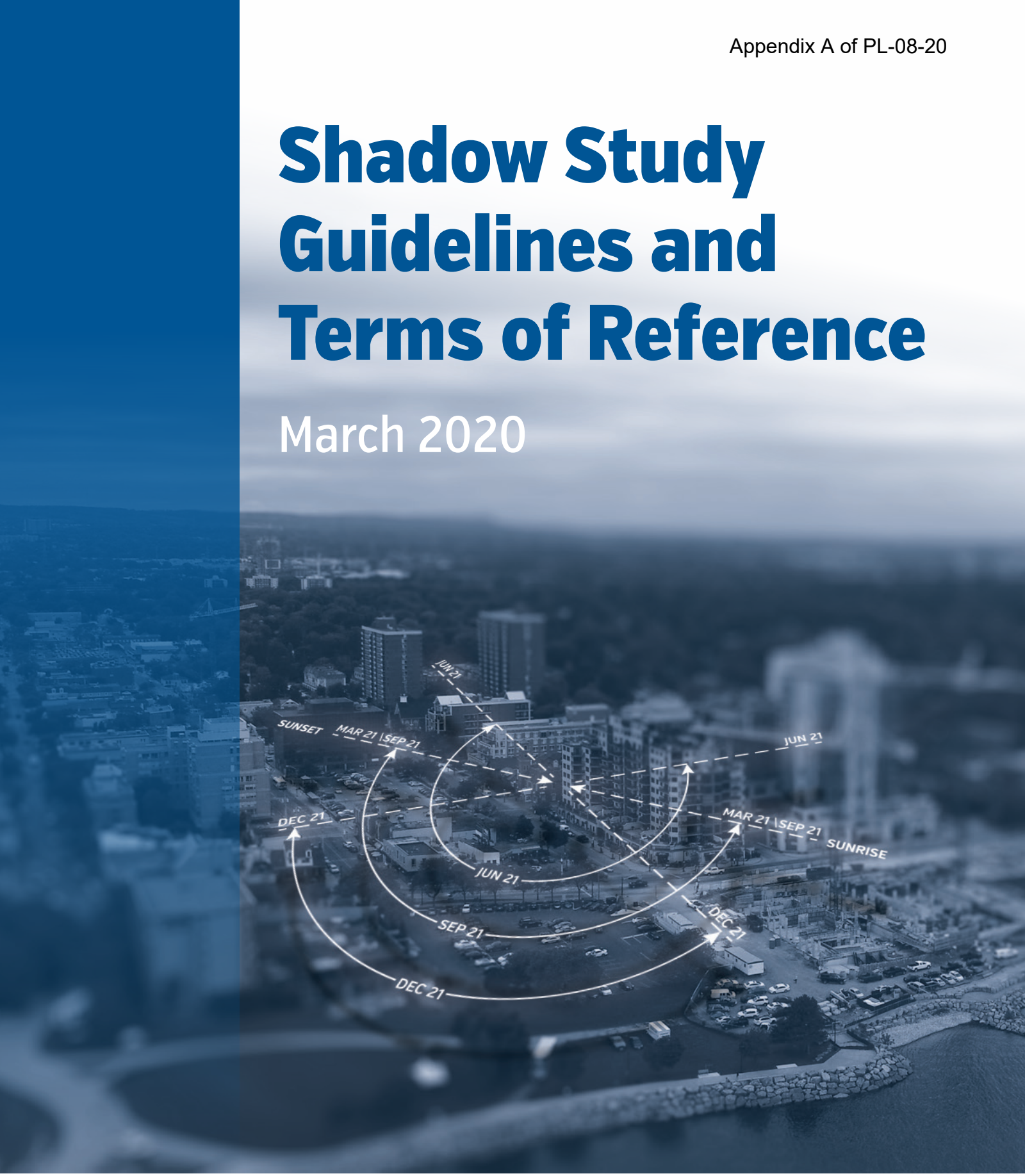
Shadow Study Guidelines and Terms of Reference

March 2020



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Contents

1.0 Introduction

1.1 Purpose

Pedestrian thermal comfort is affected by the presence of direct sunlight. The size, shape, and articulation of new buildings will create new shadows at different times of day and year that may limit the penetration of direct sunlight onto both public and private spaces. A Shadow Study demonstrates the potential shadow impacts of a proposed development on its surrounding context. By analyzing existing and proposed shadows together, both incremental and cumulative shadow impacts can be evaluated as Burlington continues to grow.

The purpose of this document is to provide a best practices approach to Shadow Studies in order to promote high-quality development proposals that ensure adequate access to sunlight is maintained for the enjoyment of public and private spaces alike throughout the City.

1.2 How to Use the Guidelines

This document should be used by the development community to inform development proposals within the City of Burlington. It should be read in its entirety when designing buildings of all scales and sizes, particularly buildings that meet the thresholds set out in Section 2.0.

This document sets expectations for high-quality design outcomes but does not anticipate every design scenario. It is not the intention of this document to limit creativity. Where it can be demonstrated that an alternative achieves the intent of the guidelines, the alternative solution may be permitted.

This document is a tool for City Staff to be used in the review and evaluation of development applications. When additional advice is appropriate, the City may consider peer review by an independent third party.

Terms defined

Find a definition for underlined terms in the Glossary included on page 17.

1.3 Who can conduct a Shadow Study?

Shadow Studies should be prepared by a Registered Architect, Professional Engineer (P. Eng.), Registered Professional Planner (RPP), or Registered Landscape Architect. If a Shadow Study is prepared by an individual or company that does not have extensive experience in preparing Shadow Studies, an independent peer review may be requested by City staff at the expense of the proponent; per the Official Plan of the City of Burlington.

1.4 When is a Shadow Study required?

A Shadow Study may be required as part of proposals for the following development applications:

- Official Plan Amendment;
- Zoning By-law Amendment;
- Site Plan Approval;
- Plan of Subdivision Approval; and,
- Committee of Adjustment (height increase).

Notwithstanding the above, a Shadow Study may also be required at the discretion of City staff, where development applications could result in additional shadowing on the surroundings.

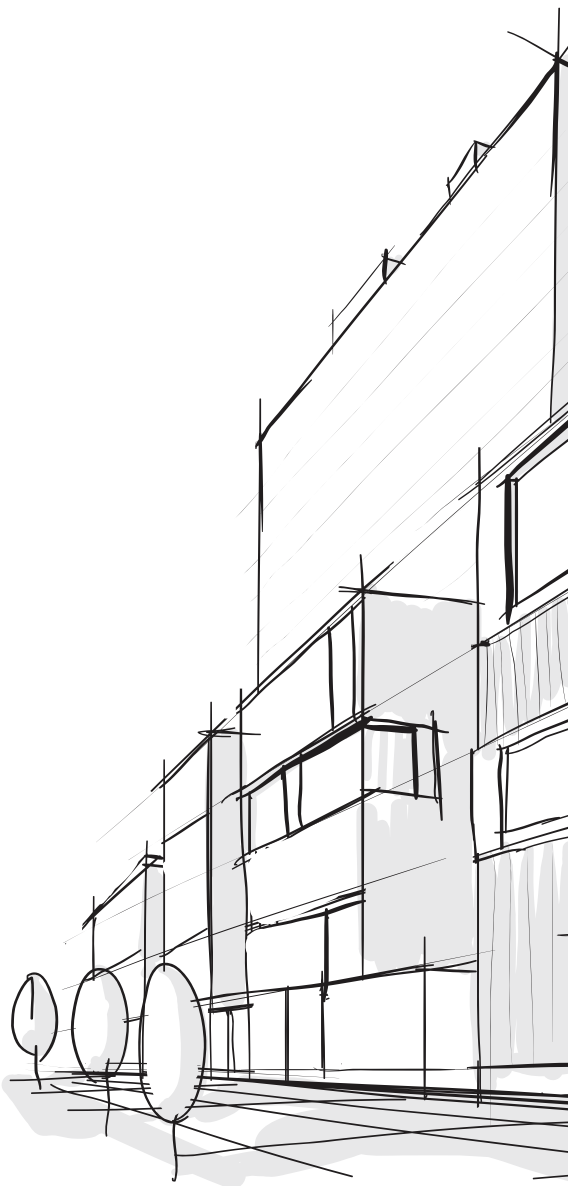
The requirement for a Shadow Study will be identified at the Formal Pre-consultation stage of a development application.

