# SOLAR LIGHT REFLECTIVITY ANALYSIS

# ALEXANDRIA PARK COMMUNITY SCHOOL

WD711-03F02(REV0)- SR REPORT

DECEMBER 11, 2017

Prepared for:

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# DOCUMENT CONTROL

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## EXECUTIVE SUMMARY

This report presents the results of a detailed study for the effect of potential solar glare from the proposed Alexandria Park Community School. This study identifies any possible adverse reflected solar glare conditions affecting motorists, pedestrians, and to occupants of neighbouring buildings. If necessary, recommendations are made to mitigate any potentially adverse effects. This study assesses compliance with the controls for solar glare from the City of Sydney Development Control Plan 2012.

A site survey has been undertaken to obtain photographs of the critical sightlines of motorists on the surrounding streets. These photographs are calibrated and are able to be overlaid with a glare meter, which allows the extent, if any, of potential solar glare reflections from the subject development to be determined.

The results of the study indicate that, to avoid any adverse glare to motorists and pedestrians on the surrounding streets, occupants of neighbouring buildings, and to comply with the abovementioned planning control requirements, the following is recommended:

- The glazing of the windows on the 254° aspect of Building B which do not have sunshade louvers should have a maximum normal specular reflectance of visible light of 11%. Alternatively, sunshade louvers could be installed over those windows.
- All other glazing used on the external façade of the development should have a maximum normal specular reflectance of visible light of 20%.

It should be noted that the most reflective surface on the façade of a building is the glazing. Reflected solar glare from concrete, brickwork, timber, etc. is negligible (i.e. less than 1% normal specular reflectance) and hence will not cause any adverse solar glare effects. Note also that, for any painted or powder-coated metallic surfaces on the exterior façade of the development, the maximum normal specular reflectance of visible light for those types of surfaces is in the range of 1% to 5%, which is well within the abovementioned limit.

Hence, with the incorporation of the abovementioned recommendations, the results of this study indicate that the subject development will not cause adverse solar glare to pedestrians or motorists in the surrounding area, or to occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity from the City of Sydney DCP 2012.

## CONTENTS

# 1 METHODOLOGY

This study assesses compliance with the controls for solar glare from the City of Sydney Development Control Plan 2012.

The reflectivity analysis of the subject development has been carried out using the technique published by Hassall (1991). The limiting veiling luminance of 500 cd/m$^2$ for the comfort of motorists, as suggested in Hassall (1991), has been adopted as a basis of assessing the glare impact from the subject development. In meeting this criterion for vehicle motorists, conditions will also be satisfactory for pedestrians. The glare impact on occupants of neighbouring buildings is also discussed in this assessment.

The various critical glazed aspects were determined for the development and are shown in Figures 1a, 1b, 1c and 1d. Solar charts for each of these critical glazed aspects are presented in Appendix B, and these are used to derive the check zones which are shown in Figure 2. The check zones highlight the areas that are potentially affected by solar reflections from each critical glazed aspect. It should be noted that the check zones shown in Figure 2 do not take into account the effect of overshadowing by neighbouring buildings or the shielding effect of any existing trees or other obstructions. These effects are examined in the detailed analysis described in Section 2 of this report.

Study point locations are selected within the check zone areas where motorists are facing the general direction of the subject development. These are shown in Figure 2. For each of the study point locations, photographs have been taken from the viewpoint of motorists using a calibrated camera. Views from the study point locations are presented in Appendix A of this report. A scaled glare protractor has been superimposed over each photograph.

The glare protractor is used to assess the amount of glare likely to be caused and to provide a direct comparison with the criterion of 500 cd/m$^2$. Alternatively, the glare protractor can be used to determine the maximum acceptable reflectivity index of the façade material of the development for the glare to be within the criterion of 500 cd/m$^2$.

If it is found that a section of the subject development will be within the zone of sensitive vision of a motorist at a selected study point location (the central area of the glare protractor), the glare protractor is used to determine what the maximum normal specular reflectance of visible light should be for the glazing or any other reflective material used on that section of the façade of the development to ensure that solar glare will not cause discomfort or threaten the safety of motorists or pedestrians, and hence to allow the subject development to comply with the relevant planning control requirements.

