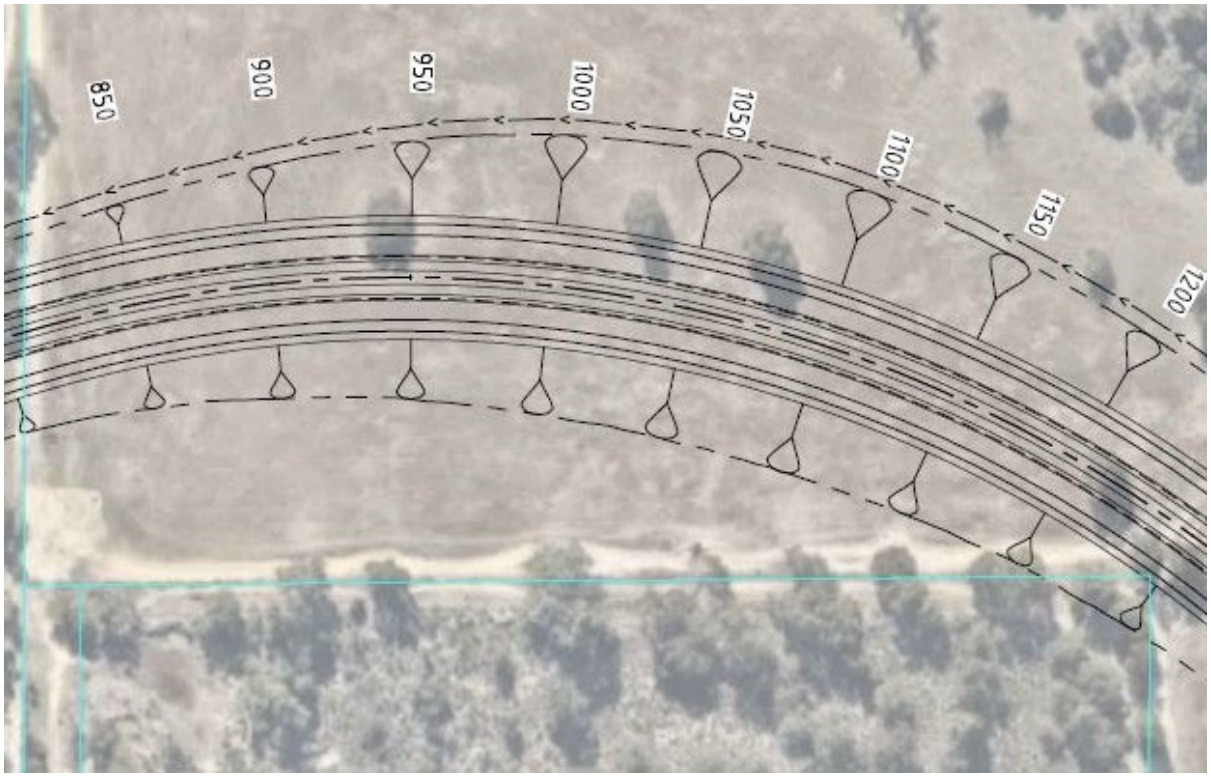
DEPARTMENT OF PLANNING, LANDS AND HERITAGE

MUCHEA INDUSTRIAL PARK

ROAD NETWORK / RAV 10 ASSESSMENT

APRIL 2020

CONFIDENTIAL



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Muchea Industrial Park
Road Network / RAV 10 Assessment

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 PROJECT BACKGROUND

1.1 STUDY AREA

The Muchea Industrial Park – Road Network/ RAV 10 Options Assessment project (the project) aims to define a road alignment, typical intersection treatment, typical cross section and minimum lot requirements capable of accommodating RAV10 vehicles within the Muchea Employment Node Structure Plan Area as outlined in Figure 1.1.

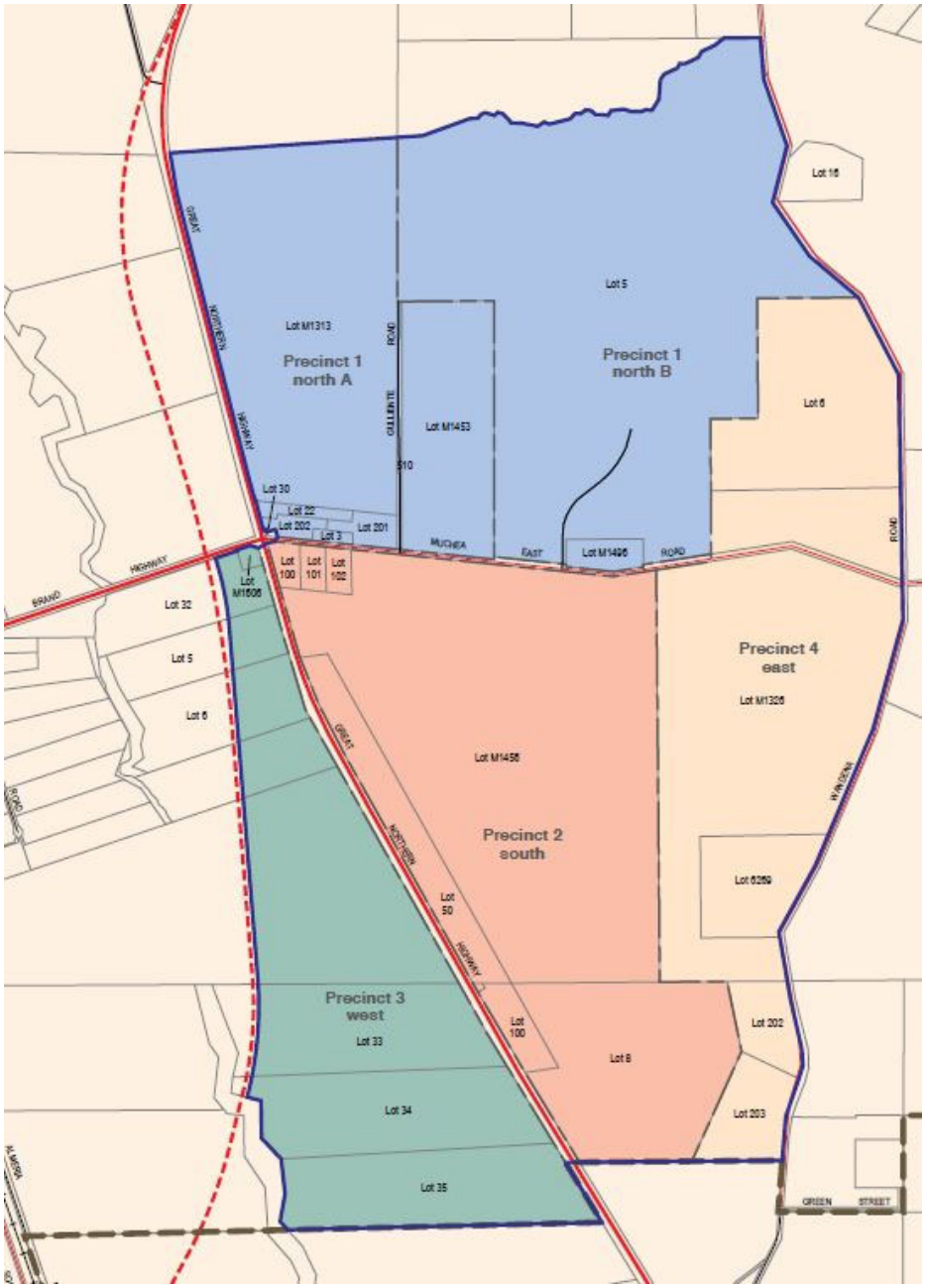


Figure 1.1 Study Area Precincts (Muchea Employment Node Structure Plan 2011)

The Structure plan nominates a road network layout, however the technical feasibility of these road alignments and requirements was not tested. Figure 1.2 outlines the Department of Planning, Lands and Heritage (DPLH) revised road

network layout which forms the basis for the project, with each being investigated. Each of the white hatched areas in the graphic represent the area in which it was requested WSP fit the required roads.

Figure 1.2 Roads 1 to 7 within the Study Area (DPLH Brief 2019)

1.2 SCOPE

The scope includes the following tasks:

1. Concept Road Design for Roads 1, and 2 (horizontal and vertical)
2. Concept Road Design for Road 6 (horizontal only as assumed to match existing vertical)
3. Broader Sketch Road Design for Roads 3, 4, 5, and 7 based on the outcomes of Task 1
4. Order of magnitude cost estimates
5. Test feasibility for individual lot access requirements

To inform this scope a series of tasks was undertaken, and data collected. This is set out in the remainder of this report.

1.3 INFORMATION PROVIDED

- DPLH provided the following information to inform the study: Muchea Employment Node Structure Plan Final Report August 2011
- Muchea Employment Node Lot 102 Great Northern Highway Local Structure Plan 1 Part one Implementation September 2017
- Muchea Industrial Park Structure Plan Precinct 3 February 2019
- Proposed subdivision road network for Lot 809 Great Northern Highway, Muchea
- Cadastral, 1m Contours and Aerial Image extracted for DPLH database
- Northlink Design Tin 2m and 10m grid

2 CONSTRAINTS ANALYSIS

2.1 INTRODUCTION

To provide context, and inform the concept / sketch design process, it was necessary first to identify design constraints. This consisted of a desktop exercise to develop a base data set of information, as set out below.

2.2 EXISTING ROAD NETWORK

The proposed road alignments tie-in to the existing road network at various locations of Great Northern Highway, Muchea East Road and a development access road. As a result, this introduces several constraints to the design, including:

- Existing roads are currently gazetted for RAV 7 on Great Northern Highway, Brand Highway and Muchea East Road to the WAMIA entrance. Gulliente Road and Wandena Road are gazetted as RAV 2
- No upgrade at intersection of Great Northern Highway / Brand Highway / Muchea East Road is proposed, therefore there is no potential to have RAV10 complete turning movements at this location
- The design of Road 1 needs to tie at the north to the road currently being constructed for the Harvis subdivision.
- Road 6 is required to follow the profile of the existing Muchea East Road
- The proposed intersection of Road 2 / Road 6 / Road 5 / Muchea Road East needs to be located in relatively flat area to allow for RAV10 turning stability
- The land surrounding the proposed intersections of Road 7 (south) / Great Northern Highway / Road 3 to change in land use from farming to industrial, and as such needs to be located such that a northbound approach design speed of 110kph can be accommodated.

These constraints have been incorporated into the proposed design.

2.3 CURRENT STRUCTURE PLANS

There is currently a Structure Plan in place for the wider area (Figure 1.1) and two Local Structure Plans for Stage 1 of Precinct 1a (Figure 2.1) and for Precinct 3 (Figure 1.1). Whilst all structure plans reflect the desire/need for RAV10 access, the proposed typical cross sections and lot sizing do not necessarily facilitate this.

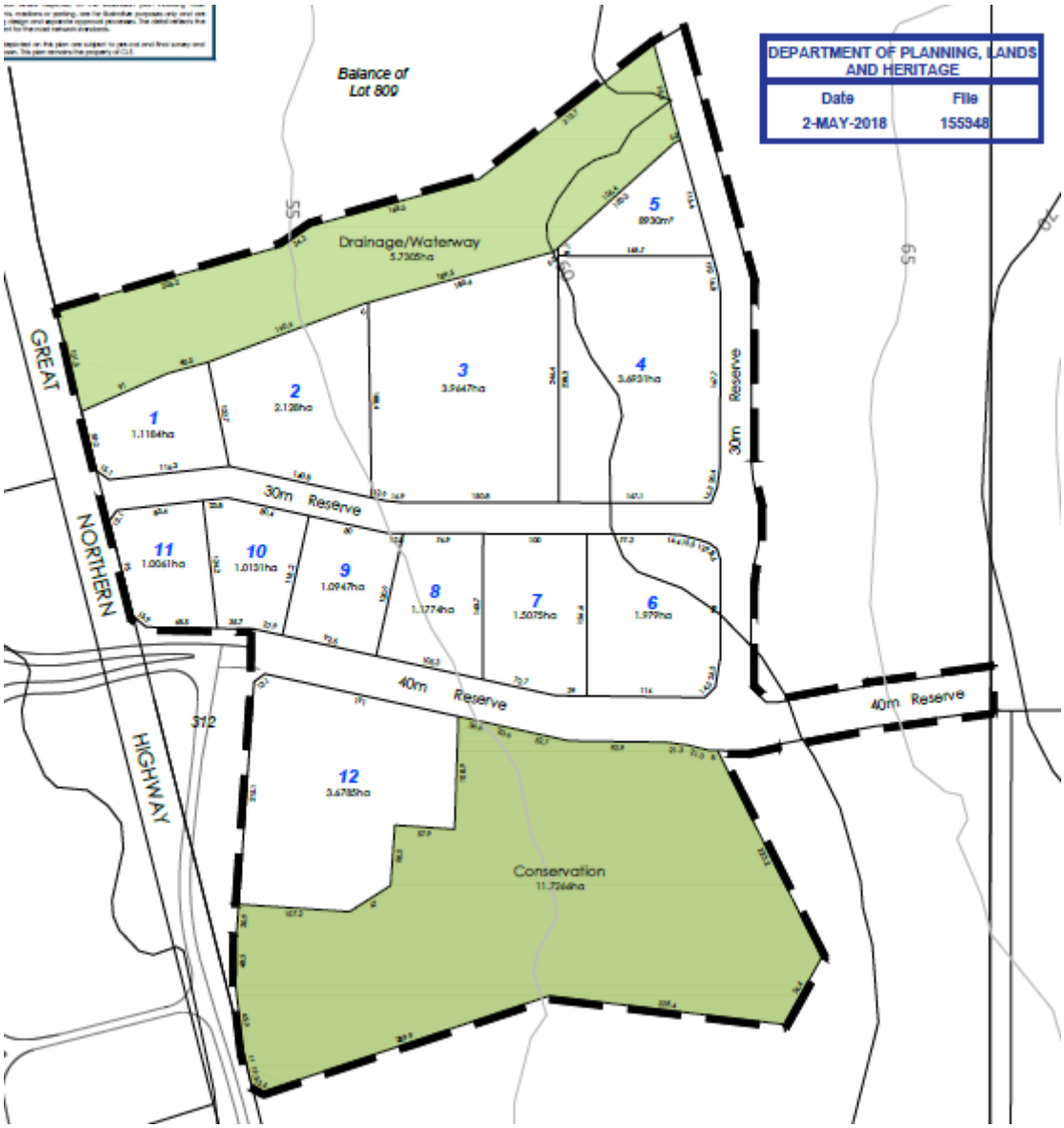


Figure 2.1 Precinct 1a Stage 1 Subdivision of Lot 809 Great Northern Highway

A review of minimum lot sizes to provide internal straight sections for unloading, decoupling and general operation have been provided within Drawings PS116975-SK-0041 to 43 in Appendix C. The minimum lot requirements are defined by the driveway access arrangements, which ensure safe access and egress.

