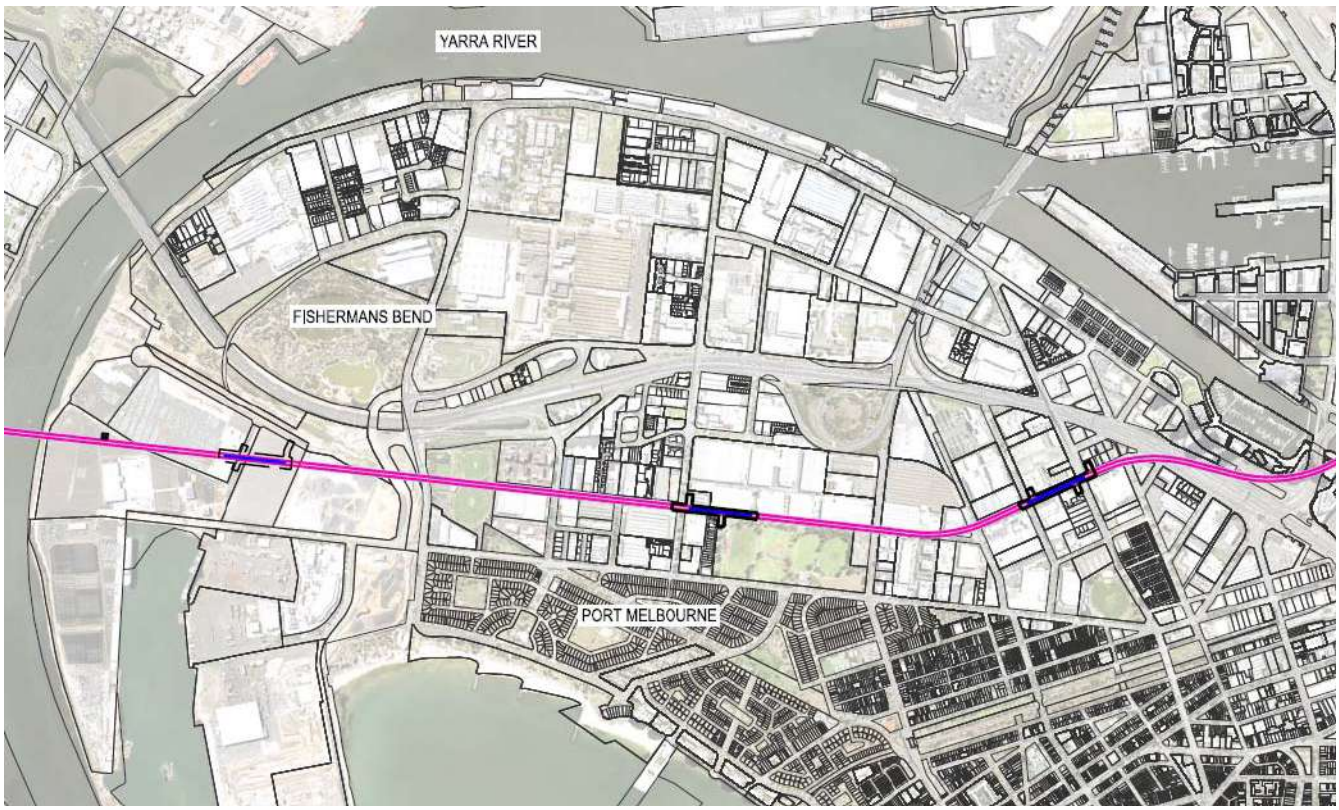

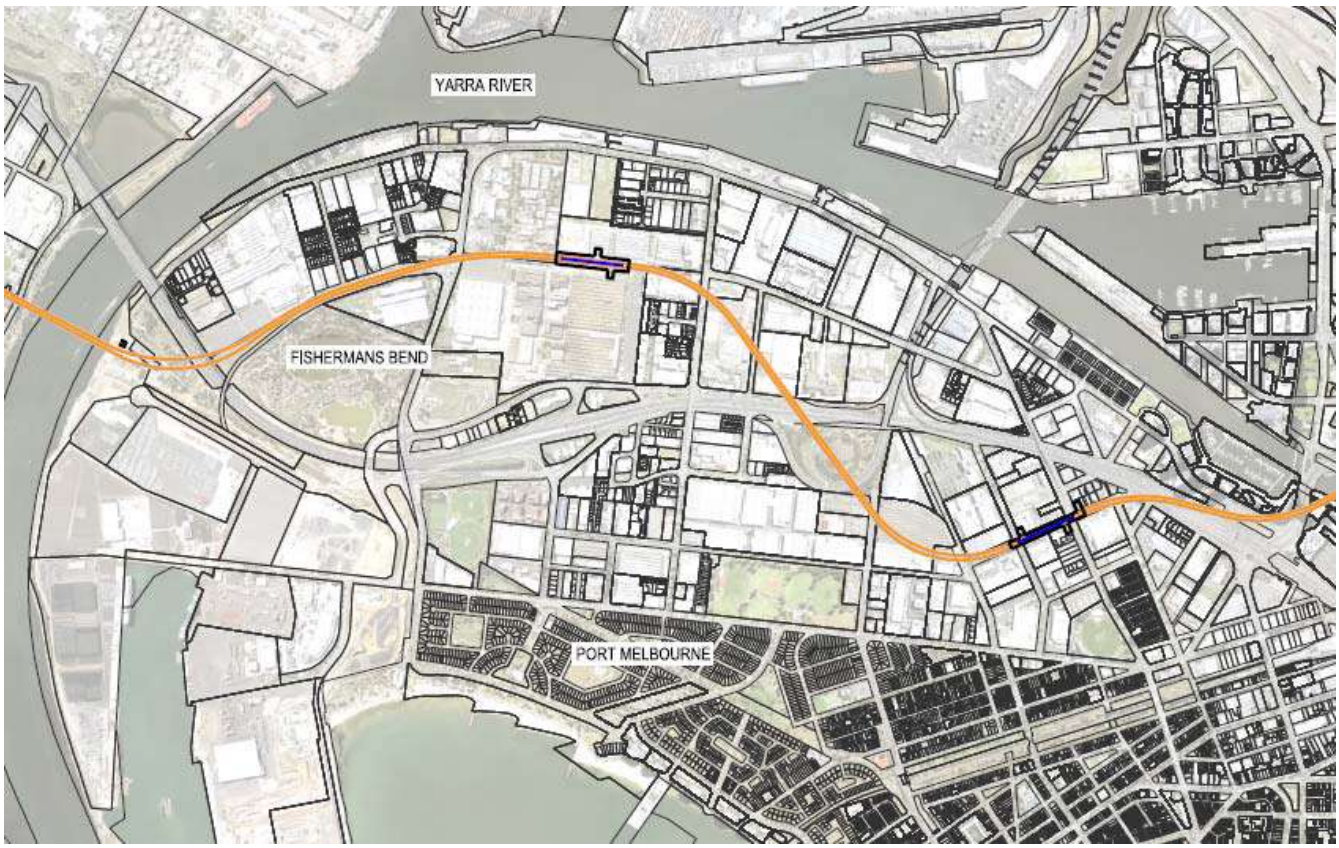

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Fishermans Bend Metro Alignment and Feasibility Options

Department of Environment, Land, Water & Planning

17 February 2017

Revision: 0.1

Reference: 252532

Bringing ideas to life

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Contents

1 Executive Summary 8

2 Introduction 10

2.1 Approach 10

3 Key Inputs and Assumptions 11

4 Project Requirements 12

5 Rail Operations 13

5.1 Key Design Parameters 13

5.2 Basis of Rail Alignment Design 13

5.3 Public Transport Integration 15

5.3.1 Heavy Rail 15

5.3.2 Tram network 16

5.3.3 Bus network 16

5.3.4 Active transport 16

6 Constraints and Opportunities Analysis 17

6.1 Key Constraints 17

6.2 Geotechnical Conditions 17

6.2.1 Basis of Geotechnical Conditions 17

6.2.2 Summary of Expected Geotechnical Conditions 18

6.2.3 Geological Setting 18

6.2.4 Geotechnical Considerations 20

6.3 Major Physical Constraints 21

6.4 Current and Future Built Form 22

6.5 Planning Permits 22

7 Identified Alignments 24

7.1 Background 24

7.2 Option 1 – West Gate Freeway 26

7.2.1 Option 1A – Alternative West Gate Freeway 28

7.3 Option 2 – Plummer Street 29

7.4 Option 3 – Williamstown Road 32

7.4.1 Option 3A – Alternative Williamstown Road 33

7.5 Option 4 – Turner Street 34

7.6 Option 5 – Sandridge/Employment Precinct 35

7.6.1 Alternative Station Locations 36

7.7 Summary 37

8 Analysis of Options against Identified Constraints 38

8.1 Patronage 38

8.2 Geotechnical / geological and tunnelling issues 38

8.3 Option 1 – West Gate Freeway 39
8.3.1 Major physical constraints 39
8.3.2 Strategic impacts 40
8.3.3 Option 1A – Alternative West Gate Freeway 40
8.4 Option 2 – Plummer Street 42
8.4.1 Major physical constraints 42
8.4.2 Strategic impacts 42
8.5 Option 3 – Williamstown Road 43
8.5.1 Major physical constraints 43
8.5.2 Strategic impacts 44
8.5.3 Option 3A – Alternative Williamstown Road 44
8.6 Option 4 – Turner Street 46
8.6.1 Major physical constraints 46
8.6.2 Strategic impacts 46
8.7 Option 5 – Sandridge/Employment Precinct 47
8.7.1 Major physical constraints 47
8.7.2 Strategic impacts 48
8.7.3 Option 5A – Sandridge/GM Holden 48
8.7.4 Option 5B – Sandridge/Cook Street 49
8.8 Outcomes of Analysis 49
9 Costs 50
9.1 Basis for Estimates 50
9.2 Calculated Cost of Options 52
9.2.1 Option 1A Alternative West Gate Freeway 52
9.2.2 Option 2 Plummer Street 52
9.2.3 Option 3 Williamstown Road 53
9.2.4 Option 5 Sandridge/Employment Precinct 53
9.3 Key Findings 54
10 Options Assessment 55
10.1 Evaluation Framework 55
10.1.1 Network Development Plan 55
10.1.2 Fishermans Bend Vision (2016) 55
10.1.3 Evaluation Framework 55
10.1.4 Land Use Planning Objectives 56
10.2 Evaluation criteria 58
10.3 Assessment approach 60
10.4 Decision 1: Horizontal alignment 61
10.4.1 Horizontal alignment decisions 61
10.4.2 Decision 1A: Newport Station 61
10.4.3 Decision 1B: Alignment Options 1A, 2, 3 and 5 (including 5A and 5B) 68

10.5 Decision 2: Vertical Alignment 75
10.5.1 Decision description and considerations 75
10.5.2 Decision assessment 75
10.5.3 Recommendation and key assumptions 78
10.6 Decision 3: Additional Webb Dock Station 78
10.6.1 Decision description and considerations 78
10.7 Key Findings 78
11 Land Use Implications 79
11.1 Shortlisted Options 79
11.2 Approach 81
11.3 Land Requirements 82
11.3.1 Construction (temporary): 82
11.3.2 Permanent: 82
11.3.3 Value Capture 82
11.3.4 Option 1A – Alternative West Gate Freeway 83
11.3.5 Option 2 – Plummer Street 83
11.3.6 Option 5 – Sandridge/Employment Precinct site 83
11.3.7 Option 5A – Sandridge/GM Holden site 84
11.3.8 Newport Options 84
11.4 Acquisition costs 85
11.4.1 Tunnels 85
11.4.2 Options 1A – West Gate Freeway alternative 85
11.4.3 Option 2 – Plummer Street 86
11.4.4 Option 5 – Sandridge/Employment Precinct 87
11.4.5 Option 5A – Sandridge/GM Holden 87
11.4.6 Newport Options 88
11.5 Planning controls 88
11.5.1 Public Acquisition Overlay 89
11.5.2 Protection of Tunnel Land 89
11.6 Key Land Acquisition Findings 90
12 Preferred Alignments 91
12.1 Option 2 Plummer Street 91
12.2 Option 5 Sandridge/Employment Precinct 92
13 Recommendations and Next Steps 93
13.1 Recommended Preferred Alignments 93
13.2 Recommended Next Steps 94

Appendices

Contents

Appendix A

Alignment Options Drawings

Appendix B

Golders High Level Geotechnical Input 2012

Appendix C

Geological Long Section

Appendix D

Max Building Height Map

Appendix E

Planning Permit Status Map

Appendix F

August 2016 FB Summary Document population demographics

Appendix G

Aquenta Initial Costings

1 Executive Summary

The Fishermans Bend Taskforce, as part of its planning for Fishermans Bend and aligned with longer term metropolitan rail needs, has identified that there will be a possible future requirement for a new rail line between Clifton Hill and Newport. The future stages of Melbourne Metro have been recognised in PTV and Transport for Victoria's strategies, as well as in Infrastructure Victoria's 30 year plan for infrastructure provision for the state. The new rail tunnel linking Newport and Clifton Hill offers a potential solution to meet major capacity uplift requirements, and provides greater accessibility to Fishermans Bend and Parkville. Infrastructure Victoria also notes this is a particularly high cost solution and further network planning is required, which consider how such an investment could deliver greater benefits, or indeed alternative options.

Most important to the Fishermans Bend Taskforce is understanding the alignment of this rail within the urban renewal precinct. This feasibility study, which seeks to assess the highest and best option for the future rail, will inform best practice integrated land use and transport planning and in turn may have a role in supporting the feasibility of the rail itself by helping deliver the vision for Fishermans Bend.

This report is the cumulative output of a series of incremental working papers which Aurecon has prepared. The aim is to inform the Fishermans Bend Taskforce of the most suitable alignment for the proposed Fishermans Bend metro rail. This report sets out, as a series of chapters, the content and findings of each working paper. It then brings the findings together and provides an ultimate recommendation and possible next steps to best utilise the information in planning for Fishermans Bend.

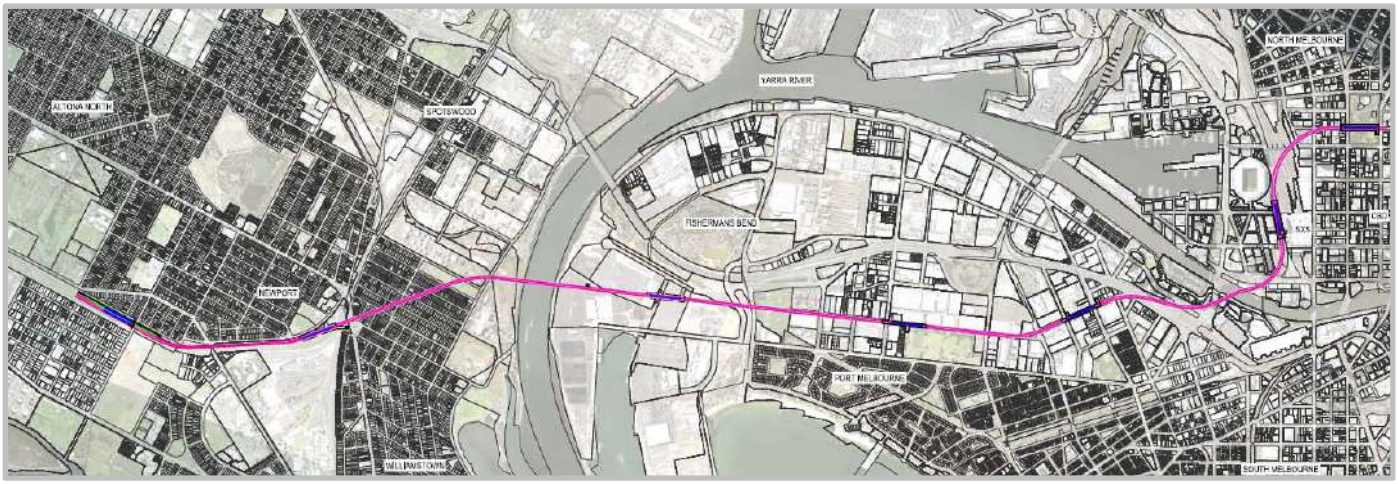
The new stations are proposed within defined activity centres in Fishermans Bend, offering the best land use outcomes and integrating with proposed surface public transport nodes.

Both preferred alignments surface at a new Newport station on **Maddox Road**.

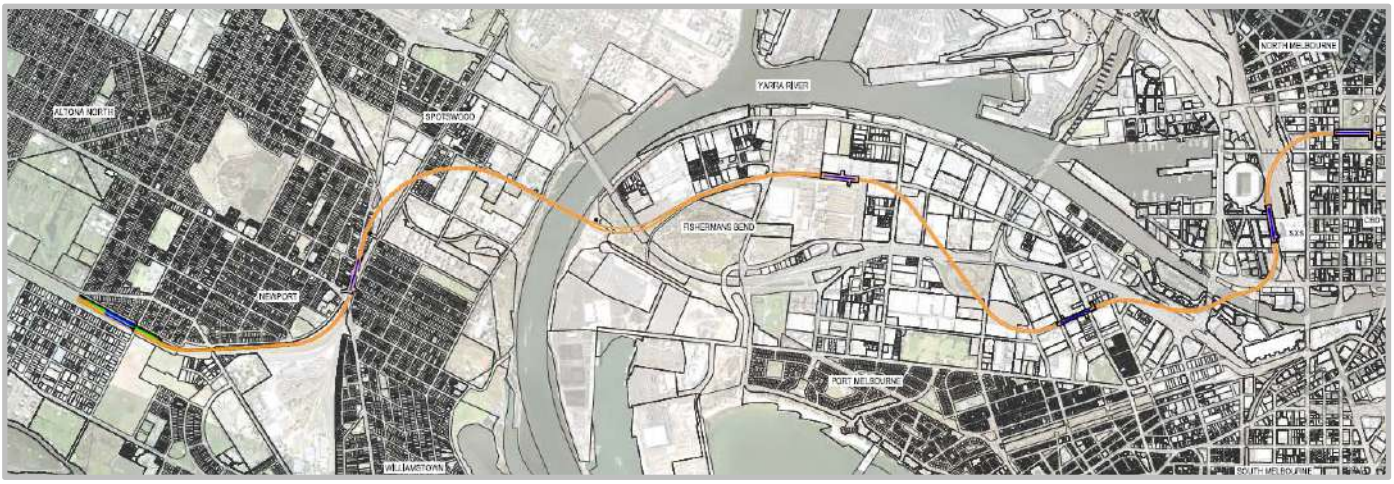
The tunnels are considered more feasible as a **shallow alignment** due to cost and access and urban renewal benefits, and deliverability. Additionally, by preserving the shallow alignment the deep alignment is also necessarily preserved.

Some private land will need to be acquired: significantly less for the stations proposed within the Employment Precinct which are generally located on government land.

This feasibility study identifies the most appropriate options for the rail line between Clifton Hill and Newport, and ensures the Fishermans Bend Taskforce can plan for the renewal of the area including a high-quality, feasible key transport connection.



Drawing 1: Preferred Alignment - Option 2



Drawing 2: Preferred Alignment - Option 5

2 Introduction

The Department of Environment, Land, Water & Planning (DELWP), commissioned Aurecon to undertake an options and feasibility study on various metro (heavy rail) alignments, principally through the Fishermans Bend Area. The preferred option will form part of a proposed rail alignment from Newport, beneath the Yarra River through to Fishermans Bend to Southern Cross and then on to Parkville and Clifton Hill.

The assignment seeks to identify the most suitable alignment for this section of the route. It will recognise that this preferred alignment must practicably insert into the broader network planning for this line (but does not specifically include study into connections to the existing stations). It will acknowledge the emerging nature of Fishermans Bend, and build in flexibility for a future employee and resident population, and land use pattern, that the Taskforce with Public Transport Victoria (PTV), Transport for Victoria and other relevant agencies will confirm.

This report presents the findings of the study of engineering alignment options for the construction of the proposed rail line. This assessment has considered the initial options provided by the Fishermans Bend Taskforce and refined these options for assessment in order to determine the preferred alignment.

Through the process a range of engineering, land use planning and functional issues in determining the alignments have been considered including:

- Major constraints to both the horizontal and vertical alignments.
- Likely geotechnical conditions.
- Alignment routes including station locations in terms of achieving lowest cost, highest benefit and deliverability.
- Project cost estimates.
- Land use planning opportunities and implications.

The findings of this report are intended to inform the transport and land use planning strategy for the Fishermans Bend Framework, due for release in 2017.

2.1 Approach

Our approach involves separating the feasibility study into a number of discrete stages which are set out as chapters to this report. Each stage informs the next and have occurred of a series of months in 2016. The Fishermans Bend Taskforce has been involved in the progression of each stage.

3 Key Inputs and Assumptions

The key inputs to the overall study are:

- Previous Geotechnical investigation documentation, including Golder Associates report dated 28th June 2012 9 Ref 127613038-003-R-Rev0 entitled “High level Geotechnical Input Fishermans Bend Development”.
- Raylink report entitled “Fishermans Bend Metro Rail Summary” for Places Victoria dated May 2013.
- High resolution aerial imagery including any recent feature/cadastral survey and any recent utility detection.
- Concept schemes of the Fishermans Bend Precinct along with any relevant planning documentation, including planning permit status maps and current built form controls.
- Concept of rail operations. Any documentation that will enable us to establish an agreed set of parameters with DELWP which will form the basis of our design (Sections 4 and 5).
- DELWP preferred areas identifying both commercial and residential clusters. This information includes any current or future developments that may pose restrictions on how our designs are developed.
- *Fishermans Bend Vision September 2016* (the Vision) and *Fishermans Bend Strategic Framework Plans* (2014, 2015 and 2016) to inform the current and future built form context.
- Fishermans Bend population demographics document, August 2016.

In addition to this, we will interrogate previous project documentation and CAD data that we have compiled over various past projects. These include but are not limited to:

- Melbourne Metro
- Melbourne Metro 2 (from Domain to the Dandenong Corridor)
- Doncaster Rail Link Engineering Options
- Melbourne Rail Link (Fishermans Bend alternative to Melbourne Metro)
- Clifton Hill to Newport Study

4 Project Requirements

To provide a level of documentation that suits this feasibility study, we have set out a number of requirements that can be built upon throughout the life of the project. These requirements predominantly relate to future operational needs which will form a basis of design that takes into consideration the future project area itself, future rolling stock requirements and that of the wider network.

These design parameters can be identified within Section 5 and are based around the following operational assumptions:

Table 1 Key Project Requirements – Fishermans Bend Metro

Item:	Requirements:	Basis / Source:
Service Frequency	Service frequency to be 18 trains per hour. Potential frequency of 24 trains per hour.	PTV assumed operational characteristics
Patronage	To cater for: 60,000 Employment by 2050 80,000 Residential by 2050	PTV Options Assessment Demand Forecasting Specification dated 6 July 2016. Note PTV is currently determining the patronage numbers to inform wider Fishermans Bend.
Operations	Single direction operation on individual Up and Down tracks in separate tunnels	Assumed operational characteristics
Operating Speed	Desirable line speed of 80km/h A reduced speed will be acceptable in some sections including in the vicinity of Southern Cross Station.	Assumed operational characteristics
Rolling Stock	Next generation train length – 230m length	Assumed operational characteristics

5 Rail Operations

5.1 Key Design Parameters

The adopted key design parameters for the core alignment options are shown below, and these parameters are generally consistent with those adopted for the Metro Tunnel. Based on discussions between Aurecon, DELWP and Public Transport Victoria (PTV) it is assumed that the longer next generation High Capacity Metro Trains (HCMT) will operate along this section of the network and throughout the Werribee to Mernda corridor. We assume these trains will be 7 or 10 cars in length and will have the capability of operating along steeper grades in excess of what current standards specify for current rolling stock. These assumed operational parameters are shown within Table 1 of Section 4 and will be documented as part of this feasibility study.

The adopted key design parameters for the Fishermans Bend Metro tracks within tunnels are shown in Table 2 below. The parameters when on surface are shown in Table 3.

