Toronto Metropolitan University

Investigating the Use of **ANGULAR PLANES**

Final Report & Recommendations

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School of Urban & Regional Planning

Blair Scorgie

Prepared for the use of **WE HBA**

Hamilton & Burlington, Ontario

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TABLE OF CONTENTS

0.0 Purpose

Students from Toronto Metropolitan University's School of Urban and Regional Planning have prepared this final report for their client The West End Home Builders' Association (WE HBA). The purpose of this report is to provide WE HBA with a comprehensive review of angular planes as a policy tool specifically in the context of Burlington and Hamilton, Ontario. It will outline critical research about angular planes in efforts to better understand the outcomes and effects of applying this planning tool through analyzing the impacts on the natural environment, housing market, and local population while drawing from case studies and specialized professionals. The report will conclude with a series of potential recommendations and an analysis of both the positives and negatives for each option. This final report aims to support WE HBA in initiating important conversations with both the City of Burlington and City of Hamilton regarding the use of angular planes

Angular planes have been a prominent planning tool throughout the Greater Toronto Area for over a decade. Initially, they were implemented with the purpose of preserving privacy and protecting the streetscape from shadows cast by surrounding mid-rise and high-rise buildings. Over time, the narrative behind angular planes has shifted with increased criticism for its contributions to the significant housing crisis across the GTA.

The West End Home Builders' Association (WE HBA) is looking to initiate a conversation about implementing angular planes with the City of Burlington and the City of Hamilton. The following report aims to provide WE HBA with a comprehensive review of angular planes as a policy tool. In addition, this report will outline critical research about angular planes to better understand the implications of this planning policy tool.

A preliminary Interim Report was also completed surrounding the topic of angular planes in Burlington and Hamilton. It can be found here:

Key Points

Angular planes create significant economic implications as they directly contribute to housing unaffordability. For example, irregular floor plans require complex designs, which leads to higher unit prices, weak thermal performance means higher utility and maintenance costs, and reduced sellable space deters developers from building mid-rise buildings, which is a significant reason for the “missing middle.”

There are many environmental impacts of building with angular planes. Due to varying building typologies, environmental factors need to be considered. Angular planes affect the environmental sustainability of buildings. Setbacks raise concerns about the increased material requirements and longevity of the structures.

The social implications of angular planes can vary. Size and density impact the first potential difference; Burlington is a more compact city than Hamilton, influencing projects to be mid-rise and high-rise compared to Hamilton, with predominantly low and mid-rise buildings. With adjacent sites, shadowing sunlight and visibility impacts the height and orientation of new developments. Illumination is an essential factor for livelihood, enabling people to work and perform activities. With the proper lighting, many activities and jobs would be easier to perform.

Regarding political implications, housing units are often lost to angular planes making it difficult to balance attainable housing while allowing adequate sunlight to benefit the city streetscape. Implementing angular planes accommodates wealthy single-family homes by prioritizing sunlight for them while simultaneously neglecting middle-income individuals and families.

1.0 EXECUTIVE SUMMARY

GREATER HAMILTON AREA

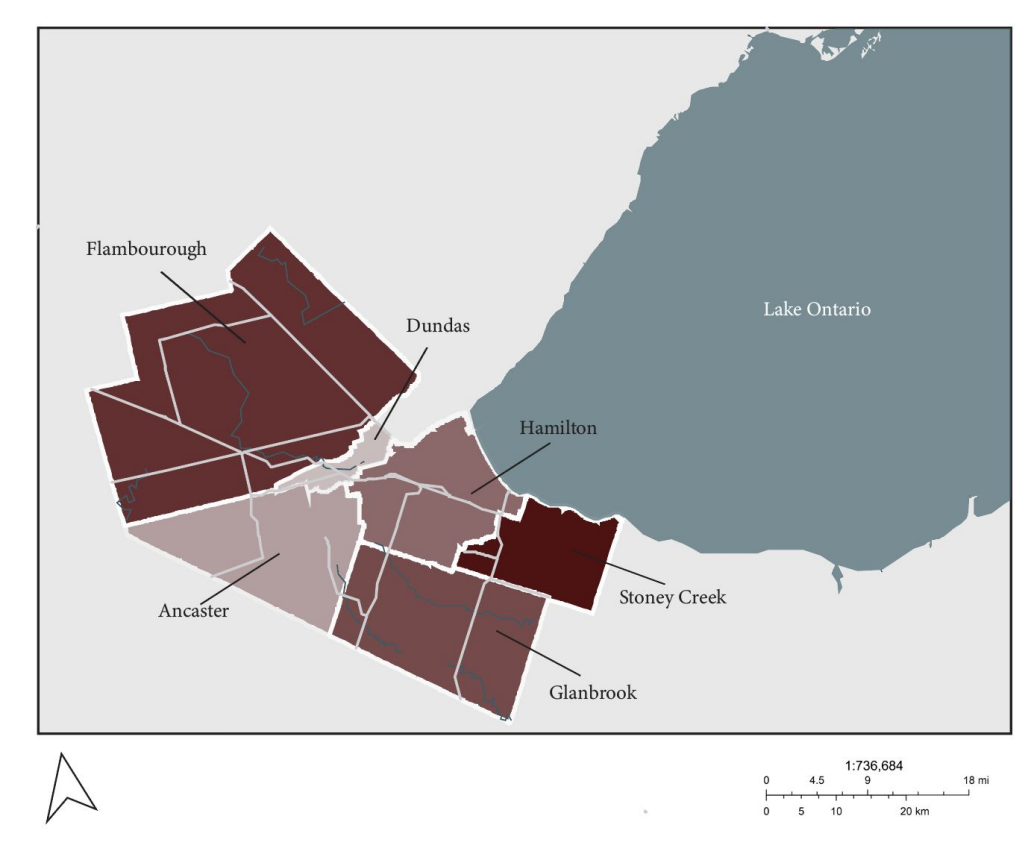


Figure #1: *Districts of Hamilton (Klysen, 2023)*

GREATER BURLINGTON AREA

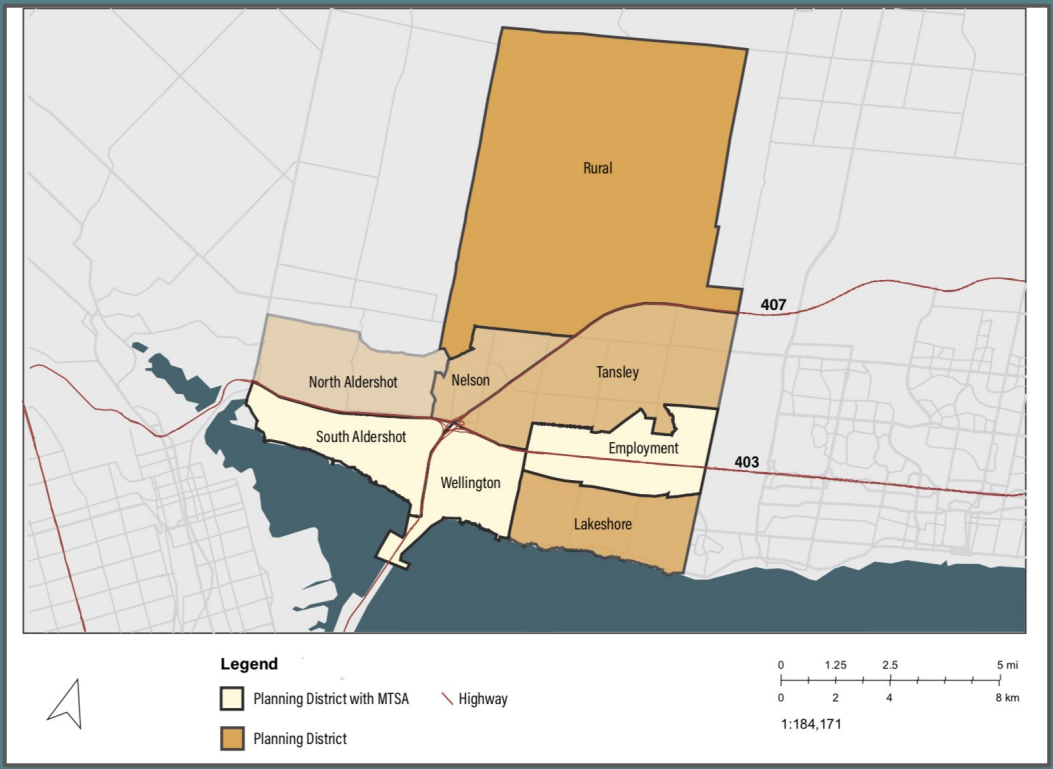


Figure #2: Planning districts of Burlington (Klysen, 2023)

1.1 *Hamilton v. Burlington*

This report will examine the use of angular planes with a primary focus on the City of Hamilton and the City of Burlington. The urban aspirations of Burlington and Hamilton differ because of their political landscapes, social realm, and overall structural design. These neighbouring cities experience different challenges and advantages throughout the planning process because of their differences in history and population demographics. The use of angular planes and proposed recommendations will be applied differently within these municipalities, specifically in regards to their use within urban growth centres.

The City of Hamilton will focus on mid-rise development along the LRT corridor on King Street and has completed the process of pre-zoning in the area. This neighbourhood has always had a focus on the diversity of uses and streetscape as apparent through the establishment of Westdale in 1911. This neighbourhood surrounds King Street which runs east to west just north of Main Street. Since its establishment this neighbourhood has been recognized as an *'urban innovator'* because of its difference from other surrounding areas that were low density and car centric. Westdale utilised King Street to create accessibility for citizens seeking goods and services inside of their neighbourhoods' boundaries. Residential space along King had an increased focus on density offering mid-rise apartments which transitioned into single detached housing towards the inner city. This street runs through Hamilton's urban growth centre which is currently in the downtown area; development in this area will conform to provincial standards regarding density and affordability. Further mid-rise development will be concentrated on Upper James which has seen substantial urban growth efforts. The City of Burlington has recently shifted their urban growth centre from the southern downtown area to the Burlington GO station in the north. This area encompasses 10 precincts (RPPP's 2021-2022) that will see increased intensification along the major transit corridor and represent mixed use development. The mobility hub study that occurred in 2017 has helped inform the MTSA project for growth and shows the desire for increased density around Burlington, Aldershot and Appleby GO to conform to provincial standards regarding intensification in MTSAs.

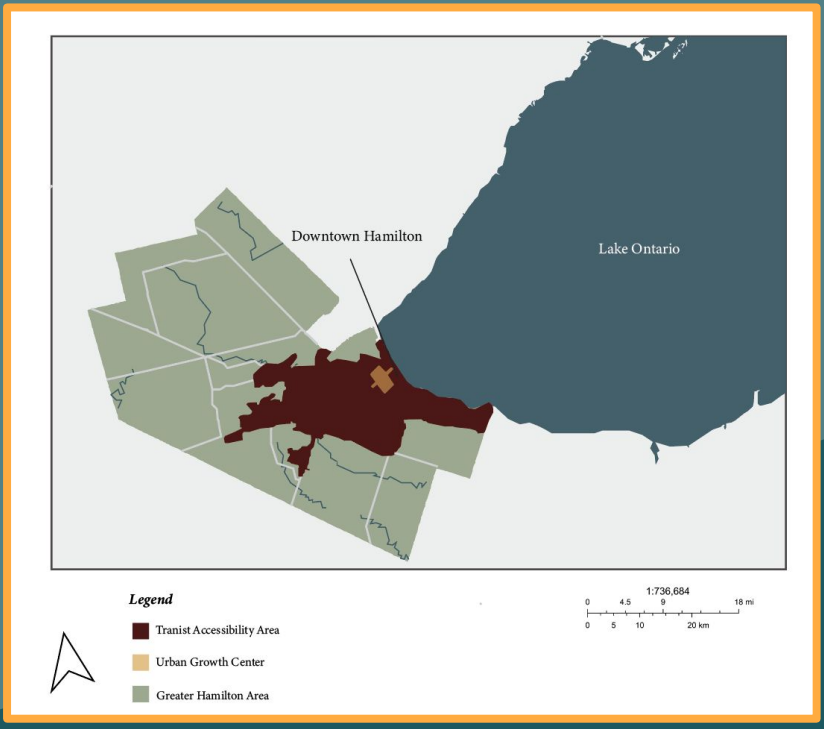


Figure #3: *Hamilton's Growth Center - downtown area (Klysen, 2023)*

1.1 *Hamilton v. Burlington*

Under the Places to Grow Act Burlington will be required to have a density of 120 to 150 residents and jobs per hectare surrounding the three MTSA's. The Burlington GO station underwent renovations during 2008 to expand the capacity of its parking and is currently surrounded by employment land and single detached housing. The area first experienced a change in residential density and height during the construction of Paradigm Condominiums in 2019. The buildings are 24 storeys high and encompass 350 mixed units. This site has the potential for effective mixed-use development on the land offering access to housing and employment opportunities. However, unlike the growth center in Hamilton, these changes will represent unprecedented intensification in the area regarding density and must be planned accordingly.

