Appendix 6.20

Reflectivity Study

Prepared by Arup

University of Technology Sydney

UTS Dr Chau Chak Wing Building

Reflectivity Study

220911-80/040204/R001

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Contents

Executive Summary

The proposed building analysed in this report is the University of Technology Sydney Dr Chau Chak Wing Building, an approximately 15,488m² faculty building designed by Gehry Partners LLP to house the Faculty of Business of the University of Technology Sydney (UTS). This Reflectivity Report assesses the impact of solar reflections off the proposed development on traffic and occupants of nearby buildings in the surrounding area of the proposed site, in terms of reduced visibility of visual tasks. This is to address the qualitative requirements of Section 7.2 *Environmental Issues: Reflectivity Impact* of the Urban Development Plan Ultimo-Pyrmont. This assessment is performed following the methodology of David N.H. Hassall of the University of New South Wales.

Preliminary analysis carried out on an earlier design iteration had identified some glazing that produced reflections potentially causing glare to traffic in Mary Ann St and Ultimo Rd. Subsequently the design was altered in response with the identified glazing areas slightly rotated in plan to mitigate reflections, and the analysis has been updated with the current design.

With the proposed design it is found that the building 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.

- Traffic:
  Glare risks have been eliminated from any façade aspects that could potentially cause reflections affecting traffic for either or several of the following reasons:
  - Reflections are below the threshold of 500Cd/m² stipulated by Hassall
  - Surrounding buildings will be blocking reflections
  - Other parts of the building itself will be blocking reflections
  - Vegetation considered a permanent feature due to redundancy of several trees behind each other and presence of leaves during times of expected reflections, will be blocking reflections
- Pedestrians:
  Pedestrians are easily able to adjust their view in any location where unwanted reflections may be received, reducing the impact of the reflections. They 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.
- Adjacent buildings:
  Adjacent building facades exposed to reflections are also exposed to direct sun at other times, such that glare from reflections does not appear significant. Any potential glare reflections that may occasionally be produced towards these buildings will be reduced / offset by the following:
  - The glass reflectance limited to 20% reduces intensity of reflections significantly
  - Overshading of neighbouring buildings by the proposed development will serve to reduce direct solar glare potential to these buildings and thus offset reflections

The study has found that every façade aspect can have a maximum external reflectance of 20% in accordance with council regulations without causing unacceptable glare.

1 Introduction

This report supports the Project Application for the proposed University of Technology Sydney Dr Chau Chak Wing Building submitted to the Minister for Planning pursuant to Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act). It has been produced in response to the Director General's requirements. It addresses the controls laid out in Section 7.2 *Environmental Issues: Reflectivity Impact* of the Urban Development Plan Ultimo-Pyrmont referenced in the Director General's requirements.

This Reflectivity Report assesses the likelihood of rogue solar reflections off the proposed development on traffic in the surrounding area and on occupants of nearby buildings. This assessment is performed following the methodology of David N.H. Hassall of the University of New South Wales [1].

The reflectivity study presented in this report was performed with three-dimensional building and site models received from Gehry Partners LLP on 29th October, 3rd November and 12th December 2010.

2 Project Description

2.1 General

The proposed Dr Chau Chak Wing Building development is an approximately 15,488m² faculty building designed by Gehry Partners LLP to house the Faculty of Business of the University of Technology Sydney (UTS).

The development will contain teaching, research and office spaces as well as support facilities in a single building volume rising to 12 storeys in height. The building is articulated into several sub-volumes that are arranged stacked and rotated against each other.

2.2 Facades

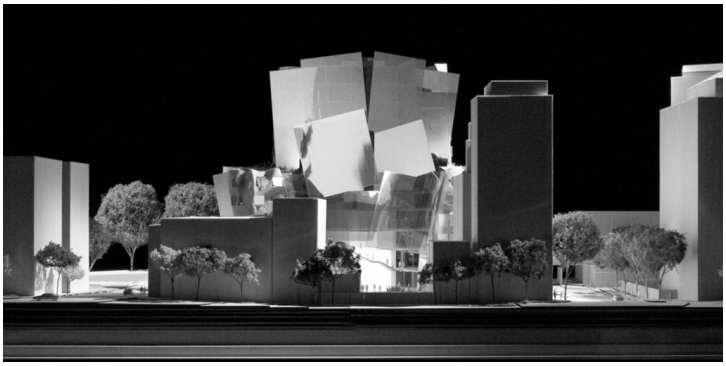
Upper level plan. Blue - punched windows; red - inclined full height glazing

The facade of the building is divided into areas with two main characters. The east, south and north facing are clad in brick with large glazed punched windows. The west facing facade and some infill areas are full height glazed.

Model east elevation

The brick chosen for the solid facade areas has a rough texture. It is considered not to produce any specular reflections, and was therefore not included in the reflection analysis in this report.

The punched windows in the brick facade are of roughly 2.2m high × 2m to 2.8m high × 2m size. The proposed glass has an external reflectivity of 20% in line with the allowable maximum under the UDP. The glazing in punched windows is vertical, but plan orientation follows the undulating facade such that most windows have an individual orientation.



Model west elevation

The full height glazed areas do not incorporate any external elements. This glazing is divided into several 2-6 storey high planes at different angles of inclination and plan orientation. The selected glass is the same as for the punched windows with an external reflectivity of 20%.

2.3 Site relations

The proposed building is located on the site 14-28 Ultimo Road, Ultimo. UTS's buildings are organised as an urban campus with buildings integrated into Sydney's Ultimo neighbourhood. The Dr Chau Chak Wing Building is surrounded by buildings that are not a part of the University: the Australian Broadcasting Corporation (ABC) headquarters to the south, an apartment building and a Sydney TAFE building to the west, and the Powerhouse Museum to the north.

The development is taller than the surrounding buildings, hence its facades can be seen from locations further away in the neighbouring streets.

3 Assessment of Facade Reflections

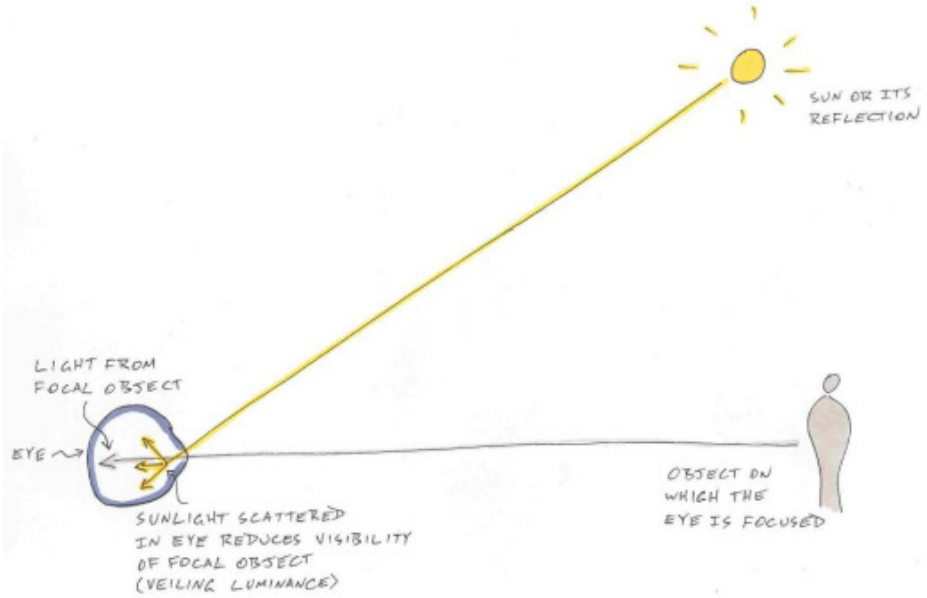
3.1 Criteria for Assessment

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 3.2 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.

3.2 Methodology

The assessment of undesirable solar reflections is based on the methodology described by David N. H. Hassall [1]. This 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.

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

- A nominal glazing reflectance of 20% has been considered, as this is the reflectance of the proposed glass reference product as well as the allowable limit under the

provisions of the Ultimo-Pyrmont UDP. Where the results show that no disabling reflections are produced by this glass, no disabling reflections will be produced by glass of a lesser reflectivity.

