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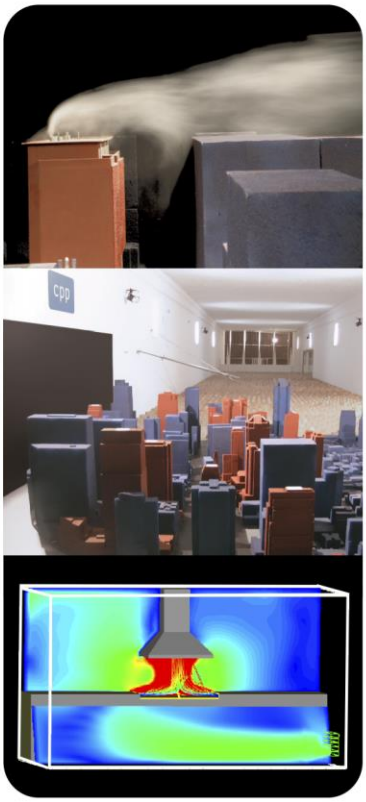
Final Report



Solar Reflectivity Assessment for:

388 Pitt St

Sydney, Australia

Prepared for:

Han's Sydney Pty Ltd

Suite 6.02, Level 6, 233 Castlereagh Street

Sydney NSW 2000

Australia

January 2020

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DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
28/01/20	Final Report	JS	AN	MG

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This report supports a Stage Significant Development Application (SSDA) for the mixed use redevelopment of 338 Pitt Street, Sydney, which is submitted to the City of Sydney pursuant to *Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). China Centre Development Pty Ltd is the proponent of the SSDA.*

The site is located at the corner of Pitt Street and Liverpool Street, within the 'Mid Town' precinct of Sydney's Central Business District (CBD). The site is approximately 150m west of Museum Station and Hyde Park, and approximately 350m from Town Hall Station. The site includes several allotments and constitutes nearly one third of the city block between Bathurst Street, Pitt Street and Liverpool Street. The site is an irregular shape and has a combined area of approximately 5,900m².

The proposed development comprises of hotel, residential, commercial and retail uses and will include:

- *demolition of all existing structures;*
- *excavation and site preparation, including any required remediation;*
- *construction and use of a mixed-use development, with an iconic 258m two-tower built form above a podium and internal courtyard;*
- *four (4) basement levels and a lower ground level accommodating residential, retail and hotel car parking, motorcycle parking, bicycle parking, loading dock, storage and relevant building services;*
- *improvements to the public domain, including landscaping, pedestrian thoroughfares/connections, and landscaping; and*
- *augmentation and extension of utilities and services.*

A detailed description of development is provided by Ethos Urban within the EIS.

The following table summarises the requirements of the SEARS relevant to this report:

Key issues	Requirement	Relevant Report Section
1. Statutory and Strategic context	Address the statutory provisions applying to the development contained in all relevant environmental planning instruments, including: Sydney Development Control Plan 2012.	Section 2
5. Amenity	Detail on the amenity and solar access in accordance with the Sydney DCP 2012 and Apartment Design Guide	Sections 3,4

1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Han's Sydney Pty Ltd to provide an assessment on the potential of the proposed development at 388 Pitt St, Sydney, Australia, to produce solar reflectivity impacts on surrounding public roadway locations, Figure 1. The proposed development is located within the Sydney CBD, and consists of 2 slim residential towers, joined by a rigid skybridge, and a mixed-use podium reaching 260 m above ground level with facades comprising mostly glazing.

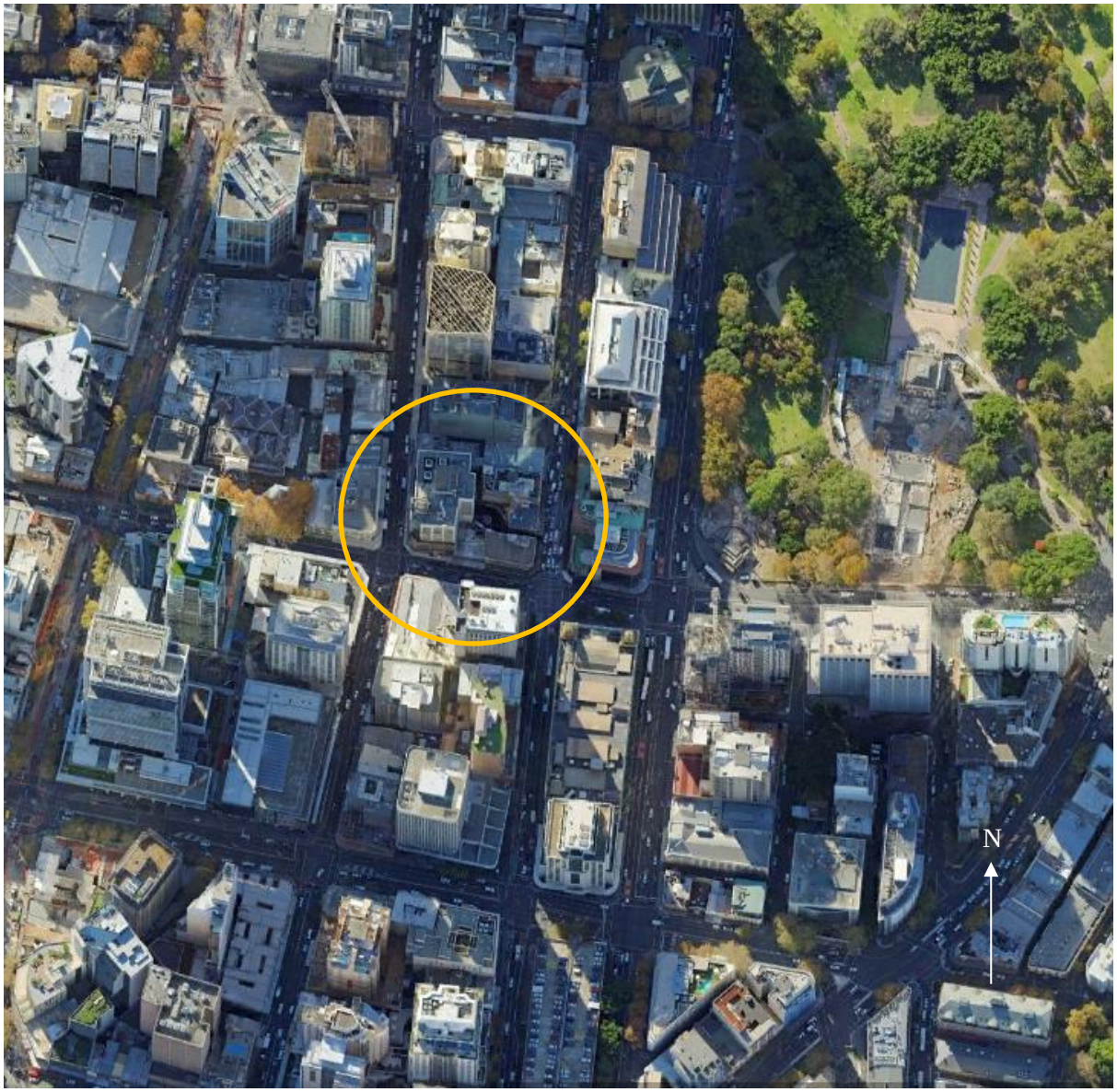

Figure 1: Aerial view of the proposed development site (Google Earth, 2019).

Figure 2: Structures and massing within the proposed development.

2 CITY OF SYDNEY COUNCIL CONSIDERATIONS

Sydney Development Control Plan 2012 outlines the requirements for the assessment of solar reflections emanating from proposed developments. To assess the solar impacts of the 388 Pitt St, this report considers Sydney DCP 2012, General Provisions, Section 3.2.7 Reflectivity, specifically:

Provisions

(1) *A Reflectivity Report that analyses potential solar glare from the proposed building design may be required for tall buildings.*

(2) *Generally, light reflectivity from building materials used on facades must not exceed 20%.*

It is not explicitly defined in Councils' DCP to which component to reflections, specular or diffuse, the prescribed limit is applicable. CPP presumes the reflectivity limit is applicable to the specular component of reflections as they are most associated with traffic disability glare. It is therefore recommended that Han's Sydney Pty Ltd ensure exterior elements on the facades studied in this report will have a specular reflectivity coefficient of 20% or less. This is defined as the percentage of solar reflection when light strikes and reflects normal to the façade plane.

This study does not directly study non-glazing materials/surfaces that produce more diffuse than specular reflections; diffuse reflections are more associated with discomfort glare than disability glare. As CPP are aware, there are no industry accepted criteria guiding design to control discomfort glare from diffuse components of reflections, due to the subjective nature and difficulty of quantifying glare from diffuse components of reflections in terms of amenity. As good practice, it is generally recommended the external surface reflectivity coefficient of chosen materials/surfaces that are more likely to emit diffuse than specular reflections is limited to 20% for the specular component.

3 ASSESSMENT METHODOLOGY

This report assesses the potential for disability glare from solar reflections from the proposed development taking into consideration:

- Seasonal and diurnal solar paths (sun altitude and azimuth) at the project altitude, and the relative angle of the incident and reflected solar rays (reflectivity coefficients of glazing increase with increasing incident angle),
- An assumed specular reflectivity coefficient of 20%, per Council requirements, for the external glazing is used in the calculations, and the incident angle of the solar rays is also accounted for (allowance is made for reflectivity coefficients of glazing to increase with increasing incident angle),
- Receiver locations of interest (the alignment of adjoining public roadways being of particular interest, Figure 3), and
- Architectural drawings provided by Han's Sydney Pty Ltd dated November 19.

Calculations in this report assume the façade surfaces of the proposed development will produce specular type reflections, such as glazing, where the reflected ray angle is equal to the incident solar ray angle, being valid for many smooth surface façade materials. Curved surfaces are not directly quantified in this report; any curved facades of the proposed building were approximated for the assessment by modelling them as multiple vertical flat surfaces to estimate the degree of reflections onto the investigated locations.

