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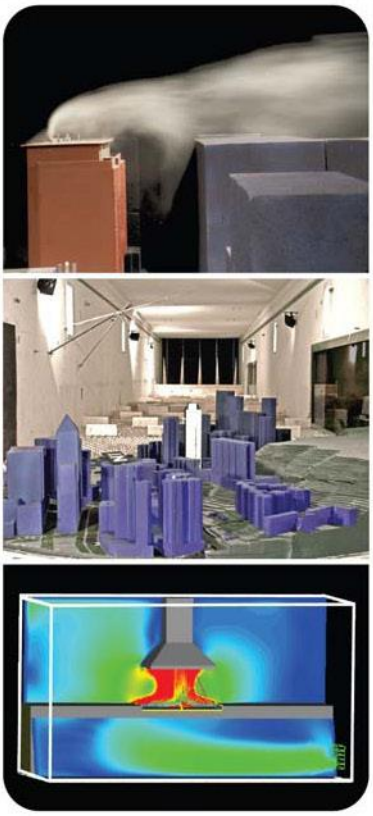
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report Revision 2

Solar Reflectivity Assessment for:



SICEEP
Sydney, Australia

CPP Project 6949

March 2013

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EXECUTIVE SUMMARY

Cermak Peterka Petersen Pty. Ltd. has been engaged by Darling Harbour Live to assess the proposed Sydney International Convention Centre, Exhibition and Entertainment Precinct (SICEEP) Public Private Partnership (PPP) component in terms of Solar Reflectivity Impact. This report addresses the Director Generals Requirements dated 21 January 2013 for a 'Facade reflectivity statement'.

This report supports a State Significant Development Application (SSD 12_5752) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This report makes reference to the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity. Specifically, Section 3.2.7 states that "A Reflectivity Report that analyses potential for solar glare from the proposed building design may be required for tall buildings".

Darling Harbour Live will ensure all exterior façade elements used throughout the development will limit light reflectivity to 20% or less as required under the Sydney Development Control Plan 2012.

This report quantifies the potential for solar reflectivity glare impact upon motorist using roadways intersecting and surrounding the SICEEP precinct. CPP use in part methodology developed by Hassall (1991) and the concept of veiling glare and contrast when quantifying the potential for hazard rogue reflections to be cast onto surrounding motorway receiver locations. Pedestrian impacts are assessed more broadly in this report in terms of amenity and usability of the site. This report does not assess solar glare impact onto surrounding buildings nor glare from artificial lighting.

With the measures adopted by the designers as described in this report regarding choice of façade materials and façade articulation, the proposed SICEEP development does not present a driver hazard in terms of solar glare and will meet the Sydney Development Control Plan 2012 controls for reflectivity.

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1. INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Darling Harbour Live to assess the proposed Sydney International Convention Centre, Exhibition and Entertainment Precinct (SICEEP) Public Private Partnership (PPP) component in terms of Solar Reflectivity Impact. This report addresses the Director Generals Requirements dated 21 January 2013 for a 'Facade reflectivity statement'.

This report supports a State Significant Development Application (SSD 12_5752) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The Application seeks approval for construction of the Public Private Partnership (PPP) component of the Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) Project at Darling Harbour.

The SICEEP Project will deliver Australia's global city with world class convention, exhibition and entertainment facilities that can compete effectively in the national and international events markets. The SICEEP Project importantly forms a critical element of the NSW Government's aspiration to "make NSW number one again". The SICEEP Project also involves the creation of a new neighbourhood and a community hub.

This report makes reference to the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity. Specifically, Section 3.2.7 states that "A Reflectivity Report that analyses potential for solar glare from the proposed building design may be required for tall buildings".

2. OVERVIEW OF PROPOSED DEVELOPMENT

The proposed development involves construction of the PPP component of the SICEEP Project, comprising new, integrated and world-class convention, exhibition and entertainment facilities with associated retail and public domain upgrades.

The application more specifically seeks approval for the following development:

- Demolition of existing improvements on the site, including existing Sydney Convention Centre (part) and Sydney Exhibition Centre;
- Associated tree removal and replanting;

- Construction of a new, integrated and world-class Convention, Exhibition and Entertainment Centre;
- Public domain improvements, including:
  - reinvigorating and expanding Tumbalong Park;
  - provision (part) of a new active north-south pedestrian connection (known as the Boulevard);
  - provision of new east-west connections, including Harbourside Place and Tumbalong Place;
  - Provision of a pedestrian bridge link from Quarry Street;
  - Retention of the tidal cascade water feature;
  - Reconfiguration and upgrade of Darling Drive (part);
  - Provision of a new square adjoining the Chinese Garden;
  - Provision of a new open space 'event deck' (connected with the Exhibition Centre);
  - Integrated art, play zones, water play and recreation areas;
  - Provision of retail kiosks;
- Provision of ground level parking within the Exhibition and Entertainment Centre facilities;
- Ground and elevated loading docks (accessed off Darling Drive) for Convention, Exhibition and Entertainment Centre facilities;
- Two vehicle drop off points off Darling Drive;
- Provision of signage; and
- Extension and augmentation of physical infrastructure / utilities as required.

3. BACKGROUND

The existing convention, exhibition and entertainment centre facilities at Darling Harbour were constructed in the 1980s and have provided an excellent service for Sydney and NSW.

The facilities however have limitations in their ability to service the contemporary exhibition and convention industry which has led to a loss in events being held in Sydney.

The NSW Government considers that a precinct-wide renewal and expansion is necessary and is accordingly committed to Sydney reclaiming its position on centre stage for hosting world-class events with the creation of the SICEEP Project.

Following an extensive and rigorous Expressions of Interest and Request for Proposals process, Darling Harbour Live (formerly known as 'Destination Sydney'- a consortium comprising AEG Ogden, Lend Lease, Capella Capital and Spotless) was announced by the NSW Government in December 2012 as the preferred proponent to transform Darling Harbour and create the new Sydney International Convention, Exhibition and Entertainment Precinct.

