Lend Lease (Millers Point) Pty Limited

Barangaroo South - C3 Commercial Building

Reflectivity Study - Project Application

Rev A | 26 October 2011

Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
Level 10
201 Kent Street
Sydney
NSW 2000
Australia
www.arup.com

Job number 220316

ARUP

Contents

1 Introduction

1.1 Introduction

This report supports a Project Application submitted to the Minister for Planning pursuant to Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Application seeks approval for construction of a commercial building (known as Building C3) and associated works at Barangaroo South as described in the Project Description section of this report.

1.2 Background

The 22 hectare Barangaroo site has been divided into three distinct redevelopment areas (from north to south) – the Headland Park, Barangaroo Stage 2 (also known as Barangaroo Central) and Barangaroo Stage 1 (herein after referred to as Barangaroo South).

Lend Lease was successfully appointed as the preferred proponent to develop Barangaroo Stage 1 (otherwise known as Barangaroo South) on 20 December 2009.

1.3 Site Location

Barangaroo is located on the north western edge of the Sydney Central Business District, bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and bounded to the south by a range of new development dominated by large CBD commercial tenants.

The Barangaroo site has been divided into three distinct redevelopment areas (from north to south) – the Headland Park, Barangaroo Stage 2 (also known as Barangaroo Central) and Barangaroo South.

The area of land within which development is proposed under this Project Application extends over land generally known and identified in the approved Concept Plan as Block 3 which comprises Lot 5 in DP 876514.

1.4 Purpose of this Report

This report has been prepared to accompany the Project Application for the C3 Commercial Building and associated works at Barangaroo South. It addresses the relevant Director-General Requirements for the project. These Director-General Requirements are discussed in the Environmental Assessment Report (EAR) that has been prepared to support the submission.

This Reflectivity Report assesses the impact of solar reflections off the proposed development on traffic in the surrounding area of the Barangaroo site and adjacent area of Millers Point and Sydney CBD, in terms of reduced visibility of visual tasks, to address the qualitative requirements of the Central Sydney DCP 1996 Provision 4.5.3. As per this provision, the report focuses on the impact on pedestrians and motorists. The assessment of the impact of reflections on air and water traffic is beyond the scope of this report. This assessment is performed following the methodology of David N.H. Hassall of the University of New South Wales (Hassall 1991).

The reflectivity study presented in this report was performed with architectural drawings and three-dimensional building and site models received from Rogers Stirk Harbour and Partners architects for Revision C (see Appendix B1).

1.5 Description of Proposed Facades

The Project Application seeks approval for the construction of a 49 storey building, comprising ground floor retail, a commercial lobby, childcare, podium and office tower, provision for associated cars and bicycle parking and the construction of the surrounding ancillary temporary public domain which includes access streets and landscaping.

Drivers, pedestrians, and neighbouring building occupants will observe the building's facades. The building comprises three distinct components, defined as the tower facade, the North Core, and the podium.

Figure 1 shows a typical floor and solar shading set out plan at tower low rise level of each façade. Figure 2 shows a podium floor plan. Figure 3 shows the West elevation of the building, including the tower, the Podium, and part of the North Core.

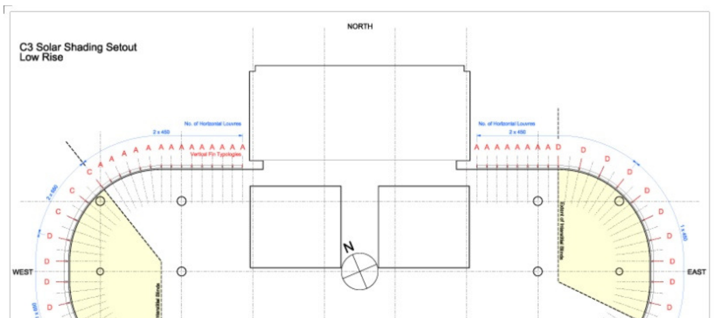


Figure 1: Typical Tower Solar Shading Set-out Plan (Low Rise)

Figure 2: Podium Floor Plan

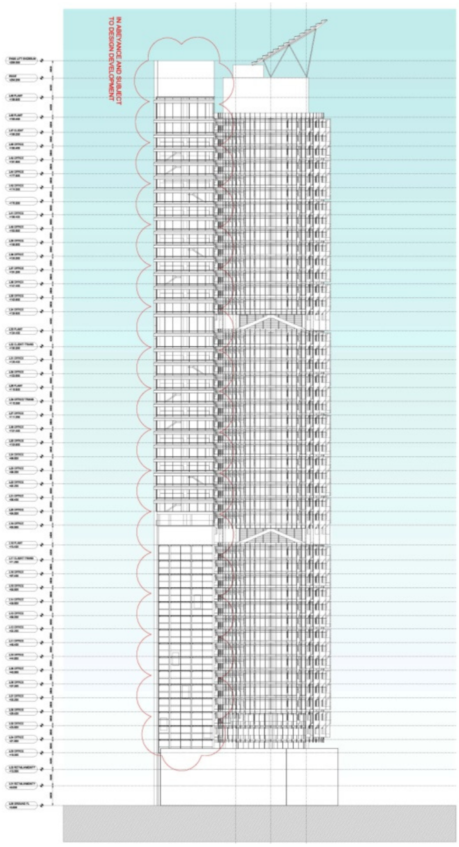


Figure 3: West Elevation

The majority of the tower facade is clad in full-height 1.5 m width module unitised curtain wall systems. These panels follow the shape of the floor plate, and are faceted around the rounded corners of the tower. The glazing in these systems is set to the front face of the mullion. These projections would likely mitigate any adverse reflections off the glazing to a degree. However, as these mitigating effects are difficult to quantify, for the purpose of this exercise structural elements such as mullions have been ignored.

Different measures of solar control are introduced to these facades in response to changing orientations. External horizontal and vertical shading devices are added to block or filter the sun to suit solar exposure.

Figure 4 shows one of the external vertical fins typologies. The vertical fins will also shade the curtain wall facade and mitigate the facade reflectivity to an extent. However, the shades themselves are glazed and could potentially introduce glare to road users, which adversely impacts the overall building reflectivity.

Therefore, the vertical fins are considered in the analysis and all facades were assumed to be fully glazed to model a worst case condition. While currently investigated reference glass products have a lower external reflectance, it was assumed that the external reflectivity of the fully glazed facades is equal to or less than 20% in accordance with the Central Sydney DCP 1996 Provision 4.5.2.

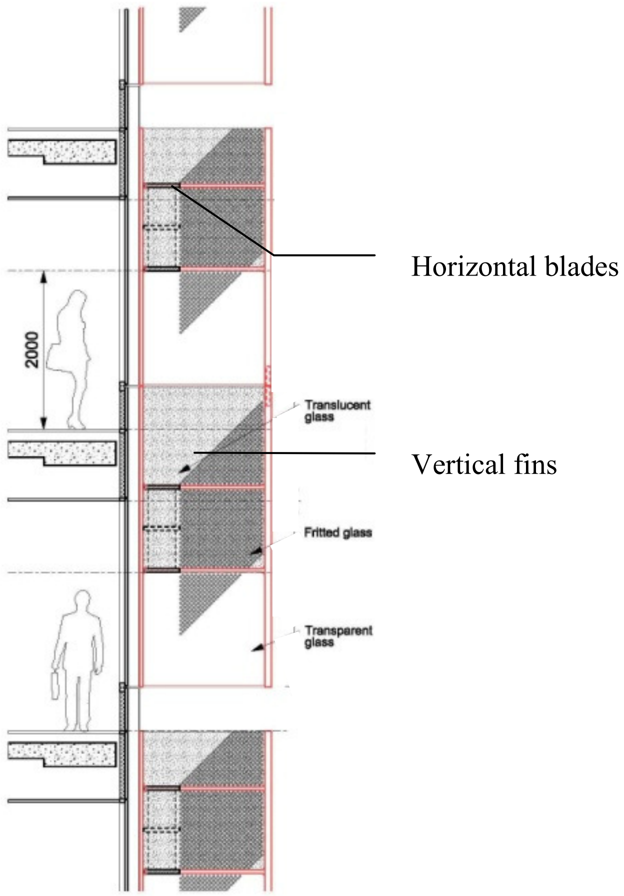


Figure 4: Building section showing external vertical fins

The lower three levels of the building form a podium on top of which the tower is situated. This element has a larger foot print and houses the entrance foyer as well as future tenanted spaces. The Podium is subject to ongoing design development.

