



Methodology for the Analysis of the Freeway Weaving Area Capacity

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Background

Efficient freeway planning, design and operation rely on reliable estimates of how much traffic different parts of the network can sustainably carry. Weaving areas (where vehicles entering or exiting a freeway must cross other traffic streams over a short distance) are a recurring source of congestion and reduced performance on urban freeways. If these locations are not well designed or assessed, they can become significant bottlenecks that affect network reliability, safety and travel times.

In Australia and New Zealand, freeway capacity guidance in the Austroads Guide to Traffic Management and Guide to Smart Motorways has historically been based on the US Highway Capacity Manual (HCM). Practitioners have consistently reported that HCM methods often over-estimate capacity under local conditions and do not adequately handle common real-world weaving configurations such as auxiliary lanes, lane drops and lane adds.

To address these shortcomings, Australian jurisdictions have increasingly adopted the Maximum Sustainable Flow Rate (MSFR) concept. MSFR is a probabilistic measure of capacity based on the likelihood of traffic breakdown, rather than a single deterministic value. While MSFR is now embedded in guidance for basic freeway sections, there has been no equivalent, fit-for-purpose method for analysing weaving areas. This project was undertaken to close that gap.

Approach

The project developed a new, Australia-specific methodology for assessing weaving area capacity that is consistent with the MSFR concept and suitable for practical use by practitioners.

Key elements of the approach included:

- **Review of existing methods:** International weaving capacity methods were reviewed, including the HCM, recent US NCHRP research, and selected European approaches. Each was assessed for scope, usability, plausibility and suitability for Australian conditions.
- **Selection of an MSFR-aligned framework:** Two candidate approaches were shortlisted for further investigation, an updated US methodology (Extended STRIDE) and a preliminary MSFR-based method previously developed by the Department of Transport and Planning Victoria (Vic DTP).
- **Data collection from Australian freeways:** Detailed traffic data were analysed from weaving areas in Western Australia and Victoria, including speed, volume and occupancy data, as well as lane changing and origin–destination information derived from automated number plate recognition (ANPR) and advanced detector technologies.
- **Understanding lane changing as the key driver:** The analysis focused on lane changing concentration (LCC) (the number of lane changes that vehicles must make per kilometre of weaving length) as the primary contributor to flow turbulence and capacity loss.
- **Method development and testing:** A refined MSFR-based methodology was developed that directly links LCC to capacity reduction through a simple adjustment factor. The method was then tested at independent sites in Western Australia, Victoria and Queensland to assess performance relative to observed capacity outcomes.

Findings

The analysis confirmed that sustained lane changing activity in weaving areas has a clear and measurable impact on freeway performance.

Key findings include:

- **Lane changing intensity drives capacity loss:** There is a statistically significant relationship between lane changing concentration and reduced sustainable flow. As LCC increases, weaving areas experience progressively lower MSFR values than equivalent non-weaving sections.
- **Capacity reduction follows a predictable pattern:** The relationship between LCC and remaining capacity follows a logarithmic trend. At high lane changing intensities, achievable capacity tends to plateau at around 70% of a comparable non-weaving freeway section.
- **The refined MSFR-based method performs well under local conditions:** Compared with the updated US Extended STRIDE approach, the refined Vic DTP MSFR method produced results that more closely matched observed capacities across Australian case study sites.
- **Simplicity and transparency are key strengths:** The new method avoids complex speed–density assumptions and instead uses a direct adjustment factor that practitioners can clearly interpret and apply.
- **Challenges remain for complex weaves:** Estimating lane changing demand is straightforward for simple weaves (single entry and exit lanes with auxiliary lanes), but more complex layouts (such as multi-lane ramps or freeway bifurcations) require additional judgement and supporting tools.

Implementation opportunities

The project delivers a practical foundation for improving how weaving areas are assessed in Australia and New Zealand.

Key implementation opportunities include:

- **Incorporation into national guidance:** The methodology is well aligned with current Australian practice and is suitable for inclusion in future updates of the Austroads Guide to Traffic Management and Guide to Smart Motorways.
- **Improved planning and design decisions:** Agencies can use the method to better identify when weaving will constrain capacity and to test the benefits of design options such as auxiliary lanes, extended weaving lengths or modified ramp layouts.
- **Support for operational strategies:** The approach complements managed motorway and smart freeway operations by providing more realistic expectations of sustainable flow through weaving sections.
- **Development of practitioner tools:** The usability of the method (particularly for complex weaving configurations) would be improved through simple automation, such as spreadsheet-based calculation tools that support consistent lane change estimation.
- **Ongoing refinement through further testing:** Additional data from other jurisdictions will allow the method to be further validated, refined and tailored to emerging freeway designs and traffic patterns.

References

This summary is based on the WARRIP 2025-001 project report *Methodology for the Analysis of the Freeway Weaving Area Capacity*.

The methodology reflects Australian data and operating conditions and is intended to support informed, evidence-based freeway planning, design and operation.