# Planning Study Report

## PR-1268 – Planning Study Report: Goodwood Road and Cross Road Intersection

## IPP-AMJV-422-001-RP-OP-DO-0176

## Rev B

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aurecon

MOTT MACDONALD

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# Summary

The Department for Infrastructure and Transport (DIT) has engaged Aurecon and Mott Macdonald, Aurecon Mott Macdonald Joint Venture (AMJV), to deliver Packages D and E of the Network Planning Studies in conjunction with DIT under the Integrated Planning Partner (IPP) Contract. Package D comprises a number of Planning Studies on the Portrush Road and Cross Road corridors.

**About this Planning Study**

The Goodwood Road and Cross Road Intersection Planning Study (the Planning Study) investigated potential upgrades of the Goodwood Road and Cross Road intersection. This Planning Study aligns with Tasks 1–5 of DIT's *Framework for Planning Studies* and the requirements within their Master Specification *PC-PL1 Framework for Planning Studies* (Version 3, August 2020). This includes development of long list options, short list options, and 2 preferred options for the potential intersection upgrade.

The development of the preliminary long list, long list, short list and preferred options were informed primarily by impact assessment, costing, design, and intersection performance. The short timeframes of the Planning Study necessitated a focus on the risks associated with land acquisition, services impacts, costing, and heritage to facilitate option selection. This process has helped to inform the development of this *Planning Study Report*, which represents the conclusion of this Planning Study.

**Preferred option recommendations**

Progression to 2 preferred options was undertaken using a Multi-criteria Assessment and Benefit-Cost Analysis in collaboration with DIT. Following the Multi-criteria Assessment and Benefit-Cost Analysis, an at-grade and a grade separated option were recommended, as listed in Table 1 below.

**Table 1: Preferred options**

| Option name | Description |
|---|---|
| **Option 3A – Cross Road Grade Separation** | 2 through lanes and a bicycle lane on the Cross Road overpass<br>1 through, 2 right turn, bicycle lane and a U-turn facility at-grade on Cross Road<br>2 through lanes, 2 right turn lanes, 1 bus lane and bicycle lane on Goodwood Road |
| **Option 5A – At-Grade 3T, 2RT Cross + Goodwood 2T, 1 Bus, 2RT** | 3 through lanes, 2 right turn lanes and bicycle lane on Cross Road<br>2 through lanes, 1 bus lane, 2 right turn lanes and bicycle lane on Goodwood Road |
| **Key:** **T = Through** **RT = Right Turn** | |

An updated Level 3 cost estimate (estimate reference EST 600-2 2683 OE L3 R2) and Benefit-Cost Analysis was prepared for the preferred options in accordance with DIT's *Estimating Manual*, as summarised in Table 2 below. These cost estimates were developed with reference to the 10% Concept Designs, requirements for land acquisition, and the proposed constructability programs.

**Table 2: Updated Level 3 cost estimate and benefit-cost analysis for short list options**

| Option name | P50 | | | P90 | | |
|---|---|---|---|---|---|---|
| | Updated L3 cost estimate* | $NPV^{2021}$ ($) | BCR | Updated L3 cost estimate* | $NPV^{2021}$ ($) | BCR |
| **Grade separated (Option 3A)** | $393.4m | -152 | 0.6 | $415.3m | -172 | 0.6 |
| **At-grade (Option 5A)** | $171.6m | -20 | 0.9 | $180.7m | -29 | 0.8 |
| * Costs rounded to nearest $0.1M | | | | | | |

Each preferred option has been developed to a 10% level of design.

**Next steps**

The Cross Road Corridor Strategy is currently being developed and it has been recognised that, once completed, this strategy will directly influence the future of this intersection's function and purpose within the Cross Road Corridor. Moving forward, the single preferred option for this intersection will need to be considered within the broader context of the Cross Road Corridor Strategy.

A plan for additional and more comprehensive stakeholder and community engagement on the preferred option(s) will need to be developed and actioned as a critical next step in validating and mitigating the potential impacts identified in this report.

Key community facilities impacted by the proposed works at the intersection include an aged care retirement village, a ten-pin bowling centre, and a large Big W/Woolworths complex.

It will also be critical to 'close the loop' with stakeholders – to report back what we heard during engagement, inform them what was done with their feedback, and what the outcomes and next steps for the project are.

Further investigations will be required to progress the design of the preferred options, including:

- engineering survey
- vegetation survey
- services potholing
- geotechnical investigations
- stormwater study
- completion of a climate change risk assessment
- completion of a green infrastructure assessment.

Critically, any future investment decisions for the project need to include assessment of alignment with the State's climate change commitments, including net zero emissions by 2050. To enable this, it is recommended that transport modelling be updated to allow accurate characterisation of all investment options' GHG emissions generating potential, for ease of identifying low-carbon options.

Additional investigations will be required to understand local street impacts where side streets are restricted or closed as a result of the project.

Furthermore, additional testing of the preferred option will be required following the updated future traffic demands that incorporate demand forecasts associated with the ultimate North–South Corridor design. Traffic modelling used for this study was based on approach growth rates. The traffic modelling and intersection options should be reviewed when new traffic volume forecasts are available that include the planned improvements to the North–South Corridor.

# 1 Introduction

## 1.1 Integrated Planning Partners

The Department for Infrastructure and Transport (DIT) has appointed two Integrated Planning Partners (IPP), consisting of Arup and AECOM and the Aurecon Mott MacDonald Joint Venture (AMJV), to deliver the Network Planning Studies Program of Work (the Program).

The AMJV was engaged to deliver Packages D and E of the Program in conjunction with DIT. Package D comprises a number of planning studies on the Portrush Road and Cross Road corridors.

## 1.2 About this Planning Study Report

The Goodwood Road and Cross Road Intersection Planning Study (the Planning Study) is for the upgrade of the Goodwood Road and Cross Road intersection, which generally follows Tasks 1–5 of DIT's *Framework for Planning Studies*, as shown in Figure 1, and the requirements within their Master Specification *PC-PL1 Framework for Planning Studies* (Version 3, August 2020).

This *Planning Study Report* represents the conclusion of this Planning Study. This report summarises why this intersection has been examined, the current conditions and future problems expected at the intersection, the process of developing and assessing options for this site, the preferred options that have been recommended, and the next steps that will need to be undertaken should any improvements at this intersection be pursued.

The 2 preferred options have been developed to a 10% level of design, and they are supplemented by accompanying Level 3 cost estimates and project management documentation, in addition to other deliverables.

The information presented in this report, its appendices and all supporting documentation represent a point in time with respect to the Planning Study and is reported as relevant to Tasks 1–5 of the Master Specification.

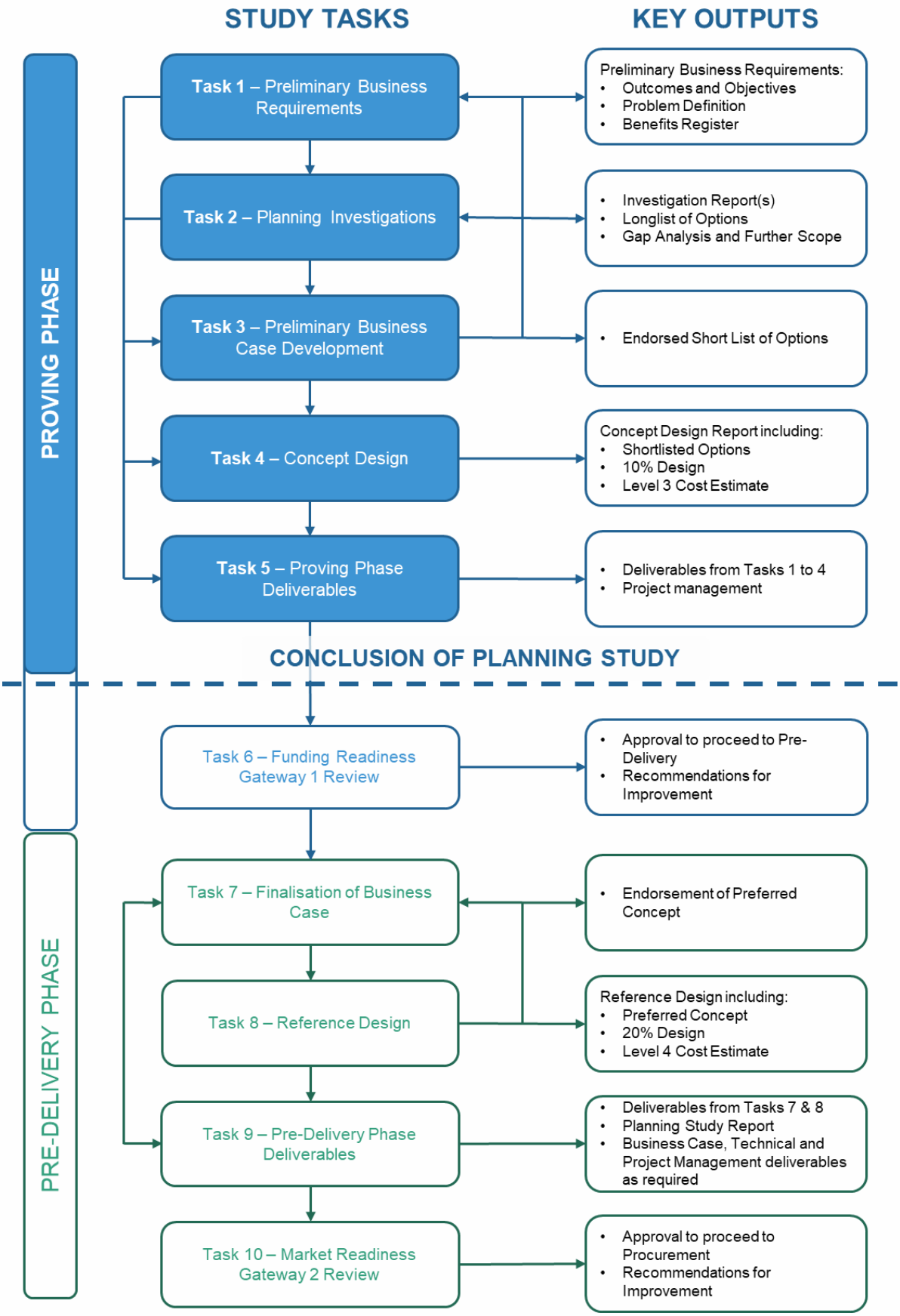



**Figure 1: DIT's *Framework for Planning Studies***

## 1.3 Project background

Cross Road is a major east–west arterial road located within the inner southern suburbs of Greater Metropolitan Adelaide used by both general commuter and freight traffic. Cross Road extends from Anzac Highway to the junction of the South Eastern Freeway, Portrush Road and Glen Osmond Road and spans across 7 key intersections, 3 at-grade level crossings and 3 local government areas including the City of Marion, City of Unley and City of Mitcham. Cross Road forms part of Adelaide's Outer Ring Route, which plays an important role in the metropolitan Adelaide road network, providing a cross-city travel route without the need to pass through the central city precinct. The Outer Ring Route also functions as a key freight route, providing connectivity between the city's urban arterials, export/import gateways and intermodal terminals.

The Goodwood Road and Cross Road intersection carries approximately 26,400 to 31,500 vehicles per day on each of its approaches, with a freight task of approximately 4%. Cross Road is identified as a standard frequency public transport corridor. Goodwood Road is a high frequency north–south public transport corridor (i.e. Go Zone). A number of previous transport planning studies undertaken by DIT have identified that future traffic volumes will saturate the key signalised intersections and mid-block sections along the length of the Cross Road Corridor and along the intersecting north–south arterials, including at Goodwood Road.

## 1.4 Study area

The study area is located at the intersection of Goodwood Road and Cross Road on the southern side of Metropolitan Adelaide approximately 4.6 km south of Adelaide's CBD, as shown in Figure 2. The intersection is located within the jurisdiction of the City of Unley and the City of Mitcham, and in the suburbs of Clarence Park, Kings Park, Cumberland Park and Westbourne Park.

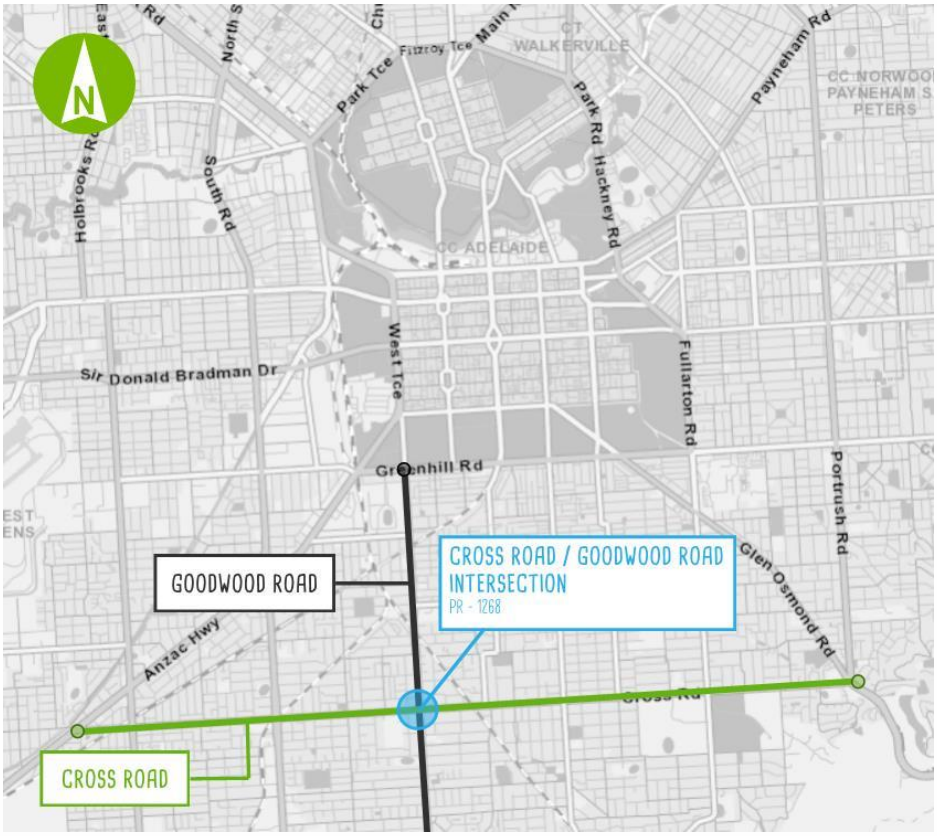



**Figure 2: Study area and surrounding context**

## 1.5 Planning Study program

The Planning Study has been progressed in a short timeframe to meet the requirements of DIT's funding submissions.

The Planning Study tasks undertaken to date include:

- project inception and data collection, October 2020
- preliminary business requirements and problem definition preparation, December 2020–March 2021
- initial fast-track long list to short list development, October–December 2020
- planning investigations gap analysis, March 2021
- long list development, February–March 2021
- short list development, March 2021
- short list costing, May 2021
- preferred development, April–July 2021
- finalisation of deliverables, August–September 2021.

Due to the constraints of the Planning Study timeframes, the development of options focussed on key risks associated with land acquisition, services, and impact on non-Indigenous heritage properties to inform the option selection process.

Following discussions with DIT it was agreed that the 2 preferred options will represent the conclusion of the Goodwood Road and Cross Road Intersection Planning Study. As such, no single option will be progressed to a 20% Reference Design at this stage.

The Cross Road Corridor Strategy is currently being developed and it has been recognised that, once completed, this strategy will directly influence the future of this intersection's function and purpose within the Cross Road Corridor. Moving forward, the single preferred option for this intersection will need to be considered within the broader context of the Cross Road Corridor Strategy.

## 1.6 Project governance

Project governance for the Planning Study included the founding of a Steering Committee, which was formed with senior DIT officers, as shown in Figure **3**.

The function of the IPP Steering Committee was to guide, add value to, and facilitate the decision-making process throughout the project. The IPP Steering Committee met in accordance with key Planning Study milestones to review the progress of this Planning Study and provide endorsement at crucial decision points. Separate meeting minutes were prepared and issued to the IPP Steering Committee.

Due to the short timeframes of the Planning Study, the IPP Steering Committee meetings with DIT were held as needed.

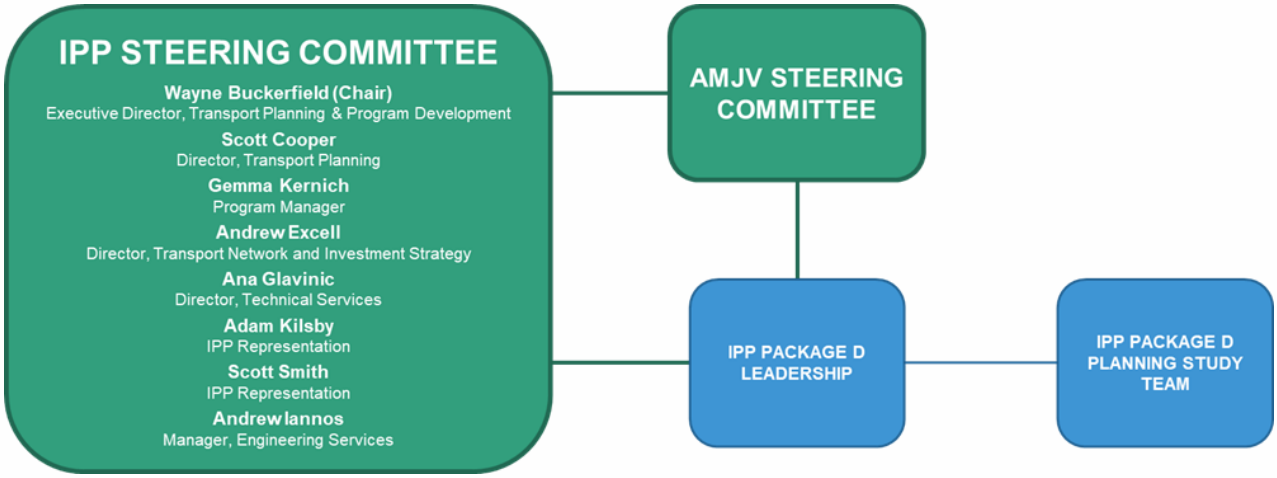



**Figure 3: Project governance structure**

## 1.7 Stakeholder and community engagement

An 'engagement plan' for the intersection was initially prepared and approved. The plan outlined an approach for stakeholder engagement – primarily with local government and transport associations – and focused on gathering information from these stakeholders in a forum of issues and opportunities. However, since this project overlapped with the corridor studies (and linked to adjacent intersection investigations) an overlap of stakeholders was identified. To mitigate the risk of confused messaging between sites and avoid stakeholder fatigue, engagement for the intersection was broadly included within a series of workshops undertaken for the Cross Road Corridor and Portrush Road Corridor Planning Studies (PR-1255 and PR-1266).

The workshops were used to gather information of a more general nature, focussing on current function, issues and opportunities. It is noted that no options, including the preferred options, have been presented to stakeholders for feedback.

Community engagement specific to this Planning Study was not undertaken, and due to timing, relevant information and feedback from the community, gained as part of the broader community engagement process, has not been incorporated into this Planning Study.

