BaT project

Chapter 3
Project description

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3. Project Description

3.1 Introduction

This chapter describes the Project in terms of design, construction and operation. This includes detail on the nature and scale of work, methods of delivery, workforce, work hours and the likely staging.

This chapter addresses part of section 9.1 of the Terms of Reference (ToR).

3.2 Overview

The Bus and Train project (the Project) would combine rail and bus operations in a single, double-decked, 15m wide tunnel beneath the Brisbane River and the Brisbane Central Business District (CBD). The 6.7km link stretches from Dutton Park in the south to Spring Hill in the north with new underground stations at Woolloongabba, George Street and Roma Street. The Dutton Park Station would also be retained.

The engineering requirements for the Project are significant, comprising substantial underground and surface works and infrastructure that includes underground stations, tunnels, bridges, new and modified track, rail and bus systems and associated services. The infrastructure proposed has been designed to meet technical design requirements as well as environmental and safety standards. The Project reference design seeks to minimise impacts on people and property, with the rail and busway alignment avoiding the need for any private, surface resumptions.

The tunnel alignment and depth is constrained by the limitations of rail operations (maximum horizontal and vertical gradients) as well as geological conditions, the Brisbane River and inner city building basements. Further details on design are provided in **section 3.6**.

Construction of such a large, complex project requires a number of work sites of sufficient area and dimension for large-scale logistical tasks and the manoeuvring and operation of large machines. Construction work sites are proposed in Dutton Park to the south and Spring Hill in the north. Smaller sites are also proposed in and adjacent to each station site at Woolloongabba, George Street and Roma Street.

3.3 Objective and benefits

Population forecasts indicate that South East Queensland's population would grow from 3.1 million to 4.4 million people by 2031. Demand for public transport would rise, with 1.1 million daily bus and rail trips forecast within the region. Additional infrastructure capacity is required to ensure services can accommodate this demand.

The Brisbane River is a significant barrier to the transport of people. Inner city crossings for bus and rail are limited and are currently constrained to:

- Victoria Bridge and Captain Cook Bridge (bus)
- Merivale Bridge (rail).

Network infrastructure services are currently at or nearing capacity at these crossings. Congestion and reductions in the level of service are forecast to increase if additional capacity is not provided. This would result in delays, longer trip times and overcrowding on the public transport network.

In operation, the Project would provide a dedicated, direct crossing of the Brisbane River for both bus and rail. This increase in capacity relieves congestion, with resulting improvements in the networks function and reliability. Additional services would be able to be provided to commuters, resulting in:

- reduced wait and trip times
- more frequent and direct options for travel
- less crowding.

The Project would improve the level of service, ensuring the regions passenger transport network is attractive, resilient and able to cater for future demands.

The estimated cost to plan, design, construct and commission the Project would be $5 billion dollars (2014).

3.4 Location

The Project is located in the Brisbane local government area (LGA) of South East Queensland. It is approximately 6.7km long, extending from Dutton Park in the south to Spring Hill in the north, via Woolloongabba and the Brisbane CBD (refer to **Figure 3-1**).

3.4.1 Transport corridor

The transport corridor for the Project is approximately 6.7km in length. In general, the volumetric area for the tunnel is approximately 35m wide, while the underground station cavern areas are approximately 50m wide. The station shaft volumetric areas range from about 80m to 100m wide. The corridor width also varies at the surface connections and station entries, increasing to include the relevant infrastructure and associated services.

3.4.2 Study corridor

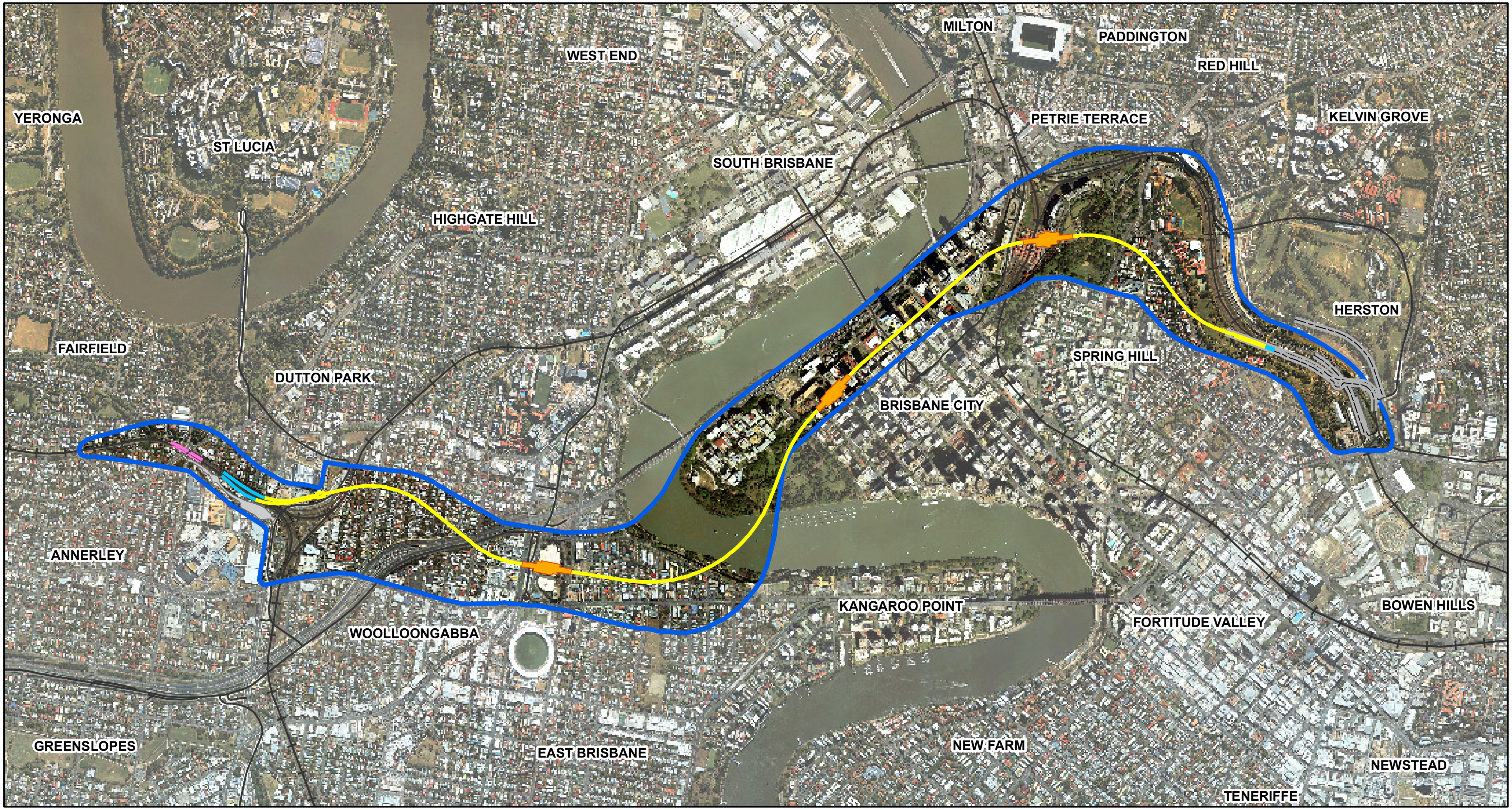
Impact assessment of the Project extended beyond the transport corridor, with an additional area 50m either side included. Due to a number of sub surface features, the assessment also extends below ground and to distance of approximately 50m around the associated infrastructure. This overall envelope is referred to as the study corridor and was the minimum area of assessment. In some cases, the impacts of the Project would extend beyond the study corridor, requiring an additional area of assessment. Where this is the case, the extended area of assessment is defined in the specific chapter of the Environmental Impact Statement (EIS).

3.5 Adjacent or adjoining infrastructure

3.5.1 Existing infrastructure

The Project would connect with a number of State-controlled transport networks, including:

- Eastern Busway in Woolloongabba and Northern Busway in Herston
- Gold Coast-Beenleigh Line in Dutton Park
- Exhibition Line in Spring Hill.



LEGEND

Existing rail line

Existing busway

Study corridor

Project Infrastructure

Busway Connection

Underground station

Bus layover

Dutton Park Station (upgraded)

Alignment

Above ground

Underground

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-1

Location of Project

0 0.5 1

Kilometres

1:25,000 (at A4)

Projection: GDA 1994 MGA56

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Infrastructure intersecting or influencing the Project includes:

- Inner City Bypass (ICB) at Spring Hill
- Inner Northern Busway at Spring Hill
- Clem Jones Tunnel (Clem 7) at Woolloongabba
- South-East Busway at Buranda and Woolloongabba
- Cleveland Line at Dutton Park
- Main and Suburban line at Brisbane CBD
- Princess Alexandra Hospital (PA Hospital) cycleway at Dutton Park.

Further detail on the Project's interactions and integration with existing transport networks is provided in **Chapter 4 – Traffic and transport** and **Chapter 5 – Land use and tenure**.

3.5.2 Other major projects

Major projects occurring within the same construction timeframe and study corridor as the Project include:

- Queen's Wharf Brisbane in the Brisbane CBD
- One William Street in the Brisbane CBD
- Woolloongabba Priority Development Area (PDA) between Stanley Street and Vulture Street.

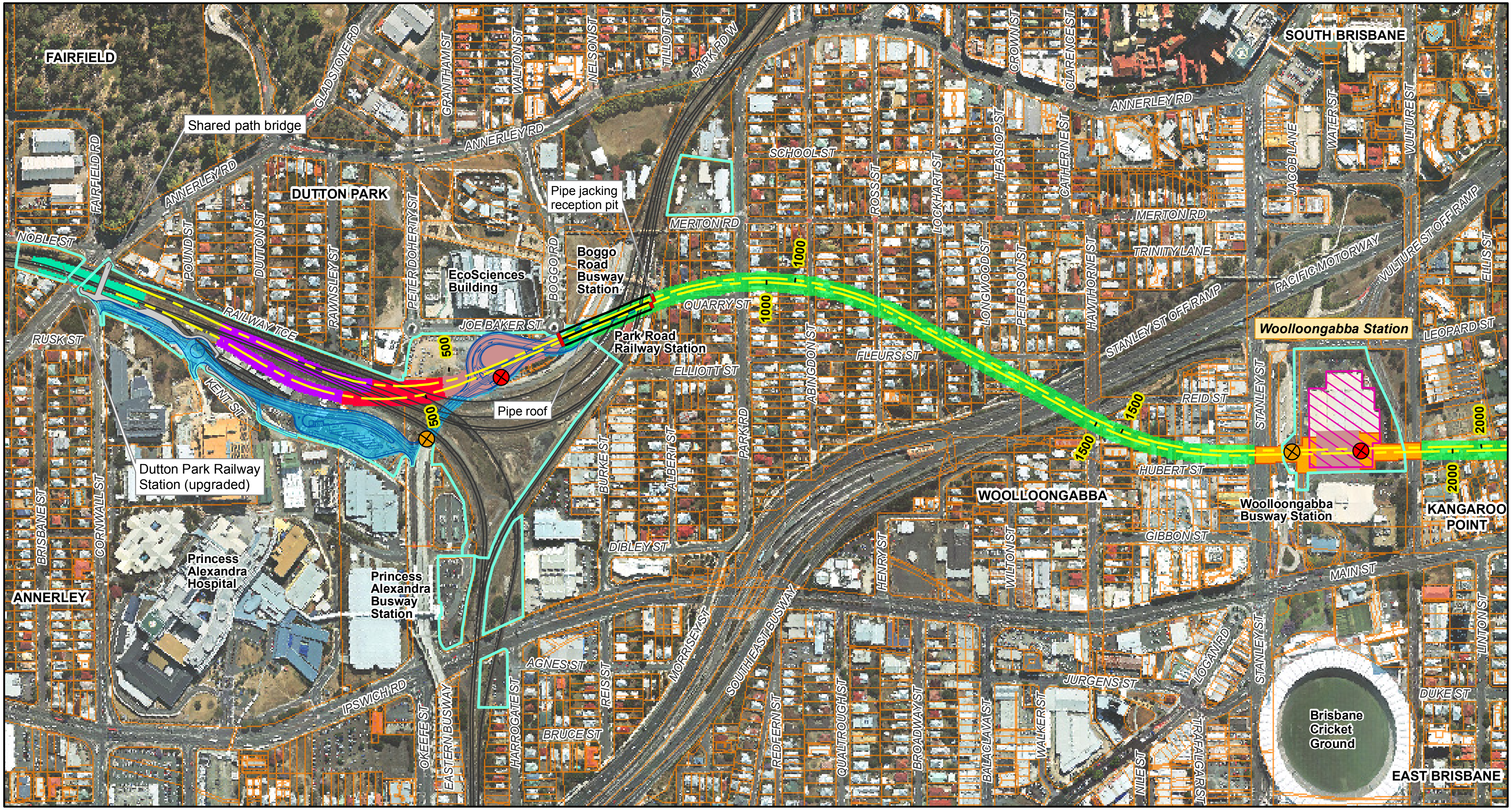
Construction associated with major development sites within the study corridor has the potential for cumulative impacts with the Project where construction timeframes occur concurrently. As an example, spoil transfer and equipment and material delivery has the potential to share the same road network and spoil transfer sites, resulting in potential for cumulative noise and vibration impacts and changes to local traffic and access.

Detailed discussions of interactions and integration of the Project with major transport projects and networks are provided in **Chapter 4 – Traffic and transport**, and with major urban development projects in **Chapter 5 – Land use and tenure**. **Chapter 17 – Cumulative impacts** provides an assessment of the potential cumulative impacts relating to the construction and operation of the Project.

3.6 Design

The Project would provide a crucial link between Brisbane's inner city bus and rail networks. This augmentation includes an extension of busway and rail related infrastructure between Dutton Park and Woolloongabba in the south, and Spring Hill and Herston in the north (refer to **Figure 3-2** to **Figure 3-4)**.

On this basis, the Project would interface with 'live' transport infrastructure. Although in a built environment, areas that do not currently include transport infrastructure would be considered to be greenfield components of the Project.



LEGEND

- Existing rail line
- Property boundary

Project Infrastructure

- Vent inlet
- Vent outlet
- BaT rail centreline
- Busway connection
- Construction worksite
- Decommissioned infrastructure
- Dive structure
- Station cavern

Primary tunnel

- Bored

Secondary tunnel

- Mined
- Cut and cover

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-2

General arrangement - 1 of 3

0 0.1 0.2
Kilometres
1:7,500 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

- Existing rail line
- Property boundary

Project Infrastructure

- Vent inlet
- Vent outlet
- BaT rail centreline
- Busway connection
- Construction worksite
- Decommissioned infrastructure
- Station cavern

Primary tunnel

- Bored

Secondary tunnel

- Mined
- Cut and cover

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-3

General arrangement - 2 of 3

0 0.1 0.2
Kilometres
1:7,500 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

- Existing rail line
- Property boundary

Project Infrastructure

- Vent inlet
- Vent outlet
- BaT rail centreline
- Busway connection

- Construction worksite
- Decommissioned infrastructure
- Dive structure
- Station cavern

Primary tunnel

- Bored

Secondary tunnel

- Mined
- Cut and cover

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-4

General arrangement - 3 of 3

0 0.1 0.2
Kilometres
1:7,500 (at A4)
Projection: GDA 1994 MGA56

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3.6.1 Overview

The Project is significant in size, extending across inner Brisbane. Particular aspects of the development are distinct in function and form while others are specific to location. The Project has been described on this basis, with the principle components of infrastructure and their location defined in **Table 3-1** and the relevant following sections.

Table 3-1 Principle components of infrastructure and their location

Precinct	Location	Principle components		
		Bus	Rail	Common
Southern Connection	Dutton Park Woolloongabba	Busway Bus layover Road intersections	Railway Railway junctions Feeder station Equipment room	Dive structures Access roads Shared path Ventilation
Tunnel	Dutton Park Woolloongabba Brisbane CBD Spring Hill	Busway	Railway	Ventilation Drainage
Woolloongabba Station	Woolloongabba	Busway	Railway	Ticket machines Escalators and lifts Concourse Boarding platforms Ventilation
George Street Station	Brisbane CBD			
Roma Street Station	Brisbane CBD			
Northern Connection	Spring Hill Herston	Busway Bus layovers Road intersections ICB overpass ICB on ramp	Railway Railway junctions Feeder station Equipment room	Dive structures Access roads Shared path Ventilation

Busway

The Project would link the Eastern Busway at Boggo Road and the Northern Busway at Herston through a new section of busway below the Brisbane CBD and the Brisbane River. In its primary form, the busway comprises a dual lane, single carriageway with a posted design speed of up to 70kph. Additional areas of busway infrastructure which integrate with surface networks include:

- upgraded intersections at:
  - Kent Street and Cornwall Street, Dutton Park
  - Gilchrist Avenue and the Northern Busway, Herston
- new intersections with the:
  - Eastern Busway at Kent Street, Dutton Park
  - Northern Busway, Herston
- ICB on-ramp
- ICB overpass

- new bus layovers and associated accesses adjacent to the:
    - Eastern Busway, Dutton Park
    - Gilchrist Avenue, Herston
    - Victoria Park, Spring Hill.

Infrastructure associated with the busway extension would include pavements, safety barriers, overhead lighting, drainage, power, traffic signals and communications. Design standards would accommodate operating systems to manage air quality, fire events and safety, security and network logistics.

The busway and stations has been designed to accommodate:

- 12.5m rigid buses (77 passengers)
- 14.5m rigid buses (89 passengers)
- 18m articulated buses (89 passengers)
- 24m bi-articulated buses (220 passengers).

All buses in the South East Queensland urban service fleet would continue to be air-conditioned with a *Disability Discrimination Act 1992* (DDA) compliant low floor, accessible front entry.

Railway

The Project would include a new section of double track, narrow gauge rail. This south-north link would provide a direct connection between the Gold Coast-Beenleigh Line at Dutton Park in the south and the Exhibition Line at Spring Hill in the north. The new section of rail would be 6.7km long and would have a maximum design speed of 80kph.

Additional areas of rail which comprise the railway extension would include new junctions with the:

- Gold Coast-Beenleigh Line, Dutton Park
- Exhibition Line, Spring Hill.

Track infrastructure would include new track, concrete sleepers and track fasteners. Ballasted track with 50kg rail on concrete sleepers is proposed for all surface sections and 60kg rail on track slab in the tunnel and station areas. Resilient fasteners would also be used in some areas below ground, further reducing vibration.

Track infrastructure would be designed to cater for fully loaded passenger trains (new generation rolling stock) and track maintenance vehicles. This includes six car sets with the following capacity:

- 480 seated passengers
- 750 seated and standing passengers (maximum design load)
- two door carriage configuration.

Structures

A number of permanent structures are proposed to be constructed as part of the Project. They include:

- 5.7km of tunnel, includes approximately 5.1km of tunnel boring machine (TBM) driven tunnel
- five dive structures from the surface to the tunnel
- three underground stations at Woolloongabba, George Street and Roma Street

- a new bridge (shared path) adjacent to the Annerley Road Bridge, Dutton Park
- a new bridge over the ICB and on-ramp from the Northern Busway to the ICB.

The following sections provide an overview of these structures.

Tunnel

The principal component of the Project would comprise a single tunnel, double-decked structure that extends from Dutton Park in the south to Spring Hill in the north. This section of TBM driven tunnel would be approximately 5.1km in length and 15m in diameter (externally). Smaller, mode-specific sections of tunnel would link with the primary tunnel, allowing for the eventual separation of bus and rail at the surface connections. These secondary tunnels would also be located in the suburbs of Dutton Park and Spring Hill.

