SOLAR LIGHT REFLECTIVITY ANALYSIS

ARTHUR PHILLIP SCHOOL, PARRAMATTA

WC769-01AF02(REV0)- SR REPORT

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Prepared for:

Grimshaw Architects

Level 3, 24 Hickson Rd
Walsh Bay, NSW 2000

WINDTECH Consultants Pty Ltd ABN 72 050 574 037
Head Office: 607 Forest Road, Bexley, NSW 2207, Australia
P +61 2 9503 0300 **E** reception@windtech.com.au **W** www.windtech.com.au

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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 development located at 102-118 Macquarie Street, Arthur Phillip High School (APHS) and 171-177 Macquarie Street Parramatta Public School (PPS), Parramatta. The analysis has been undertaken based on the architectural drawings prepared by the project architect Grimshaw Architects, received during March 2016.

This study identifies any possible adverse reflected solar glare conditions affecting motorists, pedestrians, train drivers within the local surrounding area, 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 Parramatta City Council Development Control Plan 2011.

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

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

- The maximum normal specular reflectance of visible light for the glazing used on the main building façade of the curved aspect of the all levels of the PPS building should be 16%.
- The maximum normal specular reflectance of visible light for the glazing used on the exterior façade elements on Levels 3 to 5 of the eastern aspect of the APHS building the should be 11%.
- 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 (ie: 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.

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 and motorists in the surrounding area, train drivers, or to occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity for the Parramatta City Council Development Control Plan 2011.

CONTENTS

1 METHODOLOGY

This study assesses compliance with the controls for solar glare from the Parramatta city Council Development Control Plan 2011.

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 onto train drivers and occupants of neighbouring buildings is also discussed in this assessment.

The various critical glazed aspects were determined for the development and are shown in Figure 1. 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 Figures 2 and 3. 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 Figures 2 and 3 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 Figures 2 and 3. 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.

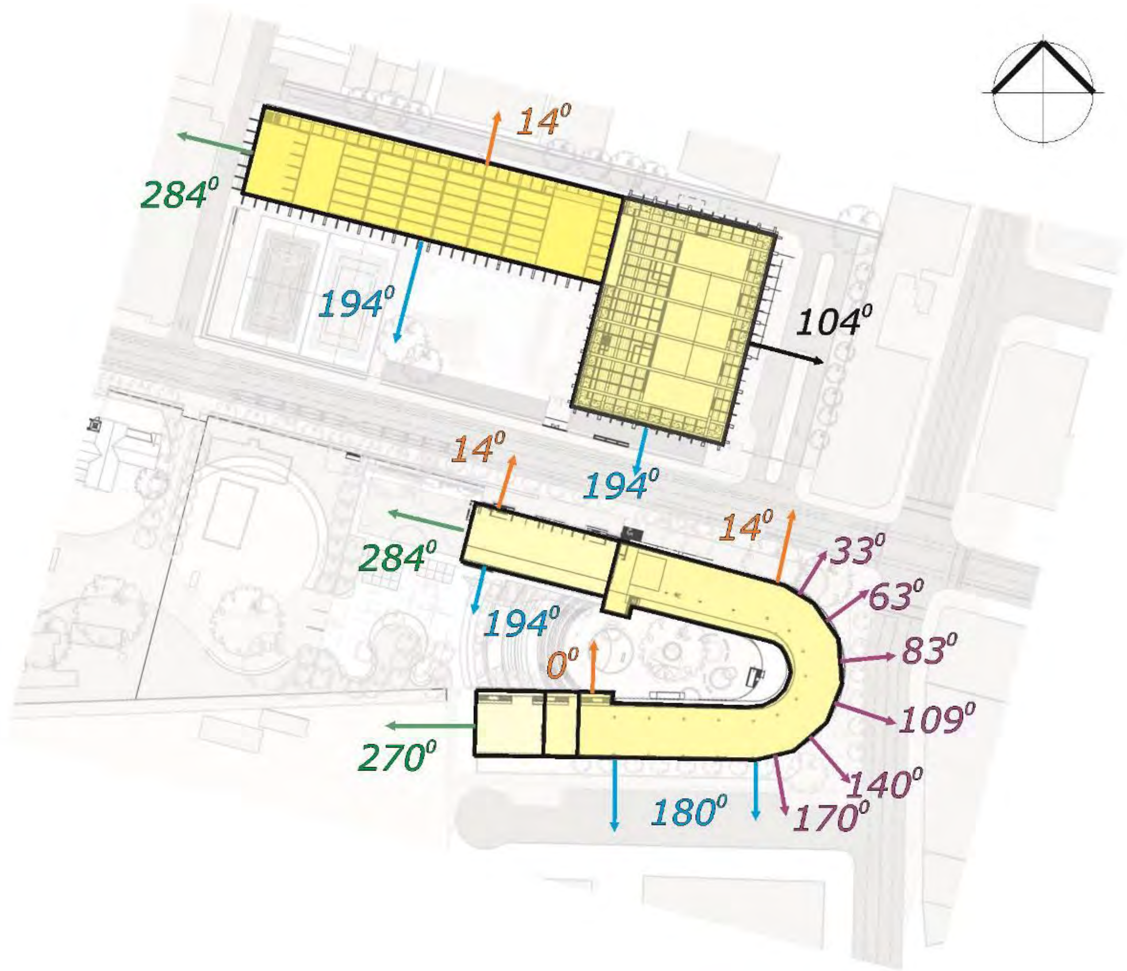

Figure 1: Critical Glazed Aspects of the Development

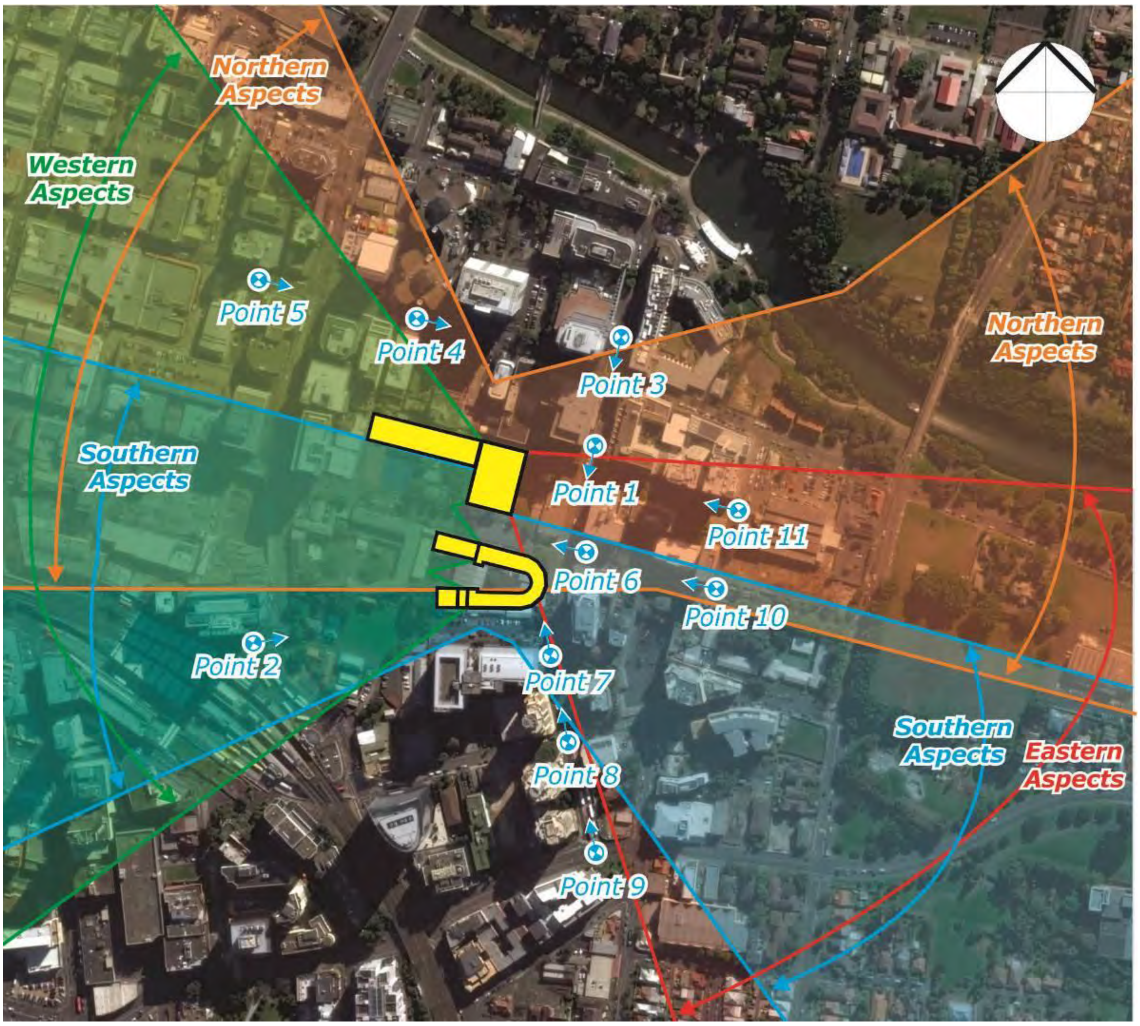

Figure 2: Check Zones and Study Point Locations for Cardinal Aspects
(the check zones are the areas where glare could potentially be observed)

