

C4 Growth Cell Transportation Assessment

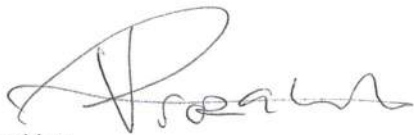
Waipa District Council

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C4 Growth Cell Transportation Assessment

Waipa District Council



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EXECUTIVE SUMMARY

Background

Gray Matter Ltd has been engaged by Waipa District Council to prepare an Integrated Transport Assessment (ITA) to inform development of and assess the transportation impacts of the C4 Structure Plan. The site is located within the Waipa District just outside of Cambridge. The site is currently zoned rural. The C4 residential structure plan area is identified in the Waipa 2050 Growth Strategy and included in Appendix S1 of the District Plan.

Trip Generation

We understand that the Growth Cell could provide approximately 1,020 dwellings. Based on 85th percentile published trip generation rates the development could generate approximately 11,100 veh/day and 1,200 veh/hr.

We anticipate that most vehicles will be travelling towards Cambridge during the morning peak and returning via Cambridge during the afternoon peak. Some residents may commute to Hamilton via Kaipaki Road or to Te Awamutu via Cambridge Road.

Proposed Intersections

New intersections will be required on Lamb Street and Cambridge Road. The locations indicated in the structure plan layout (attached at Appendix 1) are based on providing minimum sight distance from the intersection and minimum separation of 90m from other intersections. The locations are based on there being no direct access from the development to the proposed roundabout at the Kaipaki Road/Cambridge Road/Lamb Street intersection. To provide safe and efficient access we recommend the structure plan includes two intersections on Lamb Street. Given the relatively high volume of traffic at the intersections we prefer that these intersections are formed as roundabouts.

Lamb Street/Kaipaki Road/Cambridge Road Intersection

Given the expected increase in traffic at the Lamb St/ Kaipaki Road/Cambridge Road intersection, a roundabout is the most appropriate form of intersection at this location. A roundabout provides a safe system solution consistent with Vision Zero and would provide a rural/urban threshold. It would be desirable to construct the roundabout prior to any development within the C4 structure plan. However, constructing the roundabout after Area C (or 300 lots) is developed and prior to any development in Area A and B is acceptable.

Recommended Infrastructure

We recommend that the following infrastructure is implemented as part of the C4 structure plan:

- = A roundabout at the Kaipaki Road/Cambridge Road/Lamb Street intersection;
- = 3m wide shared path on Lamb Street and Cambridge Road with links through the development;
- = Roundabouts at new intersections on Lamb Street;
- = Roundabout at the Lamb Street/ Shakespeare Street intersection;
- = Upgrading Lamb Street and Cambridge Road to arterial road standards; and
- = Walking and cycling connection via 3838 Cambridge Road.

1. INTRODUCTION

1.1. Background

Gray Matter Ltd has been engaged by Waipa District Council (Waipa DC) to prepare an Integrated Transport Assessment (ITA) to inform development of and assess the transportation impacts of Waipa DC's C4 Structure Plan.

1.2. Purpose and Basis of this Report

The purpose of this ITA is to assess the traffic and transportation impacts of the proposed development on the surrounding area.

This ITA presents an assessment of the likely traffic and transportation issues associated with the C4 structure plan. It comprises:

- = A summary description of the site, and comments on the surrounding road network, including function and traffic volumes;
- = Comments on the proposal, including traffic generation and access;
- = Concept designs for the main intersections and typical cross-section for the arterial network;
- = Evaluation of the likely traffic impacts; and
- = Conclusions, including a summary of impacts and recommendations.

2. SITE AND SURROUNDING NETWORK

2.1. Site Description

The site is located within the Waipa District just outside of Cambridge. The site is currently zoned rural. The C4 residential structure plan area is identified in the Waipa 2050 Growth Strategy and included in Appendix S1 of the District Plan. The Growth Cell is intended for residential development on the Leamington side of Cambridge. Development of the growth cell is anticipated before 2035.

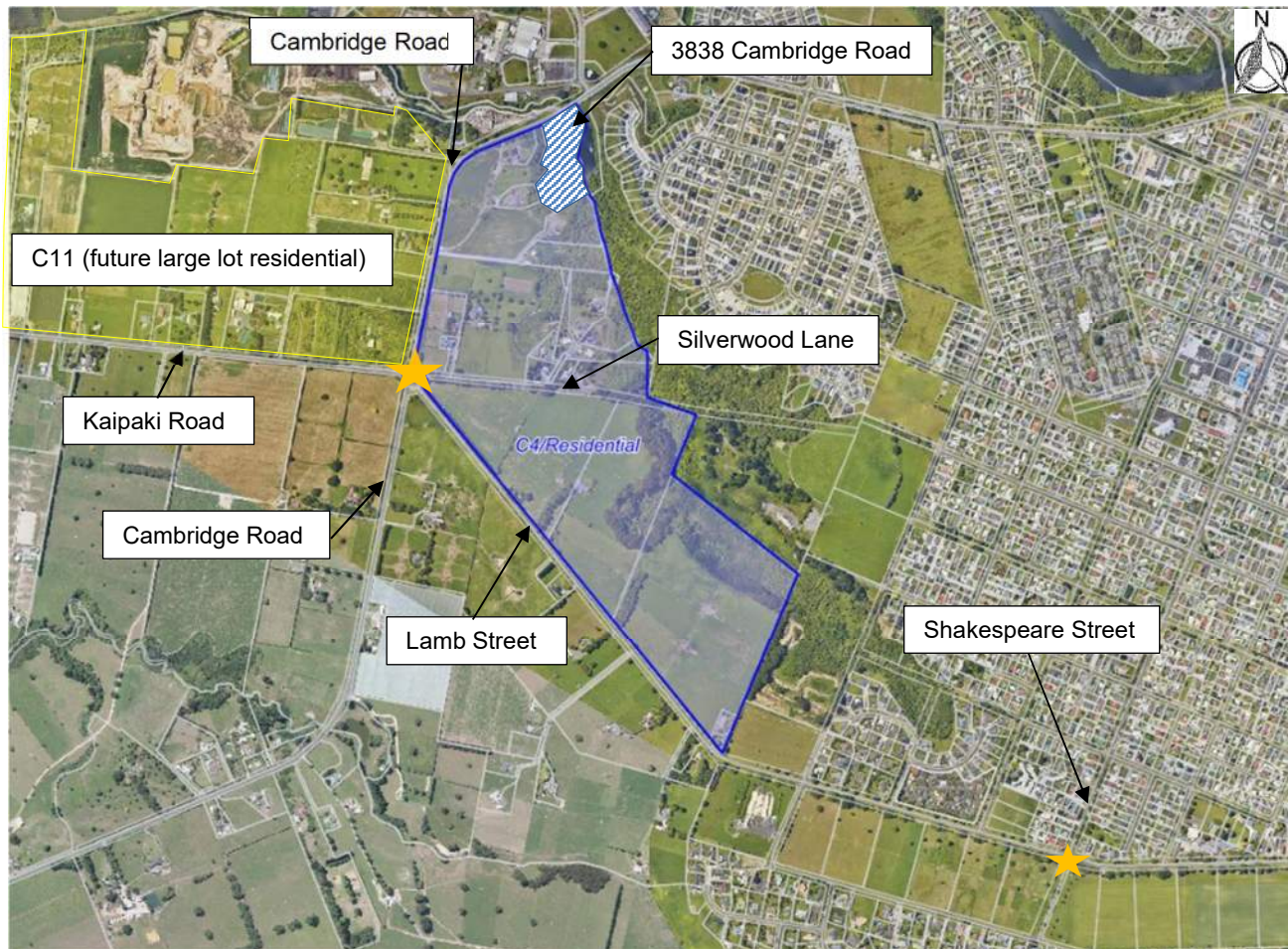


Figure 1: Site Locality

The site is bounded by Lamb Street and Cambridge Road. Silverwood Lane is entirely within the Structure Plan area.

The C11 growth cell is located west of Cambridge Road and is planned for development beyond 2035. That growth cell is intended for large lot residential development with capacity for approximately 258 dwellings.

2.2. Transport Network

The transport network surrounding the site consists of the following roads:

Road Name	Speed Limit (as at 4 November 2019)	Road Hierarchy	ONRC	Traffic Volume ¹	% HCV
Cambridge Road	80km/h	Major Arterial	Arterial	7,200 veh/day	11%
Lamb Street	80km/h	Minor Arterial	Primary Collector	2,800 veh/day	6.7%
Kaipaki Road	100 km/h	Minor Arterial	Primary Collector: Route Consistency	3,200 veh/day	10.2%
Silverwood Lane	80km/h	Local Road	Access	76 veh/day	0%
Shakespeare Street	50km/h	Minor Arterial	Primary Collector	4,955 veh/day	5.5%

Table 1: Transport Network

2.3. Crash History

We have completed a search of NZTA's crash analysis system (CAS) for crashes from 2015-2019 along Cambridge Road, Lamb Street, at the Lamb Street/Cambridge Road/Kaipaki Road/Silverwood Lane intersection and at the Lamb Street/Shakespeare Street intersection.

There have been three reported crashes at the Lamb Street/Cambridge Road/Kaipaki Road/Silverwood Lane intersection. Two crashes have been minor injury crashes with one crash a serious injury crash. The reported crashes all appear to be related to the Lamb Street leg. We note that one minor injury crash was related to poor driver behaviour rather than the road environment.

There have been two minor injury crashes at the Lamb Street/Shakespeare Street intersection. The crashes were a result of vehicles failing stop at the intersection.

There have been two loss of control crashes on Cambridge Road north of the Kaipaki Rd/Cambridge Rd/Lamb St intersection near the horizontal curve which is posted with a 65km/h curve advisory sign. Both crashes appear related to vehicles driving too fast for the conditions. Both crashes occurred in wet conditions.

There has been an injury crash every 1.6 years at the Lamb Street/Cambridge Road/Kaipaki Road/Silverwood Lane intersection and one crash every 2.5 years at the Lamb Street/Shakespeare Street intersection. The actual injury crash rate is slightly higher than the predicted crash rate for these intersections and this would be expected to increase with more traffic using the intersections in the future.

¹ <https://mobileroad.org/desktop.html>

2.4. Lamb Street Existing Cross Section

Lamb Street is a minor arterial road and has ONRC classification of primary collector. The posted speed limit is 80km/h but would likely reduce to 60km/h with development of the structure plan and associated roundabouts. The existing road reserve is 20.1m wide. The existing carriageway is approximately 7.9m wide and consists of two lanes and narrow (<0.5m) shoulders.



Figure 2: Existing Lamb Street carriageway

2.5. Cambridge Road Existing Cross Section

Cambridge Road is a major arterial road in the District Plan and has an ONRC classification of an arterial road. The carriageway is approximately 8.5m wide and consists of two traffic lanes and shoulders. There are right turn bays on Cambridge Road for turning into Kaipaki Road and Lamb Street and a left turn lane on Cambridge Road (south) for turning into Kaipaki Road.

2.6. Access to 3838 Cambridge Road

The vehicle crossing for access to 3838 Cambridge Road is located approximately 100m west of Matos Segedin Drive and opposite an industrial vehicle crossing (garden supplies business). There are right turn bays on Cambridge Road into Matos Segedin Drive and the garden supplies business vehicle crossing. Visibility is restricted by the horizontal and vertical alignment of Cambridge Road. The right turn bay at the industrial vehicle crossing makes access to this property potentially confusing for vehicles turning right.

Clearway Consulting completed an assessment² for 3838 Cambridge Road which included an assessment of speed and crashes on Cambridge Road. At the time of the assessment the speed limit on this section of Cambridge Road was 100km/h. The assessment concluded that there may be some justification for lowering the speed limit to 70km/h or 80km/h. We note that the speed limit has changed to 80km/h as part of the recent Waipa Speed Limits Bylaw update.

2.7. Lamb Street/ Kaipaki Road/ Cambridge Road Intersection

The existing intersection is a staggered “T” intersection. There is approximately 35m separation between the two intersections. The intersections are stop controlled on both the Kaipaki Road and Lamb Street approaches.

² Speed Limits 3838 Cambridge Road, Cambridge – Urban Village Property Limited (20 February 2014)
2019-11-19 C4 Structure Plan V4

There are right turn bays on Cambridge Road for movements into Kaipaki Road and Lamb Street. There is a left turn deceleration lane for movements into Kaipaki Road from Cambridge Road. Silverwood Lane currently forms a “T” intersection with Lamb Street. The existing intersection layout is shown in Figure 3 below.

Based on crash prediction models³ the estimated crash rate for the intersection is 0.334 injury crashes/year or an injury crash approximately every 3 years, we note that there have been three crashes at the intersection within the last five years (or 1.6 injury crashes/year). The intersection is performing poorer than expected.