2.4 TRAFFIC GENERATED

The Muchea Employment Node Structure Plan outlines that the Primary Loop Road (Road 1) would need to be staged and ultimately upgraded to a dual carriageway with two lanes in each direction. Through a review of the traffic volumes that would be generated by the ultimate development, it was determined that the entire structure plan area would generate 7,935vpd in the short to medium term and 19,987vpd as outline in Table 2.1. This is based on adopting a 23 trips per hectare traffic generation rate, which is the rate outlined in the Muchea Employment Node Structure Plan. The Plan highlights that the traffic generation rate is on the lower end of the scale with respect to industrial traffic generation, due to the type of industries that will be developed as part of the structure plan area. It is noted in the Structure Plan that Precinct 4 is unlikely in the short to medium term as clay extraction is still occurring.

Table 2.1 Ultimate Traffic Generation

	SHORT/MEDIUM TERM AREA (HA)	LONG TERM AREA (HA)	TOTAL AREA (HA)	S/M TRIPS	TOTAL TRIPS
Precinct 1	90	100	190	2070	4370
Precinct 2	115	164	279	2645	6417
Precinct 3	140	50	190	3220	4370
Precinct 4	0	210	210	0	4830
Total With P4	345	524	869	7935	19987
Total Without P4		314	659	0	15157

Based on the trips generated and the distribution of trips outlined in Table 2.2 there is no demand for two lanes on the Primary Loop Road even with the fully realised ultimate development as less than 10000vpd would be on the Primary Loop Road.

Table 2.2 Ultimate traffic distribution

	S VIA GNH (55%)	N VIA GNH (25%)	W VIA BRANDHWY (15%)	E VIA MUCHEA EAST (5%)	S VIA WARDENA THEN GNH	TOTAL
Precinct 1	2403	1093	655	219		4370
Precinct 2	3529	1604	962	321		6416
Precinct 3	2404	1093	655	219		4371
Precinct 4		1207	725	241	2657	4830
Total With P4	8336	4997	2997	1000	2657	19987

Traffic on the Primary Loop Road is only local traffic as all through traffic will remain on the existing road network like Great Northern Highway. Therefore, based on the Precinct traffic distribution shown in Table 2.2 the Precincts would not generate sufficient traffic to require a dual lane dual carriageway on the Primary Loop Road.

2.5 ENVIRONMENTAL

As an outcome of the desktop investigations, there are a number of environmental constraints that have been determined and considered, including:

- Wetland located to the south of Road 1 – To mitigate this, the proposed road alignment ties into the Harvis subdivision road design and avoids interaction with the wetland and its buffer zone
- Crossing of a creek immediately south of Muchea East Road on Road 5 – The road alignment of Road 5 is perpendicular to the general creek alignment and the impact can be minimised in the next stage of design through culvert provision.
- There is a large section of retained vegetation in the vicinity of Road 1 and 2 – The alignment of Road 1 and 2 has aimed to minimise the clearing of the retained vegetation by using reverse curves (Refer to Drawing 116975-SK-021 in Appendix B) to avoid the larger section of the retained vegetation and provide horizontal curves which complies with the design criteria.

2.6 GEOTECHNICAL

The existing soil is generally loamy sand covering 10 to 20 metres of clay according to the Muchea Employment Node Structure Plan. The Muchea Industrial Park Structure Plan, Precinct 3 and Precinct 1a's Structure Plan (Muchea Employment Node Lot 102 Great Northern Highway Local Structure Plan) also state that groundwater is found at ground level and roads and buildings should be built up a minimum of 500 to 800mm to provide clearance to groundwater in affected areas. The extent of groundwater interaction will need to be confirmed as each precinct implements the Structure Plans.

To inform the road design as part of this scope it is assumed that imported fill will be provided to achieve appropriate levels for the road and properties whereby not resulting in additional fill batters. The Road 1 and Road 2 vertical alignment is in cut to achieve the maximum permissible gradient of 3% which is required to allow for the potential High Wide Load (HWL) route.

As soil testing has not been completed to confirm a maximum achievable cut batter, a conservative batter of 1 in 3 has been chosen. Further testing should be undertaken to confirm the maximum cut batter.

2.7 EXISTING ACCESS

Existing access to WAMIA and properties along Muchea East Road adjacent to Great Northern Highway need to be retained, or a reasonable alternate provided. It is considered driveway accesses cannot be relocated, but the WAMIA site has two potential proposed accesses points to suit RAV 10 vehicles. In this context, the upgrade of the existing Muchea East Road allows existing access to be maintained.

2.8 TOPOGRAPHY

The topography of Precinct 1 is considered a constraint for the road design. The topography rises at approximately 6% from west to east along the horizontal alignment of Road 1. Due to the need to minimise gradient to 3% this results in significant cut, which extends over larger areas and reduces the potential access opportunities in the northern section of Precinct 1b.

The other topography constraint is the WAMIA site which is significantly higher than the surrounding land and includes a number of dams that act as a constraint to the location of Road 2. The height difference also needs to be considered when considering the driveway location, as this directly impacts the grades of the driveway, potentially limiting the ability of RAV 10 vehicles to navigate. Road 2 has been located so as not to interact with the dam embankments, whilst maximising the potential usable land to the west of the Road 2.

2.9 SERVICES

All major services in the area are within the road reserves of Great Northern Highway and Muchea East Road. There are no services of a critical nature identified. Therefore, services are not considered a constraint to the proposed road alignments or intersection treatments.

3 CONCEPT AND SKETCH DESIGNS

3.1 DESIGN CRITERIA

The design criteria have been determined based on the desired design speed of 80kph and the RAV10 design vehicle.

Table 3.1 Design Criteria for Road Alignment

TYPICAL ROAD SECTIONS 1, 2 AND 6 (3,4, 5 AND 7 HORIZONTAL ONLY)	
Design Vehicle	Double B Double (RAV10 53.5m)
Design Speed on approaches	80kph
Reaction Time	2.5 seconds
Lane widths	3.5m
Crossfall	3%
Maximum superelevation	3%
Maximum Vertical Grade	3%, 2% on HWL route
Minimum Vertical Grade	0.5%
Lane Configuration	2 lanes
Median Width	5m
Shoulders	2.0m, 1.5m sealed
Minimum Horizontal Curve	460m
Minimum Horizontal Curve Length	200m
Minimum Crest curve	80K
Minimum Sag Curve	30K
Minimum Vertical Curve Length	80m
Minimum Truck Stopping Distance	172m
Minimum Car stopping sight distance	152m
Swale Foreslope	1 in 6 (7.2m)
Swale Backslope	1 in 4 (4m)
Swale Drain Width	11.2m
Verge Width	3m (outside of swale)

The above criteria have been applied in determining the preferred road alignments.

3.2 TYPICAL INTERSECTIONS

The Muchea Industrial Park Structure Plan area has two typical intersections proposed to accommodate RAV10 vehicles. It is proposed that three-leg intersections are provided as priority controlled intersections designed in accordance with Main Roads WA typical drawing 201431-001 (refer Appendix B) whilst four leg intersections will be roundabouts.

The use of roundabouts at 4 leg locations reduces conflict and the gap acceptance required for RAV10 vehicles to cross between the two minor legs. Whilst a staggered T-intersection could have been proposed to avoid the land take of a roundabout the separation between the leg to accommodate a RAV10 vehicle left then right turning is over 100m and the intersection treatment is inherently less safe than the roundabout treatment due to the poor acceleration characteristics of the RAV10 vehicle.

The following typical intersections (refer to drawing PS116975-SK-0010 in Appendix B) are proposed:

- Priority Controlled intersection with auxiliary turn lanes
  - Road 6 and Gulliente Road (southern access to Precinct 1)
  - Road 4 / Road 5 / Road 3
  - WAMIA Access / Road 2
- Roundabout
  - Road 2 / Road 6 / Muchea East Road / Road 5
  - Road 7 North / Great Northern Highway / Road 4
  - Road 7 South / Great Northern Highway / Road 3
  - Road 3/ Precinct 2 Access / Precinct 4 Access

The design criteria for the typical priority controlled intersection and roundabout are outlined in Table 3.2 and Table 3.3. Note that the design criteria for the approach speeds has been based on the existing speed limits and is taken as the approach speed to the reverse curves for the roundabouts.

Table 3.2 Design Criteria for Roundabout

TYPICAL INTERSECTION ROUNDABOUT	
Design Vehicle	Double B Double (RAV10 53.5m); adjacent vehicle (passenger car 5.2m)
MRWA Guideline Drawing	200331-0199 to 0202; 200331-0198; 201231-0014;200331-203
Design Speed on approaches	110kph on Great Northern Highway 70kph on other approaches
Minimum Central Island radius	40m
Lane widths	3.5m
Crossfall within circulating lane	2%
Reverse Curves	Yes. On GNH
Lane Configuration	GNH 4 lanes Side Road 2 lanes
Median Width	5m
Shoulders	2.0m, 1.0m
High Wide Load Minimum Kerb to Kerb Clearance; Desirable Clearance to kerb	7.22m; 1.0m

The typical roundabout has a minimum radius set as 40m. This is larger than the absolute minimum radius of 30m defined by Main Roads WA in guideline drawing 200331-199 to addresses the following concerns:

- Manoeuvrability – the tighter radius results in increased pressure on the RAV10 vehicles and increases the likelihood of the driver easing the radius and increasing the potential for conflict
- Excessive pavement – the circulating lanes within the roundabout would need to be widened further to ensure two lanes to operate through the roundabout
- Pavement damage – the tighter roundabout radius would decrease pavement life and increase maintenance requirements
- Large number of RAVs – the RAV traffic volume percentage through the proposed roundabouts are likely to be higher than 20%. The increased radius results in less speed differential between vehicles and improves conflict angles.

Whilst the roundabout allows for all movements including U turns, U turns should be discouraged given the length of time that RAV 10 vehicle would spend within the circulating lanes to complete the manoeuvre. This means access arrangement should rely on the ability to complete a U turn manoeuvre at any roundabout

Table 3.3 Design Criteria for Priority Controlled intersection with Auxiliary Turn Lanes

TYPICAL INTERSECTION AUXILIARY TURN LANES	
Design Vehicle	Double B Double (RAV10 53.5m)
MRWA Standard Drawing	201431-002
Design Speed on approaches	80kph
Lane widths	3.5m, 4m where defined by guideline drawing
Auxiliary Lane Length	170m
Crossfall	2%
Maximum Vertical Grade	2% on approach to intersection
Minimum Vertical Grade	0.5%
Acceleration Lane	No
Lane Configuration	2 lanes
Median Width	5m
Shoulders	2.0m, 1.5m sealed
Minimum Crest curve	80K
Minimum Sag Curve	30K
Minimum Vertical Curve Length	80m
Minimum Truck Stopping Distance	172m
Minimum Car stopping sight distance	152m
Swale Foreslope	1 in 6 (7.2m)
Swale Backslope	1 in 4 (4m)
Swale Drain Width	11.2m
Verge Width	3m (outside of swale)

The other typical intersection proposed is the priority controlled auxiliary turn lane intersection for three leg intersections. This provides the auxiliary turn lanes for the left and right turn into the terminating leg and acceleration lanes for the turns out of the terminating leg. The left turn is a free flow left turn moving the conflict point to a merge point whilst the right turn out provide the overturn bulb with acceleration lane to minimise conflict with the slow moving RAV10 vehicle.

3.3 TYPICAL CROSS SECTION

The typical cross section was determined based on advice received from MRWA that the design should reflect Wedgefield Industrial area, which is considered a good example of roads designed to accommodate RAV10 vehicles. MRWA also indicated that the design should comply with the MRWA road design guides and that the minimum criteria outlined in the Standard Restricted Access Vehicle (RAV) Route Assessment Guidelines should not be utilised as design criteria.

Three options were developed by WSP to be assessed and a preferred identified as the typical cross section to apply to all road sections. Each option was based on previously proposed or built typical cross sections, with modifications to improve the operation feasibility for RAV10 vehicles. The Options (refer to Appendix A for detailed cross sections) were:

- Option 1 – Flush Median – based on Wedgefield Industrial Area
- Option 2 – Central Swale – based on proposed Nambeelup Industrial Park
- Option 3 – Single Carriageway – based on first stage of Muchea Employment Node Structure Plan

Note that all options only include one lane for travel in each direction. This is based on a review undertaken by WSP of available Structure Plan documentation which demonstrates that traffic volumes generated by the full development are not expected to exceed volumes that would warrant a two-lane in each direction dual carriageway. The proposed traffic volumes are outlined in Section 2.4.