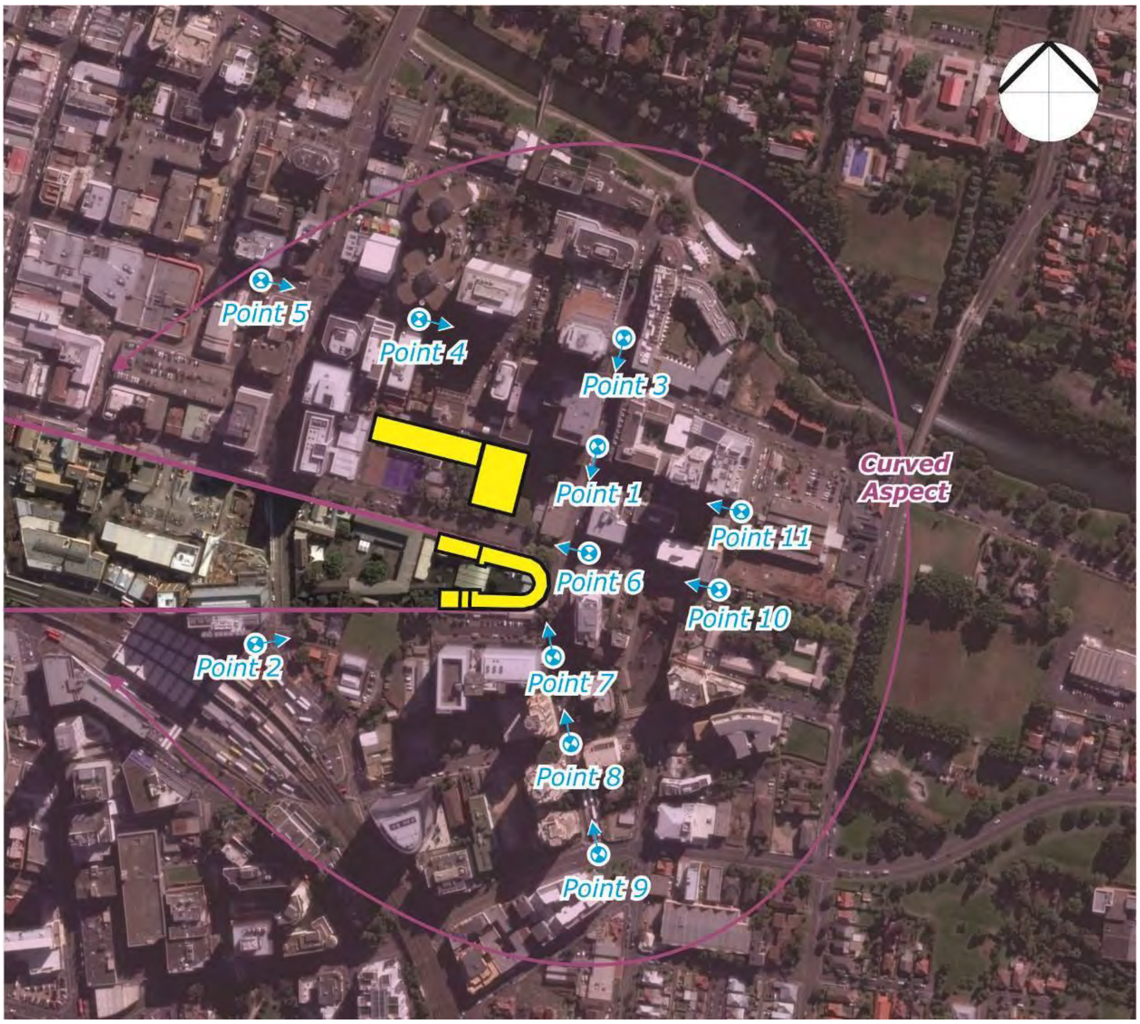

Figure 3: Check Zones and Study Point Locations for Curved Aspects

2 ANALYSIS

2.1 Impact onto Motorists and Pedestrians

From the study of the check zones shown in Figures 2 and 3, a total of 11 street level locations have been identified for detailed analysis. A summary of the location of each study point, and the 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 Figures 2 and 3 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	Charles St, heading south	Northern and Curved Aspects
2	Darcy St, heading east	Southern, Western and Curved Aspects
3	Charles St, heading south	Curved Aspects
4	George St, heading east	Northern Aspects
5	George St, heading east	Western Aspects
6	Macquarie St, heading west	Southern, Eastern and Curved Aspects
7	Charles St, heading north	Southern and Curved Aspects
8	Charles St, heading north	Curved Aspects
9	Charles St, heading north	Curved Aspects
10	Macquarie St, heading west	Eastern, Southern and Curved Aspects
11	Union St, heading west	Northern and Eastern Aspects

2.1.1 Drivers heading south along Charles Street

Points 1 and 3 are located along Charles Street, to the north-east of the development site. These points represent the critical sightlines of drivers heading south along Charles 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. Each photograph has been scaled to enable the glare meter to be overlaid onto these images, as shown in Figure A1 and A3 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 1 and 3 indicates that all levels of the curved aspect of the PPS building of the subject development are visible and is within the zone of sensitive vision of motorists at both points. The analysis indicates that the visible portion of the curved aspect of the development is inside the check zone for Points 1 and 3. However, the proposed vertical fins located around the curved aspect of the PPS building will be effective in mostly blocking solar glare which could have otherwise been observed from Points 1 and 3. The results of this analysis indicate that, to avoid adverse solar glare for motorists or pedestrians heading south along Charles Street, the maximum normal specular reflectance of visible light for the glazing used on the external façade of the curved aspect of all levels of the PPS building should be 16%.

2.1.2 Drivers heading east on Darcy Street

Point 2 is located along Darcy Street, to the south-west of the development site. This point represents the critical sightlines of represents drivers heading east on Darcy Street. A site survey of these points has been undertaken, and a photograph showing the viewpoints of drivers at this location was 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 A2 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 2 indicates that a majority of the APHS building is not visible due to the obstruction of other buildings and trees, and the parts that are visible are not in the zone of sensitive vision of motorists and hence, there will be no adverse solar glare observed by motorists or pedestrians heading east on Darcy Street.

2.1.3 Drivers heading east on George Street

Points 4 and 5 are located along George Street, to the north-west of the development site. These points represent the critical sightlines of drivers heading east along George 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. Each photograph has been scaled to enable the glare meter to be overlaid onto these images, as shown in Figure A4 and A5 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 4 and 5 indicates that the APHS and PPS development is not visible and is not within the zone of sensitive vision of motorists. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading south on George Street.

2.1.4 Drivers heading west along Macquarie Street

Points 6 and 10 are located along Macquarie Street, to the east of the development site. These points represent the critical sightlines of drivers heading west along Macquarie 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. Each photograph has been scaled to enable the glare meter to be overlaid onto these images, as shown in Figure A6 and A10 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 6 and 10 indicates that the northern aspect of the PPS development is visible and within the zone of sensitive vision for Point 10 only. Further investigation indicates that no adverse glare will be observed from the visible portion of the northern aspect of the PPS building at Point 10 due to the effective use of the vertical fins on the northern aspect of the building, and the fact that the western portion of that building is shorter and features a stepped façade.

2.1.5 Drivers heading north on Charles Street

Points 7, 8 and 9 are located along Charles Street, to the south of the development site. These points represent the critical sightlines of drivers heading north along Charles 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. Each photograph has been scaled to enable the glare meter to be overlaid onto these images, as shown in Figure A7, A8 and A9 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 7, 8 and 9 indicates that portions of the southern, eastern and curved aspects of both the PPS and APHS developments are visible and are within the zone of sensitive vision of motorists. However, further analysis indicates that these locations are only within the checkzone for the curved aspect of the PPS building. When viewed from these locations, the curved aspect of the PPS building benefits from the effective use of the vertical fins on the façade, which will block solar glare which would have otherwise been observed. Hence, there will be no adverse solar glare observed by motorists or pedestrians heading north on Charles Street.

2.1.6 Drivers heading west on Union Street

Point 11 is located along Union Street, to the east of the development site. This point represents the critical sightlines of represents drivers heading west on Union Street. A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers at this location was 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 A11 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 11 indicates that a portion of the eastern aspect of the APHS building visible and within the zone of sensitive vision. The visible portion is the exterior façade at the northern end of the eastern aspect of Floors 3 to 5. Hence, to avoid adverse solar glare for motorists or pedestrians heading west along Union Street, it is recommended that the maximum normal specular reflectance of visible light for the glazing used on the exterior façade elements on Levels 3 to 5 of the eastern aspect of the APHS building the should be 11%.

2.2 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.

2.3 Train Drivers at Parramatta Station

Trains coming into Parramatta Station from the west fall into the southern, western and curved aspects. However, the view of the subject development will be outside the zone of sensitive vision for train drivers and hence no adverse solar glare is expected to be observed from the development by train drivers.

2.4 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.

2.4.1 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%

2.4.2 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 development located at 102-118 Macquarie Street, Arthur Phillip High School (APHS) and 171-177 Macquarie Street, Parramatta Public School (PPS), Parramatta. The analysis has been undertaken based on the architectural drawings prepared by the project architect Grimshaw Architects, received during March 2016.

This study identifies any possible adverse reflected solar glare conditions affecting motorists, pedestrians, train drivers within the local surrounding area, 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 Parramatta City Council Development Control Plan 2011.

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

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

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- The maximum normal specular reflectance of visible light for the glazing used on the exterior façade elements on Levels 3 to 5 of the eastern aspect of the APHS building the should be 11%.
- 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 (ie: 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.

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 and motorists in the surrounding area, train drivers, or to occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity for the Parramatta City Council Development Control Plan 2011.

REFERENCES

Parramatta City Council, 2011, "Parramatta Development Control Plan 2011".