Figure 3: Kaipaki Road/Cambridge Road/Lamb Street Intersection

2.8. Silverwood Lane/Lamb Street intersection

Silverwood Lane is local road which forms a stop controlled priority intersection with Lamb Street. There is approximately 30m separation from the Cambridge Road intersection. This does not meet minimum separation requirements for the current posted speed of 100km/h.

The traffic volume on Silverwood Lane is estimated to be 76veh/day, equivalent to trip generation for approximately eight residential dwellings. Silverwood Lane will require realignment due to the proposed roundabout and residential development within the structure plan.

³ NZTA Crash Estimation Compendium
2019-11-19 C4 Structure Plan V4



Figure 4: Existing Silverwood Lane Intersection

2.9. Lamb Street/ Shakespeare Street

The existing crossroads intersection is priority controlled with stop control on the Shakespeare Street approaches. There have been two crashes within the last five years relating to vehicles on Shakespeare Street failing to give way. There is likely to be an increase in movements at the intersection due to development within the structure plan resulting in more trips to the Leamington Village and school via Lamb Street.

During a site visit we noted that there have been some minor improvements such as kerb and channel. Given the proximity of the intersection to the school it would be prudent to provide a safe form of intersection whilst controlling speeds at the intersection.



Figure 5: Existing Shakespeare Street Intersection

2.10. Walking and Cycling

There are currently no walking or cycling facilities located near the C4 growth cell. There is a footpath on Lamb Street east of Rawlings Place which provides a connection to Leamington School and an existing path on Cambridge Road which terminates on Cambridge Road approximately 320m east of the Matos Segedin Drive/Cambridge Rd intersection.

3. THE PROPOSAL

3.1. Description

The C4 Growth Cell is identified in the Waipa District Growth Strategy. Through Plan Change 5 to the Waipa District Plan it has been confirmed as a Residential Zone with the timeframe for development being “now to 2035”. We understand that Growth Cell C4 could accommodate 1,020 lots.

3.2. Trip Generation

We understand that the Growth Cell could provide approximately 1,020 dwellings. The NZTA Research Report 453 (RR453) provides trip generation rates for various residential activities. The 85th percentile trip generation rates and trip generation for dwellings are summarised in Table 2 based on 1,020 lots.

Activity	Units	Peak hour		Daily	
		Rate	Trips (veh/hr)	Rate	Trips (veh/day)
Dwelling (inner suburban)	1,020	1.2/unit	1,224	10.9/unit	11,118

Table 2: 85th Percentile Trip Generation

We have based our assessment on trip generation rates for inner suburban dwellings. As the site is slightly remote from Leamington, the daily trip generation could be less. For the purposes of this assessment we have assessed trip generation as approximately 11,100 veh/day and 1,200 veh/hr.

Our assessment of trip generation is based on one dwelling per lot. There is a risk that trip generation could be higher if the lots were developed as duplexes. We understand that the estimate of 1,020 lots is a conservative estimate and likely to be less once other infrastructure such as stormwater treatment wetlands, parks and open spaces have been identified.

3.3. Trip Distribution

As the subdivision layout is not yet available, we have divided the proposed residential area into three broad catchments. However, all access will via two intersections on Lamb Street.

We have considered providing access to Area A directly to Cambridge Road via a new intersection (indicated by the blue star on Figure 6). Following consultation with Waipa DC this intersection has not been included. Council's preference is that the Lamb Street/ Kaipaki Road/ Cambridge Road intersection is developed to provide access to the C4 and C11 structure plan areas. Providing another intersection on Cambridge Road would minimise travel distance for trips to/from Area A. However, it would introduce a new intersection on the major arterial network which is inconsistent with good traffic engineering practice. The intersection would also increase delay and increase the risk of crashes for trips along Cambridge Road.

The catchments are summarised in the figure and table below.

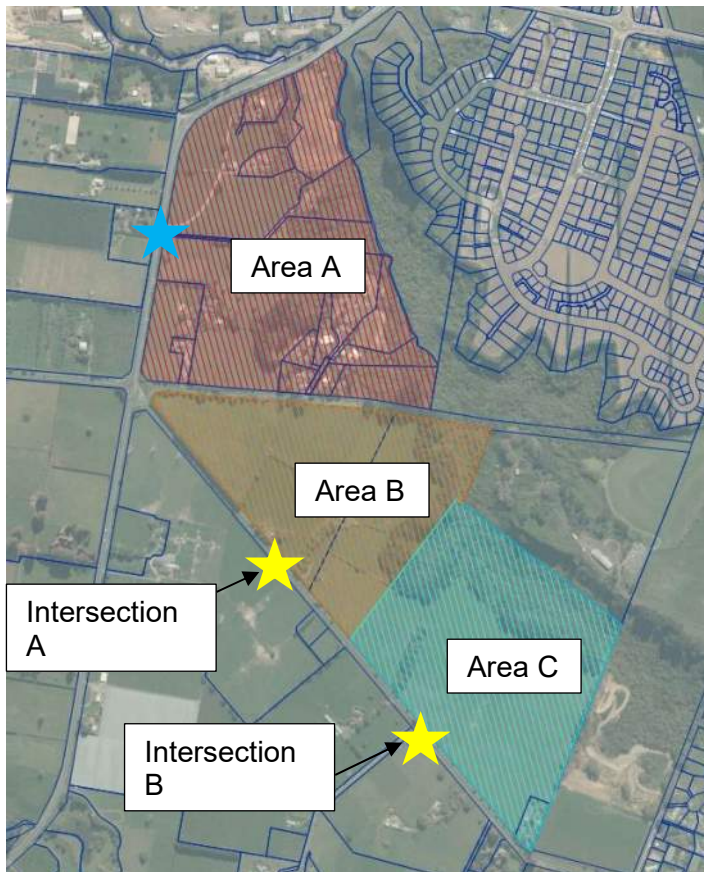


Figure 6: Development Areas (yellow star = possible intersections)

Based on the areas shown in Figure 6 we have distributed the total vehicle trips at the intersection based on percentage of land area as shown in Table 3 below.

Area	% Land Area	Lots (% of 1020 lots)	Daily trips (10.9/unit)	Peak hour (1.2/unit)
Area A	42%	428	4,665	514
Area B	28%	286	3,117	343
Area C	30%	306	3,335	367
Total		1,020	11,117	1,224

Table 3: Anticipated trip generation at intersections

We anticipate that most vehicles will be travelling towards Cambridge during the morning peak and returning via Cambridge during the afternoon peak. Some residents may commute to Hamilton via Kaipaki Road or to Te Awamutu via Cambridge Road.

The shortest route into Cambridge is north via Cambridge Road. This will require right turns out of the intersections including the Lamb St/Cambridge Rd/Kaipaki Rd intersection as well. Given that Leamington School is located south of the site we anticipate some trips to Cambridge will be via Shakespeare Street (left turn at the intersections).

Based on the above assumptions we have summarised the peak hour movements for each intersection in Table 4 (AM peak) and Table 5 (PM peak).

Intersection	AM Peak Total	Exiting (80%)		Entering (20%)	
		Left out (20%)	Right out (80%)	Left in (80%)	Right in (20%)
Intersection A	857 veh/hr	137 veh/hr	549 veh/hr	137 veh/hr	35 veh/hr
Intersection B	367 veh/hr	59 veh/hr	235 veh/hr	59 veh/hr	15 veh/hr
Total	1,224 veh/hr	196 veh/hr	784 veh/hr	196 veh/hr	50 veh/hr

Table 4: AM Peak volumes

Intersection	PM Peak Total	Exiting (20%)		Entering (80%)	
		Left out (80%)	Right out (20%)	Left in (20%)	Right in (80%)
Intersection A	857 veh/hr	137 veh/hr	35 veh/hr	137 veh/hr	549 veh/hr
Intersection B	367 veh/hr	59 veh/hr	15 veh/hr	59 veh/hr	235 veh/hr
Total	1,224 veh/hr	196 veh/hr	50 veh/hr	196 veh/hr	784 veh/hr

Table 5: PM Peak volumes

3.4. Structure Plan Access

3.4.1. Proposed Intersections

New intersections will be required on Lamb Street to serve the proposed development. The posted speed limit on both Lamb Street and Cambridge Road was reduced to 80km/h in November 2019. Therefore, we have used a design speed of 90km/h for new intersection the concept design

As part of future works, we recommend that the posted speed limit on Lamb Street is changed to 50km/h or 60km/h depending on the form of the intersections and level of direct property access.

We have summarised the intersection spacing and sight distance requirements for a 90km/h design speed in Table 6. We note that the Regional Infrastructure Technical Specification (RITS) requirement for intersection spacing is based on road hierarchy rather than speed environment.

Criteria	Reference	90km/h	Comment
Safe Intersection Sight Distance	Austroroads Part 4A	214m	Based on reaction time of 2.0 seconds
Vehicle crossing separation to intersection	Waipa District Plan	200m	
Intersection spacing – same side	RITS	90m	Based on spacing for arterial roads
Intersection spacing opposite side	RITS	45m	Based on spacing for arterial roads

Table 6: Intersection design criteria

We understand Council's preference is for two intersections on Lamb Street with no direct access to Cambridge Road. Our preferred locations are shown in Figure 7 below. The locations are based on providing minimum sight distance from the intersection and minimum separation of 90m to other intersections. The layout assumes that there will be no access to the structure plan area via the Kaipaki Road/Cambridge Road/Lamb Street intersection or Cambridge Road. If an access to the C4 Growth Cell were provided at the Kaipaki Road/ Cambridge Road /Lamb Street intersection, then it is likely that only one intersection on Lamb Street would be required.

There are existing residential vehicle crossings located on the opposite side of Lamb Street which may not meet minimum separation to the new intersections. The vehicle crossings are low volume and the non-compliance is unlikely to result in significant adverse safety effects.

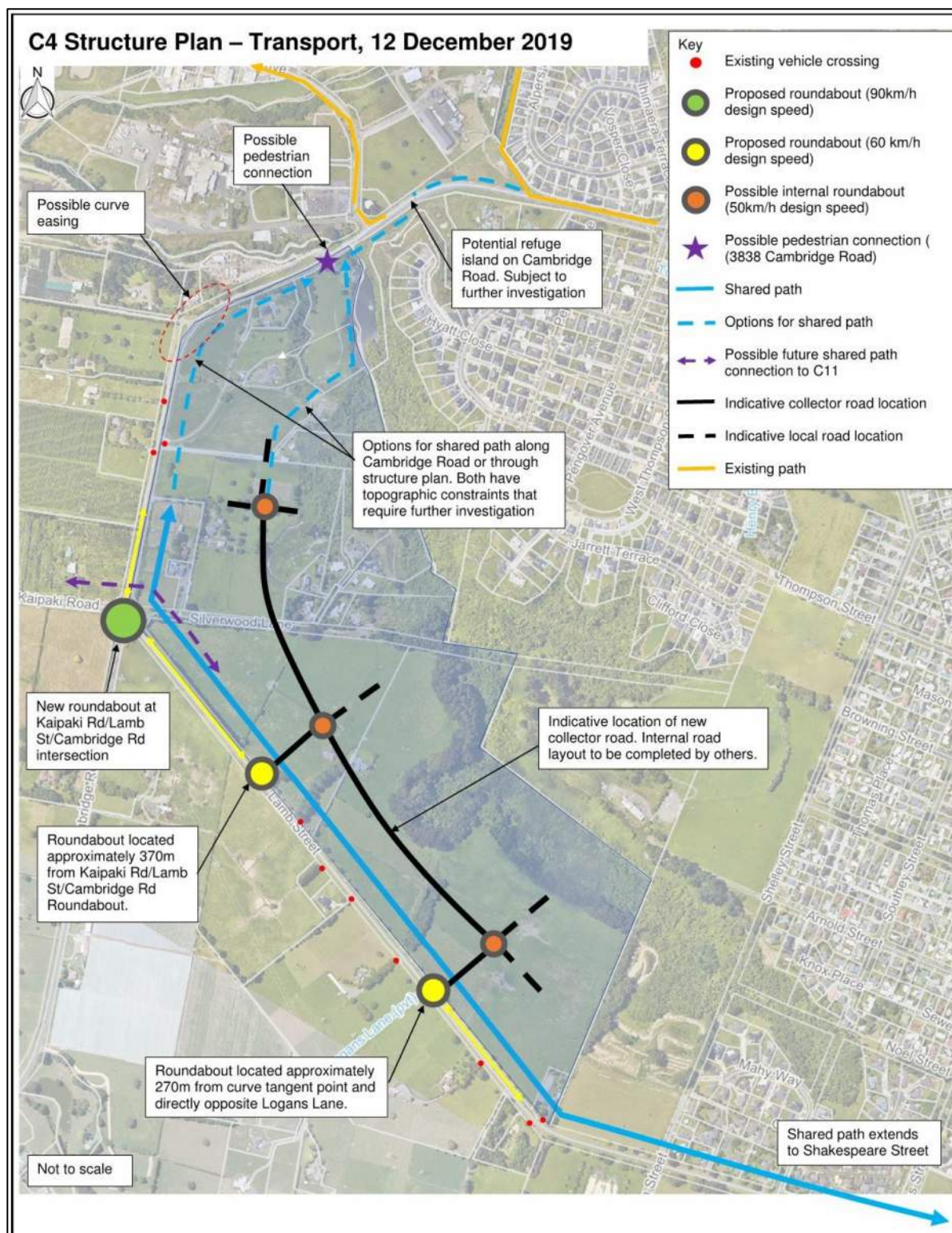


Figure 7: Structure Plan – Transport Layout (refer Appendix 1 for larger copy)

3.4.2. Arterial/ Collector Road Intersections

Austrroads Guide to Traffic Management provides guidance on intersection traffic controls based on road hierarchy. Lamb Street is a minor arterial road, meaning that roundabouts and priority-controlled intersections are the most appropriate forms of intersection.

