


# Independent Comparison of AusRAP Star Rating results from AiRAP and Manual Coding using iRAP model v3.02

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# Summary

Through the WARRIP partnership, NTRO was engaged to independently review the first large-scale deployment of AiRAP (Accelerated and Intelligent Road Assessment Program), an automated AusRAP coding methodology that uses LiDAR, 360° imagery, autonomous extraction and supporting datasets to extract road attributes at scale and to produce coded data in accordance with iRAP's global standard format. This review compared AiRAP derived AusRAP star ratings and traditional manual coding across a diverse sample of representative road types, including rural open roads, rural forest roads, urban freeways, urban highways and fringe highway environments. Collectively, these representative road environments account for approximately 94.8% of the Western Australian state road network by length and 88.3% of vehicle kilometres travelled (VKT), enabling the findings to be interpreted in the context of statewide AiRAP implementation. The objective was to determine where AiRAP aligns with manual coding, where it diverges, the practical implications of those differences for star ratings and star rating scores (SRS) and the opportunities to improve future large-scale deployment.

Overall, the review found that AiRAP generally produced strategically comparable outcomes to manual coding for vehicle occupants and motorcyclists across much of the assessed network. Strong agreement was observed on **rural open roads**, representing **77.1% of the state road network by length and 18.0% of vehicle kilometres travelled** and **urban freeways**, representing **2.8% of the network by length but 34.6% of VKT**. Across these representative road environments, the proportion of roads achieving 3-star or better remained broadly consistent between the AiRAP and manual assessments, despite some variation in individual road attribute coding. The representative rural open road (Great Northern Highway (H006-9)) and urban freeway corridor (Mitchell Freeway (H016-150)) demonstrated only minor differences in smoothed vehicle occupant and motorcyclist star ratings, with the urban freeway environment producing almost identical vehicle occupant star ratings between the two methods. Similarly, the representative **rural forest road** environment (Caves Road (M043-123)) showed strong alignment in overall star rating outcomes, with differences in roadside hazard coding having only a limited influence on network-level results. These findings demonstrate that, despite differences in individual coding attributes, the proportion of roads achieving 3-star-or-better outcomes for vehicle occupants remained broadly comparable between the AiRAP and manual assessments, providing confidence that AiRAP can reliably support strategic network-level safety assessment and investment prioritisation across the predominant road environments within the Western Australian State road network.

The greatest differences between AiRAP and manual coding were observed on road environments characterised by greater geometric and operational complexity. **Urban highways**, representing **5.7% of the state road network by length but 30.6% of VKT**, exhibited some of the largest coding differences. The representative urban highway corridor (Albany Highway (H001-134)) demonstrated that AiRAP commonly overestimated intersection-related risk through duplicated intersections, driveway misclassification, lane count overestimation and differing median type interpretation, contributing to higher assessed risk. **Outer metropolitan/fringe highways**, representing **0.9% of the state road network by length and 2.9% of VKT**, demonstrated strong agreement in vehicle occupant outcomes. The representative fringe highway (Great Northern Highway (H006-140)) demonstrated differences in merge treatment, median interpretation and recognition of bicycle facilities which primarily influenced motorcyclist and bicyclist star ratings. These findings demonstrate that the greatest differences between AiRAP and manual coding occur in environments characterised by more complex intersections, lane configurations, medians, roadside hazards and vulnerable road user infrastructure, although these differences generally had a limited influence on the proportion of roads achieving **3-star-or-better** vehicle occupant outcomes.

The largest divergence between AiRAP and manual coding occurred for vulnerable road users. Across the representative road environments assessed, differences in pedestrian and bicyclist star ratings were driven less by differences in the physical road infrastructure than by differing assumptions regarding road user applicability, exposure and facility recognition. For the manual assessment, pedestrian and bicyclist applicability was generally assigned only where facilities and surrounding land use indicated that meaningful pedestrian or cyclist activity could reasonably be expected. In contrast, the AiRAP assessment applied jurisdictional pedestrian and bicyclist volume datasets, with pedestrian flows assigned in accordance with

Main Roads business rules that applied pedestrian volumes to residential land use irrespective of the presence of pedestrian facilities. AiRAP also more consistently recognised adjacent facilities within the principal shared path (PSP) network, including shared paths that were not directly accessible from the roadway or not readily identifiable in the available imagery. These differing assumptions resulted in AiRAP assessing a greater proportion of the network for vulnerable road users and contributed to more pronounced differences in pedestrian and bicyclist star ratings and SRS than those observed for vehicle occupants and motorcyclists. This was most evident on Albany Highway (H001-134), where differences in lane count, median type and pedestrian applicability substantially increased pedestrian crossing SRS, and on Great Northern Highway (H006-140), where recognition of bicycle facilities influenced bicyclist star ratings.

Despite these differences, the review found that many coding discrepancies reflected ambiguity in the iRAP coding guidance available at the time of the project, or differences in how that guidance was implemented, rather than limitations of automated assessment by AiRAP. One example was AiRAP's use of an 'intersection mask', whereby specified midblock attributes were treated as continuous through an intersection rather than recording changes within the intersection area. AiRAP extended this treatment to additional attributes, including median type, paved shoulder and delineation, based on a broader interpretation of the guidance, whereas Manual coding applied the guidance as explicitly documented. This difference in implementation resulted in coding discrepancies between the two methods. Version 3.10 of the iRAP Coding Manual has since formalised elements of AiRAP's approach through Point of Turning (POT) zone rules and expanded the specified attributes to include those that AiRAP had treated as continuous through intersections.

Differences also arose in the measurement of distance to roadside hazards. The coding manual used for the project specified measurement from the edgelines of the nearest driving lane but did not explicitly address how this should be applied where turning, merge or diverge lanes were present. AiRAP measured from the edge of the through traffic lane, resulting in differences from Manual coding in these locations. Version 3.10 has since provided greater clarity and formalised this element of AiRAP's approach by specifying the through traffic lane as the measurement reference.

A significant outcome of the review was the translation of these findings into improvements to future AusRAP delivery. The review informed updates incorporated into the **iRAP Coding Manual for Star Ratings Version 3.10**, including further guidance for Point of Turning Zone (intersection masking), lane width assessment, curvature, roadside hazards, pedestrian and bicycle facilities, vehicle parking and other attributes identified as key sources of inconsistent coding. The review also informed refinements to the AiRAP methodology, including improved detection and classification of intersections, lane configurations, medians and roadside features, together with enhanced quality assurance processes for attributes with the greatest influence on star ratings. In parallel, Main Roads Western Australia is refining its business rules governing pedestrian and bicyclist applicability and pedestrian flow estimation to better reflect likely vulnerable road user activity and improve consistency with the intent of the iRAP methodology.

Overall, the review concludes that AiRAP is a credible, repeatable and operationally scalable methodology for network-wide AusRAP delivery. More importantly, it demonstrates the value of independent validation in strengthening both automated and manual coding practices. By assessing representative road environments encompassing the predominant Western Australian road types, the review has increased confidence in the application of AiRAP for future network-wide assessments while directly informing improvements to international coding guidance, the AiRAP methodology and Main Roads Western Australia business rules. Collectively, these outcomes provide a stronger foundation for consistent, transparent and scalable AusRAP assessments, ensuring that future road safety investment decisions are based on robust, repeatable and evidence-based assessments of infrastructure-related risk.

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# Glossary of Terms

| Term | Definition |
|---|---|
| **AADT** | Annual average daily traffic – a measure of traffic volume on a road, or section of road, over a full year, averaged to represent the number of vehicles using that road per day. |
| **AusRAP** | Australian Road Assessment Program – a proactive network-level infrastructure risk assessment tool used to code, analyse, and report levels of road safety risk. AusRAP is the Australian version of, and methodologically identical to, the International Road Assessment Program (iRAP). |
| **AusRAP star rating score (SRS)** | Star rating score (SRS) – a measure of the individual risk of a severe (fatal or serious injury) casualty crash for a specific road user type on each 100 m road segment. SRS is calculated for multiple crash types (e.g. run-off-road, head-on, intersection, and property access for vehicle occupants) and is only produced where relevant road user volumes are recorded. SRS is available through ViDA and is not generated where no applicable road user activity exists or where major roadworks are underway. |
| **AusRAP star ratings** | A road safety performance measure derived by assigning each 100 m road segment's star rating score (SRS) to a predefined risk band, resulting in a star rating for vehicle occupants, motorcyclists, pedestrians, and bicyclists, where applicable road user volumes are available. |
| **LOC** | Loss of control. Refers to crashes in which a driver loses control of the vehicle, including run-off-road and head-on crash types. |
| **Road attribute** | A characteristic of a road environment used in AusRAP coding and risk assessment, such as sealed shoulder width, curvature, AADT, or traffic volume category. Each attribute contains multiple categories, with associated risk values based on road safety research evidence. |
| **Smoothed sections** | A reporting approach used by AusRAP that averages the risk scores of individual ('raw') 100 m road segments over a longer, similar section of road to provide a more representative network-level view of risk. Smoothed sections are typically 1 km in urban areas and 3 km in rural areas. |
| **ViDA** | The International Road Assessment Program's (iRAP) software platform used for AusRAP to upload, process, and analyse road attribute data, generate star rating scores) and star ratings, and support development of road investment plans and program-level safety benefit analysis. |
| **VKT** | Vehicle kilometres travelled – a measure of total travel demand representing the cumulative number of kilometres travelled by vehicles across a road network or road section over a defined period. VKT is often used to indicate network usage intensity and exposure, particularly when comparing the strategic significance of different road types. |
| **VPD** | Vehicles per day – a traffic volume measure representing the estimated number of vehicles using a road or intersection approach each day. VPD is commonly used within AusRAP coding to classify intersecting road traffic volumes and influence crash risk calculations. |

# 1 Introduction

## 1.1 Overview of AusRAP star ratings

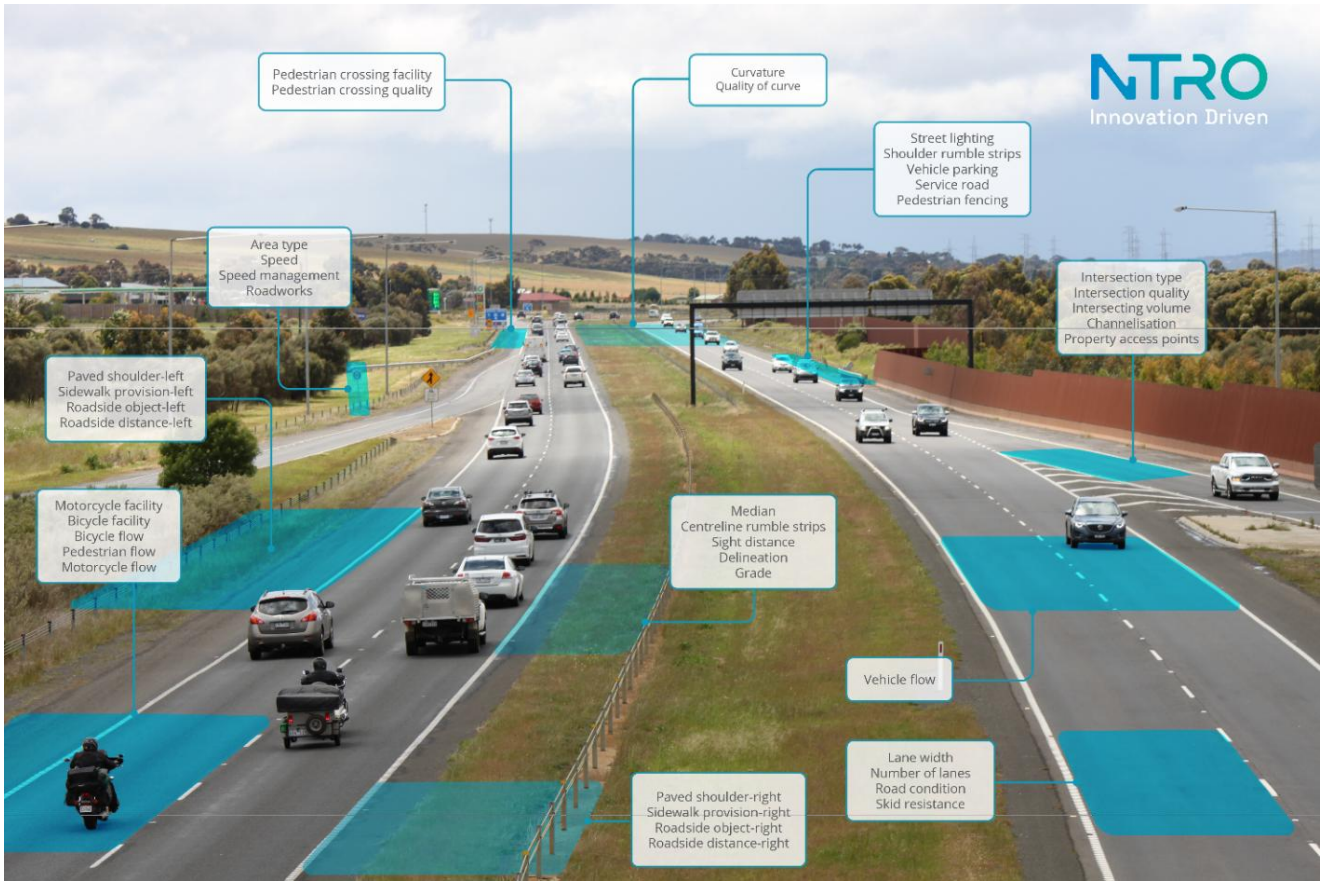
The Australian Road Assessment Program (AusRAP) is a proactive network level infrastructure risk assessment tool used to code, analyse and report levels of road safety risk. Instead of relying on historical crash data, AusRAP assesses the inherent safety of road infrastructure to identify where severe crashes are likely to occur and how they can be prevented. The results support road agencies in prioritising infrastructure improvements, guiding investment decisions and setting star rating performance targets – for example, achieving 3-star or better for all road users. AusRAP applies the International Road Assessment Programme (iRAP) protocols for coding and rating, which are internationally recognised and used in over 100 countries, providing consistency in evaluating road safety risk across networks.

Star ratings are calculated for four groups of road users (provided volumes are available for each road user type), being:

- vehicle occupants
- motorcyclists
- pedestrians
- bicyclists.

The AusRAP process involves the assessment of over 50 infrastructure attributes that are known to have an impact on crash likelihood and/or severity as shown in Figure 1.1.

**Figure 1.1: AusRAP road attributes**




Source: NTRO.

A star rating score (SRS) is calculated for each 100 m segment of road for different crash types. Motorised road user scores are based on head-on, run-off-road and intersection crashes; pedestrian scores are based on walking along and across the road; and bicyclist scores are based on riding along the road and at intersections. The SRS for each 100 m segment is then assigned to a band to determine the star rating, ranging from 1 star (least safe) to 5 stars (safest), as shown in Table 1.1. Separate bands are used for motorised road users, bicyclists and pedestrians as their scores are calculated using different equations. While star ratings are calculated for individual 100 m segments (raw star ratings), for reporting purposes these results are generally averaged over homogenous sections of road, typically 1 km in urban areas and 3 km in rural areas, to produce smoothed star ratings, which are used to support reporting, network comparison and investment decision making.

**Table 1.1: AusRAP star rating bands and colours for display**

| Star Rating | Star Rating Score | | | | |
|---|---|---|---|---|---|
| | Vehicle occupants and motorcyclists | Bicyclists | Pedestrians | | |
| | | | Total | Along | Crossing |
| 5 | 0 to < 2.5 | 0 to < 5 | 0 to < 5 | 0 to < 0.2 | 0 to < 4.8 |
| 4 | 2.5 to < 5 | 5 to < 10 | 5 to < 15 | 0.2 to < 1 | 4.8 to < 14 |
| 3 | 5 to < 12.5 | 10 to < 30 | 15 to < 40 | 1 to < 7.5 | 14 to < 32.5 |
| 2 | 12.5 to < 22.5 | 30 to < 60 | 40 to < 90 | 7.5 to < 15 | 32.5 to < 75 |
| 1 | 22.5 + | 60+ | 90 + | 15 + | 75 + |

Source: iRAP model factsheet 7 (2013).

Figure 1.2 presents a summary of the typical attributes expected for a section of road that is rated as 1-star, 3-star, or 5-star for each of the 4 road user groups.

**Figure 1.2: Typical attributes for 1-star, 3-star and 5-star roads**



| Star Rating | | | | |
|---|---|---|---|---|
| ★ | No sidewalk, No safe crossing, 60 km/h traffic | No cyclepath, No safe crossings, poor road surface, 70 km/h traffic | No motorcycle lane, undivided road, trees close to road, winding alignment, 90 km/h traffic | Undivided road with narrow centerline, trees close to road, winding alignment, 100 km/h traffic |
| ★★★ | Sidewalk present, pedestrian refuge, street lighting, 50 km/h traffic | On-road cycle lane, good road surface, street lighting, 60 km/h traffic | On-road motorcycle lane, undivided road, good road surface, >5m to any roadside hazards, 90 km/h traffic | Wide centerline separating oncoming vehicles, >5m to any roadside hazards, 100 km/h traffic |
| ★★★★★ | Sidewalk present, signalized crossing with refuge, street lighting, 40 km/h | Off-road dedicated cycle facility, raised platform crossing of major roads, street lighting | Dedicated separated motorcycle lane, central hatching, no roadside hazards, straight alignment, 80 km/h traffic | Safety barrier separating oncoming vehicles and protecting roadside hazards, straight alignment, 100 km/h traffic |

* For details on the full model for all road users and more urban and rural examples see https://www.irap.org//3-star-or-better/what-is-star-rating.

Source: Global Status Report on Road Safety (2018).

Traditionally, AusRAP assessments have been undertaken through manual coding. Road survey imagery is first collected from the driver's perspective in accordance with iRAP survey protocols. Trained coders then review the imagery and code road attributes in accordance with the iRAP Coding Manual. The Coding Manual sets out the definitions, categories and coding rules for each attribute.

More recently, AiRAP (Accelerated and Intelligent Road Assessment Program) has been introduced as an alternative approach, enabling road safety related data to be extracted through autonomous, repeatable and scalable methods. This includes artificial intelligence, machine learning, vision systems, LiDAR, telematics and other data sources. AiRAP is not an artificial intelligence system in itself but a protocol for applying autonomous and intelligent methods to produce coded data in accordance with iRAP's global standard format.

## 1.2 Project background

Main Roads Western Australia (Main Roads) initiated the Network LiDAR project in 2022 to establish a complete set of contemporary 3D point cloud data and 360° imagery of the Western Australian state road network. The project finalised the collection of LiDAR data for approximately 19,000 km of the network by early 2024.

Following data collection, AiRAP coding was undertaken to extract road attributes from the LiDAR and 360° imagery data for use in AusRAP star ratings across the network. This represented the first application of the AiRAP methodology at this scale, and the processes were documented to ensure they are clear and repeatable.

As part of the project's quality assurance, the National Transport Research Organisation (NTRO) was commissioned to undertake an independent review of the AiRAP coding processes and outcomes. The key objectives of the review were to:

- examine the business rules developed to supplement the AiRAP-extracted data with other data sources
- conduct an independent manual coding exercise for approximately 50 km of roads across a range of road types
- compare the variability and robustness of the AiRAP and manually coded star ratings and attribute coding for the sampled roads
- conduct a stakeholder workshop with all relevant parties to discuss the findings, with further reviews conducted following the workshop.

