# 9 APPENDICES

## Appendix A.1 – Change to Program / Alternatives

2009 | 2010 | 2011 | 2012 | 2013

Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

Cable Paths Available & Precommissioning

AL MEFT Systems Commissioning

186 Ramp B - Tunnel Excavation Heading - Ch 733

126 Ramp B - Tunnel Excavation Benching

15 Ramp B - Tunnel Excavation Heading Ch 117 to Ch 80

49 Ramp B Remaining Bench & Invert

Ramp B - Complete Archlining, Smoke Duct & Fitout

Ramp B [KF06>ChB80] Cable path available

129 Ramp C - Tunnel Excavation Heading incl Canopy Tube Installation

23 C3 Access cross-cut to Westbound Off Ramp D [ChC420>ChD360]

29 Ramp C - Tunnel Excavation Bench & Invert Front 2 - Bottom of Ramp C

95 Ramp C - Tunnel Excavation Bench & Invert Front 1

Ramp C - Complete Arch Lining,Smoke Duct & Fitout

Ramp C [KE02>ChC245] Cabling path available

252 Ramp D - Tunnel Excavation Heading - Front 1

66 Ramp D - Tunnel Excavation Heading - Front 2

68 Ramp D - Tunnel Excavation Bench & Invert - Front 2

Ramp D - Complete Arch Lining, Smoke Duct & Fitout

Ramp D [KB05>ChD665] Cable path available

121 EB Cavern - Excavation Heading

74 EB Cavern - Excavation Benching

TBM Arrival to Kedron Cavern Eastbound

TBM Complete through Kedron Cavern Eastbound

Eastbound Cavern - Complete Arch Lining, Smoke Duct & Fitout after TBM

59 WB Cavern - Excavation Heading

40 WB Cavern - Excavation Benching

TBM Arrival to Kedron Cavern Westbound

TBM Complete through Kedron Cavern Westbound

Westbound Cavern - Complete Arch Lining, Smoke Duct & Fitout after TBM

WB TBM Excavation & Precast Invert to Kedron Cavern

WB TBM - Excavation & Precast Invert to From Kedron Caverns to Chalk St

Westbound TBM - Complete Smoke Duct, Roadway & Fitout

EB TBM Excavation & Precast Invert-to Kedron Cavern

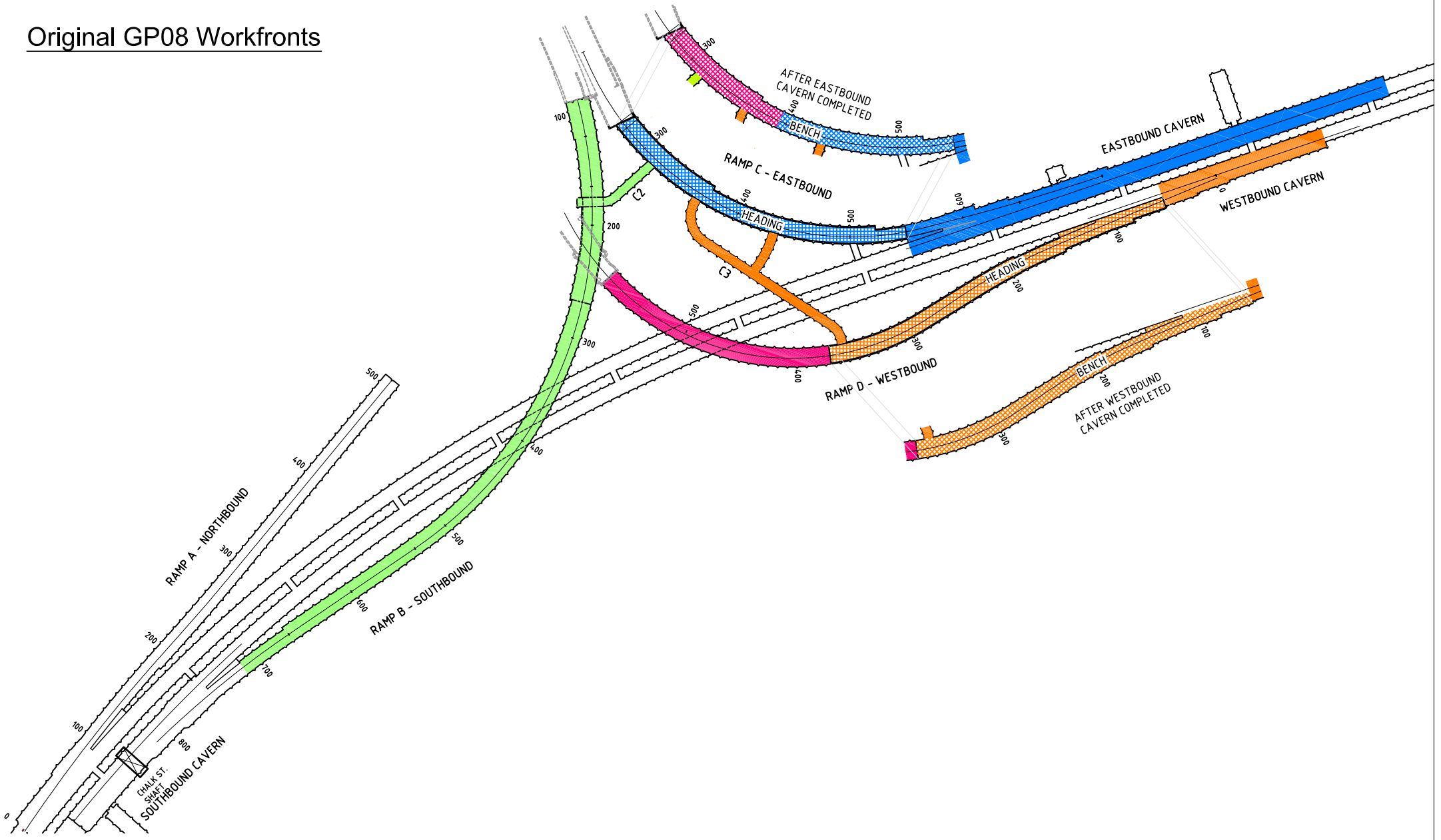
EB TBM Excavation & Precast Invert - Kedron Caverns to Chalk St

Eastbound TBM - Complete Smoke Duct, Pavement & Fitout

# Original GP08 Workfronts

Summary Bar
Summary Bar
RH 1
Milestone
RH 2
RH 3
RH 4

# Original GP08 Workfronts




PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

| Issue | Date | Description | Appd |
|---|---|---|---|
| A | 22.05.09 | INITIAL ISSUE | |

A1 ORIGINAL

Project/Contractor: BRISCONNECTIONS

Construction / Design Team: THIESS, John Holland



Designed: -
Checked:
Drawn: TM
Checked:
Approved:
Date: 22.05.09

Drawing Title: Airport Link
Mined Tunnel - Tunnel
Kedron On-Ramps
Original GP08 Workfronts

Project: AIRPORT LINK AND NORTHERN BUSWAY PROJECT

Drawing No:

Issue: A

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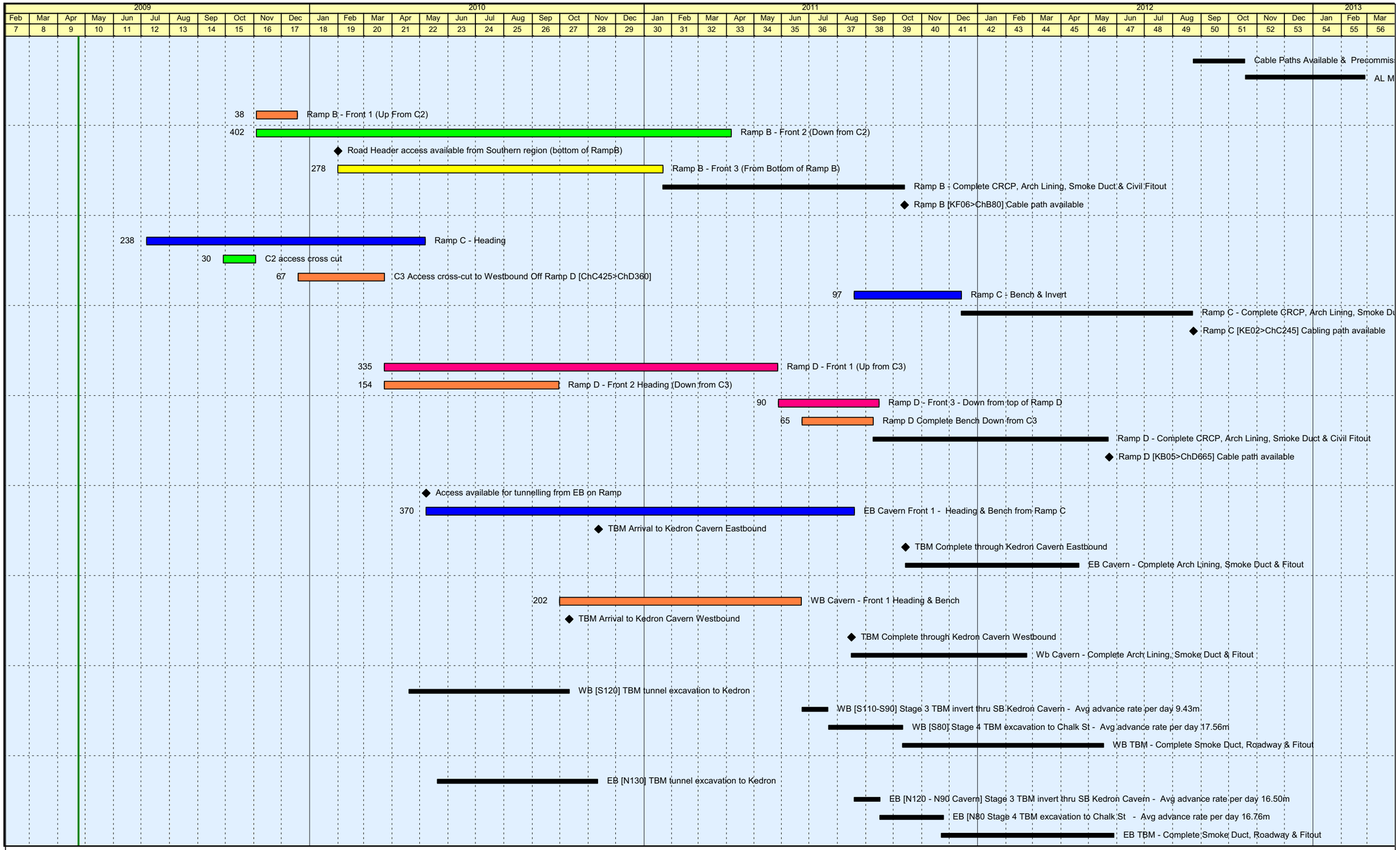


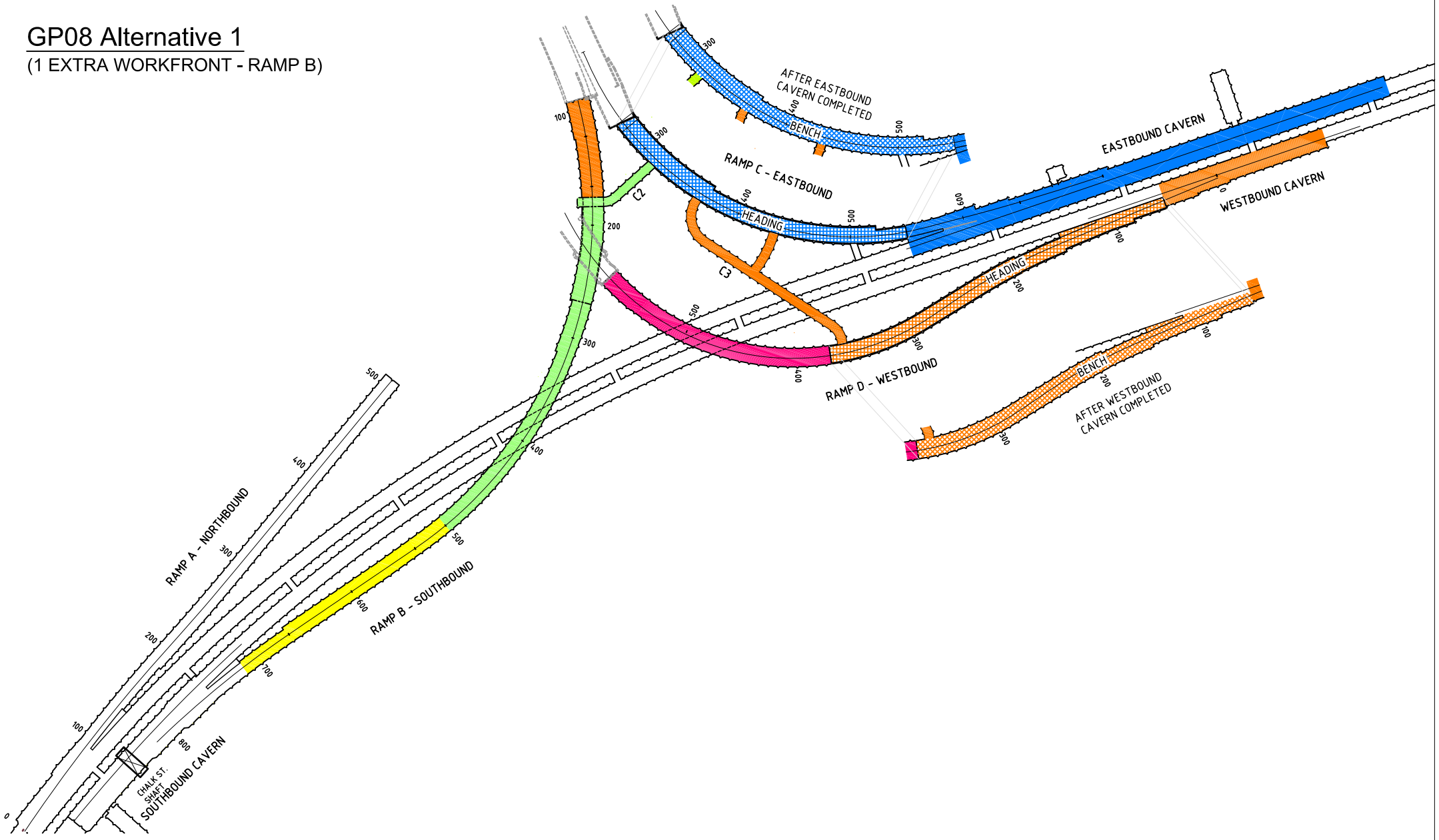

# GP08 Alternative 1

## 1 Extra Workfront (Ramp B)

Summary Bar
RH 1
RH 2
RH 3
RH 4
RH 5
Summary Bar
Milestone

# GP08 Alternative 1

(1 EXTRA WORKFRONT - RAMP B)




PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

| Issue | Date | Description | Appd |
|---|---|---|---|
| A | 22.05.09 | INITIAL ISSUE | |

A1 ORIGINAL

Project/Contractor: BRISCONNECTIONS

Construction / Design Team: THIESS, John Holland



Designed: -
Checked:
Drawn: TM
Checked:
Approved:
Date: 22.05.09

Drawing Title: Airport Link
Mined Tunnel - Tunnel
Kedron On-Ramps
GP08 Alternative 1

Project: AIRPORT LINK AND NORTHERN BUSWAY PROJECT

Drawing No:

Issue: A

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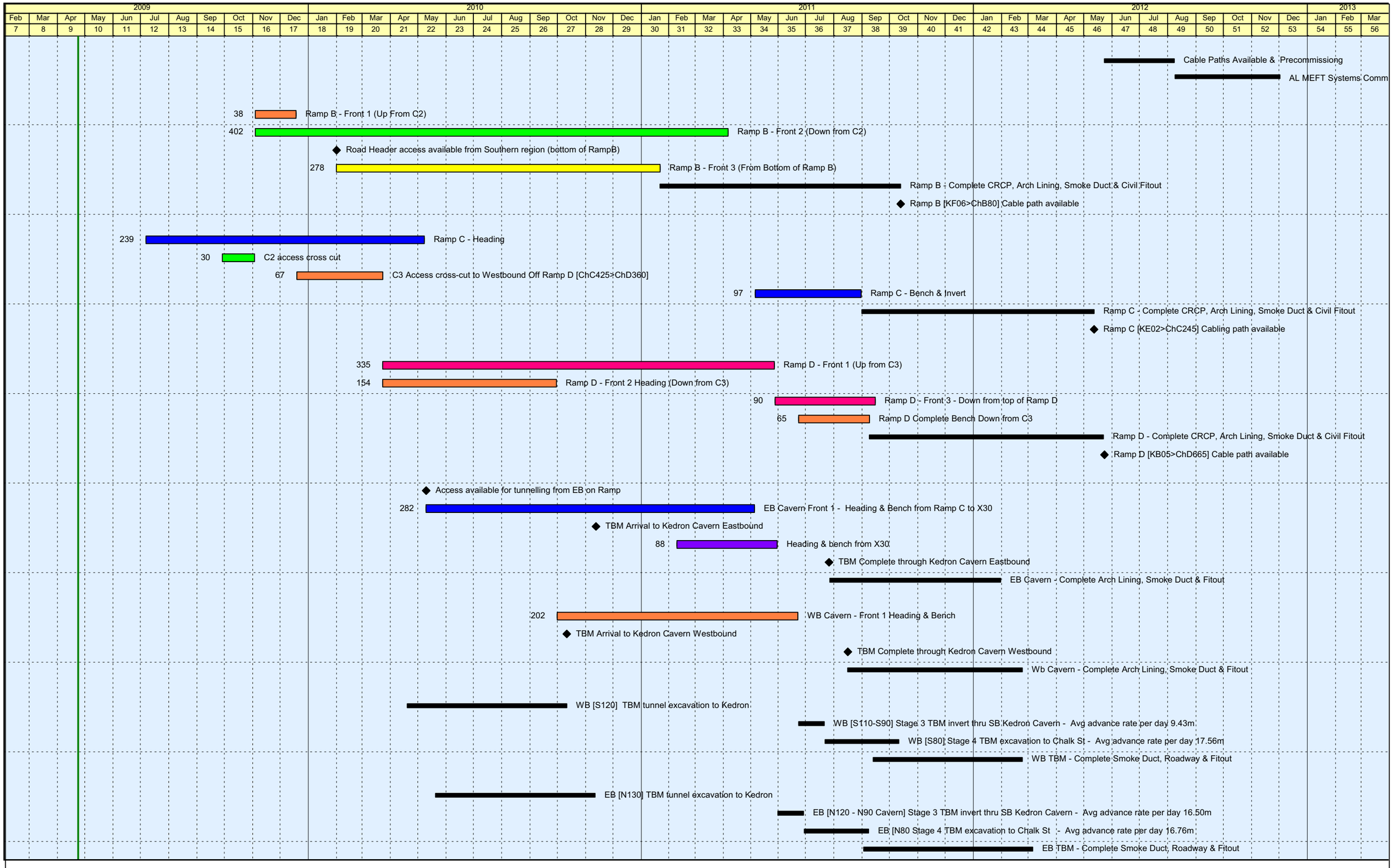


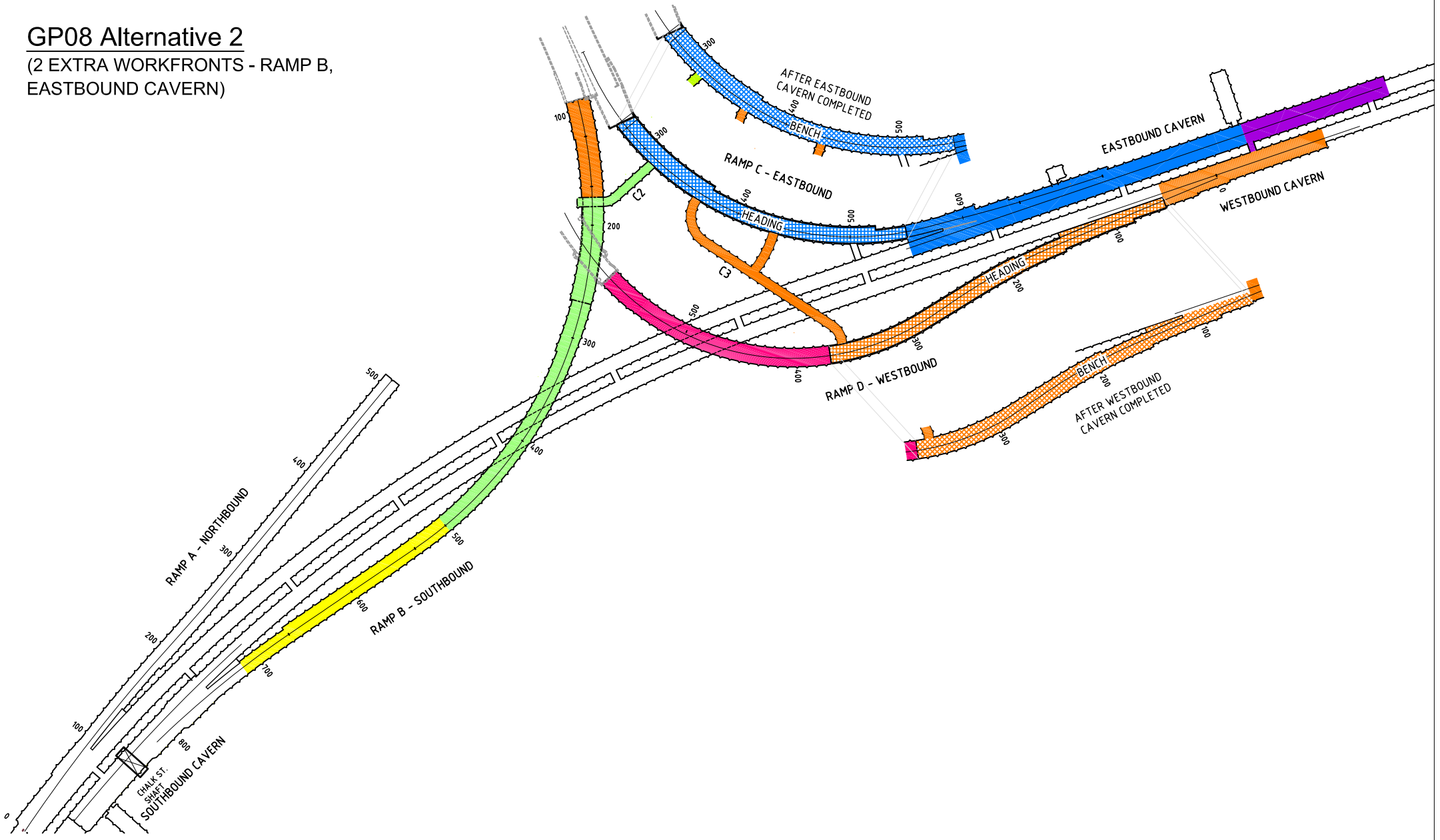

# GP08 Alternative 2

## 2 Extra Workfronts (Ramp B, EB Cavern)

Summary Bar
RH 1
RH 2
RH 3
RH 4
RH 5
RH 6
Summary Bar
Milestone

# GP08 Alternative 2

(2 EXTRA WORKFRONTS - RAMP B, EASTBOUND CAVERN)




PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

| Issue | Date | Description | Appd |
|---|---|---|---|
| A | 22.05.09 | INITIAL ISSUE | |

A1 ORIGINAL

Project/Contractor: BRISCONNECTIONS

Construction / Design Team: THIESS, John Holland



Designed: -
Checked:
Drawn: TM
Checked:
Approved:
Date: 22.05.09

Drawing Title: Airport Link
Mined Tunnel - Tunnel
Kedron On-Ramps
GP08 Alternative 2

Project: AIRPORT LINK AND NORTHERN BUSWAY PROJECT

Drawing No:

Issue: A

Last saved by: TTMARSHALL Plot Date: 29 May, 2009 - 9:32 AM Cad File No: C:\Documents and Settings\ttmarshall\My Documents\On-Ramps Plan - No Rose Street 2.dwg

2009 | 2010 | 2011 | 2012 | 2013

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7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

Cable Paths Available & Precommissiong

AL MEFT Systems Commissioning

38 Ramp B - Front 1 (Up From C2)

402 Ramp B - Front 2 (Down from C2)

Road Header access available from Southern region (bottom of RampB)

278 Ramp B - Front 3 (From Bottom of Ramp B)

Ramp B - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

Ramp B [KF06>ChB80] Cable path available

238 Ramp C - Heading

30 C2 access cross cut

67 C3 Access cross-cut to Westbound Off Ramp D [ChC425>ChD360]

97 Ramp C - Bench & Invert

Ramp C - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

Ramp C [KE02>ChC245] Cabling path available

325 Ramp D - Front 1 Heading & Bench (Up from C3)

218 Ramp D - Front 2 Heading & Bench (Down from C3)

Ramp D - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

100 Ramp D - Front 3 - Down from top of Ramp D

Ramp D [KB05>ChD665] Cable path available

Rose St Shaft

242 EB Cavern Front 1 - Heading & Bench from Rose St

Access available for tunnelling from EB on Ramp

128 EB Cavern - Front 2 - Heading & Bench from Ramp C

TBM Arrival to Kedron Cavern Eastbound

TBM Complete through Kedron Cavern Eastbound

EB Cavern - Complete Arch Lining, Smoke Duct & Fitout

202 WB Cavern - Front 1 Heading & Bench

TBM Arrival to Kedron Cavern Westbound

TBM Complete through Kedron Cavern Westbound

Wb Cavern - Complete Arch Lining, Smoke Duct & Fitout

WB [S120] TBM tunnel excavation to Kedron

WB [S110-S90] Stage 3 TBM invert thru SB Kedron Cavern - Avg advance rate per day 9.43m

WB [S80] Stage 4 TBM excavation to Chalk St - Avg advance rate per day 17.56m

WB TBM - Complete Smoke Duct, Roadway & Fitout

EB [N130] TBM tunnel excavation to Kedron

EB [N120 - N90 Cavern] Stage 3 TBM invert thru SB Kedron Cavern - Avg advance rate per day 16.50m

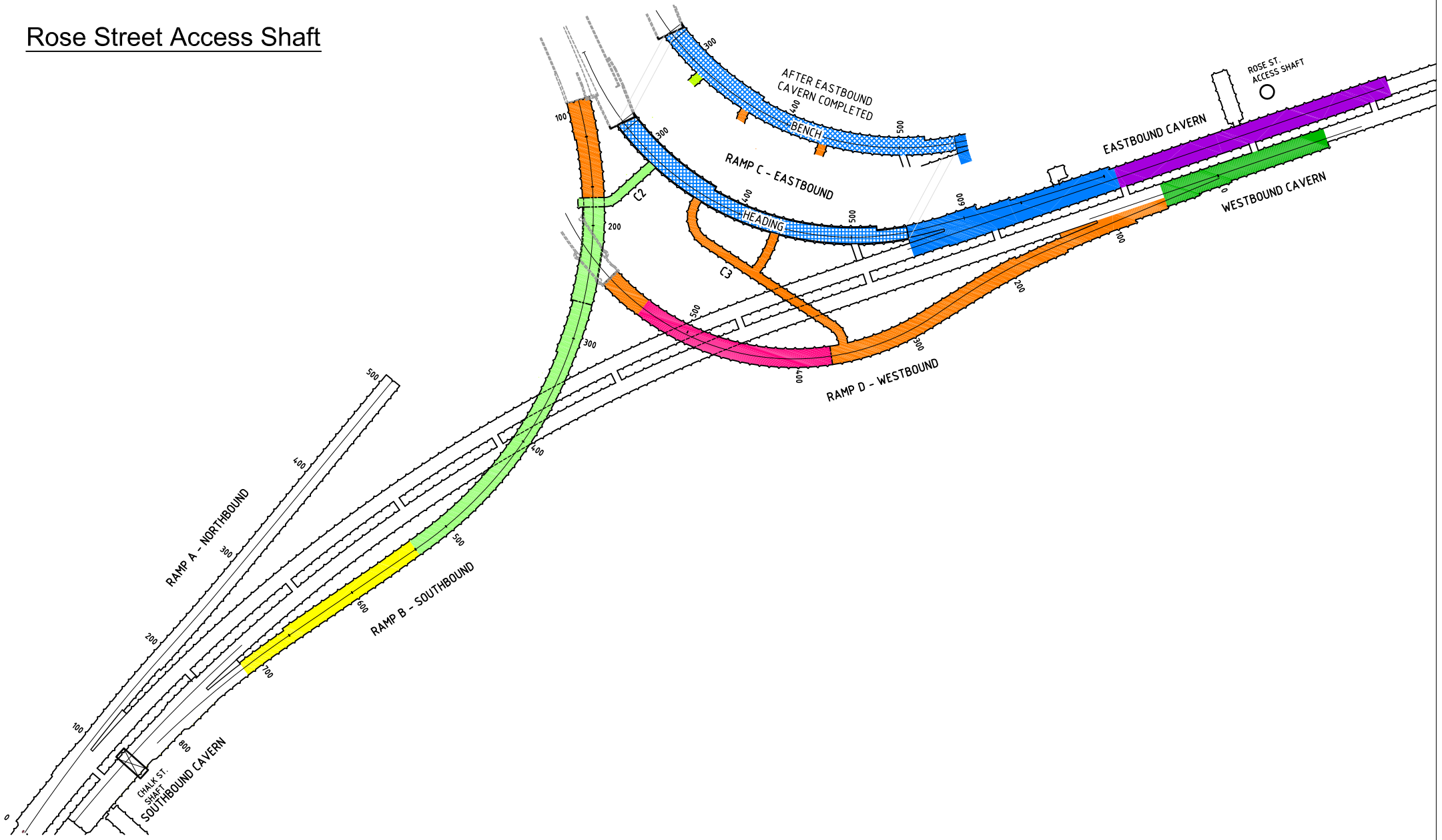
EB [N80 Stage 4 TBM excavation to Chalk St - Avg advance rate per day 16.76m

