SOLAR LIGHT REFLECTIVITY STUDY

SITE 2A+2B SYDNEY OLYMPIC PARK

WE468-05F02(REV0)- SR REPORT

OCTOBER 24, 2019

Prepared for:

Ecove Site 2 Pty Ltd

Corner of Australia Avenue and Herb Elliot Avenue,
Sydney Olympic Park, NSW 2127

WINDTECH Consultants Pty Ltd
Head Office: 607 Forest Road, Bexley, NSW 2207, Australia
P +61 2 9503 0300 **E** reception@windtechglobal.com **W** www.windtechconsult.com

Sydney | Dubai | London | Melbourne | Mumbai | New York | Hong Kong | Singapore

DOCUMENT CONTROL

Date	Revision History	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
October 24, 2019	Initial.	0	AB	SWR	AB

The work presented in this document was carried out in accordance with the Windtech Consultants Quality Assurance System, which is based on International Standard ISO 9001.
This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.
This document is prepared for our Client's particular requirements which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Windtech Consultants. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

EXECUTIVE SUMMARY

This report presents the results of a detailed study for the effect of potential solar glare from the proposed development known as Site 2A+2B Sydney Olympic Park. This study identifies any possible adverse reflected solar glare conditions affecting motorists, train drivers, pedestrians, and to occupants of neighbouring buildings. If necessary, recommendations are made to mitigate any potentially adverse effects.

The results of the study indicate that, to avoid any adverse glare to motorists, train drivers, pedestrians, and to occupants of neighbouring buildings, the following limitations to the maximum normal specular reflectance of visible light of the external façade glazing is recommended:

- The glazing used on the 066º aspect of Building 2B should have a maximum normal specular reflectance of visible light of 13%.
- 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. Façade materials of this type used on this development include the perforated aluminium sun shading hoods of 2A, aluminium horizontal spandrels of 2A, aluminium, cladding to external columns of 2A, extruded aluminium louvres of 2A and 2B, the exposed steel structure of 2B, and the roof of 2B.

The proposed brushed metal façade on the fire stairs of Building 2B is not expected to cause adverse solar glare due to the circular shape (only a very narrow vertical strip of the curved surface could cause solar glare at any given moment in time), the effect of the brushed finish on the façade material (this reduces the intensity of reflected glare), and due to the fact that they will be overshadowed by the building form over/around the fire stairs and from the sunshade fins on the outer façade of the development.

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 motorists, train drivers or pedestrians in the surrounding area, or to occupants of neighbouring buildings.

CONTENTS

1 GLARE OBSERVED BY MOTORISTS

1.1 Methodology

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.

The various critical aspects of the development were determined and are shown in Figure 1. Solar charts for each of these critical aspects are presented in Appendix B, and these are used to derive the check zones which are shown in Figures 2 and 3. The solar chart of each critical aspect is determined from the standard sun chart of the region, provided in Appendix C (Phillips, 1992), using the method detailed in Hassall (1991). 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 0 of this report.

Study point locations are selected within the check zone areas where motorists are facing the general direction of the subject development (within ±10° of the direct sight-line). These are shown in Figures 2 and 3, and summarised in Table 1. Photographs have been taken from the viewpoint of motorists at each study point location using a calibrated camera. A scaled glare protractor has been superimposed over each viewpoint image.

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, to ensure that solar glare will not cause discomfort or threaten the safety of motorists and hence to enable the subject development to comply with the relevant planning control requirements regarding solar light reflectivity.

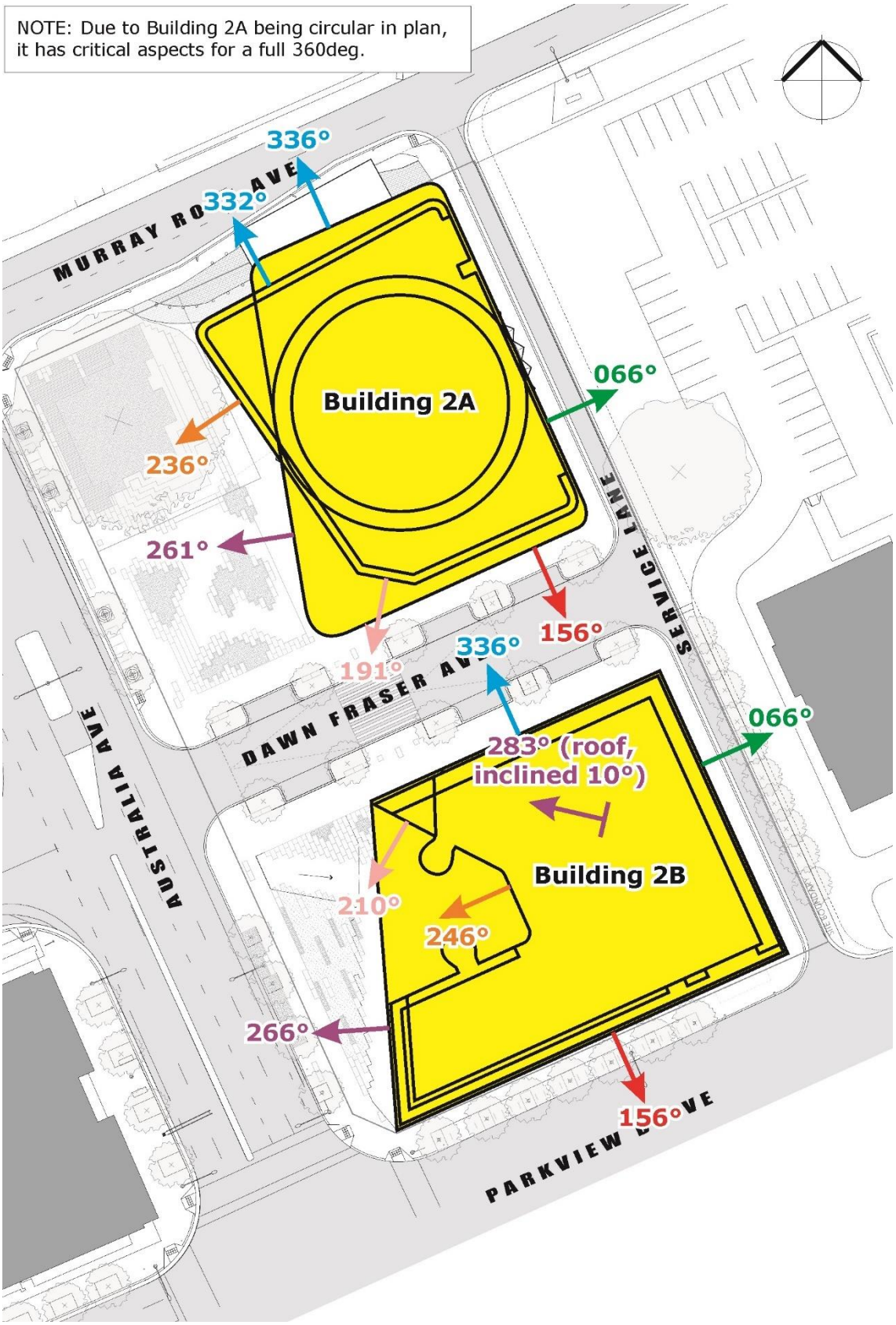

Figure 1: Critical Aspects of the Development

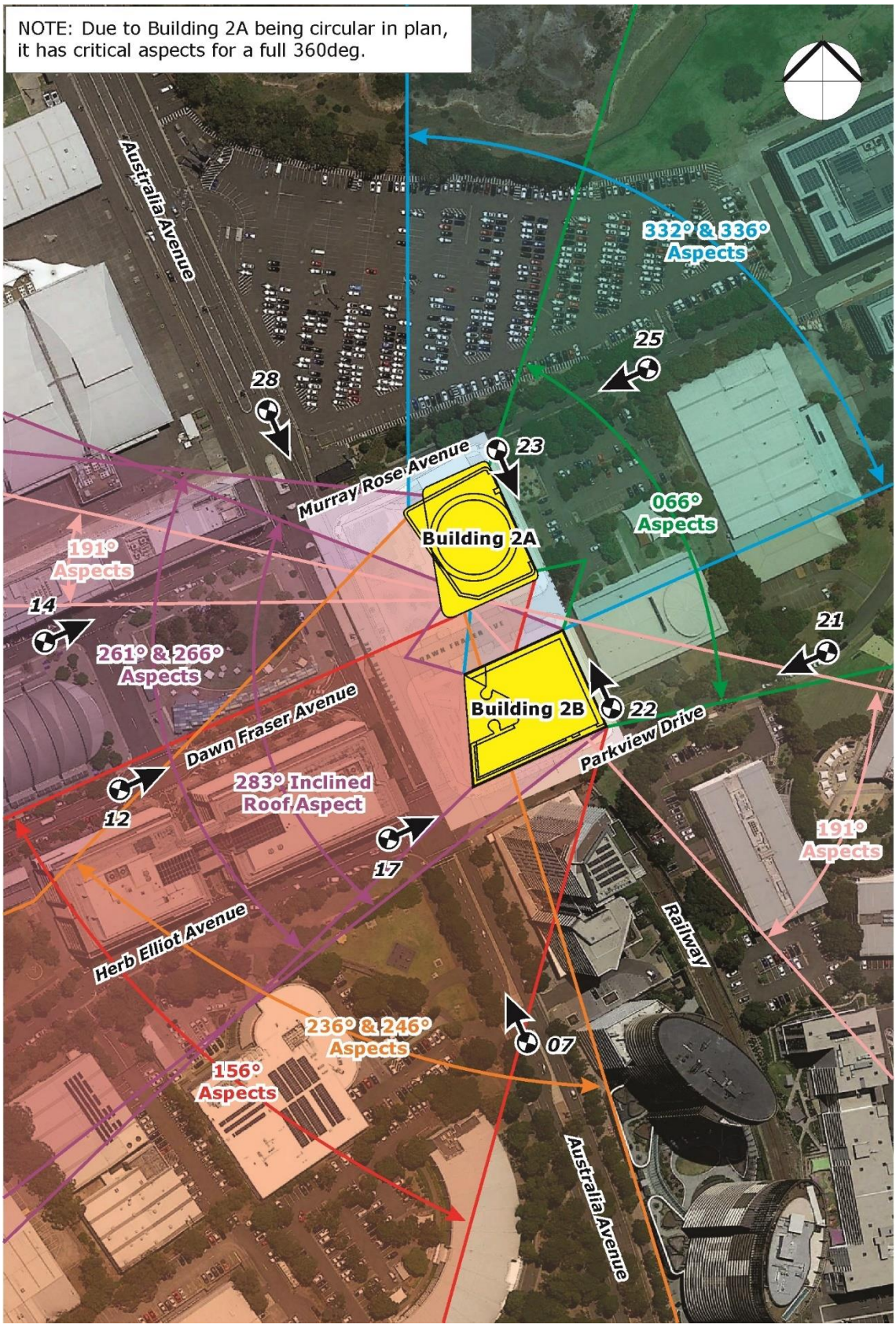

Figure 2: Check Zones and Study Point Locations (areas close to the site)
(the check zones are the areas where glare could potentially be observed)

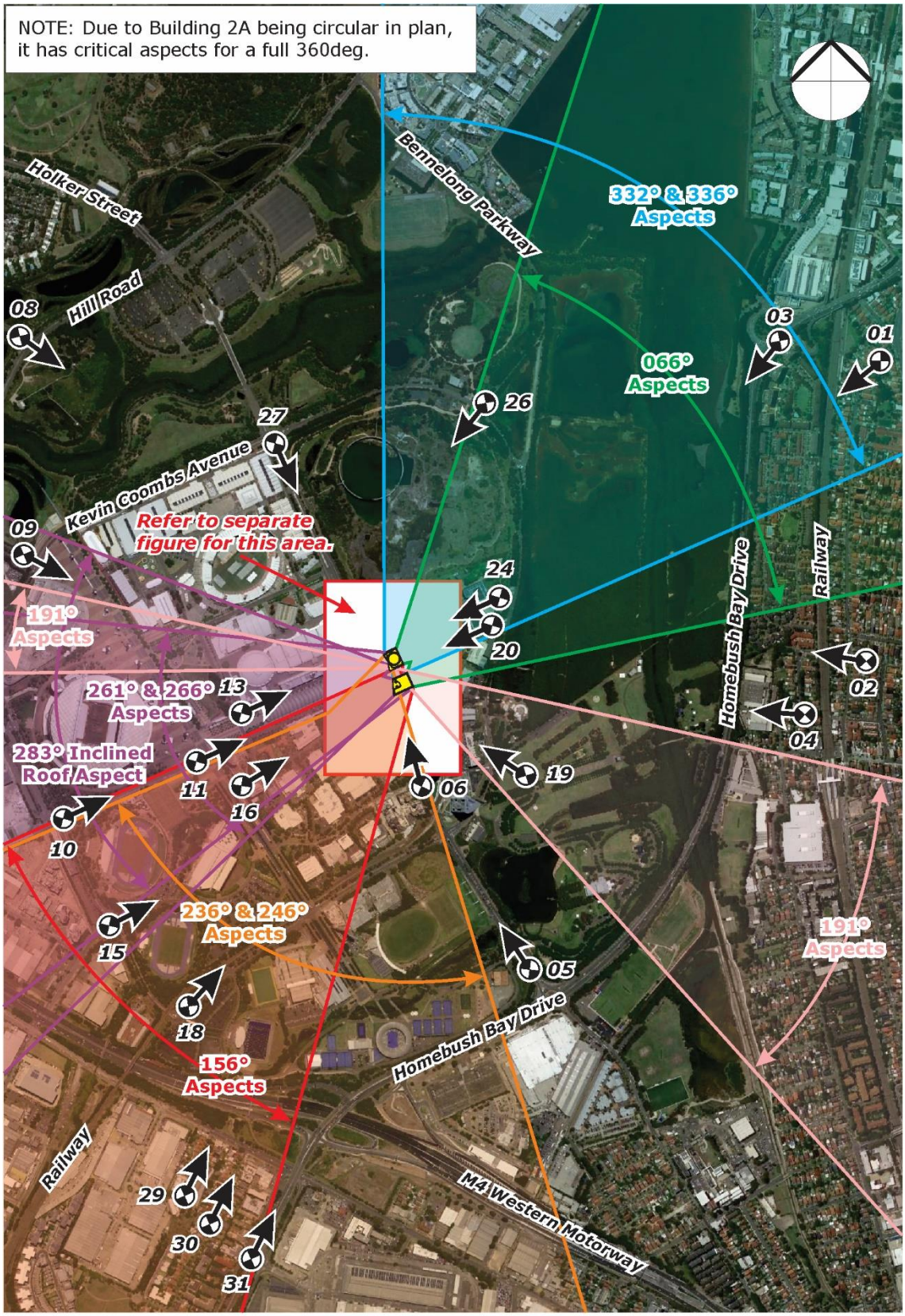

Figure 3: Check Zones and Study Point Locations (areas further from the site) (the check zones are the areas where glare could potentially be observed)

Table 1: Aspects of the Development that could reflect Solar Glare to Each Study Point for Motorists

Study Point	Location and Viewpoint	Aspect(s) of the Development
01	Killoola Street, heading south-west.	2A: Curved tower façade, 066º, 332º, 336º. 2B: 066º, 336º.
02	Concord Avenue, heading west.	2A: Curved tower façade. 2B: None.
03	Homebush Bay Drive, heading south.	2A: Curved tower façade, 066º, 332º, 336º. 2B: 066º, 336º.
04	Station Avenue, heading west.	2A: Curved tower façade. 2B: None.
05	Australia Avenue, heading north-west.	2A: Curved tower façade. 2B: None.
06	Australia Avenue, heading north-west.	2A: Curved tower façade, 236º. 2B: None.
07	Australia Avenue, heading north-west.	2A: Curved tower façade, 236º. 2B: None.
08	Avenue of Oceania, heading south-east.	2A: Curved tower façade. 2B: None.
09	Pondage Link, heading east.	2A: Curved tower façade. 2B: Inclined roof.
10	Dawn Fraser Avenue, heading north-east.	2A: Curved tower façade, 156º, 261º. 2B: Inclined roof, 266º.
11	Dawn Fraser Avenue, heading north-east.	2A: Curved tower façade, 156º, 261º. 2B: Inclined roof, 266º.
12	Dawn Fraser Avenue, heading north-east.	2A: Curved tower façade, 156º, 261º. 2B: Inclined roof, 266º.
13	Murray Rose Avenue, heading north-east.	2A: Curved tower façade, 261º. 2B: Inclined roof, 266º.
14	Murray Rose Avenue, heading north-east.	2A: Curved tower façade, 261º. 2B: Inclined roof, 266º.
15	Shane Gould Avenue, heading north-east.	2A: Curved tower façade, 156º, 236º, 261º. 2B: 156º, 246º, 266º.
16	Herb Elliot Avenue, heading north-east.	2A: Curved tower façade, 156º, 236º, 261º. 2B: Inclined roof, 156º, 246º, 266º.
17	Herb Elliot Avenue, heading north-east.	2A: Curved tower façade, 156º, 236º, 261º. 2B: Inclined roof, 156º, 246º, 266º.
18	Sarah Durack Avenue, heading north-east.	2A: Curved tower façade, 156º, 236º. 2B: 156º, 246º.
19	Bicentennial Drive, heading north-west.	2A: Curved tower façade, 191º. 2B: None.
20	Parkview Drive, heading south-west.	2A: Curved tower façade, 066º, 332º, 336º. 2B: 066º, 336º.
21	Parkview Drive, heading south-west.	2A: Curved tower façade. 2B: 066º.
22	New Service Lane, heading north-west.	2A: Curved tower façade, 191º. 2B: 066º.

Study Point	Location and Viewpoint	Aspect(s) of the Development
23	New Service Lane, heading south-east.	2A: Curved tower façade, 066º, 332º, 336º. 2B: 336º.
24	Murray Rose Avenue, heading south-west.	2A: Curved tower façade, 066º, 332º, 336º. 2B: 066º, 336º.
25	Murray Rose Avenue, heading south-west.	2A: Curved tower façade, 066º, 332º, 336º. 2B: 066º, 336º.
26	Bennelong Parkway, heading south.	2A: Curved tower façade, 066º, 332º, 336º. 2B: 336º.
27	Australia Avenue, heading south-east.	2A: Curved tower façade. 2B: None.
28	Australia Avenue, heading south-east.	2A: Curved tower façade. 2B: None.
29	Telopea Avenue, heading north.	2A: Curved tower façade, 156º, 236º. 2B: 156º, 246º.
30	Courallie Avenue, heading north.	2A: Curved tower façade, 156º, 236º. 2B: 156º, 246º.
31	Centenary Drive, heading north.	2A: Curved tower façade, 236º. 2B: 156º, 246º.

1.2 Analysis and Discussion

The amount of solar glare observed by motorists from the façade of the development at each study point location is presented in this section. Treatment options are provided if excessive solar glare conditions are observed.

1.2.1 Motorists heading south-west along Killoola Street

Point 01 is located along Killolla Street, to the north-east of the development site. This point represents the critical sightline of motorists heading south-west along Killoola Street at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 01 indicates that the view of the development will be blocked by trees and houses. Hence there will be no adverse solar glare observed by motorists heading south-west along Killoola Street at this location.

1.2.2 Motorists heading west along Concord Avenue

Point 02 is located along Concord Avenue, to the east of the development site. This point represents the critical sightline of motorists heading west along Concord Avenue at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 02 indicates that the view of the development will not be within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading west along Concord Avenue at this location.

1.2.3 Motorists heading south along Homebush Bay Drive

Point 03 is located along Homebush Bay Drive, to the north-east of the development site. This point represents the critical sightline of motorists heading south along Homebush Bay Drive at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 03 indicates that the top portions of Buildings 2A (the curved façade of the tower) and Building 2B (the 066º aspect) of the development will be visible within the zone of sensitive vision. Point 03 is located within the check zones of these aspects, and hence solar glare can potentially be observed from the façade of the development at Point 03.

The rounded shape of the 2A tower causes only a very narrow vertical strip of the façade to be capable of causing glare to Point 03 at any single point in time. The width of that strip of glare when viewed from Point 03 will be less than 0.5º arc, and hence the intensity of that glare will be less than 500cd/m^2 (provided that the maximum normal specular reflectance of visible light of the glazing is 20%, which is already a general requirement for the entire development as stated in Section 2). Furthermore, it should be noted that the sun hoods across the façade of the 2A tower will further reduce the intensity of glare when observed from Point 03.

The 066º aspect of Building 2B will be partially shaded by the many small sunshade fins across that façade at the times when solar will be observed from Point 03. Nonetheless, to ensure that the intensity of that glare is not adverse, it is recommended that the glazing used on this aspect has a maximum normal reflectance of visible light of 13%.

1.2.4 Motorists heading west along Station Avenue

Point 04 is located along Station Avenue, to the east of the development site. This point represents the critical sightline of motorists heading west along Station Avenue at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 04 indicates that the view of the development will be blocked by trees and houses. Hence there will be no adverse solar glare observed by motorists heading west along Station Avenue at this location.

1.2.5 Motorists heading north-west along Australia Avenue

Points 05, 06 and 07 are located along Australia Avenue, to the south-east and south of the development site. These points represent the critical sightline of motorists heading north-west along Australia Avenue at these locations. Calibrated images of the viewpoint of motorists at these locations has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 05 indicates that the view of the development will be blocked by other buildings. Hence there will be no adverse solar glare observed by motorists heading north-west along Australia Avenue at this location.

An analysis of the glare meter overlaid onto the viewpoint at Point 06 indicates that the view of the development will not be within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading north-west along Australia Avenue at this location.

An analysis of the glare meter overlaid onto the viewpoint at Point 07 indicates that only a very small and narrow portion of the 156º aspect of Building 2B will be visible within the zone of sensitive vision. However, Point 07 is not located within the check zone for this portion of this aspect. Hence there will be no adverse solar glare observed by motorists heading north-west along Australia Avenue at this location.

1.2.6 Motorists heading south-east along Avenue of Oceania

Point 08 is located along Avenue of Oceania, to the north-west of the development site. This point represents the critical sightline of motorists heading south-east along Avenue of Oceania at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 08 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading south-east along Avenue of Oceania at this location.

1.2.7 Motorists heading south-east along Pondage Link

Point 09 is located along Pondage Link, to the west of the development site. This point represents the critical sightline of motorists heading south-east along Pondage Link at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 09 indicates that a small portion of Building 2A (the curved façade of the tower) will be visible within the zone of sensitive vision. Point 09 is located within the check zone of this curved façade, and hence solar glare can potentially be observed from the façade of the development at Point 09.

The rounded shape of the 2A tower causes only a very narrow vertical strip of the façade to be capable of causing glare to Point 09 at any single point in time. The width of that strip of glare when viewed from Point 09 will be less than 0.5º arc, and hence the intensity of that glare will be less than 500cd/m^2 (provided that the maximum normal specular reflectance of visible light of the glazing is 20%, which is already a general requirement for the entire development as stated in Section 2). Furthermore, it should be noted that the sun hoods across the façade of the 2A tower will further reduce the intensity of glare when observed from Point 09.

1.2.8 Motorists heading north-east along Dawn Fraser Avenue

Points 10, 11 and 12 are located along Dawn Fraser Avenue, to the south-west and west of the development site. These points represent the critical sightline of motorists heading north-east along Dawn Fraser Avenue at these locations. Calibrated images of the viewpoint of motorists at these locations has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meters overlaid onto the viewpoints at Points 10, 11 and 12 indicates that all or most of the 2A tower (the curved façade of the tower), portions of the 210º and 336º aspects of Building 2B, and portions of the inclined roof of Building 2B, to be visible within the zone of sensitive vision at these locations. Solar glare is not able to be reflected from the 210º aspect of Building 2B to Points 10, 11 or 12 since it will be overshadowed by the remainder of Building 2B, due to the horse-shoe shape of that corner of the development. However, Points 10, 11 and 12 are located within the check zones of the curved façade of the 2A tower, the 336º aspect of Building 2B, and the inclined roof of Building 2B, and hence solar glare from those aspects can potentially be observed from those aspects at Points 10, 11 and 12.

The rounded shape of the 2A tower causes only a very narrow vertical strip of the façade to be capable of causing glare to Points 10, 11 or 12 at any single point in time. The width of that strip of glare when viewed from Points 10, 11 or 12 will be less than 0.5º arc, and hence the intensity of that glare will be less than 500cd/m^2 (provided that the maximum normal specular reflectance of visible light of the glazing is 20%, which is already a general requirement for the entire development as stated in Section 2). Furthermore, it should be noted that the sun hoods across the façade of the 2A tower will further reduce the intensity of glare when observed from Points 10, 11 or 12.

