooked in station area planning (Engström and Qviström, 2022). More recent work has begun addressing this gap empirically. Wang et al. (2023) address this gap by implementing street-view imagery to measure visible green space around subway stations, finding that disparities in green space

provision diminish with distance from the station (Wang et al., 2023), suggesting that TOD's development intensity itself may be associated with reduced visible greenery at the station core. Together, these studies suggest that green space access is not ancillary to TOD implementation but a systematically under-examined variable; the gap this study's geospatial analysis is positioned to address.

Bolleter and Ramalho (2020) further this critique, arguing that despite two decades of TOD-informed planning in Australian cities, its application has proven a persistent challenge, proposing Greenspace-Oriented Development (GOD) as a complementary planning strategy. GOD argues for densification that prioritizes upgraded, well-distributed green spaces while retaining proximity to public transport (Bolleter & Ramalho, 2020). They frame this as more than amenity access, emphasizing the ecosystem services derived from urban green space such as urban heat island mitigation, physical and mental health benefits, and biodiversity (Bolleter & Ramalho, 2020). They also emphasize the political role of greenspace, as the leafy, open qualities of GOD are more likely to align with the lifestyle expectations of suburban residents, who might otherwise reject densification outright (Bolleter & Ramalho, 2020). Under this framing, green space becomes not a constraint on intensification, but a condition that can make intensification more widely acceptable, a reframing directly relevant to this study as it evaluates provincial density targets against the existing geography of green space.

2.2 Ecosystem Services

Urban green space provides a myriad of benefits, including social well-being, health, and everyday urban life. Walker (2012) argues that green space is conceptually complex, encompassing parks, naturalized areas, green corridors, recreational spaces, and community gardens, each with distinct meanings, levels of accessibility, and uses. Walker outlines several key benefits, including psychological improvements, recreation and physical activity, community cohesion, food production, and the mitigation of environmental risks such as air pollution, heat, and flooding. Despite these benefits, he acknowledges that green spaces are not universally seen as positive and can be perceived as exclusionary or unsafe, thereby reproducing inequalities along lines of gender, race, age, and class (Walker, 2012). Walker reviews empirical studies

from Global North countries and concludes that there is no universal pattern of greenspace inequality (Walker, 2012). Instead, spatial outcomes depend on historical development processes, methodological choices, and differing definitions of access, measurement, and what counts as green space. Walker criticizes simplistic equality models and argues in favour of justice frameworks grounded in minimum standards of access, adjusted for uneven needs across populations, and supported through participatory planning (Walker, 2012). He also highlights concern with compensatory approaches and market-oriented governance, which can deepen disparities when communities lack resources (Walker, 2012). Walker's (2012) call for justice frameworks grounded in minimum, enforceable standards of access, rather than compensatory or market-based approaches, directly underpins this study's central claim: that green space, like density, requires a binding provincial standard.

Ecosystem services are the ecological functions and processes generated by natural systems that support human well-being, serving as an analytical framework linking scientific research with decision-making for collective problem-solving (Thompson et al., 2019). Urban ecosystem services are generated from green spaces, parks, vacant land, and features such as wetlands, rivers, streams, lakes, and river channels (Thompson et al., 2019). Noteworthy ecosystem services include the regulation and maintenance services of temperature regulation, air purification, waste treatment and runoff mitigation; the provisioning services of water and food; and the cultural services of aesthetics, recreation and a sense of place (Thompson et al., 2019). Although not mainstream in urban planning, ecosystem service concepts are linked to better recognition of the natural environment in land-use planning and decision-making processes (Thompson et al., 2019). Ecosystem services in planning can build capacity for climate change adaptation, improve biodiversity and support human wellbeing and health (Thompson et al., 2019). The ecosystem services framework is used in this research to conceptualize the benefits of access to urban green space in MTSAs by developing a green space typology score to assess green space quality.

2.3 Planning for Intensification

Even when compact city and transit-oriented development models are pursued with genuine environmental ambitions, green space is often the first casualty as density and open

space compete for the same land. There is growing evidence that green space is increasingly threatened by urban densification, particularly through infill development (Haaland & Van Den Bosch, 2015). Managing and planning green space in densifying urban areas is complex, as limited green areas are expected to provide essential ecosystem services (Haaland & Van Den Bosch, 2015). While compact urban development is intended to mitigate the negative impacts of urban sprawl, it introduces its own challenges (Haaland & Van Den Bosch, 2015). Urban density must be understood not only in quantitative terms but also through qualitative aspects, such as how space is perceived and experienced. Haaland & Van Den Bosch's research in developed countries shows that infill development often reduces the amount and accessibility of both public and private green space (Haaland & Van Den Bosch, 2015). Sivam et al. (2012) observed significant losses in private green areas (such as front and back yards?) during infill development, without corresponding increases in public green space. This pattern has been acknowledged in the Greater Golden Horseshoe, where residential growth has outpaced parkland acquisition in some areas (Advisory Panel, 2015). For green space to function effectively, planning must extend beyond individual sites to consider regional systems (Haaland & Van Den Bosch, 2015). These findings about the tension between increased densities and the availability of public green spaces are highly relevant to this study, prompting the development of a regional geospatial database that integrates the qualitative aspects of ecosystem services through a weighted green space typology score.

Balikçi et al. (2022) offer a valuable examination of compact city planning and urban green space policy in the European context. Since the 1990s, the compact city model has been promoted as the ideal sustainable urban form, featuring high density, mixed-use development, and strict urban–rural boundaries that support lower per capita energy consumption, increased transit use, and the protection of greenfield land (Balikçi et al., 2022). In parallel, urban green space has been championed for its role in delivering key ecosystem services such as thermal regulation, recreation, and public health benefits (Balikçi et al., 2022). However, tensions arise as both compact development and green space policies often compete for the same limited land (Balikçi et al., 2022). Infill, redevelopment, and urban transformation frequently target underused green parcels that are easiest to convert for construction, creating what Balikçi et al. describe as the dilemma of "planning the compact and green city at the same time" (Balikçi et

al., 2022). GIS and remote sensing analyses demonstrate that infill and inner-city redevelopment reduce not only the quantity of green space but also its ecological integrity by increasing patch density, reducing average patch size, and fragmenting connectivity (Balikçi et al., 2022). Case studies of Amsterdam and Brussels, each operating within distinct planning frameworks, reveal green space losses of 4.7% and 11.9%, respectively (Balikçi et al., 2022). A key finding is that land-use change followed development-focused planning directives rather than green policy guidance. This supports the findings of Colsaet et al. (2018), who argue that when green infrastructure is treated as an ancillary component of objectives such as residential development, economic growth, or brownfield redevelopment, green space is typically the first element compromised (Colsaet et al, 2018). In both cities, green planning strategies proved insufficient in the face of intense housing demand (Balikçi et al., 2022). Market-driven densification, escalating land values, and delays in green planning make it difficult to deliver adequate green infrastructure alongside urban growth (Balikçi et al., 2022). Cities that either own land or can enforce mandatory green space requirements at the subdivision or development stage tend to achieve better outcomes (Balikçi et al., 2022). However, as Balikçi et al. (2022) emphasize, current strategies for integrating "green–gray" infrastructure frequently lack the necessary scale to offset the environmental trade-offs of densification (Balikçi et al., 2022). In this study, MTSAs provide an empirical case to test whether Ontario's own compact, transit-oriented growth strategy is confronting this same dilemma: whether density is being delivered without the green space needed to make that density liveable.

2.4 Geospatial Analysis

In their article "Socio-Spatial Disparities in Urban Green Space Accessibility," Dong & Miller (2024) examine how equitably distributed and accessible green space is across Toronto's neighbourhoods. The authors find that Toronto's inner core and inner suburbs face significant deficits in park access, exacerbated by high population density, limited land availability and socio-economic disparities (Dong & Miller, 2024). To investigate inequity, Dong and Miller use advanced spatial interaction models, spatial statistics, inequality metrics, and geographically weighted regression. They use open-source datasets from the City of Toronto. Accessibility of green spaces is modelled through a geographically weighted regression model and a Gaussian-based two-step floating catchment (2SFCA) model. The latter models crowding and demand, and the former models travel distances, combined to create a holistic model (Dong & Miller, 2024).

A Gini Index (0.33), a standard measure of inequality ranging from 0 (perfectly equal) to 1 (maximally unequal), and a Lorenz Curve, which plots the cumulative share of green space against the cumulative share of population, were used to calculate how unequally park accessibility is distributed. This article provides a robust methodology for conducting geospatial analysis of green space inventory and accessibility, serving as the backbone of the methodology described in Chapter 4.

Chapter 3: Policy review

This study examines the policy and regulatory framework governing green space provision within Ontario's Major Transit Station Areas, utilizing Richmond Hill Centre and Langstaff GO-Bridge as case studies. The policy review tracks across three descending scales: Provincial, Municipal, and Secondary Plans. Section 3.1 examines the provincial framework, chiefly the Planning Act and Bill 23, which establish the legal tools available to municipalities and set the limits of what parkland dedication can achieve. Section 3.2 examines how Richmond Hill and Markham have translated provincial legislation into their Official Plans and Parks Plans. Section 3.3 examines the Secondary Plans governing Richmond Hill Centre and Langstaff GO-Bridge, specifically their site-specific policies that will guide green space provision upon buildout. This structure is relevant because the geospatial findings presented in Section 4 are based upon the MTSA policy framework that will guide the specific decisions made at each of these regulatory scales. Tracing policy from provincial statute down to site-specific plans makes it possible to identify not only where planned green space provisions are lowest, but why MTSA-level disparities exist.

3.1 Lowest Resolution – Provincial

3.1.1 Provincial Planning Statement

This section outlines the provincial policy framework governing Major Transit Station Areas, beginning with the Provincial Planning Statement, 2024, which sets out the definitions, boundaries, and density requirements that structure everything discussed in the remainder of this chapter. The Provincial Planning Statement, 2024, in effect since October 20, 2024, replaces the Previous Provincial Policy Statement and consolidates the Growth Plan for the Greater Golden Horseshoe, 2019. Policy 2.4.2.1 requires all planning authorities situated on high-order transit corridors to delineate Major Transit Station Areas (Ontario, 2024). These MTSA boundaries are based on a 500–8000-metre radius around stations, designed to maximize the number of transit users within walking distance (Ontario Ministry of Municipal Affairs and Housing, 2024, Policy 2.4.2.1). Policy 2.4.2.2 defines the baseline density targets of MTSAs, carried over from the Growth Plan, set at 200 residents and jobs per hectare for subway-served MTSAs, 160 for those

served by light rail or bus rapid transit, and 150 for those served by commuter or regional rail (Ontario Ministry of Municipal Affairs and Housing, 2024, Policy 2.4.2.2).

The PPS baseline targets are significantly lower than the site-specific targets seen at Richmond Hill Centre and Langstaff GO-Bridge, set at 1,400 and 1,200 people and jobs/hectare, respectively (O. Reg. 344/22, 2022; O. Reg. 345/22, 2022). These higher-density targets were set through Ministers' Zoning Orders, under the Transit-Oriented Communities Program (O. Reg. 344/22, 2022; O. Reg. 345/22, 2022). This creates a two-tiered provincial approach to MTSA density: a general framework applied through the PPS and municipal official plans, and a parallel site-specific approach applied to priority stations. Through Policy 2.4.2.4, the PPS enables planning authorities to request lower-than-standard density targets where the standard targets cannot be achieved (Ontario Ministry of Municipal Affairs and Housing, 2024, Policy 2.4.2.4).