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

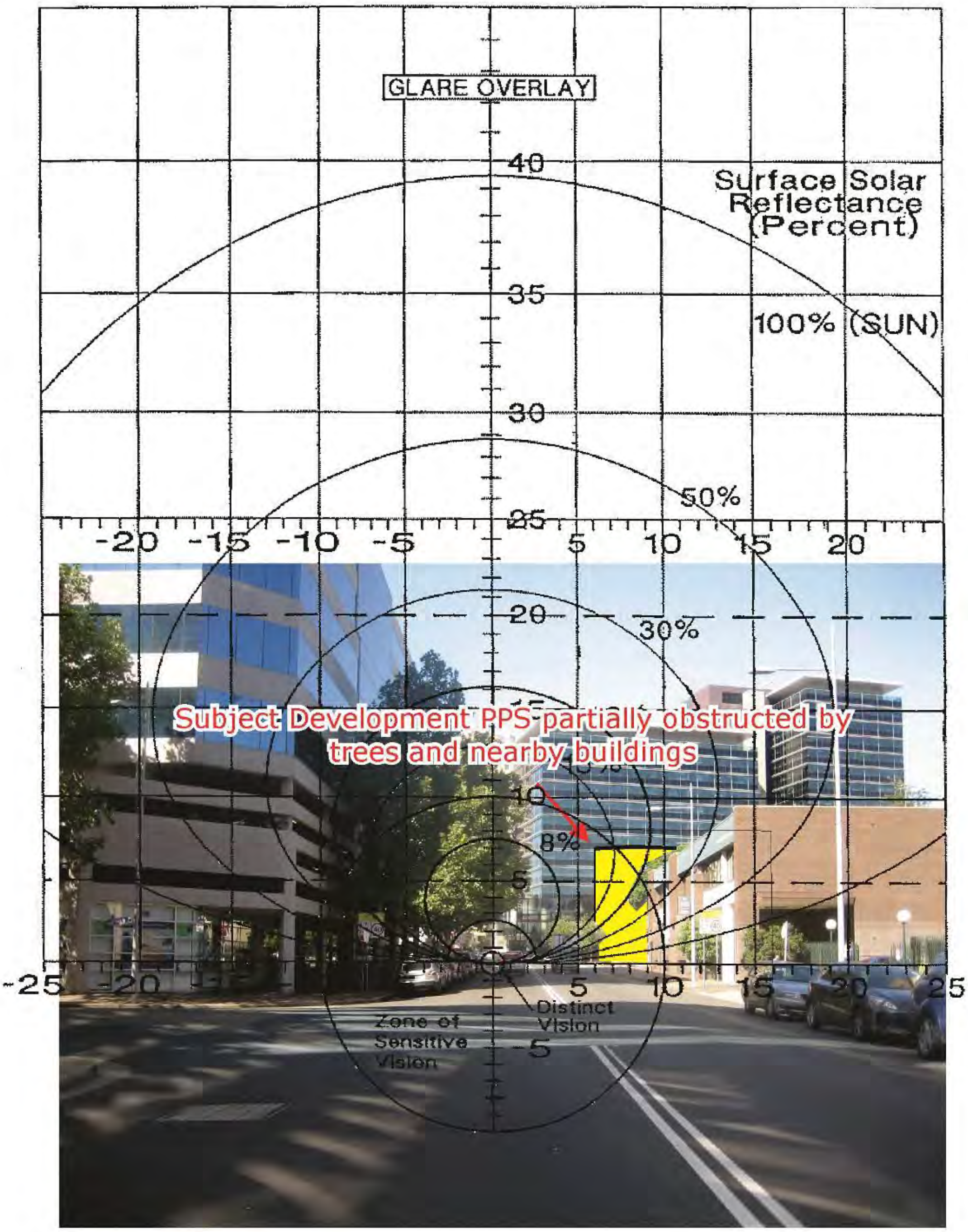


Figure A1: Glare Overlay for Point 1

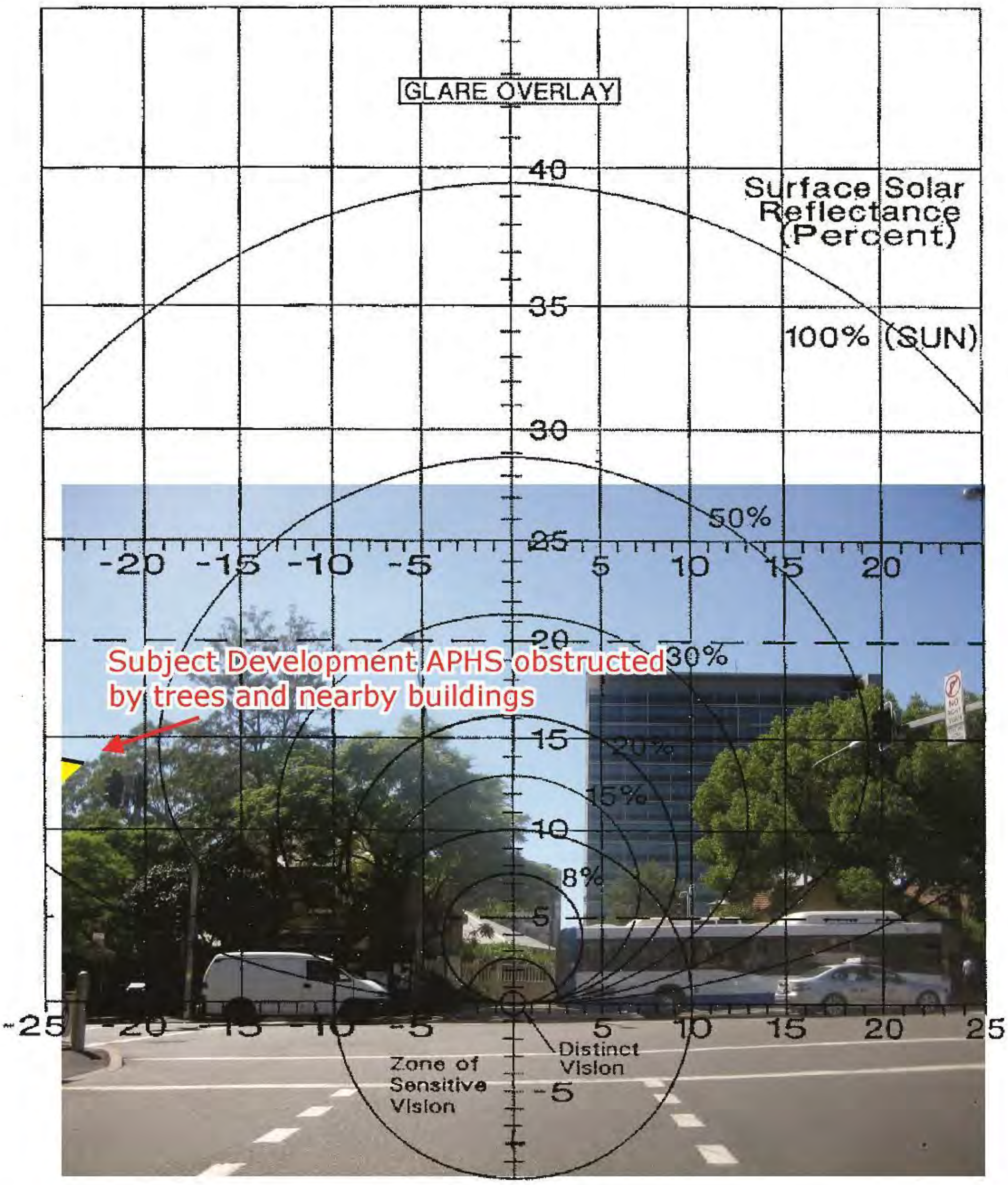


Figure A2: Glare Overlay for Point 2

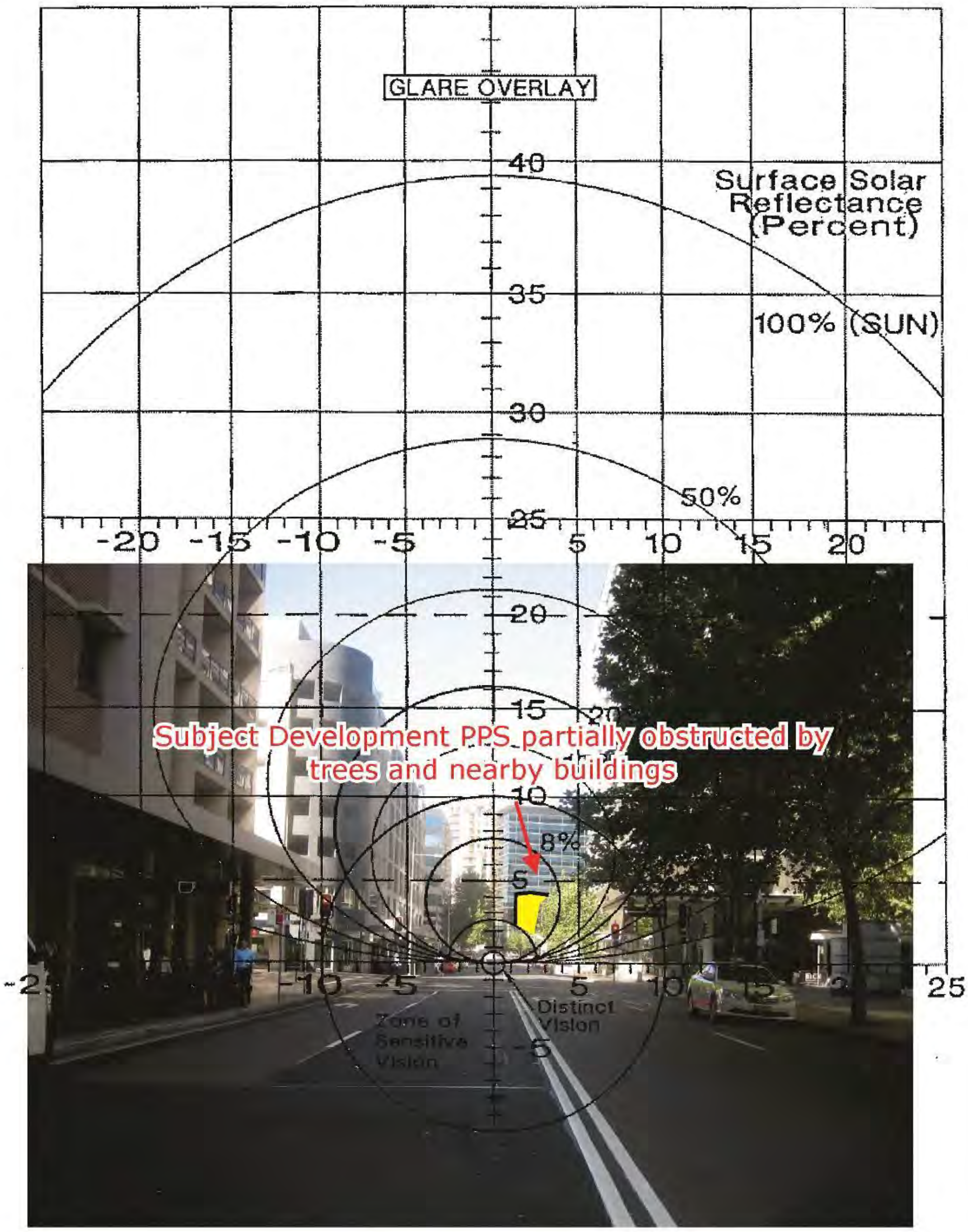
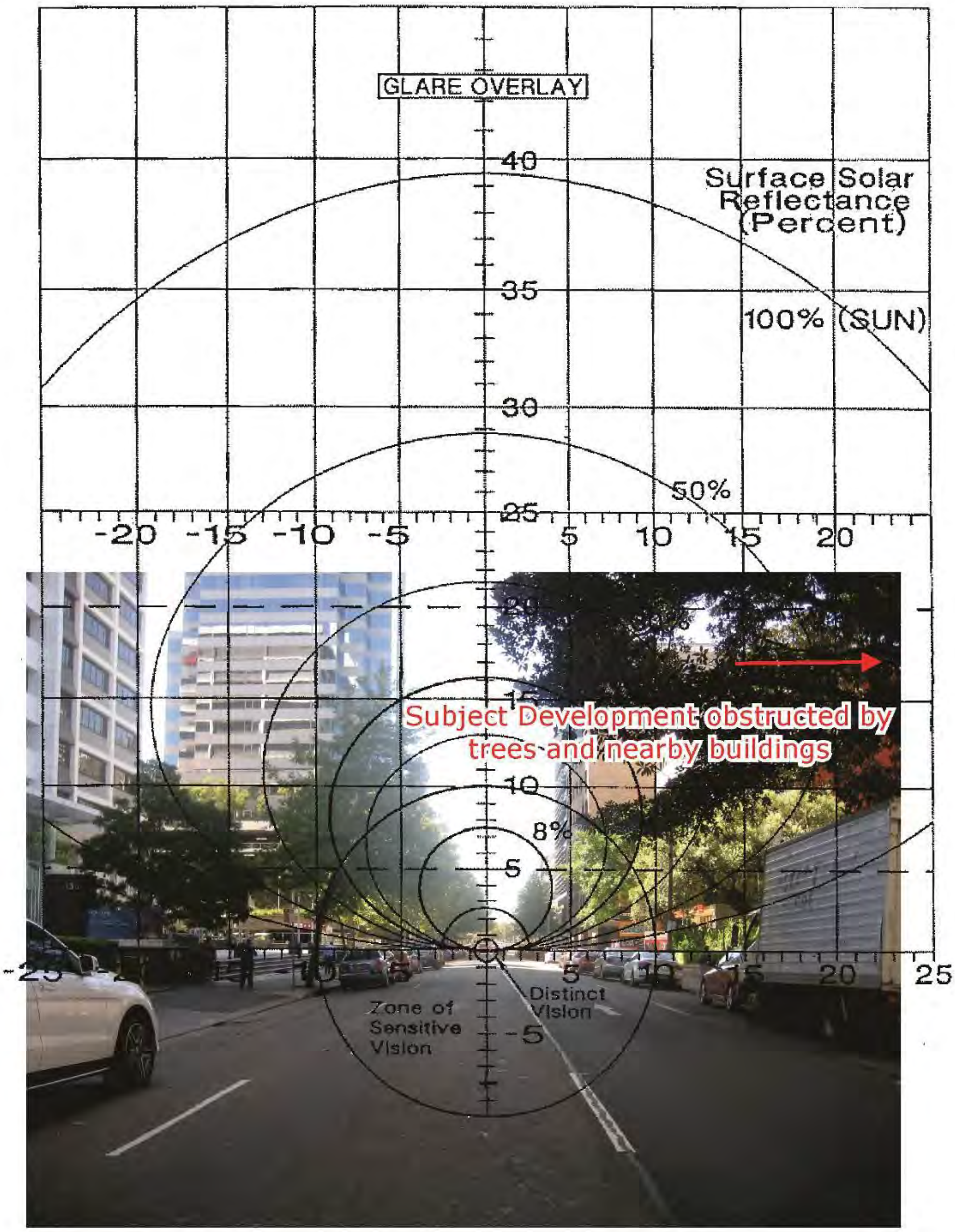


