Reflectivity Report

Crows Nest Site C

Sydney Metro

Prepared for
SMEC

Date: 7 April 2021

Reference: 18082

Revision: 01

Surface Design

Document prepared by:

Surface Design Pty Ltd
ABN 19 570 343 498
68 York Street, SYDNEY NSW 2000 Australia
T: +61 2 9249 1400
E: info@surfacedesign.com.au

Document control

Revision	Date	Revision details	Author	Signed	Verifier	Signed	Approver	Signed
00	24/02/2020	Issue to client	IV		GMc			
01	7/04/2021	Update for new design	RM					

Contents

Executive Summary

This reflectivity study has been prepared for the Crows Nest Site C project.

This reflectivity study has been carried out to review the risk of solar reflections, resulting in disability glare to drivers and pedestrians, caused by the façade of the proposed project. Reflections to existing and future buildings have not been considered as part of this assessment.

The project has been assessed from 4 viewpoints from drivers and 2 from pedestrians to determine areas where there is a risk of a reflected image of the sun being formed. The methodology proposed by David Hassall has been used to assess where there is a risk of disability glare as calculated by the Holladay formula.

Images taken from google maps of the viewpoints have been used to complete this assessment.

The analysis has been carried out based on the revision A drawings by Crows Nest Design Consortium, as listed in Section 1.6. These are dated 19 March 2021.

All viewpoints considered have been analysed and it has been determined that the risk of rogue reflections causing disability glare to drivers and pedestrians are limited and acceptable where the normal specular reflectivity of façade materials is limited to 20%.

1. Introduction

1.1 Purpose of this Report

This report details the results of a reflectivity study that reviews the potential for adverse reflected solar glare that may affect drivers and pedestrians within the proximity of the Crows Nest site C.

For the purpose of this assessment, we have specified a maximum normal specular reflectivity of 20% as the limit for all façade materials, as adopted by the City of Sydney Council.

The project has been assessed from 4 viewpoints from drivers and 2 from pedestrians, in order to determine areas where there is a risk of a reflected image of the sun being formed. Each viewpoint has been reviewed for its potential to cause disability glare to drivers and pedestrians. Any additional measures required for compliance have been identified in this report.

This report should be read in conjunction with the revision A drawings prepared by Crows Nest Design Consortium as listed in Section 1.6.

1.2 Development Description

The Crows Nest Metro Station Site C project forms part of the City and Southwest stage of the Sydney Metro construction. Site C involves the construction of an nine-storey commercial building. The building is to be constructed above the station entrance.

The building façade typically consists of a glazed curtain wall with masonry to the vertical spandrels. The north-west elevation consists entirely of masonry. The podium level has framed glass, masonry and a solid awning.

Figure 1 – Project Image

1.3 Site Location

The site has been assessed to determine appropriate viewpoints where drivers (red), and pedestrians when they are crossing the road (blue), are able to see the building façade in their direct line of vision.

Viewpoints where a driver would be required to be travelling the wrong way down a street have not been considered in this assessment. It has been assumed that this condition will not change.

It has been assessed that the building is visible to drivers from the following locations:

- Travelling North East on Hume Street (VP1)
- Travelling North West on Clarke Lane (VP2)
- Travelling North West on Clarke Street (VP3)
- Travelling South East on Clarke Street (VP4)

It is also directly visible to pedestrians crossing roads at pedestrian crossings at the following locations:

- Crossing South East at Clarke Street (VPA)
- Crossing North West at Hume Street (VPB)

Figure 2 - Satellite Image with Viewpoints[1]

[1] Image from Google Maps

1.4 Site Orientation

Visible Façade Aspects are outlined in *Figure 3* below. The Crows Nest Site C façade is a stepped façade, where each level has varying protruding aspects. A typical plan of the building was considered for this assessment.

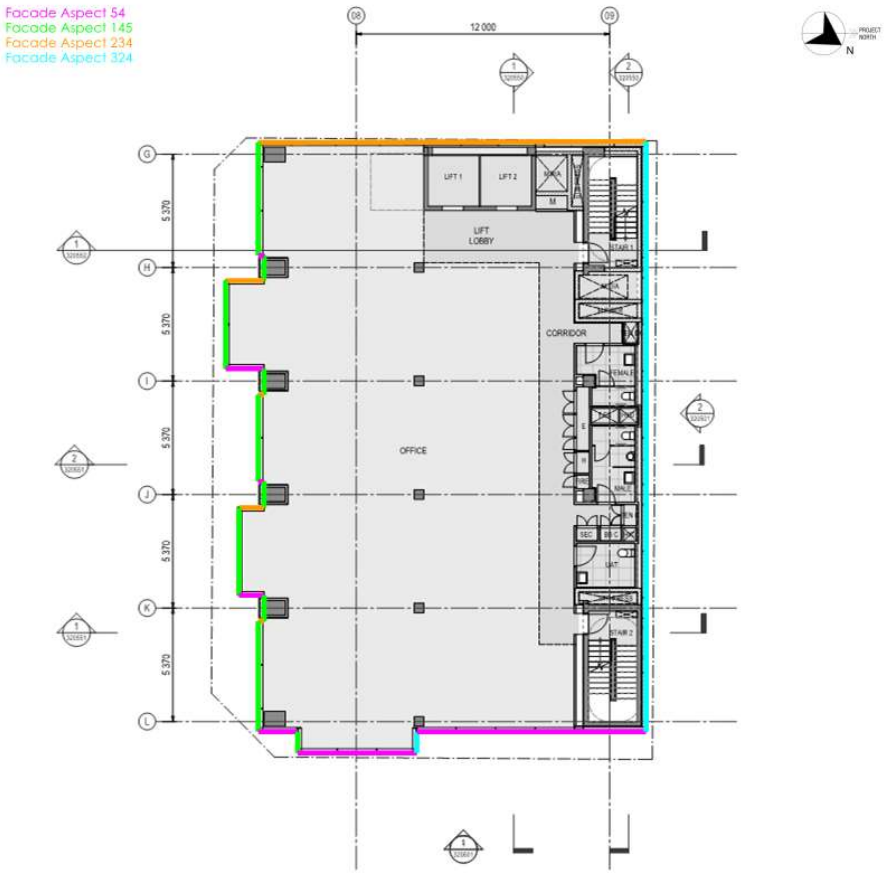

Figure 3 – Tower Building Aspects – Level 2

List of façade aspects as defined in *Figure 3*:

- Façade Aspect 054
- Façade Aspect 145
- Façade Aspect 234
- Façade Aspect 324

1.5 Stereographic Sun Chart

The position of the sun in the sky throughout the year varies depending on the latitude of the location of assessment. A stereographic sun chart is a two-dimensional representation of this path of the sun for a particular line of latitude.

This chart is used in order to determine the location of a virtual reflected sun in accordance with the Hassall methodology in order to assess the potential for glare. Refer to Section 2 of this report for more detailed information on the assessment methodology

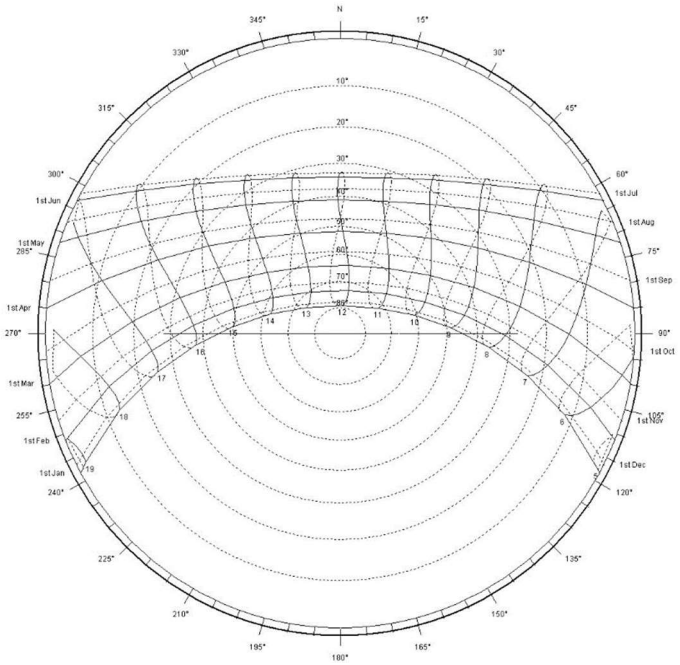

Figure 4 – Stereographic Sun Chart for Sydney (34 degree latitude)

1.6 Referenced Drawings

Drawing Number	Revision	By	Status
SMCSWSCN-SMC-SCN-AT-DWG-100010	All Rev A	All by Crows Nest Design Consortium	All for DA
SMCSWSCN-SMC-SCN-AT-DWG-100516			
SMCSWSCN-SMC-SCN-AT-DWG-120530			
SMCSWSCN-SMC-SCN-AT-DWG-120511			
SMCSWSCN-SMC-SCN-AT-DWG-120522			
SMCSWSCN-SMC-SCN-AT-DWG-207517			
SMCSWSCN-SMC-SCN-AT-DWG-208518			
SMCSWSCN-SMC-SCN-AT-DWG-209519			
SMCSWSCN-SMC-SCN-AT-DWG-209510			
SMCSWSCN-SMC-SCN-AT-DWG-209521			
SMCSWSCN-SMC-SCN-AT-DWG-209522			
SMCSWSCN-SMC-SCN-AT-DWG-209523			
SMCSWSCN-SMC-SCN-AT-DWG-209524			
SMCSWSCN-SMC-SCN-AT-DWG-209525			
SMCSWSCN-SMC-SCN-AT-DWG-209526			
SMCSWSCN-SMC-SCN-AT-DWG-209527			
SMCSWSCN-SMC-SCN-AT-DWG-209528			
SMCSWSCN-SMC-SCN-AT-DWG-320520			
SMCSWSCN-SMC-SCN-AT-DWG-320521			
SMCSWSCN-SMC-SCN-AT-DWG-320570			
SMCSWSCN-SMC-SCN-AT-DWG-320572			
SMCSWSCN-SMC-SCN-AT-DWG-460555			
SMCSWSCN-SMC-SCN-AT-DWG-470601			
SMCSWSCN-SMC-SCN-AT-DWG-470602			

2. Assessment Methodology

2.1 Analysis Philosophy

The glare assessment has been carried out as per the methodology outlined in the technical bulletin "Reflectivity: Dealing with Rogue Solar Reflections" written by David Hassall from the Faculty of Architecture at the University of New South Wales.