5.2 Basis of Rail Alignment Design

Table 2 Key Design Parameters – Fishermans Bend Metro Tracks (Tunnel)

Item:	Design Parameters:	Basis / Source:
Design Speed	80 km/h (maximum) – Speed to be maximised where 80 km/h not achievable	Section 9 in MTM standard MTST 000002-01, Track Design & Construction
Track Gauge	Broad Gauge 1.6m	Section 2.1, in MTM standard MTST 000002-01 Track Design & Construction
Track Centres	For two single track tunnels tracks centres with be tunnel centre spacing which will be approximately 14.0m nominal (not including stations). For surface tracks, track centres will be 4m (minimum) Single tunnel was excluded and twin tunnels preferred to match the existing configuration for MMRP.	To suit tunnelling design intent. Nominal one tunnel diameter clearance between adjacent tunnels (TBM)
Horizontal Curve Radius	300m (absolute minimum) 500m (desirable)	Section 10.1, in MTM standard MTST 000002-01 Track Design & Construction
Adopted horizontal radii, speed, transition length and applied cant relationship	As per Track Design & Construction in MTM standard MTST 000002-01	Section 10.1, in MTM standard MTST 000002-01 Track Design & Construction
Vertical Curves	Sag: 2,650m Minimum Sag radius – absolute	Section 10.2 in MTM standard MTST 000002-01 Track Design & Construction
	Summit: 1,700m Minimum Summit radius – absolute	Section 10.2 in MTM standard MTST 000002-01 Track Design & Construction

Item:	Design Parameters:	Basis / Source:
Vertical Clearances top of rail to soffit off cut and cover tunnel	5.11m (minimum) Design clearance based on overhead space proofing	Clause 11.1.1.3, MTM Electrical Networks Standard - Overhead Line Electrification (L1-CHE-STD-011), Inclusive of OHLE support allowance
Horizontal Clearances from centreline of track to face of wall for decline structures / cut and cover tunnel, with vertical walls	3.0m (minimum)	VRIOGS-001 Revision B No Curve and Cant allowance based on direct fix rail assumption
Maximum track gradient within tunnel (outside stations)	1:26 (3.8%)	Assumed performance of HCMT Rolling Stock as required by PTV
Minimum track gradient within tunnel (outside stations) (drainage)	1:300 (0.33%)	Part B Heavy Rail Track Design Standards
Maximum gradient within tunnel (through platforms)	1:150 (0.67%)	Section 4.3.2.1, Part B Heavy Rail Track Design Standards. L1-CHE-WS-008 MTM Design Practice Note, Absolute Limit of Gradients at Passenger Platforms
Grade on decline structures	1:26 (3.8%) maximum	Assumed capability of HCMT Rolling Stock as required by PTV
Platform Requirements		
Number of platform faces	2	To match number of tracks
Platform Configuration	Side-Side or Island (Safeguarded provision dependant on option progressed	Assessment
Platform Length	220m to match those proposed for Melbourne metro but set up to allow initial operations using 160m long platforms.	Section 18.2, VRIOGS 002.1 - Railway Station Design Standards and Guidelines

Table 3 Key Design Parameters – Surface Tracks

Item:	Design Parameters:	Basis / Source:
Design Speed	80 km/h (maximum) – Speed to be maximised where 80 km/h not achievable	Section 9, Track Design & Construction MTST 000002-01
Track Gauge	Broad Gauge 1.6m	Section 2.1, Track Design & Construction MTST 000002-01
Track Centres	4.0m minimum.	VRIOGS-001 Revision B
Horizontal Curve Radius	300m (minimum) 500 (desirable)	Section 10.1, Track Design & Construction MTST 000002-01
Adopted horizontal radii, speed, transition length and applied cant relationship	As per Track Design & Construction MTST 000002-01	Section 10.1, Track Design & Construction MTST 000002-01
Vertical Curves	Sag: 25,000m Minimum Sag radius – desirable 2,650m Minimum Sag radius – absolute	Section 10.2, Track Design & Construction MTST 000002-01

Item:	Design Parameters:	Basis / Source:
	Summit: 12,500m Minimum Summit radius – desirable 1,700m Minimum Summit radius – absolute	Section 10.2, Track Design & Construction MTST 000002-01
Vertical Clearances	5.75m (minimum) 5.26m (absolute minimum subject to waiver)	VRIOGS-001 Revision B As adopted for other recent projects (subject to stakeholder approval)
Horizontal Clearances	3.0m plus curve and cant effect	VRIOGS-001 Revision B
Longitudinal track gradient (outside stations)	1:100 (1%) design, 1:40 (2.5%) absolute No worse than existing ruling grade of the corridor	Section 10.3, Track Design & Construction MTST 000002-01
Longitudinal track gradient (through platforms)	1:300 (0.33%) design, 1:50 (2%) absolute Risk assessment required where gradients steeper than 1:150 (0.667%)	Section 10.3, Track Design & Construction MTST 000002-01
Platform Requirements		
Number of platform faces	2	To match number of tracks
Platform Configuration	Side-Side or Island (Safeguarded provision dependant on option progressed	Assessment
Platform Length	225m but set up either to be 160m extendable to 225m or 225m to initially be used by 160m long trains.	Section 18.2, VRIOGS 002.1 - Railway Station Design Standards and Guidelines
Turnouts and Crossing work		
Crossing angle	1:15 for all existing mainline connections (where achievable)	MTM advise note L1-CHE-GDL-021

5.3 Public Transport Integration

The Metro Rail in Fishermans Bend will be part of a wider network of public transport improvements, for heavy rail and other forms of transport, including active transport. We have considered the following as relevant factors in assessing options for alignments.

5.3.1 Heavy Rail

This rail alignment forms part of a broader proposed rail alignment from Newport beneath the Yarra River through Fishermans Bend to Southern Cross, and then to Parkville and Clifton Hill. The study considers the section of the alignment between Newport and Southern Cross Station. According to PTV in its *Network Development Plan – Metropolitan Rail*, 2012, the objectives of the extension of this rail corridor (and of growing Melbourne's rail network generally) are:

- To expand the capacity of the existing network to meet the growing needs of the city.
- To redesign train services to maximise opportunities for seamless coordination with buses and trams.
- To extend the network to areas not currently serviced by metropolitan rail.

The options selected must be able to deliver these objectives.

Fishermans Bend is part of Melbourne's plan to meet its growth challenge, and an important part of this is ensuring this urban peninsula is appropriately connected. Part of its strategic planning includes

new tram and bus services, as well as walking and cycling trails, which any new heavy rail must seamlessly align with.

5.3.2 Tram network

The Fishermans Bend Vision seeks to build on the light rail lines which run through Montague Precinct, expanding tram connections throughout the five neighbourhoods. Although the Vision isn't specific, it notes a high-frequency east-west light-rail link in Lorimer, connecting the CBD and the Employment Precinct. Either Lorimer Street or Turner Street may accommodate this line. It also confirms the Fennell/Plummer Street light rail route which extends through Sandridge and Wirraway and possibly to the Sandridge beach. The tram lines are located to take advantage of north-south connections which can become multi-modal hubs: Ingles/Fennell Streets, Plummer/Salmon Streets and the Lorimer/Turner/Salmon intersection will each be vital in ensuring Fishermans Bend is an easy place to move around, and to get to and from.

5.3.3 Bus network

The two bus routes along Lorimer Street from the city are to be enhanced with new routes and high-frequency services. The Vision is not specific about the routes but it can be assumed that these will be developed to complement the train and tram services, given the stated objective to create an integrated public transport system connecting Fishermans Bend with the CBD and surrounding suburbs. It is likely that at a minimum, one route will be north-south along Ingles Street and another along Salmon Street, given the Vision identifies these intersections with the Fennell/Plummer light rail route as being future activity centres and multi-modal hubs. It is also likely that until the tram tracks are constructed, buses will run these routes.

5.3.4 Active transport

Planning for Fishermans Bend seeks to achieve a precinct with "unprecedented levels of walking, cycling and public transport connectivity that will set a new benchmark for Melbourne". This would include both formal walking and cycling infrastructure, as well as a fine–grain street network which contributes to walkability. 800m walkable catchments have been assumed for the stations. This distance should not be measured "as the crow files" but in real terms. An enhanced road network which considers pedestrians and cyclists as important as vehicles will ensure stations have significant walkable catchments. New pedestrian and cycle bridges across the Westgate Freeway will reduce the current severance caused by this structure.

6 Constraints and Opportunities Analysis

6.1 Key Constraints

As part of this study, preliminary investigations have been undertaken to identify key constraints along the key alignments as identified by DELWP. These possible constraints have been designated into the following categories:

- **Geology and ground conditions**. Based on our understanding of the geology throughout the study area, plus information provided by other third party reference material, there are variable materials and geotechnical conditions throughout the study area (refer section 6.2 below);
- **Existing structures or land uses** which restrict access to the proposed underground station or tunnel from the surface limiting cut and cover options, construction shafts and work sites without the need for major cost associated with land/property acquisition;
- **Future high rise structures** that are currently in the process of obtaining planning permits or in some cases where permits have already been obtained (refer section 6.4);
- **Existing structures constructed beneath the surface**, typically building or bridge foundations and major utilities such as deep sewers and water mains;
- **Built form controls** which allow structures of significant height and therefore of significant footings given the geotechnical conditions (refer section 6.4);
- Other **planning and environmental considerations** including heritage and environmental overlays;
- **Sensitive structures located at surface level** which may be difficult to protect from the effects of tunnelling or vibration caused by the new railway system. These structures would typically be vulnerable to settlement damage caused by tunnelling too close to the surface or in poor ground;
- Identifying **suitable walk-up catchments** that generally alignment with Fishermans Bend. It has been identified that not all alignments and related stations will suit the typical 800m catchments of two stations while still maintaining beneficial employment and residential links;
- **Connectivity to the existing railway network** at Newport may pose significant operational delays if offline construction cannot be undertaken. Similarly any occupational delays will likely impact the rail operations on both broad and standard gauge networks; and
- **Major physical constraints** for the area, such as sewers, gas main and piled foundations. These are set out in section 6.3.

Topographical features in Newport and Port Melbourne are not expected to influence the vertical alignment, which will be determined by the geological features in this area.

6.2 Geotechnical Conditions

6.2.1 Basis of Geotechnical Conditions

The expected geotechnical conditions in the Fishermans Bend precinct are based upon the report provided by DELWP: *Fishermans Bend Precinct High Level Geotechnical Input Fishermans Bend Development*, Golders Associates, report no. 127613038-003-R-Rev 0, 28 June 2012 (Appendix B).

The geotechnical information provided in this report is noted as being considered preliminary in nature and used for master planning purposes to determine foundation depths. The Golders report notes that "*Neilson (1996) has attempted to map these units using historical borehole information, as outcrops of these units are limited.*" Sections A and B from Figure 1 of this report present the interpretations prepared by Neilson.

It is noted that the proposed alignments extend beyond these precincts. However, contour maps (based on existing geological maps, published papers and Golders data) for following levels are provided that cover the general region east of the Yarra River:

- Top of Silurian
- Top of Older Volcanics
- Base of Moray Street Gravels
- Base of Coode Island Silt

Whilst the above will assist in developing geological appreciation along the alignments it does not provide sufficient information for complete geological long sections, e.g there are no contours for the top of Moray Street Gravel or base of the Older Volcanics. Therefore, additional interpretation may be required.

Also, the contours do not extend to the West of the Yarra River towards Newport. However, Section A) extends 2km from the Newport Power Station. Therefore, it is proposed that this be used for this reach of the alignment.

The reach between Southern Cross to Fishermans Bend is supplemented by the contour information provided in the Golders work with geological long sections prepared for the Melbourne Rail Link (Appendix C).

6.2.2 Summary of Expected Geotechnical Conditions

The geology along the alignment is anticipated to be variable and relatively complex. The table below summarises the expected geotechnical conditions.

Table 4: Anticipated Geotechnical Conditions

West of the Yarra River (i.e. Newport)	Flat lying tertiary units displaying very little distortion overlaying Silurian bedrock.
Fishermans Bend (from the Yarra Delta through Port Melbourne)	Shallowing Quaternary units overlaying distorted and non-continuous Tertiary units.
Docklands to CBD (north of Yarra River)	Dominated by Older Volcanics underlain by Werribee Formation and Silurian units.

Ground water levels are expected to be at approximately RL 0 m. i.e. typically close to the surface for the purposes of this study.

6.2.3 Geological Setting

The basement rock in the Melbourne metropolitan area is the Silurian Melbourne Formation, which is present at varying depth over the entire length of the alignments being considered in this study. The Silurian is found near surface to the north east of the city but dips to the west of the city towards and beyond the Yarra River.

Overlaying the Silurian is a complex array of Quaternary and Tertiary sedimentary and volcanic units that have undergone episodes of erosion and deposition. Post Silurian the next significant depositional episode is the formation of the Port Phillip Basin during the Tertiary age, where mostly fluvial deposits and lava flows occurred with minor marine sedimentary units also deposited.

On the cusp of the Tertiary-Quaternary age boundary a tectonic event, called the Melbourne Warp, occurred causing the downward tilting of the now called Yarra Delta. The consequence of this event caused the Tertiary units in the Yarra Delta to remain below the sea level, whereas the areas north of the warp were generally eroded back to the Silurian. Some of the Tertiary layers in the Delta were deformed and eroded resulting in distorted and non-continuous bedding especially in the Older Volcanics (Tov) and Werribee Formation (Tew).

During the Quaternary age, deposits of paludal, volcanic extrusive and marine sediments where laid down in the Yarra Delta. Apart from Anthropogenic deposits, the majority of the Delta is overlaid by Quaternary Port Melbourne Sands that are exposed on the current surface.

As the alignment heads north crossing the Yarra River and prior to reaching Southern Cross Station the Quaternary Yarra Delta units pinch out. Through the CBD the dominant outcropped unit is Tertiary Older Volcanics.

A brief description of the rock units (from youngest to oldest) expected to be encountered along the proposed alignments is as follows:

Table 5: Rock Units

Period	Name	Label	Description
	Fill	-	Highly variable properties which typically contain varying proportions of waste materials
Quaternary	Port Melbourne Sand	Qp	Aeolian: beach ridge deposit: stratified sand with shells. Loose to medium dense.
	Coode Island Silt	Qc	Paludal: lagoon deposits: soft to firm dark grey-brown silty clay with marine molluscs. Known to contain pockets of gas.
	Newer Volcanics – Burnley Basalt Flow	Qvn	Extrusive: basalt, fresh, vesicular and dense.
	Fishermans Bend Silt	Qf	Marine: firm to stiff yellow-grey silty clay; in parts sandy clay.
	Moray Street Gravel	Qm	Paludal/Lacustrine: Sands, gravels and irregular clay beds. Dense to very dense.
Tertiary	Newer Volcanics – Werribee Plains Phase	Tvn	Extrusive: basalt, fresh to slightly weathered, vesicular and dense.
	Brighton Group	Tb	gravel, sand, silt and hard clay in varying proportion of fluvial and shallow marine deposits. Dense to very dense.
	Newport Formation	Tmn	Marine: grey and greenish silt, clayey silts and fine sandy silts; minor ligneous silts.
	Lorimer Street Gravels	Tl	Possibly fluvial: cobbles, gravels and sands, including detrital basalt.
	Older Volcanics	Tov	Extrusive: tholeitic and minor alkaline basalts. Typically weathered.

	Altona Coal Measures	Tea	Possibly fluvial: brown coal with minor ligneous sand and clay.
	Werribee Formation (Werribee Sands)	Tw	Fluvial: brown and fawn clays and silty clays, dark brown ligneous clays, with underlying sands and minor gravels.
Silurian	Melbourne Formation (formerly Dargile Formation)	Sud	Marine: mudstone with lesser interbedded fine sandstone.

6.2.4 Geotechnical Considerations

The tunnels may intersect many of the units described above for the various horizontal and vertical alignment options. This variability poses many challenges for the tunnelling along the alignment as tunnelling is most effective through uniform ground conditions. Each of these challenges will require careful consideration of the risks and implementation of suitable control measures.

Through the Yarra Delta the units encountered will depend on whether a shallow or deep tunnel alignment is adopted. If a shallow alignment is adopted the tunnel will need to be constructed through the Quaternary units (including the Coode Island Silt). Whilst the stiffness of the Coode Island Silt is expected to vary, it will require an earth pressure balance Tunnel Boring Machine to minimise ground movement. Accurate face balancing to minimise settlements is expected to be challenging as is alignment control of the cutter head in this soft material. Potential for methane and/or hydrogen sulphide gas is also likely to be a key risk. Where the tunnel is within or above the Coode Island Silt, differential settlement will also be a key risk. Suitable controls to manage these risks will impact the programme and costs for tunnelling through the Coode Island Silt. Station construction in the Coode Island Silt will be limited to cut and cover methods and will most likely require more expensive undrained construction methods and potentially ground treatment.

If a very deep tunnel is adopted the only units likely to be encountered in the tunnels (excluding the initial decline from surface in the vicinity of Newport) are Tertiary Older Volcanic (Tov), Werribee Formation (Tew) and Silurian Melbourne Formation (Sud). In this scenario higher than typical ground water pressures will be a key consideration for the tunnels and stations.

Of all the units, the Quaternary Moray Street Gravels are expected to pose the most significant risks to tunnel construction. This unit is generally described as being typically moderately dense to very dense silty sands, sands, gravely sands and sandy gravels. There are also noted interbedded gravel beds containing cobbles and boulders. The unit is wide spread with varying thicknesses. The Moray Street Gravels unit is a known pressurised aquifer. This would likely require a slurry type Earth Pressure Balance Tunnel Boring Machine for the driven rail tunnels. Station construction in the Moray Street Gravels is also expected to be problematic and will likely require mitigation measures such as ground freezing. If allowed to depressurise, the works could contribute to settlement in areas around the proposed tunnel. This settlement may vary in magnitude across the interface with buildings and infrastructure and in such cases there is potential for damage. This potential for damage will likely require careful monitoring, damage protection and damage repair.

The depressurising of this unit is further exacerbated by the overlying Coode Island Silt, which is a highly compressible slightly over consolidated silt. Chemical testing of the Coode Island Silt also indicates in some cases that it is highly aggressive to steel and concrete due to high presence of acid sulphates. Even with engineering control measures in place, the residual risks of construction in this material are considered to be too high and it is recommended that the alignment avoid the Moray Street Gravels at this stage of the investigations.

6.3 Major Physical Constraints

The following is a description of the major physical constraints identified within the vicinity of the four alignments as outlined in the DELWP brief.

Starting at the western end near Newport Railway Station the following constraints have been identified.

- In the vicinity of Newport Station the existing bridge structure carries the road over the Williamstown and Werribee rail lines. This bridge structure is expected to be founded at high level on the Basalt. However, as a matter of good practice, the alignment should avoid the abutment.
- Williamstown main sewer near Douglas Parade. This sewer is not a main sewer and it is not expected to be deeper than the proposed tunnel.
- Newport power station outfall, which carries cooling water to Port Phillip Bay. The outfall is expected to be at water level in the Bay. It is expected that the tunnels will pass significantly deeper than the outfall.
- Melbourne Water pumping station. The Hobsons Bay Main Sewer and the North Yarra Main enter the station from the north and the east. The area has been re-configured in its history and there are likely to be abandoned structures in the area. It is preferred to set the alignment clear of the area.
- Former ferry terminal. It is possible that piles were driven to support part of the infrastructure for the ferry, which was driven by a chain across the river. If possible, the alignment should avoid the area immediately beneath the old site. Petrochemical pipelines, which run along the Yarra riverbank are also located in this area. These lines are typically at or above ground level and are expected to impose little influence on the tunnel vertical alignment.
- Old ferry terminal on the eastern bank of the Yarra River. The alignment should miss this area because of the possibility of deep foundations, although deep foundations are unlikely.
- Approach spans of the West Gate Freeway. The bridge structures are founded on deep piles. These deep foundations impose constraints on both vertical and horizontal alignments.
- Hobson Bay main sewer and the gas transmission pipeline. The gas transmission pipeline is expected to be a relatively shallow service, not affecting the sewer vertical alignment. The Hobson Bay main is a major gravity sewer which feeds the sewage system to the pump station on the western side of the Yarra River. It is expected to be approximately 16 m to 20 m deep and will be a structure that the tunnel alignments will need to avoid.
- Port Melbourne, branch sewers and drainage systems. These are expected to be relatively minor services at high level and are not expected to influence the vertical alignment.
- Bolte Bridge approach spans. The bridge structures are piled to depth. These deep foundations impose constraints on both vertical and horizontal alignments.
- In between the Bolte Bridge approaches and the Yarra River, the alignment passes beneath the developments on the south bank of the river.
- Melbourne Main sewer. The Melbourne main sewer is a major piece of infrastructure.
- Normanby Road branch sewer, which is expected to be a minor, relatively shallow service.
- All four alignments pass beneath the viaducts of the West Gate Freeway and one follows the freeway alignment. The bridge structures are piled to depth, typically to the Silurian bedrock. These deep foundations impose constraints on both vertical and horizontal alignments.
- Between the West Gate Freeway and the Yarra River, all four alignment pass between the developments on the south bank of the river including the Convention Centre. Most structures are founded on deep piles. Consideration will be required to ensure that regenerating noise from the tunnelling activity does not adversely impact the occupants of buildings.

- Existing or remnant river edge piling systems. Timber piles would be expected through this area from the construction of the nearby wharves and factories.
- On the north bank of the Yarra River, the alignment would need to pass beneath river edge piling systems and the buildings on the North Bank. The alignment again crosses the path of Melbourne Main sewer.
- Melbourne Quarter Development and Southern Cross Station. Melbourne Quarter Development is a major commercial development that will span over Wurundjeri Way and the piles for this development are likely to clash with a future tunnel.

6.4 Current and Future Built Form

This section refers to the current and proposed structures in Fishermans Bend, which have arisen as a result of the Capital City Zoning and designation of the precinct as an urban renewal area.

The current built form controls that operate in the Capital City Zone (CCZ) land are set out in the Fishermans Bend Strategic Framework Plan (November 2016) and the relevant schedules to the CCZ and Design and Development Overlays (DDO). Important to this study are the maximum allowable heights, which to an extent determine the depth of the footings required for the structures.

The mandatory heights are varied across the precinct with higher areas generally closer to the CBD or with interfaces to the freeway, and lower areas stepping down to the existing low built form south of Williamstown Road and in South Melbourne. These height limit areas are a general reflection of corresponding projected densities of residents and employees (with increased density in higher height limit areas), and the Vision broadly envisages local centres to develop in these areas. The activity centres are planned to be located near public transport, community services and public spaces to ensure that people can access their daily needs close to where they live and work, with higher densities driving activity and supporting the demand for services, retail and commercial mix to support the growing residential population. These locations present clear opportunities for supporting train or other public transport stations, and will underpin the aim for Fishermans Bend to benefit from an integrated and sustainable transport network.

Conversely, the denser areas with potentially higher buildings will require deeper footings given the unsupportive soil structure (see section 6.2) which presents a constraint for potential tunnel alignments. Maximum building heights maps are taken from the DDOs in the planning scheme and illustrate preferred distribution of height across the urban renewal area (refer Appendix D).

There are no significant heritage places or objects in Fishermans Bend that would influence the alignments.

The Special Building Overlay (SBO) – Schedule 1, 2 and 3 of the Port Phillip Planning Scheme affect parts of Fishermans Bend, generally in the Montague and Sandridge precincts. The SBO identifies land which may be liable to inundation by overland flows, and implements controls to ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity. These SBOs recognise the Melbourne Water Main Drain and local drains. The SBO is not located where any stations are proposed aside from on Plummer/Fennell Street. The station would have to be designed with input from Melbourne Water, but it is not considered that this is an influencing factor in determining alignment feasibility.

6.5 Planning Permits

A number of permits have been issued or are under consideration. Many of these, pursuant to the maximum height controls, have sought to “max out” their height and there are concentrations of

particularly tall structures which have been approved or are currently being assessed by the Minister for Planning or council.

Planning permits and their height in storeys as of July 2016 were mapped by the Fishermans Bend Taskforce and provided to Aurecon to inform this study (Appendix E).

It is noted that many of these permits are considered “speculative” and may not in fact be built, at least not to the approved or proposed specifications. However it is important to consider the potential impacts of these projects on the alignments.