Figure A3: Glare Overlay for Point 3



Fi

gure A4: Glare Overlay for Point 4

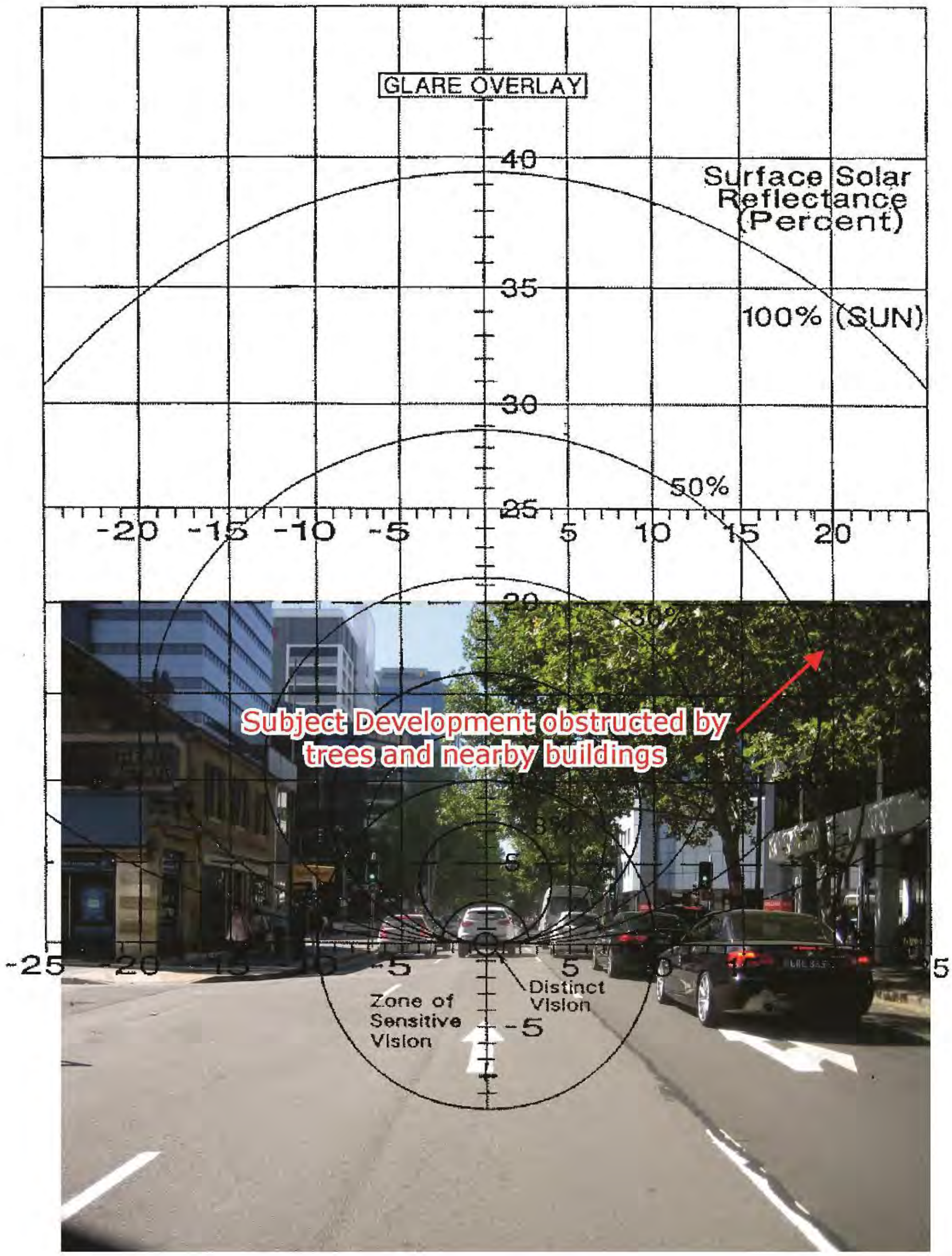


Figure A5: Glare Overlay for Point 5

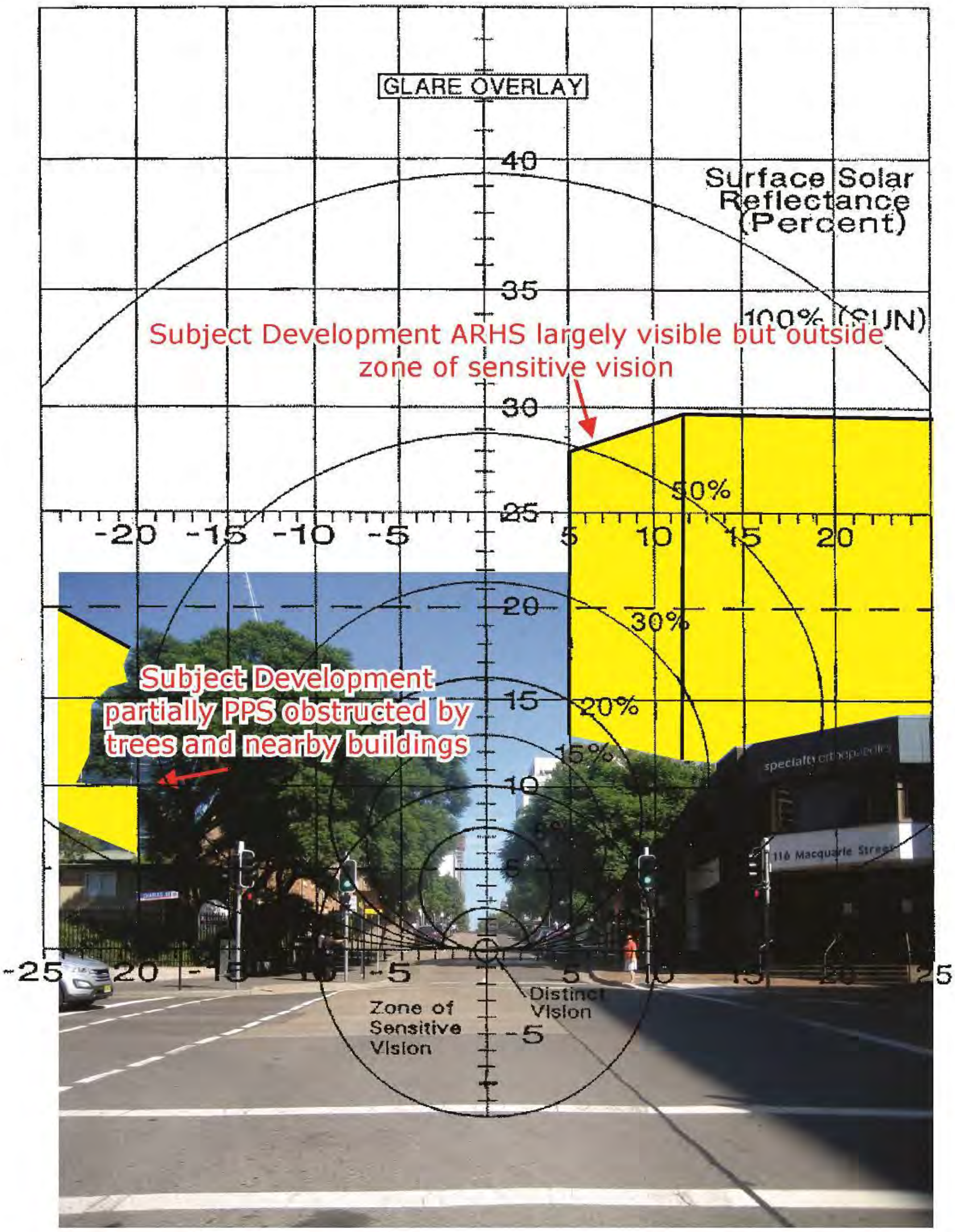


Figure A6: Glare Overlay for Point 6

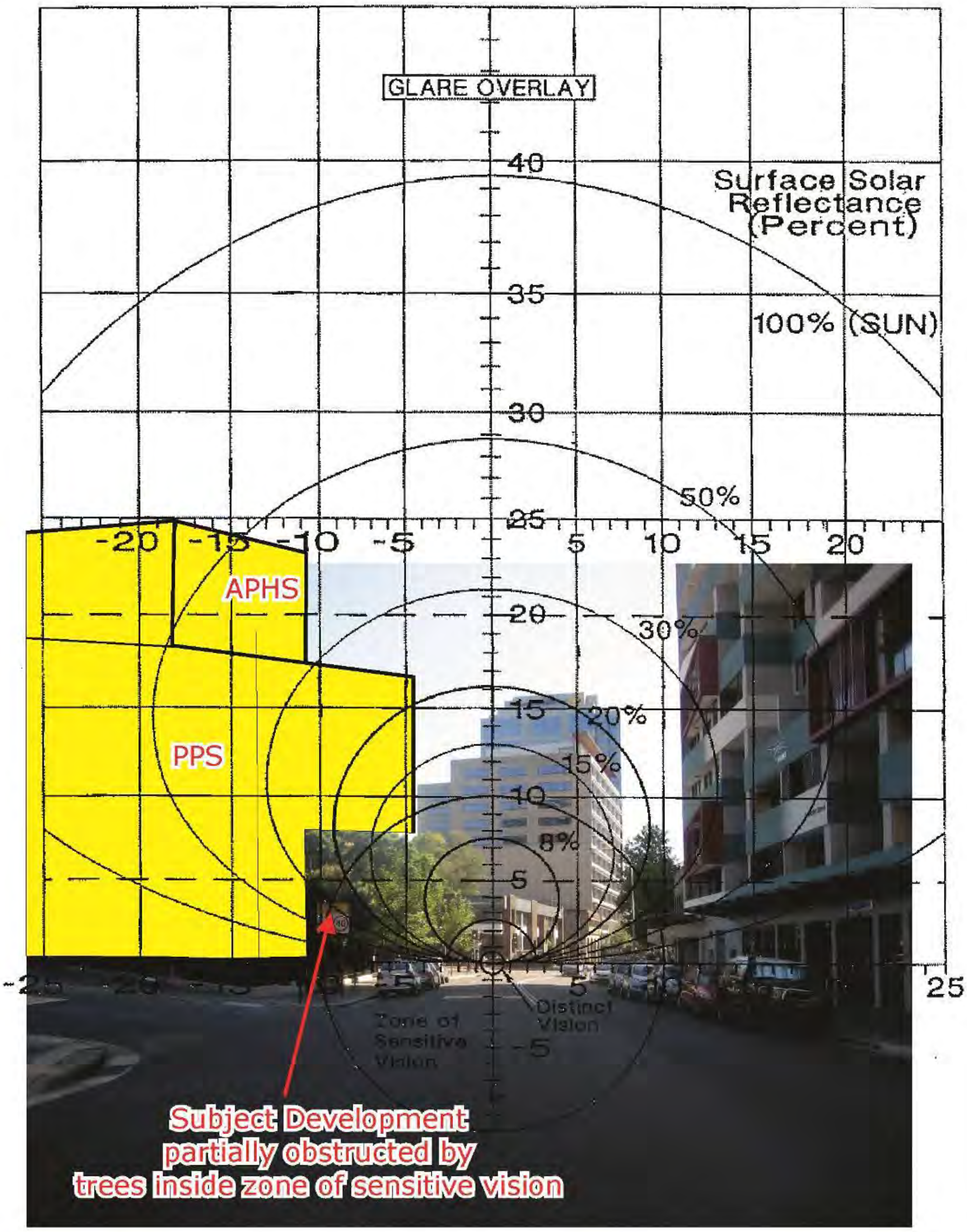


Figure A7: Glare Overlay for Point 7

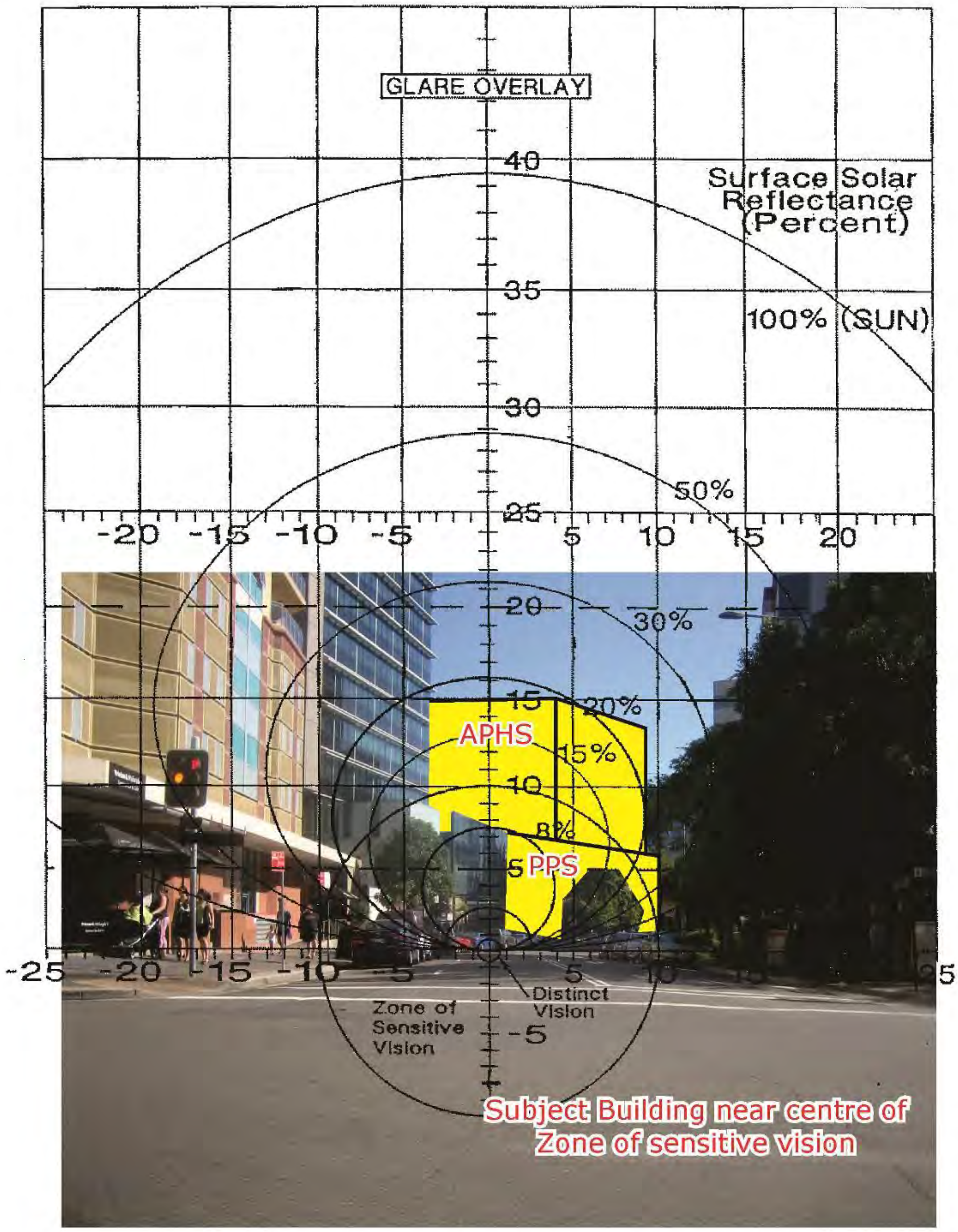