CPP use, in part, methodology developed by Hassall (1991), and the concept of veiling glare and contrast when quantifying the potential for hazard rogue specular solar reflections from the proposed development onto selected surrounding receiver locations, Figure 3.

Threshold Increment (TI) is the percentage by which the contrast must be increased relative to the background to make the object just visible due to the addition of glare (generated by the solar reflections) and is the parameter calculated in this study to assess the acceptability of potential glare events. TI is a parameter used in the design of Road Lighting, e.g. AS/NZS 1158.1.1:2005 where a maximum TI value of 20% is used for all roadway lighting categories and is the acceptability criterion adopted in this study for assessing disability glare impact on passing traffic.

Proprietary software was used to calculate TI values at expected maximum impact locations of vehicles travelling in the directions as marked in Figure 3 where potential future changes in traffic conditions have been considered.

Certain building materials other than glass, including metallic framing and supports, produce diffuse reflections that are not directly quantified by the methodology adopted in this report. By definition, diffuse reflections have a greater scatter of reflected angles with lower concentration of reflected light in any given direction and are generally less likely to cast hazardous distant disability glare reflections than flat surface glazing. Notwithstanding, these materials and surfaces have potential to produce discomfort glare, and to reduce this impact it is recommended that all non-glazed façade surfaces adopt low lustre, non-glossy, textured or matte finishes.

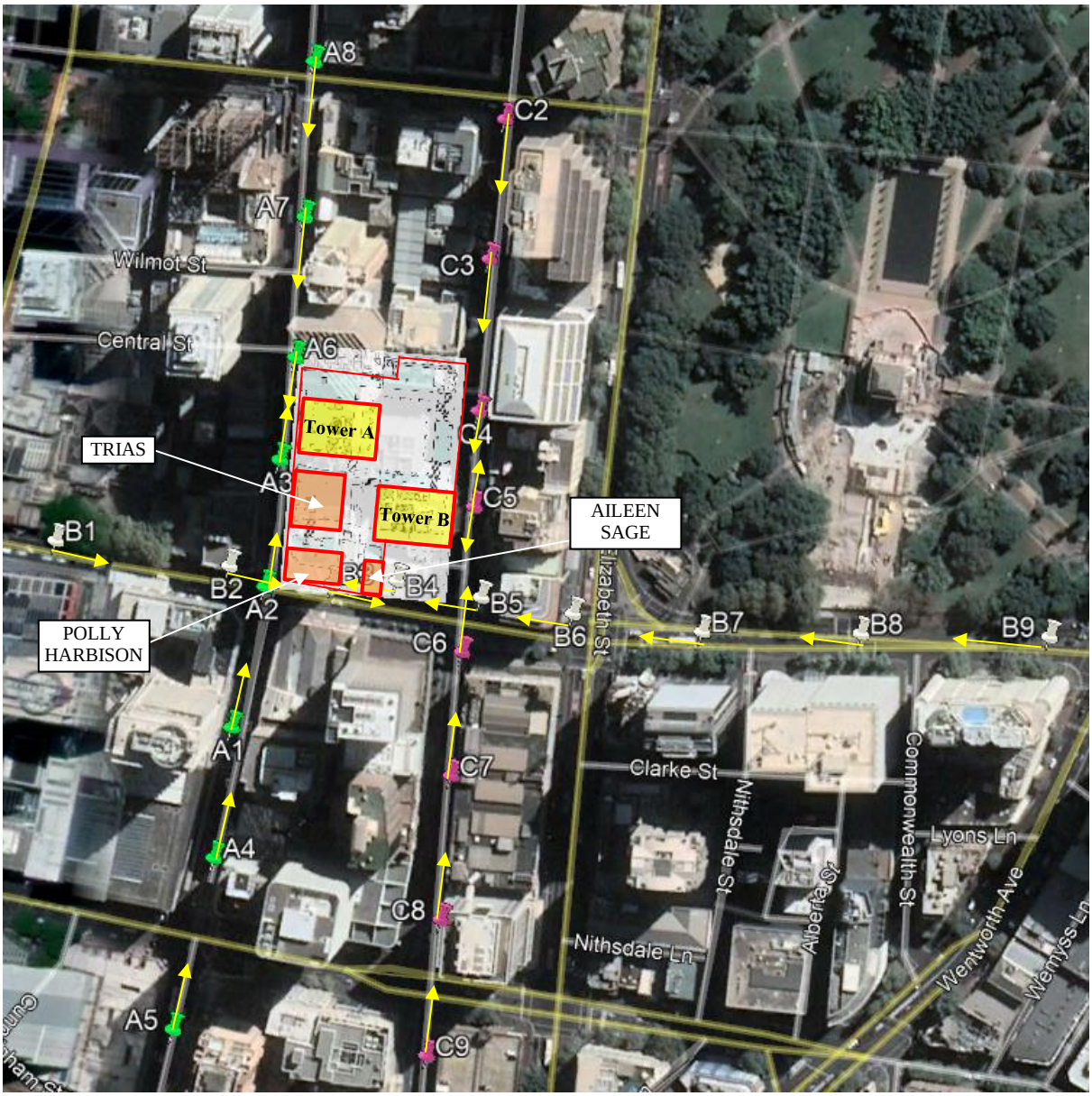

Figure 3: Investigated impact locations of vehicles travelling in indicated directions.

Results of the assessment are visualised using the publicly available SunCalc tool (Hoffmann), which plots the movement of the sun and sunlight-phase at a specific location and time in the year, Figure 4. The solar plot in Figure 4 plots the incoming solar rays (radial yellow line) from the Sun (orange circle) reflecting off the façade of a building (green line) in the southern hemisphere, at 9am in mid-February, onto a receiver location (labelled "a"). The orange radial line, red radial line, and yellow arc mark the Sun's sunrise position, sunset position, and trajectory, respectively, on this particular day. The shaded yellow region shows the variation of the path of the sun throughout the year; the closer the Sun is to the centre, the higher the sun is above the horizon.

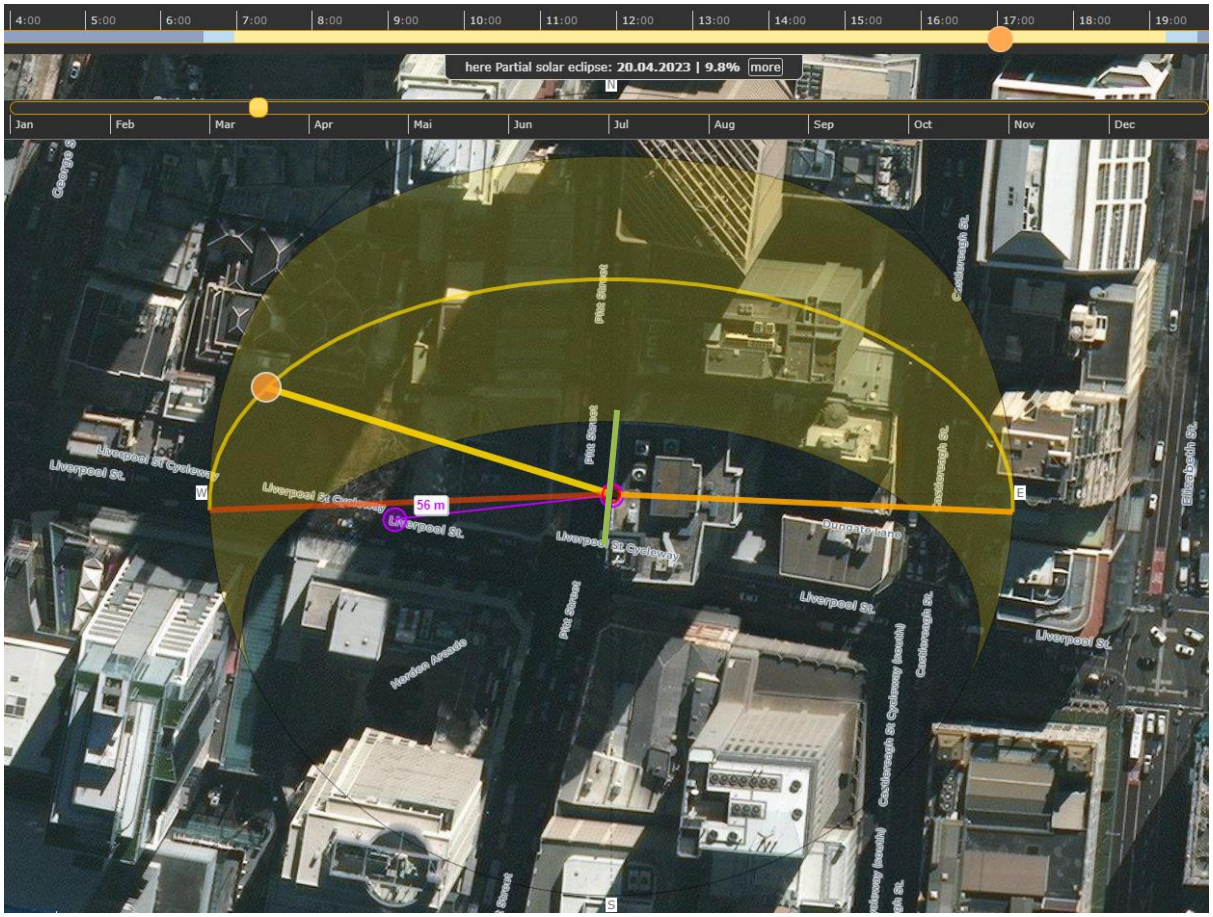

Figure 4: Example usage of the SunCalc tool to visualise solar rays reflecting off a façade.

3 REFLECTIVITY IMPACT RESULTS

3.1 Specular Reflections

Assessment has shown the facades of the proposed 388 Pitt St development have the potential to produce specular solar reflections with varying degrees of glare onto surrounding public surrounding roadways. In the first instance as a 'worst' case scenario, the proposed building was modelled as isolated from surrounding buildings and the investigated locations in Figure 3 consider future changes to traffic conditions along the adjacent roadways by assuming traffic can travel in both directions. The façade surfaces that were considered and modelled in this assessment is shown in Figure 5.

