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Appendices

Executive Summary

Aurecon has been engaged by the former Department of Transport (DOT) – now Department of Transport, Planning and Local Infrastructure (DTPLI) to undertake a feasibility investigation into potential options for extending Melbourne's tram network into Fishermans Bend. This is in response to the Government's decision to declare Fishermans Bend a site of State significance and rezone the area as part of an expanded Capital City Zone.

As a result of previous work DOT and Public Transport Victoria (PTV) have identified several alignment options to extend the tram network into Fishermans Bend. The principal barriers to extending light rail in Fishermans Bend are the Yarra River and M1 freeway. For each option Aurecon has considered a number of horizontal and vertical alignments, taking into account land requirements, operating constraints of light rail vehicles and impacts on the existing road network. The table below summarises some key features of each route option.

Comparison of route options

	Comparison of Route Options					
	Option 1	Option 1A	Option 2	Option 3	Option 4	Option 5
Route length	2.20km	2.77km	2.75km	1.75km	2.10km	1.57km
Number of proposed stops	4	6	5	4	5	5
Journey time (two way)	16.5mins	20.8mins	25.7mins	10.5mins	16.5mins	11.8mins
Operating cost ($/annum)	$1.31m	$1.66m	$1.54m	$1.05m	$1.31m	$0.94m
Rolling stock requirement	3	3	4	2	3	2
Impacts on road network operations	Medium	Medium	High	Low/Medium	High	Low
Major infrastructure requirements (to pass Yarra River and M1 Freeway)	1	1	2	2	2	0

Each route assessed presents different major issues to overcome, principally associated with the crossing of the Yarra River and M1 Freeway.

The most western of the new river crossings are proposed in the Options 1 and 1A alignments, crossing the river from the extended Collins Street Wharf alignment. Accommodating the bridge and ramps here will require changes to the proposed road geometry approved for the Victoria Harbour Development Plan. These options also use the Ingles Street alignment to traverse the M1 freeway, requiring a new bridge or tunnel parallel to the existing road bridge. The new structure, whether bridge or tunnel would need to begin in Rogers St close to the intersection with Lorimer Street and has significant impacts on access and property along both Rogers Street and Ingles Street.

Option 2 considers the use of Charles Grimes Bridge slip road to cross the river. Although this appears feasible, there would be major impacts on the already complex and busy Montague Street/Lorimer Street intersection, which is also a key route into Docklands from the south and west. Without area wide traffic management, this option is likely to lead to adverse traffic impacts over a wide area, including the M1 Freeway.

Of the new river crossings the most direct route into Fishermans Bend is that proposed in Options 3 and 4. Option 3 also provides a feasible route over the M1 Freeway, with the continuous elevated structure across the river and freeway being the preferable option from a traffic operation and constructability perspective.

Option 5 does not require a new crossing of the river or freeway, being a spur from the existing Route 109 corridor through South Melbourne. The major considerations for this option are likely to be network performance and impact on existing tram routes outside the study area, notably through Spencer Street. These are outside the scope of this study.

Finally we have considered crossing of the M1 freeway along all alignments either by bridge or tunnel. Given the need to provide passage for two light rail vehicles, pedestrians and cyclists, we have concluded that a bridge option, most likely a single span across the freeway, is the preferred option based on available geotechnical information, constructability and impacts on the freeway both during construction and on completion.

1. Background

1.1 Introduction

Aurecon has been engaged by the former Department of Transport (DOT) – now the Department of Transport, Planning and Local Infrastructure (DTPLI) - to undertake a feasibility investigation into potential options for extending Melbourne's tram network into Fishermans Bend. This is in response to the Government's decision to declare Fishermans Bend a site of State significance and rezone the area as part of an expanded Capital City Zone.

1.2 Project Scope

As a result of previous work DOT and Public Transport Victoria (PTV) have identified several alignment options to extend the tram network into Fishermans Bend. The proposed alignments are shown coloured in Figure 1-1 below.

Figure 1-1: Proposed Alignment Options

This investigation includes high level concept alignments for all options investigated. A key requirement is to separate tram/light rail operations from general vehicular traffic. Concept alignments have considered the following:

- Track alignments, both horizontal and vertical;
- Location of stops;
- Potential form of structures;
- Impact on intersections;
- Impact on parking and development; and
- Typical cross-sections at constrained locations.

Three types of bridge crossing have been considered at the Yarra River, namely:

- A low bridge that allows small boats only to navigate under (assumed clearance of 3.5m);
- A medium bridge that allows medium size boats, such as motor boat cruisers, to navigate under (assumed clearance of 6.0m); and
- A swing bridge that can be opened to allow larger boats, such as yachts and larger boats, to navigate through.

Any new river crossing needs to accommodate light rail and segregated cycle and pedestrian paths in each direction. General traffic does not need to be accommodated.

As part of the study we have investigated light rail options that go both under (tunnel) and over (bridge) the M1 Freeway.

We understand from DOT that buses could be used initially along any route, and so all routes have been designed to accommodate bus movements.

For each route option, high level operating costs (opex) have been estimated based on generic cost rates received from Yarra Trams. It should be noted that general operation costs include items such as labour but exclude items such as track maintenance and power.

Concept design drawings and typical cross sections are included in Appendix A. It should be noted that the alignment along Collins Street Wharf, shown on plan 234636.001-SK-C0010 is known to be inconsistent with latest development plans for Victoria Harbour. Future more detailed work should note the true alignment, however, the discrepancy in alignments does not materially affect the feasibility of these routes.

1.3 Bus Routings into Fishermans Bend

Separate to the assessment of light rail route options, there is potential for new bus routes to provide better links to Fishermans Bends from surrounding areas, which could be introduced in advance of the light rail services. As part of this commission Aurecon was asked to consider the suitability of key intersections to accommodate anticipated bus manoeuvres. Both 14.5m long base rigid buses and 19.0m articulated buses were tested.

The following is manoeuvres were assessed using Autoturn on aerial photography backgrounds..

- Williamstown Road to Prohasky Street;
- Plummer Street to Prohasky Street;
- Plummer Street to Salmon Street;
- Bridge Street to Plummer Street; and
- Brady Street to Montague Street.

The manoeuvre from Kings Street and Collins Street was also identified for assessment. However, suitable aerial photography was not available due to the adjacent tall buildings to accurately bus turning manoeuvres using Autoturn. However, given the geometry of the intersection, and the lack of any physical constraints in the centre of the carriageways, we are confident that both articulated and 14.5m buses would be able to make both the left and right turns at the intersection, without significantly impacting on other vehicular movements.

Autoturn outputs for the five sites are included in Appendix C.

1.4 Information Supplied by DOT

A number of background documents have been provided by DOT, these have been reviewed where relevant. These documents are listed as follows:

- Fishermans Bend Development Area, Light Rail Concept Designs – Prepared by Aecom 2011;
- Fishermans Bend Infrastructure Assessment – Prepared by GHD 2012;
- High Level Geotechnical Input Fishermans Bend Development – Prepared by Golder Associates 2012;
- Fishermans Bend Precinct, Preliminary Land Contamination Study – Prepared by Golder Associates 2012.
- Victoria Harbour Development Plan, 2010, Lend Lease; and
- Docklands Waterways Strategic Plan 2009-2018, City of Melbourne.

In addition to this information, DOT has supplied high resolution aerial mapping which forms the basis of the concept alignment design. DOT has also provided direction on the alignment of potential new bridge crossings over the Yarra River.

2. General Design Assumptions

2.1 Tram Services

In Melbourne, around 80% of the existing tram network operates in mixed traffic conditions, and the average speed of a tram through the network is typically 16 km/hr. This increases to about 24 km/hr in those sections where there is full segregation and a true light rail service. It is therefore desirable to move the network towards a fully accessible light rail network with full segregation from general traffic, priority through signals and greater spacing between stops, to improve reliability and average journey speeds.

The proposed alignments have therefore been designed for a light rail type service with full segregation from other traffic wherever possible and priority through intersections.

The DOT has indicated that the new services into Fishermans Bend will run to a minimum headway of 10 mins during peak periods and 20 mins at all other times, and this has been used to determine to minimum stock rolling requirements for each option. Light rail vehicles are assumed to be the 33m long E-type class vehicle currently being introduced onto the network.

2.2 Tram Stops

The average stop spacing on the Melbourne network is currently 270 metres. To reflect a true light rail type service and increase average speeds we have designed the extensions to have an average stop spacing in the order of 350-400 metres. Stops have been located, where possible, near key amenities or interchanges and with due consideration of likely catchment. The Yarra River and M1 sever the study area. As such, stop locations have been developed to capture the catchment area of the land parcels sandwiched between these two features.

All stops are required to be fully accessible. The following stop designs have been considered in this high level assessment:

- Single Face Platform Stop (SFPS) – typically allows boarding from the right hand side of the stop only. A pedestrian crossing is required to give pedestrians a safe route to the adjacent footway. The minimum width of stop is assumed to be 2.85m in line with DOT's guidelines for accessible tram stops.
- Central Island Platform Stop (CIPS) – typically allows boarding from both sides of the stop. Pedestrian crossings are required to give pedestrians a safe route to the adjacent footways. A minimum width of 3.5m has been assumed, which reflects the design of stops currently proposed for Route 86 along Plenty Road, Darebin.
- Kerb Extension Platform Stop (KEPS) – in these designs the existing footway is built out so that the tram stops adjacent to the footway. Note that for a tram route to be fully segregated; this type of stop can only be introduced where the road is closed to general traffic.
- Easy Access Tram Stops (EATS) – in this design the roadway adjacent to the stop is raised so that pedestrians can walk out from the footway on a level surface to board and alight from the tram. A minimum width of 3.7m has been assumed in line with VicRoads guidance.

The preferred stop type is the SFPS as this provides boarding from the left side, consistent with the vast majority of stops on the existing network, while providing passengers with a safe area adjacent to the tram thereby minimising boarding and alighting times. Where possible, SFPSs have been included in the alignment design.

Given the proposed frequency of the light rail vehicles along the route into Fishermans Bend, all stops are assumed to accommodate one vehicle only at any one time, and are therefore designed to be approximately 30m in length.

2.3 Horizontal and Vertical Alignments

The minimum width for two rail tracks is 6.8m, assuming that power is supplied via poles located on the side of the road. Where pedestrian and cycle provision is needed, for example across river crossings the alignments allow for a 3m shared path in each direction. The minimum width of these structures, excluding parapets, is therefore 13.8m.

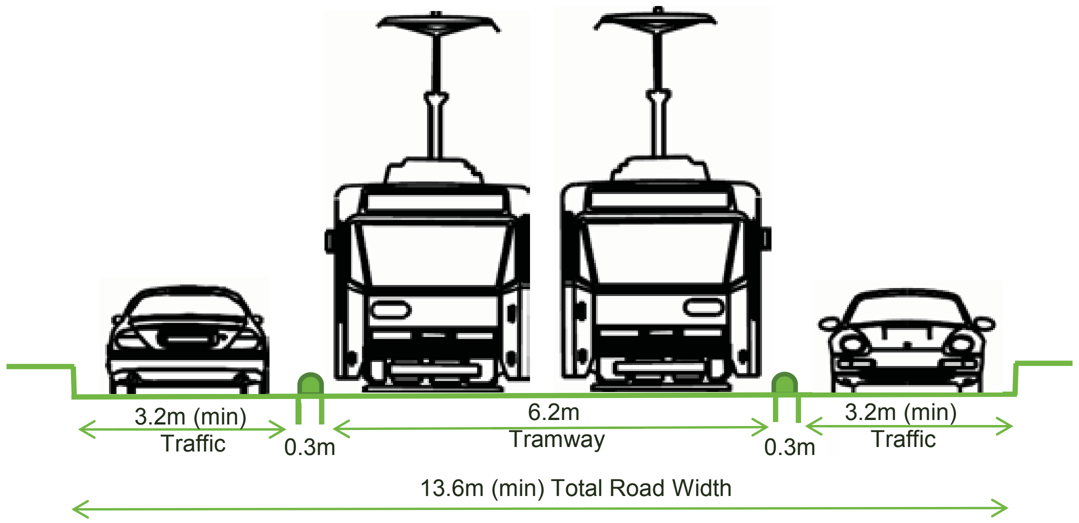


Figure 2-1: Potential tram lane configuration (two way traffic)

In addition to recommending the implementation of tram lanes with two way traffic, we have considered locations where tram lanes could operate with one way traffic in order to maintain on street parking.

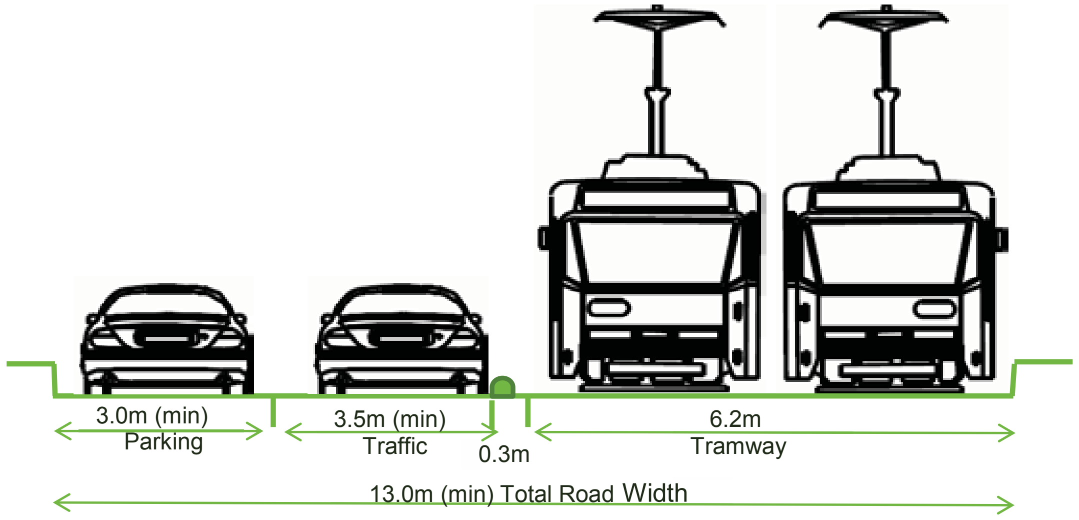


Figure 2-2: Potential tram lane configuration (one way traffic)

3. Option 1 Route Extension

3.1 Route description

The route extension would commence on Collins St, Docklands, by extending the existing tracks along the alignment of an extended Collins Street and Collins Street Wharf, as proposed in the Victoria Harbour Development Plan 2010 (Lend Lease). The route would be required to bridge over the Yarra River between Collins Street Wharf and Riggers Place on the south side. The river is approximately 160m wide along this alignment. On the south side of the river, the route turns into Lorimer Street before turning into Rogers Street. From Rogers Street, the route would be required to bridge over, or tunnel underneath, the M1 Freeway approximately along the alignment of Ingles Street.

South-east of the M1 Freeway, the route would run along Ingles St before turning into Fennell Street. The route then runs along Fennell Street to Bridge Street and into Plummer Street.

It is noted that from Fennell Street, west of Ingles Street, all route options are the same.

Between Fennell St and Plummer St the route performs a double dog-leg manoeuvre with two acute turns. This cannot be performed by the light rail vehicles unless there is some land take on the north-west corner of the Plummer St/Bridge St intersection. Even so, this manoeuvre would need to be undertaken very slowly and is likely to cause some discomfort to passengers.

To address this, the intersection of Bridge St with Fennell St and Plummer St could be reconfigured to remove the dog-leg and provide a much safer traditional four arm intersection. There would also be benefits to light rail journey times. However, reconfiguring the intersection in this manner would require the purchase of significant land to the north west of the intersection. Notwithstanding this, we believe reconfiguring the intersection has significant benefits and recommend steps be taken to safeguard this land against future development.

The total length of the Option 1 route extension is 2.6km.

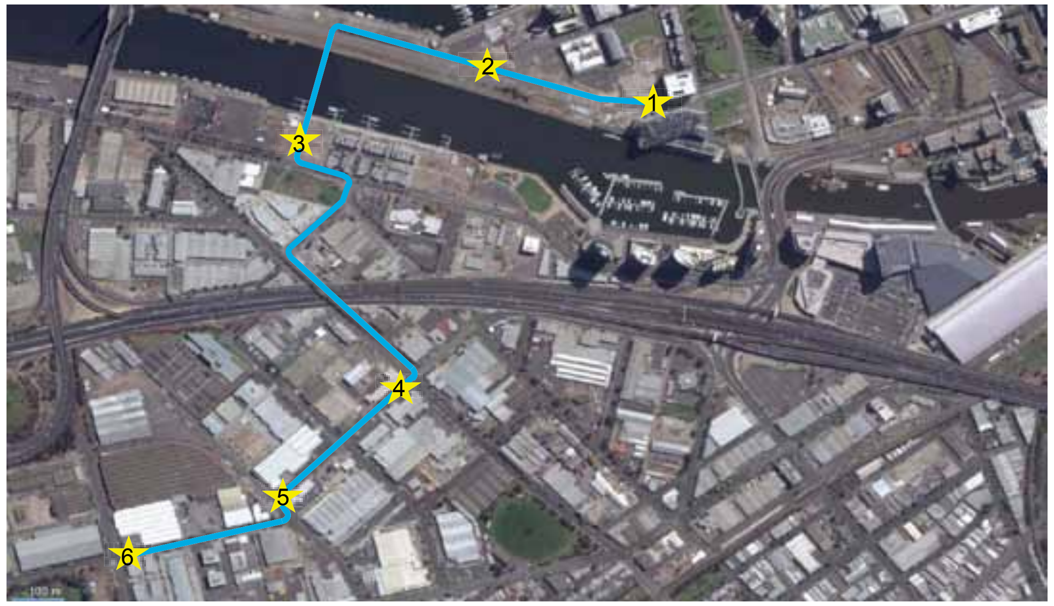


Figure 3-1: Tram extension Option 1

3.2 Stop locations

The following potential tram stop locations have been identified along Route Option 1:

1. The existing stop located outside the ANZ Centre on Collins Street would be retained.
2. A new pair of SFPSs would be located on Collins Street in close proximity to Bourke Street. (We understand that new stops are soon to be implemented in the vicinity as part of the development of North Wharf. At the time of preparing our plans, the precise location of the stops is unknown. Should the location of this stop (stop 2) be closer to stop 1 than we have assumed, it may be appropriate to introduce a further pair of SFPSs on Collins Street Wharf prior to the new bridge across the Yarra.)
3. A new pair of SFPSs would be located in Riggers Place, north of Lorimer Street intersection.
4. A new pair of SFPSs would be located on Fennell St, to the south- west of the Ingles St intersection.
5. A new pair of SFPSs would be located to the east of the Bridge Street intersection.
6. A new of EATSs would be located adjacent to the Graham Street intersection.

Table 3-1: Route Option 1 Proposed Tram Stops

Route Option 1 Proposed Tram Stops			
Approximate stop location	New or existing stop	Stop type	Approximate distance between stops
1. ANZ Centre Collins Street	Existing	Retain existing SFPSs	
			320m
2. Collins Street	New	SFPSs	
			640m[1]
3. Riggers Place	New	SFPSs	
			790m[2]
4. Fennell Street	New	SFPSs	
			390m
5. Bridge Street	New	SFPSs	
			430m
6. Graham Street	New	EATSs	

3.3 Vertical alignment

Route Option 1 would require the construction of two significant pieces of infrastructure to cross the Yarra River and M1 Freeway.

[1] Introduction of an additional pair of stops just prior to the bridge would reduce spacing between stops to approximately 300m.
[2] The large distance between stops is primarily because the light rail is not at grade along most of this length

3.3.1 Crossing of the Yarra River

The route would require a bridge to traverse the Yarra River. The width of the river crossing at the point of the proposed alignment is approximately 160m. Both 3.5m and 6m clearance bridges can be provided, albeit the 6m clearance over a shorter span.

The bridge would provide an elevated structure for light rail, cyclist and pedestrians over approximately 280m.

The bridge structure would begin along the new Collins Street Wharf alignment and land in Riggers Place approximately 70m south of the river embankment to enable the SFPS to be located before the Lorimer Street intersection.

3.3.2 Traversing the M1 Freeway

Beyond the river, there are two options to pass the M1 Freeway:

1. **Construct a bridge structure parallel to the Ingles Street Bridge over the M1 Freeway:** This option would provide an elevated structure for light rail, cyclists and pedestrians over an approximate length of 500m. The designs meets VicRoads guidance for clearance over freeways. A number of potential alignments have been considered for the bridge.

   The first constructs a separate light rail/ pedestrian/cycle bridge to the east of the existing Ingles Street bridge. Due to constraints with adjacent buildings a shared pedestrian/cycle path would only be provided along one side of the bridge. Access to properties from the eastern side of Ingles Street, south of the freeway, would be denied.

   The alternative solution would be to construct a new road bridge to the west of the existing bridge and convert the current road bridge for exclusive use of light rail vehicles. This would impact on properties on the western side of Ingles Street. However, there does appear to be sufficient road reserve and nature strip to maintain access.

   For both alignments the light rail bridge structure would need to commence in Rogers Street due to the short distance between the freeway and Rogers Street.

   For each alignment, two bridge structures have been considered to span the freeway: the first provides a single 80m span similar to the Ingles Street bridge, the second provides for two 40m spans with a central pier on the freeway. Although the shorter spans allow a reduced bridge deck depth, and therefore a smaller level change for the tram, the central reserve on the freeway at this location is very narrow and innovative pier designs and construction methodology would be needed to minimise impacts on the freeway during construction and permanent operations. For this reason the 80m span option would appear to be the preferred bridge solution, albeit the greater bridge depth indicating a bridge height of approximately 8.6m would be required.

2. **Construct a tunnel parallel to Ingles Street bridge under the M1 Freeway:** The alignment of the tunnel would be to the west of Ingles Street bridge with the alignment passing under it to turn into Rogers Street. It is noted that the tunnel would extend to the intersection with Lorimer Street and some major works may be required at this intersection to merge the alignment into the existing levels and retain other vehicular access into Rogers Street. To the south of the freeway, the tunnel would emerge on the western side of Ingles

Street just north of the intersection with Fennell Street. The tunnel would provide for light rail over an approximate length of 600m.

