Airport Link

Phase 2 – Detailed Feasibility Study

CHAPTER 3

PROJECT DEVELOPMENT

- October 2006

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3. Project Development

This chapter addresses that part of Section 2.3 of the Terms of Reference requiring an outline of the development of the Project and a discussion of design options considered in arriving at the Project reference design. The objectives that led to the development of the Project reference design and the design options (including ventilation outlets) that were assessed are addressed. The options are discussed in terms of the technical, commercial, social and environmental issues to demonstrate the reasons for selecting the preferred option. The chapter also addresses options for spoil management arrangements (Section 3.1 of the ToR).

3.1 Initial Development of the Project

The Strategic Transport Opportunities for Brisbane (STOB) initiative launched by Brisbane City Council (BCC) in June 2000 developed the North-South Bypass Tunnel (NSBT) as a key outcome. In that early investigation, the general route for Airport Link was referred to as NSBT Stages 2 and 3, with stage 2 being the northern route to Gympie Road, and stage 3 being the eastern route from there to Sandgate Road. The NSBT has since been the subject of detailed feasibility studies including traffic studies, engineering feasibility studies, a business case investigation and an environmental impact assessment (EIS) process. The EIS for the NSBT Project was evaluated by the Coordinator-General in a report dated 25 August 2005. The Brisbane City Council subsequently called for tenders to deliver the NSBT Project and announced a preferred tender in April 2006, with the execution of the contract completed in August 2006.

Since the release of the Transport Plan for Brisbane in 2002, the Brisbane City Council has proceeded with the detailed feasibility studies for the NSBT Project, as well as pre-feasibility studies for *TransApex*. This is an integrated transport initiative which encompasses the NSBT Project and proposes a range of other transport infrastructure projects and measures. Other elements of road transport infrastructure include the Airport Link Project, the Hale Street project and the Northern Link project. The TransApex pre-feasibility study, commissioned in May 2004 by Brisbane City Council, found the Airport Link Project technically and financially feasible.

The *South-East Queensland Infrastructure Plan and Program 2005 – 2026* (SEQIPP), released by the Queensland Government in 2005, includes the Airport Link Project as part of an over-arching strategy for transport infrastructure intended to cater for the anticipated growth in population and consequential growth in travel demand in the region, and the City, through to 2026.

Following the *TransApex* pre-feasibility study findings and the release of the SEQIPP, the Queensland Government and the Brisbane City Council agreed to progress to detailed feasibility studies of the Airport Link Project. Concurrently with this initiative, TransLink initiated similarly detailed studies into the Northern Busway project. The detailed feasibility studies for the Airport Link Project have included:

- Engineering feasibility investigations, culminating in a reference project and design;
- Traffic and transport studies; and
- An environmental impact assessment process.

In seeking to develop the concept for the Airport Link Project, taking into account the findings of the pre-feasibility studies, the detailed feasibility studies, among other things, sought to identify the preferred corridor for the Airport Link Project and the preferred alignment for the project within the corridor.

3.2 Corridor & Alignment Assessment

The TransApex Prefeasibility Report of March 2005 identified, investigated and documented two possible alignment options for the Airport Link Project. Both options were found to provide similar strategic connectivity between the arterial road network at Bowen Hills, including Lutwyche Road, the Inner City Bypass and NSBT, and north-east and north-west connections. However, each option differed fundamentally in terms of construction and secondary levels of connectivity. The Detailed Feasibility Study for the Airport Link Project commenced in June 2005 and the two corridor options were assessed.

This study recommended the detailed feasibility study continue with the western option, which places the major tunnel in ground, beneath Lutwyche Road to Gympie Road and then east beneath Wooloowin to join the East West Arterial Road at Sandgate Road. The western corridor was chosen as it would allow:

- Better opportunities to connect Airport Link to other road and public transport projects;
- The construction to be in tunnel, reducing impacts on the community during and after construction; and
- Opportunities for integration with the Northern Busway in concept development and possibly in project delivery.

Central corridor options, which generally followed the northern railway line and included elevated structures, were not preferred due to their visual and environmental impacts and greater surface disruption to residential areas, especially during construction.

Following the identification of the preferred corridor, alignment alternatives were considered for each of the connections and for the form of the mainline tunnel. The major connection requirements for the Airport Link Project included:

- Southern connection – surface connections in Bowen Hills and Windsor to NSBT, Inner City Bypass (ICB) westbound, Bowen Bridge Road to ICB west and Mayne Road ramp to NSBT/ICB (south);
- North-western connection – Surface connection to Gympie Road, Stafford Road and an east-west connection from Stafford/Gympie Road;
- North-eastern connection – surface connection to Sandgate Road and East-West Arterial; and
- Mainline tunnels - dual tunnels driven on a north-south alignment from the southern connection to Gympie Road, and dual tunnels driven from the north-western connection at Gympie Road Kedron beneath Wooloowin to link with Sandgate Road and the East-West Arterial at Clayfield.

3.3 Concept Design Development

The development of the concept design for the Airport Link Project focused on:

- Meeting the project objectives outlined in Chapter 2 of the EIS;
- Engineering constraints and design standards;
- Minimising environmental and social impacts and providing opportunities for managing those impacts, including rehabilitation of the urban landscape in the portal areas.

In developing the concept design within the preferred corridor, a number of alternatives were considered for the surface connection arrangements, the mainline tunnel alignments, and the locations of the ventilation stations and ventilation outlets.

Concept Design – Overview

The likely alignment of the mainline tunnels would run north from Bowen Hills and Windsor, beneath the Lutwyche Road corridor, to Kedron with surface connections to Gympie Road and Stafford Road at Kedron. The mainline tunnels would then proceed generally east to Sandgate Road and the East-West Arterial Road at Clayfield. For much of the route, the mainline tunnels run beneath the existing transport corridor of Lutwyche Road, passing under the commercial precinct of Lutwyche and residential areas of Windsor, Lutwyche and Wooloowin.

The alignment deviates away from Lutwyche Road at Kedron, passing beneath Lutwyche Road to enable connections to Gympie and Stafford Roads above ground. The alignment continues between Kedron Brook and Kedron State High School before heading to the east, north of Melrose Park, and connecting to Sandgate Road and the East-West Arterial.

The alignment has a total length of approximately 6.7km, of which approximately 5.7km would be constructed in tunnel. The project provides three lanes each way from the southern connection to the north-western connection and two lanes each way from there to the north-eastern connection. The configuration of the traffic lanes both within the mainline tunnels and at the various surface connections has been determined in seeking to achieve the project objectives.

The Airport Link tunnel system would be equipped with a longitudinal ventilation system, which seeks to minimise the release of vitiated air from the mainline tunnels at the exit portals. Integral components of the ventilation system include ventilation stations for the extraction fans and ventilation outlets for high-level dispersion of vitiated air from the tunnels. Each of the mainline tunnels would be equipped with a longitudinal ventilation system, with a ventilation station and ventilation outlet to be provided adjacent to each of the surface connections at Bowen Hills, Kedron and Clayfield. In addition, the tunnel system would be equipped with smoke extraction facilities, and fire and life safety facilities.

A tunnel control and management centre would be situated near one of the ventilation stations, with either the Windsor station or the Kedron station providing suitable opportunities for this facility.

Project Delivery - Overview

The mainline tunnels for the Airport Link Project would be delivered mostly as driven tunnels, with sections of cut and cover construction as they approach or leave the surface connections. The surface connections would be delivered as a combination of elevated roads in either structures or on embankments, and on surface roads.

Much of the mainline tunnel construction would be undertaken utilising driven tunnel construction because of its significant length, combined with a relatively deep alignment between Bowen Hills and Kedron within sound rock. The section between Kedron and Clayfield would also be constructed as driven tunnel. Construction techniques for this section would need to address a number of construction and environmental risks including soft ground conditions and groundwater movement.

The delivery of the project anticipates major construction worksites adjacent to each of the surface connections at Windsor, Kedron/Lutwyche and Clayfield/Toombul. Construction spoil and construction materials would be conveyed to and from the worksites by a range of means, but primarily by road.

3.4 Tunnel Connection Options

3.4.1 Southern Connection

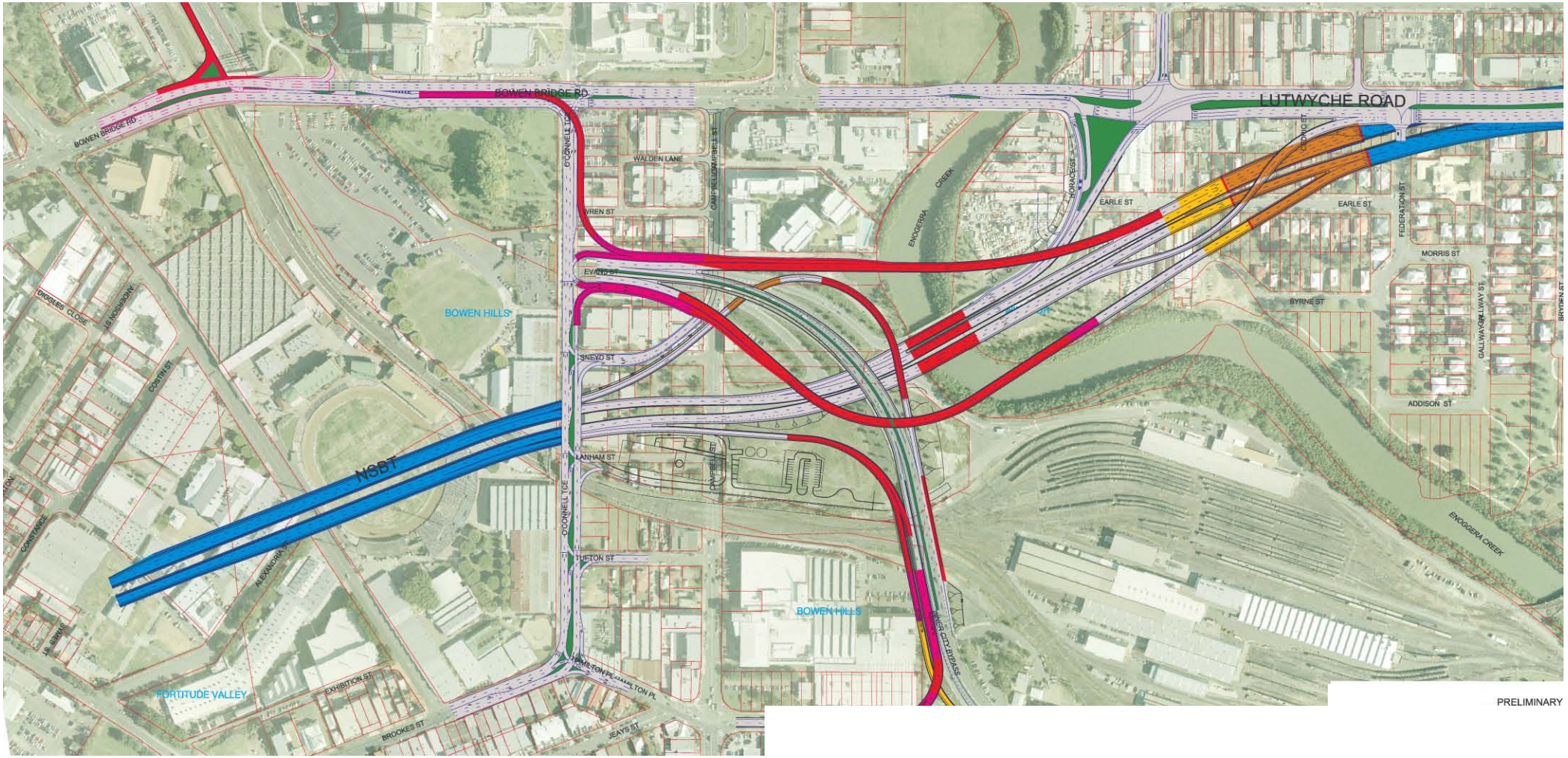
The connection of the Airport Link with the City's road network in the Bowen Hills / Windsor area is required to achieve some of the strategic objectives for the project and for further development of the City's road network to cater for the expected growth in population and consequential increase in travel demand. For these reasons also, it was considered important for the Airport Link Project to provide connections to the city centre as well as the major bypass routes, being the Inner City Bypass and the North-South Bypass Tunnel.