3.1.2 The Planning Act

Parkland dedication is governed through a separate section of the Planning Act, section 42. As a condition of development approval, a municipality may require the conveyance of land for park or other recreational purposes, or a cash payment in lieu (P.I.L.) of equivalent value, at the municipality's discretion (Planning Act, R.S.O. 1990, c. P.13, s. 42). This is calculated through two distinct formulas, the 'standard requirement' and the 'alternative requirement'. The 'standard requirement' allows for municipalities to require the greater of 5% of the land proposed for residential development, and 2% of the land proposed for commercial or industrial development (Planning Act, R.S.O. 1990, c. P.13, s. 42). The 'alternative requirement' enabled through section 42.3 is calculated based on unit count rather than a percentage of land area, typically enabling municipalities to secure higher parkland yields from high-density development, since the 'standard requirement' does not scale with unit count or population.

Where a municipality does not require land itself, section 42 allows it to require an equivalent cash payment instead, Cash-In-Lieu, or a blended land-and-cash conveyance at the municipality's discretion (Planning Act, R.S.O. 1990, c. P.13, s. 42). Municipalities value land in one of two ways: either conducting individual appraisals of specific parcels or adopting a fixed

city-wide, or area-specific per-unit or per-hectare rate schedule by by-law (Planning Act, R.S.O. 1990, c. P.13, s. 42). Once collected, section 42 requires cash-in-lieu revenue to be placed in a restricted reserve fund for park acquisition, improvement, or recreational facilities (Planning Act, R.S.O. 1990, c. P.13, s. 42).

3.1.2 Bill 23: The More Homes Built Faster Act

Bill 23, The More Homes Built Faster Act, 2022, substantially limited the implementation of the alternative requirement. Under Bill 23, the alternative rate was cut from 1 hectare per 300 dwelling units to one hectare per 600 residential units (More Homes Built Faster Act, 2022). The cash-in-lieu rate was cut from 1 hectare per 500 dwelling units to 1 hectare per 1,000 dwelling units (More Homes Built Faster Act, 2022). This represents a 50% reduction in both scenarios.

The impact of these changes is not uniform in impact and hits hardest where density is highest. A November 2022 assessment by Watson & Associates Economists Ltd modelled the impact of Bill 23 during its legislative review. The modelling assessed Bill 23's impact on low-density, medium-density, low-rise, and high-rise development. The modelling found that low-density development of 20 units/hectare would see conveyance fall to 75% of the existing rate. In comparison, medium-density developments of 50 units/hectare would fall to 50% of the existing rate (Watson & Associates Economists Ltd., 2022). Low-rise developments of 150 units/hectare would yield 20% of their existing rate, and high-rise developments of 300 units/hectare would reach just 10% of pre-Bill 23 levels, with cash-in-lieu payments falling to 17% of their prior level (Watson & Associates Economists Ltd., 2022). These figures are illustrative modelling conducted by a consulting firm, not statute, but they demonstrate a critical point: Bill 23’s reduction in parkland yield scales inversely with density. The City of Richmond Hill formally responded to Bill 23 and quantified the direct impact of capping the alternative rate, with staff estimating $329.8 million in lost revenue over ten years (Richmond Hill, 2023). Bill 23 did not merely maintain the density-parkland disconnect; it widened it.

Bill 23 reduced the scope of development subject to dedication in the first place. Affordable, attainable, and inclusive zoned residential units are now entirely excluded from the

unit count used to calculate the alternative parks requirement or used to proportionally discount the 5% requirement (More Homes Built Faster Act, 2022). Parkland dedication rates are now also ‘frozen’ at the value at the time the site plan or zoning bylaw amendment is submitted (More Homes Built Faster Act, 2022). This means municipalities cannot capture an increase in the dedication rate or in land value between the application and the building permit.

Additionally, Bill 23 impacts cash-in-lieu payments, requiring municipalities to spend or allocate at least 60% of their reserve fund for park acquisition annually (More Homes Built Faster Act, 2022). It also allows developers to submit “payment under protest” followed by an application to the Ontario Land Tribunal for independent determination (Planning Act, R.S.O. 1990, c. P.13, s. 42). This right of appeal operates asymmetrically in practice, since well-funded proponents of large developments are typically better positioned to arrange appraisal and legal resources than a municipality is to defend valuations across its geography (Tribunal Watch Ontario, 2024).

3.2 Medium resolution-municipal

3.2.1 Richmond Hill Official Plan

Analysis of the Richmond Hill Official Plan provides valuable context for this study as it provides citywide policy context. Richmond Hill has no citywide hectare-per-population parkland provision target, instead relying on the Planning Act's dedications mechanism alone. For residential purposes, it utilizes the greater of 5% of the land proposed or 1 hectare per 600 dwelling units (Richmond Hill, 2025b, p. 3-13). The only Ha/1,000-Population standards found in the official plan are secondary plan specific, applying only to the North Leslie Secondary Plan. The North Leslie Secondary Plan sets 1.0 ha/1,000 population for neighbourhood parks, and not less than 1.6 ha/1,000 population for community parks (Richmond Hill, 2025b, s. 9.6.6.2(d)–(e)). This confirms that the absence of quantitative parkland targets in the Richmond Hill Centre Secondary Plan is a deliberate choice, not a city-wide gap. The Official Plan identifies the five park typologies used in this study’s geospatial analysis: Destination Parks, Community Parks, Neighbourhood Parks, Linear Parks, Urban Squares, and Urban Plazas, (Richmond Hill, 2025b, p. 3-78).

Richmond Hill implements cash-in-lieu payments through by-law no 123-22, utilizing a fixed dollar amount schedule by dwelling type currently: $23,400 per multi-residential unit, $19,792 per semi or detached unit, and $15,000 per townhouse unit (Richmond Hill, 2022a, ss. 10–12, Table 1). The by-law itself was appealed to the Ontario Land Tribunal by a coalition of major developers and was not approved in its final form until June 2024 (*Acorn Major Mack Inc. v. Richmond Hill (City)*, 2024). Additionally, it permits a 'strata park' credit of 80% of the value for city-owned parkland built atop a structure the city does not own, such as a parking podium (Richmond Hill, 2022a, s. 9). A tool highly suited to land-constrained sites such as Richmond Hill centre

3.2.2 Richmond Hill Parks Plan

The Richmond Hill Draft Parks Plan 2022 classifies Richmond Hill's park system into five categories: Destination parks, Community parks, Neighbourhood Parks (further split into local parks and parkettes), Linear Parks, and Urban squares, totalling approximately 358 hectares as of August 2021, and reports a city-wide provision of 15.6 M^2 per person, or 1.56 per 1,000 people (Richmond Hill, 2022b).

The Draft Parks plan identifies the Yonge Street corridor between Bernard Avenue and Richmond Hill Centre as one of the areas expected to see the steepest per capita decline in park space by 2031 anywhere in the city (Richmond Hill, 2022b). The plan itself overtly acknowledges the reasons behind this, citing the city's decades of greenfield development and straightforward application of the standard 5% of land dedication rate on large sites as the reason for the city's current provision level of 1.56 Ha/1,000 people (Richmond Hill, 2022b). The city's approved planning target carried forward from the 2013 parks plan already anticipates this to be lower, anticipating 1.37 ha/1,000 people, anticipating some decline as the city intensifies (Richmond Hill, 2022b). However, the Draft Parks Plan calculates this future rate based on the Planning Act's previous alternative rate, not the updated rate introduced by Bill 23 (Richmond

Hill, 2022b). The plan overtly states that the small and medium size of most medium and high-density developments necessitates the city seeking cash-in-lieu for parkland dedication rather than taking land (Richmond Hill, 2022b). In the city's analysis, it recognizes the structural impossibility of maintaining the city's planned future target of 1.37ha/1,000 people (Richmond Hill, 2022b).

For Richmond Hill Centre specifically, the Draft Parks plan quantifies the Urban Square/Linear Park need at 3.15 hectares, within the larger city-wide land need of 53.56 hectares to 2031, of which 24.23 hectares were already secured through the North Leslie and West Gormley secondary plans (Richmond Hill, 2022b). Separately, the plan estimates that the city will need approximately $75 million in cash-in-lieu revenue through 2031 to cover park revitalization, the construction of newer, more expensive park types explicitly including Urban Squares and interim 'pop-up' park projects (Richmond Hill, 2022b).

Turning to Privately Owned Accessible Spaces, the Draft Parks Plan States that the city will need to "consider incorporating certain park-related matters into the forthcoming Community Benefits Charge Strategy and By-law, including a credit for privately owned and publicly accessible spaces (POPS)" (Richmond Hill, 2022b, Section 7.0). This creates significant tension, as there is no formal mechanism to secure POPs, requiring individual negotiations during site plan approval.

3.2.3 Markham Official Plan and Integrated Leisure Master Plan

Unlike Richmond Hill's official plan, which sets no citywide hectare-per-population target and relies on the Planning Act dedication mechanism alone, Markham's Official Plan establishes explicit citywide standards: a minimum provision of 1.2 hectares of City Parks per 1,000 persons, which city hall states it will exceed (Markham, 2024a). Markham's Integrated Leisure master plan brings the same structural critique seen in Richmond Hill's Draft Parks Plan, finding "current and proposed parkland dedication tools and funding mechanisms are insufficient for meeting all parkland needs" (Markham, 2019, p. 34), citing intensification as the root cause because it "generates less Parkland Per capita than traditional greenfield development" (Markham, 2019, p. 34). Additionally, Markham's parks classification system is much more

granular than Richmond Hill's five-type classification system, with eight policy classifications and 35 operational categories.

Furthermore, Markham's Official Plan makes an explicit equity commitment not seen in Richmond Hill's official plan, with Council directing policy to distribute parks and open spaces equitably throughout the municipality by allocating needed parkland to areas that are currently underserved, including intensification areas and other areas of high projected growth, and separately commits the parks and open space system to prioritize connectivity in new mixed-use neighbourhoods and intensification areas specifically (Markham, 2024a, Policies 4.3.1.2, 4.3.1.4(c)).

Chapter 2 of Markham's Official Plan provided the legal basis for the cross-boundary coordination required for the development of Langstaff GO-Bridge. Designating the Langstaff Gateway together with Richmond Hill Centre as jointly forming the single Richmond Hill/Langstaff Gateway urban growth centre and regional growth centre, requiring that the implementation of the Langstaff Gateway Secondary be coordinated with the secondary plan for the adjoining Richmond Hill Centre (Markham, 2024a, Policy 2.5.1.4).

Markham implements parkland dedication through By-law 2022-102, taking a different approach to Richmond Hill by using individual valuations instead of the fixed-schedule approach seen in Richmond Hill. The printed dedication rates predate Bill 23 by roughly two months, still specifying the pre-amendment alternative requirements of one hectare per 300 dwelling units for land and one hectare per 500 units for cash-in-lieu (Markham, 2022, ss. 3(b), 4(b)). These figures are effectively halved by Bill 23. Apartments are carved out as a special case, with the city taking 0.55 hectares per 500 units, regardless of whether the city takes land or cash (Markham, 2022, ss. 3(a), 4(a)). The by-law also carries a pre-existing carve-out for affordable housing, exempting developments by Housing York Inc or other non-profit housing corporations, when more than half of the units are affordable (Markham, 2022, s. 5). Like Richmond Hill, Markham allows land that is stratified or structurally encumbered to count towards dedication but leaves discretion to council on a case-by-case basis (Markham, 2022, ss. 9–10). By-law 2022-102 was repealed and replaced by by-law 2025-101, which was updated to reflect the changes under Bill

23 (Markham, 2025). By-law 2022-102 no longer governs current applications, but it was the operative by-law for nearly the entire approval process for the Langstaff GO-Bridges approval period.

The Integrated Leisure Management Plan places Langstaff within the broader Thornhill study area, one of four planning districts the ILMP uses for its parkland Inventory. Importantly noting that as of 2019 “the City does not have the land for parks, recreation facilities and libraries that will be required to meet the needs of future residents” (Markham, 2019, p. 12) of Langstaff and the adjacent Leitchcroth intensification area. This is a direct admission of a parkland securement gap at the exact site this study found to have the lowest access to existing green space inventory.