The facade typology for the podium and the north core is subject to ongoing design development and will be confirmed as part of the detailed design process. For the purpose of this assessment, all podium and North Core facades were therefore considered fully glazed with an external reflectivity of 20% to model a worst case allowable condition. Actual glazing to be selected for the project is likely to have a lower reflectivity.

It is proposed that photovoltaic panels for energy generation are installed on the tower rooftop. These have been modelled as surfaces of 20% external reflectivity as a worst case assumption, as the actual PV panel product is not known at this stage. Typical reflectivity of suitable PV panel products is well below this figure.

The proposed C3 building is likely to be partly overshadowed by future buildings on the Barangaroo South development site. However, since building C3 may be constructed before any of these, any overshadowing effect by these other proposed buildings potentially mitigating any reflection issues has not been considered in this study. Similarly, future landscaping including tree planting around the site may have a mitigating effect on any problematic low-level reflections but has not been taken into account. Building C3 has been considered as standing on an otherwise empty Barangaroo South site to model a worst case condition.

Assumptions about facade reflectivity and overshadowing / obscuring are thus conservative in several ways and reflect a worst case scenario.

2 Assessment of Facade Reflections

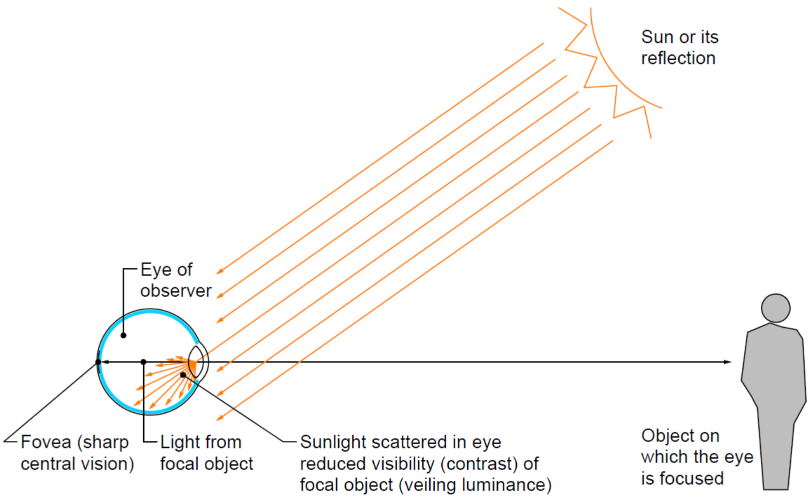
2.1 Criteria for Assessment

This report assesses the likelihood of undesirable solar reflections that affect nearby roadways and traffic. The assessment follows the methodology of David N. H. Hassall of the University of New South Wales. This methodology is detailed in Section 2.2 of this report.

Any glazed building has the potential to cause solar reflections in many directions at any time at which the sun is visible. The study will assess the importance of these reflections in terms of 'disability glare' and 'discomfort glare'. These are defined in the Hassall methodology as follows:

- Disability glare – glare from reflections which impact the observer in a way that they are unable to perform a visual task, such as reading or driving, without taking evasive action (such as turning away or raising a hand to shield the eyes). It is critical that a driver's view is unaffected by disability glare as this has the potential to cause road accidents. Note that the term 'Disability' indicates temporary impact on the ability to perform visual tasks and does not imply that the glare effect leads to long-term disability in any form.
- Discomfort glare – glare from reflections causing the observer psychological annoyance.

Calculations following this method centre on equivalent veiling luminance in the eyes of observers due to solar reflections. The terms 'veiling luminance' and 'veiling glare' refer to the effect of multiple reflection and scattering within the eye of direct light from a bright source. This produces a perception similar to a thin veil being overlaid on the visual scene, and reduces the contrast in the scene, potentially impairing visual tasks.



The equivalent veiling luminance is a measure of this effect, and hence considered a measure of the visual impact of glare. Luminance is measured in Cd/m² (candela per metre squared) and is a representation of how bright a surface will appear to the human eye. Where the equivalent veiling glare figure exceeds the level of 500Cd/m², the solar reflection is considered excessive (potentially causing disability glare) in accordance with the Hassall methodology.

2.2 Methodology

The assessment of undesirable solar reflections is based on the methodology described by David N. H. Hassall [1]. It involves several steps, as outlined below.

1. The size, orientation and extent of reflective objects on each facade are determined by examination of drawings provided by the architect, the site and surrounds, and expected glazing materials.
2. Several observer locations are chosen for critical facades, representing locations from which traffic participants may observe the facades.
3. Times at which the sun is reflected off the facade are determined, as well as the directions in which it is reflected.
4. For each observer, the equivalent veiling luminance in the eye of the observer is calculated. This involves calculations of the strength of solar illumination, the position of the sun in front of the facade, the apparent position of the sun reflected in the facade, and the reflected solar illumination received by the observer.
5. The calculated equivalent veiling luminance is compared with the maximum allowed level of 500Cd/m². Veiling luminance in excess of this limit is considered to potentially cause glare impairing visual tasks (disability glare) and thus pose a risk to traffic if it cannot be effectively blocked.
6. For situations where the maximum level is exceeded, the case is further investigated to assess whether the offending section of facade is not shaded by external elements, and whether it presents a sufficiently large solid angle to the observer. If the offending facade section is shaded or too small to reflect a portion of the sun disk large enough to cause disability glare to the observer, the case is disregarded.
7. In some situations, high veiling luminance may be caused by grazing reflections, when the sun itself is close to its reflection in the observer's field of view. In this case the impact of the reflection is considered minimal when compared to that of the actual sun. Consequently, grazing reflections, where the angle between the observer direction and the real sun is less than 20°, are not included in the results. Reflections where the angle is greater than 20° are included and are considered on an individual basis.
8. With knowledge of the impact of solar reflections on numerous observers for each facade, the investigation is generalised for all similar observers within sight of each facade.
9. For calculation purposes, it is assumed that to carry out the visual tasks required for traffic participation drivers and pedestrians generally face parallel to the ground, and parallel to their direction of travel.

To allow calculations to proceed, a number of assumptions were made:

- A nominal glazing and cladding specular reflectance of 20% has been considered, as this the allowable limit under the provisions of the Sydney City DCP. Where the results show that no disabling reflections are produced by this glass, no disabling reflections will be produced by glass or cladding of a lesser reflectivity.

- Each glazed facade area is assumed to be 100% glazed as a worst case assumption. Glazing joints and framing elements theoretically reduce the reflectivity of the facades, but this effect is difficult to quantify.

Each of the above assumptions is considered appropriate in this case, and the Hassall methodology is considered best practice for such analysis.

2.3 Model / analysis approach

The analysis was undertaken using 3D models and the daylight simulation and rendering software Radiance [2] as well as Arup developed software. The rendering analysis converts real illuminance into equivalent veiling luminance after Hassall's definition, depending on reflectivity of the facade and observer direction. A glass with nominal external reflectivity of 20% was modelled for all glazed facades.

Models provided by Rogers Stirk Harbour and Partners (RSHP) included the proposed building with all reflective facade surfaces as well as mass modelling of the surrounding topology and structures.

The software used allows rendering of sunlight reflections in the following principal ways:

1. Observing distribution of reflected light on ground and other surfaces for a specific time. This allows assessing towards which observer locations reflections are cast off the facades. The equivalent veiling luminance is calculated for a specific observer direction
2. Highlighting all areas on the reflecting surface that produce excessive reflections towards a specific observer location, but covering the entire year. This allows assessing in detail if and from which precise areas excessive reflections originate from the facade. Arup has developed an in-house software that can perform high level analysis of this second type dynamically along defined pathways, which enables finding worst case locations in terms of reflections along traffic roads.