In its entirety, the tunnel would descend below ground to a maximum depth of up to approximately 66m, under the Brisbane River and high rise buildings (basements) in the Brisbane CBD (refer to **Figure 3-5**). Operational limitations also constrain the maximum gradient to 3.25 per cent for rail. In combination, these factors have dictated the vertical alignment of the tunnel and associated dive structures (refer to **Table 3-2**).

The route alignment has been determined on the basis of forecast network demand. Future planning intent and engineering constraints have also been considered and integrated where required.

Figure 3-5 Tunnel long section

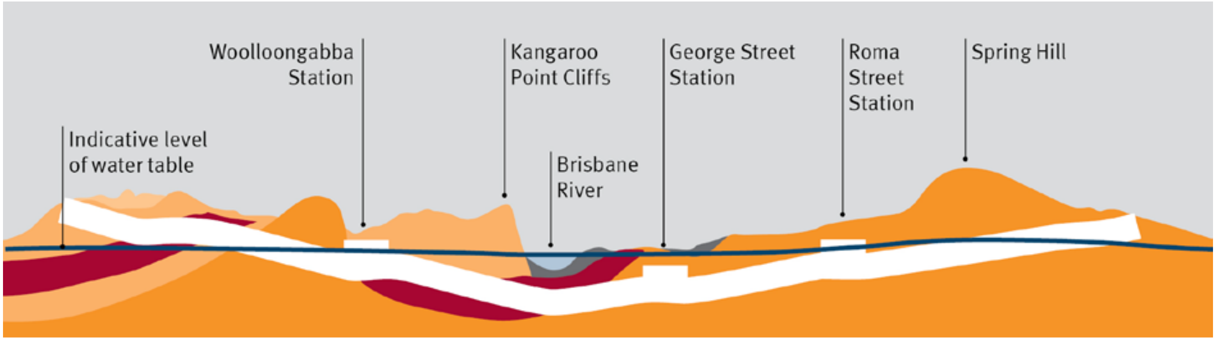


Table 3-2 Indicative tunnel depth along the alignment

Section		Chainage	Range of depth (below ground level)
Start	End		
Dutton Park	Woolloongabba Station	385-1,725m	11-46m
Woolloongabba Station	George Street Station	1,955-3,510m	45-66m
George Street Station	Roma Street Station	3,720-4,745m	35-48m
Roma Street Station	Spring Hill	4,970-6,040m	12-58m

The primary tunnel would be a bored structure, lined with steel reinforced, concrete rings. The rings are modular and would be progressively lifted into place after boring is complete. Rubber gaskets and waterproofing membranes would seal the joints and overall structure.

Smaller, shallower areas of the tunnel that support the separate busway and rail connections would be constructed by road headers and cut and cover methods. These secondary tunnels would be lined with pre-cast and cast insitu concrete products.

Within the primary tunnel, busway and rail infrastructure would be separated by an intermediate, concrete deck (refer to **Figure 3-6**). This would divide the tunnel into two sections, with the busway situated on the upper level. The lower level which houses the railway would be divided by a central, structural wall which would support the intermediate deck and busway above. This overall configuration provides sufficient area for two rail tracks and two bus lanes, with each mode confined to an individual deck.

Ventilation would be provided for the busway and rail sections of the tunnel, managing thermal and exhaust emissions (bus only) and smoke in the event of fire. A large overhead duct would be provided in the crown of the tunnel for busway and rail ventilation. This arrangement would avoid the need for jet fans within trafficked areas.

Dive structures

The Project would link with existing, surface infrastructure at its southern and northern extents. Dive structures are required in these areas as the Project transitions from the surface to below ground (refer to **Table 3-3**). In built form, concrete retaining walls would stabilise the dive structures while base slabs provide foundations suitable for rail and busway. Horizontal bracing between walls would also be provided in the form of steel struts.

Figure 3-6 Tunnel cross section

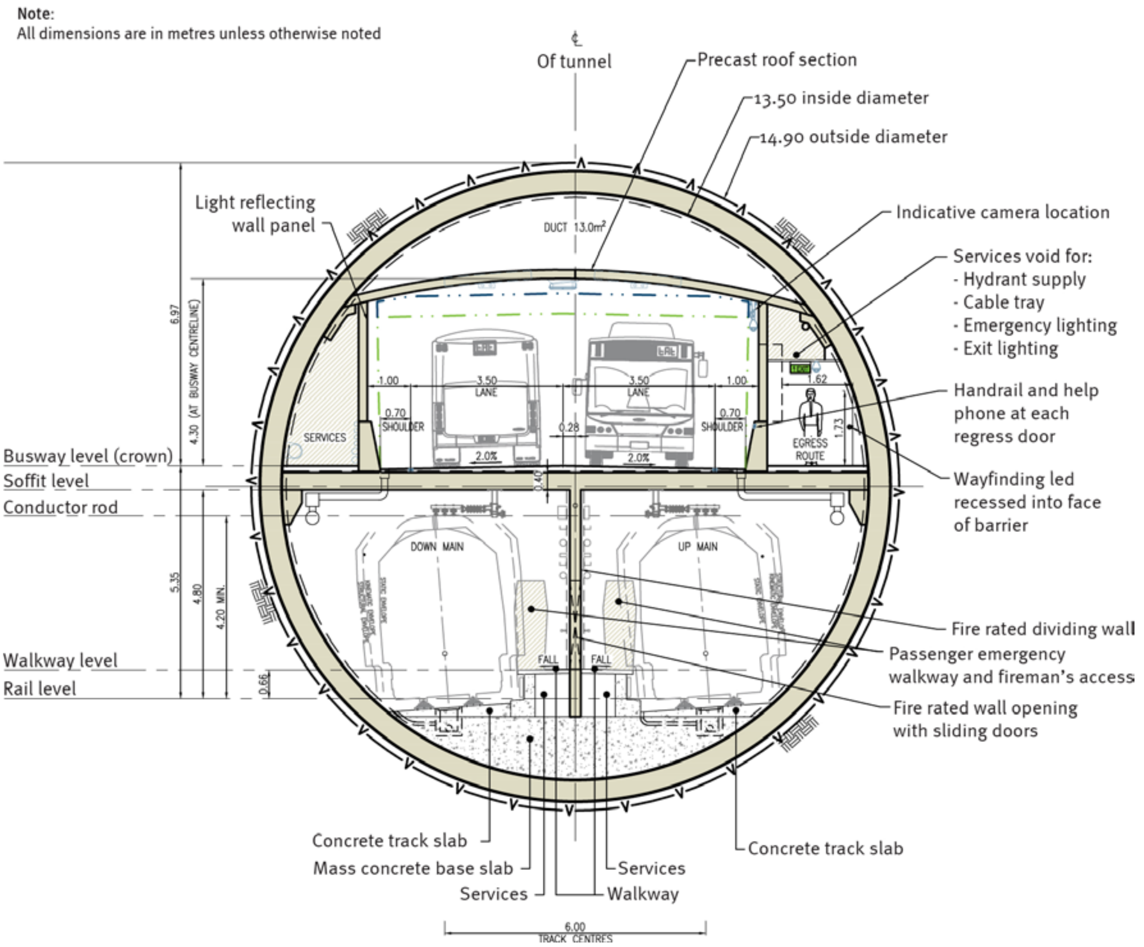


Table 3-3 Indicative dive structure depth

Location	Transport mode	Number	Chainage	Depth (below ground level)
Dutton Park	Bus	1	500-705m	8-22m
	Rail	2	85-385m	2-7m
Spring Hill	Bus	1	6,040-6,185m	0-6m
	Rail	1	6,040-6,270m	3-12m

Stations

Three underground, busway-and-rail stations are proposed as part of the Project. These would be located at Woolloongabba, George Street and Roma Street. Further detail on the location, depth and general configuration of each station is provided in **Table 3-4**.

General features of each station would be surface entry and exit points, a vertical access shaft and a large, open cavern. Each cavern would house multiple platforms for bus and rail and align with the configuration of the tunnel – busway on the upper level and rail on the lower level (refer to **Figure 3-7**). Station infrastructure below ground would be constructed within rock and is reinforced with concrete and steel.

Table 3-4 Indicative station configuration

Station	Location	Chainage (m)		Length (m)	Width (m)	Height* (m)	Depth** (m)
		Start	End				
Woolloongabba Station	Woolloongabba	1,725	1,955	229	53	16	39
George Street Station	Brisbane CBD	3,510	3,720	211	55	17	49
Roma Street Station	Brisbane CBD	4,745	4,970	229	53	16	37

** – cavern height measured from top of rail*

*** – depth from ground level to top of rail*

Public access to the bus and rail platforms would be provided through escalators, lifts and stairs (the later for emergency access). Escalators in lieu of stairs would be used where the vertical rise is greater than 4.5m. The requirements for escalators would be determined on the basis of forecast station patronage, with an allowance for future growth and requirements for programmed maintenance. Lifts to all platforms would also be provided and suitable to carry cleaning and maintenance equipment between levels. Emergency fire stairs would be located appropriately on all platforms, allowing patrons to walk up and out of the station should it be required.

Platforms would be configured to the side as opposed to an island. Access to buses and trains would be regulated through platform screen doors. In addition to passenger safety, these doors would also provide for climate control, reductions in noise and the management of dust. Doors would be built of glass and include a full height screen that separates commuters from the areas of traffic.

In operation, station doors would automatically open when alighting or boarding from both buses and trains. At other times they would be kept closed for passenger safety and ventilation. All stations would include a lower rail platform suitable for an initial operation of six car train sets (with 15m of additional platform to facilitate longer trains in the future) and an upper busway platform that includes six bus bays in each direction.

Acoustically absorptive surfaces would be used on the cavern ceiling and walls to achieve an acceptable acoustic environment. This would limit the reverberation of noise and allow a public address system to be clearly audible.

Figure 3-7 General station overview

Further detail on each of the proposed stations and their design is provided below.

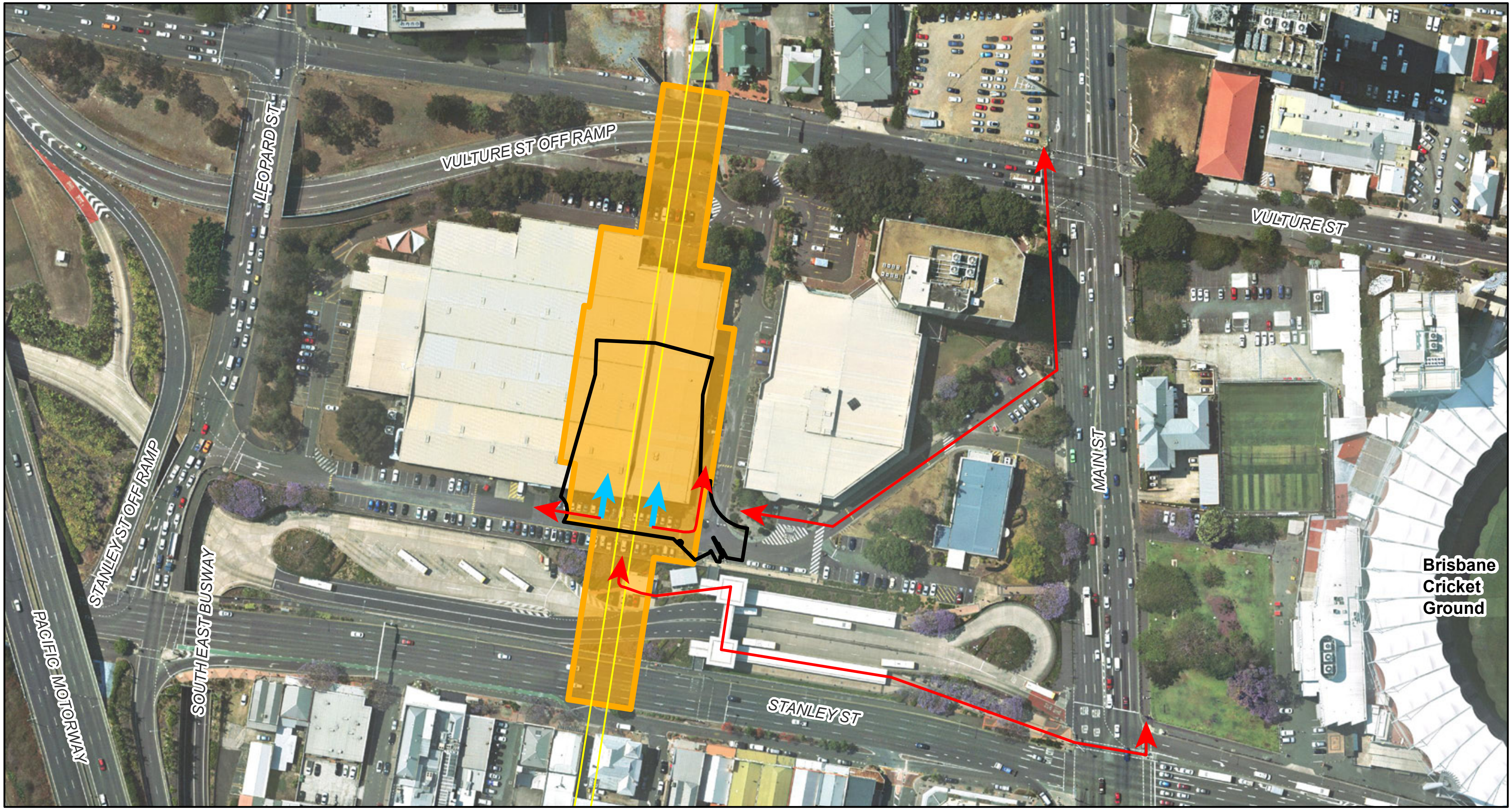
Woolloongabba Station

The proposed new station (refer **Figure 3-8** and **3-9**) at Woolloongabba would support the planned renewal of Woolloongabba centre and Kangaroo Point south Neighbourhood Plan areas. Access to a wider catchment would be achieved through a ground level interchange with the Woolloongabba Busway Station. The location and design of the station would allow for the efficient movement of patrons attending events at the nearby Brisbane Cricket Ground (Gabba Stadium).

The Woolloongabba Station would be located within the area currently occupied by the GoPrint building at 867 Main Street, Woolloongabba. This building would be demolished to allow construction of the new station. The new station would include a full length canopy, allowing the ingress of natural light and ventilation.

Street access to and from the new station would be through one primary point. This entry plaza provides the required access for regular commuters whilst also assisting in the management of patrons to and from the Gabba Stadium. The entry would be highly visible from Stanley Street with pedestrians enjoying a direct line of sight from the stadium. These features would provide ease of navigation and the efficient movement of people during large sporting events.

Facilities for cyclists would also be included, with short term storage facilities located in public areas outside of the station. This would promote the integration of sustainable transport modes and access for a wider catchment of commuters.



LEGEND

- BaT rail centreline
- Station entry/exit
- Access way
- Station cavern
- Station access

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-8

Woolloongabba Station

N

0 25 50
Metres
1:2,000 (at A4)
Projection: GDA 1994 MGA56

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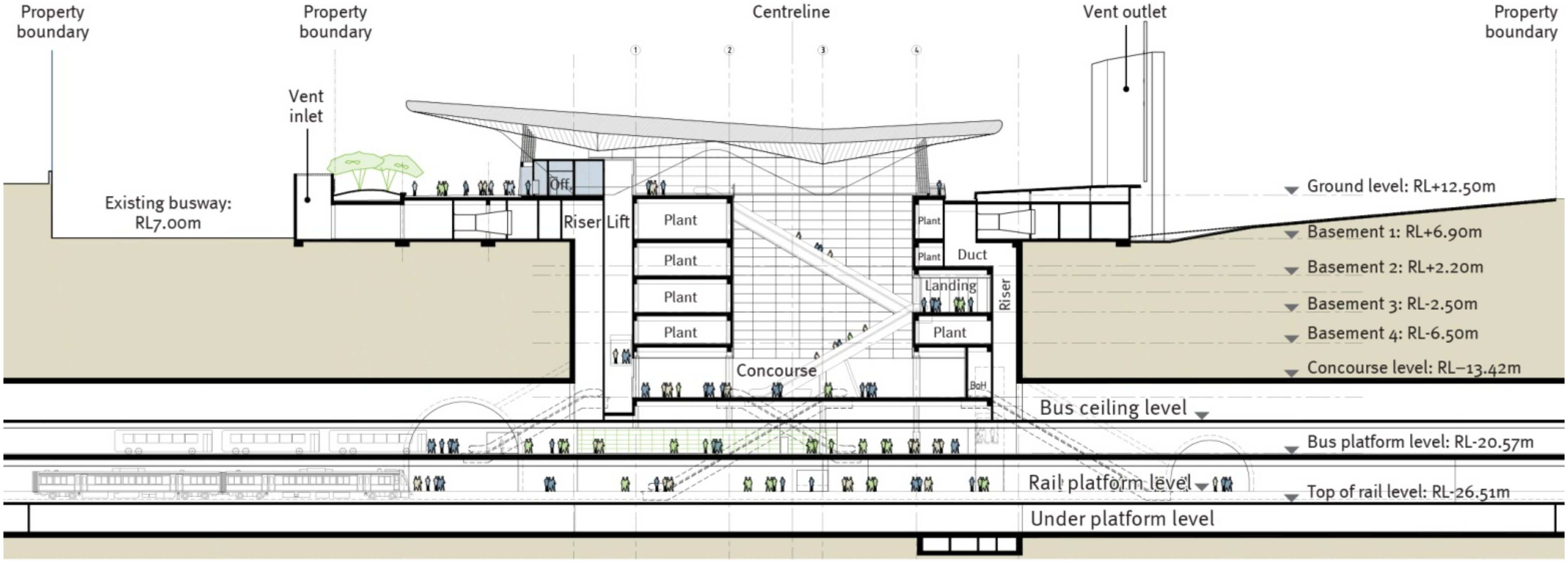

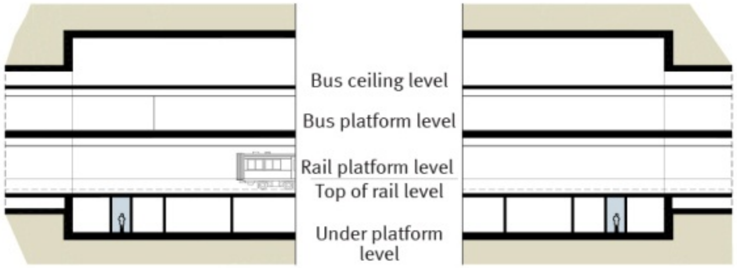

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-9

Woolloongabba Station

George Street Station

A new station at George Street (refer to **Figure 3-10** and **Figure 3-11**) would provide direct access to the nearby government and education precincts and Brisbane's southern CBD. The proposed station would address the public transport shortage in the southern CBD with opportunities to service the Queen's Wharf Brisbane development at ground and sub-surface levels.

The station would be located at the corner of George Street and Mary Street in the Brisbane CBD. This area coincides with the QIC Limited buildings which are located at 63 and 81 George Street. Both buildings would be demolished to allow construction of the station.

Entry and exit to the Station would be available through both George Street and Mary Street. Access below ground may also be provided, allowing access to and from the nearby Queen's Wharf Brisbane development. Internally, commuters would be transferred throughout the station on a series of escalators and lifts. Emergency access would also be provided in the form of stairs should it be required.

Roma Street Station

Extensions to the existing Roma Street Station (refer to **Figure 3-12** and **Figure 3-13**) are proposed as part of the Project, including an additional section of subway and an underground concourse with side platforms for bus and rail.