The highest concentration of approvals is within the Montague Precinct, with over 30 permit applications in various stages. Many of the structures are of significant height: up to 40 storeys. There is a particularly dense cluster of applications along Normanby Road with approximately 11 approved or live applications for this area and a further two pre-applications. Further, there is a small concentration of design and post-production studios which exist in Montague: these will be particularly sensitive to any vibrations as a result of construction or operation of the tunnels. It is clear that no alignment should be proposed which would be affected by the potential footings of these projects.

The vision for the Sandridge precinct describes an area with a range of built form and land uses, including towers. Three approved permits (A2, F20 and F2 in Appendix E) are of height 46 storeys, 28 storeys and 42 storeys respectively with footings that would require consideration when determining alignments. It is expected more large buildings will be approved in the future.

The Lorimer Precinct has a number of similarly tall buildings, in line with the Vision, both approved and under consideration: A5 is 49 storeys; F18 is 46 storeys; F16 is 45 storeys and F17 is 40 storeys (refer Appendix E). Note that all of these permit applications are for multiple towers. Both Lorimer and Sandridge Precincts are expected to require piles of between 50 and 70 mbgl (Appendix B).

Development in the Wirraway Precinct presents few structures which would impact the alignment of the tunnels.

The Employment Precinct has no height controls. While this may change as the strategic planning for the precinct progresses, it is less likely there will be very tall buildings here. The Vision describes the location as being one that supports high-tech manufacturing, IT, defence, education and other innovative industries. This area will support the CBD’s global competitiveness rather than compete with it, and an alternative built form is envisioned.

It is also worth noting the significant land holdings in Fishermans Bend – particularly Goodman along Plummer Street and the General Motors Holden site in the Employment Precinct (owned by the government). These “superlots” enjoy heights of up to 18 storeys in Wirraway and no specified height control in the Employment Precinct. It is possible in the future that higher-density proposals for development will be submitted for permit application or form part of the government’s strategic planning for the land. This is increasingly likely with any public transport announcement. Any alignment should consider both the potential patronage from these sites, as well as the impact of development on the alignment.

7 Identified Alignments

7.1 Background

The alignments as identified in the following sections are generally based on those set out by DELWP in their brief to consultants. Aurecon reviewed these options and suggested modifications based on project requirements and an analysis of constraints and key requirements as presented in sections 4, 5 and 6 of this report. These revised alignments were mapped, and tested in consultation with the Fishermans Bend Taskforce, including representatives from DELWP, PTV, DEDJTR and VicRoads at a workshop held on 8 August 2016. Aurecon then mapped the revised and new alignments which were agreed by the Taskforce. These options are set out below.

Each alignment option was developed taking into account the locations of the current and future employment/commercial and residential clusters as described in the Fishermans Bend Vision document, while maintaining achievable rail alignment. Stations have been strategically located to correspond to development clusters.

All options commence at Southern Cross Station where two new underground platforms are proposed to be constructed beneath Wurundjeri Way with direct access to other platforms and facilities within Southern Cross station. This location is similar to that proposed for Melbourne Rail Link project in 2014.

From Southern Cross station all options would follow a similar path beneath Wurundjeri Way to Flinders Street then across the Yarra River near Charles Grimes Bridge. Due to major physical constraints in the area, a tight horizontal curve would need to be constructed which would locally restrict operating speed to 50 km/hr. We understand that the proposed Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.

Beyond this location, all options have been optimised to achieve the minimum desired operating speed of 80 km/hr as per Metro Trains operational requirements.

Five options have been identified; some with alternatives.

The full set of horizontal and vertical alignments are mapped in the Map Book attached in Appendix A and in Figure 1 below..

Through the course of this study the alignments have been refined and many eventually eliminated. This section seeks only to set out the originally considered routes.

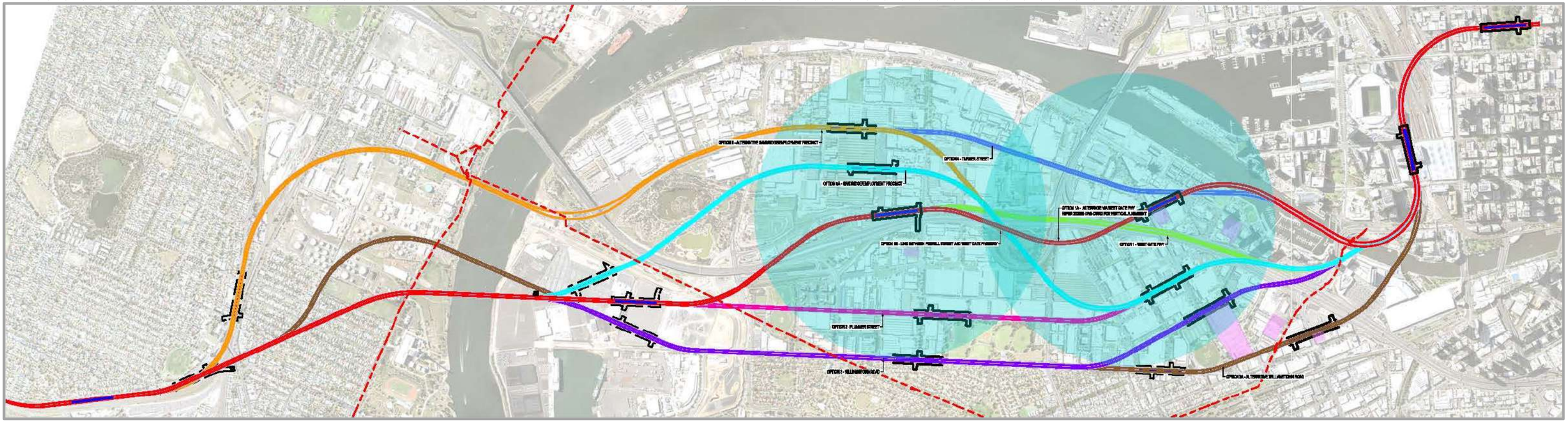


Figure 1: Identified Alignments

7.2 Option 1 – West Gate Freeway

The objective of this Option is to require the least land acquisition by aligning underneath the centre of the West Gate Freeway. It connects to the Employment Precinct and north Wirraway, assuming much of the rest of Fishermans Bend will be serviced by light rail or other public transport.

Crossing beneath the Yarra River, the alignment continues to pass beneath the ANL building and the Melbourne Main Sewer situated adjacent to the DFO complex. Prior studies undertaken for Melbourne Rail Link (MRL) project identified that this building would need to be acquired and partially demolished or modified as its deep foundations would likely clash with the proposed tunnels. As part of this study, the extra depth deemed achievable based on the less constrained vertical alignment through Southern Cross Station, along with the assumed operational characteristics of the HCMT rolling stock, the proposed tunnels in this area could be deeper and although they would be close to the building foundations there is a possibility that the ANL building could be retained. Further detailed work would need to be undertaken to confirm this.

Continuing to the west, the alignment is located beneath the West Gate Freeway. Locating the alignment within this road easement avoids any unnecessary need for land acquisition but further compounds the requirement for deep tunnels.

A single station is proposed to be located to the north of the freeway, adjacent to Salmon Street and residing within the site currently occupied by the Shell service station (Figure 2). A second station is not proposed for this option, as construction of a station beneath the freeway may result in significant disruptions to freeway traffic during the construction phase.

Figure 2 General location of proposed Cook Street Station in the Employment Precinct, facing east with Salmon Street overpass behind

The alignment continues to the west while crossing the freeway from north to south and running adjacent to the Melbourne Main Sewer through the Webb Dock site. It crosses the Yarra River directly opposite Craig Street prior to turning to the south alongside the Melbourne – Williamstown Road.

Two options have been investigated for a new station at Newport.

- A new underground interchange station could be constructed to the north of the existing station. Land acquisition would be required but the land is predominantly industrial and likely less open to challenge from the wider community.
- A station on the Melbourne side of Champion Road. This station would be a surface station constructed in a cutting to allow the future rail road grade separation at Champion Road. The station may be similar to Mitcham station which was recently lowered as part of a level crossing removal project.

PTV has indicated that it expects that the passenger interchange volumes at Newport would be relatively low and if so a high cost underground interchange station at Newport may not be warranted. Patronage at this location will need to be better understood to justify this interchange option.

Continuing beneath the existing rail corridor in the direction of the proposed Champion Road station, the alignment transitions from a deep TBM/mined construction to a shallower cut and cover. The need for retaining walls to facilitate the decline structure at this location will require minor realignment of the

existing tracks, however the corridor has sufficient width at this location and the changes are likely to be minor and are unlikely to impact the existing ARTC standard gauge line.

The alignment could be constructed either relatively shallow or deep.

If a shallow alignment was chosen land acquisition would be required in various areas. This could be in the form of purchasing the land closer to the time of construction, or should DELWP wish to set aside the land at an earlier stage, a planning overlay could be imposed to restrict the construction of high rise structures with deep foundations, reducing the impact of tunnelling through this location in the future.

Land acquisition would be minimised with a deep alignment, but the Salmon Street station would need to be constructed as mined station with individual platform tunnels similar to Parliament Station. The station adjacent to Salmon Street will likely be in the order of 70m deep as will the alignment beneath the West Gate Freeway, minimising disruption to the surface. Vertical transportation will likely be via large lifts at both ends of the station as opposed to escalators to reduce commuter journey time.

A shallow alignment is likely to be discounted as land would need to be acquired or significant planning overlays imposed, as the future tunnels could clash with any deep piled foundations used for buildings above. The deep alignment ensure the tunnels are well below any building foundations.

7.2.1 Option 1A – Alternative West Gate Freeway

This option seeks to create the highest level of connectivity for all precincts in an efficient manner by locating on the central West Gate Freeway and providing station locations that may be accessed from Lorimer, Sandridge, Wirraway and the Employment Precinct.

Passing beneath Charles Grimes Bridge, the alignment continues to follow the Yarra River for approximately 700m, turning to the south.

The first station is located at Ingles Street and crosses beneath the West Gate Freeway (Figure 3). Station entrances could be located on both sides of the freeway, picking up the employment and residential catchments in both the Lorimer and Sandridge precincts. If a shallow alignment is adopted, station construction works would need to be carefully staged to minimise the impact on Freeway traffic. It is possible that, should it prove impractical to construct a station below the freeway, the proposed station may be located further north.

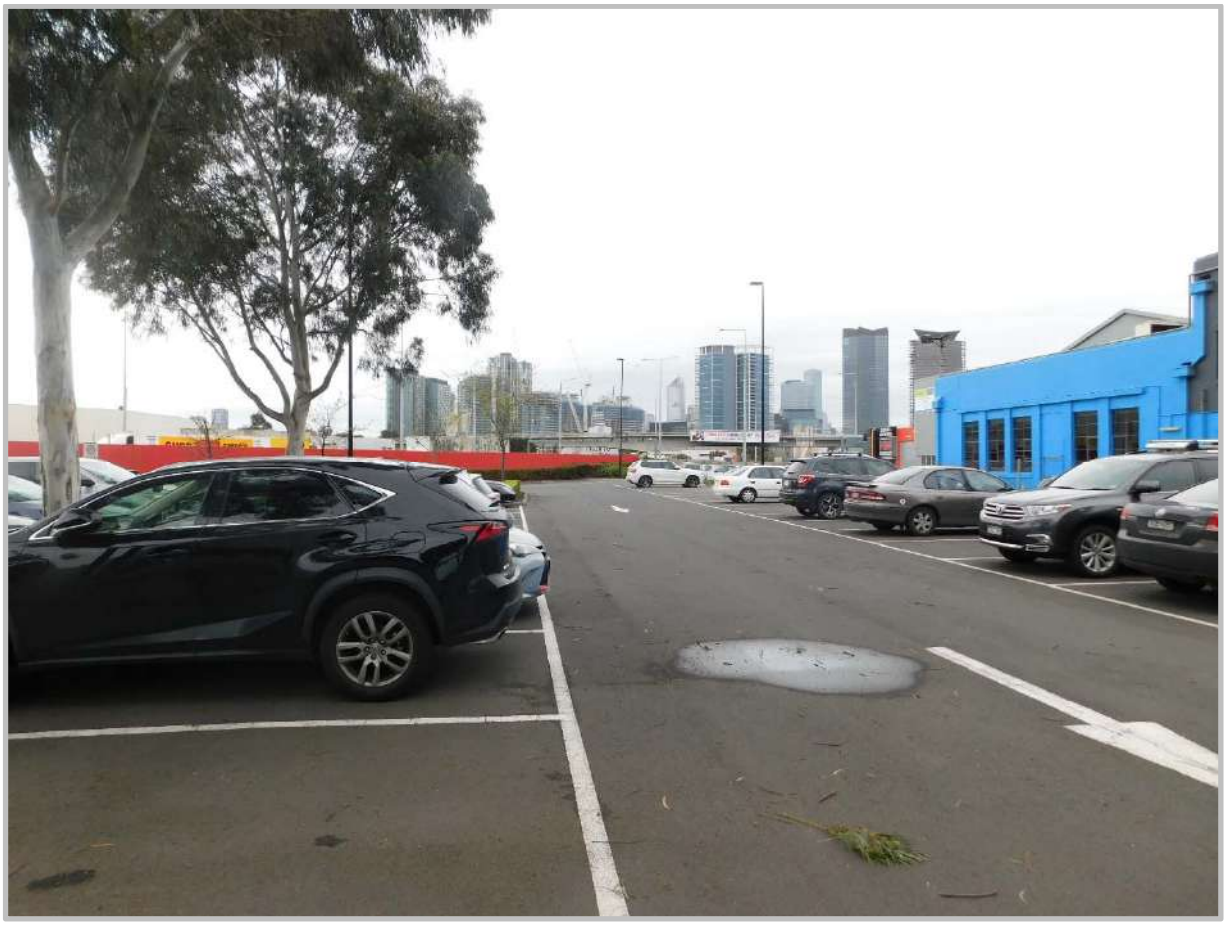


Figure 3: General location of proposed Bertie/Ingles Station, looking N/E to CBD over the West Gate Freeway from possible Bertie Street entrance. Main entrance likely to be on northern side of West Gate Freeway.

Exiting the station the alignment immediately turns back to the north and crosses the freeway to connect to the second station located adjacent to Salmon Street. This station and the alignment to Newport is identical to Option 1 above.

7.3 Option 2 – Plummer Street

This Option recognises the importance of connecting to the light rail link along the Plummer/Fennell Civic Boulevard.

Leaving Southern Cross Station as for Option 1 and then crossing beneath the West Gate Freeway, the alignment continues south underneath Fennell Street with a station located between Ingles Street to the east and Bertie Street to the west (Figure 4). Station entrances could be provided at both Ingles Street and Bertie Streets. This location has been chosen to minimise interference with freeway structure foundations, but there may be potential for locating this station closer to the freeway to provide better access over Ingles Street to the Lorimer precinct.

Figure 4: Sandridge Station location viewed from its eastern point on Fennell Street looking north over the Ingles Street bridge to Lorimer Precinct. One of the station entrances would be on the grassed area shown above.

Continuing along Fennell Street, the alignment turns to the west along Plummer Street with a second station located centrally beneath the road easement with access directly off Salmon Street (Figure 5). Station entrances could be located at multiple points to suit developments in the area.

Figure 5: Wirraway Station location on Plummer Street (20m wide road reserve). Viewed from Plummer Street facing west this is the easternmost station entrance location, with JL Murphy Reserve on the southern side of the road.

The alignment continues along Plummer Street with a possible third station option located within Webb Dock with access likely provided via Todd Road. The station was located west of Todd Road to avoid a clash with the Melbourne Main Sewer running directly through this location.

The alignment continues to the west, crossing the Yarra River directly opposite Burleigh Street prior to turning sharply to the south, Crossing beneath the Shell Terminal and residential housing located between the Melbourne – Williamstown Road and Douglas Parade, the alignment will likely be relatively deep so to avoid significant land acquisition as well as impact to the Old Melbourne Road overpass and Newport Junction.

Like Options 1 and 1A, two options have been investigated for a new station at Newport.

- A new underground interchange station could be constructed on VicTrack land adjacent to Market Street near the Newport Sports ground. Unlike Option 1 a direct interchange cannot be provided between the new and existing stations but the stations are very close and in easy walking distance.
- A station on the Melbourne side of Champion Road. This station would be a surface station constructed in a cutting to allow the future rail road grade separation at Champion Road. The station may be similar to Mitcham station which was recently lowered as part of a level crossing removal project.

PTV has indicated that it expects that the passenger interchange volumes at Newport would be relatively low and if so a high cost underground interchange station at Newport may not be warranted.

7.4 Option 3 – Williamstown Road

This Option seeks to connect to the high-density Sandridge mixed-use area, as well as the existing residential community south of Williamtown Road. It aligns with the planned Sandridge transport hub.

The alignment via Williamstown Road is similar to the Plummer Street alignment but one block further south. After crossing beneath the West Gate Freeway, the alignment continues south along Woodruff Street with a station between Boundary Street to the east and Ingles Street to the south, entrances being on the Boundary Street road reserve (Figure 6). This also moves the station away from a proposed future open space and low rise development and provides opportunities to link into the top of the Montague Precinct.

Figure 6: Woodruff Street Station location in the Sandridge Precinct, looking east towards Boundary Street and the CBD from Woodruff Street at its intersection with Ingles Street

Along Woodruff Street, the alignment turns to the west along Williamstown Road with a second station located centrally beneath the road easement with access directly off Salmon Street from both the north and south (Figure 7)

Figure 7: Location of WIlliamstown Road station entrance, looking east. Garden City residential areas is visible

The alignment continues along Williamstown Road with a possible third station option located within Webb Dock in a similar location to the Plummer Street alignment.

West of Webb Dock the alignment is identical to Option 2 above.

It has been noted in previous discussions that while this option provides one of the more geometrically pleasing alignments with a wide road easement to take advantage of, it is not ideal from a catchment perspective as this is centred on the lower rise transitional elements of Fishermans Bend along Williamstown Road and the lower density residential areas located to the south of Williamstown Road that would already have access to the planned Southern Cross – Port Melbourne tram/light rail corridor along Plummer Street.

7.4.1 Option 3A – Alternative Williamstown Road

This Option includes the Montague Precinct as well as the local residential population in its alignment. It remains under streets to reduce land acquisition. It acknowledges a third station near the planned North Port Oval community hub. It is impacted by the same catchment constraints as Option 3 above.

An alternative to Option 3 between Southern Cross station and the start of Williamstown Road has been investigated whereby the alignment passes beneath the multi-level carpark and apartments on the north Bank of the Yarra River, the Convention Centre at South Wharf, along Munro Street and connects onto Williamstown Road west of Ingles Street. The route would intersect locations with a number of permitted developments and developments which are under consideration for planning permits. A new station would be constructed beneath Munro Street in the Montague precinct, the

second in the same location as the Option 3 second station, with a possible third station beneath Williamstown Road east of Bridge Street (Figure 8).

Figure 8: Williamstown Road station location facing west towards the port. Possible entrance location at right side of image adjacent to Bunnings site.

On the assumption that demolishing the buildings the alignment passes under (or refusing the permit applications on the grounds of the alignment) is not feasible at this stage, a proposal for a deeper alignment and a deep station at Southern Cross station is the most likely scenario.

The depth will add considerable disruption and cost to the overall project along with the additional impacts to journey time and likely catchments of service. Montague precinct is also already serviced by two tram lines. This option's alignment with the 109 light rail bridge would serve little interchange and distribution purpose given the proximity of both rail and tram at this location to the CBD.

7.5 Option 4 – Turner Street

This single station Option acknowledges the importance of connecting the Employment Precinct directly to the CBD. Other transport will be relied upon to access the other neighbourhoods.

Adopting the same alignment as Option 1A beginning at Southern Cross station and running through to Lorimer Street, the alignment continues along Turner Street with the station located on the continuation of Turner Street west of Salmon Street (Figure 9).

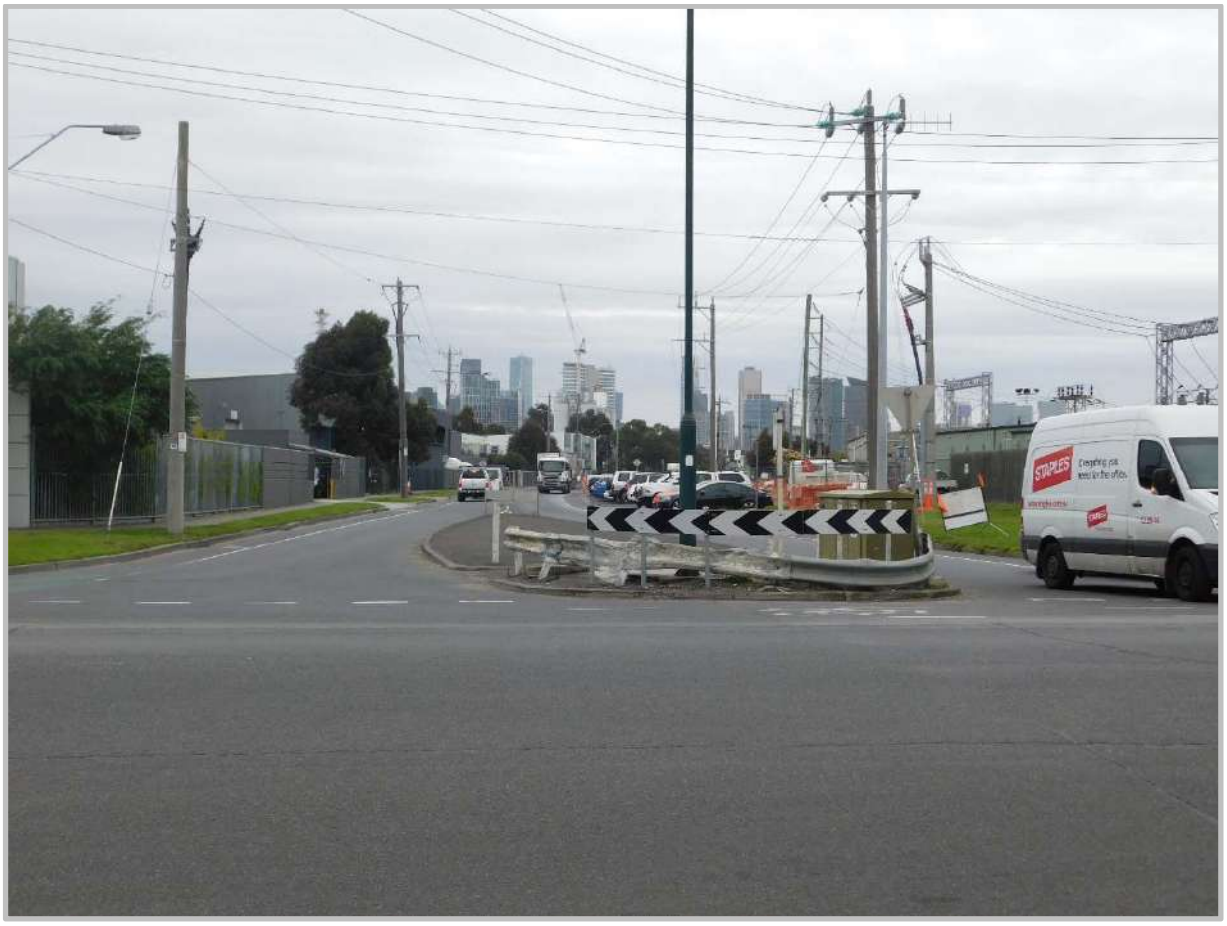


Figure 9: Turner Street Station, station would be located behind photographer. View is east along Turner Street through the Employment Precinct

Upon exiting this station, the alignment continues along Wharf Road running perpendicular to the Yarra River before crossing beneath the West Gate Freeway and joining onto Options 1/1A that cross the river adjacent to Craig Street and continuing along that alignment through to the Newport Interchange station.

This alignment heavily favours the northern cluster and does not provide such benefits to the future mixed use clusters located to the south of the West Gate Freeway, particularly those that border Williamstown Road some 1.2km away.

7.6 Option 5 – Sandridge/Employment Precinct

This Option seeks to connect the two most important employment areas of Fishermans Bend to the CBD. The Employment Precinct station location can be adjusted to better cater for different parts of the precinct, including one location providing a connection to Wirraway.