Using the first method, reflections off the facades were first simulated at numerous different times representative of the variation in sunlight over the hours of the day and over the course of a year.

From the results, roads in which potentially adverse reflections off the building occur were identified. These were then assessed in detail with perspective images generated using the second method.

All images used in this report use the following colour coding:

- Any sun reflections or areas on the facades producing sun reflections towards the observer, whether excessive or deemed tolerable, are highlighted in **blue and yellow**
- All areas where the equivalent veiling luminance exceeds the 500Cd/m² threshold are highlighted in **yellow**

3 Results

3.1 Global analysis

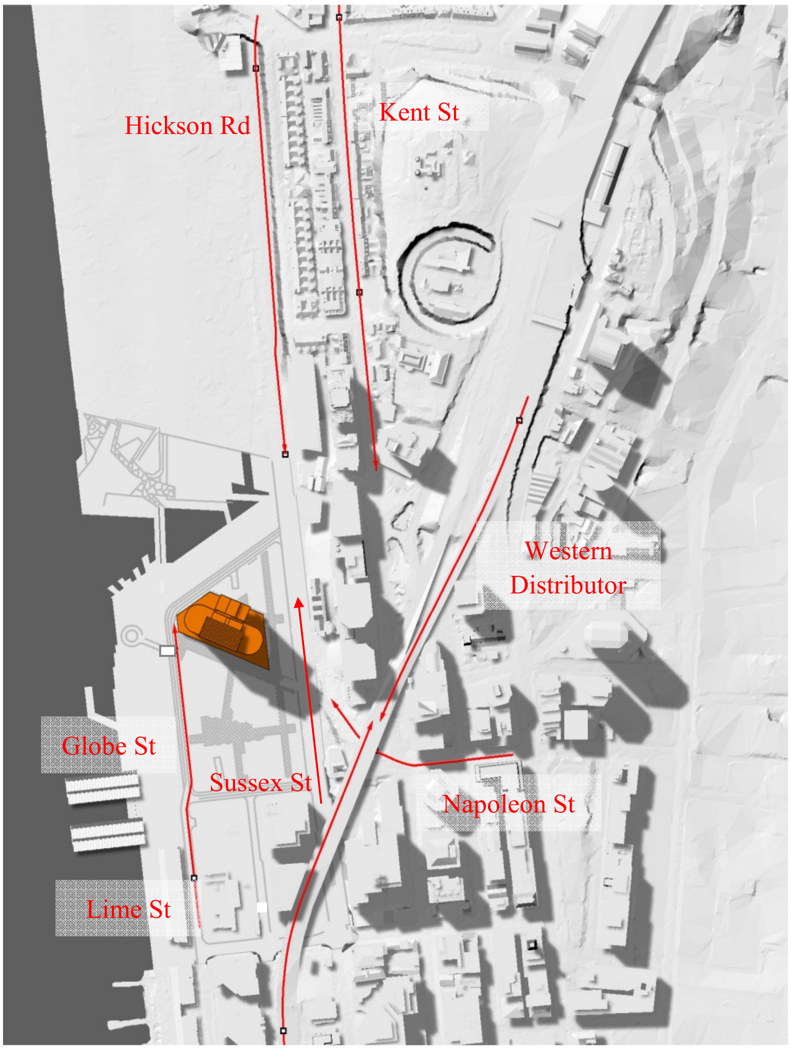


Figure 5: Plan view showing extent of surroundings modelled and roads leading towards site

Renderings of the 3D model were made in plan view of the area surrounding the site to approximately 450m distance, as shown in Figure 5.

Reflections off the facades were firstly simulated at 15-min intervals over an entire day for each month of the year (See Appendix A for an overview).

From inspection of the generated results, it was apparent that some reflections fall onto roads and may be visible to traffic participants. As the plan renderings returned only a limited resolution result, and observer directions could not be finely tuned to accurately represent veiling luminance in all locations following the roads, perspective studies from road locations were undertaken in any areas where the renderings highlighted reflections which appeared to be thrown in the direction of the observer. These areas included Lime and Globe Street, Sussex Street, Hickson Road, Napoleon Street, Kent Street, and Western Distributor. High level dynamic perspective analysis was undertaken along the entire length of paths along these roads as shown as red lines in Figure 5. Selected representative perspectives were then rendered in detail from locations shown as small squares in Figure 5. Analysis findings are presented below.

Reflections to other surrounding streets were found to be either entirely blocked by other buildings or not falling close to traffic participants' expected view directions, thus not reaching a concerning level of equivalent veiling luminance.

3.2 Lime Street and Globe Street

Lime St connects to Globe St, leading onto the Barangaroo site from the south, and past the western side of Building C3.

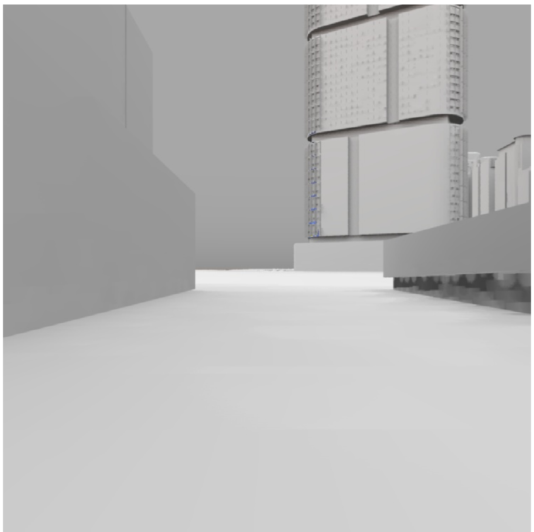


Figure 6: View down Globe Street

Figure 6 shows a representative perspective view from Lime St heading north, before the intersection with Margaret St West at approximately 230 m from the podium of Building C3. The assessment has shown no reflections exceeding the acceptable threshold along the assessed pathway. **Excessive reflections causing glare in Lime / Globe St were therefore discounted.**

3.3 Sussex Street and Hickson Road

Sussex St is located on the eastern edge of the Barangaroo site and continues as Hickson Rd on the north. Road users travelling north on Sussex St and south on Hickson Rd will observe Building C3.

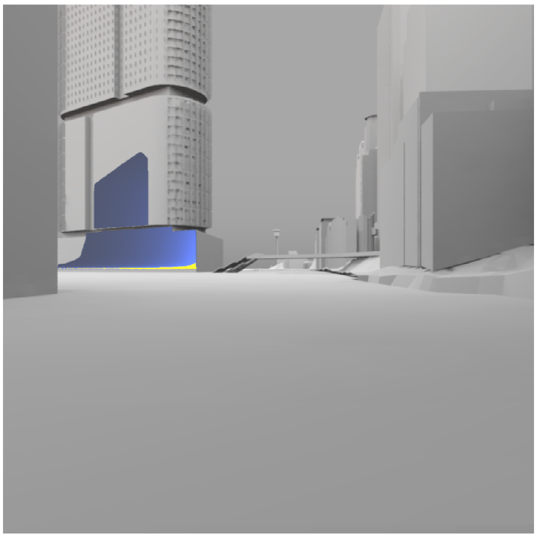


Figure 7: View from Sussex Street

Figure 7 shows a representative perspective view from Sussex St heading north after emerging from the underpass under the Western Distributor and where the building becomes visible, at approximately 180m from the podium of Building C3.