The differences between these two cities and their historic growth impacts the planning process and public discourse surrounding development in the present day. The use of angular planes in Hamilton or Burlington should be considered independent of one another because of the inherent differences in the city's structures, populations, and city densities. The resistance to development and the difference in community needs within these cities will ultimately shape new growth. Determining whether angular planes are an appropriate use of land in these municipalities will be a question of form over function and be weighed against the urgency of accommodations amidst Ontario's housing crises.

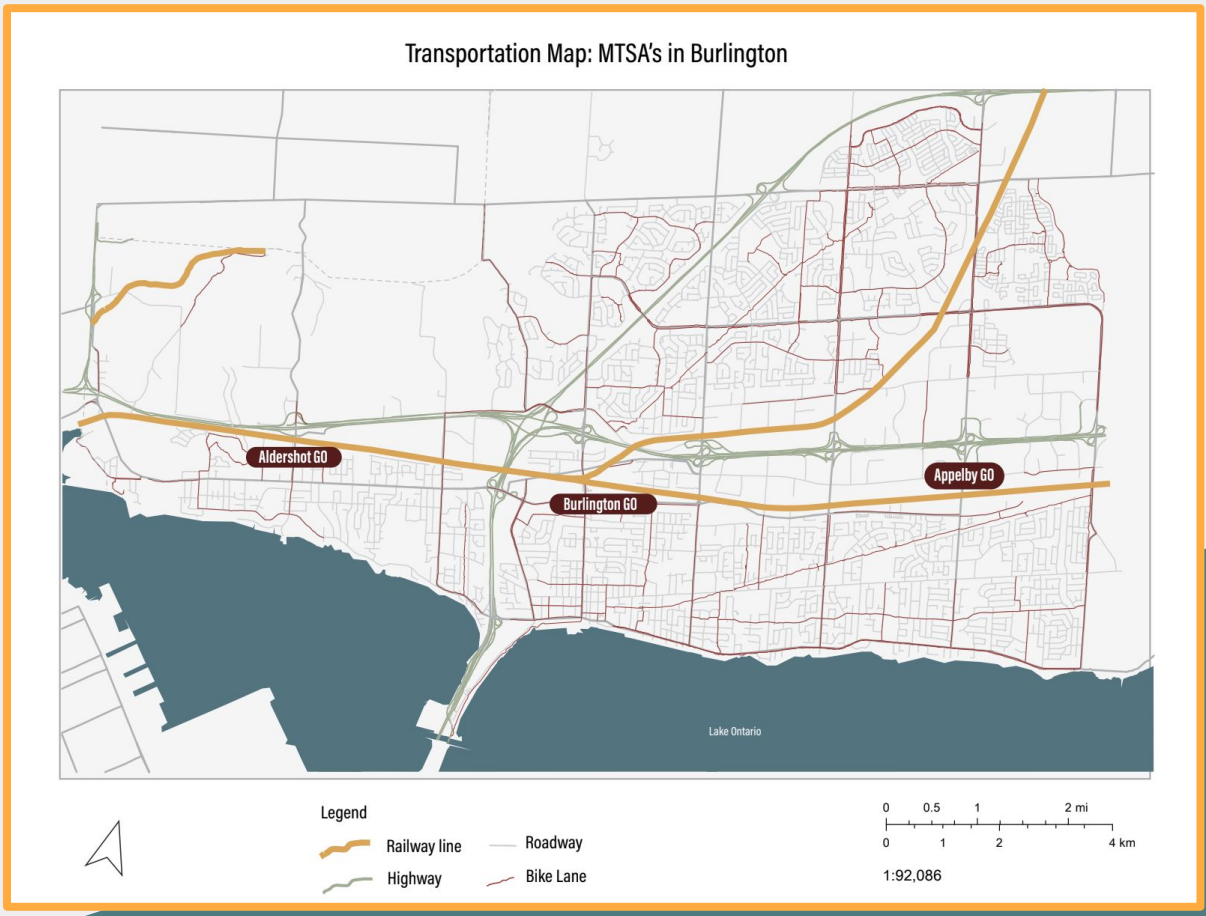


***Figure #4: Burlington's three major Transit Station Areas** (Klysen, 2023)*

1.2 History of Angular Plane Use

Angular planes date back to the early 20th century. Angular planes had different methods of dynamic shapes, specifically in Canada. Over the 1950s and 1960s, urbanization and economic expansions in the country grew rapidly. As a result, many new structures and buildings were constructed with various techniques incorporating angular planes. Due to urban areas encouraging the development of mid- and high-rise structures, angular planes are used in these new urban areas.

The use of angular planes in the GTA can be traced back to 2008 when angular planes were first outlined in the 2008 “Avenues and Mid-Rise Buildings Study”. This was a study conducted by Toronto City Planning Division with assistance from Brook McIlroy Planning + Urban Design/Pace Architects. The study was intended to support and encourage further development of mid-rise buildings. The city decided to adopt the Mid-Rise Building Performance Standards in 2010 as suggested by the study, this included the implementation of angular planes.

Implementing angular planes requires towers to have floors that steadily step back from the building as it rises creating an inclined plane of typically 45 degrees. The intentions behind using angular planes as a planning tool was originally to preserve sky views and to mitigate the large shadow a tall building would cast onto the streetscape and surrounding single-family homes.

1.3 Policy Review

1.3.1 Provincial Policy Statement (2020)

This report will outline the importance of housing and the impacts angular planes have on satisfying the objectives of the Provincial Policy Statement (PPS). Official Plans, Zoning By-laws and development permit bylaws are important tools for enforcing implementation of the PPS Policies. Increased housing and opportunities for addressing the housing shortage can address the goals and objectives of the PPS, it is imperative that regional and local planning documents implement these objectives.

1.3.2 Growth Plan for the Greater Golden Horseshoe

The Growth Plan for The Greater Golden Horseshoe provides guidance for planners; keeping in mind the main goal of the Growth Plan being aimed at building compact, complete and vibrant communities; to provide a range of housing options including affordable housing; managing growth to support a strong competitive economy; and planning for more resilient communities that are adaptive to climate change. Cooperation between all levels of governments, the private sector as well as residents and non-profit agencies, these goals and objectives can be implemented. All regional and local Official Plans must conform to the Growth Plan.

1.3.3 Niagara Escarpment Plan

The purpose of this Plan is to protect the remaining Escarpment environment. Within the area of focus of this report there are Urban Area and near Natural Area designations under the Niagara Escarpment Plan. The development criterion set out in the plan include the following provisions in relation to the purpose of this report:

1. Where appropriate, provision for maximum heights, adequate setbacks and screening are required to minimize the visual impact of urban development; and
2. Encouraging reduced energy consumption and greenhouse gas emissions.

1.3.4 Region of Halton Official Plan

The Regional Official Plan (“The Regional Plan”) outlines the long-term vision for Halton’s physical form and community character. The Regional Plan is the overarching plan for the City of Burlington. The Planning Horizon for the Regional Plan extends until 2051 with an intensification target of 20,500 new housing units within the Built-Up Area. The Regional Plan also includes provisions and objectives relating to strategic growth around MTSA, Priority Transit Corridors, and Commuter Rail Corridors.

1.3 Policy Review

1.3.5 City of Burlington Official Plan

The City of Burlington Official Plan ("Burlington OP" or "OP') must conform to the Region of Halton Official Plan. Section 1.4 of the Burlington OP sets out the strategic directions and planning horizon with the anticipation of being a ""City that grows, a city that moves, a healthy and greener city, and an engaging city." Burlington looks at achieving these goals through intensification and land use patterns that support transit, while also promoting development patterns for resilient community and building design. Section 1.5 of the Burlington OP provides for the primary growth tool being within intensification and MTSA areas, while limiting growth in Natural Heritage Systems (Section 2.1).

The following are some additional highlights of the Burlington Official Plan in relation to angular plane use and impacts:

1. MTSAs "will offer substantial development opportunities and represent a key element in this Plan's strategy to accommodate and direct growth in the city over the planning horizon and beyond." (Section 2.3.1 (a))These areas are a focal point for higher intensity and mixed-use transit supportive development;
2. Further, Section 8.1.2 states that growth and development shall be oriented to MTSAs areas however, Area-Specific Plans are in progress and will replace the current policies once complete;
3. MTSAs shall provide for appropriate transition in scale, intensity, height, massing and spacing of development, including appropriate transitions between various land uses;
4. MTSAs are mainly comprised of land designations of Mixed-Use Nodes and Intensification Corridors, while these designations encourage higher density the maximum building height is 6 storeys. It is further noted that 4 to 6 storey buildings may be required to be terraced back from adjacent residential areas and/or streets;
5. Other land designations that concern angular plane usage are Established Neighbourhood and Existing Community Areas. Intensification is discouraged in these areas and an emphasis on appropriate built form transition in scale between buildings through the use of stepbacks or angular planes is noted. Reduction of shadow impacts and uncomfortable wind conditions on the streetscape are also noted.

1.3.6 City of Hamilton Urban Official Plan

The City of Hamilton Urban Official Plan ("Hamilton OP" or "OP") directs that intensification must represent good planning and not cause unacceptable impacts, residential intensification shall be encouraged throughout the built up area. The OP notes that the Primary Strategic Growth Areas shall be the Urban Nodes and Major Transit Station Areas.

1.3 Policy Review

Section 2.4.10 of the OP states that "the City shall partner with the Hamilton-Halton Home Builders Association (former name of the West-End Home Builders Association) and other provincial, regional and community organizations to provide educational opportunities about residential intensification for the public and the building and development industry." The City is willing to work with developers and homebuilders to achieve the goals and objectives throughout the OP. When reviewing the Urban Design Policies an emphasis is placed on the existing environment and locale. Development shall be compatible with and enhance the existing character, fostering a sense of community pride and identity by respecting existing character, development patterns, built form and landscape (Section 3.2.2.3).

The Hamilton OP acknowledges that urban design plays a significant role on the physical and mental health of our citizens, one way of doing this is use of active transportation. Throughout this report physical and mental impacts will be outlined in relation to angular planes.

1.3.7 Zoning Bylaws

There is no particular mention in either the City of Burlington or the City of Hamilton zoning bylaws to stipulate how the angular plane should be measured. Within the subject areas of study there are height limitations, and the City of Hamilton sets out stepback provisions within the Downtown General Zone as follows:

1. A minimum 3.0m stepback shall be required from the building base façade height shown in Schedule "F" – Special Figure 15; and
2. A minimum 3.0m stepback shall be required for any portion of a building exceeding 22.0m in height from a side or rear lot line.

1.3.8 Guidelines

i. City of Burlington Design Guidelines for Mixed-Use/Residential Mid-Rise

The guidelines "provide for a scale of building that is very important when transitioning from lower scale residential neighbourhoods to more intense communities." (pp. 1) The objective of the Guideline is to ensure that well designed mid-rise buildings fit in with existing established neighbourhoods. It is noted that the intention of the guidelines is to not limit creativity, but to also welcome and encourage alternative built forms that achieves the intent of guidelines.

In Section 2.3 (Built Form) of the guidelines, it states that "on streets with a planned right of way of 26m or more, new mid-rise buildings up to 6-storeys do not require an upper building step-back." Stepping back upper level building volumes is encouraged to assist with transitions between neighbouring buildings and lower heights. The City does also have a guideline document for completing and submitting Shadow Impact Studies with development applications.