A hybrid alignment combining Option 2 and Option 4 has been produced. In this option a station along Fennell Street (Sandridge Precinct) and a station in the Employment Precinct south of the Turner Street station and north of the West Gate Freeway ensures both northern and southern catchments are considered.

In order to combine both options, the alignment upon exiting the station along Fennell Street turns sharply to the north.

This alignment passes beneath a number of properties.

If a shallow alignment was chosen the tunnels may clash with existing or future deep building or structure foundations. If this option was being considered then DELWP should either acquire the land at an earlier stage, or include a planning overlay which would only permit light weight low rise buildings on shallow foundations or align the future corridor with new road/ open space networks.

Land acquisition would be minimised if a deep alignment was adopted but both the Fennell Street and Salmon Street stations would need to be constructed as mined station with individual platform tunnels similar Parliament Station. The stations would be of the order of 70m deep. Vertical transportation will likely be via large lifts at both ends of the station as opposed to escalators.

7.6.1 Alternative Station Locations

Option 5A and 5B identify two alternative locations for stations within the Employment Precinct.

Option 5A (Sandridge/GM Holden) locates the station within the GM Holden site (Figure 10) so the tunnel is slightly shorter. This option is similar to Option 5 but with the station located closer to Salmon Street and the West Gate Freeway.

Figure 10: Station entrance location on Salmon Street. View is south along Salmon looking over the West Gate Freeway

Option 5B (Sandridge/Cook Street) utilises the Option 1A station location at Cook Street to better link to Wirraway. The tunnel is shorter again.

7.7 Summary

The above information gives an introduction to each of the possible alignment options and how they have been set based on the initial DELWP scope of works, key opportunities and constraints, and discussions with PTV and DEDJTR as important stakeholders.

Each vertical alignment has been set to achieve the desired operational requirements stipulated by Metro Trains of 80kph where feasible. This has been achieved at each location outside of the highly constrained Southern Cross station to Yarra River/Charles Grimes bridge crossing.

The vertical alignment relating to each option is consistent in terms of a high level and deeper alignment option. Each brings a mix of advantages and disadvantages where existing infrastructure including deep footings, existing services and challenging ground conditions will determine where the alignment resides, as well as how feasible each option is from a construction methodology point of view and future operational characteristics. The map book at Appendix A maps the vertical alignments.

An above ground option was originally considered but discounted for the following reasons:

- It is assumed the Southern Cross Station would be underground, and therefore that the Yarra Rive crossing would be underground. The railway would not surface until Ingles Street.
- The second Yarra River crossing may either be above or below ground. If the railway is to cross above the river the infrastructure would need to achieve a height commensurate with the West Gate Bridge to achieve appropriate clearance. This makes providing stations in the appropriate locations difficult: it would need to begin raising off the ground in Wirraway and would be elevated well into Newport.
- The underground second crossing of the river would necessitate the railway to again go underground in Wirraway to ensure appropriate depth was achieved to reach Newport. Given it only surfaced at Ingles Street, the aboveground section is very short and largely impractical, and any cost saved in above ground construction would likely be lost through significant depth changes and land acquisition.
- Further, above ground options are particularly disruptive and in this case would require significant land acquisition.

8 Analysis of Options against Identified Constraints

Section 6 of this report sets out the key issues and constraints that may impact any metro rail alignment within the Fishermans Bend area. These include physical constraints such a geological and ground conditions, existing structures which would limit tunnel or station construction, and sensitive structures which would be affected by construction and operation impacts. Other constraints or issues acknowledged were built form controls – existing and future – which may influence outcomes on the ground and sub-surface; identified catchments; connectivity issues and planning permit applications.

This section describes the advantage and disadvantages of all options, based on both physical and functional constraints. It analyses key benefits or otherwise of each based on relevant considerations for planning for a metro rail in Fishermans Bend, including patronage and catchments, land affected by tunnels or stations, social or environmental factors and strategic opportunities. The Fishermans Bend Vision, relevant Capital City Zone schedules and the *Fishermans Bend Strategic Framework Plan, 2016* have informed discussion about population, built form and land use patterns.

8.1 Patronage

Aurecon has made assumptions in regard to strategic impacts and patronage and accessibility based on information provided by the Fishermans Bend Taskforce in regard to the planned Fishermans Bend community, currently envisaging 80,000 residents by 2051 and 60,000 employees (Appendix F).

Walk-up catchments to proposed stations have been set at 800 m for all land uses.

Each alignment and station has also been set so as to avoid any planned future high rise developments (permitted or under consideration). These are discussed in greater detail for each option.

8.2 Geotechnical / geological and tunnelling issues

The geological setting for the options is discussed in Section 6 which describes the available sources of information, the interpretation that has been made from the information, and, importantly, the limitations on the confidence on aspects of the interpretation. That report forms the basis for assessing the implications of the complex geology that would be encountered in any of the options crossing the Yarra Delta deposits, and is the main reference for the following consideration of geological issues.

In terms of the current preliminary ground model, the engineering implications of the geological conditions will be similar along each of the alignments. Therefore the main considerations will be:

- whether the potentially more favourable tunnelling conditions at depth warrant the long term operation implications of deep stations; and
- how the geological conditions have affected the depths of foundations, and thus the extent to which the intensity of development at the surface might create obstructions for a shallow alignment in particular areas.

Section 6 identified that both vertical alignment options require some form of face control in the selected form of TBM that will limit the inflow of ground water during tunnelling. It can be assumed the that lining of the tunnel will be formed using precast concrete segments with seals between the segments to limit inflows to the tunnel to amounts that will not affect the ground water, even in the long term. The deeper alignment will be subject to higher water pressures, requiring appropriate tail skin

seals on the TBM and seals on the segments for pressures up to 7.5 bar; these are not unusually high.

The type of tunnelling machine adopted will be a consideration for the contractor, and there are no absolute rules for the selection of the appropriate system. Therefore, at this stage this should not be a significant differentiator.

The more clayey materials that would be encountered in the higher alignments are likely to be suitable for tunnelling using an earth pressure balance machine (EPBM), which maintains a pressure in the head of the machine by controlling the extraction of spoil using a screw conveyor. This relies on having a cohesive spoil that will resist water pressure. Construction and ventilation egress shaft sites will be required at various locations, which, at this stage have not been assessed as a significant differentiator.

When excavating in sands, gravel, or rock such as basalt, where the spoil is likely to be more granular, an EPBM can still be used, but might require conditioning agents to be added to the cuttings to maintain a seal against the water pressure. However, when such materials are expected over a considerable length of the alignment, and particularly if water pressures are a consideration, the TBM selected might be a slurry machine, which as its name suggests crushes the spoil and forms a slurry in the head which is then removed by pumping. This system provides a more predictable system of control of ground water inflow as it does not rely upon the characteristics of the spoil to create a seal, but is typically slower, more expensive, and requires more treatment plant at the surface to deal with the spoil which arrives in the slurry form.

As the ground conditions are similar on each of the alignments, there is unlikely to any difference between the horizontal alignments on the basis of the likely tunnelling technology based upon the current level of understanding.

The hydrogeological systems through the Yarra Delta have been recognised as an important consideration, particularly the Moray Street Gravels. It has already been noted that the tunnel linings will be sealed, but physical interference should also be reviewed. This has been an important consideration further upstream where some of the main aquifers are relatively narrow and could be affected by being intersected by the tunnel that effectively blocks a portion of the flow path for the ground water. The available ground models suggest that the aquifers in this area of the Yarra Delta are relatively wide and unlikely to be affected by intrusion of the tunnel through them. While the deeper alignments, which are below the aquifers for most of their length, would have less potential intrusion, it is unlikely that this hydrogeological difference would be a significant factor in the selection of the vertical alignment. The fact the that tunnel alignments are broadly running parallel rather than crossing the aquifers helps to minimise the impacts. This aspect should be subject to review once better definition of the aquifers is available.

Therefore, the hydrogeological conditions are also likely to be similar in the different horizontal options but it should be noted that the ground types forming the aquifers might influence the selection of the appropriate type of TBM.

8.3 Option 1 – West Gate Freeway

8.3.1 Major physical constraints

Major Physical constraints are:

- Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.

- The tunnels will need to pass beneath the Melbourne main sewer at three locations , the first is at Flinders Street, the second at Montague Street near the ANL building and final location on the east side of the Yarra River. At all locations the rail tunnel will be beneath the sewer. The proposed rail tunnels will also run parallel to the sewer across the Yarra River. Further investigation will be required to ensure that sufficient distance is provided between the rail sewer tunnels.
- Proposed development on the North Bank of the Yarra River near Charles Grimes Bridge. The tunnels will need to pass beneath this future development and they could impact the foundation layout of any building proposed.
- ANL building. Depending upon depth of the rail tunnels this building may need to be acquired, partially demolished, piles removed and rebuilt.
- West Gate Freeway structures. If a shallow rail alignment option is adopted the tunnels will need to be aligned to be clear of any piled structures supporting the bridges and structures associated with the West Gate Freeway. The concept has been based on clearing these structures but further detailed surveys would need to be undertaken to confirm
- Salmon Street Station. At this location all the existing buildings would need to be acquired and demolished to allow construction of a new station. However these buildings could be replaced with new over station developments.
- Various other services and structures would be impacted by the alignment and these would need to be relocated or protected.

8.3.2 Strategic impacts

This option will not be impacted by any approved or planned high-rise buildings within the Fishermans Bend precinct given its alignment under the West Gate Freeway. Any future building at the corner of Salmon Street and Vegemite Way will need to design footings considerate of the tunnel below, which extends to the periphery of this land.

This single station option caters to passenger access to the Employment Precinct, and therefore to workers, given there is no planned residential land use in this area. This is planned to be a significant worker population by 2051 – up to 20,000 people in the precinct – who will largely require good access to the CBD.

The station would also provide access to the north of Wirraway, via a concourse under the freeway to Salmon Street. The northern portion of Wirraway is expected to accommodate buildings of four to eighteen storeys which are generally residential, with a significant portion of family housing. Direct walking access from these residences will be important, however it is the connection to the Wirraway town centre at the intersection of Plummer and Salmon Streets (about 500 m in distance) that will ensure the station usefully contributes to the population as a destination as well as point of departure. A future tram or bus route up Salmon Street would enhance the volume of traffic using this connection. This location on the West Gate Freeway would require significant public realm improvements to create a successful station environment.

Overall, the 800 m walking catchment to the station as a centre point includes a significant portion of the western section of Fishermans Bend. This catchment does, however, assume an upgraded finer-grain street network to enhance permeability, as per the current SFP. However, while providing good access to the Employment Precinct it does not service the more densely populated areas of Fishermans Bend, catering largely to the more family-oriented Wirraway.

8.3.3 Option 1A – Alternative West Gate Freeway

8.3.3.1 Major physical constraints

Major Physical constraints are:

- Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.
- The tunnels will need to pass beneath the Melbourne main sewer at three locations , the first is at Flinders Street, the second beneath the Yarra River at Charles Grimes Bridge and final location on the east side of the Yarra River. At Charles Grimes Bridge the Sewer is founded on piles and the tunnel needs to be of a sufficient depth to pass beneath these piles. At all locations the rail tunnel will be beneath the sewer. The proposed rail tunnels will also run parallel to the sewer across the Yarra River. Further investigation will be required to ensure that sufficient distance is provided between the rail sewer tunnels.
- Proposed development site on the North Bank of the Yarra River near Charles Grimes Bridge. The tunnels will need to pass beneath this future development and they could impact the foundation layout of any building proposed.
- Lorimer Street residential development. The tunnels will need to pass beneath an existing low rise residential development fronting the Yarra River in Lorimer St east of Ingles Street. It is expected that these structures are founded on piles and the tunnel needs to be of a sufficient depth to pass beneath these piles.
- West Gate Freeway structures (between City Link and Ingles St). For this option it is proposed to construct an underground station partially beneath the freeway. If a shallow rail alignment option is adopted the station may be a cut and cover station which would need to be carefully staged to minimise impact on freeway traffic. Structures supporting the partially elevated sections may need to be modified. It is possible that, should it prove impractical to construct a station below the freeway, the proposed station may be located further north.
- Salmon Street Station. At this location all the existing buildings would need to be acquired and demolished to allow construction of a news station. However these buildings could be replaced with new over station developments.
- Various other services and structures would be impacted by the alignment and these would need to be relocated or protected.

8.3.3.2 Strategic impacts

The alignment of this option allows for two stations on the centrally located West Gate Freeway. However, the tunnel placement tends away from the freeway, traversing under both roads and public and private land. As the tunnel veers south from the Yarra River, it passes under the Yarra's Edge River Precinct townhouses, along Rogers Street and under the freeway where a station is accessible to both Lorimer and Sandridge precincts. Aside from providing a CBD connection to two high concentrations of work-age households, this station has the potential to link the precincts which are otherwise only connected by the Ingles Street bridge. The planned development in Lorimer is expected to be the highest density for all of Fishermans Bend, with couples and single households making up 75% of the 8,800 households in a 40-storey height limit area. A link to the CBD, as well as to the Sandridge commercial precinct, is imperative. There is opportunity to create this station as more than just a transit point, but as an urban portal.

Further, due to the planned fine grain network of streets in Lorimer the station will be within a few hundred metres of most dwellings. It is also about 350 m away from Fennell Street, the planned tram route for Fishermans Bend, providing access all the way through Wirraway along Plummer Street, the civic boulevard.

It is worth noting though that both Metro stations are located close to the freeway. Concentrating density and activity around these locations will limit amenity as well as emphasise this physical barrier.

While attractive in creating an alignment largely under road reserves, it is not the best urban realm outcome.

South of the freeway the tunnel will affect the development opportunities at the north of Bertie and Bridge Streets: planning controls will need to consider heights (and consequentially, footings) for this land. The remainder of this alignment prior to its connection with Option 1 is generally under either public land or the freeway, and built form controls should not impact construction prospects.

This options does not connect directly with the proposed east/west light rail corridors along Fennell/Plummer and Turner Streets. It does have the potential to connect with planned high frequency north/south bus services along Ingles Street and Salmon Street, or will require passengers to walk significant distances to access the main boulevards north and south of the freeway.

8.4 Option 2 – Plummer Street

8.4.1 Major physical constraints

Major Physical constraints are:

- Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.
- The tunnels will need to pass beneath the Melbourne main sewer at three locations , the first is at Flinders Street, the second at Montague Street near the ANL building and final location on near Todd Road. At all locations the rail tunnel will be beneath the sewer.
- Proposed development site on the North Bank of the Yarra River near Charles Grimes Bridge. The tunnels will need to pass beneath this future development and they could impact the foundation layout of any building proposed.
- ANL building. Depending upon depth of the rail tunnels this building may need to be acquired, partially demolished, piles removed and rebuilt.
- West Gate Freeway structures. If a shallow rail alignment option is adopted the tunnels will need to be aligned to be clear of any piled structures supporting the bridges and structures associated with the West Gate Freeway. The concept has been based on clearing these structures but further detailed surveys would need to be undertaken to confirm
- Fennell Street Station and Plummer Street/ Salmon Street Station. If a shallow option is adopted it is likely that the station would be a cut and cover station. It is expected that local services will need to be relocated or incorporated into the structure. The works will need careful staging to minimise impact on the local community.
- Various other services and structures would be impacted by the alignment and these would need to be relocated or protected.

8.4.2 Strategic impacts

From a land use and acquisition perspective this alignment is attractive. Remaining almost entirely under road reserves, acquisition of property is unlikely to be required. Its path below the proposed Plummer-Fennell tram corridor ensures that both stations will enjoy intermodal connectivity and efficiently serve the significant portion of the community south of the West Gate Freeway. This corridor is within current height limit areas of between 12 and 18 storeys and can expect a considerable local population and well as daily employment population in defined activity nodes.

The easterly station is located within the heart of the Sandridge Precinct, intended for a high concentration of commercial activity to complement the CBD. It is also very close to the Normanby

Road corridor in Montague which, with its height limit of 40 storeys, is expected to be characterised by high-density high-rise dwellings generally home to working age residents. Aside from its commercial and retail core which will be reliant upon rapid transport, Sandridge is envisaged to support a diversity of housing types which take advantage of both public transport access to the city and walking and cycling access to South Melbourne's amenity.

The second station is at the key intersection of Plummer and Salmon Streets, with entrances north and south of the junction, as well as further east near the JL Murphy reserve. This station has a particularly diverse catchment, incorporating Garden City to the south of Williamstown Road; the lower density residential development south of Plummer; the increasing height and density residential development to the north interspersed with smaller business hubs; and the Employment Precinct over the West Gate Freeway, still only 600 m away. This station is strategically placed to enhance connection into the Employment Precinct via an improved public transport link along Salmon Street across the West Gate Freeway, connecting new jobs with the new community.

Both stations are strategically located so as to also provide north-south linkages to the precincts north of the West Gate Freeway. They both provide opportunity for densification and corresponding public realm activation in these key locations.

This alignment will need to consider the impact of cut and cover construction on the operation of the future light rail route along Plummer Street. It is likely the approach would be similar to the earlier high tunnel alignment for Melbourne Metro Rail Project (MMRP) CBD North and CBD South stations where tram diversions were required. During construction of the station boxes (if the shallow alignment was adopted) the trams would need to be temporarily rerouted via another road. This would be significant cost as a new tram route would need to be built.

The third possible station within the current Webb Dock would service a future community which has not yet been considered. It also has good links to the existing school grounds, an important feature which will possibly serve a population beyond its current role, and to the West Gate Freeway Park, the beginning of the green link through the Employment Precinct to Lorimer and the opportunity to link into any future high capacity public transport route along Todd Road.

8.5 Option 3 – Williamstown Road

8.5.1 Major physical constraints

Major Physical constraints are:

- Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.
- The tunnels will need to pass beneath the Melbourne main sewer at three locations , the first is at Flinders Street, the second at Montague Street near the ANL building and final location on near Prohasky Street. At all locations the rail tunnel will be beneath the sewer.
- Proposed development site on the North Bank of the Yarra River near Charles Grimes Bridge. The tunnels will need to pass beneath this future development and they could impact the foundation layout of any building proposed.
- ANL building. Depending upon depth of the rail tunnels this building may need to be acquired, partially demolished, piles removed and rebuilt.
- West Gate Freeway structures. If a shallow rail alignment option is adopted the tunnels will need to be aligned to be clear of any piled structures supporting the bridges and structures associated with

the West Gate Freeway. The concept has been based on clearing these structures but further detailed surveys would need to be undertaken to confirm

- Woodruff Street Station site. If a shallow option is adopted it is likely that the station would be a cut and cover station. It is expected that local services will need to be relocated or incorporated into the structure. The works will need careful staging to minimise impact on the local community. Particular consideration must be given to the townhouse development on the corner of Inlges and Woodruff Streets, which is already under construction.
- Williamstown Road / Salmon Street Station. If a shallow option is adopted it is likely that the station would be a cut and cover station. It is expected that local services will need to be relocated or incorporated into the structure. The works will need careful staging to minimise impact on the local community. In particular the heritage buildings at the intersection of Williamstown Road and Salmon Street need to be considered as part of emerging public realm associated with station.
- Various other services and structures would be impacted by the alignment and these would need to be relocated or protected.

8.5.2 Strategic impacts

After crossing under the West Gate Freeway, this alignment's first station emerges within the four storey height limit area in the southern sector of Sandridge, about 250 m from the Fennell Street alignment. This immediate area of Sandridge is expected to accommodate lower scale built form to better interface with the residential areas of Port Melbourne and Garden City. The projected population therefore will be somewhat lower than that of the northerly Sandridge and neighbouring Montague Precinct. And although on Ingles Street, the distance from this station to the Lorimer Precinct over the freeway is about 570 m. This is approximately two and a half city blocks, lengthwise, for example from the top of Collins Street at Spring Street, down to the Regent Theatre. Importantly, the station is particularly close to the North Port Oval, a future community "anchor".

The tunnel after that extends below Woodruff Street to Williamstown Road all the way along to Webb Dock. The second station on this alignment is located at the termination of Salmon Street, at the western end of JL Murphy Reserve. This location is expected to be typified by a large portion of the 25% row or townhouses of the total 8,800 dwellings in Wirraway: close neighbours to Garden City's double storey semi-detached residences. Although about 250 m to the Salmon/Plummer junction and planned activity centre, it is unlikely the catchment would support a metro train station in this location.

The third possible station has similar potential as set out above for the third station described in Option 2.

8.5.3 Option 3A – Alternative Williamstown Road

8.5.3.1 Major physical constraints

Major Physical constraints are:

- Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.
- The tunnels will need to pass beneath the Melbourne main sewer at three locations, the first is at Flinders Street, the second at Montague Street and final location on near Prohasky Street. At all locations the rail tunnel will be beneath the sewer.
- Existing multi-level carpark and residential apartments on the North Bank of the Yarra River. The tunnels will need to pass beneath this existing development. It is expected that these building could not be acquired or modified and this option is only viable if a deep rail alignment was adopted.

- Existing and future planned extension to the Convention Centre. The tunnels will need to pass beneath this existing and planned development. It is expected that these building could not be acquired or modified and this option is only viable if a deep rail alignment was adopted.
- West Gate Freeway structures. If a deep alignment was adopted the tunnels will be beneath any piled structures.
- Permitted residential development on the corner of Normanby Road and Montague Street. Two towers on the site, over 40 storeys high. These will have significant piles.
- Proposed high rise buildings in Normanby Road. A station is proposed to be located in Munro Street adjacent to a number of proposed 40 storey apartment towers. Although the station will need to be deep. Construction may have impact on the building foundations. Also a suitable site would need to be acquired for station entrances.
- Williamstown Road (east) Station site. It is expected that this station would be a deep station and appropriate areas would need to be acquired for station entrances and constriction sites.
- Various other services and structures would be impacted by the alignment and these would need to be relocated or protected.

8.5.3.2 Strategic impacts

This alternative Williamstown Road options presents further difficulties associated with planning controls and development. The DFO complex and Melbourne Convention and Exhibition Centre, already on significant footings which the alignment has been designed to miss, are likely to undergo significant redevelopment. Any tunnel passing beneath must be designed with this in mind, and specific planning controls which manage development capacity may be required for the sites. They are, however, important sites to the Melbourne economy and an approach will have to be agreed between the relevant government agencies.

Beyond the West Gate Freeway, the alignment progresses under Munro Street to join Williamstown Road. Munro Street and surrounds are currently in a 40 storey height limit area, and numerous planning permit applications which seek to maximise the allowable opportunity are currently under consideration by the Minister for Planning. These buildings would require significant footings and although the alignment remains largely beneath the road reserve, the station box at the intersection of Munro and Montague Streets is likely to extend to private land. Note that there is already one permitted residential development on the corner of Normanby Road and Montague Street. Two towers on the site, over 40 storeys high, will have significant piles which may affect tunnel and station alignment.

Planning controls which allow the construction as well as operation of the station and tunnel in this area by managing the risk of deep footings will be required. Note that this alignment would not preclude tall development, but footings will require careful design to span across or alongside the tunnels, creating additional cost to developers and a fairly complex network of pilings under the Montague area. Montague Street is an extremely busy road providing access to the West Gate Freeway and the city: construction will have to be carefully managed on this thoroughfare. The planned high-rise high-density development in this location may be constrained by the location of this tunnel and station alignment.

The second station in this alignment is on Williamstown Road, adjacent to the North Port Oval and the Australia Post site, one of the few lots of government owned land. While there is sense in locating a station near these community facilities, the low population densities of Port Melbourne and Garden City, and the planned low-rise buildings for this area of Sandridge may be unable to support a metro station.

The alignment then joins the Williamstown Road alignment.