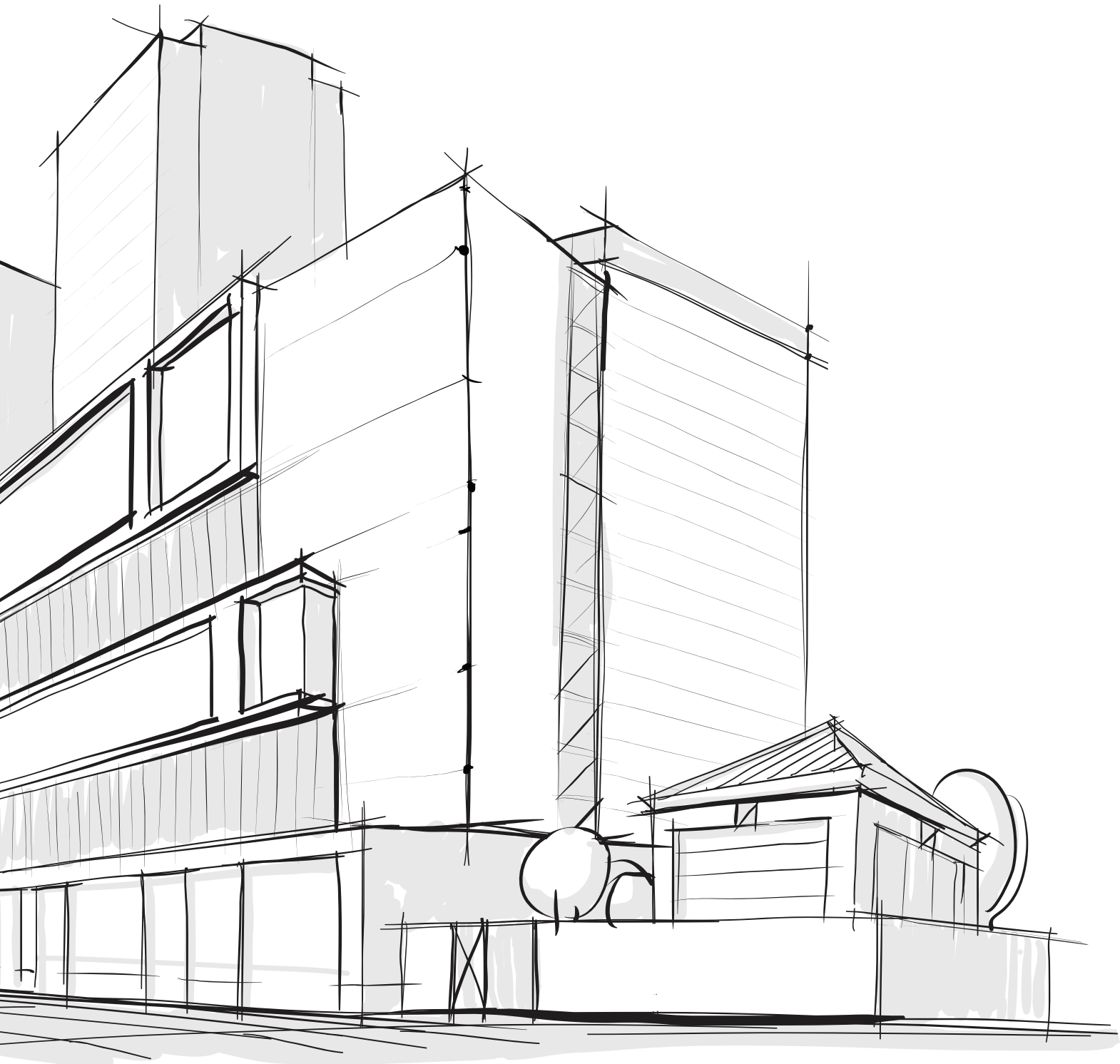
2.0 Triggers for a Shadow Study

2.1 Introduction

Shadow Studies are generally required for development proposals with building heights of 5-storeys or more; however, a shadow study may be required at the discretion of City staff in circumstances that meet one of the following triggers:

- Building height, especially when additional height is being requested; or,
- Proximity to shadow-sensitive uses, including but not limited to those listed in Section 4.0.





3.0 Methodology

3.1 Introduction

The required Shadow Study dates and times of day will vary depending on the specific Shadow Impact Criteria (see Section 4.0). Each Shadow Impact Criterion has a unique methodological standard corresponding to the shadow impact on the solstices or equinoxes.

The solstices, June 21st and December 21st, represent the seasonal extremes for each season (Figure 3.1). June 21st is the longest day of the year when the sun angle is at its highest and shadows are shortest. December 21st is the shortest day of the year when the sun angle is at its lowest and shadows are longest. The equinoxes, March 21st and September 21st, represent seasonal averages (Figure 3.1). Each Shadow Impact Criterion in Section 4.0 utilizes different dates and times based on the expected seasonal use.

Shadows shall be determined using the applicable solar altitude and azimuth (sun angle) data for Burlington and the project site.

3.2 Study Test Dates

- March 21st;
- June 21st;
- September 21st; and,
- December 21st

3.3 Study Test Times

Hourly test times may include:

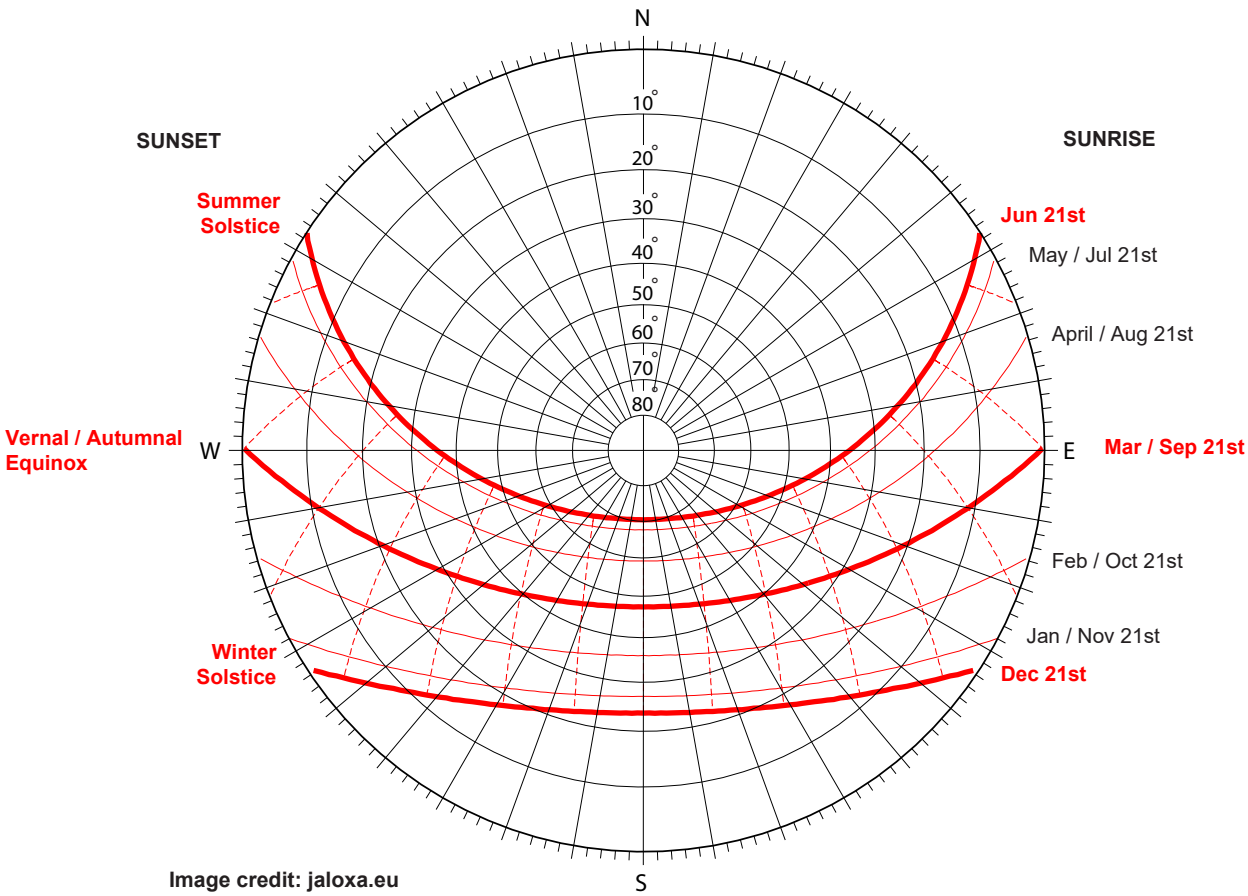
- 08:00
- 09:00
- 10:00
- 11:00
- 12:00
- 13:00
- 14:00
- 15:00
- 16:00
- 17:00
- 18:00
- 19:00

