Independent Technical Advice: Northern Link Road Tunnel Project Change

December 2010

Department of Infrastructure and Planning

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Glossary

CMP	Construction Management Plan
DIP	Department of Infrastructure and Planning
DTMR	Department of Transport and Main Roads
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ICB	Inner City Bypass
INB	Inner Northern Busway
NLRT	Northern Link Road Tunnel
PB	Parsons Brinkerhoff
RD	Reference Design
SDPWO Act	*State Development Public Works Organisation Act 1971*
SEQIPP	South East Queensland Infrastructure Plan and Programme
SID	Safety in Design
TBM	Tunnel Boring Machines
TCC	Tollroad Control Centre
VM Act	*Vegetation Management Act 1994*

1. Introduction

Parsons Brinckerhoff (PB) has been engaged by Significant Projects Coordination of the Department of Infrastructure and Planning (DIP) to undertake an independent technical review of the key aspects associated with the proposed changes to the Reference Design (RD) for the Northern Link Road Tunnel (NLRT) Project.

Previously the Coordinator-General approved the NLRT Project under Section 35(3) of the *State Development Public Works Organisation Act 1971* (SDPWO Act) in April 2010. A request was subsequently lodged with the Coordinator-General for changes to the RD in October 2010. This report is intended to provide the Coordinator-General with a technical assessment of the key changes to the NLRT Project to assist with the criteria assessment of the Changed Project under Section 35H of the SDPWO Act.

We confirm our independence to act for the Coordinator-General and that we have no association with the RD or the successful tendered design. PB was previously aligned with another project bidder who was unsuccessful.

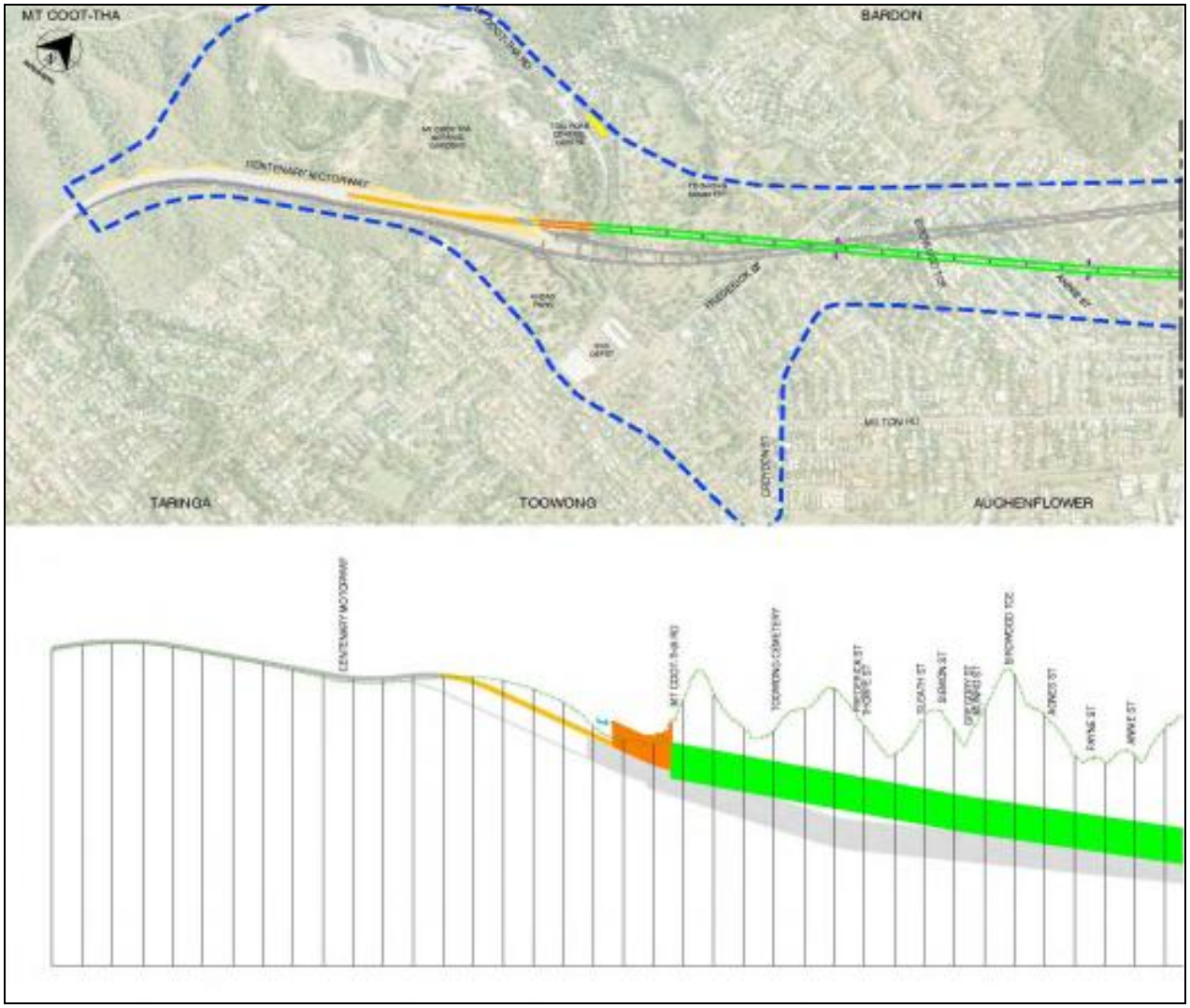
A review has been undertaken on the *Northern Link: Application for Project Change* Report prepared in October 2010, referred to in this document as the Project Change Report (contained in Appendix A). Other relevant supporting documents were examined as part of this review, including (Section 6 contains the reference list):

- Northern Link Environmental Impact Statement (2008)
- Northern Link Environmental Impact Statement Supplementary Report (2009).

The technical review also included an evaluation of other relevant documents, which are referenced in this report, and a further meeting was held between DIP, PB and the proponent (Brisbane City Council) on 19 November 2010 regarding additional technical queries.

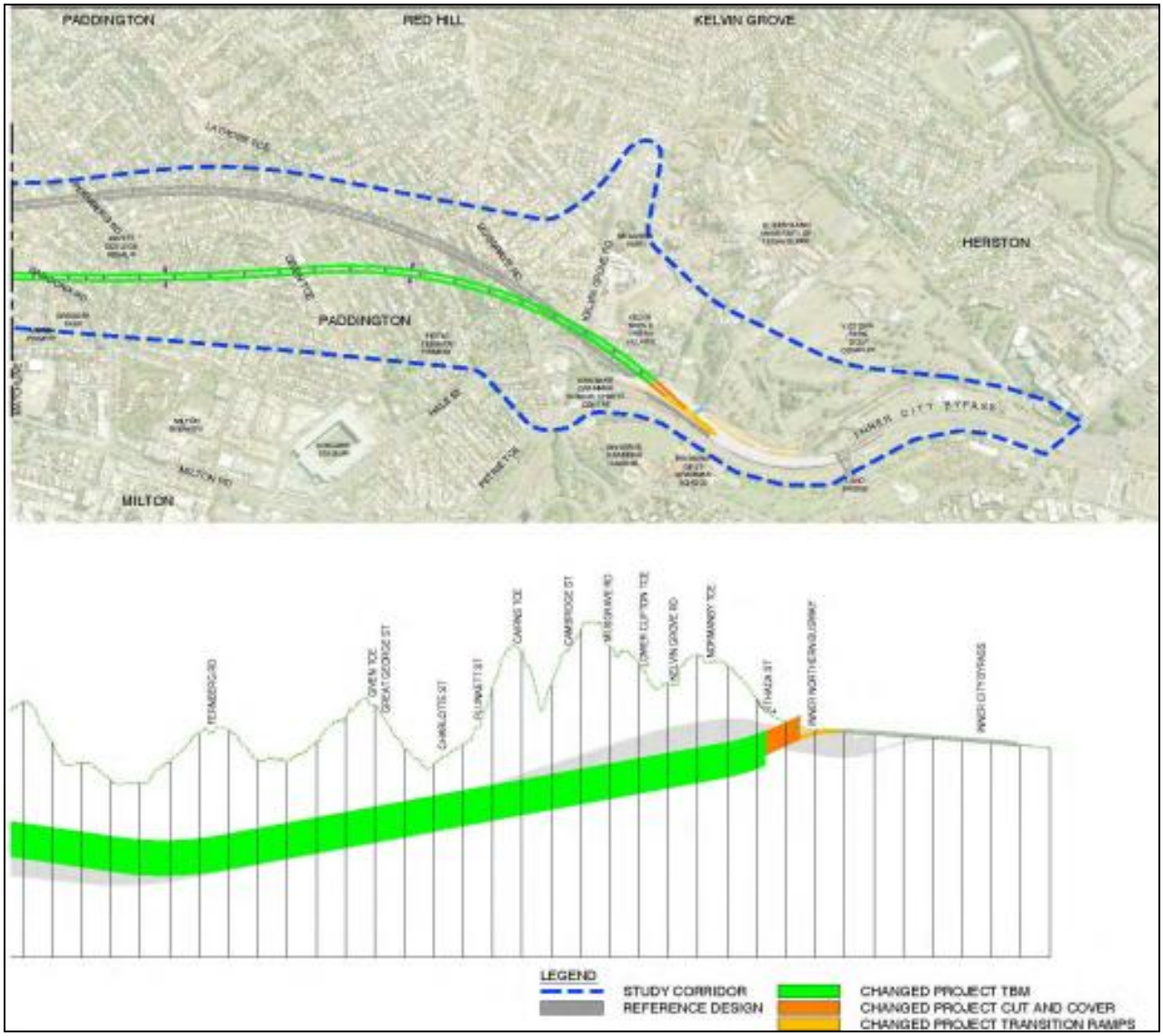
The scope of the technical review has been for the main tunnel alignment, Eastern Connection and Western Connection, as depicted in Figure 1 and 2 below (sourced from Figure 1 of the Project Change Report contained in Appendix A of this report). All changes are contained within the original EIS study corridor and the original assessment that was completed applies to the Changed Project.

The following details an overview of the proposed changes.



(Source: *Northern Link: Application for Project Change Report* (2010))

Figure 1.1 Western Connection comparison of the Reference Design and Changed Project



(Source: *Northern Link: Application for Project Change Report* (2010))

Figure 1.2 Eastern Connection comparison of the Reference Design and Changed Project

1.1 Overview of main tunnel alignment changes

The proposed changes, as described in the Project Change Report, present a number of alterations to the design of the main alignment in comparison to the RD. The key changes to the design of the main alignment include:

- the realignment of the main tunnels generally to the east and south between the two connections
- a change to the vertical alignment of the main tunnels so that they are shallower for much of the tunnel route than those proposed in the RD.

The rationale for these changes stems from the need for the main alignment to provide a more direct route between the connections and to optimise tunnel gradients. As a result of the changes to the alignment, the number of properties affected by the Changed Project (334 properties) is less than previously identified in the RD (374 properties). There will be 269 newly affected properties by the changed alignment.

Several construction changes to the main alignment are also proposed. The Changed Project will entail the use of Tunnel Boring Machines (TBMs) with the installation of continuous, segmented, pre-cast concrete rings to enhance ground support and prevent the inflow of groundwater. This is a key difference from the Reference Project, which proposed a drained-tunnel construction by TBMs with in-situ concrete lining.

1.2 Overview of eastern connection changes

The key changes between the Changed Project and the RD at the Eastern Connection are identified to include:

- the realignment of the eastbound lanes on the Inner City Bypass (ICB) to the north to allow the portals for the NLRT main tunnels to be located centrally
- the consequent realignment of the NLRT transition ramps so they are located in the centre of the realigned ICB
- changes to the Inner Northern Busway (INB) to allow an additional span to be constructed beneath it to accommodate the realignment of the eastbound ICB lanes.

The Changed Project will involve a small increase (acquisition of less than 1,000 m^2) to the size of the land required over Brisbane Grammar School playing fields due to the realignment of the eastbound lanes on the ICB.

1.3 Overview of western connection changes

The key design changes between the Changed Project and the RD for the Western Connection include:

- the relocation of the tunnel entry and exit portals, and the associated transition ramps, to the inside of the Centenary Motorway

- the consequential realignment of the eastbound lanes of the Centenary Motorway to the north and east to incorporate the changed connections with the motorway.

The Changed Project also proposes to alter the location of key project infrastructure in proximity to the Western Connection. These changes include:

- the movement of the western ventilation station and ventilation outlet to a position north-west of the proposed RD location
- the relocation of the Tollroad Control Centre (TCC) from an area in the western worksite presented in the RD, to a site located opposite to the entrance of the Mt Coot-tha Botanic Gardens (see Section 5).

The latter of these changes will serve to increase the area of the western worksite from approximately 4 ha to 6 ha.

1.4 Report structure

The following technical assessment has been undertaken to address the three areas of the NLRT Project works (i.e. main tunnel alignment and Western and Eastern Connections). Where applicable, each area has been assessed in terms of the following technical field:

- tunnel design
- tunnel alignment
- transport and traffic
- geology and soils
- hydrology and hydrogeology
- air quality and greenhouse gases
- surface water quality
- environmental management
- flora and fauna
- noise
- vibration
- ventilation and fire and life safety
- urban planning, social and land use
- non-indigenous cultural heritage.

Each technical review details a comparison of the RD to the Changed Project, the proponent's justification for those changes, potential impacts highlighted in the Project Change Report, mitigation measures identified in the Project Change Report, an assessment of the Coordinator-General's conditions that are relevant to the proposed change and recommendations for and amendment or further conditions from the existing conditions issued by the Coordinator-General under the SDPWO Act approval.

This technical review has been undertaken with regard to the alignment changes and as such, those changes that are not strictly part of the technical review include the Toll Control Centre and vegetation impacts under the *Vegetation Management Act 1999*. Indigenous cultural heritage has been considered in the EIS document and no further assessment has been made as the changes are accommodated within the EIS study area.

2. Main tunnel alignment technical assessment

Section 2 of this report addresses the relevant technical issues associated with the proposed changes to the main tunnel alignment.

2.1 Tunnel design

2.1.1 Comparison of Reference Design to Changed Project

The horizontal and vertical alignments of both tunnel bores have been changed.

The lining design for the TBM tunnels have been changed to a gasketted (sealed) precast segmental system.

The change in construction methodology would require the delivery of pre-cast concrete segments to the western worksite in time to meet the requirements of continuous TBM operation. It is noted that the TBMs for the RD also were proposed to operate on a continuous basis. With either project, TBM operations would incorporate a maintenance period of up to 4 hours each day on average.

One of the other key design changes involved the delivery, storage and handling of pre-cast concrete segments for the tunnel rings. The pre-cast segments would be delivered to the western worksite by truck via the Centenary Motorway. The segments are likely to be manufactured at a plant in the western industrial corridor (e.g. Wacol or similar).

2.1.2 Justification for proposed changes

The modifications to the alignment deliver improved geometry both for tunnels and for cut and cover structures and allows both TBMs to be launched off-line reducing the impact on existing traffic whilst maintaining ‘suitable geology’ through which to tunnel.

The tunnel lining system provides a sealed tunnel reducing groundwater drawdown and overall seepage rates. The construction methodology has been revised to adopt the use of pre-cast, reinforced, concrete rings to be installed by the TBM. This revised approach would provide enhanced ground support and prevent the inflow of groundwater.

2.1.3 Impacts associated with proposed changes

Tunnel lining

The adoption of a tunnel lining consisting of gasketted segments represents current best practice and an improvement to the RD proposal. The segments will be manufactured at a precast factory distant from the worksite at a location identified in the Project Change Report. Pre-casting and prefabricating generally moves construction works to locations away from sensitive environmental and social receptors. There will be associated changes in heavy vehicle movements which are discussed under the Traffic section of this report.

For the delivery of the concrete rings to be installed by the TBM, two truckloads would be required for each of the 4,300 rings estimated for the two main tunnels.

Alignment

The modification to the horizontal alignment will impact the volumetric title requirements. Given the nature of the surface terrain, it will also change the depth of overburden above the tunnel. The change in vertical alignment will generally reduce the overburden (depth of burial) of the tunnel. On the RD alignment there are no locations other than close to the portals where the tunnel main drive lies within one diameter (1D) of the ground surface. There are three such locations on the changed alignment (refer Figure 2.4 of the Project Change Report). These represent a significant challenge to the proponent.

The change in the alignment will potentially lead to some of the mined tunnel excavations being carried out in more permeable ground, close to soil deposits which may be prone to consolidate if pore pressures are impacted.

Reducing the distance between the bored tunnels at the western end of the drives will reduce the overall width of the settlement trough within Toowong Cemetery as the outer limits of the zone of influence of the two tunnels will move closer together. It will also potentially increase the total settlement as the settlement troughs of the two mainline tunnel bores superimpose upon one another. The final outcome and total settlement will depend upon the combination of ground conditions and overburden.

An assessment of the potential use of ground anchors and rock bolts for the Changed Project was undertaken. The volumetric boundary is identified as lying 1.5 m from the extrados of the tunnel excavation. Should the use of ground anchors and rock bolts be required, the volumetric boundary may not provide sufficient space. The installation of ground anchors as an initial support for mined excavations such as the tunnel cross passages, low point sump or underground substations without projecting beyond the volumetric title limits and impinging on other properties. A meeting held with BCC on 19 November 2010 confirmed that Section 37 of the *Acquisition of Land Act 1967* provides BCC with powers to occupy land temporarily as required for the NLRT Project, which would address this concern.

The design of the Changed Project uses removable ground anchors as part of the retaining system in the cut and cover tunnels (Drawing CC-510).

2.1.4 Proposed mitigation measures

Tunnel lining

No specific mitigation measures are proposed within the change document. This is appropriate for the change in tunnel lining system as it is considered an improvement on the system proposed for the RD.

In terms of traffic and transport, no additional mitigation measures are required to address the proposed changes. The additional delivery from Wacol (or similar location) to the Western worksite should be covered by a separate traffic management plan for the delivery of construction materials to the Western worksite.

It is also noted that access to/from the western worksite would remain unchanged as a left-in, left-out arrangement.

Alignment

Table 2.3 of the Project Change Report tabulates approximate depths of cover to the tunnel crown, but the figures do not fully reflect the minimum levels of cover indicated on the long section provided in Figure 2.4 of the report.

No specific mitigation measures are proposed to deal with the changes in tunnelling conditions generated by the change in alignment.

The construction methodology for the support of the cross passage, substations and sump linings is not shown in detail. No mitigation measures are identified in the Project Change Report.

2.1.5 Assessment of Coordinator-General's conditions

The Coordinator-General's requirements are generally adequate and cover these issues under Section 25 Hazard and Risk although reference is made to a superseded Risk Management standard. Control of the construction risks identified here should be achieved through the Safety in Design process. However, it is considered that the Coordinator-General's requirements could be amended in response to the differing risks associated with the changed alignment. Specifically, in relation to risk management of tunnelling works in areas of particularly low cover i.e. tunnelling within one and a half diameters (1.5D) of the ground surface it is recommended that additional requirements are considered for inclusion.

In terms of traffic management during the construction phase of the NLRT Project, the requirements shall be in accordance with Schedule 3 Clause 16 (a) to (l). The existing Coordinator-General's conditions for traffic management during construction are considered sufficient to cover potential impacts for the delivery of concrete rings for the TBM during the construction phase.

2.1.6 Recommendations

It is recommended that the following be considered by the Coordinator-General:

- a traffic management plan for the delivery of concrete rings from Wacol or similar to the Western worksite should be submitted for approval in accordance with Coordinator-General's traffic management condition Schedule 3 Clause 16
- the Coordinator-General Report makes reference to AS 4360:2004 Risk Management. This document has been revised and redesignated as AS/NZS ISO 31000:2009. It is recommended that the Coordinator-General's requirements are amended accordingly
- the Contractor's tunnel Construction Management Plan should be required to include specific reference to locations of low overburden and special measures put in place to ensure a heightened level of vigilance when construction activities are being undertaken in these areas. Surveys and ground instrumentation should be required to be in place and a detailed ground monitoring regime installed and fully baselined before tunnelling is allowed to proceed below points where the tunnel excavation is within 1.5D of the ground surface.

- in areas where tunnelling through a weathered horizon is expected (i.e. conditions where the weathering of the rock in the tunnel face varies from relatively unweathered in the invert to significantly weathered in the crown), there should be a requirement that the associated risks must be specifically identified in the NNLRT Project Risk Register and managed as part of the contractor's tunnel CMP

- a detailed geotechnical assessment and hydrogeological assessment for each cross passage, particularly those at shallower depths and with overlying sedimentary deposits, accompanied by pore pressure monitoring in the overlying deposits before, during and after tunnelling should be specifically required

- a detailed plan of additional site investigation proposals must be submitted and detailed requirements assessed for areas of high risk including areas of low cover (less than 1.5D) and areas of mined tunnel excavation close to potentially sensitive surface deposits and structures

- removable anchors: the contractor must be able to demonstrate that the anchors used are indeed removable.

It is arguable that these requirements would all be considered good practice and could be generally covered under the requirements of the engineering design standards, Safety in Design and risk management processes applicable to the NLRT Project. However; when considering potential third party impacts it is our view that the tunnelling challenges on this project require particular attention with regard to:

- tunnelling with low cover

- tunnelling where a wide range of degrees of weathering are expected in the tunnel face.

In these zones and circumstances the challenges are such that international best practice must be applied to the design, management and construction of the works to ensure that third party impacts are kept within acceptable levels. This is best ensured by requiring the provision of specific studies and documentation to address the attending issues.

2.2 Tunnel alignment

2.2.1 Comparison of Reference Design to Changed Project

The following horizontal and vertical alignment changes were identified in the Project Change Report:

Horizontal alignment

The mainline tunnel horizontal alignment has been revised to provide a more direct alignment, generally to the south-east of the RD (300 m maximum shift). This has resulted in a straighter alignment and reduction of minimum horizontal curves within the tunnel to approximately 1,500 m

The proposed alignment remains in the EIS study corridor.

Vertical alignment

Mainline vertical alignment has reduced lengths of maximum grade (5%) and overall contains 'gentler' grades (majority around 2%) and is shallower than the RD.

2.2.2 Justification for proposed changes

The Project Change Report detailed the following justifications for the changes:

Horizontal alignment

The reduced TBM tunnel length of approximately 60 m providing a shorter, more direct route for between surface connections.

Vertical alignment

The gentler gradients and reduced length of maximum grade will have a positive effect on traffic flow and operation. The change is driven by the topography associated with the changed horizontal alignment.

2.2.3 Impacts associated with proposed changes

Potential impacts detailed in the Project Change Report include:

Horizontal alignment – A reduction in the number of volumetric resumptions is proposed, down from 374 in the RD to 334. Sixty-five of these are common between the schemes resulting in 269 newly affected properties.

There is minimal impact on road geometry and safety as all elements exceed DTMR requirements. .

Vertical alignment – Only positive impacts on traffic performance and operation have been identified for the proposed vertical alignment.

2.2.4 Proposed mitigation measures

The Project Change Report does not identify any mitigation measures.

2.2.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions make no specific reference to the tunnel alignment.

2.2.6 Recommendations

This tunnel alignment assessment does not recommend any amendments to the Coordinator-General's conditions and no additional studies are required in relation to the alignment design and operational speed of the tunnel

2.3 Transport and traffic

2.3.1 Comparison of Reference Design to Changed Project

The tunnel configuration for the Changed Project would be generally unchanged from the RD, consisting of two separate parallel road tunnels each with two lane carriageways and shoulders. The estimated traffic volumes through the Changed Project would be substantially the same as those estimated for the RD.

Horizontal alignment

The proposed change in the main alignment provides a more direct route between the connections. The main alignment in the Project Change Report starts at the western side of Mt Coot-tha Road, approximately 100 m north of the RD alignment. Under the Toowong Cemetery, the main alignment is a straighter route up to 300 m south of the RD and connects with the ICB on the south side of Normanby Terrace. The eastern connection is in close proximity to the location indicated in the RD.

Vertical alignment

The vertical alignment for the main tunnel is shallower for most of the route apart from the section from Carins Terrace east as a result of changes in the horizontal alignment and ground surface levels and subsequent design changes.

The proposed flatter grades provide for more efficient flows for all traffic, especially for heavy commercial traffic. As a result, reductions in emissions and a safer, more reliable traffic flow can be expected.

The changes to the project delivery arrangements include:

The Changed Project proposes the following:

- the key changes in the design of the main alignment are that the main tunnel alignment is generally shifted to the east and south, with a shallower vertical alignment of the main tunnel when compared to the RD
- an increase to the construction area on the northern side of the Centenary Motorway in the Botanic Garden
- the removal of the requirement for surface road and tunnel construction on the south side of the motorway
- the avoidance of road construction impacting on the Anzac Park wetlands and the existing bicycle path along the motorway
- construction staging strategies that are proposed to mitigate the potential impacts on traffic flows on the Centenary Motorway and Mt Coot-tha Road during construction. Initial construction activities are proposed off the Centenary Motorway and behind construction barriers
- temporary construction workforce parking areas in Anzac Park for up to 300 vehicles, without any loss of significant trees in the park, and with access from Dean Street only
- minor changes to the spoil haulage volumes due to the increase in size of the TBMs from 12.0 m in diameter to 12.4 m in diameter and to changed excavation requirements and quantities
- The Changed Project has shorter distances of roadway with descending grades steeper than 3% than the RD.

2.3.2 Justification for proposed changes

The following justification was provided in the Project Change Report:

- he vertical and horizontal changes to the main tunnel alignment provide a more direct route and easier traffic conditions for heavy vehicles exiting the tunnel portals
- the Changed Project is expected to still cater for the same or similar traffic flows as forecast for the RD
- some network benefits would result as a consequence of the changed connections to the Centenary Motorway and the ICB.

2.3.3 Impacts associated with proposed changes

The flatter descending grades can be expected to reduce the demand for lane changing and assist in the maintenance of vehicle speeds (due to less braking) with resulting safety benefits. This should provide an improvement to traffic flow, safety and vehicle operating efficiencies.

2.3.4 Proposed mitigation measures

In terms of traffic and transport, no mitigation measures are required to address the proposed changes to the main alignment.

2.3.5 Assessment of Coordinator-General's conditions

The following details the relevant conditions imposed by the Coordinator-General in Appendix 1, Schedule 3 (Imposed Conditions) of the Coordinator-General's Report:

- for traffic management:
  - during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 16 (a) to (l)
  - for the operations phase of the project, the requirements shall be in accordance with Schedule 3 Clause 30 (a) to (c).
- for spoil handling and placement: during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 17 (a) to (f)
- other relevant conditions: for general construction during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 18 (a) to (o).

2.3.6 Recommendations

Based on PB's review of the Changed Report and Coordinator-General's conditions, it is our view that no changes are recommended to Coordinator-General's conditions.

2.4 Geology and soils

2.4.1 Comparison of Reference Design to Changed Project

The proponent's interpretation of the ground conditions has not been reviewed in relation to the RD.

It is noted that significant lengths of the tunnel are identified as having no geotechnical data within 90 m.

2.4.2 Justification for proposed changes

The contractor has made his own interpretation for the ground conditions.

2.4.3 Impacts associated with proposed changes

The Project Change Report does not identify any tunnel design impacts resulting from this change.

2.4.4 Proposed mitigation measures

The Project Change Report does not propose any specific mitigation measures in relation to this item.

The Contractor's risk assessment must review this in detail. Mitigation measures will include some or all of the following; additional site investigation, control of tunnelling rates and face pressure, monitoring of spoil extraction rates, detailed monitoring of ground and property movements ahead of and above the machine and ground treatment. In discussion with BCC it was made clear to the reviewer that additional site investigation will be carried out.

2.4.5 Assessment of Coordinator-General's conditions

The existing Coordinator-General's conditions are silent on this issue. The change itself impacts the engineering design. The changes to the tunnel design and consequent effects are typically risks or opportunities, which are managed through the design review and project risk management processes and are not purely environmental impacts. However, the potential consequences represent significant challenges to the project with potential impacts on the environment and have thus been viewed as relevant to the scope of this review.

By changing the alignment of the tunnel and generally reducing the level of cover to the tunnel crown, the Change Project design has been moved into more highly weathered and potentially weaker material. In particular, at MCA1 approximate Ch 2370 mixed face conditions (i.e. the rock materials through which the tunnel is being driven exhibit a wide range of degrees of weathering within the horizon of the tunnel face) combine with less than 10 m of cover.

Such conditions in tunnelling are more commonly associated with increased ground loss and possible surface impacts and thus represent a significant project challenge. In discussion, BCC have advised that additional site investigation will be carried out by the contractor, particularly in areas of low cover. This will be a key action to managing these challenges effectively.

2.4.6 Recommendations

It is recommended that additional conditions are added to the Coordinator-General report requiring specific attention to the risks in areas where tunnelling through mixed face or variably weathered conditions is anticipated and a submission of a detailed action plan from the contractor to address and mitigate these risks. In combination with the additional site investigation, measures such as those identified in section 2.1.6 would be appropriate.

2.5 Hydrology and groundwater

2.5.1 Comparison of Reference Design to Changed Project

The key changes to the RD that would impact upon the surface water and groundwater are:

Hydrology (surface water)

- The proposed realignment of the main tunnels closer to the Milton Road.
- Change in the vertical alignment of the TBM between 10 m to 50 m which would mean generally shallower depths for the TBMs compared to the RD except at the section between Cairns Terrace and the ICB.
- The reduction in the lengths of the TBMs.

Hydrogeology (groundwater)

- The tunnels are to be constructed as an undrained or waterproof system of tunnels, which will allow for a reduction in estimated groundwater inflow rates and drawdown induced settlement.
- With the proposed Changed Project there will be some impacts on the surface water (flooding and drainage) and groundwater quantity that are different compared to those assessed in the EIS.

2.5.2 Justification for proposed changes

The Project Change Report details amendments to the main tunnel alignment, including shallower depth of TBMs and sealed tunnels. These amendments appear to be justified since they would; create a more direct and shorter length motorway link, potentially lower the seepage draining into the tunnels and would generally lower ground settlements within the TBM alignment.

2.5.3 Impacts associated with proposed changes

In general, the impacts on surface and groundwater identified in the Project Change Report are lower in comparison to that assessed in the EIS. The key impacts are:

Hydrology (surface water)

- There would be minor flooding impacts due to the estimated ground settlement of 0–10 mm for both RD and Changed Project. The impact of this is deemed to be negligible.

Hydrogeology (groundwater)

- The groundwater inflow rates are expected to reduce from 4 L/s for a drained tunnel compared to 3 L/s for an undrained tunnel.
- The shallower vertical alignment would decrease the zone of potential lateral drawdown and potential drawdown induced settlement.
- The change in the horizontal alignment brings the tunnel closer to the Brisbane River with the possibility of some hydrogeological connection between the aquifers and the river. The risk is however deemed low due to the nature of the tunnel construction (lining and grouting).
- Due to the shorter realignment, the total volume of seepage water into the tunnel will be lower.

2.5.4 Proposed mitigation measures

In general, the Project Change Report states that the NLRT Project changes do not increase the impacts on surface water and groundwater in comparison to the RD. Some additional mitigation measures proposed for the Changed Project are:

Hydrology (surface water)

- In terms of the identified impacts, the mitigation measures outlined in the EIS for surface water are still considered to be applicable to the Changed Project.
- Impacts for the Changed Project are considered to be negligible and no mitigation measures will be required.

Hydrogeology (groundwater)

- In terms of the identified impacts, the mitigation measures outlined in the EIS for groundwater are still considered to be applicable to the Changed Project.
- Consideration should be given to run the groundwater model for the Changed Project to determine if the impacts are similar and if additional mitigation measures may be required.

2.5.5 Assessment of Coordinator-General's conditions

The existing Coordinator-General's conditions generally address any impacts on surface water and groundwater in relation to the Changed Project.

Hydrology (surface water)

The Coordinator-General's conditions for surface water remain relevant to the Changed Project.

Hydrogeology (groundwater)

The Coordinator-General's conditions for groundwater are presented in Schedule 3, Part 2, Item 21 and remain relevant to the Changed Project.

2.5.6 Recommendations

Hydrology (surface water)

No additional conditions are considered necessary.

Hydrogeology (groundwater)

No additional conditions are considered necessary.

2.6 Air quality and greenhouse gases

2.6.1 Comparison of Reference Design to Changed Project

The principal change to the RD is the proposed realignment of the main tunnels between the connections with the Centenary Motorway and the ICB. The main tunnel alignments would be straighter and shallower.

The proposed ventilation system for the main alignment essentially matches with what was proposed in the RD. A longitudinal ventilation scheme with exhaust outlets at the tunnel ends is proposed. Airflows in the tunnel are to be controlled by jet fans. The efficacy of the proposed ventilation system was not considered in this review. The material changes affecting the ventilation system include the change in alignment as outlined in the Project Change Report. The change in alignment affects pollution generation, which affects both in-tunnel air quality and emissions from the ventilation outlets.

2.6.2 Justification for proposed changes

The changes to the main tunnel alignment is justified in the Project Change Report on the ground that it would create a more direct, safer and more efficient motorway-standard link between the Centenary Motorway and the ICB.

In terms of operational air quality and greenhouse gas emissions, the proponent has identified the flatter vertical alignment of the Changed Project to the RD would result in reduced climbing distances and a reduction in the length of 5% maximum climbing grade.

The Changed Project Report provides results of analysis undertaken to demonstrate that the ventilation system given the alignment changes will meet the in-tunnel air quality requirements listed in the Coordinator-General's Report (Schedule 1 Section 4 items e, f, g, h, i, j, k). Discussion was also provided outlining that the reduced grades would result in less pollution being generated.

2.6.3 Impacts associated with proposed changes

The Project Change Report predicts improvements in traffic safety and reductions in motor vehicle emissions within the Changed Project tunnels compared with the RD. Based on the reduced climbing distances, traffic modelling indicates that heavy vehicle speeds could be maintained closer to the general traffic speed.

This would reduce the demand for lane changing and consequential disruption to traffic flow, providing an improvement in vehicle operating efficiency. As a result, improvement to the air quality in each tunnel and the receiving environment (ambient air quality) and reduced greenhouse gas emissions are predicted.

The proposed changes in the alignment would affect pollution generation and hence levels being emitted by the ventilation outlet. It was documented that the proposed change would produce an improvement (i.e. positive impact).

2.6.4 Proposed mitigation measures

In terms of the identified impacts, the mitigation measures outlined in the EIS for air quality (including ventilation system) and greenhouse gas emissions are still considered to be applicable to the Changed Project.

2.6.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for air quality and greenhouse gas emissions are presented in Schedule 1, Condition 4 and Schedule 3, Condition 2. The conditions remain relevant to the Changed Project.

2.6.6 Recommendations

No additional Coordinator-General's conditions are considered necessary. If there are any design changes to the Changed Project, then consideration will be required for the in-tunnel air quality goals to ensure the revisions to the project continue to meet the Coordinator-General's requirements.

2.7 Surface water quality

2.7.1 Comparison of Reference Design to Changed Project

The principal change to the RD is the proposed realignment of the main tunnels between the connections with the Centenary Motorway and the ICB. The main tunnel alignments would be straighter and shallower.

2.7.2 Justification for proposed changes

The changes to the main tunnel alignment is justified in the Project Change Report on the ground that it would create a more direct, safer and more efficient motorway-standard link between the Centenary Motorway and the ICB.

2.7.3 Impacts associated with proposed changes

The Project Change Report does not identify any surface water impacts resulting from this change. Given that the proposed changes to the main tunnel alignment in this section occur underground, it is considered that they will not impact on quality of surface water resources in a manner which is different to that assessed in the EIS.

2.7.4 Proposed mitigation measures

The Project Change Report does not propose any mitigation measures in relation to this item.

In terms of surface water, no mitigation measures are required to address the proposed changes to the main alignment.

2.7.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for surface water conditions are presented in Schedule 3, Conditions 21 and 32. The conditions remain relevant to the Changed Project.

2.7.6 Recommendations

No additional conditions are considered necessary.

2.8 Environmental management

2.8.1 Comparison of Reference Design to Changed Project

The principal change to the RD is the proposed realignment of the main tunnels between the connections with the Centenary Motorway and the ICB. The main tunnel alignments would be straighter and shallower.

2.8.2 Justification for proposed changes

The Project Change Report details that the amendments to the main tunnel alignment is justified on the ground that it would create a more direct, safer and more efficient motorway-standard link between the Centenary Motorway and the ICB.

2.8.3 Impacts associated with proposed changes

The Project Change Report does not identify any surface water impacts resulting from this change. It is considered that proposed changes to the main tunnel alignment do not impact on environmental management in a manner differently than assessed in the EIS.

2.8.4 Proposed mitigation measures

The Project Change Report does not propose any mitigation measures in relation to this item.

It is considered that the various management measures in the RD as part of the construction and operation EMP are still appropriate and are expected to effectively mitigate general environmental impacts arising from the construction and operation of the Changed Project.

2.8.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions relating to environmental management are presented in Schedule 3, Conditions 14, 15 and 29. The conditions remain relevant to the Changed Project.

2.8.6 Recommendations

No additional Coordinator-General's conditions are considered necessary.

2.9 Flora and fauna

2.9.1 Comparison of Reference Design to Changed Project

The principal change to the RD is the proposed realignment of the main tunnels between the connections with the Centenary Motorway and the ICB. The main tunnel alignments would be straighter and shallower.

2.9.2 Justification for proposed changes

The changes to the main tunnel alignment is justified on the ground that it would create a more direct, safer and more efficient motorway-standard link between the Centenary Motorway and the ICB.

2.9.3 Impacts associated with proposed changes

The Project Change Report does not identify any ecological impacts resulting from this change. Given that the proposed changes to the main tunnel alignment in this section occur underground, it is considered that they will not impact on ecological resources in a manner which is different to that assessed in the EIS.

2.9.4 Proposed mitigation measures

The Project Change Report does not propose any mitigation measures in relation to this item.

In terms of ecological issues, no mitigation measures are required to address the proposed changes to the main alignment.

2.9.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for flora and fauna are presented in Schedule 3, Condition19. The conditions remain relevant to the Changed Project.

2.9.6 Recommendations

No additional conditions are considered necessary.

2.10 Noise

2.10.1 Comparison of Reference Design to Changed Project

The Project Change Report describes that the most important and relevant difference between the Changed Design and the RD is that the main tunnel alignment has become substantially shallower beneath the natural ground surface level, which would have the effect of decreasing the vibration propagation slant distance from the TBM cutting face and thereby increasing the ground vibration and the ground-borne noise level.

2.10.2 Justification for proposed changes

There is no justification in relation to noise provided in the Project Change Report. The Project Change Report indicates that the proposed changes would increase the potential for noise impacts.

2.10.3 Impacts associated with proposed changes

The Project Change Report indicates that there is potential that additional residences would be affected by noise above the objectives due to ground-borne noise from construction activity. This is due to the Changed Design of the tunnel typically being located at shallower depths under residential properties. Assuming that the geological features which have the potential to transmit vibration from the tunnel construction activities to the residence above would be similar for the RD and the Changed Design then the conclusion that additional residences would be affected due to a shallower tunnel is justified.

A summary of the additional residences potentially affected due to the Change Design is presented in Table 3.2 of the Project Change Report. The Project Change Report further clarifies that the modelling indicates that the affected residences would exceed the criteria applicable during the night time for approximately seven to ten days during the construction of each tunnel.

It should be noted that in the prediction of ground-borne noise most consultants would typically take a conservative approach (over predict) to take account of potential variations in regenerated noise. The Project Change Report does not present any detailed information in relation to the prediction methodology or source data used for this analysis and therefore we are unable to determine whether the predictions are likely to be conservative or not. However, additional data has been supplied to PB upon which the Project Change Report was based that allows a more technical assessment of the prediction methodology used in the Project Change Report.

The prediction of ground-borne noise levels in the Project Change Report has been undertaken using a stand-alone prediction methodology that is unrelated to the method used to predict the ground vibration. However, ground-borne noise is directly and inherently related to the vibration of the ground and the receiver buildings from construction activities. Consequently, it is appropriate to link the two prediction methods and use the predicted vibration to directly estimate the noise.

It is noted that the vibration levels have been predicted as 1/3 octave spectral values, which would be ideal to use for the subsequent conversion of vibration levels into acoustic energy. If it is desirable to incorporate a degree of conservatism into the predictions, this can be accomplished simply with the addition of a linear safety factor.

2.10.4 Proposed mitigation measures

The risk associated with any potential inaccuracy with the predictions would be minimised due to the Coordinator-General's Condition 22, which would require the proponent to prepare a Noise and Vibration EMP Sub-Plan at least one month prior to the commencement of any construction. The condition would also require the proponent to conduct noise measurements on a weekly basis to refine the modelling predictions as construction proceeds. As part of the report, the proponent would be required to provide specific details of mitigation measures.

For ground-borne generated noise, the mitigation measures which are practically achievable typically consist of provision of short term accommodation for affected residents or reduction of the cutting head rotational speed in close proximity to sensitive receivers and/or at sensitive times of the day or night.

2.10.5 Assessment of Coordinator-General's conditions

The Changed Design has applied the noise criteria proposed in the Coordinator-General's conditions.

It is noted that the Acoustic Quality Objectives for air-borne construction noise in Table 9 are more stringent than the ground-borne noise objectives in Table 11. The Co-ordinator General's representative has advised that the difference between these criteria is understood, and is acceptable due to the difference in the duration of the two types of impact, since airborne construction noise is a long-term impact, the criterion has been nominated to be appropriately lower.

It is internationally accepted that ground-borne noise is potentially more intrusive than other common types of airborne noise due to its predominantly low-frequency sound content. Ground-borne noise may therefore sometimes attract an additional penalty of up to +5 dB(A) due to its low-frequency noise annoyance qualities.

It is understood that the criterion for ground-borne noise levels proposed for the Northern Link tunnel are consistent with the limits previously used on other tunnel projects in Brisbane including the Clem7. Provided these limits have been successfully applied on these other projects, it may be appropriate to adopt them again for the Northern Link project.

Notwithstanding these issues, if the objectives in a future revised version of Table 11 are exceeded, the management measures nominated in Clause 22(i) of the Coordinator-General's conditions would still be relevant to minimise the risks associated with regenerated noise.

2.10.6 Recommendations

Based on our review of the information contained in the Project Change Report and Coordinator-General's conditions we would recommend the following:

- the proponent should confirm that they believe that their current modelling predictions represent a conservative approach or otherwise. If they do not believe that the modelling they have presented would represent a conservative approach then some indication of the potential worst case level of impact should be provided. This would enable the Coordinator-General to make an informed decision in relation to the risk of impacts due to regenerated noise

- the prediction and assessment of ground-borne noise impact in the Project Change Report should be revised, such that it is based on the predicted level of ground vibration, instead of being undertaken based on a separate prediction methodology.

2.11 Vibration

2.11.1 Comparison of Reference Design to Changed Project

The key aspect differentiating the Changed Project from the RD, with respect to vibration impacts and personal amenity, is the realignment of the main tunnels. In particular, the Changed Project tunnels lie generally closer to the surface than those for the RD. As a consequence of these proposed refinements, areas about the Toowong Cemetery and Beck and Hayward Streets at Paddington are nearer to the tunnel alignment and properties in these areas will receive increased levels of vibration.

The realignment of the tunnel will result in some properties not listed in the EIS being affected, other properties identified in the RD analyses no longer being impacted upon, and yet others noted in the EIS subjected to a different level of vibration than predicted, some higher and others to a lesser extent.

The approximate depths from the existing surface to the crown of the tunnel alignment are given in Table 2.3 of the Project Change Report and are summarised as follows:

- a decrease in the depth of the tunnel through the Toowong Cemetery from around 15 metres to 8 metres
- at Frederick Street (near the intersection with Thorpe Street), the Changed Project is accompanied by a reduction from 36 metres of cover to around 19 metres
- at Birdwood Terrace (intersection with Gregory Terrace), the Changed Project decreases the extent of cover above the tunnel from 58 metres to 49 metres
- for sections of the tunnel passing Cannington Street (intersection with Daintree Street Paddington), Baroona Road (between Howard and McNab Streets at Paddington) and Beck Street (west of the intersection with Nash Street), the Changed Project lies approximately 10 metres nearer to the surface than the RD. The RL in this section varies between 20 and 40 metres
- at Fernberg Road (east of intersection with Ellena Street Paddington), the Changed Project is approximately 12 metres deeper than the RD
- at Latrobe Terrace (north of intersection with Cochrane Street Paddington), the Changed Project lies approximately 8 metres higher than the RD
- at Hayward Street (between Plunkett and Charlotte Streets Paddington), the minimum depth of cover above the tunnel reduces to around 14 metres
- for the remainder of the Changed Project alignment east of Cairns Terrace (intersection of Great George Street at Red Hill), the alignment is deeper than the RD by up to 12 metres.

Methods of tunnel construction for the Changed Project are consistent with those identified in the Supplementary EIS document.

2.11.2 Justification for proposed changes

The Changed Project provides no advantages with respect improving amenity from vibration aside from reduced impact for isolated properties in the Fernberg Road area and those properties above the section of the tunnel east of Cairns Terrace. The increased amenity for these properties is however offset by the increased level of vibration for the greater number of other properties about the alignment.

2.11.3 Impacts associated with proposed changes

A technical assessment of the expected level of vibration from road header and TBM construction methods have been provided in the EIS and the associated technical documents. The RD was assessed using these relationships, partly derived from data collected in Brisbane, partly from other internationally published information and partly from other generic vibration relationships.

In the typical analysis, the recent tunnelling projects in Brisbane and other relevant constriction projects have yielded a more refined and more relevant data base.

The Changed Project has been assessed using these more developed relationships. The reported benefits of the Changed Project should be viewed in respect of the revised vibration relationships. However, the predicted effects may be less for the Changed Project than indicated in the RD by virtue of improved modelling methods, rather than any effect associated with the altered alignment.

For the majority of the Changed Project, the alignment is shallower from ground level than the RD. The Changed Project would result in:

- increase levels of vibration for residents in areas where the tunnel alignment is shallower than the RD
- increase levels of regenerated noise for residents where the tunnel alignment is shallower than the RD
- impact upon residents not initially considered in the EIS study.

For those areas where the tunnel depth exceeds the RD, the converse also holds true and the predicted level of disturbance is less.

Table 9.8 of the EIS document for the NLRT Project proposes categories of vibration levels and the corresponding degrees of human perception. These values are supported in the international literature and consistent with the perceptions of residents for other recently completed projects in Brisbane. These data are appropriate for establishing the expected effects of the Changed Project.

Data collected from other tunnelling and construction projects, together with a review of data published in the international literature, indicate that vibration from the tunnelling activities will be incapable of inducing or promoting structural damage to any properties about the alignment. The potential impacts of the tunnelling activities for the Changed Project are therefore limited to short term reduction in personal amenity. Some minor movement of objects within buildings above the alignment may also be experienced for those properties where vibration levels approach 1 mm/s (i.e. possible tilting of picture frames, slight movement of small, lightweight objects on hard surfaces etc.). Similar effects would have been anticipated from tunnelling of some sections of the RD.

The Project Change Report identifies that the peak vibration from the TBM tunnelling activities at residential properties will be around 1 mm/s for the area of the tunnel about Hayward Street. For the western section of the tunnel passing beneath the Toowong Cemetery, the vibration is predicted to exceed 2 mm/s. The majority of residences about the Changed Project will be subjected to vibration less than 0.5 mm/s.

The separation distance between the tunnel alignment and the potentially sensitive receivers has the greatest impact upon the level of vibration. Any adjustments to the alignment that reduces the separation distance will necessarily increase the level of impact. The potential effects of the TBM tunnelling activities has been analysed using data recorded from the Clem 7 Project, rather than the historical and less relevant information provided in the EIS. Table 3.3 of the Project Change Report provides a summary listing the expected level of vibration as a function of distance for distances varying between 5 and 50 metres from the cutter head.

A comparison of these data with other data collated and analysed as part of the Clem 7 Project show strong agreement, confirming that the proposed levels of vibration from the Changed Project are well supported.

Whilst the level of vibration will necessarily increase for sections of the tunnel where the alignment is nearer to the surface, the perceptibility and potential effect depends upon the magnitude of the vibration. Where the vibration level increases however, the level remains below the threshold value of perception. The implications of the Changed Project alignment are therefore minimal to nil. Based upon measured data from the Clem 7, the vibration from the TBM operating with a depth of cover of around 50 metres would be *'imperceptible'* to *'barely noticeable'* to residents above the alignment. The section of tunnel beneath Birdwood Terrace and a second section in the Cairns Terrace to Musgrave Road meet this criterion. All other sections of the tunnel are expected to produce perceptible levels of vibration.

Where the depth of cover above the tunnel above the tunnel reduces to around 35 metres, the level of vibration is expected to increase and exceed the permissible evening criterion of 0.5 mm/s. Mitigation measures will be necessary. Tunnelling through areas beneath Frederick Street, Beck Street and Hayward Street are all expected to fall within this category of disturbance and produce vibrations exceeding the 0.5 mm/s.

These same areas were however anticipated to produce perceptible levels of vibration from tunnelling in accordance with the RD.

For other sections of the alignment, the perceptibility of vibration from the tunnelling activities will vary according to the time of the tunnelling operations, the type of building and the activity of the persons within the property. Tunnelling in these areas is expected to be adequately managed through a well constructed and soundly implemented Environmental Management Plan (EMP).

When compared with the RD, the Changed Project alignment will increase the level of vibration at properties above and either side of the alignment by virtue of the shallower depth. With respect to potential effects of vibration, there are no advantages in reducing the depth of cover above the alignment. The reported benefits with respect to vibration for the Changed Project alignment are a consequence of the improved and more appropriate vibration relationships developed from the information collected from the Clem 7 Project rather than any physical adjustment of the alignment.

The revised location of the ventilation station, cross passages and the connecting tunnels are expected to be completed within the proposed compliance conditions. Where these areas are excavated using drilling and blasting methods, the scale of drilling and blasting will be adjusted to promote compliance.

2.11.4 Proposed mitigation measures

Minimising the effect of the tunnelling induced vibration and ensuring amenity of residences about the alignment are not unnecessarily compromised will be best achieved through a combination of approaches, including:

- compliance with vibration criteria that are acceptable to the vast majority of persons, supported by international literature and shown to be successfully implemented on previous projects

- condition surveys of potentially affected properties with an adjustment to the acceptable level of vibration depending upon the condition of the property and any potentially sensitive equipment housed within the building
- predictive modelling to identify the expected peak level and duration of vibration at affected properties about the tunnel alignment
- where drilling and blasting methods are adopted, trial blasting and modelling should be undertaken to confirm an acceptable scale of blasting
- conveyance of the potential impacts and effects of the construction activities via community forums, one-on-one meetings and/or letter drops
- monitoring of vibration levels at multiple locations about the tunnel alignment. Equipment with back-to-base capabilities should be considered to ensure minimal delay time between measurement and assessment of any complaints
- periodic analysis of the measured vibration data to confirm the relationship between distance and vibration level. The information should be used to allow continual refinement of the vibration predictions, and remodelling of expected effects where there are significant departures between expected and measured values
- an EMP detailing the process of measurement, analysis and modelling of vibration data.

The Changed Report indicates that 84 properties will be subjected to vibration levels varying between 0.5 mm/s and 1.0 mm/s with no properties predicted to receive above 1 mm/s. Vibration levels up to 1 mm/s are considered manageable through the implementation of well engineered EMP, well briefed community relations team and state-of-the-art monitoring equipment to alert operators, and in turn residents, in advance of the tunnelling activities. In the event that vibration levels exceed 1mm/s, this may require temporary relocation to ensure personal amenity of residents is not unduly affected.

In addition to reduced amenity from vibration, vibration levels in the range of 0.5 mms to 1.0 mm/s may also manifest as higher than acceptable levels of regenerated noise, more so during the quieter evening periods where low background values exist. Modelling of the tunnel alignment has not identified the number of properties within the 0.5 mm/s to 1.0 mm/s range which could be considered to reflect the number of potentially affected properties with respect to regenerated noise.

2.11.5 Recommendations

Although no analyses relating to drilling and blasting activities are considered in the Changed Project, it is expected that small scale blasting will be necessary for some areas of the excavation, possibly the low point sump, western portal, cross passages and ventilation passages. The technical documents provide generic relationships between vibration level, distance and explosive quantity, and again more recent and relevant projects provide for a significantly more accurate analysis of expected vibration levels.

In some sections of tunnelling, additional assessment methods may also be necessary to ensure construction generated vibrations do not impact upon the integrity of the infrastructure. Methods may include the use of vibrating wire extensometers, crack gauges, glass slides or other physical methods to quantify any impacts of the tunnelling activities. These methods are expected to be necessary where condition surveys show infrastructure to be in poor condition, such as through the Toowong Cemetery.

A site inspection of the Toowong Cemetery indicates that a very large percentage of the gravestones and monuments are in very poor condition and imposing a vibration condition, irrespective of the value, will not ensure the integrity of the monuments are not impacted by the vibration produced by the tunnelling activities. The condition of the monuments will continue to deteriorate during the construction period and will necessitate that additional mitigation measures, other than vibration monitoring, are incorporated into the EMP to control the effects. Some repair works may be necessary although any correlation between the tunnelling works and extent of damage may be challenging.

The proposed Coordinator-General's conditions regarding vibration specified for the NLRT RD are considered appropriate to ensure that the amenity of residents about the Changed Project alignment is maintained at acceptable levels. Near identical guidelines have been successfully applied for the other Brisbane tunnelling projects to make sure '*quality of life*' for residents is maximised as well as ensuring the contractor applied best practices with respect to minimising potential impacts.

No adjustments to the Coordinator-General's conditions with respect to vibration are recommended.

2.12 Planning, social and land use

2.12.1 Comparison of Reference Design to Changed Project

A planning, social and land use assessment has been undertaken for the Project Change Report to determine the implications of the relevant changes. Details of the changes from the RD to the proposed tender design are provided below:

- the Western Connection would be located approximately 100 m north of the RD, on the western side of Mt Coot-tha Road, while the Eastern Connection would remain relatively close to the location proposed for the RD. The tunnel alignment would be a straighter route that is up to 300 m south of that proposed in the RD
- the changed alignment would no longer pass beneath the 'Baroona' (90 Howard Street, Paddington) State Heritage Place, however would affect two new State Heritage Places being 'Boondah' (50 Howard Street, Auchenflower) and 'Cross Terrace' (50 Cairns Street, Paddington)
- the Change Project also required modifications to the land required for surface construction. This would only impact BCC and State owned properties.

2.12.2 Justification for proposed changes

The Changed Project would provide a tunnel alignment that is more cost effective to construct between the two connections, including a reduction of the number of properties requiring acquisition through volumetric subdivision.

2.12.3 Impacts associated with proposed changes

Although the proposed Changed Project alignment would reduce the number of volumetric properties affected, there are a number of new properties that were not originally affected by the RD.

The RD proposed 374 properties to be affected volumetrically, and the new alignment would require 334 properties to be acquired through volumetric subdivision, of which 269 are newly affected from the RD. There are 65 properties that continue to be affected by the Changed Project, with six of the properties being BCC owned.

Generally the future use of the properties affected by tunnelling works would not be diminished.

2.12.4 Proposed mitigation measures

Section 3.3.6 of the Project Change Report details that the proponent has commenced consultation with the property owners anticipated to be approached for acquisition and compensation as a result of the volumetric subdivisions. This process will be carried out in accordance with the *Acquisition of Land Act 1967* and other relevant transaction protocols.

2.12.5 Assessment of Coordinator-General's conditions

Appendix 1, Schedule 1, Item 2 of the Coordinator-General's conditions details development approvals required for works proposed on a State Heritage Place. This continues to be relevant to the NLRT Project.

The proponent will need to ensure that all approvals triggered outside the *State Development and Public works Organisation Act 1971* are in place prior to commencing work. For example, any supporting infrastructure and environmentally relevant activities, including office facilities, construction car parking, concrete batching plants, concrete segment factories and equipment lay down areas. This is currently addressed through Schedule 3, imposed conditions which reads:

These conditions do not relieve the proponent of the obligation to obtain all other approvals and licences from all relevant authorities required under any other Act.

The Changed Project would have a reduction in the overall number of properties affected by the tunnel alignment. However, there are a significant number of private properties that are now required to facilitate the construction and ongoing operation of the tunnel system. Appropriate consultation and negotiation is required in accordance with the relevant legislation to limit the impact of this change. Schedule 3, Part 2 (design and construction phase), Item 6 relating to communication and consultation highlights the communication protocol.

2.12.6 Recommendations

Once the detailed design is finalised the proponent will need to identify any changes to the properties that are affected. Although the future use of the properties affected by the tunnel would not generally be reduced, appropriate consultation would need to occur with the landowners, including applications for volumetric subdivision. A site access schedule would be required to allow access to the surface properties affected by the proposed works.

It is recommended that Coordinator-General's condition contained in Appendix 1, Schedule 1, Item 2(b), development on a State Heritage Place be amended to reflect the following:

- **remove** Baroona, 90 Howard Street, Paddington
- **insert** Boondah, 50 Howard Street, Auchenflower and Cross Terrace, 50 Cairns Street, Paddington.

Schedule 3, imposed conditions, remains relevant to the NLRT Project.

Appropriate consultation and negotiation is required in accordance with the relevant legislation to limit the impact of this change. Schedule 3, Part 2 (design and construction phase), Item 6 relating to communication and consultation highlights the communication protocol.

If there are any significant amendments to the NLRT Project to that approved under the Coordinator-General's Change Report, an additional request for Project Change Report will need to be applied for by the proponent.

2.13 Non-indigenous cultural heritage

2.13.1 Comparison of Reference Design to Changed Project

As with the RD, the Changed Project would pass beneath the Toowong Cemetery, however the eastbound tunnel has moved approximately 100 m to the north and the westbound tunnel approximately 200 m to the north. In addition, the vertical alignment is shallower, with less cover in some places between the crown of the tunnels and the surface than the RD.

2.13.2 Justification for proposed changes

The change to the alignment has removed the tunnels from the area below the Governor Blackall Memorial and the steeply sloping terraces that include elaborate headstones such as Trooper Cobb's Grave. In addition, the density of burial sites, monuments and headstones in the Changed Project is lower than the elevated and sloping areas of the RD alignment.

2.13.3 Impacts associated with proposed changes

Vibration during construction of the tunnels has the potential to impact on burial sites, monuments and headstones within the Toowong Cemetery. For the western section of the tunnel passing beneath the Toowong Cemetery, the vibration is predicted to exceed 2 mm/s. Vibration impacts are addressed further in Section 2.11.

The Queensland Heritage Registered site of 'Baroona' at 90 Howard Street, Paddington would no longer be affected by the Changed Project. However, ground vibration from underground tunnel construction (TBM) associated with the Changed Project has the potential to affect two other registered sites, namely 'Boondah' at 50 Howard Street, Auchenflower and 'Cross Terrace' at 50 Cairns Street, Paddington.

2.13.4 Proposed mitigation measures

The various management measures in the RD as part of the construction and operation EMP cultural heritage sub-plan, particularly those relating to the Toowong Cemetery or State Heritage Places are still considered to be appropriate for the construction and operation of the Changed Project.

It is recommended that the Queensland Heritage Register be rechecked to ensure that no other heritage listed properties are affected by the proposed alignment.

2.13.5 Assessment of Coordinator-General's conditions

An amendment to Schedule 1 condition 2(b) of the Coordinator-General's conditions has been recommended in the Application for Project Change Report to remove reference to 'Baroona' and include 'Boondah' at 50 Howard Street, Auchenflower and 'Cross Terrace' at 50 Cairns Street, Paddington as additional places that will require specific Cultural Heritage Management Plans prior to any construction works commencing.

2.13.6 Recommendations

Additional recommendations to address vibration impacts on Toowong Cemetery are outlined in Section 2.11. No further recommendations or changes to the Coordinator-General's conditions are required.

3. Eastern connection project change technical assessment

This section provides a technical review of the proposed amendments to the Eastern Connection for the Project. The areas that have been included for assessment reflect those that are relevant to the changes proposed at the Eastern Connection.

3.1 Tunnel alignment

3.1.1 Comparison of Reference Design to Changed Project

The Project Change Report details the following alignment amendments associated with the Eastern Connection:

- tunnel portals surfacing west of Victoria Park Road
- tunnel portals located centrally in the ICB
- vertical alignments for NLRT connections at portals have been designed to reduced design speeds
- re-alignment of the ICB eastbound accommodated by additional spans to the Northern Busway and pedestrian overbridges.

3.1.2 Justification for proposed changes

The key justifications contained in the Project Change Report include:

- tunnel portals brought closer together to allow simpler construction and traffic flows
- reduced construction and temporary traffic impacts on the ICB westbound
- reduction in length (300m) of the westbound cut and cover tunnel.

3.1.3 Impacts associated with proposed changes

The impacts identified in the Project Change Report for the alignment include:

- the proposed reduction in the speed limit of the ICB is restricted to a short length of roadway immediately surrounding the eastern portal. In such an isolated section of 60 km/h speed limit it may be difficult achieve the operating speeds necessary for the vertical alignment as operating speeds on either side (both on the ICB and within the tunnel) are set at 80 km/h.
- additional property impacts on Brisbane Grammar School and Victoria Park
- reduced impact on traffic during construction
- re-alignment of stormwater infrastructure on the northern side of ICB.

3.1.4 Proposed mitigation measures

The mitigation measures detailed in the Project Change Report include:

- reduction of design speeds for ICB traffic, although location of speed limit signs were not identified in the Signs and Lines component of the proposed design
- line merge arrangements to be better developed through the detailed design process
- negotiations with landholders/lessees to minimise long-term impacts on land.

3.1.5 Assessment of Coordinator-General's conditions

No imposed conditions relating to alignment issues or operating speeds were identified for the Eastern Connection however, Imposed Condition 30 relating to traffic management may provide scope to include additional requirements to monitor traffic and safety through this section.

3.1.6 Recommendations

The project specification calls for 80km/h posted speeds. It is noted that the contractor has applied for an agreed exception on this point

The Coordinator-General must be comfortable that Project Design Standards are being adequately addressed throughout the verification and approval process to ensure high levels of road user safety are provided.

It is therefore recommended that Imposed Condition 30 include a clause requiring the O&M Traffic EMP Sub-Plan to provide measures to monitor and report upon traffic speeds and road safety incidents throughout the road network.

3.2 Structures

3.2.1 Comparison of Reference Design to Changed Project

The Changed Project at the Eastern Connection involves the relocation of the eastbound carriageways of the ICB to the northern side of the cut and cover tunnel alignment and the tunnel transition structures. This realignment requires the extension to the north of the existing INB bridge over the ICB by one span to cross over the realigned east bound carriageway. The existing pedestrian bridge over the ICB from Brisbane Grammar School to Victoria Park is also extended to the north to span over the relocated eastbound carriageway.

The Changed Project also significantly reduces the length of the cut and cover and transition structures for the westbound carriageway entering the tunnel from the ICB.

3.2.2 Justification for proposed changes

The primary justification contained in the Project Change Report for the changes is to provide better access to the eastern portals of the tunnel for extraction of the TBMs and for construction of the cut and cover and transition structures at these portals.

3.2.3 Impacts associated with proposed changes

The key impacts detailed in the Project Change Report include the structural impacts associated with the construction of the additional spans to the INB bridge structure.

This change would require a diversion of the busway traffic to allow the construction of the additional span. A diversion of pedestrian traffic will also be required to extend the existing pedestrian overpass.

3.2.4 Proposed mitigation measures

The Project Change Report does not detail proposed mitigation measures for these impacts.

3.2.5 Assessment of Coordinator-General's conditions

Clause 3 (a), Schedule 2 of the Coordinator-General's conditions requires that the proponent must obtain approval from Department of Transport and Main Roads (DTMR) prior to any interference with the busway.

Clause 3 (b), Schedule 2 of the Coordinator-General's conditions requires that the proponent must consult with the Busway Manager to 'identify and implement actions which will minimise disruption to busway operations'.

The Coordinator-General's conditions do not include any specific provisions relating to pedestrian traffic using the existing bridge from Brisbane Grammar School to Victoria Park.

3.2.6 Recommendations

It is recommended that an additional condition be included in the Coordinator-General's conditions that the proponent must consult with Brisbane Grammar School to identify and implement actions to minimise disruption to pedestrian traffic between the School campus and Victoria Park.

Existing Coordinator-General conditions in Clause 3 of Schedule 2 are considered to adequately cover potential impacts of the changes on the busway operations.

3.3 Transport and traffic

3.3.1 Comparison of Reference Design to Changed Project

A review of the Project Change Report identified the following key changes between the Changed Project and RD:

- changes to the tunnel alignment connections. The ICB eastbound lanes would be shifted to the north of their current locations creating a widened median for the ICB. The additional area allows the NLRT Project portals to be located in this central location and for the proposed cut and cover associated with the westbound cut and cover to be decreased, resulting in a reduction on the ICB traffic during the construction phase and also more 'efficient' connections and grades than originally proposed in the RD

- the eastern ventilation station and outlet would remain unchanged in terms of the traffic impact. The Changed Project would access the station and outlet from the eastbound lane of the ICB

- a revised northern bridge span for the INB and pedestrian linkage is required to facilitate the realignment of the ICB eastbound lanes
- in terms of traffic management requirements, one primary traffic switch is required to allow the construction of the revised ICB eastbound lanes. The construction methodology requires a cut and cover section of the central portals south of Normanby Terrace
- the location of the westbound Changed Project entry portal would be shifted approximately 300 m west and the driven tunnel section would be moved approximately 30 m further east. This construction methodology change would result in a reduction of the length of the cut and cover works by approximately 330 m
- the road geometry for the 'tie-ins' to the ICB and for some of the local road geometry would be changed to allow the proposed modification of the eastbound ICB lanes. The entry to Victoria Park Road from the ICB would reconfigured, however still provide the left-in, left-out configuration
- the pedestrian bridge that currently spans the ICB from the Brisbane Grammar School to the Victoria Park pedestrian and cycle path would be extended to maintain connectivity
- in terms of parking for the construction workforce, the RD proposed a temporary parking at the eastern end of Victoria Park between Gilchrist Avenue and the ICB, while the Changed Project would provide this car parking between Gilchrist Avenue and the ICB, as well as an additional area for temporary off-street car parking spaces in the construction area accessed from Victoria Park Road and the ICB.

3.3.2 Justification for proposed changes

The Project Change Report indicated that the key benefits from the proposed Changed Project would include:

- a reduced impact on the ICB traffic flows during construction and improved connections and grades from the Changed Project to the ICB as the revised entry and exist portals would allow the eastbound lanes of the ICB to be outside the construction site work area
- as the portals are located closer together in the centre of the ICB, the length of cut and cover works would be reduced, improving the traffic management requirements on the westbound lanes of the ICB during construction
- the westbound ICB lanes are no longer required for the construction of the cut and cover construction works. This would reduce the original impacts on the city bound traffic flows.

3.3.3 Impacts associated with proposed changes

Design changes and effects

As indicated in the Project Change Report, the following described the key impacts of the proposed Changed Project:

- the extension of the ICB merges to the east would require a larger area of land take from the Victoria Park golf course for the ventilation outlet and station. The location remains unchanged from the RD

- traffic connections would remain unchanged for access to and from the tunnel portals and ICB. The Changed Project would provide similar levels of service to that proposed in the RD and the implementation of appropriate geometric design standards would be undertaken to ensure safe traffic operations

- the diverge length from the ICB to the entry portal of the Changed Project would be increase from 90 m to 240 m

- improved exist speeds, particularly for heavy commercial vehicles, would be achieved with the vertical alignment or gradient of the tunnels for the Changed Project. This may also result in improved vehicle safety on entering the tunnel.

Construction changes and effects

In terms of construction changes and effects, the following was identified in the Project Change Report:

- the worksite associated with the ICB eastbound lane realignment would be extended to include additional land from the Brisbane Grammar School playing fields and extend beneath the existing INB and land bridge

- a worksite would also be located adjacent the proposed ventilation station. Access to the temporary construction workforce car parking would be undertaken along the Victoria Park cycle path

- construction of the realigned eastbound ICB lanes would occur off-line, requiring only a single traffic switch

- the 'tie-in' works required between the ICB and entry and exist portals would be undertaken as night works, to limit the impacts on the existing traffic conditions for the ICB

- during the construction phase, the Victoria Park pedestrian and cycle path would be shifted north to accommodate the proposed worksite. The realigned path would connect to Victoria Park Road and the existing ICB pedestrian pathway.

Spoil hauling and placement

The Project Change Report detailed the following spoil haulage and placement impacts:

- the hourly spoil truck numbers would increase for the Changed Project from less than one truck per hour in each direction for 23 months for the RD to two trucks per hour per direction for three months and then one truck per hour per direction for 15 months. This would result from the increased spoil quantities, reduction to the operating hours and reduced construction period. For the Changed Project, the average of truck movements per hour during the busiest time of the construction phase would mean that the traffic generation on this route would remain low

- there would be a small increase in the background traffic on the haulage route, with no anticipated impact on traffic conditions

- the haulage route would remain nominally the same for the Changed Project as the RD, however there is a change to the proposed spoil placement site. This would result in the Changed Project avoiding the Gateway Bridge and Port of Brisbane Motorway as a haul route, however will require Eagle Farm Road as a primary haul route. This was identified as an appropriate route. It was identified that overall the journey time would remain generally unchanged for the Eastern connection.

Ventilation station access

The Project Change Report detailed the following impacts on transport and traffic for the proposed ventilation station access:

- There would be occasional maintenance access required for the Changed Project. The access would be undertaken from the eastbound carriageway of the ICB through the 'specially widened section of the shared pedestrian/cycle pathway'. The vehicles accessing this property would be able to decelerate safely and provide appropriate notice to other vehicles using the ICB. The Changed Project proposes the use of manned traffic control, which has been approved in principle by Brisbane City Council (Road Use Management).