A number of construction methods have been considered for a tunnel. These include a single or twin tube using a tunnel boring machine, precast segments jacked incrementally, and cut and cover. In considering these potential options, we have reviewed the geotechnical information provided by Golders for the area. Each construction methodology has different but significant issues and risks, including impact on the existing freeway structure, stability of the soil during construction, maintaining structural integrity of the tunnel and cost. In addition the cut and cover option is discounted due to unacceptable impacts on the operation of the freeway for long construction periods (likely that at least three traffic lanes would not be available at any one time).

Our conclusion is that a large span bridge over the freeway, whether as a separate bridge or larger elevated structure, appears to offer the best potential a new light rail route to traverse the M1 freeway. Sketches of potential bridge structures are provided in the appendix to this report. More detailed analysis of concept options is recommended should Ingles Street be the preferred location to traverse the freeway.

3.4 Potential Impacts

The following potential impacts on existing roads have been identified at this stage:

Intersections

- New signalled intersections would be needed at Collins St/Merchant St, Lorimer St/ Riggers Place, Lorimer St/ Rogers St and Ingles Street/Fennell Street.
- Major intersection remodelling would also be required at Collins Street/Bourke Street, Fennell St/Bertie St, Fennell St/Bridge St and Plummer St/Bridge St.
- Provision of new signalled intersections at Lorimer St would significantly reduce capacity along Lorimer St.

Collins Street Wharf

- The Victoria Harbour Development Plan envisages that Collins Street Wharf would be two lanes only, plus a car parking lane, with any light rail sharing the road with general traffic. With the light rail bridge as proposed in Option 2, this would not be possible, as light rail would need to be segregated from general traffic prior to the bridge. The preferred layout would be for two general traffic lanes to be provided to the north of the bridge along Collins Street Wharf.

Rogers Street

- Rogers Street ranges from approximately 17m to 23m in width between kerbs and nature strips ranging from 1.5 to 4.0m. Parallel or angled parking is provided on both sides of the road
- The width required for the bridge or underpass structure would be approximately 15m, and so local road widening utilising the current nature strips would be needed to maintain access into frontages at some locations. Parking would need to be banned along both sides of the road along certain sections.

Ingles Street

- The extent of impacts along Ingles Street will depend on whether a bridge or tunnel is provided to traverse the freeway, and the alignment of the structure. An alignment to the west of the existing Ingles Street bridge appears to have less impact on frontage access along Ingles Street. However, further detailed assessment is needed to determine the extent of the impact on frontages of the bridge or tunnel structures.

Fennell Street

- Fennel St is approximately 15m wide between kerbs with nature strips approximately 5m wide on either side. Parallel or angled parking is provided on both sides of the road. A wide lane of 4.1m can be maintained in each direction adjacent to the tram tracks. Parking would need to be banned, although there is the potential to reduce the nature strip to maintain some parking and/or provide cycle lanes. Local widening of at least 4.5m would be needed adjacent to stops.

Plummer Street

- Plummer St is only 12m wide. As such, a segregated light rail cannot be provided unless the road is widened along the entire length. Provision of 3.5m traffic lanes adjacent to the tram tracks would require widening by 1.8m. Additionally, all on street parking would need to be banned.
- Access to, and egress from, properties along Plummer Street would be affected. Many businesses requiring heavy vehicles are located within Plummer Street.

3.5 Journey Time and Rolling Stock Requirements

Route Option 1 is predominantly an indirect route requiring a large number of turning movements. The route would also pass through 2 or 3 signalised intersections, and has an average stop spacing of about 500m. As such we estimate that average journey speeds would be lower than Melbourne's average (approximately 16km/hour). For the purposes of estimating journey times and rolling stock needs, we have therefore conservatively estimated that average journey speeds are 12km/hour along Route Option 1. This would give an average journey time for the extension (two-way) of 25.7 minutes, requiring 3 or 4 LRVs (based on a10 minute headway).

3.6 Operating costs

High level operating costs (opex) have been estimated based on a generic cost rate of $7 per tram kilometre as advised by Yarra Trams. It should be noted that these general operation costs include items such as labour but exclude items such as track maintenance and power. The approximate cost of operating tram services at 10 mins and 20 mins headways (as outlined in Section 2.1) along Route Option 1 is $1.54m per annum.

4. Option 1A Route Extension

4.1 Route description

The route extension utilises the proposed extension of Route 48 along Collins Street to Bourke Street as proposed in the Victoria Harbour Development Plan. From there, the route bridges across the river to land in Foundry Way and then crosses Lorimer Street into Rogers Street. From Rogers Street the route is the same as Option 1.

The advantage of this route over Option 1 is that it presents a shorter more direct route linking Fishermans Bend to Victoria Harbour and on to the CBD. It also reduces the impact of the light rail on Lorimer Street. The key issue being that the route passes through the Yarras Edge development. However, the Foundry Way alignment does appear to have sufficient width to accommodate two-way light rail.

The total length of the Option 1A route extension is 2.1km.

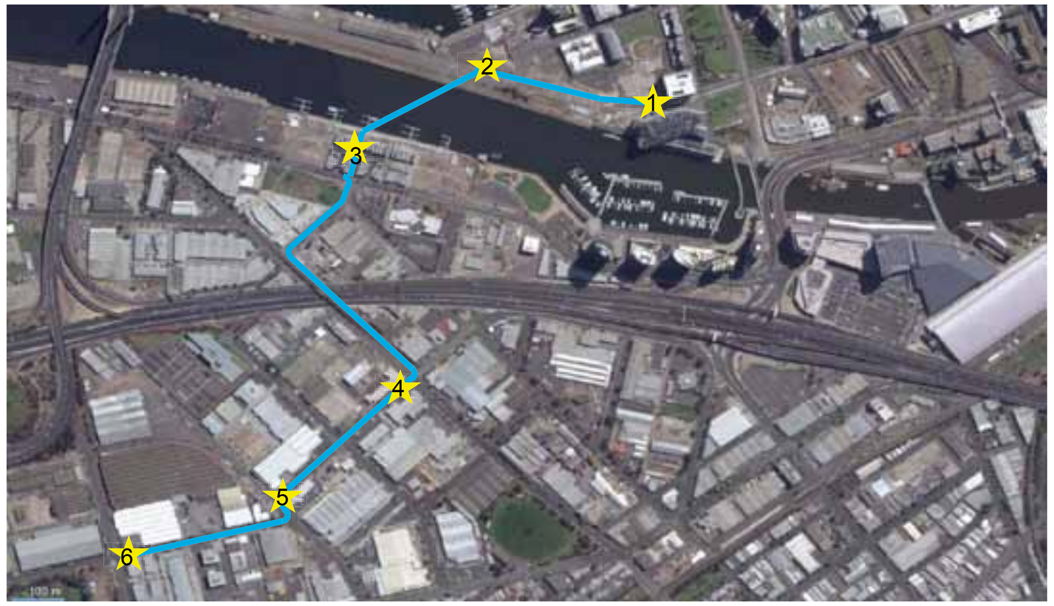


Figure 4-1: Tram extension Option 1A

4.2 Stop locations

The following potential tram stop locations have been identified along Route Option 1A:

1. The existing stop located outside the ANZ Centre on Collins Street would be retained.
2. A new pair of SFPSs would be located on Collins Street in close proximity to Bourke Street. (We understand that new stops are soon to be implemented in the vicinity as part of the development of North Wharf. At the time of preparing our plans, the precise location of the stops is unknown. Should the location of this stop (stop 2) be closer to stop 1 that we have assumed, it may be appropriate to introduce a further pair of SFPSs on Collins Street Wharf prior to the new bridge across the Yarra.)
3. A new pair of SFPSs would be located in Foundry Way, north of Lorimer Street intersection.

4. A new pair of SFPSs would be located on Fennell St, to the south- west of the Ingles St intersection.
5. A new pair of SFPSs would be located to the east of the Bridge Street intersection.
6. A new of EATSs would be located adjacent to the Graham Street intersection.

Table 4-1: Route Option 1A Proposed Tram Stops

Route Option 1A Proposed Tram Stops			
Approximate stop location	**New or existing stop**	**Stop type**	**Approximate distance between stops**
1. ANZ Centre Collins Street	Existing	Retain existing SFPSs	320m
2. Collins Street	New	SFPSs	350m
3. Foundry Way	New	SFPSs	640m[3]
4. Fennell Street	New	SFPSs	390m
5. Bridge Street	New	SFPSs	430m
6. Graham Street	New	EATSs	

4.3 Vertical alignment

Route Option 1A would require the construction of two significant pieces of infrastructure to cross the Yarra River and M1 Freeway.

4.3.1 Crossing of the Yarra River

The route would require a bridge to traverse the Yarra River. The width of the river crossing at the point of the proposed alignment is approximately 250m.

The bridge would provide an elevated structure for light rail, cyclist and pedestrians over approximately 300m.

The bridge structure would begin along the new Collins Street Wharf alignment and land in Foundry Way adjacent to the river embankment to minimise the visual intrusion and impact on properties in Yarras Edge and to enable the SFPS to be located before the Lorimer Street intersection.

4.3.2 Traversing the M1 Freeway

South of Lorimer Street the route follows the same alignment as for Option 1. Potential alignments for crossing the M1 Freeway are therefore the same as discussed in Option 1 above.

[3] The large distance between stops is primarily because the light rail is not at grade along most of this length

4.4 Potential Impacts

The following potential impacts on existing roads have been identified at this stage:

Intersections

- New signalled intersections would be needed at Collins St/Merchant St, Lorimer St/ Rogers St and Ingles Street/Fennell Street.
- Major intersection remodelling would also be required at Collins Street/Bourke Street, Fennell St/Bertie St, Fennell St/Bridge St and Plummer St/Bridge St.
- Provision of new signalled intersections at Lorimer St would reduce capacity along Lorimer St.

Foundry Way

- Foundry Way is currently used to access Yarras Edge. There are alternative accesses into the development. Introduction of light rail along the alignment would require closure to general traffic, although access would need to be maintained to adjacent properties.

Rogers Street

- Rogers Street ranges from approximately 17m to 23m in width between kerbs and nature strips ranging from 1.5 to 4.0m. Parallel or angled parking is provided on both sides of the road.
- The width required for the bridge or underpass structure would be approximately 15m, and so local road widening utilising the current nature strips would be needed to maintain access into frontages at some locations. Parking would need to be banned along both sides of the road along certain sections.

Ingles Street

- The extent of impacts along Ingles Street will depend on whether a bridge or tunnel is provided to traverse the freeway, and the alignment of the structure. An alignment to the west of the existing Ingles Street bridge appears to have less impact on frontage access along Ingles Street. However, further detailed assessment is needed to determine the extent of the impact on frontages of the bridge or tunnel structures.

Fennell Street

- Fennel Street is approximately 15m wide between kerbs with nature strips approximately 5m wide on either side. Parallel or angled parking is provided on both sides of the road. A wide lane of 4.1m can be maintained in each direction adjacent to the tram tracks. Parking would need to be banned, although there is the potential to reduce the nature strip to maintain some parking and/or provide cycle lanes. Local widening of at least 4.5m would be needed adjacent to stops.

Plummer Street

- Plummer Street is only 12m wide. As such, a segregated light rail cannot be provided unless the road is widened along the entire length. Provision of 3.5m traffic lanes adjacent to the tram tracks would require widening by 1.8m. Additionally, all on street parking would need to be banned.
- Access to, and egress from, properties along Plummer Street would be affected. Many businesses requiring heavy vehicles are located within Plummer Street.

4.5 Journey Time and Rolling Stock Requirements

Route Option 1A is a more direct route (compared to Option 1) into Fishermans Bend, passing through 4 or 5 signalised intersections, and has an average stop spacing of about 400m. As such we estimate that average journey speeds would be similar to Melbourne's average (approximately 16km/hour). For the purposes of estimating journey times and rolling stock needs, we have therefore conservatively estimated that average journey speeds are 16km/hour along Route Option 1A. This would give an average journey time for the extension (two-way) of 16 minutes, requiring 3 LRVs (based on a10 minute headway).

4.6 Operating costs

The approximate cost of operating tram services at 10 mins and 20 mins headways (as outlined in Section 2.1) along Route Option 1A is $1.26m per annum.

5. Option 2 Route Extension

5.1 Route description

The route extension would commence on the southern end of Harbour Esplanade by extending over the Yarra River along the existing northbound slip lane of the Charles Grimes Bridge. The route would run along Wurundjeri Way for approximately 150m and turn into Lorimer Street.

Two alignment options for Lorimer Street were investigated; along the central median and along the median between the northern service road and main Lorimer Street carriageway. It was concluded that the complexities involved in moving the light rail alignment from the western side of Charles Grimes Bridge into the central median through the already complex intersection of Wurundjeri Way and Lorimer Street were too great. In addition to reducing stop line capacities, this measure would introduce complex and potential confusing signalling arrangements with additional phases required for light rail movements. This option has therefore not been considered further.

Our assessment of Option 2 therefore assumes the route would utilise the northern alignment along the Lorimer Street service road.

The route would continue along the alignment of Lorimer Street before turning south to bridge over, or tunnel beneath the M1 Freeway. This alignment shift would occur east of Point Park Crescent and would traverse the M1 Freeway to reconnect with the existing road network at the northern end of Fennell Street, just to the east of the Ingles Street intersection.

South-west of the M1 Freeway, the route would run along Fennell St to Bridge St and turns into Plummer St. West of Ingles St, the route follows the same alignment as Route Option 1.

The total length of the Option 2 route extension is 2.20km.

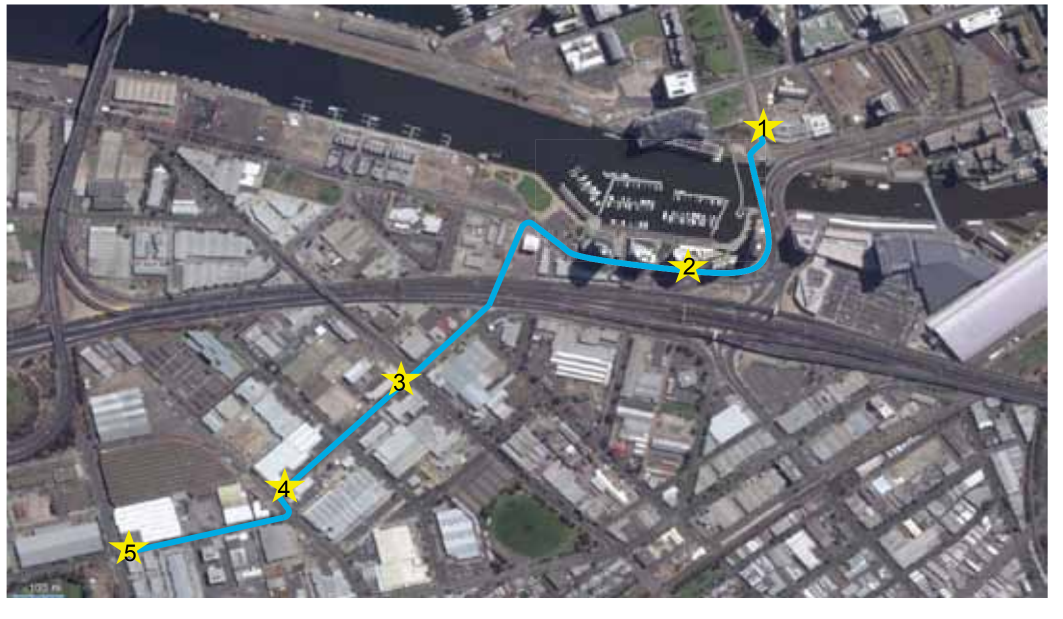


Figure 5-1: Tram extension Option 2

5.2 Stop locations

The following potential tram stop locations have been identified along Route Option 2:

1. The existing stops located on Harbour Esplanade would be retained.
2. A new pair of SFPSs would be located on Lorimer Street in close proximity to the Lorimer Street Citylink Exit ramp.
3. A new pair of SFPSs would be located adjacent to the Fennel Street/Ingles Street intersection.
4. A new pair of SFPSs would be located to the east of the Fennel Street/Bridge Street intersection.
5. A new pair of EATSs would be located adjacent to the Plummer Street/Graham Street intersection.

Table 5-1: Route Option 2 Proposed Tram Stops

Route Option 2 Proposed Tram Stops			
Approximate stop location	**New or existing stop**	**Stop type**	**Approximate distance between stops**
1. Harbour Esplanade	Existing	Retain existing SFPS and EATS	
			540m
2. Lorimer Street Exit	New	SFPSs	
			840m[4]
3. Ingles Street	New	SFPSs	
			390m
4. Bridge Street	New	SFPSs	
			430m
5. Graham Street	New	EATSs	

5.3 Vertical alignment

Route Option 2 would require the modification of an existing bridge to cross the Yarra River and the construction of another piece of infrastructure to pass the M1 Freeway.

5.3.1 Crossing of the Yarra River

The route would require modification of the existing Charles Grimes Bridge northbound slip road. This slip road currently carries northbound traffic from Wurundjeri Way to Navigation Drive and is approximately 7m wide including the footpath, with a 4.5m wide roadway catering for one traffic lane and an on-road bicycle lane. The slip road would be converted to accommodate two light rail vehicles only, with the removal of all other modes, including pedestrians. There is a pedestrian and cycle bridge (Webb Bridge) adjacent to Charles Grimes Bridge that could be used as an alternative route for pedestrians and cyclists. Alternatively, a cantilevered structure could be constructed from Charles Grimes Bridge to retain a pedestrian and cycle route across the bridge. A structural assessment of the slip road would be needed to confirm whether strengthening would be needed to accommodate trams.

All traffic using the northbound slip road would need to remain on Wurundjeri Way and use Batmans Hill Drive.

[4] The large distance between stops is primarily because the light rail is not at grade along most of this length

5.3.2 Traversing the M1 Freeway

Turning south from Lorimer Street, both bridge and tunnel options have been considered to traverse the M1 Freeway.

For the bridge, two options have been considered to span the freeway: the first provides a single 80m span similar to the Ingles Street bridge, the second provides for two 40m spans with a central pier on the freeway. Although the shorter spans allow a reduced bridge deck depth, and therefore a smaller level change for the tram, the central reserve on the freeway at this location is very narrow and innovative pier designs and construction methodology would be needed to minimise impacts on the freeway during construction and permanent operations. For this reason the 80m span option would appear to be the preferred bridge solution, albeit the greater bridge depth indicating a bridge height of approximately 8.6m would be required. This is likely to require a tram track gradient from Lorimer Street greater than the preferred 6.7% standard.

Provision of a tunnel would also require track gradients greater than the preferred 6.7% standard. A number of construction methods have been considered for a tunnel. These include a single or twin tube using a tunnel boring machine, precast segments jacked incrementally, and cut and cover. In considering these potential options, we have reviewed the geotechnical information provided by Golders for the area. Each construction methodology has different but significant issues and risks, including impact on the existing freeway structure, stability of the soil during construction, maintaining structural integrity of the tunnel and cost. In addition the cut and cover option is discounted due to unacceptable impacts on the operation of the freeway for long construction periods (likely that at least three traffic lanes would not be available at any one time).

5.4 Potential Impacts

The following potential impacts on existing roads have been identified at this stage:

Intersections

- Intersection remodelling would be required at Harbour Esplanade/Navigation Drive, Lorimer Street/Wurundjeri Way, Fennell Street/Ingles Street, Fennell Street/Bertie Street, Fennell Street/Bridge Street and Plummer Street/Bridge Street.
- As part of the remodelling, a new signalled intersection would also be needed at Lorimer Street for both the bridge and tunnel options.
- Provision of a new signalled intersection at Lorimer Street would significantly reduce capacity along Lorimer Street.

Charles Grimes Bridge Road

- Intersection remodelling would be required at Charles Grimes Bridge Road and Wurundjeri Way. The introduction of the tram route would require redirecting northbound general traffic to Docklands via Batmans Hill Drive. A detailed traffic analysis is recommended to assess the impacts of this redirected traffic, particularly in the morning peak period.

Lorimer Street

- The northern Lorimer Street service lane caters for one through lane and parallel parking on both sides side of the street. The median, including the southern parking bays, is approximately 4.5m wide. The installation of a tram route within the existing median will mean

that parking would be restricted to the northern kerb of the service road only. The main Lorimer Street carriageway and traffic lanes would also need to be realigned to accommodate the tram.
- Access to and from frontages on the north side of Lorimer Street are likely to be impacted.

Fennell Street

- Fennel Street is approximately 15m wide between kerbs with nature strips varying between 5m and 7m wide on either side. Parallel or angled parking is provided on both sides of the road. For the section east of Ingles Street, the width required for the bridge or underpass structure would be approximately 15m, and so local road widening utilising the current nature strips would be needed to maintain access to frontages, particularly as these are used by larger trucks. Parking would need to be banned along both sides of the road along this section.
- To the west of Ingles Street, a wide lane of 4.1m can be maintained in each direction adjacent to the tram tracks. Parking would need to be banned, although there is the potential to reduce the nature strip to maintain some parking and/or provide cycle lanes. Local widening of at least 4.5m would be needed adjacent to stops.

Plummer Street

- Plummer Street is only 12m wide. As such, a segregated light rail cannot be provided unless the road is widened along the entire length. Provision of 3.5m traffic lanes adjacent to the tram tracks would require widening by 1.8m. Additionally, all on street parking would need to be banned.
- Access to, and egress from, properties along Plummer Street would be affected. Many businesses requiring heavy vehicles are located within Plummer Street.

5.5 Journey Time and Rolling Stock Requirements

Route Option 2 is a relatively direct route with an average stop spacing of about 550m. However, the route would pass through 5 or 6 signalised intersections and has a number of acute turns. As such we estimate that average journey speeds would be equal to Melbourne's average (approximately 16km/hour). The estimated average travel speed would give an average journey time for the extension (two-way) of 16.5 minutes, requiring 2 or 3 LRVs (based on a 10 minute headway).