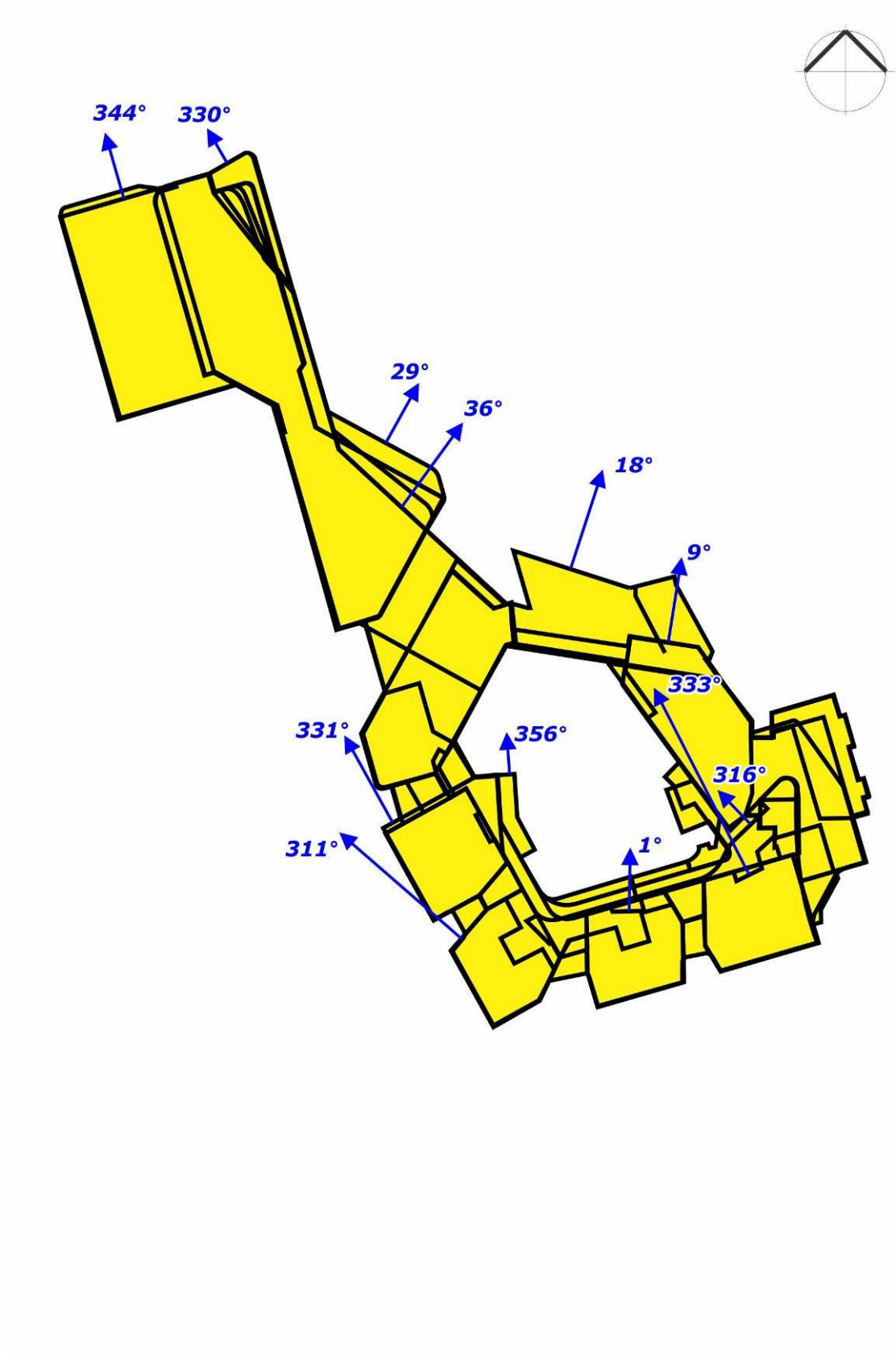


**Figure 1a: Critical Northern Glazed Aspects of the Development**

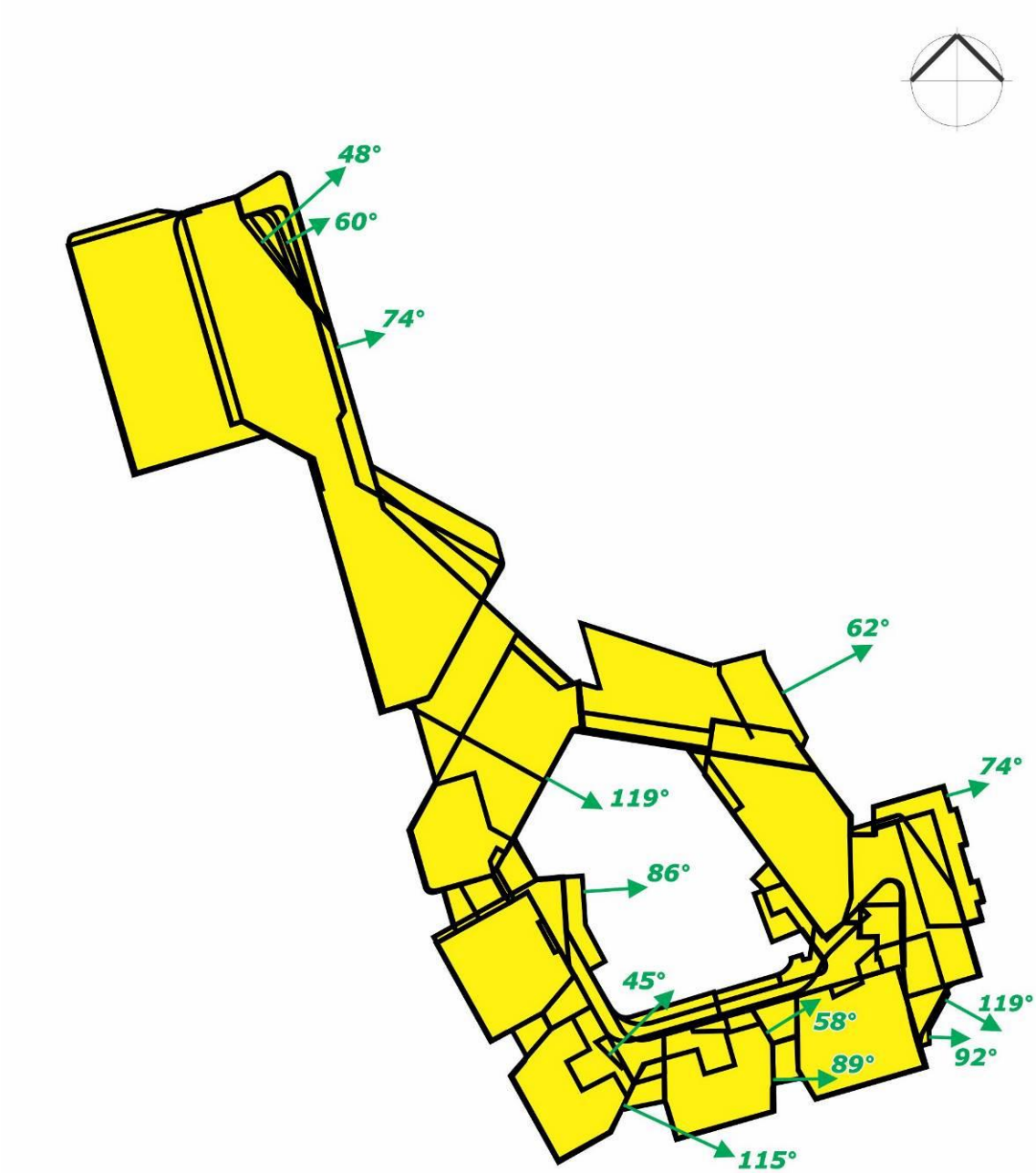


**Figure 1b: Critical Eastern Glazed Aspects of the Development**

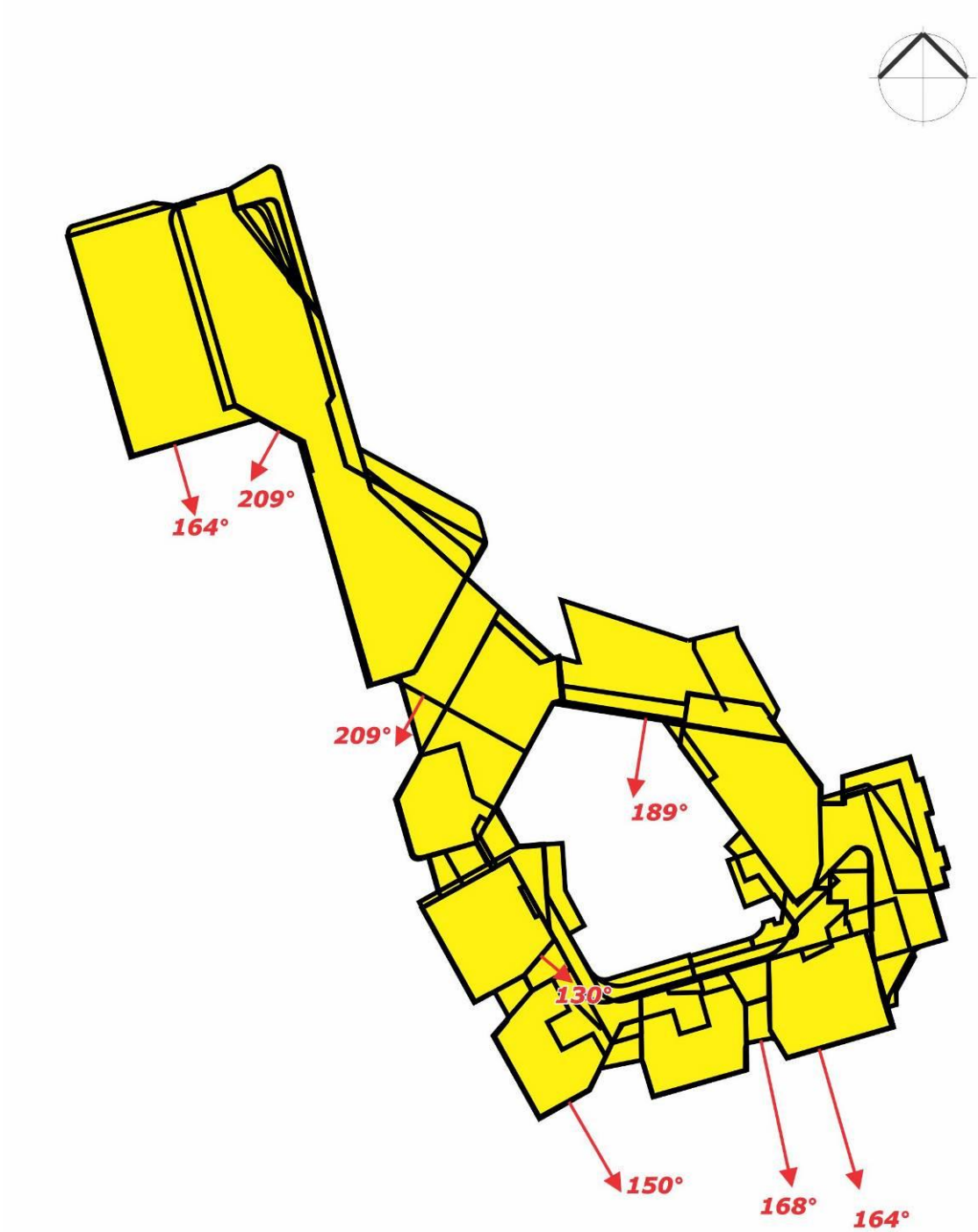


**Figure 1c: Critical Southern Glazed Aspects of the Development**

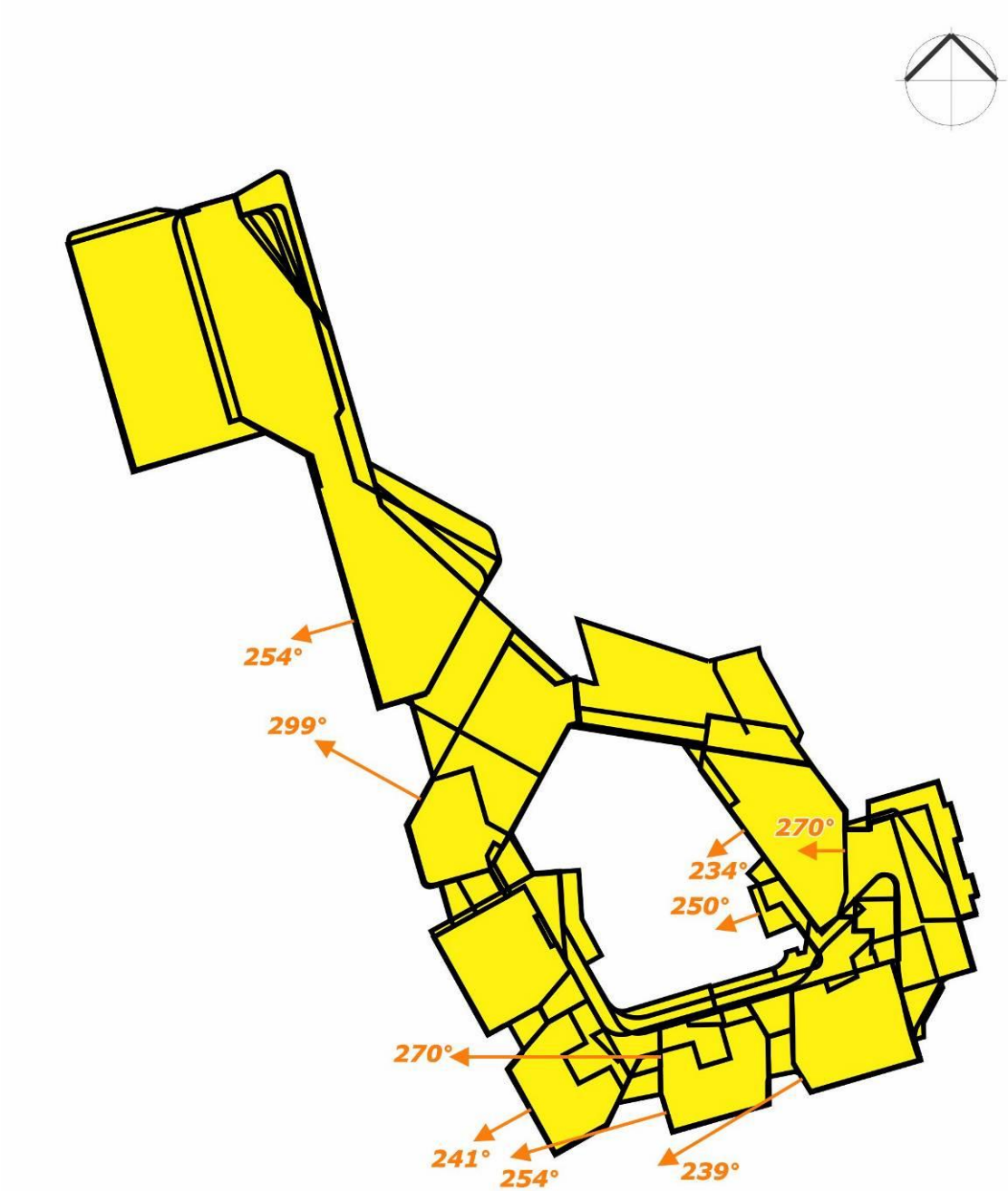


**Figure 1d: Critical Western Glazed Aspects of the Development**

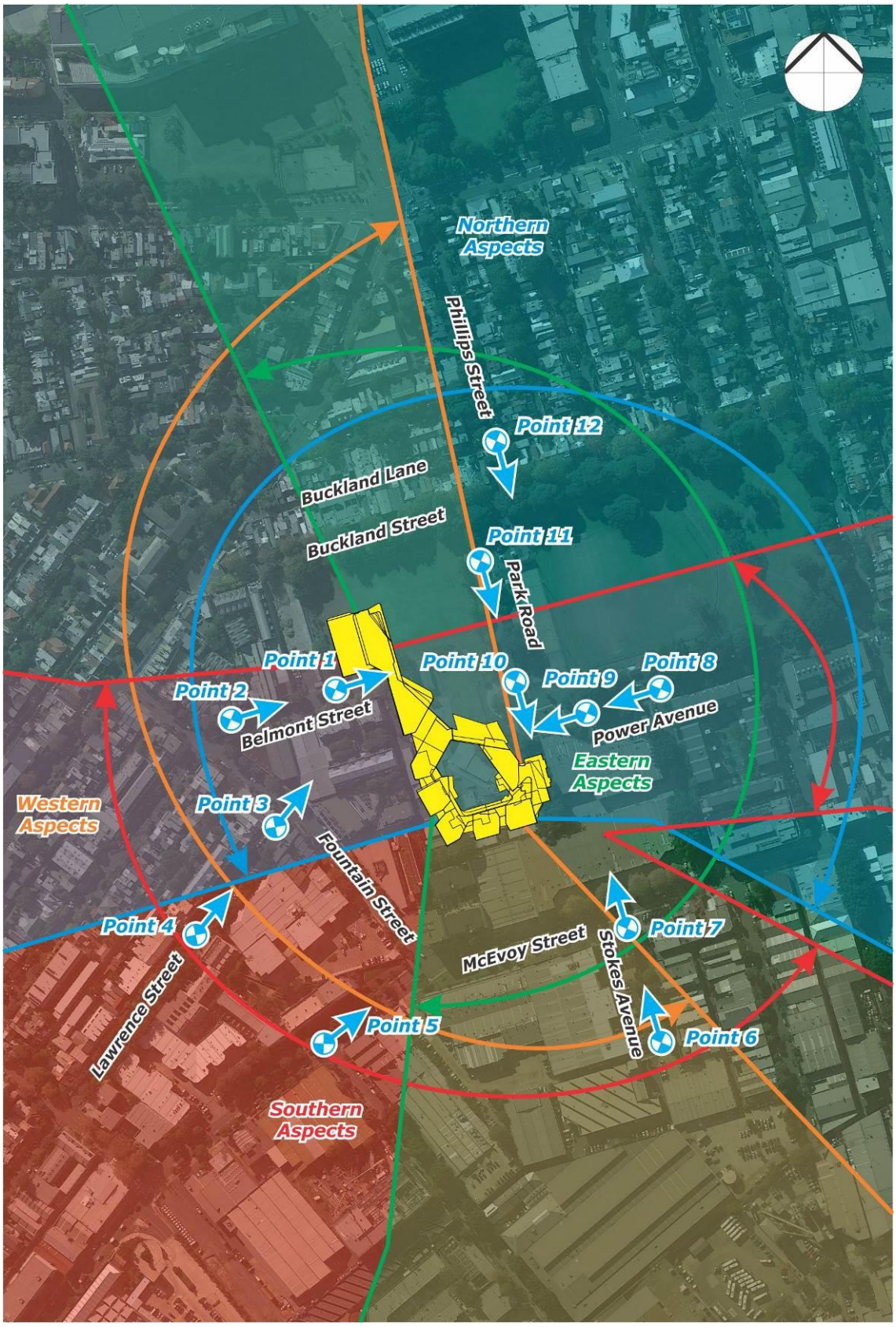


**Figure 2: Check Zones and Study Point Locations**
**(the check zones are the areas where glare could potentially be observed)**

# 2 ANALYSIS

## 2.1 Impact onto Motorists and Pedestrians

From the study of the check zones shown in Figure 2, a total of 12 locations have been identified for detailed analysis. A summary of the location of each study point, and the vertical aspects of the subject development could potentially reflect solar glare to each study point location, is shown in Table 1 below. Note that, as mentioned in Section 1, the check zones shown in Figure 2 do not take into account the effect of overshadowing by neighbouring buildings or the shielding effect of any existing trees or other obstructions. These effects are examined in the detailed analysis described in the following sub-sections.

**Table 1: Aspects of the Proposed Development that could reflect Solar Glare to each Study Point**

| Study Point | Location and Viewpoint | Aspect(s) of the Development |
|---|---|---|
| 1 | Belmont Street – Heading east | Northern, southern and western aspects |
| 2 | Belmont Street – Heading east | Northern, southern and western aspects |
| 3 | Lawrence Street – Heading north-east | Northern, southern and western aspects |
| 4 | Lawrence Street – Heading north-east | Southern and western aspects |
| 5 | McEvoy Street – Heading north-east | Southern and western aspects |
| 6 | Stokes Avenue – Heading north | Eastern, southern and western aspects |
| 7 | Stokes Avenue – Heading north | Eastern and southern aspects |
| 8 | Power Avenue – Heading west | Northern, eastern and southern aspects |
| 9 | Power Avenue – Heading west | Northern, eastern and southern aspects |
| 10 | Park Road – Heading south | Northern, eastern and southern aspects |
| 11 | Park Road – Heading south | Northern and eastern aspects |
| 12 | Phillips Street – Heading south | Northern and eastern aspects |

### 2.1.1 Drivers heading east along Belmont Street

Points 1 and 2 are located along Belmont Street, to the west of the development site. These points represent the critical sightlines of drivers heading east along Belmont Street at these locations. A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers at these locations were obtained using a calibrated camera. The photographs have been scaled to enable the glare meter to be overlaid onto the images, as shown in Figures A1 and A2 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 1 and 2 indicate that the 164°, 209° and the 254° aspects of the proposed development will be visible and within the zone of sensitive vision of motorists at this location. Further analysis indicates that Points 1 and 2 are not within the check zone for the 209° aspect, and hence no solar glare will be observed

at Points 1 and 2 from that aspect. Points 1 and 2 are within the check zone for the 164° aspect, however at the times of the day when solar glare could have been observed from that aspect at Points 1 and 2, that aspect will be overshadowed by the taller component of Building A. Hence there will be no glare observed from the 164° aspect of the development at Points 1 and 2. The 254° aspect will reflect glare to Points 1 and 2 in the late afternoon during summer. The adjacent buildings and trees to the west will provide shading onto the lower levels of the 254° aspect of the development at these times, however the higher levels will be exposed to this late afternoon sun. It is noted that many of the windows on this portion of the 254° aspect feature sunshade louvers, and these will be effective in blocking glare from those windows. However, for the windows on the 254° aspect of Building B which do not have sunshade louvers, it is recommended to limit the maximum normal specular reflectance of visible light of those windows to 11%. With the incorporation of this recommendation, no adverse glare will affect motorists and pedestrians heading east at Points 1 and 2.

### 2.1.2 Drivers heading north-east along Lawrence Street

Points 3 and 4 are located along Lawrence Street, to the west of the development site. These points represent the critical sightlines of drivers heading north-east along Lawrence Street at these locations. A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers at these locations were obtained using a calibrated camera. The photographs have been scaled to enable the glare meter to be overlaid onto the images, as shown in Figures A3 and A4 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 3 indicate that the proposed development will not be visible within the zone of sensitive vision of motorists at these locations. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading north-east along Lawrence Street at Point 3.

An analysis of the glare meter overlaid onto the viewpoint at Point 4 indicate that the 209° and the 254° aspects of the proposed development will be visible and within the zone of sensitive vision of motorists at this location. However, further analysis indicates that Point 4 is not within the check zone of the visible portions of the 209° aspect, and hence no glare will be observed at Point 4 from those aspects of the development. The visible portion of the 254° aspect of Building B will be blocked from view by the various trees lining the eastern side of Lawrence Street, and hence these trees will be effective in blocking glare observed from that aspect at Point 4, which would have otherwise occurred late in the afternoon during winter. Hence there will be no adverse solar glare observed by motorists or pedestrians heading north-east along Lawrence Street at Point 4.