1.3 Policy Review

In relation to the Upper Building portion as outlined in the guidelines; Section 3.1 provides for transitions and considers potential shadowing and pedestrian level wind impacts on neighbouring properties. More specifically, "where the building is on a site that is transitioning to a low-rise residential neighbourhood area, a 45-degree angular plane should be applied from the shared property line" and applied at the lowest grade of the property.

ii. City of Hamilton Transit Oriented Development Guidelines

Within the Transit Oriented Development Guidelines for Hamilton, the objectives are to ensure compact, mixed use development near facilities, and include a high quality walking environment. Some of the design elements throughout the guidelines encourage a continuous street wall and guide development to utilize the Right of Way to expand sidewalks and incorporate shade trees.

iii. City of Hamilton Tall Building Design Guidelines

The Tall Building Design Guidelines are comprised of guidelines and objectives for Tall Building in the Downtown area. While 45-degree angular planes are not specified, it is encouraged to incorporate setbacks from the base of the building to the top in order to respond to pedestrian realm and adjacent areas.

Section 3.2 of the guidelines emphasizes Neighbourhood Transition where in setbacks, stepbacks, and building articulation to minimize shadow impact on properties shall be implemented. This will ensure that new development is sensitive to and compatible with the existing or planned low-rise residential neighbourhoods.

1.4 *Environmental Considerations*

1.4.1 Structural

Concerning angular planes, structural factors are one of the main concerns with environmentally friendly building practices. Stepbacks complicate the structural design of buildings, increasing the degree of engineering required. Each corner requires its own lateral support. As stepbacks are added, more structural columns and beams are needed to support those corners. From an engineering perspective, this is not a significant concern, although, from an environmental perspective, more supports results in more materials required. Highly complex structural systems tradeoff material efficiency for structural integrity. (See Figure #5).

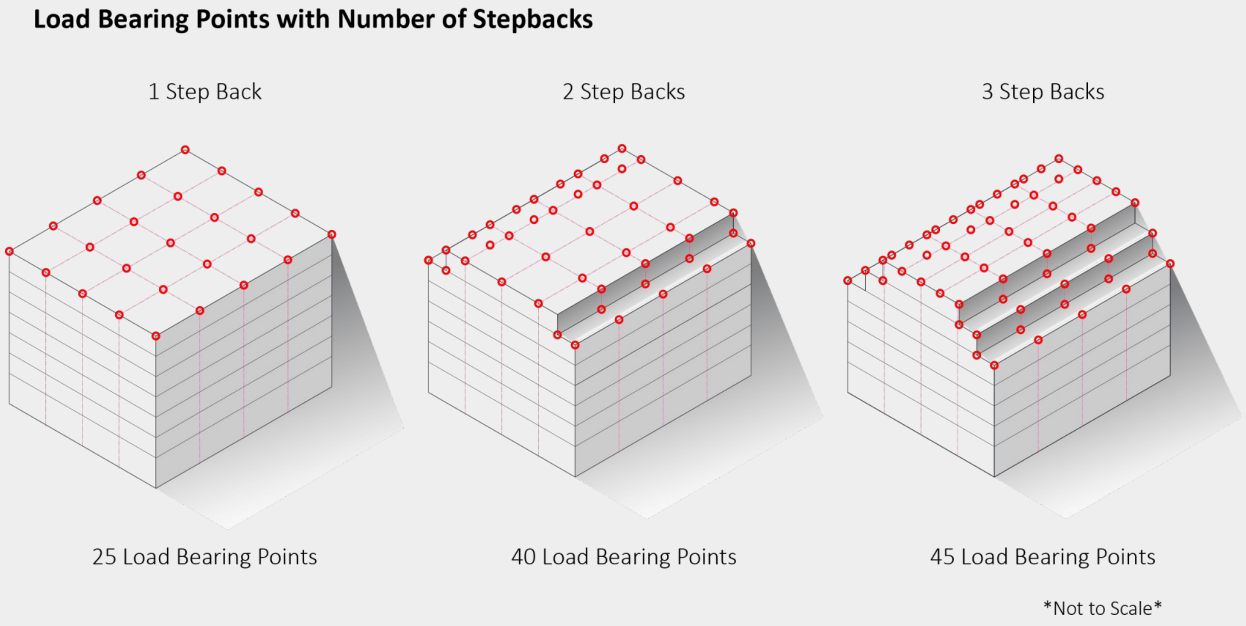


Figure #5. Structural Drawing as Step-Backs Increase (Richardson-Duffy, 2023)

1.4.2 Drainage Systems

Another factor that increases the material usage on stepped-back buildings is the drainage system. Similarly to the structural concerns, the issues of multiple drainage systems become increasingly difficult as more steps are added to a building. Each roof needs its own drainage system, further adding to the number of materials used. It is imperative that flat-roofed buildings have an adequate drainage system in order to ensure that the accumulation of debris, pooling of water and ice dams are prevented. Ice dams form during the winter as the snow melts and refreezes, slowing snow melt and blocking drainage. Both pooling and ice dams pose serious issues as the added weight puts stress on the structure of the roof leading to leakages, sagging, and in severe cases, roof collapse. In northern cities, ice dams add to the materials used as heated drainage systems are important to prevent the long-term issues that pools, snow and ice present.

1.4 *Environmental Considerations*

1.4.3 Thermal Bridging

Thermal bridging refers to points in a building where heat is transferred through highly conductive materials. This typically occurs when metal, or other conductive materials, penetrate through the insulation of a building. Thermal bridging decreases a building's efficiency due to increased energy transfer through the envelope. Concerning angular planes, as steel beams and columns are added to support the stepbacks in the building, more thermal bridging becomes possible. Thermal bridging is more likely to occur where floors intersect the wall and at the corners of buildings. Stepbacks create an intersection between the floor and wall and add corners to the buildings. While it is possible to engineer a stepped-back building's envelope to be equally efficient as its counterparts, more materials are required.

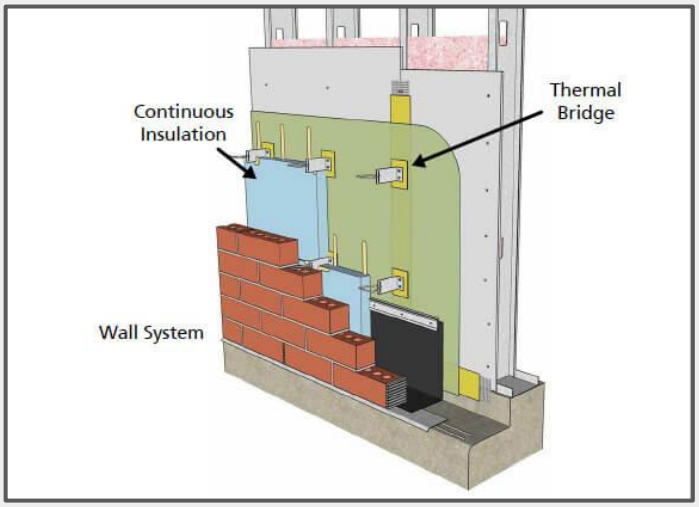


Figure #6: How thermal Bridging occurs

1.4.4 Snow and Ice Accumulation

As aforementioned, ice dams, condensation and the weight of snow can be strenuous on the structural integrity of a building. Stepped-back roofs are prone to snow drifting caused by windward and leeward drift effects (See Figure 7). In the case of windward drifting, vertical walls create a barrier for snow to accumulate in the bottom corner. Leeward drifting creates an eddy or "trapped vortex" in the bottom corner where the wind cannot blow it away. This presents an issue of concentrated weight. When weight is concentrated on specific points of the building it places disproportionate stress on the structure. In regions that receive high precipitation events, these factors can put a weight of 50 pounds per square foot on the roof of a building. Light and fluffy snow is not concerning, although as snow and ice thaw and refreeze they become much heavier.

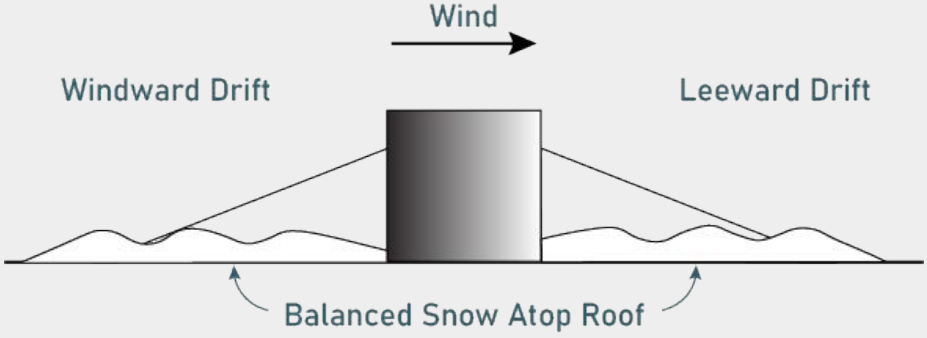
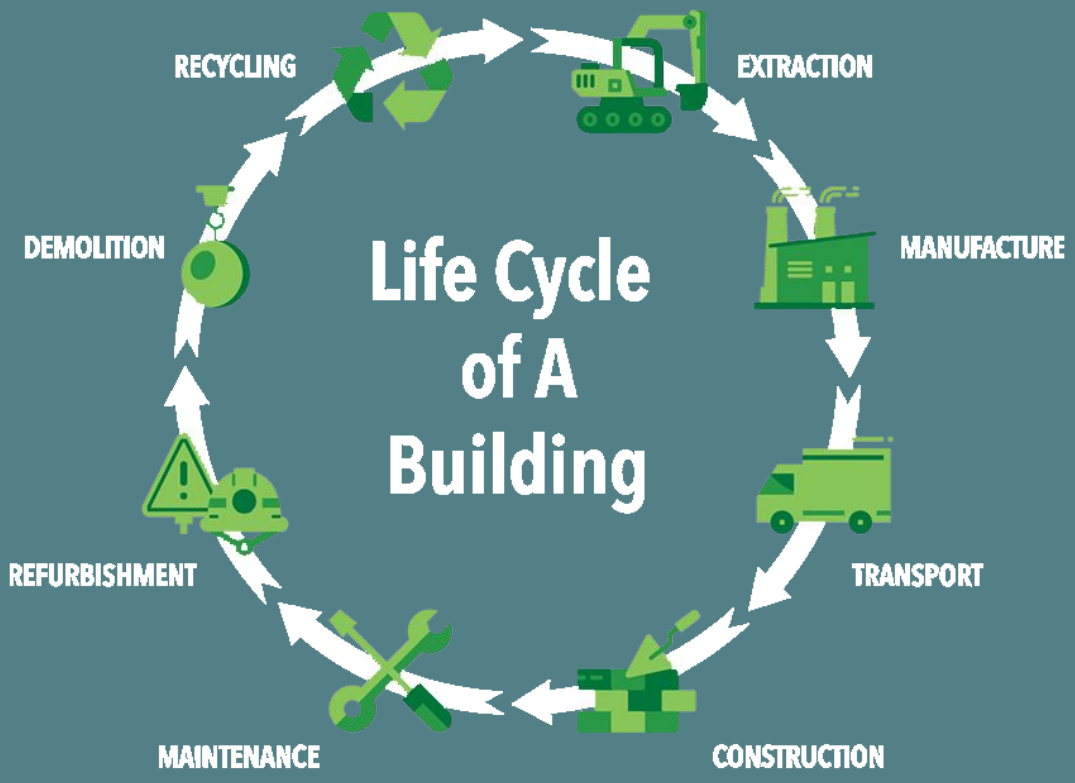


Figure #7: Snow and ice accumulation on step-backs

1.4 *Environmental Considerations*

1.4.4 Environmental Summary

When considering different building typologies it is essential to factor in environmental concerns. “The building and construction industry contributes roughly 39% of greenhouse gas emissions worldwide, with 28% coming from the operational phase and 11% coming from the embodied energy of the construction materials” (Lambert, 2023). In analyzing how angular planes affect the environmental sustainability of a building it becomes apparent that step-backs present serious concerns in the operational phase, the increased material requirement and the longevity of the structure. Simple buildings maximize efficiency and reduce the amount of materials required. While it is possible for a stepped building to achieve equal efficiency, it comes at the cost of embodied carbon in the extra materials required



Figure#8: https://www.igbc.ie/certification/levels-eu-sustainable-buildings-framework/

1.5 *Economic Considerations*

Angular planes create a significant burden on the financial feasibility of developments. This as a result causes new homes to be a lot less affordable to acquire and maintain.

