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ANALYSIS
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CERTIFICATION

TRAFFIC ANALYSIS

TRAFFIC IMPACT ASSESSMENT

Revision 4 — Response to SARA
Information Request

134 South Street
Thornlands QLD 4164



Prepared for
Development application
MCU26/0056



Lot 1 on RP124525



Multiple dwelling, 15 units
(12 two-bedroom and 3 three-bedroom)



29 car parking spaces

ENGINEERING
SAFER, SMARTER
MORE CONNECTED
PLACES

CLEVELAND REDLAND BAY ROAD

SOUTH STREET

134

EXPERTISE
IN MOTION



Council ref:
MCU26/0056



SARA ref:
2606-52866 SRA



Prepared by:
Craig Harris,
RPEQ 13194



15 October 2026
Revision 4
Public issue



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DOCUMENT CONTROL

CURRENT ISSUE TRAFFIC IMPACT ASSESSMENT

REVISION 4
Public issue

PROJECT PARTICULARS

Site / project	134 South Street, Thornlands QLD 4164
Lot on plan	Lot 1 on RP124525
Land area	1,011 m ² (drawing 2.1 Issue A schedule; 1,012 m ² was stated in Revision 2)
Development / scope	Multiple dwelling, 15 units (12 two-bedroom and 3 three-bedroom), 29 car parking spaces
Client / Council reference	MCU26/0056 (pre-lodgement meeting PLM25/0045)
External / agency reference	SARA 2606-52866 SRA, Information Request dated 26 June 2026
Prepared for	Development application MCU26/0056, in response to the SARA Information Request

ISSUE & AUTHORISATION

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REVISION HISTORY

Table 1: Revision history

Rev.	Date	Status	Description
1	December 2025	Not issued	Preparation version, superseded by Revision 2
2	9 January 2026	Issued for DA lodgement	Original Traffic Impact Assessment lodged as Appendix F of the application
3	14 September 2026	Issued for RFI Response	Revised assessment responding to SARA Information Request 2606-52866 SRA: measured access geometry, August 2026 intersection survey, first-principles operational assessment, GTIA road safety risk assessment, access driveway review, conditions
4	15 October 2026	Public issue	Public issue of Revision 3: internal notes removed and wording finalised; no change to engineering content

CURRENT: Revision 4 is the public issue of Revision 3 (14 September 2026), which was issued in response to SARA Information Request 2606-52866 SRA and supersedes Revision 2 for the traffic matters of the application. Revision 2 remains the lodged baseline and is not amended. Revision 4 makes no change to engineering content.

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1. INTRODUCTION

1.1 Purpose

This revised Traffic Impact Assessment has been prepared for the proposed 15-unit multiple dwelling development at 134 South Street, Thornlands, under development application MCU26/0056.

This document is Revision 4, the public issue of Revision 3 (14 September 2026). Revision 3 updates the Revision 2 report dated 9 January 2026, which was lodged with the development application.

Two information requests have been issued in relation to the application:

Redland City Council issued an Information Request on 9 June 2026 addressing civil engineering matters, including stormwater quantity and quality, water supply and sewerage. These matters are addressed in separate civil engineering submissions and are outside the scope of this report.

The State Assessment and Referral Agency (SARA) issued an Information Request on 26 June 2026 under reference 2606-52866 SRA. Item 1 of that request concerns the potential impacts of the development on the State-controlled road network.

This report responds solely to Item 1 of the SARA Information Request.

Section 2 summarises the SARA request and the response to each of its elements. Appendix A reproduces Item 1 in full and provides, for each element, the corresponding response and a reference to the section of this report containing the supporting assessment.

1.2 Application background

The application was received by Redland City Council on 20 April 2026 with the Revision 2 TIA as Appendix F. SARA is a referral agency because the proposed access to South Street lies within 100 m of the intersection of South Street with Cleveland Redland Bay Road, a State-controlled road. SARA's Information Request records that the proposed crossover is about 50 m from the intersection and describes the non-standard frontage cross-section, the peak demands on both roads and the intersection's susceptibility to queuing, and identifies two conflict scenarios for right-turning development traffic. It asks for a revised TIA in accordance with the Department of Transport and Main Roads' Guide to Traffic Impact Assessment (GTIA) that sources up-to-date survey data, determines the operational impacts, undertakes a road safety risk assessment covering crash history and queue-related turning risks, and reviews the suitability of all driveway movements, arrangement and form.

The site is on the south side of the east leg of the intersection, and the proposed crossover is 42.5 m from the westbound stop line at its nearest point. This revision assesses the development on that measured geometry throughout.

1.3 Scope of this revision

This revision replaces the site context, background traffic, generation, operational, access, State code and conclusion sections of Revision 2 with assessments based on:

- the submitted architectural plans (Interworks Architects drawing 2.1 Issue A dated 30 October 2025, Appendix A of the application), which fix the dwelling schedule, the parking provision and the crossover geometry;
- the access separation and frontage cross-section measured from the submitted plan, the State digital cadastre and Council aerial imagery, confirmed by the project CAD;
- a classified turning-movement and queue survey of the Cleveland Redland Bay Road / South Street / Bloomfield Street signals on Tuesday 11 August 2026, with video;
- a first-principles operational assessment of the signals, existing and with the development, with the signal timing read from the survey video and the calculated queues validated against the observed queues;

- a road safety risk assessment to GTIA section 9.3 covering the crash history of South Street and the four conflict scenarios SARA describes, with a mitigation package and residual risk;
- a review of each driveway movement, the sight distance available under queued and parked conditions, the interaction with the unmarked frontage, and the access form against AS/NZS 2890.1 and Council standard drawing R-RCC-2.

The Revision 2 coverage of internal circulation, parking layout, waste collection and pedestrian and bicycle access is retained in section 10, re-read against drawing 2.1 Issue A.

1.4 Basis of assessment

- State Assessment and Referral Agency, Information Request, 134 South Street Thornlands, reference 2606-52866 SRA, 26 June 2026.
- Redland City Council, Information Request MCU26/0056, 9 June 2026 (civil items; not addressed in this report).
- Interworks Architects, drawings 1.1 to 5.1 Issue A, 30 October 2025 (Appendix A of the application).
- Department of Transport and Main Roads (TMR), Guide to Traffic Impact Assessment, December 2018.
- TMR, Road Planning and Design Manual, Edition 2, Volume 3: Supplement to Austroads Guide to Road Design Part 4A, September 2025.
- AS/NZS 2890.1:2004 Parking facilities, Part 1: Off-street car parking.
- Redland City Plan 2018, Version 14: Transport, servicing, access and parking code; Planning Scheme Policy 2, Infrastructure works; standard drawing R-RCC-2, Commercial / industrial / multiple dwelling driveway crossover.

2. SARA INFORMATION REQUEST AND RESPONSE SUMMARY

SARA's request is a single Item 1. For traceability it is divided here into eleven editorial elements, SARA-1.1 to SARA-1.11, keeping SARA's wording.

Table 2 gives the response in summary;

Appendix A gives the full request wording with each response and its evidence.

SARA, notice page 1, under the heading "1. Impacts to the State-controlled Road network":

"Following review of the submitted Traffic Impact Assessment the following concerns were identified."

Table 2: SARA Information Request 2606-52866: concerns identified, and where each is answered

Element	SARA concern or request (abridged)	Response	Report section
SARA-1.1	The proposed crossover to South Street is located approximately 50m away from the State-controlled Road ...	Agreed.	Sections 3.2 and 3.3, Figure 1, Appendix E
SARA-1.2	The road cross section directly fronting the access is of non-standard form. There is approximately 10m ...	Confirmed and measured.	Sections 3.3 and 9.5
SARA-1.3	Cleveland Redland Bay Road is a major north-south connection within the broader Cleveland / Redlands area and ...	Confirmed by survey.	Section 5, Appendix B
SARA-1.4	The intersection is susceptible to queuing of vehicles. There is a 70m long right-turn lane into South Street ...	Confirmed for the South Street east approach: the westbound queues reach and pass the access in most AM peak-hour signal cycles (calculated 95th percentile back of queue of 106 m existing and 108 m with the development, observed maximum 14 to 16 vehicles).	Sections 7.5 to 7.7, Figure 3

SARA, notice page 2: “The abovementioned concerns may result in safety concerns for the users of the state-controlled road network, in particular.”

Table 3: SARA Information Request 2606-52866: safety concerns, and where each is answered

Element	SARA concern or request (abridged)	Response	Report section
SARA-1.5	Conflicts between right-turning development traffic exiting the site and right-turning traffic from Cleveland ...	Substantiated.	Sections 8.4 to 8.6, 9.3, 9.4 and 9.6
SARA-1.6	Conflicts between right-turning development traffic entering the site and traffic from Cleveland Redlands Bay ...	Assessed and rated Low with and without the development (hazards H3 and H4).	Sections 8.4 to 8.6 and 9.4

SARA, notice page 2. The request and its four minimum requirements:

Table 4: SARA Information Request 2606-52866: response requested, and where each is answered

Element	SARA concern or request (abridged)	Response	Report section
SARA-1.7	Please provide a revised Traffic Impact Assessment, in accordance with the Department of Transport and Main ...	This report is the revised Traffic Impact Assessment.	Whole report
SARA-1.8	Sources up-to-date traffic survey data for the Cleveland Redlands Bay Road / South Street signalised ...	Classified turning-movement counts and once-per-cycle queue observations were commissioned for this response and surveyed on Tuesday 11 August 2026.	Section 5, Appendix B
SARA-1.9	Conducts either a traffic analysis and / or SIDRA analysis to determine operational impacts due to the ...	Done by a documented signalised-intersection calculation to the Highway Capacity Manual 7th edition, Chapters 19 and 31, with the signal timing read from the survey video and validated against the surveyed queues.	Section 7, Appendix C
SARA-1.10	Undertakes a road safety risk assessment in accordance with the GTIA that, at a minimum, includes a review of ...	Ten and a half years of Transport and Main Roads crash records were assessed against the GTIA section 9.3 method, and four hazards rated without, with and after mitigation.	Section 8, Appendix D
SARA-1.11	Undertakes a review of the access driveway and confirms suitability of all movements arrangement and form on ...	Every movement was reviewed against sight distance measured under queued and parked conditions; left in, left out and right in are supported and the right turn out is not.	Sections 9 and 12, Figure 7

3. SITE AND ROAD NETWORK

3.1 Site

The site is 134 South Street, Thornlands, Lot 1 on RP124525, 1,011 m² per the drawing 2.1 schedule, zoned Medium density residential under the Redland City Plan and affected by the Transport noise corridor overlay. It has a single 25.125 m frontage to South Street (cadastre 25.136 m) on the southern side of the road and currently contains a dwelling house with a 3.0 m residential crossing near the eastern end of the frontage.

3.2 Location relative to the Cleveland Redland Bay Road signals

South Street meets Cleveland Redland Bay Road (the State-controlled road, south leg) and Bloomfield Street (north leg) at a four-leg signalised intersection. The site is on the south side of the **east leg** of that intersection. Measured on 11 September 2026 from the vector geometry of drawing 2.1 Issue A, chainage from the State digital cadastre and the westbound stop line digitised from the Council aerial basemap, and confirmed the same day by the project CAD within 0.5 m on every line, the proposed crossover is:

- **42.5 m** from the South Street westbound stop line to the nearest point of the access (the western splay toe at the kerb; CAD 42.46 m, desktop 42.96 m);
- 43.4 m to the western edge of the crossover at the property boundary;
- **46.4 m** to the crossover centreline;
- **49.5 m** to the far (eastern) edge of the crossover at the boundary and 51.0 m at the kerb.

SARA's approximately 50 m corresponds to the far edge of the crossover. The separation and the site's position relative to the intersection are as measured above, superseding the figures reported in Revision 2. Figure 1 shows the measured separation on the Queensland Government orthophoto; the measurement basis is set out in Appendix E.

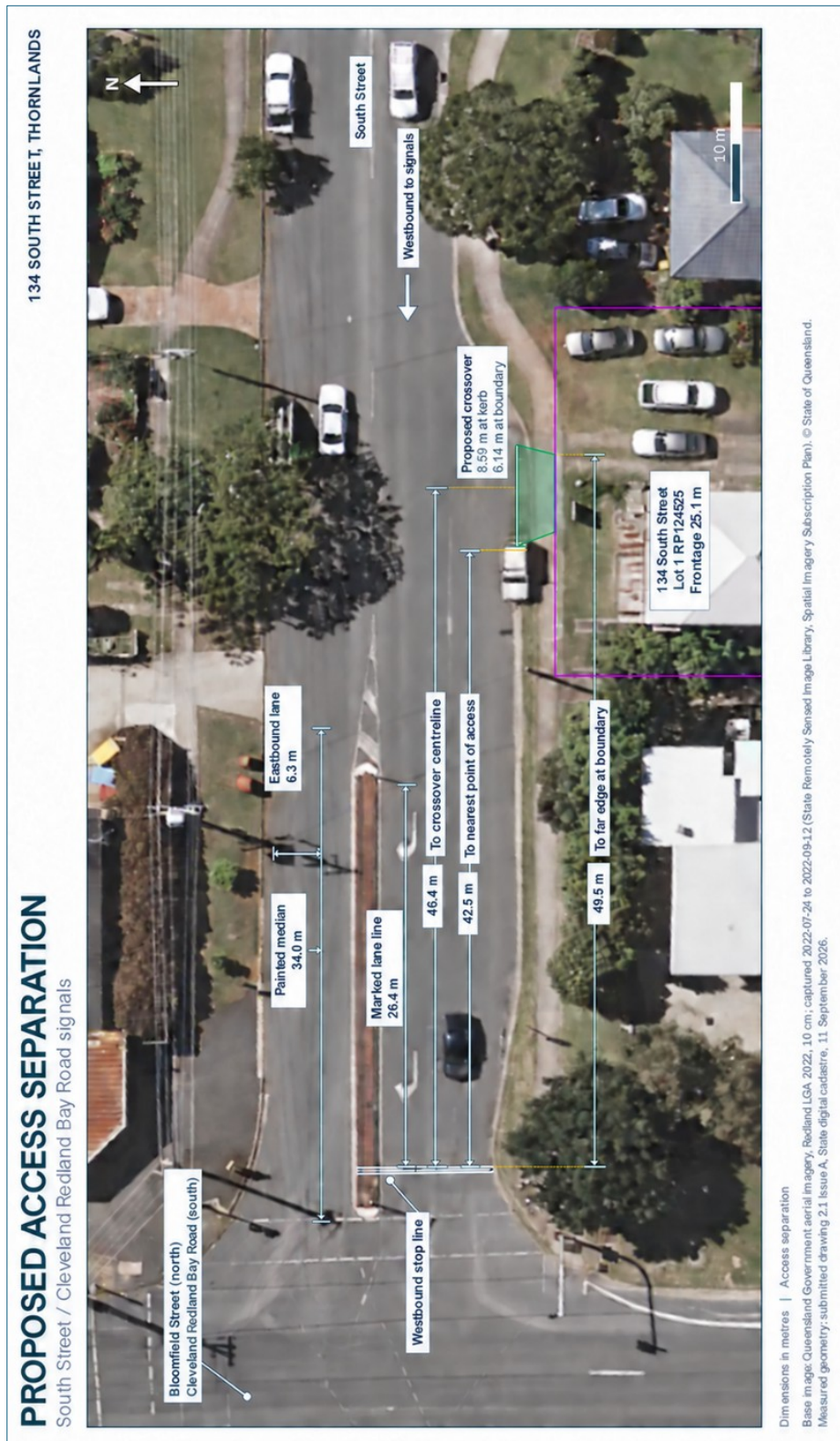


Figure 1: Proposed access and its separation from the Cleveland Redland Bay Road / South Street signals.

Proposed access at 134 South Street and its separation from the Cleveland Redland Bay Road / South Street signals: 42.5 m from the westbound stop line to the nearest point of the access (western splay toe at the kerb), 46.4 m to the crossover centreline and 49.5 m to its far edge at the property boundary. Crossover per submitted drawing 2.1 Issue A (6.14 m at the boundary, 8.59 m at the kerb); stop line, 26.4 m marked lane line and painted median as measured on 11 September 2026. Base image: Queensland Government aerial imagery, Redland LGA 2022, 10 cm, captured 2022-07-24 to 2022-09-12 (State Remotely Sensed Image Library, Spatial Imagery Subscription Plan); © State of Queensland. Measured geometry: submitted drawing 2.1 Issue A, State digital cadastre, project Civil 3D drawing, 11 September 2026.

3.3 South Street frontage cross-section

The cross-section at the frontage was measured in a road-aligned rectification of the Council aerial and checked against the project CAD (offsets from the property boundary):

Table 5: South Street cross-section at the site frontage

Element	Offset from the site boundary	Width	Note
Footpath	1.5 to 3.0 m	1.5 m	Concrete path in the southern verge
Kerb and channel	4.00 m		Project Civil 3D drawing; drawing 2.1 shows 4.21 m
Unmarked kerbside lane (through and left, past the site)	4.00 to 10.35 m	6.1 to 6.35 m	No bay marking, no separating line, no defined entry taper; two vehicles stand in it 2 to 5 m from the kerb in the aerial. SARA describes it as an indented parking lane; it is the kerbside westbound lane, wide enough to hold a parked vehicle beside moving traffic
Lane line	10.35 m		Runs from the stop line to 7.15 m west of the site (26.8 m); no longitudinal marking between 3.5 m west of the site and 17.4 m east of its western boundary, about 21 m
Westbound right-turn lane	10.35 to 14.0 m	3.65 m	Marked storage 26.4 m from the stop line (CAD 26.36 m) within a 34.0 m painted median
Painted median	14.0 to 16.2 m	2.2 m	Red-surfaced; ends 3.5 m west of the site
Eastbound lane	16.2 to 21.8 m	5.6 m	Single eastbound lane; wide enough for a vehicle to pass a stationary right-turning vehicle on its left
Northern kerb; road reserve boundary	21.8 m; 30.1 m		Carriageway 17.55 m kerb to kerb; reserve 30.1 m

Centreline to the southern kerb at the access is 9.65 m (SARA: approximately 10 m). The carriageway is about 4.8 m wider on the southern side from the intersection to the site's eastern frontage; that widening tapers out over the eastern part of the frontage, so the kerb taper begins inside the proposed crossover. East of the site the carriageway narrows to 12.7 m kerb to kerb with a broken centre line. Westbound drivers arrive in a single two-way section, enter the widening at the taper and sort themselves into the through-left and right-turn lanes across the unmarked frontage before the lane line begins 7 m west of the site. The proposed crossover, 6.14 m wide at the boundary and 8.59 m at the kerb, keeps the eastern edge of the existing 3.0 m crossing within 0.3 m and widens it westward: it is a widening of the existing access, not a new access point.