There exists the opportunity to undertake additional and more comprehensive stakeholder and community engagement on the preferred options. This would form an important next step in validating and mitigating the potential impacts identified in this report.

It will also be critical to 'close the loop' with stakeholders – to report back what we heard during engagement, inform them what was done with their feedback, and what the outcomes and next steps for the project are.

# 2 Case for change

## 2.1 Existing intersection

### 2.1.1 Functional Hierarchy

The functional hierarchy for South Australia's land transport[1] has been identified as follows:

- Cross Road's role as a Freight Route, Standard Frequency Public Transport Corridor, Major Cycling Route (metro) and Major Traffic Route
- Goodwood Road's role as a High Frequency Public Transport Corridor, Pedestrian Public Transport Corridor and Peak Hour Traffic Route.

### 2.1.2 Existing movements

The existing movements within the intersection of Goodwood Road and Cross Road are shown in Figure 4.

Currently, the western and eastern approaches of Cross Road comprise 3 general traffic lanes: 2 through lanes and 1 (one) right turn lane (approximately 40 m on the western approach and 65 m on the eastern approach). The kerbside general traffic through lane allows vehicles to enter a short separate lane for high entry left turn movements. A continuous and narrow unidirectional bicycle lane is located kerbside on both approaches but is not separated with line marking from the left turn lanes.

The Goodwood Road approaches are relatively similar. They comprise 4 general traffic lanes: 2 general traffic lanes and 2 right turn lanes. The kerbside general traffic lane allows vehicles to enter the high entry left turn lane. There are currently no bicycle lanes on the Goodwood Road approaches.

The existing traffic volumes at this intersection are presented in Table 3, as per data from the 2019 Goodwood Road/Cross Road intersection survey.

**Table 3: Existing traffic volume estimates (2019)**

| Intersection Leg | Traffic Volumes |
|---|---|
| **Cross Road (west)** | 26,400 |
| **Cross Road (east)** | 31,500 |
| **Goodwood Road (north)** | 26,400 |
| **Goodwood Road (south)** | 31,300 |

[1] Department of Planning Transport and Infrastructure, *A Functional Hierarchy for South Australia's Land Transport Network*, 2013

With Cross Road designated as a major cycling route, a total of 130 cyclists were recorded over an 11-hour survey period[2] in October 2019, with more than three quarters of those on Cross Road. A majority of cyclists were surveyed travelling in the AM peak on both Cross Road approaches. No pedestrian movement data was available for this intersection.

Cross Road is a key arterial road for both general commuter and freight traffic. Congestion on Cross Road is currently impacting on efficient movements in both the AM and PM peak periods, with average travel speeds under 30 km/h[3].

The upgrade of this intersection must also consider the implications of the forthcoming North–South Corridor (Torrens to Darlington) on future traffic demand. The transformation of South Road as part of the North–South Corridor could potentially see changes in the broader metropolitan freight network, including the potential redirection of freight traffic away from Portrush Road across to the North–South Corridor via Cross Road, the extent of which is yet to be defined.

The upgrade of the Goodwood Road and Cross Road intersection is cognisant of this both in the short and long-term. In the short-term it helps to reduce the traffic disruption caused from vehicles avoiding the North– South Corridor construction works as they try to access the city. In the long-term it provides enhanced access for vehicles wanting to access the North–South Corridor from the South Eastern Freeway.

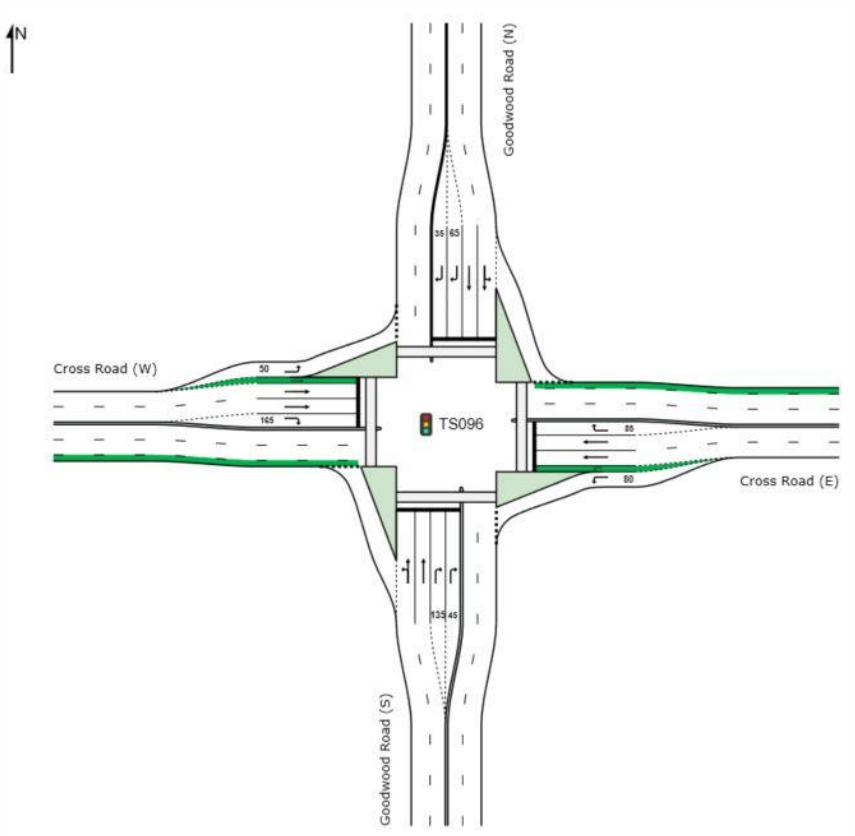



**Figure 4: Existing intersection movements**

[2] DIT, *Vehicle Turning Movement Survey TG799279_20191030,* 2019
[3] AddInsight Bluetooth data sets 2019

### 2.1.3 Public transport

This location mainly caters for city-centric services along Goodwood Road, with some suburban connector services along Cross Road. The Goodwood Road Corridor is classified as a high frequency public transport link and services commuters travelling between the CBD and the City of Mitcham (to the south). Cross Road is designated a standard frequency public transport corridor, servicing cross-city commuters between the suburbs of Glen Osmond and the bus interchange at Arndale (adjacent to the Arndale Shopping Centre). There are currently no bus priority lanes at this intersection. The public transport services at the intersection are shown in Figure 5.

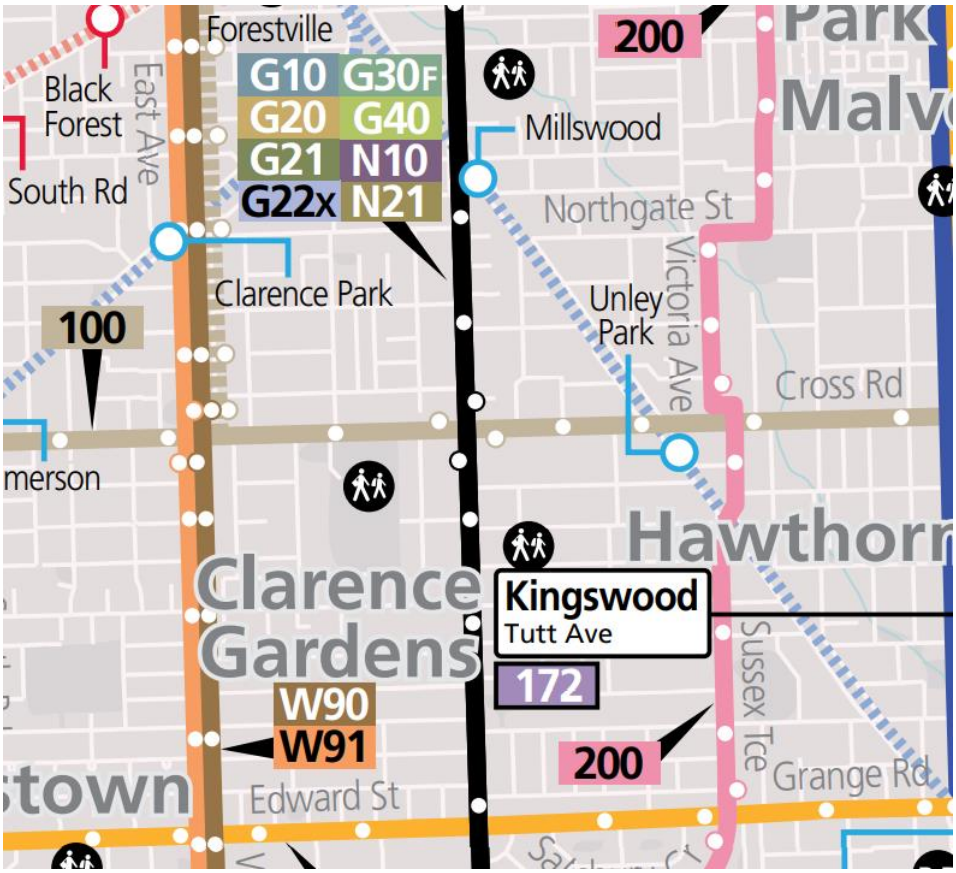



**Figure 5: Public Transport Network at the intersection of Goodwood Road and Cross Road**

A review of bus service performance found that most bus services are currently running behind schedule as they approach the intersection (with the exception of northbound in the AM peak). However, as the bus services move through the intersection, there is an increase in delays for both the north–south and east–west routes. The increase in delays is greatest in the north–south direction, averaging a 40.5 second increase. Whereas the east–west delay average is 35.5 seconds. More information on bus service delays is contained in the *Strategic Business Case* (*IPP-AMJV-422-001-RP-OA-DO-0068*) issued separately to DIT.

Future intersection designs will need to enhance pedestrian access to bus stops and interchange movements, maintain flexible network options, seek network reliability and be cognisant of travel times.

### 2.1.4 Road safety

In the 5-year period between 2015 to 2019, a total of 48 crashes were reported at the intersection of Goodwood Road and Cross Road, resulting in 17 casualties, comprising 1 (one) instance of serious injury and 16 instances of minor injury casualties. With an average of 9.6 crashes (with 3.2 casualties) per year, this intersection is classified as a 'Black Spot'[4].

Of the 48 crashes, 38 (or 79%) occurred at the intersection, with the remaining 10 crashes on the approaches in close proximity to the intersection. According to the crash history dataset, 1 (one) hit pedestrian crash has occurred inside the Cross Road and Goodwood Road intersection over the assessment period resulting in a serious injury. No cyclists have been involved in crashes at the intersection over the period 2015 to 2019.

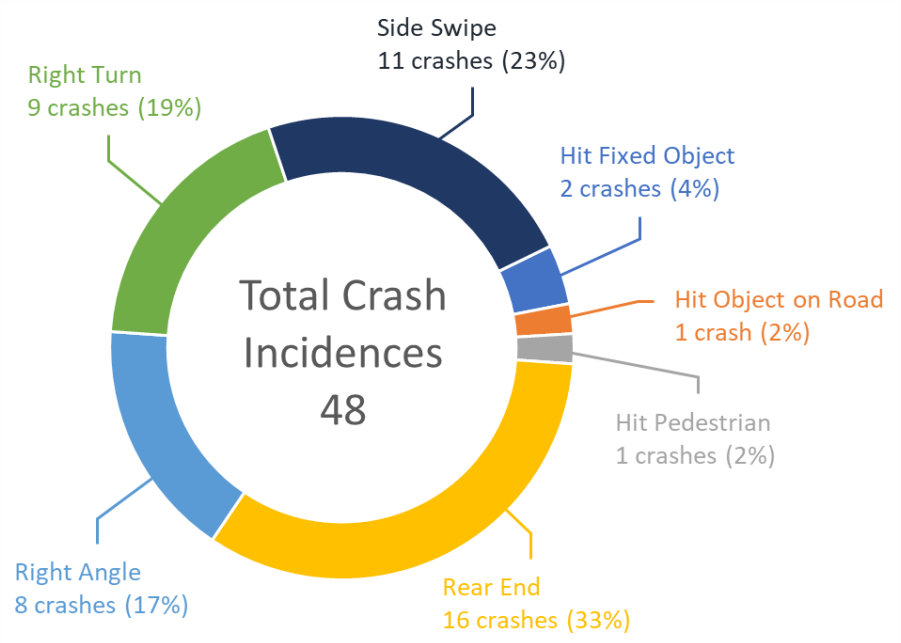



**Figure 6: Number of crash incidences by type, between 2015 to 2019**

As can be seen in **Error! Reference source not found.**, rear end crashes were the predominate vehicle c rash type, followed by right turn and side swipe crashes.

- All rear end collisions were due to inattention with one exception of reversing without due care.
- All right turn collisions have occurred between the through and filter right turn movements of Cross Road.
- Heavy vehicles have been involved in 5 crashes (approximately 10% of total intersection crashes), including 3 side swipe, 1 rear end, and 1 hit fixed object collision.

The intersection upgrade should include full control of right turns, improve storage space for turning movements and widening of bike and kerbside traffic lanes wherever corridor widening is proposed.

[4] https://investment.infrastructure.gov.au/infrastructure_investment/black_spot/

### 2.1.5 Active transport

Cross Road is a Major Cycling Route, with narrow (1.2 m) kerbside bicycle lanes adjacent to 3 m traffic lanes along much of its length. Bicycle lanes are presently interrupted through the intersections at the left turn lanes. Cross Road is also a freight route. Bicycle push buttons present for the Cross Road bicycle lanes require cyclists to progress over the stop bar to access the push buttons.

No bicycle lanes currently exist along Goodwood Road, and whilst this is not identified as having a significant role in cycling, there is an opportunity to include 1.8 m bicycle lanes into proposed designs to improve safety for cyclists through the intersection and connecting to local destinations.

A turning movement survey undertaken on a weekday in October 2019 between the hours of 6.30 am and 7 pm identified a total of 130 cyclists traversing, with 106 approaching from Cross Road (east or west) and 23 approaching from Goodwood Road (north or south).

*Cycling Aspects of Austroads Guides* describes a minimum requirement of 1.0 m clearance and a preferred 1.5 m clearance between the cyclist envelope (which typically starts 0.4 m out from kerb face and is 1.0 m wide) and where heavy vehicles could be expected. Minimum bicycle lane widths under Austroads, which should be measured from the lip of channel/edge of bitumen (so that the running width is clear of hazard), is 1.2 m with 1.5 m desirable (1.2–2.5 m acceptable range with actual width selection to account for function and use). As Cross Road is an identified major cycling route, overtaking should ideally be incorporated into design. The minimum cross section for overtaking is 2.4 m.

The footpath systems on Goodwood Road and Cross Road in the vicinity of the intersection offer only limited accessibility, with key issues existing, listed below.

- A-frames, trees and numerous objects along the building line are a hazard for pedestrians with vision impairments.
- Left turn slip lanes are very narrow, generally not compliant, and have extremely limited storage space for pedestrians.
- On Goodwood Road at the shopping centre carpark entrance, access is limited by narrow footpaths, misaligned/non-complying ramps and a road-style design that muddies perception of priority to pedestrians.
- On Cross Road adjacent to OTR Clarence Park, the paths are narrow and driveway crossings have significant crossfall and non-compliant ramps that are a significant hazard for people with a broad range of mobility impairments.
- paths along Cross Road are too small to permit 2 wheelchairs passing, including at the retirement home on Cross Road.
- Constrained manoeuvring areas for wheelchairs exist behind the kerb ramps at the north-west and south-east corners of the intersection.
- Delineation for people with a vision impairment crossing at the intersection is limited to line marking and directional Tactile Ground Surface Indicators (TGSIs) at the island entrances (which fails to warn pedestrians of the hazard). No support is provided by central medians.
- Narrow medians present a risk to pedestrians of overbalancing when using them to cross mid-block in 2 stages.

A minimum of 1.8 m clear width should be provided for all footpaths with a minimum of 1.5 m clear width behind pedestrian ramps to allow for wheelchair manoeuvring. All bus stops and connecting pathways through the interchange area must comply with the *Disability Standards for Accessible Public Transport 2002*.

### 2.1.6 Constraints

The intersection is constrained by the following (refer Figure 7):

- significant adjacent commercial businesses (service station, McDonalds, Ten Pin Bowling Centre and Big W)
- aged care retirement village
- Cabra Dominican College
- Cabra Chapel and Gatehouse (State Heritage place)
- Church of Trinity (local heritage place)
- local heritage shops and dwellings at:
    - 315-316 Goodwood Road, Kings Park
    - 12-13 Cross Road, Kings Park
    - 2a Deepdene Avenue, Westbourne Park
- Belair passenger rail line and ARTC line approximately 600 m east of intersection
- DN650 diameter potable water main under Goodwood Road.


**Figure 7: Key constraints at the intersection of Cross Road and Goodwood Road**

## 2.2 Problem statements

Three (3) problems have been identified with the current operation of the Goodwood Road and Cross Road intersection:

**Problem 1**

- High traffic volumes and competing transport priorities are compromising the efficient movement of people and goods for all approaches.

**Problem 2**

- High traffic volumes and competing E–W transport priorities are compromising the provision of high frequency public transport services on Goodwood Road.

**Problem 3**

- High traffic and growth in freight volumes on Cross Road are compromising the safe movement of people.

Refer to the *Strategic Business Case (IPP-AMJV-422-001-RP-OA-DO-0068)* issued separately to DIT for further details of the problem statements.

## 2.3 Business requirements

### 2.3.1 General

The preliminary business requirements of this project have been drafted in conjunction with DIT. Refer to the *Business Requirements* in Appendix A for further detail.

The Preliminary Business Requirements document the agreed-upon objectives, principles, outcomes, and measures required by the project in alignment with DIT's integrated business perspective.

### 2.3.2 Objectives

The primary objective of this project is:

| | |
|---|---|
| 1 | **Safe, reliable and efficient movements** - Transport networks are developed, regulated and managed to maximise accessibility and enable safe, integrated, reliable and efficient movement of people, goods and services, balancing demand with capacity. |

The secondary objectives of this project are:

| | |
|---|---|
| 2 | **Economic Growth** – Land use policy and transport network infrastructure, policy settings, regulation and management enables appropriate uses that support economic growth and job creation in key industry sectors across the state. |
| 3 | **Customer and community centred** – All aspects of operation and service delivery are centred on making best use of available resource to meet customer needs and take into account community issues and expectations. |
| 4 | **Successful places** – Land use and transport policy settings, planning and program delivery enable more liveable, better connected, safer, healthier and more sustainable communities. |

### 2.3.3 Benefits and outcomes

An Investment Logic Map has been developed for the upgrade of the Goodwood Road and Cross Road intersection. Indicative benefits and outcomes are shown in the Benefits Map (refer Figure 8).