## 1.3 Objective and scope

This report presents the key findings of the independent review comparing AusRAP star ratings and attribute coding produced through the AiRAP coding methodology with those derived from traditional manual coding, using the iRAP model v3.02 and associated coding manual (iRAP Coding Manual version 5.5). The report covers the results of the comparison between the two methods, including where they produce similar outcomes, where they differ, and the nature and magnitude of those differences at both the attribute and star rating level. It also identifies the relative benefits and limitations of each approach and provides recommendations for improving the AiRAP methodology based on the findings of the review.

The report is intended for road safety practitioners, road agencies and others involved in the AusRAP and iRAP process. It is intended to assist government and industry practitioners in understanding the nuances between AiRAP and manual coding methods, and to support informed decision-making when applying or interpreting AusRAP results produced through either approach. The review is not intended to be prescriptive about which method should be used, but rather to provide an objective evidence base from which both methods can be better understood and continuously improved.

# 2 Methodology

The methodology for the independent review comprised the selection of existing AiRAP-coded road sections, independent manual coding of the corresponding sections, comparison of the coding and star rating outcomes, and subsequent workshops and detailed reviews to interpret the findings and identify opportunities for improvement.

## 2.1 Site selection

Site selection targeted road types representing varying levels of complexity, coding difficulty and corner cases to more rigorously test coding variability between the two methods. The roads selected are presented in Table 2.1 and described in further detail in Section 4 and Section 5.

**Table 2.1: Road list**

| Road – Section number | Road name | Road type | Local government area | Start location (latitude, longitude) | End location (latitude, longitude) | Length (km) |
|---|---|---|---|---|---|---|
| H006-9 | Great Northern Hwy | Rural open | Town of Port Hedland | (−21.681533, 118.823287) | (−21.595285, 118.819058) | 10 |
| M043-123 | Caves Rd | Rural forest | City of Busselton | (−33.675531, 115.031743) | (−33.620524, 115.094106) | 10.1 |
| H016-150(1) | Mitchell Fwy | Urban freeway | City of Perth – City of Stirling | (−31.9618, 115.847021) | (−31.891013, 115.802106) | 10 |
| H001-134(2) | Albany Hwy | Urban highway and main road | Town of Victoria Park – City of Canning – | (−31.971535, 115.896817) | (−32.004695, 115.921632) | 4.5 |
| H006-140 | Great Northern Hwy | Fringe highway | City of Swan | (−31.812005, 116.018849) | (−31.727631, 116.034627) | 10 |
| | | | | | **Total** | **44.6** |

Notes:

1. The Mitchell Freeway (H016-150) is a dual carriageway. The coded length represents the northbound carriageway only; the southbound carriageway was not coded.
2. The selected section of Albany Highway (H001-134) comprises both single and dual carriageway sections. For the dual carriageway sections, the coded length represents the southbound carriageway only; the northbound carriageway was not coded.

Source: Main Roads (2026).

As shown in Table 2.2, selected road types collectively capture a substantial proportion of both network length and vehicle kilometres travelled (VKT) across Western Australia's state road network, providing a representative basis for evaluating AiRAP coding performance across the road environments most commonly encountered, particularly:

- **Rural single carriageway open roads**, represented by Great Northern Highway (H006), comprise 77.1% of the total state road network by length and 18.0% of VKT.
- **Urban freeways and controlled-access highways**, represented by Mitchell Freeway (H016), account for 34.6% of total network VKT while comprising only 2.8% of network length.
- **Urban highways and main roads**, represented by Albany Highway (H001), account for 30.6% of total VKT despite representing only 5.7% of network length.

**Table 2.2: Representative portion of network**

| Road – Section number | Road name | Area type | Road category description | % Length of WA state network | % of VKT on WA state network |
|---|---|---|---|---|---|
| H006-9 | Great Northern Hwy | Regional | Rural single carriageway open road | 77.1 | 18.0 |
| M043-123 | Caves Rd | Regional | Rural single carriageway | 8.3 | 2.2 |
| H016-150 | Mitchell Fwy | Metro | Urban freeways & control of access highways | 2.8 | 34.6 |
| H001-134 | Albany Hwy | Metro | Urban highways and main roads | 5.7 | 30.6 |
| H006-140 | Great Northern Hwy | Metro | Fringe (outer metro & rural) highways and main roads | 0.9 | 2.9 |
| | | | **Total** | **94.8** | **88.3** |

Source: Main Roads (2026).

## 2.2 Coding of AusRAP attributes

The selected road sections were independently coded using the two methods to enable direct comparison of coding outputs and resulting star ratings. The coded road attributes were subsequently processed in ViDA to generate star ratings for the four iRAP road user groups: vehicle occupants, motorcyclists, bicyclists and pedestrians. AiRAP coding was undertaken by Anditi in consultation with Main Roads through automated extraction of road attributes from LiDAR and 360° imagery datasets. Where required attributes could not be directly derived from the available source data, supplementary estimation methodologies and business rules were developed and applied to assign coding values.

Manual coding was undertaken by NTRO using the traditional iRAP methodology, whereby an experienced coder independently reviewed 360° road imagery and utilised Main Roads LiDAR data to assess and code road attributes in accordance with the iRAP coding manual.

### 2.2.1 Road lengths coded for road user types

A total of 44.6 km of road was selected for comparison across the two coding methods. Star ratings were generated in ViDA where corresponding road user volume data was available. As pedestrian and bicyclist volume data was generally only available for road sections with pedestrian and bicyclist facilities, and these facilities did not extend across the full length of the selected road network (particularly on rural roads), the length for which star ratings were generated differed between road user groups.

Differences were also identified in the pedestrian and bicyclist volume data applied by the manual and AiRAP assessments. For the manual assessment, NTRO classified pedestrian and bicyclist star ratings as not applicable where pedestrian or bicyclist activity would not reasonably be expected, such as on motorways or rural highways with no pedestrian or bicycle facilities and no surrounding land use or amenities likely to generate vulnerable road user activity. In contrast, the Main Roads volume dataset used for the AiRAP assessment assigned pedestrian and bicyclist volumes to some road sections where shared user paths were located adjacent to the roadway but did not provide direct access to the carriageway, and in some cases the facilities were not visible from the road. These differences resulted in variations in the road lengths for which pedestrian and bicyclist star ratings were generated. The implications of these differences are discussed in the road-specific results presented in Section 4 and Section 5.

The review also identified an opportunity to refine the Main Roads business rules used to estimate pedestrian flows. Under the current implementation, pedestrian flows are assigned where the surrounding land use is classified as residential, educational or commercial. While this approach is broadly consistent with the iRAP methodology, which uses land use as an indicator of likely pedestrian activity, the iRAP Coding Manual also requires consideration of the accessibility of the road and the likelihood of pedestrian use. The assessment confirmed that the existing Main Roads approach is appropriate in some rural environments, such as sections of Great Northern Highway (H006-140) in Upper Swan, where clusters of residential dwellings, schools, local businesses and other community facilities generate genuine pedestrian activity despite the absence of dedicated pedestrian facilities. Conversely, the review identified locations

such as Caves Road where isolated farmhouses or dispersed rural development resulted in residential or educational land use classifications despite there being little evidence of meaningful pedestrian activity. Although both road environments satisfy the same land use criteria, they represent markedly different levels of pedestrian activity. To better align pedestrian flow estimates with the intent of the iRAP methodology, additional business logic will be incorporated into the Main Roads coding process to distinguish between dispersed rural development with limited pedestrian activity and rural settlements where surrounding land use is likely to generate genuine pedestrian movements.

Additionally, along the Mitchell Freeway (H016-150), AiRAP coding classified 0.7 km of road as not applicable because road works were present when the imagery was captured.

The lengths of road for which star ratings were generated for each road user type and coding method are summarised in Table 2.3.

**Table 2.3: Star rating lengths produced for each road user**

| Road – Section number | Road name | Area type | Selected road length (km) | Road length assessed by road user groups (km) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Vehicle occupants | | Motorcyclists | | Bicyclists | | Pedestrians | |
| | | | | Manual | Ai | Manual | Ai | Manual | Ai | Manual | Ai |
| H006-9 | Great Northern Hwy | Regional | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M043-123 | Caves Rd | Regional | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 | 0.0 | 0.0 | 0.0 | 4.7 |
| H016-150 | Mitchell Fwy | Metro | 10.0 | 10.0 | 9.3 | 10.0 | 9.3 | 0.2 | 9.3 | 0.2 | 9.3 |
| H001-134 | Albany Hwy | Metro | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| H006-140 | Great Northern Hwy | Metro | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 1.5 | 1.5 | 3.4 | 5.6 |
| | | **Total** | **44.6** | **44.6** | **43.9** | **44.6** | **43.9** | **6.4** | **16.4** | **8.1** | **24.1** |

## 2.3 Comparison of AiRAP and manual coding methods

NTRO compared AiRAP and manual coding results at both the attribute and star rating level. The analysis was undertaken in the following stages.

### 2.3.1 Raw and smoothed star rating differences

A comparison of raw and smoothed star ratings was undertaken to identify key differences in the outputs produced by the two coding methods, and to assess the nature and magnitude of these differences across each road type and road user group at a network level. The results of this comparison are presented in Section 3.

### 2.3.2 Workshop with stakeholders and independent review

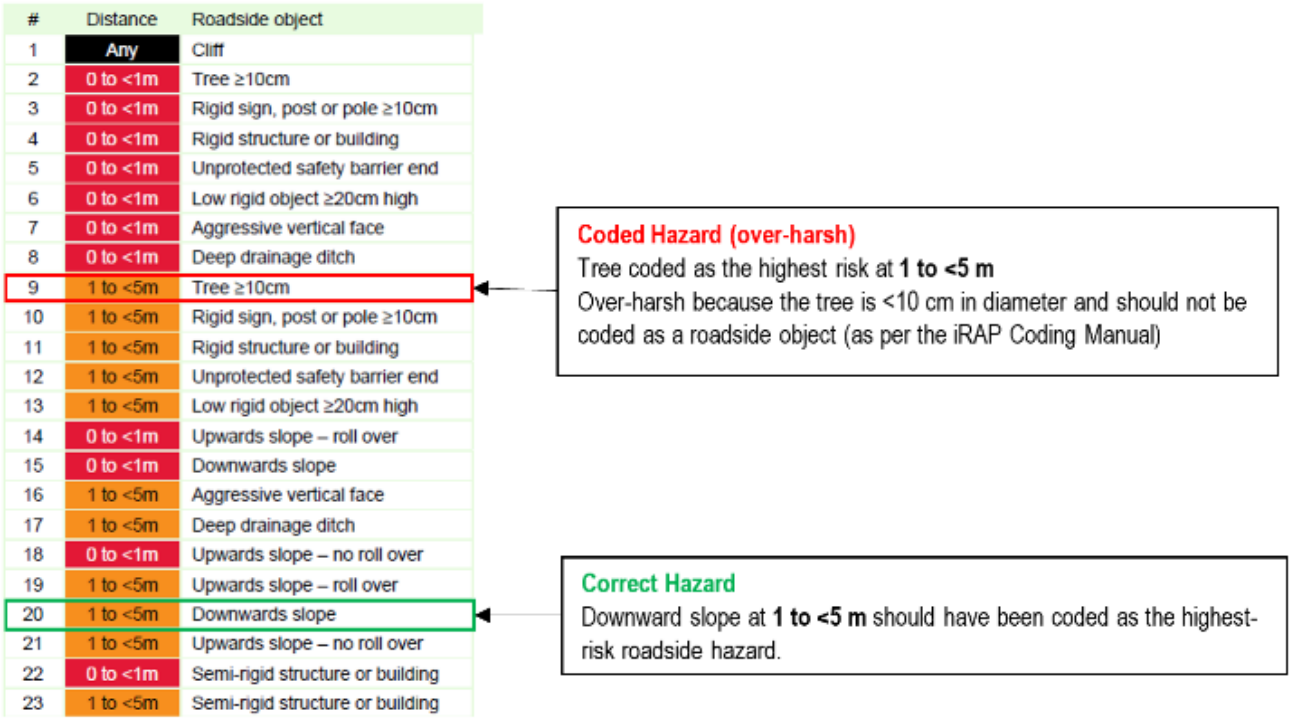
NTRO and Main Roads held a workshop with iRAP and Anditi to identify the reasoning behind the differences observed between the two coding methods. This was followed by an independent review of both coding results by iRAP, and a subsequent detailed review by NTRO (refer to Section 2.3.3). The outcomes of the workshop and subsequent reviews, including key points of difference between the two methods and areas identified for further action, are captured in Section 7 and Section 8.

### 2.3.3 Detailed review to identify attribute level coding differences

Building on the analysis undertaken by iRAP, NTRO performed a detailed review of coding at the 100 m segment level to independently validate the coded road attributes for both the AiRAP and manual coding methods. Where differences in the coded attributes and the detailed validation were identified, these have been classified as either **over-harsh** or **over-generous**, as defined below.

- **Over-harsh:** The coded attribute assigned a higher level of risk than was supported by detailed validation. This occurred because the highest-risk roadside object, its distance from the roadway, or both, were incorrectly coded, resulting in a more hazardous roadside environment being represented. **Example:** Figure 2.1 provides part of the roadside hazard list from the iRAP Coding Manual, with roadside hazards arranged from highest risk at the top to lowest risk at the bottom. A tree was coded as the highest-risk roadside object located **1 to < 5 m** from the roadway. However, detailed validation identified that the tree was less than 10 cm in diameter and therefore did not meet the iRAP definition of a roadside tree hazard. Consequently, the tree should not have been considered in determining the highest-risk roadside object. The adjacent downward slope, located **1 to < 5 m** from the roadway, represents the highest-risk applicable roadside object and should have been coded instead. By incorrectly selecting the tree, the coding assigned a higher roadside risk than was present, resulting in an **over-harsh** classification.
- **Over-generous**: The coding method applied has assigned a lower level of risk than identified during detailed validation. For example, a paved shoulder was coded and identified during detailed review in a location where no continuous shoulder actually existed due to the presence of a bus stopping bay.

**Figure 2.1: Example of over-harsh coding – roadside hazard classification**




| # | Distance | Roadside object |
|---|---|---|
| 1 | Any | Cliff |
| 2 | 0 to <1m | Tree ≥10cm |
| 3 | 0 to <1m | Rigid sign, post or pole ≥10cm |
| 4 | 0 to <1m | Rigid structure or building |
| 5 | 0 to <1m | Unprotected safety barrier end |
| 6 | 0 to <1m | Low rigid object ≥20cm high |
| 7 | 0 to <1m | Aggressive vertical face |
| 8 | 0 to <1m | Deep drainage ditch |
| 9 | 1 to <5m | Tree ≥10cm |
| 10 | 1 to <5m | Rigid sign, post or pole ≥10cm |
| 11 | 1 to <5m | Rigid structure or building |
| 12 | 1 to <5m | Unprotected safety barrier end |
| 13 | 1 to <5m | Low rigid object ≥20cm high |
| 14 | 0 to <1m | Upwards slope – roll over |
| 15 | 0 to <1m | Downwards slope |
| 16 | 1 to <5m | Aggressive vertical face |
| 17 | 1 to <5m | Deep drainage ditch |
| 18 | 0 to <1m | Upwards slope – no roll over |
| 19 | 1 to <5m | Upwards slope – roll over |
| 20 | 1 to <5m | Downwards slope |
| 21 | 1 to <5m | Upwards slope – no roll over |
| 22 | 0 to <1m | Semi-rigid structure or building |
| 23 | 1 to <5m | Semi-rigid structure or building |

Source: iRAP (2024).

- **% Over-harsh or Over-generous:** For each attribute, the proportion of reviewed raw (~100 m) road sections classified as over-harsh or over-generous was calculated across the reviewed road length for both the Manual and AiRAP coding methods.

Table 2.4 provides an example of a 1 km road comprising ten raw (100 m) segments, where the manual and Ai coding has been validated. Manual coding was classified as over-harsh for one segment (10%) and over-generous for three segments (30%), while AiRAP coding was classified as over-harsh for one segment (10%) and over-generous for three segments (30%).

It is noted that the segments classified as over-harsh or over-generous do not necessarily occur at the same locations for each coding method.

**Table 2.4: Example of over harsh and over generous classifications for coded sections**

| Section number | Section length (km) | Manual coding (roadside severity driver side distance) | Validation of manual coding | Ai coding (roadside severity driver side distance) | Validation of Ai coding |
|---|---|---|---|---|---|
| **1** | 0.1 | **Code: 3** (5 to < 10 m) | Manual incorrect – Tree too small (**Over-harsh**) | **Code: 4** (≥ 10 m) | Ai correct |
| **2** | 0.1 | **Code: 4** (≥ 10 m) | Manual incorrect – Tree closer (**Over-generous**) | **Code: 4** (≥ 10 m) | Ai incorrect – Tree closer (**Over-generous**) |
| **3** | 0.1 | **Code: 3** (5 to < 10 m) | Manual correct | **Code: 4** (≥ 10 m) | Ai incorrect – Slope closer (**Over-generous**) |
| **4** | 0.1 | **Code: 4** (≥ 10 m) | Manual correct | **Code: 3** (5 to < 10 m) | Ai incorrect – Tree further away (Over-generous) |
| **5** | 0.1 | **Code: 4** (≥ 10 m) | Manual correct | **Code: 4** (≥ 10 m) | Ai correct |
| **6** | 0.1 | **Code: 4** (≥ 10 m) | Manual incorrect – Tree closer (**Over-generous**) | **Code: 3** (5 to < 10 m) | Ai correct |
| **7** | 0.1 | **Code: 3** (5 to < 10 m) | Manual incorrect – Slope closer (**Over-generous**) | **Code: 4** (≥ 10 m) | Ai incorrect – Slope closer (**Over-generous**) |
| **8** | 0.1 | **Code: 4** (≥ 10 m) | Manual correct | **Code: 4** (≥ 10 m) | Ai correct |
| **9** | 0.1 | **Code: 2** (1 to < 5 m) | Manual correct | **Code: 2** (1 to < 5 m) | Ai correct |

| Section number | Section length (km) | Manual coding (roadside severity driver side distance) | Validation of manual coding | Ai coding (roadside severity driver side distance) | Validation of Ai coding |
|---|---|---|---|---|---|
| **10** | 0.1 | **Code: 1** (0 m to < 1 m) | Manual correct | **Code: 1** (0 m to < 1 m) | Ai correct |

The extent to which these coding differences influenced star rating scores and subsequently translated into star rating differences by road type, was then assessed. The results of this assessment are presented in Section 4 and Section 5.

### 2.3.4 Practical implications of coding differences

To understand the practical significance of the differences identified between the two coding methods, NTRO assessed how variations in star rating outcomes may influence decision-making by quantifying the extent to which differences between AiRAP and manual coding affected star ratings, particularly the proportion of road length achieving greater than 3-star ratings. This assessment also considered how representative the sampled roads are of Western Australia's broader road network in terms of length and traffic function, providing context for the wider network relevance of the findings. NTRO also identified the attributes most frequently driving coding differences, determined whether these differences reflected over-harsh or over-generous risk allocation and assessed their influence on star rating scores and resulting star ratings. The results of this analysis are presented in Section 6.