This methodology defines a glare (I_v) limit of 500 candelas/m^2, calculated to the Holladay formula, to which a driver can be exposed without causing disability.

Viewpoints have been defined from which it is expected that either drivers or pedestrians where they are crossing the road, are able to see the building. A stereographic sun path diagram and the building geometry are then used to determine whether a viewpoint will be subject to the reflected sun during the year.

A glare protractor, scaled and oriented in the direction of drivers or pedestrians as appropriate, is used to determine the glare based on the reflectivity of the surface and the apparent angle of viewing.

Images taken from Google Maps of the viewpoints have been used to complete this assessment. It must be noted that images extracted from Google street view often appear distorted due to the photographic process used. The process uses a 360° camera, mounted on a moving vehicle, to take panoramic pictures which are then stitched together to create an interactive panorama. To address these limitations, all viewpoint photographs have been adjusted by overlaying the glare protractor in the direction of viewing and aligning its axes with the building boundary points.

2.2 Virtual Sun Location

The virtual suns location is determined with the stereographic sun chart for the project location.

This is completed by plotting the virtual sun on the stereographic sun chart based on the orientation of the façade. The apparent reflective surface of the façade is plotted based on the bounding horizontal and vertical angles from the viewpoint.

2.3 Glare Assessment

In order to allow assessment of buildings for glare David Hassall has developed a glare protractor that provides a diagrammatic limit of 500 candelas/m^2 based on viewing angle and inclination and reflectivity of the viewing surface. This glare protractor is shown in *Figure 5* and is used where the stereographic sun path indicates that there is glare to a particular viewpoint.

A brief description of the calculation of the glare (equivalent veiling luminance) is provided below for reference. The glare protractor has thereafter been used in this assessment.

The equivalent veiling luminance (I_v) is calculated based on the Holladay formula (1), which defines the illumination of a viewer's eye based on a calculated illuminance perpendicular to the surface (EG) and a factor based on the angle of viewing (θ).

$$I_v = 10 \times EG \div \theta^2 \quad (1)$$

The angle of viewing (θ) is based on the angle between the direct line of sight and the glare source (α) and the inclination between a viewing normal and the glare source (β). This is calculated with trigonometry based on Equation 2 below and is shown diagrammatically in *Figure 5* below.

$$\theta = ATAN \times [\sqrt{\{\tan^2(\beta) + \sin^2(\alpha)\}} \div \cos(\alpha)] \quad (2)$$

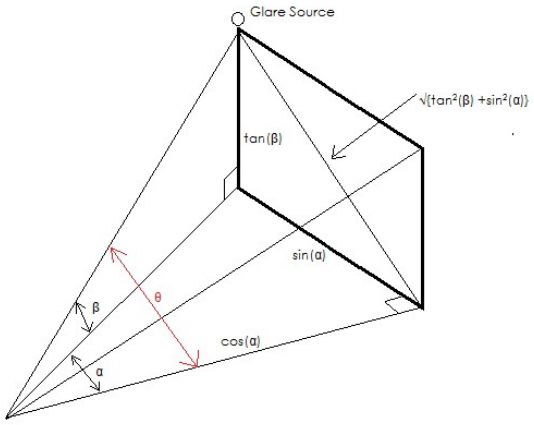

Figure 5 – Diagrammatic Angle of Viewing Calculation

The illumination of the viewer's eye normal to the light source (EG) is calculated based on the solar illumination (E), the reflectivity of the surface (R) and the angle of viewing (θ) calculated in Equation 2. The solar illumination is calculated in Equation 4 based on the solar power (W), which is dependent on the inclination of the virtual sun (β) and the luminance efficacy (l_e).

$$EG = E \times R \times \cos(\theta) \quad (3)$$

$$E = W \times l_e \quad (4)$$

The solar power is determined as 50 watts per degree up to 10 degrees and 15 watts per degree thereafter.

The luminance efficacy is 90 lumens/watt at 7.5° and 117 lumens/watt at 25° and is interpolated for other angles.

The glare protractor by Hassall joins points at incremental reflectivity (iso-glare loops) with varying a and β values in order to set a limit where the equivalent veiling luminance is limited to 500 candelas/m^2.

By overlaying the glare protractor on a photo or computer generated image in the direction of viewing and aligning the verticals with the building it is possible to graphically determine the maximum reflectivity to not cause disability glare.

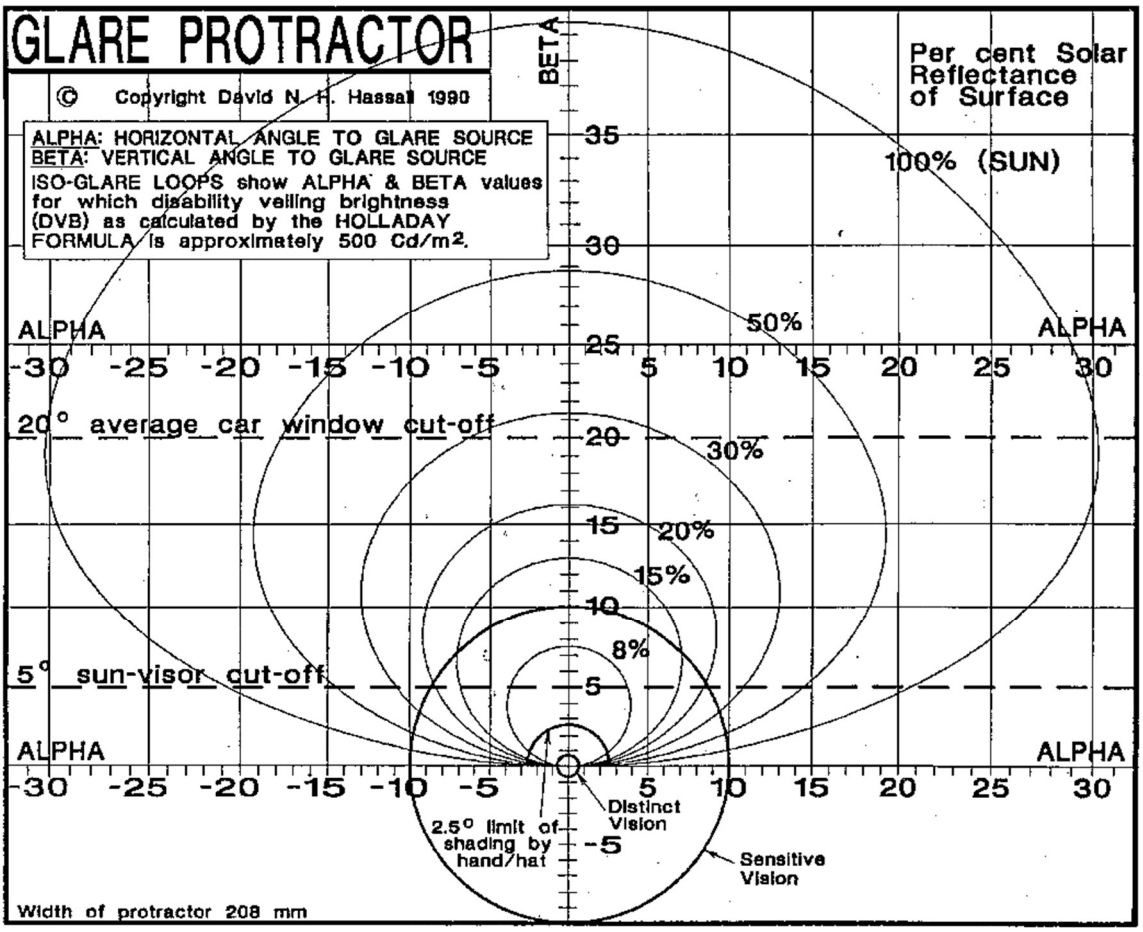

Figure 6 – Glare Protractor[2]

2.4 Maximum Normal Specular Reflectivity

For the purpose of this report, a normal specular reflectivity of all façade materials is limited to a maximum 20%.

As the normal specular reflectivity of all building materials is limited to 20% a limit is taken such that any area viewed with a vertical bearing angle above 16° is adequate without need for further studies. Refer to *Figure 6* above.

[2] "Reflectivity: Dealing with Rogue Solar Reflections" – David Hassall

3. Results

3.1 General

The façade has been assessed from each viewpoint identified in Section 1 of the report.

Where it is identified that there is reflected image of the sun, the glare protractor is applied in order to determine the maximum reflectivity allowable on the façade surface to achieve a maximum equivalent veiling luminance of 500 candelas/m^2.

Detailed results have been included as part of Appendix A. A summary of these results is provided in this section.

3.2 Viewpoint 1

Viewpoint 1 is taken from the viewpoint of a driver travelling North East on Hume Street. The viewing angle of the driver is 56°.

The path of the reflected sun has been assessed from all visible façade aspects from this viewpoint. Refer to Appendix A for detailed assessment.