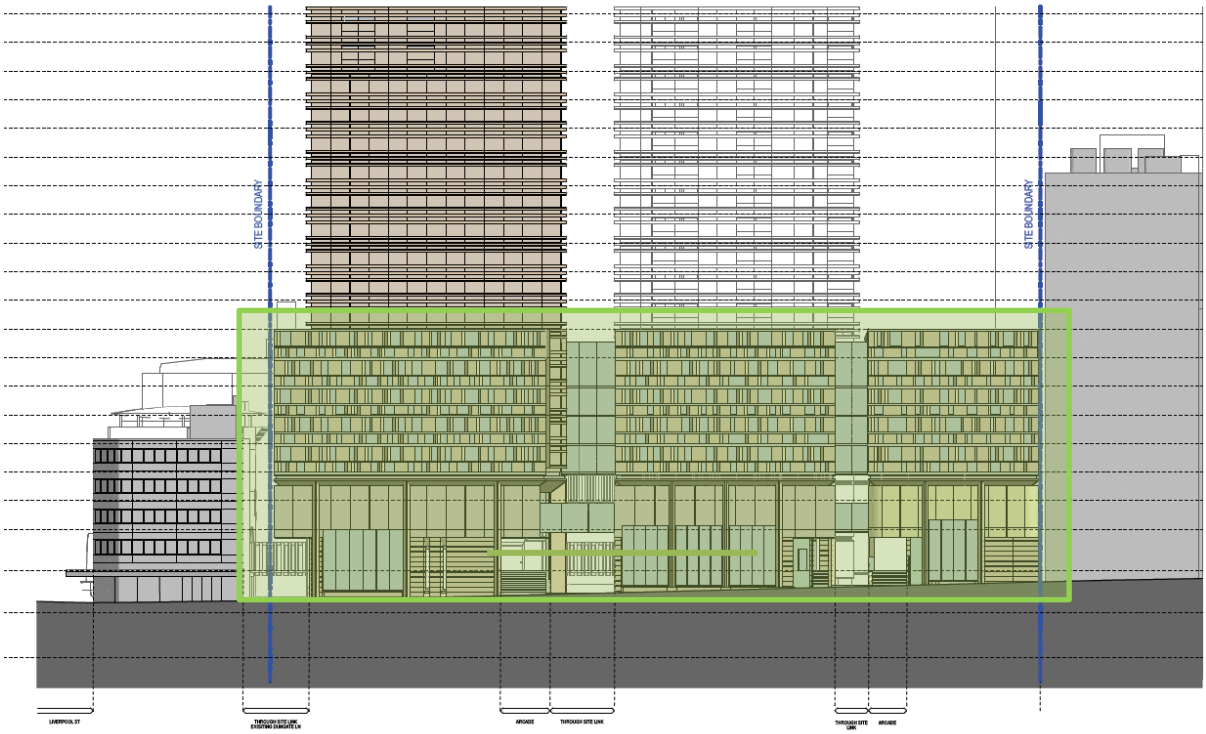

Figure 5: Modelling approximation of facades (green) for the reflectivity assessment.

3.2 Diffuse Reflections

3.2.1 Curved Façade Elements

Diffuse solar reflections that will emanate from any convex façade surfaces on the proposed development will diverge into different directions and continually shift throughout the day. The divergent nature of the solar reflections is usually less substantial than specular solar reflections from flat surfaces since divergent solar reflections are not concentrated in one direction, thus producing lower levels of glare than specular reflections.

From a thermal perspective, concave façade curvature is known to potentially concentrate reflections to hazardous levels at focal points a distance from the development site. This report does not

evaluate thermal properties or visual impacts of solar reflections from concave facades of the proposed building.

3.2.2 Non-glazed Façade Elements

Non-glazed façade elements such as metallic framing and supports have the potential to generate localised glare of both a diffuse and specular nature that can produce a discomfort glare and affect the amenity of the site. It is recommended these elements have an external specular reflectivity coefficient of less than 20% to comply with the recommendations of the various Australian DCPs that have adopted the limit.

3.3 Summary

The summary table below lists the investigated locations that were found to potentially experience solar glare from the proposed building. The following sections of the report will discuss the assessment results in detail, including recommendations for mitigating glare issues.

The remaining investigated locations not listed in Table 1 were found to experience negligible levels of solar glare emanating from the proposed building. Some facades such as the north façade of the podium and south façade of the Aileen Sage building were omitted in the analysis as majority of the north façade of podium is shielded by the neighbour building (320 Pitt Street), and the south façade of Aileen Sage is predominantly made of masonry which not produce any hazardous glare.

Table 1: Summary of reflectivity assessment results along surrounding roadways.

Building	Façade	Street Name	Investigated Location	Level of Glare (TI)	Approximate Time Period (GMT +10)	Season	Discussion
Podium	East	Liverpool St	B6	<20%	7am to 8am	Mid-autumn and early-spring	
		Castlereagh St	C5	~5%	10am to 12pm	Mid-autumn till early-spring	
Polly Harbison	South	Liverpool St	B4, B5, B6	>20%	4pm to 6pm	Late summer till mid autumn, spring	Low altitude, incident solar rays likely blocked by upstream buildings during this time period. Vertical fin proposed and setback of glazing is expected to reduce the impact of glare onto investigated locations.
Tower A	North	Castlereagh St	C1,C2	<20%	12pm to 1pm	Late-autumn till winter	
		Pitt St	A7, A8	~5%	10am to 11am	Late-autumn till winter	
	West	Pitt St	A2	<20%	12pm to 1pm	Mid-autumn till early-spring	
	East	Liverpool St	B6	<20%	7am to 8am	Mid-autumn till late-autumn, Late-winter till early-spring	
		Castlereagh St	C7, C8, C9	~5%	10.30am	Late-autumn till winter	
Tower B	North	Castlereagh St	C1,C2,C3,C4	<20%	12pm	Late-autumn till winter	
		Pitt St	A7, A8	~5%	9.30am to 10am	Late-autumn till winter	
	West	Liverpool St	B1,B2	<20%	3pm to 6pm	Late summer till mid autumn, spring	
	East	Liverpool St	B6	<20%	7am to 8am	Autumn, Mid-winter till early spring	
		Castlereagh St	C7, C8, C9	~5%	11am	Mid-autumn till early-spring	

4 SOLAR REFLECTIVITY ASSESSMENT

4.1 Podium- East Façade

4.1.1 Liverpool Street

Assessment showed there is potential for drivers at Location B6, Figure 3, travelling West along Liverpool Street toward the development site, to experience low levels of glare from the East façade in the morning during mid- autumn and early- spring.

Analysis showed that between approximately 7am to 8am, drivers travelling west at Location B6, Figure 6, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Liverpool travelling West toward the development site were found to experience lower levels of TI values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling West along Liverpool Street.

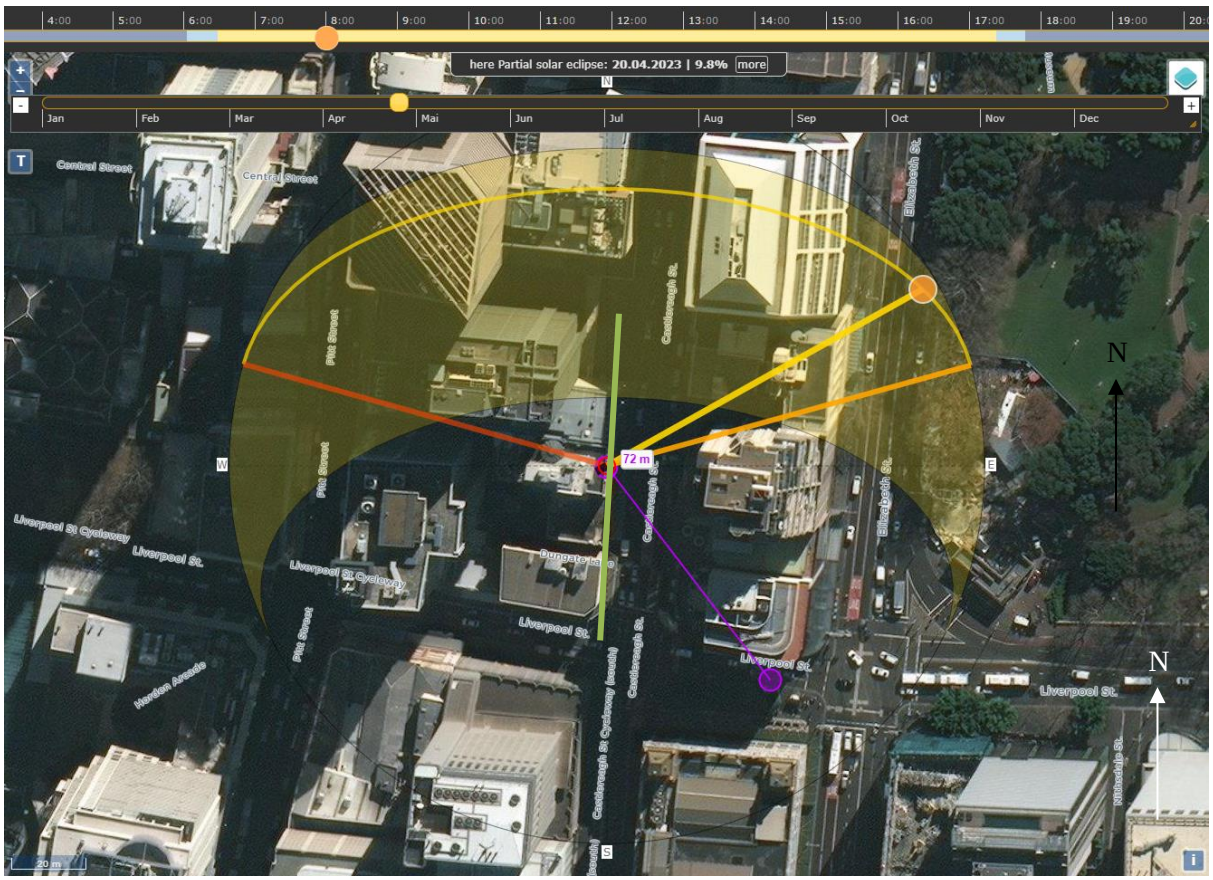

Figure 6: Representation of incident and reflection of solar rays from the East façade onto Liverpool Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the East façade.