Consultation with stakeholders revealed that there are a lot of factors that affect cost and feasibility of construction that result from angular planes applied to building design. First and foremost , land costs across Burlington and Hamilton have experienced significant appreciation in recent years and redevelopment sites in the Urban Growth Centres are a fixed cost borne by developers and reflect the type and cost of development that is financially feasible. Other fixed costs such as foundation and underground garage construction, equipment and crane rental, design and engineering consultants and financing remain comparable whether a developer seeks to construct a mid rise vs a highrise project.

From an engineering perspective, buildings designed with several setbacks require more complex and costly labour and material costs due to the need for transfer beams to support the weight of the building. The thermal performance of the units that are set back is significantly poorer since there are more exterior walls and corners that can act as points of failure and weakness. The implication of angular planes leads to higher heating and maintenance costs that are spread among fewer units within the building. The irregular nature of the floorplates that developers have to work with makes the task of design and construction significantly more complex and less scalable. Angular planes when applied to a potential development site reduce the salable area and as a result we are seeing developers forgo mid rise construction.

A report by the 2022 Ryerson University PLG720 class prepared for HousingNowTO looked at a 1,709.68 sq/m site and the effects that angular planes would have on this site. The study looked at how a 45 degree angular plane applied from the rear lot line as well as starting at 16 metres in height at the front of the site an arterial road following the City of Toronto's Mid Rise Design guidelines . The study compared the differences in GFA and total units feasible between designs that did use these angular plane assumptions versus "boxy' designs at 6, 8 and 10 storey heights.

The study found that at 6 stories and an FSI of 4.0 the boxy design yielded a total of 73 as whereas when angular planes were applied the project would only yield 60 units at an fsi of 3.3. At 8 stories the boxy design at an fsi of 5.5 yielded 97 units whereas when angular planes were applied the project would only yield 65 units at an fsi of 3.5. At 10 stories the boxy design at an fsi of 6.6 yielded 122 units whereas when angular planes were applied the project would only yield 67 units at an fsi of 3.

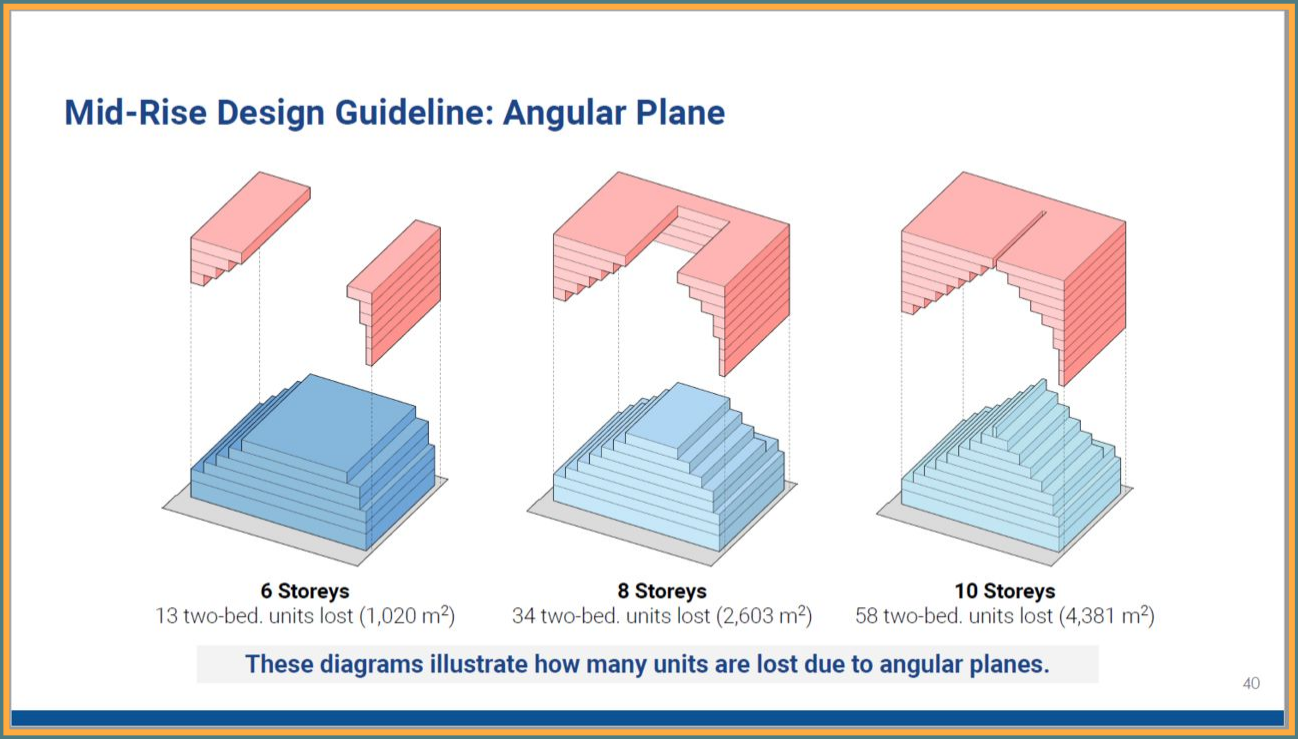


Figure #9: How angular planes can create a potential loss of unit

When the land costs and construction timelines to develop mid rise typologies is comparable to that of a high rise development, developers aren't keen on risking tens of millions of dollars and the next decade on a mid rise development and we are left with the phenomena of 'tall and sprawl' development patterns seen across the GTHA. (TMU City Building Institute,n.d.).

In order to adequately and sustainably plan for the population growth targets set out by the PPS and Official Plans of Burlington and Hamilton and avoid 'tall and sprawl' development patterns that strains municipal resources and transportation infrastructure then we must be encouraging and incentivising developers by creating a policy framework that to construct missing middle typologies with as little bureaucratic red tape as possible and a great place to start would be angular plane regulations.

The cities of Burlington and Hamilton need to take proactive steps to plan for the population growth targets set out by the PPS and their Official Plans. In order to avoid the 'tall and sprawl' development patterns of high rise developments crowding the MTSA and sprawling suburbs that strains municipal resources and transportation infrastructure, we need to create a policy framework that encourages and incentivises developers to construct mid rise developments in a shorter timeline and utilising sustainable building practices. By limiting the use of angular plane requirements in developments we can create a more favourable policy framework that allows for more financially and environmentally sustainable communities.

1.6 *Social and Political Considerations*

The angular plane impact can vary on mid-rise and high-rise municipal building development. This depends on these different factors:

1. ***Zoning regulation***s: in different municipalities, zoning restrictions can limit both height and density in certain regions. Limitations make it challenging to achieve the height and density restrictions in place. The construction of mid- and high-rise buildings will be impacted due to the geometrics needing to be adjusted.
2. ***Building codes:*** these regulations can impact the development of angular planes. These require minimal setbacks for angular planes to minimize glares and visual impacts affecting nearby properties.
3. ***Planning policies:*** Municipalities have different policies that prevent or promote using angular planes. Communities need cohesiveness throughout an urban area, which might impact the regulations around angular plane development.

The size and density of both Burlington and Hamilton differ. Burlington is more compact than Hamilton. As of 2022, Burlington has a population of 194,175 people, and Hamilton has a population of 584,775. Both size and density influence different projects, and impact the need for mid and high-rise developments in Burlington compared to Hamilton. This will impact the need for angular planes. Another distinction between Burlington and Hamilton is the development patterns. Lastly, the planning policies differ in Burlington and Hamilton for using angular planes.

The adjacent sites of developments impact the importance of shadowing sunlight and visibility over the number of units, and shadowing affects adjacent developments. This is an essential factor in urban planning and design, influencing the impact of both height and orientation of new developments. Sunlight is similar to shadowing, affecting nearby properties of the amount of sunlight and the time it reaches the building. Trees and neighbouring structures alter and obstruct sunlight at different daytime periods. This reduces the amount of natural light in buildings and units. Illumination is essential for one's livelihood, making a home more appealing. Lighting has an impact on the number of units and layouts. Adjacent sites influence visibility inside and outside the site. For example, developments on busy streets will favour shops and entrances. Meanwhile, developments in calm residential areas will value privacy and want to be more secluded. This affects the market, safety, and success of developments by visibility.

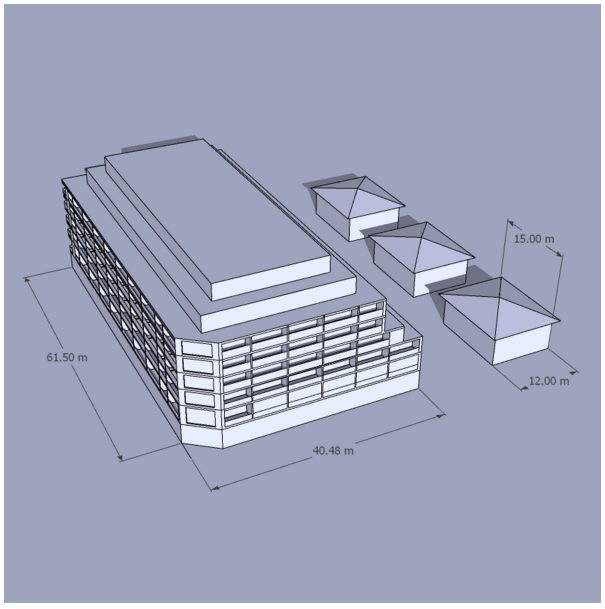
When prioritizing design during a housing crisis, many concerns must be considered. Well designed buildings are vital for an appealing and liveable environment, but affordability is also an essential factor to consider for residents. The factors that must be considered are the local environment, the housing market, and the residents' demand. With both objectives being met, with intelligent planning techniques, attainable housing can be achievable with good designs.

2.0 OPTIONS

2.1 *Keep Angular Plane Use the Same*

The following recommendation proposes the preservation of the current policy and use of angular planes in municipalities as regulated through the mid-rise building guidelines and zoning bylaws. Further, it recommends more consistent standards regarding the measurement of the 45-degree plane to maximise the effectiveness of this design tool and mitigate impacts on the areas of streets that are the most highly travelled. In the absence of regulated shadow studies for new developments (if not requested by the municipality), angular planes provide a focus on the form of new buildings and their subsequent impact on the accessibility to light and visibility for pedestrians. The use of angular planes along avenues helps to fill the missing middle that currently exists within the GTA providing incentivization for municipalities to allow more dense residential developments that fall in-between single detached housing and high-rise towers. In the context of Hamilton and Burlington, angular planes may represent an effective tool for regulating both form and function as these municipalities intensify along the LRT corridor and MTSA's.