- Each facade is assumed to be 100% glazed as a worst case assumption. Glazing joints and framing elements theoretically reduce the reflectivity of the facades, but due to the choice of flush glazing to the larger curtain wall areas and large glass panes in windows this effect is very small.
- It is assumed that to carry out the visual tasks required for traffic participation, drivers and pedestrians face parallel to the ground, and parallel to their direction of travel.

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

3.3 Model / Analysis Approach

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

In order to allow assessment of the complex geometry of the building with numerous glazing plane orientations, the analysis was undertaken using 3d models and the daylight simulation and rendering software Radiance [2]. 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 Gehry Partners 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

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, areas 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**

4 Results

4.1 Global analysis

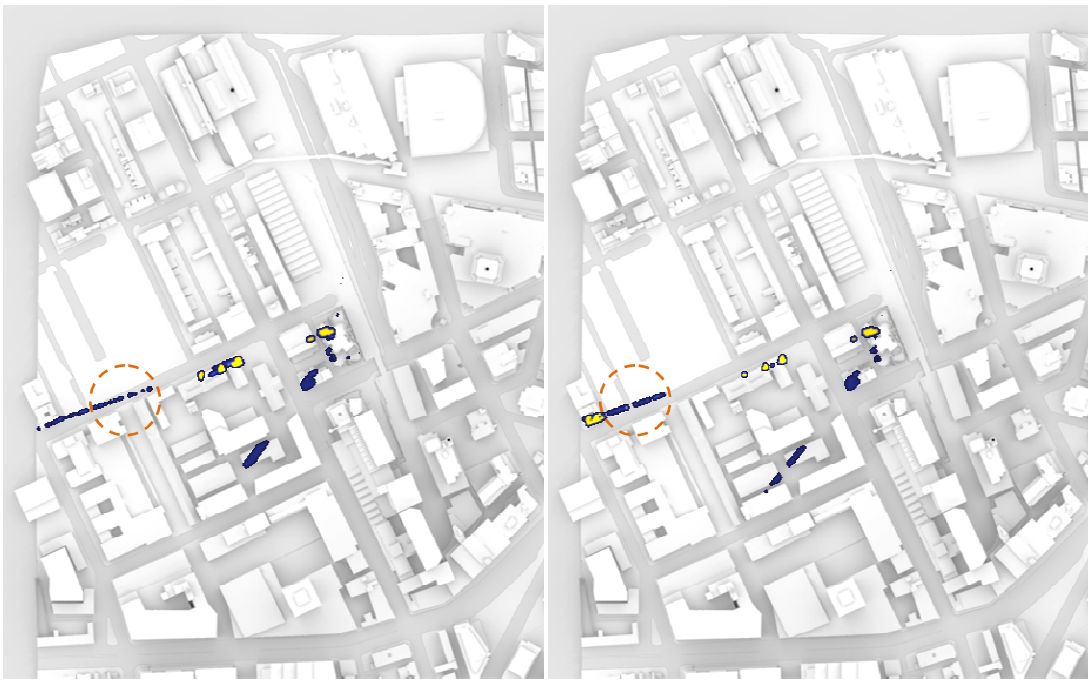
Renderings of the 3d model were made in plan view of the area surrounding the site to approximately 400m distance.

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. Plan renderings in sections below are excerpted from this series).

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 driver locations were undertaken in any areas where the renderings highlighted reflections exceeding the 500Cd/m² threshold and in locations where smaller scattered reflections appeared to be thrown in the direction of the observer (where high peak intensities may not be visible from the resolution of the generated plan images). These areas included Mary Ann St, Darling Drive, and Ultimo Rd, and analysis findings are presented below.

Reflections in Harris St, Thomas St, on Broadway, and in 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. Reflections in other locations are discussed below.

4.2 Mary Ann St



December 21, 18:00 December 21, 18:15

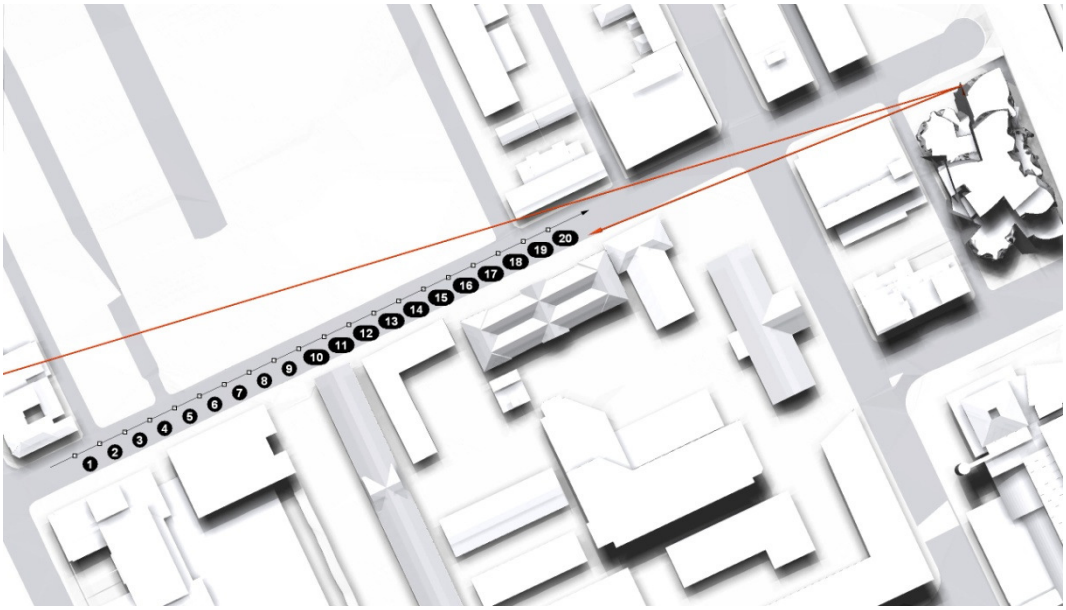
Reflections reaching Mary Ann St (at approx. times of highest intensities)

Reflections off the northern areas of the western facade of the building hit the north side of Mary Ann St in the late afternoon during summer. Traffic in Mary Ann St is one way only, but leading in the direction of the site, so that drivers may be able to see the top of the building when driving more to the northern side of the street. Reflections 'wander' across the road for a short period during the day only at the following times:

- November – January: periods varying between 0 and approximately 30 minutes, shifting between 5pm and 7pm

Reflections take the form of long 'shards' of projected light. This means that they do not cover large areas of the street, and traffic participants will travel through the zone of exposure to reflections in a short period of time. However, the 'shards' stretch roughly in the direction of the road, and the length of these zones when passing through in travel direction may be in the order of 60m. The calculations not taking vegetation into account indicate that the equivalent veiling luminance of some reflections would exceed the threshold of 500Cd/m² for these periods.

Worst case reflections were thus assessed from observer locations spaced at 10m intervals for the length of the stretch of Mary Ann St where any reflections could be observed.



Viewpoints / driver locations analysed in Mary Ann St. Red arrow qualitatively indicates path of reflections cast in direction of observers

