SOLAR LIGHT REFLECTIVITY STUDY

LOT 3003, THORNTON CENTRAL VILLAGE, PENRITH

WD459-07F03(REV2)- SR REPORT - STAGE 1

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EXECUTIVE SUMMARY

This report presents the results of a detailed study for the effect of potential solar glare from the Thornton Central Village development, located at 184 Lord Sheffield Circuit, Penrith (Lot 3003 in DP1184498). 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. This study assesses compliance with the controls for solar glare from the State Environmental Planning Policy No. 65 (SEPP65, Part 04 (Designing the Building) for Amenity), which contains the Apartment Design Guide (ADG), and the Penrith Development Control Plan 2014.

The analysis presented assumes that the adjacent Stage 2 development located at 41, (part) 184 and 192 Lord Sheffield Circuit, Penrith (Part Lot 3003, Lot 3004 and Lot 3005 in DP1184498) is built concurrently or within a reasonable amount of time from the Stage 1 development.

The results of the study indicate the development is quite exposed, and 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 limitations to the maximum normal specular reflectance of visible light of the external façade glazing is recommended:

- Lot 3003 Podium:
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the western aspect of the Lot 3003 podium from Levels 01 to 04 to a value of 11%.
- Tower A:
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the western aspect from Levels 05 to 16 to a value of 11%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the western aspect from Levels 17 to 30 to a value of 18%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the western aspect from Levels 05 to 16 to a value of 6%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the western aspect from Levels 17 to 30 to a value of 15%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the eastern aspect from Levels 05 to 07 to a value of 14%.
    - Vertical sunshade fins to be included on the eastern aspect of Tower A for Levels 06 to 09. The vertical fins are required to protrude from the body of the façade at an angle not normal to the façade line.
    - For Level 10 to 30, a façade articulation (panel rotation) is to be applied to the eastern external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations.

- Tower B:
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the 293º western aspect from Levels 04 to 08 to a value of 11%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the southern half of the 293º western aspect from Levels 09 to 12 to a value of 11%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the northern half of the 293º western aspect from Levels 10 to 12 to a value of 16%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the 301º western aspect from Levels 04 to 08 to a value of 11%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the southern half of the 293º western aspect from Levels 09 to 12 to a value of 8%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the northern half of the 293º western aspect from Levels 04 to 12 to a value of 10%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the 293º western aspect from Levels 04 to 08 to a value of 11%.
    - For Level 10 to 12, a façade articulation (panel rotation) is to be applied to the eastern external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations.
- All other glazing on the external façade and balustrades for all buildings should have a maximum normal specular reflectance of visible light of 20%.

The following treatments may be used in lieu of the abovementioned treatments for the eastern aspects of Towers A and B:

- Perforated panels: It is recommended that the permeability of the panels not exceed 35%. The panels must also be non-reflective.
- Vertical fins: to be placed at all levels along the eastern façade of the tower. The width and spacing of the sunshade fins should be such that an early morning summer glare should be blocked by westbound motorists. In order to achieve this, the vertical fins are required to protrude from the body of the façade at an angle not normal to the façade line.
- Façade articulation - level rotation: To be applied to the eastern external façade from Levels 05 to Roof for all towers. A small rotation is applied to the façade orientation at each level (in the range of 1 to 2 degrees per level). The façade must alternate between at least three different façade orientations. Fins would still need to be applied to Levels 05 to 10 for each of the towers.

- In some cases (particularly along the western façade), the normal specular reflectance of visible light used on the balustrades may be increased slightly, if a small rotation (in the range of 1 to 2 degrees) is applied to the aspect of the balustrades.

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 motorists, pedestrians or train drivers in the surrounding area, or to occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity from SEPP65 and the Penrith Development Control Plan 2014.

CONTENTS

1 INTRODUCTION

This Solar Light Reflectivity Study report has been prepared to support a development application (DA) which seeks consent for the following development at 184 Lord Sheffield Circuit Penrith (Lot 3003 in DP1184498):

- Demolition of all existing site features and improvements;
- Construction and operation of a new mixed use development, comprising:
    - One storey basement, containing a total of 85 x retail car parking spaces, a click-and-collect facility, waste rooms, a retail lobby entry, plant rooms, and other ancillary back-of-house areas;
    - Five-storey podium comprising:
        - Retail tenancies, a mainline supermarket, residential and commercial lobby entries, a loading dock, vehicle access, and back-of-house areas at Ground Level;
        - A child care centre and medical facility at Level 01;
        - Shared car parking at Levels 01 – 04 (providing a total of 333 x residential car parking spaces, 35 x retail car parking spaces, and 2 x car wash bays);
    - A residential building (referred to as Tower A), with a maximum rise of 27 storeys (Level 05 – Level 31) containing a total of 241 x residential apartments;
    - A residential building (referred to as Tower B), with a maximum rise of 9 storeys (Level 05 – Level 13) containing a total of 75 x residential apartments;
- Creation of new east-west publicly accessible through-site link;
- New landscaping works and other public domain works; and
- Ancillary works, including site services and connections and stormwater infrastructure.

2 GLARE OBSERVED BY MOTORISTS AND TRAIN DRIVERS

2.1 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. In meeting this criterion for vehicle motorists, conditions will also be satisfactory for train drivers.

The various critical glazed aspects of the development were determined 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. 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 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 2.2 of this report.

Study point locations are selected within the check zone areas where motorists or train drivers are facing the general direction of the subject development (within ±16° of the direct sight-line). These are shown in Figures 2, and summarised in Table 1. The viewpoint of motorists or train drivers at each study point location is assessed using either photographs from a calibrated camera, or images generated from a 3D computer model of the local area. A scaled glare protractor has been superimposed over each viewpoint image. Views from the study point locations are presented in Appendix A of this report

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 or train drivers and hence to enable the subject development to comply with the relevant planning control requirements regarding solar light reflectivity.

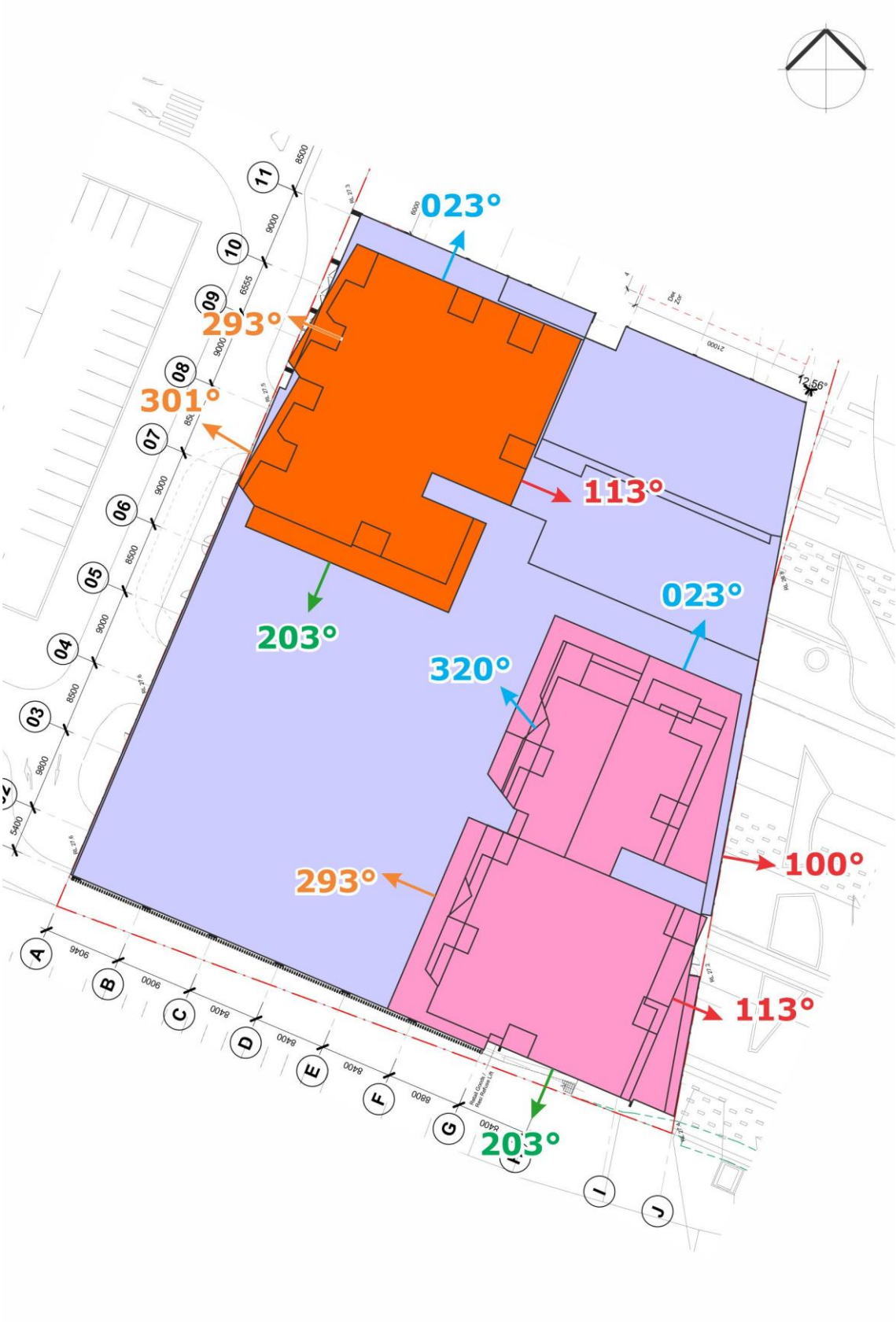

Figure 1: Critical Glazed Aspects of the Development (plan view)

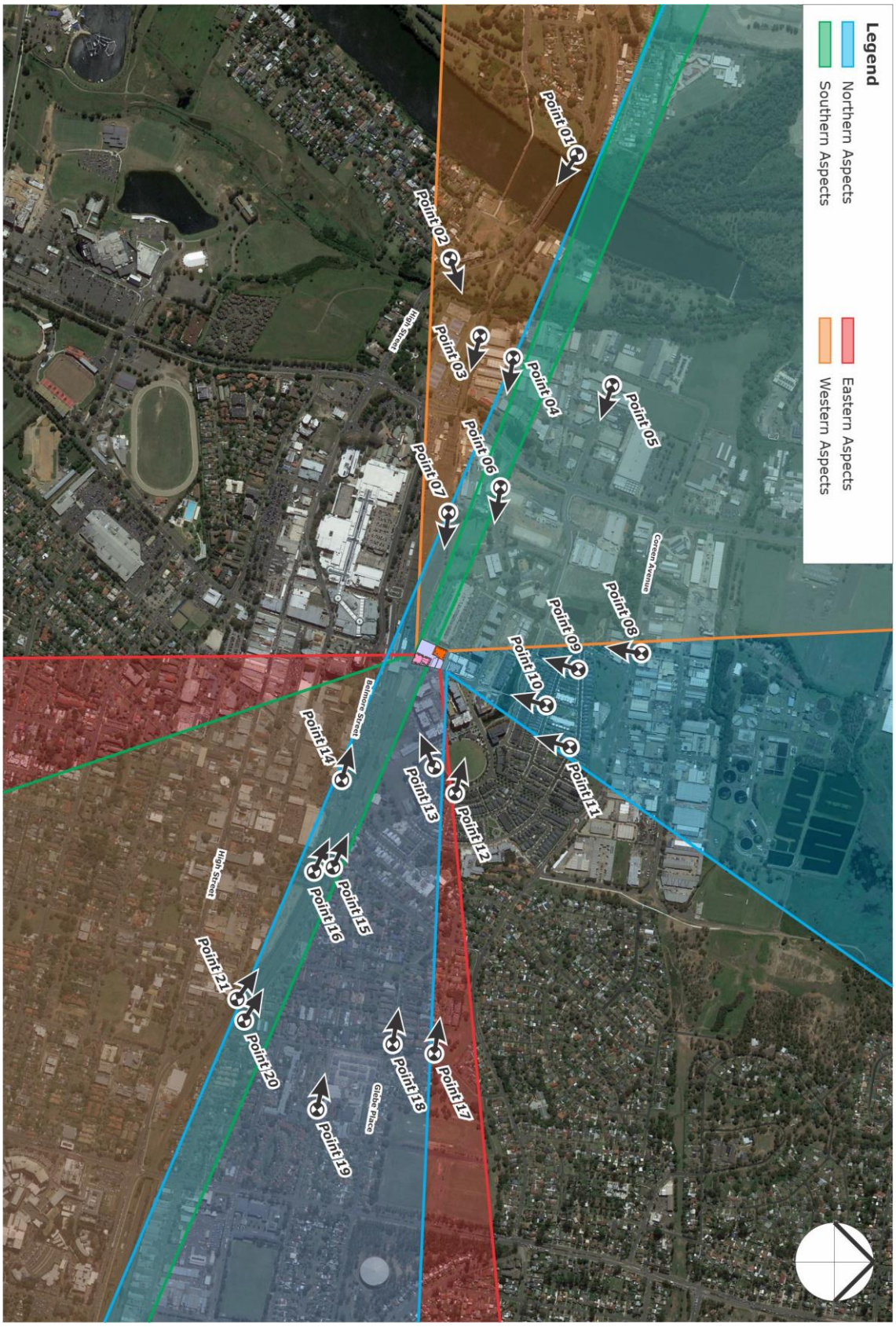

Figure 2a: Check Zones and Study Point Locations (for further afield locations)
(the check zones are the areas where glare could potentially be observed)

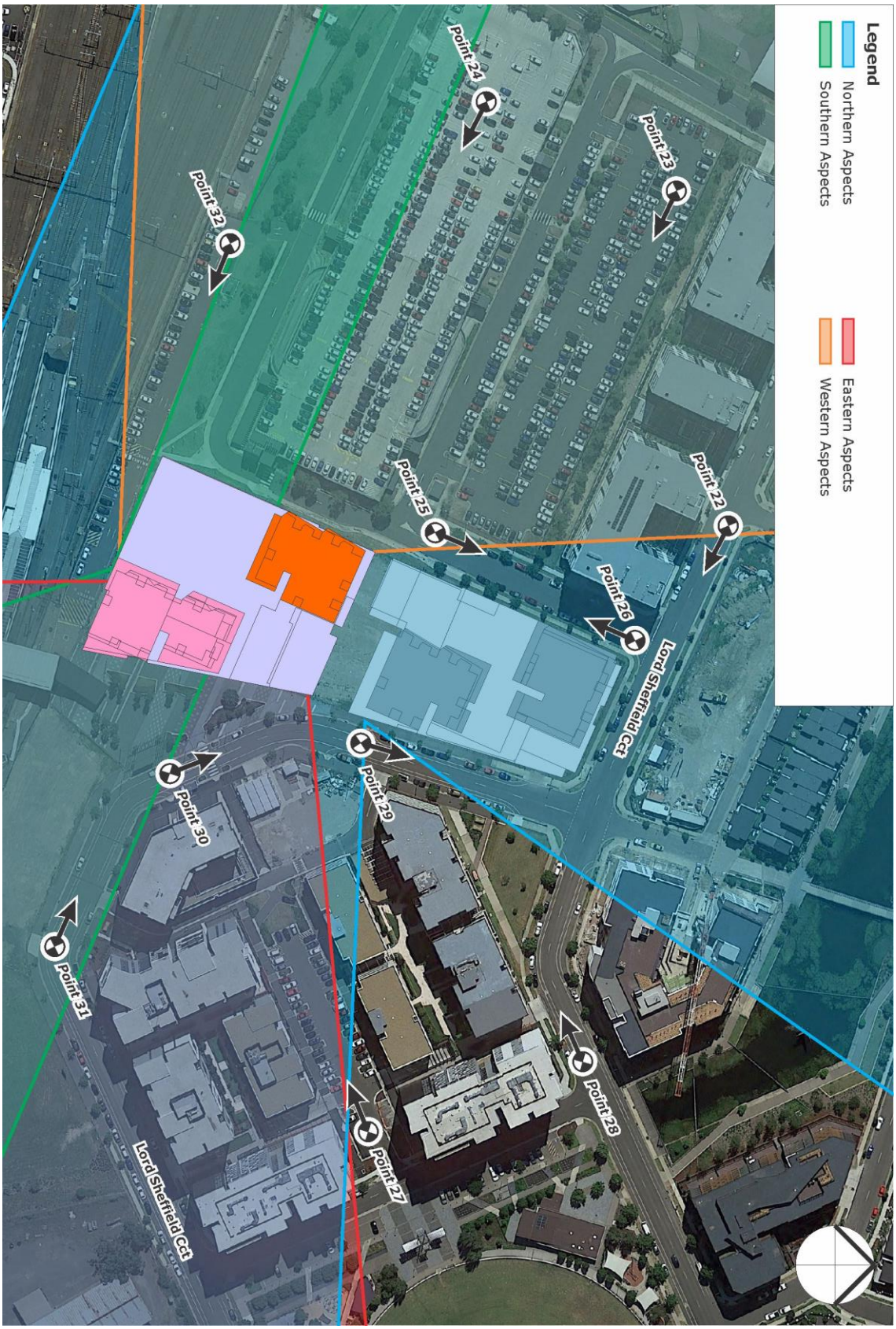

Figure 2b: Check Zones and Study Point Locations (for closer locations)
(the check zones are the areas where glare could potentially be observed)

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

Study Point	Location and Viewpoint
01	Great Western Highway, heading south-east
02	Ladbury Avenue, heading north-east
03	Eastbound Train Drivers, heading east
04	Peachtree Road, heading east
05	Peachtree Road, heading east
06	Museum Drive, heading east
07	Eastbound Train Drivers, heading east
08	Coombes Drive, heading south
09	Woodman Street, heading south
10	Woodrow Way, heading south
11	Durant Street, heading south
12	Cricketers Avenue, heading west
13	Lord Sheffield Circuit, heading south-west
14	Belmore Street, heading west
15	The Crescent, heading north-west
16	North Street, heading north-west
17	Robert Street, heading west
18	Thurston Street, heading west
19	Gascoigne Street, heading west
20	The Crescent, heading north-west
21	Henry Street, heading north-west
22	Lord Sheffield Circuit, heading south-east
23	Western Parking Lot, heading south-east
24	Western Parking Lot, heading south-east
25	Dunshea Street, heading north-east
26	Dunshea Street, heading south-west
27	Engineers Place, heading south-west
28	Lord Sheffield Circuit, heading south-west
29	Lord Sheffield Circuit, heading north-east
30	Lord Sheffield Circuit, heading north-west
31	Lord Sheffield Circuit, heading north-west
32	Southern Parking Lot, heading south-east

2.2 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.

2.2.1 Motorists heading south-east along Great Western Highway

Point 01 is located along the Great Western Highway, to the west of the development site. This point represents the critical sightline of motorists heading south-east along the Great Western Highway 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 not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading south-east along Great Western Highway at this location.

2.2.2 Motorists heading north-east along Ladbury Avenue

Point 02 is located along Ladbury Avenue, to the west of the development site. This point represents the critical sightline of motorists heading north-east along Ladbury 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 be significantly obstructed by densely foliating trees and other planting. Hence there will be no adverse solar glare observed by motorists heading north-east along Ladbury Avenue at this location.

2.2.3 Eastbound Train Drivers

Points 03 and 07 are located along the railway line to the west of the development site. These points represent the critical sightline of eastbound train drivers at these locations. Calibrated images of the viewpoint of the train drivers at these locations have 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 a large portion of the development will be visible within the zone of sensitive vision. Point 03 is only located within the 293° aspect check zone for each of the four Towers. Further analysis indicates the following:

- For Tower A, the stepped, external façade and the vertical fins/columns will overshadow a portion of the 293° aspect of Tower A. In total, approximately 45% of the area of the western aspect will be able to reflect light onto eastbound train drivers at Point 03, thus reducing the perceived intensity of glare. Note that, the balustrades for this aspect are more exposed and thus the magnitude of the reduction in perceived glare will be lower than the external façade.

- For Tower A, it is recommended to limit the maximum normal specular reflectance of visible light of the glazing used on the 293° western aspect from Levels 13 to 30 to a value of 18% for the external façade and 15% for the balustrades (refer to Figures 3).

- For Tower B, the intensity of glare at Point 03 will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing of the 293° aspect does not exceed 20% for Levels 10 and above.

An analysis of the glare meter overlaid onto the viewpoint at Point 07 indicates that a large portion of the development will be visible within the zone of sensitive vision. The Point 07 is only located within the 293º aspect check zone for Tower A, Tower B and a small portion of the Lot 3003 podium. Further analysis indicates the following:

- For the Lot 3003 Podium, the portion of the podium façade visible within the zone of sensitive vision is comprised of non-reflective material and will not cause any adverse glare.
- Tower A:
    - Tower B will overshadow a portion of western aspect of Tower A between Levels 05 to 11.
    - The stepped external façade and the vertical fins/columns will overshadow a portion of the 293º aspect of Tower A. In total, approximately 45% of the area of the 293º aspect will be able to reflect light onto eastbound train drivers at Point 07, thus reducing the perceived intensity of glare. Note that, the balustrades for this aspect are more exposed and thus the magnitude of the reduction in perceived glare will be lower than the external façade.
    - Hence, it is recommended to limit the maximum normal specular reflectance of visible light of the glazing used on the 293º western aspect from Levels 05 to 16 to a value of 11% for the external façade and 6% for the balustrades (refer to Figures 3). Furthermore, it is recommended to limit the maximum normal specular reflectance of visible light of the glazing used on the 293º western aspect from Levels 17 to 30 to a value of 18% for the external façade and 15% for the balustrades (refer to Figures 3).
- Tower B:
    - The stepped external façade and the vertical fins will provide overshadowing to the 293º aspect of Tower B. In total, approximately 45% of the area of the external façade will be able to reflect light onto eastbound train drivers at Point 07, thus reducing the perceived intensity of glare. Note that, the balustrades for this aspect are more exposed and thus the magnitude of the reduction in perceived glare will be lower than the external façade.
    - Hence, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing on the southern half of the 293º western aspect does not exceed 11% on the external façade and 8% for the balustrades for Levels 04 to 12 (refer to Figures 3).

With the inclusion of the abovementioned treatments, no adverse solar glare will be observed by eastbound train drivers at Points 03 and 07.

2.2.4 Motorists heading east along Peachtree Road

Points 04 and 05 are located along Peachtree Road, to the west of the development site. These points represent the critical sightline of motorists heading east along Peachtree Road at these locations. Calibrated images of the viewpoint of motorists at these locations have 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 western aspects of Towers A and B will be visible within the zone of sensitive vision and within the check zones. Point 04 is only located within the 293º aspect check zone for each of the Towers. Further analysis indicates that approximately 40% shielding is provided by the stepped façade features and the vertical fins/columns for each of the towers. It is recommended to limit the maximum normal specular reflectance of visible light used on the 293º western aspect glazing to the following (refer to Figures 3):

- Tower A: 20% for the external façade and 15% for the balustrades between Levels 19 to 30.
- Tower B: 16% for the external façade and 10% for the balustrades between Levels 10 to 12.

With the inclusion of the abovementioned treatments, no adverse solar glare will be observed by motorists heading east along Peachtree Road at Point 04.

An analysis of the glare meter overlaid onto the viewpoint at Point 05 indicates that the view of the development will not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading east along Peachtree Road at Point 05.

2.2.5 Motorists heading east along Museum Drive

Point 06 is located along Museum Drive, to the west of the development site. This point represents the critical sightline of motorists heading east along Museum 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 06 indicates that the view of the development will not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading east along Museum Drive at Point 06.

2.2.6 Motorists heading south along Coombes Drive

Point 08 is located along Coombes Drive, to the north of the development site. This point represents the critical sightline of motorists heading south along Coombes 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 08 indicates that the northern and western aspects of Tower A will be visible within the zone of sensitive vision and within the check zones. Hence, for Tower A, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing of the northern and western aspects does not exceed 20% for Levels 13 and above.

2.2.7 Motorists heading south along Woodman Street

Point 09 is located along Woodman Street, to the north of the development site. This point represents the critical sightline of motorists heading south along Woodman 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 09 indicates that the western aspect of Tower A will be visible within the zone of sensitive vision. However, further analysis indicates the Point 09 is not within the check zone for this aspect. Hence there will be no adverse solar glare observed by motorists heading south along Woodman Street at this location.

2.2.8 Motorists heading south along Woodrow Way

Point 10 is located along Woodrow Way, to the north of the development site. This point represents the critical sightline of motorists heading south along Woodrow Way 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 10 indicates that a large portion of the development will be visible within the zone of sensitive vision. Further analysis indicates that the study point is only within the check zone of the 320º aspect of Tower A. The 320º aspect of Tower A will be completely obstructed by Tower A itself at times when glare would have otherwise been observed (late afternoon during spring and summer). Hence there will be no adverse solar glare observed by motorists heading south along Woodrow Way at this location.