Road type	Primary arterial	Secondary arterial	Collector and local crossing road	Local street
Roundabouts				
Primary arterial	A	A	X	X
Secondary arterial	A	A	A	X
Collector & local crossing road	X	A	A	O
Local street	X	X	O	O
Traffic signals				
Primary arterial	O	O	O	X
Secondary arterial	O	O	O	X
Collector & local crossing road	O	O	X	X
Local street	X	X	X	X
Stop signs or give way signs				
Primary arterial urban/(rural)	X/(X)	X/(O)	A	A
Secondary arterial urban/(rural)	X/(O)	X/(O)	A	A
Collector & local crossing road	A	A	A	A
Local street	A	A	A	A

A = Most likely to be an appropriate treatment
 O = May be an appropriate treatment
 X = Usually an inappropriate treatment.

Figure 8: Austroads Guide to Traffic Management – Intersections, Interchanges and Crossings (Table 2.6 – suitability of types of traffic control)

Austroads⁴ provides guidance on warrants for turning treatments at priority-controlled intersections. The peak hour right turning volumes are likely to exceed 20 veh/hr and the Lamb Street peak hour volume is 308 veh/hr therefore, a right turn treatment is required at each of the intersections.

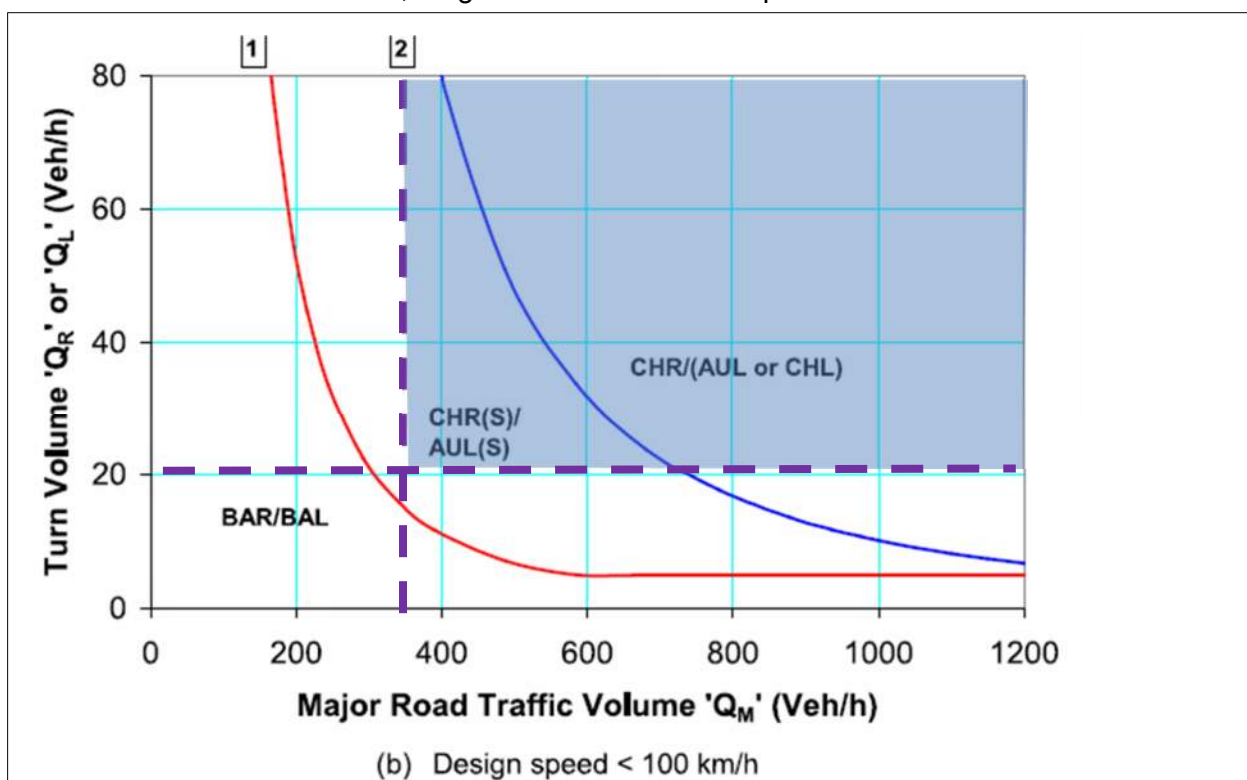


Figure 9: Austroads Turn Warrants

We have completed SIDRA traffic modelling for Intersection A which is likely to generate the most traffic during AM peak. We have tested both a priority-controlled intersection and a roundabout.

⁴ Guide to Road Design Part 4: Intersections and Crossings – Figure A 10
2019-11-19 C4 Structure Plan V4

We have assumed that 11% of AADT occurs during peak time on Lamb Street (308 veh/hr) and allowed for a 50:50 directional split on Lamb Street (154 veh/hr northbound and 154 veh/hr southbound).

The SIDRA modelling for the priority-controlled intersection shows delays and queues of just under 30sec/veh and 95%ile queues of just under 180m. The delays and queues are related to the high number of vehicles turning right out of the intersection. In practice, drivers may turn left-out to avoid long delays. Long delays can lead to driver frustration and crashes.

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Lamb St (NB)												
2	T1	154	10.0	0.084	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	50.0
3	R2	35	10.0	0.028	5.7	LOS A	0.1	0.9	0.39	0.57	0.39	45.2
Approach		189	10.0	0.084	1.1	NA	0.1	0.9	0.07	0.11	0.07	49.0
East: New Road A												
4	L2	137	10.0	0.921	21.5	LOS C	23.6	179.5	0.86	1.77	2.97	36.3
6	R2	549	10.0	0.921	27.8	LOS D	23.6	179.5	0.86	1.77	2.97	36.0
Approach		686	10.0	0.921	26.6	LOS D	23.6	179.5	0.86	1.77	2.97	36.1
North: Lamb St (SB)												
7	L2	137	10.0	0.163	4.7	LOS A	0.0	0.0	0.00	0.25	0.00	47.9
8	T1	154	10.0	0.163	0.0	LOS A	0.0	0.0	0.00	0.25	0.00	48.5
Approach		291	10.0	0.163	2.2	NA	0.0	0.0	0.00	0.25	0.00	48.3
All Vehicles		1166	10.0	0.921	16.4	NA	23.6	179.5	0.52	1.12	1.76	40.4

Table 7: SIDRA Modelling – Movement Summary

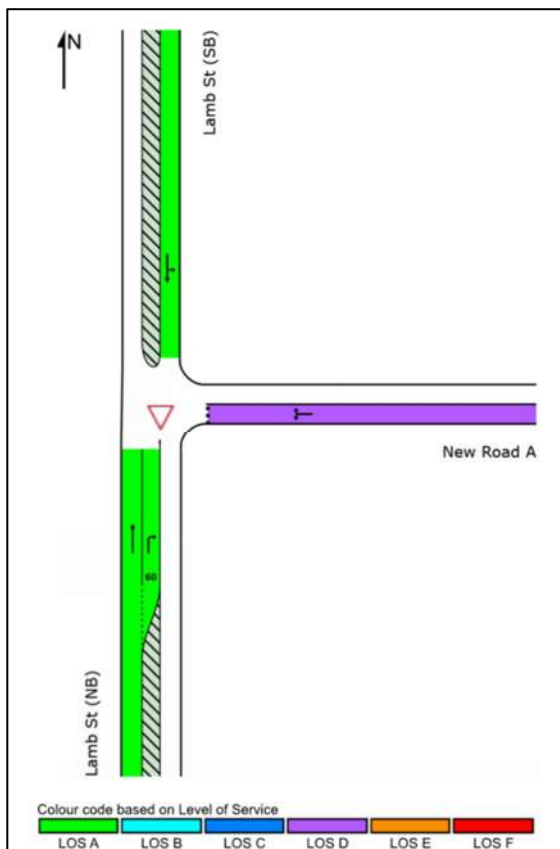


Figure 10: LOS Diagram - Priority Controlled Intersection

A roundabout is more efficient for all legs with the intersection operating at Level of Service (LOS) A. The roundabout will provide a safer intersection when compared to a priority-controlled intersection.

Movement Performance - Vehicles												
Mov ID	Turn	Demand Total veh/h	Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back Vehicles veh	of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Lamb St (NB)												
2	T1	154	10.0	0.221	5.3	LOS A	1.5	11.4	0.73	0.67	0.73	47.2
3	R2	35	10.0	0.221	11.1	LOS B	1.5	11.4	0.73	0.67	0.73	47.8
Approach		189	10.0	0.221	6.4	LOS A	1.5	11.4	0.73	0.67	0.73	47.4
East: New Road A												
4	L2	137	10.0	0.523	3.6	LOS A	4.7	35.3	0.53	0.59	0.53	45.2
6	R2	549	10.0	0.523	8.9	LOS A	4.7	35.3	0.53	0.59	0.53	47.0
Approach		686	10.0	0.523	7.8	LOS A	4.7	35.3	0.53	0.59	0.53	46.6
North: Lamb St (SB)												
7	L2	137	10.0	0.193	2.4	LOS A	1.4	11.0	0.20	0.27	0.20	48.4
8	T1	154	10.0	0.193	1.9	LOS A	1.4	11.0	0.20	0.27	0.20	49.9
Approach		291	10.0	0.193	2.2	LOS A	1.4	11.0	0.20	0.27	0.20	49.2
All Vehicles		1166	10.0	0.523	6.2	LOS A	4.7	35.3	0.48	0.52	0.48	47.3

Table 8: SIDRA Modelling – Movement Summary

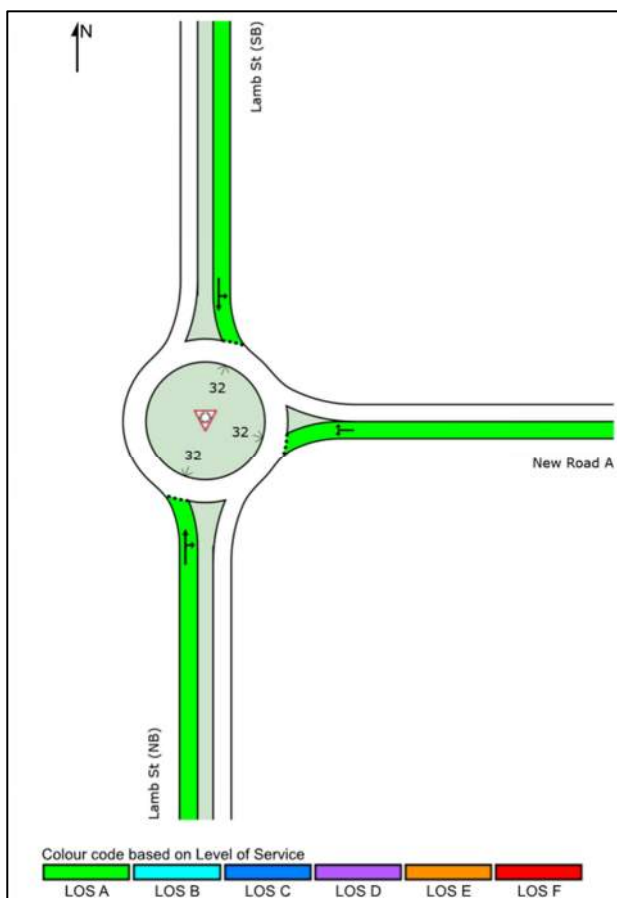


Figure 11: LOS Diagram - Roundabout

Given the relatively high volume of traffic at the intersections and better safety performance we prefer that the intersections are formed as roundabouts.

We have completed a generic concept design for an arterial road/collector road roundabout based on the design criteria summarised in Table 9. The concept layout is based on a 16m central island radius which is suitable for a design speed of 70km/h. The concept layout indicates a possible fourth leg if required (e.g. Logans Lane).