3.3 Highest resolution: site-specific design guidelines and Secondary plans

3.3.1 Richmond Hill Centre Secondary Plan

The Richmond Hill Centre Secondary Plan, January 2025, confirms the two-tier density structure found in the geospatial source files. Planning for a minimum density of 1,400 persons and jobs per hectare for lands subject to Ontario Regulation 344/22, and 400 people and jobs per hectare for the remainder of the MTSA (O. Reg. 344/22, 2022). Estimating that under full build-out the site will accommodate up to 51,000 people and at least 10,000 jobs. The Secondary Plan lists 6 core principles in section 10.1.3: A new downtown for Richmond Hill, A Place defined by its high-quality design and public realm, a place for all people, a place for people to walk, bike and take transit, a sustainable, a healthy and resilient place, and a place that supports technology and innovation (Richmond Hill, 2025a, s. 10.1.3). Additionally, the plan heavily emphasizes improved connectivity between the Richmond Hill Centre MTSA and the Langstaff GO-Bridge MTSA, through the development of a north-south pedestrian and cycling spine (Richmond Hill, 2025a, s. 10.4.4).

Section 10.2.8 addresses the utility corridor directly south of the site, between Richmond Hill Centre and Langstaff Go-Bridge. It identifies the transmission lines within the corridor as

regionally significant, including three lines, with a fourth set planned for the northern extent of the corridor. While the utility corridor is expected to maintain much of its current use, the Secondary Plan encourages compatible secondary uses that will benefit the environment and the public, subject to further consultation with Hydro One. However, the city also acknowledges the corridor's future development potential, leaving it in a state of uncertainty.

Section 10.5 of Richmond Hill Centre's secondary plan, Parks and open space, is organized by character area rather than by explicit quantitative parkland targets. It identifies three urban squares as POPS to be concentrated around the future high-tech station, three neighbourhood parks, a system of linear parks, a 6-hectare major urban open space featuring a naturalized stormwater management pond, and a protected woodland natural heritage feature (Richmond Hill, 2025a, s. 10.5). Comparing the secondary plan against Richmond Hill's existing greenspace inventory, the woodland and the 6-hectare major urban open space are preexisting features, already counted in the geospatial analysis.

Notably, the secondary plan sets no minimum hectare-per-population parkland provision standard, instead relying on a schedule of planned locations that development is required to contribute to conceptually (Richmond Hill, 2025a, p. 24). The plan also confirms that affordable housing requirements set at a minimum of 35% affordable units elsewhere in Richmond Hill Centre do not apply to the lands subject to the Minister's zoning order O. Reg 344/22, broadly illustrating the province's ability to supersede municipal policy (Richmond Hill, 2025a, s. 10.7.1(3)).

Importantly, Schedule 3 of the secondary plan clarifies that the parks and open space system is illustrated only as location diagrams, without hectare figures, sizes, or per-park quantities being assigned to any of the individual urban squares, neighbourhood parks, or linear parks shown, with the schedule itself caring the disclaimer that it "is not a plan or survey", and that depicted boundaries are subject to further confirmation (Richmond Hill, 2025a, Schedule 3).

Schedule 3 also reveals an unevenness in the plan's own stated objective of providing "a public park in each character area" (Richmond Hill, 2025a, p. 24). Comparing Schedule 3 against

the Character Area boundaries shows that, in Schedule 1, the three urban squares and three neighbourhood parks cluster primarily around the High-Tech subway station, within or at the edges of the Inner Transit Core, Bantry, and South of High-Tech Character Areas (Richmond Hill, 2025a, Schedule 1). Red Maple, the single largest character area by land, has no park symbol assigned to it in Schedule 3 (Richmond Hill, 2025a, Schedule 3). It likely relies on its proximity to existing green space such as the Dr. James Langstaff community park to meet the secondary plans' stated objectives.

3.3.2 Langstaff GO-Bridge Secondary Plan

Langstaff GO-Bridge falls under Markham's Bridge Transit-Oriented Community (TOC) designation, developed alongside Richmond Hill's High Tech TOC under the same provincial Transit-Oriented Communities Program for the Yonge North Subway Extension Corridor (O. Reg. 345/22, 2022). Together, the two developments are expected to bring approximately 80,000 new residents and over 40,000 new homes across their combined 40 hectares, with 32,000 residents planned for the Langstaff Bridge MTSA (Markham, 2011, s. 2.0). The areas are planned at densities that York Region's chief planner described as roughly double what the region had been planning for (Xing, 2022). The site is governed by a Minister's Zoning Order issued through Regulation 345/22, the direct counterpart to Regulation 344/22 governing Richmond Hill Centre (O. Reg. 345/22, 2022).

The Langstaff Gateway Secondary Plan provides nine named green space elements: Pomona Mills Creek Park (0.36 ha), Cedar Park (0.71 ha), Transit Green (0.06 ha), Linear Park West (0.54 ha), Linear park East (0.73 ha), Hub Green (0.48 ha), Promenade Park (0.13 ha), Woodlot Park (0.69 ha), and the EPA Woodlot/Langstaff Woodlot (3.12ha), summing to the plans stated total of approximate 6.8 hectares of public parkland, plus a further 5.4 hectares of public open space (Markham, 2011, s. 6.1). Notably, the woodlot is credited toward the total parkland figure at the discretion of the town, pending the completion of a woodlot management plan (Markham, 2011, s. 6.6.3)

Taken together, this policy review traces a consistent pattern across three regulatory scales. Bill 23 halved the dedication and cash-in-lieu rates available under the Planning Act, and

simultaneously narrowed what counts toward those calculations, while no equivalent provincial mechanism constrains or backstops density targets. At the municipal scale, Richmond Hill's reliance on the Planning Act's dedication formula alone, without any citywide hectare-per-population target, contrasts with Markham's explicit numeric standard, illustrating that green space provision is a matter of municipal discretion. This discretion narrows further at the site-specific scale: Richmond Hill Centre's Secondary Plan sets no quantitative parkland target, while Langstaff GO-Bridge's Secondary Plan specifies green space elements.

Chapter 4. Methodology

4.1 Research Design

This research utilizes quantitative geographic information system (GIS) tools to evaluate the accessibility of public green space in Major Transit Station Areas in southern York Region. This analysis integrates network-based accessibility modelling, spatial overlay techniques, standardized green infrastructure classification, and population-normalized indicators to assess development pressure on existing public green space. It assesses the adequacy of existing green infrastructure across study sites and development-induced demand.

This research diverges from existing park accessibility studies, which use census population data, by instead using provincial development targets as a proxy for future demand. This approach reflects the primary objective of MTSAs as designated growth areas, providing an assessment of development-induced pressure on existing green spaces.

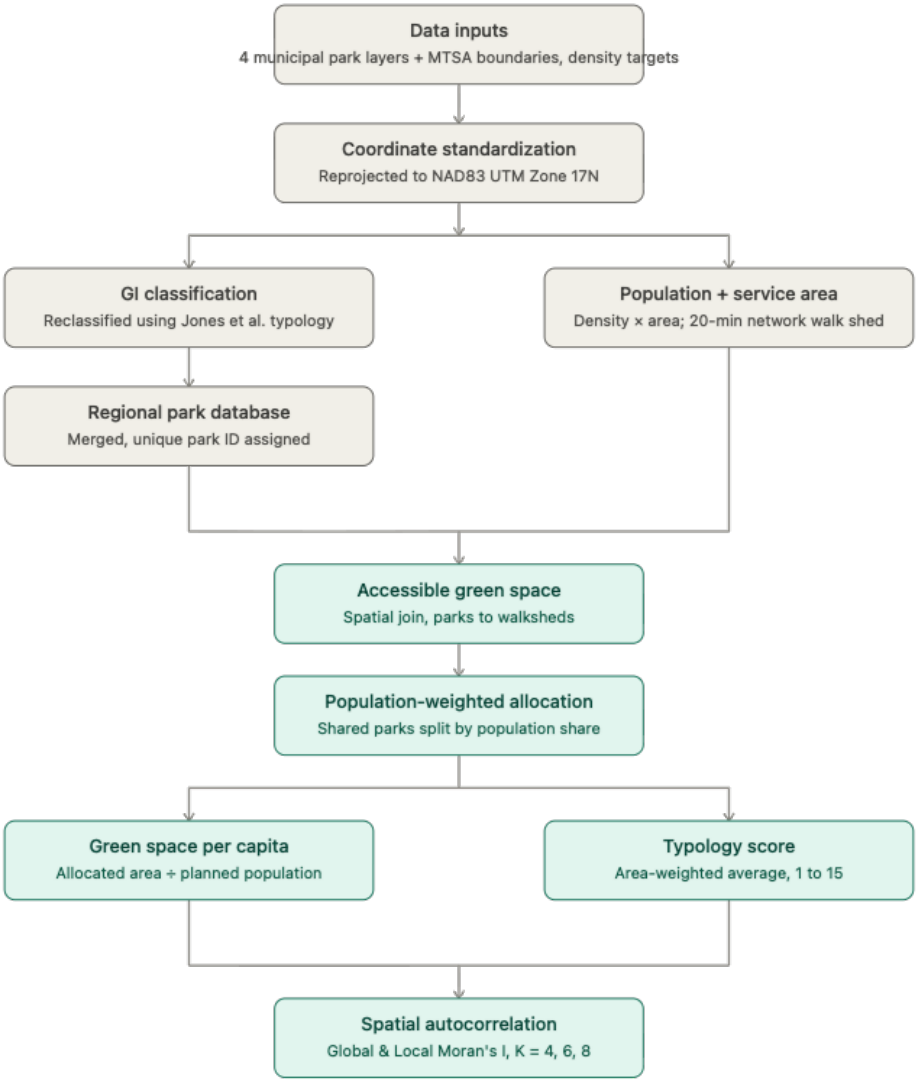


Figure 3: Geospatial workflow flowchart

4.2 Study Area

Spatial datasets were obtained from publicly available open data portals and sourced directly from municipalities' planning departments. The City of Toronto and Markham park datasets were sourced directly from their associated open data portals. The Richmond Hill and Vaughan park datasets are not publicly available and were obtained with assistance from municipal staff. The MTSA shapefile for York Region was obtained with assistance from municipal staff, as it is not publicly available.

Four municipal park inventories were used:

- City of Toronto
- City of Vaughan
- City of Markham
- City of Richmond Hill

Each municipal dataset contained polygonal features representing parks and open space, along with municipality-specific land-use classifications.

Major Transit Station Area spatial data was sourced from the upper-tier municipality of York Region.

MTSA datasets included

- MTSA boundary polygons
- MTSA point locations
- Provincial density targets (residents and jobs per hectare)

Each municipality in the study area employs a different greenspace classification system, requiring extensive data preparation before regional analysis could be conducted.

4.3 Data preparation

4.3.1 Coordinate System Standardization

All spatial datasets were projected into a common projected coordinate system (NAD 1983 UTM Zone 17N) to ensure consistent alignment and accurate spatial processing.

4.3.2 Green Infrastructure Classification

Municipal green space inventories contained different classification systems and attribute structures, making direct comparison impossible.

To facilitate the development of a consistent regional dataset, a standardized green infrastructure typology framework was developed, based on the work of Jones et al. (2022), *A typology for urban Green Infrastructure, to guide multifunctional planning of nature-based solutions.* At this phase, existing municipal classifications were reclassified -using the framework developed by Jones et al. (2022), creating two new attribute fields within each municipal dataset: GI_sub

(higher resolution) and GI_main (lower-resolution). Municipal green space datasets were manually reclassified into standardized categories using rule-based field calculation in Python, developed for each municipality.