2.2.9 Motorists heading south along Durant Street

Point 11 is located along Durant Street, to the north-east of the development site. This point represents the critical sightline of motorists heading south along Durant 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 11 indicates that Tower A will be visible within the zone of sensitive vision. Further analysis indicates that the study point is only within the check zone of the 320º aspect of Tower A. The 320º aspect of Tower A will be completely obstructed by Tower A itself at times when glare would have otherwise been observed (late afternoon during spring and summer). Hence there will be no adverse solar glare observed by motorists heading south along Durant Street at this location.

2.2.10 Motorists heading west along Cricketers Avenue

Point 12 is located along Cricketers Avenue, to the east of the development site. This point represents the critical sightline of motorists heading west along Cricketers 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 12 indicates that the view of the development will not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading west along Cricketers Avenue at Point 12.

2.2.11 Motorists heading south-west along Lord Sheffield Circuit

Points 13 and 28 are located along Lord Sheffield Circuit, to the east of the development site. These points represent the critical sightline of motorists heading south-west along Lord Sheffield Circuit at these locations. Calibrated images of the viewpoint of motorists at these locations have been overlaid with a scaled glare meter, as shown in Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 13 indicates that the view of the development will not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading south-west along Lord Sheffield Circuit at Point 13.

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

2.2.12 Motorists heading west along Belmore Street

Point 14 is located along Belmore Street, to the south-east of the development site. This point represents the critical sightline of motorists heading west along Belmore 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 14 indicates that southern and eastern aspects of Tower A will be visible within the zone of sensitive vision and within the check zones. Various structural elements (columns/fins) etc will provide some overshadowing to the southern and eastern aspects and thus, reducing the perceived intensity of glare observed by the motorist at Point 14. Hence, for Tower A, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing on the southern and eastern aspects does not exceed 20% for Levels 05 to 16.

2.2.13 Motorists heading north-west along The Crescent

Points 15 and 20 are located along The Crescent, to the south-east of the development site. These points represent the critical sightline of motorists heading north-west along The Crescent at these locations. Calibrated images of the viewpoint of motorists at these locations have 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 a large portion of the development will be visible within the zone of sensitive vision and within the corresponding check zones. Further analysis indicates the following:

- For the Lot 3003 Podium, the portion of the façade visible within the zone of sensitive vision will be obstructed by the adjacent 83 Lord Sheffield Circuit buildings at the times when solar glare would have otherwise been observed (early morning during summer).

- For Tower A, it is recommended that additional vertical sunshade fins be included on the eastern aspect of Tower A for Levels 06 to 09. The width and spacing of the sunshade fins should be such that an early morning summer glare should be blocked when viewed from Point 15. In order to achieve this, the vertical fins are required to protrude from the body of the façade at an angle not normal to the façade line. For Level 10 to 30, a façade articulation (panel rotation) is to be applied to the eastern external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations (refer to Figures 3).

- For Tower B, between Levels 10 to 12, a façade articulation (panel rotation) is to be applied to the eastern external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations (refer to Figures 3).

An analysis of the glare meter overlaid onto the viewpoint at Point 20 indicates that the eastern aspect of Tower A will be visible within the zone of sensitive vision and within the check zones, and hence the following treatments are recommended to be included in the design of the development:

- For Tower A, limit the maximum normal specular reflectance of visible light used on the eastern aspect glazing to 14% for the external façade and balustrades between Levels 10 to 30 (refer to Figures 3).

With the inclusion of the abovementioned treatments, there will be no adverse solar glare observed by motorists heading north-west along The Crescent at Points 15 and 20.

2.2.14 Motorists heading north-west along North Street

Point 16 is located along North Street, to the south-east of the development site. This point represents the critical sightline of motorists heading north-west along North 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 16 indicates that the eastern aspect of Tower A will be visible within the zone of sensitive vision and with the check zones. Hence the following treatments are recommended to be included in the design of the development:

- For Tower A, it is recommended that additional vertical sunshade fins be included on the eastern aspect of Tower A for Levels 06 to 09. The width and spacing of the sunshade fins should be such that an early morning summer glare should be blocked when viewed from Point 15. In order to achieve this, the vertical fins are required to protrude from the body of the façade at an angle not normal to the façade line. For Level 10 to 30, a façade articulation (panel rotation) is to be applied to the eastern external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations (refer to Figures 3).

With the inclusion of the abovementioned treatments, there will be no adverse solar glare observed by motorists heading north-west along North Street at this location.

2.2.15 Motorists heading west along Robert Street

Point 17 is located along Robert Street, to the east of the development site. This point represents the critical sightline of motorists heading west along Robert 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 17 indicates that the view of the development will be significantly obstructed by densely foliating trees and other planting. Hence there will be no adverse solar glare observed by motorists heading west along Robert Street at this location.

2.2.16 Motorists heading west along Thurston Street

Point 18 is located along Thurston Street, to the east of the development site. This point represents the critical sightline of motorists heading west along Thurston 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 18 indicates that a large portion of the development will be visible within the zone of sensitive vision. Further analysis indicates that the study point is not within any of the check zones. Hence there will be no adverse solar glare observed by motorists heading west along Thurston Street at this location.

2.2.17 Motorists heading west along Gascoigne Street

Point 19 is located along Gascoigne Street, to the east of the development site. This point represents the critical sightline of motorists heading west along Gascoigne 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 19 indicates that Towers A and D will be visible within the zone of sensitive vision. Further analysis indicates that the study point is not within any of the check zones. Hence there will be no adverse solar glare observed by motorists heading west along Thurston Street at this location.

2.2.18 Motorists heading north-west along Henry Street

Point 21 is located along Henry Street, to the south-east of the development site. This point represents the critical sightline of motorists heading north-west along Henry 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 21 indicates that a large portion of the development will be visible within the zone of sensitive vision. Further analysis indicates the following:

- For Tower A, it is recommended to limit the maximum normal specular reflectance of visible light used on the eastern aspect glazing to 13% for the external façade and balustrades between Levels 10 to 30 (refer to Figures 3).

With the inclusion of the abovementioned treatments, there will be no adverse solar glare observed by motorists heading north-west along Henry Street at this location.

2.2.19 Motorists heading south-east along Lord Sheffield Circuit

Point 22 is located along Lord Sheffield Circuit, to the north-west of the development site. This point represents the critical sightline of motorists heading south-east along Lord Sheffield Circuit 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 view of the development will not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading south-east along Lord Sheffield Circuit at Point 22.

2.2.20 Motorists heading south-east along the Western Parking Lot

Points 23 and 24 are located along the western parking lot, to the west of the development site. These points represent the critical sightline of motorists heading south-east along the Western Parking Lot at these locations. Calibrated images of the viewpoint of motorists at these locations have 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 western and northern aspects of Tower B will be visible within the zone of sensitive vision and within the check zones. Further analysis indicates the following:

- For Tower B, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing on the external façade of the northern aspect does not exceed 20%.

An analysis of the glare meter overlaid onto the viewpoint at Point 24 indicates that the western aspects of Tower A, Tower B and the Lot 3003 podium will be visible within the zone of sensitive vision. Further analysis indicates the following:

- For the Lot 3003 Podium, of the section of the podium façade visible within the zone of sensitive vision, only the northern half of the western aspect is comprised of glazing. Of that portion, only a very small amount of overshadowing will be provided by the proposed vertical fins/columns. As a result, it is recommended to limit the maximum normal specular reflectance of visible light of the glazing used on the western aspects of the Lot 3003 podium from levels 01 to 03 to a value of 11% (refer to Figures 3).

- For Tower A, it is recommended to limit the maximum normal specular reflectance of visible light of the glazing used on external façade and balustrades of the western aspect from Levels 05 to 07 to a value of 11% (refer to Figures 3).

- For Tower B, the glazing on the external façade of the western aspect is segmented into 8 panels which alternates between two different orientations. As a result, there will be a reduction in the perceived intensity of glare from the western aspect observed by motorists at this location. Hence for Tower B, it is recommended to limit the maximum normal specular reflectance of visible light of the glazing used on the 293º and 301º western aspects from Levels 04 to 08 to a value of 11% (refer to Figures 3).

With the inclusion of the abovementioned treatments, there will be no adverse solar glare observed by motorists heading west along the western parking lot at Points 23 and 24.

2.2.21 Motorists heading north-east along Dunshea Street

Point 25 is located along Dunshea Street, to the west of the development site. This point represents the critical sightline of motorists heading north-east along Dunshea 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 25 indicates that the view of the development will not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading north-east along Dunshea Street at Point 25.

2.2.22 Motorists heading south-west along Dunshea Street

Point 26 is located along Dunshea Street, to the north-west of the development site. This point represents the critical sightline of motorists heading south-west along Dunshea 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 26 indicates that a portion of the northern and western aspects of the Lot 3003 podium and Tower B will be visible within the zone of sensitive vision. Further analysis indicates Point 26 will not be within any of the check zones for portions of the development visible within the zone of sensitive vision. Hence, there will be no adverse solar glare observed by motorists heading south-west along Dunshea Street at this location.

2.2.23 Motorists heading south-west along Engineers Place

Point 27 is located along Engineers Place, to the east of the development site. This point represents the critical sightline of motorists heading south-west along Engineers Place 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 27 indicates that a portion of the northern and eastern aspect of Tower A and the eastern aspect of the Lot 3003 podium will be visible within the zone of

sensitive vision. Further analysis indicates that Point 27 will not be within any of the check zones for the portions of the development visible within the zone of sensitive vision. Hence, there will be no adverse solar glare observed by motorists heading south-west along Engineers Place at this location.

2.2.24 Motorists heading north-east along Lord Sheffield Circuit

Point 29 is located along Lord Sheffield Circuit, to the east of the development site. This point represents the critical sightline of motorists heading north-east along Lord Sheffield Circuit 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 not be visible within the zone of sensitive vision at this location. Hence there will be no adverse solar glare observed by motorists heading north-east along Lord Sheffield Circuit at Point 29.

2.2.25 Motorists heading north-west along Lord Sheffield Circuit

Points 30 and 31 are located along Lord Sheffield Circuit, to the east of the development site. These points represent the critical sightline of motorists heading north-west along Lord Sheffield Circuit at these locations. Calibrated images of the viewpoint of motorists at these locations have 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 eastern aspect of the Lot 3003 podium will be visible within the zone of sensitive vision. Further analysis indicates the following:

- For the Lot 3003 podium, the portion of the eastern aspect façade visible within the zone of sensitive vision will be overshadowed by the adjacent 91 and 101 Lord Sheffield Circuit Towers at the times where solar glare would have otherwise been observed (early morning autumn and winter).

An analysis of the glare meter overlaid onto the viewpoint at Point 31 indicates that the eastern aspect of the Lot 3003 podium, Tower A, Tower B a portion of the southern aspect of Tower B and a portion of the northern aspect of Tower A will be visible within the zone of sensitive vision. Further analysis indicates the following:

- Lot 3003 podium:
    - Levels 02 to 04 are comprised of a non-reflective material.
    - The northern two-thirds of the eastern aspect of the podium will be overshadowed by the adjacent 81a, 83 and 91 Lord Sheffield Circuit buildings at the times where solar glare would have otherwise been observed (early morning autumn, morning summer).
    - For the southern two-thirds of the eastern aspect of the podium, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing on the external façade does not exceed 20% for Levels 00 to 01.
- For Tower A, it will provide overshadowing onto itself at the times where solar glare from the northern aspect would have otherwise been observed (late afternoon winter).

- For Tower A, it is recommended to limit the maximum normal specular reflectance of visible light used on the eastern aspect glazing to 14% for the external façade and balustrades between Levels 05 to 07 (refer to Figures 3).

- For Tower B, it will provide overshadowing onto itself at the times where solar glare from the southern aspect would have otherwise been observed (late afternoon winter).

- For Tower B, approximately 85% of the southern-third of the eastern aspect which is visible within the zone of sensitive vision is comprised of a non-reflective material. As a result, only a small portion of the full intensity of the glare from the southern-third of the eastern aspect will be reflected onto motorists at this location. Hence, for Tower B, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing on the external façade of the entire eastern aspect does not exceed 20% for Levels 07 to 10.

With the inclusion of the abovementioned treatments, no adverse solar glare will be observed by motorists heading north-west along Lord Sheffield Circuit at Points 30 and 31.

2.2.26 Motorists heading south-east along Southern Parking Lot

Point 32 is located along the southern parking lot, to the west of the development site. This point represents the critical sightline of motorists heading south-east along Southern Parking Lot 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 32 indicates that the western and southern aspect of the Lot 3003 podium and Tower A will be visible within the zone of sensitive vision. Further analysis indicates the following:

- For the Lot 3003 podium, Point 32 will not be within the check zones for the southern aspects of the Lot 3003 podium and Tower A, and the western aspect of the Lot 3003 podium which is visible within the zone of sensitive vision is comprised of a non-reflective material.

- Tower A:

    - Only the southern half of the western aspect of Tower A is visible within the zone of sensitive vision. The stepped external façade and the vertical fins/columns will provide overshadowing to approximately 40% of the western aspect of Tower A.

    - Hence, for the southern-most window glazing of the western aspect of Tower A, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used for the glazing on the external façade of the western aspect does not exceed 12% for Levels 05 to 09 (refer to Figures 3).

    - For Tower A, the intensity of glare will not exceed 500cd/m^2 provided that the normal specular reflectance of visible light used does not exceed 20% for the external façade and 15% for the balustrades for Levels 05 to 09 (refer to Figures 3).

With the inclusion of the abovementioned treatments, no adverse solar glare will be observed by motorists heading south-east along the southern parking lot at Point 32.

2.2.27 Westbound Train Drivers

The abovementioned assessments of the viewpoints of motorists at Points 14, 15, 16, 20 and 21 are also applicable to westbound train drivers near to those locations, and the implementation of the treatments described for limiting glare observed by motorists at these locations will also be effective in ensuring no adverse solar glare is observed from the façade of the development by westbound train drivers.

3 GLARE OBSERVED BY 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.

4 TYPICAL REFLECTANCES OF FAÇADE MATERIALS

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.

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:

- Low reflectance glazing, such as Guardian Clarity – less than 5%
- 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%

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.

5 SUGGESTED TREATMENTS

The suggested treatments described in this report for ensuring the development does not cause adverse glare conditions are described in Figures 3 and summarised below:

- Lot 3003 Podium:
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the western aspect of the Lot 3003 podium from Levels 01 to 04 to a value of 11%.
- Tower A:
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the western aspect from Levels 05 to 16 to a value of 11%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the western aspect from Levels 17 to 30 to a value of 18%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the western aspect from Levels 05 to 16 to a value of 6%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the western aspect from Levels 17 to 30 to a value of 15%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the eastern aspect from Levels 05 to 07 to a value of 14%.
    - Vertical sunshade fins to be included on the eastern aspect of Tower A for Levels 06 to 09. The vertical fins are required to protrude from the body of the façade at an angle not normal to the façade line.
    - For Level 10 to 30, a façade articulation (panel rotation) is to be applied to the eastern external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations.
- Tower B:
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the 293º western aspect from Levels 04 to 08 to a value of 11%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the southern half of the 293º western aspect from Levels 09 to 12 to a value of 11%.
    - Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the northern half of the 293º western aspect from Levels 10 to 12 to a value of 16%.

- Limit the maximum normal specular reflectance of visible light of the glazing used on the external façade of the 301º western aspect from Levels 04 to 08 to a value of 11%.
- Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the southern half of the 293º western aspect from Levels 09 to 12 to a value of 8%.
- Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the northern half of the 293º western aspect from Levels 04 to 12 to a value of 10%.
- Limit the maximum normal specular reflectance of visible light of the glazing used on the balustrades of the 293º western aspect from Levels 04 to 08 to a value of 11%.
- For Level 10 to 12, a façade articulation (panel rotation) is to be applied to the eastern external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations.

- All other glazing on the external façade and balustrades for all buildings should have a maximum normal specular reflectance of visible light of 20%.

5.1 Alternative Treatment Measures

The following treatments may be used in lieu of the abovementioned treatments for the eastern aspects of Towers A and B:

- Perforated panels: It is recommended that the permeability of the panels not exceed 35%. The panels must also be non-reflective.
- Vertical fins: to be placed at all levels along the eastern façade of the tower. The width and spacing of the sunshade fins should be such that an early morning summer glare should be blocked by westbound motorists. In order to achieve this, the vertical fins are required to protrude from the body of the façade at an angle not normal to the façade line.
- Façade articulation - level rotation: To be applied to the eastern external façade from Levels 05 to Roof for all towers. A small rotation is applied to the façade orientation at each level (in the range of 1 to 2 degrees per level). The façade must alternate between at least three different façade orientations. Fins would still need to be applied to Levels 05 to 10 for each of the towers.
- In some cases (particularly along the western façade), the normal specular reflectance of visible light used on the balustrades may be increased slightly, if a small rotation (in the range of 1 to 2 degrees) is applied to the aspect of the balustrades.

Treatments Legend

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 11%.

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 18%.

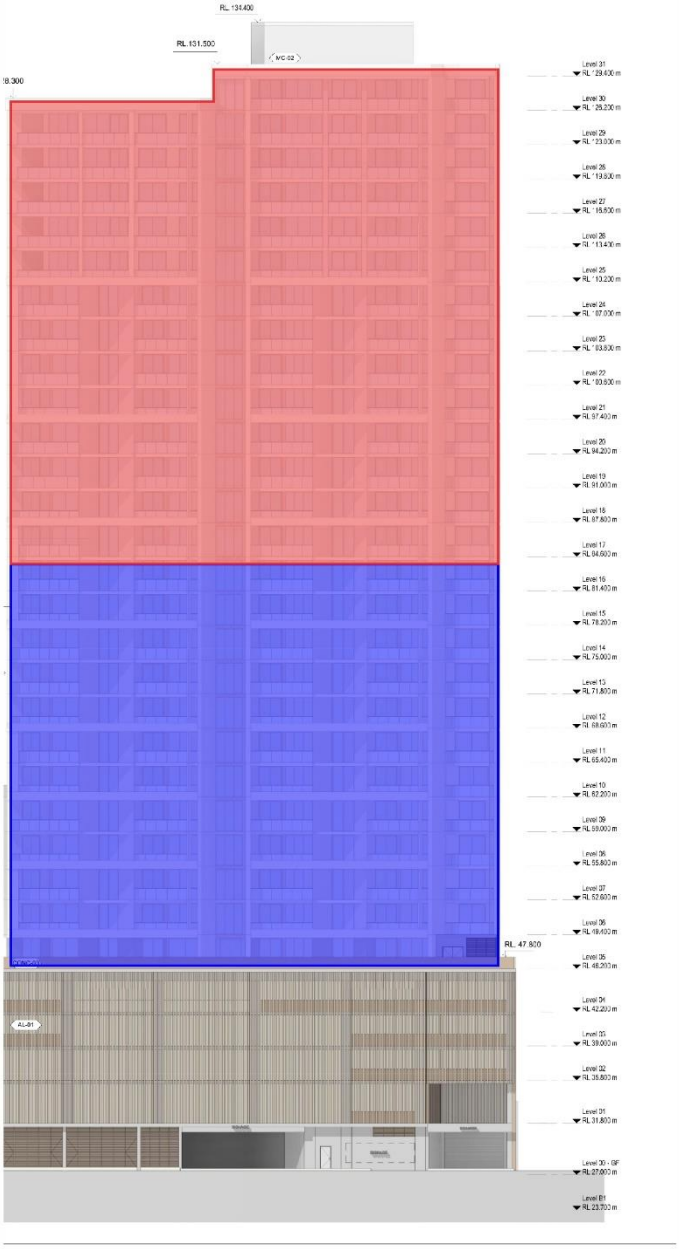

Figure 3a: Suggested Treatments – Tower A, Western Elevation (for external façade)

Treatments Legend

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 6%.

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 15%.

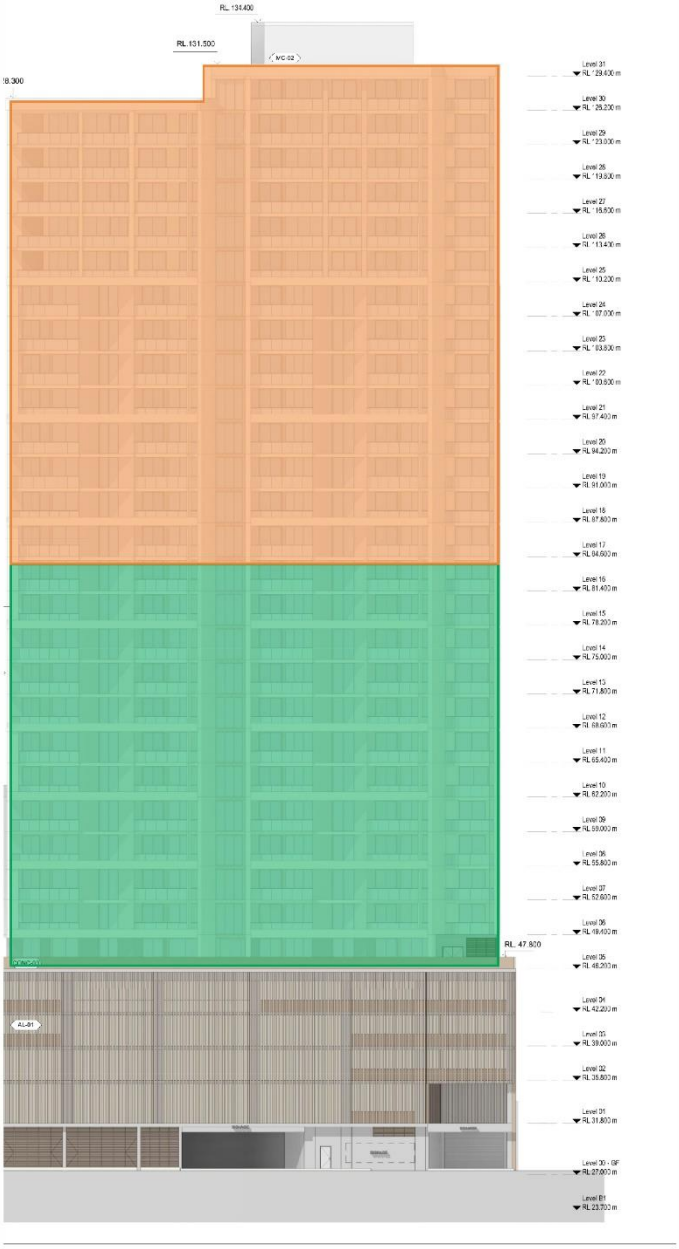

Figure 3b: Suggested Treatments – Tower A, Western Elevation (for balustrades)

Treatments Legend

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 14%.

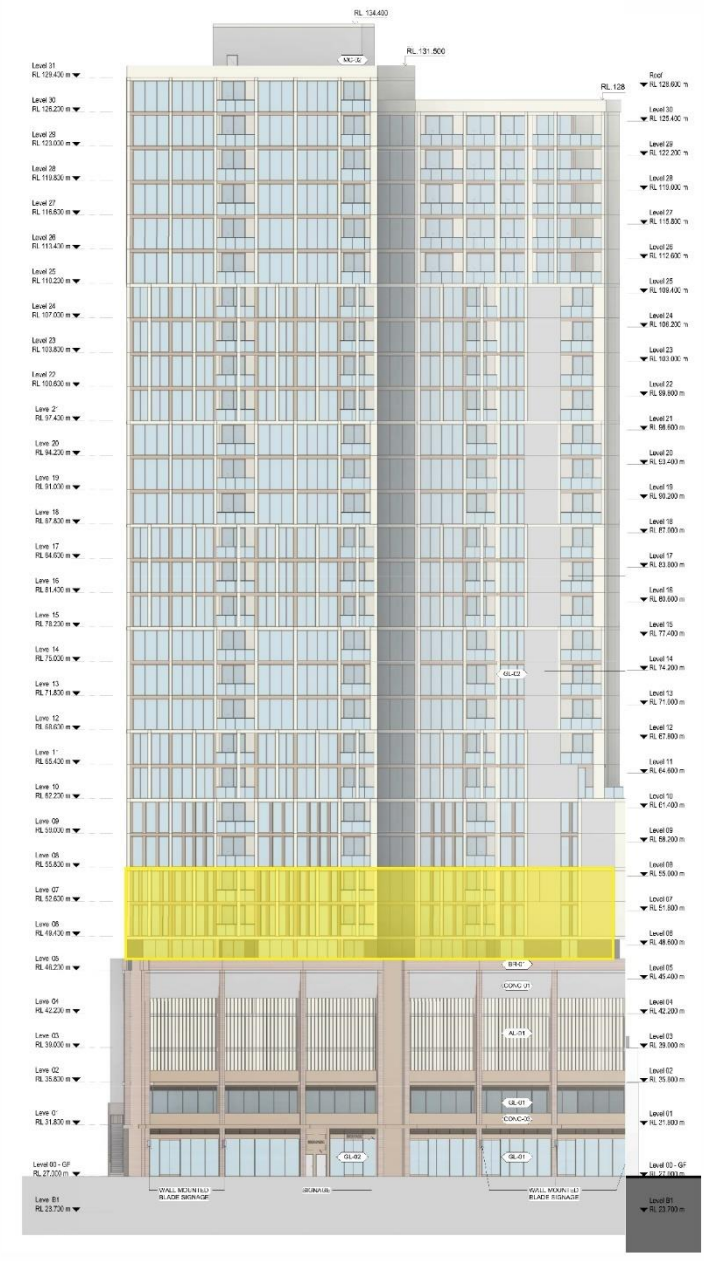

Figure 3c: Suggested Treatments – Tower A, Eastern Elevation (for balustrades)

Treatments Legend

Additional vertical sunshade fins to be included. The vertical fins are required to protrude from the body of the façade at an angle not normal to the façade line.

