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Dear Dave

Karratha City Centre Infrastructure Works Project
Proposal to install signals at the intersection of Karratha Terrace/ Wellard Way/
Searipple Road

Over the next 12-15 months, LandCorp and the City of Karratha will be constructing the eastern extension of Karratha Terrace to Searipple Road. Karratha Terrace will form a new four-way junction with Searipple Road and Wellard Way South (existing street).

Separately, the City of Karratha is assessing the case for a road connection through Bulgarra, which could function as collector road and alternative route to Searipple and Millstream Roads. The new road alignment may connect Wellard Way South and Nairn Street.

The current letter addresses relevant specifications – Section 4.1 - in Main Roads WA's draft *Policy and Application Guidelines for Traffic Control Signals* (Document No. D14#298973, June 2014). Arup undertook a feasibility-stage Road Safety Audit (RSA) of the concept intersection design concurrently and summary findings are provided at the end of this document. The audit was led by Darryl Patterson who is a Main Roads WA-accredited Senior Auditor. We are also aware that the City of Karratha is providing a letter of support for traffic signals rather than priority or stop control.

Section 4.1.1 Alternative Treatments

In June/ July 2015, Arup completed a refresh of modelling for the Karratha City Centre Infrastructure Works Project. This work took account of existing and committed network changes and intersection upgrades in the study area; however, it was not calibrated to forecast demand flows with any degree of precision on the proposed strategic east-west link outside of the boundary of the city centre.

Micro-simulation (Paramics) modelling found that signalisation of the subject intersection may not be warranted – on capacity grounds – until 2026 or soon after (the modelled medium-term). The short-term (year 2021) modelling forecast an average Level of Service (LoS) C for each approach in the PM peak hour. More detail can be found in the

associated report ('0003KACIP Transport Modelling Refresh Report_FINALv2_080915.pdf').

More detailed intersection modelling for year 2021 using SIDRA found:

- Adopting Paramics junction geometry as a base-case (**Figure 1**), the intersection functions within capacity in the short-term assuming stop control. Movements through and right from Karratha Terrace and Wellard Way experience moderate delays, resulting in LoS D and C, respectively for these approaches. Due to low demands on these minor roads, negligible queuing is expected as a result of the delays. All other movements are forecast to function well
- All movements on Searipple Road function well in the short-term; however, shared through/ right lanes are not recommended due to potential conflicts and risk of rear-end crashes. In the medium-term, intersection geometry is upgraded in Paramics to include separate right-turn pockets. Arup recommends construction of these pockets as part of initial civil works on safety grounds and to avoid the need for a further geometric upgrade in a relatively short timeframe. We are aware that the current line-marking (LM) plans for the intersection prepared by Wood & Grieve include the turning pockets
- Movements through and right from Karratha Terrace and Wellard Way worsen in the short-term assuming stop control and the addition of turning lanes on Searipple Road as described previously (**Figure 2**). All approaches still operate within capacity but delays increase further for the minor road exits. The right-turn exit from Karratha Terrace is forecast to operate at LoS F with an average delay of ~55 seconds. Demands are low and there is forecast to be limited queuing (and therefore impacts on upstream intersections); however, on road safety grounds, Arup does not recommend construction of a four-way junction where movements from the minor legs have to cross at least three (and up to five) traffic lanes. Signalisation should therefore be brought forward to the short-term. Relevant junction geometry is shown in **Figure 3**
- An alternative intersection layout was tested with the eastern approach converted to a seagull configuration. Wellard Way would therefore be restricted to left-in/ left-out, which would have practical implications for residential access to this development cell. The layout was tested in SIDRA using network analysis. The northbound and southbound lanes of Searipple Road were treated as separated sites with a shared median leg representing a staged crossing for right-turning vehicles. This layout was found to operate well within capacity in both 2021 and 2026; however, the two-stage crossing may be difficult to deliver geometrically and there would remain potential for conflict between vehicles turning to and from Searipple Road. In addition, the two-stage crossing would not suit heavy vehicles and light vehicles towing trailers. Moreover, limitations to access to Wellard Way would lead to redistribution of traffic via Sharpe Avenue and Warambie Road, and increase U-turn manoeuvres at Welcome Road.