The view of the 336º aspect of Building 2B, and the inclined roof of Building 2B, will be very narrow when viewed from Points 10, 11 or 12 (less than 0.5º arc), and hence the intensity of that glare will be less than 500cd/m^2 (provided that the maximum normal specular reflectance of visible light of the glazing is 20%, which is already a general requirement for the entire development as stated in Section 2).

1.2.9 Motorists heading north-east along Murray Rose Avenue

Points 13 and 14 are located along Murray Rose Avenue, to the west of the development site. These points represent the critical sightline of motorists heading north-east along Murray Rose Avenue at these locations. Calibrated images of the viewpoint of motorists at these locations has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meters overlaid onto the viewpoints at Points 13 and 14 indicate that a portion of Building 2A (the curved façade of the tower) will be visible within the zone of sensitive vision. Points 13 and 14 are located within the check zone of this curved façade, and hence solar glare can potentially be observed from the façade of the development at Points 13 and 14.

The rounded shape of the 2A tower causes only a very narrow vertical strip of the façade to be capable of causing glare to Points 13 and 14 at any single point in time. The width of that strip of glare when viewed from Points 13 and 14 will be less than 0.5º arc, and hence the intensity of that glare will be less than 500cd/m^2 (provided that the maximum normal specular reflectance of visible light of the glazing is 20%, which is already a general requirement for the entire development as stated in Section 2). Furthermore, it should be noted that the sun hoods

across the façade of the 2A tower will further reduce the intensity of glare when observed from Points 13 and 14.

1.2.10 Motorists heading north-east along Shane Gould Avenue

Point 15 is located along Shane Gould Avenue, to the south-west of the development site. This point represents the critical sightline of motorists heading north-east along Shane Gould Avenue at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 15 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading north-east along Shane Gould Avenue at this location.

1.2.11 Motorists heading north-east along Herb Elliot Avenue

Points 16 and 17 are located along Herb Elliot Avenue, to the south-west of the development site. These points represent the critical sightline of motorists heading north-east along Herb Elliot Avenue at these locations. Calibrated images of the viewpoint of motorists at these locations has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 16 indicates that the view of the development will not be within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading north-east along Herb Elliot Avenue at this location.

An analysis of the glare meter overlaid onto the viewpoint at Point 17 indicates that the view of the development will not be within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading north-east along Herb Elliot Avenue at this location.

1.2.12 Motorists heading north-east along Sarah Durack Avenue

Point 18 is located along Sarah Durack Avenue, to the south-west of the development site. This point represents the critical sightline of motorists heading north-east along Sarah Durack Avenue at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 18 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading north-east along Sarah Durack Avenue at this location.

1.2.13 Motorists heading north-west along Bicentennial Drive

Point 19 is located along Bicentennial Drive, to the south-east of the development site. This point represents the critical sightline of motorists heading north-west along Bicentennial Drive at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 19 indicates that the view of the development will not be within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading north-west along Bicentennial Drive at this location.

1.2.14 Motorists heading south-west along Parkview Drive

Points 20 and 21 are located along Parkview Drive, to the north-east of the development site. These points represent the critical sightline of motorists heading south-west along Parkview Drive at these locations. Calibrated images of the viewpoint of motorists at these locations has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 20 indicates that small portions of Building 2A (the curved façade of the tower) and Building 2B (the 066º and 336º aspects) will be visible within the zone of sensitive vision. Point 20 is located within the check zone for all of these aspects, and hence solar glare can potentially be observed from these portions of the façade of the development at Point 20.

The rounded shape of the 2A tower causes only a very narrow vertical strip of the façade to be capable of causing glare to Point 20 at any single point in time. The width of that strip of glare when viewed from Point 20 will be less than 0.5º arc, and hence the intensity of that glare will be less than 500cd/m^2 (provided that the maximum normal specular reflectance of visible light of the glazing is 20%, which is already a general requirement for the entire development as stated in Section 2). Furthermore, it should be noted that the sun hoods across the façade of the 2A tower will further reduce the intensity of glare when observed from Point 20.

Only small portions of the 066º aspect of Building 2B will be visible within the zone of sensitive vision at Point 20 through/above the trees. The use of the many small sunshade fins across this aspect of Building 2B will be effective in reducing the intensity of the glare. Nonetheless, to ensure that the intensity of that glare is not adverse, it is recommended that the glazing used on this aspect has a maximum normal reflectance of visible light of 15%.

An analysis of glare being observed from the 336º aspect of Building 2B indicates that the sun itself will also be in the direct line of sight at the times when glare from that aspect of the development could be observed (late summer afternoon). The intensity of the direct view of the sun will be far more severe than any glare from the façade of the development, and hence the development will not cause adverse solar glare to be observed from Point 20.

An analysis of the glare meter overlaid onto the viewpoint at Point 21 indicates that portions of the lower levels of the 156º aspect of Building 2B will be visible through the trees within the zone of sensitive vision. However, Point 21 is not located within the check zone for that aspect, and hence there will be no adverse solar glare observed by motorists heading south-west along Parkview Drive at this location.

1.2.15 Motorists heading north-west along New Service Lane

Point 22 is located along New Service Lane, to the east of the development site. This point represents the critical sightline of motorists heading north-west along New Service Lane at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 22 indicates that the 066º aspects of the lower levels of Building 2A and Building 2B will be visible within the zone of sensitive vision. Point 22 is located within the check zone for the 066º of Building 2B and hence solar glare can potentially be observed from that aspect at Point 22. However, closer inspection reveals that Point 22 is only located within the check zone of the southern end of the 066º aspect of Building 2B, which is not within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading north-west along New Service Lane at this location.

1.2.16 Motorists heading south-east along New Service Lane

Point 23 is located along New Service Lane, to the north of the development site. This point represents the critical sightline of motorists heading south-east along New Service Lane at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 23 indicates that the 066º aspects of the lower levels of Building 2A and Building 2B will be visible within the zone of sensitive vision. Point 23 is located within the check zone for the 066º of Building 2A and hence solar glare can potentially be observed from that aspect at Point 23. However, closer inspection reveals that Point 23 is only located within the check zone of the northern end of the 066º aspect of Building 2A, which is not within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading south-east along New Service Lane at this location.

1.2.17 Motorists heading south-west along Murray Rose Avenue

Points 24 and 25 are located along Murray Rose Avenue, to the north-east of the development site. These points represent the critical sightline of motorists heading south-west along Murray Rose Avenue at these locations. Calibrated images of the viewpoint of motorists at these locations has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 24 indicates that a small portion of Building 2A (the curved façade of the tower) will be visible within the zone of sensitive vision. Point 24 is located within the check zone of this curved façade, and hence solar glare can potentially be observed from the façade of the development at Point 24.

The rounded shape of the 2A tower causes only a very narrow vertical strip of the façade to be capable of causing glare to Point 24 at any single point in time. The width of that strip of glare

when viewed from Point 24 will be less than 0.5º arc, and hence the intensity of that glare will be less than 500cd/m^2 (provided that the maximum normal specular reflectance of visible light of the glazing is 20%, which is already a general requirement for the entire development as stated in Section 2). Furthermore, it should be noted that the sun hoods across the façade of the 2A tower will further reduce the intensity of glare when observed from Point 24.

An analysis of the glare meter overlaid onto the viewpoint at Point 25 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading south-west along Murray Rose Avenue at this location.

1.2.18 Motorists heading south along Bennelong Parkway

Point 26 is located along Bennelong Parkway, to the north of the development site. This point represents the critical sightline of motorists heading south along Bennelong Parkway at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 26 indicates that the view of the development will not be within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading south along Bennelong Parkway at this location.

1.2.19 Motorists heading south-east along Australia Avenue

Points 27 and 28 are located along Australia Avenue, to the north-west of the development site. These points represent the critical sightline of motorists heading south-east along Australia Avenue at these locations. Calibrated images of the viewpoint of motorists at these locations has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 27 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading south-east along Australia Avenue at this location.

An analysis of the glare meter overlaid onto the viewpoint at Point 28 indicates that the view of the development will not be within the zone of sensitive vision. Hence there will be no adverse solar glare observed by motorists heading south-east along Australia Avenue at this location.

1.2.20 Motorists heading north along Telopea Avenue

Point 29 is located along Telopea Avenue, to the south of the development site. This point represents the critical sightline of motorists heading north along Telopea Avenue at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 29 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading north along Telopea Avenue at this location.

1.2.21 Motorists heading north along Courallie Avenue

Point 30 is located along Courallie Avenue, to the south of the development site. This point represents the critical sightline of motorists heading north along Courallie Avenue at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 30 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading north along Courallie Avenue at this location.

1.2.22 Motorists heading north along Centenary Drive

Point 31 is located along Centenary Drive, to the south of the development site. This point represents the critical sightline of motorists heading north along Centenary Drive at this location. A calibrated image of the viewpoint of motorists at this location has been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 31 indicates that the view of the development will be blocked by trees. Hence there will be no adverse solar glare observed by motorists heading north along Centenary Drive at this location.

2 GLARE OBSERVED BY TRAIN DRIVERS, PEDESTRIANS AND 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 pedestrians and 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 pedestrians and occupants of neighbouring buildings.

The check zone diagrams presented in Figures 2 and 3 indicate that, at the locations where train drivers on the Olympic Park railway line will have a direct view of the development within the zone of sensitive vision, the train driver will only be within the check zone of the circular façade of Building 2A. Provided that the glazing used on the circular façade of Building 2A has a maximum normal specular reflectivity of visible light of 20%, the intensity of glare from that façade when viewed by train drivers will not exceed 500cd/m^2 and hence will not cause adverse conditions. The curved shape of the façade causes only a very narrow vertical strip of the façade to reflect solar glare at any given moment in time. Furthermore, the effective use of the perforated sun hoods across the façade of Building 2A further reduces the intensity of any perceived solar glare.

3 TYPICAL NORMAL SPECULAR REFLECTANCE OF 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.

3.1 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%

3.2 Painted and/or Powder-Coated Metallic Surfaces

It is not expected that adverse glare will be observed from the powder-coated or painted metallic surfaces of the development 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. Façade materials of this type used on this development include the perforated aluminium sun shading hoods of 2A, aluminium horizontal spandrels of 2A, aluminium, cladding to external columns of 2A, extruded aluminium louvres of 2A and 2B, the exposed steel structure of 2B, and the roof of 2B.

3.3 Brushed Metal Surfaces of the Building 2B Fire Stairs

The proposed brushed metal façade on the fire stairs of Building 2B is not expected to cause adverse solar glare due to the circular shape (only a very narrow vertical strip of the curved surface could case solar glare at any given moment in time), the effect of the brushed finish on the façade material (this reduces the intensity of reflected glare), and due to the fact that they will be overshadowed by the building form over/around the fire stairs and from the sunshade fins on the outer façade of the development.

4 CONCLUSION

A detailed study has been undertaken for the effect of potential solar glare from the proposed development known as Site 2A+2B Sydney Olympic Park. This study identifies any possible adverse reflected solar glare conditions affecting motorists, train drivers, pedestrians, and to occupants of neighbouring buildings. If necessary, recommendations are made to mitigate any potentially adverse effects.

The results of the study indicate that, to avoid any adverse glare to motorists, train drivers, pedestrians, and to occupants of neighbouring buildings, the following limitations to the maximum normal specular reflectance of visible light of the external façade glazing is recommended:

- The glazing used on the 066º aspect of Building 2B should have a maximum normal specular reflectance of visible light of 13%.
- 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. Façade materials of this type used on this development include the perforated aluminium sun shading hoods of 2A, aluminium horizontal spandrels of 2A, aluminium, cladding to external columns of 2A, extruded aluminium louvres of 2A and 2B, the exposed steel structure of 2B, and the roof of 2B.

The proposed brushed metal façade on the fire stairs of Building 2B is not expected to cause adverse solar glare due to the circular shape (only a very narrow vertical strip of the curved surface could cause solar glare at any given moment in time), the effect of the brushed finish on the façade material (this reduces the intensity of reflected glare), and due to the fact that they will be overshadowed by the building form over/around the fire stairs and from the sunshade fins on the outer façade of the development.

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 motorists, train drivers or pedestrians in the surrounding area, or to occupants of neighbouring buildings.