4.1.2 Castlereagh Street

Assessment showed there is potential for drivers at Location C5, Figure 3, travelling North along Castlereagh Street toward the development site, to experience low levels of glare from the East façade in the morning during mid- autumn and early- spring.

Analysis showed that between approximately 10am to 12pm, drivers travelling North at Location C5, Figure 7, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Castlereagh travelling North toward the development site were found to experience lower levels of TI values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling North along Castlereagh Street.

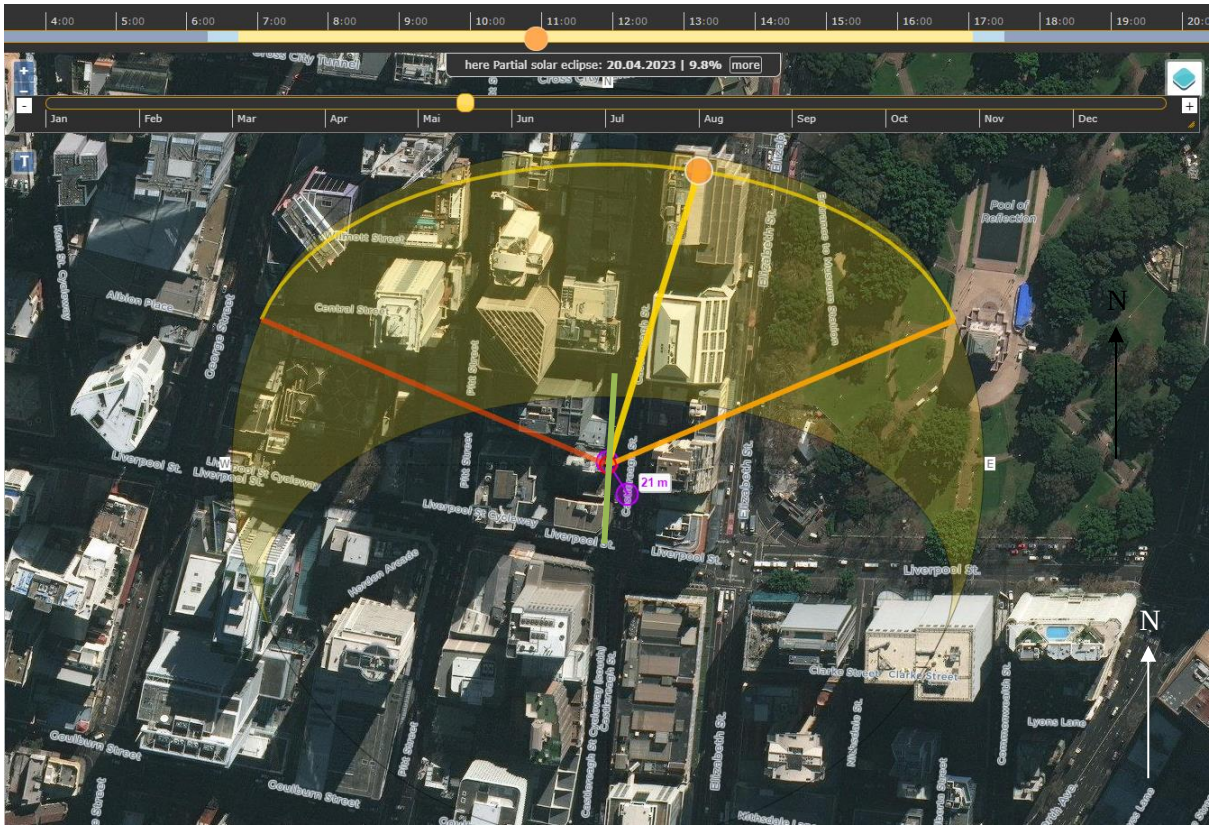

Figure 7: Representation of incident and reflection of solar rays from the East façade onto Castlereagh Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the East façade.

4.2 Polly Harbinson- South Façade

4.2.1 Liverpool Street

Assessment showed there is potential for drivers at Location B4, B5 and B6, Figure 3, travelling West along Liverpool Street toward the development site, to experience high levels of glare from the South façade in the afternoon during late summer till mid- autumn and spring.

Analysis showed that between approximately 4pm to 6pm, drivers travelling west at Location B4, B5 and B6, Figure 8, experienced solar glare with TI values of approximately 80%, which is higher than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

The reflections generating the high levels of glare will occur when the sun's altitude is low, and its solar rays are emanating near parallel to the horizon. Thus, the incident solar rays will be blocked by upstream building and topography before reaching the development site, and hence it is expected solar reflections from the South façade will not negatively impact the vision of drivers' who are travelling West along Liverpool Street. In addition, the setback of the glazing due to presence of vertical fins, Figure 9 is also expected to reduce the impact of glare upon the amenity of site.

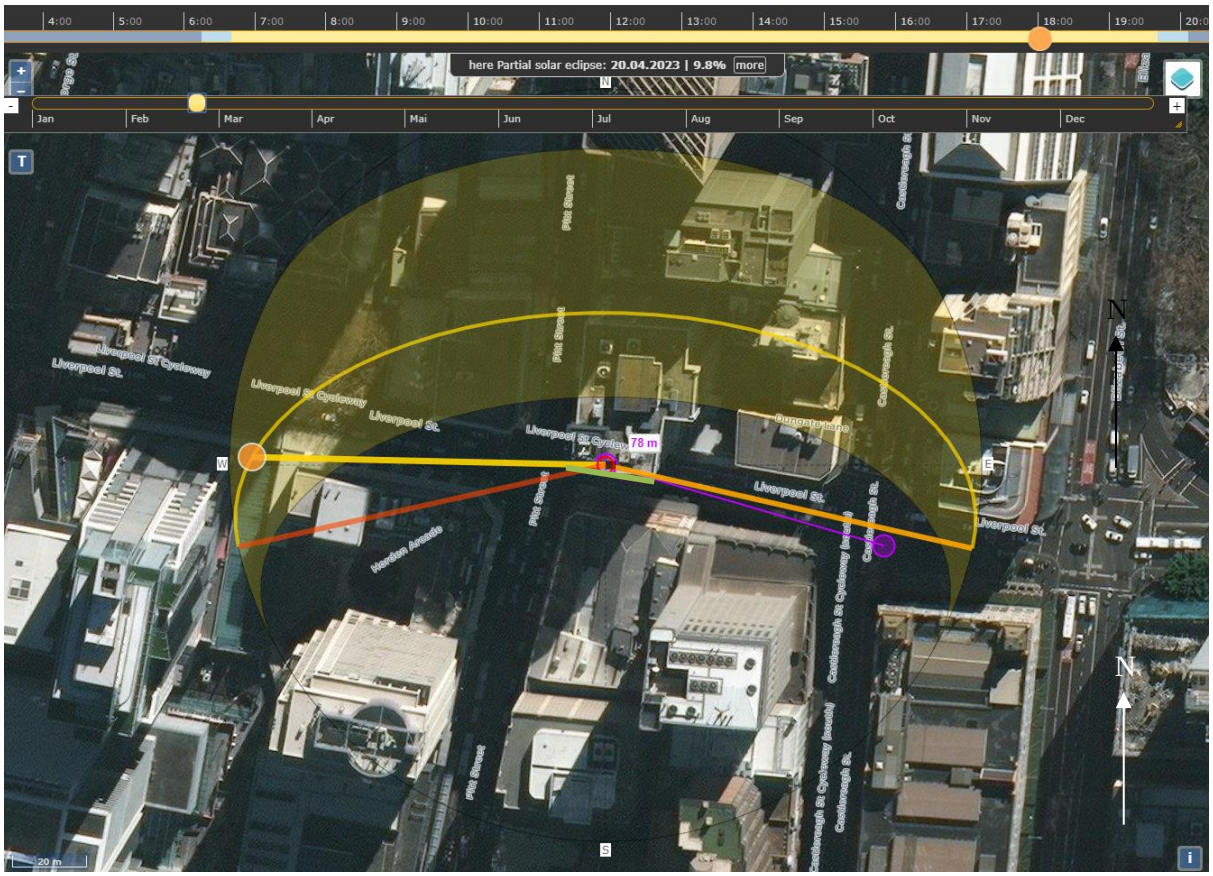

Figure 8: Representation of incident and reflection of solar rays from the South façade onto Liverpool Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the South façade.

Figure 9: Perspective view of Polly Harbinson (Southwest view)

4.3 Tower A- North

4.3.1 Castlereagh Street

Assessment showed there is potential for drivers at Location C1 and C2, Figure 3, travelling South along Castlereagh Street toward the development site, to experience low levels of glare from the North façade in the afternoon during Late- autumn till winter.

Analysis showed that between approximately 12pm till 1pm, drivers travelling South at Location C1 and C2, Figure 10, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Castlereagh Street travelling South toward the development site were found to experience lower levels of TI values for shorter periods of time from the North façade. Thus, it is expected solar reflections from the North façade will not negatively impact the vision of drivers' who are travelling South along Castlereagh Street.