5.6 Operating costs

The approximate cost of operating tram services at 10 mins and 20 mins headways (as outlined in Section 2.1) along Route Option 2 is $1.31m per annum.

6. Option 3 Route Extension

6.1 Route description

The route extension commences on Collins Street, Docklands, by extending over the Yarra River in close proximity to the ANZ Centre. The river is approximately 175m wide along this alignment. On the south side of the river the route crosses Lorimer Street, either at grade or on an elevated structure, through land that is currently not developed to then either bridge over, or tunnel underneath, the M1 Freeway.

South-west of the M1 Freeway, the route emerges in Fennell Street to the north-east of the Ingles Street intersection. The route then continues along Fennell Street to Bridge Street and into Plummer Street.

It is noted that west of Ingles Street, all route options are the same.

The total length of the Option 3 route extension is 1.75km.

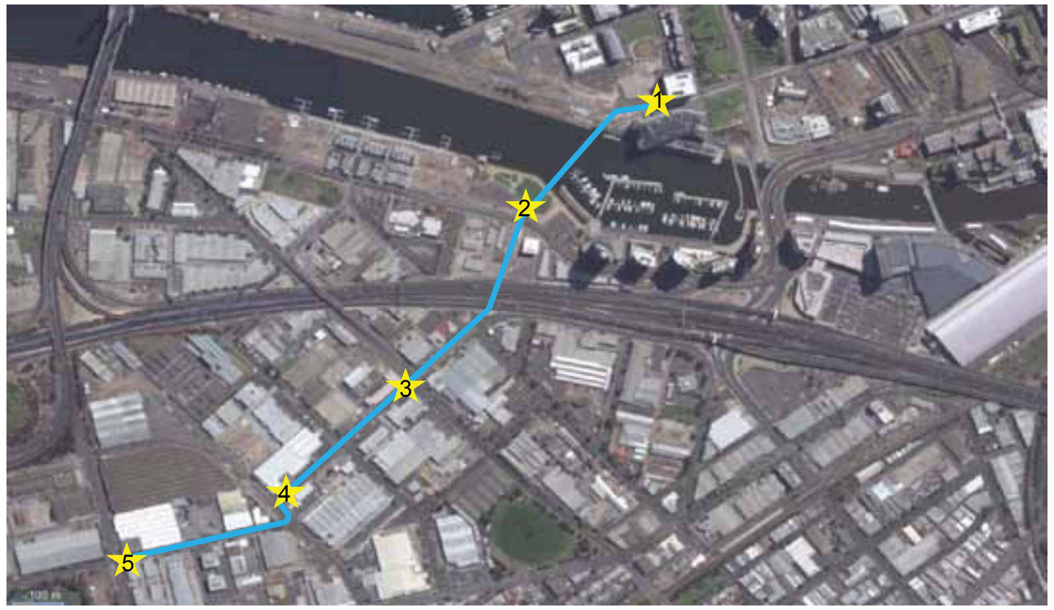


Figure 6-1: Tram extension Option 3

6.2 Stop locations

The following potential tram stop locations have been identified along Route Option 3:

1. The existing stop located outside the ANZ Centre on Collins Street would be retained.
2. A new pair of SFPSs would be located in close proximity to Lorimer Street. The location of these stops would depend on the preferred structure selected to traverse the river and M1 Freeway.
3. A new pair of SFPSs would be located adjacent to the Fennel Street/Ingles Street intersection.

4. A new pair of SFPSs would be located to the east of the Fennel Street/Bridge Street intersection.
5. A new pair of EATSs would be located adjacent to the Graham Street intersection.

Table 6-1: Route Option 3 Proposed Tram Stops

Route Option 3 Proposed Tram Stops			
Approximate stop location	**New or existing stop**	**Stop type**	**Approximate distance between stops**
1. ANZ Centre Collins Street	Existing	Retain existing SFPSs	430m
2. Lorimer Street	New	SFPSs	500m
3. Ingles Street	New	SFPSs	390m
4. Bridge Street	New	SFPSs	430m
5. Graham Street	New	EATSs	

6.3 Vertical alignment

Route Option 3 would require the construction of two significant pieces of infrastructure to cross the Yarra River and M1 Freeway.

6.3.1 Crossing of the Yarra River

The route would require a bridge to traverse the Yarra River. The width of the river crossing at the point of the proposed alignment is approximately 175m.

The bridge could be constructed to provide clearance of 3.5m to 6.0m over the Yarra River and would provide an elevated structure for light rail, cyclist and pedestrians over an approximate length of 350m.

6.3.2 Traversing the M1 Freeway

The M1 Freeway is approximately 75 metres wide at the crossing point. Options to bridge over or tunnel under have been investigated. Key to consideration of the most appropriate structure is constructability and in particular the need to minimise disruption to the M1 Freeway – Melbourne's major east west route carrying over 160,000 vehicles per day. Beyond the river, there are three options to pass the M1 Freeway:

1. **Extend the Yarra River bridge structure over Lorimer Street and the M1 Freeway:** This option would provide an elevated structure for light rail, cyclist and pedestrians over an approximate length of 600m (Yarra River and M1 Freeway clearance). Clearance over both Lorimer St and the freeway would meet VicRoads design guidance. Ramps would be provided near Lorimer Street to provide access to street level for pedestrians and cyclists.

   To the south of the freeway, the elevated structure would land in the centre of Fennell Street, to the east of the Ingles Street intersection.

The main benefits would be a smoother journey for light rail users due to the reduced rise and fall of the alignment. The elevated structure would also eliminate conflicts with other traffic at the Lorimer St intersection as well adjacent frontages. This alignment could also present opportunities to integrate the light rail into development of the block between Lorimer Street and the M1 Freeway, enabling development both below and above the light rail so that the light rail becomes an attraction to the development rather than additional infrastructure.

2. **Terminate the Yarra River bridge structure prior to Lorimer Street and construct a separate bridge structure to pass over the freeway:**
   In this option the bridge over the river returns to street level north of Lorimer Street so that an accessible at-grade stop can be provided at Lorimer Street. Both 3.5m and 6m clearance bridges can be provided, albeit the 6m clearance over a shorter span.

   Immediately south of Lorimer Street, the light rail climbs onto a second bridge that spans the M1 Freeway. Two options have been considered to span the freeway: the first provides a single 80m span similar to the Ingles Street bridge, the second provides for two 40m spans with a central pier on the freeway. Although the shorter spans allow a reduced bridge deck depth, and therefore a smaller level change for the tram, the central reserve on the freeway at this location is very narrow and innovative pier designs and construction methodology would be needed to minimise impacts on the freeway during construction and permanent operations. For this reason the 80m span option would appear to be the preferred bridge solution, albeit the greater bridge depth indicating a bridge height of approximately 8.6m would be required. This is likely to require a tram track gradient from Lorimer Street greater than the preferred 6.7% standard.

   South of the freeway the bridge structure would land in the centre of Fennell Street as in the elevated structure option.

3. **Terminate the Yarra River bridge structure prior to Lorimer Street and tunnel beneath the freeway:**
   In this option, the bridge over the river to Lorimer Street is the same as for the second option above.

   South of Lorimer Street the light rail goes into a tunnel under the freeway to emerge in the centre of Fennell Street.

   A number of construction methods have been considered for a tunnel. These include a single or twin tube using a tunnel boring machine, precast segments jacked incrementally, and cut and cover. In considering these potential options, we have reviewed the geotechnical information provided by Golders for the area. Each construction methodology has different but significant issues and risks, including impact on the existing freeway structure, stability of the soil during construction, maintaining structural integrity of the tunnel and cost. In addition the cut and cover option is discounted due to unacceptable impacts on the operation of the freeway for long construction periods (likely that at least three traffic lanes would not be available at any one time).

   Our conclusion is that a large span bridge over the freeway, whether as a separate bridge or larger elevated structure, appears to offer the best potential a new light rail route to traverse the M1 freeway. Sketches of potential bridge structures are provided in the appendix to this report.

6.4 Potential impacts

The following potential impacts on existing roads have been identified at this stage:

Intersections

- Major intersection remodelling would be required at Collins Street/Merchant Street, Fennell Street/Ingles Street, Fennell Street/Bertie Street, Fennell Street/Bridge Street and Plummer Street/Bridge Street.
- A new signalled intersection would also be needed at Lorimer Street for all options where the light rail alignment is at-grade at this intersection.
- Provision of a new signalled intersection at Lorimer Street would significantly reduce capacity along Lorimer Street. Access from properties adjacent to the new intersection would also need to be reviewed.

Fennel Street

- Fennel Street is approximately 15m wide between kerbs with nature strips varying between 5m and 7m wide on either side. Parallel or angled parking is provided on both sides of the road. For the section east of Ingles St, the width required for the bridge or underpass structure would be approximately 15m, and so local road widening utilising the current nature strips would be needed to maintain access to frontages, particularly as these are used by larger trucks. Parking would need to be banned along both sides of the road along this section.
- To the west of Ingles Street, a wide lane of 4.1m can be maintained in each direction adjacent to the tram tracks. Parking would need to be banned, although there is the potential to reduce the nature strip to maintain some parking and/or provide cycle lanes. Local widening of at least 4.5m would be needed adjacent to stops.

Plummer Street

- Plummer Street is only 12m wide. As such, a segregated light rail cannot be provided unless the road is widened along the entire length. Provision of 3.5m traffic lanes adjacent to the tram tracks would require widening by 1.8m. Additionally, all on street parking would need to be banned.
- Access to, and egress from, properties along Plummer Street would be affected. Many businesses requiring heavy vehicles are located within Plummer Street.

6.5 Journey time and rolling stock requirements

Route Option 3is a relatively direct route, passing through 3 or 4 signalised intersections with few turning movements required and an average stop spacing of about 450m. As such we estimate that average journey speeds would be higher than Melbourne's average (approximately 16km/hour), but lower than the true light rail sections of the network, such as route 109 through South Melbourne (average speed 25km/hour). For the purposes of estimating journey times and rolling stock needs, we have therefore conservatively estimated that average journey speeds are 20km/hour along Route Option 3. This would give an average journey time for the extension (two-way) of 10.5 minutes, requiring 2 or 3 LRVs (based on 10 minute headways).

6.6 Operating costs

High level operating costs (opex) have been estimated based on a generic cost rate of $7 per tram kilometre as advised by Yarra Trams. It should be noted that these general operation costs include items such as labour but exclude items such as track maintenance and power. The approximate cost of operating tram services at 10 mins and 20 mins headways (as outlined in Section 2.1) along Route Option 3 is $1.05m per annum.

7. Option 4 Route Extension

7.1 Route description

This route follows the same alignment as Option 3 over the Yarra River cross from Collins Street, in Docklands, in close proximity to the ANZ Centre, to Lorimer Street. The route then turns along the alignment of Lorimer Street before turning into turning into Rogers Street. From Rogers Street, the route would be required to bridge over, or tunnel underneath, the M1 Freeway approximately along the alignment of Ingles Street.

South-east of the M1 Freeway, the route would run along Ingles St before turning into Fennell St.

West of Ingles St, the route follows the same alignment as Route Option 1.

The total length of the Option 3B route extension is 2.2km.

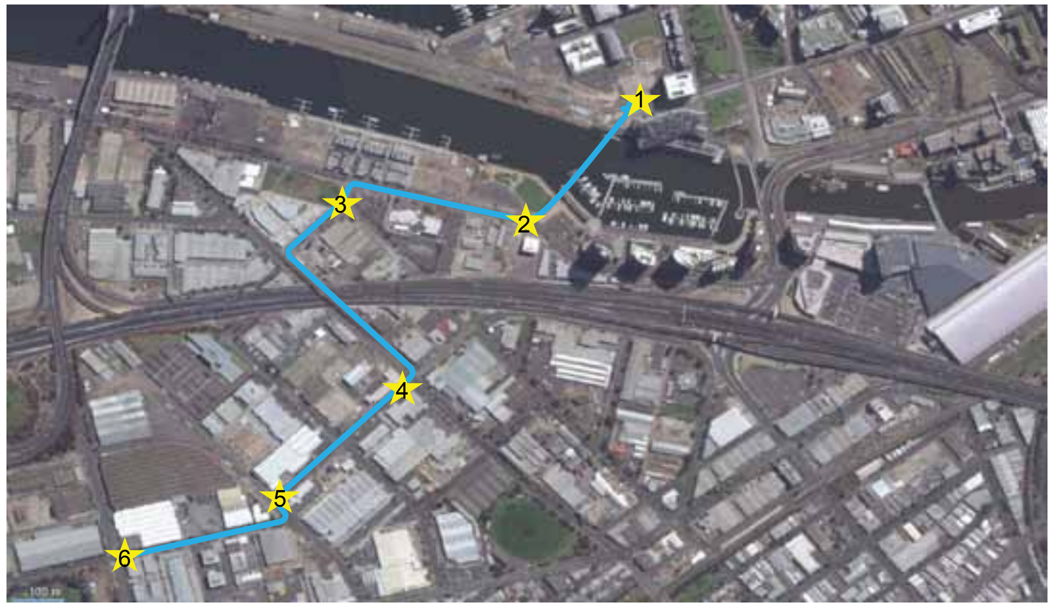


Figure 7-1: Tram extension Option 4

7.2 Stop locations

The following potential tram stop locations have been identified along Route Option 4:

1. The existing stop located outside the ANZ Centre on Collins Street would be retained.
2. A new pair of SFPSs would be located in close proximity to Lorimer Street.
3. A new pair of SFPSs would be located on Lorimer Street, just east of Rogers Street.
4. A new pair of SFPSs would be located on Fennell Street, to the south- west of the Ingles St intersection.
5. A new pair of SFPSs would be located to the east of the Bridge Street intersection.
6. A new pair of EATSs would be located adjacent to the Graham Street intersection.

Table 7-1: Route Option 4 Proposed Tram Stops

Route Option 4 Proposed Tram Stops

Approximate stop location	New or existing stop	Stop type	Approximate distance between stops
1. ANZ Centre Collins Street	Existing	Retain existing SFPSs	540m
2. Lorimer Street	New	SFPSs	340m
3. Lorimer Street	New	SFPSs	675m
4. Fennell Street	New	SFPSs	390m[5]
5. Bridge Street	New	SFPSs	430m
6. Graham Street	New	EATSs	

7.3 Vertical alignment

Route Option 4 would require the modification of an existing bridge to cross the Yarra River and the construction of another piece of infrastructure to pass the M1 Freeway.

7.3.1 Crossing of the Yarra River

Crossing of the Yarra River would be via a new bridge as described in Option 3.

7.3.2 Traversing the M1 Freeway

Traversing the freeway would be via a bridge or tunnel as described in Option 1.

7.4 Potential Impacts

The following potential impacts on existing roads have been identified at this stage:

Intersections

- Major intersection remodelling would be required at Collins Street/Merchant Street, Fennell Street/Ingles Street, Fennell Street/Bertie Street, Fennell Street/Bridge Street and Plummer Street/Bridge Street.
- A new signalled intersection would also be needed at Lorimer Street for all options where the light rail alignment is at-grade at this intersection.
- Provision of a new signalled intersection at Lorimer Street would significantly reduce capacity along Lorimer Street. Access from properties adjacent to the new intersection would also need to be reviewed.
- Intersection remodelling would be required at Harbour Esplanade/Navigation Drive, Lorimer Street/Wurundjeri Way, Lorimer Street/Rogers Street, Fennell Street/Ingles Street, Fennell Street/Bertie Street, Fennell Street/Bridge Street and Plummer Street/Bridge Street.

[5] The large distance between stops is primarily because the light rail is not at grade along most of this length

- As part of the remodelling, a new signalled intersection would also be needed at Lorimer Street/ Rogers Street.
- Provision of new signalled intersections at Lorimer Street would significantly reduce capacity along Lorimer Street.

Lorimer Street

- Along this section of the Lorimer Street the road currently comprises of two traffic lanes and bicycle lane in each direction with a median strip (approx. 17m wide). There is also a nature strip on along the south side of the road. Maintaining the current traffic and cycle lane configuration with trams with segregated light rail in the centre of the road will require the removal of the central median and nature strip. The number of traffic lanes would be reduced to one in each direction near around any stops located in Lorimer Street.
- Parking would need to be banned along this section of Lorimer Street.
- Access to and from frontages on the north side of Lorimer Street are likely to be impacted.

Rogers Street

- Rogers Street ranges from approximately 17m to 23m in width between kerbs and nature strips ranging from 1.5 to 4.0m. Parallel or angled parking is provided on both sides of the road
- The width required for the bridge or underpass structure would be approximately 15m, and so local road widening utilising the current nature strips would be needed to maintain access into frontages at some locations. Parking would need to be banned along both sides of the road along certain sections.

Ingles Street

- The extent of impacts along Ingles Street will depend on whether a bridge or tunnel is provided to traverse the freeway, and the alignment of the structure. An alignment to the west of the existing Ingles Street bridge appears to have less impact on frontage access along Ingles Street. However, further detailed assessment is needed to determine the extent of the impact on frontages of the bridge or tunnel structures.

Fennell Street

- Fennel Street is approximately 15m wide between kerbs with nature strips approximately 5m wide on either side. Parallel or angled parking is provided on both sides of the road. A wide lane of 4.1m can be maintained in each direction adjacent to the tram tracks. Parking would need to be banned, although there is the potential to reduce the nature strip to maintain some parking and/or provide cycle lanes. Local widening of at least 4.5m would be needed adjacent to stops.

Plummer Street

- Plummer Street is only 12m wide. As such, a segregated light rail cannot be provided unless the road is widened along the entire length. Provision of 3.5m traffic lanes adjacent to the tram tracks would require widening by 1.8m. Additionally, all on street parking would need to be banned.
- Access to, and egress from, properties along Plummer Street would be affected. Many businesses requiring heavy vehicles are located within Plummer Street.

7.5 Journey Time and Rolling Stock Requirements

Route Option 4 is a relatively direct route that would pass through 5 or 6 signalised intersections. The route has a number of turning movements and an average stop spacing of about 410m. As such we estimate that average journey speeds would be near to Melbourne's average (approximately 16km/hour). The estimated average travel speed would give an average journey time for the extension (two-way) of 16.5 minutes, requiring 3 LRVs (based on a 10 minute headway).

7.6 Operating costs

The approximate cost of operating tram services at 10 mins and 20 mins headways (as outlined in Section 2.1) along Route Option 4 is $1.31m per annum

8. Option 5 Route Extension

8.1 Route description

The Option 5 route commences at the Route 109 light rail corridor where it turns north along Ingles Street before turning before turning into the western section of Fennell Street. West of Ingles Street the route follows the same alignment as Route Option 1.

The total length of the Option 5 route extension is 1.57km.

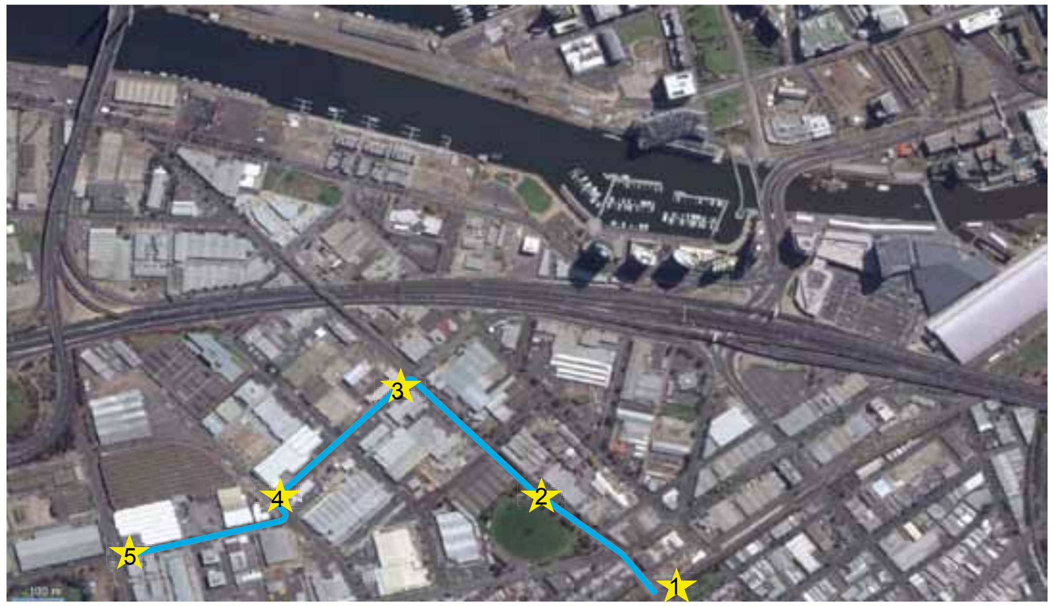


Figure 8-1: Tram extension Option 5

8.2 Stop locations

The following potential tram stop locations have been identified along Route Option 5:

1. A new pair of SFPSs would be located in the route 109 light rail corridor, just east of Ingles Street.
2. A new pair of SFPSs would be located on Ingles Street adjacent to the Port Melbourne Cricket Ground.
3. A new pair of SFPSs would be located on Fennell St, to the south- west of the Ingles Street intersection.
4. A new pair of SFPSs would be located to the east of the Bridge Street intersection.
5. A new pair of EATSs would be located adjacent to the Graham Street intersection.

Table 8-1: Route Option 5 Proposed Tram Stops

Route Option 4 Proposed Tram Stops			
Approximate stop location	**New or existing stop**	**Stop type**	**Approximate distance between stops**
1. Light Rail Corridor	New	SFPSs	330m
2.Port Melbourne Cricket Ground	New	SFPSs	420m
3. Ingles Street	New	SFPSs	390m
4. Bridge Street	New	SFPSs	430m
5. Graham Street	New	EATSs	

8.3 Vertical alignment

Route Option 5 will run at grade for the entire extension. The route does not require any grade separations, as it avoids conflict with major roadways (M1) and the Yarra River.

8.4 Potential Impacts

Route 109 Corridor

- At present Route 109 has full priority along the light rail corridor at Ingles Street.