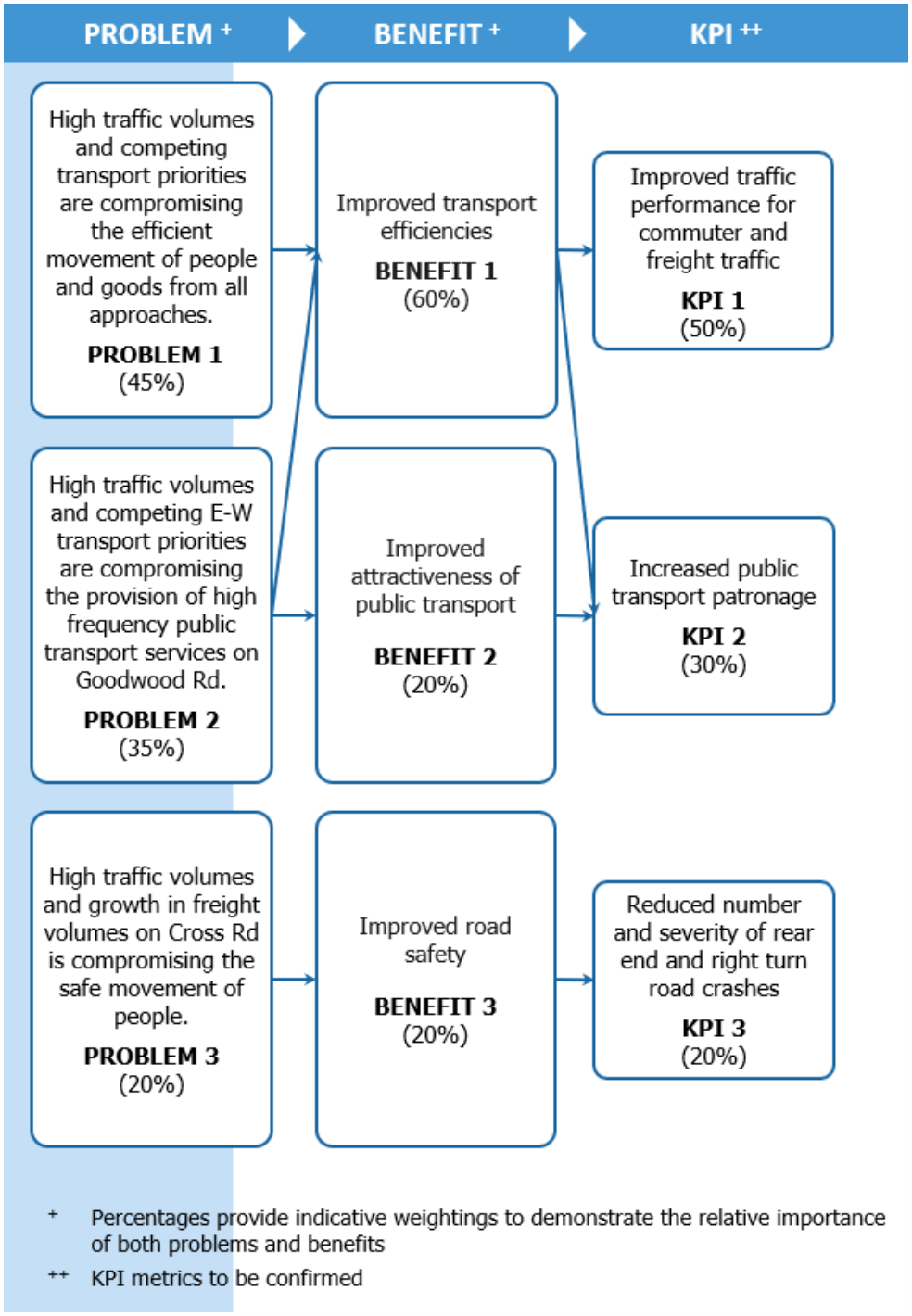



**Figure 8: Benefits map**

# 3 Desktop studies for this intersection

Several desktop studies were undertaken to understand the challenges and opportunities of the Goodwood Road and Cross Road intersection, including:

- desktop geotechnical study
- preliminary hydrological assessment
- *EBS Ecology Cross Road and Goodwood Road Intersection Upgrades Desktop Flora and Fauna Report 2021 (EBS Ecology Report)*
- heritage desktop assessment
- site contamination desktop assessment.

The following sections detail the key considerations concerning each discipline or speciality area.

## 3.1 Desktop geotechnical study

A high-level desktop study was completed to provide a preliminary assessment of the key geotechnical issues at this intersection.

The desktop study indicated that key geotechnical issues which need to be considered for this intersection are as follows:

- reactivity of clay soils at this site is very high and this has implications on the design of drainage, landscaping and services
- soft soils may be encountered within the site
- non-engineered fills are likely to be encountered on site
- soil removed in excavations is likely to be unsuitable for re-use as engineering fill
- previous geotechnical investigations suggest that groundwater would be encountered at a depth of between 5 and 10 m.

A site-specific geotechnical investigation including interpretive report will be required to inform the pavement design, design of associated infrastructure for the upgraded intersection and provide relevant construction recommendations.

Refer to Appendix B for the complete *Geotechnical Desktop Study* Report.

## 3.2 Preliminary hydrology assessment

Existing hydrology information was reviewed to assess the existing site conditions and identify key site constraints, including flood-prone areas and locations of underground stormwater infrastructure.

The site is located within proximity of two major water courses: Brown Hill Creek and Keswick Creek. Typically, the site grades west to east towards Brown Hill Creek, with no apparent large trapped low points (pending engineering survey).

There is currently a 750 mm stormwater drain in Cross Road (west) that continues along Goodwood Road (south), in addition to a 375 mm stormwater drain, and a 675 mm stormwater drain in Cross Road (east).

The average slope of the wider catchment is approximately 2% and substantial widenings will create challenges in resolving levels for overland flow, footpaths and driveway connections. These issues would need to be resolved during reference and detail design.

The *Flood Inundation and Hazard Mapping Study for Brown Hill and Keswick Creeks* (2003)[5] indicates that flooding of this intersection may not be expected in a 1 (one) in 50 year flood event but some flooding may be seen in a 1 (one) in 500 year flood event. There is no 1 (one) in 100 year flood event data available.

Based on the available data, it is not expected that the intersection has a significant flood risk and additional hydrological studies are not recommended for any upgrades due to the significant work that has already gone into the Brown Hill Creek studies. It is recommended that a stormwater study is completed as a part of a reference design.

## 3.3 EBS Ecology Report

In May 2021, EBS Ecology (EBS) was engaged to conduct a desktop flora and fauna assessment for the intersection of Cross Road (RN6215) and Goodwood Road (RN6461), metropolitan Adelaide.

The key objectives of the ecological assessment were to:

- identify potential ecological constraints and sensitive areas for the project
- identify the potential for threatened flora, fauna and ecological communities to occur within the project area.

*The EBS Ecology Report* helped inform the following flora and fauna findings for the site:

- The Protected Matters Search Tool identified a nationally endangered ecological community, but which is unlikely to occur in the project area due to urbanisation - *Grey Box (Eucalyptus macrocarpa) Grassy Woodlands and Derived Native Grasslands of South-east Australia*.
- Two (2) trees significant to the City of Unley that are listed under Part 10 of the Planning and Design Code.
- Other Regulated and Significant trees under the *Planning, Development and Infrastructure Act 2016* may be present.
- Grey-headed Flying-foxes (nationally vulnerable and rare in South Australia) and Southern Brown Bandicoots (nationally endangered and endangered in South Australia) have been recorded within proximity of the project area.

To minimise impacts, the project should:

- avoid and minimise impacts to native vegetation
- avoid impacting significant, regulated or hollow-bearing trees
- consider impacts to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *National Parks and Wildlife Act 1972* for threatened fauna species.

The complete *EBS Ecology Report* can be found as an appendix to the *Preliminary Environmental and Heritage Impact Assessment Report* (refer Appendix C).

[5] Patawalonga Catchment Water Management Board, *Flood Inundation and Hazard Mapping Study for Brown Hill and Keswick Creeks*, 2003. Further information on this study is available from the Department for Environment and Water (DEW).

## 3.4 Heritage Desktop Assessment

In May 2021, Independent Heritage Consultants (IHC) completed a heritage desktop assessment for this intersection. The heritage assessment included relevant heritage register searches of both DPC-AAR Taa Wika (site register) and the State Heritage Register. The report identified all national, state and local heritage items in the project area, and provided mitigation measures appropriate for each. It also provided a risk assessment for encountering unknown Aboriginal heritage sites/objects.

The IHC report identified 7 non-Aboriginal heritage items in the project area, of which 1 (one) is a state heritage item, and 6 local heritage items.

The complete Heritage Desktop Assessment can be found as an appendix to the *Preliminary Environmental and Heritage Impact Assessment Report* (refer Appendix C).

## 3.5 Site contamination desktop assessment

A desktop assessment of site contamination was completed to provide a summary of the key site contamination constraints considered to be relevant to the upgrade of the intersection of Cross Road and Goodwood Road. The report's assessment area is the maximum boundary extent of the proposed design options, in addition to the surrounding area (as required).

The objectives of this desktop assessment were to provide

- an understanding of the existing site limitations with regards to potential site contamination risks that may impact the design development
- data limitations or additional requirements to address any data gaps.

The desktop assessment identified various Potentially Contaminating Activities (PCAs) and matters of environmental interest within the assessment area and within the boundaries of adjacent land. There is no information on the existing contamination status of the soils in these areas and it is therefore recommended that further investigation is undertaken if either soil disturbance is proposed or if adjacent land is proposed to be acquired.

Soil sampling is recommended to be undertaken to assess the likely contamination status of soils that may be disturbed during the project activities in order to provide waste classification for off-site disposal of surplus soils to a suitable licensed disposal facility, and an assessment of suitability for reuse (on and off-site).

Discussions may be required to be held with the Environmental Protection Authority South Australia to determine the possibility of creating one project site, where materials can be moved across property boundaries for the purposes of construction and without approval constraints.

Review of drillhole data and recorded depths found groundwater to likely be encountered onsite at depths of between 6.00 metres below ground level (m bgl) to 14.00 m bgl (Reduced Standing Water Level between 33.20 m Australian Height Datum (AHD) and 44.63 m AHD) and so there is potential for contaminated groundwater to impact project activities. Therefore, it is recommended that further assessment of depths to groundwater is undertaken if project activities are to extend deeper than 6.00 m bgl to assess whether dewatering / shoring activities may be required.

For further details of key site contamination considerations, refer to Appendix D for the *Site Contamination Desktop Assessment*.

# 4 Outline of options assessment process

This section outlines the overarching process and methodology of options development and assessment for upgrades to the intersection throughout the preliminary long list, long list, short list and preferred stages.

## 4.1 Assessment framework

The methodology for the development and assessment of the intersection options, outlined in Figure 9, comprises a three staged decision-making process.

- Strategic Merit Test – used to assess preliminary long list options
- Rapid Multi-criteria Assessment – used to assess long list options
- Multi-Criteria Assessment and Benefit-Cost Analysis – used to assess short list options.

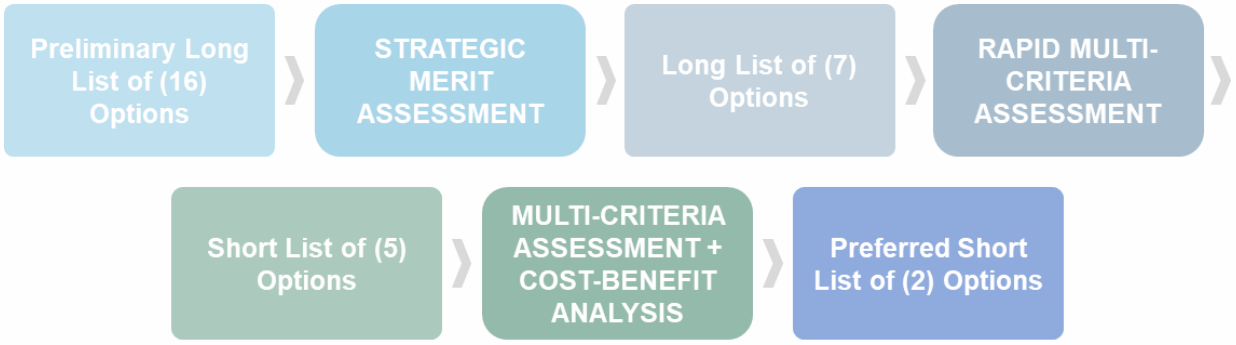



**Figure 9: Options development and assessment framework for options**

Each stage of assessment was underpinned by the development of value criteria grounded by evidence-based metrics. The value criteria defined generally aligned with the following (non-monetised) categories:

- strategic alignment
- economic
- socio-economic
- environment
- deliverability.

For more details about the decision-making process, refer to the *Strategic Business Case (IPP-AMJV-422-001-RP-OA-DO-0068)* issued separately to DIT.

The development of the preliminary long list, long list, short list and, finally, preferred options, were informed primarily by impact assessment, costing, design, and intersection performance. The short timeframes of the Planning Study necessitated a focus on the risks associated with land acquisition, services impacts, costing, and heritage to facilitate option selection.

### 4.1.1 Strategic Merit Assessment

The preliminary long list options were qualitative assessed using a Strategic Merit Assessment in order to identify the long list of options. Assessment criteria focused solely on both economic and strategic alignment value criteria to ensure the broader outcomes of the initiative would ultimately be met. Economic (non-monetised) scores were attributed to indicative capital costs based on a comparative 'order-of-magnitude' judgement. Each preliminary long list option was assessed against a 5-point cost/benefit scale.

### 4.1.2 Rapid Multi-criteria Assessment

The long list of options undertook a Rapid Multi-criteria Assessment which included an expanded list of non-monetised criteria compared to the Strategic Merit Test. Each long list option was assessed against a 5-point cost/benefit scale. Each long list option was then attributed indicative capital and operational costs based on a comparative order of magnitude judgement. Again, economic (non-monetised) scores were attributed to indicative capital and operational costs based on a comparative 'order-of-magnitude' judgement. From this, the short list of options was identified.

### 4.1.3 Multi-criteria Assessment and Benefit-Cost Analysis

The short list of options was assessed against the value criteria using the Multi-criteria Assessment, excluding any monetised metrics, with each short list option assessed against a 7-point cost/benefit scale. The monetised metrics were instead assessed using the Benefit-Cost Analysis. The outcomes of the (non-monetised) Multi-criteria Assessment and the (monetised) Benefit-Cost Analysis were then considered concurrently in order to recommend 2 preferred options.

## 4.2 Overview of options development

The intersection has been through 2 revisions of preliminary long list to short list.

The first preliminary long list of 8 options developed in 2020 was taken through a Strategic Merit Test to refine the list to 5 long list options. These 5 options were further developed and assessed through a Rapid Multi-criteria Assessment to obtain a short list. Since all of the short list options involved either grade separation or significant road widening, the intersection was re-examined to identify if any lower impact options could be identified to meet the criteria.

As such, a second preliminary long list was developed and included a range of options with reduced land impacts and means for bus priority. This new preliminary long list included 16 options, comprising the previous list plus 8 new options. The Strategic Merit Test was improved to include greater emphasis on the functional road hierarchy and road safety strategy and was used to refine the list to 7 long list options.

The identified long list options were further analysed prior to going through a Rapid Multi-criteria Assessment to identify a short list of options. The Rapid Multi-Criteria Assessment identified some common themes of issues with the options to date, including design for vulnerable road users and impacts on constraining sites with high heritage, environmental or community value. Design development of the short list options aimed to address these themes and further focus on traffic modelling performance and vehicle swept paths.

An overall summary of the options development and assessment throughout this second revision is presented in Figure 10.

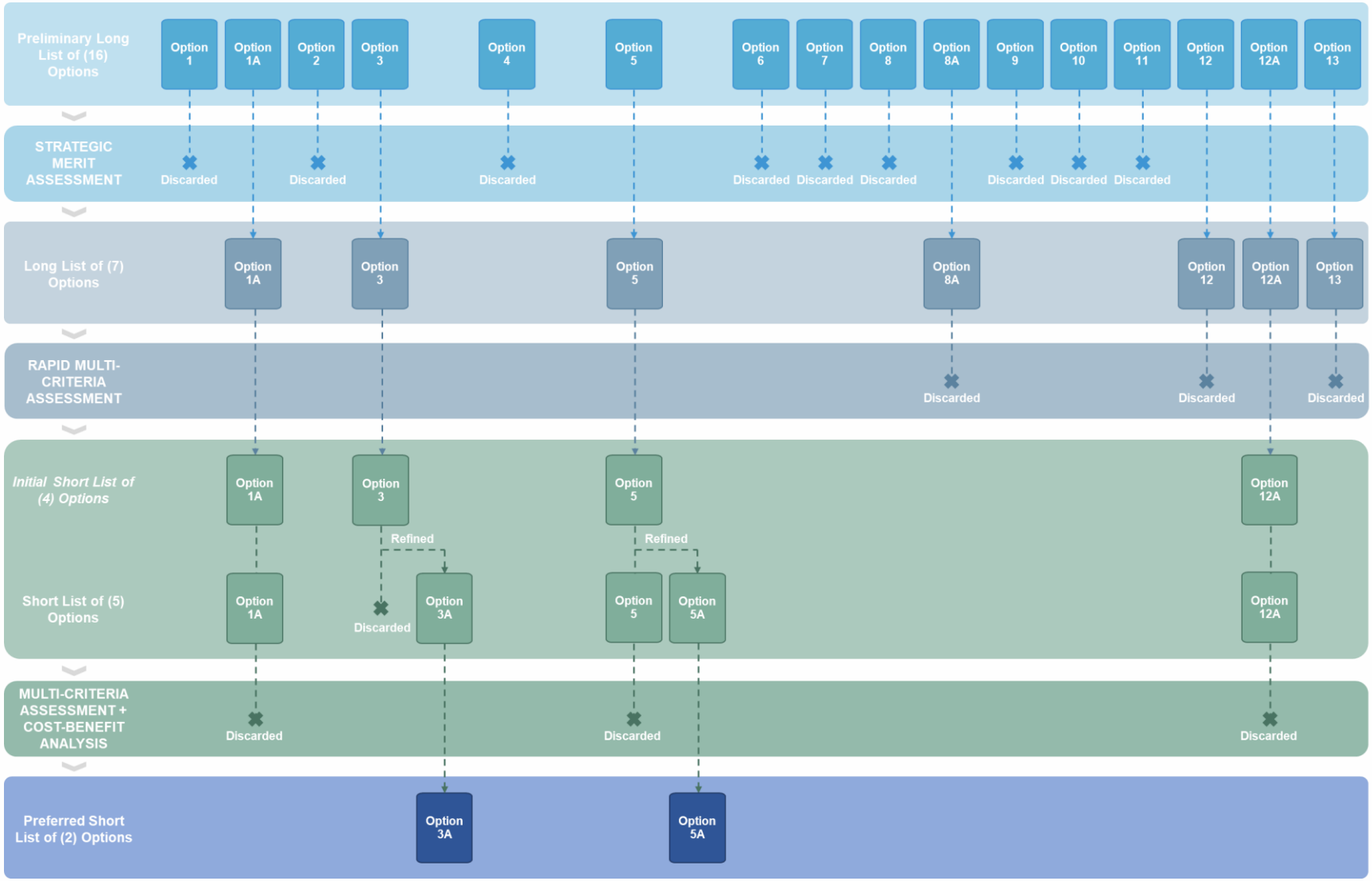



**Figure 10: Summary of options development and assessment process**

# 5 Assessment of preliminary long list options

## 5.1 Preliminary long list of options

Following the re-examination of an initial short list of options (see Section 4.1 for relevant discussion), a second preliminary long list of 16 options (see Table 4), including a range of low, medium and high impact infrastructure solutions, was developed.