This standardization allowed for all municipal datasets to be merged into a single regional dataset while maintaining accuracy across municipalities, enabling regional-level analysis. The primary benefit of using the matrix from Jones et al. (2022), compared with other green space typologies, was its ability to quantify ecosystem services. This quantification was translated into GIS by assigning each object category a numeric value from 1-15, based on the object categories' cumulative scores for 'supporting physical activity', 'supporting social interactions', and 'restorative capabilities – stress reduction and cognitive restoration', referenced in Table 1. This resulted in a quantification of green spaces' recreational ecosystem services.

Brief description	Object type	Object category	Food provision	Air pollution removal	Noise mitigation	Heat mitigation	Water quality mitigation	Water flow management	Maintaining carbon stocks	Supporting physical activity	Supporting social interactions	Restoring capacities - stress reduction and cognitive restoration	Supporting biodiversity
Mainly private space linked to dwellings	Gardens	Balcony	Low	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Low	High	Low
		Private garden	Medium	Low	Low	Medium	Medium	Medium	Low	Very high	Medium	Very high	High
		Shared common garden area	Medium	Low	Low	Medium	Medium	Medium	Low	Medium	High	Medium	Low
Mainly public space, but some access restrictions may apply	Parks	Pocket park	Low	Low	Low	Low	High	Medium	Low	Medium	Very high	High	Medium
		Park	Low	High	High	High	High	Medium	High	Very high	Very high	Very high	High
		Botanical garden	Low	High	Very high	Very high	High	Medium	High	Medium	High	Very high	Very high
		Heritage garden	Medium	Medium	High	High	High	Medium	Medium	Medium	High	Very high	High
		Nursery garden	Medium	Medium	Low	Low	High	Medium	Medium	Low	Medium	Medium	Low
Areas designed primarily for specific amenity uses	Amenity areas	Sports field	Negligible	Low	Low	Low	Low	Low	Low	Very high	High	Medium	Negligible
		School yard	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Very high	Very high	Medium	Negligible
		Playground	Negligible	Negligible	Negligible	Negligible	Low	Low	Negligible	Very high	Very high	Medium	Negligible
		Golf course	Negligible	Medium	Low	Low	Negligible	Medium	Low	Medium	High	High	Medium
		Shared open space (e.g. square)	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Medium	Very high	Low	Negligible
Areas designed primarily for specific uses (not leisure); some access restrictions may	Other public space	Cemetery	Negligible	Medium	Medium	Medium	Medium	Medium	High	Low	Low	Very high	High
		Allotment/other growing space	Very high	Medium	Low	Low	Negligible	Medium	Negligible	High	High	Very high	High
		City farm	Very high	Medium	Low	Low	Negligible	Medium	Negligible	Medium	Medium	High	Medium
		Adopted public space	Low	Medium	Low	Low	Low	Low	Negligible	Negligible	Low	Medium	Low
Linked to routeways, geographical features and boundaries	Linear features/routes	Street tree	Low	High	Low	High	Low	Low	Medium	Negligible	Low	High	Medium
		Cycle track (as green/blue corridor)	Low	Low	Low	Low	Low	Low	Low	Very high	Medium	High	Low
		Footpath (as green/blue corridor)	Low	Low	Low	Low	Low	Low	Low	Very high	Very high	High	Low
		Road verge	Low	Low	Low	Low	Medium	Medium	Low	Negligible	Negligible	Low	Low
		Railway corridor	Negligible	Very high	Very high	Very high	Low	Medium	High	Negligible	Negligible	Low	Very high
		Riparian woodland	Low	Very high	Very high	Very high	Very high	High	Very high	High	High	Very high	Very high
		Hedge	Low	Medium	Low	Low	High	High	Medium	Negligible	Negligible	Medium	Medium
Constructed green and blue space, added to infrastructure	Constructed GI on infrastructure	Green roof	Negligible	Low	Negligible	Low	Low	High	Low	Negligible	Negligible	Low	Low
		Green wall	Negligible	Medium	Medium	Low	Negligible	Low	Low	Negligible	Negligible	Medium	Low
		Roof garden	Medium	Medium	Low	Medium	Low	Low	Medium	Low	High	Very high	Medium
		Pergola (with vegetation)	Negligible	Medium	Low	High	Low	Low	Medium	Negligible	Low	Low	Low
Infrastructure designed to incorporate some GBS components	Hybrid GI (for water)	Permeable paving	Negligible	Negligible	Negligible	Negligible	High	High	Negligible	Low	Negligible	Negligible	Negligible
		Permeable parking/roadway	Negligible	Negligible	Negligible	Negligible	High	High	Low	Negligible	Negligible	Negligible	Negligible
		Attenuation pond	Negligible	Low	Low	Low	Very high	Very high	Medium	Negligible	Low	Medium	High
		Flood control channel	Negligible	Low	Negligible	Low	Low	Very high	Low	Negligible	Low	Negligible	Medium
		Rain garden	Low	Medium	Negligible	Low	High	High	Medium	Negligible	Negligible	High	Medium
		Bioswale	Negligible	Medium	Low	Low	Medium	Very high	Medium	Negligible	Negligible	Low	Medium
Bluespace features	Waterbodies	Wetland	Negligible	Medium	Low	Medium	Very high	Very high	Medium	Low	Medium	Very high	High
		River/stream	Low	Low	High	High	Medium	High	Low	Medium	High	Very high	High
		Canal	Low	Low	Low	Medium	Low	Medium	Low	Medium	High	Very high	Low
		Pond	Negligible	Low	Low	Low	Low	High	Medium	Low	High	Very high	High
		Lake	Medium	Low	Medium	High	High	High	Medium	High	High	Very high	Very high
		Reservoir	Low	Low	Medium	High	High	Very high	Medium	High	High	Very high	Medium
		Estuary/tidal river	High	Low	High	High	High	N/A	Medium	Medium	High	Very high	Very high
		Sea (incl. coast)	High	Low	High	Very high	High	N/A	Very high	Very high	Very high	Very high	Very high
Other un-sealed features without specified use, often on private land	Other non-sealed urban areas	Woodland (other)	Low	Very high	Very high	Very high	High	High	Very high	High	High	Very high	Very high
		Grass (other)	Low	Low	Low	Low	Medium	Medium	Low	Very high	High	Medium	Medium
		Shrubland (other)	Low	Medium	Low	Low	High	High	Medium	Medium	Medium	High	High
		Arable agriculture	Very high	Medium	Low	Low	Negligible	Low	Negligible	Low	Negligible	Low	Low
		Sparsely vegetated land	Negligible	Negligible	Low	Negligible	Low	Low	Negligible	Medium	Medium	Medium	Low

Table 1: Green infrastructure matrix (Jones et al., 2022)

4.3.3 Regional park database

Following the standardization of green space typology, a municipality identifier was added to each dataset to preserve the source municipality. The four park inventories were then merged into a comprehensive regional layer using ArcGIS Pro Merge tools with customized field mapping to ensure data consistency. Subsequently, the green space area was calculated in square metres, utilizing polygon geometry. Each park polygon was assigned a park identifier at the time of standardization. During analysis, an identifier inherited from the source municipal datasets was found to repeat across municipalities rather than being unique region-wide, which had allowed population values to be joined incorrectly onto unrelated parks sharing the same recycled identifier. This was corrected by calculating a verified unique regional park identifier from the merged layer's internal feature ID before the spatial join and population-weighted allocation described in Sections 4.6 and 4.7.

4.4 Estimation of Planned Population

Rather than relying on the existing census population, this study aims to analyze future demand on existing infrastructure and assess the adequacy of green space procurement in rapidly developing areas of the GTA. This study estimates future demand for green space using minimum density targets set provincially for each Major Transit Station Area. Density targets, expressed as residents and jobs per hectare, are multiplied by the area of each MTSA to estimate the minimum planned population and employment density expected under a full build-out.

This approach tailors the accessibility assessment to meet the intended function of Major Transit Station Areas as future centers for growth. It allows for the evaluation of green space provision against planned rather than existing conditions. Currently, in these MTSAs, very few people and jobs are present relative to the planned density. The purpose of the study is to understand if green space policy is keeping up with intensification policy in urban areas.

4.5 Network-Based Accessibility Analysis

Accessibility was evaluated using the ArcGIS Pro Network Analysis extension. In each MTSA, the station itself was used as the starting destination of the service area network analysis.

A twenty-minute pedestrian service area was generated using the walk time mode. A twenty-minute walkshed was used due to competing factors and limitations in network analysis. Service area network analysis must be run using a point (the station) and cannot be run using polygons in ArcGIS Pro. Zhang et al. (2022) identify ten minutes as the average distance people are willing to walk to access green space, and MTSAs are designed to encourage high-density development within a ten-minute walk of major transit stations. Because of these factors, a twenty-minute walkshed was selected in the research design.

Unlike Euclidean buffers, network service areas account for the actual pedestrian street network, intersections, and barriers to movement, thereby improving modelling of human behaviour and creating a more realistic representation of walkable accessibility (Comber, Brunsdon & Green, 2008). Service area polygons based on the twenty-minute walksheds were exported as independent feature classes for subsequent analysis.

4.6 Identification of Accessible Green Space

Accessible green space was identified through a one-to-many spatial join, linking the regional parks dataset and the twenty-minute service area polygons. The intersect relationship was selected so that any park intersecting with a walkshed was considered to be accessible from that MTSA.

A one-to-many join was selected due to the close geographic proximity of the MTSA study sites, allowing parks to be counted as accessible by multiple MTSAs if the walksheds overlapped. Population estimates calculated for each MTSA were joined to MTSA points before the spatial join, ensuring that each park-MTSA relationship retained its corresponding planned population.

4.7 Population-Weighted Allocation of Shared Green Infrastructure

A major limitation of conventional accessibility measures is that sites that span multiple service areas are counted repeatedly, artificially inflating green space accessibility figures. A green space servicing multiple MTSAs is fully attributed to each, essentially duplicating a green space's area

by the number of service areas it touches. To combat this issue, a population-weighted allocation procedure was used.

First, summary statistics were used to calculate the total planned population capable of accessing each individual park by summing the populations of all MTSAs with a walkshed overlapping that park. Following this, each park's area in square metres was then allocated proportionally among the MTSAs according to that MTSAs share of the total accessible population.

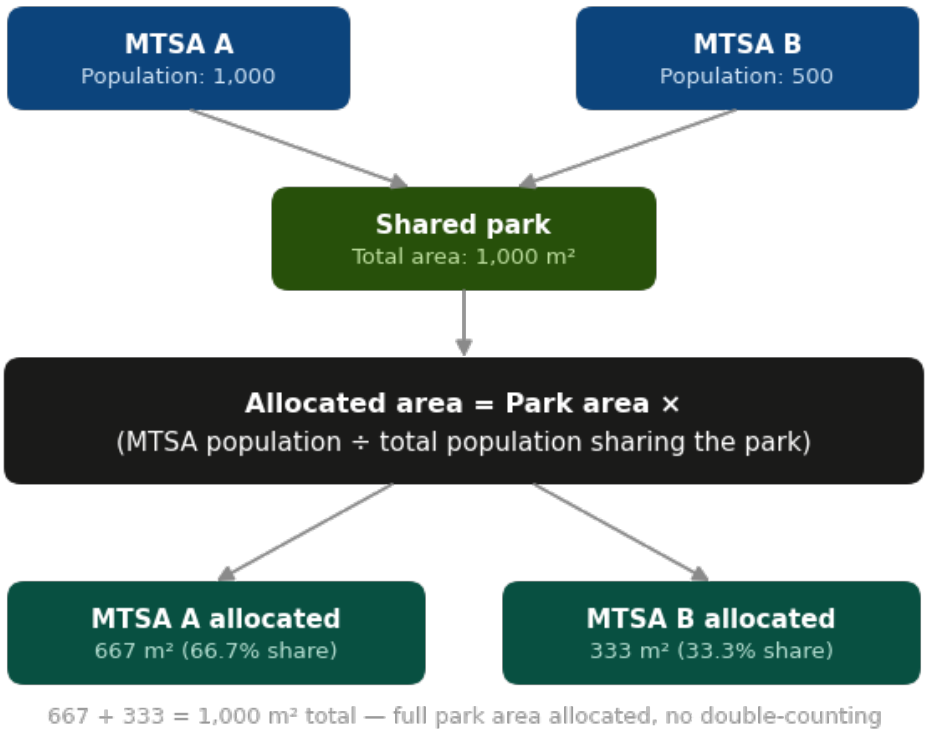


Figure 4: Population weighted allocation calculation

This process ensures that each square metre of green space is allocated only once across the study area, while accounting for the overlapping access of many parks in the study area. The allocation was validated using an area-conservation check, confirming that for every park in the

regional dataset, the sum of allocated area across all MTSAs sharing access to it equals that park's original surveyed area.

