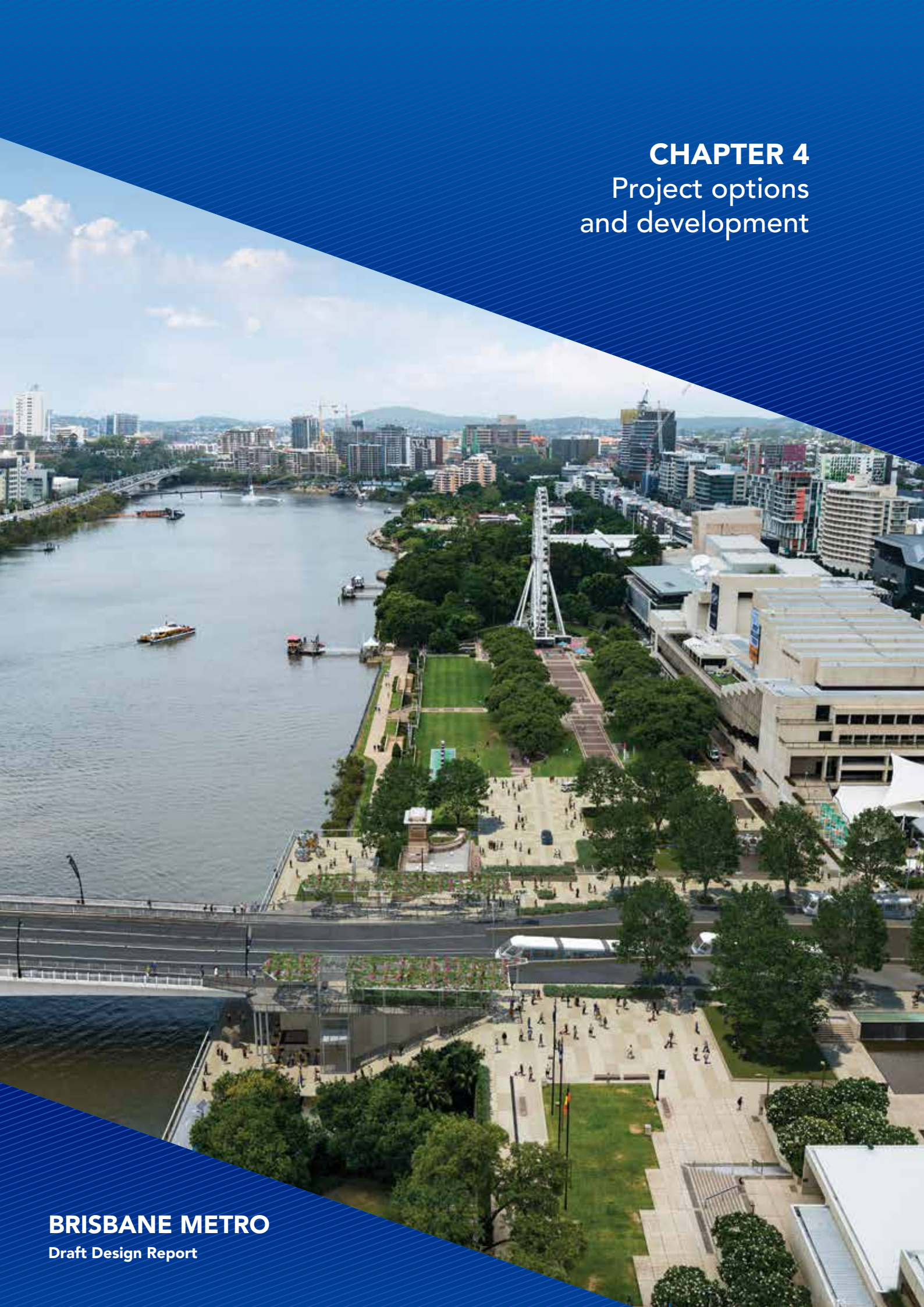
PART B
Concept Design

CHAPTER 4
Project options and development



BRISBANE METRO
Draft Design Report

Contents

4. Project options and development

This chapter provides an overview of the project options and development of Brisbane Metro. It describes the process used to identify and assess possible project options and determine the preferred option, as well as the development of various elements for the concept design.

4.1 Project objectives

Council identified a set of strategic objectives to guide an integrated approach to the delivery of Brisbane Metro. These included:

- delivering high-frequency 'turn-up-and-go' services
- increasing the capacity of the busway network
- reducing bus congestion on the busways in the CBD and inner city
- reducing the number of buses in the CBD
- improving travel times and reliability
- freeing up buses to allow for more services in the suburbs.

For the options assessment, criteria were designed to achieve optimal outcomes for the customer, city and place based on the strategic objectives.

- Customer: supporting easy journeys – a high-quality customer experience that puts the customer at the centre of planning and service delivery for making the customer's journey as easy and comfortable as possible.
- City: a catalyst for shaping new growth – Brisbane's growth and economic development ensures it will become a competitive, New World City; providing a highly-desirable lifestyle, encouraging business innovation, creativity and entrepreneurship and positioning the city as a world-class destination for business, investment, tourism and talent attraction.
- Place: creating memorable places and spaces – ensuring inner Brisbane's amenity and liveability is underpinned by an interconnected network of memorable places and spaces that are attractive and provide safe and convenient accessibility, promote walking and cycling, and contribute to the city's identity and reputation.

In addition to the above objectives and criteria, Council seeks to understand community and stakeholder views and concerns, and provide stakeholders with an opportunity to contribute to the development of Brisbane Metro.