3.4 Time Zone

Shadow Studies must be prepared using the following time zone standards:

- Time Zone: Eastern
- Standard Time: Universal Time minus 5 hours (Winter Solstice - December 21st)
- Daylight Saving Time: Universal Time minus 4 hours (Vernal Equinox - March 21st; Summer Solstice - June 21st; and Autumnal Equinox - September 21st)

Figure 3.1 - Sterographic Sunpath Diagram (Latitude 43N)



4.0 Shadow Impact Criteria

4.1 Introduction

Shadow Impact Criteria cannot be applied universally due to unique site specific and surrounding built form and land use attributes. Five unique Shadow Impact Criteria have been developed to respond to desired uses. As such, each area will include unique evaluation criteria with different times, dates, and standards.

Shadow Impact Criteria will specify:

- How a criterion is fulfilled; and,
- The test dates and times the criterion applies.

Shadow Impact Criteria are organized by the application of the concepts Net New Shadows and Sun Access Factor (SAF).

Net New Shadows are incremental shadows that exceed the existing building shadows.

Sun Access Factor (SAF) is a measure of sun penetration on a given area, during a specified time frame, calculated as follows:

1. Measure the total area (A_T) of the feature (e.g. boulevard, private outdoor amenity or pack space).
2. Measure the area exposed to sunshine ($A_{S(test)}$) at each of the hourly test times.
3. Calculate the average area exposed to sunshine ($A_{S(interval)}$) over each hourly interval as the mean between the ($A_{S(test)}$) at the beginning of the interval, and at the end of the interval.
4. Find the overall average area exposed to sunshine ($A_{S(average)}$) by dividing the sum of the ($A_{S(interval)}$) values by the number of hourly intervals (e.g. hourly measurements between 09:00 and 18:00 = 9 intervals).
5. Find the SAF by dividing the $A_{S(average)}$ by A_T (passes if > the specified standard; i.e. 0.22 or 0.50).

This section provides some example shadow drawings that show how to measure for calculating SAF (Figures 4.1 and 4.2). See Appendix B for example calculations.

4.2 Key Civic and Cultural Spaces

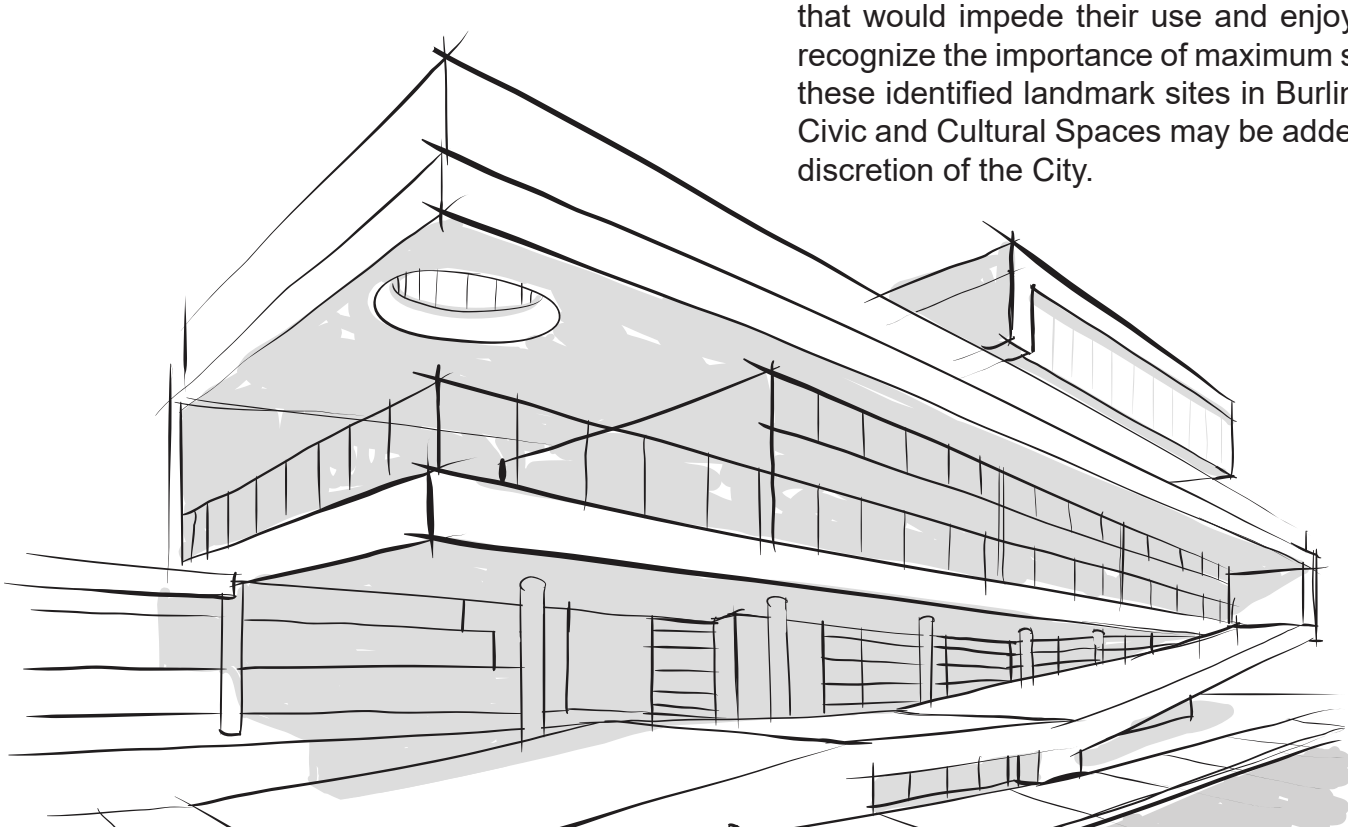
Proposed developments should not cast any net new shadows on Key Civic and Cultural Spaces between 10:00 and 16:00 on the following dates:

- March 21st; and,
- September 21st.

Key Civic and Cultural Spaces include but are not limited to:

- Civic Square
  (426 Brant Street)
- Elgin Promenade Square
  (391 Brant Street)
- Spencer Smith Park
  (1340 and 1400 Lakeshore Road)

The purpose of this criterion is to protect Key Civic and Cultural Spaces from new shadowing that would impede their use and enjoyment and recognize the importance of maximum sunlight on these identified landmark sites in Burlington. Key Civic and Cultural Spaces may be added to at the discretion of the City.