8.6 Option 4 – Turner Street

8.6.1 Major physical constraints

Major Physical constraints are:

- Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.
- The tunnels will need to pass beneath the Melbourne main sewer at three locations , the first is at Flinders Street, the second beneath the Yarra River at Charles Grimes Bridge and final location on the east side of the Yarra River. At Charles Grimes Bridge the Sewer is founded on piles and the tunnel needs to be of a sufficient depth to pass beneath these piles. At all locations the rail tunnel will be beneath the sewer. The proposed rail tunnels will also run parallel to the sewer across the Yarra River. Further investigation will be required to ensure that sufficient distance is provided between the rail sewer tunnels.
- Proposed development site on the North Bank of the Yarra River near Charles Grimes Bridge. The tunnels will need to pass beneath this future development and they could impact the foundation layout of any building proposed.
- Lorimer Street residential development. The tunnels will need to pass beneath an existing low rise residential development fronting the Yarra River in Lorimer Street east of Ingles Street. It is expected that these structures are founded on piles and the tunnel needs to be of a sufficient depth to pass beneath these piles.
- Turner Street Station. If a shallow option is adopted it is likely that the station would be a cut and cover station. It is expected that local services will need to be relocated or incorporated into the structure. The works will need careful staging to minimise impact on the local community.
- Various other services and structures would be impacted by the alignment and these would need to be relocated or protected.

8.6.2 Strategic impacts

This single station option follows the Turner Street road reserve with station box located within the former GM Holden site in the Employment Precinct. The initial crossing under the Yarra River and Mirvac's Yarra's Edge townhouse development is unlikely to pose concern in terms of deep footings. However within Lorimer the tunnel will go beneath a portion of the precinct which allows 40 storey development, and associated deep footings given the particularly difficult soil conditions. The central six storey zone in Lorimer – the neighbourhood heart – is a low scale, fine grain area which can largely be constructed on floating slabs so footings will be less of an issue. No station is shown in Lorimer due to the restricted catchment available and journey time comparability to the future proposed light rail connection. However, it may be worth considering a second station location in Lorimer given the Vision for the precinct as being the highest density of all of Fishermans Bend, reflecting the continuation of the Docklands and CBD pattern of development.

From the Lorimer centre the tunnel continues below Turner Street through to the Employment Precinct and the station site on what is the termination of Caprice Ave. This location on this significant parcel of land presents the opportunity for the land owner to undertake a master planning exercise to incorporate a station precinct in to the final built form outcome. While no height controls exist on this land, this may change as the strategic planning for the precinct progresses. However it is less likely there will be very tall buildings, with IT, defence, education and other innovative industries encouraged. This area will support the CBD's global competitiveness rather than compete with it, and an alternative built form is envisioned. A station here makes good planning sense providing direct

access to the CBD from this important future economic hub. However the types of jobs envisioned for the area, and associated built form, may not create sufficient demand for a metro station. This needs further investigation.

This option however does not favour the parts of Fishermans Bend south of the West Gate Freeway and it is unlikely to contribute to achieving the vision for Sandridge Precinct which is seen as a future high density employment precinct to expand the CBD activities. It is assumed a tram or other public transport services would be required to serve the population and workers – to and from the city, as well as within the precincts, including the Employment Precinct.

The alignment continued under private land, which will require planning controls to manage risk of deep footings which would affect the tunnel alignment. It re-joins Wharf Road crossing under the West Gate Freeway Bridge through parkland before crossing the Yarra River. While this parkland is expected to expand it is unlikely to affect the potential alignment of the tunnel.

8.7 Option 5 – Sandridge/Employment Precinct

8.7.1 Major physical constraints

Major Physical constraints are:

- Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.
- The tunnels will need to pass beneath the Melbourne main sewer at three locations , the first is at Flinders Street, the second at Montague Street near the ANL building and final location on the east side of the Yarra River. At all locations the rail tunnel will be beneath the sewer. The proposed rail tunnels will also run parallel to the sewer across the Yarra River. Further investigation will be required to ensure that sufficient distance is provided between the rail sewer tunnels.
- Proposed development site on the North Bank of the Yarra River near Charles Grimes Bridge. The tunnels will need to pass beneath this future development and they could impact the foundation layout of any building proposed.
- ANL building. Depending upon depth of the rail tunnels this building may need to be acquired, partially demolished, piles removed and rebuilt.
- West Gate Freeway structures. If a shallow rail alignment option is adopted the tunnels will need to be aligned to be clear of any piled structures supporting the bridges and structures associated with the West Gate Freeway. The concept has been based on clearing these structures but further detailed surveys would need to be undertaken to confirm.
- Fennell Street station. If a shallow option is adopted it is likely that the station would be a cut and cover station. It is expected that local services will need to be relocated or incorporated into the structure. The works will need careful staging to minimise impact on the local community.
- Existing and planned properties between Bertie Street and Salmon Street. If a shallow alignment was chosen the tunnels may clash with existing or future deep building or structure foundations. If this option was being considered the Victorian Government should either acquire the land at an earlier stage, or include a planning overlay which would only permit light weight low rise buildings on shallow foundations.
- Land acquisition would be minimised if a deep alignment was adopted but both the Fennell Street and Salmon Street stations would need to be constructed as mined stations with individual platform tunnels similar to Parliament Station. The stations would be of the order of 70m deep. Vertical transportation will likely be via large lifts at both ends of the station as opposed to escalators.

- Salmon Street Station. If a shallow option is adopted it is likely that the station would be a cut and cover station. It is expected land acquisitions would be required for the station and entrances.
- Two crossings of the West Gate Freeway in this alignment will require additional engineering solutions than if freeway is only crossed once.
- Various other services and structures would be impacted by the alignment and these would need to be relocated or protected.

8.7.2 Strategic impacts

This option benefits from the same tunnel and station alignment as Option 2, until it veers north to cross the West Gate Freeway and join the Option 4 station and tunnel to the west. The alignment to be assessed then is between these two stations.

The tunnel crosses under some public land – the land within the Bolte off/on-ramp. However, between the first station and the Bolte ramp it goes under large parcels of private land which have significant development opportunity in the 18 storey height limit area. Further, within the Employment Precinct north of the freeway it goes beneath a series of larger lots of land which will be redeveloped to meet the demands of the emerging technology economy. While these buildings may not have deep piles, planning controls will still need to manage risk associated with the tunnel alignment.

Despite the difficulties which may be associated with both planning and development controls and possible acquisition depending on tunnel depths and construction, this alignment is particularly well located to cater to the employment and residential population, both within Fishermans Bend, and outside allowing good access to both residential and commercial locations. As discussed in Options 2 and 4 these stations are very well located to cater to a predicted high-density population. They also align well with future surface public transport routes.

This is the longest of all the routes.

8.7.3 Option 5A – Sandridge/GM Holden

The Major Physical Constraints and planning considerations associated with this option are the same as described for Option 5 until the alignment crosses the West Gate Freeway to the Employment Precinct. It then takes the same path as Option 5 as it crosses the West Gate Freeway, then veers west to cross Salmon Street about 220m north of the freeway.

The tunnel would go under the Kraft factory which at this time would not have significant footings given its lower height as a series of factories. It is possible in the future Kraft would relocate in line with the realisation of the Employment Precinct as an innovation hub, so controls which mitigate risk of deep piles under this area would be required.

The remainder of the alignment before it rejoins Options 4 and 5 at West Gate Freeway Park goes under the GM Holden site, now owned by the government. This presents a significant opportunity for creating a transport hub on the land, integrated with development determined by government as best use of the site to meet the objectives of Fishermans Bend. The station would be in the middle of the GM Holden site, creating a focal point which could be made complementary to the Salmon Street and Todd Road frontages. It is also fairly central to the Employment Precinct, and may be able to accommodate higher densities and more intense land uses within the precinct oriented around this station. It is also aligned with the Salmon Street boulevard, providing planned public transport connection to the neighbourhoods.

Planning controls will need to be in place to ensure piles do not jeopardise the future alignment, but this is perhaps an easier negotiation than that which may occur with a private land owner. West of Todd Road the tunnel continues under the West Gate Freeway Park Printing Business, at 127 Todd Road, which would also require limiting planning controls.

8.7.4 Option 5B – Sandridge/Cook Street

The Major Physical Constraints and planning considerations associated with this option are the same as described for Option 5 until the alignment crosses the West Gate Freeway to the Employment Precinct, at which point it then aligns with those constraints set out for Option 1A.

Strategically, this option provides the highest level of connectivity across the precincts, servicing the Sandridge Hub (and linking to Lorimer via Ingles Street) and both the Employment Precinct and Wirraway, with a strong connection in the immediate vicinity of the station entrances as well as along the Salmon Street boulevard linking the Plummer Street intermodal hub and the same planned for the Employment Precinct on this axis.

8.8 Outcomes of Analysis

The above assessment shows that some alignments are more feasible than others, based on physical and functional constraints. This has been made clear in the analyses.

The following options **are retained** for further assessment.

- 1A – West Gate Freeway
- 2 – Plummer Street
- 3 – Williamstown Road
- 5 – Sandridge/Employment Precinct (including sub options 5A – Sandridge/GM Holden and 5B – Sandridge/Cook Street)

Options 1, 3A and 4 are **not** further evaluated.

Option 1 can feasibly only accommodate a single station as second (eastern) station under the freeway would considerably disrupt freeway traffic during construction. One station alone does not capture the potential associated with the intent of urban renewal, and does not achieve the connectivity desired for the easterly neighbourhood precinct to the CBD and more broadly within Fishermans Bend. There are also amenity concerns regarding the single station location in such close proximity to the West Gate Freeway.

Option 3A would require strong planning controls to limit development in the planned high density precinct of Montague, as well as acquisition due to the direct interface with a number of approved tall developments north of Normanby Road. This area is already connected to the CBD via two tram lines. Combined with its extension along Williamstown Road which is not anticipated to reach a high catchment population, this option is significantly less feasible than others.

Option 4 Turner Street is considered to locate too far north of the Fishermans Bend neighbourhoods, and only considers a single Employment Precinct station.

The remaining options are costed in Section 9 of this report.

9 Costs

This section provides high-level costings for the alignments determined to take forward following the outcome detailed in Section 8.8 of this report.

Aquenta was engaged as a sub-consultant to undertake this work and has specifically assessed four horizontal options, two vertical options (for each horizontal option) plus two underground stations for each option.

Costings (dated 26 September 2016) are attached at Appendix G.

9.1 Basis for Estimates

Overview

The Estimate is based on Scope produced by Aurecon and preliminary drawings issued: *Horizontal Alignment Options 252532-DRG-C0001 Rev.P4 dated 31/08/2016 & 252532-DRG-C002 Rev.P4* dated 14/09/2016; and *Vertical Alignment Options 252532-DRG-C003 Rev.P3* dated 14/09/2016; *Fishermans Bend Metro Alignment and Feasibility Options WP1 Constrains and Key Requirements Ref. 252532 Rev. 0* dated 27 July 2016.

Estimate options are based on drawings *Fishermans Bend Metro Alignment and Feasibility Options WP 2 & 3 Horizontal and Vertical Alignments Ref. 252532 Rev. 0.1* dated 6 September 2016 issued by Aurecon.

Alignments

The feasibility estimate consists of 8 options, namely option 1A, 2, 3, and 5 each in shallow & deep options. The shallow options and the deep options are approx. 40m deep and approx. 80m deep respectively.

Option 1A (Alternative West Gate Freeway): Driven tunnel from Flagstaff Station to Southern Cross Station, Ingles Street Station, Salmon Street Station and Champion Road Station. This tunnel is approx. 9,701m long one way. The station works at Southern Cross Station, Ingles Street, Salmon Street and Champion Road station. Assumed no station works at Flagstaff Station.

Option 2 (Plummer Street): Driven tunnel form Flagstaff Station to Fennell Street, Plummer Street and Champion Road. This tunnel is approx. 8,990m long one way. The station works at Southern Cross Station, Fennell Street, Plummer Street and Champion Road Station. Assumed no station works at Flagstaff Station.

Option 3 (Williamstown Road): Driven tunnel form Flagstaff Station to Southern Cross Station, Woodruff Street, Williamstown Road and Champion Road. This tunnel is approx. 9,103m long one way. The station works at Southern Cross Station, Woodruff Street and Williamstown Road Station. Assumed no station works at Flagstaff Station.

Option 5 (Sandridge / Employment Precinct): Driven tunnel form Flagstaff Station to Southern Cross Station to Fennell Street, Station Close to Salmon Street and Champion Road. This tunnel is approximately 9,996m long one way. The station works at Southern Cross Station, Fennell Street Station close to Salmon Station and Champion Road Station. Assumed no station works at Flagstaff Station.

Items for further clarification

Land and property acquisition / compensation costs for each option: allowance at time of calculation during the earlier phases of the study was plugged figure of $120,000,000.

The final costs for the **preferred alignments** (Options 2 and 5) have since been calculated using the land acquisition findings set out in Section 11 and the costs below updated.

Exclusions

No line item allowance made for any work on underground Melbourne main sewer, and various other services.

No line item allowance made for structures would be impacted by the alignments and/if these would need to be relocated and protected.

No line item allowance made for deeper alignment options with higher water pressures compare with the shallow options.

Key Assumptions

Indirect Costs

On-site overheads including staff, accommodation, general plant, insurance, etc. – 20 % allowance

Contractor's off-site overheads & profit – 12 % allowance

Design, geotech, surveys, miscellaneous consultants – 10 % allowance

PTV project management costs, including staff and stakeholder costs – 7 % allowance

PTV levy costs – 5%

PTV insurance – no allowance - tbc

Contingency/risk on design and construction – 20 %

Driver Training – no allowance – tbc

Risk & Contingency

Contingency and Risk allocations are calculated. Risk is essentially the P50 value, and Contingency is the P95-P50 value. Risk + Contingency = P95.

These amounts have been inserted into the estimate, P50, P5, P75, P95 indicative only.

9.2 Calculated Cost of Options

Following are the comparative cost estimates for each of the schemes. These estimates were used for the Options assessment stage in Section 10.

The estimates set out here are calculated as P95.

As the construction phase may be decades away these estimates are not intended to be used to provide an exact estimate of overall construction costs but as a comparator.

9.2.1 Option 1A Alternative West Gate Freeway

Items	Shallow Option ($) (approx. 40m)	Deep Option ($) (approx. 80m)
Direct Costs	2,569,061,800	2,746,021,600
Indirect Costs	1,494,906,233	1,597,877,017
PTV Levy Costs	208,198,402	222,194,931
Contingency/risk on design and construction	878,433,287	937,218,710
Land and property acquisition / compensation costs	120,000,000	120,000,000
Estimate (P95)	6,851,779,638	7,310,305,934

The P95 estimate for the shallow alignment is approximately half a billion dollars less expensive than the deep alignment.

9.2.2 Option 2 Plummer Street

Items	Shallow Option ($) (approx. 40m)	Deep Option ($) (approx. 80m)
Direct Costs	2,537,744,000	2,716,913,800
Indirect Costs	1,476,682,781	1,580,939,537
PTV Levy Costs	205,721,339	219,892,667
Contingency/risk on design and construction	868,029,624	927,549,201
Land and property acquisition / compensation costs	189,660,000	189,660,000
Estimate (P95)	6,879,300,667	7,343,553,360

The P95 estimate for the shallow alignment is approximately $450m less expensive than the deep alignment.

9.2.3 Option 3 Williamstown Road

Items	Shallow Option ($) (approx. 40m)	Deep Option ($) (approx. 80m)
Direct Costs	2,553,175,300	2,731,185,100
Indirect Costs	1,485,662,069	1,589,243,835
PTV Levy Costs	206,941,868	221,021,447
Contingency/risk on design and construction	873,155,847	932,290,076
Land and property acquisition / compensation costs	120,000,000	120,000,000
Estimate (P95)	6,810,615,610	7,271,862,596

The P95 estimate for the shallow alignment is approximately $450m less expensive than the deep alignment.

9.2.4 Option 5 Sandridge/Employment Precinct

Items	Shallow Option ($) (approx. 40m)	Deep Option ($) (approx. 80m)
Direct Costs	2,739,316,400	2,906,712,700
Indirect Costs	1,593,975,341	1,691,381,240
PTV Levy Costs	221,664,587	234,904,697
Contingency/risk on design and construction	934,991,266	990,599,727
Land and property acquisition / compensation costs	73,545,000	73,545,000
Estimate (P95)	7,220,462,071	7,654,208,073

The P95 estimate for the shallow alignment is approximately $430m less expensive than the deep alignment.

It is likely that the variations on Option 5 (5A and 5B) will cost less than Option 5 itself due to decrease in tunnel distance and presence of government owned land where the Employment Precinct station is proposed.

9.3 Key Findings

- Option 3 is shown to be the least expensive Option for both shallow and deep alignments.
- Option 5 is the most expensive for both shallow and deep alignments.
- The shallow alignment is cheaper than the deep alignment. The deep alignment is shown to consistently increase cost by between $450m and $500m. This is largely a result of lower construction and maintenance costs associated with shallow stations.
- The longer routes cost more than the shorter routes. The operational cost and cost to the economy of the longer journey time associated with longer routes should also be considered in the full project business case.
- Deeper tunnels will have longer construction times and being further below ground, will incur longer travel times for passengers. In developing a project business case the cost of longer construction and travel times should be assessed.

10 Options Assessment

A workshop was held with stakeholder representatives from the Fishermans Bend Taskforce, Public Transport Victoria (PTV), the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) and Aurecon. The purpose of the workshop was to undertake a cost/benefit analysis of the four short-listed alignment options identified and costed in Sections 8 and 9 of this report.

10.1 Evaluation Framework

In preparing the evaluation framework the broader business objectives of the Network Development Plan (NDP) and the Fishermans Bend Vision (2016) were identified so that evaluation criteria in this are consistent.

10.1.1 Network Development Plan

Section 16 of the NDP report sets out the Key Projects for Victoria. It states that "the new tunnel from Clifton Hill to Southern Cross will also be extended to provide a good transport connection into the Fishermans Bend area".

Section 16.11 further specifies that:

> *The Fishermans Bend area will undergo significant redevelopment in the coming decades and become an important new hub in the expanding CBD. This area will need significant additional public transport capacity and connections as it develops and it is anticipated that the initial enhanced bus network will not be sufficient to support the longer term needs for passengers wishing to access the area. This project enables a fast and frequent train service to be provided into Fishermans Bend connecting to the new Mernda – Southern Cross Line. This will provide rapid connections to the inner city and hospital precincts as well as connections with all other rail lines through interchanges at Southern Cross, Flagstaff and Parkville. The new extension also foreshadows the longer term requirement to provide a new connection to Newport to enable more capacity to be delivered from Sunbury and Werribee.*

The key benefits of this project are:

- *Provides improved network reach by extending the new tunnel into Fishermans Bend urban redevelopment area*
- *Improves travel time and access to and from growing residential and employment precinct taking pressure off the road network and deferring the need for tram network extensions*
- *Provides staging opportunity for ultimate extension from Fishermans Bend to Newport to facilitate connection to Werribee and Sunbury lines to relieve capacity constraints.*

10.1.2 Fishermans Bend Vision (2016)

The Vision was prepared by the Fishermans Bend Taskforce. It sets out the future development of Fishermans Bend up to 2050, and reflects the opportunity to set new benchmarks for inner city urban renewal and the importance of connectivity within Fishermans Bend and to neighbouring areas. The Vision sets the underlying principles to assist in the detailed future planning work and delivery of the Fishermans Bend Framework and precinct plans. It has specific goals around integrated land use and transport planning (see 10.1.4).

10.1.3 Evaluation Framework

The evaluation framework for the options assessment considers both the transport and land use objectives. It recognises that the preferred alignment must fit with the broader transport network plan

and take into account the emerging nature of Fishermans Bend land use pattern, providing for a future employee and resident population.

The objectives in relation to the transport planning through this corridor are based upon the *Public Transport Victoria's (PTV) Network Development Plan – Metropolitan Rail (December 2012)* objectives to deliver benefits in travel time, reliability, convenience and comfort for passengers as follows:

1. **Overcome existing network constraints and provide a strong foundation for further expansion of capacity in the future**

   Addressing current constraints will give passengers more frequent, reliable and convenient services, as well as maximising the use of existing infrastructure and providing the basis for future growth.

2. **Introduce a metro-style train system for Melbourne**

   Moving to a metro-style operation will provide more high capacity, high frequency services, allowing passengers to 'turn up and go'.

3. **Extend the network into growth areas and existing areas without good access to rail services**

   New lines and the electrification of existing lines will support Melbourne's high growth areas and places currently not served by the rail network.

4. **Prepare for further growth and protect future options**

   As the city continues to grow and travel needs change, future options for the metropolitan rail network will be investigated, planned and protected.

10.1.4 Land Use Planning Objectives

The Ten Strategic Directions for Fishermans Bend were developed for the original Draft Vision of 2013, carried through the Fishermans Bend Strategic Framework Plan (2014) and formed the baseline for the Vision of 2016. The final Strategic Directions have been refined in the Vision (September 2016): they outline key aspirations and qualities for Fishermans Bend and continue to inform planning for the precinct.

They are as follows:

1. **The creation of 21st century jobs**

   Fishermans Bend enhances Victoria's economy through the creation of additional high-value jobs and businesses, capitalising on its strategic location close to the CBD and the Port. Major connections to Melbourne Airport and the city's growth areas are complemented by new and improved active and public transport to support jobs growth.

2. **The timely provision of infrastructure**

   Fishermans Bend is supported by a holistic infrastructure plan and funding model that promotes the early delivery of catalyst projects, co-ordinates the staged delivery of key infrastructure by all levels of Government and the private sector and balances the transition of existing industries.

3. **A place that is easy to get around**

   Fishermans Bend is underpinned by an integrated and sustainable transport network that provides ease of movement, both within the district and to surrounding areas, including the CBD. Walking, cycling and public transport infrastructure ensures that people use sustainable transport modes as their first choice.

4. **A vibrant mix of uses and activities**

   Fishermans Bend supports a vibrant mix of uses across its precincts, including employment. A mix of well-designed and located housing, employment opportunities, retail and community facilities are integrated with the design of Streets and public spaces to provide a strong foundation for community life.

5. **Distinctive and unique neighbourhoods**

   Fishermans Bend is home to a series of distinctive neighbourhoods that reflect their unique locations, histories and urban form. The planning and design of each precinct responds to elements such as proximity to the CBD, Yarra River, Port and the Bay, as well as a rich layering of Indigenous, natural and industrial heritage. A grid of safe and inviting Streets and public spaces is complemented by well-designed buildings of different types and scales.

6. **Diverse communities**

   Fishermans Bend is a place for a diverse range of people at all stages of life. A variety of housing types, including higher density and medium scale apartments, are complemented by community services, well-designed open spaces and tree-lined Streets. This creates a place where families of all types can live fulfilling lives. Affordable housing is provided as part of the residential mix.

7. **A high quality built environment**

   The neighbourhoods of Fishermans Bend have a high quality built environment that promotes best practice environmentally sustainable design with compact, high density urban form at human scale.

8. **A sustainable and resilient place**

   Fishermans Bend is sustainable and resilient. The principles of Green Star – Communities are embedded in the planning and design of the project, and sustainability commitments and outcomes will be independently certified. Integrated design of energy, water and waste infrastructure supports sustainable and resilient living.

9. **Manage industrial legacy and ground conditions**

   Precinct planning allows the early consideration of environmental constraints and implementation of cost effective, collaborative solutions to achieve safe outcomes for the community. Development controls take into account local ground conditions and areas subject to flooding.

10. **Strong partnerships, effective governance and civic leadership**

    Most of the developable land in Fishermans Bend is privately owned, making it distinct from many other high-profile urban renewal projects around the world. Fishermans Bend is underpinned by collaborative, strong partnerships and a clear governance framework. Plans and approval processes promote best-practice design and construction methods and provide certainty to the development industry.

Source: *Fishermans Bend Vision, September 2016.*

Direction 3 “a place that is easy to get around” is most relevant to this study. It sets the imperative for creating a connected and legible precinct with an integrated public transport network complemented by active transport. Metro rail will have a significant role in achieving this objective. However, many of the other directions are relevant in our consideration of the alignments, a metro rail connection contributing significantly to the realisation of job creation, vibrant neighbourhoods, and a high-quality and sustainable built environment.

As part of the next stage of planning, the Fishermans Bend Taskforce with other relevant stakeholders is developing a series of principles for transport integration and public transport. These are draft, but provide a context for the ambition for transport planning for Fishermans Bend.

The overarching integration principles for transport are as follows:

- Deliver high quality, connected, scalable and adaptable transport network that will provide a catalyst for land use development.
- Provide a transport network that prioritises convenient, safe and accessible walking, cycling and public transport and supports great places
- Effectively manage freight and private vehicle movements through the area to support Melbourne's role as a significant transport and logistics hub, while protecting the amenity of Fishermans Bend and surrounding areas.
- Provide a series of transport choices for people.