Pedestrian, cyclist and public transport issues

The Project Change Report indicates the following impacts for pedestrian, cyclist and public transport components of the NLRT Project:

- during the construction phase the Changed Project would provide temporary pedestrian and bicycle links. This would include the north worksite being connected to the Victoria Park cycleway with Victoria Park Road, then a connection to Kelvin Grove Road via Musk Avenue and the Kelvin Grove Urban Village

- the existing pedestrian bridge spanning the ICB would be extended to connect with the new pedestrian / cycleway to the north. These works would be conducted off line during the early stages of the construction phase. A temporary closure is required to install the new deck. The Changed Project has identified that consultation is required with relevant parties

- the existing pedestrian bridge between Brisbane Grammar School and the playing fields would be extended to the north, over the realigned eastbound carriageway of the ICB. This would re-establish the existing connectivity

- at project close, the Changed Project would reinstate the existing level of pedestrian and bicycle connectivity in the Eastern Connection.

Crossing under the Inner Northern Busway

The Project Change Report details the following impacts associated with the crossing of the INB:

- the realignment of the eastbound ICB carriageway as part of the Changed Project would require changes to the existing INB bridge. To limit the impact on the bus operations, it is proposed to provide a temporary INB bridge over the ICB that could be used during the realignment of the existing INB bridge. It is proposed that the switching for the bus traffic occur at night to minimise the impact on bus operations

- consultation would be undertaken with the DTMR Busway Manager, Translink and other relevant stakeholders for the proposed bus operation switch. It was identified in the Project Change Report that minimal interference was anticipated.

Once these works are carried out, it was anticipated that the NLRT Project would not impact on the Busway operations.

3.3.4 Proposed mitigation measures

The Project Change Report identifies the temporary realignment routes and tie-ins for the shared pedestrian and cycle paths around and through the construction area. As identified in the RD the existing footbridge across the ICB to the Brisbane Girls Grammar School would be retained although the Changed Project will need to extend the footbridge over the realigned ICB lanes and tie into the realigned footpath around the northern side of the construction areas.

In terms of construction workforce parking, the Changed Project would provide similar arrangement as proposed in the RD but with an additional area for temporary off-street car parking spaces to be provided within the construction area accessed from Victoria Park Road and the ICB.

3.3.5 Assessment of Coordinator-General's conditions

For the changes to the INB to allow an additional span to be constructed beneath it for the realigned eastbound ICB lanes, additional approvals are required in according with Schedules 2 (Recommended Conditions) and 3 (Imposed Conditions) of CG's conditions:

- Schedule 2 Clause 3 (a), approval must be obtained from the busway manager DTMR or Railway Manager (Queensland Rail) prior to any interference with a busway or railway under the *Transport Infrastructure Act 1994*.

- Schedule 2 Clause 3 (b), if any project works are likely to interfere with the operation of busway or railway services, consultation must be undertaken with the Busway Manager or Railway Manager to identify and implement actions which will minimise disruption to busway or railway operations.

- In terms of traffic management during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 16 (a) to (l).

- In terms of spoil handling and placement during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 17 (a) to (f).

- In terms of other conditions for general construction during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 18 (a) to (o).

- In terms of traffic management for the operations phase of the project, the requirements shall be in accordance with Schedule 3 Clause 30 (a) to (c).

3.3.6 Recommendations

Based on PB's review of the Project Change Report and CG's conditions, it is our view that the Project Description in the Coordinator-General Report will require amendment to reflect the Changed Report's proposed rearrangement of connections with ICB and minor changes to local road geometry to accommodate the realigned eastbound ICB lanes.

Moreover, the spoil haulage and placement description will also require to be amended based on the spoil placement sites identified by the Changed Project.

It is our view that the existing Coordinator-General's conditions mentioned in the above section are considered sufficient to cover potential impacts during construction and operation phases.

3.4 Air quality and greenhouse gases

3.4.1 Comparison of Reference Design to Changed Project

The Changed Project would have flatter road alignments and possibly more efficient connections to the ICB than the RD, resulting in more freely flowing traffic in most conditions. No change in the location of the eastern ventilation outlet and station is proposed.

The Changed Project extends the connections for the realignment of the eastbound ICB lanes, resulting in a larger work area for the NLRT Project. Additionally the quantity of spoil to be removed from the eastern worksite has increased with the Changed Project.

In addition, the eastbound tunnel exit portal would occur approximately 60 m to the east of the RD location, removing it slightly away from the some of the adjoining residences in Normandy Terrace.

3.4.2 Justification for proposed changes

The Changed Project would provide a more direct link and provide easier traffic conditions for heavy vehicles leaving the tunnels in either direction.

3.4.3 Impacts associated with proposed changes

The flatter alignments may result in minor reductions in vehicle emissions within the Changed Project tunnels compared to the RD. However, the difference in motor vehicle pollution, when measured at ground level is expected to be very small and not significant.

The Application for Project Change Report indicates that there is no predicted change for construction air quality from the reference project. However, the quality of spoil to be removed from the eastern worksite has increased and consequently hourly spoil truck numbers will be higher with the Changed Project than with the RD.

3.4.4 Proposed mitigation measures

The Project Change Report does not detail proposed mitigation measures the change to construction air quality as a result of increased spoil truck movements. However, the various management measures in the RD as part of the construction and operation EMP air quality sub-plan are still considered to be appropriate as they are expected to effectively mitigate air quality related impacts arising from the construction and operation of the Changed Project.

3.4.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for air quality are presented in Schedule 3, Condition 20. The conditions remain relevant to the Changed Project.

3.4.6 Recommendations

No additional conditions are considered necessary.

3.5 Surface water quality

Significant drainage and water quality features at the eastern end of the alignment include the Victoria Park Drain at Herston and York's Hollow, a culturally significant wetland within Victoria Park. The York's Hollow wetland was part of an original lagoon system, which was remodelled as part of the Inner City Bypass (ICB) project in 2000. This wetland provides an important habitat for waterbirds and acts as a fish refuge/breeding area.

The key differences between the Changed Project and RD in terms of water quality are the stormwater infrastructure realignment and upgrade works.

3.5.1 Justification for proposed changes

The Changed Project would reduce the extent of the ICB cut and cover works required, reducing the duration of construction works and associated impacts at this location.

3.5.2 Impacts associated with proposed changes

The Changed Project involves a re-alignment of stormwater infrastructure on northern side of ICB. Degraded surface water travelling via the drainage system during storm events would have a direct impact on downstream water quality.

3.5.3 Proposed mitigation measures

The various management measures in the RD as part of the construction and operation surface water EMP sub-plans are still considered to be appropriate as they are expected to effectively mitigate water-related impacts arising from the construction and operation of the Changed Project.

3.5.4 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for surface water conditions are presented in Schedule 3, Conditions 21 and 32. The conditions remain relevant to the Changed Project.

3.5.5 Recommendations

No additional conditions are considered necessary.

3.6 Flora and fauna

3.6.1 Comparison of Reference Design to Changed Project

The Changed Project requires a larger area of the playing fields leased by Brisbane Grammar School and the easterly extension of the ICB merges for the eastbound lane requires a larger area from the Victoria Park golf course.

3.6.2 Justification for proposed changes

The Changed Project would reduce the extent of the ICB cut and cover works required, reducing the duration of construction works and associated impacts at this location.

3.6.3 Impacts associated with proposed changes

The ventilation facilities and worksite for the Changed Project shows some additional removal of vegetation along the bikeway that borders Victoria Park golf course in comparison to the RD. This vegetation, which is mapped as non-remnant and unconfirmed remnant, occurs within a landscaped open space with a variety of trees and other vegetation. These include Hoop Pine, White Bottlebrush (*Callistemon salignus*), Blue Quandong (*Elaeocarpus grandis*), Grey Ironbark and various common urban weeds and grasses.

This vegetation provides very little habitat value for wildlife. The planted trees within this area are likely to provide a food source for some birds and bats and may provide some roosting opportunities. While mapped as non-remnant and unconfirmed remnant, it is considered valued urban vegetation under the Brisbane City Council's Natural Assets Local Law. No significant vegetation protected under a VPO or significant landscape trees have been identified from this area.

3.6.4 Proposed mitigation measures

The Project Change Report does not detail proposed mitigation measures for the additional impact on vegetation in this area. However, the general mitigation measures for vegetation management and rehabilitation and landscaping, as identified in the EIS, are considered appropriate to cover the additional impacts to this vegetation.

3.6.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for flora and fauna are presented in Schedule 3, Condition 19. The conditions remain relevant to the Changed Project.

3.6.6 Recommendations

No additional conditions are considered necessary.

3.7 Noise

3.7.1 Comparison of Reference Design to Changed Project

The main tunnel and connections and through traffic of the ICB for the Changed Project would be aligned to the north of the proposed locations for the Reference Design.

3.7.2 Justification for proposed changes

There is no justification in relation to noise provided in the Project Change Report. The Project Change Report indicates that the proposed changes would increase the potential for noise impacts.

3.7.3 Impacts associated with proposed changes

3.7.3.1 Operational road traffic noise

The Project Change Report would indicate that the Changed Design would require an increase in the RD barrier heights and two additional noise barriers, one of which would be up to 6 m high.

Without having any detailed noise modelling presented in the Project Change Report it is concluded that the increase in barriers would be due to an increase in traffic noise at nearby residences.

3.7.3.2 Construction noise

The impacts due to construction noise from the Changed Design are likely to be similar to the RD but with minor changes to the location of construction work. Generally construction works of the tunnel connections would be located further towards the north.

3.7.4 Proposed mitigation measures

3.7.4.1 Operational road traffic noise

The proposed mitigation measures would consist of increasing barrier heights and two additional barriers up to 6 m high. Barriers of such a height would have the potential to not only influence the acoustic amenity of nearby residences but have the potential to affect other factors such as visual amenity, pedestrian access, interference with prevailing breezes etc. The Coordinator-General's Representative should consider all impacts of increasing noise barriers or constructing barriers up to 6m high and whether this is an acceptable outcome in terms of all factors, not just control of road traffic noise.

The Project Change Report indicates that full compliance with the Coordinator-General's Road Traffic Noise Condition will be achieved through detailed design. The information contained in the Project Change Report is not detailed enough to verify the validity of the noise modelling results presented in the report. It is recommended that more detailed information is provided during detailed design to allow an independent consultant to verify the validity of the noise modelling and proposed mitigation measures. This would include noise contours plots and the input data used in the modelling.

3.7.4.2 Construction noise

The Project Change Report does not provide details of mitigation measures to achieve the required noise limits for construction work but rather it indicates that mitigation measures will be specified in the Noise and Vibration EMP Sub Plan.

3.7.5 Assessment of Coordinator-General's conditions

3.7.5.1 Operational road traffic noise

The Project Change Report does not specifically present the noise limits presented in the Coordinator-General's conditions, but provides a more general statement confirming that the preliminary modelling indicates compliance with the Coordinator-General's conditions can be achieved by implementing the noise barriers discussed in Section 3.13.4 above.

For Council roads, the Coordinator-General's conditions allow the proponent to achieve status quo noise levels in locations which currently exceed 63dBA $L_{A10(18\ hour)}$. The status quo noise limit would be determined based on modelling of the existing road under 2026 conditions.

Regardless of whether the current noise levels exceed 63dBA $L_{A10(18\ hour)}$, the Project is modifying roads at the connections and therefore every practical attempt to achieve appropriate noise criteria should be considered.

In the event that the noise criteria cannot be practically achieved, such as instances where noise barriers would be unacceptably high or cause other road safety, access or amenity issues then the status quo criteria would be considered a reasonable approach.

3.7.5.2 Construction noise

The Coordinator-General's conditions are broadly referred to by the Project Change Report, but it does not contain any specific assessment of construction noise against the noise limits contained in the Coordinator-General's Condition 22. The Condition would require that such an assessment is provided in the Noise and Vibration EMP Sub Plan.

3.7.6 Recommendations

Based on our review of the information contained in the Project Change Report and Coordinator-General's conditions we would conclude and recommend the following:

3.7.6.1 Operational road traffic noise

The proposed noise mitigation measures for the Changed Design would consist of increasing barrier heights and high noise barriers (up to 6m) in some locations. This is consistent with the generally accepted practice of maximum noise barrier heights on Queensland TMR projects. The final noise barrier design height may be higher or lower than 6m depending on other factors.

The Coordinator-General's representative should consider the impacts of these noise barriers not only in terms of their ability to control noise but in terms of other important amenity issues, which may be associated with the barriers such as visual amenity, pedestrian access, interference with prevailing breezes etc. The Coordinator-General would need to decide whether this would be considered an acceptable outcome considering all factors associated with the barriers, not just noise.

It is recommended that the proponent provide specific details of the noise control measures to achieve the Coordinator-General's conditions during detailed design. In addition, these proposed measures should be presented in a report which has an appropriate level of detail to enable an independent consultant to review the design. To enable an independent review of the Changed Design would require the following information:

- noise contour maps of the worst case noise exposure at nearby residences both with and without noise barriers
- the input data used in the modelling such as traffic volumes, percentage heavy vehicle, speed etc.
- information relating to the design contours, either in a separate drawing/plan or labelled contours in the noise contour maps.

3.7.6.2 Construction noise

As proposed by the proponent, the impact of construction noise can be addressed by preparing a Noise and Vibration Sub Plan as detailed in the Coordinator-General's conditions (e.g. Schedule 3, Condition 24) or during detailed design. To enable an independent consultant to conduct a review of the assessment would require the following information:

- source noise levels assumed for construction activities
- the height (RL AHD) of the sources
- the location of noise sources in relation to nearby receivers
- any screening of noise sources which would be provided due to topography, intervening buildings or proposed noise barriers
- the predicted noise levels at nearby receivers.

3.7.6.3 Other operational noise

Although not mentioned in the Project Change Report, it would be expected that the noise emissions from other operational sources such as ventilation outlets would be addressed in the Noise and Vibration EMP Sub Plan or through detailed design.

3.8 Planning, social and land use

3.8.1 Comparison of Reference Design to Changed Project

The key changes identified in the Project Change Report for the Eastern Connection in terms of planning, social and land use include

- the eastbound lanes of the ICB would move north of the location identified in the RD to allow a central location for the tunnel entry and exit portals to connect to the ICB. As a result the eastbound exit portal would move 60 m closer to the Inner Northern Busway, while the westbound portal would move 300 m west
- a new worksite location is proposed adjacent the ventilation station, while an extension to the ICB merges to the east are also identified under the Changed Project. These modifications would require an increase in the land to facilitate construction, including Brisbane Grammar School playing fields and the Victoria Park Golf Course. The ventilation station remains in the same location as proposed in the RD
- the temporary car parking during the construction phase would be larger in size and located in a similar location to the RD, being at the eastern end of Gilchrist Avenue, north of the ICB
- spoil haulage is to be transported to an approved placement site adjacent to the Brisbane Airport at Pinkenba, rather than the RD proposal of the Port of Brisbane.

3.8.2 Justification for proposed changes

The Project Change Report highlights that the relocation of the Inner City Bypass and location of the portals within a widened median strip would reduce traffic disruption during construction, particularly as the works can occur off line and the length of the westbound cut and cover structure would be reduced. In the long term, the report details that the changes produce more efficient connections and grades between the portals and the ICB.

3.8.3 Impacts associated with proposed changes

Potential impacts identified in the Project Change Report in relation to planning, social and land use factors include:

- the new worksite location would require additional land owned by the Brisbane Grammar School that is currently used as a playing field
- the overflow car parking for the construction workforce onto the local road network resulting in increased traffic and a reduction to parking availability for local residents
- the revised placement of spoil from the Eastern Connection to the site located in Pinkenba would potentially trigger new approvals for development approval to dispose of spoil and impact on matters of national significance
- increased number of noise barriers and increased height of noise barriers to 6 m
- change to the pedestrian bridge over the ICB to the Brisbane Grammar School
- change to the pedestrian and cycle footpath in Victoria Park Golf course.

3.8.4 Proposed mitigation measures

The Changed Project has proposed a number of mitigation measures to reduce the potential impacts including:

- the use of public transportation or parking within the temporary car parking facility by the construction workforce would be encouraged to avoid impacts on the local road network. To encourage public transportation use, the provision of shuttle buses between the Roma Street Transit Centre and the eastern worksite is proposed along with prepaid tickets
- the surface works for the Eastern Connection are proposed to be stage to ensure that there are limited impacts to the existing traffic conditions for the Inner City Bypass
- consultation with the DTMR Busway Manager is proposed for the interference that would be required for the Busway traffic
- no mitigation is proposed for the spoil placement. Approvals would be gained from the relevant entities
- consultation with the affected stakeholders, particularly Brisbane Grammar School and Victoria Park Golf Course.

3.8.5 Assessment of Coordinator-General's conditions

The Coordinator-General has conditioned (under Schedule 2) that approval must be obtained:

- under the *Transport Infrastructure Act* 1994 where works will affect Busway infrastructure. Approval from the Busway Manager would be required. This condition remains applicable to the changed works at the Eastern Connection (Item 1)

- for any temporary or permanent road closures required for the Eastern Connection Changed Project would need to be sort under the BCC Local Law. Item 4 remains relevant to the works

- for spoil placement, the Coordinator-General's conditions (Schedule 6, Item 17(d)) states that *All placement of spoil at spoil placement areas must comply with the performance criteria of the filling and excavation code in City Plan 2000 or any similar applicable local authority plan.* The approval requirement remains applicable to the project.

3.8.6 Recommendations

Given that projects of this scale can result in over flow construction workforce parking within the surrounding local road networks and result in access issues for local residents, it is important that the proponent implements their proposed mitigation measures to encourage public transport use by their workforce. It is suggested that under Schedule 3, Item 16 (traffic management), that the condition (g) be amended to state the following:

(vi) measures to prevent the parking of construction traffic on streets near to work sites, including provision of prepaid public transportation tickets and shuttle buses between Roma Street Transit Centre and the eastern worksite to the construction workforce.

Insert condition under Schedule 2 relating to the requirement for the proponent to lodge relevant applications under the BCC's Local Laws, including, but not limited to, vegetation clearing under the *Natural Assets Local Law 2003* and to undertake works within a BCC controlled road under Chapter 6 Streets, Bridges, Culverts etc.

Appropriate consultation and negotiation is required in accordance with the relevant legislation to limit the impact of this change. Schedule 3, Part 2 (design and construction phase), Item 6 relating to communication and consultation highlights the communication protocol.

If there are any significant amendments to the NLRT Project to that approved under the Coordinator-General's Report, an additional request for Project Change Report will need to be applied for by the proponent under Division 3A of the *State Development and Public Works Organisation Act 1971*.

3.9 Visual amenity

3.9.1 Comparison of Reference Design to Changed Project

The key changes between the Changed Project and RD are detailed below as part of the visual amenity assessment:

- the Changed Project requires the acquisition of less than 1,000 m^2 of the Brisbane Grammar School playing field as well as additional area from the Victoria Park Golf Course
- the location of the underground ventilation station in to the north of the location proposed in the RD. The outlet would be located above ground level, to the west of the station, approximately 43 m north-west of the RD. The height of the outlet would be at a minimum of that proposed in the RD (RL 67 m or 20 m above ground level).

3.9.2 Justification for proposed changes

The modifications have been proposed as a result of design changes for the Eastern Connection portals and connection of the road alignment to the ICB.

3.9.3 Impacts associated with proposed changes

No visual impacts are identified for the additional land take from the Brisbane Grammar School and Victoria Park Golf Course or ventilation station and outlet.

3.9.4 Proposed mitigation measures

No mitigation measures have been identified for the visual impact resulting from the additional land take or ventilation station and outlet.

3.9.5 Assessment of Coordinator-General's conditions

Appendix 1, Schedule 1, Item 4 of the Coordinator-General's conditions states the following requirements for making a Material Change of Use for an ERA 51 – road tunnel ventilation stack operation:

- *(d) The eastern ventilation outlet for the project is to be situated adjacent to the Inner City Bypass (ICB) at the location indicated in the EIS 2. The height of the ventilation outlet must be at least 15 metres above ground level in that location, or no less than RL 58 metres, whichever is the higher.*

3.9.6 Recommendations

The assessment of the Changed Project Report determined that the proof of the visual impact on the open space from the additional land take from the Brisbane Grammar School and Victoria Park Golf Course was not provided.

Furthermore, there were limited mitigation measures proposed by the proponent that would address the visual amenity reduction and include appropriate consultation with key stakeholders to identify opportunities to mitigate the visual impacts of the project.

The Coordinator-General's Condition 18 (Schedule 3), (m) details requirements to meet appropriate visual amenity outcomes for the NLRT Project. PB recommends upfront consultation with the key community groups to ensure early input to the detailed design phase. An amendment to Item (iii) of Condition 18(m) is proposed, being:

(iii) *Consultation with the CLGs* **commencing at the design stage** *to discuss additional solutions to mitigating the visual impact of the construction areas*

Appendix D of the Supplementary Environmental Impact Statement details provisions under the EMP for the tunnel portals and connections. A comparison of the Changed Project against the RD and these criteria were not undertaken by the proponent to determine the potential visual amenity impacts or improvements.

3.10 Non-indigenous cultural heritage

3.10.1 Comparison of Reference Design to Changed Project

The Changed Project requires a larger area of the playing fields leased by Brisbane Grammar School and the easterly extension of the ICB merges for the eastbound lane requires a larger area from the Victoria Park.

3.10.2 Justification for proposed changes

The Changed Project would reduce the extent of the ICB cut and cover works required, reducing the duration of construction works and associated impacts at this location.

3.10.3 Impacts associated with proposed changes

The proposed easterly extension of the ICB merges for the eastbound lane will require a larger area from Victoria Park. Victoria Park is listed on the Queensland Heritage Register and has also been identified as an important Aboriginal cultural heritage place.

3.10.4 Proposed mitigation measures

An application would need to be made under Part 6 of the *Queensland Heritage Act 1992* to the Director-General of the Department of Environment and Resource Management for any development that is likely to occur within the heritage listed boundary.

The various management measures in the RD as part of the construction and operation EMP cultural heritage sub-plan, particularly those relating to Victoria Park and State Heritage Places are still considered to be appropriate for the construction and operation of the Changed Project.

3.10.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for air quality are presented in Schedule 1, Conditions 2 and 3. The conditions remain relevant to the Changed Project.

3.10.6 Recommendations

No additional conditions are considered necessary.

4. Western connection project change technical assessment

The Changed Project identified a number of amendments at the Western Connection. These changes have been assessed by technical specialists where relevant.

4.1 Tunnel alignment

4.1.1 Comparison of Reference Design to Changed Project

The alignments associated with the Western Connection are located to the north west of the RD with the tunnel entry and exit connections brought to the centre of the Centenary Motorway. All alignments are retained within the EIS Study Corridor.

4.1.2 Justification for proposed changes

The following justification is provided in the Project Change Report:

- tunnel portals brought closer together to allow for the simpler launch operations for TBMs, clear of existing Centenary Highway traffic
- avoid construction through the existing Mt Coot-tha roundabout
- promote the Centenary Highway to NLRT connection as the primary freight route
- provide a safer route for Centenary Highway on-road cyclists.

4.1.3 Impacts associated with proposed changes

The Project Change Report detailed the following potential impacts as a result of the Changed Project:

- increased encroachment on the Mt Coot-tha Botanic Gardens
- reduced impact to the westbound Centenary Highway
- reduced impact on traffic during construction.

4.1.4 Proposed mitigation measures

No mitigation measures were identified in the Project Change Report.

4.1.5 Assessment of Coordinator-General's conditions

Imposed conditions; 26 – Centenary Motorway connection; and 27 – Impact on the Moggill Road Interchange of the Centenary Motorway relate to alignment proposals.

'26(a) – The connection and 'tie-in' of the project to the Centenary Motorway is to be designed, constructed and operated to ensure that the operation of the project does not limit the ability for possible widening of the Centenary Highway.'

Item is addressed in sections 7.1 and 8.3 of the Project Change Report which requests:

- *26(a) (i) and 26(a) (ii) be replaced with the wording; 'Completed earthworks are required for a possible third lane on the left hand side of the inbound carriageway of the Centenary Motorway between its junction with the Mt Coo-tha intersection and the limit line of below grade Northern Links Works identified in Schedule 8 and being a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886). This future construction zone shall exclude structures, drainage pipes, drainage materials (aggregate), lighting columns, conduits, cabling, pits, manholes etc.'*

- *Schedule 8 is replaced with Figure 8-2 (of change report)*

- *add reference to Schedule 8 to end of 26(b) (iii)*

- *delete condition 26(a) (iv).*

26(b) – Future planning for Brisbane has identified a new 'Inner Orbital' tunnel between the Centenary Motorway and Stafford Road at Everton Park as a transport network improvement option. The connection and 'tie-in' of the project to the Centenary Motorway is to be designed and constructed to ensure that:

(i) Operation of the project shall not compromise the ability for a future connection of Centenary Highway with an 'Inner Orbital':

- *item addressed in Section 7.2 of the change report.*

(ii) Operation of the project should not compromise the ability for future operation of the 'Inner Orbital' tunnel and the centenary Motorway as a continuous motorway route (that is maintaining the speed environment) with traffic flow priority on Centenary Motorway directed to the continuous route:

- *item addressed in section 7.2 of the change report.*

(iii) The Northern Link connection excavation works are not to be below the existing motorway surface levels west of a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886):

- *item confirmed in Section 7.2 of the change report (unable to verify without access to CAD data).*

(iv) The western Northern link portals troughs and associated 'tie-in' with the Centenary Motorway shall favour the outer lanes of the motorway carriageway without affecting the existing median width or narrowing motorway lane widths:

- *portals have been located to the centre of the motorway and Section 7.2 of the change report notes that this condition would need to be varied or deleted to accommodate the change project tie-in with the Centenary Motorway. Section 4.1 of the change report makes reference to observations in the Coordinator-General's report that 'the construction of road tunnels is often simpler and less costly if portals are located on the inside of major feeder roads and that, subject to further assessment, there was potential merit in an inner-portal final design option at the western end.'*

Condition 27 – Moggill Road Interchange.

No alignment impacts are identified for this condition, Section 7.3 of the Project Change Report deals mainly with traffic performance issues.

4.1.6 Recommendations

The following details the recommended amendments to the Coordinator-General's conditions identified in Section 4.2.5:

- 26(a) (i) – (iii) amended/replaced as requested in Section 8.3
- 26(b) (iii) amended to suggested wording in Section 8.3
- 26(b)(iv) to allow central location of portals. This is in line with the above referenced observation reported.

4.2 Structures

4.2.1 Comparison of Reference Design to Changed Project

The Changed Project relocates the westbound carriageway of the NLRT Project from the south side of the existing Centenary Motorway to be adjacent to the eastbound carriageway of the tunnel on the Northern side of the existing Centenary Motorway. The ultimate east bound carriageway of the Centenary Motorway is also relocated to the north of the tunnel transition structures crossing over the transition structures to the west of the Centenary Motorway, Mt Coo-tha road roundabout. The Changed Project also relocates the tunnel portals further to the west than in the RD.

These changes require the construction of a bridge carrying the eastbound carriageway of the Centenary Motorway over the tunnel transition structures that was not required in the RD.

4.2.2 Justification for proposed changes

The Project Change Report provided reasoning that the changes would consolidate the construction activities, in particular the launching and servicing of the two TBM's to a single location to the north west of the existing Motorway roundabout.

The relocation of the portals to the west also eliminates the need to construct the cut and cover section of the westbound tunnel carriageway across the existing roundabout.

4.2.3 Impacts associated with proposed changes

The changes do not have any adverse impacts from a structural point of view. No impacts were detailed in the Project Change Report.

4.2.4 Proposed mitigation measures

There were mitigation measures identified in the Project Change Report.

4.2.5 Assessment of Coordinator-General's conditions

The existing Coordinator-General's conditions are considered to adequately address any impacts of the changes.

4.2.6 Recommendations

There are no changes recommended to the Coordinator-General conditions.

4.3 Transport and traffic

4.3.1 Comparison of Reference Design to Changed Project

Changes to the Western Connections

The Project Change Report identifies the following key differences in the Changed Project compared with the RD at the Western Connection:

- a realignment of the eastbound lanes of the Centenary Motorway to the north to the centre of the motorway is proposed to accommodate the revised location for the entry and exit portals
- a shorter merge is proposed for the Changed Project from the Mt Coot-tha roundabout traffic to the outbound traffic from the NLRT Project onto the Centenary Motorway. The Project Change Report confirms that the proposed merge would comply with agreed design standards
- the ventilation station and infrastructure utility area and the Tollroad Control Centre (TCC) would be located at a different site, on the corner of Richer Street and Mt Coot-tha Road. The access to these facilities would be via Mt Coot-tha Road. The relocation limits any impacts that the RD TCC location would have the Botanic Gardens and no direct access to the Centenary Motorway is required
- the western worksite requires access onto the Centenary Motorway via a left out egress in the eastern direction. Consultation would be required with DTMR regarding the specific traffic impacts and implications.

Design changes and effects

The Project Change Report details the following impacts for the Changed Project:

- the revised location of the NLRT Project portals to the centre of the Centenary Motorway road corridor. The further realignment of the eastbound lanes of the Centenary Motorway would also be triggered as part of the works
- an amendment to the merge/diverge arrangements for the ramps to the portals and for the eastbound lanes of the Centenary Motorway is proposed. The changes would result in the merge/diverges to be further west than proposed in the RD, to allow the tunnel portals to be located centrally. The westbound lanes of the motorway remain unchanged
- the proposed changed connection arrangements would still allow the future widening of the Centenary Motorway (i.e. three lanes in each direction) that may be required by DTMR
- further design changes include more efficient and more ‘legible’ connections to be constructed between the motorway and the NLRT Project

- the Changed Project detailed that there would be limited impact on the future capacity of the motorway, the future design changes to allow the construction of the northern motorway (Inner Orbital) connection with the motorway, as identified under the South East Queensland Infrastructure Plan and Programme 2010 – 2031 (SEQIPP)

- the proposed changes to the NLRT Project would not impact the acceptable performance of the Centenary Motorway or impede the performance of the motorway if a major traffic incident occurred.

Construction changes and effects

The changes in construction method for the Changed Project provide:

- different access arrangements, to include access for light vehicles off Mt Coot-tha Road just west of the roundabout

- construction workforce car parking, a temporary car park, in Anzac Park adjacent to the existing pedestrian and cycle bridge over the Centenary Motorway.

Spoil hauling and placement

The Project Change Report detailed the following changes for the haulage of spoil:

- approximately 932,000 m^3 of spoil would be transported to the quarry under the Changed Project, compared with 973,000 m^3 for the RD

- approximately 303,000 m^3 would be removed from the Changed Project construction area and worksite by truck compared to approximately 265,000 m^3 for the RD. The TBM spoil would make up approximately half of this quantity that would be accommodated in the quarry

- the Changed Project nominated approved site in Rudd Street, Oxley or those site approved in accordance with the Coordinator-General's conditions

- the revised haulage task would require four to five trucks per hour for 12 months, or possibly 35 trucks per hour.

Configuration of western worksite

The Project Change Report detailed that the proposed motorway access would be the same as in the RD. The report highlighted a requirement for an additional access for light vehicles from Mt Coot-tha Road on a left-in basis only.

Ventilation station access

The Project Change Report highlighted the following changes with regard to the ventilation station access:

- the location remains generally in the same location as the RD (i.e. northern side of the Centenary Motorway, approximately 400 m west of Mt Coot-tha Road)

- maintenance access and inspection for station and supporting infrastructure would be from the eastbound carriageway of the Centenary Motorway

- a deceleration lane is to be provided for vehicles to enter the site safely and without affecting traffic on the Centenary Motorway. The width of the access width allows vehicle to pass each other while waiting to turn out of the site. DTMR has generally accepted this change. Final consultation and approval is required from DTMR.

Centenary Motorway worksite access and egress

The following changes were identified in the Project Change Report for the worksite access:

- temporary access would enable a heavy vehicle (only) to enter and exit the construction site. Light vehicle access is to be from Mt Coot-tha Road. The Changed Project proposes that the vehicle movements entering and exiting the worksite will be restricted to out of traffic peak periods

- length of the acceleration lane and taper is in excess of 145 m. This is proposed so that there is appropriate conditions for heavy vehicle to reach 60 km/hr at the motorway merge (downgrade at this location is greater than 4%)

  the Construction Traffic Management Plan would include a vehicle weave analysis. This would ensure that the vehicles accessing the worksite can adequately merge with motorway traffic

- consultation would be required with DTMR to ensure that the traffic volumes and types of vehicles making these manoeuvres is appropriate and to avoid any safety or capacity issues for the motorway.

Temporary workforce car parking

The Project Change Report identified the following changes for the workforce car parking:

- up to 300 workforce car parking spaces to be provided temporarily in Anzac Park. This car park would be accessed via the pedestrian and cycle bridge over the Centenary Motorway

- public access would be maintained from Dean Street and Wool Street, with project worker's access to be restricted to access only from Dean Street

- the RD car parking area on Sir Samuel Griffiths Drive would be retained as part of the Changed Project to support the project office staff and visitors' centre, which will be located on the former Freers potato chip factory site.

Pedestrian and cyclist arrangements

The Project Change Report provided the following changes as part of the Changed Project:

- the same pedestrian and cyclist connectivity around the Western Connection would remain the same as detailed in the RD, including the extension of the existing pathway along Mt Coot-tha Road to the Botanical Gardens entrance near Ada Street

- the pedestrian/cycle crossings of Dean Street and Miskin Street would be improved by a larger median island on Dean Street and a kerb build-out on the eastern side of Miskin Street, improving cyclists' safety

- the amended central portal locations would negate the requirement for cyclists travelling along the Centenary Motorway to or from the Mt Coot-tha Road roundabout to cross motorway lanes. The Changed Project would allow the use of the motorway by group and sport cyclists in accordance with DTMR's current arrangement with Bicycle Queensland.

As summarised in the Project Change Report, the Changed Project would help to alleviate construction impacts in the following ways:

- *no impact on the DTMR Centenary Motorway pedestrian and cyclist bridge structure during or after construction*
- *full connectivity provided for the pathway to Mt Coot-tha Road from the overpass during construction with realignment work conducted offline where appropriate and night works to tie into existing infrastructure to minimise any impacts*
- *maintaining access in relation to the Centenary Motorway bikeway to the south*
- *no impacts on Mt Coot-tha Road roundabout or on the southern side of Centenary Motorway*.

4.3.2 Justification for proposed changes

The following details the justification for the changes contained in the Project Change Report:

- the changed location of the connection enables the launch of the TBMs and other construction works to occur off-line from the Centenary Motorway. The surface works require only a single traffic switch to the ultimate alignment on completion of that package of works
- the revised connection avoids construction impacts on Mt Coot-tha Road and the roundabout. This change results in a consolidation of the construction area, simplified construction traffic management and improves grades for the associated cut and cover and transition structures
- the design changes provide more efficient and more 'legible' connections between the motorway and the NLRT tunnels, with limited impacts on the future development of the motorway, including the future widening of the Centenary Motorway to three lanes each way
- the revised connection between the motorway and NLRT Project would achieve acceptable performance in the event of a major traffic incident on the motorway
- the vertical alignment or gradient of the tunnels and transitions have been revised to improve the exit speeds for heavy commercial vehicles. The downgrade length where gradients are greater than 3% have been reduced by approximately half, from 1,200 m in the RD to 650 m in the Change Project. This change would result in the potential for improved vehicle safety when entering the tunnel
- a temporary construction workforce car park in Anzac Park has been identified for up to 300 spaces which is additional to what was proposed in the RD. The access to the car park would be granted via the pedestrian and cycle bridge over the Centenary Motorway and vehicle access for workers' would be restricted to Dean Street.

The Project Change Report indicated that there would be several advantages in this arrangement over the RD including:

- *no tunnel or road construction through Anzac Park, Toowong*
- *no construction within the west-bound lanes of the Centenary Motorway*
- *maintaining access to the existing cycleway and the pedestrian and cycle bridge structure over the Centenary Motorway*
- *the removal of proposed cut and cover construction through Mt Coot-tha Road and the Mt-Coot-tha roundabout*
- *improved traffic management and pedestrian and cycle access during construction.*

4.3.3 Impacts associated with proposed changes

From the Project Change Report, the key changes to the RD include:

- no impacts are anticipated on the ability for DTMR to undertake future upgrades of the Centenary Motorway and local road network, including the proposed future widening of the motorway, the connection with a possible future Inner Orbital or mitigation works for the Moggill Road ramps
- the proposed road layouts would ensure safety benefits through an improved for easy way finding for motorists, providing clear choices between the NLRT Project and surface roads via the motorway
- the proposed change to the design speeds, length of merges and line marking would provide an equivalent to better outcome that the RD, while satisfying the DTMR requirements
- the portal locations and connecting lanes on the western end of the NLRT Project provides a suitable route as a primary traffic and freight route, resulting in Milton Road becoming a secondary route
- the temporary construction workforce car park to be located in Anzac Park would provide sufficient spaces to meet the Changed Project requirements. Although the additional car park would potentially increase traffic flows during the construction phase.

The Project Change Report also summarised that the central portals arrangement for the Western Connection of the Changed Project would:

- *allow the Centenary Motorway merge and diverge areas to operate safely and efficiently*
- *allow traffic to enter the tunnels even with traffic queues associated with both the Mt Coot-tha roundabout and the Toowong roundabout*
- *allow traffic to access Milton Road, even with an incident in either of the tunnels.*

Effect of design changes on adjacent road network

The Project Change Report indicated that the Changed Project would maintain the forecasted volumes (reduced traffic demands than currently experienced) on the Mt Coot-tha and Toowong roundabouts as identified in the RD. The EIS intersection performance analysis would continue to apply to the Changed Project. Further improvements for the Changed Project include:

- a clear distance between the Mt Coot-tha roundabout and the NLRT diverge
- no impact on the traffic entering the NLRT Project from the Mt Coot-tha and Toowong roundabouts until after 2026.

4.3.4 Proposed mitigation measures

The Project Change Report identified the following mitigation measures for the identified potential impacts:

- the temporary access to the worksite would be from the motorway in accordance with the RD, however an additional temporary entry and exit for lighter construction vehicles would be provided to the on-site parking and access to site offices to and from Mt Coot-tha Road
- an additional 300 car parking spaces would be provided in Anzac Park to address the Coordinator-General's conditions and the requirement for sufficient temporary spaces.

4.3.5 Assessment of Coordinator-General's conditions

For the Western Connection, in according with Schedule 2 Clause 2, approval must be obtained from the Chief Executive of the DTMR under the *Transport Infrastructure Act 1994* for carrying out works for connections to any State Controlled Road.

For the pedestrian/cycle connectivity, in accordance with:

- Schedule 3 Clause 12 (a), the existing connectivity and functionality of the Centenary Motorway Bikeway and Centenary Motorway Cycle and Pedestrian Bridge at Toowong will be maintained during the construction period. Where occasional closure to the Centenary Motorway Cycle and Pedestrian Bridge is required for modification of the structure to span the new road works or other safety issues, an alternative route must be provided and such closures will not exceed 50 days in total for the duration of the construction works of the NLRT Project and the proponent is to schedule the works to minimise disruption to cyclists where possible. No single closure is to be greater than 30 calendar days.
- Schedule 3 Clause 12 (b), a pedestrian/cycle path consistent with the existing pedestrian/cycle infrastructure must be constructed from the Centenary Motorway pedestrian/cycle overpass adjacent to the Mt Coot-tha roundabout to the main entrance of the Mt Coot-tha Botanic Gardens prior to commencement of operations including assessment of the conditions and rigour of Project Change Report statements regarding no impacts etc.
- In terms of traffic management during the construction phase of the NLRT Project, the requirements shall be in accordance with Schedule 3 Clause 16 (a) to (l)

- In terms of spoil handling and placement during the construction phase of the NLRT Project, the requirements shall be in accordance with Schedule 3 Clause 17 (a) to (f)

- In terms of other conditions for general construction during the construction phase of the NLRT Project, the requirements shall be in accordance with Schedule 3 Clause 18(a) to (o).

In particular, specific measures must be taken to manage and mitigate construction impacts including:

- access points for pedestrian and vehicular traffic must be situated according to the Transport, Access, Parking and Servicing Planning Scheme Policy in *Brisbane City Plan 2000*

- the construction workforce must not park in local streets. A dedicated and adequate construction workforce off-street parking area must be provided. All construction workforce vehicles must be directed to project construction workforce car parks. To avoid construction workforce car parking in local streets, shuttle transport between construction workforce car parks distant from a construction area must be provided for the duration of the period the construction area is in use.

4.3.6 Recommendations

Based on PB's review of the Changed Report and Coordinator-General's conditions, it is our view that the Project Description in the Coordinator-General Report will require to be amended to reflect the Changed Report's proposed connections between the Centenary Motorway and the NLRT Project.

Furthermore, the spoil haulage and placement description will also require to be amended based on the spoil placement sites identified by the Changed Project.

Changes to Schedule 3 Clause 26 will be necessary to account for the proposed changes to the connection between the Centenary Motorway and the NLRT.

Apart from the following specific additional condition and recommendation, it is our view that the existing Coordinator-General's conditions mentioned in the above section are considered sufficient to cover potential impacts during the construction and operation phases.

PB recommends that further consultation be undertaken with DTMR to clarify that the opportunity for future upgrades to the Centenary Motorway and local road network , the connection with the future Inner Orbital and works required for the Moggill Road ramps would not be jeopardised by the Changed Project.

Ventilation station access

As indicated in the Project Change Report, access for maintenance and inspection for the ventilation station and associated supporting infrastructure would be provided from the eastbound carriageway of the Centenary Motorway. Controlled/restricted access has been requested by DTMR via Centenary Motorway. General maintenance and security access is to be provided at the back of the ventilation building via the Botanic Gardens.

Moreover, in accordance with Schedule 2 Clause 2, approval must be obtained from the Chief Executive of the DTMR under the *Transport Infrastructure Act 1994* for carrying out works for connections to any state controlled road.

It is our view that an additional condition should be included in the Coordinator-General's conditions that the proponent must consult with the Botanic Gardens to identify and provide mitigation measures to minimise impacts to the Botanic Gardens, due to provision for general maintenance/security vehicle accessing the ventilation building through the gardens.

Adequate parking provision

The proposal to provide a temporary car park for the construction workforce in Anzac Park would meet the requirements for the Changed Project. The provision shall be in accordance with Schedule 3 Clause 18(k). Moreover, it is likely that traffic will increase in the local area due to traffic flows into and from the temporary car parking for the duration of the construction period. It is our view and recommendation that the proponent is required to confirm the adequacy of the number of parking spaces provided for the anticipated number of construction workforce.

4.4 Air quality and greenhouse gases

4.4.1 Comparison of Reference Design to Changed Project

The Changed Project at the Western Connection would have flatter road alignments and possibly more efficient connections to the Centenary Motorway than the RD, resulting in more freely flowing traffic in most conditions. In addition, the location of the western ventilation outlet would be approximately 43 m to the north-west of the RD outlet and the height would remain the same.

The locations of the conveyor and workshed for spoil handling have also changed as a result of the Changed Project. The conveyor will be approximately 500 m longer under the Changed Project. In addition to the use of the conveyor, spoil will also be removed from the construction site by truck. The Changed Project will require a 14.3% increase in spoil removal by truck in comparison to the RD.

4.4.2 Justification for proposed changes

The proposed conveyor alignment was amended by Council to specifically avoid the public areas and established plantings within the Botanical Gardens.

The change to the location of the ventilation shaft was justified on the grounds that it was further away from sensitive receptors.

4.4.3 Impacts associated with proposed changes

Flatter alignments may result in minor reductions in vehicle emissions within the Changed Project tunnels compared to the RD. The difference in motor vehicle pollution when measured at ground level is expected to be very small and not significant.

In terms of the location of the ventilation shaft, the topography of the new location under the Changed Project is noted as being the same as the RD location and would not influence the performance of the ventilation outlet. However, with the movement of the location of the ventilation shaft, the ambient air quality assessments undertaken as part of the RD are no longer strictly relevant. The distance between the ventilation shaft and sensitive receptors has increased as a result of this relocation.

During the delivery phase, earthworks associated with the establishment of the western worksite and construction of the Western Connection would create the potential for dust.

4.4.4 Proposed mitigation measures

The majority of spoil excavated by the TBMs will travel by conveyor from each TBM at the western tunnel portals to a transfer station located within the western worksite. From the transfer station, a single conveyor will transport the material to the Mt Coot-tha Quarry. The conveyor will be fully enclosed along its length between the worksite shed and the quarry. All stockpiling, truck and conveyor loading activities at the western worksite will be undertaken entirely within worksite shed or within the tunnel excavation area.

The above described arrangements relating to the RD would be maintained for the Changed Project.

4.4.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for air quality are presented in Schedule 1 Condition 4 and Schedule 3, Condition 20. In general, the conditions remain relevant to the Changed Project.

4.4.6 Recommendations

No additional conditions are considered necessary; however the following changes are required to be made to the conditions stipulated.

Condition 4 (c) describes the location of the western ventilation outlet for the NLRT Project. This should be amended for the revised location under the Changed Project.

Table 3 outlines the monitoring sites for ambient air quality in the vicinity of the ventilation outlets. Revised monitoring location for the western ventilation outlet should be provided to reflect the changed location of this facility.

4.5 Surface water quality

4.5.1 Comparison of Reference Design to Changed Project

Altered surface connections at the western end of the Changed Project would result in some changes in relation to the collection, treatment and disposal of surface water runoff. Key differences include:

- pavement surface runoff on the eastbound Centenary Motorway would be collected and directed under the westbound Centenary Motorway carriageway to water quality management features before release to the existing natural watercourse. The westbound Centenary Motorway carriageway would drain to the existing drainage system including water quality management features before its release to the watercourse

- all surface runoff from the transitions to the tunnel portals would be collected and taken via water quality control features into a rock lined gully and directed into the newly constructed 18 ML water storage dam in the south-east corner of the Botanic Gardens.

4.5.2 Justification for proposed changes

There is no justification in relation to surface water quality provided in the Project Change Report.

4.5.3 Impacts associated with proposed changes

The Changed Project incorporates arrangements to protect against erosion or impacts on downstream water quality.

4.5.4 Proposed mitigation measures

The various management measures in the RD as part of the construction and operation surface water EMP sub-plans are still considered to be appropriate as they are expected to effectively mitigate water-related impacts arising from the construction and operation of the Changed Project.

4.5.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for surface water conditions are presented in Schedule 3, Conditions 21 and 32. The conditions remain relevant to the Changed Project.

4.5.6 Recommendations

No additional conditions are considered necessary.

4.6 Flora and fauna

4.6.1 Comparison of Reference Design to Changed Project

The Changed Project proposed relocating the tunnel portals, with the entry and exit ramps to be placed together in a central location on the inside of the existing Centenary Motorway lanes.

4.6.2 Justification for proposed changes

The Changed Project would not impact on fragmented regional ecosystems to the south of the Centenary Highway within Anzac Park, This is in contrast to the loss of approximately 2 ha that would occur as part of the RD.

4.6.3 Impacts associated with proposed changes

Although the Changed Project would have a reduced impact on the regional ecosystems contained in Anzac Park, it would impact approximately up to 15 ha of vegetation protected under the VM Act to accommodate the realignment of the Centenary Motorway and construction activities. This includes approximately:

- 9 ha of 'least concern' RE (12.11.3 and 12.11.5)
- 6 ha of regulated regrowth.

By comparison the RD was estimated to affect 1.6 ha of remnant vegetation.

4.6.4 Proposed mitigation measures

In the RD, it was considered that neither the size of the area or its values were such that a formal offset agreement under the Queensland Environmental Offset Policy is required. However, with the increase in vegetation clearing from 1.6 ha to 15 ha as a result of the changed alignment of the Centenary Motorway and construction activities, it is recommended that the need for a formal offset agreement under the Queensland Environmental Offset Policy is reassessed to ensure that this is still the case.

The various management measures in the RD, as part of the construction and operation EMP flora and fauna sub-plan are still considered to be appropriate as they are expected to effectively mitigate flora and fauna related impacts arising from the construction and operation of the Changed Project.

4.6.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for flora and fauna are presented in Schedule 3, Condition19. The conditions remain relevant to the Changed Project.

4.6.6 Recommendations

No additional conditions are considered necessary.

4.7 Noise

4.7.1 Comparison of Reference Design to Changed Project

The Changed Design would locate the tunnel alignment further to the north of the RD. In addition the east bound lanes of the Centenary Motorway would be located further to the north.

The Project Change Report has also identified some changes to the layout of the Western Worksite.

4.7.2 Justification for proposed changes

There is no justification in relation to noise provided in the Project Change Report.

4.7.3 Impacts associated with proposed changes

4.7.3.1 Operational road traffic noise

The relocation of the tunnel alignment and the eastbound lanes of the Centenary Motorway would be the source of additional road traffic noise exposure to the Botanic Gardens to the north.

4.7.3.2 Construction noise

The Project Change Report anticipates some changes to potential noise impacts as a result of construction activities, such as spoil handling. In particular, TBM operation and ventilation fans have been identified. The Project Change Report has also identified the potential for noise impacts due to noise emissions from the temporary construction workforce car park in Anzac Park.

4.7.4 Proposed mitigation measures

4.7.4.1 Operational road traffic noise

To address the impacts of additional noise resulting from the tunnel alignment and eastbound lanes of the Centenary Motorway being located further to the north, the proponent is proposing the construction of a 4 m high noise barrier on the northern side of the realigned eastbound lanes. The height and location of this barrier would need to be further refined during detailed design.

4.7.4.2 Construction noise

Conceptual noise control measures have been described in the Project Change Report such as a 6 m high noise barrier, spoil enclosure, TBM enclosure, conveyor motor and transfer motor enclosures and attenuators for ventilation fans. Details of these mitigation measures would need to be more specific in the Noise and Vibration EMP Sub Plan or provided for review through detailed design.

Mitigation measures for controlling construction noise and noise from the car park would need to be addressed in more detail in the Noise and Vibration EMP Sub Plan or through detailed design.

4.7.5 Assessment of Coordinator-General's conditions

4.7.5.1 Operational road traffic noise

The Project Change Report confirms that the traffic noise limits in the Conditions would be achieved. It should be noted that there is insufficient detail in the Project Change Report to verify the validity of the traffic noise modelling conducted. More detailed information should be provided to enable a review of the detailed design as per the required information specified in Section 3.13.6.1.

For local roads, the Coordinator-General's conditions allow the proponent to achieve status quo noise levels in locations, which currently exceed 63dBA $L_{A10(18\ hour)}$. The status quo noise limit would be determined based on modelling of the existing road under 2026 conditions.

Regardless of whether the current noise levels exceed 63dBA $L_{A10(18\ hour)}$, the NLRT Project will modify roads at the connections and therefore, every practical attempt to achieve appropriate noise criteria should be considered. In the event that the noise criteria cannot be practically achieved, such as instances where noise barriers would be unacceptably high or cause other road safety, access or amenity issues and then the status quo criteria would be considered a reasonable approach.

4.7.5.2 Construction noise

The Project Change Report assesses noise impacts against noise limits contained in the Coordinator-General's conditions. There is not enough detail in the Project Change Report to enable verification of the validity of the assessment. This would not pose a risk as the Coordinator-Generals conditions would require noise control measures to be detailed in the Noise and Vibration EMP Sub Plan or through detailed design, and that the EMP is to be reviewed by an Independent Verifier. However, it is recommended that the proponent should provide sufficiently detailed information to enable an independent review of the proposed mitigation measures.

4.7.6 Recommendations

4.7.6.1 Operational road traffic noise

For local roads, the Coordinator-General's conditions allow the proponent to achieve status quo noise levels in locations which currently exceed 63dBA $L_{A10(18\ hour)}$. If there is modification to local roads as part of the NLRT Project, all practical measures should be considered to achieve the Coordinator-General's noise limits. In the event that the noise criteria cannot be practically achieved, such as instances where noise barriers would be unacceptably high or cause other road safety, access or amenity issues and then the status quo criteria would be considered a reasonable approach.

As required by Coordinator-General's Schedule 3, Condition 22 (b), a Noise and Vibration Sub-EMP would be required for the NLRT Project and assessed by an independent acoustic specialist. Although no amendment is recommended to this condition, it is noted that as part of this condition, the proponent should include specific details of the noise control measures to achieve the Coordinator-General's conditions during detailed design. To enable an independent review of the Changed Design would require the following information:

- noise contour maps of the worst case noise exposure at nearby residences both with and without noise barriers
- the input data used in the modelling such as traffic volumes, percentage heavy vehicle, speed etc. information relating to the design contours, either in a separate drawing/plan or labelled contours in the noise contour maps.

4.7.6.2 Construction noise

As proposed by the proponent, the impact of construction noise can be addressed by preparing a Noise and Vibration Sub Plan as detailed in the Coordinator-General's conditions or during detailed design. To enable an independent consultant to conduct a review of the assessment would require the following information:

- source noise levels assumed for construction activities
- the height (RL AHD) of the sources
- the location of noise sources in relation to nearby receivers
- any screening of noise sources which would be provided due to topography, intervening buildings or proposed noise barriers.

The predicted noise levels at nearby receivers.

4.7.6.3 Other operational noise

Although not mentioned in the Project Change Report, it would be expected that the noise emissions from other operational sources, such as ventilation outlets, would be addressed in the Noise and Vibration EMP Sub Plan or through detailed design.

4.8 Ventilation and fire and life safety

4.8.1 Comparison of Reference Design to Changed Project

Tender documentation for the ventilation system proposed was reviewed by PB and compared to the system outlined in the RD. At the western end the material change affecting the ventilation system was the location of the ventilation outlet. This change was documented in the Project Change Report.

The Coordinator-General's report specifies requirements for the ventilation outlet. These were assessed as part of this review.

4.8.2 Justification for proposed changes

For the relocation of the ventilation outlet at the western end, justification was provided that the minimum height of 20 m above natural ground level or RL67m (whichever is higher) would still be met (Coordinator-General's Report Schedule 1, Section 4, Item c). The location has moved 43 metres northwest of the RD location. Justification was provided by outlining that this direction was further away from sensitive receptors.

4.8.3 Impacts associated with proposed changes

The changed stack location would mean that air quality assessments undertaken as part of the RD for the western end would no longer be strictly relevant.

4.8.4 Proposed mitigation measures

The changed stack location requires no mitigation measures as long as ambient air quality requirements are achieved. This has not been analysed and documented. It is assumed this documentation would follow as part of the future design processes.

4.8.5 Assessment of Coordinator-General's conditions

The relevant Coordinator-General's condition is Schedule 1, Condition 4, which relates to obtaining a Material Change of Use approval for an Environmentally Relevant Activity 51 (road tunnel ventilation stack operation). This includes criteria relating to tunnel air quality.

4.8.6 Recommendations

To ensure the changed ventilation outlet location meets the Coordinator-General's requirements, a review of the air quality studies that would form part of the design process should be undertaken.

4.9 Planning, social and land use

4.9.1 Comparison of Reference Design to Changed Project

The Western Connection design and construction changes to the RD in terms of planning and land use considerations are detailed below:

- the revised Western Connection requires the realignment of the eastbound lanes of the Centenary Motorway to the north to allow the co-location of the of the entry and exit portals for the tunnels. This change avoids surface construction impacts to Mt Coot-tha Road and the roundabout as well as allowing surface works to occur within the newly created median strip. The relocation of the motorway would also occur off line

- the proposed modification to the portal locations would result in service infrastructure and the ventilation station and outlet moving to the west adjacent the Botanic Gardens

- temporary construction workforce parking areas would be established in Anzac Park for up to 300 vehicles, without any loss of significant trees in the park and with access from Dean Street only. The site on Mt Coot-tha Road proposed for car parking in the RD would no longer be required for this purpose

- a temporary project office and visitor centre, including parking, is proposed along Sir Samuel Griffith Drive between Mt Coot-tha Road and Simpsons Road from 2011 to 2014

- the proposed spoil conveyor has been modified to ensure the protection of public areas and plantings in the Botanic Gardens. The spoil from the worksite would be disposed at the Mt Coot-tha Quarry or at another approved site, potentially Rudd Street, Oxley.

4.9.2 Justification for proposed changes

The proposed arrangement of both east and westbound portals in the centre of the Centenary Motorway were identified in the Project Change Report as providing the following benefits:

- improve the potential traffic impacts than those proposed in the RD for the vehicles travelling along the motorway as the works would occur off line

- negate the requirement for inference of the NLRT Project with Mt Coot-tha Road and the roundabout during the construction phase

- the workforce carpark located along Sir Samuel Griffith Drive would remain from the RD, however the proposed carpark located in the overflow carpark located across from the Botanic Gardens along Mt Coot-tha Road would now be used for construction parking associated with the Toll Control Centre (refer to Section 5 of this report for a full assessment). The proponent has identified shuttle buses as a means to transport the construction works to the worksite

- additional worksite carparking was proposed in the Project Change Report to address the Coordinator-General's request to provide adequate parking for the workforce at the Western Connection.

4.9.3 Impacts associated with proposed changes

The following describes potential impacts from the Changed Project:

- Stage 2 of the Changed Project works requires a switch to the realigned eastbound lanes of the Centenary Motorway. These works would affect the vehicle users along the motorway to a lesser level than proposed in the RD. All other works are proposed to be located within the widened median strip

- the construction of the surface works, such as the realigned eastbound lanes of the Centenary Motorway, would also occur off-line. This would require only a single traffic switch to the ultimate alignment on completion of that package of works

- the proposed changed location for the workforce carparking would be on land that is currently vacant or contains a disused factory on 95 Sir Samuel Griffith Drive, Bardon, as well as the additional 300 car parks in Anzac Park. The Anzac Park construction parking would be located approximately 80 m from the nearest residences in Wool Street

- the relocation of the ventilation station and service infrastructure would be required

- the change to the location of the ventilation shaft results in a location that is further away from sensitive receptors than the RD.

4.9.4 Proposed mitigation measures

The following summarises the mitigation measures proposed in the Project Change Report:

- to reduce the impacts on the local road network from the construction workforce parking:

  - additional carparking facilities were proposed to satisfy the request from the Coordinator-General's for adequate carparking

  - the use of public transportation would be encouraged through the provision of shuttle buses between the Roma Street Transit Centre and the eastern worksite is proposed along with prepaid tickets.

- the size of the construction area located in the Botanic Gardens on the northern side of the motorway reduces the need for surface and tunnel works on the southern side, avoiding the Anzac Park wetlands and existing bicycle path. Anzac Park remains impacted by the proposed construction parking area

- staging is provided to control the impacts on motorway users. A single traffic switch is proposed by the proponent to realign the eastbound lanes to allow the construction of the increased median strip.

4.9.5 Assessment of Coordinator-General's conditions

- The Coordinator-General's condition Schedule 3, Item 18 details that standard construction hours are between 6.30 am Mondays to 6:30 pm Saturdays, with no construction to be undertaken on Sundays or public holidays. This remains applicable for the NLRT Project.

- Schedule 2, Item 2 details approval requirements from the Chief Executive of DTMR for the connection to a State Controlled Road. This is still applicable for the Changed Project.

- Any temporary or permanent road closures would also require approval from either DTMR or BCC under the relevant legislation, as stated in Schedule 2, Item 4.

- Schedule 3, Item 16 (traffic management)(g)(vi) requires measures to prevent the parking of construction traffic on streets near to work sites.

- Schedule 3, Item 18(k) (general conditions) states that *the construction workforce must not park in local streets. A dedicated and adequate construction workforce off-street parking area must be provided. All construction workforce vehicles must be directed to project construction workforce car parks. To avoid construction workforce car parking in local streets, shuttle transport between construction workforce car parks distant from a construction area must be provided for the duration of the period the construction area is in use.*

4.9.6 Recommendations

In terms of approvals, the proposed Changed Project has not proposed any modification that would trigger approvals significantly different to those required under the RD. For example, the same service infrastructure approvals would be required however, the extent of approvals would need to be identified by the proponent at the detailed design stage. It is recommended that the Coordinator-General's conditions include a requirement for obtaining permits or licences under the relevant local laws, including Park Access Permits.

A road corridor permit should also be sought by the proponent from the DTMR for interference with a State Controlled Road, including an interface agreement between the NLRT Project and DTMR.

The proposed temporary office and visitor car parking facility would not limit the future use of the properties, however rehabilitation of the properties would be required. Appropriate consultation with key stakeholders should be undertaken in this regard. Furthermore, projects of this scale can result in over flow construction workforce parking within the surrounding local road networks, resulting in access issues for local residents. It is important that the proponent implements the proposed mitigation measures to encourage public transport use by their workforce. It is suggested that under Schedule 3, Item 16 (traffic management), that the condition (g) be amended to state the following:

(vi) measures to prevent the parking of construction traffic on streets near to work sites, including provision of prepaid public transportation tickets and shuttle buses.

Other suggested condition amendments include:

- insert condition under Schedule 2 relating to the requirement for the proponent to lodge relevant applications under the BCC's Local Laws including, but not limited to, vegetation clearing under the *Natural Assets Local Law 2003* and undertaking works within a BCC controlled road under Chapter 6 Streets, Bridges, Culverts etc

- insert Item 7, Building Approval for associated infrastructure, including the development of the Toll Control Centre.

Appropriate consultation and negotiation is required in accordance with the relevant legislation to limit the impact of this change. Schedule 3, Part 2 (design and construction phase), Item 6 relating to communication and consultation highlights the communication protocol.

4.10 Visual amenity

4.10.1 Comparison of Reference Design to Changed Project

The following section highlights the key changes to the Western Connection with regard to the Changed Project's visual amenity implications:

- the revised alignment of the eastbound lanes of the Centenary Motorway and relocation of the tunnel portals to the centre of the motorway allows the water and power utility area and ventilation station to be repositioned to the west of the RD and onto the rising ground adjacent the Botanic Gardens

- the Changed Project proposes to bury the ventilation station completely to the north of the utility area, with an outlet of approximately 43 meters to the northwest of the RD. Figure 2.38 from the Project Change Report provides a representation of the location in Figure 4.1 of this report.

4.10.2 Justification for proposed changes

An improvement identified by the Project Change Report relates to the relocation of the tunnel portal within the central median strip, as well as the realignment of the eastbound lanes of the Centenary Motorway. The report states that the visual impact would be similar or less than the impact anticipated for the RD due to the Changed Project having less exposed infrastructure and retention of the outbound land on their existing alignment.

4.10.3 Impacts associated with proposed changes

The main visual amenity impacts detailed in the Project Change Report relate to the ventilation structures, with the Changed Project incorporating a buried station and exposed outlet approximately 43 m to the west of the RD. The outlet would be a minimum of 20 m high, with an elevation of at least 67 m (AHD).

4.10.4 Proposed mitigation measures

To mitigate the visual impacts associated with the ventilation outlet, the Changed Project has identified an architectural treatment that would integrate with the surrounding Botanic Gardens and Mt Coot-tha. While the Changed Project has proposed that the buried ventilation station be landscaped and allow for public use.

4.10.5 Assessment of Coordinator-General's conditions

Appendix 1, Schedule 1, Item 4 of the Coordinator-General's conditions states the following requirements for making a Material Change of Use for an ERA 51 – road tunnel ventilation stack operation:

- *(c) The western ventilation outlet for the project is to be situated adjacent to the Centenary Motorway at the location indicated in the EIS 1 , and must be at least 20 metres in height above natural ground level in that location, or no less than RL 67metres, whichever is the higher.*

The condition continues to be applicable to the NLRT Project.

4.10.6 Recommendations

The Project Change Report details that the proposed ventilation outlet would meet the Coordinator-General's conditions relating to height and RL.I It is recommended however, that the Coordinator-General request visual proof from the proponent that the visual impact from the Changed Project ventilation station is reduced, equal or better than that proposed in the RD. In addition, details of the proposed architectural treatment for the outlet that is to assimilate with the surrounding landscape are required.

Appendix D of the Supplementary Environmental Impact Statement details provisions under the EMP for the tunnel portals and connections. A comparison of the Changed Project against the RD and these criteria were not undertaken by the proponent to determine the potential visual amenity impacts or improvements.

Figure 4.1 Changed Project – Western ventilation station and outlet

4.11 Non-indigenous cultural heritage

4.11.1 Comparison of Reference Design to Changed Project

The Changed Project proposed relocating the tunnel portals, with the entry and exit ramps to be placed together in a central location on the inside of the existing Centenary Motorway lanes. The Changed Project also proposes to alter the location of key project infrastructure. This includes the movement of the western ventilation station and ventilation outlet to a position north-west of the proposed RD location, and the relocation of the Tollroad Control Centre (TCC) from an area in the western worksite presented in the RD, to a site located opposite to the entrance of the Mt Coot-tha Botanic Gardens.

The latter of these changes will serve to increase the area of the western worksite from approximately 4 ha to 6 ha.

In addition, the Changed Project allows for a temporary construction workforce parking area for up to 300 vehicles in Anzac Park.

4.11.2 Justification for proposed changes

Provision of parking within Anzac Park has been included in the Changed Project to satisfy the Coordinator-General's condition with regard to the provision of adequate off-street parking.

4.11.3 Impacts associated with proposed changes

The Changed Project does not result in an effective change on the State Heritage Registered Mt Coot-tha Forest from that predicted for the RD. As identified in the Project Change Report, the RD required approximately 1.4 ha of vegetation clearing in the Mt Coot-tha Forest. This clearing occurred on both the northern and southern sides of the Centenary Motorway. With the Changed Project, approximately 1.4 ha of vegetation clearing is still required from the Mt Coot-tha forest; however all of this clearing is to occur on the northern side of the Centenary Motorway. As identified in the Project Change Report, the heritage values of the State Heritage Area will not be affected differently from the RD.

With the Changed Project impact on Anzac Park would be reduced. In the RD, Anzac Park would have been impacted by the exit tunnel and connection to the Centenary Motorway. In the Changed Project it is to be affected by temporary construction workforce carpark. While this is a temporary change in the character of the park, it is not considered to be as extensive as the permanent change that would have occurred with the RD.

4.11.4 Proposed mitigation measures

The various management measures in the RD as part of the construction and operation EMP cultural heritage sub-plan, particularly those relating to Victoria Park and State Heritage Places, are still considered to be appropriate for the construction and operation of the Changed Project.

4.11.5 Assessment of Coordinator-General's conditions

The Coordinator-General's conditions for air quality are presented in Schedule 1, Conditions 2 and 3. The conditions remain relevant to the Changed Project.

4.11.6 Recommendations

No additional conditions are considered necessary.

5. Conclusion

This report provides a summary of the findings for the independent technical review of the Northern Link: Application for Project Change Report (2010) and included an assessment of other supporting information.

The key findings from this technical assessment have been summarised in the table provided in Appendix B of this report.

The findings of this report will provide information to the Coordinator-General for the preparation of the Coordinator-General's Change Report under Section 35I of the *State Development Public Works Organisation Act 1971*.

6. References

Brisbane City Council 2010, 'Northern Link Application for Project Change – Northern Link Road Tunnel Project October 2010'.

Queensland Government (Department of Infrastructure and Planning) 2010, 'Coordinator-General's Report: Northern Link Tunnel April 2010'.

Queensland Government (Department of Infrastructure and Planning) 2010, *South East Queensland Infrastructure Plan and Program 2010-2031*, Queensland.

SKM, Connell Wagner 2008, 'Northern Link Phase 2 - Detailed Feasibility Study, Northern Link Environmental Impact Statement September 2008'.

SKM, Connell Wagner 2009, 'Environmental Impact Statement Supplementary Report June 2009'.

Appendix A

Northern Link: Application for
Project Change Report 2010

Application for Project Change

Northern Link Road Tunnel Project

October 2010

Application for Project Change

Northern Link Road Tunnel Project

October 2010

Dedicated to a better Brisbane

Major Infrastructure Project Office
2/171 George Street, Brisbane Q 4001

Phone: 07 3403 7330
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Northern Link Road Tunnel Project

Application for Project Change

October 2010

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Executive Summary

1 Overview

The Northern Link Road Tunnel (**NLRT**) project was proposed by Brisbane City Council (**Council**) as a motorway-standard link between the Centenary Motorway at Toowong and the Inner City Bypass (**ICB**) at Kelvin Grove/ Herston to cater for cross-city trips and alleviate traffic congestion in the Brisbane central city area. The NLRT project is part of Council's TransApex plan, to create a system of motorway-standard link roads to divert cross city traffic away from the Central Business District. The NLRT is consistent with Council's Transport Plan for Brisbane 2006-2026, which provides strategies and actions around the public transport services and infrastructure needed for a sustainable future.

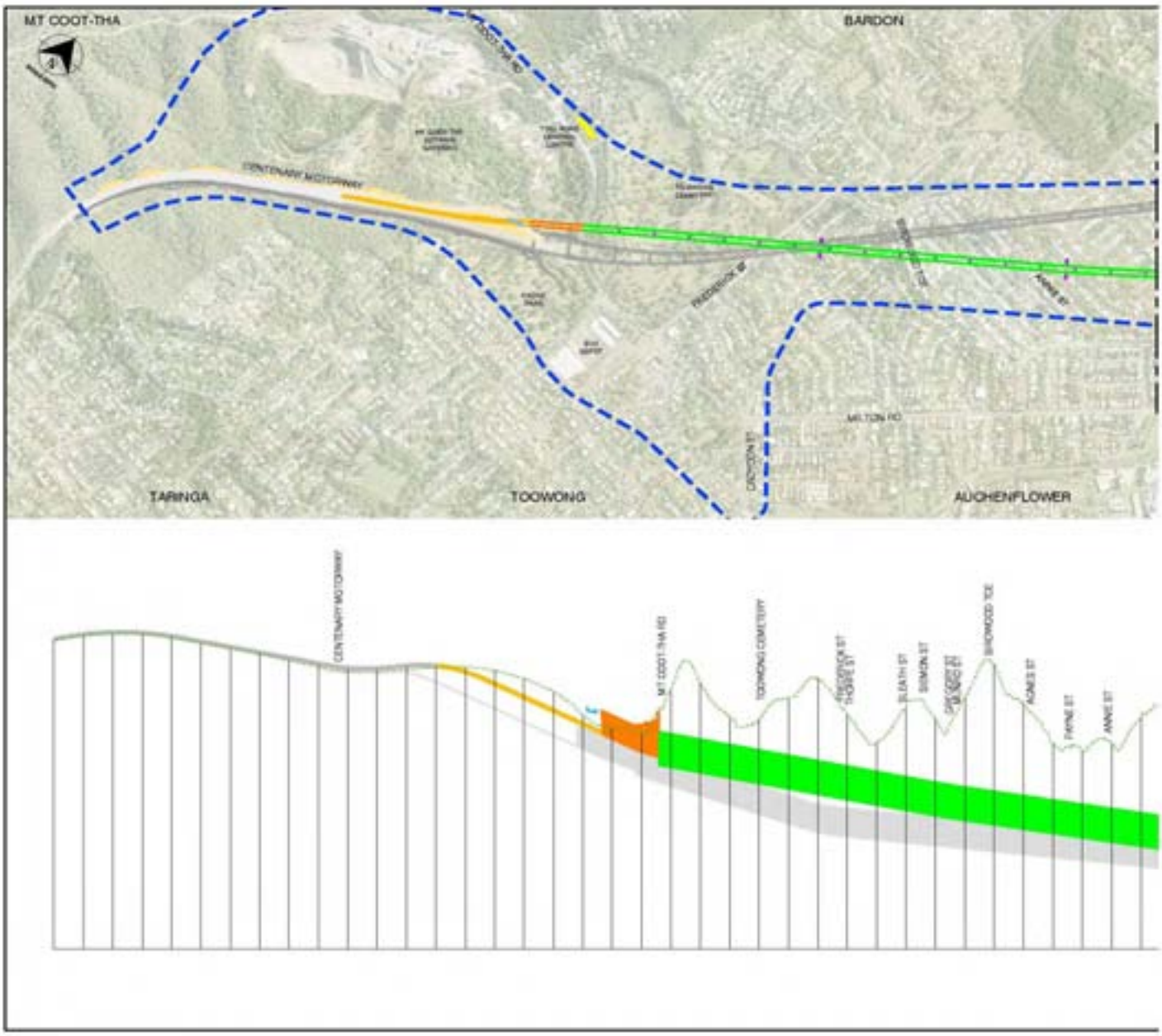
The NLRT Project would be approximately 5km in length and would consist of two carriageways constructed mostly in parallel tunnels, each of two lanes, passing beneath the inner western and northern suburbs. The NLRT Project would be operated by Brisbane City Council, through its agent Transcity, as a tolled road. The project would include fire and life safety measures, ventilation plant and equipment, communications and traffic monitoring equipment, maintenance facilities and equipment, and tollroad management facilities and equipment.