Figure A8: Glare Overlay for Point 8

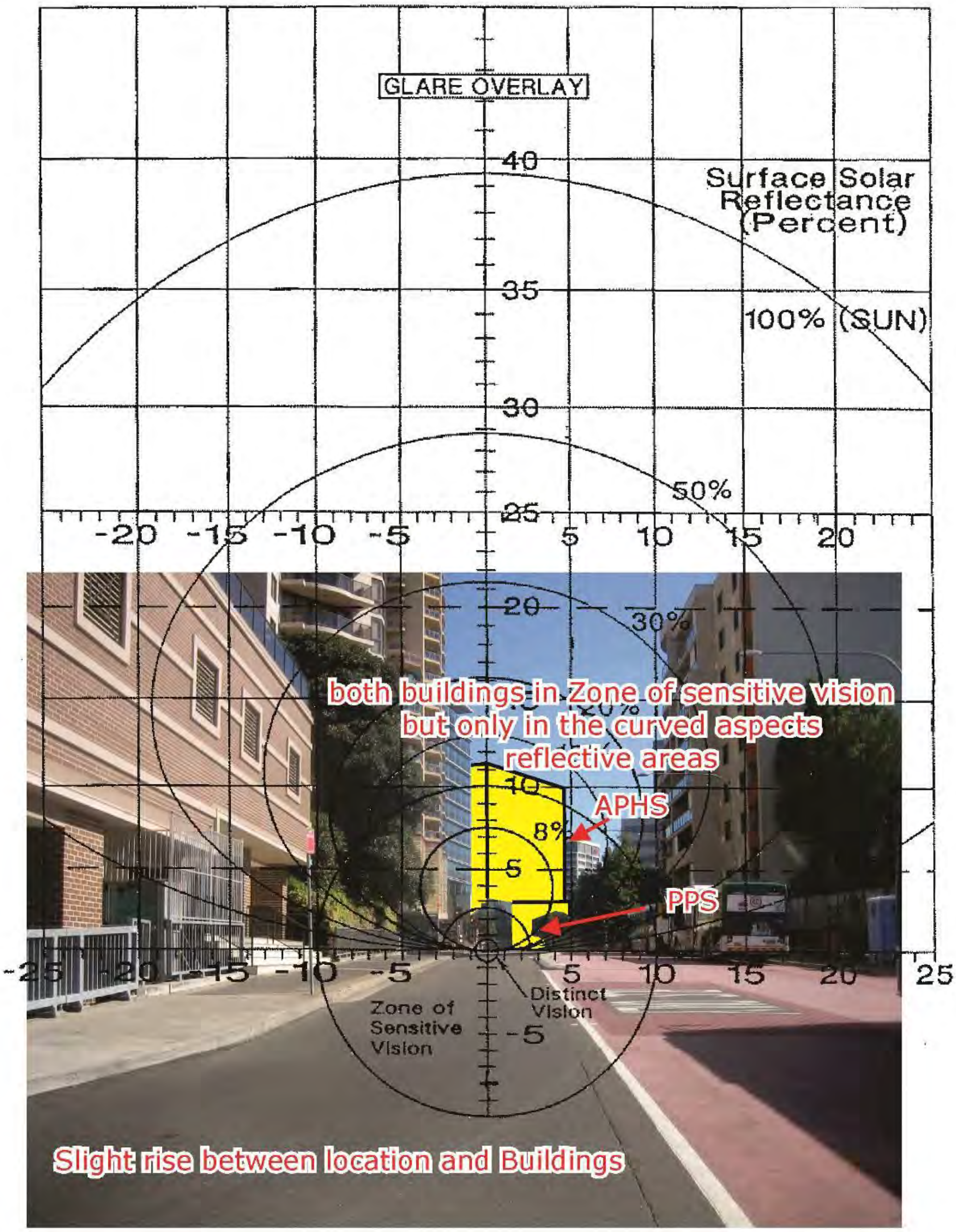


Figure A9: Glare Overlay for Point 9

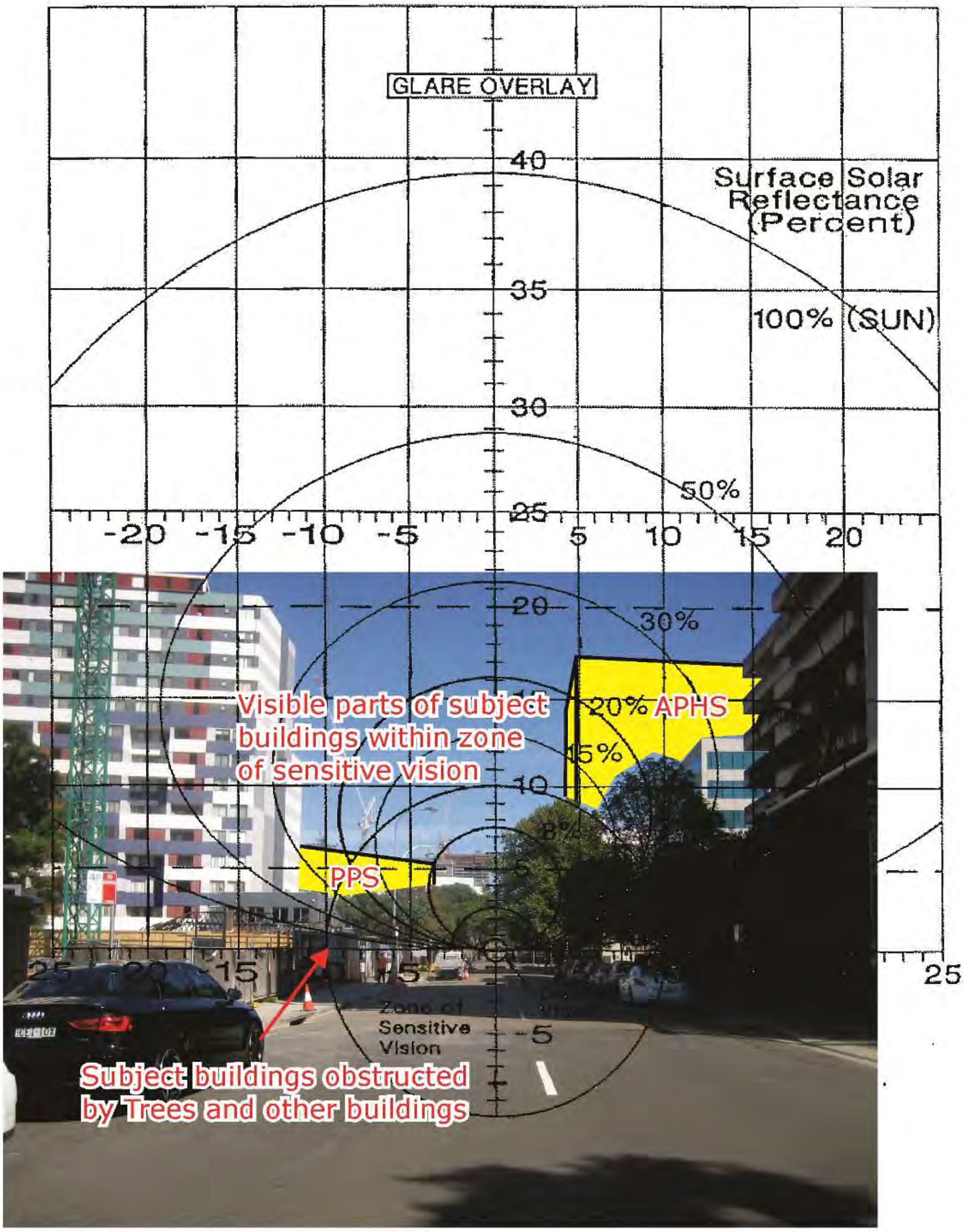


Figure A10: Glare Overlay for Point 10

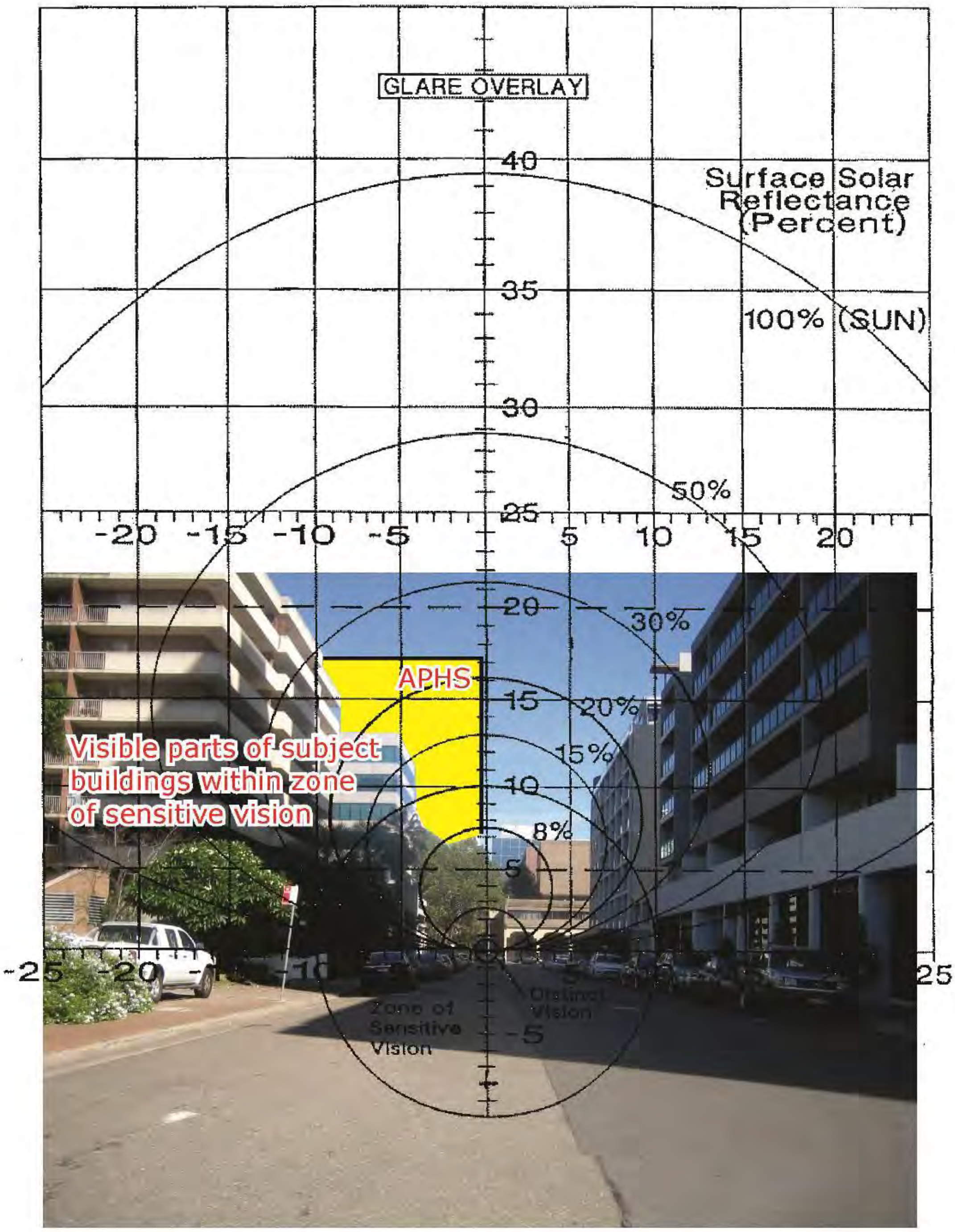


Figure A11: Glare Overlay for Point 11

APPENDIX B - SOLAR CHARTS FOR THE VARIOUS CRITICAL ASPECTS

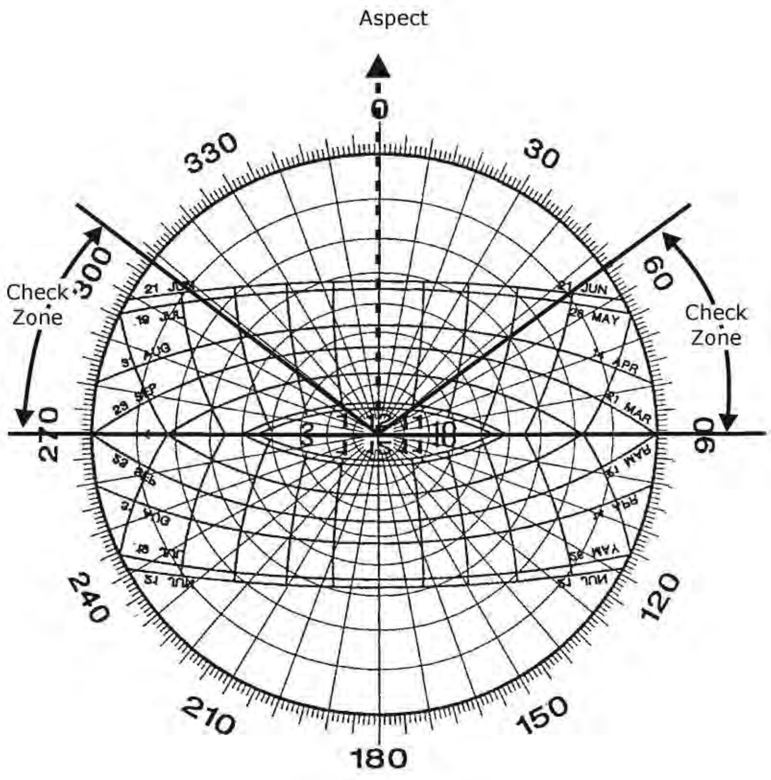