Key features of the Darling Harbour Live Preferred Master Plan include:

- Delivering world-class convention, exhibition and entertainment facilities, including:
  - Up to 40,000m2 exhibition space;
  - Over 8,000m2 of meeting rooms space, across 40 rooms;
  - Overall convention space capacity for more than 12,000 people;
  - A ballroom capable of accommodating 2,000 people; and
  - A premium, red-carpet entertainment facility with a capacity of 8,000 persons.
- Providing up to 900 hotel rooms in a hotel complex at the northern end of the Precinct.
- A vibrant and authentic new neighbourhood at the southern end of the precinct, called 'The Haymarket', home to an IQ Hub focused on the creative industries and high-tech businesses, apartments, student accommodation, shops, cafes and restaurants.
- Renewed and upgraded public domain, including an outdoor event space for up to 25,000 people at an expanded Tumbalong Park.
- Improved pedestrian connections linking to the proposed Ultimo Pedestrian Network drawing people between Central, Chinatown and Cockle Bay Wharf as well as east-west between Ultimo/Pyrmont and the City.

4. SITE DESCRIPTION

The SICEEP Site is located within the Darling Harbour precinct. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the Light Rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south.

The SICEEP Site has been divided into three distinct redevelopment areas (from north to south) – Bayside, Darling Central and The Haymarket. The PPP Application Site area is located within Bayside and Darling Central as shown in Figure 1.

Figure 1: Extent of SICEEP Preferred Masterplan

5. PLANNING APPROVALS STRATEGY

In response to separate contractual agreements with the NSW Government and staging requirements, Darling Harbour Live is proposing to submit a number of separate development applications for key elements of the overall Project.

This Application involves the PPP component of the SICEEP Project, comprising the convention centre, exhibition centre, entertainment facility, and associated public domain upgrades.

Development of The Haymarket is to be staged and accordingly a staged development application is to be lodged. Detailed development applications will follow seeking approval for specific aspects of The Haymarket.

A separate development application will also be submitted for the Hotel Complex.

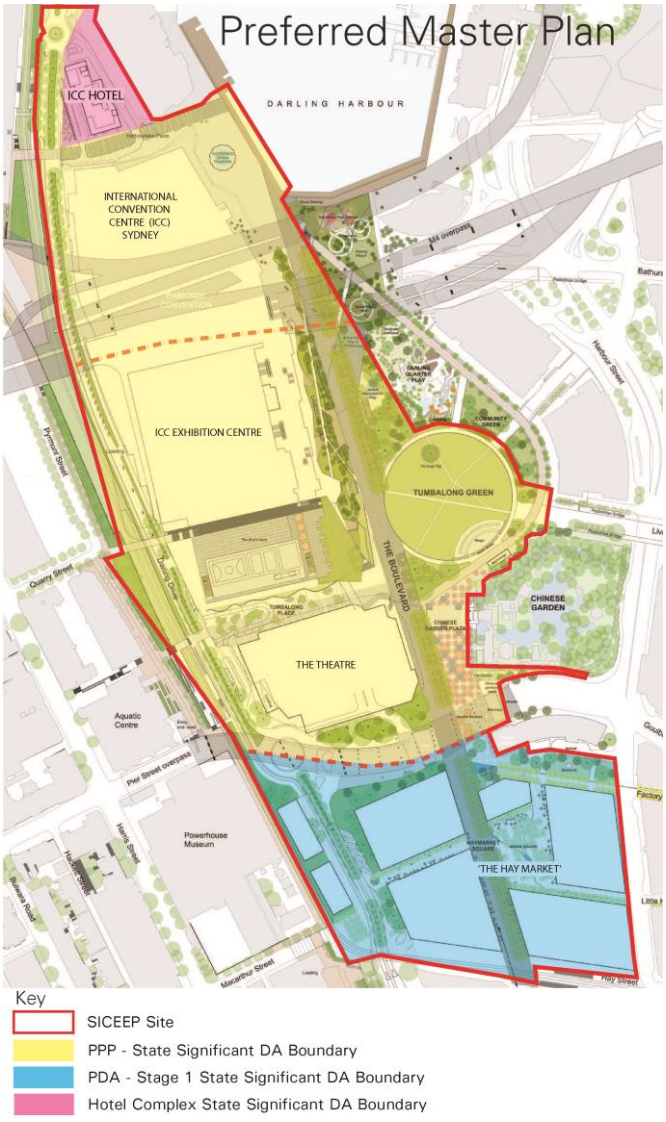

Figure 2: SICEEP Planning Approvals Strategy

6. REFLECTIVITY IMPACT CONSIDERATIONS

To assess the impacts of the proposal, this report considers the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity, specifically:

Provisions

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

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

(3) For buildings in the vicinity of arterial roads/major roads and Sydney Airport, proof of light reflectivity is required and is to demonstrate that light reflectivity does not exceed 20%.

As outlined under 3.2.7, Darling Harbour Live will ensure all exterior façade elements used throughout the development will limit light reflectivity to 20% or less. For glazing producing specular type reflections this is defined as the percentage solar reflection when light strikes and reflects normal to the façade plane. When incident solar rays strike near parallel to the façade plane (large incident angle of typically greater than 70° also referred to as glancing reflections), it is known that the reflectivity of all glazing types increases dramatically towards the properties of a mirror, Figure 3.

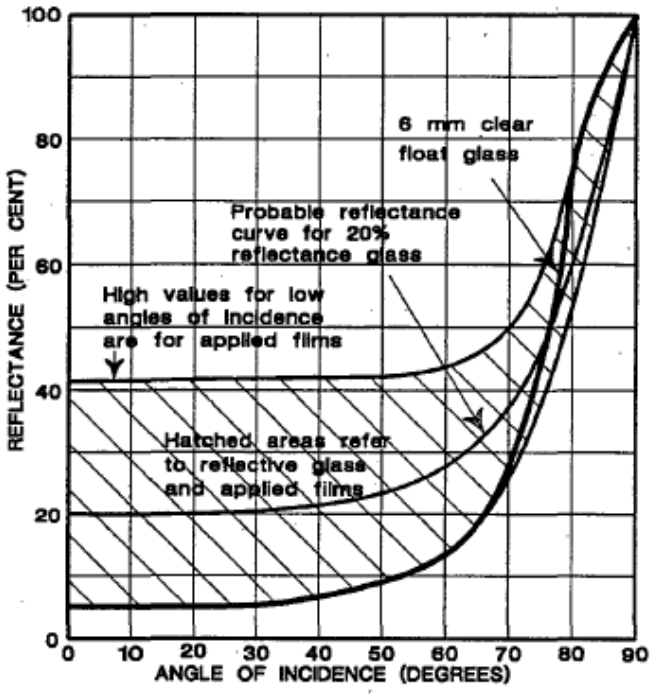

Figure 3: Façade Reflectivity versus angle of incidence (Hassall, 1991)