5 REFERENCES

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

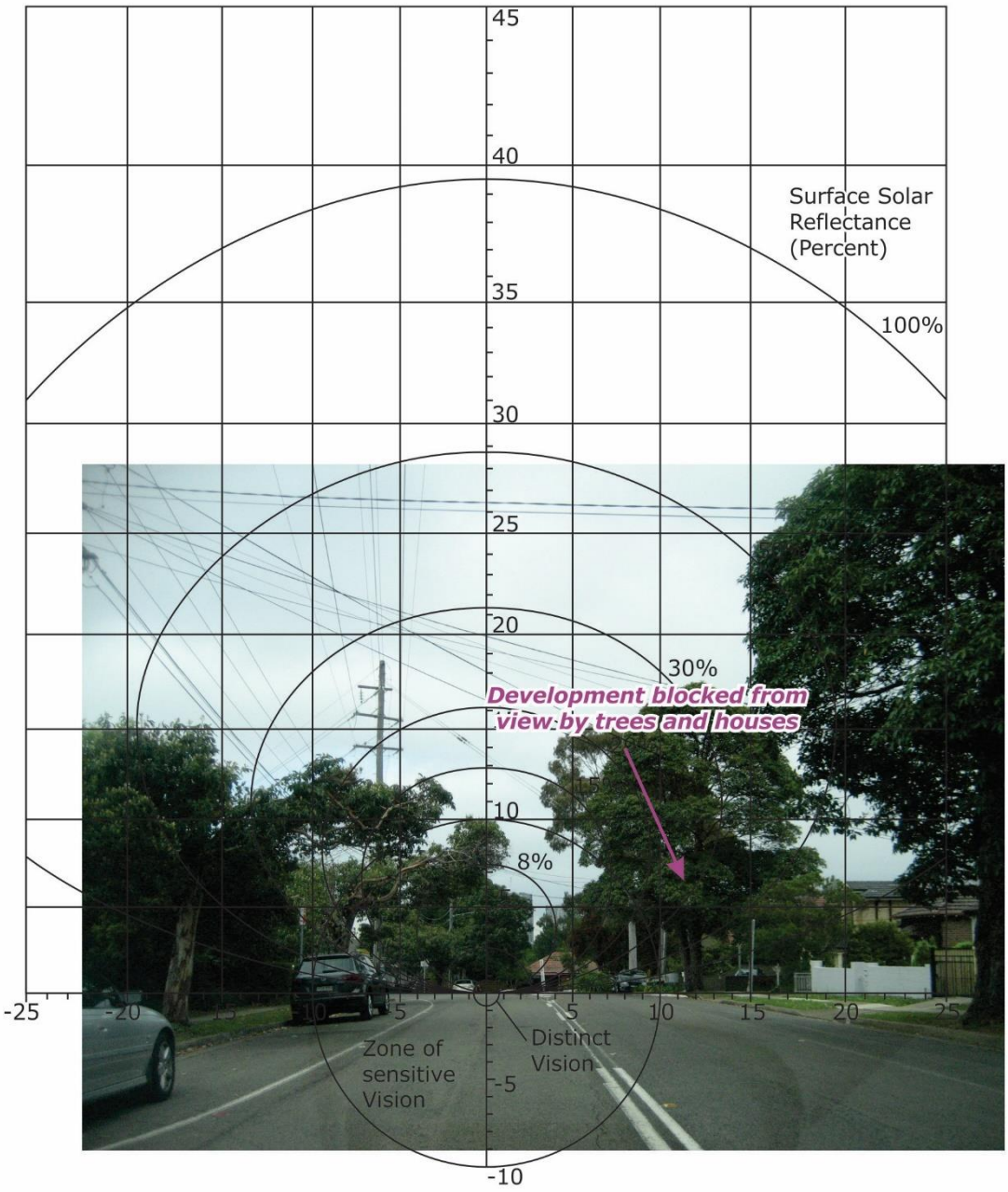

Figure A.1: Glare Overlay of the Viewpoint at Point 01

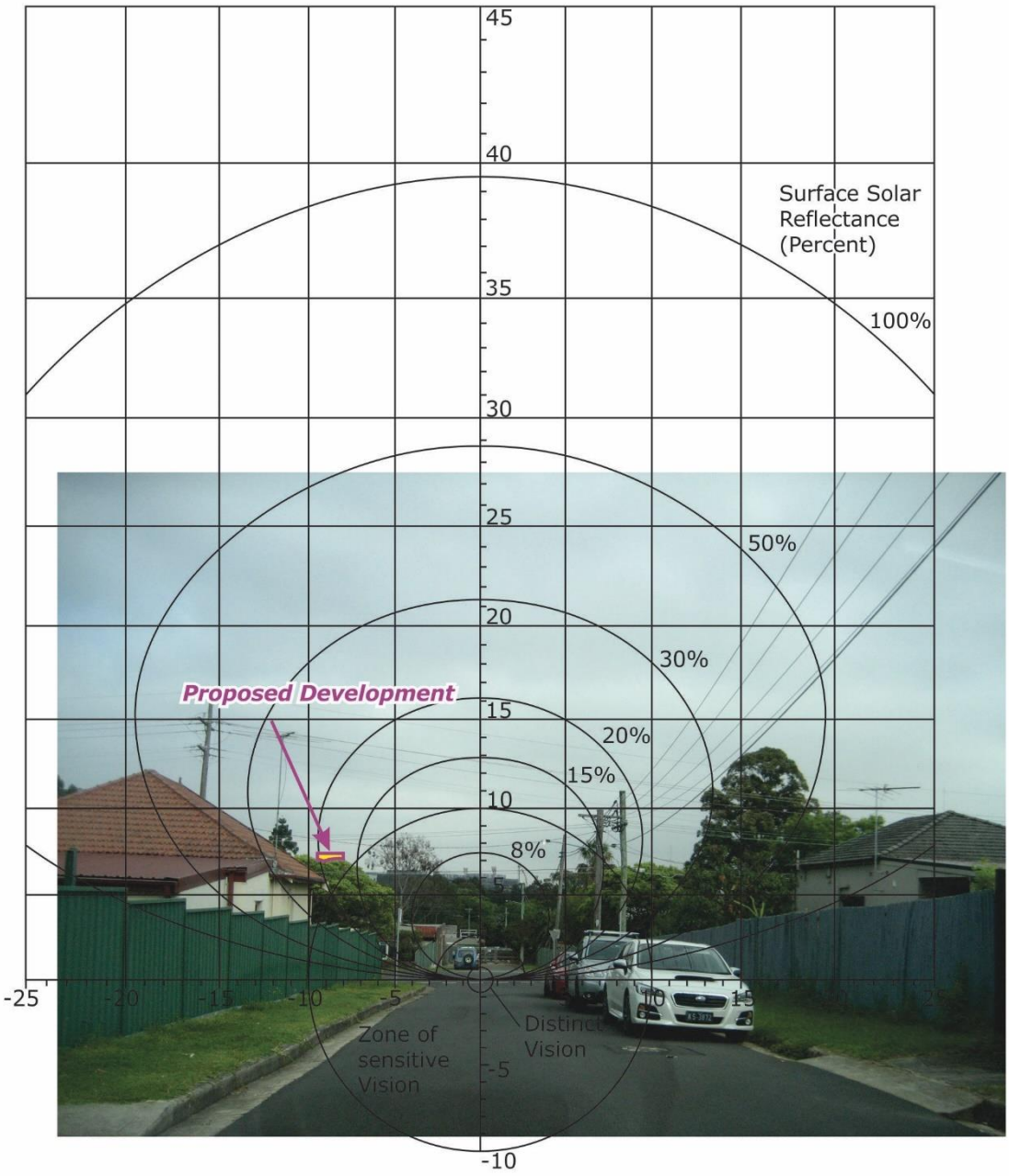

Figure A.2: Glare Overlay of the Viewpoint at Point 02

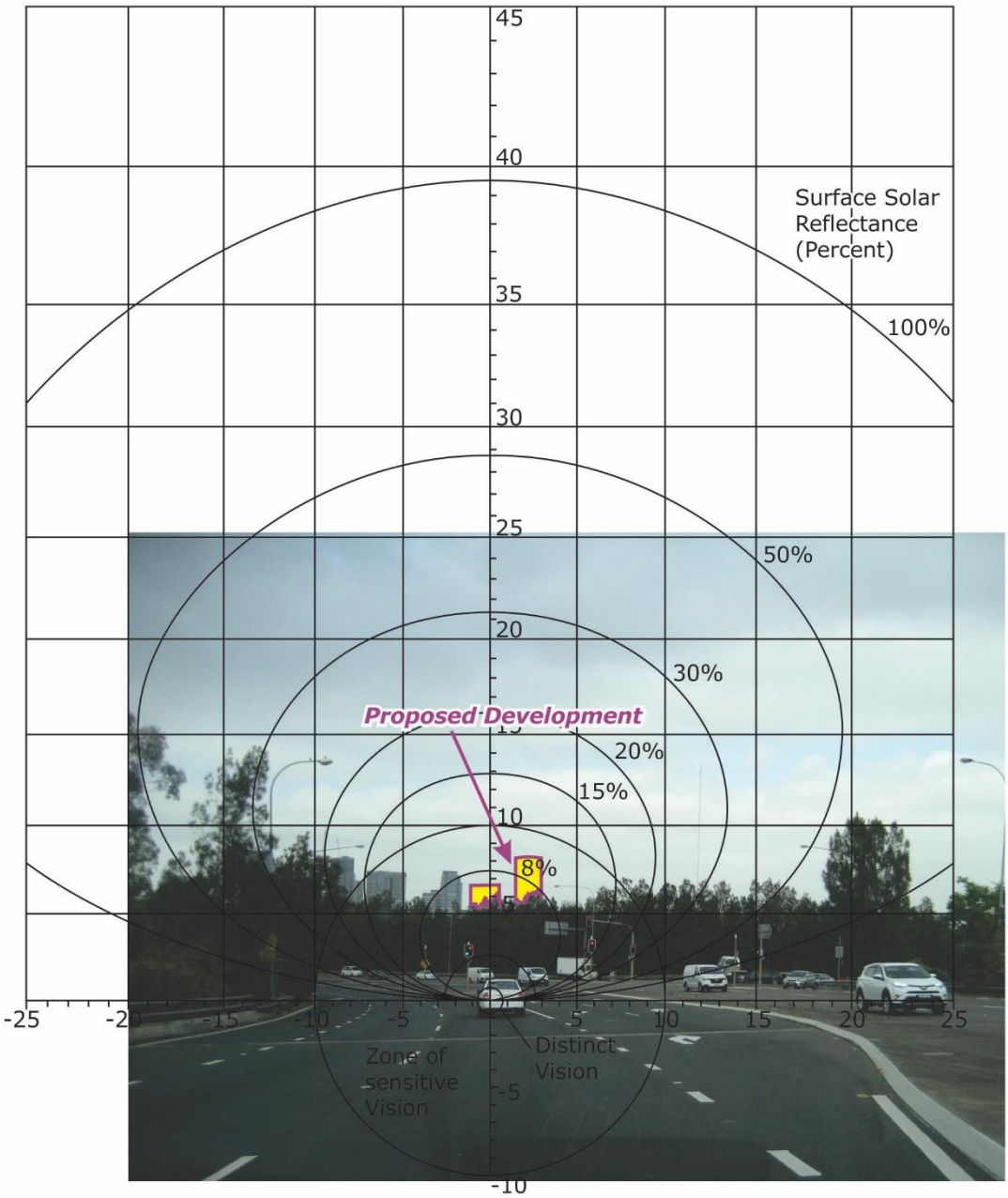

Figure A.3: Glare Overlay of the Viewpoint at Point 03

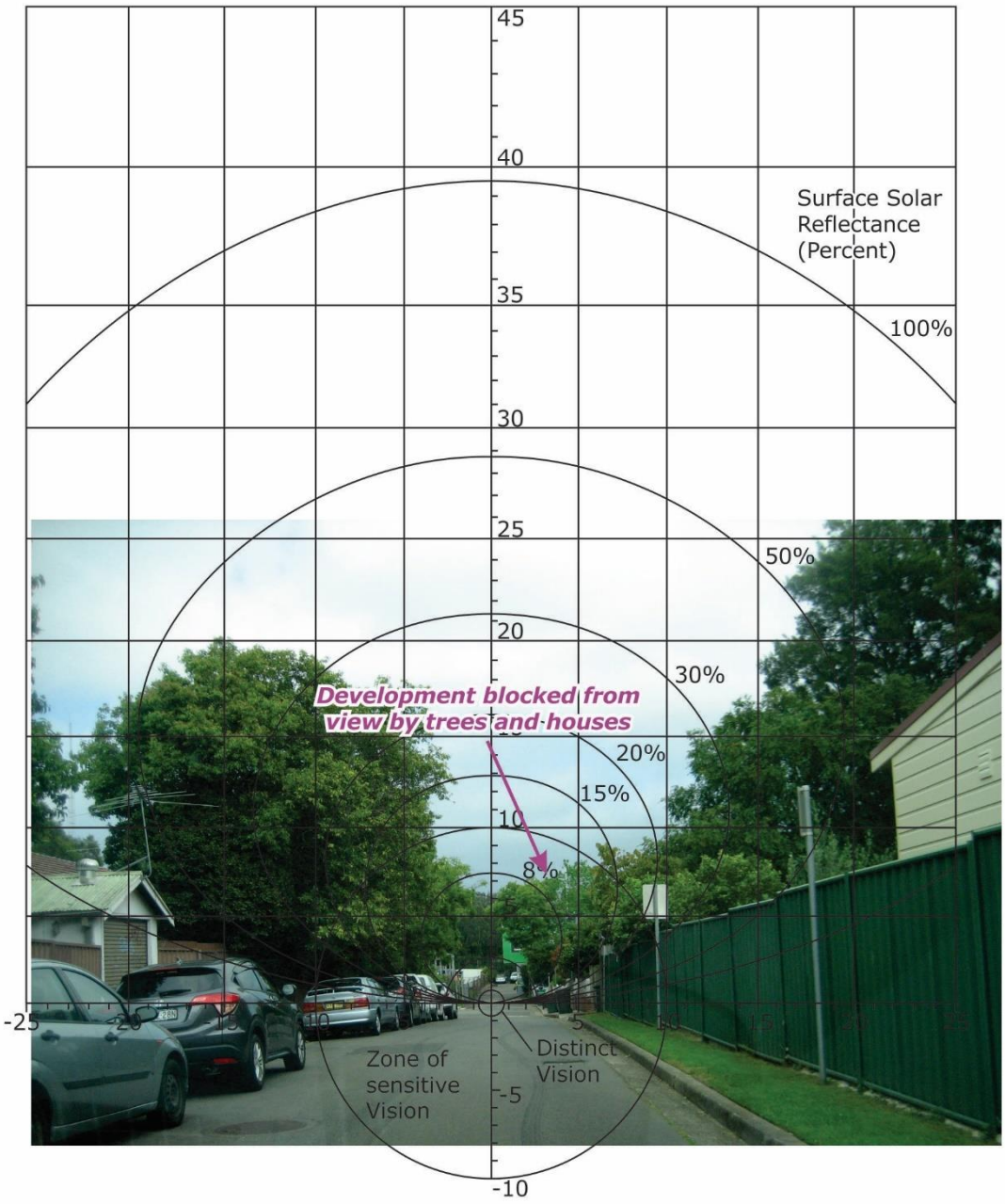

Figure A.4: Glare Overlay of the Viewpoint at Point 04

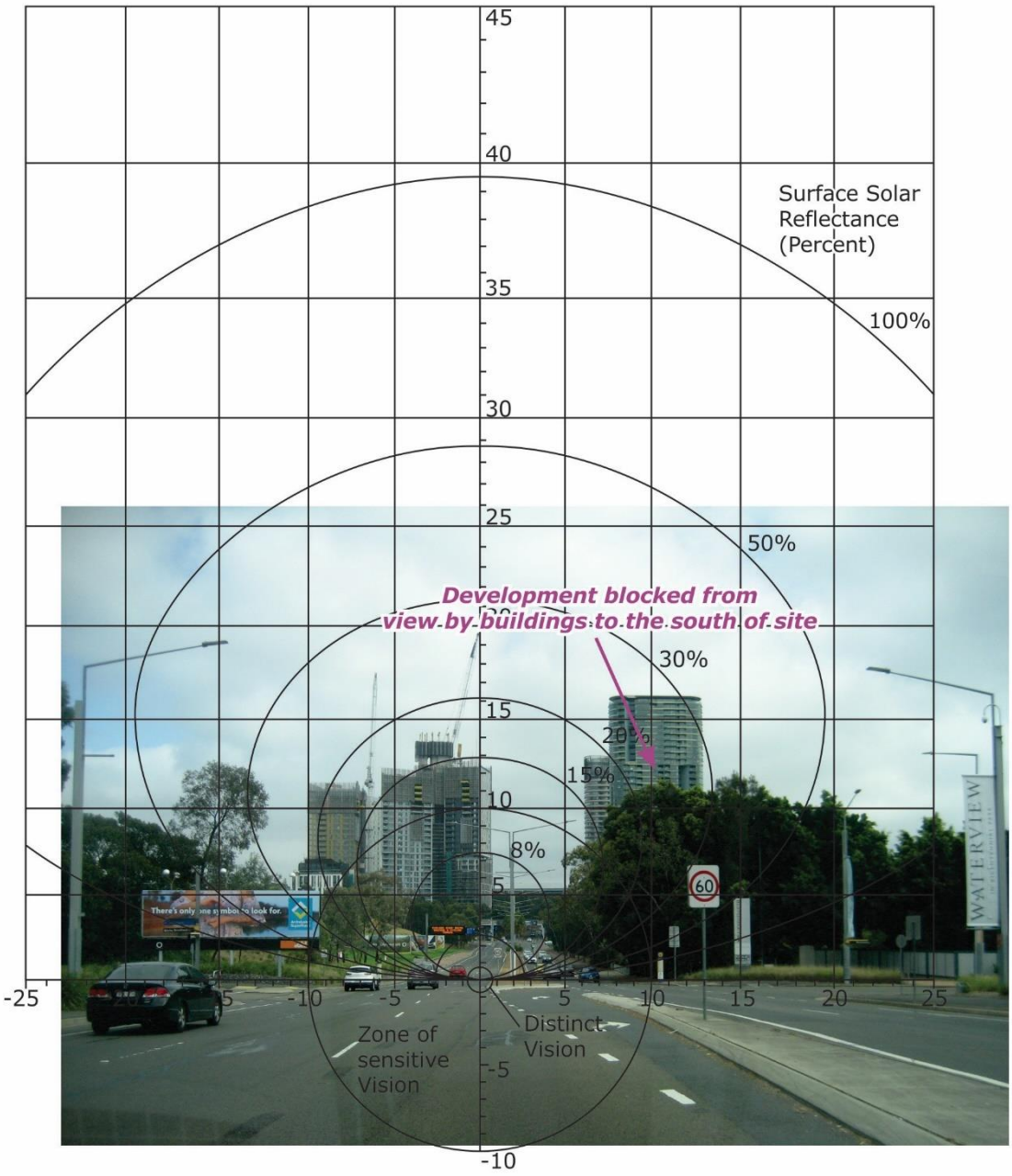

Figure A.5: Glare Overlay of the Viewpoint at Point 05

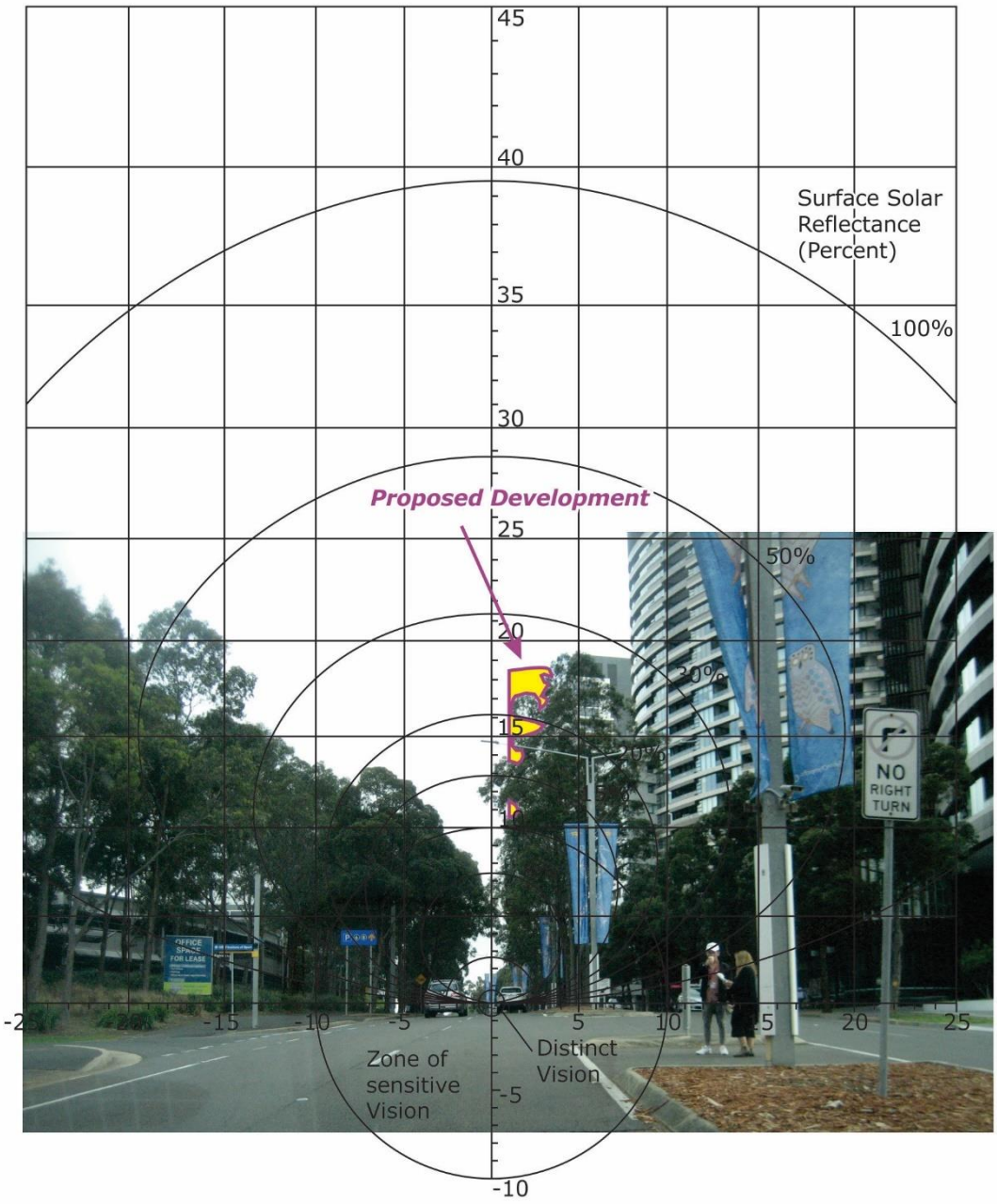

Figure A.6: Glare Overlay of the Viewpoint at Point 06

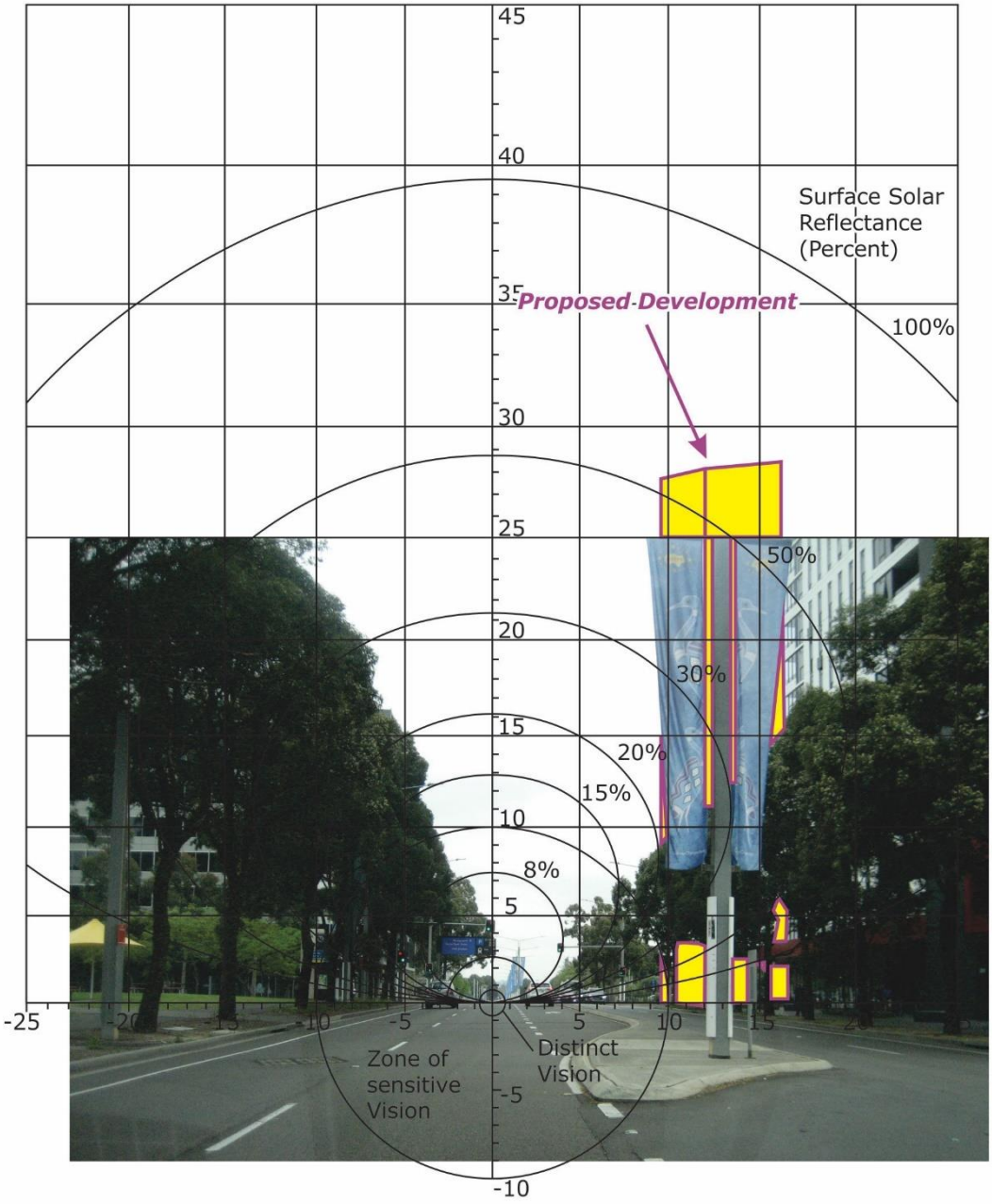

Figure A.7: Glare Overlay of the Viewpoint at Point 07

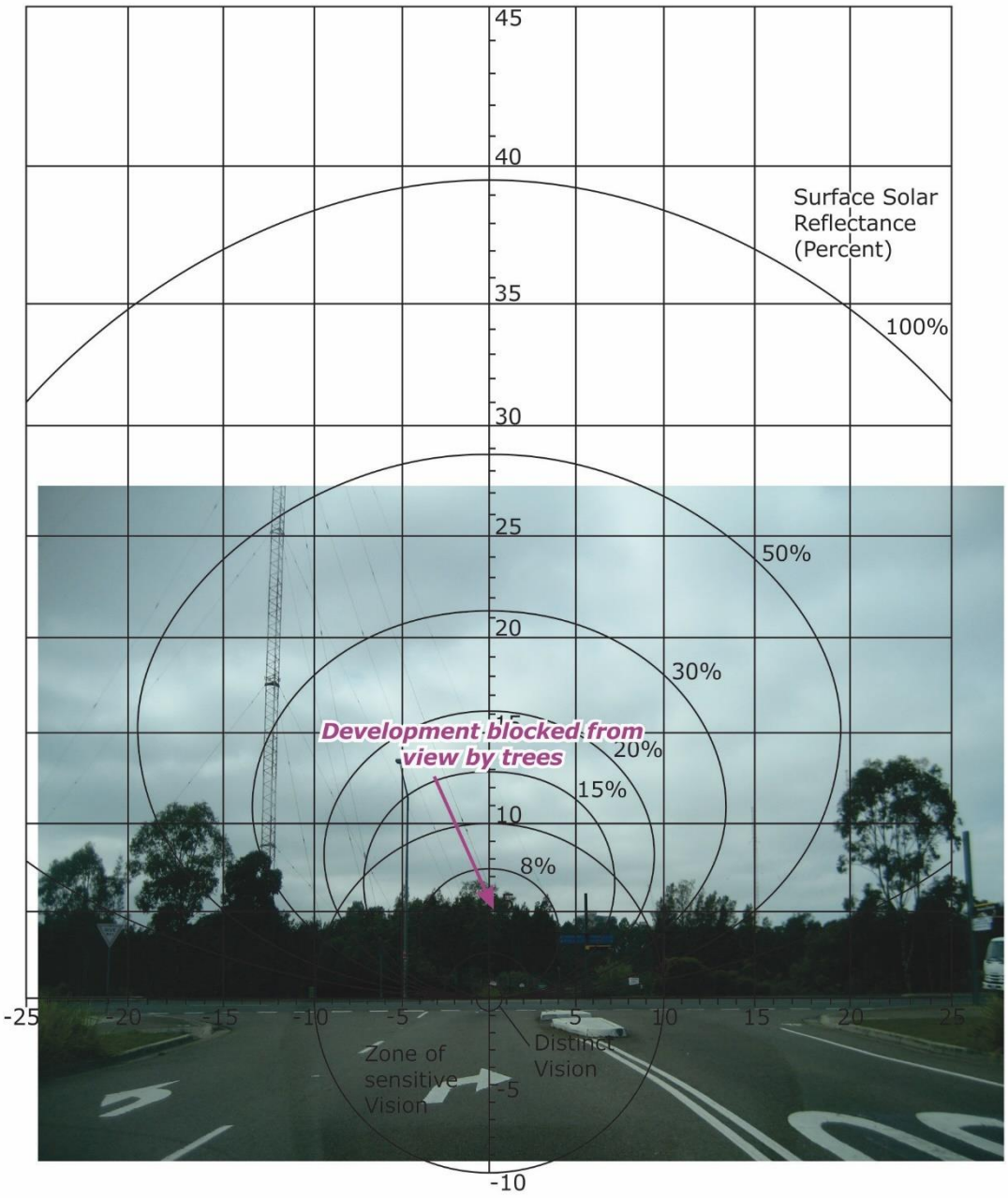

Figure A.8: Glare Overlay of the Viewpoint at Point 08