Intersections

- Intersection remodelling would be required at Ingles Street/Route 109 crossing, Ingles Street/Normanby Road/Williamstown Road, Ingles Street/Munro Street, Ingles Street/Woodruff Street and Fennell Street/Bertie Street.
- New signalled intersections would be required at Fennell Street/Ingles Street, Fennell Street/Bridge Street and Plummer Street/Bridge Street to allow tram turning movements.

Ingles Street

- Ingles Street varies in width between 18.0m, close to the light rail corridor, and 22.0m. Parallel parking is currently provided on both sides of the street and angled parking is provided on the east side. Without road widening, some on-street parking provision would be lost as angled parking would have to be replaced by parallel parking with removal of all on-street parking adjacent to stops.

Fennell Street

- Fennel Street is approximately 15m wide between kerbs with nature strips approximately 5m wide on either side. Parallel or angled parking is provided on both sides of the road. A wide lane of 4.1m can be maintained in each direction adjacent to the tram tracks. Parking would need to be banned, although there is the potential to reduce the nature strip to maintain some parking and/or provide cycle lanes. Local widening of at least 4.5m would be needed adjacent to stops.

Plummer Street

- Plummer Street is only 12m wide. As such, a segregated light rail cannot be provided unless the road is widened along the entire length. Provision of 3.5m traffic lanes adjacent to the tram tracks would require widening by 1.8m. Additionally, all on street parking would need to be banned.
- Access to, and egress from, properties along Plummer Street would be affected. Many businesses requiring heavy vehicles are located within Plummer Street.

8.5 Journey Time and Rolling Stock Requirements

Route Option 5 is a direct route that would pass through 3 or 4 signalised intersections. The route is relatively short with a number of turning movements and an average stop spacing of about 400m. As such we estimate that average journey speeds would be equal to Melbourne's average (approximately 16km/hour). The estimated average travel speed would give an average journey time for the extension (two-way) of 11.8 minutes, requiring 2 or 3 LRVs (based on a10 minute headway).

8.6 Operating costs

The approximate cost of operating tram services at 10 mins and 20 mins headways (as outlined in Section 2.1) along Route Option 5 is $0.94m per annum.

9. Yarra River Bridge Options

9.1 Yarra River bridge options

A number of horizontal alignments are considered for crossing the river within this study. Vertical alignments have been considered with clearances (water to underside of the structure) of between 3.5m and 6.0m for a fixed bridge. All crossing alignments can accommodate this clearance using a fixed bridge structure, based on maximum gradients for light rail vehicles of 6.7%. However, these clearances would preclude the passage of vessels that require higher vertical clearance. It is noted that the marina opposite the ANZ building includes tall mast yachts over 6m.

A fixed bridge with a higher vertical clearance could be designed but this would require potentially unacceptable impacts on the approaches to the crossing. A potential solution would be to provide a bridge that can be opened to allow the passage of vessels requiring a clearance over 6m. However, an opening bridge does have several inherit disadvantages which mainly include:

- Increased and sophisticated maintenance requirements;
- Potential for operational problems;
- Safety concerns associated with movement of the bridge;
- Disruption to traffic when the span is drawn; and
- More complex design considerations that require interdisciplinary coordination of structural, mechanical and electrical components.

The three major categories of opening bridges are bascule, swing and vertical lift. This list is not exclusive and there are other types that are not commonly used.

Bascule bridge:

The bascule span leaf (or leaves if there are two) rotates from the horizontal (closed) position to the vertical (open) position to allow use of the waterway below. Bascules fall into two general categories: trunnion bascules or rolling lifts.

The trunnion has a fixed point of rotation located at or near the centre of gravity of the movable span, while on the rolling lift bridges, the centre of rotation of the span moves in a vertical plane as the span opens and closes.

Within rolling lifts, the movable span rolls back from the channel as it rotates. This allows for rolling lift spans to be shorter, and require a lesser angle of opening in comparison to a trunnion bascule in order to achieve the same channel clearances.

Swing bridge:

Swing bridges pivot in a horizontal plane about a centre support, usually providing two navigation channels of equal width. Typically the span swings open 90 degrees to allow vessels to pass, creating unlimited vertical clearance.

The pivot pier could require an elaborate, difficult-to-maintain, and expensive fender system. As a result, swing spans are infrequently used for movable spans. However, they can be a cost-effective solution, particularly for a double-swing span.

Vertical lift bridge:

Vertical lift bridges consist of simple spans that are raised vertically when the span operates. Towers at each end of the lift span contain sheaves over which wire ropes pass. These wire ropes connect to each corner of the span and to counterweights within the towers. At the top of the towers, trunnion shafts and bearings support the sheaves, and thus the full weight of the lift span and counterweight.

The proposed opening bridge type for the Fishermans bend over the Yarra River should be selected based on the following main criteria:

- Minimal maintenance and operation work;
- Speed of opening and closing and therefore interruption time to traffic;
- Simplicity and therefore less operation problems; and
- Short and long term costs.

A detailed comparison must be carried out based on the latest bridge configuration and available technologies in order to select the most appropriate movable span(s) type.

At this stage, it looks that a Bascule type span could be the most suitable opening span option. Typically opening times for a Bascule Bridge are 5-10 minutes. This would obviously impact light rail services during the peak periods when a 10 minute service would operate in each direction, equivalent to one service crossing the river every 5 minutes. However, outside peak periods, when a 20 minute service operates, it appears that a Bascule type bridge could be introduced without significantly impacting light rail services.

10. Discussion

10.1 Evaluation of Options

During the course of this study Aurecon has considered a number of horizontal and vertical alignments for the extension of the tram/light rail network into Fishermans Bend. Table 10.1 summarises some key features of each option.

Table 10-1: Comparison of route options

Comparison of Route Options						
	Option 1	**Option 1A**	**Option 2**	**Option 3**	**Option 4**	**Option 5**
Route length	2.20km	2.77km	2.75km	1.75km	2.10km	1.57km
Number of proposed stops	4	6	5	4	5	5
Journey time (two way)	16.5mins	20.8mins	25.7mins	10.5mins	16.5mins	11.8mins
Operating cost ($/annum)	$1.31m	$1.66m	$1.54m	$1.05m	$1.31m	$0.94m
Rolling stock requirement	3	3	4	2	3	2
Impacts on road network operations	Medium	Medium	High	Low/Medium	High	Low
Major infrastructure requirements (to pass Yarra River and M1 Freeway)	1	1	2	2	2	0

Each route assessed presents different major issues to overcome. The major barriers to extending the tram network into Fishermans Bend are the Yarra River and M1 Freeway.

The most western of the new river crossings are proposed in the Options 1 and 1A alignments, crossing the river from the extended Collins Street Wharf alignment. Accommodating the bridge and ramps here will require changes to the proposed road geometry approved for the Victoria Harbour Development Plan. These options also use the Ingles Street alignment to traverse the M1 freeway, requiring a new bridge or tunnel parallel to the existing road bridge. The new structure, whether bridge or tunnel would need to begin in Rogers St close to the intersection with Lorimer Street and has significant impacts on access and property along both Rogers Street and Ingles Street.

Option 2 considers the use of Charles Grimes Bridge slip road to cross the river. Although this appears feasible, there would be major impacts on the already complex and busy Montague Street/Lorimer Street intersection, which is also a key route into Docklands from the south and west. Without area wide traffic management, this option is likely to lead to adverse traffic impacts over a wide area, including the M1 Freeway.

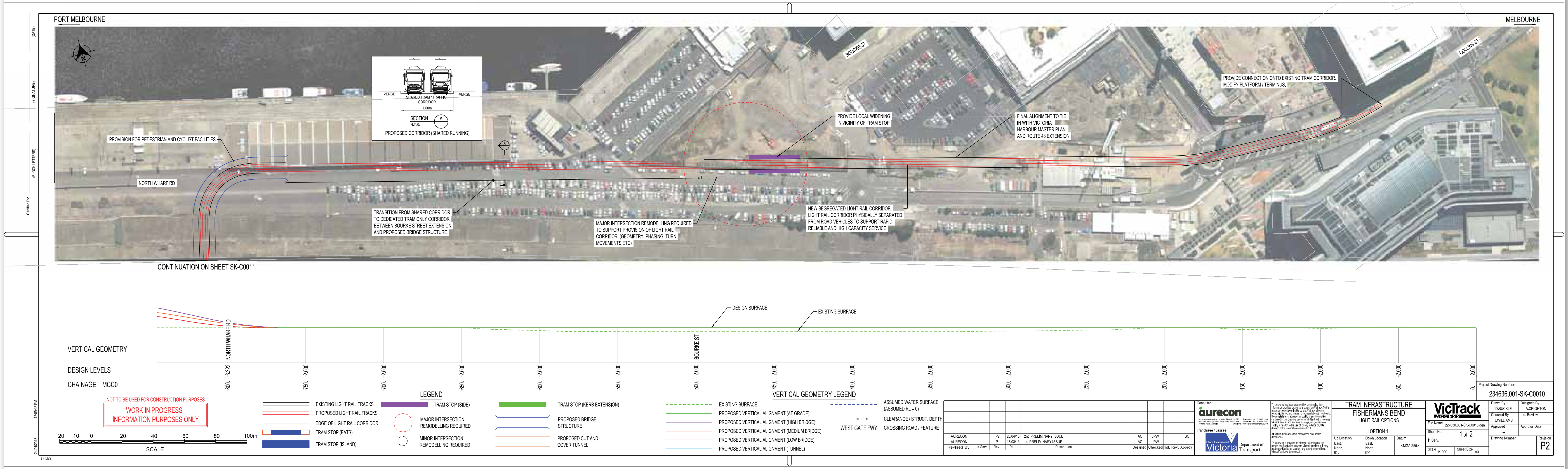
Of the new river crossings the most direct route into Fishermans Bend is that proposed in Options 3 and 4. Option 3 also provides a feasible route over the M1 Freeway, with the continuous elevated structure across the river and freeway being the preferable option from a traffic operation and constructability perspective.

Option 5 does not require a new crossing of the river or freeway, being a spur from the existing Route 109 corridor through South Melbourne. The major considerations for this option are likely to be network performance and impact on existing tram routes outside the study area, notably through Spencer Street. These are outside the scope of this study.

Finally we have considered crossing of the M1 freeway along all alignments either by bridge or tunnel. Given the need to provide passage for two light rail vehicles, pedestrians and cyclists, we have concluded that a bridge option, most likely a single span across the freeway, is the preferred option based on available geotechnical information, constructability and impacts on the freeway both during construction and on completion.

Appendix A

Concept Plans and Typical Cross Sections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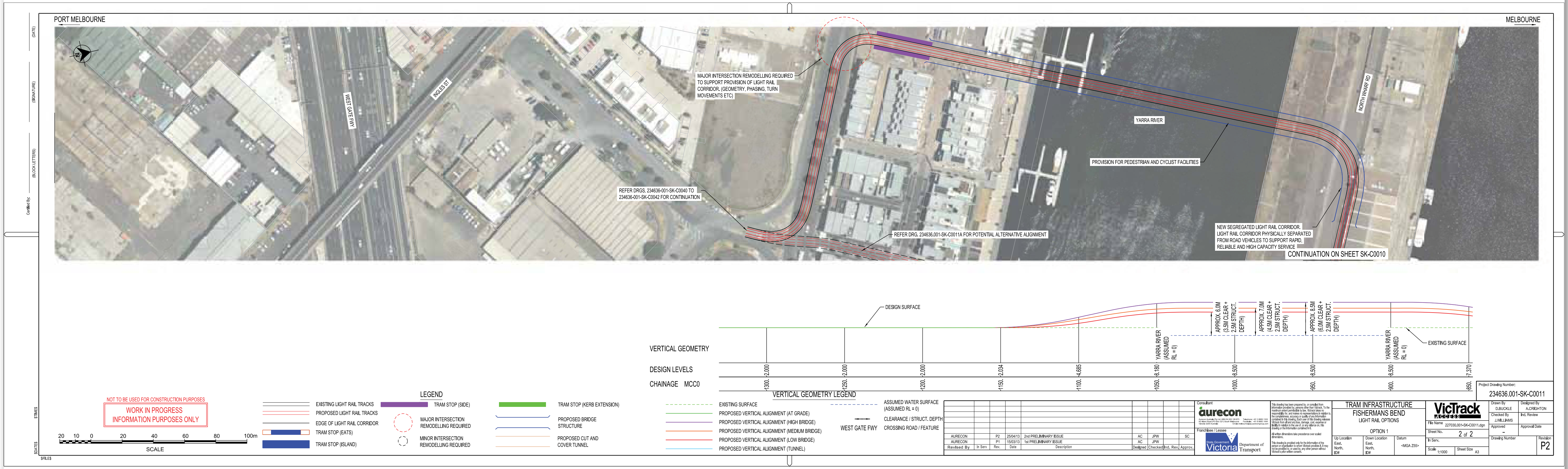
MELBOURNE
SECTION A
N.T.S.
PROPOSED CORRIDOR (SHARED RUNNING)
PROVISION FOR PEDESTRIAN AND CYCLIST FACILITIES
NORTH WHARF RD
TRANSITION FROM SHARED CORRIDOR TO DEDICATED TRAM ONLY CORRIDOR BETWEEN BOURKE STREET EXTENSION AND PROPOSED BRIDGE STRUCTURE
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
PROVIDE LOCAL WIDENING IN VICINITY OF TRAM STOP
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
FINAL ALIGNMENT TO TIE IN WITH VICTORIA HARBOUR MASTER PLAN AND ROUTE 48 EXTENSION
PROVIDE CONNECTION ONTO EXISTING TRAM CORRIDOR. MODIFY PLATFORM / TERMINUS.
BOURKE ST
COLLINS ST
CONTINUATION ON SHEET SK-C0011
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
NORTH WHARF RD
BOURKE ST
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL ± 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
P2 2nd PRELIMINARY ISSUE
P1 1st PRELIMINARY ISSUE
aurecon
Victoria
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 1
VicTrack
234636.001-SK-C0010
1 of 2
P2


PORT MELBOURNE
MELBOURNE
WEST GATE FWY
INGLES ST
NORTH WHARF RD
YARRA RIVER
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
REFER DRGS. 234636-001-SK-C0040 TO 234636-001-SK-C0042 FOR CONTINUATION
REFER DRG. 234636.001-SK-C0011A FOR POTENTIAL ALTERNATIVE ALIGNMENT
PROVISION FOR PEDESTRIAN AND CYCLIST FACILITIES
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
CONTINUATION ON SHEET SK-C0010
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
VERTICAL GEOMETRY LEGEND
LEGEND
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL ± 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
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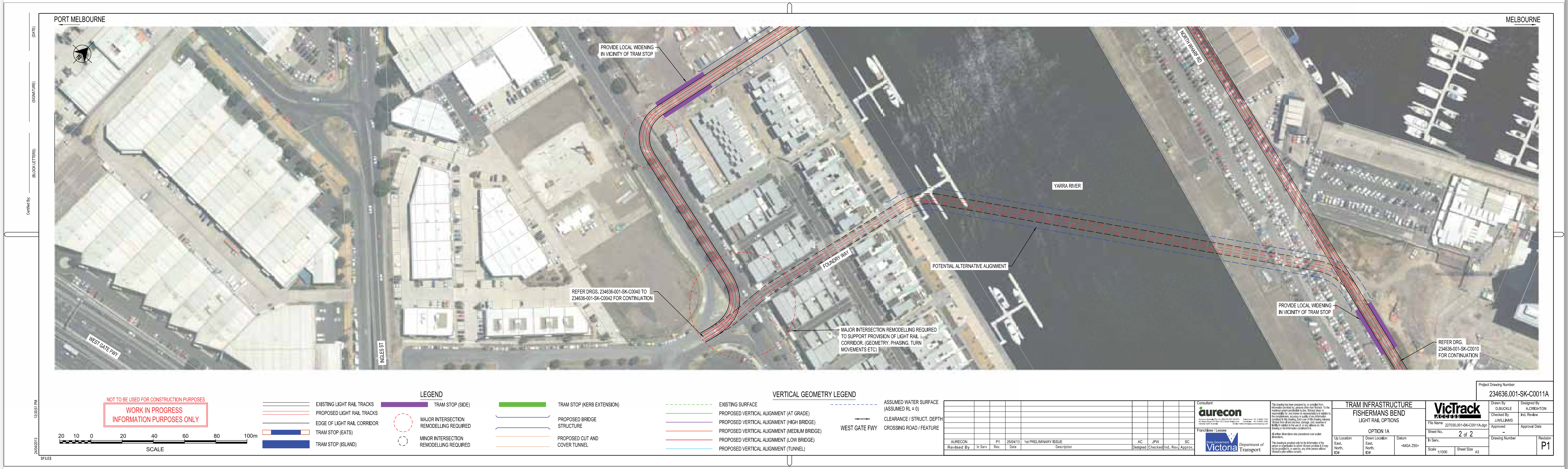
Victoria Department of Transport
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 1
VicTrack
234636.001-SK-C0011
P2
P2 2nd PRELIMINARY ISSUE
P1 1st PRELIMINARY ISSUE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MELBOURNE
PROVIDE LOCAL WIDENING IN VICINITY OF TRAM STOP
NORTH WHARF RD
YARRA RIVER
FOUNDRY WAY
POTENTIAL ALTERNATIVE ALIGNMENT
REFER DRGS. 234636-001-SK-C0040 TO 234636-001-SK-C0042 FOR CONTINUATION
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WEST GATE FWY
INGLES ST
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
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SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
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Revised By In Serv Rev. Date Description Designed Checked Ind. Rev. Approv.
Consultant
aurecon
Franchisee / Lessee
State Government Victoria Department of Transport
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 1A
Project Drawing Number:
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Drawn By D.BUCKLE
Designed By A.CRIGHTON
Checked By J.WILLIAMS
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Datum <MGA Z55>
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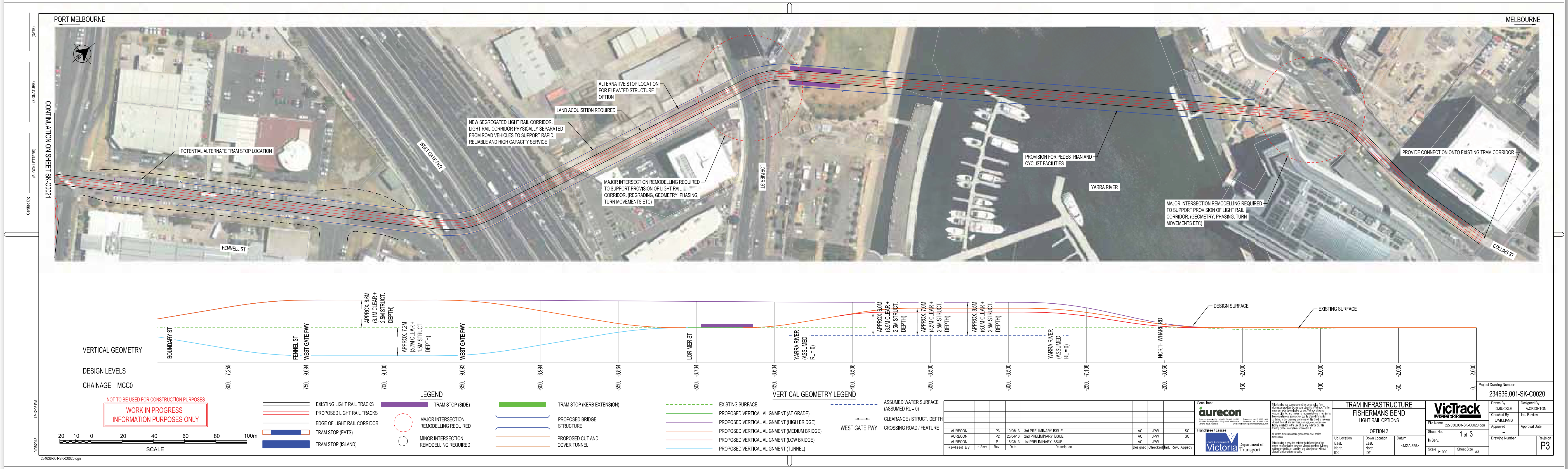
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MELBOURNE
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POTENTIAL ALTERNATE TRAM STOP LOCATION
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LAND ACQUISITION REQUIRED
ALTERNATIVE STOP LOCATION FOR ELEVATED STRUCTURE OPTION
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (REGRADING, GEOMETRY, PHASING, TURN MOVEMENTS ETC)
LORIMER ST
PROVISION FOR PEDESTRIAN AND CYCLIST FACILITIES
YARRA RIVER
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
PROVIDE CONNECTION ONTO EXISTING TRAM CORRIDOR
COLLINS ST
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
BOUNDARY ST
FENNEL ST
WEST GATE FWY
NORTH WHARF RD
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
aurecon
VicTrack
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 2
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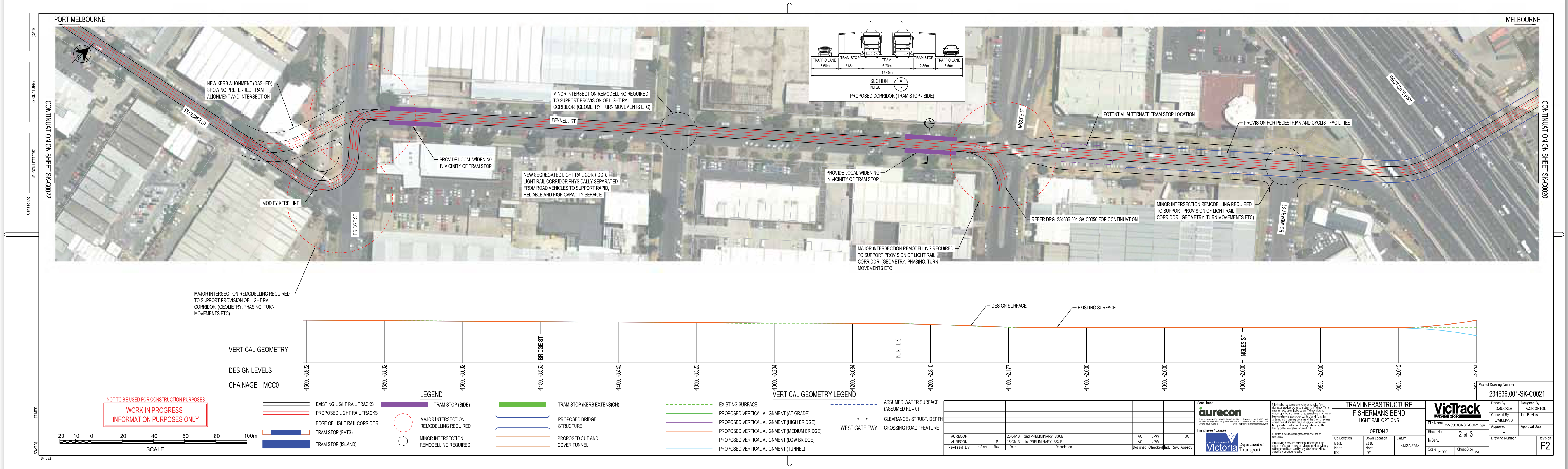