Thus, even for glazing with low reflectivity coefficients, the potential for glare increases significantly when incoming solar rays can impact on a building close to parallel to the plane of the glazing, i.e. a glancing reflection. The following report quantifies potential for solar reflections of all incident angles on glazing to impact upon the surrounds taking into consideration:

- Seasonal and diurnal solar paths (sun altitude and azimuth) at the SICEEP latitude and longitude and the relative angle between incident solar rays and façade orientation.
- Reflectivity coefficients of the external glazing being used.
- Roadway receiver locations of interest; the alignment of adjoining public roads.

Where the combination of these factors suggests there is potential for hazardous rogue reflections to impact on surrounding areas, the potential magnitude of reflections can be quantified and compared with acceptability criterion described below. This report quantifies the potential for solar reflectivity glare impact upon motorist using roadways intersecting and surrounding the SICEEP precinct. CPP use in part methodology developed by Hassall (1991) and the concept of veiling glare and contrast when quantifying the potential for hazard rogue reflections onto surrounding receiver locations. In many instances the potential for a façade to generate rogue reflections can be eliminated without the need for calculation by taking into account the above factors as well as shading offered by surrounding building massing.

Pedestrian impacts are less likely to be of safety concern and are assessed more broadly in this report in terms of general amenity and usability of the site. A pedestrian can more readily divert their viewing angle away from the glare source or halt walking momentarily. It must be appreciated it is impractical to mitigate potential solar reflections at all potential pedestrian receiver locations across and surrounding the precinct.

Similarly, this report does not assess the impact of reflected solar glare onto surrounding building windows. Notwithstanding, designers have minimised glass sloping toward the sky in order to minimise solar reflections back onto surrounding multi-storey buildings, i.e. most glass is either aligned vertically or sloping downward toward the ground.

7. GLARE ACCEPTABILITY CRITERION

Consider an object that is just visible in the absence of glare. The object will no longer be visible when glare is introduced and it will be necessary to increase the contrast to make the object visible again. Threshold Increment (TI) is the percentage by which the contrast must be increased to make the object just visible and is the parameter calculated in this study to assess the acceptability or otherwise of potential reflectivity glare events.

TI is a parameter used in the design of Road Lighting, e.g. AS/NZS 1158.1.1:2005 where a maximum TI value of 20% is used for all roadway lighting categories and is the TI acceptability criterion adopted in this study for assessing solar glare impact on passing traffic.

Where high TI values are identified it is useful to investigate the angular limits of façade reflections relative to the motorist observer using a glare protractor (Hassall 1991). The glare protractor comprises a series of loops indicating whether a glare source will be above a predetermined veiling glare limit for the resultant % level of cladding reflectivity.

Calculations in this report assume specular type reflective façade surfaces, where the reflected ray angle is equal to the incident solar ray angle; being valid for most smooth surface glazing materials. Other building materials including surface fritted glazing, masonry, brickwork, tiles, and metal deck roofing produce diffuse components of reflection that are not directly quantified by the methodology adopted in this report. By definition, diffuse reflections have a greater scatter of reflected angles with lower concentration of reflected light in any given direction and are generally less likely to cast hazardous distant glare reflections than glazing.

8. REFLECTIVITY IMPACT RESULTS

The SICEEP buildings are tall relative to surrounding roadways, so reflections from the facades and angled roofs are able to extend significant distances; especially early morning and late afternoon events when the solar altitude angle is low. Also important is the solar shading available from surrounding and proposed developments and the massing of the Sydney CBD.

The M4 Western Distributor Freeway, Druitt Street and Pier Street were considered most at risk to glare from the development and were primarily assessed for reflectivity impact in this report. With reference to the Holladay formula (Hassall, 1991); the greatest potential for glare impact upon drivers is when the angle between the centre of the glare source and line of sight is small. Therefore the greatest potential for glare impacts is for motorists travelling *toward* the SICEEP Site.

M4 Western Distributor Freeway (east side of SICEEP Precinct travelling west toward the site)

The greatest potential for the proposed SICEEP developments to generate reflections onto westbound motorists on the M4 Western Distributor Freeway is solar interaction with the southern facades of the International Convention Centre (ICC) and northern and eastern facades of the ICC Exhibition Centre.

The highest TI values calculated for these facades were caused by evening reflection conditions. Evening (around 7pm daylight savings time) low altitude solar rays during the summer months strike all levels of the northern facades (above road deck) of the ICC Exhibition Centre from the west-south-west with reflections towards the east along the M4 Western Distributor Freeway and also Druitt Street.

An example of this reflection condition is on February 12, which is illustrated in Figure 4 showing reflections off the north façade of ICC Exhibition Centre between the roadway and roof levels. The impact point is just to the west of the CCT Ventilation stack at the photo location in Figure 5.

reflections start	7:00 pm	TI = 40
reflections cease	7:20 pm	TI = 64

The TI levels are in excess of the criterion and it is noted the altitude angle of the incident solar rays is low being less than 10 degrees. These solar rays can therefor pass beneath the northern roof eaves.