3.4 Intersection layout and control

The intersection is signalised and runs split phasing on South Street: the east approach is served alone, then the west approach alone, so the right turn on each South Street approach is protected within its own phase. At the westbound stop line the South Street east approach has two lanes: the kerbside lane carries the through and left-turn movements and runs past the site frontage as a 56 m short lane; the lane beside it is the right turn into Bloomfield Street and is full length, running continuously from the previous intersection. A U-turn is permitted for westbound traffic at the signals (U TURN PERMITTED sign on the median signal post). The west approach (eastbound) has left, through and right-turn lanes, the right-turn bay 20.6 m. The Cleveland Redland Bay Road northbound approach has three lanes, two through and left and an exclusive right turn of about 80 m into South Street east — the lane SARA refers to — with no free-flow left-turn slip lane. The Bloomfield Street southbound approach has two through lanes and an exclusive right turn of about 130 m, with a 2.2 m bicycle lane on its east side. Dimensions are measured from the project Civil 3D drawing and are shown on Figure 2. The cycle observed in the survey averaged 163.3 s in the AM peak hour and 142.0 s in the PM, with South Street westbound displayed green of 35.9 s and 27.4 s and eastbound of 25.3 s and 18.3 s (section 7.3).

INTERSECTION GEOMETRY

South Street / Bloomfield Street / Cleveland Redland Bay Road

134 SOUTH STREET, THORNLANDS



Dimensions in metres | Approximate lengths as annotated | Not to scale

Intersection and site access

Figure 2: Intersection geometry, South Street / Bloomfield Street / Cleveland Redland Bay Road. Lane widths and turn-bay lengths in metres as annotated; approximate lengths as shown, not to scale.

3.5 Speed limits

South Street is signed 60 km/h west of the signals and 50 km/h east of them. The TMR speed-limit register (point-in-time collection, 2019) records two 50 km/h signs facing eastbound traffic 15 and 26 m east of the westbound stop line, that is 8 and 19 m west of the site's western boundary, and a 60 km/h sign facing westbound traffic 58 m west of the stop line. The site frontage is therefore in the 50 km/h zone in both directions. Revision 2 assumed 50 km/h. Sight-distance criteria in this report are taken at 60 km/h as the conservative basis, with the 50 km/h values shown alongside; the current signs require confirmation on site at Operational Works. Cleveland Redland Bay Road is signed 70 km/h south of the intersection.

4. DEVELOPMENT PROPOSAL

4.1 Proposal

The submitted plans (Interworks Architects, drawing 2.1 Issue A, 30 October 2025, and floor plans 2.2 to 2.5) show a four-storey multiple dwelling of 15 units, being 12 two-bedroom and 3 three-bedroom units (four two-bedroom and one three-bedroom unit on each of three residential levels), over ground-level car parking of 29 spaces including two visitor spaces (spaces 28 and 29), a bin store and a pedestrian entry from South Street on the western side of the frontage. Revision 2 described a dwelling mix of 2 one-bedroom and 13 two- or three-bedroom units, 25 spaces and basement parking; those descriptions are superseded by the submitted plans. Vehicle access is by a single combined entry and exit crossover to South Street.

4.2 Parking provision

The Redland City Plan Transport, servicing, access and parking code, Table 9.3.5.3.2, sets the multiple dwelling rate for sites within 400 m of a bus stop with at least ten return services on weekdays and Saturdays (or within a centre or 800 m of a railway station) at 1 space per one-

bedroom unit, 1.5 spaces per two-bedroom unit, 2 spaces per unit of three or more bedrooms and 1 visitor space per 10 units; elsewhere the rates are 1.5 per one-bedroom unit, 2 per unit of two or more bedrooms and 1 visitor space per 4 units. Revision 2 and the architect's schedule applied the first band, on the strength of the bus stops at the Cleveland Redland Bay Road intersection.

Table 6: *Parking requirement and provision*

Component	Rate (first band)	Spaces required
12 two-bedroom units	1.5 per unit	18.0
3 three-bedroom units	2 per unit	6.0
Visitor parking, 15 units	1 per 10 units	1.5, rounded up to 2
Total required		26
Total provided (drawing 2.1)		29, including 2 visitor spaces

The provision of 29 spaces exceeds the 26 required under the first band. The architect's schedule states 24.5 required because it applies 1.5 spaces to the three-bedroom units as well; the correct first-band figure is 26 and the provision still complies. Under the second band (all other areas) the requirement would be 34 spaces. Applicability of the first band turns on the bus service frequency at the nearest stops, which is a planning-scheme matter for confirmation with Council; it does not affect the SARA matters assessed in this report.

4.3 Access arrangement as lodged

Drawing 2.1 shows a single two-way crossover 6.14 m wide at the property boundary and 8.59 m wide at the kerb (splays included), centred 13.2 m from the site's western boundary, with all four turning movements available. Forward-gear entry and exit is provided by the on-site aisle and turning area. This report assesses that arrangement as lodged and recommends how it should operate (section 9).

5. TRAFFIC SURVEY

5.1 Survey

Turning-movement counts and queue observations were made by Matrix Traffic and Transport Data (job AUQLD16436) on Tuesday 11 August 2026 (fine weather, Queensland state-school Term 3) from 07:00 to 09:00 and 16:00 to 18:00 at the Cleveland Redland Bay Road / South Street / Bloomfield Street signals. Counts are classified light and heavy vehicles in 15-minute intervals for all twelve turning movements and four U-turns, with cyclists and pedestrians counted separately. Queues on the two South Street approaches were recorded once per signal cycle during the red by lane. Video from two intersection cameras and two queue cameras was supplied and retained. Source workbooks, the Matrix summary sheets and the supplier's quote and method statement are held in the project file; Appendix B summarises the data. The four survey camera views are shown at Figures 8 to 11 in Appendix B.

5.2 Peak hours and turning volumes

The intersection peak hours are 08:00 to 09:00 (2,516 motor vehicles) and 16:15 to 17:15 (2,401), the highest rolling hours within the surveyed sessions. The South Street east leg (the site side) peaks earlier in the morning, 07:30 to 08:30 (535 vehicles westbound against 471 in the intersection peak hour); that own peak is carried as a sensitivity in the operational assessment. The east-leg westbound movements in the AM peak hour are 24 left, 222 through and 225 right (471); the eastbound entries to the east leg are 10 from the Cleveland Redland Bay Road right turn, 92 from the Bloomfield Street left turn and 102 through from South Street west (204). The full peak-hour turning table is in Appendix B; heavy vehicles are 3.1 per cent of the AM and 2.1 per cent of the PM peak-hour total.

5.3 Queue observations on the South Street east approach

Table 7 gives the once-per-cycle queue counts (vehicles) in the two east-approach lanes for the matched peak hours and the whole sessions. Lane 1 is the kerbside lane past the site; Lane 2 is the right-turn lane. The share of cycles with seven or more vehicles is the share in which the queue stands across the proposed access (seven vehicles at 6.5 m per queued vehicle is 45.5 m, beyond the 42.5 m to the access), and five or more vehicles extend beyond the 26.4 m of marked lane line into the unmarked frontage.

Table 7: Observed queues, South Street east approach (westbound), vehicles per lane, one sample per signal cycle

Period	Lane	Samples	Mean	Median	95th percentile of the sample	Maximum	Share of cycles with 7 or more (queue across the access)
AM 08:00 to 09:00	Lane 1 kerbside (through and left, past the site)	22	8.6	8.5	13	14	73 %
AM 08:00 to 09:00	Lane 2 offside (right turn)	22	8.1	9.0	15	16	59 %
AM session 07:00 to 09:00	Lane 1	50	7.5	7.0	13	14	60 %
AM session 07:00 to 09:00	Lane 2	50	7.2	6.0	15	16	48 %
PM 16:15 to 17:15	Lane 1 kerbside (through and left, past the site)	25	4.2	4.0	8	10	12 %
PM 16:15 to 17:15	Lane 2 offside (right turn)	25	3.6	4.0	5	7	4 %
PM session 16:00 to 18:00	Lane 1	54	3.7	3.5	7	10	7 %
PM session 16:00 to 18:00	Lane 2	54	3.0	3.0	5	7	4 %

The observed values are counts at the sampling instant during the red, which precedes the end of red; they are therefore a floor on the true end-of-red queue and are used to validate the calculated queues rather than as the design queue (section 7.9).

5.4 Representativeness of the survey day

The day fell between the Redland show holiday (Monday 10 August) and the Brisbane show holiday (Wednesday 12 August) but was an ordinary working and school day in both areas. The surveyed peak-hour two-way flows on Cleveland Redland Bay Road, 1,573 and 1,566 vehicles per hour, are 9.1 and 9.0 per cent of the 2024 annual average daily traffic recorded by the TMR permanent counter in the same road segment 1.0 km south (site 140025, 17,378 vehicles per day), which is the customary peak-hour share, and the 15-minute profile shows the normal weekday school-term shape. The counts are therefore adopted as representative of normal weekday demand. No growth factor has been applied: the Department's counter shows a decline of about 2 per cent a year on this segment since 2019, and the assessment horizon is the development's own opening as SARA's request concerns the operational impacts of the development.

5.5 Verification

All 256 interval-by-movement records, 32 peak-hour movement records and 514 queue observations were reconciled against the supplier workbooks. The video was used to establish that the queue counts are vehicles (not metres), that Lane 1 is the kerbside lane, and that sampling is once per cycle during red (intervals of 93 to 180 s, an actuated-cycle pattern). The lane arrangement and marking seen in the video agree with the aerial measurement of section 3.3.

6. TRAFFIC GENERATION AND ASSIGNMENT

6.1 Generation rates

Following the GTIA section 8.2.1 hierarchy, no survey of a comparable local development is held and the Queensland traffic generation dataset has no medium-density residential category, so the directly applicable source is the RTA Guide to Traffic Generating Developments (2002) section 3.3.2, which distinguishes the bedroom mix: up to two bedrooms 4 to 5 daily and 0.4 to 0.5 peak-hour vehicle trips per dwelling; three or more bedrooms 5.0 to 6.5 daily and 0.5 to 0.65 peak-hour trips. Consistent with GTIA Appendix A1 (design at the 85th percentile rather than the average) and with two Redland precedents at 0.6 peak trips per dwelling, the top of each range is adopted. The Revision 2 range of 0.5 to 0.7 trips per dwelling had no stated source; its upper bound is retained as the sensitivity case.

Table 8: Development traffic generation

Quantity	12 two-bedroom units	3 three-bedroom units	Total	Adopted
Daily trips	$12 \times 5.0 = 60.0$	$3 \times 6.5 = 19.5$	79.5	80 vehicle trips per day
Peak-hour trips (either peak)	$12 \times 0.50 = 6.00$	$3 \times 0.65 = 1.95$	7.95	8 vehicle trips per hour
Peak-hour sensitivity			10.0	Revision 2 upper bound

6.2 Existing dwelling

The existing dwelling house generates about 9.0 daily and 0.85 peak-hour trips at the RTA dwelling-house rate, so the net addition is about 70.5 daily and 7.1 peak-hour trips. The operational and safety assessments use the gross figures (8 per hour, 80 per day) and take no credit, which is conservative for every conflict SARA has raised.

6.3 Directional split, distribution and assignment

Peak-hour trips are split AM 20 per cent in / 80 per cent out and PM 60 per cent in / 40 per cent out (the split adopted for a comparable Redland Bay apartment development; sensitivity PM 80/20). Every regional destination for a Thornlands household is reached through the Cleveland Redland Bay Road signals 42.5 m west of the access, and South Street east of the site serves local streets only; 90 per cent of site trips are therefore assigned through the signals and 10 per cent east along South Street (sensitivity 80/20). The observed tidal pattern supports this: 471 vehicles left the east leg westbound in the AM peak hour against 204 entering it eastbound. Site trips through the signals are shared across the intersection movements in the observed peak-hour proportions.

Table 9: Development trips by driveway movement, design case

Driveway movement	AM peak (vehicles per hour)	PM peak (vehicles per hour)	Adverse envelope AM / PM	Interaction
Left turn out (joins the westbound kerbside lane toward the signals)	5.7	2.9	6.4 / 1.6	Westbound kerbside lane and its queue
Right turn out (crosses both westbound lanes, joins the eastbound lane)	0.6	0.3	1.6 / 0.4	SARA-1.5: sight line blocked by the westbound queue; conflict with eastbound traffic including the Cleveland Redland Bay Road right-turners
Right turn in (eastbound, across both westbound lanes)	1.4	4.3	1.6 / 6.4	SARA-1.6: held by the westbound queue, waits in the eastbound lane 42.5 m from the stop line
Left turn in (from the westbound kerbside lane)	0.2	0.5	0.4 / 1.6	Westbound kerbside lane

Driveway movement	AM peak (vehicles per hour)	PM peak (vehicles per hour)	Adverse envelope AM / PM	Interaction
Added to the westbound approach at the signals	5.7 (+1.2 per cent of 471)	2.9 (+1.2 per cent of 248)		
Added to the eastbound departure from the signals	1.4	4.3		
Added to the whole intersection	7.2 (+0.3 per cent)	7.2 (+0.3 per cent)		

The adverse envelope combines 10 trips per hour, 80 per cent through the signals and the PM 80/20 split. The right turn out never exceeds two vehicles per hour in either peak under any case; about four vehicles a day make it. These are the exposure figures the risk assessment and the access review use.

7. OPERATIONAL ASSESSMENT

7.1 Method

The operational impacts were determined by a documented calculation of the signalised intersection with every input visible, following the Highway Capacity Manual 7th edition (2022), Chapter 19 Signalized Intersections and Chapter 31 Signalized Intersections: Supplemental. Saturation flow, capacity and degree of saturation follow Chapter 19 equations 19-8, 19-16 and 19-17; control delay and level of service follow equations 19-18 to 19-27 and exhibit 19-8; and the average and percentile back of queue follow Chapter 31 equations 31-141 to 31-153. Opposed right turns use the Chapter 31 permitted and protected-permitted procedures, equations 31-100, 31-119 and 31-124. The calculation is carried in a workbook of live formulas so that every reported figure is traceable cell by cell; the equations, parameters and the drive-side convention applied to a left-hand-drive intersection are set out in Appendix C.

7.2 Analysis periods and horizon

Existing and with-development cases are analysed for the AM (08:00 to 09:00) and PM (16:15 to 17:15) intersection peak hours with a one-hour flow period. The westbound own peak (07:30 to 08:30) and the peak 15 minutes are sensitivities. The horizon is the development's opening on the surveyed demand (section 5.4).

7.3 Inputs

Signal timing was read from the survey video rather than assumed. The intersection runs split phasing on South Street: the east approach is served alone, then the west approach alone, so the right turn on each South Street approach is protected within its own phase and does not filter. This was read directly from the eastbound governing signal faces, which stand at the far end of the west-leg queue camera view, sampled at three-second steps through six cycles across both peaks. The north-south displays were read from the two intersection cameras. The cycle time over each whole analysis hour comes from the survey's own once-per-cycle queue sampling: 163.3 s in the AM peak and 142.0 s in the PM. Displayed green, AM / PM: South Street eastbound 25.3 / 18.3 s, South Street westbound 35.9 / 27.4 s, the north-south right turns 16.0 / 15.2 s, the southbound lead 13.9 / 11.0 s and both north-south through movements 50.8 / 41.5 s, with three seven-second intergreens. The westbound display is in no camera view, so its green is derived as the longest interval compatible with the observed onset of the north-south movements; the westbound green cannot therefore be longer than modelled. A demand-dependent interval of about 7.5 s appears in five of ten PM cycles and is credited to no movement.

Table 10: Operational model inputs

Input	Value	Basis
Demand per movement	Verified survey counts, light plus heavy vehicles (Appendix B); heavy vehicles at 2.0 through-car units	Survey
Development increments	Table 6 design case; sensitivities per section 6.3	Section 6
East approach lanes	Kerbside lane through and left, 56 m short lane past the site; adjacent lane exclusive right turn, full length; access 42.5 m from the westbound stop line	Measured, project Civil 3D drawing (section 3)
Other approaches	West: left, through and right lanes, right-turn bay 20.6 m. Cleveland Redland Bay Road northbound: two through and left lanes and an exclusive right turn about 80 m. Bloomfield Street southbound: two through and left lanes, an exclusive right turn about 130 m and a 2.2 m bicycle lane. No free-flow left-turn slip lane on any approach	Measured, project Civil 3D drawing
Cycle time	163.3 s AM peak hour; 142.0 s PM	Survey queue sampling intervals
Displayed green, AM / PM	South Street eastbound 25.3 / 18.3 s; South Street westbound 35.9 / 27.4 s; north-south right turns 16.0 / 15.2 s; southbound lead 13.9 / 11.0 s; north-south through 50.8 / 41.5 s; three 7 s intergreens. Split phasing on South Street, each approach served alone	Survey video signal faces; westbound green derived as the longest interval compatible with the north-south onset
Saturation flow	1,800 through-car units per hour per lane (through), 1,750 (kerbside shared through-left), 1,700 (exclusive turn lane)	Assumed, within Australian practice; sensitivity 1,700 to 1,950
Opposed right turns	Critical headway 4.5 s, follow-up headway 2.5 s, 2.0 sneakers per cycle. Only the Bloomfield Street right turn is protected-permitted; the South Street right turns are protected within their own phase	Highway Capacity Manual 7th edition, Chapter 31
Arrivals	Isolated operation, random arrivals (progression factor 1.0)	No coordinated upstream signal in view
Incremental delay factor k	Equation 19-22, clamped to its stated range 0.04 to 0.50	Highway Capacity Manual 7th edition, Chapter 19
Queue spacing	6.5 m per queued vehicle; the manual's 7.6 m carried beside it	Adopted for this assessment (section 7.4)

7.4 Definitions

Degree of saturation is demand divided by capacity.

Average delay is control delay per vehicle; the intersection figure is the demand-weighted average over the signalised lane groups.

Average back of queue is the queue that forms during the red and the part of the green needed to clear it, plus any overflow carried between cycles, per lane, in vehicles.

The 95th percentile back of queue is the queue exceeded in one cycle in twenty, calculated by the Highway Capacity Manual 7th edition percentile back-of-queue method (equations 31-150 to 31-153) with $z = 1.64$.

Queue lengths in metres use 6.5 m per queued vehicle, this office's adopted spacing for the site, stated wherever a storage ratio is reported; the manual's own 7.6 m value is carried beside it in the calculation.

The survey's once-per-cycle counts are 22 to 25 samples per peak hour taken before the end of red; the 95th percentile of such a sample is its second-largest value and is a floor on the true end-of-red queue, so it is used to validate the calculated queues (section 7.9), not as the design queue.

7.5 Intersection performance

Table 11: Intersection summary, existing and with the development

Peak	Case	Signalised demand (veh/h)	Worst degree of saturation (movement)	Average delay (s/veh)	Level of service
AM 08:00 to 09:00	Existing	2,516	0.82 (Cleveland Redland Bay Road northbound through and left)	53.2	D
AM 08:00 to 09:00	With development	2,523	0.82 (Cleveland Redland Bay Road northbound through and left)	53.3	D
PM 16:15 to 17:15	Existing	2,401	0.75 (South Street west approach through)	45.9	D
PM 16:15 to 17:15	With development	2,408	0.76 (South Street west approach through)	46.1	D

The intersection operates at level of service D in both peaks, existing and with the development alike: 53.2 s of average control delay in the AM peak and 45.9 s in the PM. The worst degree of saturation is 0.82 in the AM, on the Cleveland Redland Bay Road northbound through and left movement, and 0.75 in the PM, on the South Street west approach through movement. Individual lane groups are less comfortable than that intersection average: under the split phasing in force on the survey day the South Street west approach runs at level of service E in both peaks, and the east approach at the site frontage runs at level of service E in the AM peak. These are existing conditions, set by the signal allocation at a State-controlled intersection, and the development does not change any of them. The lane-group results for every approach are in Appendix C.