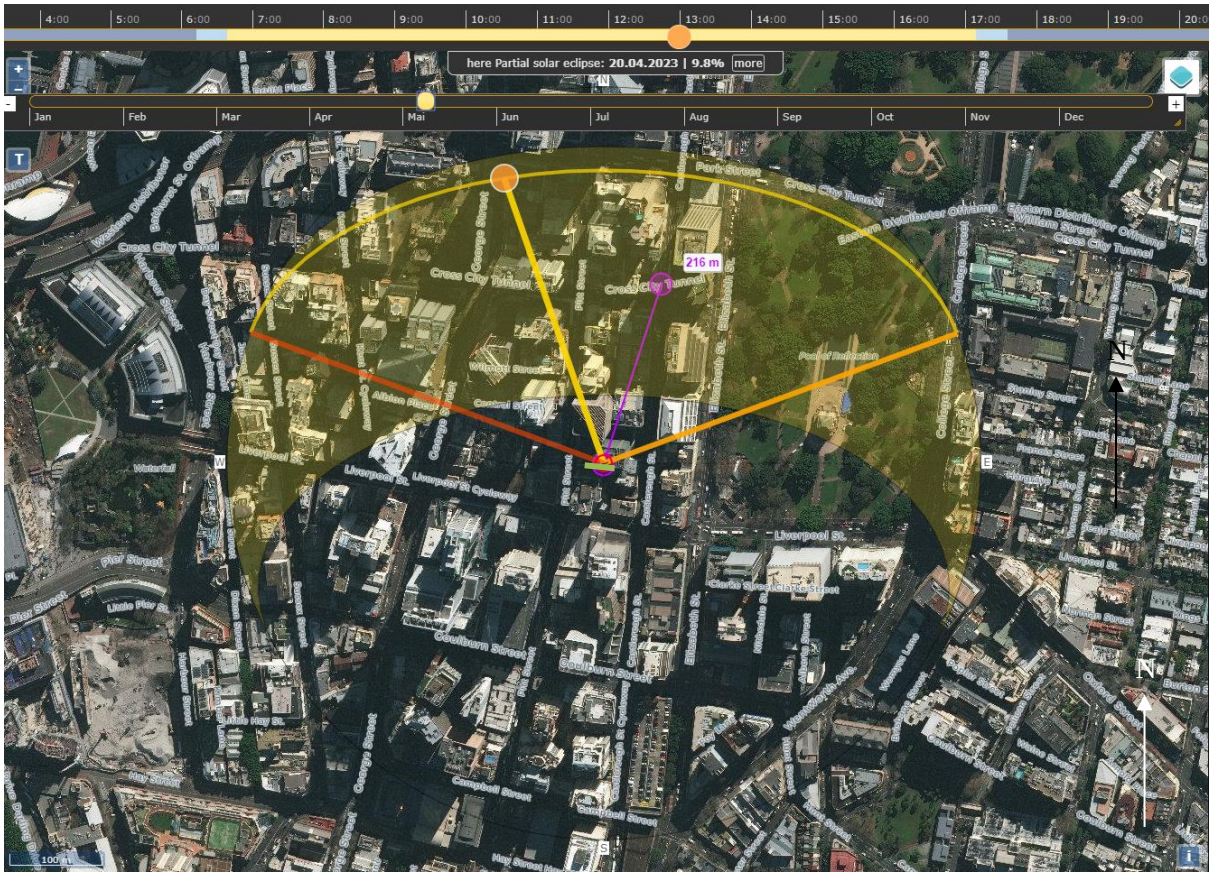

Figure 10: Representation of incident and reflection of solar rays from the North façade onto Castlereagh Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the North façade.

4.3.2 Pitt Street

Assessment showed there is potential for drivers at Location A7 and A8, Figure 3, travelling South along Pitt Street toward the development site, to experience low levels of glare from the North façade in the morning during Late- autumn till winter.

Analysis showed that between approximately 10am till 11am, drivers travelling South at Location A7 and A8, Figure 11, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Pitt Street travelling South toward the development site were found to experience lower levels of TI values for shorter periods of time from the North façade. Thus, it is expected solar reflections from the North façade will not negatively impact the vision of drivers' who are travelling South along Pitt Street.

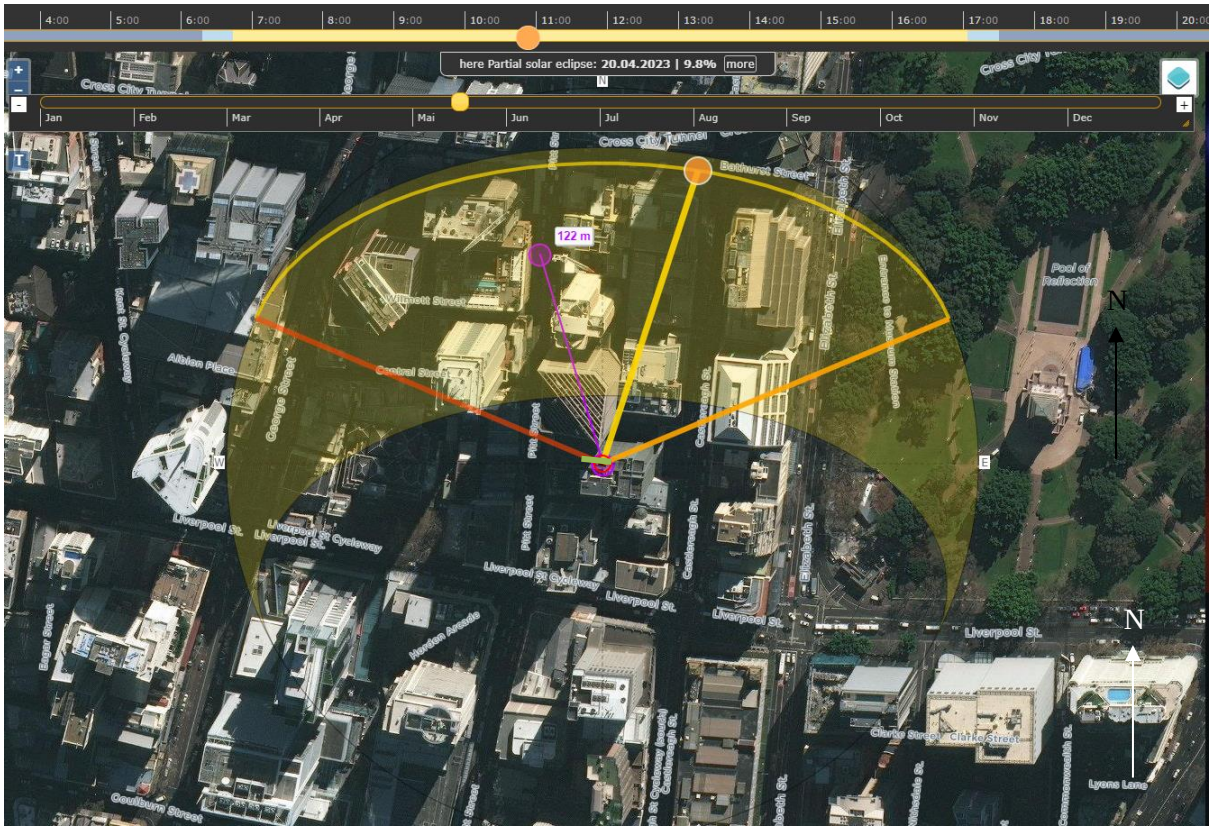

Figure 11: Representation of incident and reflection of solar rays from the North façade onto Pitt Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the North façade.

4.4 Tower A- West

4.4.1 Pitt Street

Assessment showed there is potential for drivers at Location A2, Figure 3, travelling North along Pitt Street toward the development site, to experience low levels of glare from the West façade in the afternoon during mid- autumn till early spring.

Analysis showed that between approximately 12pm to 1pm, drivers travelling North at Location A2, Figure 12, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Pitt travelling North toward the development site were found to experience lower levels of TI values for shorter periods of time from the West façade. Thus, it is expected solar reflections from the West façade will not negatively impact the vision of drivers' who are travelling North along Pitt Street.

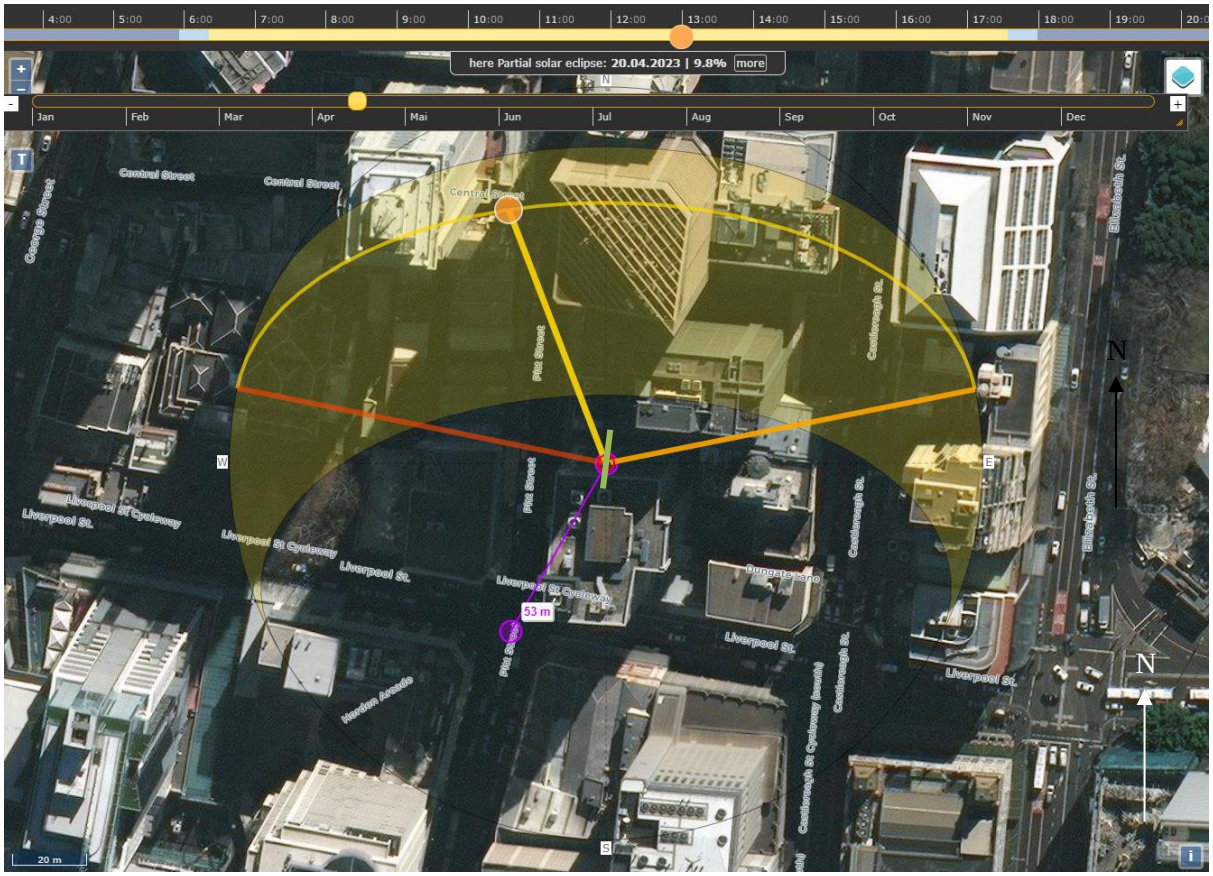

Figure 12: Representation of incident and reflection of solar rays from the West façade onto Pitt.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the West façade.