Figure 4: Afternoon reflection condition off ICC Exhibition Centre

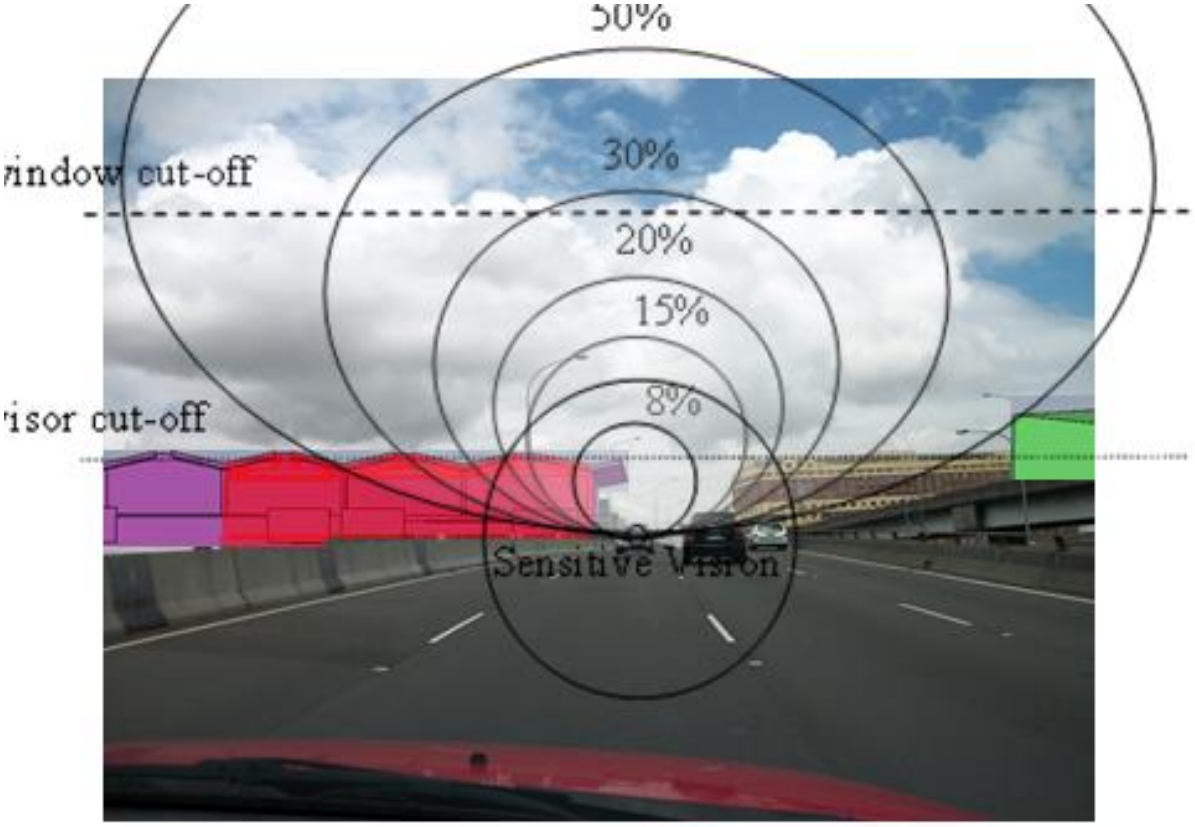

Figure 5: Glare protractor for M4 Western Distributor just west of the CCT Ventilation stack westward view.

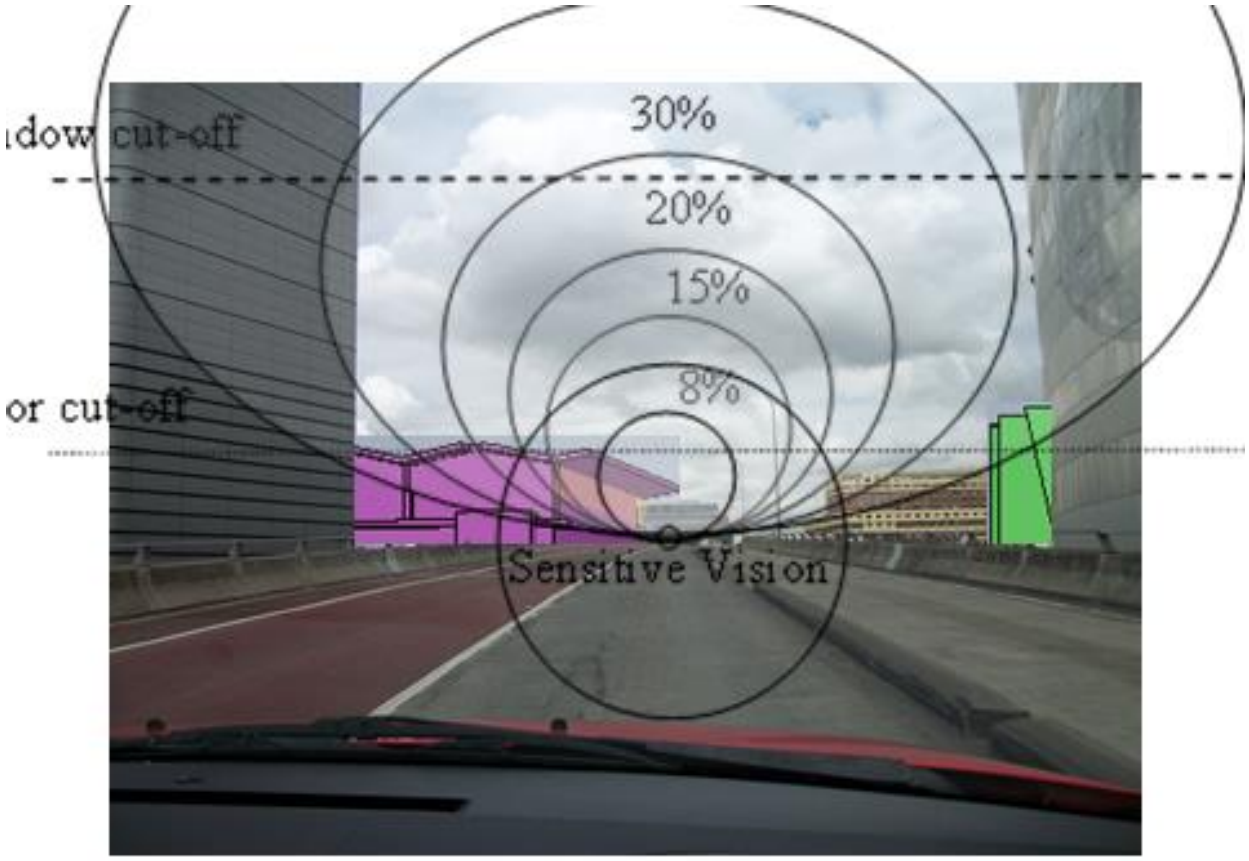

Figure 6: Glare protractor for Druitt Street between the CCT Ventilation stack and Imax, westward view.