## 2.4 Targeted actions to address discrepancies

Findings were consolidated through project presentations, stakeholder workshops and independent review to identify and close gaps contributing to differences. Variances were categorised according to their impact on star rating outcomes, with targeted actions assigned to the relevant parties (iRAP, Anditi, or Main Roads) to address identified issues. Differences were assessed to determine whether they arose from AiRAP methodology, business rule application, coding manual gaps or ambiguity, or limitations within the manual coding process, enabling practical attribute-specific actions to reduce future star rating variance. Findings and agreed actions are detailed in Section 8.

# 3 Network Level Results

At the network level, the comparison of AiRAP and manual coding results indicates that vehicle occupant star rating outcomes remain relatively consistent across both raw and smoothed analyses, with generally minor variation between methods.

Greater variance was observed for motorcyclist star ratings, particularly in lower star bands. The most substantial differences were for pedestrian and bicyclist results associated with the extent of road length classified as applicable and the distribution of applicable road length across star rating bands. These findings indicate that coding differences for pedestrian and bicyclist attributes, and to a lesser extent motorcyclist attributes, may have a more pronounced influence on reported network outcomes than vehicle occupant coding differences. These differences are explored in greater detail in the road specific review provided in section.

## 3.1 Smoothed star ratings

For vehicle occupants, smoothed star ratings, as shown in Table 3.1, showed relatively close alignment between the two methods, with the largest difference occurring in the 1-star band, where AiRAP allocated 6.5% more road length than manual coding. For motorcyclists, the greatest variation was also in the 1-star band, where AiRAP allocated 26.4% more road length, while manual coding allocated substantially more road length to the 2-star band (23.8% difference).

For pedestrians, the largest difference related to the proportion of road length classified as not applicable, with manual coding assigning 35.8% more road length as unrated. Across rated pedestrian road lengths, AiRAP allocated a greater proportion to both the 1-star band and higher star bands, including notably more 3-star and 5-star road lengths. For bicyclists, the largest variation was similarly in the not applicable category, where manual coding assigned 22.5% more road length as unrated. Across rated bicyclist road lengths, AiRAP generally allocated more road length to the 3-star and 4-star bands, while manual coding allocated more to the 2-star band.

Overall, smoothed star rating differences were most pronounced in the 1-star band for vehicle occupants and motorcyclists, while for pedestrians and bicyclists, related to whether road lengths were assigned a rating and how rated road lengths were distributed across star rating bands.

## 3.2 Raw star ratings

Raw star rating outcomes (provided in Appendix A) were broadly consistent with the smoothed results, with similar patterns observed across all road user types. The primary differences were that smoothing accentuated differences between adjacent star rating bands for vehicle occupants and motorcyclists, while the dominant differences for pedestrians and bicyclists remained the classification of road lengths as not applicable rather than changes in the distribution of rated road lengths.

**Table 3.1: Smoothed star ratings comparison by road length – Network level**

| Star ratings | Vehicle occupant | | | | |
|---|---|---|---|---|---|
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 0.0 | 0.0% | 0.0 | 0.0% | 0.0% |
| 4 stars | 3.8 | 8.5% | 4.0 | 9.0% | −0.5% |
| 3 stars | 21.1 | 47.3% | 23.1 | 51.8% | −4.5% |
| 2 stars | 16.0 | 35.9% | 17.4 | 39.0% | −3.1% |
| 1 star | 3.0 | 6.7% | 0.1 | 0.2% | 6.5% |
| Not applicable | 0.7 | 1.6% | 0.0 | 0.0% | 1.6% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |
| **Star ratings** | **Motorcyclist** | | | | |
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 0.0 | 0.0% | 0.0 | 0.0% | 0.0% |
| 4 stars | 0.0 | 0.0% | 0.0 | 0.0% | 0.0% |
| 3 stars | 12.1 | 27.1% | 14.1 | 31.6% | −4.5% |
| 2 stars | 16.4 | 36.8% | 27.0 | 60.5% | −23.8% |
| 1 star | 15.4 | 34.5% | 3.6 | 8.1% | 26.4% |
| Not applicable | 0.7 | 1.6% | 0.0 | 0.0% | 1.6% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |
| **Star ratings** | **Pedestrian** | | | | |
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 3.0 | 6.7% | 0.2 | 0.4% | 6.3% |
| 4 stars | 0.0 | 0.0% | 0.0 | 0.0% | 0.0% |
| 3 stars | 5.0 | 11.2% | 1.6 | 3.6% | 7.6% |
| 2 stars | 2.4 | 5.4% | 2.3 | 5.2% | 0.2% |
| 1 star | 13.7 | 30.7% | 4.0 | 9.0% | 22.2% |
| Not applicable | 20.5 | 46.0% | 36.5 | 81.8% | −35.8% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |
| **Star ratings** | **Bicyclist** | | | | |
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 0.0 | 0.0% | 0.2 | 0.4% | −0.4% |
| 4 stars | 4.2 | 9.4% | 0.0 | 0.0% | 9.3% |
| 3 stars | 7.2 | 16.1% | 1.0 | 2.2% | 13.8% |
| 2 stars | 2.7 | 6.1% | 4.9 | 11.0% | −4.9% |
| 1 star | 2.4 | 5.4% | 0.3 | 0.7% | 4.7% |
| Not applicable | 28.2 | 63.2% | 38.2 | 85.7% | −22.5% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |

Source: iRAP (2025) (reproduced by NTRO 2026).

# 4 Vehicle occupant and Motorcyclist Results

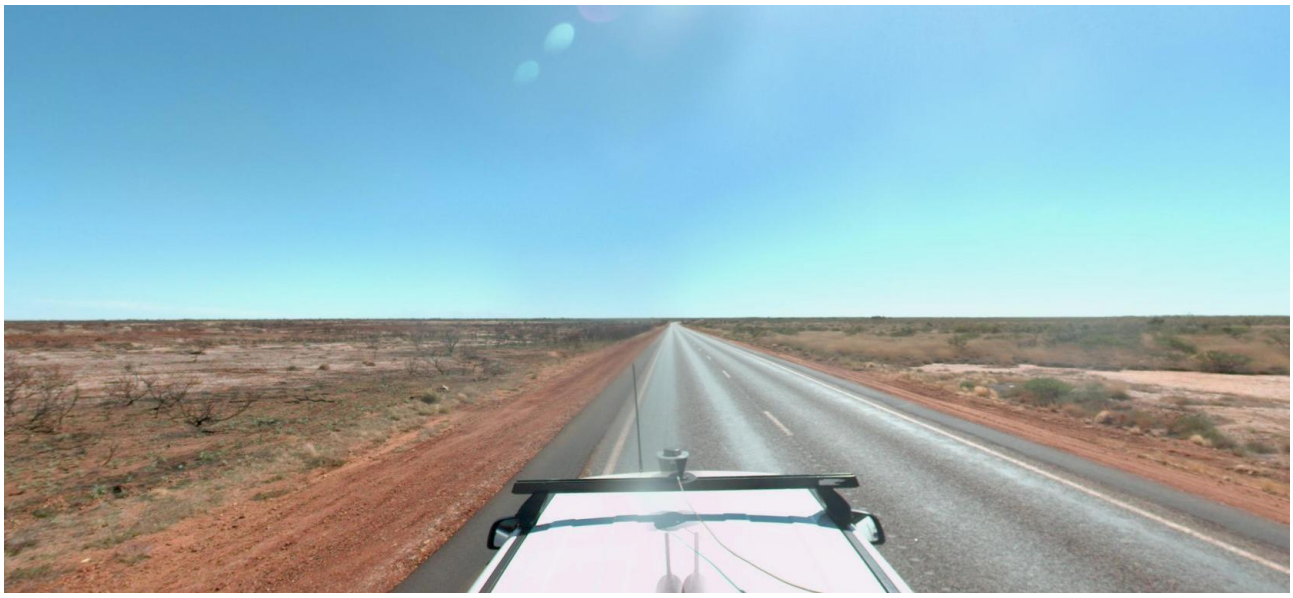
While network-level analysis provides a high-level picture of overall differences between AiRAP and manual coding, road-specific analysis by road user type enabled identification of attribute level coding differences across varying road cross-sections and environmental scenarios. This detailed assessment helped determine why coding differences occurred for various road cross-sections and identified opportunities to better refine coding approaches for road user types.

## 4.1 Rural single carriageway open (H006 Section 9 – Great Northern Hwy)

### 4.1.1 Road type characteristics

The assessed section of Great Northern Highway, shown in Figure 4.1, is located within the Town of Port Hedland Local Government area in the Pilbara region and represents a typical high-speed rural open road environment. This road section passes primarily through remote undeveloped areas and is characterised by an undivided single carriageway, narrow shoulders, rumble strips, and generally clear roadsides, with trees typically located at least 10 m from the roadway, alongside intermittent hazards such as downward slopes. This road type is highly significant at a network level, representing 77.1% of the Western Australian state road network by length and 18.0% of VKT, making it broadly representative of the majority of road infrastructure across the state while also carrying a notable share of vehicle travel demand. For this road type, the highest star rating score (SRS) risks for passenger vehicles and motorcycles are primarily driven by Head-on Overtaking, Head-on Loss of Control, and Run-off Loss of Control crash types due to high operating speeds, lack of median separation, limited recovery space and roadside hazards where present.

**Figure 4.1: Cross-section of H006 Section 9 – Great Northern Hwy**



Source: Pointerra data provided by Main Roads (2024).

### 4.1.2 Star rating

#### Raw star rating

AiRAP and Manual coding produced broadly different raw star rating outcomes for vehicle occupants, but comparatively closer alignment for motorcyclists, as shown in Table 4.1. For vehicle occupants, AiRAP generally assessed the road more favourably, assigning substantially more road length to the 4-star band, while manual coding shifted a greater proportion into the 3-star band, indicating a more moderate risk profile. For motorcyclists, both methods largely agreed that most of the route was 3-star, though Manual coding was slightly harsher by allocating more road length to 2-star. Across both road user groups, AiRAP identified small isolated 1-star segments not captured in manual coding.

#### Smoothed star rating

**No difference** was identified between AiRAP and manual coding in the smoothed star ratings (provided in Appendix B) for vehicle occupants or motorcyclists, with both methods assigning a consistent **3-star rating** across the full 10 km section.

**Table 4.1: Raw star ratings comparison by road length – Vehicle occupant and motorcyclist (H006-9)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | **8.6** | 3.5 | **5.1** | **51.0%** |
| 3 stars | 0.7 | **6.0** | **−5.3** | **−53.0%** |
| 2 stars | 0.3 | 0.5 | −0.2 | −2.0% |
| 1 star | 0.4 | 0.0 | 0.4 | 4.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |
| **Star ratings** | **Motorcyclist** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | **9.0** | **8.1** | 0.9 | 9% |
| 2 stars | 0.4 | 1.9 | −1.5 | −15.0% |
| 1 star | 0.6 | 0.0 | 0.6 | 6.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### 4.1.3 Star rating scores and attribute coding

Manual coding produced higher total SRS than AiRAP for both Vehicle occupants and motorcyclists, as shown in Table 4.2, indicating a consistently higher assessed risk under manual coding. For vehicle occupants, manual coding produced a total SRS 140.9 points higher than AiRAP, with the difference almost entirely attributable to higher passenger- and driver-side Run-off LOC SRS. For motorcyclists, total SRS differences were similarly confined to Run-off LOC crash types, with Along, Intersection and Head-on LOC SRS identical between the two methods. These results indicate that roadside hazard interpretation, rather than differences in conflict-related crash risk, was the primary driver of the observed star rating differences.

The higher Run-off LOC SRS under manual coding primarily reflected differences in roadside hazard identification, severity and distance. AiRAP was comparatively over-generous in roadside object severity coding on approximately 54% of the route and roadside object distance on 31%, largely because roadside hazards such as trees and downward slopes were either not detected or coded as presenting a lower level of hazard. This reduced the assessed severity of roadside hazards and consequently lowered run-off LOC SRS.

Conversely, manual coding was comparatively over-harsh, coding roadside object severity more severely on approximately 51% of the route and roadside object distance more harshly on 19%. This generally reflected a more conservative interpretation of roadside hazards, where trees were frequently coded as the nearest hazard. In some instances, however, these trees may have been below the typical iRAP hazard significance threshold (less than 10 cm diameter), resulting in higher assessed roadside risk than may have been warranted.

The same pattern was observed for motorcyclists, where AiRAP again tended to code roadside object severity and distance more generously, while manual coding more frequently identified hazards as being closer to the travelled way and of greater severity. Differences in these roadside attributes generally exceeded 50% and were the dominant contributors to the higher motorcyclist Run-off LOC SRS under manual coding. Although AiRAP produced marginally higher risk for some isolated crash types, including Head-on LOC and Property Access, these differences were comparatively minor and had little influence on the overall assessment.

Overall, the differences between AiRAP and manual coding on this corridor were almost entirely attributable to contrasting interpretations of roadside hazard severity and proximity. AiRAP generally assessed a more forgiving roadside environment, while manual coding more frequently identified closer and more severe roadside hazards, resulting in higher Run-off LOC SRS and correspondingly lower star rating outcomes for both vehicle occupants and motorcyclists.

**Table 4.2: Star rating score comparison – Vehicle occupant and motorcyclist (H006-9)**

| Vehicle occupant SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Property access | 4.0 | 2.4 | 1.6 |
| Intersection | 0.0 | 0.0 | 0.0 |
| Head-on overtaking | 41.2 | 41.2 | 0.0 |
| Head-on LOC | 223.6 | 214.1 | 9.5 |
| Run-off LOC passenger-side | 151.6 | 203.5 | **−51.9** |
| Run-off LOC driver-side | 154.7 | 254.8 | **−100.1** |
| **Total** | **575.1** | **716** | **−140.9** |
| **Motorcyclist SRS** | **Ai** | **Manual** | **Difference (Ai – Manual)** |
| Along | 205.8 | 205.8 | 0.0 |
| Property access | 2.8 | 1.6 | 1.2 |
| Intersection | 0 | 0 | 0.0 |
| Head-on overtaking | 41.2 | 41.2 | 0.0 |
| Head-on LOC | 226.2 | 214.1 | 12.1 |
| Run-off passenger-side | 160.5 | 212.1 | **−51.6** |
| Run-off LOC driver-side | 164.3 | 263.5 | **−99.2** |
| **Total** | **800.8** | **938.3** | **−137.5** |

Source: iRAP (2025) (reproduced by NTRO 2026).

## 4.2 Fringe (outer metro and rural) highway and main roads (H006 Section 140 – Great Northern Hwy)

### 4.2.1 Road type characteristics

The assessed section of Great Northern Highway, as shown in Figure 4.2, is located in the City of Swan, in Perth's eastern metropolitan area and represents a typical outer metropolitan/fringe road environment. This road is characterised by a predominantly undivided carriageway traversing a transitional corridor between urban fringe and semi-rural land uses, with median treatments generally limited to intersection locations. The corridor passes through residential and farming land uses before extending into more undeveloped semi-rural surroundings. The common infrastructure features include street lighting, roadside poles, trees and bicycle lane provision across much of the section. This road stereotype represents 0.9% of the Western Australian state road network by length and only 2.9% of VKT indicating comparatively lower traffic demand than major metropolitan routes.

For this road type, the highest star rating score (SRS) risks for vehicle occupants and motorcyclists are likely to be primarily influenced by Head-on Overtaking, Head-on Loss of Control, Run-off Loss of Control, and Intersection crash types, driven by the predominantly undivided cross-section, high-speed operating conditions, intermittent median protection at intersections only, roadside hazards such as poles and trees and the variable urban-to-rural roadside environment.

**Figure 4.2: Cross-section H006 Section 140 – Great Northern Hwy**



Source: Pointerra as provided by Main Roads (2024).

### 4.2.2 Star rating

#### Raw star rating

Raw star ratings from AiRAP and manual coding, as shown in Table 4.3, demonstrated close alignment for vehicle occupants, and slightly more notable differences for motorcyclists. For vehicle occupants, both methods largely agreed that the majority of the route was 3-star, indicating strong segment-level consistency, though manual coding assigned slightly more road length to the 2-star band, reflecting a somewhat harsher risk allocation. Both methods also identified small portions of 1-star road, with only minor variation.

For motorcyclists, AiRAP generally assessed the road with less risk, assigning 1.8 km more road length to the 3-star band, while manual coding allocated 1.9 km more in the 2-star band. Despite this, both methods showed close agreement on 1-star segments, suggesting consistency in identifying the highest-risk locations.

#### Smoothed star rating

Raw star ratings demonstrated better alignment than smoothed star rating results (provided in Appendix B), with the primary differences relating to how moderate-risk segments were distributed between adjacent star rating bands.

**Table 4.3: Raw star ratings comparison by road length – Vehicle occupant and motorcyclist (H006-140)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 7.5 | 6.7 | 0.8 | 8.0% |
| 2 stars | 1.9 | 2.9 | −1.0 | −10.0% |
| 1 star | 0.6 | 0.4 | 0.2 | 2.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |
| **Star ratings** | **Motorcyclist** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 2.4 | 0.6 | 1.8 | 18.0% |
| 2 stars | 6.1 | 8.0 | −1.9 | −19.0% |
| 1 star | 1.5 | 1.4 | 0.1 | 1.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### 4.2.3 Star rating scores and attribute coding

AiRAP coding produced a lower total SRS than manual coding for vehicle occupants, as shown in Table 4.4, with an overall reduction of 80.9 points. The difference was primarily driven by lower Run-off LOC SRS on both the driver side (−108.0) and passenger side (−84.9), which outweighed higher intersection SRS (+92.0) and Head-on LOC SRS (+26.3). This indicates that differences in roadside recovery and hazard interpretation had a greater influence on the overall vehicle occupant assessment than the increased conflict-related risk coded by AiRAP.

The higher Intersection SRS under AiRAP primarily reflected overestimation of intersecting traffic volumes, where lower-volume rural side roads (100–1,000 vpd) were in some instances coded as substantially higher-volume roads (10,000–15,000 vpd). In one case, this higher-volume intersection was also incorrectly duplicated across subsequent segments, further increasing the intersection SRS. The higher Head-on LOC SRS resulted from more conservative coding of median type and lane width. Median type was coded over-harshly on approximately 41% of the corridor where a wide centreline (0.3–1.0 m) was coded instead of central hatching greater than 1.0 m. In addition, due to intersection masking (discussed further in Section 7), centrelines were carried through intersections where physical medians were present, reducing perceived separation between opposing traffic flows and further increasing Head-on LOC risk. Lane width was also coded over-harshly on 22% of the route where wide lanes were classified as medium. Conversely, AiRAP coded the number of lanes over-generously on approximately 36% of the route by recording a standard 1:1 undivided carriageway as a 2+1 configuration, likely due to wider centre treatments or central hatching being interpreted as an additional lane. This reduced Head-on LOC risk and partially offset the effects of the harsher median and lane width coding. Overall, however, the net effect was an increase in both Intersection and Head-on LOC SRS.

The lower Run-off LOC SRS under AiRAP was primarily associated with more generous interpretation of paved shoulder continuity and roadside hazard distance. AiRAP overestimated paved shoulder continuity on approximately 43% of the driver side and 33% of the passenger side by carrying paved shoulders through bus stopping bays, turning lanes and intersections where no effective shoulder existed. This increased the perceived recovery area and contributed to roadside hazards being coded further from the traffic lane on approximately 29% of the driver side and 16% of the passenger side. In contrast, manual coding more frequently underestimated roadside hazard distance, placing hazards closer to the roadway on approximately 12% of the driver side and 21% of the passenger side. Although manual coding also demonstrated some over-generous shoulder continuity assumptions, these were less frequent and generally limited to bus stop locations. Collectively, these differences reduced Run-off LOC severity under AiRAP while increasing roadside risk under manual coding, making run-off LOC the dominant contributor to the lower vehicle occupant SRS.