7.6 South Street westbound queues at the site access

Table 12 gives the calculated queues in the two east-approach lanes against the 42.5 m from the westbound stop line to the nearest point of the access, existing and with the development. The kerbside lane past the site is a 56 m short lane; the right-turn lane beside it is full length, running continuously from the previous intersection.

Table 12: South Street westbound queues at the site access, existing / with development

Peak	Lane	Average back of queue, veh (m)	95th percentile back of queue, veh (m)	95th percentile ÷ 56 m kerbside short lane	95th percentile ÷ 42.5 m to the access	Modelled probability of 7 or more	Observed share of cycles with 7 or more
AM peak	Lane 1 (kerbside, past the site)	10.9 (71) / 11.1 (72)	16.3 (106) / 16.5 (108)	1.89 / 1.92	2.5 / 2.5	77 to 92 % / 78 to 92 %	73 % (n = 22)
AM peak	Lane 2 (right turn)	9.2 (60) / 9.4 (61)	14.2 (92) / 14.4 (94)	–	2.2 / 2.2	68 to 81 % / 69 to 82 %	59 % (n = 22)
PM peak	Lane 1 (kerbside, past the site)	4.9 (32) / 4.9 (32)	8.5 (55) / 8.6 (56)	0.99 / 1.00	1.3 / 1.3	16 to 22 % / 16 to 23 %	12 % (n = 25)
PM peak	Lane 2 (right turn)	3.7 (24) / 3.8 (25)	6.7 (44) / 6.8 (44)	–	1.0 / 1.0	7 to 9 % / 7 to 9 %	4 % (n = 25)
AM own peak 07:30 to 08:30	Lane 1 (kerbside, past the site)	12.1 (79)	17.8 (116)	2.07	2.7	80 to 96 %	67 % (n = 24)
AM own peak 07:30 to 08:30	Lane 2 (right turn)	11.0 (71)	16.4 (107)	–	2.5	79 to 92 %	54 % (n = 24)

In the AM peak the 95th percentile back of queue in the kerbside lane past the site is 106 m, two and a half times the 42.5 m to the access, and the average queue of 10.9 vehicles is 71 m, which also stands across it. The right-turn lane reaches 92 m. In the PM the kerbside 95th percentile

queue is 55 m and still exceeds the distance to the access. These are red-time queues on a long cycle under split phasing — the kerbside lane has 35.9 s of green in a 163.3 s cycle in the AM — rather than queues caused by a shortage of capacity, which is why the degree of saturation on that lane is 0.71 while its delay reaches level of service E. The queue reached the access in 60 per cent of the surveyed AM peak-hour observations, which is consistent with these figures. The development adds 1.6 m.

South Street westbound queues at the proposed access: calculated and observed

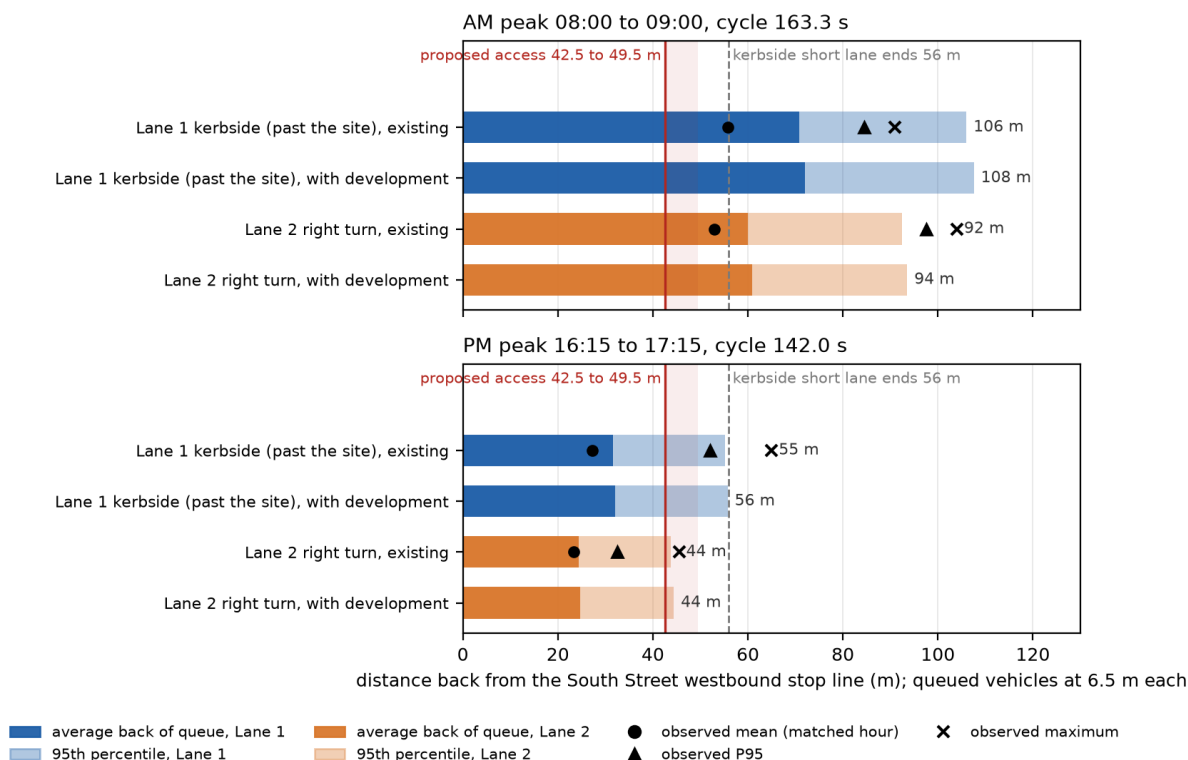


Figure 3: South Street westbound back of queue at the proposed access, existing and with the development.

calculated for the surveyed AM and PM peak hours, existing and with the development: average and 95th percentile back of queue per lane, drawn to scale against the 42.5 to 49.5 m to the proposed crossover and the 56 m kerbside short lane, with the observed matched-hour mean, nearest-rank 95th percentile and maximum of the once-per-cycle survey counts marked on the existing rows (6.5 m per queued vehicle). Signal timing reconstructed from the survey video (section 7.3); the 95th percentile follows the Highway Capacity Manual 7th edition method.

7.7 Change with the development

The largest change on any lane group in either peak is 3.0 vehicles per hour of demand, 0.009 in degree of saturation, 1.0 s of average control delay and 0.24 vehicles or 1.6 m of 95th percentile back of queue. The largest degree-of-saturation and queue changes both fall on the kerbside lane past the site in the AM peak, which moves from 0.712 to 0.720 and from 106.0 m to 107.6 m; the largest delay change falls on the west approach through movement in the PM, 71.7 to 72.7 s. Intersection average delay rises by 0.1 s in the AM and 0.2 s in the PM. No lane group changes level of service in either peak. The full change table is in Appendix C.

Signalised lane groups, existing and with development

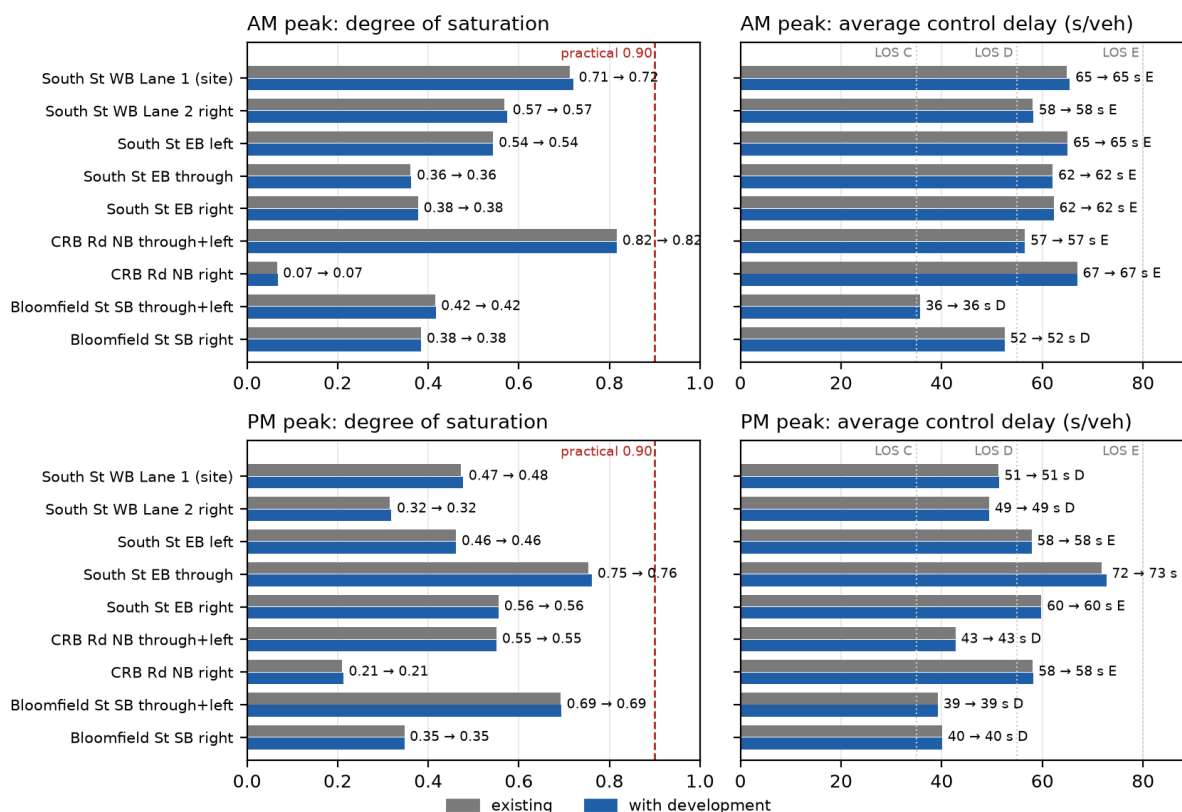


Figure 4: Degree of saturation and average control delay per signalised lane group, AM and PM peaks.

Degree of saturation and average control delay per signalised lane group, existing and with the development, AM and PM peaks. The practical limit of 0.90 and the level-of-service thresholds are shown. The Cleveland Redland Bay Road and Bloomfield Street values depend on an assumed north-south green split; the South Street values do not.

7.8 Sensitivity

Sixteen sensitivity cases were run on a separate copy of the calculation workbook, recalculated case by case. The generation, distribution and split assumptions, the saturation flow (1,700 to 1,950), the westbound green (± 5 s), the queue spacing, the incremental delay factor, the intergreen (6 to 8 s), the north-south head mapping and the effective-green convention each move the east-approach 95th percentile queue by under two vehicles, and most by under one. The westbound own peak of 07:30 to 08:30 gives 17.8 and 16.4 vehicles. The worst quarter-hour gives 24.8 and 23.7 vehicles, above every observed hourly maximum of 14 and 16, as a per-cycle sample over an hour should be, and lifts the worst degree of saturation to 0.94 and 0.92. The alternative north-south head mapping moves the worst degree of saturation between approaches — 0.72 in the AM and 0.88 in the PM — but changes no South Street figure. Nothing in the table alters the finding that the westbound queue stands across the access in most AM cycles today and that the development adds a fraction of a vehicle to it.

Sensitivity of the South Street westbound 95th percentile queue

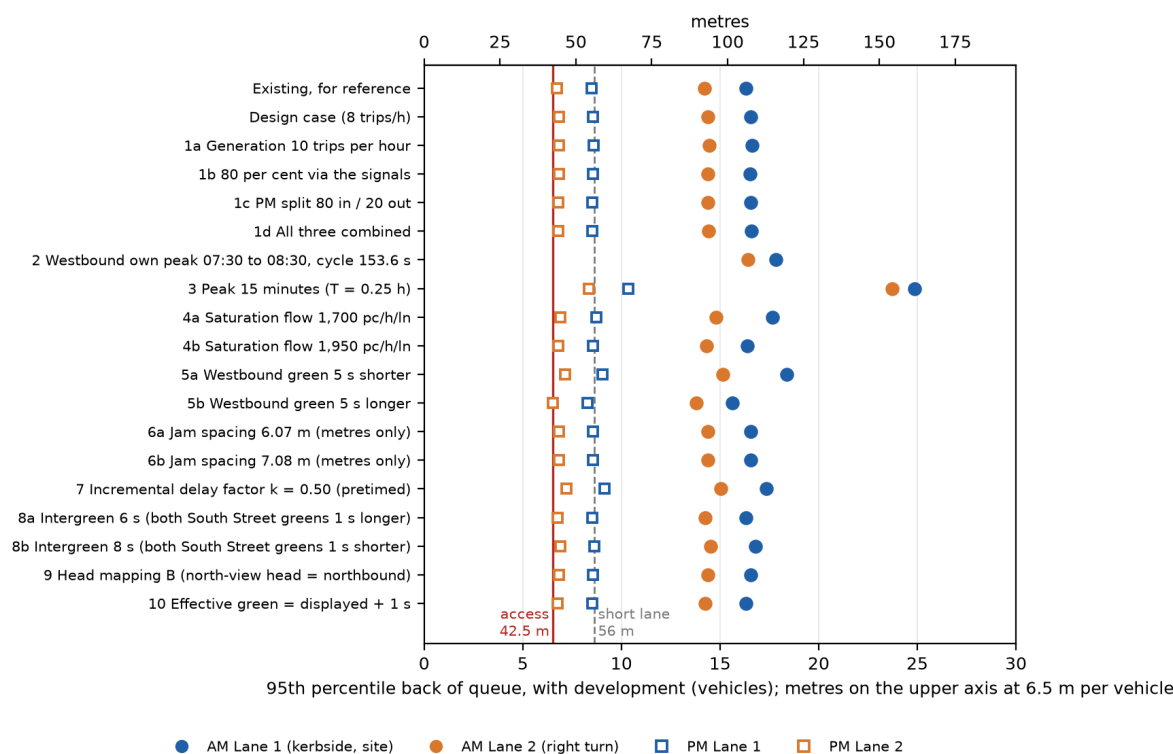


Figure 5: Sensitivity of the South Street westbound 95th percentile back of queue.

with the development, to the inputs listed in Table 22, against the 42.5 m from the westbound stop line to the access. The worst quarter-hour case is a per-cycle statistic over an hour and lies above every observed hourly maximum.

7.9 Validation against the observed queues

The calculated queues were compared with the survey's once-per-cycle counts in all ten matched lane and peak cells, in vehicles, so the adopted queue spacing plays no part in the test. Every modelled average lies at or above the lower bound of the 95 per cent confidence interval of the observed mean: ten of ten cells pass. The model sits a mean 0.9 vehicles above the observed means, so it is on the conservative side rather than the optimistic one. The modelled 95th percentiles sit within one vehicle of the observed nearest-rank 95th percentile in the four cells where they fall below it, which is expected of a 22 to 25 sample statistic that is itself a floor. None of the 514 queue observations is on a north-south approach, so the north-south greens are validated by the signal-face readings rather than by a queue count. No input was changed to fit the observations. The validation table is in Appendix C.

7.10 Limitations

- No controller data was obtained from Transport and Main Roads. The cycle time comes from the survey's once-per-cycle queue sampling and the phase structure and green times from the signal faces visible in the survey video.
- Saturation flows are stated assumptions within Australian practice, not site measurements; the sensitivity range changes the South Street 95th percentile queue by under one vehicle.
- Isolated operation with random arrivals is assumed; no coordinated upstream signal is within view. The signals operate adaptively, so the phase times reported here are those of the surveyed day rather than a fixed timing plan.
- The survey is a single representative day (section 5.4).

7.11 Finding

The development's traffic does not measurably change the intersection's degree of saturation, delay, level of service or queues: at most 0.009, 1.0 s and 1.6 m on any lane group in either peak, with no change of level of service anywhere. The intersection operates at level of service D in both peaks with and without it. The westbound queues on the South Street east approach are long relative to the site access because of the split phasing and the long cycle, not because of a shortage of capacity: they stand across the access in most AM peak-hour cycles today and will continue to do so with the development, which lengthens them by 1.6 m. The operational question SARA raised is therefore not one of capacity, nor of the development worsening the queue; it is how the development's own turning movements interact with a queue that already exists, which sections 8 and 9 address.

8. ROAD SAFETY RISK ASSESSMENT

8.1 Method

The assessment follows GTIA section 9.3. Each risk item is scored on the Figure 9.3.2(a) matrix (likelihood 1 Rare to 5 Almost certain; consequence 1 Property only to 5 Fatality; score Low, Medium or High) for three cases: without the development, with the development, and with the development and mitigation where the score rises or is high. A risk is significantly worsened when its category changes. The GTIA defines the likelihood and consequence scales by their labels only and leaves the scoring to expert opinion; the working likelihood descriptors adopted here are: Rare, not expected within the life of the development and no such crash in the ten-year record; Unlikely, could occur perhaps once in five to ten years; Moderate, once in one to five years; Likely, about once a year; Almost certain, several times a year. Consequence is the credible worst reasonable outcome for the road users exposed at the speeds of the conflict, taking the cyclist or pedestrian case where those users are in the conflicting stream. Each rating cites the exposure of the movement (section 6), the share of that exposure that meets the hazard condition (sections 5.3 and 7.6), the conflicting stream and geometry (section 3), and the crash record (section 8.2).

Table 13: GTIA Figure 9.3.2(a) risk matrix

Likelihood \ Consequence	Property only (1)	Minor injury (2)	Medical treatment (3)	Hospitalisation (4)	Fatality (5)
Almost certain (5)	M	M	H	H	H
Likely (4)	M	M	M	H	H
Moderate (3)	L	M	M	M	H
Unlikely (2)	L	L	M	M	M
Rare (1)	L	L	L	M	M

8.2 Crash history

TMR's public crash dataset (version June 2025, updated 24 April 2026; casualty crashes only since 2011) was searched for every record on South Street, Thornlands, from 2015 to June 2025. Twelve records were found on the corridor from Wellington Street to about 730 m east of the signals. The study area adopted for the access is the signalised intersection (60 m radius) and the east leg of South Street from the signals to 300 m east, 60 m either side of the road line; it covers the access at 42.5 to 49.5 m and the observed and calculated queue reach of about 100 m with margin (Figure 6). One record lies inside it in ten and a half years: crash 295287 of April 2018 (Sunday 09:00), hospitalisation, an angle crash coded vehicles manoeuvring, entering from footway, between a car and a bicycle, located at the Cleveland Redland Bay Road / South Street signals; the public record snaps the location to the intersection and does not identify the driveway. No crash is recorded in the study area from 2019 to June 2025. The 2021 rear-end and 2024 driveway-related crashes that the

earlier corridor review noted lie 340 and 280 m west of the signals, on the west leg; the two east-side records lie 660 and 730 m east and are not driveway or queue crashes. All twelve records are placed against the access in Appendix D.