4.3Private Outdoor Amenity Spaces

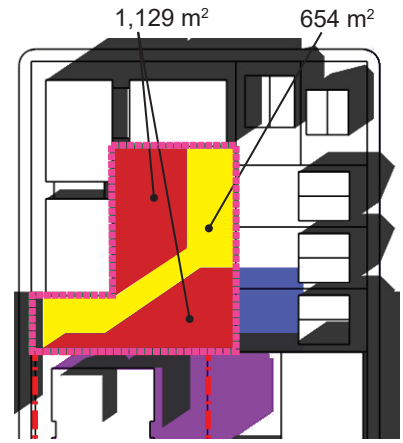
To maximize the usability of private outdoor amenity areas such as rear yards, decks, and (rooftop) patios, including common outdoor amenity areas, shadows from proposed developments should not exceed 2 hours in duration, between 09:00 and 18:00 on:

- March 21st.

In cases where existing shadows limit access to sun during the above times, net new shadows resulting from proposed buildings should allow a minimum amount of sunlight to reach nearby private residential outdoor amenity areas, including common outdoor amenity areas, at the discretion of the City of Burlington, between the hours of 09:00 and 18:00 on the specified date.

The criterion is met if the Sun Access Factor is at least 0.22 on each of the test dates. Figures 4.1 and 4.2 provide a demonstration of how to measure for calculating SAF in the case of a privately shared common space and private residential rear yard, respectively. See Appendix B, Examples 1 and 2, respectively, for corresponding detailed sample calculations.

Figure 4.1 - Measuring SAF for Privately Shared Common Spaces

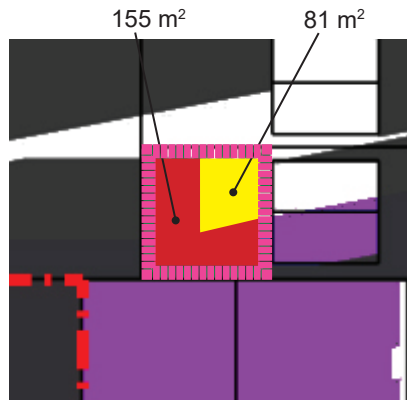


Adjacent Residential Amenity Space Total Area: 1,783 m²

Area Exposed to Sunshine: 652 m²

Area in Shadow (including existing and proposed shadows): 1,129 m²

Figure 4.2 - Measuring SAF for Private Residential Rear Yards



Adjacent Residential Amenity Space Total Area: 236m²

Area Exposed to Sunshine: 81 m²

Area in Shadow (including existing and proposed shadows): 155 m²

4.4 Parks and Open Spaces

On the following dates, shadows cast by all existing buildings and proposed developments onto lands designated or used for Parks and Open Spaces must allow for either: a) full sunlight 50 per cent of the time; or b) 50 per cent sun coverage at all times during the specified periods.

- March 21st (09:00 to 18:00);
- September 21st (09:00 to 18:00); and,
- December 21st (11:00 to 15:00).

The purpose of this criterion is to ensure adequate access to sunlight at all times of the year. December 21st is included to encourage the use of lands designated or used for Parks and Open Spaces during the winter season.

The criterion is met if the Sun Access Factor is at least 0.50 on each of the three test dates. See Appendix B, Example 3 for a sample calculation.

4.5 Places Where Children Play

On the following dates, shadows cast by all existing buildings and proposed developments onto places where children play including but not limited to school yards, playgrounds, and park features such as wading pools or other outdoor shadow-sensitive activity areas as identified by the City of Burlington, must allow for either a) full sunlight 50 per cent of the time; or b) 50 per cent sun coverage at all times during the specified periods.

- March 21st (09:00 to 18:00);
- September 21st (09:00 to 18:00); and,
- December 21st (11:00 to 15:00) - applies to school yards and playground areas only.

Solar access on December 21st is included to indicate how places where children play will be affected during winter months. Areas such as school yards and playground areas are likely to be used year-round.

The criterion is met if the Sun Access Factor is at least 0.50 on each of the three test dates.

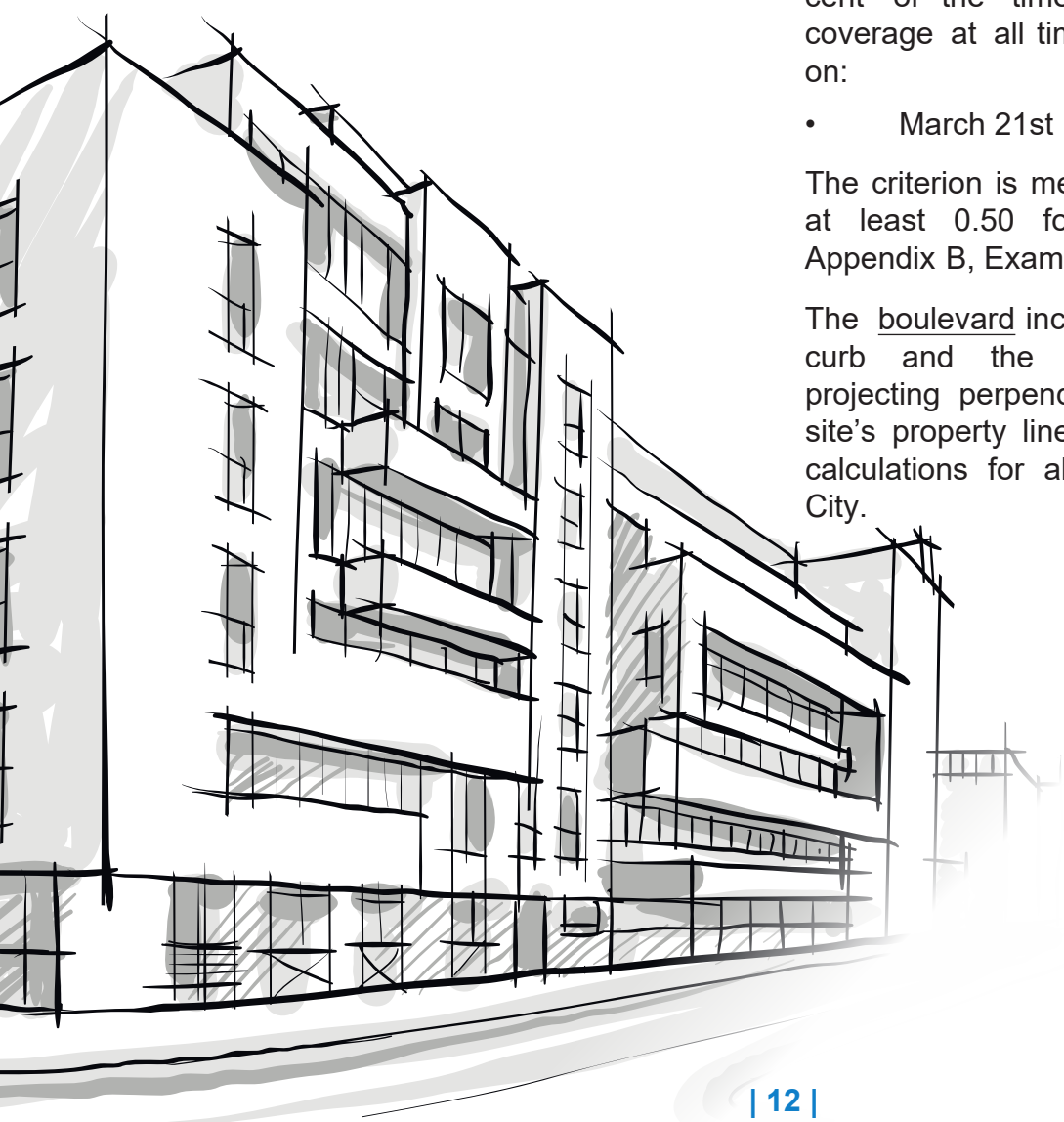
4.6 Public Realm and Sidewalks

On the following date, shadows cast by all existing buildings and proposed developments onto the full extents of the boulevard and sidewalk on the opposite side of the adjacent right-of-way, must allow for either a) full sunlight 50 per cent of the time; or b) 50 per cent sun coverage at all times between 09:00 and 18:00 on:

- March 21st

The criterion is met if the Sun Access Factor is at least 0.50 for the specified date. See Appendix B, Example 4 for a sample calculation.