The NLRT is progressing through development from the detailed feasibility phase, in which a business case, reference design and environmental impact statement (**EIS**) were prepared, to the procurement phase, in which tenders for delivery were called. The EIS for NLRT was evaluated by the Coordinator-General in accordance with the *State Development and Public Works Organisation Act 1971*. The Coordinator-General recommended that the Northern Link Project as described in detail in the Environmental Impact Statement and the Supplementary Report (**Reference Design**) may proceed, subject to the conditions contained in Appendix 1 of the Coordinator-General's Report dated April 2010.

Since the Coordinator-General's Report was issued, Brisbane City Council has selected the Transcity Consortium (**Transcity**) to design, construct, maintain and operate for 10 years the NLRT project. Transcity is a consortium of BMD Constructions Pty Ltd. as Main Contractor supported by international sub contractors Acciona Infrastructures Pty Ltd (Acciona) and Ghella Pty Ltd (Ghella).. The Transcity proposal (**Changed Project**) includes changes to the Northern Link Project and the Project delivery arrangements. The tendered design, or Changed Project, would be substantially the same as the Reference Design, and would remain consistent with the project objectives. The Northern Link Project continues to be a motorway link connecting the Centenary Motorway at Toowong in the west, with the Inner City Bypass (**ICB**) at Kelvin Grove/ Herston in the east, constructed mostly in tunnels beneath the inner western suburbs of Brisbane.

Figure 1 shows the general alignment of the Changed Project in comparison with the Reference Design.

A summary of the proposed changes and the reasons for those changes follow.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TOOWONG
AUCHENFLOWER
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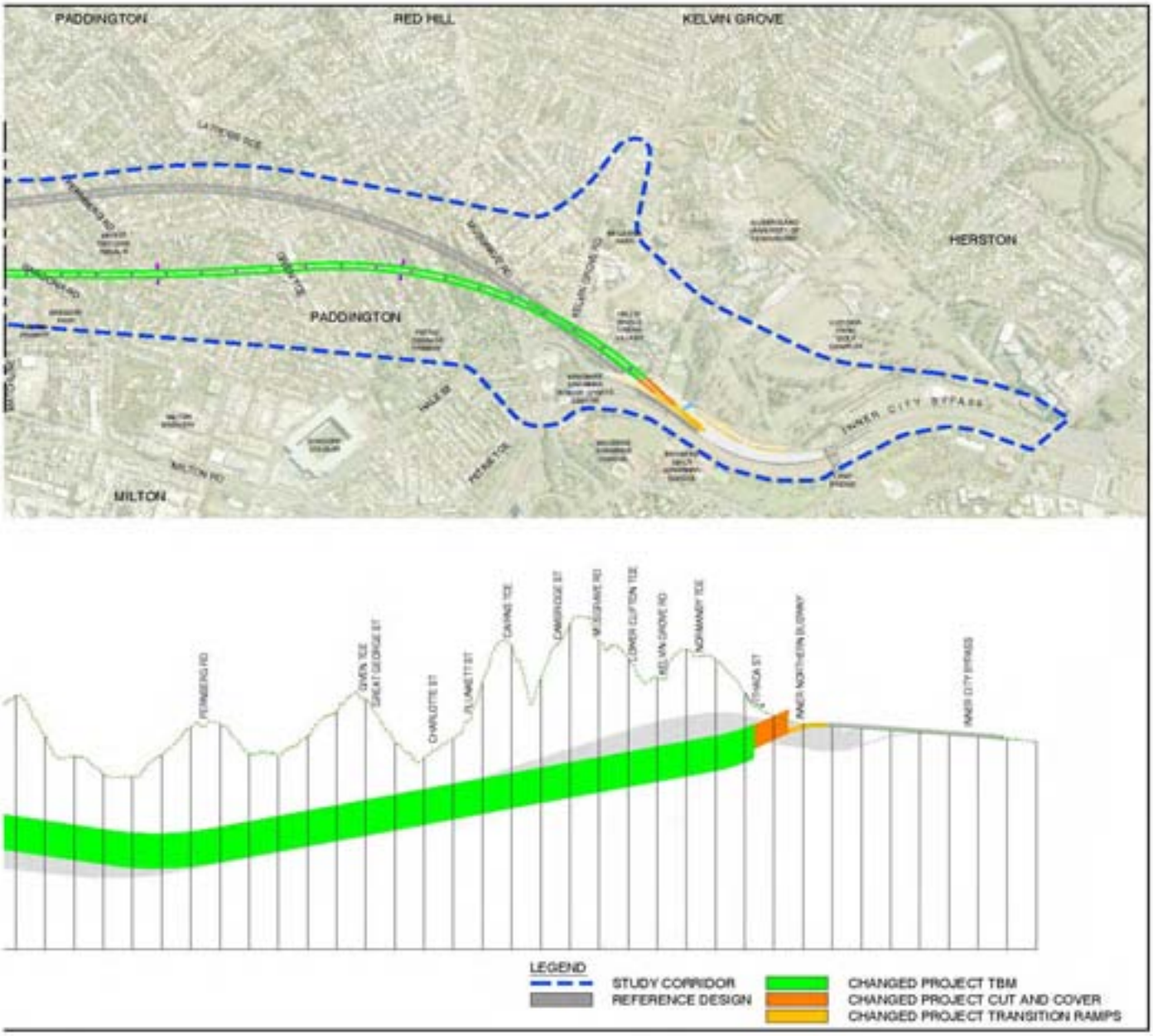

Figure 1: General Alignment– Changed Project

Changes to the main alignment:

- Horizontal Alignment – the main alignment between the connections would differ from the Reference Project by commencing at the western side of Mt Coot-tha Road approximately 100m north of the Reference Design alignment. The main alignment would then pass under the Toowong Cemetery, in a straighter route up to 300m south of the Reference Design to connect with the ICB on the southern side of Normanby Terrace. The connection would be near to the location indicated for the Reference Design. The proposed change in the main alignment would provide a more direct route between the connections. There would be a reduction in the number of properties affected by acquisition of volumetric title;
- Vertical Alignment - The vertical alignment of the main alignment for the Changed Project would be shallower for most of the route apart from the section from Carins Terrace east. This is due to the change in the horizontal alignment and ground surface levels at those locations and design changes to optimise tunnel gradients;
- Flatter or 'easier' grades within the main tunnels in the Changed Project, compared to the Reference Design, would provide for more efficient flows for all traffic, but especially for heavy commercial traffic. There would be consequential reductions in emissions and a safer, more reliable traffic flow;
- Volumetric Title Requirements - 334 properties would be affected by the Changed Project where the Reference Design identified approximately 374. Of these, 269 would be newly affected, including 6 Council owned parcels, and 65 of these would continue to be affected as they would be with the Reference Design. There may be minor changes to the number of affected properties during detailed design;
- There are some minor changes to surface land requirements for Council and State land as a result of changes in alignment, but there remain no requirements for the surface acquisition of privately owned land.

Changes to the Western Connections:

- The key differences in the Changed Project compared with the Reference Design at the western connections would be the realignment of the eastbound lanes of the Centenary Motorway to the north. This change would accommodate the location of the entry and exit portals to the NLRT tunnels in the centre of the motorway corridor.
- The changes in location of the western connections would enable construction works, including the launch of the TBMs for the driven tunnel construction, to occur off-line from traffic on Centenary Motorway. The construction of the surface works, such as the realigned eastbound lanes of the Centenary Motorway would also occur off-line, requiring only a single traffic switch to the ultimate alignment on completion of that package of works.
- The changed connection would also avoid construction through Mt Coot-tha Road and the roundabout, consolidating the construction area and simplifying construction traffic management and provides improved grades for the associated cut and cover and transition structures to the Centenary Motorway.
- Compared with the Reference Design, the Changed Project would provide a shorter merge from the Mt Coot-tha roundabout traffic to the outbound traffic from the NLRT onto the Centenary Motorway. The merge would still comply with agreed design standards.
- With the realignment of the Centenary Motorway eastbound lanes, and the positioning of the NLRT entry and exit portals in the centre of the motorway corridor, the critical support infrastructure, such as the ventilation station and ventilation outlet, and the water and power utility area, would move further west, in to the rising ground adjacent to the Botanic Gardens.
- The western ventilation station would be fully buried immediately north of the infrastructure utility area. The above ground ventilation outlet would be relocated approximately 43 metres north-west of the location proposed in the Reference Design. The ventilation station would be buried to mitigate its visual impact and to enable its inclusion in the future expansion area of Botanic Gardens.
- As a consequence of the changes to the western connections, and the relocation of the ventilation station and infrastructure utility area, the Tollroad Control Centre (TCC) would be located to a different site situated on the corner of Richer Street and Mt Coot-tha Road. Access would be provided

off Mt Coot-tha Road. This avoids the impact the TCC in the Reference Design would have had on the Botanic Gardens and would avoid the requirement for direct access to the Centenary Motorway.

Changes to the Eastern Connections:

- As with the western connection, the key difference between the Changed Project and the Reference Design would be the rearrangement of the connections, such that the eastbound lanes of the ICB would move to the north to accommodate the central location for the entry and exit portals of the NLRT Project.
- The realignment of the eastbound lanes on the ICB would involve a small increase in the land required over the Brisbane Grammar School playing fields, as well as the construction of a new span beneath the Inner Northern Busway.
- Similar benefits would include a reduction in disruptions to traffic flows on the ICB during construction and more efficient connections and grades between the Changed Project and the ICB.
- The eastbound exit portal would be located 60m further east nearer to the Inner Northern Busway (INB) overpass. The westbound entry portal would be located 300m further west in line with Victoria Park Road. The tunnel portals would be located together in the centre of the ICB corridor. This arrangement creates a widened median within the ICB and enables the westbound cut and cover to be significantly reduced and would also reduce the impact on ICB traffic during construction;
- The transition ramps between the NLRT portals and the ICB would be together in the centre of the ICB and extend from generally in line with the Brisbane Girls Grammar School to the tunnel portals between Victoria Park Road and the INB overpass. Apart from the construction benefits, the proposed change would create better sight lines for merge and diverge conditions.
- The location of the eastern ventilation station and ventilation outlet would be unchanged from that proposed in the Reference Design. Access to the eastern ventilation station would be from the eastbound carriageway of the ICB.

The changes to the project delivery arrangements include:

- The delivery program would expand from 45 months to 49 months, commencing in late 2010 to December 2014;
- The Changed Project provides for both tunnels to be lined with pre-cast, reinforced, concrete rings installed by the TBM, providing enhanced ground support and preventing the inflow of groundwater. Underground cross passages and substation sites would remain 'drained' and consequently would allow groundwater to enter the tunnels. Overall, the inflow of groundwater to the Changed Project tunnels would be at a lower rate than estimated for the Reference Design which proposed cast in-situ concrete lining.
- The TBMs would be assembled at the western worksite in the Botanic Gardens in the excavated cut and cover tunnel and transition areas during surface working hours (6.30am – 6.30pm Monday to Saturday). After assembly of the main component of each TBM, an acoustic-lined workshed would be erected over and beside the TBM launch-box to facilitate continuous underground operations;
- An increase to the construction area on the northern side of the Centenary Motorway within the Botanic Gardens, would remove the requirement for any surface road and tunnel construction area on the southern side of the motorway. This change also would avoid road construction impacting on the Anzac Park wetland and the existing bicycle path along the Centenary Motorway.
- Construction staging strategies to mitigate the potential impacts on traffic flows on the Centenary Motorway and Mt Coot-tha Road during construction. The initial construction activities would be carried out off the Centenary Motorway and behind construction barriers.
- Temporary construction workforce parking areas would be established in Anzac Park for up to 300 vehicles, without any loss of significant trees in the park, and with access from Dean Street only.
- Minor changes to the spoil haulage volumes because of the increase in size of the TBMs from 12m in diameter to 12.4m in diameter and to changed excavation requirements and quantities.
- The majority of spoil at the western worksite would be transported to the Mount Coot-tha Quarry by conveyor and would be used for quarry rehabilitation, with approximately 10% transported by truck to a placement site located at Rudd Street, Oxley or other approved locations.

- The spoil conveyor alignment has been changed to avoid the public areas and the plantings within the Botanic Gardens. The spoil conveyor would be enclosed to achieve noise and dust criteria.
- Spoil from the eastern worksite would be transported to a placement site adjacent to the Brisbane Airport at Pinkenba or other approved locations.

2 Application for Project Change

Before the Changed Project can proceed, the Coordinator-General will be asked, by way of this application from the Brisbane City Council, whether a further evaluation of the proposed changes to the design and construction of the NLRT is required, and if so, whether the Changed Project would require further consultation and a period of public notification. The Coordinator-General will also be requested to consider what changes to the existing conditions, or additional conditions, would be required to allow the Changed Project to proceed. These requests will also be made in accordance with the *State Development and Public Works Organisation Act 1971*.

This application for Project Change is consistent with the approach taken with other major infrastructure projects and is essential to the project development process in that it allows the proponent (Council) to encourage and deliver the benefits of innovation in design, construction and delivery from a competitive market.

3 Project Changes – Main Alignment

3.1 Design Changes and Effects

The key changes in the design of the main alignment, compared with the Reference Design, would be:

- the realignment of the main tunnels generally to the east and south, to take a shorter, more direct route between the two connections; and
- the realignment of the main tunnels so that they would lie generally closer to the surface than those proposed for the Reference Design, again to provide a more direct link and to provide easier traffic conditions for heavy vehicles leaving the tunnels in either direction.

As a consequence of these proposed refinements, the Changed Project would lie closer to the surface beneath low points in the Toowong Cemetery and in other low points along the route, such as Baroona Road Rosalie, and Charlotte Street Paddington. Another consequence of the changes in the main alignments would be that some different properties to those above the Reference Design, would be affected by volumetric acquisition of land, and potentially, by construction effects such as regenerated noise and vibration.

There would be no material adverse effects on these new properties affected by volumetric acquisition during the operation phase of the NLRT.

The Changed Project would still carry the same or similar traffic flows as forecast for the Reference Project. Consequently, there would be no significant change in related, consequential effects on traffic noise and ambient air quality. There would be some network benefits as a consequence of the changed connections to the Centenary Motorway and the ICB.

While 334 properties would be affected by the Reference Design, 328 properties would be affected by the Changed Project, There would be 65 properties affected by both the Reference Design and the Changed Project. Of the properties affected by the Changed Project, 6 would be Council-owned or controlled properties. There may be some minor changes to these numbers during detailed design.

3.2 Construction Changes and Effects

The key change in the construction of the main alignments would be the use of double-shielded TBMs which install pre-cast, segmented, concrete lining as they progress along the route. The benefits of this change include a greatly reduced risk of ground settlement during tunnel construction, and a greatly reduced potential for groundwater inflow during both the construction phase and subsequent period of tunnel operations.

The Reference Design proposed to construct each tunnel with TBMs but would follow with a cast in-situ concrete lining for structural support and groundwater resistance. Some ground settlements were predicted in the EIS for this method. Similarly, some groundwater inflow was predicted to the main tunnels. Neither the settlement nor the groundwater inflow predictions were considered to be of such significance as to warrant a different method of construction or extra-ordinary mitigation measures. The rate of inflow is estimated to reduce from 4l/sec for the Reference Design to less than 3l/sec for the Changed Project.

As with the Reference Design, the Changed Project would be constructed with drained cross-passages. That is, groundwater would possibly enter the tunnel system via the cross-passages and would require collection and treatment prior to release.

The change in construction would require the delivery of pre-cast concrete segments to the western worksite in time to meet the requirements of continuous TBM operation. It is noted that the TBMs for the Reference Design also were proposed to operate on a continuous basis. With either project, TBM operations would incorporate a maintenance period of up to 4 hours each day on average.

4 Project Changes – Western Connection

4.1 Design Changes and Effects

The key design changes embodied in the Changed Project at the western connection relate to the location of the NLRT entry and exit portals in the centre of the Centenary Motorway corridor, and the consequential realignment of the eastbound lanes of the Centenary Motorway to the north before they swing back to connect with Mt Coot-tha Road at the roundabout.

There would be related changes to the merge / diverge arrangements for the ramps to the NLRT portals and for the eastbound lanes of the Centenary Motorway. The merge/diverges with the Centenary Motorway would be further west than proposed in the Reference Design to accommodate the central location for the entry / exit portals. There would be no changes to the westbound lanes of the Centenary Motorway.

The changed connection arrangements would still be able to accommodate any future widening of the Centenary Motorway, to three lanes in each direction, that might be planned by DTMR.

Off-line, there would be changes in the location of project infrastructure including:

- the TCC would move from the location in the western worksite proposed in the Reference Design to a site situated opposite the entrance to the Mt Coot-tha Botanic Gardens on Mt Coot-tha Road;
- the ventilation station and ventilation outlet would move approximately 43m to the west of the site proposed in the Reference Design. The ventilation station would be completely buried and its roof landscaped and incorporated into an expansion of the Botanic Gardens. There would be no change in the minimum height of the ventilation outlet;

- project utilities such as groundwater treatment and power supply would be located in the western worksite area, as proposed in the Reference Design.

The design changes for the Changed Project would result in more efficient and more 'legible' connections between the Centenary Motorway and the NLRT, without impacting on the potential for future capacity development on the motorway. Similarly, the proposed design changes would not prejudice a possible future northern motorway (Inner Orbital) connection with the Centenary Motorway, as indicated might be required in the *South East Queensland Infrastructure Plan and Programme 2010 - 2031* (SEQIPP).

The detailed changes in road geometry proposed in the Changed Project, such as the changes in gradient and merge arrangements are anticipated to be acceptable to the DTMR.

The proposed design changes for the connection with the Centenary Motorway would achieve acceptable performance in the event of a major traffic incident on the Centenary Motorway. The visual impact of the central connections, and the realignment of the eastbound lanes on the Centenary Motorway, would be similar to or lower than that anticipated for the Reference Design, because of the reduction in exposed infrastructure and the retention of the outbound lanes on their present alignment.

The proposed change in location of the ventilation station and ventilation outlet would be expected to result in the same air quality outcomes as the Reference Design. The Changed Project for the NLRT would not lead to adverse air quality outcomes, when compared with the Reference Project.

The design and siting of the ventilation outlet for the Changed Project would mitigate the potential visual impact of the facility from most viewpoints. As with the Reference Design, the ventilation outlet would remain visible and evident for outbound traffic.

4.2 Construction Changes and Effects

The key changes in construction method for the Changed Project relate mostly to:

- the different method of and location for assembling and launching the TBMs;
- the delivery, storage and handling of pre-cast concrete segments for the tunnel rings;
- the proposal to re-use some spoil for construction of the road invert in each of the tunnels, after tunnel boring has been completed;
- the different configuration of the western worksite, including an increase in the area required for the worksite;
- different access arrangements, to include access for light vehicles off Mt Coot-tha Road just west of the roundabout;
- the conveyor route to the quarry has changed;
- the proposal to deliver spoil into the Mt Coot-tha quarry on a continuous basis, with spreading and compaction activities being limited to the quarry standard operational hours;
- the proposal to provide construction workforce car parking from a temporary car park in Anzac Park, adjacent to the existing pedestrian and cycle bridge over the Centenary Motorway.

TBM assembly and launching

The two TBMs would be delivered in parts and assembled in the incomplete, cut and cover troughs leading down to the portals for the driven tunnel sections, just south of Mt Coot-tha Road.

The assembly would take place as day time surface works with acoustic screening provided by the cut and cover troughs. The troughs would remain open for the duration of the assembly to allow the operation of the large, overhead cranes required to lift large, heavy components into place. Once the TBMs have been assembled and launched, a portal shed would be constructed above the launch box to

accommodate a large gantry crane and the laydown and handling area for the pre-cast concrete segments.

The portal shed would remain in place for the remainder of the tunnel construction period including civil fit-out but not during the commissioning phase of the project works.

The pre-cast segments would be delivered to the western worksite by truck via the Centenary Motorway. The segments are likely to be manufactured at a plant in the western industrial corridor (eg Wacol or similar). Two truck loads would be required for each of the 4,300 rings estimated for the two main tunnels.

Spoil handling and placement

The spoil conveyor from the worksite into the quarry would follow a different alignment to that proposed in the Reference Design. The changed alignment would be further to the west, following earthworks for the realignment of the Centenary Motorway and to avoid public areas and plantings within the Botanic Gardens.

For the Changed Project, spoil would be taken from each of the tunnels by enclosed conveyor to an acoustic-lined spoil shed situated at the western end of the worksite. The spoil would be transferred, within this shed, from the TBM-fed conveyor to the main external spoil conveyor to the Mt Coot-tha quarry. Spoil would be released onto the quarry floor for subsequent spreading and compaction. The spoil conveyor would operate on a continuous basis, providing the noise goals for night-time works are achieved. In the event of breakdown of the conveyor, there will be capacity to stockpile two full days production of TBM spoil in the spoil shed. Any stockpiled material would then be removed with conventional loader/excavator and trucking operations.

Approximately 932,000m^3 of spoil would be delivered to the quarry with the Changed Project, compared with 973,000m^3 for the Reference Design. Approximately 303,000m^3 would be transported from the construction area and worksite by truck compared to approximately 265,000m^3 for the Reference Design. Approximately half of this amount would be TBM spoil that cannot be accommodated within the quarry. The Reference Design identified an approved placement site for western construction spoil at Swanbank while the Changed Project has identified an approved site in Rudd Street, Oxley or at alternative approved sites in accordance with the Coordinator-General's conditions. The haulage task would involve 4 – 5 trucks per hour for 12 months, but may be much higher (35 trucks per hour) should the spoil conveyor be out of operation.

Configuration of western worksite

The western worksite for the Changed Report would be larger (6ha) than that proposed for the Reference Project (4ha), due to the rearrangement of the western connections, the intention to construct the eastbound lanes for the new Centenary Motorway alignment off-line and the supports required for the TBM launch box in a location further north than proposed in the Reference Design.

Access from the Centenary Motorway would remain unchanged as a left-in, left-out arrangement. However an additional access for light vehicles would be provided from Mt Coot-tha Road.

The reconfigured western worksite, the changed alignment for the spoil conveyor and the realignment of the eastbound lanes of the Centenary Motorway would result in the loss of some vegetation mapped under the *Vegetation Management Act 1999*. Some of this vegetation also is recognised in mapping by the Council under its Natural Assets Local Law. Generally, this impacted vegetation is of ‘least concern’ or regulated regrowth according to the mapping. Approvals and permits to clear are required under the

Nature Conservation Act 1992, the *Vegetation Management Act 1999* and the *Natural Assets Local Law 2003*.

Most of the fauna species in the area affected by the changes to the western worksite, and the realignment of the Centenary Motorway eastbound lanes are mobile and unlikely to be adversely affected by the proposed works. Normal fauna spotting and relocation activities would be undertaken in conjunction with clearing operations and in accordance with the approvals.

Temporary Workforce Car Parking

The Changed Project would provide construction workforce car parking in a temporary car park in Anzac Park. This temporary car park would provide up to 300 spaces, with access to the worksite via the pedestrian and cycle bridge over the Centenary Motorway. The temporary car park would not remove any significant trees or require the relocation of any active park use facilities. Access to the park for local people would be maintained at both Dean Street and Wool Street, whereas workers' access would be restricted to access from Dean Street.

The car parking area on Sir Samuel Griffiths Drive proposed in the Reference Design would be retained to service the project office staff and visitors' centre proposed to be established in the former Freers potato chip factory site.

5 Tollroad Control Centre

5.1 Design and Siting and Effects

The Changed Project proposes to locate the tollroad control centre (TCC) on land off Mt Coot-tha Road, and presently used for overflow car parking for the Mt Coot-tha Botanic Gardens. A site accessed from the Centenary Motorway as proposed in the Reference Design within the rehabilitated worksite would not be feasible as it would require access through the Botanic Gardens. The proposed site has direct access off Mt Coot-tha Road.

The TCC would incorporate the support workshops for tunnel equipment maintenance and spare parts storage, incident control room, traffic control room and office space for administration. A motor vehicle workshop would not be included in the TCC and vehicle maintenance would not be undertaken at the TCC. All data collected by the in-tunnel monitoring systems would be processed and all the services controlled from this location.

The TCC for the Changed Project also would contain the control room which would be a 24 hour, seven days per week operation with at least two on-duty operators at any time while other functions such as office administration and equipment maintenance would generally take place during 6:30am to 6:30pm Monday to Friday.

The TCC would include a training and incident room, office space for the operations and maintenance contractor staff as well as Council and emergency services personnel, a computer and communications equipment room, a plant room, two meeting rooms, workshop space for the maintenance of tunnel equipment, tunnel spare parts store, toilets, showers, change rooms, a reception area and a lunch room. A secure hardstand area will provide parking for incident management vehicles and replacement equipment layby and manoeuvring. Driveway access to and from the TCC would be provided from Mt Coot-tha Road. On-site parking for approximately 30 vehicles would be provided in the TCC site, including 2 disabled spaces.

Obtaining water for the tunnel wash down operations, and installation of the pressure booster for use by the fire brigade would not be undertaken at the proposed location for the TCC as was proposed in the Reference Design. Equipment maintenance would include the servicing of a range of tunnel equipment including, for example, electronic monitoring equipment, pumps and fans.

The TCC building would be approximately 90m in length, and approximately 10m in height. The height of the building would be mitigated by siting it on a bench to be excavated into the rising ground towards the northern boundary of the site. The building would not be obtrusive in the views available for the dwellings higher up the same slope. The length of the building would be mitigated by a range of architectural variations and treatments to the facade. Combined with the setback from Mt Coot-tha Road, the building would change but not impact adversely on the visual amenity of the setting. The topography and proposed landscaping of the TCC site would provide an effective mitigation for this change.

There are no heritage values attaching to the proposed TCC site. Similarly, there is no mapped remnant vegetation that would require an approval under the *Vegetation Management Act 1999*. However, the clearing of vegetation on the land would require an approval under the *Natural Assets Local Law 2003*.

Use of the land for the TCC would constitute a use for road purposes, and consequently, would be exempt from assessment under City Plan. The assessment would be conducted through this Application for Project Change, as a State controlled process. A building approval will be required from a building certifier.

The land is classified mostly as parkland with a smaller section covering most of the bitumen carparking areas used as overflow for the Botanic Gardens as unclassified land being the old Mt-Coot-tha road reserve. Having regard to the setting of the TCC adjacent to the Botanic Gardens and the Toowong Cemetery, the loss of less than 1 ha of green space is not considered to be significant.

5.2 Traffic

Traffic flows during operation of the TCC, based on preliminary designs and experience with other facilities of similar size, are anticipated to average 20 vehicle trips per hour in the peak, and 80 vehicle trips per day. The majority of these would be cars for workers within the TCC, with some being incident management vehicles and trucks for the movement of tunnel maintenance parts. Traffic flows to and from Mt Coot-tha Road would have no adverse effect on overall traffic levels.

Some residents currently use land along the rear of the TCC site off Ada Street to access the rear of properties in Ada Street and Horrocks Street. This area is designated "Parkland" under the current planning scheme. While all residential properties can be accessed from their road reserve boundary, either from Ada Street or Horrocks Street, consideration will be given during detailed design to retaining and formalising this rear access for local residents,

5.3 Construction

The construction of the TCC is currently programmed to commence in mid 2012, with building works taking approximately one year. Works would continue at the TCC once constructed for activities such as fitout, commissioning and testing. Full operation of the TCC would commence once the tollroad is opened.

6 Project Changes – Eastern Connection

6.1 Design Changes and Effects

The eastbound lanes on the ICB would be realigned to the north, to accommodate centrally-located entry and exit portals for the NLRT main tunnels. The entry portal (westbound) to the NLRT would be situated approximately 300m further to the west, while the exit portal for the eastbound NLRT lanes would be situated approximately 60m further east.

There would be consequential changes to the road geometry for the tie-ins with the ICB in each direction, and there would some changes in local road geometry to accommodate the realignment of the eastbound ICB lanes. The connection of Victoria Park Road with the ICB would be reconfigured but would still provide the left-in, left-out access as presently exists.

There would be changes to the INB to allow an additional span to be constructed beneath it for the realigned eastbound ICB lanes. The merges with the ICB, eastbound, would extend further east to the land bridge.

The existing pedestrian bridge over the ICB from the Brisbane Grammar School (BGS) would be extended to maintain connectivity with the BGS playing fields and the Victoria Park pedestrian and cycle path.

The design changes would require a slightly larger area of the BGS playing fields than would be required for the Reference Project. Current indications are that this additional permanent area required would be less than 1,000 square metres. The easterly extension of the ICB merges for the eastbound lanes would also require a larger area from the Victoria Park golf course. As with the Reference Design, the ventilation outlet and ventilation station for the Changed Project would be situated in Victoria Park golf course land. The locations are the same.

The changed connections with the ICB would not be affected by flooding events in the Brisbane River. However, stormwater drainage works in the vicinity of the eastern connections would be required to convey drainage waters and local flood flows beyond the connections and beyond the playing fields. The impact on the playing fields would be an increase of approximately 20mm on peak flood levels for a 100year ARI event.

The changed traffic connections with the ICB would operate much the same and would deliver similar levels of service to those anticipated for the Reference Design. Safe traffic operations would be achieved through the implementation of appropriate geometric design standards.

6.2 Construction Changes and Effects

With the extended connections for the realignment of the eastbound ICB lanes, the work area for the Changed Project would be larger than that anticipated for the Reference Project. The worksite would include part of the BGS playing fields and extend beneath the Inner Northern Busway to the ICB land bridge.

A worksite would be established in the area to be occupied by the ventilation station, with access to be provided by a left-in, left-out arrangement. A temporary access along the Victoria Park cycle path would be relied upon to connect this worksite with the nearby temporary construction workforce car parking.

As with the Reference Project, the ICB land south of Normanby Terrace would be required for construction including the removal of the TBMs.

The proposed realignment of the eastbound ICB lanes would allow construction to occur off-line, with a single traffic switch required then to direct eastbound traffic to the ultimate ICB alignment. Construction of the entry and exit portals would also be constructed off-line with only a single traffic switch required to commence operations of the NLRT project.

For the duration of the construction period, the Victoria Park pedestrian and cycle path would be realigned to the north of the worksite and would connect back to Victoria Park Road and to the existing pedestrian bridge over the ICB.

The quantity of spoil to be removed from the eastern worksite has increased for the Changed Project but remains a comparatively smaller quantity of spoil, compared with the western worksite. Most of this spoil would be generated by the construction of the central portals, the realignment of the eastbound ICB lanes and works through and beneath the INB. For the Changed Project, spoil would be taken to a site at Eagle Farm Road, Pinkenba or other sites approved in accordance with the Coordinator-General's conditions.

7 Relationship with other projects

As with the Reference Design, the Changed Project would interact with a number of other projects, including:

- Centenary Motorway;
- future 'Inner Orbital' Road;
- Moggill Road Interchange; and
- Inner Northern Busway.

7.1 Centenary Motorway

The Changed Project would satisfy the requirement of the Coordinator-General's conditions (Schedule 3, condition 26(a)) that the connection and 'tie in' of the NLRT project to the Centenary Motorway would be designed, constructed and operated so that it does not limit the ability for possible future widening of the Centenary Motorway to six 'through lanes' – 3 lanes each way. The design objective for the tie-in and connection is that the extension of the Centenary Motorway past the NLRT portals must be achieved without any impact on structures forming part of the NLRT project.

7.2 Future 'Inner Orbital' Road

The Coordinator-General's conditions (Schedule 3, condition 26(b)) requires that the connection and 'tie in' of the NLRT project to the Centenary Motorway is to be designed and constructed to ensure that:

- operation of the project shall not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel;
- operation of the project should not compromise the ability for future operation of the 'Inner Orbital' tunnel and the Centenary Motorway as a continuous motorway route (that is, maintaining the speed environment) with traffic flow priority on Centenary Motorway directed to the continuous route;
- the Northern Link connection excavation works are not to be below the existing motorway surface levels west of a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886).

The proposed configuration of the western connection for the Changed Project would not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel. There would be no excavation works for the Changed Project to the west of the line identified in the existing condition.

7.3 Moggill Road Interchange

The Reference Design would lead to increase traffic volumes through the signalised intersections at the Centenary Motorway ramps at Moggill Road by approximately 5% and 13% in the AM and PM peaks respectively in 2014 compared to the scenario without NLRT.

The forecast daily traffic increase on Moggill Road between Indooroopilly and the Centenary Motorway would be 3% in 2014 and 4% in 2026. With these predicted increases, the Moggill Road connections could be managed satisfactorily with signal co-ordination in early years post NLRT opening.

Ultimately, upgrades to the interchange configuration at Moggill Road would be required in association with the future upgrading of the Centenary Motorway in the 2010 to 2031 time-frame identified in the Southeast Queensland Infrastructure Plan and Program and/or in association with any future 'Inner Orbital' connection with the Centenary Motorway.

To mitigate the potential for impacts in relation to the Moggill Road – Centenary Motorway Interchange, the Coordinator-General's conditions (Schedule 3, condition 27) requires Council to design and upgrade the interchange to mitigate traffic impacts resulting from the operation of the NLRT.

The Changed Project would not change this situation at the Moggill Road intersection, such that the conditions for the Reference Design, including the implementation of the Interface Agreement between Council and DTMR, remain relevant and necessary.

7.4 Inner Northern Busway

The Reference Design made an allowance for a possible future opportunity to deliver a busway-type link for future cross-town bus services between key trip generators in the western and northern suburbs to travel via the NLRT and the Northern Busway or other surface routes. The Changed project would not preclude such a connection.

1 Introduction

1.1 Background

The western part of Greater Brisbane has become the third largest economic generator area after the Central Business District and the Australia Trade Coast precinct (including the Port Of Brisbane). There is a growing need to link these residential and economic growth centres and Northern Link will fill a fundamental gap in the motorway network.

The Northern Link Road Tunnel (**NLRT**) project was proposed by the Brisbane City Council (**Council**) to be an approximately 5km long toll cross-city tunnel linking the Centenary Motorway at Toowong in the west of Brisbane with the Inner City Bypass and Kelvin Grove/ Herston to the north of Brisbane. The NLRT project is the fourth of five crucial projects to be delivered in Brisbane City Council's TransApex plan, to improve cross city travel in Brisbane's inner and middle suburbs by creating a formal ring road system to divert cross city traffic away from the Central Business District. It also meets the strategic objectives of Council's Transport Plan for Brisbane 2006-2026, which provides strategies and actions around the public transport services and infrastructure needed for a sustainable future.

The project was assessed by the State Government as a Significant Project pursuant to the process described in Part 4 of the *State Development Public Works Organisation Act 1971* (SDPWO Act). Council prepared a Reference Design for the NLRT project and then in October 2008 published an Environmental Impact Statement (EIS) based on the Reference Design that assessed the project's potential impacts and mitigation measures to respond to those impacts. Council, and the State Government, undertook broad consultation on the Reference Design and EIS. In response to concerns raised in submissions made on the EIS Council removed intermediate access points to the tunnels from the Reference Design and in June 2009 published a Supplementary Report to address these changes and other issues raised in EIS submissions.

In April 2010, the Coordinator-General issued an evaluation report[1] (**Coordinator-General's Report**) recommending that the NLRT project, as described in detail in the EIS[2] and the Supplementary Report[3], may proceed, subject to the conditions contained in Appendix 1 of the Co-ordinator General's Report.

The Coordinator-General's Report also noted that the detailed design process may result in amendments to the Reference Design which would be likely to require a Coordinator-General's change report under the process afforded by Division 3A Part 4 of the SDPWO Act.

The project that was evaluated in the Coordinator-General's Report is referred to throughout this application as the Reference Design.

1.1.1 Implementation of NLRT Project

Following a competitive tender process, Council engaged the Transcity consortium (**Transcity**) to design, construct, maintain and operate for 10 years the NLRT project. Transcity consists of BMD Constructions

[1] in accordance with Part 4, Division 3, section 35(3) of the *State Development and Public Works Organisation Act 1971* (SDPWO Act)

[2] Northern Link Environmental Impact Statement dated September 2008

[3] Northern Link Environmental Impact Statement Supplementary Report dated June 2009

Pty Ltd. as the Main Contractor supported by international sub contractors Acciona Infrastructures Pty Ltd (Acciona) and Ghella Pty Ltd (Ghella). BMD Constructions is a Brisbane-based construction company operating in the provision of infrastructure and it's parent company, BMD Holdings, is one of the largest privately owned companies in Australia. Acciona is a multidisciplinary company listed on the Madrid Stock Exchange and working in over 30 countries. Ghella is owned by Ghella S.p.A. who are a privately owned Italian construction contractor with over 60% of their work in tunnelling in a wide range of countries.

The accepted tender is generally consistent with the Reference Design and would accord with the approval and conditions provided in the Coordinator-General's Report. Changes proposed to the Reference Design and project delivery would provide an improved outcome for Council and the people of Brisbane.

The Project objectives remain unchanged except as noted for the timing of the project delivery. They are:

- to improve east-west cross-city movement of people and freight;
- to address deficiencies in the national freight network to improve freight distribution in and around Brisbane;
- to provide opportunities for additional public transport capacity;
- to protect and, where possible, enhance the environment;
- to assist development of a sustainable urban environment for inner-western suburbs;
- to deliver value-for-money over whole of project life; and
- to deliver Northern Link by December 2014 (was previously June 2014).

The Changed Project would optimise the configuration of the NLRT project with a range of benefits to meet these objectives. However, the delivery program would expand from 45 months to 49 months, commencing in late 2010 with delivery by December 2014, subject to detailed design and approval. The essential features of the Project remain unchanged.

1.1.2 Project Benefits

Peak employment during the construction phase of the Project would be approximately 1,000 people. The NLRT project is expected to deliver $10.5 billion in economic benefits from travel time, vehicle operating costs and road safety savings and environmental benefits. Benefits expected from the implementation of the NLRT project include:

- connecting the Western Growth Corridor to the Brisbane Airport and Australia Trade Coast, thereby supporting economic development;
- reducing congestion on surface roads such as Milton Road and Coronation Drive by up to 14 per cent in 2026, and reduce through-traffic on a number of local streets;.
- completing the missing link in the motorway network between the Centenary Motorway and the Inner City Bypass (ICB), allowing motorists to avoid seven sets of traffic lights;
- reducing travel times by up to 66 per cent by 2026 between the Centenary Bridge and the Inner City Bypass; and
- providing opportunities for improved public transport outcomes by freeing up capacity on the surface road network (eg removing 38,000 vehicles per day for cross-city trips).

1.1.3 Application for Project Change

This application for project change identifies the design and delivery changes proposed to the NLRT project relative to the Reference Design, and requests evaluation by the Coordinator-General of the project changes. The project presented in this application is referred to as the Changed Project.

The Changed Project is described briefly below, with a more detailed description of the changes relative to the Reference Design in Chapter 2 and an assessment of the effects of those changes in Chapters 3 to 6. Chapter 7 discusses the relationship of NLRT with other projects, while Chapter 8 provides the conclusions to be drawn from this assessment.

The process for evaluating the project changes is set out in section 1.2 and further approvals for the project that may be required are discussed in section 1.3. The consultation process is summarised in section 1.4. An overview of the Changed Project including design and delivery changes and reasons for the proposed changes are presented in chapter 2. The effects of the proposed changes to the Reference Design are described in chapters 3, 4, 5, and 6, together with any further mitigation measures required in addition to those contained with the Coordinator-General's Report. The relationship of the NRLT with other projects is set out in chapter 7. Conclusions and recommendations including proposed changes to the conditions in Appendix 1 of the Coordinator-General's Report are set out in Chapter 8.

1.1.4 Summary of proposed changes to Reference Design

The Changed Project is similar to the Reference Design but includes design changes, such as the configuration of surface road network connections, the alignment of the main tunnels, location of tunnel portals and supporting infrastructure, and different property access requirements.

The Changed Project also revises the way in which the Project would be delivered, including changes to the layout and access/egress arrangements with construction worksites, minor changes to spoil management and the improved provision for temporary off-street construction workforce car parking.

1.1.5 Design Changes

The Changed Project includes changes to the tunnel horizontal and vertical alignment from the Reference Design, realigning the western portals northwards so that they connect with the centre lanes of the Centenary Motorway, straightening the tunnel alignment, and re-positioning the eastern portals to enable Northern Link to merge within the centre lanes of the Inner City Bypass. The changed alignment is still located within the Northern Link study corridor identified in the Terms of Reference for the Environmental Impact Statement (EIS).

The changed alignment at each of the connections would be accompanied by realignment, off-line, of the eastbound lanes for both the Centenary Motorway and the ICB. Construction would progress off-line to allow a switch in traffic to the new motorway and ICB alignments, to undertake the portal constructions in the centre of each corridor.

The changed arrangements provide a straighter and more direct connection between the Centenary Motorway and the ICB and will involve much less disruption to traffic during construction than the Reference Design.

The Changed Project design has flatter grades within the main tunnels compared to the Reference Design, making for more efficient movement of traffic through the tunnels, especially heavier commercial vehicles, reducing emissions and providing a safer, more reliable traffic flow.

At the western connection, the realignment of the eastbound lanes on the Centenary Motorway would occur off-line on the northern side. Compared to the Reference Design the Changed Project provides simpler construction traffic management – the westbound Centenary Motorway lanes and the Mt Coot-tha Road roundabout at Toowong would be unaffected during construction (with the exception of longitudinal drainage works which would be constructed behind barriers in the final stages of construction), with important benefits for Brisbane motorists. There would be no impact on known future upgrading requirements for the Centenary Motorway due to the changes. Road traffic noise sources would be located further away from residential properties to the south than in the Reference Design and noise barriers, including earth berms will reduce noise impacts within the Mt Coot-tha Botanic Gardens. The Changed Project's urban design features are an improvement to the Reference Design and will facilitate the future extension of the Botanic Gardens into the area adjacent to the motorway.

The Changed Project includes the relocation of the Tollroad Control Centre (TCC) from the possible location identified in the Reference Design within the future extension of the Botanic Gardens to a location opposite the gardens entry gate off Mt Coot-tha Road. This location provides public road access which is restricted from the Botanic Gardens site and would also remove the infrastructure from the visual catchment of the gardens. The land opposite the gardens gate provides suitable ground levels for the building to be dug into the slope and to retain a vegetated buffer to the residential boundary to the north.

The proposed design changes for the ICB connections would require the realignment of the eastbound lanes to the north, to accommodate the central location of the exit and entry portals to the main tunnels of the Changed Project. At the same time, the Changed Project would reduce the extent of the ICB cut and cover works required. This change would reduce the duration of construction works and associated impacts at that location.

The proposed changes to the alignment of the main tunnels would result in some minor changes to surface land requirements for Council and State land, but there remain no requirements for the surface acquisition of privately owned land. Volumetric title requirements for the main tunnels below surface properties would change in location, and there would be a reduction in the number of properties affected by volumetric requirements. There remains no anticipated impact on future development opportunities above the changed alignment of the tunnels at the depths proposed.

Consultation with directly affected property owners commenced as soon as the Changed Project was publicly announced and Council is likely to commence the acquisition of volumetric lots within the next six months under the *Acquisition of Land Act 1967*.

1.1.6 Construction Changes

There are few changes in construction method proposed with the Changed Project. The key change is to install waterproof lining in the main tunnels, by way of pre-cast, segmented rings applied by a tunnel boring machine (TBM). Apart from reducing the potential for groundwater inflow, the adopting of this different method would also reduce any possible risks associated with traversing possibly softer ground along the main tunnel alignment.

Spoil management would be similar to the Reference Design, with the majority of tunnel spoil material being placed in the Mt Coot-tha quarry. However, the arrangements at the Mt Coot-tha quarry now make provision for the placement of tunnel spoil in an exhausted area of the quarry to facilitate the eventual rehabilitation of the quarry rather than for re-use, and also separate from the normal quarry operations. The conveyor transporting spoil material to the quarry will operate on a continuous basis as identified in the Reference Design, subject to complying with the requirements of the Coordinator-General's Report.

1.2 Project Change Process

Under the terms of Division 3A of the SDPWO Act, Council can apply to the Coordinator-General to assess a proposed change to the project or a condition of the project and to evaluate the environmental effects of the proposed change, its effects on the project and any other related matters. The application must:

- describe the proposed change and its effects on the project;
- state reasons for the proposed change; and
- include enough information about the proposed change and its effects on the project to allow the Coordinator-General to make the evaluation.

After receiving the application, the Coordinator-General may:

- refer details of the proposed change, its effects on the project or any other related matter to anyone the Coordinator-General considers may be able to give comments or information to help the making of the evaluation.
- ask the proponent for further information about the proposed change, its effects on the project or any other related matter.
- require the proponent to publicly notify the proposed change and its effects on the project, in a way decided by the Coordinator-General.

In making the evaluation, the Coordinator-General must consider each of the following:

- the nature of the proposed change and its effects on the project;
- the project as currently evaluated under the Coordinator-General's Report for the EIS for the project;
- the environmental effects of the proposed change and its effects on the project;
- if public notification was required, all properly made submissions about the proposed change and its effects on the project;
- the submissions made to the EIS to the extent that it is relevant to the proposed change and its effect on the project.

The Coordinator-General may refer the proposed changes to anyone to seek input on the changes, and within this, may decide to publicly notify the change request for comment. Submissions made will be among materials the Coordinator-General uses to inform his decision on the changes. The Coordinator-General must prepare a report (a Coordinator-General's Change Report) that makes an evaluation and may make recommendations, amend any conditions, impose conditions or refuse to allow the proposed change[4].

After completing the Coordinator-General's Change Report, the Coordinator-General must:

- give a copy of it to the proponent; and
- publicly notify the report.

To the extent that there is any inconsistency between the Coordinator-General's Report and the Change Report, the Change Report prevails.

[4] in accordance with Part 4, Division 3A, section 35I of the SDPWO Act

1.3 Approvals for the Project

The approvals required for the Project are described in Chapter 4 of the EIS (Section 4.6) and also Section 3.4 of the Supplementary Report. The range of approvals required for the Changed Project are largely the same as those required for the Reference Design. As for the Reference Design, approval may be required under the Natural Assets Local Law of Brisbane City Council for clearing of vegetation. Recommended changes or amendments to the Coordinator-General's conditions contained in Appendix 1 of the Coordinator General's Report, including amendments to the stated conditions for Sustainable Planning Act 2009 (SPA) approvals, are proposed in Section 8 of this application.

1.4 Consultation

Extensive public information and consultation was undertaken throughout the EIS process for the Reference Design. In support of the application for project change, the proponent is facilitating a range of targeted government agency briefings and community engagement on the Changed Project, both before and during any notification period required by the Coordinator-General and in addition to any formal notification required by the Coordinator-General.

Consultation on the Changed Project commenced from the moment the Transcity tender was announced on 20 September 2010 and included:

- Updating the Council project website (www.northernlinkeis.com.au) with the Changed Project concept design drawings;
- Issuing media releases to advise of the Changed Project decision;
- Provision of information to Council's call centre on the Changed Project;
- Establishment and manning of 1800 phones to assist with public enquires on the Changed Project;
- Receipt of and responding to email and written correspondence from the public;
- Direct communication with property owners who would be directly affected by the Changed Project by either a full or partial acquisition of their land or a volumetric acquisition to provide separate tenure for the underground tunnels and associated infrastructure.
- Letters delivered by Council to:
    - Newly affected property owners under the Changed Project tunnel alignment;
    - Property owners previously affected under the EIS Reference Design who are still affected under the Changed Project tunnel alignment;
    - Property owners previously affected under the Reference Design who are no longer affected under the Changed Project tunnel alignment;
- visits to directly-affected property owners and residents;
- meetings with directly affected property owners;
- establishment of a visitor information centre from Monday 4 October. The location of the visitor information centre is 160 Edward Street, Brisbane

Upcoming consultation activities include:

- a series of community and Government Agency information sessions for interested parties to view details of and discuss the proposed changes with project staff;
- Letters will be mailed to each of the affected property owners advising of the release of the Change Report.
- Letters will be mailed to community members who have registered interest in receiving information about the Changed Project.

- Distribution of a community newsletter to the Northern Link study corridor and the wider catchment area for the project (Timing: first week of November)
- Staging information sessions for members of the community. Information sessions will be advertised in daily and suburban newspapers. Information sessions will be held at Milton State School on the following dates:
  - Saturday 6 November 2010
  - Wednesday 10 November 2010
- Information including maps and drawings of the proposed changes to the project will be available on the EIS website (www.northernlinkeis.com.au)
- Static display locations will be advertised in the daily newspapers and will be set up with the following materials:
  - A3 poster announcing the Change Report
  - Two copies of the Change Report
  - Two copies of project maps and urban design drawings
  - CD of the Change Report

Display locations are:

- Libraries:
  - Toowong Library – Toowong Village Shopping Centre, 9 Sherwood Road, Toowong
  - Indooroopilly Library – Level 4, Indooroopilly Shopping Centre, 318 Moggill Road, Indooroopilly
  - Mt Coot-tha Library – Administration Building, Mt Coot-tha Botanic Gardens, Mt Coot-tha Road, Toowong
  - Grange Library – 79 Evelyn Street, Grange
  - Brisbane Square Library – Brisbane Square, 266 George Street, Brisbane
  - Ashgrove Library – 87 Amarina Avenue, Ashgrove
- Ward offices:
  - Toowong Ward Office – 50 High Street, Toowong
  - Central Ward Office – Shop 11, 31 Duncan Street, Fortitude Valley
  - Walter Taylor Ward Office – Level 4, Indooroopilly Shopping Centre, 318 Moggill Road, Indooroopilly
- State and Federal Electorate offices:
  - Mt Coot-tha State Electorate Office – 76 MacGregor Terrace, Bardon
  - Brisbane Central State Electorate Office – Unit 2, Hill House, 541 Boundary Street, Spring Hill
  - Brisbane Federal Electorate Office – Shop 1, 209 Days Road, Grange
  - Ryan Federal Election Office – 31 Station Road Indooroopilly

Any person may make a submission to the Coordinator-General about the proposed changes to the project during the period of public notification. Submissions to the Coordinator-General must:

- be made within the submission period;
- be in writing and signed by each person making the submission;
- state the name and the address of each person making the submission; and
- state the grounds for the submission, and the facts and circumstances relied upon in support of those grounds;

Submissions can be made via:

Email: northernlink@dip.qld.gov.au

Or

Post: Coordinator-General
c/- Project Manager: Northern Link Project
Significant Projects Coordination
Department of Infrastructure and Planning
PO Box 15009 City East Qld 4002
Fax: +61 7 3225 8282

2 Overview of Changed Project

A graphic comparison between the Reference Design and the Changed Project is shown in the Figures identified in **Table 2-1**.

Table 2-1: Design comparison figures

Design Element	Reference Design	Changed Project
Tunnel Horizontal Alignment	Figure 2-1	Figure 2-2
Tunnel Vertical Alignment	Figure 2-3	Figure 2-4
Western Connection – Tunnel Portals	Figure 2-5	Figure 2-6
Western Connection – Centenary Motorway Connection	Figure 2-7	Figure 2-8
Western Connection – Urban and Landscape Design	Figure 2-9	Figure 2-10
Western Connection – Western Worksite	Figure 2-11	Figure 2-12
Eastern Connection – Tunnel Portals	Figure 2-13	Figure 2-14
Eastern Connection – Urban and Landscape Design	Figure 2-15	Figure 2-16