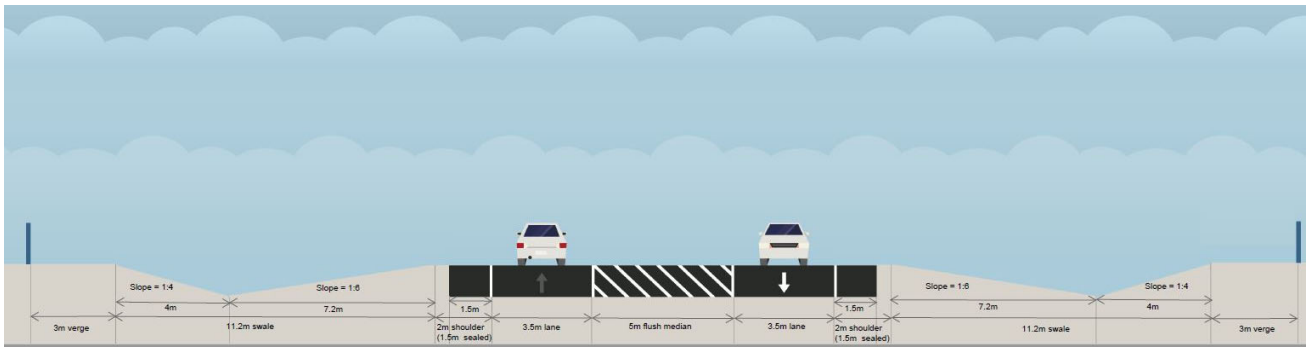


Figure 3.1 Option 1 – Flush Median

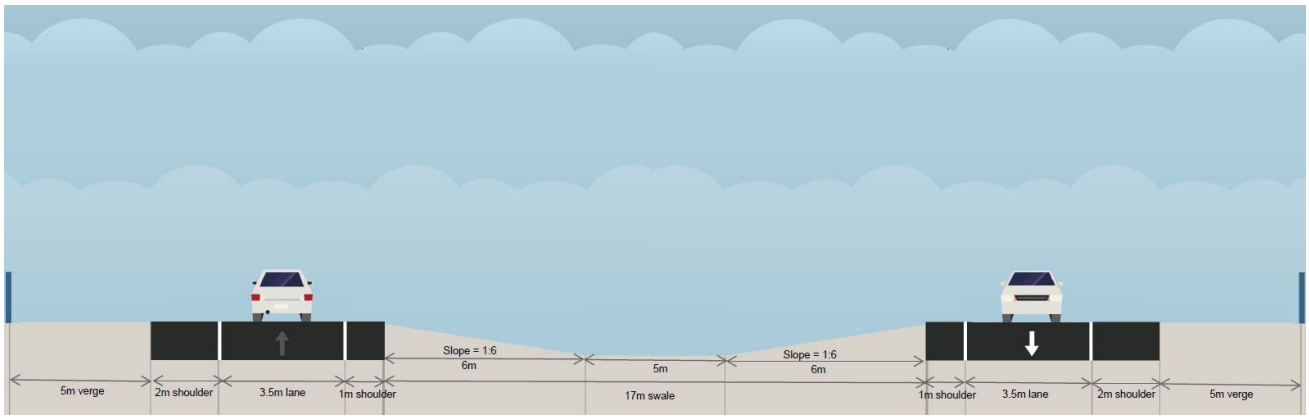


Figure 3.2 Option 2 – Central Swale

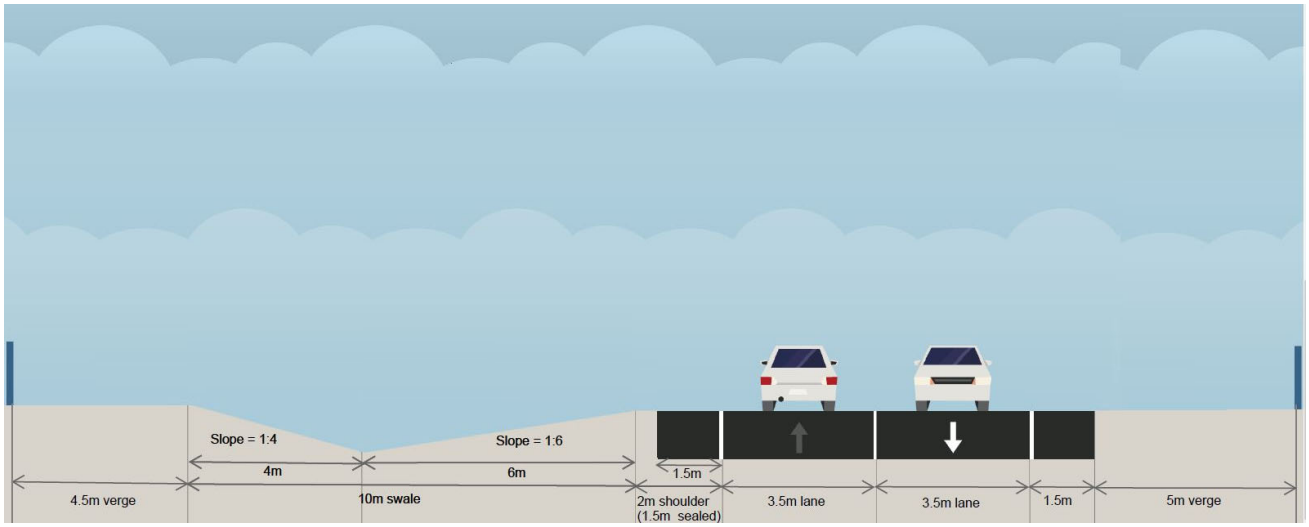


Figure 3.3 Option 3 – Single Carriageway

The cross sections were developed based on the design criteria outlined in Table 3.1.

Table 3.4 Assessment of Typical Cross Section Options

	OPTION 1 – FLUSH MEDIAN	OPTION 2 – CENTRAL SWALE	OPTION 3 – SINGLE CARRIAGEWAY
Pros	— Can provide HWL corridor — Provides additional manoeuvring space for RAV10s turning in / out of crossovers — Provide auxiliary right turn lanes with line marking modifications — Median separates opposing traffic — Ease of Construction	— Fits within the 40m Reserve — Allows additional width for vehicle turning out of properties — Provides WSUD opportunities — Increases separation between opposing traffic	— Fits in a 40m road Reserve — Provides a 4.5 and 5m verge for services — Minimises construction

	OPTION 1 – FLUSH MEDIAN	OPTION 2 – CENTRAL SWALE	OPTION 3 – SINGLE CARRIAGEWAY
Cons	— 44.4m road reserve — Provides only 3m verges on both side for services — Additional longitudinal drainage due to increased unsealed area	— Does not suit HWL corridor — Additional construction to provide for vehicles turning in / out of driveways — Requires cross fall changes on approaches to intersections to avoid drainage issue resulting in additional drainage and rolling crossfall — Seagull intersection approach decreases driver sightlines	— No allowance for HWL corridor — No Separation between opposing traffic — No assistance for RAV10 vehicles turning in and out of crossovers — Traffic turning out of driveways will turn into opposing lane

Based on this assessment Option 1 is the preferred approach due to the manoeuvring space and conflict reduction especially for vehicle entering and exiting driveways. Option 1 has been applied to all road alignments.

3.4 ROAD ALIGNMENTS

The above information was used to determine the optimum alignment for each of the proposed road sections as detailed below. The design drawings are provided in Appendix B.

3.4.1 ROAD 1 AND 2

The horizontal and vertical alignment of Road 1 and Road 2 have been dictated by the following requirements:

- Match into the Harvis subdivision road design
- Minimise impact on retained vegetation
- Maintain a maximum gradient of 3% and comply with other design criteria
- No impact on WAMIA dam embankments
- Allow for WAMIA access
- Locate intersection with Road 6 / Muchea East Road / Road 5 in an area with minimal grade through the intersection.

These requirements have been achieved.

Road 1 and Road 2 vertical alignment results in significant cut (up to 10m) and therefore the concept design drawing include a cut off drain along the top of the batter to minimise the potential run-off down the batter. Detailed survey is required of Road 2 adjacent to the WAMIA dam. As part of the detailed design the typical cross section provision may need to be altered (through verge and swale narrowing) or vertical alignment modified to address any potential cut batter.

The WAMIA access intersection has been located at Chainage 2100 to maximise clearance to the roundabout, not impact on the overflow dam and enable a full movement intersection. Note that this location is higher than the existing intersection with Muchea East Road and therefore the vertical profile for the access is similar to the existing access.

An alternative WAMIA access approximately 400m east of the existing intersection is also possible on Muchea East Road. This location is considered feasible vertically and horizontal and is within WAMIA land. The vertical crest on Muchea Road East to the west of the access may need to be eased to ensure sight distance.

3.4.2 MUCHEA EAST ROAD (ROAD 6)

The design for Road 6 involves provision of the typical cross section from the intersection with Road 2 through to Gulliente Road. A priority controlled auxiliary lane intersection then provides access to the southern section of Precinct 1. The design for Road 6 then ties back into Muchea East Road to the east of the traffic signals at Great Northern Highway as no RAV10 vehicles turning allowance is provided at the intersection and Brand Highway will be maintaining its RAV7 status. This approach also requires no modifications to the existing access arrangement for Lot 700.

3.4.3 ROAD 3 AND 5

Road 5 effectively runs along a north south alignment to match into the Road 2/ Road 6 / Muchea roundabout. Road 5 continues as Road 3 south of the priority controlled intersection with Road 4.

Road 3 has been aligned to match perpendicularly into Great Northern Highway with a 400m radius horizontal curve. The horizontal curve relocates the intersection further north than originally proposed in Figure 1.2. This results in the staggered T intersection not being feasible for Road 7 South / Great Northern Highway / Road 3 and therefore the side roads were aligned to allow the intersection to be a roundabout. The provision of a roundabout at this location also acts as an entrance point to the Industrial Park and highlights the change in land use.

In terms of horizontal alignment for Road 3, the provision of the 400m horizontal radius curve to suit the design speed results in Road 3 being slightly further east than originally proposed. To match back into the alignment of Road 5, a large horizontal curve has been provided through the intersection with Road 4. As Road 4 is on the outside of the horizontal curve this approach improves sight distance at the intersection.

3.4.4 ROAD 4

The design for Road 4 involves a straight east west alignment from the intersection with Road 3/ Road 5 and then a horizontal curve adjacent to Great Northern Highway to tie into the proposed roundabout perpendicular to Great Northern Highway.

3.4.5 ROAD 7

The design for Road 7 initially included a loop road between two intersections on Great Northern Highway. Utilising the agreed design criteria to produce the road alignment resulted in two 400m horizontal curve at either end of the loop road. Given that Precinct 3 is a standalone precinct and Road 7 is considered to only service traffic within that precinct the road has been removed except for the intersection throats at either end of the loop road.

4 ORDER OF MAGNITUDE COST ESTIMATE

4.1 COST DETERMINATION

A concept level horizontal and vertical design for Roads 1, 2 and 6 has been developed to inform the order of magnitude cost estimate. For Roads 3, 4, 5 and 7 a kilometre rate has been determined based on the typical cross section applicable to all roads. There are a number of key assumptions driving the cost including:

- Cost rate taken from multiple sources including rates for the Great Northern Highway Upgrade: Muchea to Wubin project
- Contingency bounds of 20% and 40% have applied for both the lower and upper limits respectively and are included in the price
- No escalation included
- Quantities for these items were estimated from the proposed alignment based on a pavement depth of 450mm. For seal quantities, a two coat seal was assumed along the road length. If pavement design requires 40mm dense graded asphalt or full depth asphalt further cost would be applicable
- The preliminary vertical profile of Road 1 and Road 2 resulted in approximately 500,00m3 of excess material. This excess of cut over fill will be required to be disposed of to a suitable location off site and has been allowed for within the cost estimate. Note: if cut was suitable it could be used within the industrial park leading to a cost saving but this has not been allowed for at this stage
- Designs for similar projects were investigated in providing estimates and assumptions for items such as storm water drainage, landscaping, bituminous surfacing and miscellaneous items. Service relocation details for Road 6 were based on dial before you dig data with costs prepared from similar projects
- Project management / construction supervision costs, pavement markings and signage costs were based on elemental rates (cost per m2 of proposed pavement) of similar projects within the region
- In determining the costs for Roads 3, 4, 5 and 7 and Great Northern Highway, the per $/km rate from Road 1 and Road 2 was adopted, excluding the costs for the disposal of surplus material off site.
- The above results in the costs estimates presented in Table 4.1.

Table 4.1 Order of Magnitude Cost Estimate

ITEM	ESTIMATED CONTRACT VALUE		COST PER KM	
	LOWER	UPPER	LOWER	UPPER
ROAD 1 and ROAD 2	$ 6,513,208	$ 7,598,743	$ 2,713,837	$ 3,166,143
ROAD 6	$ 1,574,112	$ 1,836,464	$ 1,479,429	$ 1,726,000
ROAD 3 (1650m)	$ 2,350,933	$ 2,742,756	$ 1,424,808	$ 1,662,276
ROAD 4 (1000m)	$ 1,424,808	$ 1,662,276	$ 1,424,808	$ 1,662,276
ROAD 5 (700m)	$ 997,366	$ 1,163,593	$ 1,424,808	$ 1,662,276
ROAD 7 (2500m)	$ 3,562,020	$ 4,155,690	$ 1,424,808	$ 1,662,276
GNH (2900m)	$ 4,131,943	$ 4,820,601	$ 1,424,808	$ 1,662,276

The length of Road 1 and Road 2 in Precinct 1a is approximately 800m of which 500m has been built to service the approved Harvis subdivision, with a different cross section to the typical cross section proposed.