4.2 Project options

4.2.1 Options assessment framework

Brisbane Metro has been developed in accordance with the objectives and goals of a range of policies and frameworks for prioritising significant infrastructure projects. A number of these policies outline the development and prioritisation of project options. The Queensland Government's *State Infrastructure Plan* presents an options assessment framework, with the purpose of prioritising infrastructure investment and filtering infrastructure related investment decisions across government[1]. An overview of the Queensland Government options assessment framework is provided in Figure 4.1. This is consistent with the strategic options development stage outlined in *Infrastructure Australia's Assessment Framework*[2], which seeks to develop and describe a range of solutions that have the potential to address problems and achieve desired outcomes.

The options analysis process for Brisbane Metro is based on the Queensland Government options assessment framework. Identified options were sorted into four categories – reform, better use, improve existing and new. This aligns with Infrastructure Australia's strategic options development, which encourages the identification and

[1] DILGP (2016) *State Infrastructure Plan, Part A: strategy*, March 2016
[2] Infrastructure Australia (2017) *Assessment Framework: for initiatives and projects to be included in the Infrastructure Priority List*

consideration of reform and better asset use options through technologies and integrated systems that drive greater efficiency of infrastructure and provide flexible, customer-focused solutions[3].

Figure 4.1: Queensland Government options assessment framework

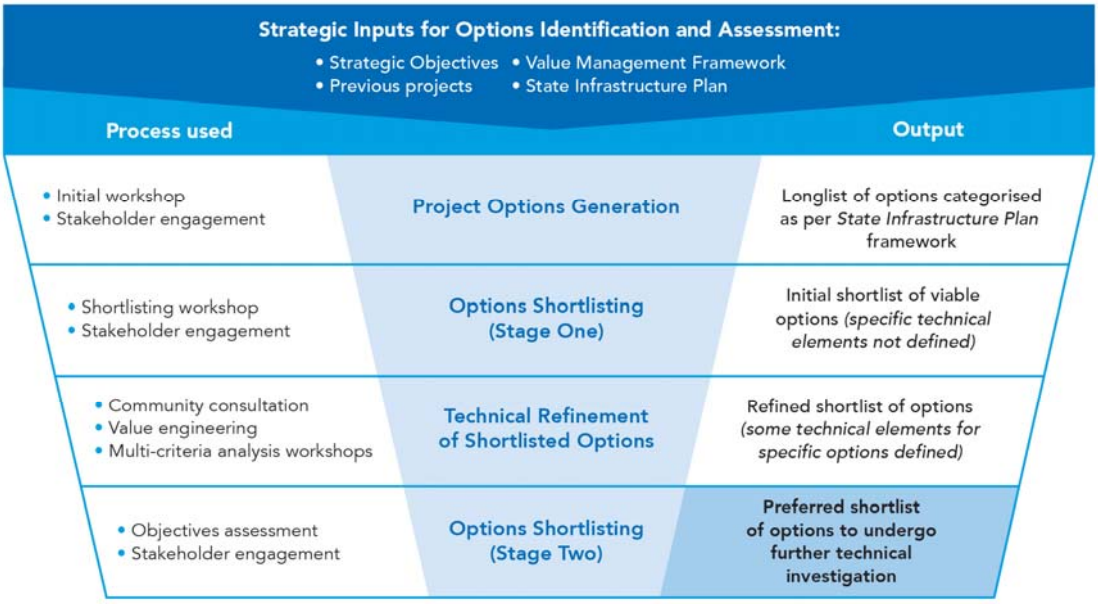
4.2.2 Options analysis methodology

A value management framework was also adopted to guide the identification and assessment of project options. Value management is a structured and analytical process that defines a project's needs and its delivery strategy to achieve a 'best value' approach for decision making. Value management principles are stated in Australian Standard *AS 4183-2007 Value Management*. The Australian Standard identifies four key phases that have formed the backbone of the value management framework (refer to Figure 4.2) for Brisbane Metro.

- Goal definition and problem identification – determine key outcomes, problems, constraints, opportunities and establishing cause and effect relationships between the identified problems.
- Stakeholder analysis – identify and describe potential key stakeholders.
- Options generation – encourage creative thinking and engage project stakeholders to convert identified problems into innovative solutions.
- Options assessment – evaluate each generated solution to determine the most effective implementation strategy.

The value management framework was used to identify and assess possible options available for Brisbane Metro. The methodology process summarised in Figure 4.2, includes the identification and shortlisting of options through workshops and multi-criteria analysis.

Figure 4.2: Options analysis process



[3] Infrastructure Australia (2017)

4.2.3 Options analysis outcomes

Project options generation

A number of 'project options generation' workshops were conducted to identify the broad range of project options. The workshops involved various stakeholders and Council representatives and resulted in the identification of a 'long list' of options for further review.

The identified options were reviewed and revised to determine the initial project options. These are presented in Figure 4.3. These were classified as either pre-existing options (i.e. those that had been previously identified and investigated), new options, and other options. These were further categorised in accordance with the Queensland Government options assessment framework (i.e. reform, better use, improve existing and new).

Figure 4.3: Initial project options

Reform	Better Use	Improve Existing	New
Pre-Existing Options			
Nil	• 2013 SEQ Bus Network Review • Brisbane Inner Rail Solution	Nil	• Suburbs 2 City Buslink • Bus and Train Project
New Options			
Nil	• Rail operational initiatives – sectorisation, timetable reviews, dwelling time management • Council's 10 Point Plan (public transport alliance model)	• European Train Control System (ETCS) between Northgate and Milton rail stations	• Minimal Bus Infrastructure upgrades • Brisbane Metro (as publicly announced in January 2016) • Cross River Rail
Other Options			

Nil	• Policy Options
	  ○ Multi-door boarding
	  ○ Wider/more doors
	  ○ Off-vehicle transactions
	• Bus Rapid Transit
		• Enhanced Glider options	• Light Rail options

Options shortlisting (stage one)

Using a 'best for project' approach, the initial project options were reviewed to determine those that best achieve a balanced and favourable outcome against the strategic objectives. The following provides a summary of the key outcomes from the options shortlisting process.