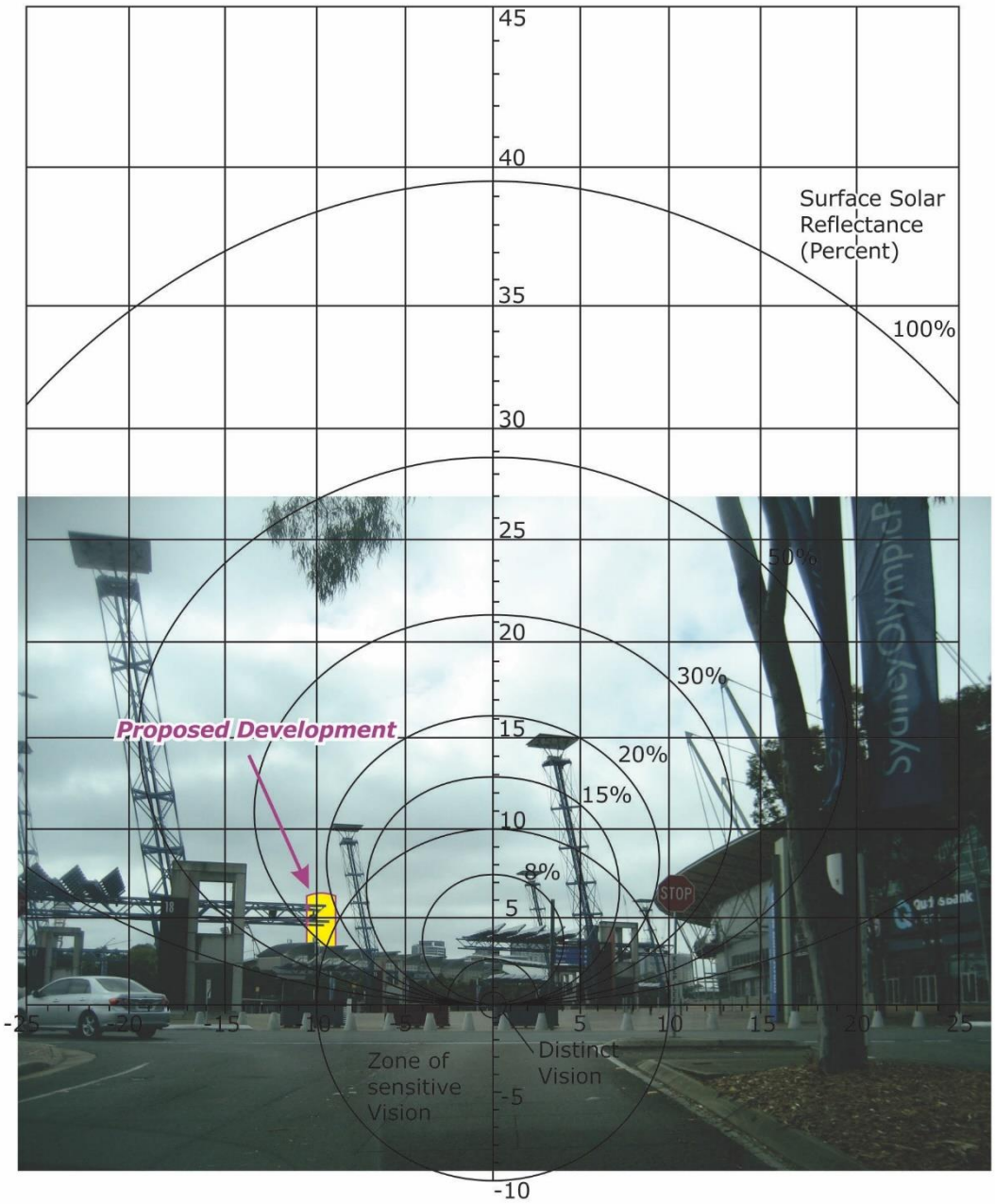

Figure A.9: Glare Overlay of the Viewpoint at Point 09

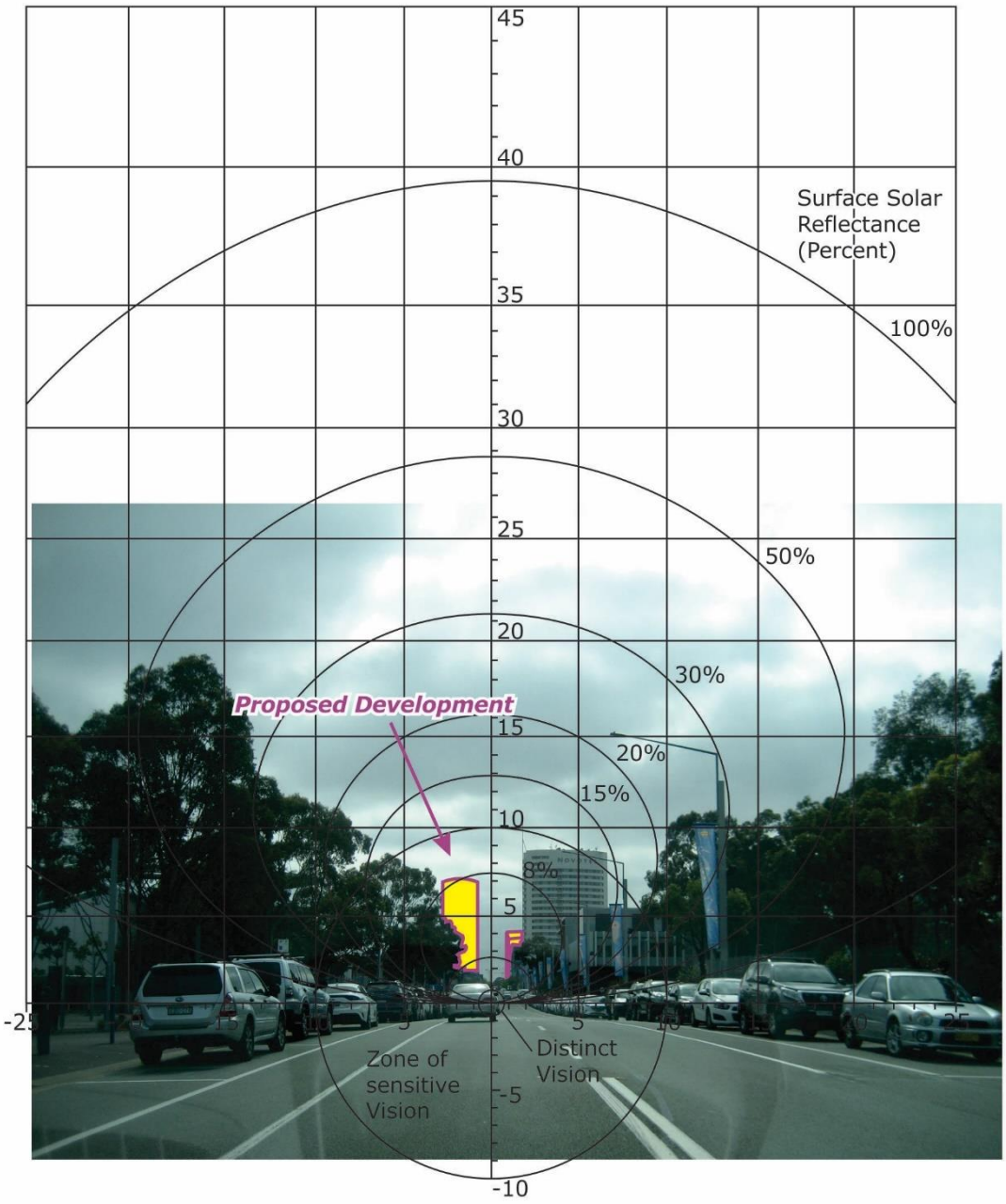

Figure A.10: Glare Overlay of the Viewpoint at Point 10

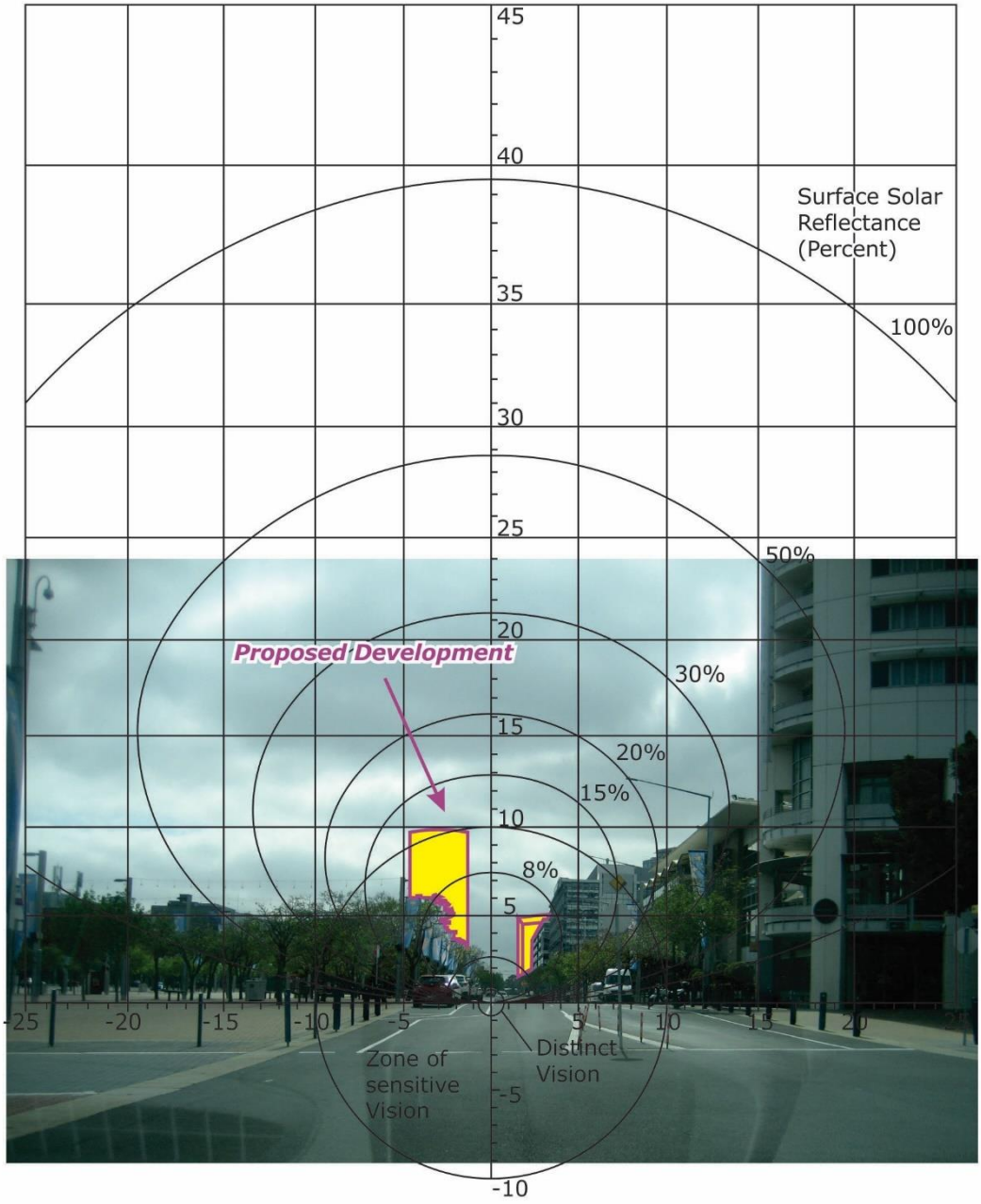

Figure A.11: Glare Overlay of the Viewpoint at Point 11

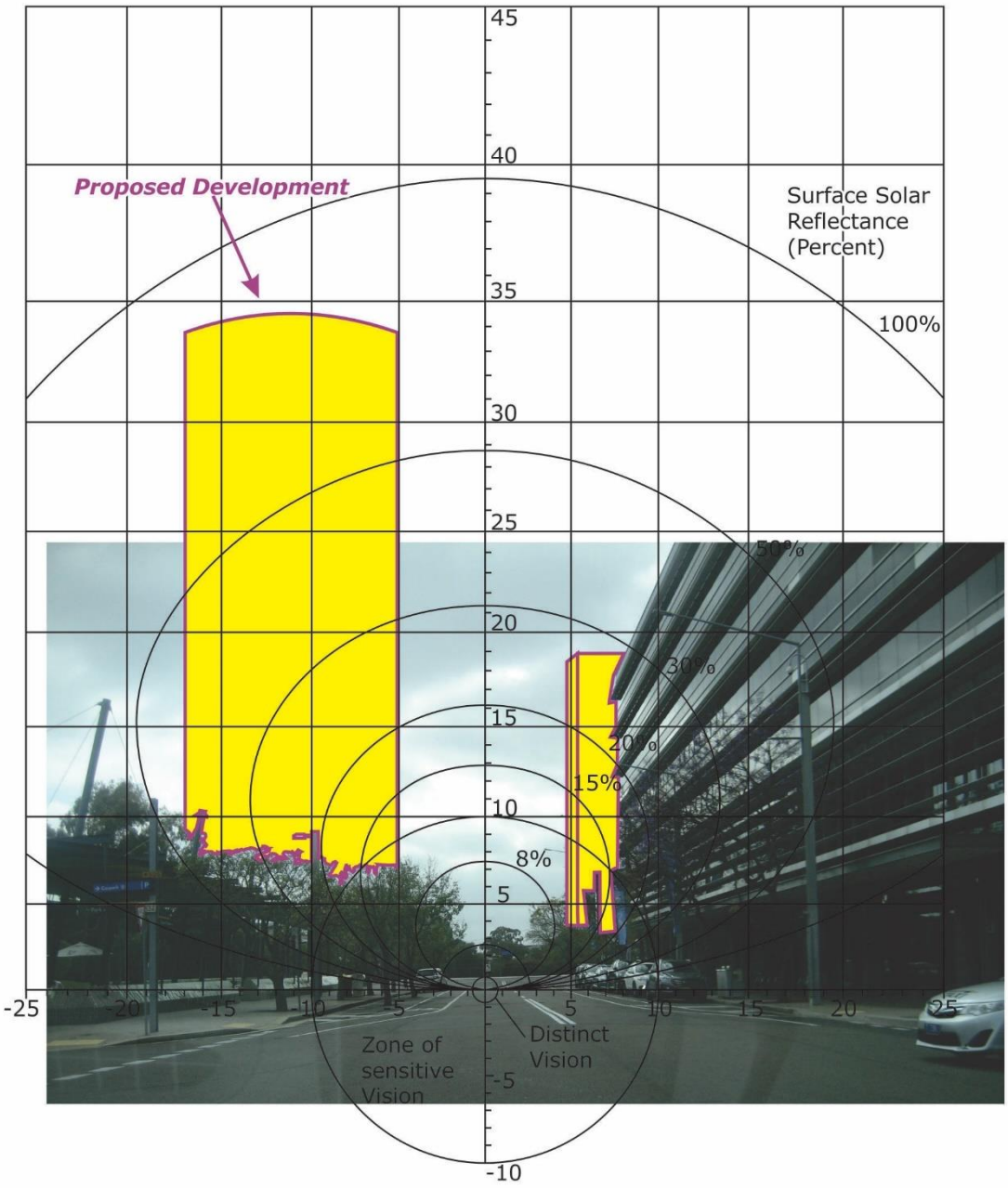

Figure A.12: Glare Overlay of the Viewpoint at Point 12

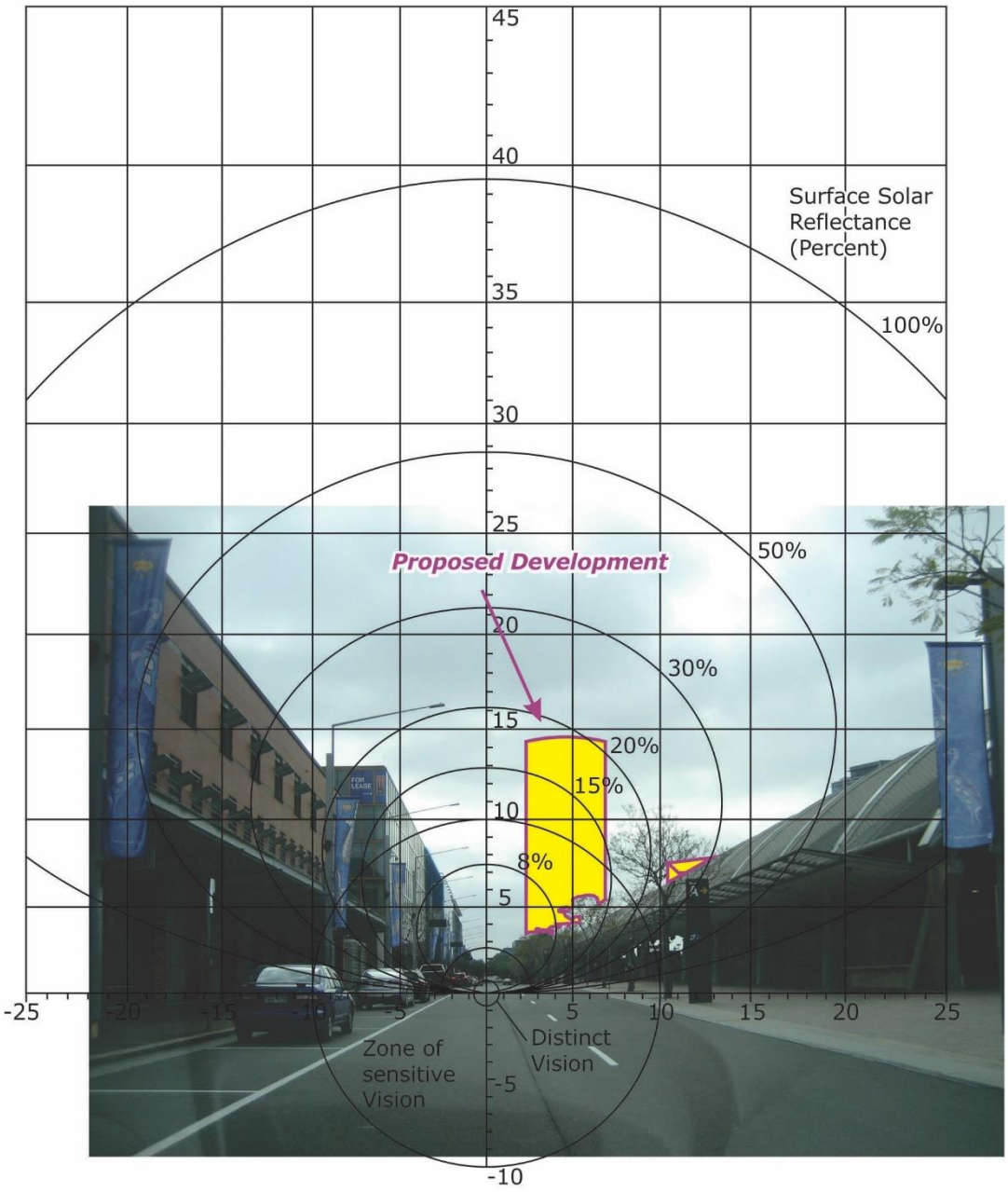

Figure A.13: Glare Overlay of the Viewpoint at Point 13

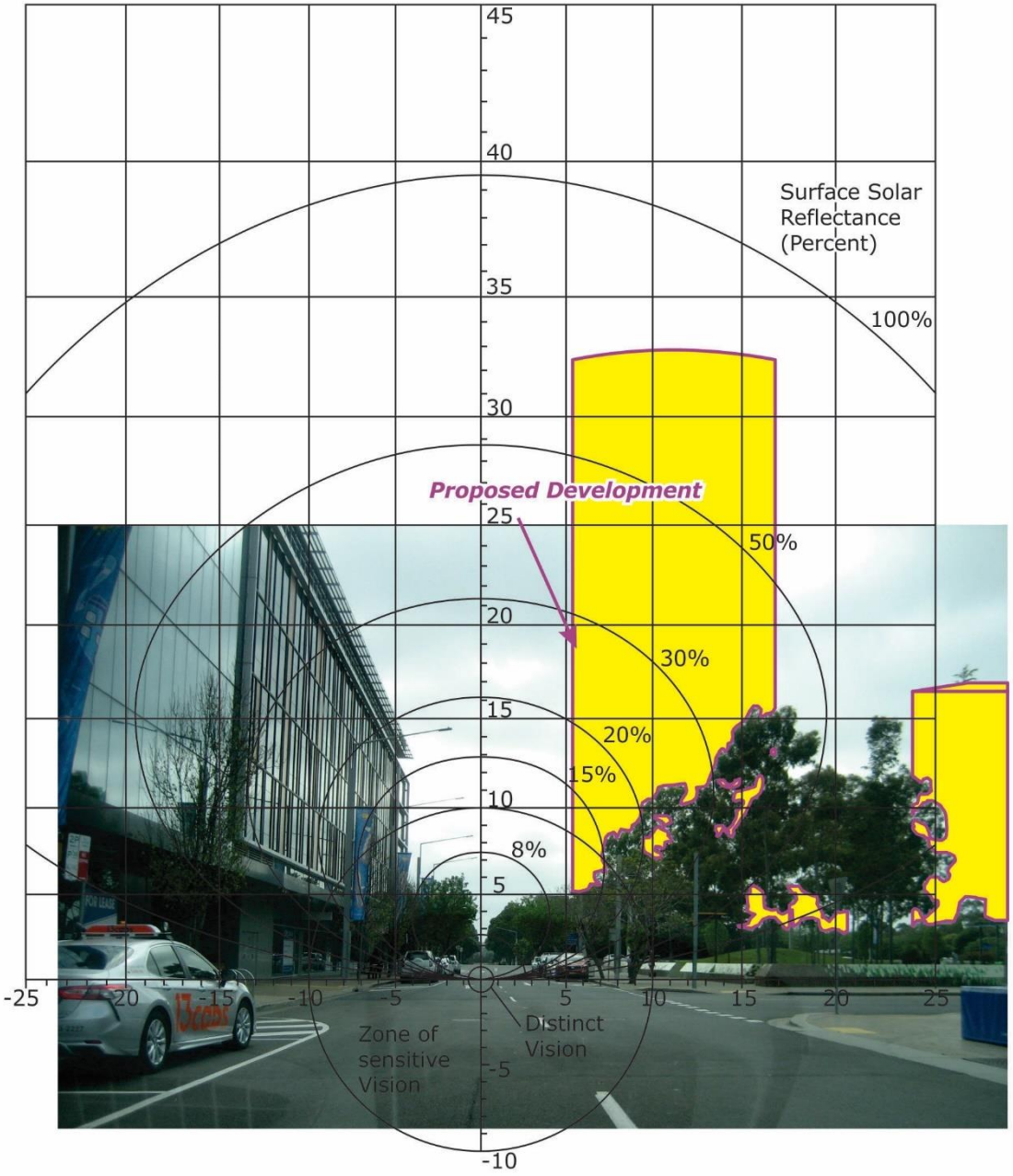

Figure A.14: Glare Overlay of the Viewpoint at Point 14

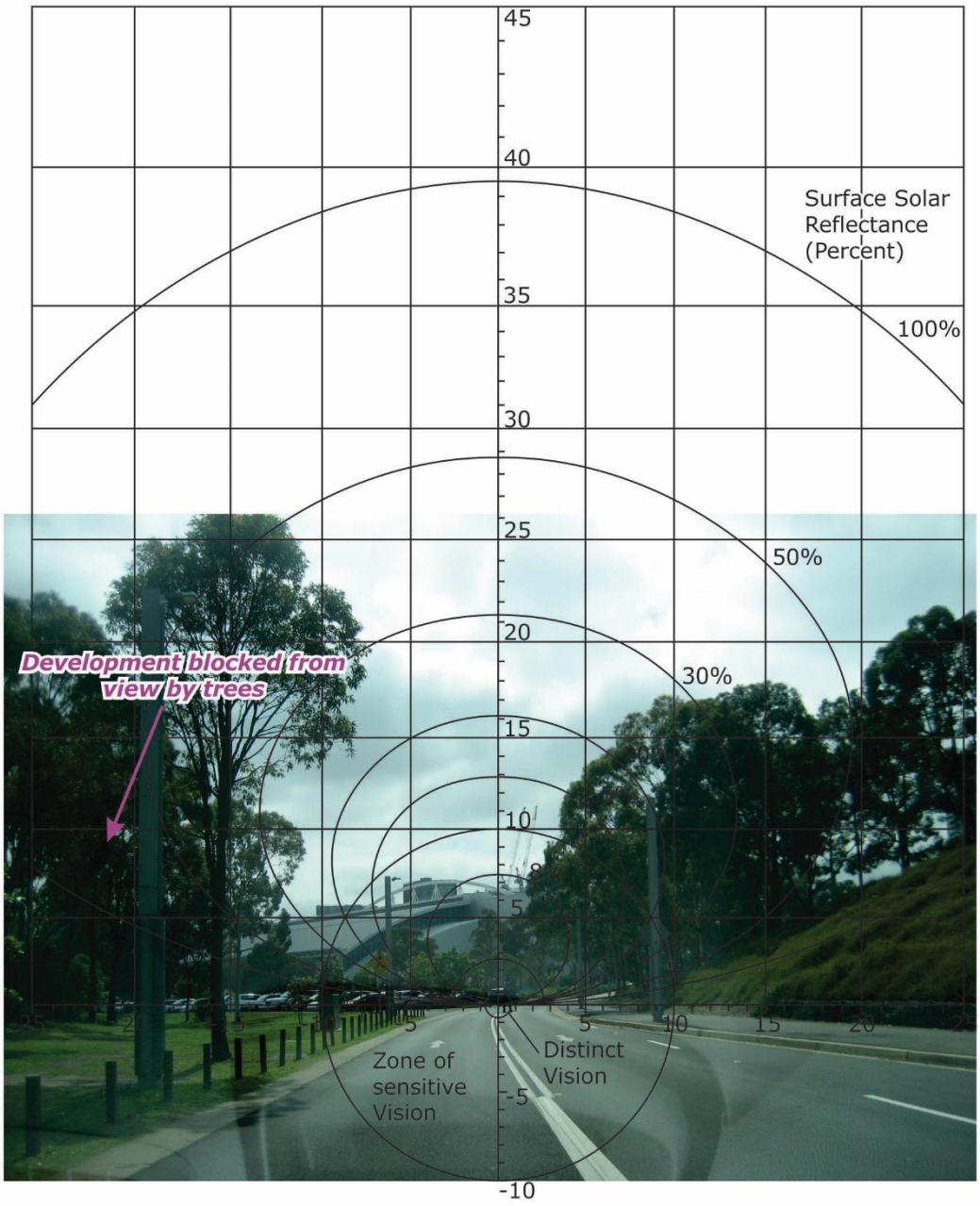

Figure A.15: Glare Overlay of the Viewpoint at Point 15

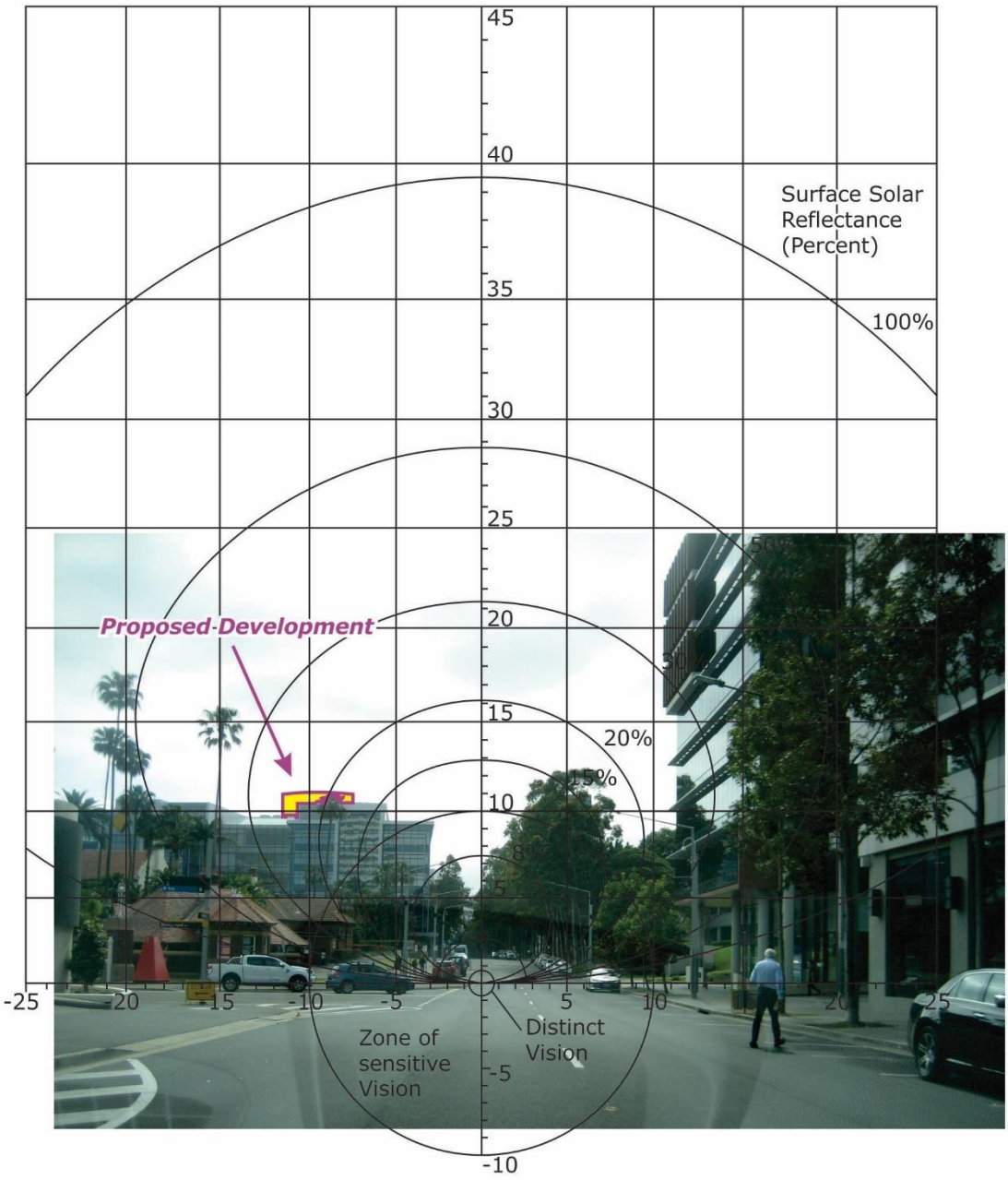

Figure A.16: Glare Overlay of the Viewpoint at Point 16