EB TBM - Complete Smoke Duct, Roadway & Fitout

## Rose St Access

Summary Bar
RH 1
RH 2
RH 3
RH 4
RH 5
RH 6
RH 7
Summary Bar
Milestone

# Rose Street Access Shaft




PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

| Issue | Date | Description | Appd |
|---|---|---|---|
| A | 22.05.09 | INITIAL ISSUE | |

A1 ORIGINAL

Project/Contractor: BRISCONNECTIONS

Construction / Design Team: THIESS, John Holland



Designed: -
Checked:
Drawn: TM
Checked:
Approved:
Date: 22.05.09

Drawing Title
Airport Link
Mined Tunnel - Tunnel
Kedron On-Ramps
Rose Street Access Shaft

Project: AIRPORT LINK AND NORTHERN BUSWAY PROJECT

Drawing No:

Issue: A

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Cable Paths Available & Precommissiong

AL MEFT Systems Commissioning

38 Ramp B - Front 1 (Up From C2)

402 Ramp B - Front 2 (Down from C2)

Road Header access available from Southern region (bottom of RampB)

278 Ramp B - Front 3 (From Bottom of Ramp B)

Ramp B - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

Ramp B [KF06>ChB80] Cable path available

238 Ramp C - Heading

30 C2 access cross cut

67 C3 Access cross-cut to Westbound Off Ramp D [ChC425>ChD360]

97 Ramp C - Bench & Invert

Ramp C - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

Ramp C [KE02>ChC245] Cabling path available

325 Ramp D - Front 1 Heading & Bench (Up from C3)

218 Ramp D - Front 2 Heading & Bench (Down from C3)

Ramp D - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

100 Ramp D - Front 3 - Down from top of Ramp D

Ramp D [KB05>ChD665] Cable path available

Planning & Approval - Melrose Park

Establish & Excavate Melrose Park Shaft

Melrose Park Access Tunnel

Access available for tunnelling from EB on Ramp

220 EB Cavern - Front 2 - Heading & Bench from Ramp C

150 EB Cavern Front 1 - Heading & Bench from Melrose Access

TBM Arrival to Kedron Cavern Eastbound

TBM Complete through Kedron Cavern Eastbound

EB Cavern - Complete Arch Lining, Smoke Duct & Fitout

202 WB Cavern - Front 1 Heading & Bench

TBM Arrival to Kedron Cavern Westbound

TBM Complete through Kedron Cavern Westbound

Wb Cavern - Complete Arch Lining, Smoke Duct & Fitout

WB [S120] TBM tunnel excavation to Kedron

WB [S110-S90] Stage 3 TBM invert thru SB Kedron Cavern - Avg advance rate per day 9.43m

WB TBM - Complete Smoke Duct, Roadway & Fitout

WB [S80] Stage 4 TBM excavation to Chalk St - Avg advance rate per day 17.56m

EB [N130] TBM tunnel excavation to Kedron

EB [N120 - N90 Cavern] Stage 3 TBM invert thru SB Kedron Cavern - Avg advance rate per day 16.50m

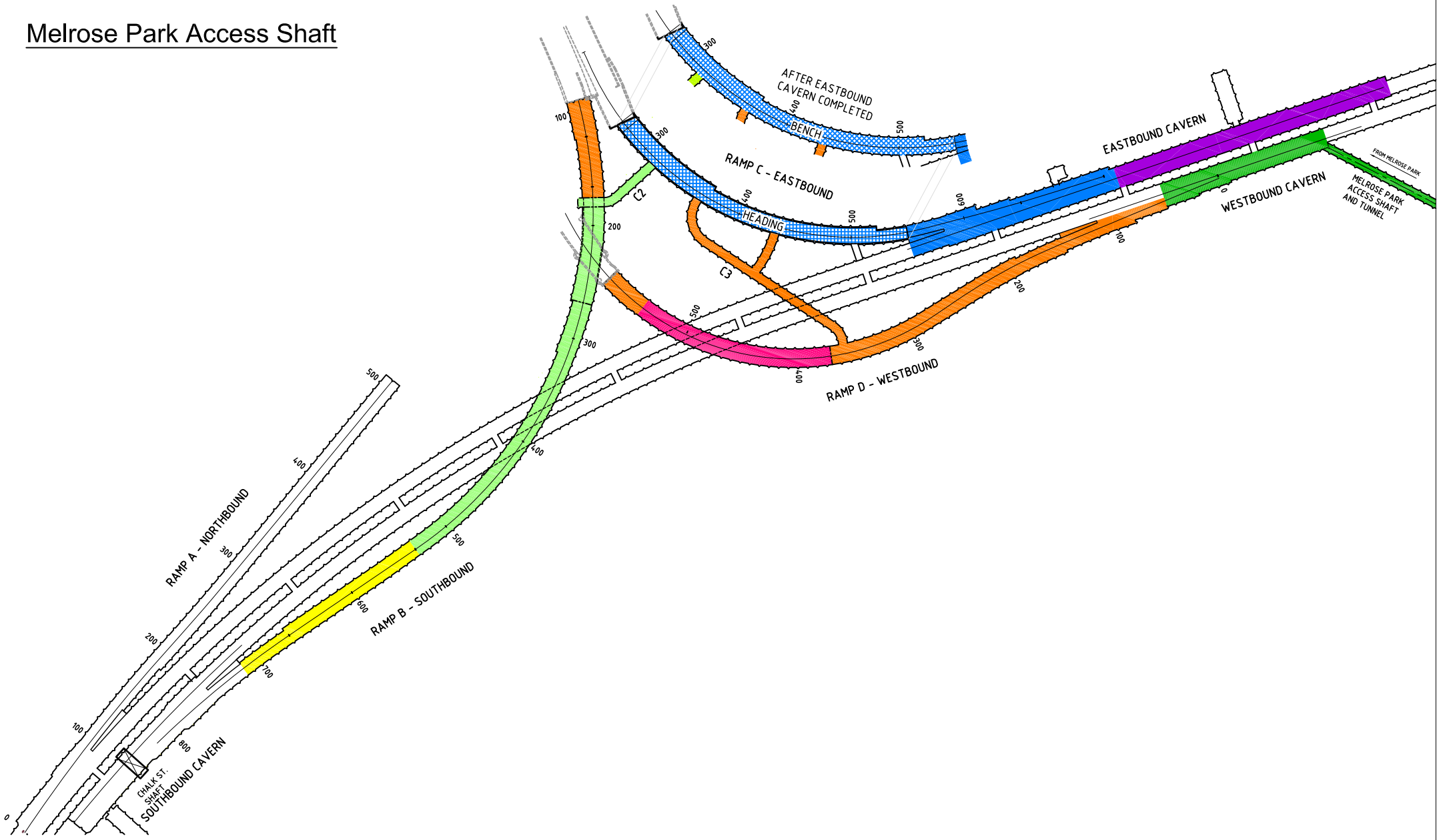
EB [N80 Stage 4 TBM excavation to Chalk St - Avg advance rate per day 16.76m

EB TBM - Complete Smoke Duct, Roadway & Fitout

# Melrose Park Access

Summary Bar
RH 1
RH 2
RH 3
RH 4
RH 5
RH 6
RH 7
Summary Bar
Milestone

# Melrose Park Access Shaft




PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

| Issue | Date | Description | Appd |
|---|---|---|---|
| A | 22.05.09 | INITIAL ISSUE | |

A1 ORIGINAL

Project/Contractor: BRISCONNECTIONS

Construction / Design Team: THIESS, John Holland



Designed: - Checked:
Drawn: TM Checked:
Approved:
Date: 22.05.09

Drawing Title: Airport Link
Mined Tunnel - Tunnel
Kedron On-Ramps
Melrose Park Access Shaft

Project: AIRPORT LINK AND NORTHERN BUSWAY PROJECT

Drawing No: Issue: A

Last saved by: TTMARSHALL Plot Date: 29 May, 2009 - 9:57 AM Cad File No: C:\Documents and Settings\ttmarshall\My Documents\ On-Ramps Plan - Melrose Park.dwg

2009 | 2010 | 2011 | 2012 | 2013

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7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

Cable Paths Available & Precommissiong

AL MEFT Systems Commissioning

38 Ramp B - Front 1 (Up From C2)

402 Ramp B - Front 2 (Down from C2)

Road Header access available from Southern region (bottom of RampB)

278 Ramp B - Front 3 (From Bottom of Ramp B)

Ramp B - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

Ramp B [KF06>ChB80] Cable path available

238 Ramp C - Heading

30 C2 access cross cut

67 C3 Access cross-cut to Westbound Off Ramp D [ChC425>ChD360]

97 Ramp C - Bench & Invert

Ramp C - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

Ramp C [KE02>ChC245] Cabling path available

325 Ramp D - Front 1 Heading & Bench (Up from C3)

218 Ramp D - Front 2 Heading & Bench (Down from C3)

Ramp D - Complete CRCP, Arch Lining, Smoke Duct & Civil Fitout

100 Ramp D - Front 3 - Down from top of Ramp D

Ramp D [KB05>ChD665] Cable path available

Planning & Approval - DES Access

Establish & Excavate - DES Shaft

DES Access Tunnel

Access available for tunnelling from EB on Ramp

210 EB Cavern - Front 2 - Heading & Bench from Ramp C

160 EB Cavern Front 1 - Heading & Bench from DES Access

TBM Arrival to Kedron Cavern Eastbound

TBM Complete through Kedron Cavern Eastbound

EB Cavern - Complete Arch Lining, Smoke Duct & Fitout

202 WB Cavern - Front 1 Heading & Bench

TBM Arrival to Kedron Cavern Westbound

TBM Complete through Kedron Cavern Westbound

Wb Cavern - Complete Arch Lining, Smoke Duct & Fitout

WB [S120] TBM tunnel excavation to Kedron

WB [S110-S90] Stage 3 TBM invert thru SB Kedron Cavern - Avg advance rate per day 9.43m

WB [S80] Stage 4 TBM excavation to Chalk St - Avg advance rate per day 17.56m

WB TBM - Complete Smoke Duct, Roadway & Fitout

EB [N130] TBM tunnel excavation to Kedron

EB [N120 - N90 Cavern] Stage 3 TBM invert thru SB Kedron Cavern - Avg advance rate per day 16.50m

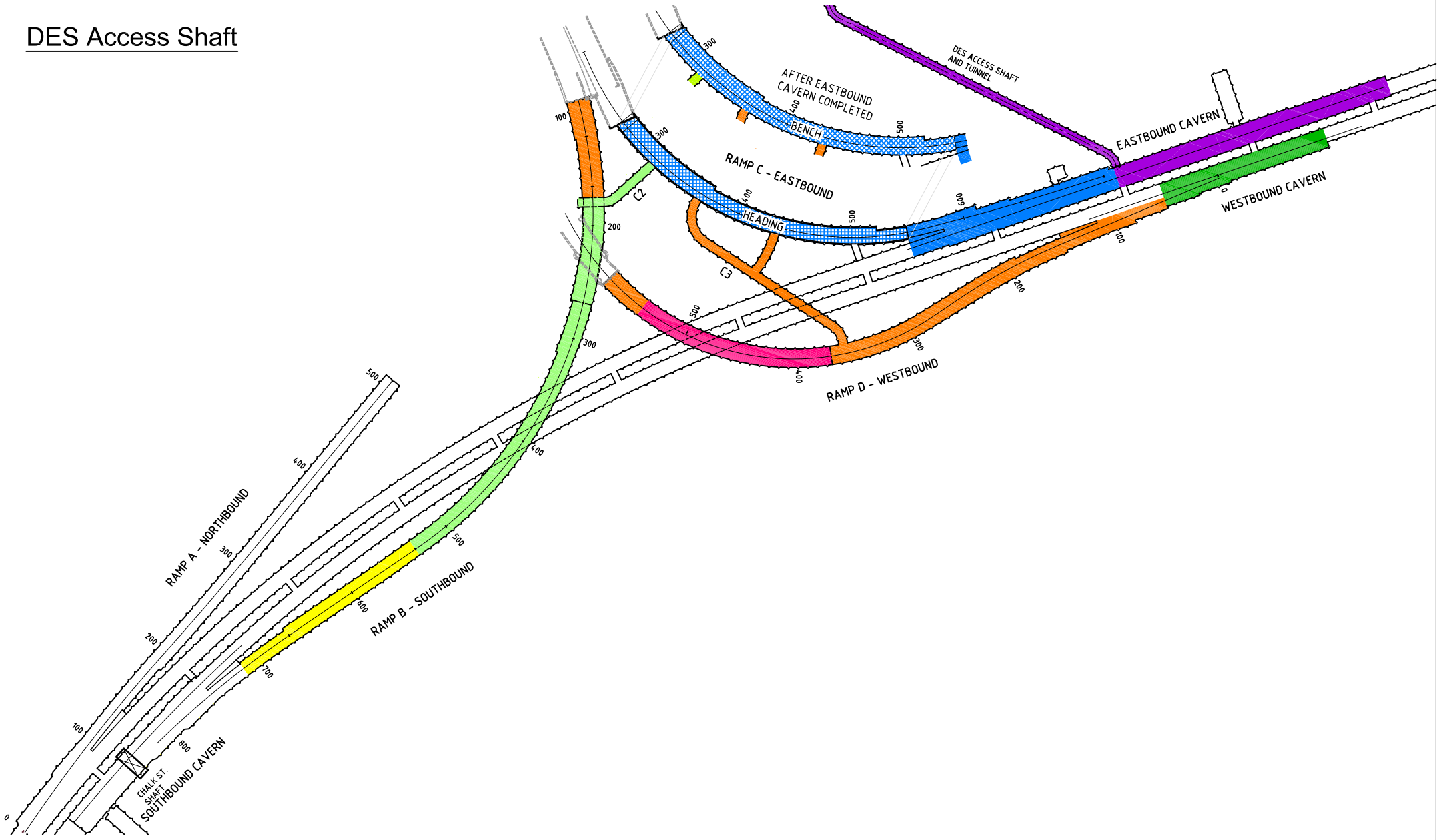
EB [N80 Stage 4 TBM excavation to Chalk St - Avg advance rate per day 16.76m

EB TBM - Complete Smoke Duct, Roadway & Fitout

# DES Access

Summary Bar
RH 1
RH 2
RH 3
RH 4
RH 5
RH 6
RH 7
Summary Bar
Milestone

# DES Access Shaft




PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

| Issue | Date | Description | Appd |
|---|---|---|---|
| A | 22.05.09 | INITIAL ISSUE | |