For traffic travelling north on Sussex St, the assessment has only shown reflections exceeding the threshold at the very lowest edge of the podium facade, below 2° from the horizontal. Reflections at these inclinations would in reality be strongly reduced by atmospheric particles, and also would be most likely blocked by buildings and topology in Pyrmont across Darling Harbour, which were not included in the analysis 3D model. **Excessive reflections causing glare in Sussex St travelling north were therefore discounted.**

Figure 8: View from Hickson Road

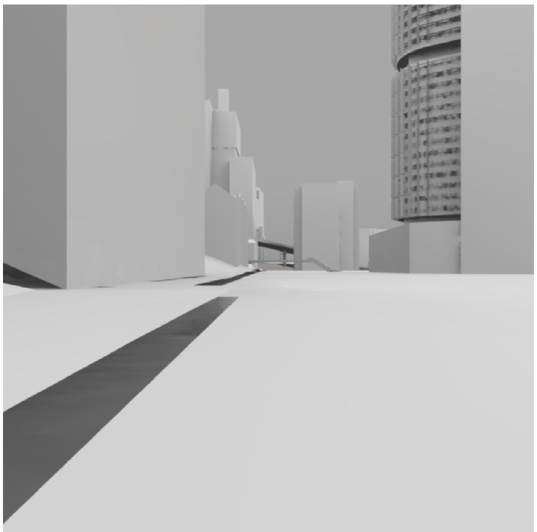


Figure 9: View from Hickson Road

Figure 8 shows a representative perspective view from Hickson Rd travelling south near the Argyle Place overpass, at approximately 580 m from Building C3. Figure 9 shows another view from Hickson Rd near Ball St, at approximately 170m from the Building C3 tower.

The assessment has shown no reflections exceeding the acceptable threshold along the assessed pathway. **Excessive reflections causing glare in Hickson Rd were therefore discounted.**

3.4 Margaret Street and Napoleon Street

Margaret St is located east of the Barangaroo site, leading west down the slope from the CBD area towards the Barangaroo foreshore. It continues beyond Kent St as Napoleon St, following a curving trajectory down to Sussex St. Road users travelling west can observe Building C3 from the end of Margaret St onwards.

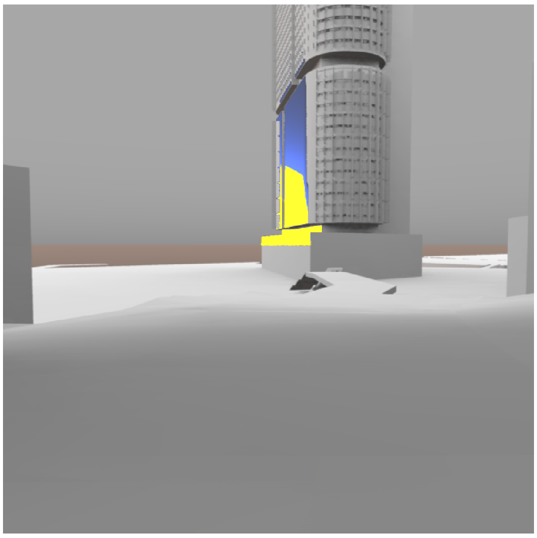


Figure 10: View from Napoleon Street

Figure 10 shows reflections off the building facade in perspective from a location in Napoleon St underneath the Western Distributor overpass, at approximately 160m from the Building C3 tower.

The analysis has identified that the glazing plane of the main south facing elevation of the lowest tower section and the top of the parallel podium facade can produce reflections above the threshold of 500Cd/m² to locations along the assumed roadway within a section of approximately 70m length around the viewpoint of the perspective image shown. These reflections occur roughly at the following times:

- Apr and Sept-Oct, between 15.00-16.30 Mar – for up to 30min intervals

Reflections are cast at a glancing angle along the facade. The real sun may be directly visible as well at the same times from some locations along Napoleon St, however reflections may be visible when the real sun is blocked from view.

Mitigating factors that will likely reduce the impact from these reflections include:

- Tolerance in panel alignment
- Pillowing of double glazing (bulges slightly with change in temperature and atmospheric pressure)
- Low rise buildings planned along Sussex St possibly blocking low angle view to facade
- External facade features shading the facade plane and blocking view onto it

It is difficult to assess the former factors, and low rise building may not be present yet at completion of Building C3. However, the last point above will effectively prevent excessive reflection as long as expressed mullions assumed at panel joints at 1.5m centres protrude approx. 150mm minimum from the plane of glass (see Figure 11).

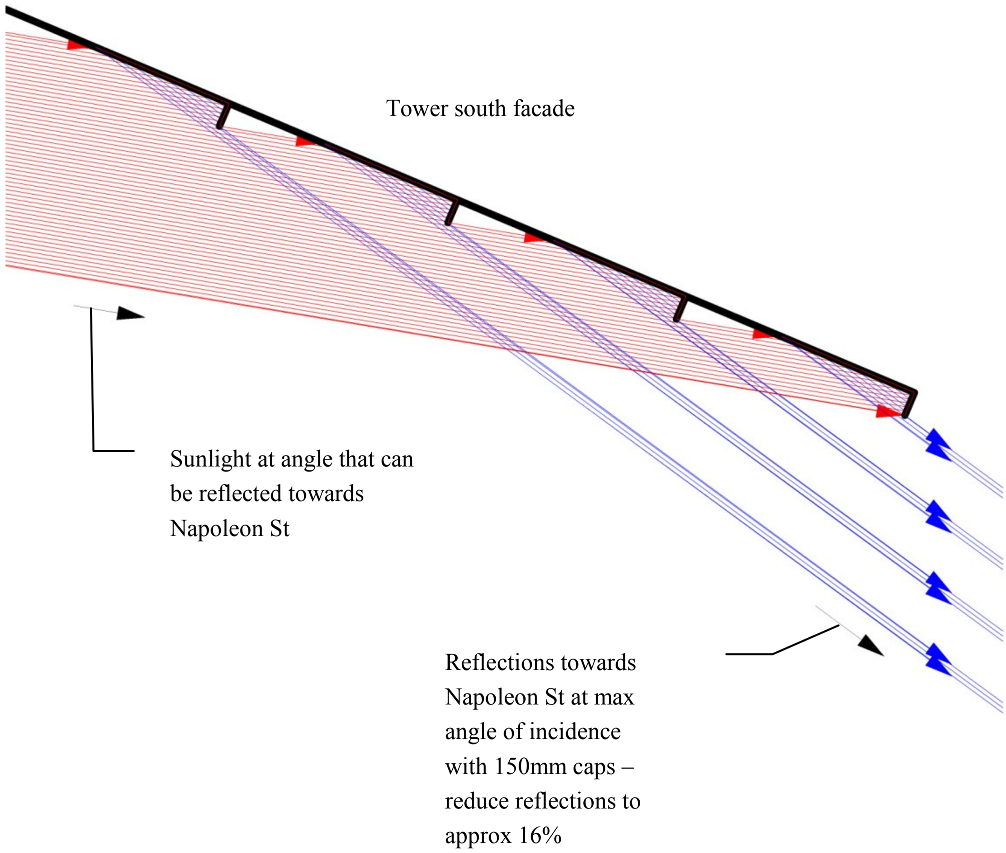


Figure 11: Expressed mullions principle

Excessive reflections causing glare in Margaret St were discounted. Excessive reflections causing glare in Napoleon St can be discounted, subject to implementation of expressed mullions of min 150mm depth or assessment of alternative mitigation measures in the further development of the design.

3.5 Kent Street

Kent St is located in the CBD / Millers Point area east of the Barangaroo site, parallel to and elevated above Hickson Rd. Road users travelling south on Kent St can observe Building C3 at some locations where buildings along the street do not obstruct the view.

Figure 12: View from Kent Street

Figure 13: View from Kent Street

Figure 12 shows a representative perspective view from Kent St travelling south near Argyle Place, at approximately 650m from Building C3. Figure 13 shows another view from Kent St near High St, at approximately 470m from the Building C3 tower.

The assessment has shown no reflections exceeding the acceptable threshold along the assessed pathway. **Excessive reflections causing glare in Kent St were therefore discounted.**

3.6 Western Distributor

The Western Distributor follows an elevated trajectory running south to north on the south of the Barangaroo site, then turning towards northeast and continuing through the northern part of the CBD area towards Harbour Bridge.

Road users travelling north on the Western Distributor south of the site, and travelling south on it between the Bridge and the site, can intermittently observe Building C3 between other buildings.