A Hassall glare protractor is used to investigate potential solar glare impacts on the westbound motorist. With reference to Figure 5, it is evident that reflections from the northern facade of the ICC Exhibition Centre (pink building) fall within the sensitive vision zone. Another glare protractor for drivers travelling west on Druitt Street is also shown in Figure 6. With reference to Figure 5 and Figure 6, the ICC Exhibition Centre façade zones marked orange and red fall within the driver's sensitive vision zone and further treatment is required.

The northern façade of the ICC Exhibition Centre will comprise mostly pre-cast concrete panels. The panels will not be painted and will have a matt off form concrete finish that will produce a more diffuse type reflection; thereby mitigating reflective glare over most of the northern façade area shaded orange in Figure 6.

A strip of polycarbonate 'Danpalon' product will span the width of the northern façade directly above the pre-cast concrete and below the northern eaves and within the orange zone in Figure 6. Danpalon is known to produce diffuse reflections and wide ranging luminous reflectance properties depending on the selected product. Designers have therefore incorporated vertical aligned opaque fins to block high incident angle solar reflections able to impact on the sensitive vision zone of

approaching motorists. The vertical fins will run perpendicular to the façade line over the height of the Danpalon strip and will be spaced horizontally.

A fin depth ratio of 1:8 will be adopted whereby the fin needs a depth of 1 unit for every 8 units of Danpalon width being protected; for example a 125 mm deep fin will need to be placed at 1000 mm horizontal centres. The final dimensions will be chosen during detailed design but will comply with this ratio. This ratio is needed to block incident angles approaching 15 degrees to shield drivers approaching the ICC Exhibition Centre on the northern most lanes of Druitt Street, viz Figure 6. The fin also needs to extend vertically below the bottom of the Danpalon strip by at least 1 ratio unit.

Mid seasonal morning incident solar rays can strike the east façade of the ICC Exhibition Centre with reflections back onto M4 westbound motorists. Here the reflections are near perpendicular to the façade and a lowering of the glass reflectivity coefficient will be effective. For areas shaded red in Figure 5, the designers have adopted anti-reflective coatings to the glass resulting in a reflectivity coefficient of less than 5%. All other glazing on the east façades will have a reflectivity coefficient of between 10% to 11% to minimise reflections onto approaching city streets as discussed later in this report.

With reference to the glare protractor of Figure 5 and Figure 6, façades on the ICC Exhibition (green building) appear to have limited impact upon westbound motorists using M4 Western Distributor Freeway and Druitt Street.

M4 Western Distributor Freeway (west side of SICEEP Precinct travelling east toward the site)

The greatest potential for the proposed SICEEP developments to generate reflections onto eastbound motorists on the M4 Western Distributor Freeway is solar interaction with the southern facades of the ICC and northern facades of the ICC Exhibition Centre.

The highest TI values calculated for these facades were caused by early morning reflection conditions. Here early morning (7am to 8am outside daylight savings time) low altitude solar rays strike all levels of the southern facades (above road deck) of the International Convention Centre (ICC) from the east with reflections towards the west along the M4 Western Distributor Freeway.

An example of this reflection condition is on June 21, which is illustrated in Figure 7 showing reflections off the south south-east façade segment of ICC between the road deck and roof levels. The impact point is adjacent to the Goldsborough Building at the photo location in Figure 8.

reflections start	7:00 am	TI = 1
reflections cease	7:35 am	TI = 30

The TI values in the later part of this occurrence are in excess of the driving criterion however it is noted the altitude angle of the incident solar rays in this condition are less than 10 degrees and will be partly intercepted by building massing of the Sydney CBD, particularly the Darling Park Complex towers. As the eastbound motorist moves closer to the ICC however the altitude of maximum TI increases above the CBD building line.