### 2.1.3 Drivers heading north-east along McEvoy Street

Point 5 is located along McEvoy Street, to the south of the development site. This point represents the critical sightlines of drivers heading north-east along McEvoy Street at these locations. A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers at this location were obtained using a calibrated camera. The photographs

have been scaled to enable the glare meter to be overlaid onto the images, as shown in Figures A5 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Point 5 indicate that the proposed development will not be visible within the zone of sensitive vision of motorists at these locations. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading north-east along McEvoy Street.

### 2.1.4 Drivers heading north along Stokes Avenue

Points 6 and 7 are located along Stokes Avenue, to the south of the development site. These points represent the critical sightlines of drivers heading north along Stokes Avenue at these locations. A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers at these locations were obtained using a calibrated camera. The photographs have been scaled to enable the glare meter to be overlaid onto the images, as shown in Figures A6 and A7 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 6 and 7 indicate that the proposed development will not be visible within the zone of sensitive vision of motorists at these locations. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading north along Stokes Avenue.

### 2.1.5 Drivers heading west along Power Avenue

Points 8 and 9 are located along Power Avenue, to the east of the development site. These points represent the critical sightlines of drivers heading west along Power Avenue at these locations. A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers at these locations were obtained using a calibrated camera. The photographs have been scaled to enable the glare meter to be overlaid onto the images, as shown in Figures A8 and A9 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 8 and 9 indicate that the 9$^{o}$, 36$^{o}$, 58$^{o}$, 62$^{o}$, 74$^{o}$, 86$^{o}$ and 119$^{o}$ aspects of the proposed development will be visible and within the zone of sensitive vision. Further analysis indicates that Points 8 and 9 are not located within the check zones for the visible portions of the 36$^{o}$ and 119$^{o}$ aspects of the development, and hence there will be no solar glare observed from those aspects at Points 8 and 9. The visible portions of the 9$^{o}$ aspect of the development will be overshadowed by Buildings A and B of the development at the times when solar glare could have otherwise been observed at Points 8 and 9, and hence there will be no solar glare observed from that aspect at Points 8 and 9. The view of the 58$^{o}$ and 62$^{o}$ aspects will be obscured from Points 8 and 9 by the proposed trees located in front of those aspects, and hence there will be no solar glare observed from that aspect at Points 8 and 9. The visible portion of the 74$^{o}$ aspect of the development is covered by a perforated sunshade screen, which will be effective in blocking reflected glare from the glazing on that aspect. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading west along Power Avenue.

### 2.1.6 Drivers heading south along Park Road

Points 10 and 11 are located along Park Road, to the east of the development site. These points represent the critical sightlines of drivers heading south along Park Road at these locations. A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers at these locations were obtained using a calibrated camera. The photographs have been scaled to enable the glare meter to be overlaid onto the images, as shown in Figures A10 and A11 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 10 and 11 indicate that the 1°, 9°, 58°, 62°, 316° and 344° aspects of the proposed development will be visible and within the zone of sensitive vision of motorists at these locations. Further analysis indicates that Points 10 and 11 will not be within the check zones for the visible portions of the 1°, 9° and 344° aspects, and hence no solar glare will be observed from those aspects of the development at Points 10 and 11. The view of the 58°, 62° and 316° aspects will be obscured by the proposed large trees to be located on the western side of Park Road. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading south along Park Road.

### 2.1.7 Drivers heading south along Phillips Street

Point 12 is located along Phillips Street, to the north of the development site. This point represents the critical sightlines of drivers heading south along Phillips Street at this location. A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers at this location were obtained using a calibrated camera. The photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figure A12 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 12 indicates that the proposed development will not be visible within the zone of sensitive vision of motorists at this location. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading south along Phillips Street.

## 2.2 Curved Façade

Further analysis has been undertaken for the effect of potential solar glare from the convex curved surfaces located throughout the subject development. The results of this analysis indicate that the convex curvature will disperse solar reflections, significantly reducing the intensity of any potential solar glare from this surface. Hence, there will be no adverse solar glare observed from the surfaces of the development which have a convex curvature.

## 2.3 Occupants of Neighbouring Buildings

Our past experience involving more than 250 projects, and also research by Rofail and Dowdle (2004), tends to indicate that Buildings which cause a nuisance to occupants of neighbouring buildings are those that have a normal specular reflectivity of visible light greater than 20%. This seems to justify the suggested limit of 20% reflectivity by many local government authorities and state planning bodies.

Hence a general recommendation is made that all glazing and other reflective materials used on the façade of the subject development have a maximum normal specular reflectivity of visible light of 20% to avoid adverse solar glare to occupants of neighbouring buildings.