- Bus network reform and boarding efficiency measures alone will not meet the long-term future public transport demand without major infrastructure investment. However, they should be considered further as service enhancements to support an ultimate project solution.
- Improved CityGlider services alone will not meet the long-term future public transport demand without major infrastructure investment. However, they should be considered further as service enhancements to support an ultimate project solution.
- Bus rapid transit on an extended busway network could potentially meet the future public transport demand. This would require major infrastructure investment and new fleet, and should be considered further.
- Light rail transit on a dedicated alignment could potentially meet the future public transport demand. This would require major infrastructure investment and new fleet, and should be considered further.

- A metro system on a dedicated alignment, such as Brisbane Metro, was considered likely to meet the future public transport demand. This is most likely to be viable if existing infrastructure can be repurposed, and should be considered further.
- A variant of the S2C Buslink option, which includes repurposing Victoria Bridge as a green bridge, was considered likely to meet the future public transport demand. This will require major infrastructure investment and a new fleet, and should be considered further.
- The previously investigated BaT project option was considered likely to meet the future public transport demand. The Queensland Government has replaced the BaT project with the proposed CRR project, although it was determined the BaT project option should be considered further for comparative purposes.
- Queensland Government projects such as ETCS – Inner City and the proposed CRR project should be considered during the development of Brisbane Metro. However, a solution that addresses the critical bus problems is still required in addition to these projects.

Six options were shortlisted through the options shortlisting (stage one). These are shown in Figure 4.4 and summarised in Table 4.1.

Figure 4.4: Initial options shortlist (stage one)

Table 4.1: Description of initial options

Category	Description
Better use/improve existing/build new options	1. Brisbane Metro Subway System option – this comprises the initial Brisbane Metro option announced in January 2016 – using Victoria Bridge with a new tunnel in Adelaide Street, an underground station at the Cultural Centre precinct and stabling/maintenance at Woolloongabba.
	2. Bus rapid transit option – this option includes high-capacity vehicles, possibly bi-articulated, running on a dedicated path with station-style stops. The dedicated path would most likely need to be a separate dedicated way. Rigid buses running to logical nodes on the bus and rail trunk networks would serve the suburbs.
	3. Light rail transit option – this option includes light rail vehicles running the entire busway network with station style stops. Buses would run to logical nodes on the rail and light rail trunk networks to serve the suburbs.
Build new options	4. Minimal bus infrastructure upgrades option – this option includes a range of infrastructure augmentations to the existing busways and CBD bus tunnels.
	5. S2C Buslink option – this option is a variation of the original S2C Buslink option, repurposing the Victoria Bridge rather than constructing a new green bridge.
	6. BaT project option – this option is the BaT project option described in the 2014 BaT project Business Case jointly completed by Council and the Queensland Government.

Technical refinement of shortlisted options

Each of the initial shortlisted options were subjected to further technical review and refinement to better understand the key technical elements. This involved:

- generation and assessment of the key technical elements of each project option, through technical studies and an unweighted multi-criteria analysis
- additional generation and assessment of technical elements based on feedback received through community and stakeholder consultation, for input into a final weighted multi-criteria analysis.

In parallel to the refinement and analysis of technical elements for the initial Brisbane Metro option (Brisbane Metro Subway System), elements of other options (e.g. the bus rapid transit, minimal bus infrastructure and S2C Buslink options) were reviewed, to determine their feasibility as viable alternatives to the initial Brisbane Metro option. Preliminary analysis sought to understand:

- various elements of each option, including project alignment, terminus stations, and vehicle/rolling stock requirements
- the overarching operational impacts to the Brisbane bus network.

The preliminary investigations were informed by the outcomes and feedback received through community and stakeholder engagement, including community consultation undertaken between August and October 2016. The investigations determined that a suitable project solution, as an alternative to the initial Brisbane Metro option announced in January 2016, could be derived by combining various alignment and infrastructure elements of the S2C Buslink and minimal bus infrastructure options, with the high-capacity vehicles proposed for the Bus rapid transit option. This revised Brisbane Metro option was included in the 'revised options shortlist' for further consideration (refer to Table 4.2).

Table 4.2: Revised options shortlist (stage one)

Category	Description
Better use/improve existing/build new options	The initial Brisbane Metro option (Brisbane Metro Subway System announced in January 2016) – using Victoria Bridge with a new tunnel in Adelaide Street, an underground station at the Cultural Centre precinct, a multi-storey bus/metro interchange at Woolloongabba and a light maintenance depot at Herston (with additional stabling at Countess Street). Busway infrastructure will be repurposed to become a dedicated corridor to accommodate rubber-tyred metro vehicles between Woolloongabba and Herston. Bus services will be truncated at Woolloongabba and Herston for customers to transfer to the metro service to access the CBD. The initial Brisbane Metro option will deliver a 'turn-up-and-go' service with two minute frequencies in peak times, with an ultimate capacity to carry up to 25,000 passengers per hour per direction.
	Revised Brisbane Metro option, inclusive of elements from Bus rapid transit, minimal bus infrastructure and S2C Buslink options – this option includes high-capacity metro vehicles on the busway only. Some bus services will terminate at logical transfer locations for customers to transfer to a metro service, while services in other bus corridors (e.g. western and north-western) will continue to operate to the CBD. With the exception of tunnel and above-ground works around the Cultural Centre and Adelaide Street, the revised Brisbane Metro option includes repurposing sections of the existing busway corridors (e.g. the South East Busway, Eastern Busway and Inner Northern Busway). All stations, apart from the new underground Cultural Centre station, are existing public transport stops or interchanges. The new Cultural Centre station is as proposed in the initial Brisbane Metro option, providing a major bus, rail and metro interchange. Most stations will require either no changes, minor changes or increased platform lengths and other minor works to support the revised Brisbane Metro option. The revised Brisbane Metro option includes two metro-style trunk routes delivering high performing, high-capacity, and high-quality rapid transit services. The existing fleet will continue to run along the busway, with a busway management system in place in the future to ensure headways are achieved. The revised Brisbane Metro option will deliver a 'turn-up-and-go' service with peak services up to every 90 seconds and the capacity to carry up to 22,000 passengers per hour per direction (inclusive of metro and all other bus services).
	Light rail transit option – this option includes light rail vehicles running the entire busway network with station style stops. Buses will run to logical nodes on the rail and light rail trunk networks to serve the suburbs.