Spring Equinox (March 20th)



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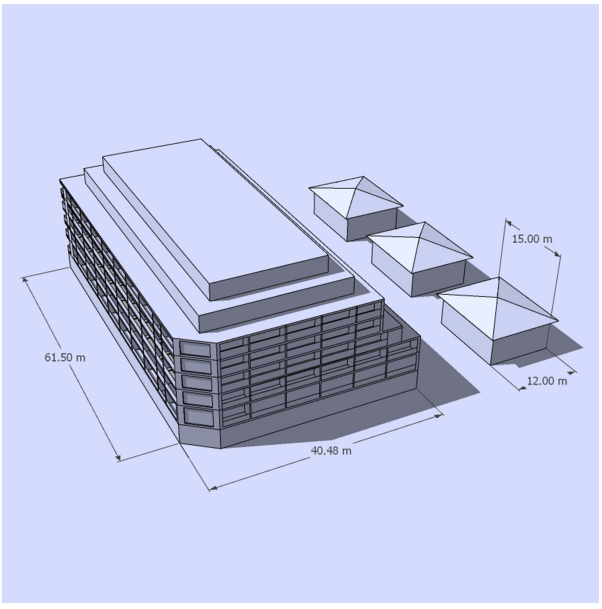

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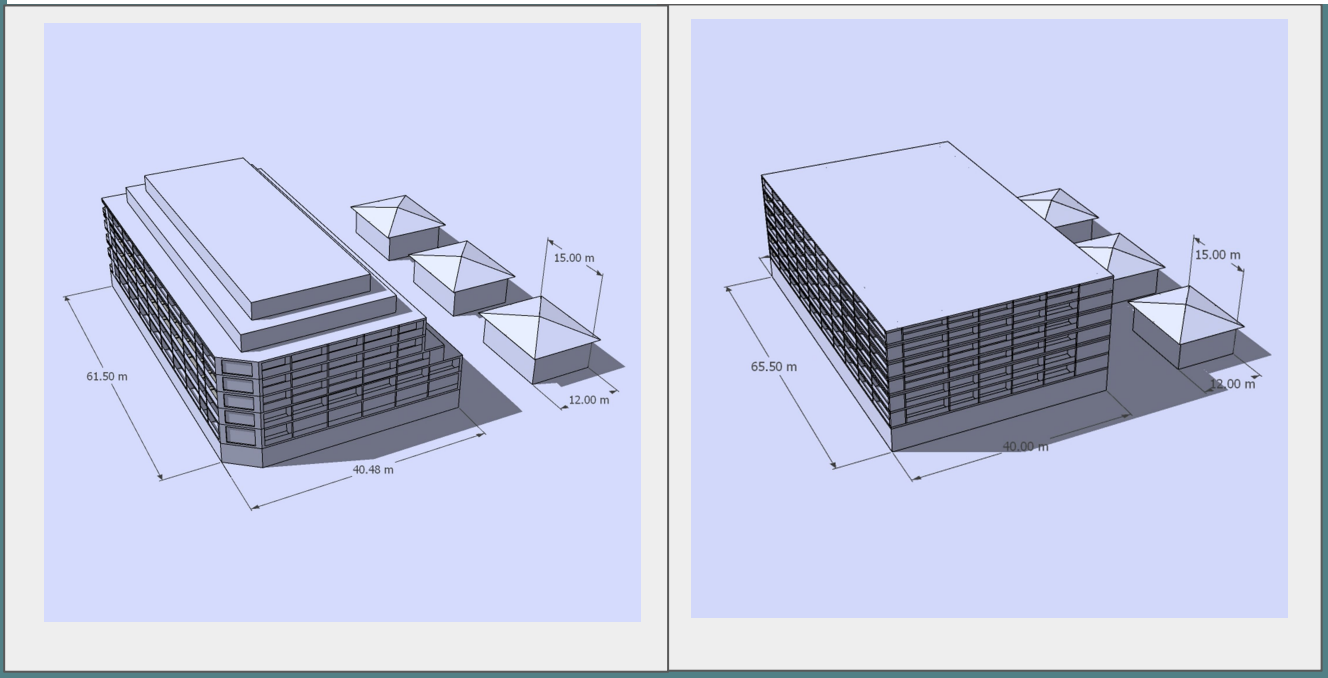
Figure #10: Shadow impacts study (Duffy Richardson, 2023)

Autumn Equinox (September 23rd) - Angular Plane vs. Block tower



2.1.1 Impacts on Streetscapes

Angular planes help to regulate the appropriate height and massing of new mid rise buildings along avenues. In the context of Burlington and Hamilton, the establishment of appropriate height transitions and density between mid-rise buildings and lower-density residential will be key to limiting pushback from current residents. Angular planes represent a recognition for surrounding homeowners and community stakeholders, who have concerns about deprecated land values and less desirable outdoor space because of shadowing from large buildings. The assurance of 5 hours of sunlight a day addresses the impacts of shadowing on aspects of the pedestrian realm such as parks, patios, sidewalks, and backyards helping to preserve the character of a place while allowing municipalities to increase height. The use of angular planes addresses many of the concerns brought forward regarding high-rise development addressing factors such as site overlook, wind impacts, and the feeling of corridors while on the streetscape.

2.1.2 Policy Regulation of Angular Plane use

The use of angular planes is regulated through the Hamilton's and Burlington's mid-rise building guidelines which provide direction for municipalities regarding the development of buildings between 5 to 11 stories. ***Section 2.3*** examines the impacts of built form on the function and composition of surrounding neighbourhoods specifically when there is variance between existing low-density conditions and new mid-rise developments. The guidelines in this section prescribe the use of setbacks to allow for 5 hours of consecutive sunlight for surrounding residential properties and sixty percent of adjacent public spaces. The use of angular planes and step-backs is further described in the performance standards for mid-rise buildings in ***section 3.1.***

2.1.3 Impacts of Angular Planes on buildings

Angular planes provide various benefits for the pedestrian realm, however, their use in municipalities also impacts factors such as density, unit diversity, environmental sustainability, and cost. These factors can be managed through structural design and the angle of step-backs to help alleviate the impacts of decreased floor area, yet, when compared to the capacities of block towers there are still tangible losses that accompany the use of angular planes. As described in previous sections, the vertical supports, materials, and ducts that are present in the structure of angular planes impact the construction timelines for development and often end up passing the increased costs onto the end user. Further, the need to modify floor plans at each level (because of step-backs) impacts the speed at which developers can build and creates incentives for them to favor one-bedroom dwellings to maximize their square footage, profit, and time. A lack of unit diversity and loss of square footage pose a threat to municipalities that are attempting to meet provincially regulated density targets in MTSAs. When compared to the structure of block towers, the step backs of angular planes limit the number of units as height increases. In the context of Burlington and Hamilton, this could represent a large loss of units across the cities because of the number of new developments that are occurring within MTSA's and in the LRT corridor. Amidst a housing crisis, issues of affordability and space must be considered when examining the importance of form and its subsequent impact on the function of spaces.

2.1.4 Measurements of Angular Planes

Currently, there is a lack of consistency across municipalities and developments within the same municipalities regarding the measurement of angular planes in reference to the location that the slope of the plane is drawn. The height of the plane is determined by calculating 80% of the street's right of way, however, the plane can begin at the center of the street, the front of the property line, the front of the adjacent property line, or from the curb of the adjacent sidewalk depending on the development site. The current policy that governs the use of angular planes could further regulate the depth of stepbacks, and the subsequent loss of space and shadowing through a more deliberate definition of a property's "lowest possible grade". The regulation of the angular plane's origin point should be regulated within municipalities zoning bylaws and cities' official plans to create real parameters for builders that can be amended on a site-specific basis. Creating consistency in policy rather than guidelines will help to ensure that the measurement of planes will have minimal impact on the building's available square footage and prioritize the relevant points of streetscapes that would be negatively impacted by shadowing.

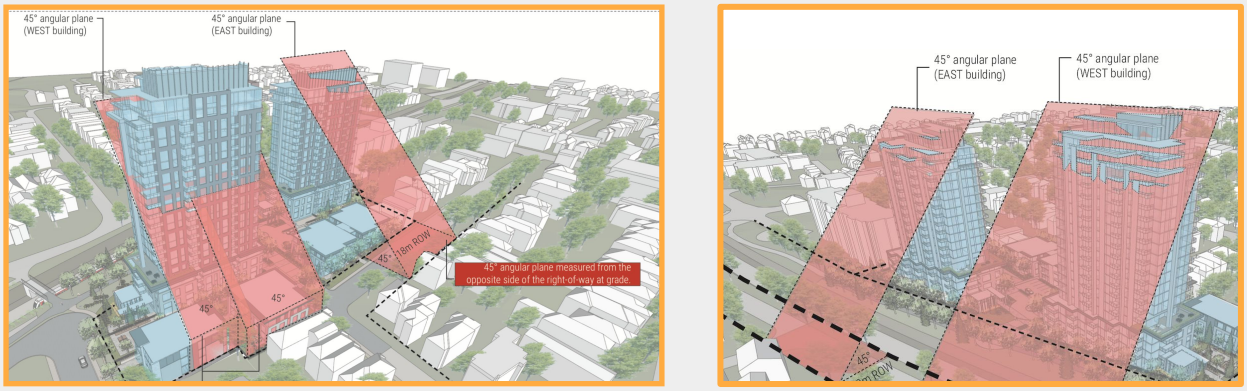


Figure #11: Measurement of angular Planes (Ottawa, 2020)

2.1.5 *Summary*

The regulation and use of angular planes in the GTA was only initiated in 2008, therefore there is still much to be learned about their long-term impacts on streetscapes and residential forms. The continued sprawl throughout the GTA onto the borders of naturally protected areas and the need for housing is currently a pressing issue across municipalities. Yet, when this immediate need for density is diffused, the importance of design and built form will be more apparent to ensure that communities are vibrant, pedestrian-oriented, and appealing to residents. Angular planes are a tool that strikes a balance between the focus on form and function, ultimately representing an effective method for managing both growth and community impacts within new developments.

PROS	CONS
Provide appropriate transitions between low density residential areas and mid-rise development	Impacts diversity of unit types
Mitigates the impacts of shadows and wind on avenues	Increase costs for builders
Ensures there is a focus on form amidst the process of rapid development within the GTA to meet housing needs	Impacts the number of units that are available in new developments
Protection of the public realm	Does not represent the most appropriate use of land in limited MTSA's
Recognition of current residents	Decreased thermal performance because of exterior facing walls
Can be regarded as "gentle density"	

2.2 *Eliminating the Use of Angular Planes Completely*

This section analyzes a scenario where angular planes are no longer permitted or used in a setting where rapid development is expected. The purpose of this section is to weigh out the various considerations that would take part of the decision process of deciding how to regulate the use of, or completely eliminate angular planes. As mentioned earlier in this report, various arguments exist for why angular planes are used in areas experiencing rapid growth. However, there are some considerations of this design choice to take note of, including environmental, financial and considerations for the streetscape to analyze. Reviewing the different factors and considerations is done out of hopes for an equitable decision-making process, as well as providing an informative overview of the impact of angular planes.

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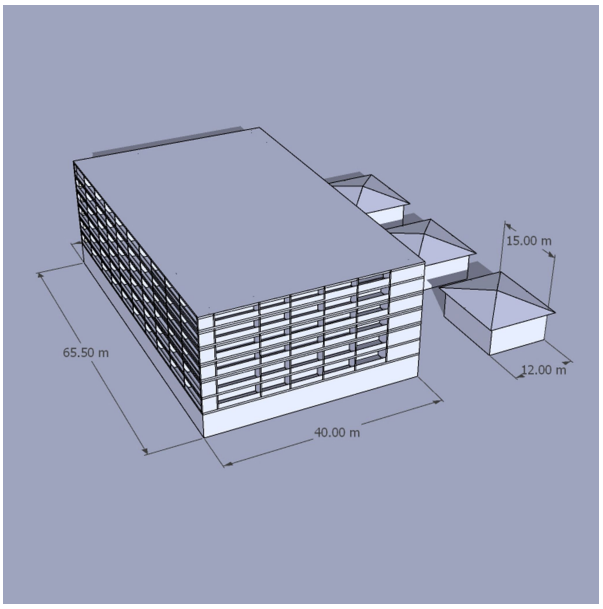	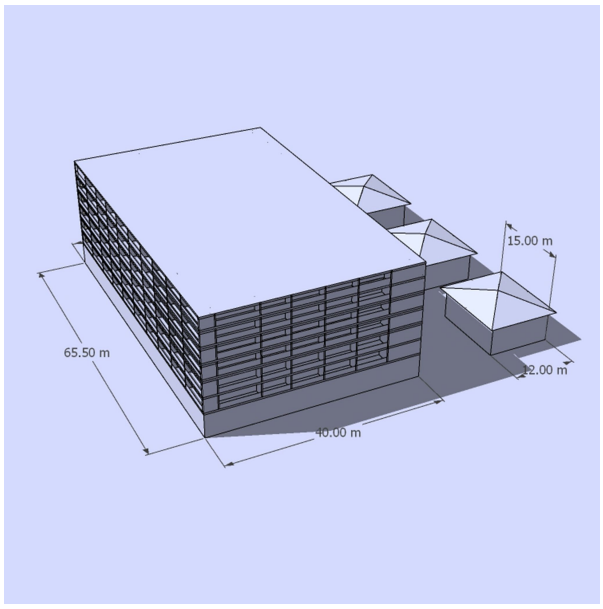

Figure #12: Shadow impacts study
(Richardson-Duffy, 2023)