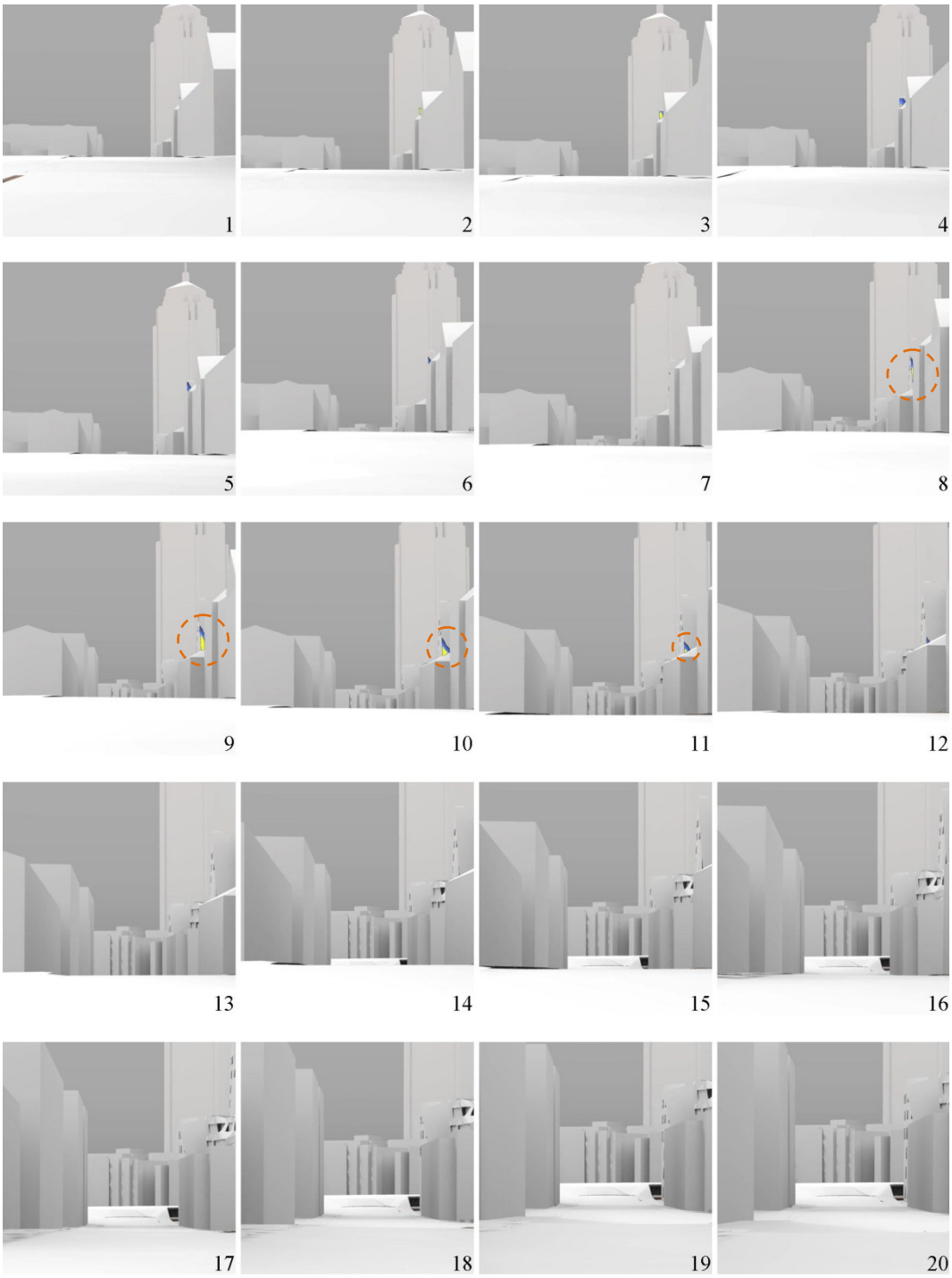
Preliminary analysis from observer locations carried out on an earlier design iteration had identified one glazing plane that produced reflections above the threshold of 500Cd/m² from areas which were potentially visible through or above trees. Subsequently the design was altered in response with this plane slightly rotated in plan towards the south to mitigate reflections, and further analysis was carried out with the current design.

Earlier design

Reflections after change of glazing orientation (below vegetation)

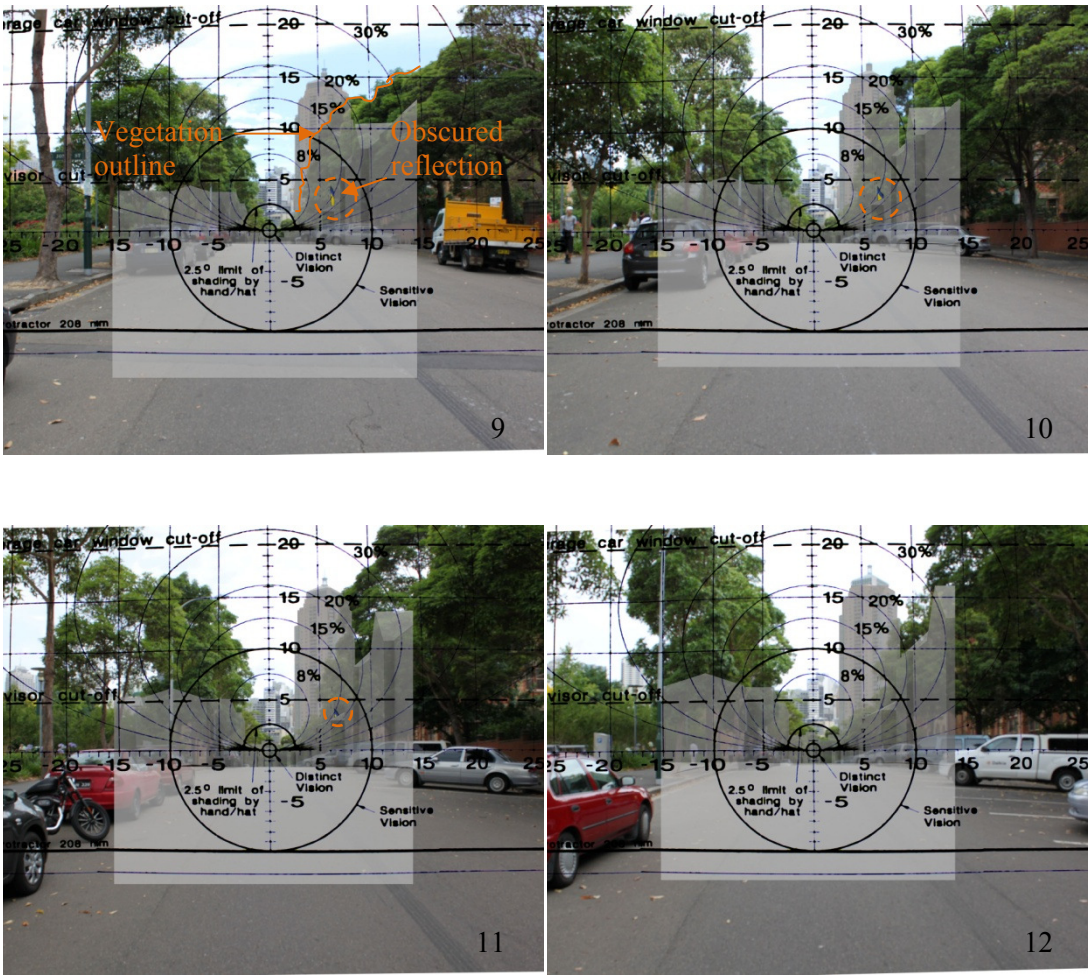
Comparison in reflection intensity earlier and current design (disregarding vegetation)

All images shown and analysis described in the following are based on the revised design.



Reflections off the building facade shown in perspective from Mary Ann St viewpoints at 10m intervals approaching the Dr Chau Chak Wing Bldg. Note these images show cumulative worst case intensities of the entire year

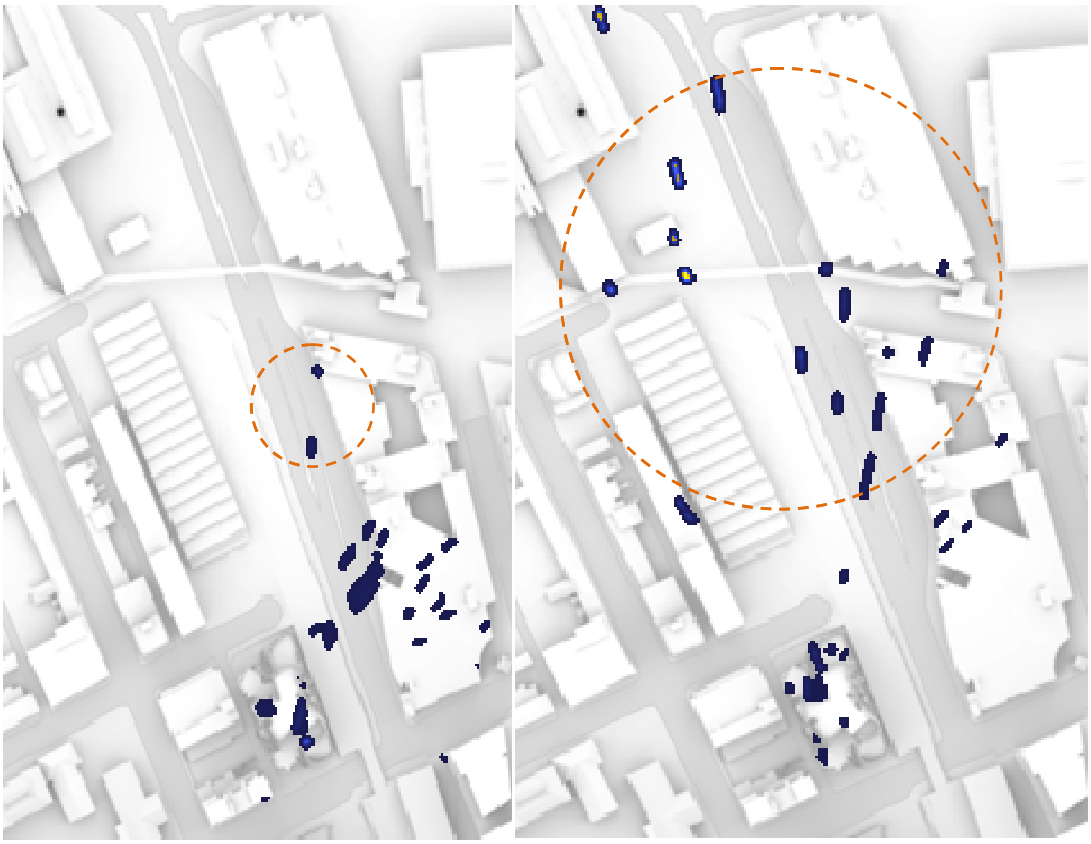
As shown in the series of images, reflections are visible above the modeled building geometry. Mary Ann St is however flanked by vegetation not included in the model. The rendered images were thus overlayed with photos taken in the same locations on site to assess the effect of vegetation on the visibility of reflections.