Figure C. Crash study area for the GTIA road-safety assessment and the single recorded crash



Figure 6: Crash study area adopted for the GTIA road safety assessment.

Crash study area adopted for the GTIA road-safety assessment: the signals (60 m radius) and the east leg of South Street from the signals to 300 m east, 60 m either side of the road line. One casualty crash is recorded inside it in the ten and a half years to June 2025: crash 295287 of April 2018, a vehicle entering from a driveway striking a cyclist at the signals, hospitalisation (Transport and Main Roads public crash data; the record snaps the location to the intersection and does not identify the driveway). Base image: Queensland Government aerial imagery, Redland LGA 2022, 10 cm, captured 2022-07-24 to 2022-09-12 (State Remotely Sensed Image Library, Spatial Imagery Subscription Plan); © State of Queensland. Measured geometry: submitted drawing 2.1 Issue A, State digital cadastre, project Civil 3D drawing, 11 September 2026.

What the record shows is that the existing driveways on the east leg, including the site's, have operated with the same westbound queues for the whole period without a recorded casualty crash at them, so the existing-condition likelihoods are Rare on the evidence; and that the one recorded crash is of exactly the kind SARA's first concern describes, a vehicle from a driveway striking a cyclist, with a hospitalisation outcome, which fixes the consequence for that hazard. Property-damage-only crashes and near misses are not in the public record, so it cannot prove the absence of minor collisions.

8.3 Exposure and operating conditions

Table 14: Turning exposure at the access under queue conditions (250 working days; two surveyed hours per peak)

Case	Right turn in per hour AM / PM	Right turn out per hour AM / PM	Right turn in per year in queue conditions	Right turn out per year in queue conditions
Existing dwelling (9.0 trips per day)	0.15 / 0.46	0.07 / 0.03	83	27
Development (80 trips per day)	1.43 / 4.29	0.64 / 0.32	778	250

The kerbside queue stands across the access in 60 per cent of the surveyed AM peak-hour observations, and is a red-time queue of a 163.3 s cycle with 127 s of westbound red, so a vehicle held by it waits up to about two minutes. The conflicting eastbound stream past the access is 204 vehicles per hour in the AM and 374 in the PM, of which the right-turners from Cleveland Redland Bay Road that SARA names are 10 and 39; all of it has just left a stop line or completed a turn 42 to 50 m away, so its speed at the access is low (inferred 20 to 40 km/h). The eastbound carriageway is a single 5.6 m lane, wide enough for a vehicle to pass a waiting right-turner on its left, which Queensland Road Rule 141 permits, and about seven vehicle lengths separate the access from the

stop line. Cyclists use South Street and are in the eastbound stream a right-turn-out driver must see. Sight distance from the access under queued and parked conditions is set out in section 9.3: the right-turn-out driver has no sight line to the eastbound lane whenever a queue stands across the access.

8.4 Hazards

H1: right turn out with the view obstructed by the westbound queue (SARA-1.5, first bullet). A driver leaving the site to head east must cross both westbound lanes and enter the eastbound lane. When the westbound queue stands across the access the driver can go only when queued drivers leave a gap, and the queued vehicles block the view west along the eastbound lane toward the signals, so the driver emerges into the eastbound stream (cars and cyclists) with no sight line: an angle crash. Existing: the dwelling's driveway makes the same movement about 27 times a year under queue conditions with no crash in the record, Rare. With the development: 250 a year, nine times the existing exposure, Unlikely. Consequence Hospitalisation for the cyclist case, which the 2018 record at these signals shows to be the real outcome of this crash type here. Score Medium without and Medium with the development. This is the one hazard the development materially adds to.

H2: right turn out entering the eastbound lane ahead of vehicles turning right from Cleveland Redland Bay Road (SARA-1.5, second bullet). The emerging vehicle accelerates from rest into a stream that is itself accelerating from the stop line or completing a turn; a following driver slows, and following traffic could bunch back toward the intersection. Exposure 0.6 per hour against 10 to 39 right-turners and 204 to 374 eastbound vehicles per hour at low speed. Rare, Minor injury, Low in both cases.

H3: right turn in held at the access by the westbound queue, waiting in the eastbound lane (SARA-1.6). The entering driver stops in the eastbound lane opposite the access until the queue moves at the next green and then filters through the discharging westbound flow; following eastbound drivers slow and either wait or pass on the left in the 5.6 m lane; a rear-end or sideswipe at low speed. Existing 83 such waits a year, Rare; with the development 778 a year, about one per AM peak hour, Unlikely; Minor injury; Low in both cases.

H4: eastbound queue behind the waiting right-turn-in vehicle reaching the stop line and the intersection (SARA-1.6 and SARA-1.5, second bullet). As H3, but the queue behind the waiting vehicle grows to the seven vehicles that fill the 42 m and obstructs the Cleveland Redland Bay Road right turn and the eastbound through movement inside the intersection. For that to happen a right-turn-in vehicle must arrive at the start of a westbound red and about seven following eastbound drivers must stop behind it rather than pass. On the reconstructed timing a full westbound red is 127 s in the AM peak, in which about seven eastbound vehicles arrive at the surveyed 204 vehicles per hour, so a full-length wait now reaches the stop line on average arrivals if nobody passes; at the previously modelled 127 s red about six arrived. The coincidence remains the trigger: the right turn in must arrive early in the red, a fraction of the one held arrival per AM peak hour, and the 5.6 m eastbound lane lets following drivers pass on the left, which the survey video shows them doing. The rating is therefore held at Unlikely / Minor injury / Low with the development, and the KEEP CLEAR marking (M2) remains an option offered to Council rather than a required mitigation.

8.5 Risk assessment table

Table 15: Road safety risk assessment (GTIA Figure 9.3.2(b) format). L Low, M Medium, H High; likelihood 1 Rare to 5 Almost certain; consequence 1 Property only to 5 Fatality

Ref	Risk item (SARA concern)	Without development L / C / score	With development L / C / score	Mitigation	With development and mitigation L / C / score
H1	Right turn out of the site with the view of eastbound traffic obstructed by the	1 / 4 / M	2 / 4 / M	Left-out-only access with raised	1 / 2 / L

Ref	Risk item (SARA concern)	Without development L / C / score	With development L / C / score	Mitigation	With development and mitigation L / C / score
	westbound queue standing across the access; angle crash with an eastbound vehicle or cyclist (SARA-1.5 first bullet)			splitter island (M1); No Stopping on the frontage (M3)	
H2	Right turn out entering the eastbound lane 42 to 50 m from the stop line ahead of vehicles turning right from Cleveland Redland Bay Road; merge or rear-end at low speed (SARA-1.5 second bullet)	1 / 2 / L	1 / 2 / L	Removed by the left-out-only access	Eliminated
H3	Right turn into the site held at the access by the westbound queue, waiting in the eastbound lane; rear-end or sideswipe at low speed (SARA-1.6)	1 / 2 / L	2 / 2 / L	None required by score; KEEP CLEAR marking optional (M2)	2 / 2 / L
H4	Eastbound queue behind a waiting right-turn-in vehicle extending to the stop line and into the intersection (SARA-1.6, SARA-1.5 second bullet)	1 / 2 / L	2 / 2 / L	None required by score; KEEP CLEAR marking optional (M2)	2 / 2 / L

No risk item changes category with the development. H1 is reduced to Low and H2 eliminated by the mitigation. The intersection queue that SARA's concerns turn on is changed by 0.24 vehicles, 1.6 m, by the development. No rating turns on the operational model: the observed queue shares are at or above the modelled ones, and the consequence classes rest on the distance from the stop line and the road users present, not on calculation. Had the vehicle-only consequence (Medical treatment) been taken for H1, its score would rise from Low to Medium with the development, a category change; the finding and the mitigation are the same either way.

8.6 Mitigation package and residual risk

Four measures were tested against the scores:

- **M1, left-out-only access.** The right turn out is prohibited by a raised splitter island in the crossover throat, angled to steer an exiting vehicle into the westbound kerbside lane and prevent it swinging across, with a LEFT ONLY sign facing the exit; the right turn in, left turn in and left turn out are unaffected. H1 falls to Rare / Minor injury / Low (the residual is the left-turn merge into the westbound lane, into or behind a standing queue at walking pace) and H2 is eliminated. Cost to the development: about four right-out trips a day, whose lawful route east is the signalised U-turn 46 m away (U TURN PERMITTED at the signals; the survey recorded no westbound U-turns in four hours, so the movement is available and unused), about 93 m of extra travel and the right-turn lane's 43 to 49 s average delay, or a side-street U-turn east of the site. A physical island, not a sign, carries the score reduction. Recommended.
- **M2, KEEP CLEAR** marking on the two westbound lanes across the access (about 12 m). Shortens the wait of a held right-turn-in vehicle (H3, H4) but changes no score, and depends on driver compliance in a queue that stands for a 127 s red; Council practice on KEEP CLEAR at private accesses is not verified. It does not restore the right-out sight line (section 9.3). Offered to Council as optional; not relied on.
- **M3, No Stopping** along the full 25 m site frontage on the southern kerb. Removes the parked-vehicle sight obstruction in the wide unmarked kerbside lane, which alone cuts the left-out view east to about 7 m and the right-out view west to 14 m (section 9.3). Recommended; it is the reason the residual left-out merge is Low.
- **M4, relocating the crossover** to the eastern end of the frontage would gain 8.9 m (centreline 55.3 m from the stop line) and cut the share of AM cycles with the kerbside queue across the access from 73 to 59 per cent, but would place the crossover in the kerb taper and is not available: the submitted plans are assessed as lodged. Recorded for completeness.

Existing controls relied on: the signals, which meter the eastbound stream into platoons released from a stop line 42 to 50 m away and keep its speed at the access low; the split

phasing, which serves the westbound approach alone so that its right turn is protected and its queues are red-time queues, not overflow queues; the 5.6 m eastbound lane; the 6.1 m unmarked kerbside lane, which gives an exiting driver room to wait clear of the through path; and the U-turn provision at the signals. Proposed controls: M1 and M3; the crossover built to drawing 2.1 at 6.14 m so that entering and exiting vehicles do not conflict in the throat; 29 on-site spaces so that no development parking demand is placed on the frontage; forward-gear entry and exit. Residual with the package: H1 Rare / Minor injury / Low; H2 eliminated; H3 and H4 Unlikely / Minor injury / Low. The residual not reducible by design at this access is the westbound queue itself: a red-time queue of the signal cycle that stands across every driveway on the east leg in most AM cycles, which the development lengthens by 0.2 vehicles and cannot shorten. No monitoring is warranted by the residual scores.

8.7 Level of design review

GTIA section 9.3.3 requires any access works, once designed, to be assessed by a road safety assessment or a road safety audit according to Tables 9.3.3(a) and (b). South Street at the frontage carries about 7,000 vehicles per day in a 50 km/h zone (60 km/h west of the signals), a Low (at most Medium) road environment rating, and the development is a Planning Act development, so a **road safety assessment** of the crossover and island design by an RPEQ with road safety experience or a registered road safety auditor is required. It is proposed as a condition to be met with the Operational Works application (section 12). No works on the State-controlled road are proposed.

8.8 Findings against the SARA concerns

- **SARA-1.5, first bullet (visibility impeded by the westbound queue):** substantiated as a hazard the development adds to (H1, Medium); removed by making the access left-out only (M1) rather than mitigated by marking, because the sight line cannot be restored while the queue stands.
- **SARA-1.5, second bullet (right-turners from Cleveland Redland Bay Road slowing and queuing into the intersection):** the merging movement that would cause it (H2, Low) is removed with M1.
- **SARA-1.6 (right turn in restricted by the westbound queue, queuing into the intersection):** assessed Low with and without the development (H3, H4) because the eastbound lane is wide enough to pass a waiting vehicle, the wait rarely exceeds one westbound red, and the development's right-in volume under queue conditions is about one vehicle per AM peak hour; no measure is required by score and M2 is offered.
- **Crash history:** one casualty crash in the study area in ten and a half years, of the H1 kind, which sets that hazard's consequence; no crash pattern at the east-leg driveways.
- **Queue lengths with intensified turning:** the queue is unchanged by the development; the risks are ones of exposure of the development's own turning movements to an existing condition, and the package addresses the one movement whose exposure matters.

9. ACCESS DRIVEWAY REVIEW

9.1 Access form, category and width

The access is an access driveway in the sense of AS/NZS 2890.1:2004 clause 3.1.1 (kerb and footpath continuous through it, pedestrians and frontage-road traffic with priority), built to the form of Council standard drawing R-RCC-2 for multiple dwelling crossovers. Drawing 2.1 shows it 6.14 m wide at the property boundary and 8.59 m at the kerb, which exceeds the R-RCC-2 two-way width W of 5.5 m; the kerb width is 0.55 m less than the standard drawing's W + 3.0 m splay, a detail for Operational Works. For a residential (user class 1A) car park of 29 spaces on a local collector road, AS/NZS 2890.1 Table 3.1 gives access category 1 (combined width 3.0 to 5.5 m); the proposed width sits within the category 2 range (6.0 to 9.0 m), which clause 3.2.1 permits where traffic-flow

data or turning from the kerbside lane justify it, and it is what makes the splitter island of section 9.7 possible. The crossover and its splays lie wholly within the lot frontage, 9.2 m clear of the western boundary and 7.3 m clear of the eastern boundary at the kerb (City Plan acceptable outcome AO2.1), and the driveway location and design otherwise comply with the standard drawing (AO1.1). The Revision 2 statements of an 8.0 m crossover and a class 1 design are superseded.

9.2 Location relative to the signals

Clause 3.1.1 of AS/NZS 2890.1 makes any right turn into or out of a driveway on a two-way frontage road of more than two lanes a matter of special design; South Street at the frontage has three lanes. Clause 3.2.3(a) requires a driveway near a signalised intersection to be located beyond the influence of normal queue lengths and, where that is not practicable, contemplates an arrangement confining traffic to turning left when entering or leaving, a signalised driveway, or other traffic management; Table 3.1 note 2 adds that left-turn-only movements are preferable in some circumstances. The access is 42.5 m from the stop line on a 25.1 m frontage that cannot be moved beyond the queue: the kerbside queue stands across it in 73 per cent of AM peak-hour cycles, and even the eastern end of the frontage lies inside the AM 95th percentile queue. The clause's fallback therefore applies, and the arrangement recommended in section 9.6 applies its first option in part: traffic leaving the site is confined to the left turn.

9.3 Sight distance

AS/NZS 2890.1 clause 3.2.4 and Figure 4.2 set the entering sight distance along the frontage road for drivers leaving a car park: at 60 km/h, 83 m desirable (5 s gap) and 65 m minimum (stopping sight distance); at 50 km/h, 69 and 45 m; GTIA Appendix A11 would take a design speed of posted plus 10 km/h, giving 97 and 85 m at 70 km/h. Note 3 of the figure foresees restricting parking either side of the driveway so that the sight distance is not obstructed; note 7 takes the driver's eye and the object at 1.15 m above the road, so queued and parked vehicles are opaque. The TMR Road Planning and Design Manual supplement to Austroads Part 4A (clause 3.4) confirms the AS/NZS 2890.1 criterion as the minimum for a property entrance in a constrained situation; the 97 m safe intersection sight distance quoted in Revision 2 is the intersection criterion rather than the property-access criterion, and is superseded by the values above.

Sight distance was assessed in plan on the road-aligned aerial with the driver's eye 2.5 m behind the kerb line on the crossover centreline (3.0 m also tested, same conclusions), targets along the eastbound lane and the approaching westbound lane at 0.5 m steps, queued vehicles as 1.9 m by 4.6 m boxes at 6.5 m pitch from the stop line, and a parked vehicle as a box 0.3 m off the kerb 1 m clear of the crossover. Table 14 gives the results against the Figure 4.2 values at 60 km/h.

Table 16: *Sight distance from the access against AS/NZS 2890.1 Figure 4.2 (posted 50 km/h; 60 km/h basis adopted conservatively)*

Case	Available sight distance	Desirable at 60 km/h	Minimum at 60 km/h	Meets the minimum
Left turn out: view east along the approaching westbound lane, frontage kept clear (M3)	110 m or more	83 m	65 m	Yes
Left turn out: a vehicle parked at the kerb immediately east of the crossover	about 7 m	83 m	65 m	No
Right turn out: view west along the eastbound lane, no queue, no parking	110 m or more	83 m	65 m	Yes
Right turn out: four-vehicle queue in the right-turn lane only (the PM mean)	34 m	83 m	65 m	No
Right turn out: any queue standing across the access (7 or more vehicles; 73 per cent of AM peak-hour cycles)	none beyond 5 m	83 m	65 m	No
Right turn out: a vehicle parked at the kerb west of the crossover, no queue	14 m	83 m	65 m	No
Right turn out: with a KEEP CLEAR gap at the crossover and the queue either side	14 m	83 m	65 m	No

With the frontage kept clear of parked vehicles, the left turn out has more than the desirable sight distance to approaching westbound traffic; a single vehicle parked at the kerb beside the crossover takes it below every minimum, which is the Figure 4.2 note 3 case and the reason for the No Stopping restriction. The right turn out has adequate sight distance only when both westbound lanes are empty. Any queue across the access removes the sight line to the eastbound lane altogether, because the queued vehicles stand between the driver and every point of that lane; even a four-vehicle offside queue blocks the view of the stop line and the first 12 m beyond it, where every eastbound vehicle originates; and a KEEP CLEAR gap does not restore the view because the queue either side of the gap still blocks the oblique line. SARA's first concern is confirmed as a matter of geometry, and the right turn out is removed rather than mitigated by marking. When the westbound queue extends east past the crossover the left-out driver merges into or behind a standing queue rather than into moving traffic. The assessment is desktop and plan-view (verge objects are not modelled); site confirmation of the left-out sight line with the No Stopping restriction in place is recommended at Operational Works with the road safety assessment.