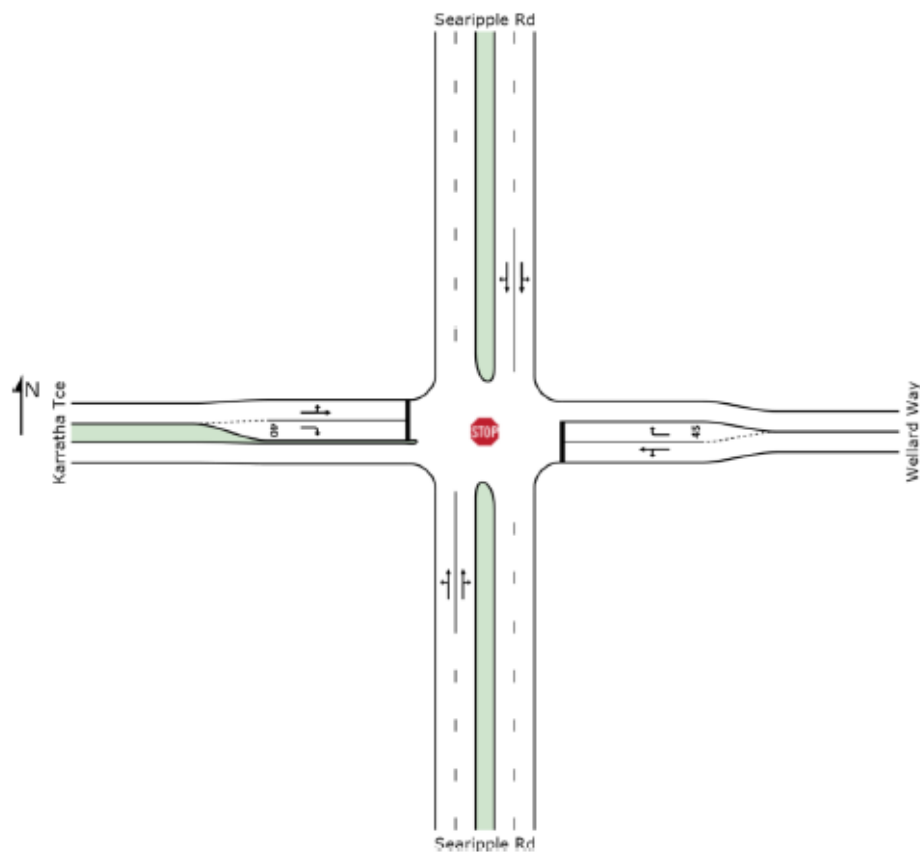


Figure 1 – Base-case intersection geometry from Paramics short-term scenario (no turning pockets on Searipple Road)