**Table 4: Preliminary long list of options**

| Option no. | Option description |
|---|---|
| **Option 1** | 3T 1RT Cross + 3T 2RT Goodwood |
| **Option 1A** | 3T 1RT Cross + 3T 2RT Goodwood + bus lane Goodwood |
| **Option 2** | 3T 2RT Cross Road + 3T Goodwood (north) |
| **Option 3** | Grade Separation on Cross Road |
| **Option 4** | Grade Separation on Goodwood Road |
| **Option 5** | 3T + 2RT on Cross & Goodwood |
| **Option 6** | Indented bus bay on Goodwood (north) |
| **Option 7** | Contraflow on Goodwood Road |
| **Option 8** | Widening on Cross Road only |
| **Option 8A** | Widening on Cross + bus lane Goodwood |
| **Option 9** | Displaced RT Cross (east) to Goodwood (north) |
| **Option 10** | Displaced RT Goodwood (south) to Cross (east) |
| **Option 11** | 3T Cross + new T and ban RT from Goodwood |
| **Option 12** | 3T Cross + Goodwood 3T, 1RT (RT converted to T) |
| **Option 12A** | 3T Cross + Goodwood 2T, 1 Bus, 1 RT (RT converted to Bus) + bus phase |
| **Option 13** | 3T Cross and ban RT from Cross |
| **Key: T = Through** | **RT = Right Turn** |

## 5.2 Preliminary long list options considerations

The preliminary long list options were developed with a primary focus on traffic efficiency and reliability, as well as addressing identified road safety issues. The initial preliminary long list (8 options) was developed based on brainstorming ideas to achieve remove or signal-control right turn movements and improved traffic capacity, with the core aim to achieve future intersection operation with a Degree of Saturation (D0S) of 0.9 or lower. The initial timeframes gave little time for contextual appreciation of the intersection or a finer consideration of current issues and future goals. This generally resulted in a range of large-scale intersection expansions advantaging general vehicle use proceeding through to long list. A second tranche of preliminary long list options (adding Options 1A, 8A, 9, 10, 11, 12, 12A and 13) was developed to seek a reduced intersection footprint and with a somewhat improved consideration of current gaps and contextual setting.

## 5.3 Strategic merit assessment

The 16 preliminary long list options were assessed using a Strategic Merit Assessment. When compared to the first assessment, the second strategic merit assessment was expanded to better examine the options for a broader range of road users, considering the functional road hierarchy.

Refer to the *Strategic Business Case (IPP-AMJV-422-001-RP-OA-DO-0068)* issued separately to DIT for further details on the Strategic Merit Assessment.

Seven (7) options were selected to progress to the long list: 1A, 3, 5, 8A, 12, 12A, and 13. Options were eliminated where disbenefits outweighed benefits and where benefitting options were similar, the best performing one was selected.

Those that were eliminated since they were attributed no benefits and moderate disbenefits were Options 6, 9 and 10.

Option 7 was eliminated due to the significant adverse safety outcomes identified with a contra-flow arrangement. It also achieved the lowest score in the Strategic Merit Assessment.

Of the two (2) right turn ban options (Options 11 and 13), Option 11 was eliminated since it had the greatest land impacts.

Of the two grade separation options (Options 3 and 4), Option 4 was eliminated since it did not address freight and traffic movement on Cross Road and because of its negative impacts on businesses and on access (including bus stop access) along Goodwood Road.

Of the very large at-grade widening options (Options 1, 1A, 2 and 5), Option 5 was selected since it provided the greatest benefits in traffic performance and Option 1A was selected since it provided both benefits to traffic performance and bus priority measures along Goodwood Road. Options 1 and 2 were eliminated since they equally scored the lowest in this grouping.

Of the smaller at-grade intersection options (Options 8, 8A, 12 and 12A), Option 8 was eliminated, since it scored the lowest in terms of overall traffic performance and in terms of public transport provision and performance. Options 8A and 12A proceeded based on achieving some improvement to overall traffic performance whilst providing public transport priority measures on Goodwood Road. Option 12 performed the best in terms of traffic performance.

The recommended long list of 7 options is provided in Table 5.

**Table 5: Long list of options**

| No. | Option name | Description |
|---|---|---|
| **1A** | 3T 1 RT Cross + 2T 2RT Goodwood + bus lane Goodwood | 3 through lanes on Cross Road<br>Additional short through lane on Goodwood Road<br>Bus lanes on Goodwood Road (both approaches) |
| **3** | Grade Separation Cross | 2 through lanes and a bicycle lane on the Cross Road overpass<br>1 combined through and right turn lane, 1 right turn, and a bicycle lane at-grade on Cross Road<br>2 through lanes, 2 right turn lanes, 1 bus lane and bicycle lane on Goodwood Road |
| **5** | 3T + 2RT on Cross and Goodwood | 3 through lanes and 2 right turn lanes on Cross Road and Goodwood Road approaches |
| **8A** | Widening on Cross + bus lane Goodwood | 3 through lanes on Cross Road<br>Bus lanes on Goodwood Road (both approaches) |
| **12** | 3T Cross + Goodwood 3T, 1RT (RT converted to T) | 3 through lanes on Cross Road<br>One right turn lane converted into short through lane on Goodwood Road (both approaches) |
| **12A** | 3T Cross + Goodwood 2T, 1 Bus, 1 RT (RT converted to Bus) + bus phase | 3 through lanes on Cross Road<br>One right turn lane converted into short through lane on Goodwood Road (both approaches)<br>Bus phase on Goodwood Road (both approaches) |
| **13** | 3T Cross + Ban RT (EW) | 3 through lanes on Cross Road (right turn converted to through) |
| **Key:** | **T = Through** | **RT = Right Turn** **EW = East West** |

# 6 Assessment of long list options

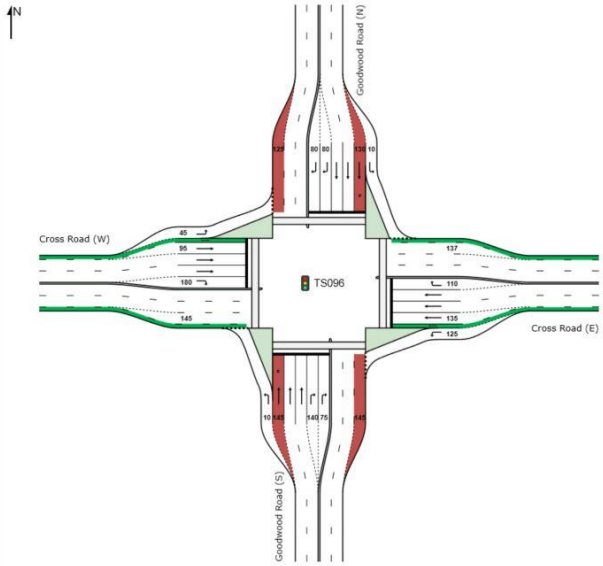
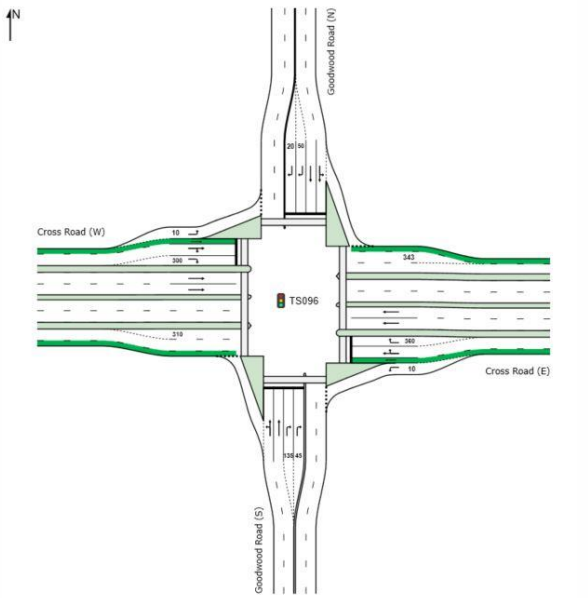
## 6.1 Development of long list options

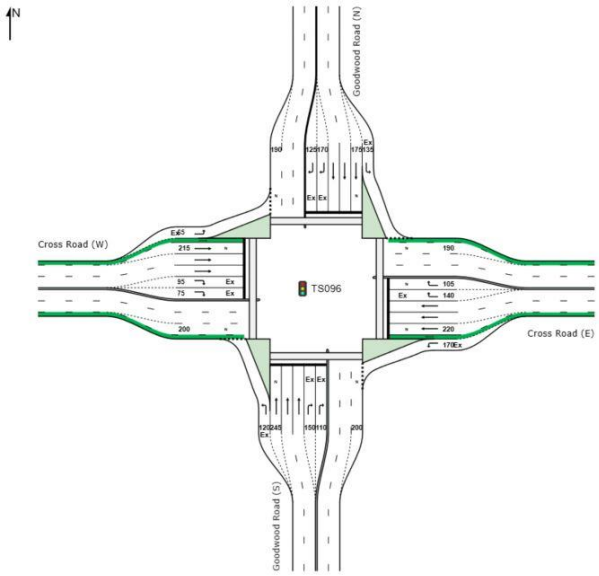
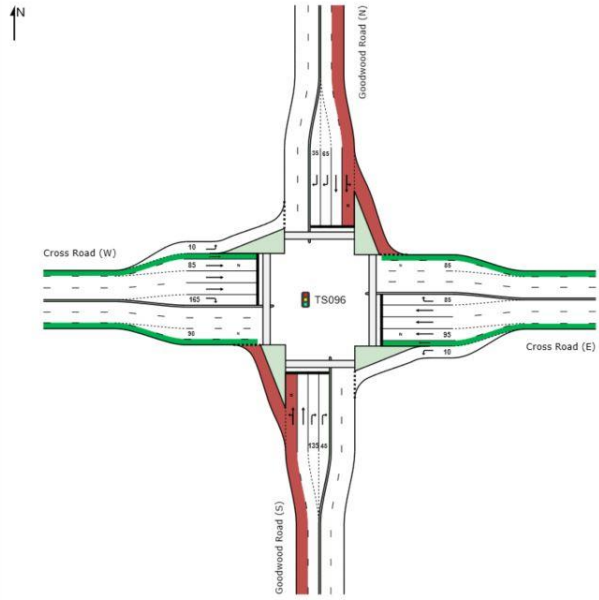
Due to the rapid progression from long list to short list within a restricted timeframe, the development of the long list options was limited. Minor updates to the long list options mostly comprised drafting corrections, including adjustments to the extent of road widening, and minor updates to traffic modelling in order to account for modifications such as changed lane arrangements and adjusted lane lengths.

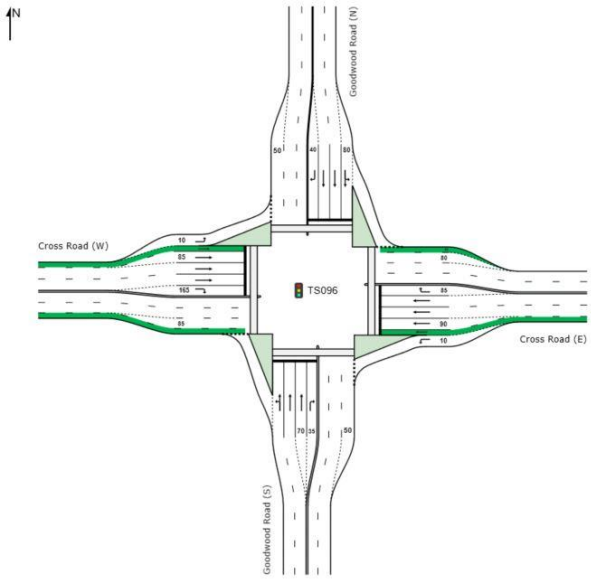
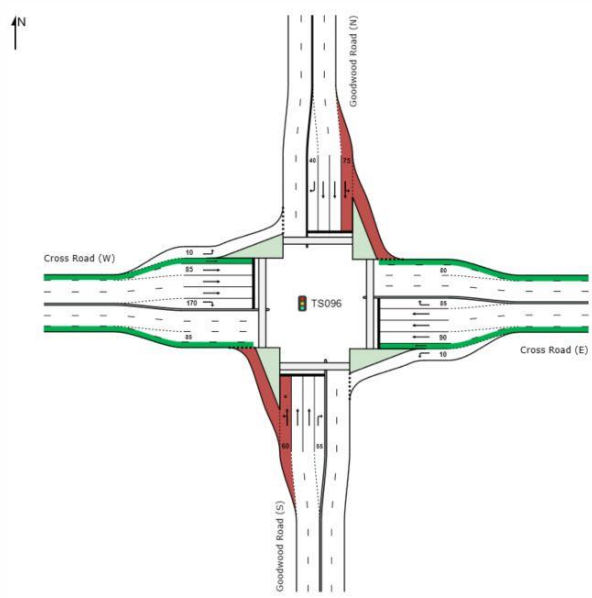
## 6.2 Long list options

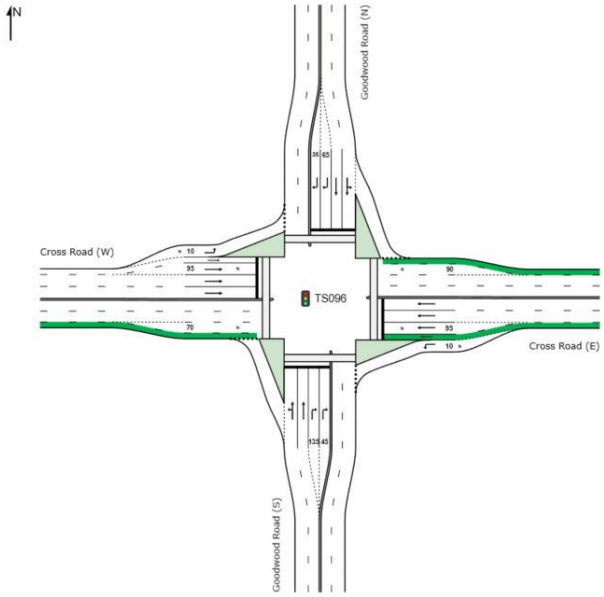
Indicative schematics are provided for each long list option in Table 6. For further details of each option layout, refer to Appendix E for the *Long List 5% Engineering Sketches*. For further details of the long list to short list considerations, refer to Appendix F for the *Long List Technical Notes*.

**Table 6: Long list option layouts**

| No. | Option name | Layout |
|---|---|---|
| **1A** | 3T 1 RT Cross + 2T 2RT Goodwood + bus lane Goodwood<br>• 3 through lanes on Cross Road<br>• Additional short through lane on Goodwood Road<br>• Bus lanes on Goodwood Road (both approaches) |  |
| **3** | Grade Separation Cross<br>• 2 through lanes and a bicycle lane on the Cross Road overpass<br>• 1 combined through and right turn lane, 1 right turn, and a bicycle lane at-grade on Cross Road<br>• 2 through lanes, 2 right turn lanes, 1 bus lane and bicycle lane on Goodwood Road |  |
| **Key:** | **T = Through** | **RT = Right Turn** **EW = East West** |

| No. | Option name | Layout |
|---|---|---|
| **5** | 3T + 2RT on Cross and Goodwood<br>• 3 through lanes and 2 right turn lanes on Cross Road and Goodwood Road approaches |  |
| **8A** | Widening on Cross + bus lane Goodwood<br>• 3 through lanes on Cross Road<br>• Bus lanes on Goodwood Road (both approaches) |  |
| **Key:** | **T = Through** | **RT = Right Turn** **EW = East West** |

| No. | Option name | Layout |
|---|---|---|
| **12** | 3T Cross + Goodwood 3T, 1RT (RT converted to T)<br>• 3 through lanes on Cross Road<br>• One right turn lane converted into short through lane on Goodwood Road (both approaches) |  |
| **12A** | 3T Cross + Goodwood 2T, 1 Bus, 1 RT (RT converted to Bus) + bus phase<br>• 3 through lanes on Cross Road<br>• One right turn lane converted into short through lane on Goodwood Road (both approaches)<br>• Bus phase on Goodwood Road (both approaches) |  |
| **Key:** | **T = Through** | **RT = Right Turn** **EW = East West** |

| No. | Option name | Layout |
|---|---|---|
| **13** | 3T Cross + Ban RT (EW)<br>• 3 through lanes on Cross Road (right turn converted to through) |  |
| **Key:** | **T = Through** | **RT = Right Turn** **EW = East West** |

## 6.3 Long list options considerations

### 6.3.1 Traffic modelling

Option 1A was anticipated to provide short-term benefits to capacity and delays at the intersection but did not fully cater for the future 2036 demands. The intersection was expected to be oversaturated in 2036.

Option 3A was expected to significantly improve traffic efficiency of the intersection but did not cater for future 2036 demands. The intersection performs with a DoS of 0.87 with the current 2019 base model traffic demand, thereby increasing average speeds for passenger and commercial vehicles during peak periods. In 2036, while the intersection cannot fully cater for the demands, the operations are predicted to improve significantly.

Option 5 was expected to significantly improve intersection performance with both current and future demands. It was expected to operate with a DoS of 0.63–0.70 with current traffic demands and a DoS of 0.85–0.89 with future traffic demands.

Option 8A was anticipated to perform significantly worse than the future base case, and therefore failed to improve traffic efficiency at the intersection.

Option 12 and Option 12A were expected to perform similarly to the future base case. It was identified that there may be an opportunity to extend the short through lanes to three continuous through lanes and enhance the intersection capacity and efficiency, therefore reducing the DoS.

Option 13 was expected to improve intersection performance but did not cater for future 2036 traffic demands.

Furthermore, it was identified that there may be opportunity to increase road safety at the intersection for all long list options by removing the filtered right turn movement from Cross Road onto Goodwood Road, thereby reducing the risk of right turn collisions.

It is noted that traffic modelling results were indicative only at this stage and were subject to further refinement during the next stage of the design development.

### 6.3.2 Cost estimates

Formal cost estimates were sought for the initial long list of options. However, upon review, these cost estimates were scaled up based on engineering judgement to match the costs experienced in practice relative to the scale of each option. The new and previous options were thus attributed indicative capital and operational costs based on a comparative order-of-magnitude judgement.

## 6.4 Rapid Multi-criteria Assessment

The long list options were assessed using a Rapid Multi-criteria Assessment. For further details of the rapid Multi-criteria Assessment and the long list to short list process, refer to the *Strategic Business Case (IPP-AMJV-422-001-RP-OA-DO-0068)* issued separately to DIT.

Four (4) options were selected to progress to short list:

- **Option 1A** and **Option 3** were considered viable solutions to be taken forward based on their potential to provide significant transport efficiency gains. Option 1A provided considerable gains for moderate cost. The considerable transport efficiency gains in Option 3 are offset by high socio-economic, environmental and delivery disbenefits (local movement and accessibility, urban design and visual impacts and project complexity).
- **Option 5** was identified to provide greater economic growth and commercial transport and road user benefits. However, this was offset by commercial land acquisition and land use requirements.
- **Option 12A** provided the best balance between cost of investment, addressing the broader objectives and benefits (value for money).