A reflected image from Façade Aspect 145 forms for approximately 30 minutes each day between 8:00am and 8:30am during June each year.

Façade Aspect 145 lies with the 15% and 20% iso-glare loop for Levels 3 to 5 of the building.

The viewing angle of the driver is located within close proximity (1°) of the sun path.

The driver would be looking almost directly into the sun when travelling North East on Hume Street. Limiting the reflectivity of the façade aspect will not address the source of glare from the direct sun. Therefore, we consider the risk of disability glare from Facade Aspect 145 to Viewpoint 1 limited and acceptable.

A reflected image from Façade Aspect 234 forms for approximately 30 minutes each day between 5:30pm and 6:00pm during November each year.

The viewpoint has been assessed with an image from google maps and the Hassall glare protractor overlaid. Façade Aspect 234 is outside of the 20% iso-glare loop. Therefore, the risk of disability glare from this aspect to this viewpoint is limited and acceptable if the reflectivity is limited to 20% on this façade.

3.3 Viewpoint 2

Viewpoint 2 is taken from the viewpoint of a driver travelling North West on Clarke Lane. The viewing angle of the driver is 325°.

The path of the reflected sun has been assessed from all visible façade aspects from this viewpoint. Refer to Appendix A for detailed assessment.

A reflected image from Façade Aspect 145 forms for approximately 1 hour each day between 5:00am and 6:00am between January and April each year.

The viewpoint has been assessed with an image from google maps and the Hassall glare protractor overlaid. It can be seen that façade aspect 145 is outside of the 20° iso-glare loop when looking in the direction of travel. Therefore, the risk of disability glare from this aspect to this viewpoint is limited and acceptable if the reflectivity is limited to 20% on this façade.

There is no reflected image on Façade Aspect 234 from this viewpoint. No further studies are required.

3.4 Viewpoint 3

Viewpoint 3 is taken from the viewpoint of a driver travelling North West on Clarke Street. The viewing angle of the driver is 325°.

The path of the reflected sun has been assessed from all visible façade aspects from this viewpoint. Refer to Appendix A for detailed assessment.

There is no risk of rogue reflections from this viewpoint and no further studies are required.

3.5 Viewpoint 4

Viewpoint 4 is taken from the viewpoint of a driver travelling South East on Clarke Street. The viewing angle of the driver is 150°.

The path of the reflected sun has been assessed from all visible façade aspects from this viewpoint. Refer to Appendix A for detailed assessment.

There is no reflected image of the sun that reaches Viewpoint 3 from Façade Aspect 54 of the building. No further studies are required.

A reflected image from Façade Aspect 324 forms for approximately 1.5 hours each day between 4:30pm and 6:00pm between July and September each year.

The viewpoint has been assessed with an image from google maps and the Hassall glare protractor overlaid. It can be seen that façade aspect 324 is outside of the 20° iso-glare loop when looking in the direction of travel. Therefore, the risk of disability glare from this aspect to this viewpoint is limited and acceptable if the reflectivity is limited to 20% on this façade.

3.6 Viewpoint A

Viewpoint A is taken from the viewpoint of a pedestrian crossing North West at Clarke Street. The viewing angle of the pedestrian is 325°.

The path of the reflected sun has been assessed from all visible façade aspects from this viewpoint. Refer to Appendix A for detailed assessment.

There is no risk of rogue reflections from this viewpoint and no further studies are required.

3.7 Viewpoint B

Viewpoint B is taken from the viewpoint of a pedestrian crossing South West at Hume Street. The viewing angle of the pedestrian is 240°.

The path of the reflected sun has been assessed from all visible façade aspects from this viewpoint. Refer to Appendix A for detailed assessment.

There is no risk of rogue reflections from this viewpoint and no further studies are required.

4. Conclusion

This reflectivity study has been carried out in order to review the potential for disability glare to pedestrians and drivers that could be caused by this project.

The analysis has been completed based on the architectural drawings issued for review as listed in Section 1.6.

The glare assessment has been carried out as per the methodology outlined in the technical bulletin "Reflectivity: Dealing with Rogue Solar Reflections" written by David Hassall.

A total of six viewpoints have been selected for this study to represent possible views from drivers and pedestrians of the proposed project. Reflections to existing and future buildings have not been considered as part of this assessment.

All viewpoints considered have been analysed and it has been determined that the risk of rogue reflections causing disability glare to drivers and pedestrians are limited and acceptable where the normal specular reflectivity of façade materials is limited to 20%.

Appendix A

Appendix A – Detailed Results

Viewpoint 1

Viewpoint 1 is taken from the viewpoint of a driver travelling North East on Hume Street. The viewing angle of the driver is 56°.

The following Façade Aspects are visible from the Viewpoint in a 180° segment oriented to the direction of viewing and the distance to the corners of the aspect in brackets:

- Façade Aspect 145 (68m)
- Façade Aspect 234 (68m)

In *Figure 7* below yellow lines have been drawn to represent the bearing angles to the visible portions of the building. The red arrow indicated the direction of travel and viewing.

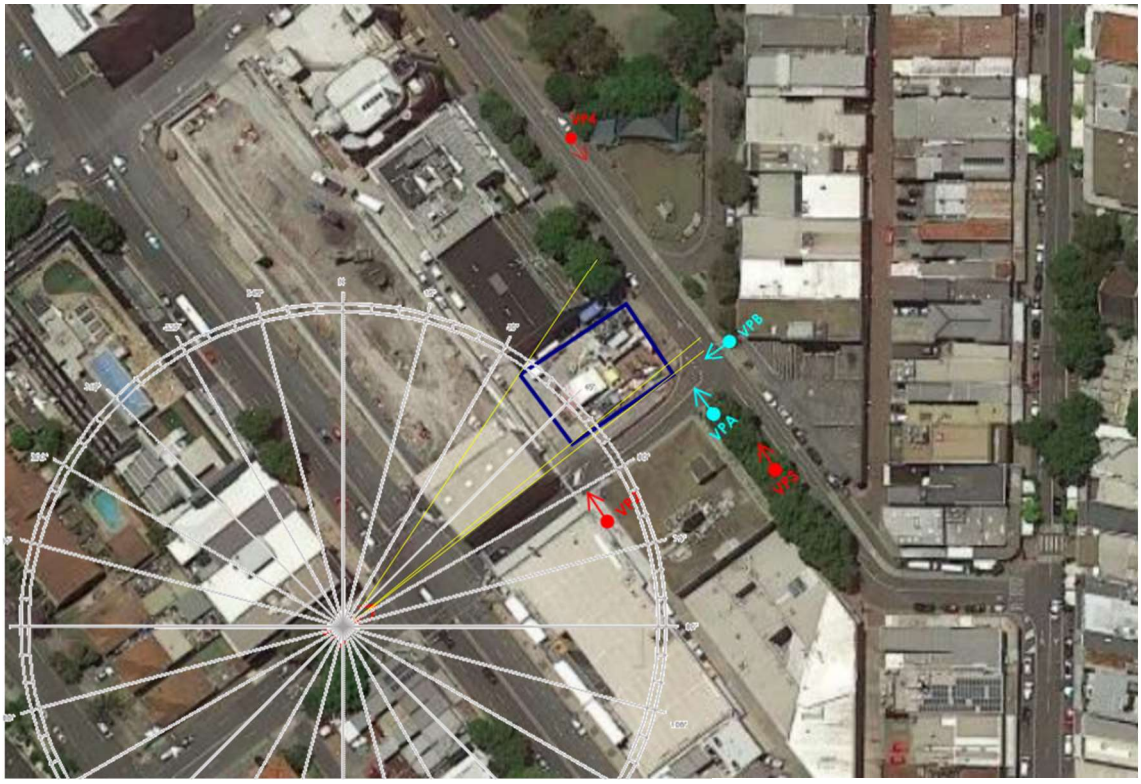

Figure 7 – Viewpoint 1 horizontal bearing angles

The upper limit vertical bearing angle that has been used is 16°. As set out in Section 2 of this report, any glare source above 16° will be outside of the zone of disability glare caused by materials with a specular normal reflectivity of 20%, which is the limit for buildings in Sydney.

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Façade Aspect 145	0°	16°	51°	53°
Façade Aspect 234	0°	16°	35°	51°

These bearing angles have been plotted on the reflected sun path diagrams below.

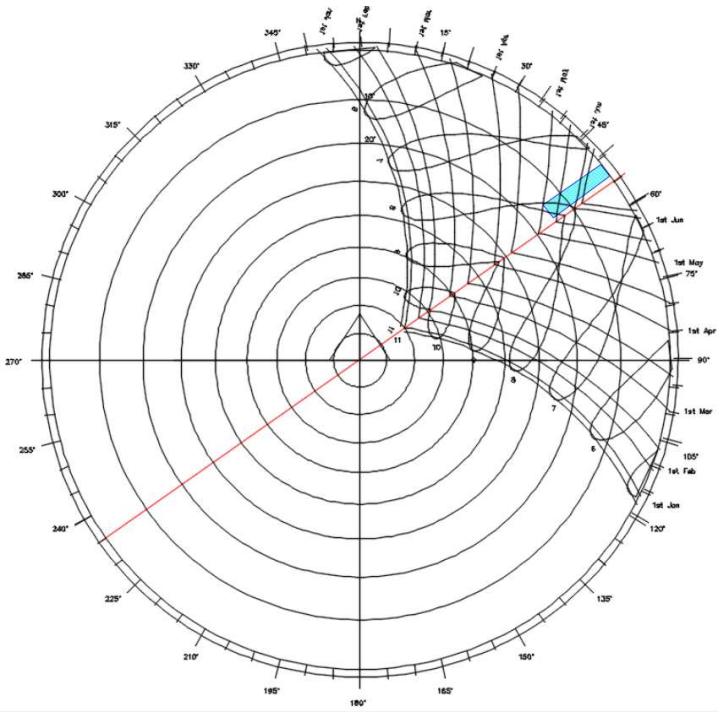

Figure 8 – Façade Aspect 145 Reflected Virtual Sun from Viewpoint 1

There is a reflected image of the sun that reaches Viewpoint 1 from Façade Aspect 145 of the building. This reflected image occurs between 8:00am and 8:30am from June to July each year.