Category	Description
Build new options	BaT project option – this option is the BaT project option described in the 2014 BaT project Business Case jointly completed by Council and the Queensland Government.

Options shortlisting (stage two)

A final analysis process was undertaken for the revised shortlist of options to reduce the number of options. This involved assessing each option against the project objectives and goals. The shortlisting process identified two options that met all project objectives, namely the initial Brisbane Metro option) and the revised Brisbane Metro option. In particular, the two metro options were considered to address the 'customer', 'city' and 'place' objectives as well as community and stakeholder acceptance objectives.

The light rail option was considered to deliver positive outcomes against all objectives apart from 'customer', as this option would not be able to meet the required future capacity requirements. The BaT project option scored favourably against the 'customer', 'city' and 'place' objectives, as well as against the community acceptance criteria. However, this option scored poorly against stakeholder acceptance, given it has been replaced by the Queensland Government with the proposed CRR project. The BaT project option was also considered to not be cost-effective compared to other options, due to the volume of infrastructure works required.

The two options selected to undergo detailed technical analysis were:

- the initial Brisbane Metro option, with a number of technical elements refined from the initial announced project
- the revised Brisbane Metro option, with high-capacity metro vehicles, travelling between Eight Mile Plains, RBWH, and UQ Lakes.

For comparative purposes, the BaT project option was included in the shortlist of options to be further analysed due to its size and integrated transport solution. The revised options are shown in Figure 4.5.

Figure 4.5: Revised options shortlist

Preferred option selection

A detailed comparative analysis was completed for the three shortlisted options to select a preferred option for further analysis. Factors considered in the options analysis included:

- customer and product
- technical
- city and place
- environmental and social
- community consultation
- legal and risk
- cost analysis.

A multi-criteria analysis process was developed to assess the three shortlisted options. This was based on criteria generated by Building Queensland's Prioritisation Framework[4] for the purposes of prioritising Queensland Government projects, supplemented with additional criteria relevant to the technical analysis.

The revised Brisbane Metro option was identified as the preferred option through the multi-criteria analysis process, scoring highest against the criteria. In particular, it consistently scored higher than other options, rating first in 10 of the 14 criteria. The positive scores were largely due to superior customer and product outcomes, with the revised Brisbane Metro option scoring highest in all customer and product categories except for vehicles. This highlights that the revised Brisbane Metro delivers better operational and transport outcomes for the network compared to the other two options.

Design of the revised Brisbane Metro option was considered to be comparatively simple compared to the initial Brisbane Metro option and BaT project options, resulting in fewer constructability issues and avoiding adverse impacts triggered by the initial Brisbane Metro option. The revised Brisbane Metro also scored well in relation to environment and society, and will have a smaller number of key risks than the initial Brisbane Metro option and BaT project options. However, the revised Brisbane Metro option scored lower than the other options in relation to legal matters due to a higher number of likely regulatory requirements. The BaT project option ranked second and the initial Brisbane Metro option was ranked third.

Analysis of capital costs identified the revised Brisbane Metro option as being lower in cost compared to the initial Brisbane Metro option and BaT project options, due to the reduced new infrastructure requirements. The revised Brisbane Metro option also avoided capital costs required for the initial Brisbane Metro option; including track, power and traction and signalling. This is due to the different vehicles and the supporting infrastructure and systems required to support the operation of vehicles for the initial Brisbane Metro option. Furthermore, while the revised Brisbane Metro has a higher number of stations requiring upgrades, major infrastructure works to modify Woolloongabba and Herston into large metro interchanges are avoided. The BaT project was considered the most expensive option largely due to the extensive tunnelling requirements and new station construction works.

The operating cost analysis showed that the initial Brisbane Metro option has a far higher cost per kilometre, due to the range of ongoing operational costs that are not required under either the revised Brisbane Metro or BaT project (assuming bus operations only). These include maintenance of key power, track and signalling infrastructure, and maintenance of the rubber-tyred metro vehicles.

Overall, the detailed options assessment and cost analysis ranked the revised Brisbane Metro higher than both the initial Brisbane Metro option and the BaT project. The revised Brisbane Metro option was considered to meet the project objectives and addresses key strategic issues, while also being a more fiscally prudent solution compared to the other options considered.

Accordingly, the revised Brisbane Metro option was publicly announced in March 2017 as the preferred option. This is now known as Brisbane Metro and is the project assessed in this draft Design Report.

4.3 Design development for the Business Case and draft Design Report

Key elements of Brisbane Metro include the alignment being a dedicated and segregated route, reuse of the existing busway infrastructure (alignment and stations) and the use of Victoria Bridge (removal of general traffic).

Development of the Brisbane Metro concept design considered a range of different project element options. This process commenced with options investigation for the initial Brisbane Metro option, which considered the options for the alignment and infrastructure elements in South Brisbane and the CBD.