For motorcyclists, total SRS differed by only 1.4 points between AiRAP and manual coding, indicating broad agreement in overall risk despite substantial variation across individual crash types. AiRAP produced a higher intersection SRS (+223.0) arising from the same intersection volume assumptions and duplicated intersection coding identified for vehicle occupants. This was largely offset by lower Run-off LOC SRS on the driver side (−124.5) and passenger side (−82.3), together with lower Along SRS (−28.7), resulting from the same more generous shoulder continuity and roadside hazard coding. Consequently, while the overall motorcyclist SRS was similar between methods, this masked significant differences in the way individual crash types were assessed.

Overall, the principal differences between AiRAP and manual coding on this corridor reflected contrasting interpretations of conflict-related and roadside risk. AiRAP generally assessed higher intersection and Head-on LOC risk through more conservative coding of intersection traffic volumes, median type and lane width, while simultaneously assessing lower Run-off LOC risk through more generous assumptions regarding shoulder continuity and roadside hazard distance. For vehicle occupants, the reduction in Run-off LOC outweighed the increases in conflict-related crash risk, resulting in a lower overall SRS. For motorcyclists, the opposing crash-type differences were of greater magnitude but largely balanced, producing similar overall SRS despite materially different underlying risk profiles.

**Table 4.4: Star rating score comparison – Vehicle occupant and motorcyclist (H006-140)**

| Vehicle occupant SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Property access | 11.4 | 10.0 | 1.4 |
| Intersection | 196.5 | 104.5 | **92.0** |
| Head-on overtaking | 38.6 | 46.3 | −7.7 |
| Head-on LOC | 457.2 | 430.9 | **26.3** |
| Run-off LOC passenger-side | 266.3 | 351.2 | **−84.9** |
| Run-off LOC driver-side | 250.2 | 358.2 | **−108.0** |
| **Total** | **1,220.2** | **1,301.1** | **−80.9** |
| **Motorcyclist SRS** | **Ai** | **Manual** | **Difference (Ai – Manual)** |
| Along | 292.2 | 320.9 | **−28.7** |
| Property access | 8.5 | 8.2 | 0.3 |
| Intersection | 360.0 | 137.0 | **223.0** |
| Head-on overtaking | 38.6 | 46.3 | −7.7 |
| Head-on LOC | 460.2 | 438.9 | **21.3** |
| Run-off passenger-side | 275.4 | 357.7 | **−82.3** |
| Run-off LOC driver-side | 266.1 | 390.6 | **−124.5** |
| **Total** | **1,701** | **1,699.6** | **1.4** |

Source: iRAP (2025) (reproduced by NTRO 2026).

## 4.3 Urban highway and main roads (H001 Section 134 – Albany Hwy)

### 4.3.1 Road type characteristics

The assessed section of Albany Highway, as shown in

Figure 4.3, is located between the Town of Victoria Park and the City of Canning within Perth's metropolitan region and represents an urban highway environment in an established suburban and commercial corridor. It is characterised by residential and commercial land use, signalised intersections, frequent left-in/left-out access points, absence of paved shoulders, and roadside hazards such as poles and trees. This road type represents approximately 5.7% of the Western Australian state road network by length, but carries a disproportionately high share of travel, accounting for 30.6% of VKT.

For this road type, the dominant star rating score (SRS) risks for both vehicle occupants and motorcyclists are expected to be primarily driven by Intersection and Property Access crash types due to the high frequency of signalised intersections, turning movements and continuous roadside access activity. Along crash risk is also likely to be more relevant for motorcyclists given the increased complexity of same direction traffic interactions in an urban arterial setting, while Run-off LOC remains relevant for both road user groups due to limited roadside recovery space and the close proximity of roadside hazards. Collectively, this road type is expected to present a more conflict driven and access related risk profile than with rural highway environments, with coding accuracy for intersections, property access, roadside hazards and recovery space being particularly important for star rating outcomes.

**Figure 4.3: Cross-section H001 Section 134 – Albany Hwy**



Source: Pointerra as provided by Main Roads (2024).

### 4.3.2 Star rating

#### Raw star rating

For this section, raw star ratings from AiRAP and manual coding, as shown in Table 4.5, produced broadly similar outcomes for vehicle occupants, with differences occurring between the 3-star and 4-star bands. Both methods showed identical road lengths in the 2-star and 1-star bands. Manual coding assigned a greater proportion of road length to the 4-star band, while AiRAP assigned a correspondingly greater proportion to the 3-star band.

For motorcyclists, raw star ratings showed more noticeable variation, with AiRAP producing slightly harsher outcomes than manual coding. Manual coding assigned a greater proportion of road length to the 3-star band, while AiRAP coded more road length into the 2-star band, indicating comparatively higher assessed motorcycle risk for AiRAP. Manual coding also identified slightly more 1-star road length, though this difference was relatively minor.

#### Smoothed star rating

Compared with the raw star ratings, the smoothed star ratings (provided in Appendix B) produced similar overall trends but reduced local variation in the results. For vehicle occupants, smoothing reduced the differences between the methods by consolidating much of the route into the 3-star band. For motorcyclists, smoothing increased the separation between the methods, with AiRAP assigning a greater proportion of the route to the 2-star band and manual coding assigning a greater proportion to the 3-star band than in the raw results.

**Table 4.5: Raw star ratings comparison by road length – Vehicle occupant and motorcyclist (H001-134)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.4 | 1.1 | −0.7 | −15.6% |
| 3 stars | 2.6 | 1.9 | 0.7 | 15.6% |
| 2 stars | 1.3 | 1.3 | 0.0 | 0.0% |
| 1 star | 0.2 | 0.2 | 0.0 | 0.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **4.5** | **4.5** | | |
| **Star ratings** | **Motorcyclist** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 2.3 | 2.9 | −0.6 | −13.3% |
| 2 stars | 1.8 | 1.0 | 0.8 | 17.8% |
| 1 star | 0.4 | 0.6 | −0.2 | −4.4% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **4.5** | **4.5** | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### 4.3.3 Star rating scores and attribute coding

AiRAP coding produced slightly higher total SRS than manual coding for both vehicle occupants and motorcyclists on this section, as shown in Table 4.6, indicating a consistently higher assessed level of risk coded by AiRAP.

For vehicle occupants, AiRAP produced a total SRS 48.9 points higher than manual coding. The increase was primarily driven by higher intersection SRS (+60.7) and Head-on LOC SRS (+52.5), while lower passenger- and driver-side Run-off LOC SRS partially offset these increases.

The higher Intersection SRS reflected AiRAP's more conservative interpretation of conflict points, with intersection risk overestimated along approximately 35% of the route through duplicated intersections, misclassification of driveways as intersections and coding left-in/left-out merge arrangements as three-leg intersections. The increase in Head-on LOC SRS was primarily attributable to median type coding, where the back-to-back kerb separating opposing carriageways was coded as a centreline by AiRAP on approximately 57% of the corridor. This reduced the perceived separation between opposing traffic streams, increased median traversability and elevated Head-on LOC risk.

The lower Run-off LOC SRS under AiRAP primarily reflected differences in roadside hazard distance. AiRAP more frequently coded roadside hazards further from the traffic lane than observed (approximately 22–28% of the route), reducing the assessed roadside hazard severity, whereas manual coding more frequently positioned hazards closer to the travelled way (approximately 24–37% of the route), resulting in higher Run-off LOC risk. On the driver side, however, AiRAP's median misclassification also caused some hazards to be referenced closer to the travelled lane, partially offsetting its otherwise more generous roadside hazard coding and reducing the overall Run-off LOC difference.

For motorcyclists, AiRAP similarly produced a total SRS 52.2 points higher than manual coding. The increase was again driven by higher Intersection SRS (+64.6) and Head-on LOC SRS (+54.6) arising from the same intersection and median coding differences identified for vehicle occupants. Along SRS was identical between the two methods, while lower passenger- and driver-side Run-off LOC SRS, resulting from the same roadside hazard distance coding differences, partially offset the higher conflict-related crash risks but was insufficient to offset the increases in Intersection and Head-on LOC SRS.

Overall, for this urban highway road type, the higher total SRS and lower star ratings produced by AiRAP were primarily driven by more conservative coding of conflict-related crash risks, particularly intersection frequency and median type. In contrast, manual coding generally assessed greater roadside hazard severity, resulting in higher Run-off LOC SRS. However, these roadside differences were outweighed by AiRAP's higher weighting of Intersection and Head-on LOC risk, making these crash types the principal drivers of the observed differences in SRS and star rating outcomes.

**Table 4.6: Star rating score comparison – Vehicle occupant and motorcyclist (H001-134)**

| Vehicle occupant SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Property access | 2.7 | 1.9 | 0.8 |
| Intersection | 229.6 | 168.9 | **60.7** |
| Head-on overtaking | 0.2 | 0.07 | 0.13 |
| Head-on LOC | 126.9 | 74.4 | **52.5** |
| Run-off LOC passenger-side | 77.7 | 124.7 | **−47.0** |
| Run-off LOC driver-side | 74.3 | 92.5 | **−18.2** |
| **Total** | **511.4** | **462.5** | **48.9** |
| **Motorcyclist SRS** | **Ai** | **Manual** | **Difference (Ai – Manual)** |
| Along | 82.5 | 82.5 | 0.0 |
| Property access | 1.9 | 1.7 | 0.2 |
| Intersection | 256.5 | 191.9 | **64.6** |
| Head-on overtaking | 0.2 | 0.07 | 0.13 |
| Head-on LOC | 129.0 | 74.4 | **54.6** |
| Run-off passenger-side | 78.9 | 126.7 | **−47.8** |
| Run-off LOC driver-side | 75.5 | 95.0 | **−19.5** |
| **Total** | **624.5** | **572.3** | **52.2** |

Source: iRAP (2025) (reproduced by NTRO 2026).

## 4.4 Urban freeway and controlled access highway (H016 Section 150 – Mitchell Fwy)

### 4.4.1 Road type characteristics

The assessed section of Mitchell Freeway, as shown in Figure 4.4, located between the City of South Perth and City of Stirling in Perth's metropolitan region, represents a typical high speed, high volume urban freeway environment. It is characterised by a fully divided, multi-lane dual carriageway operating through a predominantly developed urban setting but functionally separated from adjacent land uses through controlled access design. Although located in an urban area, this road type is classified as rural under iRAP due to its access-controlled, freeway operating environment. Common features include wide lanes, medium to wide paved shoulders, street lighting and roadside protection primarily consisting of metal and concrete barriers. This road type represents approximately 2.8% of the Western Australian state road network by length but carries approximately 34.6% of total network VKT.

For this road type, the dominant star rating score (SRS) risks for vehicle occupants and motorcyclists are expected to be driven primarily by Run-off LOC and Along crash types due to high travel speeds, roadside barrier exposure and the absence of property access and at-grade intersection conflict. As a result, accurate coding of carriageway configuration, median type, shoulder width and roadside barriers, is particularly important to star rating outcomes on this road type.

**Figure 4.4: Cross-section of H016 Section 150 – Mitchell Fwy**



Source: Pointerra as provided by Main Roads (2024).

### 4.4.2 Star rating

#### Raw star rating

Raw star ratings for this section, as shown in Table 4.7, showed broadly similar outcomes between AiRAP and manual coding. For vehicle occupants, both methods classified the route across the 1-star to 5-star bands, with the majority of the route classified as 3-star and 4-star. AiRAP classified a greater proportion of the route as 1-star, while manual coding classified a greater proportion as 3-star. For motorcyclists, both methods classified the route predominantly within the 1-star to 3-star bands, with the majority of the route classified as 2-star and 3-star. AiRAP classified a greater proportion of the route as 1-star, while manual coding classified a greater proportion as 2-star. Overall, the raw star rating results showed broadly similar star rating distributions between AiRAP and manual coding.

#### Smoothed star rating

Smoothed star ratings for this road section (provided in Appendix B), differed from the raw star ratings by producing a more consolidated distribution of star ratings. For vehicle occupants, manual coding classified the route entirely within the 3-star and 4-star bands, whereas AiRAP classified the route across the 2-star to 4-star bands. For motorcyclists, the differences between the two methods became more pronounced, with manual coding classifying the route within the 1-star and 2-star bands, while AiRAP classified the route within the 1-star and 3-star bands.

**Table 4.7: Raw star ratings comparison by road length – Vehicle occupant and motorcyclist (H016-150)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.7 | 1.0 | −0.3 | −3.0% |
| 4 stars | 5.0 | 5.6 | −0.6 | −6.0% |
| 3 stars | 2.0 | 2.8 | −0.8 | −8.0% |
| 2 stars | 0.7 | 0.5 | 0.2 | 2.0% |
| 1 star | 0.9 | 0.1 | 0.8 | 8.0% |

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| Not applicable | 0.7 | 0.0 | 0.7 | 7.0% |
| **Total length** | 10.0 | 10.0 | | |
| **Star ratings** | **Motorcyclist** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 1.0 | 1.4 | −0.4 | −4.0% |
| 2 stars | 4.1 | 5.0 | −0.9 | −9.0% |
| 1 star | 4.2 | 3.6 | 0.6 | 6.0% |
| Not applicable | 0.7 | 0.0 | 0.7 | 7.0% |
| **Total length** | 10.0 | 10.0 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### 4.4.3 Star rating scores and attribute coding

AiRAP coding produced a higher total SRS than manual coding for both vehicle occupants and motorcyclists on this section, as shown in Table 4.8, indicating higher assessed overall risk across both road user groups.

For vehicle occupants, AiRAP produced a total SRS 188.8 points higher than manual coding. The largest contributor was intersection SRS (+134.5), followed by passenger-side Run-off LOC (+21.4) and driver-side Run-off LOC (+32.9).

The higher intersection SRS primarily reflected one duplicated intersection, repeated overestimation of merge-ramp traffic volumes to greater than 15,000 vehicles per day, application of these volumes to filter lanes on three occasions and harsher coding of merge quality. AiRAP also classified 93% of the route as urban, although the regulated-access environment would typically be classified as rural under the iRAP methodology. This increased the external flow assumptions applied to intersections and further elevated the intersection SRS. Manual coding also contributed to the variance by failing to identify four merge intersections, thereby understating intersection risk.

The higher Run-off LOC SRS under AiRAP was primarily associated with over-harsh coding of passenger-side shoulder width on 87% of segments, driver-side shoulder width on 50%, lane width on 85%, and curvature on 11%. Roadside hazard coding varied under both methods. AiRAP coded hazard distance over-harshly on 10% of segments and over-generously on 13%, while manual coding showed greater passenger-side variance, with 28% coded over-harshly and 12% over-generously. These opposing roadside hazard differences likely reduced the overall Run-off LOC gap to some extent.

For motorcyclists, AiRAP produced a total SRS 260.2 points higher than manual coding. As for vehicle occupants, Intersection SRS was the largest contributor (+179.4), reflecting the same duplicated intersection, merge volume, filter-lane, merge quality and area-type coding differences. AiRAP also produced a combined increase of 138.6 points in passenger- and driver-side Run-off LOC SRS, primarily due to underestimation of shoulder and lane widths, which increased the assessed motorcycle loss-of-control risk.

Along SRS was 57.8 points lower under AiRAP; however, this reduction was largely attributable to the 0.7 km section for which AiRAP produced no star rating. That length was therefore excluded from the AiRAP Along SRS, while manual coding continued to assess and assign risk across it. The lower Along SRS

consequently reflected a difference in assessed length rather than a consistently lower interpretation of Along???-route risk and was insufficient to offset the higher Intersection and Run-off LOC scores.

Overall, the higher total SRS and lower star ratings produced by AiRAP for both road user groups were primarily driven by intersection frequency and traffic volume coding, together with over-harsh coding of shoulder width, lane width and curvature. The variance was further increased by over-generous manual intersection coding, particularly the omission of merge intersections, although the higher-weighted AiRAP differences remained the dominant influence.

**Table 4.8: Star rating score comparison – Vehicle occupant and motorcyclist (H016-150)**

| Vehicle occupant SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Property access | 0.0 | 0.0 | 0.0 |
| Intersection | 183.9 | 49.4 | **134.5** |
| Head-on overtaking | 0.0 | 0.0 | 0.0 |
| Head-on LOC | 0.0 | 0.0 | 0.0 |
| Run-off LOC passenger-side | 319.3 | 297.9 | **21.4** |
| Run-off LOC driver-side | 249.1 | 216.2 | **32.9** |
| **Total** | **752.3** | **563.5** | **188.8** |
| **Motorcyclist SRS** | **Ai** | **Manual** | **Difference (Ai – Manual)** |
| Along | 1,081.9 | 1,139.7 | **−57.8** |
| Property access | 0.0 | 0.0 | 0.0 |
| Intersection | 245.3 | 65.9 | **179.4** |
| Head-on overtaking | 0.0 | 0.0 | 0.0 |
| Head-on LOC | 0.0 | 0.0 | 0.0 |
| Run-off LOC passenger-side | 486.9 | 422.1 | **64.8** |
| Run-off LOC driver-side | 402.9 | 329.1 | **73.8** |
| **Total** | **2,217.0** | **1,956.8** | **260.2** |

Source: iRAP (2025) (reproduced by NTRO 2026).

## 4.5 Rural single carriageway (M043 Section 123 – Caves Rd)

### 4.5.1 Road type characteristics

The assessed section of Caves Road, as shown in Figure 4.5, located within the Local Government area of City of Busselton, in Western Australia's southwest region, represents a rural road environment. This section is characterised by an undivided single carriageway with a single lane in each direction, traversing predominantly undeveloped surroundings with occasional settlements and property access points. The route reflects a rural single carriageway road environment with narrow shoulders, shoulder rumble strips, and dense roadside vegetation, including extensive tree cover located in close proximity to the roadway, creating a comparatively constrained and more challenging roadside hazard environment. While the corridor primarily passes through natural and semi-rural landscapes, intermittent local access and settlement interfaces introduce additional roadside complexity. This road type represents approximately 8.3% of the Western Australian state road network by length but carries approximately 2.2% of total network VKT.

For this road type, key SRS risks for passenger vehicles and motorcycles are likely to be strongly influenced by Run-off LOC, Head-on LOC, and Head-on Overtaking crash types, driven by the undivided cross-section, narrow recovery space and the presence of severe roadside hazards such as trees close to the carriageway.

**Figure 4.5: Cross-section of M043 Section 123 – Caves Rd**



Source: Pointerra as provided by Main Roads (2024).

### 4.5.2 Star rating

#### Raw star rating

Raw star ratings for this section, as shown in Table 4.9, showed broadly similar overall patterns between AiRAP and manual coding, with both methods primarily coding the route within the 1-star to 3-star bands. For vehicle occupants, both methods coded the greatest proportion of road length within the 2-star band, followed by the 3-star band, indicating general alignment in the overall risk profile. Differences in the 3-star to 5-star bands were relatively minor, with the most notable variance occurring in the 1-star band, where AiRAP coded more road length than manual coding. Overall, vehicle occupant differences primarily reflected redistribution from the 2-star band to the 1-star band under AiRAP rather than substantial divergence across the broader star rating distribution.