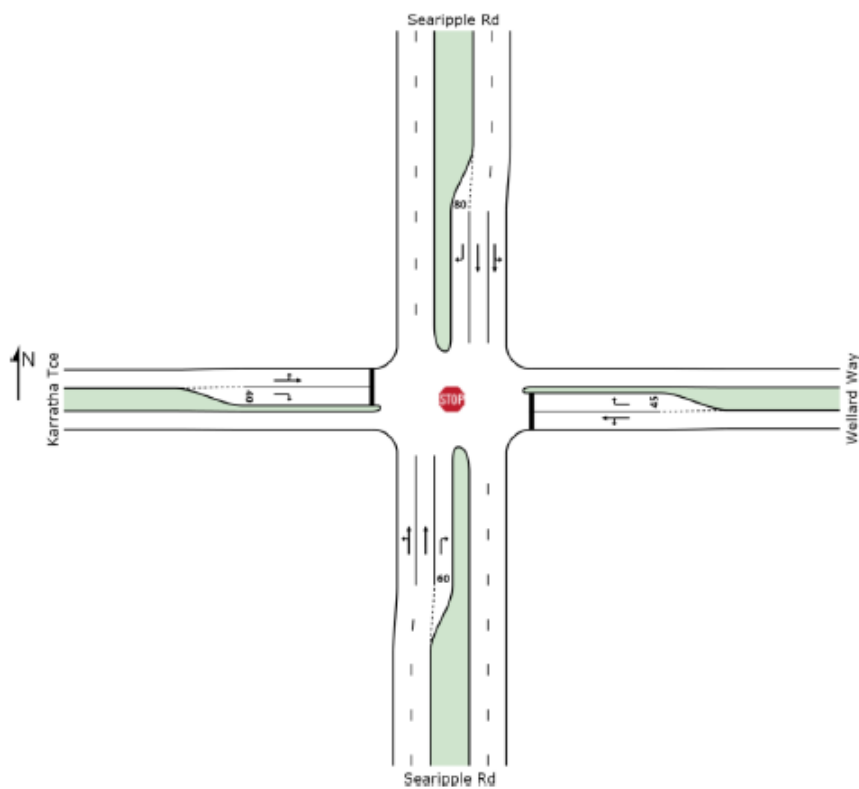


Figure 2 – Modified intersection geometry from Paramics medium-term scenario (right-turn pockets on Searipple Road)

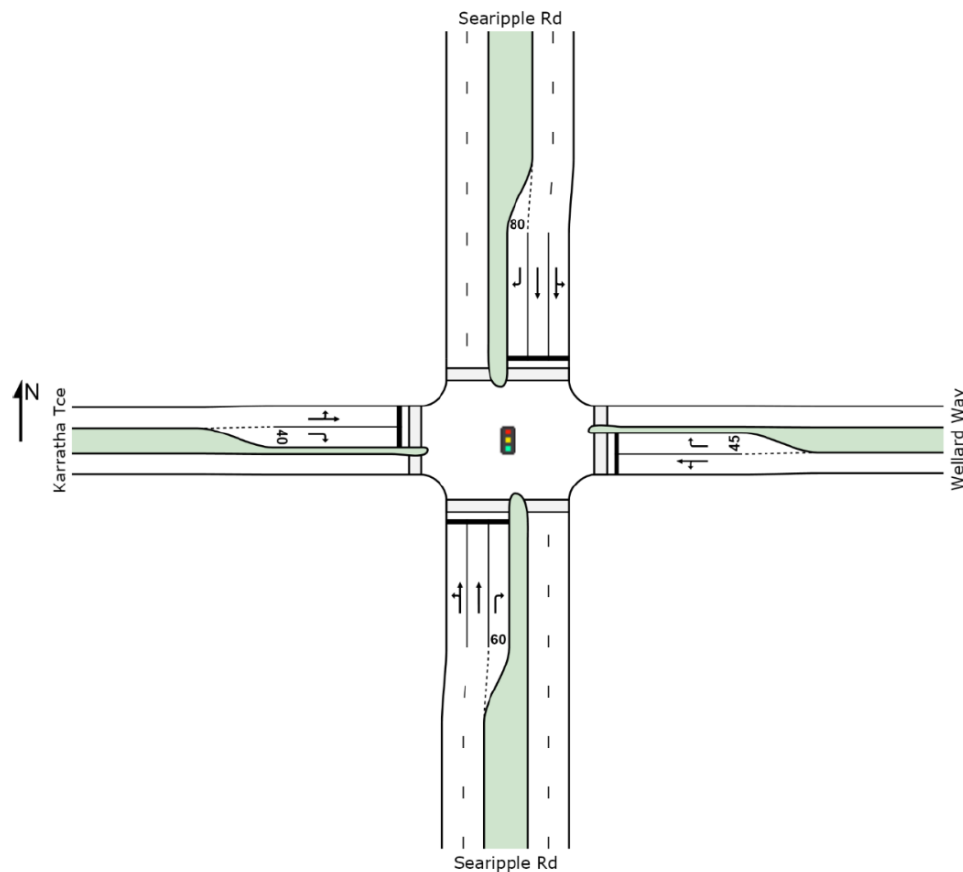


Figure 3 – Modified intersection geometry assuming signalisation (preferred layout and control)

Results in **Table 1** show high LoS and low Degree of Saturation (DoS) at this intersection in both the short and medium-term assuming signalisation. Filter-turns and parallel walks were adopted in the analysis. Detailed movement summaries are appended to the letter.