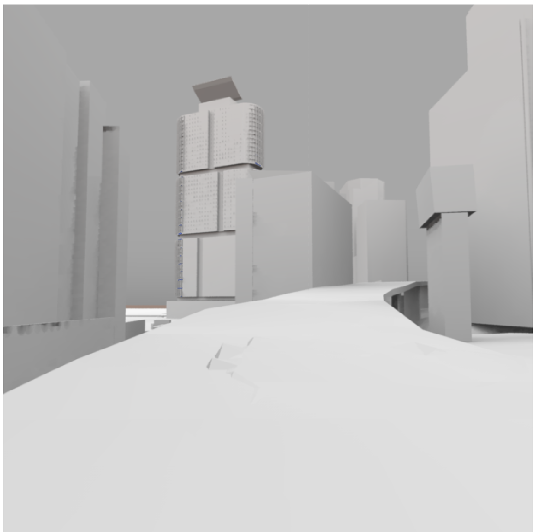


Figure 14: View from Western Distributor

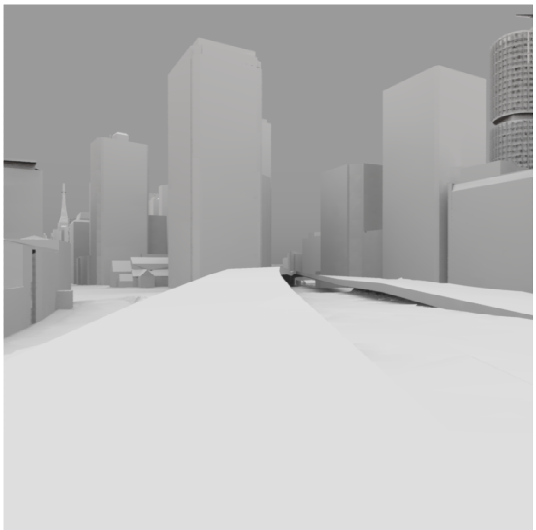


Figure 15: View from Western Distributor

Figure 14 shows a representative perspective from the Western Distributor heading north between King St and Erskine St, at approximately 380 m from Building C3. Figure 15 shows a representative perspective from the Western Distributor heading south, near Essex St, at approximately 350m from Building C3.

The assessment has shown no reflections exceeding the acceptable threshold along the assessed pathways in either direction. **Excessive reflections causing glare on the Western Distributor were therefore discounted.**

4 Qualitative Considerations

4.1 Impact on Pedestrians

From the perspective of pedestrians moving along roadways, the incidence of reflections from the building is generally similar to the examined road traffic locations. Glare from reflections close to the viewing direction is therefore not expected in these locations.

In other locations accessible to pedestrians where any glare from reflections may occur, the observer is easily able to adjust their view and thus reduce the glare impact of reflections. Pedestrians move at a rate significantly slower than that of a vehicle. For this reason it is acceptable to assume that it will be safe for pedestrians to divert their vision in order to avoid glare.

4.2 Impact on Surrounding Buildings

Solar reflections off the facade will reach surrounding buildings in the CBD area and future buildings on the Barangaroo South site. This may occur for short intermittent time periods during the morning, when low angle sun is reflected off faceted glazing on the east facade and glazing on the North Core east facade towards the CBD area.

In these cases, the effective reflectivity of glazing would be lowest due to the angle of incidence of sunlight from the east being close to normal; also, surrounding building occupancy may be expected to be low during hours of particularly low sun angles before 8am. From late morning to afternoon, reflections would be at a high vertical angle and thus not travelling far and also not penetrating deep into any building floor plates. Low angle evening sun could be reflected at glancing angles off the facade towards buildings in the CBD area, however west facing facades of these buildings would likely be reached by direct sunlight during similar times, so that reflections off the building are unlikely to cause significant additional discomfort.

In general, reflections from facades with external reflectance below 20% are much less likely to cause discomfort to occupants of surrounding buildings than facades with strongly reflective glazing. Building C3 is targeting a glass reflectance below 20% which will serve to reduce potential glare reflections that may occasionally be produced towards other buildings. In addition, external facade elements and opaque facades on the core side will further limit reflections towards other buildings.

The limited visible light transmittance of glazing in surrounding office buildings (in existing buildings likely below 50%) will further reduce the intensity of any reflections. Any reflections off the facades of the proposed development will reach other buildings for only short periods of time. Building occupants do not perform visual tasks as demanding as those required of drivers, so that they are capable of altering their direction of view during these brief periods. Reflections would be visible only from limited locations within any affected buildings.

For the above reasons it is expected that the development will have minimal solar reflection impact on the occupants of surrounding buildings.

4.3 Impact on Air and Water Traffic

This report addresses the qualitative requirements of the relevant Central Sydney DCP 1996 (Provision 4.5.3) and thus focuses on the impact of reflections on pedestrians and motorists. The effect of reflections on air and water traffic has not been included in the assessment in this report.

Air traffic to be considered would include airplanes travelling in the approach corridor towards Kingsford Smith airport from the north. Reflections from the building's vertical facade of the sun above the horizon are generally directed downwards and will not affect airplanes travelling at heights above the building height.

Commercial water traffic routes do not generally lead towards the building, however water traffic potentially affected by oblique reflections off the facades of Building C3 would include ferries, cruise ships and other vessels travelling into and out of Darling Harbour and other upstream bays. Water traffic generally operates at lower speeds and densities than road traffic.

In general, the visual task requirements of air and naval traffic operators differ from those of motorists, such that the methodology according to Hassall used in this report to assess reflections may not apply. It is noted that as a general measure to restrict the impact of sun reflections, the facades on Building C3 will have a reflectivity limited to within the bounds stipulated by the DCP Provision 4.5.2 (i.e. external reflectivity not exceeding 20%).

5 Conclusion

The proposed Building C3 performs well in terms of solar reflectivity, and glare affecting motorists on surroundings streets will not exceed the limits of acceptability according to the Hassall methodology with the provisions summarised below.

Glare risks have been discounted for most façade aspects, either because it could be shown that these do not reflect the sun towards traffic, or the intensity of reflections will be below the limit of acceptability as set out by Hassall, or because surrounding buildings and topology or other parts of the building itself will be blocking reflections that could cause glare to drivers.

The only exceptions occur on the south facade of the lower part of the tower, where glancing reflections of low angle sun may cause glare to drivers on Napoleon St, and potentially on the north-west facade of the podium, if this is a fully glazed facade following the development boundary.

It is therefore proposed that the expressed mullions on the mentioned part of the south facade are kept to a minimum of 150mm protrusion from the face of the reflecting glazing. The design of the podium facades is under development, and the configuration should take into account the potential for causing undesirable reflections and take suitable measures to mitigate these (e.g. external vertical sunshades, orientation more towards the north or the west, use of predominantly non-reflective materials, outward sloping glazing, or similar). Developed facade systems for the south that do not match the protrusion size above and any design for the podium north-west facade should be assessed for reflections when available.

The study has found that apart from the above qualifications every façade aspect can have a maximum external specular reflectance of 20% in accordance with council regulations without causing unacceptable glare. This result was obtained making worst case assumptions about the reflectivity of the facade, not taking into account any overshadowing effects from future proposed buildings on the Barangaroo South site and surrounding vegetation, or reduction of facade reflectivity through spandrel cladding, external shading devices, and reduced external glass reflectivity. In reality, a considerable fraction of some facades may be clad with non-specular spandrel materials, expressed structural elements of the facade would obscure or overshadow part of the glazing, and the typical vision glass is intended to have a reflectivity considerably below the 20% limit. These mitigating factors would serve to further reduce the impact of any reflections off the facade on the surroundings, as would the planned future buildings on the Barangaroo site.

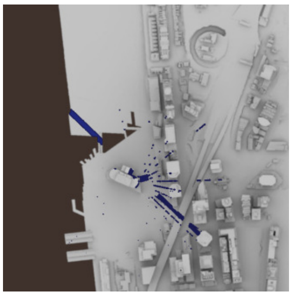
Pedestrians are easily able to adjust their view in any location where unwanted reflections may be received, reducing the impact of the reflections. Pedestrians move at a rate significantly slower than that of a vehicle. For this reason it is acceptable to assume that it will be safe for pedestrians to divert their vision in order to avoid glare. The glass reflectance below 20% and further mitigating factors in the facade construction will also serve to reduce potential glare reflections that may occasionally be produced towards other buildings.