[4] Building Queensland (2016) Prioritisation Framework, June 2016

Additional element options investigated for Brisbane Metro related to:

- Brisbane Metro infrastructure, including the metro depot and new underground Cultural Centre station siting and design, layover and turnaround locations
- construction methodology at key locations
- metro vehicles, including fuel type.

4.3.1 Key infrastructure options

The concept development process for the initial Brisbane Metro option considered infrastructure options which were further investigated in the development of the Brisbane Metro concept design. These related to:

- the new Cultural Centre station
- arrangement of metro and bus lanes on Victoria Bridge and North Quay
- Queen Street bus station (QSBS) as an option to the Adelaide Street tunnel.

New underground Cultural Centre station

The existing surface Cultural Centre station is critically constrained by two closely spaced intersections immediately south of the station, being Melbourne Street and Grey Street and the Melbourne Street busway portal. These intersections limit the bus throughput of the station, constraining its overall capacity, and preventing any further growth in services through the station in peak hours.

Options were identified in terms of both underground and above-ground solutions including:

- underground station connecting the BCEC busway tunnel south of the Melbourne Street busway portal under the rail corridor, the property at 125 Grey Street and QPAC Green (part) and transitioning to the surface on Melbourne Street before Victoria Bridge (variations of the underground alignment were considered)
- an at-surface station on Melbourne Street between the Melbourne Street busway portal and Grey Street.

The at-surface option was not considered suitable as it did not provide a grade separated alignment. A grade separated alignment is crucial to achieving travel time savings. It relied on maintaining the Melbourne Street busway portal which did not address pedestrian, general traffic and surface bus conflicts. It was also very difficult to fit the station along Melbourne Street and across Grey Street in terms of:

- conflicts with buildings, open space and heritage values
- major changes to the surface through the provision of the station building
- impacts to surface traffic movements on Melbourne Street and Grey Street.

While the underground option was in a very constrained urban space in terms of the railway corridor, buildings, heritage considerations and utilities, it was identified as the preferred option. The new underground station at the Cultural Centre precinct will connect to a new section of dedicated and segregated busway connecting Victoria Bridge to the South East Busway bypassing the conflicts with the two intersections. It will allow for two new underground platforms serving South East Busway services (Brisbane Metro, BUZ, and Glider) and two new surface level platforms serving West End to the CBD and Fortitude Valley/New Farm services. It provides the segregated and dedicated station and alignment which will realise the project objectives around time savings, reliability and customer outcomes.

The proposed infrastructure changes will provide additional station capacity for both vehicles and passengers and enhance customer experience. In addition to crowding relief, customers that use the new underground Cultural Centre station will benefit from a modern station that includes a climate-controlled environment with platform screen doors and improved passenger information.

The underground solution also provides minimal permanent surface impact apart from the station entries and the transition structure along Melbourne Street to Victoria Bridge and removes the pedestrian and vehicle conflicts relating to the Melbourne Street busway portal.

The design development process took the underground station forward and investigated refinements in terms of alignment, changes to utilities and potential entry and exit points. Options were considered for the station entry and exit points at 125 Grey Street as well as the Queensland Museum forecourt and QPAC Green. Entry and exit points at 125 Grey Street were preferred as they supported the more significant pedestrian movements along Melbourne Street towards West End and South Bank. This location also will not permanently affect the heritage values and public spaces adjoining the Queensland Museum and QPAC.

Metro and bus lanes on Victoria Bridge and North Quay

The removal of general traffic from Victoria Bridge leaves four lanes available for metro vehicles and buses. Options were investigated to place the two Brisbane Metro lanes on the upstream side, the middle two lanes, or the downstream side. The consideration of these options were linked to the location of the transition structure at Melbourne Street and the surface bus stops at Melbourne Street, as well as the arrangements through North Quay towards the Adelaide Street transition structure.

To enable surface buses to run on the outside of Melbourne Street at the Cultural Centre precinct as well as on Adelaide Street between North Quay and George Street, the preferred alignment involves Brisbane Metro using the middle lanes from Melbourne Street, across Victoria Bridge and through North Quay. This will also allow outbound buses from QSBS to connect to Victoria Bridge without crossing the Brisbane Metro lanes.

Victoria Bridge pedestrian and cycle

Victoria Bridge is the primary pedestrian river crossing connecting the CBD to South Brisbane, and is heavily utilised at all times of the day by visitors and commuters. Council recognises the importance of this link to the future of the inner city.

The existing upstream and downstream pedestrian and cycle pathways across Victoria Bridge are currently congested. An existing 2.7-metre shared pathway (pedestrians and cyclists) is provided along the upstream side of the bridge and a 2.7-metre ‘pedestrian only’ pathway is provided on the downstream side. There is currently no weather protection provided on either side of the bridge. Dedicated one-metre wide, on-road cycle lanes are currently located adjacent to the general traffic lanes. The existing shared path on the upstream side of Victoria Bridge does not meet the minimum horizontal clearance requirements for either a cycle only path, shared path or segregated path.

Brisbane Metro will remove the dedicated on-road cycle lanes to provide space for four lanes for metro vehicles and buses and to prevent conflict between cyclists and buses. Victoria Bridge is not a major commuting cycling route with the key cycling routes into the CBD being Kurilpa Bridge and Goodwill Bridge.

An options analysis was conducted to assess potential pedestrian and cycle arrangements on Victoria Bridge for Brisbane Metro. This assessment focused on how to improve the existing Victoria Bridge arrangements recognising the project changes at North Quay and removal of on-road cycle lanes across Victoria Bridge.