Nine options for this connection were investigated in the concept design stage. Each option considered the design criteria outlined in **Table 3-1**. Apart from these criteria, concept design has been undertaken in full knowledge that connection with the NSBT tunnels was a project requirement for the Airport Link Project. At that stage the NSBT reference design submitted with the EIS for the Coordinator-General's approval was taken to be the most likely layout into which the Airport Link would need to connect. Since then, further refinement of the Airport Link design has proceeded to ensure connection with the NSBT Changed Project as described in the *Request for Project Change* submitted to the Coordinator-General for evaluation in May 2006.

Table 3-1 Option Selection Criteria – Southern Connection

Options selection criteria for southern connection
▪ Major connections must be provided from Airport Link to the NSBT Changed Project and Airport Link to the ICB west-bound and Airport Link to the City via the existing surface road network.
▪ Existing traffic movements on the surrounding road network to be maintained or improved.
▪ Provision for direct access to and from the NSBT Changed Project main carriageways, AL main carriageways, and the ICB is required to be provided / maintained for emergency and authorised vehicles
▪ Vertical alignment of the connection must maintain existing road network surface levels (i.e. ICB, Lutwyche Road) and must meet future road connection levels (i.e. NSBT Changed Project)
▪ Pedestrian and cycle movements along the Enoggera Creek corridor from Mann Park to Bowen Park, to be established as part of the NSBT Changed Project, are to be maintained, and pedestrian connections from Windsor East to the community facilities south and west of Lutwyche Road are also to be maintained.
▪ The design must accommodate Horace Street levels under the ICB and the Horace Street bridge link levels over Enoggera Creek and its associated flood protection / immunity requirements
▪ Weaving and merging issues, which are of particular importance for this connection due to the multitude of traffic movements in a relatively small area, are to be minimised
▪ Horizontal alignment of the connection must minimise effects on sensitive properties and infrastructure such as the ICB substation, the Rosemount Hospital, the Queensland Rail (QR) corridor and Mayne Rail Depot and the Boral concrete batching plant
▪ It is considered desirable to utilise the existing Horace Street bridge crossing of Enoggera Creek and the existing Horace Street underpass of the ICB to minimise any impact and cost to these structures
▪ 10,000 year ARI flood immunity is to be provided to the tunnel portals and the exit/entry ramp portals
▪ Design not to create adverse hydraulic impacts upon external properties under a 100 year ARI design event
▪ Disturbance to Enoggera Creek waterway and associated riparian vegetation to be kept to a minimum
▪ Intersections at Lutwyche Road / Federation Street and Lutwyche Road / Newmarket Road to remain signalised with layouts and infrastructure modified to suit the proposed geometry of the NSBT Changed Project
▪ Mayne Rail Depot to the east of Enoggera Creek must be maintained and provision allowed for an additional track on the northern side of the railway corridor running south from the Depot
▪ Design is to make allowance for integration opportunities with the Northern Busway.

As the design options were developed they were evaluated against the option selection criteria and were eliminated if they did not meet the criteria. Options SC_2B and SC_2C were developed further as they generally met the design criteria. A summary of the evaluation for each of these options is presented in **Table 3-2**, and shown in **Figure 3-1** and **Figure 3-1a**.



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AIRPORT LINK - Figure 3-1

Southern Connection SC_2B

N

0 1 2km

Airport Link

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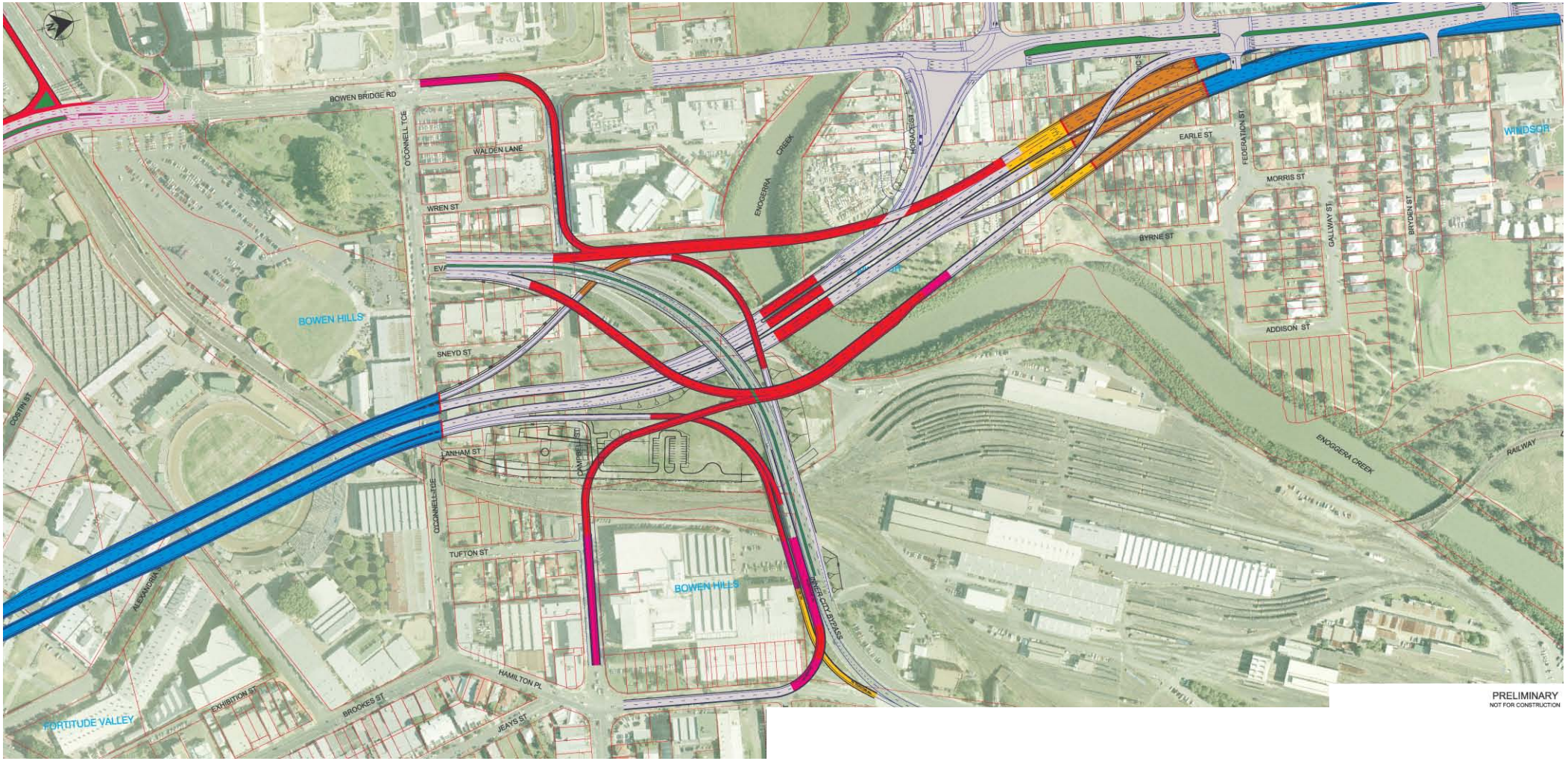

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AIRPORT LINK - Figure 3-1a

Southern Connection SC_2C

0 1 2km

Airport Link

SKM Connell Wagner JOINT VENTURE

- **Table 3-2 Options Assessment – Southern Connection**

Options Considered	Assessment of Options
Option SC_2B Option SC_2B provides a connection at Bowen Bridge Road to ICB west in lieu of an elevated structure for Lutwyche Road (northbound) over Lutwyche Road to ICB west. It also provides a dedicated ramp connection to the ICB/NSBT southbound from Mayne Road and a city connection from Airport Link to O'Connell Terrace.	**Option SC_2B** Potential for impacts on the waterway and riparian vegetation of Enoggera Creek due to additional bridge structures. Potential impacts on residential areas and visual impacts.
Option SC_2C This option had virtually the same connections as SC-2B except that it connected with Campbell Street rather than O'Connell Terrace.	**Option SC_2C** The city connection via Campbell Street may result in fewer traffic and property impacts compared with the O'Connell Terrace connection in Option 2B.

Each of the options provided the essential road connections and all or most of the desirable connections. The evaluation of the options (**Table 3-2**) allowed the conclusion that Option SC_2C best meets the design criteria. The Concept Design Report and Project Definition Report, completed in March 2006, expressed the results of the option selection process just described.

Further Concept Development of the Southern Connection

On 26 April 2006 River City Motorways (RCM) was announced as the preferred tenderer for the North South Bypass Tunnel (NSBT). RCM proposed a design for the NSBT connection to Lutwyche Road and Inner City Bypass (ICB) at Bowen Hills, which differed from the NSBT Reference Project evaluated in the Coordinator-General's report of August 2005. The changes from the Reference Project embodied in the RCM design have been evaluated by the Coordinator-General[1]. The RCM design is hereafter referred to as the NSBT Changed Project[2]. As a consequence, the Airport Link concept was further developed (Option SC_2C) for the southern connection to connect into the NSBT Changed Project. The amended connections are described below.