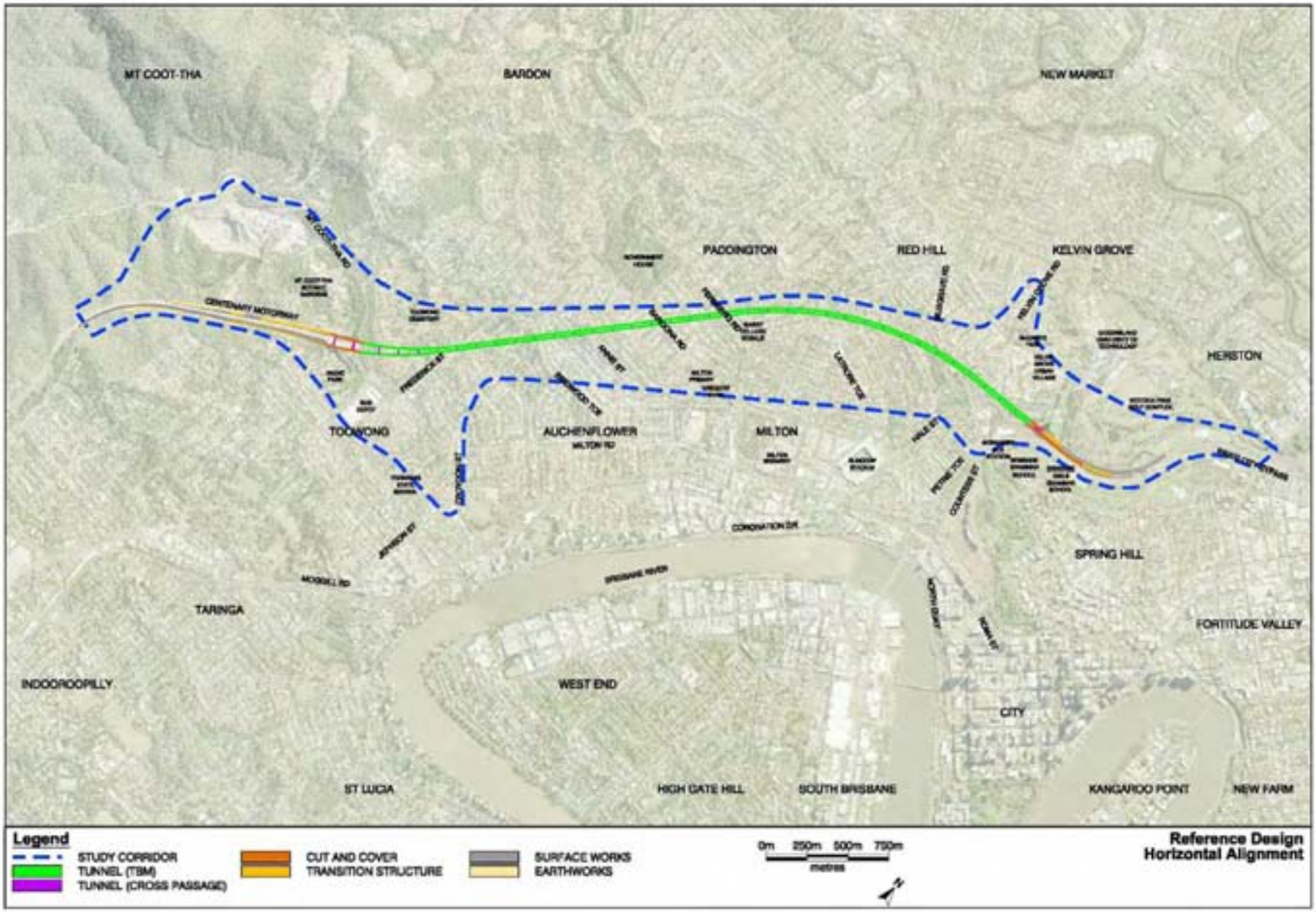

Figure 2-1: Reference Design Horizontal Alignment

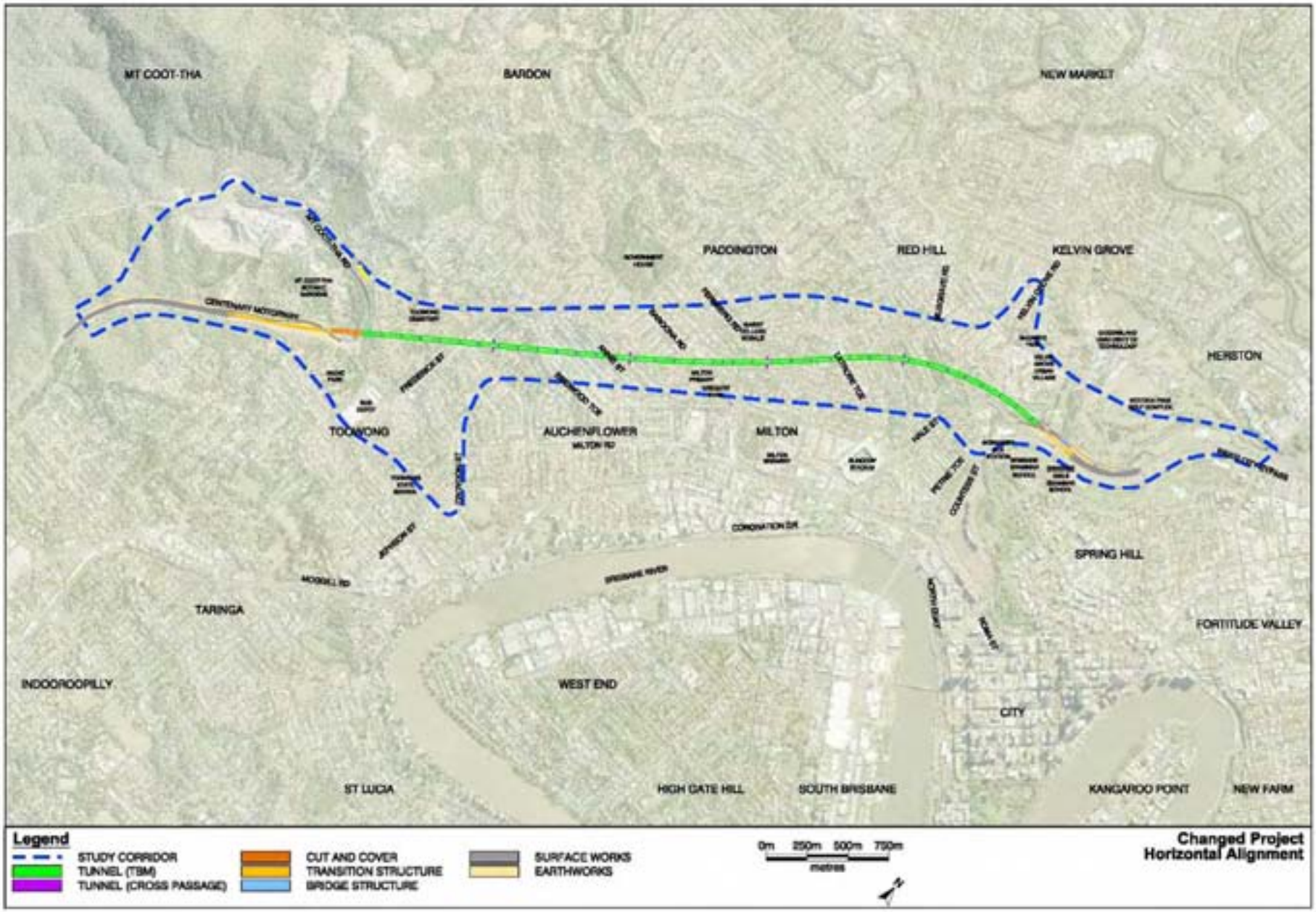

Figure 2-2: Changed Project Horizontal Alignment

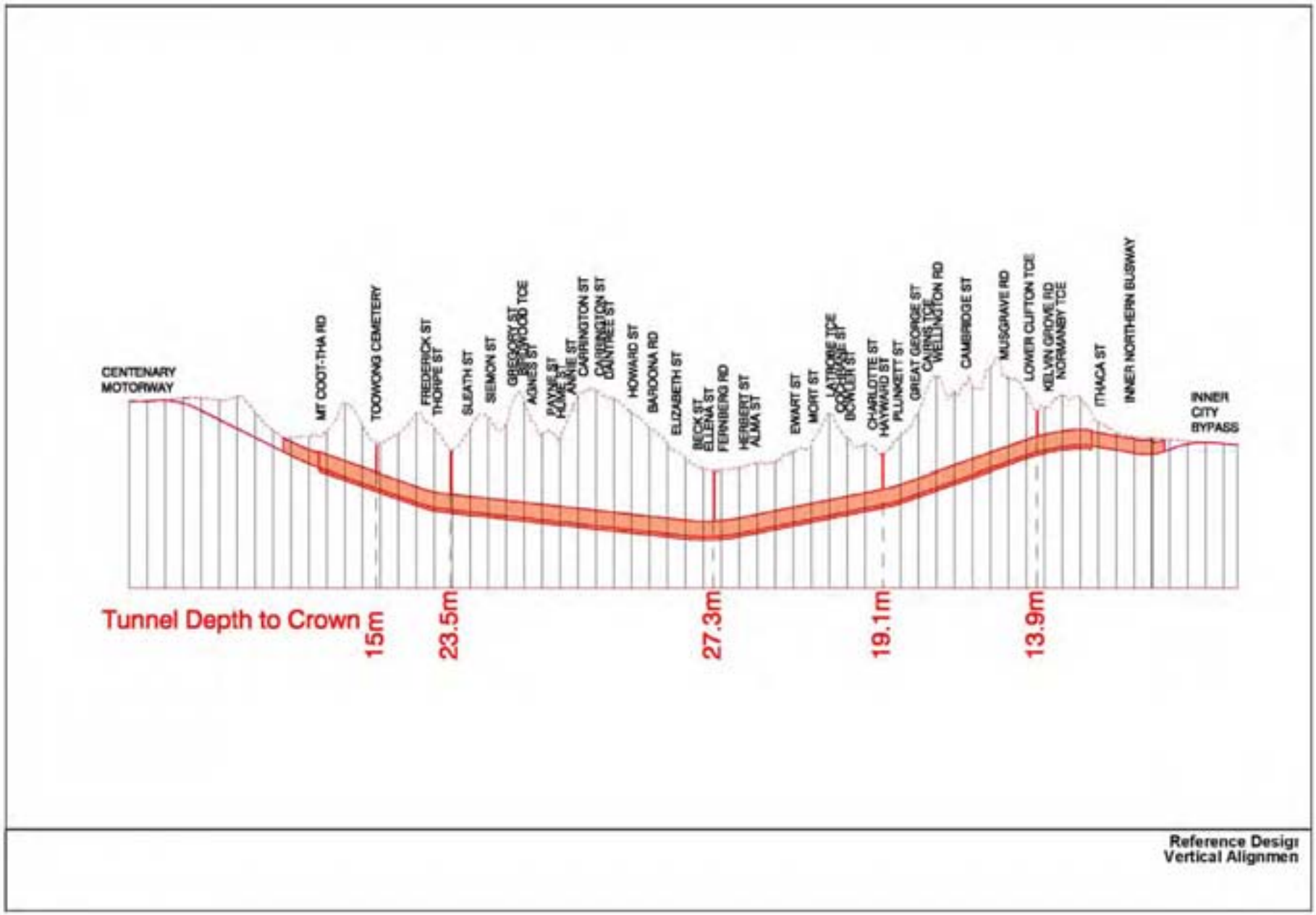

Figure 2-3: Reference Design Vertical Alignment

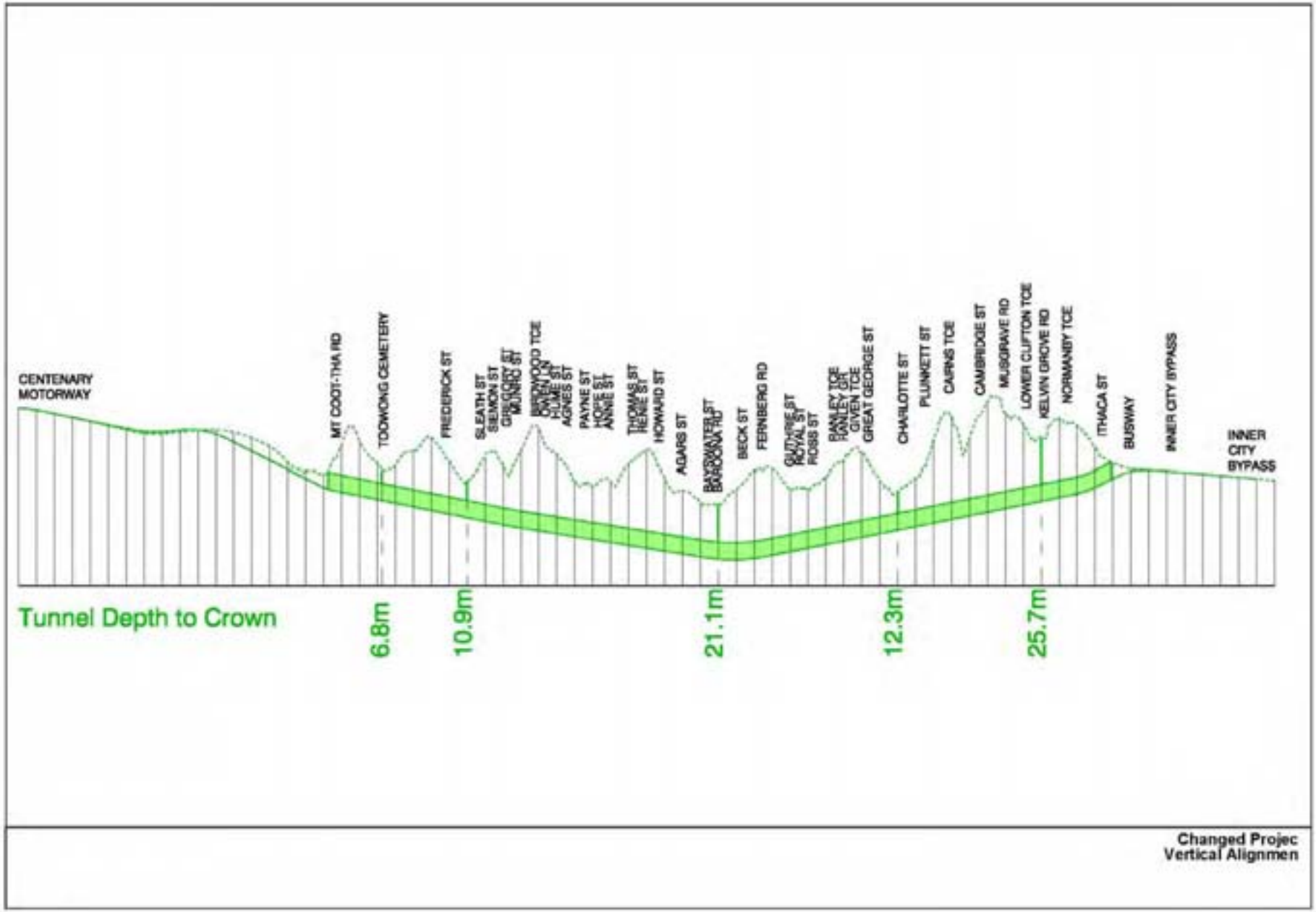

Figure 2-4: Changed Project Vertical Alignment

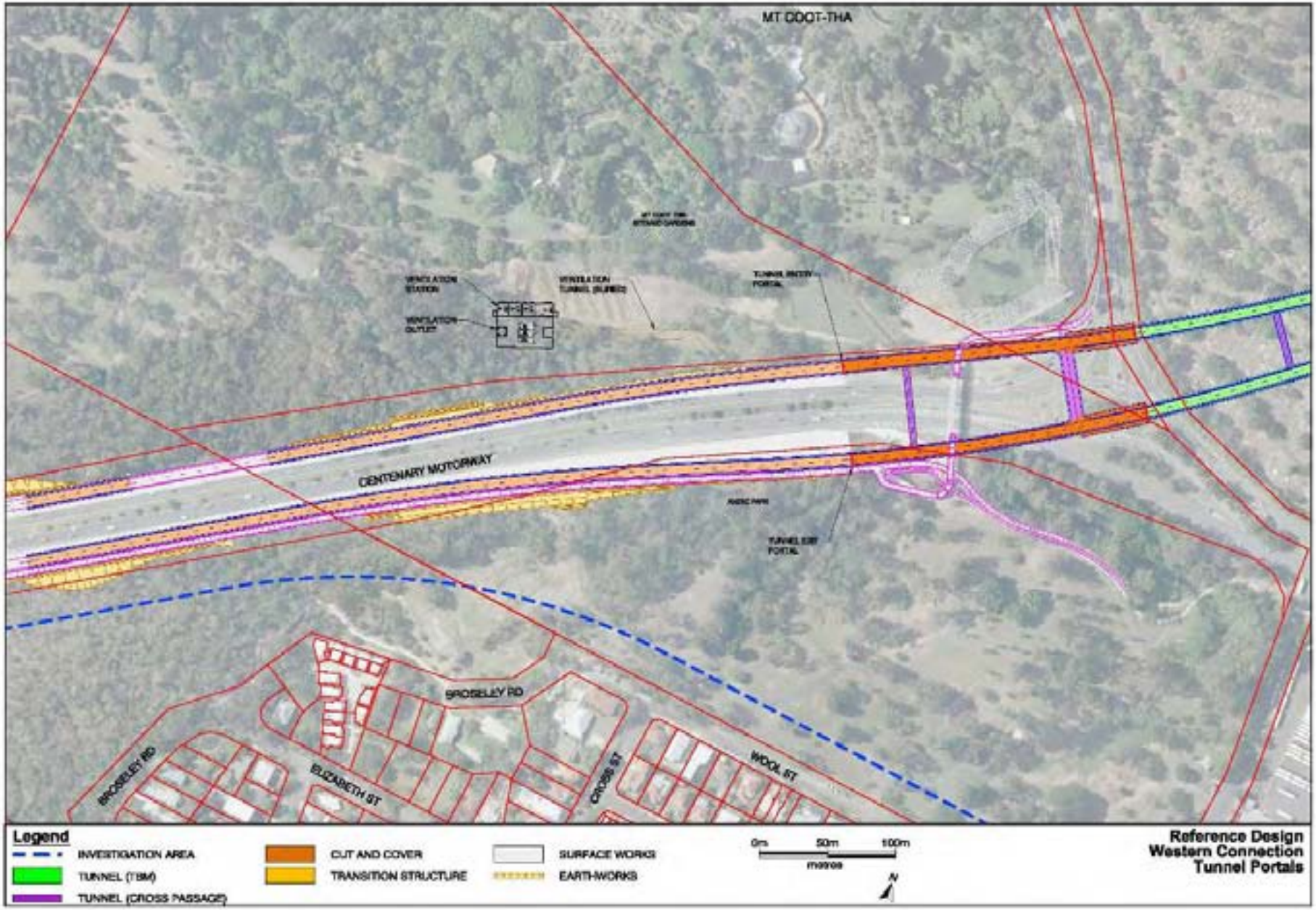

Figure 2-5: Reference Design Western Connection – Tunnel Portals

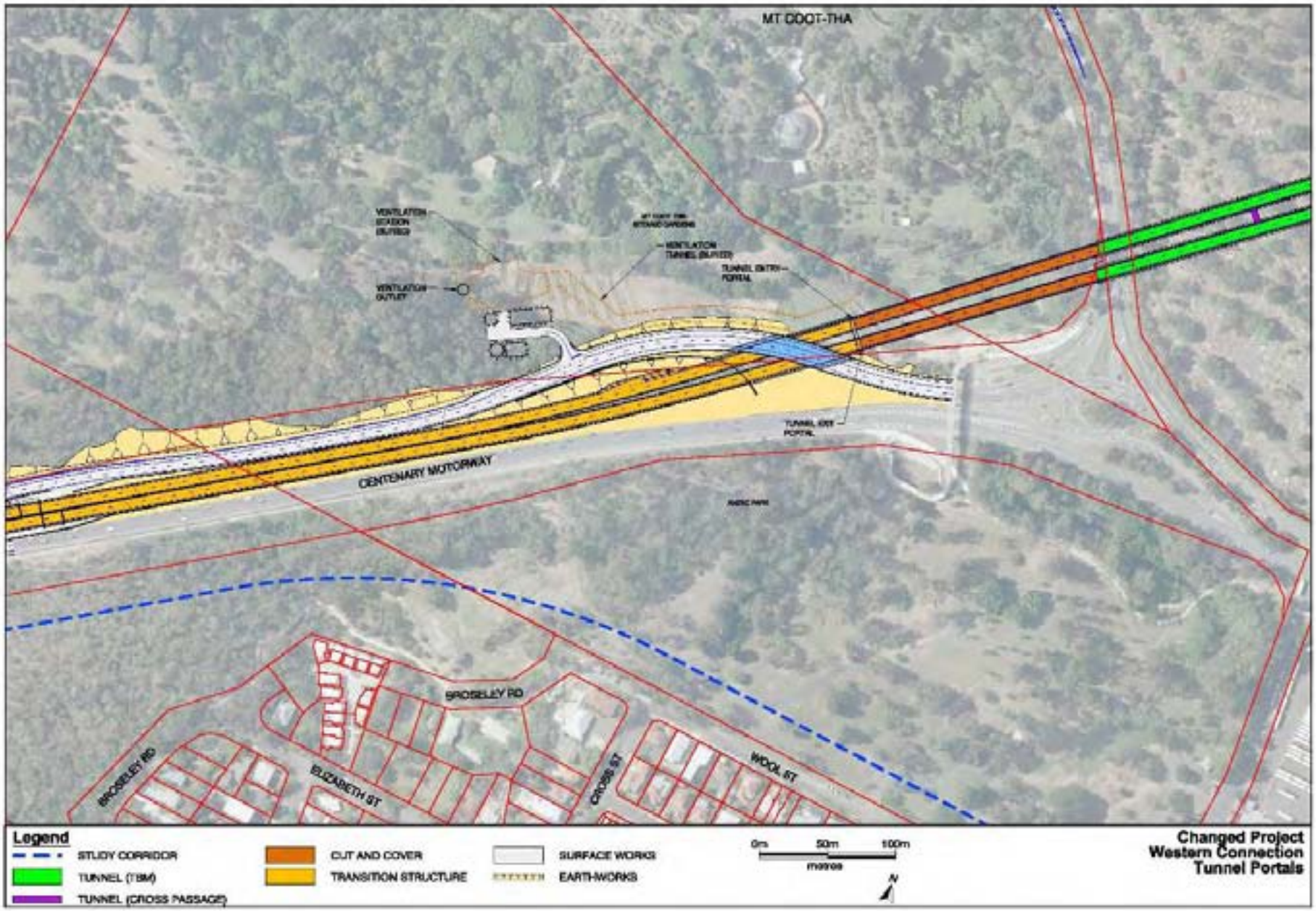

Figure 2-6: Changed Project Western Connection – Tunnel Portals

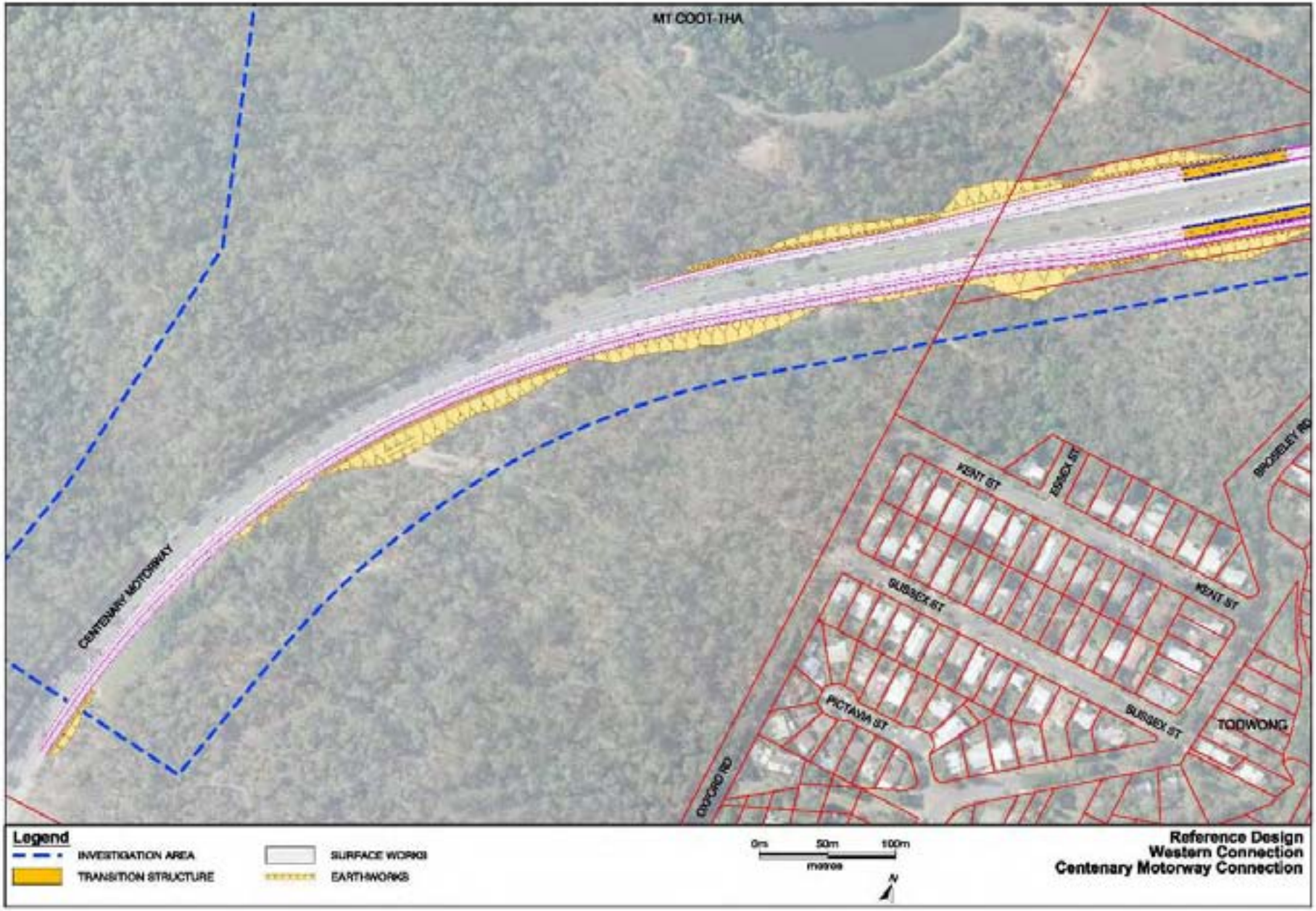

Figure 2-7: Reference Design Western Connection – Centenary Motorway connection

Figure 2-8: Changed Project Western Connection – Centenary Motorway connection

Figure 2-9: Reference Design Western Connection – Urban and Landscape Design

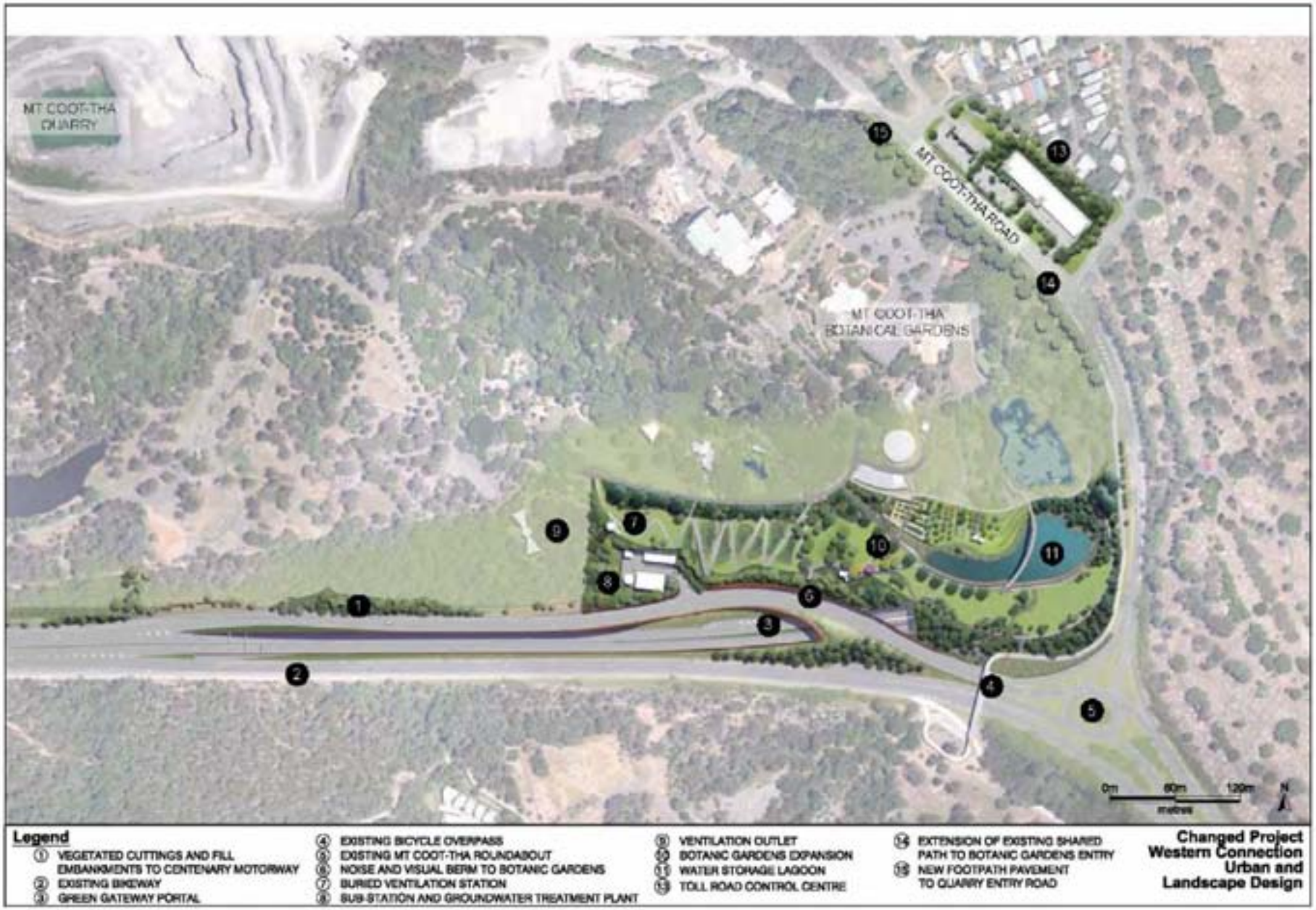

Figure 2-10: Changed Project Western Connection – Urban and Landscape Design

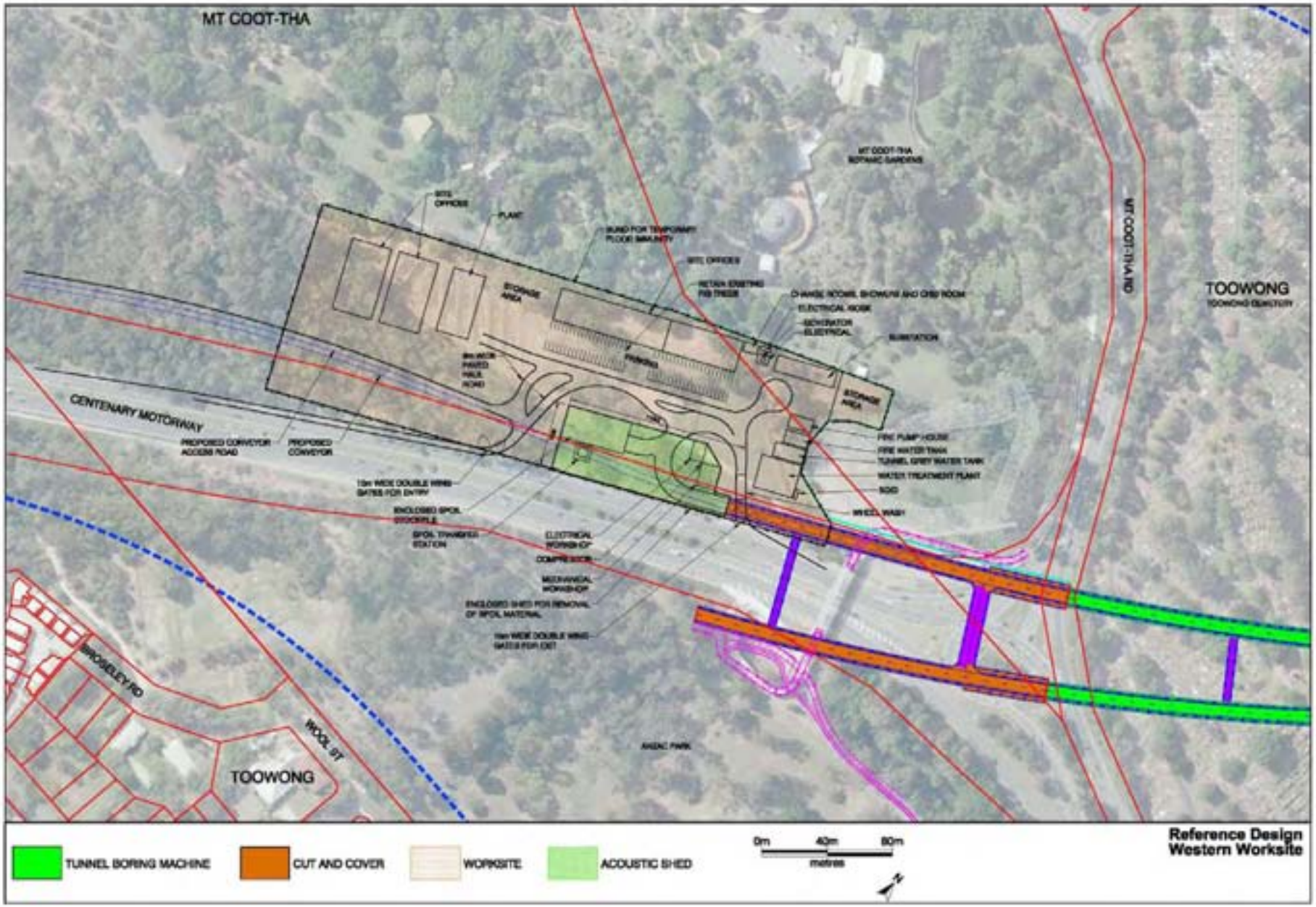

Figure 2-11: Reference Design – Western Worksite

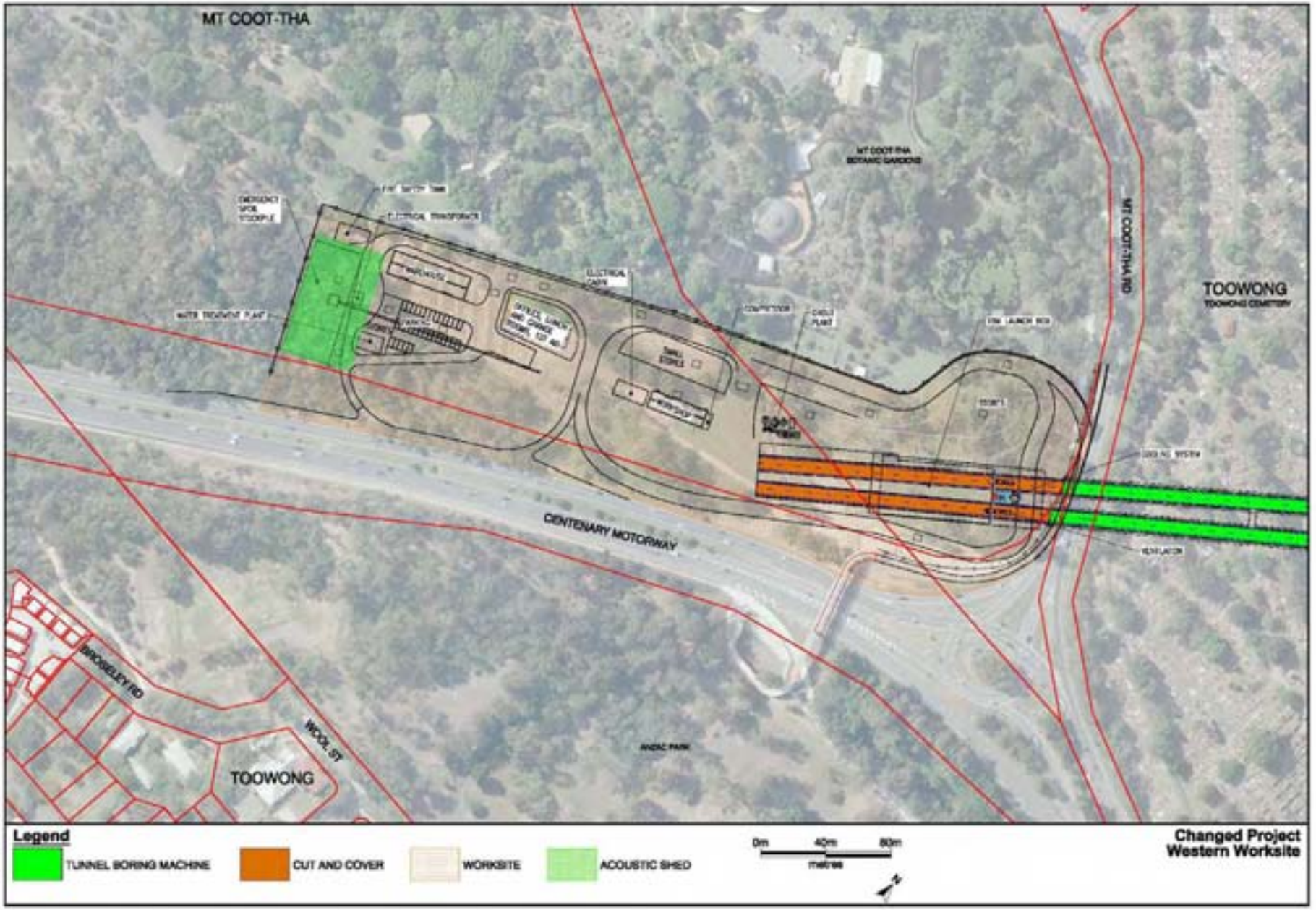

Figure 2-12: Changed Project – Western Worksite

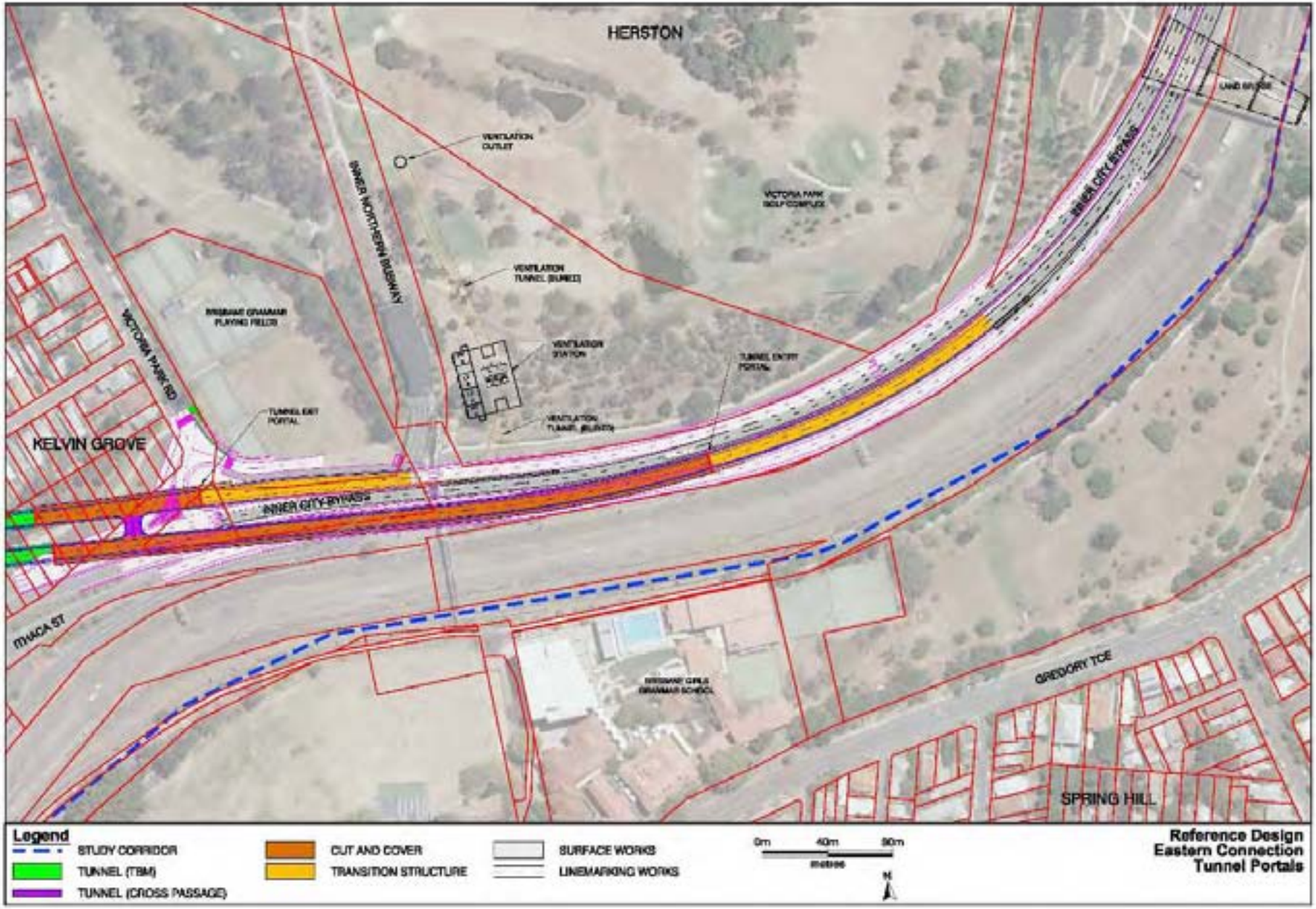

Figure 2-13: Reference Design Eastern Connection – Tunnel Portals

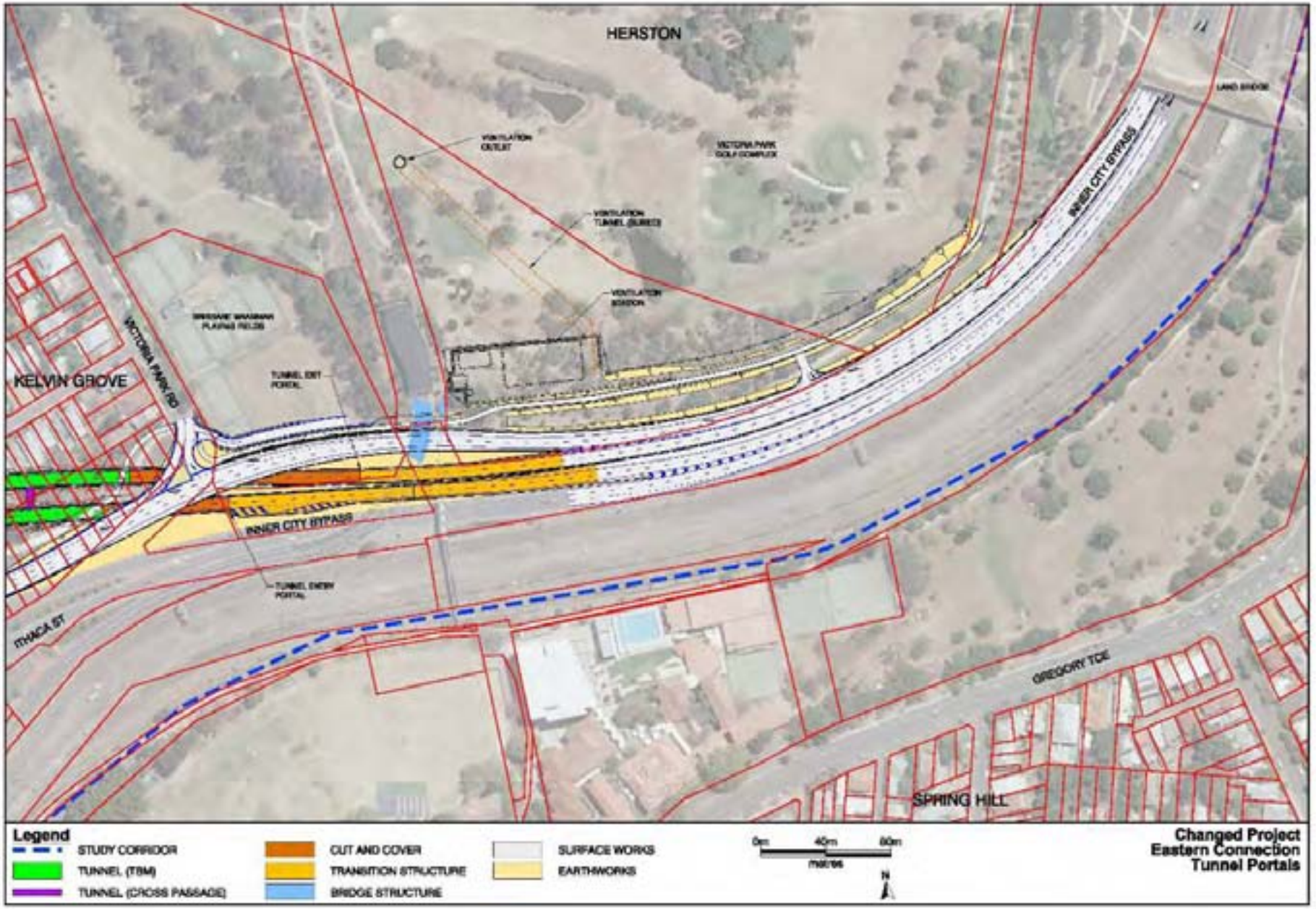

Figure 2-14: Changed Project Eastern Connection – Tunnel Portals

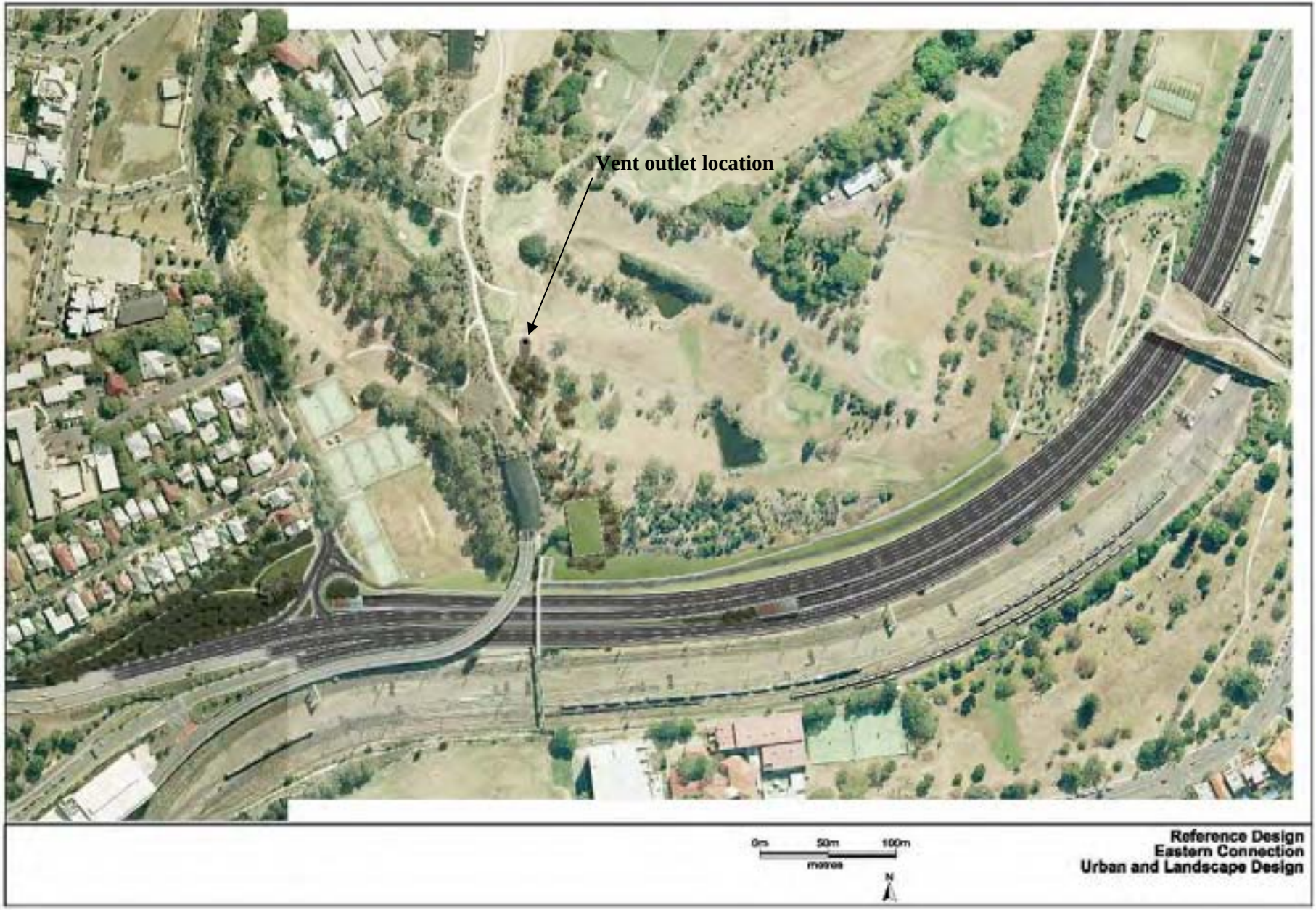

Figure 2-15: Reference Design Eastern Connection – Urban and Landscape Design

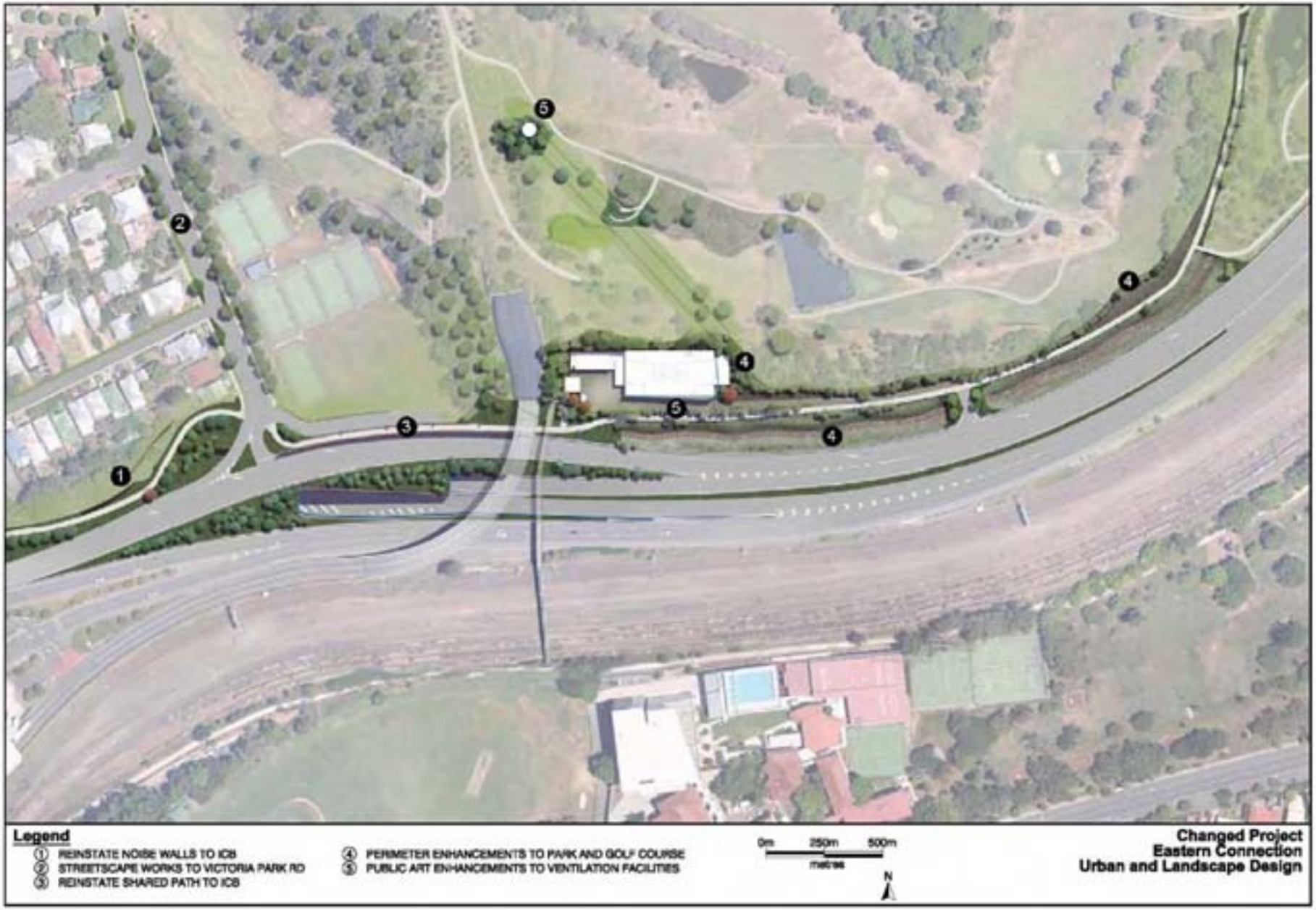

Figure 2-16: Changed Project Eastern Connection – Urban and Landscape Design

2.1 General Arrangement

2.1.1 Reference Design

The Reference Design for the NLRT would connect the Centenary Motorway at Toowong with the Inner City Bypass at Kelvin Grove/ Herston. The NLRT would comprise two separate, parallel road tunnels of uniform cross-section, each with two lane carriageways. Both tunnels would have openings (portals) to the surface on the Centenary Motorway just west of the Mt Coot-tha Road roundabout at Toowong, and on the Inner City Bypass (ICB), near its junction with Victoria Park Road at Kelvin Grove / Herston.

The overall project presented in the Reference Design would be approximately 7 kilometres in length, including surface connections. The eastbound tunnel (northern) is approximately 4.6 kilometres long and the westbound tunnel is approximately 4.9 kilometres long. The two tunnels would be at least 10 metres apart and connected by cross passages every 120 metres along their length. The excavation of the two tunnels would be by tunnel boring machine (TBM) commencing from the western end with spoil carried by conveyor to the Mount Coot-tha Quarry for processing.

The alignment of the Reference Design progressed from the western connection to the eastern connection in a wide arc west of the former Marist College, Rosalie and then deep beneath St Brigid's Church, Red Hill. This alignment was proposed based on the original EIS tunnel ramp connections, which were subsequently removed during the Supplementary Report. However, the horizontal alignment was not modified during the Supplementary Report. The alignment also follows the assumed geotechnical conditions associated with the high ground conditions in Toowong, Rosalie and Red Hill.

Changed Project

The Changed Project would retain the general features of the Reference Design in that it would connect the Centenary Motorway at Toowong and with the ICB at Kelvin Grove/ Herston. The Changed Project also would consist of two parallel road tunnels, each with a uniform cross-section comprising containing two lanes.

The overall length of the Changed Project remains approximately 7km. The length of the westbound tunnel would be shorter by about 400m due largely to the reduction of cut and cover required. Similar to the Reference Design, the tunnels for the Changed Project would be aligned in parallel approximately 10m apart and connected by cross passages at the same distance along the length of the tunnels (120m).

The Changed Project would connect with the Centenary Motorway by way of centrally-located portals to the east and west-bound tunnels and associated transition structures. Similarly, the Changed Project would connect with the ICB via centrally-located portals and associated transition structures. For both connections, the existing motorway lanes would be realigned to accommodate the central connection location.

The Changed Project would be up to 60m north of the Reference Design at the driven tunnel portals at the eastern edge of the Botanic Gardens. The alignment continues approximately 100m north of the Reference Design underneath the Mt Coot-tha Cemetery until crossing the Reference Design alignment just to the east of Frederick Street, between Thorpe and Sleath Streets, Auchenflower. The alignment continues south of the Reference Design to the north of Gregory Park at Baroona Road and approximately 350m south of the Reference Design in the area of Guthrie Street, Paddington. The alignment rejoins the Reference Design alignment near Kelvin Grove Road, with the driven tunnel

finishing south of Normanby Terrace to the west of Victoria Park Road. The vertical alignment is generally shallower than the Reference Design, except at the eastern end north of Cairns Terrace, Paddington.

The tunnel ventilation system would be similar to the Reference Design with a longitudinal ceiling smoke duct and ventilation outlets at each end of the Changed Project. Both western and eastern ventilation stations would be located in the general localities as proposed in the Reference Design.

The western ventilation station would be buried underground in a location immediately north of the Reference Design location. The ventilation outlet for this ventilation station would be above ground on the western side of the buried ventilation station and approximately 43m north-west of the outlet location identified in the Reference Design. Maintenance access to the western ventilation station and associated infrastructure would be agreed with DTMR during detailed design. The eastern ventilation station would be cut into the side of the hill and the ventilation outlet would be situated in the same location as proposed for the Reference Design. Controlled access would be provided to and from the eastbound ICB.

The Tollroad Control Centre (TCC) for the Changed Project would be located on the northern side of Mt Coot-tha Road opposite the entrance to the Mt Coot-tha Botanic Gardens, whereas the Reference Design indicated a possible location for the TCC within the western worksite off the Centenary Motorway.

A summary of the design changes to the Reference Design, including references to relevant Reference Design drawings and Changed Project concept design drawings are identified in **Table 2-2.** The Reference Design drawings are available from the EIS Supplementary Report Volume 2: Project Design set of drawings available from the Northern Link Project Website and the Changed Project drawings referenced in **Table 2-2** are provided in this application following the table. **Table 2-2** also identifies the reason for each of the identified changes described in the table.

Table 2-2: Design Changes

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
TBM Tunnel Alignment			
Horizontal Alignment	From south-west corner of Toowong Cemetery in an arc along the northern section of the Study Area to surface on the southern side of Normanby Terrace residences west of Victoria Park Road. Refer to **Figure 2-1** above and Supplementary Report Volume 2 Planning Layout Drawings[1].	From the western side of Mt Coot-tha Road and 100m north of the RD alignment under the Toowong Cemetery in a straighter alignment through the centre of the Study corridor up to 300m south of the RD alignment to land on the southern side of Normanby Terrace residences. Refer **Figure 2-17 to Figure 2-20**	Enables both TBMs to be launched off-line within the construction worksite and outside of existing traffic areas. Avoids construction through Mt Coot-tha Road and the roundabout. Provides improved grades for the associated cut and cover and transition structures to the Centenary Motorway. Provides a more direct alignment while maintaining suitable geology with some reduction in TBM length (westbound TBM -60m and eastbound TBM – 30m) and private property volumetric requirements.
Vertical Alignment (Depth)	The RD ranged in vertical alignment depths under the surface between some 11m	The changed vertical alignment of the tunnels under private properties	Consequence of the amended horizontal geometry and ground surface heights.

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
	and 66m Refer to **Figure 2-3** above and Supplementary Report Volume 2 Longitudinal sections	varies between approximately 10-50m and would be generally shallower than the Reference Design, although the section between Cairns Terrace and the ICB would be deeper. Refer **Figure 2-4** and **Figure 2-21 to Figure 2-28.**	Also due to design changes to optimise tunnel gradients.
Volumetric Title Requirements	374 parcels of land identified as affected in Supplementary EIS. Refer to Section 3.3.2 of the Supplementary Report.	334 property holdings are affected by the Changed Project. Some 269 of these are newly affected (including 6 Council owned parcels) and 65 of these continue to remain affected as identified in the Reference Design. There may be some minor changes to these numbers as a result of detailed design and survey.	Newly identified properties are required due to the revised horizontal alignment design and further design development of tunnel infrastructure including volumetric buffer requirements (1.5m surrounding the underground structures) as well as the concept design for cross passages and underground sub-stations.
Tunnel and cross passage configuration	The Reference Design proposed undrained or sealed cut and cover tunnels with a drained or unsealed driven TBM tunnel and drained cross passages and substations. Groundwater inflow to the tunnel was estimated at 4 litres per second. Refer to Supplementary Report Volume 2 Typical Cross Sections[3]	The Changed Project has chosen to seal both the tunnels to prevent the inflow of groundwater. The TBM tunnels would be fully sealed with pre-cast tunnel segment rings and grouting. Underground cross passages and substation sites would remain drained and as a source of groundwater entry into the tunnels but less than that estimated for the Reference Design (ie approx 3 litres per second). Refer to **Figure 2-29 to Figure 2-30**	Development of more efficient construction methodology using pre-cast tunnel rings to line the tunnel in one process as the tunnel is being constructed.
Western Surface Connections			
TBM portal locations	The TBM portals are separated some 50m apart, with the northern entry portal located at the corner of Mt Coot-tha Road and the roundabout adjacent to the Toowong Cemetery and the southern exit portal located in line with the middle of the roundabout adjacent to the cemetery. Refer to **Figure 2-5** and Supplementary Report Volume 2 Planning Layouts[1]	The TBM portals are located together some 60m north of the northern Reference Design portal and some 100m north of the southern Reference Design portal on the western side of Mt Coot-tha Road within the western worksite Refer to **Figure 2-6** and **Figure 2-31**	Enables both TBMs to be launched off-line within the construction worksite and outside of existing traffic, avoiding construction through Mt Coot-tha Road and the roundabout. Provides improved grades for the associated cut and cover and transition structures to the Centenary Motorway. Provides for the tunnel cut and cover portals to be together consolidating the construction area and also simplifying construction traffic management

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
Cut and Cover tunnels and tunnel entry and exit portal locations	The cut and cover tunnel portals being the entry and exit portals to and from the tunnels, are located either side of the Centenary Motorway, west of the Mt-Coot-tha roundabout. These portals are 60m apart on either side of the Centenary Motorway. The northern entry cut and cover tunnel is approximately 215m in length along the northern side of the Centenary Motorway. The southern exit cut and cover tunnel is 220m along the southern area of the Centenary Motorway within Anzac Park. Further cut and cover cross passages are constructed between the tunnels through the Centenary Motorway and a larger second cross passage through the roundabout and the off ramp to Mt Coot- tha Road. Refer to **Figure 2-5** and Supplementary Report Planning Volume 2 Planning Layouts[1]	The cut and cover tunnel portals for the Changed Project are located together north of the Centenary Motorway and approximately 40m north of the northern Reference Design portal and some 175 west of Mt Coot-tha Road. The cut and cover tunnels are generally 10m apart and some 30-40m shorter than the Reference Design tunnels. The cut and cover areas would be replanted and returned for public use to the Botanic Gardens apart from a 10m to 50m section of semi covered transition structure west of the tunnel portal within the gardens area. Refer to **Figure 2-6** and **Figure 2-31**	Consolidates the construction area north of the Mt Coot-tha roundabout avoiding cut and cover construction through Mt Coot-tha Road and the roundabout simplifying construction traffic management. Also retains sensitive areas of Anzac Park and the existing pedestrian and cycle bridge across the Centenary Motorway.
Tunnel entry and exit transition ramps to the Centenary Motorway	An approximately 500m tunnel entry ramp with maximum downgrades of 7% and a 610m tunnel exit ramp with maximum upgrades of 5% are located on the outside of the Centenary Motorway. Refer to **Figure 2-5** and Supplementary Report Volume 2 Planning Layouts[1]	The Changed Project entry and exit transition ramps are located together on the inside of the Centenary Motorway. These ramps are longer than the Reference Design (the entry by 145m and the exit by 40m) with generally maximum grades of 5%. Refer to **Figure 2-6** and **Figure 2-17**	Consultation with DTMR indicates some benefit in making the CM-NLRT route the primary traffic and freight route by connecting from the inside lanes of the Centenary Motorway. Also provides a safer route for approved on-road cyclists using the Centenary Motorway outside lanes.
Realignment of the Centenary Motorway inbound lanes to the north	No design changes to the inbound lanes of the Centenary Motorway. Refer to **Figure 2-5** and Supplementary Report Volume 2 Planning Layouts[1]	The inbound lanes of the Centenary Motorway would be realigned to the north. The inbound lanes, including the earthwork for the future widening would be constructed off-line followed by a single switch of traffic onto the new lanes. Refer to **Figure 2-6** and **Figure 2-17**	To provide a single construction area and space for the centre connection of the Northern Link within the median of the Centenary Motorway.
Centenary Motorway merge and diverge	The Reference Design provides for a merge from the tunnel to the Centenary motorway of approximately 800m and for a diverge from	The Changed Project provides for a merge from the Mt Coot-tha roundabout traffic to the exit traffic from the tunnel onto the Centenary	The shorter merge (150m) is due to the commencement of the merge being further west than the Reference Design due to the difference in

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
locations	the Motorway to the tunnel of approximately 175m Refer to drawing **Figure 2-7** and Supplementary Report Volume 2 Planning Layouts[1]	Motorway of approximately 650m and a diverge of approximately 375m. Refer to **Figure 2-8** and **Figure 2-17**	vertical geometry. The longer (200m) diverge is due to the improved geometry and to comply with agreed design standards.
Western ventilation and infrastructure maintenance access.	Ventilation station and associated facilities partially buried into the higher ground at the western end of the western worksite. Access not defined. Refer to **Figure 2-5** and Supplementary Report Volume 2 Ventilation Site Plans[4]	Ventilation station fully buried. The ventilation outlet has moved approximately 43 metres north west, which is further away from the nearest residence. A water and power utility area would remain cut into the higher ground with final access arrangements to be approved by DTMR. No change to the minimum height of the ventilation outlet. Refer to **Figure 2-31** and **Figure 2-38**	There is no change to ventilation outlet minimum level. The reason for the decision to fully bury the ventilation station was to further reduce visual impact from within the Botanic Gardens. The change in the location of the ventilation outlet is as a result of the burying of the ventilation station in order to mitigate visual impact.
Tollroad Control Centre (TCC) location	The TCC would be situated adjacent to the Centenary Motorway within the rehabilitated worksite area with access off the Centenary Motorway. Refer to EIS Volume 1 Part 4 Section 4.4.1	The TCC would be located on the corner of Richer Street and Mt Coot-tha Road with access off Mt Coot-tha Road. Refer to **Figure 2-33 to Figure 2-36**	The Reference Design proposed site would have impacted on the Botanic Gardens, whereas the Changed Project location would avoid further above ground infrastructure and traffic within this significant public area.
Eastern Surface Connections			
TBM portal locations	TBM portals located south of the residences along Normanby Terrace Refer to **Figure 2-13** and Supplementary Report Volume 2 Planning Layouts[1]	Changed Project has similar TBM portal locations although the eastbound TBM portal has moved approximately 60m east and the westbound TBM portal has moved approximately 30m east. Both being further distant from the majority of residences along Normanby Terrace. Refer to **Figure 2-14** and **Figure 2-37**	Provides for better capacity for TBM extraction using machinery above tunnel alignment. Reference Design eastbound tunnel portal was very close to existing residences.
Cut and Cover tunnels and tunnel entry and exit portal locations	Westbound entry portal located in line with the eastern side of the Brisbane Girls Grammar School with cut and cover approximately 406m long through the westbound lanes of the ICB Eastbound exit portal located in line with Victoria Park Road some 100 m east of the TBM portal	Westbound entry portal located 300m further west in line with Victoria Park Road. Eastbound exit portal located 60m east to the western side of the INB overpass. Tunnel portals located together and within the centre of the ICB Refer to **Figure 2-14** and **Figure 2-37**	Significantly reduces the impact of the works on ICB traffic during construction by some 330m of cut and cover through the westbound lanes of the ICB

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
	Refer to **Figure 2-13** and Supplementary Report Volume 2 Planning Layouts		
Tunnel entry and exit transition ramps to the ICB	Eastbound transition exit ramp from Victoria Park Road portal to the INB Busway. Westbound transition entry ramp from the eastern side of the Brisbane Girls Grammar School (BGGS) for approximately 190m Refer to **Figure 2-13** and Supplementary Report Volume 2 Planning Layouts[1]	The transition ramps for the Changed Project have also been brought together from a position in line with the middle of BGGS to the tunnel portals between Victoria Park Road and the INB overpass. Refer to **Figure 2-14** and **Figure 2-37**	Due to changes in the positions of the cut and cover tunnels due to the realignment of the ICB in order to create off-line construction conditions with significantly reduced traffic impacts and also better sight lines for merge and diverge conditions.
Realignment of the ICB outbound lanes to the north	ICB eastbound maintains similar alignment to existing.	ICB realigned approximately 40m through the lower section of the Brisbane Grammer playing fields and beneath an additional INB bridge span Refer to **Figure 2-14** and **Figure 2-37**	The ICB realignment to the north provides additional median space within which to construct the Northern Link Connection off-line - ie no requirement to relocate and replace the westbound lanes of the ICB to construct the extensive cut and cover tunnel entry. Will significantly reduce construction conflicts with the operation of the westbound lanes of the ICB.
ICB merge and diverge locations	The Reference Design eastbound merge length was approximately 375m to an area some 50m west of the landbridge. Due to the extensive cut and cover tunnel with the Reference Design the westbound diverge length was restricted to some 90m. Refer drawings **Figure 2-13** and Supplementary Report Volume 2 Planning Layouts[1]	The Changed Project merge length is some 410m which extends the merge to the landbridge. The Changed Project's diverge length into the relocated tunnel portal is approximately 240m and provides better sight distances to motorists compared to the Reference Design. Refer to **Figure 2-14** and **Figure 2-37**	An additional benefit resulting from the change to portal locations
Eastern ventilation and other infrastructure and maintenance access.	Location to the east of the INB with no urban design or access identified. Refer to **Figure 2-13** and Supplementary Report Volume 2 Ventilation Site Plans[4]	Urban design developed and controlled access identified off the eastbound carriageway of the ICB Refer to **Figure 2-37** and **Figure 2-39**	No change to the general location. Further development of the project design to identify urban design and maintenance access.

[1] Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawing EIS-PL-00 to EIS-PL-10
[2] Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawings EIS-LS-01 to EIS-LS-04
[3] Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawings EIS-TX-01 to EIS-TX-03
[4] Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawing EIS-VS-00 to EIS-VS-02
(The above drawings can be viewed at http://www.northernlinkeis.com.au/EISDocuments.html#1)

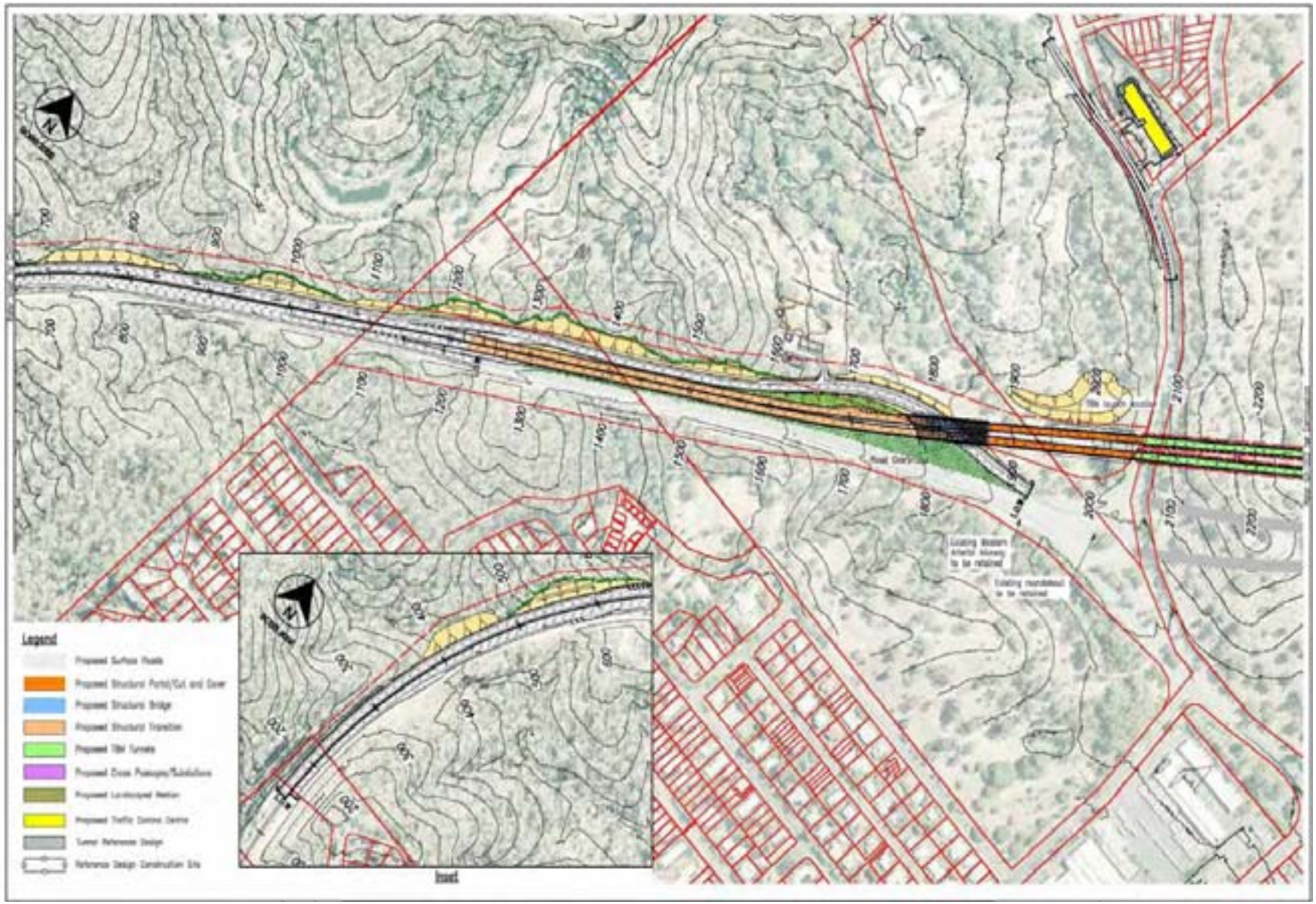

Figure 2-17: Changed Project alignment – Centenary Motorway Connection

Figure 2-18: Changed Project alignment – Toowong Cemetery to Thomas Street

Figure 2-19: Changed Project alignment – Thomas Street to Plunkett Street

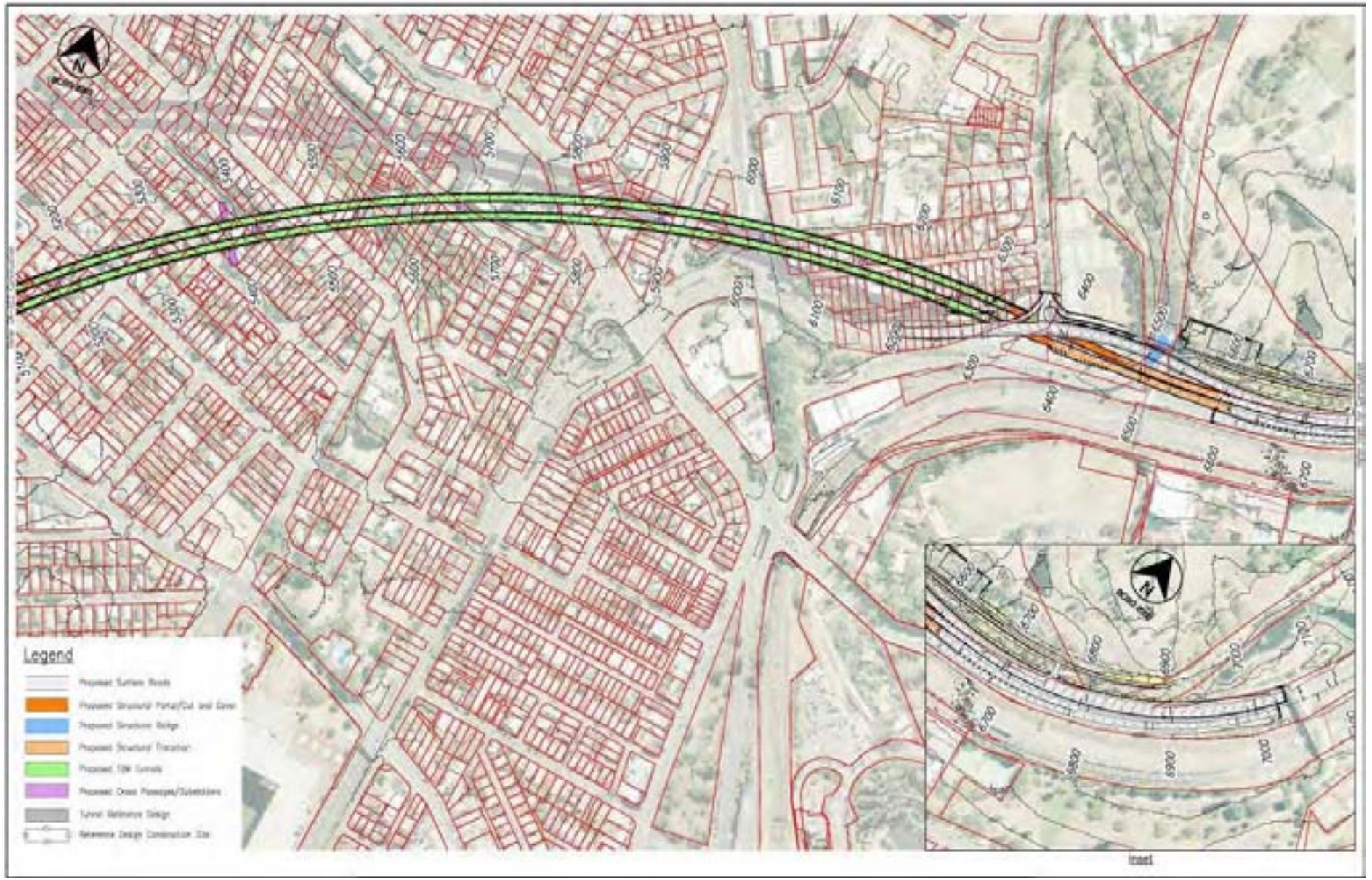

Figure 2-20: Changed Project Alignment – ICB Connection

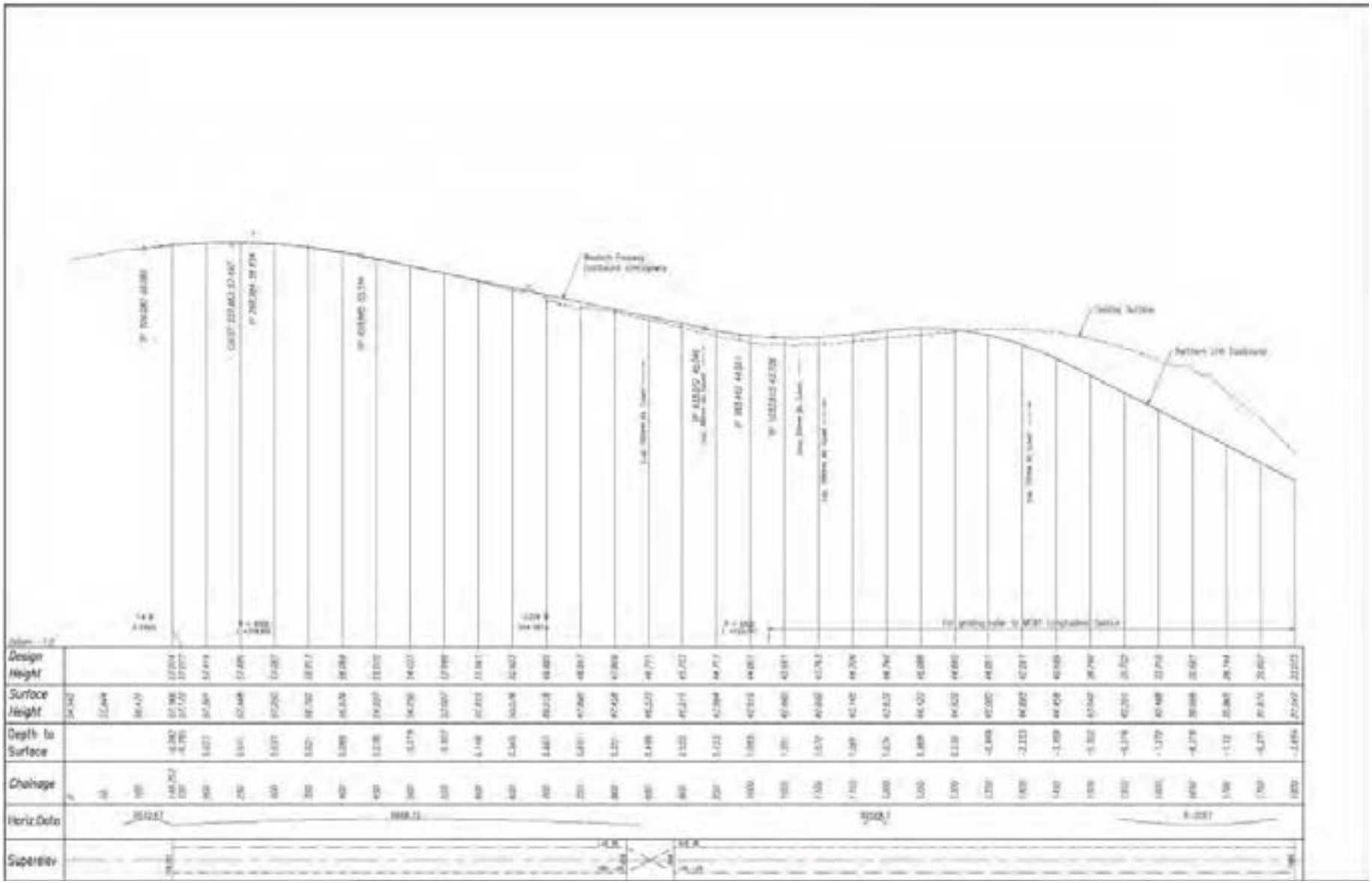

Figure 2-21: Eastbound tunnel vertical alignment –Centenary Motorway Connection

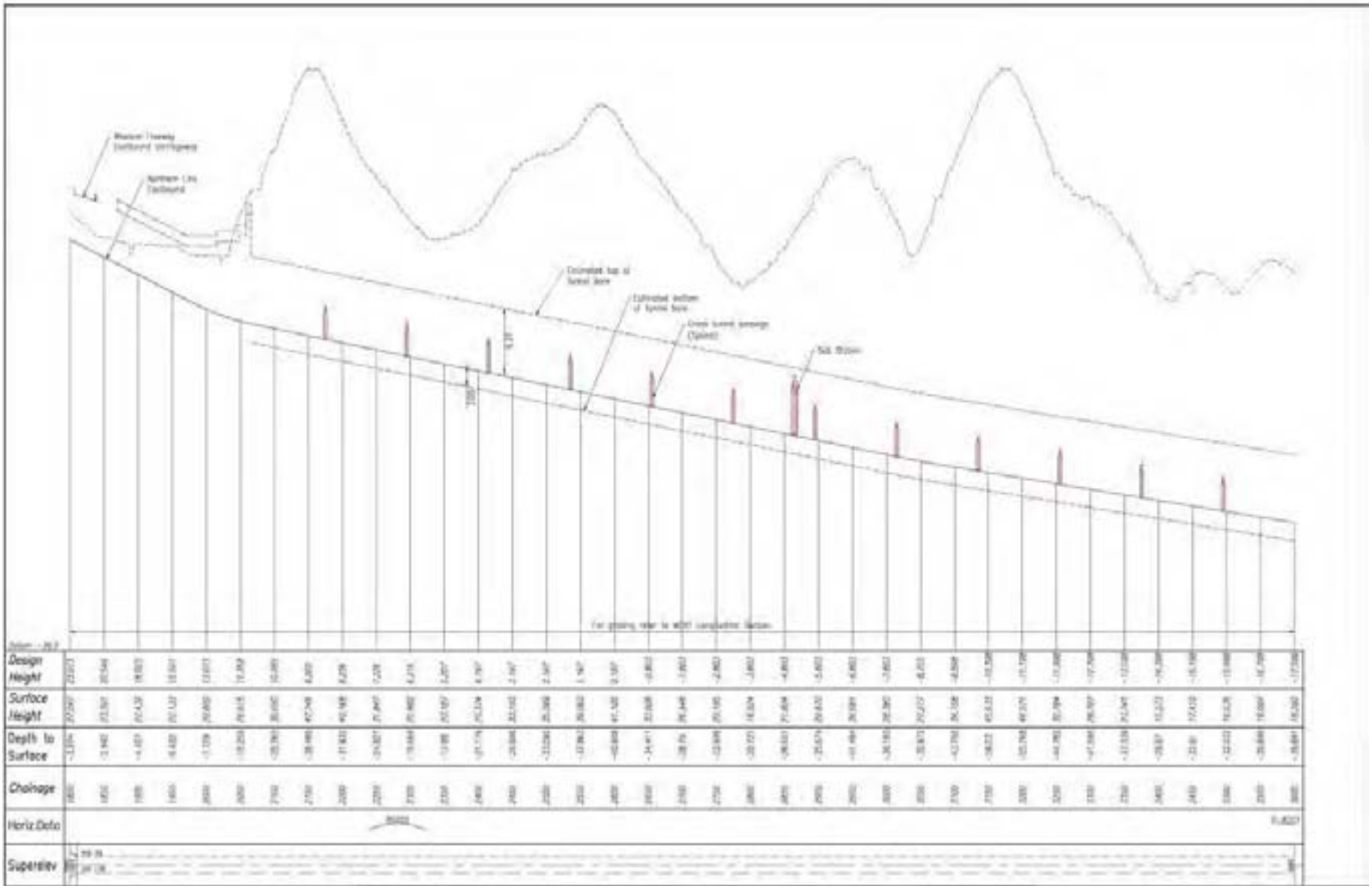

Figure 2-22: Eastbound tunnel vertical alignment – Toowong Cemetery to Thomas Street