Figure B1: Sun Chart for Aspect 000°

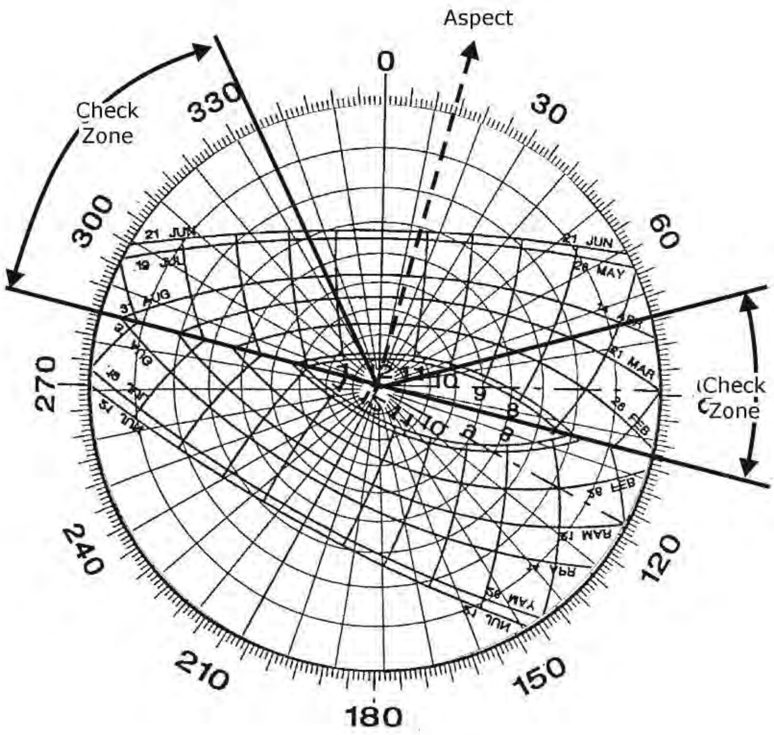


Figure B2: Sun Chart for Aspect 014°

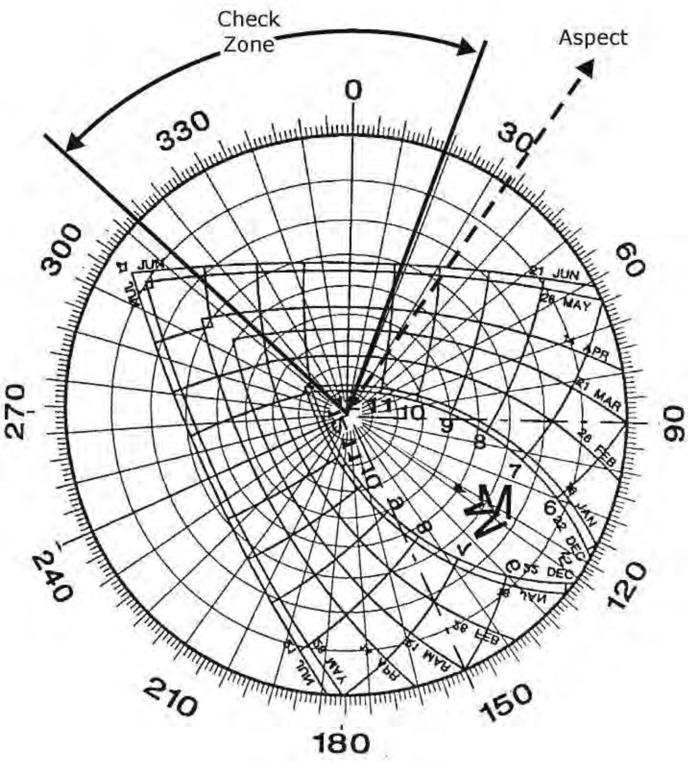


Figure B3: Sun Chart for Aspect 033º

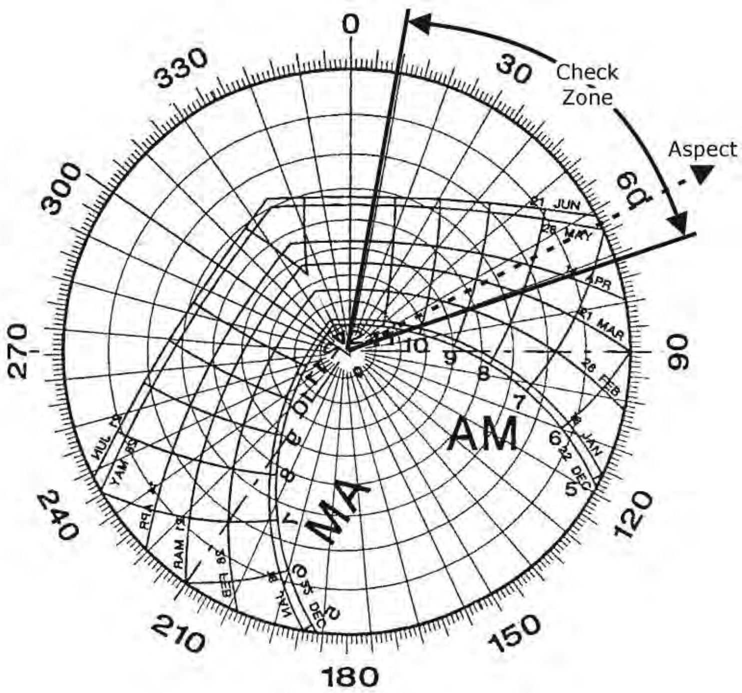


Figure B4: Sun Chart for Aspect 063º

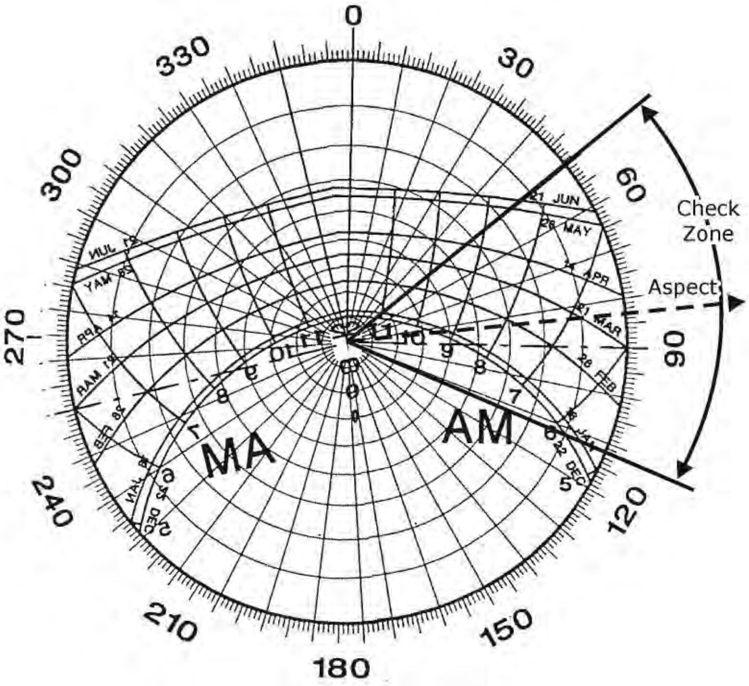


Figure B5: Sun Chart for Aspect 083º

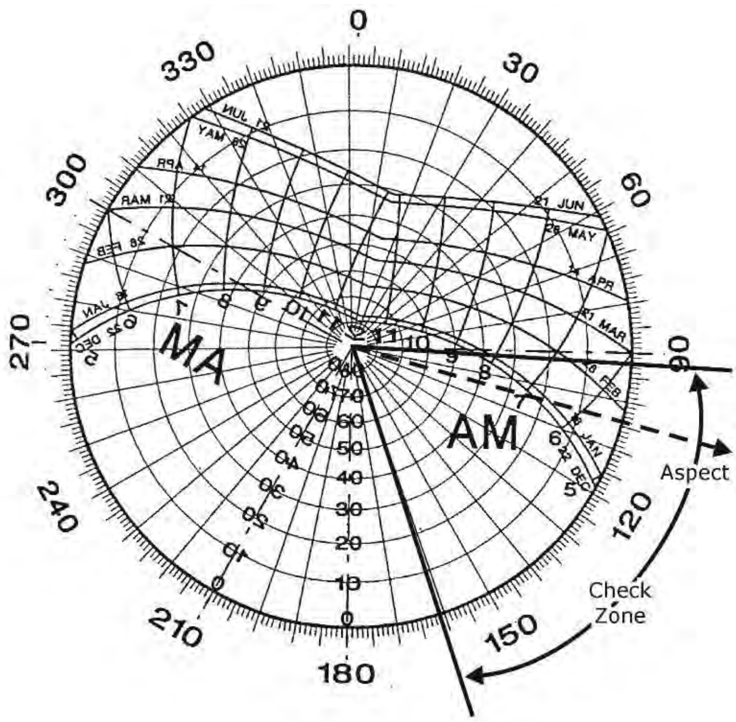