Compared with more straightforward park-per-capita measures, this methodology provides a much more accurate representation of reality, accurately representing overlapping demand at neighbouring study sites.

4.8 Accessible Green Space Per Capita

The allocated park area was summarized for each MTSA using summary statistics. The total allocated green space accessible to each MTSA was then divided by its planned population to calculate an accessibility indicator expressed as square metres of accessible green space per planned resident and job.

This indicator measures the amount of green infrastructure available within a twenty-minute walk of stations. Constructed from the average acceptable walking distance to green space of 10 minutes plus a ten-minute travel time from the station to the outer edge of MTSAs (Zhang et al., 2022).

4.9 Typology-Based Green Infrastructure Assessment

In addition to developing a green space per capita score, the standardized green infrastructure typology was incorporated into the accessibility analysis as an area-weighted average typology score. This enabled the comparison of not just the quantity of green infrastructure but also its composition. The area-weighted average typology score was calculated for each MTSA by multiplying the base typology score assigned to each green space in step 4.4 by its population-allocated area calculated in step 4.8. The weighted scores were summed and divided by the total allocated accessible green-space area for each MTSA, producing an average typological quality score that accounted for both the composition and quantity of accessible green infrastructure while avoiding double-counting shared green spaces.

$$\text{Average Typology Score} = \frac{\sum(\text{Base_typo} \times \text{Allocated Area})}{\sum(\text{Allocated Area})}$$

Figure 5: Average typology score formula

The result of this phase of the analysis was an area-weighted typology score ranked from 1 to 15, enabling easy visualization of access to ecosystem services.

4.10 Spatial Autocorrelation Analysis

To test whether green space accessibility outcomes are spatially clustered across the study area rather than distributed independently of geographic location, Global and Local Moran's I statistics were calculated for accessible green space per capita and average weighted typology using the spatial statistics toolset in ArcGIS Pro.

Spatial relationships between MTSAs were conceptualized using a K-nearest neighbours approach with row standardization, selected over a fixed distance band because MTSAs are unevenly spaced across the study area. To confirm that results were not an artifact of arbitrarily selected neighbourhood size, Global Moran's I was calculated at K = 4, 8, and 8 neighbours. Therefore, consistency in Moran's I results across these three neighbourhood specifications would indicate that any observed spatial pattern reflects a genuine geographic relationship rather than an artifact of how spatial adjacency was defined.

Chapter 5. Geospatial Findings

5.1 Overview of the Dataset

The regional Major Transit Station area dataset produced findings for 50 MTSAs across Richmond Hill, Vaughan, and Markham. Data were generated for the MTSAs' planned populations, allocated accessible green space, and typology scores. MTSAs from the neighbouring municipalities of Newmarket, East Gwillimbury, King, Whitchurch-Stouffville, and Aurora were included in the source dataset but removed from the final product to maintain the scope of this study. Additionally, several future MTSA sites on the Jane corridor were removed from the dataset due to the lack of confirmed provincial density targets. Furthermore, the Highway 407 station was removed from the final regional MTSA dataset as it carries a provincial density target of zero. All figures reported below are drawn from the sample of 50 MTSAs with complete records and planned populations, in Richmond Hill, Vaughan, and Markham.

5.2 Accessible Green Space Per Capita

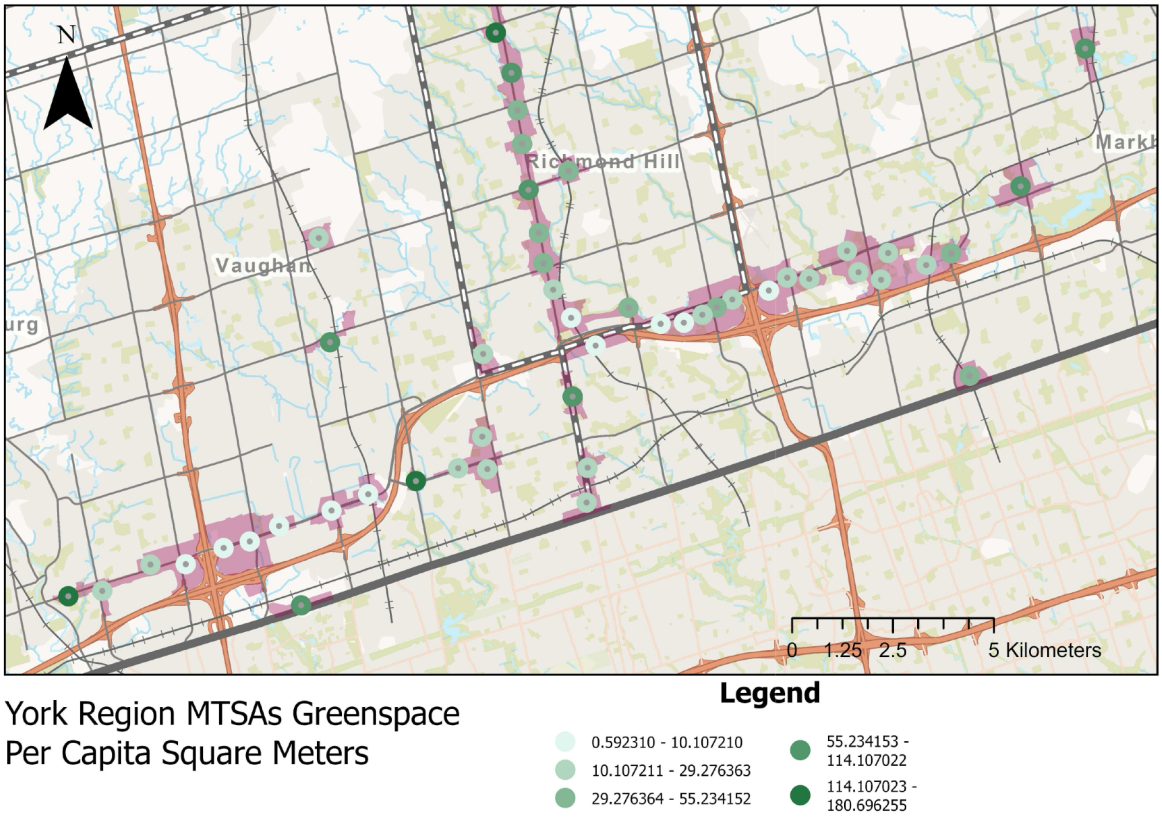


Figure 6: Green space per capita m^2, for 50 MTSA study sites

Accessible green space per capita across the 50 MTSA study sites ranges from 0.6 to 180.7 square metres per planned resident and job, with a mean of 40.8 m^2 and a median of 26.3 m^2. Half of all MTSAs' accessible green space per capita falls between 14.3 and 45.9 m^2, while the remaining half diverges sharply in both directions.

5.3 Green Space Declines as Planned Density Increases

Accessible green space per capita is negatively correlated with planned population (r = -0.34), density target (r = -0.26), and MTSA area (r = -0.25). Larger, higher-density station areas have significantly lower inventories of accessible green space than smaller, lower-density ones. This pattern is most evident among the MTSAs with the highest populations in the dataset, including Richmond Hill Centre, Langstaff GO-Bridge, and Vaughan Metropolitan Centre.

MTSA	Municipality	Planned population + jobs (calculated from minimum density targets)	Accessible green space per capita (m²)
Richmond Hill Centre	Richmond Hill	48,782	6.5
Vaughan Metropolitan Centre	Vaughan	44,302	0.9
Langstaff GO-Bridge	Markham	38,536	1.2
Commerce	Vaughan	24,991	0.9
Weston	Vaughan	22,073	2.3

Table 2: Five highest population study sites: planned build-out (Population + Jobs), and accessible green space per capita in square metres

Vaughan Metropolitan Centre stands out as a significant portion of its build-out has been completed, approximately 45-50% (City of Vaughan, 2024), highlighting the findings of Balikçi et al. (2022) that infill and inner-city redevelopment closely follows development-focused planning directives, while neglecting green policy guidance.

5.4 Patterns by Transit Type

Median accessible green space per capita varies significantly by transit mode. MTSAs served by GO have the highest median access at 36.3 m²/person, followed by subways at 26.5 m²/person, and bus rapid transit at 24.9 m²/person. The median is used here in favour of the mean because two of these groups are small; the dataset contains six subway stations, seven GO stations, and thirty-six bus rapid transit stops. The small sample size results in these groups being skewed by a few well-performing outliers. Subway's mean is 36.6 m²/person, substantially skewed by two stations, Pioneer Village (91.8 m²/person) and Royal Orchard (67.4 m²/person). Excluding these two sites lowers subways' mean to 15.1 m²/person, suggesting that MTSAs served by subways may be the most severely underserved category, once these outliers are set

aside. A similar pattern exists within the bus rapid transit and GO categories. Bus rapid transit has a mean of 38.6 m^2/person, positively skewed by three high-access stops, with greenspace per capita ranging from 178.5-180.7 m^2/person. GO has a mean of 45.5 m^2/person, positively skewed by two MTSAs, Mount Joy and Rutherford, with greenspace per capita scores of 114.1 m^2/person and 85 m^2/person.

While this finding may seem intuitive, that a higher concentration of people and jobs would overwhelm green space accessibility, the findings suggest that this dilution effect is not simply mathematical but a direct result of policy design: because green space provision is not mandated to scale alongside density the way population and job targets are, the highest-density transit types are structurally the most likely to fall short, regardless of how much absolute green space exists nearby. This matters most where it is least visible: subway-served MTSAs are marketed as complete communities offering a full range of environmental and social benefits (Advisory Panel, 2015), yet it is precisely these highest-density, most transit-connected areas where residents and workers are most shortchanged on the green space that supports human well-being (Thompson et al., 2019).