A façade articulation (panel rotation) is to be applied to the external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations.

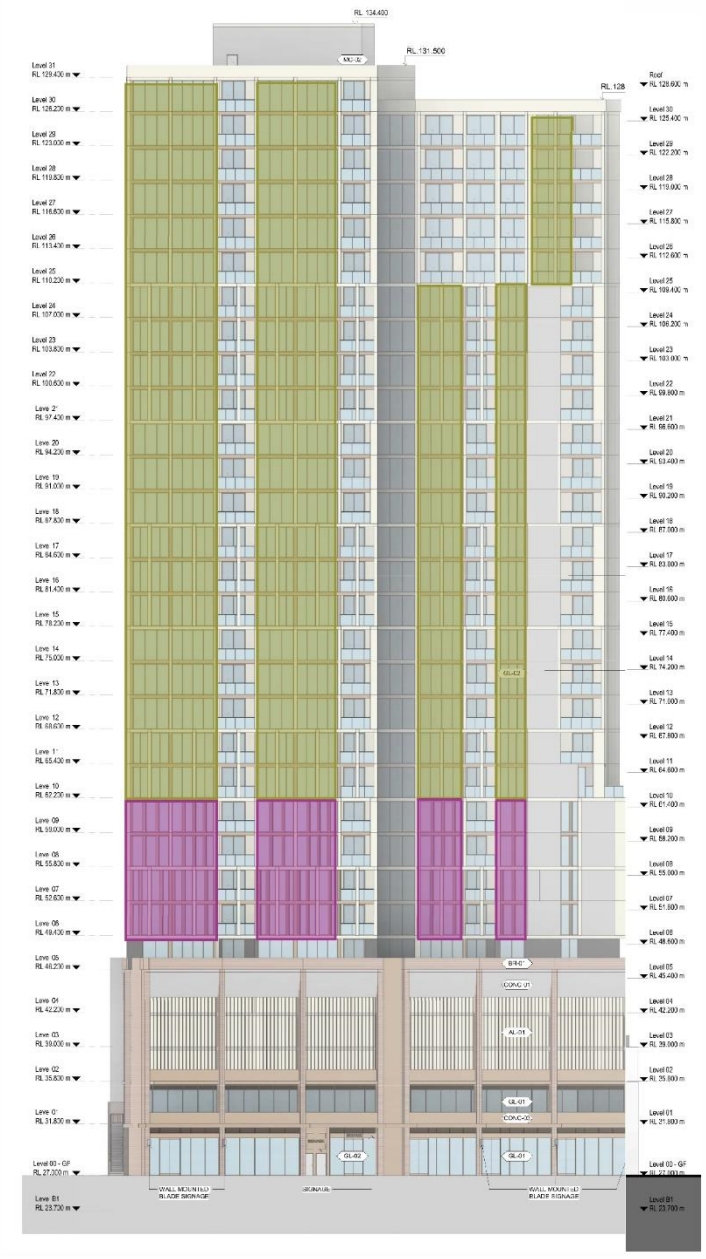

Figure 3d: Suggested Treatments – Tower A, Eastern Elevation (for external façade)

Treatments Legend

Example of additional vertical sunshade fins required. Dimensions and orientation not to scale. Fins required to shade most of facade. Fins to be applied to all locations as indicated in the elevation figure.

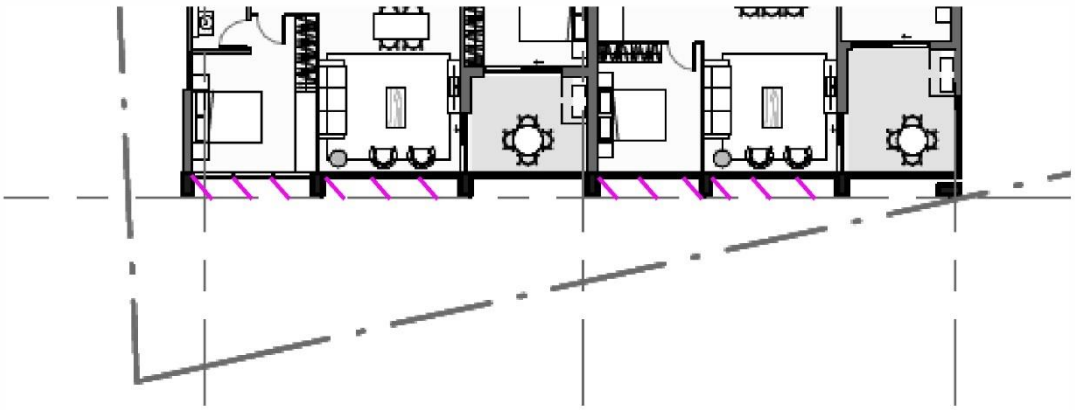

Figure 3e: Suggested Treatments – Tower A, Standard Level Plan

Treatments Legend

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 11%.

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 16%.

Figure 3f: Suggested Treatments – Tower B, Western Elevation (for external façade)

Treatments Legend

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 11%.

Limit the normal specular reflectance of visible light of the glazing in this location to a maximum value of 16%.

Figure 3g: Suggested Treatments – Tower B, Western Elevation (for balustrades)

Treatments Legend

A façade articulation (panel rotation) is to be applied to the external façade. A small rotation is applied to each individual panel (in the range of 1 to 2 degrees per panel). The design must alternate between at least 3 different panel orientations.

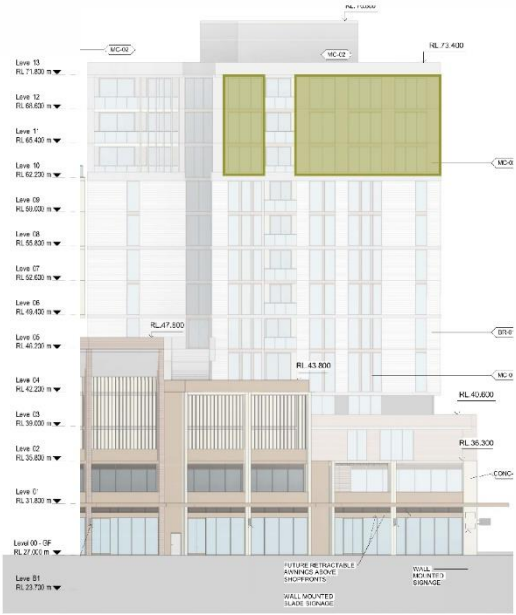

Figure 3h: Suggested Treatments – Tower B, Eastern Elevation (for external façade)

6 CONCLUSION

A detailed study has been undertaken for the effect of potential solar glare from the Thornton Central Village development, located at 184 Lord Sheffield Circuit, Penrith (Lot 3003 in DP1184498). The study has identified any possible adverse reflected solar glare conditions affecting motorists, train drivers and pedestrians within the local surrounding area, and also to occupants of neighbouring buildings. Recommendations have been made to mitigate any adverse effects. With the incorporation of the recommended treatments described within this report, the results of this study indicate that the subject development will not cause adverse solar glare to motorists, pedestrians or train drivers in the surrounding area, or to occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity from the State Environmental Planning Policy No. 65 (SEPP65, Part 04 (Designing the Building) for Amenity), which contains the Apartment Design Guide (ADG), and the Penrith Development Control Plan 2014.

The analysis presented assumes that the adjacent Stage 2 development located at 41, (part) 184 and 192 Lord Sheffield Circuit, Penrith (Part Lot 3003, Lot 3004 and Lot 3005 in DP1184498) is built concurrently or within a reasonable amount of time from the Stage 1 development.

7 REFERENCES

Penrith City Council, 2014, "Penrith Development Control Plan 2014, Volume 2".

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.

State Environmental Planning Policy No. 65 (SEPP65), 2015, "Apartment Design Guide", NSW Department of Planning and Environment.