9.4 Movement review

Table 17: Driveway movement review

Movement	Path and conflicts	Sight condition	Queue interaction	Risk rating	Finding
Left turn in (westbound vehicle entering)	From the westbound kerbside lane, slowing in the 6.1 m unmarked lane, across the footpath into the crossover; conflicts with following westbound vehicles at low speed, pedestrians on the footpath, cyclists in the kerbside lane	Straight approach; footpath visible both ways from the boundary; pedestrian sight triangles per section 9.8	When the queue stands across the access the entering vehicle is itself in the queue and turns in from rest; the wide kerbside lane gives room to slow clear of the through path	Not a SARA hazard; ordinary driveway entry	Supported
Left turn out (toward the signals)	Into the westbound kerbside lane; the largest movement (5.7 per hour AM); conflicts with westbound traffic from the east (246 per hour AM, 138 PM), cyclists in the kerbside lane, pedestrians	More than 110 m with the frontage clear; about 7 m with a vehicle parked beside the crossover	In 73 per cent of AM cycles the driver merges into or behind a standing queue at walking pace, waiting for a courtesy gap or the queue to discharge; delay to the exiting driver, not a crossing conflict	Residual of H1 after M1: Rare / Minor injury / Low	Supported, with M3 No Stopping and the M1 island channelising the exit to the left
Right turn in (eastbound vehicle entering across the westbound lanes)	From the eastbound lane across both westbound lanes into the crossover; waits in the 5.6 m eastbound lane 42.5 to 49.5 m from the stop line when opposed; conflicts with opposing westbound traffic (471 per hour AM, 248 PM) or the standing queue, and following eastbound traffic (204 AM, 374 PM)	The waiting driver looks east along a straight road at approaching westbound traffic, which comes from the side away from the queue; no obstruction identified in plan with the frontage clear	About one arrival per AM peak hour and 0.5 per PM hour meets the queue and waits up to one westbound red (127 s AM), then filters through the discharging flow; about seven vehicle lengths of eastbound storage lie between the access and the stop line	H3 and H4 Unlikely / Minor injury / Low with the development; no category change	Supported without restriction; M2 KEEP CLEAR offered as optional
Right turn out (across the westbound lanes to head east)	Across both westbound lanes into the eastbound lane 42.5 to 49.5 m from the stop line that every eastbound vehicle has just left; conflicts with eastbound traffic including cyclists and the Cleveland Redland Bay Road right-turners; the smallest movement (0.6 per hour AM, about 4 a day)	More than 110 m unobstructed; none beyond 5 m with any queue across the access; 34 m with a four-vehicle offside queue; 14 m with a parked vehicle	Needs courtesy gaps through two standing lanes and then emerges into the eastbound lane without a sight line; about 250 such manoeuvres a year under queue conditions with the development against 27 today	H1 Unlikely / Hospitalisation / Medium with the development; H2 Low	Not supported; prevented by the M1 raised splitter island and LEFT ONLY sign; route east by the signalised U-turn 46 m away or a side street

9.5 Interaction with the unmarked kerbside lane and approach lanes

SARA describes the frontage as an indented parking lane with two unmarked lanes that separate into through-left and right-turn movements. Measured, it is a wide unmarked kerbside lane 6.1 to 6.35 m between the kerb and the lane line, with no bay marking, separating line or entry taper, in which vehicles stand 2 to 5 m from the kerb; there is no longitudinal marking for 21 m across the western two-thirds of the frontage and almost all of the crossover, and the carriageway widening tapers out inside the crossover. Its consequences for the access are:

- **Parked vehicles are the sight obstruction the access can do something about.** A vehicle standing in the kerbside lane immediately west of the crossover cuts the right-out view to 14 m; one immediately east cuts the left-out view to about 7 m. The lane invites parking because it is wide and unmarked. The No Stopping restriction over the 25 m frontage (M3) removes the obstruction for the movements the access retains; it is part of the package, not optional. The on-street parking lost is 25 m of unmarked kerbside standing, which the City Plan code weighs against safety (performance outcome PO1(5)); the sight-distance finding justifies it.
- **The kerbside lane is also the westbound through-left lane.** With vehicles parked in it, moving traffic shifts toward the lane line and the effective through path is about 3.3 to 4 m wide; a left-out driver merges into that path and a left-in driver slows in it. With the frontage clear the full 6.1 m is available and an entering vehicle can slow clear of the through path.
- Lane sorting happens across the crossover. Westbound drivers sort themselves into the through-left and right-turn lanes over the unmarked frontage before the lane line begins 7 m west of the site, so a right-in driver judges gaps in two lanes that are still forming and a left-out driver joins a lane whose edge is undefined for 21 m. In most AM cycles both lanes are defined at the access by standing vehicles rather than by marking, because the right-turn queue routinely stands beyond the 26.4 m of marked lane line (five or more vehicles in 66 per cent of AM cycles in Lane 2 and 82 per cent in Lane 1).
- **The taper inside the crossover** means the eastern part of the crossover meets the kerb where the widening is being taken away; the exit lane of the M1 island should sit on the western side of the throat so that a departing vehicle enters the full-width kerbside lane, and the entry lane on the eastern side.
- **An optional marking (M5).** Extending the through-left / right-turn lane line east from 7 m west of the site to the start of the kerb taper, about 18 m, would define the two westbound lanes across the crossover and give a KEEP CLEAR marking a lane structure to sit in. It is a Council line-marking matter, changes no risk score, and is offered with M2 as optional; nothing relies on it.
- **Cyclists and the planned cycle lane.** The Local Government Infrastructure Plan lists an on-road cycle lane upgrade on South Street (TR-L-422); the wide kerbside lane is the space it would occupy. M3 keeps that space clear of parked vehicles at the access and the M1 island removes the only movement that would cross the eastbound cyclist line without a sight line. Nothing in the package compromises the future cycle lane.

9.6 Supportable movements

Table 18: Movement options tested

Option	Effect	Result
A. All four movements unrestricted (as lodged)	H1 Medium with the development on a nil sight line under queue conditions; H2 to H4 Low	Rejected: the right turn out relies on a sight line that the queue removes in most AM cycles and that a marking cannot restore
B. Left in and left out only (right turns prohibited)	Removes H1 to H4 at the access; diverts about 36 right-in trips a day to side-street U-turns east of the site or a loop of at least 1,135 m via Bloomfield Street, Beach Street and Paranka Drive, creating exposure elsewhere; needs an island shaped to block the right turn in as well, or a median on South Street	Not adopted: H3 and H4 are Low with and without the development and change no category, so the GTIA requires no mitigation for them, and the diverted right-in volume is nine times the right-out volume
C. Left in, left out and right in supported; right out prohibited (M1), No Stopping on the frontage (M3), KEEP CLEAR optional (M2)	H1 Low (residual left-out merge), H2 eliminated, H3 and H4 Low; about four right-out trips a day rerouted 93 m via the signed U-turn	Adopted

The revised TIA supports the left turn in, the left turn out and the right turn in at the proposed access, and does not support the right turn out. The access is the single combined entry and exit crossover shown on drawing 2.1 Issue A, operated left-out only by a raised splitter island in its throat with a LEFT ONLY sign, with a No Stopping restriction along the full frontage and a KEEP CLEAR marking offered to Council as optional. Figure 7 shows the arrangement.

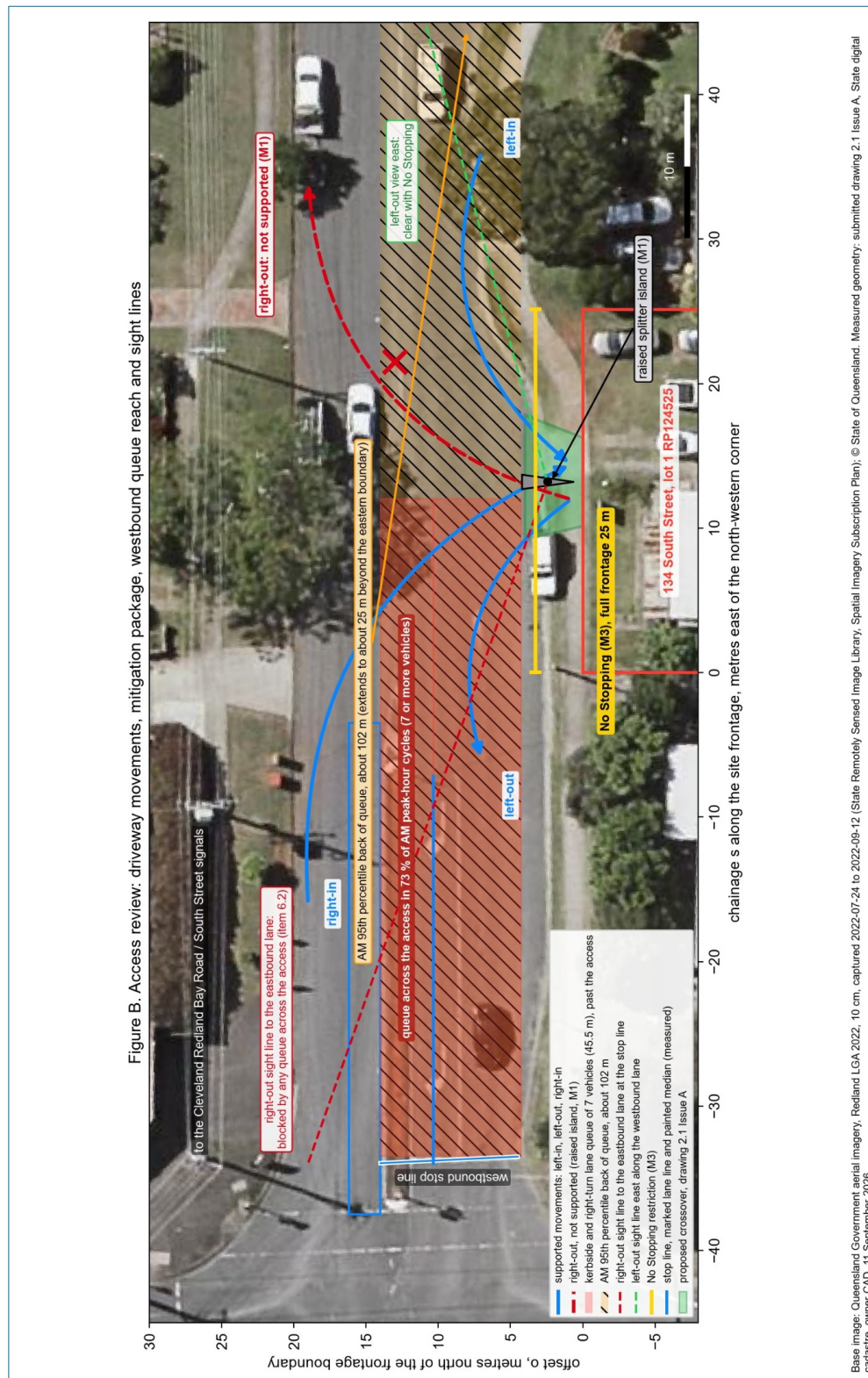


Figure 7: Access review at the proposed crossover: supported and unsupported movements.

Access review at the proposed crossover: left-in, left-out and right-in are supported; the right turn out is not supported and is prevented by a raised splitter island in the crossover throat (M1), with a No Stopping restriction along the full 25 m frontage (M3). The westbound queue of seven or more vehicles, which stands across the access in 73 per cent of AM peak-hour signal cycles, and the calculated AM 95th percentile back of queue of about 102 m are shown from the stop line; the right-out sight line to the eastbound lane is blocked by any queue across the access and the left-out view east is clear with the frontage kept free of parked vehicles. Island shown schematically; design at Operational Works. Base image: Queensland Government aerial imagery, Redland LGA 2022, 10 cm, captured 2022-07-24 to 2022-09-12 (State Remotely Sensed Image Library, Spatial Imagery Subscription Plan); © State of Queensland. Measured geometry: submitted drawing 2.1 Issue A, State digital cadastre, project Civil 3D drawing, 11 September 2026.

9.7 Recommended access arrangement and conditions

The following are recommended as conditions of the approval, in the form Council and SARA may adopt:

- Vehicular access to South Street is to operate left-out only. The crossover is to include a raised splitter island that physically prevents the right turn out while permitting the right turn in, left turn in and left turn out, with a LEFT ONLY sign facing the exit; the entry lane on the eastern side and the exit lane on the western side of the island. Design details are to be provided with the Operational Works application.
- A No Stopping restriction is to apply along the full South Street frontage of the site on the southern kerb, installed at the developer's cost with Council approval before the use commences.
- The crossover and island design is to be the subject of a road safety assessment under section 9.3.3 of the Guide to Traffic Impact Assessment, by an RPEQ with road safety experience or a registered road safety auditor, submitted with the Operational Works application.
- Optional, at Council's discretion: a KEEP CLEAR marking on the westbound lanes across the crossover, and extension of the through-left / right-turn lane line east to the kerb taper.
- Retained from the lodged design: the single combined crossover as drawn, forward-gear entry and exit, and 29 on-site spaces so that no development parking is placed on the frontage.

Nothing in the package touches the State-controlled road or the signals; every approval is Council's.

9.8 Matters for the Operational Works design

- **Island geometry.** A 3.0 m exit lane, a 1.0 m island (AS/NZS 2890.1 clause 3.2.1 minimum separation) and a 3.0 m entry lane need 7.0 m. The crossover provides that over its outer 2.6 m measured from the kerb line, so a short splitter island fits inside the drawing 2.1 splays; an island carried to the boundary needs the boundary width increased from 6.14 m to 7.0 m.
- **Pedestrian sight lines.** The AS/NZS 2890.1 Figure 4.3 sight triangles at the property boundary on the exit side are to be kept clear of fences, walls, signs, bin enclosures and planting above about 1.0 m; the 2 m landscaping strip shown on drawing 2.1 either side of the crossover is to be planted accordingly, and the island and its sign kept clear of the pedestrian sight line.
- **Grades.** Not steeper than 1 in 20 between the frontage road and the property boundary and for the first 6 m into the site (AS/NZS 2890.1 clause 3.3), with the R-RCC-2 layback (1 in 8 over 0.9 m, then 3 per cent), to be shown on the crossover long section.
- **Site confirmation** of the left-out sight line with the No Stopping restriction in place, and of the current speed signs, as part of the road safety assessment.

10. INTERNAL CIRCULATION, PARKING LAYOUT, WASTE COLLECTION AND ACTIVE TRANSPORT

10.1 Internal circulation and parking layout

Drawing 2.1 Issue A provides all 29 spaces at ground level with a single internal aisle and a turning area, entered and left in forward gear; there is no basement or ramp, so the Revision 2 ramp-grade and transition provisions no longer apply. The dimensions annotated on the drawing (spaces 2.7 m by 5.4 m; aisle widths of 5.98 m and 6.74 m; 4 m clear head height at the collection point) meet the AS/NZS 2890.1 user class 1A requirements of 2.4 m by 5.4 m spaces and a 5.8 m aisle for 90-degree parking. Two visitor spaces (28 and 29) are at the front of the site. Accessible parking to AS/NZS 2890.6, bicycle parking and the detailed layout require confirmation on the Operational Works drawings.

10.2 Waste collection

The Revision 2 waste assessment is retained: on-site collection by a small rigid waste collection vehicle (6.5 m long, 2.4 m wide, 7.4 m kerb-to-kerb turning radius) from the bin store at ground level, entering and leaving South Street in forward gear with a single body-length reversing movement at the collection point, and 4 m clear height at the collection point (drawing 2.1). The swept paths in Appendix F were prepared for the Revision 2 layout; the ground-floor arrangement on drawing 2.1 Issue A is the same in principle. The specific collection vehicle used by Council's contractor requires confirmation before Operational Works approval, and the swept paths re-run on the Operational Works drawings with the splitter island in place, because the island narrows the exit throat to 3.0 m and the waste vehicle must leave the site by the left turn like every other vehicle.

10.3 Pedestrian and bicycle access

Pedestrian access is by a dedicated path from South Street to the building entry on the western side of the frontage, separated from the vehicle access. Bicycle parking is to be provided in accordance with the Transport, servicing, access and parking code within the ground-level parking area for residents and near the entry for visitors. The footpath along the frontage is continuous through the crossover (R-RCC-2 form), and the pedestrian sight triangles at the exit are addressed in section 9.8.

10.4 Local Government Infrastructure Plan

The Local Government Infrastructure Plan identifies an on-road cycle lane upgrade (TR-L-422) and an off-road cycle lane upgrade (TR-L-217) along South Street. The access arrangement and the No Stopping restriction do not compromise either; the wide kerbside lane at the frontage is the space the on-road lane would occupy, and the left-out-only access removes the only site movement that would cross the eastbound cyclist line without a sight line.

11. STATE CODE 1 RESPONSE

SARA's pre-lodgement advice (reference 2512-49745 SPL, 8 January 2026) identified performance outcomes PO19, PO20, PO25 and PO26 of State Code 1, Development in a state-controlled road environment, of the State Development Assessment Provisions. The responses below replace those of Revision 2, which relied on the incorrect 100 m separation and a daily percentage comparison. The performance outcome wording is as reproduced in Revision 2 and is to be checked against the current State Development Assessment Provisions version at issue.

PO19: Access safety

New or changed access to a local road within 100 m of an intersection with a state-controlled road does not compromise the safety of users of the state-controlled road.

The access is 42.5 m from the intersection. Its safety was assessed by a GTIA road safety risk assessment of the four conflict scenarios SARA identified, with sight distance measured under the queued and parked conditions that actually occur. The one hazard the development would add to, a right turn out without a sight line to the eastbound lane, is removed by making the access left-out only; the remaining hazards are Low with and without the development and change no category. With the recommended conditions the access does not compromise the safety of users of the state-controlled road or of the intersection.

PO20: Intersection operating performance

New or changed access to a local road within 100 m of an intersection with a state-controlled road does not adversely impact on the operating performance of the intersection.

The development adds 7.2 vehicles per hour to the intersection (0.3 per cent), of which 5.7 join the westbound approach in the AM peak. The first-principles assessment, validated against the surveyed queues, shows no change in level of service on any lane group, at most 0.009 in degree of

saturation, 1.0 s in average delay and 0.24 vehicles (1.6 m) in 95th percentile back of queue, with the intersection's worst degree of saturation unchanged at 0.82 (AM) and 0.75 (PM). A held right-turn-in vehicle waits in a 5.6 m lane that following traffic can pass, so the access does not queue traffic back into the intersection in any but a rare combination of events, assessed Low.

P025: Network safety

Development does not compromise the safety of users of the state-controlled road network. The development has no direct access to the state-controlled road. Its interaction with the state-controlled road network is through the South Street access 42.5 m from the intersection, assessed above; with the left-out-only access and the frontage No Stopping restriction the residual risks are Low.

P026: Network operating performance

Development ensures no net worsening of the operating performance of the state-controlled road network.

The calculated effect of the development on the intersection is below the resolution of any practical measurement (section 7.7). No road upgrades, intersection modifications or works on the state-controlled road are required; the recommended works are on the Council road and within the site.

11.5 Road widening

SARA's pre-lodgement advice confirmed that no land requirements affect the site. No road widening or land resumption is required.