The Roma Street Station would be located in the north of Brisbane's CBD. The station extension would provide two access points to the new platforms for bus and rail – one to the north and a second to the south. The southern access would link with the existing underground subway, providing access to the existing surface networks of bus and rail as well as the Brisbane Transit Centre and Roma Street. The northern access would provide improved access to Parkland Boulevard and Albert Street. Internally, the station would provide vertical access to the platforms for rail and bus through a combination of escalators, lifts and stairs.

Bridges

A new bridge adjacent to the Annerley Road Bridge, Dutton Park is proposed to improve access over the Gold Coast-Beenleigh Line. This structure would include a 10m wide shared path for pedestrians and cyclists on its northern side (refer to **Figure 3-2**). Anti-throw screens and guard rail would also be incorporated to provide the required level of safety.

A new dual lane busway bridge over the Exhibition Line and ICB at Spring Hill and Herston would be required to link with the Northern Busway and Gilchrist Avenue (refer to **Figure 3-14**). The bridge would be constructed of concrete and of sufficient width to accommodate two 3.5m lanes and associated shoulders. Access for pedestrians and cyclists would not be provided due to safety and access constraints. Further detail on the ICB overpass is provided in **Table 3-5**.

Table 3-5 Indicative bridge height

Bridge	Location	Chainage	Height (above ground)
ICB overpass	Spring Hill/ Herston	6185-6610m	0-6.5m

An on ramp between the Northern Busway and ICB is proposed as part of the Project. This ramp would allow buses from the Project and the Northern Busway to connect and move west bound along the ICB. This would provide the opportunity for outbound services to connect with Legacy Way, providing additional improvements in network function and capacity.

LEGEND

- BaT rail centreline
- Station entry/exit
- Access way
- Station cavern
- Station access

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-12

Roma Street Station

N

0 50 100
Metres
1:3,000 (at A4)
Projection: GDA 1994 MGA56

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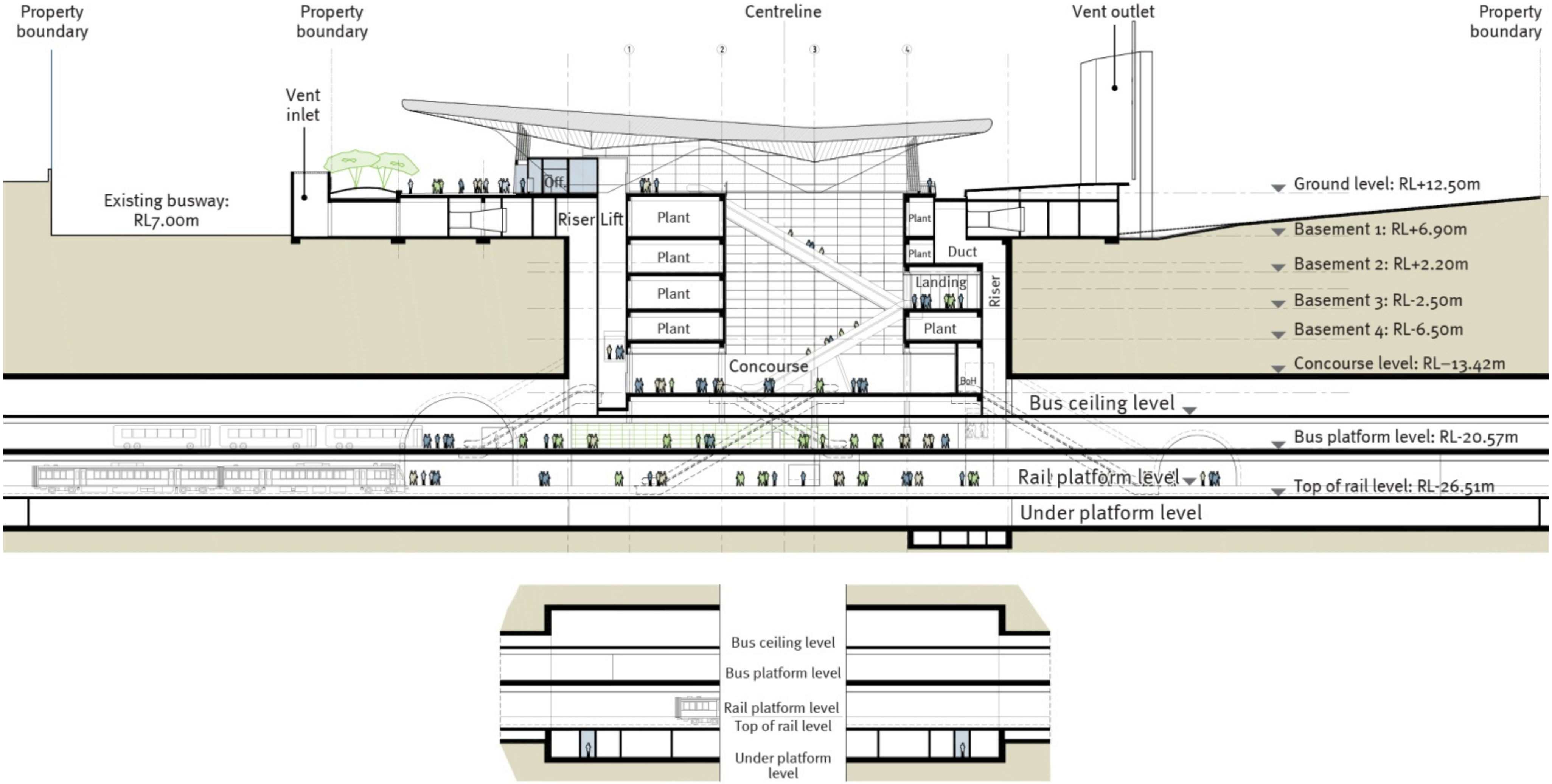

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-9

Woolloongabba Station

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-10

George Street Station

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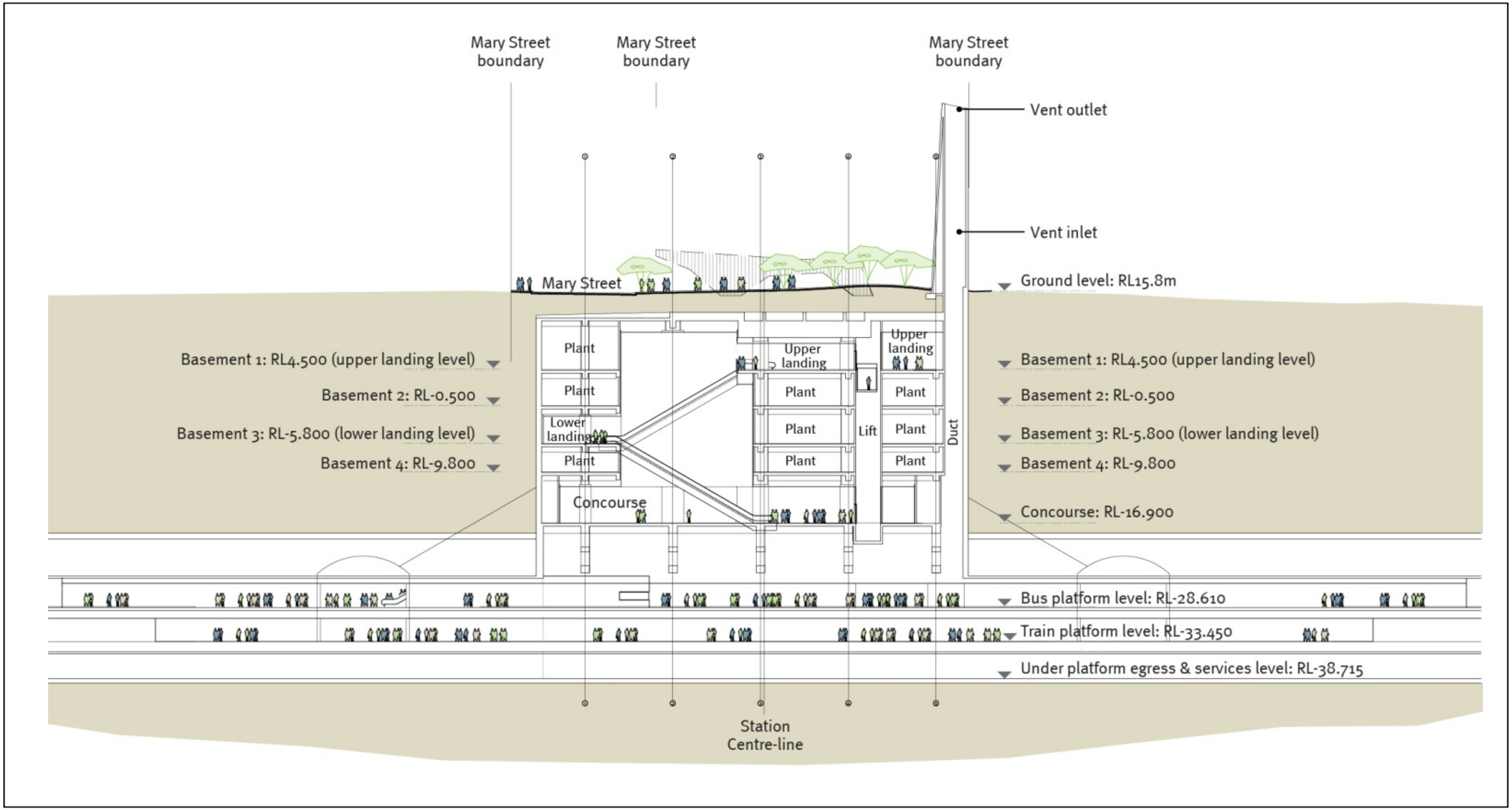
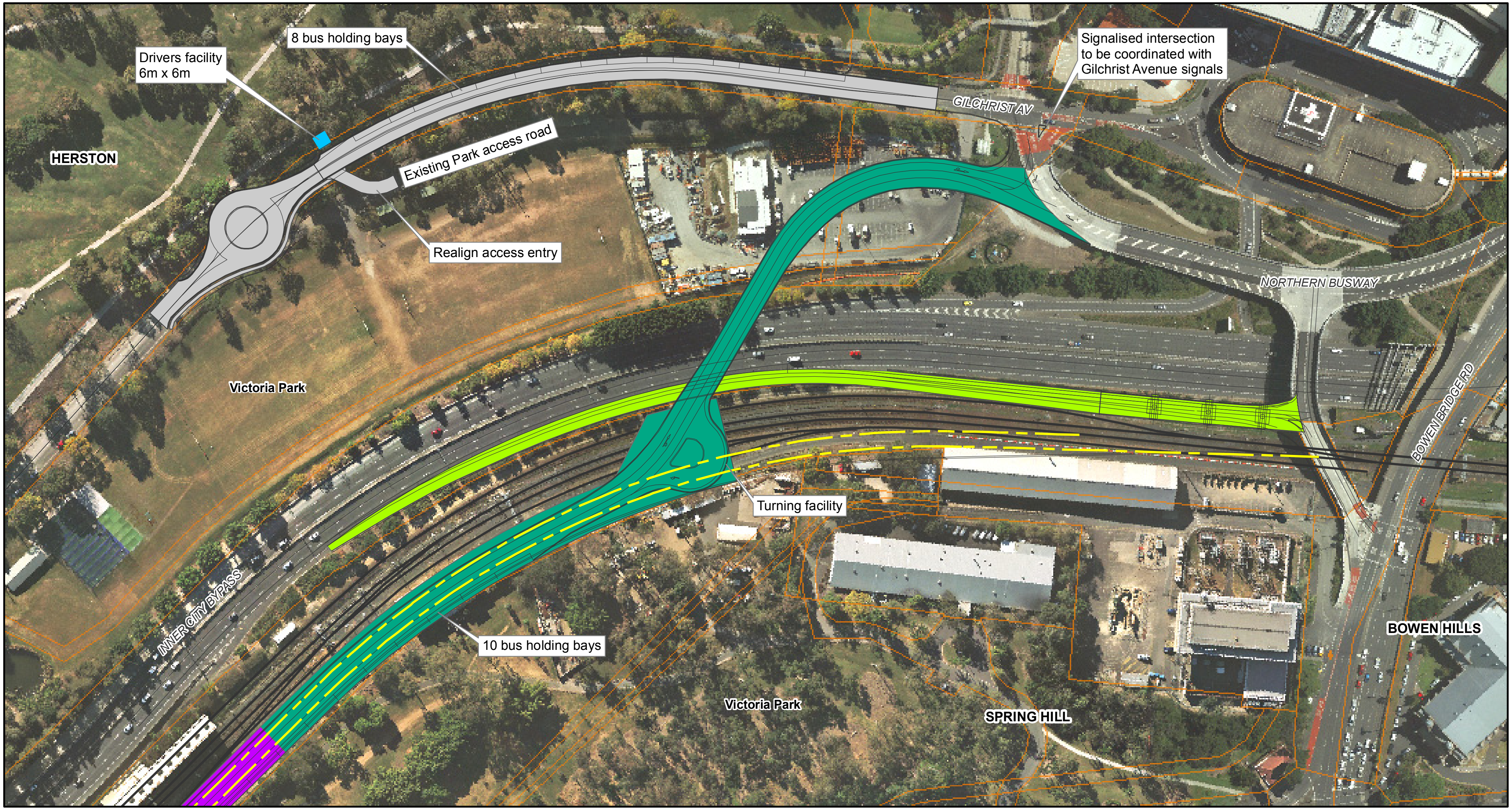


BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-11

George Street Station



LEGEND

- Existing rail line
- Property boundary
- BaT rail centreline
- Busway layover
- Dive structure
- ICB overpass
- ICB on ramp

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-14

ICB overpass and on ramp

0 0.05 0.1
Kilometres
1:2,500 (at A4)
Projection: GDA 1994 MGA56

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Ventilation

Integrated ventilation systems with redundancies would be used to maintain air quality within the tunnel and each station. This would include active systems which are able to control the direction and rate of air flow and more passive systems which would be the function of vehicle movement through the tunnel. Collectively, these systems would manage the amenity of stations, exhaust emissions (bus) and smoke in the event of fire.

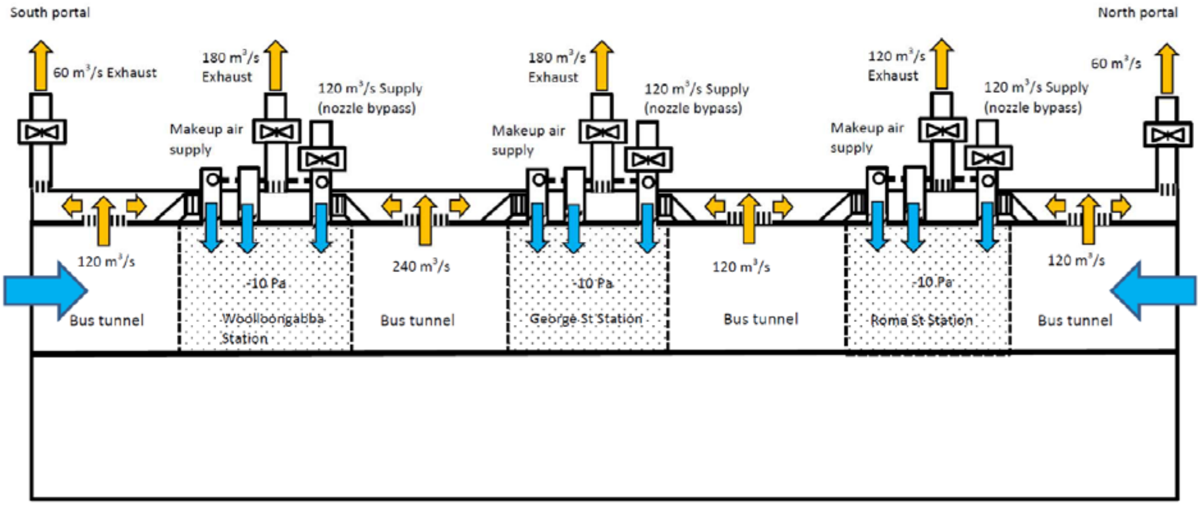
The southern and northern portals are large openings at the entry and exit points of the tunnel system. Regular operation would result in buses and trains moving through the tunnel, drawing and pushing air through the tunnel in a piston like effect. In this capacity, the portals would function as inlets and outlets, allowing for the dispersion of heat and other bus related emissions. Above ground entries would also facilitate the passive movement of air in and out of each station. These airways would provide for circulation and maintenance of the ambient environment.

A number of active systems would also be implemented to control amenity and safety within the tunnel and stations. This would include air conditioning of station foyers and the concourse to maintain patron comfort behind the platform screen doors, and fire and life safety systems in the tunnel that separate and control smoke and heat in the advent of fire. Exhaust emissions and smoke in the event of an accident are also contained and subsequently managed within the tunnel.

Additional infrastructure and equipment would be required to actively manage ventilation. Below ground, this would include a series of ducts, fans and intelligent control systems that maintain the positive flow of air. A large overhead duct in the crown of the tunnel would be a principal component of the system, providing the necessary capacity for both bus and rail (refer to **Figure 3-6**). Its position and overall shape would promote ventilation along the tunnel while avoiding the need for jet fans within trafficked areas. This would allow for the efficient use of space and a smaller diameter tunnel.

Vents would be required at each station precinct and in areas adjacent to the southern and northern connections. These vents would provide additional air flow and the ability to control air flow within each station and the tunnel independently (refer to **Figure 3-15**). They would also provide the ability to 'segment' the tunnel, allowing smoke to be confined and extracted in the general area should an incident occur.

Figure 3-15 Active ventilation system



Vents would include intakes for the supply of fresh air and outlets to disperse heat and other bus related emissions (refer to **Figure 3-2** to **Figure 3-4**). Their location and overall configuration would be defined by a number of factors that include the natural and built environment, community, function and cost.

An overview of these constraints relative to outlets and the options for their location is provided in **Table 3-6**. The locations of assessed vents are shown in **Figure 3-17** to **Figure 3-19**.

Ventilation systems at and above ground level would be enclosed or treated to retain the surrounding amenity. This would include the option to include ducts and vents within and on top of existing buildings or the stipulation of covenants that require their inclusion during subsequent redevelopment over the underground stations. The overall dimension of the preferred vent outlets for the Project is provided in **Table 3-7**.

Table 3-6 Assessment of indicative vent outlet locations

Suburb	Location	Option	Accessibility	Engineering	Function	Amenity	Availability of land	Cost	Proximity of Sensitive receptors
Dutton Park	Southern connection	VO-DP1 (Preferred)	Low	Low	Low	Medium	Low	Low	Low
		VO-DP2	Low	Low	Low	Medium	Medium	Medium	Low
		VO-DP3	Medium	Low	Low	Medium	Medium	High	Medium
Woolloongabba	Woolloongabba Street station	VO-WS1 (Preferred)	Low	Medium	Low	Low	Low	Medium	Low
		VO-WS2	Medium	Medium	Low	Low	Low	High	Low
Central Business District	George Street station	VO-GS1 (Preferred)	Low	Low	Low	Low	Low	Medium	Medium
	Roma Street station	VO-RS1 (Preferred)	Medium	Medium	Low	Low	Low	Low	Low
		VO-RS2	Low	Low	Low	Medium	Low	Low	Medium
		VO-RS3	Medium	Medium	Low	Low	Low	Medium	Low
		VO-RS4	Low	Low	Low	Medium	Low	Low	Medium
Spring Hill	Northern connection	VO-SH1 (Preferred)	Low	Low	Low	Medium	Low	Low	Low
		VO-SH2	Low	Low	Low	Medium	Low	Medium	Low

Low constraint   Medium constraint   High constraint

Table 3-7 Indicative ventilation outlet dimensions

Ventilation outlet	Precinct	Location	Estimated configuration	
			Cross section (m^2) (internal)	Height (m)
VO-DP1	Southern Connection	Dutton Park	15	11
VO-WS1	Woolloongabba Station	Woolloongabba	35	24
VO-GS1	George Street Station	CBD	35	25
VO-RS1	Roma Street Station	CBD	35	8
VO-SH1	Northern Connection	Spring Hill	15	11

Drainage

A large proportion of the Project would be situated below ground and within areas that intersect the groundwater table. In this environment higher specification concrete, seals and non-permeable membranes would be used to minimise seepage into each of the stations, tunnel and associated dive structures. Infrastructure to collect, treat and discharge groundwater seepage would still be required. This approach would also cater for small surface inflows that may result at the dive structures during rainfall events. The following section provides an overview of the proposed drainage system.