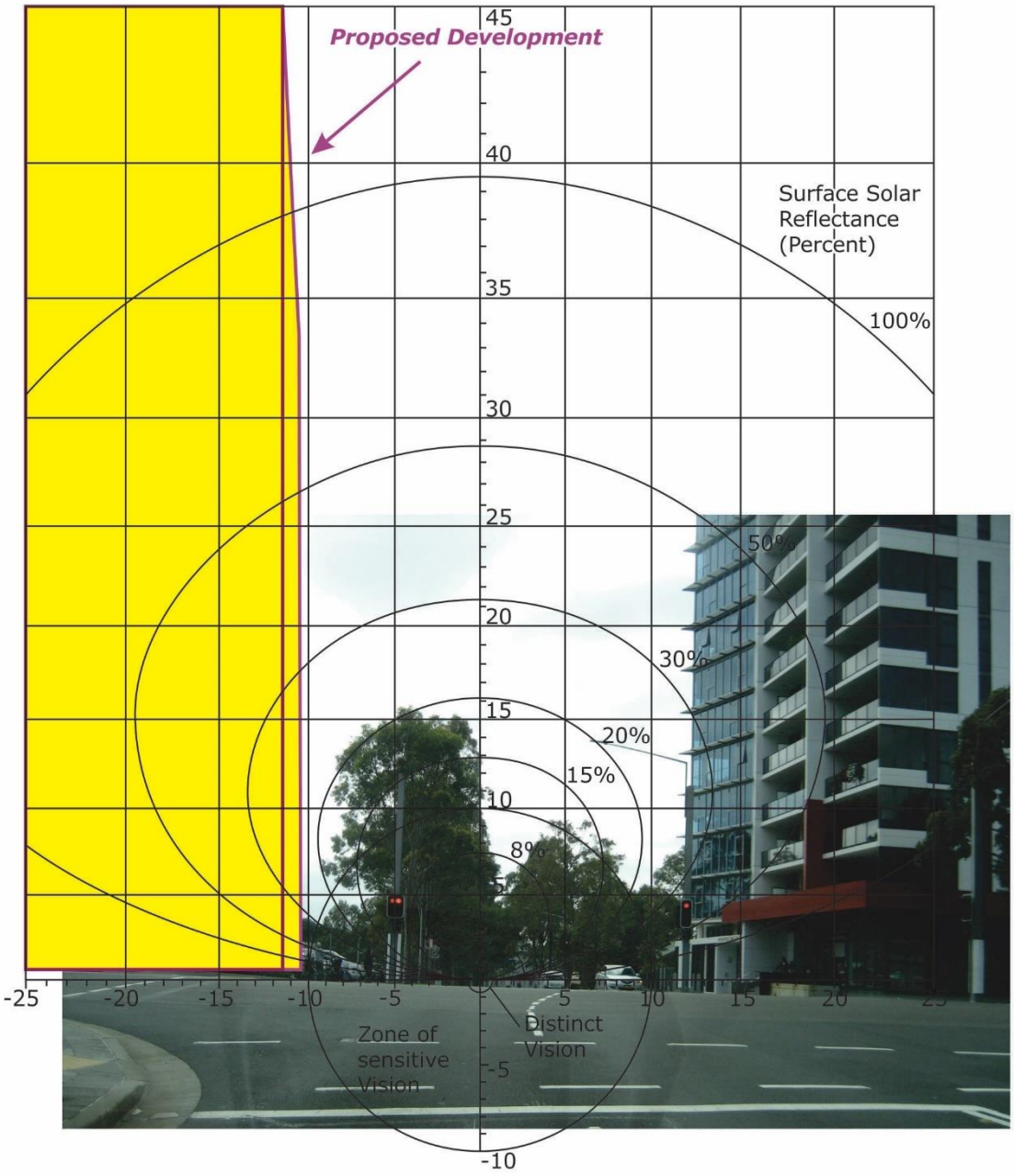

Figure A.17: Glare Overlay of the Viewpoint at Point 17

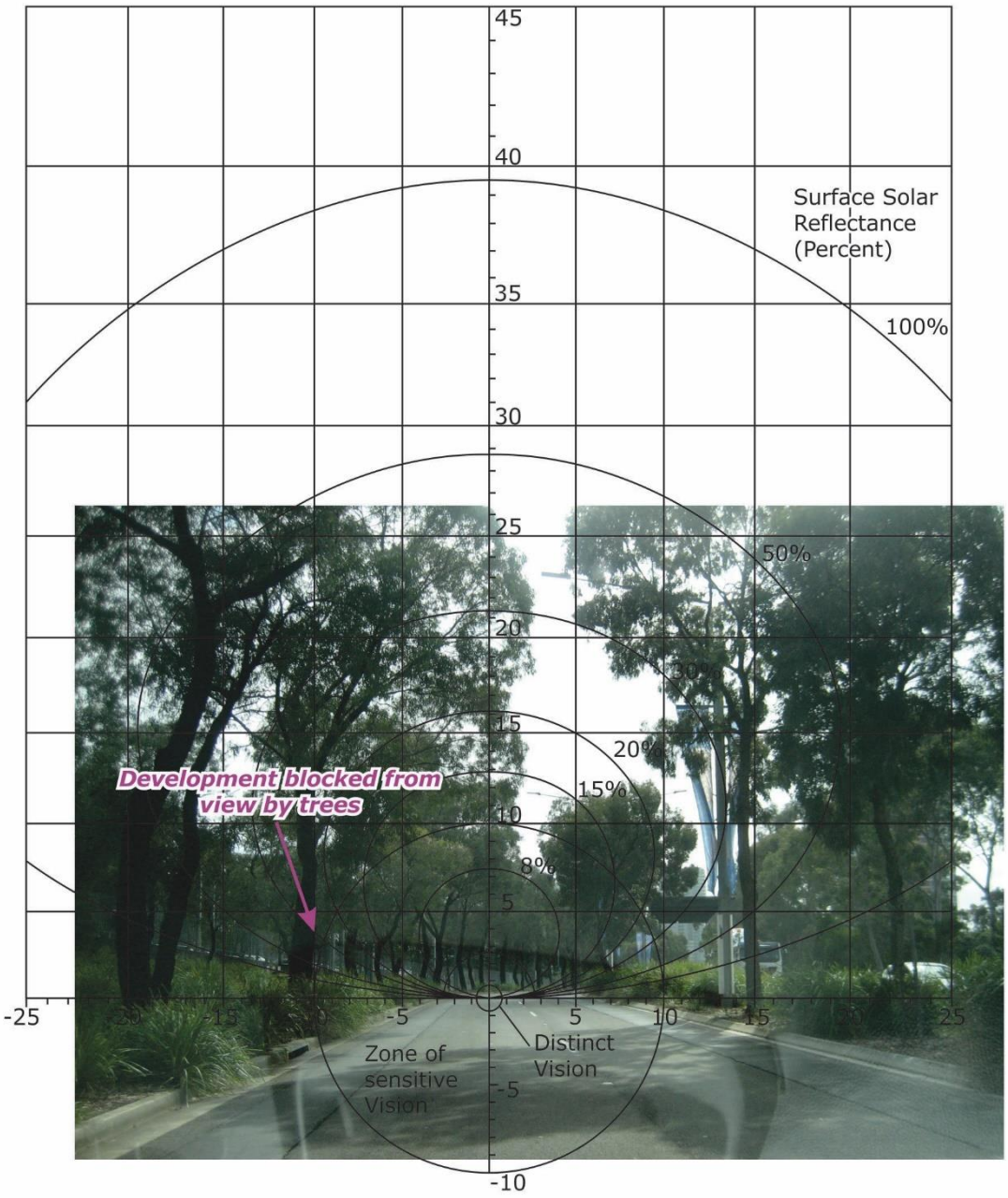

Figure A.18: Glare Overlay of the Viewpoint at Point 18

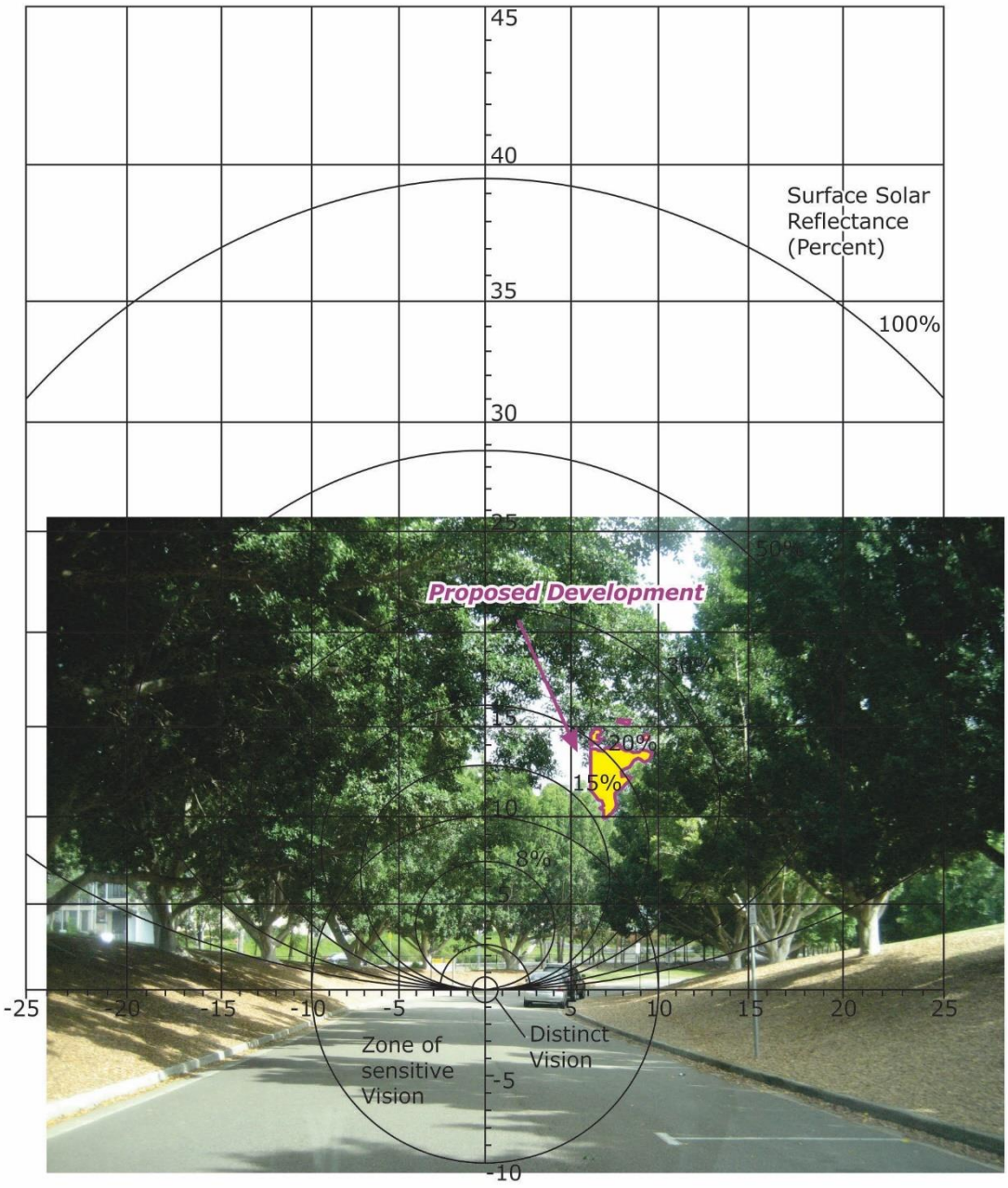

Figure A.19: Glare Overlay of the Viewpoint at Point 19

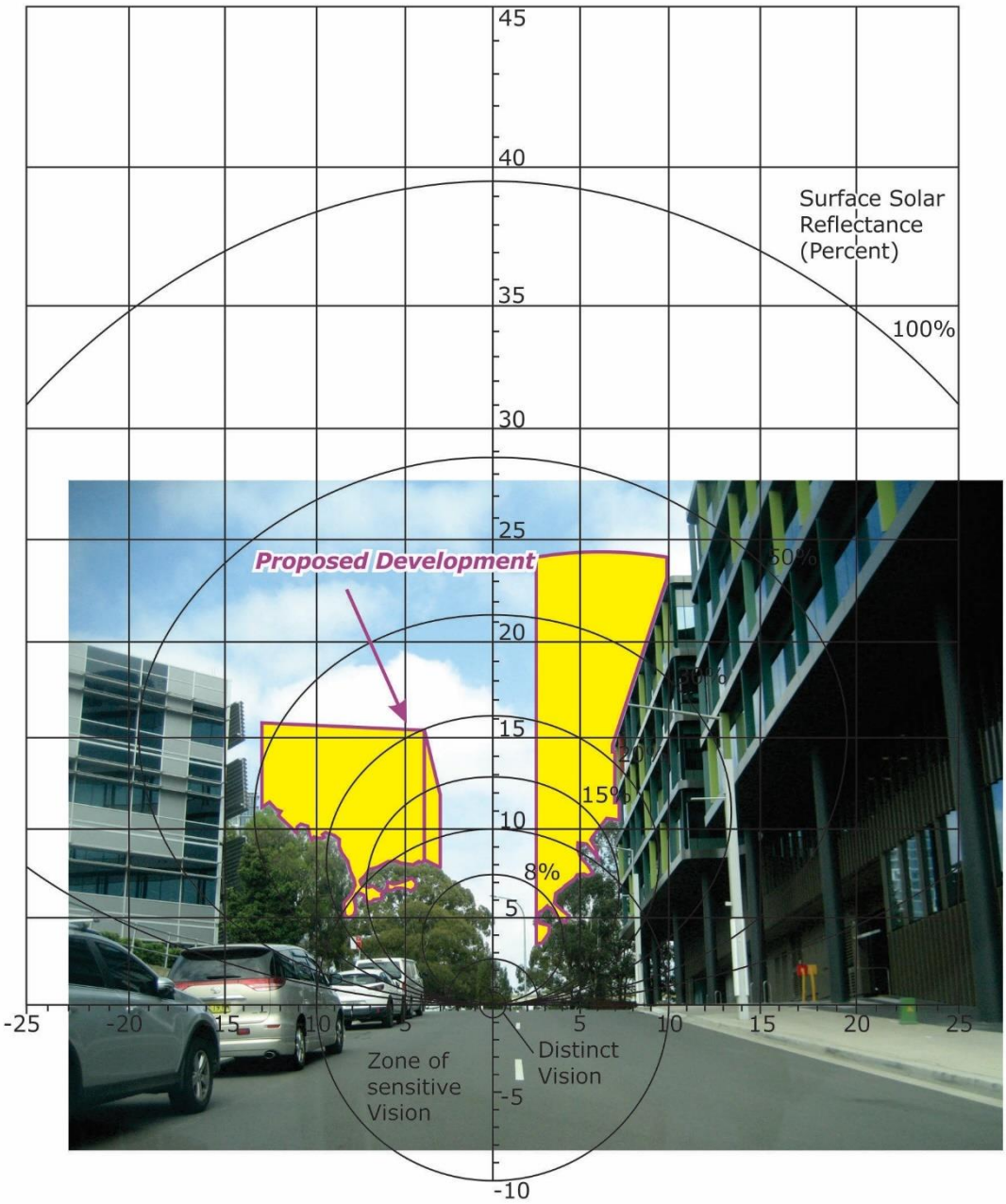

Figure A.20: Glare Overlay of the Viewpoint at Point 20

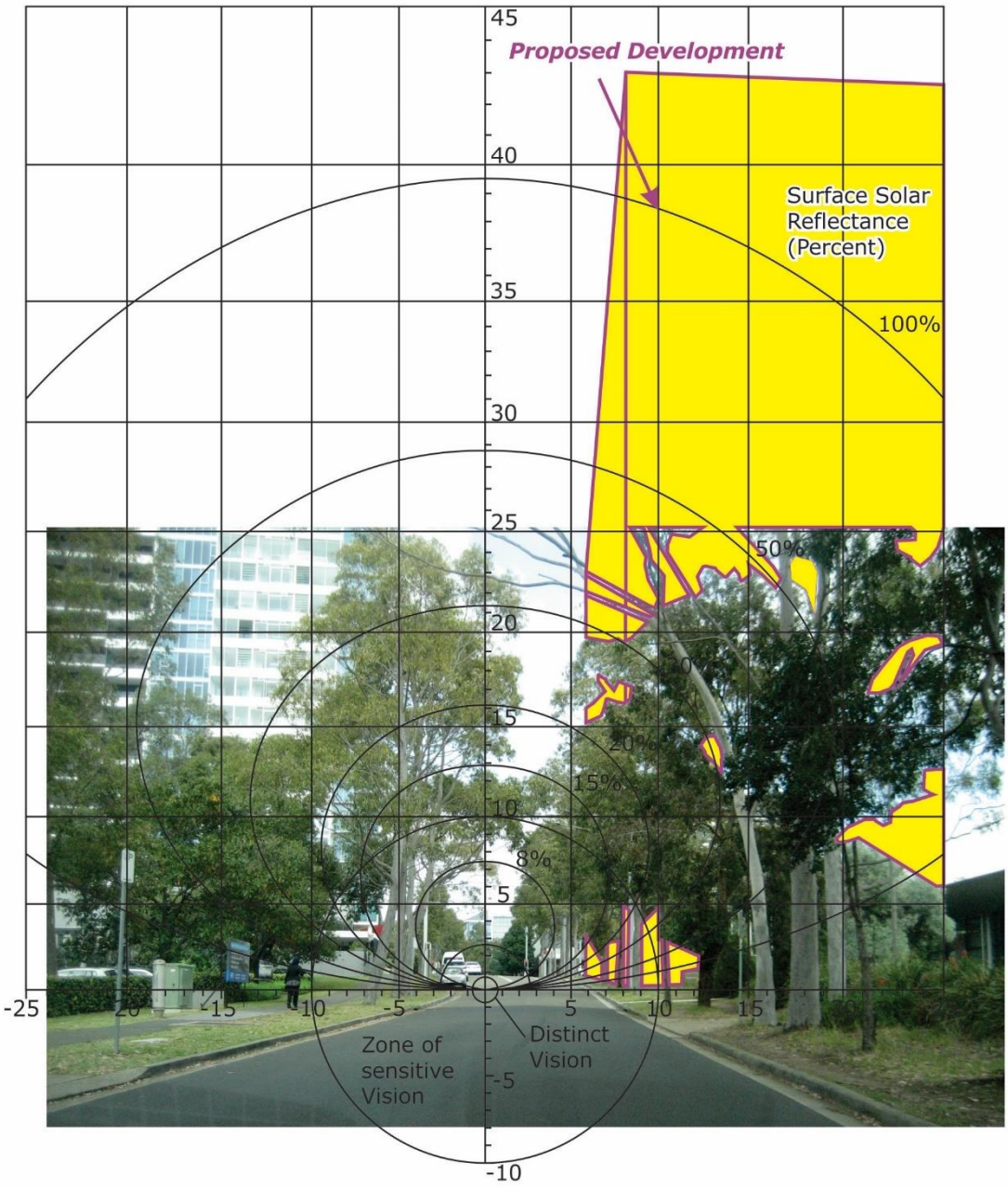

Figure A.21: Glare Overlay of the Viewpoint at Point 21

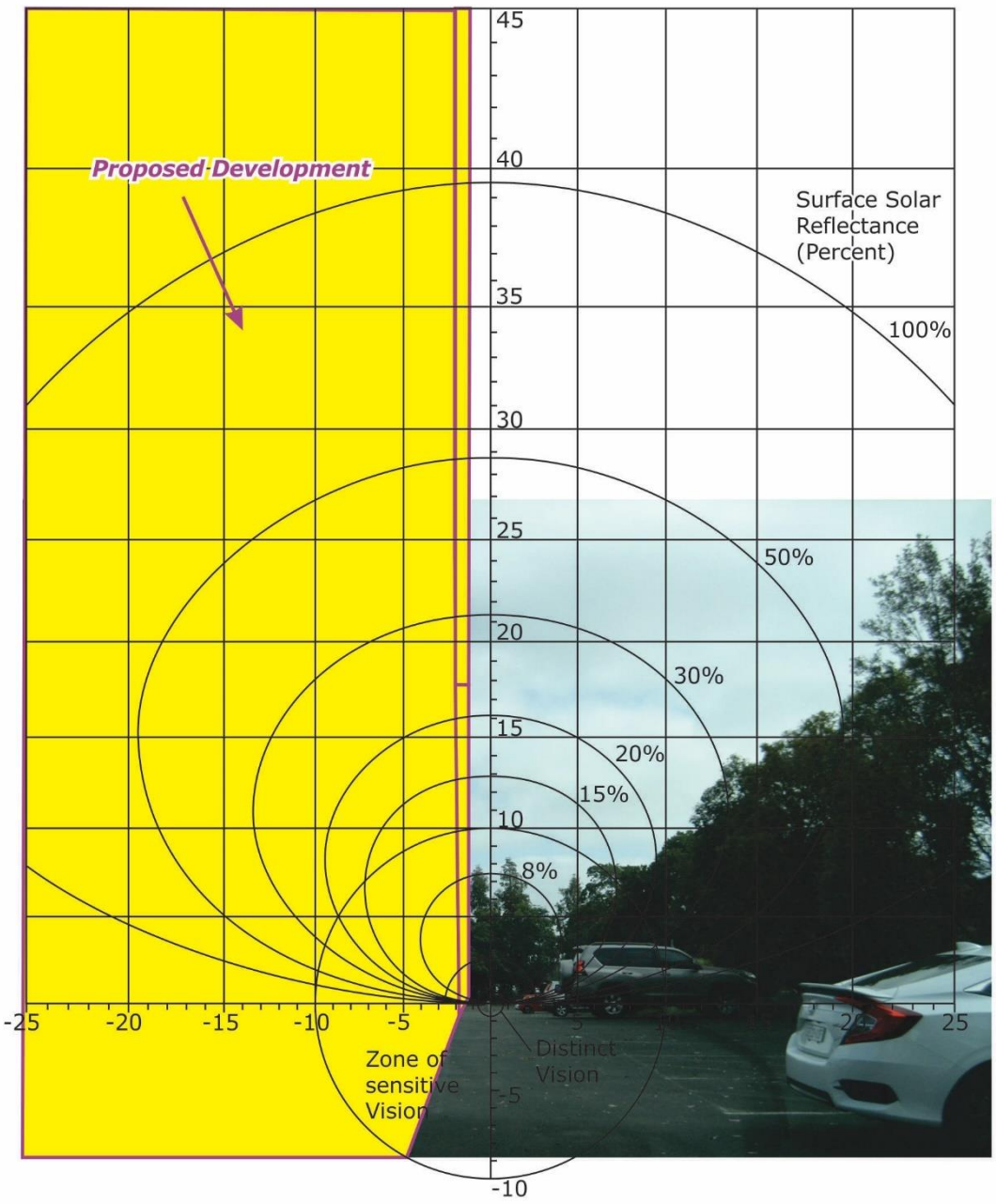

Figure A.22: Glare Overlay of the Viewpoint at Point 22

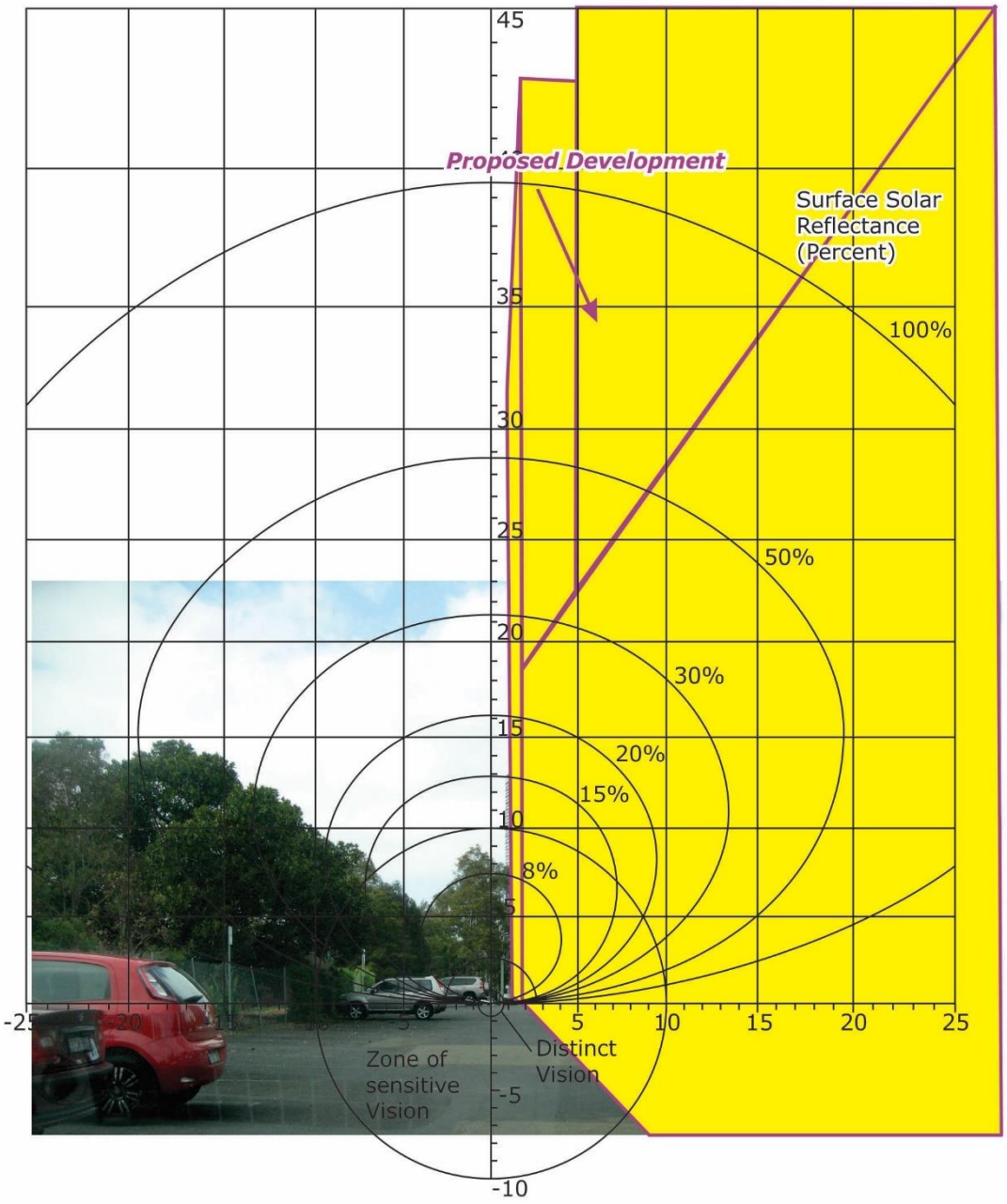

Figure A.23: Glare Overlay of the Viewpoint at Point 23

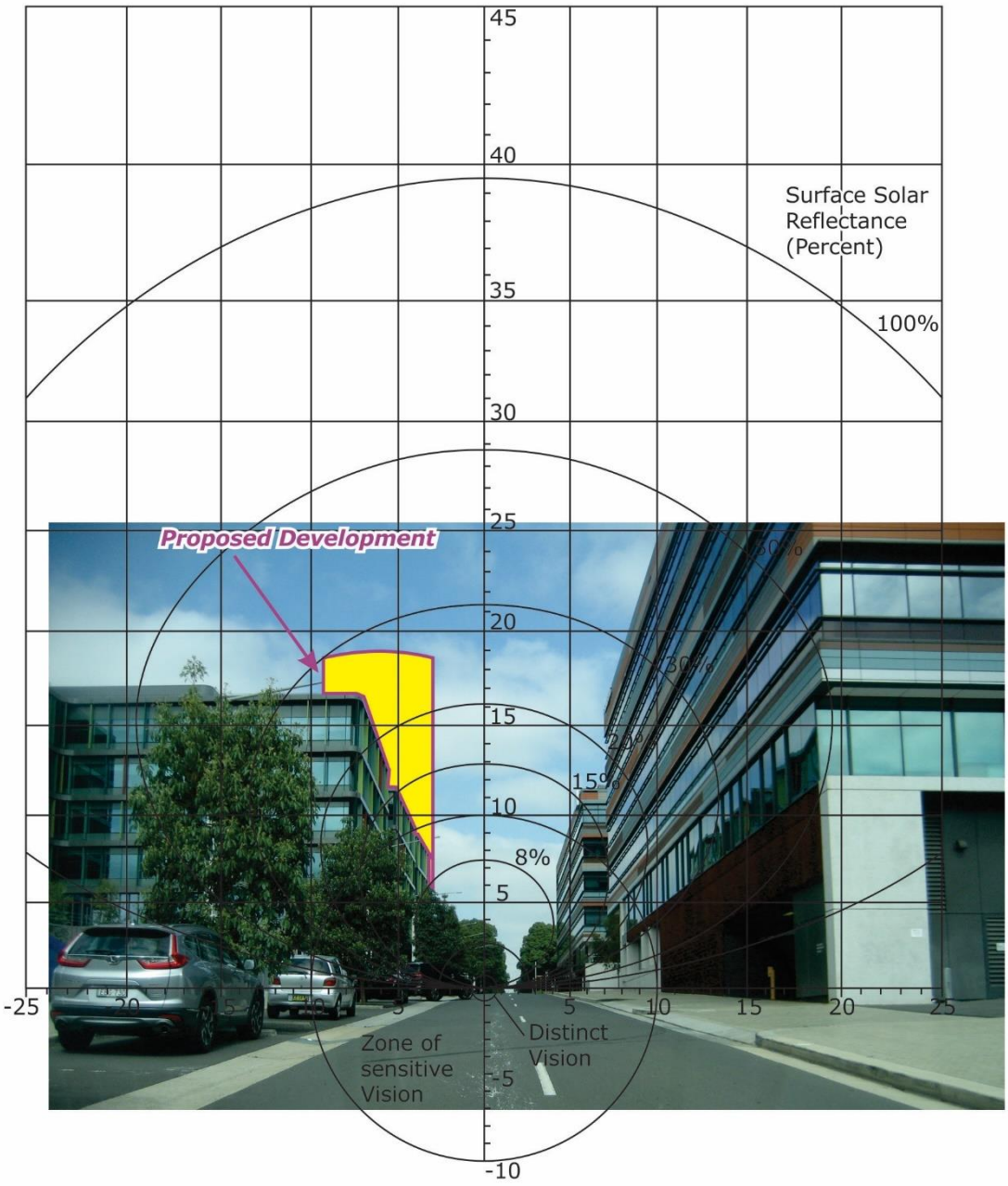

Figure A.24: Glare Overlay of the Viewpoint at Point 24

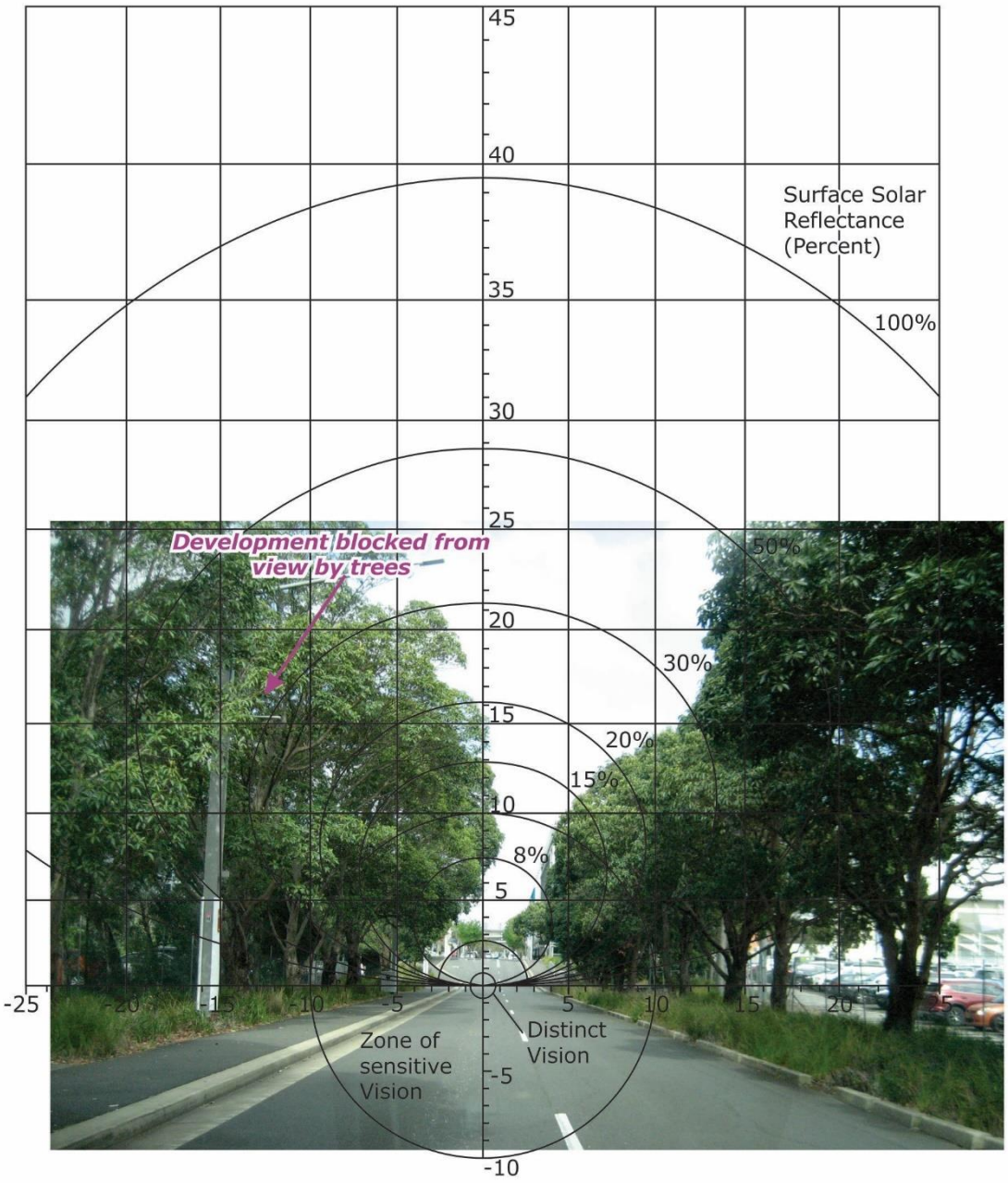