Autumn Equinox (September 23rd)	
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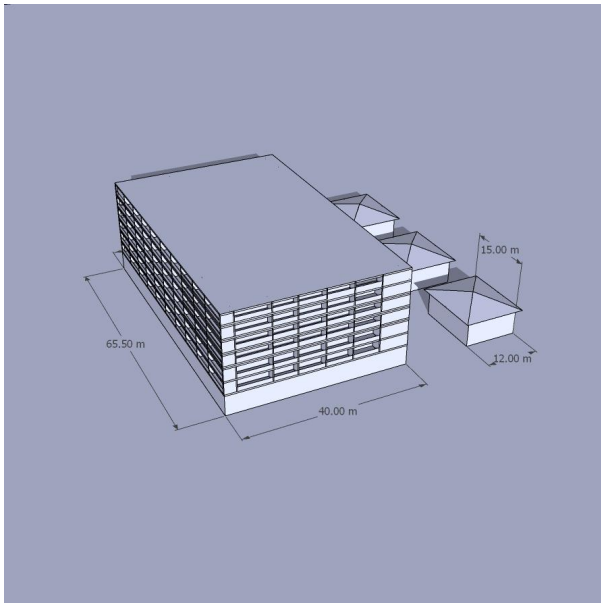
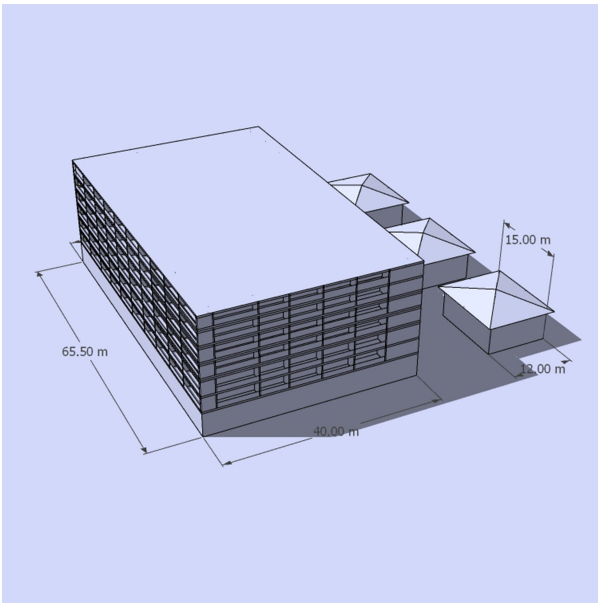
	

(Richardson-Duffy, 2023)

2.2.1 Environmental Sustainability

The recommendation to eliminate 45-degree angular planes has several factors to consider. In the context of Burlington and Hamilton, this would create a unique set of benefits and costs. Eliminating angular planes will make the development construction much more environmentally sustainable, durable and less costly. A significant drawback of angular planes is the need for more opportunity to use mass timber construction due to the complex floor plan layouts and positioning of elevator shafts. In addition to the reduced amount of setbacks, the uniform floor plan layout would not require complex drainage systems and structural bearings.

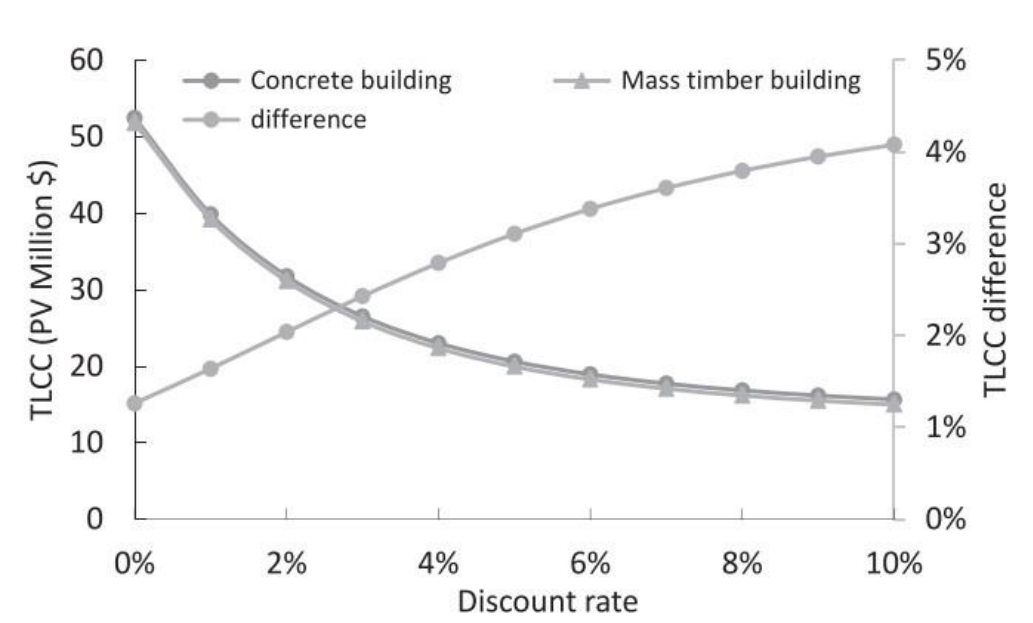
Thus, eliminating future use of angular planes and stepbacks to the design of buildings would make the construction less labour-intensive and cut down time in the development and construction timeline. In the case of Hamilton and Burlington, this is an important consideration due to the current housing market climate and the extremely high demand for housing.

However, another environmental consideration to note is the shadow impact of angular planes on surrounding areas. As shown in the shadow study above, the shadow impact of angular planes cast onto adjacent properties can affect possible vegetation on personal property. Though this may be a case-by-case scenario, the instance of a resident with a rear lot adjacent to a high-density development with affected vegetation is possible. However, it is imperative to analyze the different considerations. The shadows are not cast at the same place or time throughout the day or year.

2.2.2 Financial Factors

As stated previously, the design of layouts will be less labour intensive because developments will no longer permit stepbacks. According to Gu et al., the lifespan of a mass timber building is roughly 100 years, versus a concrete building is 75 years (2020). Additionally, the overall life cycle cost of a mass timber constructed building would be much less than a concrete building, despite costing more initially, as displayed in Figure 13 Thus, in the scenario where future development will not include angular planes would greatly benefit the lower overall cost of construction, the structural integrity and quality of buildings as well as the ability for the best use of each parcel can be practiced. Therefore, buildings that do not incorporate 45-degree angular planes are more cost-effective and sustainably built.

Figure #13: Total Life Cycle Cost of Concrete vs Mass Timber Buildings



(Gu et al., 2020)

Thus, restricting the use of angular planes in residential developments will increase the efficiency of buildings. Given the targets set out by the Hamilton Housing and Homelessness Strategy to reduce cost and time to develop housing, especially in the case more affordable housing. As stated in the Burlington Housing Strategy, identifying gaps is a crucial factor in speeding up development times, and completely eliminating angular planes can be a powerful tool in this process.

2.2.3 Streetscape Articulation and Design Considerations

As mentioned in the site context section, Hamilton and Burlington is primarily comprised of lower-density housing, including in the MTSAs. Given this case, this would present developers a series of scenarios of what to prioritize. There is an urgent need for higher-density housing within both cities. As discussed, angular planes can be a tool to balance interests for future and longtime residents in both cities. Sunlight for example, is one of the leading factors in favour of angular planes, as it creates minimal disruptions to older, low-density neighbourhoods. Without the use of angular planes, density targets may be halted to please the interest of long-time residents, which would delay goals set out by the city.

Another scenario that may occur if developments are to not incorporate angular planes would be high-density development projects located near current low density neighbourhoods. This would greatly disrupt the streetscape by prolonged shadow cast throughout the day and would not allow for the neighbourhood to transition to a high-density neighbourhood with ease.

Another consideration for the argument between angular plane versus non-angular plane development is the option for the city of Hamilton and Burlington to preserve historical façades. According to the New Buildings in Heritage Precinct Guidelines from the City of Melbourne, buildings around and incorporating preserved façades should not overbear the façades. Thus is encouraged that façadism should be practiced with little to no angular planes included in the design of buildings.

Implementing Facadicism & Angular Planes

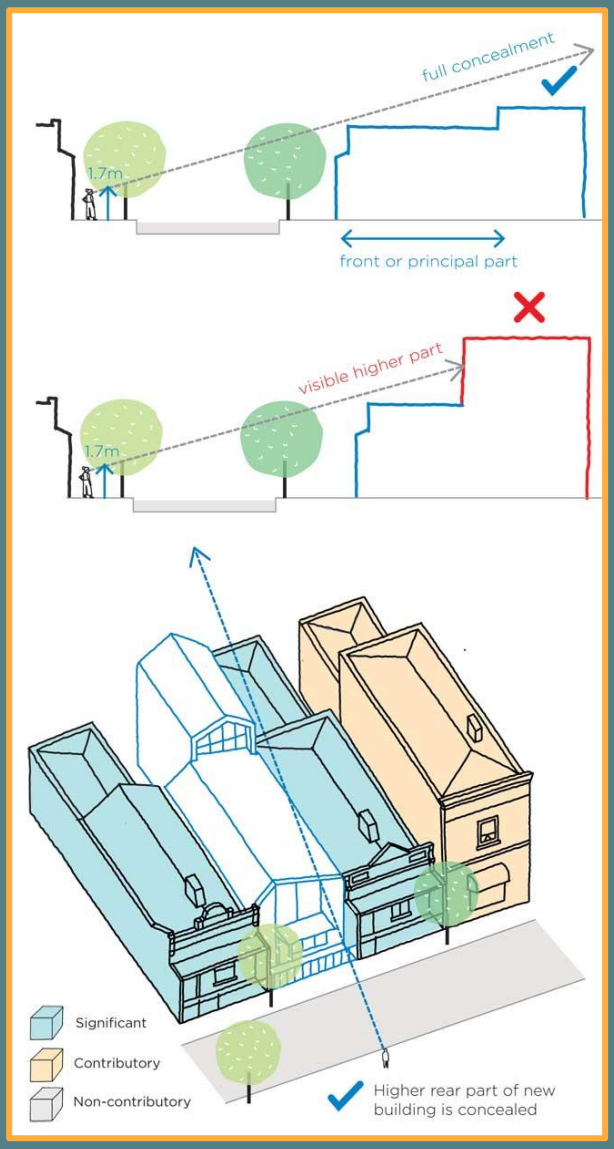


Figure #14: (New Buildings, n.d.)

Pros & Cons of Eliminating the Use of Angular Planes

PROS	CONS
Developers balance fewer issues at once: the choice between building the highest density feasible for a lot or building lower densities to appease the surrounding neighbourhood.	May result in developers to chose to develop lower density buildings due to height considerations. Thus, less leeway with the amount of height.
Not incorporating stepbacks into the design would make construction less labour intensive, as well as increasing the environmental sustainability of buildings.	Articulation and appropriate streetscape is lost, which would heavily restrict architectural design.
Developers are able to build cost-effectively, which would be beneficial in the long run.	
The restriction of angular planes can encourage for better articulation of preserved façades.	

2.3 *Site-Specific Use of the Angular Plane*

To preface this section, it is important to remember that generally, guidelines are not held to the same legal standards as that of an Official Plan policy, for instance, unless they have been specifically amended. Section 1.2 of the City of Burlington Downtown Urban Design Guidelines states that urban design guidelines themselves are not part of the OP or zoning. Rather, they "become a toolbox for municipal planners to assess the application and engage in meaningful discussion with the applicant on a basis of a clear set of expectations" (City of Burlington, 2006). However, guidelines are also considered as an important tool that should not be overlooked when read in conjunction with relevant municipal official plan policies (Mary Flynn-Guglietti, McMillan LLP pg. 3-4).

2.3.1 The Contrast Between the Hamilton and Burlington Context

Different socioeconomic status among Hamilton residents resulted in different urban forms from Burlington in regards to mid- and high-rise developments, social housing, co-op housing, and townhomes. An immediate need for housing required Hamilton to focus on rapidly increasing the diversity and density of unit types, and the historic reliance on industry yielded a concentration of dense housing in proximity to factories along the waterfront. On the other hand, Burlington's reliance on the farming industry led to more sprawled residential communities dominated by family homes. In order to understand density in Hamilton, it is important to recognize the contrast of land uses due to the amalgamated areas. When looking at the census data comparison of Hamilton and Burlington, they appear to be very similar. The reality is that the rural areas of Hamilton skew the data, resulting in an inaccurate representation of the differences in land use.