The NSBT Changed Project is not affected by the proposed reference design for Airport Link. On the contrary Airport Link has been designed to show that it can connect efficiently with the NSBT Changed Project at Bowen Hills and Windsor. The detailed design phase of Airport Link should include close coordination with RCM to ensure effective interconnection between the two projects in design, construction, operation and maintenance.

Airport Link to NSBT

This connection would extend from the Airport Link driven tunnel via cut and cover, transition structure and embankment to connect with the NSBT Changed Project mainline carriageways at Windsor East in the vicinity of the present locations of Horace Street and Earle Street.

Airport Link to ICB (west)

The southbound connection of Airport Link to ICB (west) would be provided from an off-ramp from the Airport Link driven tunnel via cut and cover, transition structure and embankment, leading to the proposed bridge over Enoggera Creek. The ramp would then connect into the NSBT Changed Project and continue to the ICB (west).

[1] *NSBT Change Report,* July 2006, Coordinator-General.
[2] *NSBT Request for Project Change*, 27 May 2006, Brisbane City Council

The northbound connection from ICB (west) would be via an off ramp across Enoggera Creek, over the NSBT Changed Project/Lutwyche Road off-ramp, then under Lutwyche Road to ICB/NSBT Changed Project connection in cut and cover before connecting into the Airport Link driven tunnel.

Airport Link to/from O'Connell Terrace

The southbound connection from Airport Link to O'Connell Terrace would be provided from the off-ramp from the Airport Link driven tunnel, along the Airport Link/ICB (west) ramp before diverging to connect to O'Connell Terrace at surface.

The northbound connection would commence with a right-turn lane from Bowen Bridge Road to O'Connell Terrace before turning north to an on ramp to Airport Link driven tunnel.

Airport Link to/from Campbell Street

The southbound connection would link the Airport Link driven tunnel with an off-ramp over Enoggera Creek parallel with the Airport Link/ICB (west) ramp before departing as a single lane elevated ramp over the ICB (east) to NSBT Changed Project connection. The ramp would then head east above the at-grade railway crossing at Tufton Street before connecting to the existing road surface at the intersection with Hamilton Place/Mayne Road.

The northbound connection would depart from Campbell Street at the intersection with Hamilton Place/Mayne Road and head west over the at-grade railway crossing at Tufton Street in elevated structure. It would then continue west over the NSBT Changed Project before turning north over the ICB and the O'Connell Terrace off-ramp. The ramp would then connect adjacent to the O'Connell Terrace/ Airport Link on-ramp before connecting to Airport Link driven tunnel.

Lutwyche Road to NSBT/ICB (west)

A connection would be provided from Lutwyche Road (northbound) to the NSBT Changed Project/ICB. The Lutwyche Road (northbound) connection would be via a right-turn movement from Lutwyche Road to traffic signals and then on to either the NSBT Changed Project on-ramp or the ICB (westbound) on-ramp.

A connection would be also provided from Lutwyche Road (southbound) to NSBT Changed Project/ICB. The Lutwyche Road (southbound) connection would be via a left-turn movement from Lutwyche Road to traffic signals and then on to either the NSBT Changed Project (southbound) on-ramp or the ICB (westbound) on-ramp. The preferred option as described above is detailed in Chapter 4 – Project Description.

3.4.2 North-western Connection

To achieve the strategic objectives of the Transport Plan for Brisbane, the *TransApex* initiatives and to implement the transport strategies of the *South East Queensland Infrastructure Plan and Program 2005 – 2026* as they relate to the inner northern suburbs, it is necessary for Airport Link to connect with Gympie Road and with Stafford Road. Gympie Road provides a major connection for northern communities both within and beyond the City to the city centre, whereas Stafford Road provides an important link for east-west trips from the north-western suburbs and south-western suburbs to the Brisbane Airport, Port of Brisbane and the growing Australia TradeCoast via Junction Road and the East-West Arterial.

Due to the multiple trip movements being directed through this part of the City's road network now and in the future, twenty-five design options for this connection were investigated in the concept design stage. The present intersections between Gympie Road and Stafford Road, and the junction of Gympie Road, Lutwyche Road and Kedron Park Road, all in the vicinity of Kedron Brook and significant community facilities, combine within the

overall road network of northern Brisbane to create a highly complex and important transport interchange. Each option was considered against the design criteria outlined in **Table 3-3**.

Table 3-3 Option Selection Criteria – North-western Connection

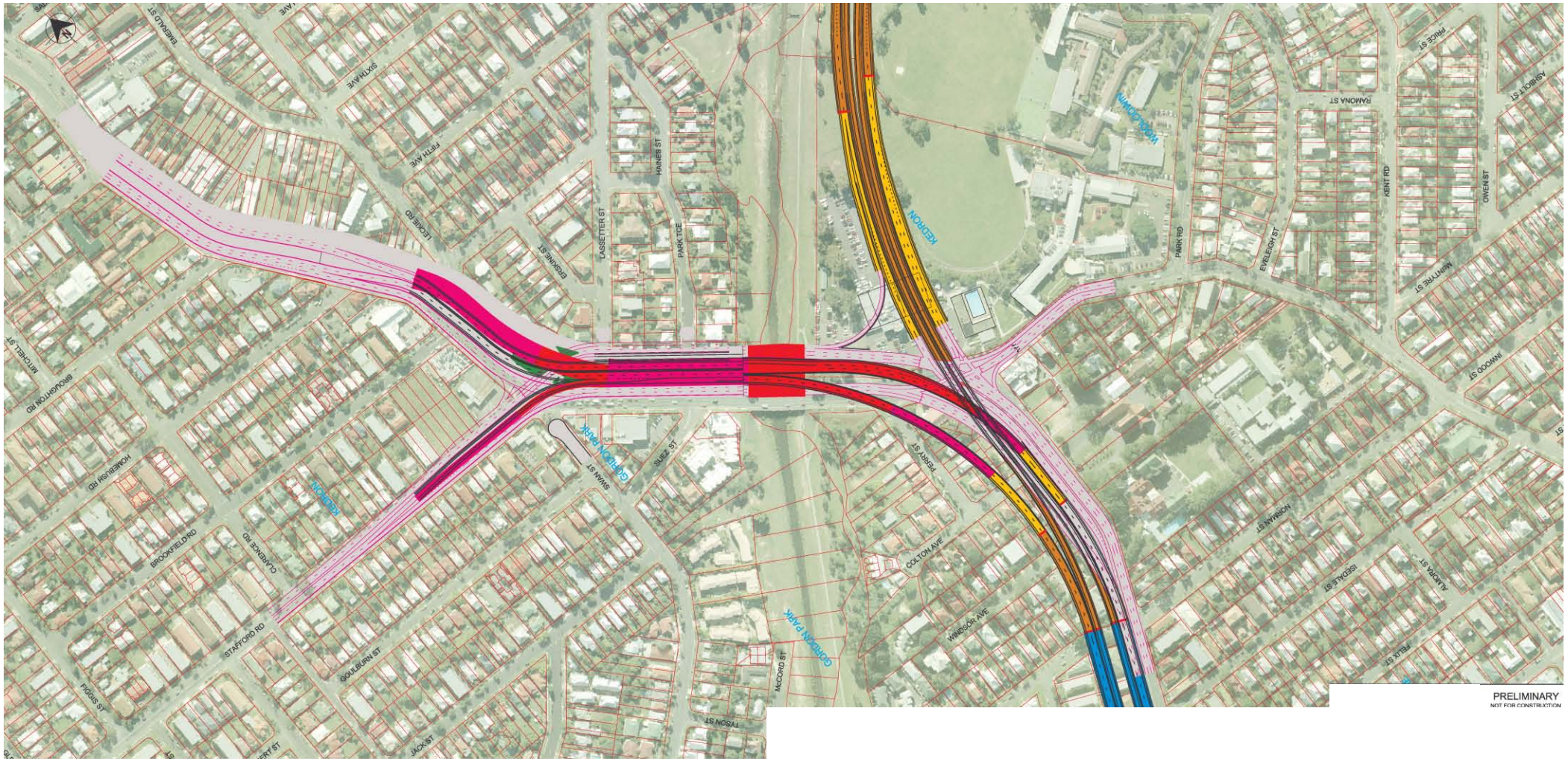
Options selection criteria for north-western connection
■ Road connection is to be established between Gympie and Stafford Roads and the Airport Link tunnel in both directions ■ All existing traffic and pedestrian movements and volumes at the Y-junction with Lutwyche Road running to the south, Kedron Park Road running to the east and Gympie Road running to the north (the southern intersection) are to be maintained ■ All existing traffic and pedestrian movements at the T-junction of Gympie and Stafford Roads (the northern intersection) and also along the Kedron Brook pedestrian and cycle path are to be maintained or improved. Other pedestrian and cycle connections to be either maintained or reinstated include those to the Kedron State High School and the Wooloowin State School on Lutwyche Road, for students living to the west of Kedron Brook or to the west of Lutwyche Road. ■ Weaving and merging issues, which are of particular importance for this connection due to the multitude of traffic movements in a relatively small area, are to be minimised ■ Vertical alignment is to maintain existing road levels (i.e. Lutwyche, Gympie, Kedron Park and Stafford Roads), including Kedron Brook Bridge, and is to meet Kedron Brook flood protection/immunity requirements. ■ Horizontal alignment is to minimise impacts on the Kedron Brook bridge, buildings on the west of Gympie Road, just north of Kedron Brook bridge, which have been designed to cater for a Busway, Kedron Park Hotel, Energex substation on the corner of Gympie and Stafford Road; and existing freehold properties ■ Transitional structures to be avoided north of the Gympie/Stafford Roads intersection due to the increasing surface gradient ■ 10,000 year ARI flood immunity is to be provided to the tunnel portals and the exit/entry ramp portals ■ Design not to create adverse hydraulic impacts upon external properties under a 100 year ARI design event ■ Disturbance to Kedron Brook waterway and associated riparian vegetation to be minimised ■ Local traffic access to the Colton and Windsor avenues area and Leckie Road, Lasseter Street/Park Terrace area to be maintained ■ Service road connection from Norman Avenue to Windsor and Colton Avenues and Perry Street is required to maintain local traffic access to this area ■ Upgrade of Leckie Road/Gympie Road intersection is required to maintain local traffic access to this area. ■ Design is to make allowance for integration opportunities with the Northern Busway ■ Design is to minimise impact on major in-ground infrastructure namely, sewerage, water, fibre optic and gas main lines and above ground components such as the Energex substation adjacent to Stafford/Gympie Roads intersection.

The design options were evaluated against the option selection criteria and those not meeting the criteria were eliminated. As they generally met the design criteria, Options NWC_9B and NWC_11B were developed further to refine function and to the extent possible resolve impacts. The options are shown in **Figure 3-2** and **Figure 3-2a**. The evaluation of these options is shown in **Table 3-4** and Option NWC_9B best meets the design criteria. Option NWC_9B is outlined in detail in Chapter 4 – Project Description.