The boulevard includes the area between the curb and the building face, defined by projecting perpendicular lines from the subject site's property lines. Corner sites must include calculations for all frontages identified by the City.



5.0 Mitigation Measures

5.1 Design Strategies for Shadow Mitigation

Where shadow impacts are considered unacceptable for the given Shadow Impact Criteria, mitigation strategies must be developed and tested. Test results must demonstrate the resultant conditions meet the applicable Shadow Impact Criteria.

Unacceptable shadow impacts occur when an area is being partially or fully shadowed for a duration and extent such that the use and enjoyment of the space is impeded. The definition of unacceptable will vary based on use, location, and the specific metrics used in defining the acceptability of conditions.

The most effective shadow impact mitigation measures involve adjustments to the building and site design early in the design process. This may include:

- Lot assembly;
- Reduced building footprints;
- Building massing adjustments including but not limited to building setbacks and stepbacks (Figure 5.1);
- Reduction in building height; and,
- Building placement and orientation (Figure 5.2).

Figure 5.1 - Building massing stepbacks
Image credit: Brook McIlroy

Figure 5.2 - Slender towers oriented to maximize sun access
Image credit: Brook McIlroy

6.0 Submission Format

A technical report shall be prepared upon the completion of the Shadow Study. In General, the report should address the following items set out in Sections 6.1 - 6.6, inclusive:

Submissions shall be completed to the satisfaction of the Community Planning Department.

6.1 Study Drawings

Required Shadow Study drawings include the following test dates and times:

Spring and Fall Equinoxes:

- March 21st, hourly increments between 09:00 – 18:00; and,
- September 21st, hourly increments between 09:00 – 18:00.

Winter and Summer Solstices:

- December 21st, hourly increments between 11:00 – 15:00; and,
- June 21st, hourly increments between 08:00 –19:00.

Some test dates and times will be for illustrative purposes only. Calculations and accompanying drawings are required only for the specified dates and times required for each of the applicable Shadow Impact Criteria.

6.2 Base Mapping

Because shadow impacts are greatest to the north and east, the base mapping must include a study area with a minimum coverage area of:

- 4 times the building height to the north;
- 6 times the building height to the east;
- 3 times the building height to the west; and,
- 1.5 times the building height to the south.

Identification of shadow-sensitive areas as defined in Section 4.0 or by City staff.

6.3 Shadow Drawings

Shadow Studies should show a complete set of shadow drawings for each of the dates and times listed in Section 6.1 together with calculation drawings for each applicable Shadow Impact Criteria.

Drawings should conform to the following graphic standards:

- 2-Dimensional planimetric view with true north oriented to the top of the drawing;
- Stated scale with scale bar;
- Format each drawing to at least 8.5” x 11” size;
- Submissions must be generated in full colour;
- Indicate the following features within the study area as defined in Section 6.2:
    - Development site boundaries (red dashed lines);
    - Footprint and mass of the building(s) proposed (thick black solid lines);
    - Footprint and mass of existing buildings (thin black solid lines);
    - Any Parks, Natural Heritage Systems, Major Parks or Open Space designated lands, Key Civic and Cultural Spaces, or Places where Children Play (thick green dashed lines);
    - Public Realm and Sidewalks (thin blacksolid lines); and,
    - Private Outdoor Amenity Space (thick pink dashed lines).

Reference graphic standard examples illustrated in Section 4.0 and Appendix A.

Based on 3D simulations, Shadow Study diagrams should include colour-coded shadows cast from the proposed buildings and all existing buildings within the study area, conforming to the following graphic standards:

- Shadows cast by existing buildings on all surfaces (black/grey);
- Net New Shadows cast by proposed building(s) on ground surfaces (blue);
- Net New Shadows cast by proposed building(s) on roof surfaces (purple); and,
- Shadows no longer proposed resulting from proposed changes (beige).

Where calculations are required to show conformance with the applicable Shadow Impact Criteria, shadow coverage at each test time (in m^2) should be noted either next to the applicable shadow drawing, or in a chart.

All graphic elements including shadow colours should be illustrated in a printed legend.

6.4 Configurations

- Existing and Proposed: Include the Proposed Development and all existing buildings, significant topographic features, and approved or under construction developments within the study area as defined in Section 6.2.
- Future (if applicable): Add any proposed developments as identified by the City of Burlington.
- Mitigation (if applicable): Show any changes to the proposed buildings intended to mitigate shadow impacts.

6.5 Other Required Contents

- Project name and address;
- Date;
- Legend;
- Names of Streets, Parks, Natural Heritage Systems, Major Parks or Open Spaces, Key Civic and Cultural Spaces, and Places where Children Play; and,
- A metric scale suitable to show the entire study area, per Section 6.2.

6.6 Written Analysis

- Description of how the proposal meets the applicable Shadow Impact Criteria;
- If applicable, quantification of how the proposal meets the shadow impact criteria (see Appendix B for details);
- Description of any locations/uses of areas not meeting the Shadow Impact Criteria (include a key plan for reference);
- Description of any cumulative shadows;
- Quantification and assessment of the impact in the areas that do not meet the Shadow Impact Criteria; and,
- Summary outlining how the Shadow Impact Criteria have been met and description of any mitigating features that have been incorporated into the site and building design.

Glossary

Boulevard: The boulevard area is between the curb and building face, including but not limited to vegetated grass areas and the sidewalk.

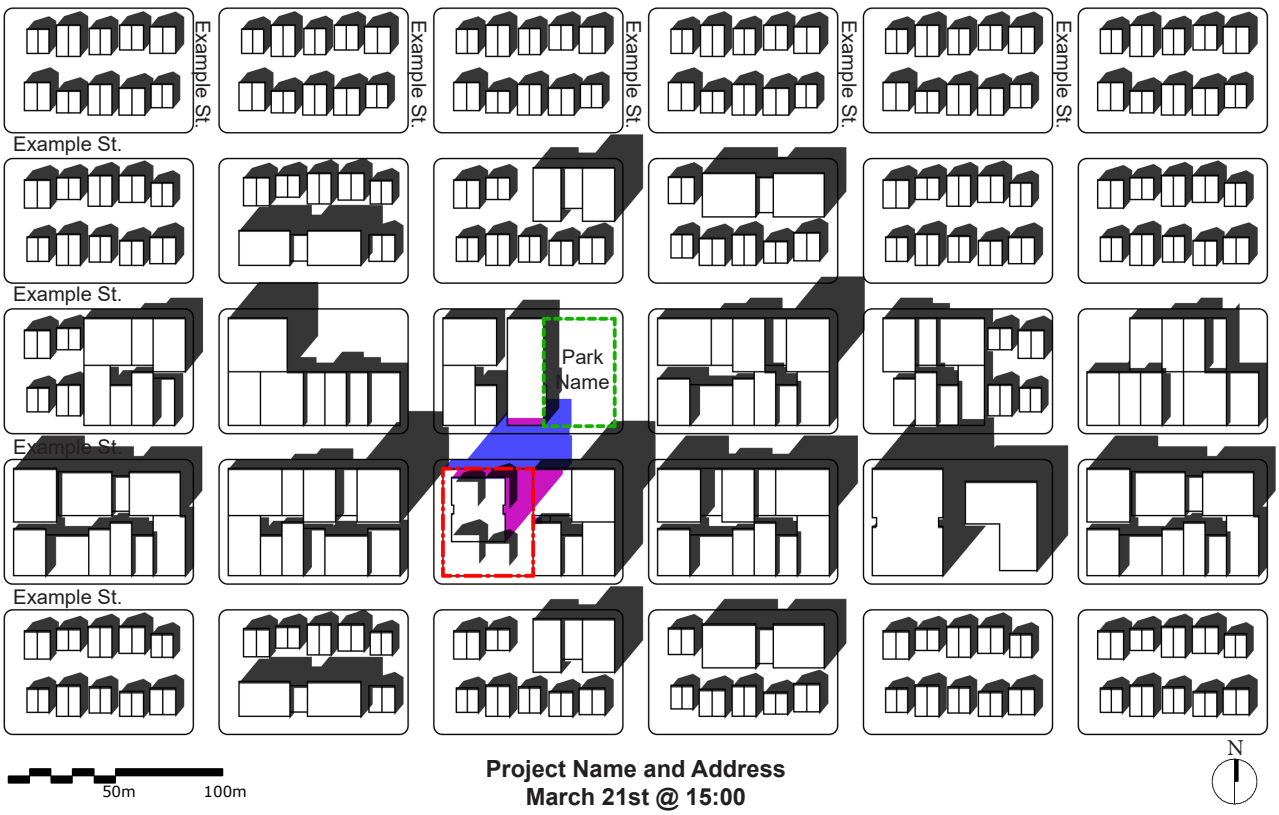
Net New Shadow: Incremental shadows that exceed the existing building shadows.