Variations of these 4 options were further considered as part of the design development process. Refer to Section 6.5 in this document for more information on the final short list of options assessed in this report.

The following options did not progress to the short list:

- Option 8A provided a high benefit to public transport users through added bus lanes. However, the inclusion of a bus lane compromised the commercial transport and road user benefits.
- Option 12 aligned closely with Option 1A given the similarities in functionality. The conversion of one right turn lane into a short through lane reduced the extent of land acquisition required but had a corresponding reduction in user benefit.
- Option 13 was identified as having a broad range of low socio-economic and environmental disbenefits with few benefits.

## 6.5 Refinement of short list options

Comments throughout the rapid Multi-criteria Assessment process reflected that more should be considered for large intersection options to include bus priority measures, to avoid constraining sites with high heritage, environmental or community value, and include improvements to walking and cycling facilities. As such, variations of options were considered with bus jumpstart and bus lanes through the intersection.

Traffic modelling was undertaken alongside design to help determine the relative merit of the variations presented. A Design Basis Report was drafted to provide greater consistency and comparability of options.

Verge and footpath widths were considered with a 3 m verge width allowance wherever road widening was considered. This addressed locations around the intersection where footpath widths are narrow, have accessibility limitations and allow for a consistent approach to kerbside space. Splitter island widths were checked for accessibility and 2 m median islands were included on wide intersection approaches to permit the installation of centre-road signal poles. Median islands were also considered where they would improve safety, including pedestrians choosing to cross mid-block.

**Option 1A** already included bus priority measures. Design refinements included:

- improving accessibility of through traffic for bus lanes
- improving alignment to avoid key site constraints
- including bicycle lane widening and line marked separation on Cross Road
- introducing bicycle lanes on Goodwood Road.

**Option 3** was amended to **Option 3A** which included a bus jump start. This was based on the at-grade intersection efficiency and span considerations.

Bicycle lanes were widened on Cross Road and added to Goodwood Road. Long section design was undertaken to provide a more accurate assessment of impact and cost. The pedestrian crossing for Cabra College was found to conflict with the merge/diverge area and required relocation. An alternative desire line was identified along Eaton Street with the main pick-up/drop-off zone for Cabra College and an alternative entry point.

Bus stops would need to be relocated to support the new crossing location and a pedestrian link through to Dixon Street would be possible within the otherwise required land acquisitions. A pedestrian crossing in this location would also support the shopping centre.

Whilst efforts to avoid identified site constraints were made, construction and road design requirements required that, either the Cabra Dominican College and its state heritage listed gatehouse, or the Auscare at Unley Retirement Community, would be physically impacted. The choice was made to prioritise the heritage listed gatehouse based on its significant heritage value.

**Option 5** was retained based on high traffic performance that addressed current bus delays. However, variations of this option were also considered with bus priority, which, with allocated space, addresses the risk of bus gains being eroded away by additional traffic being attracted to/induced by the large capacity improvements. Bus jumpstart and bus lane options were tested, but the bus lane option provided superior performance for bus operations and formed the basis of Option 5A.

**Options 5 and 5A** were also refined to improve alignment (avoiding key site constraints), including bicycle lane widening and line marked separation on Cross Road, and introducing bicycle lanes on Goodwood Road.

**Option 12A** already included bus priority measures. Design refinements included improving accessibility of through traffic for bus lanes, improving alignment to avoid key site constraints, including bicycle lane widening and line marked separation on Cross Road, and introducing bicycle lanes on Goodwood Road.

A summary of the final 5 recommended short list options is provided in Table 7.

**Table 7: Refined short list of 5 intersection options**

| No. | Option name | Description |
|---|---|---|
| **1A** | 3T 1 RT Cross + 2T 2RT Goodwood + bus lane Goodwood | 3 through lanes on Cross Road<br>Additional short through lane on Goodwood Road<br>Bus lanes on Goodwood Road (both approaches) |
| **3A** | Cross Road Grade Separation | 2 through lanes and a bicycle lane on the Cross Road overpass<br>1 through, 2 right turn, bicycle lane and a U-turn facility at grade on Cross Road<br>2 through lanes, 2 right turn lanes, 1 bus lane and bicycle lane on Goodwood Road |
| **5** | 3T + 2RT on Cross and Goodwood | 3 through lanes and 2 right turn lanes on Cross Road and Goodwood Road approaches |
| **5A** | 3T, 2RT Cross + Goodwood 2T, 1 Bus, 2RT | 3 through lanes and 2 right turn lanes on Cross Road<br>2 through lanes, 1 bus lane and 2 right turn lanes on Goodwood Road |
| **12A** | 3T Cross + Goodwood 2T, 1 Bus, 1 RT (RT converted to Bus) + bus phase | 3 through lanes on Cross Road<br>One right turn lane converted into short through lane on Goodwood Road (both approaches)<br>Bus phase on Goodwood Road (both approaches) |
| **Key:** | **T = Through** | **RT = Right Turn** |

# 7 Assessment of short list options

## 7.1 Design development of short list options

### 7.1.1 Design basis

For further details of the short list option design basis, refer to the *Design Report* in Appendix G.

### 7.1.2 Grade separation considerations

If a grade separation option (Option 3A) is considered beyond the short list stage, a detailed assessment of an over-road versus an under-road grade separation will be required. This would be informed by ground investigations of the site, in particular the impacts of Brown Hill Creek (located to the west of the intersection).

In the meantime, a high-level, preliminary investigation of the viability of grade separation was undertaken for the Goodwood Road and Cross Road intersection, as well as for the Unley Road, Cross Road and Belair Road intersection. To the east of the Goodwood Road and Cross Road intersection, the rail level crossing for the Belair line has been identified for possible future grade separation upgrades. Given the relative proximity of these 3 intersections, the possibility of treating each of these three grade separations as individual structures was investigated to ensure they do not create a noncompliant geometry.

A 40 m distance can be maintained between the critical point of an overpass over Goodwood Road and a rail overpass (see Table 8 and Figure 11). Similarly, a 500 m distance can be maintained between the critical point of a rail overpass and an overpass over Unley/Belair Road. Therefore, based on the above assumptions, it is possible for each of these 3 intersection overpasses to be designed individually to the relevant design standards and requirements, without compromising potential adjacent structures.

Notwithstanding, designing and implementing individual grade separations will result in an undulating arrangement and it would be advisable to decide on a corridor approach to improve the vertical geometry, safety, driver experience and interfaces for side roads and vulnerable road users.

**Table 8: Assumptions for grade separation structures**

| Overpass interaction | Distance between existing intersection | Distance between adjacent overpasses | Does overpass intersection affect compliance? |
|---|---|---|---|
| Goodwood Road to rail level crossing | 600 m | 40 m | No |
| Unley Road to rail level crossing | 1,000 m | 500 m | No |

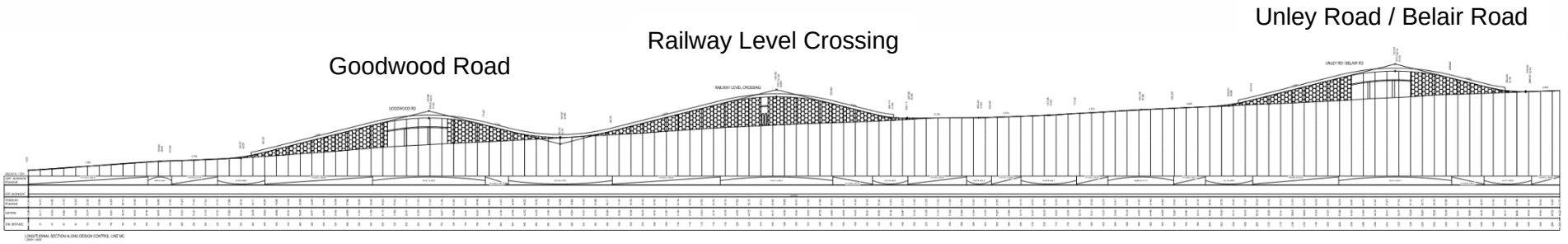



**Figure 11: Longitudinal section of three consecutive grade separation structures**

## 7.2 Short list option descriptions

Indicative layouts are provided for each option in the subsequent sections. The 10% Engineering Sketches, which provide further details of each option's layout, can be found as an appendix to the *Short List Technical Note* (refer Appendix H).

### 7.2.1 Option 1A

Option 1A, as shown in Figure 12, includes the following changes to the existing intersection:

- 3 through lanes on both Cross Road approaches
- added bus lanes on Goodwood Road (north, south) approaches
- extended high entry left turn lanes on Cross Road (west, east) approaches
- road reserve areas of 3 m width where widening is proposed
- added bicycle lanes on Goodwood Road (north, south) approaches and exits
- bicycle lane widening and line marked separation on Cross Road (west, east) approaches and exits.

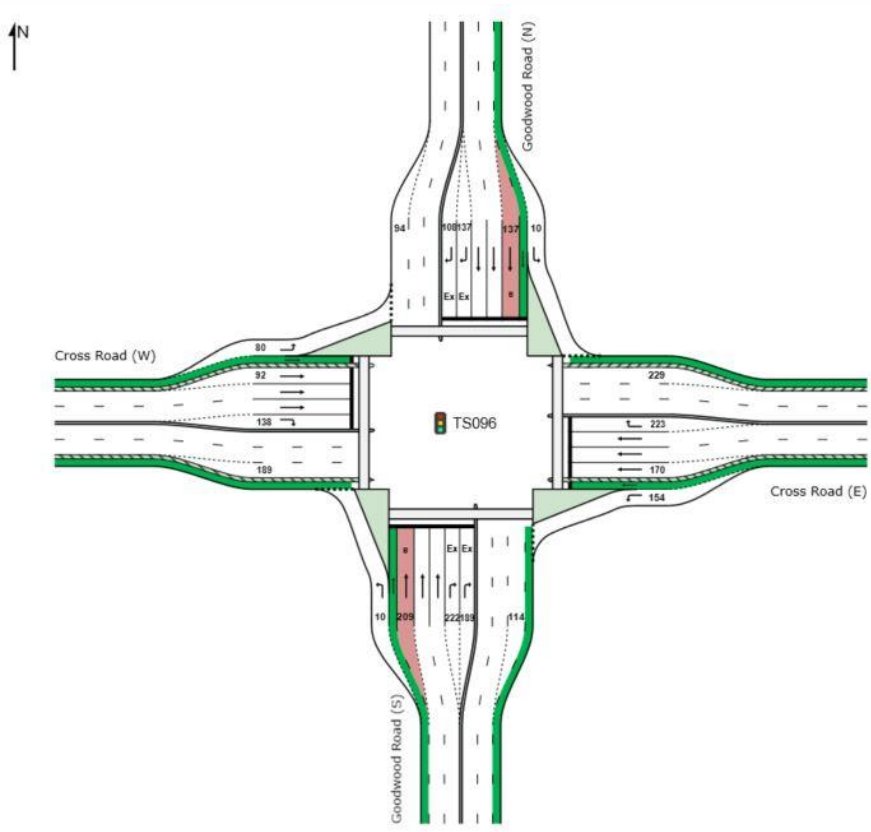



**Figure 12: Short List Option 1A**

### 7.2.2 Option 3A

Option 3A, as shown in Figure 13, includes the following changes to the existing intersection:

- grade separation of Cross Road (dual lane, both directions, with bicycle lanes) over Goodwood Road between Churchill Avenue and Seymour Avenue (widening to north)
- added bus jump start lanes on Goodwood Road (north, south) approaches
- extended high entry left turn lanes on all intersection approaches
- at-grade U-turn movements on Cross Road
- road reserve areas of 3 m width where widening is proposed
- bicycle lanes widened on Cross Road with line marked separation on overpass
- bicycle lanes on Goodwood Road (north, south) approaches and exits.

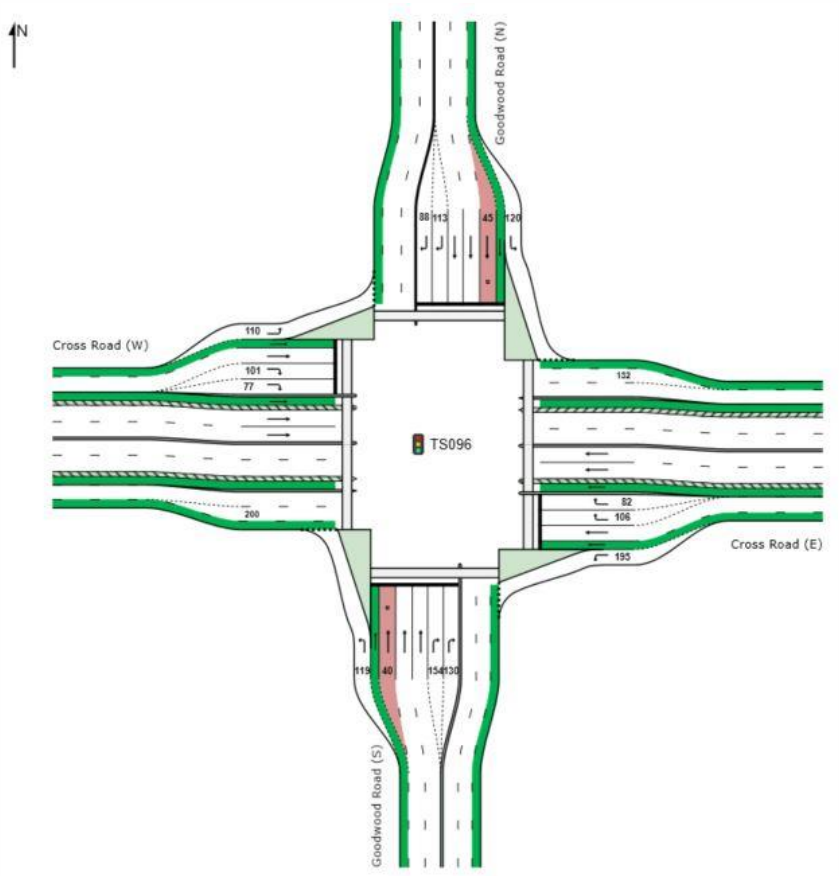



**Figure 13: Short List Option 3A**

### 7.2.3 Option 5

Option 5, as shown in Figure 14, includes the following changes to the existing intersection:

- 3 through lanes on both Cross Road approaches
- 2 right turn lanes from Cross Road (west, east)
- high entry left turn auxiliary lanes on Cross Road (west, east) approaches
- road reserve areas of 3 m width where widening is proposed
- added bicycle lanes on Goodwood Road (north, south) approaches and exits
- bicycle lane widening and line marked separation on Cross Road (west, east) approaches and exits.

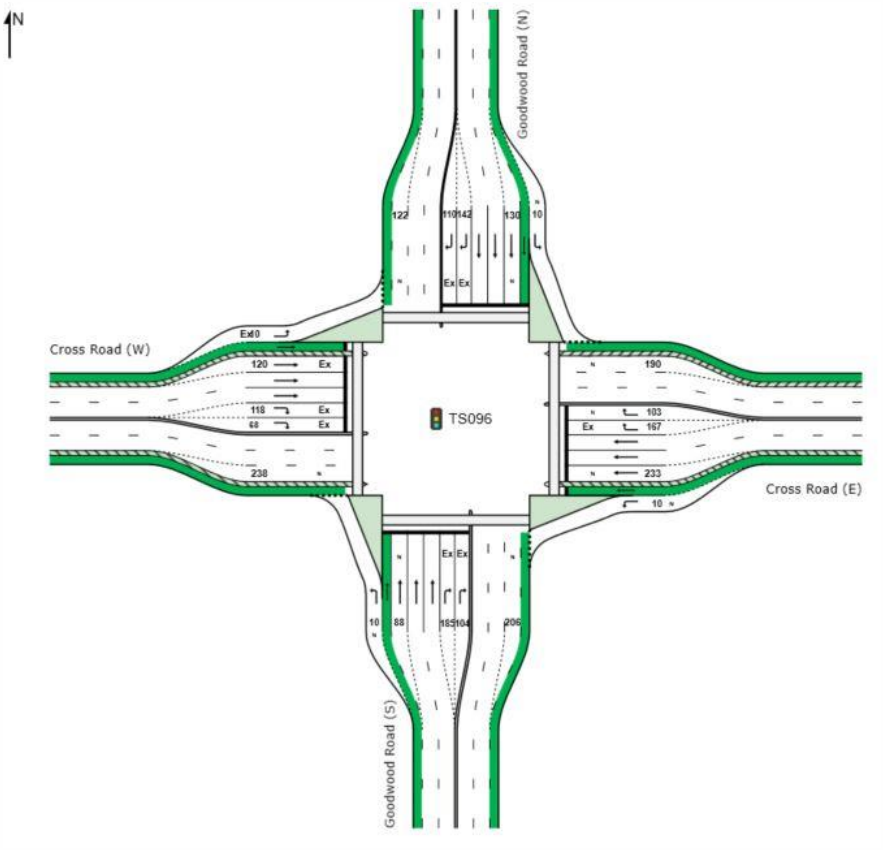



**Figure 14: Short List Option 5**

### 7.2.4 Option 5A

Option 5A, as shown in Figure 15, includes the following changes to the existing intersection:

- 3 through lanes on both Cross Road approaches
- 2 right turn lanes from Cross Road (west, east)
- high entry left turn auxiliary lanes on Cross Road (west, east) approaches
- added short dedicated bus lanes on Goodwood Road (north, south) approaches
- road reserve areas of 3 m width where widening is proposed
- added bicycle lanes on Goodwood Road (north, south) approaches and exits
- bicycle lane widening and line marked separation on Cross Road (west, east) approaches and exits.