Criteria	
Design Speed	70 km/h
Central Island Radius	16m
Circulating width (single Lane)	7m
Inscribed circle diameter (ICD)	46m
Criterion 2 visibility	70m
Design vehicle	Semi-trailer

Table 9: Roundabout Design Criteria - collector road intersections

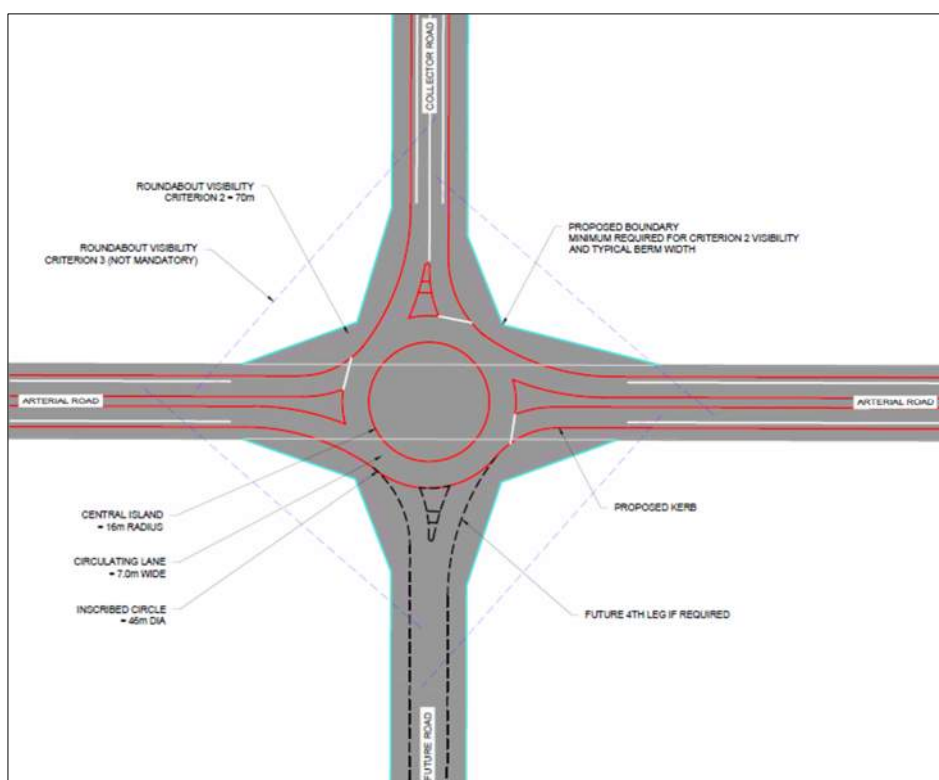


Figure 12: Typical arterial/collector road roundabout (also refer to Appendix 2)

3.5. Minor Arterial Cross Section (Lamb Street and Cambridge Road)

The District Plan does not provide specific design criteria for an arterial road.

We recommend that the Lamb Street and Cambridge Road cross-sections include two 3.5m lanes, 1.5m shoulders/on-road cycle lane on both sides and a 3m wide shared path on the development side. Typically, the District Plan⁵ requires 2.1m wide utility corridor on both sides for residential roads. The proposed cross-section allows for a 2.5m wide utility corridor on the development side and a 4.6m wide berm on the opposite side of the road to allow for drainage swale or future footpath.

⁵ Waipa District Plan Appendix T4 – Criteria for Public and Private Roads.
2019-11-19 C4 Structure Plan V4

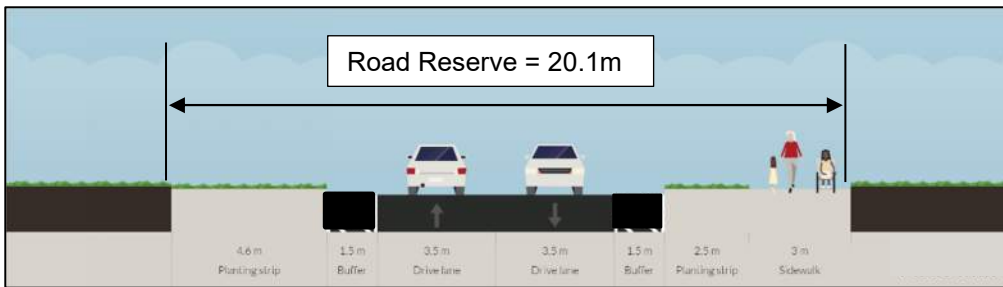


Figure 13: Proposed Cross Section for Lamb Street and Cambridge Road

Providing direct property access to a minor arterial is not consistent with its primary mobility function. We do note that the ONRC classification is Primary Collector which generally have a higher degree of property access. Providing direct property access to Lamb Street is likely to be acceptable if the posted speed on Lamb Street reduces to 50km/h.

3.6. Lamb Street/ Kaipaki Road/ Cambridge Road Intersection

3.6.1. Intersection Form

Given the increase in traffic volumes at this intersection, a roundabout appears to be the most appropriate form of intersection rather than a signalised intersection. A roundabout provides a safe system solution consistent with Vision Zero and would provide a rural/urban threshold.

The difference in safety performance between other intersections in particular traffic signals is mainly attributable to the higher potential speed of vehicles that are possible at a signalised intersection. A well-designed roundabout will achieve lower relative speeds through geometric design and should therefore experience less severe injuries when crashes do occur. In addition, the number of conflict points is greatly reduced from 32 at traffic signals to 16 at a multi-lane roundabout (for four leg intersections).

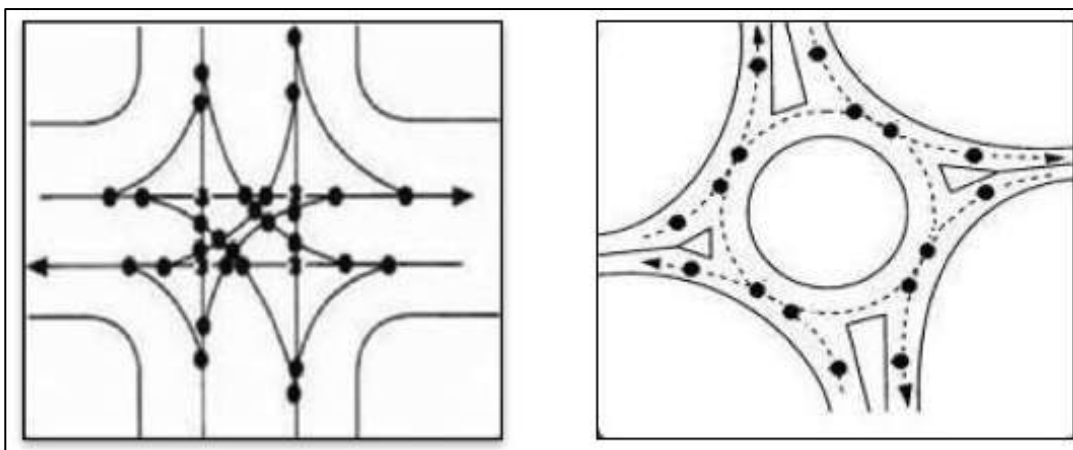


Figure 14: Vehicle conflict points. Traffic signals = 32 conflict points, multi-lane roundabout = 16 (Source: NZ Transport Agency Research Report 476)

It is important to note that most of the research is specifically relevant to urban areas with speed limits $\leq 50\text{km/hr}$ and focused on intersections with daily traffic volumes $>20,000\text{vpd}$. The research found that no pedestrian fatality was reported at any roundabout in New Zealand during 2005-2008, compared to 11 at traffic signal intersections. This could be a result of a reduced exposure if pedestrians are avoiding roundabouts and crossing elsewhere.

We have completed concept design for a single lane roundabout at the Kaipaki Road/Lamb Street/Cambridge Road intersection. The roundabout is based on the following design criteria.

Criteria	
Design Speed	90km/h (refer to table shown on drawing for approach design speeds)
Central Island Radius	22m
Circulating width (single Lane)	6.5m
Inscribed circle diameter (ICD)	57m
Criterion 2 visibility	70m (50km/h approach speed)
Design vehicle	Semi-trailer

Table 10: Roundabout Design Criteria

The following roundabout options have been considered (refer Appendix 2):

- = Option 1: Five leg roundabout (including Silverwood Lane as a fifth leg);
- = Option 2: Four leg roundabout (no Silverwood Lane approach) (two sub-options); and
- = Option 3: Four leg roundabout (realigned Lamb Street approach).

Our assessment indicates that an appropriately designed roundabout can be provided as this intersection. The final location will be confirmed during detailed design. The location of the central island could be shifted which would result in affecting different properties (e.g. land take within the structure plan vs on Kaipaki Road). Our preference is to optimise the roundabout geometry by shifting the central island towards Kaipaki Road.

Land acquisition will be required for all options to comply with criterion 2 visibility. The concept plans show criterion 3 visibility requirements. This is not mandatory and could be achieved with additional land take. We note that providing visibility beyond criterion 3 can result in higher roundabout approach speeds and higher impact speeds.

Options 1 and 2A show a small radius curve (50km/h) on Cambridge Road (south) as the alignment is constrained by existing boundaries and power pylon. The approach curve could be improved during detailed design which would result in earlier visibility to the central island for approaching drivers. Option 2B results in better approach geometry when compared to the other options but requires land on Kaipaki Road.

We understand that Council's preference is a roundabout with no direct access to the structure plan. Providing a connection to Silverwood Lane at the roundabout provides more direct access to the structure plan and may reduce the need for multiple roundabouts on Lamb Street.

3.6.2. Option Assessment

We have assessed the following roundabout layouts using a high/medium/low assessment scale for a range of criteria:

- = Option 1: Five leg roundabout (including Silverwood Lane as a fifth leg);
- = Option 2: Four leg roundabout (no Silverwood Lane approach) (two sub-options); and
- = Option 3: Four leg roundabout (realigned Lamb Street approach).

Option 2B, a four leg roundabout is the preferred option. Option 3 would be acceptable and is likely to operate efficiently and safely. The final configuration of the roundabout would be subject to detailed design.

3.6.3. Timing of Roundabout

We have completed SIDRA modelling for the existing staggered T intersection to determine when a roundabout is required at the Kaipaki Road/Cambridge Road/Lamb Street intersection. We have modelled the following three AM peak scenarios:

- = Scenario A: Baseline using WRTM 2021 traffic volumes;
- = Scenario B: Baseline + full development of Area C (306 lots);
- = Scenario C: Baseline + full development of Area A (428 lots) and Area B (286 lots);

Scenario A operates at LOS A on both the Kaipaki Road and Lamb Street approaches. Scenario B with the addition of development traffic from Area C results in LOS B on Lamb Street. There appears to be sufficient capacity at the intersection to accommodate traffic from Area C. Adding development from Area A and Area B (Scenario C) results in LOS F on Lamb Street and LOS C on Kaipaki Road.

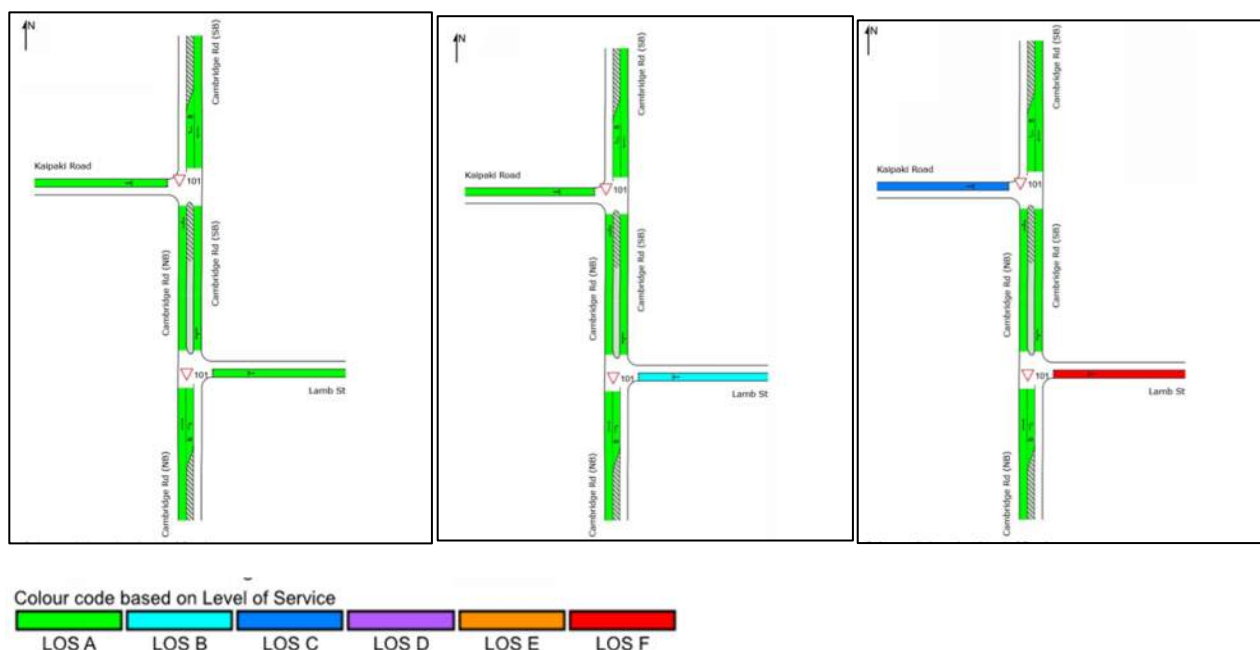


Figure 1: Lane LOS (left = Scenario A, middle = Scenario B, right = Scenario C)

We understand that it is likely that Area C will be developed first and there appears to be sufficient capacity at the existing staggered T intersection to accommodate development traffic from Area C (assumed to be 306 lots). Adding traffic from Area A and Area B results in poor LOS on Lamb Street and less than desirable LOS on Kaipaki Road. Adverse safety effects are also likely.