4.5 Tower A- East

4.5.1 Liverpool Street

Assessment showed there is potential for drivers at Location B6, Figure 3, travelling West along Liverpool Street toward the development site, to experience low levels of glare from the East façade in the morning during mid- autumn till late- autumn and late- winter till early- spring.

Analysis showed that between approximately 7am to 8am, drivers travelling West at Location B6, Figure 13, experienced solar glare with TI values of approximately 2.5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Liverpool Street travelling West toward the development site were found to experience lower levels of TI values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling West along Liverpool Street.

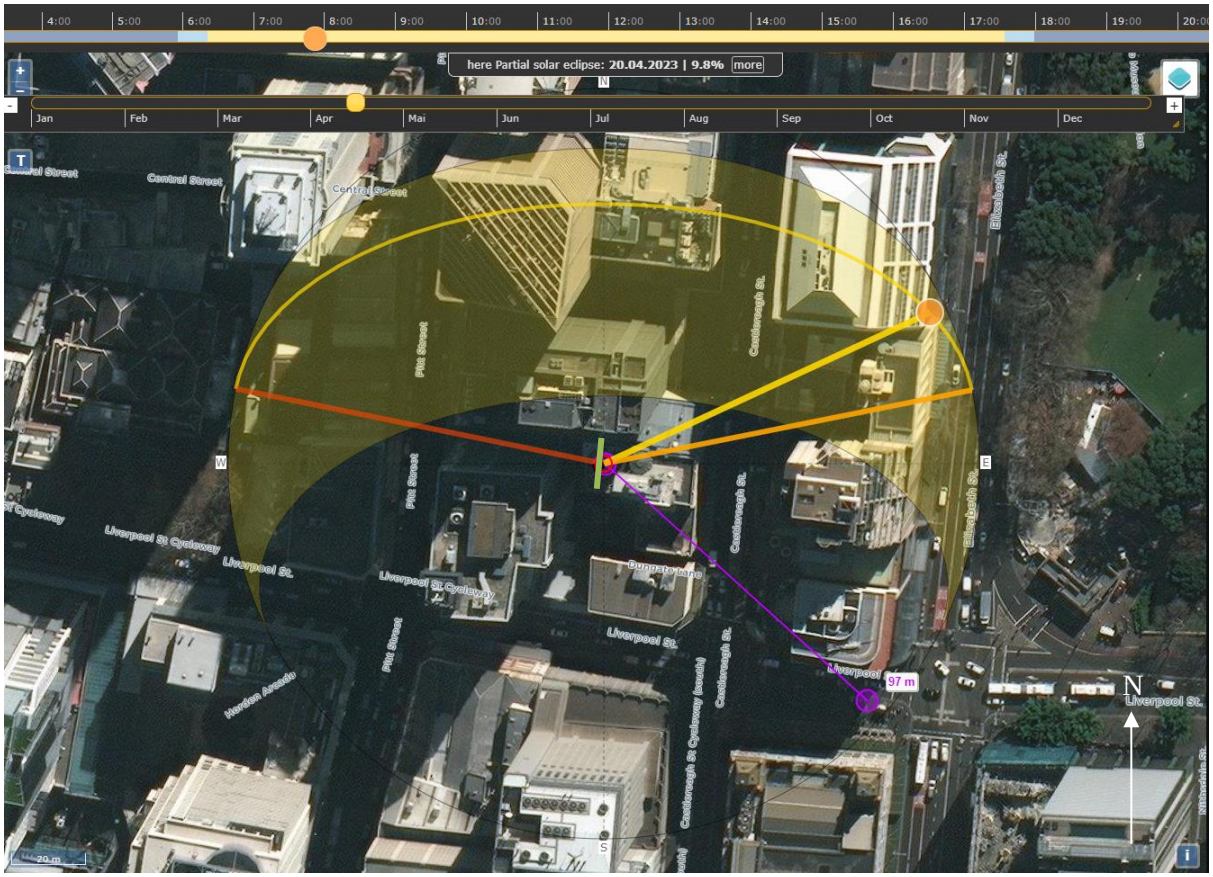

Figure 13: Representation of incident and reflection of solar rays from the East façade onto Liverpool Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the East façade.

4.5.2 Castlereagh Street

Assessment showed there is potential for drivers at Location C7, C8 and C9, Figure 3, travelling North along Castlereagh Street toward the development site, to experience low levels of glare from the East façade in the morning during late- autumn till winter.

Analysis showed that between approximately 10.30am, drivers travelling North at Location C7, C8 and C9, Figure 14, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Castlereagh Street travelling North toward the development site were found to experience lower levels of TI values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling North along Castlereagh Street.

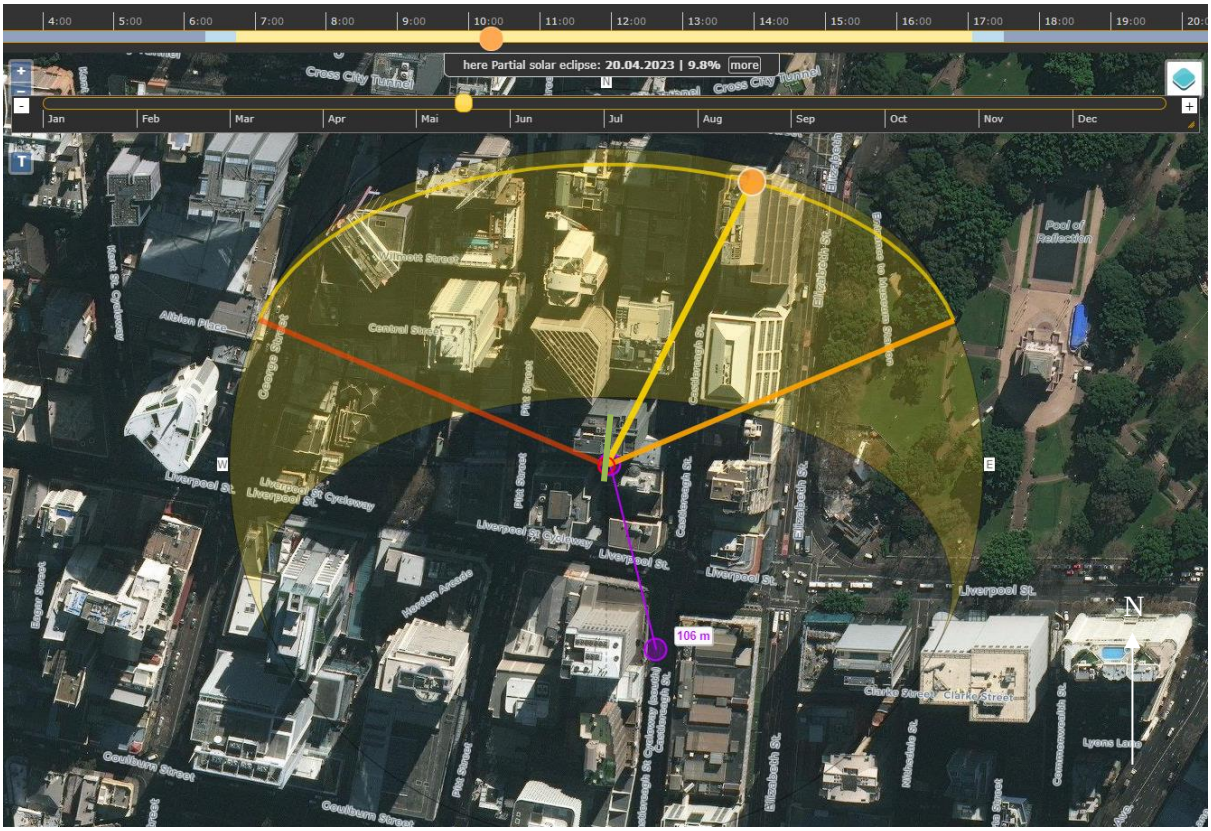

Figure 14: Representation of incident and reflection of solar rays from the East façade onto Castlereagh Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the East façade.

4.6 Tower B- North

4.6.1 Castlereagh Street

Assessment showed there is potential for drivers at Location C1, C2, C3 and C4, Figure 3, travelling South along Castlereagh Street toward the development site, to experience low levels of glare from the North façade in the afternoon during late- autumn till winter.

Analysis showed that between approximately 12pm, drivers travelling South at Location C1, C2, C3 and C4, Figure 15, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Castlereagh Street travelling South toward the development site were found to experience lower levels of TI values for shorter periods of time from the North façade. Thus, it is expected solar reflections from the North façade will not negatively impact the vision of drivers' who are travelling South along Castlereagh Street.