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CONTINUATION ON SHEET SK-C0020
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MODIFY KERB LINE
BRIDGE ST
FENNELL ST
MINOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, TURN MOVEMENTS ETC)
PROVIDE LOCAL WIDENING IN VICINITY OF TRAM STOP
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
SECTION
PROPOSED CORRIDOR (TRAM STOP - SIDE)
TRAFFIC LANE
TRAM STOP
TRAM
INGLES ST
BOUNDARY ST
WEST GATE FWY
POTENTIAL ALTERNATE TRAM STOP LOCATION
PROVISION FOR PEDESTRIAN AND CYCLIST FACILITIES
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DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
BRIDGE ST
BERTIE ST
INGLES ST
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
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AURECON P1 15/03/13 1st PRELIMINARY ISSUE AC JPW
Revised By In Serv Rev. Date Description Designed Checked Ind. Rev. Approv.
Consultant
aurecon
Franchisee / Lessee
State Goverment Victoria Department of Transport
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 2
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Designed By A.CRIGHTON
Checked By J.WILLIAMS
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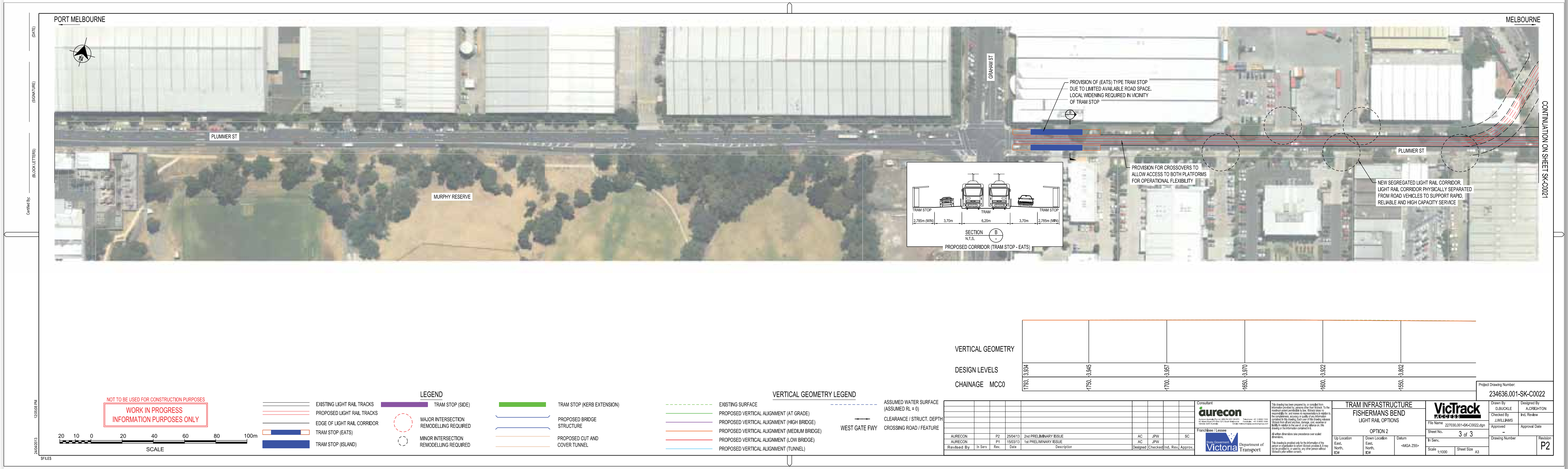
PORT MELBOURNE
MELBOURNE
PLUMMER ST
GRAHAM ST
MURPHY RESERVE
PROVISION OF (EATS) TYPE TRAM STOP DUE TO LIMITED AVAILABLE ROAD SPACE. LOCAL WIDENING REQUIRED IN VICINITY OF TRAM STOP
PROVISION FOR CROSSOVERS TO ALLOW ACCESS TO BOTH PLATFORMS FOR OPERATIONAL FLEXIBILITY
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
CONTINUATION ON SHEET SK-C0021
TRAM STOP
TRAM
TRAM STOP
2,785m (MIN)
3,70m
6,20m
3,70m
2,785m (MIN)
SECTION B
N.T.S.
PROPOSED CORRIDOR (TRAM STOP - EATS)
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
3.934
3.945
3.957
3.970
3.922
3.802
1793.
1750.
1700.
1650.
1600.
1550.
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
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SCALE
LEGEND
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PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
AURECON P2 25/04/13 2nd PRELIMINARY ISSUE AC JPW SC
AURECON P1 15/03/13 1st PRELIMINARY ISSUE AC JPW
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Consultant
aurecon
Franchisee / Lessee
State Goverment Victoria
Department of Transport
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 2
VicTrack ACCESS
Project Drawing Number: 234636.001-SK-C0022
Drawn By D.BUCKLE
Designed By A.CRIGHTON
Checked By J.WILLIAMS
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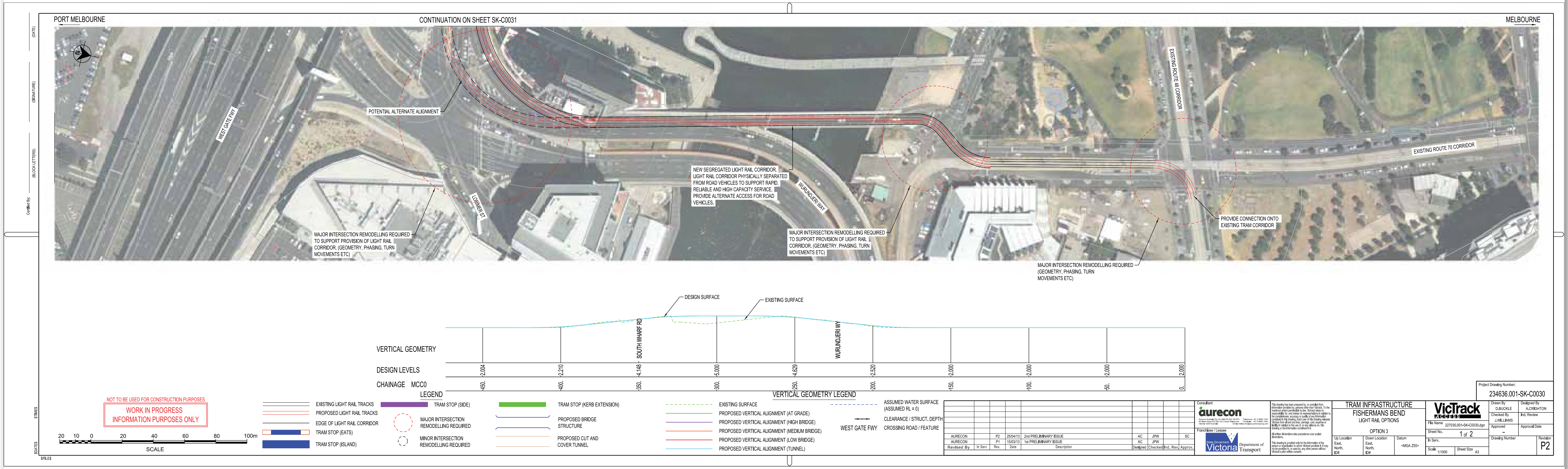

PORT MELBOURNE
CONTINUATION ON SHEET SK-C0031
MELBOURNE
POTENTIAL ALTERNATE ALIGNMENT
WEST GATE FWY
EXISTING ROUTE 48 CORRIDOR
EXISTING ROUTE 70 CORRIDOR
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE. PROVIDE ALTERNATE ACCESS FOR ROAD VEHICLES.
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
PROVIDE CONNECTION ONTO EXISTING TRAM CORRIDOR
MAJOR INTERSECTION REMODELLING REQUIRED (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
SOUTH WHARF RD
WURUNDJERI WY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY CROSSING ROAD / FEATURE
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Consultant aurecon
Franchisee / Lessee
State Government Victoria Department of Transport
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 3
VicTrack ACCESS
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Designed By A.CRIGHTON
Checked By J.WILLIAMS
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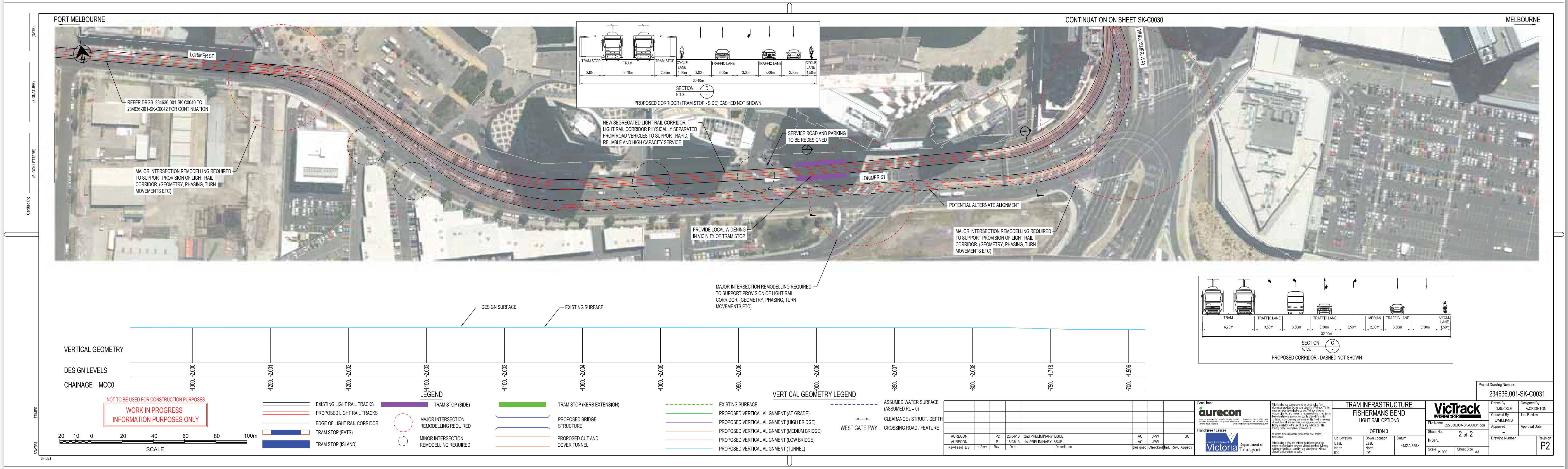
VOLUME 3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MELBOURNE
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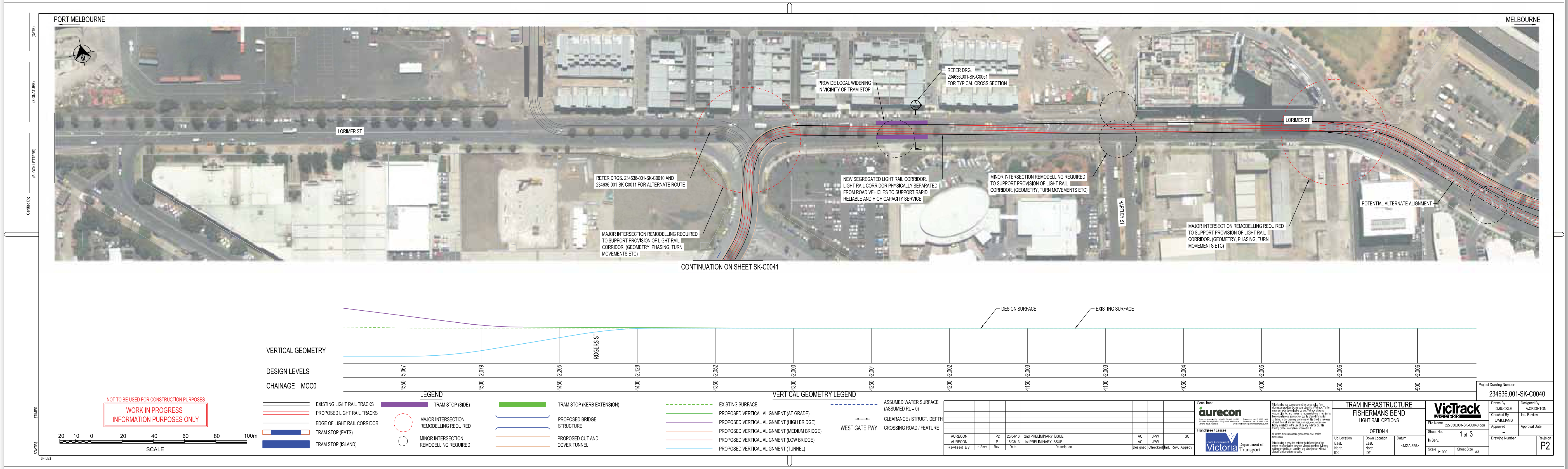
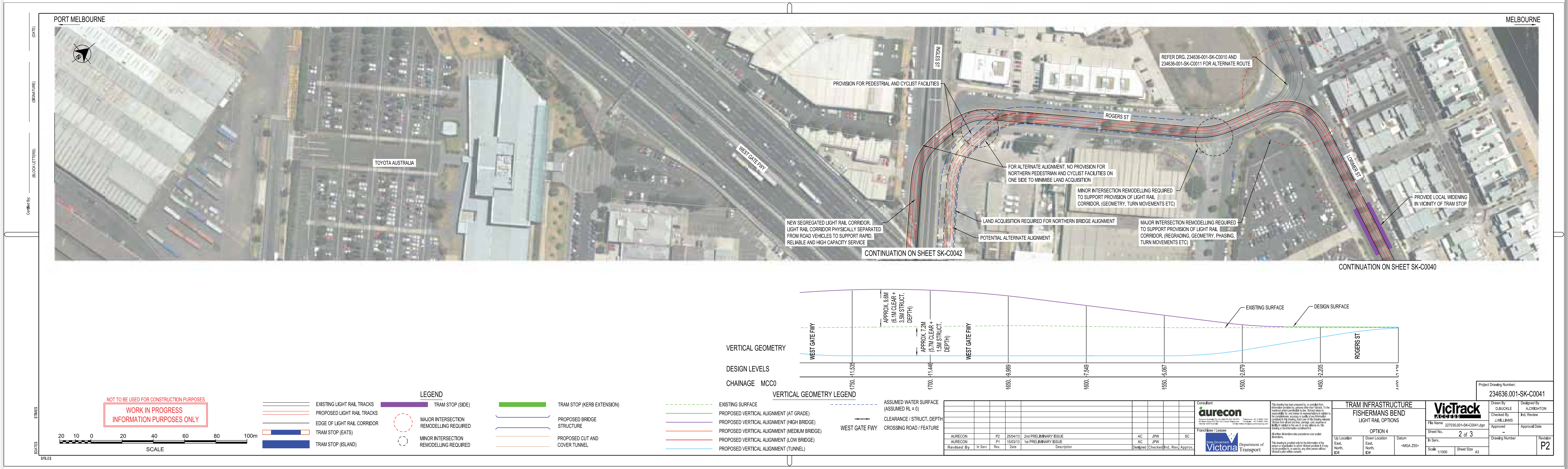
PROPOSED CORRIDOR - DASHED NOT SHOWN
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
LEGEND
VERTICAL GEOMETRY LEGEND
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 3
aurecon
VicTrack
234636.001-SK-C0031
P2



PORT MELBOURNE
MELBOURNE
LORIMER ST
PROVIDE LOCAL WIDENING IN VICINITY OF TRAM STOP
REFER DRG. 234636.001-SK-C0051 FOR TYPICAL CROSS SECTION
REFER DRGS. 234636-001-SK-C0010 AND 234636-001-SK-C0011 FOR ALTERNATE ROUTE
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
MINOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, TURN MOVEMENTS ETC)
HARTLEY ST
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
POTENTIAL ALTERNATE ALIGNMENT
CONTINUATION ON SHEET SK-C0041
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
ROGERS ST
DESIGN LEVELS -5.067 -2.679 -2.205 -2.128 -2.052 -2.000 -2.001 -2.002 -2.003 -2.003 -2.004 -2.005 -2.006 -2.006
CHAINAGE MCC0 -1550. -1500. -1450. -1400. -1350. -1300. -1250. -1200. -1150. -1100. -1050. -1000. -950. -900.
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
20 10 0 20 40 60 80 100m
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
AURECON P2 25/04/13 2nd PRELIMINARY ISSUE AC JPW SC
AURECON P1 15/03/13 1st PRELIMINARY ISSUE AC JPW
Revised By In Serv Rev. Date Description Designed Checked Ind. Rev. Approv.
Consultant
aurecon
Franchisee / Lessee
State Goverment Victoria Department of Transport
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 4
Up Location East. North. ID#
Down Location East. North. ID#
Datum <MGA Z55>
VicTrack ACCESS
File Name 227030.001-SK-C0040.dgn
Sheet No. 1 of 3
In Serv.
Scale 1:1000
Sheet Size A3
Project Drawing Number: 234636.001-SK-C0040
Drawn By D.BUCKLE
Designed By A.CRIGHTON
Checked By J.WILLIAMS
Ind. Review
Approved -
Approval Date
Drawing Number
Revision P2

VOLUME 3



PORT MELBOURNE
MELBOURNE
TOYOTA AUSTRALIA
WEST GATE FWY
INGLES ST
ROGERS ST
LORIMER ST
PROVISION FOR PEDESTRIAL AND CYCLIST FACILITIES
REFER DRG. 234636-001-SK-C0010 AND 234636-001-SK-C0011 FOR ALTERNATE ROUTE
FOR ALTERNATE ALIGNMENT, NO PROVISION FOR NORTHERN PEDESTRIAN AND CYCLIST FACILITIES ON ONE SIDE TO MINIMISE LAND ACQUISITION
MINOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, TURN MOVEMENTS ETC)
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
LAND ACQUISITION REQUIRED FOR NORTHERN BRIDGE ALIGNMENT
POTENTIAL ALTERNATE ALIGNMENT
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (REGRADING, GEOMETRY, PHASING, TURN MOVEMENTS ETC)
PROVIDE LOCAL WIDENING IN VICINITY OF TRAM STOP
CONTINUATION ON SHEET SK-C0042
CONTINUATION ON SHEET SK-C0040
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
EXISTING SURFACE
DESIGN SURFACE
APPROX. 9.6M (6.1M CLEAR + 3.5M STRUCT. DEPTH)
APPROX. 7.2M (5.7M CLEAR + 1.5M STRUCT. DEPTH)
ROGERS ST
-1550. -5.067
-1500. -2.679
-1450. -2.205
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL ≈ 0)
CLEARANCE / STRUCT. DEPTH
CROSSING ROAD / FEATURE
Consultant
aurecon
Franchisee / Lessee
Department of Transport
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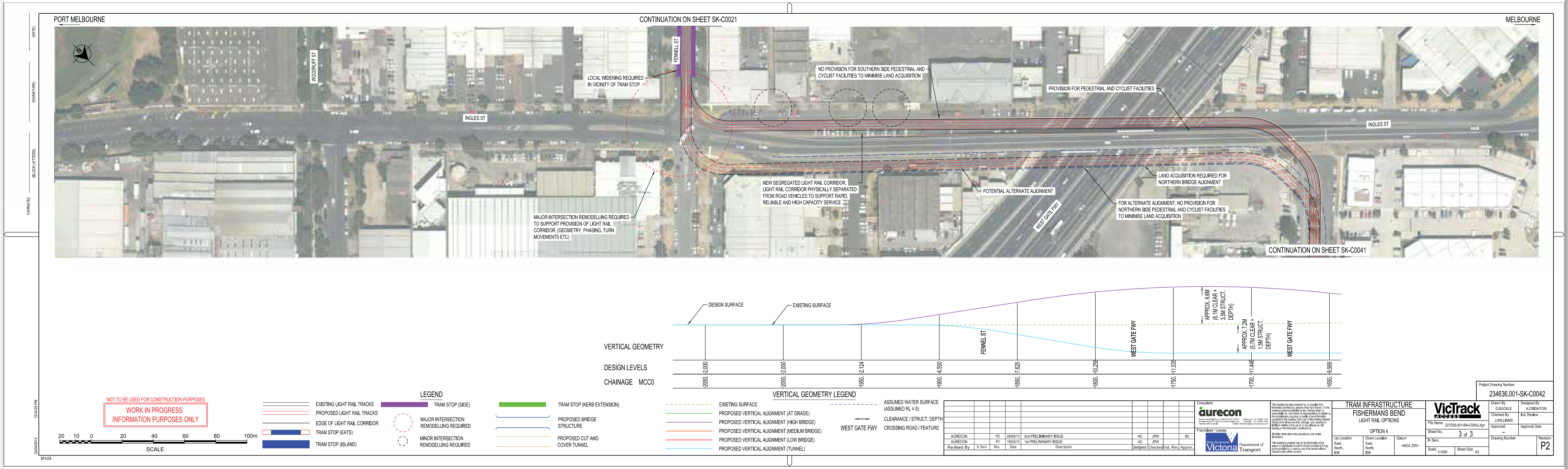
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 4
Datum <MGA Z55>
Project Drawing Number: 234636.001-SK-C0041
Drawn By D.BUCKLE
Designed By A.CRIGHTON
Checked By J.WILLIAMS
File Name 227030.001-SK-C0041.dgn
Sheet No. 2 of 3
Scale 1:1000
Sheet Size A3
Revision P2