The order of magnitude cost estimate is considered to be high level and is best suited to evaluate and compare different options. The estimate is based on preliminary design information which is considered where the design is considered between 5-15% in design definition. The available documentation for the estimate included proposed horizontal and vertical alignment, but no general arrangement drawings or other discipline designs were available at the time of estimate.

5 LOT ACCESS FEASIBILITY

5.1 DRIVEWAY RESTRICTIONS

To minimise the potential impact of RAV driveways on the operation of the local distribution roads, access restrictions are proposed at a minimum of 100m from the tangent point of the intersections. This provision minimises conflict by ensuring driveways are not located within auxiliary turn lanes, merges or reverse curves on the approach to roundabouts.

The prohibited locations are highlighted in drawing PS116975-SK-010. This is however an approximation and will need to be confirmed as part of the detailed design and subdivision layout development.

5.2 ACCESS OPTIONS

An assessment of minimum lot requirements has been undertaken based on the following driveway layouts:

- Two-way driveway with one-way internal circulation for RAV10 (PS116975-SK-043)
- One-way driveways on same frontage with one-way internal circulation for RAV10 between the access and egress (PS116975-SK-041 and 42)
- One-way driveway on opposite frontages with straight one-way lane between the access and egress.

The minimum lot size has been determined solely on the circulating requirement of the RAV 10 swept path. To ensure feasible operations the minimum lot sizing has been based on straightening the RAV 10 vehicle between turns to suit parking and unloading / loading requirements as shown in Appendix C.

Based on the swept paths the minimum lot sizes are:

- Two-way driveway –324m long by 197m wide
- One-way driveways on same frontage – 159m long by 197m wide
- One-way driveway on opposite frontages with straight one way lane between the access and egress – minimum of 159m long.

5.3 DRIVEWAY CROSSOVERS

The drawings included in Appendix C outline the driveway requirements. By providing the flush median in the road cross-section, there is space allocated to allow an auxiliary right turn lane into the site access and for oversteer of vehicles turning out of the site access. The swept paths for the turn in and out of the accesses have been undertaken from / to the correct lane to define the driveway crossover. Note that the two-way crossover has been designed to allow swept path conflict to minimise the crossover extent as vehicles will not utilise the driveway at the same time due to low volumes.

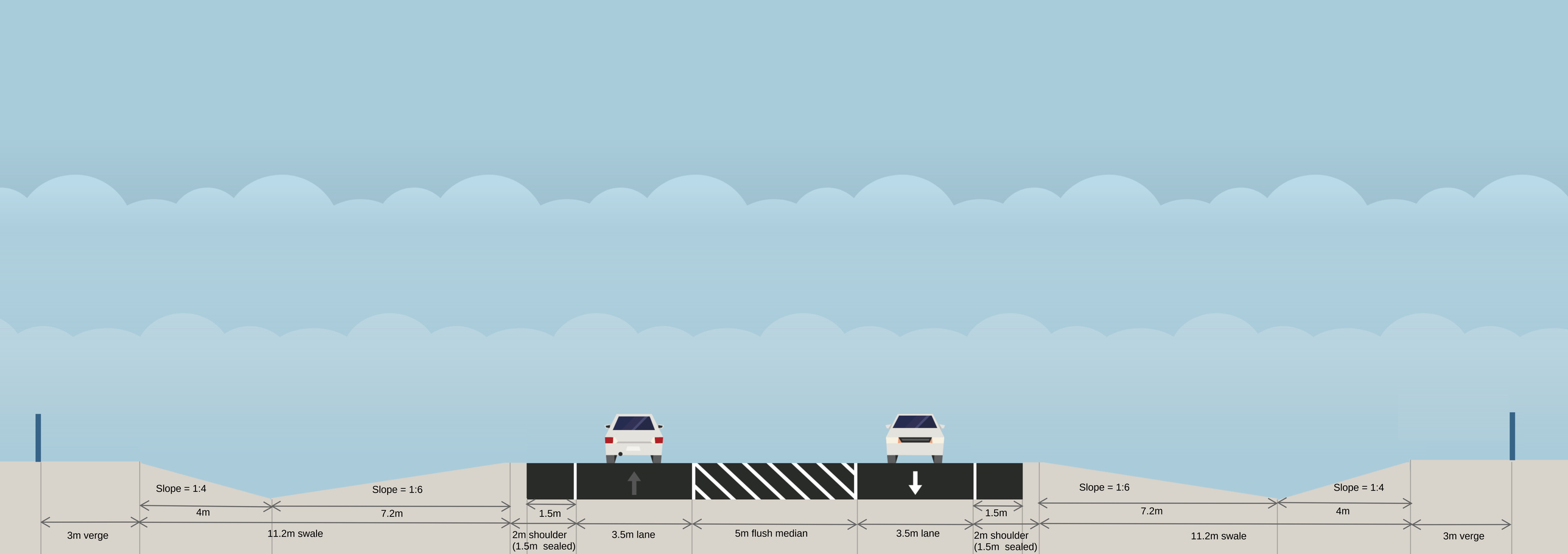
6 CONCLUSION

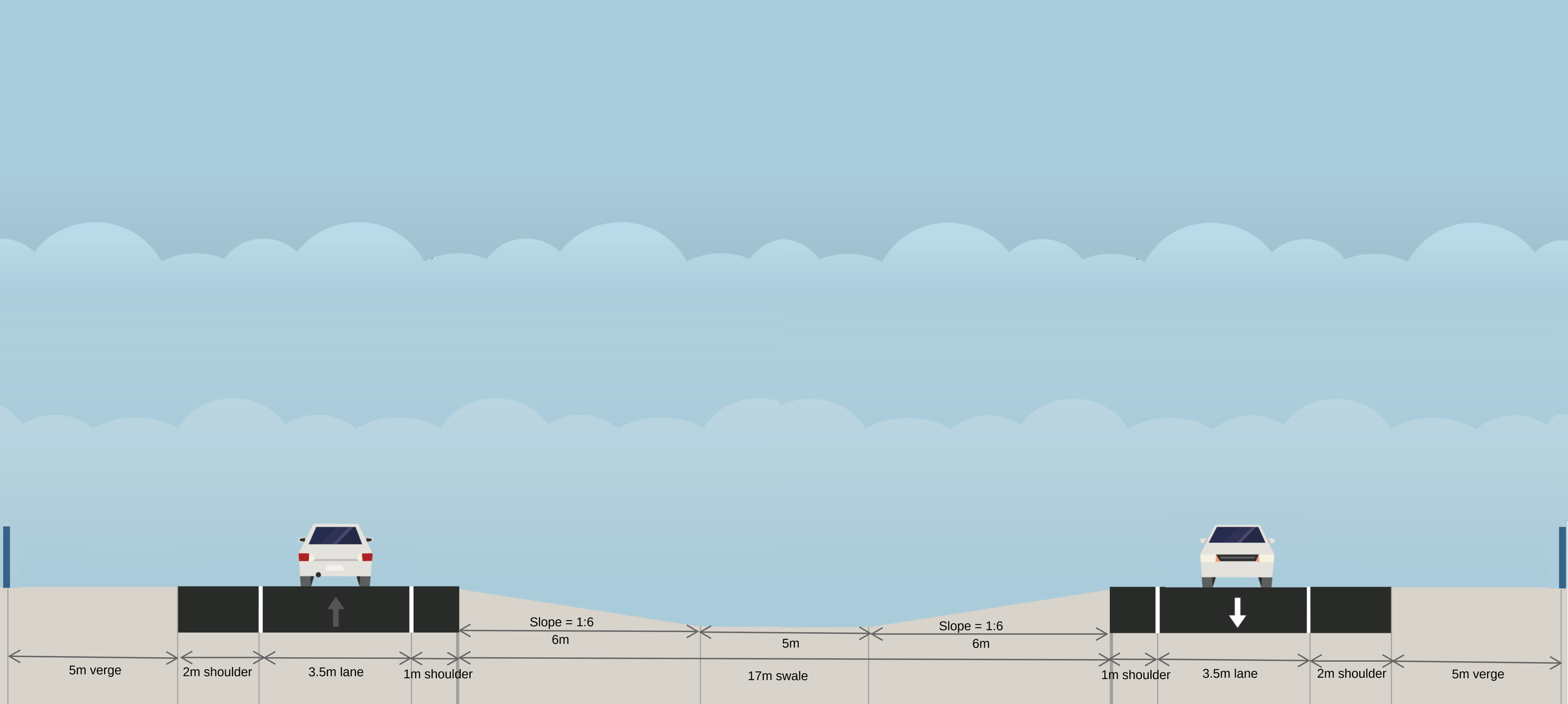
The Muchea Industrial Park Road Network and RAV 10 Assessment has determined the following:

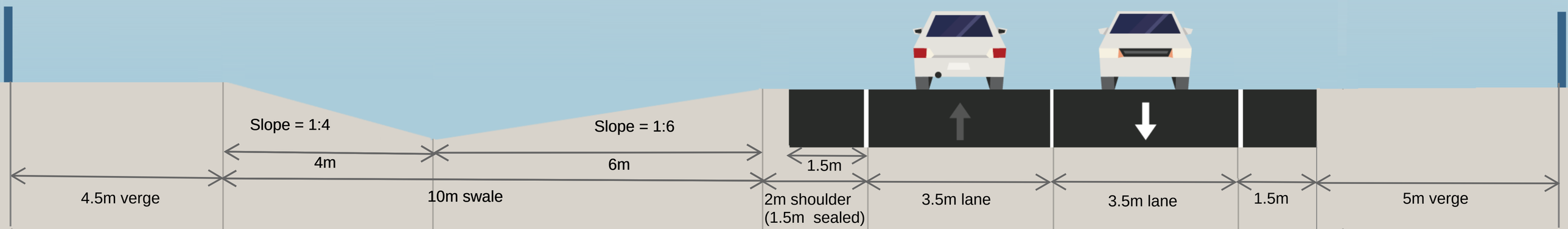
- The road network concept and sketch design outline in Appendix B allows for RAV10 access
- Preferred cross section for Road 1 to 7 is Option 1 Flush Median
- Typical Intersection for three leg intersection is priority controlled auxiliary turn lanes
- Typical Intersection for four leg intersection is roundabout
- Driveway crossovers should not be permitted with 100 m of the intersection tangent points
- There are two feasible accesses for WAMIA with the preferred being the one intersecting with Road 2
- The minimum lot sizing is dependent on the driveway access arrangement with separate in and out driveway crossover allowing a minimum lot size of 3.13ha (159m long by 197m wide) to allow RAV10 vehicle to straighten for loading unloading etc.

APPENDIX A

CROSS SECTION OPTIONS


Slope = 1:4
4m
3m verge
Slope = 1:6
7.2m
11.2m swale
1.5m
2m shoulder
(1.5m sealed)
3.5m lane
5m flush median
3.5m lane
1.5m
2m shoulder
(1.5m sealed)
Slope = 1:6
7.2m
11.2m swale
Slope = 1:4
4m
3m verge


Slope = 1:6
6m
5m
Slope = 1:6
6m
5m verge
2m shoulder
3.5m lane
1m shoulder
17m swale
1m shoulder
3.5m lane
2m shoulder
5m verge

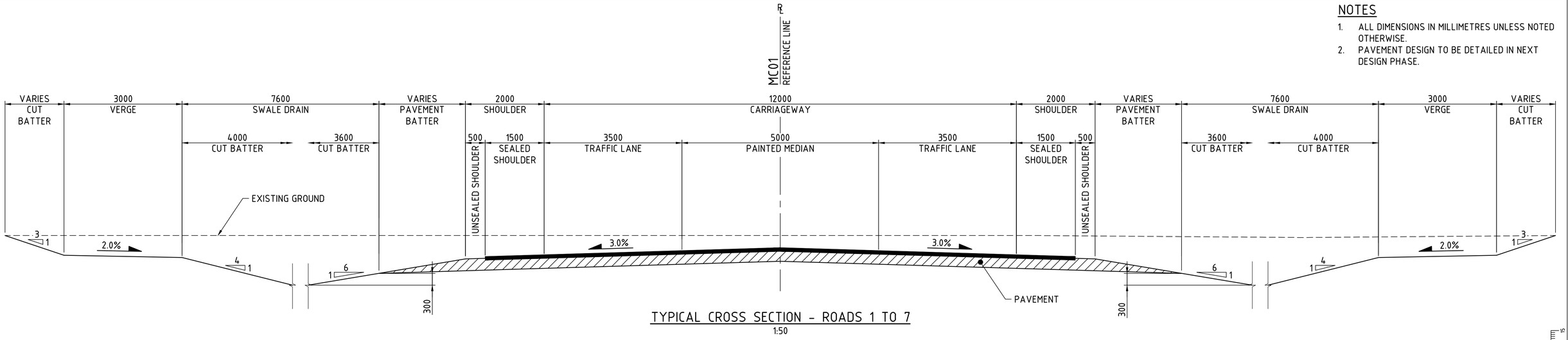

Slope = 1:4
Slope = 1:6
4m
6m
1.5m
4.5m verge
10m swale
2m shoulder
(1.5m sealed)
3.5m lane
3.5m lane
1.5m
5m verge