For motorcyclists, variation between methods was more pronounced. While both methods coded the largest proportion of road length within the 2-star band, AiRAP coded its second largest proportion as 1-star, whereas manual coding coded its second largest proportion as 3-star. The most notable difference was the greater proportion of 1-star road length coded by AiRAP, indicating a clearer shift toward lower-star, higher-risk bands relative to manual coding.

Collectively, these findings indicate that at the raw segment level, AiRAP and manual coding produced broadly comparable star rating distributions for this section, with both methods identifying the route primarily within the 1-star to 3-star range. However, AiRAP generally coded more road length into lower-star, higher-risk bands, particularly for motorcyclists.

#### Smoothed star rating

Compared with the raw star ratings, the smoothed star ratings (provided in Appendix B) showed substantially greater differences between AiRAP and manual coding. For vehicle occupants, the raw distribution across the 1-star to 4-star bands was consolidated into the 1-star and 2-star bands, with manual coding classifying the entire route as 2-star, while AiRAP classified the route as a combination of 1-star and 2-star. For motorcyclists, the differences became more pronounced, with manual coding classifying the entire route as 2-star, whereas AiRAP classified the majority of the route as 1-star, with the remainder classified as 2-star.

**Table 4.9: Raw star ratings comparison by road length – Vehicle occupant and motorcyclist (M043-123)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.1 | 0.0 | 0.1 | 1.0% |
| 4 stars | 0.2 | 0.1 | 0.1 | 1.0% |
| 3 stars | 3.3 | 3.6 | −0.3 | −3.0% |
| 2 stars | 4.0 | 4.8 | −0.8 | −7.9% |
| 1 star | 2.5 | 1.6 | 0.9 | 8.9% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | 10.1 | 10.1 | | |

| Star ratings | Motorcyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.2 | 0.0 | 0.2 | 2.0% |
| 3 stars | 2.2 | 3.1 | −0.9 | −8.9% |
| 2 stars | 4.5 | 5.0 | −0.5 | −5.0% |
| 1 star | 3.2 | 2.0 | 1.2 | 11.9% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | 10.1 | 10.1 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### 4.5.3 Star rating scores and attribute coding

AiRAP coding produced a higher total SRS than manual coding for both vehicle occupants and motorcyclists on this section, as shown in Table 4.10, indicating higher assessed overall risk across both road user groups.

For vehicle occupants, AiRAP produced a total SRS 318.3 points higher than manual coding, representing a 16.6% increase. The largest contributors were Head-on LOC (+145.5) and passenger-side Run-off LOC (+145.6), followed by driver-side Run-off LOC (+49.5) and Property Access (+1.9). Intersection SRS was 24.4 points lower under AiRAP, but this reduction was insufficient to offset the higher LOC-related risk.

The higher Head-on LOC SRS primarily reflected AiRAP's more consistently over-harsh coding of delineation, lane width and curve-related attributes. AiRAP coded delineation as poor across the entire section where it was assessed as adequate, coded wide lanes as medium on 22% of segments and coded moderate curves instead of straights on 10% of segments. Curve quality was also coded over-harshly on 26% of segments, including both curves and straights incorrectly identified as curves. Manual coding was over-generous for curve quality on 12% of segments where vegetation restricted visibility; however, this had a smaller overall influence than AiRAP's broader pattern of over-harsh coding.

The higher Run-off LOC SRS was driven by the same delineation, lane width and curve coding differences, together with shoulder rumble strip, shoulder width and roadside hazard coding. AiRAP failed to detect shoulder rumble strips on 20% of the route and coded passenger-side shoulder width over-harshly on 18% of segments. Driver-side shoulder coding was mixed, with over-generous coding on 12% of segments where shoulders were recorded at intersections or turn lanes despite no effective shoulder being present, and over-harsh coding on a further 12% where shoulders were narrower than observed.

Roadside hazard coding also varied in both directions. AiRAP failed to detect hazards or coded them farther from the roadway on 30% of driver-side and 29% of passenger-side segments, while manual coding more frequently positioned hazards too close to the roadway on 26% and 17% of segments, respectively. These opposing differences likely reduced the net effect of roadside hazard coding on Run-off LOC SRS. Overall, the higher vehicle occupant SRS was therefore driven more consistently by delineation, lane width, curve, rumble strip and shoulder coding than by roadside hazard distance alone.

For motorcyclists, AiRAP produced a total SRS 519.6 points higher than manual coding, representing a 21.7% increase. The difference was again concentrated in Head-on LOC (+194.0), passenger-side Run-off LOC (+221.6) and driver-side Run-off LOC (+133.4), while Intersection SRS was 30.5 points lower under AiRAP and Along SRS was unchanged.

The higher motorcyclist SRS arose from the same underlying coding differences identified for vehicle occupants, including poorer delineation, narrower lane and shoulder coding, missed shoulder rumble strips and more severe curve radius and curve quality coding. These attributes had a larger effect on motorcyclist SRS because motorcycle risk is more sensitive to lane configuration, delineation, shoulder provision and roadside severity. As a result, the combined increase in Head-on LOC and Run-off LOC was substantially greater for motorcyclists than for vehicle occupants.

For both road user groups, the lower Intersection SRS under AiRAP was primarily attributable to underestimated intersecting road volumes at two intersections, where volumes were coded as less than 100 vehicles per day rather than 100–1,000 vehicles per day. This occurred despite some isolated over-harsh AiRAP coding of intersection quality, channelisation and area type. AiRAP coded an additional 8% of intersections as poor quality, failed to detect channelisation at 4% of intersections, and classified 11% of the route as urban where a rural classification may have been more appropriate. The effect of these differences was nevertheless outweighed by the lower intersecting traffic volume assumptions.

Overall, AiRAP was more consistently over-harsh across the attributes most influential to Head-on LOC and Run-off LOC, particularly delineation, lane width, shoulder width, shoulder rumble strips, curve radius and curve quality. These coding differences were the primary drivers of the higher total SRS and lower star rating outcomes produced by AiRAP for both vehicle occupants and motorcyclists.

**Table 4.10: Star rating score comparison – Vehicle occupant and motorcyclist (M043-123)**

| Vehicle occupant SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Property access | 7.4 | 5.5 | 1.9 |
| Intersection | 22.2 | 46.6 | **−24.4** |
| Head-on overtaking | 35.2 | 35.0 | 0.2 |
| Head-on LOC | 456.5 | 311.0 | **145.5** |
| Run-off LOC passenger-side | 766.5 | 620.9 | **145.6** |
| Run-off LOC driver-side | 634.0 | 584.5 | **49.5** |
| **Total** | **1,921.8** | **1,603.5** | **318.3** |
| **Motorcyclist SRS** | **Ai** | **Manual** | **Difference (Ai – Manual)** |
| Along | 175.1 | 175.1 | 0.0 |
| Property access | 5.7 | 4.8 | 0.9 |
| Intersection | 27.8 | 58.3 | **−30.5** |
| Head-on overtaking | 35.2 | 35.0 | 0.2 |
| Head-on LOC | 519.6 | 325.6 | **194.0** |
| Run-off LOC passenger-side | 874.2 | 652.6 | **221.6** |
| Run-off LOC driver-side | 757.1 | 623.7 | **133.4** |
| **Total** | **2,394.7** | **1,875.1** | **519.6** |

Source: iRAP (2025) (reproduced by NTRO 2026).

# 5 Bicyclist and Pedestrian Results

## 5.1 Fringe (outer metro and rural) highway and main roads (H006 Section 140 – Great Northern Hwy)

### 5.1.1 Smoothed and raw star rating

The assessed section of Great Northern Highway, as shown in Figure 5.1, is located in the City of Swan in Perth's eastern metropolitan region and represents a typical outer metropolitan/fringe road environment (refer to Section 4.2 for a detailed description of the corridor characteristics). The corridor includes dedicated on-road bicycle lanes along much of the route and an adjacent pedestrian/shared user path along portions of the corridor, with varying levels of continuity and separation from live traffic. The route also passes through sections of residential and commercial development that are likely to generate pedestrian and bicyclist activity. Collectively, these characteristics result in pedestrian and bicyclist star ratings being applicable across much of the corridor, while the quality, continuity and separation of the facilities influence the resulting vulnerable road user star ratings.

For bicyclists, key SRS risks for this road type are likely to be concentrated in Along, Run-off, and Intersection crash types, influenced by bicycle facility provision, continuity, roadside hazard proximity, traffic speed and intersection treatment. For pedestrians, primary SRS risks are likely to be associated with Along and Crossing crash types, influenced by pedestrian path provision, path separation from traffic, crossing opportunities, intersection design and roadside infrastructure. While dedicated bicycle lanes and pedestrian/shared paths may reduce exposure compared with roads lacking such infrastructure, variations in facility design, separation, crossing treatment and roadside hazard environment remain important determinants of pedestrian and bicyclist safety outcomes.

**Figure 5.1: Cross-section H006 Section 140 – Great Northern Hwy**



Source: Pointerra as provided by Main Roads (2024).

### 5.1.2 Star rating

#### Raw star rating

For this section, raw star ratings for bicyclists and pedestrians, as shown in Table 5.1, showed differences between AiRAP and manual coding.

For bicyclists, both methods agreed that the majority of the route was not applicable (8.5 km), indicating broad alignment that most of the corridor had limited bicyclist applicability. Within the remaining 1.5 km of applicable road length, however, AiRAP produced a more varied distribution, coding 0.8 km as 4-star, 0.1 km as 3-star, and 0.6 km as 2-star, while manual coding primarily coded the same length as 2-star (1.4 km), with only a small 0.1 km section coded as 1-star. Overall, this indicates that while both methods identified similar bicyclist-applicable road lengths, AiRAP generally coded that applicable section within comparatively higher star rating bands than manual coding at the raw segment level.

For pedestrians, both methods broadly agreed that the majority of pedestrian-applicable road length fell within the 1-star band, indicating similar assessment of higher pedestrian risk where pedestrian exposure was considered present. AiRAP coded 5.4 km as 1-star compared with 3.2 km under manual coding, while both methods coded 0.2 km as 2-star. The key difference was again the extent of road length considered pedestrian-applicable, with manual coding classifying more of the corridor as not applicable (6.6 km compared with 4.4 km under AiRAP). Overall, pedestrian differences were primarily related to the length of road considered applicable rather than differences in the star rating of assessed sections.

#### Smoothed star rating

Compared with the raw star ratings, the smoothed star ratings (provided in Appendix B) produced only minor changes to the overall assessment. For bicyclists, the applicable road length was consolidated into a single star rating by each method, with AiRAP classifying the entire applicable section as 3-star and manual coding classifying the same section as 2-star. For pedestrians, the smoothed star ratings were broadly consistent with the raw results, with the only notable change being the reclassification of a small section of 2-star road to 1-star under AiRAP. The difference between the two methods in the extent of road length classified as not applicable remained unchanged.

**Table 5.1: Raw star ratings comparison by road length – Bicyclist and pedestrian (H006-140)**

| Star ratings | Bicyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.8 | 0.0 | 0.8 | 8.0% |
| 3 stars | 0.1 | 0.0 | 0.1 | 1.0% |
| 2 stars | 0.6 | 1.4 | −0.8 | −8.0% |
| 1 star | 0.0 | 0.1 | −0.1 | −1.0% |
| Not applicable | 8.5 | 8.5 | 0.0 | 0.0% |
| **Total length** | 10.0 | 10.0 | | |
| **Star ratings** | **Pedestrian** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 2 stars | 0.2 | 0.2 | 0.0 | 0.0% |
| 1 star | 5.4 | 3.2 | 2.2 | 22.0% |
| Not applicable | 4.4 | 6.6 | −2.2 | −22.0% |
| **Total length** | 10.0 | 10.0 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### 5.1.3 Star rating scores and attribute coding

AiRAP and manual coding produced markedly different SRS outcomes for bicyclists and pedestrians on this section, as shown in Table 5.2. For pedestrians, however, the network-level comparison was strongly influenced by differences in the road length assessed as applicable. Accordingly, pedestrian results were also compared across the 3.4 km of road for which both methods produced pedestrian star ratings, as shown in Table 5.3, to better isolate differences arising from attribute coding.

The generation of pedestrian and bicyclist SRS and subsequent star ratings depends on the application of corresponding road user volumes. For the manual assessment, NTRO applied Main Roads-supplied volumes where pedestrian or bicyclist facilities were identified and user activity was therefore considered likely. Under the Main Roads business rules applied in AiRAP, pedestrian volumes were assigned across a longer portion of the corridor, including sections where pedestrian facilities were not consistently present. As a result, AiRAP generated pedestrian SRS and star ratings over a materially greater road length than manual coding. Conversely, although dedicated on-road bicycle lanes were present along much of the corridor, bicyclist volumes were supplied for only 1.5 km. Bicyclist SRS and star ratings were therefore limited to that length, with the remainder classified as not applicable under both assessments.

For bicyclists, AiRAP produced a total SRS 271.5 points lower than manual coding, indicating lower assessed bicyclist risk. The difference was concentrated almost entirely in Along SRS (−268.9), with Crossing Intersecting Road (−2.4) and Crossing Inspected Road (−0.2) showing close alignment. This indicates that the principal difference related to the interpretation of the along-route cyclist operating environment rather than crossing risk.

The lower Along SRS under AiRAP was primarily attributable to bicycle facility coding. On this 80 km/h corridor, cyclists using the dedicated on-road bicycle lane are exposed to adjacent higher-speed traffic and would typically attract a higher SRS than cyclists using a separated facility. AiRAP frequently did not

recognise the dedicated on-road bicycle lane, instead coding the adjoining footpath as the bicyclist facility on 60% of the relevant length or coding no bicycle facility where an on-road lane was present on the remaining 40%. This reduced the extent to which cyclists were assessed as operating within the higher-risk on-road environment and was the dominant contributor to the lower Along SRS.

AiRAP also coded the number of lanes over-harshly on 47% of segments, commonly recording a 1:1 arrangement as 2+1, and coded lane width over-harshly on 53% of segments by assigning medium width where wide was more appropriate. However, the risk-increasing effect of these differences was outweighed by the bicycle facility coding, which produced a more favourable representation of cyclist separation from traffic. Overall, bicyclist SRS variance was driven primarily by facility type and continuity, particularly whether cyclists were assessed as using the dedicated on-road bicycle lane or the adjoining footpath.

For pedestrians, AiRAP produced a substantially higher network-level total SRS than manual coding (+4,805.8). This result largely reflected the greater road length assessed as pedestrian-applicable under AiRAP rather than harsher coding alone. Because pedestrian volumes were applied across a longer portion of the corridor, AiRAP accumulated Along, Crossing Intersecting Road and Crossing Inspected Road SRS over a larger assessed length.

When the comparison was limited to the mutually applicable 3.4 km, the total SRS difference reduced to +809.7 under AiRAP, representing an 18% difference. Along SRS was broadly aligned (−5.2), while the remaining variance was almost entirely attributable to Crossing Inspected Road SRS (+836.0). Crossing Intersecting Road SRS was slightly lower under AiRAP (−21.1). This demonstrates that once differences in applicability were controlled for, the principal source of pedestrian variance was the interpretation of crossings across the inspected road.

The higher Crossing Inspected Road SRS under AiRAP was primarily associated with over-harsh coding of the number of lanes on 56% of relevant segments, commonly recording a 1:1 arrangement as 2+1, and over-harsh coding of median type at 59% of crossings, including coding a centreline or narrow centreline where hatching greater than 1 m or a physical median was present. AiRAP also failed to detect pedestrian crossings at 10% of relevant locations. Although median type was over-generous in 9% of cases, this had comparatively less influence. Because attributes associated with crossing the inspected road carry greater weighting than those associated with crossing side roads, these differences disproportionately increased Crossing Inspected Road SRS.

Along-route pedestrian conditions were more closely aligned because several coding differences offset one another. AiRAP coded the number of lanes over-harshly on 56% of applicable segments and lane width over-harshly on 44%, which tended to increase risk. In contrast, moderate curves were coded as straight on 11% of the applicable route, reducing perceived pedestrian risk and likely offsetting some of the effect of the lane and width differences. Sidewalk separation coding was evenly divided between over-harsh and over-generous outcomes, each occurring on 17% of the applicable length. These offsetting effects resulted in the broadly similar Along SRS produced by the two methods.

Overall, for this outer metropolitan fringe road type, bicyclist SRS differences were primarily driven by recognition of bicycle facility type and continuity, particularly whether cyclists were assessed as operating in the dedicated on-road bicycle lane beside 80 km/h traffic or on the adjoining footpath. Pedestrian differences at the network level were initially dominated by the greater applicable length under AiRAP. Once equivalent lengths were compared, the remaining variance was principally associated with inspected road crossing interpretation, particularly lane count, median type and pedestrian crossing provision.

**Table 5.2: Star rating score comparison –Bicyclist and pedestrian (H006-140)**

| Bicyclist SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Along | 276.6 | 545.5 | **−268.9** |
| Intersection | 37.5 | 39.9 | −2.4 |
| Run-off (passenger-side and driver-side) | 0.2 | 0.4 | −0.2 |
| Along | **314.3** | **585.8** | **−271.5** |
| **Pedestrian SRS** | **Ai** | **Manual** | **Difference (Ai – Manual)** |
| Along | 2,231.0 | 1,251.4 | **979.6** |
| Crossing intersecting road | 273.0 | 153.1 | **119.9** |
| Crossing inspected road | 5,994.0 | 2,287.7 | **3,706.3** |
| **Total** | **8,498.0** | **3,692.2** | **4,805.8** |

Source: iRAP (2025).

**Table 5.3: Star rating score comparison – Pedestrian (H006-140 – comparable length of 3.4 km)**

| Pedestrian SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Along | 1,246.2 | 1,251.4 | −5.2 |
| Crossing intersecting road | 132.0 | 153.1 | **−21.1** |
| Crossing inspected road | 3,123.7 | 2,287.7 | **836.0** |
| **Total** | **4,501.9** | **3,692.2** | **809.7** |

Source: iRAP (2025).

## 5.2 Urban freeway and controlled access highway (H016 Section 150 – Mitchell Fwy)

### 5.2.1 Road type characteristics

The assessed section of Mitchell Freeway, as show in Figure 5.2, is located between the City of South Perth and the City of Stirling in Perth's metropolitan region and represents a typical high-speed, access-controlled urban freeway environment (refer to Section 4.4 for a detailed description of the corridor characteristics).

Pedestrian and bicyclist activity is predominantly shaped by segregated off-road infrastructure rather than direct interaction with the freeway carriageway. At the southern extent near the Swan River crossing, a shared user path adjoins the freeway for approximately the first 200 m, physically separated from traffic, before diverging away from the roadway and continuing as a dedicated shared user path that is grade separated and laterally > 10 m away for the remainder of the assessed length. Pedestrian and cyclist movement is further supported by grade-separated crossing facilities at key locations, enabling corridor access without direct at-grade exposure to high-speed traffic. For the majority of the route, pedestrians and cyclists similarly have no direct interaction with freeway traffic, with vulnerable road user movement occurring within segregated infrastructure rather than conflict-driven roadside environments.

**Figure 5.2: Cross-section of H016 Section 150 – Mitchell Fwy**



Source: Pointerra as provided by Main Roads (2024).