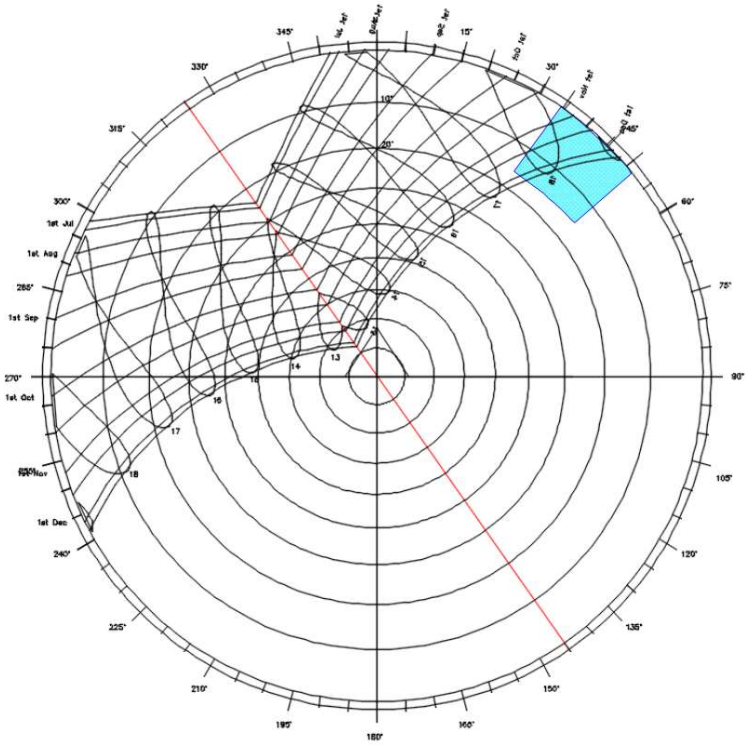

Figure 9 – Façade Aspect 234 Reflected Virtual Sun from Viewpoint 1

There is a reflected image of the sun that reaches Viewpoint 1 from Façade Aspect 234 of the building. This reflected image occurs between 5:30pm and 6:00pm from November to January each year.

The image below has been taken from Google Maps at the location of Viewpoint 1. The Hassall glazing protractor has been overlaid at scale. The grey shading represents Building B, the red shading represents Façade Aspect 234 of Building C, and the orange shading represents Façade Aspect 145 of Building C.

Façade Aspect 145 lies with the 15% and 20% iso-glare loop for Levels 3 to 5 of the building.

The viewing angle of the driver is located within close proximity of the sun path. The 1° of separation between Viewpoint 1 and the sun path is outlined in *figure 10* below.

The driver would be looking almost directly into the sun when travelling North East on Hume Street. Limiting the reflectivity of the façade aspect will not address the source of glare from the direct sun. Therefore, we consider the risk of disability glare from this aspect to Viewpoint 1 limited and acceptable.

It can be seen that Façade Aspect 234 is outside of the 20% iso-glare loop. Therefore, no further studies are required.

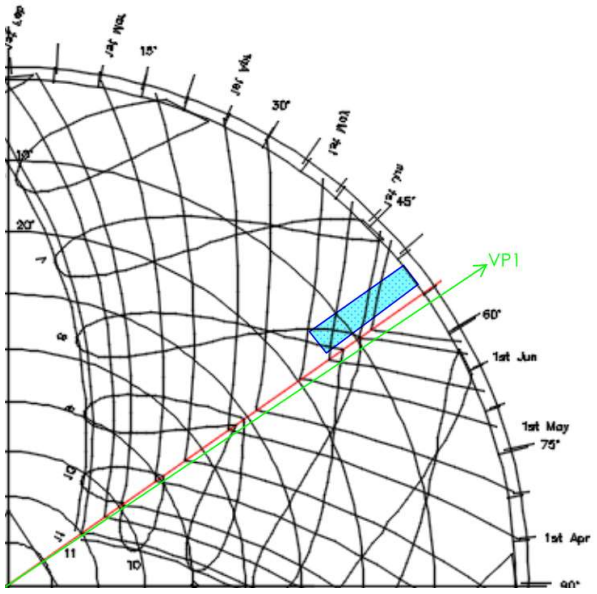

Figure 10 - Façade Aspect 145 Reflected Virtual Sun from Viewpoint 1

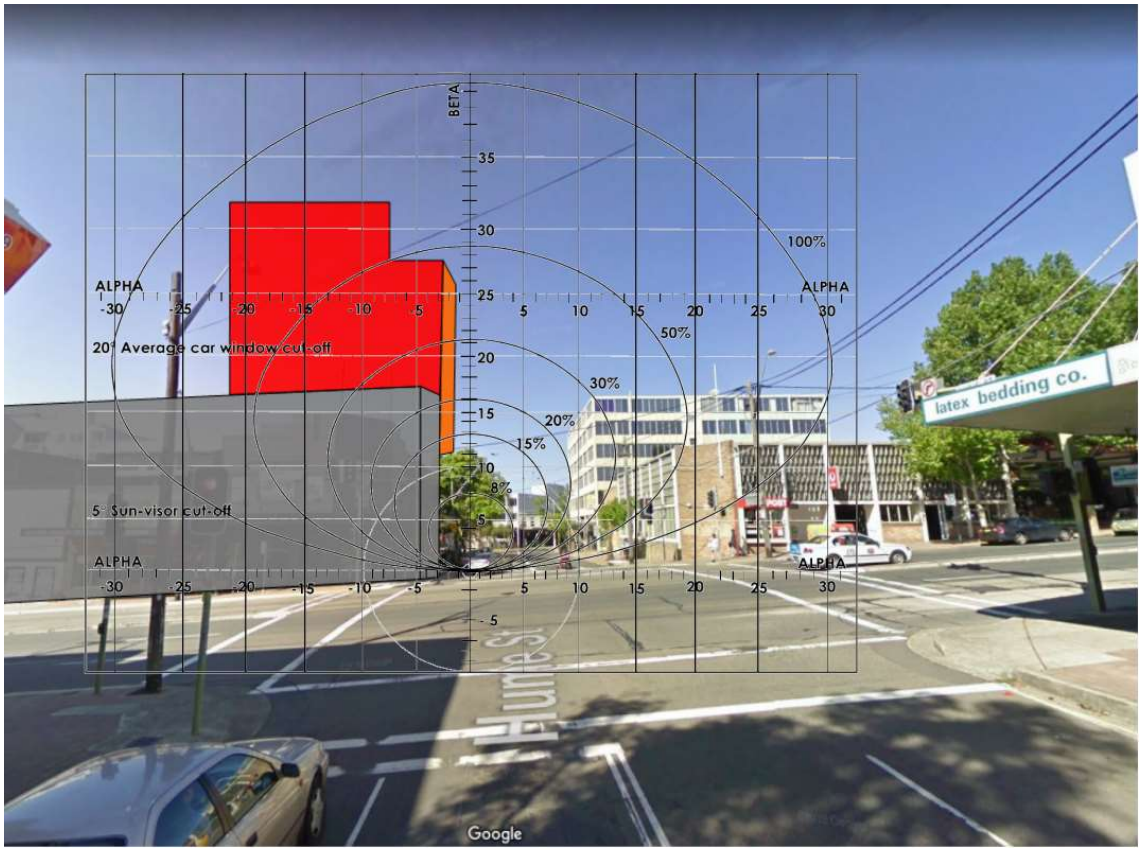

Figure 11 – Viewpoint 1 with Glare Protractor Overlay.

Viewpoint 2

Viewpoint 2 is taken from the viewpoint of a driver travelling North West on Clarke Lane. The viewing angle of the driver is 325°.

The following Façade Aspects are visible from the Viewpoint in a 180° segment oriented to the direction of viewing and the distance to the corners of the aspect in brackets:

- Façade Aspect 145 (12m)
- Façade Aspect 234 (12m)

In *Figure 12* below yellow lines have been drawn to represent the bearing angles to the visible portions of the building. The red arrow indicated the direction of travel and viewing.

Figure 12 – Viewpoint 2 horizontal bearing angles

The upper limit vertical bearing angle that has been used is 16°. As set out in Section 2 of this report, any glare source above 16° will be outside of the zone of disability glare caused by materials with a specular normal reflectivity of 20%, which is the limit for buildings in Sydney.

	Vertical Bearing Angle		**Horizontal Bearing Angle (0° at North)**	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Façade Aspect 145	0°	16°	23°	335°
Façade Aspect 234	0°	16°	328°	335°

These bearing angles have been plotted on the reflected sun path diagrams below.