APPENDIX A SIGHT-LINES WITH GLARE OVERLAYS

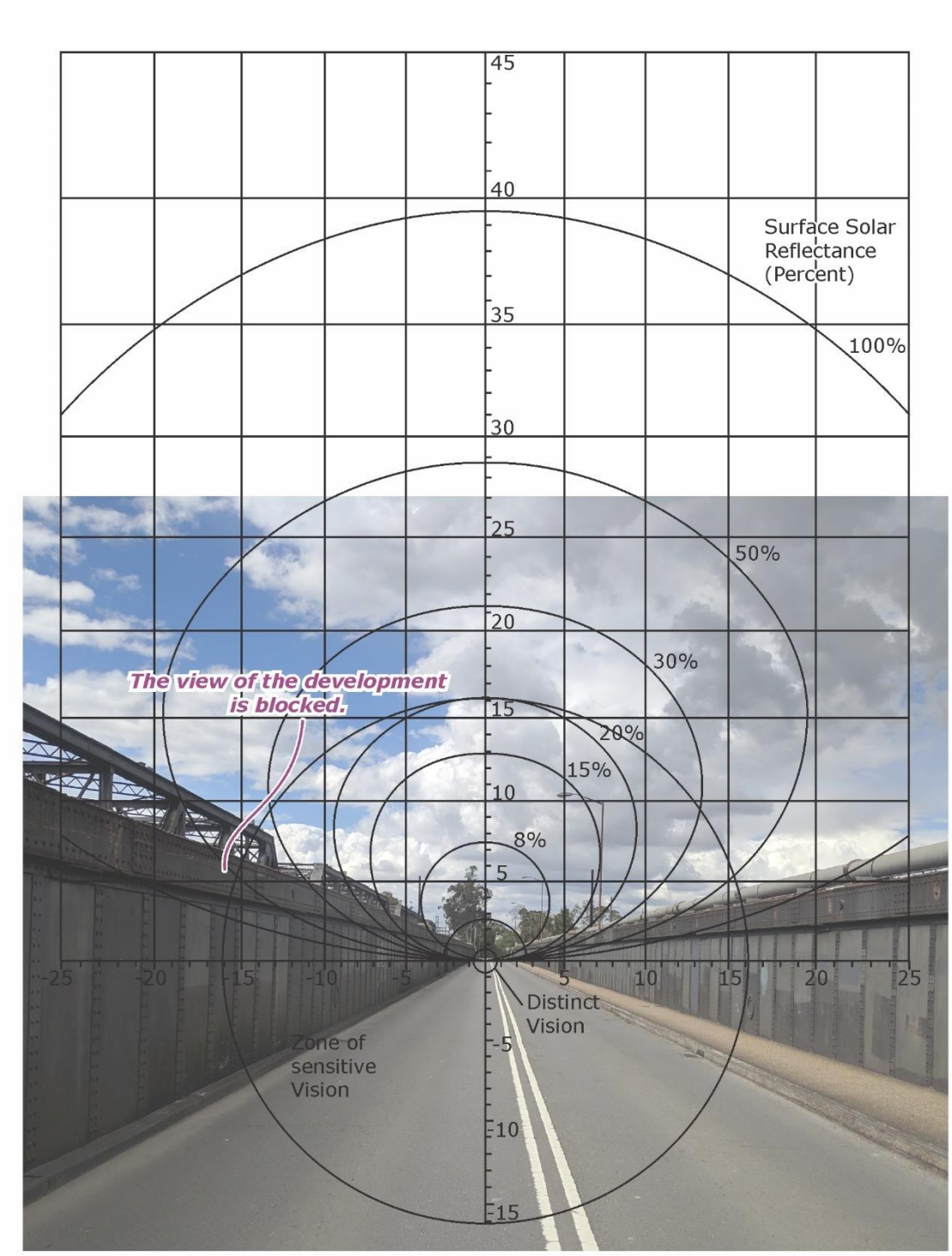

Figure A.1: Glare Overlay of the Viewpoint at Point 01

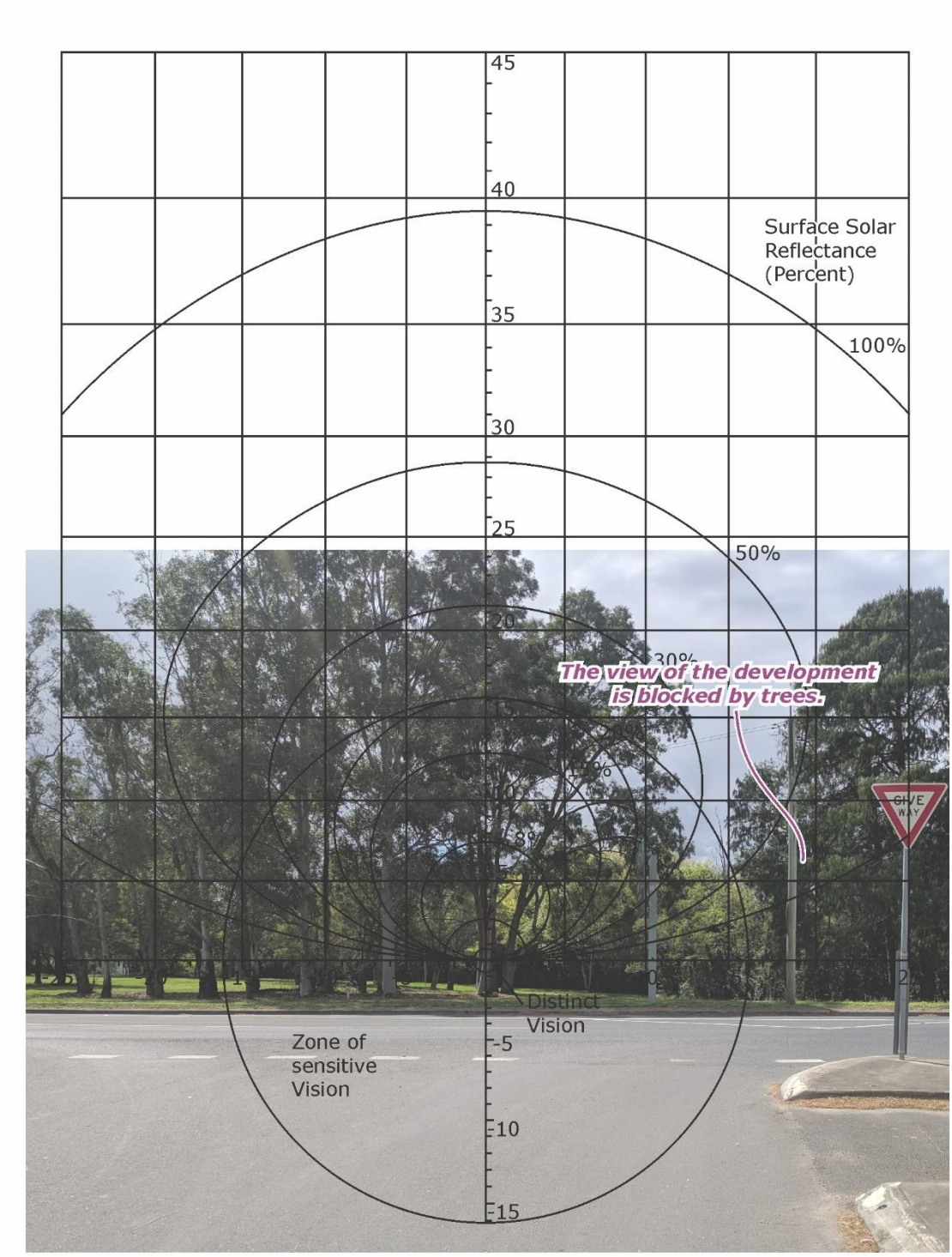

Figure A.2: Glare Overlay of the Viewpoint at Point 02

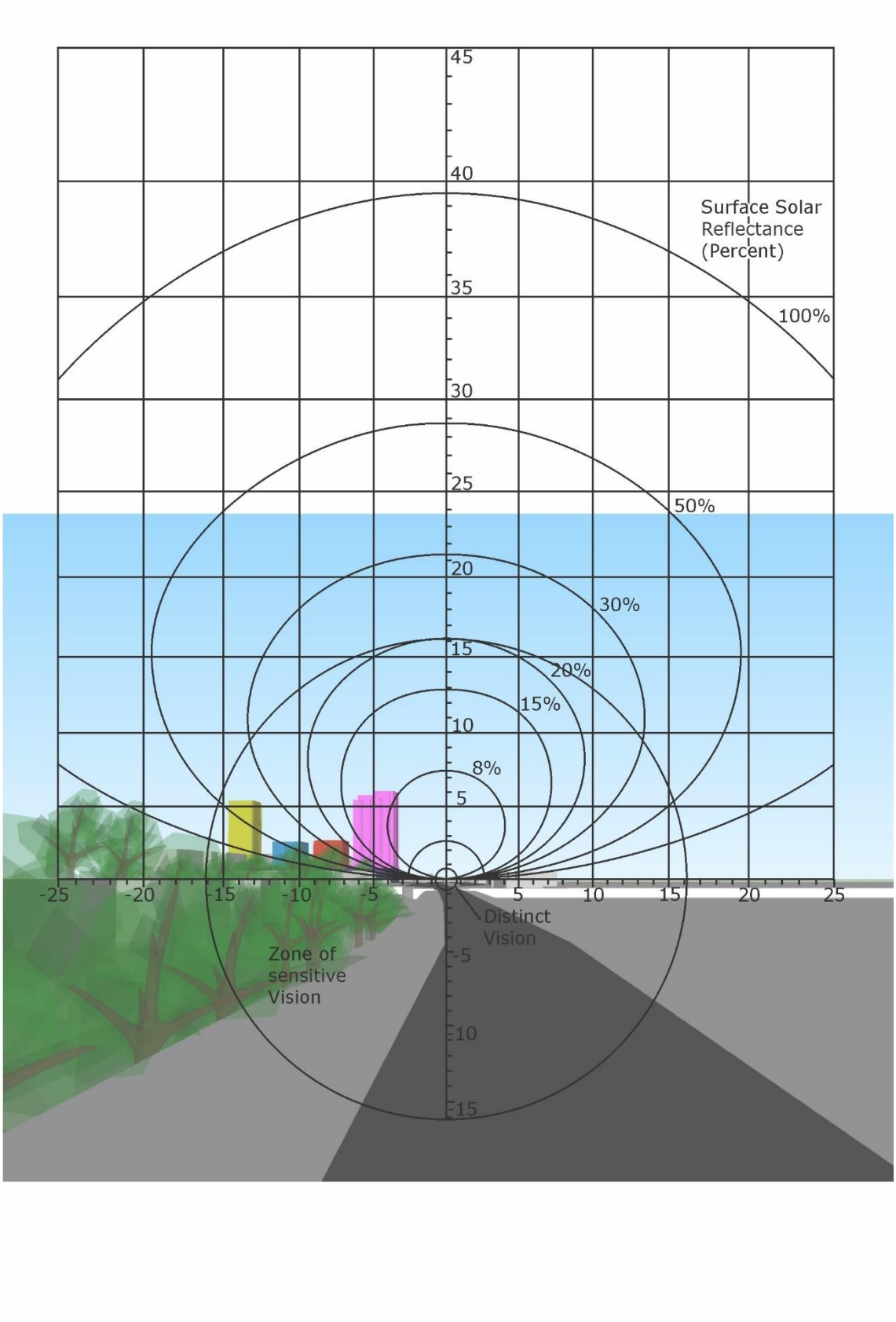

Figure A.3: Glare Overlay of the Viewpoint at Point 03

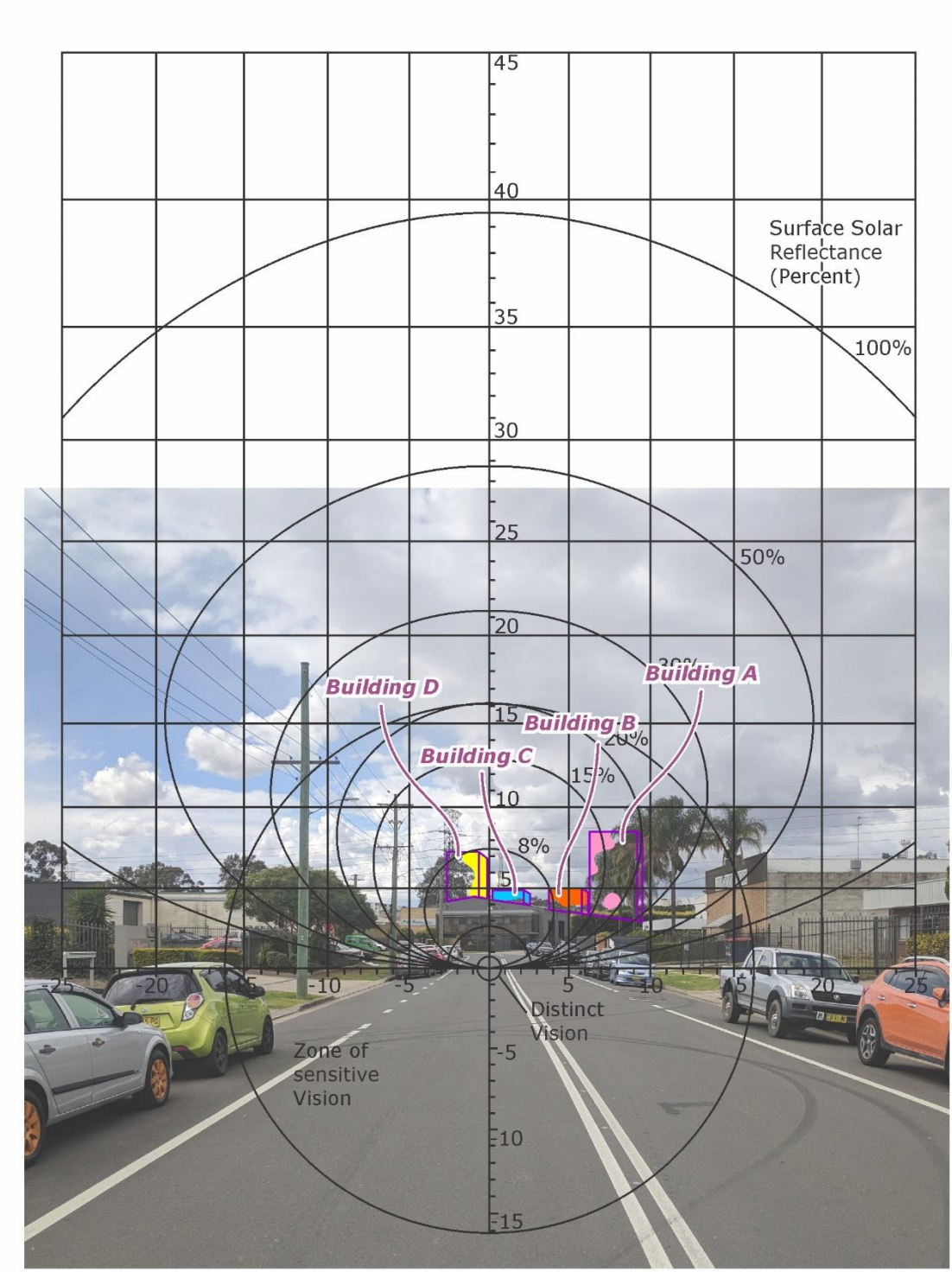

Figure A.4: Glare Overlay of the Viewpoint at Point 04

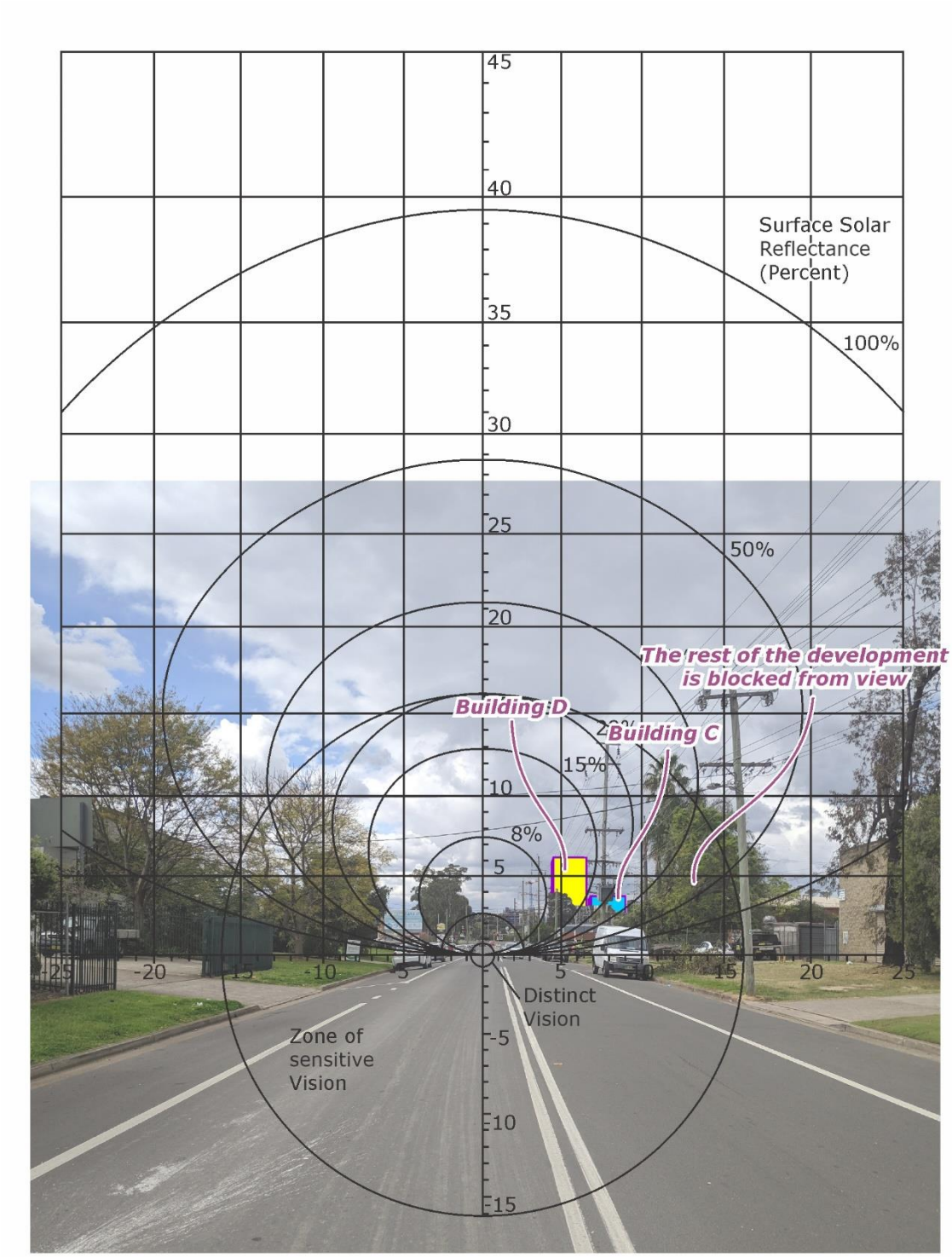

Figure A.5: Glare Overlay of the Viewpoint at Point 05

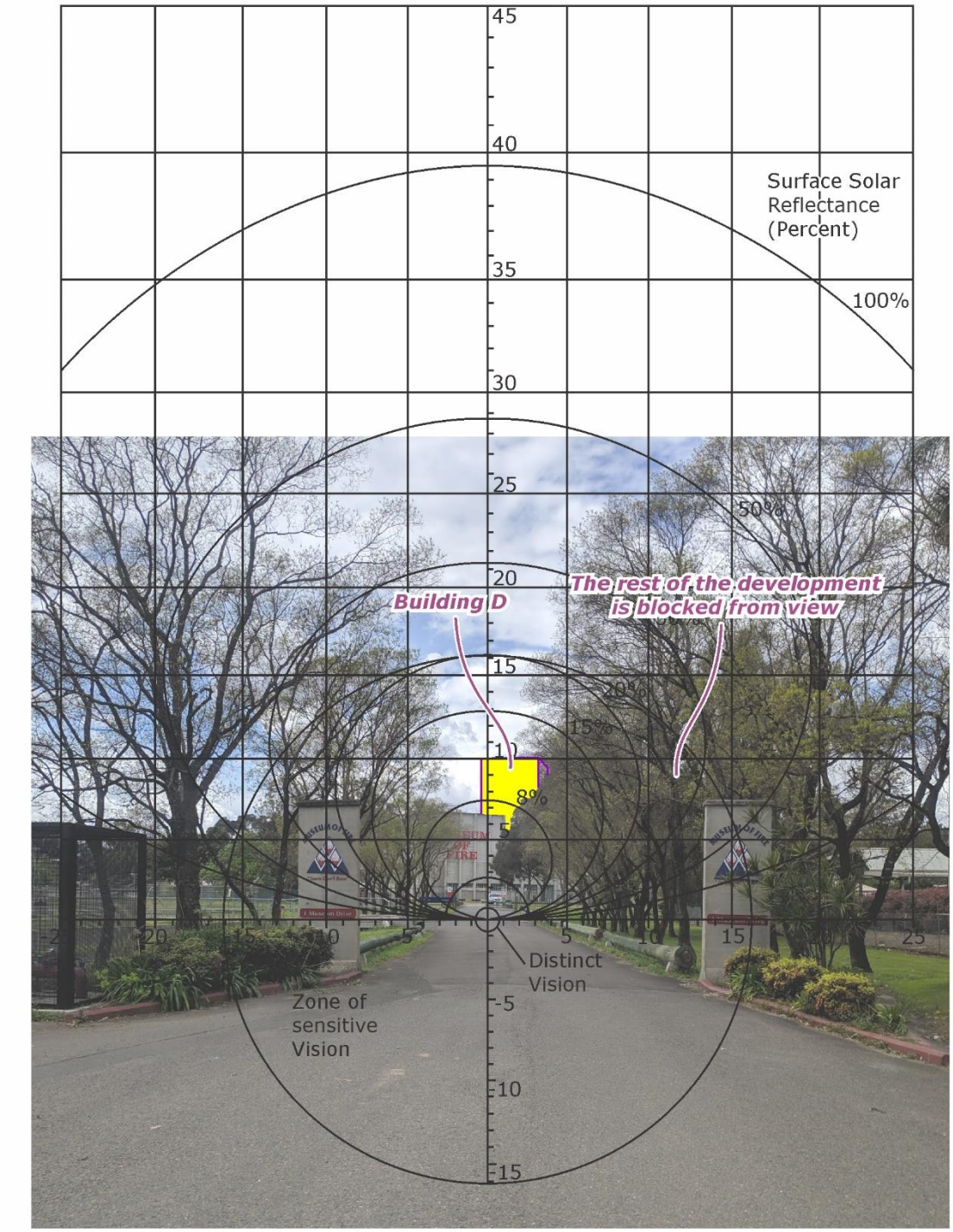

Figure A.6: Glare Overlay of the Viewpoint at Point 06

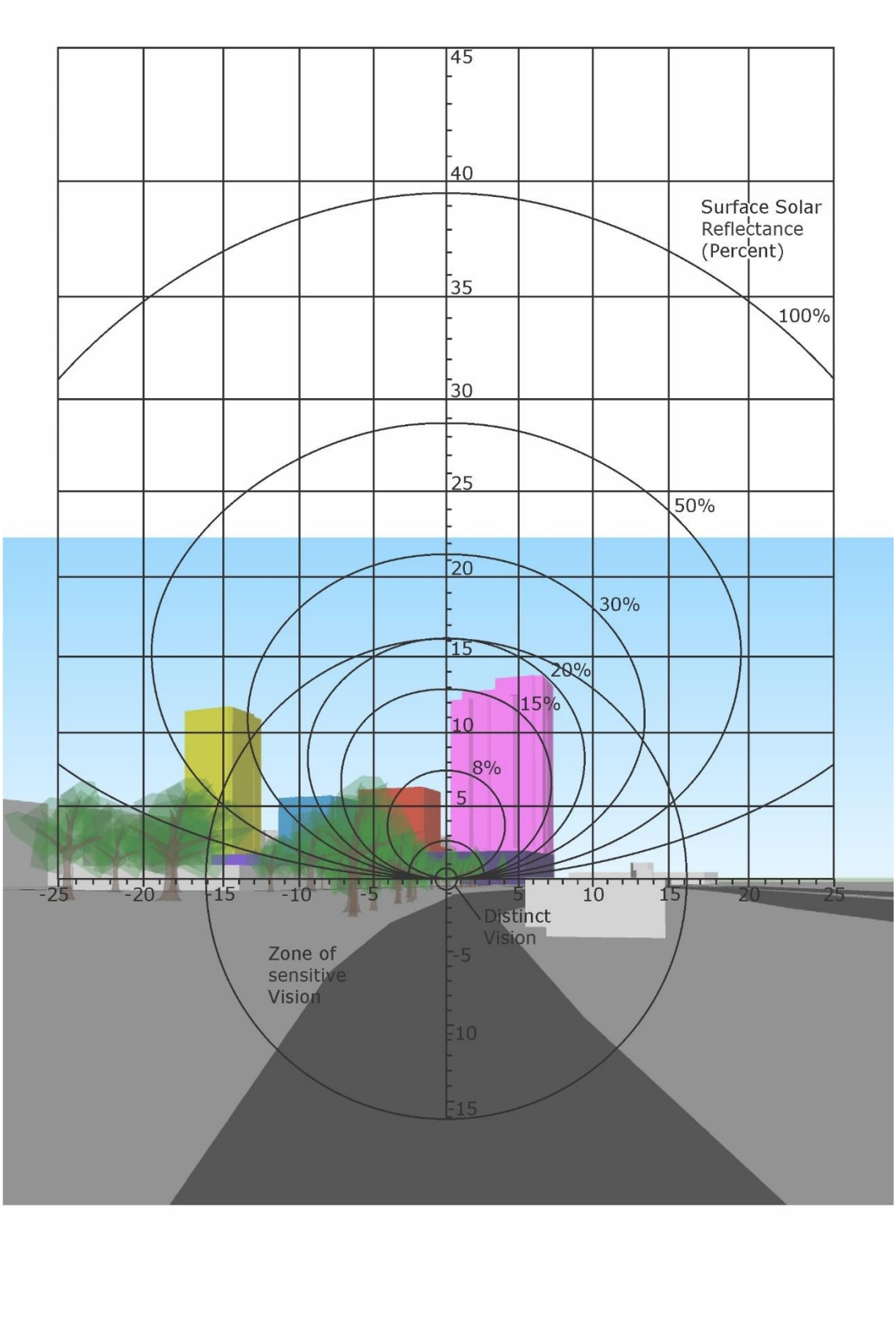

Figure A.7: Glare Overlay of the Viewpoint at Point 07

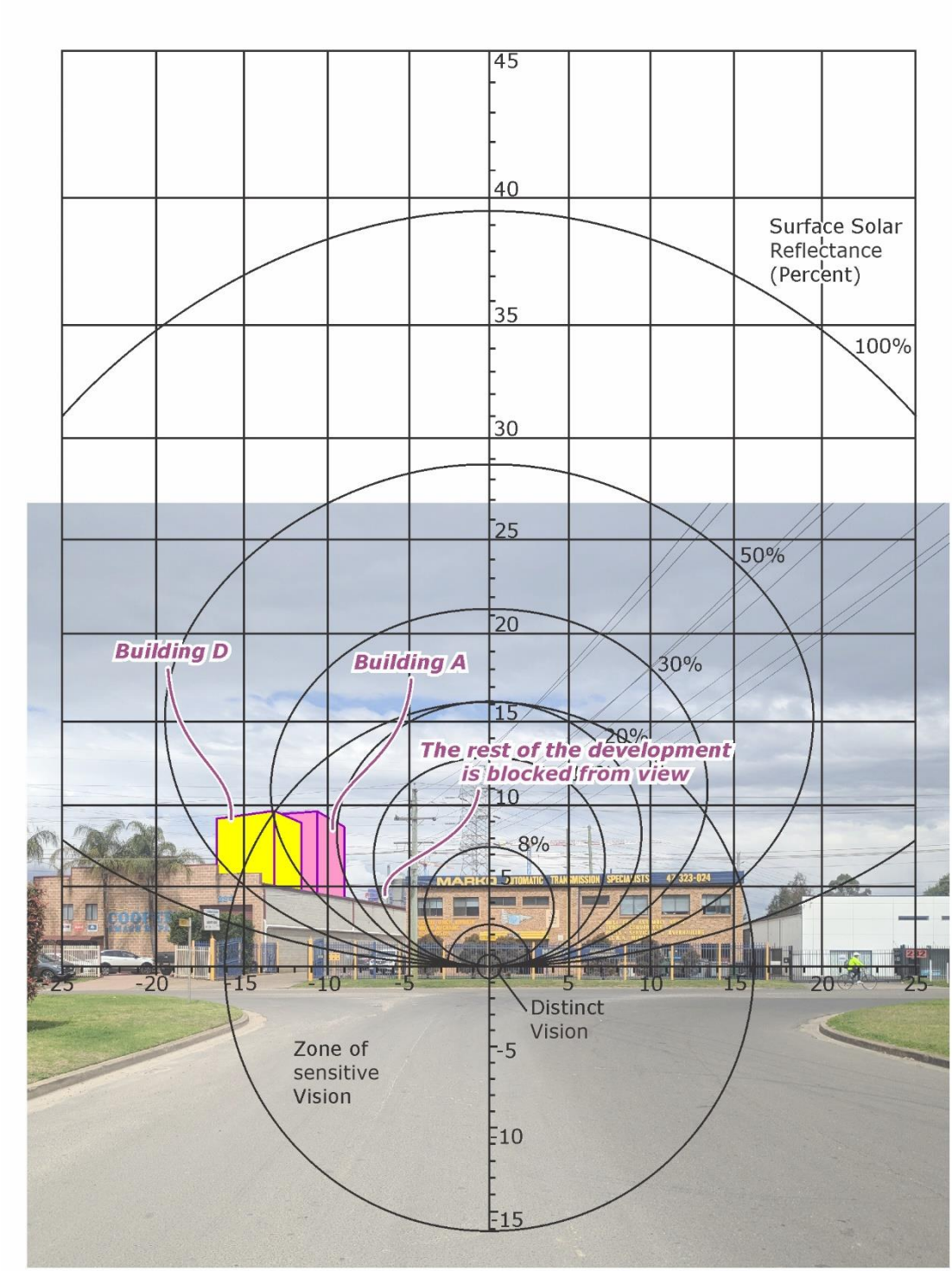