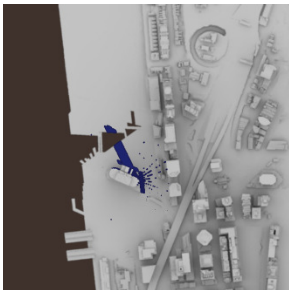
Appendix A

Annual Reflections Overview

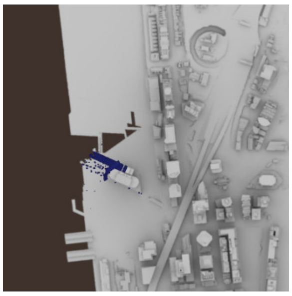
A1 Annual Reflections Image Sequence

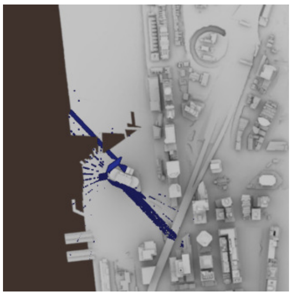
January 21

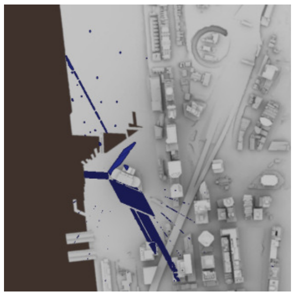

8:00


10:00

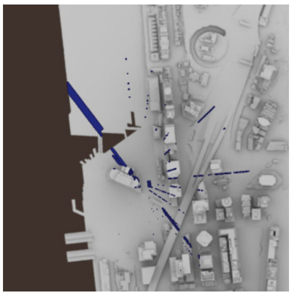

12:00

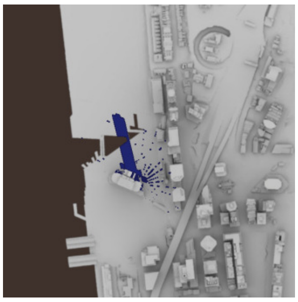

14:00


16:00

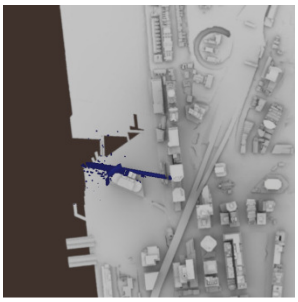

18:00

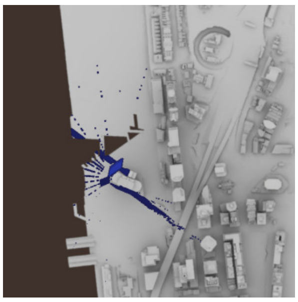
February 21

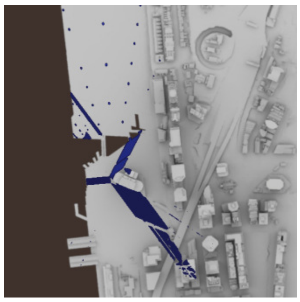

8:00

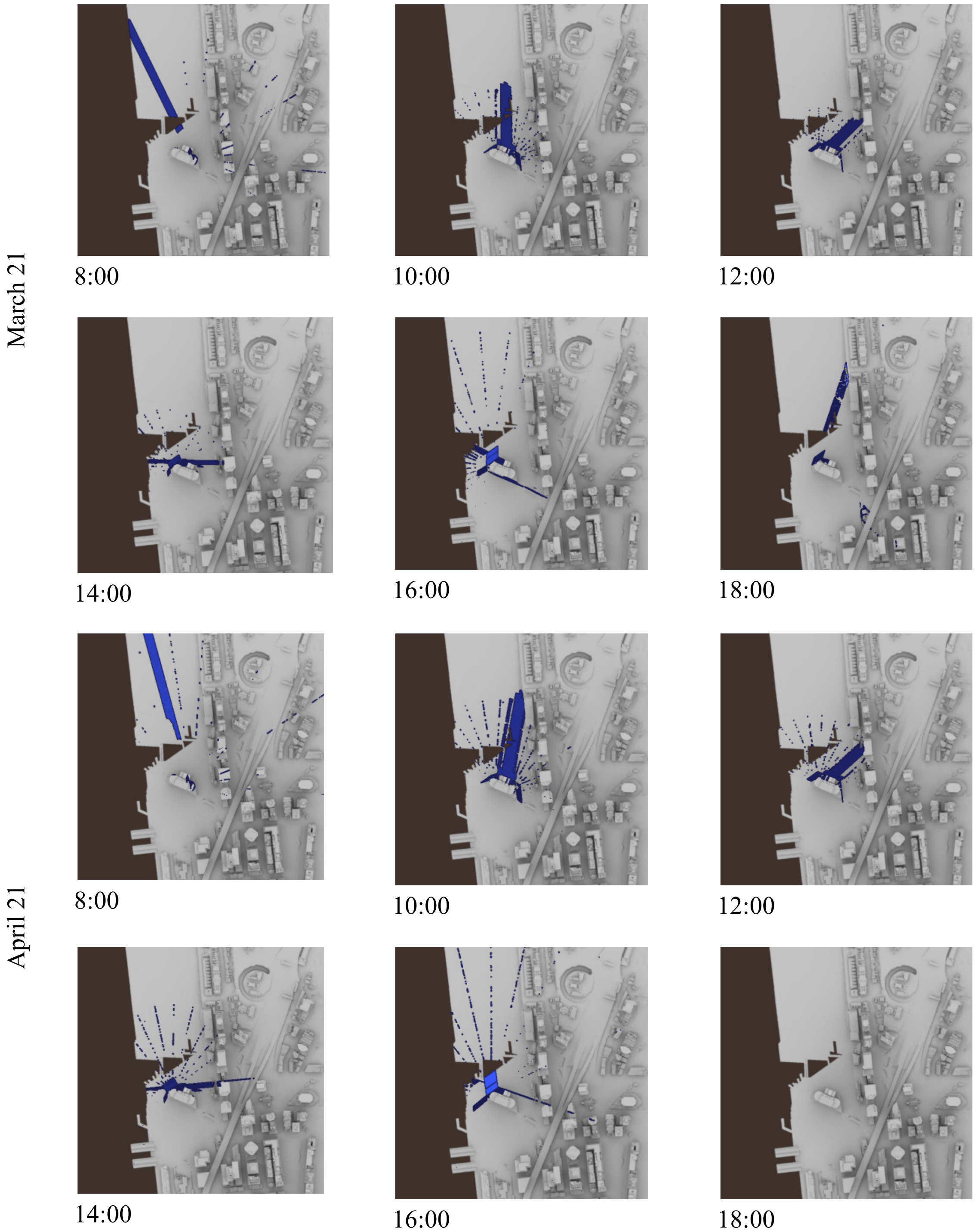

10:00

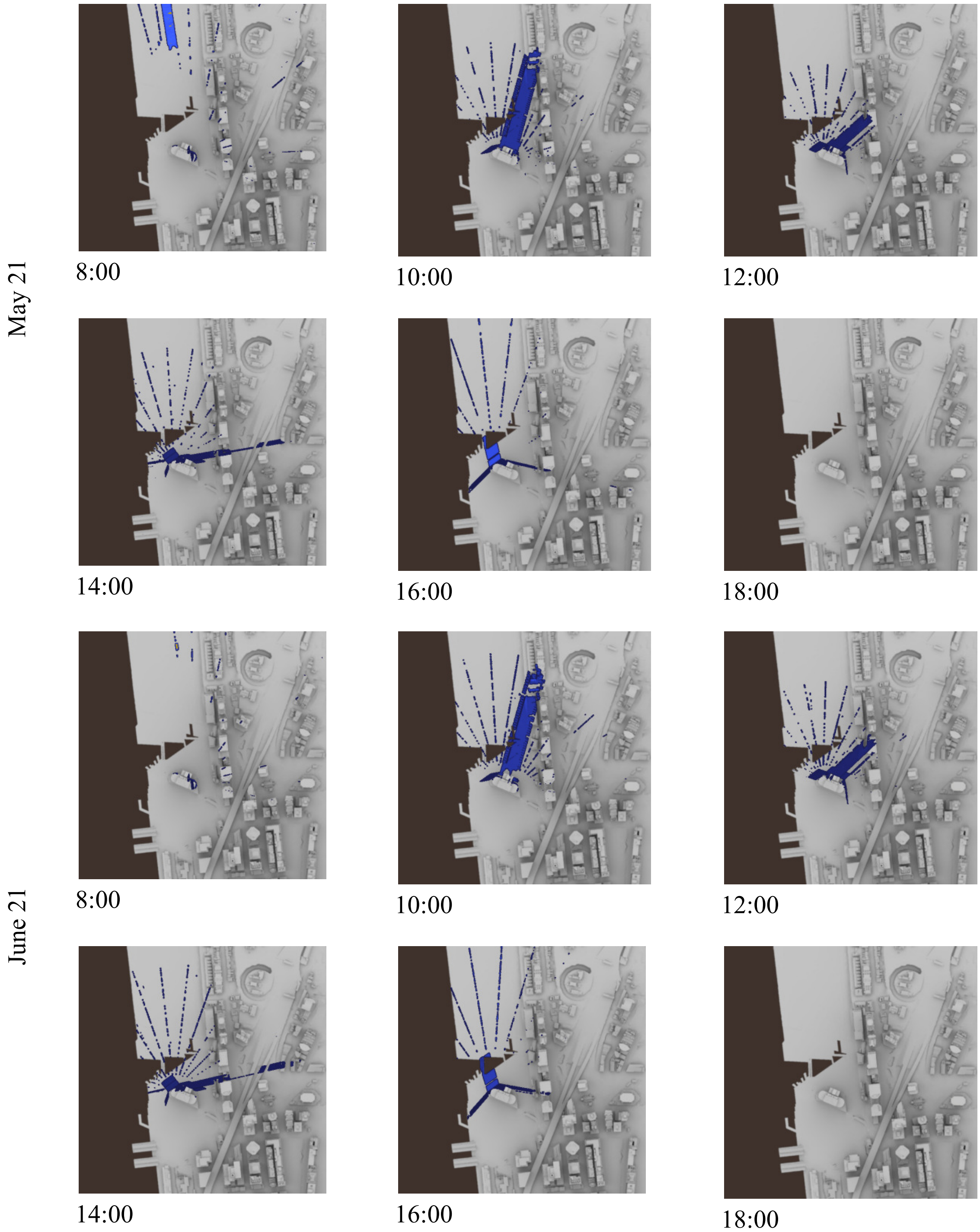

12:00

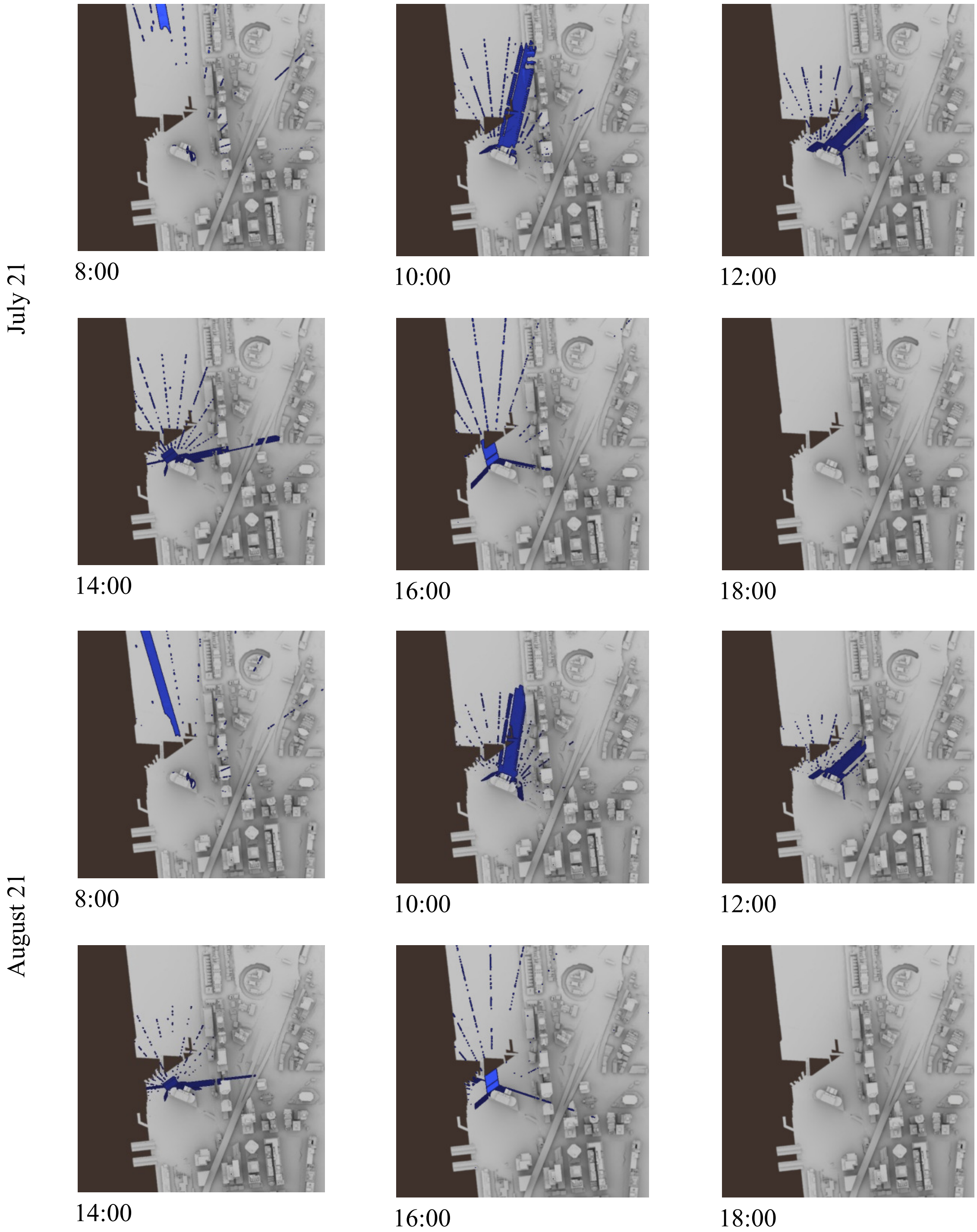

14:00

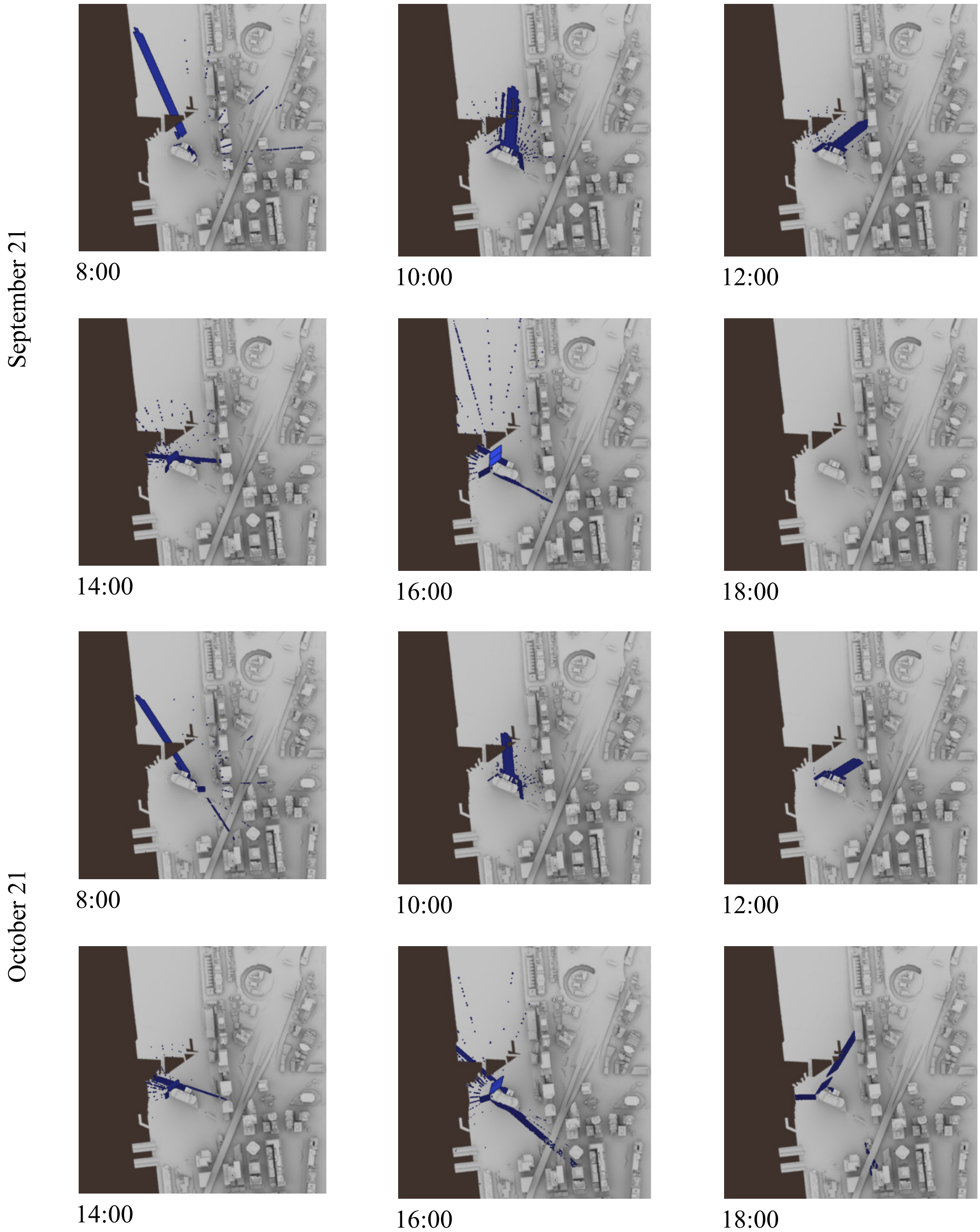

16:00

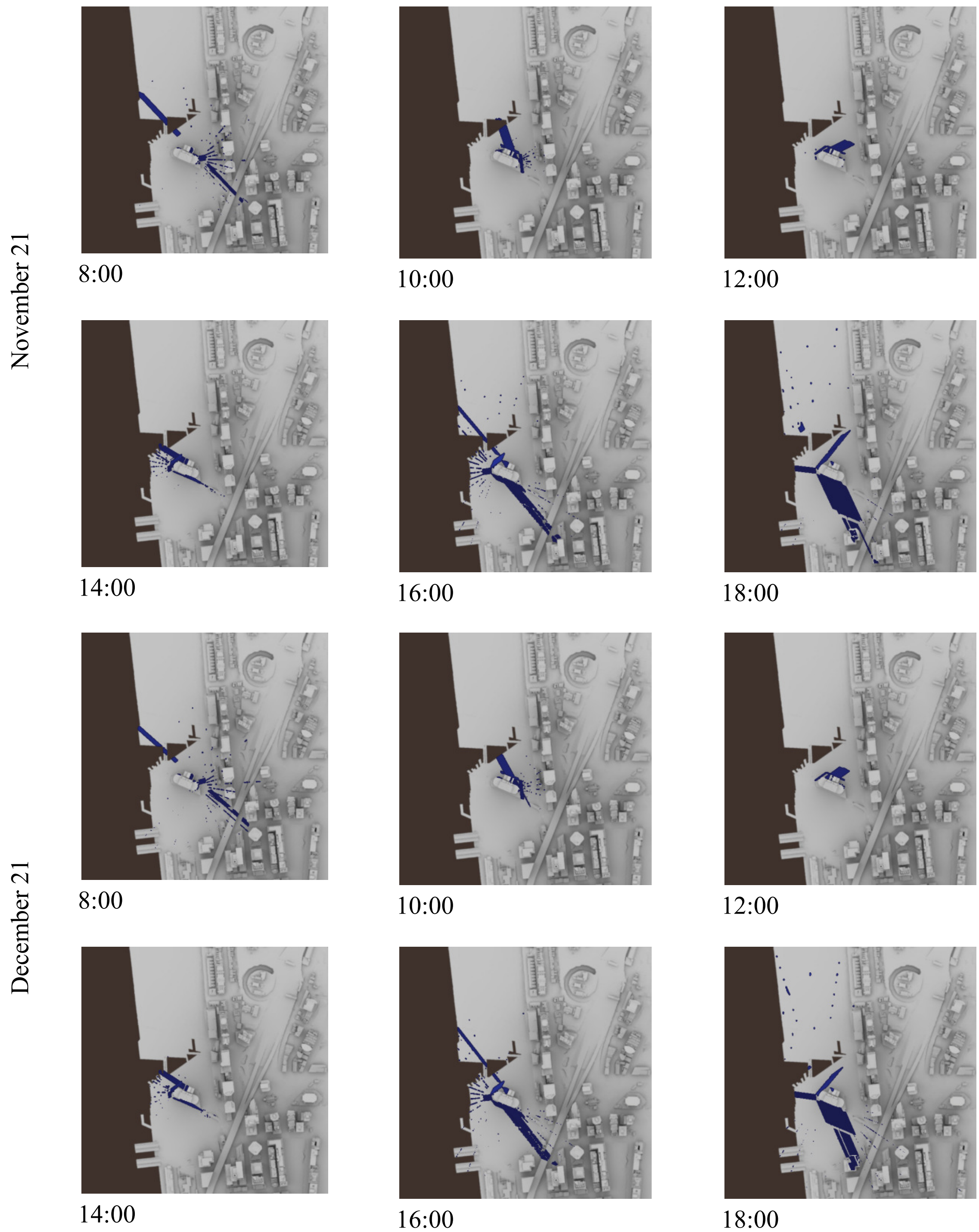

18:00


March 21
8:00
10:00
12:00