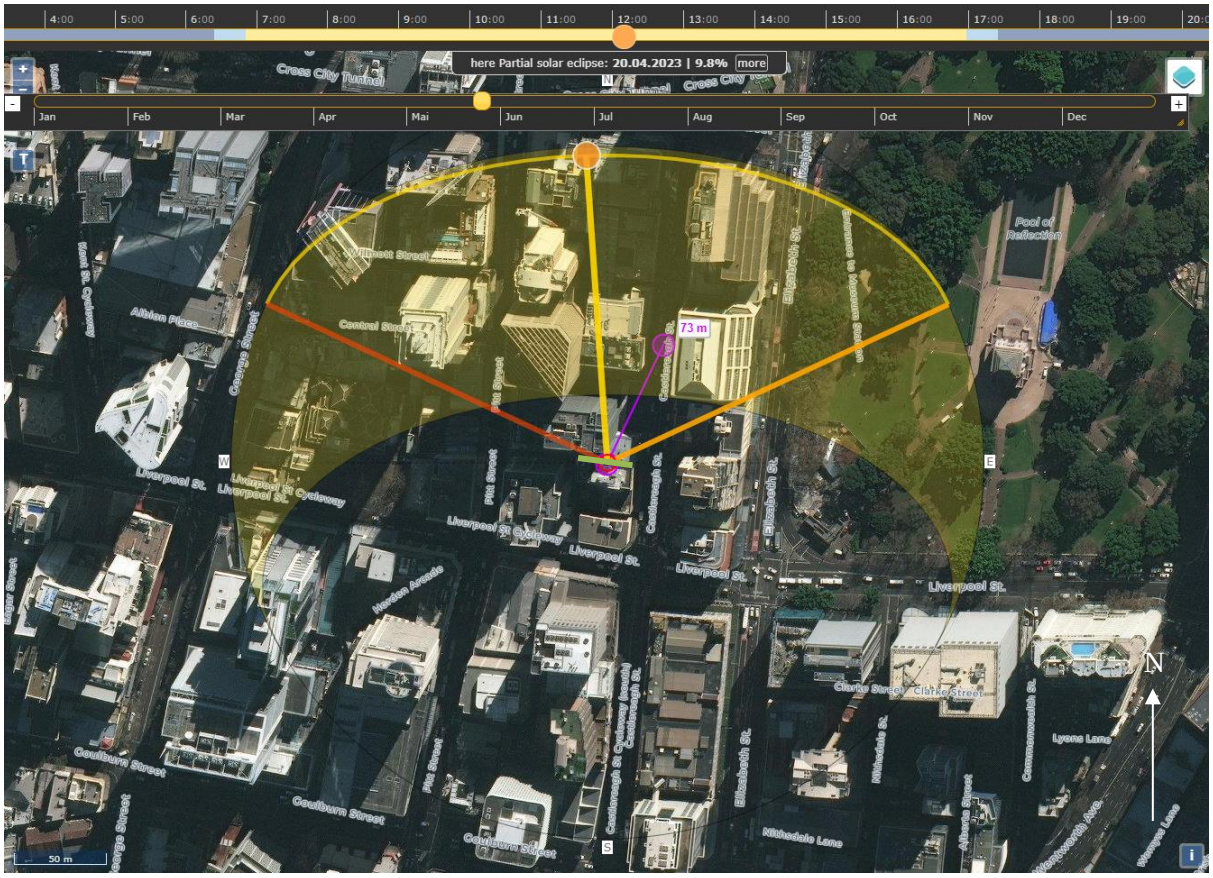

Figure 15: Representation of incident and reflection of solar rays from the North façade onto Castlereagh Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the North façade.

4.6.2 Pitt Street

Assessment showed there is potential for drivers at Location A7 and A8, Figure 3, travelling South along Pitt Street toward the development site, to experience low levels of glare from the North façade in the morning during late- autumn till winter.

Analysis showed that between approximately 9.30am to 10am, drivers travelling South at Location A7 and A8, Figure 16, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Pitt Street travelling South toward the development site were found to experience lower levels of TI values for shorter periods of time from the North façade. Thus, it is expected solar reflections from the North façade will not negatively impact the vision of drivers' who are travelling South along Pitt Street.

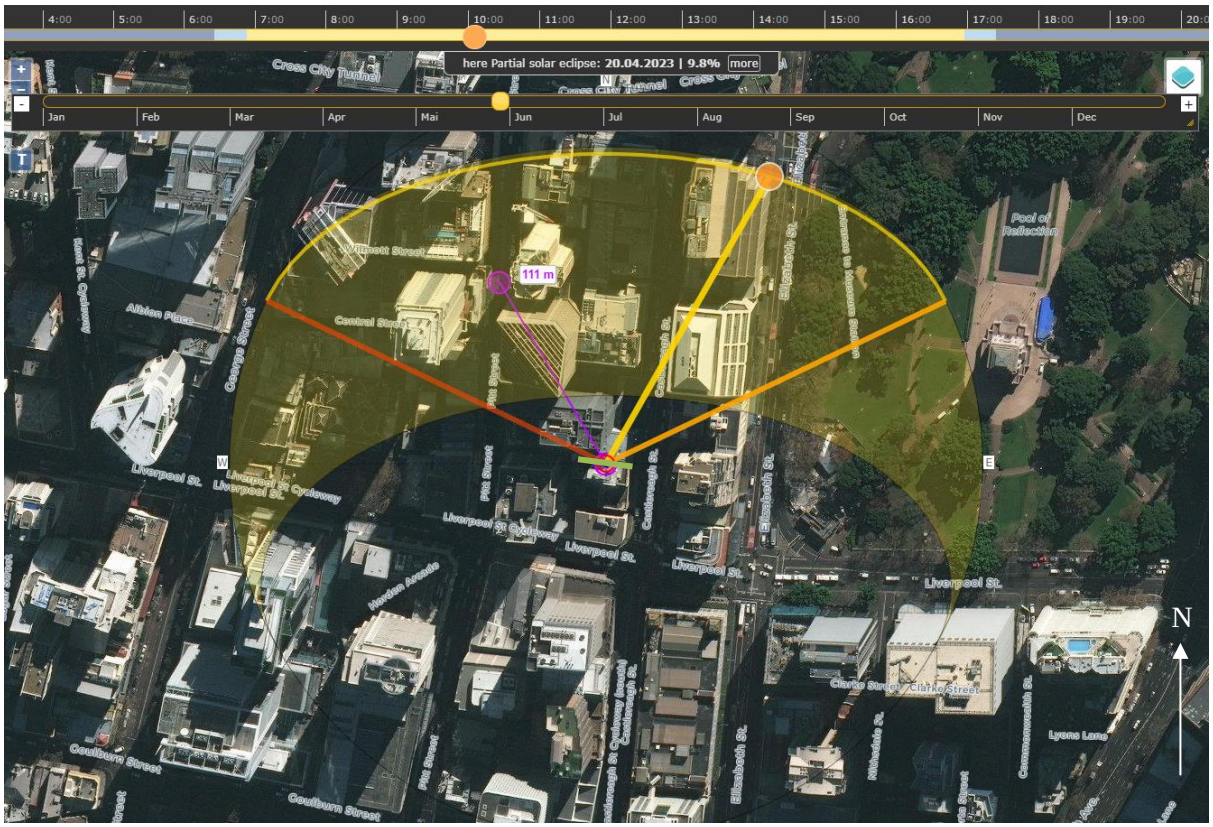

Figure 16: Representation of incident and reflection of solar rays from the North façade onto Pitt Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the North façade.

4.7 Tower B- West

4.7.1 Liverpool Street

Assessment showed there is potential for drivers at Location B1 and B2, Figure 3, travelling East along Liverpool Street toward the development site, to experience low levels of glare from the West façade in the afternoon during late- summer till mid- autumn and spring.

Analysis showed that between approximately 3pm to 6pm , drivers travelling East at Location B1 and B2, Figure 17, experienced solar glare with TI values of approximately 15%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Liverpool Street travelling East toward the development site were found to experience lower levels of TI values for shorter periods of time from the West façade. Thus, it is expected solar reflections from the West façade will not negatively impact the vision of drivers' who are travelling East along Liverpool Street.

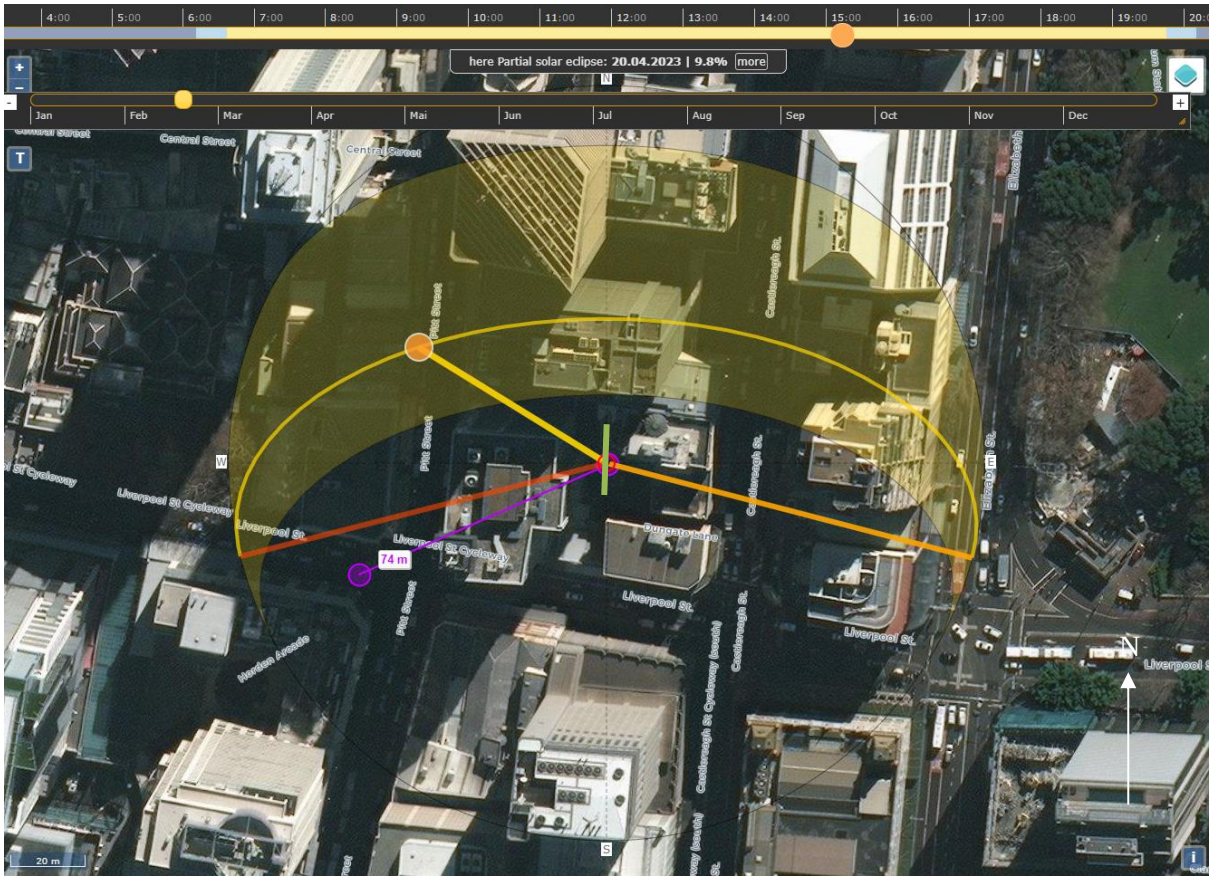

Figure 17: Representation of incident and reflection of solar rays from the West façade onto Liverpool Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the West façade.