Sealed structures within areas of groundwater are typically buoyant, which can result in their upwards movement known at 'floatation'. The effects of buoyancy are typically managed by the addition of mass either through the addition of backfill or increasing the structures thickness. It can also be reduced through pumping and localised depressurisation of the water table. Both approaches, mass and pumping, are proposed to stabilise the Project below ground.

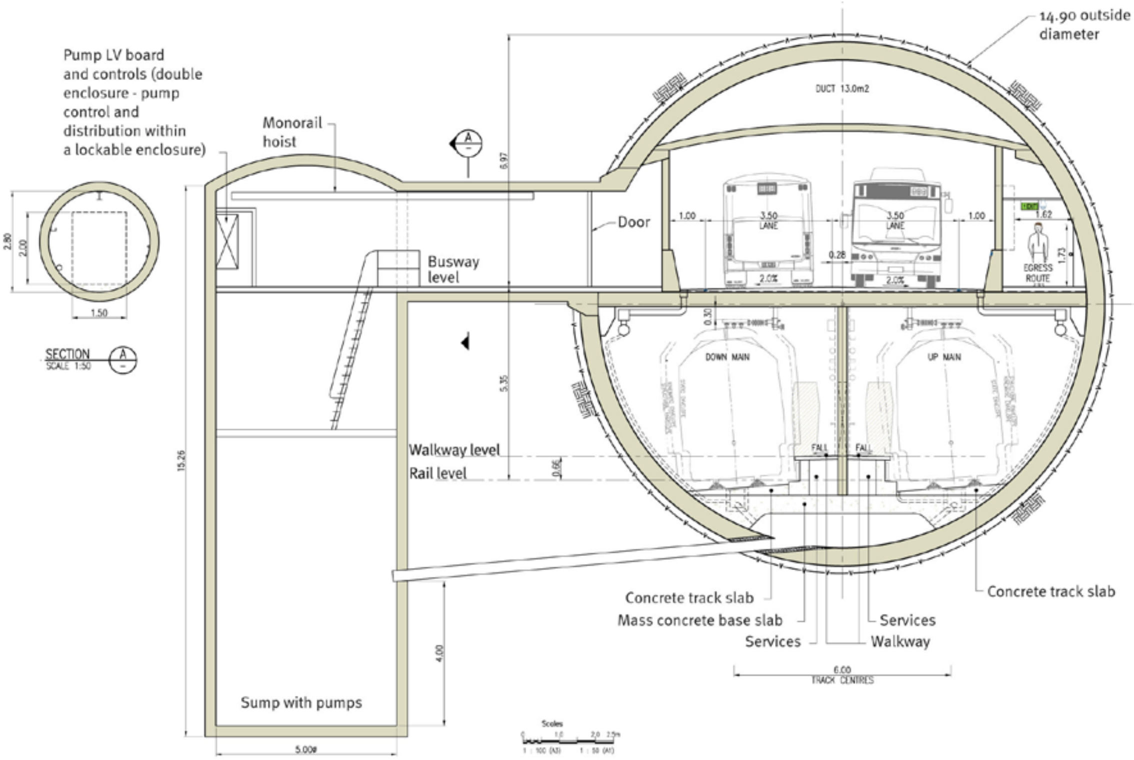
Ground conditions and the overall mass of the structure would be sufficient to counteract the effects of floatation on the tunnel. This is not the case for dive structures which are open topped and level (at their upper margins) with the ground. Systems to lower groundwater would be required and would include a network of drains, pipes and pumps (refer to **Figure 3-16**). This would allow groundwater to enter the dive structures through defined areas of the base slab. The water would subsequently be collected in a series of longitudinal pipes, which in turn lead to sumps. Automated testing and treatment would be undertaken, with the water pumped to nearby sewers, when of suitable quality, for ultimate disposal. This overall approach would reduce the level of groundwater surrounding the dive structure and extent of buoyancy it experiences.

The groundwater drainage system would manage general seepage and surface inflows that may result during rainfall. This system would be complemented by an internal sump in the lowest areas of the tunnel and stations.

Drainage from the upper deck of the tunnel would be contained and separated from the running area of the lower, rail deck. This system would employ a series of drains and longitudinal pipes within and immediately below the upper deck. Regular, controlled discharge points to the sumps and treatment systems would also be provided.

Drainage for the busway and rail incorporates standard design measures. This includes embankments, kerb and channel, table drains and elevated ballast.

Figure 3-16 Tunnel low point incorporating sump and pump



Lighting

Station lighting would be provided to all public and back-of-house areas and is an integral component of the passenger experience. Where possible, lighting would be indirect and diffused to maximise comfort levels.

Lighting within the tunnel would also be included for the purpose of operation and maintenance.

Services

A number of services would be required to support the construction and operation of the Project. These services may include water, sewer, telecommunications and power.

Preliminary design indicates that existing infrastructure networks are sufficient and have the required capacity. More significant upgrades or additions may be required for power and are discussed in the following sections.

Rail electrification

Powered passenger vehicles would be used to power trains through the Project. Infrastructure to supply and distribute power is required and would be designed consistent with Queensland Rail Statutory Authority current 25kV network.

Distribution

With the additional train traffic and movements, the demand on traction power would increase requiring additional feeder stations and track section cabins to bolster the delivery of power to the suburban network and tunnels.

New 25kV feeder stations would be required for the Project at each end of the tunnel and adjacent to:

- Kent Street, Dutton Park
- Victoria Park, Spring Hill.

Once energised, the feeder stations would supply power to the Project through two independent circuits. The addition of circuits and feeder stations provides greater reliability and contingency in the event of a localised power failure. The source of power for each feeder station would be the nearby ENERGEX main supply points.

Overhead lines

The overhead wiring system for the Project would comprise above and below ground components. Surface works would utilise a conventional 25kV, Advanced Control (AC) system with overhead masts and catenary supports. Below ground, the system would consist of a solid conductor supported by special fixings to the tunnel roof, as this would provide advantages for operations and maintenance with reduced outages on the network.

Stations

Electrical power for the stations would be derived from ENERGEX main supply points. Internally, contingent infrastructure and operating systems would be included for the critical components of each station. This would include systems for fire, life safety and station access.

Signalling, signs and communications

Rail

A new automatic train protection system would also be used, incorporating the latest advances in signal technology from Europe. Referred to as the European Train Control System, this system allows trains to operate safely at close headways and to interface with the automated platform screen doors at all underground stations.

A train communication system would also be provided throughout the tunnel, stations and above ground network, facilitating train operations under all conditions.

Stations

Information systems and signage in the stations would include:

- electronic passenger information display screens
- public address system
- help points for passenger communication with customer care/station staff for emergency and information use
- emergency information and evacuation systems
- staffed assistance points, located at bus and rail platform level and which are permanently attended during operating hours.

Busway

An AC System for bus control would be integrated within the Project to maintain reliability and safety. Each bus would have a Global Positioning System (GPS) receiver to report the bus location to a computer that contains the schedule, a tracking communications system that shares information with the existing Brisbane Metropolitan Transport Management Centre (BMTMC) and a transponder that sends the information to receivers at tunnel and station entrances and exits.

The communications system provides real time information making it possible to proactively manage buses entering and travelling through the tunnel and stations, adjusting the schedule and managing buses approaching and entering platforms to improve operations and reliability for bus passengers. This includes a satellite control centre allowing continuous supervision of busway operations. This system would allow the continuous supervision of busway operations.

Safety and security

Fire and life safety

Fire and life safety systems for the Project would be integrated within design and meet strict international standards for underground rail and busway. The tunnel and stations would include electrical and mechanical systems that detect fire and activate ventilation systems to maintain tenable conditions during evacuation. Both the stations and tunnel ventilation systems would be designed as independent systems and have the ability to operate in isolation.

Additional infrastructure to ensure the safety of commuters and staff during emergency situations would include:

- deluge systems and fire control rooms near station entries (at ground level)
- emergency access to all parts of the station, including fire isolated access routes and lobbies
- automatic fire detection and occupant warning systems
- firefighting facilities including hydrants, tanks, boosters, gas suppression to communications rooms
- tunnel egress refuges at platform ends and central areas
- platform screen doors
- closed circuit television (CCTV)
- good way finding systems in the event of an incident.

Security

Features to prevent crime through environmental design (CPTED) would be incorporated into the stations, including:

- CCTV monitoring of concourse, entry shafts and platforms
- intrusion detection and monitoring
- platform screen doors (to avoid the unauthorised or accidental access to rail and bus operational zones)
- ability to close entries to stations during non-operational hours
- integration of security bollards where vehicular access/ approach to the station is available
- clear sight lines on approach to station entrances

- effective lighting in and about the station entry points
- easily located help points
- minimal ‘dead spaces’ behind columns or other barriers
- public toilets within the paid concourse, with entrances visible from staff positions, well-lit and monitored.

Decommissioned infrastructure

During the reference design, efforts to avoid redundancy and the decommissioning of existing infrastructure have been undertaken. This has been achieved with the exception of a small number of government owned buildings and infrastructure. An overview of the location and reasoning for this decommissioning is provided below.

QIC buildings

The buildings at 63 and 81 George Street, Brisbane City would be demolished to allow construction of the George Street Station. These buildings are owned by subsidiaries of QIC Limited, a Queensland government owned corporation.

GoPrint building

The GoPrint building at 867 Main Street, Woolloongabba would be demolished to allow construction of the Woolloongabba Station. This building is owned by the State of Queensland and is administered by the Department of Housing and Public Works.

Other rail infrastructure

Integration of the Project with the South East Queensland rail network would require the removal and or relocation of a small number of existing assets. This includes:

- an area of Platform 10 at the Roma Street Station
- Dutton Park Rail Maintenance Facilities
- Normanby Maintenance and Storage Sheds.

These facilities are owned by the State of Queensland and are administered by Queensland Rail Statutory Authority.

3.6.2 Design development

The reference design has evolved from an early concept design completed in September 2013. The concept design sought to test the technical feasibility of extending rail and bus infrastructure in a shared tunnel and with shared underground stations as an affordable response to the existing and future capacity constraints in the public transport network.

Concept design

The concept design examined a possible vertical and horizontal alignment based on several important parameters, including:

- operating gradients for rail rollingstock, including the new generation rollingstock being procured by the Queensland Government
- ground conditions and geology, especially for the crossing beneath the bed of the Brisbane River

- government's desire to avoid surface acquisitions of private property
- affordability
- satisfaction of core design standards relating to fire and life safety, energy requirements, and network operations.

The concept design was accepted by the Queensland Government in late 2013 as the basis for further investigations into the technical, transport planning, financial and environmental aspects to determine whether the project should proceed.

The concept design informed preparation of the Initial Advice Statement to the Coordinator-General under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) and a referral to the Commonwealth Minister administering the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Coordinator-General declared the project to be a coordinated project for which EIS is required, and the Commonwealth Minister determined that the project was not a controlled action under the EPBC Act.

Draft reference design

A draft reference design was developed following further but as yet still preliminary investigations into the parameters for the concept design and some of the baseline conditions in the study corridor. Some early geotechnical information was derived from several previous investigations for the construction of the Captain Cook Bridge and for the Cross River Rail reference design which proposed a river crossing downstream of the Captain Cook Bridge.

The draft reference design was also informed by progressive transport modelling studies addressed in this EIS in **Chapter 4 – Traffic and transport**. Early background environmental and land use information also informed the design development process.

The draft reference design was released for consultation with stakeholders and the community on 19 March 2014. The draft reference design was developed on the assumption that rail rolling stock would operate at a maximum gradient of 3 per cent. This assumption, in combination with the available geotechnical information and the location of fixed constraints such as the depth of the Brisbane River, the alignment of CLEM7 tunnel and the depth of a number of basements in the Brisbane CBD, dictated the horizontal and vertical alignments from south to north.

The draft reference design proposed a number of features including:

- connections with the Gold Coast-Beenleigh Line at Dutton Park Station, requiring the decommissioning and demolition of the station
- connections with the Eastern Busway adjacent to the busway connection at Joe Baker Street, Dutton Park
- a pedestrian and cycle underpass of the rail corridor to provide a connection between Dutton Park and Woolloongabba
- underground stations at Woolloongabba, 63 George Street and at Roma Street Station
- connections with the Exhibition Line at Spring Hill, requiring part of Victoria Park to be closed for the rail transition structure connection with the surface railway
- connections with the Northern Busway also requiring a partial closure of Victoria Park for the above-grade connection across the Exhibition Line, the bus lay-over area and the bus turn-back facility.

The feedback received during the month-long consultation period indicated community concern about several of the features listed above. Of greatest concern were the:

- closure of Dutton Park Station and the impacts that would have for the local community, for people accessing the health services offered at the PA Hospital campus and for vision-impaired people for whom the station was critical for accessing the city and its services
- safety implications arising from an underpass of the rail corridor. Feedback suggested that people would not feel safe using the underpass and encouraged an investigation into alternatives
- likely construction impacts associated with excavation of the TBM launch-box east of Joe Baker Street, Dutton Park, with particular concern about the movement of spoil trucks on Peter Doherty Street and Boggo Road
- likely construction impacts of noise, vibration and dust associated with excavation of the deep stations at both George Street and Roma Street for people residing in apartment buildings immediately adjacent to the proposed worksites
- alignment of the draft reference design beneath Spring Hill resulting in the portal and transition structures being situated in and requiring the partial closure of Victoria Park. Of particular concern was the incremental loss of areas of Victoria Park to transport infrastructure over many decades of infrastructure development
- visual impact of above-ground infrastructure, and specifically the busway crossing of the ICB, in relation to the cultural heritage and landscape values of Victoria Park
- likely construction impacts of traffic, noise and dust associated with a large worksite in Victoria Park.

Reference design

The feedback in relation to the draft reference design, combined with further geotechnical information, building survey information and revised operating criteria for the rolling stock (increased gradient to 3.25 per cent), were considered in further design development. Community views regarding ventilation outlets also assisted in the site selection process for the Project ventilation outlets required at each of the portals and the underground stations.

The reference design for the Project, to which this EIS relates, now incorporates a number of design refinements. Of these, notable refinements from a community perspective are likely to include:

- the realignment of the rail and busway connections in the south to allow Dutton Park Station to be retained. Dutton Park Station would be serviced with 13 additional train services in the peak periods and four additional train services in most off-peak periods
- the upgrade of Dutton Park Station to incorporate DDA-compliant vertical transport (lifts) and a pedestrian plaza at grade with Annerley Road, alleviating the challenging pedestrian/ cycle conflict on the rail overbridge
- the incorporation of a bus layover and turn-around facility in Kent Street, adjacent to Dutton Park Station and the PA Hospital that provides for bus operational requirements
- provision of traffic management arrangements to reduce construction vehicle traffic movements to a one-way flow along Peter Doherty Street, Joe Baker Street and Boggo Road to reduce traffic noise and amenity impacts
- investigation into alternative construction methods and impact mitigation methods to address potentially adverse construction impacts for the deep stations at George Street and Roma Street

- the realignment of the tunnel to allow both the rail and bus alignments to surface within the Exhibition Line railway corridor rather than within Victoria Park. Construction works would still be required in Victoria Park to facilitate this realignment, the installation of underground ventilation plant and equipment and the removal of the TBM
- the stacking of the rail and busway alignments in the rail corridor to allow the busway crossing of the ICB to avoid a permanent impact on Victoria Park (south)
- use of Gilchrist Avenue for the bus layover instead of an area of Victoria Park.

The reference design described in this chapter reflects the design refinements summarised above. Further refinements have also occurred in relation to detailed technical considerations such as fire and life safety, signalling, station designs and operating requirements.

The EIS notification process will provide the community and stakeholders with a further opportunity to comment on the design refinements.

Detailed design

If the Queensland Government decides to proceed with the Project, further refinement of the design would occur during the tendering process and then again during detailed design for implementation. Typically, the design of large complex infrastructure projects is a continually evolving process reflecting the continual introduction of more detailed technical information, community and environmental investigations, and construction and operating cost reviews.

Where such refinement would result in a change to the Project or the conditions of the Project, the Proponent would apply to the Coordinator-General for consideration of the project change. The Coordinator-General may seek further information in relation to the proposed change if required, and determine whether such changes are to be the subject of further public notification including an opportunity for further written submissions.

The flexibility in the environmental evaluation process allows the Proponent to bring further innovation to the Project design, while providing the community and stakeholders with an opportunity to remain informed of possible changes and the potential implications of such changes.

3.6.3 Process and program

Project delivery would be staged with design, construction and operation likely to be facilitated through a number of commercial contracts. This work would be administered by the Department of Transport and Main Roads (TMR) (on behalf of the State of Queensland) and consistent with departmental procedures. An overview of the general design process for the Project is provided below.

Process

A reference design has been developed early to determine Project feasibility. It has guided and informed a number of additional studies including geotechnical investigation, environmental impact assessment, transport modelling and economic assessments. Subsequent outputs such as the business case and EIS have provided additional information or recommendations that have required design refinement. This iterative process has sought to minimised impacts and cost, as well as ensuring the Project’s design is fit for purpose.

Upon evaluation, the Project reference design would be refined consistent with the nominated conditions as well as a number of standards relative to safety and engineering. Additional studies including more detailed geotechnical investigation and survey would be required to inform this process. At completion, the resulting design would be more detailed and of a standard suitable for construction. Additional approvals and management plans to ensure the Project is delivered in a safe and sustainable manner would also be in place prior to construction.

Further detail on the program for the Project during design is detailed in **Table 3-8**.

Table 3-8 Indicative program during the design phase

Activity	2014				2015				2016				2017				2018			
Reference design	■	■																		
Geotechnical investigation	■	■																		
Environmental impact assessment		■	■																	
Business case		■	■																	
Procurement				■	■															
Detailed design						■	■	■	■	■	■									
Approvals						■		■												
Management plans						■		■												

3.6.4 Standards

Bus and rail networks within South East Queensland provide safe, reliable forms of transport through good design and the operating systems of Translink and Queensland Rail Statutory Authority.

As an extension of existing infrastructure, the Project would align with the current design and operating standards for rail and bus. This includes a number of international and national standards. Programmed upgrades (by Queensland Rail Statutory Authority and Brisbane Transport) to rolling stock and bus fleets and their particular infrastructure requirements have also been considered. An overview of standards used to develop the Project is provided below.

Busway and rail

The busway extension has been designed in accordance with a number of national and state specific standards and guidelines. This includes:

- Guide to Road Design 2010, Austroads
- Busway Planning and Design Manual 2012, TMR
- Road Planning and Design Manual 2013, TMR.

The busway is not designed for future co-location with or conversion to light rail. Further detail on the proposed design standards for the busway extension and associated infrastructure is provided as follows.