PORT MELBOURNE
CONTINUATION ON SHEET SK-C0021
MELBOURNE
WOODRUFF ST
FENNELL ST
LOCAL WIDENING REQUIRED IN VICINITY OF TRAM STOP
INGLES ST
NO PROVISION FOR SOUTHERN SIDE PEDESTRIAL AND CYCLIST FACILITIES TO MINIMISE LAND ACQUISITION
PROVISION FOR PEDESTRIAL AND CYCLIST FACILITIES
INGLES ST
LAND ACQUISITION REQUIRED FOR NORTHERN BRIDGE ALIGNMENT
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
POTENTIAL ALTERNATE ALIGNMENT
FOR ALTERNATE ALIGNMENT, NO PROVISION FOR NORTHERN SIDE PEDESTRIAL AND CYCLIST FACILITIES TO MINIMISE LAND ACQUISITION
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
WEST GATE FWY
CONTINUATION ON SHEET SK-C0041
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
FENNEL ST
WEST GATE FWY
WEST GATE FWY
APPROX. 9.8M (6.1M CLEAR + 3.5M STRUCT. DEPTH)
APPROX. 7.2M (5.7M CLEAR + 1.5M STRUCT. DEPTH)
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
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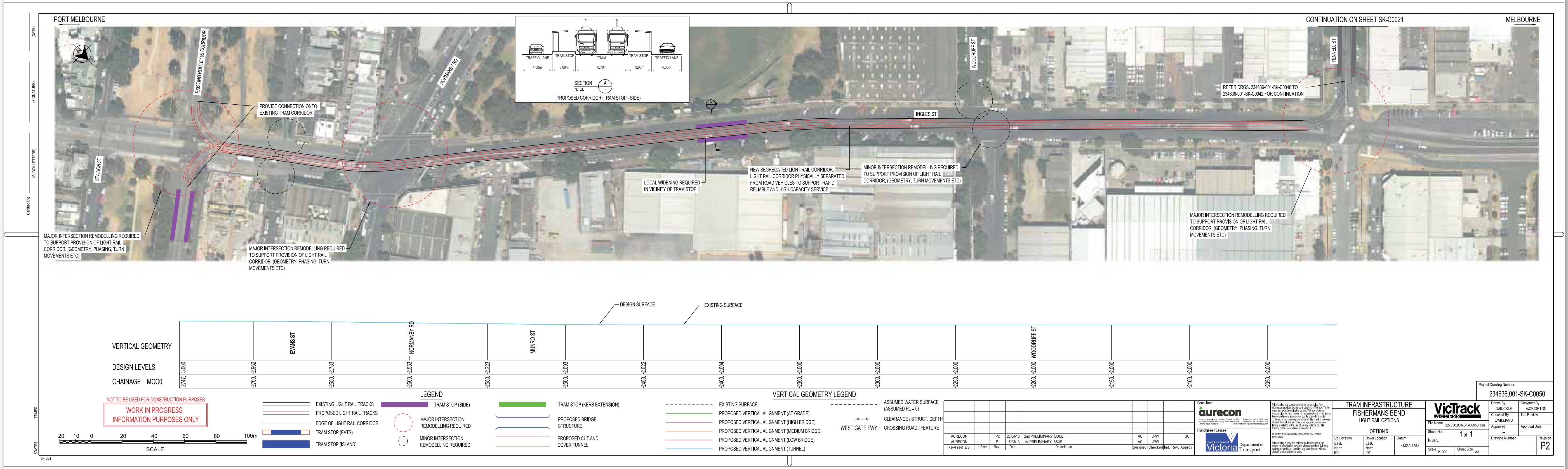
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 4
VicTrack
234636.001-SK-C0042
3 of 3
P2
2nd PRELIMINARY ISSUE
1st PRELIMINARY ISSUE


PORT MELBOURNE
MELBOURNE
CONTINUATION ON SHEET SK-C0021
EXISTING ROUTE 109 CORRIDOR
STATION ST
NORMANBY RD
INGLES ST
WOODRUFF ST
FENNELL ST
PROVIDE CONNECTION ONTO EXISTING TRAM CORRIDOR
LOCAL WIDENING REQUIRED IN VICINITY OF TRAM STOP
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
MINOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, TURN MOVEMENTS ETC)
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
SECTION A
PROPOSED CORRIDOR (TRAM STOP - SIDE)
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
DESIGN LEVELS
CHAINAGE MCC0
EVANS ST
MUNRO ST
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL ± 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY
CROSSING ROAD / FEATURE
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TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 5
VicTrack
234636.001-SK-C0050
P2

Appendix B

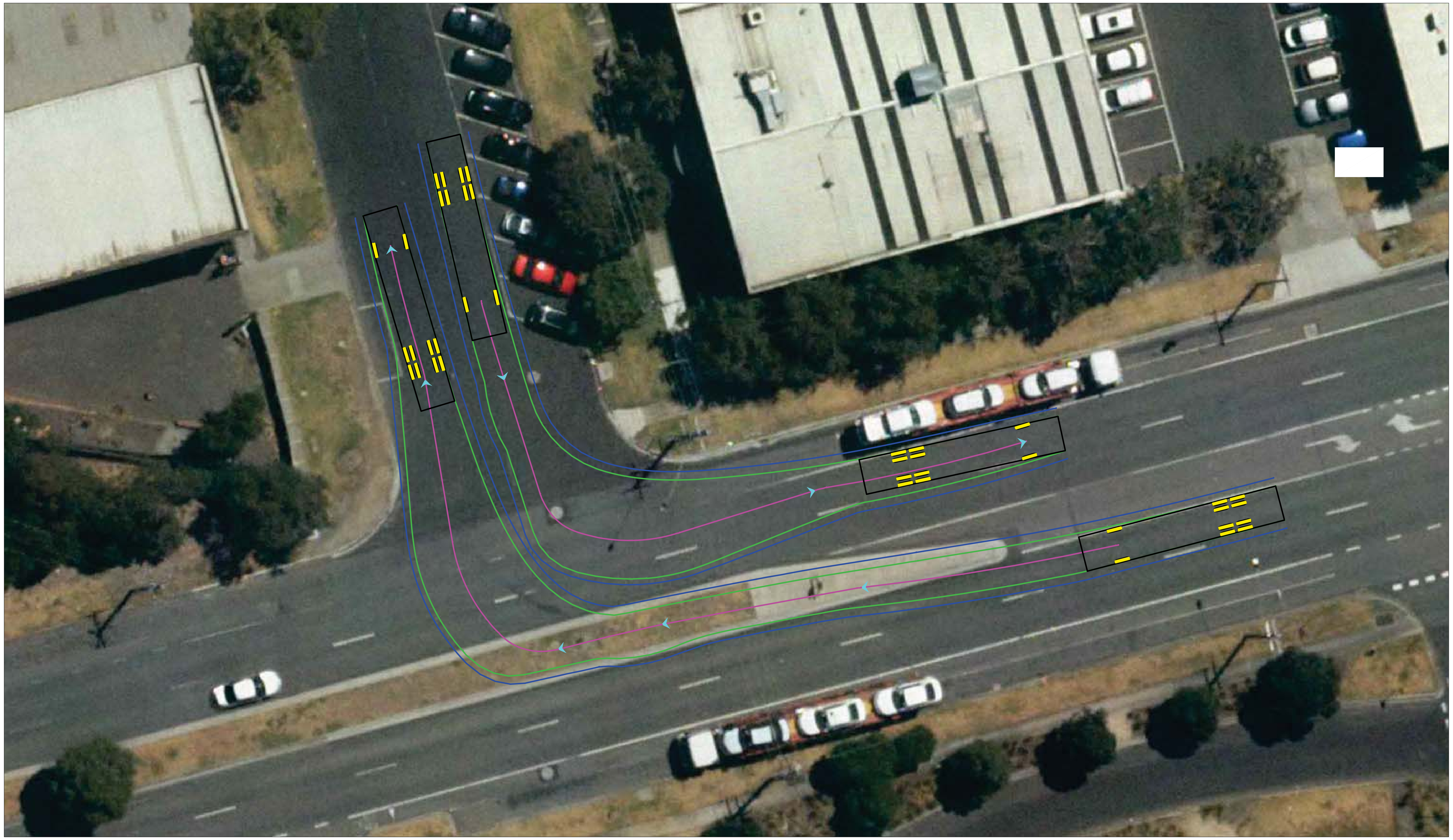
Cost Estimate of Options

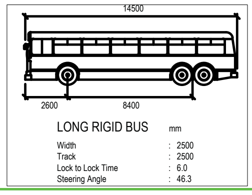
High level costs have been estimated by the Department of Transport and Public Transport Victoria for several of the options outlined in this report. These are provided in the following table.

Fishermans Bend Light Rail Options							
COST ELEMENTS		%	Option One	Option Two	Option Three	Option Four	Option Five
CONSTRUCTION COSTS							
Construction Cost		N/A	120,550,000	101,742,000	119,260,000	122,110,000	24,730,000
Contractor overheads and margin		*30%*	36,165,000	30,522,600	35,778,000	36,633,000	7,419,000
Contingency		30%	47,014,500	39,679,380	46,511,400	47,622,900	9,644,700
TOTAL CONSTRUCTION COSTS			**203,729,500**	**171,943,980**	**201,549,400**	**206,365,900**	**41,793,700**
Land Acquisition			-	-	-	-	-
TOTAL CONSTRUCTION COSTS INCL. LAND ACQUISITION			**203,729,500**	**171,943,980**	**201,549,400**	**206,365,900**	**41,793,700**
DESIGN		*10.0%*	20,372,950	17,194,398	20,154,940	20,636,590	4,179,370
TOTAL CONSTRUCTION COSTS INCL DESIGN			**224,102,450**	**189,138,378**	**221,704,340**	**227,002,490**	**45,973,070**
Principal supplied Project Insurance		*0.77%*	1,570,754	1,325,688	1,553,946	1,591,081	322,229
PROJECT MANAGEMENT							
DOT Project Management (major role)		6.0%	12,223,770	10,316,639	12,092,964	12,381,954	2,507,622
Lessee/Operator PM (minor role)		*0.5%*	1,018,648	859,720	1,007,747	1,031,830	208,969
Other Authority/Agency Consultee charges		*0.5%*	1,018,648	859,720	1,007,747	1,031,830	208,969
TOTAL PROJECT MANAGEMENT			**14,261,065**	**12,036,079**	**14,108,458**	**14,445,613**	**2,925,559**
Risk - Nominal 20%			**40,745,900**	**34,388,796**	**40,309,880**	**41,273,180**	**8,358,740**
TOTAL DIRECT COSTS			**280,680,169**	**236,888,941**	**277,676,624**	**284,312,364**	**57,579,598**
DOT Corporate Levy		*1%*	2,806,801.69	2,368,889.41	2,776,766.24	2,843,123.64	575,795.98
DOT Project Development Levy		*4%*	11,227,206.78	9,475,557.63	11,107,064.95	11,372,494.56	2,303,183.94
TOTAL PROJECT COST ($Real)	**Apr 13**		**294,714,178**	**248,733,388**	**291,560,455**	**298,527,982**	**60,458,578**
Escalation	**Apr 13**		-	-	-	-	-
TOTAL ESTIMATED INVESTMENT (TEI)	**Apr 13**		**294,714,178**	**248,733,388**	**291,560,455**	**298,527,982**	**60,458,578**

Appendix C

Bus Turning Circles at Key Intersections





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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
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DRAWN	DG
DESIGNED	SC
CHECKED	SC
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
WILLIAMSTOWN ROAD EAST - PROHASKY STREET
14.5M RIGID BUS

FOR INFORMATION ONLY

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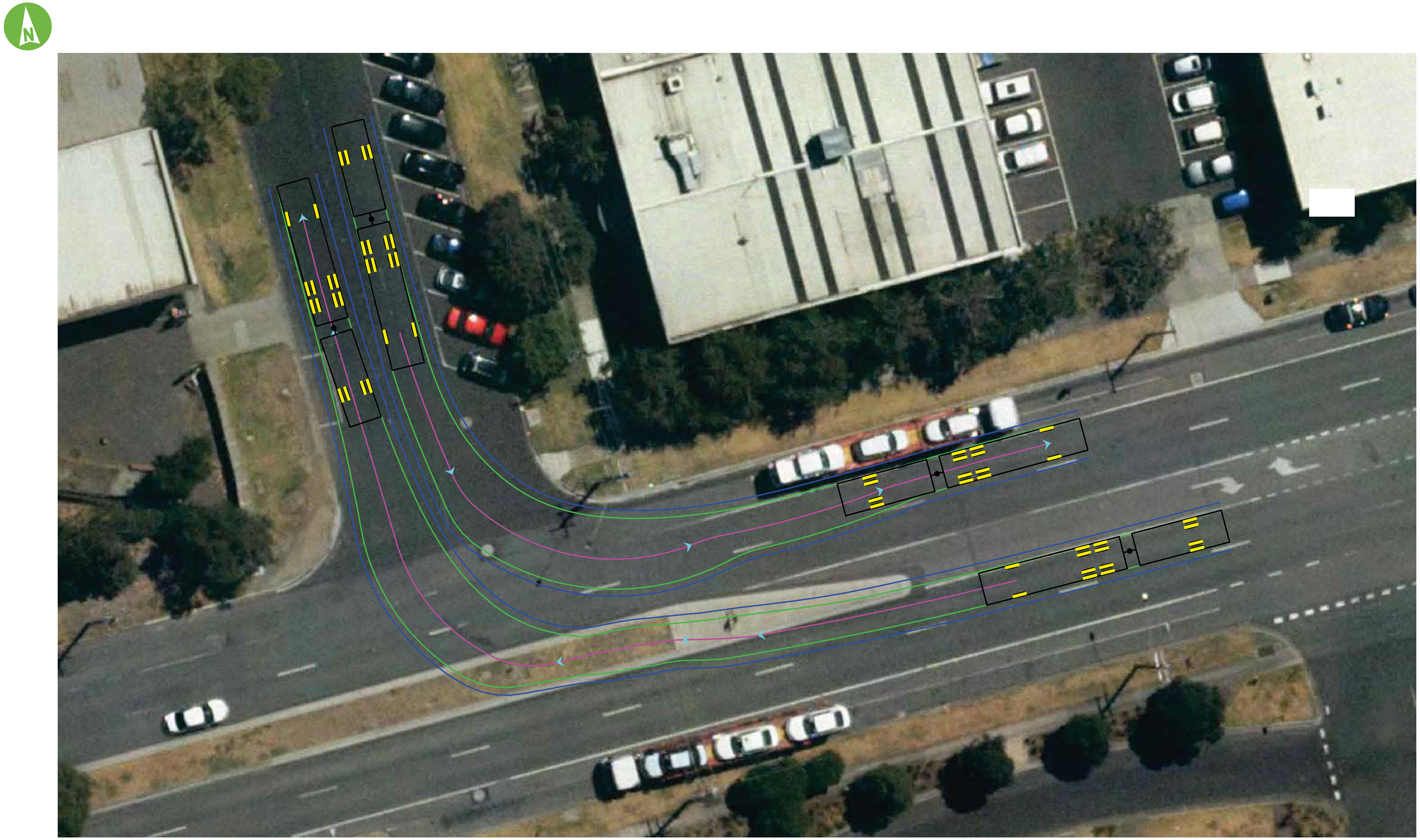

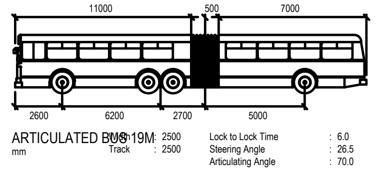

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DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
WILLIAMSTOWN ROAD EAST - PROHASKY STREET
19.0M ARTICULATED BUS

FOR INFORMATION ONLY

PROJECT No.	
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SCALE	SIZE
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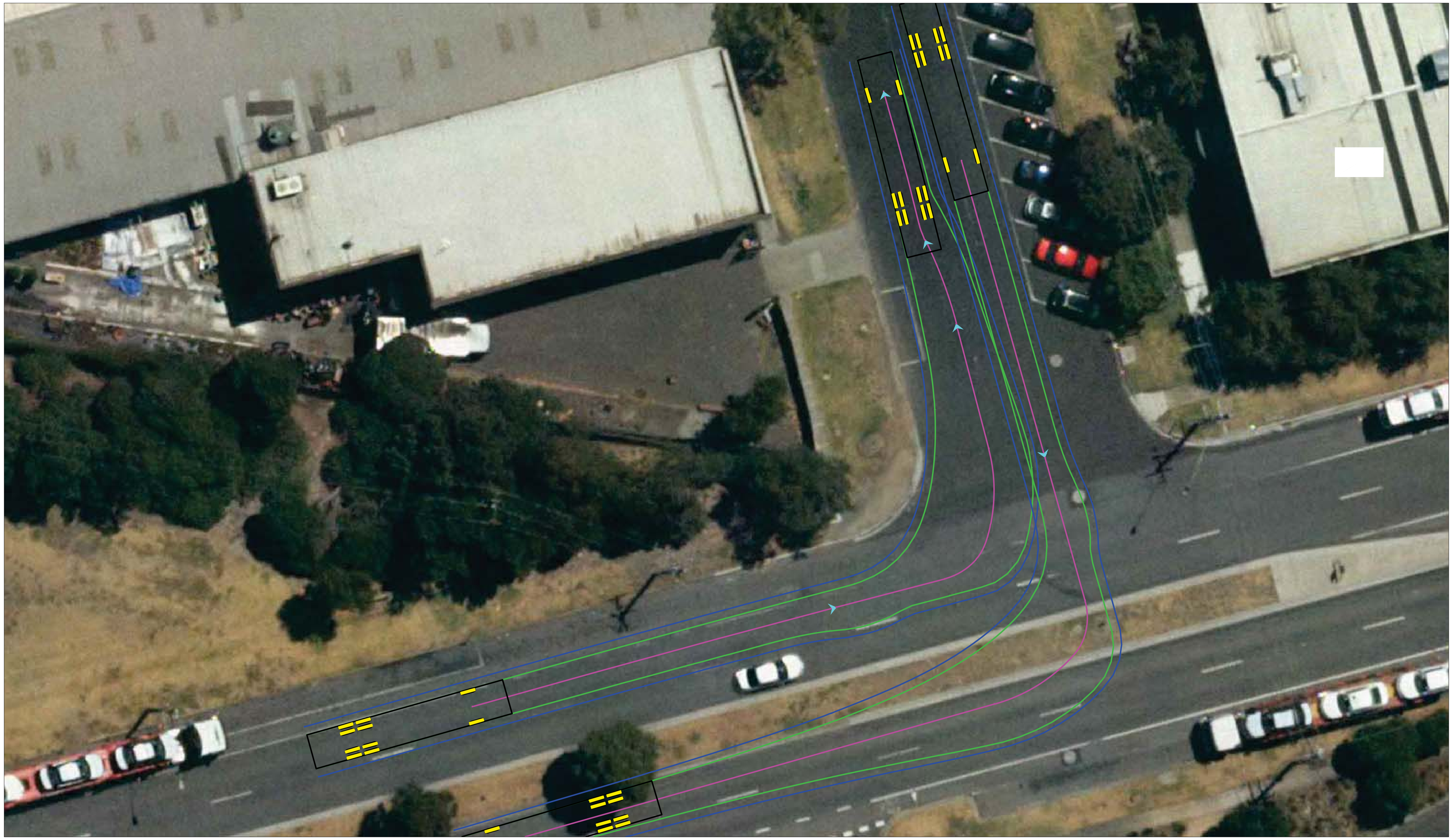
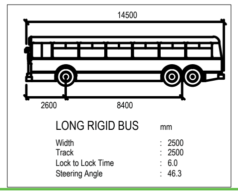
DRAWING No.	REV
SK-T-02	





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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
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DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
WILLIAMSTOWN ROAD WEST - PROHASKY STREET
14.5M RIGID BUS

FOR INFORMATION ONLY

PROJECT No.
234636

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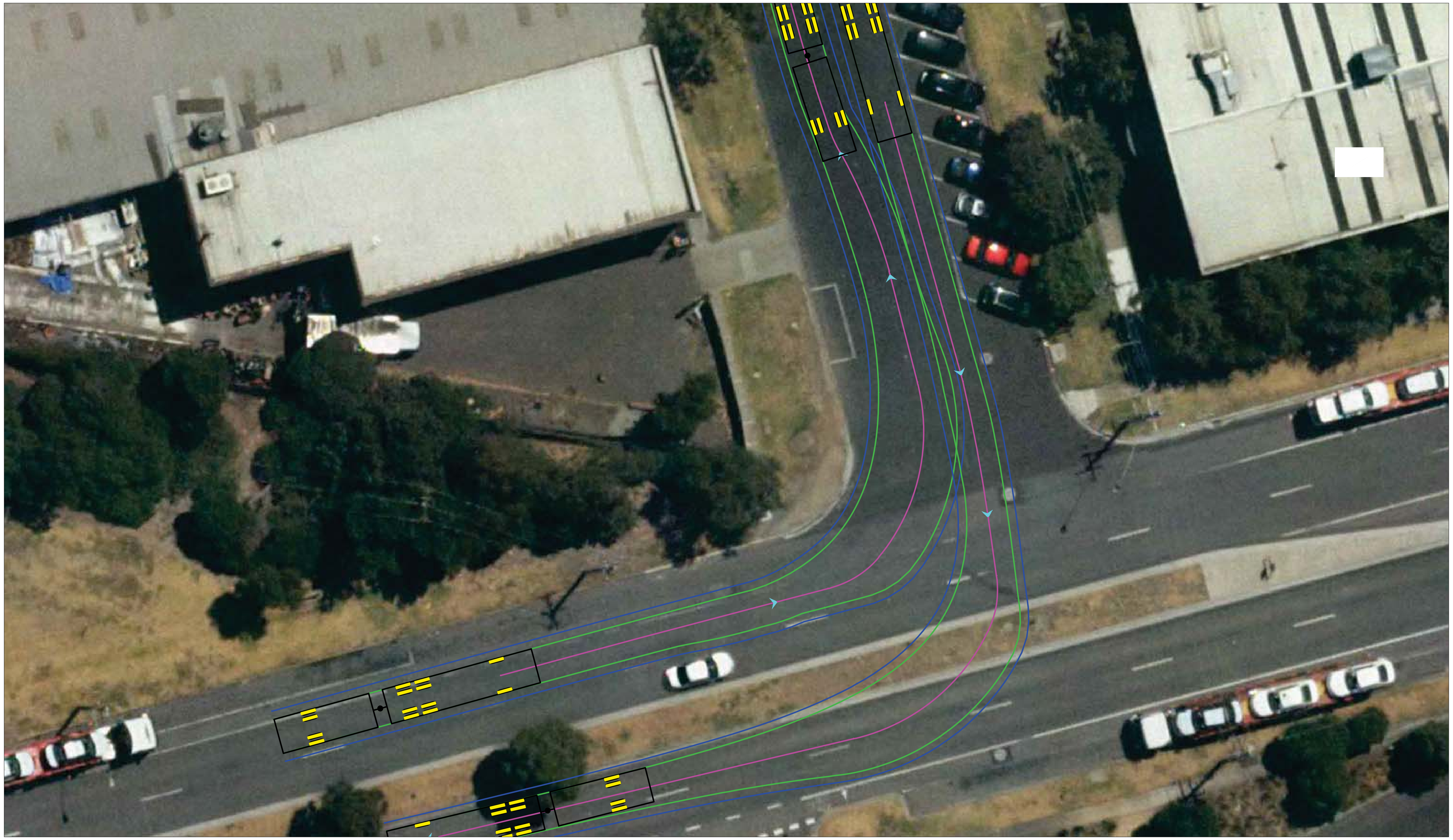