4.8 Tower B- East

4.8.1 Liverpool Street

Assessment showed there is potential for drivers at Location B6, Figure 3, travelling West along Liverpool Street toward the development site, to experience low levels of glare from the East façade in the morning during autumn and mid- winter till early spring.

Analysis showed that between approximately 7am to 8am, drivers travelling East at Location B6, Figure 18, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Liverpool Street travelling West toward the development site were found to experience lower levels of TI values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling West along Liverpool Street.

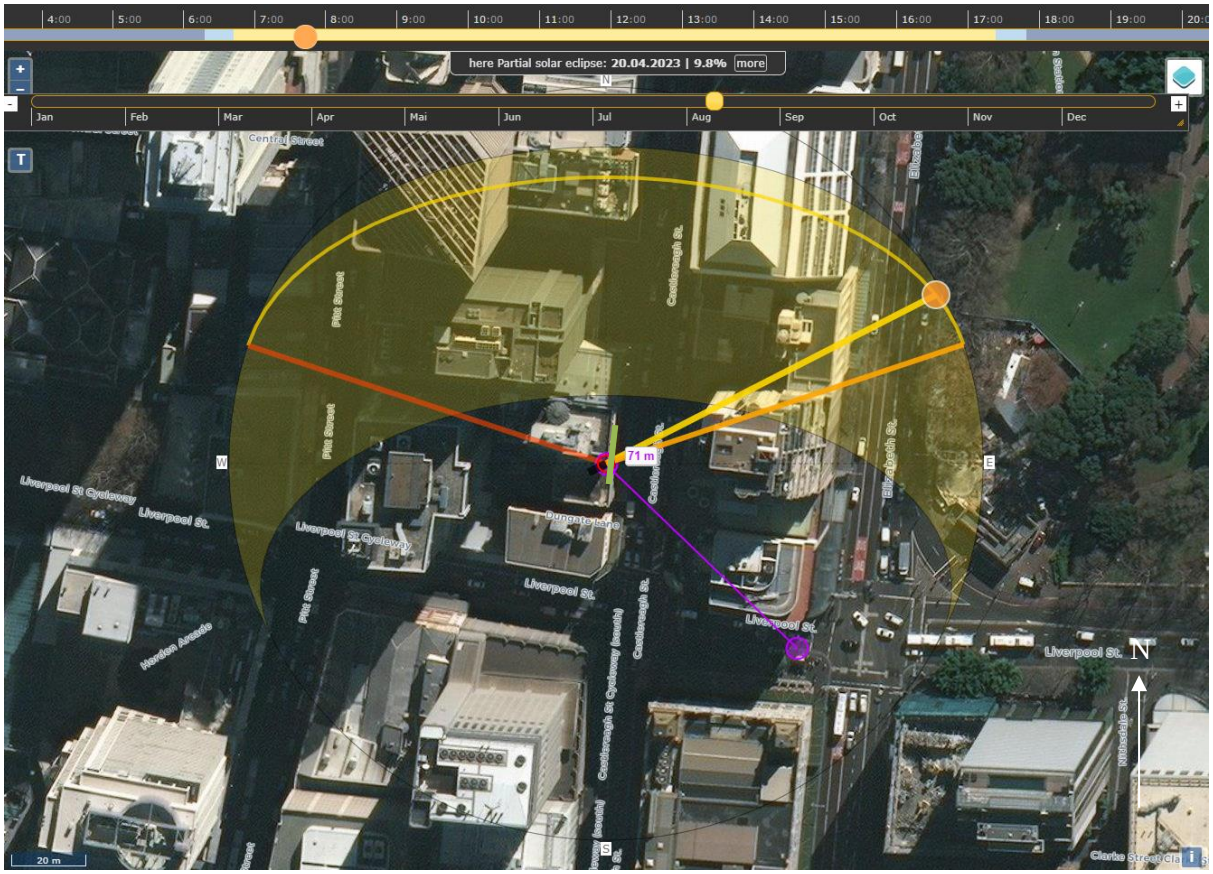

Figure 18: Representation of incident and reflection of solar rays from the East façade onto Liverpool Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the East façade.

4.8.2 Castlereagh Street

Assessment showed there is potential for drivers at Location C7, C8 and C9, Figure 3, travelling North along Castlereagh Street toward the development site, to experience low levels of glare from the East façade in the morning during mid- autumn till early spring.

Analysis showed that between approximately 11am, drivers travelling North at C7, C8 and C9, Figure 19, experienced solar glare with TI values of approximately 5%, which is lower than the prescribed public roadway limit of 20% (AS/NZS 1158.1.1:2005).

Drivers at other locations analysed along Castlereagh Street travelling North toward the development site were found to experience lower levels of TI values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling North along Castlereagh Street.

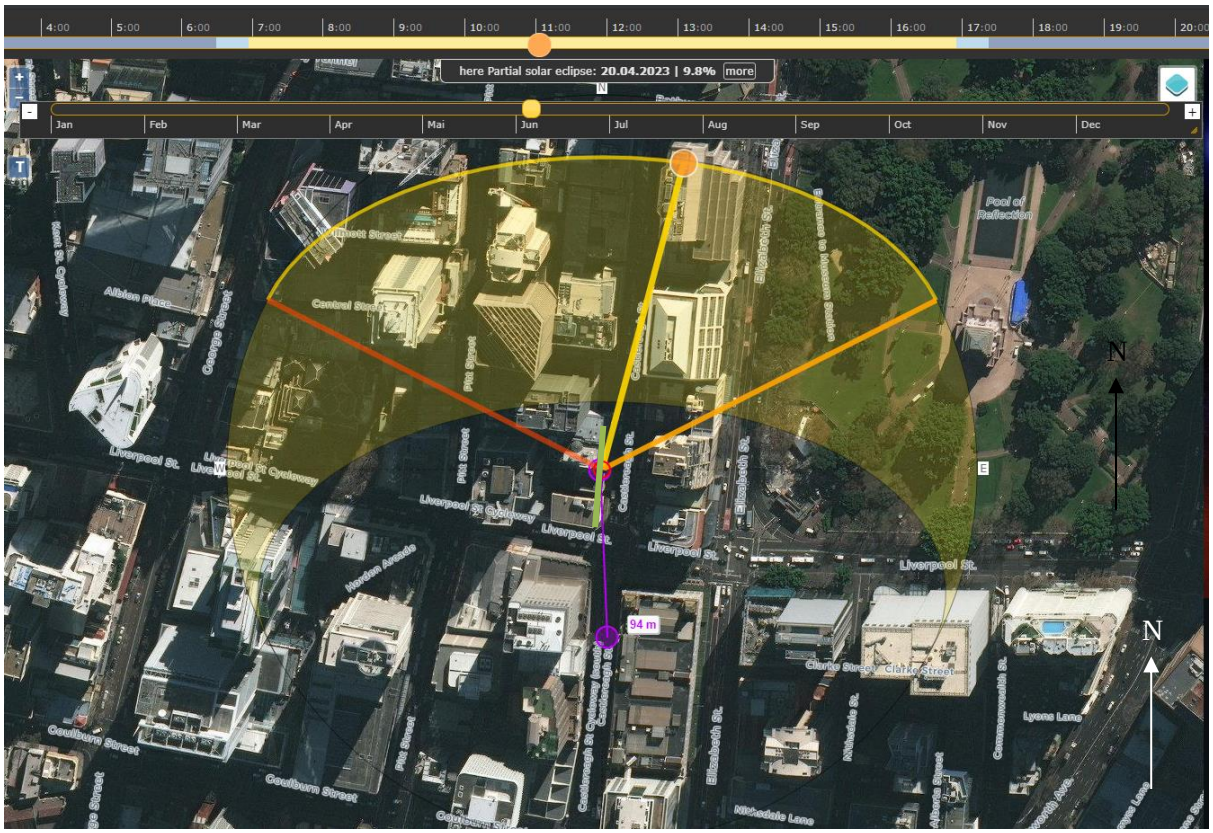

Figure 19: Representation of incident and reflection of solar rays from the East façade onto Castlereagh Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the East façade.

5 CONCLUSION

The proposed 388 Pitt St development in Sydney, Australia was assessed to ascertain any potential its facades will produce traffic disability solar reflectivity glare events onto surrounding roadway locations. At all investigated locations along the adjacent roadways, it is expected the proposed development as currently configured will not produce significant disability glare onto vehicles travelling toward the development, and solar glare detected were within recommended limits.

6 REFERENCES

Hassall (1991), “Reflectivity, Dealing with Rogue Solar Reflections”, Faculty of Architecture, University of NSW.

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