### 5.2.2 Star rating

#### Raw star rating

For this section, raw star rating outcomes for both bicyclists and pedestrians, as shown in Table 5.4, were primarily shaped by different assumptions regarding star rating applicability rather than conventional differences in risk band allocation. Under the traditional manual coding approach, pedestrian facilities were not observed along the majority of the freeway corridor in direct roadside proximity or directly adjoining the road, and accordingly pedestrian facilities and associated pedestrian and bicyclist volumes were generally not coded for most of the route. This resulted in 9.8 km of the 10.0 km corridor being coded as not applicable for both pedestrians and bicyclists by manual coding, with only limited (0.2 km) directly adjoining infrastructure coded where appropriate.

In contrast, AiRAP applied pedestrian and bicyclist volumes across the full corridor and generally interpreted the broader segregated shared user path network (shown in Figure 5.3) as applicable protected infrastructure, resulting in only 0.7 km coded as not applicable for both user groups. Consequently, AiRAP generated star ratings across most of the corridor, with bicyclist ratings distributed across the 1-star to 4-star bands and pedestrian ratings largely concentrated in the 3-star and 5-star bands.

Within the limited approximately 0.2 km of directly comparable length where both AiRAP and manual coded adjoining vulnerable road user infrastructure, results were broadly similar, indicating that where like-for-like applicability assumptions were applied, star rating outcomes were generally aligned. This suggests that the principal differences in results were methodological and driven by differing assumptions regarding applicability, rather than by substantial like-for-like coding variance.

While AiRAP's broader corridor-based approach differs materially from traditional manual coding methodology, which focuses on directly observed roadside pedestrian and cyclist infrastructure, it may better reflect that pedestrians and cyclists are provided a generally safe, continuous and largely grade-separated route for much of the freeway length. As transport planning increasingly moves toward more integrated multimodal networks and greater consideration of active travel connectivity, there may be value in further considering how corridor-wide provision of active mode infrastructure is reflected within future coding methodologies.

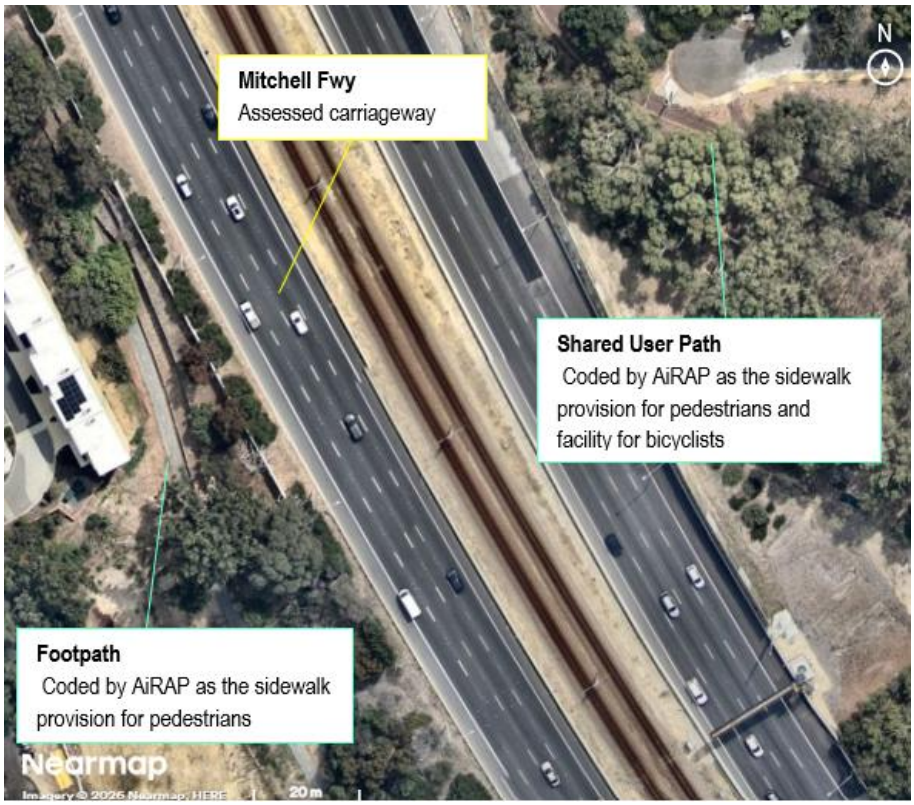
Overall, these results highlight that on highly access-controlled freeway environments with segregated off-road active transport infrastructure, star rating outcomes may be highly sensitive to whether coding is based strictly on direct roadside facility presence or adopts a broader corridor-based interpretation of active travel provision. As these fundamentally different coding approaches were applied, further detailed SRS and attribute-level comparison of coding variations was not undertaken, as differences in outcomes were primarily methodological rather than reflective of like-for-like coding variance.

**Table 5.4: Raw star ratings comparison by road length – Bicyclist and pedestrian (H016-150)**

| Star ratings | Bicyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 1.0 | 0.3 | 0.7 | 7.0% |
| 4 stars | 4.8 | 0.4 | 4.4 | 44.0% |
| 3 stars | 2.0 | 0.0 | 2.0 | 20.0% |
| 2 stars | 0.6 | 0.3 | 0.3 | 3.0% |
| 1 star | 0.9 | 8.3 | −7.4 | −74.0% |
| Not applicable | 0.7 | 0.7 | 0.0 | 0.0% |
| **Total length** | 10.0 | 10.0 | | |
| **Star ratings** | **Pedestrian** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 4.5 | 0.6 | 3.9 | 39.0% |
| 4 stars | 1.2 | 0.1 | 1.1 | 11.0% |
| 3 stars | 0.1 | 0.0 | 0.1 | 1.0% |
| 2 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 1 star | 3.5 | 8.6 | −5.1 | −51.0% |
| Not applicable | 0.7 | 0.7 | 0.0 | 0.0% |
| **Total length** | 10.0 | 10.0 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

**Figure 5.3: AiRAP coding of pedestrian and bicyclist facilities**




Source: Nearmap (2026), Glendalough, Western Australia, aerial map data, nearmap, Sydney, NSW.

## 5.3 Urban highway and main road (H001 Section 134 – Albany Hwy)

### 5.3.1 Road type characteristics

The assessed section of Albany Highway, as shown in Figure 5.4, is located between the Town of Victoria Park and the City of Canning in Perth's metropolitan region and represents a typical urban arterial environment (refer to Section 4.4.1 for a detailed description of the corridor characteristics). The corridor includes continuous pedestrian facilities and passes through established residential and commercial areas that support pedestrian and bicyclist activity. While dedicated on-road bicycle lanes are generally absent, cyclists may travel either within the traffic lane or on adjoining footpaths in accordance with Western Australian road rules, resulting in pedestrian and bicyclist star ratings being applicable across the corridor.

For this road type, pedestrian and bicyclist star rating score (SRS) outcomes are likely to be strongly influenced by facility provision, continuity, crossing opportunities, intersection density and property access frequency. Pedestrian risk is likely to be particularly sensitive to sidewalk continuity, crossing treatment and intersection design given the high pedestrian activity environment. Bicyclist risk is likely to be influenced by the absence of dedicated cycling infrastructure and whether cyclists are coded as operating within traffic lanes or utilising footpaths under Western Australian conditions, as this can materially alter Along and Crossing risk profiles.

**Figure 5.4: Cross-section H001 Section 134 – Albany Hwy**



Source: Pointerra as provided by Main Roads (2024).

### 5.3.2 Star rating

#### Raw star rating

The raw star ratings, as shown in Table 5.5, also showed notable differences between AiRAP and manual coding for both bicyclists and pedestrians.

For bicyclists, AiRAP generally assessed less risk than manual coding, coding 2.2 km of the corridor as 5-star and a further 0.1 km as 4-star, while manual coding produced no bicyclist road length above 3-star. Manual coding instead concentrated most bicyclist road length within the 2-star (2.4 km) and 3-star (1.9 km) bands. This reflects a substantial redistribution of bicyclist road length by AiRAP into lower-risk star rating bands.

For edestrians, the reverse pattern was observed, with AiRAP generally assessing more risk than manual coding. AiRAP coded most of the corridor (3.0 km) within the 1-star band, compared with only 0.8 km under manual coding. Manual coding instead distributed more pedestrian road length across the 2-star to 4-star bands, particularly within the 2-star band (2.3 km). This indicates that AiRAP assessed a substantially greater proportion of pedestrian road length within higher-risk bands.

Overall, both raw and smoothed results showed consistent divergence between methods, but in opposite directions by user group: AiRAP generally assessed less bicyclist risk while assessing greater pedestrian risk than manual coding. This indicates that differences in how cyclist and pedestrian operating environments were interpreted had a substantial influence on vulnerable road user star rating outcomes for this corridor.

#### Smoothed star rating

Compared with the raw star ratings, the smoothed star ratings (provided in Appendix B) retained the overall differences between AiRAP and manual coding for both bicyclists and pedestrians. For bicyclists, the smoothed results showed a more consolidated distribution of star ratings, with AiRAP primarily classifying the route within the 3-star and 4-star bands, while manual coding classified most of the route as 2-star. For pedestrians, the overall pattern remained largely unchanged, with AiRAP continuing to classify most of the route as 1-star, whereas manual coding classified the majority of the route within the 2-star and 3-star bands.

**Table 5.5: Raw star ratings comparison by road length – Bicyclist and pedestrian (H001-134)**

| Star ratings | Bicyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 2.2 | 0.0 | 2.2 | **48.9%** |
| 4 stars | 0.1 | 0.0 | 0.1 | **2.2%** |
| 3 stars | 0.4 | 1.9 | −1.5 | **−33.3%** |
| 2 stars | 1.9 | 2.4 | −0.5 | **−11.1%** |
| 1 star | 0.0 | 0.3 | −0.3 | **−6.7%** |
| Not applicable | 0.0 | 0.0 | 0.0 | **0.0%** |
| **Total length** | 4.5 | 4.5 | | |
| **Star ratings** | **Pedestrian** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.2 | 0.7 | −0.5 | −11.1% |
| 3 stars | 0.3 | 0.8 | −0.5 | −11.1% |
| 2 stars | 1.0 | 2.2 | −1.2 | −26.7% |
| 1 star | 3.0 | 0.8 | 2.2 | 48.9% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | 4.5 | 4.5 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### 5.3.3 Star rating scores and attribute coding

As shown in Table 5.6, AiRAP and manual coding produced materially different SRS, outcomes for both bicyclists and pedestrians on this section, reflecting the opposing star rating trends observed in both the raw and smoothed results.

For bicyclists, manual coding produced a substantially higher total SRS than AiRAP (+932.8), indicating that AiRAP assessed lower overall bicyclist risk along the corridor. This difference was almost entirely attributable to Along SRS (+901.2), while differences in Intersection SRS (+31.1) and Run-off SRS (+0.5) were comparatively minor. The higher Along SRS under manual coding primarily reflected differences in the interpretation of the cyclist operating environment, particularly recognition of shared user paths. Manual coding was over-harsh on approximately 45% of segments by not coding the shared user path, despite Western Australian road rules permitting cyclists to legally ride on footpaths and iRAP guidance allowing these facilities to be coded as shared user paths where applicable. Consequently, cyclists were more frequently assessed as operating within a higher-risk on-road environment.

By comparison, AiRAP was over-generous on approximately 4% of segments by coding shared user paths where they were not present. Differences in intersection detection, intersecting traffic volume assumptions and cyclist facility provision resulted in only minor variation in Intersection SRS, while Run-off SRS demonstrated broad agreement regarding cyclist roadside hazard exposure. Collectively, these differences explain the higher bicyclist star ratings produced by AiRAP in both the raw and smoothed analyses, with interpretation of the cyclist operating environment, particularly recognition of legally accessible shared user path infrastructure, being the dominant contributor to the reduced Along SRS.

For pedestrians, AiRAP produced a substantially higher total SRS than manual coding (+2,054.4), indicating greater overall pedestrian risk. This increase was primarily driven by Crossing Inspected Road SRS

(+1,686.7), followed by Along SRS (+474.1), while Crossing Intersecting Road SRS (−106.4) was lower under AiRAP. The higher Crossing Inspected Road SRS primarily reflected differences in AiRAP's coding of crossing and intersection-related attributes, including duplicated crossings (9%), duplicated or misclassified intersections (35%) and more conservative coding of crossing and intersection quality where manual coding more frequently assessed facilities as adequate or not applicable. Collectively, these differences increased the coded crossing frequency and reduced the perceived quality of pedestrian crossing opportunities.

Differences in Along SRS were primarily associated with pedestrian path detection and interpretation of pedestrian separation. Both methods frequently coded driver-side pedestrian paths as being closer to traffic than observed due to inconsistent recognition of the separation provided by the pencil kerb. However, the more influential difference occurred on the passenger side, where AiRAP failed to detect the pedestrian path on approximately 29% of the route, while manual coding generally identified the facility. Because pedestrian volumes were applied along this corridor, omission of pedestrian infrastructure increased the assessed pedestrian exposure to traffic. AiRAP also coded the carriageway as undivided on approximately 48% of the route, further reducing perceived pedestrian separation. The lower Crossing Intersecting Road SRS under AiRAP reflected omissions or underestimation of intersections and intersecting traffic volumes on approximately 20% of the route, although this had only a minor influence on the overall pedestrian assessment. Collectively, these coding differences explain the lower pedestrian star ratings produced by AiRAP in both the raw and smoothed analyses, with more conservative coding of inspected road crossing frequency and quality, together with less consistent pedestrian path detection and separation, substantially increasing assessed pedestrian risk.

Overall, the SRS results demonstrate that differences in the interpretation of vulnerable road user operating environments, rather than roadside hazard exposure, were the primary drivers of the divergent star rating outcomes on this corridor. For bicyclists, recognition of shared user path infrastructure reduced Along SRS under AiRAP, resulting in higher star ratings. Conversely, for pedestrians, more conservative coding of crossing attributes and less consistent recognition of pedestrian infrastructure increased Crossing Inspected Road and Along SRS, resulting in lower star ratings.

**Table 5.6: Star rating score comparison –Bicyclist and pedestrian (H001-134)**

| Bicyclist SRS | Ai | Manual | Difference (Ai – Manual) |
|---|---|---|---|
| Along | 686.9 | 1,588.1 | **−901.2** |
| Intersection | 197.9 | 229.0 | **−31.1** |
| Run-off (passenger-side and driver-side) | 1.3 | 1.8 | −0.5 |
| **Total** | **886.1** | **1,818.9** | **−932.8** |
| **Pedestrian SRS** | **Ai** | **Manual** | **Difference (Ai – Manual)** |
| Along | 486.3 | 12.2 | **474.1** |
| Crossing intersecting road | 146.8 | 253.2 | **−106.4** |
| Crossing inspected road | 4,368.8 | 2,682.1 | **1,686.7** |
| **Total** | **5,001.9** | **2,947.5** | **2,054.4** |

Source: iRAP (2025) (reproduced by NTRO 2026).

# 6 Impact of Star Rating Differences

This review has examined in detail the key differences in star ratings, risk scores, and coding outcomes between manual and AiRAP methods, including the specific coding variations contributing to those differences. While coding discrepancies between the two approaches have been established, this section assesses whether those differences materially affect the overall smoothed star ratings assigned to each road segment. Specifically, it examines whether variations in coding alter the proportion of roads achieving a 3-star or better rating for vehicle occupants and motorcyclists, and, where pedestrian and bicyclist facilities are present, whether similar impacts occur for those road users. This is an important consideration because 3-star or better is widely used as a strategic road safety benchmark under the International Road Assessment Programme (iRAP), AusRAP, and many Safe System-aligned road safety frameworks. Common network performance targets often focus on increasing the proportion of travel occurring on roads rated 3-star or better, which can influence infrastructure investment priorities and upgrade programs.

The analysis presented in this section compares the smoothed star rating assigned by each method for the same road segment. Unlike the network-level comparisons presented previously, which compare the total length of road within each star rating band, this assessment examines agreement between AiRAP and manual coding on a **segment-by-segment basis**. This approach identifies whether the same section of road receives the same smoothed star rating under both methods and quantifies the extent to which coding differences result in different star rating classifications for individual road segments.

## 6.1 Rural single carriageway open (H006 Section 9 – Great Northern Hwy)

For the assessed section of the Great Northern Highway (H006-9), although coding differences between manual and AiRAP exist, they were not significant enough to affect the final smoothed star rating outcome, with both methods producing identical 3-star classifications across 100% of the corridor for both vehicle occupants and motorcyclists, as shown in Table 6.1. As a result, there would be no difference in 3-star or better decision-making outcomes between the two methods for this road section. Given this road type represents 77.1% of the Western Australian state road network by length, this suggests that for similar rural single carriageway open road environments, observed coding differences may not materially influence strategic investment or policy decisions where 3-star or better thresholds are applied.

**Table 6.1: Smoothed star rating difference (H006 Section 9) – Manual and AiRAP**

| Star ratings – Vehicle occupants | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | AiRAP coding | | | | | | Total (Manual) |
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | 10.0 | | | | **10.0** |
| | 2 stars | | | | | | | |
| | 1 star | | | | | | | |
| | N/A | | | | | | | |
| **Total (Ai)** | | | | **10.0** | | | | **10.0** |

| Star ratings – Motorcyclist | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | AiRAP Coding | | | | | | Total (Manual) |
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | 10.0 | | | | **10.0** |
| | 2 stars | | | | | | | |
| | 1 star | | | | | | | |
| | N/A | | | | | | | |
| **Total (Ai)** | | | | **10.0** | | | | |

Note: Lengths above the diagonal represent locations where AiRAP coding resulted in lower star ratings (higher risk) compared to Manual coding assessment. Lengths below the diagonal represent locations where Manual coding resulted in lower star ratings (higher risk) compared to AiRAP coding assessment.
Source: iRAP (2025) (reproduced by NTRO 2026).

## 6.2 Fringe (outer metro and rural) highways and main roads (H006 Section 140 – Great Northern Hwy)

For the assessed section of Great Northern Highway (H006-140), the most notable change in smoothed star ratings was for vehicle occupants, where AiRAP increased 3-star or better coverage by 12%, from 3.4 km by manual coding to 4.6 km by AiRAP, as shown in Table 6.2. This increase resulted from road segments being reclassified between the 2-star and 3-star bands by the two methods. In contrast, the strongest alignment was observed for motorcyclists, where both methods classified almost the entire route as 2-star, with 8.9 km receiving the same smoothed star rating. A similar improvement in 3-star or better road length was observed for bicyclists, where AiRAP increased the applicable 3-star road length from 0 km to 1.5 km. However, because 8.5 km of the corridor was classified as not applicable for bicyclists, the broader significance of this change is limited. Overall, as this road type represents only 0.9% of the Western Australian state road network by length and 2.9% of total VKT, the broader network-level implications of these differences are likely to be limited.