Table 3-4 Options Assessment – North-western Connection

Options Considered	Assessment of Options
Option NWC_9B This option requires twelve lanes and has a broad footprint. It provides all existing traffic movements with elevated roadway above Kedron Brook and includes Lutwyche Road traffic access to the mainline tunnel (east). The mainline tunnel is aligned with Kedron Brook.	**Option NWC_9B** Commercial and residential properties are impacted. Direct access to Gympie Road from Lasseter Street is removed. Direct access to Lutwyche Road from Windsor and Colton Avenues is removed and relocated via a service road to Norman Avenue/Lutwyche Road intersection. The mainline tunnel connects adjacent to Lutwyche Road and minimises residential property impacts. The tunnel alignment impacts on the Department of Emergency Services' building.

Options Considered	Assessment of Options
Option NWC_11B This option has a similar layout as Option NWC_9B, however has only a two lane mainline driven tunnel connecting to single lanes through the connection then two lanes east to Clayfield.	**Option NWC_11B** This option has similar impacts as Option NWC_9B.



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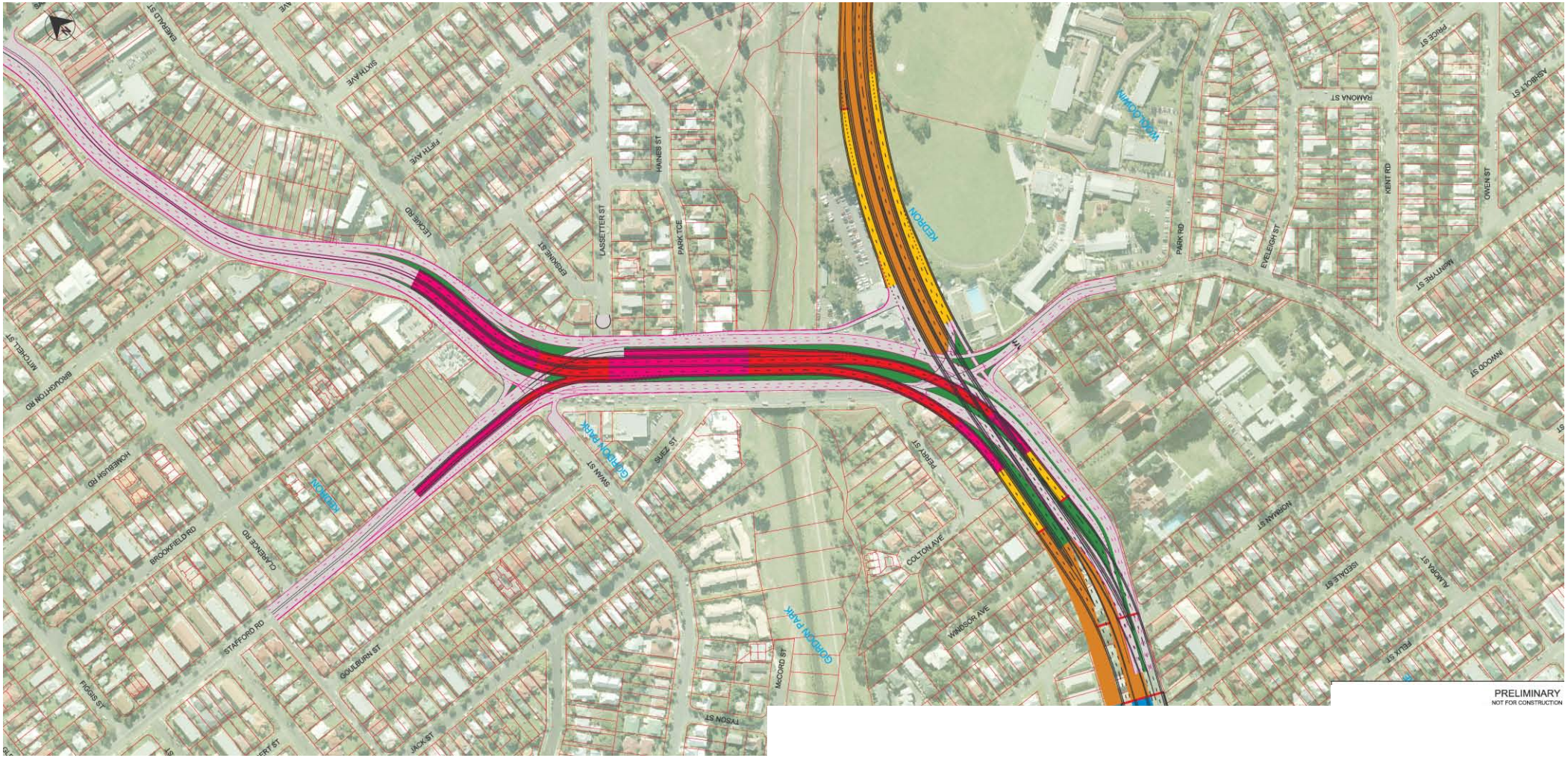
AIRPORT LINK - Figure 3-2

Gympie Road Connection GR_11B

0 1 2km

Airport Link

SKM Connell Wagner JOINT VENTURE



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AIRPORT LINK - Figure 3-2a

Gympie Road Connection GR_9B

0 1 2km

Airport Link

SKM Connell Wagner JOINT VENTURE

3.4.3 North-eastern Connection

A key objective for the Airport Link Project and for future development of the road network in northern Brisbane, is to provide for east-west movements to the Brisbane Airport, Port of Brisbane and the Australia TradeCoast, and also to provide enhanced connections for southbound trips from the north-eastern suburbs to the city centre and other employment centres to the south and south-west of the city centre (eg University of Queensland). The traffic studies undertaken for this EIS also found that there was existing and increasing demand for trips from the northern suburbs to the airport, via Sandgate Road and the East-West Arterial.

While the Airport Link Project completes the link from the East-West Arterial to the city's arterial road network, there is a present need to investigate and plan for anticipated growth in traffic through the Nudgee Road intersection with the East-West Arterial and at the Airport roundabout on the Gateway Motorway. These investigations have commenced as part of a separate undertaking to this EIS, and as an extension of a number of other investigations into this part of the network on-going since 2002.

Seven different options for this connection were investigated in the concept design stage. Each option was considered against the option selection criteria outlined in **Table 3-5**.

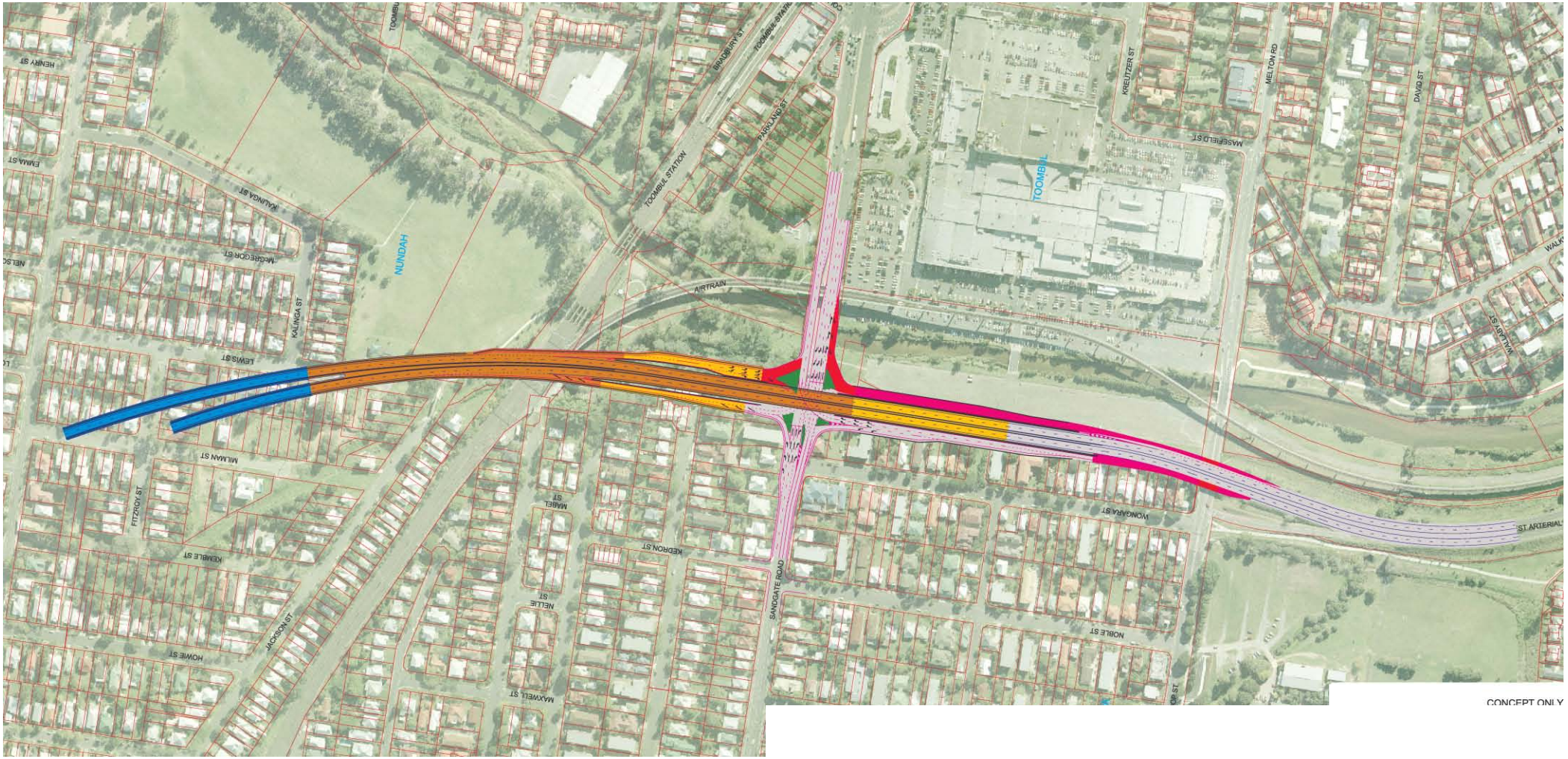
Table 3-5 Option Selection Criteria – North-eastern Connection

Option Selection Criteria for North-eastern Connection
• Existing traffic movements from Sandgate Road to East West Arterial are to be maintained • Traffic movements from Sandgate Road and the East West Arterial to Airport Link are required • Storage capacity of the right turn movement from Sandgate Road (south) to the East-West Arterial needs to be improved • Left turn movement from Sandgate Road (north) to East-West Arterial to be improved • Pedestrian and cycle movements along and across Kedron Brook / Schulz Canal are to be maintained in the vicinity of Sandgate Road at Kalinga Park • Impacts on Kalinga Park are to be minimised • Existing horizontal and vertical alignments of Sandgate Road are generally to remain • Vertical alignment of mainline tunnel to be below the North Coast Railway, the drainage culverts at the railway embankment, and Sandgate Road prior to exiting east of Sandgate Road • Airtrain structures and northern rail lines to be accommodated in existing positions, and minimise settlement • Impacts on properties south of the main tunnel alignment, east and west of Sandgate Road, to be minimised • Mainline tunnel to be aligned to intersect Quaternary alluvium as little as possible • 10,000 year ARI flood immunity to be provided to the tunnel portal and exit/entry ramp portals • Adverse hydraulic impacts upon external properties under a 100 year ARI design event to be avoided • Diversion of the creek that flows through the culverts under the North Coast Railway to be planned for construction and operation • Major sewer, optic fibre, and gas pipelines and facilities to be accommodated.