The rail extension has been designed generally in accordance with Queensland Rail Statutory Authority standards. Additional requirements have been applied for underground passenger rail and are based on international practice.

A general overview of the design criteria applied to the Project is provided in **Table 3-9**.

Table 3-9 Proposed rail design criteria

Design aspect	Design criteria
Vertical clearance for surface tracks	6,400mm
Maximum grade	3.25 per cent
Horizontal curves	Tunnel • R 400m desirable minimum • R 300m absolute minimum
Vertical curves – curve constants	0.4 m/sec^2 acceleration comfort level
Transitions	Minimum 60m
Design speeds in tunnel	R 400 = 80km/hr R 300 = 70km/hr
Tunnel – fixation	Resilient fastening on track slab

Structures

Geotechnical investigations have confirmed that ground conditions are stable and of a condition that exceeds the structural requirements for below ground structures. The rock is self-supporting and is suitable for tunnel and station excavations. Pillars and natural arches of rock would also be retained to ensure that above ground building and general ground loads are accommodated.

Encroachment into these supporting areas would be limited by volumetric area, ensuring the structural integrity of the tunnel and stations respectively. Loads from future developments have also been considered, with volumetric areas 10m and 12m wide extending around the outer extent of the tunnel and stations. Internally, sprayed and in-situ reinforced concrete would also be used to line the roof and walls of structures, except for the bored tunnel which would be lined and supported by reinforced, segmented concrete rings.

Major structures associated with the Project would been designed for a life of 100 years. This includes the tunnel, dive structures and outer structure of the stations. Replaceable fixtures and fittings would have a design life of 40 years.

Tunnel

The Project would be an extension of the existing rail network as well as a key link in the Brisbane busway network, providing additional links between southern and northern sections of the bus and rail passenger networks. Some particular design considerations include:

- enhanced fire and life safety and ventilation requirements
- impacts on surrounding buildings and infrastructure
- allowance for future development
- focus on construction technique
- inter-operability with the existing Queensland Rail Statutory Authority network and systems
- integration with the existing busway network
- safety.

The tunnel reference design has been defined by operational, engineering, construction and cost effectiveness requirements. The decision to adopt a large diameter tunnel with double-decked capacity was driven by the objective of creating an efficient, cost-effective project of low impact.

The decision was made at the concept stage taking into account operational, design, risk, constructability and whole-of-life criteria.

Stations

Woolloongabba, George and Roma Street stations have been designed in accordance with:

- *Disability Discrimination Act 1992* (DDA)
- Disability Standards for Accessible Public Transport 2002
- Queensland Rail Guideline– Station Design Manual 2013, Queensland Rail
- Public Transport Infrastructure Manual 2012, Translink
- Infrastructure Signage Manual – Railway Stations 2011, Translink
- Building Code of Australia 2012, Australian Building Codes Board
- Accessible Rail: Code of Practice 2011, Rail Industry Safety and Standards Board
- Busway Planning and Design Manual 2012, TMR.

Station capacity

Stations have been designed to meet projected passenger loadings at each station based on two-hour peak travel periods in both the morning and evening. Escalator capacity and sizing would be designed to meet the forecast station patronage with an additional allowance for future growth. Criteria for design include:

- escalators in lieu of stairs where the vertical rise is greater than 4.5m
- a minimum of three escalators between respective station levels where no alternative route is available to allow for the maintenance of one escalator
- accessible lifts to all public areas and rated to carry cleaning and maintenance equipment between levels.

Services

Services would be designed in accordance with a number of state and national standards, including those particular to the administrating authority.

Sustainability

The Project promotes a number of sustainable outcomes with the key outcome being the provision and subsequent use of public transport. Operation of the Project would reduce the need for private vehicle use to and within the city and southern region, and the associated issues of pollution and congestion. Additional measures specific to design, construction and operation would also include:

- use of green energy sources and energy efficient materials and plant
- collection and re-use of rain water and the use of water efficient fittings
- use of recycled materials
- footprint minimisation
- low energy, long life concrete
- long design life with high quality and robust materials
- minimisation of disruption and impact on surrounding communities.

3.7 Construction

Construction of the Project would involve major surface and ground works, including approximately 5.7km of tunnel, five dive structures, three underground stations and an amount of ancillary surface infrastructure.

The design, construction and commissioning of the Project is expected to take approximately five years to complete and would generally involve:

- worksite establishment
- major construction, including tunnelling and station construction
- fit-out of stations and tunnels
- surface rail and busway infrastructure works testing and commissioning.

3.7.1 Overview

Construction of the Project would be undertaken using a range of recognised and proven methods. These methods were selected from a suite of options on the basis of safety, efficiency and reduced environmental impact. This resulted in a preferred approach that was the basis of assessment within the EIS.

During delivery, construction would be managed by a dedicated team of qualified and experienced professionals who in turn are supported by a large, modern fleet of vehicles and machinery. This would ensure the Project is delivered on time and of a quality that is fit for purpose.

A general overview of the building and civil methods proposed to be undertaken during the course of construction is provided below.

Pre-construction

To achieve the desired program a number of pre-construction works are proposed. They include:

- site establishment and preparation
- cadastral survey and set out
- relocation of public utility plant
- demolition of redundant infrastructure
- track realignment.

Site establishment would include the preparation of worksites and their access. Fencing around their perimeters would also be undertaken to ensure general safety and security. Where required, site offices and general amenities would be established along with the provision of services such as power, water, sewer and telecommunications. Hardstands and work sheds would also be prepared and built.

Survey and set out of the Project would confirm the boundary of works and their general location. This would be undertaken by cadastral surveyors who in turn are aided by ground stations and other measuring instruments. This would ensure that temporary and permanent works are in the correct location prior to their undertaking.

Areas of the Project would incorporate a variety of above and below ground public utility infrastructure. This includes power, water, sewer and telecommunications.

Efforts during design have been undertaken to avoid this infrastructure, however, some components continue to conflict with the work and relocation may be required. This would be undertaken by, or in accordance with the requirements of the asset owner to minimise disruptions.

Buildings and some areas of rail may require removal and realignment to allow construction of the Project. These structures would be demolished and dismantled, with subsequent material being recycled or re-used where possible. All buildings would be stripped to ensure they are able to be safely demolished. Sections of existing track within the Southern and Northern connections would also be realigned where required.

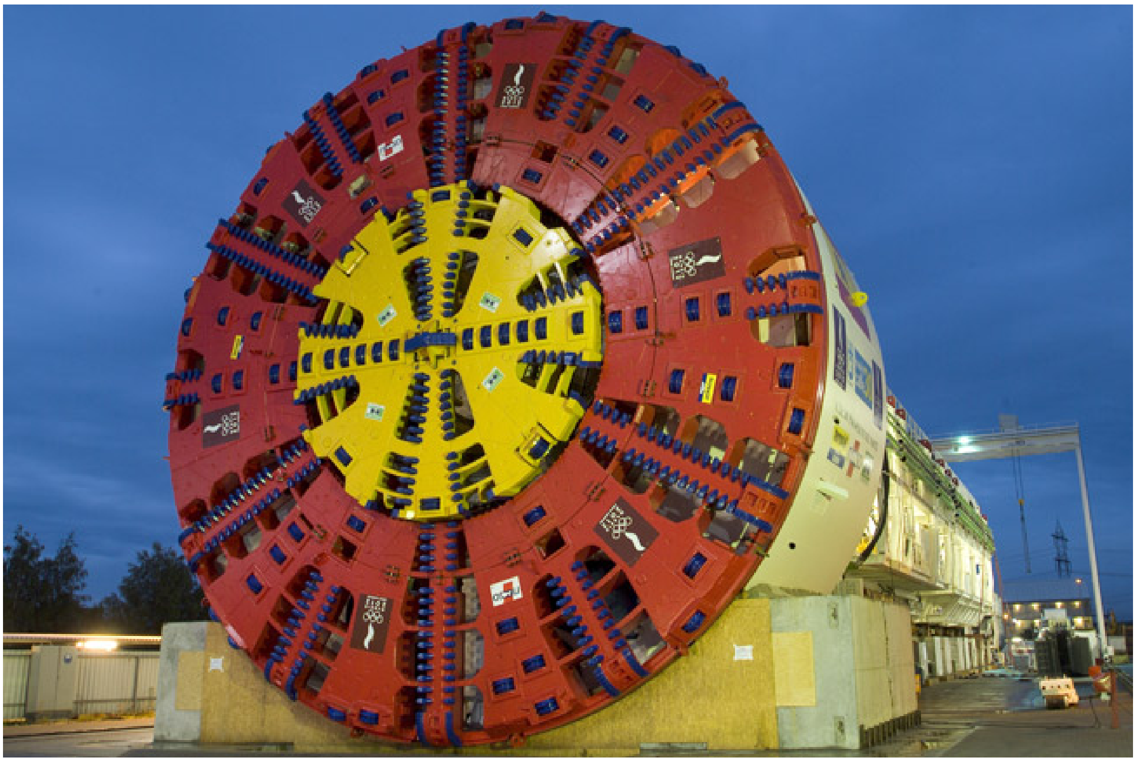
Excavation

Large sections of the Project are situated below ground. Excavation would require 1.78 million bank cubic metres (4.31 million tonnes) of soil and rock to be removed from the tunnel, dive structures and station cavities. The greater part of this material (generally referred to as spoil) would be managed at the worksites within and adjoining the Southern Connection. An amount would also be transferred from other worksites associated with each station and the Northern Connection.

Excavation within the Project site would be constrained by geology, nearby sensitive receptors and a lack of space. An integrated approach, using a combination of methods would be required, including boring, mining and general excavation. Drilling and blasting may also be required in areas to support the advance of excavations. This would typically be limited to particularly very hard rock and where other excavation methods are inefficient or ineffective.

The primary tunnel would be constructed through boring, with pre-cast concrete segmental linings erected directly behind a mechanised shield. This would be facilitated by a large, purpose built TBM specifically designed for hard rock (refer to **Photograph 3-1**). A pipe roof may also be used in the shallower areas, re-enforcing ground conditions prior to boring. This structure would comprise a series of smaller concrete beams immediately above the primary tunnel. These longitudinal beams support and stabilise the ground, minimising surfacing settlement and the risk to properties and infrastructure above.

Photograph 3-1 Tunnel boring machine (TBM)



Ground conditions and desired programs for operation indicate that one TBM would be sufficient with tunnel boring commencing at the Southern Connection. Although unlikely, a second TBM may be employed from the north (commencing at the Northern Connection) should difficult ground conditions be encountered or program considerations change.

Material produced during boring would continually be collected and conveyed from the tunnel. Truck and dog trailers would then be loaded either through a continuation of conveyors or front end loaders. Trains may also be used for transport, if available and practical. All loading would occur under cover, within purpose built sheds or enclosures for the containment of noise and dust. Material would then be transported to the nominated transfer site for subsequent re-use. To ensure safe, reliable access, temporary road closures and changes to pedestrian and cycle ways would be undertaken, if required. Road closures and changes to access are discussed further in **Chapter 4 – Traffic and transport**.

Smaller, shallower sections of the tunnel (secondary tunnels) would be formed through mining and general methods of excavation. Road headers would mine below ground, retaining the ability to operate overhead infrastructure such as the Gold Coast – Beenleigh Line (refer to **Photograph 3-2**). This type of machine employs a rotating head which progressively cuts and mines the rock surface. Piling rigs, bulldozers and excavators would facilitate general excavation, allowing for the stabilisation of ground and its excavation. Piles would be driven or bored while bulldozers and excavators dig, rip and push the material to be moved. Underpinning may also be required to support structures (such as the southern freight flyover on the Cleveland Line) that are situated above the area of excavation. This work would be undertaken prior to excavation, providing additional strength and bearing capacity. This would maintain the integrity of the structure and associated operations. Pins would comprise preformed concrete piles or cast insitu piers. Excavated material would be loaded for transport by front end loaders, conveyors or other suitable method. Loading would occur within enclosed areas of excavation or purpose built sheds, minimising noise and dust. Transport of the material from site would then occur by road.

Photograph 3-2 Road header

Smaller areas of excavation would also be undertaken to establish areas such as the worksites, load out sheds and TBM launch box. General excavation methods would also be used to undertake this work. Due to their preliminary nature, loading within enclosed sheds may not be possible. These activities would be managed through alternative means such as the modification of work hours and the use of water trucks.

Station caverns and vertical shafts would be constructed using a top down or bottom up approach. In a top down approach, excavators with rock breakers would assist in the advance of excavations, with subsequent material loaded within enclosed sheds and trucked from site. Below ground, station cavities would be cut by road headers. Cranes and conveyors would lift the material generated to enclosed load out areas.

Excavated material would be transported from site by truck and dog. Before leaving each worksite, each truck would pass through either a wheel wash or shaker grid (or other suitable method) to remove loose material. Each load would also be covered to manage dust. Each truck would be fitted with a GPS tracking unit to ensure it follows the designated route to the spoil placement site, and to manage traffic flows and queuing at the worksites. Each truck would be clearly identified as being a Project spoil truck. Trains may also be used if network capacity is available and practical.

Construction

Construction would encompass a wide variety of civil and building work. Components would include internal and external superstructures of the tunnel, dive structures, stations and bridges as well as foundations for rail and busway.

Major load bearing structures of the Project would be constructed from steel and concrete. A number of these (such as the tunnel rings, bridge beams and retaining walls) comprise pre-cast proprietary units. These units would be formed off-site in standardised segments, allowing for transportation and progressive installation on site. Others that are not able to be formed offsite would require construction through form work, steel reinforcing and the pouring or spraying of concrete. These insitu structures include smaller sections of tunnel (secondary tunnels outer walls), tunnel decks and bridge components such as piers and headstocks. Waterproofing to minimise seepage underground is also required, membranes and seals would be applied in the relevant areas.

Building work would be generally confined to the stations, with aluminium, steel and various forms of cladding used to establish the internal and external (surface) structure. Pre-formed and cut materials would be used, promoting quality and saving time. External structures for ventilation and power would also be established.

Busways would be formed through the construction of subgrades and pavements. This would involve an amount of machinery such as trucks, graders, excavators, rollers and specialised paving machines. Drainage, barriers and line marking would then be completed with busway furniture such as lighting and signage following. Rail would involve the placement of ballast, sleepers and track. Similar machinery would be employed as for the busway with the exception of track laying. Track would be laid by contiguous, mechanical methods which employs specialised track laying machines. Once complete, overhead masts and wire supports, power supplies, signals and communications would follow. Rail and busway work would generally be off-line and can be carried out independently of current operations. Interfaces with live traffic and trains would require temporary closures and possessions, many of which would be undertaken at night.

Fit-out

Fit-out would involve the provision of ancillary infrastructure and services to support general operation (refer to **Table 3-10**). This would primarily concern the stations which contain numerous systems relative to network function, fire and life safety, access, security, communication and general amenity. Communication and signalling systems for busway and rail would also be completed, with these works commencing from each connection.

Standard procedures, industry standards and manufacturers recommendations would be followed or employed during fit out. Modifications would be required to accommodate the sub-surface nature of the stations and their restricted access. The lack of surface space at George Street and Roma Street Stations would also require a high degree of trade coordination in order to maintain safety and program.

Table 3-10 Service infrastructure to be established during fit-out

System	Infrastructure and service
Power	Power cabling, transformers and switchgear
Access	Escalators and lifts, tactile indicators, gating and ticket machines
Fire and Life Safety	Platform and fire doors Deluge systems and emergency signage Ventilation plant and ducting European Train Control System AC System
Security	CCTV
Communication	Signs, signals and audio
Amenity	Toilet and wash facilities, lighting, water stations
Drainage	Pumps, pipes, transformers and switchgear

Landscaping

Landscaping would include hard and soft treatments with a focus on the station precincts, as well as Victoria Park in the north. Requirements for top soil and planting, as well as urban design features would be implemented as per design. Conventional methods would be applied that include the placement of bulk materials such as top soil and mulch by machine and planting by hand. Plant material would include areas of advanced stock in pots and rolled turf. Hydraulic seeding and mulching would also be undertaken in areas.

Demobilisation

Upon the completion of works, excess construction materials, plant and machinery, waste, fencing and general facilities would be removed from the worksites. Disturbed areas would be reinstated to their original condition or as otherwise agreed with the relevant landowner. Cranes, trucks, front end loaders and skid steers would be used to undertake this work.

3.7.2 Process and program

Project delivery would require a large amount of work, over an extended period of time. Some aspects would be staged while more major components are to be undertaken concurrently across different areas of the Project. An overview of this general process and the likely program to deliver the Project is provided in the following sections.

Process

Construction would be facilitated by a number of documents, ensuring all works are undertaken in a safe and suitable manner. Physical works would be constructed in accordance with detailed design drawings, while work methods would be guided by a series of Project specific plans and procedures. The period of construction and the overall sequencing of work would also be defined within a work program. These documents would be defined within commercial contracts, ensuring compliance and certainty during Project delivery.

Physical works associated with the Project would be undertaken systematically and in an order that facilitates subsequent activities. This includes a number of early, pre-construction works that would enable the overall program for delivery.

Pre-construction work for the Project would include:

- site establishment and preparation (temporary access, site offices, hardstands and fencing)
- cadastral survey and set out
- relocation of public utility plant (including services for power, water and telecommunications)
- demolition of redundant infrastructure
- track realignment.

Once enabled, more major construction work would commence across each of the station sites and at both connections. This would include:

- earthworks
- construction
- fit out
- landscaping
- demobilisation.

Pre-construction

Survey of the worksites would be undertaken to confirm boundaries and the area of available land. Fencing would be erected, identifying the extent of permanent and temporary work. Site establishment would commence, with ground preparation and services prepared for the siting of offices and amenities. Where required, hardstands and work sheds would also be established. The additional workforce, equipment and machinery and materials would then be brought to site.

Public utilities and infrastructure in conflict with the Project would be relocated or removed in coordination with the administrating authority. Redundant infrastructure would be stripped and prepared for demolition. Material able to be salvaged would be removed and recycled with the remainder of material transferred to landfill. Tracks would be realigned.

Excavation

Excavation would occur concurrently at multiple sites across the Project, including the tunnel (primary and secondary tunnels) within the south as well as the three stations. This approach is required due to:

- safety – the vertical shafts at each station would likely to be constructed using a top down approach, a method that is most safe when the insitu ground is intact and free of voids. This requires the station shafts to be complete prior to the TBM arriving

- program – the overall duration of station excavation, construction and fit out is long. Concurrent work faces at each of the stations is required to compress the overall program for Project delivery.

Once established, the TBM would commence boring of the tunnel from Dutton Park and proceed north, deep beneath the Brisbane River to the retrieval shaft in Victoria Park.

An overview of the general approach to excavation on the Project is provided in **Table 3-11**.