A1 ORIGINAL

Project/Contractor: BRISCONNECTIONS

Construction / Design Team: THIESS, John Holland



Designed: -
Checked:
Drawn: TM
Checked:
Approved:
Date: 22.05.09

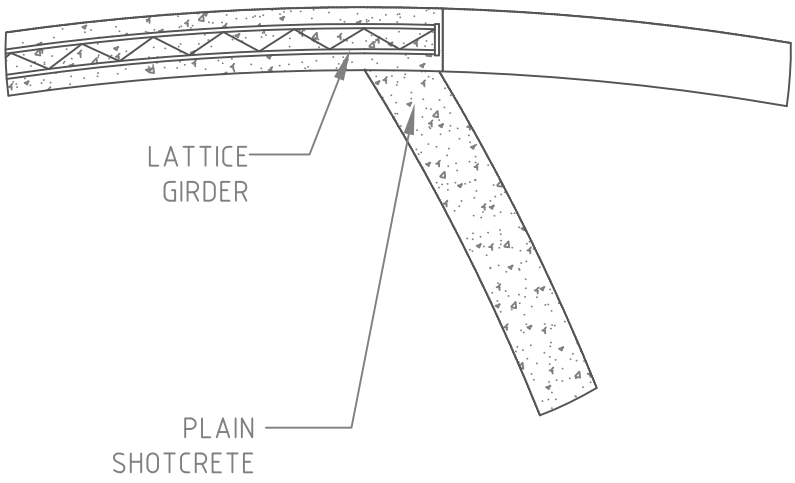
Drawing Title: Airport Link
Mined Tunnel - Tunnel
Kedron On-Ramps
DES Access Shaft

Project: AIRPORT LINK AND NORTHERN BUSWAY PROJECT

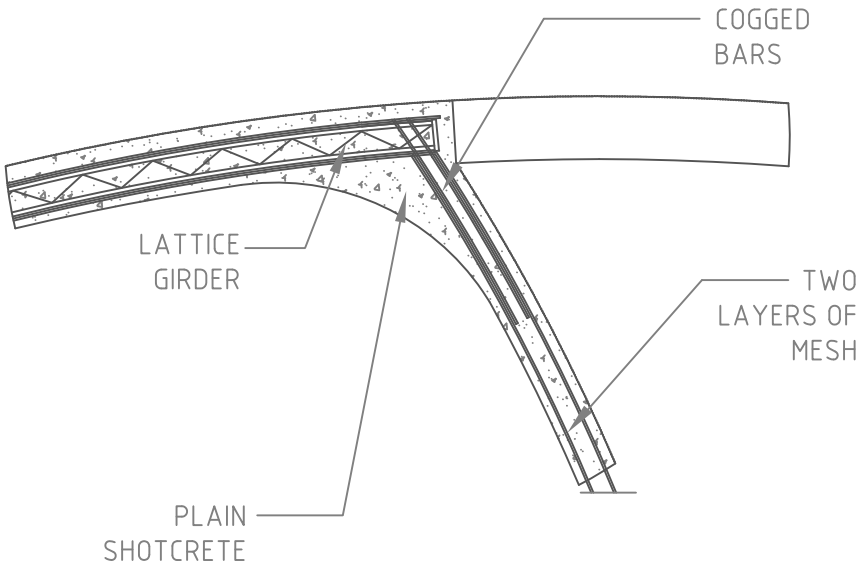
Drawing No:

Issue: A

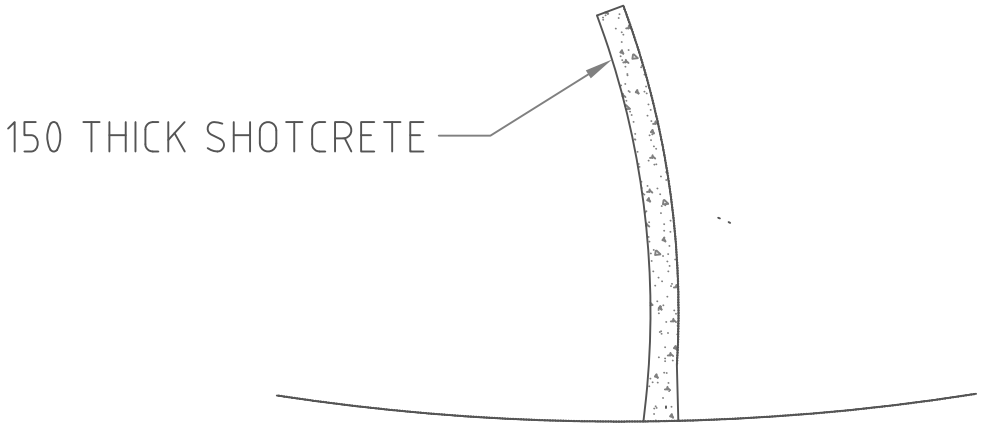
Last saved by: TTMARSHALL Plot Date: 29 May, 2009 - 9:50 AM Cad File No: C:\Documents and Settings\ttmarshall\My Documents\ On-Ramps Plan - DES.dwg



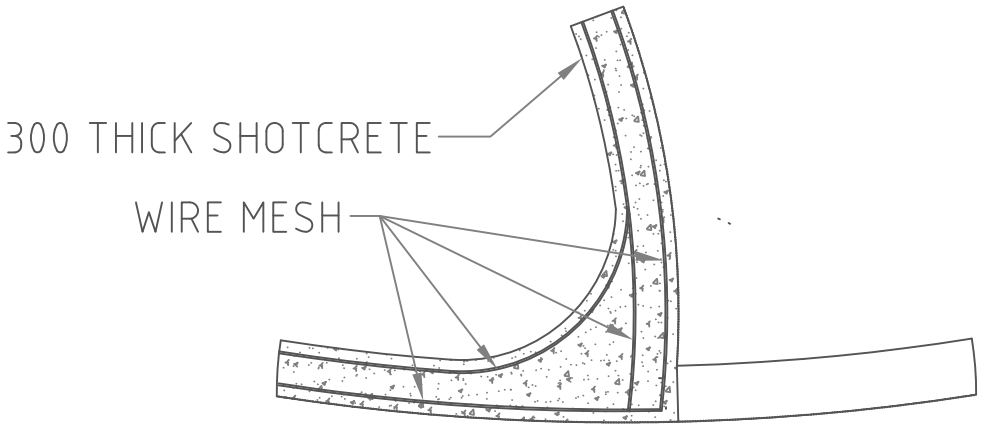

CROWN JOINT DETAIL - TENDER



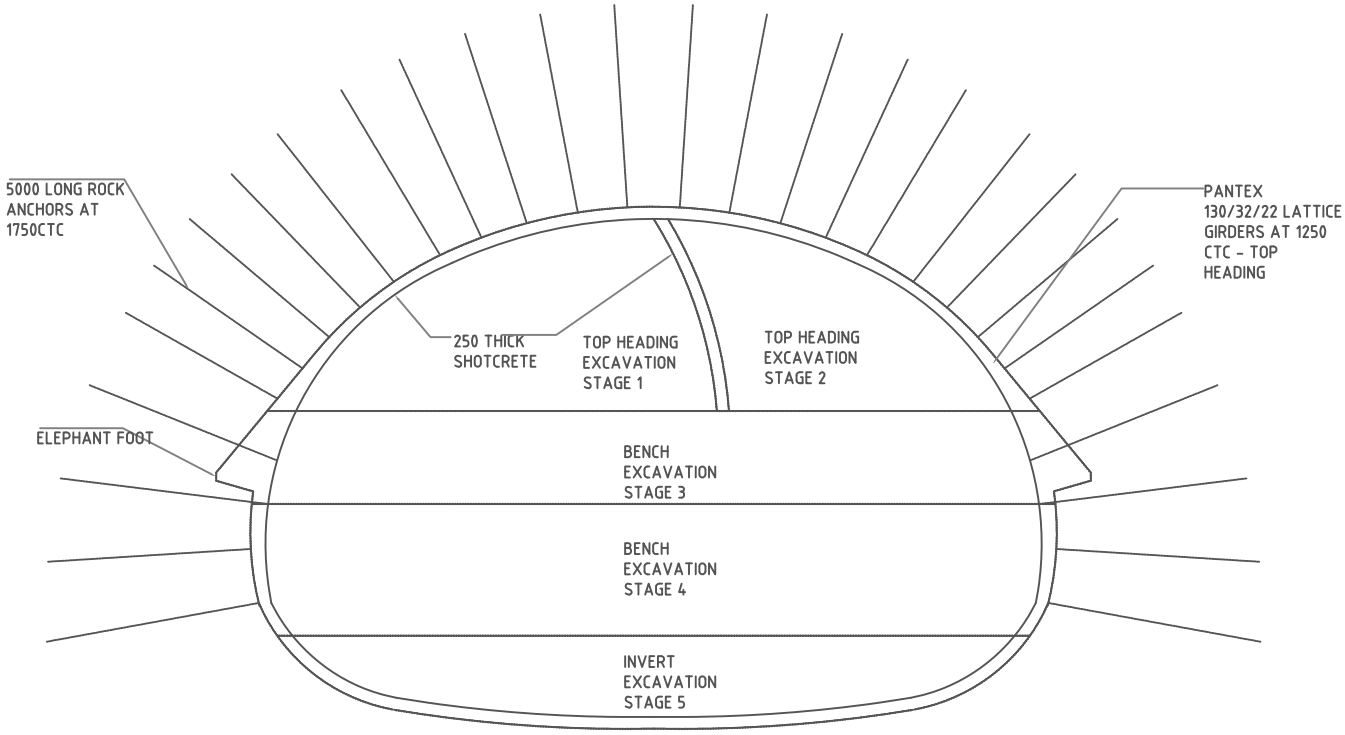

CROWN JOINT DETAIL - CURRENT




TOP HEADING
INVERT JOINT DETAIL - TENDER




TOP HEADING
INVERT JOINT DETAIL - CURRENT

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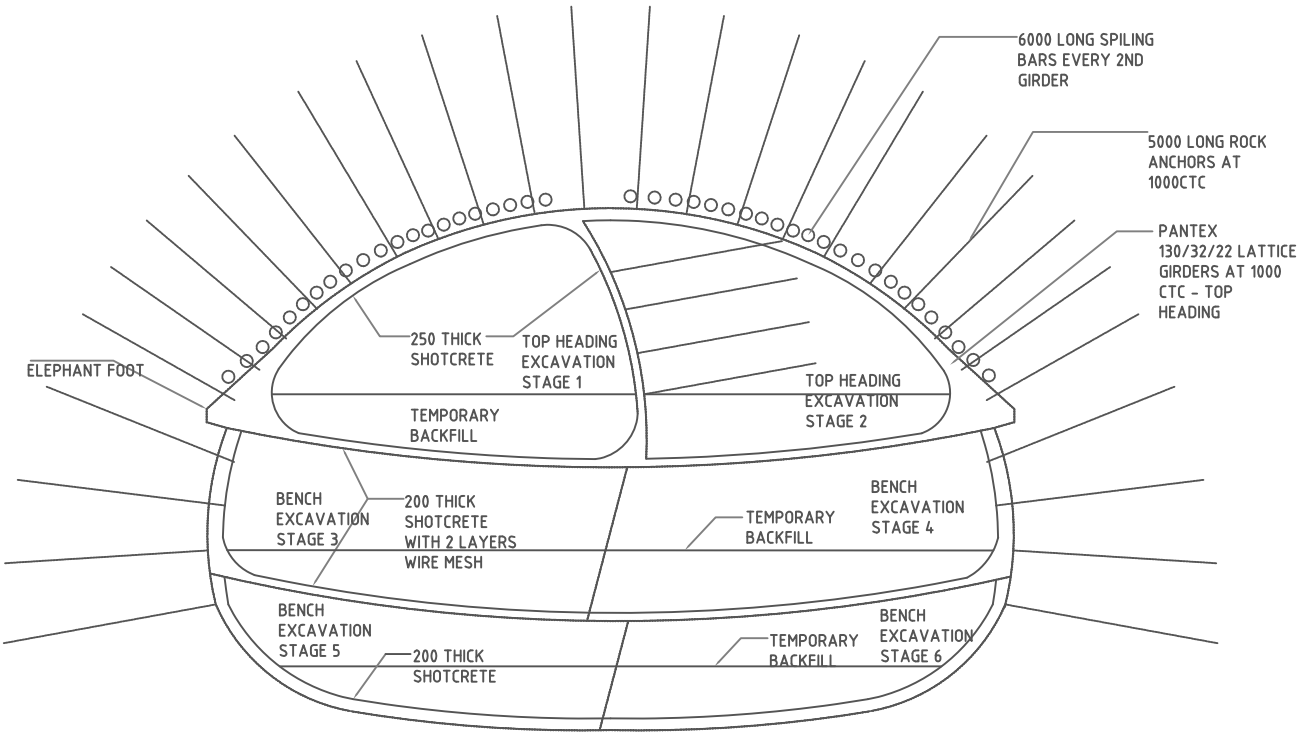


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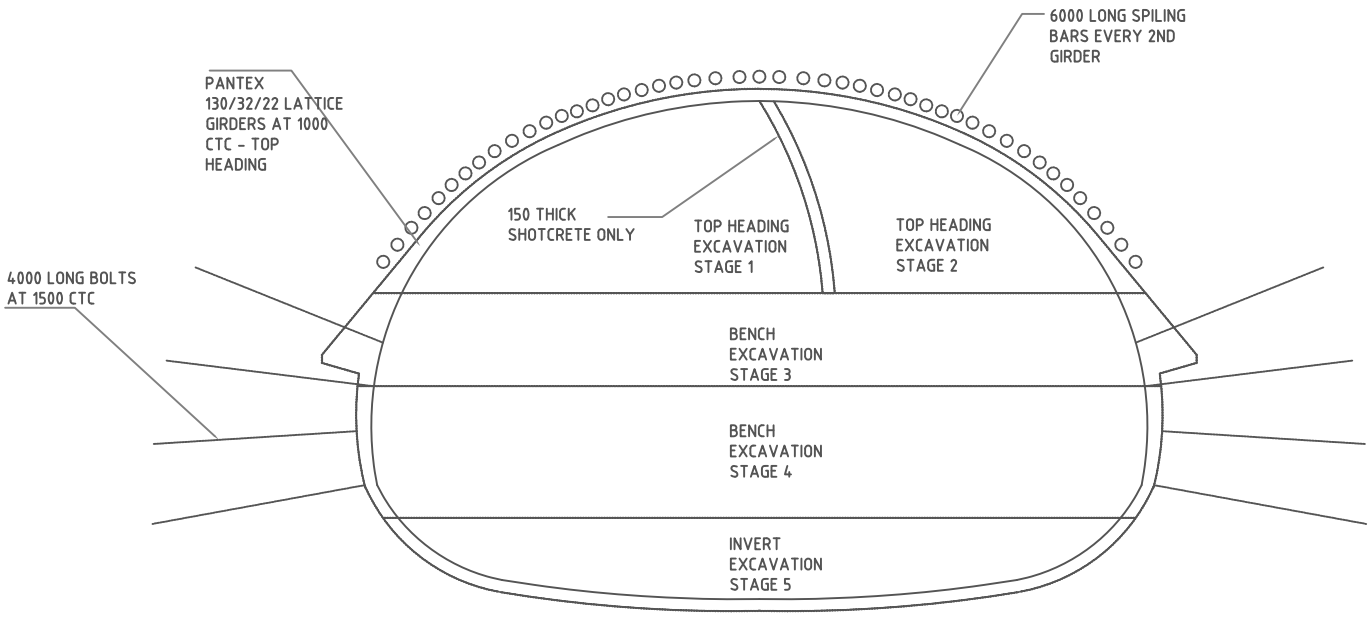