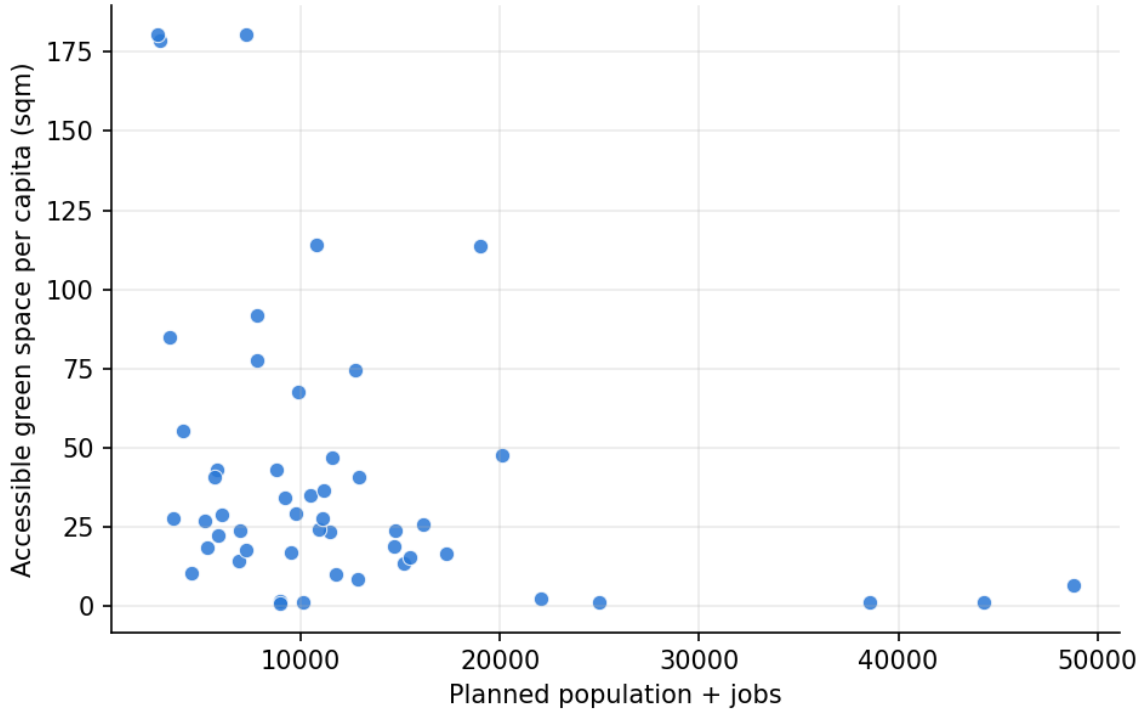


Figure 7: Planned population (residents + jobs) plotted against accessible green space per capita for 50 York Region MTSA Study Sites

5.5 Distributional inequality: Gini Index and Lorenz curve

Following the approach used by Dong and Miller (2024) to quantify inequality in park accessibility in Toronto, a population-weighted Gini coefficient was calculated for the distribution of accessible green space relative to the planned population of the 50 MTSA study sites. Figure 6 visualizes this inequality by plotting the cumulative share of accessible green space, on the Y-axis, from 0 to 1, where 1 represents the entire regional supply, against the cumulative share of planned population on the X-axis; MTSAs ranked from most to least access are shown by the blue line. The diagonal line shows perfect equality, the point at which every share of the population holds an equal share of greenspace; the shaded area between this line and the observed curve represents the magnitude of inequality: the larger the shaded area, the more unequal the distribution. The Gini coefficient is 0.589, indicating substantial inequity across study sites. The least-served half of the region's planned MTSA population holds approximately one-tenth of the region's MTSA-accessible green space inventory. This disparity exceeds comparable findings for the city of Toronto with a Gini coefficient of 0.33 (Dong and Miller, 2024).

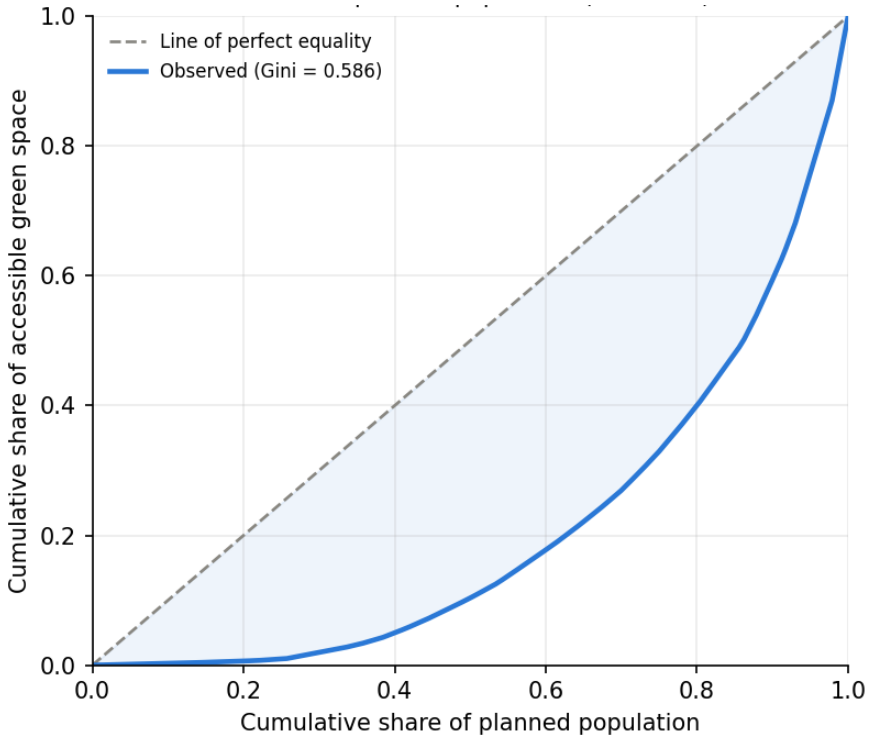


Figure 8: Lorenz curve of accessible green space relative to planned population across 50 MTSAs (Gini = 0.586).

5.6 Green Infrastructure Typology

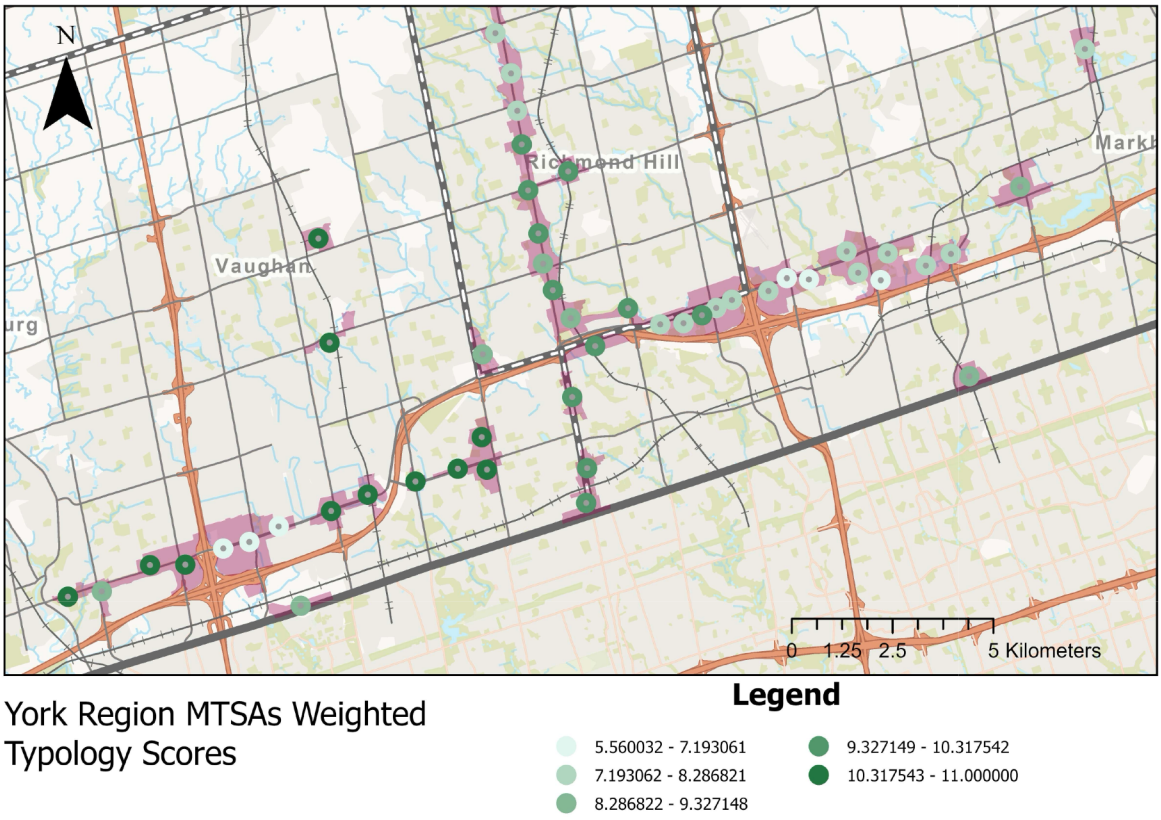


Figure 9: Green infrastructure typology map

The Area-weighted average typology score, developed to capture the composition and quality of green spaces rather than quantity alone, demonstrates a weak positive correlation with per-capita access (r = 0.15) and a weak negative correlation with MTSA area (r = -0.16). This suggests that the quality and quantity of green space are largely independent of each other. MTSAs with better per-capita access to green space do not necessarily have access to higher-quality green space. As shown in Figure 1, higher-quality spaces include parks, sports fields, footpaths, and playgrounds.

Global Moran's I conducted on the typology score demonstrated statistically significant positive clustering, consistent across K = 4, 6, and 8 neighbours, yielding index values of 0.055-0.425, Z scores of 6.23-6.35, and a P value < 0.001 for every tested K value.

Local Moran's I confirmed a High-High cluster concentrated almost entirely in Vaughan, with ten MTSAs sharing an identical typology score, and a Low-Low cluster including several Markham sites.

This clustering was identified as a resolution limitation in the green space source datasets rather than a defensible geographic pattern in green infrastructure composition. Within Vaughan's municipal parkland dataset, 79.4% of all green space records were classified as 'neighbourhood 2', which was reclassified as 'park' under the standardized typology framework (section 4.3.2). Vaughan's municipal green space classification uses seven categories, Toronto uses nineteen, Richmond Hill uses nine, and Markham uses thirty-six. The regional typology score can only be as granular as its least-granular source dataset, meaning Vaughan's green infrastructure was rendered artificially homogeneous in the regional dataset. This resulted in the spatial clustering being an artifact of the source dataset, rather than a defensible finding about the geographic distribution of green space quality across the region. As a result, conclusive findings on green space disparities between MTSAs, based on the green infrastructure score, are limited.

5.7 Spatial Autocorrelation: Global and Local Moran's I

To test the geographic clustering of green space access, Global and Local Moran's I statistics were calculated for accessible green space per capita across the 50 MTSA study sites. A K-nearest neighbours' approach with row standardization and a fixed distance band was used to conceptualize spatial relationships among MTSA study sites. Global Moran's I were calculated at K=4, 6, and 8 neighbours to confirm that the results were not sensitive to an arbitrarily chosen neighbourhood size.

k (neighbours)	Moran's Index	z-score	p-value
4	0.029	0.58	0.559
6	0.004	0.36	0.722
8	0.016	0.63	0.529

Table 3: Moran's I values

Results proved consistent across all three neighbourhood definitions. All Moran's I index values were close to zero, every Z-score fell within the +/-1.96 threshold, and every P-value exceeded 0.05, indicating that there was no statistically significant global spatial clustering of green space across the study area. Meaning that an MTSA's green space per capita does not suggest that neighbouring MTSAs have similar levels of access. Spatial clustering was a plausible expectation here: neighbouring MTSAs often fall within the same municipality and are therefore subject to the same park policies, and shared physical geography which could produce similar access outcomes across adjacent stations. Importantly, the finding that neighbouring sites do not share similar levels of green space access speaks to the effectiveness of network-based analysis in capturing barriers to pedestrian movement; this is illustrated by the disparities between Richmond Hill Centre and Langstaff GO-Bridge, which have 6.5 and 1.2 m^2 of accessible green space per capita, respectively, a disparity largely created through limited pedestrian connections across Highway 407.