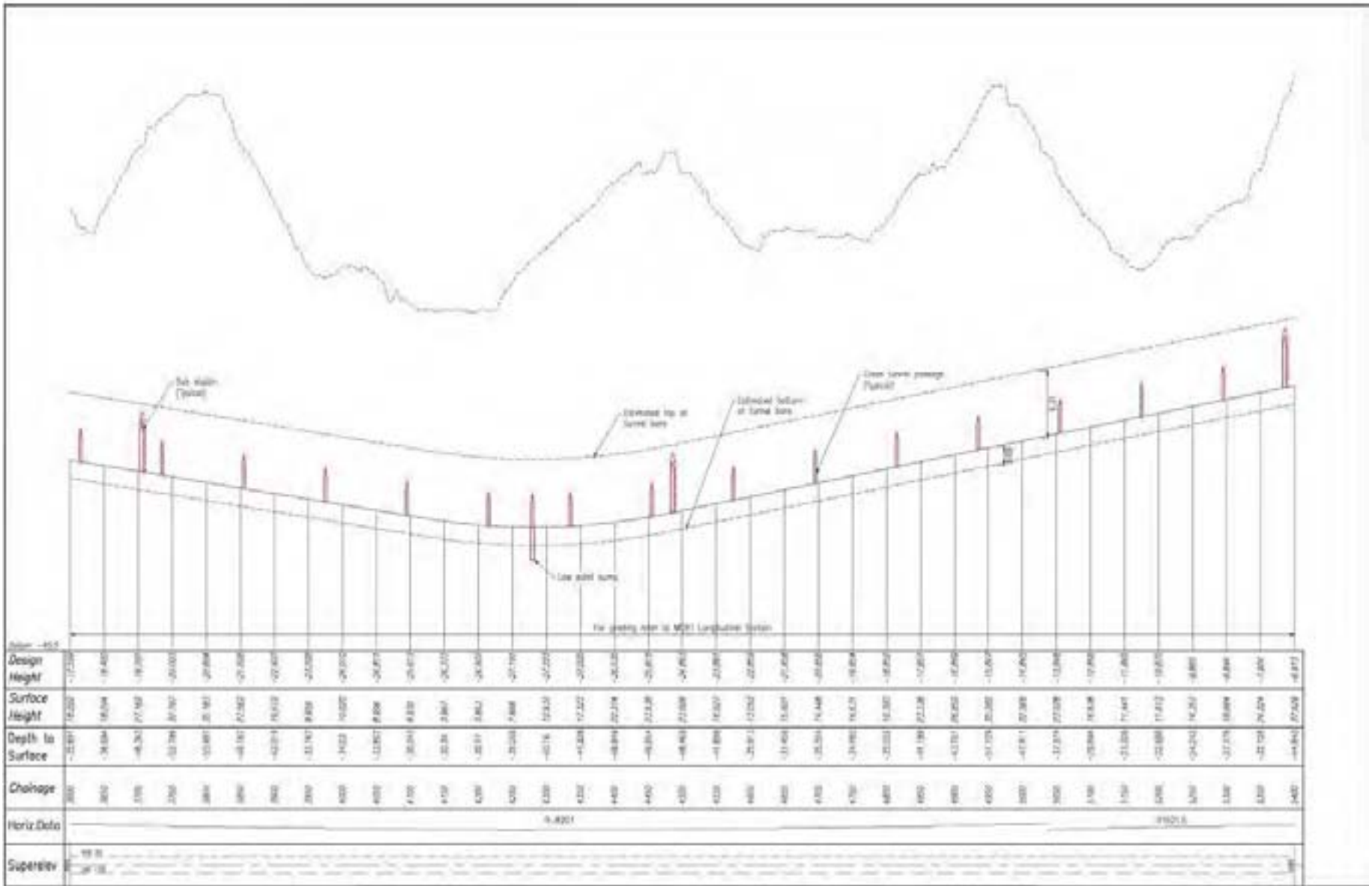

Figure 2-23: Eastbound tunnel vertical alignment –Thomas Street to Plunkett Street

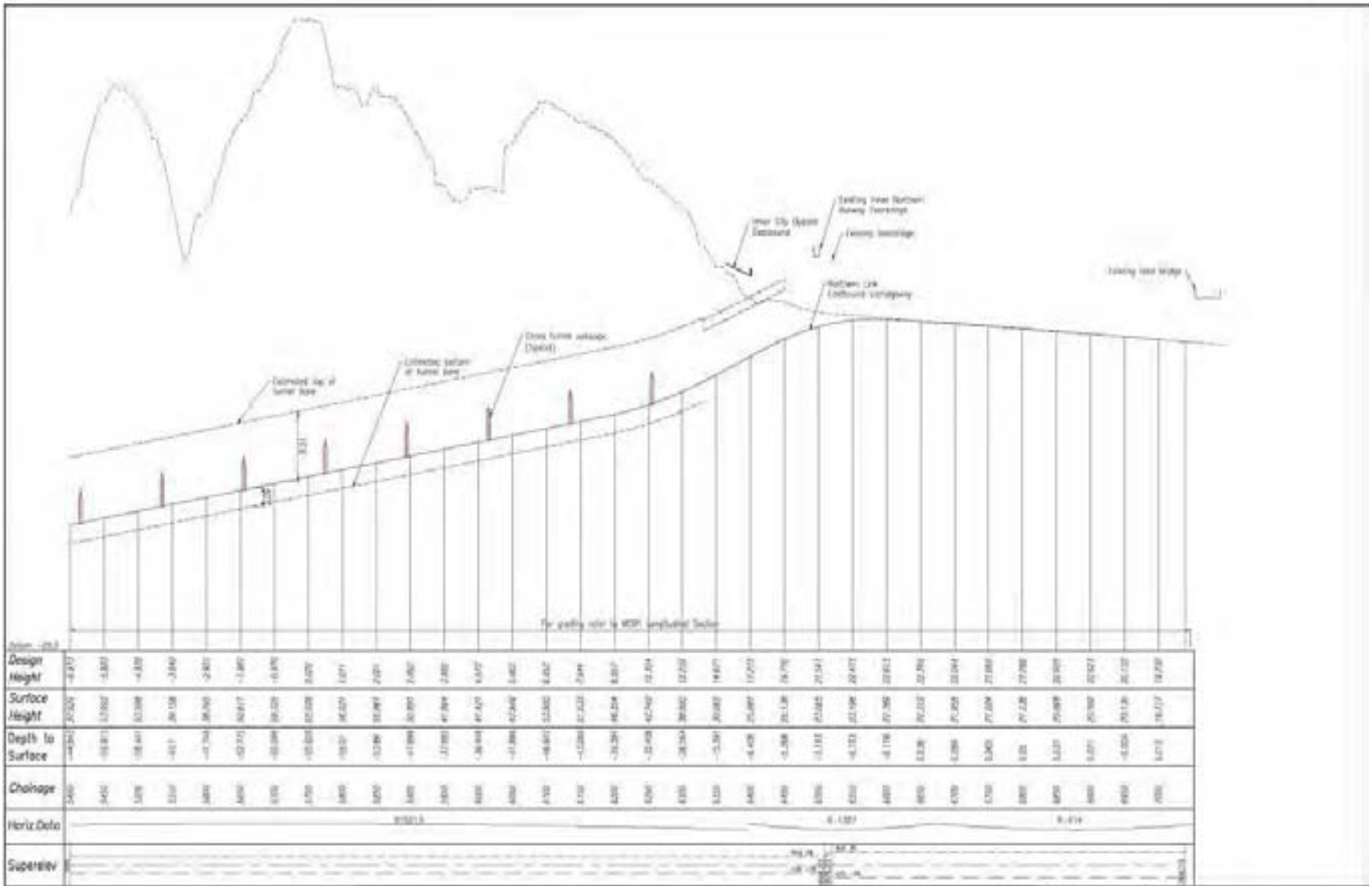

Figure 2-24: Eastbound tunnel vertical alignment –ICB Connection

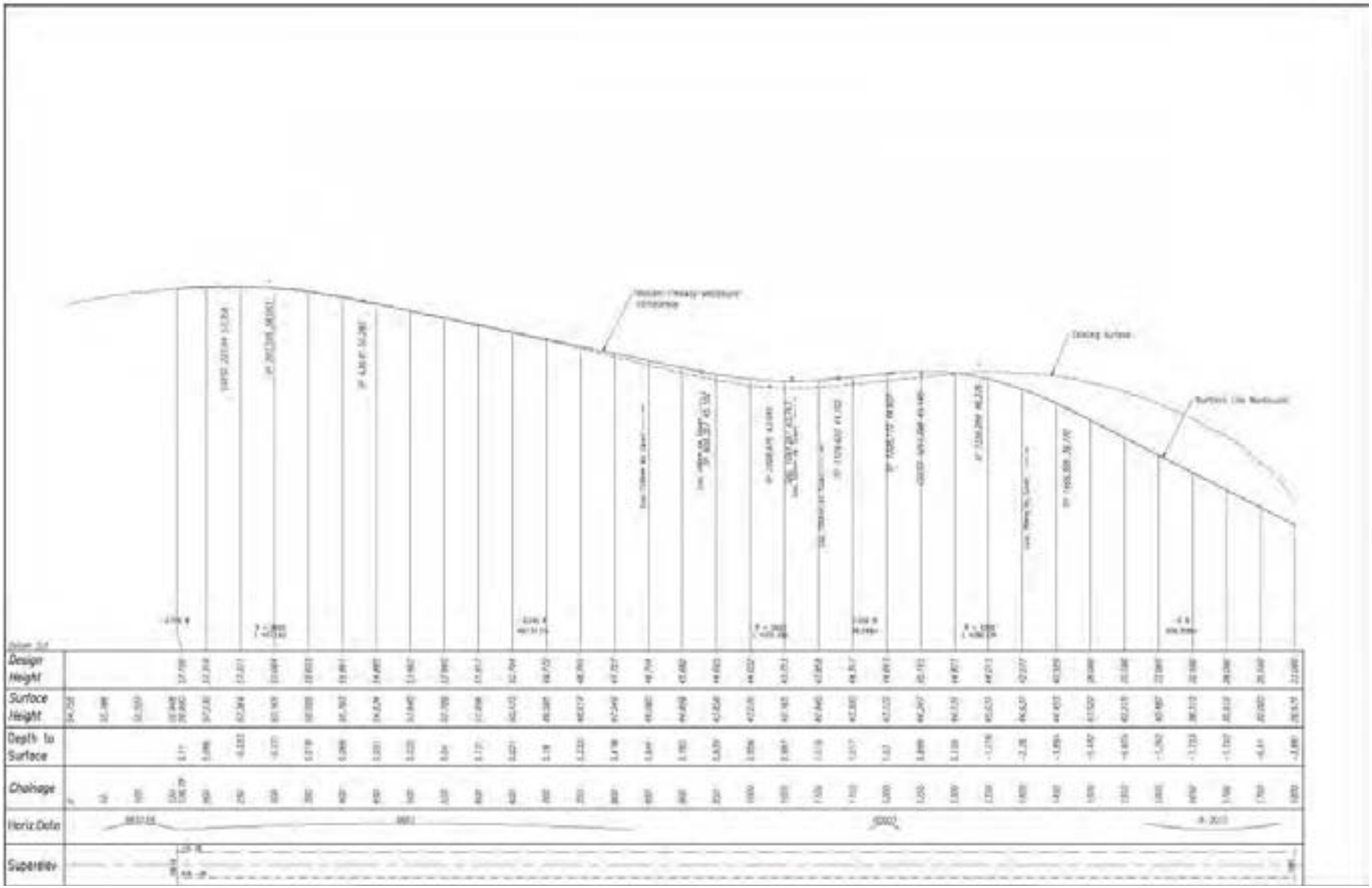

Figure 2-25: Westbound tunnel vertical alignment – Centenary Motorway Connection

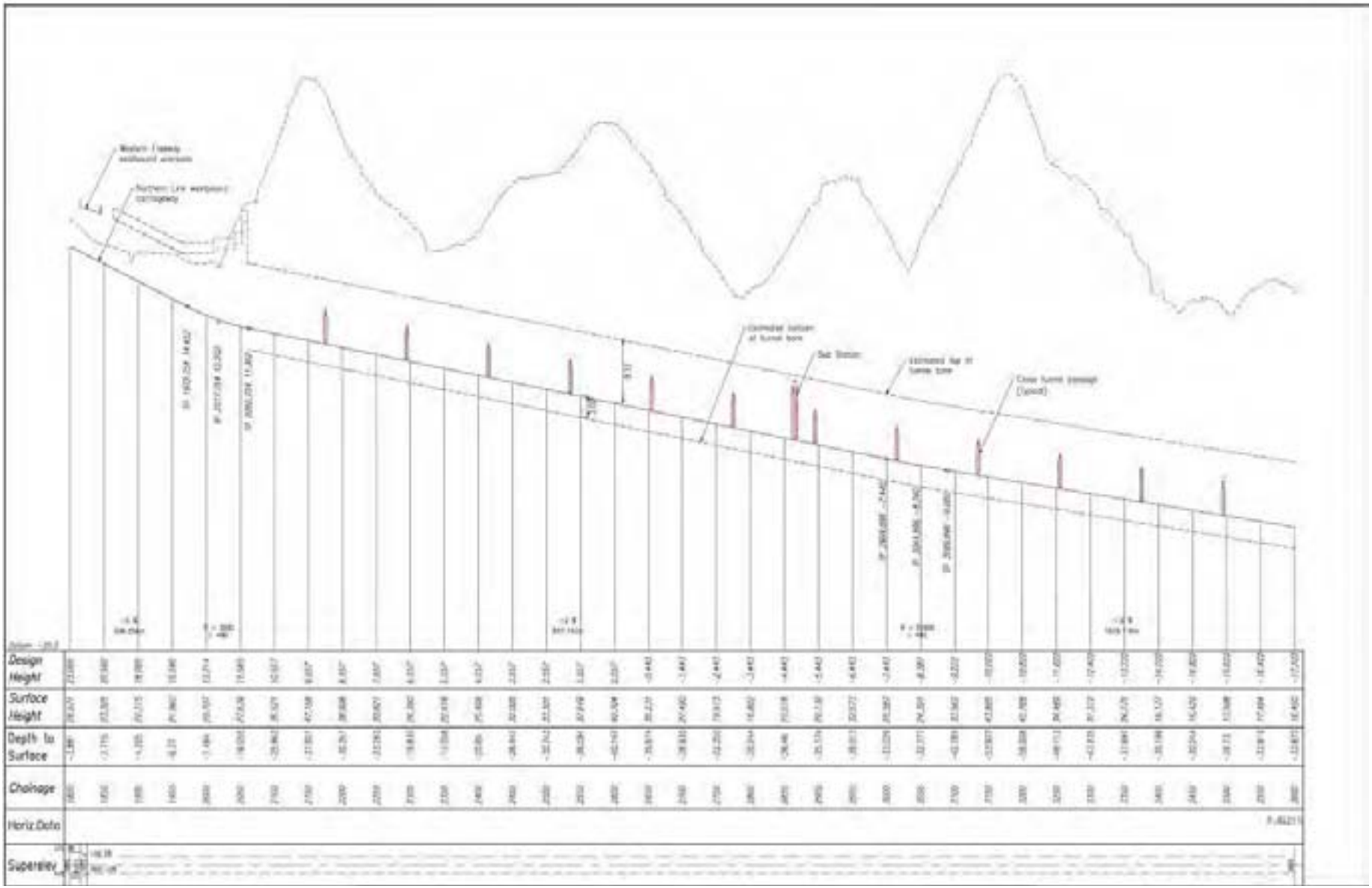

Figure 2-26: Westbound tunnel vertical alignment – Toowong Cemetery to Thomas Street

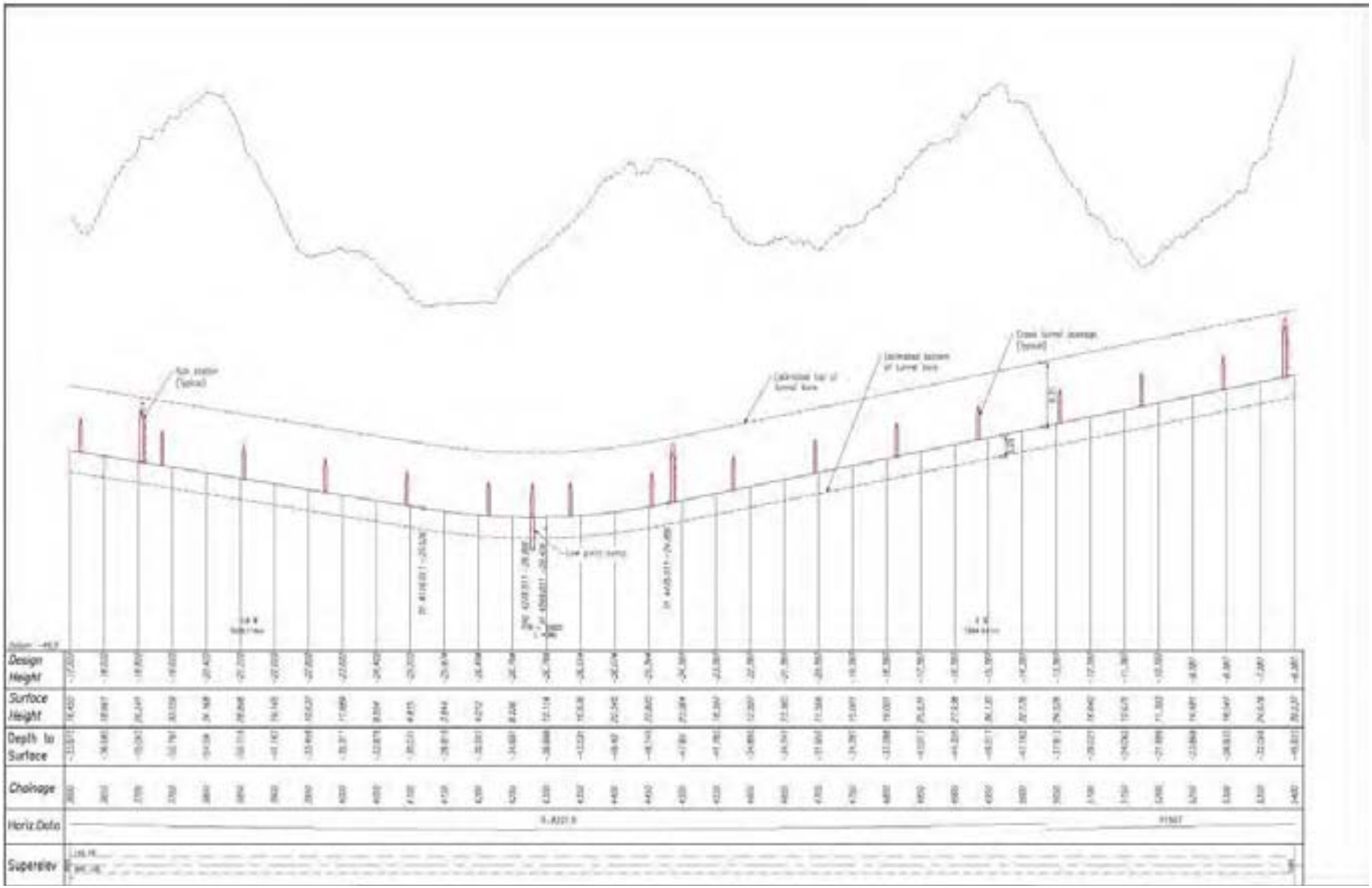

Figure 2-27: Westbound tunnel vertical alignment – Thomas Street to Plunkett Street

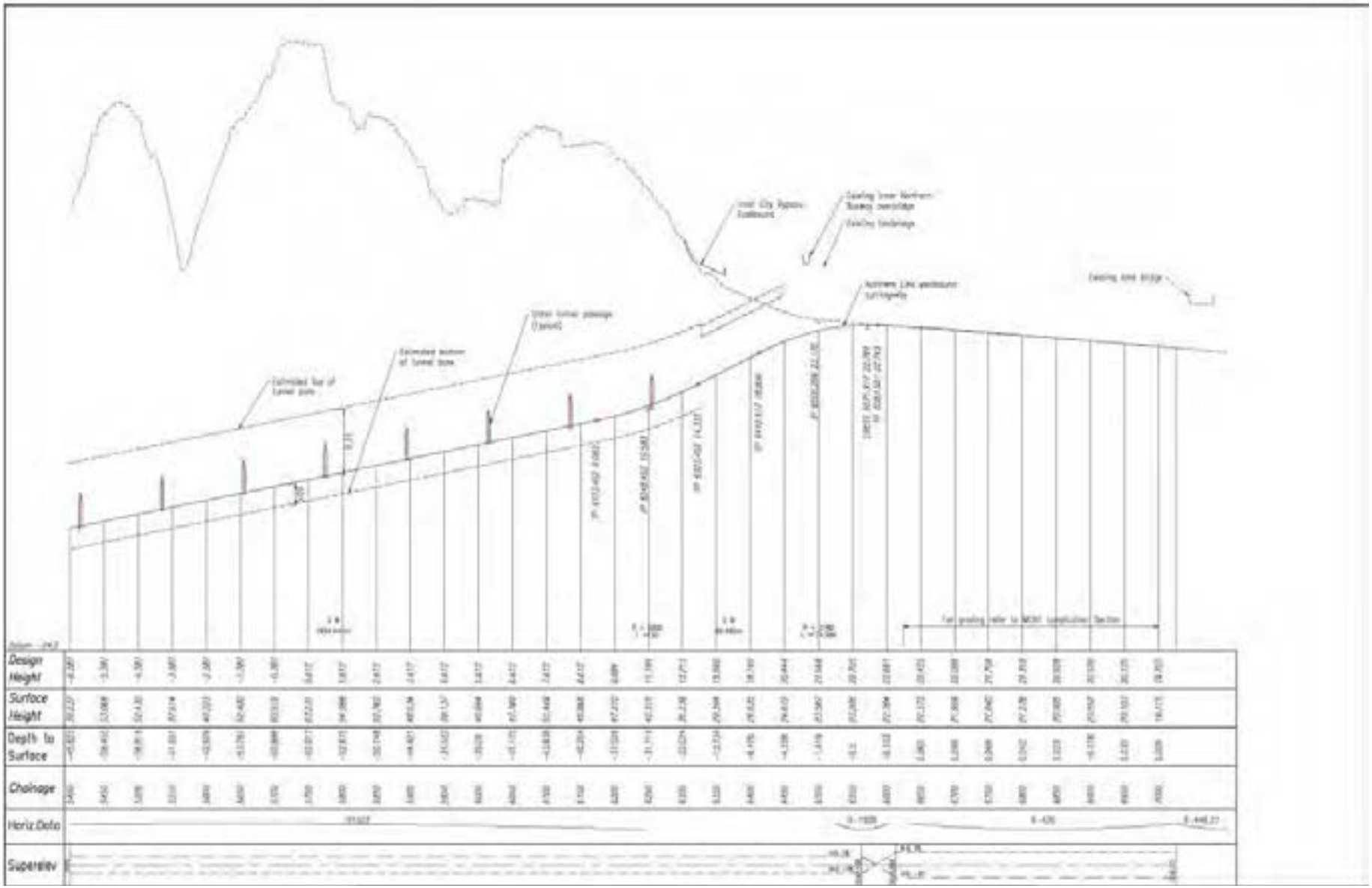

Figure 2-28: Westbound tunnel vertical alignment –ICB Connection

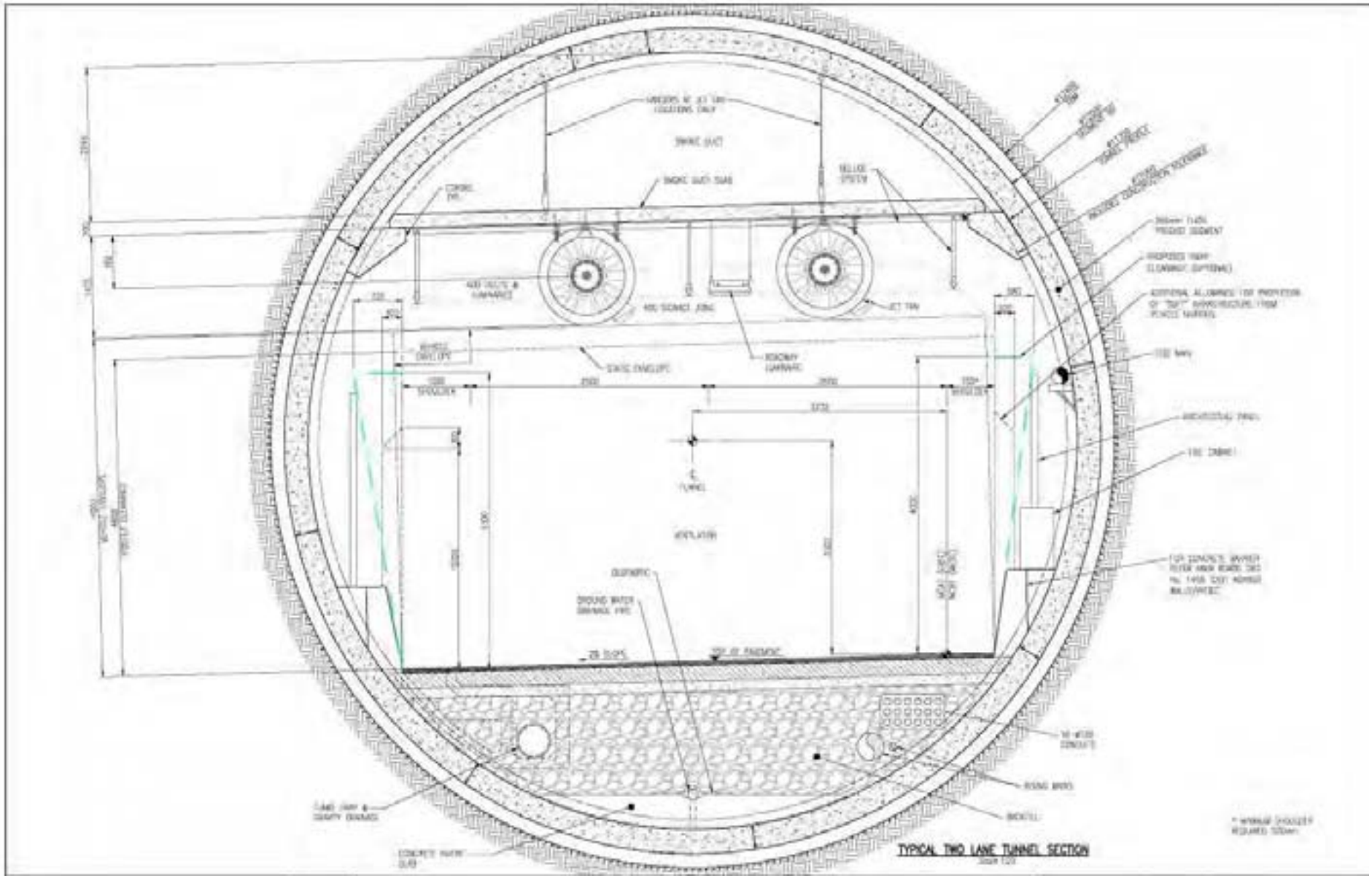

Figure 2-29: Tunnel profile cross section

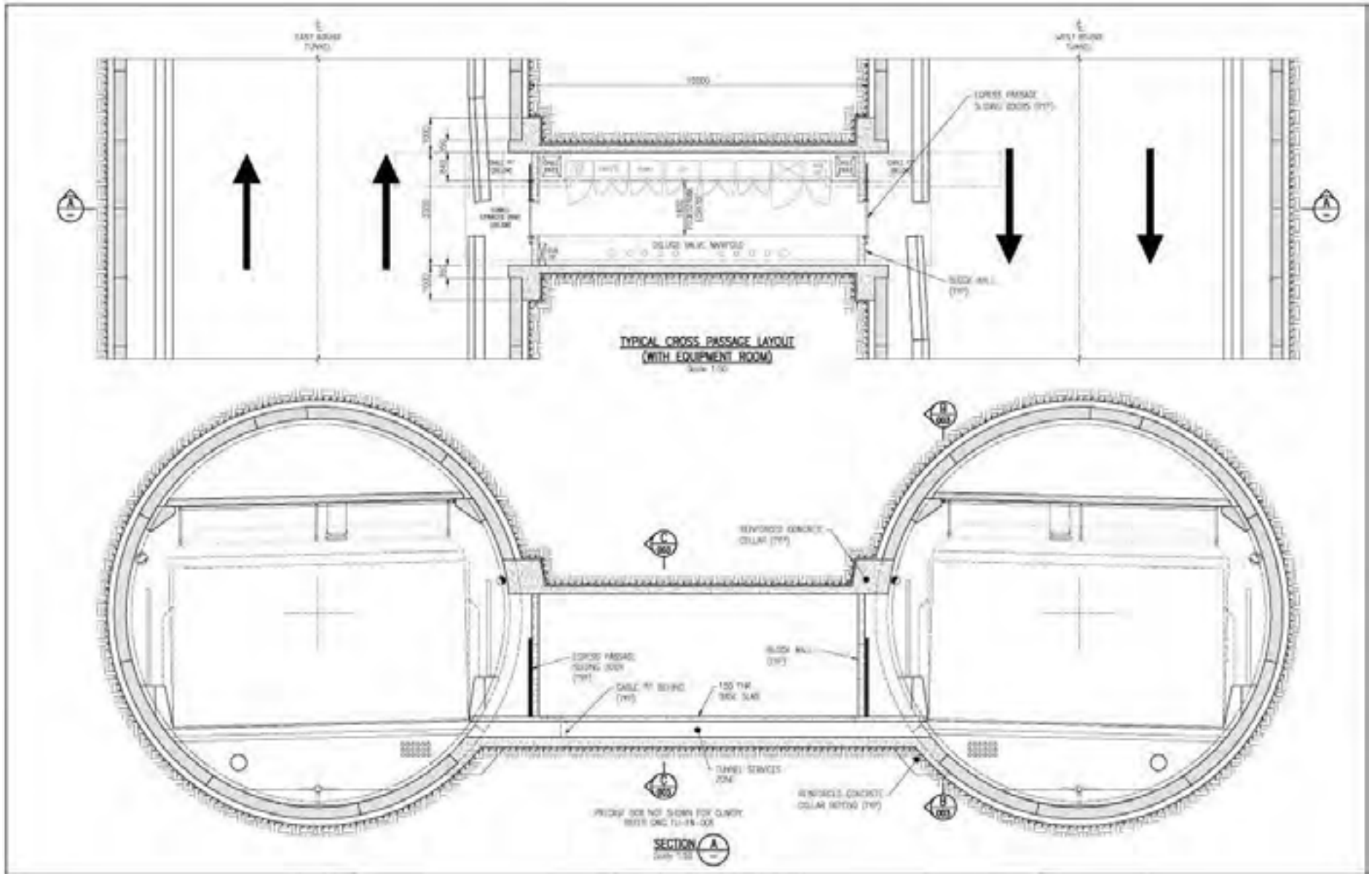

Figure 2-30: Typical cross passage – Plan and Elevation

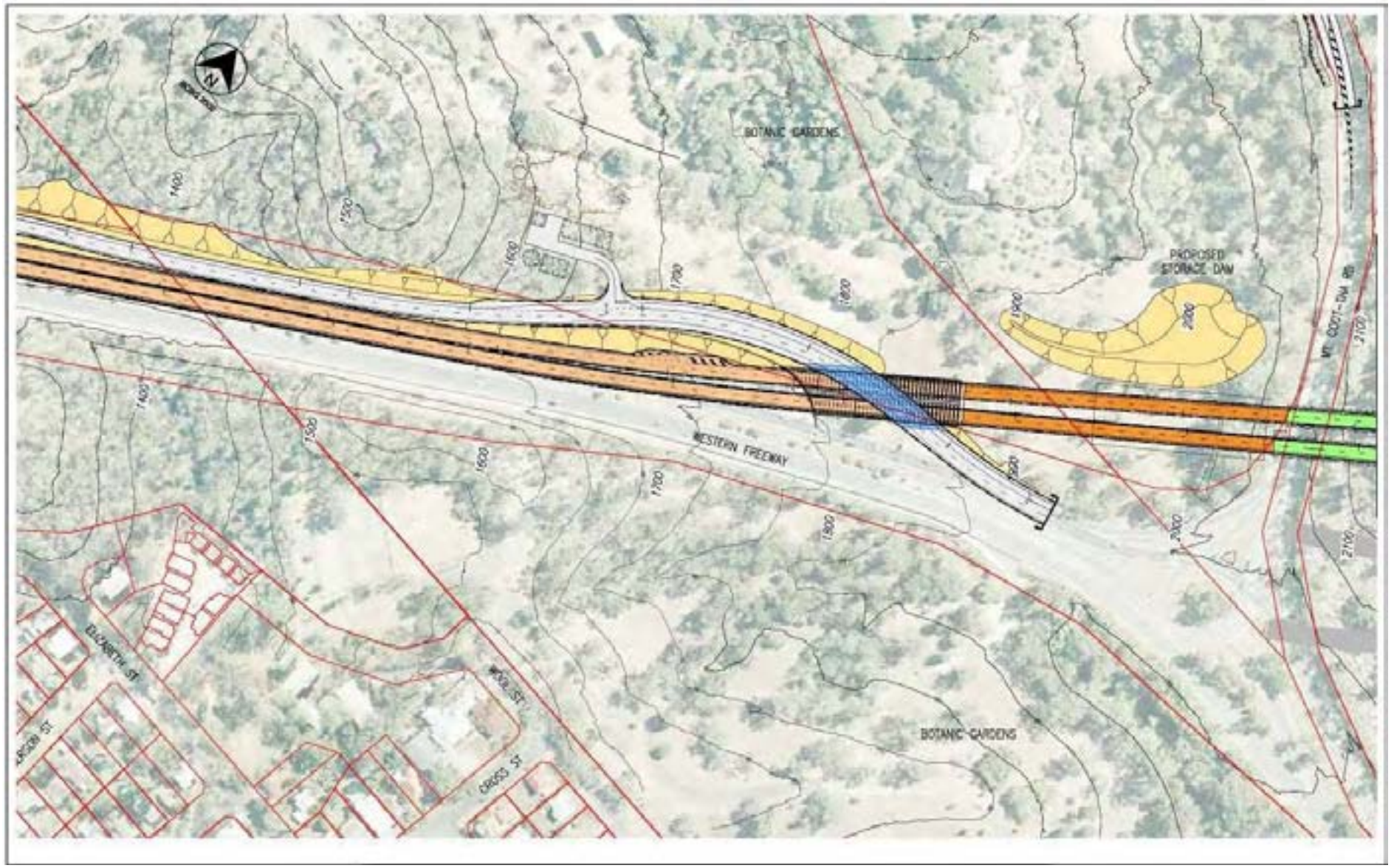

Figure 2-31: Changed Project – Western connection overview

Figure 2-32: Tollroad Control Centre – Proposed Site

Figure 2-33: Tollroad Control Centre – Landscape master plan

Figure 2-34: Tollroad Control Centre – Artist impression view north

Figure 2-35: Tollroad Control Centre – Artist impression view east

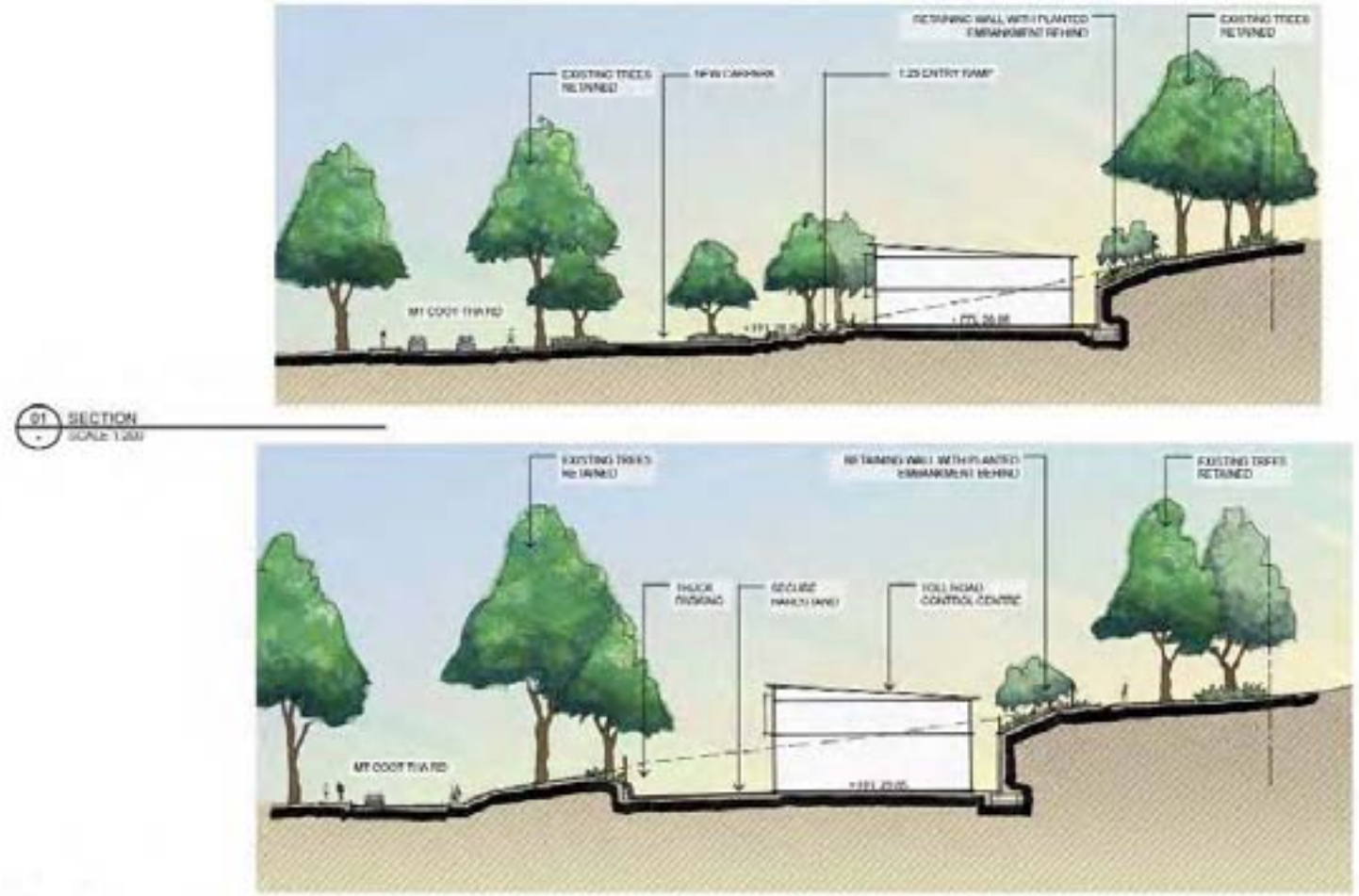

Figure 2-36: Tollroad Control Centre – Cross section

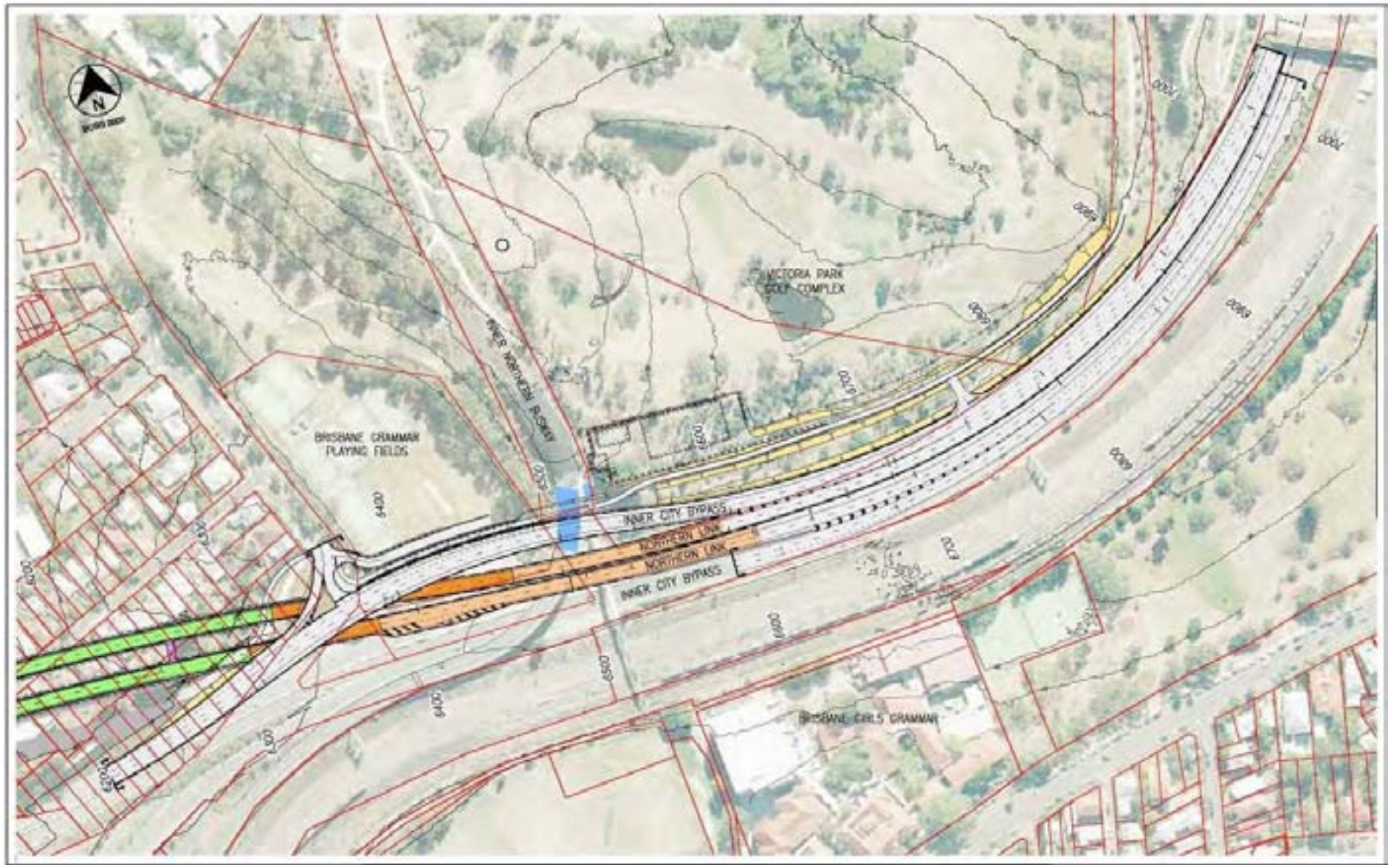

Figure 2-37: Changed Project – Eastern connection overview

Figure 2-38: Western ventilation station and outlet

Figure 2-39: Eastern ventilation station and outlet

2.2 Main Alignment

2.2.1 Design Changes – Main Alignment

The alignment of the main tunnels in the Changed Project would be straighter than for the Reference Project. This change would provide a more direct route between the Centenary Motorway and the ICB. This alignment would be generally shallower than the Reference Design, particularly for the western half of the route due to the local topography above the changed alignment and flatter tunnel gradients. These flatter gradients would provide greater efficiencies for traffic use and tunnel operations, such as safety and ventilation.

The horizontal alignment would be up to 60m north of the Reference Design at the tunnel portals at the eastern edge of the Botanic Gardens and up to 100m north of the Reference Design underneath the Mt Coot-tha Cemetery until meeting the Reference Design alignment just to the east of Frederick Street, between Thorpe and Sleath Streets, Auchenflower. The alignment would then be located south of the Reference Design passing just to the north of Gregory Park at Baroona Road, Rosalie and 350m south of the Reference Design in the area of Guthrie Street, Paddington and joining the Reference Design location near Kelvin Grove Road, Kelvin Grove with the driven tunnel finishing south of Normanby Terrace and to the west of Victoria Park Road, Herston.

The vertical alignment would be generally shallower and flatter than the Reference Design although the eastern area from Cairns Terrace, Red Hill to the ICB is deeper than the Reference Design as shown in **Table 2-3** below.

Table 2-3: Approximate depth from existing surface to crown of the tunnels

	Reference Design		Changed Project	
Location	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)
Western Driven (TBM) Tunnel Portal	11	9	9	8
Toowong Cemetery	15	16	9 to 33	8 to 31
Frederick Street (near its intersection with Thorpe Street), Toowong	36	33	19	18
Birdwood Terrace at its intersection with Gregory Street), Auchenflower The equivalent Changed Project location is Birdwood Terrace between Hume Street and Gregory Street, Auchenflower	58	58	49	49
Carrington St at its intersection with Daintree Street, Paddington The equivalent Changed Project location is Thomas Street west of Renie Street, Auchenflower	60	66	39	38
Baroona Road (between Howard and McNab Streets), Paddington The equivalent Changed Project location is Howard Street near its intersection with Bass St, Paddington	50	48	40	37
Beck Street (west of its intersection with Nash Street), Paddington The equivalent Changed Project location is Baroona Road near its intersection with Bayswater Road, Paddington	30	30	21	21

	Reference Design		Changed Project	
Location	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)
Fernberg Road (east of its intersection with Ellena Street) Paddington The equivalent Changed Project location is Fernberg Road to the south of Guthrie Street, Paddington	29	29	41	39
Latrobe Terrace, north of its intersection with Cochrane Street, Paddington The equivalent Changed Project location is Given Terrace near its intersection with Great George St, Paddington	48	48	40	38
Hayward Street (between Plunket and Charlotte Streets), Paddington The equivalent Changed Project location is Charlotte Street between Great George St and Martha St, Paddington	20	20	16	14
Cairns Terrace at its intersection with Great George Street, Red Hill The equivalent Changed Project location is Cairns Terrace between Great George Street and Dowse Street, Red Hill	43	47	52	49
St Brigid's Church on Musgrave Road, Red Hill	48	48	51	51
Kelvin Grove Road (north of the ICB) Kelvin Grove	16	15	27	25
Eastern Driven (TBM) Portal, Kelvin Grove	9	8	10.5	12.5

Table source – Northern Link EIS Supplementary Report Sept 2009 – Table 3-1.

There remains the need for volumetric acquisitions of property where the Changed Project passes beneath as shown in **Table 2-4** below.

Table 2-4: Changes to volumetric property requirements

	Volumetric	
	Reference Design	Changed Project
Private	374	328
State	NIL	NIL
Council	NIL	6

There are 334 properties currently identified as being affected by the need for the acquisition of a volumetric (subsurface) title for the Changed Project. Of these, 269 would be newly affected, including 6 Council-owned parcels, with a further 65 properties affected by the Changed Project as they would be by the Reference Design. Subject to detailed design and detailed property survey, there may be some further minor changes to the location and numbers of volumetric property requirements.

The changes in volumetric property requirements are brought about through the design changes in the main alignment together with further design investigations. Such investigations include the provision of a 1.5m buffer around the perimeter of each tunnel to accommodate tunnel supports and other contingencies for volumetric land tenure, as well as the inclusion of underground cross passages and substations.

2.2.2 Delivery Changes – Main Alignment

Generally, the construction method for the two main tunnels would be substantially the same as the Reference Design. The main difference in the delivery modes for the Reference Project and the Changed Project relates to the proposed lining of the main tunnels to prevent the inflow of groundwater and to provide enhanced structural support. The linings would be provided by continuous installation of pre-cast concrete segments made off-site during the construction phase. The Reference Project proposed a drained tunnel construction by TBMs with cast in-situ concrete lining. The drained cross passages would remain as proposed in the Reference Design, with cast in-situ concrete lining.

This change in delivery mode would require regular delivery of pre-cast concrete segments to the western worksite, where they would be stored, or laid down, pending their application by the TBMs. The transport task and effects of this proposed change are discussed in section 3.3.1 of this Application.

As with the Reference Project, the construction of the Changed Project would entail launching two TBMs from the western worksite adjacent to the Botanic Gardens. The TBMs would be extracted from the proposed cut and cover areas south of Normanby Terrace as proposed in the Reference Design.

The management systems for the tunnel's operation, including mechanical, electrical and ventilation systems and fire and life safety systems remain as described for the Reference Design.

2.3 Western Connection

2.3.1 Design Changes – Western Connection

Tunnel portals

The Changed Project connects with the Centenary Motorway in the west via portals located in the centre of the motorway, whereas the Reference Design proposed connections and portals on either side of the motorway. With the associated realignment of the Centenary Motorway through lanes to Mt Coot-tha Road, the portals for the Changed Project would be immediately west of Mt Coot-tha Road approximately 60m to 100m north of those proposed in the Reference Design.

The portals for the Changed Project would connect with the Centenary Motorway by cut and cover tunnel sections located approximately 185m west of Mt Coot-tha Road, similar to the Reference Design connection. However the Changed Project connections would be adjacent to each other rather than on either side of the Centenary Motorway as proposed for the Reference Design. This enables all cut and cover work for the launching of the TBMs to be off-line from the existing live traffic lanes of the motorway and within the western worksite.

There would be several advantages in this arrangement over the Reference Design including:

- no tunnel or road construction through Anzac Park, Toowong;
- no construction within the west-bound lanes of the Centenary Motorway;
- maintaining access to the existing cycleway and the pedestrian and cycle bridge structure over the Centenary Motorway;

- the removal of proposed cut and cover construction through Mt Coot-tha Road and the Mt-Coot-tha roundabout; and
- improved traffic management and pedestrian and cycle access during construction.

The tunnel infrastructure within the Botanic Gardens for the Changed Project would be covered and landscaped consistent with the possible future expansion of the Botanic Gardens.

There would be a length of semi-enclosed transition structure up to approximately 50m within the future extension area of the Botanic Gardens where the realigned inbound lanes of the motorway would cross the lanes of the Changed Project. The realigned Centenary Motorway and associated cross-over of the tunnel transition access would be located at-grade and would not intrude on views from public areas within the Gardens.

Motorway surface connection

The ramps proposed to connect with the Centenary Motorway inbound would extend for some 650m or approximately 40m further than the Reference Design but within the centre of the Centenary Motorway. The inbound lanes of the Centenary Motorway would be realigned to the north of their current position to accommodate the central portals.

The realigned inbound lanes would come back over the tunnel connection to rejoin the motorway to the west of the Mt Coot-tha roundabout.

For the Changed Project, the eastbound diverge from the Centenary Motorway to the Mt Coot-tha roundabout would be approximately 375m in length, compared with the diverge length of 175m in the Reference Design. This would improve traffic arrangements further and would comply with relevant design standards.

The westbound merge from the Mt Coot-tha roundabout to the Centenary Motorway would be approximately 650m in length for the Changed Project compared with the Reference Design merge length of approximately 800m. The commencement of the merge for the Changed Project would be further west than the Reference Design due to the differences in vertical geometry.

Any potential future widening of the Centenary Motorway to three lanes each way by DTMR could still be accommodated with the Changed Project. However, any such widening, if required, would be on the outside of the motorway, rather than within the existing median area as proposed in the Reference Design.

The vertical alignment or gradient of the tunnels and transitions to the surface have also changed, improving exit speeds particularly for heavy commercial vehicles. The length of downgrade into the tunnels with gradients greater than 3% has also been reduced by almost half from 1200m for the Reference Design to 650m for the Changed Project with an associated potential for improved vehicle safety on tunnel entry.

Tollroad Control Centre (TCC)

The Reference Design proposed that the TCC be located adjacent to the Centenary Motorway within the rehabilitated worksite area. The TCC for the Changed Project would be located at the corner of Richer Street and Mt Coot-tha Road adjacent to the existing Botanic Gardens overflow car park (refer **Figure 2-33 to Figure 2-36**). The Reference Design proposed site would have impacted on the Botanic Gardens, whereas the Changed Project location would avoid further above ground infrastructure and

traffic within this significant public area.. The DTMR has raised concerns about unrestricted access from the Centenary Motorway which would then have required public road access through the Botanic Gardens.

Ventilation Station and Outlet

The ventilation station for the Changed Project would be buried next to the supporting surface infrastructure (eg sub-station, groundwater treatment, water storage). The supporting surface infrastructure would be above ground but constructed in a cutting in a similar location to that identified in the Reference Design and it would be infrequently serviced by left-in, left-out access from the Centenary Motorway. DTMR will be further consulted during the detailed design for this infrequent access.

The ventilation outlet is proposed to be situated above the western end of the buried ventilation station about 43m to the west of the site proposed in the Reference Design. The ventilation outlet would be at least 20m high and reach an elevation of at least 67m (AHD), consistent and complying with the Coordinator-General's conditions. There would be no change to the minimum height of the ventilation outlet.

The architectural treatment of the ventilation outlet for the Changed Project would ensure its assimilation into the landscape of the Botanic Gardens and the rising terrain to the west, towards Mt Coot-tha. The roof of the ventilation station would be landscaped to provide a functional pedestrian connection across the structure between the existing Gardens and areas to be rehabilitated and reinstated as Gardens space.

Property requirement

No private properties would be required for the Changed Project's surface works at the western connection, consistent with the Reference Design. Two additional State-owned properties would be required. One is at the far western end of the Centenary Motorway and the other is the site required for the proposed Tollroad Control Centre. There would be an additional parcel of freehold land owned by the Council, adjacent to the State land at the far western end shown in **Table 2-5** below.

Table 2-5: Western surface property access requirements

	Western Surface	
	Reference Design	Changed Project
Private	NIL	NIL
State	1	3
Council	4	5

2.3.2 Delivery Changes – Western Connection

The Changed Project provides a further refinement of the method proposed in the Reference Design for the western worksite as shown on the stage 1 layout (**Figure 2-40**)and the stage 2 and 3 layout (**Figure 2-41**).

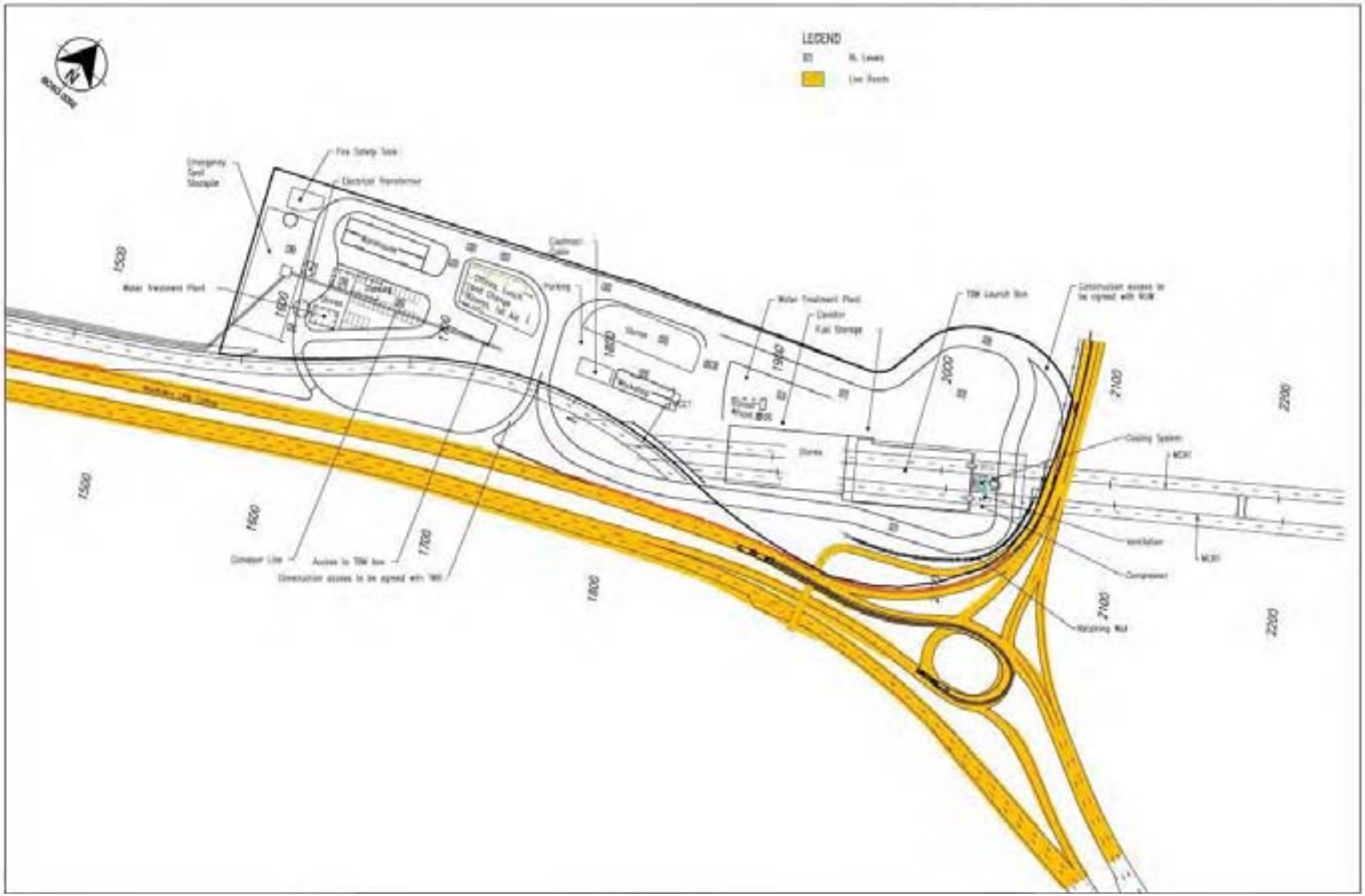

Figure 2-40: Western worksite – Stage 1 layout

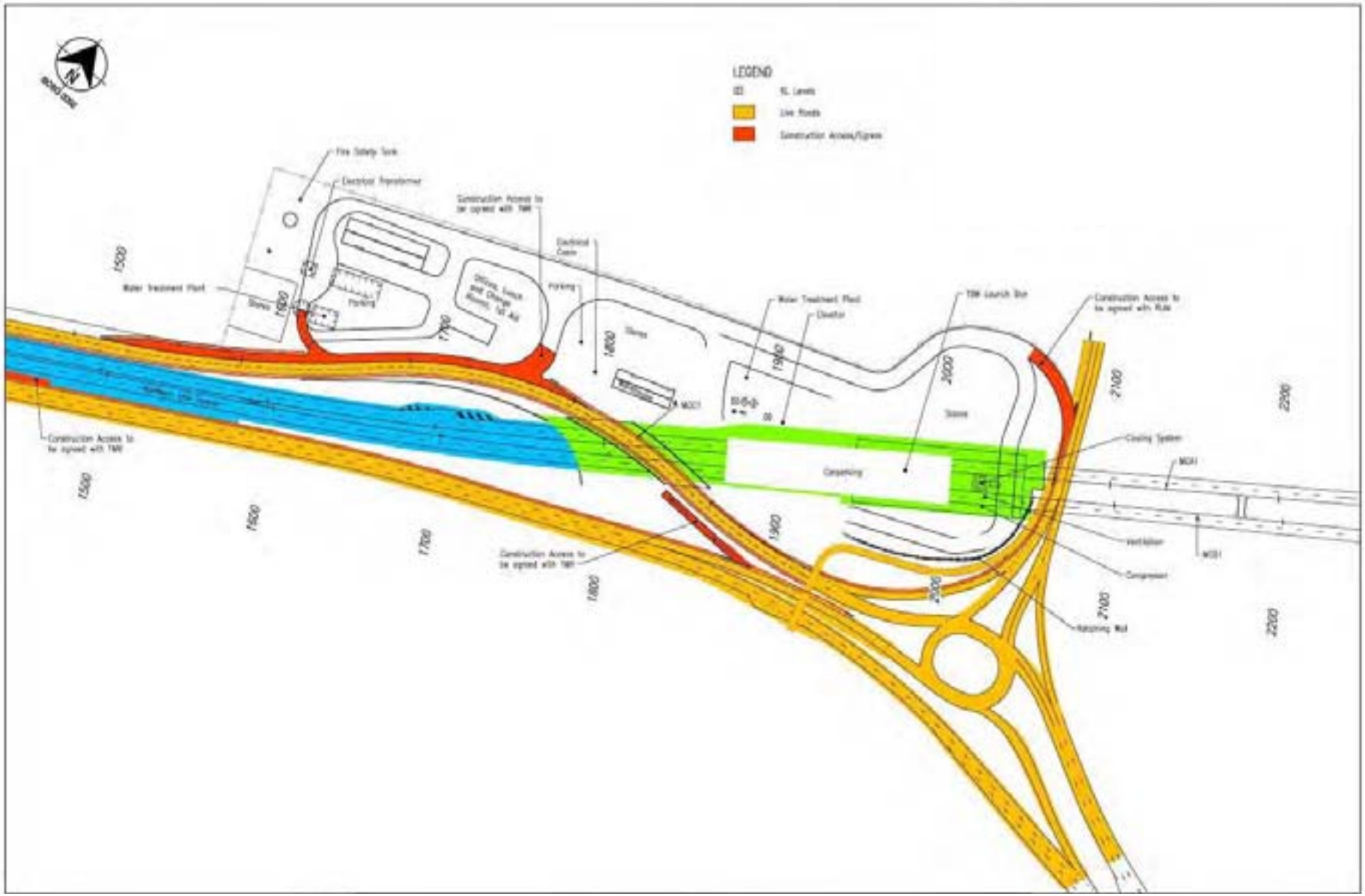

Figure 2-41: Western worksite – Stage 2 & 3 layout

Delivery Mode – Reference Design

The Reference Design western worksite would be located on Council owned land on the northern side of the Centenary Motorway, adjacent to the Mt Coot-tha Botanic Gardens. The worksite would be used primarily for the launch and operation of the TBMs and would be approximately 4 hectares in area.

An enclosed, acoustic-lined shed approximately 110m long by 40m wide would sit over and to the west of the tunnel entry portal. This work shed would mitigate the anticipated effects of the removal and handling of spoil from the TBMs to the external conveyor to the Mt Coot-tha Quarry.

The spoil from the southern (westbound) tunnel would be re- routed through an enlarged cross passage to the northern (eastbound) tunnel and then to the shed at the entry portal. The worksite also would provide access to and from the adjacent Centenary Motorway. Other more general aspects of the worksite included some car parking, site offices, general plant, storage, and water and flood protection.

The worksite did not include construction areas required for the cut and cover tunnels and the associated cross passages through areas of Anzac Park, the pedestrian and cycle bridge, the Centenary Motorway, the roundabout and through Mt Coot-tha Road.

The Reference Project identified that to avoid workforce parking on local streets, project parking areas would be established either in the overflow car park across Mt Coot-tha Road from the entrance to the Mt Coot-tha Botanic Gardens or in areas along Sir Samuel Griffith Drive between Mt Coot-tha Road and Simpsons Road. Shuttle buses would be provided to transport workers between the parking areas and the worksites.

The Coordinator-General specified in the imposed conditions of approval for the Project (18j) that:

- The construction workforce must not park in local streets
- A dedicated and adequate construction workforce off-street parking area must be provided
- All construction workforce vehicles must be directed to project construction workforce car parks
- To avoid construction workforce car parking in local streets, shuttle transport between construction workforce car parks distant from a construction area must be provided for the duration of the period the construction area is in use

Delivery Mode – Changed Project

The Changed Project worksite would be in the same location but larger than that proposed for the Reference Design. The proposed worksite would now include an additional area to the east allowing for both areas of the cut and cover tunnel construction up to the western edge of Mt Coot-tha Road. The site extension is approximately 2.1 hectares and is also Council owned land. This additional area was identified in the Reference Design as the area required for the future water storage required by the Botanic Gardens.

The enlarged worksite for the Changed Project would include the future water storage and landscape feature as well as areas for constructing and launching of the TBMs, areas for the storage and handling of the precast tunnel segments and a grout batching plant.

The western and northern boundary, along the existing fence line, remains the same as the Reference Design.

Each of the TBMs would be assembled in the excavated cut and cover tunnel and transition areas during surface working hours (6.30am – 6.30pm Monday to Saturday) only.

After assembly of the main component of each TBM, an acoustic-lined workshed would be erected over and beside the TBM launch-box to facilitate the continuous underground operations by mitigating the potential noise and light impacts of segment handling and general TBM operations. The segments would be stored, pending installation, inside the shed. The pre-cast tunnel segments would be lifted by a gantry crane onto special vehicles for transport to the TBM. They would be used to line the tunnels immediately after excavation by the TBM. The Changed Project would require approximately 4,300 rings for the tunnel lining.

An enclosed conveyor from the tunnel portal (operating on a continuous basis) will transport spoil to an acoustically-lined spoil handling shed located at the western end of the site, from which the spoil material will be further transported by enclosed conveyor to the Mt Coot-tha Quarry.

The tunnel spoil material will arrive at the quarry at an approximate elevation of RL 94m and will be deposited into the designated quarry stockpile area.

The conveyor and transfer stations would be designed and operated to not affect the continued operation of the quarry and the delivery of spoil into the quarry would be managed to mitigate any adverse impacts in accordance with conditions as set out by the Coordinator-General, including:

- the environmental objectives and the performance criteria for noise (Schedule 3, condition 22 Table 10 of the Coordinator-General's conditions)*;* and
- the environmental objectives and the performance criteria for air quality (Schedule 3, condition 20 of the Coordinator-General's conditions).

The spreading and compaction of the spoil material within the designated quarry stockpile area will be carried out during regular quarry operating hours (7am – 5pm Monday to Friday), in accordance with the existing quarry development permit.

Temporary access to the worksite would be from the Centenary Motorway generally as proposed in the Reference Design. A further temporary entry and exit for lighter construction vehicles requiring on-site parking and access to site offices is proposed for the Changed Project in the north-east corner of the site to and from Mt Coot-tha Road.

The Changed Project generally would comply with the Coordinator-General's conditions with regards to workforce car parking. The Changed Project would provide an additional dedicated temporary off-street construction workforce parking area for up to 300 vehicles within Anzac Park, with connection via the pedestrian/cycle bridge over the Centenary Motorway.

2.4 Eastern Connection

2.4.1 Design Changes – Eastern Connection

Tunnel Portals

With the Changed Project, the eastern connections would be located centrally in the ICB corridor, with the ICB through lanes being realigned to the outside of the project ramps. This would be a similar approach to that taken for the western connection, with the eastbound lanes of the ICB being realigned to the north and outside the central NLRT project entry and exit portals.

Consequently, the entry and exit portals for the Changed Project would be relocated to the north, with the ICB east-bound lanes realigned to pass over and to the outside of the project connections. The portals would be situated close together within an extended landscaped median, in the centre of the ICB between

Victoria Park Road and the Inner Northern Busway (INB). These arrangements would reduce the length of cut and cover works along the westbound lanes of the ICB and would improve traffic management during the construction of the ICB connection.

The portal for the eastbound driven tunnel would be approximately 60m east of the Reference Design position and the cut and cover portal would be approximately 100m further east to a position some 20m west of the INB. Overall the cut and cover tunnel for the eastbound connection would increase by approximately 40m over the Reference Design in order to accommodate the realignment of the outbound lanes of the ICB.

The ICB eastbound lanes would be realigned up to approximately 30m to the north, requiring further land, approximately 1,000m^2 in addition to the 3,000m^2 required by the Reference Design, within the BGS playing fields area. A new bridge span is proposed on the northern side of the existing INB bridge and also for the existing pedestrian bridge, to allow for the northern re-alignment of the ICB to pass below both structures. The traffic management of the ICB eastbound would require one primary traffic switch over the cut and cover section of the central portals south of Normanby Terrace.

The westbound entry portal would be approximately 300m further west and the driven tunnel section would commence approximately 30m further east. The total length of cut and cover section proposed in the Reference Design would be reduced by approximately 330m and would be situated mostly to the west of the Brisbane Girls Grammar School. The westbound ICB lanes would no longer be required for construction of the cut and cover section of the Reference Design, removing the potential for construction under inbound city traffic flows.

ICB surface connection

The connections for the Changed Project would both be located in the centre of the realigned ICB whereas with the Reference Design, only the westbound entrance ramp was situated in the centre of the ICB.

For the Reference Design, the eastbound merge length was approximately 375m to a point some 50m west of the existing landbridge. In comparison, the merge length for the Changed Project would be some 410m which extends the merge to the landbridge.

The Changed Project would continue to give priority to the ICB westbound traffic lanes however the diverge into the tunnel would occur further to the west, with the tunnel portal located in line with Victoria Park Road. With the extensive cut and cover tunnel for the Reference Design, the westbound diverge length was restricted to some 90m. In comparison, the diverge length into the relocated tunnel portal for the Changed Project would be approximately 240m.

The realigned eastbound lanes of the ICB would provide controlled maintenance access to the project's eastern ventilation station which like the Reference Design is located on the eastern side of the INB.

The vertical alignment or gradient of the tunnels and transitions to the surface have also changed, marginally improving exit speeds, particularly for heavy commercial vehicles and with the associated potential for improved vehicle safety on tunnel entry.

Supporting Infrastructure

The eastern ventilation station would be cut into the side of the hill in the general location of the Reference Design with the ventilation outlet located as identified in the Reference Design and controlled access to and from the eastbound ICB.

Property requirement

The Changed Project will require a larger area of the playing fields occupied by the Brisbane Grammar School. No acquisition of private property on the surface would be required for the Changed Project's surface works consistent with the Reference Design.

Access would be required to two additional State owned properties during construction. One is north of the playing fields where access is required to relocate the pedestrian path around the north of the construction sites as shown on **Figure 2-46**. Access to additional State land also would be required for the INB construction works where this was not proposed in the Reference Design.

There would be two fewer lots of Council owned properties required as the two previously acquired from the Brisbane Grammar School for the ICB are now counted as one and the lots below Normanby Terrace were previously counted as two lots and are now counted as one land holding owned by Council. Overall changes to land access requirements for the eastern surface works are shown in **Table 2-6** below.

Table 2-6: Eastern surface property access requirements

	Eastern Surface	
	Reference Design	Changed Project
Private*	NIL	NIL
State	4	6
Council	4	2

* Does not include Brisbane Grammar School playing fields – see discussion above

2.4.2 Delivery Changes – Eastern Connection

The eastern worksites required for the Changed Project are substantially the same as those required for the Reference Project. The worksites for the Changed Project include:

- the widened cut and cover areas between the ICB and Normanby Terrace to extract the TBMs as proposed in the Reference Design;
- road and drainage construction within the southern area of the Brisbane Grammar School playing fields;
- excavation through the northern abutment of the INB overpass; and
- a construction worksite east of the INB for the tunnel ventilation station and associated works.

As with the Reference Design, tunnel construction works at the ICB would involve road reconfiguration. The TBMs would be disassembled and removed within the cut and cover tunnel sections north of the ICB following completion of the tunnel drives from the western worksite in Toowong.

The Changed Project would require a construction area on the northern side of the ICB whereas the Reference Design proposed that all work be undertaken within the cut and cover and transition ramps for the project connections. The proposed realignment of the ICB eastbound lanes on the northern side of

the ICB, through a new widened section of the Inner Northern Busway overpass, would allow the ICB connections to be constructed without affecting the westbound ICB lanes.

The extent of the westbound cut and cover tunnel construction is significantly shortened by some 300m. Consequently, only one traffic movement switch is required for the eastbound ICB lanes following completion of the off-line realignment of the ICB to the north, on the outside of the tunnel connection.