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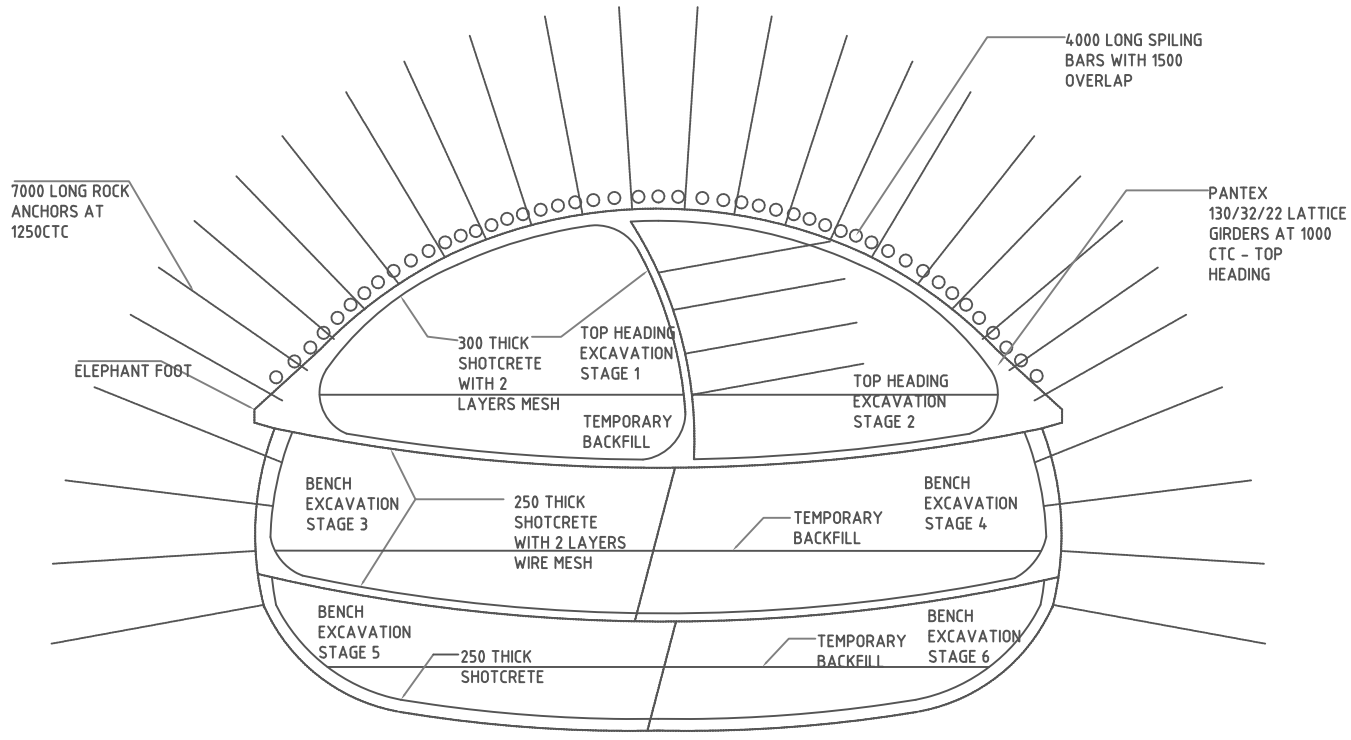


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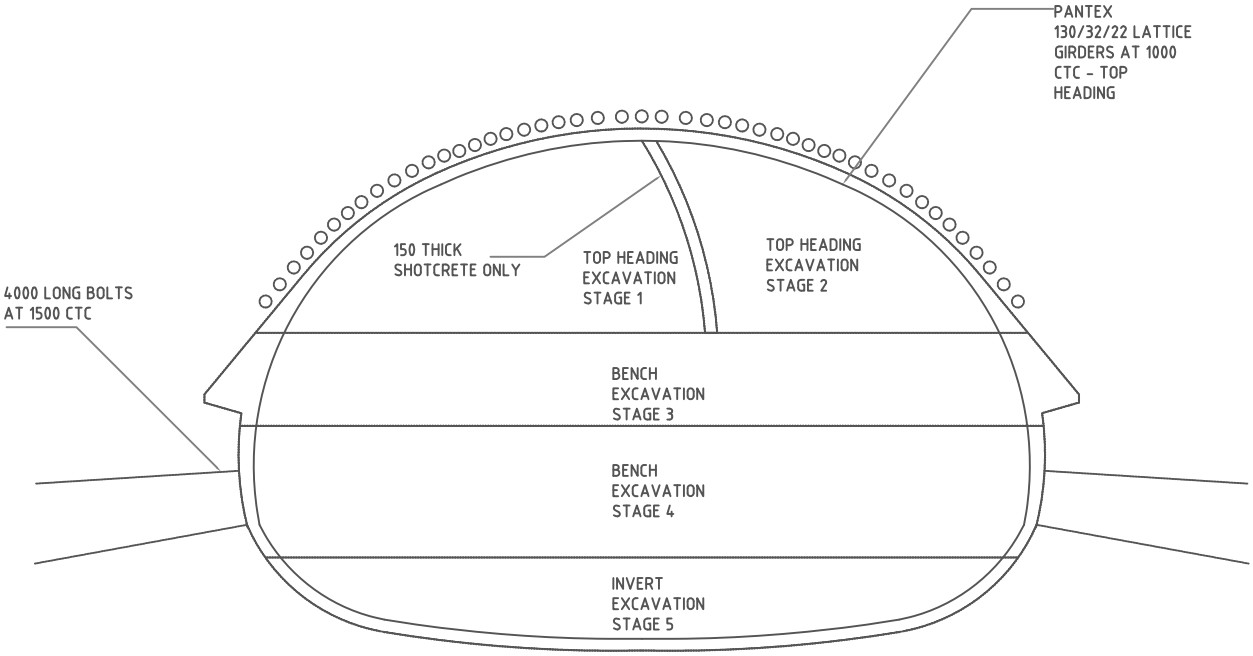


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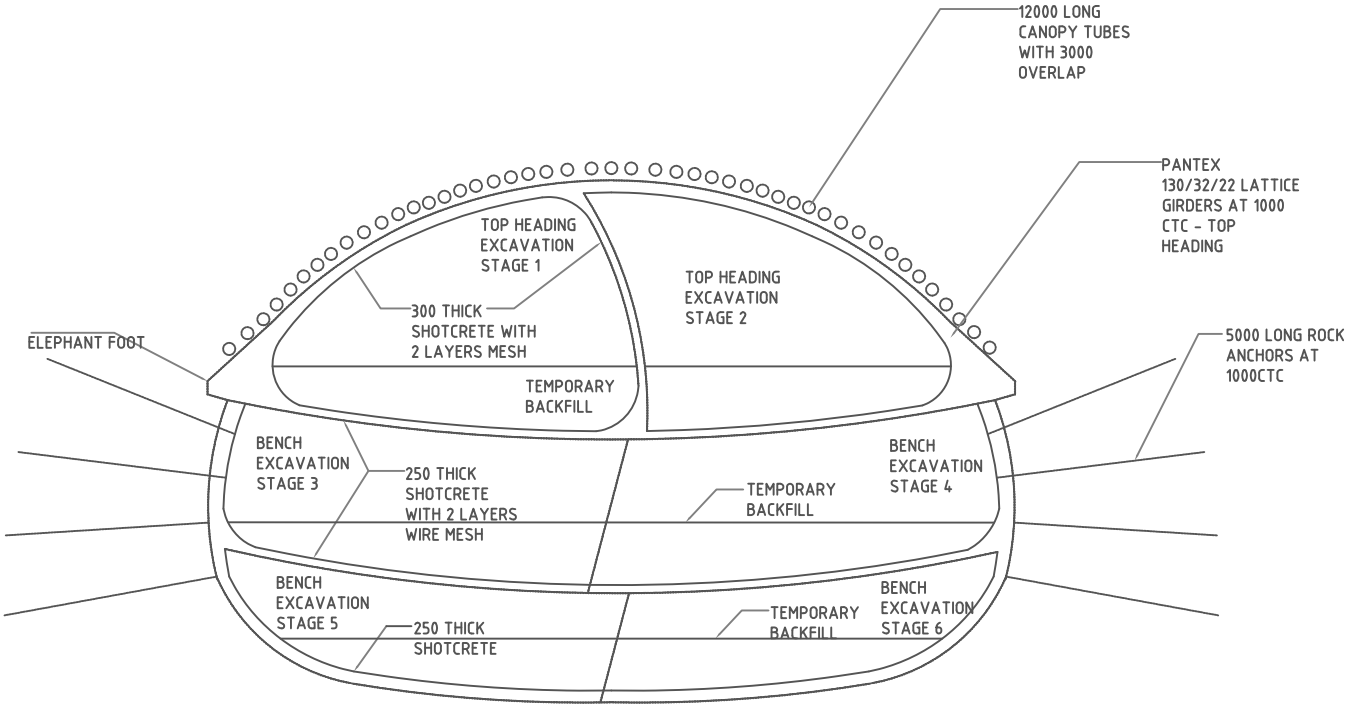



TYPE 6 - CURRENT ISSUE

# Appendix A.2 – Work Method Statement – Rose Street Worksite


# WORK METHOD STATEMENT
# ROSE STREET WORKSITE - ESTABLISHMENT AND OPERATIONS

# TJH-AM-WMS-CO

| Rev | Date | Revision Description | Prepared | Reviewed | Approved |
|---|---|---|---|---|---|
| B | 26/05/09 | FOR REVIEW | MB | | |
| C | 28/05/09 | UPDATED WITH COMMENTS | MB | | |
| D | 05/06/09 | UPDATED WITH ACCESS ADIT | MB | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# Table of Contents

## 1. DISTRIBUTION

There are no restrictions on the distribution or circulation of this procedure within Thiess John Holland (TJH).

## 2. DEFINTIONS

| | |
|---|---|
| ALNB | Airport Link and Northern Busway |
| TJH | Thiess John Holland |
| Site Activity Pack (SAP) | A document system used to control specific construction activities required to carry out works in compliance with the contract and demonstrates conformance of work activities upon completion |
| Construction Method Statement (CMS) | A document that provides a macro description of nominated project activities |
| Work Method Statement (WMS) | A work instruction which details the specific Technical / Engineering / Quality / Safety / Environmental methodology for a particular activity |
| SEP | Site Environmental Plan |
| TMP | Traffic Management Plan |
| JSEA | Job Safety and Environment Assessment |
| ITP | Inspection and Test Plan |
| CKL | Checklist |
| CV | Construction Verifier |
| IV | Independent Verifier |
| PECV | Proof Engineer and Construction Verifier |
| AQC | Area Quality Coordinator |

| | |
|---|---|
| AQM | Area Quality Manager |
| AM | Area Manager |
| PM | Project Manager |
| PE | Project Engineer |
| QE | Quality Engineer |
| AEC | Area Environmental Coordinator or delegate |
| CLC | Community Liaison Coordinator |

## 3. PURPOSE AND SCOPE

This work method statement outlines the construction activities and the work methods implemented in the establishment and ongoing operations taking place from the Rose St worksite as part of the tunnelling and fitout works for the Airport Link Project.

The Rose St worksite will be utilised as a means of access for personnel, plant and equipment in the construction of the east and westbound galleries and ramp drives.

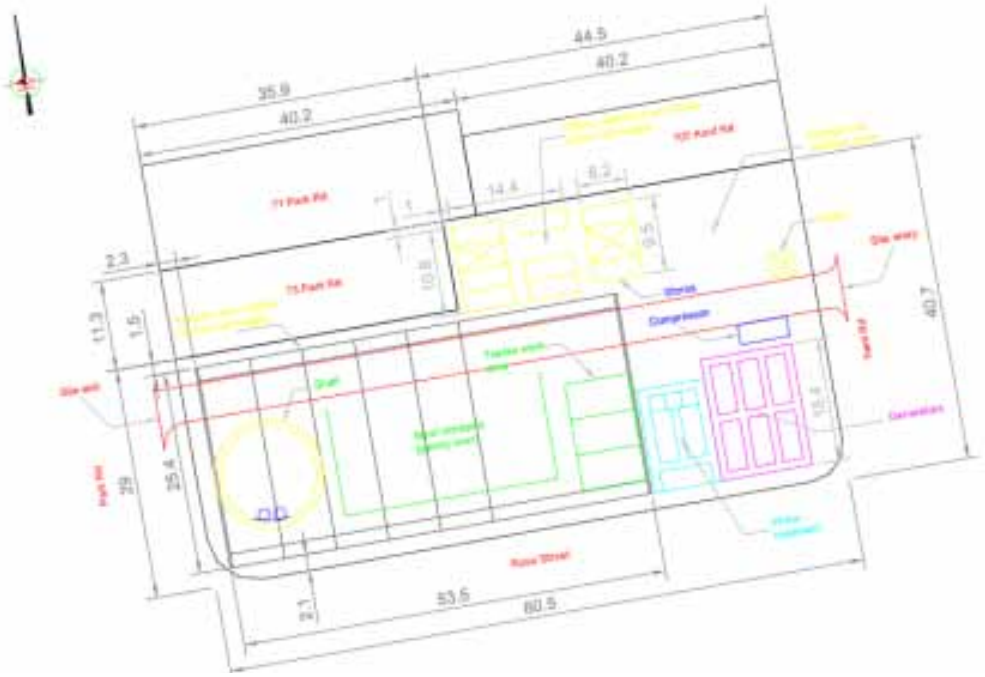
Two roadheaders will operate from the Rose St worksite and will excavate the caverns between approximate CH5100 and CH5300. The caverns are the sections of tunnel where ramps meet the mainline tunnel drives.