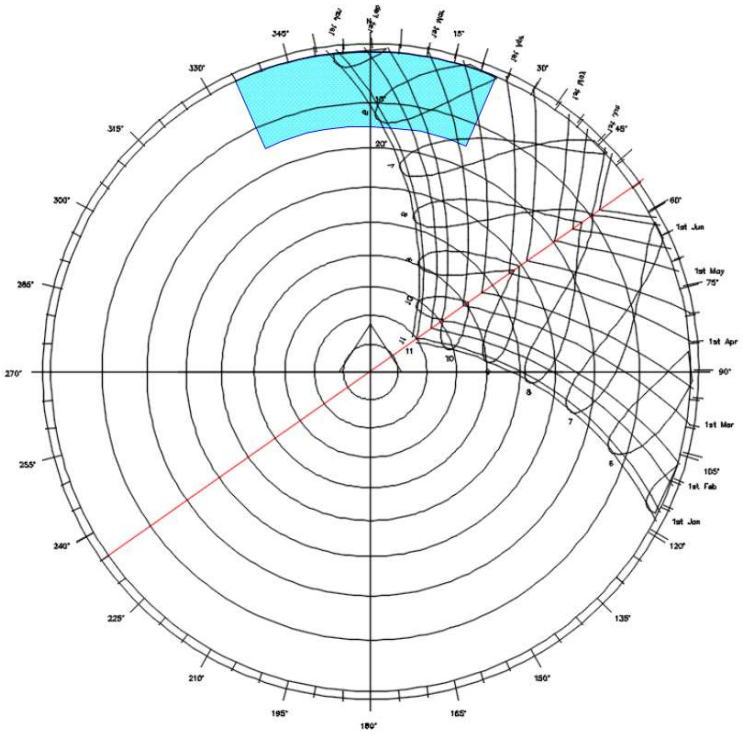

Figure 13 – Façade Aspect 145 Reflected Virtual Sun from Viewpoint 2

There is a reflected image of the sun that reaches Viewpoint 2 from Façade Aspect 145 of the building. This reflected image occurs between 5:00am and 6:00am from September to April each year.

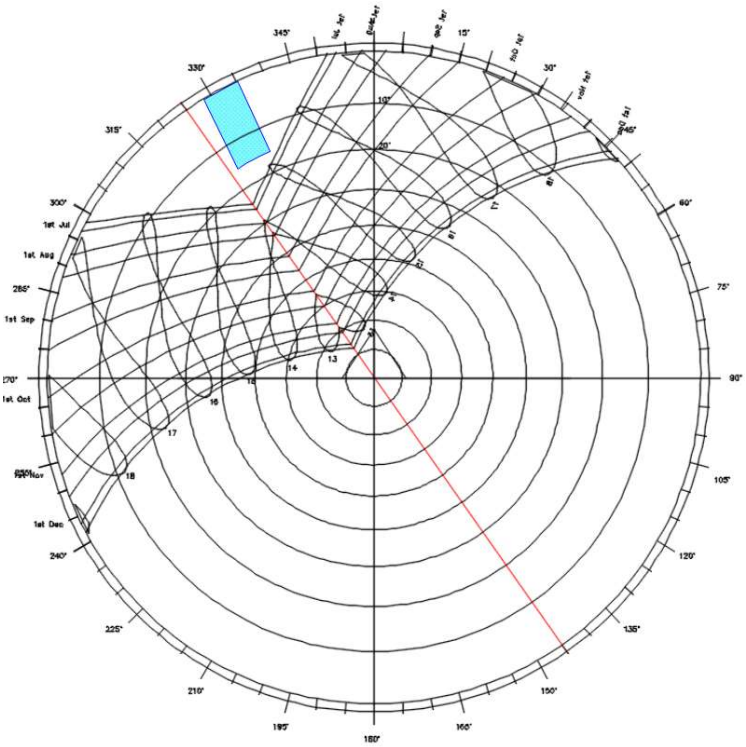

Figure 14 – Façade Aspect 234 Reflected Virtual Sun from Viewpoint 2

There is no reflected image of the sun that reaches Viewpoint 2 from Façade Aspect 234 of the building. No further studies are required.

The image below has been taken from Google Maps at the location of Viewpoint 2. The building outline has been overlaid with shading; the red shaded area represents Façade Aspect 145. The Hassall glazing protractor has been overlaid at scale.

It can be seen that Façade Aspect 145 is outside of the 20% iso-glare loop. No further studies are required.

Figure 15 – Viewpoint 2 with Glare Protractor Overlay

Viewpoint 3

Viewpoint 3 is taken from the viewpoint of a driver travelling North West on Clarke Street. The viewing angle of the driver is 325°.

The following Façade Aspects are visible from the Viewpoint in a 180° segment oriented to the direction of viewing and the distance to the corners of the aspect in brackets:

- Façade Aspect 54 (33m)
- Façade Aspect 145 (33m)

In *Figure 16* below yellow lines have been drawn to represent the bearing angles to the visible portions of the building. The red arrow indicated the direction of travel and viewing.

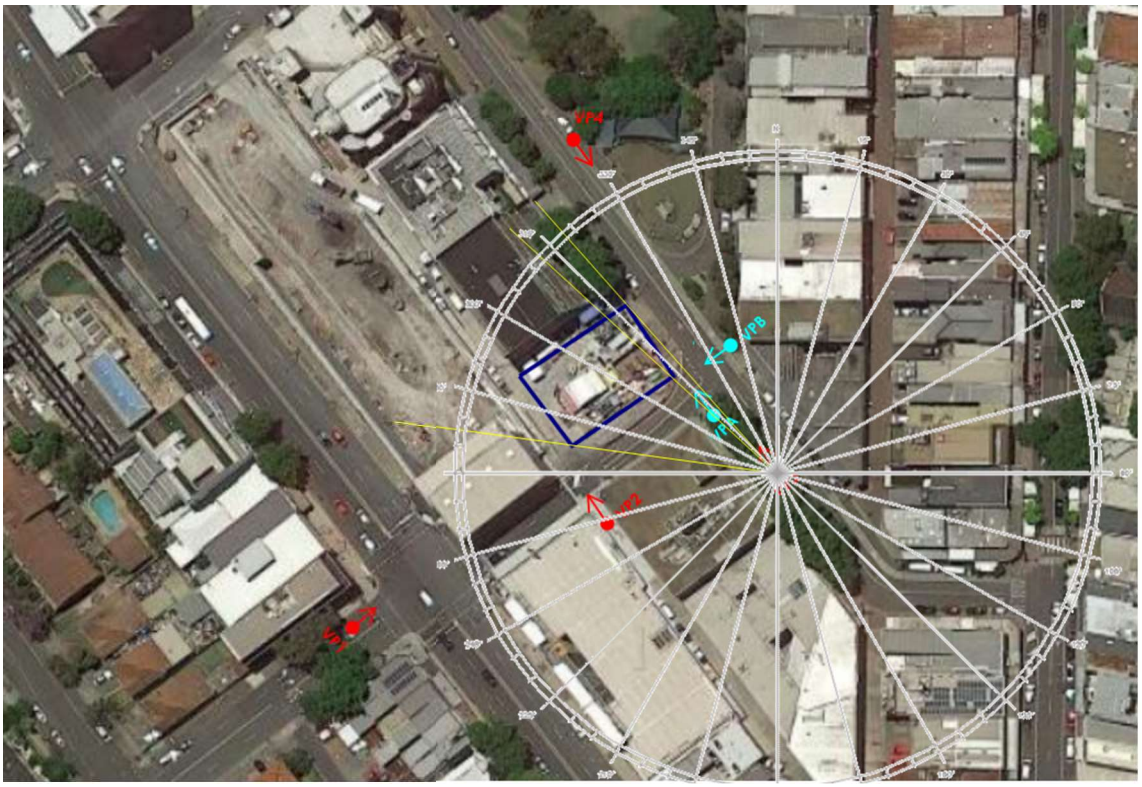

Figure 16 – Viewpoint 3 horizontal bearing angles

The upper limit vertical bearing angle that has been used is 16°. As set out in Section 2 of this report, any glare source above 16° will be outside of the zone of disability glare caused by materials with a specular normal reflectivity of 20%, which is the limit for buildings in Sydney.

	Vertical Bearing Angle		**Horizontal Bearing Angle (0° at North)**	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Façade Aspect 54	0°	16°	313°	318°
Façade Aspect 145	0°	16°	277°	318°

These bearing angles have been plotted on the reflected sun path diagrams below.

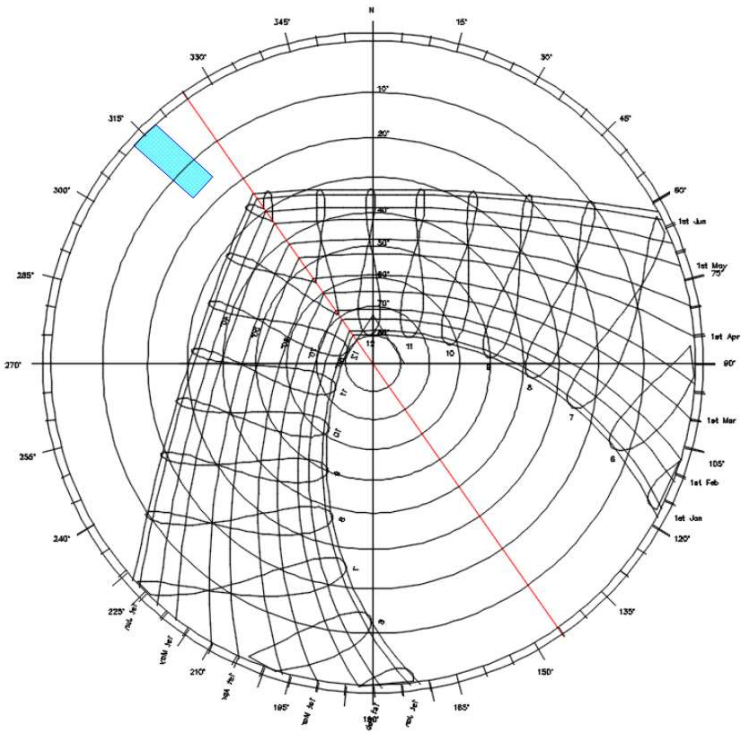

Figure 17 – Façade Aspect 54 Reflected Virtual Sun from Viewpoint 3

There is no reflected image of the sun that reaches Viewpoint 3 from Façade Aspect 54 of the building. No further studies are required.