APPENDIX B

CONCEPT DRAWINGS

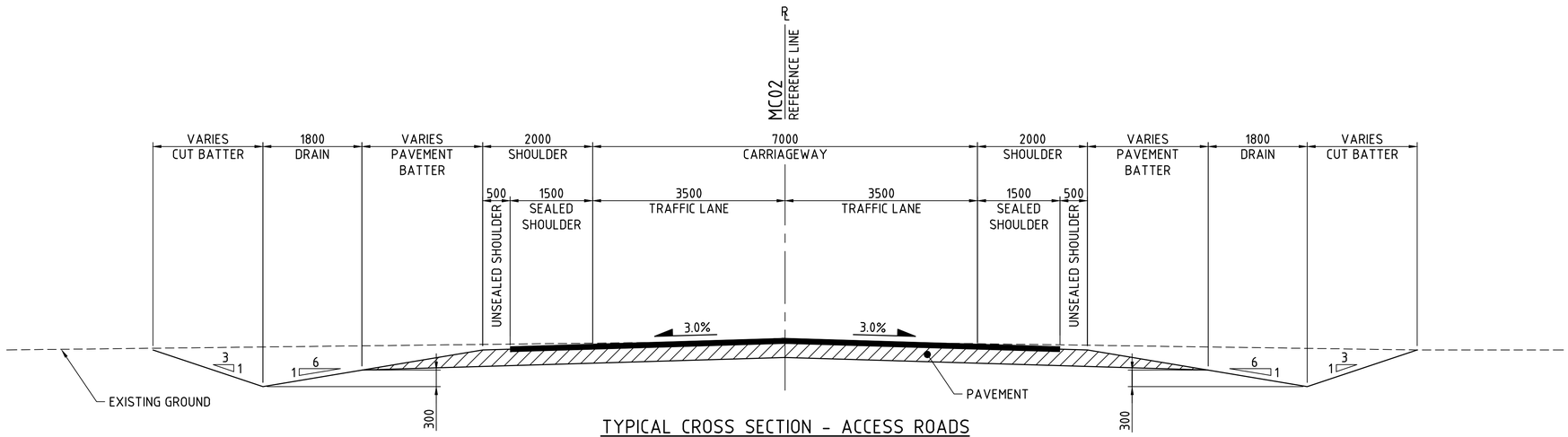
NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. PAVEMENT DESIGN TO BE DETAILED IN NEXT DESIGN PHASE.



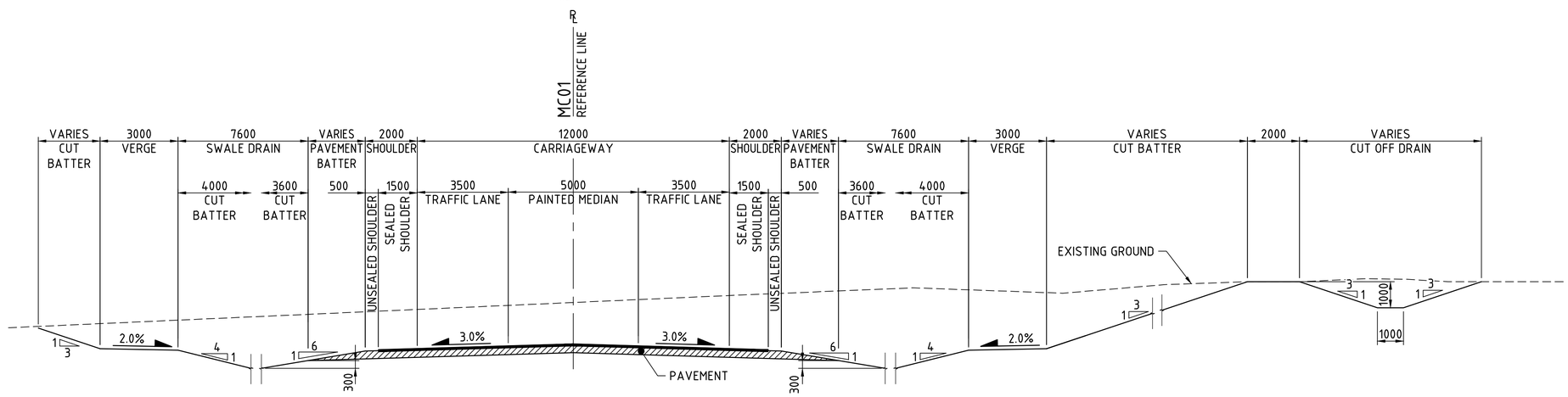
TYPICAL CROSS SECTION - ROADS 1 TO 7

1:50



TYPICAL CROSS SECTION - ACCESS ROADS

1:50



TYPICAL CROSS SECTION - ROAD 1 TO 2 WITH CUT-OFF DRAIN

1:100

SKETCH ONLY

Level 5
503 Murray Street
Perth WA 6000
Telephone +61 8 9489 9700
Facsimile +61 8 9489 9777
Email: perth@wsp.com

DATE	12/11/2019
SCALE AT A1	AS SHOWN
GRID	PCG94
PREPARED	M.BOCESKI
SHEET	

PROJECT **MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN**

TITLE **TYPICAL CROSS SECTION**

PROJECT No. **PS116975** | SKETCH No. **SK-0001** | REV **B**

NOTES

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. REFER TO DRAWING No. PS116975-SK-0001 FOR TYPICAL CROSS SECTIONS.
3. REFER TO DRAWING No. PS116975-SK-0021 AND PS116975-SK-0022 FOR PLAN AND PROFILES.
4. REFER TO DRAWING No. PS116975-SK-0031 AND PS116975-SK-0032 FOR INTERSECTION PLAN AND VEHICLE SWEPT PATH.

LEGEND

CADASTRAL BOUNDARY

NO DRIVEWAY ACCESS ALLOWED

MUCHEA EAST ROAD

MATCH TO EXISTING

ALTERNATE ACCESS

MATCH TO EXISTING

INDICATIVE ACCESS ONLY SUBJECT TO FURTHER DETAIL DESIGN

ROAD 2

ROAD 5

T JUNCTION TYP REFER TO SKETCH No. PS116975-SK-0031

ROAD 3

MATCH TO EXISTING

40m ROUNDABOUT TYP REFER TO SKETCH No. PS116975-SK-0031

ROAD 1

ROAD 6

ROAD 4

GREAT NORTHERN HIGHWAY

ROAD 7 SOUTH

MUCHEA EAST ROAD

MATCH TO EXISTING

ROAD 7 NORTH

MATCH TO EXISTING

MAINTAIN EXISTING TRAFFIC SIGNALS

NORTHLINK

MATCHES INTO HARVIS DESIGN TIE IN TBC

1:5000

PLAN
1:5000

SKETCH ONLY

wsp
Level 5
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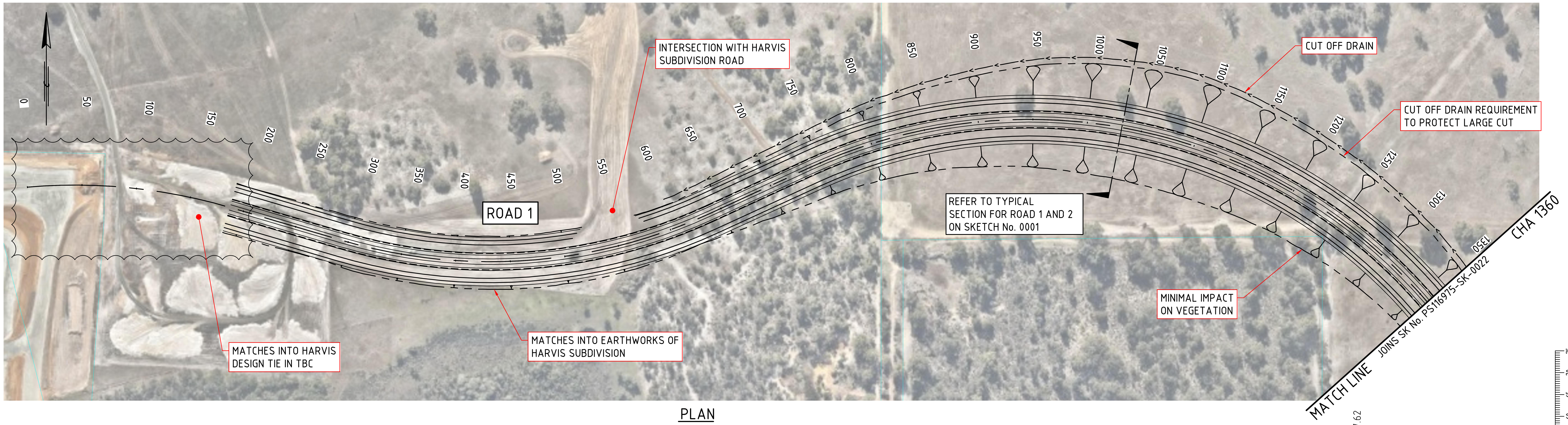
Facsimile +61 8 9489 9777
Email: perth@wsp.com

DATE	26/03/2020
SCALE AT A1	0 50 100 150m SCALE 1:5000
GRID	PCG94
PREPARED	D.MARKOV
SHEET	

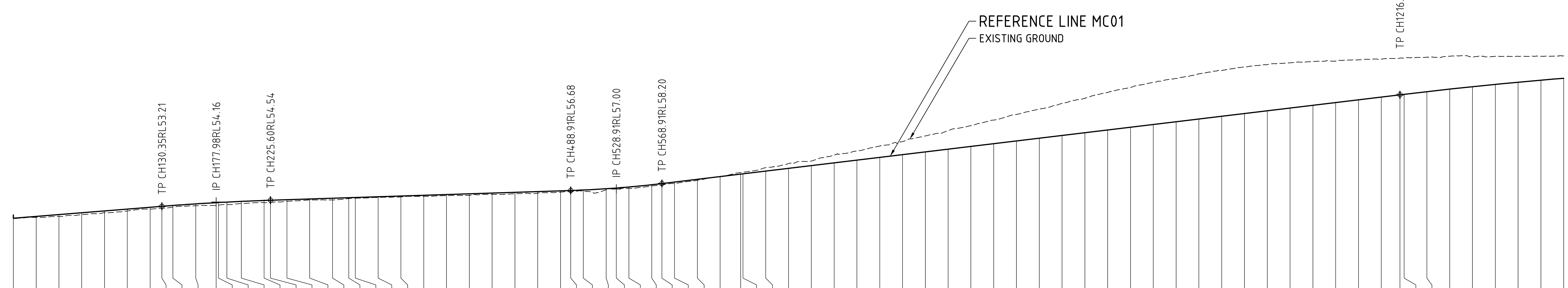
PROJECT **MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN**

TITLE **GENERAL ARRANGEMENT**

PROJECT No. **PS116975** | SKETCH No. **SK-0010** | REV **C**



PLAN
1:2000



DATUM RL. 35.00

VERTICAL DATA: L=130.35m, G=2% | K=80, L=95.25m | L=263.31m, G=0.81% | K=36.52, L=80m | L=647.47m, G=3% | K=150, L=900m

HORIZONTAL DATA: L=187.36m, R=503.44m | TAN L=106.84m | L=343.79m, R=-480.00m | TAN L=102.39m | L=918.60m, R=480.00m

CHAINAGE	FILL +/CUT -	DESIGN LEVELS	EXISTING LEVELS
0.0	0.000	50.600	50.600
20.0	0.200	51.000	50.800
40.0	0.400	51.400	51.000
60.0	0.420	51.800	51.380
80.0	0.398	52.200	51.802
100.0	0.400	52.600	52.200
120.0	0.400	53.000	52.600
130.4	0.407	53.207	52.800
140.0	0.345	53.394	53.049
160.0	0.410	53.745	53.335
178.0	0.618	54.018	53.400
180.0	0.596	54.046	53.450
187.4	0.526	54.144	53.618
200.0	0.493	54.297	53.804
220.0	0.478	54.498	54.019
225.6	0.454	54.545	54.091
240.0	0.363	54.662	54.298
260.0	0.223	54.823	54.600
280.0	0.385	54.985	54.600
294.2	0.192	55.100	54.908
300.0	0.145	55.147	55.002
320.0	0.160	55.309	55.149
340.0	0.192	55.471	55.278
360.0	0.233	55.633	55.400
380.0	0.232	55.795	55.563
400.0	0.357	55.957	55.600
420.0	0.318	56.118	55.800
440.0	0.336	56.280	55.944
460.0	0.355	56.442	56.087
480.0	0.290	56.604	56.314
488.9	0.276	56.676	56.400
500.0	0.263	56.783	56.520
520.0	0.246	57.060	56.814
528.9	0.219	57.219	57.000
540.0	0.313	57.447	57.134
560.0	0.267	57.944	57.676
568.9	0.272	58.200	57.928
580.0	0.326	58.533	58.207
600.0	0.206	59.133	58.926
620.0	0.026	59.733	59.707
638.0	-0.331	60.273	60.603
640.0	-0.314	60.333	60.647
660.0	-0.743	60.933	61.676
680.0	-1.038	61.533	62.571
700.0	-0.981	62.133	63.114
720.0	-1.710	62.733	64.443
740.0	-2.001	63.333	65.334
760.0	-2.485	63.933	66.417
780.0	-2.878	64.533	67.411
800.0	-3.496	65.133	68.629
820.0	-4.052	65.733	69.785
840.0	-4.545	66.333	70.878
860.0	-5.171	66.933	72.103
880.0	-5.782	67.533	73.315
900.0	-6.361	68.133	74.494
920.0	-7.007	68.733	75.740
940.0	-7.554	69.333	76.887
960.0	-8.225	69.933	78.158
980.0	-8.691	70.533	79.224
1000.0	-9.200	71.133	80.332
1020.0	-9.481	71.733	81.214
1040.0	-9.900	72.333	82.233
1060.0	-9.979	72.933	82.912
1080.0	-10.209	73.533	83.742
1100.0	-10.108	74.133	84.241
1120.0	-9.902	74.733	84.635
1140.0	-9.590	75.333	84.923
1160.0	-9.088	75.933	85.020
1180.0	-8.744	76.533	85.277
1200.0	-8.287	77.133	85.419
1216.4	-8.054	77.624	85.678
1220.0	-7.956	77.732	85.688
1240.0	-7.549	78.314	85.863
1260.0	-7.193	78.869	86.062
1280.0	-6.543	79.398	85.941
1300.0	-6.156	79.900	86.056
1320.0	-5.693	80.375	86.067
1340.0	-5.247	80.823	86.070
1360.0	-4.910	81.245	86.155