Figure 7: Morning reflection condition off ICC

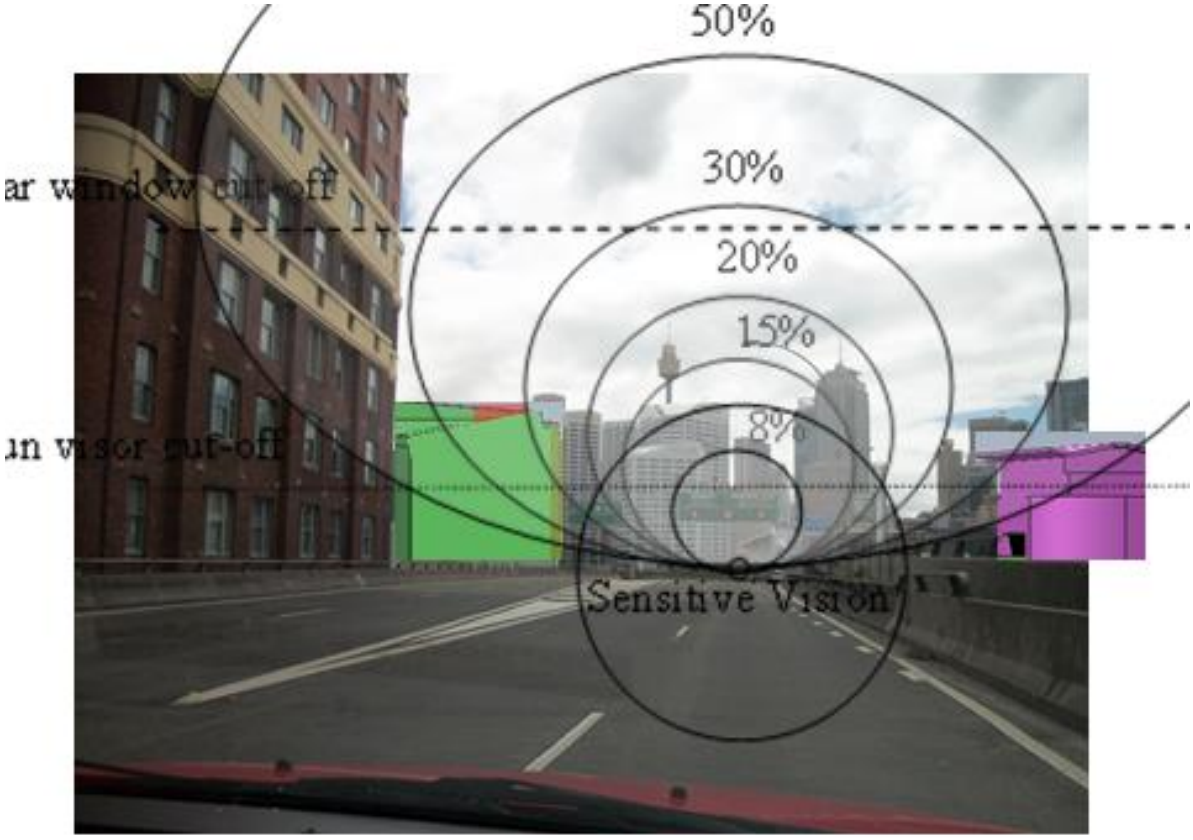

Figure 8: Glare protractor for M4 Western Distributor adjacent the Goldsborough Building eastward view.

A Hassall glare protractor is again used to investigate potential solar glare impacts on the eastbound motorist and is overlayed on Figure 8. For a number of locations on the M4 motorway eastbound and the Fig Street Entry ramp, the ICC façade zone marked orange falls within the driver's sensitive vision zone.

To mitigate this condition the designers have included vertical fin elements to block high incident angle reflections. A fin depth ratio of 1:6 will be adopted over the façade areas shaded orange in Figure 9.

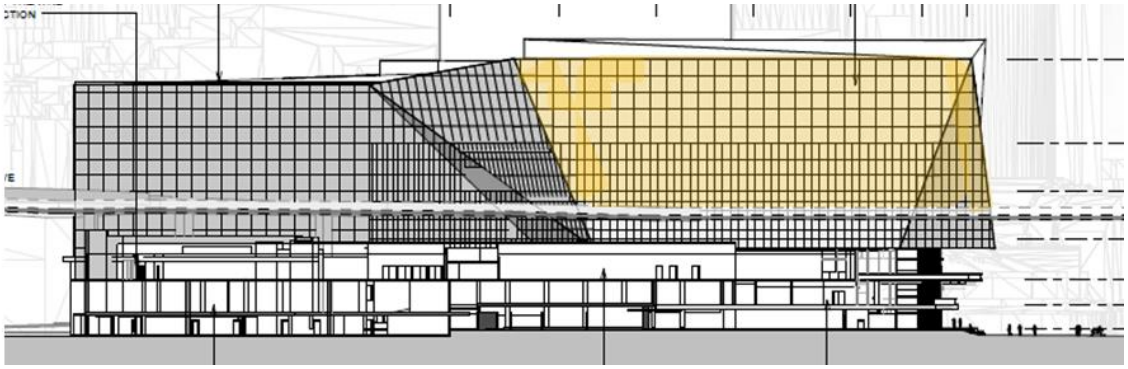

Figure 9: South southeast façade areas requiring fin treatment in ratio 1:6.

The small ICC west facing roof section shaded red in Figure 8 will include cladding elements with low reflectivity.

The northern façade of the ICC Exhibition Centre falls within the sensitive vision zone for the eastbound motorist as shown in Figure 10. Fin treatment to the Danpalon strip as described earlier will also mitigate this condition. The metal drum also within the sensitive vision zone will be a dark charcoal colour metal cladding with low sheen over the northern most section seen from the motorway to minimise any diffuse solar reflections.

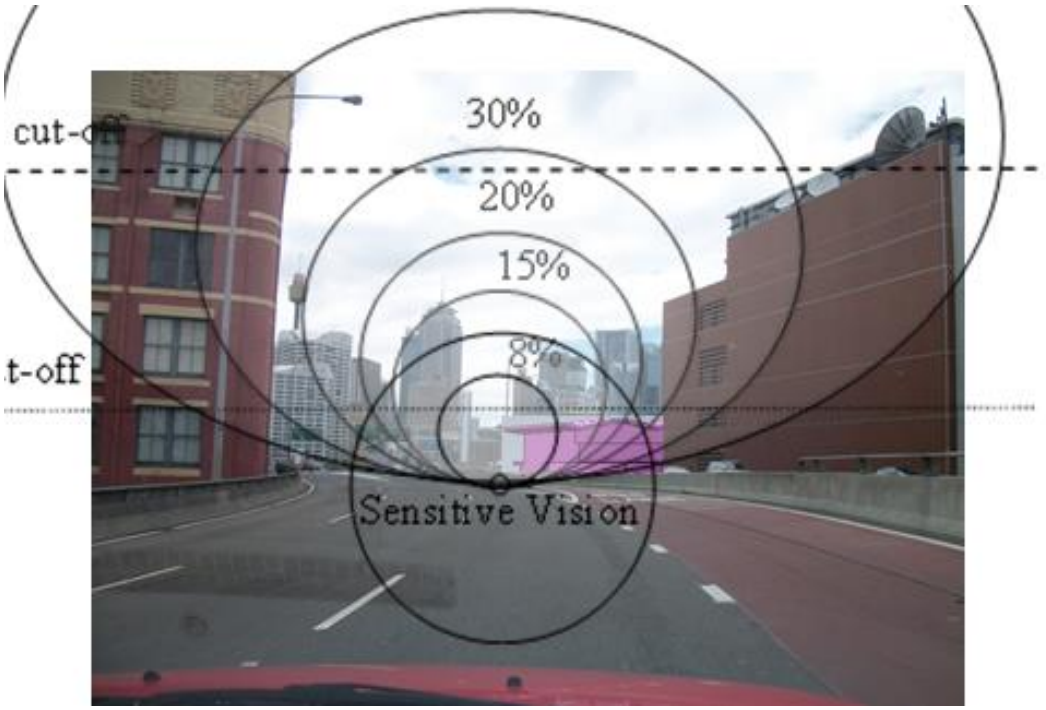

Figure 10: Glare protractor for M4 Western Distributor west of Goldsborough Building eastward view.

Pier Street

The greatest potential for the proposed SICEEP developments to generate reflections onto motorists using Pier Street is solar interaction with the roof and facades of The Theatre. A Hassall glare protractor is again used to investigate potential solar glare impacts on the eastbound motorist and is overlayed on Figure 11.