Outcomes of this assessment proposed to widen the downstream footpath by 1.2 metres to increase pedestrian capacity. This will be achieved by narrowing the bus lanes, noting that the achievable width will depend on the final selected metro vehicle and its operational requirements. This will address medium-term capacity needs and pedestrian comfort. This will be facilitated by improved connectivity between Reddacliff Place and the downstream pathway. The downstream pathway also directly links to the entries for the new underground Cultural Centre station along the eastern side of Melbourne Street and across the proposed scramble crossing of Melbourne and Grey Streets.

No change is proposed to the upstream shared pathway and movements across North Quay towards the CBD. Further discussion on proposed options investigation for pedestrian and cycle access across North Quay is provided in section 4.3.2.

Adelaide Street and QSBS

Similar to the intersection constraints on the southern side of Victoria Bridge, bus movements are also constrained by the intersection capacities at North Quay/William Street/QSBS portal and Victoria Bridge. This intersection is complex with a number of conflicting traffic, pedestrian and bus movements causing significant delays and long queues of buses frequently occur – particularly during peak periods. This results in longer than scheduled bus journey times and poor journey time reliability.

Furthermore, the current route for buses from Victoria Bridge to King George Square station is via the existing Queen Street and Albert Street bus tunnels. The Queen Street bus tunnel itself suffers from peak period congestion as it is the terminus for over 30 services from the south, east and west. The station is constrained by the T-intersection at its northern end which allows northern through services to turn left (towards King George Square station) and terminating south, east and western routes to turn right (to access their set-down or pick-up bay). The intersection only allows one movement at a time due to width constraints, preventing simultaneous movements to and from the bus tunnel to King George Square. As such this intersection constrains the capacity of this critical central link in the inner city busway network.

Investigations were undertaken into determining whether the metro alignment was able to run through the QSBS instead of a new tunnel along Adelaide Street. Key constraints identified with this option included:

- the layout of QSBS particularly in terms of accommodating the metro vehicles at platforms and circulation
- access from QSBS to King George Square station, including geometric constraints and a one-way, traffic light managed tunnel section.

To overcome these constraints, major underground construction works will be required, affecting key buildings on the surface and creating significant disruption to inner city busway operations during construction. These impacts were not considered to be acceptable.

The proposed Adelaide Street tunnel, along with changes to the configuration of North Quay, will generally create a dedicated and segregated busway corridor from Victoria Bridge to King George Square station, bypassing the Queen Street bus tunnel and its intersection constraints. This will allow buses to operate at higher average speeds with less conflict and less variability in journey time caused by bus congestion and signal delays. The QSBS will continue in its current form and support a range of bus services. Bus access from Victoria Bridge to QSBS will be via the Adelaide Street tunnel and right-turn into the Albert Street bus tunnel. Bus access to Victoria Bridge from QSBS will continue to be provided via the QSBS portal at North Quay.

4.3.2 Additional infrastructure investigations

Brisbane Metro will repurpose large sections of the existing busway infrastructure, including existing stations. The development of the concept design focused on options for new infrastructure, including the metro depot, changes to existing infrastructure such as platforms, and ancillary infrastructure such as layover and turnaround areas.

Metro depot

A depot will be required for the maintenance and stabling of metro vehicles. The functional requirements which underpin the rationale for the metro depot location and design include:

- safe and efficient operations, including entry and egress
- staff facilities for drivers including car parking, meal break facilities, driver sign-in/sign-out and lockers
- vehicle refuelling including fuel storage tanks (depending on fuel type)
- mechanical maintenance facilities, including diagnostic equipment, hoists, pits
- cleaning facilities including both external wash down and internal cleaning
- depot capacity for 10 or more years of operation.

The metro vehicles will be substantially longer than the existing bus fleet and cannot be accommodated in the existing bus depots without significant modification and displacement of existing fleet capacity. To provide flexibility for future decision-making, a new location was identified for the metro depot.

A new metro depot removes the complexity of having to retrofit an existing Transport for Brisbane bus depot, such as Garden City, to accommodate the larger metro vehicles (e.g. reconstruction of equipment such as hoists and pits and reconfiguration of external parking areas).

A long list of possible sites were identified within approximately six kilometres of the Brisbane Metro alignment that met the functional requirements. These were assessed against identified critical issues relating to:

- lot size, shape and topography
- property ownership
- existing land use of the site and surrounding area
- compatibility with anticipated/planned future development potential, including land use zoning
- road access to/from the busway and proposed depot site
- potential flood impacts
- environmental considerations such as flora and fauna, and heritage
- potential community impacts and likely issues (e.g. noise, light, air quality)
- network operational impacts, such as dead running optimisation, network reliability and access requirements
- operational and facility requirements
- land acquisition cost estimates.

A high-level ‘relative merit’ options assessment was undertaken to provide an overall ranking and recommendation of possible metro depot sites. This included consideration of:

- privately-owned and government-owned land at School Road, Rochedale
- privately-owned land at Miles Platting Road, Rochedale
- Council-owned land at Gardner Road, Rochedale
- existing Council bus depot at Upper Mt Gravatt.

The options assessment compared key development issues based on low, medium or high impact and sites were ranked based on the number and severity of development issues. Key considerations in the options assessment included:

- enabling infrastructure requirements and costs, including connection to the busway network
- community impacts and potential for community and stakeholder concerns
- compatibility with land use planning expectations (e.g. land use and zoning, existing development applications, potential for conflict with anticipated/planned future development)
- land availability, including size, shape and topography
- ownership
- land acquisition cost
- enabling infrastructure relative costs (including connection to busway network)
- potential community/stakeholder objection
- compatibility with town planning expectations (including development application issues)
- network operational impacts
- available land size (expandability).