SUPERELEVATION: 0 – LHS and RHS -3% – 280 – 297.5 – 310 – RHS 3% / LHS -3% – 620 – 657.5 – 690 – 720 – 750 – LHS 3% / RHS -3% – 1360

PROFILE - RD 01 AND RD 02
1:2000H, 1:500V

SKETCH ONLY

wsp
Level 5
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Email: perth@wsp.com

DATE	30/03/2020
SCALE AT A1	0 20 40 60m SCALE 1:2000
GRID	PCG94
PREPARED	D.MARKOV
SHEET	
PROJECT	MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN
TITLE	PLAN AND PROFILE MC01 - CHA 0 TO CHA 1360
PROJECT No.	PS116975
SKETCH No.	SK-0021
REV	C

PLAN
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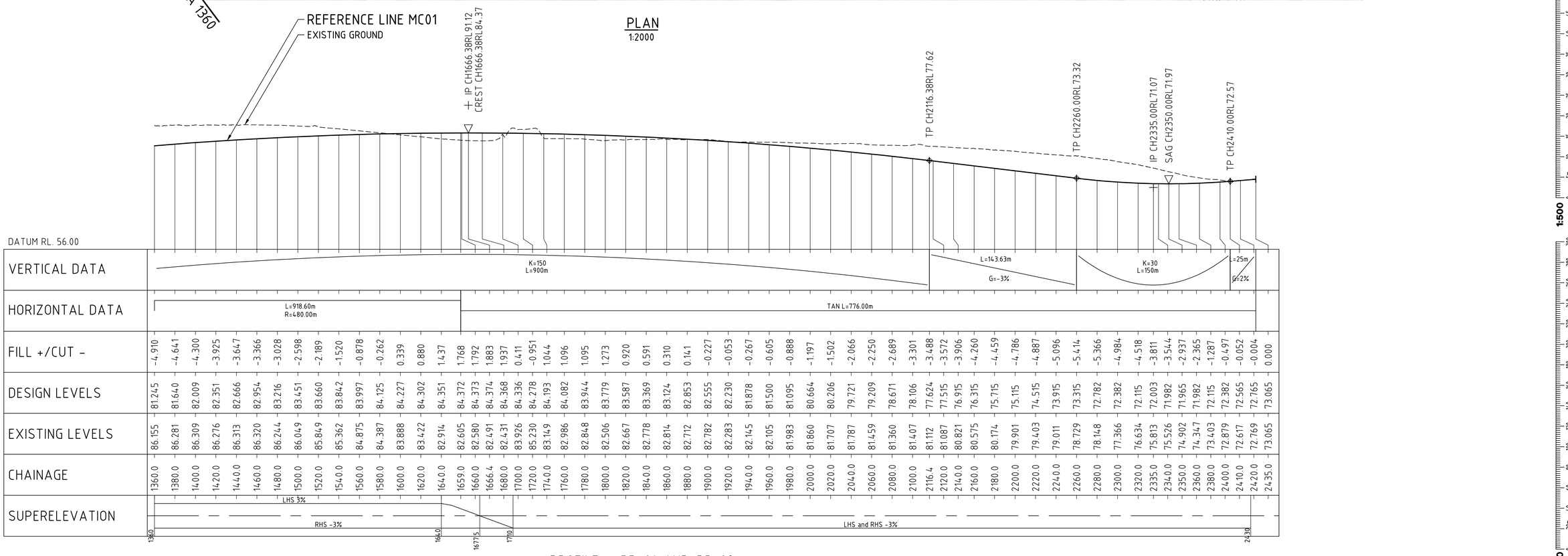

PROFILE - RD 01 AND RD 02
1:2000H, 1:500V

SKETCH ONLY

Level 5
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Telephone +61 8 9489 9700
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Email: perth@wsp.com

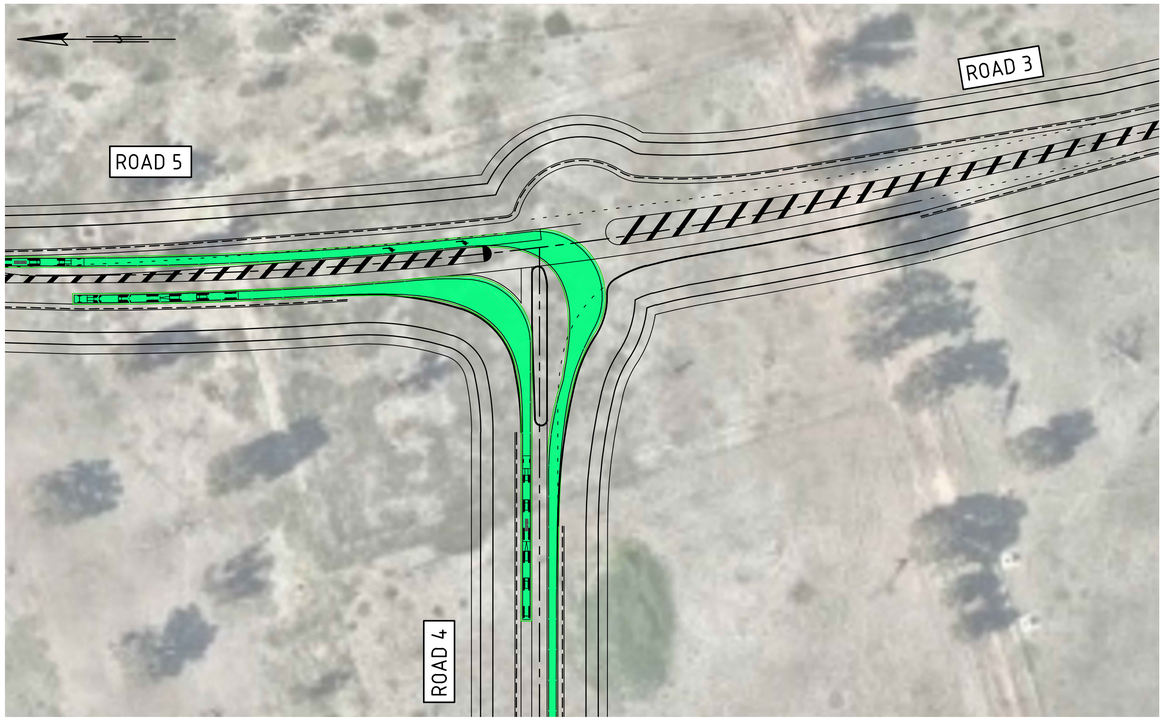
DATE	30/03/2020
SCALE AT A1	0 20 40 60m SCALE 1:2000
GRID	PCG94
PREPARED	D.MARKOV
SHEET	

PROJECT **MUCHEA INDUSTRIAL PARK**
5% CONCEPT DESIGN

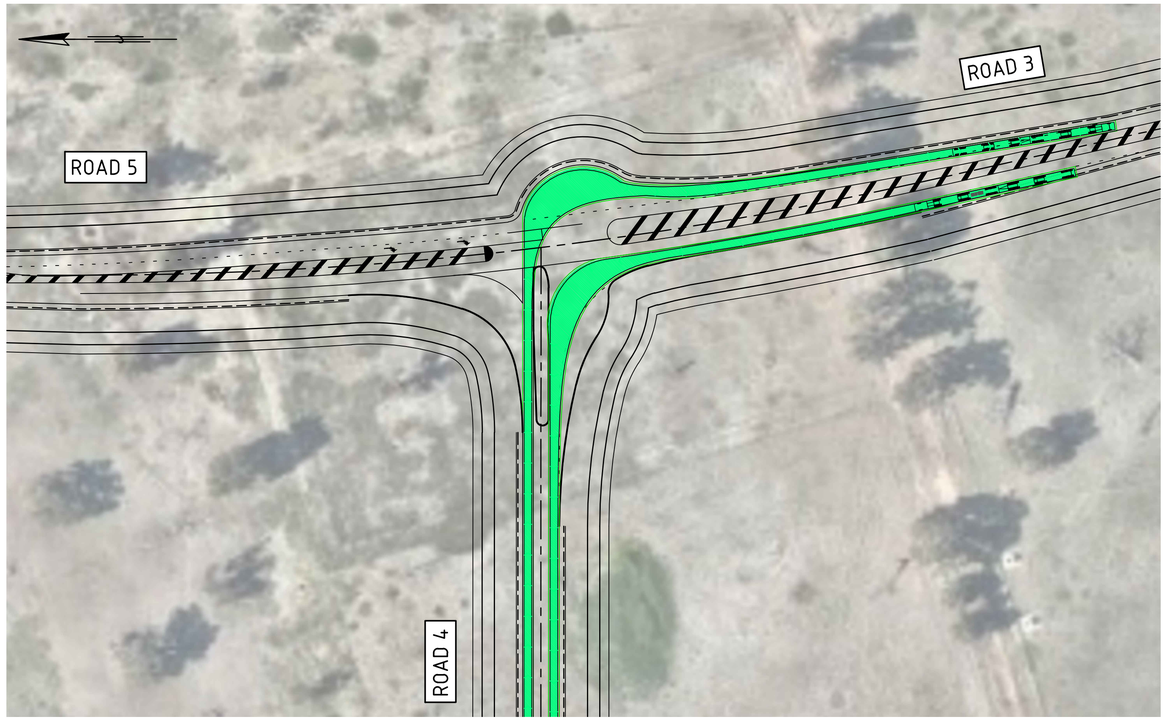
TITLE **PLAN AND PROFILE**
MC01 - CHA 1360 TO CHA 2435

PROJECT No. **PS116975** | SKETCH No. **SK-0022** | REV **C**

1:500 1:2000

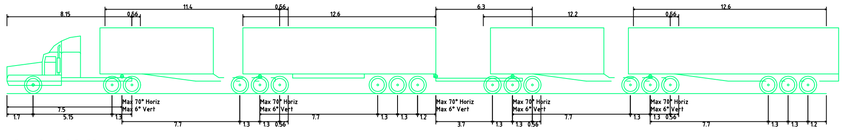


PLAN
1:1000



PLAN
1:1000

PLAN
1:1000



MRWA RAV 10(B) REV1

Overall Length	53.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.540m
Track Width	2.500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m

SKETCH ONLY

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Perth WA 6000
Telephone +61 8 9489 9700
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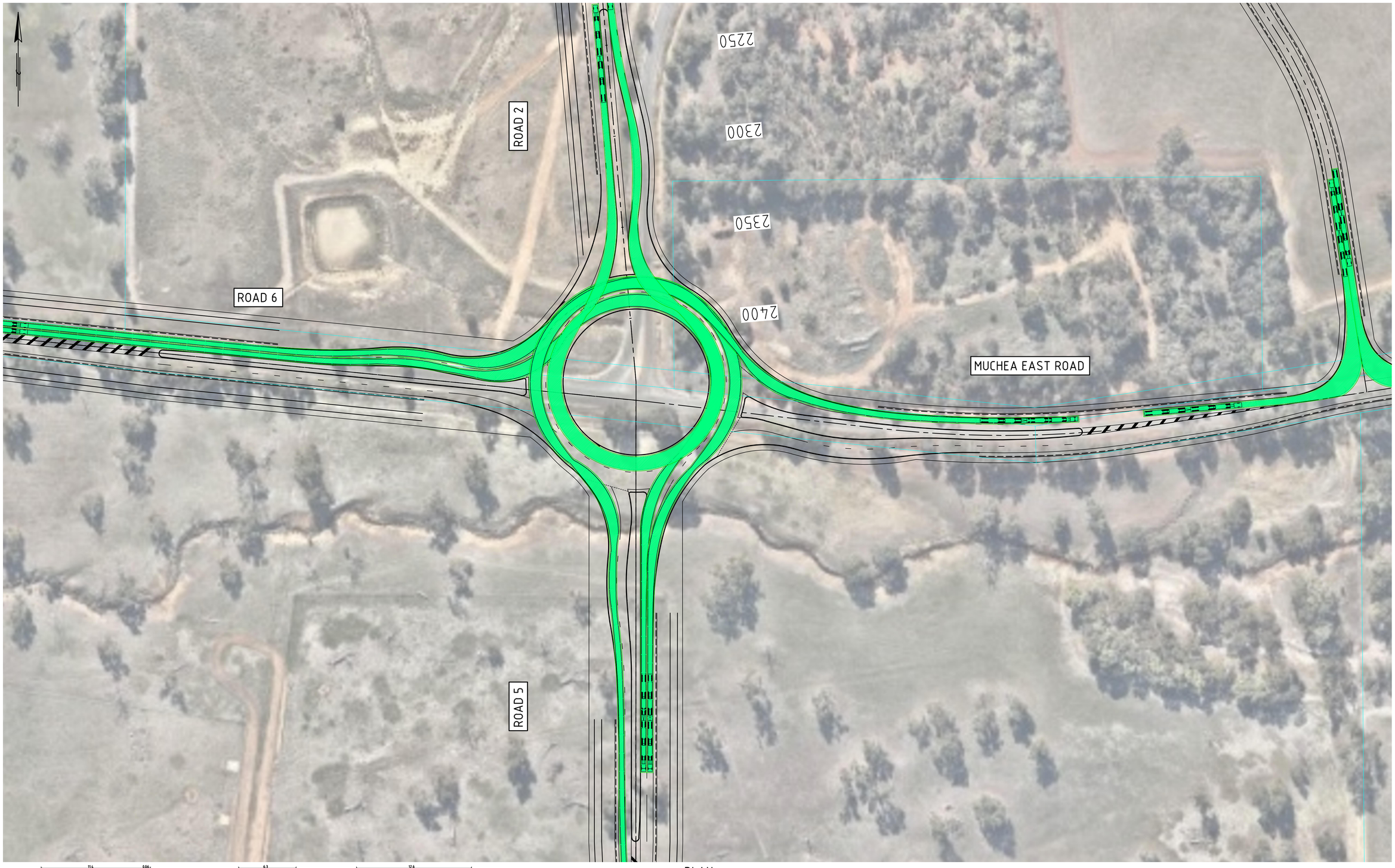
Email: perth@wsp.com