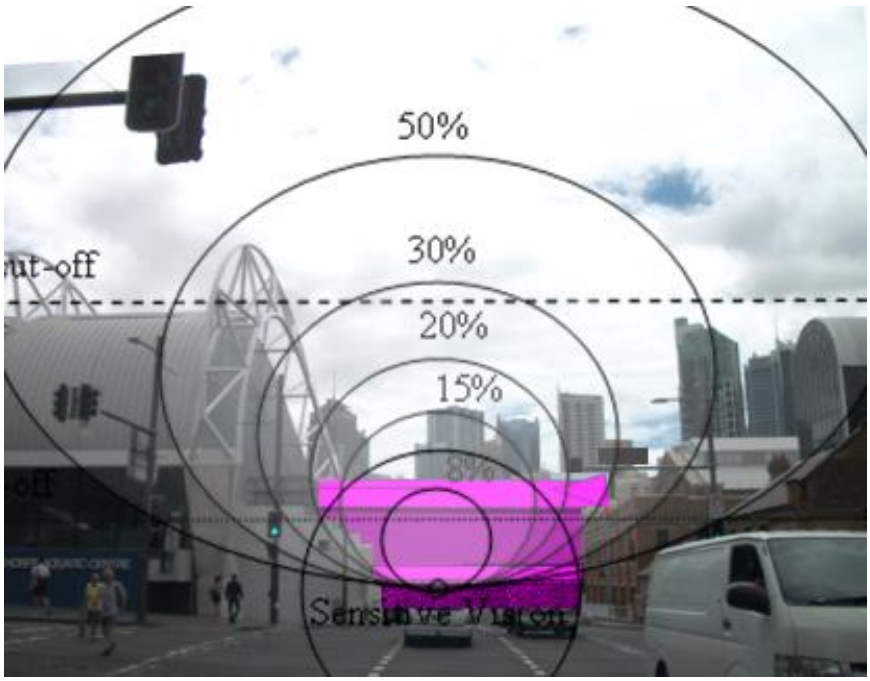

Figure 11: Glare protractor for Pier Street at Harris Street intersection eastward view.

Summer afternoon incident solar rays can strike the west façade of The Theatre (pink building) with reflections directly back onto Pier Street eastbound motorists. Here the reflections are near perpendicular to the west façade and a lowering of the glass reflectivity coefficient will be effective. For areas within view of Figure 11, the designers have adopted low reflectivity Alpolic.

Morning reflections off The Theatre roof also have potential to impact upon eastbound Pier Street motorists. Reflections off metal deck roofing will comprise both diffuse and specular components. To minimise the diffuse reflections a dark charcoal colour will be adopted. To minimise the specular component, a low sheen metal deck roofing will be adopted. Samples of roof material will be reviewed during detailed design.

A Hassall glare protractor is again used to investigate potential solar glare impacts on the eastbound motorist closer to The Theatre and is overlayed on Figure 12. At this location high TI values were calculated for reflections off the south façade but for an observer looking directly at the building. For a driver looking directly forward as would normally be the case, the glare source lies well outside the zone of sensitive vision and glare should not be problematic. Notwithstanding, there is also pedestrian amenity to consider and the designers will continue the same dark charcoal colour roof metal cladding down the southern façade of The Theatre above Pier Street level. To minimise the specular component a low sheen metal cladding will be adopted. The same metal cladding will line the northern façade in order to minimise reflections onto pedestrians.

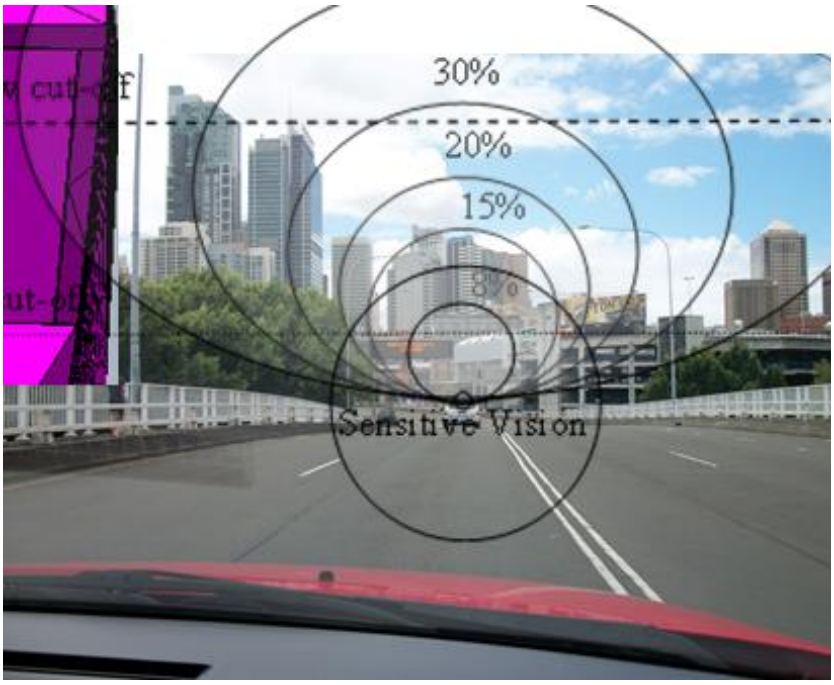

Figure 12: Glare protractor for Pier Street adjacent The Theatre eastward view.

A Hassall glare protractor is again used to investigate potential solar glare impacts on the westbound motorist on Pier Street and is overlayed on Figure 13. Mid-winter morning incident solar rays can strike the east façade of The Theatre with reflections back onto Pier Street westbound motorists. Here the reflections are near perpendicular to the façade and a lowering of the glass reflectivity coefficient will be effective. For areas shaded red in Figure 13, the designers have adopted anti-reflective coatings to the glass resulting in a reflectivity coefficient of less than 5%. All other glazing on The Theatre east façade will have a reflectivity coefficient of between 10% to 11% to minimise reflections onto approaching city streets as discussed later in this report.