## 2.4 Rooftop Solar Panels

The photovoltaic cells proposed on the rooftop are to be at a fixed angle of inclination. Rooftop solar panels can sometimes cause adverse solar glare which can be observed by motorists and pedestrians in the local surrounding area, and/or to occupants of neighbouring buildings. However, in the case of the subject development, the rooftop solar panels will not be visible by motorists and pedestrians in the local surrounding area. Furthermore, the nearby surrounding buildings are shorter than the rooftop height where the solar panels are to be located, and hence solar glare from the panels will not be observed by the occupants of the neighbouring buildings.

## 2.5 Typical Normal Specular Reflectivity from Building Surfaces

It should be noted that the most reflective surface on the façade of a building is the glazing. Reflected solar glare from concrete, brickwork, timber, etc, is negligible (ie: less than 1% normal specular reflectance) and hence will not cause any adverse solar glare effects. The following sub-sections provide some general reflectance values of more reflective materials used on building facades.

### 2.5.1 Glazed Surfaces

A glazing supplier will be able to provide information on the maximum normal specular reflectance of visible light of different types of glazing. Some typical reflectivity values of different types of glazing are listed as follows:

- Clear float glass – typically 5% to 8%
- Low-e solar control glazing – typically 8% to 12%
- Other types of compliant performance glazing – up to 20%

### 2.5.2 Painted and/or Powder-Coated Metallic Surfaces

In the event that some portions of the external façade of the development feature powder-coated or painted metallic surfaces, it is not expected that adverse glare will be observed from those surfaces since the maximum normal specular reflectance of visible light of these types of façade materials range from 1% to 5%. This is well within the maximum limits specified in previous sections of this report.

# 3 CONCLUSION

An analysis has been undertaken to assess the potential for solar glare from the proposed Alexandria Park Community School. This study identifies any possible adverse reflected solar glare conditions affecting motorists, pedestrians, and to occupants of neighbouring buildings. If necessary, recommendations are made to mitigate any potentially adverse effects. This study assesses compliance with the controls for solar glare from the City of Sydney Development Control Plan 2012.

A site survey has been undertaken to obtain photographs of the critical sightlines of motorists on the surrounding streets. These photographs are calibrated and are able to be overlaid with a glare meter, which allows the extent, if any, of potential solar glare reflections from the subject development to be determined.

The results of the study indicate that, to avoid any adverse glare to motorists and pedestrians on the surrounding streets, occupants of neighbouring buildings, and to comply with the abovementioned planning control requirements, the following is recommended:

- The glazing of the windows on the 254° aspect of Building B which do not have sunshade louvers should have a maximum normal specular reflectance of visible light of 11%. Alternatively, sunshade louvers could be installed over those windows.
- All other glazing used on the external façade of the development should have a maximum normal specular reflectance of visible light of 20%.

It should be noted that the most reflective surface on the façade of a building is the glazing. Reflected solar glare from concrete, brickwork, timber, etc. is negligible (i.e. less than 1% normal specular reflectance) and hence will not cause any adverse solar glare effects. Note also that, for any painted or powder-coated metallic surfaces on the exterior façade of the development, the maximum normal specular reflectance of visible light for those types of surfaces is in the range of 1% to 5%, which is well within the abovementioned limit.

Hence, with the incorporation of the abovementioned recommendations, the results of this study indicate that the subject development will not cause adverse solar glare to pedestrians or motorists in the surrounding area, or to occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity from the City of Sydney DCP 2012.

## REFERENCES

City of Sydney Development Control Plan 2012.

Hassall, D.N., 1991, "Reflectivity, Dealing with Rogue Solar Reflections", (published by author).

Phillips, R.O., 1992, "Sunshine and Shade in Australasia", Sixth Edition, CSIRO Publishing.

Rofail, A.W., and Dowdle, B., 2004, "Reflectivity Impact on Occupants of Neighbouring Properties", International Conf. on Building Envelope Systems & Technologies, Sydney.