Table 3-11 General excavation process

Precinct	Excavation
Southern Connection *Dive structures* *New bridge (shared path)*	• Strip topsoil • Establish erosion and sediment controls and water treatment system • Bore or drive piles and excavate dive structures. Spray shotcrete to stabilise mined areas • Bore piers for new bridge (shared path) • Establish shed for load out of spoil (if required) • Load and transfer spoil • Undertake environmental monitoring
Tunnel *Primary tunnel* *Secondary tunnels*	• Strip topsoil • Establish erosion and sediment controls and water treatment system • Bore or drive piles for TBM launch box and secondary tunnels • Excavate launch box and secondary tunnels • Establish shed over load out area and cover over TBM operation area • Bore and jack, pipe roof beams. Underpin existing structures, where required • Launch TBM (and associated infrastructure) to commence tunnelling boring • Manage groundwater and subsequent flows • Load and transfer spoil
Woolloongabba Station George Street Station Roma Street Station	• Establish erosion and sediment controls • Form piles and excavate vertical access of station • Establish shed for load out of spoil • Cut station cavity (concourse) prior to TBM passing. Excavation would generally extend out from the vertical access in a series of cut headings and benches. Drill and blast, if required • Load and transfer spoil • Undertake environmental monitoring
Northern Connection *Dive structures* *ICB overpass* *ICB ramp*	• Clear and grub. Strip topsoil • Establish erosion and sediment controls and water treatment system • Bore or drive piles and excavate dive structures. Spray shotcrete to stabilise mined areas • Bore piers for bridge and ramp • Load and transfer spoil • Undertake environmental monitoring

Construction

Civil works would generally commence upon the completion of excavation (refer to **Table 3-12**). For the tunnel, construction would commence in the south with the primary and secondary tunnels established in parallel.

The segmental, concrete rings of the primary tunnel would be lifted into place as the TBM advances north while the secondary tunnels would be constructed through more conventional insitu methods. In the cut and cover sections, this would include the construction of concrete roof slabs over walls of already established soldier piles. Upon curing, the area beneath would be excavated and the concrete base slab poured. Smoothing on the inside of walls and the roof would then be progressed. Mined areas would use similar methods for the base slab while the walls and roof would be formed from shotcrete. Construction of the secondary tunnels in the north would be delayed until the arrival and subsequent removal of the TBM.

With the exception of a roof slab, construction of the dive structures would follow a similar process to that of the cut and cover components of the tunnel. Shallower areas may however incorporate pre-cast concrete walls, with each section lifted and tilted into place as the work progresses. Steel cross bracing would replace the need for a roof, with beams lifted into place upon smoothing and sealing of cast insitu or tilting of walls.

At the stations, retaining walls (for the shaft and cavern) would be formed through the application of shotcrete, smoothed upon curing and then sealed with water proof membranes. Inner walls would then be formed from concrete in a bottom up approach using pre-cast and insitu methods. Construction of the stations would generally follow the program of excavation, with stations in the south commencing earlier than those to the north.

Building work would commence upon the completion of civil works, with the above ground aspects of stations delayed until temporary structures such as the acoustic work sheds are dismantled. Steel, timber and cladding would be used to form the stations sub structure while pipe and wire would be used to supply services.

Table 3-12 Construction overview

Precinct	Construction
Southern Connection *Dive structure* *New bridge*	• Place formwork and lay/ tie steel for reinforcement • Pour concrete base slab and tilt pre-cast concrete wall. Pour pile cap, pier and headstock for bridge • Lift and secure steel bracing cross supports for dive structure. Place bridge beams and deck units. Form parapets • Construct busway and rail and associated infrastructure
Tunnel *Primary tunnel* *Secondary tunnels*	**Primary tunnel** • Erect pre-cast concrete segmented linings behind a mechanised shield • Place formwork and lay/tie steel for reinforcement of internal decks and supporting columns. Pour concrete • Construct busway and rail and associated infrastructure **Secondary tunnel** • Apply seal to initial layer of shotcrete in mined sections • Place formwork and place/tie steel for reinforcement. Pour concrete base slab (and roof if using cut and cover method) • Tilt pre-cast walls or spray final layer of shotcrete to wall and roof. Smooth shotcrete

Precinct	Construction
	• Modify TBM launch box – add concrete roof and base slab for busway • Backfill cut and cover component of secondary tunnel • Retrieve TBM in north • Construct busway and rail and associated infrastructure
Woolloongabba Station George Street Station Roma Street Station	• Retaining walls (vertical access and cavern) formed with shotcrete, smoothed and sealed • Inner walls constructed from concrete using precast and insitu methods. • Build sub structure and install services
Northern Connection *Dive structure* *ICB overpass* *ICB onramp*	• Place formwork and lay/tie steel for reinforcement • Pour concrete base slab and tilt pre-cast concrete wall. Pour pile cap, pier and headstock for bridge • Lift and secure steel bracing cross supports for dive structure. Place bridge beams and deck units. Form parapets • Construct busway and rail and associated infrastructure

Fit-out

Ancillary infrastructure for the busway and rail would be installed throughout the tunnel consecutively from both connections. Stations would be progressed in parallel, with large facilities such as lifts, escalators and plant installed as priority. Systems for power, access, fire and life safety, security communications, amenity and drainage would proceed and be completed prior to commissioning.

Landscaping

Landscaping would be undertaken progressively and as construction and fit-out is complete. This would be guided by a program for work and detailed design, with the requirements for areas such as Victoria Park confirmed with Brisbane City Council confirmed prior to their undertaking. Plant material would be ordered in advance, allowing sufficient time for procurement and to ensure the advance stage of stock, if required. Compacted areas would be ripped and the area prepared for planting, including the use of soil ameliorants where required. Plants and turf would be established, watered and maintained.

Demobilisation

Demobilisation of the various sites would take place as and when fit out and landscaping is completed. This would be undertaken progressively, with excess machinery and plant removed from site when no longer required. Site offices and fencing would be removed in the later stages with the site then being stabilised and returned as previously agreed with the owner.

The condition of works (such as landscaping) would continue to be monitored and maintained during demobilisation and the overall liability period. Defects would be remedied in accordance with the nominated standard.

Program

General construction would be staged over a period of approximately five years. Works associated with pre-construction would be undertaken in advance, thereby enabling longer term, more major work activities to be commenced early and in multiple areas. This approach manages interdependent activities, allowing the program for delivery to be compressed and minimised in duration.

Key stages of the program include pre construction and construction are provided in **Table 3-13**. A number of activities within these stages are also interdependent and cannot commence until the preceding work is complete.

Table 3-13 Indicative program of work

Activity	2015				2016				2017				2018				2019				2020			
Pre-construction																								
Site establishment and preparation			■	■																				
Cadastral survey and set out			■		■		■		■		■		■		■		■		■		■		■	
Relocation of public utility plant			■	■					■															
Demolition of redundant infrastructure				■	■	■	■																	
Track and road realignment			■	■	■	■	■	■	■	■	■	■	■											
Construction																								
Southern Connection																								
Excavation						■	■	■										■						
Construction							■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Woolloongabba Station																								
Excavation							■	■	■	■	■	■	■											
Construction											■	■	■	■										
Fit out															■	■	■							
George Street Station																								
Excavation								■	■	■	■	■	■	■										
Construction													■	■	■	■								
Fit out																	■	■	■					
Roma Street Station																								
Excavation									■	■	■	■	■	■	■	■								
Construction															■	■	■	■						
Fit out																			■	■	■			
Tunnel																								
Excavation						■	■	■	■	■	■	■	■	■	■	■								
Construction							■	■	■	■	■	■	■	■	■	■	■							
Fit out (including connections)																		■	■	■	■			
Northern Connection																								
Excavation														■	■	■	■							
Construction																		■	■					
Landscaping (all areas)																								
															■		■		■		■		■	
Demobilisation (all areas)																								
																■		■		■		■		■

3.7.3 Worksites

A number of worksites would be required to facilitate construction of the Project (refer to **Figure 3-17** to **Figure 3-19**). This includes the provision of space for fabrication, loading, laydown and storage as well as general access. Facilities and services to support workers and works would also be required and include offices, amenities and some parking. Worksites that are safe, suitably sized and adjacent to the area of permanent work provide efficiencies in time and cost (refer to **Table 3-14**). Land availability, access to arterial roads and the need to avoid the surface resumption of private property were also primary considerations in the selection of sites.

Where possible, the Project's worksites would be located within the area of permanent works. Of the 16 principle sites proposed, eight include land within the area nominated for operation. The eight remaining worksites would be located in areas adjacent to the northern and southern connections and the Roma Street Station due to spatial constraints and the general lack of available land. Enabling works may also be required to facilitate delivery of the Project. Such works would include, among other things, track re-alignments in the existing rail corridor, adjustments to signalling, and temporary measures for safe and efficient operations on both the bus and rail networks during construction. Such enabling works may occur beyond the worksite boundaries and would be subject to the existing codes and guidelines for such works[1] as well as the goals for construction noise established in the Draft Outline EMP (refer to **Chapter 18 – Draft Outline EMP**).

Public access to worksites would be prohibited. Security fencing and screening would be provided for safety and to minimise visual impacts and nuisance such as noise and dust on nearby communities.

Indicative layouts for each worksite are detailed in **Figure 3-20** to **Figure 3-24**.

Table 3-14 Indicative worksite areas

Number	Worksite	Suburb	Primary service area	Size (ha)
1	WS1-DP	Dutton Park Woolloongabba	Southern Connection Tunnel	10.30
2	WS2-DP			0.49
3	WS3-DP			0.57
4	WS4-DP			0.29
5	WS5-DP			0.64
6	WS6-WS	Woolloongabba	Woolloongabba Station	2.34
7	WS7-GS	Brisbane CBD	George Street Station	0.27
8	WS8-RS		Roma Street Station	0.21
9	WS9-RS			0.16
10	WS10-RS			0.56
11	WS11-RS			0.18
12	WS12-RS			0.79
13	WS13-VP	Spring Hill Herston	Northern Connection Tunnel	1.74
14	WS14-VP			3.60
15	WS15-H			1.43
16	WS16-H			0.47

[1] Queensland Rail: Code of Practice – Railway Noise Management

LEGEND

Vents

- Vent inlet
- Vent outlet
- BaT rail centreline
- Property boundary
- Transport corridor
- Construction worksite

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-17

Construction worksites - 1 of 3

0 0.1 0.2
Kilometres
1:7,500 (at A4)
Projection: GDA 1994 MGA56

N

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LEGEND

Vents

- Vent inlet
- Vent outlet

- BaT rail centreline
- Property boundary
- Transport corridor
- Construction worksite

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-18

Construction worksites - 2 of 3

0 0.1 0.2
Kilometres
1:7,500 (at A4)
Projection: GDA 1994 MGA56

N

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LEGEND

Vents

- Vent inlet
- Vent outlet

- BaT rail centreline
- Property boundary
- Transport corridor
- Construction worksite

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-19

Construction worksites - 3 of 3

0 0.1 0.2
Kilometres
1:7,500 (at A4)
Projection: GDA 1994 MGA56

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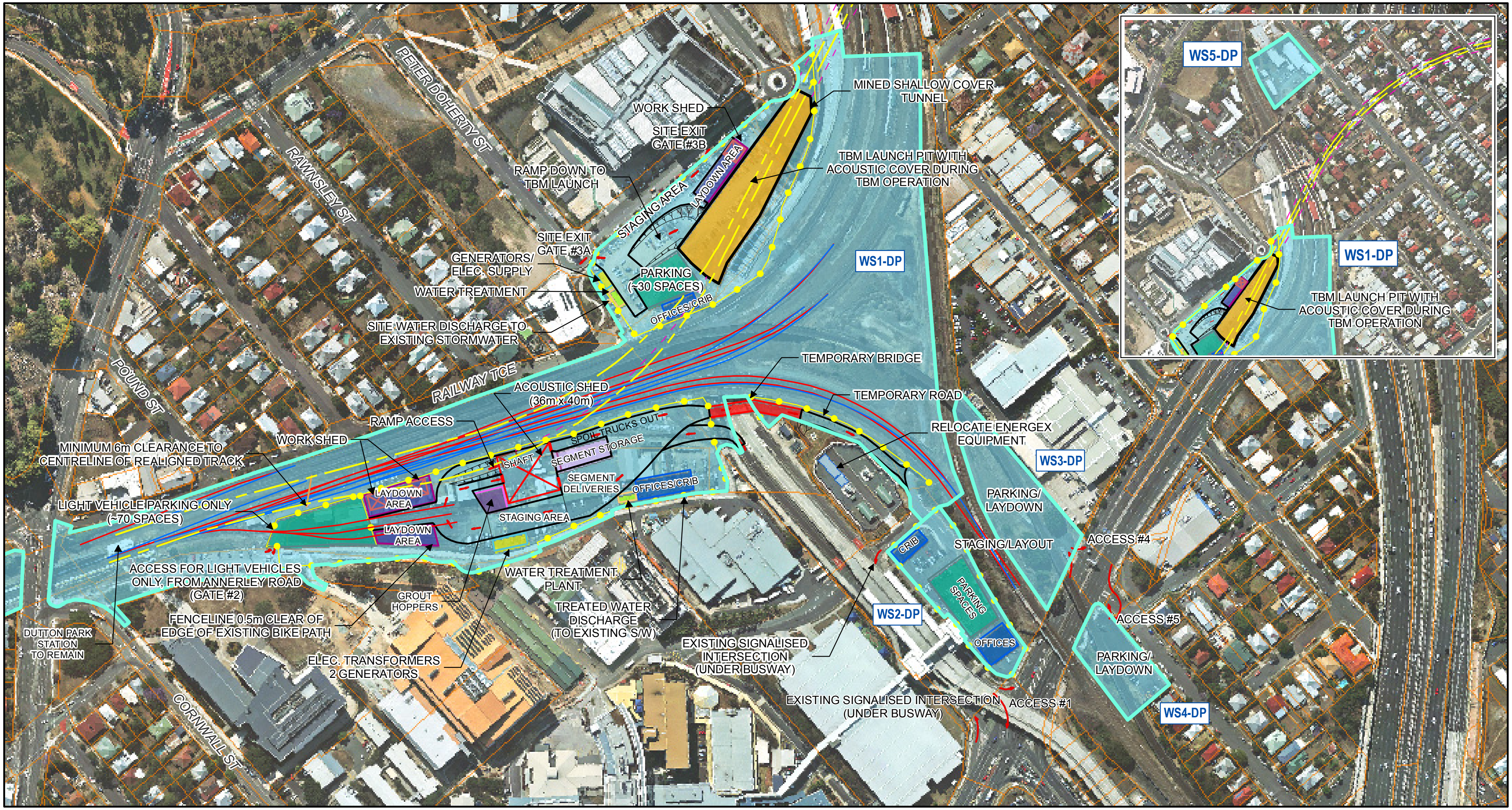

LEGEND

- BaT rail centreline
- Cadastre
- Construction worksite
- Acoustic shed
- Office/crib

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-20

Construction worksite concept layout - Southern Connection

N

0 50 100
Metres
1:4,000 (at A4)
Projection: GDA 1994 MGA56

Aerial Photo: Brisbane City Council 2012

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LEGEND

- BaT rail centreline
- Cadastre
- Construction worksite
- Acoustic shed
- Office/crib

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-21

Construction worksite concept layout - Woolloongabba Station

N

0 25 50
Metres
1:1,500 (at A4)
Projection: GDA 1994 MGA56

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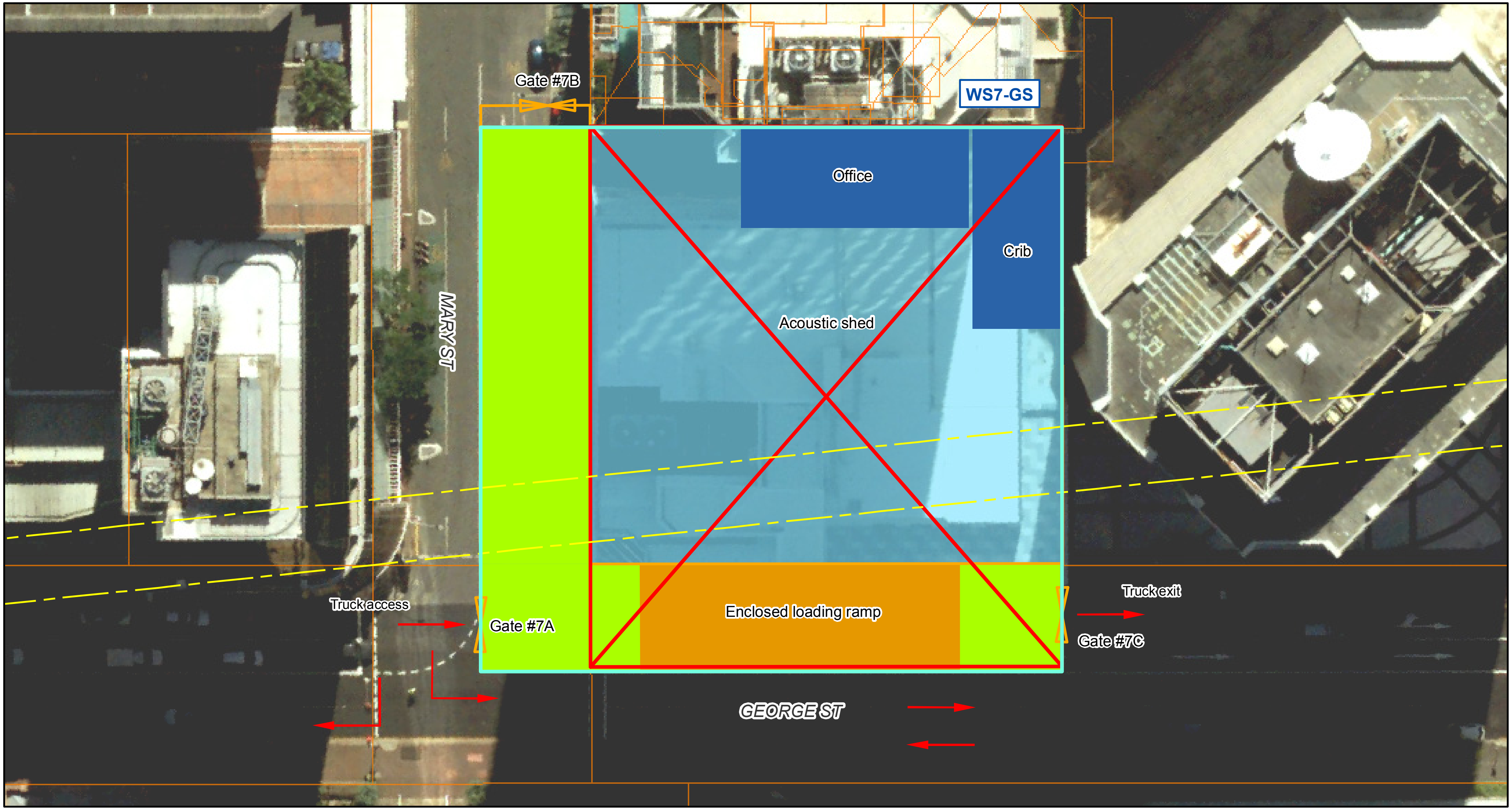

LEGEND

- BaT rail centreline
- Cadastre
- Construction worksite
- Acoustic shed
- Office/crib