Overlay of observer perspectives with site photos showing vegetation

With the current design any reflections that exceeded the 500Cd/m² threshold were found, as shown in the image sequence excerpt, to occur only where view of the building would in reality be obscured by a row of trees. As reflections only occur during summer when these trees are carrying leaves, and as in any instance several trees behind each other block the line of sight towards the facade such that removal of single trees will not affect the obscuration, the trees can be regarded as permanent features obscuring reflections. **Excessive reflections causing glare in Mary Ann St were therefore discounted**.

4.3 Darling Drive



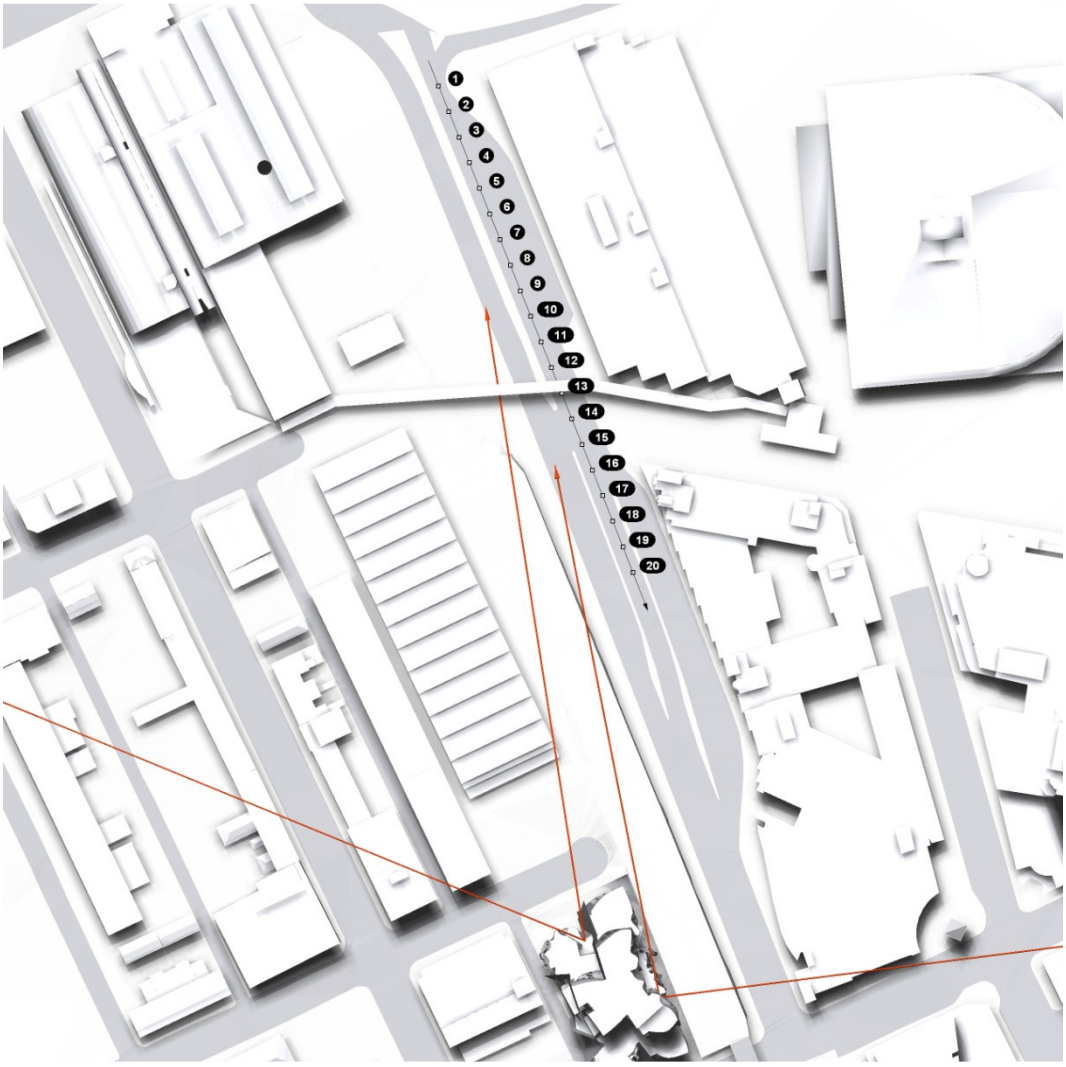
February 21 6:45 June 21 16:00

Examples of reflections cast on Darling Drive (disregarding vegetation)

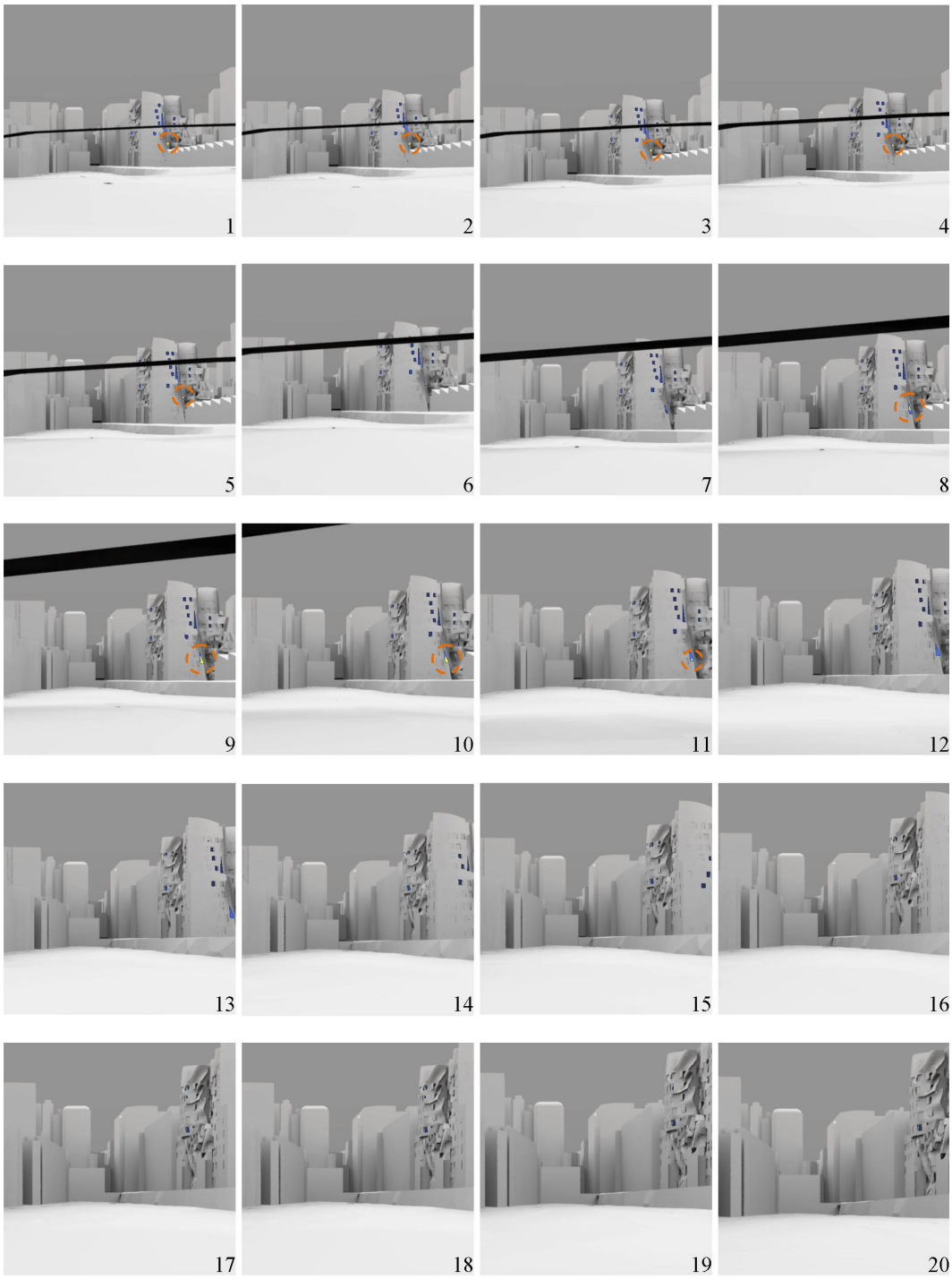
From the plan studies some reflections off punched windows on the building's north and north-east could be observed to be thrown towards Darling Drive, potentially close within the viewing direction of traffic travelling south. These occur throughout the year for minutes at a time due to the small window areas reflected, approximately around the following times:

- Jan 6.00-6.30
- Feb - Apr 6.30-8.00 and 16.00-17.30
- May-Jun 8.00-8.30 and 15.00-16.00
- Jul-Aug 8.30-9.00 and 15.30-17.00
- Sep 7.00-8.00 and 15.30-17.30
- Oct-Dec 6.00-6.30 and 17.00-18.30

Worst case reflections were thus assessed from observer locations spaced at 10m intervals for the length of the stretch of Darling Drive where reflections close to driver direction of vision could be observed.



Viewpoints / driver locations analysed on Darling Drive



Reflections off the building facade shown in perspective from Darling Drive viewpoints at 10m intervals approaching the Dr Chau Chak Wing Bldg. Note these images show cumulative worst case intensities of the entire year

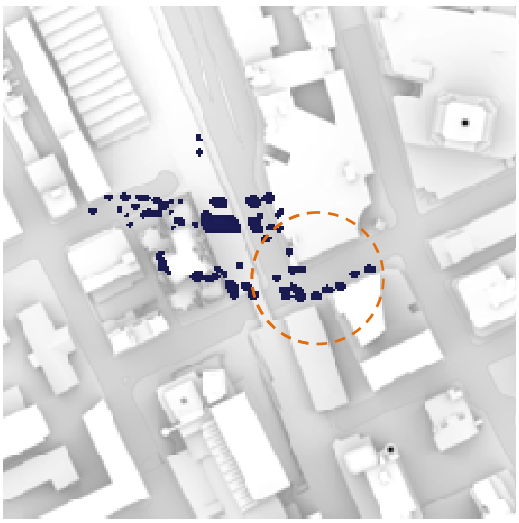
All worst case reflections off punched windows were found to cause veiling luminance below the threshold of 500Cd/m² and are thus not regarded as problematic in accordance with the Hassall methodology. The only reflections in excess of the threshold were cast off small areas of the full height glazing infills on lower levels (Levels 2 - 4).

Trees between Darling Dr and the Dr Chau Chak Wing Building site

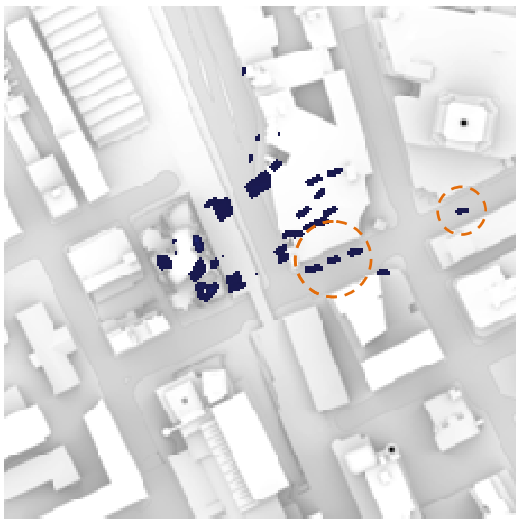
The model used for the study does not reflect vegetation. Along the entire section of Darling Dr analysed, dense and tall tree planting is likely to significantly obscure view of the site. Trees are approximately 20-25m in height and evergreen.

Any reflections at lower levels shown by the rendering to exceed the 500Cd/m² mark would be effectively masked by these trees. As these trees are evergreen, and as in any instance several trees behind each other block the line of sight towards the facade such that removal of single trees will not affect the obscuration, the trees can be regarded as permanent features obscuring reflections. **Excessive reflections causing glare to drivers on Darling Drive were therefore discounted**.

4.4 Ultimo Rd



March 21 7:00



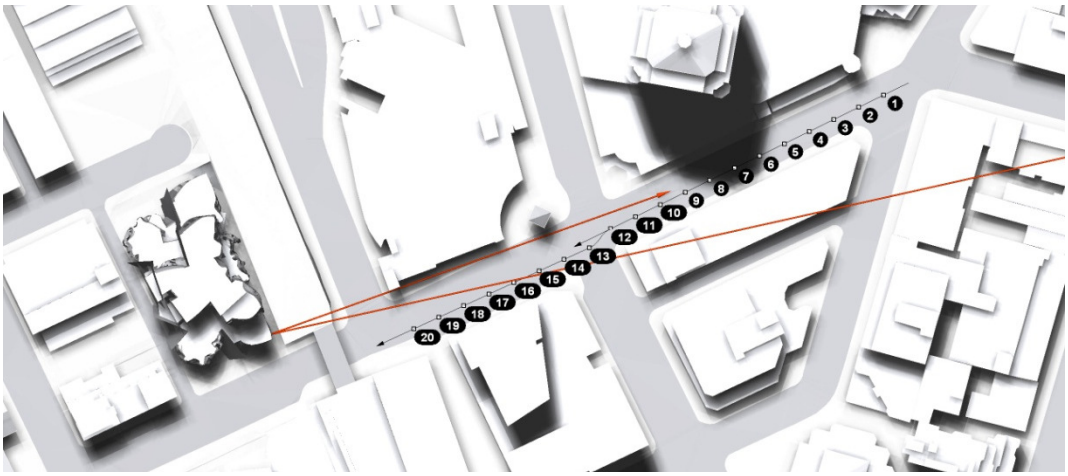
May 21 9:00

Examples of reflections cast on Ultimo Rd during morning hours

On Ultimo Rd, small flashes of reflections are cast from punched windows in the south-eastern segment of the building. These can be seen by drivers travelling west the stretch east of the UPN bridge. Reflections in this area occur during the following times:

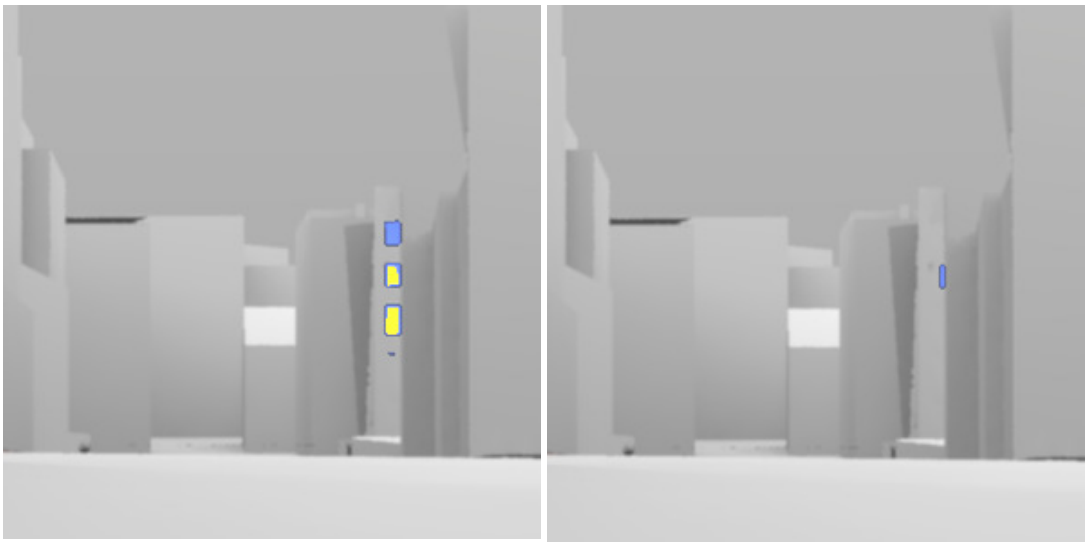
April to October: periods varying between 0 and approximately 10 minutes, shifting between 8.30am and 11am

They cover relatively small areas and thus would only be perceived for brief periods of time, but since even brief flashes of glare may affect driver vision, worst case reflections were assessed in more detail from observer locations spaced at 10m intervals for the length of the stretch of Ultimo Rd where any reflections could be observed.