Figure A.25: Glare Overlay of the Viewpoint at Point 25

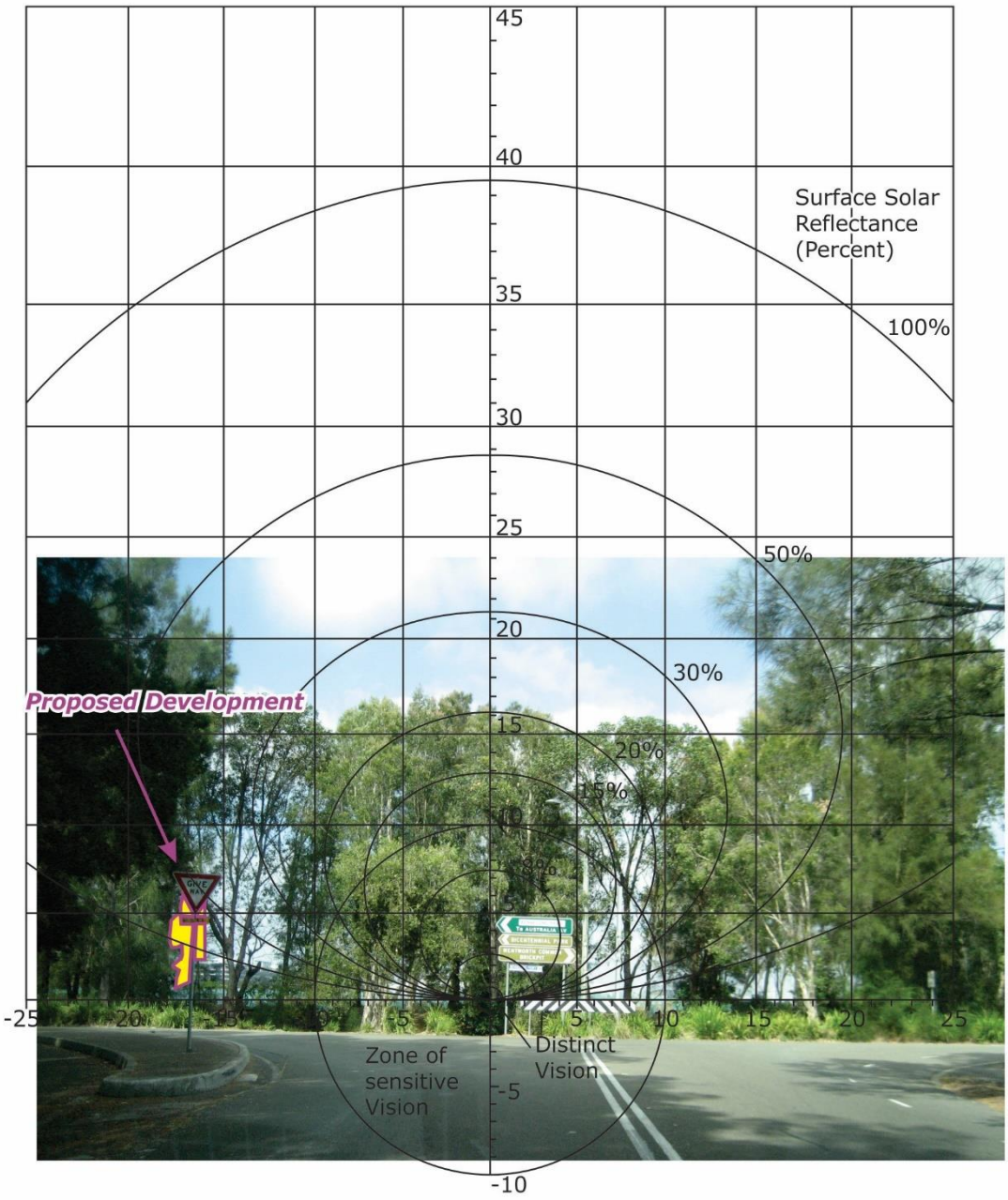

Figure A.26: Glare Overlay of the Viewpoint at Point 26

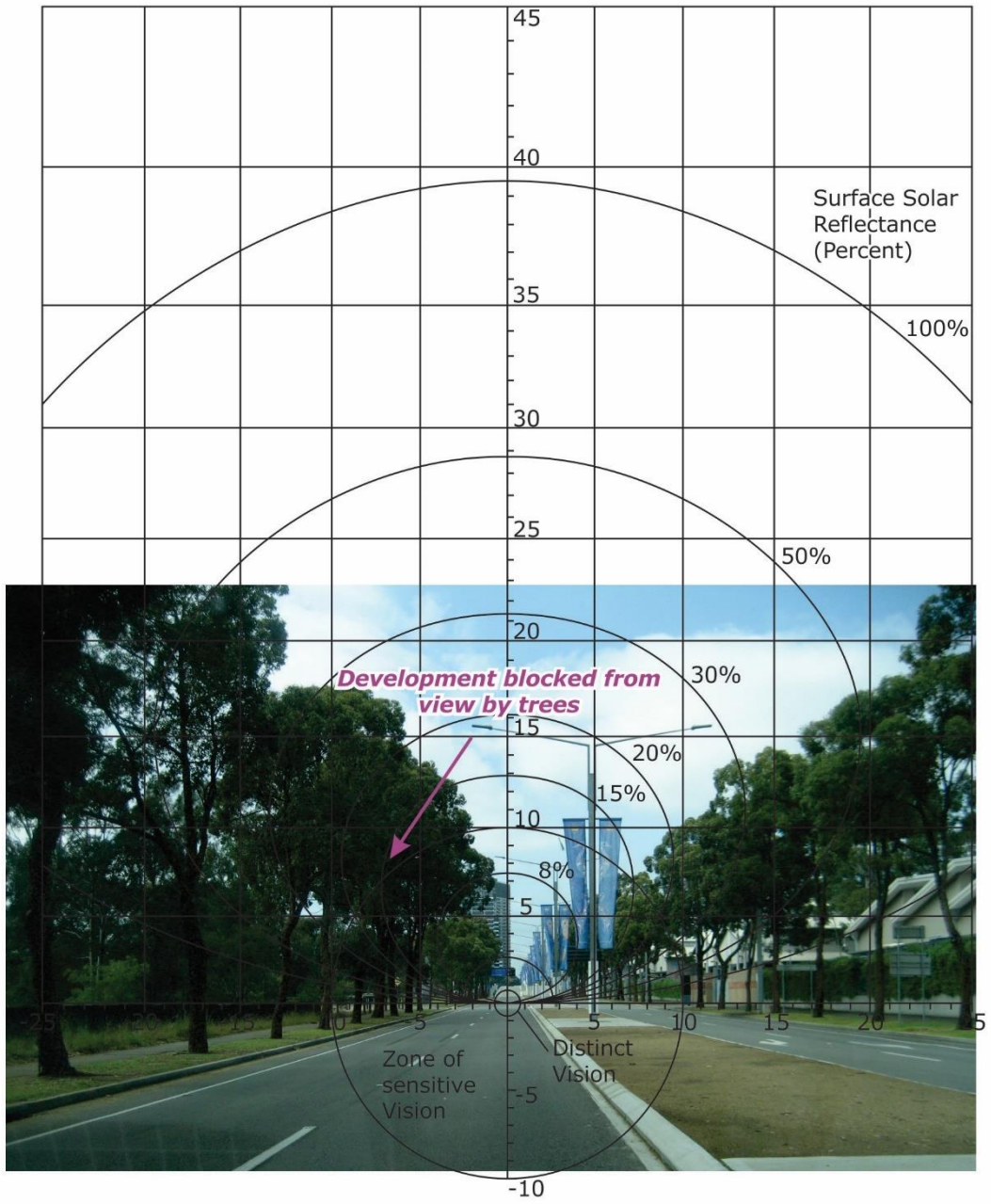

Figure A.27: Glare Overlay of the Viewpoint at Point 27

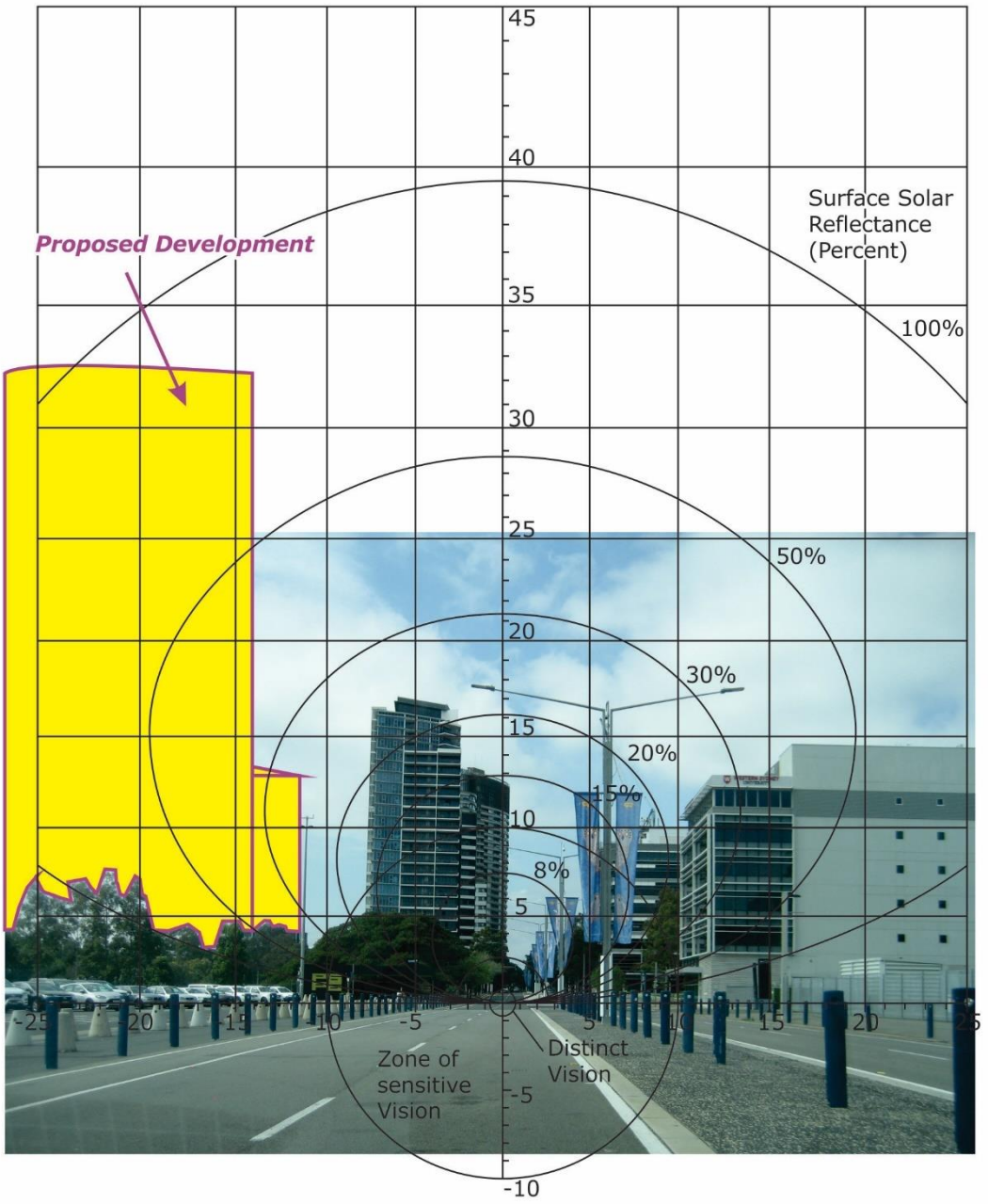

Figure A.28: Glare Overlay of the Viewpoint at Point 28

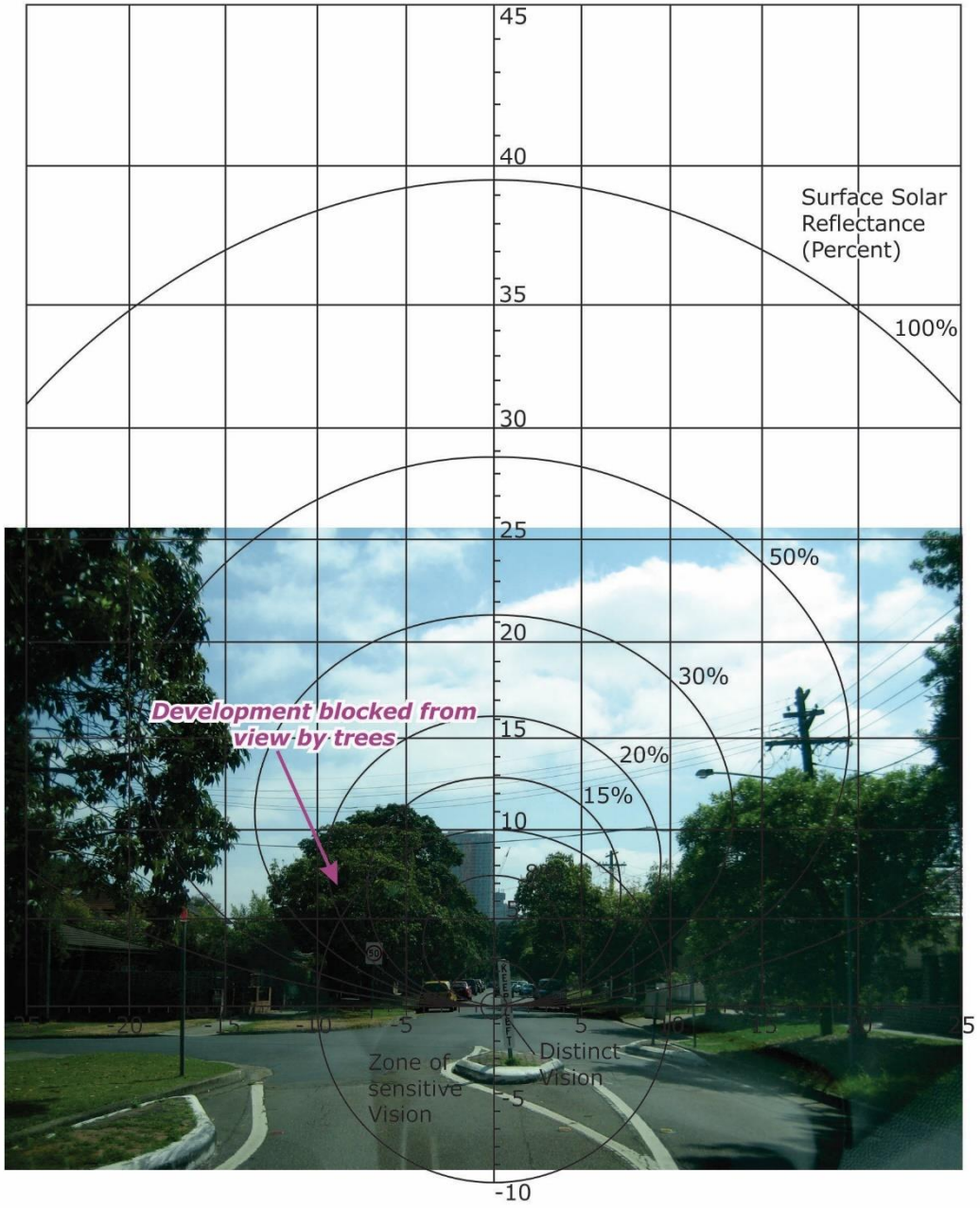

Figure A.29: Glare Overlay of the Viewpoint at Point 29

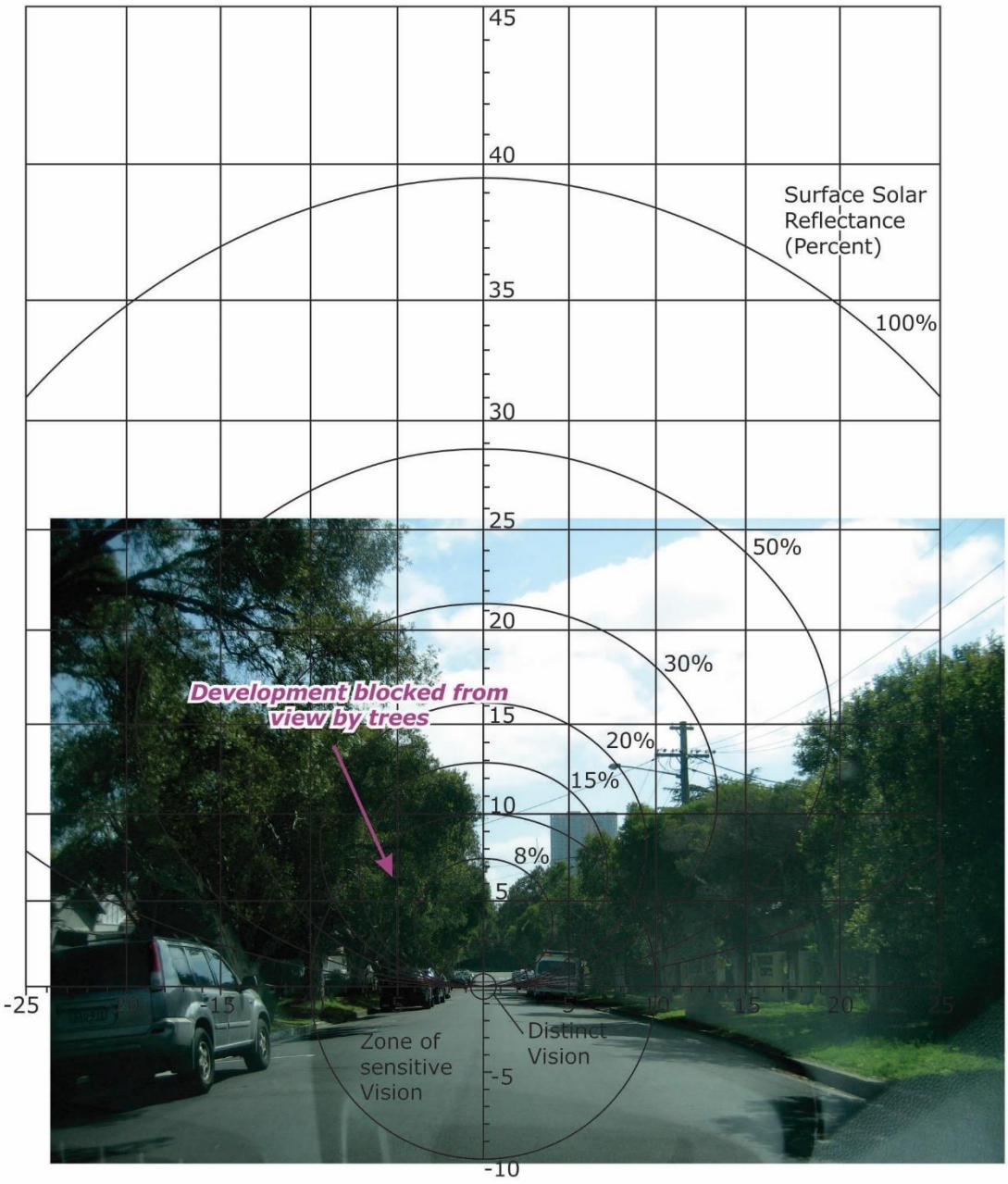

Figure A.30: Glare Overlay of the Viewpoint at Point 30

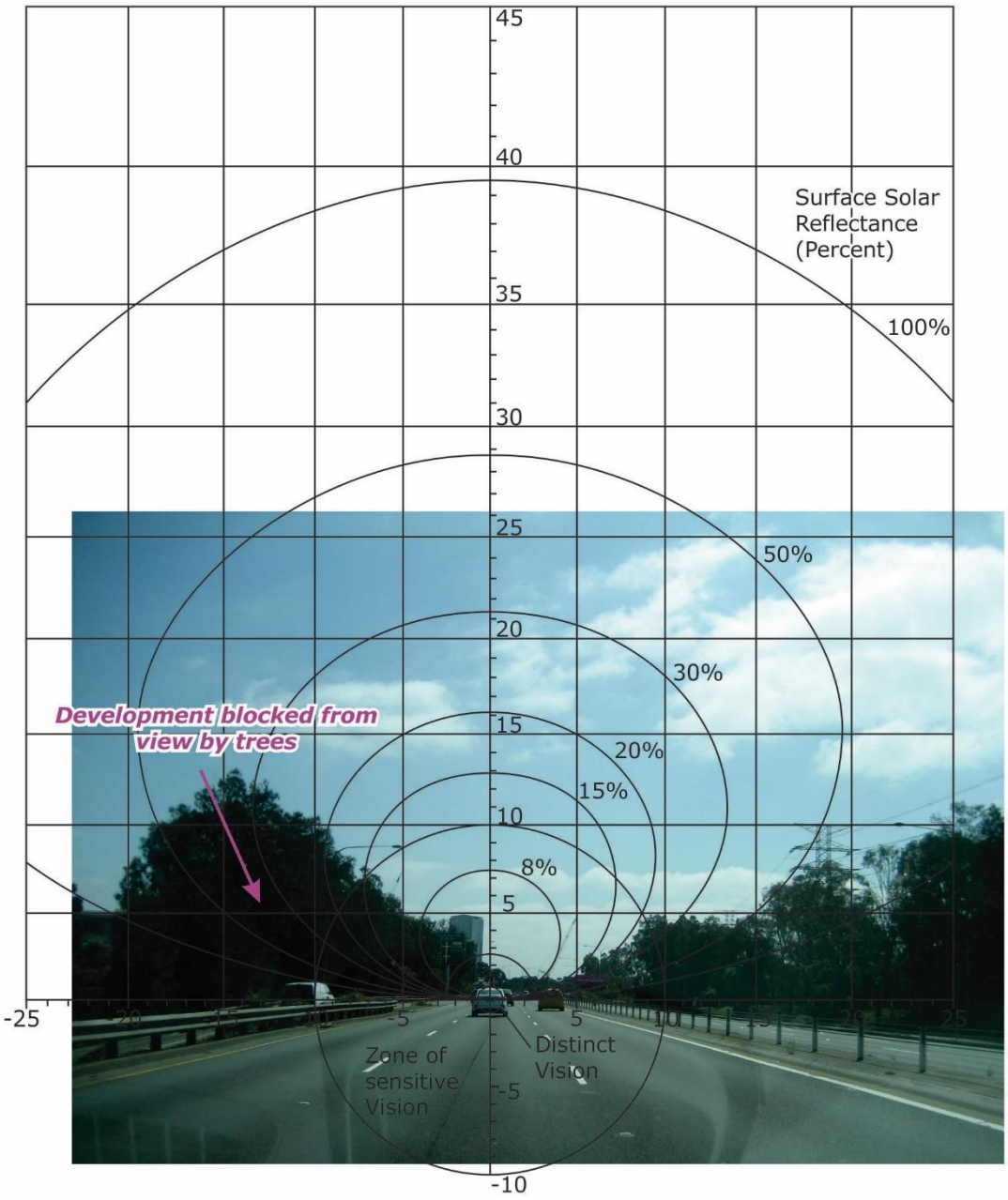

Figure A.31: Glare Overlay of the Viewpoint at Point 31

APPENDIX B SOLAR CHARTS FOR THE VARIOUS CRITICAL ASPECTS

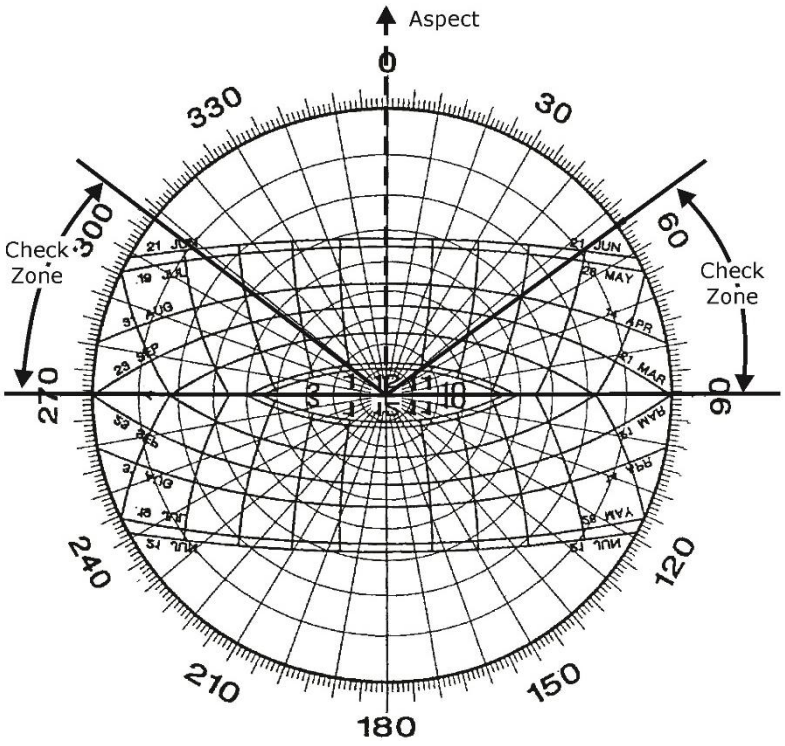

Figure B.1: Sun Chart for the 000° Aspect

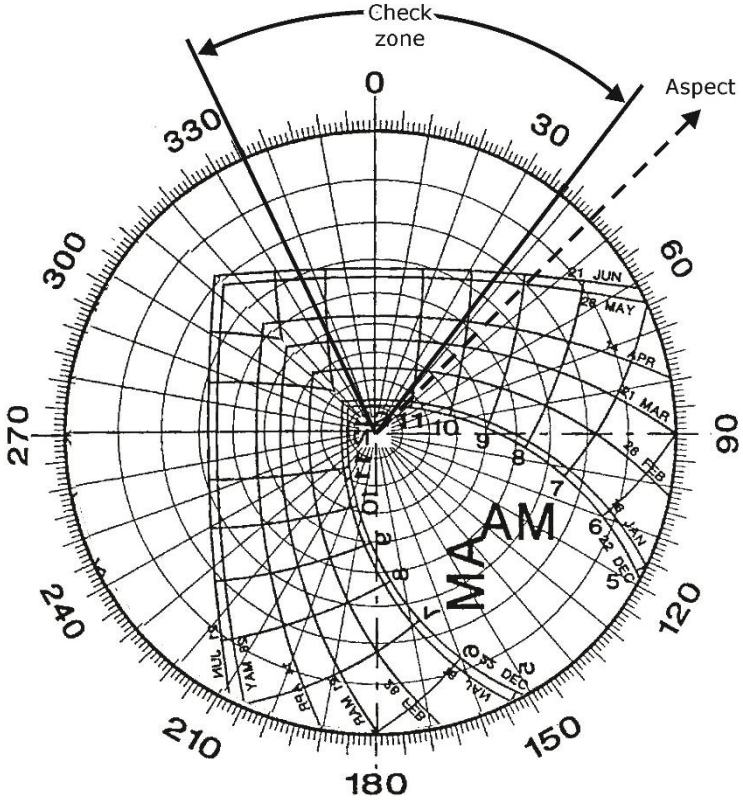