The design options were evaluated against the option selection criteria and those not meeting the criteria were eliminated. Options NEC_3B and NEC_6 were developed further as they generally met the design criteria. The layout of these options is shown in **Figure 3-3**. The evaluation of these options is summarised in **Table 3-6**. Option NEC_6 best meets the design criteria and this option is outlined in detail in Chapter 4 – Project Description.

Table 3-6 Options Assessment – North-eastern Connection

Options Considered	Assessment of Options
Option NEC_3B This option allowed for all turning movements at the connection, no structures constructed in Schulz Canal, and a fast diamond intersection (i.e. right hand turns from opposite directions can be made at the same time through one set of traffic lights only). Elevated embankment required south of and adjacent to Schulz Canal.	**Option NEC_3B** Potential flooding impacts in Schulz Canal that would need to be mitigated. Impacts on Kalinga Park in the construction period. Potential impacts on the North Coast railway and Airtrain.
Option NEC_6 This option is similar to Option NEC_3B as it allows for all turning movements with a fast diamond intersection. Structures (a single traffic lane on piers north and adjacent to the East-West Arterial Road) are constructed in Schulz Canal so that there is minimal property impact to the east of Sandgate Road. The tunnel alignment west of Sandgate Road was moved to the north with the driven tunnel commencing just east of the properties in Kalinga Street. The exit ramp from Airport Link to Sandgate Road moved to the north so that the Airtrain abutment and piers are minimally affected. The exit ramp also provides for two lanes to Sandgate Road (north) and Sandgate Road (south).	**Option NEC_6** Similar impacts to Option 3B except that it minimises property impacts and provides greater capacity at the off-ramps to eliminate the queuing into the cut and cover tunnel.



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AIRPORT LINK - Figure 3-3

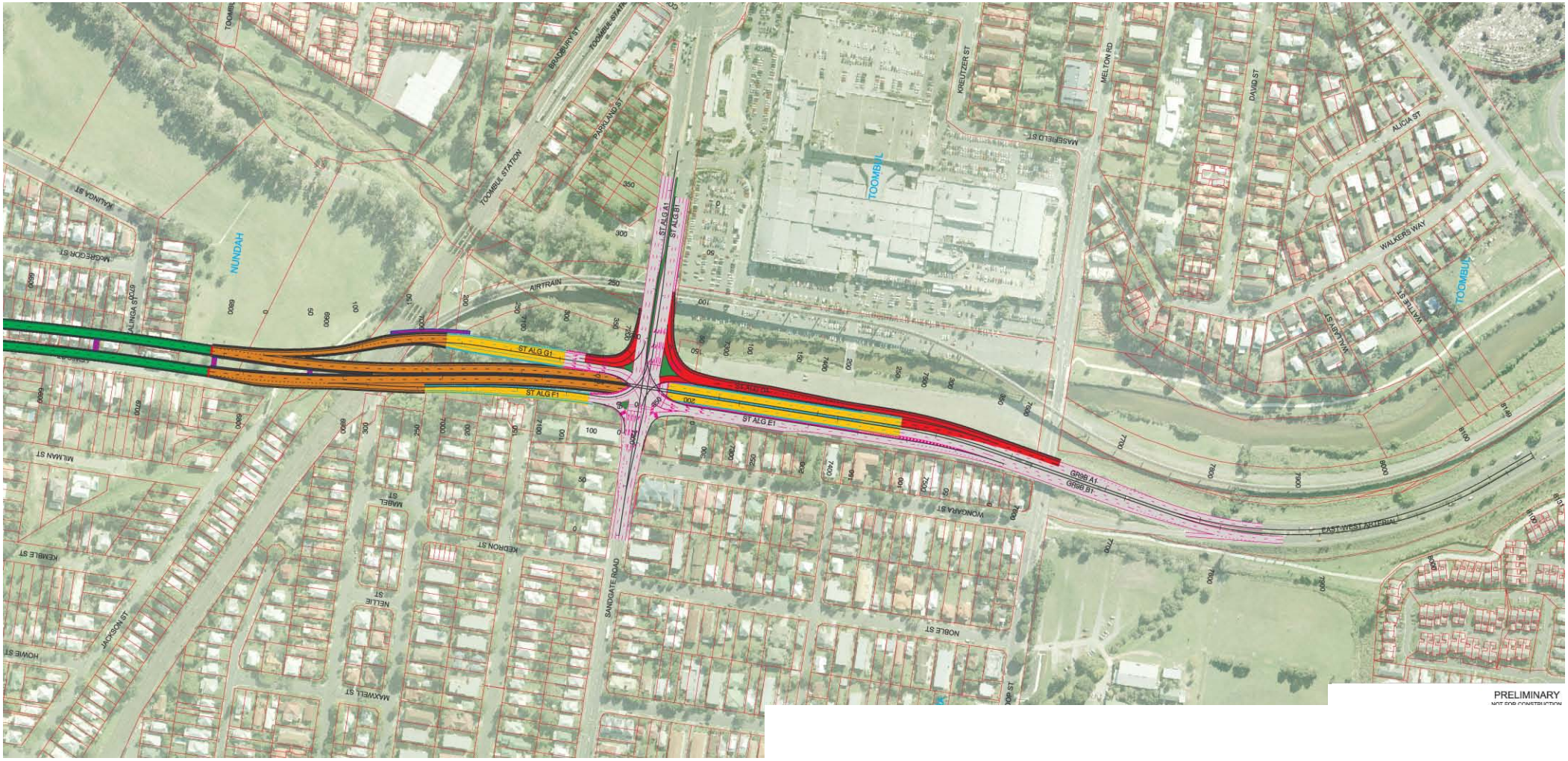
Sandgate Road Connection SR_3B

N

0 1 2km

Airport Link

SKM Connell Wagner JOINT VENTURE



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AIRPORT LINK - Figure 3-3a

Sandgate Road Connection SR_6

N

0 1 2km

Airport Link

SKM Connell Wagner JOINT VENTURE

3.5 Ventilation Systems and Outlets

Tunnel ventilation systems are designed to control the air quality within the tunnel by diluting the concentration of pollutants arising from the vehicle emissions to acceptable concentrations for in-tunnel air. Vehicle pollutants are a function of traffic volumes, vehicle mix (age and type), speed and the effect of gradients within the tunnel. For longitudinal ventilation of a tunnel, under normal operations, ambient air would enter the tunnel from all portals and would be moved along the tunnel by a combination of vehicle-induced airflow and mechanical ventilation through the use of jet fans located throughout the main tunnel and associated ramps. The air would then be extracted at a point within the tunnel towards the exit portal, and from there vented to the atmosphere by means of a ventilation outlet.

The use of longitudinal ventilation systems is expected to deliver the best outcome for both in-tunnel air quality and for ambient air quality (refer to Chapter 9 – Air Quality for an analysis of the ambient air quality impacts). Longitudinal ventilation systems require three ventilation stations and ventilation outlets for Airport Link, with one located near each of the connections with the surface road network. The location of the ventilation outlets is a matter of community interest and concern. The locations proposed in the reference design were determined having regard to a range of community, environmental and construction and operational criteria discussed later in this section.

The location of the extraction point about 150 m from the portal constrains the location of the ventilation outlet to a position to achieve cost-effective construction and operational conditions. Feasible options for ventilation outlet sites were selected within a distance of 500 m from each extraction point, all of which were 150 m from the end of each tunnel.

3.5.1 Ventilation Stations & Outlets – Site Options

To identify possible locations for ventilation stations and outlets for each of the surface connections, general investigation areas were established, generally within, but not limited to, 500 m of the likely location of the extraction points. For each of the three locations, there were constraints limiting the number of practical and realistic options for ventilation stations and outlets. Such constraints included physical, environmental, hydrological and community aspects.

At the southern connection three sites (shown in **Figure 3-4**) were considered for further analysis, as follows:

- SC_A – on vacant land between the southern end of Byrne Street and Enoggera Creek;
- SC_B – on the northern bank of Enoggera Creek adjacent to the inbound approach to Enoggera Creek bridge; and
- SC_C – directly on top of the cut and cover tunnel structure between Earle and Byrne Streets.

Two sites (shown in **Figure 3-5**) were further considered at the north-western connection, as follows:

- NW_A – adjacent to the Emergency Services Building on the eastern side of Gympie Road adjacent to Kedron Brook; and
- NW_B – between the southern ends of the twin bridge structures over Kedron Brook, just west of the Gympie Road to Kedron Park Road to Lutwyche Road intersection;

Four sites (shown in **Figure 3-6**) were further considered at the north-eastern connection, as follows:

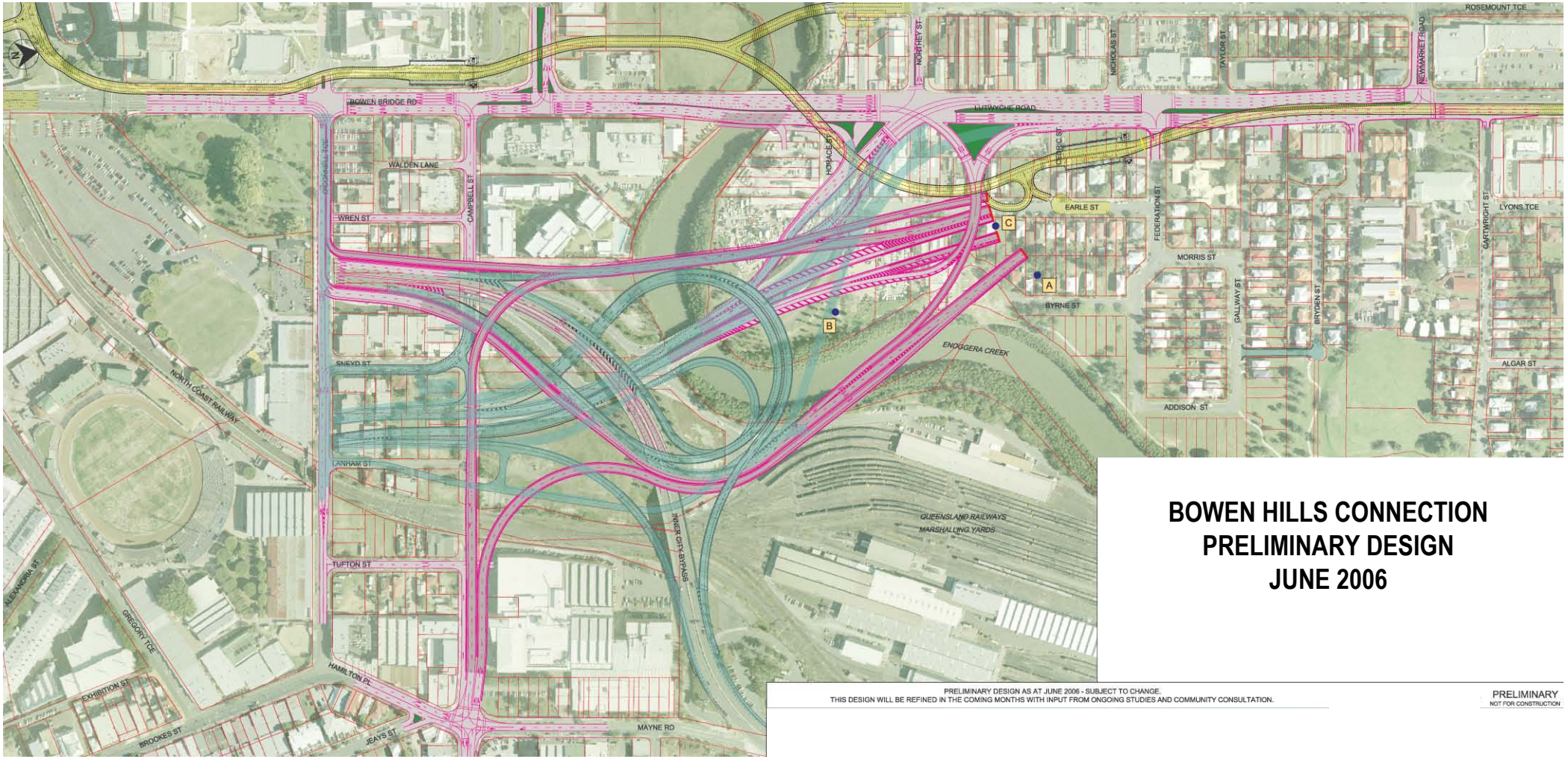
- NE_A – directly on top of the cut and cover tunnel structure immediately west of the Sandgate Road to East-West Arterial intersection;
- NE_B – within the loading dock on the southern face of Centro Toombul and not protruding south of the building line so as to avoid impeding stream flow in the event of a flood.
- NE_C – in Ross Park adjacent to Sandgate Road but north of the line of the southern face of Centro Toombul building projected west across Sandgate Road; and
- NE_D – the small triangular block of land south of the intersection of Parkland Street and Sandgate Road directly across Sandgate Road from Centro Toombul.

3.5.2 Selection of Ventilation Stations & Outlet Sites

Each option was assessed against a range of criteria including ventilation function, air quality, land use, physical constraints, access, visual impact and relative indicative costs of construction of the ventilation shaft connecting the ventilation station with the outlet.

Discussion of the comparison of options against the criteria are outlined in **Table 3-7**. These options were available for public comment in June 2006 as part of material presented and discussed in preliminary consultation activities. The preferred options are outlined in Chapter 4 of the EIS.

Since presentation of the site options, further design studies found that, for option NE_A, there would be engineering constraints to siting the ventilation station directly on top of the mainline tunnels under Sandgate Road. These constraints include the scale of the air ducting from the extraction point under Kalinga Park preventing an acceptable connection with a fan station atop the mainline tunnels. Alternative sites north of and immediately beside the Sandgate Road exit ramp would lead to potential flooding impacts in Schulz Canal. Alternative sites south of and immediately beside the Sandgate Road entry ramp would provide better opportunities for visual screening and screening of traffic noise from the ramp for properties south of the alternative site in Alma Road and Stuckey Road, while still achieving a good outcome in terms of dispersion and minimising impacts on ambient air quality.



BOWEN HILLS CONNECTION
PRELIMINARY DESIGN
JUNE 2006

PRELIMINARY DESIGN AS AT JUNE 2006 - SUBJECT TO CHANGE.
THIS DESIGN WILL BE REFINED IN THE COMING MONTHS WITH INPUT FROM ONGOING STUDIES AND COMMUNITY CONSULTATION.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- Surface Works
- Median/Islands
- Northern Busway Alignment
- Possible Ventilation Outlet
- North South Bypass Tunnel Tender Design

AIRPORT LINK - Figure 3-4

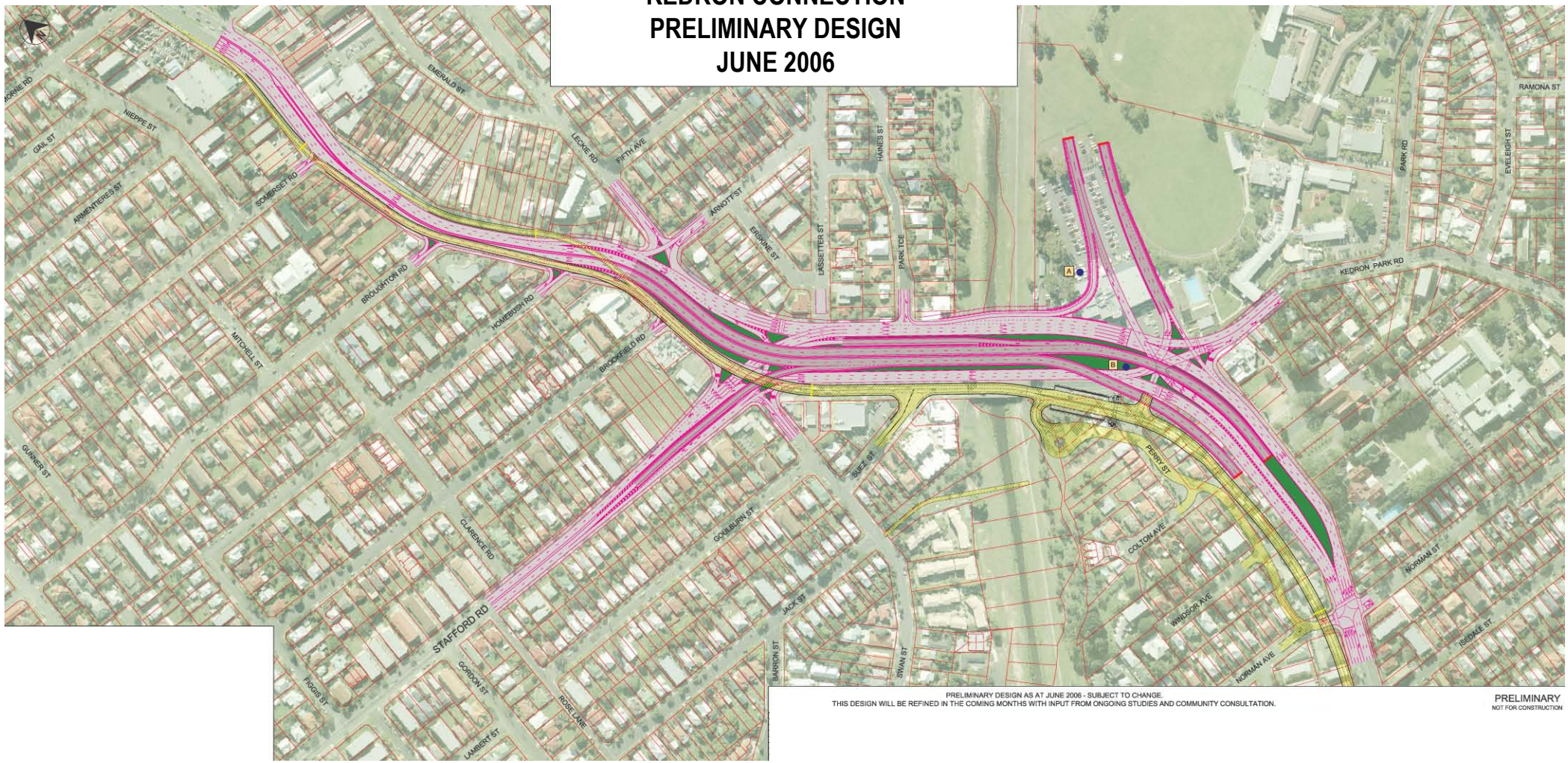
Southern Connection Ventilation Outlet Options

0 1 2km

Airport Link

SKM Connell Wagner
JOINT VENTURE

KEDRON CONNECTION
PRELIMINARY DESIGN
JUNE 2006



PRELIMINARY DESIGN AS AT JUNE 2006 - SUBJECT TO CHANGE.
THIS DESIGN WILL BE REFINED IN THE COMING MONTHS WITH INPUT FROM ONGOING STUDIES AND COMMUNITY CONSULTATION.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- Surface Works
- Median/Islands
- Northern Busway Alignment
- Possible Ventilation Outlet