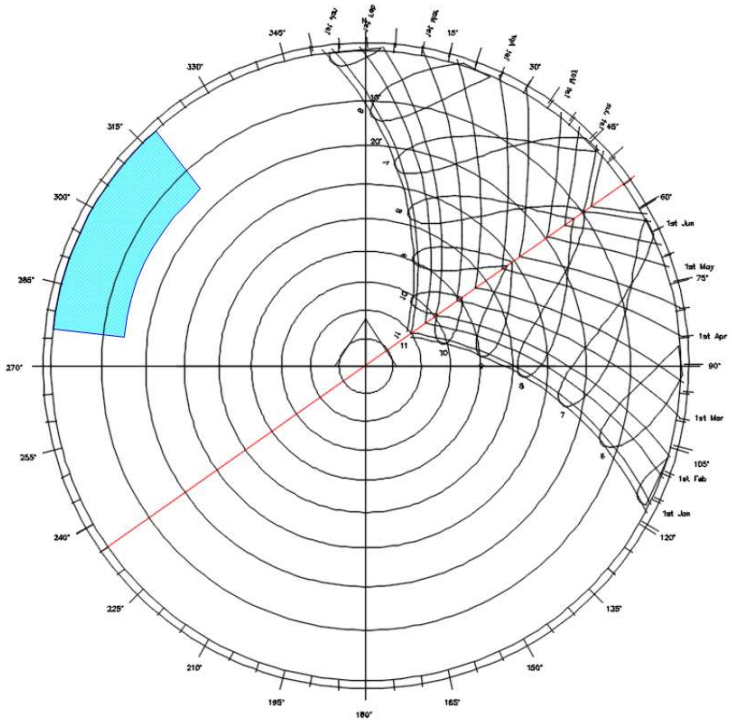

Figure 18 – Façade Aspect 145 Reflected Virtual Sun from Viewpoint 3

There is no reflected image of the sun that reaches Viewpoint 3 from Façade Aspect 145 of the building. No further studies are required.

Viewpoint 4

Viewpoint 4 is taken from the viewpoint of a driver travelling South East on Clarke Street. The viewing angle of the driver is 150°.

The following Façade Aspects are visible from the Viewpoint in a 180° segment oriented to the direction of viewing and the distance to the corners of the aspect in brackets:

- Façade Aspect 54 (42m)
- Façade Aspect 324 (42m)

In *Figure 19* below yellow lines have been drawn to represent the bearing angles to the visible portions of the building. The red arrow indicated the direction of travel and viewing.

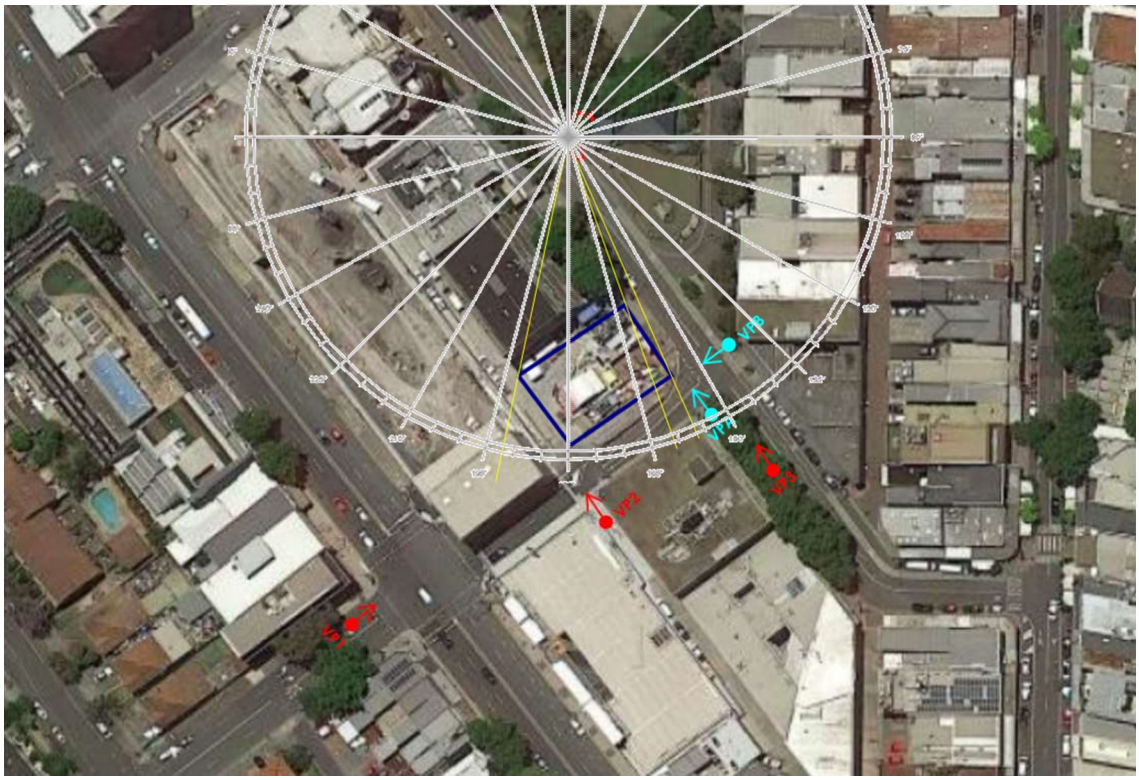

Figure 19 – Viewpoint 4 horizontal bearing angles

The upper limit vertical bearing angle that has been used is 16°. As set out in Section 2 of this report, any glare source above 16° will be outside of the zone of disability glare caused by materials with a specular normal reflectivity of 20%, which is the limit for buildings in Sydney.

	Vertical Bearing Angle		**Horizontal Bearing Angle (0° at North)**	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Façade Aspect 54	0°	16°	157°	162°
Façade Aspect 324	0°	16°	157°	193°

These bearing angles have been plotted on the reflected sun path diagrams below.

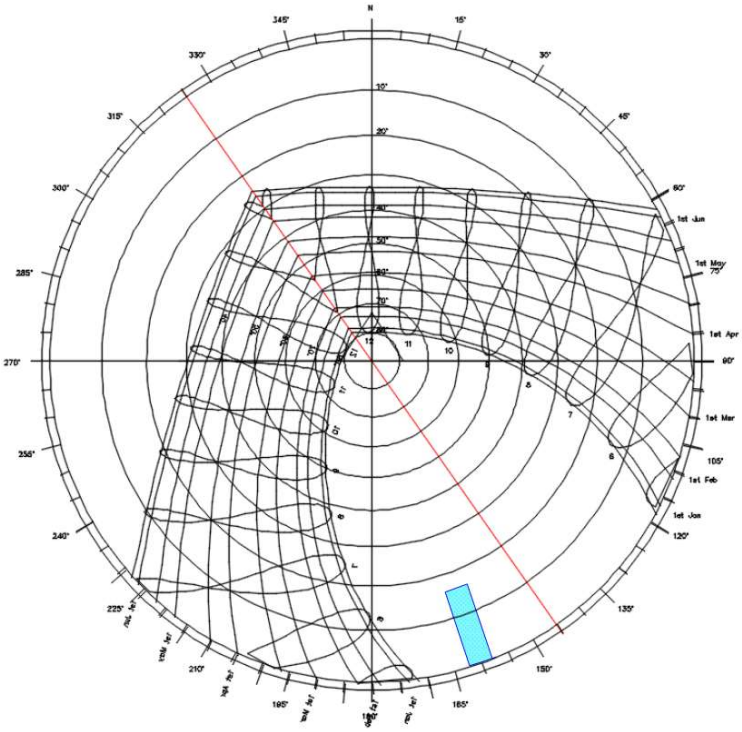

Figure 20 – Façade Aspect 54 Reflected Virtual Sun from Viewpoint 4

There is no reflected image of the sun that reaches Viewpoint 4 from Façade Aspect 055 of the building. No further studies are required.

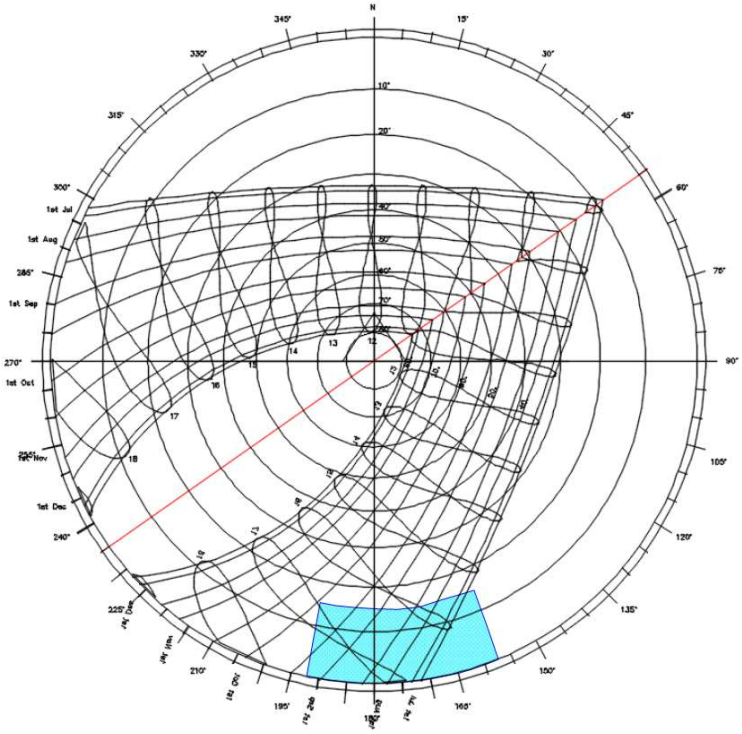

Figure 21 – Façade Aspect 324 Reflected Virtual Sun from Viewpoint 4

There is a reflected image of the sun that reaches Viewpoint 5 from Façade Aspect 324 of the building. This reflected image occurs between 4:30pm and 6:00pm from April to September each year.