Figure A.8: Glare Overlay of the Viewpoint at Point 08

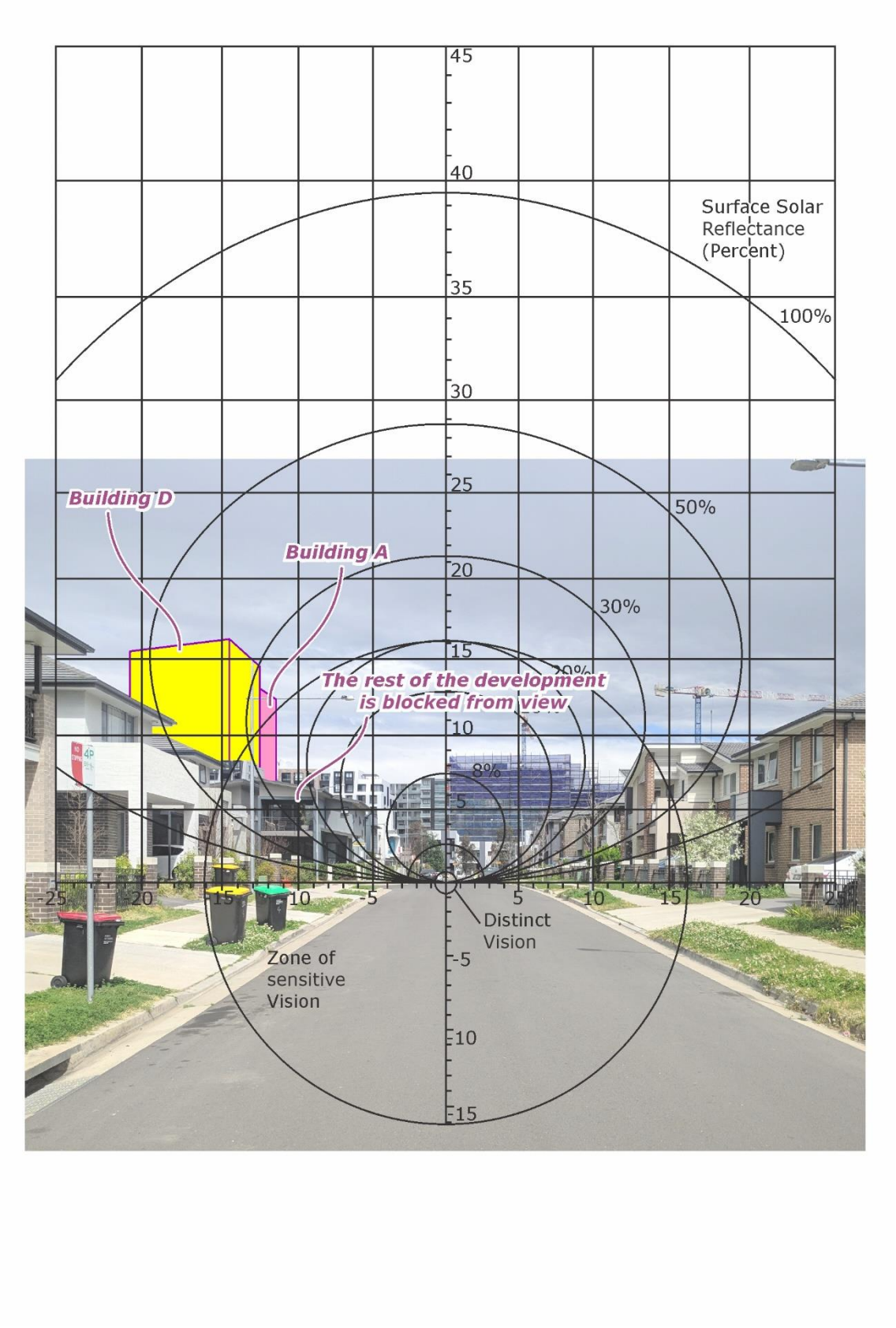

Figure A.9: Glare Overlay of the Viewpoint at Point 09

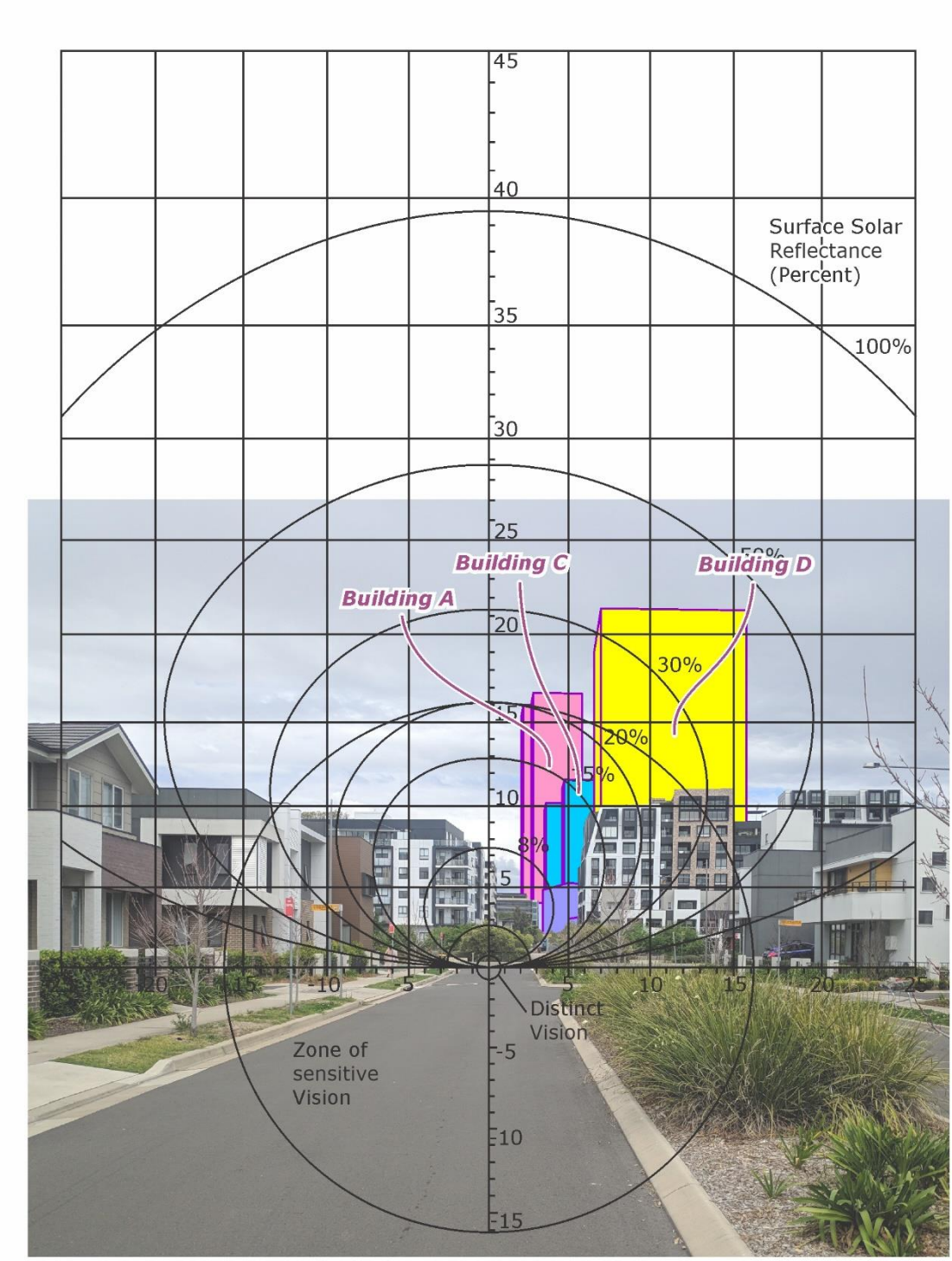

Figure A.10: Glare Overlay of the Viewpoint at Point 10

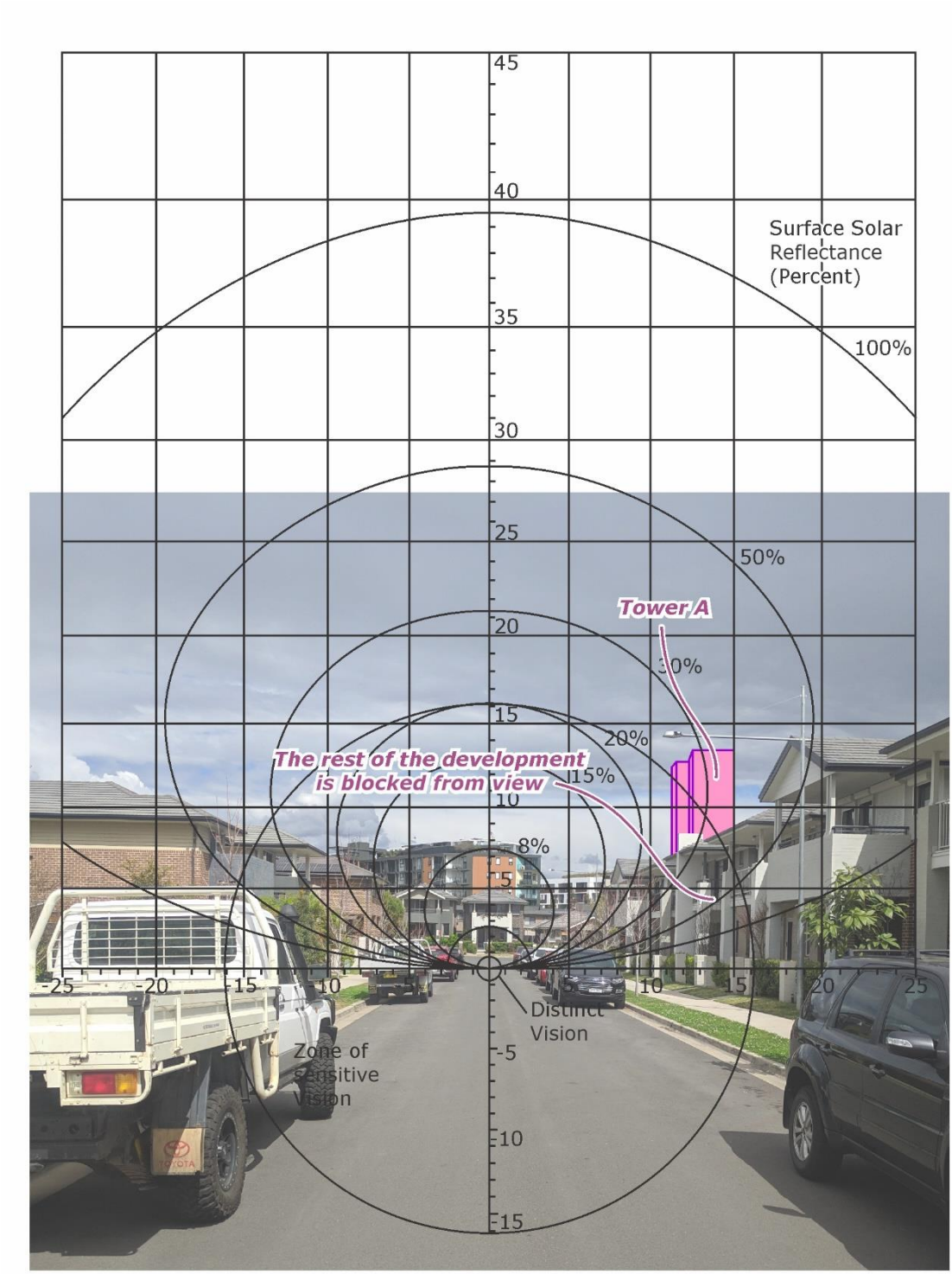

Figure A.11: Glare Overlay of the Viewpoint at Point 11

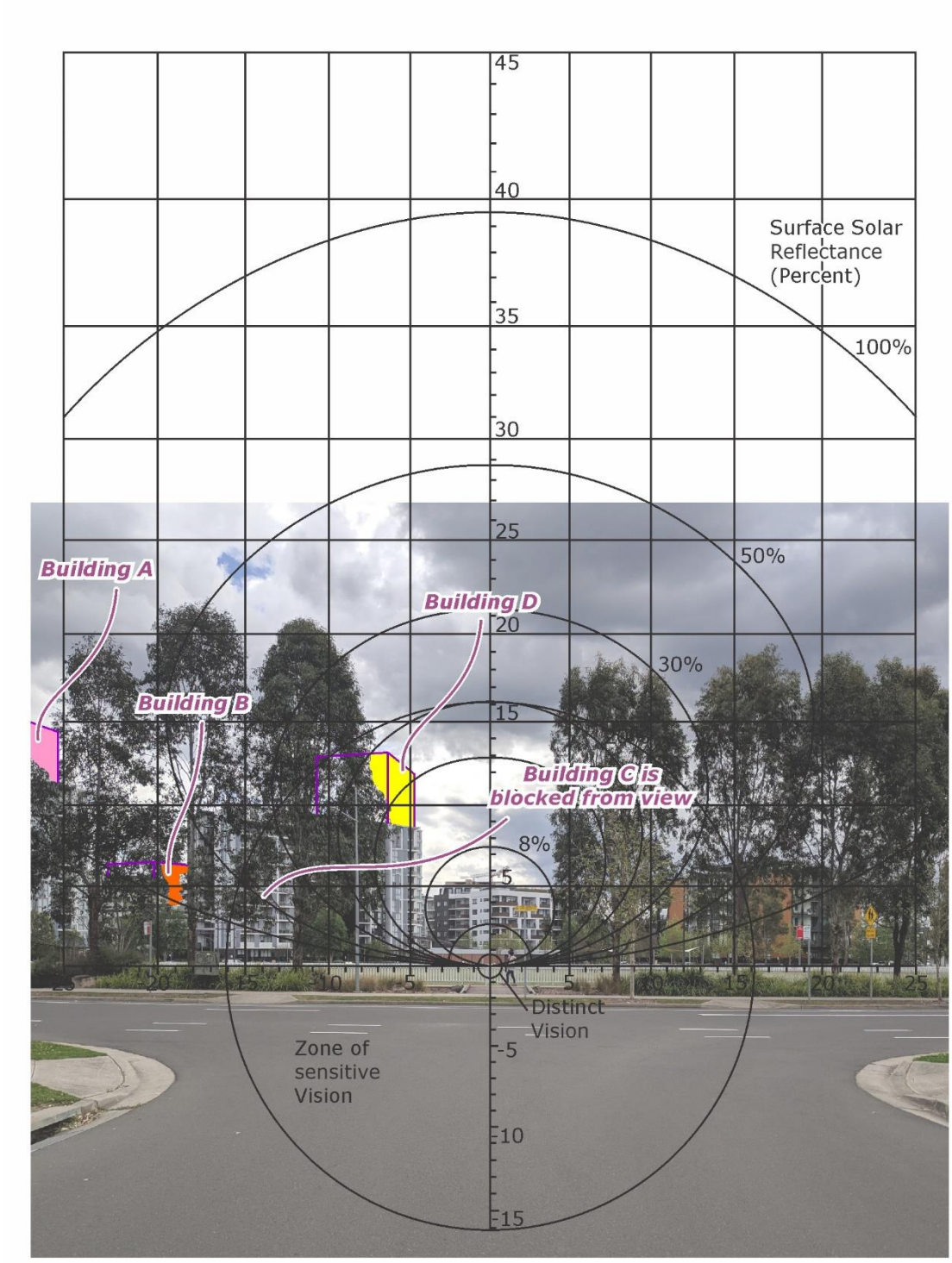

Figure A.12: Glare Overlay of the Viewpoint at Point 12

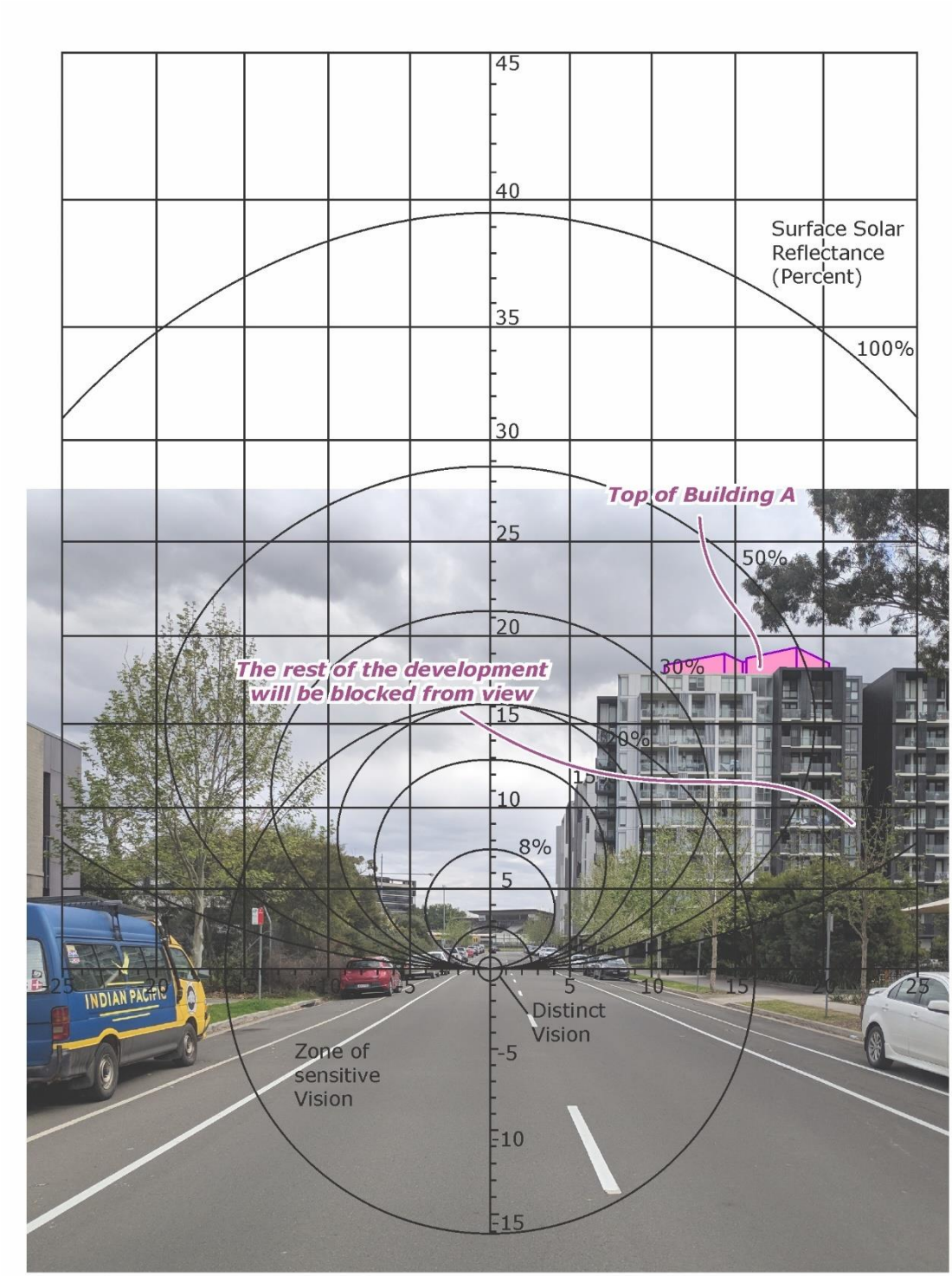

Figure A.13: Glare Overlay of the Viewpoint at Point 13

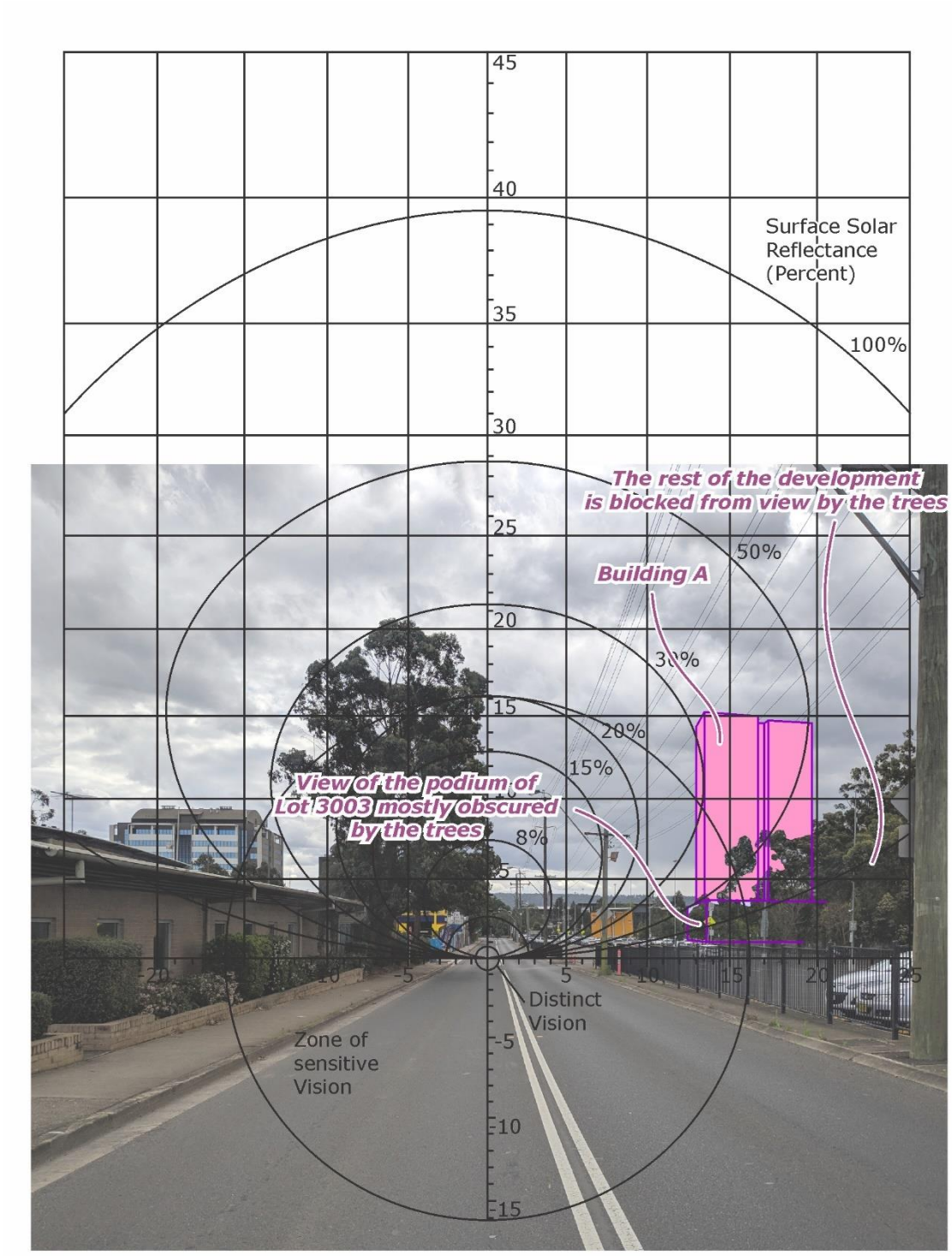

Figure A.14: Glare Overlay of the Viewpoint at Point 14

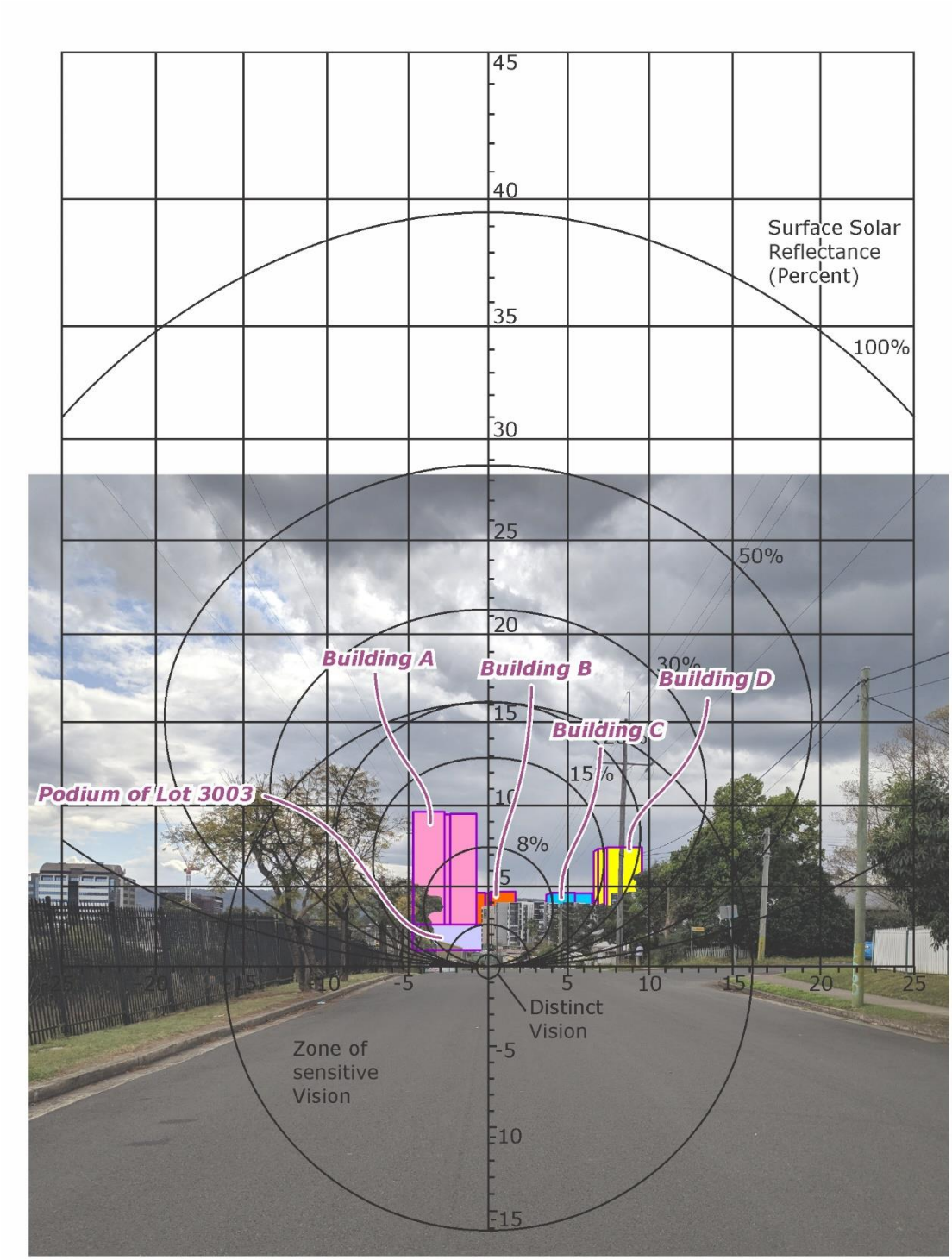

Figure A.15: Glare Overlay of the Viewpoint at Point 15

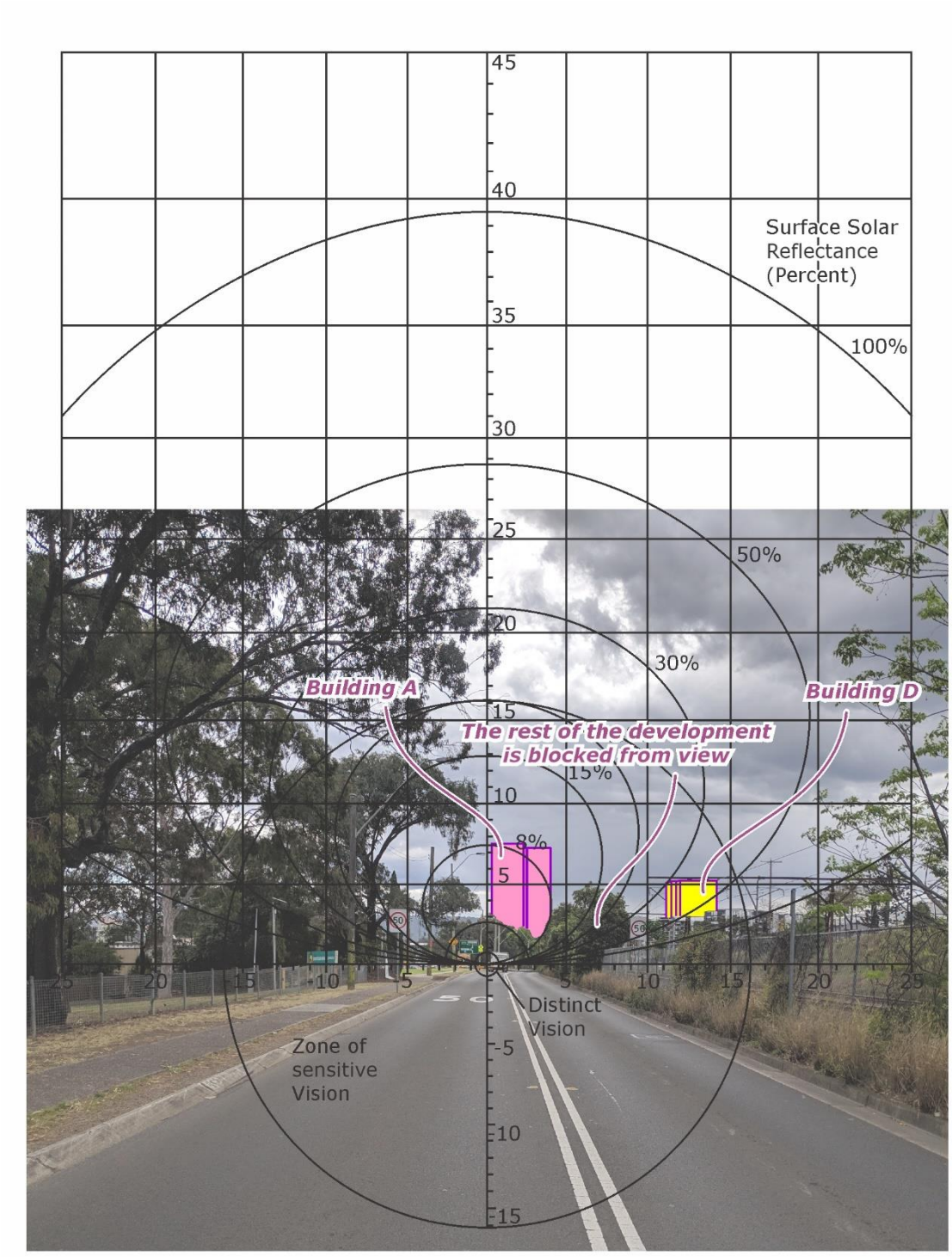

Figure A.16: Glare Overlay of the Viewpoint at Point 16