The Changed Project worksites would include the following:

- the TBM portal and cut and cover area below Normanby Terrace required to extract the TBMs as proposed in the Reference Design (**Figure 2-44**);
- an enlarged area of the Brisbane Grammar School playing fields required to realign Victoria Park Road over the completed cut and cover works, realign the ICB eastbound lanes and also realign the major drainage channel north of the ICB (**Figure 2-42** and **Figure 2-43**);
- the construction through the northern abutment of the INB to provide the additional bridge span for the realigned ICB lanes, drainage and final shared path alignment (**Figure 2-42** and **Figure 2-43**)
- as with the Reference Design, the area to the east of the INB required for the construction of the ventilation station and associated infrastructure; and
- as with the Reference Design, an area in Victoria Park required for site facilities including construction car parking, offices and utility areas (**Figure 2-42** and **Figure 2-43**)

The Changed Project also identifies the temporary realignment routes and tie-ins for the shared pedestrian and cycle paths around and through the construction area. As identified in the Reference Design the existing footbridge across the ICB to the Brisbane Girls Grammar School would be retained although the Changed Project will need to extend the footbridge over the realigned ICB lanes and tie into the realigned footpath around the northern side of the construction areas (**Figure 2-45** and **Figure 2-46**)

In terms of construction workforce parking, the Reference Project would provide dedicated temporary construction workforce parking facilities at the eastern end of Victoria Park between Gilchrist Avenue and the ICB. The Changed Project would provide temporary construction car parking in an area between Gilchrist Avenue and the ICB as identified in the Reference Project and an additional area for temporary off-street car parking spaces within the construction area accessed from Victoria Park Road and the ICB.

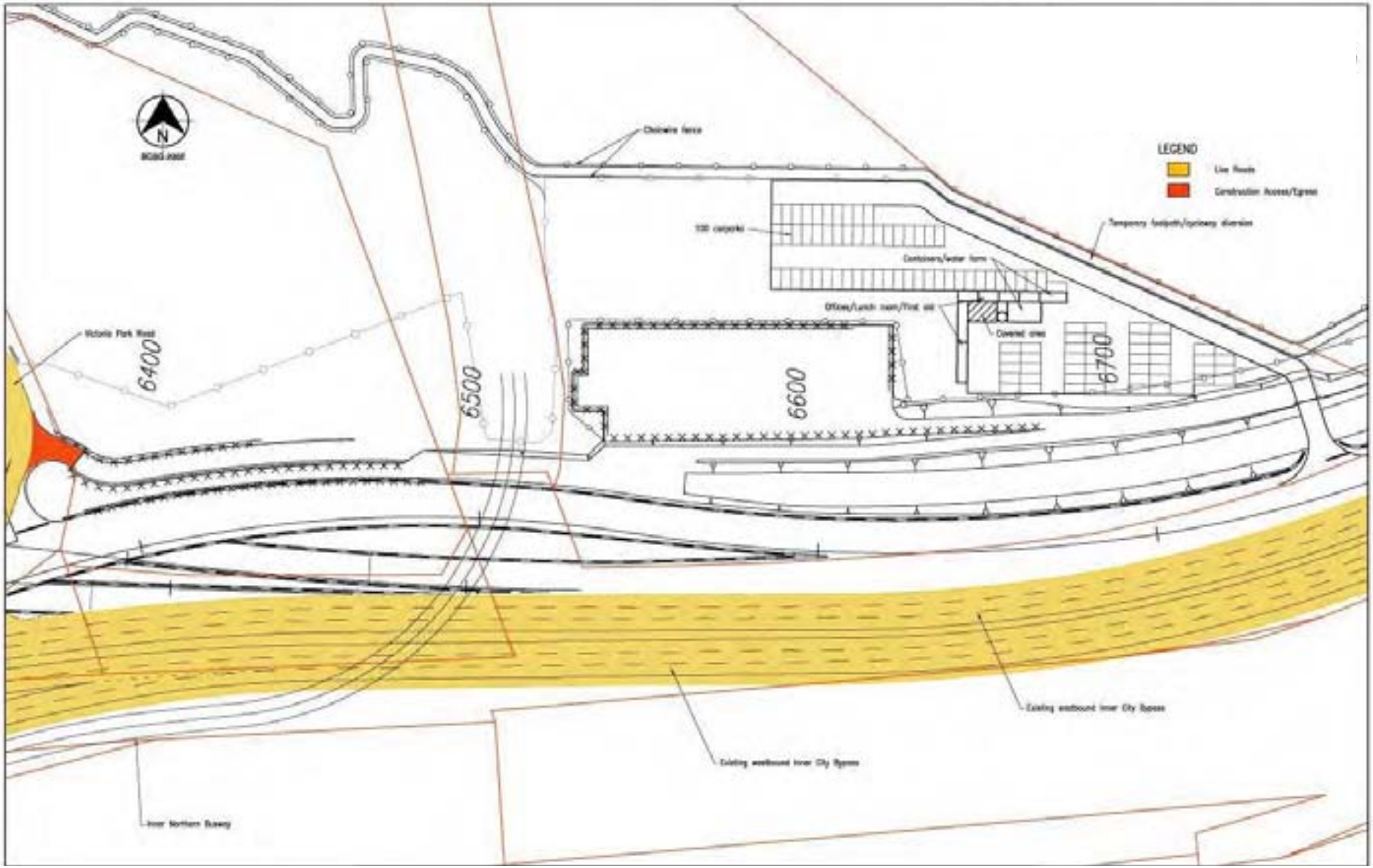

Figure 2-42: Eastern worksite – Stage 1, 2 & 3 layout

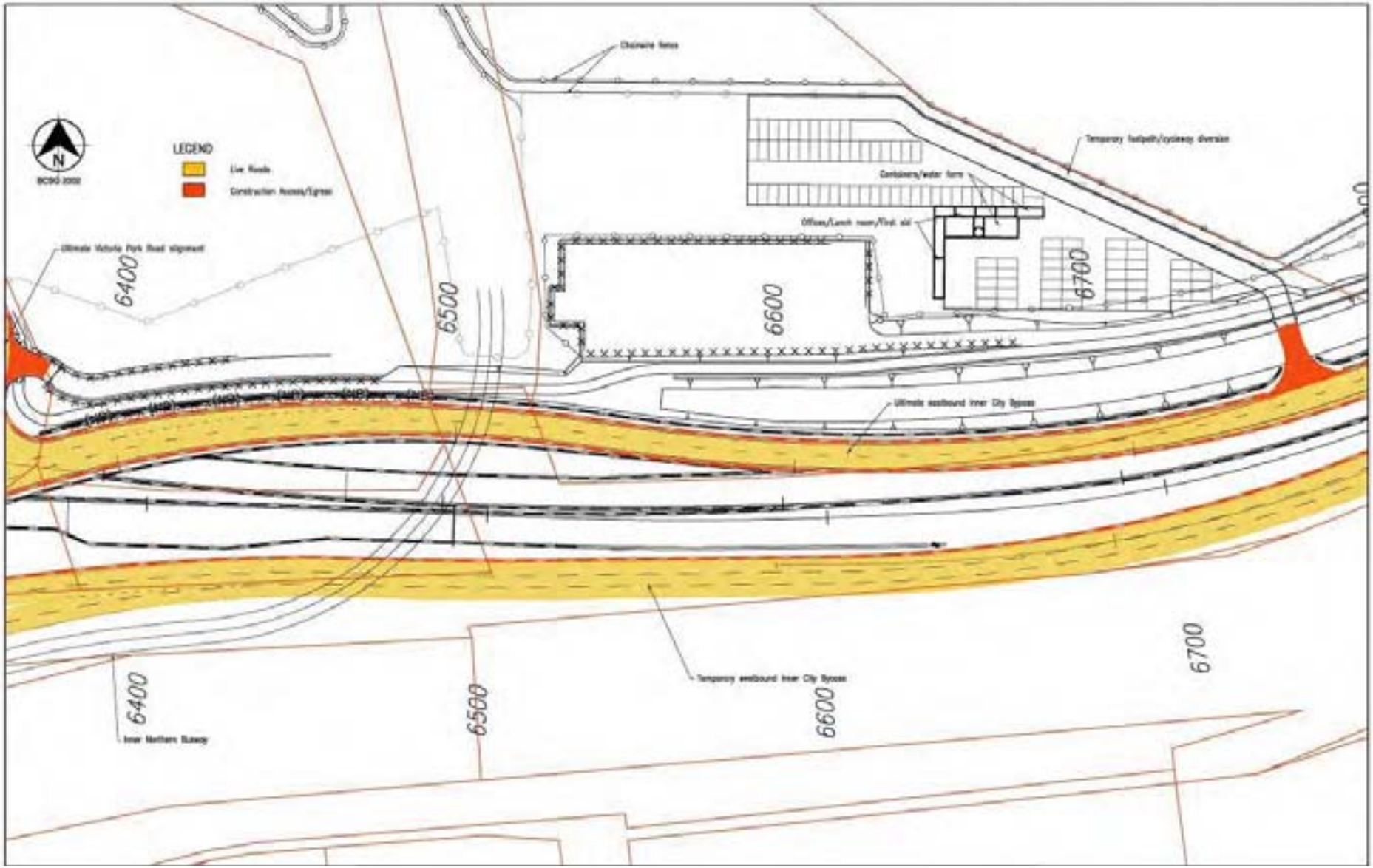

Figure 2-43: Eastern worksite – Stage 4 layout

Figure 2-44: Construction Sequencing – TBM Extraction Site

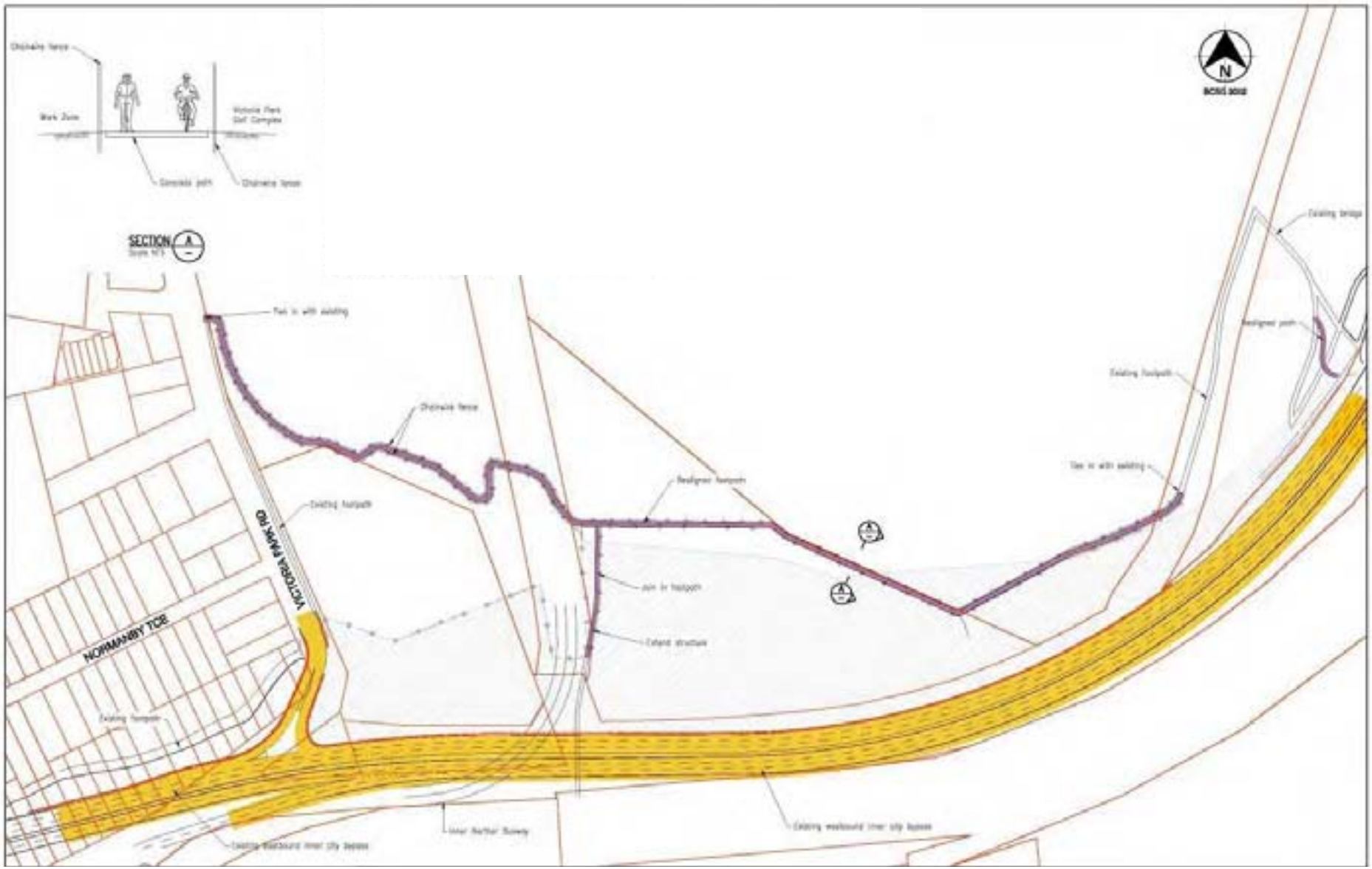

Figure 2-45: Pedestrian & Cyclist Provisions Stage 1 – Eastern Connection

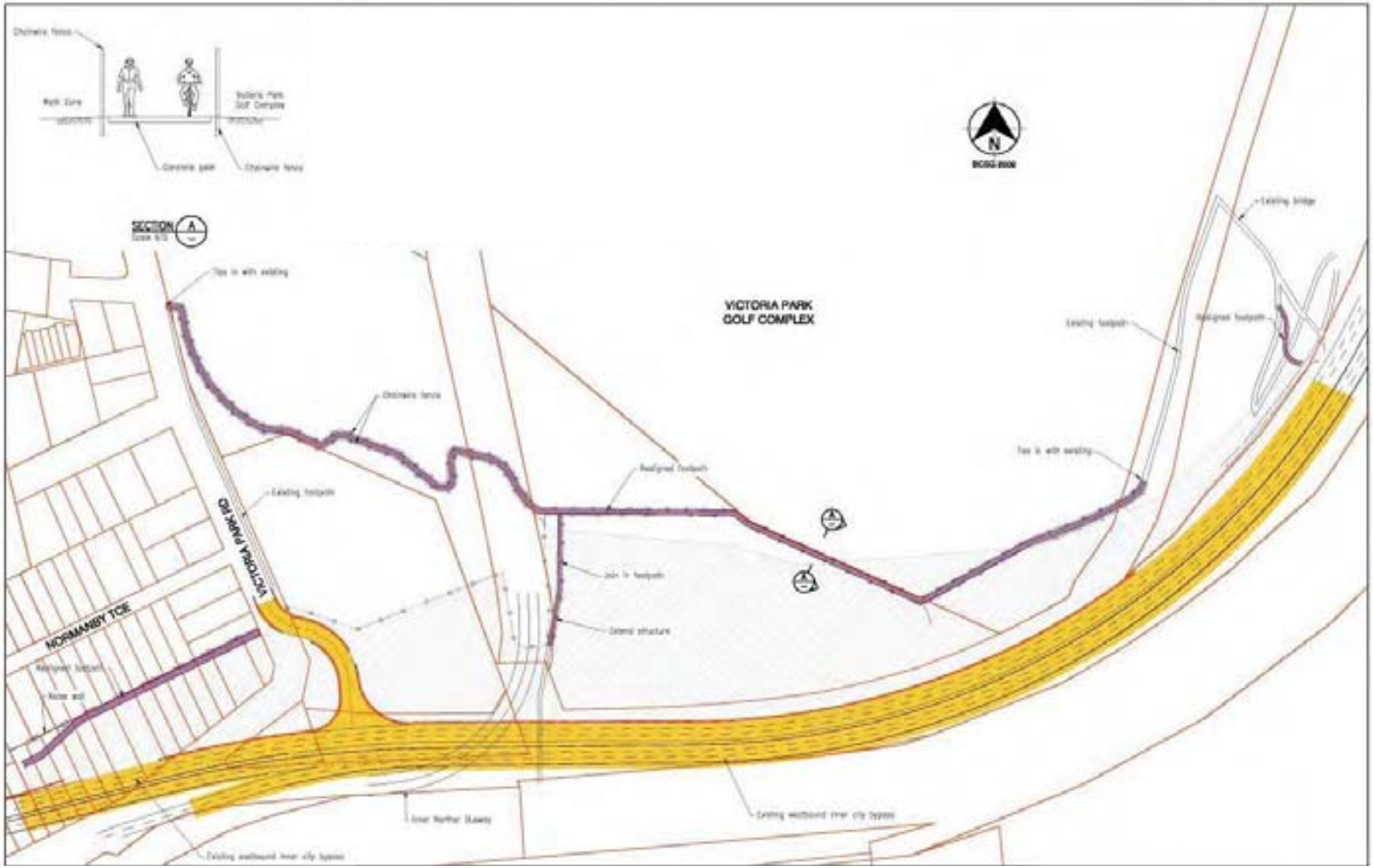

Figure 2-46: Pedestrian & Cyclist Provisions Stage 2, 3 & 4 – Eastern Connection

2.5 Spoil handling, haulage and placement

The Changed Project proposes some changes in regards to spoil haulage arrangements compared to the Reference Design. These changes include:

- minor increase (less than 1%) to spoil volumes (summarised in **Table 2-7**) and changes to placement areas from both western worksites and eastern worksites;
- changed location of the proposed western spoil handling shed and its use for both conveyor transfer and truck haulage access;
- changes to the alignment of the spoil conveyor from the western worksite to the Mt Coot-tha quarry. The conveyor alignment for the Changed Project would exit the western worksite and follow an alignment along the earthworks for the widening of the Centenary Motorway for approximately 630m. At this point the conveyor alignment would proceed towards the quarry around the western side of the Botanic Gardens as shown on **Figure 2-47**; and
- changes to the management and use of spoil placed within the Mt Coot-tha quarry.

The estimated quantities of spoil to be removed from the Changed Project from both the tunnel construction, including the cut and cover tunnels, and the surface works are generally consistent with the estimates provided for the Reference Design, however some additional truck movements will be required. These estimates are provided in **Table 2-7** along with estimated truck haulage requirements and durations.

Table 2-7: Total spoil quantity estimates and haulage requirements

Worksites and Construction Areas	Conveyor to Mt Coot-tha Quarry (Bank m3)		Truck Haulage West (Bank m3)			Truck Haulage East (Bank m3)		Total Estimate Spoil Quantity and Truck Haulage Movements (Bank m3)	
	Ref Design (TBM)	Changed Project (TBM)	Ref Design	Changed Project	Changed Project (TBM)	Ref Design	Changed Project	Ref Design	Changed Project
Western and Centenary Motorway	973,000[1]	932,000[1]	265,000	151,300[2]	151,700[3]	NIL	NIL	1,238,000	1,235,000
Eastern and ICB	NIL	NIL	NIL	NIL	NIL	25,000	40,500	25,000	40,500
Total Spoil	**973,000**	**932,000[1]**	**265,000**	**303,000**		**25,000**	**40,500[4]**	**1,263,000**	**1,275,500**
Truck Haulage Movements	NIL	NIL	20,400	11,600[2]	11,700[3]	2000	3100	**22,400**	**26,400**
Duration of Works (months)	14	12	14	12	14	23	15		
Average No of Truck Loads per day	NIL	NIL	58	37	50	3	8		
Average No of truck loads per hour[5]	NIL	NIL	6	4	5	0.3	0.8		

Table Notes

1. Spoil from the TBMs via conveyor to the Western Worksite Spoil Handling Shed and then by conveyor into the quarry.
2. Lower due to Changed Project not having the deep transition cuts and extensive cut and cover of the Reference Design

3. Excess spoil from the driven TBM tunnel construction would be handled within the acoustic shed at the western end of the site and hauled out along the approved routes between the hours stipulated in the Coordinator-General's conditions Schedule 3 condition 16 and between 6.30am Monday to 6:30 pm Saturday with allowances to avoid peak hours.

4. Includes spoil estimates associated with the buried vent outlet duct and the partial burial of the ventilation station not accounted for in the Reference Design.

5. Normal truck haulage (Surface Works) is based on standard construction hours (6.30am to 6.30 pm Monday to Saturday).

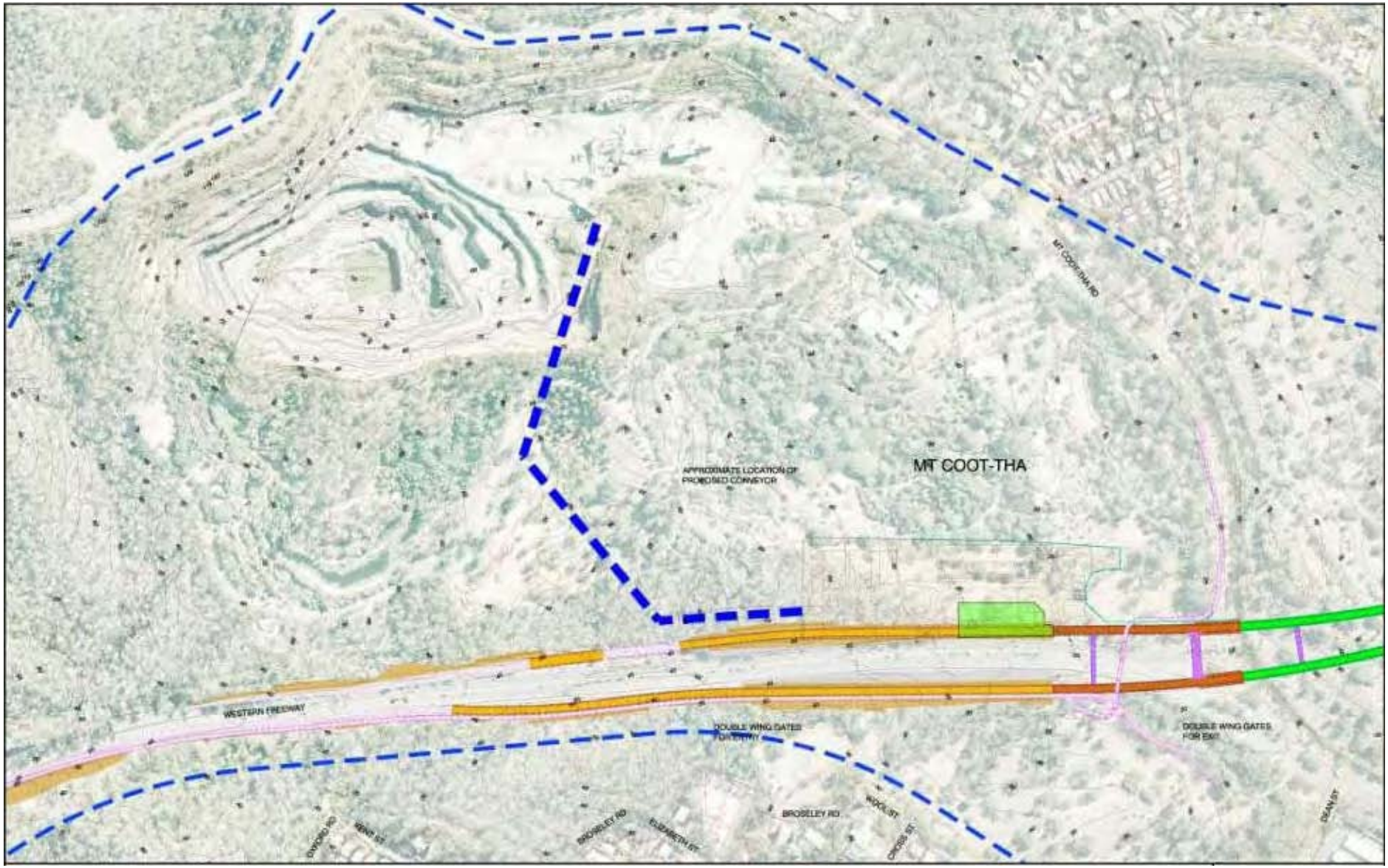

Figure 2-47: Reference Design - Spoil conveyor route

Figure 2-48: Change Project – Spoil conveyor route and stockpile design

Overall, the Changed Project would produce an additional approximately 12,500 bank cubic metres (bcm) of spoil material. This is made up from,

- marginally less spoil material (41,000 bcm) being conveyed into the quarry than from the Reference Project,
- marginally more spoil material (38,000 bcm) being hauled by trucks to the western spoil placement site,
- more spoil from the eastern worksite (15,500 bcm) being hauled by trucks to the eastern spoil placement site

The TBM material for the Changed Project which cannot be accommodated within the quarry placement area (approximately 10% of the tunnel spoil or 151,700 bcm) will need to be trucked to the western spoil placement area. This task would require approximately 11,700 truck movements.

Under normal operations the excess tunnel spoil material will be progressively transported off site west along the Centenary Motorway to the spoil site. Should the spoil conveyor be out of operation and the stockpile facility start to reach capacity, all the tunnel spoil would need to be removed by road transport. Approximately 450 truck loads per day at an approximate average rate of 35 trucks per hour would be required to take the material to the western spoil placement site in these circumstances.

There is an estimated reduction of spoil of some 115,000bcm from the western cut and cover, transition structures and surface works due largely to the shallower transition structures within the Centenary Motorway. There is an additional 15,000bcm from the eastern worksites from the additional cuttings required for the realignment of the ICB and the ventilation station and outlet tunnel.

The conveyor route to the quarry has changed as shown on **Figure 2-48**. The length of the conveyor for the Changed Project would be approximately 1,500m or approximately 500m longer than that for the Reference Design. The first 630m of the conveyor alignment from the workshed would be within the earthworks required for the future third lane on the realigned Centenary Motorway. This land is required for the future road widening by DTMR and would be returned as landscaped and stabilised road earthworks. Approximately 550m of the conveyor alignment would pass between the Centenary Motorway through the Mt Coot-tha Forest along the western boundary of the Botanic Gardens, to the quarry. For the Reference Project , this alignment was initially through Council owned land within the Botanic Gardens and then also through State owned land identified as the Mt Coot-tha Forest, but used for the Botanic Gardens and also the Mt Coot-tha Quarry. The proposed alignment was amended by Council to specifically avoid the public areas and established plantings within the Gardens.

The preferred placement sites have changed from Swanbank in the west to an approved landfill site at Rudd Street, Oxley and from Port of Brisbane in the east to future Australia Trade Coast development land at Pinkenba. Other suitable locations may be identified during the course of the project and would be subject to complying with the Coordinator-General's conditions (refer Schedule 3, Condition 16).

The road haulage of all spoil from the western worksite and associated construction areas would be on an approved route to the west using the Centenary Motorway and then the Ipswich Motorway to Oxley. The road haulage of all spoil from the eastern worksite and associated construction areas would be on an approved route to the east using the ICB and Kingsford Smith Drive to Pinkenba. All surface spoil from surface and cut and cover excavations for the Changed Project will be handled between the hours of 6:30am to 6:30pm, Monday to Saturday. Excess spoil from the driven tunnel construction would be handled within the acoustic shed at the western end of the site and hauled out along the approved routes between the hours stipulated in the Coordinator-General's conditions (refer Schedule 3, condition 16).

Placement of spoil within the Mt Coot-tha Quarry would also change. It is no longer proposed to use the material from the TBM to replace the further extraction of material at the quarry for the duration of the project as identified in the Reference Design as reported in the Coordinator-General's Report. For the Changed project, there would be no processing of the TBM spoil through the existing quarry facility and there would be no transport of spoil generated by the Changed Project from the quarry. Spoil from the Changed Project to the quarry would be placed within an identified area of the quarry no longer required as a source of quarrying material. The proposed placement would be part of the future rehabilitation of the quarry and would off-set future transport of material that would be required for back-filling and quarry rehabilitation.

The Mt Coot-tha Quarry will continue to operate under the existing Development Permit issued by DERM. The conveyor transporting spoil material into the quarry will operate on a continuous basis while the spreading and compacting of the tunnel spoil material within the quarry will be carried out under the existing quarry operating hours of Monday to Friday 7am to 5pm. This use of the conveyor and the quarry will avoid impacts on the adjacent road network. If this method of spoil disposal was not available all tunnel spoil would have to be hauled off site west along the Centenary Motorway to Oxley or another approved spoil location. This would require traffic movements of up to 35 trucks per hour 6.30am Monday to 6.30pm Saturday, which would require changes to the existing Coordinator-General's conditions in regards to allowable truck types and frequency of use.

3 Project Changes to Main Alignment

3.1 Changes to Design – Main Alignment

The principal change to the Reference Design is the proposed realignment of the main tunnels between the connections with the Centenary Motorway and the ICB. The main tunnel alignments would be straighter and shallower to create a more direct, safer and more efficient motorway-standard link between the Centenary Motorway and the ICB. These changed alignments are shown in **Figure 2-1** and **Figure 2-2**.

The horizontal alignment would be up to 60m north of where the Reference Design alignment would be at the eastern edge of the Botanic Gardens. The changed alignment would be approximately 100m north of the Reference Design alignment through the Toowong Cemetery and would converge with the Reference Design alignment just to the east of Frederick Street, between Thorpe and Sleath Street, Auchenflower. Further on, the changed alignment would then pass south of the Reference Design alignment by approximately 300m in the vicinity of Gregory Park at Baroona Road. The main tunnels would emerge to the south of Normanby Terrace and Victoria Park Road, as would the Reference Design.

The vertical alignment of the Changed Project generally would be shallower than the Reference Design alignment, particularly in the western section beneath the cemetery and areas of Auchenflower. However, the alignment is deeper than the Reference Design alignment on the eastern side of Paddington and Red Hill.

3.2 Changes to Delivery – Main Alignment

The excavation of the two mainline tunnels by tunnel boring machines (TBMs) is, consistent with the approach proposed for the Reference Design. For both the Reference Project and the Changed Project, the TBMs would be launched from the main worksite, in the west and adjacent to the Mt Coot-tha Botanic Gardens. Similarly, the TBMs would be removed at the Normanby Terrace cut and cover section with both the Reference Design and the Changed Project.

The Reference Project proposed a drained tunnel construction by TBMs with in-situ concrete lining installed. Unlike the Reference Design approach, the Changed Project proposes to waterproof the main tunnels with installation of continuous, segmented, pre-cast concrete rings with associated grouting behind the segments. The excavated diameter of each of the main tunnels would increase from a nominal 12m with the Reference Design to 12.4m diameter for the Change Project.

The cross passages would be constructed by a combination of mechanical excavation and selected drill and blast, following the construction of the main driven tunnels. The cross passages would remain drained with in-situ lining as proposed in the Reference Design. As with the Reference Design, the cross-passages would be constructed at approximately 120m intervals. There would be up to ten underground substations (4 in each driven tunnel and 1 at each end within the cut and cover tunnels) to support the Changed Project with final power supply arrangements to be determined during detailed design.

The Changed Project entails the delivery and handling of pre-cast concrete ring segments used to line the tunnels. Each complete tunnel ring would consist of nine pre-cast segments. These segments would be cast at an off-site facility and be transported to the western worksite by delivery vehicles over approximately 14 months. Each ring would require two truckloads of segments. Approximately 4,300 rings would be required for the tunnel linings, generating 8,600 return trips for their delivery.

The segments would be stored on the site and lifted by a gantry crane into the cut and cover trough for transportation to the head of the TBM.

3.3 Effects of Project Changes – Main Alignment

3.3.1 Traffic and Transport

The tunnel configuration for the Changed Project would be generally unchanged from the Reference Design, consisting of two separate, parallel road tunnels each with two lane carriageways and shoulders. The traffic flows through the Changed Project would be substantially the same as those estimated for the Reference Design.

The flatter vertical alignment of the Changed Project compared to the Reference Design offers improvements in traffic flow and safety. As a result of the reduced lengths of 5% maximum upgrade and the reduced climbing distances, traffic modelling indicates that heavy vehicle speeds could be maintained closer to the general traffic speed. This would reduce the demand for lane changing and consequential disruption to traffic flow, providing an improvement in safety and vehicle operating efficiency.

Compared to the Reference Design, the Changed Project has shorter distances of roadway with descending grades steeper than 3%, again reducing the demand for lane changing and assisting in the maintenance of vehicle speeds (due to less braking) with resulting safety benefits.

3.3.2 Geology and Soils

As with the Reference Design, the Changed Project would encounter a wide range of ground conditions during its construction. The following **Table 3-1** provides a comparison of the ground conditions that would be encountered by the Changed Design alignment and the Reference Design alignment, both horizontally and vertically.

Table 3-1: Comparison of Changed Project alignment versus Reference Design alignment

Reference Design	Changed Project	Comments
Mt Coot-tha Rd Tunnel alignment commenced at Mt Coot-tha Road, just to the north of the Mt Coot-tha Rd roundabout. Each mainline tunnel was horizontally separated approximately 60-70m to enable the proposed connections to the Centenary Motorway to occur.	**Mt Coot-tha Rd** Tunnel alignment commences further to the north up Mt Coot-tha Road. Mainline tunnels horizontally separated approximately 10m. Tunnels approximately 8m deep beneath Mt Coot-tha Rd.	**Mt Coot-tha Rd** Ground conditions are expected to consist of extremely weathered to distinctly weathered, very low to low strength material in the tunnel crown (roof), improving with depth to slightly weathered, high strength in the tunnel side walls and floor. Roadheader tunnels of this span and depth (cover to the crown of the tunnel) in these ground conditions with forward pre-support and immediate ground support have been undertaken throughout Brisbane previously with minimal impact on the existing surface infrastructure.
Toowong Cemetery Two mainline tunnels come closer together horizontally beneath the Toowong Cemetery, to be approximately 10-15m horizontally separated by Frederick St.	**Toowong Cemetery** Mainline tunnels remain horizontally separated by approximately 10m beneath the Toowong Cemetery, however tunnel alignment is further north compared with the Reference Design.	**Toowong Cemetery** Ground conditions are expected to consist of extremely weathered to distinctly weathered, very low to medium strength material in the tunnel crown (roof) in the shallow area, improving with depth to fresh, very high strength in the deeper areas of the tunnel alignment.

Reference Design	Changed Project	Comments
The vertical depth beneath the Toowong Cemetery varied between approximately 15m to 40m.	The vertical depth beneath the Toowong Cemetery varies between approximately 8m to 32m.	
Frederick St to Baroona Rd (Fernberg Road) Horizontal alignment remains to the north of the study corridor. Mainline tunnels remain horizontally separated by approximately 10m. Depth varies between approximately 24m to 68m. The depth (18m) beneath the alluvial channel in the Baroona/Fernberg Rd with tunnel expected to be located in slightly weathered to fresh, high strength rock at this location.	**Frederick St to Baroona Rd** Mainline tunnels remain horizontally separated by approximately 10m, however tunnel alignment is further south compared with the Reference Design. The vertical depth in this area varies between approximately 10m to 55m. 13m depth beneath the alluvial channel in Baroona Rd with tunnel expected to be located in slightly weathered to fresh, high strength rock at this location.	**Frederick St to Baroona Rd** The majority of this section is expected to be located within slightly weathered to fresh, high to very high strength rock, which is essentially the same as the Reference Design through this section, hence no additional requirement for TBM excavation and support. Whilst depth beneath the alluvial channel for the Changed Project is slightly less, the anticipated ground conditions above and within the tunnel area are expected to be similar, consisting of competent, high strength rock. The proposed TBM excavation and support will be able to appropriately excavate and support these ground conditions similar to that proposed in the Reference Design.
Baroona Rd to Plunkett St Horizontal alignment remains to the north of the study corridor (due to old EIS with ramps alignment as discussed above). Mainline tunnels remain horizontally separated by approximately 10m. Depth varies between 18m and 26m. 18m depth beneath Hayward St with tunnel expected to be located in slightly weathered to fresh, high to very high strength rock.	**Baroona Rd to Plunkett St** Mainline tunnels remain horizontally separated by approximately 10m, however tunnel alignment is further south compared with the Reference Design. Based on the regional geological maps, the Changed Project comes within 70-80m (in plan) of an alluvial channel near the southern end of Charlotte Street. Vertical depth varies between 12m and 45m. 12m depth beneath Charlotte St with tunnel expected to be located in slightly weathered, medium to high strength rock or better.	**Baroona Rd to Plunkett St** The majority of this section is expected to be located within slightly weathered to fresh, high to very high strength rock, which is essentially the same as the Reference Design geology through this section, hence no additional impact for TBM excavation and support. Whilst depth beneath Charlotte St for the Changed Project is slightly less (to improve operational efficiency of the tunnel), the anticipated ground conditions above and within the tunnel area are expected to be appropriate, consisting of competent, medium to high strength rock. The proposed TBM excavation and support will be able to excavate and support these ground conditions similar to that proposed in the Reference Design.
Plunkett St to Inner City Bypass Horizontal alignment heads southwards back towards to the Inner City Bypass. Mainline tunnels remain horizontally separated by approximately 10m. Depth varies between 11m and 52m. 11m depth at the driven tunnel portal with ground conditions expected to be distinctly weathered to	**Plunkett St to Inner City Bypass** Horizontal alignment remains south of Reference Design alignment until Musgrave Rd where the Changed Project horizontal alignment coincides with the Reference Design alignment up to the Inner City Bypass connection. Depth varies between 11m and 60m. 11m depth at the driven	**Plunkett St to Inner City Bypass** The majority of this section is expected to be located within slightly weathered to fresh, high to very high strength rock, which is essentially the same as the Reference Design geology through this section, hence no additional impact for the TBM excavation and support. Changed Project intercepts the possible Normanby Fault at approximately the same location as the Reference Design, thus no additional impact for the TBM excavation and support.

Reference Design	Changed Project	Comments
slightly weathered, medium to high strength rock.	tunnel portal with ground conditions expected to be distinctly weathered to slightly weathered, medium to high strength rock.	

The Changed Project would engage two TBMs for excavation and lining each of the tunnels between the surface connections. Pre-cast concrete segments would be erected in a ring within the TBM shield in the excavated tunnel to form both the temporary (immediate) and permanent support system. The completed ring would provide structural tunnel support, minimising impacts of ground movement surrounding each tunnel.

This approach to tunnel excavation and support would allow for a wide range of ground conditions from extremely weathered, low to very low strength rock, up to fresh (weathered), very high strength rock to be encountered with low risk, while mitigating impacts such as settlement and groundwater drawdown.

The Changed Project would undertake additional geotechnical investigation works along the Changed Project alignment, prior to the completion of the detailed design phase. These works will include the following:

- up to 30 geotechnical boreholes drilled to depths of up to 30m, to be positioned in areas where limited existing information is currently present in the geological/geotechnical models;
- in-situ pressuremeter and dilatometer testing in soils where direct measurement of at-rest earth pressure is relevant to the design (at the eastern and western approaches);
- piezocone (CPTu) penetration testing, for the purpose of providing more accurate data on strength and variability of the alluvial and residual soils; and
- seismic velocity surveys at the eastern and western approaches, for the purpose of providing validation of rippability estimates and rock surface profiles.

Settlement

Types of Settlement

Settlement resulting from tunnel excavation/construction activities may arise due to the following effects:

- Elastic ground settlements caused by the excavation of the tunnel.
- Consolidation settlements caused by groundwater drawdown into the tunnel.

As was the case with the EIS/Reference Design, the Changed Project will make an assessment of the settlement impacts from both of the above effects.

The elastic settlement assessment for the Reference Design was based on experience and judgement of similar large diameter TBMs in hard rock. As no large diameter TBMs had been excavated in Brisbane geology at the time of the Reference Design, key input parameter assumptions had to be made based on similar large diameter TBMs in similar hard rock conditions in order to estimate the Reference Design elastic settlement impacts.

Since the Reference Design, the CLEM7 tunnel has been excavated with two large diameter TBMs through Brisbane geology. Throughout the excavation and support of the CLEM7 tunnels, settlement monitoring at the surface above the excavating TBMs was undertaken. The NL project has used this

settlement monitoring data to better calibrate the key input parameter assumptions for the assessment of the elastic settlement induced impacts associated with excavating two large diameter TBMs. In order to compare the difference between the Reference Design and the Changed Project, the theory's used for estimating the elastic settlement in the Reference Design and the Changed Project have been the same, noting however that the key input assumptions have been modified based on the actual elastic settlement data obtained from CLEM7.

The estimates of elastic settlement at the surface for the Reference Design were generally less than 5mm for the majority of the Reference Design alignment. There were some isolated locations which were greater than this general 5mm settlement including in the vicinity of Mt Coot-tha Road, Toowong Cemetery and the Inner City Bypass

Estimates for elastic settlement at the surface for the Changed Project are comparable to those of the Reference Design, with less than 5mm predicted for the majority of the new alignment. As with the Reference Design, there are isolated areas with the potential for settlement greater than 5mm as for the Reference Design, however the magnitudes of these potential settlements are lower for the Changed Project.

3.3.3 Hydrology (groundwater)

The Changed Project would be constructed as an undrained or waterproof system of road tunnels into which the average rate of inflow for groundwater would be less than 3L/sec. This compares with the estimated inflow rate for the Reference Design of 4L/sec which was proposed as a drained tunnel system. Neither rate of flow is considered significant, such that both rates of inflow would be considered to be 'dry' tunnels.

The Coordinator-General's conditions pertaining to groundwater management remain relevant and appropriate for managing the potential effects of the Changed Project

As with the Reference Design, groundwater that was admitted to the Changed Project tunnels would be collected and treated if necessary to required standards before being released. Any required approvals will be obtained.

Settlement induced by groundwater drawdown for the Reference Design was assessed in the EIS and found generally to be of no consequence in terms of property effects and groundwater-dependent ecosystems. For example, settlement for properties above much of the tunnel alignment for the Reference Design was assessed to fall within the lowest range of 0 – 10mm. With a much lower inflow rate, the Changed Project would have even less effect on properties due to groundwater induced settlement. Further discussion on the settlement induced by groundwater drawdown (consolidation settlement) is discussed in section 3.3.2.

The Reference Design potentially would lead to the following groundwater impacts:

- drawdown effects over a 50 year period located in an area up to 800m from the driven tunnel;
- approximately 4L/s inflow;
- low risk of effect on existing bore users,
- low risk of settlement due to groundwater drawdown,
- low risk of saline water infiltration from the Brisbane River,
- negligible risk of encountering acid sulphate soils,

- potential risk of impacts to groundwater dependant ecosystems, however the risk is mitigated by the likely occurrence of clay between the alluvium and the fractured rock aquifer, and
- potential risk of contaminant movement from isolated (and as yet unknown) contaminated properties.

The proposed change in the horizontal alignment would move the NLRT towards Milton Road, and towards the Brisbane River. While there may be some hydrogeological connection with the Brisbane River with local aquifers in some locations along the changed alignment, the risk of groundwater entering the tunnels is very low due to the nature of their construction (ie segmental lining and grouting).

The shallower vertical alignment would also reduce the hydrogeological risks by reducing the zone of potential lateral groundwater drawdown.

The lined cut and cover tunnels at the western end are the same as the Reference Design and would restrict groundwater movement into the tunnel system. Similarly, the lined cut and cover tunnels at the eastern end of the Changed Project would limit groundwater inflow from the alluvium beds adjacent to Victoria Park Road.

The proposed changes in design would reduce the risk of groundwater inflow to the tunnels even further than predicted in the EIS/Supplementary Report in respect of the Reference Design.

Nevertheless, the Coordinator-General's requirement for a full detailed investigation to inform detailed design must be maintained to address potential risks arising from the movement of contaminated groundwater and groundwater-dependent ecosystems.

3.3.4 Air Quality and Greenhouse Gases

The air quality implications of the Changed Project design and operational features are the same as the Reference Design. As a result, the current Coordinator-General's conditions remain appropriate.

The tunnel ventilation system is similar to the Reference Design with a longitudinal air flow aided by jet fans in the ceiling and a ventilation station and outlet linked with the exit portal of each tunnel. The traffic flows through each of the main tunnels would be the same as forecast for the Reference Project, resulting in the same motor vehicle emissions passing through the ventilation system. The modelling presented in relation to air quality effects for the Reference Project remain relevant for the Changed Project.

The flatter vertical alignment of the Changed Project compared to the Reference Design would result in reduced climbing distances and a reduction in the length of 5% maximum climbing grade. As a result there would be improvements in traffic safety and reductions in motor vehicle emissions within the Changed Project tunnels compared with the Reference Design. These changes would result in some improvement to the air quality in each tunnel and the receiving environment (ambient air quality), and would also result in reduced greenhouse gas emissions. Greenhouse gas emissions must be calculated in accordance with the Coordinator-General's condition 2 of Schedule 3, Appendix 1.

3.3.5 Noise and Vibration

As a consequence of the change in the main tunnel alignment, there is the potential for noise and vibration impacts arising from construction activities to manifest in different locations to those notified during the EIS process for the Reference Design. However, the Coordinator-General's conditions for managing the noise and vibration effects of tunnel construction remain relevant and appropriate.

The design changes may give rise to noise and vibration impacts in different locations due to changes in the vertical and horizontal alignments for the driven tunnel (TBM) section. Compared with the Reference Design, the vertical alignment of the Changed Project is generally shallower as follows:

- the main tunnels would be less than 15 metres underground around parts of the Toowong Cemetery and east of Frederick Street, Toowong; and
- the main tunnels would be less than 20 metres underground near Charlotte Street, Paddington.

The potential impacts from the proposed design change would vary according to the depth of construction relative to the undulating terrain on the surface and include:

- regenerated noise; and
- vibration.

Construction Regenerated Noise

Whereas refined data for vibration has been collected from the CLEM7 project since preparation of the Northern Link EIS, no such refined data is available for regenerated noise for that project. Consequently, there has been no refinement of the regenerated noise predictions which may be lower based on the lower vibration levels experienced during the CLEM7 construction.

It will be important to collect data early on actual regenerated noise to guide further predictions and mitigation implementation.

The predictions for regenerated noise from tunnel construction take into account the following factors:

- the slant distance between the tunnel crown and a sensitive location for each individual property;
- the ground elevation at each property derived from the existing topography digital terrain model; and
- the source emission data.

The currently predicted regenerated noise for tunnel construction for the whole of the Changed Project, relative to the Reference Design and the environmental objectives adopted in the Coordinator-General's evaluation, is presented in **Table 3-2**. These predictions will be further refined during detailed design.

Table 3-2: Changed Project - Regenerated Noise Predictions

Predicted Regenerated Noise Level (Leq) greater than the night time regenerated noise objectives (35(dB(A))	Number of Potentially Affected Properties		
	Reference Design	Changed Project	Additional to the Reference Design
>40 dBA	208	270	62
35 - 40 dBA	226	253	27
Total	434	523	89

The shallower tunnel alignment of the Changed Project may result in more properties being exposed to regenerated noise levels than would be for the Reference Design. Current modelling suggests that there could be an additional 89 properties that exceed the night-time regenerated noise objective of 35 dBA Leq during the night (10pm to 6:30am). These predictions will be refined during detailed design and as a result of monitoring during construction. These properties would be in addition to the 434 residences identified in the Supplementary Report. There are approximately 11,500 residential properties within the study corridor for the NLRT project.

Based on a planned progress rate of 100m/week for the TBM, current modelling indicates that some residential properties close to the tunnel alignment may experience noise levels in excess of 35 dBA Leq for between 7 and 10 days during the excavation of each tunnel. Following the submissions received on the EIS about noise, the Coordinator-General conditions set out mitigations required. These conditions remain appropriate for the Changed Project.

Construction Vibration

The indicative ground vibration levels predicted for the Reference Design and reported in the EIS were based on the use of 12m diameter TBMs in hard rock, referenced against a comparable project, the Dublin Port Tunnel Project[5]. Since then TBMs of approximately 12m in diameter have been employed in Brisbane for the construction of the CLEM7 tunnel through hard rock. Useful and relevant data from construction of the CLEM7 project has been adopted as the more relevant local data for TBM vibration modelling and predictions.

Table 3-3 outlines Reference Design vibration source emission values and also more relevant CLEM7 emission values. These predictions will be further refined during detailed design.

Table 3-3: TBM Vibration Source Emission Data

Slant Distance from Source	EIS Predicted PPV (mm/s)[1]	CLEM7 Predicted PPV (mm/s) [2]	Difference (mm/s)
5 m	35	2.7	-32.3
10 m	10	1.6	-8.4
20 m	3	0.9	-2.1
30 m	1.5	0.7	-0.8
40 m	0.8	0.5	-0.3
50 m	0.5	0.4	-0.1

Table Notes

[1]. As reported in Table 27 of the Northern Link EIS Technical Report 9A Construction Noise and Vibration

[2]. Based on the data set of measured levels of the CLEM7 TBM

Table 3-3 shows that the CLEM7 vibration data is lower than the EIS data at all distances, particularly at shallow distances where the decrease in vibration emission is significant. It is noted that submissions to the EIS raised issues regarding vibration caused by roadwork near houses. The EIS vibration predictions were higher than for the Changed Project. With the revised vibration predictions below, and with implementation of the Coordinator-General's conditions, vibration impacts from the construction works are anticipated to be further reduced by the Changed Project.

Table 3-4 shows that the shallower tunnel alignment of the Changed Project is off-set by the lower vibration source data resulting in 161 fewer properties predicted to exceed the night-time guide for vibration levels for human comfort of 0.5mm/s.

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[3] Sound pressure is related to vibration velocity as 20 x log10(V), in the ground, vibration velocity varies with distance-1.5 as an approximation across a range of rock conditions. (The exponent can typically vary from -0.5 to -2.5) depending on the particular rock conditions.) Combining these, the sound pressure is related to distance as -30 x log10(distance).

Table 3-4: Changed Project – Vibration Predictions

Predicted Vibration Levels Greater than the Guide value for sleep disturbance (0.5mm/s)	Number of Affected Properties		
	Reference Design	Changed Project)	Additional to the Reference Design
> 10 mm/s	0	0	0
5 – 10 mm/s	0	0	0
2 – 5 mm/s	37	0	-37
1 - 2 mm/s	63	0	-63
0.5 - 1 mm/s	145	84	-61
Total	**245**	**84**	**-161**

Operational Noise and Vibration

No noise or vibration operational impacts with traffic travelling underground through the tunnels following the opening of the tunnels to road traffic are predicted for the change in tunnel alignment proposed for the Changed Project.

3.3.6 Planning and Land Use

While no additional privately-owned land would be acquired to accommodate the Changed Project for surface works, the proposed change in alignment of the main tunnels would affect different properties through the acquisition of volumetric title. As identified in **Table 2-4**, there would be approximately 334 properties affected by acquisition of a volumetric title for the tunnels and associated underground infrastructure. Of these, 269 would be newly affected, including 6 Council owned parcels, and a further 65 properties would remain affected as with the Reference Design.

There may be some small variations to these numbers during detailed design development, in which case further consultation with those people affected would be required. All property owners potentially affected by the Changed Project have been contacted and will be kept informed as the project progresses.

The owners of properties potentially affected by volumetric acquisition for the Changed Project have been notified of their changed status. On completion of the final detailed design, Council will negotiate with landowners regarding compensation, and the acquisitions will be finalised in accordance with the provisions of the Acquisition of Land Act 1967, and other regular property transaction protocols.

There are two locations within the Ithaca Local Plan area where, due to topography, the main tunnels would be shallowest beneath Baroona Road, Rosalie where it is intersected by Bayswater Road (21m), and at Charlotte Street, Paddington between Great George and Martha Streets (14m).

The former location in the locality bounded by Baroona Road, Elizabeth Street, Carrington Street and Howard Street, is referred to under the Ithaca Local Plan as the Rosalie Village Special Area. It is partially designated as a local convenience centre, and is surrounded by low-medium density residential development and the near-by Milton State School. The latter is in a low-density character residential area characterised by the typically steep, undulating terrain of Paddington and Red Hill, and as such the depth of cover increases sharply in each direction along the tunnel alignment.

The future use of these areas, for their designated purposes, would not be affected by the Changed Project.

3.3.7 Cultural Heritage

The EIS documented the cultural heritage values of the Toowong Cemetery and the sensitivities of that place to the potential effects of underground construction, particularly in places of shallow cover above the main tunnels. The EIS, and the Coordinator-General's evaluation, identified the need for specific studies to recommend ways to protect the heritage values of Toowong Cemetery during construction of the NLRT project. Such studies were to precede the commencement of works beneath the cemetery.

As with the Reference Project, the Changed Project would pass beneath the Toowong Cemetery. The changed alignment has moved to the north along Mt Coot-tha Road. The eastbound tunnel has moved approximately 100m north and the westbound tunnel approximately 200m north. The vertical alignment is also shallower, with less cover in some places between the crown of the tunnels and the surface than the Reference Design. The change to the alignment has however removed the tunnels from the area below the Governor Blackall Memorial and the steeply sloping terraces that include elaborate headstones such as Trooper Cobb's Grave. The density of burial sites, monuments and headstones in the changed alignment is lower than the elevated and sloping areas of the Reference Design alignment.

The Coordinator-General's evaluation and conditions for continuous vibration for heritage listed places establishes a guide value of 2 mm/sec peak particle velocity to achieve minimal risk of cosmetic damage (refer Schedule 3, condition 22, Table 14, Coordinator-General's report). The conditions remain relevant and appropriate for the Changed Project.

Modelling of ground vibration due to TBM works beneath Toowong Cemetery indicated that for the Reference Design alignment using the same source emission data reported in the EIS:

- there would be possible exceedances of the vibration goal of 2mm/sec PPV in the vicinity of 13th Avenue (the low drainage line through the cemetery) and Boundary Road (adjacent to Mt Coot-tha Road) within the cemetery. These areas coincide with the low points and shallow cover, which generally have a lower density of burial sites, monuments and headstones than other places in the cemetery;
- vibration would possibly reach levels of 1 – 2 mm/sec PPV on the surface, following the construction path between Boundary Road and 1st Avenue within the cemetery.

More recent source emission data[6] has been derived from monitoring of underground construction works on the CLEM7 road tunnel project. This data suggests that the EIS data was overly conservative such that vibration impacts were predicted to be greater than might actually be experienced. Modelling of ground vibration due to TBM works for the Changed Project alignment, and using the CLEM7 source emission data beneath Toowong Cemetery indicates that:

- vibration would possibly reach levels of 1 – 2 mm/sec PPV in a small area either side of the low point drainage line and adjacent to 8th Avenue;
- vibration would possibly range from 0.35mm/sec to 1.0mm/sec PPV along the tunnel alignment beneath the cemetery.

[6]Council commissioned independent measurements of the TBM and roadheader driven tunnelling throughout the construction of the CLEM7 tunnel (and after preparing the Northern Link EIS). The data collected during these measurements is considered relevant to the further evaluation of the Changed Project vibration impacts as it is based on the first driven tunnelling vibration data collected for a TBM in Brisbane. The TBMs used/proposed for both tunnels (CLEM7 and Northern Link) are of a similar 12 metre diameter and it is expected that the rock strength along the Northern Link alignment (uniaxial compression strength up to around 100 MPa) will be similar to the rock encountered for the CLEM7 tunnel.

It is noted that submissions on the EIS raised issues with the vibration effects and duration of vibration effects at Toowong Cemetery. The revised vibration data and detailed mitigation measures for the Changed Project and the existing Coordinator-General's conditions appropriately address and mitigate potential vibration effects at the Cemetery.

To date the geotechnical investigations in Toowong Cemetery have been commensurate with the requirements of a detailed feasibility study. The modelling undertaken for this Application for Project Change identifies and confirms the need for additional investigations to identify and mitigate the potential risks to the heritage values of the place arising from TBM construction, particular under the low points in the cemetery.

These additional investigations, particularly within the low cover area of the Toowong Cemetery, would be undertaken only within areas where appropriate, to ensure that impacts on existing monuments within the Cemetery are adequately addressed and mitigated. This may require techniques such as inclined borehole investigations, non-destructive surveys to detect possible underground artefacts prior to undertaking further geotechnical works, or other non-intrusive geotechnical investigations techniques.

The Changed Project would not affect the Queensland Heritage registered site of "Baroona" at 90 Howard Street Paddington as would the Reference Design. Ground vibration from underground tunnel construction (TBM) associated with the Changed Project would have the potential to affect two other sites directly above the tunnels with volumetric title requirements. These are properties are registered as "Boondah" at 50 Howard Street, Auchenflower and "Cross Terrace" at 50 Cairns Street, Paddington.

Development on a State Heritage Place must comply with Schedule 1 of the Coordinator-General's conditions.

An amendment to the Coordinator-General's conditions is requested to Schedule 1 condition 2(b) of the conditions to remove reference to 'Baroona' and include as "Boondah" at 50 Howard Street, Auchenflower and "Cross Terrace" at 50 Cairns Street, Paddington as additional places that will require specific Cultural Heritage Management Plans prior to any construction work commencing.

4 Project Changes to Western Connection

4.1 Changes to Project Design – Western Connection

The key changes arising from the Changed Project in the vicinity of the western connection relate to the:

- location of the tunnel portals to an area north of those proposed for the Reference Design;
- location of the tunnel entry and exits and the related relocation of entry and exits transition ramps to the inside of the Centenary Motorway;
- realignment of the Centenary Motorway east-bound lanes to the north and east to accommodate the changed connections with the motorway, resulting in an increased encroachment upon the Mt Coot-tha Botanic Gardens; and
- relocation of the Tollroad Control Centre (TCC) from a position adjacent to the southern boundary of the Botanic Gardens to a site situated opposite the entrance.

The Coordinator-General's report observed that the construction of road tunnels is often simpler and less costly if portals are located on the inside of major feeder roads and that, subject to further assessment, there was potential merit in an inner-portal final design option at the western end.

In response to this observation, the Changed Project proposes relocating the portals, with the entry and exit transition ramps to be placed together in a central location on the inside of the existing Centenary Motorway lanes. The traffic effects are discussed below in Section 4.3.1. The central transitions to and from each tunnel would be of similar length to the Reference Design.

To accommodate this change in portal location, the eastbound lanes of the Centenary Motorway would be realigned to swing outside and to the north of the existing lanes before swinging back to connect with Mt Coot-tha Road at the roundabout. All surface road widening works for the east-bound lanes would occur on the northern side of the existing Centenary Motorway.

The alignment of the westbound lanes of the Centenary Motorway would be unaffected by the relocation of the portals for the Changed Project. The westbound merge arrangements of the Changed Project with the Centenary Motorway would be shorter than the merge for the Reference Design by about 150m.

Traffic management for the realignment of the Centenary Motorway eastbound lanes would require only one primary traffic switch. The existing Mt Coot-tha roundabout and the adjacent existing pedestrian/cycle bridge structure also both remain unaffected by the Changed Project.

The western ventilation station would be buried underground in a location immediately north of the Reference Design location. The ventilation outlet for this ventilation station would be above ground on the western side of the buried ventilation station and approximately 43 \m north-west of the outlet location identified in the Reference Design. The ventilation outlet would be at least as high as the Reference Design outlet which must be at least to RL 67m or 20m above the land surface.

The Reference Design, at the western connection, provided for the reinstatement of the area between the Botanic Gardens and the western connection of Northern Link with the Centenary Motorway. The reinstatement works were to be conducted in consultation with the Botanic Gardens management. The Changed Project would also be compatible with requirements for the Botanic Gardens management and future expansion, including a water feature and recreational space adjoining the existing gardens complex.

4.2 Changes to Delivery – Western Connection

4.2.1 Worksite Layout and Construction Areas

As with the Reference Design, the Changed Project would entail a major construction site and construction activity at the western connection (Toowong).

The Changed Project would adopt construction staging strategies to mitigate the potential impacts on traffic flows on the Centenary Motorway and Mt Coot-tha Road during construction. The initial construction activities will be carried out off the Centenary Motorway and behind construction barriers**.**

Figure 4-1, Figure 4-2 and **Figure 4-3** below show the three main construction stages for the delivery of the western connections with the Changed Project. The larger area indicates the location of the western worksite at the intersection of Mt Coot-tha Road and the Centenary Motorway.

Stage 1 – Worksite arrangements

Figure 4-1, identifies stage 1, being the establishment of the construction areas and western worksite (blue) to the north of the Centenary Motorway. Construction access and egress (red) would be established off the Centenary Motorway and also off Mt Coot-tha Road, north of the roundabout. The construction of the realigned eastbound lanes of the Centenary Motorway would be off-line with the existing road network unaffected (yellow), apart from access requirements to and from the worksite. Stage 1 would be approximately 26 months in duration and include:

- site establishment, land clearing and earthworks to the north of the Centenary Motorway and within the western worksite;
- establishment of the western worksite facilities and equipment;
- construction of the ultimate eastbound carriageway;
- cut and cover and portal construction including the TBM assembly area and launch box, within the excavations for the cut and cover tunnels;
- daytime assembly of the TBMs in the uncovered, 'cut and cover' and transition excavations and subsequent erection of the TBM sheds;
- the completion of the TBM tunnelling.

Stage 2 – Worksite arrangements

Figure 4-2 identifies stage 2 which would be of approximately 14 months duration and includes:

- the traffic switch to the realigned eastbound lanes of the Centenary Motorway (yellow);
- the construction of the east and westbound transition ramps and tie-ins within the newly created central median to the surface road network (blue);
- completion of the cut and cover (green); and
- construction of the western ventilation station.

Stage 3 – Worksite arrangements

Figure 4-3 identifies Stage 3 of the delivery of the western connection which would be of approximately 4 months duration and include:

- completion of the ramps and tie-ins to the surface motorway;
- construction drainage work off the existing westbound Centenary Motorway;
- completion of the tunnel fit-out; and
- site demobilisation and urban design and landscape works.

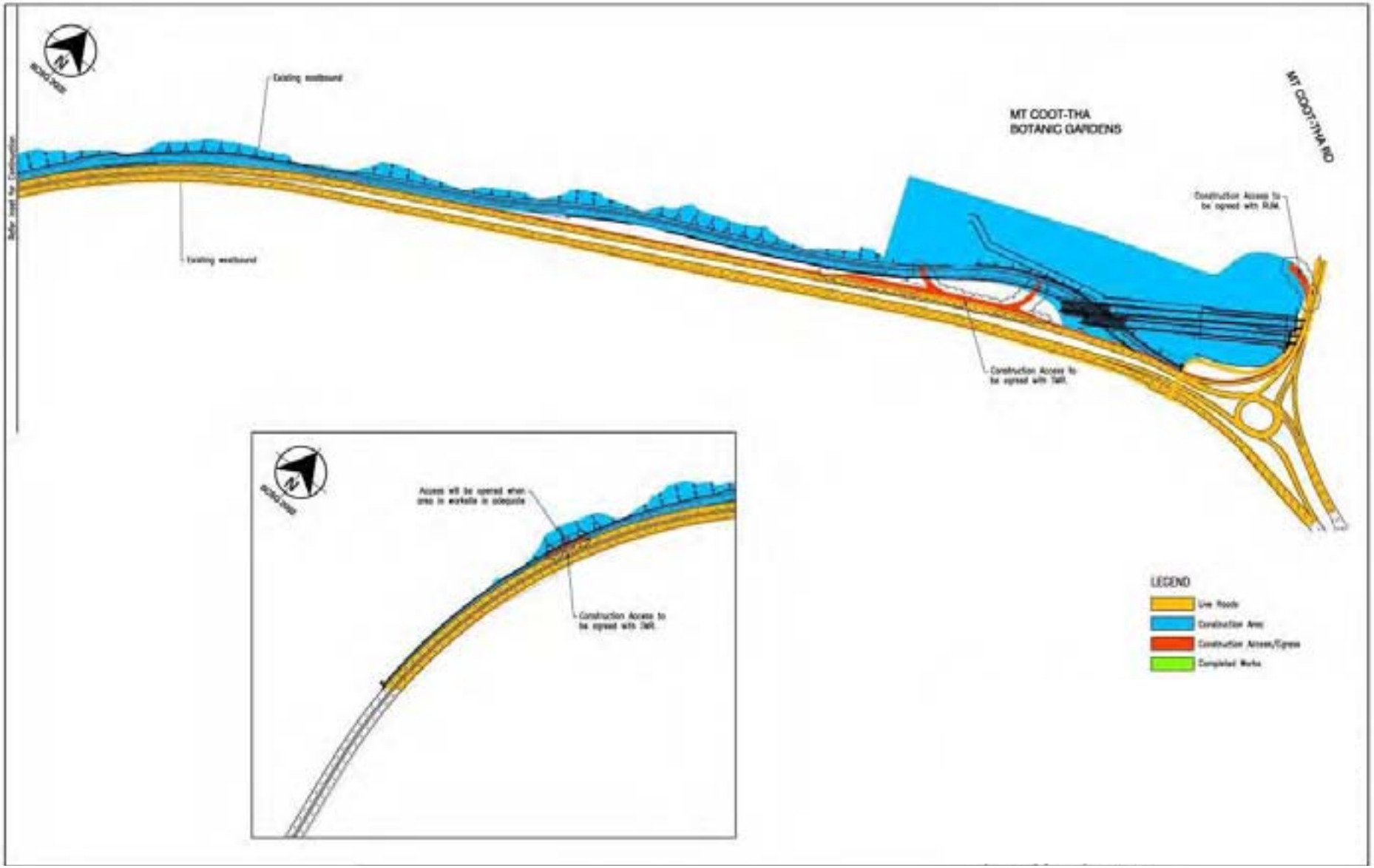

Figure 4-1: Stage 1 construction sequencing – Western connection

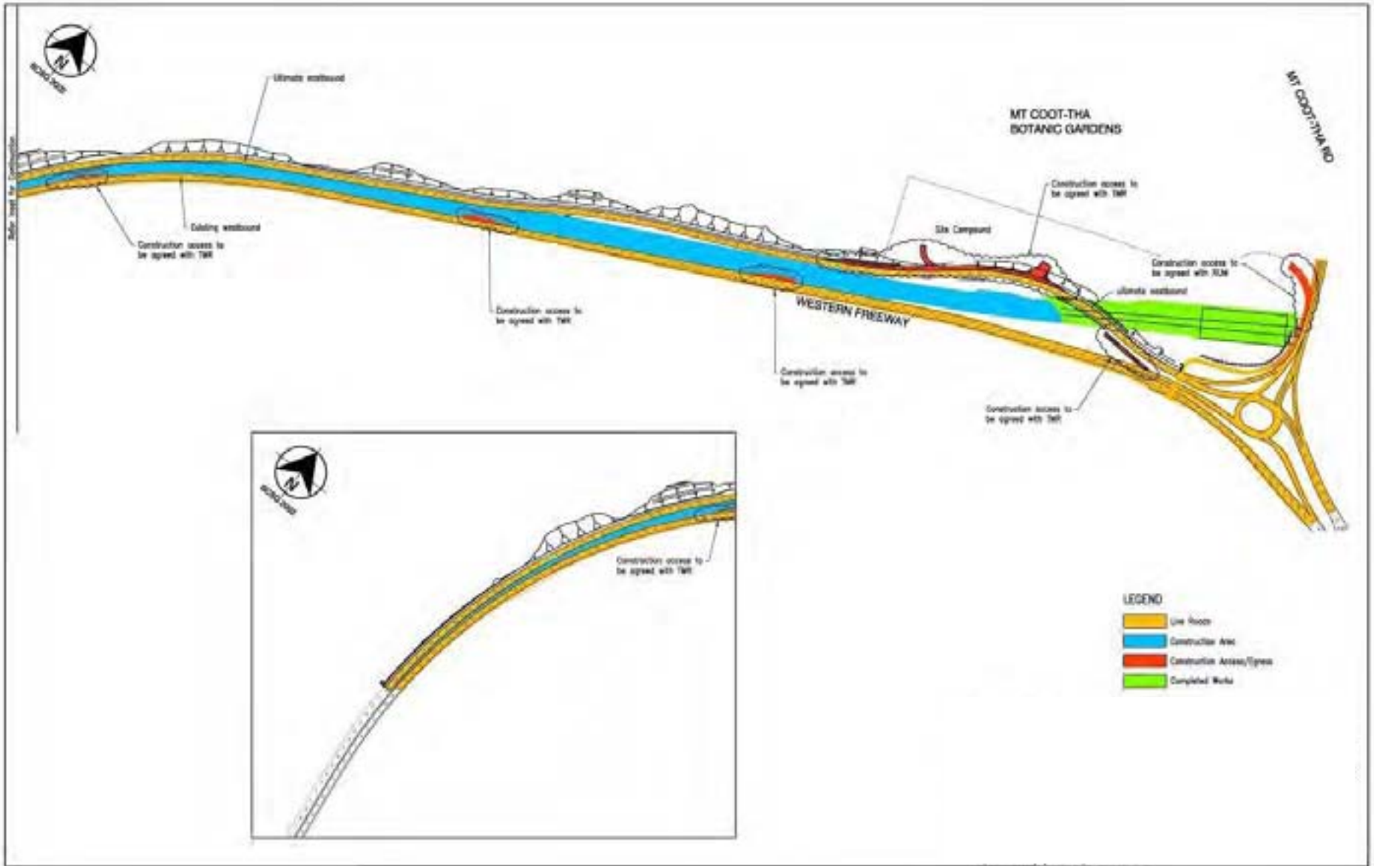

Figure 4-2: Stage 2 construction sequencing – Western connection

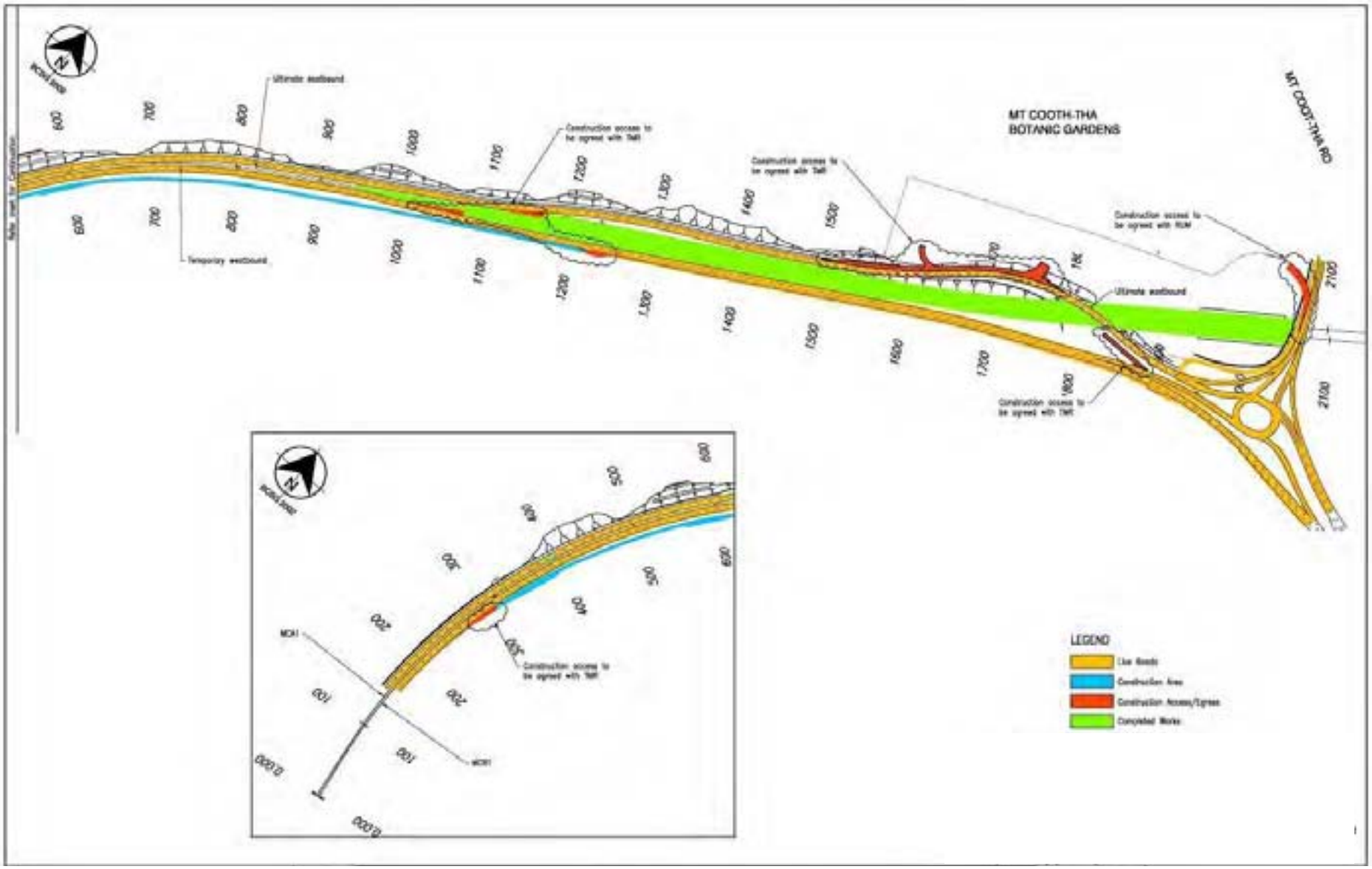

Figure 4-3: Stage 3 construction sequencing – Western connection

The general layout of the western worksite is shown on **Figure 2-40** during Stage 1 and **Figure 2-41** during Stage 2 following the switch of traffic onto the new eastbound lanes of the Centenary Motorway.