The high-level options assessment identified School Road, Rochedale, as the preferred metro depot site. The site has a sufficient usable area and comprises six adjacent lots – one owned by TMR, one road reserve, three private freehold rural-residential lots with occupied dwellings, and one freehold lot accommodating the Brisbane Immanuel Church. The site is bounded by the South East Busway, School Road and a rural-residential lot.

The key factor in ranking the School Road site as the preferred metro depot location was the direct access to the South East Busway. This avoids requirements to obtain certification to run metro vehicles on local roads, minimises dead running costs, and significantly reduces enabling infrastructure costs to connect the metro depot to the busway.

North Quay pedestrian and cycle connectivity

The removal of at-surface pedestrian and cycle crossing of North Quay to Reddacliff Place and the CBD was investigated to allow the uninterrupted operation of metro vehicles and surface buses through this location. This required pedestrians and cyclists accessing the CBD to divert to Adelaide Street and George Street. Concerns were raised through community and stakeholder consultation about this arrangement and potential impacts on pedestrian and cycle access between South Brisbane and the CBD. Alternative options to provide pedestrian and cycle connectivity from the Victoria Bridge upstream footpath across North Quay included:

- connections above- and below-ground at North Quay between the upstream Victoria Bridge shared path and Reddacliff Place
- connections above- and below-ground from the upstream Victoria Bridge shared path to the other side of the Victoria Bridge abutment.

This initial investigation did not identify any feasible options due to:

- above-ground connections:
  - visual impacts to views to and from Queen Street Mall and South Brisbane of elevated structures
  - impact of stairs and lifts at surface level to available public space and movements
  - customer experience in relation to traveling up and down to cross the road.
- below-ground connections:
  - physical constraints in relation to the Riverside Expressway, Victoria Bridge abutment, utilities and existing infrastructure
  - impact of stairs and lifts at surface level to available public space and movements
  - customer experience in relation to travelling down into a tunnel, safety issues with a tunnel and then travelling back to surface.

An at-surface pedestrian crossing of North Quay was maintained to achieve an appropriate level of pedestrian and cycle connectivity.

Station platform extensions

Brisbane Metro includes a range of fleet and network changes that will alter the number of vehicles stopping at stations as well as the mix of vehicles including average length. Combined with the policy and operational solutions, these changes will result in changes to average dwell time and dwell time variability, affecting station capacity.

A two-part assessment process was undertaken to inform the required platform length to accommodate these changes as follows:

- static calculations based on the bus loading area (or bay) formulae
- microsimulation modelling outputs.

The result of this process was an initial set of platform lengthening recommendations as follows:

- Eight Mile Plains station – extension of 9.25 metres to create 64.5-metre long platforms
- Upper Mt Gravatt station – extension of 9.25 metres to create 64.5-metre long platforms
- Griffith University station – extension of 29 metres to achieve ultimate platform lengths of 84.5 metres
- Buranda station – extension of 9.25 metres to create 64.5-metre long platforms
- Mater Hill station – extensions of the outbound platform by three metres and inbound platform by six metres inbound to create 50-metre long platforms, noting that physical constraints limited the ability to extend platforms
- new underground Cultural Centre station – a minimum of 76-metre long platforms to provide for three metro vehicle capable bays due to the requirement to provide platform screen doors
- Roma Street station – extension of 13.5 metres outbound to create an 84.5-metre long platform (no lengthening for the inbound platform is required as this is currently 98 metres long)
- King George Square station – reconfiguration of existing bays only, including platform screen doors to allow for two lead stops.

The platform length changes were modelled using the Vissum microsimulation software along with other proposed changes to the busway infrastructure, services and operations. The modelling showed that despite major improvements to inner city bus journeys as a result of Brisbane Metro, delays on the approach to Buranda station still occurred in the 2021 morning peak hour with queues in excess of 200 metres at times. By 2041, this was forecast to deteriorate further with queues in excess of 800 metres at certain times during the morning peak hour.

The two-part platform capacity assessment indicated that in order to accommodate the proposed 2041 operations and patronage forecasts with an appropriate and acceptable level of performance, platform lengthening described previously will be generally sufficient apart from:

- Buranda station – extension of 29.5 metres (instead of 9.25 metres) to create 84.5-metre long platforms
- new underground Cultural Centre station – platforms will be 100 metres (instead of 76 metres) to provide for future flexibility to accommodate forecasted 2041 operational requirements.

Layover and turnaround for metro vehicles

Layover facilities for the metro vehicles will be required at the metro depot and at various locations along the alignment, to allow for a period of recovery time between scheduled services. This allows for minor fluctuations in journey time to be recovered so as not to cascade and delay subsequent services.

The following summarises calculated and proposed recovery layover provision for Brisbane Metro services.

- Metro 1 route – up to five metro vehicle bays may be required at either end of the route by 2041 with three at each end of the route to support year one operations. Three metro vehicle bays at Eight Mile Plains station and four at Countess Street have been identified with the opportunity to provide additional layover bays at a later date through minor works. For example, an additional metro vehicle bay could be achieved by converting existing bus layover north of Eight Mile Plains station to metro or metro/bus layover. Furthermore, an additional two metro vehicle layover bays could be achieved at Countess Street by relocating the existing demountable staff amenities building and new line marking.
- Northern end of Metro 2 route – four marked metro vehicle bays are proposed at Ernie's Roundabout which is sufficient to 2041, at two-minute headways.
- Southern end of Metro 2 route – four metro vehicle bays may be required at UQ Lakes by 2041 with three bays required for year one operations. Two metro vehicles can be accommodated simultaneously on the northern platform (stops D and E), which will be dedicated to the Metro 2. While these are operational bays for passenger loading and unloading, an element of the recovery layover function will occur in-bay given this is the terminus stop. Up to two further metro vehicles can be

accommodated in the internal layover bays within the station and therefore no physical works are required.