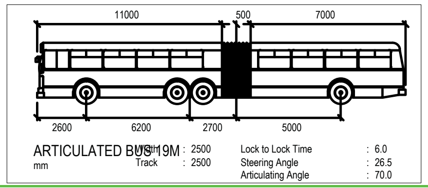

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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A			

DRAWN	DESIGNED
DG	MS
CHECKED	
MS	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL
TITLE
AUTOTURN SWEPT PATH WILLIAMSTOWN ROAD WEST - PROHASKY STREET 19.0M ARTICULATED BUS

FOR INFORMATION ONLY	
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234636	
SCALE	SIZE
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DRAWING No.	REV
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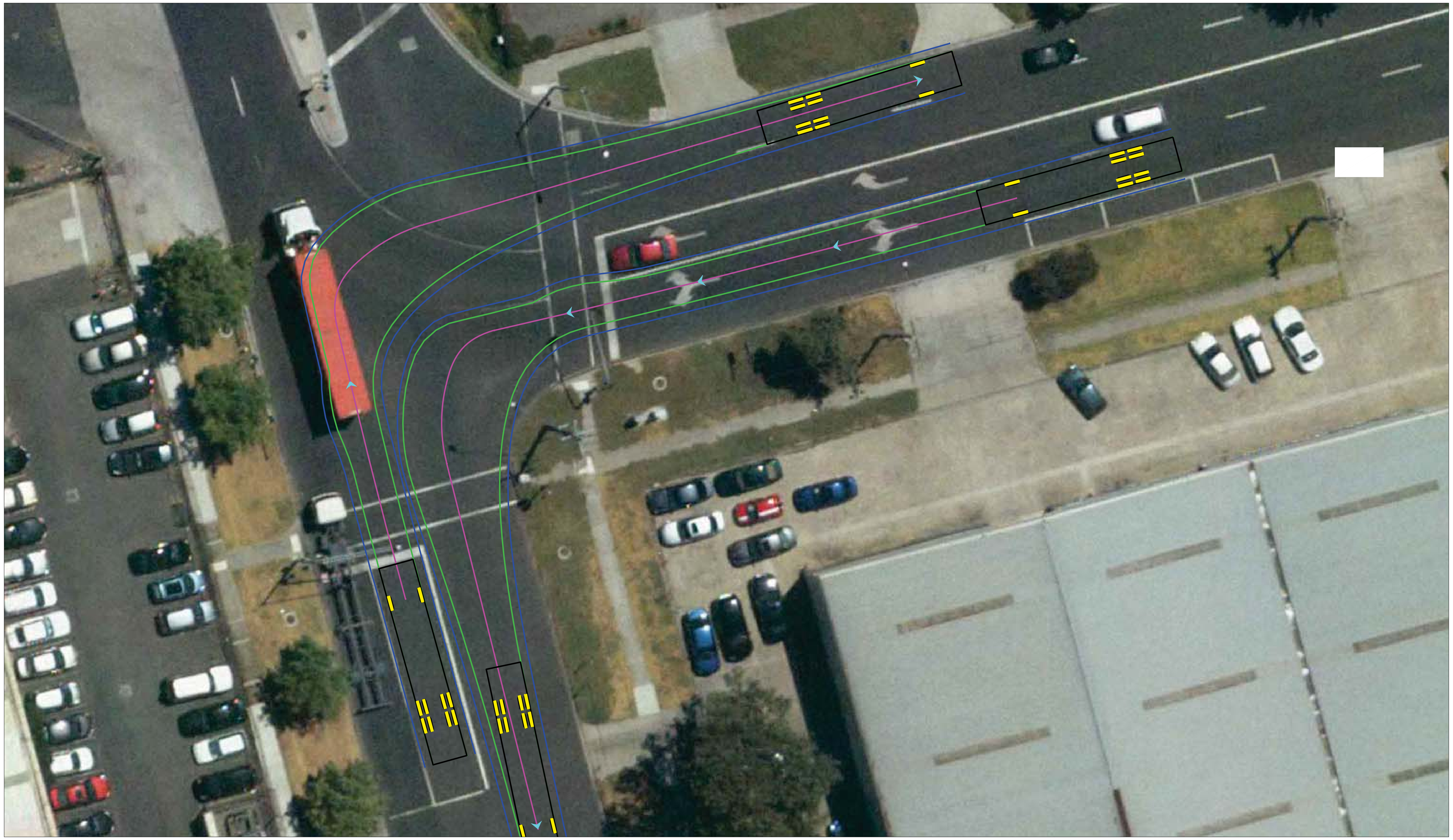
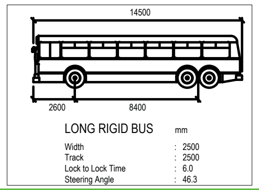
VOLUME 3





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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A			

DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
PLUMMER STREET - PROHASKY STREET
14.5M RIGID BUS

FOR INFORMATION ONLY

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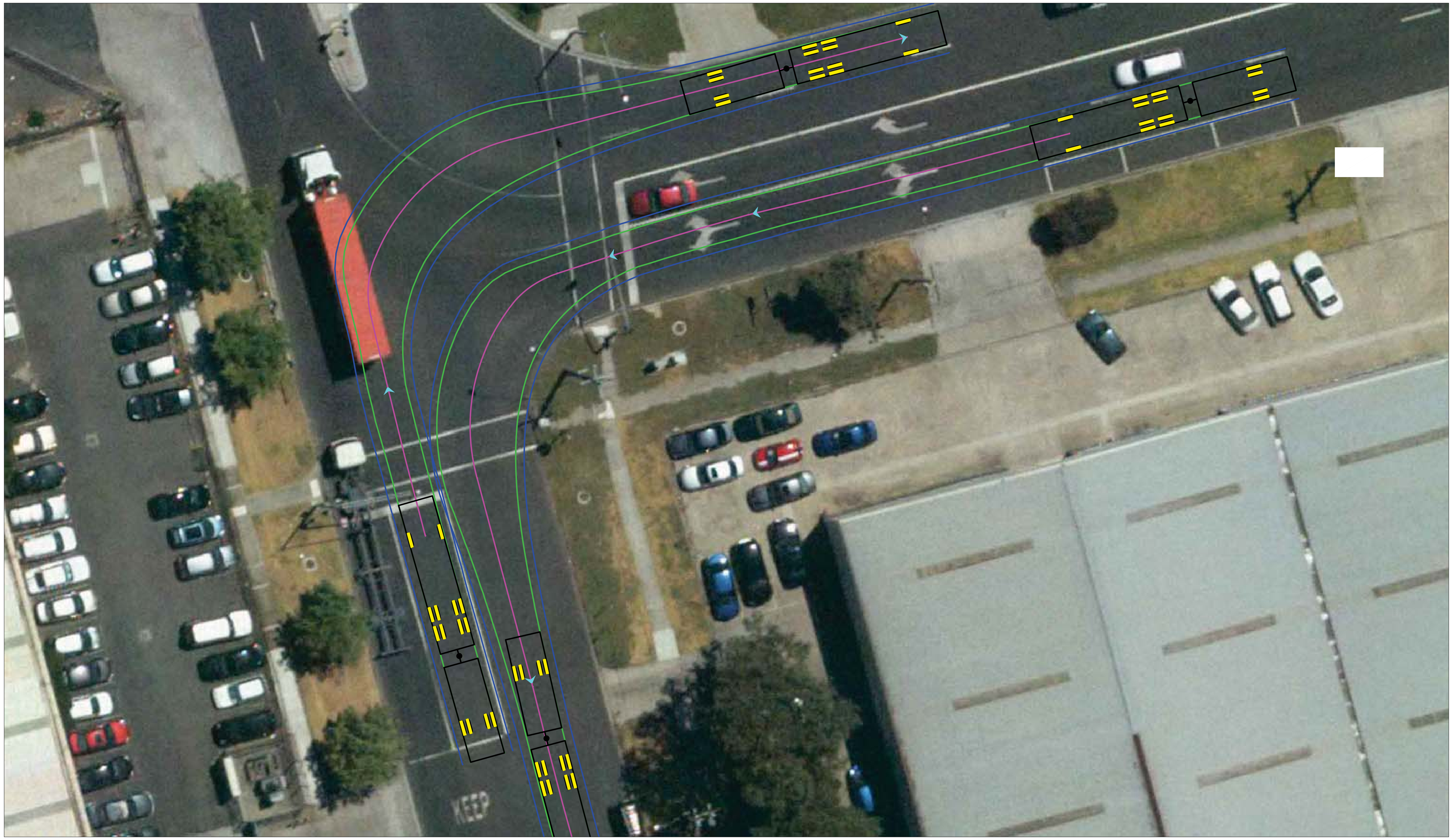

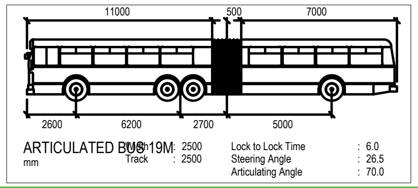

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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
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DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
PLUMMER STREET - PROHASKY STREET
19.0M ARTICULATED BUS

FOR INFORMATION ONLY

PROJECT No.
234636

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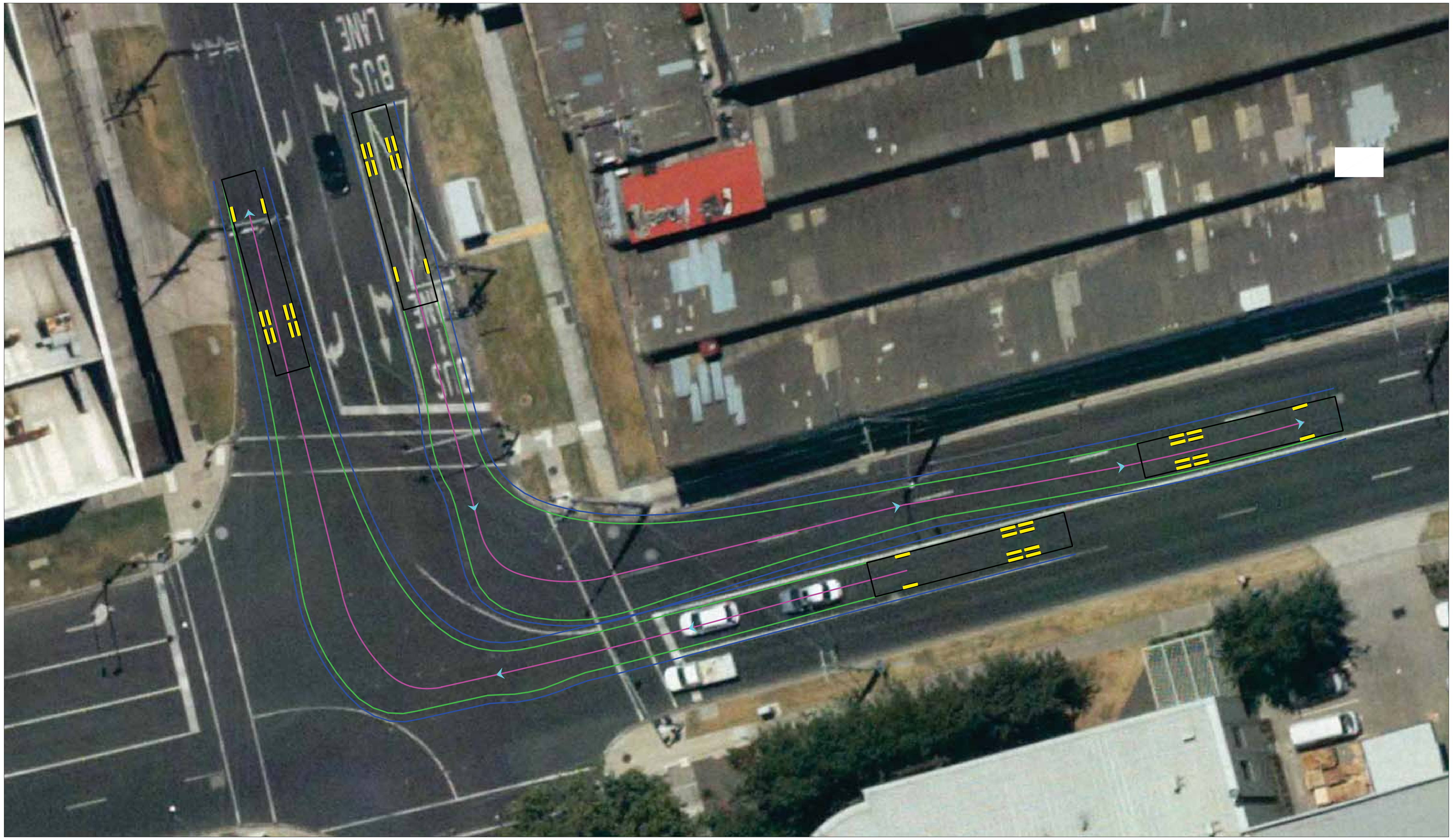

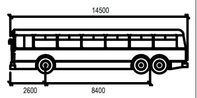

LONG RIGID BUS mm

Width	:	2500
Track	:	2500
Lock to Lock Time	:	6.0
Steering Angle	:	46.3

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CLIENT

REV	DATE	REVISION DETAILS	APPROVED
A			

DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
PLUMMER STREET - SALMON STREET
14.5M RIGID BUS

FOR INFORMATION ONLY

PROJECT No.	
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SCALE	SIZE
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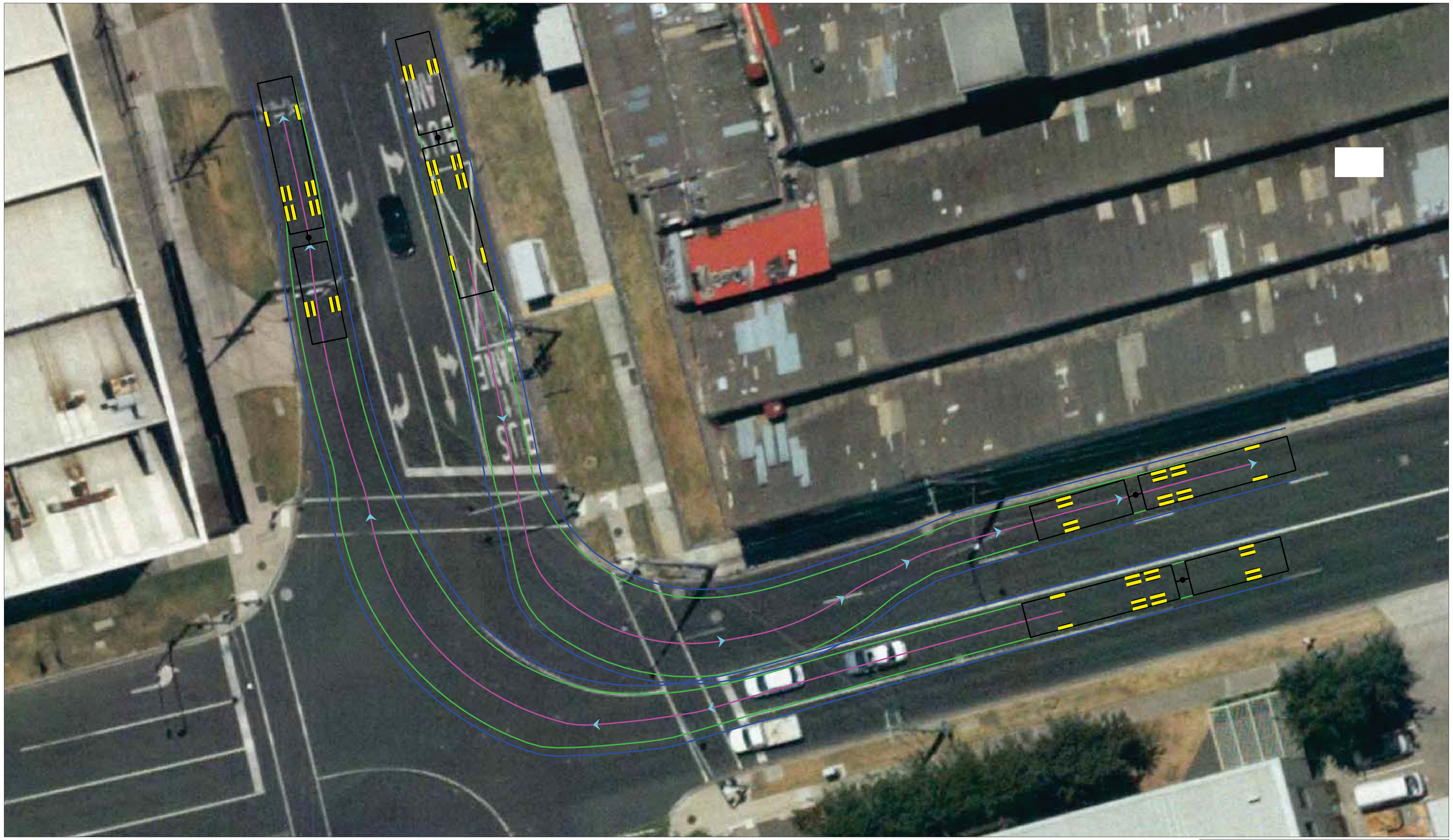
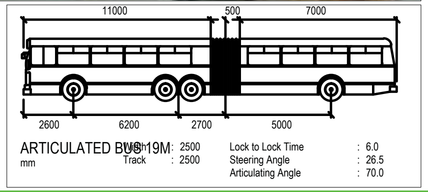
DRAWING No.	REV
SK-T-07	





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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A			

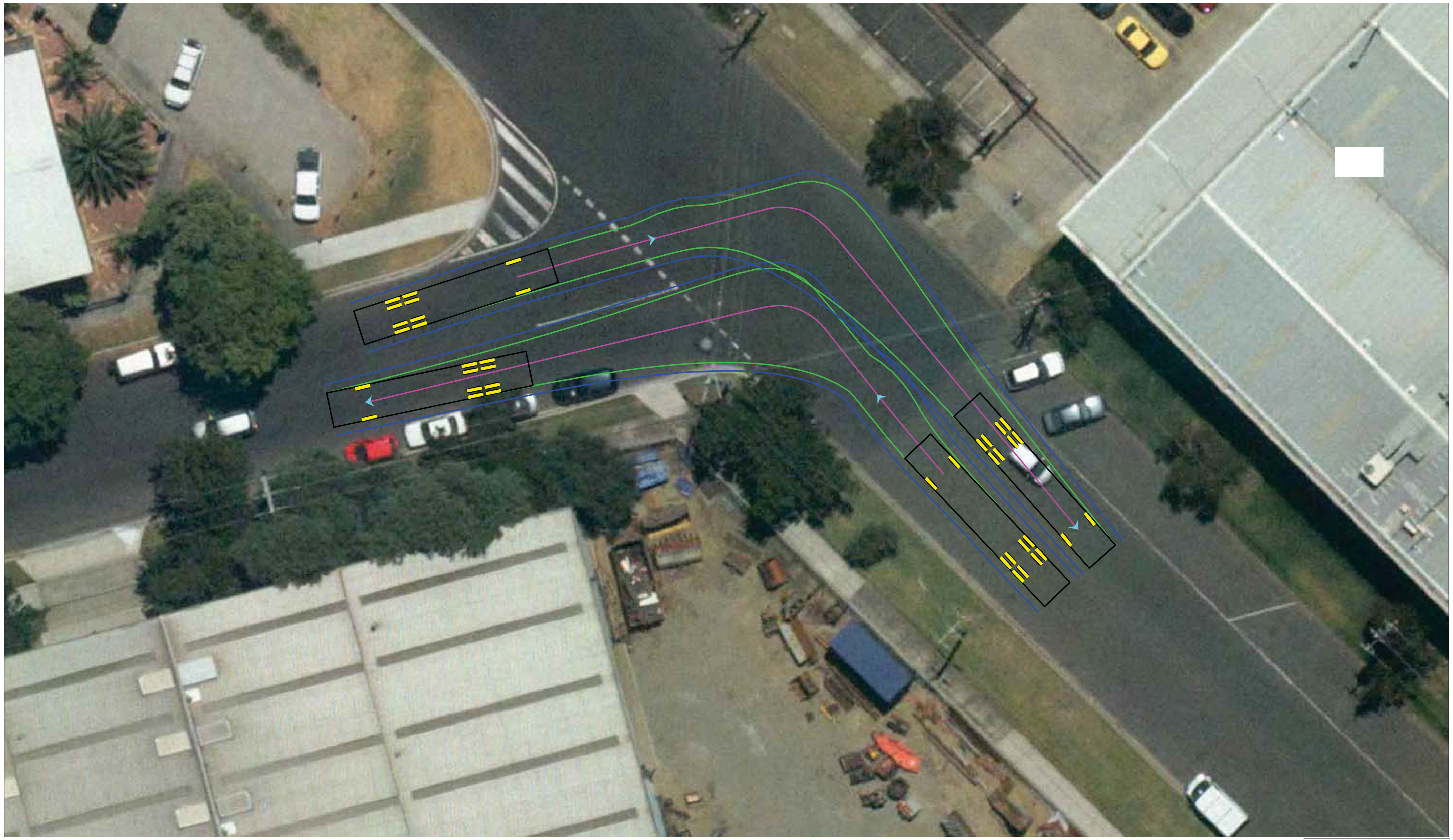
DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