2.3.2 Discussing Pertinent OLT Decisions

The shift away from the angular planes requirement in Toronto is now prompting planning professionals and consultants to try to achieve balance when considering site specific needs with the city's needs, developers' needs and local residents' needs to reach a more desirable common ground. In the City of Hamilton, some residents and neighbourhood association representatives have voiced their concerns with the impacts of mid-rise and tall buildings on the surrounding low-rise residential and commercial uses. For example, the MM Green Developments (Stoney Creek) Inc. v. Hamilton (City) OLT decision from 2019 is exemplary of a dispute between the parties of whether or not the proposed setbacks, stepbacks and overall character of the development aligns with Urban Hamilton Official Plan (UHOP) policy, and how a planning professional is able to provide different options that considers the surrounding context as well as what is achievable in the perspective of a developer.

The case discusses the failure of the City of Hamilton to make a decision on a Zoning By-Law amendment application submitted by a development company in Stoney Creek. The proposed development contemplates an 8-storey mixed-use building on King Street West, containing 62 residential units with commercial at-grade. For context, the subject site is adjacent to two low-rise buildings to the east (3-storey residential) and to the west (1-storey commercial).

Figure #15: Rendering, MM Green Developments

Amidst the discussion surrounding providing a good transition between the proposed building and the adjacent buildings, Daniel Barnett, Planning & Economic Development Department for the City of Hamilton, was appointed by the Tribunal to provide expert land use and planning evidence and provided a few options that could be considered. Option 1 includes a 1.5 metre setback at the west and a 3 metre setback on the east where the 3-storey residential building resides, in addition to 3 metre stepbacks above the third storey. This option allows for an angular plane transition of up to 75 degrees. Option 2 includes the same setbacks and stepbacks above the sixth storey, and option 3 incorporates staff recommendation to Council for ZBAs requiring a 6 metre setback on both side yards with no stepbacks. Mr.Barnett recommended the first option as it provides a gradual transition through modest setbacks and stepbacks, and stated that it is within his professional opinion that this option is best suited for this case.

The case further discusses appropriate setbacks and stepbacks at the front of the proposed development. A resident of the community expressed their view that larger stepbacks would be better for the proposal and this historic area, and that a front yard setback could contribute to a pedestrian-friendly street. The council highlights, “it is clear that the intent of the UHOP policy at this location is to provide for transition between adjacent buildings of different heights and massing. Such a transition is necessary at this location given that the proposal is for an eight storey building located adjacent to a one-storey commercial building to the west and a three-storey residential building with west-facing windows to the east” (paragraph 34). The Council agrees with Mr.Barnett in saying that a balance between the existing and planned context is needed. In this case, the council found that a zero side-yard setback combined with stepbacks can be supported at this location and achieves the intent of UHOP policy in promoting a pedestrian-friendly street. The development was approved by the OLT in 2019 and is now in the pre-construction phase.

Figure #16: Rendering, Amico Properties Inc.

A 2021 OLT decision of Amico Properties Inc v. Burlington (City) discusses the matter of appeals by the appellants (Amico Properties Inc. and Spruce Partners Inc) from the failure of the City to adopt an OPA and a ZBA for the Site, municipally known as 1157 - 1171 North Shore Boulevard East (figure x).

The purpose of the OPA and ZBA applications was to allow for the development of a seniors' living campus consisting of a 17-storey tower and a 12-storey mid-rise building, and at the north of the Site, a 6-storey and a 2-storey low-rise element that is adjacent to a low-rise residential area. The settlement proposal that the parties agreed upon included a height reduction from 17 storeys to 16 storeys to fit within the 45 degree angular plane, which reduced the number of units from 475 to 379 (which means a total reduction of 96 units). Expert land use planner at Bousfields, Tyler Grinyer, reviews the proposal and recognizes the proposal's regard for provincial interest, the consistency with the PPS, the conformity with the Growth Plan with the OPA and ZBA as it supports growth and intensification in urban growth centres, the conformity with the Region of Halton OP and the general intent of City's OP.

As depicted in the paragraph above, in order for the development of the senior's living campus to be approved the applicants agreed to reduce the height of the 17-storey building to 16 storeys so that the building can fit within the 45-degree angular plane. This resulted in a reduction of 96 units in total. In this case the development is catered specifically to seniors. As residents 65 years and over in Burlington continue to age, the demand for senior housing becomes more significant. According to Statistics Canada, the 65 and over age cohort experienced the most significant increase in population of about 11% from the 2016 Census to the 2021 Census. Due to the 45 degree angular plane, the reduction of 96 units within a 16-storey residential building for the development of a senior living campus yielded a significant reduction of units. That isn't to say that these units couldn't be built otherwise within other senior housing developments throughout Burlington, but it is something to recognize when considering the use of the angular plane.

2.3.3 Site Orientation and Built Form Articulation

The use of the angular plane applied to mid-rise development might differ on a site-by-site basis due to each site's orientation. It is common for angular planes to be applied to mid-rise residential developments in Ontario despite the fact that it wouldn't improve shadows. If a building is to the north of something, the shadow impact to the south will be very minimal or non-existent (at least in the northern hemisphere) (Giulio Cescasto, 2022; CHBA 2022). Recognizing that site orientation can contribute to the impact of a mid-rise or tall building's shadow can shift towards less of a blanket urban design guideline amongst municipalities like Hamilton and Burlington.

In some cases, achieving good transition can be articulated through built form features. A mid-rise development along Lakeshore Boulevard West next to the Long Branch GO station in Toronto had proposed to convert three 2-storey mixed-use buildings into an 11-storey mid-rise building. The challenge that arose from this development was framing Lakeshore Boulevard West while simultaneously providing transition and good articulation to create a human scale environment - this was achieved through good transition and articulated built form. The proposed building appears to be broken up into 6 boxes and paired with stepbacks, creating an interesting facade that is simple and feels smaller than it actually is (see figure 17).

The proposal applies a design approach that achieves a rear transition that has minimal impact on adjacent land uses through an increased setback and multiple stepbacks because:

1. **North-facing site orientation creates minimal shadow impacts on adjacent neighborhoods**
2. The majority of the rear property line abuts triplexes rather than single-detached homes, and there are parking and storage uses at the rear of those properties, therefore a less significant transition is required to meet the intent of the Official Plan
3. The proposed rear setback (12.6 metres) is greater than the required setback (7.5 metres).

Figure #17: Rendering of 11-storey mid-rise building, Smart Density

*For further discussion on angular planes and transition zones, see **section 2.5** of this report.*

2.3.4 Summary

The use of the 45 degree angular plane can not always be confined to a "one size fits all" guideline. Decision makers in Burlington might find that it is within the public interest and the interest of the city to continue to use the 45 degree angular plane guideline in the areas outside of their growth centres or MTSAs, while re-establishing the intent behind the use of the angular plane amongst mid-rise and high-rise developments that occur within the MTSAs in Burlington. Due to the different land uses, the demographics, the socio-economic statuses, and housing needs in Hamilton, the story might differ from Burlington.

PROS	CONS
On a case by case basis where the angular plane is being disputed, a professional with land use expertise can provide options catered to the specific site. This way applicants and the municipality can reach common ground.	A case by case basis can be unclear as a guideline or regulation, creating the potential for a more complex development approval process that takes more time, slows development, requires more staff and resources, and may yield higher costs for the developer and city staff.
A case by case basis can allow for the potential of more units within a proposed development. Not all sites require an angular plane as it is dependent on the neighbourhood context.	Some developments might have a greater impact on surrounding low-rise neighbourhoods, a shadow impact study may be required by the municipality.
Good transition can be achieved through an alternative means - building facade articulations. Density targets can be achieved while maintaining a pedestrian-friendly environment at street level.	There is still potential for some negative shadow impacts with buildings that aim to achieve good transition through building facade articulations.

2.4 *Location of Angular Plane at Rear or Front*

2.4.1 Angular planes for mid and high-rise buildings are very similar as per the mid-rise guidelines that implement the height, use, and specific location for the use of angular planes in regards to the built form that surrounds the subject site. From a planning perspective, we are aware that as per the mid-rise guidelines, the maximum height for mid-rise buildings is the length from one property line to another or what we call the right of way. Additionally figuring out the exact location of angular planes for the front of a property consists of taking an imaginary line up from the property line that extends 80% of the existing right-of-way distance. This is where the angular plane of 45 degrees will begin and shave off units and square footage for the upper floors of the subject building. Furthermore, in the rear of the subject building, the angular plane will begin 7.5 meters in from the back property line as well as begin up 7.5 meters or 10.m meters varying on how shallow the site is. This is in place to create lower buildings at the rear with a more gradual transition from the property line that borders existing residential areas. Additionally the mid-rise guidelines of having at least 5 hours of sunlight from the spring through fall directly affect where the angular planes are placed in the rear and the front of mid and high-rise buildings.

Furthermore, when discussing the location of angular planes, the grade level of the property has to be taken into account. The rear angular plane should always be taken from the lowest grade point on the rear property line according to the mid rise guidelines. This is a significant factor because this will make sure the adjacent properties at the rear do not get additional sunlight blocking and shadows. Furthermore, this will ensure that the changes in a grade level will limit the effects of taller buildings adjacent to these property lines. The use of angular planes in mid-rise and high-rise buildings is strategically implemented to limit the drastic transitions from low-rise residential buildings, and open spaces to high-density buildings.

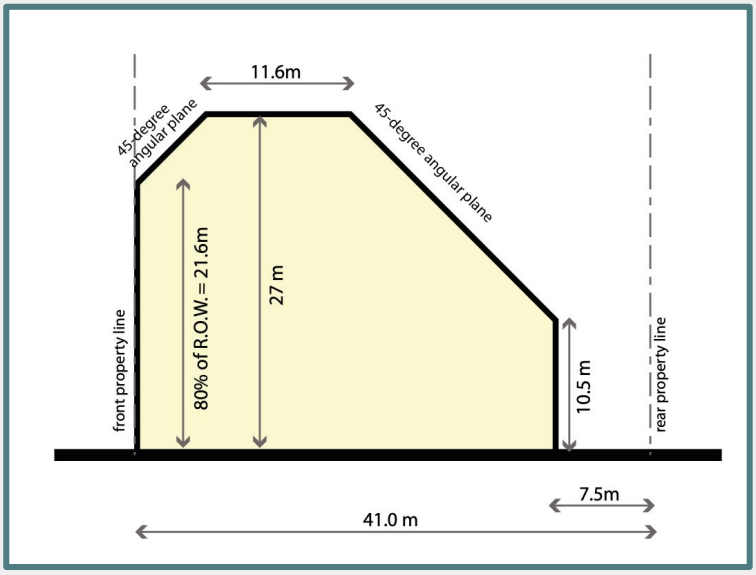


Figure #18: measurement of step back

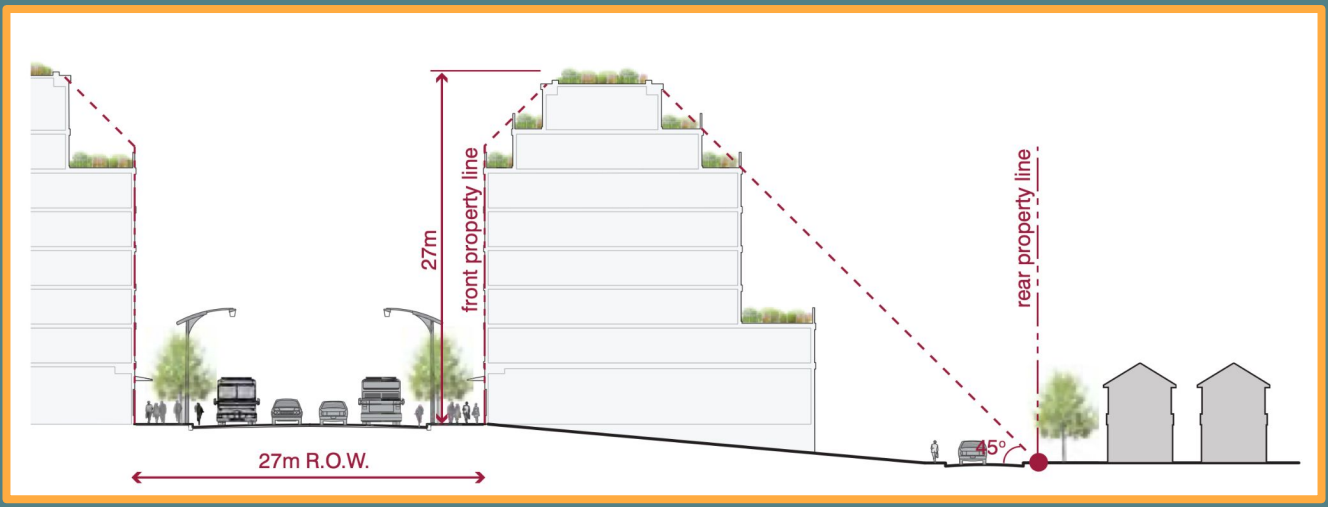


Figure #19: measurement of step back given the right of way

Implementing angular planes in the rear or front of buildings can vary based off of the mid-rise guidelines. When using different design and zoning laws in locations such as Hamilton and Burlington, it is important to factor in the developers, designers, and engineers if certain changes need to be made to the front or rear of the buildings in regards to their right of way length and the height at where the angular planes begin. As these are guidelines in place, various projects and sites will differ based on the desired transitional zone, and surrounding sites. Additionally recommendations can be made by the developers, designers, and engineers in regards to the social, environmental, and financial objectives of a subject site.