Further the Fishermans Bend Taskforce has developed more specific goals for public transport:

- Public transport services should be direct, creating clear links to critical destinations and central city interchanges to promote jobs growth.
- Public transport services should be segregated where possible from general traffic to create fast and reliable journey times.
- Public transport network should be planned with the final network in mind but enable scalable delivery of infrastructure and services.
- The public transport network should integrate and provide clear and easy to navigate interchange points.
- Land use density and a mix of employment uses should be clustered around public transport stops.

10.2 Evaluation criteria

The evaluation criteria for the options assessment have been derived from the above NDP objectives, Strategic Directions and Fishermans Bend transport objectives, as well as the assessment criteria set out in the original RFQ for this project.

The following three broad criteria are used for the assessment:

- Cost
- Benefit (conceived broadly as Access and Urban Renewal)
- Deliverability (impacts and issues)

The above broad criteria have been adopted to provide a preliminary qualitative style cost-benefit assessment. The first criterion being cost, the second considered to align with benefits and the third to consider impacts and issues that at this stage cannot be readily considered in the cost or benefit criterion.

In order to differentiate between the options and finesse the criteria, sub-criteria have been developed that cascade from the above criteria. Table 6 below describes the evaluation criteria.

Table 6 Description of evaluation criteria

Evaluation Criteria	Description

Cost	This criterion includes consideration of: ▪ **P95 capital cost (quantitative)** ▪ **Key construction risks allowed for in capital cost** ▪ **Operating and maintenance costs**
Access and urban renewal (Benefit)	This criterion includes consideration of: ▪ *Increased overall capacity, reliability and convenience of the rail network* ▪ *Provides staging opportunity for ultimate extension from Fishermans Bend to Newport* ▪ *Facilitate connection to Werribee and Mernda lines to relieve capacity constraints* ▪ *Relieve tram and bus congestion* ▪ *Provide choice of transport options to the community* ▪ **Improved customer experience and liveability** ▪ **Improved productivity by minimising passenger travel times on board train** ▪ **Improved productivity and employment growth through access to Fishermans Bend employment growth areas (station accessibility to patronage demand in development catchments), including travel time from ground to platform level** ▪ **Catalyse development of Fishermans Bend by locating in areas of prescribed higher density (transport and land use integration)** ▪ **Transport Connectivity: locate at critical points in Fishermans Bend to allow premium connectivity between transport modes, including walking and cycling infrastructure**
Deliverability (impacts and issues)	This criterion includes consideration of: ▪ *The extent of business impacts* ▪ *The extent of environmental impacts* ▪ **Deliverability: the extent to which the options are deliverable/feasible** ▪ **Future proofing: the extent of impact from future proofing requirements to preserve or create the rail corridor, including planning certainty for developers (The extent of controls required to limit development)** ▪ **Road disruption: the extent of road disruptions including public transport network** ▪ **Property Acquisition: the extent of property acquisition**

Those sub-criteria in *italics* are considered consistent to each project. Those in **bold** are considered variables for the basis for the assessment undertaken for each alignment.

Safety in design was considered as part of this evaluation, but as the concepts are high-level, there was no differentiation between options at this stage.

10.3 Assessment approach

Aurecon and the Fishermans Bend Taskforce, alongside representative from PTV and DEDJTR, assessed each option in a workshop held on Thursday 6 October 2016.

The options short listed in Section 8 were assessed against the criteria described above for each of the following key decisions:

- Newport Station
- Horizontal alignment
- Vertical alignment

The additional Webb Dock Station was also discussed, but did not go through full evaluation.

Key decisions in relation to the above cannot be made in isolation, and the extent to which certain options would complement or constrain decision-making in relation to the other has been considered.

Each option was assessed relative to a baseline, rather than based on its absolute measure.

Option 1 – Champion Road Station in cutting is the baseline for the Newport decision.

Option 2 - Plummer Street Alignment, has been selected as the baseline for the horizontal alignment based on the findings from *Fishermans Bend Metro Rail Summary for Places Victoria, May 2013,* acknowledging that at this time the Employment Precinct was not part of the urban renewal area. Similarly, for the two versus three station decision, the two station option has been chosen as the baseline.

The shallow alignment is the baseline for the vertical alignment decision.

Comments are provided relative to the baseline and where possible rated as positive (better than baseline) or negative (worse than baseline) using the following scale:

Table 7 Rating scale

Rating	Description
+3	Major positive difference
+2	Moderate positive difference
+1	Minor positive difference
0	Neutral/No discernible difference
-1	Minor negative difference
-2	Moderate negative difference
-3	Major negative difference

Where the workshop did not produce a rating, the Taskforce subsequently provided a score.

The rating points have purposely not been added up to produce a final “score” as the criteria were not weighted and therefore attributing a score may not provide a reliably measurable output. This assessment was based on a discussion about the costs, benefits and deliverability associated with each option and the scores for each criterion used as a guide rather than a definitive scored outcome to assess the relative feasibility of alignment, as described by the project brief.

10.4 Decision 1: Horizontal alignment

10.4.1 Horizontal alignment decisions

While the interchange station to Southern Cross Station is common to the short listed horizontal alignment options, there are three options for the junction to the existing rail corridor in the vicinity of Newport. Therefore, the first decision (1A) was to establish the preferred location for the Newport Station. Following this decision the short-listed horizontal alignment options are assessed with a common Newport station (Decision 1B).

The Alignments are set out in Appendix A.

10.4.2 Decision 1A: Newport Station

10.4.2.1 Decision description and considerations

The final alignment will be required to extend to Newport and connect with the Werribee rail corridor. This decision identifies the most attractive option for the location of this station. It must consider, and also has a role in driving, the westerly alignment of the tunnel in Fishermans Bend and through the Webb Dock area. It must also take into account the nature of the Newport catchment and the opportunities it presents, as well as the future potential of that station to provide either interchange or upgraded functions to the Werribee corridor.

10.4.2.1.1 Option description

Three options have been investigated for a new station at Newport.

- A station on the Melbourne side of Champion Road. This station would be a surface station constructed in a cutting to allow the future rail road grade separation at Champion Road. The station may be similar to Mitcham station which was recently lowered as part of a level crossing removal project (Option 1 below).
  - Note that a new sub-option 1A was introduced during the workshop which allows four platforms rather than two at the Champion Road Station. This was not fully explored but was raised as an opportunity in allowing an interchange capacity at that station similar to that for Option 2. It would connect onto either the Werribee or Altona Lines at Maddox Road.
  - An alternative location for the Option 1 station was also introduced: located at Maddox Road west of the Champion Road Station.
- An underground station constructed on Market Street to the south of the existing station. It would need to be a shallow cut and cover station with all the station facilities required for an underground Station and could align to either the north or south tunnel alignments from Fishermans Bend (Option 2 below).
- A new underground interchange station could be constructed to the north of the existing station alongside Melbourne Road (Option 3 below).

PTV has indicated that it expects that the passenger interchange volumes at Newport from the Williamstown Line would be relatively low. There are numerous considerations around the future use of the station and station land, including possible urban redevelopment and densification opportunities that council will be interested in. These opportunities should be explored to inform the feasibility of a high-cost underground interchange Newport station.

Continuing west beneath the existing rail corridor, the alignment transitions from a deep TBM/mined construction to a shallower cut and cover. The need for retaining walls to facilitate the decline structure at this location will require minor realignment of the existing tracks, however the corridor has sufficient

width at this location and the changes are likely to be minor and are unlikely to impact the existing ARTC standard gauge line.

10.4.2.2 Decision assessment – Newport Station

See Table 8 below for assessment of the Options.

Note that Option 1 is the baseline against which the other options are tested and therefore does not receive any scores.

Table 8 Newport Station alignment options assessment

PROJECT OPTION	EVALUATION CRITERIA			INTERDEPENDENCIES
	Cost	**Access and urban renewal (benefit)**	**Deliverability (impacts and issues)**	
Option 1 – Champion Road Station in cutting (baseline)	• **Direct costs** for Champion Road station would be around $40M. The station arrangement may be similar to a number of the recent level crossing removal projects eg Mitcham station. **(0 - baseline)** • **Sub-option (identified in workshop): possibility to move further west to Maddox Road at similar cost.** Maddox Road option reduces 'confusion' between various Newport station options and allows Altona interchange. Can always add further options between Maddox and Newport **(+2)**	• **Improved customer experience and liveability**: neutral • **Travel Time**: further away than other identified Newport station options (aside from sub-option Maddox Road) • **Improved productivity and employment growth, patronage demand**: Base case will provide a new railway station in the vicinity of Champion Road which will provide additional walk up facilities for sections of Newport suburb, significantly improving access to transport for many households and businesses, [and Victoria University campus]. • **Catalyse development**: possibly not a desirable location for encouraging urban density – low rise residential urban form. Location adjacent to Victoria University is a benefit. • **Transport connectivity**: The station is NOT an interchange station and will only serve the Werribee to Southern Cross line via Fishermans Bend. There will be no access to Fishermans Bend from the existing Newport station.	• **Deliverability**: Base case option is readily constructed without major impact on surrounding areas. It will also accommodate a partial grade separation of Champion Road. • **Future proofing**: • **Road disruption**: • **Property acquisition**:	

NEW Sub-option 1A – four platforms	• **Cost**: increased **(-1)**	• **Improved customer experience and liveability**: **(0)** • **Travel Time**: **(0)** • **Improved productivity and employment growth, patronage demand**: **(0)** • **Catalyse development**: Impact on strategic planning for Newport – question of where we want opportunity for densification, and where it's feasible. May negatively impact Newport centre. May not get benefits from locating in higher density location – poor urban outcome **(0)** • **Transport connectivity**: Interchange capacity **(+2)**	• **Deliverability**: **(0)** • **Future proofing**: **(0)** • **Road disruption**: **(0)** • **Property acquisition**: VicTrack land **(0)**	•
Option 2 – Underground Market Street	• **Cost:** If an underground station is constructed closer to Newport adjacent to Market Street it would need to be a shallow cut and cover station with all the station facilities required for an underground Station. This station has not been costed but direct costs are likely to be in the order of $150M **(-2)** • Potential sub-option of underground pedestrian link to connect the two station and provide direct interchange point. This would need further investigation.	• **Improved customer experience and liveability**: **(0)** • **Travel Time**: **(0)** • **Improved productivity and employment growth, patronage demand**: **(0)** • **Catalyse development**: Surrounding area is constrained in land use opportunity – potential less walk-up patronage and employment growth. But better alignment with Newport growth planning **(0)** • **Transport connectivity**: A station in Market Street would provide partial access to Newport station (easy walking Distance). Although it will not be an interchange some	• **Deliverability**: The Market Street station is readily constructed with minimal impact on surrounding areas although an existing carpark would need to be temporarily closed. **(0)** • **Future proofing**: **(0)** • **Road disruption**: existing carpark would need to be temporarily closed. **(-1)** • **Property acquisition**: **(0)**	

		passengers could use it as an interchange if needed (although volumes likely quite low). Cannot have four platform option – only two. Limits Altona connectivity**. (0)**		
Option 3 – Underground Interchange Melbourne Road	• An underground interchange station at Newport can only work with a full underground station with a longer tunnel connection to Fishermans Bend. The direct costs of the station would be of the order of $270M plus addition tunnelling costs of the order of $400M **(-3)**	• **Improved customer experience and liveability**: **(0)** • **Travel Time**: As the tunnel length will need to be longer the overall travel time for passengers not using Newport will be longer. The time will depend on what Fishermans Bend option that was adopted but could be close to 1 minute extra per train service. **(-2)** • **Improved productivity and employment growth, patronage demand**: **(0)** • **Catalyse development**: Newport itself doesn't necessarily require this level of service **(0)** • **Transport connectivity**: Station provides a full interchange with Newport and the Williamstown line. **(+2)**	• **Deliverability**: **(0)** • **Future proofing**: Potential value capture/urban enhancement opportunity associated with land acquisition – but pretty unamenable environment **(+2)** • **Road disruption**: Minimal disruption to surface rail operation – intent to build offline as much as possible **(0)** • **Property acquisition**: Construction of the new underground station would require some land acquisitions and road disruptions during construction. Mainly light industrial **(-2)**	• This option will not accommodate the shorter tunnelling option to Fishermans Bend.

Table 9 Newport Station alignment options assessment - summary

PROJECT OPTION	EVALUATION CRITERIA		
	Cost	Access and urban renewal (benefit)	Deliverability (impacts and issues)
Option 1 – Champion Road Station in cutting (baseline)	baseline	baseline	baseline
NEW Sub option 1a – Maddox Road Station in cutting (baseline)			Not assessed
NEW Sub-option 1A – four platforms			
Option 2 – Underground Market Street			
Option 3 – Underground Interchange Melbourne Road			

Key:

	Generally scored lower than baseline
	Generally on par with baseline
	Generally scored better than baseline

10.4.2.3 Recommendation

- Removal of Champion Road option (Option 1), replacement with Maddox Road option as identified within the workshop. This new option provides a more appropriate station spacing between it and the existing Newport Station. The tunnel would pass beneath Champion Road and the existing rail corridor to surface west of Maddox Road. It is possible that it would have interchange functionality and enable uninterrupted operations of ARTC standard gauge line.
- Option 2 – Underground Market Street carried forward as potential but additional costs for only a minor benefits means option not as preferred.
- Option 3 – Underground Interchange Melbourne Road is unlikely to go ahead in feasibility study due to very high cost relative to other options.
- Northern tunnel alignment along Craig Street and Melbourne Road was abandoned as remaining options could be accommodated via southern, shorter tunnel alignment.
- Further modelling of the transport benefits and future opportunity to catalyse land use change should take place to inform the final station location decision.

10.4.3 Decision 1B: Alignment Options 1A, 2, 3 and 5 (including 5A and 5B)

10.4.3.1 Decision description and considerations

Options 1A, 2, 3 and 5 (including 5A and 5B) have been taken forward from the analysis undertaken in section 8, which established and informed key advantages and disadvantages (including issues and risks) for a number of options and made recommendations as to which options were most suitable for continued testing.

Each alignment option has been developed taking into account the locations of the current and future employment/commercial and residential clusters as described in the *Vision September 2016* document, while maintaining achievable rail alignment geometry as presented in the basis of design in Section 5. Stations have been strategically located to correspond to development clusters.

All options commence at Southern Cross Station where two new underground platforms are proposed to be constructed beneath Wurundjeri Way with direct access to other platforms and facilities within Southern Cross station. This location is similar to that proposed for Melbourne Rail Link project in 2014.

From Southern Cross station all options would follow a similar path beneath Wurundjeri Way to Flinders Street then across the Yarra River near Charles Grimes Bridge. Due to major physical constraints in the area, a tight horizontal curve would need to be constructed which would locally restrict operating speed to 50km/hr. We understand that the proposed Melbourne Quarter development will span over Wurundjeri Way at Collins Street and would have building foundations located within the existing roadway median. These building footings (likely piles) may clash with the proposed rail tunnels and if so the building foundations would need to be modified or the rail tunnels and station lowered.

Beyond this location, all options have been optimised to achieve the minimum desired operating speed of 80 km/hr as per Metro Trains operational requirements.

In considering these options against the baseline option, there was a particular focus on how the alignment would best achieve the strategic objectives of Fishermans Bend. Important was consideration of how the alignment would deliver the transport connectivity required to facilitate the growth, productivity of the area over time: the alignment and stations must demonstrate the most opportune mix between cultivating the type of employment uses envisaged and supporting residential growth. This included complex decision-making around optimum locations based on proposed activity centres, the impact of transport on different types of land use, and the acknowledgment that transport and land use are significantly interdependent. On the one hand we can include a station where there is planned density: an integrated transport and land use planning decision. But on the other, we know the density can only occur where there is a station and the station can only function where there is density: the station is the determinant rather than the necessary outcome. The implication is that there are a finite number of stations and a variety of planned land uses and activity areas that would benefit indeterminably from a metro station and the associated benefits it brings.

10.4.3.1.1 Option description

Four options were investigated for the horizontal alignment.

- Option 2 (Plummer Street) is the baseline. The alignment runs below Fennell/Plummer Streets with two stations: one within the Sandridge Precinct to cater to the future planned higher density commercial mixed use precinct, and the other in Wirraway, also a mixed use precinct, at the important activity centre intersection of Plummer and Salmon Streets. This is the shortest option in terms of travel time.

- Option 1A Alternative West Gate Freeway locates on the central West Gate Freeway and provides station locations that may be accessed from Lorimer, Sandridge, Wirraway and the Employment Precinct.
- Option 3 Williamstown Road seeks to connect to the high-density Sandridge mixed-use area, as well as the existing residential community south of Williamtown Road. It is generally aligned below road reserves.
- Option 5 connects the two most important employment areas of Fishermans Bend to the CBD at the Sandridge and Employment Precincts. It runs beneath significant portions of private land and the station is located close to the extension of Turner Street.
- Option 5A locates the Employment Precinct station in a more southerly location within the government owner GM Holden site, providing connectivity to Salmon Street and therefore to Wirraway.
- Option 5B locates the Employment Precinct station further south on at Cook Street (where Option 1A station is located) to better link to Wirraway.

10.4.3.2 Decision assessment – Alignment Options 2 (baseline), 1A, 3, 5 (including 5A and 5B)

See Table 10 below for assessment of the Options.

Note that Option 2 is the baseline against which the other options are tested and is therefore not scored.

Table 10 Horizontal alignment options assessment

PROJECT OPTION	EVALUATION CRITERIA			INTERDEPENDENCIES
	Cost	**Access and urban renewal**	**Deliverability (impacts and issues)**	
Option 2 – Plummer Street Station (baseline)	• Base Case **cost**: P95 = $6.77B • **Construction risk**: Melbourne Qtr development; northbank development; widespread strata present less interruption; ANL building; Yarra Delta deposits (all options much the same) • **Operation and maintenance costs**: lowest	• **Improved customer experience and liveability**: will focus transport oriented development in high-amenity areas on the Civic Boulevard • **Travel Time**: Shortest Route shortest rail travel time • **Improved productivity and employment growth, patronage demand**: services Sandridge centre; missed opportunity in Employment Precinct. Good patronage demand in Sandridge, not so in Wirraway which is generally residential in nature with less commercial land use. • **Catalyse development**: Locates stations in designated centres in Sandridge and Wirraway. • **Transport connectivity**: good connectivity to n/s transport routes across Ingles and Salmon Streets; connects with Fennell/Plummer tram alignment **All options facilitate**: • Increased overall capacity of rail network • Connection between Werribee and Mernda to relive capacity.	• **Deliverability**: Melbourne main sewer crossed twice. • **Future proofing**: minimal planning controls required to control development of corridor • **Road disruption**: Partial closure of Fennell and Plummer Streets during construction – impact on tram route. • **Property acquisition**: Land required for station entrances and construction site. • All options are the same for **environmental and business impacts**.	This option could be adopted for both the shallow or deep alignments.

		• Relieved tram and bus congestion • Provide staging opportunities for Fishermans Bend • Choice of transport options to the community		
Option 1A – Alternative West Gate Freeway	• **Cost**: P95 $6.85B. Approximately $80M higher capital cost than baseline primarily due to slightly longer route and ventilation shafts. **(-1)** • **Construction risk –** location of Cook St station jeopardised by future freight route **(-2)** • **Operation and maintenance costs**: similar **(0)** • [Option to move Lorimer station northward away from freeway decreases construction risk and marginally improves amenity]	**Lorimer station:** • **Improved customer experience and liveability:** low amenity freeway location **(-3)** • **Travel Time** Slightly longer but insignificant change to travel time. ***(0)*** • **Improved productivity and employment growth, patronage demand (-2)** • **Catalyse development (-2)** • **Transport connectivity (-1)** **Employment Precinct (EP) station:** • **Improved customer experience and liveability (-2)** • **Travel Time** Slightly longer but insignificant change to travel time **(0)** • **Improved productivity and employment growth, patronage demand (+2)** • **Catalyse development (+2)** • **Transport connectivity (-2)**	• **Deliverability**: consider future freight route **(-2)** • **Future proofing**: More controls required to limit development than in base case **(-2)** • **Road disruption**: Construction of the Ingles St station will require significant disruption to freeway traffic. An alternative is to move the station further north into Lorimer. Some road closure required. Minimal disruption to Cook St. **(-2)** **[0 if station moved north away from freeway]** • **Property acquisition**: Cook St service centre to be acquired/lease broken, plus land for station entrances and construction sites. **(-2)**	This option could be adopted for both the shallow or deep alignments.
Option 3 – Williamstown Road	• **Cost:** P95 $6.810B. Approximately $40M higher capital cost than baseline primarily due to slightly longer route **(-1)** • **Construction risk: (0)** • **Operation and maintenance costs:** similar **(0)**	• **Improved customer experience and liveability (-2)** • **Travel Time** Slightly longer but insignificant change to travel time **(0)** • **Improved productivity and employment growth, patronage demand** Woodruff St station is distant from the Sandridge employment area and the Williamstown Rd station is in residential area with limited access to significant employment **(-2)**	• **Deliverability**: **(+1)** • **Future proofing**: Limited reservation/safeguarding of land required **(0)** • **Road disruption**: Partial closure of Woodruff Street and Williamstown Road during construction **(+1)**. • **Property acquisition**: Land required for station entrances and construction site. **(0)**	This option could be adopted for both the shallow or deep alignments.

		• **Catalyse development** Both stations in prescribed low density areas **(-3)** • **Transport connectivity** Limited to planned bus connectivity **(-3)**		
Option 5 – Sandridge/Employment	• **Cost:** P95 $7.29B. Approximately $400M higher capital cost than baseline primarily due to longer route. **(-3)** • **Construction risk:** proportional **(0)** • **Operation and maintenance costs:** proportional **(0)** **[If this option was considered and a Champion Road station adopted there may be opportunity to reduce the overall length with a corresponding reduction in cost. However the length will be greater than all other options]**	**EP station vs baseline Wirraway station** (note Sandridge Station the same) • **Improved customer experience and liveability (0)** • **Travel Time** Route is 1.2km longer than Base case resulting in rail journey time increase of 54sec for passengers Newport to Southern Cross. **(-3)** • **Improved productivity and employment growth, patronage demand (+1)** • **Catalyse development** both stations offer opportunities to catalyse development in identified high amenity activity areas **(0)** • **Transport connectivity** both locations will have connectivity to other transport modes **(0)**	• **Deliverability**: does not facilitate Webb Dock future station options • **Future proofing**: Significant planning controls required to safeguard land for tunnels and stations. **(-2)** • **Road disruption**: Very limited disruption to roads (but both tram routes disrupted – can be ameliorated on government land) **(0)** • **Property acquisition**: Government owns Turner Street station site **(+3)**	This option could be adopted for both the shallow or deep alignments.
Option 5A – Sandridge/GM Holden	• **Cost:** As per Option 5 except costs would be slightly less due to shorter route **(+1)** [**+1** as compared to Turner] • **Construction risk:** proportional **(-1)** • **Operation and maintenance costs:** proportional **(-1)** • **Overall: (-1) compared to baseline** **[If this option was considered and a Champion Road station adopted there may be opportunity to reduce the overall length with a corresponding reduction in cost.**	• **Improved customer experience and liveability** Station locations in identified high-amenity population concentrations **(0)** • **Travel Time** Route is 0.95km longer than Base Case resulting in rail journey time increase of 43sec for passengers Newport to Southern Cross. **(-2)** • **Improved productivity and employment growth, patronage demand** Employment job-rich but not necessarily high density location (Sandridge same as base case). **(+1)** • **Catalyse development:** both stations location ideally suited to	• **Deliverability**: **(0)** • **Future proofing**: Some planning controls required to safeguard land for tunnels and stations. **(-1)** • **Road disruption**: Very limited disruption to roads (aside from Fennell as per base case) **(+1)** • **Property acquisition**: Government owns Turner St station site, would require some land for station entrance **(0)**	This option could be adopted for both the shallow or deep alignments.