12. CONCLUSIONS AND RECOMMENDATIONS

12.1 Findings

- The proposed crossover is 42.5 m from the South Street westbound stop line at its nearest point, 46.4 m at its centreline and 49.5 m at its far edge, on the south side of the east leg of the Cleveland Redland Bay Road / South Street / Bloomfield Street signals. This supersedes the separation reported in Revision 2.
- The intersection carried 2,516 and 2,401 vehicles in the surveyed AM and PM peak hours of Tuesday 11 August 2026, a day adopted as representative of normal weekday demand. It operates at level of service D in both peaks, existing and with the development, with a worst degree of saturation of 0.82 in the AM and 0.75 in the PM. Under the split phasing in force on the survey day the South Street west approach runs at level of service E in both peaks and the east approach at the site frontage at level of service E in the AM; these are existing conditions of the signal allocation, not effects of the development.
- The development generates about 80 vehicle trips a day and 8 in each peak hour (RTA 2002 rates at the top of the range), 90 per cent of them through the signals. It adds at most 0.009 to any degree of saturation, 1.0 s to any delay and 1.6 m to any 95th percentile queue, and changes no level of service anywhere.
- The westbound queues on the South Street east approach are red-time queues of a long signal cycle under split phasing. The 95th percentile back of queue in the kerbside lane past the site is 106 m in the AM peak and 55 m in the PM, against 42.5 m from the stop line to the nearest point of the access, and the queue reached the access in 60 per cent of the surveyed AM observations. The development lengthens it by 1.6 m.
- One casualty crash is recorded in the study area in ten and a half years, a 2018 vehicle from a driveway striking a cyclist at the signals. Of the four conflict scenarios SARA raised, the right turn out with the view obstructed by the westbound queue is a Medium risk with the development and the one the development materially adds to; its driver has no sight line to the

eastbound lane whenever a queue stands across the access. The other three are Low with and without the development and change no category.

- The left turn in, the left turn out and the right turn in are suitable movements at the access; the right turn out is not. The crossover form and width are consistent with AS/NZS 2890.1 and Council standard drawing R-RCC-2 and lie within the lot frontage.

12.2 Supportability and conditions

The development can be supported from a traffic and road safety standpoint subject to the following:

- the access operates left-out only, with a raised splitter island in the crossover throat preventing the right turn out and a LEFT ONLY sign facing the exit, detailed with the Operational Works application;
- a No Stopping restriction along the full South Street frontage on the southern kerb, at the developer's cost, before the use commences;
- a road safety assessment of the crossover and island design under GTIA section 9.3.3, by an RPEQ with road safety experience or a registered road safety auditor, submitted with the Operational Works application;
- optionally, at Council's discretion, a KEEP CLEAR marking on the westbound lanes across the crossover and extension of the westbound lane line east to the kerb taper;
- the single combined crossover as drawn on drawing 2.1 Issue A, forward-gear entry and exit, and the 29 on-site spaces retained.

With those conditions the residual risk at the access is Low for every hazard, no works are required on the state-controlled road or at the signals, and the performance outcomes PO19, PO20, PO25 and PO26 of State Code 1 are met.

12.3 Limitations and matters carried to Operational Works

- Signal timing was read from the survey video and the survey's cycle sampling, not from controller data; saturation flows are stated assumptions; the sensitivity analysis shows the conclusions do not turn on either.
- The survey is a single representative weekday; the TMR permanent counter's hourly record for that day would confirm it if required.
- Sight distance was assessed in plan from aerial imagery (Council aerial for measurement; Queensland Government orthophoto captured July to September 2022 for the figures); verge objects were not modelled. Site confirmation of the left-out sight line and of the current speed signs is recommended with the road safety assessment.
- The crash record is the public casualty-crash dataset; property-damage-only crashes are not recorded and the driveway of the 2018 crash is not identified.
- AS/NZS 2890.1:2004 table and figure values were taken from a text extract of the standard; they are to be verified against the published standard at Operational Works detailed design.
- The waste vehicle swept paths are to be re-run on the Operational Works drawings with the splitter island in place; the collection vehicle requires confirmation with Council's contractor.
- The parking requirement (26 spaces under the first band of Table 9.3.5.3.2) depends on the bus-service criterion, a planning-scheme matter for confirmation with Council; the provision of 29 spaces complies under that band.

12.4 Preparation

Prepared by:



Craig Harris

Registered Professional Engineer of Queensland (RPEQ 13194)

15 October 2026

Revision 4 — public issue.

13. REFERENCES

- Transportation Research Board, Highway Capacity Manual, 7th edition (2022), Chapter 19 Signalized Intersections and Chapter 31 Signalized Intersections: Supplemental.
- Roads and Traffic Authority of New South Wales (2002), Guide to Traffic Generating Developments, Issue 2.2, section 3.3.
- TMR, Crash data from Queensland roads, dataset version June 2025 (public release updated 24 April 2026).
- TMR, Traffic census (annual average daily traffic) 2014 to 2024, site 140025, Cleveland Redland Bay Road at Island Outlook Avenue.
- TMR, Speed limits for state and local roads (point-in-time register, 2019 to 2020), Redland resource.
- Matrix Traffic and Transport Data, job AUQLD16436, Cleveland Redland Bay Road / South Street / Bloomfield Street, Thornlands, 11 August 2026: turning-movement counts, queue-length survey and video.

APPENDIX A: SARA INFORMATION REQUEST AND RESPONSE

SARA Information Request 2606-52866 SRA, 26 June 2026, Item 1. The request has three parts — the concerns identified, the safety concerns they may give rise to, and the response requested — and they are set out below in that order. SARA's wording is reproduced verbatim and shown in *italics*; the element identifiers in brackets are editorial and are used for cross-reference in the body of this report.

A.1 Concerns identified

SARA, notice page 1, under the heading "1. Impacts to the State-controlled Road network": "Following review of the submitted Traffic Impact Assessment the following concerns were identified:"

Concern 1 (SARA-1.1)

The proposed crossover to South Street is located approximately 50m away from the State-controlled Road intersection. The Traffic Impact Assessment is based off a separation distance of approximately 100m.

Response Agreed. The access is 42.5 m from the South Street westbound stop line at its nearest point, 46.4 m at the crossover centreline and 49.5 m at its far edge, measured from the submitted plan, the State cadastre and the Council aerial and confirmed by the project CAD within 0.5 m. The site is on the south side of the east leg of the intersection. Every assessment in this report uses that geometry, which supersedes the separation reported in Revision 2.

Where addressed Sections 3.2 and 3.3, Figure 1, Appendix E

Concern 2 (SARA-1.2)

The road cross section directly fronting the access is of non-standard form. There is approximately 10m separation between the kerb and centre line, an indented parking lane and two unmarked traffic lanes where vehicles separate into through/left-turn and right-turn movements on approach to the intersection.

Response Confirmed and measured. Centreline to kerb 9.65 m at the access; a 6.1 to 6.35 m wide unmarked kerbside lane with no bay marking or separating line; no longitudinal marking for 21 m across the western two-thirds of the frontage and almost all of the crossover; the marked lane line and painted median begin about 7 m west of the site. The interaction of the access with this cross-section, and the parking restriction and optional line-marking it leads to, are assessed.

Where addressed Sections 3.3 and 9.5

Concern 3 (SARA-1.3)

Cleveland Redland Bay Road is a major north-south connection within the broader Cleveland / Redlands area and likely experiences large peak hour flows. South Street likely also facilitates heavy peak flows connecting considerable residential area to Cleveland Redland Bay Road and the broader network.

Response Confirmed by survey. The intersection carried 2,516 vehicles in the AM peak hour (08:00 to 09:00) and 2,401 in the PM peak hour (16:15 to 17:15) on Tuesday 11 August 2026; the South Street east leg carried 471 vehicles westbound in the AM peak hour. The survey day is adopted as representative of normal weekday demand.

Where addressed Section 5, Appendix B

Concern 4 (SARA-1.4)

The intersection is susceptible to queuing of vehicles. There is a 70m long right-turn lane into South Street from Cleveland Redland Bay Road.

Response Confirmed for the South Street east approach: the westbound queues reach and pass the access in most AM peak-hour signal cycles (calculated 95th percentile back of

queue 106 m, observed maximum 14 to 16 vehicles). The 70 m northbound right-turn lane into South Street carries 10 vehicles per hour in the AM and 39 in the PM; its calculated 95th percentile queue is 1 and 3 vehicles (6 and 21 m), well inside its storage, existing and with the development.

Where addressed Sections 7.5 to 7.7, Figure 3

A.2 Safety concerns

SARA, notice page 2: “The abovementioned concerns may result in safety concerns for the users of the state-controlled road network, in particular:”

Safety concern 1 (SARA-1.5)

Conflicts between right-turning development traffic exiting the site and right-turning traffic from Cleveland Redlands Bay Road, where visibility could be impeded by queuing westbound traffic on South Street, or right-turning traffic from Cleveland Redlands Bay Road slow and queue into the intersection.

Response Substantiated. With any queue across the access a driver turning right out has no sight line to the eastbound lane; with only a four-vehicle offside queue the view is 34 m. The hazard is rated Medium with the development (hazard H1). The right turn out is therefore not supported: the access is to operate left-out only, enforced by a raised splitter island. The merge hazard (H2) is eliminated with it.

Where addressed Sections 8.4 to 8.6, 9.3, 9.4 and 9.6

Safety concern 2 (SARA-1.6)

Conflicts between right-turning development traffic entering the site and traffic from Cleveland Redlands Bay Road, where queuing westbound traffic on South Street restricts entering traffic, resulting in queuing into the intersection.

Response Assessed and rated Low with and without the development (hazards H3 and H4). About one right-turn-in arrival per AM peak hour meets the queue and waits at most one westbound red in the 5.6 m eastbound lane, which following traffic can pass; a queue of six or seven vehicles back to the stop line needs a full-red wait and no passing, a few times a year at most. The right turn in is supported; a KEEP CLEAR marking is offered to Council as optional.

Where addressed Sections 8.4 to 8.6 and 9.4

A.3 Response requested

SARA, notice page 2. The request itself is set out immediately below; its four minimum requirements follow as Requests 1 to 4.

The request (SARA-1.7)

Please provide a revised Traffic Impact Assessment, in accordance with the Department of Transport and Main Road’s Guide to Traffic Impact Assessment, which at a minimum:

Response This report is the revised Traffic Impact Assessment. Its generation (section 6), operational assessment (section 7), road safety risk assessment (section 8) and access review (section 9) follow the Guide’s sections 8.2, 9.2, 9.3 and 10.3.

Where addressed Whole report

Request 1 (SARA-1.8)

Sources up-to-date traffic survey data for the Cleveland Redlands Bay Road / South Street signalised intersection

Response Done. Classified turning-movement counts in 15-minute intervals and once-per-cycle queue observations on the South Street approaches, with video, by Matrix Traffic and Transport Data on Tuesday 11 August 2026 (07:00 to 09:00 and 16:00 to 18:00); units, lane order and sampling verified from the video.

Where addressed Section 5, Appendix B

Request 2 (SARA-1.9)

Conducts either a traffic analysis and / or SIDRA analysis to determine operational impacts due to the proposed development

Response Done by a documented signalised-intersection calculation to the Highway Capacity Manual 7th edition, Chapters 19 and 31, carried in a workbook of live formulas, with the signal timing read from the survey video and the results validated against the surveyed queues in all ten matched lane and peak cells. The development adds at most 0.009 to any degree of saturation, 1.0 s to any delay and 1.6 m to any 95th percentile queue; no level of service changes.

Where addressed Section 7, Appendix C

Request 3 (SARA-1.10)

Undertakes a road safety risk assessment in accordance with the GTIA that, at a minimum, includes a review of surrounding crash history on South Street, and a review of queue lengths / risks associated with intensified turning movements as a result of the proposed development traffic

Response Done. Ten and a half years of Transport and Main Roads crash records placed against the access (one casualty crash inside the study area, a 2018 vehicle-from-driveway strike on a cyclist at the signals); four hazards rated on the Guide's Figure 9.3.2(a) matrix without, with, and with mitigation; the westbound queue is unchanged by the development (0.2 vehicles) and the risks are ones of exposure to it.

Where addressed Section 8, Appendix D

Request 4 (SARA-1.11)

Undertakes a review of the access driveway and confirms suitability of all movements arrangement and form on South Street.

Response Done, movement by movement. Left turn in, left turn out and right turn in are supported; the right turn out is not and is prevented by a raised splitter island with a LEFT ONLY sign. A No Stopping restriction is proposed along the frontage, and the crossover form and width are consistent with AS/NZS 2890.1 and Council standard drawing R-RCC-2. The development can be supported subject to the conditions in section 12.

Where addressed Sections 9 and 12, Figure 7

APPENDIX B: TRAFFIC SURVEY SUMMARY

Matrix Traffic and Transport Data, job AUQLD16436, Tuesday 11 August 2026, fine weather. Sessions 07:00 to 09:00 and 16:00 to 18:00. Turning-movement counts by light vehicle (LV) and heavy vehicle (HV) in 15-minute intervals; cyclists and pedestrians counted separately; queue observations once per signal cycle on the two South Street approaches; video from four cameras. Source data: turning-count workbook (AUQLD16436 SITE1), queue-length workbook (AUQLD16436 Thornlands Queue Length Survey), Matrix summary sheets (map, intersection diagram, peak hour, pedestrians, queues) compiled as the survey data appendix supplied with this report.

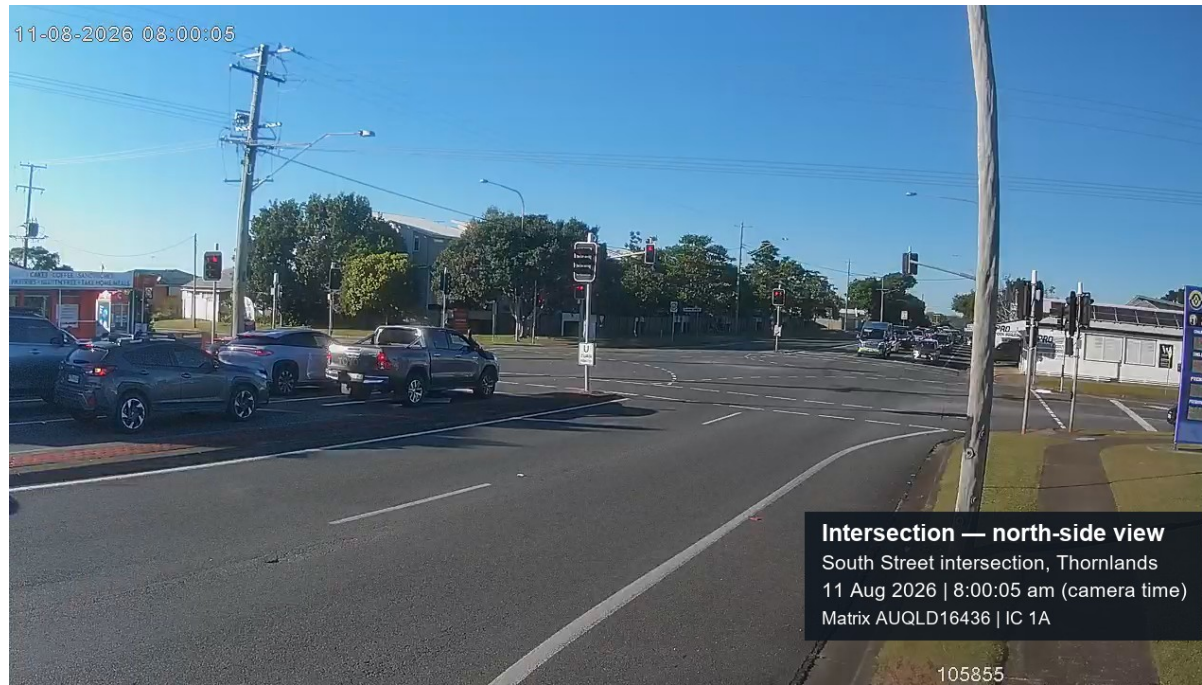


Figure 8: North-side view of the South Street / Bloomfield Street / Cleveland Redland Bay Road intersection, Thornlands. Matrix survey AUQLD16436, camera IC 1A; 11 August 2026 at 8:00:05 am (camera time).



Figure 9: South-side view of the South Street / Bloomfield Street / Cleveland Redland Bay Road intersection, Thornlands. Matrix survey AUQLD16436, camera IC 1B; 11 August 2026 at 8:00:05 am (camera time).



Figure 10: South Street east leg, westbound queue survey view. Matrix survey AUQLD16436, camera 1 WBQ; 11 August 2026 at 8:00:05 am (camera time).

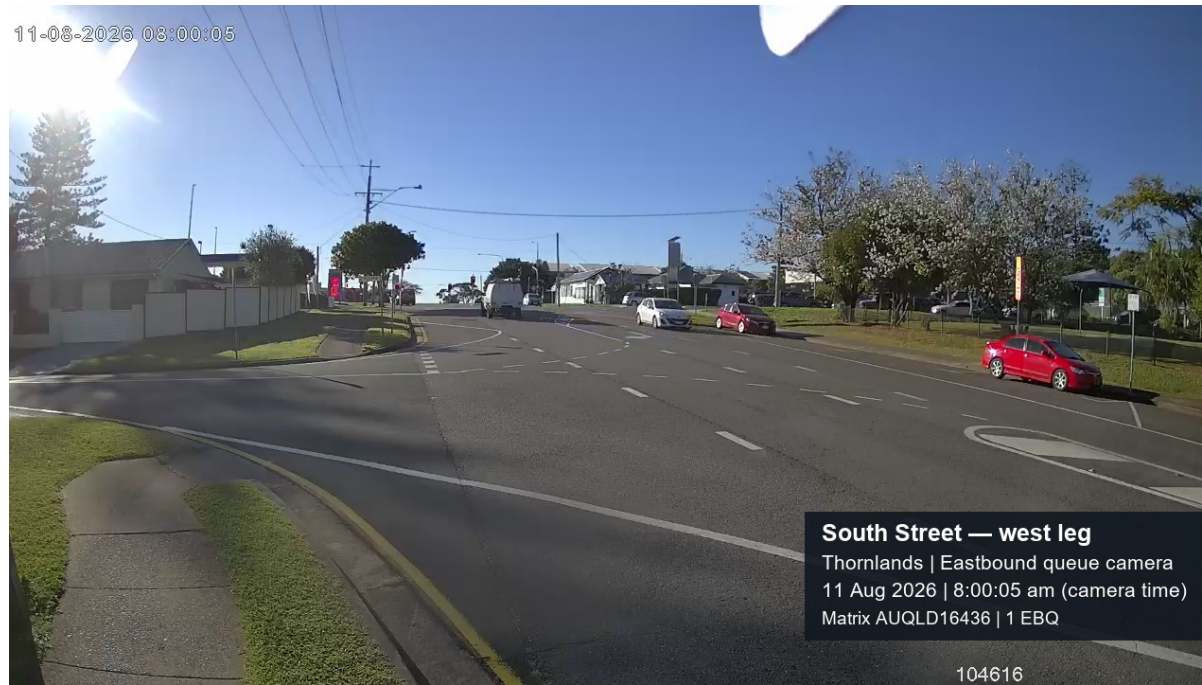


Figure 11: South Street west leg, eastbound queue survey view. Matrix survey AUQLD16436, camera 1 EBQ; 11 August 2026 at 8:00:05 am (camera time).