Viewpoints / driver locations analysed on Ultimo Rd

Preliminary analysis from observer locations carried out on an earlier design iteration had identified three windows that produced reflections slightly above the threshold of 500Cd/m². Subsequently the design was altered in response with these windows slightly rotated in plan towards the south to mitigate reflections, and further analysis was carried out with the current design.

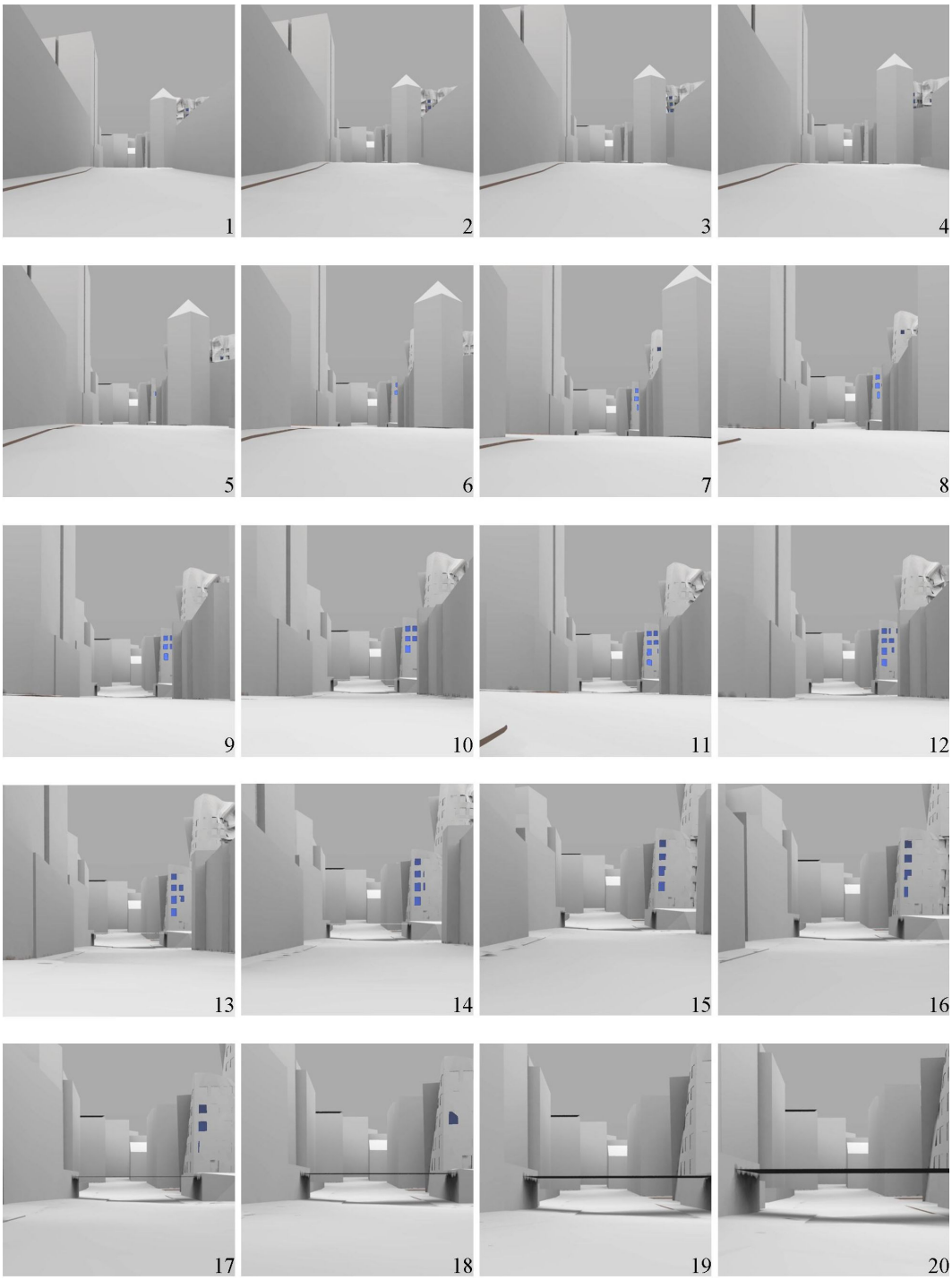


Earlier design

Reflections after change of window orientation

Comparison in reflection intensity earlier and current design (disregarding vegetation)

All images shown and analysis described in the following are based on the revised design.



Reflections off the building facade shown in perspective from Ultimo Rd viewpoints at 10m intervals approaching the Dr Chau Chak Wing Bldg. Note these images show cumulative worst case intensities of the entire year.

No reflections reaching viewpoints of drivers travelling along Ultimo Rd were found above the threshold of 500Cd/m² in this analysis. **Excessive reflections causing glare in Ultimo Rd were therefore discounted**.

Note that any reflections below the threshold (and therefore considered acceptable; shown blue in images) still produced would likely be significantly further reduced by the trees planted along the north side Ultimo Rd in front of the UTS Building 5. The mitigating effect of trees was not considered in image generation.

4.5 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.

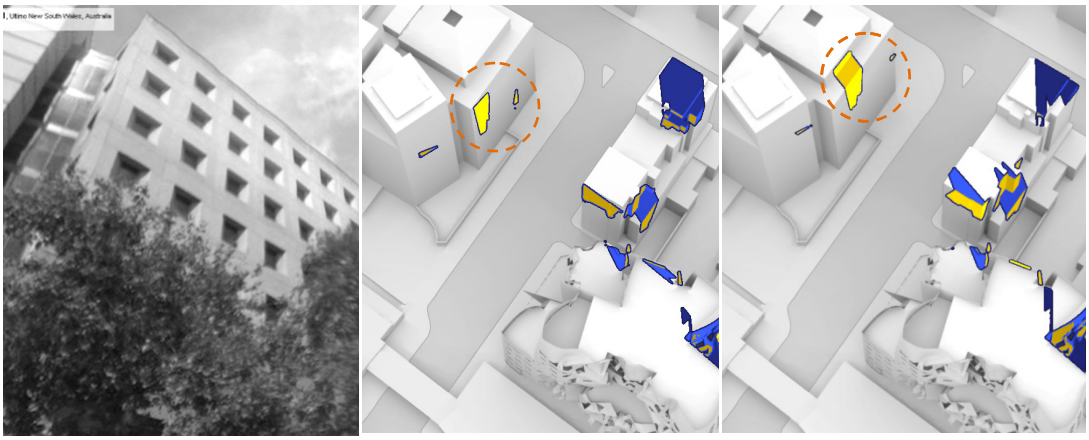
In other locations accessible to pedestrians where any glare from reflections may occur, the observer is easily able to adjust their view and thus reduce the glare impact of reflections. Pedestrians move at a rate significantly slower than that of a vehicle. For this reason it is acceptable to assume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

4.6 Impact on Surrounding Buildings

The initial studies show that some reflections are cast onto the facades of surrounding buildings and could enter these through window areas. The nature of these is described in the sections below.

In general, 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.