DATE	28-10-19
SCALE AT A1	0 10 20 30m SCALE 1:1000
GRID	PCG94
PREPARED	D.MARKOV
SHEET	

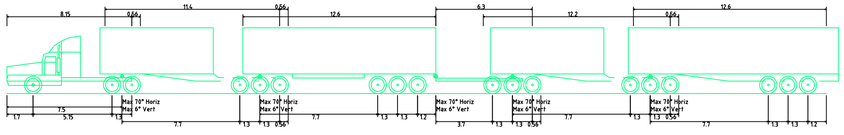
PROJECT	MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN
TITLE	INTERSECTION PLAN AUXILIARY LANE TYPE VEHICLE SWEPT PATH

PROJECT No.	SKETCH No.	REV
PS116975	SK-0031	A

1:1000



PLAN
1:1000



MRWA RAV 10(B) REV1	
Overall Length	53.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.540m
Track Width	2.500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m

SKETCH ONLY

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Level 5
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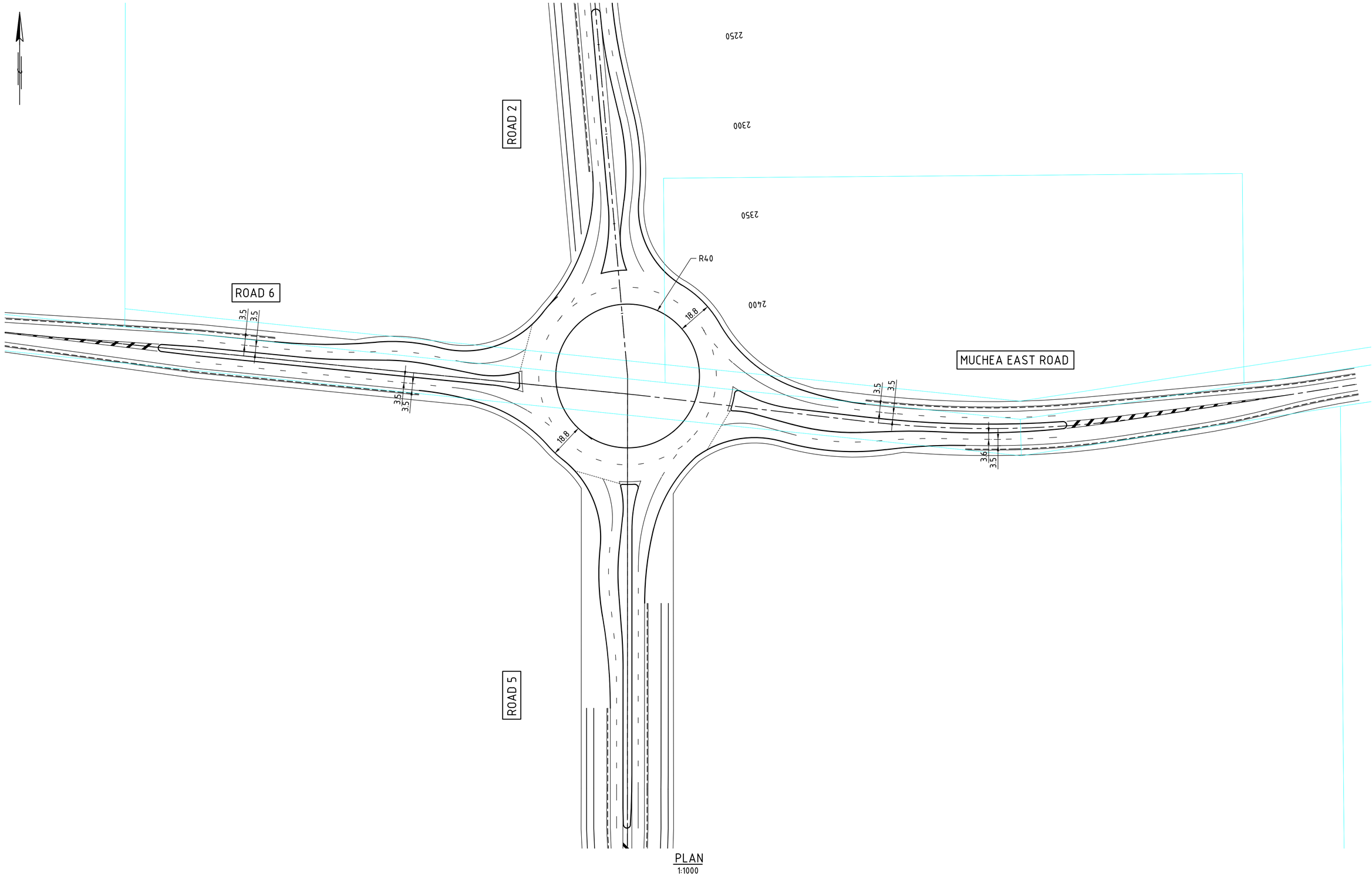
Email: perth@wsp.com

DATE	26/03/2020
SCALE AT A1	0 10 20 30m SCALE 1:1000
GRID	PCG94
PREPARED	D.MARKOV
SHEET	

PROJECT	MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN	
TITLE	INTERSECTION PLAN ROUNDABOUT VEHICLE SWEPT PATH	
PROJECT No. PS116975	SKETCH No. SK-0032	REV B

1:1000



PLAN
1:1000

SKETCH ONLY

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Email: perth@wsp.com

DATE	28-10-19
SCALE AT A1	0 10 20 30m SCALE 1:1000
GRID	PCG94
PREPARED	D.MARKOV
SHEET	

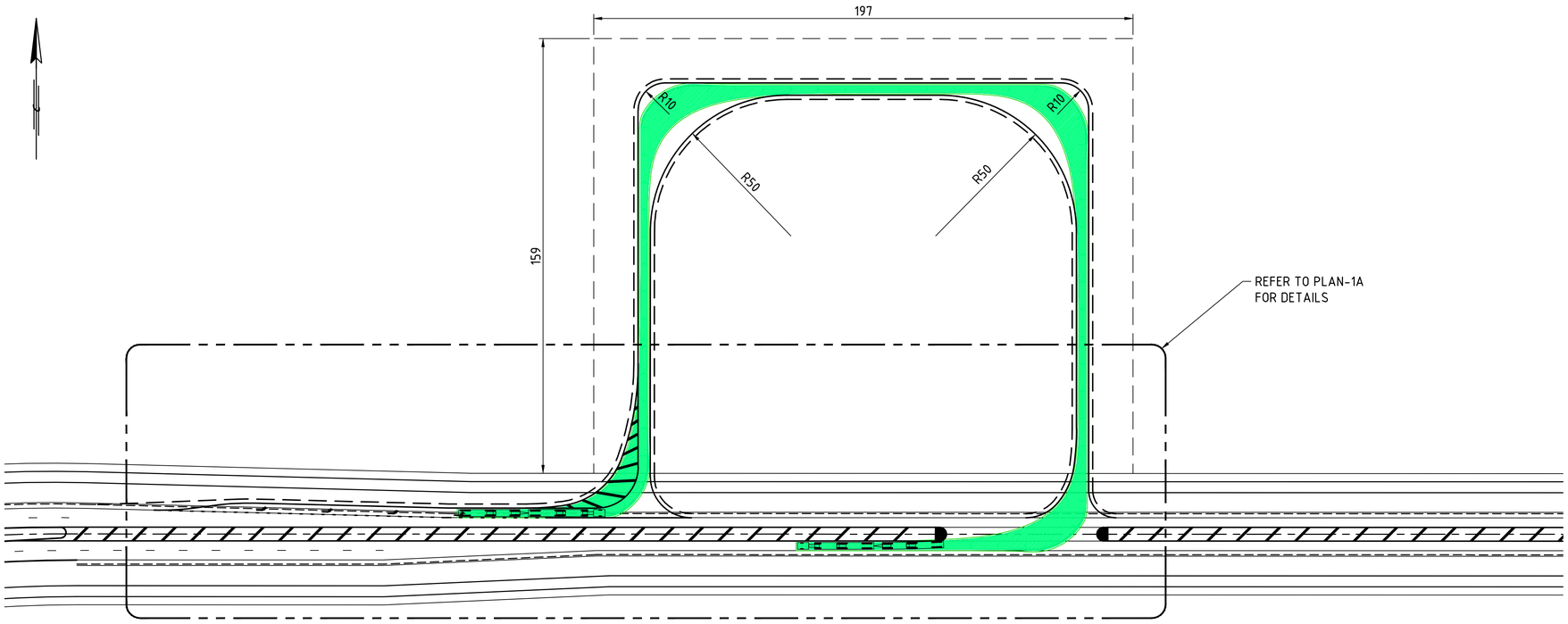
PROJECT **MUCHEA INDUSTRIAL PARK**
5% CONCEPT DESIGN

TITLE **INTERSECTION PLAN**
ROUNDABOUT

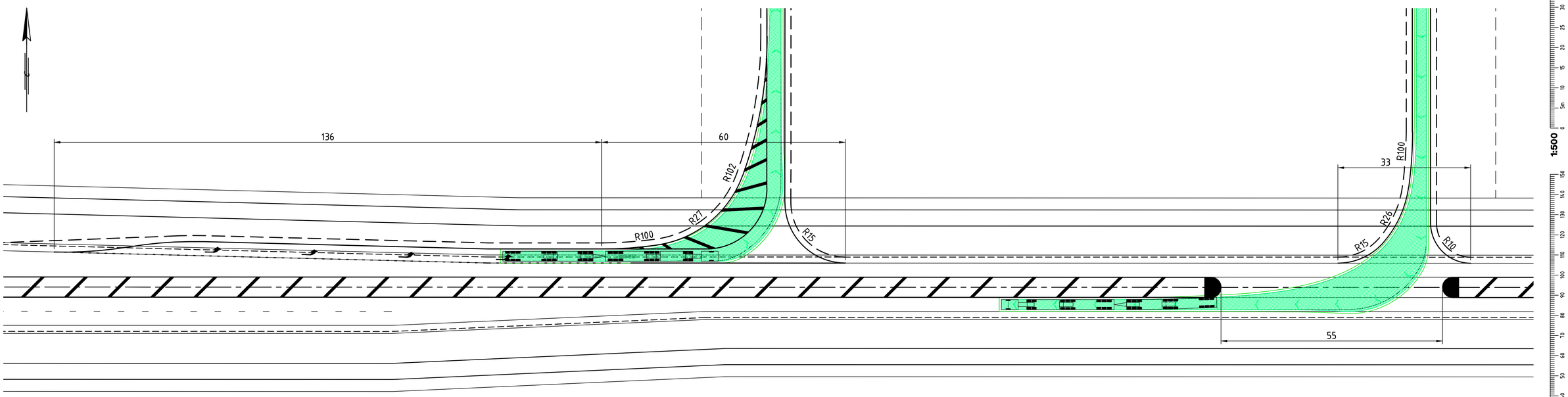
PROJECT No. **PS116975** | SKETCH No. **SK-0033** | REV **A**

APPENDIX C

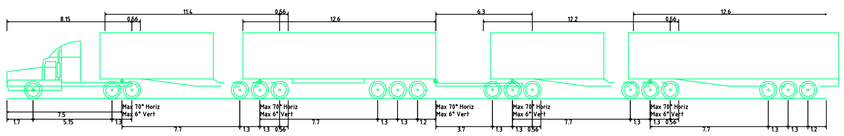
LOT FEASIBILITY AND DRIVEWAY CROSSOVER DRAWING



PLAN - OPTION 1
1:1000



PLAN-1A
1:500



MRWA RAV 10(B) REV1	
Overall Length	53.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.540m
Track Width	2.500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m