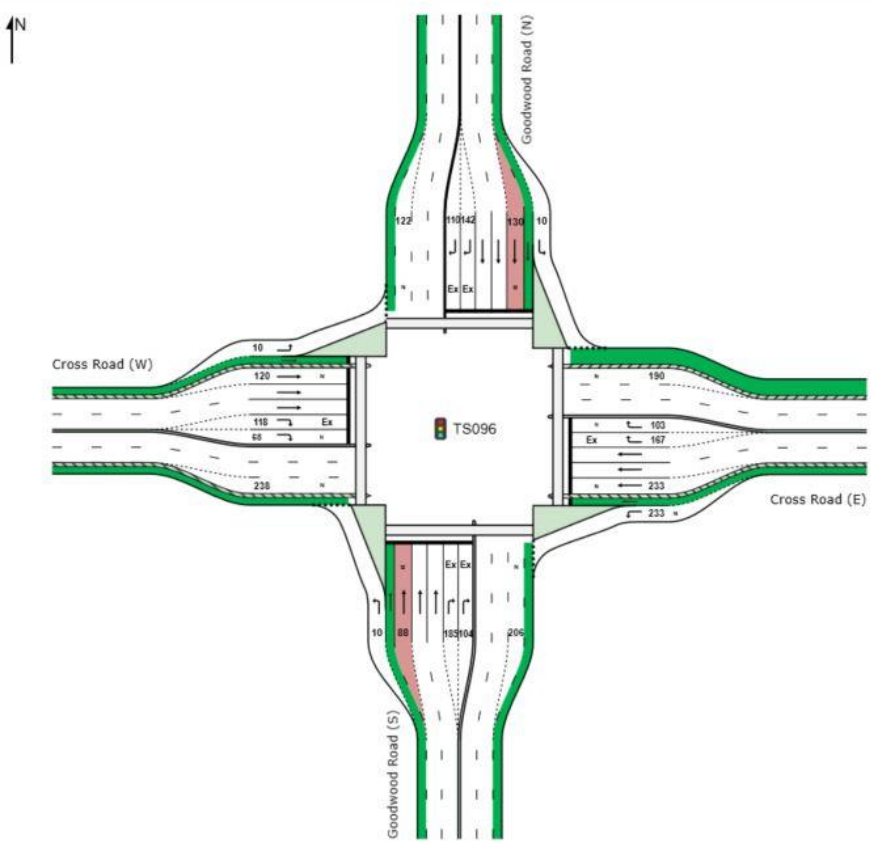



**Figure 15: Short List Option 5A**

### 7.2.5 Option 12A

Option 12A, as shown in Figure 16, includes the following changes to the existing intersection:

- 3 through lanes on both Cross Road approaches
- high entry left turn auxiliary lanes on Cross Road (west, east) approaches
- added bus jump start lanes with bus phase (B light) on Goodwood Road (north, south) approaches
- road reserve areas of 3 m width where widening is proposed
- added bicycle lanes on Goodwood Road (north, south) approaches and exits
- bicycle lane widening and line marked separation on Cross Road (west, east) approaches and exits.

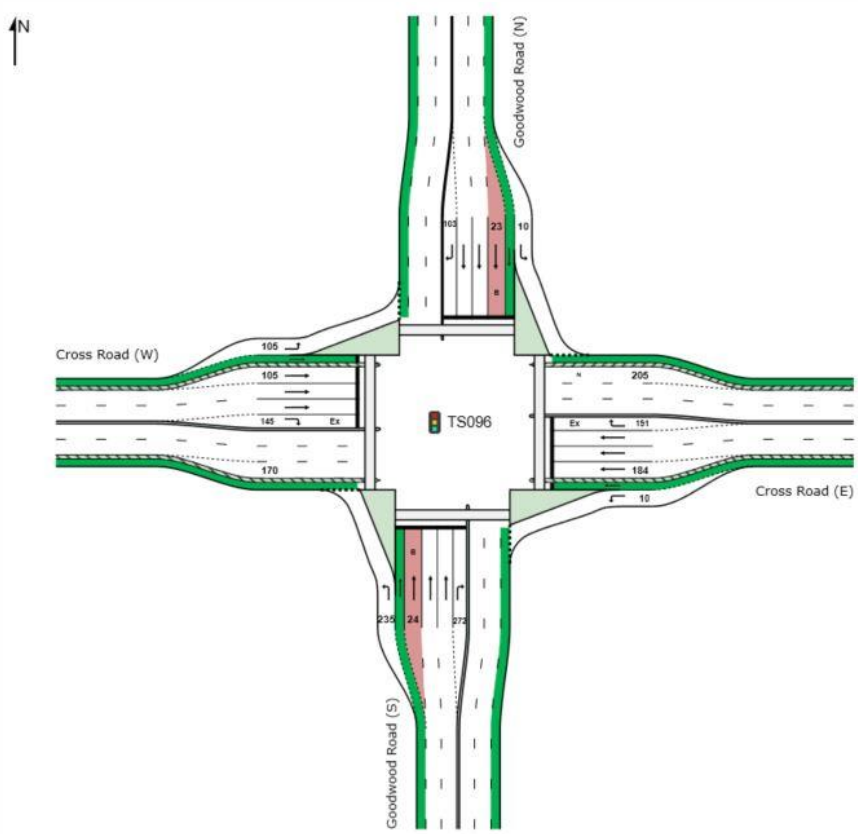



**Figure 16: Short List Option 12A**

## 7.3 Short list options considerations

This section provides a summary of each key impact and individual discipline considerations for the 5 short list options.

Refer to the *Short List Technical Note* in Appendix H for more detailed discussions with reference to each short list option consideration.

### 7.3.1 Land acquisition

Each option has been assessed to determine the extent of residential land or dwellings and commercial land or buildings/tenancies impacted with reference to each respective 10% Engineering Sketch. The extent of impacts for each of the 5 short list options can be found in Table 9.

**Table 9: Extent of residential and commercial land acquisition impacts for short list options**

| Option | Residential Impacts | Commercial Impacts |
|---|---|---|
| **Option 1A** | 7 parcels requiring whole acquisition<br>9 parcels requiring partial acquisition | 19 businesses impacted over 31 parcels, including:<br>• 12 which will no longer be viable<br>• 7 with car parking impacts only |
| **Option 3A** | 49 parcels requiring whole acquisition<br>19 parcels requiring partial acquisition | 24 businesses impacted over 35 parcels, including:<br>• 18 which will no longer be viable<br>• 6 with car parking impacts only |
| **Option 5** | 7 parcels requiring whole acquisition<br>13 parcels requiring partial acquisition | 17 businesses impacted over 27 parcels, including:<br>• 11 which will no longer be viable<br>• 6 with car parking impacts only |
| **Option 5A** | 7 parcels requiring whole acquisition<br>13 parcels requiring partial acquisition | 17 businesses impacted over 27 parcels, including:<br>• 11 which will no longer be viable<br>• 6 with car parking impacts only |
| **Option 12A** | 5 parcels requiring whole acquisition<br>8 parcels requiring partial acquisition | 20 businesses impacted over 28 parcels, including:<br>• 16 which will no longer be viable<br>• 4 with car parking impacts only |

### 7.3.2 Traffic performance

The short list options aimed to address the problem statements and improve intersection performance compared to the future base case. The overall safety and modelled performance of these options is summarised in the subsequent sections.

**Safety**

For all options, the fully controlled right turn lanes (either dual or single) from Cross Road remove the safety risk which the existing filter right turns pose.

**Performance**

The modelled performance for these options in the interim (2026) and horizon (2036) forecast year is shown in Table 10 and Table 11 respectively.

The 2026 results suggest that Option 3A and Option 5 can perform with an overall DoS ≤ 0.9 up to 2026.

Option 3A and Option 5 can also perform with the shortest average AM and PM peak period delays in the interim and horizon forecast years of all short list options.

Overall, Option 3A can operate with the shortest average delays.

**Table 10: Model intersection performance summary (2026)**

| Scenario Modelling | AM Peak Hour | | | | PM Peak Hour | | | |
|---|---|---|---|---|---|---|---|---|
| **Design Options** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** |
| **Current performance** | 1.03 | 85.9 | F | 573 | 1.08 | 95 | F | 588 |
| **Future Base Case (2026)** | 1.14 | 137 | F | 778 | 1.17 | 152 | F | 706 |
| **Option 1A** | 0.92 | 54 | D | 364 | 0.97 | 65 | E | 387 |
| **Option 3A** | 0.90 | 30 | C | 355 | 0.86 | 28 | C | 294 |
| **Option 5** | 0.85 | 46 | D | 243 | 0.80 | 46 | D | 207 |
| **Option 5A** | 0.94 | 56 | E | 393 | 0.96 | 60 | E | 378 |
| **Option 12A** | 1.06 | 84 | F | 506 | 1.23 | 151 | F | 670 |

**Table 11: Model intersection performance summary (2036)**

| Scenario Modelling | AM Peak Hour | | | | PM Peak Hour | | | |
|---|---|---|---|---|---|---|---|---|
| **Design Options** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** |
| **Current performance** | 1.03 | 86 | F | 573 | 1.08 | 95 | F | 588 |
| **Future Base Case (2036)** | 1.33 | 255 | F | 1123 | 1.40 | 287 | F | 1092 |
| **Option 1A** | 1.11 | 110 | F | 692 | 1.16 | 149 | F | 711 |
| **Option 3A** | 0.98 | 37 | D | 470 | 1.00 | 35 | D | 435 |
| **Option 5** | 1.00 | 69 | E | 413 | 0.96 | 69 | E | 407 |
| **Option 5A** | 1.09 | 101 | F | 676 | 1.12 | 128 | F | 671 |
| **Option 12A** | 1.21 | 172 | F | 838 | 1.39 | 286 | F | 1043 |

### 7.3.3 Active and intermodal public transport

**Active transport**

The at-grade short list designs (1A, 5, 5A and 12) included a 1.5–1.8 metre bicycle lane and a 0.8–1.0 metre buffer zone. Where road widening was required in all options, a 3 m verge width and widened left turn slip lane islands to generally improve footpath capacity and wheelchair manoeuvrability and provide greater consistency in the pedestrian environment. Long crossing distances were created for pedestrians where additional vehicle lanes were added. Option 1A created long conflict zones where the bicycle lane continued between the left turn and through lanes on Cross Road and represented a likely source of side swipe collisions. Option 5, Option 5A, and Option 12 offer similar outcomes to Option 1A, but with improved safety for cyclists since the bicycle lanes are not wedged between through and left lanes. Option 12A also included reduced crossing distances at the intersection and mid-block on Goodwood Road when compared to the other short list options.

Option 3A included widened and continuous bicycle lanes at-grade and bicycle lanes with a buffer separation on the overpass on Cross Road. It also included 3-metre verges on all approaches. Several conflict zones were created for cyclists in the long merge and diverge zones, and on long interfaces where the bicycle lanes were positioned between through and left turn lanes. The size of at-grade intersection created a risk of cyclists getting caught in the intersection when the next traffic phase commenced. Likewise, very long crossing distances were created for pedestrians, though the option provided improvements to wayfinding for people with a vision impairment traversing Cross Road. The overpass, merge and diverge zones presented a significant barrier to cyclists and pedestrians seeking to traverse Cross Road, and whilst the Rugby Street bicycle and pedestrian crossing was maintained, an existing pedestrian median refuge was removed by the option.

The removal of uncontrolled right turn movements at the intersection and into side roads improved safety for pedestrians and cyclists in each of the short list options.

**Intermodal public transport**

Due to Goodwood Road being a High Frequency Corridor for public transport, most of the options include some form of bus priority, i.e. dedicated bus lane or bus queue jump, to improve public transport trip times and reliability.

Option 5 provides no bus priority. The improved performance of the intersection leads to improved public transport trip times and reliability, with general traffic able to progress through the intersection within approximately 3 signal cycles.

Option 1A and Option 5A provide dedicated bus lanes on Goodwood Road. This is predicted to save one signal cycle for buses compared to general traffic for Option 1A but does not provide any significant improvement for buses in Option 5A.

Option 3A and 12A provide a bus queue jump on Goodwood Road. This is expected to save one signal cycle and one to 2 signal cycles for buses compared to traffic for Option 3A and Option 12A respectively.

For all options except Option 3A, connectivity between buses along the Cross Road Corridor and Goodwood Road is generally expected to be retained. No significant changes to bus stop locations are expected. The increased intersection footprint and grade separation in Option 3A will result in longer crossing delays and distances for public transport customers to walk to, from, and between bus stops, which will limit accessibility for some public transport customers. Some bus stop relocations would be required where the current location becomes no longer viable and to minimise impacts on transfer movements.

### 7.3.4 Engineering

**Civil and roads**

The existing pavement conditions have been assessed for the intersection, and the approach roads leading into the intersection as per the latest Google Maps imagery.

Pavement condition within the intersection and on each of the intersection approaches appears to be poor, with minor potholing, moderate transverse and longitudinal cracking, and general patching evident in several areas. It does not appear that crack sealing has been used to assist in maintaining the pavement within the intersection. Several utility service top stones and lids have been cut patched with new asphalt, creating uneven pavement surfaces throughout the intersection. There is also minor rutting at the hold lines on all 4 approaches.

As part of the project, the existing pavement will require redesign in accordance with current Master Specifications and increased traffic volumes. This may take the form of a Plane and Reinstate treatment pending the outcomes of a rehabilitation design and changes to traffic assumptions. Areas of road widening will require new pavement designs. The over-road Cross Road grade separation proposed in Option 3A will require more extensive pavement treatment due to the wider extents of the upgrades.

Appropriate ground remediation works are likely to be required for all 5 short list options to address the removal of large underground fuel tanks (likely to be present at the OTR Clarence Park site).

### Utilities

Option 3A is anticipated to have more extensive impacts on existing utilities due to the construction of the grade separated overpass compared to the 4 at-grade short list options. However, all options are likely to impact major utility services, including:

- SAPN overhead cables, Stobie poles and transformers (including on private property)
- high pressure gas mains (70–350 kPa)
- DNC650 potable water main (60+ years old)
- various communications services.

It is noted that SAPN typically have long lead times associated with any 66 kV High Voltage works, including preliminary advice and guidance.

### Drainage and hydrology

All 5 short list options are anticipated to impact on several side entry pits and drains existing within the intersection and intersection legs.

Drainage at the intersection will be impacted more significantly by the Option 3A over-road Cross Road grade separation than the at-grade upgrades proposed in the 4 at-grade short list options.

A complete redesign of the drainage will be required for Option 3A due to the extent of excavation required at the intersection.

### Structures

All 5 short list options are likely to impact upon the following:

- existing gantries for road direction signs
- three (3) existing speed cameras on the north-western, south-western and south-eastern corners of the intersection (if impacted, the camera's viability will need to be assessed against the new road alignments)
- existing lighting poles
- existing roadside bus stops.

The grade separation proposed in Option 3A is anticipated to have more significant impacts on the abovementioned structures than the at-grade upgrades proposed in the 4 at-grade short list options.

Option 3A will also require the significant construction of structural elements to elevate the road corridor for approximately 550 m on Cross Road. No concept bridge design has been undertaken to date for Option 3.

### 7.3.5 Constructability

A high-level constructability review has been completed for each of the short list options.

Generally, the at-grade options (1A, 5, 5A and 12A) will have moderate impact on traffic flows during construction. Lane, turn and speed restrictions will be necessary at various stages of the construction as there will be limited space within the construction zone. Most of the lane and turn restrictions should be contained to off-peak periods and major traffic switches could be contained to night works. Service relocation, road widening works and pavement construction can all be managed on day and night shift behind temporary concrete barriers with staged weekend works and minimal road closures.

The grade separation option (3A) will result in numerous stages of construction to maintain the strategic through movements on Cross Road and Goodwood Road. Similar upgrade projects have resulted in most of the underpass alignment being constructed offline within the acquired land boundary. The construction of the bridge deck above the underpass (likely to be built in 2 halves) will cause the greatest impact and it will be likely that right turns will need to be banned.

### 7.3.6 Sustainability and environmental impacts

**Sustainability**

The anticipated sustainability impacts of the short list options are as follows:

- Option 3A will contribute significant GHG emissions in comparison to the other options, requiring:
  - significant materials, particularly concrete and steel, and energy usage to construct the bridge structure
  - substantial vegetation clearance
  - operational lighting will be required to illuminate the under-croft area
  - large volumes of demolition waste.
- Options 1A, 5, 5A and 12A will involve a considerably reduced construction effort compared to Option 3A, requiring:
  - materials and energy usage to construct including pavements and sub-base
  - vegetation clearance
  - demolition waste.

**Flora and fauna**

The *EBS Ecology Report* helped inform the following flora and fauna findings for the site.

Mature large London plane trees are the dominant flora (vegetation) along both sides of Cross Road between Fullarton and South Roads. Whilst offering limited habitat value, the trees have high amenity and shade (canopy cover) value. There are also a high number of large eucalypts (including regulated and significant tree size) offering habitat value, and large non-native amenity trees within private residences/businesses along both Cross and Goodwood Roads.

Due to the extent of the grade separation works, Option 3A is anticipated to have more significant flora and fauna impacts than Options 1A, 5, 5A and 12A.

**Noise and air quality**

Noise exposure and air quality impacts are anticipated to be similar for Options 1A, 5, 5A and 12A. Compared to the other options, Option 3A poses the potential for increased adverse impacts to local air quality due to the overpass bridge.

DIT's Road Traffic Noise Guidelines (RTNG) will apply to all options given the proposal moves traffic closer to the sensitive receivers by at least one lane width and the demolition of buildings or structures as part of the proposal potentially increases road traffic noise exposure at the sensitive receivers located behind. The RTNG is also triggered for Option 3A because the proposal produces noise at sensitive receivers from a different direction (i.e. from the elevated overpass) that makes a 'significant' contribution to existing noise.

### 7.3.7 Planning and social impacts

**Land use planning**

This intersection lies within 2 council areas – City of Unley and City of Mitcham – and consists of a mixture of Established Neighbourhood, Housing Diversity Neighbourhood, General Neighbourhood, Local Activity Centre, Suburban Activity Centre and Urban Corridor (Living) in accordance with South Australia's *Planning and Design Code*. Other than some minor verandah and carport development applications, there are no significant current or recently approved development applications on adjacent land to this project area.

Any impact on existing carparking spaces, particularly on the southern side of Cross Road (shopping centre and bowling centre), will require significant consideration and consultation with the council and land use operator as to how their developments would still function in accordance with their development consents, as each land use would have been conditioned to a particular number of spaces dependant on the type of use. Any change of this condition would likely result in a non-compliance with their relevant approvals. With regard to the southern properties, it could be possible to redevelop these to include either multi-storey or under-croft parking facilities.

It should be advised that some options have a likelihood to impact an existing free-standing telecommunications facility (consisting of 3 separate carriers – Telstra, Optus and Vodafone). It should be acknowledged that if this facility is impacted (i.e. required to be demolished) it will need to be relocated to support each carriers' coverage requirements. This may result in a cumulative visual impact of the intersection. Consultation with the telecommunications carriers will be required if this option was explored further. Anticipate a lengthy negotiation/relocation process.

Any remaining residential properties post-construction will need to consider council requirements under the *Planning and Design Code* for setback requirements. For instance, the acquisition of properties should not result in inadequate lot sizes for the relevant zones.

### Aboriginal and non-Aboriginal heritage

Considering the Aboriginal heritage context for the project area, the environmental landforms, and the level of previous development, the Heritage Desktop Assessment identified a low risk of works encountering unknown Aboriginal heritage sites/objects for all 5 short list options.

Options 1A and 3A are anticipated to directly impact on the following local heritage listed items:

- local heritage listed shops at 315-319 Goodwood Road, Kings Park (Heritage no. 24236), impacts to awning/verandah
- local heritage listed Church of Trinity at 318 Goodwood Road, Clarence Park (Heritage no. 3971), impacts to land parcel which may materially impact heritage value
- land parcel containing local heritage listed dwelling (Glenavalin) at 12-13/242 Cross Road, Kings Park (Heritage no. 24191), impacts to land parcel which may materially impact heritage value.

It is noted that the works proposed in Options 5 and 5A will be in close proximity to local heritage listed shops at 315-319 Goodwood Road, Kings Park (Heritage no. 24236).

Option 12A is not anticipated to have any impacts on non-Aboriginal heritage.