For turnaround locations, an assessment was made of metro vehicle and bus needs based on the proposed future bus network strategy. This assessment identified the need for turnarounds at:

- for metro vehicles – Eight Mile Plains, UQ Lakes, Countess Street and Ernie's Roundabout (Herston) to support the Metro 1 and Metro 2 services
- for buses – Griffith University and Woolloongabba.

4.3.3 Construction

Constructability review

Council engaged an independent consultancy to conduct a high-level constructability review to provide additional industry input into the concept design, site investigations and early works program. The objectives of the review were to challenge the concept design with respect to mitigating the construction impacts on affected stakeholders and the community, and the consideration of risk transfer to potential Design and Construct contractors. The constructability review presented several options for major infrastructure works that were further assessed.

To facilitate the construction of the new Cultural Centre station, a new underpass of the existing railway corridor is required adjacent to the existing South Brisbane railway station. The worksite for the underpass has the potential to affect public transport infrastructure on both the heavy rail line and the South East Busway. The worksite is constrained by the need to keep both the rail line and busway open during construction. It also involves working in close proximity to live rail lines and is severely space constrained. The concept design for the underpass has investigated a number of possible construction methodologies that addresses these constraints and has included an external, independent constructability options review.

Possible construction methodologies for the underpass of the existing railway corridor and new underground Cultural Centre station include:

- top-down cut-and-cover solution
- jacked box solution
- canopy tube mined solution.

The jacked box solution is assessed in this draft Design Report. The final construction methodology for the underpass of the railway corridor will be confirmed through the detailed design phase.

For Adelaide Street, the constructability review looked at:

- top-down cut-and-cover-tunnel
- driven tunnel with canopy tube construction
- mined tunnel
- combination of top-down cut-and-cover and mined tunnel.

The top-down cut-and-cover-tunnel option is assessed as part of this draft Design Report. The final construction methodology for the Adelaide Street tunnel will be confirmed through the detailed design phase.

Council has investigated options for constructability for the section of the Adelaide Street tunnel break through to the Albert Street busway adjacent to King George Square station. This site is constrained by the location of existing infrastructure and utilities. The options focus on avoidance or relocation of services such as water, sewer and fire and life safety. The constructability review also looked at options for the construction activities at Buranda station and impacts on utilities. These will be further investigated in future design stages.

4.3.4 Metro vehicle

Proposed metro vehicle

For Brisbane Metro to realise its full potential as a high-capacity, high-frequency, turn-up-and-go public transport system, a high-quality vehicle is required. A highly-legible, frequent, comfortable, attractive high-capacity vehicle is required to provide capacity and customer comfort that the journey after interchange will be seamless, faster and more enjoyable and maximise the capacity of the existing busway investment. The functional requirements of the metro vehicles are:

- high-capacity – to allow for the replacement of existing well-utilised services, provide capacity for new customers from terminated/feeder services and provide capacity for growth
- low floor entry and accessible – for quicker boarding and alighting
- multiple, large (double) doors – to allow for efficient boarding and alighting
- metro-like style and quality.

Low floor entry metro vehicles with four double doors and capacity for approximately 150 people each are therefore envisaged to operate the two Brisbane Metro routes.

A specific metro vehicle has not been selected at this stage to avoid unnecessarily precluding potential vehicle suppliers and project delivery methodologies. In order to progress the concept design, a reference vehicle which had publicly-available information relating to its specifications has been adopted.

This reference metro vehicle would be able to operate on the existing busways without significant modification. The existing platform height will be maintained, with metro vehicles equipped with ramps that are manually deployed or motor powered by the bus driver when required. The vehicle will facilitate same platform seamless interchange.

Council has undertaken industry engagement, inspections of operational high-capacity vehicles and associated facilities, and research, to obtain further information about potential metro vehicles to inform future phases of Brisbane Metro.

Fuel types

Several fuel options are being investigated to guide the final selection process.

- compressed natural gas – the price of natural gas is significantly less than oil and Australia has an abundant supply.
- electric-powered vehicle – full electric public transport vehicles are in their infancy. They currently have limited range, and require charging infrastructure at multiple locations.
- diesel-powered vehicle – diesel is the most common fuel used in mass transport vehicles world-wide. Recent improvements in emission control and fuel efficiency have made diesel-powered vehicles a feasible option.
- diesel/electric hybrid-powered vehicle – a diesel/electric hybrid vehicle combines a conventional diesel engine system with an electric propulsion system. The introduction of hybrid electric vehicles and other green vehicles for purposes of public transport forms a part of many sustainable transport schemes.

For the purposes of the assessment for the draft Design Report, diesel-powered vehicles have been selected as the reference vehicle. To aid in the selection of a preferred fuel type, an assessment of potential fuel types has been undertaken to inform the procurement process.

4.4 Conclusion

Throughout the project options assessment and development, Council has maintained a thorough comparison and review framework to ensure the best possible outcomes are achieved. Key Council project objectives were identified early in the process and guided decision-making on possible options. The solution represents a well-considered suite of new, upgraded and existing assets.

Infrastructure changes are targeted at unlocking key constraints on the existing busway to facilitate growth in services and customer volumes. This includes the elimination of some intersection delays through grade separation at the Cultural Centre and Adelaide Street, as well as station and platform delays through platform lengthening or augmented station capacity.

Vehicle changes will see the introduction of the high-capacity metro vehicles enabling more efficient busway operations, allowing more people to be carried with fewer vehicles for lower overall operating costs per passenger. This also provides the capacity for growth on the network.

The overall suite of initiatives proposed as part of the Brisbane Metro solution is expected to result in positive outcomes relative to project objectives.