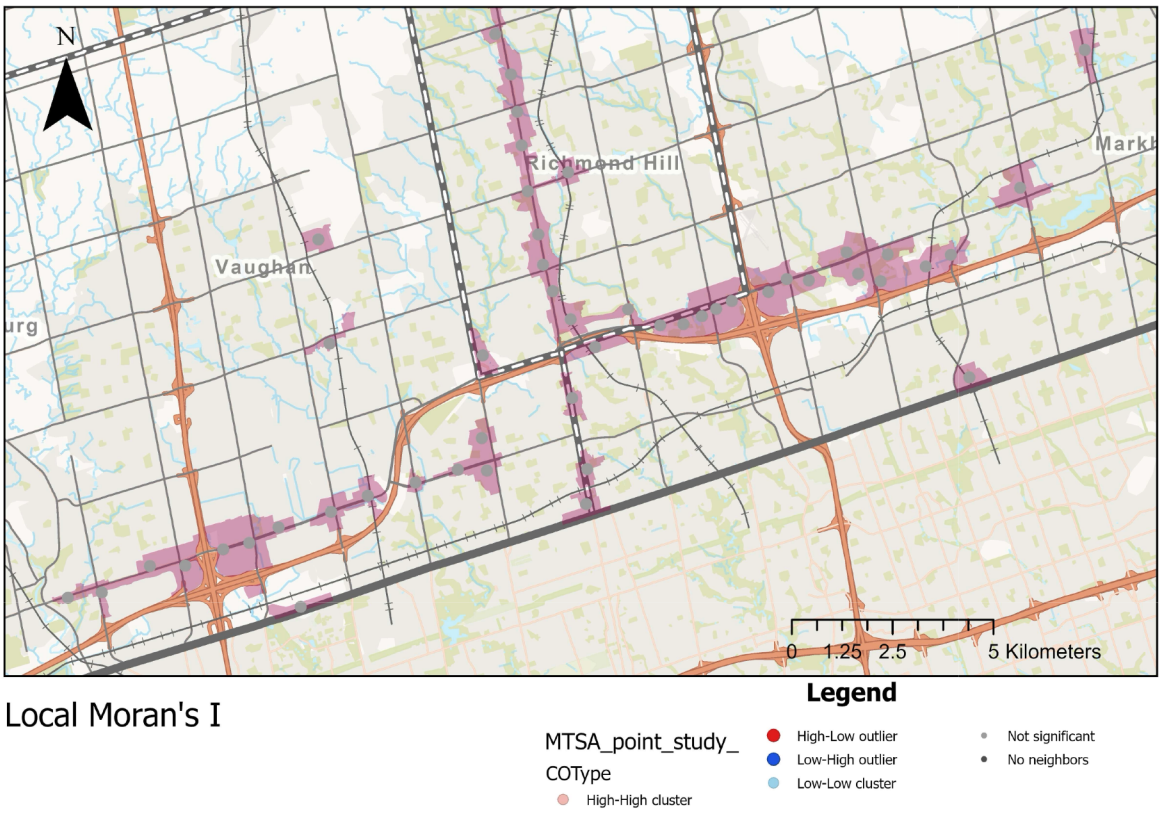


Figure 10: Local Moran's I Values

Following the Global Moran's I calculations, Local Moran's I was calculated at K = 6 to test for localized clusters and outliers that global statistics might not have detected. A False Discovery Rate (FDR) correction was applied to account for the increased likelihood of false positives across the 50 simultaneous local significance tests. None of the MTSA study sites met the corrected threshold to constitute a statistically significant High-High cluster, Low-Low cluster, or spatial outlier classification. A small number of sites returned uncorrected P-values below 0.05, but none survived FDR correction.

Together, the results of the Global and Local Moran's I indicate that the green space accessibility deficits identified in this study are not spatially clustered at a regional scale. This suggests that the low access seen at sites such as Vaughan Metropolitan Center, Langstaff GO-Bridge, and Richmond Hill Center is driven by site-level factors such as planned density, population scale, and proximity to other MTSA sites, rather than a broader geographic pattern of low green space access across the region.

5.8 Summary of Findings

Accessible green space per capita across the 50 MTSA study sites is highly unequal (Gini = 0.586), and systematically lower in higher-density, larger station areas, where provincial policy plans for the greatest populations and job growth. This pattern places significant pressure on existing green space and the provisioning process. Vaughan Metropolitan Centre and Langstaff GO-Bridge stand out as the most severely green-space-deficient large-population sites in the regional dataset, and Richmond Hill Centre remains firmly in the bottom fifth of all study sites. Vaughan Metropolitan Centre is already substantially built out, meaning its green space deficit is much more representative of how the density-green space mismatch looks at build-out, while Langstaff GO-Bridge remains undeveloped relative to its planned density, meaning its deficit represents a forward-looking projection of problems that will materialize as development proceeds.

Global and Local Moran's I tests found no statistically significant spatial clustering of greenspace access at either the regional or local scale, indicating the deficits are largely driven

by station-level characteristics rather than broader geographic patterns. Read together, these results demonstrate that the province's highest-priority growth centres are the most constrained and require significant greenspace provision; the region's greenspace problem is not simply one of distribution but one of significant planned undersupply. A planner would have no problem imagining that there will not be enough green space to adequately serve future residents and workers in MTSAs. This study began with this concern and, through modelling, confirmed that a mismatch between density and green space poses a significant challenge to the development of truly complete communities.

Chapter 6. Discussion

This study asked whether Major Transit Station Areas are being planned to provide adequate green space for their future populations. The answer across 50 MTSAs in Richmond Hill, Vaughan, and Markham is that green space is disproportionately absent from the sites the province has designated to hold the most people. The negative correlation between accessible green space per capita and both planned populations ($r = 0.34$) and density target ($r = -0.26$) is not a marginal statistical relationship; it portrays a structural pattern where the province's own growth strategy directs the greatest population pressure towards the station areas least equipped in terms of green space to serve. This pattern, in a sense, is obvious; Cervero and Kockelman's (1997) foundational "3Ds" framework established density, diversity and design as the built-environment variables that define Transit Oriented Design, omitting green space as a fourth dimension. This study has found that green space remains absent in both scholarship and legislation. The findings of this study give empirical weight to Engström and Qviström's (2022) observation that recreation is a 'silence' in TOD scholarship, and Bolleter and Ramalho's (2020) argument that TOD planning, left to its own logic, treats green space as incidental rather than an equal design principle. York Region's MTSA framework illustrates this; density is mandated provincially, in absolute figures, and green space is an afterthought.

The regional Gini coefficient of 0.586 makes the imbalance legible in a way that per-site figures alone do inadequately. The least served half of the region's planned MTSA population holds roughly one-tenth of the region's MTSA-accessible green space inventory. Measured against Dong and Miller's (2024) Gini coefficient of 0.33 for green space distribution across the City of Toronto, MTSA-level inequality is substantially more severe than city-wide inequality in the same region. The newer, more tightly regulated growth centers show potential for worse inequality than the existing metropolis.

These regional-inequality findings can also be benchmarked against an absolute standard of provision. Natural England's Accessible Natural Greenspace Standard is the most widely used green space provision benchmark in UK planning, built primarily around proximity and size criteria. The Standard is for at least one green space of two hectares in size within 300 metres, a five-minute walk of every home, rather than a fixed area-per capita target (Natural England,

2010). The complementary quantity-based standard that Natural England's own guidance is articulated in Fields in Trusts Planning and Design for Outdoor Sport and Play, Six Acre Standard, which recommends a minimum of six acres or 2.4 hectares of accessible recreation green space per 1,000 residents, equivalent to 24 m^2/person (Fields in Trust, 2008; Natural England, 2010). The Fields in Trust/Natural England standard was chosen for subsequent discussion over the American NRPA, as it provides a blanket recommendation, whereas the American NRPA publishes recommendations based on municipal population, making application difficult across York Region's municipal boundaries.

Measured against this 24 m^2/person standard, none of the major growth centres in this study come close. Richmond Hill's own city-wide figures fall short of the benchmark today, even without MTSA deficits: the City's current provision rate of 1.56 ha/1,000 people, 15.6 m^2/person, sits at 65% of the Fields In Trust Standard—and is already acknowledged to be structurally unachievable based on the City's self-imposed future rate of 1.37 ha/1,000 people (Richmond Hill, 2022b). With the future MTSAs, the City's green space provision rate will fall to 57%. This demonstrates the inadequacy of the City's own future target, separate from the severely greenspace-deprived MTSAs, showing that the region's greenspace problem is not simply one of distribution but one of significant planned undersupply.

The policy review helps explain the specific mechanisms at play, and maps closely to the findings from outside Ontario's context. In the Richmond Hill Centre Secondary Plan, the City sets no quantitative parkland target at all, instead relying on a schedule of conceptual park locations without assigned hectare figures (Richmond Hill, 2025a, p. 24), while the city's own draft parks plan openly concedes that its planned future provision rate of 1.37 ha/1,000 people is structurally unachievable given standard dedication tools (Richmond Hill, 2022b), a comment notably made just months before Bill 23 halved dedication rates. This closely mirrors what Colsaet et al. (2018) described as the typical fate of green infrastructure treated as an optional add-on rather than an essential alongside housing and economic growth: it is the first element compromised when the two compete for the same land. Bill 23 compounds this by halving both the alternative dedication rate and the cash-in-lieu rate just as these sites approach built-out, gutting the primary mechanism municipalities have to keep pace with provincially mandated

density targets. Balikçi et al. (2022) identified the same underlying dynamic in Amsterdam and Brussels, where green space losses of 4.7% and 11.9%, respectively, were driven by land use change that followed development-focused planning directives rather than green policy guidance, even in cities with formally stated commitments to green space. Bill 23's rate reduction is, in effect, a provincial-scale version of the same directive, legislated rather than left to municipal discretion, forcing consistently worse outcomes for municipalities across the province.

The inclusion of a quantified parkland schedule within the Langstaff GO-Bridge Secondary Plan allows for a final build-out parks per capita calculation to be conducted, something that is not an option for this study's other case study, Richmond Hill Centre, as the Secondary Plan does not include quantitative figures. Langstaff's Secondary Plan designates nine green space elements: Pomona Mills creek Park, Cedar Park, the Transit Green, Two Linear Parks, Hub Green, Promenade Park, Woodlot park, and the EPA woodlot, summing the plan's stated total of approximately 6.8 hectares of public parkland (Markham, 2011, s.6.1). Adding this full allocation to the sites currently accessible greenspace and dividing by its planned population yields 2.9 m^2/person, roughly two-and-a-half times the current figure, but still only 12% of the Fields in Trust benchmark discussed above. The more realistic figure is lower still, as the plan credits the 3.12-hectare EPA Woodlot towards the parkland total only at the municipality's discretion, contingent on a woodlot management plan (Markham, 2011, s. 6.6.3). Excluding that contingent element, full build-out of Langstaff's guaranteed parkland allocation reaches 2.1 m^2/person, under 9% of the benchmark. This distinction matters because it provides two distinct explanations for Langstaff's current shortfalls; if the deficiency were purely a function of the site being undeveloped, it would be reasonable to expect that accessible green space score to approach an adequate level by completion. Rather, Langstaff GO-Bridges secondary plans' own stated allocation limit fails to meaningfully close the gap, meaning that Langstaff's shortfall is not a temporary lag; rather, it is a planned outcome.

Langstaff GO-Bridge build out scenarios	**Green space per capita**	**Fields in Trust benchmark (24 m^2)**
Existing	1.2 m^2	5%
Complete built-out	2.1 m^2	9%
Complete build-out including woodlot	2.9 m^2	12%

Table 4: Langstaff GO-Bridge build-out scenarios

Comparing Vaughan Metropolitan Centre and Langstaff GO-Bridge adds a temporal dimension to this finding. Vaughan Metropolitan Centre, roughly 45-50% built out, demonstrates the lowest accessible green space per capita in the regional dataset at 0.9 m^2/person; Langstaff GO-Bridge, still undeveloped relative to its planned population density, currently sits at 1.2 m^2/person. Together, these two sites function as a before-and-after and a comparative warning; Vaughan Metropolitan Centre demonstrates the challenges in provisioning green space for a new and substantial population, and Langstaff GO-Bridge sits early on that same trajectory, albeit from a better starting point. It is unclear whether the land earmarked for future green space will come to fruition in a changing economic and political landscape.