A roundabout solution was dismissed for three reasons:

- Relative land take and capital cost
- Traffic signals allow coordination with the treatment at Karratha Terrace/ Sharpe Avenue, and in the future at Searipple Road/ Dampier Highway/ Millstream Road and, Welcome Road/ Searipple Road
- A major roundabout would not provide a suitable, safe crossing opportunity for pedestrians, which is important given the desire line between the city centre and urban cell to the east including St Paul's Primary School.

Table 1 – Results of SIDRA analysis for Karratha Terrace/ Searipple Road/ Wellard Way, PM peak hour, years 2021 and 2026

Movement/ scenario	LoS	DoS	95 th percentile back-of-queue
Short-term, stop control (KCCNM geometry)			
Karratha Terrace (W)	D	0.34	7.6
Searipple Road (N)	A	0.26	7.8
Wellard Way (E)	C	0.18	4
Searipple Road (S)	A	0.07	2.3
Short-term, stop control (added geometry – right-turn pockets)			
Karratha Terrace (W)	E	0.49	10.8
Searipple Road (N)	A	0.26	7.8
Wellard Way (E)	C	0.25	5.4
Searipple Road (S)	A	0.05	1.0
Short-term, stop control (seagull on east approach)			
Karratha Terrace (W)	A	0.06	0
Searipple Road (N)	A	0.25	7.5
Wellard Way (E)	-	-	-
Searipple Road (S)	A	0.05	0
Short-term, signal control (added geometry – right-turn pockets)			
Karratha Terrace (W)	C	0.19	8.9
Searipple Road (N)	A	0.31	23.8
Wellard Way (E)	C	0.11	5.6
Searipple Road (S)	A	0.08	7.9
Medium-term, stop control (added geometry – right-turn pockets)			
Karratha Terrace (W)	F	2.45	425.7
Searipple Road (N)	A	0.16	4.4
Wellard Way (E)	F	0.84	65.6
Searipple Road (S)	A	0.22	6.1
Medium-term, signal control (added geometry – right-turn pockets)			
Karratha Terrace (W)	C	0.32	18.8
Searipple Road (N)	B	0.24	20.3
Wellard Way (E)	C	0.31	27.5
Searipple Road (S)	B	0.32	23.1

Section 4.1.2 Spacing Between Signalised Intersections

Specifications for urban routes are addressed in sub-section 4.1.2.1. Searipple Road is a Local Distributor and care-and-control is vested with the City of Karratha. According to the guidelines, the minimum spacing between signalised intersections should be 250 metres. Separation between Karratha Terrace and Welcome Road, a location for future signals (from 2026), is around 290 metres.

Sub-section 4.1.2.2 refers to the provisions of Liveable Neighbourhoods and how the design code articulates minimum intersection spacings for arterials in country centres. Searipple Road is not classed as an arterial road but the minimum specification of 150 metres separation along a road in a centre is exceeded.

Section 4.1.3 Minimum Number of Approach Lanes

Intersection geometry meets minimum requirements with two through-lanes proposed on the northern and southern approaches (kerbside lanes proposed shared through/ left). Separate right-turn pockets are planned on these approaches.

The eastern and western approaches each incorporate shared through/ left and right stand-up lanes.

Section 4.1.4 Road Space Allocation and Lane Management

Approach and intersection geometry (currently designed in concept) accords generally with specifications in Tables 5.2-5.4 of *Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings*. Arup anticipates detailed geometry including taper and pocket lengths satisfying the City of Karratha's specifications for this intersection given its proposed function. We note Wood & Grieve's role on the project as civil engineer.

The intersection will serve as a controlled crossing point for pedestrians, and have a strategic function for pedestrian access to St Paul's Primary School and Centro shopping centre for residents in adjacent urban cells. Arup recommends shared through/ left lanes on Searipple Road rather than slip-turns to reduce impacts on pedestrian crossing movements. It is also understood that spatial constraints in this location preclude slip-turns.

Section 4.1.5 Bus Priority

This section is not applicable to the subject intersection.

Section 4.1.6 Heavy Vehicles

This intersection is not proposed to form part of the Restricted Access Vehicles (RAV) Network in the future; however, it needs to accommodate turning movements by 19-metre articulated vehicles, which service Centro shopping centre. Arup understands that Wood & Grieve's detailed intersection design will accommodate the necessary turning radii.