We note that Cambridge Road is a major arterial road and there are likely to be efficiency and safety effects during the construction of the roundabout which will result in traffic being dispersed to other parts of the traffic network during the construction period. It would be desirable to construct the

roundabout prior to development within the C4 structure plan to avoid additional development traffic being dispersed to other parts of the network during the construction period.

As mentioned above a well-designed roundabout is generally a safer intersection form compared to priority controlled intersections. SIDRA modelling indicates that there is sufficient capacity at the staggered-T intersection to accommodate development traffic from Area C. It would be desirable to construct the roundabout prior to development within the C4 structure plan. However, constructing the roundabout once Area C (or approximately 300 lots) is developed but prior to any development in Area A and B is acceptable.

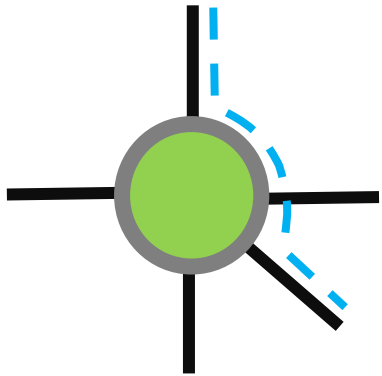
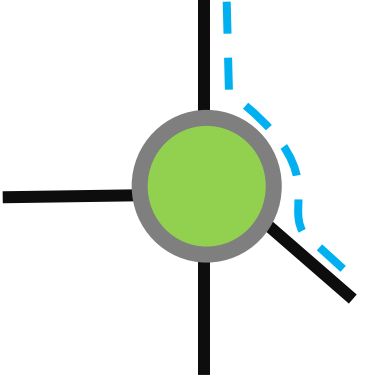
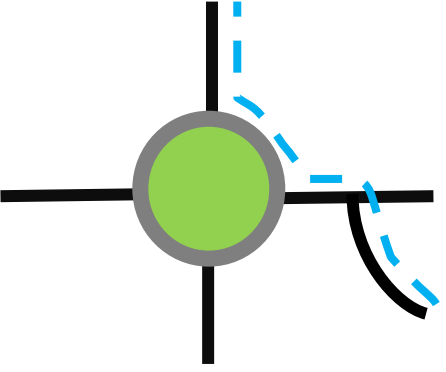
Option	Layout (blue line = shared path)	Safety	Efficiency	Cost	Pedestrians	Summary
Option 1: Five Leg roundabout (Cambridge Rd/ Kaipaki Rd/ Lamb St/ Silverwood Ln) Concept option attached at Appendix 2		Low <ul style="list-style-type: none"> More roundabout approaches result in less desirable approach leg separation. Introduces additional conflict points to this intersection 	Medium <ul style="list-style-type: none"> Provides direct access (gateway) to the structure plan May only required one new intersection on Lamb Street. Minimal impact on alignment of Lamb Street 	Medium <ul style="list-style-type: none"> Will require upgrading Silverwood Lane to accommodate increase in traffic (currently used for residential access only). Likely to be more expensive than Option 2. 	Medium <ul style="list-style-type: none"> Will require an at grade pedestrian crossing at Silverwood Lane to provide a pedestrian connection from Lamb St to Cambridge Road (north). 	Undesirable This option provides direct access to the structure plan. This option is likely to result in fewer intersections on Cambridge Road and Lamb Street. Increased risk of crashes at 5-leg roundabout.
Option 2: Four Leg roundabout (Cambridge Rd/ Kaipaki Rd/ Lamb St) Different options for land take are attached at Appendix 2 (Option 2A and 2B).		Medium <ul style="list-style-type: none"> Results in two relatively close approaches (Cambridge Rd (south) and Lamb St), but complying visibility provided. Maybe challenging for less familiar users due to closely spaced approaches. 	Low <ul style="list-style-type: none"> Provides no direct access from roundabout to structure plan Likely to require two roundabouts on Lamb St introducing additional delay to that corridor 	Medium <ul style="list-style-type: none"> Likely to be the cheapest roundabout option, but requires two roundabouts on Lamb St 	High <ul style="list-style-type: none"> No at grade crossing required for a pedestrian connection from Lamb St to Cambridge Road (north) 	Option 2B Preferred The option results in no direct access to the structure plan, requiring other infrastructure be provided. Access to the structure plan will be via new roundabouts on Lamb Street. Issues related to closely spaced approaches can be managed.
Option 3: Four Leg roundabout (Cambridge Rd/ Kaipaki Rd/ Silverwood Ln and re-align Lamb St) We have not yet completed a concept design for this option.		High <ul style="list-style-type: none"> Provides the best roundabout layout in terms of approach geometry as the approach legs intersect at 90° Only four roundabout approach legs, results in simpler roundabout geometry. Likely to result in a safer roundabout layout compared to Options 1 and 2. 	High <ul style="list-style-type: none"> Provides direct access (gateway) to the structure plan Only one roundabout on Lamb Street will be required. 	High <ul style="list-style-type: none"> Requires realigning Lamb Street – higher construction costs and greater property impact Will require upgrading Silverwood Lane to accommodate increase in traffic (currently used for residential access only) Likely to be the most expensive option Realignment of Lamb Street results in inefficient land use in south east corner of roundabout (i.e. reduces subdivision yield). 	Medium <ul style="list-style-type: none"> Will require an at grade pedestrian crossing at Silverwood Lane to provide a pedestrian connection from Lamb St to Cambridge Road (north). 	Acceptable This option provides direct access to the structure plan area. This option results in more desirable approach geometry, but is likely to be the most expensive option. Due to cost and inefficient land impacts this option is not preferred.

Table 11: Roundabout Option Assessment (blue dashed line = walking/cycling route)

3.7. Lamb Street/Shakespeare Street

Provided that safe walking and cycling facilities can be provided, a roundabout is our preferred option for this intersection. We have completed a concept design based on a 60km/h design speed, 10m central island radius, 6.3m wide circulating lane and large rigid truck design vehicle.

A pedestrian crossing facility is required on Shakespeare Street (north) to allow for a shared path connection along Lamb Street to Leamington School. Given that the intersection is located near a school we recommend considering implementing physical speed management such as raised safety platforms on the roundabout approaches. The raised safety platforms would also provide a crossing point for pedestrians.

There are vehicle crossings located near the intersection which may limit the length of splitter islands. This should be investigated during detailed design.

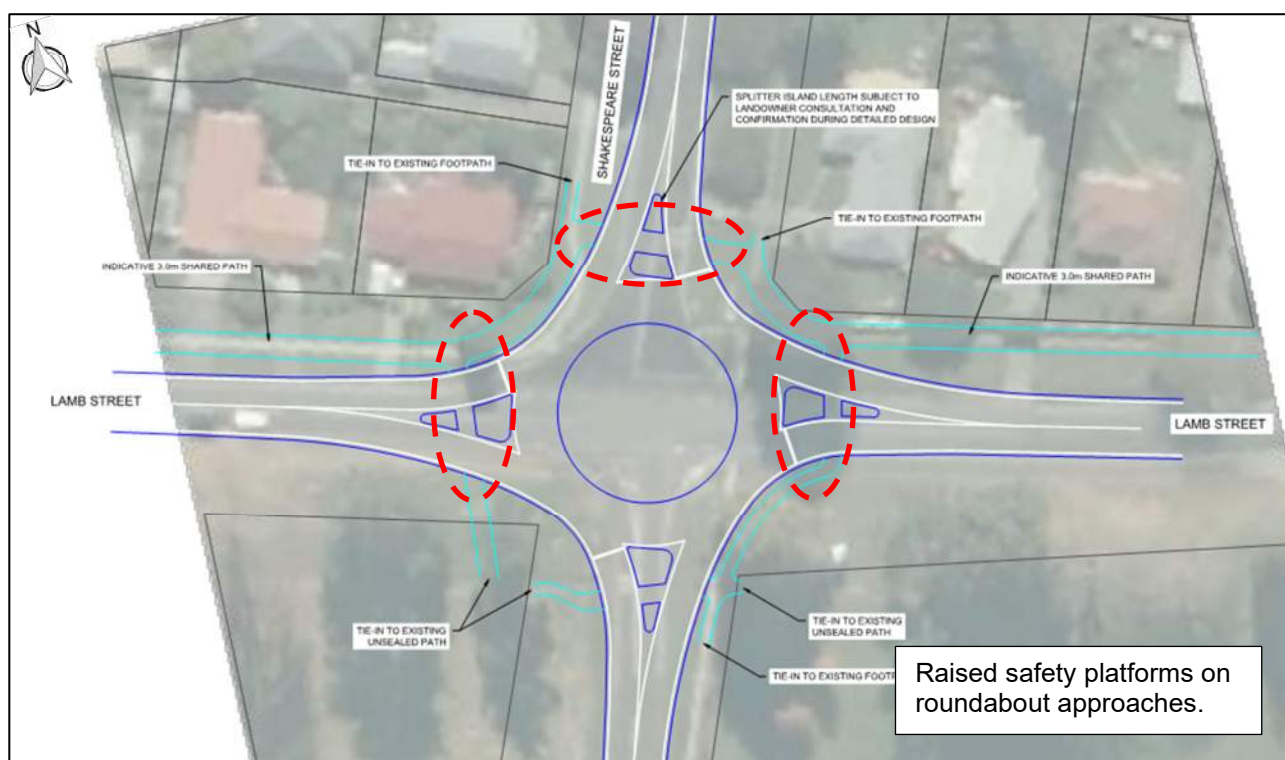


Figure 15: Lamb Street/Shakespeare Street intersection concept design

3.8. Walking and Cycling

There is likely to be an increase in walking and cycling on Lamb Street. We recommend that a shared path be provided on the development side of Lamb Street. This could be extended to provide a continuous path along Maungatautari Road to Lake Karapiro.

There are two options for a connection on Cambridge Road north of Kaipaki Road. One option is to continue the path along Cambridge Road, the other option is to provide a shared path through the development joining at 3838 Cambridge Road.

Our concept plans do not show pedestrian connections at the Cambridge Road roundabout. At this stage there is no demand for a crossing point on Cambridge Road or Lamb Street until the C11 growth cell is developed. A crossing point could be provided on Cambridge Road to provide connectivity to the future C11 growth cell.

3.9. Access to 3838 Cambridge Road

Providing a connection between 3838 Cambridge Road to the remainder of the structure plan area is likely to be very difficult due to the steep topography. The only form of access appears to be direct to Cambridge Road. The posted speed of 80km/h requires 203m sight distance⁶. The current vehicle crossing location does not comply with sight distance requirements for an 80km/h posted speed. There is unlikely to be any location that provides complying sight distance.

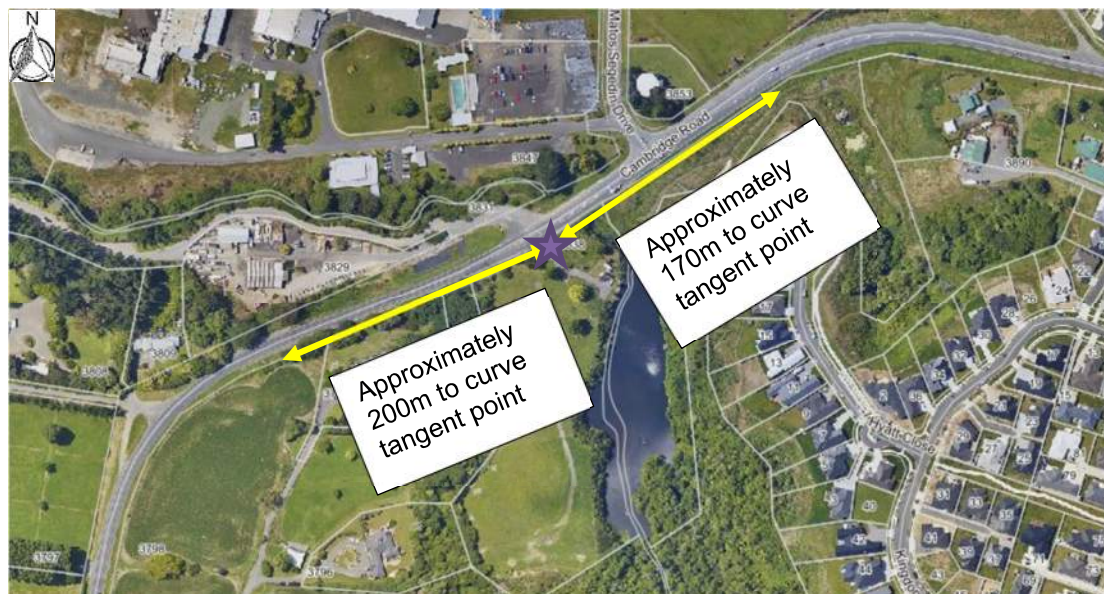


Figure 16: 3838 Cambridge Road Access (purple star = vehicle crossing)

The location of the right turn bay for access into the industrial site makes right turns in and out of 3838 Cambridge Road confusing and difficult. However, the current vehicle crossing is located directly opposite the crossing on the northern side of Cambridge Road (effectively forming a low volume crossroads intersection).