Figure B.2: Sun Chart for the 045° Aspect

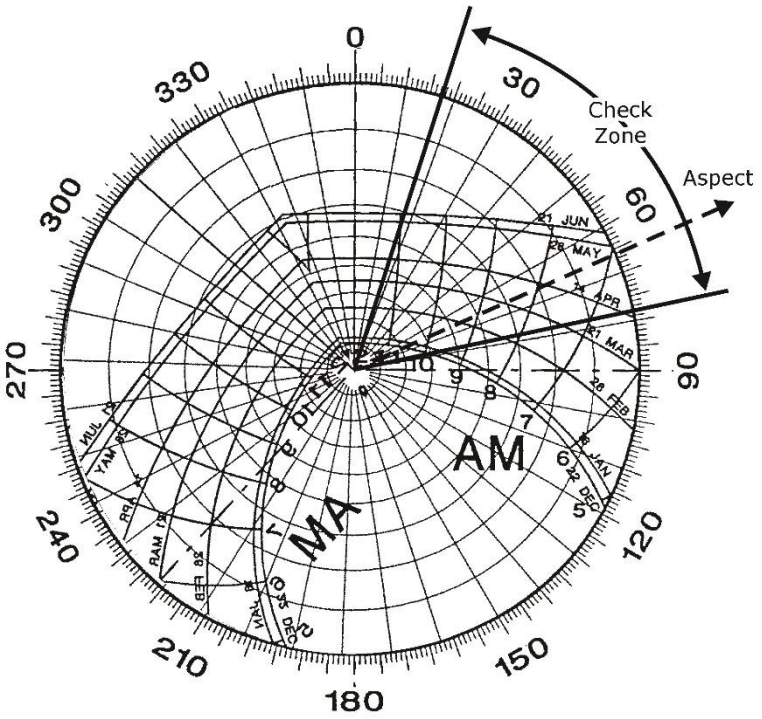

Figure B.3: Sun Chart for the 066° Aspect

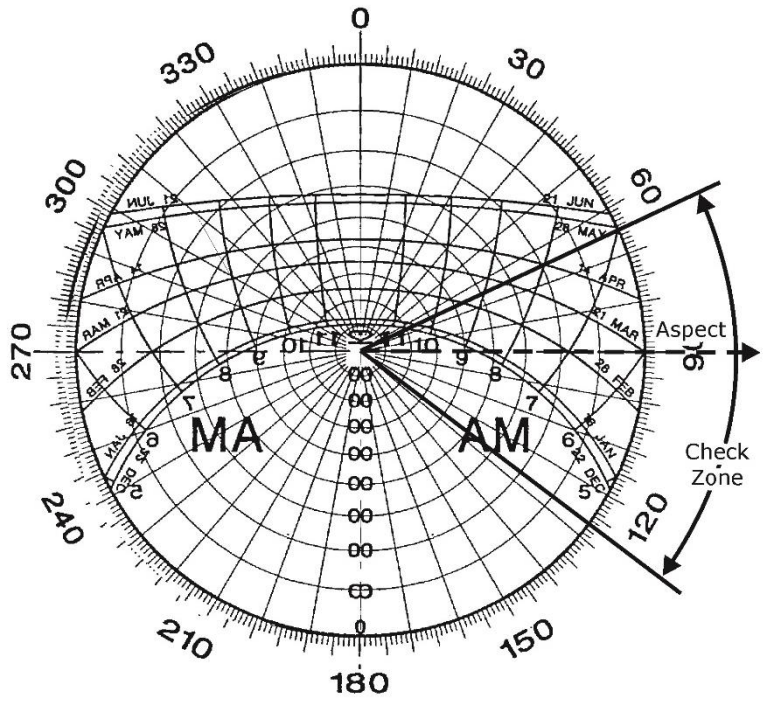

Figure B.4: Sun Chart for the 090° Aspect

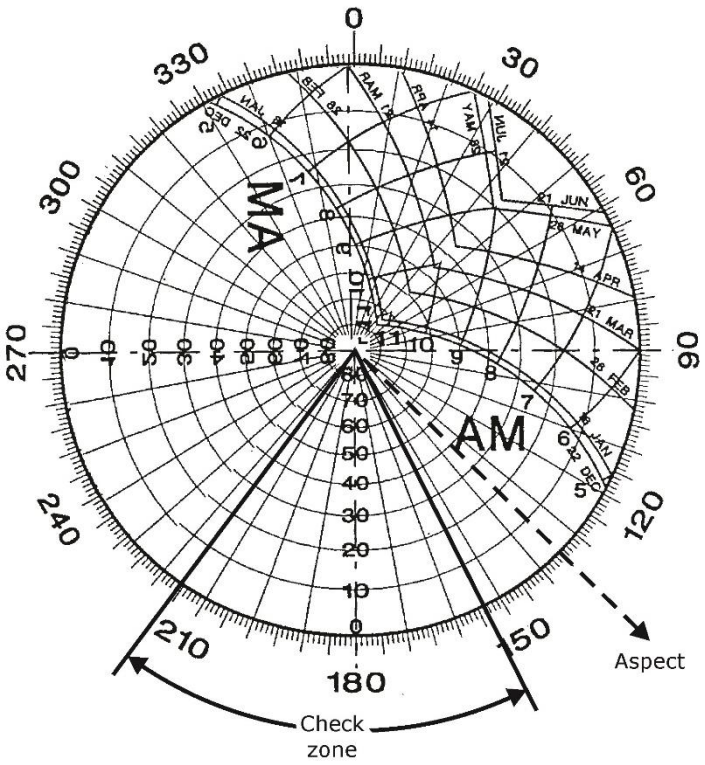

Figure B.5: Sun Chart for the 135° Aspect

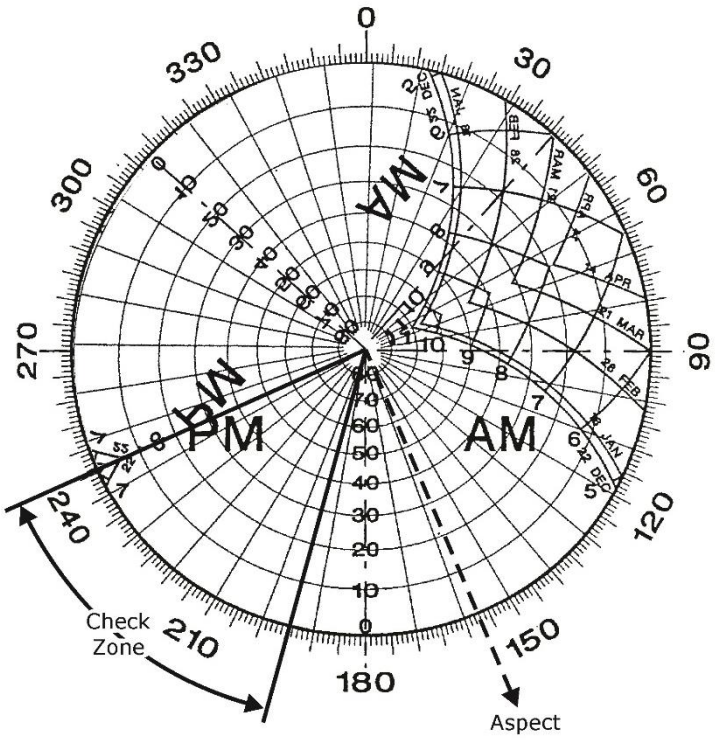

Figure B.6: Sun Chart for the 156° Aspect

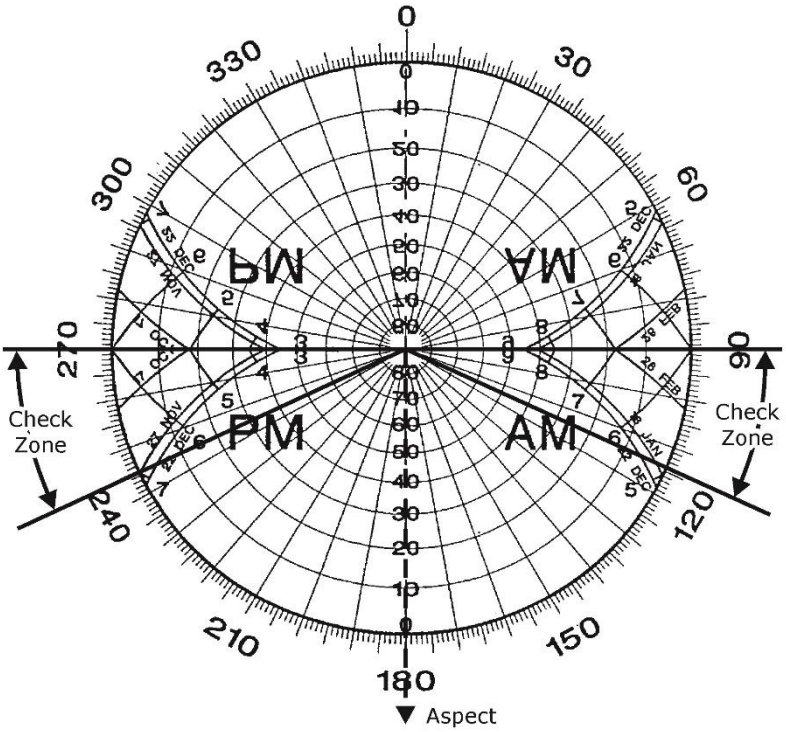

Figure B.7: Sun Chart for the 180° Aspect

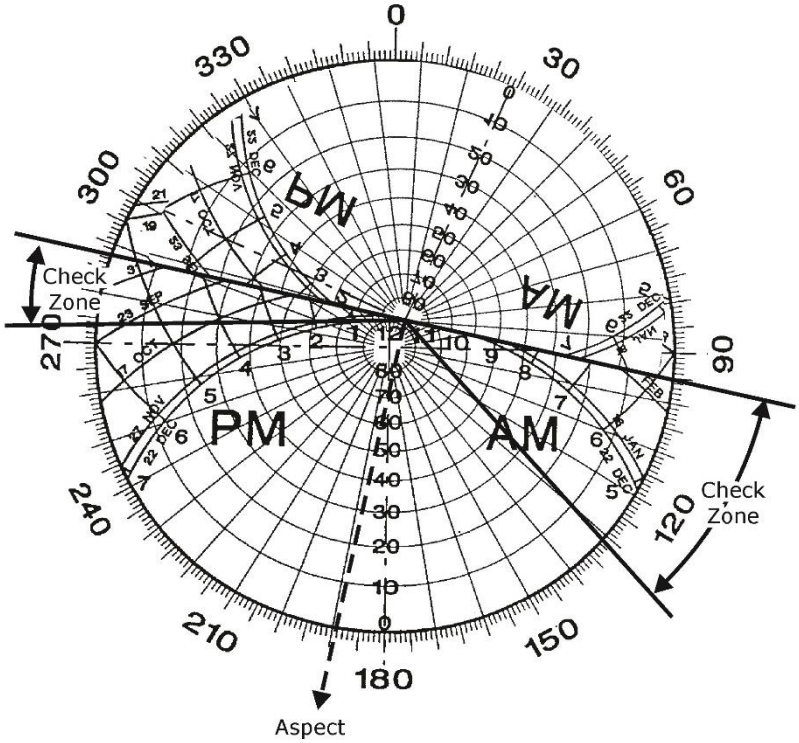

Figure B.8: Sun Chart for the 191° Aspect

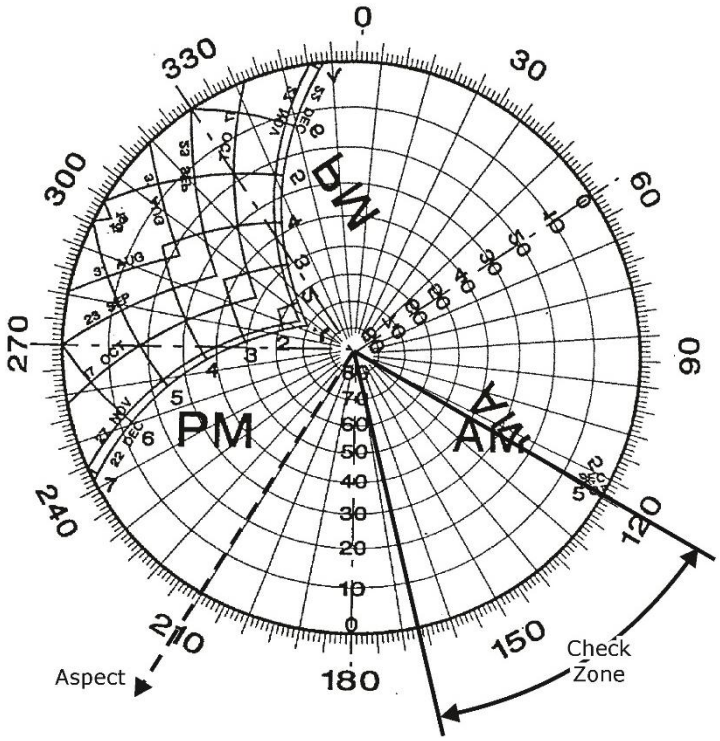

Figure B.9: Sun Chart for the 210° Aspect

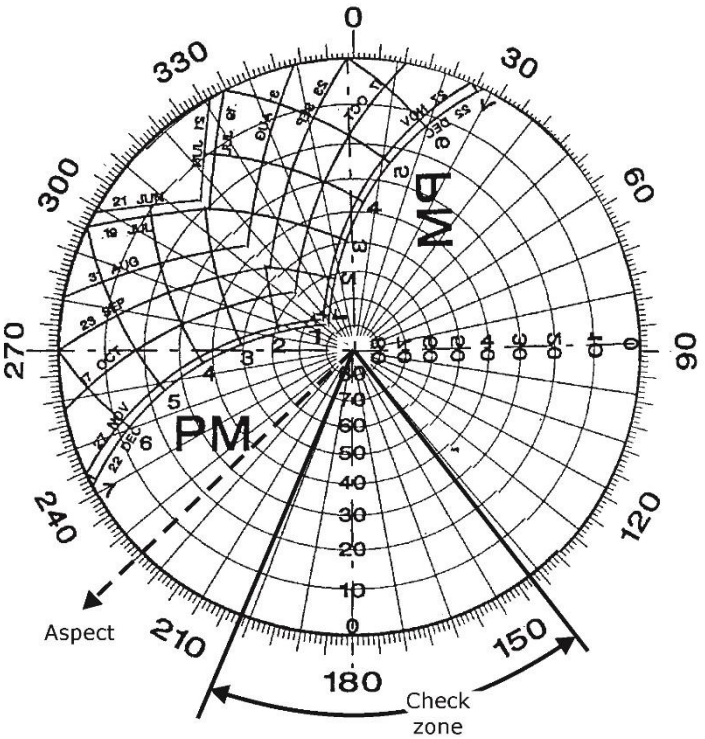

Figure B.10: Sun Chart for the 225° Aspect

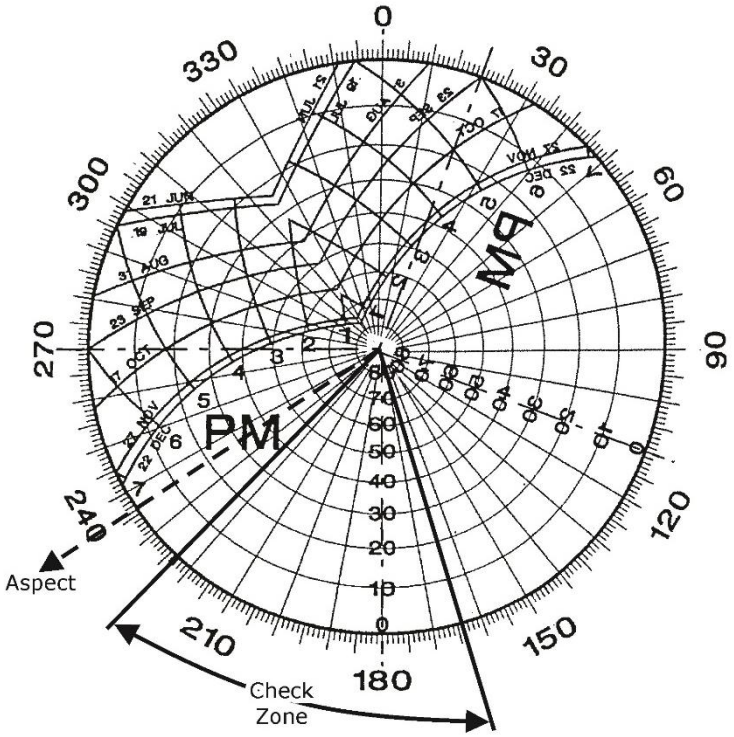

Figure B.11: Sun Chart for the 236° Aspect

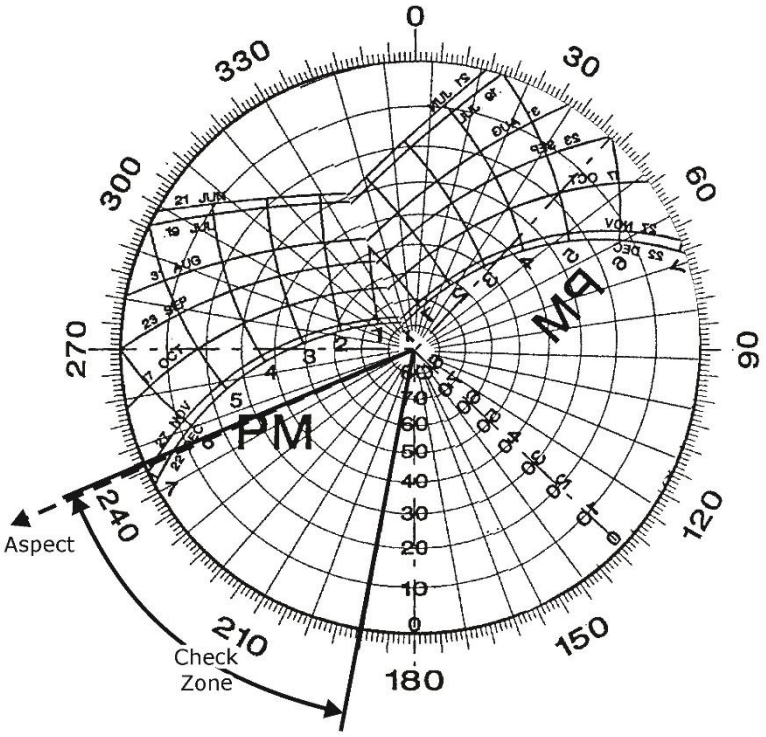