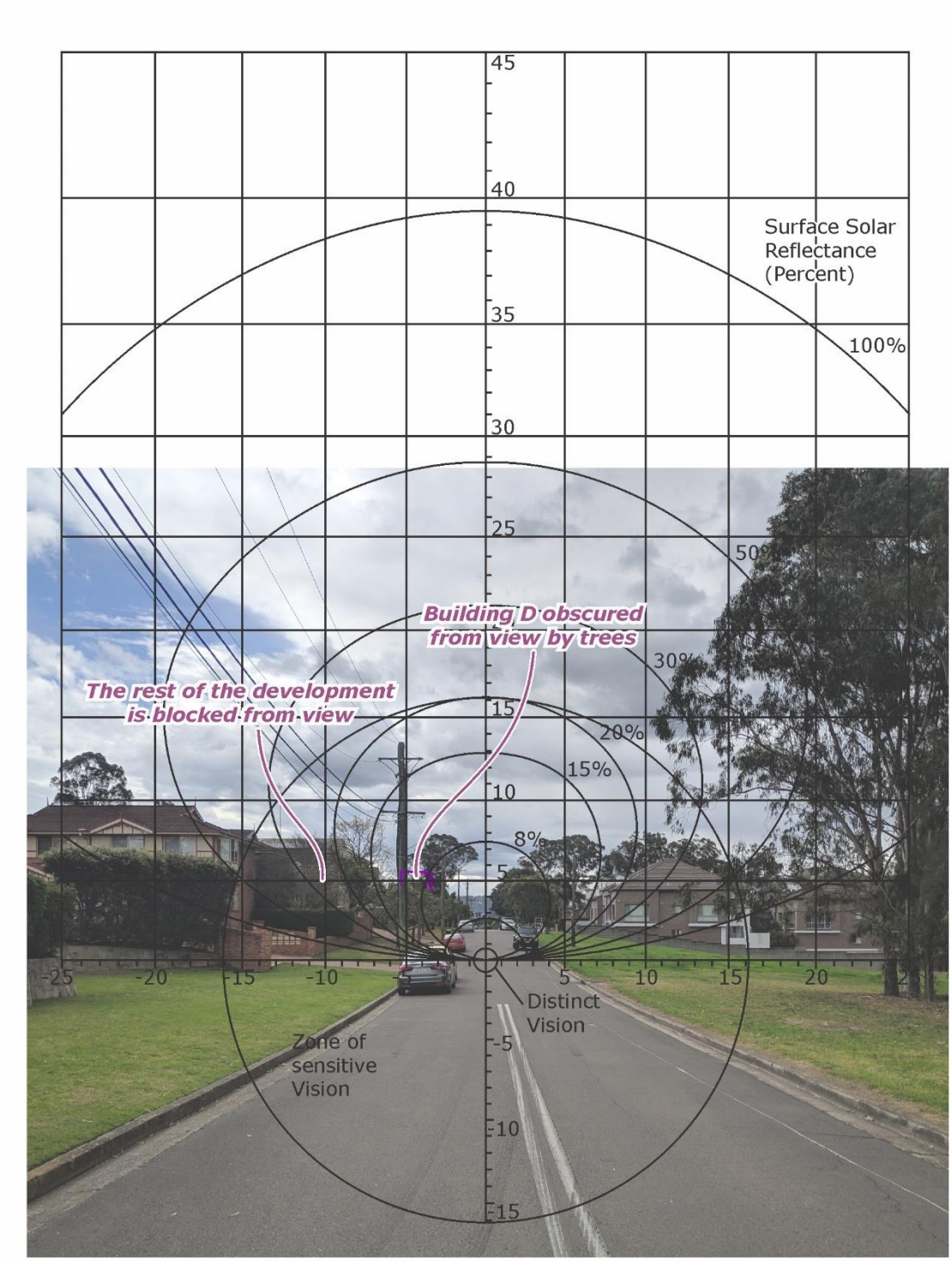

Figure A.17: Glare Overlay of the Viewpoint at Point 17

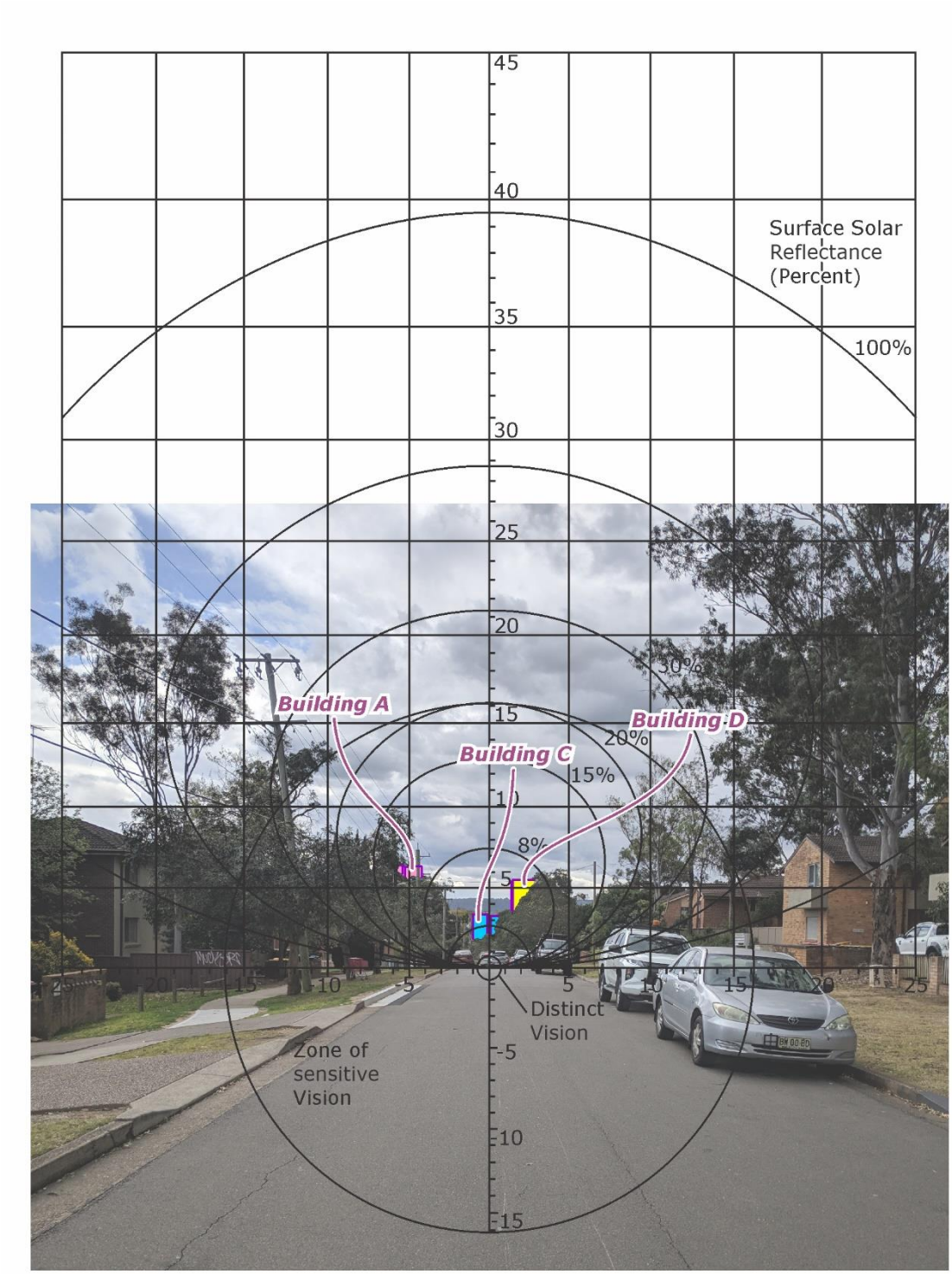

Figure A.18: Glare Overlay of the Viewpoint at Point 18

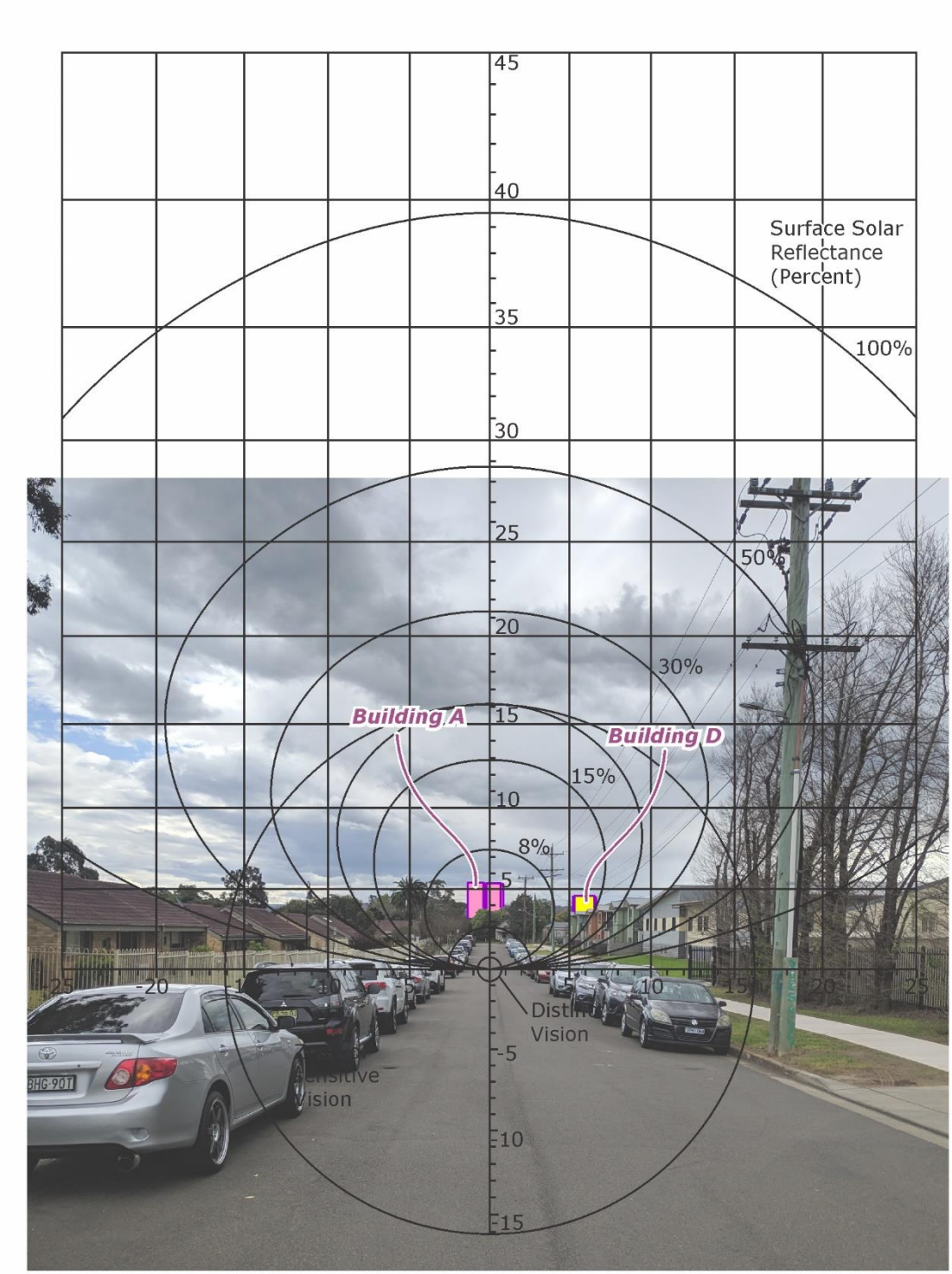

Figure A.19: Glare Overlay of the Viewpoint at Point 19

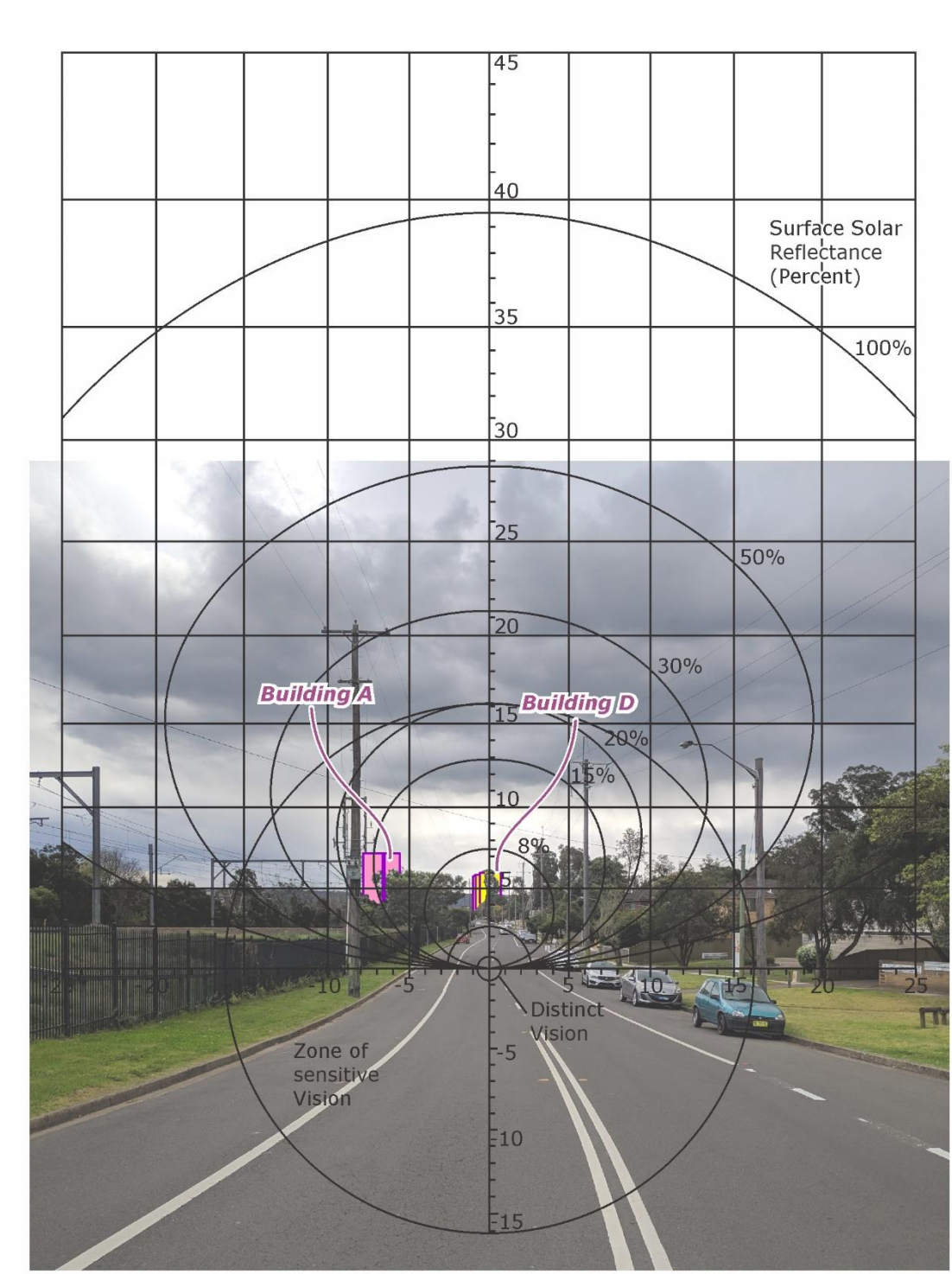

Figure A.20: Glare Overlay of the Viewpoint at Point 20

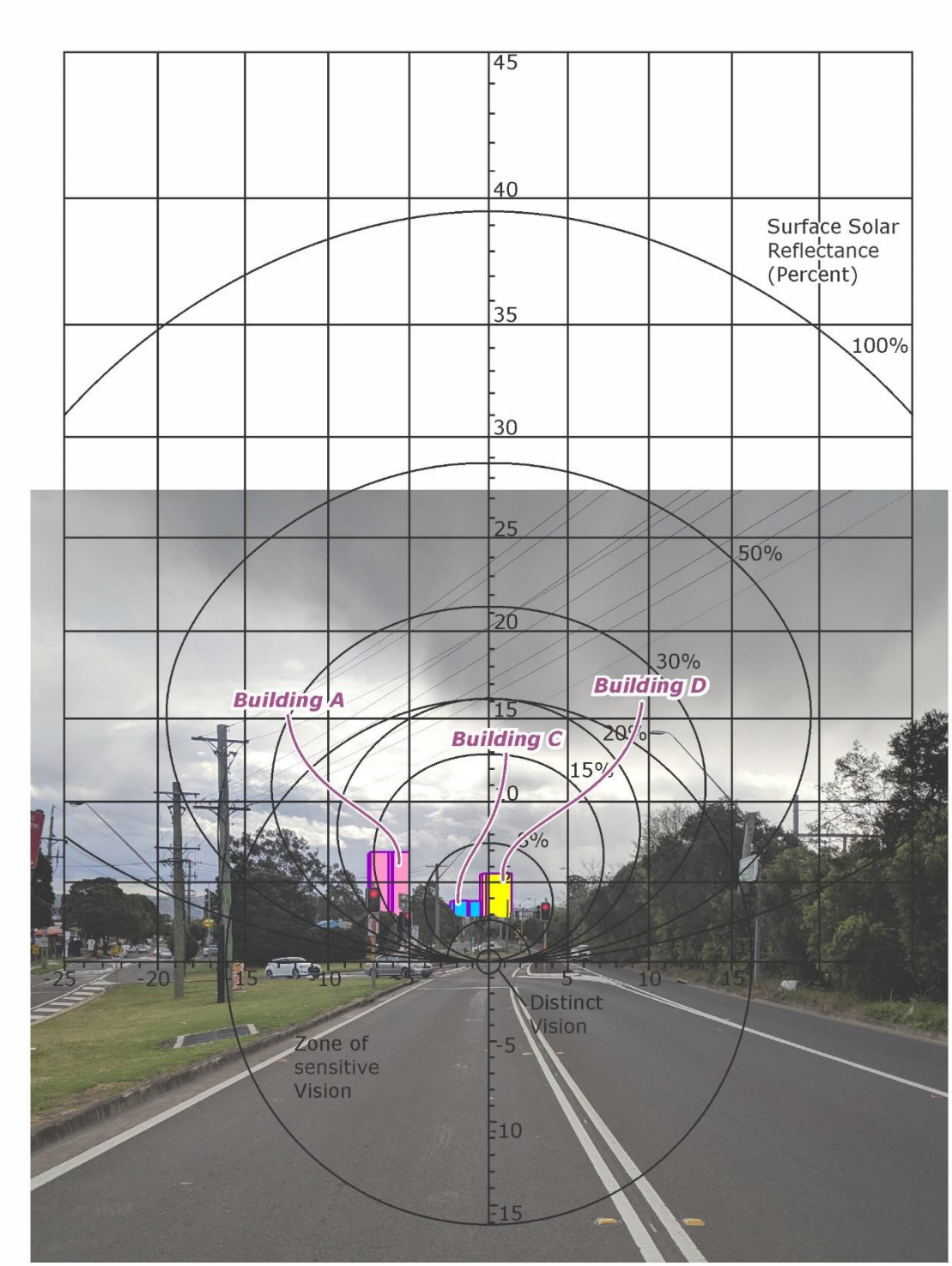

Figure A.21: Glare Overlay of the Viewpoint at Point 21

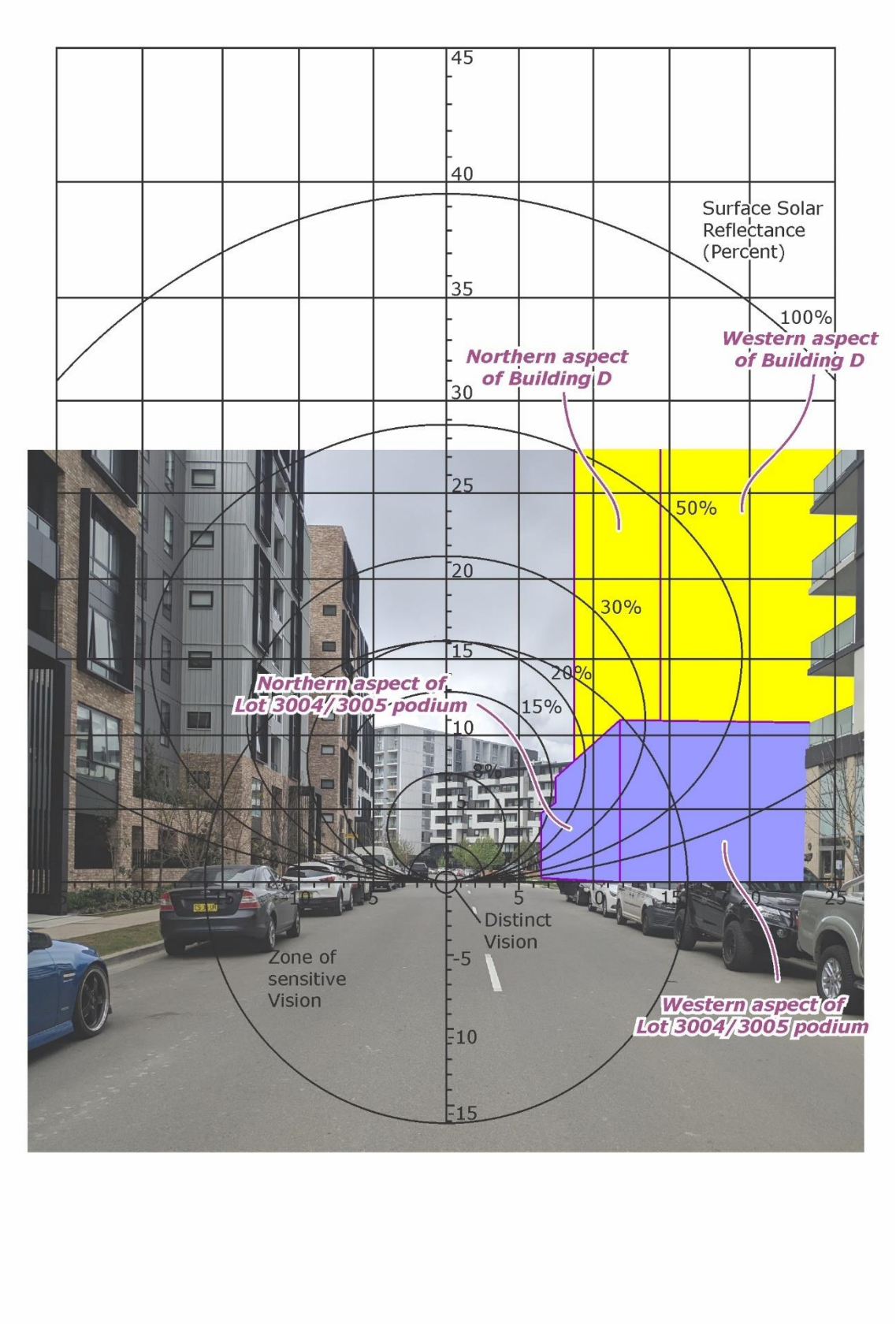

Figure A.22: Glare Overlay of the Viewpoint at Point 22

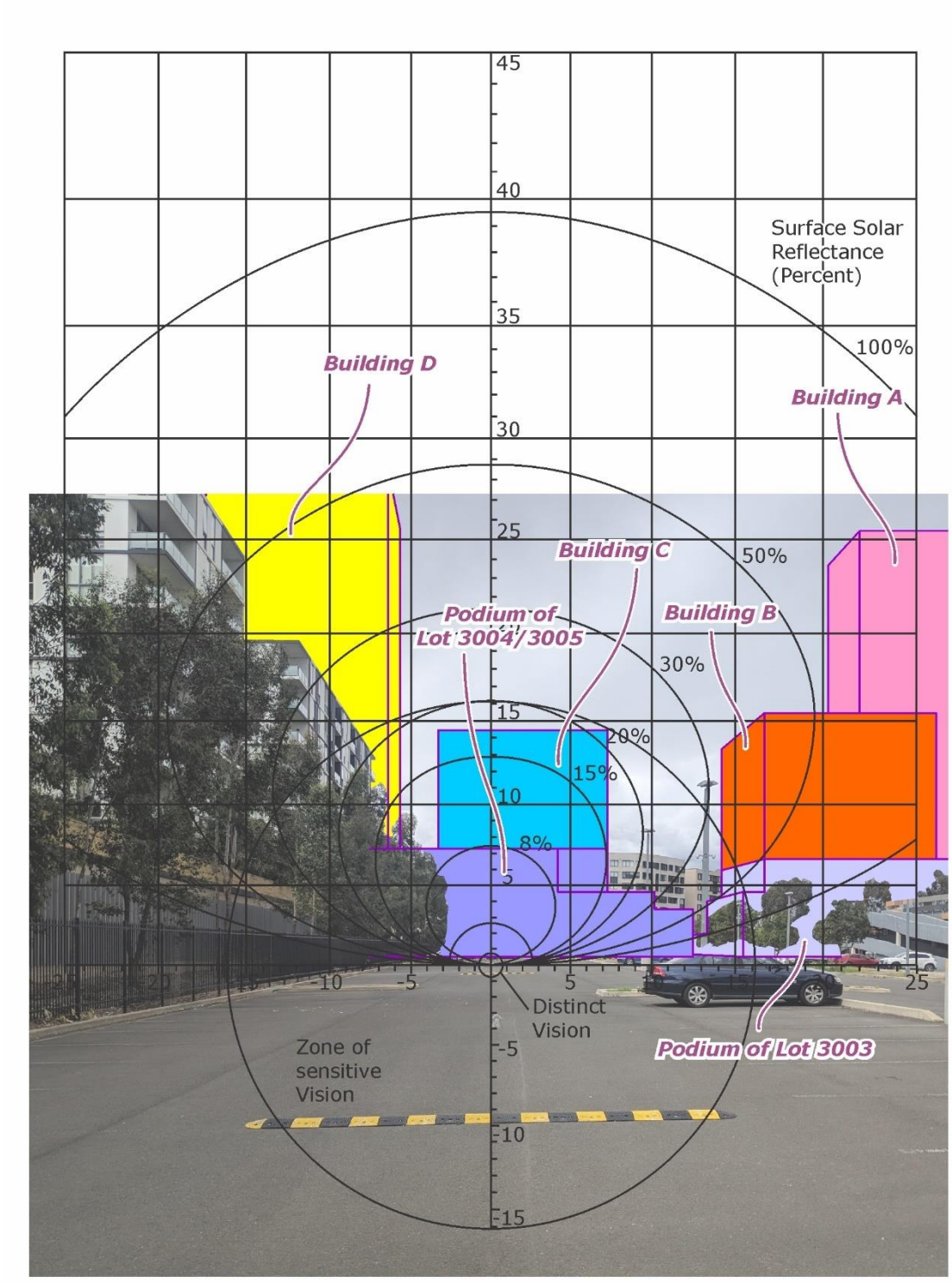

Figure A.23: Glare Overlay of the Viewpoint at Point 23

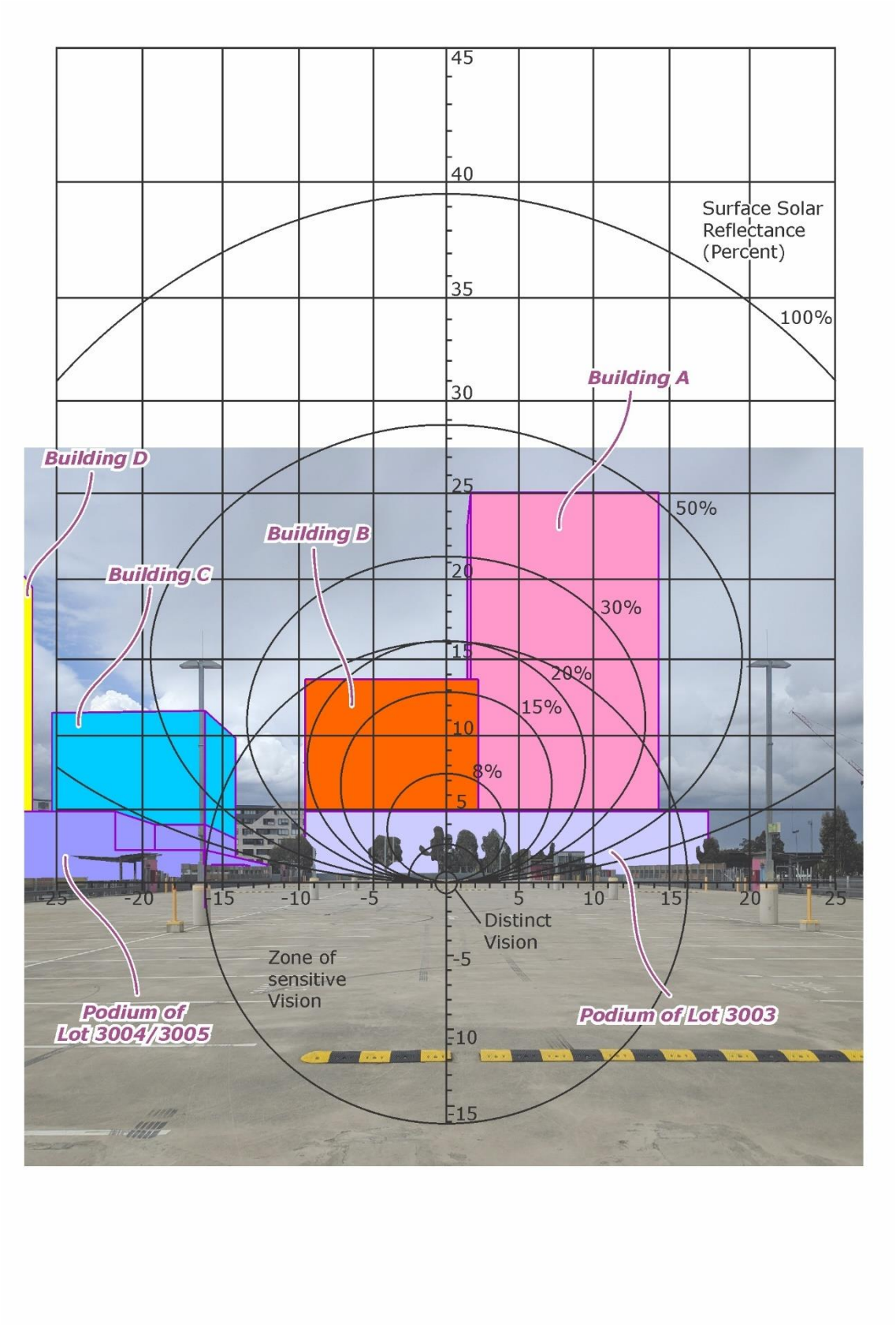

Figure A.24: Glare Overlay of the Viewpoint at Point 24