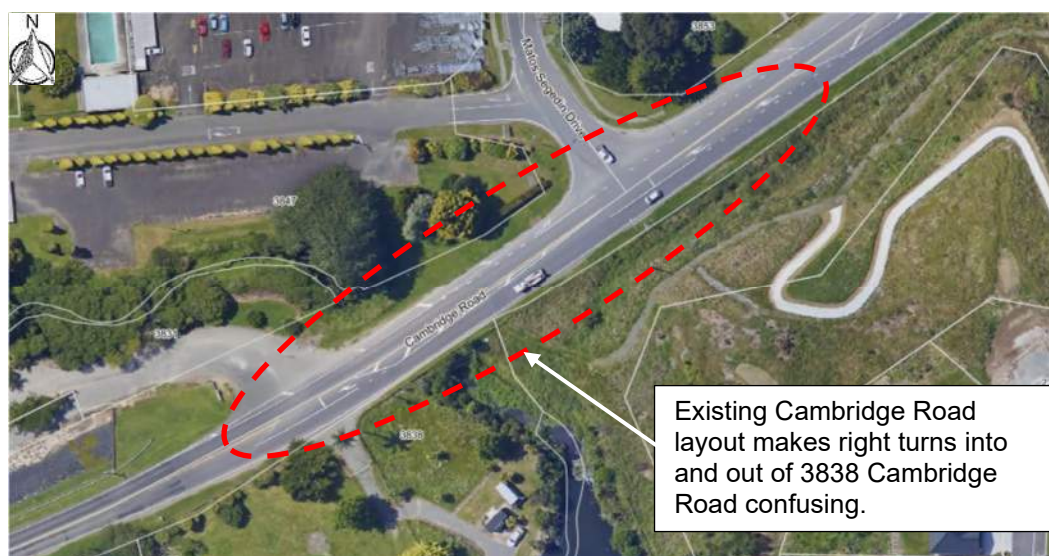


Figure 17: 3838 Cambridge Road Access (purple star = vehicle crossing)

The adverse effects of providing vehicle access to Cambridge Road will depend on the nature of the activity and trip generation of that activity. Given the location and concerns about access, it appears best suited to low trip generating activities. An alternative, could be to restrict access to left-in/left-

⁶ NZTA Planning Policy Manual – Appendix 5B, Table App5B/1
2019-11-19 C4 Structure Plan V4

out. However, this may limit use of the property and result in in appropriate u-turns elsewhere on the network.

As noted elsewhere, there is the potential for the shared path to join Cambridge Road in this area. Further investigation is required to confirm the most appropriate location for a pedestrian crossing facility.

3.10. Internal Road Layout

The internal road layout will consist of a collector road and local roads for access to individual lots. The final road layout has not been confirmed yet. The District Plan provides guidance on cross sections for residential collector roads. We recommend that the internal roads are designed to these standards.

Type and description	Road reserve width	Carriageway Width	Lane Width	Cycleway width	Street Parking widths	Kerb	Berm swale etc	Path	Utilities
Collector	25m	15m	2 x 3.5m	Both sides 1.5m	1 park per lot @ 2.5m wide	Barrier	Both sides	2 x 1.5m	Both sides 2.1m min

Table 12: Waipa District Collector Road Standards (Appendix T4)

We recommend that all internal collector road intersections are designed to allow for a central throat island. The island width should be at least 1.8m wide to shelter pedestrians. Roundabouts or raised safety platforms are preferred at crossroads intersections.

The final layout of internal intersections will need to be confirmed at detailed design stage and should include:

- = Intersection design in accordance with the RITS and current design best practice.
- = Providing minimum safe intersection sight distance based on the proposed internal road posted speed.
- = Providing channelisation at the intersection with throat islands.
- = All marking and signs are in accordance with the Traffic Control Devices Rule and MOTSAM.
- = Providing appropriate street lighting at the intersections.

3.11. Parking

We anticipate that on-site parking will be provided for each lot. The District Plan requires 1 parking space per lot.

District Plan Appendix T4 recommends that residential collector road and local roads provide one on-street space per lot. The requirement for cul-de-sac is 0.75 parking spaces per lot. We recommend that each structure plan road provides sufficient on street parking. The use of recessed parking is increasingly common in residential subdivisions.

4. DISCUSSION

4.1. Efficiency

The proposed structure plan will result in an additional 1,020 lots generating approximately 11,100 veh/day.

Assuming 80% of traffic heads north to Cambridge, the traffic volume on Cambridge Road will increase in by approximately 8,900veh/day. The proposal is likely to more than double the existing traffic volume on Cambridge Road with approximately 16,000veh/day once the structure plan is fully developed.

We have completed SIDRA modelling for Intersection A on Lamb Street for both a roundabout and a priority-controlled intersection. The Sidra modelling indicates that there are likely to be delays and queues on the structure plan road during the AM peak if the intersection is formed as a priority-controlled intersection. A roundabout is more efficient and safer than a priority-controlled intersection.

We recommend that Lamb Street and Cambridge Road are upgraded to accommodate the additional traffic. Our preferred cross-section is shown below.

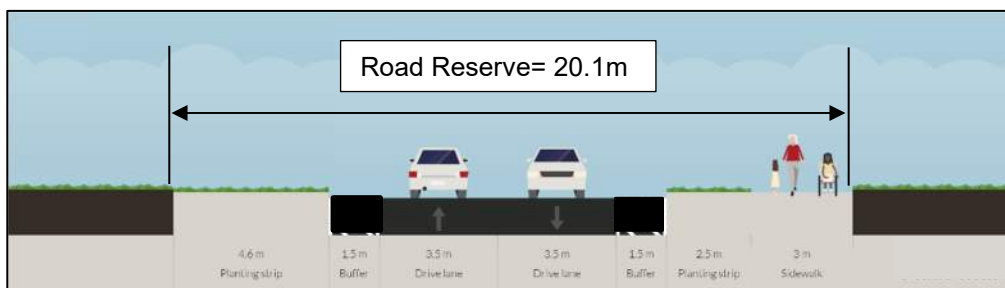


Figure 18: Proposed Cross Section for Lamb Street and Cambridge Road

4.2. Safety

There will be an increase in turning movements on Lamb Street and at the Kaipaki Road/ Cambridge Road/ Lamb Street intersection. The increase in turning movements increases the risk of crashes.

The existing staggered-T intersection could accommodate traffic from Area C (or approximately 300 lots) but is unlikely to safely accommodate traffic from the entire development. Typically, well designed roundabouts are safer compared to priority-controlled intersections as there are less conflict points and speeds are generally controlled with approach and entry geometry. Upgrading the existing intersection to a roundabout will result in a safer form of intersection.

It would be desirable to construct the roundabout prior to development within the C4 structure plan. However, constructing the roundabout once Area C (approximately 306 lots) is developed and prior to any development in Area A and B is acceptable.

4.3. Internal Road Layout

We recommend that the internal road layout is designed to meet the District Plan requirements. We anticipate that the roads forming intersections with Lamb Street and Cambridge Road are likely to be collector roads with the other roads formed to local residential road standards.

4.4. Walking and Cycling

We recommend that a shared path is provided from Leamington School to the structure plan. Further investigation is required to determine the feasibility of a shared path north of the Kaipaki Road intersection on Cambridge Road. There appears to be two options for a shared path. One option

would be a shared path within the road reserve on Cambridge Road and the other option is a shared path connection within the development to 3838 Cambridge Road.

5. CONCLUSION

5.1. Summary

The C4 growth cell could yield approximately 1,020 lots. Based on typical trip generation rates this could generate approximately 11,100 veh/day and 1,200 veh/hr. The existing Kaipaki Road/ Cambridge Road/ Lamb Street intersection is not considered appropriate to accommodate all the additional traffic. Therefore, we recommend that the intersection is upgraded to a roundabout.

The structure plan should include an internal collector road that joins the arterial network at a series of roundabouts.

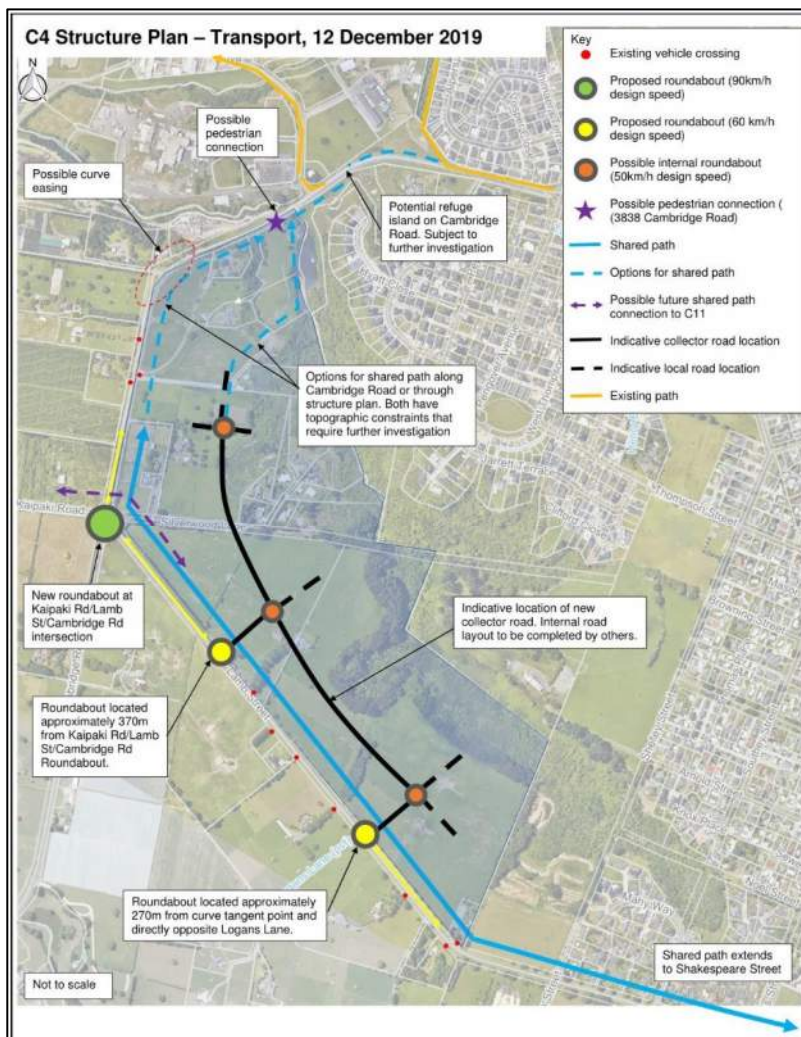


Figure 19: Structure Plan – Transport Layout (refer Appendix for larger copy))

5.2. Recommendations and Conclusion

Based on providing 1,020 lots the following transport infrastructure is required:

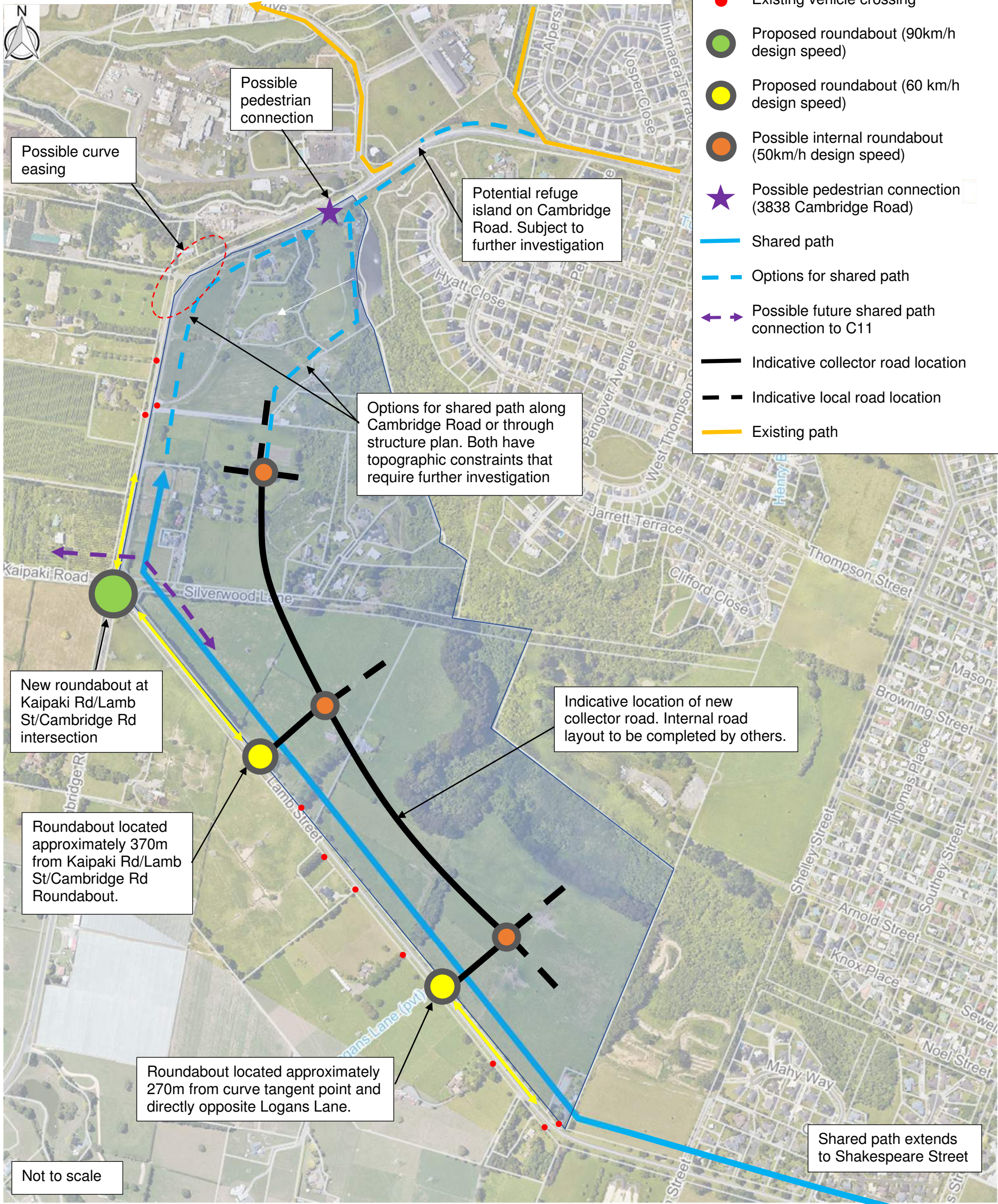
- = A roundabout at the Kaipaki Road/Cambridge Road/Lamb Street intersection;
- = 3m wide shared path on Lamb Street and Cambridge Road with links through the development;
- = Roundabouts at new intersections on Lamb Street;
- = Roundabout at the Lamb Street/ Shakespeare Street intersection;
- = Upgrading Lamb Street and Cambridge Road to arterial road standards; and
- = Walking and cycling connection via 3838 Cambridge Road.

Provided that the infrastructure improvements are staged in a way to suit the development, the transport effects of residential development in the C4 growth cell are likely to be acceptable.

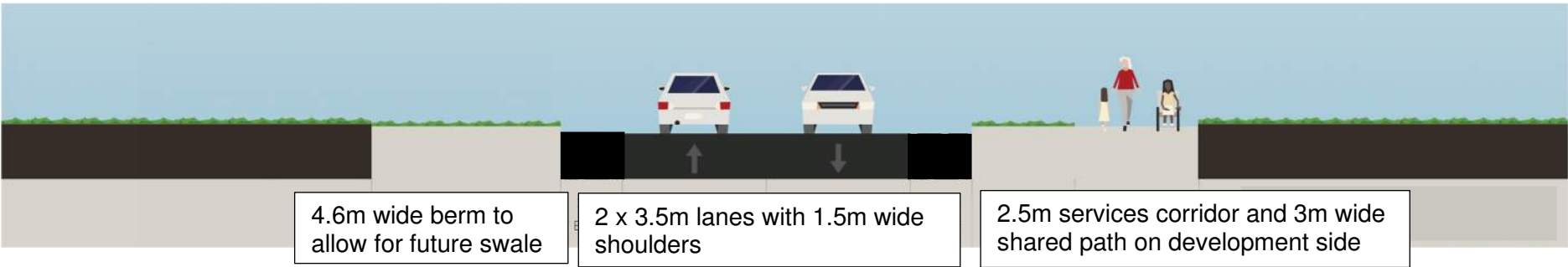
APPENDICES

Appendix 1: Structure Plan layout

C4 Structure Plan – Transport, 12 December 2019



Lamb St and Cambridge Rd (north of Kaipaki Rd) typical cross section

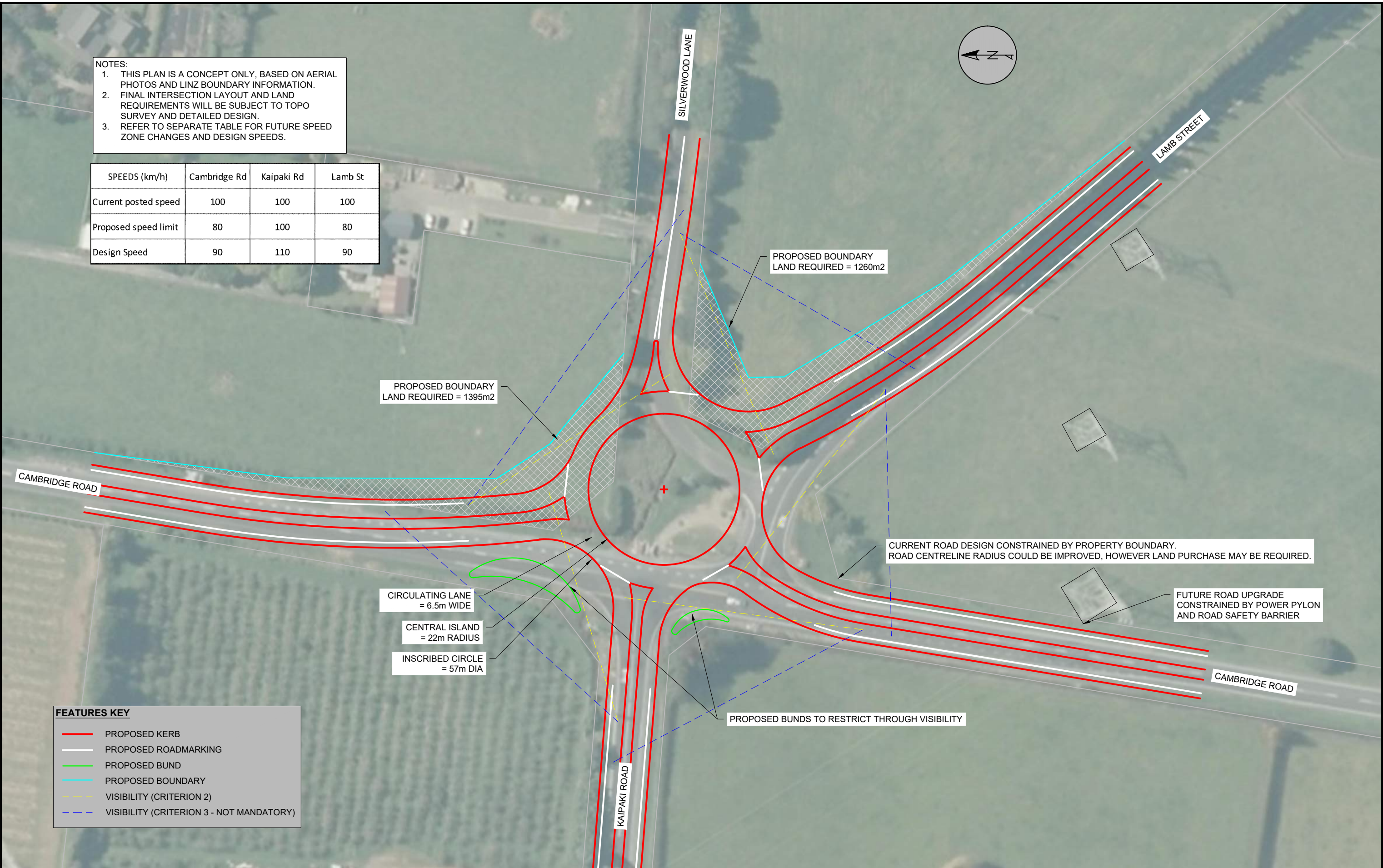


Appendix 2: Intersection Concept Drawings



- NOTES:
1. THIS PLAN IS A CONCEPT ONLY, BASED ON AERIAL PHOTOS AND LINZ BOUNDARY INFORMATION.
 2. FINAL INTERSECTION LAYOUT AND LAND REQUIREMENTS WILL BE SUBJECT TO TOPO SURVEY AND DETAILED DESIGN.
 3. REFER TO SEPARATE TABLE FOR FUTURE SPEED ZONE CHANGES AND DESIGN SPEEDS.

SPEEDS (km/h)	Cambridge Rd	Kaipaki Rd	Lamb St
Current posted speed	100	100	100
Proposed speed limit	80	100	80
Design Speed	90	110	90



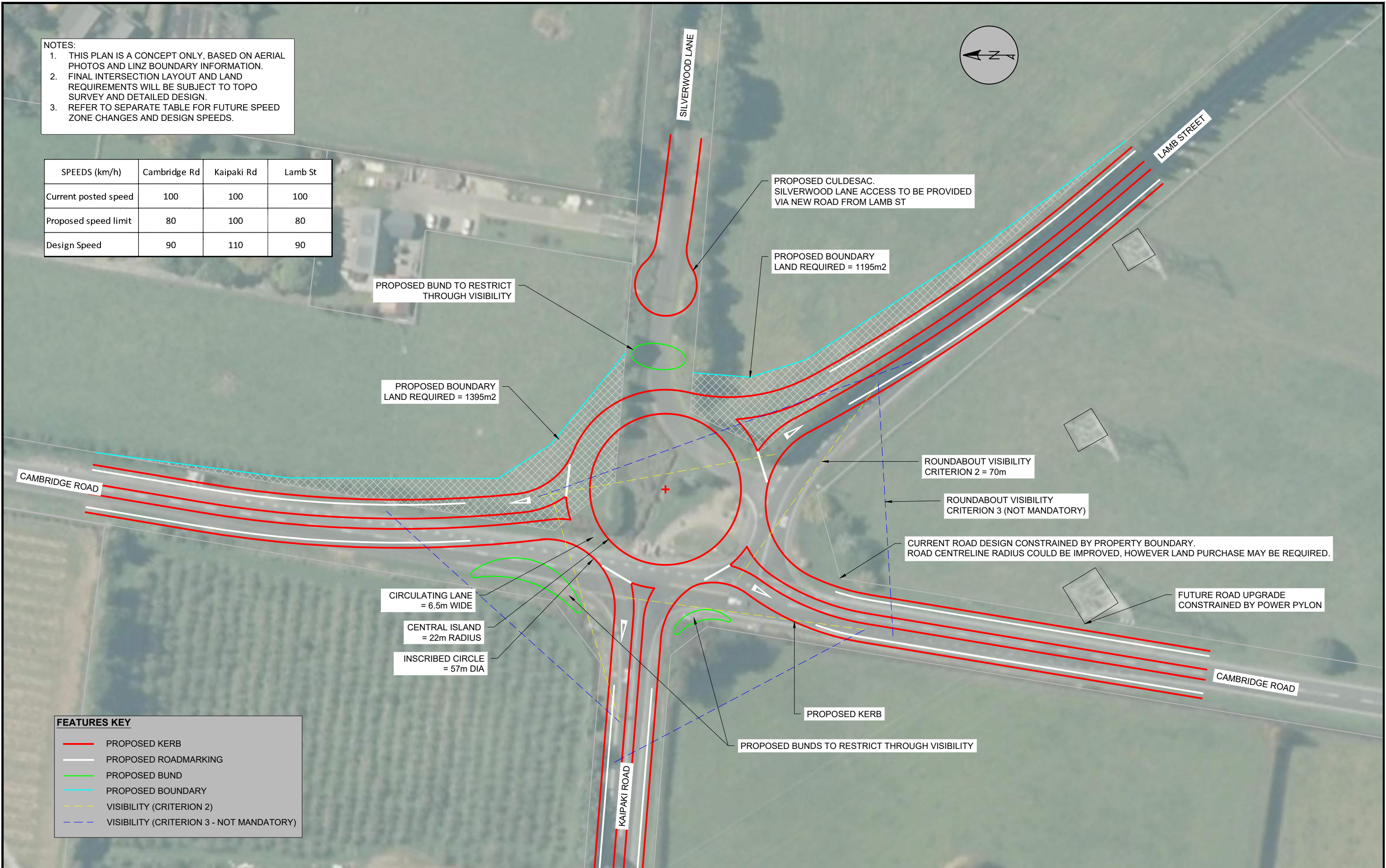
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—	PROPOSED ROADMARKING
—	PROPOSED BUND
—	PROPOSED BOUNDARY
---	VISIBILITY (CRITERION 2)
---	VISIBILITY (CRITERION 3 - NOT MANDATORY)

REF	AMENDMENT	APPD	DATE	DESIGN	BY	CHECKED	DATE	RECOMMENDED	DATE	OFFICE	CLIENT	PROJECT	STATUS
					D. MILLS		08 / 19			gray matter	Waipa DISTRICT COUNCIL	WAIPA DISTRICT COUNCIL C4 STRUCTURE PLAN	CONCEPT
				DRAWN	D. MILLS	V. PRAKASH	09 / 19					LAMB ST / CAMBRIDGE RD / KAIPAKI RD PROPOSED ROUNDABOUT CONCEPT - OPTION 1	GEODETIC & VERTICAL DATUM NZGD2000
								APPROVED					PLAN NUMBER 05_142_100_O
													SHEET Sketch 1
													SCALE 1:1000 (@ A3)
													REVISION R0



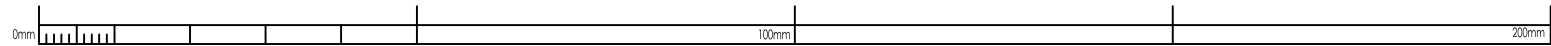
- NOTES:
1. THIS PLAN IS A CONCEPT ONLY, BASED ON AERIAL PHOTOS AND LINZ BOUNDARY INFORMATION.
 2. FINAL INTERSECTION LAYOUT AND LAND REQUIREMENTS WILL BE SUBJECT TO TOPO SURVEY AND DETAILED DESIGN.
 3. REFER TO SEPARATE TABLE FOR FUTURE SPEED ZONE CHANGES AND DESIGN SPEEDS.