	However the length will be greater than all other options] **Does not facilitate good option for Webb Dock station – needs testing**	catalyse development in appropriate location **(+1)** • **Transport connectivity** Link to Salmon St connection – route yet to be confirmed **(+1)** ***Against Option 5 (Turner Street Station):*** • ***Improved customer experience and liveability (0)*** • ***Travel time (+1)*** • ***Improved productivity and employment growth, patronage demand (0)*** • ***Catalyse development (0)*** • ***Transport connectivity (+1)***		
Option 5B – Sandridge/Cook Street	• **Cost:** As per Option 5 except costs would be slightly less due to shorter route **(+1)** [**+1** as compared to Turner] • **Construction risk:** proportional **(-2)** • **Operation and maintenance costs:** proportional **(-1)** • **Overall: (-1) compared to baseline** **[If this option was considered and a Champion Road station adopted there may be opportunity to reduce the overall length with a corresponding reduction in cost. However the length will be greater than all other options]**	**Against Option 5 (Turner Street Station):** • **Improved customer experience and liveability (-2)** • **Travel time (+1)** • **Improved productivity and employment growth, patronage demand (+2)** • **Catalyse development (-2)** • **Transport connectivity (-1)**	**Against Option 5 (Turner Street Station):** • **Deliverability**: consider future freight route **(-2)** • **Future proofing**: Few planning controls required to safeguard land for tunnels and stations. **(-1)** • **Road disruption**: Potentially impacts freeway off ramps **(-1)** • **Property acquisition**: Purchase of Cook St service centre required **(-1)**	This option could be adopted for both the shallow or deep alignments.

Table 11 Horizontal alignment options assessment - summary

PROJECT OPTION	EVALUATION CRITERIA		
	Cost	Access and urban renewal (benefit)	Deliverability (impacts and issues)
Option 2 – Plummer Street Station (baseline)	baseline	baseline	baseline
Option 1A – Alternative West Gate Freeway			
Option 3 – Williamstown Road			
Option 5 – Sandridge/Employment			
Option 5A – Sandridge/GM Holden			
Option 5B – Sandridge/Cook Street			

Key:

	Generally scored lower than baseline
	Generally on par with baseline
	Generally scored better than baseline

10.4.3.3 Recommendation

- Option 2 Plummer St (baseline) is preferred.
- Option 5A Sandridge/GM Holden is preferred.
- Option 5 is possible – further work on the future placement of the station within the GM Holden site should occur to inform final station locations.
  - UPDATE: Following the workshop the Fishermans Bend Taskforce undertook further evaluation of development opportunities on the former GM Holden site and have identified issues with Option 5A. If this general alignment was chosen the Employment Precinct station may need to be located closer to Option 5 station location (on the extension of Turner Street). Based on this advice **both option 5 and 5A will be included in the following section as *preferred***.
- Option 1A is possible but only due to central location along Freeway and importance of preserving this opportunity as feasible.
- Options 3 and 5B are non-preferred.
- The preferred alignments are materially the same in the eastern sector where they share Sandridge Station. Discussion at the workshop found that both alignments going west from Sandridge are meritorious and offer different opportunities for Fishermans Bend. It is necessary to consider the uplift associated with the Wirraway Station as a catalyst for more intense mixed-use development, better preparing Melbourne for meeting its growth challenge, versus the uplift for the Employment Precinct gained by locating a station there, thereby genuinely seeking realisation of the stated aspiration for globally competitive innovation and research precinct. It was considered that it is beyond the group to determine the most appropriate location for the second station based on these policy-based decisions.

10.5 Decision 2: Vertical Alignment

10.5.1 Decision description and considerations

Both vertical alignments were set to achieve the desired operational requirements stipulated by Metro Trains of 80kph where feasible. This has been achieved at each location outside of the highly constrained Southern Cross station to the Yarra River/Charles Grimes bridge crossing.

The vertical alignment relating to each option is consistent in terms of a high level and deeper alignment option. Each brings a mix of advantages and disadvantages where existing infrastructure including deep footings, existing services and challenging ground conditions will determine where the alignment resides, as well as how feasible each option is from a construction methodology point of view and future operational characteristics. Important also is the customer experience which will vary between being able to access the station platforms via elevator or in high-capacity lifts.

The elevated rail option was eliminated in previous sections of this report and has not been tested.

The Alignments are set out in Appendix B.

10.5.1.1 Option description

The shallow option reaches a depth of around 30 metres as a maximum; the deep option will be as far as 75 metres underground to reach bedrock and miss building piles.

10.5.2 Decision assessment

See Table 12 below for assessment of the Options.

Note that the shallow options is the baseline against which the deep option is tested and therefore not scored.

Table 12 Vertical alignment options assessment

PROJECT OPTION	EVALUATION CRITERIA			INTERDEPENDENCIES
	Cost	**Access and urban renewal**	**Deliverability (impacts and issues)**	
Shallow (baseline)	• The base case is Option 2 Plummer Street shallow alignment • **Cost:** P95 is $6.85B	• Option 2 is taken as the base alignment	• Option 2 is taken as the base alignment	
Deep	• **Cost**: For option 2 Plummer Street the deep alignment P95 cost is $7.31B which is $470M more than the shallow option. • For Options 1A,3 and 5 the cost difference of the deep alignment is similar to Option 2 **(-3)** • Lower risk as you'll be below anything that will be an obstacle. Comes down to geology instead. • Operation costs slightly higher – grade change **(-1)**	• **Improved customer experience and liveability**: As the stations are deep the platforms would need to be built in separate tunnels and the stations will be more confined than the shallow cut and cover stations. An example would be parliament station with lift access only, compared to Melbourne central station with escalators. **(-2)** • **Travel Time**: The deep alignment is similar to the shallow alignment for all access and urban renewals except for travel time from ground to platform for the deep station the platforms are of the order of 80m deep and it is likely that high capacity lifts would need to be used instead of escalators. This will increase overall travel time required to get to the platforms. Will never have CBD capacity though given proposed land uses and density, and aim for precinct to be complementary to CBD rather than competition **(-2)** • **Improved productivity and employment growth, patronage demand**: same • **Catalyse development**: same • **Transport connectivity**: same	• **Deliverability**: higher production rates • **Future proofing**: For the deep alignment the stations and tunnels will very deep and would not impact any developments above. Land would need to be reserved for station entrances and construction sites only which will be smaller than for the shallow option. **(+2)** • **Road disruption**: Apart from station entrances and construction sites road disruptions will be significantly less than that required for the shallow option. Significantly reduced surface foorprint **(+3)** • **Property acquisition**: As station entrances will require less land, land acquisitions could be minimised. The station tunnels could be constructed beneath existing buildings. Better opportunity to skew stations **(+2)**	

Table 13 Vertical alignment options assessment - summary

PROJECT OPTION	EVALUATION CRITERIA		
	Cost	**Access and urban renewal (benefit)**	**Deliverability (impacts and issues)**
Shallow (baseline)	**baseline**	**baseline**	**baseline**
Deep			

Key:

	Generally scored lower than baseline
	Generally on par with baseline
	Generally scored better than baseline

10.5.3 Recommendation and key assumptions

- The shallow option is preferred. By planning for the shallow alignment, the deep alignment is inherently preserved. The reverse is not true.
- All depths require ventilation shafts – at each end of stations, and along the lengths of tunnel. There is minimal variation in cost between deep and shallow alignment for the ventilation shafts and it is not thought to impact the overall cost of the project.

10.6 Decision 3: Additional Webb Dock Station

10.6.1 Decision description and considerations

The possible third future station within the Webb Dock precinct was not tested in the workshop. However the opportunity to preserve the land for the future station was raised, and it was understood that:

- It is easier and less expensive to allow for a station box when constructing the project, even if the station is not immediately required.
- All alignments aside from Option 5 have the capacity to connect to Newport via a Webb Dock station.
- The Webb Dock Station has not been costed.

10.7 Key Findings

The following key future actions are recommended:

- Options to be carried forward for final assessment are:
  - Maddox Station at Newport
  - Underground Market Street at Newport
  - Option 2 (Plummer Street)
  - Options 5 and 5A (Sandridge/Employment Precinct)
  - Option 1A is still possible
- The shallow alignment is preferred because it is cheaper to construct and provides better customer experience despite advantage of less land acquisition. Further, by selecting the shallow option the deep option is necessarily also preserved.
- Further patronage information to be developed to test against land use and density assumptions to inform final route choice decisions.
- Policy position in regard to importance of either catalysing development in the Employment Precinct or Wirraway will aid decision-making.

11 Land Use Implications

This section identifies the temporary and permanent land requirements for the preferred alignments determined during the Options Assessment Stage (Section 10). This information will aid the Taskforce's strategic planning for Fishermans Bend, informing land use controls and acquisition to reserve land for the future construction of the project, as well as for the finished infrastructure and potential integrated development opportunities.

11.1 Shortlisted Options

Four options are carried forward. All options commence at Southern Cross Station where two new underground platforms are proposed to be constructed beneath Wurundjeri Way with direct access to other platforms and facilities within Southern Cross station. This location is similar to that proposed for Melbourne Rail Link project in 2014.

From Southern Cross station all options would follow a similar path beneath Wurundjeri Way to Flinders Street then across the Yarra River near Charles Grimes Bridge.

- Option 1A Alternative West Gate Freeway locates on the central West Gate Freeway and provides station locations that may be access from Lorimer, Sandridge, Wirraway and the Employment Precinct.

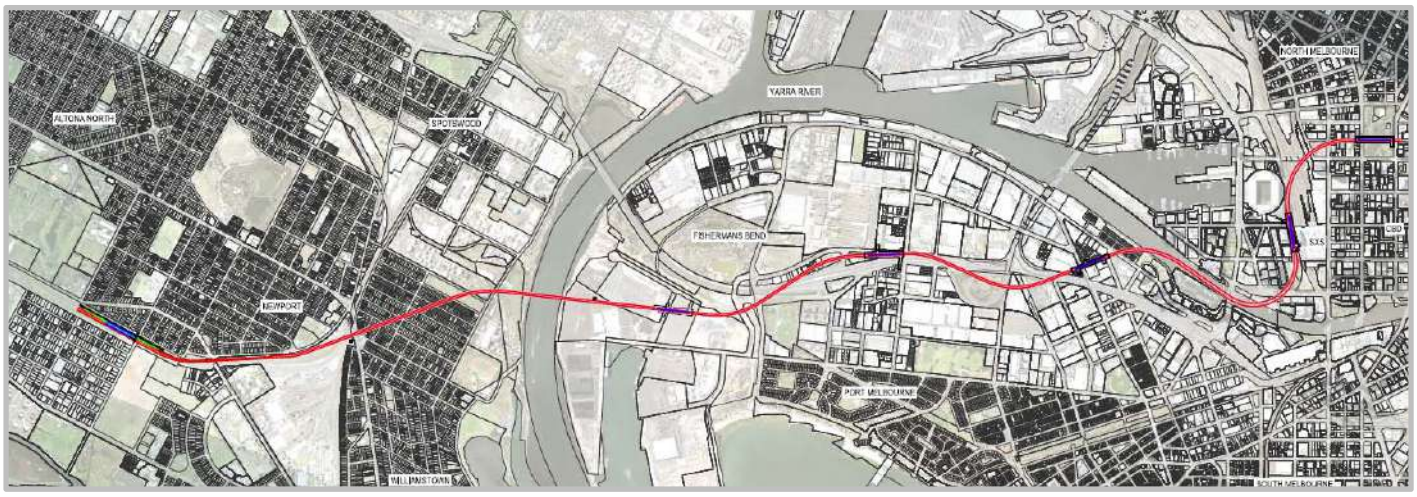


Figure 11 Shortlisted Option 1A Alignment

- Option 2 Plummer Street runs below Fennell/Plummer Streets with two stations: one within the Sandridge Precinct to cater to the higher-density mixed-use location, and the other in Wirraway at the important activity centre intersection of Plummer and Salmon Streets. This is the shortest option in terms of travel time.

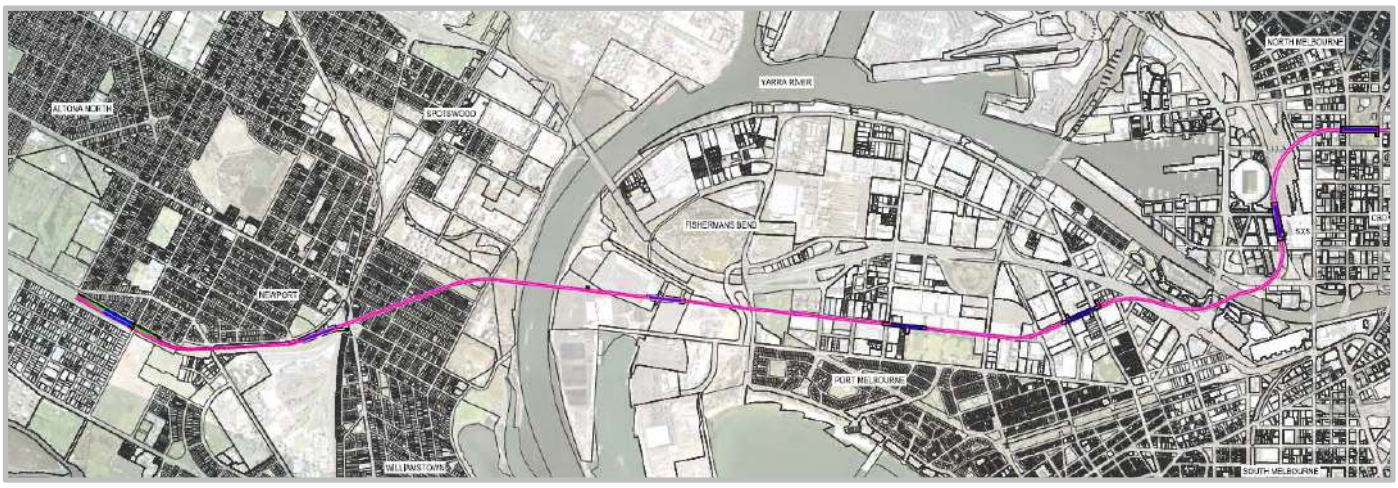


Figure 12 Shortlisted Option 2 Alignment

- Option 5 connects the two most important employment areas of Fishermans Bend to the CBD. The first station is in the identified high-density precinct of Sandridge, and the second station is located on the future extension of Turner Street in the Employment Precinct. It runs beneath more private land than any other option. The alignment continues on the northern route across the river to Newport. Rail geometry means that the current location of the station on the future proposed extension of Turner Street does not allow the alignment to connect to the southern river crossing to Newport. This is because of the location of the West Gate Freeway Bridge piers and the desirable requirement for a straight section of tunnel crossing the river. It may be possible to engineer a southern connection for Option 5 via one of the following opportunities:
  - Skewing the station to allow the tunnels to join the southern alignment for river crossing;
  - Testing the rail geometry to find the northernmost point at which the 5a station can be located (i.e. north of 5A and south of 5 – the “sweet spot” between the two); or
  - Reducing the curve radii to allow the southern connection which has corresponding reduction in train travel speed and increased journey time.

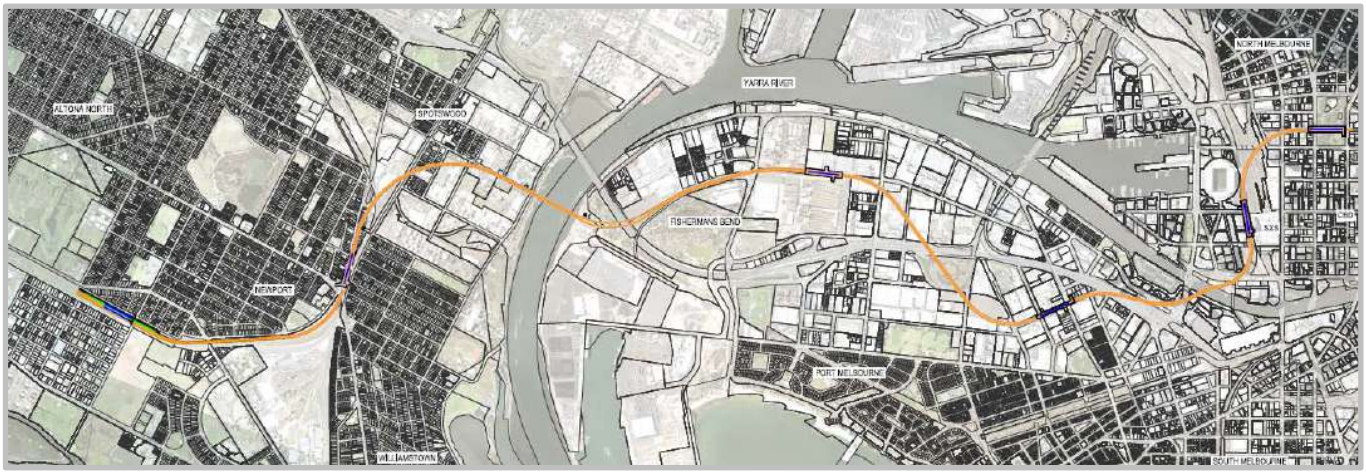


Figure 13 Shortlisted Option 5 Alignment

- Option 5A is a variation of Option 5. It follows generally the same alignment but locates the Employment Precinct station further south within the government owned GM Holden site, providing connectivity to Salmon Street and therefore to Wirraway. It connects to Newport via the southern alignment.

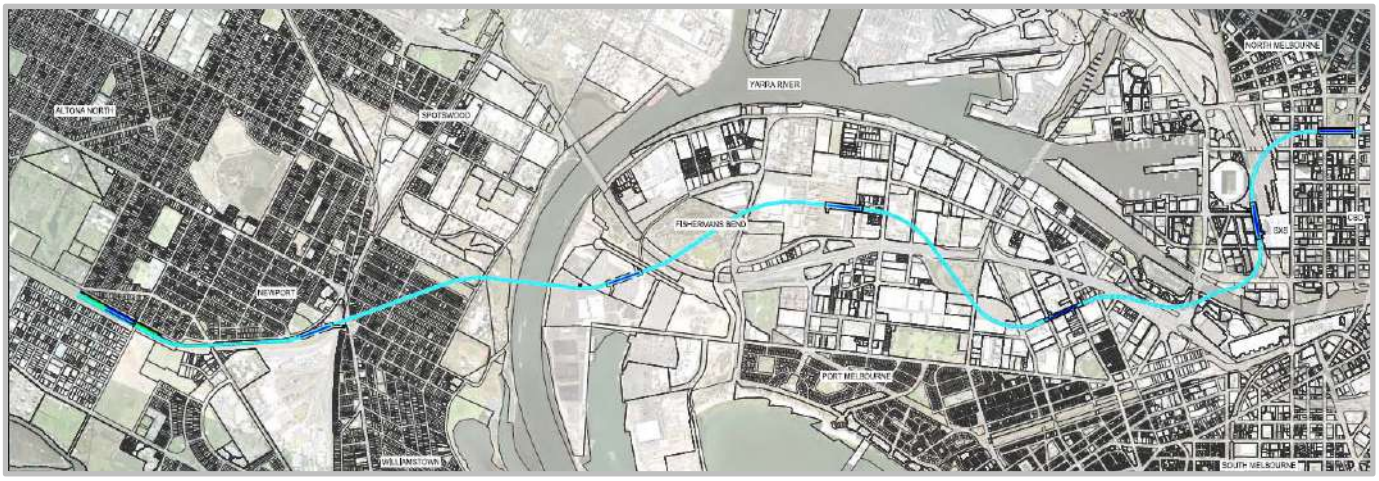


Figure 14 Shortlisted Option 5A Alignment

11.2 Approach

The shortlisted options are assessed to:

- Identify land requirements for the preferred permanent (as built) solutions. The land will need to be either acquired by the government or its use and development for the project negotiated with private land owners.
- Identify where planning controls should be implemented to ensure development does not jeopardise future alignment of the tunnel and stations.
- Define the construction sites required for the preferred options. As construction of the rail link and stations may be built many years after development commences in the precinct, land would need to be reserved for Metro construction in the precinct planning phase. Reservation may include:
  - Planning controls to limit development over the course of the construction period so as not to jeopardise access or activity;
  - Acquisition of land in the instance it is not practical to for it to remain in private ownership during or after construction (including possibility to resell land post construction of the rail link when a value capture mechanism could be used);
  - Open space/Civic Squares which are temporarily used for construction similar to Melbourne's City Square for current Melbourne Metro project;
  - Temporary use of the land for construction sites and possible for site activation until construction commences.
- Prepare plans which show future station sites, tunnel locations and land which would be required for Metro construction.

The alignments set out in this section reflect the preferred options as discussed and reviewed in the workshop held at the Fishermans Bend Taskforce's office on 6 October 2016.

The following section is divided into construction requirements (temporary) and permanent land requirements, and are accompanied by plans to illustrate the findings. It also includes analysis as to the extent of planning controls required to limit development – the quantity of land that will require

reservation and the existing planning controls (ie the impact on future development). Planning controls required to safeguard land are also discussed.

11.3 Land Requirements

This section sets out the land requirements for the construction phase as well as land required for the permanent rail infrastructure. Specifically, the land would be required for the following:

11.3.1 Construction (temporary):

- Land required to access the construction site;
- Laydown areas, for plant and materials required during construction; and
- Construction sites, the land on which construction occurs.

It is acknowledged that a variety of uses may be allowed or encouraged on the land temporarily required for construction, before it is required for rail construction.

11.3.2 Permanent:

- Stations and station entrances
- Buildings required to be demolished for tunnels

Note that there are numerous opportunities to negotiate with landowners to accommodate stations on private land and be incorporated into future development.

11.3.2.1 Tunnels

For the shallow alignment the tunnels will need to pass beneath *private* property and these properties would need to be either acquired or planning constraints imposed. Some old titles will go to the centre of the earth and thus strata acquisitions may also be required. Further investigation will be needed to inform detailed design and business case development. Tunnels beneath publically owned land have not been calculated.

For the tunnel works a major worksite along the corridor will be required from where the TBM will be launched, spoil removed and tunnel segments installed from. Depending on staging requirements a second major site north of Southern Cross station may be required, but this has not been shown.

11.3.3 Value Capture

Value capture is capturing the windfall gain in land prices created by new infrastructure or a planning decision. There are a variety of models around the world that governments employ to successfully capture the uplift in land value associated with new public infrastructure. Value capture schemes have the benefit of both creating capital from which the government may turn a profit, as well as allowing the government to contribute to the urban regeneration of an area beyond infrastructure provision.

Similarly, there is potential for the government to create on the land to be acquired by undertaking showcase development. Value creation may be achieved when a government creates a set of circumstances around which land values or social capital is uplifted because of better amenity or potential amenity in the area.

Value capture and creation are linked, and there are numerous opportunities to consider the possibility of both where the government requires land temporarily or permanently for the project.

11.3.4 Option 1A – Alternative West Gate Freeway

11.3.4.1 Temporary Land Requirements

- Part of Lot R3 PS434050 (ROAD parcel)
- Part of Lot R6 PS431458 (ROAD parcel)
- Part of the land known as 331 Ingles Street for use as a construction site.
- Part of land at 3 Gateway Court, Port Melbourne for a construction site.
- 1 West Gate Freeway for a construction site.

11.3.4.2 Permanent Land Requirements

- Part of land at corner of Bourke Street and Wurundjeri Way known as 122-148 Harbour Esplanade to allow for a new station entrance.
- 1 Rogers Street, Port Melbourne for station entrance.
- Part of land at corner Ingles and Rogers Streets known as 28 Rogers Street for a new station entrance. Land includes a number of titles within the business park complex.
- Site at 323 Ingles Street, Port Melbourne consisting a number of titles.
- Part of land at 3 Gateway Court, Port Melbourne for station entrances.
- 19 Salmon Street, 21-29 Rocklea Drive, Port Melbourne for station entrance.
- Part of 51 Williamstown Road, Port Melbourne (Webb Dock) for ventilation shaft.

11.3.5 Option 2 – Plummer Street

11.3.5.1 Temporary Land Requirements

- Part of Lot R3 PS434050 (ROAD parcel)
- Part of Lot R6 PS431458 (ROAD parcel)
- 351 Williamstown Road, Port Melbourne for a construction site.