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-22

Construction worksite concept layout - George Street

0 10 20
Metres
1:500 (at A4)
Projection: GDA 1994 MGA56

Aerial Photo: Brisbane City Council 2012

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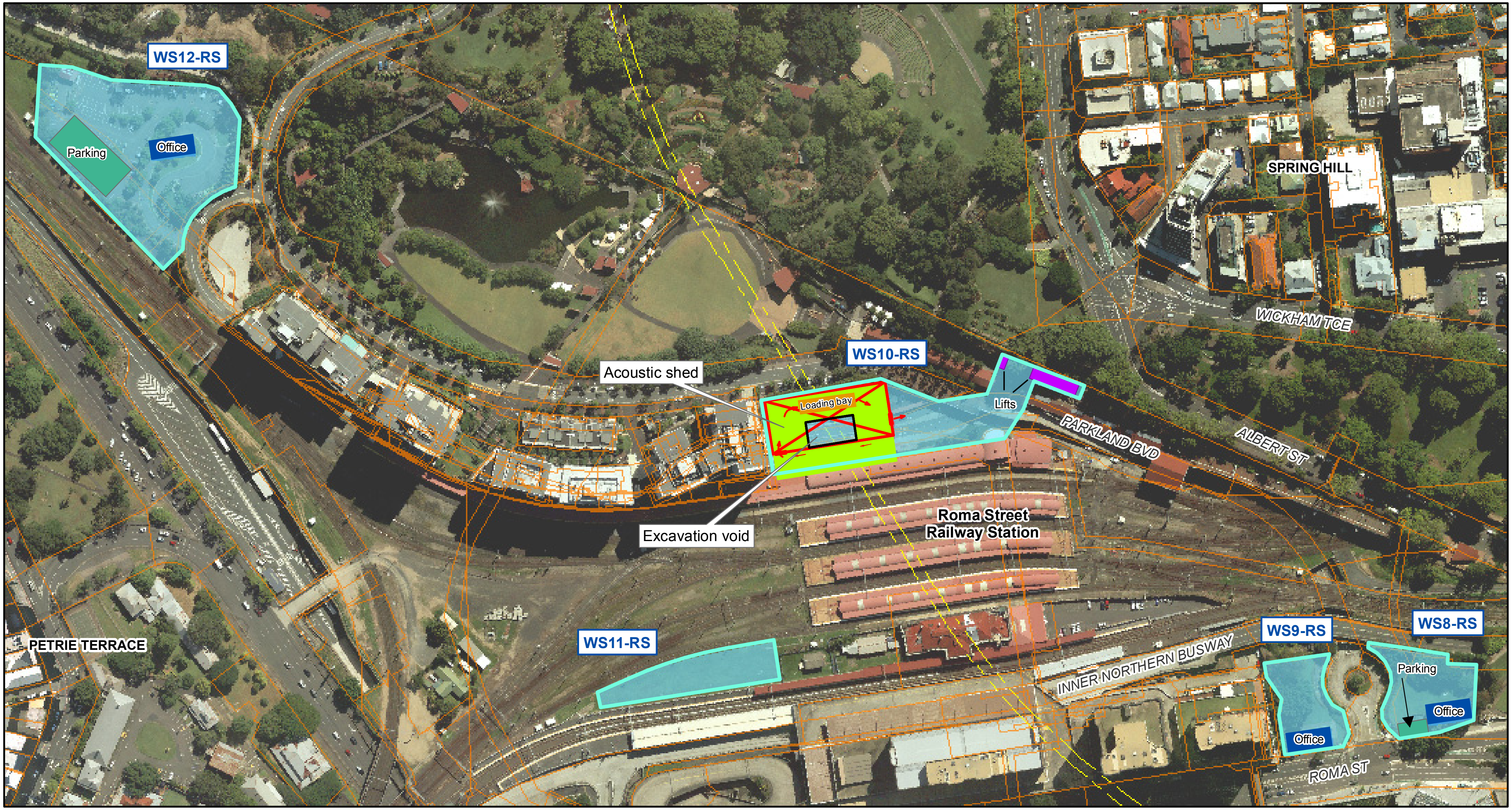


LEGEND

- BaT rail centreline
- Cadastre
- Construction worksite
- Acoustic shed
- Office/crib

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

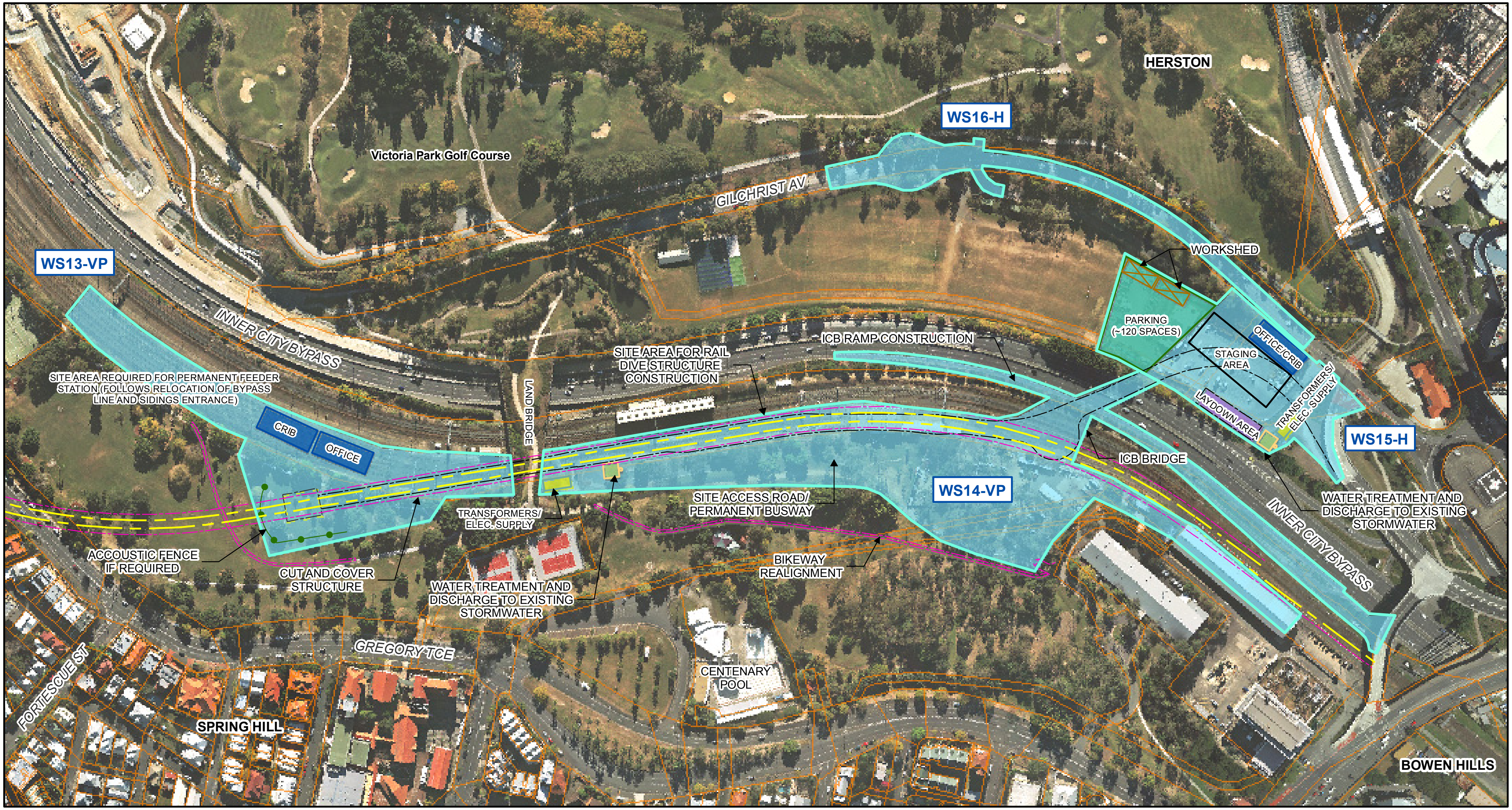
FIGURE 3-23

Construction worksite concept layout - Roma Street

N

0 50 100
Metres
1:3,000 (at A4)
Projection: GDA 1994 MGA56

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\03_Project_Description\ProjectDescr_Figure3-23_WorksiteConceptLayout_RomaSt.mxd Date: 12/08/2014



LEGEND

- BaT rail centreline
- Cadastre
- Construction worksite
- Office/crib

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 3-24

Construction worksite concept layout - Northern Connection

0 75 150
Metres
1:4,000 (at A4)
Projection: GDA 1994 MGA56

Aerial Photo: Brisbane City Council 2012

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\03_Project_Description\ProjectDescr_Figure3-24_WorksiteConceptLayout_NthConn.mxd Date: 12/08/2014

3.7.4 Workforce

Delivery of the Project would be coordinated through a program of works and over a number of worksites. Forecasts indicate that year three of the program involves the greatest amount of work, with up to 1,200 people employed across the Project. This would represent a maximum shift of 800 workers per 12 hour shift, across the Southern Connection and the three station precincts.

Further detail on the projected workforce over the duration of construction is provided in **Table 3-15**.

Table 3-15 Construction workforce

Precinct	Workforce		
	Average	Peak	Peak – single shift
Southern Connection	200	300	200
Woolloongabba Station	150	200	150
George Street Station	150	200	150
Roma Street Station	150	200	150
Northern Connection	200	300	150
Total	850	1200	800

Parking

Worker and visitor parking would be provided at the worksites according to demand and available space. At the George Street Station and Roma Street Station work areas, on-site parking would not be provided or is limited due to spatial constraints. Workers would be required to use commercial off street parking or public transport in these areas.

An overview of the parking to be provided at the worksites is provided in **Table 3-16**. The potential impacts of parking and measures for management are detailed in **Chapter 4 – Traffic and transport**.

Table 3-16 Worker and visitor parking at worksites

Precinct	Worksite area (ha)	Number of car parking spaces
Southern Connection	12.29	310
Woolloongabba	2.34	130
George Street	0.27	0
Roma Street	1.9	140
Northern Connection	7.24	120

During operation, parking facilities would be provided for short term access or maintenance tasks within or adjacent to the stations. These areas would be agreed with the relevant authority during detailed design.

3.7.5 Work hours

Construction would require work above and below ground. With the exception of emergencies, all work would be undertaken in a manner that achieves the environmental outcomes for noise and vibration. Specific actions to achieve these outcomes are described in **Chapter 11 – Noise and vibration** and **Chapter 18 – Draft Outline EMP**.

Consistent with the objectives for noise and vibration, works are proposed to be undertaken continuously over the period of construction. On this basis, works which accord with the environmental outcomes would be undertaken 24 hours per day, 7 days per week. This approach would minimise the period of construction and disruption to nearby residents, the travelling public and businesses surrounding the Project. It would also facilitate the transport of oversize loads (such as the TBM), spoil and other materials or products on public roads outside of peak demand, the hours of which would be regulated by the Queensland Police Services, TMR and Brisbane City Council.

The transfer of spoil and other materials to and from site would occur predominantly along major roads designated under the Brisbane City Plan 2014. General construction on site (above ground) and haulage off-site has the potential to impact residents and the travelling public.

To manage these effects, working hours would be constrained and in addition to the controls proposed in **Chapter 4 – Traffic and transport** and **Chapter 11 – Noise and vibration**.

An overview of these limits particular to areas or aspects of the Project are provided in **Table 3-17**. Further details on construction working hours is provided in **Chapter 18 – Draft Outline EMP**.

Table 3-17 Construction working hours

Worksite	Surface works – standard hours*	Extended work hours	Managed works**	Spoil haulage and materials/ equipment delivery*
Southern Connection WS1-DP (west of rail), WS5-DP	Monday to Saturday 6.30am-6.30pm	For approved rail possession – 80 hours continuous work	24 hours, 7 days	Monday to Friday 6.30am to 7.00am 9.00am to 2.00pm 4.30pm to 6.30pm Saturday 6.30am to 6.30pm Sunday – No work
Southern Connection WS1-DP (east of rail), WS2-DP, WS3-DP, WS4-DP	Monday to Saturday 6.30am-6.30pm		24 hours, 7 days	24 hours, 7 days
Southern Connection WS1-DP (within rail)	Monday to Saturday 6.30am-6.30pm	For approved rail possession – 80hrs continuous work	n/a	24 hours, 7 days, except during peak traffic periods being Monday to Friday 7.00am – 9.00am 4.30pm – 6.30pm

Worksite	Surface works – standard hours*	Extended work hours	Managed works**	Spoil haulage and materials/ equipment delivery*
Woolloongabba Station WS6-WS	Monday to Saturday 6.30am-6.30pm	6:30pm- 10:00pm Monday to Friday	24 hours, 7 days	24 hours, 7 days, except during peak traffic periods being Monday to Friday 7.00am – 9.00am 4.30pm – 6.30pm,
Roma Street and George Street stations WS7-GS, WS8-RS, WS9-RS, WS10-RS, WS11-RS, WS12-RS	Monday to Saturday 6.30am-6.30pm	6:30pm- 10:00pm Monday to Friday	24 hours, 7 days	Monday to Friday 6.30am to 7.00am 9.00am to 2.00pm 4.30pm to 6.30pm Saturday 6.30am to 6.30pm Sunday – No work
Northern Connection WS13-VP, WS14-VP, WS-15H, WS16-H	Monday to Saturday 6.30am-6.30pm	For approved rail possession – 80hrs continuous work	24 hours, 7 days	Monday to Friday 6.30am to 7.00am 9.00am to 2.00pm 4.30pm to 6.30pm Saturday 6.30am to 6.30pm Sunday – No work

** Note: works may be undertaken outside of these hours in the following special circumstances:*

1. *Works undertaken within a rail corridor or road reserve that cannot be undertaken reasonably nor practicably during standard hours due to potential disruptions to rail operations or peak traffic flows.*
2. *Works involving the transport, assembly or decommissioning of oversized plant, equipment, components or structures.*
3. *Emergency works to avoid the loss of lives, damage to property or to prevent environmental harm.*
4. *Materials and equipment deliveries include the delivery of 'in time' materials such as concrete, hazardous materials, large components and machinery.*

*** Managed works are those works carried out sub-surface or within an acoustic enclosure or shed, and which meets environmental goals.*

3.7.6 Material and equipment

Bulk quantities of materials would be required to construct and build the Project. Similarly, large amounts of spoil resulting from the excavation of the tunnel and station and waste would be produced during construction. The following sections provide an overview of these materials, their source, movement and disposal methods, as appropriate.

Type

Construction and building

Bulk materials including concrete, steel, aggregate, bitumen, timber, soil, plants and water would be required to facilitate civil and building work. This would include raw materials for fabrication and use on site as well as units that would be pre-formed off-site.

These materials would be used to establish temporary and permanent works for:

- retaining (soldier piles and formwork as well as decks, floors and walls)
- stabilising (aggregates and cements for backfilling and grouting)
- access (road base and wearing coarses and rail ballast)
- drainage (concrete for kerb and channel)
- landscaping.

Proprietary units would be used primarily in the construction and building of permanent works. This would relate predominantly to pre-cast, formed or fabricated items for:

- retaining (concrete tunnel rings, tilt slabs and deck units)
- drainage (pipe and box culverts)
- access (rail track, concrete sleepers, lifts and escalators)
- power (ventilation, masts, lighting, control systems)
- safety (cladding, glass panels, guardrails, signals, signs and lighting).

Spoil

Construction of the Project's tunnel, dive structures and stations require the excavation of insitu material. In the majority, this material is clean and retains properties suitable for construction. Projected quantities from the reference design indicates that approximately 1.78 million bank cubic metres of spoil would be generated (refer to Table 3-18).

This would occur throughout the earlier stages of construction, that being years one to three. Internally, excavated material would be lifted from the area of excavation to the surface via excavators, cranes and conveyors. The spoil would be temporarily stored and loaded at the worksite, ready for transport to the spoil placement sites.

Table 3-18 Approximate spoil quantities

Worksite location	Spoil quantity			Haulage rate*	
	Volume (m^3)	Average rate (m^3/week)	Peak rate (m^3/week)	Average rate (trucks/day**)	Peak rate (trucks/day)
Southern Connection					
WS1-DP (west of rail)	123,500	9,360	16,167	22	60
WS1-DP (east of rail)	922,600	35,737	107,210	84	194
Woolloongabba Station	217,900	5,956	20,350	14	41
George Street Station	263,900	10,636	17,017	25	40
Roma Street Station	185,300	5,105	18,719	12	44
Northern Connection	67,800	9,360	9,785	22	23

** Average estimated density of insitu material 2.42 tonnes/m^3 with the maximum capacity of a Truck & Dog being 29.3t*

*** one way trip*

Equipment and machinery

Heavy equipment and machinery would be required to construct the Project as depicted in **Table 3-19**. This would include a variety of commonly used civil construction plant as well as specialised underground tunnelling equipment. With the exception of road registered vehicles, all plant would be trucked to the relevant worksite.

Table 3-19 Anticipated construction equipment and machinery

Area	TBM	Road Header	Drilling Rig	Piling Rig	Cranes	Front end Loader	Excavators	Scissor Lifts	Compressors	Generators	Pumps
Southern Connection	1	2	2	4	7	9	13	6	5	5	4
Woolloongabba Station		2	2	2	3	4	4	4	2	2	4
George Street Station		2	2	2	3	4	4	4	2	2	4
Roma Street Station		2	2	2	3	4	4	4	2	2	4
Northern Connection	*	1	1	3	6	6	8	5	4	4	4

** – a second unit may be utilised.*

Source

Equipment and machinery, as well as raw building and civil materials would be sourced through a range of local, state and national suppliers. Specialised machinery such as the TBM would be sourced through an international supplier.

Aggregates would be required for use in the busway and rail ballast, as well as general construction. Sands and soil would also be used in grouts, backfilling and landscaping. Collectively, these materials would be sourced from local quarries, such as Narangba, Stapylton, Mount Cotton and/ or Ferny Grove.

Transport

Construction of the Project requires a large amount of equipment and material transported to each of the worksites over the course of the five year construction period. Further detail on the transport of equipment and material is provided below.

Spoil

Multiple options to transport spoil have been considered, including road, rail and water. An overview of these options and the preferred approach is provided below.

Rail

Transport by rail would require extensive land bases at either terminus for the loading and unloading of spoil (onto trains) stored in sidings. Apart from the Normanby Yard adjacent to Victoria Park, there is no other location in the inner urban rail network which has sufficient land accessible to the rail corridor for spoil loading and materials unloading. Similarly, only two of the nominated spoil sites (Swanbank, Port of Brisbane) have rail handling facilities. While there would be capacity at Swanbank, the Port facilities are heavily used for the handling of bulk commodities.

Rail would only service one worksite (namely that for the TBM) due to the location of the existing network. If rail was to be used, approximately half of the total spoil volume to be removed from the Project would still require transport by road. Transport by rail would also requires 'slots' in the operating rail network. At present the network is heavily committed during day-time hours, potentially limiting the movement of spoil to the night.

Water

Transporting spoil and materials by barge would require wharf, loading and unloading facilities at both ends of the single route. Apart from the unavailability of suitable land, the loading facilities would need to avoid the risk for spills into the river. The unloading point would either be the end-point for spoil, or would involve further handling to transport spoil to the final placement site. This would be costly and inefficient.

Transport by barge would be slow and would lack the flexibility offered by road, and would be less flexible than a rail-based option. The transport of spoil from worksites distant to the wharf would also require the use of trucks on road.

Road

Spoil and the transport of materials is undertaken conventionally by road, due to the flexibility and low costs involved relative to other modes. Road transport for the Project would involve more direct interaction with other road users and the wider community, increasing the potential for adverse impacts.

Preferred Option (Road)

Spoil from the Project would be transported to the placement sites by road. Project delivery time, overall quantity of spoil and the relatively small worksites associated with the Project requires regular removal of spoil to these areas.

The transport of spoil would be undertaken regularly throughout construction. This ensures more constant, but less intensive periods of movement. To achieve this, spoil would be transported to placement sites for re-use through periods of the day and night, seven days a week. These times would be considerate of peak traffic periods and the need for people to rest. On this basis, the transfer of spoil would align with Project working hours and the environmental outcomes for noise and traffic.

Further detail on these aspects is provided in **section 3.7.5**, **Chapter 4 – Traffic and transport** and **Chapter 11 – Noise and vibration**.

Construction and building materials

Materials for general construction and building would be delivered by road vehicles that include concrete mixers, cement bowsers, semi-trailers, rigid platforms and vans. During fit-out, light vehicles would be more common, delivering smaller specialist loads to each of the worksites. Projected forecasts of these vehicles travelling to and from the Project worksites are provided in **Table 3-20**.