Figure B6: Sun Chart for Aspect 104º

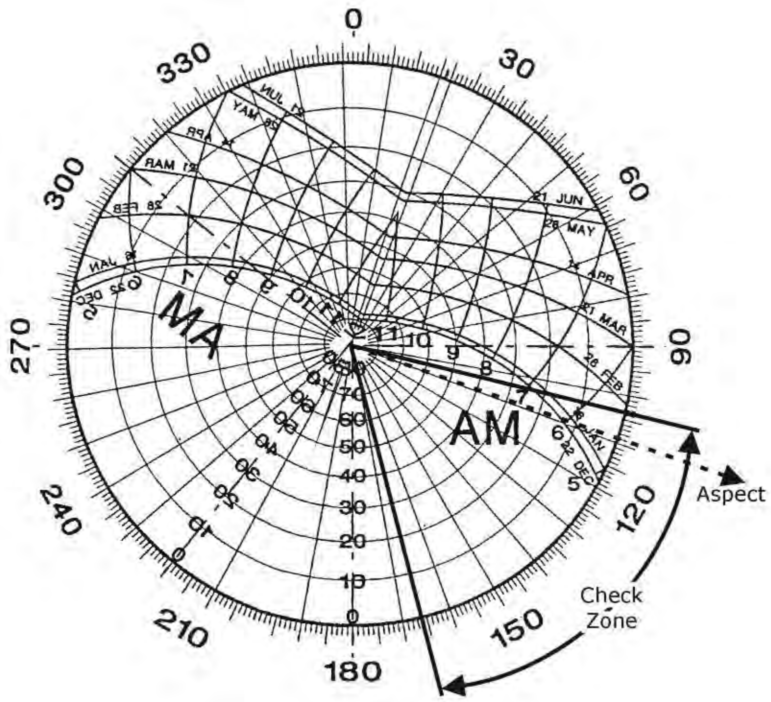


Figure B7: Sun Chart for Aspect 109°

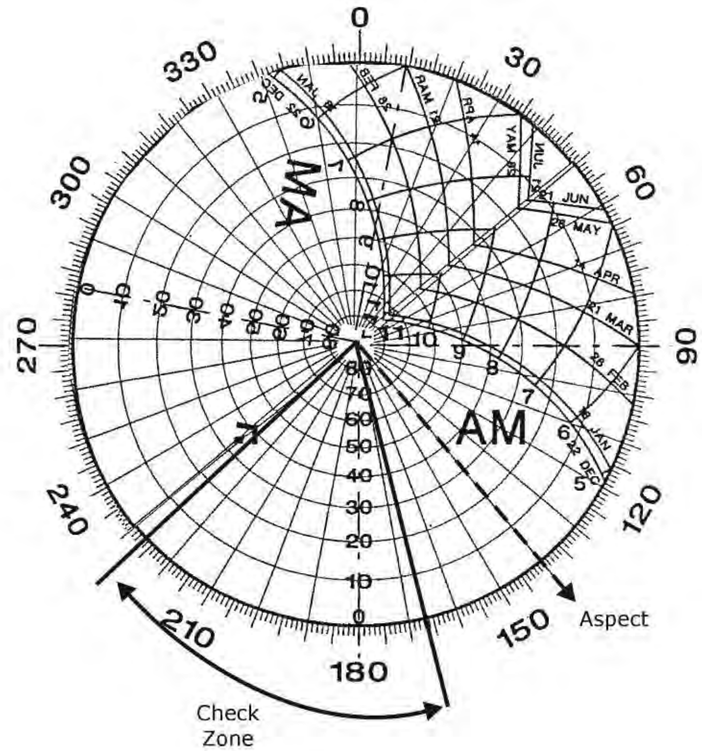


Figure B8: Sun Chart for Aspect 140°

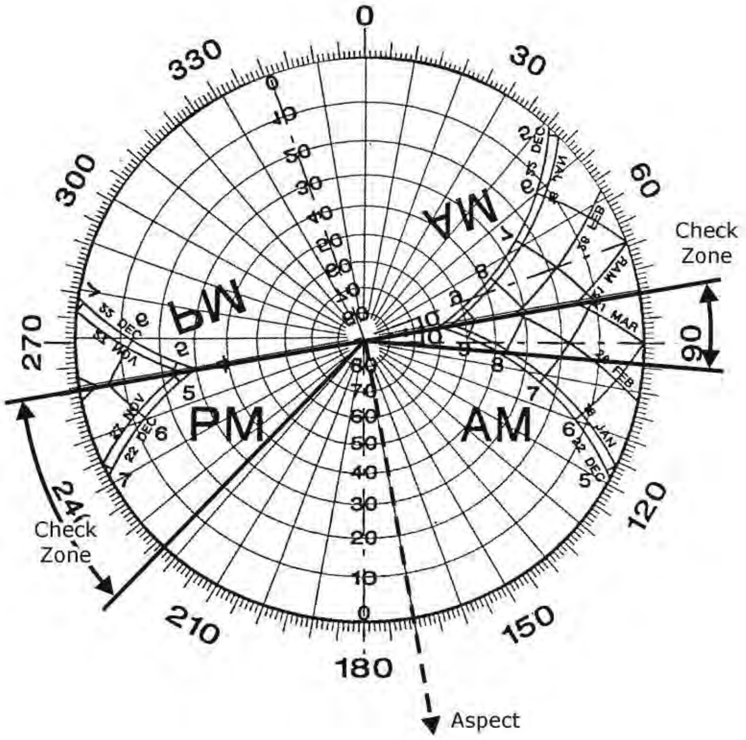


Figure B9: Sun Chart for Aspect 170°

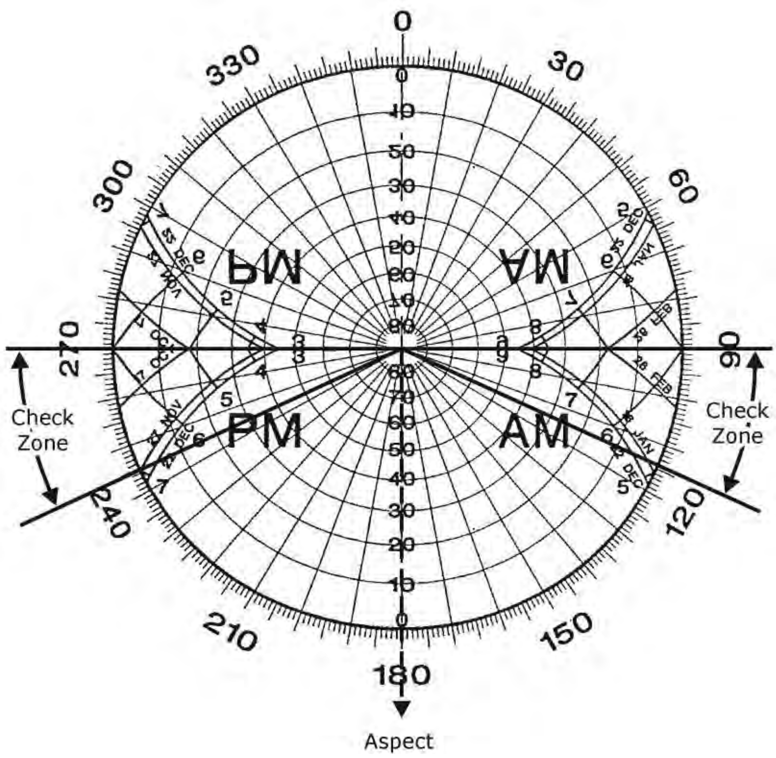


Figure B10: Sun Chart for Aspect 180°