4.6.1 ABC Building



August 21, 16:00 August 21, 16:30

Examples of reflections cast onto the ABC Building facade

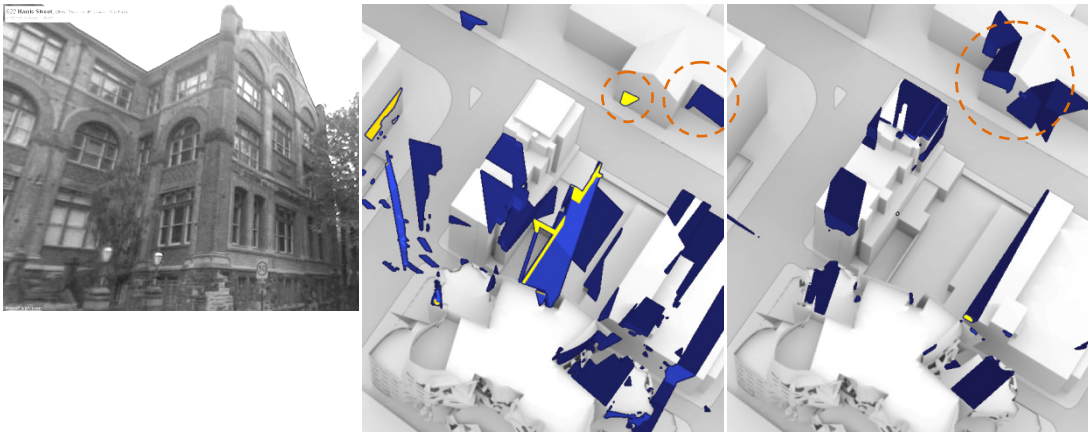
Some reflections were found to reach the Ultimo Rd facade of the ABC building at 700 Harris St. Reflections are scattered across the facade for varying durations in the afternoon throughout the year, intermittently approximately during the following intervals:

- Dec- Feb 15.30-17.30
- Mar - Apr 15.00-17.30
- May 16.00-16.45, Jun - Jul 16.30-17.00
- Aug 16.15-17.15
- Sep 15.00 and 16.45-17.15
- Oct - Nov 15.00-17.30

Individual patches of reflected sunlight do not appear to fall into individual windows for longer than 15-30min maximally.

As this facade is north facing, it is expected that direct sun enters this building for significant durations on sunny days. Given the short duration of reflections, the fact that the reflective surfaces of the proposed building are limited to 20% in reflectivity, and the further mitigating effect of the visual light transmission of the ABC building glazing it is **unlikely that reflections off its facades will cause significant additional discomfort to occupants of the ABC Building**.

4.6.2 TAFE Building (The Muse)



December 21, 16:30 December 21, 18:30

Examples of reflections cast onto TAFE Building facades across Harris St

Some reflections were found to reach the facade of the TAFE Building (also referred to as The Muse) opposite 634-642 Harris St. Reflections are scattered across the facade for varying durations during summer afternoons, intermittently approximately during the following intervals:

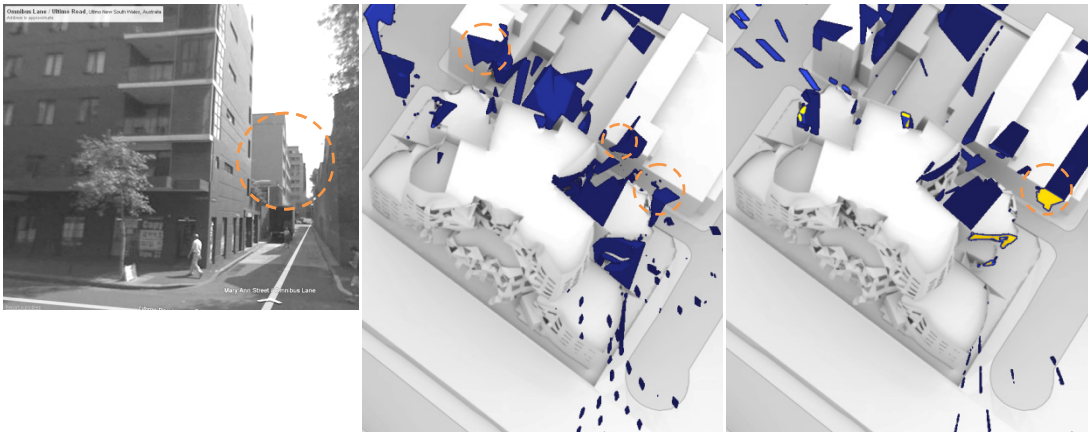
- Dec-Jan 15.45-19.00
- Feb 15.45-18.00,
- Mar 16.30-17.30
- Sep 16.00-17.00
- Oct 15.30-18.00
- Nov 15.15-18.30

Reflections reaching this facade are cast across the lot 634-642 Harris St. The windows in the main affected area of facade are opening onto internal circulation space.

It is assumed that occupants can avert their eyes during navigating the circulation space and are not unacceptably affected in the visual tasks required to do so. While it is possible that these reflections can cause subjective nuisance to occupants, the intensity of reflected sunlight is significantly reduced by the 20% limit on glazing reflectivity in accordance with the UDP, and this is **assumed to be adequate to limit the likelihood of any discomfort to occupants**. In addition the following factors are considered to reduce the impact of reflections:

- The circulation space mainly reached by any reflections is transitory in nature so that it is unlikely that occupants are affected for any longer periods of time
- The affected facade is East facing and currently exposed to direct sunlight during morning hours from the direction of the Dr Chau Chak Wing Building site. This direct sunlight is significantly more intense than any reflections off the proposed building would be due to the 20% limit on glazing reflectivity, hence the development is not likely to increase the maximal glare impact to this building
- Glass absorbtance and reflectance of the TAFE Building glazing reduces the intensity of reflections, depending on glass build-up.

4.6.3 Apartment Building / former National Cash Register



December 21, 15:15 December 21, 17:15

Examples of reflections cast onto building rear facades in Omnibus Lane

Some reflections were also found to reach the rear facade of the apartment building 6-10 Ultimo Rd and the former National Cash Register Building (now part of TAFE) 622-632 Harris St, facing Omnibus Lane. Reflections are scattered across the facade for varying durations, intermittently approximately during the following intervals:

- Jan 14.15-18.30
- Feb 14.00-18.00
- Mar 13.30-17.30
- Apr 13.30-16.30
- May 13.00-16.00
- Jun 12.00-15.00
- Jul 12.30-15.30
- Aug 13.00-16.00
- Sep 13.30-16.30
- Oct 13.30-17.30
- Nov 14.00-18.00
- Dec 14.00-18.15

Patches of reflected sunlight are from both punched windows and larger areas of curtain wall glazing on the north of the planned Dr Chau Chak Wing building. These patches can fall onto individual locations on the rear facade for up to approximately 90 minutes during summer afternoons.

While it is possible that these reflections can cause subjective nuisance to occupants, the intensity of reflected sunlight is significantly reduced by the 20% limit on glazing reflectivity in accordance with the UDP, and this is **assumed to be adequate to limit the likelihood of any discomfort to occupants**. In addition the following factors are considered to reduce the impact of reflections:

- Windows in the apartment building facing east are largely high-level small area windows presumably opening into bathrooms or kitchens, so that impact from reflections is mainly limited to spaces where less permanent occupancy is expected, as well as in size of sun patches reaching the inside. Windows in the former NCR Building contain blinds allowing occupants to control sunlight penetration from intermittent reflections
- Currently, the affected East facing facade is exposed to direct sunlight from the direction of the Dr Chau Chak Wing Building site throughout the morning. On inspection on site, most windows appeared to have blinds lowered. This direct sunlight is significantly more intense than any reflections off the proposed building would be due to the 20% limit on glazing reflectivity, hence the development is not likely to increase the maximal glare impact to this building
- Glass absorbtance and reflectance of the apartment building and former NCR building glazing reduces the intensity of reflections, depending on glass build-up.

5 Conclusions

The proposed building 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.

Glare risks have been eliminated from façade aspects that could potentially cause reflections affecting traffic, either because surrounding buildings or other parts of the building itself, or vegetation considered a permanent feature due to redundancy of several trees behind each other and presence of leaves during times of expected reflections, will be blocking reflections that could cause glare to drivers.

The study has found that every façade aspect can have a maximum external 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 reduction of facade reflectivity through joints and framing elements.

Pedestrians are easily able to adjust their view in any location where unwanted reflections may be received, reducing the impact of the reflections. They 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.