As an alternative in the red zone shown in Figure 13, the designers are also considering modifying the horizontal glazing sunshades over the area shaded red. Currently 70mm deep horizontal shelves are proposed at 100 vertical spacing. By halving the vertical spacing and inclining these louvres by 35 degrees to the horizontal, blockage to solar rays can be achieved.

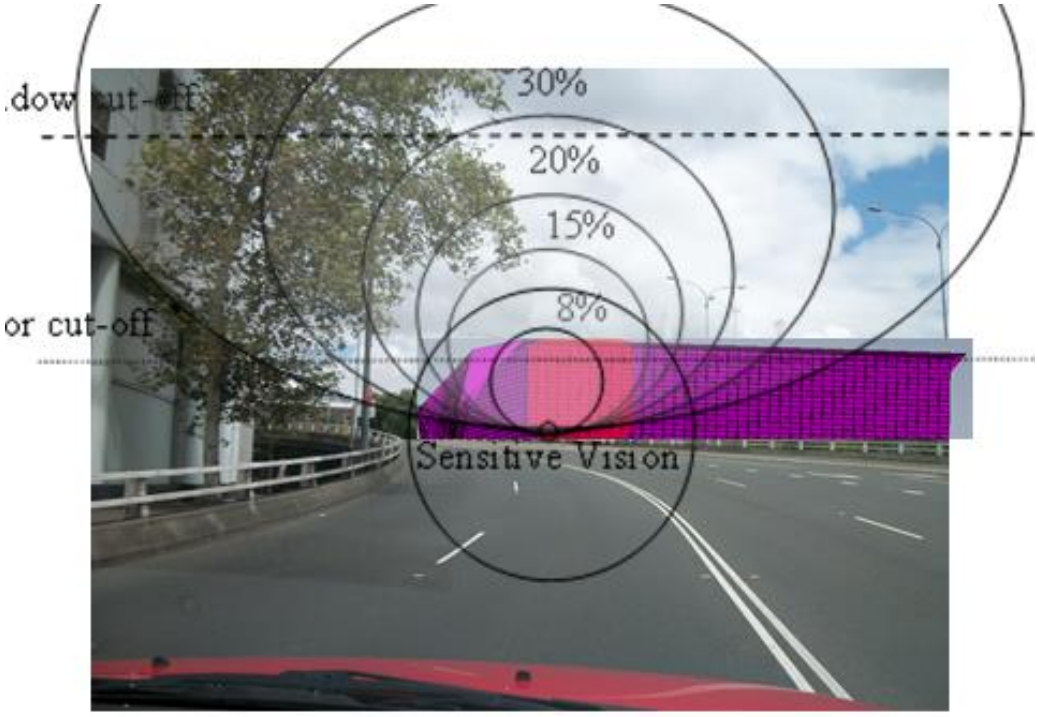

Figure 13: Glare protractor for Pier Street near Harbour Street westward view.

Sydney CBD Streets

The site will be visible from a number of Sydney CBD roadways as shown below in Figure 14. This figure includes photographs taken near the intersections of Goulburn, Liverpool and Bathurst Streets with Harbour Street representing some of the highest potential for glare impact onto Sydney CBD roadways. Corresponding to each photograph is a picture of the CPP wind tunnel model taken from the same viewing angle with the future SICEEP developments in place.

At all these locations reflections are near perpendicular to the SICEEP façades and a lowering of the glass reflectivity coefficient will be effective. All glazing on SICEEP east façades (ICC, ICC Exhibition and The Theatre) as well as the ICC north façade will therefore have a reflectivity coefficient of between 10% to 11% to minimise reflections onto approaching city streets.

A low glazing reflectivity coefficient on these facades will also be of benefit to pedestrian users of the precinct in areas such as Tumbalong Green, Darling Walk and Chinese Gardens as well as pedestrian locations further afield such as Darling Park, Figure 15.

Goulburn Street Liverpool Street Bathurst Street

Figure 14 Sydney CBD roadways with westward sight lines toward SICEEP.

Figure 15 Example of Sydney CBD pedestrian sight line toward SICEEP, Darling Park.

Darling Drive

There is some potential for mid-afternoon winter solar rays to strike the western Alpolic façade of The Theatre with reflections southward toward northbound motorists using Darling Drive. Here we note there is limited potential for reflections to impact the northbound motorists due to the incident solar ray altitude being above the Hassall car window cut-off line. Further, the Pier Street road deck will block a large proportion of reflected rays.

Vehicles travelling northward along Darling Drive will pass pre-cast panels of The Theatre lower west façade and Event Deck. These facades will be painted off-white with a matt finish and will not produce reflective glare. Green facades of the event deck will include foliage to cover the backing façade and block solar reflections.

Travelling further northward on Darling Drive the metal drum will pass within the sensitive vision zone and the curved surface could cast diffuse and specular reflections onto approaching motorists. The designers will incorporate a dark charcoal colour metal cladding with low sheen over the southern most curved sections as seen from the roadway to minimise any diffuse solar reflections.

Diffuse Reflections

Other façade and roof ancillaries to be developed during detailed design should each be assessed for potential to generate nuisance reflections. Elements such as external louvers, metallic awnings, photovoltaic arrays, signage, blade walls, and masonry walls have potential to generate localised glare of both a diffuse and specular nature. Assessment of these is not made in the current study but will be assessed during detailed design.

9. CONCLUSIONS

Darling Harbour Live will ensure all exterior façade elements used throughout the development will limit light reflectivity to 20% or less as outlined under the Sydney Development Control Plan 2012.

To meet the qualitative requirements of the Sydney Development Control Plan 2012, this reflectivity analysis has assessed the potential for the proposed developments to cause adverse glare events at surrounding motorway locations.

In summary, with the measures adopted by the designers as described in this report regarding choice of façade materials and façade articulation, the proposed SICEEP development does not present a driver hazard in terms of solar glare and will meet the Sydney Development Control Plan 2012 controls for reflectivity.

10. REFERENCES

Australia/New Zealand Standard AS/NZS 1158.1.1:2005 "Lighting for Roads and Public Spaces" Part 1.1: Vehicular Traffic (Category V) lighting – Performance and design requirements".

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

Architectural Drawings

Assessment of reflectivity in this report has been based upon development drawings prepared by Darling Harbour Live February 2013.