Section 4.1.7 Criteria for Traffic Signal Control

Sub-section 4.1.7.1 refers to intersection vehicle volumes. The warrants are (page 15):

For four-way intersections the approach vehicle volumes shall be at least:

- (1) 900 vehicles per hour on the major road (total both directions) and the minor road concurrently carrying at least 100 vehicles per hour (highest approach volume) on one approach, over any four hours of an average day, and*
- (2) 10 000 vehicles approaching (total for all approaches) between 7am and 7pm on the same day.*

For T-junctions, the criteria are the same as for four-way intersections, except the lowest approach volume is counted twice.

In July 2014, Metrocount completed a tube counter survey on Searipple Road south of Gregory Way (North), approximately 350 metres south of the future location of the intersection of Karratha Terrace/ Wellard Way/ Searipple Road. The data shows that warrant (1) cannot be met for Searipple Road under current conditions: the four-hour weekday peak period is 1400-1800 hours and hourly counts range from about 600 to 650 vehicles, two-way. There is no data for Karratha Terrace (road connection does not exist) and Wellard Way (minor access street, only).

The year 2021 SIDRA analysis completed for the subject intersection applied the following forecast demand flows:

- Searipple Road (both approaches) – 833
- Highest minor approach – 53.

Under these conditions, warrant (1) remains unsatisfied.

Year 2026 SIDRA analysis completed for the subject intersection applied the following forecast demand flows:

- Searipple Road (both approaches) – 903
- Highest minor approach – 198.

These metrics satisfy warrant (1) for the peak hour. Subsequently, demands were estimated for the shoulder period.

SCATS data from the signalised intersections of Karratha Terrace/ Sharp Avenue, Warambie Road/ Sharpe Avenue and Sharpe Avenue/ Dampier Highway was compiled and averaged to produce a daily traffic demand profile. In turn, this profile was used to estimate ratios of demand in peak shoulder hours relative to the peak hour. The values in **Table 2** were calculated.

Application of these values to the forecast demands used in SIDRA yields the demand flow estimates for the four-hour peak period shown in **Table 3**. The data show that warrant (1) is not satisfied in either the 2021 or 2026 forecasts.

Table 2 – Estimated ratio of total traffic demands to peak hour values (four-hour peak period)

Time-period (15-minute intervals)	Calculated ratio (relative to peak hour)
1330-1345	0.77
1345-1400	0.80
1400-1415	0.80
1415-1430	0.77
1430-1445	0.76
1445-1500	0.73
1500-1515	0.73
1515-1530	0.75
1530-1545	0.78
1545-1600	0.85
1600-1615	1.00
1615-1630	1.00
1630-1645	1.00
1645-1700	1.00
1700-1715	0.87
1715-1730	0.78

Table 3 – Peak-period (four-hour) volume estimations applying available SCATS data, years 2021 and 2026

Forecast year/ hourly totals	Major (both approaches)	Minor (highest approach)
2021		
1	832	52
2	646	40
3	636	40
4	668	42
2026		
1	904	200
2	702	155
3	691	153
4	726	161

The empirical data collected by Metrocount on Searipple Road was used to compile a similar daily traffic profile and alternative ratios were then derived. These were applied subsequently to the modelled peak hour volumes as a cross-check. The results are shown in **Table 4** but are insignificant in this instance.

The same two ratio-based methods were then applied to estimate the 12-hour (7am-7pm) aggregate demands as per warrant (2). Summary statistics are shown in **Table 5**. Neither method satisfies warrant (2) in 2021 but both satisfy it in the 2026 scenario.

Sub-section 4.1.7.2 refers to crash history. The warrant is (page 15):

For existing intersections, an average of three (3) or more casualty crashes per year over a recent five (5) year period shall have been recorded and that traffic signal control would have been the most effective form of treatment to prevent these crashes from occurring.