The Changed Project would increase the area of the worksite from approximately 4 hectares to 6 hectares by including the area to the west of Mt Coot-tha Road. This area includes the TBM tunnel portals and TBM launch chambers within a large open section of the cut and cover excavations, storage areas either side of the launch chambers for the unloading and handling of pre-cast tunnel ring segments and additional site access for light vehicles from Mt Coot-tha Road.

Temporary access and egress for heavy vehicles would be off the eastbound lanes of the Centenary Motorway with an additional temporary access for light vehicles off Mt Coot-tha Road.

Temporary construction on-site parking would be provided with those parking areas becoming available during successive stages. As construction progresses, access to the work zone between the realigned eastbound and existing westbound carriageways of the Centenary Motorway would be provided as left-in entries or left-out exits to the westbound carriageway, with a left-in entry to this area from the eastbound lanes added in later stages.

Subject to the Coordinator-General conditions, all surface construction work would be undertaken during standard construction hours between 6.30am to 6.30pm (Monday to Saturday) and at no time on Sundays and public holidays.

The workshops and stores on the construction site would be acoustically lined to mitigate construction noise. Early construction of a noise barrier, up to 6m high, would also be undertaken along the northern boundary of the construction site to mitigate noise impacts to the adjacent Mt Coot-tha Botanic Gardens.

The TBMs would be assembled in the cut and cover transitions during the standard construction hours (Monday to Saturday 6.30am – 6.30pm). After assembly of the main components of each TBM an acoustic-lined work shed would be erected over and beside the TBM launch-box to facilitate the continuous underground operations by mitigating the potential noise and light pollution impacts of segment handling and general TBM operations.

The segments would be stored, pending installation, inside the shed. The pre-cast tunnel segments would be lifted by a gantry crane onto special vehicles for transport to the TBM. They would be used to line the tunnels immediately after excavation by the TBM from within the TBM shield. The Changed Project would require 4,300 rings for the tunnel lining.

The tunnel ventilation system during construction includes the installation of two ventilation fans with sound attenuators located above the two edges of the fans A noise enclosure would be provided to mitigate construction ventilation noise.

During Stage 1 and the TBM construction, an acoustic workshed for spoil handling would be provided on the western end of the worksite. This workshed would transfer spoil from the in-tunnel conveyors to the external quarry conveyor. The in-tunnel conveyor between the TBM tunnel and the spoil handling workshed would be enclosed for noise attenuation and dust control. From the transfer station, a single conveyor will transport the material to the Mt Coot-tha Quarry. The external conveyor will be fully enclosed along its length between the worksite shed and the quarry.

The workshed would have capacity of approximately 16,000m^3 or two full days of TBM operation to store spoil for transport off site in the event of the conveyor being out of operation.

The second stage of construction would continue within the worksite for tunnel fit out and also within the transition structures and tie-in areas within the centre of the Centenary Motorway following completion of the tunnel construction and routing of eastbound traffic onto the realigned Centenary Motorway. Some tie-in works would need to be constructed during lane closures and night works. The pedestrian and cycle bridge structure would be retained with access maintained during construction. Some minor realignment of the shared path would be required on the northern side of the bridge to accommodate the worksite adjacent to Mt Coot-tha Road. This work would be conducted off-line or at night under relevant approvals in order to minimise disruption to local pedestrian and cycle access.

Compared to the Reference Project, the Changed Project provides for minimal disruption to pedestrian and cycle access to the Botanical Gardens and Toowong Cemetery, addressing concerns raised in some submissions to the EIS.

4.2.2 Workforce Car Parking

The Reference Design included dedicated temporary construction workforce parking areas at the western end in the overflow car park across Mt Coot-tha Road from the entrance to the Mt Coot-tha Botanic Gardens or in areas along Sir Samuel Griffith Drive between Mt Coot-tha Road and Simpsons Road, or any combination of more than one of these sites where required to avoid workforce parking on local streets. Shuttle buses would be provided to transport workers between the parking areas and the worksites.

For the Changed Project the overflow car park on Mt Coot-tha Road would no longer be used for temporary construction workforce parking as identified in the EIS but would include workforce construction parking only for the construction of the TCC. The proposed changed use of this site for the TCC is addressed in Section 5 of this application.

Construction project office and visitor centre

For the Changed Project a site along Sir Samuel Griffith Drive between Mt Coot-tha Road and Simpsons Road has been identified to establish the construction project office and visitor centre with temporary parking for office staff and visitors during the construction of the project between 2011 and 2014. This arrangement is shown on **Figure 4-4**. subject to detailed design. The land contains the ex-Freers chip factory building on Lot 1 RP76740 at 95 Sir Samuel Griffith Drive, Bardon as well as the vacant land parcels either side of the existing building.

If required, additional staff parking requirements may be provided at this location, No construction activities would originate from the construction project office once it is established and the site would not be used during night shift construction activities.

A public visitor information centre would be established with associated car parking at the construction project office site. Development approval for the construction project office would be sought, where required in accordance with the *Sustainable Planning Act 2009* and City Plan.

Figure 4-4: Proposed construction project office at 95 Sir Samuel Griffith Drive

Construction car parking at Anzac Park

A temporary construction workforce parking area for up to 300 vehicles would be provided in Anzac Park, as shown in **Figure 4-5**. This has been included to satisfy the Coordinator-General's condition with regards adequate off-street construction workforce parking to ensure the construction workforce does not park on surrounding local streets. This additional temporary construction parking site would be located in the northern part of Anzac Park, adjacent to the recently-constructed pedestrian and cycle bridge and behind a topographic ridge which would visually separate the site from Wool Street.

Access to the workforce parking for construction workers would be limited to and from Dean Street, with no access for construction workers from Wool Street. From this temporary parking area, construction workers could walk between the car park and the western worksite using the existing pedestrian/cycle bridge over the Centenary Motorway.

The construction workforce would also be encouraged to use public transport, linking the western worksite to the Toowong train station and nearby bus stops. Shuttle buses and prepaid public transport tickets would be provided to the construction workforce to reduce construction-related traffic and parking demand.

The temporary construction workforce parking area would be securely fenced at all times and would be only available for access and use by the construction workforce. Upon completion of the works, this section of Anzac Park will be reinstated in line with Council, stakeholder and community requirements.

The Coordinator-General's condition 22 remains relevant to the mitigation of the potential effects of construction workers parking. An addition to this condition is recommended in Section 8 to manage potential car park noise.

The proposed temporary construction workforce car park in Anzac Park would be approximately 80m from the nearest residences in Wool Street. Most of the temporary construction workforce car park along the existing bicycle path would be approximately 200m from the nearest residences along Wool Street.

Protocols and procedures for all construction personnel in interacting with the community will be established and implemented through ongoing workforce induction, training and an agreed code of conduct or code of behaviour to be adhered to by all personnel while on any construction site associated with the Changed Project.

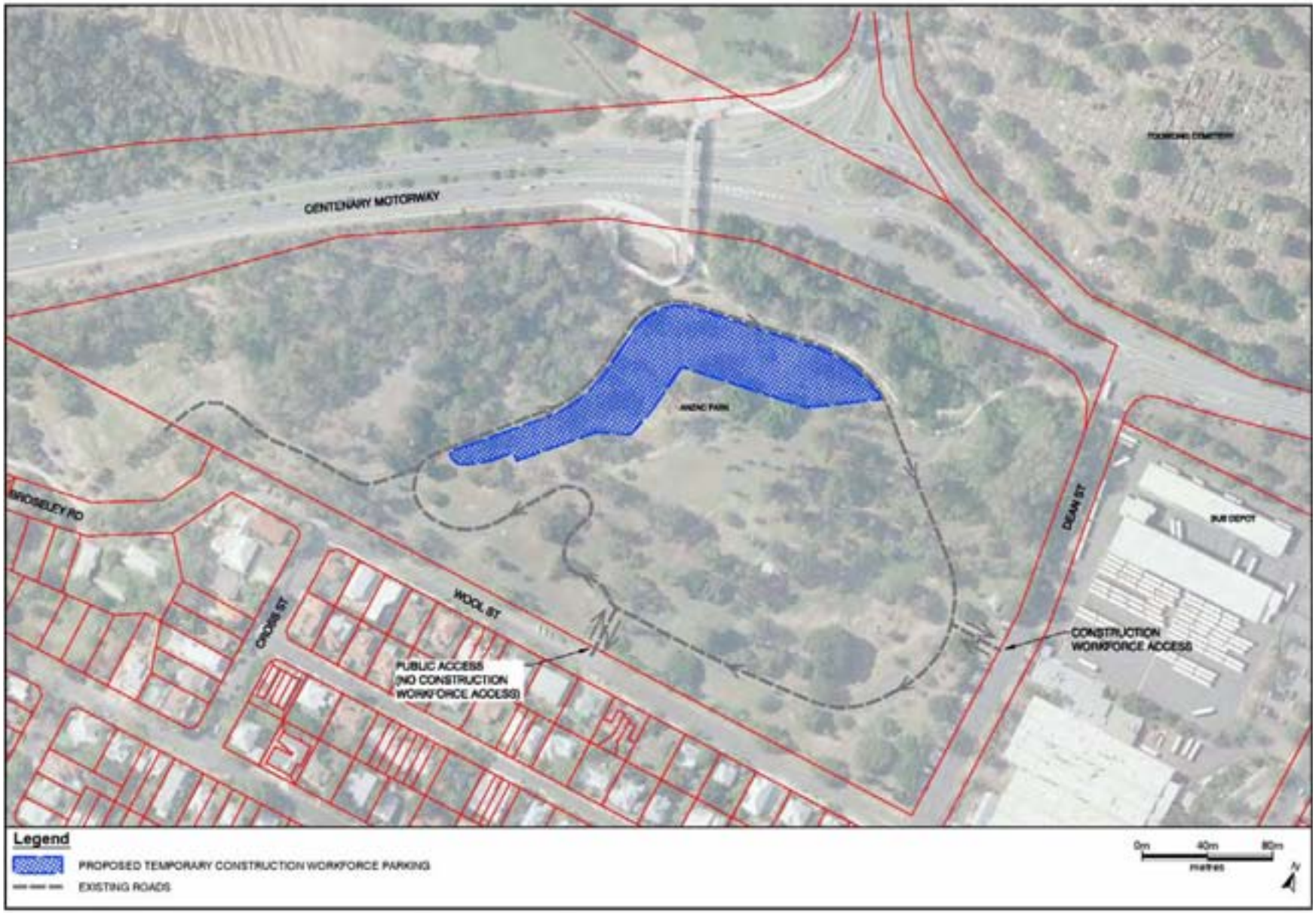

Figure 4-5: Proposed temporary workforce construction parking – Anzac Park

4.2.3 Spoil Handling, Haulage and Placement – Western Worksite

Spoil Handling

Spoil handling arrangements from the western worksite for the Changed Project and for the Reference Design are summarised in **Table 4-1**.

Table 4-1: Summary of change in spoil handing (bank cubic metres) – western worksite

Criterion	Reference Design	Changed Project	Change (%)
Total spoil (Bank m3)	1,238,000	1,235,000	-0.25%
Spoil via conveyor to Mt Coot-tha Quarry (Bank m3)	973,000	932,000	-4.2%
Disposal site (for spoil not disposed of in Mt Coot-tha Quarry)	Swanbank	Rudd Street, Oxley (or other location as approved)	
Haulage route	Centenary Motorway – Ipswich Motorway – Cunningham Highway – Swanbank Road	Centenary Motorway – Ipswich Motorway – Ipswich Mwy Service Road – Douglas Street – Rudd Street (or other location as approved)	
Spoil by truck (Bank m3)	265,000	303,000	14.3%
Haulage hours	6:30am Monday to 6:30pm Saturday,	Standard construction hours: 6:30am to 6:30pm Monday to Saturday TBM spoil (in case conveyor is out of operation): 6:30am Monday to 6.30pm Saturday	
Ave. haulage per hour (trucks in each direction)	6 for 14 months	14 months; 5 for excess TBM spoil 35 for TBM spoil when conveyor is out of operation	

The Changed Project would provide a spoil conveyor between the western worksite and the Mt Coot-tha quarry, as did the Reference Design. The conveyor would follow an alignment adjacent to the realigned Centenary Motorway and around the western edge of the Botanic Gardens.

The surface and cut and cover spoil as well as the TBM spoil that cannot be placed within the quarry would be transported by truck (303,000bcm) to an approved site located at Rudd Street, Oxley or other approved locations. The haulage task to Rudd Street would require approximately 4-5 trucks per hour. The proposed haul route would be via Centenary Motorway, Ipswich Motorway, Ipswich Motorway Service Road, Douglas Street and Rudd Street. Other approved spoil sites may be used subject to the approval of Construction Traffic Management Plans and Coordinator-General's Conditions Schedule 3 Section 16. The haulage hours for the Changed Project address the concerns raised in submissions to the EIS regarding noise impacts for residents.

Should the spoil conveyor be out of operation and the emergency stockpile facility within the spoil shed start to reach capacity, all the tunnel spoil would need to be removed by road transport. Approximately 450 truck loads per day at an approximate average rate of 35 trucks per hour would be required to take the material to the western spoil placement site in these circumstances. This operation, if required, would be carried out between 6.30am Monday to 6.30pm Saturday.

Spoil Conveyor

In relation to the Reference Design, the Coordinator-General, on page 16 of Coordinator-General's report stated that:

> *The majority of spoil excavated by the TBMs will travel by conveyor from each TBM, existing at the western tunnel portals to a transfer station located within the western worksite. From the transfer station, a single conveyor will transport the material to the Mount Coot-tha Quarry. The conveyor will be fully enclosed along its length between the worksite shed and the quarry. All stockpiling, truck and conveyor loading activities at the western worksite will be undertaken entirely within worksite shed or within the tunnel excavation area.*

The above described arrangements relating to the Reference Design would be maintained for the Changed Project.

Condition 18c of the Coordinator-General's report provides for the operation of the conveyor to transport spoil from the tunnel boring machine into the Mt Coot-tha Quarry, provided the relevant noise limits in Condition 22 can be met.

The spoil conveyor would operate from the TBM portal shed through to the spoil handling shed and transfer station and then on to the quarry. Spoil would be delivered by conveyor into the quarry on a continuous basis to support the operation of both TBMs, while achieving the required noise conditions.

Spoil Placement

For the Changed Project, the spoil would be spread and compacted within an allocated area of the quarry to facilitate the eventual rehabilitation of the quarry. This is different to the Reference Design. The placement of spoil would not affect the continued operation of the quarry.

Spoil placement within the quarry, being the distribution, spreading and compaction of conveyor spoil from the project works, would be controlled in accordance with the existing quarry development permit.

The existing quarry development permit remains appropriate for the operations within the quarry. It is proposed that for delivery of spoil into the quarry, the following further Coordinator-General's conditions would apply:

Conveyor spoil delivery into the quarry must be managed to mitigate any adverse environmental impacts including:

- *Spoil may be delivered by conveyor into the quarry providing the environmental objectives and the performance criteria for noise (Schedule 3, condition 22 of the Coordinator-General's conditions) and air quality (Schedule 3, condition 20 of the Coordinator-General's conditions) are met at adjacent residential properties.*

These proposed and existing Coordinator-General conditions will ensure that concerns raised in submissions to the EIS regarding amenity impacts of the conveyor and spoil placement operation at the quarry will continue to be appropriately managed.

Noise monitoring and dust deposition monitoring would be implemented to confirm that spoil placement activities meet the Coordinator-General's conditions. The noise monitoring station would be in place two months prior to the commencement of conveyor operations and would continue until either completion of Northern Link spoil placement at the quarry or sooner if the Coordinator-General is satisfied that noise emissions for spoil placement at the quarry are not causing residential impacts.

4.3 Effects of Project Changes – Western Connection

4.3.1 Traffic and Transport

The key changes to the Reference Design entail the realignment of the Centenary Motorway eastbound lanes to accommodate central portals for the NLRT project. The alignment of the westbound Centenary Motorway lanes and the Mt Coot-tha roundabout would be unchanged.

There would be no impact on future, known upgrading requirements to the Centenary Motorway and the local road network. The Changed Project would be compatible with future widening of the Centenary Motorway, and would accommodate a connection with a possible future Inner Orbital. Similarly, the Changed Project would not affect the design of the mitigation works for the Moggill Road ramps.

The road layouts for the Changed Project would provide for easy way finding for motorists, with clear choices between the NLRT and the surface roads via the Centenary Motorway.

DTMR has indicated acceptance for the Changed Project of a design speed of 70km/h (posted at 60 km/h) downstream of the exit to Northern Link on the Centenary Motorway eastbound, but that a transition in design speeds from 90km/h on the mainline to 70km/h on the realigned eastbound Centenary Motorway would be required. With some minor adjustments to the length of merges and line marking, the western connections are equivalent to or better than that proposed in the Reference Design, and in principle satisfy DTMR requirements.

The location of the portals and connecting lanes at the western end of Northern Link reinforces the Centenary Motorway – Northern Link route as the primary traffic and freight route, with Milton Road becoming a secondary route. The central portal location reinforces this transport benefit.

The central portals arrangement for the western connection of the Changed Project would:

- allow the Centenary Motorway merge and diverge areas to operate safely and efficiently;
- allow traffic to enter the tunnels even with traffic queues associated with both the Mt Coot-tha roundabout and the Toowong roundabout; and
- allow traffic to access Milton Road, even with an incident in either of the tunnels.

Performance of merge and diverge arrangements

Micro-simulation modelling (Paramics) demonstrates the performance of the merge and diverge arrangements for the Changed Project at the western connection. This is the same approach used to assess the performance of the Reference Design in the EIS Supplementary Report (June 2009).

The results of this analysis, with the Reference Design performance results from the EIS Supplementary Report for comparison, are shown in **Table 4-2.** The Changed Project would provide similar performance to the Reference Design in the western connection area, with the same forecast levels of service throughout. The merge and diverge arrangements would operate with satisfactory levels of service.

The required geometric design standards for sight distance and manoeuvring space provide for safe traffic operations. Line-marking arrangements in the merge and diverge areas would be developed during detailed design in consultation with DTMR.

Table 4-2: Comparison of western connection performance results (2014)

Road Network Element	Reference Design				Changed Project			
	Eastbound		Westbound		Eastbound		Westbound	
	Av Speed (2)	LoS (3)	Av Speed (2)	LoS (3)	Av Speed (2)	LoS (3)	Av Speed (2)	LoS (3)
AM Peak								
Northern Link Tunnel	80	A	80	A	80	A	80	A
Centenary Motorway east of tunnel portal (towards Mt Coot-tha Road)	80	A	70	B	78	A	73	A
Centenary Motorway at Northern Link diverge zone	70	B	-	-	72	B	-	-
Centenary Motorway at Northern Link merge zone	-	-	67	B	-	-	65	B
PM Peak								
Northern Link Tunnel	80	A	80	A	80	A	80	A
Centenary Motorway east of tunnel portal (towards Mt Coot-tha Road)	80	A	66	B	79	A	64	B
Centenary Motorway at Northern Link diverge zone	75	B	-	-	72	B	-	-
Centenary Motorway at Northern Link merge zone	-	-	52	C	-	-	50	C

Table Notes:

1. Data extracted from Paramics micro-simulation modelling using input 2 hour peak demands from cordon matrix prepared using Northern Link Traffic Model run TR_2014_257. No peak spreading applied.
2. Average Speed = average speed on link during the middle hour of the peak two hour micro-simulation period.
3. Level of service (LoS) is an index of the operational performance of traffic on a road when accommodating various traffic volumes under different operating conditions. The indicative level of service has been calculated based upon ratio between actual speed and free-flow speed, using Figure 5.12 of the Road Planning and Design Manual (Queensland Department of Main Roads, 2005). Level of service ranges from A (highest) to F (lowest performance).

Effect of design changes on adjacent road network

The Reference Design is expected to reduce traffic demands at both the Mt Coot-tha roundabout and the Toowong roundabout, and also on Milton Road. The forecast volumes at these intersections would remain the same with the Changed Project as with the Reference Design. The intersection performance analysis presented in the EIS Supplementary Report would still apply.

Key performance measures for these two intersections with NLRT in place, drawn from the SIDRA prepared for the EIS Supplementary Report, are presented in **Table 4-3**. The 95th percentile queue on the western approach to the Mt Coot-tha roundabout would be less than 100 metres in both morning and evening peak periods in both 2014 and 2026, while the eastbound queue at the Toowong roundabout would be less than 120 metres.

As the available queuing space for eastbound traffic between these roundabouts exceeds 350m, the Mt Coot-tha roundabout would not be expected to be affected by downstream blocking effects. The queue on the eastbound Centenary Motorway back towards the Northern Link portals would be determined by the Mt Coot-tha roundabout alone, giving a 95th percentile length of under 100m.

The Changed Project would provide a clear distance of approximately 900m between the Mt Coot-tha roundabout and the NLRT diverge. The Mt Coot-tha roundabout and the Toowong roundabout are not expected to have any impact on traffic entering NLRT up to and including 2026.

Table 4-3: Performance of Toowong Roundabouts (SIDRA analysis)

Intersection and Approach	Peak	Degree of Saturation	Delay (s)	Level of Service	95% back of queue (m)
Mt Coot-tha Road Roundabout - 2014					
Overall Intersection	AM	0.84	13	B	98
	PM	0.71	9	A	65
Western Approach	AM	0.81	7	A	98
	PM	0.71	7	A	65
Mt Coot-tha Road Roundabout – 2026					
Overall Intersection	AM	0.89	14	B	95
	PM	0.92	16	B	104
Western Approach	AM	0.81	7	A	93
	PM	0.77	8	A	82
Frederick Street Roundabout – 2014					
Overall Intersection	AM	0.80	10	A	88
	PM	0.91	11	B	152
Western Approach	AM	0.80	10	A	88
	PM	0.68	7	A	63
Frederick Street Roundabout – 2026					
Overall Intersection	AM	0.86	11	B	115
	PM	0.95	16	B	192
Western Approach	AM	0.86	12	B	115
	PM	0.77	10	A	85

Table Note: 1. Demands from Northern Link Traffic Model runs TR_2014_257 and TR_2026_257

Effect of a major incident on Centenary Motorway

The normal operation of the Changed Project would not lead to adverse interaction between diverging Centenary Motorway traffic and potential queuing on the NLRT carriageways, as shown by the micro-simulation analysis described above.

As with the Reference Design, a major incident in the NLRT project would have the potential to produce substantial queues on the eastbound carriageway and in some circumstances the Centenary Motorway would be affected if this is not managed. However, in the event of a major incident, a Major Incident

Management Plan would be implemented by the operator to ensure continued operation of the Centenary Motorway and access to Milton Road through the Mt Coot-tha roundabout.

Incident Management Plans would be finalised during detailed design with stakeholder comments incorporated to ensure confidence in the effectiveness of the plans.

Ventilation station access

For the Changed Project, like the Reference Design, the western ventilation station would be located on the northern side of the Centenary Motorway, approximately 400m west of Mt Coot-tha Road.

Access for maintenance and inspection for the ventilation station and associated supporting infrastructure would be provided from the eastbound carriageway of the Centenary Motorway. A deceleration lane would be provided to allow vehicles to enter the site safely and without affecting motorway traffic. The access width would allow an entering vehicle to pass a vehicle waiting to turn out of the site. This arrangement has been generally approved by DTMR with final details to be developed in detailed design and further consultation with DTMR.

Anzac Park Temporary Construction Workforce Parking

Access to the construction parking area would be via the internal Anzac Park private road, which connects to both Dean Street and Wool Street. Dean Street would be the specified access point due to its proximity to the major road network. Current traffic volumes on Dean Street are low, and the road width is sufficient to allow right turning vehicles to be overtaken, so the increase in usage of this access point is not expected to significantly affect the street's operation. The land use opposite the Dean Street entry and exit access is not residential and is used for the bus depot.

Access routes to the construction workforce carpark would primarily be via the Centenary Motorway and the two Toowong roundabouts, although this proposal would also allow alternative routes from the south and south-east. Although right turns into and out of the northern end of Dean Street are restricted to buses only, the nearby roundabouts facilitate U-turns. The impact of construction traffic on these intersections is likely to be reduced by the timing of construction shifts, which are typically earlier than the commuter peaks.

The Construction Traffic Management Plans (CTMPs), to be prepared for the Changed Project during detailed design, would include examination of the impacts of construction related parking in Anzac Park and identification of suitable mitigation and management measures.

Pedestrian and cyclist arrangements

The Changed Project would provide for the same pedestrian and cyclist connectivity around the western connections as the Reference Design, including the extension of the existing pathway along Mt Coot-tha Road to the Botanical Gardens entrance near Ada Street. Further east, the pedestrian/cycle crossings of Dean Street and Miskin Street would be enhanced, with a larger median island on Dean Street and a kerb build-out on the eastern side of Miskin Street improving cyclists' safety.

As a result of the central portal locations, the Changed Project would not require cyclists travelling along the Centenary Motorway to or from the Mt Coot-tha Road roundabout to cross motorway lanes. The configuration of the Changed Project would support continued use of the Centenary Motorway by group and sport cyclists, consistent with DTMR's current arrangement with Bicycle Queensland. Use of the

Centenary Motorway by cyclists should be re-considered by DTMR as recommended in the Coordinator-General's report.

Additionally the Changed Project would help alleviate construction impacts in the following ways:

- no impact on the DTMR Centenary Motorway pedestrian and cyclist bridge structure during or after construction;
- full connectivity provided for the pathway to Mt Coot-tha Road from the overpass during construction with realignment work conducted offline where appropriate and night works to tie into existing infrastructure to minimise any impacts;
- maintaining access in relation to the Centenary Motorway bikeway to the south; and
- no impacts on Mt Coot-tha Road roundabout or on the southern side of Centenary Motorway.

Effects of delivery on the road network

The Changed Project would minimise the potential impact of construction on road users in the western connection area, with no significant or long-term impacts on the westbound lanes on the Centenary Motorway and no works on the Mt Coot-tha roundabout. The existing number of lanes and traffic capacity would be maintained throughout the construction period.

A draft Construction Traffic Management Plan is proposed for construction of the Centenary Motorway connection to Northern Link, with only one major traffic switch for existing motorway traffic.

The early works would involve construction off-line of the proposed eastbound Centenary Motorway alignment to avoid direct impact on present traffic flows. The off-line works would extend from the diverge away from the Changed Project to the tie-in with the Mt Coot-tha roundabout. A section of the transition structure and Centenary Motorway underpass would also be built during this stage.

Eastbound traffic on the Centenary Motorway would be switched to the new alignment to enable the construction of the second stage. This will be a permanent arrangement and would occur after about 26 months of work. Short-term night works would be required for this switch. Traffic operations on Mt Coot-tha Road, Mt Coot-tha roundabout and the approaches to the roundabout would be unaffected during this stage.

No traffic switches would be required for westbound traffic on the Centenary Motorway. Some disruption, and work under traffic should be anticipated, when the westbound merge from Northern Link is constructed. Some drainage works would be required, with little effect on traffic capacity, in the vicinity of the westbound lanes towards the completion of the construction programme at the western connections.

No capacity reductions through the area are expected with the existing westbound Centenary Motorway retaining all its lanes and the realigned eastbound carriageway having two lanes throughout construction.

Centenary Motorway Worksite Access and Egress

The proposed temporary access from the Centenary Motorway to the worksite would satisfy DTMR standards in accordance with Chapter 13 of the Road Planning and Design Manual. The temporary access would enable a heavy vehicle to enter and exit the construction site. It is intended that this access is only for use by heavy vehicles. A light vehicle access is provided off Mt Coot-tha Road.

The length of the acceleration lane and taper is in excess of 145m which should be adequate for a heavy vehicle to reach 60km/hr at the merge with the motorway. The downgrade is greater than 4% in this location.

A vehicle weave analysis is required during the preparation of the Construction Traffic Management Plan to ensure that vehicles from the worksite can adequately change lanes to enable a U-turn to occur at the Mt Coot-tha Road roundabout for vehicles heading westbound on the motorway.

Heavy vehicle movements entering and exiting the worksite will be restricted to out of traffic peak periods on the motorway.

The additional access on Mt Coot-tha Road, just north of the roundabout, would be subject to a Construction Traffic Management Plan and EMP Sub-Plan with associated mitigation measures with the objective to not materially affect traffic conditions on this route, or affect the amenity of the residential areas further north. Sight distance, turning radii and traffic control measures to ensure safe operation of this entry, considering both the shared pathway along the site boundary and traffic from the roundabout slip lane, would be resolved during detailed design.

Tunnel Ring Pre-cast Segment Delivery

The precast segments would be made at an off-site facility at Wacol and transported to the western worksite by road over approximately a 14 month period. A full ring would be transported to the western worksite in two loads. During peak production, there would be approximately 16 rings (32 loads) per 24 hour period transported to the worksite.

To minimise the effect on traffic and the community, a fleet of 4 trucks would operate 16 hours a day 7 days a week between the Wacol site and the western worksite. The delivery of the tunnel precast segments entering and exiting the western worksite will be at an average volume of 4 truck loads per hour (4 trucks in and 4 trucks out). **Figure 4-6** shows the nominated route for the delivery routes for the precast tunnel segment vehicles.

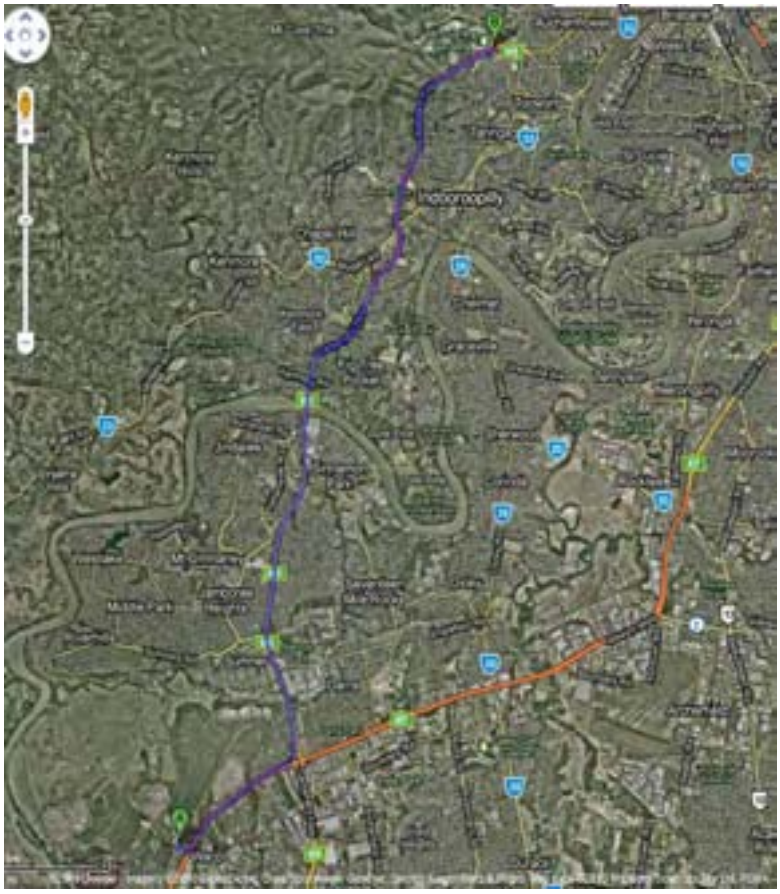

Figure 4-6: Nominated pre-cast segment route

Grout and Other Material Deliveries

Delivery of grout and sand for the grout plant for the western worksite would involve approximately 5 truck and trailers of sand per day and 1 semi-trailer load of grout per day.

During surface construction works approximately 5 truck deliveries of materials would arrive at the western work site per hour. The traffic management plans would direct light vehicle (only) movements to the site via Mt Coot-tha Road whilst strictly retaining access/egress for larger construction vehicles via the Centenary Motorway in accordance with the Coordinator-General's conditions. This would minimise traffic impacts on both local and Centenary Motorway traffic.

Deliveries of Tunnel Backfill

Following the construction of the raw TBM tunnels an amount of back-filling is required to create the required surface level for the road pavement. The quantity of back-filling required for the Changed Project is estimated at approximately 95,000 bank cubic metres which would be approximately 20% less than would have been required for the Reference Design. Over a 7 month period following the construction of the TBM tunnels this amounts to approximately 4 truck loads per hour over a 24 hour period excluding peak hour times.

For the Changed Project the material to be utilised for backfill of the tunnel may also be material removed by the TBMs during the tunnel excavation activities and unable to be placed in the quarry. This surplus

material will be transported off site by road truck to a designated fill site in the western corridor for reprocessing and returned to site for the tunnel backfill operation.

4.3.2 Hydrology

Flooding (Operational)

Flooding characteristics relevant to the western connection were assessed as part of the Northern Link Reference Design and described in Technical Report No. 6 Flooding (SKM-CW JV, May 2008). That report assessed the potential for the Western Connection to be affected by regional Brisbane River flooding. Flood levels for the 1 in 10,000 AEP and Probable Maximum Flood (PMF) were assessed as being well below the terrain levels at the Western Connection (Mt Coot-tha roundabout) from regional Brisbane River flooding. This remains the case for the Changed Project.

Local catchment flood levels essentially would be unchanged in relation to the Western Connection. Two local drainage paths flow through the Botanical Gardens to a pond at a low point in the Gardens immediately upstream of the Centenary Motorway, before flowing through pipes under the Motorway to the natural water course running west-east in Anzac Park. The capacity of the pond storage area would be increased as with both the Changed Project and for the Reference Project.

As part of the Reference Design, flood immunity for the western portal would be provided by a combination of flood protection walls, use of the storage volume available in the ponding area within the Botanical Gardens and extension of the existing drainage pipe under the Centenary Motorway. Modelled upstream flood impacts in the 1 in 100 AEP flood event were generally less than 100mm and located within the existing ponds and water features of the Botanical Gardens.

The Changed Project would include the flood protection wall and the proposed water storage but does not include any changes to the existing pipe under the Centenary Motorway. The Changed Project would involve the following enhancements to the Reference Design case:

- construction of three (3) outlet pipes from the enhanced water storage dam;
- construction of an additional storm water pipe under the Centenary Motorway adjacent to the existing pipe if required during detailed design;
- provision of an overland flow path over the top of the tunnels at the western portal; and
- a change in the location of the wall of the new dam compared to the Reference Design arrangements further to the north within the Botanical Gardens.

The flood levels upstream of the portal for all average recurrence interval events up to the 100 year ARI for the Changed Project operational arrangements would increase by between 700 mm to 980 mm compared to existing peak levels. The Changed Project increases would be confined to the open space areas within the new Botanic Gardens precinct. At peak flood levels, approximately 6.6ha would be inundated under the Changed Project compared with 4ha under the Reference Design.

Modelling confirms that there would be no significant changes in discharge volumes or velocity through the pipes or to downstream areas for the Changed Project during operations.

The altered surface connections at the western end for the Changed Project would result in some changes in regards to the collection, treatment and disposal of surface water runoff. Overall the designs have a comparable effect but the key differences are described below.

Pavement surface runoff on the eastbound Centenary Motorway would be collected and taken under the westbound Centenary Motorway carriageway to water quality management features before release to the existing natural watercourse. The westbound Centenary Motorway carriageway would drain to the existing drainage system including water quality management features before its release to the watercourse.

All surface runoff from the transitions to the tunnel portals would be collected and taken via water quality control features into a rock lined gully and directed into the newly constructed 18ML water storage dam in the south-east corner of the Botanic Gardens. Overflow from the water storage dam would discharge to the southern side of the existing Centenary Motorway into the existing watercourse.

Existing overland flow adjacent to Mt Coot-tha Road would be captured via the water storage dam. Overflow from larger events would be discharged through the pipes described above. Overland flow coming from the north-west would also be collected in the water storage dam as an integral part to the drought proofing of the Botanic Gardens.

In summary flooding and stormwater arrangements for the Changed Project does not cause any increase in flood level beyond the Botanic Gardens site, with no increase in peak flood level across the Centenary Motorway or in the areas downstream of the Changed Project. The Changed Project incorporates arrangements to protect against erosion or impacts on downstream water quality. The current Coordinator-General conditions remain appropriate.

Flooding (Construction)

It is intended to fully excavate the western cut and cover structure prior to installing the roof girders and slab. Flood protection of the western cut and cover structure during construction would therefore be provided by temporary earth bunding of the northern (upstream) face of the cut and cover tunnel and ventilation duct structure. An earth bund with top at RL 24.50 would provide 300mm free board above the predicted Q100 year flood level during construction. The bund would be located near to the northern wall but far enough to permit excavation sufficient to construct headstocks and capping beams. The bund would be required until the majority of the roof structure was installed and ventilation structure (tunnel) constructed. A flood protection barrier would be constructed around the TBM access opening prior to the bund being removed to ensure Q100 year flood levels could not flow into the TBM tunnels during construction.

This compares to the Reference Design as follows. During construction, both the transition and cut and cover sections would have been exposed and required protection from local flooding. This was to be achieved by walls or sheet piles / diaphragm walls along the two faces of construction exposed to flooding, or a combination of the two.

In addition, the construction area upstream of the Centenary Motorway in the Botanical Gardens grounds was also to be protected from local flooding during construction in the Reference Design. This was to be achieved by construction of a bund, to provide 1 in 100 AEP immunity to the construction area and it would have been approximately 400-600 m long and 2 m high, at its highest point. An artificial channel would have been constructed on the upstream face of the bund to allow overland flow to flow into the detention area upstream of the Centenary Motorway. The existing 1.65m diameter reinforced concrete pipe under the Centenary Motorway was to be maintained during construction while the existing 0.9m diameter reinforced concrete pipe to the west would have become redundant and removed.

Groundwater

The tunnel sections of the Changed Project would be fitted with a waterproof lining of segmental pre-cast concrete rings as part of the TBM operation. This is different to the Reference Design which proposed the use of a TBM for excavation and then the installation of an in-situ cast concrete lining and floor slab resulting in a drained tunnel.

As with the Reference Design, the cross passages, substation niches and drainage sumps for the Changed Project would have in-situ lining and will be drained. This may result in localised groundwater inflows, predominantly at the 120m longitudinal spacing of the cross passages. Construction treatments, such as grouting, would be undertaken if required in these drained sections to reduce groundwater inflows. The cut and cover sections at the tunnel portals would be 'tanked' or waterproofed where the structure sits within the soil horizon.

These arrangements would result in groundwater inflows anticipated to be substantially less than those anticipated for the drained Reference Design.

Groundwater entering either of the tunnels for the Changed Project would collect in sumps and be taken to treatment facilities located at the western worksite. The treated groundwater would be made available for beneficial use, or discharged in accordance with the existing Coordinator-General's conditions.

4.3.3 Air Quality and Greenhouse Gases

The Changed Project, at the western connection, would have flatter road alignments and possibly more efficient connections to the Centenary Motorway than the Reference Design, resulting in more freely flowing traffic in most conditions.

The flatter alignments may result in minor reductions in vehicle emissions within the Changed Project tunnels compared to the Reference Design. However, the differences in motor vehicle pollution, when measured at ground level, are expected to be very small and not significant.

The location of the western ventilation outlet would be approximately 43m to the north-west of the Reference Design outlet and the height would remain the same and be at least at the required RL 67m and 20m above ground level. The topography is the same and would not influence the performance of the ventilation outlet. Similarly, there are no different or additional sensitive receptors that would be affected by the minor relocation to the north-west. The proposed change in the location of the ventilation outlet would make no difference to the ambient air quality at either the regional or local levels.

The current Coordinator-General's conditions remain appropriate.

During the delivery phase, the earthworks associated with establishment of the western worksite and construction of the western connections would create the potential for dust. The potential for dust would be mitigated by worksite management and the observance of the existing Coordinator-General conditions

All stockpiling, truck and conveyor loading of tunnel construction spoil is required to occur within acoustically-lined and ventilated worksheds or within the tunnel excavation area to control dust emissions and noise.

Together with the existing Coordinator-General's conditions, these construction air quality measures will continue to respond to issues raised in submissions to the EIS regarding amenity impacts associated with the worksites.

4.3.4 Noise and Vibration

Noise modelling of traffic flows through the western connection in the operational phase indicates the Coordinator-General's conditions would be achieved without the need for noise barriers to the south of the motorway and transition areas. The noise levels at all residences, including at the closest residents in Wool Street, are predicted to be less than or equal to 68 dBA LA10(18hour) as would be the case with the Reference Design. These modelled predictions took account of reflected noise from the proposed noise barrier to the north of the Centenary Motorway.

A noise barrier up to 4m high is proposed subject to detailed design on the northern side of the re-aligned east-bound Centenary Motorway lanes. Modelling indicates that the noise barrier would achieve the environmental (acoustic) outcome sought by the Department of Transport and Main Roads' (DTMR) Code of Practice for parks which requires that a minimum area of 2000m^2 to be less than or equal to 63 dBA L10(12hour). The predicted noise levels with the proposed barrier in place are marginally lower within the Botanical Gardens than would have existed in Year 2026 without the project.

It is noted that submissions to the EIS raised concerns regarding road traffic noise from the Western Freeway (Centenary Motorway). However, with the mitigation measures proposed for the Changed Project, the Coordinator-General's road traffic noise conditions would be achieved at the western connection. Noise barrier designs would be further refined using acoustic three dimensional modelling during detailed design.

During construction, noisy activities would be governed by the Coordinator-General's conditions, specifically Schedule 3, condition 18 – General construction. The conditions provide that surface construction works be restricted to 6.30 am to 6.30 pm Monday to Saturday, and at no time on Sundays and public holidays. Underground construction could be undertaken on a continuous basis, provided the environmental objectives and goals pertaining to regenerated noise and vibration are achieved.

For the Changed Project, the TBMs would be assembled in the uncovered, 'cut and cover' excavations and would be limited to standard construction hours by the Coordinator-General's conditions controlling hours of work (Schedule 3, condition 18) and noise (Schedule 3, condition 22). Once the TBMs are assembled, an acoustic shed would be constructed over the portals and the segment lay-down area to screen the operation of the gantry crane and segment delivery and handling activities during the TBM launch and operation.

The Changed Project would provide several forms of construction noise mitigation including:

- a noise barrier possibly up to 6m high, subject to detailed design, running along the northern side of the worksite as shown in **Figure 4-7** below;
- an acoustically lined spoil handling enclosure to contain night-time spoil handling noise and lighting impacts;
- an acoustically lined shed to contain TBM operation activity noise and lighting impacts;
- all conveyor motors and transfer stations either within the cut of the new road (closer to the tunnel portal) or within acoustically designed enclosures; and
- the installation of two construction ventilation fans with sound attenuators within a specific noise enclosure for the main body of the fans.

Figure 4-7: Western worksite noise barrier location

The proposed temporary construction workforce car park in Anzac Park would be approximately 80m from the nearest residences in Wool Street. Most of the temporary construction workforce car park along the existing bicycle path would be approximately 200m from the nearest residences along Wool Street. The Coordinator-General's conditions (condition 22) require that where there is a potential for the goals to be exceeded, further action would be required to mitigate the predicted impact. Any such further action would be supported by consultation with potentially-affected sensitive receptors to discuss possible mitigation measures.

Protocols and procedures for all construction personnel in interacting with the community will be established and implemented through ongoing workforce induction, training and an agreed code of conduct or code of behaviour to be adhered to by all personnel while on any construction site associated with the Changed Project. This code of behaviour will include reference to, and as a condition of employment on the Changed Project, parking only in designated parking areas and not parking "on-street' under any circumstances. A further imposed condition is also proposed in Section 8 of this application to address the potential for temporary construction workforce parking to cause nuisance.

These construction noise management measures, and the existing Coordinator-General's conditions, will continue to respond to submissions on the EIS regarding amenity impacts associated with the construction worksites.

4.3.5 Ecology

Reference Design

The potential loss of remnant vegetation and potential fauna habitat associated with construction of the Reference Design was estimated at approximately 1.6 hectares of remnant vegetation. The relevant vegetation was identified under the State Regional Ecosystem mapping as remnant regional ecosystems (12.11.5 / 12.12.5). These ecosystems are classified as 'of least concern' vegetation under the Vegetation Management Act 1999 (VM Act).

Changed Project – Effects on flora

The impact on vegetation will be further assessed during detailed design and the undertaking of more detailed surveys. Current information suggests that the Changed Project would impact a total of approximately up to 15 hectares of VM Act protected vegetation to accommodate the realignment of the Centenary Motorway and construction activities. This total includes:

- Approximately 9 hectares of 'least concern' RE (12.11.3 and 12.11.5)
- Less than 6 hectares of regulated regrowth.

The Changed Project would not impact upon fragmented RE to the south of the Centenary Highway, compared to the loss of approximately less than 2 ha that would occur under the Reference Design.

The Mount Coot-tha Forest and the Botanic Gardens contain approximately 25,000 hectares of contiguous remnant vegetation. Some of the areas cleared of remnant vegetation would not be used for road use purposes following the completion of construction and would be replanted with native species. Also some work areas would be rehabilitated and returned to the Botanic Gardens as part of the expansion area.

For the western worksite, the Changed Project would require an expansion of the Reference Design worksite by approximately 2.1ha. This additional worksite area would encompass two categories of vegetation:

- an area of approximately 1.8ha containing a sparse landscaped eucalypt community; and
- an area of approximately 0.3ha affecting the Botanic Gardens.

The eucalyptus community is dominated by Forest Red Gums (*Eucalyptus tereticornis*), Tallowood (*Eucalyptus microcorys*) and contains several Cabbage Tree Palms *(Livisonia australis*) and Ficus sp. This community appears to be predominately regrowth vegetation containing some remnant individuals.

The encroachment by the construction area into the boundary of the Botanic Gardens will impact upon a small area of subtropical plantings including bamboo sp., *Syzygium sp*., *Cycad sp*. and a Wollemi (*Wollemi nobolis*).

Neither area is mapped under the *Vegetation Management Act 1999* (VMA).

The alignment required for the spoil conveyor would have a footprint of approximately 2 hectares. Vegetation covering approximately 1.3 hectares of this area is mapped under the VMA as ‘of least concern’ remnant regional ecosystems. On completion of the tunnelling works and removal of the structures, the conveyor route would be rehabilitated.

The proposed temporary construction workforce car park in Anzac Park comprises open grassland with scattered trees. Existing trees within the proposed car park would be retained and protected during its construction and use.

Changed Project – Effects on fauna

There would be potential for construction activities to indirectly impact on local fauna for the Changed Project as there would be for the Reference Design.

Fauna species currently occurring within the study area are likely to be exposed to indirect impacts such as noise, lighting, vibration and odours, which are common within urban environments. With the exception of some nocturnal species, most of the fauna likely to occur within the study area are mobile and disperse through the urban landscape. Mobile fauna in the immediate vicinity of each worksite, and particularly the Western worksite, are expected to be readily able to temporarily move away from the worksites for the duration of the construction activities. In the Northern Link EIS, the Reference Project was assessed for its potential threats to Endangered, Vulnerable and Rare fauna. The EIS concluded that there would be no significant impact on these species or their habitat as a result of the Project works in the vicinity of the western worksite. The Changed Project results in no change in this regard.

It is noted that prior to construction activities, fauna surveys will be undertaken to identify the presence of all fauna species inhabiting the site. Prior to construction it is the responsibility of the Contractor to assess construction activities against the requirements of the Nature Conservation Act 1992. Also prior to construction, a suitably licensed fauna spotter-catcher will be engaged to assist with decisions regarding the need to capture and relocate any potentially affected animals to a nearby suitable equivalent habitat. Any relocation will be undertaken by a licensed spotter-catcher.

Concentrated lighting sources during construction may deter nocturnal fauna such as arboreal mammals, birds and bats from being present in the area. However, the Centenary Motorway already provides a source of artificial lighting which would buffer the effect of additional lighting for the worksite on fauna in the wider area. Light spill onto surrounding areas is also controlled through the approval conditions.

Impacts from worksites are temporary and mobile fauna are expected to continue to utilise the study area once construction activities have ceased and the rehabilitation of the area is completed.

Rehabilitation of the worksites associated with the Changed Project, including plantings and water features, would result in improved habitat values within the Mount Coot-tha Forest / Botanic Gardens.

Approvals for clearing vegetation

As with the Reference Design, there would be a range of approvals required for the clearing of vegetation proposed for the Change Report. These approvals are summarised below:

- Nature Conservation Act 1992 (NC Act) – An approval for the clearing of protected native vegetation may be required for the proposed works prior to the disturbance of protected vegetation. The clearing of any listed Endangered, Vulnerable or Near Threatened (EVNT) species as recognised under the NC Act requires a clearing (protected plants) permit to be granted prior to clearing.
- Vegetation Management Act 1999 (VM Act) – Since the assessment of the Reference Design was completed, regulated regrowth vegetation has become protected under the VM Act. However, 'Significant Community projects' are exempt from assessment under the regrowth vegetation code for the clearing of regulated regrowth as is clearing in a road reserve for the purposes of road construction. Clearing activities outside of the proposed road reserve is assessable under the VMA. The construction of the spoil conveyor to the quarry would also be likely to require an approval under the VMA.
- Natural Assets Local Law 2003 (NALL) – The clearing of all vegetation within the proposed realignment of the Centenary Motorway and also for the spoil conveyor would require assessment under NALL.

4.3.6 Cultural Heritage

The Changed Project would have no effective change on the State Heritage Registered Mount Coot-tha Forest from that predicted for the Reference Design. The Reference Design required approximately 1.4 hectares of land clearing on both northern and southern sides of the Centenary Motorway through the

Mount Coot-tha Forest section of the motorway. The Changed Project also requires approximately 1.4 hectares of land clearing, all on the northern side of the Mount Coot-tha Forest area. The heritage values of the place would not be affected differently from the Reference Design and the Coordinator-General's conditions for development on a State Heritage Place continue to be relevant to the Mount Coot-tha Forest section of the Changed Project.

Anzac Park is a local heritage place listed on the City Plan 2000 Heritage Register. Anzac Park would have been impacted by the Reference Design exit tunnel and connection to the Centenary Motorway.

In the Changed Project it would only be affected by the temporary construction workforce car park. Development on a local heritage place requiring a CHMP would be relevant to the Changed Project for the design and development of the proposed temporary parking area.

Anzac Park was once a paddock and was originally part of the Crown Cemetery Reserve. In September 1918, a number of ornamental trees including Macadamia nut trees (*Macadamia integrifolia*), were planted in Anzac Park to commemorate the men from the district who died in World War I. The trees were apparently planted in rows, with the nearby palms being a later addition. There are no records which indicate the number of trees that were planted or which trees were memorials. Although the exact location of the memorial plantings is unknown, a 1946 aerial photograph shows a distinct double row of trees along the park border on Wool Street, which are possibly part of the plantings.

The trees within and in the immediate vicinity of the proposed carpark have been surveyed. There is no indication that any of the trees surveyed are associated with the memorial plantings of 1918. As identified above, all existing trees within or adjacent to the construction area dedicated to temporary parking must be retained and protected.

4.3.7 Social Environment

The potential effects of the Reference Design on the social values of the locality around the western connections were discussed in relation to the Botanic Gardens, Toowong Cemetery and Anzac Park. Other social and community values stemmed from environmental amenity characterised by air quality, acoustic amenity and accessibility to transport and urban facilities.

The Changed Project, being of similar configuration and operation to the Reference Design, would have the same effects on the Botanic Gardens during construction, but would present a comprehensive mitigation strategy for the worksite, for the post-construction phase.

The effects of the Changed Project on Toowong Cemetery also would be similar to those predicted for the Reference Project, and would require the implementation of a cultural heritage management plan prepared for the purpose of minimising and mitigating such impacts.

Whereas the Reference Project required part of Anzac Park for realignment of the westbound lanes of the Centenary Motorway, the Changed Project on Anzac Park would be initiated by the provision of up to 300 car parking spaces for workforce parking.

While this would be a significant temporary change in the character of the park in this area, it is not considered to be as extensive as the permanent change that would have been introduced by the Reference Design to the area of the park adjacent to the existing Centenary Motorway. It is also noted that comprehensive rehabilitation would be carried out upon completion of the Changed Project construction. During construction, the loss of access to parts of Anzac Park would require consultation

with the local community. While there would be no direct mitigation for the temporary loss of access to part of Anzac park during construction, the maintenance of the pedestrian / cycle overpass of the Centenary Motorway would assist in linking the Toowong (west) community with alternative open space and recreation opportunities.

4.3.8 Urban Design and Visual Environment

The Coordinator-General's Urban Design and Landscape condition (Appendix 1 Schedule 3 condition 24(c)) requires that the project must rehabilitate the western worksite to a state fit for incorporation into the Botanic Gardens master plan, and revegetate disturbed areas to retain the integrity of the "green gateway" experience along the Centenary Motorway.

The rehabilitation proposed for the western worksite for the Changed Project would adopt the principles of the Botanic Gardens Expansion Plan.

The Changed Project would have reduced impacts on the southern side of the Centenary Motorway, when compared with the Reference Design. The Changed Project would provide noise walls, sound berms and embankment planting to reduce noise and visual impacts on the Botanic Gardens during construction. However, there would be some deterioration of existing viewsheds to the Cemetery.

In the short-term, the visual effect of the western worksite and surface works along the Centenary Motorway for both the Reference Design and the Changed Project would be to diminish the 'green gateway' sought by the Coordinator-General's conditions. This effect would be mitigated with the implementation of the condition requiring rehabilitation of the works areas.

The ventilation station would be buried and integrated into the visual and functional setting of the Botanic Gardens. The ventilation outlet would be visually subsumed into the landscape as a consequence of the changed location, retention of vegetation on the ridge to the south, and the effective architectural and colour treatments proposed.

The Coordinator-General's conditions require that any construction spoil handling facilities within the Mt Coot-tha Botanic Gardens, such as the conveyor, must not impede existing access to public areas. The Changed Project proposes to realign the spoil conveyor further south to avoid public areas within the Botanic Gardens, in response to this condition.

5 Tollroad Control Centre

The EIS for the Northern Link Road Tunnel Project identified that in the operational phase of the project, a number of services would be required for the safe and effective operation of the tunnel. These services would be monitored and controlled from the Tunnel Control Centre (since identified as the Tollroad Control Centre (TCC) due to the wider application of the definition of the tollroad rather than being simply applied to the tunnel aspect of the tollroad).

The TCC would be a dedicated building with the need for road network and tollroad access. The Reference Design proposed that the TCC would be located adjacent to the Centenary Motorway within the rehabilitated worksite area. The TCC for the Changed Project would be located at the corner of Richer Street and Mt Coot-tha Road adjacent to the existing Botanic Gardens overflow car park. In the Northern Link EIS, this site was identified and subsequently approved by the Coordinator-General for use as temporary construction workforce car parking.

The construction of the TCC is currently programmed for mid 2012, with building works taking approximately one year. Works will continue at the TCC once constructed for activities such as fitout, commissioning and testing. Full operation of the TCC would commence once the tollroad is opened.

A site accessed from the Centenary Motorway within the rehabilitated worksite as proposed in the Reference Design would have required access through the Botanic Gardens or directly from the Centenary Motorway. Reasonable attempts has been made with the Changed Project to avoid above ground road tunnel infrastructure within the Botanic Gardens and the Botanic Gardens strongly opposed further above ground infrastructure and TCC access through the public areas of the gardens. The proposed site has direct access off Mt Coot-tha Road.

A site option was developed off Miskin Street within the existing bus depot area. The development on this site however would constrain depot operations, which include bus assembly, maintenance and stabling. This depot is of strategic importance to the operations of the bus fleet servicing the western suburbs, and is one of the principal stabling areas within reasonable proximity to the city centre. Access from this location to the main tunnels would be further constrained, and would not present the efficiencies offered by the site proposed in the Changed Project. The developed option also required the retention of existing parking under the building adding considerably to building cost and to the height and visual impact of the building, even when stepping down the steep slope of Miskin Street.

The consideration of a further alternative associated with land proposed for the temporary site offices on Sir Samuel Griffith Drive was not considered possible due to the temporary lease of the land under consideration and also less favourable access to the toll road and the associated greater impact of TCC traffic on Mt Coot-tha Road.

The TCC concept plan identifies a two storey building approximately 90m long by 20m wide with the height varying from approximately 9 m for the eastern half (due to the additional ground floor height of 5m for the garage area) to approximately 7 m for the western half of the building.

Within the TCC would be the support workshops (for tunnel equipment maintenance and spare parts storage), incident control room, traffic control room and office space for administration. A motor vehicle workshop is not included in the TCC and vehicle maintenance will not be undertaken at the TCC. All data collected by the in-tunnel monitoring systems would be processed and all the services controlled from this location. Obtaining water for the tunnel wash down operations, and installation of the pressure booster

for use by the fire brigade would not be undertaken at the Changed Project TCC location as proposed in the EIS.

The Changed Project TCC will contain the control room which will be a 24 hour, seven days per week operation with at least two on-duty operators at any time while other functions such as office administration and tunnel equipment maintenance would generally take place during 6:30am to 6:30pm Monday to Friday. Equipment maintenance would include the servicing of a range of tunnel equipment including, for example, electronic monitoring equipment, pumps and fans. The TCC would include a training and incident room, office space for the operations and maintenance contractor staff as well as Council and emergency services personnel, a computer and communications equipment room, a plant room, two meeting rooms, workshop space for the maintenance of tunnel equipment, tunnel spare parts store, toilets, showers, change rooms, a reception area and a lunch room. A secure hardstand area will provide parking for incident management vehicles and replacement equipment movements. Driveway access to and from the TCC would be provided from Mt Coot-tha Road.

The TCC would occupy part of a 1 hectare site with all access to and from Mt Coot-tha Road on the southern side of the building. The concept plan for the TCC building is shown on **Figure 5-1**. The current overflow carpark area for the Botanic Gardens on the site contains approximately 88 car spaces. Approximately 58 spaces would be retained for the gardens overflow car park following the toll-road construction. Approximately 30 spaces would be incorporated into the new TCC car park.

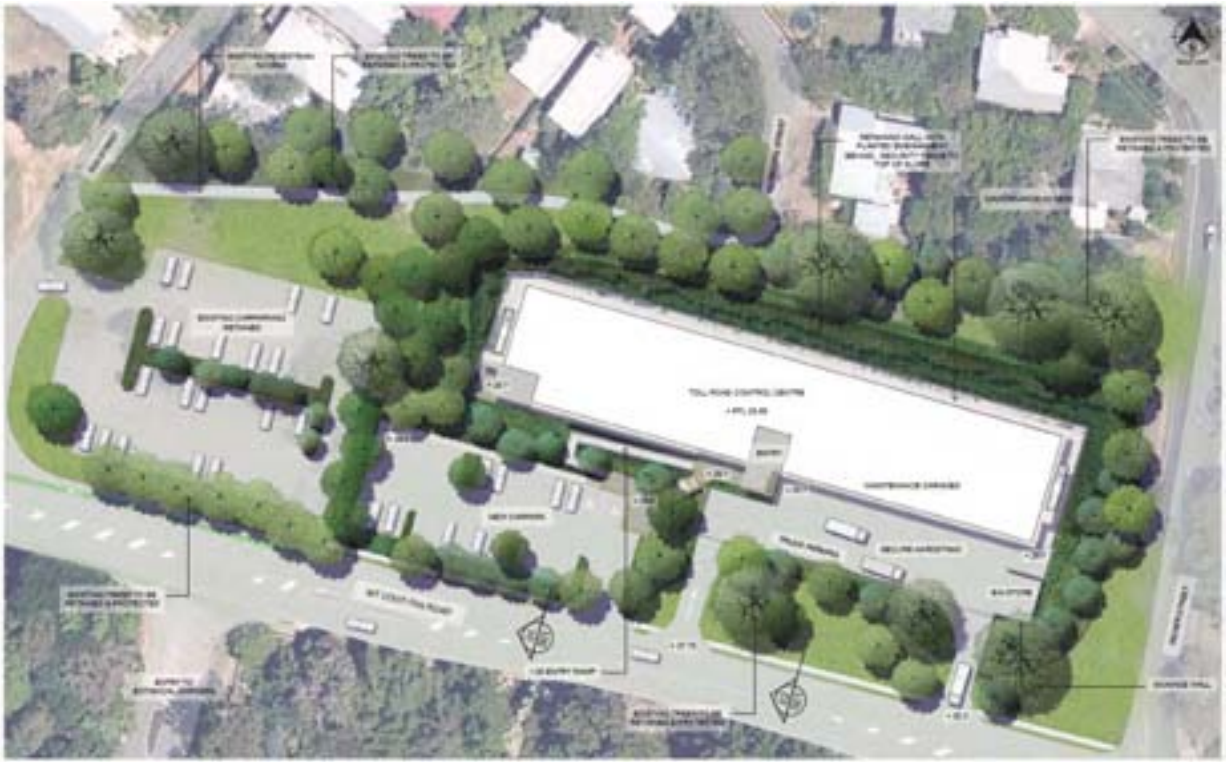

Figure 5-1: TCC concept plan

5.1.1 Traffic and Transport

Before construction of the TCC, due to start in mid 2012 the 88 parking spaces used as an overflow from the Botanic Gardens would remain available for public use. During construction from mid 2012, all public car parking will be unavailable as it will be used for construction purposes. Once construction of the TCC is complete, approximately 58 overflow car parking spaces for the Botanic Gardens would be reopened

for public use. There would be an associated long-term impact from the loss of approximately 30 overflow parking spaces. Council is investigating alternatives to addressing this loss to avoid impacts on local streets.

During operation the TCC, based on preliminary designs and experience with other facilities of similar size, is anticipated to generate approximately 20 vehicle trips per hour in the peak, and 80 vehicle trips per day. The majority of these would be cars for workers within the TCC, with some being incident management vehicles and trucks for the movement of tunnel maintenance parts.

The peak hour trip generation of the TCC represents less than 1% of the expected peak hour traffic at the Mt Coot-tha Road / Centenary Motorway roundabout in 2014 with the Changed Project in place. During operation of the Changed Project this intersection is expected to operate within capacity and with a reasonable level of service. The TCC would not be expected to materially affect the operation of the intersection.

Across the day during operation, the TCC would add less than 0.5% to the forecast traffic volume of approximately 15,000 vehicles per day on Mt Coot-tha Road and would not have a material effect on overall traffic levels.

5.1.2 Geology and Soils

Construction of the TCC building is proposed to involve excavation into the hillside on the subject site to create a level platform and to enhance the way in which the building is incorporated sympathetically into the existing land profile. A retaining wall will be required to ensure the stability of the embankment after excavation of the cutting. The design of this retaining wall will be subject to engineering assessment of the ground conditions in order to determine the required strength and construction method, as well as the expected rate of seepage of groundwater. In addition, the permanent drainage design will need to ensure that ground and surface water can be adequately captured and discharged to Council's stormwater system.

During construction, erosion and sediment controls will need to be implemented to ensure that sediment-laden stormwater does not enter Council's stormwater drainage system or adjacent waterways.

5.1.3 Air Quality and Greenhouse Gases

The primary purpose of the TCC will be management of the ongoing operation and maintenance of the NLRT. The design of any air exhaust systems for the building, including air-conditioning will be undertaken in accordance with the relevant standards.

5.1.4 Noise and Vibration

Protection of adjacent residential amenity will be undertaken in accordance with Brisbane City Council's Noise Impact Assessment Planning Scheme Policy (NIAPSP). The three main acoustic issues associated with such a facility will be air conditioning, maintenance activities, and vehicles entering and exiting the car park.

A preliminary assessment against NIAPSP has been undertaken for the Changed Project to give confidence that an acceptable acoustic amenity will be achievable for the residences directly behind the proposed TCC, and the findings are set out below. Modelling of the predicted maximum noise levels will be carried out during detailed design to determine any appropriate mitigation measures to comply with the NIAPSP requirements.

Air Conditioning

- The applicable limits from NIAPSP are (1) internal noise levels in adjoining residences under the levels recommended in Australian Standard (AS) 2107 and (2) 'background creep' where noise attributable to steady-state sources from the TCC are not allowed to exceed existing background levels.
- A high standard of noise attenuation is readily available for mechanical plant to ensure compliance with NIAPSP via methods such as full acoustic enclosures incorporating acoustic louvres, localised noise barriers or silencers, selecting quiet plant and/or locating such plant at the base of the large cut at the back of the TCC where significant shielding is likely.

Maintenance Activities

- The Sound Power Levels (SWL) of some limited workshop activities may be such that specific noise mitigations, including screening and potentially acoustic linings, may be required to ensure that NIAPSP requirements are achieved.
- The applicable limit from NIAPSP is 'comparison of like parameters' where the intermittent noise emissions from a workshop are not allowed to exceed other short-term noise event noise levels (for example from car passbys, fauna calls, neighbourly residential activities) by more than 3 dBA. In addition, NIAPSP conditions in regard to sleep disturbance will be applicable. Any maintenance activities that need to be carried out at night would be limited and would not exceed night time noise limits.
- A worst case scenario was undertaken involving a hypothetical noise source of up to 105 dBA L10. Unmitigated, it is predicted that such levels would result in noise levels of around 65 dBA L10 at the nearest residences. This compares to existing noise levels around 60 dBA L10 during the day (based on the measurements undertaken at 9 Horrocks St for the Northern Link Road Tunnel EIS).This is a minor 2 dBA exceedence of the NIAPSP goal which may be mitigated by the screening effects of the retaining wall behind the TCC and the rear wall of the workshop. If this was not the case, further mitigations would be required.

Vehicle Movements

- The applicable limit from NIAPSP is 'comparison of like parameters' where the intermittent noise emissions from vehicle movements are not allowed to exceed other short-term noise event noise levels (for example from car pass-bys, fauna calls, neighbourly residential activities) by more than 3 dBA. As the carpark will be used during the night-time period (it is a 24 hour operation), the 45 dBA 'sleep disturbance' limit from NIAPSP would also be applicable.
- The predicted maximum intermittent noise level of cars using the car park at the western end of the TCC at the nearest homes is 54 dBA (based on a 60m separation distance). This is below ambient maximum intermittent noise levels in the area of 55-65 dBA (based on the noise monitoring results in Horrocks St) and the 'comparison of like parameters' limit would be achieved. Using NIAPSP's 5 dBA façade noise reduction for open windows, the external 'sleep disturbance' limit becomes 50 dBA. Without mitigation measures, car parking activities at night, in this area could exceed the sleep disturbance limit by 4 dBA.
- A 4 dBA noise reduction can be readily achieved through the implementation of mitigation measures. The exact mitigation measure(s) for ensuring the sleep disturbance limit is not exceeded will be determined as part of the detailed design process. An example of how the estimated required noise reduction may be readily achieved if found to be required is by the use of a noise barrier to block line of site between the residences and the carpark. Given the topography, a possible location could either be directly surrounding the western end of the TCC car park itself or at the top of the bank/retaining wall near the footpath.
- For all vehicle movements due south of the proposed TCC building (including the truck parking area), compliance with NIAPSP limits would be achieved by the acoustic shielding provided by the TCC building itself.

During the construction period, all construction activities will occur between the hours of 6:30am and 6:30pm Monday to Saturday (in accordance with the Environmental Protection Act and the Coordinator-General's Report conditions for the NLRT).

Vibration

Excavation of the site to create a level construction platform will primarily be carried out using excavators and dozers. Near the surface, the rock is likely to be weathered and therefore relatively soft. However, for the deeper rock, it is possible that limited use of rockbreakers will be required. If required, rockbreakers would be used on site for a short duration and would be operated only during normal daylight construction hours as referred to above.

The nearest dwelling is approximately 20 m from the likely position of the cut face. At this distance, and given that rockbreakers (if required) will only be needed for the deeper rock, vibration is unlikely to pose any structural risk to nearby properties. However, to allay any residential concerns, vibration monitoring would be carried out if requested during rockbreaking activities at the two closest identified properties, in Horrocks Street. Additionally, consultation will be undertaken with adjacent property owners in accordance with the Coordinator-General's conditions.