Figure B.12: Sun Chart for the 246° Aspect

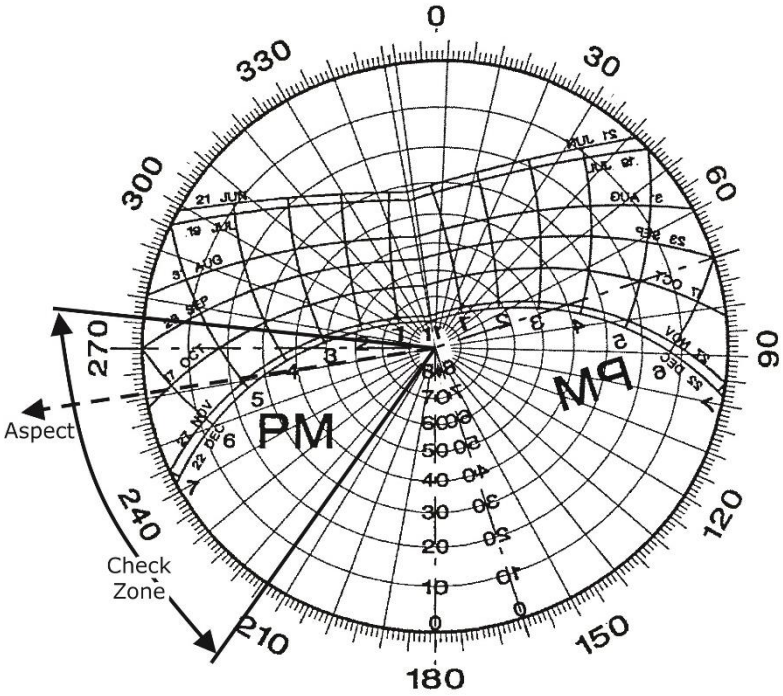

Figure B.13: Sun Chart for the 261° Aspect

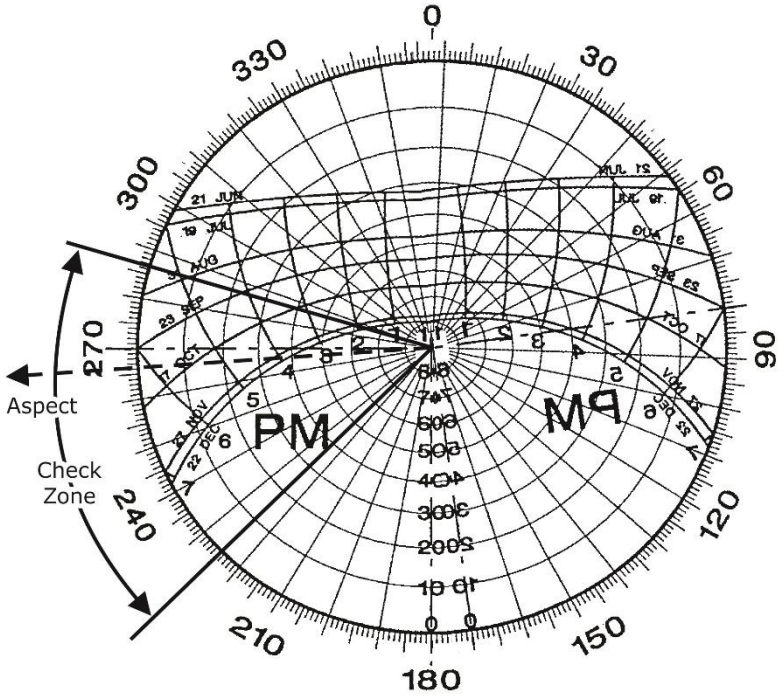

Figure B.14: Sun Chart for the 266° Aspect

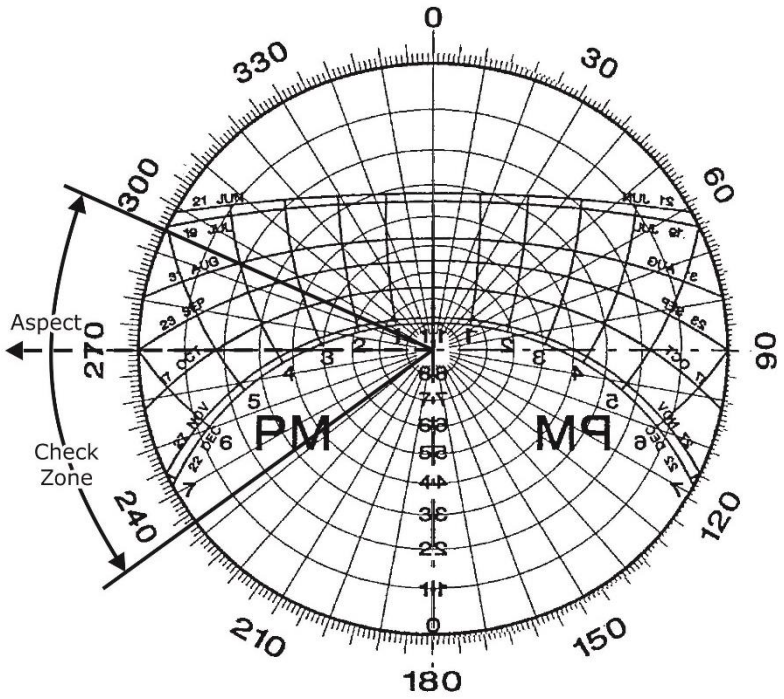

Figure B.15: Sun Chart for the 270° Aspect

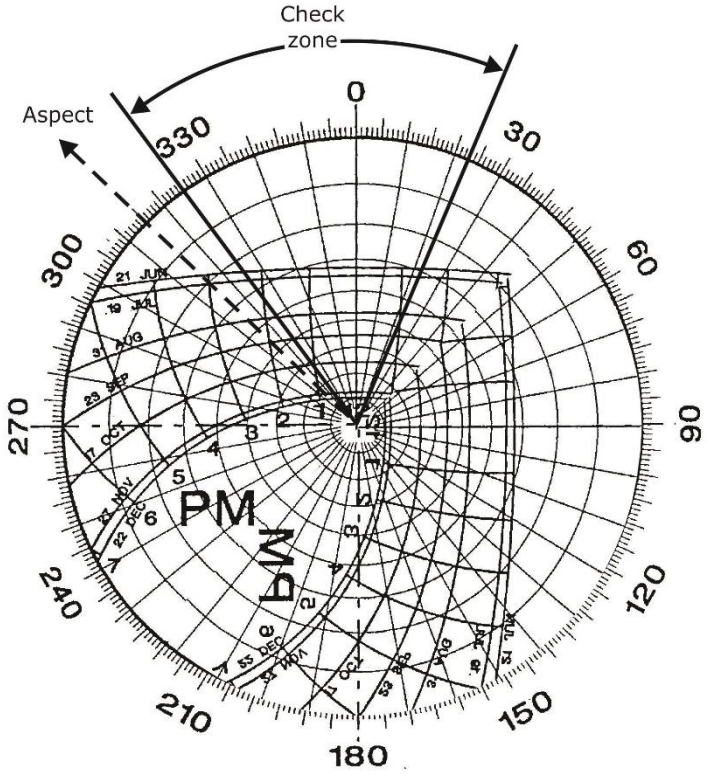

Figure B.16: Sun Chart for the 315° Aspect

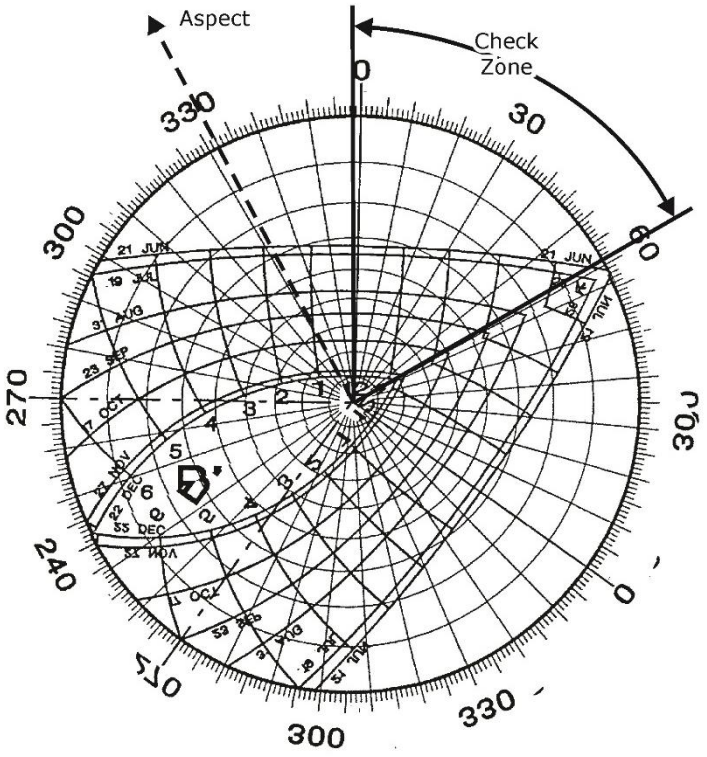

Figure B.17: Sun Chart for the 332° Aspect

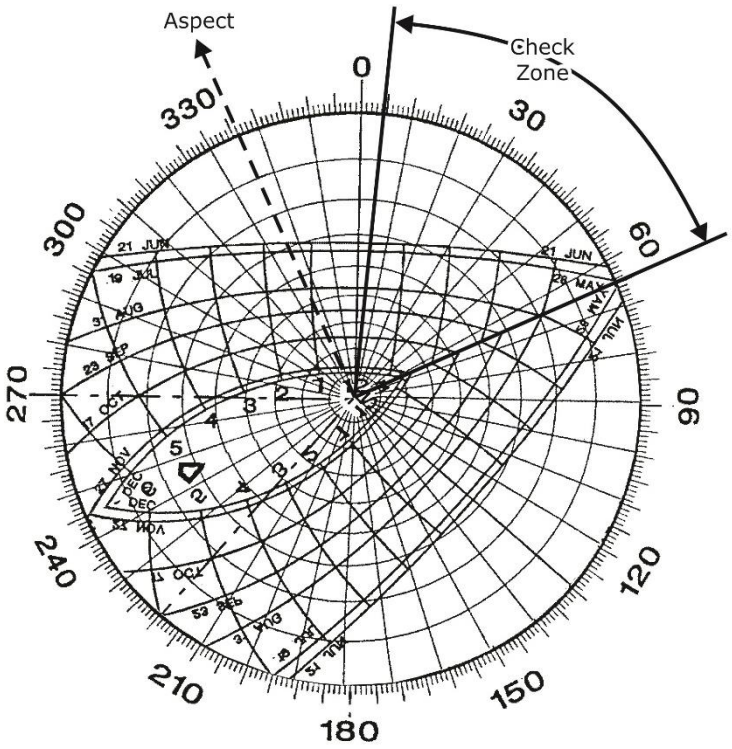

Figure B.18: Sun Chart for the 336° Aspect

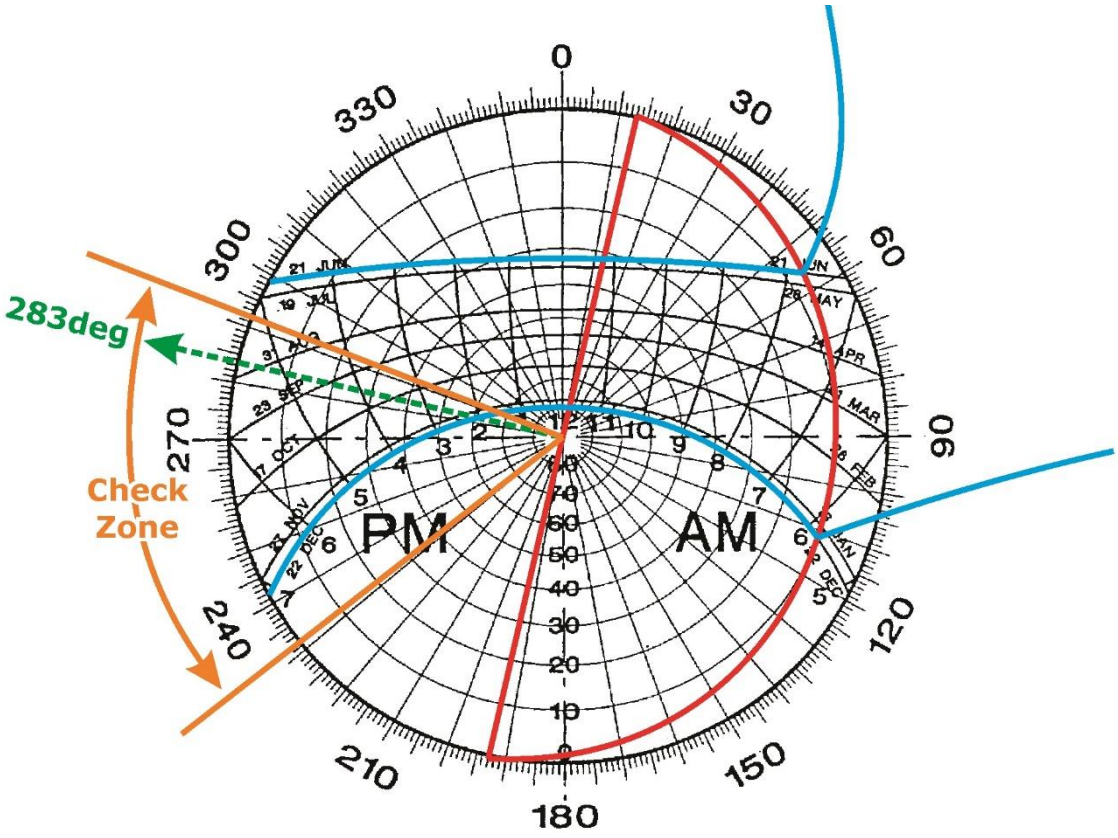

Figure B.19: Sun Chart for the 283° Aspect, inclined by 10° (for the 2B roof)

APPENDIX C STANDARD SUN CHART FOR THE REGION

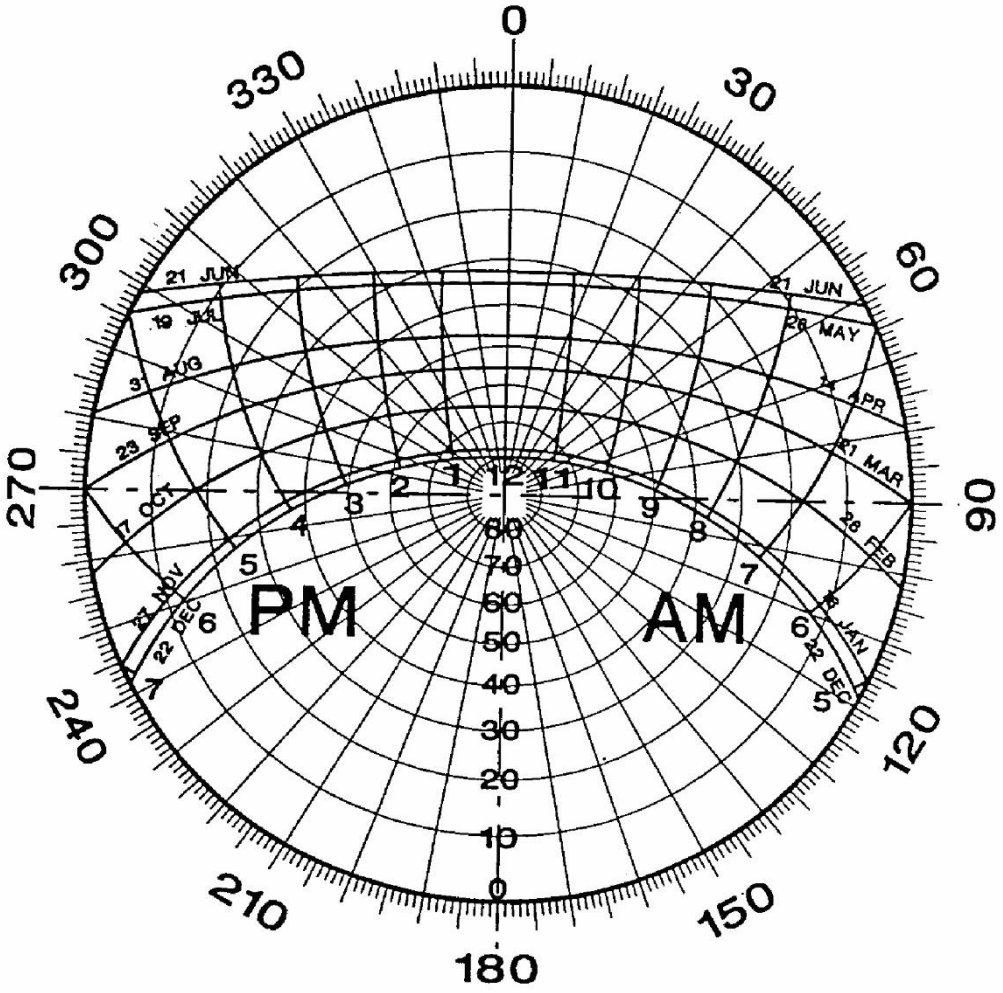

Figure C.1: Standard Sun Chart for the Sydney Region