Table 4 – 12-hour volume estimation, all approaches, both methods (SCATS and tube counter data), years 2021 and 2026

Forecast year/ hourly totals	Major (both approaches)	Minor (highest approach)
2021		
1	832	52
2	758	47
3	659	41
4	770	48
2026		
1	904	200
2	713	158
3	620	137
4	724	160

Table 5 – Peak-period (four-hour) volume estimations applying empirical data from tube counts on Searipple Road, years 2021 and 2026

Forecast year/ hourly totals	Method 1 (SCATS)	Method 2 (tube counter)
2021	8,776	8,378
2026	11,988	10,189

The subject intersection does not exist. Existing road geometry in this location includes the offset T junctions of Hedland Place/ Searipple Road and Wellard Way (South)/ Searipple Road. According to Main Roads WA's Online Reporting Centre, between 1 January 2010 and 31 December 2014, there were nine reported crashes on Searipple Road between Padbury Way (North) and Wellard Way (North) (SLK 0.23-0.59). These included three rear-end and five right-angle collisions, indicating issues with turning movements and (potentially) a lack of channelisation for right-hand turns on Searipple Road.

Intersection-related crash statistics for the same period reveal no reported data for Wellard Way (South)/ Searipple Road; however, three accidents were reported for Hedland Place/ Searipple Road. These included two rear-end and one right-angle collision.

The published warrant – three crashes reported *per annum* over a five year period - is not satisfied; however, the proposed intersection works incorporating appropriate channelisation and traffic signals, is considered likely to yield traffic safety benefits compared to the status-quo. The separate Road Safety Audit will comment on the merits of signals compared to stop or give-way control assuming the creation of the four-way junction of Karratha Terrace/ Wellard Way/ Searipple Road.

Section 4.1.8 Consideration of Traffic Control Signal Installation

Detail regarding forecast LoS, queuing and delays is provided on pages 2, 3 and 4 of this letter. It is Arup's professional view that traffic signals rather than stop or priority control is warranted by 2021 on both capacity and traffic safety grounds. The alternative of restricting access to Wellard Way to mitigate capacity and safety concerns is untenable to the City of Karratha.

The SIDRA analysis for 2021 demonstrates that intersection LoS A can be achieved assuming signalisation and channelisation on Searipple Road for right-turns. The forecast DoS is 0.31. Queue lengths are not forecast to interfere within intersections upstream.

In 2026, the analysis forecasts intersection LoS B with DoS 0.39. Again, forecast queue lengths are insignificant.

We note that a Benefit-Cost Ratio (BCR) has not been calculated as per sub-section 4.1.8.2. This is not considered necessary given the broad case for signals in this location, the City of Karratha's support for the treatment and availability of funding for the capital works.

The specifications under sub-section 4.1.8.3. (pedestrian volumes) do not apply directly in this instance; however, signalisation will yield clear benefits for pedestrians in this location given the desirability of access westwards to the city centre/ Centro shopping centre and eastwards to St Paul's Primary School.

Section 4.1.9 Control of Right-Turns

This section considers when certain right-turning facilities are required depending on peak hour approach volumes and the traffic profile over the course of an average day. There are seven warrants for a dedicated right-turn signal phase operating all day with a ban on filter turns. Only one warrant need be met. The warrants are listed and discussed in the following table (**Table 6**). In short, it is unlikely that any are satisfied.