5.1.5 Cultural Heritage

Despite the land being held in the same land holding as the parcels associated with the Toowong Cemetery, Lot 2/18901 required for the TCC is not part of the Queensland State Heritage registered listing of the Toowong Cemetery.

5.1.6 Ecology

Brisbane City Council's mapping shows a designated watercourse generally following the southern side of Mt Coot-tha Road. This is in relation to a creek within the Mt Coot-tha Botanic Gardens, however, the waterway buffer zone as mapped under City Plan 2000 encroaches on the TCC allotment but not the building footprint. This area does not generally contain riparian habitat and therefore there will be no significant impact on habitat values associated with this waterway buffer zone mapping.

Given the TCC site's proximity to the Mt Coot-tha Botanic Gardens and Toowong Cemetery, and given the number of mature native trees on the site, it is likely that there are arboreal and terrestrial fauna species inhabiting the site, in addition to birds.

Prior to construction of the TCC, fauna surveys will be undertaken to identify the presence of all fauna species inhabiting the site. Prior to construction it is the responsibility of the Contractor to assess construction activities against the requirements of the Nature Conservation Act 1992. Also prior to construction, a suitably licensed fauna spotter-catcher will be engaged to assist with decisions regarding the need to capture and relocate any potentially affected animals to a nearby suitable equivalent habitat. Any relocation will be undertaken by a licensed spotter-catcher.

There is no mapped remnant vegetation on the land. Detailed flora and fauna survey for protected species under the Nature Conservation Act 1992 will be required before construction.

All vegetation within the TCC site is protected under the Natural Assets Local Law 2003. A NALL Permit for this vegetation will be required.

5.1.7 Planning and Land Use

The land is classified mostly as parkland with a smaller section covering most of the bitumen carparking areas used as overflow for the Botanic Gardens as unclassified land being the old Mt-Coot-tha road reserve. Having regard to the setting of the TCC adjacent to the Botanic Gardens and the Toowong Cemetery, the loss of less than 1 ha of green space is not considered to be significant. Development

approval for the TCC would be sought, where required in accordance with the *Sustainable Planning Act 2009* and City Plan. The TCC will result in a loss of approximately 1 hectare of public parkland including car parking areas for the Botanic Gardens. It is considered that the immediate area is well served in terms of both park and conservation areas. A building approval certificate will be required from a building certifier.

The TCC is being assessed by the Coordinator-General under the provisions of the State Development and Public Works Organisation Act 1971 (Qld) (SDPWO Act), as part of the Northern Link Road Tunnel Project. The purpose of the project as a whole is to assist in reducing road congestion in the western and northern areas of Brisbane. As part of an overall transport strategy, the project would help relieve congestion currently experienced on major roads from the west of Brisbane and would assist in providing an effective bypass of the Brisbane CBD.

The current land tenure of the TCC site is a State Reserve (Parks and Recreation) owned by the State with Council as the trustee. The TCC land was originally part of the Toowong Cemetery Deed of Grant in Trust (DOGIT or State Land in trust to Council for a Cemetery). In 2005 Council requested the State to modify the DOGIT to transfer the Deed of Grant for this land from Cemetery to Parks and Recreation. The reason for this was that the land was never used for burial but it was being used by the Botanic Gardens, and still is, as an overflow car park. It was assessed by the cemetery at the time of the transfer that there were never any graves on this land.

5.1.8 Social Environment

Concerns have been raised in relation to a range of issues that are perceived as potentially causing a deterioration in amenity for local residents. Specifically, residents have expressed concerns regarding matters including:

Light Spill

External lighting will be required to illuminate the TCC entry, garage forecourt and staff parking areas, all of which will be located at the front (southern) side of the building. There will be limited requirements to illuminate the rear (northern) side of the building or its rooftop, nor the eastern and western ends of the building. The limited lighting in these areas would be primarily for the purpose of security.

Brisbane City Plan 2000 provides guidance for outdoor lighting through the Light Nuisance Code. While City Plan 2000 and the respective Codes do not apply to the Northern Link Project, the Code provides a useful guide in terms of protecting residential amenity. External lighting of the TCC building will comply with the Light Nuisance Code which requires compliance with AS4282 – Control of the Obtrusive Effects of Outdoor Lighting. The Code goes further to restrict flood lighting to the types of light that give no upward illumination where mounted horizontally, ie a full cut off luminar. It is expected that this further requirement would only be applicable to the limited lighting at the rear and sides of the building. The lighting at the front of the building is likely to require a greater level of illumination for safe access and operation of the TCC.

It is likely that window openings in the western and eastern facades (subject to detailed design) will spill some light from internal spaces. However, at the eastern end (Richer Street) this will have no impact on any nearby residences, while the western end of the building (closest to Ada Street) will be screened by landscaping.

Local Access to Properties

Some residents currently use land along the rear of the TCC site to access the rear of properties in Ada Street and Horrocks Street. Residents refer to this as 'Little Ada Street'. This area is designated "Parkland" under the current planning scheme. There is no road reserve or other form of land title to what is referred to as Little Ada Street, and there is no designated formal access to residences from this land. Residents have expressed concern that the TCC development will result in loss of this access to the rear of properties.

All residential properties can be accessed from their road reserve boundary, either from Ada Street or Horrocks Street. It may be possible to formalise some of the current informal local access arrangements in consultation with affected residents during the detailed design of the TCC.

The existing extension to Horrocks Street within the boundary of the proposed TCC land will be retained and protected from construction work. This area provides a necessary turning ability at the end of Horrocks Street and will not be affected by the location of the TCC as it is presently within the proposed vegetated buffer area.

5.1.9 Urban Design and Visual Environment

The TCC concept plan identifies a 2 storey building approximately 90m long by 20m wide with the height varying from approximately 9m for the eastern half (due to the additional ground floor height of 5m for the garage area) to approximately 7m for the western half of the building.

In isolation, on a flat piece of open ground, and without any attention to the design of the building enclosure, the TCC would have a significant impact on the character of the surrounding residential area.

The building however would be situated on a steeply sloping site with the natural ground level at the rear of the site (ie closest to adjoining residents) between 10 and 14 metres higher than at the front of the site (along Mt Coot-tha Road). The site rises from a level of approximately 28m AHD on Mt Coot-tha Road to approximately 42m AHD on Richer St, 41m AHD at the end of Horrocks St and 32m AHD on Ada St. The building will be cut into this slope, and an existing vegetated buffer approximately 10 to 20m wide will be retained along the northern residential boundary. With the inclusion of a flat roof and integrated landscaping, the potential visual impact to the adjoining residences would be mitigated. An indication of this effect is shown in **Figure 2-34** and **Figure 2-36**.

Views over the TCC toward the Botanic Gardens will be affected only to the extent that the TCC's roof line breaks the horizon from any particular vantage point. It is noted that the existing tree canopy, which already obstructs these views to some extent, will also provide a natural screen against the visibility of the TCC. Additional landscaping is proposed to fill gaps in the existing natural vegetation screen.

When viewed from Mt Coot-tha Road, the overall length of the TCC and its setting cut into the site, will give the building a low-set appearance. While a detailed design has not been prepared, the materials and colours chosen will be sympathetic to the semi-natural setting, and the façade design will be articulated so as to soften its appearance. The site will also be landscaped, with the remaining overflow car parking area returned for use by the Botanic Gardens. The appearance and visual amenity of this portion of the site would not be altered significantly other than through some additional landscaping, in keeping with the approach to landscaping across the remainder of the TCC site.

6 Project Changes to Eastern Connection

6.1 Changes to Project Design – Eastern Connection

The Changed Project would be similar to the Reference Design at the eastern connection, with the tunnel portals in much the same location just to the west of Victoria Park Road.

The key differences between the Changed Project and the Reference Design for the Eastern Connection would be:

- tunnel portals surfacing to the west of the Victoria Park Road access to the ICB
- tunnel portals to be located centrally in the ICB
- tunnel portals to be accommodated by realigning ICB eastbound lanes to the north with access under an additional bridged section of the Inner Northern Busway and adjacent footbridge
- stormwater infrastructure realignment and upgrade works
- new construction site offices and parking allowances.

Similar to the western connection arrangement, the Changed Project would provide both portals in the centre, with the eastbound lanes of the ICB being realigned just to the north and outside of the portals. Compared to the Reference Design, the eastbound exit portal would be approximately 60m further east, adjacent to the western side of the Inner Northern Busway (INB) overpass. The westbound entry portal would be approximately 300m further west of the location proposed in the Reference Design.

The transition structures to the ICB would also be in a similar location to the Reference Design but the ICB lanes have been moved to the north with access under an additional bridged section of the INB structure over the ICB. Consequently, the Northern Link transition structures would be located in the centre of the realigned ICB, with the westbound entry transition structure much shorter than was proposed in the Reference Design.

ICB road works are proposed to extend to the existing land bridge in the east as per the Reference Design, although the Changed Project will have different lane merge and diverge markings. A new span is proposed on the north side of the existing INB bridge, and also for the existing pedestrian bridge to allow for the realigned, eastbound lanes of the ICB. The westbound ICB lanes would remain largely unaffected.

The ventilation station for the Changed Project would be in the same location as proposed in the Reference Design. The ventilation outlet location is also in the same location as the Reference Design.

The Changed Project would provide pedestrian and cycle pathways that are similar to those proposed in the Reference Design. Access would be maintained to existing public transport services.

6.2 Changes to Project Delivery – Eastern Connection

6.2.1 Worksite Layout and Construction Areas

The eastern worksite would extend from Victoria Park Road to the land bridge spanning the Inner City Bypass. The worksite would encompass playing fields used by the Brisbane Grammar School, the northern abutment of the INB and the southern edge of Victoria Park golf course. As with the Reference Design, land within the ICB corridor and to the south of Normanby Terrace would be required.

The site compound for the eastern construction areas would be located on the northern side of the ICB and to the east of the Inner Northern Busway overbridge. Work would also occur between the eastbound and westbound lanes of the ICB.

Access to the site compound would be provided by left-in, left-out connections to the ICB and from Victoria Park Road near the ICB intersection. A site access from Victoria Park Road was proposed also in the Reference Design. Access to the median worksite would also be provided from the ICB westbound.

The ICB surface road works would be constructed in various stages, interacting with and maintaining the existing traffic conditions on the ICB.

The works for the eastern connections would progress in stages, as would works for the Reference Design. During much of the works programme, traffic would continue to use the existing lanes of the ICB in both directions. Eastbound traffic will be restricted to two lanes during phases of the eastern portal construction. The final stage would require a traffic switch for eastbound motorists on the ICB to the new, permanent alignment, to the north of the Northern Link lanes. Westbound lanes on the ICB would be retained on their present alignment throughout the full construction program. There would be some minor disruption when the Northern Link diverge lanes westbound are built into the ICB median.

Access for the ventilation station construction area east of the INB would be provided from the ICB eastbound, via Victoria Park Road. This area includes sites offices and associated functional areas. .

Workforce car parking would be provided for in the construction area adjacent to the ventilation station construction area east of the INB. This area includes sites offices and associated functional areas. Access for construction workers would be provided from the ICB eastbound, via Victoria Park Road. A left-in, left-out access directly from the ICB would be provided for secondary visitor access.

The majority of the workforce parking would be accommodated at an off-site parking area at the eastern end of Gilchrist Avenue, north of the ICB, as proposed in the Reference Design and shown on **Figure 6-1**.

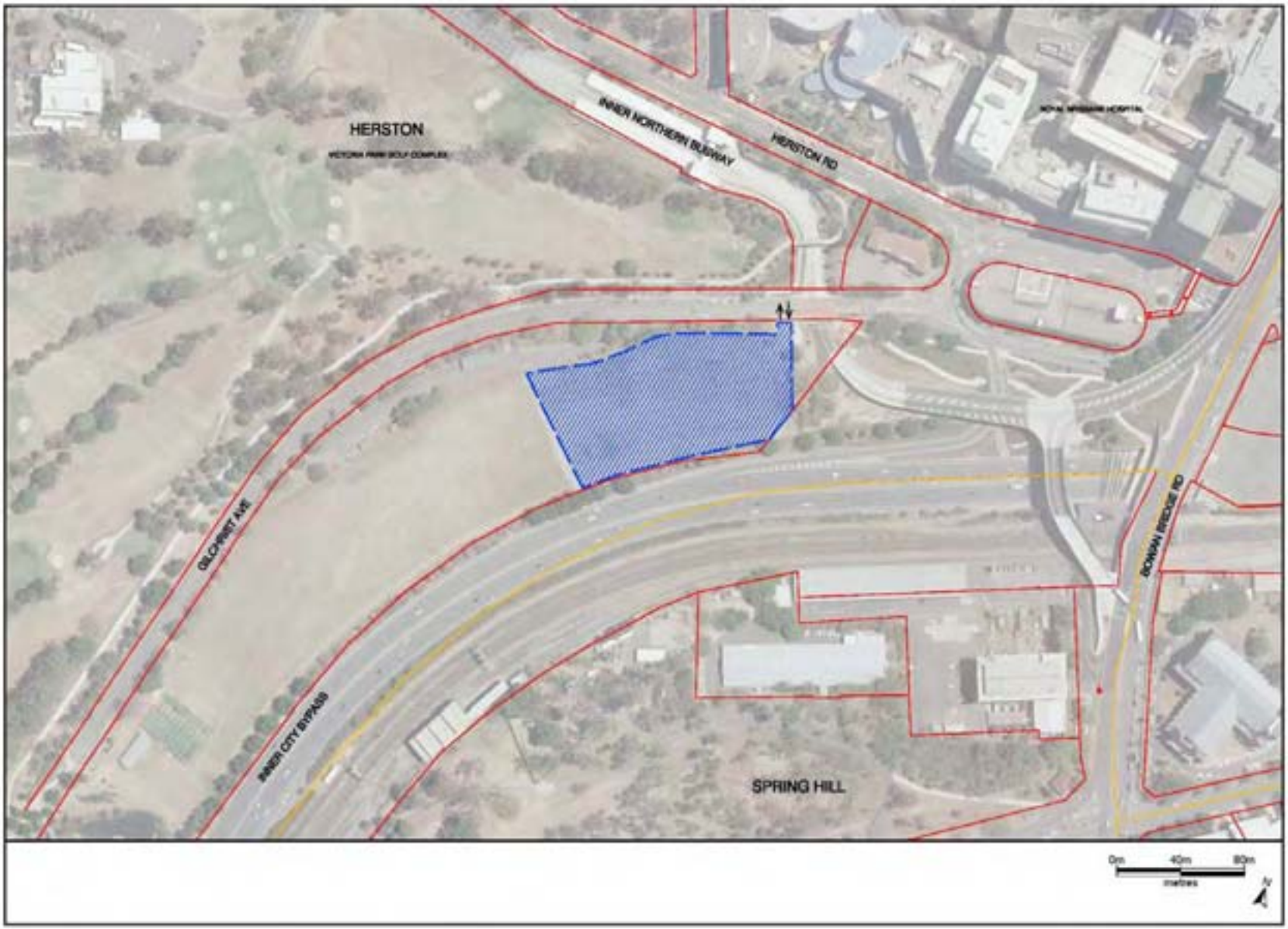

Figure 6-1: Proposed temporary workforce construction parking – Gilchrist Ave, Herston

Shuttle buses would be provided between the Roma Street Transit Centre and the eastern worksite, linking workers to both the rail and busway networks. To avoid and manage the effects of parking in local streets, construction personnel would be directed to use either public transport or the dedicated parking areas. Prepaid public transport tickets would be provided to encourage workers to use these options.

Access to local roads would be maintained during construction. Pedestrian and cyclist facilities would also be maintained but would be diverted around the worksite on its northern side.

The existing pedestrian bridge spanning the ICB would be extended to a new concrete path through the site and adjacent to the INB, linking to the realigned path around the construction site and over the INB. Prior to the final stages of construction the path south of Normanby Terrace would be realigned directly along the back of the residential properties facing the worksite west of Victoria Park Road. Noise barriers would also be constructed.

6.2.2 Crossing under the Inner Northern Busway

With the Changed Project, the proposed realignment of the eastbound carriageway of the ICB would require a restructuring of the current INB bridge over the ICB.

In order to minimise the effect on bus operations on the INB, the Changed Project would provide a separate, temporary INB overbridge that would be used during the realignment of the ICB and construction of the final extended INB structure. Switches in INB traffic between the temporary and permanent bridges would occur at night.

Planning for the switches in busway traffic would be in consultation with the DTMR busway manager, Translink and other stakeholders. With these measures it is expected that the works could be carried out without major interruption to INB services.

6.2.3 Spoil Handling, Haulage and Placement

For the Reference Project, spoil generated at the eastern worksite from construction of the transition structures and cut and cover tunnels would be transported to the Port of Brisbane. For the Changed Project, spoil from the eastern worksite is currently proposed to be transported to an approved placement site adjacent to the Brisbane Airport at Pinkenba.

There may be a requirement for development approval to be obtained prior to the commencement of spoil placement at this site. There may also be a need to consult with the Commonwealth Government to ensure that spoil placement at Pinkenba would not impact on matters of national environmental significance or Commonwealth land. Other suitable approved locations may be identified during the course of the project and would be subject to complying with appropriate approvals and referrals where necessary as well as the Coordinator-General's conditions (refer Schedule 3, Condition 16).

Spoil from the eastern worksite would originate from the cut and cover tunnels and transition ramps onto and from the ICB, the eastern portal structure to extract the TBMs, the eastern site compound and works for the ventilation station and ventilation shaft connecting with the outlet.

Spoil haulage arrangements from the eastern worksite for the Changed Project and for the Reference Design are summarised in **Table 6-1**.

Table 6-1: Summary of change in spoil haulage from eastern worksite

Criterion	Reference Design	Changed Project
Disposal site	Port of Brisbane	Eagle Farm Road, Pinkenba (or other approved route)
Haulage route	Inner City Bypass – Kingsford Smith Drive – Gateway Motorway – Port of Brisbane Motorway	Inner City Bypass – Kingsford Smith Drive – Eagle Farm Rd
Spoil by truck (Bank m^3)	25,000	40,500
Haulage hours	6:30 am Monday to 6:30 pm Saturday, 18 hours per day	6:30 am to 6:30 pm Monday to Saturday,
Ave. haulage per hour (trucks in each direction)	less than 1 for 23 months (3 per day)	2 for 3 months; 1 for 15 months

Site access for haulage vehicles from the Inner City Bypass initially would be via the ICB and Victoria Park Road and then directly from the worksites once necessary works have been undertaken.

The spoil from the eastern worksite would be taken to Eagle Farm Road, Pinkenba via the Inner City Bypass, Kingsford Smith Drive and Eagle Farm Road. The haulage tasks would involve on average two trucks per hour in each direction for the first three months, and then one truck per hour on average in each direction for 15 months. Spoil haulage traffic would be of little significance in terms of traffic flows on Kingsford Smith Drive and Eagle Farm Road. Haulage routes for any other spoil disposal sites would need to be approved by the relevant road authorities.

6.3 Effects of Project Changes – Eastern Connection

6.3.1 Traffic and Transport

The Changed Project would provide connections between the central lanes of the Inner City Bypass and Northern Link in both directions, in contrast to the Reference Design which proposed a tunnel connection to the kerbside lanes of the Inner City Bypass eastbound. To achieve this, the ICB eastbound carriageway would be realigned northwards in the vicinity of Victoria Park Road, and the Victoria Park Road connection to the ICB would be moved slightly to the west. As with the Reference Design, the entry portal for westbound traffic on Northern Link would be from the centre.

The Changed Project would locate the ICB eastbound lanes on the left side of the Northern Link eastbound lanes in the merge area. The most appropriate line-marking arrangement to be implemented would be developed during detailed design. It is likely that an arrangement termed a 'Major Branch Connection' layout which would maintain priority for the two ICB eastbound lanes would be best for implementation in early years of operation. This line marking would reflect the expected balance of traffic demands which would initially have the higher eastbound flows associated with the ICB lanes (rather than Northern Link).

The auxiliary lane in the Northern Link / ICB eastbound merge area would have a similar length to the Reference Design, with the auxiliary lane length for the westbound diverge to the tunnel entry reduced by approximately 80 m.

Performance of merge / diverge arrangements

The performance of the eastern connection for the Changed Project would operate safely and effectively particularly in respect of the proposed merge and diverge arrangements.

Micro-simulation modelling (Paramics) indicate that the performance of the Changed Project would be similar to the Reference Design, as presented in the EIS Supplementary Report and shown in **Table 6-2**. Levels of service are generally similar to the Reference Design, and remain Level of Service C or better, as previously forecast. These results demonstrate that the Northern Link / Inner City Bypass merge and diverge areas would operate with satisfactory levels of service. This finding, together with the application of suitable geometric design standards for sight distance and manoeuvring space, supports the expectation of safe traffic operations.

Table 6-2: Comparison of eastern connection performance results (2014)

Road Network Element	Reference Design				Changed Project			
	Eastbound		Westbound		Eastbound		Westbound	
	Av Speed (2)	LoS (3)	Av Speed (2)	LoS (3)	Av Speed (2)	LoS (3)	Av Speed (2)	LoS (3)
AM Peak								
Northern Link Tunnel	80	A	80	A	76	A	80	A
Inner City Bypass east of tunnel portal (towards Landbridge)	68	B	64	B	66	B	52	C
Inner City Bypass west of tunnel portal (towards Kelvin Grove Road on-ramp)	65	B	-	-	67	A	-	-
Inner City Bypass west of tunnel portal (towards Ithaca Street off-ramp)	-	-	55	C	-	-	65	B
PM Peak								
Northern Link Tunnel	80	A	80	A	73	A	80	A
Inner City Bypass east of tunnel portal (towards Landbridge)	65	B	71	B	60	B	72	B
Inner City Bypass west of tunnel portal (towards Kelvin Grove Road on-ramp)	59	B	-	-	53	B	-	-
Inner City Bypass west of tunnel portal (towards Ithaca Street off-ramp)	-	-	71	B	-	-	75	A

Table Notes:
1. Data extracted from Paramics micro-simulation modelling using input 2 hour peak demands from cordon matrix prepared using Northern Link Traffic Model run TR_2014_257. No peak spreading applied.
2. Average Speed = average speed on link during the middle hour of the peak two hour micro-simulation period.
3. Level of service (LoS) is an index of the operational performance of traffic on a road when accommodating various traffic volumes under different operating conditions. The indicative level of service has been calculated based upon ratio between actual speed and free-flow speed, using Figure 5.12 of the Road Planning and Design Manual (Queensland Department of Main Roads, 2005). Level of service ranges from A (highest) to F (lowest performance).

Ventilation station access

As with the Reference Design, the Changed Project proposes access to the eastern ventilation station from the northern side of the Inner City Bypass, east of the Inner Northern Busway overpass.

The building would require only occasional maintenance access, which would be obtained from the eastbound carriageway of the ICB via a specially widened section of the shared pedestrian/cycle pathway. Maintenance vehicles would be able to decelerate safely, with suitable notice to other vehicles, to use the proposed access point. Use of the shared pathway by project maintenance vehicles would be subject to manned traffic control on these occasions. Brisbane City Council (Road Use Management) have indicated that in principle this arrangement is acceptable.

Pedestrian, cyclist and public transport issues

On completion of construction, the Changed Project would reinstate the level of connectivity provided by pedestrian and cycle facilities in the vicinity of the eastern connection.

During construction, temporary pedestrian and cycle links would be provided around the northern side of the worksite to connect the Victoria Park cycleway with Victoria Park Road, and from there, to Kelvin Grove Road via Musk Avenue and the Kelvin Grove Urban Village. The existing pedestrian bridge across the ICB would be extended to allow connection into the new pedestrian / cycleway to the north. This would be done offline in the early stages of construction, with a temporary closure to install the new deck which would be scheduled in consultation with the relevant parties.

The existing pedestrian bridge between the grammar schools and playing fields would be extended to the north, over the realigned eastbound carriageway of the Inner City Bypass, to re-establish its existing connectivity.

Once complete, Northern Link would not affect bus operations on the Inner Northern Busway.

The Changed Project responds to issues raised in submissions on the EIS regarding pedestrian/cycle connectivity, particularly along Kelvin Grove Road and to the Kelvin Grove Urban Village.

Traffic effects during construction

With the Changed Project, the majority of works for the eastern connection would take place outside the existing carriageways, limiting the impact on road users in this area.

The western carriageway would remain in its existing configuration until the final stage of construction, when a minor realignment would be required to allow completion of the tunnel transition structures. Capacity would not be affected with three traffic lanes maintained throughout the works.

Eastbound, the existing three lanes would be maintained until after the completion of the main tunnel. As with the Reference Design, there would be a limited two lane section eastbound, east of Victoria Park Road, during phases of the works.

In each direction, only a single alignment change would be required, as traffic switches from the existing to the final configurations. Tie-in works would be undertaken during night works to minimise impacts on the existing traffic on the ICB.

The existing connectivity of the local area would be maintained throughout the project. The Victoria Park Road connection to the Inner City Bypass, would be switched to a temporary alignment east of its existing location before switching to its final position. This connection would remain open throughout construction.

It would not be necessary for construction traffic to pass residential areas on Victoria Park Road to reach the site access points. This would be managed through the provisions of the construction traffic management plan and the sub-plan(s) for the eastern worksite.

Spoil haulage

Hourly spoil truck numbers would be higher with the Changed Project than with the Reference Design, due to higher total spoil volumes, reduced operating hours, and a shorter construction period. However, with an average of 2 truck loads per hour moved during the busiest construction period, the spoil haulage traffic generation on this route would remain very low.

This represents a minimal increase in the background traffic on the haulage route, and would not be expected to have any material impact on traffic conditions.

The haulage route from the eastern worksite for the Changed Project would follow the ICB, Kingsford Smith Drive to Eagle Farm Road. The proposed spoil placement site for the Changed Project would be on land adjacent to but separate from the Brisbane Airport at Pinkenba. The spoil haul route would be the same as that nominated for the Reference Design, up to the Gateway Motorway. The proposed change in spoil placement sites, from the Port of Brisbane to Pinkenba would avoid spoil traffic using the Gateway Bridge and Port of Brisbane Motorway. Eagle Farm Road is the primary route serving the Pinkenba heavy industry area and is a designated 25m B-Double route. Eagle Farm Road is an appropriate route for spoil haulage vehicles.

As for spoil haulage from the western worksite, a Construction Management EMP Sub-Plan for the removal of spoil from the eastern worksite would be prepared, in accordance with the approval conditions, to ensure that acceptable operating conditions are maintained. This would include the proposed use of Hale Street / Caxton Street interchange by empty haulage vehicles returning from Pinkenba to U-turn to the Inner City Bypass eastern carriageway. For the Reference Design, returning spoil trucks would travel north along Hale Street to access and reverse into the ICB worksite for loading. The increase in return trips from 3 returning trucks per day to 2 returning trucks per hour would be insignificant in traffic terms and would not impact on road traffic noise on either road. Other suitable locations may be identified during the course of the project and would be subject to complying with the Coordinator-General's conditions (refer Schedule 3, Condition 16).

The haulage hours identified in **Table 6-1** include an allowance of two hours non-haulage time daily to avoid peak hour traffic. This allowance would be reviewed during the preparation of the Construction Traffic Management Plan and EMP Sub-Plan.

Overall, the expected impact from the change in spoil haulage traffic and journey times around the eastern connection associated with the Changed Project would be minimal.

6.3.2 Hydrology

Flooding (Operational)

The location of the eastern connection for the Changed Project is substantially the same as that proposed for the Reference Design. The worksites would also be in the same locations.

The site of the proposed eastern portal is not affected by flooding from the Brisbane River in the estimated 10,000 year ARI flood event (Northern Link EIS – Flooding Report, SKM-Connell Wagner JV, October 2008).

As part of the Changed Project, the following stormwater drainage works in the vicinity of the eastern portal would be undertaken to convey the flood flows from the external catchment:

- reconstruction of the three existing stormwater pipes within the BGS sports field;
- relocation of the grated inlet structure at associated stormwater culverts located within the BGS sports field;
- provide an opening through the existing earth embankment at the northern end of the Inner Northern Busway bridge, to allow for the reconstruction of the cycleway in this area;
- reconstruction of the bikeway and open channel located adjacent to the ICB.

As a result of the above works, the flood levels for all average recurrence interval events up to the 100 year event for the Changed Project (operational) at the BGS fields will be within 20 mm of the existing modelled peak levels. The construction of the eastern portal for the Changed Project would not cause an adverse impact on flood levels in the vicinity of the BGS sports field.

Flooding (Construction)

Flood protection of the eastern cut and cover structure during construction will be provided by a combination of bunding and appropriately staged construction of the external drainage and ventilation duct tunnel structures for the Changed Project. These ventilation tunnel structures, from the take off at the eastbound tunnel to the ventilation station building are in a different location to the Reference Design, hence the structure can be utilised for provision of flood immunity to the works during construction of the Changed Project. The construction of the ICB interchange over stages 1 and 2 (25 month duration) will involve the construction of the eastbound and part of the westbound cut and cover structure, the INB bridge extension, the BGS footbridge extension, tunnel ventilation duct, tunnel structures, drainage culverts and open channel and new eastbound ICB roadway east of Victoria Park Road.

The construction of the cut and cover tunnel requires the installation of a secant pile wall along the northern face of the eastbound cut and cover. A temporary platform will be constructed to facilitate installation of these piles, and this platform will apply over the length of the secant pile wall. The secant piles will extend above the Q10,000 year flood level along the majority of this wall.

Following construction of the INB and BGS bridge extensions, it is planned to excavate for and construct the new drainage inlet pit and culvert and that section of ventilation duct tunnel alongside whilst maintaining the existing pit, culvert and drainage channel to cater for storm events. Following construction of the final open drainage channel and bunding around the new inlet pit and across to the existing ICB eastbound, the existing drainage line will become redundant and it will be demolished. The new ICB eastbound carriageway and northern barrier would then be constructed and will contain any overflow from the detention basin within the designated overland flow path and open drainage channel. An earth bund would then extend around the ventilation duct tunnel to the secant pile wall, thus providing flood immunity for the completion of the ventilation duct tunnel and its connection to the cut and cover structure. This is

similar to the Reference Design where it was proposed to construct the new permanent drainage elements first, then commence construction works, including temporary bunding, such that the Q100 year flood immunity of the tunnelling works could be achieved.

Thus, all of the proposed drainage system for the local catchment will be in place prior to the construction of the eastern portal commencing. The construction site for the eastern portal will therefore have the same immunity as the ultimate design, i.e. 10,000 year ARI event as per the Reference Design.

Groundwater and Surface Waters

The Coordinator-General's conditions for groundwater and surface water conditions are presented in Schedule 3, conditions 21 and 32. These conditions remain relevant to the Changed Project.

No changes to the existing conditions are warranted on the basis of the design changes described above in relation to eastern part of the Changed Project. The various management measures in the Changed Project as part of the construction and operation groundwater and surface water EMP sub-plans are still considered to be appropriate as they are expected to effectively mitigate water-related impacts arising from the construction and operation of the Changed Project.

6.3.3 Air Quality and Greenhouse Gases

The Changed Project, at the eastern connection, would have flatter road alignments and possibly more efficient connections to the ICB than the Reference Design, resulting in more freely flowing traffic in most conditions.

The flatter alignments may result in minor reductions in vehicle emissions within the Changed Project tunnels compared to the Reference Design. However, the differences in motor vehicle pollution, when measured at ground level, are expected to be very small and not significant.

The air quality design and operational features are generally unchanged compared to the Reference Design and the current Coordinator-General conditions remain appropriate.

The eastern ventilation outlet and ventilation station would be situated in the same location as proposed by the Reference Design. The height of the ventilation outlet would be in accordance with the coordinator-General's conditions.

There is no predicted change for construction air quality from the Reference Project.

6.3.4 Noise and Vibration

The main tunnels and connections in the east, for the Changed Project, would be aligned just to the north of the alignments proposed in the Reference Design. There would be some differences in the position and length of the connecting ramps from the Changed Project to the ICB.

The traffic flows through the Changed Project would be substantially the same as anticipated for the Reference Design.

Preliminary modelling (noting that detailed 3D modelling of the new portal/transition areas will form part of the detailed design phase of the project) indicates that compliance with the Coordinator-General's Conditions can be achieved:

- by increasing the existing noise barriers adjacent the Normanby Terrace residences by 1m;
- by installing two new noise barriers – one up to 6m high to the west of Victoria Park Road and one to the east of Victoria Park Rd adjacent to the Brisbane Grammar School sports fields – north of the ICB; and
- without the need for noise barriers to mitigate noise to the schools south of the ICB.

Full compliance with the Coordinator-General's road traffic noise conditions will be achieved through detailed design.

The Coordinator-General's conditions addressing noise and vibration are presented in Schedule 3 conditions 23 and 31. These conditions remain relevant to the Changed Project. The Changed Project and the conditions respond to the issues raised in submissions to the EIS in relation to amenity impacts associated with the construction worksites.

That is, no changes to the existing noise conditions are warranted on the basis of the design changes described above in relation to the eastern part of the Changed Project. The various management measures being proposed as part of the construction and operation Noise EMP sub-plans are still considered to be appropriate as they are expected to effectively mitigate noise impacts arising from the construction and operation of the Changed Project.

6.3.5 Planning and Land Use

The Changed Project would impact on land and land use in the same locations as would the Reference Design.

The extent of property impact would be increased on the playing fields used by the Brisbane Grammar School, to accommodate the realignment of the eastbound lanes of the ICB and the central portals of the Changed Project. Subject to detailed design it is expected that the long term land requirement for operation of the Changed Project will be similar to that described and illustrated in the NLRT EIS for the Reference Project.

The impacts on the use of the Victoria Park golf course would be the same for the Changed Project as those for the Reference Design, with construction of the ventilation shaft between the ventilation station and the ventilation outlet crossing under the 6th green to the 7th tee. As with the Reference Design, this impact would be resolved in consultation with management of the golf course.

7 Relationship with Other Projects

7.1 Centenary Motorway

As described in Chapter 2 of this Application, the connection between the Centenary Motorway and the Changed Project would be via centrally-located portals, within the Botanic Gardens worksite. This will enable a single excavation into the tunnel, co-location of all major road construction to the northern side of the Centenary Motorway, retention of the cycleway and the existing pedestrian and cycle bridge over the motorway with minimal traffic disruption during construction as well as significant benefits to traffic management on the motorway and the roundabout during construction. The central transition structure configuration would meet DTMR requirements, allowing for a continuous motorway arrangement from the Centenary Motorway to the NRLT.

The Changed Project configuration would ensure a minimum of three lanes in each direction along the Centenary Motorway is achievable in the future. Provision has been made for the earthworks for the future widening of the realigned inbound lanes of the motorway as well as a three lane bridge over the centrally aligned tunnel ramps where the tunnel ramps pass into the Botanic Gardens precinct.

DTMR future planning requirements for the Centenary Motorway past the NLRT portals must be achieved without any impact on structures forming part of the NLRT project. This requirement includes provision for cost-effective widening of any new bridge structures provided as part of the project.

7.2 Future planning for a new 'Inner Orbital'

Future planning for Brisbane has identified a new 'Inner Orbital' tunnel between the Centenary Motorway and Stafford Road at Everton Park as a western Brisbane transport network improvement option. Condition 26(b) requires that the connection and 'tie in' of the project to the Centenary Motorway is to be designed and constructed to ensure that:

- operation of the project shall not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel;
- operation of the project should not compromise the ability for future operation of the 'Inner Orbital' tunnel and the Centenary Motorway as a continuous motorway route (that is, maintaining the speed environment) with traffic flow priority on Centenary Motorway directed to the continuous route;
- the Northern Link connection excavation works are not to be below the existing motorway surface levels west of a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886).

Condition 26(b)(iv) seeking an arrangement favouring the outer lanes of the motorway, would need to be varied, or deleted to accommodate the Changed Project tie-in with the Centenary Motorway.

The proposed western interchange configuration for the Changed Project would not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel. There would be no excavation works for the Changed Project to the west of the line identified in the existing condition. The likely or possible future staging at the transition to the Inner Orbital has been identified for the Changed Project to include the following possible stage approach:

Stage 1:

- The Centenary Motorway traffic would remain (as required for the NLRT) while the ultimate southbound carriageway is constructed south;
- The existing shared path along the southern edge would need to be retained and possibly temporarily relocated while the new infrastructure is being built along the southern edge;
- Existing services located along the Centenary Motorway to the south would need to be maintained and relocated to the south.

Stage 2:

- Both Centenary Motorway carriageways would switch to the constructed southbound carriageway. Northern alignments would then be constructed;
- The temporary eastbound approach to the NLRT would require careful consideration. Clear visibility to the major fork is needed and would likely involve the relocation of gantry structures and [set out in full] (ITS) provisions;
- The temporary westbound lanes departing from the NLRT would merge with the Centenary Motorway. Consideration would need to be given to the lane arrangement, parallel lane length and merge visibility;
- This stage would enable the Inner Orbital tunnel portal to be constructed.

Stage 3:

- Following the construction of the tunnel portal area, the Centenary Motorway traffic would then be split along outer edges, allowing the completion of the Inner Orbital transition structures;
- The eastbound traffic lanes would be repositioned in this stage to a permanent alignment. This would involve new gantry locations for the signage and new ITS provisions;
- The westbound traffic lanes would be able to be repositioned onto a permanent alignment.

Council, in agreement with DTMR, will request as part of the conclusion and recommendations of this Application for Project Change that the Condition 26(b) (iv) is amended such that the NLRT portals, troughs and associated tie-in with the Centenary Motorway favours the inner lanes of the motorway.

7.3 Moggill Road Interchange

The amendment of the Reference Design by deleting the local Toowong connections in response to community submissions lodged in relation to the EIS, resulted in predicted increases in traffic at the connections of the Centenary Motorway to Moggill Road. The amended project, now known as the Reference Design, was projected to increase volumes through the signalised intersections at the motorway on and off ramps at Moggill Road by approximately 5% and 13% in the AM and PM peaks respectively in 2014 compared to the scenario without NLRT.

Potential users of NLRT from Taringa, Indooroopilly and St Lucia would utilise this route. The forecast daily traffic increase on Moggill Road between Indooroopilly and the motorway was 3% in 2014 and 4% in 2026. The assessment concluded that the connections could be managed satisfactorily with signal co-ordination in early years post NLRT opening given the lower forecast traffic volumes following the removal of the Toowong Connections. Ultimately upgrades to the interchange configuration at Moggill Road were anticipated in association with the future upgrading of the Centenary Motorway in the 2010 to 2031 time-frame identified in the Southeast Queensland Infrastructure Plan and Program and/or in association with any future 'Inner Orbital' connection with the Centenary Motorway.

DTMR anticipate that the Level of Service (LoS) for the Centenary Motorway on-ramp at Moggill Road would decline with implementation of the Reference Design.

To mitigate the potential for impacts in relation to the Moggill Road/Centenary Motorway Interchange, Council is required, through imposed condition 27 in Schedule 3 of Appendix 1 to the Coordinator-General's Report to design and upgrade the interchange to mitigate traffic impacts resulting from the operation of the project.

The Coordinator-General has recommended that an Interface Agreement between DTMR and Council (Condition 27(d)) be finalised within 120 days of commencement of construction to permit the Interchange upgrades to be in place before the NLRT becomes operational.

The Changed Project would not change this situation at the Moggill Road intersection, such that the conditions for the Reference Design, including the implementation of the Interface Agreement between Council and DTMR, remain relevant and necessary.

Council, in agreement with DTMR, would request as part of the conclusion and recommendations of this application for Project Change that the wording of Condition 27(d)(i) is amended to clarify the LoS for the Moggill Road Interchange.

7.4 Connection with the Inner Northern Busway

The NLRT project would provide an opportunity to deliver a busway-type link for future cross-town bus services between key trip generators in the western and northern suburbs (e.g. Chermside to Indooroopilly, Indooroopilly to Australia TradeCoast) to travel via the NLRT and the Northern Busway or other surface routes. Council is also in consultation with DTMR to examine the potential for efficient and cost-effective bus connectivity between the Inner Northern Busway and the project for the diversion of existing ‘Rocket’ bus services that operate in peak periods between the western suburbs and the CBD.

Council will continue working with the state to analyse the potential for bus-only ramp options at the eastern end of the project to join the Inner Northern Busway or Northern Busway.

Approval for any future connection with the Inner Northern Busway or Northern Busway would be undertaken through the Transport Infrastructure Act.

8 Recommendations and Conclusions

The need and justification for the NLRT project was established when the Coordinator-General recommended that NLRT project proceed in April 2010. The Changed Project is substantially the same as the Reference Project to which the Coordinator-General's evaluation report and conditions of approval relate. The changes for which approval is now sought, relate to redesigned connections with both the Centenary Motorway and the Inner City Bypass for improved traffic flow during both construction and operation, realignment of the tunnel, relocation of the TCC, together with related Project delivery requirements.

The Changed Project would achieve the strategic objectives of Council's Transport Plan for Brisbane 2006-2026, which provides strategies and actions around the public transport services and infrastructure needed for a sustainable future.

The Project would have a significant strategic role in delivering State and Federal infrastructure strategies, including:

- the South East Queensland Regional Plan (SEQRP);
- the South East Queensland Infrastructure Plan and Program (SEQIPP);
- the Australia TradeCoast development; and
- the AusLink national objectives.

It is recommended that the Changed Project proceed, subject to the conditions of the Coordinator-General's Report on the Northern Link Road Tunnel dated April 2010, except where varied by the conditions described below.

8.1 Miscellaneous Conditions

There are a number of miscellaneous matters arising from the Changed Project which could be addressed by further suggested conditions in the Change Report. This includes corrections to typographicals and for clarification. Such matters, and the recommendations with regard to possible additional conditions include:

Amendments or additions to the existing Planning Approval conditions in Appendix 1, Schedule 3 (Imposed Conditions) of the Coordinator-General's Report as follows:

- Add to the end of condition 1(a) the words "as varied by the Coordinator-General's Change Report and the application for the Change Report", to address that the Conditions will include those of the Change Report.
- The Council has engaged an environmental representative to conduct the functions contemplated by condition 14. To avoid unnecessary duplication of functions it is suggested that to the end of condition 5 (c) the following words are added: "The Environmental Management Representative may undertake the audit provided it complies with these requirements".
- The Environmental Management Representative is not tasked with managing compliance. The role is to monitor compliance. In these circumstances, the condition requires amendment and in particular replace in condition 14(b)(iii) the word "manage" with the words "monitor and audit".
- Replace in condition 18(c)(ii) the words "condition 21" with the words "condition 22" to correct typographical error.

Permanent construction works definition should not be limited to the Toowong Worksite. Further, the definition of surface construction works requires amendment to correct a typographical and to allow for

works in an acoustic enclosure not to be classified as surface construction works. The following changes are recommended therefore to Appendix 1, Schedule 6 (Glossary) of the Coordinator-General's Report:

- Delete in the definition of "permanent construction works" the words "for the main Toowong worksite defined in the supplementary report" and "up to the boundary of the main Toowong worksite".
- Add to the definition of "Surface Works" the word "Construction" between the words "Surface" and "Works" and the words "or on and above the surface within an acoustic enclosure" after the words "underground works".

The proposal to provide a temporary car park for the construction workforce in Anzac Park would meet the requirements for the Changed Project, while having the potential to cause nuisance due to noise from the change-over to the night shift workforce. There would be an increase in traffic flows into and from the temporary car parking. This activity would require careful management and monitoring to ensure the acoustic objectives are achieved for nearby sensitive receptors, such as the residential areas to the south of Wool Street. A specific condition is proposed to address this issue. The condition could be addressed most effectively by way of an amendment to Schedule 3, condition 22(h) of the Coordinator-General's conditions as follows:

- Add to Schedule 3, condition 22(h):
  Any night-time noise sources from designated temporary construction workforce car parking must be managed in such a way to achieve the limits set out in Table 10.

  Replace to Schedule 3, condition 22(h):

Table 10: Night-time noise limit

Noise type	**Time of day**	$L_{A10,(adj)(10mins)}$ (measures at a sensitive place)[1]	$L_{A1,(adj)(10mins)}$ (measures at a sensitive place)[1]
• steady construction noise • noise from designated temporary construction workforce car parking	6:30pm – 6:30am	Background +3dB(A)	Background +5dB(A)

1. Measured in accordance with the most recent edition of the *Queensland Government's Noise Measurement Manual*

8.2 Changes to Mainline Tunnel Alignment

As a consequence of the changed alignment, the following State Heritage listed properties are not affected by the Changed Project:

- Baroona, 90 Howard Street, Paddington.

The Changed Project does however have an alignment that directly passes beneath the following State Heritage listed properties:

- Cross Terrace, 50 Upper Cairns Terrace, Paddington;
- Boondah, 50 Howard Street, Auchenflower.

8.3 Connections of the Project to the Centenary Motorway

As identified in Appendix 1, Schedule 3, Condition 26 (a) of the Coordinator-General's Report, the connection and 'tie in' of the project to the Centenary Motorway would be designed, constructed and operated so that it does not limit the ability for possible future widening of the Centenary Motorway to six 'through lanes' – 3 lanes each way. The condition at 26(a)(i) requires a minimum future construction zone to provide for the possible future widening and refers to this as "(Schedule 8). However the drawing referred to (ANX1-6-01 Rev B) as shown in **Figure 8.1** is not the figure shown in Schedule 8 of the Appendix 1**. Figure 8-1** is illustrative only of the Reference Design in relation to outside portals and the allowance for a future construction zone within the median area of the Centenary Motorway.

The Changed Project would satisfy the requirement of the Coordinator-General's condition 26 in that construction would not impede operation of the Centenary Motorway. However, the requirements of condition 26(a)(i) should be amended to accommodate the Changed Project's connection with the Centenary Motorway and provision for future widening on the outside of the motorway.

Condition 26(a)(ii) also requires amendment to remove reference to Schedule 8. The Schedule 8 figure relates to the future planning for a new 'Inner Orbital' and specifically the Condition 26(b)(iii) identifying the extent of Northern Link excavation works. A recommended revised Schedule 8 figure to identify the limit of the future construction zone for a possible future widening of the Centenary Motorway is shown below as **Figure 8-2.**

As a consequence of the changes to the connections of the Changed Project with the Centenary Motorway as well as corrections to the existing conditions it is recommended that:

- The following wording is used to replace conditions 26(a)(i) and 26(a)(ii):
  - "Completed earthworks are required for a possible third lane on the left-hand side of the inbound carriageway of the Centenary Motorway between its junction with the Mt Coot-tha intersection and the limit line of below grade Northern Links Works identified in Schedule 8 and being a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886).
  - This future construction zone shall exclude structures, drainage pipes, drainage materials (aggregate), lighting columns, conduits, cabling, pits, manholes, etc."
- Schedule 8 is replaced by the **Figure 8-2** above
- Add reference to Schedule 8 to the end of Condition 26(b)(iii), and
- Delete condition 26(b)(iv).

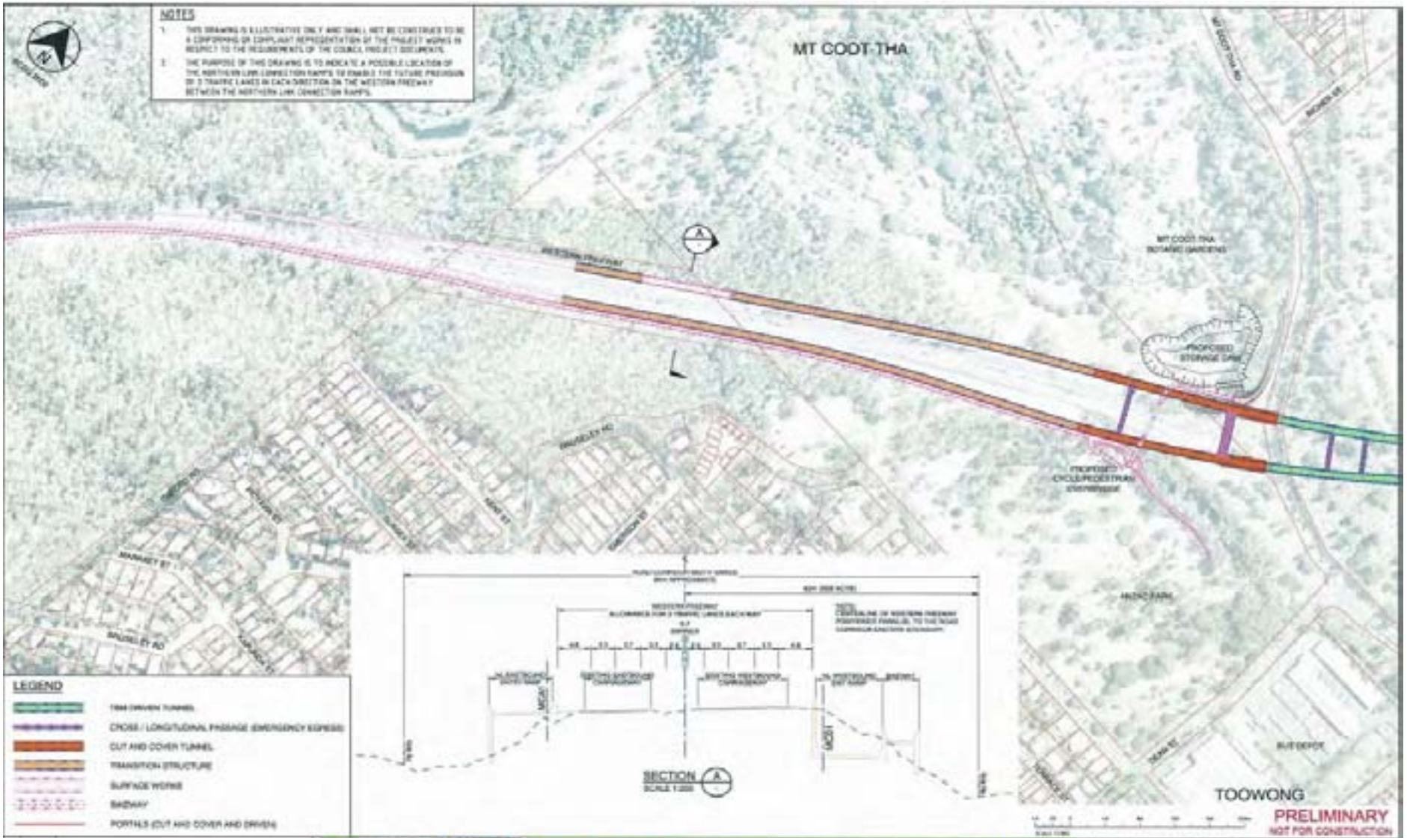

Figure 8-1: Minimum construction zone width for future Centenary Motorway widening

Figure 8-2: Changed Project – Limit of excavation works below Centenary Motorway

8.4 Spoil Conveyor and Quarry Placement

For the Changed Project, the spoil would be placed to facilitate the eventual rehabilitation of the quarry. This is different to the Reference Design. The placement of spoil would not affect the continued operation of the quarry.

The existing quarry development permit remains appropriate for the quarry operations. It is proposed that for delivery of spoil into the quarry, the following new Coordinator-General's conditions should apply:

Conveyor spoil delivery into the quarry must be managed to mitigate any adverse environmental impacts including:

- Spoil may be delivered by conveyor into the quarry providing the environmental objectives and the performance criteria for noise (Schedule 3, condition 22 Table 10 of the Coordinator-General's conditions) are met*;* and
- the environmental objectives and the performance criteria for air quality (Schedule 3, condition 20 of the Coordinator-General's conditions) are met at adjacent residential properties for spoil delivery and placement in the Mt Coot-tha Quarry;

Spoil placement within the quarry, being the distribution, spreading and compaction of conveyor spoil from the project works, must be contolled in accordance with the existing quarry development permit rather than condition 17 of the Coordinator-General's conditions.

As delivery of spoil via the conveyor into the quarry will occur on a continuous basis, this will need to be reflected in condition 18, subject to meeting the noise limits in condition 22 and the air quality requirements of condition 20. Hours of operation for conveyor spoil placement, being the distribution, spreading and compaction of conveyor spoil from the project works, are limited to and the same as the hours of the Mt Coot-tha quarry operations.

It is recommended then that Condition 22(h) is modified to include the words "delivery of spoil into the Mt Coot-tha Quarry" after the word "conveyor".

It is recommended that condition 20(b) is modified to add the words "at a sensitive place of more than" after the words "dust deposition".

It is recommended that condition 18 (c) (ii) is amended to replace the words to the Mt Coot-tha Quarry" with the words " and delivery into the Mt Coot-tha Quarry". Add to the end of condition 18(c)(ii) the words "Delivery into the Mt Coot-tha Quarry does not include spreading and compaction of the conveyor spoil."

These proposed and existing Coordinator-General conditions will ensure that concerns raised in submissions to the EIS regarding amenity impacts of the conveyor and spoil placement operation at the quarry will continue to be appropriately managed.

Appendix B

Summary of Coordinator-General's conditions and recommendations

Summary of Coordinator-General's condition assessment and proposed recommendations			
Technical expert assessment	**Main Alignment**	**Eastern Connection**	**Western Connection**
Tunnel design			
Condition review	▪ Schedule 3, Part 2, Condition 25 ▪ Schedule 3 Clause 16 (a) to (l)	Not applicable.	Not applicable.
Recommendations	▪ Traffic management plan for the delivery of concrete rings from Wacol or similar to the Western worksite should be submitted for approval in accordance with Coordinator-General's traffic management condition Schedule 3 Clause 16 ▪ The Coordinator-General Report reference to AS 4360:2004 Risk Management, should be amended to reflect the revised AS/NZS ISO 31000:2009 ▪ tunnel Construction Management Plan should be required to include specific reference to locations of low overburden and special measures put in place to ensure a heightened level of vigilance when construction activities are being undertaken in these areas. Surveys and ground instrumentation should be required to be in place and a detailed ground monitoring regime installed and fully baselined before tunnelling is allowed to proceed below points where the tunnel excavation is within 1.5D of the ground surface ▪ In areas where tunnelling through a weathered horizon is expected (i.e. conditions where the weathering of the rock in the tunnel face varies from relatively unweathered in the invert to significantly weathered in the crown) there should be a requirement that the associated risks must be specifically identified in the project Risk Register and managed as part of the contractor's tunnel CMP ▪ detailed geotechnical assessment and hydrogeological assessment for each cross passage, particularly those at shallower depths and with overlying sedimentary deposits, accompanied by pore pressure monitoring in the overlying deposits before, during and after tunnelling should be specifically required ▪ A detailed plan of additional site investigation proposals must be submitted and detailed requirements assessed for areas of high risk including areas of low cover (less than 1.5D) and areas of mined tunnel excavation close to potentially sensitive surface deposits and structures ▪ Removable anchors: the contractor must be able to demonstrate that the anchors used are indeed removable	Not applicable.	Not applicable.
Tunnel alignment			
Coordinator-General's condition review	No specific conditions are identified.	No specific conditions are identified.	▪ Imposed conditions: 26 – Centenary Motorway connection and 27 – Impact on the Moggill Road Interchange of the Centenary Motorway
PB's Recommendations	No further conditions deemed necessary	No further conditions deemed necessary The project specification calls for 80km/h design speeds. It is noted that the contractor has applied for an agreed exception on this point The Coordinator-General must be comfortable that Project Design Standards are being adequately addressed throughout the verification and approval process to ensure high levels of road user safety are provided.	▪ Imposed conditions: 26(a) (i) and 26(a) (ii) be **replaced** with the wording; '*Completed earthworks are required for a possible third lane on the left hand side of the inbound carriageway of the Centenary Motorway between its junction with the Mt Coo-tha intersection and the limit line of below grade Northern Link Works identified in Schedule 8 and being a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886)* *This future construction zone shall exclude structures, drainage pipes, drainage materials (aggregate), lighting columns, conduits, cabling, pits, manholes etc.'* ▪ Schedule 8 is **replaced** with Figure 8-2 (of change report)

			▪ **Insert** reference to Schedule 8 to end of 26(b) (iii) ▪ **Delete** condition 26(a) (iv) ▪ 26(b) – Future planning for Brisbane has identified a new 'Inner Orbital' tunnel between the Centenary Motorway and Stafford Road at Everton Park as a transport network improvement option. The connection and 'tie-in' of the project to the Centenary Motorway is to be designed and constructed to ensure that: (i) Operation of the project shall not compromise the ability for a future connection of Centenary Highway with an 'Inner Orbital': **item addressed in Section 7.2 of the change report** (ii) Operation of the project should not compromise the ability for future operation of the 'Inner Orbital' tunnel and the centenary Motorway as a continuous motorway route (that is maintaining the speed environment) with traffic flow priority on Centenary Motorway directed to the continuous route: item addressed in section 7.2 of the change report. (iii) The Northern Link connection excavation works are not to be below the existing motorway surface levels west of a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886): **item confirmed in Section 7.2 of the change report (unable to verify without access to CAD data)** (iv) The western Northern link portals troughs and associated 'tie-in' with the Centenary Motorway shall favour the outer lanes of the motorway carriageway without affecting the existing median width or narrowing motorway lane widths: portals have been located to the centre of the motorway and Section 7.2 of the change report notes that this condition would need to be varied or deleted to accommodate the change project tie-in with the Centenary Motorway. Section 4.1 of the change report makes reference to observations in the Coordinator-General's report that 'the construction of road tunnels is often simpler and less costly if portals are located on the inside of major feeder roads and that, subject to further assessment, there was potential merit in an inner-portal final design option at the western end.' ▪ Condition 27 – Moggill Road Interchange
Structures			
Coordinator-General's condition review	No specific conditions are identified.	▪ Clause 3 (a) of Schedule 2 ▪ Clause 3 (b) of Schedule 2 ▪ No specific provisions relating to pedestrian traffic.	No specific conditions are identified.
PB's Recommendations	No specific conditions are identified.	▪ **Insert** condition that the proponent must consult with Brisbane Grammar School to identify and implement actions to minimise disruption to pedestrian traffic between the School campus and Victoria Park ▪ Clause 3 of Schedule 2 are considered to adequately cover potential impacts of the changes on the busway operations.	No further conditions deemed necessary
Transport and traffic			
Coordinator-General's condition review	*Traffic management:* ▪ During the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 16 (a) to (l) ▪ For the operations phase of the project, the requirements shall be in accordance with Schedule 3 Clause 30 (a) to (c). ▪ For spoil handling and placement: during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 17 (a) to (f)	▪ Schedule 2 Clause 3 (a), approval must be obtained from the Busway Manager DTMR or Railway Manager (Queensland Rail) prior to any interference with a busway or railway under the *Transport Infrastructure Act 1994* ▪ Schedule 2 Clause 3 (b), if any project works are likely to interfere with the operation of busway or railway services, consultation must be undertaken with the Busway Manager or Railway Manager to identify and implement actions which will minimise disruption to busway or railway operations	▪ Schedule 2 Clause 2: DTMR approval for connections to SCR ▪ Schedule 3 Clause 12 (a) and (b): pedestrian/cycle connectivity ▪ Schedule 3 Clause 16 (a) to (l): traffic management ▪ Schedule 3 Clause 17 (a) to (f): spoil handling and placement ▪ Schedule 3 Clause 18(a) to (o): other conditions ▪ Specific measures must be taken to manage and mitigate construction impacts include: i. Access points for pedestrian and vehicular traffic must be situated

	Other relevant conditions: ▪ For general construction during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 18 (a) to (o).	▪ Traffic management during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 16 (a) to (l) ▪ Spoil handling and placement during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 17 (a) to (f) ▪ Other conditions for general construction during the construction phase of the project, the requirements shall be in accordance with Schedule 3 Clause 18 (a) to (o) ▪ Traffic management for the operations phase of the project, the requirements shall be in accordance with Schedule 3 Clause 30 (a) to (c).	according to the Transport, Access, Parking and Servicing Planning Scheme Policy in City Plan 2000. ▪ The construction workforce must not park in local streets. A dedicated and adequate construction workforce off-street parking area must be provided. All construction workforce vehicles must be directed to project construction workforce car parks. To avoid construction workforce car parking in local streets, shuttle transport between construction workforce car parks distant from a construction area must be provided for the duration of the period the construction area is in use
PB's Recommendations	No further conditions deemed necessary	No further conditions deemed necessary	▪ Spoil haulage and placement description will also require to be amended based on the spoil placement sites identified by the Changed Project ▪ Schedule 3 Clause 26 will be necessary to account for the proposed changes to connection between the Centenary Motorway and the NLRT ▪ Existing Coordinator-General Conditions mentioned in the above section is considered sufficient to cover potential impacts during construction and operation phases ▪ Additional condition: the proponent must consult with Botanic Gardens to identify and provide mitigation measures to minimise impacts to the Botanic Gardens due to provision for general maintenance/security vehicle accessing the ventilation building through the Garden ▪ Schedule 3 Clause 18(k). Moreover, it is likely that traffic will increase in the local area due to traffic flows into and from the temporary car parking for the duration of the construction period. There is also the need to confirm the adequacy of the number of parking spaces provided for the anticipated number of construction workforce ▪ PB recommends that further consultation be undertaken with DTMR to clarify that the opportunity for future upgrades to the Centenary Motorway and local road network , the connection with the future Inner Orbital and works required for the Moggill Road ramps would not be jeopardised by the Changed Project
Geology and soils			
Coordinator-General's condition review	No specific conditions are identified.	Not applicable.	Not applicable.
PB's Recommendations	additional conditions are added to the Coordinator-General report requiring specific attention to the risks in areas where tunnelling through mixed face conditions is anticipated and a submission of a detailed action plan from the contractor to address and mitigate these risks. . In combination with the additional site investigation, measures such as those identified in section 2.1.6 would be appropriate.	Not applicable.	Not applicable.
Hydrology and groundwater			
Coordinator-General's condition review	**Hydrology (surface water) and Hydrogeology (groundwater)** ▪ Schedule 3, Part 2, Item 15(f)(ii): EMP sub plan for hydrogeology and ground water quality ▪ Schedule 3, Part 2, Item 21	Not applicable .	Not applicable.
PB's	No further conditions deemed necessary	Not applicable.	Not applicable.

Recommendations			
Air quality and greenhouse gases			
Coordinator-General's condition review	▪ Schedule 1, Condition 4 and Schedule 3, Condition 2	▪ Schedule 3, Condition 20	▪ Schedule 1 Condition 4 and Schedule 3, Condition 20
PB's Recommendations	No further conditions deemed necessary. If there are any design changes to the Changed Project, then consideration will be required for the in-tunnel air quality goals to ensure the revisions to the project continue to meet the Coordinator-General's requirements.	No further conditions deemed necessary.	▪ **Amendment:** Condition 4 (c) describes the location of the western ventilation outlet for the Project. This should be amended for the revised location under the Changed Project ▪ **Amendment:** Table 3 outlines the monitoring sites for ambient air quality in the vicinity of the ventilation outlets. Revised monitoring location for the western ventilation outlet should be provided to reflect the changed location of this facility
Surface water quality			
Coordinator-General's condition review	▪ Schedule 3, Conditions 21 and 32	▪ Schedule 3, Conditions 21 and 32	▪ Schedule 3, Conditions 21 and 32
PB's Recommendations	No further conditions deemed necessary.	No further conditions deemed necessary.	No further conditions deemed necessary.
Environmental management			
Coordinator-General's condition review	▪ Schedule 3, Conditions 14, 15 and 29	Not applicable.	Not applicable.
PB's Recommendations	No further conditions deemed necessary.	Not applicable.	Not applicable.
Flora and fauna			
Coordinator-General's condition review		▪ Schedule 3, Condition 19	▪ Schedule 3, Condition19
PB's Recommendations	No further conditions deemed necessary	No further conditions deemed necessary	No further conditions deemed necessary
Noise			
Coordinator-General's condition review	▪ Disparities were identified between the ground-borne noise objectives in Table 11 and the Acoustic Quality Objectives for air-borne construction noise in Table 9	*Operational & construction noise:* ▪ Condition 22 ▪ Noise and Vibration EMP Sub Plan	*Operational & construction noise:* ▪ Noise and Vibration EMP Sub Plan
PB's Recommendations	▪ the proponent should confirm that they believe that their current modelling predictions represent a conservative approach or otherwise. If they do not believe that the modelling they have presented would represent a conservative approach then some indication of the potential worst case level of impact should be provided. This would enable the Coordinator-General to make an informed decision in relation to the risk of impacts due to regenerated noise ▪ the prediction and assessment of ground-borne noise impact in the Project Change Report should be revised, such that it is based on the predicted level of ground vibration, instead of being undertaken based on a separate prediction methodology.	▪ Proponent to provide specific details of the noise control measures to achieve the Coordinator-General's Conditions during detailed design ▪ Preparation of a Noise and Vibration Sub Plan as detailed in the Coordinator-General's Conditions is deem acceptable	▪ As required by Coordinator-General's Schedule 3, Condition 22 (b), a Noise and Vibration Sub-EMP would be required for the NLRT Project and assessed by an independent acoustic specialist. Although no amendment is recommended to this condition, it is noted that as part of this condition, the proponent should include specific details of the noise control measures to achieve the Coordinator-General's conditions during detailed design. To enable an independent review of the Changed Design would require the following information: - Noise contour maps of the worst case noise exposure at nearby residences both with and without noise barriers. - The input data used in the modelling such as traffic volumes, percentage heavy vehicle, speed etc
Vibration			
Coordinator-	▪ Conditions are considered appropriate to ensure that the amenity of	Not applicable.	Not applicable.

General's condition review	residents about the Changed Project alignment is maintained at acceptable levels		
PB's Recommendations	▪ In some sections of tunnelling, additional assessment methods may also be necessary to ensure construction generated vibrations do not impact upon the integrity of the infrastructure. Methods may include the use of vibrating wire extensometers, crack gauges, glass slides or other physical methods to quantify any impacts of the tunnelling activities. These methods are expected to be necessary where condition surveys show infrastructure to be in poor condition, such as through the Toowong Cemetery	Not applicable.	Not applicable.
Planning, social and land use			
Coordinator-General's condition review	▪ Schedule 1, Item 2 ▪ Schedule 3, imposed conditions ▪ Schedule 3, Part 2 (design and construction phase), Item 6 relating to communication and consultation highlights the communication protocol	▪ Schedule 2, approvals	▪ Schedule 3, Item 18 ▪ Schedule 2, Item 2 ▪ Schedule 2, Item 4 ▪ Schedule 3, Item 16 ▪ Schedule 3, Item 18(k)
PB's Recommendations	▪ Appendix 1, Schedule 1, Item 2(b), development on a State Heritage Place be amended to reflect the following: ▪ **remove** Baroona, 90 Howard Street, Paddington ▪ **insert** Boondah, 50 Howard Street, Auchenflower and Cross Terrace, 50 Cairns Street, Paddington.	▪ Schedule 3, Item 16 (traffic management), that the condition (g) be amended to state the following: *(vi) measures to prevent the parking of construction traffic on streets near to work sites,* **including provision of prepaid public transportation tickets and shuttle buses between Roma Street Transit Centre and the eastern worksite to the construction workforce**. ▪ Insert condition under Schedule 2: requirement for relevant applications under the BCC's Local Laws, including, but not limited to, vegetation clearing under the *Natural Assets Local Law 2003* and to undertake works within a BCC controlled road under Chapter 6 Streets, Bridges, Culverts etc.	▪ Schedule 3, Item 16 (traffic management), that the condition (g) be amended to state the following: (vi) measures to prevent the parking of construction traffic on streets near to work sites, including provision of prepaid public transportation tickets and shuttle buses ▪ Insert condition under Schedule 2 relating to the requirement for the proponent to lodge relevant applications under the BCC's Local Laws, including, but not limited to vegetation clearing under the Natural Assets Local Law 2003 and to undertake works within a BCC controlled road under Chapter 6 Streets, Bridges, Culverts etc. ▪ insert Item 7, Building Approval for associated infrastructure, including the development of the Toll Control Centre ▪ Appropriate consultation and negotiation is required in accordance with the relevant legislation to limit the impact of this change. Schedule 3, Part 2 (design and construction phase), Item 6 relating to communication and consultation highlights the communication protocol.
Visual amenity			
Coordinator-General's condition review	Not applicable.	▪ Schedule 1, Item 4 (ERA 51 - road tunnel ventilation stack operation)	▪ Schedule 1, Item 4 Material Change of Use for an ERA 51 – road tunnel ventilation stack operation
PB's Recommendations	Not applicable.	▪ Clarification should be sought from the proponent on the mitigation measures that will be established to address the visual amenity reduction ▪ Furthermore, there were limited mitigation measures proposed by the proponent that would address the visual amenity reduction and include appropriate consultation with key stakeholders to identify opportunities to mitigate the visual impacts of the project. ▪ The Coordinator-General's Condition 18 (Schedule 3), (m) details requirements to meet appropriate visual amenity outcomes for the NLRT Project. PB recommends upfront consultation with the key community groups to ensure early input to the detailed design phase. An amendment to Item (iii) of Condition 18(m) is proposed, being (iii) Consultation with the CLGs commencing at the design stage to discuss additional solutions to mitigating the visual impact of the	▪ Coordinator-General request visual proof from the proponent that the visual impact from the Changed Project ventilation station is reduced, equal or better than that proposed in the RD ▪ Appendix D of the Supplementary Environmental Impact Statement details provisions under the EMP for the tunnel portals and connections. A comparison of the Changed Project against the RD and these criteria were not undertaken by the proponent to determine the potential visual amenity impacts or improvements

		construction areas ▪ Appendix D of the Supplementary Environmental Impact Statement details provisions under the EMP for the tunnel portals and connections. A comparison of the Changed Project against the RD and these criteria were not undertaken by the proponent to determine the potential visual amenity impacts or improvements	
Non-indigenous cultural heritage			
Coordinator-General's condition review	▪ Appendix 1, Schedule 1, Item 2(b)	▪ Schedule 1, Conditions 2 and 3.	▪ Schedule 1, Conditions 2 and 3
PB's Recommendations	▪ remove reference to 'Baroona' and include 'Boondah' at 50 Howard Street Auchenflower and 'Cross Terrace' at 50 Cairns Street, Paddington as additional places that will require specific Cultural Heritage Management Plans prior to any construction works commencing ▪ Additional recommendations to address vibration impacts on Toowong Cemetery are outlined in Section 2.11	No further conditions deemed necessary.	No further conditions deemed necessary.