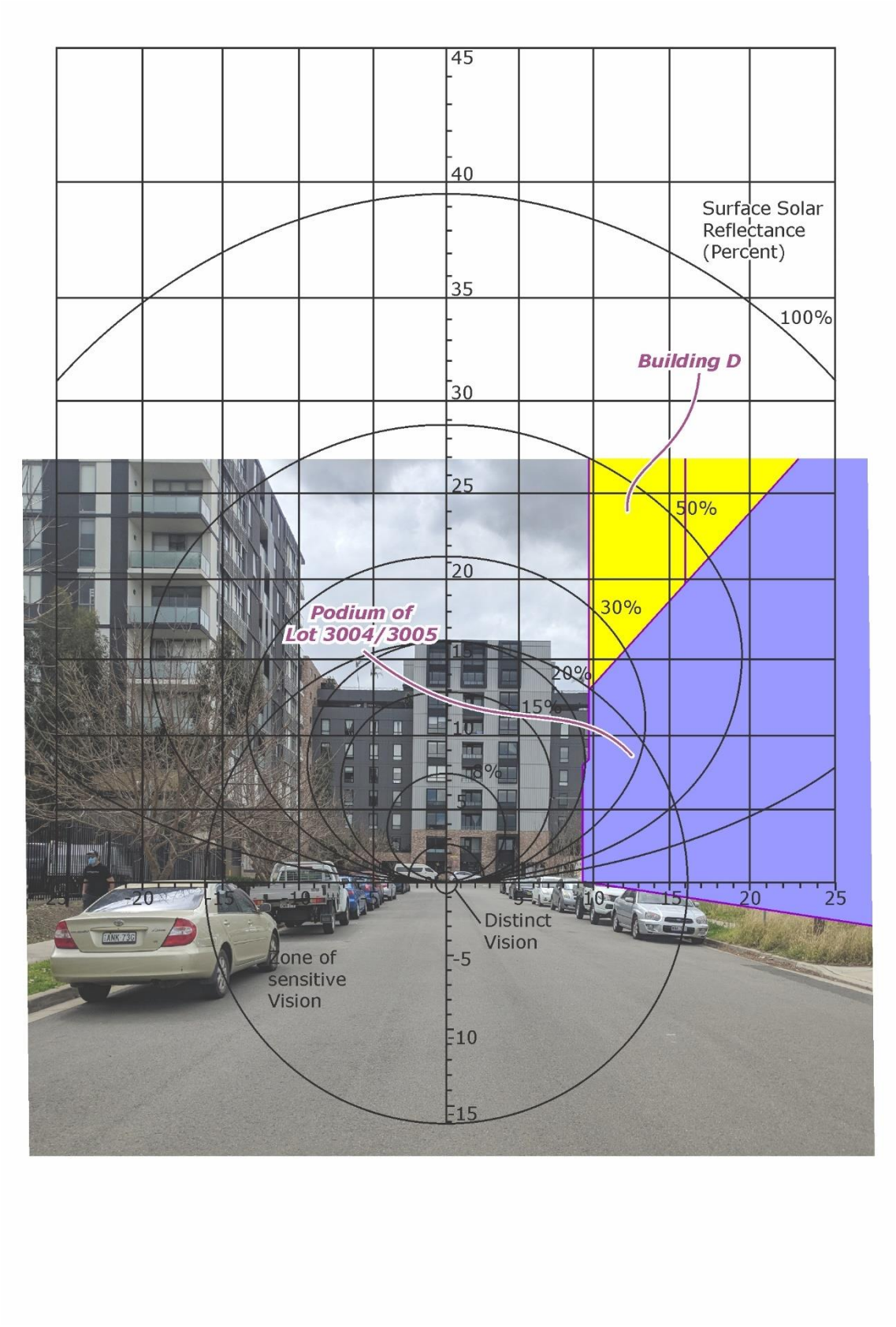

Figure A.25: Glare Overlay of the Viewpoint at Point 25

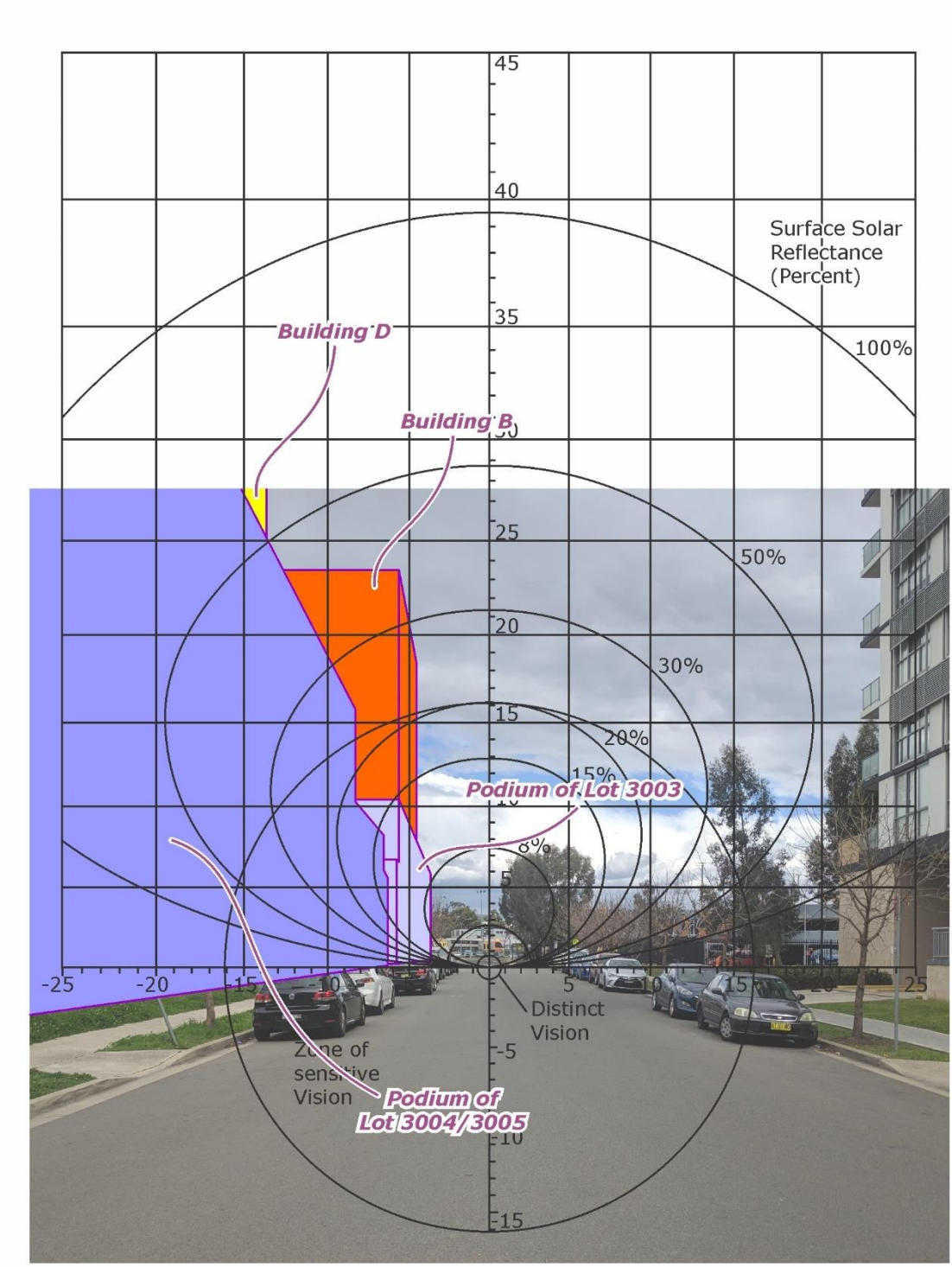

Figure A.26: Glare Overlay of the Viewpoint at Point 26

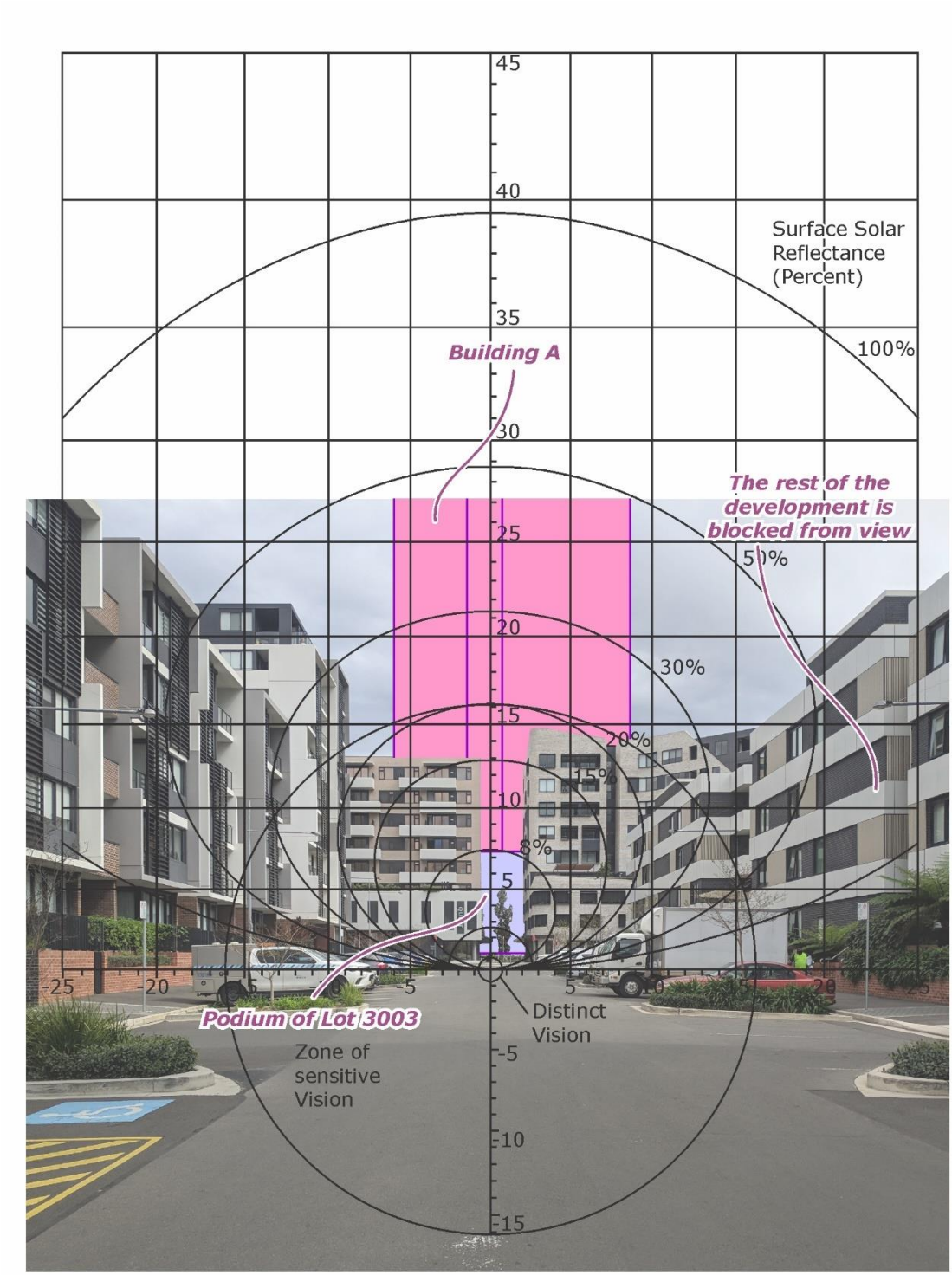

Figure A.27: Glare Overlay of the Viewpoint at Point 27

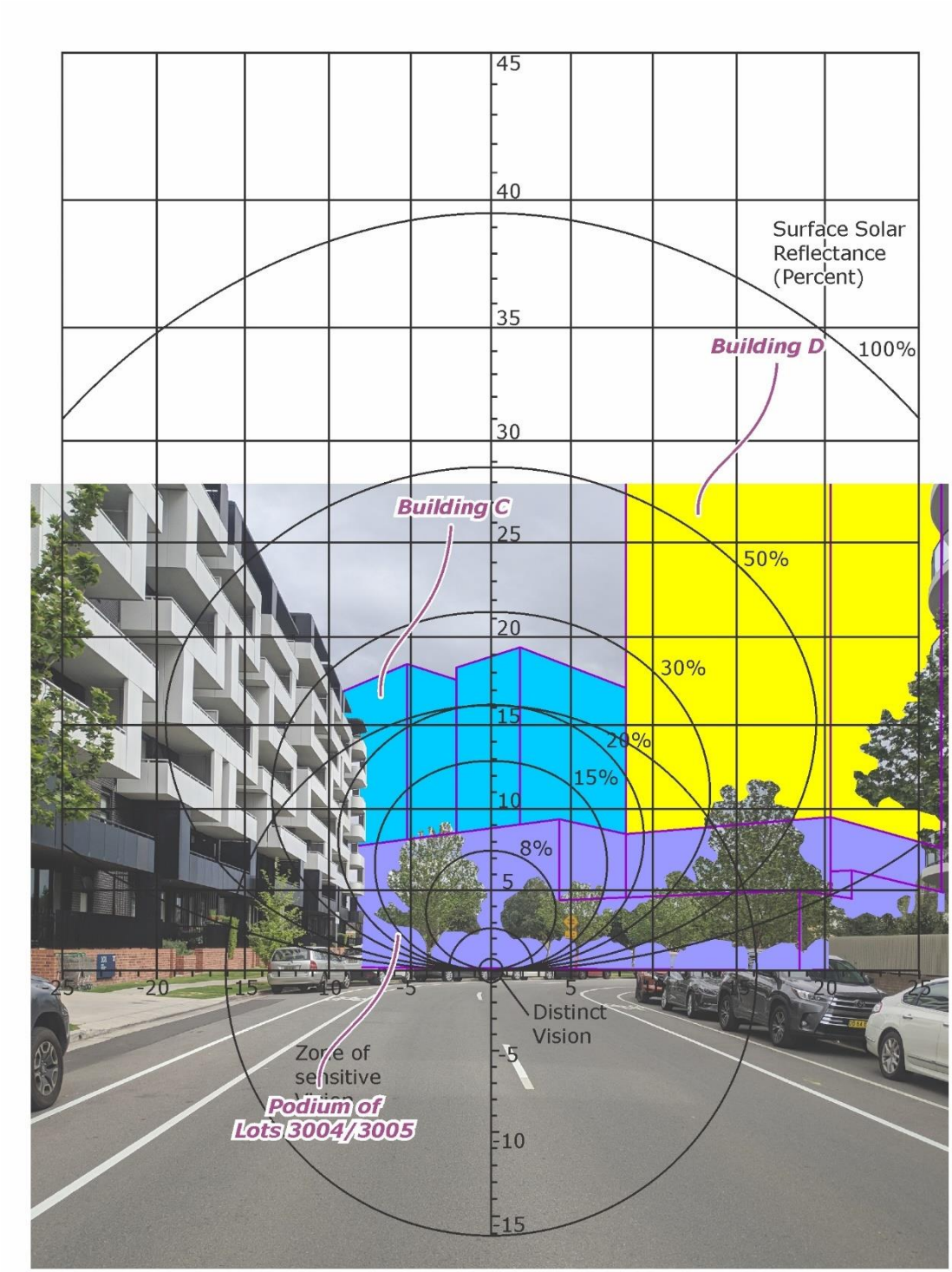

Figure A.28: Glare Overlay of the Viewpoint at Point 28

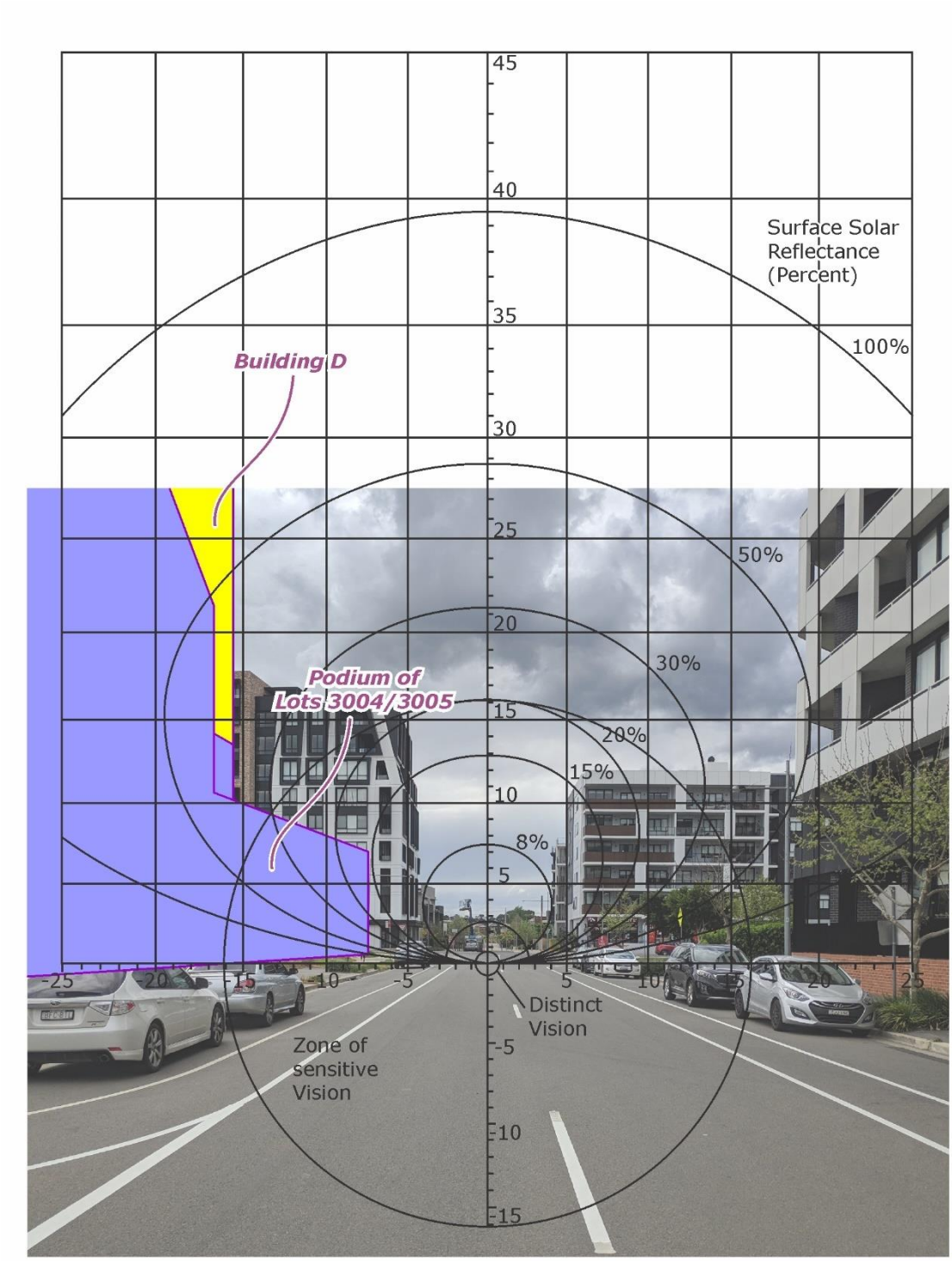

Figure A.29: Glare Overlay of the Viewpoint at Point 29

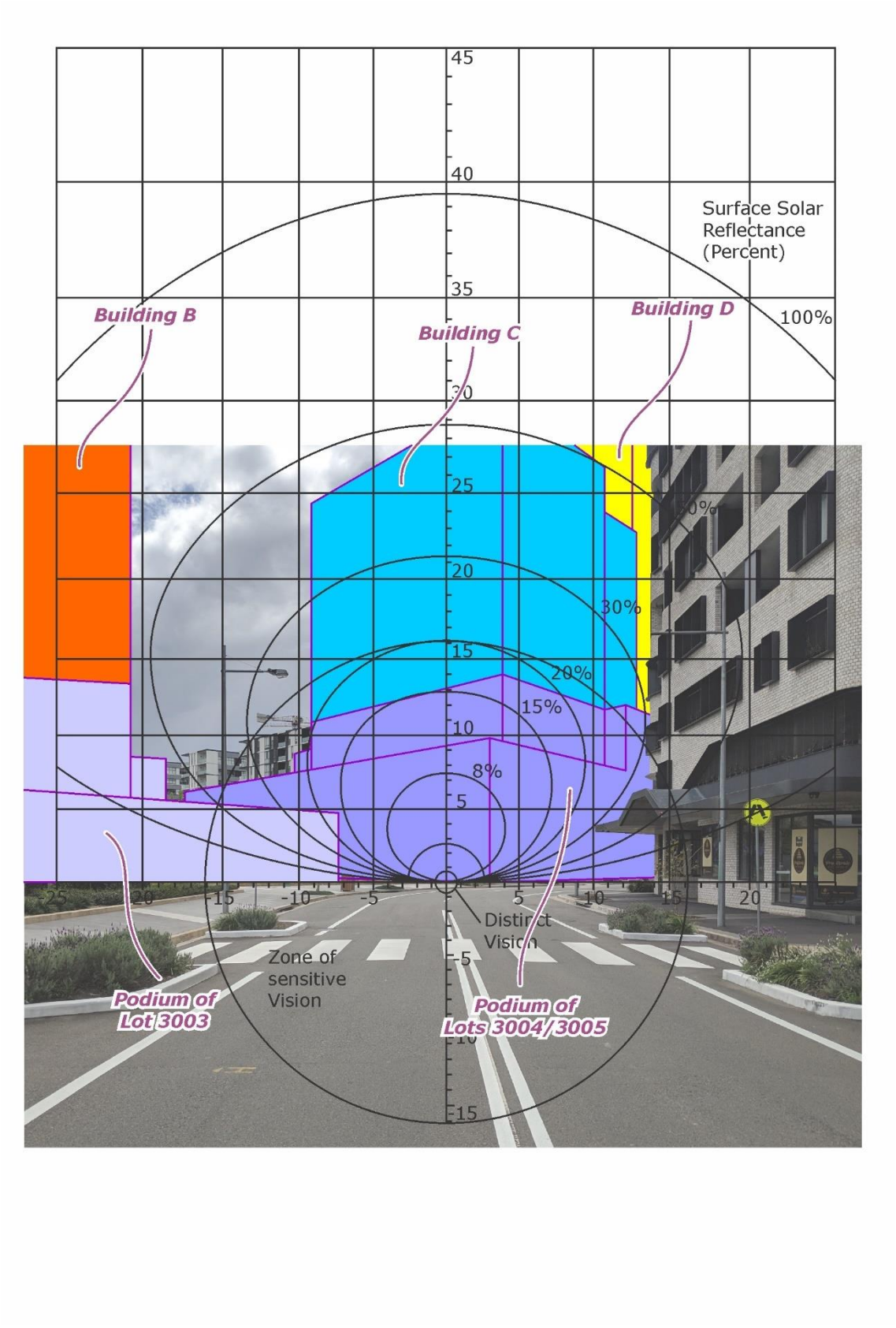

Figure A.30: Glare Overlay of the Viewpoint at Point 30

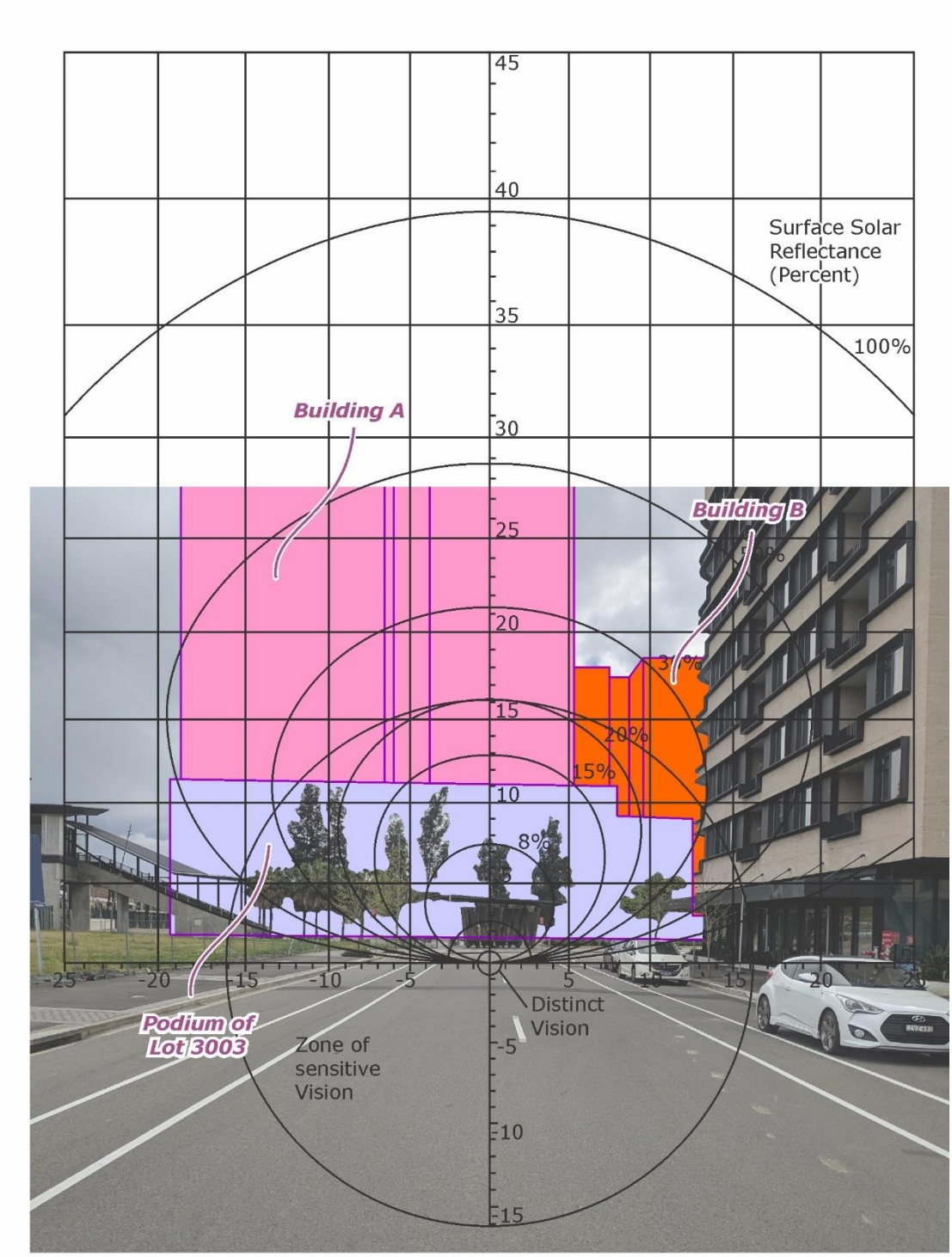

Figure A.31: Glare Overlay of the Viewpoint at Point 31

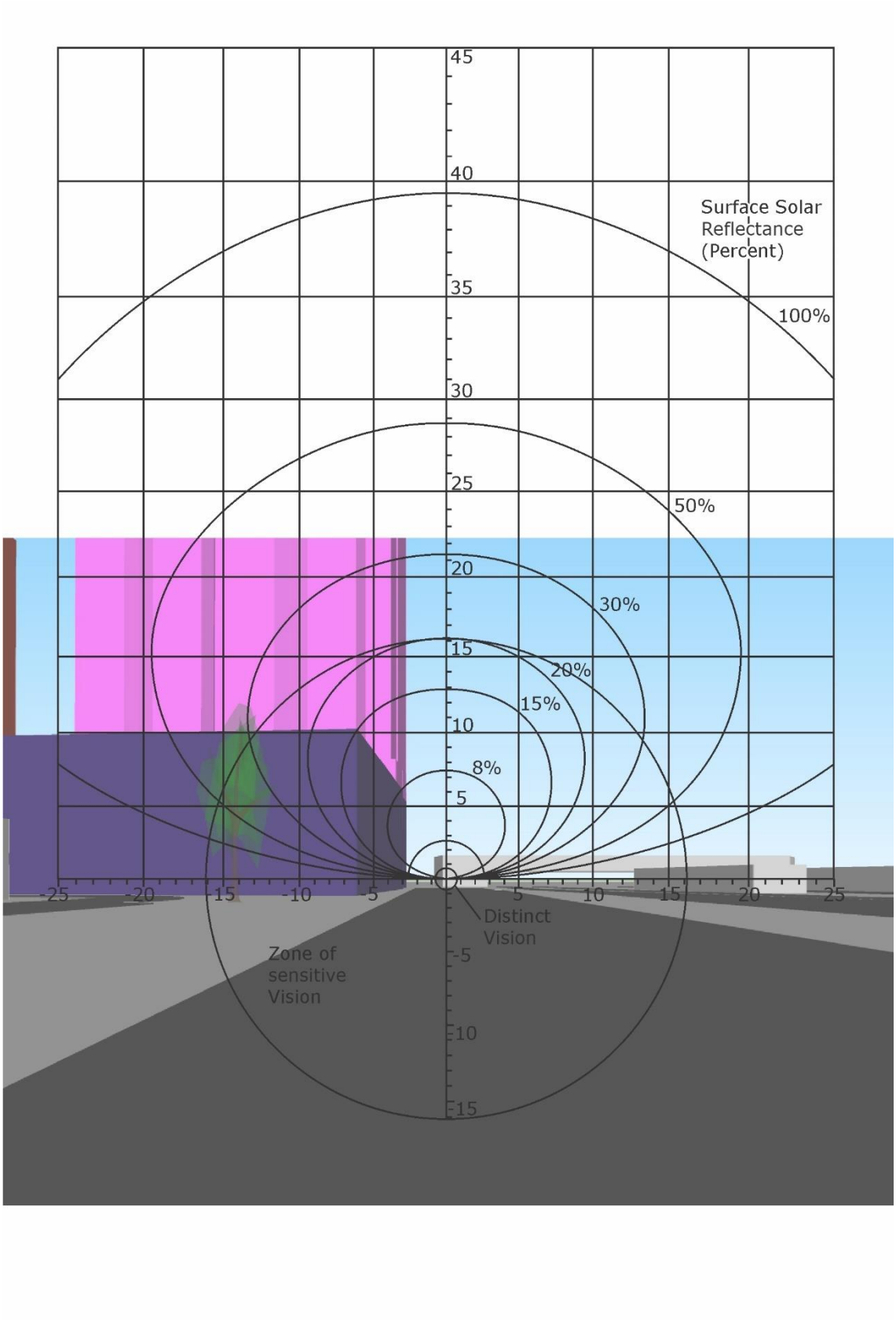

Figure A.32: Glare Overlay of the Viewpoint at Point 32