Table 19: Peak-hour turning movements, AM 08:00 to 09:00 and PM 16:15 to 17:15

Peak	From	Travel	Matrix movement	Turn	To	LV/h	HV/h	Total vehicles/h
AM	Cleveland Redland Bay Road (south leg)	Northbound	1	Left	South Street west	84	4	88
AM	Cleveland Redland Bay Road (south leg)	Northbound	2	Through	Bloomfield Street	822	20	842
AM	Cleveland Redland Bay Road (south leg)	Northbound	3	Right	South Street east	9	1	10
AM	Cleveland Redland Bay Road (south leg)	Northbound	3U	U-turn	Cleveland Redland Bay Road	1	0	1
AM	South Street (east leg, the site side)	Westbound	4	Left	Cleveland Redland Bay Road south	24	0	24
AM	South Street (east leg, the site side)	Westbound	5	Through	South Street west	219	3	222
AM	South Street (east leg, the site side)	Westbound	6	Right	Bloomfield Street	224	1	225
AM	South Street (east leg, the site side)	Westbound	6U	U-turn	South Street east	0	0	0
AM	Bloomfield Street (north leg)	Southbound	7	Left	South Street east	92	0	92
AM	Bloomfield Street (north leg)	Southbound	8	Through	Cleveland Redland Bay Road	494	13	507
AM	Bloomfield Street (north leg)	Southbound	9	Right	South Street west	150	8	158
AM	Bloomfield Street (north leg)	Southbound	9U	U-turn	Bloomfield Street	7	0	7
AM	South Street (west leg)	Eastbound	10	Left	Bloomfield Street	132	5	137
AM	South Street (west leg)	Eastbound	11	Through	South Street east	97	5	102

Peak	From	Travel	Matrix movement	Turn	To	LV/h	HV/h	Total vehicles/h
AM	South Street (west leg)	Eastbound	12	Right	Cleveland Redland Bay Road south	95	6	101
AM	South Street (west leg)	Eastbound	12U	U-turn	South Street west	0	0	0
PM	Cleveland Redland Bay Road (south leg)	Northbound	1	Left	South Street west	74	5	79
PM	Cleveland Redland Bay Road (south leg)	Northbound	2	Through	Bloomfield Street	502	7	509
PM	Cleveland Redland Bay Road (south leg)	Northbound	3	Right	South Street east	37	2	39
PM	Cleveland Redland Bay Road (south leg)	Northbound	3U	U-turn	Cleveland Redland Bay Road	0	0	0
PM	South Street (east leg, the site side)	Westbound	4	Left	Cleveland Redland Bay Road south	25	2	27
PM	South Street (east leg, the site side)	Westbound	5	Through	South Street west	108	3	111
PM	South Street (east leg, the site side)	Westbound	6	Right	Bloomfield Street	110	0	110
PM	South Street (east leg, the site side)	Westbound	6U	U-turn	South Street east	0	0	0
PM	Bloomfield Street (north leg)	Southbound	7	Left	South Street east	153	0	153
PM	Bloomfield Street (north leg)	Southbound	8	Through	Cleveland Redland Bay Road	774	10	784
PM	Bloomfield Street (north leg)	Southbound	9	Right	South Street west	168	3	171
PM	Bloomfield Street (north leg)	Southbound	9U	U-turn	Bloomfield Street	10	0	10
PM	South Street (west leg)	Eastbound	10	Left	Bloomfield Street	96	2	98
PM	South Street (west leg)	Eastbound	11	Through	South Street east	179	3	182
PM	South Street (west leg)	Eastbound	12	Right	Cleveland Redland Bay Road south	126	2	128
PM	South Street (west leg)	Eastbound	12U	U-turn	South Street west	0	0	0

Peak-hour totals: AM 2,516 motor vehicles (peak 15 minutes 08:30, 656 vehicles, peak-hour factor 0.96); PM 2,401 (peak 15 minutes 17:00, 644 vehicles, factor 0.93). Own peaks: South Street east approach 07:30 to 08:30 (535 vehicles) and 16:00 to 17:00 (253); Cleveland Redland Bay Road 07:45 to 08:45 (945); Bloomfield Street 16:30 to 17:30 (1,126). Cleveland Redland Bay Road two-way cross-section 1,573 (AM) and 1,566 (PM) vehicles per hour against the 2024 annual average daily traffic of 17,378 at TMR site 140025, 1.0 km south.

Table 20: Queue observations, South Street east approach (westbound), vehicles per lane

Period	Lane	Samples	Mean	Median	95th percentile of the sample	Maximum	Share with 7 or more
AM 08:00 to 09:00	Lane 1 kerbside (through and left, past the site)	22	8.6	8.5	13	14	73 %
AM 08:00 to 09:00	Lane 2 offside (right turn)	22	8.1	9.0	15	16	59 %
AM session 07:00 to 09:00	Lane 1	50	7.5	7.0	13	14	60 %
AM session 07:00 to 09:00	Lane 2	50	7.2	6.0	15	16	48 %
PM 16:15 to 17:15	Lane 1 kerbside (through and left, past the site)	25	4.2	4.0	8	10	12 %
PM 16:15 to 17:15	Lane 2 offside (right turn)	25	3.6	4.0	5	7	4 %
PM session 16:00 to 18:00	Lane 1	54	3.7	3.5	7	10	7 %
PM session 16:00 to 18:00	Lane 2	54	3.0	3.0	5	7	4 %

West approach (eastbound) matched-hour maxima: 11, 10 and 9 vehicles in the AM (lanes 1 to 3) and 8, 13 and 10 in the PM. Sampling intervals on the east approach were 94 to 180 s (AM) and 93 to 168 s (PM), one observation per signal cycle during the red; the count unit (vehicles) and the lane order (Lane 1 kerbside) were confirmed from the queue camera frames.

APPENDIX C: OPERATIONAL ASSESSMENT METHOD AND OUTPUTS

C.1 Equations

- Method: Highway Capacity Manual 7th edition (2022), Chapter 19 Signalized Intersections and Chapter 31 Signalized Intersections: Supplemental. Every equation number and constant below is read from those chapters; the calculation is carried in a workbook of live formulas, sheet by sheet, so each figure is traceable cell by cell.
- Saturation flow rate $s = s_0 \times f_w \times f_{HVg} \times f_p \times f_{bb} \times f_a \times f_{LU} \times \text{turn factor}$ (equation 19-8), with the lane width factor from exhibit 19-20, the heavy vehicle and grade factor from equations 19-9 and 19-10, and the parking factor from equation 19-11 applied only to the lane group beside the parking lane.
- Lane group capacity $c = N s g/C$ (equation 19-16) and degree of saturation $X = v/c$ (equation 19-17).
- Control delay $d = d_1 + d_2$ (equation 19-18). Uniform delay $d_1 = PF \times 0.5 C (1 - g/C)^2 / (1 - \min(1, X) g/C)$ (equation 19-19), with the progression adjustment factor $PF = 1.0$ for isolated operation with random arrivals (equation 19-20). Incremental delay $d_2 = 900 T [(X - 1) + \sqrt{(X - 1)^2 + 8 k l X / (c T)}]$ (equations 19-26 and 19-27), with the incremental delay factor k of equation 19-22 clamped at both of its stated limits, 0.04 and 0.50. Level of service from exhibit 19-8; any lane group with a degree of saturation above 1.0 is level of service F whatever its delay.
- Back of queue: first term Q_1 from the queue accumulation polygon (equation 31-141) and second term $Q_2 = c d_2 / (3,600 N)$ (equation 31-142). Percentile back of queue $Q\% = (Q_1 + Q_2) f_{B\%} + Q_3$ (equation 31-150), with the percentile factor from equations 31-151 and 31-153 and $z = 1.64$ at the 95th percentile. No initial queue is carried into either peak, so d_3 and Q_3 are zero.
- Queue storage ratio $RQ = L_h Q / L_a$ (equation 31-154). The queue spacing L_h is adopted at 6.5 m per queued vehicle, this office's stated assumption for the site, in place of the equation 31-155 value of 7.62 m per car and 13.72 m per heavy vehicle. The adopted value is stated wherever a storage ratio is reported, because the two spacings give different answers on the Cleveland Redland Bay Road approach.
- Opposed right turns: permitted saturation flow rate $s_p = v_o e^{(-v_o t_{cg}/3600)} / (1 - e^{(-v_o t_{fh}/3600)})$ (equation 31-100) with a critical headway t_{cg} of 4.5 s and a follow-up headway t_{fh} of 2.5 s; permitted capacity in an exclusive lane from equation 31-119 with 2.0 sneakers per cycle; protected-permitted capacity from equation 31-124. The shared through-and-kerbside-turn saturation flow follows equation 31-61.
- Drive side. The Highway Capacity Manual is written for right-hand drive traffic, in which the left turn crosses the opposing stream. In Queensland the right turn crosses. The manual's left-turn treatments are therefore applied to the right turn — equation 19-14 for the turn factor and the permitted and protected-permitted procedures of chapter 31 — and its right-turn factor, equation 19-13, is applied to the kerbside left turn.

Table 21: Lane-group results, AM peak 08:00 to 09:00 (existing / with development); cycle 163 s, westbound displayed green 63.1 s, eastbound 51.8 s

Approach and lane group	Demand (veh/h)	Capacity (veh/h)	Degree of saturation	Average delay (s/veh)	Level of service	Average back of queue (veh)	95th percentile back of queue (veh)	95th percentile (m)
South Street east approach (westbound), Lane 1 kerbside: through and left	246 / 249	346 / 346	0.71 / 0.72	64.9 / 65.5	E / E	10.9 / 11.1	16.3 / 16.5	106 / 108
South Street east approach (westbound), Lane 2: right turn	225 / 228	396 / 396	0.57 / 0.57	58.0 / 58.2	E / E	9.2 / 9.4	14.2 / 14.4	92 / 94
South Street west approach (eastbound), left turn	137 / 137	252 / 252	0.54 / 0.54	65.0 / 65.0	E / E	5.8 / 5.8	9.8 / 9.8	64 / 64
South Street west approach (eastbound), through	102 / 103	283 / 283	0.36 / 0.36	62.0 / 62.1	E / E	4.2 / 4.2	7.5 / 7.5	49 / 49
South Street west approach (eastbound), right turn	101 / 101	267 / 267	0.38 / 0.38	62.3 / 62.3	E / E	4.1 / 4.1	7.4 / 7.4	48 / 48
Cleveland Redland Bay Road (northbound), through and left, two lanes	930 / 930	1,139 / 1,139	0.82 / 0.82	56.5 / 56.5	E / E	20.2 / 20.2	27.6 / 27.6	179 / 179
Cleveland Redland Bay Road (northbound), right turn into South Street east	11 / 11	165 / 165	0.07 / 0.07	66.9 / 66.9	E / E	0.5 / 0.5	0.8 / 0.8	5 / 5
Bloomfield Street (southbound), through and left, two lanes	599 / 600	1,440 / 1,440	0.42 / 0.42	35.7 / 35.7	D / D	9.8 / 9.8	15.0 / 15.0	97 / 97
Bloomfield Street (southbound), right turn	165 / 165	429 / 429	0.38 / 0.38	52.5 / 52.5	D / D	6.3 / 6.3	10.4 / 10.4	68 / 68

Table 22: Lane-group results, PM peak 16:15 to 17:15 (existing / with development); cycle 142 s, westbound displayed green 53.2 s, eastbound 42.5 s

Approach and lane group	Demand (veh/h)	Capacity (veh/h)	Degree of saturation	Average delay (s/veh)	Level of service	Average back of queue (veh)	95th percentile back of queue (veh)	95th percentile (m)
South Street east approach (westbound), Lane 1 kerbside: through and left	138 / 140	293 / 293	0.47 / 0.48	51.3 / 51.4	D / D	4.9 / 4.9	8.5 / 8.6	55 / 56
South Street east approach (westbound), Lane 2: right turn	110 / 111	349 / 349	0.32 / 0.32	49.4 / 49.5	D / D	3.7 / 3.8	6.7 / 6.8	44 / 44
South Street west approach (eastbound), left turn	98 / 98	212 / 212	0.46 / 0.46	57.9 / 57.9	E / E	3.6 / 3.6	6.5 / 6.5	42 / 42
South Street west approach (eastbound), through	182 / 184	242 / 242	0.75 / 0.76	71.7 / 72.7	E / E	7.7 / 7.9	12.3 / 12.5	80 / 81
South Street west approach (eastbound), right turn	128 / 128	230 / 230	0.56 / 0.56	59.8 / 59.8	E / E	4.9 / 4.9	8.5 / 8.5	55 / 55
Cleveland Redland Bay Road (northbound), through and left, two lanes	588 / 588	1,067 / 1,067	0.55 / 0.55	42.8 / 42.8	D / D	9.8 / 9.8	15.0 / 15.0	97 / 97
Cleveland Redland Bay Road (northbound), right turn into South Street east	39 / 40	186 / 186	0.21 / 0.21	58.1 / 58.1	E / E	1.4 / 1.4	2.5 / 2.6	17 / 17
Bloomfield Street (southbound), through and left, two lanes	937 / 939	1,353 / 1,353	0.69 / 0.69	39.2 / 39.2	D / D	15.9 / 15.9	22.4 / 22.5	146 / 146
Bloomfield Street (southbound), right turn	181 / 181	521 / 521	0.35 / 0.35	40.1 / 40.1	D / D	5.7 / 5.7	9.6 / 9.6	62 / 62

Table 23: Change from existing to with-development on the lane groups that receive development traffic (all other lane groups unchanged)

Lane group	Peak	Added demand (veh/h)	Change in degree of saturation	Change in average delay (s/veh)	Change in 95th percentile back of queue (veh)	Change (m)
South Street east approach (westbound), Lane 1 kerbside: through and left	AM	+3.0	+0.009	+0.59	+0.24	+1.6
South Street east approach (westbound), Lane 2: right turn	AM	+2.7	+0.007	+0.21	+0.17	+1.1
South Street west approach (eastbound), through	AM	+0.7	+0.002	+0.03	+0.05	+0.4
Cleveland Redland Bay Road (northbound), right turn into South Street east	AM	+0.1	+0.001	+0.00	+0.01	+0.0
Bloomfield Street (southbound), through and left, two lanes	AM	+0.6	+0.000	+0.01	+0.01	+0.1
South Street east approach (westbound), Lane 1 kerbside: through and left	PM	+1.6	+0.005	+0.07	+0.09	+0.6
South Street east approach (westbound), Lane 2: right turn	PM	+1.3	+0.004	+0.04	+0.09	+0.6
South Street west approach (eastbound), through	PM	+2.1	+0.009	+0.99	+0.19	+1.3
Cleveland Redland Bay Road (northbound), right turn into South Street east	PM	+0.5	+0.003	+0.02	+0.03	+0.2
Bloomfield Street (southbound), through and left, two lanes	PM	+1.8	+0.001	+0.04	+0.05	+0.3

Table 24: Sensitivity of the South Street westbound 95th percentile back of queue with the development, and of the worst degree of saturation

Sensitivity	AM Lane 1 (veh)	AM Lane 2 (veh)	AM worst degree of saturation	PM Lane 1 (veh)	PM Lane 2 (veh)	PM worst degree of saturation
Existing, for reference	16.3	14.2	0.82	8.5	6.7	0.75
Design case: 8 trips per hour, AM 20/80 and PM 60/40 in/out, 90 per cent via the signals	16.5	14.4	0.82	8.6	6.8	0.76
1a Generation 10 trips per hour	16.6	14.4	0.82	8.6	6.8	0.76
1b 80 per cent via the signals	16.5	14.4	0.82	8.6	6.8	0.76
1c PM split 80 in / 20 out	16.5	14.4	0.82	8.5	6.8	0.76
1d All three combined	16.6	14.4	0.82	8.5	6.8	0.77
2 Westbound own peak 07:30 to 08:30, cycle 153.6 s (east approach only)	17.8	16.4	0.82	–	–	–
3 Peak 15 minutes (T = 0.25 h, lane-group peak-hour factors)	24.8	23.7	0.94	10.3	8.3	0.92
4a Saturation flow 1,700 pc/h/ln	17.7	14.8	0.91	8.7	6.9	0.85
4b Saturation flow 1,950 pc/h/ln	16.4	14.3	0.80	8.6	6.8	0.74
5a Westbound green 5 s shorter	18.4	15.1	0.84	9.0	7.1	0.76
5b Westbound green 5 s longer	15.6	13.8	0.82	8.3	6.5	0.76
6 Queue spacing 6.07 to 7.08 m (metres only)	100 to 117 m	87 to 102 m	–	52 to 61 m	41 to 48 m	–
7 Incremental delay factor k = 0.50 (pretimed)	17.3	15.0	0.82	9.1	7.2	0.76
8a Intergreen 6 s (both South Street greens 1 s longer)	16.3	14.3	0.82	8.5	6.8	0.72
8b Intergreen 8 s (both South Street greens 1 s shorter)	16.8	14.5	0.82	8.6	6.9	0.81

Sensitivity	AM Lane 1 (veh)	AM Lane 2 (veh)	AM worst degree of saturation	PM Lane 1 (veh)	PM Lane 2 (veh)	PM worst degree of saturation
9 Head mapping B: north-view head northbound, south-view head southbound	16.5	14.4	0.72	8.6	6.8	0.88
10 Effective green = displayed + 1 s on every lane group	16.3	14.3	0.80	8.5	6.8	0.72

Table 25: Validation of the calculated queues against the observed once-per-cycle counts (existing case)

Cell	Samples	Observed mean $\pm$ 95 per cent confidence	Modelled average	Test A	Observed 95th percentile / maximum	Modelled 95th percentile	Test B
AM East Lane 1	22	8.59 (7.40 to 9.78)	10.89	pass	13 / 14	16.3	pass
AM East Lane 2	22	8.14 (6.30 to 9.97)	9.23	pass	15 / 16	14.2	FLAG
AM West Lane 1	22	5.73 (4.69 to 6.76)	5.83	pass	10 / 11	9.8	FLAG
AM West Lane 2	22	3.91 (2.80 to 5.02)	4.16	pass	8 / 10	7.5	FLAG
AM West Lane 3	22	3.18 (2.41 to 3.95)	4.14	pass	6 / 9	7.4	pass
PM East Lane 1	25	4.20 (3.31 to 5.09)	4.87	pass	8 / 10	8.5	pass
PM East Lane 2	25	3.60 (3.08 to 4.12)	3.75	pass	5 / 7	6.7	pass
PM West Lane 1	24	3.38 (2.54 to 4.21)	3.61	pass	7 / 8	6.5	FLAG
PM West Lane 2	25	7.24 (5.82 to 8.66)	7.74	pass	13 / 13	12.3	FLAG
PM West Lane 3	25	2.48 (1.69 to 3.27)	4.85	pass	4 / 10	8.5	pass

APPENDIX D: CRASH DATA SUMMARY

Source: TMR, Crash data from Queensland roads, road crash locations resource (e88943c0-5968-4972-a15f-38e120d72ec0), dataset version June 2025, public release updated 24 April 2026, coordinates GDA2020; casualty crashes only (property-damage-only crashes have not been recorded since 2010); records for the most recent twelve months may be preliminary. Query: locality Thornlands, South Street in either street field, 2015 to June 2025; 12 records from the 657 Thornlands records. Distances are along the road from the Cleveland Redland Bay Road / South Street signals; the study area is the signals (60 m) and the east leg to 300 m east (Figure 6).