SKETCH ONLY

Level 5
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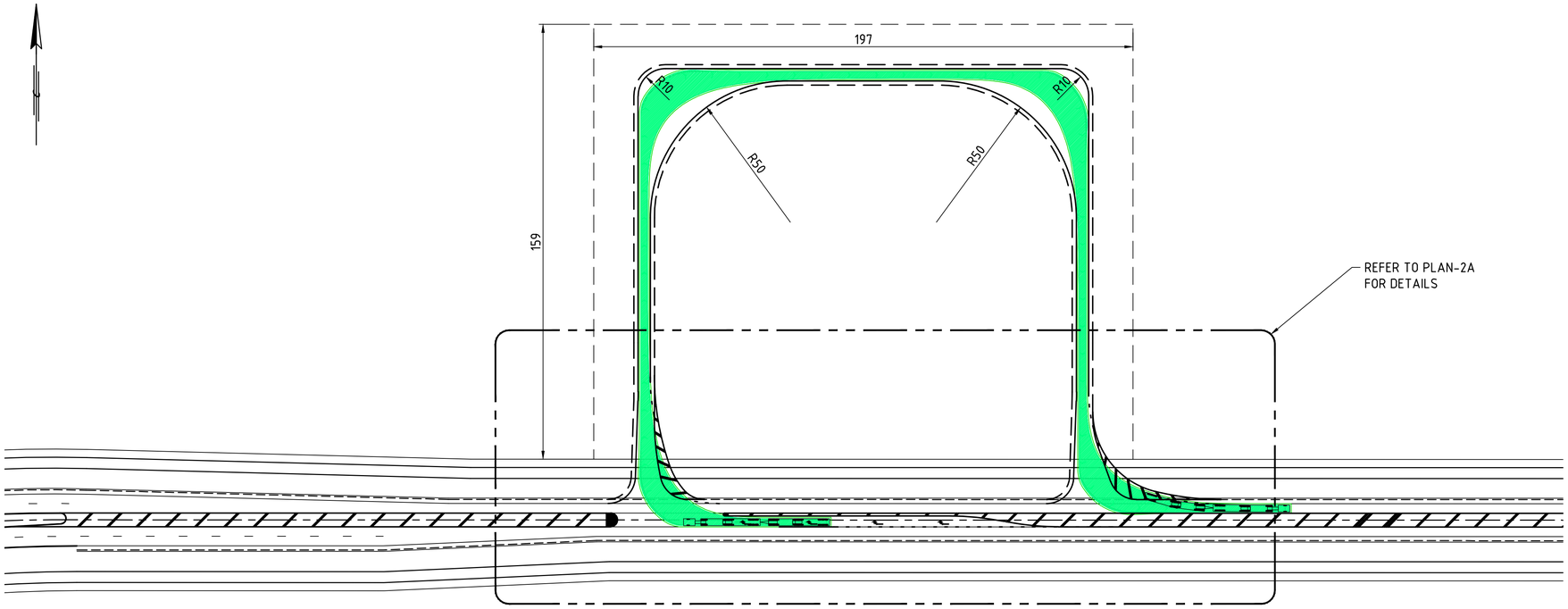
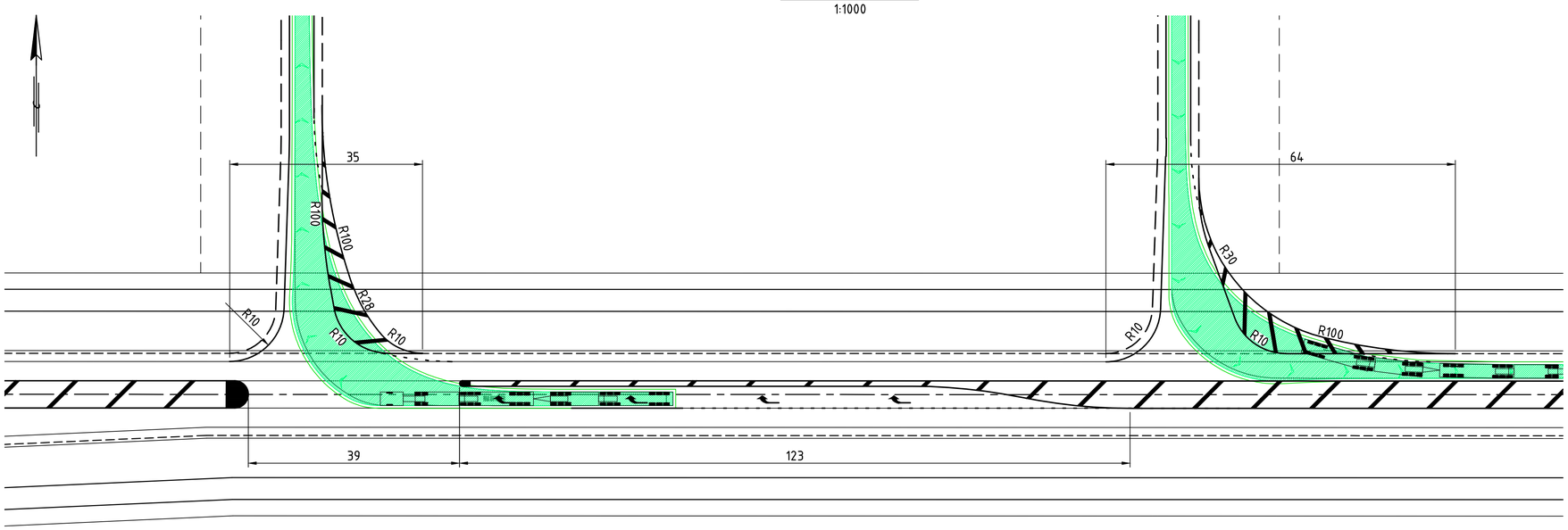
Perth WA 6000
Telephone +61 8 9489 9700
Facsimile +61 8 9489 9777
Email: perth@wsp.com

DATE	5/12/2019
SCALE AT A1	0 10 20 30m, SCALE 1:1000
GRID	PCG94
PREPARED	D.BEGOS
SHEET	

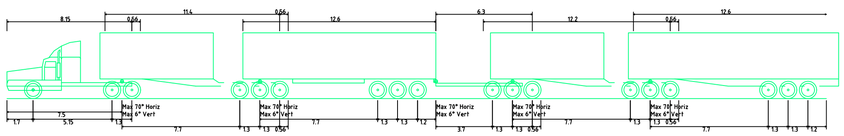
PROJECT	MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN
TITLE	DRIVEWAY CROSSOVER VEHICLE SWEPT PATH OPTION 1
PROJECT No.	PS116975
SKETCH No.	SK-0041
REV	A



PLAN - OPTION 2
1:1000



PLAN-2A
1:500



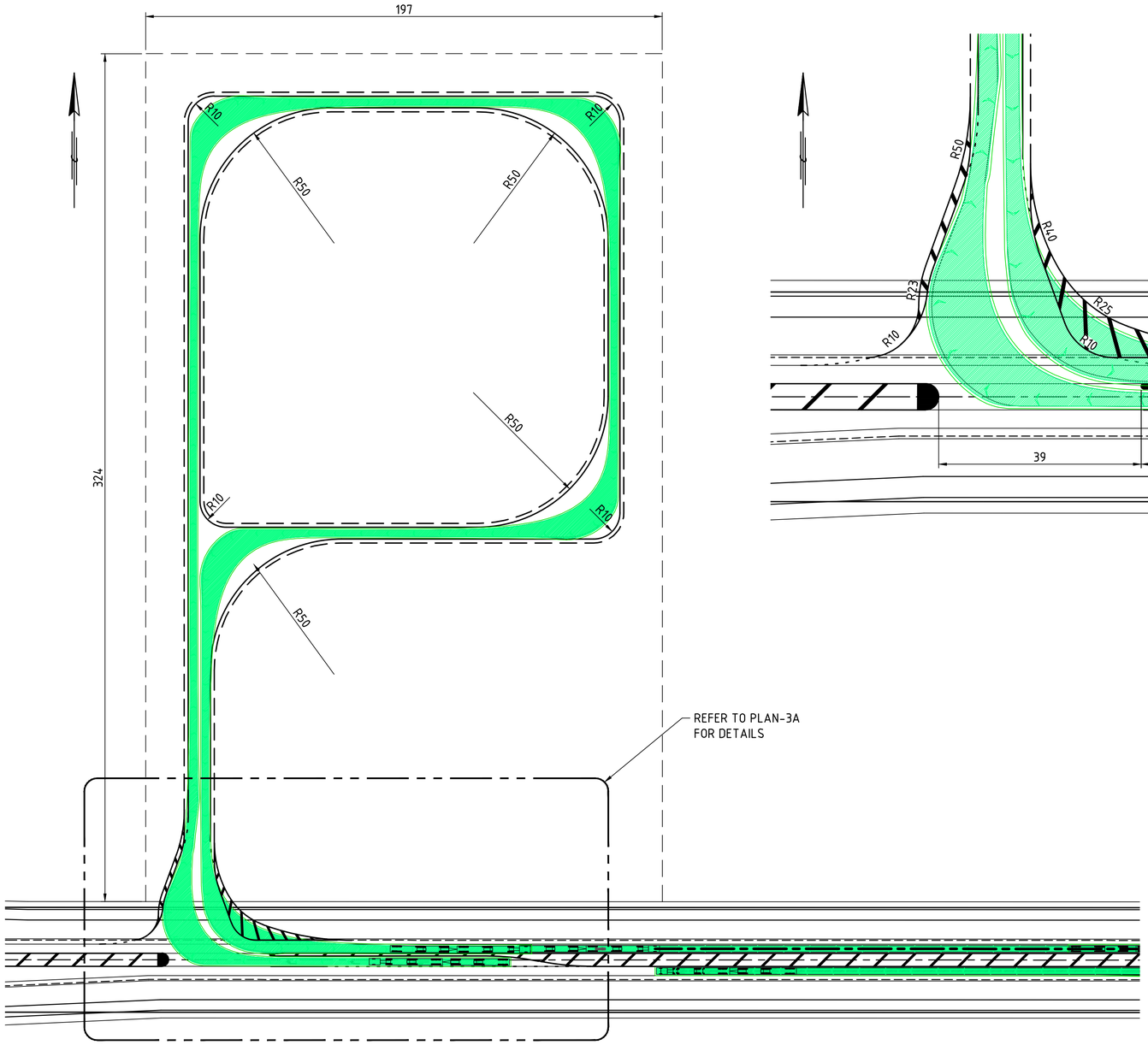
MRWA RAV 10(B) REV1	
Overall Length	53.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.540m
Track Width	2.500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m

SKETCH ONLY

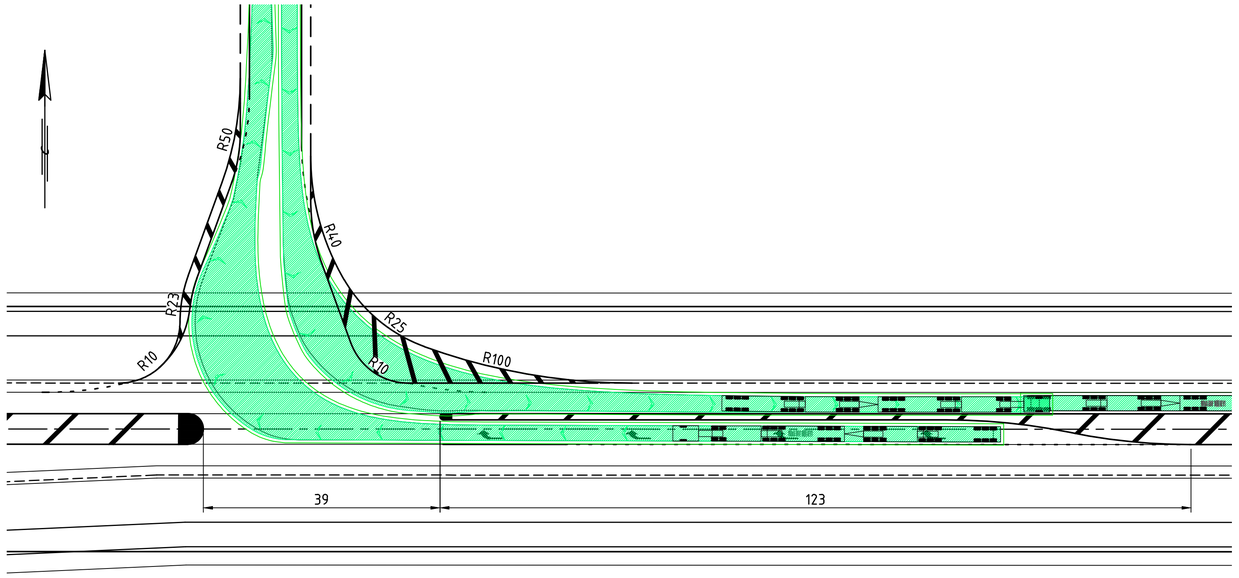
Level 5
503 Murray Street
Perth WA 6000
Telephone +61 8 9489 9700
Facsimile +61 8 9489 9777
Email: perth@wsp.com

DATE	5/12/2019
SCALE	0 10 20 30m
AT A1	SCALE 1:1000
GRID	PCG94
PREPARED	D.BEGOS
SHEET	

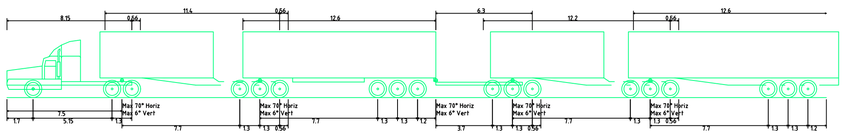
PROJECT	MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN
TITLE	DRIVEWAY CROSSOVER VEHICLE SWEPT PATH OPTION 2
PROJECT No.	PS116975
SKETCH No.	SK-0042
REV	A



PLAN - OPTION 3
1:1000



PLAN-3A
1:500



MRWA RAV 10(B) REV1	
Overall Length	53.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.540m
Track Width	2.500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m

SKETCH ONLY

Level 5
503 Murray Street
Perth WA 6000
Telephone +61 8 9489 9700
Facsimile +61 8 9489 9777
Email: perth@wsp.com

DATE	5/12/2019
SCALE AT A1	0 10 20 30m SCALE 1:1000
GRID	PCG94
PREPARED	D.BEGOS
SHEET	

PROJECT	MUCHEA INDUSTRIAL PARK 5% CONCEPT DESIGN
TITLE	DRIVEWAY CROSSOVER VEHICLE SWEPT PATH OPTION 3
PROJECT No.	PS116975
SKETCH No.	SK-0043
REV	A