Adjacent building facades exposed to reflections are also exposed to direct sun at other times, such that glare from reflections does not appear significant. The glass reflectance limited to 20% as well as the overshading of neighbouring buildings by the proposed development will serve to reduce and offset potential glare reflections that may occasionally be produced towards these buildings.

References

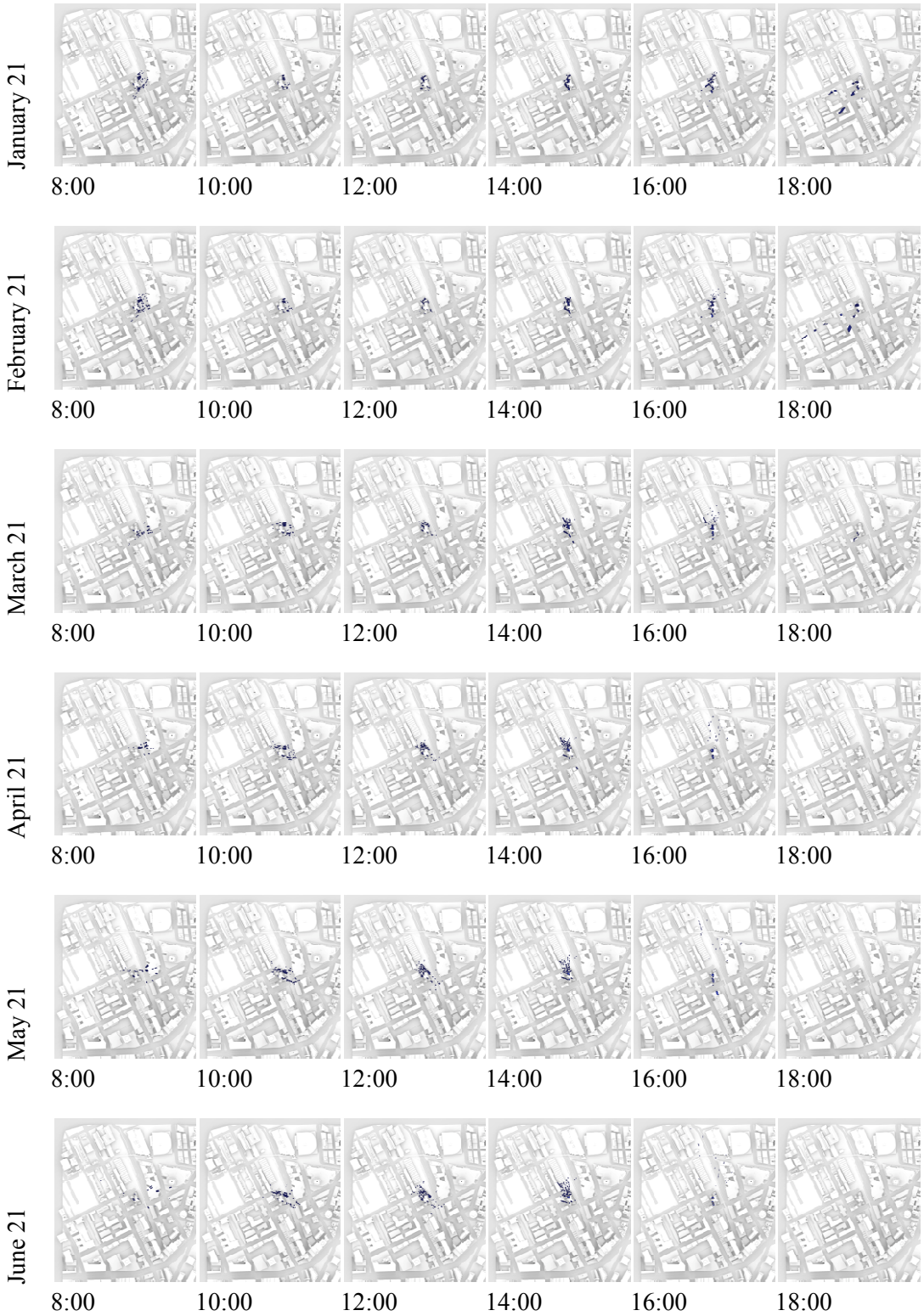
[1] Hassall, D. N. H. (1991): Reflectivity. Dealing with Rogue Solar Reflections, Faculty of Architecture, University of New South Wales, ISBN 0 646 07086 X

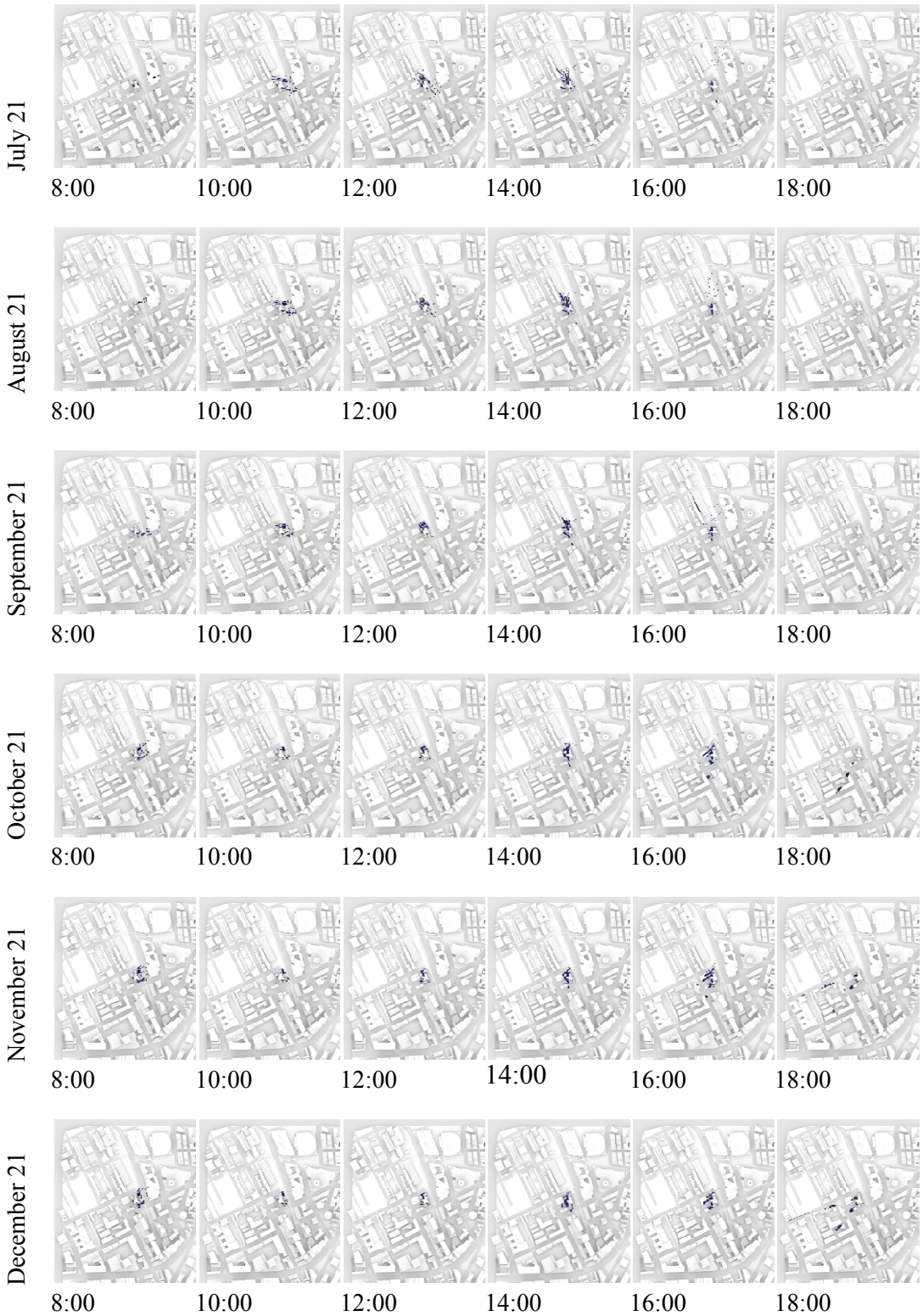
[2] Radiance (software). Homepage: http://radsite.lbl.gov/radiance/HOME.html

Appendix A

Annual Reflections Overview

A1 Annual Reflections Image Sequence





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.