Table 26: South Street crash records, 2015 to June 2025

Reference	Date	Severity	Nature and description	Location	Distance from the signals	Units	In the study area
295287	April 2018	Hospitalisation	Angle; vehicle manoeuvring, entering from footway	Cleveland Redland Bay Road / South Street signals	30 m from the signals, 52 m from the access	Car and bicycle	Yes
386537	September 2019	Hospitalisation	Hit pedestrian	South Street / Waterloo Street	227 m west of the signals	Car and pedestrian	No
266929	October 2024	Hospitalisation	Angle; vehicle manoeuvring, leaving parking	South Street	280 m west of the signals	Car and bicycle	No
387533	October 2021	Medical treatment	Rear-end	South Street	342 m west of the signals	Three cars	No
292157	July 2021	Medical treatment	Hit object, off carriageway to the right	South Street	660 m east of the signals	Car	No
104654	October 2015	Hospitalisation	Hit parked vehicle	South Street	731 m east of the signals	Three cars	No
303270	July 2018	Medical treatment	Rear-end	Osprey Drive / South Street	840 m west of the signals	Two cars	No
398124	November 2024	Medical treatment	Angle; opposing approach, through and right	Osprey Drive / South Street	840 m west of the signals	Two cars	No
298092	March 2018	Hospitalisation	Rear-end	South Street	949 m west of the signals	Two cars	No
242887	January 2018	Hospitalisation	Angle; vehicle manoeuvring, entering from footway	South Street / Wellington Street	1,103 m west of the signals	Car and bicycle	No
377396	March 2019	Medical treatment	Angle; adjacent approach, through and through	South Street / Wellington Street	1,130 m west of the signals	Two cars	No
384986	August 2024	Minor injury	Angle; adjacent approach, right and through	South Street / Wellington Street	1,130 m west of the signals	Two cars	No

Corridor context: the earlier ten-record extract from Wellington Street to the signals (2015 to 2024) contains no fatal crash, four casualty crashes in 2020 to 2024 and ten in 2015 to 2024; three of the angle crashes involve a bicycle and two are coded as a vehicle entering from a footway. None is a queue-related driveway crash on the east leg. A TMR crash data request would identify the driveway of the 2018 crash and any unreported detail; it was not required for the ratings.

APPENDIX E: ACCESS SEPARATION AND FRONTAGE MEASUREMENT

The separation and cross-section in section 3 were measured on 11 September 2026 by combining: the vector geometry of Interworks Architects drawing 2.1 Issue A (crossover western edge 10.13 m and eastern edge 16.27 m from the western side boundary; 6.14 m wide at the boundary and 8.59 m at the kerb; frontage 25.125 m); chainage along the frontage from the State digital cadastre (Lot 1 RP124525, frontage 25.136 m; GDA2020 MGA zone 56); the westbound stop line, lane line, painted median and kerb line digitised from the Redland City Council public aerial basemap in a road-aligned rectification of the frontage (chainage east along the frontage from the site's north-western corner; offset north from the boundary); and a second reference, the Cleveland Redland Bay Road road-reserve boundary, which agreed within 0.1 m. Drawing orientation was verified against the measured kerb taper. The project CAD, with the same plan and Esri and Microsoft/Maxar imagery, returned 42.46 m to the nearest point of the access (desktop 42.96 m), 6.15 and 8.55 m for the crossover widths, 4.00 m kerb to boundary, 9.65 m centreline to kerb and 26.36 m of marked right-turn lane; every line agrees within 0.5 m. The published figures use the Queensland Government orthophoto (Redland local government area, 10 cm, captured 24 July to 12 September 2022, State Remotely Sensed Image Library), registered to the same frame by the stop line and lane line with a residual of 0.75 m corrected; the measurement itself does not depend on that image. Aerial capture dates for the measurement imagery are not published; the line marking seen in the imagery was checked against the 11 August 2026 survey video.

Figure 1 (section 3.2) shows the separation; Figure 7 (section 9.6) shows the access review on the same base; Figure 6 (section 8.2) shows the crash study area.

APPENDIX F: SWEEP PATH DIAGRAMS (REVISION 2, RETAINED)

Swept paths for the small rigid waste collection vehicle (6.5 m long, 2.4 m wide) prepared for Revision 2 on the Revision 2 ground-floor layout. To be re-run on the Operational Works drawings with the splitter island in place (section 10.2).

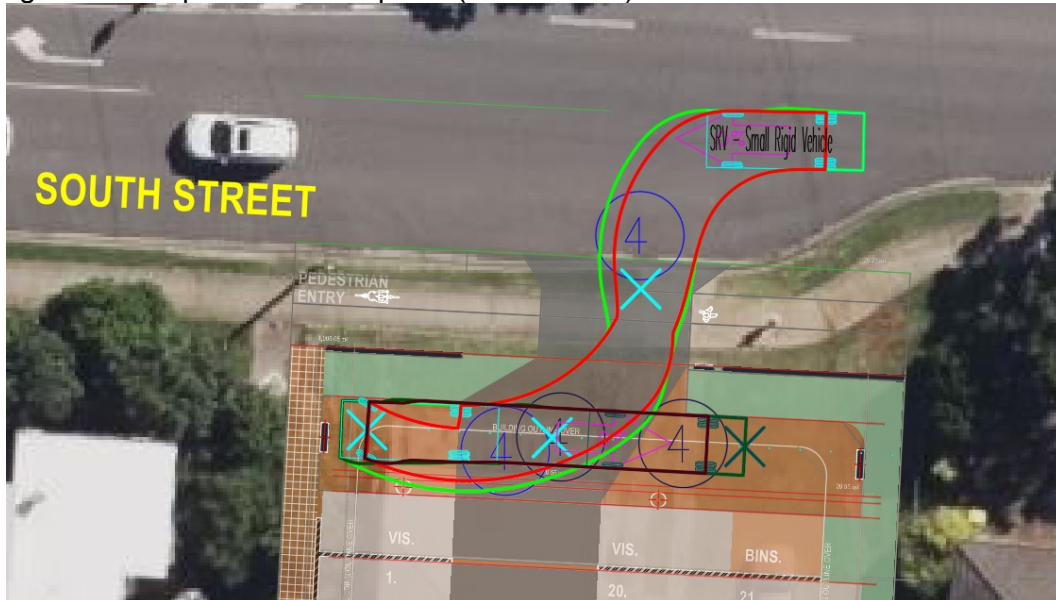


Figure 12: Small rigid waste collection vehicle: entry and manoeuvre to the bin collection point (Revision 2)

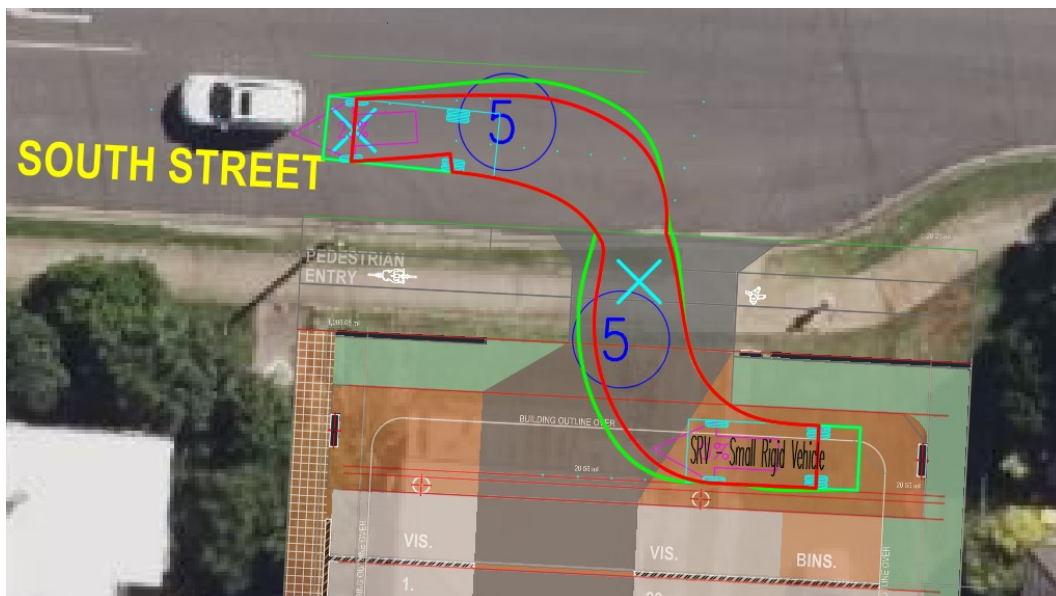


Figure 13: Small rigid waste collection vehicle: exit manoeuvre to South Street (Revision 2)

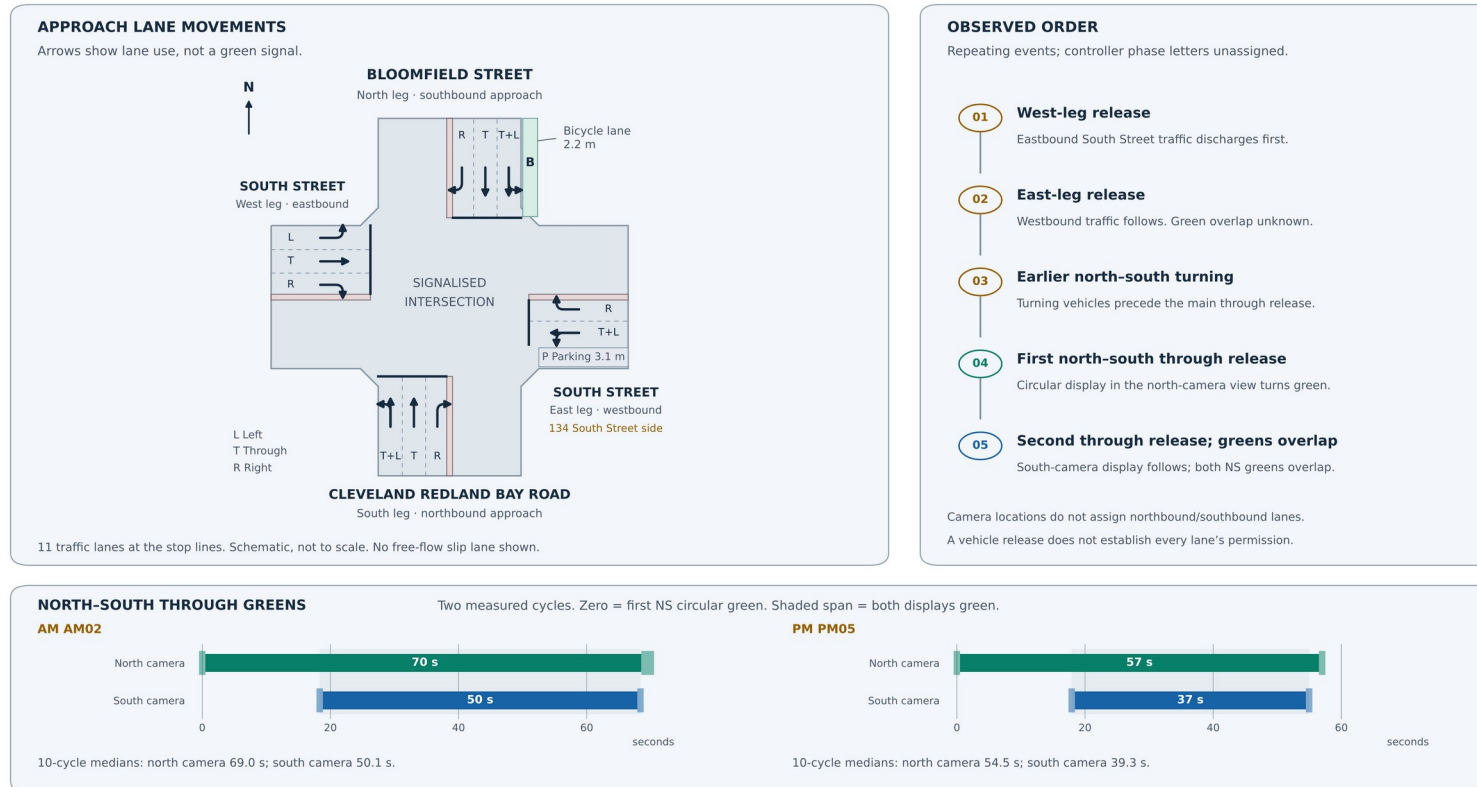
APPENDIX G: SIGNAL OPERATION OBSERVED IN THE SURVEY

The signal operation used in section 7 was read from the Matrix survey video of Tuesday 11 August 2026. Ten cycles in each peak were sampled. This appendix sets out that evidence: the approach lane movements and the order in which the approaches are released; the measured cycle timelines from the two intersection cameras; and the movement timing adopted for the calculation.

Lane movements and observed signal sequence

Bloomfield Street / Cleveland Redland Bay Road / South Street, Thornlands

Survey: 11 August 2026



Geometry: owner-reviewed layout workbook, 15 September 2026. Signal evidence: Matrix AUQLD16436; 10 AM and 10 PM cycles.

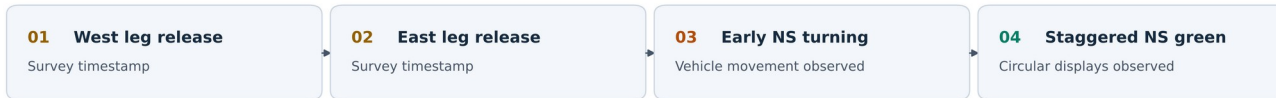
Observed operation - complete controller plan remains unverified

Figure 14: Approach lane movements and the observed order of release, from the survey video. The white arrows show lane use, not a green signal; the observed order is of events in the recorded views, not of controller stages.

Geometry from the reviewed project layout workbook of 15 September 2026; signal evidence from Matrix survey AUQLD16436, ten AM and ten PM cycles.

OBSERVED SIGNAL SEQUENCE

Cleveland Redland Bay Road / Bloomfield Street / South Street, Thornlands

MATRIX SURVEY
11 August 2026


NS = north-south. Boxes show observed event order, not exclusive controller stages.



TEN-CYCLE MEDIANS

AM North 69.0 s / South 50.1 s
PM North 54.5 s / South 39.3 s

North and south identify camera views of NS circular signals. Example timelines are actual cycles, not median timing plans.

◆ Survey stamp
 ▼ Turning onset bracket
 Displayed green
 Boundary bracket

South Street green ends and overlap, and protected/permissive turn permissions, were not resolved by the recorded views. Bars show directly observed NS green. Stamps and vehicle movement do not define an exclusive green or protected-turn duration.

Basis: Matrix AUQLD16436 survey video and queue timestamps; 10 AM + 10 PM cycles reviewed. Source clocks calibrated.

Observed sequence • not a controller timing plan

Figure 15: Measured cycle timelines, one AM and one PM example, with the ten-cycle medians. North and south identify the camera views of the north-south circular signals, not the approaches they govern.

The example timelines are actual cycles rather than median timing plans. South Street green ends and overlap, and the protected or permissive status of each turn, were not resolved by the recorded views; they are derived in the timing reconstruction.

Signal operation reconstructed from the survey video

Cleveland Redland Bay Road / South Street / Bloomfield Street, Thornlands — Matrix survey AUQLD16436, Tuesday 11 August 2026

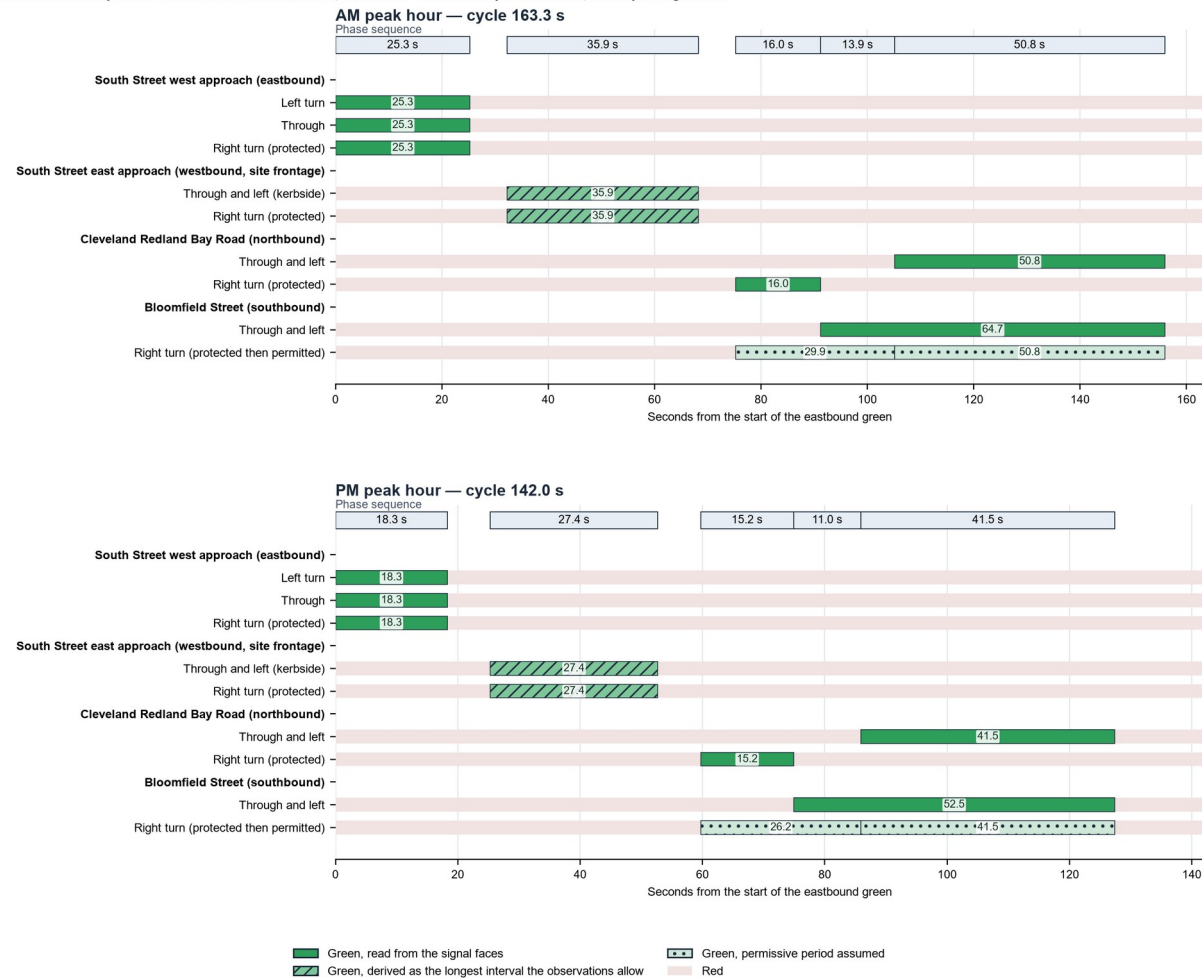


Figure 16: Movement timing adopted for the operational calculation, AM and PM peaks.

Solid bars are greens read from the signal faces. The two site-frontage movements are hatched because their display is in no camera view and their green is derived as the longest interval the observations allow, so it cannot be longer than modelled. The Bloomfield Street right turn's permissive period is shown open because no red arrow was established on that head. Intergreen 7 s, being a 4 s yellow and a 3 s all-red, from a measured mean of 7.4 s.