Notably, the Global and Local Moran's I result returned no statistically significant spatial clustering of green space access at the regional or local scale. This might seem to undercut the argument that MTSA policy systemically produces green space deficits, but the opposite interpretation is more consistent with the data. If deficits were found to be clustered geographically, they could be attributed to municipal policy. Instead, the absence of clustering points towards a site-level policy-driven mechanism tied to each MTSA's individual density target and population scale, operating independently of geography. This supports the argument of Haaland and Van den Bosh (2015) that green space planning in densifying cities must extend beyond individual sites to consider broader regional systems.

Together, these findings support Bolleter and Ramalho's (2020) argument that green space cannot be treated as a subordinate subcomponent of transit-oriented density, designed to minimize impact on development, or through parkland dedication formulas calibrated for lower

density development. The documented pattern also echoes Sivam et al.'s (2012) finding that infill development in Adelaide reduced private green space without a corresponding increase in public provision; this study's findings suggest a parallel dynamic under Ontario legislation, where public green space dedication has not scaled to match mandated density. What is at risk is not merely amenity space; following Thompson et al.'s (2019) ecosystem services framework, a lack of accessible green space corresponds to reduced capacity for temperature regulation, air purification, and stormwater management; what is at risk is the creation of truly complete communities. A planning approach that mandates density only in strict terms contradicts the very logic that defines complete communities and neglects the well-being and daily lives of the community it is meant to serve. Beyond that, it contradicts the ideals of modern planning, since Frederick Law Olmsted's advocacy for public parks as a democratic necessity in the nineteenth century (Olmsted, 1870), planning has operated on an implicit social contract: that people living at urban densities are owed access to space, light, and contact with nature as a basic condition of city life, not a discretionary amenity. Where MTSA policy sets binding density targets, this study suggests an equivalent, binding green space target is necessary to prevent the exact outcome documented here. The highest-priority growth centres are also the most green-space constrained, and the tools currently available are weakened by Bill 23, leaving municipalities with little chance of closing the gap as build-out proceeds.

6.2 Reflection and Limitations

I set out to become more proficient in using GIS through my program and major research. During my undergraduate degree, I completed a certificate in Geomatics Information Systems and Remote Sensing and sought to further my understanding and apply the skills I already had. My research design and quantitative analysis were highly iterative; my methods evolved as I gained a deeper understanding of the topic and the available spatial data. I would like to thank the GIS staff at York Region, Richmond Hill, Markham, and Vaughan for providing me with the most up-to-date data and addressing my questions.

Turning to limitations, the most significant stem from the green infrastructure typology score, which captures the quality and composition of accessible green infrastructure rather than quantity alone. In the analysis, spatial clustering was traced to a data artifact: differences in

granularity between municipal source datasets. Vaughan's municipal classification system is far coarser than Toronto's, Richmond Hill's, or Markham's, collapsing 79% of its spatial records into a single category. This means the typology findings, while suggestive that quantity and quality are largely independent ($r = -0.15$), cannot support strong claims about regional patterns in green space composition, and any future replication of this methodology would benefit from an additional harmonization step in the data preparation process. The decision to develop a regional typology score was based on the findings of Haaland & Van Den Bosh (2015), which advocate considering regional systems in green space planning, and on Jones et al.'s (2022) scholarship on green infrastructure. If anything, this reinforces the findings of Haaland & Van Den Bosh (2015), as municipal siloing has prevented the quantification of typology on the regional scale, necessary to quantify disparities in this dataset.

Another limitation of this study is that it views MTSA's in isolation. The parks-per-person score does not account for the existing population outside MTSAs. This was a deliberate choice, as there was no clean way to integrate existing census data into the calculation without encountering granularity issues associated with census tracts. As a result, per capita green space scores are artificially inflated because they do not account for neighbouring demand from established neighbourhoods.

Additionally, the green space per capita indicator described in section 4.8 presents its own limitations. It combines planned residents and jobs into a single population denominator, in line with the density targets set out in provincial policy (Ontario, 2024). However, access to green space is not necessarily equivalent for these two groups. Residents can access green space at any time of day, including evenings and weekends, and are more likely to use it for a broad range of purposes, from daily recreation to passive contact with nature. Workers, by contrast, are typically only present during working hours and are more likely to use nearby green space incidentally, such as during a lunch break, rather than as a routine part of daily life. Combining residents and jobs into a single accessibility score therefore masks this distinction: an MTSA with a high proportion of jobs relative to residents may still have an adequate accessibility score without necessarily providing meaningful access to green space for the people living there. This is a limitation of the indicator as constructed, and future research could disaggregate planned

population by resident and worker status to test whether accessibility patterns differ between the two groups.

Reflecting on my research limitations, I have learned significantly throughout this process; I have meaningfully improved my GIS skills, becoming more proficient not only in using the software but also in research design and data interpretation.

Chapter 7. Conclusion

This study set out to ask whether York Region's Major Transit Station areas are being planned to provide adequate green space for the populations they are designated to accommodate in the future. Across the 50 MTSA study sites in Richmond Hill, Vaughan, Markham, and North Toronto, the evidence points to a resounding "no", and the shortfall is concentrated precisely at the sites the province has prioritized to hold the greatest population growth. Accessible green space per capita is negatively correlated with both planned population (r= -0.34) and provincial density target (r = -0.26), with a population-weighted Gini coefficient of 0.586, which shows that green space is distributed less equally across the regions' MTSAs than existing green space is distributed across the City of Toronto (Gini = 0.33; Dong and Miller, 2024). At the region's three largest growth centres, Richmond Hill Centre, Vaughan Metropolitan Centre, and Langstaff GO-Bridge, the shortfall is severe by any external standard: even at full build-out, Langstaff GO-Bridge's secondary plan only reaches 2.9 m^2 per person, a fraction of the 24 m^2 per person that Fields in Trust's widely used benchmark recommends.

The Policy review situates this outcome in the policy mechanism that produces it. Richmond Hill Centre's Secondary plan sets no quantitative parkland target at all; the city's own Draft Parks Plan concedes its own future provision rate is structurally unachievable under standard dedication tools; and Bill 23 has since halved both the alternative dedication rate and the cash-in-lieu rate available to municipalities. The lack of spatial clustering in the green space per capita rate indicates that these unfavourable outcomes are not a localized planning failure, but a structural feature tied to the density-first-green-space-optional framework applied by the province.

These findings recommend treating green space provision as a binding requirement of MTSA planning comparable in enforceability to the density targets that currently take precedence over it. Where provincial policy mandates density in absolute terms, this study recommends an equivalent minimum for green space. This minimum could be an accessible area per capita or tied to an external benchmark, such as the Fields in Trust standard. Either would meaningfully improve the outcomes reported here. Until green space is treated as a binding requirement of MTSA planning rather than an afterthought, Ontario's transit-oriented future risks

building density without livability, and communities without the space, air, and contact with nature, breaking the core social contract of urban planning.

Chapter 8. Appendices

Appendix A. MTSA Study Site Data

Accessible green space per capita and typology scores for all 50 MTSA study sites, calculated using the population-weighted allocation methodology described in Section 4.

MTSA	Municipality	Transit mode	Density target (people+jobs/ha)	Area (ha)	Planned population	Green space per capita (m^2)	Typology score
Allstate Parkway	Markham	BRT	160	80.4	12,867	8.2	8.0
Andre De Grasse	Markham	BRT	300	57.7	17,303	16.6	7.7
Cedarland	Markham	BRT	300	51.6	15,494	15.2	7.3
Cornell	Markham	BRT	200	100.4	20,090	47.5	8.0
Enterprise	Markham	BRT	250	46.3	11,587	46.9	7.9
Langstaff GO-Bridge	Markham	GO	1200/400	46.8	38,536	1.2	10.1
McCowan	Markham	BRT/GO	200	95.1	19,019	113.6	8.5
Milliken	Markham	GO	250	44.7	11,170	36.3	9.1
Montgomery	Markham	BRT	200	34.9	6,977	23.6	5.6
Mount Joy	Markham	GO	200	53.8	10,765	114.1	8.0
Town Centre	Markham	BRT	200	80.7	16,150	25.8	7.9
Unionville	Markham	GO	300	48.9	14,680	18.8	7.4
Warden	Markham	BRT	300	50.5	15,156	13.3	7.1
Woodbine	Markham	BRT	160	33.0	5,283	18.2	7.2
Chalmers	Markham/Richmond Hill	BRT	200	22.6	4,521	10.1	7.8
East Beaver Creek	Markham/Richmond Hill	BRT	200	54.6	10,922	24.1	7.3
Leslie-Highway 7	Markham/Richmond Hill	BRT	200	46.0	9,207	34.1	8.3

MTSA	Municipality	Transit mode	Density target (people+jobs/ha)	Area (ha)	Planned population	Green space per capita (m^2)	Typology score
Valleymede	Markham/Richmond Hill	BRT	250	47.1	11,767	10.0	8.0
West Beaver Creek	Markham/Richmond Hill	BRT	250	44.4	11,089	27.4	9.6
Clark	Markham/Vaughan	Subway	250	39.1	9,775	29.3	9.8
Royal Orchard	Markham/Vaughan	Subway	250	39.5	9,872	67.4	9.9
Steeles	Markham/Vaughan	Subway	300	49.2	14,751	23.6	10.3
16th-Carrville	Richmond Hill	BRT	300	43.0	12,908	40.6	9.0
19th-Gamble	Richmond Hill	BRT	160	45.3	7,250	180.4	7.8
Bantry-Scott	Richmond Hill	BRT	200	26.1	5,210	26.9	9.5
Bathurst-Highway 7	Richmond Hill	BRT	160	43.1	6,903	14.0	8.9
Bayview	Richmond Hill	BRT	160	25.5	4,080	55.2	10.0
Bernard	Richmond Hill	BRT	200	63.6	12,728	74.6	7.9
Crosby	Richmond Hill	BRT	160	55.0	8,797	42.9	9.6
Elgin Mills	Richmond Hill	BRT	160	36.4	5,821	42.9	8.2
Major Mackenzie	Richmond Hill	BRT	160	48.8	7,802	77.5	10.0
Richmond Hill	Richmond Hill	GO	150	37.9	5,685	40.7	9.6
Richmond Hill Centre	Richmond Hill	Subway	1400/400	73.3	48,783	6.5	9.2
Weldrick	Richmond Hill	BRT	200	52.5	10,494	34.8	9.6

MTSA	Municipality	Transit mode	Density target (people+jobs/ha)	Area (ha)	Planned population	Green space per capita (m^2)	Typology score
Ansley Grove	Vaughan	BRT	200	47.4	9,478	16.8	11.0
Atkinson	Vaughan	BRT	160	45.3	7,247	17.5	11.0
Commerce	Vaughan	BRT	350	71.4	24,991	0.9	6.7
Concord	Vaughan	BRT	160	56.0	8,967	1.5	11.0
Creditstone	Vaughan	BRT	300	33.8	10,137	0.9	6.7
Disera-Promenade	Vaughan	BRT	200	57.4	11,486	23.2	11.0
Dufferin	Vaughan	BRT	160	17.5	2,801	180.7	11.0
Keele	Vaughan	BRT	160	55.8	8,933	0.6	11.0
Maple	Vaughan	GO	150	39.0	5,843	22.2	11.0
Pine Valley	Vaughan	BRT	160	37.6	6,012	28.8	9.3
Pioneer Village	Vaughan	Subway	200	39.1	7,826	91.8	8.6
Rutherford	Vaughan	GO	100	33.9	3,392	85.0	11.0
Taiga	Vaughan	BRT	160	22.3	3,575	27.6	11.0
Vaughan Metropolitan Centre	Vaughan	Subway	400	110.8	44,302	0.9	6.7
Weston	Vaughan	BRT	250	88.3	22,073	2.3	11.0
Wigwoss-Helen	Vaughan	BRT	160	18.2	2,912	178.5	11.0

Chapter 9. References

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