AIRPORT LINK - Figure 3-5

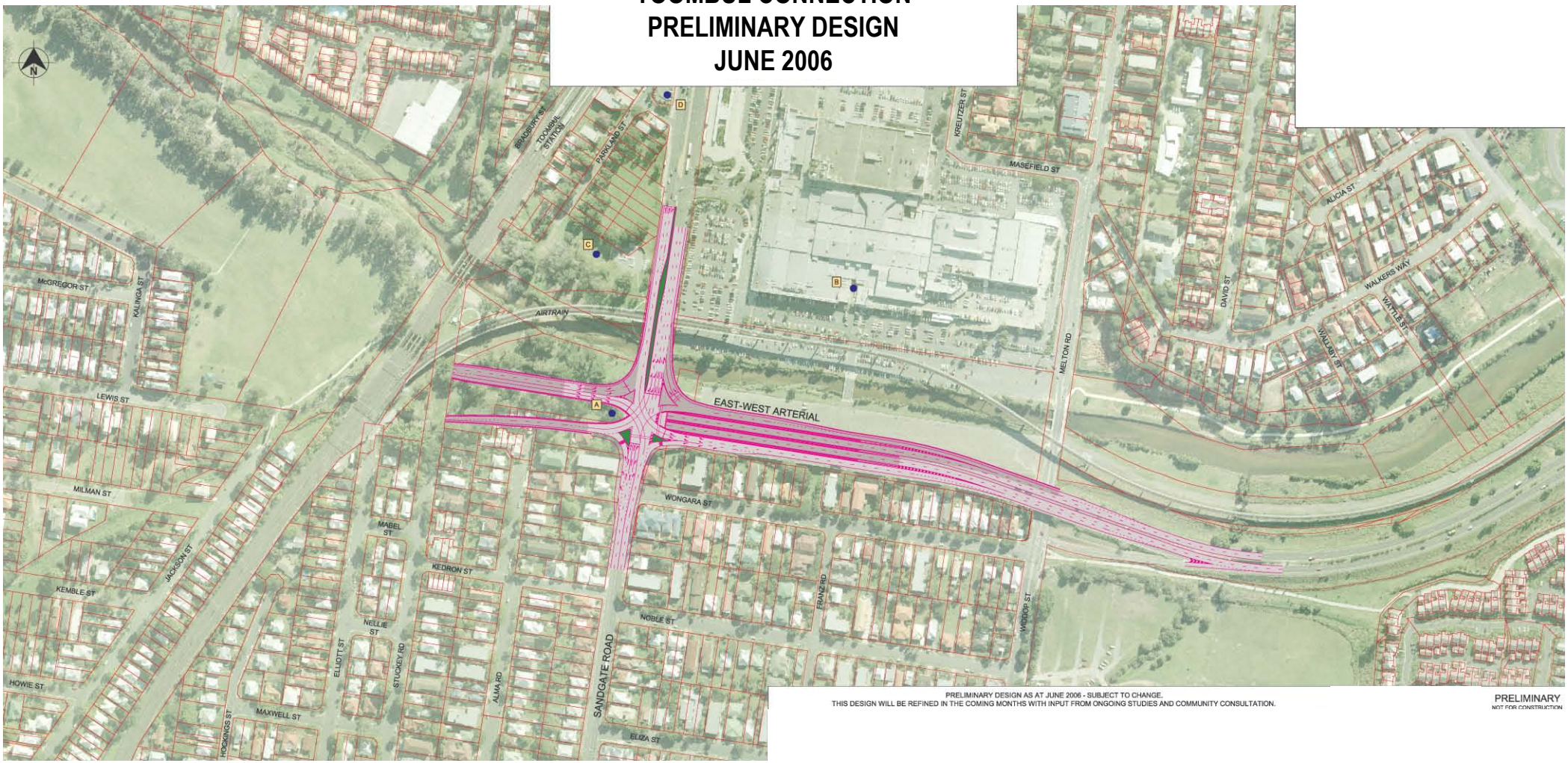
NorthWestern Connection Ventilation Outlet Options

0 1 2km

Airport Link

SKM Connell Wagner
JOINT VENTURE

TOOMBUL CONNECTION
PRELIMINARY DESIGN
JUNE 2006



LEGEND

- Surface Works
- Median/Islands
- Possible Ventilation Outlet

AIRPORT LINK - Figure 3-6

NorthEastern Ventilation Outlet Options

N

0 1 2km

Airport Link

SKM Connell Wagner JOINT VENTURE

Table 3-7 Option Selection Criteria Discussion - Ventilation Outlets

Category	Option Selection Criteria	
Ventilation function	Proximity to extraction point <500metres	Preferred locations are generally within 500m of the extraction point. In the north-eastern connection this is a constraint for a number of options. The north-western connection at Kedron needs to bring together extraction points from both north and westbound mainline tunnels and a central location to the tunnel works is favoured. At the southern connection all options are appropriate.
Air Quality	Achieve adequate dispersion to meet ambient goals	Preliminary dispersion modelling was undertaken for the emission of oxides of nitrogen (NO_x) from the outlets. NO_x is a critical air pollutant in the airshed with air quality criteria specified by the EPA and is only approx. 20% of the modelled emissions. All site locations have similar concentrations of NO_x in terms of both maximum ground level concentrations (1 hour and annual average), and the overall pattern of dispersion. Predicted concentrations of NO_x are well below specified goals for NO_x for both 20m and 30m high outlets in all site locations.
	Separation from tall buildings >100m	Only NE-D, a location opposite the Centro Toombul entrance, is close to recently proposed 6-7 story residential development in Parkland Street.
Land Use	Proximity to sensitive receptors (aged care, child care, schools, health care)	Most sites have been chosen to avoid proximity to sensitive locations. A development application for a childcare facility is before Council some 200m east of NE_B. SC_C is less than 200m south of the Regis Marooma Nursing home off Federation Street. Each option for the north-western site is within 500m of schools (primary and secondary).
	Proximity to residential areas	NE_D is close to new multi-story residential development along Parkland Street near Toombul station NE_A is adjacent to the community south of Kalinga Park (i.e. Eagle Junction) NW_A is 150m from residential areas north of Kedron Brook NW_B is 100m from the Colton Street / Perry Street residential area SC_A and SC_C are close to the residential area served by Federation Street.
	Ownership	Land acquisition will be required for a number of site options at each of the connections. Sites could be located on land to be acquired for construction or other aspects of project delivery if found to be suitable against other criteria, rather than acquire additional land for no increased benefit.
Physical constraints	Flood-free land Drainage Clear of tall vegetation	Most sites are clear of flood and drainage constraints as well as the need to clear vegetation additional to tunnel requirements, apart from the NE_C site in Ross Park, which would require both vegetation removal and flood protection. All sites in the north-eastern connection apart from NE_A would require a significant crossing of Schulz Canal for a ventilation shaft connection from the ventilation station to the outlet. Flood levels and hydrostatic pressure issues influence the locations adjacent to Kedron Brook, Schulz Canal and Enoggera Creek.
Access	Access for maintenance vehicles & Emergency Services	While all sites provide for access, NW_A is more difficult to access than the other options for the north-western ventilation station.
Visual Impact	Potential to be screened from major thoroughfares, open space and residential areas Context in terms of building height and character	Of the four options for the north-eastern ventilation station and outlet, NE_B embedded within the edge of Centro Toombul is considered able to be visually assimilated in and consistent with Centro's existing visual context. Other sites in the north-eastern connection are likely to be more visually obvious without extensive landscaping. Variations in outlet height and performance were assessed to consider alternatives. The north-western options at Kedron are capable of being integrated within the tunnel works, Due to their physical separation from sensitive landscapes, each option has the potential for successful visual impact mitigation. However, NW_B is considered to be less desirable for its visual impact than NW_A. Comprehensive and integrated landscaping and architecture will be required to reduce the visual impact of this facility.

Category	Option Selection Criteria	
		SC sites are considered able to be embedded within significant road works and elevated structures proposed in the area or largely more isolated. An integrated landscaping and architectural solution is required to reduce the visual impact of this facility, particularly from the south.
Relative Indicative Cost of construction of the Vent/tunnel Duct only	L = less than $10M M = $10M to $20M H = $20M to $40M H+ >$40M	The estimates indicate the costs involved in the construction of the vent tunnel/duct including allowances for overheads and risk. The details of the connection to the main tunnel and the vent building and stack have been assumed to be the same for all options and are subject to detailed design investigations. No allowance has been made for property acquisition costs, M&E costs, traffic management where routes cross roads, interface with co-located sites etc. Costs are largely indicative of distance required and complexity of construction.

3.6 Spoil Management

Construction of the Airport Link Project is expected to produce and remove approximately 1.6 million cubic metres of bank material[3] from the tunnel excavations (driven tunnelling and cut and cover), which would equate to approximately 2.4 million cubic metres of loose spoil to be transported to suitable placement or reuse sites. Options were identified and assessed for the production, removal and placement of spoil from the construction phase of the project.

3.6.1 Spoil Production & Removal

The volume and rate of spoil production and the location from which it would be removed would vary, depending on the types of tunnelling construction used and the timing of those processes. For example, tunnel construction by tunnel boring machine could result in a higher rate of spoil production and potentially greater quantities of spoil than for a comparable length of tunnel constructed by roadheader methods or drill and blast methods. Different options for combinations of tunnelling construction were developed and assessed and while one was adopted for the purpose of environmental impact assessment, alternative construction methods might be adopted for the project delivery.

The construction option adopted comprised the use of roadheaders on north-south tunnels and tunnel boring machines for the east-west tunnels. As discussed in Chapter 4 – Project Description, a particular type of TBM (Earth Pressure Balance Machine) on the east-west tunnels is adopted for the purpose of environmental impact assessment in response to the environmental and construction issues arising with project delivery of the east-west tunnels. The actual construction method adopted for project delivery will be determined by the contractor having regard to the environmental, commercial and construction factors, in addition to any requirements of the Coordinator-General's evaluation of the EIS.

The construction options were adopted for this EIS in response to:

- The tunnel cross-section required for three lanes in the north-south tunnel would be at the upper limit for tunnel boring machines in hard rock, which when combined with the need for sections of four-lane tunnel at the connections with the surface road network, makes the use of roadheaders more efficient and more flexible in construction planning compared with TBMs;
- The weakness of the sedimentary rock in the east-west tunnel imposes risks associated with groundwater inflow, settlement and tunnel stability during construction. Without limiting the construction method

[3] Bank material is existing in-situ material and does not include a bulking factor

ultimately adopted by a contractor, the Reference Project has adopted tunnel construction by an Earth Pressure Balance machine for the two lane east-west tunnelling works.

Estimates of amounts of spoil produced at each of the worksites were calculated for the Reference Project and are detailed in Chapter 4 – Project Description. Other construction methods may be developed prior to construction, resulting in different volumes, production rates and haulage tasks for spoil removal, handling and placement.

Consideration was given to an alternative construction method for the east-west driven tunnel works. The alternative method entails commencement of the TBM (EPBM) works on the east-west driven tunnel from the north-eastern connection and then turn it around at the north-western connection to drive the second tunnel back to the north-eastern connection. This would result in a much greater volume of spoil being extracted at the north-eastern connection. This approach offers direct access to a haul route on the East-West Arterial and the Gateway Arterial and proximity to the spoil recycling plant at Viola Place. This alternative was not adopted for EIS assessment on the bases of:

- The difficulty of transporting the TBM through local streets to place it in its starting position and then again for extraction; and
- Difficulties in the scheduling of works at the north-eastern connection, given the availability of the TBM (EPBM) and the necessities of construction of the cut and cover tunnel and other works at this connection.

Spoil will be produced from each of the major worksites at Windsor / Bowen Hills, Kedron / Lutwyche and Toombul / Clayfield. While the rate of spoil production and overall quantities for each worksite will be determined following detailed design and construction planning, the Reference Project described in Chapter 4 of this EIS adopts a probable scenario for the purposes of impact assessment.

3.6.2 Selection of Placement Sites

An analysis of spoil placement options was undertaken by contacting potential recipients, discussing opportunities with them and assessing the risks and constraints associated with those opportunities. Site options and assessments are summarised in **Table 3-8** and shown on **Figure 3-7**.