Table 3-20 Materials deliveries by road

Element	Vehicles / day	
	Average rate	Peak rate
Southern Connection	31	67
Woolloongabba Station	12	14
George Street Station	10	10
Roma Street Station	12	14
Northern Connection	12	14

Equipment

Heavy equipment and machinery would be transported to worksites using road registered trucks and trailers. Were required, oversized loads would be escorted with the required number of haulage pilots and Police. Oversized load movements to worksites are likely to occur at times when they would cause the least disruption to local traffic i.e. night time and/ or weekends.

Placement sites

Spoil and a variety of wastes would be produced during construction of the Project. Efforts to avoid and or re-use these materials would be undertaken, with the remainder transferred to off-site facilities for disposal.

Waste

General building and construction waste from the Project would be recycled or disposed. Commercial operators would collect and transfer the material to appropriately licenced facilities. Dependant on the type of waste and demand for recycled materials this may include:

Recycling

- Chandler Transfer Station, Tilly Road, Chandler
- Ferny Grove Transfer Station, Upper Kedron Road, Ferny Grove
- Nudgee Transfer Station, Nudgee Road, Nudgee
- Willawong Transfer Station, Sherbrooke Road, Willawong.

Disposal

- Rochedale Landfill, Rochedale
- Swanbank Waste Management Facility, Swanbank
- Ti Tree Bioenergy facility, Willowbank
- Larapinta, Paradise Road
- Port of Brisbane, Port Drive.

Spoil

Significant volumes of spoil (1.78 million bank cubic metres) would be generated during tunnel and station cavern excavations. This material may be transported to a number of spoil placement sites; including:

- Brisbane Airport (Lomandra Drive and Sugarmill Road)
- Swanbank, Swanbank Road
- Pine Mountain, Pine Mountain Road
- Larapinta, Paradise Road
- Port of Brisbane, Port Drive.

Approval to use the spoil at these sites is not sought as part of this assessment. If required, these approvals would be sought by the relevant landowner or developer.

An assessment and subsequent ranking of the preferred spoil placement sites has been undertaken (refer to **Table 3-21**) based on a number of criteria. This includes the general availability and size of land, retained environmental value, haul route length and the proximity of sensitive receptors.

Although five placement sites are proposed, not all sites may be used during construction. Contingency is provided in the event that commercial or environmental reasons require adjustment.

Table 3-21 Spoil placement site selection

Transfer Site	Distance – return trip (km)	Land availability	Sensitive receptors	Sensitive environment	Cultural Heritage	Environmental Values	Haul Route function / capacity	Haul distance
Brisbane Airport	40	Low	Low	Medium	Low	Low	Low	Medium
Swanbank Enterprise Park	75	Medium	Low	Low	Low	Low	Low	High
Pine Mountain Quarry	20	Medium	High	Low	Low	Low	Medium	Low
Larapinta	60	Medium	Low	Medium	Low	Low	Low	High
Port of Brisbane	65	Medium	Low	Medium	Low	Low	Low	High

Low constraint   Medium constraint   High constraint

Haulage routes

Spoil and material would be delivered to and from the work sites on pre-determined, designated transport routes. The objective of these routes is to facilitate construction in a manner that is efficient and with a minimum disruption and inconvenience to the public. Short routes on arterial roads have been selected in the attempt to avoid residential areas. Further detail on the likely routes for spoil haulage is provided in **Chapter 4 – Traffic and transport**.

3.7.7 Interface with existing operations

Large sections of the Project works would occur off-line from current rail and busway operations. As an augmentation, connections would be required at the northern and southern extents of the Project. Safety and service continuity are primary considerations during these connections. During construction this would be achieved through:

- staged and coordinated night time and weekend closures supported by rail-bus replacement services for rail and minimal alternative diversions for bus
- longer closures limited to periods of significantly lower demand such as Christmas and Easter holiday periods
- closures to avoid major sporting and cultural events (concerts, international or finals sporting matches, Riverfire, etc.)
- where possible, utilise temporary diversion of services to alternative platforms within the same station facility
- no material change to the passenger (bus and rail) and freight rail timetable (except as above).

3.8 Operation

Based on current operations, the Project would be managed by TMR, Translink and the Queensland Rail Statutory Authority. Existing operating systems are to be complemented with new procedures specific to the Project. Activities undertaken during this phase would include testing and commissioning, service delivery and maintenance.

3.8.1 Overview

Testing and commissioning

Extensive inspections and testing would be undertaken on all tunnel facilities and associated infrastructure prior to commissioning. This would ensure that as-built infrastructure and operating systems (such fire and life safety, busway and train control) are complete and meet the required standard for operation. Integration with existing busway and rail networks would also be confirmed prior to opening. This work would be undertaken by accredited bodies within and external to the asset owner and operator.

Upon satisfactory completion of all commissioning tests, the Chief Executive, Department of Transport and Main Roads would advise the Coordinator-General that the Project had been delivered in accordance with Project conditions, and is to commence operations on a nominated date. Further detail on testing and commissioning is provided in the following sections.

Busway and rail

Safety audits of busway and rail assets would be undertaken as part of commissioning. This would include an inspection of constructed infrastructure and its compliance with detailed design. Operational systems such as signals and signage would also be tested and trialled.

Stations

Station infrastructure and associated operating systems such as fire and life safety, security and CCTV cameras, ventilation, passenger control would be inspected, tested and trialled prior to opening. This would include general tests for reliability and function as well conducting ‘mock’ emergency situations to test the systems in real time.

Operating and emergency plans for the Project are to be reviewed and staff trained in their operational roles and responsibilities. Commissioning is progressive and would be undertaken over a period of three to six months.

Tunnel

The fire and life system training would extend to the tunnel system. Ventilation system operation and smoke testing would be undertaken during commissioning to ensure adequate operation of all ventilation in all tunnel systems. A mock evacuation of a vehicle in a mid-tunnel section may form part of the emergency procedures check prior to final project commissioning, certification and handing the asset over to the final owners.

Rollingstock

Testing of the signaling, control and train protection system (ETCS) would be undertaken to ensure reliability during operation. This includes extensive on board tests and reviews of the interface with Queensland Rail Statutory Authority's existing signaling system.

Driver training

Driver training is an essential part of commissioning activities. Extra training would be undertaken due to the substantially different nature of the driver environment compared with the existing suburban rail and busway network. Drivers are to be trained in underground operation, the new route and the particular station interfaces.

Service delivery

Service plans for both busway and rail in 2021 have been developed. These would be reviewed and confirmed closer to the time of operation and prior to service delivery.

Rail

On commissioning of the Project, a new rail operating sector would be created, connecting the southern lines through the new corridor to Roma Street as shown in **Figure 3-25**.

This would provide new rail network capacity, allowing for an increase in the number of peak-direction services across the Brisbane River beyond the current limit of 24 trains per hour per direction as limited by the Merivale Bridge to and from the southern line.

Figure 3-25 Potential 2021 rail service plan upon commissioning of the Project

Busway

Increases in the frequency and destination of services would be provided upon opening of the Project. This would result from the provision of new routes and the amendment of others. Surface services on CBD streets would also reduce, reducing traffic congestion while improving pedestrian capacity and urban amenity.

The new busway would complement the South East Busway and Inner Northern Busway by offering a second high-standard path of travel for buses through the city centre. The Project is more direct to the city and has less intersections and stations when compared with the South East Busway and Inner Northern Busway, and therefore offers fast, reliable and direct service to and through the city centre.

Conversely, the existing busways offer a closer station spacing and wider coverage of non-CBD destinations. These complementary differences offer the opportunity to use the Project and South East Busway/ Inner Northern Busway in combination to provide two access paths through the city for services from high frequency corridors across the network. In many of the main catchments currently served by high frequency bus routes, users would therefore have the option of travelling either via the Project or the existing inner city busways depending on their destination.

Figure 3-26 depicts the (conceptual) bus service plan adopted for 2021, showing the key corridors with services utilising the Project tunnel. While the detail within the service plans may change in response to ongoing development of network, infrastructure and operational strategies, the broader approaches and principles would remain in place.

Figure 3-26 Potential 2021 bus service plan upon commissioning of the Project

New routes

While the Project opens up further opportunities for travel within the inner city, for example from Woolloongabba to George Street, it is expected that forecast population and jobs growth within the inner city will drive the need for further 'distributor' style services.

As part of the Project (conceptual) bus service plan, two new inner-city CityGlider-style services (Northshore – Mary Street and West End – Mary Street – New Farm) were also developed as potential connections. These services would both interface with the George Street Station to provide access between the BaT project corridor and locations such as Eagle Street and the Cultural Centre. They would also provide an alternative east-west corridor through Brisbane CBD, relieving pressure on Adelaide Street based inner-city distribution services.

For rail, the new sector (refer to **Figure 3-25**) would allow for the introduction of three-tier operations on the southern rail corridor, consisting of:

a) **Varsity Lakes express services via the Project**

The existing Gold Coast express patterns would operate via the Project, stopping at all-stations to Beenleigh, then only at key interchange stations at Loganlea, Altandi and Dutton Park.

Services would then run via the new the Project alignment, stopping at Woolloongabba, George Street and Roma Street stations.

b) **Helensvale limited express services via the Project**

A new tier of express service would be introduced from Helensvale to assist in catering for the strong growth in demand from the Gold Coast, operating express from Kuraby stopping only at key interchange stations to the Project. Services would then run via the Project, stopping at Woolloongabba Station, George Street Station and Roma Street Station.

Under this operating plan, four express services per hour would be provided at stations between Beenleigh and Helensvale to the inner city via the Project. The express operation would provide a substantial improvement in travel time to the city for stations between Beenleigh and Kuraby.

c) **Kuraby all-stations services via South Brisbane**

A third tier of operations providing all-stations services would be introduced via the existing surface network to provide connectivity between the Gold Coast and the Southbank precinct.

The 15 minute frequency (introduced in the 20 January 2014 timetable) between Coopers Plains and the city (via South Brisbane) would be extended to Kuraby.

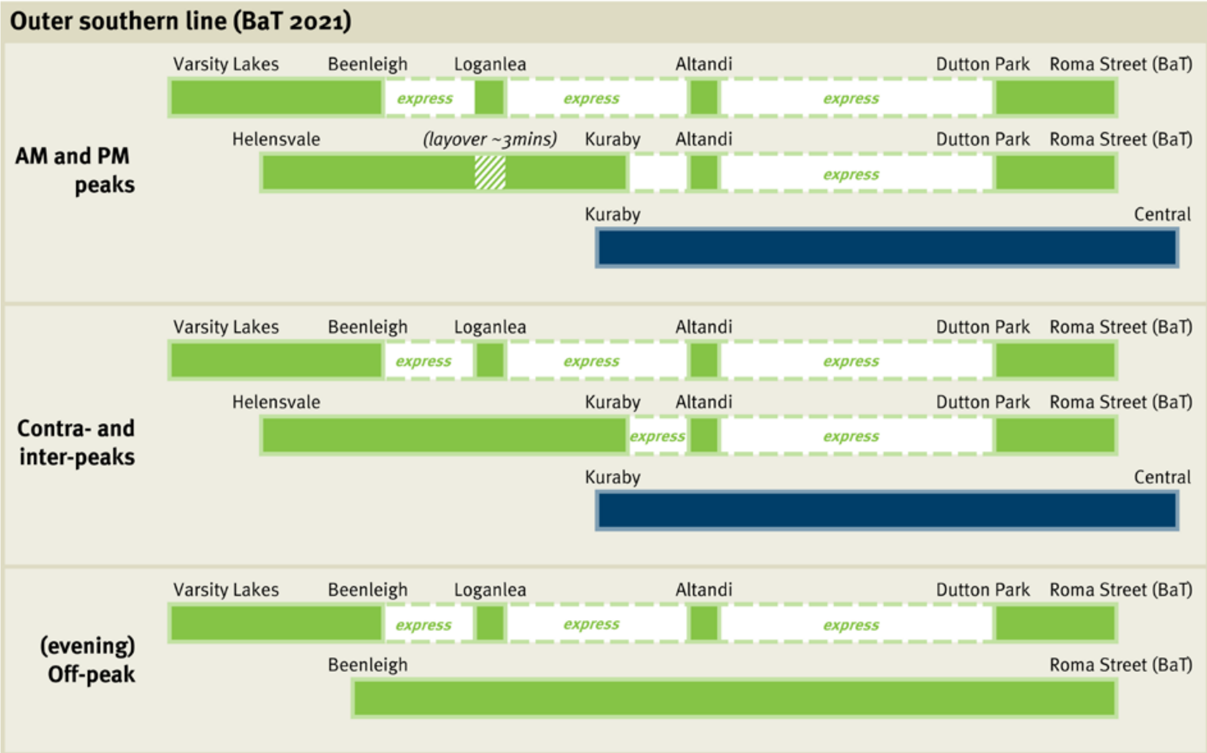
Provision of an interchange stop on the express lines at Altandi and Dutton Park would allow passengers to transfer between surface all-stops services and the Project express rail services. Bus connections at Roma Street Station and Woolloongabba Station would also provide additional transfer opportunities for the express services operating with the Project in place.

Maintenance

Suitable provision would be made for asset management and maintenance activities including cleaning and repair, delivery of supplies and provisions, inspection and certification. Wherever possible, planned or unplanned management and maintenance activities would occur outside operational hours to allow station operations to be maintained. This may include providing for out of hours access to the tunnel for specific vehicles.

All bus drivers operating on the Project would require training and accreditation and appropriate authorisation. Any person driving another vehicle onto the busway (e.g. for maintenance) will require specific induction and accreditation, as well as specific authorisation from the busway operator.

Figure 3-27 Southern corridor rail operation upon Project commissioning



3.8.2 Process and program

Operation of the Project would involve a number of public and private transport bodies. Existing systems developed by these entities are to be amended and applied to the Project. This would ensure that the asset is maintained and utilised to its full potential.

The following section provides an overview of these bodies and their systems.

Process

Transport assets and associated services within South East Queensland are owned and administered by a number of authorities.

Asset owner

The State of Queensland (through TMR) would be the asset owner upon opening. On this basis, the TMR is the primary entity responsible for coordinating overall management. The Project would be managed in accordance with internal procedures.

Service providers

Bus, train and ferry services across South East Queensland are coordinated by Translink. Aspects of the service are sub-contracted to Queensland Rail Statutory Authority and a number of bus operators, including Brisbane Transport. Queensland Rail Statutory Authority is the current railway manager of train services for the City Network while Brisbane Transport is the principle operator of buses in the Brisbane metropolitan area. These roles and responsibilities would extend to the Project upon commissioning.

Rolling stock and fleet

Trains operating through the Project would be controlled from Queensland Rail Statutory Authority's centralised train control centre (Mayne Control). Additional integrated management prior to commissioning would be used in the control of train route setting and signals, service regulation, driver communications as well as co-ordination with train-crew and station management.

Buses would be managed through the AC System, allowing continuous supervision while in transit. Reports via global positioning systems would permit the BMTMC to determine and subsequently manage the entry and exit of buses through the tunnel. This real time information allows for active management, adjusting the schedule and managing buses approaching and entering platforms to improve operations and reliability for bus passengers.

The management of passengers 'on-vehicle' would be managed by the driver/ train crew, assisted by platform staff or others at stations as required. They would continue to be responsible for:

- safe operation of the vehicle
- on-board security responsibilities (within the code of conduct and agreed procedures)
- direct vehicle operations, control and management
- on-board revenue protection procedures
- on-board passenger conduct
- first response incident management and safe passenger evacuation off-bus to a suitable place of refuge
- assisted boarding and alighting.

Workforce

Additional workers would be required to support the new services facilitated by the Project. This relates predominantly to the operation of stations, rail rolling stock and the bus fleet.

An overview of the workforce required during operation is provided in **Table 3-22**.

Table 3-22 Indicative operational workforce

Role	Activity	Staff
Commissioning	Track	5
	Signals	5 to 20
	Power	5
	Telecommunications	4
Total		19 to 34

Role	Activity	Staff
General operations	Station management	2 (per shift)
	Platform staff (bus and rail)	6 (per shift)
	Ticketing	2 (per shift)
	Train (driver and guard)	2 (per shift)
	Bus (driver)	1 (per shift)
	Maintenance inspections	2
	Track grinding	2
Total		17

Excluding maintenance and track grinding, the additional peak number of workers anticipated to be required during general operation of the Project would be approximately 55 staff.

Program

The intended design life of the Project is in excess of 100 years for structures and 40 years for buildings. Programmed maintenance and progressive upgrades during and beyond this time is anticipated to see the serviceability of the Project extended.

Key stages of the program for operation include testing and commissioning, service provision and maintenance is shown in **Table 3-23.**

Depending on need, bus and rail services are forecast to operate 20 hours per day, seven days a week. Public access to the stations would align with this period while operational and maintenance staff would require access 24 hours a day, seven days a week.

Table 3-23 Initial five year operational program

Activity	2020				2021				2022				2023				2024			
Testing and commissioning		■	■	■																
Driver training			■	■																
Service provision			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Programmed maintenance								■				■				■				■

3.9 Summary

South East Queensland's population is forecast to grow significantly by 2031. Demand for public transport would also rise, with an additional 900,000 bus and rail trips starting, finishing or travelling through the inner city of Brisbane. Critical linkages in the public transport network are experiencing capacity pressures from current demand, with consequences for travel time reliability, travel flexibility and passenger comfort and safety.

These constraints include the Merivale Bridge, being the single access for rail travel to the central city from the south and east, and the Cultural Centre Busway Station and Victoria Bridge, being the principal accesses for bus travel to the central city also from the south and east. Additional infrastructure is required to alleviate current constraints and network congestion and to accommodate this demand and maintain network reliability.

The Project is a dedicated bus and rail crossing of the Brisbane River. In built form, it would combine rail and busway in a single, double-decked, 15m wide tunnel beneath the Brisbane River and the Brisbane CBD. The 6.7km link stretches from Dutton Park in the south to Spring Hill in the north with new underground stations at Woolloongabba, George Street and Roma Street. Once constructed, the Project would improve the level of service, ensuring the region's passenger transport network is attractive, resilient and able to cater for future demands.

The Project alignment and depth is constrained by the limitations of rail (maximum horizontal and vertical gradients) as well as geological conditions, the Brisbane River and the depth of inner city basements. Impacts on people and property would be reduced with the majority of infrastructure located below ground, avoiding the need for the extensive resumptions of private property possibly required for similar capacity augmentation delivered on the surface. Stringent standards for design would also be applied, ensuring safe, reliable forms of public transport.

During construction, surface work would be limited to discrete locations for periods up to but mostly less than five years. Excavation and the loading of spoil would occur within purpose built sheds or enclosures to minimise noise and dust impacts for near neighbours. Designated haul routes based on the arterial road network would also be used for transporting spoil and construction materials, further reducing the potential for impacts. This overall approach would see the majority of work occur below ground, minimising disruptions to business and the general community.

Commissioning of the Project is planned to occur by 2021. The long terms benefits of reduced wait and trip times, more frequent and direct options for travel and less crowding would be experienced for the population residing mostly to the south and east of the Brisbane CBD over the life of Project. Connectivity to the Brisbane CBD and tertiary level services in administration and commercial services, education, health care, entertainment and retailing across the South East Queensland Region, and particularly in its central and southern sub-regions would be greatly enhanced. There would also be enhanced accessibility and mode choice for people moving around within the Brisbane CBD, due to the George Street Station and the opportunities available for interchanging at both Roma Street and George Street.