## APPENDIX A - GLARE OVERLAYS FOR THE CRITICAL SIGHT-LINES

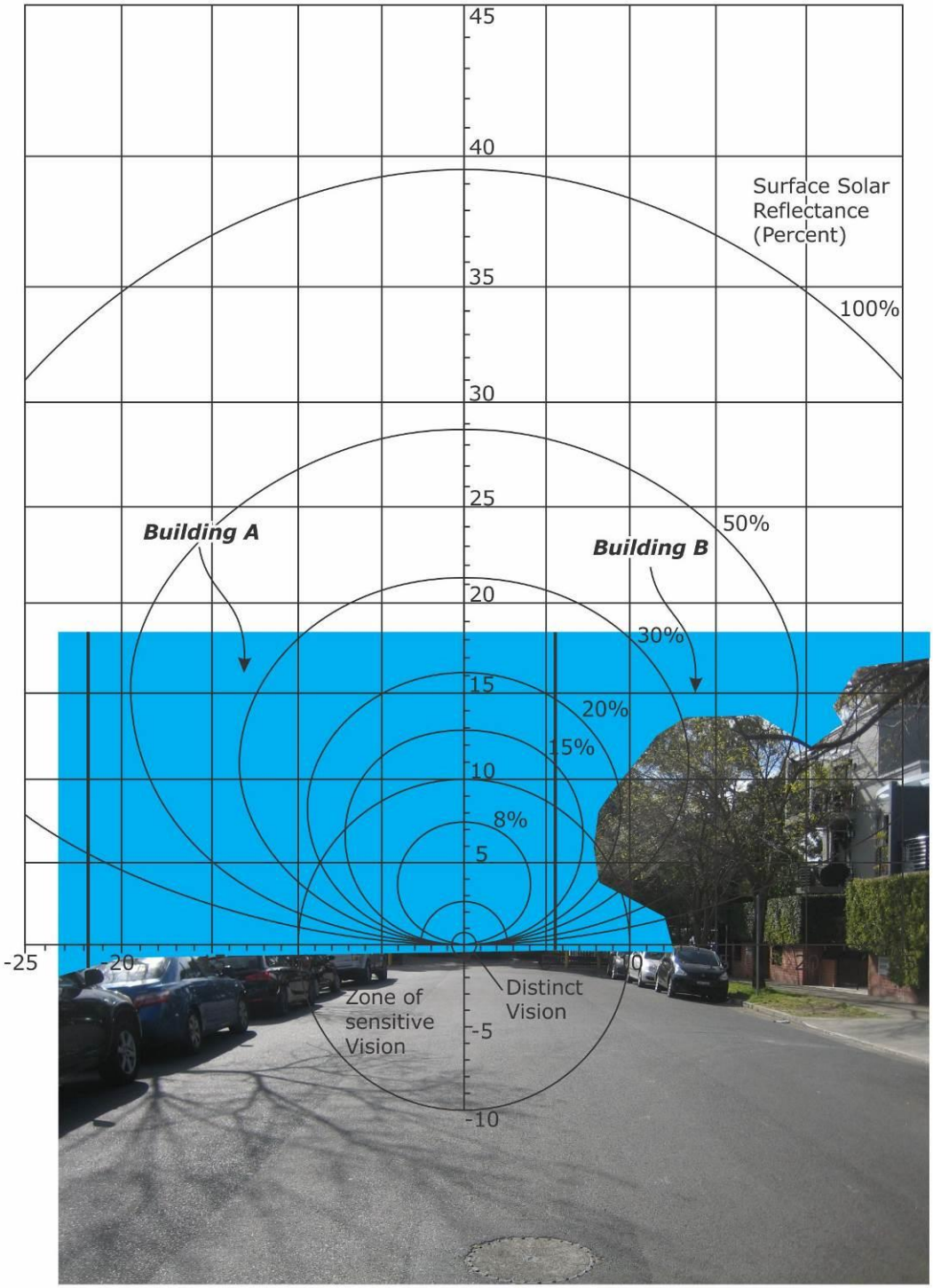


**Figure A1: Glare Overlay for Point 1**

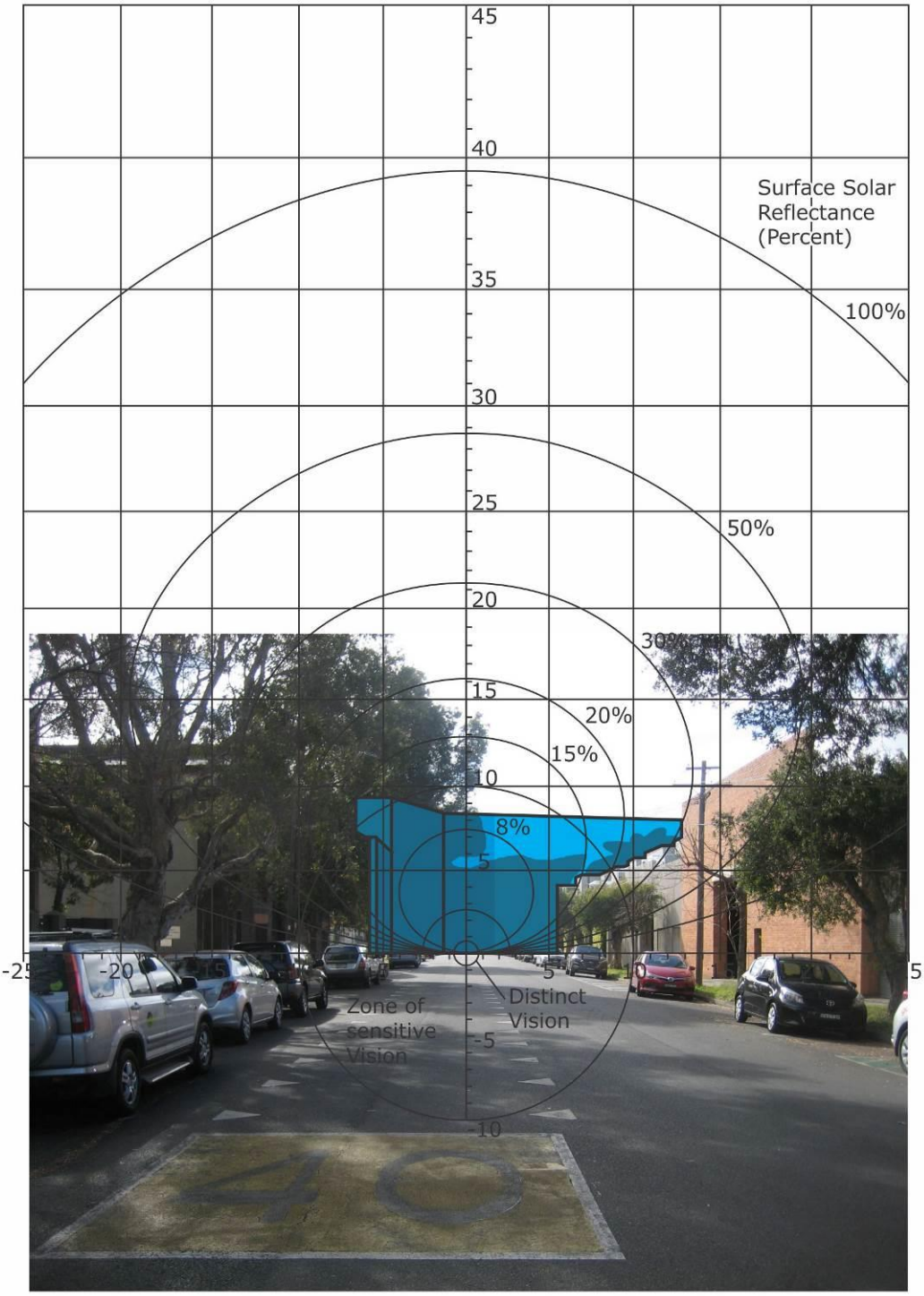


**Figure A2: Glare Overlay for Point 2**

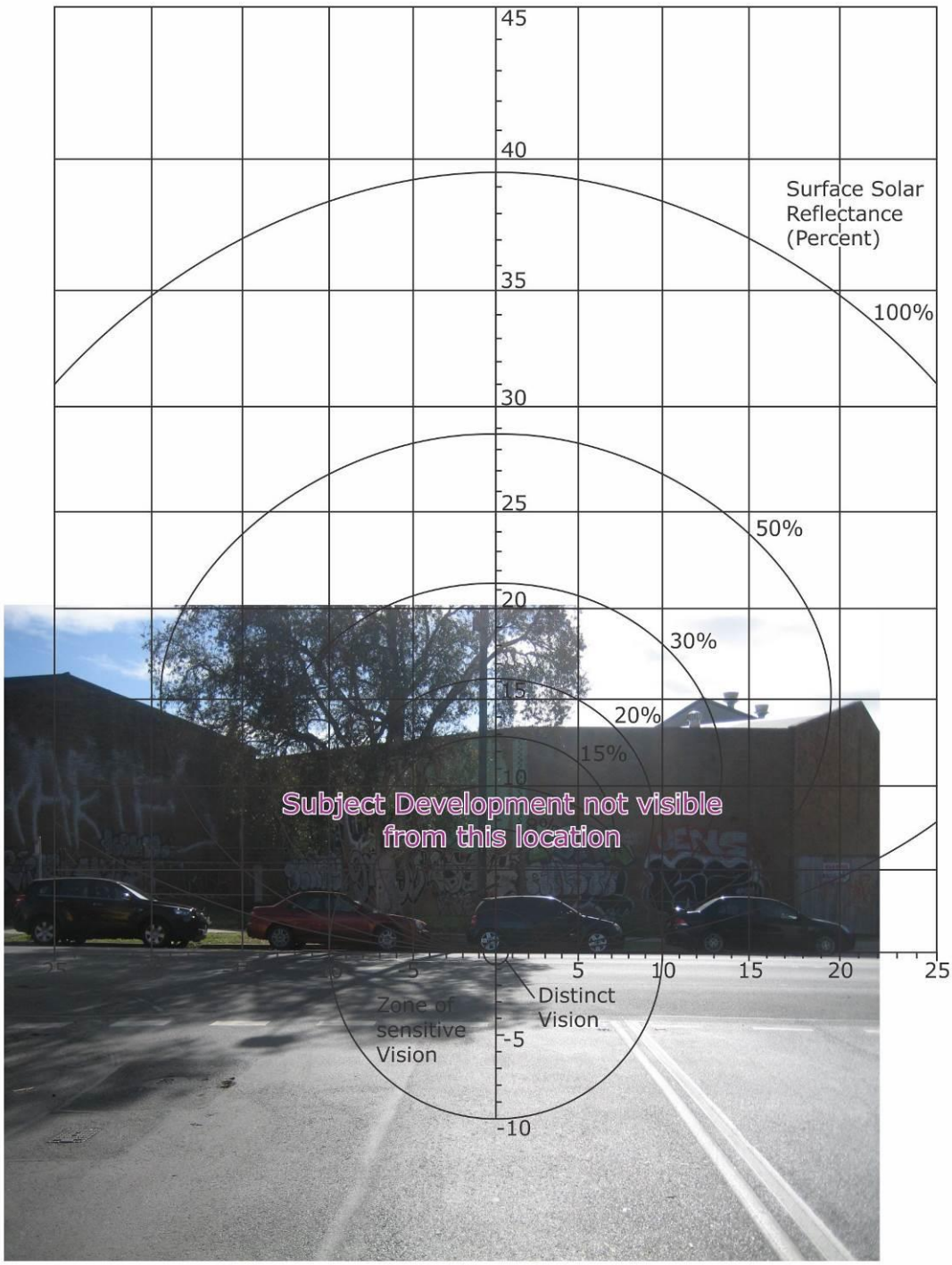


**Figure A3: Glare Overlay for Point 3**

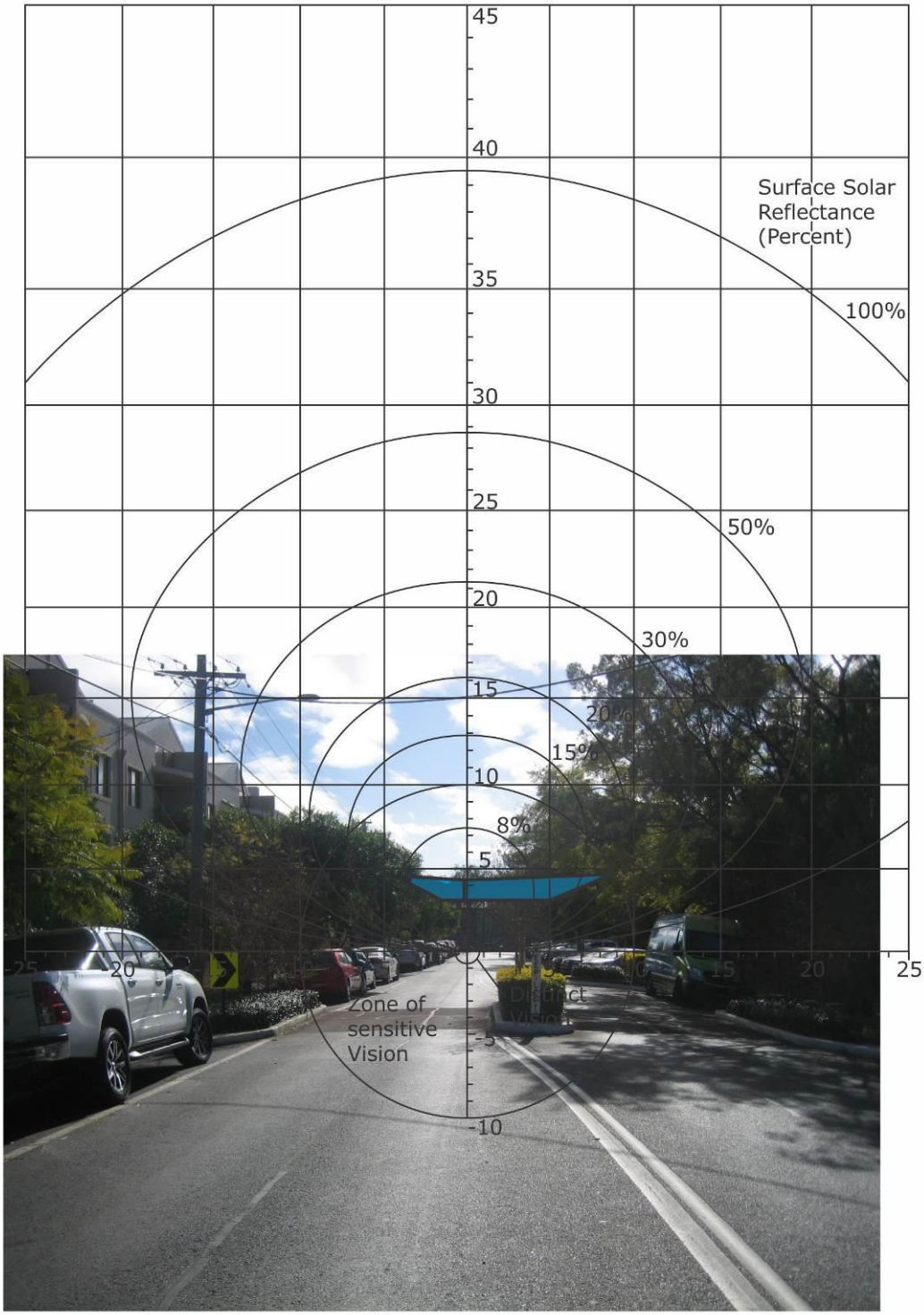