Access to the tunnels from the Rose St worksite will be via a shaft located on the western end of the site, adjacent to Park Rd. The shaft will be approximately 42 m deep and will have a short drive of approximately 15 m length at its base to access the permanent works. The shaft and access drive are considered temporary works and will be backfilled on completion of the works occurring from the site.

# 4. PROCEDURE

## 4.1 Site Layout

*Figure 1 – Site Layout*




The site is currently a vacant piece of land bounded on three sides by Park Road, Rose Street and Kent Road. Along the northern boundary the site is adjacent to residential housing.

Temporary buildings that will be erected on the site include lunch rooms, offices and amenities buildings. These buildings are located in the centre north of the site adjacent to the nearest residences as they are expected to produce negligible noise. In addition to these temporary buildings, other significant structures that will be erected temporarily on the site include an acoustic shed, water treatment plant and site electrical facilities. Shaft excavation will commence prior to the completion of the acoustic shed; however, other activities that will take place within the acoustic shed will include shaft access, spoil storage, handling, loading and repair and maintenance activities. Other facilities that will be installed on the site include storerooms and material lay-down areas.

The processes involved in site establishment and ongoing operations are described below.

## 4.2 Expected Plant and Equipment

A list of plant and equipment expected to be used throughout the establishment and use of the Rose St worksite will be numerous and will include at least the following:

- backhoe/excavator;
- piling rigs/drilling rigs;
- semi trailers;
- roller/compactor;
- hand held drills and tools;
- electrical generators;
- mobile cranes – various sizes;
- concrete pumps/trucks;
- concrete finishing tools;
- scissor lifts/boom lifts;
- hand tools/power tools;
- air compressors; and
- spoil haulage trucks.

Having completed the site establishment works, the type of equipment that will be used on the site will decrease from the list shown above. Vehicles accessing the site regularly will include concrete delivery trucks, spoil haulage trucks (truck and dog) and other delivery vehicles small and large. A loader and telehandler will be used on the site surface for moving equipment and for the handling and loading of spoil. Tunnel spoil will be hoisted from the base of the shaft to the surface via a kibble and gantry crane system. The spoil will be tipped into a spoil bin within the acoustic shed where it is stockpiled prior to loading out.

## 4.3 Site Establishment Construction Activities

*Installation of Acoustic Barrier*

An acoustic barrier, typically around 5 m in height, will be erected about the perimeter of the Rose St worksite. The barrier will serve to prevent trespassers entering the site as well as to contain noise generated within the site compound. The barrier would be constructed of ply/timber materials with a minimum mass density of 10 kg/$m^2$

*Installation of Environmental Controls*

Temporary environmental controls that will be used on the site will consist predominantly of silt fencing and sand filled geotextile socks to prevent the escape of sediment laden water off site. Temporary environmental controls would be situated in order to prevent sediment laden water escaping the site. Specific information on the likely controls to be employed at Rose St is provided in Section 4.4 - Environmental Controls.

*Clearing / Grubbing*

Given the site is currently a clean, level parcel of land, clearing and grubbing will consist of removal of grass, trees and shrubs from the site. In order to minimise the chance of environmental incident, this task will be conducted piecemeal with the placement of hardstand around the site.

*Establishment of Services*

Services that will be connected as part of the site establishment include connection to water main, stormwater and sewer. The protection or diversion (if required) of existing services running through the site will also be conducted as one of the preliminary activities.

At this stage, the locations of available service connections to supply the site have not been finalised, though it is likely that minor trenching and excavation with small excavator or backhoe will be carried out in order to expose the in ground services and effect the service connections.

*Construction of Drainage*

Site drainage will be created such that all surface water that has the potential to carry sediment laden water will be collected on site through a combination of surface drainage, spoon drains and sumps. All other water will be directed into the stormwater system. Fuels and chemicals that are stored on site with a potential to spill or leak into the stormwater system will be contained within bunds on the site.
Sediment laden water collected on site will be discharged after treatment through the water treatment plant.

*Construction of Hardstand*
Various hardstand areas will be constructed about the site. Hardstand may include concrete pavements and slabs as well as roadbase or gravel. Roadbase or gravel areas will be sealed or asphalted. The hardstand areas may be required for laydown areas, pads for various equipment and pathways etc.

Concrete pavements will be typically placed from the agitator or from a concrete pump, generally located within the site boundaries, and will be retained by formwork. Other hardstand areas will typically be placed by a loader or excavator and rolled and compacted to the desired grade and level. Water carts or similar will be used to control dust as work is undertaken.

*Construction and Connection of Services*
Services that will be required for various operational functions of the site will be reticulated about the site through in-ground conduits, above ground cable trays or similar. These services include HV and LV electricity, compressed air, potable water and discharge water.

No services appear to be present within the footprint of the site. A search will be performed prior to the commencement of the works to identify all services in the vicinity of the worksite and to establish the nearest service connection points.

The services that will need to be connected in the establishment of the site are as follows:

- water – potable water;
- sewer – connection for ablutions blocks;
- communications – telephone / internet;

- stormwater – rainwater runoff and treated discharge; and
- electricity – if sufficient power available (not known at this stage).

*Construction of Roadways / Concrete Slabs*

Concrete roadways will be placed about the site for through traffic. Concrete roadways will typically be mesh reinforced slabs of approximately 100-200mm thickness. The main roadway will be through the site shed as shown on the site layout and will serve as the haul route for spoil trucks and also various delivery trucks through the operational period of the site.

Concrete roadways will be laid much the same as concrete hardstands in that concrete will be placed via either agitator or concrete pump.

*Construction of Access*

The bus stop on Kent Road will be to the north of the proposed site entrance. The bus stop will not have to be relocated. For the site entrance, a layback and driveway will be constructed into the site as shown on the site layout drawing. Similarly, an exit from the site will be constructed on Park Road. Minor disruptions to pedestrian traffic may be expected during the construction of these works.

*Installation of Site Buildings*

Site accommodations will consist of a series prefabricated buildings that will include change rooms, lunch rooms, ablutions, offices and store rooms.

Prefabricated buildings will be placed on temporary piers by mobile crane and will then be connected to electrical and plumbing services. In some instances covered areas may be placed between these buildings to provide a covered walkway or covered outdoor area.

The buildings layout is as shown on the Site Layout. All buildings and facilities have been located within the boundary of the site. The site boundary is approximately 3.3 m from the kerb line on Park Road, Kent Road and Rose Streets. The footprint of the ancillary buildings to be located on the site are as follows:

- site accommodations (6 off) – 2.5 m x 6.5 m plus walkways and covered outdoor areas;

- electrical compound – 11.5 m x 16 m;
- water treatment plant – 8 m x 14 m
- guard house – 3 m x 3 m; and
- air compressor – 2.5 m x 5 m.

Setbacks to the installed buildings from Rose Street are approximately 5 m, whilst along the boundary with the residents to the north and the boundary along Park Road, the acoustic shed is set back 1.5 m. The site accommodations are set back 1m from each adjacent boundary as shown in the site layout drawing.

The fitout of the ancillary buildings on site will generally consist of the following:

- site sheds – office equipment including, air conditioners, photocopier, workstations, kitchen, ablutions;
- site accommodations – ablutions/showers, kitchen, change facilities lockers etc;
- storerooms – shelving, lockable cupboards, lighting; and
- covered areas – outdoor furniture.

*Installation of Water Treatment Plant*

It is envisaged at this stage that a water treatment plant will be required to be installed on the site to treat site runoff and tunnel discharge water. If required, the water treatment plant will typically consist of a series of tanks and containers plumbed together with facilities for automated dosing of the chemicals required to treat the water to a satisfactory level prior to discharge. Additionally, a facility for the removal of deposited sediment will be required as part of the plant, as will storage areas for the various chemicals used in the treatment process.

The chemicals used in the water treatment process will vary depending on the content of the water to be treated, but typically the chemicals used consist of:

- acid;
- caustic;
- coagulant; and
- flocculant.

The installation of water treatment plants generally involves the use of mobile cranes, as well as the connection of various services and pipes.

*Installation of Electrical Equipment*

At this stage, the power supply for the excavation phase of the Rose St worksite is not finalised, and the available power in the nearby streets to the site may not be of sufficient capacity to supply that power which is required. However, a likely solution for power at Rose Street is to place a series of portable gensets on the site. These have been shown on the site layout.

The number of gensets required, if this is the preferred solution, is likely to be four gensets approximately the size of a 20" container. The gensets have been positioned as shown on the site layout outside the acoustic shed along with 2 m x 6m containers of associated electrical equipment and may require additional sound proofing measures. The gensets will be installed into position by mobile crane.

The gensets will be required to be operational throughout the full period of tunnel excavation; however, the electricity supply requirement for the period of time before excavation and at the conclusion of excavation will most likely be significantly lower than that mentioned above.

*Construction of Foundations (Acoustic Shed / Gantry / Spoil Bin)*

Foundations for the above mentioned structures will be very similar and will typically involve reinforced concrete piles. Pile depths and sizes will vary for the structure and load, but essentially they are identical.

Piled foundations will be constructed with a piling rig. This work should be sequenced such that a piling rig (or rigs) are mobilised to site and drill holes for all the structures concurrently. Reinforcement cages are installed either by mobile crane or by the piling rig and concrete is placed typically with a concrete pump.

*Shaft Piling and Capping Beam*

The geotech information at this stage suggests that the piles required about the shaft will be some 25 m deep. The type of pile to be used may include secant piles or may be constructed by cutter soil mix walls. Both methods will have similar

environmental and noise impacts and the preferred method will be selected on the basis of design considerations, rig availability, economy and speed of installation.
It is expected also that during excavation, the piles will need to have some internal lateral reinforcement, which would typically consist of a waler beam, typically rolled steel beam welded or bolted into place.

At the conclusion of piling, it is expected that an *in-situ* concrete capping beam will be placed about the collar of the shaft to cap off the piles. The capping beam is a cast in-situ concrete beam with steel reinforcement.

*Construction of Spoil Bin*

Typically temporary spoil bins, or muck bins, are constructed of steel columns concreted into the ground with timber sleepers used as lagging between steel beams. The steel beams are placed in position after the piling rig has drilled the holes and are then concreted in. These structures are very efficient and quick to construct.

The muck bin will be contained within the spoil shed as shown on the site layout drawing. The volume of the muck bin is generally as large as the space on the site allows. In this instance the volume of muck bin will be the approximate equivalent of one days' production when both roadheaders are in excavation phase. The muck bin also incorporates the tipping mechanism which is a mechanical system that allows the discharge of muck from the kibble without the need for a dogman to re hook the muck skip.

*Construction of Gantry*

A gantry crane is a fixed crane which travels along a series of portal frames with a winch atop. The crane can move in two directions within the footprint of the gantry.
The gantry crane is assembled *in situ* and requires mobile cranes for pre-assembly and final assembly. It is desirable, but not essential to have the gantry crane assembled and commissioned prior to the excavation of the shaft. The gantry crane is expected to be utilised for the full duration of operations at the Rose St worksite, which is to say any post excavation activities utilising Rose Street access will most likely require the use of the gantry crane.

*Construction and Fitout of Acoustic Shed*

The acoustic shed has plan dimensions approximately 25 m x 53 m and has a stepped roof profile that is 17.5 m at its highest, and 7.5 m at the lower section. The acoustic shed is made of steel portal frames onto which acoustic panels and colourbond sheeting are attached to provide noise attenuation.

The assembly and installation of the acoustic shed will involve multiple mobile cranes as well as boom lifts and scissor lifts. An indicative duration for installation is shown on the site program. It is expected that a 100 t mobile crane will be on site for four weeks in the erection of the portal frames and installation of the acoustic cladding. Along with the mobile crane, 20 m boom lifts and scissor lifts will be required for personnel access during this time. Scissor lifts and boom lifts will be required during the installation of colourbond cladding to the shed which will occur after the installation of acoustic paneling.

On completion of the acoustic shed construction, fitout will commence. The acoustic shed will contain the trades' works areas for maintenance and repair activities. Repair and maintenance will be ongoing within the shed during the lifespan of the construction compound. Lighting will be installed throughout the shed for personnel safety.

The ventilation system used to commence tunnelling will be temporarily situated on the surface within the shed. This system will include one fan to blow fresh air into the tunnel and one fan and dust scrubber unit to extract dust laden air from the tunnel excavation face, filter out the dust particles and exhaust clean air out. As the tunnel excavation advances and enough space is created, both the blower fan and the fan/scrubber will be relocated into the tunnel. The blower fan will have a fixed position at the start of the tunnel drives with rigid ducting running up the shaft to a fresh air draw point outside of the shed. As the excavation advances, additional ventilation duct is added to enable fresh air to be delivered to the excavation face. The fan/scrubber unit will advance with the tunnel excavation. The duration that the ventilation fans will be housed within the shed on the surface is approximately four to six weeks.

For works that take place outside of the general construction hours, the doors of the acoustic shed will be closed. A silenced louvre will be installed on the acoustic shed to permit the circulation of air through the shed and the tunnels. The louvre will be situated on south side of the shed in order to minimise the potential for any disturbance to nearby residents.

*Shaft Excavation*

The shaft is expected to be approximately 42 m deep. The geotech information available indicated that the first 20+m are in conditions that will most likely permit excavation by free digging. An excavator will be positioned within the shaft and will excavate this material between the piles utilising a bucket as much as possible. The excavator will load excavated material into a kibble that will be hoisted to the surface by mobile crane or by gantry crane.

Beyond the point where an excavator is no longer able to dig freely, it is expected that the remaining material will be readily excavated by use of hydraulic hammer. An alternative to the use of hydraulic hammer is to excavate by drill and blast. It is anticipated at this stage that excavation by hydraulic hammer is feasible and drill and blast shall be considered as an alternate means of excavation in the event that rock conditions within the shaft prove to be unsuitable for a conventional excavator and hammer.

Excavation of the shaft would commence as soon as it were possible to do so. Out of hours works on the shaft excavation would commence at the completion of the acoustic shed erection.

*Construction Phases*

The operations occurring at the Rose Street worksite will consist of several discrete phases. Those phases are as follows:

- site establishment;
- tunnelling;
- civil fitout;
- mech / elec fitout; and
- demobilisation.

An indication of the personnel numbers expected during the various phases of the works, as well as the type of personnel, is provided in the table below:

*Table 1 – Expected Personnel Numbers*

| | Typical | Peak | Type of personnel |
|---|---|---|---|
| Site establishment | 10 | 20 | Subcontractors, Labourers, Site management |
| Tunnelling | 30 | 50 | Shift tunnellers, Trades, Site management |
| Civil fitout | 30 | 50 | Direct labour, Subcontract labour, Site management |
| Mech/Elec fitout | 50 | 80 | Electrical/Mechanical trades, Site management |
| Demobilisation | 10 | 20 | Subcontractors, Labourers, Site management |

*Work Hours*

During the site establishment phase, the works are expected to be conducted during the normal construction hours, that being 06:30 – 18:30 Monday to Saturday. When the acoustic shed is able to provide the requisite noise screening, the working hours shall be extended to permit activities such as shaft excavation to be carried out.