Sun Access Factor: A measure of sun penetration on a given area, during a specified time frame.

Thermal Comfort: The condition of mind that expresses satisfaction with the thermal environment. Thermal comfort may be influenced by air velocity, air temperature, radiant temperature, humidity, and other personal factors such as clothing insulation and metabolic conditions.

Appendix A: Graphical Standards

Shadow Study Diagram and Legend



Scale = 1:2,000

- Net New Shadows cast on roof surfaces
- Net New Shadows cast on ground surfaces
- Shadows cast by existing buildings on all surfaces
- Site Boundary
- Open Space[1]

Notes:

1. Open Space includes lands designated or used for Parks and Open Space, Key Civic and Cultural Spaces, or Places where Children Play.

2. Study Area includes a minimum coverage area of:
   - 4 times the building height to the north;
   - 6 times the building height to the east;
   - 3 times the building height to the west; and
   - 1.5 times the building height to the south.

Appendix B: Sun Access Factor Sample Calculations

Example 1 – Private Outdoor Amenity Area – Shared Common Space

1. Total area of adjacent residential amenity (A_T) = 1,783 m^2

2. Areas exposed to sunshine at each hourly test time ($A_{S\ (test)}$):

   09:00 ($A_{S\ (test\text{-}09:00}$) = 1,142 m^2

   10:00 ($A_{S\ (test\text{-}09:00}$) = 1,334 m^2

   11:00 ($A_{S\ (test\text{-}09:00}$) = 1,351 m^2

   12:00 ($A_{S\ (test\text{-}09:00}$) = 1,328 m^2

   13:00 ($A_{S\ (test\text{-}09:00}$) = 1,252 m^2

   14:00 ($A_{S\ (test\text{-}09:00}$) = 1,027 m^2

   15:00 ($A_{S\ (test\text{-}09:00}$) = 751 m^2

   16:00 ($A_{S\ (test\text{-}09:00}$) = 654 m^2

   17:00 ($A_{S\ (test\text{-}09:00}$) = 363 m^2

   18:00 ($A_{S\ (test\text{-}09:00}$) = 180 m^2

   Number of test times = 10

3. The averages for the nine one-hour intervals ($A_{S\ (interval)}$):

   09:00-10:00 ($A_{S\ (interval\text{-}09:00\text{-}10:00}$) = (1,142 m^2 + 1,334 m^2) ÷ 2 = 1,238 m^2

   10:00-11:00 ($A_{S\ (interval\text{-}10:00\text{-}11:00}$) = (1,334 m^2 + 1,351 m^2) ÷ 2 = 1,342.5 m^2

   11:00-12:00 ($A_{S\ (interval\text{-}11:00\text{-}12:00}$) = (1,351 m^2 + 1,328 m^2) ÷ 2 = 1,339.5 m^2

   12:00-13:00 ($A_{S\ (interval\text{-}12:00\text{-}13:00}$) = (1,328 m^2 + 1,252 m^2) ÷ 2 = 1,290 m^2

   13:00-14:00 ($A_{S\ (interval\text{-}13:00\text{-}14:00}$) = (1,252 m^2 + 1,027 m^2) ÷ 2 = 1,139.5 m^2

   14:00-15:00 ($A_{S\ (interval\text{-}14:00\text{-}15:00}$) = (1,027 m^2 + 751 m^2) ÷ 2 = 889 m^2

   15:00-16:00 ($A_{S\ (interval\text{-}15:00\text{-}16:00}$) = (751 m^2 + 654 m^2) ÷ 2 = 702.5 m^2

   16:00-17:00 ($A_{S\ (interval\text{-}16:00\text{-}17:00}$) = (654 m^2 + 363 m^2) ÷ 2 = 508.5 m^2

   17:00-18:00 ($A_{S\ (interval\text{-}17:00\text{-}18:00}$) = (363 m^2 + 180 m^2) ÷ 2 = 271.5 m^2

   Number of test intervals = 9

   Sum of ($A_{S\ (interval)}$) = 8,721 m^2

4. The overall average area in sunshine ($A_{S\ (average)}$) = [sum of ($A_{S\ (interval)}$)] ÷ [# of intervals]

   = 8,721 m^2 ÷ 9

   = 969 m^2

5. SAF = ($A_{S\ (average)}$) ÷ A_T

   = 969 m^2 ÷ 1,783 m^2

   = 0.54

   0.54 is greater than 0.22. Therefore, the SAF meets the criteria.

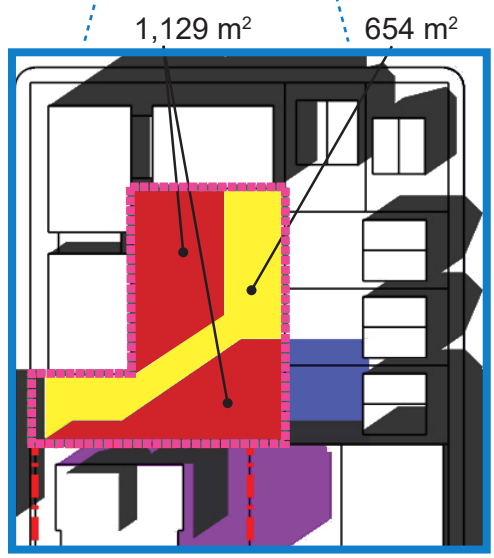
March 21st

Legend

- Site Boundary
- Open Space[1]
- Private Outdoor Amenity Area
- Net New Shadows cast on roof surfaces
- Net New Shadows cast on ground surfaces
- Existing Shadows cast on ground surfaces

Note:

1. Open Space includes lands designated for Parks and Open Space, Key Civic and Cultural Spaces, or Places where Children Play.



- Adjacent Residential Amenity Space Total Area: 1,783 m²
- Area Exposed to Sunshine ($A_{S(test)}$): 654 m²
- Area in Shadow (including existing and proposed shadows): 1,129 m²

Example 2 – Private Outdoor Amenity Area – Residential Rear Yard

1. Total area of adjacent residential amenity (A_T) = 236 m^2
2. Areas exposed to sunshine at each hourly test time ($A_{S\ (test)}$).