**Table 6.2: Smoothed star rating difference (H006 Section 140) – Manual and AiRAP**

**Star ratings – Vehicle occupants**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | 0.5 | 2.9 | | | **3.4** |
| | 2 stars | | | 4.1 | 2.5 | | | **6.6** |
| | 1 star | | | | | | | |
| | N/A | | | | | | | |
| **Total (km) (Ai)** | | | | **4.6** | **5.4** | | | **10.0** |

**Star ratings – Motorcyclist**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | | 0.6 | | | **0.6** |
| | 2 stars | | | | 8.9 | | | **8.9** |
| | 1 star | | | | 0.5 | | | **0.5** |
| | N/A | | | | | | | |
| **Total (km) (Ai)** | | | | | **10.0** | | | **10.0** |

**Star ratings – Bicyclist**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | | | | | |
| | 2 stars | | | **1.5** | | | | **1.5** |
| | 1 star | | | | | | | |
| | N/A | | | | | | 8.5 | **8.5** |
| **Total (km) (Ai)** | | | | **1.5** | | | **8.5** | **10.0** |

**Star ratings – Pedestrian**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | | | | | |
| | 2 stars | | | | | 0.2 | | **0.2** |
| | 1 star | | | | | 3.1 | | **3.1** |
| | N/A | | | | | 2.3 | 4.4 | **6.7** |
| **Total (km) (Ai)** | | | | | | **5.6** | **4.4** | **10.0** |

Note: Lengths above the diagonal represent locations where AiRAP coding resulted in lower star ratings (higher risk) compared to Manual coding assessment. Lengths below the diagonal represent locations where Manual coding resulted in lower star ratings (higher risk) compared to AiRAP coding assessment.

Source: iRAP (2025) (reproduced by NTRO 2026).

## 6.3 Urban highway and main road (H001 Section 134 – Albany Hwy)

For the assessed 4.5 km section of Albany Highway (H001-134), coding differences between manual and AiRAP resulted in several notable shifts in smoothed star rating outcomes across road users, as shown in Table 6.3. The strongest alignment was observed for vehicle occupants, where 2.7 km of the route received the same 3-star rating under both methods, despite AiRAP reducing the overall 3-star or better length by 8% (from 3.8 km to 3.4 km). In contrast, the greatest changes were observed for pedestrians and motorcyclists. For pedestrians, AiRAP reduced the 3-star or better length by 36%, with all sections rated 3-star by manual coding reclassified as either 2-star or 1-star. For motorcyclists, AiRAP reduced the 3-star or better length by 54%, primarily through reclassification of 3-star road segments to 2-star. Conversely, AiRAP increased the bicyclist 3-star or better length by 16%, with a number of sections reclassified from 2-star under manual coding to 3-star or 4-star. Overall, as this road type represents 5.7% of the Western Australian state road network by length and 30.6% of total VKT, these differences may have broader network implications, particularly on high-volume urban arterial corridors where a relatively small proportion of the network carries a substantial share of travel.

**Table 6.3: Smoothed star rating difference (H001 Section 134) – Manual and AiRAP**

**Star ratings – Vehicle occupant**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | 2.7 | 1.1 | | | **3.8** |
| | 2 stars | | | 0.7 | | | | **0.7** |
| | 1 star | | | 0.1 | | | | **0.1** |
| | N/A | | | | | | | **0.0** |
| **Total (km) (Ai)** | | | | **3.4** | **1.1** | | | **4.5** |

**Star ratings – Motorcyclist**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | 1.1 | 2.4 | | | **3.5** |
| | 2 stars | | | | 1.0 | | | **1.0** |
| | 1 star | | | | 0.1 | | | **0.1** |
| | N/A | | | | | | | |
| **Total (km) (Ai)** | | | | **1.1** | **3.4** | | | **4.5** |

**Star ratings – Bicyclist**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | 0.7 | 0.3 | | | **1.0** |
| | 2 stars | | 1.0 | 1.9 | 0.6 | | | **3.4** |
| | 1 star | | 0.1 | | | | | **0.1** |
| | N/A | | | | | | | |
| **Total (km) (Ai)** | | | **1.1** | **2.6** | **0.9** | | | **4.5** |

**Star ratings – Pedestrian**

| | | AiRAP coding | | | | | | Total (km) (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | | 0.8 | 0.8 | | **1.6** |
| | 2 stars | | | | 0.6 | 1.5 | | **2.0** |
| | 1 star | | | | | 0.9 | | **0.9** |
| | N/A | | | | | | | |
| **Total (km) (Ai)** | | | | | **1.4** | **3.1** | | **4.5** |

Note: Lengths above the diagonal represent locations where AiRAP coding resulted in lower star ratings (higher risk) compared to Manual coding assessment. Lengths below the diagonal represent locations where Manual coding resulted in lower star ratings (higher risk) compared to AiRAP coding assessment.

Source: iRAP (2025) (reproduced by NTRO 2026).

## 6.4 Urban freeway and controlled access highway (H016 Section 150 – Mitchell Fwy)

For the assessed 10 km section of Mitchell Freeway (H016-150), coding differences between manual and AiRAP resulted in relatively minor changes in smoothed star rating outcomes, as shown in Table 6.4. For vehicle occupants, AiRAP maintained 3-star or better coverage across 9.3 km (93%) of the corridor compared with 10.0 km (100%) by manual coding; however, the 0.7 km difference reflects a section classified as not applicable by AiRAP rather than a substantive downgrade in star rating. Excluding this non-applicable section, the results between manual and AiRAP for coded vehicle occupant star ratings are aligned. For motorcyclists, AiRAP increased 3-star or better coverage by 1.0 km, from 0 km by manual coding to 1.0 km. These results indicate that while coding differences did produce some reclassification, the magnitude of change was minor and did not materially alter the broader safety profile of the corridor. Given this urban freeway and controlled access highway road type represents 2.8% of the Western Australian state road network by length but 34.6% of total VKT, the findings suggest strong overall consistency between manual and AiRAP outcomes for this high-volume road environment.

**Table 6.4: Smoothed star rating difference (H016 Section 150) – Manual and AiRAP**

**Star ratings – Vehicle occupants**

| | | AiRAP coding | | | | | | Total (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | 1.8 | 1.2 | 0.3 | | 0.7 | **4.0** |
| | 3 stars | | 2.0 | 1.9 | 2.1 | | | **6.0** |
| | 2 stars | | | | | | | |
| | 1 star | | | | | | | |
| | N/A | | | | | | | |
| **Total (Ai)** | | | **3.8** | **3.1** | **2.4** | | **0.7** | **10.0** |

**Star ratings – Motorcyclist**

| | | AiRAP coding | | | | | | Total (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | | | | | |
| | 2 stars | | | 1.0 | | 5.3 | 0.7 | **7.0** |
| | 1 star | | | | | 3.0 | | **3.0** |
| | N/A | | | | | | | |
| **Total (Ai)** | | | | **1.0** | | **8.3** | **0.7** | 10.0 |

Note: Lengths above the diagonal represent locations where AiRAP coding resulted in lower star ratings (higher risk) compared to Manual coding assessment. Lengths below the diagonal represent locations where Manual coding resulted in lower star ratings (higher risk) compared to AiRAP coding assessment.

Source: iRAP (2025) (reproduced by NTRO 2026).

## 6.5 Rural single carriageway (M043 Section 123 – Caves Rd)

For the assessed 10.1 km section of Caves Road (M043-123), coding differences between manual and AiRAP resulted in no change to 3-star or better smoothed star rating outcomes for either vehicle occupants or motorcyclists, as shown in Table 6.5. For vehicle occupants, both methods classified 100% of the corridor below the 3-star threshold. Similarly, for motorcyclists, both manual and AiRAP produced no 3-star or better sections, with the full corridor also remaining below the threshold. This indicates that despite underlying coding differences, neither method changed the proportion or length of road achieving 3-star or better performance, resulting in no difference to section-level 3-star or better outcomes. Given this rural single carriageway road type represents 8.3% of the Western Australian state road network by length and 2.2% of total VKT, these findings suggest that for this road environment, coding differences between manual and AiRAP were not significant enough to influence 3-star or better classification outcomes.

**Table 6.5: Smoothed star rating difference (M043 Section 123) – Manual and AiRAP**

**Star ratings – Vehicle occupants**

| | | AiRAP coding | | | | | | Total (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | | | | | |
| | 2 stars | | | | 7.1 | 3.0 | | **10.1** |
| | 1 star | | | | | | | |
| | N/A | | | | | | | |
| **Total (Ai)** | | | | | **7.1** | **3.0** | | **10.1** |

**Star ratings – Motorcyclist**

| | | AiRAP coding | | | | | | Total (Manual) |
|---|---|---|---|---|---|---|---|---|
| | | 5 stars | 4 stars | 3 stars | 2 stars | 1 star | N/A | |
| Manual coding | 5 stars | | | | | | | |
| | 4 stars | | | | | | | |
| | 3 stars | | | | | | | |
| | 2 stars | | | | 3.0 | 7.1 | | **10.1** |
| | 1 star | | | | | | | |
| | N/A | | | | | | | |
| **Total (Ai)** | | | | | **3.0** | **7.1** | | **10.1** |

Note: Lengths above the diagonal represent locations where AiRAP coding resulted in lower star ratings (higher risk) compared to Manual coding assessment. Lengths below the diagonal represent locations where Manual coding resulted in lower star ratings (higher risk) compared to AiRAP coding assessment.

Source: iRAP (2025) (reproduced by NTRO 2026).

# 7 Discussion of Findings

The detailed comparison of AiRAP and manual coding across the assessed Western Australian road sections demonstrates that the differences between the two methods were driven by over-harsh and over-generous coding across specific high influence attributes, with these differences varying by road type and road user group.

On the rural open road environment of Great Northern Highway (H006-9), which represents 77.1% of the WA state road network by length, AiRAP generally produced more favourable raw vehicle occupant outcomes than manual coding, largely because it was comparatively over-generous in roadside severity coding. For this road section, AiRAP was over-generous by approximately 54% for roadside object severity and 31% for roadside hazard distance, failing to detect hazards or coding lower-severity roadside features, thereby reducing Run-off Loss of Control (LOC) risk. By comparison, manual coding was comparatively over-harsh, with roadside object severity differing by 51% and roadside hazard distance by 19%, often due to conservative tree classification or coding hazards closer to the road. Despite these differences, both methods still produced identical 3-star smoothed outcomes, indicating that while roadside severity was materially different at the attribute level, it was not significant enough to alter strategic network-level outcomes on this road type.

On the fringe highway environment of Great Northern Highway (H006-140), which represents 0.9% of the WA state road network length, coding differences were more mixed and demonstrate how both methods can introduce different forms of bias. AiRAP was notably over-harsh for intersection and head-on risk, overstating median severity on approximately 41% of the route by coding wide centreline (0.3 – 1 m) where central hatching (> 1 m) existed, over-harshly coding lane width on 22% of road length and miscoding 36% of the corridor as having additional lanes (2+1) where standard 1:1 carriageway existed. Some of these differences were attributable to AiRAP's intersection masking (Point of Turning) retaining broader segment characteristics consistently through intersections. AiRAP also overestimated paved shoulder continuity on 43% of driver-side and 33% of passenger-side road length, creating more generous roadside hazard distances on 29% and 16% of the route respectively, thereby reducing Run-off LOC risk. Manual coding, by contrast, was more often over-harsh on roadside hazard distance, underestimating hazard offsets on 12% of driver-side and 21% of passenger-side segments. These offsetting differences explain why AiRAP produced slightly better vehicle occupant smoothed outcomes (+12% more 3-star length), while total motorcyclist SRS remained broadly equivalent despite substantial crash-type variance.

The urban highway environment of the Albany Highway (H001-134), which represents 5.7% of network length but 30.6% of VKT, demonstrated some of the most practically significant coding differences due to its complex urban arterial environment. Here, AiRAP generally overstated conflict-related risk while manual coding was often comparatively more conservative for roadside hazards. AiRAP overestimated intersection risk on approximately 35% of the corridor through duplicated intersections, driveway misclassification and coding merge treatments as 3-leg intersections. It also miscoded median type on approximately 57% of road length by recording pencil kerbs (back-to-back kerbs) dividing the two carriageways as centrelines, materially increasing Head-on LOC and pedestrian crossing risk. For pedestrians, AiRAP's harsher lane count and median coding at crossings was particularly influential, with number of lanes over-harsh on 56% of segments and median type over-harsh on 59% of crossings, contributing to a +1,686.7 increase in Crossing Inspected Road SRS. Conversely, for bicyclists, manual coding was over-harsh on approximately 45% of segments by failing to recognise legally usable shared paths, placing cyclists into a higher-risk on-road environment and producing a substantially higher bicyclist Along SRS (+901.2). These findings were reflected in the 3-star or better comparison, where AiRAP reduced the proportion of the route achieving the 3-star threshold for vehicle occupants, motorcyclists and pedestrians, while increasing it for bicyclists, demonstrating that differences in infrastructure interpretation can materially influence star rating outcomes on high-volume urban arterial corridors.

The urban freeway environment of the Mitchell Freeway (H016-150), which carries 34.6% of WA's VKT, revealed how business rules and area type assumptions can disproportionately influence AiRAP outcomes. AiRAP coded 93% of the freeway as urban rather than rural, despite iRAP methodology typically treating access-controlled freeways as rural. This elevates external flow assumptions and intersection-related risk. AiRAP also overestimated merge ramp traffic volumes, duplicated some intersections and coded filter merges, producing a +134.5 vehicle occupant Intersection SRS increase and +179.4 motorcyclist Intersection SRS increase relative to manual coding. In addition, AiRAP under-reported shoulder width on 87% of passenger-side and 50% of driver-side segments, further increasing Run-off LOC severity. Despite these substantial attribute-level differences, final smoothed 3-star or better outcomes for vehicle occupants remained broadly aligned, demonstrating that even large SRS differences do not always materially alter strategic star rating thresholds.

The constrained rural forest corridor on Caves Road (M043-123), which carries 2.2% of WA's VKT**,** showed the clearest example of consistently over-harsh AiRAP coding. AiRAP coded poor delineation across 100% of the route where delineation was considered adequate, over-harsh lane width on 22% of segments, over-harsh curve quality on 26%, and failed to detect shoulder rumble strips on 20% of the route. These cumulative differences substantially increased Head-on LOC and Run-off LOC, contributing to a +318.3 vehicle occupant SRS increase and +519.6 motorcyclist SRS increase. However, because both methods still classified the route entirely below 3-star at the smoothed level, these significant coding differences did not alter broader strategic investment categorisation.

Across vulnerable road user assessments, volume application and facility applicability were often more influential than attribute coding accuracy. On H006-140, AiRAP's pedestrian ratings were extended across an additional 2.2 km of corridor due to broader business rule application of pedestrian volumes, while bicyclist risk was understated because AiRAP failed to consistently recognise dedicated on-road bicycle lanes, instead coding shared paths or no facility on approximately 100% of the relevant corridor (60% shared path bias; 40% no facility). This significantly reduced bicyclist Along SRS by 268.9 points. These findings indicate that for pedestrians and bicyclists, methodological assumptions around where users are present and volumes apply may have a greater effect on final outcomes than the coding of infrastructure itself.

It was also identified that several coding discrepancies were not solely attributable to AiRAP limitations but were also influenced by Main Roads business rules and source dataset interpretations that deviated from iRAP methodology to better align with jurisdictional datasets and broader network management practices. For example, on Mitchell Freeway (H016-150), area type was more heavily influenced by surrounding urban land use than functional road class, resulting in large sections of this access-controlled freeway being coded as urban rather than rural. On urban and fringe highway environments such as Albany Highway (H001-134) and Great Northern Highway (H006-140), intersection-related discrepancies were often influenced by how Main Roads datasets defined and supplied intersections, with some locations functioning more like property accesses, merge lanes or minor accesses than true intersections for AusRAP purposes despite being defined as an intersection for the purpose of asset management by Main Roads.

Overall, the assessed roads demonstrate that the most notable AiRAP coding approach inaccuracies were concentrated in area type, intersection frequency and type, lane count, roadside hazard severity, shoulder continuity and vulnerable road user facility recognition. AiRAP was more commonly over-harsh in interpreting intersection complexity, lane count, curvature, delineation and other quality-related attributes, largely because early coding logic was highly prescriptive and required all conditions to be met before assigning lower-risk categories. This frequently resulted in harsher coding where features such as delineation, channelisation, rumble strips or curve quality were present but did not fully meet the prescribed thresholds, inflating Head-on, Run-off, Along, and Intersection SRS. Conversely, AiRAP was more often over-generous in roadside hazard distance, shoulder continuity, and some vulnerable road user facility assumptions, particularly where LiDAR-derived distances, broader business rules or systematic application of facility carry-through logic (i.e. intersection masking) resulted in more generous coding than manual assessment.

Intersection masking (Point of Turning) and carry through logic were a particularly significant contributor to mixed outcomes. By maintaining dominant segment attributes such as median type, lane width, shoulder width, and delineation through intersections, AiRAP often improved consistency and reduced artificial short segment fluctuations common in manual coding. However, this could also overstate continuity where shoulders narrowed, roadside hazards were closer or geometry genuinely changed through intersections, sometimes understating localised risk. Manual coding, by contrast, more commonly captured these localised variations, but often produced harsher outcomes through conservative roadside hazard coding andinconsistent carry-through of infrastructure through intersections.

AiRAP also tended to overstate lane count where turn lanes, merge lanes or centreline datasets were interpreted, while manual coding more often overstated roadside hazard severity through visual measurement limitations or conservative object selection. The practical significance of these inaccuracies was greatest on urban and vulnerable road user corridors, where repeated discrepancies in intersections, facilities and applicability assumptions could materially alter star ratings. By contrast, on many rural and freeway environments, even substantial attribute-level variance often translated to relatively minor differences in final 3-star or better strategic outcomes, highlighting that while coding discrepancies were technically important, their network-level implications were often most significant in complex road environments characterised by high access density, frequent intersections and mixed road user activity.

# 8 Outcomes of the Review

The project and subsequent review identified several key reform areas expected to directly improve future AusRAP coding accuracy, consistency and scalability. These improvements span updates to coding guidance within the iRAP coding manual, targeted refinements to AiRAP processes, improved governance and business rule alignment by Main Roads and broader quality assurance and continuous improvement mechanisms to support more accurate and consistent outcomes across both manual and AiRAP coding approaches.

## 8.1 Coding manual reform (iRAP)

A core outcome of the project was the recognition that many coding discrepancies were driven by ambiguity, inconsistent interpretation or overly rigid application of the iRAP coding manual. To address this a series of workshops involving iRAP, Austroads, Main Roads WA and Anditi were held to work through these discrepancies and ambiguities. As a result, reform of the iRAP manual was identified as a key improvement area to reduce methodological inconsistency and ensure coding more accurately reflects intended road safety risk rather than being disproportionately influenced by localised variations. These changes have been incorporated into the *iRAP Coding Manual for Star Ratings v3.10 (2026)* and are detailed below.