**Figure A4: Glare Overlay for Point 4**

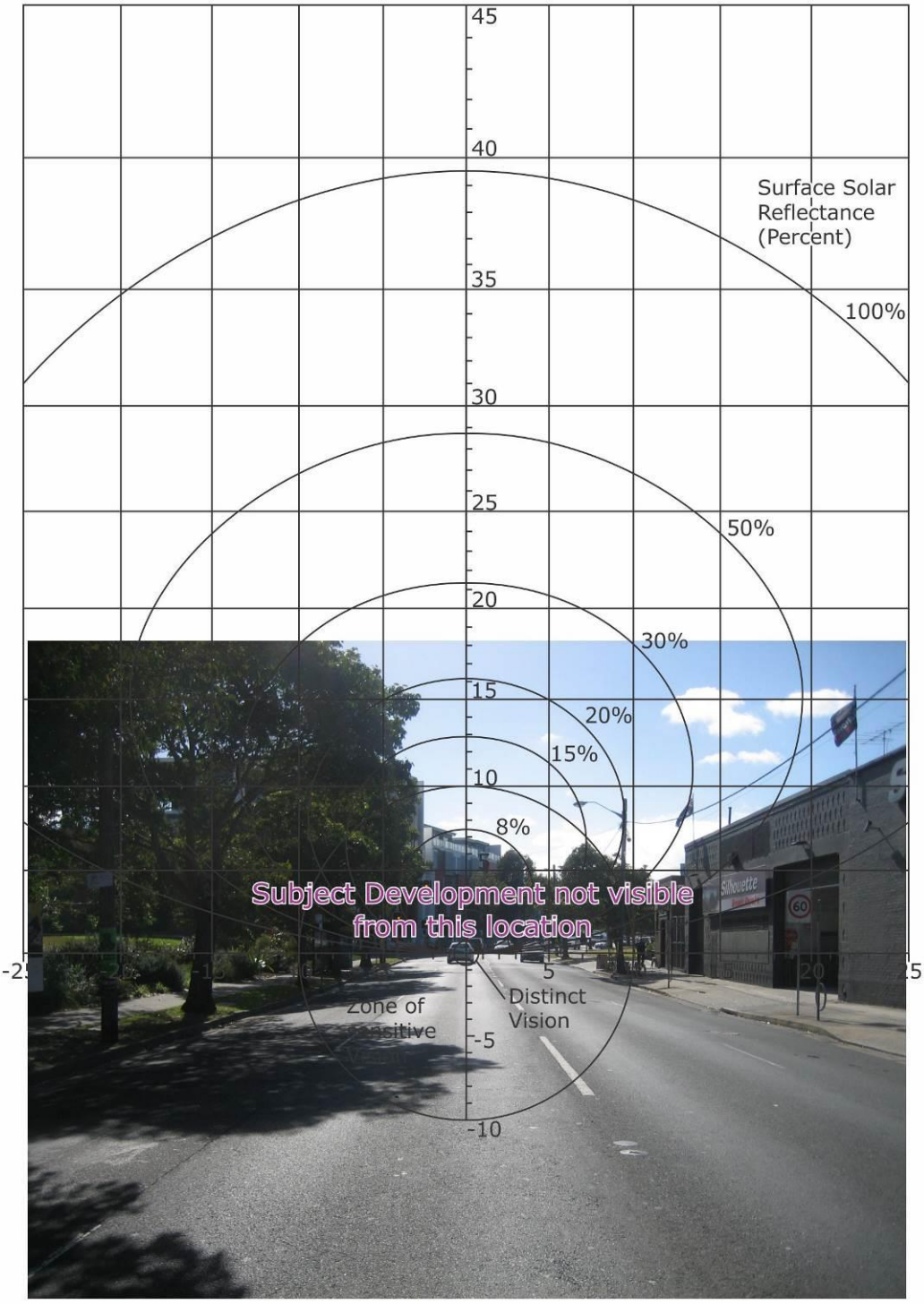


**Figure A5: Glare Overlay for Point 5**

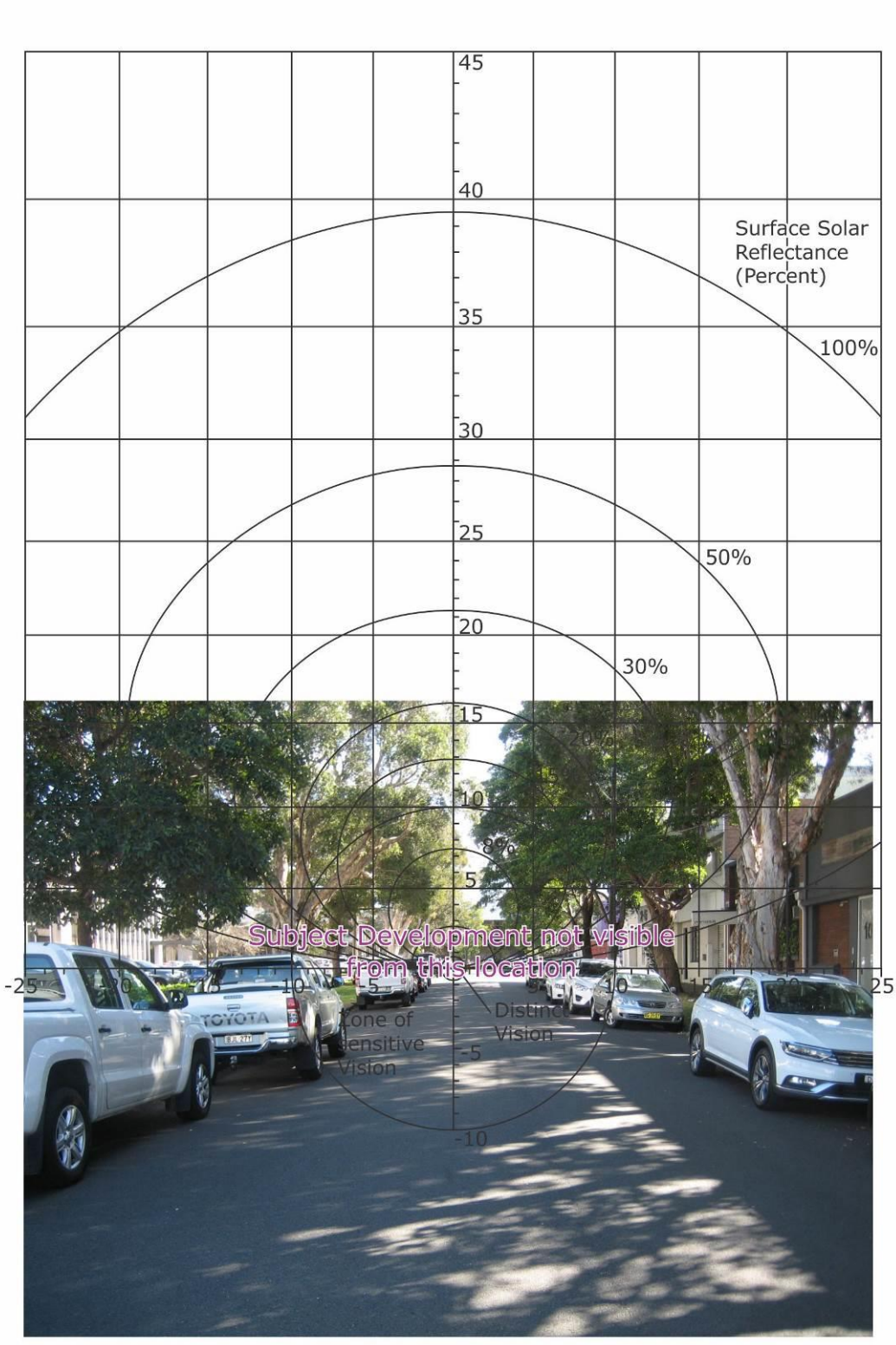


**Figure A6: Glare Overlay for Point 6**

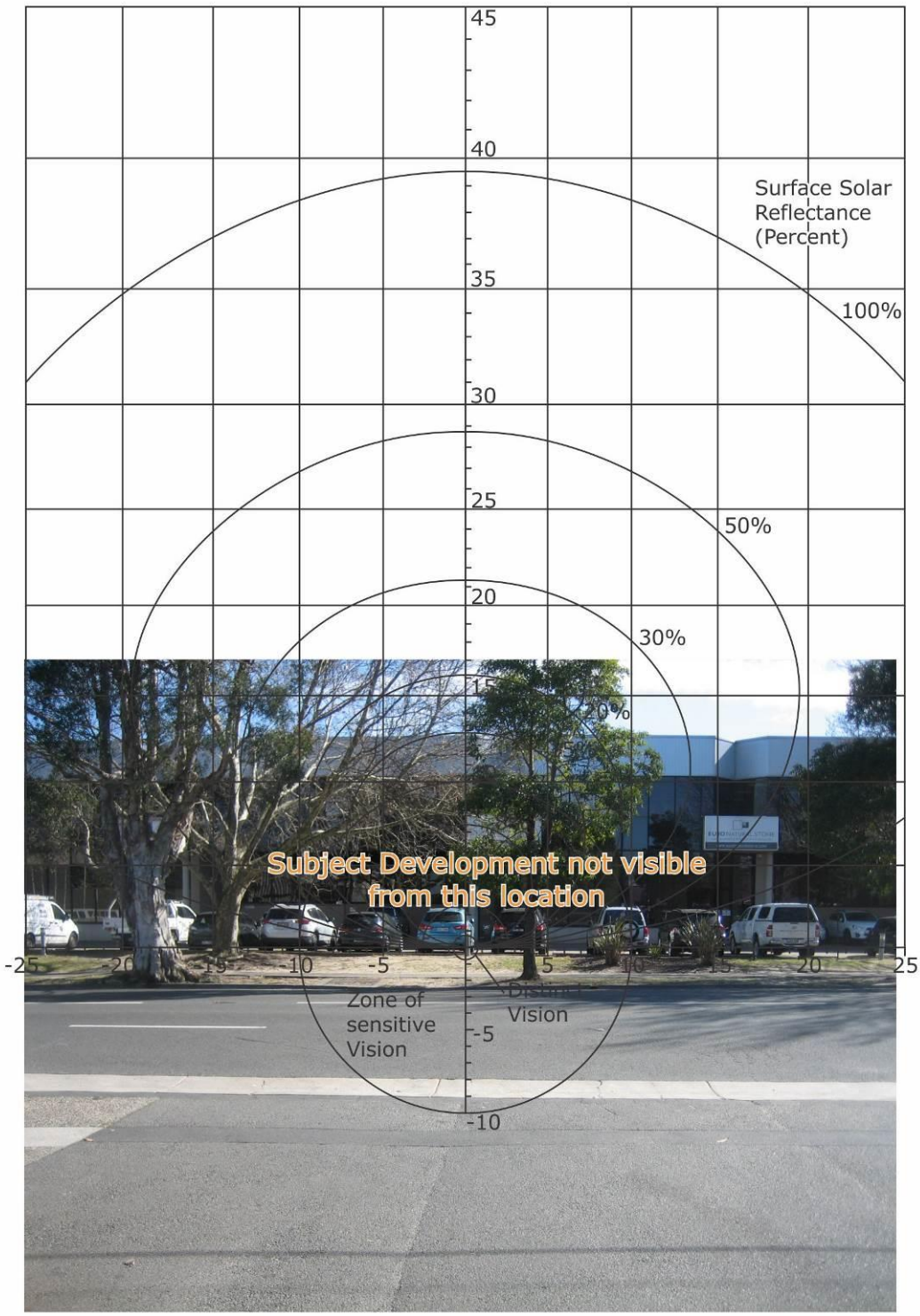


**Figure A7: Glare Overlay for Point 7**

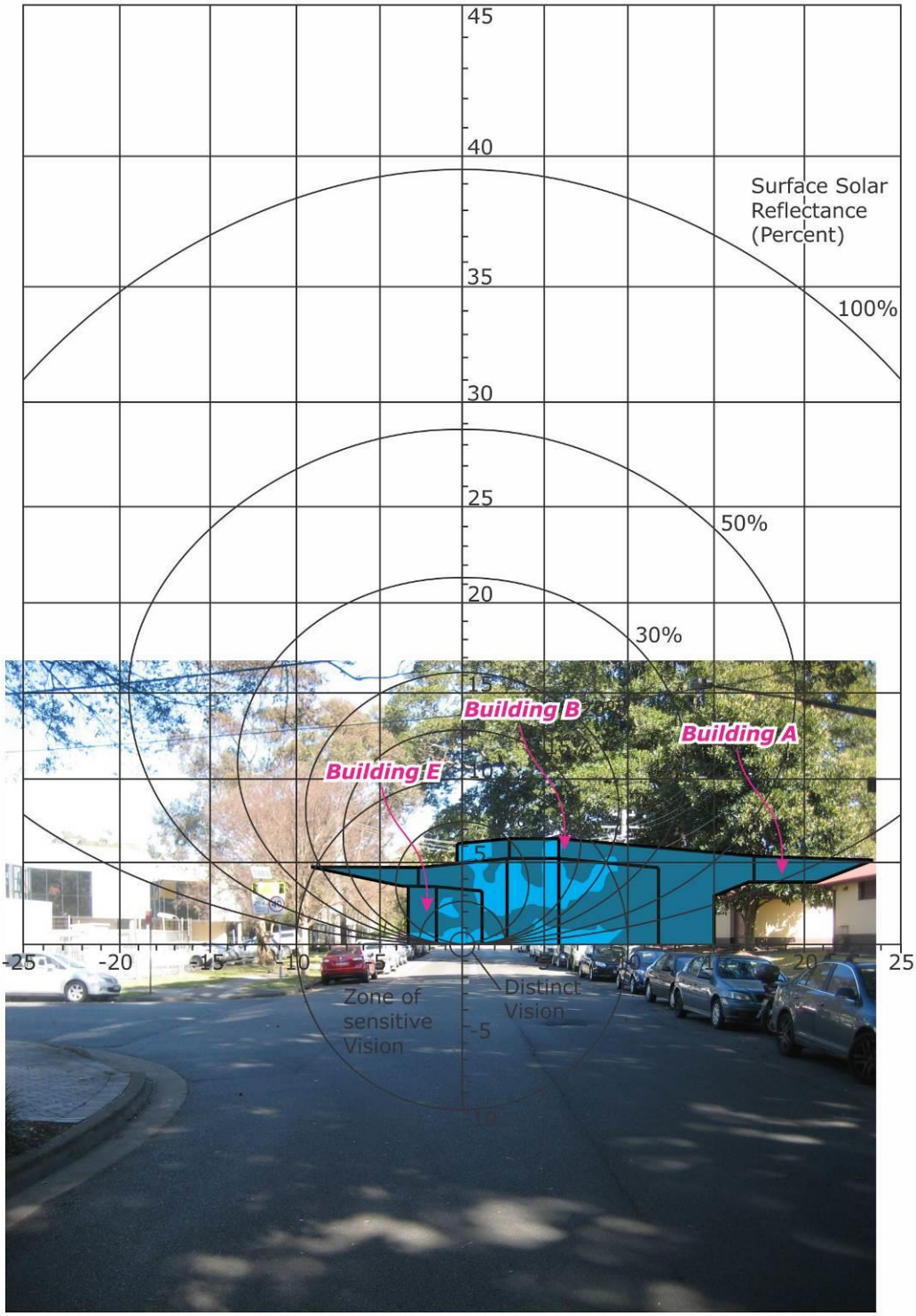