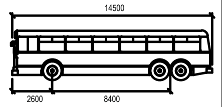
PROJECT: FISHERMANS BEND LIGHT RAIL

TITLE: AUTOTURN SWEPT PATH
PLUMMER STREET - SALMON STREET
19.0M ARTICULATED BUS

FOR INFORMATION ONLY

PROJECT No.	
234636	
SCALE	SIZE
1:400	A4
DRAWING No.	REV
SK-T-08	





LONG RIGID BUS mm

Width	:	2500
Track	:	2500
Lock to Lock Time	:	6.0
Steering Angle	:	46.3

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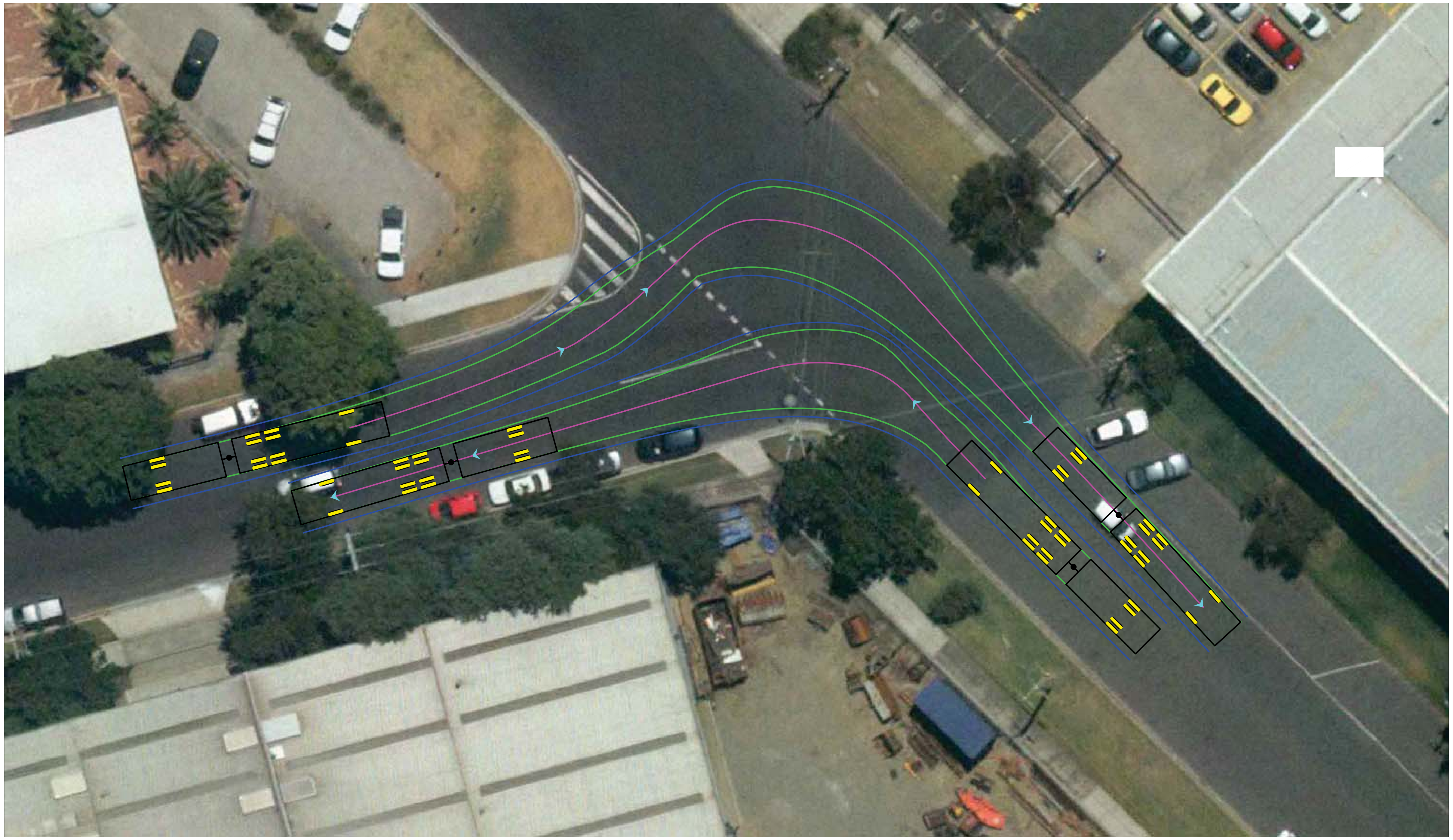
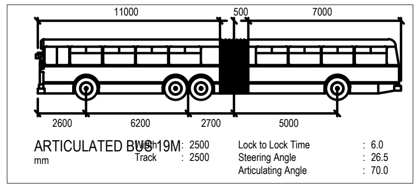
CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A			

DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
	DATE

PROJECT
FISHERMANS BEND LIGHT RAIL
TITLE
AUTOTURN SWEPT PATH BRIDGE STREET - PLUMMER STREET 14.5M RIGID BUS

FOR INFORMATION ONLY	
PROJECT No.	
234636	
SCALE	SIZE
1:400	A4
DRAWING No.	REV
SK-T-09	





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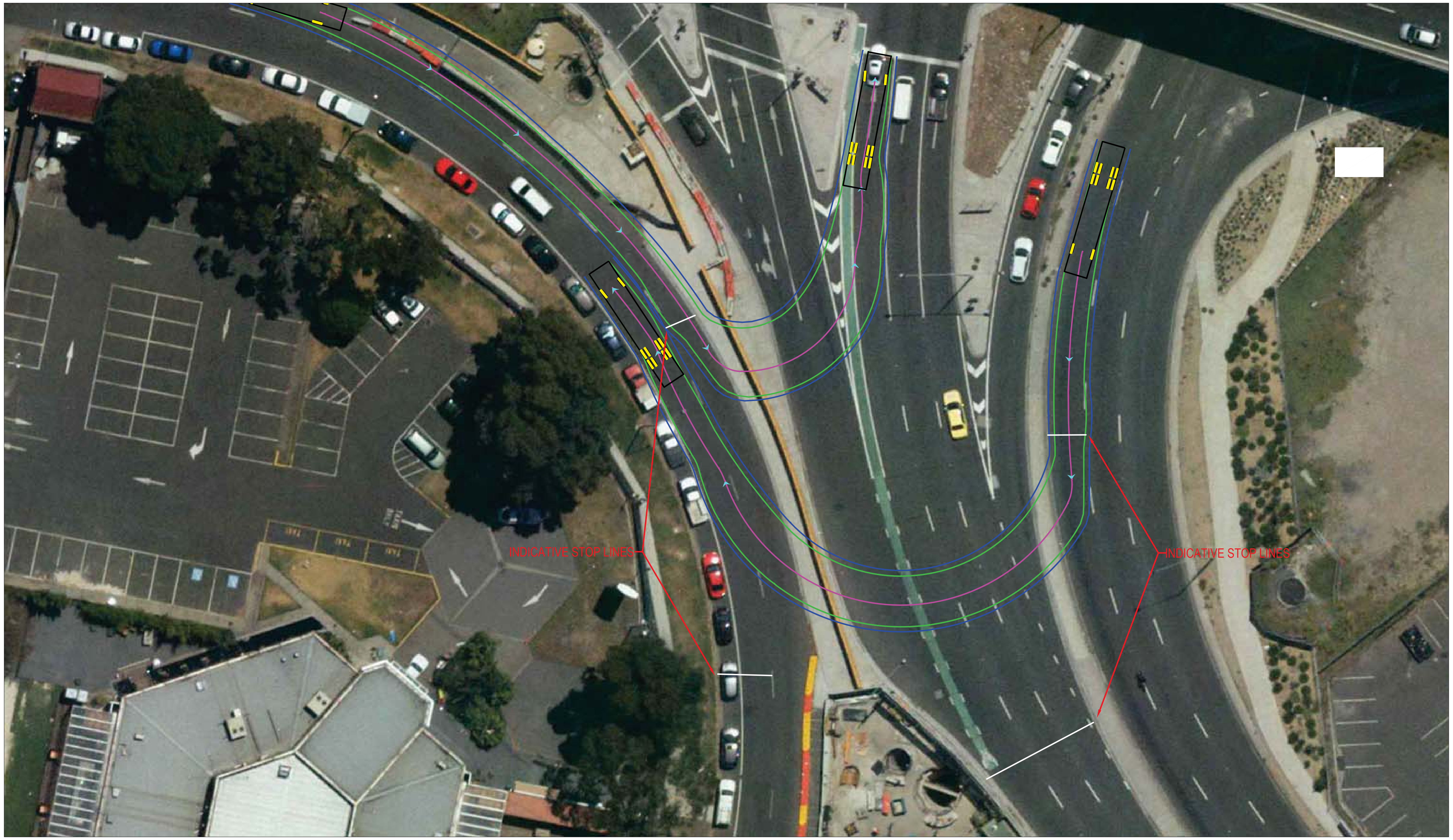
CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A			

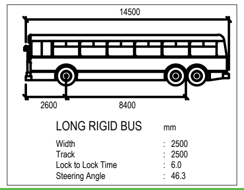
DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL
TITLE
AUTOTURN SWEPT PATH BRIDGE STREET - PLUMMER STREET 19.0M ARTICULATED BUS

FOR INFORMATION ONLY

PROJECT No.	
234636	
SCALE	SIZE
1:400	A4
DRAWING No.	REV
SK-T-10	





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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A			

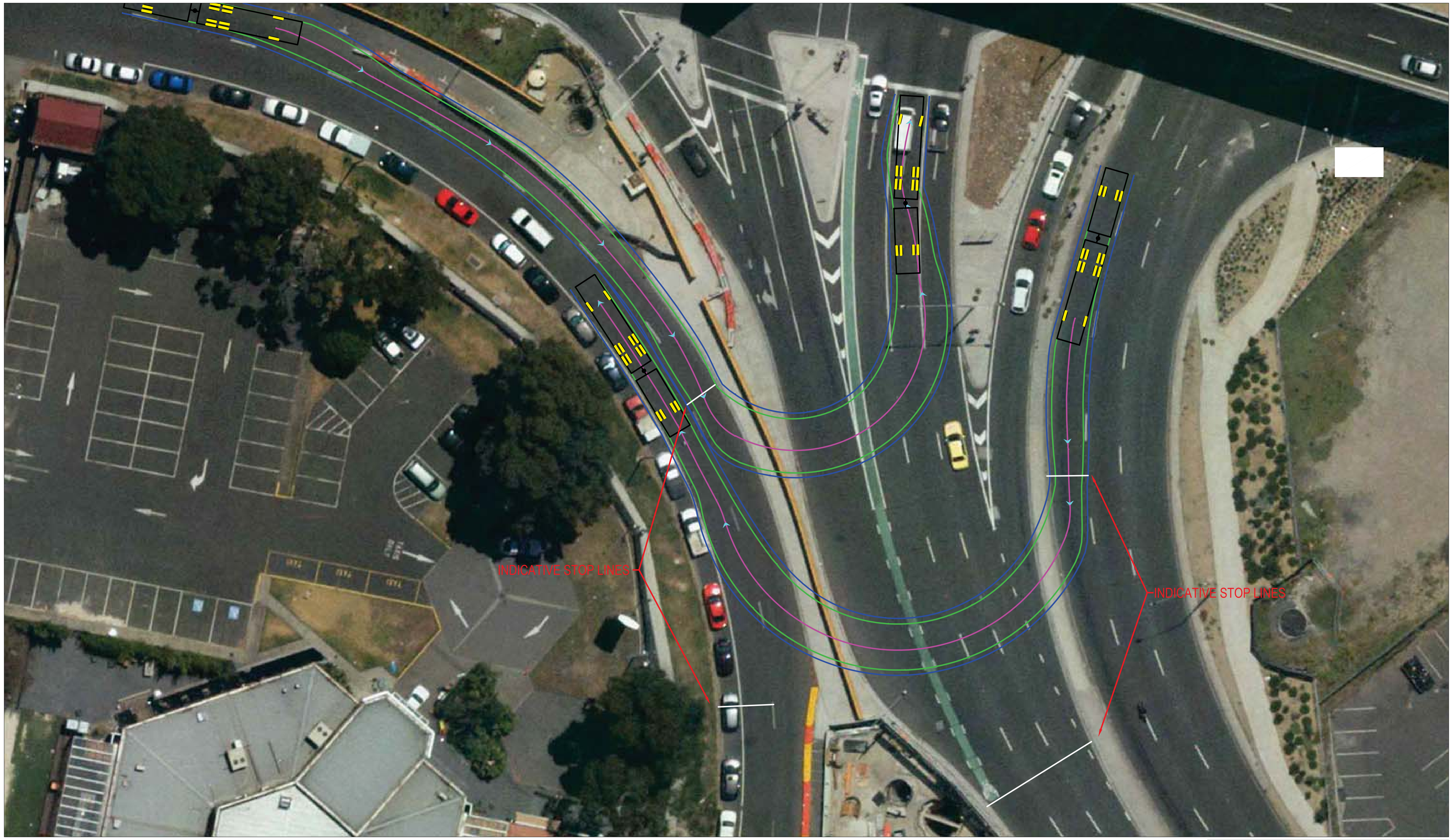
DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

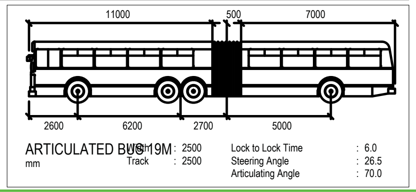
PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
BRADY STREET - MONTAGUE STREET
14.5M RIGID BUS

FOR INFORMATION ONLY

PROJECT No.	
234636	
SCALE	SIZE
1:600	A4
DRAWING No.	REV
SK-T-11	





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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A			

DRAWN	DESIGNED
DG	SC
CHECKED	
SC	
APPROVED	
DATE	

PROJECT
FISHERMANS BEND LIGHT RAIL

TITLE
AUTOTURN SWEPT PATH
BRADY STREET - MONTAGUE STREET
19.0M ARTICULATED BUS

FOR INFORMATION ONLY

PROJECT No.	
234636	
SCALE	SIZE
1:600	A4
DRAWING No.	REV
SK-T-12	

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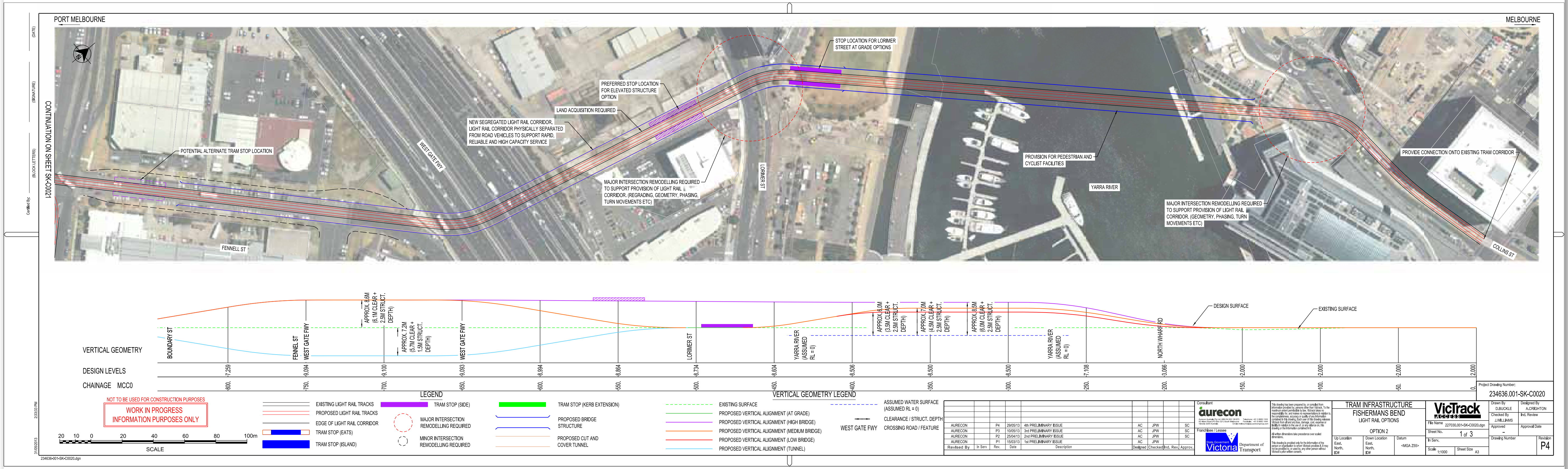
Aurecon offices are located in:
Angola, Australia, Botswana, China, Ethiopia, Hong Kong, Indonesia, Lesotho, Libya, Malawi, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.



PORT MELBOURNE
MELBOURNE
CONTINUATION ON SHEET SK-C0021
POTENTIAL ALTERNATE TRAM STOP LOCATION
FENNELL ST
WEST GATE FWY
NEW SEGREGATED LIGHT RAIL CORRIDOR. LIGHT RAIL CORRIDOR PHYSICALLY SEPARATED FROM ROAD VEHICLES TO SUPPORT RAPID, RELIABLE AND HIGH CAPACITY SERVICE
LAND ACQUISITION REQUIRED
PREFERRED STOP LOCATION FOR ELEVATED STRUCTURE OPTION
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (REGRADING, GEOMETRY, PHASING, TURN MOVEMENTS ETC)
LORIMER ST
STOP LOCATION FOR LORIMER STREET AT GRADE OPTIONS
PROVISION FOR PEDESTRIAN AND CYCLIST FACILITIES
YARRA RIVER
MAJOR INTERSECTION REMODELLING REQUIRED TO SUPPORT PROVISION OF LIGHT RAIL CORRIDOR. (GEOMETRY, PHASING, TURN MOVEMENTS ETC)
PROVIDE CONNECTION ONTO EXISTING TRAM CORRIDOR
COLLINS ST
APPROX. 8.6M (6.1M CLEAR + 2.5M STRUCT. DEPTH)
APPROX. 7.2M (5.7M CLEAR + 1.5M STRUCT. DEPTH)
DESIGN SURFACE
EXISTING SURFACE
VERTICAL GEOMETRY
BOUNDARY ST
FENNEL ST
WEST GATE FWY
LORIMER ST
YARRA RIVER (ASSUMED RL = 0)
NORTH WHARF RD
DESIGN LEVELS
7.259
9.094
9.100
9.093
8.994
8.864
8.734
8.604
8.506
8.500
8.500
7.108
3.066
2.000
2.000
2.000
2.000
CHAINAGE MCC0
800.
750.
700.
650.
600.
550.
500.
450.
400.
350.
300.
250.
200.
150.
100.
50.
0.
NOT TO BE USED FOR CONSTRUCTION PURPOSES
WORK IN PROGRESS
INFORMATION PURPOSES ONLY
20 10 0 20 40 60 80 100m
SCALE
LEGEND
EXISTING LIGHT RAIL TRACKS
PROPOSED LIGHT RAIL TRACKS
EDGE OF LIGHT RAIL CORRIDOR
TRAM STOP (EATS)
TRAM STOP (ISLAND)
TRAM STOP (SIDE)
MAJOR INTERSECTION REMODELLING REQUIRED
MINOR INTERSECTION REMODELLING REQUIRED
TRAM STOP (KERB EXTENSION)
PROPOSED BRIDGE STRUCTURE
PROPOSED CUT AND COVER TUNNEL
VERTICAL GEOMETRY LEGEND
EXISTING SURFACE
PROPOSED VERTICAL ALIGNMENT (AT GRADE)
PROPOSED VERTICAL ALIGNMENT (HIGH BRIDGE)
PROPOSED VERTICAL ALIGNMENT (MEDIUM BRIDGE)
PROPOSED VERTICAL ALIGNMENT (LOW BRIDGE)
PROPOSED VERTICAL ALIGNMENT (TUNNEL)
ASSUMED WATER SURFACE (ASSUMED RL = 0)
CLEARANCE / STRUCT. DEPTH
WEST GATE FWY CROSSING ROAD / FEATURE
AURECON P4 29/05/13 4th PRELIMINARY ISSUE AC JPW SC
AURECON P3 10/05/13 3rd PRELIMINARY ISSUE AC JPW SC
AURECON P2 25/04/13 2nd PRELIMINARY ISSUE AC JPW SC
AURECON P1 15/03/13 1st PRELIMINARY ISSUE AC JPW
Revised By In Serv Rev. Date Description Designed Checked Ind. Rev. Approv.
Consultant
aurecon
Franchisee / Lessee
State Government Victoria Department of Transport
TRAM INFRASTRUCTURE
FISHERMANS BEND
LIGHT RAIL OPTIONS
OPTION 2
Up Location East. North. ID#
Down Location East. North. ID#
Datum <MGA Z55>
VicTrack ACCESS
File Name 227030.001-SK-C0020.dgn
Sheet No. 1 of 3
Scale 1:1000
Sheet Size A3
Drawn By D.BUCKLE
Designed By A.CRIGHTON
Checked By J.WILLIAMS
Approved –
Project Drawing Number: 234636.001-SK-C0020
Revision P4
234636-001-SK-C0020.dgn

VOLUME 3

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