   09:00 ($A_{S\ (test\text{-}09:00}$) = 0 m^2

   10:00 ($A_{S\ (test\text{-}09:00}$) = 1 m^2

   11:00 ($A_{S\ (test\text{-}09:00}$) = 4 m^2

   12:00 ($A_{S\ (test\text{-}09:00}$) = 44 m^2

   13:00 ($A_{S\ (test\text{-}09:00}$) = 110 m^2

   14:00 ($A_{S\ (test\text{-}09:00}$) = 152 m^2

   15:00 ($A_{S\ (test\text{-}09:00}$) = 154 m^2

   16:00 ($A_{S\ (test\text{-}09:00}$) = 0 m^2

   17:00 ($A_{S\ (test\text{-}09:00}$) = 4 m^2

   18:00 ($A_{S\ (test\text{-}09:00}$) = 81 m^2

   Number of test times = 10
3. The averages for the nine one-hour intervals ($AS_{\ (interval)}$):

   09:00-10:00 ($A_{S\ (interval\text{-}09:00\text{-}10:00}$) = (0 m^2 + 1 m^2) ÷ 2 = 0.5 m^2

   10:00-11:00 ($A_{S\ (interval\text{-}10:00\text{-}11:00}$) = (1 m^2 + 4 m^2) ÷ 2 = 2.5 m^2

   11:00-12:00 ($A_{S\ (interval\text{-}11:00\text{-}12:00}$) = (4 m^2 + 44 m^2) ÷ 2 = 24 m^2

   12:00-13:00 ($A_{S\ (interval\text{-}12:00\text{-}13:00}$) = (44 m^2 + 110 m^2) ÷ 2 = 77 m^2

   13:00-14:00 ($A_{S\ (interval\text{-}13:00\text{-}14:00}$) = (110 m^2 + 152 m^2) ÷ 2 = 131 m^2

   14:00-15:00 ($A_{S\ (interval\text{-}14:00\text{-}15:00}$) = (152 m^2 + 154 m^2) ÷ 2 = 153 m^2

   15:00-16:00 ($A_{S\ (interval\text{-}15:00\text{-}16:00}$) = (154 m^2 + 0 m^2) ÷ 2 = 77 m^2

   16:00-17:00 ($A_{S\ (interval\text{-}16:00\text{-}17:00}$) = (0 m^2 + 4 m^2) ÷ 2 = 2 m^2

   17:00-18:00 ($A_{S\ (interval\text{-}17:00\text{-}18:00}$) = (4 m^2 + 81 m^2) ÷ 2 = 42.5 m^2

   Number of test intervals = 9

   Sum of ($A_{S\ (interval)}$) = 509.5 m^2
4. The overall average area in sunshine ($A_{S\ (average)}$) = [sum of ($A_{S\ (interval)}$)] ÷ [# of intervals] =

   509.5 m^2 ÷ 9

   = 56.61 m^2
5. SAF = (AS (average)) ÷ AT

   = 56.61 m^2 ÷ 236 m^2

   = 0.24

   0.24 is greater than 0.22. Therefore, the SAF meets the criteria.

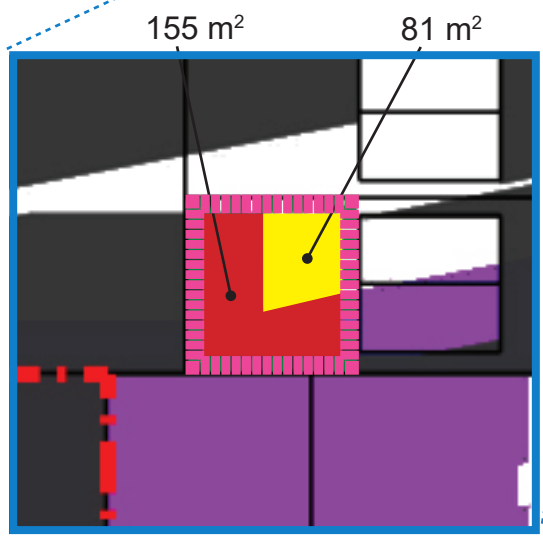
March 21st

Legend

- Site Boundary
- Open Space[1]
- Private Outdoor Amenity Area
- Net New Shadows cast on roof surfaces
- Net New Shadows cast on ground surfaces
- Existing Shadows cast on ground surfaces

Note:

1. Open Space includes lands designated for Parks and Open Space, Key Civic and Cultural Spaces, or Places where Children Play.



- Adjacent Residential Amenity Space Total Area: 236 m²
- Area Exposed to Sunshine ($A_{S(test)}$): 81 m²
- Area in Shadow (including existing and proposed shadows):155 m²

Example 3 – Parks and Open Space

1. Total area of adjacent park (A_T) = 1,650 m^2
2. Areas exposed to sunshine at each hourly test time ($A_{S\ (test)}$):

   09:00 ($A_{S\ (test\text{-}09:00}$) = 1,380 m^2

   10:00 ($A_{S\ (test\text{-}09:00}$) = 1,650 m^2

   11:00 ($A_{S\ (test\text{-}09:00}$) = 1,620 m^2

   12:00 ($A_{S\ (test\text{-}09:00}$) = 1,600 m^2

   13:00 ($A_{S\ (test\text{-}09:00}$) = 1,590 m^2

   14:00 ($A_{S\ (test\text{-}09:00}$) = 1,458 m^2

   15:00 ($A_{S\ (test\text{-}09:00}$) = 1,200 m^2

   16:00 ($A_{S\ (test\text{-}09:00}$) = 730 m^2

   17:00 ($A_{S\ (test\text{-}09:00}$) = 582 m^2

   18:00 ($A_{S\ (test\text{-}09:00}$) = 85 m^2

   Number of test times = 10
3. The averages for the nine one-hour intervals ($A_{S\ (interval)}$):

   09:00-10:00 ($A_{S\ (interval\text{-}09:00\text{-}10:00}$) = (1,380 m^2 + 1,650 m^2) ÷ 2 = 1,515 m^2

   10:00-11:00 ($A_{S\ (interval\text{-}10:00\text{-}11:00}$) = (1,650 m^2 + 1,620 m^2) ÷ 2 = 1,635 m^2

   11:00-12:00 ($A_{S\ (interval\text{-}11:00\text{-}12:00}$) = (1,620 m^2 + 1,600 m^2) ÷ 2 = 1,610 m^2

   12:00-13:00 ($A_{S\ (interval\text{-}12:00\text{-}13:00}$) = (1,600 m^2 + 1,590 m^2) ÷ 2 = 1,595 m^2

   13:00-14:00 ($A_{S\ (interval\text{-}13:00\text{-}14:00}$) = (1, 590 m^2 + 1,458 m^2) ÷ 2 = 1,524 m^2

   14:00-15:00 ($A_{S\ (interval\text{-}14:00\text{-}15:00}$) = (1, 458 m^2 + 1,200 m^2) ÷ 2 = 1,329 m^2

   15:00-16:00 ($A_{S\ (interval\text{-}15:00\text{-}16:00}$) = (1,200 m^2 + 730 m^2) ÷ 2 = 965 m^2

   16:00-17:00 ($A_{S\ (interval\text{-}16:00\text{-}17:00}$) = (730 m^2 + 582 m^2) ÷ 2 = 656 m^2

   17:00-18:00 ($A_{S\ (interval\text{-}17:00\text{-}18:00}$) = (582 m^2 + 85 m^2) ÷ 2 = 334 m^2

   Number of test intervals = 9

   Sum of ($A_{S\ (interval)}$) = 11,163 m^2
4. The overall average area in sunshine ($A_{S\ (average)}$) = [sum of ($A_{S\ (interval)}$)] ÷ [# of intervals]