Tunnelling, as with other sections of the project will be carried out on both day and night shifts. The primary measure to assist in compliance with noise goals on the project is the acoustic shed. Outside of the normal construction hours the works will take place within the shed. Spoil haulage is not planned to be undertaken outside of normal construction hours and as such spoil haulage trucks are not envisaged to be required out of hours. The expected ground support for the area relies on the application of shotcrete as the excavation advances. It is expected that several deliveries of shotcrete will be required outside of the normal construction hours, though the concrete mix provided can be designed with additives that retard the hydration process so that the concrete may be delivered many hours before it is required. The expectation is that three to four concrete trucks would be required between the hours of 18:30 -22:30. Concrete deliveries beyond 22:30 are not planned to occur.

*Personnel Car Parking and Transport*

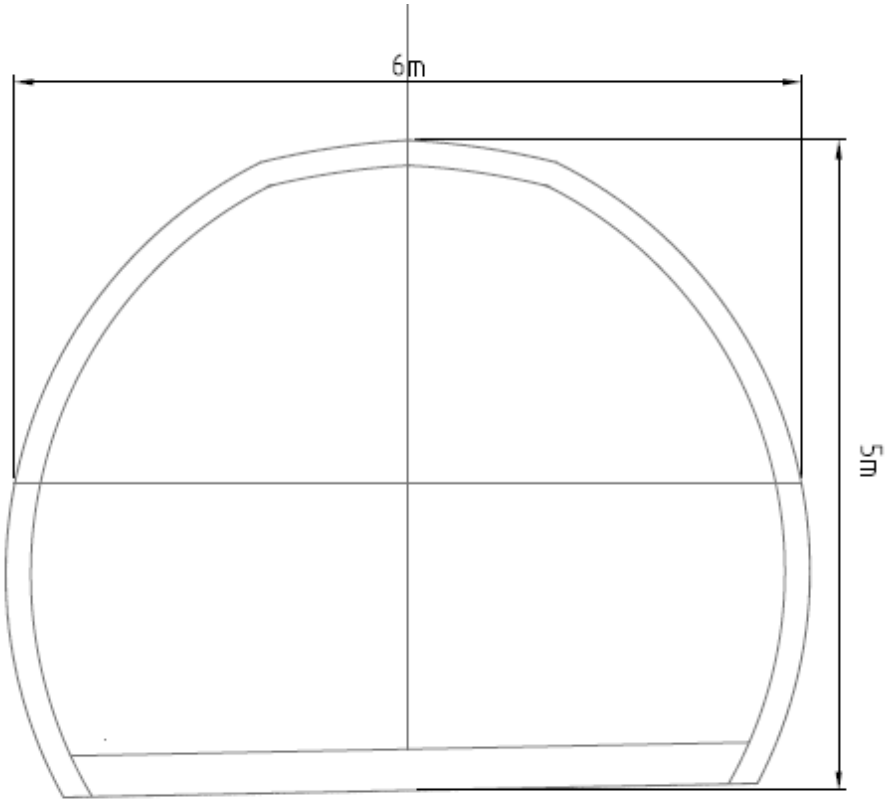
The limited size of the site prohibits the establishment of car parking facilities for

personnel working on the site. During the site establishment works, subcontractors working at the site will park their vehicles on the site, and limited parking on the surrounding streets may be required in some instances. For the tunnelling phase and beyond, parking at the site will not be available for personnel working from the Rose St worksite. Personnel will travel to the site via a shuttle operating from the main Kedron worksite.

*Construction of Access Adit*

An adit will be excavated to enable access from the shaft into the mainline driven tunnel, eastbound cavern. The adit will, as shown below, have nominal dimensions of 6 m wide by 5 m high. The length of this adit between the shaft and the mainline tunnel is 15 m.

*Figure 2 – Access Adit*




The adit will be excavated in medium to high strength Tuff and as such, anticipated rock support for this area will be rockbolts of expected 2 m – 3 m length installed in the crown with a sprayed concrete lining of anticipated thickness 250 mm.

The rock support will be installed by a specialised drill jumbo, and it is expected that

the spacing between rows of bolts will be 1 - 1.5 m. Shotcrete is applied by either a robotic shotcrete rig, or by hand utilising a concrete pump and air compressor. Excavation and support are distinct activities that will be governed by the same protocols as apply to the permanent works tunnels, that being the permit to tunnel system where excavation is only permitted to advance based on inspections of the 'as found' conditions, the installation of the required support and the observation of surface and in-tunnel monitoring data.

*Access for Tunnelling*

Initially, the primary function of the shaft and of the site are to serve as a means of access for tunnelling activities. The roadheaders, trucks and other equipment such as drilling rigs and shotcrete machines will be lowered from the surface to commence the tunnel excavation. The gantry crane is planned to be used to perform these lifts. If the roadheader component weights exceed the capacity of the gantry crane, a large mobile crane in the order of 400 t will be required. The 400 t crane will require a systematic plan for delivery, mobilisation and demobilisation. This will involve out of hours work and localised traffic management. Additionally supplementary cranage may also be required.

The shaft will also be the means by which excavated tunnel spoil will be removed to the surface. A gantry crane will straddle the shaft and the spoil stockpile and a kibble attached to the gantry will be used to hoist the excavated material out. A loader on the surface will manage the spoil stockpile and also load the road going spoil trucks. Spoil trucks will enter the acoustic shed and will be loaded at the spoil stockpile. All of these works will occur within the acoustic shed.

Spoil handling, management and transport are key issues for the operation of this site and also across the project. The process envisaged is as follows:

- Spoil is generated in excavation of the shaft, the tunnels and the caverns.
- The rate of spoil generation steadily increases as the project works progress. At this stage it is anticipated that at full production, the road headers would operating in the caverns will be producing a maximum of 4,500 bcm/week.

- This peak production is equivalent to 325 truck movements spread over a five day week, i.e. 65 trucks per day.
- The spoil as generated will be transported to the base of the shaft by an off highway dump truck and stockpiled for haulage to the surface.
- It will then be loaded into a kibble and lifted to the surface with the gantry crane located within the shed.
- The kibble will discharge into a muck bin where the loader will load the material into highway trucks for disposal off site.

The loading and haulage of the spoil off the site will be controlled to minimise impact on both the travelling public and the local residents. Some of the measures being adopted are as follows;

- The spoil trucks will enter and exit the site in a left-in / left-out configuration to limit the space taken on the road.
- All trucks will be fitted with radios and the staging of trucks will be such that trucks will be called into the project as the filled truck is leaving to ensure trucks do not queue out onto the road before entry. Trucks will either queue at an off-site location or will remain on the designated haul roads until required. Note: the site has capacity to store a maximum of three trucks onsite at any time.
- The entry point will have traffic control provision whilst truck haulage is underway to ensure pedestrian, cyclist and bus stop patrons are not impacted by truck movements.
- The trucks will be loaded on a concrete loading bay and at no time will be required to travel on unsealed ground thus eliminating the risk of dirt being transported onto the local roads.

The shaft access at Rose Street will also be a delivery point for the supply of tunnelling materials and consumables. Deliveries will typically consist of items such as ground support, temporary services pipes, concrete and shotcrete etc. The total vehicle movements to site are expected to be in the order of 100 per day at peak times, 35 of which will consist of deliveries via truck or other commercial vehicle. Other common materials to be delivered routinely include lubricants for the roadheaders, fuel for plant and equipment, steel and steel cutting gasses for boiler-

making activities.

Given the limited area on the site, storage will be kept to a minimum, with regular deliveries of supplies and equipment from the Kedron site to service the requirements of the tunnelling operation at Rose Street.

A storage and lay-down area is proposed for the north eastern area of the site. Typical materials and equipment that will be stored on the site will include ground support equipment, plant consumables such as oil, fuel and grease, steel for maintenance and repair activities, personal safety consumables and other general construction tools and consumables.

The storage and lay-down area will be a hardstand suitable for the type of material and equipment stored and the vehicles that will access the area.

Some of the materials and equipment stored on site will be categorised as hazardous or dangerous. These goods will be stored in accordance with legislative requirements and manufacturer's guidelines. The storage provisions contained within legislative and manufacturer's guidelines typically include the following:

- bunding for chemicals;
- bunding for oils and greases;
- spill kits and spill containment devices;
- fire extinguishers and other fire fighting equipment;
- barriers or fencing as may be required for materials and equipment; and
- procedural controls for elements such as refuelling.

The types of hazardous substances likely to be stored on site include but are not limited to:

- Fuel (10,000l)
- Solvents (<200l)
- Additives (5000l)
- Cleaning agents (<500l)
- Oils & grease (5,000l)
- Paints (<100l)
- Pesticides (<20l)
- Other hazardous chemicals (welding rods, cement, other)

Beyond the tunnelling phase of the works, the Rose Street site will be used as an access for civil and mechanical fitout of the tunnels. Spoil haulage will conclude at the end of the tunnel excavation phase. Similarly the requirement for maintenance and repair of plant and equipment beyond the tunnelling phase of the works will be reduced. Deliveries to the tunnel through the Rose Street shaft will consist of concrete and concreting personnel and materials, mechanical equipment and electrical equipment that will be installed within the tunnels. This can include items such as pipework, structural steel, cables and cable trays ventilation fans.

# 5. DETAILS OF PROPOSED SITE MANAGEMENT MEASURES

*Acoustic Impacts*

Report prepared by Air, Noise and Environment for Rose St worksite in May 2009.

*Vibration Impacts*

The previous EIS undertaken for the project indicates compliance with the vibration guidelines should be achieved, otherwise measures should be employed to minimise any adverse impact on the community or infrastructure. The goal values, as provided in the EIS and later produced in the Coordinator General's conditions are shown reproduced in the table below. Based on similar activities undertaken in other locations, the monitoring to date indicates that the vibration goals are achievable.

*Figure 3 – Shaft Location*

*Table 2 – Summary of the Construction Vibration Goals*

| *Daytime or Evening* | *Equipment* | *Building Type* | | |
|---|---|---|---|---|
| | | *Heritage Listed* | *Residential* | *Sensitive Commercial* |
| Daytime | Blasting | 2 mm/s | 10 mm/s | 10 mm/s |
| | TBM / Roadheader/Hydraulic Hammer | 2 mm/s | 5 mm/s | 5 mm/s |

The construction methodology indicates equipment potentially capable of inducing measurable, and therefore perceptible, levels of vibration at surrounding properties may be used, in particular in the following construction areas:

- Preparation of the area about the shaft collar, including the hardstand, roadway and foundations for site buildings may necessitate the use of a roller for footing preparation.
- The geotechnical analyses indicate that piling will be required about the shaft to a depth exceeding 25 m. Piling will, however, be restricted to bored secant piles or a soil mix wall, either of which are expected to generate very low levels of vibration and perceptible only at distance not exceeding a few metres from the shaft collar.
- Where the proposed excavation works for the shaft will be undertaken in hard rock, it is proposed that these are completed using either small scale controlled drilling and blasting methods or hydraulic hammering.

The schedule of activities and operational experience at other sites suggests no other activities will generate perceptible levels of vibration at properties adjacent to the shaft location.

*Preparation of the Works Area*

Preparation of the works area is expected to use rollers to achieve the required level of compaction. Static rollers will result in none to minimal vibration at the nearest properties. Vibration monitoring will be undertaken at the nearest sensitive receptors to confirm this during the preparation period.

*Boring of Secant Piles*

The boring of the secant piles in the upper section of the shaft will induce very low levels of vibration. Data from other project sites suggest that vibration values will be less than 0.5 mm/s at a distance of 6 m from the cutter head. At the nearest property in Park Road, the vibration levels are predicted to be around 0.25 mm/s. Vibration monitoring will also be undertaken during this operation.

*Shaft Construction with Hydraulic Hammers – [Preferred method]*

The level of vibration measured at the adjacent properties is dependent upon the hammer energy and the distance between the hammering location and the point of measurement. Measurements undertaken on a 35 t excavator at Bowen Hills, which is larger than the size of excavator proposed to excavate the Rose Street shaft, show a level of vibration in the order of 2.2 mm/s at 20 m. It is reasonable to conclude that the level of vibration from a smaller excavator within the shaft at Rose Street will be at a maximum at the rock interface (estimated to be 25 m below the collar) in the range of 0.5 mm/s to 1.0 mm/s.

Vibration levels of this magnitude will be perceptible to persons within the nearest properties although is within the compliance values specified in the Coordinator General's conditions.

*Shaft Construction with Blasting – [Alternative method]*

A review of the location of the shaft shows that it is adjacent to multiple residential properties along Park Road and Kent Street, commercial properties along Rose Street, and services, in particular a high pressure gas line, along Park Road. This infrastructure will necessarily require a small and controlled scale of blasting to ensure their integrity is unaffected.

Based upon other discussions with the service providers for blasting activities completed at Bowen Hills, a level of vibration not less than 50 mm/s is considered appropriate for ensuring the blast or equipment generated vibration does not impact on the gas line integrity.

The adjacent commercial properties along Rose Street do not house any equipment

that would be considered particularly susceptible to blast vibration. Compliance with the previously imposed Environmental Protection Act value of 25 mm/s is considered relevant for these commercial properties.

In addition to vibration monitoring at these properties, defect surveys and community liaison will be completed, as per the Environmental Management Plan. It is likely that the adjacent residential properties at Kent Road and Park Road will experience vibration levels below 25 mm/s.

Given the upper 20 m of material near the shaft collar is not expected to require blasting, the minimum separation distance between the blasting area and the nearest property (Park Road) is approximately 25 m. Blasting activities other areas in similar rock types have identified a relationship between distance, explosive type and vibration levels as follows:

$$PPV = 4185\left(\frac{d}{\sqrt{W}}\right)^{-1.49}$$

The above equation suggests that explosive quantities will be restricted to around 700 g per blasthole to comply with a 25 mm/s vibration limit at the nearest property. Other properties further from the blast will receive lower levels of vibration. Towards the base of the shaft (separation distance of 45 m), the explosive quantities are expected to approach a maximum weight of 2 kg.

Blast patterns designed with 700 g of explosive per blasthole will necessitate a blasthole diameter of 32 mm with blasthole depths of less than 2 m and use of a 25 mm decoupled explosive type. At the lower depths, blasting can continue with a larger blasthole diameter (45 mm) and 38 mm cartridge explosive.

In summary that whilst the level of vibration from the construction activities will be perceptible at properties about the works area, they can be designed to maintain vibration levels at less than those values given in the EIS conditions.

*Visual Amenity*

The acoustic shed will be approximately 25.5 m x 53.5 m and may have a stepped roof profile to accommodate the equipment housed within, similar to the acoustic shed used successfully at the Shaftston Site of the Clem Jones Tunnel. The roof of

the Shaftston acoustic shed is 16.5 m at the eave and 17.5 m at its highest along the ridge line.