**Figure A8: Glare Overlay for Point 8**

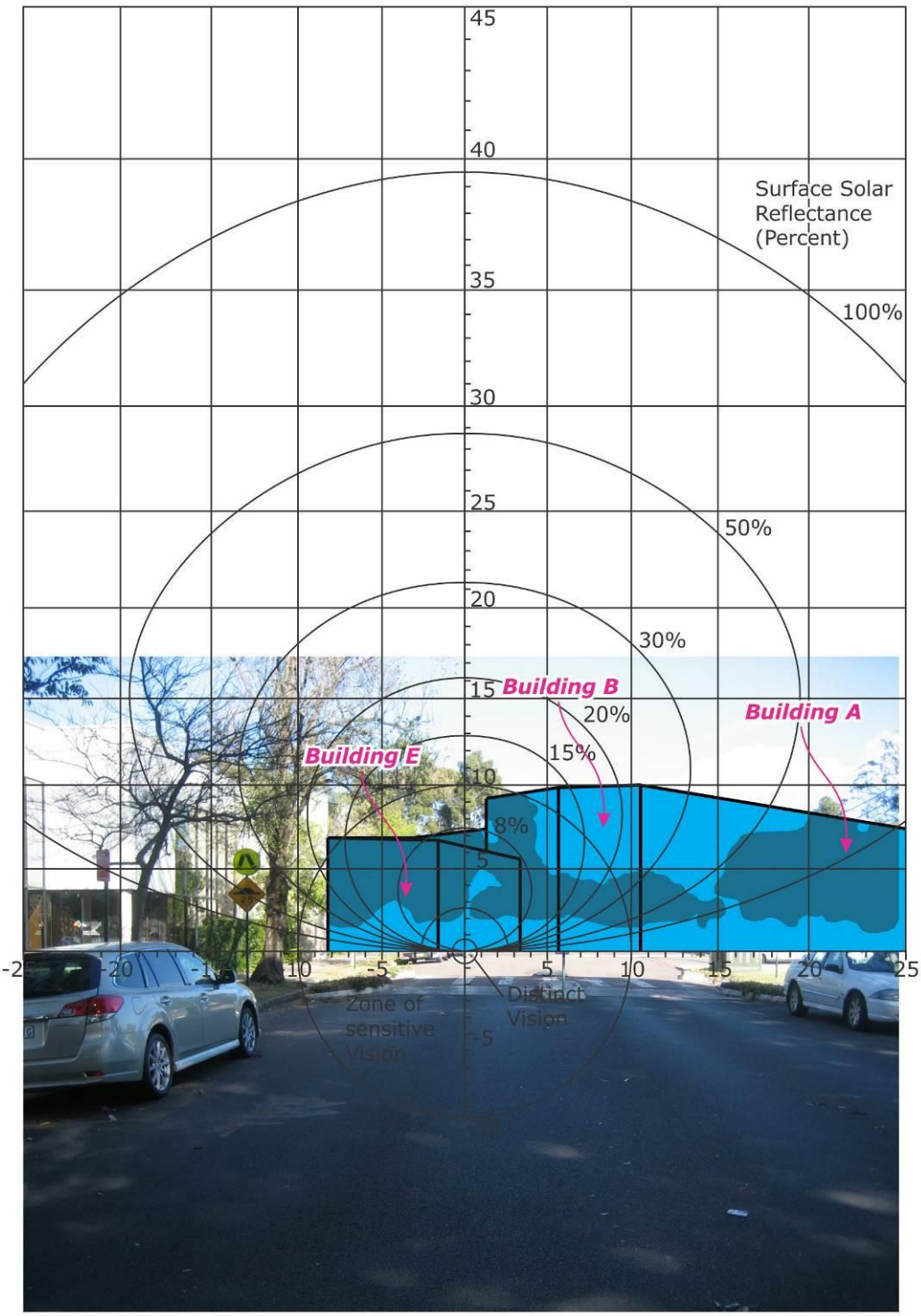


**Figure A9: Glare Overlay for Point 9**

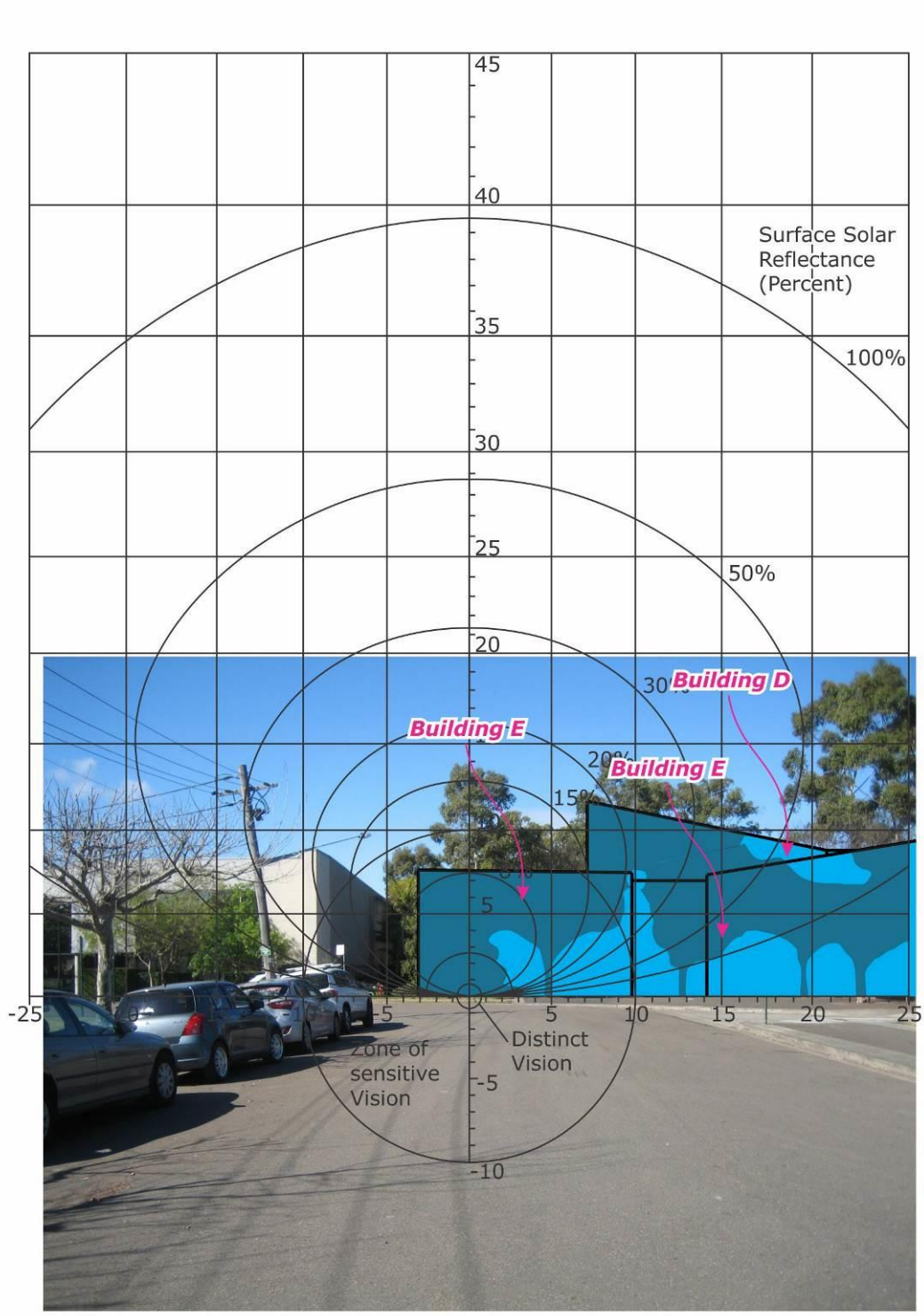


**Figure A10: Glare Overlay for Point 10**

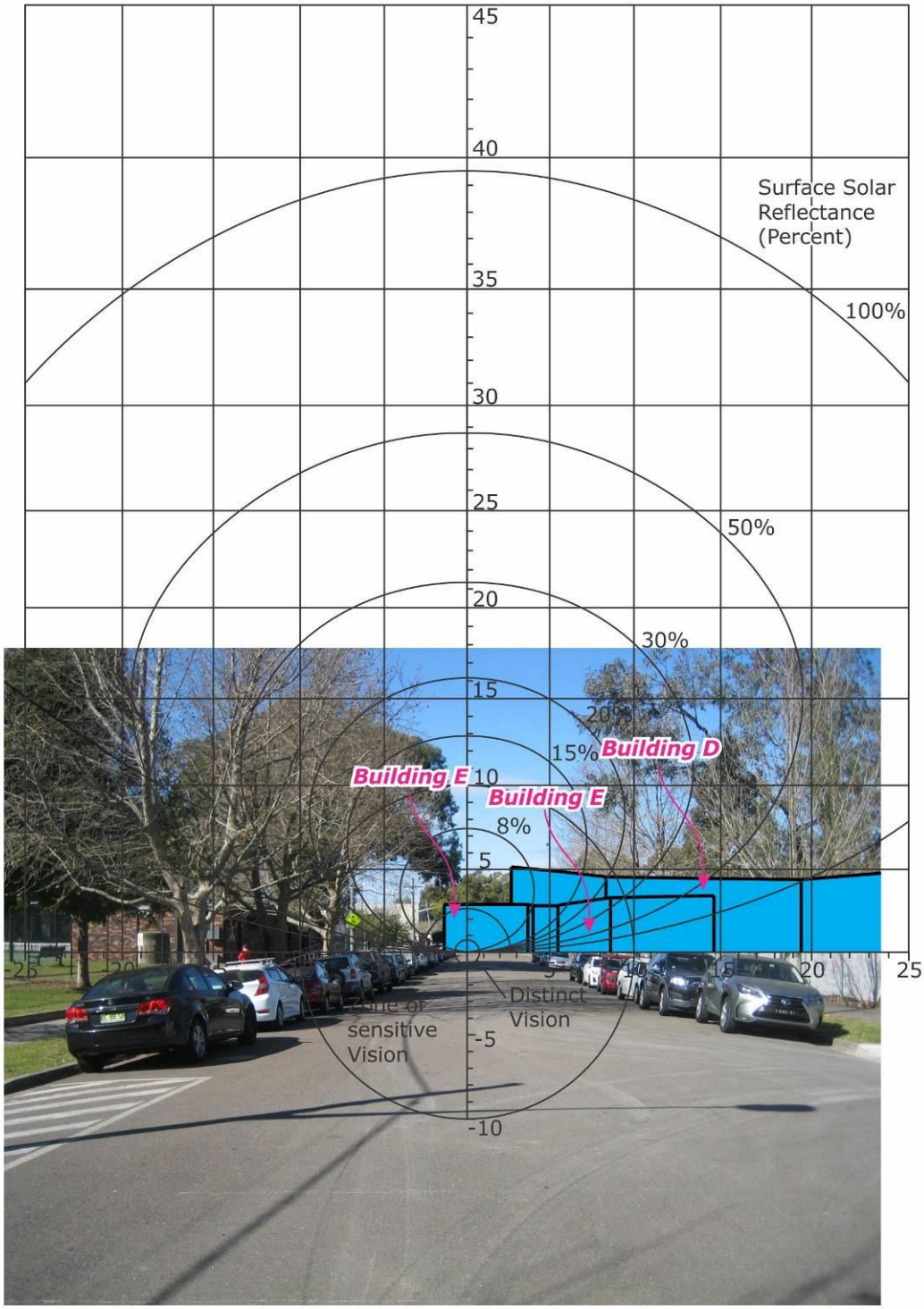