Table 6 – Warrants relating to right-turning provisions

Warrant	Discussion
Over any four (4) hours of an average day the right-turn volume on the approach exceeds 200 vehicles per hour and the volume of conflicting traffic exceeds 600 vehicles in the same hour.	Not met in the forecast peak hour in either year (2021 or 2026)
Over the last five (5) years the right-turn movement has been involved in more than five (5) reported crashes and the times of the day these crashes have occurred are generally spread across the full 24-hour period, i.e. the crashes were not confined to specific periods such as day, night or peak times only.	No relevant data available
<p>Visibility to conflicting vehicles for right-turning drivers is restricted by:</p> <ul style="list-style-type: none"> • Permanent obstructions, (e.g. a crest, bridge support, etc.), or • Opposing vehicles waiting to turn right for typically more than 75% of the time that the right turning movement operates. <p>Visibility requirements shall be based on 'Approach Sight Distance' as determined in accordance with Main Roads' Supplement to Austroads Guide to Road Design - Part 4A.</p>	Relevant approach sight distances are likely to exceed warrants
The right-turn has more than one (1) lane of turning traffic	Does not apply
The posted speed limit for opposing traffic is 80 km/h.	The posted speed limit is 60 kilometres per hour on Searipple Road and 50 kilometres per hour on Wellard Way. A limit of 40 kilometres per hour will apply to Karratha Terrace
The posted speed limit for opposing traffic is 60 km/h or more and the right-turn is across more than a combination of three (3) lanes of oncoming traffic that share the same stop line, i.e. includes auxiliary turn lanes where applicable.	Right-turns from Searipple Road will be across three lanes including a right-turn pocket, a dedicated through-lane and a shared through/ left
The particular layout of the intersection allows the right-turn to take place without ever being in conflict with an opposing traffic movement, e.g. traffic movements beyond the intersection continue in a 'one-way' direction only.	This does not apply. There will be two-way operations on all approaches and conflicting movements will be evident.

Sub-section 4.1.9.2 considers when a part-time dedicated right-turn phase should apply. The applicable warrants are (page 17):

- (1) *None of the requirements for full-time right-turn arrow control in Section 4.1.7.1 apply.*
- (2) *The right-turn volume on the approach exceeds 200 vehicles per hour and the volume of conflicting traffic exceeds 600 vehicles in the same hour, and*
- (3) *Over the last five (5) years there have been more than two (2) crashes involving the right-turn within the general time period when the above conflicting traffic volumes occur.*

Sub-section 4.1.9.3 considers when a full-time partial right-turn arrow should operate. The applicable warrants are (page 17):

- (1) *None of the requirements for full-time right-turn arrow control in Section 4.1.7.1 apply.*

- (2) The right-turn movement does not exceed 120 vehicles per hour for a typical day, or*
- (3) Over the last five (5) years the right-turn movement has been a contributing factor in no more than three (3) reported crashes.*

The warrants under 4.1.9.2 are not satisfied in either test year. Warrant 4.1.9.3 (2) is satisfied in year 2021 but not 2026. On these bases, Arup recommends that the intersection operates with filter right-turn phasing from commencement of operation.

Road Safety Audit (RSA) key outcomes

The RSA was undertaken as a feasibility-stage review of a four-way priority controlled treatment at the proposed Searipple Road/ Wellard Way/ Karratha Terrace intersection. The key outcomes from the RSA include:

- Pedestrian crossing facilities within close proximity to a priority controlled intersection are not supported due to the potential for conflict between vehicle turning movements (including heavy vehicles) and vulnerable road users including pedestrians and cyclists. Pedestrians are expected to traverse the intersection to gain access to St Paul's Primary School, which is located at the corner of Wellard Way and Karratha Terrace
- Multiple traffic lanes at a four-way controlled intersection with right turn auxiliary lanes is not a favourable design due to the potential road safety impacts. Multiple traffic lanes at an intersection with various traffic movements results in large uncontrolled crossing distances for pedestrians
- There is a high heavy vehicle percentage on Searipple Road, which has an impact on safe traffic gaps for vehicles exiting the minor roads (Wellard Way and Karratha Terrace) on to Searipple Road. This leads to vehicles taking risks to enter the major road network, leading to high risk of right-angle crashes at the intersection
- Commercial driveways (proposed and existing) are located within close proximity to the intersection, which adds to the turning movements in this location. The location of the commercial driveways in this environment may lead to rear-end and right-angle crashes.

In summary, Arup's review of the intersection proposal found that volumetric warrants for signalisation are not satisfied; however, there are several mitigating circumstances that require consideration:

- 1) The case signals increases over time on volumetric grounds
- 2) There is funding available now to complete the intersection design and install the ultimate control treatment
- 3) Traffic signal control will be the most appropriate intersection treatment on capacity and safety grounds
- 4) Signals will support and enhance the safety of east-west movements by pedestrians between the city centre, and the residential cell and St Paul's Primary School
- 5) The City of Karratha supports signalisation as the preferred treatment.

If you have any questions in relation to this correspondence, please contact me on 08 9327 8347.

Yours sincerely



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