   = 11,163 m^2 ÷ 9

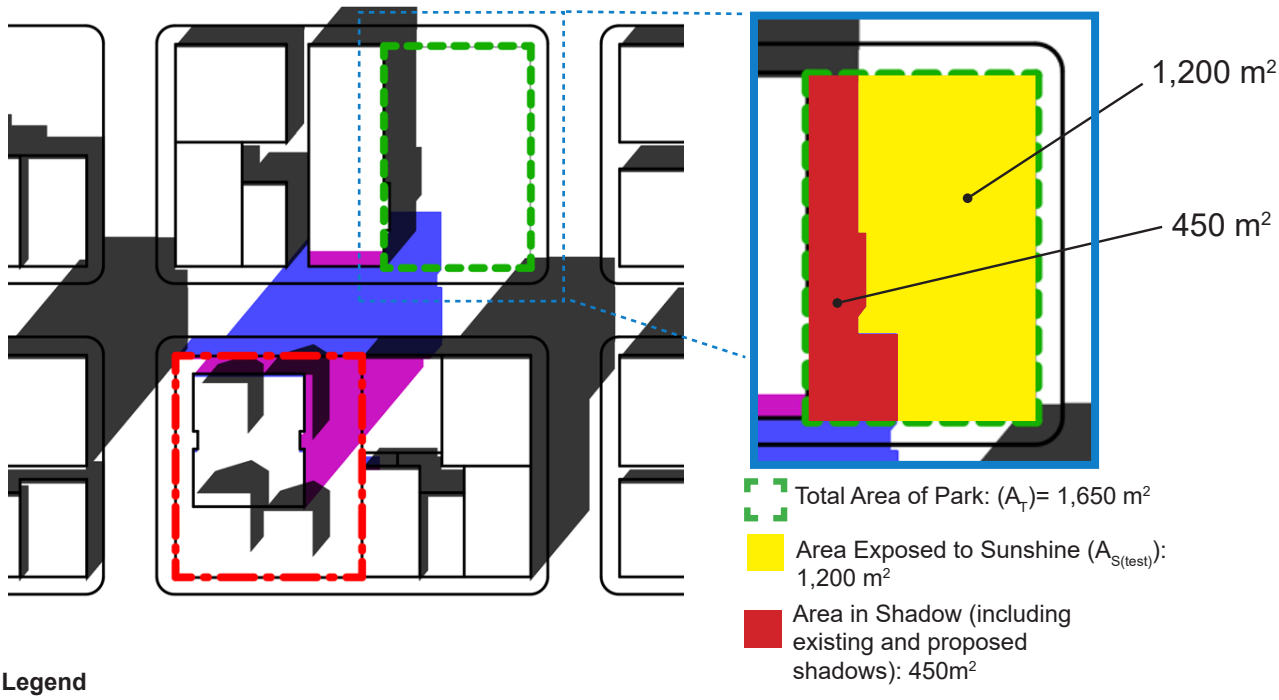
   = 1,240 m^2
5. SAF = ($A_{S\ (average)}$) ÷ A_T

   = 1,240 m^2 ÷ 1,650 m^2

   = 0.75

   0.75 is greater than 0.50. Therefore, the SAF meets the criteria.

March 21st @ 15:00



Legend

- Site Boundary
- Open Space[1]
- Net New Shadows cast on roof surfaces
- Net New Shadows cast on ground surfaces
- Existing Shadows cast on ground surfaces

Example 4 – Public Realm and Sidewalks

1. Total area of opposite boulevard (A_T) = 168 m^2
2. Areas exposed to sunshine at each hourly test time ($A_{S\ (test)}$):

   09:00 ($A_{S\ (test\text{-}09:00}$) = 168 m^2

   10:00 ($A_{S\ (test\text{-}09:00}$) = 168 m^2

   11:00 ($A_{S\ (test\text{-}09:00}$) = 138 m^2

   12:00 ($A_{S\ (test\text{-}09:00}$) = 94 m^2

   13:00 ($A_{S\ (test\text{-}09:00}$) = 68 m^2

   14:00 ($A_{S\ (test\text{-}09:00}$) = 64 m^2

   15:00 ($A_{S\ (test\text{-}09:00}$) = 90 m^2

   16:00 ($A_{S\ (test\text{-}09:00}$) = 145 m^2

   17:00 ($A_{S\ (test\text{-}09:00}$) = 168 m^2

   18:00 ($A_{S\ (test\text{-}09:00}$) = 168 m^2

   Number of test times = 10
3. The averages for the nine one-hour intervals ($A_{S\ (interval)}$):

   09:00-10:00 ($A_{S\ (interval\text{-}09:00\text{-}10:00}$) = (168 m^2 + 168 m^2) ÷ 2 = 168 m^2

   10:00-11:00 ($A_{S\ (interval\text{-}10:00\text{-}11:00}$) = (168 m^2 + 138 m^2) ÷ 2 = 153 m^2

   11:00-12:00 ($A_{S\ (interval\text{-}11:00\text{-}12:00}$) = (138 m^2 + 94 m^2) ÷ 2 = 116 m^2

   12:00-13:00 ($A_{S\ (interval\text{-}12:00\text{-}13:00}$) = (94 m^2 + 68 m^2) ÷ 2 = 81 m^2

   13:00-14:00 ($A_{S\ (interval\text{-}13:00\text{-}14:00}$) = (68 m^2 + 64 m^2) ÷ 2 = 66 m^2

   14:00-15:00 ($A_{S\ (interval\text{-}14:00\text{-}15:00}$) = (64 m^2 + 90 m^2) ÷ 2 = 77 m^2

   15:00-16:00 ($A_{S\ (interval\text{-}15:00\text{-}16:00}$) = (90 m^2 + 145 m^2) ÷ 2 = 117.5 m^2

   16:00-17:00 ($A_{S\ (interval\text{-}16:00\text{-}17:00}$) = (145 m^2 + 168 m^2) ÷ 2 = 156.5 m^2

   17:00-18:00 ($A_{S\ (interval\text{-}17:00\text{-}18:00}$) = (168 m^2 + 168 m^2) ÷ 2 = 168 m^2

   Number of test intervals = 9

   Sum of ($A_{S\ (interval)}$) = 1,103 m^2
4. The overall average area in sunshine ($A_{S\ (average)}$) = [sum of ($A_{S\ (interval)}$)] ÷ [# of intervals]

   = 1,103 m^2 ÷ 9

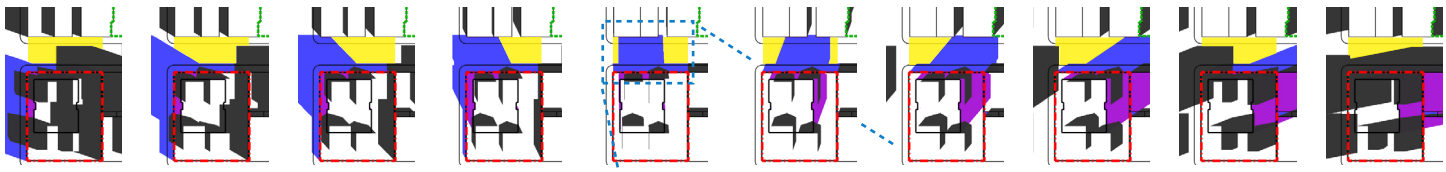
   = 122.56 m^2
5. SAF = ($A_{S\ (average)}$) ÷ A_T

   = 122.56 m^2 ÷ 168 m^2

   = 0.73

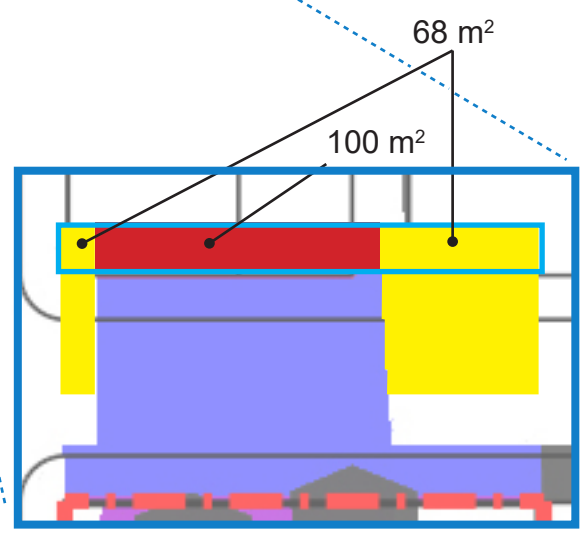
   0.73 is greater than 0.50. Therefore, the SAF meets the criteria.

March 21st



Legend

- Site Boundary
- Open Space[1]
- Net New Shadows cast on roof surfaces
- Net New Shadows cast on ground surfaces
- Existing Shadows cast on ground surfaces



Total Opposite Boulevard Area: 168 m²

Area Exposed to Sunshine ($A_{S(test)}$): 68 m²

Area in Shadow (including existing and proposed shadows): 100m²

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