APPENDIX B CRITICAL ASPECT SOLAR CHARTS

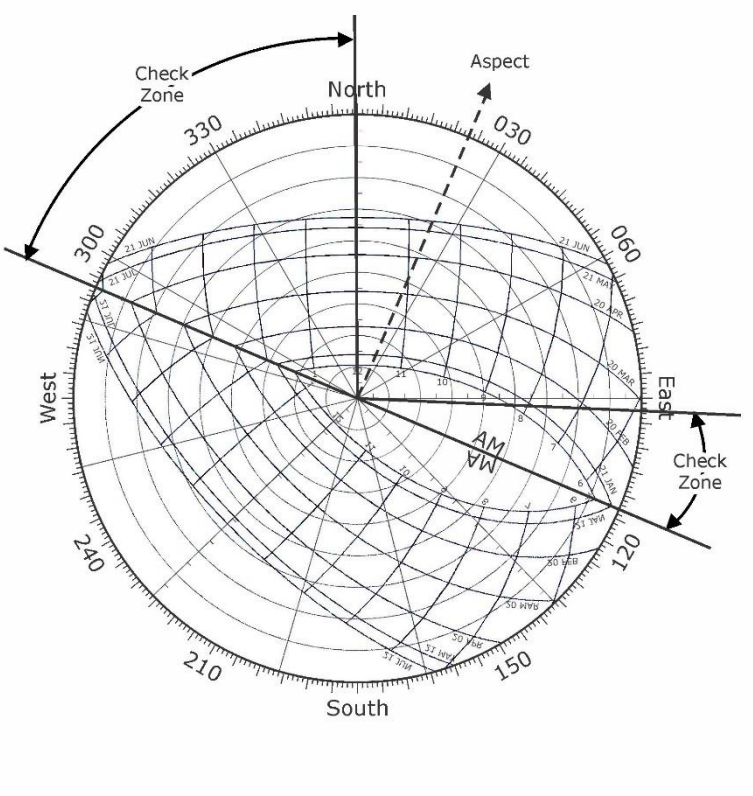

Figure B.1: Sun Chart for the 023° Aspect

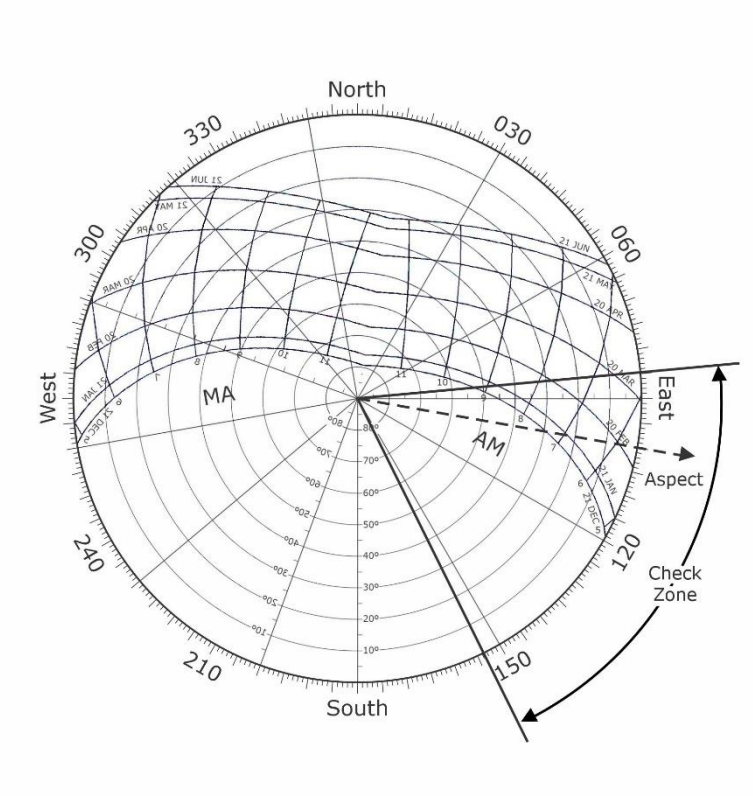

Figure B.2: Sun Chart for the 100° Aspect

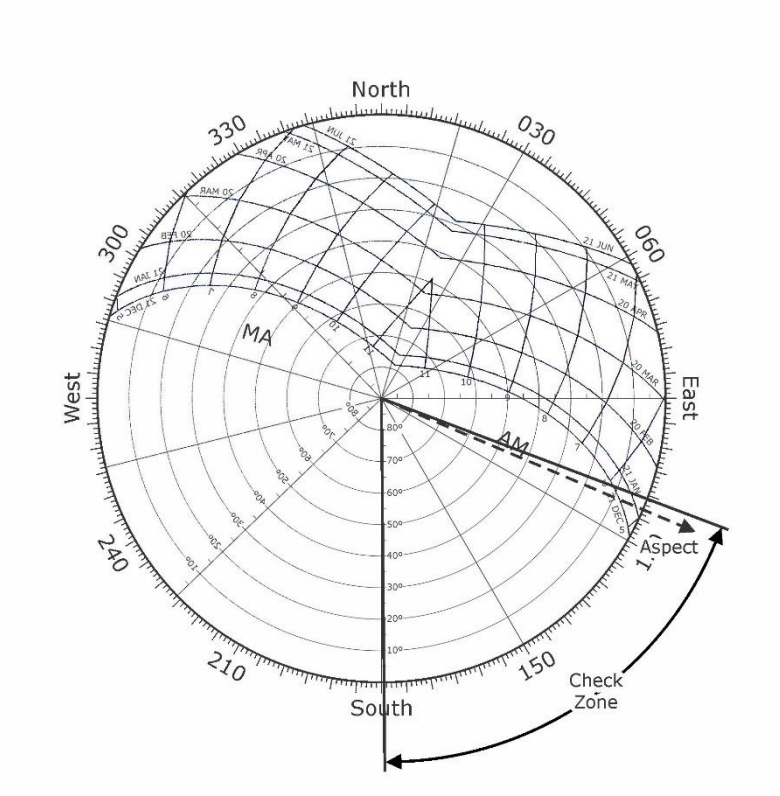

Figure B.3: Sun Chart for the 113° Aspect

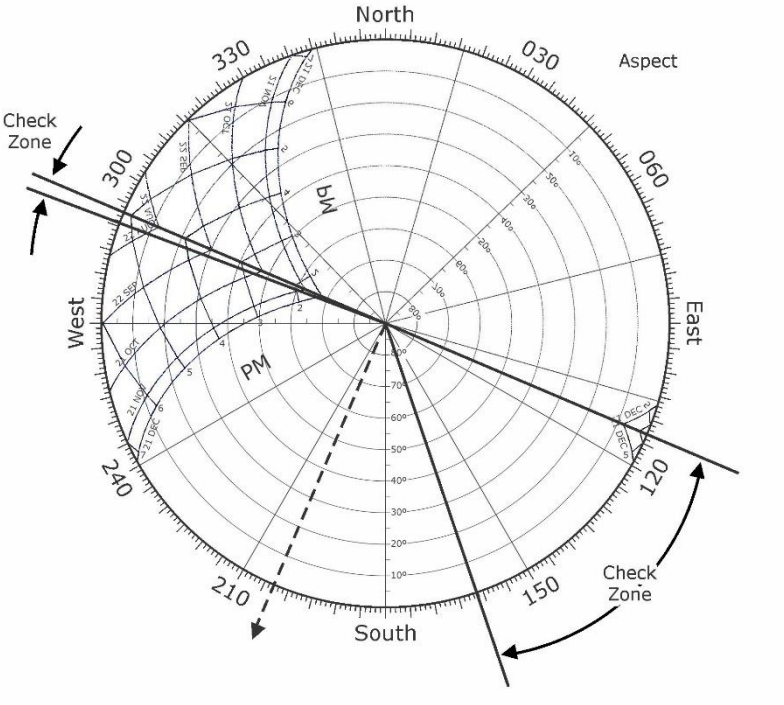

Figure B.4: Sun Chart for the 203° Aspect

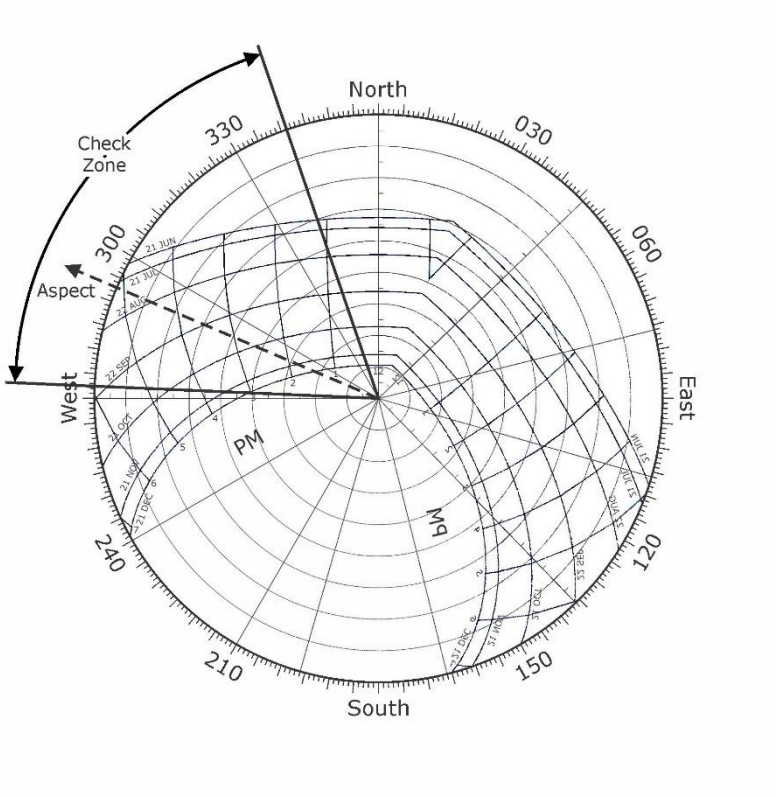

Figure B.5: Sun Chart for the 293° Aspect

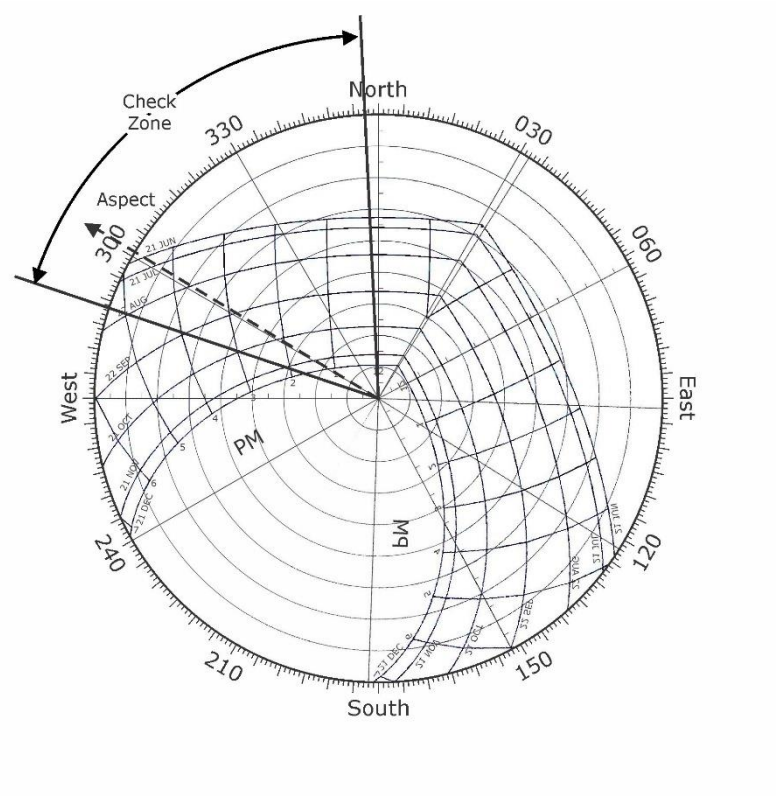

Figure B.6: Sun Chart for the 301° Aspect

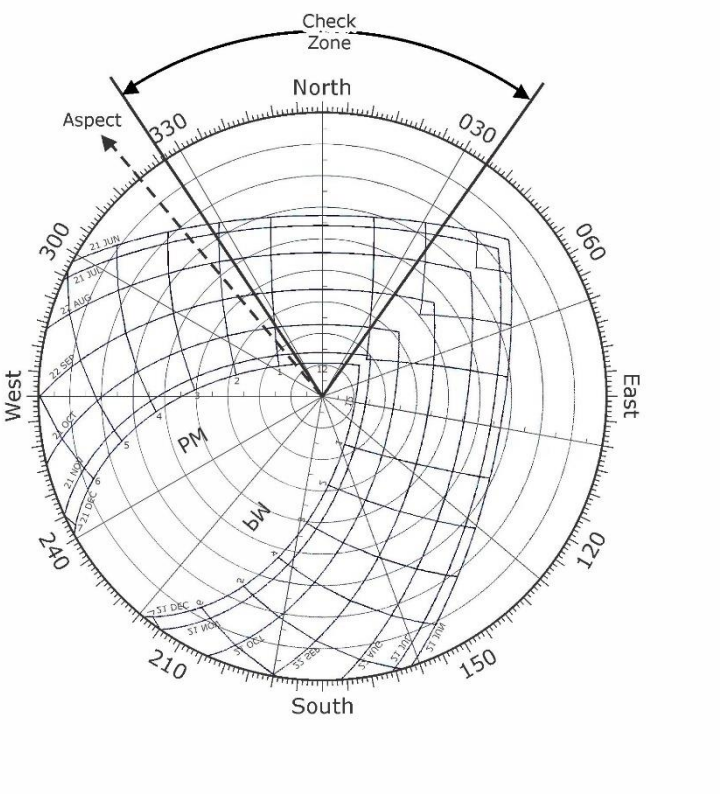

Figure B.7: Sun Chart for the 320° Aspect

APPENDIX C STANDARD SUN CHART FOR THE REGION

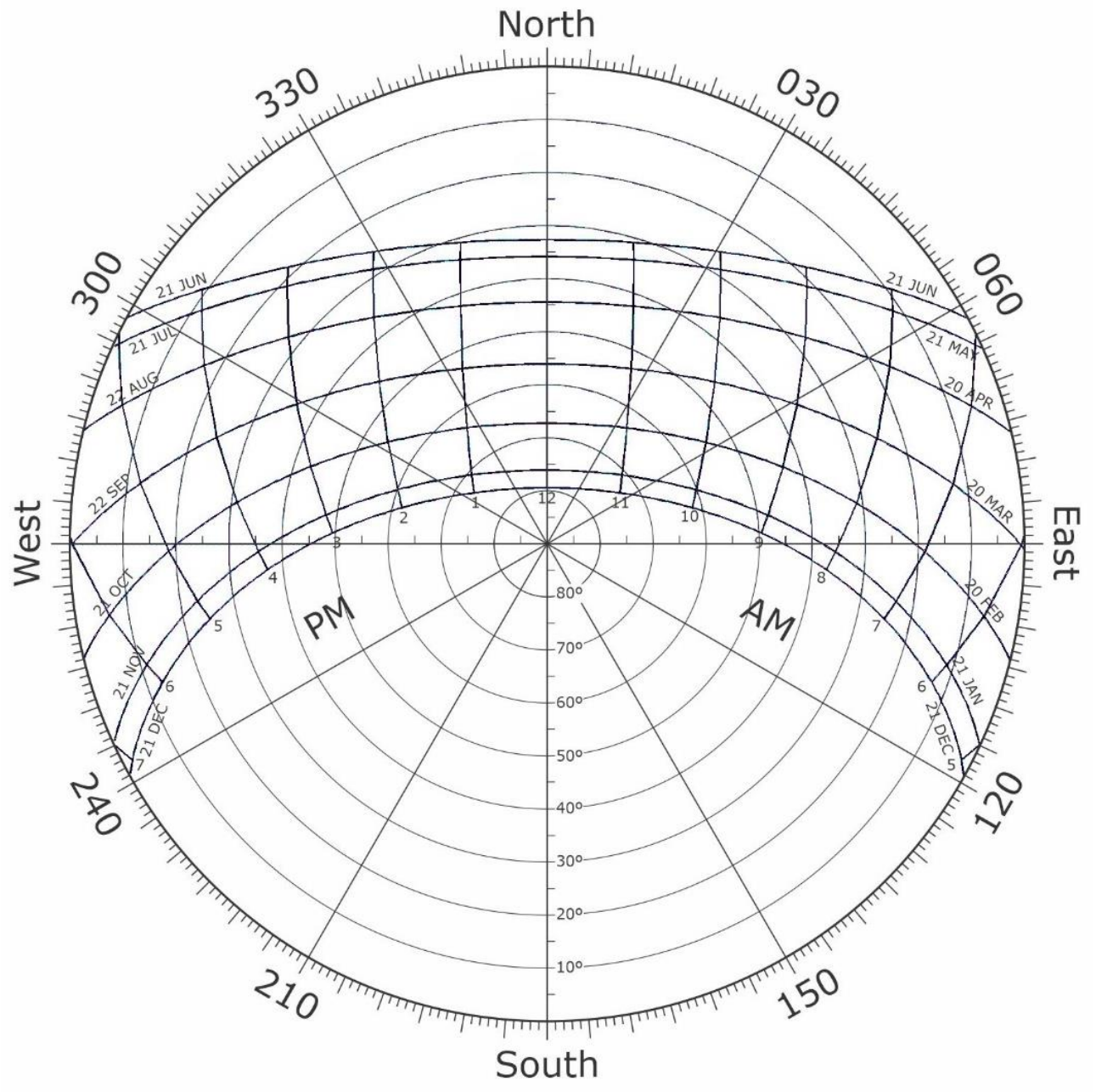

Figure C.1: Standard Sun Chart for the Sydney Region