SPEEDS (km/h)	Cambridge Rd	Kaipaki Rd	Lamb St
Current posted speed	100	100	100
Proposed speed limit	80	100	80
Design Speed	90	110	90



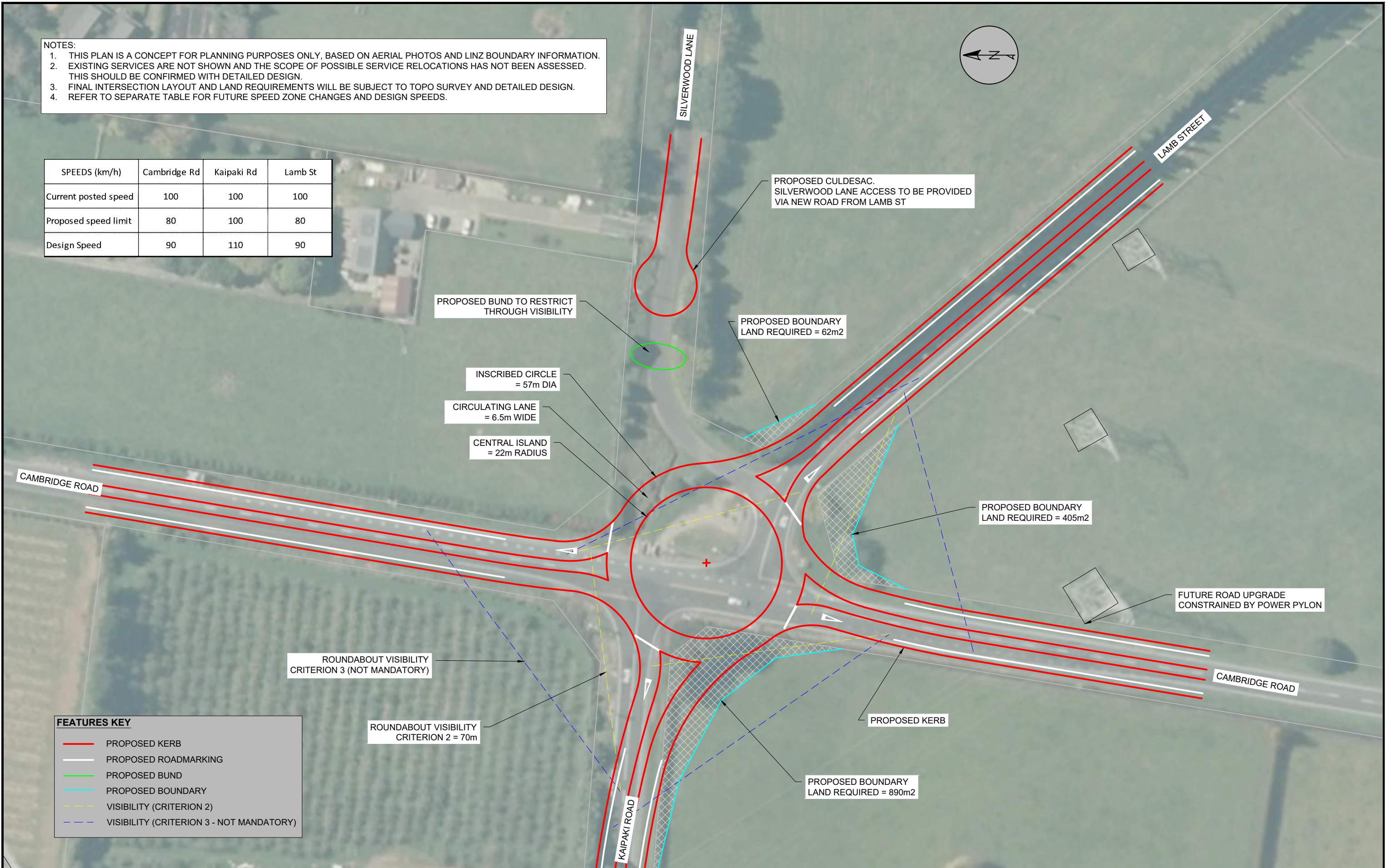
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—	PROPOSED ROADMARKING
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—	PROPOSED BOUNDARY
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---	VISIBILITY (CRITERION 3 - NOT MANDATORY)

REF	AMENDMENT	APPD	DATE	DESIGN	BY	CHECKED	DATE	RECOMMENDED	DATE	OFFICE	CLIENT	PROJECT	STATUS
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				DRAWN	D. MILLS	V. PRAKASH	09 / 19					LAMB ST / CAMBRIDGE RD / KAIPAKI RD PROPOSED ROUNDABOUT CONCEPT - OPTION 2A	GEODETIC & VERTICAL DATUM NZGD2000
								APPROVED					PLAN NUMBER 05_142_100_O
													SHEET Sketch 2
													SCALE 1:1000 (@ A3)
													REVISION R0



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 2. EXISTING SERVICES ARE NOT SHOWN AND THE SCOPE OF POSSIBLE SERVICE RELOCATIONS HAS NOT BEEN ASSESSED. THIS SHOULD BE CONFIRMED WITH DETAILED DESIGN.
 3. FINAL INTERSECTION LAYOUT AND LAND REQUIREMENTS WILL BE SUBJECT TO TOPO SURVEY AND DETAILED DESIGN.
 4. REFER TO SEPARATE TABLE FOR FUTURE SPEED ZONE CHANGES AND DESIGN SPEEDS.

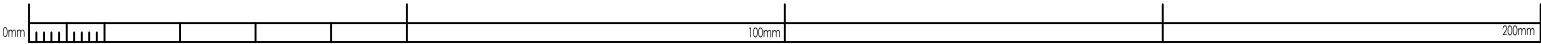
SPEEDS (km/h)	Cambridge Rd	Kaipaki Rd	Lamb St
Current posted speed	100	100	100
Proposed speed limit	80	100	80
Design Speed	90	110	90



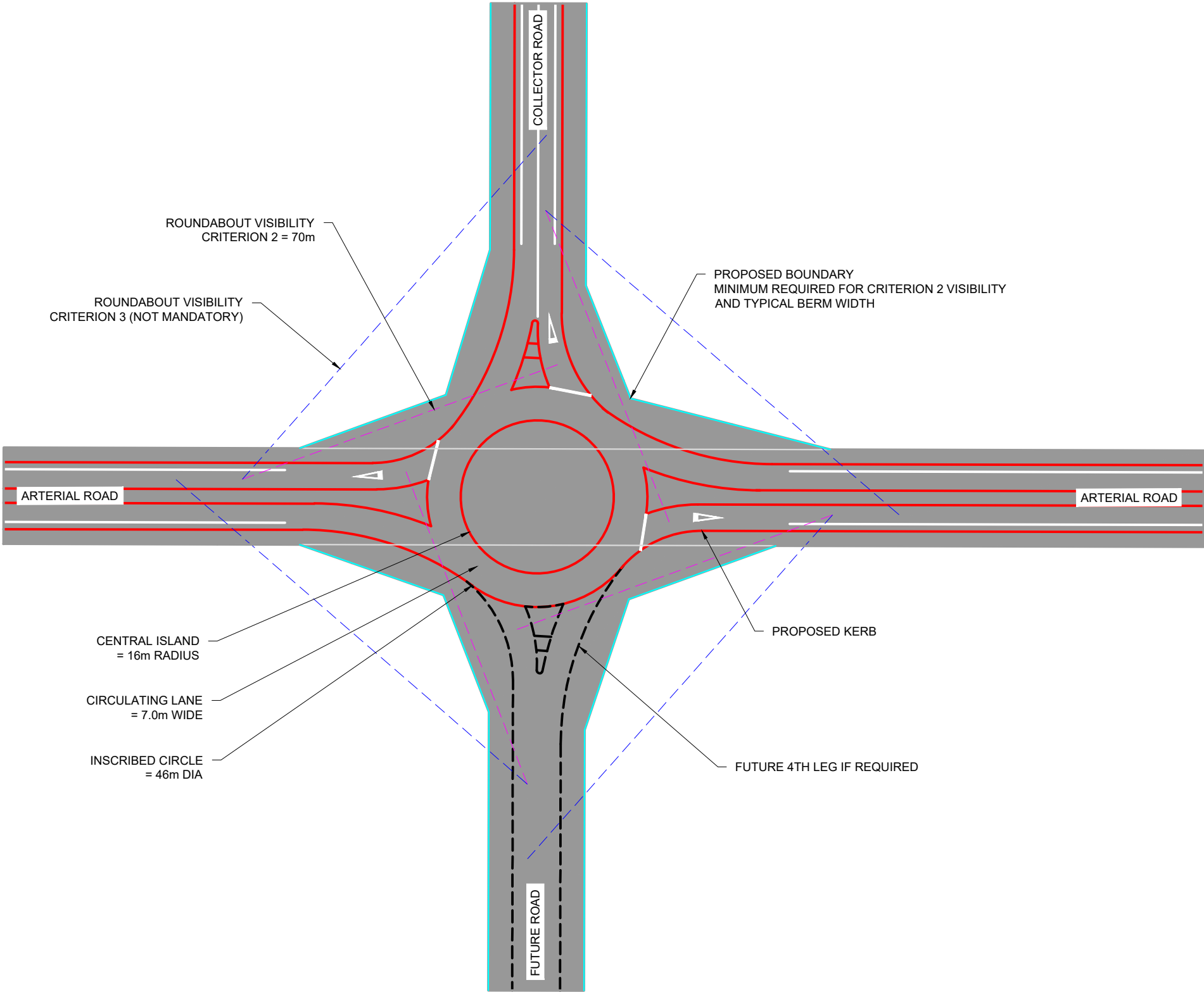
FEATURES KEY

- PROPOSED KERB
- PROPOSED ROADMARKING
- PROPOSED BUND
- PROPOSED BOUNDARY
- VISIBILITY (CRITERION 2)
- VISIBILITY (CRITERION 3 - NOT MANDATORY)

REF	AMENDMENT	APPD	DATE	DESIGN	BY	CHECKED	DATE	RECOMMENDED	DATE	OFFICE	CLIENT	PROJECT	STATUS
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								APPROVED				LAMB ST / CAMBRIDGE RD / KAIPAKI RD PROPOSED ROUNDABOUT CONCEPT - OPTION 2B	GEODETIC & VERTICAL DATUM NZGD2000
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													REVISION R0



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FEATURES KEY				
—	PROPOSED KERB			
—	PROPOSED ROADMARKING			
—	PROPOSED BOUNDARY			
---	VISIBILITY (CRITERION 2)			
---	VISIBILITY (CRITERION 3 - NOT MANDATORY)			

REF	AMENDMENT	APPD	DATE		BY	CHECKED	DATE	RECOMMENDED		OFFICE:	CLIENT:	PROJECT	STATUS	
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				DRAWN	D. MILLS	V. PRAKASH	10 / 19					GEODETIC & VERTICAL DATUM		
														NZGD2000
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				Copyright and Intellectual Property Rights for the information shown on this drawing remain the property of Gray Matter Ltd.										