### Urban design and visual effect

Through the acquisition of land (particularly a large number of properties on the north side of Cross Road), there are opportunities to expand upon greenspaces, as well as reconfigure residential or commercial land uses to revitalise urban impacts from the development. To assist with noise attenuation concerns, greenspace would be beneficial to explore in this scenario.

Further exploration will be required through Green Infrastructure initiatives once a preferred option has been selected.

All options tend to result in a large span of hard surfaces (concrete/asphalt) and would benefit from softening through greening initiatives. Focus should be placed on the northern aspect of Cross Road, whereby the removal of the nearest properties results in the next row of properties being exposed to larger traffic noises. This would also assist in alleviating noise concerns generated by the traffic. Additional consideration is required for Option 3A in order to mitigate the impacts of overlooking into properties from the grade separation.

### Socio-economic

All short list options are anticipated to have some degree of negative impact on the following:

- local residents' homes
- local business operation
- petrol filling station access (OTR Clarence Park is the only station on the western side of Goodwood Road between the city and Panorama)
- local amenity (including tree removal)
- local vehicle access
- local pedestrian access (including vulnerable road users from the Cabra Dominican College)
- local public transport network access (including nearby bus lines and the Belair train line from the Unley Park Station to the east of the intersection).

### 7.3.8 Updated Level 3 cost estimate

Following the short to preferred evaluation, the costings were further reviewed for all options to better reflect the cost of impacts to businesses and further refined land acquisition. An updated Level 3 cost estimate was prepared for the short list options by Rider Levett Bucknall in accordance with DIT's *Estimating Manual*.

The Level 3 cost estimate provides an in-depth cost analysis of the options progressed to the short list. The purpose of the Level 3 cost estimate is outlined in DIT's *Estimating Manual* as follows:

- 'Undertaken during the Proving Phase
- Provides cost analysis of specific options of an initiative being considered
- Based on minimal assumed project scope and initial design details relative to each option
- Prepared using a combination of benchmark (nominally 40%) and first principles (nominally 60%) methods
- Includes risk values which are commensurate to the nature, scale, requirements etc. of the project and the level of design upon which it is based
- Expressed as P50 and P90 values, inclusive of escalation based on assumed delivery dates
- Used to provide a more detailed cost assessment of options short listed from the previous estimate level
- May be used to seek project funding'.

A Level 3 cost estimate summary with P50 and P90 values for each short list option is provided in Table 12.

**Table 12: Level 3 cost estimate**

| Estimate Reference | Short List Option | P50* | P90* |
|---|---|---|---|
| EST 600-2 2683 OE L3 R2 | Option 1A | $139.5m | $144.9m |
| EST 600-2 2683 OE L3 R2 | Option 3A | $325.0m | $342.4m |
| EST 600-2 2683 OE L3 R2 | Option 5 | $153.2m | $158.9m |
| EST 600-2 2683 OE L3 R2 | Option 5A | $162.9m | $169.5m |
| EST 600-2 2683 OE L3 R2 | Option 12A | $131.4m | $136.5m |
| ***** Costs rounded to nearest $0.1m | | | |

Refer to Appendix I for details of the *Updated Level 3 Cost Estimate*.

## 7.4 Multi-criteria Assessment and Benefit-Cost Analysis

The short list options were assessed using a (non-monetised) Multi-criteria Assessment and a (monetised) Benefit-Cost Analysis. The results of the Multi-criteria Assessment are provided in Table 13. A summary of the Benefit-Cost Analysis is provided in Table 14.

Refer to the *Strategic Business Case (IPP-AMJV-422-001-RP-OA-DO-0068)* issued separately to DIT for further details of the assessment process.

**Table 13: Non-monetised multi-criteria assessment for short list of intersection options**

| Category | Criteria description | Option 1A | **Option 3A** | Option 5 | **Option 5A** | Option 12A |
|---|---|---|---|---|---|---|
| Strategic Alignment | Make strategic investments (freight) | | | | | |
| | Make strategic investments (public transport) | | | | | |
| | Make strategic investments (cycle) | | | | | |
| | Make strategic investments (traffic) | | | | | |
| | Alignment with Road Safety Strategy | | | | | |
| Economic | Residual land opportunity | | | | | |
| Socio-Economic | Property acquisition (residential) | | | | | |
| | Property acquisition (commercial) | | | | | |
| | Local vehicle movement and accessibility | | | | | |
| | Public transport user benefits | | | | | |
| | Cycle user benefits (connectivity) | | | | | |
| | Cycle user benefits (safety) | | | | | |
| | Pedestrian user benefits | | | | | |
| Environment | Aboriginal Heritage | | | | | |
| | Non-Aboriginal Heritage | | | | | |
| | Flora and fauna | | | | | |
| | Urban design | | | | | |
| | Greenhouse Gas Emissions | | | | | |
| | Air quality and noise impacts | | | | | |
| Deliverability | Design complexity | | | | | |
| | Utility services | | | | | |
| | Implementation timeframe | | | | | |
| | Project complexity | | | | | |
| | Operational impact | | | | | |

*Indicates options selected as Preferred Options.*

| HIGH DISBENEFIT | MOD DIS-BENEFIT | LOW DISBENEFIT | NEUTRAL | LOW BENEFIT | MOD BENEFIT | HIGH BENEFIT |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**Table 14: Monetised benefit-cost analysis**

| Indicator | | Option | | | | |
|---|---|---|---|---|---|---|
| | | 1A | 3A | 5 | 5A | 12A |
| P90 | Cost | $171.6m | $415.3m | $180.7m | $180.7m | $161.5m |
| | NPV[2021] ($) | 28.0 | 172.4 | -16.0 | 28.5 | 118.3 |
| | BCR | 0.8 | 0.6 | 1.1 | 0.8 | 0.3 |

Two (2) options were selected to progress as preferred options:

- **Option 3A** was selected as a **grade separation option** for the intersection since it provides the greatest outcomes in terms of traffic capacity, reduced delay and fewer stops for freight connecting to South Road.
- **Option 5A** was selected as an **at-grade option** for the intersection. It provides a good level of improvement for traffic movement on Cross Road, bus prioritisation and cycling, whilst maintaining a good level of access.

| No. | Option name | Description |
|---|---|---|
| 3A | Cross Road Grade Separation | 2 through lanes and a bicycle lane on the Cross Road overpass<br>1 through, 2 right turn, bicycle lane and a U-turn facility at grade on Cross Road<br>2 through lanes, 2 right turn lanes, 1 bus lane and bicycle lane on Goodwood Road |
| 5A | At-Grade 3T, 2RT Cross + Goodwood 2T, 1 Bus, 2RT | 3 through lanes, 2 right turn lanes and bicycle lane on Cross Road<br>2 through lanes, 1 bus lane, 2 right turn lanes and bicycle lane on Goodwood Road |
| **Key:** | **T = Through** | **RT = Right Turn** |

# 8 Preferred options

## 8.1 Design Basis

A design basis was established for the preferred options to maintain consistency for comparison between the options. These elements included:

- cross section requirements (traffic lane widths, bicycle facility widths and verge widths)
- design and check vehicles and clearances
- design speed
- geometric design parameters
- horizontal alignment and clearances
- vertical alignment and clearances.

Summaries of the key cross section geometry requirements and the design and checking vehicles used for the short list option designs are provided in Table 15 and Table 16 respectively.

**Table 15: Key cross section geometry requirements for preferred options**

| Criteria | Minimum Design Requirement |
|---|---|
| Number of lanes in each roadway | Road specific |
| Through Lane Widths | Preferred 3.5 m<br>Minimum 3.0 m |
| Turn Lane Widths | Preferred 3.5 m<br>Minimum 3.0 m |
| Verge Width<br>(including footpath) | Minimum 3.0 m<br>Unless in constrained areas |
| Footpath Width | Minimum 1.8 m |
| Bicycle Lane Width<br>(from edge of bitumen) | Preferred 1.8 m<br>Minimum 1.6 m |
| Bicycle lane separation | Minimum 0.8m painted separator<br>(Only applied at Option 5A not 3A) |
| Clearance to cyclist envelope | Preferred 1.5 m<br>Minimum 1.0 m |
| Clearance from bicycle lane to fixed hazards (upright objects, batter/fall) | Preferred 1.0 m<br>Minimum 0.5 m<br>Absolute Minimum to smooth upright hazard 0.3 m |
| Median Widths | Dependant on the surroundings |
| Bus Lane Width | Minimum 3.5 m |
| Indented Bus Bay Width | Minimum 3.0 m |

**Table 16: Design and checking vehicles for preferred options**

| Road | Design Vehicle PBS Level | Check Vehicle |
|---|---|---|
| Goodwood Road | Level 1A<br>(19 m HML vehicle)<br>14.5 m and 19 m articulated buses | PBS Level 2A<br>(26 m B-double HML Vehicle)<br>14.5 m and 19 m articulated buses |
| Cross Road | Level 2B<br>(26 m B-double fitted with quad axel groups HML vehicle)<br>14.5 m and 19 m articulated buses | PBS Level 3A<br>(36 m Double road train (type I) HML vehicle)<br>14.5 m and 19 m articulated buses<br>(conservative approach – see *Design Report* for more details) |
| Turning movements | Level 1A<br>(19 m HML vehicle)<br>14.5 m and 19 m articulated buses | PBS Level 2A<br>(26 m B-double HML Vehicle)<br>14.5 m and 19 m articulated buses |

Critical issues such as utility services impacts have also been examined as a part of the preferred options' designs.

For further details, refer to the *Design Report* in Appendix G.

## 8.2 Design development

### 8.2.1 At-grade option (Option 5A)

Following the Multi-criteria Assessment, the at-grade preferred option was further developed as follows:

- bus stop locations and designs resolved
- swept path modelling for shopping centre loading docks at Cross Road / Eaton Street
- refinement of general shopping centre car park access from Goodwood Road (south)
- lane widths were rationalised to reduce land acquisition extent, avoid impacts on heritage buildings and shopping centre basement car park, and encourage slower speeds
- approach and exit through lane widths were adjusted to match
- swept path modelling with refinement of stop line positions and left turn slip lanes
- merge and diverge lengths further resolved
- refinement of median island design and alignment
- increased extent of solid white lines on left turn lane approaches to reduce conflict zone for cyclists.

### 8.2.2 Grade separated option (Option 3A)

Following the Multi-criteria Assessment, the grade separated preferred option was further developed as follows:

- bus stop locations and designs resolved
- swept path modelling for shopping centre loading docks at Cross Road / Eaton Street
- refinement of general shopping centre car park access from Goodwood Road (south)
- lane widths were rationalised to reduce land acquisition extent, avoid impacts on heritage buildings and shopping centre basement car park, and encourage slower speeds
- safe cycling treatments were included for on and off ramp merge and diverge zones
- merge and diverge lengths further resolved
- relocated existing pedestrian actuated crossing on Goodwood Road (north) to Dixon Street
- at-grade intersection design refined.

## 8.3 Description of upgrades

### 8.3.1 At-grade option

The at-grade option, as shown in Figure 17, includes the following:

- 3 through lanes and 2 right turn lanes on Cross Road (west, east) approaches
- separated and extended high entry left turn auxiliary lanes on Cross Road (west, east) approaches
- existing bicycle lanes on Cross Road (west, east) widened to 1.8 m with 1.0 m line marked separation and applied greening through conflict zones
- 2 through lanes and 2 right turn lanes on Goodwood Road (north, south) approaches
- separated and extended high entry left turn auxiliary lanes on Cross Road (west, east) approaches
- dedicated short bus lanes on Goodwood Road (north, south) approaches
- added 1.8 m bicycle lanes on Goodwood Road (north, south) approaches with applied greening through conflict zones
- all existing pedestrian intersection movements retained with increased crossing distances on all legs due to road widening
- midblock 2 stage pedestrian crossing at the Cabra Dominican College on Cross Road (west) retained
- widened medians on Cross Road (west, east) and Goodwood Road (north, south)
- retained vehicle access to the Big W/Woolworths shopping complex and car park on Goodwood Road (south) with minor modifications

The *Preferred At-grade Option 10% Engineering Sketch* is provided in Appendix J.

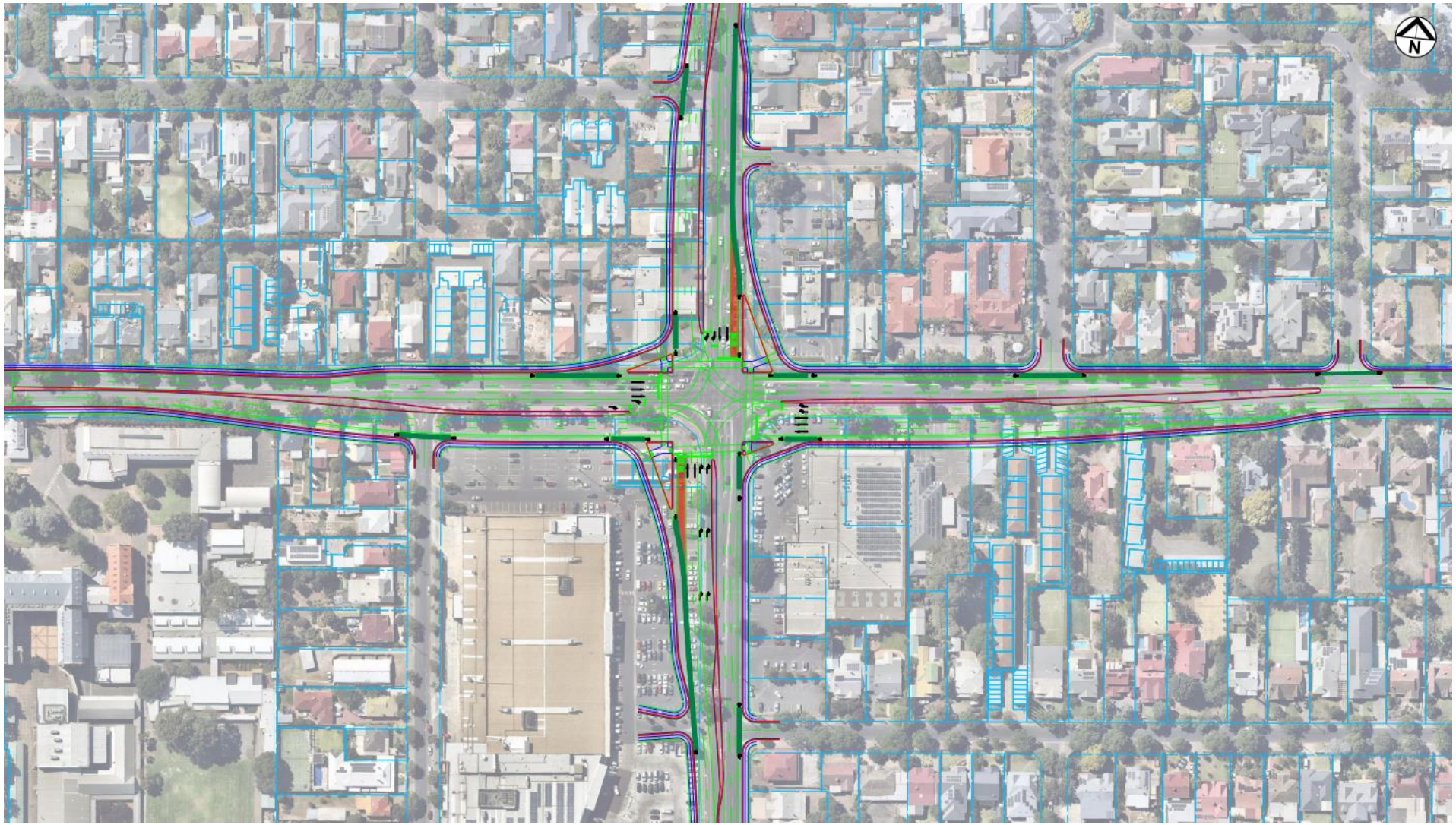


**Figure 17: At grade preferred option – 10% Concept Design**

### 8.3.2 Grade separated option

The grade separated option, as shown in Figure 18, includes the following:

- grade separation of Cross Road (dual lane, both directions, with bicycle lanes) via overpass between Churchill Avenue and Seymour Avenue (widening to north)
- at-grade 1 (one) through lane, 2 right turn lanes and 1 (one) U-turn movement lane on Cross Road (west, east) approaches
- at-grade separated and extended high entry left turn auxiliary lanes on Cross Road (west, east) approaches
- existing at grade bicycle lanes on Cross Road (west, east) widened to 1.8 m with applied greening through conflict zones
- 2 through lanes and 2 right turn lanes on Goodwood Road (north, south)
- separated and extended high entry left turn lanes on Goodwood Road (north, south)
- added bus jump start lanes on Goodwood Road (north, south)
- added 1.8 m bicycle lanes on Goodwood Road (north, south) approaches with applied greening through conflict zones
- road reserve areas of 3 m width where widening is proposed
- additional 4 indented bus stops on Cross Road (west, northern side; and east, northern and southern sides) and on Goodwood Road (south, eastern side)
- all existing pedestrian intersection movements retained with 2 stage crossings across Cross Road (west, east) and increased crossing distances on all legs due to road widening
- midblock 2 stage pedestrian crossing at the Cabra Dominican College on Cross Road (west) relocated approximately 150 m east as 2 stage crossing under grade separation structure
- widened medians on Goodwood Road (north, south)
- access at Churchill Avenue on Cross Road (west) and Ningana Avenue and Seymour Avenue on Cross Road (east) restricted to pedestrian-and-cyclist-only to avoid intersections at a merge/diverge area.

The *Preferred Grade Separated Option 10% Engineering Sketch* is provided in Appendix K.