- A **95% segment rule** has been introduced for linear road attributes, requiring the dominant attribute to be maintained where it is present across at least 95% of a segment. This applies to continuous features including speed limit, median type, shoulder rumble strips, paved shoulders, and delineation, reducing unnecessary coding variation caused by short transitional sections (p. 23).
- **Intersection masking that was developed by Anditi during the project** has been formalised through **Point of Turning (POT) Zones**, providing clear guidance on carrying continuous attributes through intersections where appropriate. This includes attributes such as median type, paved shoulders, rumble strips, lane width, delineation, curvature and curve quality to improve coding consistency (p. 22).
- **Curvature coding** guidance has been clarified, including where curvature should be measured and the section of road over which it should be assessed, improving consistency between manual and AiRAP coding (pp. 51–52 and 124).
- **Curve quality** guidance has been expanded, providing clearer definitions and automated detection guidance to improve consistency in assessing curve condition (pp. 53 and 125).
- **Grade coding** has been clarified, requiring the steepest grade over any 10 m length within the full 100 m segment to be recorded to better represent the highest infrastructure risk (pp. 54 and 125).
- **Intersection channelisation** coding guidance has been revised so that any channelisation present at an intersection including line marking is recorded, reducing underreporting of intersection safety (pp. 79 and 128).
- **Intersecting road volume and intersection quality** guidance has been expanded, providing clearer criteria for assigning traffic exposure and intersection quality, supported by automated coding guidance (pp. 80–81 and 128).
- **Lane width** guidance has been expanded, including measurement principles, application of the 95% rule and automated detection guidance (10% measurement tolerance rule) to improve consistency between manual and AiRAP coding (pp. 23, 40 and 124).
- **Sidewalk** guidance has been expanded, including clearer definitions of sidewalk separation, offset and quality, together with automated detection guidance to improve consistency between manual and AiRAP coding (pp. 95–97 and 129).
- **Bicycle facility** guidance has been expanded to require on-road facilities to have a cycleway marking at least every 100 m, recognising the use of supplementary datasets where facilities are not readily visible in road imagery and providing automated detection guidance to improve consistency between manual and AiRAP coding (pp. 100–101 and 130).
- **Vehicle parking** guidance has been clarified, providing more comprehensive direction on coding on-street parking, bus bays and time-dependent parking conditions, together with automated detection guidance (pp. 60, 100–101 and 126).
- **Roadside hazard** guidance has been expanded to clarify identification of the highest-risk roadside object, measurement of roadside hazard distance being from the edge of travel of through traffic with all

roadside hazards coded through intersection environments. Additional AiRAP detection guidance has also been provided, including recommended data sources, detection limitations and validation requirements to improve consistency between manual and AiRAP coding (pp. 64–71 and 126).
- The manual introduces expanded guidance for **automated (AiRAP) coding**, including attribute detection guidance, validation requirements and recommended data sources to improve consistency between manual and automated assessments (pp. 120–131).

## 8.2 AiRAP refinement (Anditi)

The project and subsequent review identified several recurring areas of further improvement in AiRAP, particularly around attribute definitions and consistency of application of these definitions, road geometry interpretation, object recognition and dataset logic. In response, a series of refinements were identified by Anditi to improve AiRAP's technical precision, reduce attribute interpretation ambiguity, reduce systematic over-harsh or over-generous patterns and strengthen scalability for large network assessments. These changes include:

- Refinement of the iRAP Coding Manual with the majority of the suggested changes being incorporated into version 3.10 that was released in May 2026.
- Changes to how curvature and gradient are calculated in line with version 3.10.
- A **new aerial imagery road characterisation** process to be implemented to provide broader road corridor context for the application of automated algorithms and to improve coding accuracy for number of lanes, merge lane detection and differentiation between turn lanes and true additional through lanes.
- Greater use of aerial LiDAR where available.
- **Additional quality assurance checks** are to be introduced to improve detection of slip road versus assessed road mismatches, as well as sudden or inconsistent speed limit changes between consecutive segments.
- **Roadworks coding logic** will be refined so that non-roadworks speed environments are applied, reducing temporary construction conditions distorting long-term road risk coding.
- **Intersection dataset quality assurance** is to be improved to check and validate intersection locations provided by transport authorities and any overlap with property accesses, intersection definitions and locations to be reviewed and agreed prior to coding. This includes definitions of new intersection types such as staggered intersections.
- **Side-road volume estimation** processes are to be improved to better reflect actual intersecting road exposure, reducing overestimation or underestimation of side-road risk.

Anditi has worked closely with iRAP in the development of AiRAP and continues to collaborate with iRAP to further refine the methodology and address identified areas for improvement.

## 8.3 Business rule and governance alignment (Main Roads)

Another finding was that some discrepancies were caused not by coding error, but by jurisdiction-specific business rules, applied by Main Roads, that deviated from the iRAP methodology. The following business rule and governance amendments were recommended to improve consistency in the application of coding practices, strengthen comparability between assessments and support more robust AusRAP outcomes.

- **Area type** coding for access-controlled highways revised to 'Rural' to align with current iRAP methodology, reducing overstated urban risk assumptions on functionally rural high-speed corridors.
- **Intersection dataset governance** to be strengthened through pre-project agreement of intersection definitions prior to coding, ensuring greater consistency between application of Main Roads datasets, AiRAP processes and iRAP coding intent.
- Main Roads has committed to a further review of **vulnerable road user flows** and the treatment of principal shared path corridors in relation to adjacent road corridors, to inform a more consistent approach to pedestrian and bicyclist assessments.
- **Upgrade cost** reviewed to improve consistency between Ai and manual coding outputs for investment planning and SRIP development, even where these refinements do not directly affect star rating scores.

# References

iRAP 2013, *Star Rating bands*, iRAP methodology fact sheet #7*:* International Road Assessment Programme (iRAP), London, UK.

iRAP 2013, *Smoothed star ratings*, iRAP methodology fact sheet # 8, International Road Assessment Programme (iRAP), London, UK.

iRAP 2016*, iRAP Pre-processor: user guide,* v3.10, International Road Assessment Programme (iRAP), Basingstoke, UK.

iRAP 2024, *iRAP Coding manual: drive on left edition*, version 5.5., International Road Assessment Programme (iRAP), London, UK.

World Health Organisation 2018, *Global Status Report on Road Safety*, Geneva, Switzerland, accessed 31 October 2025, < https://cdn.who.int/media/docs/default-source/searo/india/health-topic-pdf/global-status-report-on-road-safety-2018.pdf?sfvrsn=1de25920_2>

iRAP 2026, *iRAP coding manual for star ratings: version 3.10*, iRAP, London, UK.

# Appendix A Network Level Raw Star Rating Results

**Table A.1: Raw star ratings comparison by road length – Network level**

| Star ratings | Vehicle occupant | | | | |
|---|---|---|---|---|---|
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 0.8 | 1.8% | 1.0 | 2.2% | −0.4% |
| 4 stars | 14.2 | 31.8% | 10.3 | 23.1% | 8.7% |
| 3 stars | 16.1 | 36.1% | 21.0 | 47.1% | −11.0% |
| 2 stars | 8.2 | 18.4% | 10.0 | 22.4% | −4.0% |
| 1 star | 4.6 | 10.3% | 2.3 | 5.2% | 5.1% |
| Not applicable | 0.7 | 1.6% | 0.0 | 0.0% | 1.6% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |

| Star ratings | Motorcyclist | | | | |
|---|---|---|---|---|---|
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 0.0 | 0.0% | 0.0 | 0.0% | 0.0% |
| 4 stars | 0.2 | 0.4% | 0.0 | 0.0% | 0.4% |
| 3 stars | 16.9 | 37.9% | 16.1 | 36.1% | 1.8% |
| 2 stars | 16.9 | 37.9% | 20.9 | 46.9% | −9.0% |
| 1 star | 9.9 | 22.2% | 7.6 | 17.0% | 5.2% |
| Not applicable | 0.7 | 1.6% | 0.0 | 0.0% | 1.6% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |

| Star ratings | Pedestrian | | | | |
|---|---|---|---|---|---|
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 4.5 | 10.0% | 0.2 | 0.4% | 9.6% |
| 4 stars | 1.4 | 3.0% | 0.7 | 1.6% | 1.4% |
| 3 stars | 0.4 | 0.9% | 0.8 | 1.8% | −0.9% |
| 2 stars | 2.1 | 4.6% | 2.4 | 5.4% | −0.8% |
| 1 star | 15.8 | 35.0% | 4.0 | 9.0% | 26.5% |
| Not applicable | 20.5 | 46.0% | 36.5 | 81.5% | −35.8% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |

| Star ratings | Bicyclist | | | | |
|---|---|---|---|---|---|
| | Ai coding Length (km) | Ai coding Per cent | Manual coding Length (km) | Manual coding Per cent | Difference (%) |
| 5 stars | 4.0 | 8.9% | 0.2 | 0.4% | 8.5% |
| 4 stars | 5.0 | 11.2% | 0.0 | 0.0% | 11.0% |
| 3 stars | 2.4 | 5.4% | 1.9 | 4.3% | 1.1% |
| 2 stars | 3.1 | 7.0% | 3.8 | 8.5% | −1.5% |
| 1 star | 2.0 | 4.5% | 0.5 | 0.7% | 3.8% |
| Not applicable | 28.2 | 63.2% | 38.2 | 86.1% | −22.5% |
| **Total length** | **44.6** | **100.0%** | **44.6** | **100.0%** | |

Source: iRAP (2025) (reproduced by NTRO 2026).

# Appendix B Road Specific Smoothed Star Rating Results

### Rural single carriageway open (H006 Section 9 – Great Northern Hwy)

**Table B.1: Smoothed star ratings comparison by road length – Vehicle occupant and motorcyclist (H006-9)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | **8.6** | 3.5 | **5.1** | **51.0%** |
| 3 stars | 0.7 | **6.0** | **−5.3** | **−53.0%** |
| 2 stars | 0.3 | 0.5 | −0.2 | −2.0% |
| 1 star | 0.4 | 0.0 | 0.4 | 4.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |
| **Star ratings** | **Motorcyclist** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | **9.0** | **8.1** | 0.9 | 9% |
| 2 stars | 0.4 | 1.9 | −1.5 | −15.0% |
| 1 star | 0.6 | 0.0 | 0.6 | 6.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

## Fringe (outer metro and rural) highway and main roads (H006 Section 140 – Great Northern Hwy)

**Table B.2: Smoothed star ratings comparison by road length – Vehicle occupant and motorcyclist (H006-140)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 4.6 | 3.4 | 1.2 | 12.0% |
| 2 stars | 5.4 | 6.6 | −1.2 | −12.0% |
| 1 star | 0.0 | 0.0 | 0.0 | 0.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |

| Star ratings | Motorcyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 0.0 | 0.6 | −0.6 | −6.0% |
| 2 stars | 10.0 | 8.9 | 1.1 | 11.0% |
| 1 star | 0.0 | 0.5 | −0.5 | −5.0% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **10.0** | **10.0** | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

## Urban highway and main roads (H001 Section 134 – Albany Hwy)

**Table B.3: Smoothed star ratings comparison by road length – Vehicle occupant and motorcyclist (H001-134)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 3.4 | 3.7 | −0.3 | −6.7% |
| 2 stars | 1.1 | 0.7 | 0.4 | 8.9% |
| 1 star | 0.0 | 0.1 | −0.1 | −2.2% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **4.5** | **4.5** | | |

| Star ratings | Motorcyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 1.1 | 3.4 | −2.3 | −51.1% |
| 2 stars | 3.4 | 1.0 | 2.4 | 53.3% |
| 1 star | 0.0 | 0.1 | −0.1 | −2.2% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | **4.5** | **4.5** | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

## Urban freeway and controlled access highway (H016 Section 150 – Mitchell Fwy)

**Table B.4: Smoothed star ratings comparison by road length – Vehicle occupant and motorcyclist (H016-150)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 3.8 | 4.0 | −0.2 | −2.0% |
| 3 stars | 3.1 | 6.0 | −2.9 | −29.0% |
| 2 stars | 2.4 | 0.0 | 2.4 | 24.0% |
| 1 star | 0.0 | 0.0 | 0.0 | 0.0% |
| Not applicable | 0.7 | 0.0 | 0.7 | 7.0% |
| **Total length** | 10.0 | 10.0 | | |
| **Star ratings** | **Motorcyclist** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 1.0 | 0.0 | 1.0 | 10.0% |
| 2 stars | 0.0 | 7.0 | −7.0 | −70.0% |
| 1 star | 8.3 | 3.0 | 5.3 | 53.0% |
| Not applicable | 0.7 | 0.0 | 0.7 | 7.0% |
| **Total length** | 10.0 | 10.0 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

## Rural single carriageway (M043 Section 123 – Caves Rd)

**Table B.5: Smoothed star ratings comparison by road length – Vehicle occupant and motorcyclist (M043-123)**

| Star ratings | Vehicle occupant | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 2 stars | 7.1 | 10.1 | −3.0 | −29.7% |
| 1 star | 3.0 | 0.0 | 3.0 | 29.7% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | 10.1 | 10.1 | | |
| **Star ratings** | **Motorcyclist** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 2 stars | 3.0 | 10.1 | −7.1 | −70.3% |
| 1 star | 7.1 | 0.0 | 7.1 | 70.3% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | 10.1 | 10.1 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### Fringe (outer metro and rural) highway and main roads (H006 Section 140 – Great Northern Hwy)

**Table B.6: Smoothed star ratings comparison by road length – Bicyclist and pedestrian (H006-140)**

| Star ratings | Bicyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 1.5 | 0.0 | 1.5 | 15.0% |
| 2 stars | 0.0 | 1.5 | −1.5 | −15.0% |
| 1 star | 0.0 | 0.0 | 0.0 | 0.0% |
| Not applicable | 8.5 | 8.5 | 0.0 | 0.0% |
| **Total length** | 10.0 | 10.0 | | |
| **Star ratings** | **Pedestrian** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 2 stars | 0.0 | 0.2 | −0.2 | −2.0% |
| 1 star | 5.6 | 3.2 | 2.4 | 24.0% |
| Not applicable | 4.4 | 6.6 | −2.2 | −22.0% |
| **Total length** | 10.0 | 10.0 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).

### Urban freeway and controlled access highway (H016 Section 150 – Mitchell Fwy)

**Table B.7: Smoothed star ratings comparison by road length – Bicyclist and pedestrian (H016-150)**

| Star ratings | Bicyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.2 | −0.2 | −2.0% |
| 4 stars | 3.1 | 0.0 | 3.1 | 31.0% |
| 3 stars | 3.1 | 0.0 | 3.1 | 31.0% |
| 2 stars | 1.8 | 0.0 | 1.8 | 18.0% |
| 1 star | 1.3 | 0.0 | 1.3 | 13.0% |
| Not applicable | 0.7 | 9.8 | −9.1 | −91.0% |
| **Total length** | 10.0 | 10.0 | | |
| **Star ratings** | **Pedestrian** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 3.0 | 0.2 | 2.8 | 28.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 5.0 | 0.0 | 5.0 | 50.0% |
| 2 stars | 1.0 | 0.0 | 1.0 | 10.0% |
| 1 star | 0.3 | 0.0 | 0.3 | 3.0% |
| Not applicable | 0.7 | 9.8 | −9.1 | −91.0% |
| **Total length** | 10.0 | 10.0 | | |

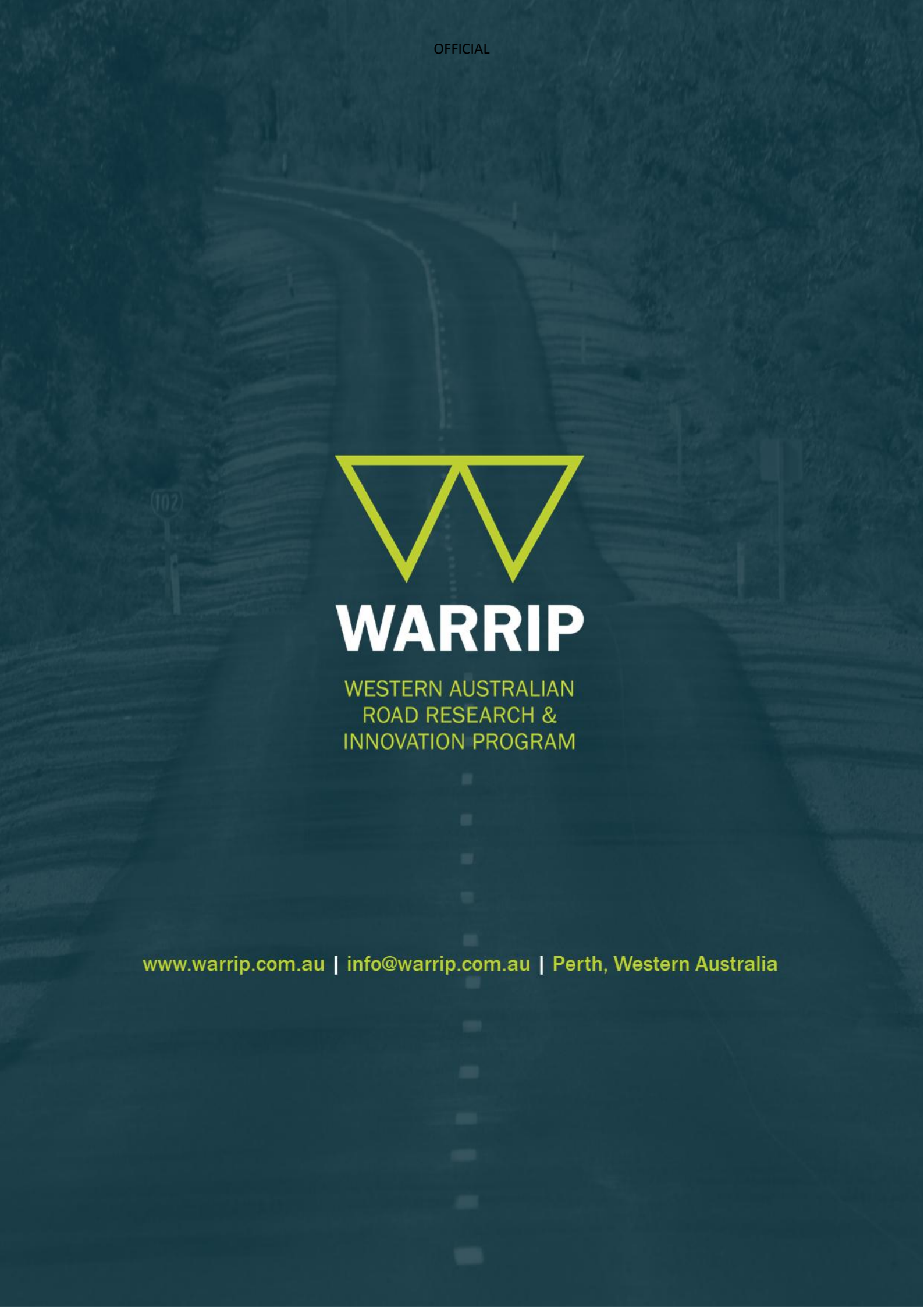
Source: iRAP (2025) (reproduced by NTRO 2026).

## Urban highway and main road (H001 Section 134 – Albany Hwy)

**Table B.8: Smoothed star ratings comparison by road length – Bicyclist and pedestrian (H001-134)**

| Star ratings | Bicyclist | | | |
|---|---|---|---|---|
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 1.1 | 0.0 | 1.1 | 24.4% |
| 3 stars | 2.6 | 1.0 | 1.6 | 35.6% |
| 2 stars | 0.8 | 3.4 | −2.6 | −57.8% |
| 1 star | 0.0 | 0.1 | −0.1 | −2.2% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | 4.5 | 4.5 | | |
| **Star ratings** | **Pedestrian** | | | |
| | Ai coding Length (km) | Manual coding Length (km) | Difference (Ai – Manual) | Difference (%) |
| 5 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 4 stars | 0.0 | 0.0 | 0.0 | 0.0% |
| 3 stars | 0.0 | 1.6 | −1.6 | −35.6% |
| 2 stars | 1.4 | 2.0 | −0.6 | −13.3% |
| 1 star | 3.1 | 0.9 | 2.2 | 48.9% |
| Not applicable | 0.0 | 0.0 | 0.0 | 0.0% |
| **Total length** | 4.5 | 4.5 | | |

Source: iRAP (2025) (reproduced by NTRO 2026).


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