The old Brisbane Airport site for the Gateway Upgrade Project and the spoil recycling site at Viola Place, Eagle Farm, are desirable options due to their proximity and accessibility to the north-western and north-eastern worksites via the arterial road network. These sites are likely to be available for spoil placement within the anticipated timeframe of the tunnel excavation.

If there is insufficient capacity at the old Brisbane Airport site or Viola Place to handle the entire spoil placement from the project or if the area is completely filled with spoil from the NSBT project, adequate capacity to place the balance of the spoil exists at the Clunies Flat or Fisherman Islands sites at the Port of Brisbane. The capacity at the Port of Brisbane is sufficient to accept all spoil generated by the Airport Link Project if necessary. This will provide considerable flexibility in the process if the area available at the old Brisbane Airport site is less than anticipated.

These options were adopted for the Airport Link Project to allow appropriate assessment. It is possible, however, that the project contractors may seek alternative locations for disposal, or that the relative proportions of material to each defined site may change. As with the preferred spoil placement sites, where alternative spoil placement sites are used by the contractor, the necessary approvals will also be required prior to the commencement of spoil placement.

- **Table 3-8 Spoil Placement Site Options**

Location	Ownership	Potential fill requirements and timing	Environmental and Planning Issues
Old Brisbane Airport Site – Gateway Upgrade Project	Brisbane City Council	Up to 800,000m^3 required.	Access to the site – either over railway at Schneider Street or past Auction House via Lamington Avenue. Ecological studies done on site as part of Masterplan. No major issues.
Viola Place recycling facility	Brisbane Airport Corporation	As a recycling facility the amount of spoil received at the site is limited by its capacity to store and process the material.	The facility is not yet operational, and obviously needs to be prior to commencement of tunnelling works. Access to the site as described above or via Sugarmill Road off Kingsford Smith Drive.
Port expansion area at Fisherman Islands	Port of Brisbane Corporation	230ha being filled behind the extended seawall. Filling to take 10-15 years.	Approved reclamation project. Necessary approvals already in place via Port authority. Could accept all Airport Link spoil if necessary
Port area-Clunies Flat	Port of Brisbane Corporation	Clunies Flat area along the Brisbane River has been used for dredge spoil placement in the past (mainly fines). Proposed for industrial development in future, but no timing for this development known. Land would take between 600,000m^3 and 1,000,000m^3.	Limited ecological values given its use for dredge spoil placement in the past.

3.6.3 Spoil Transport Options

A range of transport options has been considered in moving construction spoil to the potential placement sites. The options include:

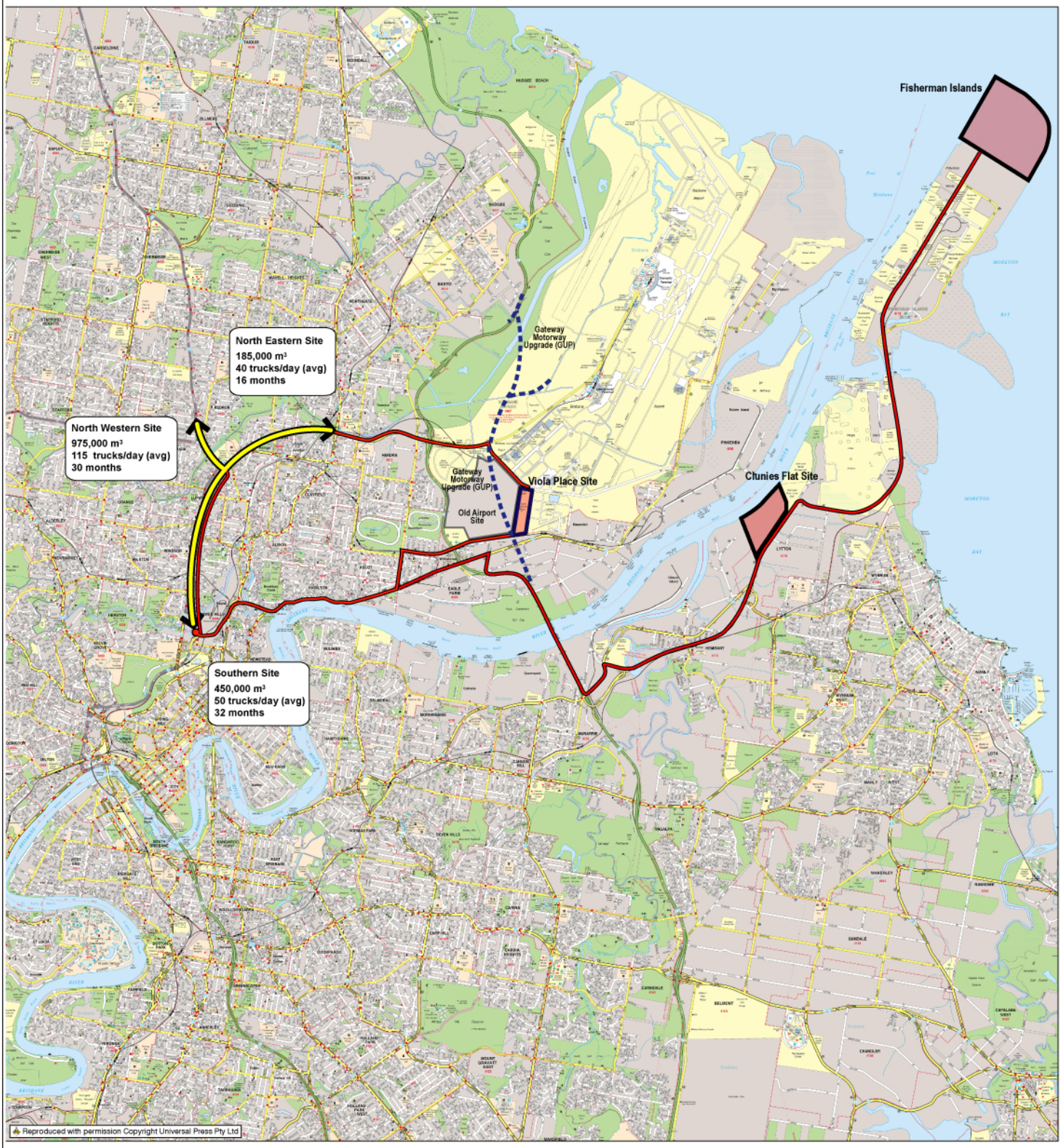
- Road transport, via the network of arterial roads servicing each of the work sites;
- Rail transport, via the urban rail network, serving the Viola Place and Gateway Upgrade (GUP) sites and providing an alternative to road transport for placement at sites in the Port of Brisbane; and
- River or barge transport from the southern worksite, via Enoggera Creek.

Road Transport

Generally, spoil haulage should be confined to the arterial road network except where the use of local roads is required to access worksites and spoil placement sites. The hours for spoil haulage will be up to 24 hours per day from 6.30am Monday to 6.30pm Saturday, with no haulage at any time on Sundays or public holidays. This approach will require adequate capacity for secure on-site storage of spoil at each of the major worksites.

The arterial road connections for spoil haulage from the southern worksite are to enable progress from Lutwyche Road to Kingsford Smith Drive. Depending on the stage of construction and bearing in mind a desire to minimise impacts on residential areas several different routes could be employed, involving different combinations of Bowen Bridge Road, the Inner City Bypass, Campbell Street, O'Connell Terrace, Gregory Terrace, Brooks Street, Hamilton Place, Montpelier Road, Breakfast Creek Road and on to Kingsford Smith Drive. The spoil haulage task will need to be supported by the preparation and implementation of a Construction Traffic Management Plan to minimise the impacts on the arterial road network, particularly for those periods of overlap with construction of the NSBT Changed Project.

The arterial road connections serving the north-western worksite at Kedron / Lutwyche are either:



0 2km

LEGEND

Road haulage route options

Airport Link Project

Figure 3-7
Potential Spoil Placement Sites
& Transport Options

Airport Link

SKM Connell Wagner JOINT VENTURE

BRISBANE CITY

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- Along Rose Street and Junction Road to Sandgate Road then along the East-West Arterial to the Gateway Arterial and any of the spoil placement sites;
- Along Lutwyche Road, then via similar route to that described above from the Southern Worksite to Kingsford Smith Drive and on to the spoil placement sites noted above.

Spoil haulage along the former route (i.e. Junction Road to East-West Arterial) would put pressure on those roadways and their suburban nature. There would likely be community concerns regarding amenity and traffic safety arising from the implementation of this option. Spoil haulage along the second route would avoid the suburban areas of Wooloowin and Clayfield but would need to be managed in conjunction with any construction traffic associated with the NSBT Changed Project and/or the Northern Busway.

Spoil haulage from the north-eastern worksite would be undertaken via the East-West Arterial to the Gateway Arterial and other roads to any of the spoil placement sites. Access from the worksite to the East-West Arterial would need to be controlled if involving the use of the Sandgate Road – East-West Arterial intersection. Alternatives could include the use of conveyors to a handling facility east of Sandgate Road, allowing direct access to the East-West Arterial.

Rail Transport

Investigations were undertaken to determine the physical and commercial feasibility of transporting project spoil. Based on the Reference Project approach to construction, much of the spoil would report to the Kedron / Lutwyche worksite with less than one-third reporting back to the Windsor / Bowen Hills worksite. There would only be a comparatively small amount to be removed from the north-eastern worksite. Consequently, the removal and haulage of construction spoil via rail from the Bowen Hills / Windsor worksite would be impractical and costly, and would involve double-handling of the material at both the dispatch and receiving depots, before placement could occur at any of the selected spoil placement sites. There is no practical option for spoil haulage by rail from the Kedron worksite as the closest rail corridor is situated well to the east between Wooloowin and Eagle Junction. Again, double handling at both the dispatch and receiving depots would be required, as well as the construction of a dispatch siding in close proximity to residential areas.

For any rail haulage option, double handling at the receiving depot is likely, to transport construction spoil from the rail head by road to spoil placement sites.

Water-based Transport

There is no practical water access to the Kedron / Lutwyche worksite. The limited creek depth, as well as narrow spans and low clearances of several of the bridges over Enoggera Creek, downstream of the southern worksite, effectively preclude the use of barge transport of spoil from this worksite.

Other Spoil Transport Options

Other options for spoil transport include the use of a slurry pipeline and conveyors. The former may be developed further in detailed design, but was not investigated in detail in this EIS due to the extent of de-watering and double-handling involved in transportation and environmental management. The use of conveyors may also be developed further in detailed design, but was not investigated in detail in this EIS due to the requirement to secure additional land both for the conveyor corridor and a remote handling site. It is noted however, that a conveyor-based solution would enable handling and loading of haul trucks to the east of the Kalinga Park worksite and access the East West Arterial. If construction spoil could be transported through the east to west tunnels without hindering or constraining construction of those tunnels, the conveyor solution would reduce the road haulage task from both the north-eastern and the north-western worksites.