11.3.5.2 Permanent Land Requirements

- Part of land at corner of Bourke Street and Wurundjeri Way known as 122-148 Harbour Esplanade to allow for a new station entrance.
- Part of 51 Williamstown Road, Port Melbourne (Webb Dock) for ventilation shaft.
- 51 Fennell Street, for station entrance.
- 247 and 249 Ingles Street, for station entrance.
- 23-31 Fennell Street, for station entrance.
- 422-430 Plummer Street for a station entrance.
- 50 Salmon Street, Port Melbourne for a station entrance.

11.3.6 Option 5 – Sandridge/Employment Precinct site

11.3.6.1 Temporary Land Requirements

- Part of Lot R3 PS434050 (ROAD parcel)

- Part of Lot R6 PS431458 (ROAD parcel)
- Part 241 Salmon Street (GM Holden Site) for construction site. The land requirement is noted but no cost is attributed as land is owned by the government.

11.3.6.2 Permanent Land Requirements

- Part of land at corner of Bourke Street and Wurundjeri Way known as 122-148 Harbour Esplanade to allow for a new station entrance.
- 51 Fennell Street, for station entrance.
- 247 and 249 Ingles Street, for station entrance.
- 23-31 Fennell Street, for station entrance.
- Part 241 Salmon Street (GM Holden Site) for station entrances. The land requirement is noted but no cost is attributed as land is owned by the government.

11.3.7 Option 5A – Sandridge/GM Holden site

11.3.7.1 Temporary Land Requirements

- Part of Lot R3 PS434050 (ROAD parcel)
- Part of Lot R6 PS431458 (ROAD parcel)
- Part 241 Salmon Street (GM Holden Site) for construction site. The land requirement is noted but no cost is attributed as land is owned by the government.

11.3.7.2 Permanent Land Requirements

- Part of land at corner of Bourke Street and Wurundjeri Way known as 122-148 Harbour Esplanade to allow for a new station entrance.
- 51 Fennell Street, for station entrance.
- 247 and 249 Ingles Street, for station entrance.
- 23-31 Fennell Street, for station entrance.
- 11-12 Phillip Court, Port Melbourne for station entrance. Land includes a number of titles within the business park complex.
- Part 241 Salmon Street (GM Holden Site) for station entrance. The land requirement is noted but no cost is attributed as land is owned by the government.
- Part of 51 Williamstown Road, Port Melbourne (Webb Dock) for ventilation shaft.

11.3.8 Newport Options

The land required for the construction and station entrances for the Newport options is within VicTrack land as follows.

11.3.8.1 Maddox Road

- Area of land between Maddox Road to the east, the rail reserve to the north and south, and Lloyd Street to the west.

11.3.8.2 Market Street Underground station

- Triangle of land north of John Liston Lane, Newport.

11.5 Planning controls

There are a variety of controls which may be employed to reserve the land required either temporarily or permanently for the project. Generally, the Public Acquisition Overlay (PAO) is the most commonly used and transparent mechanism for acquiring land for public projects (see 11.5.1), however there are a number of (often complementary) mechanisms which can set aside land either statutorily or through negotiation with private land owners. It is anticipated a suite of controls could be used in preserving land for this project.

Aside from the PAO, a formal acquisition tool, the following opportunities are available for land reservation – either to acquire the land or to limit is development until it is needed for the project:

- Planning Scheme overlays which implement built form controls to limit development;
- Referral provisions for development on affected land to determining referral authorities to prevent inappropriate development;
- Strata title station entrances out of buildings (temporary retail/commercial leases) until use is required;
- Designation as open space through the Fishermans Bend Framework or relevant Planning Scheme to protect station box/entrance/worksite;

- Temporary and longer-term activation to enable short term experimental, cultural and recreational opportunities e.g. Testing Grounds (City of Melbourne) or BoxPark (Shoreditch, London);
- Government leasing of current land to prevent redevelopment, and possible pop-up or temporary use to catalyse development of Fishermans Bend stations areas;
- Private sector station box delivery or station entrance – similar to strata title option.

Many of the above may be used in conjunction with, or prior to the application of, the PAO.

11.5.1 Public Acquisition Overlay

Generally, both the land required temporarily and permanently will require acquisition by the project. The most appropriate planning tool to signal acquisition is the Public Acquisition Overlay (PAO). The objectives of the PAO include 'to reserve land for a public purpose and to ensure that changes to the use and development of land do not prejudice the purpose for which the land is to be acquired'.

The PAO is applied to the land via a planning scheme amendment, and may apply to the entire parcel, or only a part of it. The land cannot be acquired until the PAO is in place.

Land may be included in a PAO well in advance of its proposed acquisition. There is often a period of many years between the recognition that an area will be needed for a public purpose and the actual acquisition of that land. The identification of the land at an early stage assists the affected landowners and others in the vicinity to make informed decisions about the use and development of their land. It also includes further planning permit triggers for use and development on the land that may ordinarily be allowed "as of right" to preserve the land for its future public use.

11.5.2 Protection of Tunnel Land

Land requirements must also consider the need to conserve land below ground within which the tunnels will be constructed. The shallow alignment will necessarily require that building footings are kept to a minimum within the corridor to allow the uninhibited construction and operation of the rail tunnels. Some of these titles will run to the centre of the earth and prior to construction require acquisition of the strata. However, in all cases, the land is best safeguarded through planning controls which limit development on those sites.

There are a variety of ways by which land may be protected from development through planning controls (see 11.5 above). This may be through referral and notice provisions to relevant authorities via Clause 66 of the planning scheme, as occurred in the original Fishermans Bend Strategic Framework Plan (2014) to protect the land required for the proposed Montague underground train station and tunnels. Other options may include site specific controls called up through Clause 52.03 of the planning scheme, controls set out in the new Fishermans Bend Framework, or overlays on the land.

It is considered that the most effective, and transparent, mechanism, for protecting tunnel land short of acquiring the strata titles is the use of a built form overlay, in the form of the Design and Development Overlay (DDO). This overlay is principally intended to implement requirements based on a demonstrated need to control built form and the built environment. It may be introduced as a suite of controls alongside the new Fishermans Bend Framework and integrated transport plan, or as standalone planning scheme amendment. The DDO would apply to the private land under which tunnels are to be constructed, and could limit depth of pilings to ensure the tunnels could be built. It allows existing uses to continue and may enable shorter term or temporary uses to occur on the land to activate it until construction commences. Conversely, it has the potential to preclude particular land uses which require vibration-sensitive equipment that may be affected in the future by underground rail construction or operation, including hospital operating theatres and laboratories, design imaging or

manufacture. Further, it can require relevant authorities are notified or are referral authorities for applications made within the overlay area.

Aurecon notes that in reserving the shallow alignment via planning controls, the deep alignment is necessarily also preserved. However the reverse is not true, as the deeper alignment requires less land reservation or acquisition as building piles in many cases will not reach the depth of the tunnels.

13 Recommendations and Next Steps

13.1 Recommended Preferred Alignments

This study has shown that there is variety of viable alignments for a rail line between Mernda and Newport through Fishermans Bend. The original alignments specified by the Fishermans Bend Taskforce were tested and amended in consultation with the Taskforce and via process of elimination, two preferred alignments have been identified.

This study has reviewed many of the key engineering factors including:

- known major constraints;
- geotechnical and geological conditions;
- rail alignment geometry; and
- indicative project costs.

It has also considered the land use and planning outcomes, as well as relevant public transport and strategic planning policy, in determining the most feasible options.

The two preferred alignments are **Option 2 - Plummer Street**, and **Option 5 – Sandridge/Employment Precinct**, based on both engineering factors, cost, as well as the capacity of the alignments to facilitate the connectivity, activation and urban renewal outcomes planned for Fishermans Bend.

The project cost for **Option 2** in the shallow alignment is $6.9bn.

The project cost for **Option 5** in the shallow alignment is $7.2bn.

These costs consider land compensation and acquisition for the stations, but not for reserving land associated with the tunnels.

These alignments would both be serviced by two stations on Fishermans Bend: one station in the same location in Sandridge in the vicinity of Fennell Street between Ingles and Bertie Streets (a proposed mixed-use higher density precinct) and the other to the western end of Fishermans Bend, either on the Civic Boulevard in the Wirraway precinct or on the proposed extension of Turner Street in the Employment Precinct (on government-owned land). Both alignments would then cross the Yarra River via different routes to surface at the preferred Newport station option at Maddox Road.

Both alignments going west from their shared Sandridge station location offer different opportunities for Fishermans Bend. It is necessary to consider the uplift associated with the Wirraway Station as a catalyst for more intense mixed-use development, better preparing Melbourne for meeting its growth challenge, versus the uplift for the Employment Precinct gained by locating a station there, thereby genuinely seeking realisation of the stated aspiration for globally competitive innovation and research precinct. It is considered that it is beyond this study to determine the most appropriate location for the second station based on these policy-based decisions.

13.2 Recommended Next Steps

This preliminary feasibility investigation provides a basis from which the Fishermans Bend Taskforce can continue to develop its strategic framework, embedding the alignment/s into the plans with the assurance the options are feasible and best achieve the desired land use outcomes.

To best integrate the outcomes of this study into the Fishermans Bend strategic framework, Aurecon suggests a number of aligned opportunities, as follows:

- Opportunity to understand and align with other transport studies being undertaken for Fishermans Bend, including light rail and bus network, and active and sustainable transport, prior to their completion so that transport network is fully integrated.
- Opportunity to understand and align with Fishermans Bend Freight Rail Study prior to its completion so full implications of rail infrastructure in Fishermans Bend is understood.
- Further discussion with PTV about the incorporation of the preferred alignment within the Network Development Plan and integration of the asset into long term planning for the broader network.
- Prepare further detail preferred alignment drawings, including station envelope, so as to best inform land use planning and opportunity for ground level integration.
- Prepare planning scheme amendment to introduce the recommended planning controls to preserve the alignment corridor.

Appendices

Appendix A

Alignment Options Drawings

a. **Original Horizontal Alignments and Vertical Alignment**

b. **Shortlisted Options**

c. **Long Plot Shortlisted Options**

a. Original Horizontal Alignments and Vertical Alignment

NOTE:
800m CATCHMENT AREA FROM CENTRE OF PROPOSED STATIONS IN ALL DIRECTIONS. AREA IS SHOWN ON OPTION 1A ALIGNMENTS ONLY FOR SIMPLICITY

REFER 232532-DRG-C0002 FOR CONTINUATION

OPTION 5 - ALTERNATIVE SANDRIDGE/EMPLOYMENT PRECINCT

OPTION 5A - SANDRIDGE/EMPLOYMENT PRECINCT

OPTION 4 - TURNER STREET

TURNER STREET

SALMON STREET

WEST GATE FWY

OPTION 5B - LINK BETWEEN FENNELL STREET AND WEST GATE FREEWAY

OPTION 1A - ALTERNATE VIA WEST GATE FWY
REFER 252532-DRG-C0003 FOR VERTICAL ALIGNMENT

CITY LINK

YARRA RIVER

INGLES STREET

LORIMER STREET

OPTION 1 - WEST GATE FWY

INGLES STREET

BERTIE STREET

GRAHAM STREET

BRIDGE STREET

FENNELL STREET

PLUMMER STREET

OPTION 2 - PLUMMER STREET

WOODRUFF STREET

WILLIAMSTOWN ROAD

OPTION 3 - WILLIAMSTOWN ROAD

POSSIBLE FUTURE 3RD STATION

OPTION 3A - ALTERNATIVE WILLIAMSTOWN ROAD

WEST GATE FWY

MONTAGUE STREET

MELBOURNE MAIN SEWER

DFO

WURUNDJERI WAY

ETIHAD STADIUM

REFER INSET FOR POSSIBLE CONTINUATION THROUGH FLAGSTAFF GARDENS

SXS STATION

SPENCER STREET

FLINDERS STREET

POSSIBLE STATION AT FLAGSTAFF GARDENS FOR CONTINUATION TO CLIFTON HILL
SCALE 1:10000

TYPICAL CUT AND COVER STATION HIGH ALIGNMENT ARRANGEMENT

PRELIMINARY DRAWING
FOR DISCUSSION PURPOSES ONLY

Revised By	In Serv.	Rev.	Date	Description	Designed	Checked	Eng.	Rev.	Approv.
AURECON		P6	11/10/18	OPTION 5B ADDED	R.M.H.	J.E.B.			
AURECON		P5	12/09/18	OPTIONS 5A/5B WORD ISSUE	R.M.H.	J.E.B.			
AURECON		P4	10/08/18	ALTERNATIVE DEEP WILLIAMSTOWN ROAD OPTION 3A ADDED	R.M.H.	J.E.B.			
AURECON		P2	10/08/18	DELWP/PTV COMMENTS INCORPORATED	R.M.H.	J.E.B.			
AURECON		P1	23/05/18	DRAFT ISSUE FOR INFORMATION	R.M.H.	J.E.B.			

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RAILWAY TRACK AND CIVIL
MELBOURNE
FISHERMANS BEND METRO
FEASIBILITY (STAGE)
HORIZONTAL ALIGNMENT OPTIONS

VicTrack
RAIL TRACK AND CIVIL

Drawn By: R.H.CHIRILLIS
Designed By: R.H.CHIRILLIS
Checked By: J.EBLCHER
Rev. Review:
Approved:
Approval Date:
File Name: 252532-DRG-C0001.dgn
Sheet No. 01 of 01
Drawing Number: 252532-DRG-C0001
Revision: P5

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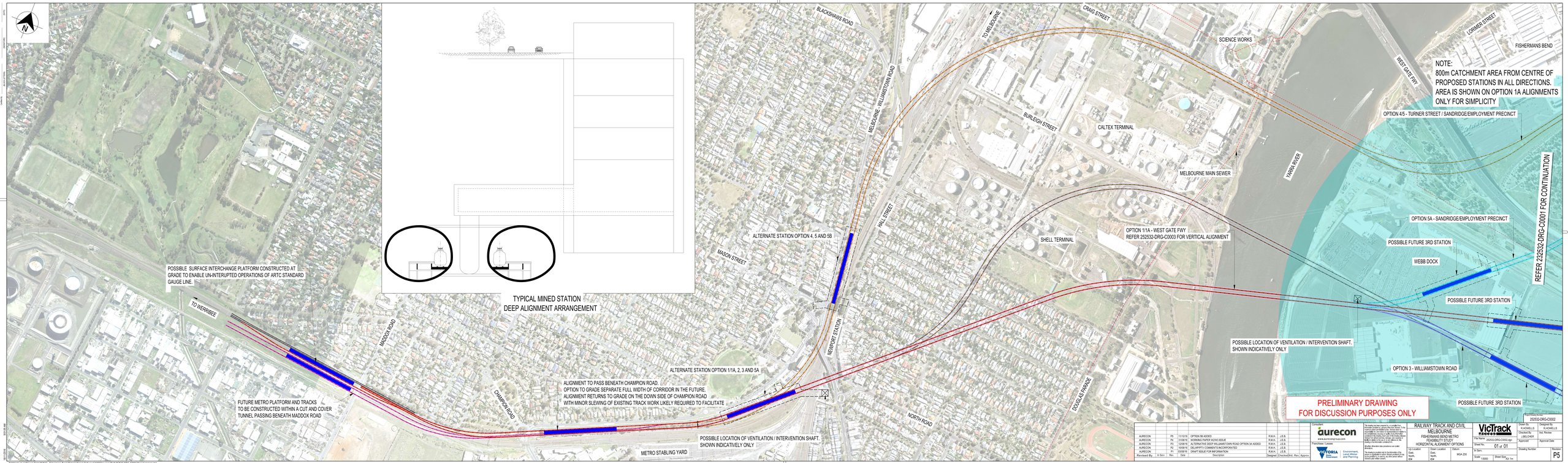

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Rev.	Approv.
AURECON		P6	11/10/16	OPTION 5B ADDED	R.M.H.	J.E.B.		
AURECON		P5	10/08/16	OPTIONS 4/5 ALIGNMENT WORD ISSUE	R.M.H.	J.E.B.		
AURECON		P4	12/06/16	ALTERNATIVE DEEP WILLIAMSTOWN ROAD OPTION 1A ADDED	R.M.H.	J.E.B.		
AURECON		P2	10/06/16	DELAPRTY COMMENTS INCORPORATED	R.M.H.	J.E.B.		
AURECON		P1	03/06/16	DRAFT ISSUE FOR INFORMATION	R.M.H.	J.E.B.		

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RAILWAY TRACK AND CIVIL
MELBOURNE
FISHERMANS BEND METRO
FEASIBILITY STUDY
HORIZONTAL ALIGNMENT OPTIONS

VicTrack

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Checked By: J.BELCHER	Sub Review:
Approved:	Approval Date:

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Sheet Size: A3
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Drawing Number
Revision: P5

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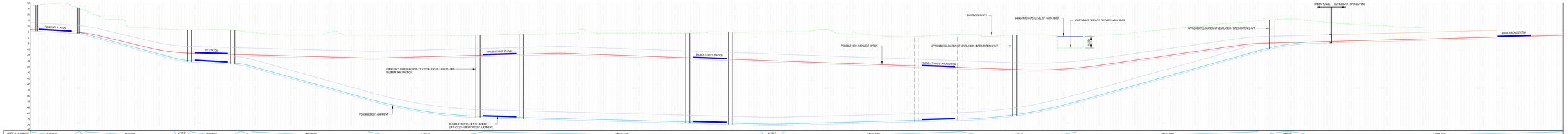
MELBOURNE

WERRIBEE / ALTONA



NOTE: VERTICAL ALIGNMENT IS TAKEN ALONG OPTION 1A.

PRELIMINARY DRAWING
FOR DISCUSSION PURPOSES ONLY

Revision	Date	Description	Drawn	Checked	Approved
A	14/04/11	WORK FLOW BASED ON OPTIONAL ASSESSMENT	YUCH	JJ/ JL	
B	15/04/11	ADDITIONAL CHAINAGES ADDED	YUCH	JJ/ JL	
C	15/04/11	SHORT DEEP STATION OPTION	YUCH	JJ/ JL	
D	21/04/11	ADDITIONAL CHAINAGES ADDED	YUCH	JJ/ JL	

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RAILWAY TRACK AND CIVIL
MELBOURNE
FRANKSTON LINE TO WERRIBEE / ALTONA
VERTICAL ALIGNMENT OPTIONS

Client: VicTrack
Project: Melbourne Metro Rail Project
Drawing Number: 2320-DRG-C003
Revision: A
Date: 01 of 05
Scale: 1:500 (A1)

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Drawing Number: P2

b. Shortlisted Options

REFER 232532-DRG-C0011 FOR CONTINUATION

MAJOR CONSTRUCTION SITE
TBM LAUNCH / EXTRACTION
IN BOTH UP / DN DIRECTIONS
OPTION 5

OPTION 5 - ALTERNATIVE SANDRIDGE/EMPLOYMENT PRECINCT

OPTION 5A - SANDRIDGE/EMPLOYMENT PRECINCT

MAJOR CONSTRUCTION SITE
TBM LAUNCH / EXTRACTION
IN BOTH UP / DN DIRECTIONS
OPTION 5A

SALMON STREET

WEST GATE FWY

OPTION TO LINK BETWEEN FENNELL STREET AND WEST GATE FREEWAY

MAJOR CONSTRUCTION SITE
TBM LAUNCH / EXTRACTION
IN BOTH UP / DN DIRECTIONS
OPTION 1A

GRAHAM STREET

PLUMMER STREET

OPTION 2 - PLUMMER STREET

MAJOR CONSTRUCTION SITE
TBM LAUNCH / EXTRACTION
IN BOTH UP / DN DIRECTIONS
OPTION 2

WILLIAMSTOWN ROAD

TURNER STREET

CITY LINK

YARRA RIVER

INGLES STREET

LORIMER STREET

OPTION 1A - ALTERNATE VIA WEST GATE FWY

BERTIE STREET

BRIDGE STREET

FENNELL STREET

WOODRUFF STREET

WEST GATE FWY

REFER INSET FOR POSSIBLE CONTINUATION
THROUGH FLAGSTAFF GARDENS

ETIHAD STADIUM

SXS STATION

SPENCER STREET

FLINDERS STREET

WURUNDJERI WAY

DFO

MELBOURNE MAIN SEWER

MONTAGUE STREET

POSSIBLE STATION AT FLAGSTAFF GARDENS
FOR CONTINUATION TO CLIFTON HILL
SCALE 1:10000

TYPICAL CUT AND COVER STATION
HIGH ALIGNMENT ARRANGEMENT

PRELIMINARY DRAWING
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LEGEND
- APPROVED PLANNING PERMIT SITE
- PERMANENT ACQUISITION:
- TEMPORARY ACQUISITION : FUTURE DEVELOPMENT SITE
- CONSTRUCTION SITE WITHIN VICTRACK LAND

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AURECON		P2	22/11/18	WPR ISSUE	R.M.H.	J.E.B.		
AURECON		P1	11/10/18	PRELIMINARY ISSUE - POST ALIGNMENT SELECTION WORK SHOP	R.M.H.	J.E.B.		

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RAILWAY TRACK AND CIVIL
MELBOURNE
FISHERMANS BEND METRO
FEASIBILITY STUDY
PREFERRED ALIGNMENT OPTIONS

VicTrack

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Sheet No. 01 of 01

Drawing Number: 252532-DRG-C0010

Revision: P2

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R.HOWELLS	R.HOWELLS
Checked By	Sub Revision
J.BELCHER	
Approved	Approval Date

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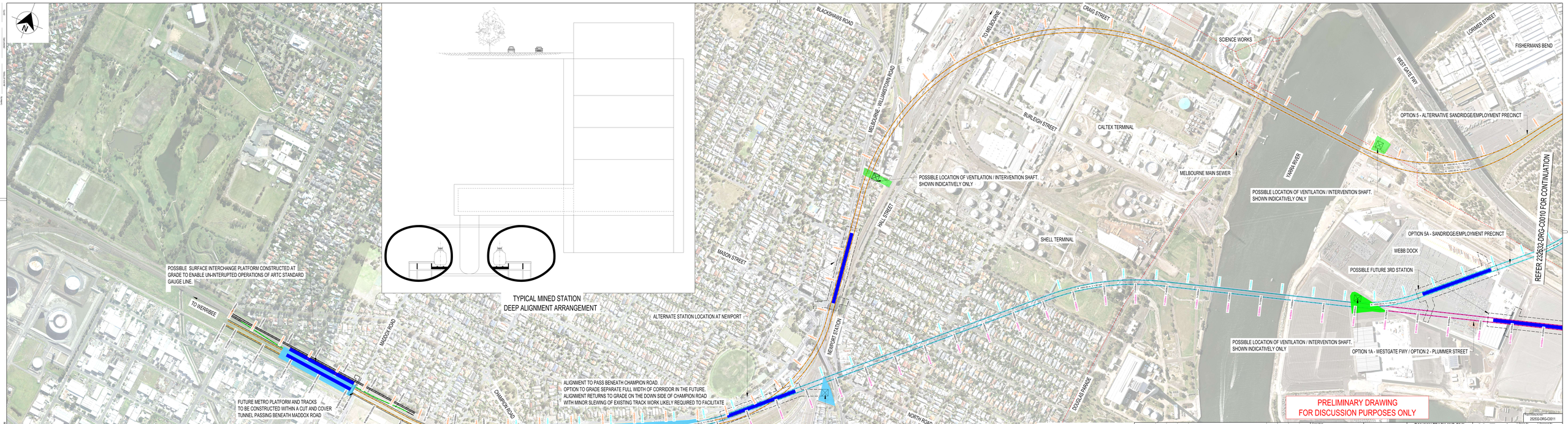

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AURECON		P2	22/11/18	WPR ISSUE	R.M.H.	J.E.B.		
AURECON		P1	11/12/18	PRELIMINARY ISSUE - POST ALIGNMENT SELECTION WORK SHOP	R.M.H.	J.E.B.		

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RAILWAY TRACK AND CIVIL
MELBOURNE
FISHERMANS BEND METRO
FEASIBILITY STUDY
PREFERRED ALIGNMENT OPTIONS

VicTrack

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Checked By: J.BELCHER	Incl. Revisions:
Approved:	Approval Date:
Sheet No.: 01 of 01	
Drawing Number: 252532-DRG-C0011	Revision: P2

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