Pros and Cons of Rear & Front Locations

Pros	Cons
- Gradual transition from surrounding property lines in the rear	- Complex development process for both cities
- Protecting the public realm with 5 hours of sunlight from Spring through fall with minimal shadow impacts	- Reduces the focus of removing and instead prioritizes low-rise detached housing as a cities normality
- Guidelines provide a uniform look to mid-rise buildings	- Significant loss of gross square footage

2.5 Transition Zones and Stepbacks

2.5.1 What are transition zones?

This section will analyze an alternative solution to building massing regulations through building height transition zones. Building height transition zones are a planning tool used to regulate the height and massing of buildings over a specified distance from a street. This tool aims to create a gradual transition between avenues and residential zones. The general intent is to transition from low to high-density areas gradually. The aim is to mitigate stark transitions between building typologies while facilitating the necessary development targets of a rapidly growing population in Hamilton and Burlington.

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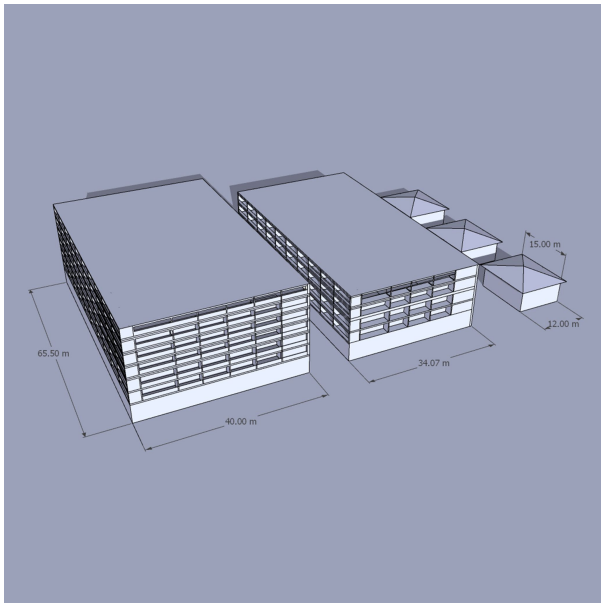
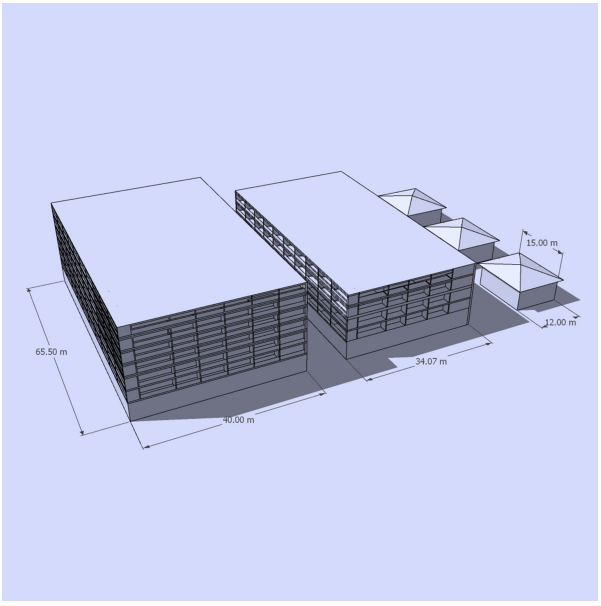
<tr><td> 
</td><td> 
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Figure #20: Shadow impacts study (Duffy Richardson, 2023)

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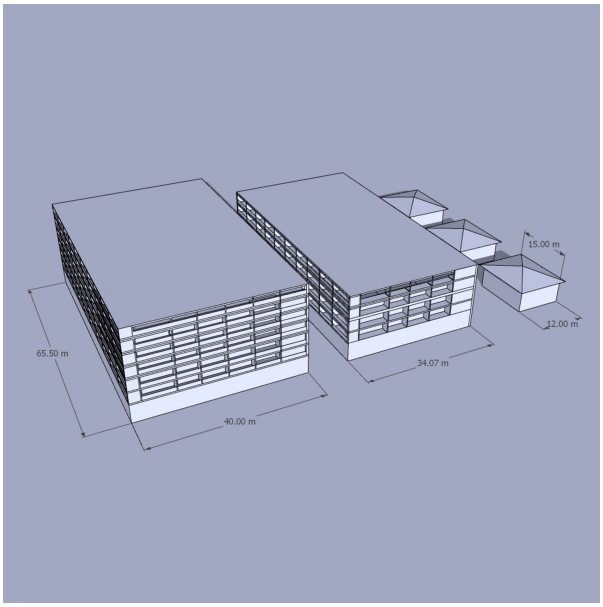	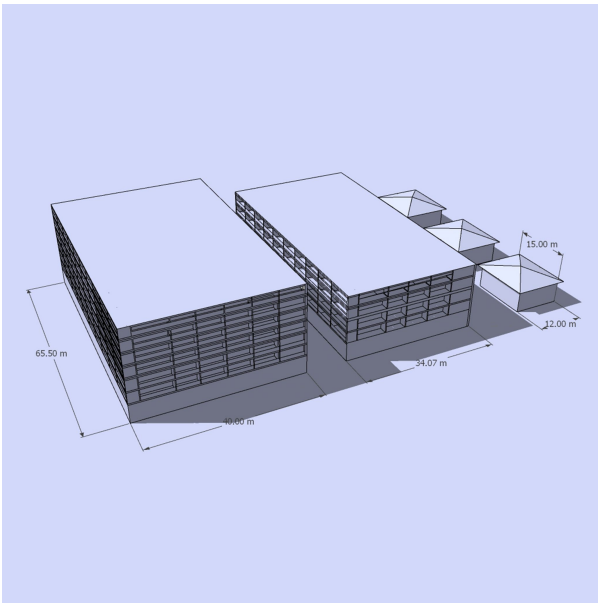

(Richardson-Duffy, 2023)

2.5.2 How are they employed?

Transition zones are typically regulated through zoning by-laws or Official Plan designations. Height maximums are commonly determined by the distance from major streets, with the maximum permitted height decreasing with distance. For example, an avenue could have a maximum designated height of ten stories and decrease to five storeys on the blocks abutting a residential zone.

2.5.3 Purpose

The purpose of transition zones is to gradually regulate the heights of buildings as they move away from major streets or high-density areas. The goals of transition zones align with angular plane regulations while allowing for block-shaped building typologies. They reduce the number of limitations placed on development. This removes some red tape associated with design considerations during the development and building process. They also aim to help fill the "missing middle" of housing, allowing for the construction of a larger diversity of housing types (triplexes, fourplexes, townhouses, and walk-up apartment buildings) (Transitions). Transition zones can help future-proof growth by designating maximum heights based on distance from the street. In the future, when density targets are increased, the maximum height limitations can easily follow to accommodate a growing population. As growth occurs, these zones can densify organically, easing planning considerations for policymakers. Transition zones provide a comprehensive solution to building height restrictions in transitionary areas.

2.5.5 Visual Appeal and Character

Building height transition zones can help to create a visually appealing cityscape. When tall buildings are constructed adjacent to short buildings, it creates a sharp transition that can feel intrusive and overwhelming for pedestrians. The use of transition zones regulates the angle at which buildings decline toward lower-density areas giving policymakers the power to choose what design is the most suitable for that area. They can also help to preserve the character of a neighbourhood. They can protect areas that house historically or culturally significant buildings. This ensures that important buildings are not overpowered by drastically tall developments.

<table>
<tr><th>PROS</th><th>CONS</th></tr>
<tr><td>Gradual transitions: Natural building height transition between low and high-density areas</td><td rowspan="2">Boxy building typologies are less visually appealing and create a more intrusive streetscape.</td></tr>
<tr><td>Faster Development Potential: Reduces the red tape during planning phases of development.</td></tr>
<tr><td>Enables cost-effective building typologies.</td><td>The wind tunnel effect on the street may be more severe due to the higher building facades.</td></tr>
<tr><td colspan="2">BOTH</td></tr>
<tr><td colspan="2">Increased shade effect near large buildings.</td></tr>
</table>

3.0 CONCLUSION

For more than a decade, angular planes have been utilised in the Greater Toronto Area to help regulate the impacts of mid rise buildings along streetscapes. The West End House Builders' Association (WE HBA) is initiating discourse with the cities of Burlington and Hamilton regarding the use of angular planes and whether they are an effective tool in helping to increase density, while reducing impacts on the public realm. As these cities continue to grow and intensify along Hamilton's LRT corridor and in Burlington's MTSAs', angular planes may prove to be an effective instrument in managing both form and function.

These two cities differ in regards to their urban objectives because of their contrast in land uses, populations and histories of development. As discussed above, angular planes have environmental, economic, and political implications because of their structural design, cost of materials and limited floor area in contrast to box towers. However they also have various positive impacts such as reductions in shadowing, wind tunnelling and site overlook in neighbourhoods and along streetscapes. This report concludes that angular planes may not represent a "one size fits all" solution to the regulation of height in lower density areas. The 5 options presented above are to be considered as conversations surrounding this planning tool continue and may offer different drawbacks or advantages across municipalities.

Eliminating angular planes in building design has pros and cons. It simplifies decision-making for developers and promotes cost-effective and sustainable building, but may lead to lower density buildings due to height limitations and restrict architectural design. However, it may result in developers choosing to build lower density buildings due to height limitations, reducing the leeway with height. When installing angular planes in the back or front of buildings, depending on mid-rise principles and social, environmental, and economical goals, it is crucial to take developers, designers, and engineers into account.

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Appendix

Figure #1: *Districts of Hamilton (Klysen, 2023)*

Figure #2: Planning districts of Burlington (Klysen, 2023

Figure #3: *Hamilton's Growth Center - downtown area (Klysen, 2023)*

Figure #4: Burlington's three major Transit Station Areas *(Klysen, 2023)*

Figure #5. Structural Drawing as Step-Backs Increase (Richardson-Duffy, 2023)

Figure #6: How thermal Bridging occurs

Figure #7: Snow and ice accumulation on step-backs

Figure#8: https://www.igbc.ie/certification/levels-eu-sustainable-buildings-framework/

Figure #9: How angular planes can create a potential loss of unit

Figure #10: Shadow impacts study (Duffy Richardson, 2023)

Figure #11: Measurement of angular Planes (Ottawa, 2020)

Figure #12: Shadow impacts study (Duffy Richardson, 2023)

Figure #13: Total Life Cycle Cost of Concrete vs Mass Timber Buildings

Figure #14: (New Buildings, n.d.)

Figure #15: Rendering, MM Green Developments

Figure #16: Rendering, Amico Properties Inc.

Figure #17: Rendering of 11-storey mid-rise building, Smart Density

Figure #18: measurement of step back

Figure #19: measurement of step back given the right of way

Figure #20: Shadow impacts study (Duffy Richardson, 2023)