The image below has been taken from Google Maps at the location of Viewpoint 4. The Hassall glazing protractor has been overlaid at scale. It can be seen that the new building is outside of the 20% iso-glare loop. No further studies are required.

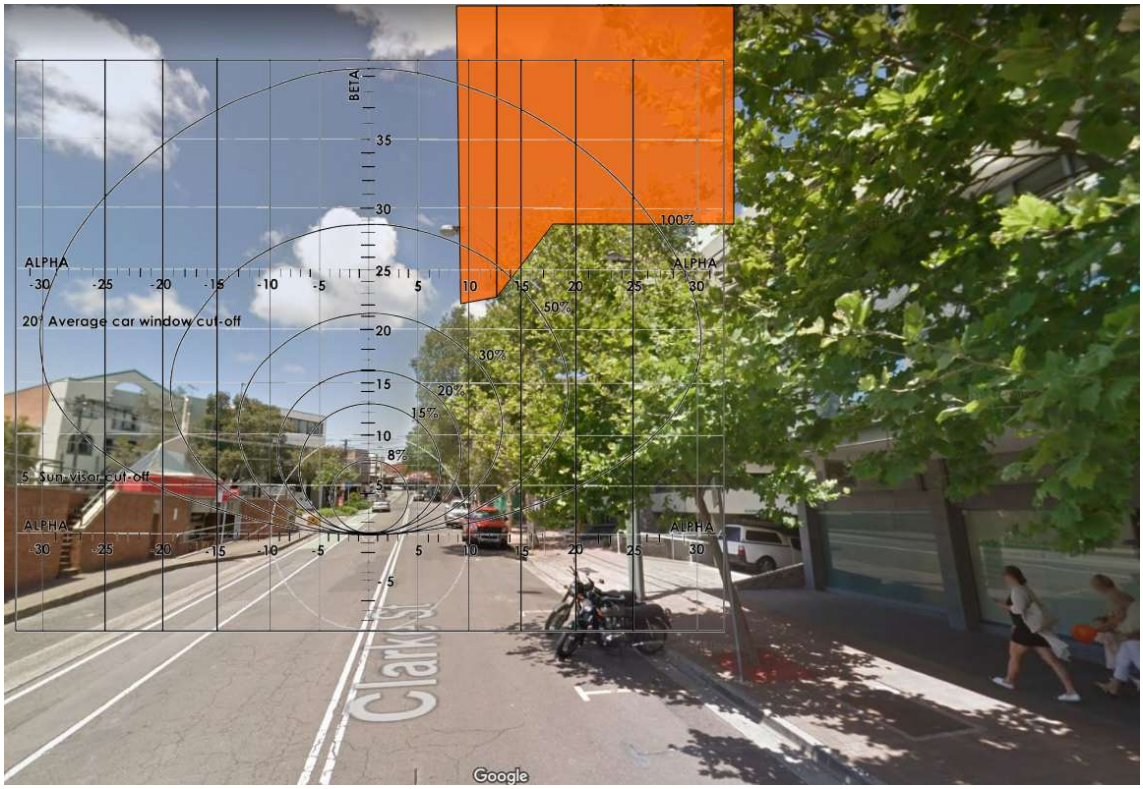

Figure 22 – Viewpoint 4 with Glare Protractor Overlay

Viewpoint A

Viewpoint A is taken from the viewpoint of a pedestrian crossing North West at Clarke Street. The viewing angle of the pedestrian is 325°.

The following Façade Aspects are visible from the Viewpoint in a 180° segment oriented to the direction of viewing and the distance to the corners of the aspect in brackets:

- Façade Aspect 54 (13m)
- Façade Aspect 145 (13m)

In *Figure 23* below yellow lines have been drawn to represent the bearing angles to the visible portions of the building. The blue arrow indicates the direction of travel and viewing.

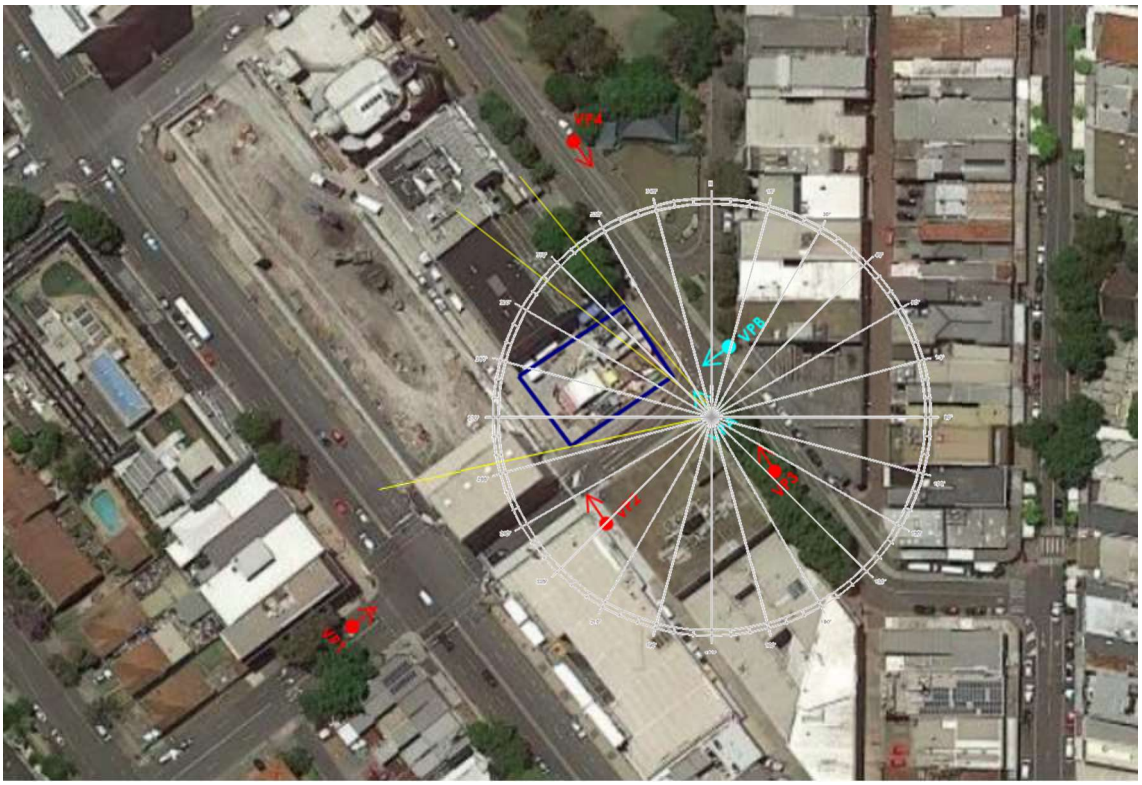

Figure 23 – Viewpoint A horizontal bearing angles

The upper limit vertical bearing angle that has been used is 16°. As set out in Section 2 of this report, any glare source above 16° will be outside of the zone of disability glare caused by materials with a specular normal reflectivity of 20%, which is the limit for buildings in Sydney.

	Vertical Bearing Angle		**Horizontal Bearing Angle (0° at North)**	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Façade Aspect 54	0°	16°	309°	321°
Façade Aspect 145	0°	16°	258°	321°

These bearing angles have been plotted on the reflected sun path diagrams below.

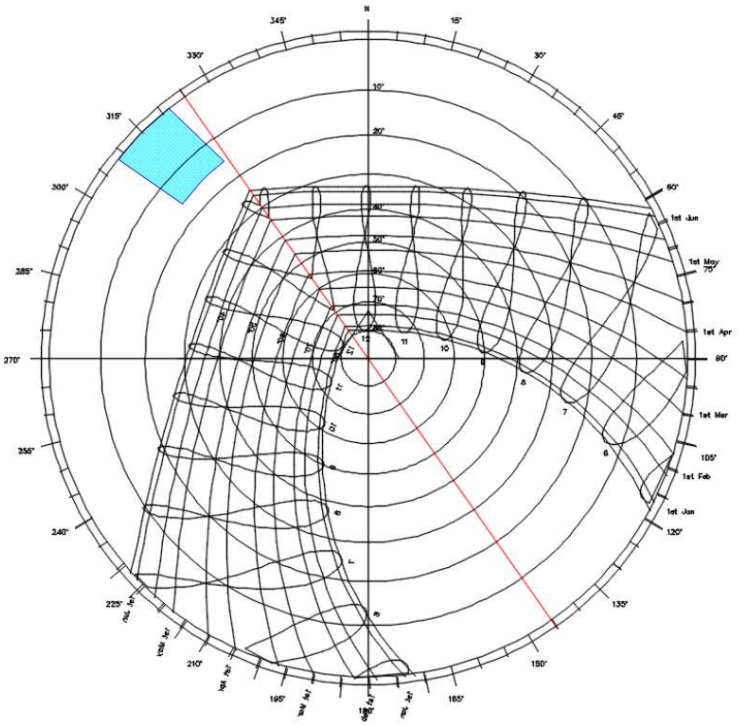

Figure 24 – Façade Aspect 54 Reflected Virtual Sun from Viewpoint A

There is no reflected image of the sun that reaches Viewpoint A from Façade Aspect 54 of the building. No further studies are required.