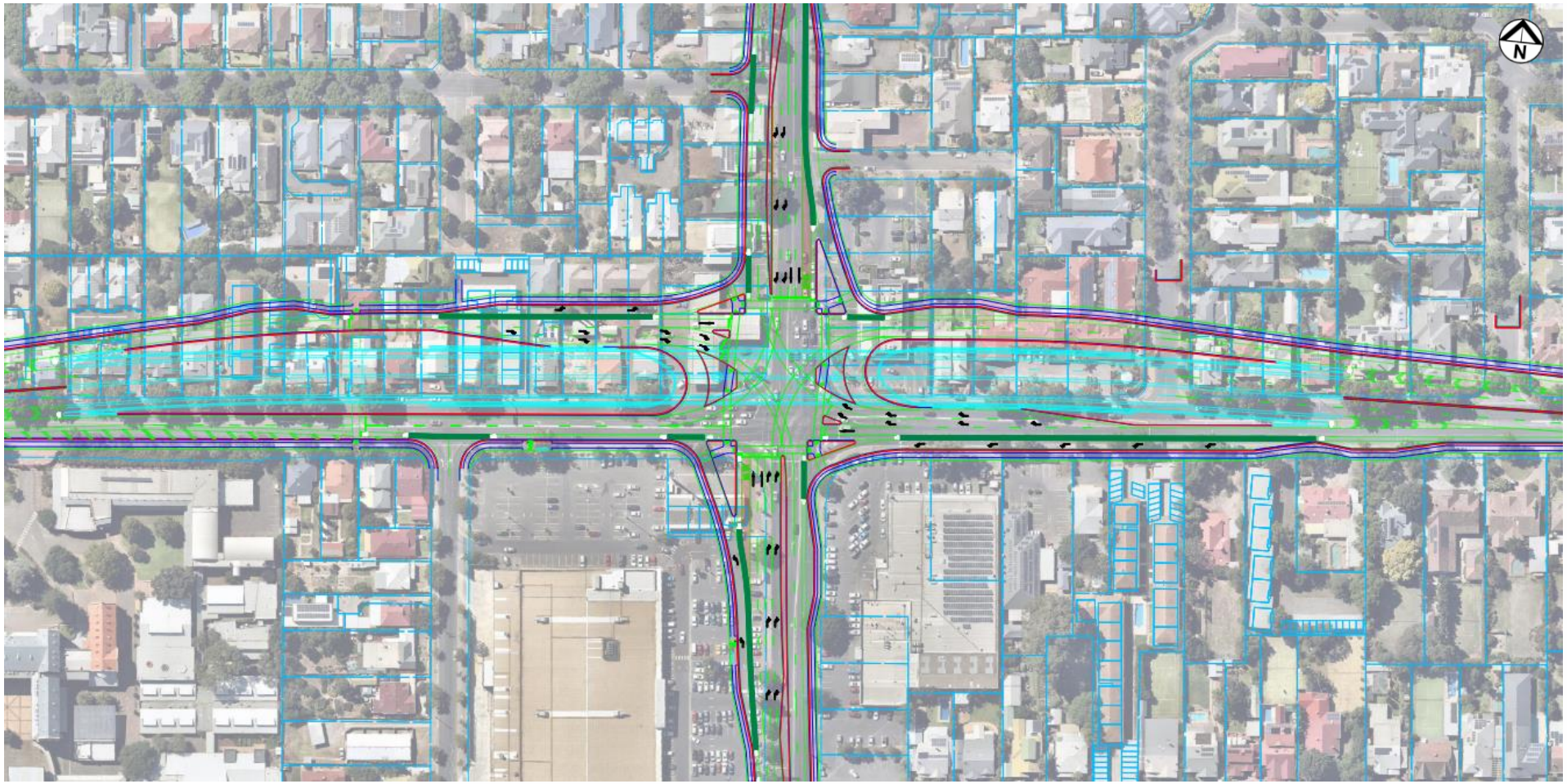



**Figure 18: Grade separated preferred option - 10% Concept Design**

## 8.4 Traffic modelling

Future volumes and detailed traffic modelling analysis can be found in the *Traffic Modelling Report* in Appendix L.

### 8.4.1 At-grade option

The at-grade option builds on Short List Option 5A, with minor changes to the detail geometry of the intersection due to the progression of the design.

The results (refer Table 17) indicate that the intersection operates close to capacity under existing demand with a DoS of 0.94 in the PM peak. In 2036, the intersection is over-saturated with DoS above 1 during both peaks.

**Table 17: Model intersection performance summary, at grade option**

| Scenario Modelling | AM Peak Hour | | | | PM Peak Hour | | | |
|---|---|---|---|---|---|---|---|---|
| **Design Options** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** |
| Current performance | 1.03 | 86 | F | 573 | 1.08 | 95 | F | 588 |
| **At-grade option (current)** | 0.83 | 46 | D | 286 | 0.94 | 56 | E | 365 |
| Future Base Case (2026) | 1.14 | 137 | F | 778 | 1.17 | 152 | F | 706 |
| **At-grade option (2026)** | 0.92 | 55 | E | 372 | 0.99 | 66 | E | 428 |
| Future Base Case (2036) | 1.33 | 255 | F | 1123 | 1.40 | 287 | F | 1092 |
| **At-grade option (2036)** | 1.07 | 95 | F | 634 | 1.16 | 135 | F | 725 |

### 8.4.2 Grade separated option

The grade separated option builds on Short List Option 3A, with slight changes to the detail geometry of the intersection due to the progression of the design.

The results (refer Table 18) show that the proposed changes provide immediate benefits to the intersection performance under existing demand, with DoS of 0.84 and 0.85 for the AM and PM peaks respectively. In 2036, the intersection performs at capacity, with DoS of 0.98 and 0.99 in the AM and PM peaks respectively.

**Table 18: Model intersection performance summary, grade separated option**

| Scenario Modelling | AM Peak Hour | | | | PM Peak Hour | | | |
|---|---|---|---|---|---|---|---|---|
| **Design Options** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** | **DOS** | **Avg. Delay (sec)** | **LOS** | **95%ile Queue (m)** |
| Current performance | 1.03 | 86 | F | 573 | 1.08 | 95 | F | 588 |
| **Grade separated option (current)** | 0.84 | 26 | C | 275 | 0.85 | 27 | C | 283 |
| Future Base Case (2026) | 1.14 | 137 | F | 778 | 1.17 | 152 | F | 706 |
| **Grade separated option (2026)** | 0.89 | 29 | C | 335 | 0.88 | 28 | C | 307 |
| Future Base Case (2036) | 1.33 | 255 | F | 1123 | 1.40 | 287 | F | 1092 |
| **Grade separated option (2036)** | 0.98 | 33 | C | 430 | 0.99 | 36 | D | 440 |

## 8.5 Land acquisition

A high-level estimate of land acquisition compensation value was obtained for the preferred options from the Office of the Valuer-General (OVG), with whole and partial acquisition parcels determined by the AMJV to inform the updated Level 3 cost estimate.

Each preferred option has been assessed to determine the extent of residential land or dwellings and commercial land or buildings/tenancies impacted with reference to the 10% Engineering Sketch. The extent of impacts, including number of residential and commercial land parcels and total area required for acquisition is provided in Table 19.

**Table 19: Extent of land acquisition for at grade option**

| Option | Total Properties Acquired | Partial Acquisitions | Whole Acquisitions | Residential | Commercial/ Other |
|---|---|---|---|---|---|
| **At grade (Option 5A)** | 41 | 19 | 22 | 17 | 24 |
| **Grade separated (Option 3A)** | 102 | 48 | 54 | 66 | 36 |

Refer to Appendix M for the *Land Acquisition Technical Note* which includes further details of the extent of required land acquisition.

## 8.6 Updated Level 3 cost estimate

An updated Level 3 cost estimate summary was completed for the at-grade option to reflect the design modifications and refinements explained in Section **Error! Reference source not found.**.

The updated Level 3 cost estimate for the at-grade option with P50 and P90 values is provided in Table 20.

**Table 20: Updated Level 3 cost estimate for at grade option**

| Estimate Reference | Preferred Option | P50* | P90* |
|---|---|---|---|
| EST 600-2 2683 OE L3 R2 | At grade option (Option 5A) | $162.9M | 169.5M |
| EST 600-2 2683 OE L3 R2 | Grade separated option (Option 3A) | $325.0M | 342.4M |
| ***** Costs rounded to nearest $0.1M | | | |

Refer to Appendix I for details of the *Updated Level 3 Cost Estimate*.

## 8.7 Preliminary Environmental and Heritage Impact Assessment

A preliminary Environmental and Heritage Impact Assessment Report (EHIAR) has been prepared for this stage of the Planning Study. The EHIAR provides an overview of the key aspects for consideration across multiple disciplines to progress this at-grade preferred option with relation to the next or subsequent phases.

During the Planning Study, a number of technical investigations were completed (refer Table 21). Additionally, an Environmental Gap Analysis was undertaken.

Key recommendations for mitigation requirements to be considered throughout the development of a single preferred option and the subsequent design development phase are provided in Table 21.

Refer to Appendix C for complete details of key findings from the *Preliminary EHIAR*.

**Table 21: Completed and required technical investigations**

| Investigation | Required (Y/N) | Completed (Y/N) | Timing (PPMF Phase)<br>Proving/ Pre-Delivery/ Procurement/ Delivery |
|---|---|---|---|
| **Flora and Fauna Survey** | Y | N | Pre-Delivery (Concept design development) |
| **Arborist Assessment** | Y | N | Pre-Delivery (Concept design development) |
| **EPBC Significant Impact Assessment** | Y | Y | Pre-Delivery (Concept design development) |
| **Preliminary Noise and Vibration Assessment** | Y | N | Pre-Delivery (Concept design development) |
| **Preliminary Air Quality Assessment** | Y | Y | Pre-Delivery (Concept design development) |
| **Non-Aboriginal Heritage Desktop Assessment** | Y | Y | Pre-Delivery (Concept design development) |
| **Aboriginal Heritage Desktop Assessment** | Y | Y | Pre-Delivery (Concept design development) |
| **Heritage Impact Assessments (HIA) for specific state heritage items** | TBC | N | Delivery (detailed design) |
| **Early works / enabling ground investigation for both geotechnical and groundwater** | TBC | N | Delivery (detailed design) |
| **Spoil Disposal Management Plan (SDMP)** | Y | N | Procurement |
| **Noise and Vibration Assessment Study** | Y | N | Delivery (detailed design) |
| **Construction Vibration Assessment** | Y | N | Delivery (detailed design) |
| **Air Quality Study (including air dispersion modelling assessment)** | Y | N | Delivery (detailed design) |
| **Hydrological investigations for the reference design** | Y | N | Delivery (detailed design) |
| **Water Quality Risk Assessment** | Y | N | Delivery (detailed design) |

## 8.8 Socio-economic Impact Assessment

A *Socio-Economic Impact Assessment* (SEIA) has been prepared for this stage of the Planning Study. The SEIA report provides a description and analysis of the socio-economic impacts that are anticipated as a result of proposed changes to the Goodwood Road and Cross Road intersection. It outlines the likely impacts of the 2 preferred options, which broadly include movement impacts, place impacts, and impacts during the construction phase.

For details of the key socio-economic impacts at the intersection, refer to Appendix N for the complete *SEIA*.

## 8.9 Preliminary sustainability assessment

Sustainability encompasses a broad range of outcomes in the areas of environmental, social and economic. DIT is committed to the delivery of state government sustainability strategies including the South Australian Government's *30-Year Plan for Greater Adelaide and Climate Change Action Plan*.

The *Preliminary Sustainability Assessment Report* is a high level desktop assessment and has been completed in consideration to (but not strictly in accordance with Task 9 of DIT's Master Specification planning document PC-PL1 (revision August 2020), PC-PL2 (revision August 2020), DIT's *Sustainability Manual* (revision F, December 2020) and its *Climate Change Adaptation Guideline* (version 8, February 2021).

The assessment focuses on the sustainability impacts and considerations for two preferred options, including:

- whole of life greenhouse gas emissions (energy and materials)
- applying the waste hierarchy
- whole of life water use
- sustainable procurement
- green infrastructure
- identification of climate change risks.

Option 3A has been identified as posing the most significant sustainability risks given the larger extent of impacts, but it also offers greater opportunities for green infrastructure associated with increased areas of land acquisition.

Refer to Appendix O for the full *Preliminary Sustainability Assessment* report.

South Australia has had a goal since 2015 to reach net zero emissions by 2050, but in February 2020 an interim goal of more than 50% reduction on 2005 emissions levels by 2030 was introduced. To support achieving this goal, and other sustainability outcomes, the *South Australian Government Climate Change Action Plan 2021–2025* (Action Plan) was released in December 2020, which describes government-led objectives and actions to help to build a strong, climate-smart economy, further reduce greenhouse gas emissions, and support South Australia to adapt to a changing climate. Implementation of the Action Plan will deliver the 'Directions for a Climate Smart South Australia' policy that was released in December 2019.

Ensuring alignment of infrastructure investment with the Government's Climate Change commitments, including net zero emissions by 2050, requires assessment of whether the initiative supports:

- aligning transport planning with net zero emissions outcomes
- delivering low emission infrastructure and operations
- increasing the use of public transport and active travel
- accelerating strategic urban greening
- assessing and addressing climate change risk in government infrastructure decisions
- achieving Net Zero Emissions in South Australia by 2050.

DIT currently uses an in-house transport model to simulate transport demand for infrastructure projects. The model takes a dynamic view of how the value and utilisation of an infrastructure asset is expected to evolve over 30 years, the same timeframe over which South Australia has committed to achieving net zero emissions. DIT acknowledges that the transport model currently used for transport planning assessments is based on outdated assumptions (noting work is currently being undertaken by DIT to investigate required changes to the transport model), and assumes little or no change over the next 30 years (i.e. behaviour, technology, investment, government commitment). It does not incorporate any economic, social or environmental changes as South Australia transitions to net zero emissions over this time.

This means there is currently a gap between the net zero future we are seeking to achieve, and the tools we are using to plan for it. Estimated benefits of a project designed to increase road capacity (in terms of travel time savings multiplied by the projected number of vehicles) are high, whereas the benefits of a project designed to improve public transport efficiency and which will result in lower carbon emissions (in terms of travel time savings multiplied by the projected number of patrons) are comparatively low – and the road project attracts the investment.

Accordingly, it is recommended any future investment decisions for the project need to include assessment of alignment with the State's climate change commitments, including net zero emissions by 2050. To enable this, we recommend transport modelling be updated to allow accurate characterisation of all investment options' GHG emissions generating potential, for ease of identifying low-carbon options.

## 8.10 Land Use and Development Study

A desktop analysis was undertaken using current and applicable zoning provisions, strategic land use policies, infrastructure plans and planning legislation for both preferred options.

The **preferred at-grade option** limits land acquisition along the Cross Road Corridor. As a result, there are limited opportunities for residual land use for this option, primarily comprising the potential implementation of Green Infrastructure solutions. Critically, this option impacts upon carparking at the ten-pin bowling centre on the south-eastern corner. Reduced car parking is likely to impact the viability of the bowling centre, potentially removing community access to the only ten-pin bowling centre within 5 km of the intersection.

The **preferred grade separation option** has more significant land acquisition requirements due to the scale of the proposed bridge structure, and therefore presents more extensive opportunities for residual land use. Impacts, and therefore residual land use opportunities, are mainly concentrated on the northern side of Cross Road, where road widening will occur to accommodate the proposed bridge structure. A range of commercial and residential properties will be impacted. Critically, this road widening impacts upon the aged care retirement village on the north-eastern corner of the intersection, resulting in significant impacts to the local community and the displacement of elderly residents.

It is also noted that both options impact upon the car parking associated with the Big W/Woolworths complex on the south-western corner of the intersection. Further investigations and consultation with local council and business owners will be required to determine if a reduction in car parking spaces will be compliant with relevant car parking requirements.

For further details of the land use, planning and zoning impacts at this intersection, refer to Appendix P for the *Land Use and Development Study Report*.

## 8.11 Constructability

A high-level constructability review was undertaken as part of the Preliminary Design stage by TSA Projects which engaged experience construction managers to provide advice.

For further details, refer to Appendix Q for the C*onstructability Report* for further details.

## 8.12 Strategic Business Case

The development of this *Planning Study Report* is complemented by a separate preliminary (high-level) rapid economic evaluation.

The details of this evaluation are presented in the *Strategic Business Case (IPP-AMJV-422-001-RP-OA-DO-0068)* provided separately to DIT.

## 8.13 Risk Register

A Risk Register is a 'living' project document used to record the identified risks at all stages of a project. Each identified risk is rated to describe the likelihood of occurrence, seriousness of impact on the project, and actions that may be taken to mitigate the risk. As the project progresses, the Risk Register is continually updated to include any new risks that have been identified, and to reflect re-grading of risk due to actions taken within the project design.

A Planning Study Risk Register has been prepared in accordance with DIT's *Risk Register Template*. The Risk Register has been developed in parallel with the preliminary long list, long list and short list stages in collaboration with DIT.

Refer to Appendix R for the complete *Planning Study Risk Register*.

## 8.14 Decision Register

A Decision Register is a project document used to capture and communicate project decision-making to key stakeholders. It includes details of how each decision was made, whether any alternatives were considered, and who is accountable for each decision. The Register not only helps to inform the current project team, but also provides a comprehensive record of decision-making that will aid future phases of the project.

A Planning Study Decision Register has been prepared to document all key decisions made throughout the Planning Study thus far.

Refer to Appendix S for the complete *Planning Study Decision Register*.

# 9 Next steps

Three key next steps have been identified as a part of future works for this Planning Study.

1. Network modelling and planning
2. Stakeholder engagement
3. Further investigations.

**Network modelling and planning**

The Cross Road Corridor Strategy is currently being developed and it has been recognised that, once completed, this strategy will directly influence the future of this intersection's function and purpose within the Cross Road Corridor. Moving forward, the single preferred option for this intersection will need to be considered within the broader context of the Cross Road Corridor Strategy.

Due to its proximity to this intersection and, in particular, the Goodwood Road and Cross Road intersection, an additional planning study will also need to be completed to investigate opportunities and challenges related to the Unley Park Level Crossing. The outcomes of this planning study would therefore inform the key decisions at both these intersections for the grade separation options.

The traffic modelling used for this study was based on approach growth rates and the traffic modelling. Review of the options and traffic modelling should be undertaken using revised demand forecasts associated with the ultimate North–South Corridor design and any revisions to the strategic model to align to the State's climate change commitments.

**Stakeholder engagement**

Community engagement was not undertaken specific to this Planning Study and, due to timing, relevant information and feedback from the community gained as part of the broader community engagement process has not been incorporated into this Planning Study.

Stakeholders have not been presented with any intersection options at the time of writing this report.

A plan for additional and more comprehensive stakeholder and community engagement on the preferred option(s) will need to be developed and actioned as a critical next step in validating and mitigating the potential impacts identified in this report. Key community facilities impacted by the proposed works at the intersection include an aged care retirement village, a ten-pin bowling centre, and a large Big W/Woolworths complex. It will also be critical to 'close the loop' with stakeholders – to report back what we heard during engagement, inform them what was done with their feedback, and what the outcomes and next steps for the project are.

**Further investigations**

Further investigations will be required to progress the design of the preferred options, including:

- engineering survey
- vegetation survey
- services potholing
- geotechnical investigations
- stormwater study
- completion of a climate change risk assessment
- completion of a green infrastructure assessment.

Critically, any future investment decisions for the project need to include assessment of alignment with the State's climate change commitments, including net zero emissions by 2050. To enable this, it is recommended that transport modelling be updated to allow accurate characterisation of all investment options' GHG emissions generating potential, for ease of identifying low-carbon options.

Additional investigations will be required to understand local street impacts where side streets are restricted or closed as a result of the project.

# Appendix A – Business Requirements

# Appendix B – Geotechnical Desktop Study

# Appendix C – Preliminary Environmental and Heritage Impact Assessment Report

# Appendix D – Site Contamination Desktop Assessment

# Appendix E – Long List 5% Engineering Sketches

# Appendix F – Long List Technical Notes

# Appendix G – Design Report

# Appendix H – Short List Technical Note

# Appendix I – Updated Level 3 Cost Estimate

# Appendix J – Preferred At-Grade Option 10% Engineering Sketch

# Appendix K – Preferred Grade Separated Option 10% Engineering Sketch

# Appendix L – Traffic Modelling Report

# Appendix M – Land Acquisition Technical Note

# Appendix N – Socio-Economic Impact Assessment

# Appendix O – Preliminary Sustainability Assessment

# Appendix P – Land Use and Development Study Report

# Appendix Q – Constructability Report

# Appendix R – Planning Study Risk Register

# Appendix S – Planning Study Decision Register