14:00
16:00
18:00
April 21
8:00
10:00
12:00
14:00
16:00
18:00


May 21
8:00
10:00
12:00
14:00
16:00
18:00
June 21
8:00
10:00
12:00
14:00
16:00
18:00


July 21
8:00
10:00
12:00
14:00
16:00
18:00
August 21
8:00
10:00
12:00
14:00
16:00
18:00


September 21
8:00
10:00
12:00
14:00
16:00
18:00
October 21
8:00
10:00
12:00
14:00
16:00
18:00



The images above show an overview of the image sequences generated to initially assess locations of reflections cast off the facade. Note this is an excerpt, actual calculations were done at 15min intervals.

Appendix B

Reference Information

B1 Reference Information

B1.1 Architectural Drawings

The following architectural plan drawing received from Rogers Stirk Harbour and Partners were used to provide facade geometry information for this reflectivity study:

Table 1: Reference Architectural Drawings

Drawing No.	**Title**	**Revision**
BC3-DSK-FP-10-00	Plan Ground Floor Level 00	C
BC3-DSK-FP-10-05	Plan Low Rise Level 05	C
BC3-DSK-FS-00-06-01	C3 Solar Shading Set-out – Low Rise	C
BC3-DSK-FS-00-07-01	C3 Solar Shading Set-out – Mid Rise	C
BC3-DSK-FS-00-08-02	C3 Solar Shading Set-out – High Rise	C
BC3-DSK-FS-00-09-02	Cladding – C3 Glass Fin Typology	C
BC3-DSK-EL-00-01-00	Elevation South	C
BC3-DSK-EL-00-02-00	Elevation East	C
BC3-DSK-EL-00-02-00	Elevation West	C
RSHP_A_M_SK_5070	3D Model	

B1.2 References

[1] Hassall, D. N. H. (1991): Reflectivity. Dealing with Rogue Solar Reflections, Faculty of Architecture, University of New South Wales, ISBN 0 646 07086 X

[2] Radiance (software). Homepage: http://radsite.lbl.gov/radiance/HOME.html