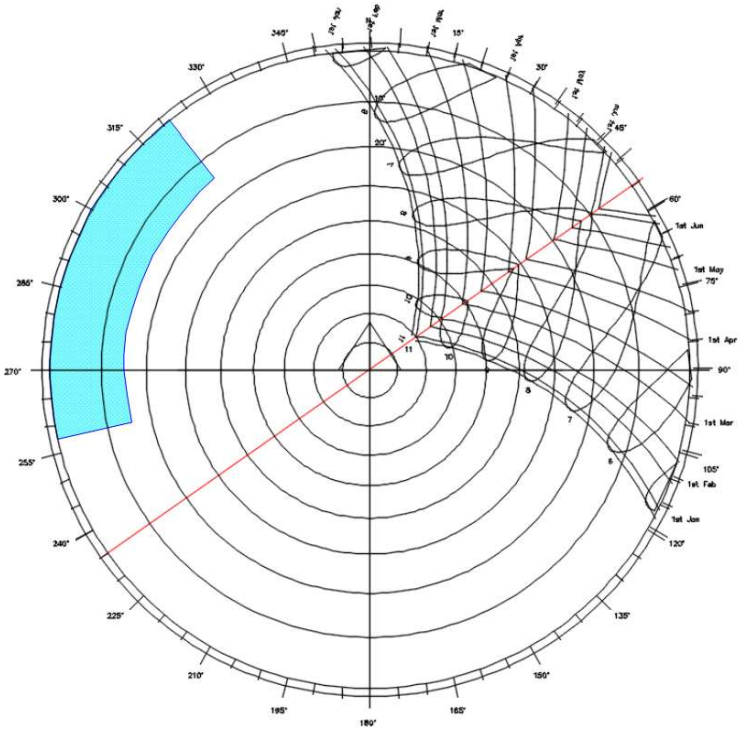

Figure 25 – Façade Aspect 145 Reflected Virtual Sun from Viewpoint A

There is no reflected image of the sun that reaches Viewpoint A from Façade Aspect 145 of the building. No further studies are required.

Viewpoint B

Viewpoint B is taken from the viewpoint of a pedestrian crossing South West at Hume Street. The viewing angle of the pedestrian is 240°.

The following Façade Aspects are visible from the Viewpoint in a 180° segment oriented to the direction of viewing and the distance to the corners of the aspect in brackets:

- Façade Aspect 54 (13m)
- Façade Aspect 145 (13m)

In *Figure* 26 below yellow lines have been drawn to represent the bearing angles to the visible portions of the building. The blue arrow indicates the direction of travel and viewing.

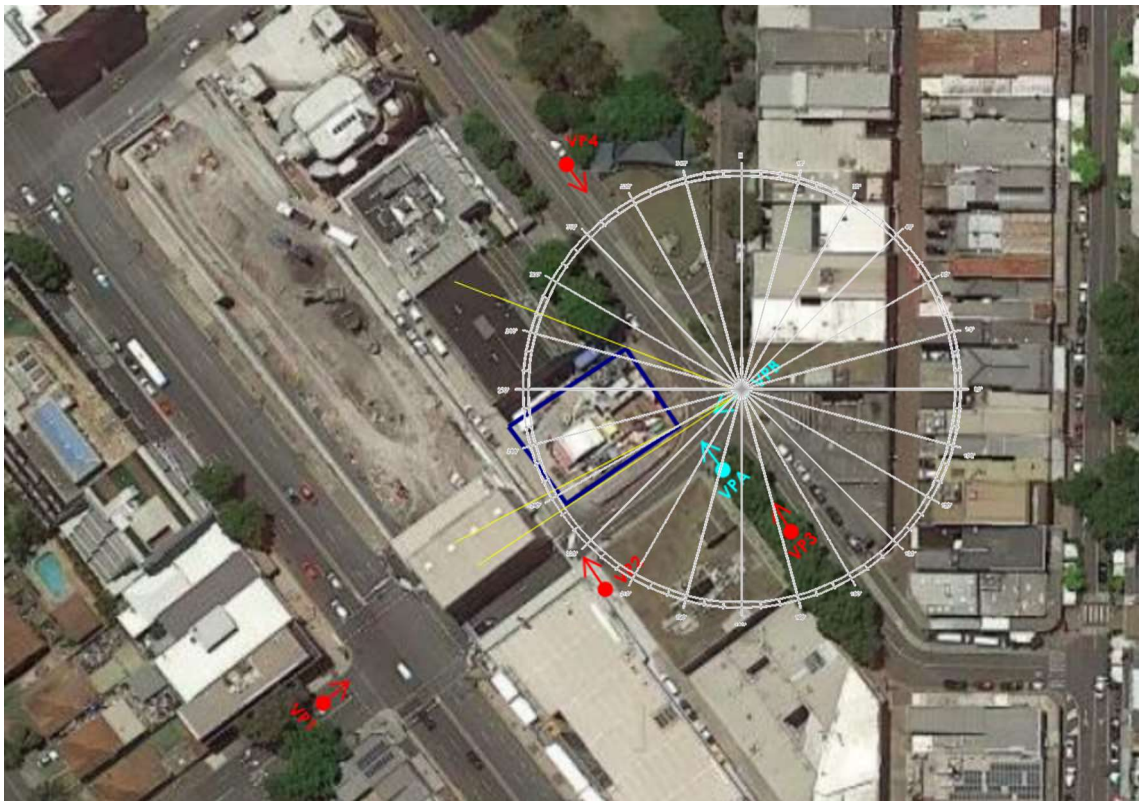

Figure 26 – Viewpoint B horizontal bearing angles

The upper limit vertical bearing angle that has been used is 16°. As set out in Section 2 of this report, any glare source above 16° will be outside of the zone of disability glare caused by materials with a specular normal reflectivity of 20%, which is the limit for buildings in Sydney.

	Vertical Bearing Angle		**Horizontal Bearing Angle (0° at North)**	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Façade Aspect 54	0°	16°	242°	290°
Façade Aspect 145	0°	16°	236°	242°

These bearing angles have been plotted on the reflected sun path diagrams below.

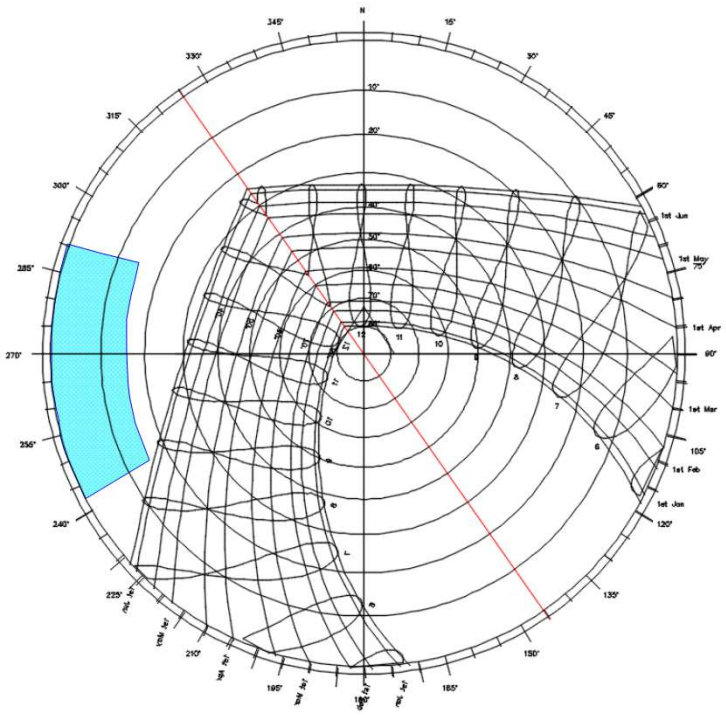

Figure 27 – Façade Aspect 54 Reflected Virtual Sun from Viewpoint B

There is no reflected image of the sun that reaches Viewpoint B from Façade Aspect 54 of the building. No further studies are required.

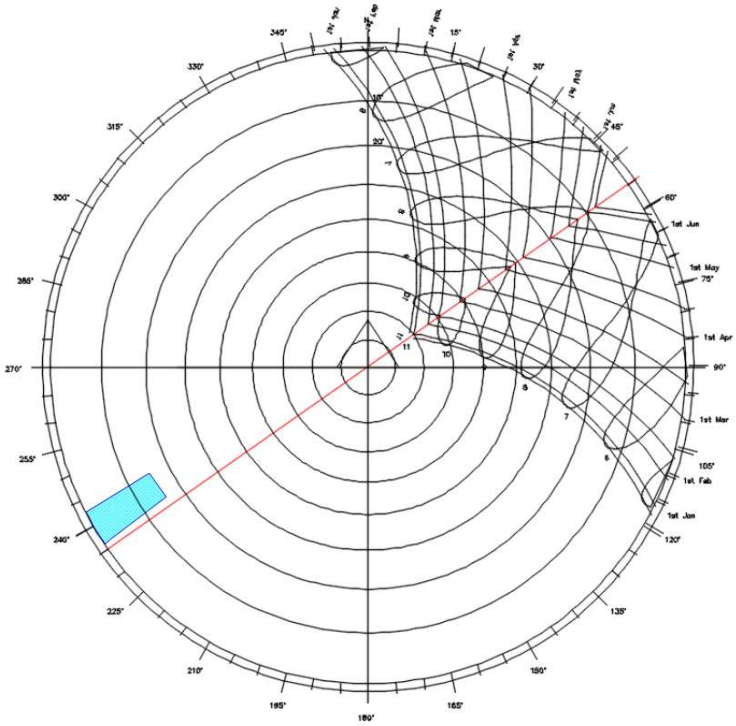

Figure 28 – Façade Aspect 145 Reflected Virtual Sun from Viewpoint B

There is no reflected image of the sun that reaches Viewpoint B from Façade Aspect 145 of the building. No further studies are required.