**Figure A11: Glare Overlay for Point 11**

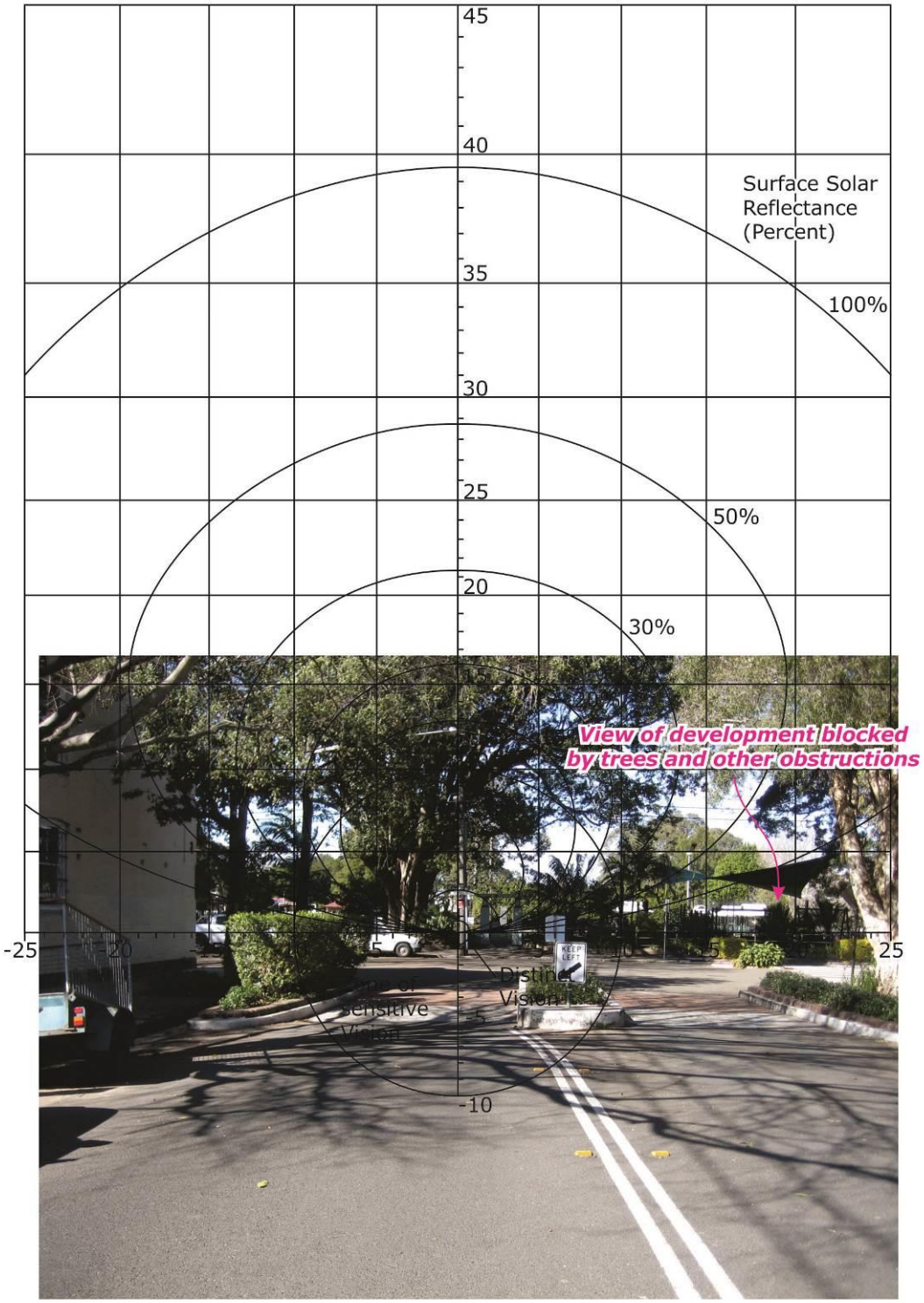


**Figure A12: Glare Overlay for Point 12**

## APPENDIX B - SOLAR CHARTS FOR THE VARIOUS CRITICAL ASPECTS

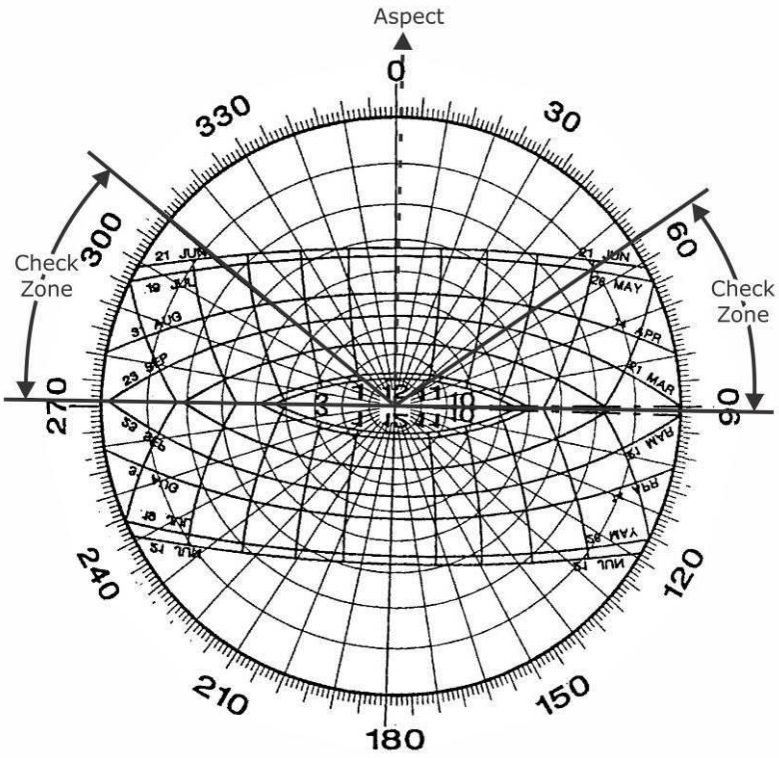


**Figure B1: Sun Chart for Aspect 001$^{o}$**

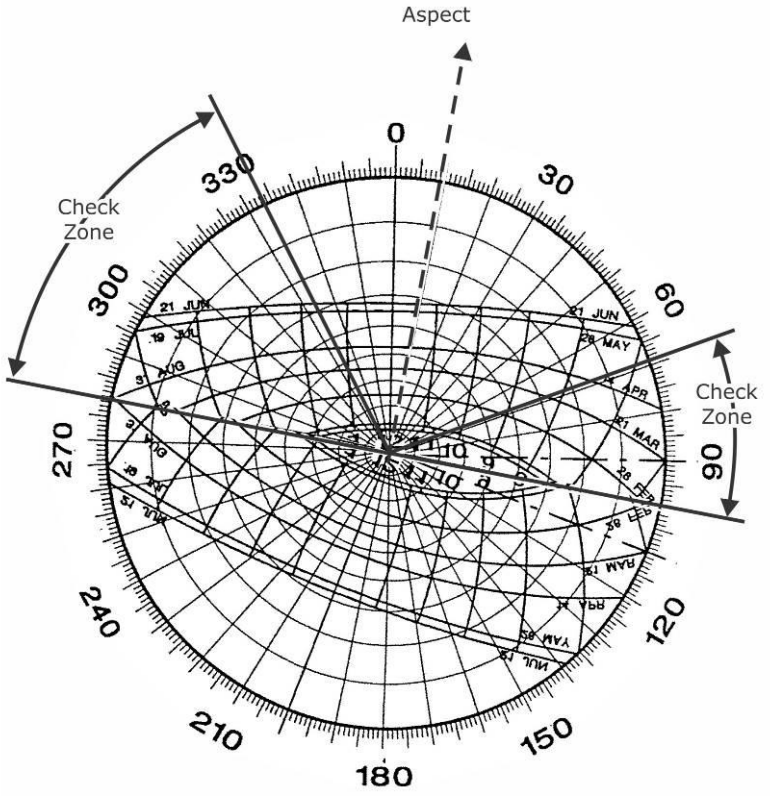


**Figure B2: Sun Chart for Aspect 009$^{o}$**