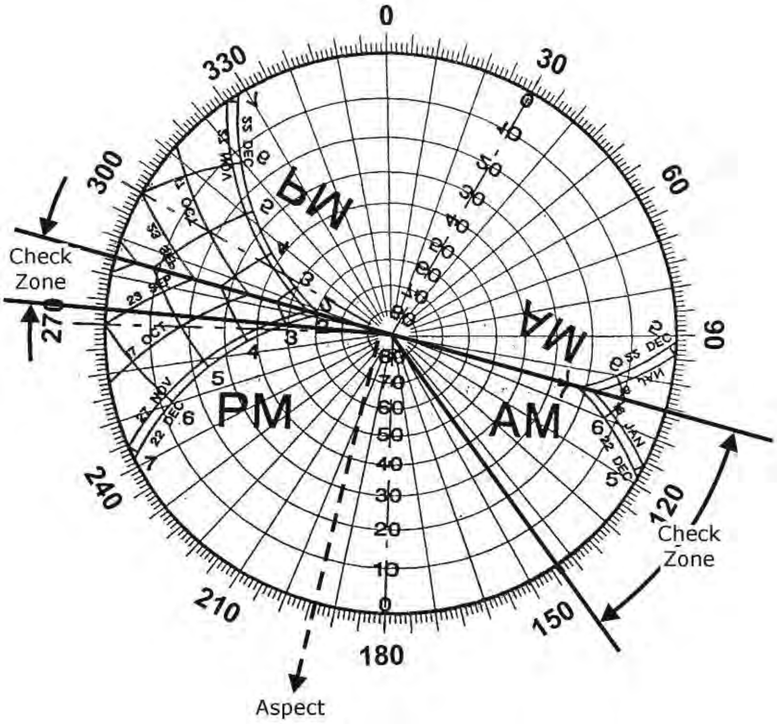


Figure B11: Sun Chart for Aspect 194°

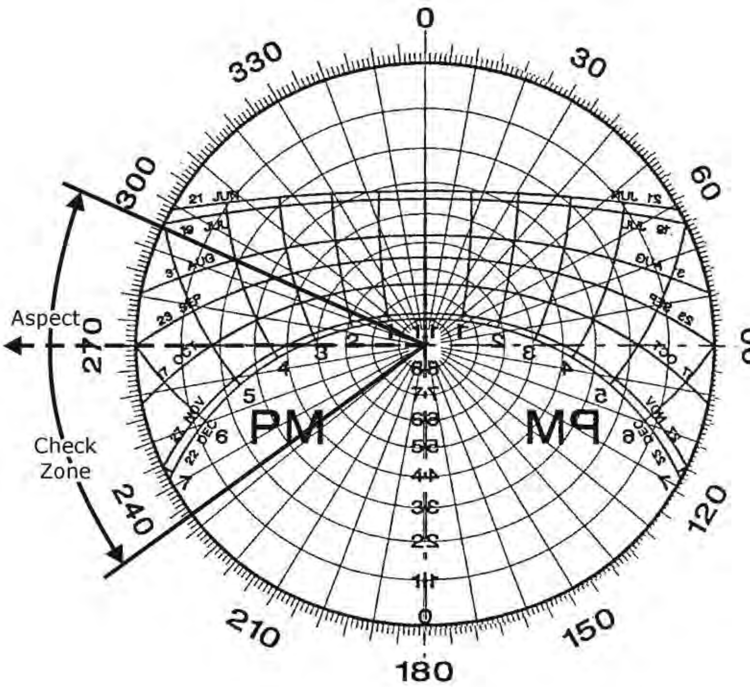


Figure B12: Sun Chart for Aspect 270°

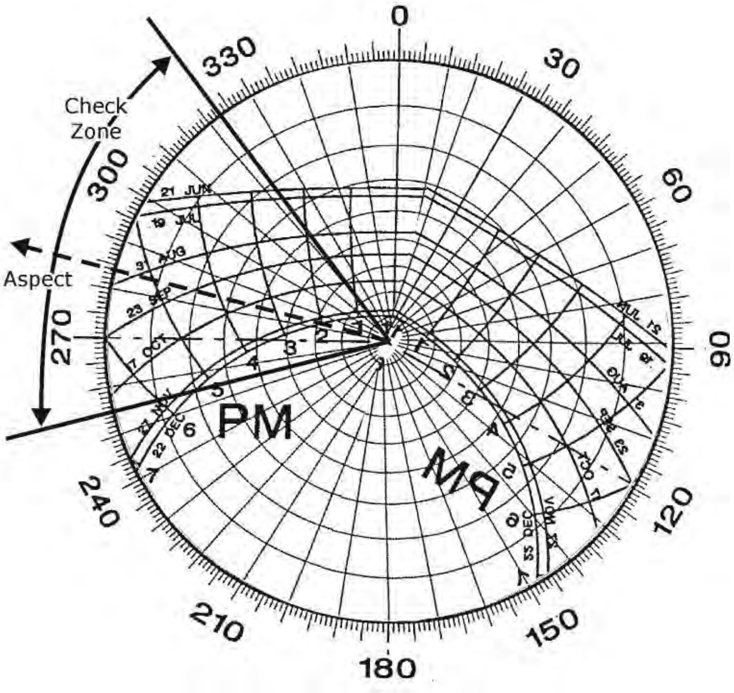


Figure B13: Sun Chart for Aspect 284°

APPENDIX C - STANDARD SUN CHART FOR THE SYDNEY REGION

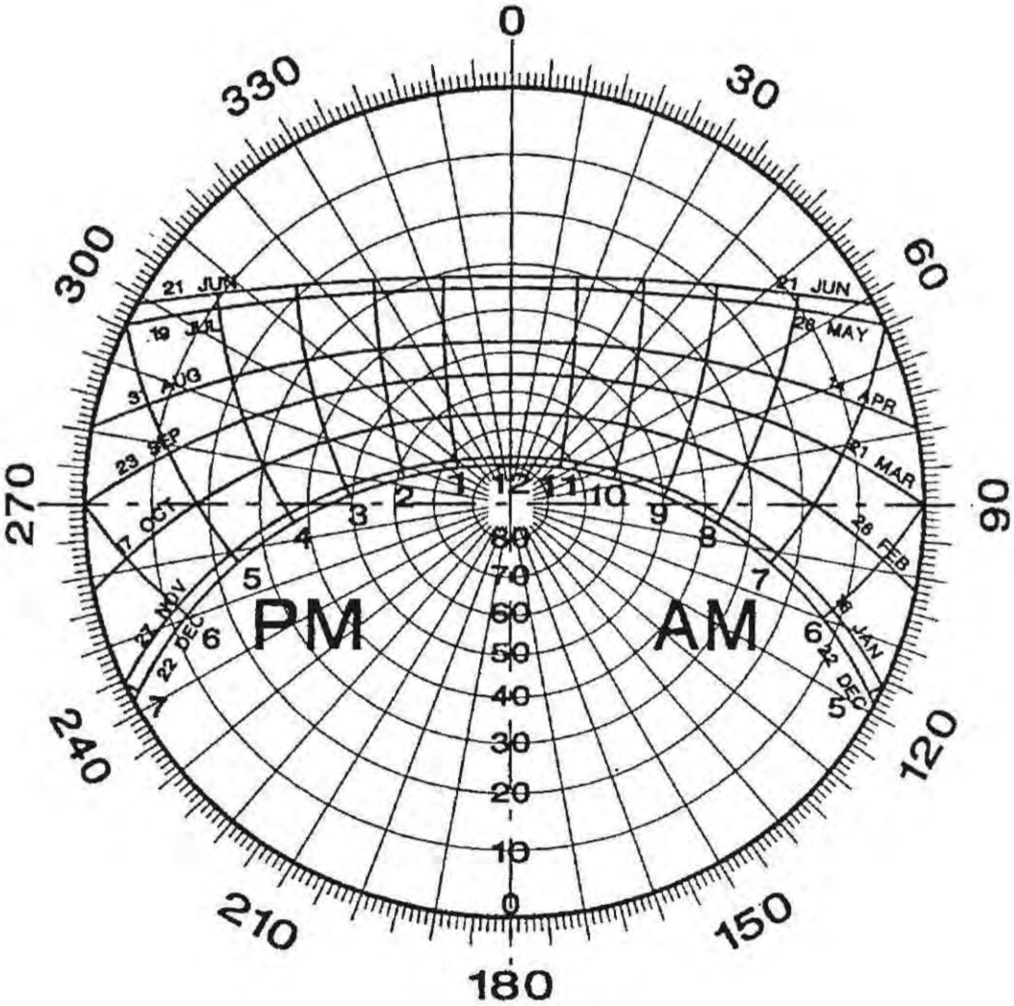


Figure C1: Standard Sun Chart for the Sydney Region