The acoustic shed is made of steel portal frames onto which acoustic panels and colourbond sheeting are attached to provide noise attenuation. A picture of the Shaftston acoustic shed is provided below.

*Figure 4 – Shafston Acoustic Shed*

In relation to buildings adjacent to the site, the bulk and form of the proposed shed will have short term visual amenity impacts both from a street and neighbours perspective. The bulk and form of the building is not consistent with the existing area however the structures form needs to be designed to ensure operational efficiency during construction.

Although visual amenity impacts will occur at this location, these are mitigated to a degree through the following:

- the shed will be temporary;
- the colour of the shed will remain neutral;
- the location of the shed is affront a main road and adjacent to commercial operations;

- the majority of works will be carried out away from the public eye within the structure;
- the site will be quickly rehabilitated following construction works;
- air quality will be managed within the shed and the loads from the site will be covered;
- water quality will be managed through water retention and treatment; and
- mitigation measures such as entry and exit points to manage dirt on roads will be implemented.

*Air Quality Impacts*

Air, Noise and Environment report prepared for Rose St worksite in May 2009.

*Surface Water Impacts*

Surface water will be impacted to varying degrees during the establishment and operation of the shaft at Rose Street.

It is anticipated that the greatest impacts for the Rose St worksite on surface water will be during the clearing and site establishment phase. It is well documented that during clearing and the subsequent exposure of soils that erosion and sediment issues present water quality issues. The site will require the removal of both aerial (sparse tree cover) and groundcover (grass) from the proposed location.

The project proposes to install adequate sediment control during the clearing and development stage of the site. The controls shall be in accordance with the “Best Practice Erosion and Sediment Control” manual. It is envisaged that the following controls will need to be installed as a minimum during these initial phases:

- sediment fences to the boundary;
- sand bagging / silt socks and other gutter protection devices;
- drainage control (clean and dirty water management);
- temporary stabilisation techniques (soil stabilisers);
- entry and exit devices to limit material being dragged onto the surrounding road network; and

- regular road sweeping to maintain traffic safety, public amenity and the protection of stormwater quality.

It is anticipated that erosion and sediment issues will abate as construction progresses with most impacts removed following the stabilisation of the site through the use of concreting pavement and the placement of hardstand on other surfaces.

A Soil and Water Management Plan (SWMP) will be created for the initial construction stages to manage erosion and sediment issues. The SWMP measures will be transferred into the projects existing environmental management documentation.

As previously discussed, the erosion and sediment issues will be substantially reduced following site stabilisation and shed erection. Construction of the shed will result in the site's inability to retain water through ground uptake. In order to manage this issue stormwater during these periods will be managed via the retention of stormwater for reuse via roof runoff capture. Tank(s) will be installed onsite to capture stormwater. Water retained via this method will generally be used in the tunnelling process. Excess clean water will be plumbed into the existing stormwater drainage system.

*Groundwater Impacts*

The site is bounded by Rose Street to the south, Kent Road to the east, Park Road to the west and residential properties to the north. An additional access shaft in the southwest corner of the site is proposed to permit excavation of the caverns from the east. The diameter of the shaft will be approximately 15 m, and extend to a depth of approximately 42 m below surface level.

Bores DT17 and DT17A are located within close proximity to the site (refer to the figure below). Bore DT17 is situated in the eastern end of the site and bore DT17A is located towards the western end of the site in the approximate shaft location. Overburden material comprises predominantly clay with some sand and gravel lenses to a depth of approximately 20 – 25 mBGL. Underlying the overburden is the Aspley-Tingalpa formation which consists of siltstone, sandstone and a 5 m thick bed of breccia/conglomerate. At a depth of approximately 30 – 35 mBGL the Brisbane Tuff is encountered.

*Figure 5 – Groundwater Borehole Locations*


The standing water level at DT17 is around 8.79 mBGL, which corresponds to the top of a sand layer in the bore log and is potentially an example of a perched water table within the clay. It is also anticipated that a bedrock aquifer would be encountered within the porous matrix of the sandstone and conglomerate units of the Aspley-Tingalpa formation, or within fractured zones of these units.

The Queensland Natural Resources and Water groundwater bore database indicates that there are no bores reported within 500m of DT17, and 15 registered bores between 500 m and 1,000 m of DT17.

*Potential Effects of the Shaft Excavation and Construction on Groundwater*

The shaft will be excavated to a depth of 42 m through overburden and bedrock.

The excavation will create a zone of negative pressure inducing groundwater flow towards the void, and causing groundwater to interact with oxygen. This may have the following effects on groundwater:

- drawdown / dewatering of perched aquifers in the overburden material;
- drawdown in the bedrock aquifer as water flows into the excavation;
- water quality – exposure to oxygen may have an effect on water quality (i.e. acid sulphate soil issues); and
- water quality – interaction of groundwater with concrete/bentonite slurry mix as the piles are being constructed may have an adverse effect on groundwater quality.

*Potential impacts of Groundwater during Construction of the Shaft*

In addition to the potential effects of the shaft excavation on the groundwater there is also potential for groundwater to impact on the sequence and methods of shaft construction. These potential effects include:

- geotechnical instability of excavation due to presence of water in soils, and water inflows to the excavation;
- groundwater inflow to rock excavation impeding construction; and
- dewatering of the shaft excavation may be required. Where water quality does not meet local licensing requirements for disposal treatment will be required.

In order to manage the effects of construction on groundwater, and the groundwater interactions during construction, the installation of cut-off/support walls are recommended. The walls would prevent groundwater drawdown and inflow into excavation, and prevent groundwater exposure to excess oxygen. Two options for cut-off/support walls are available, namely:

- secant pile wall; and
- cutter soil mix wall.

Both installation methods involve excavating a series of interconnecting boreholes and filling them with a bentonite/concrete mixture, which may or may not be reinforced depending on structural requirements.

The secant pile wall (or cutter mix walls) should be excavated into competent rock to provide protection for both the soil and weathered rock areas where perched groundwater may be encountered. The excavation within bedrock may also require a concrete/benotnite lining to prevent groundwater ingress - this may be especially significant if groundwater quality is of concern.

If bentonite is used in the piling process, particular attention should be given to the concrete/bentonite slurry mix to be used for the pile walls in regards to groundwater chemistry, storage and management of slurry.

With proper wall installation and sealing risk for increased impacts due to the addition of the Rose Street Shaft are minimal.

*Contaminated Land and ASS*

The site currently consists of a generally flat, grass covered area with several trees and shrubs growing within the site boundary. The site establishment works at Rose Street will require the removal of trees, other vegetation and topsoil from the site.

The site is surrounded primarily by residential land use and boarded on three sides by roadways including Rose Street. A historical service station is located adjacent the shaft site and currently operates as a veterinary clinic. The site is listed on the Queensland DERM's Environmental Management Register (EMR) due to its past use as a service station. As a result of this historical land use, two groundwater wells were installed in Rose Street adjacent the Wooloowin Vet. One groundwater sampling event has been completed since installation did not detect any hydrocarbon associated impacts in the groundwater.

Melrose Park is located approximately 100 m to the east of the site and is also listed on the EMR due to possible historical filling. Three groundwater wells have been installed at the site and have been sampled once and have not returned evidence of groundwater impacts.

A search of the EMR of the nominated lots has been carried out, the results of which are summarised below:

*Table 3 – Summary of EMR Nominated Lots Search*

| Lot | Plan | EMR | CLR |
|---|---|---|---|
| 1 | RP 104544 | Not listed | Not listed |
| 85 | RP 104 544 | Not listed | Not listed |
| 55 | RP 19480 | Not listed | Not listed |
| 56 | RP 19480 | Not listed | Not listed |
| 1 | RP 95711 | Not listed | Not listed |
| 2 | RP 95711 | Not listed | Not listed |

A number of historical Aerial Photographs are available and were reviewed with the general observations outlined below:

- August 1955 – 2 x large buildings present on the site, use is unclear;
- August 1964 - 2 x large buildings present on the site, use is unclear;
- June 1982 – Landuse is unclear, large red roofed buildings;
- November 1994 – Landuse is unclear 2 x large red roofed buildings;
- March 2002 – Site is vacant and buildings demolished; and
- October 2008 – Vacant site.

*Acid Sulphate Soils*

Due to the location of the site is it possible that acid sulphate soil may be present at various depths. The proposed works will involve significant excavations works and management of the excavated soil may be required to lime stabilisation or off site treatment.

*Management Requirements*

The following actions should be carried out to assess the potential risks associated with contaminated land and acid sulphate soil at the proposed shaft site:

- Complete additional rounds of groundwater sampling in the vicinity of the site, with particular reference to the historical services station site adjacent the shaft site.
- Complete a details historical review to determine the historical use of the site.
- Although the site(s) is not listed on the EMR, the historical activities are unclear at present and may warrant preliminary assessment of the

shallow soil profile. It may be required to complete a series of shallow testpits (six in total) in the areas of the large historical buildings located on the site to assess the potential for potentially shallow contaminated soils.

- Complete one deep borehole is the centre point of the proposed shaft to assess the potential for acid sulphate soil and to develop appropriate management techniques for the disposal of spoil. Contaminated land samples should be collected to assist in developing suitable offsite disposal options.

*Haul Route Management for Spoil Haulage, Construction Materials Haulage and other Movements of Heavy Vehicles Accessing the Worksite:*

The haul routes identified have been reviewed with the only identified change to the infrastructure along the routes would be a realignment to the current island located at the intersection of Park Road and Rose Street would be required to facilitate the vehicle movements. The reconfigured island would be in compliance with Road Planning and Design Manual requirements for use as a pedestrian refuge island. On site queuing is available for approximately three spoil haulage vehicles.

The preferred northern routes for spoil haulage are:

- left turn from Park Road onto Rose Street, left turn onto Dawson Street, continue onto Shaw Road, left onto Rode Road, Right turn onto Gympie Road; and
- left turn from Park Road onto Rose Street, continue along Junction Road, left turn onto Sandgate Road.

The preferred southern routes for spoil haulage are:

- left turn from Park Road onto Rose Street, continue along Junction Road, right turn onto Sandgate Road; and
- Park Road, right turn onto Kedron Park Road, left turn onto Lutwyche Road.

The routes nominated above have been proposed based on the hierarchy of road.

Local roads used during this operation include only the section of Kent Road between Rose Street and the site entry point and Park Road between Rose Street and the site exit. The other roads nominated are either classed as District Access Roads (under BCC City Plan) and Arterial Roads. The intersections along both Junction Road and Rose Street have been assessed with the extra vehicles. The current AADT (daily traffic volumes) show that the increase is marginal. During the AM and PM peak hours, the impact of the increased construction vehicles (including haulage vehicles) can be seen to be less than 0.5% increase of total traffic volumes – refer to the table below. This similarly applies for the intersections of Dawson Road/Junction Road and Junction Road/Sandgate Road.

*Table 4 – Summary of Traffic Changes*

| Location | AM Peak hour | PM Peak Hr | AADT | TJH Traffic Generation | % increase |
|---|---|---|---|---|---|
| Rose Street/ Kent Road intersection | Refer to attached STREAMS data | | | 10 vph | »0.5% |
| Dawson Street/ Rose Street intersection | Refer to attached STREAMS data | | | | »0.5% |
| Sandgate Road/ Junction Road Intersection | Refer to attached Manual Intersection Count | | | | »1.5% |

It should be noted that the vehicles will be directed to use the nominated routes above thus distributing the impact of the haulage vehicles through the intersections of Dawson Road/Rose Street and Sandgate Road/Junction Road. The above demonstrates worst case scenarios.

Access and parking arrangements along all routes are not affected by the spoil haulage routes as the routes have been chosen based on their functional classification.

## 6. RESPONSIBILITIES

**Senior Project Manager**

Review compliance of this Work Method Statement with the Occupational Health

and Safety (OH&S) plan and the Community Notification Protocol.

**Project Manager**

Ensure relevant work methods and environmental and community obligations are known by all persons and subcontractors. Ensure activities are in accordance with design and specification.

**Site Foreman / Supervisor**

Ensure the works are undertaken in accordance with their OH&S Plans, JSEAs and Site Safety requirements and in accordance with Project Objectives.

**Project / Site Engineer(s)**

Ensure correct safe work and environmental obligations are known, implemented and followed by all persons. Ensure work is carried out in accordance with designs, quality standards, environmental and community commitments. Carry out testing and monitoring of the activities.

**Subcontractors**

Ensure they review and understand the documentation and training pertinent to each task and activity prior to commencing it. Carry out works in accordance with legislative requirements, this WMS, JSEAs and Project requirements.

**Employees**

Ensure they review and understand the documentation and training pertinent to each task and activity prior to commencing it. Carry out work in accordance with legislative requirements, this WMS, JSEA's and Project requirements.

**Community Liaison Coordinator**

Plan and manage the stakeholder relations, communications and media issues associated with the construction activities at the site.

## 7. SAFETY

All personnel will have completed the following prior to commencing work activities:

Project general induction

- Site specific induction
- Blue Card or equivalent from another State
- Pre-start meeting
- JSEA's *and toolbox talk*

The use of Personal Protective Equipment (PPE) is mandatory on the site. Mandatory items of PPE must be worn at all times and include:

- Long sleeve shirt
- Long pants
- Hard hat
- High sided lace up steel capped boots
- Safety *glasses*

All PPE must meet the relevant Australian Standard. Additional PPE, such as hearing protection, dust masks, gloves, fall protection etc are to be used where required by the JSEA.

All personnel will attend a daily pre-start meeting.

All personnel shall discuss the works procedure in a toolbox meeting and prepare job specific JSEAs prior to the works commencing. The workforce and supervisors will develop JSEAs prior to an activity beginning and each time the sequence of work or people doing the work changes.

All plant and equipment is to be inspected and certified as fit for purpose prior to operation on site. All plant and equipment is to receive pre-start checks, service and maintenance as per the TJH procedures for mobile plant.

## 8. ENVIRONMENT AND COMMUNITY

*Equipment emitting impulsive or tonal noises that have specific operating criteria will be operated in accordance with those criteria.*

*Areas of environmental and community concern arising from the works will be addressed in the planning and work methodology so as to mitigate the impacts.*

Community and stakeholder liaison (including businesses and local politicians) will be undertaken by the Community Relations Team in accordance with the TJH Community and Consultation Management Plan (CCMP). The appropriate Project Manager or Site Supervisor will be made available to support the Community Relations team to participate in stakeholder briefings where required.

As part of the overall community engagement activities, letter box drops will be undertaken to notify the community of the proposed and upcoming major works. A 24 Hour Community Hotline (Phone: 1800 721 783) and dedicated email address (contactus@tjh.com.au) is established to respond to community enquiries and issues. The construction team and subcontractors should carry the Community Enquiries business card with them at all times for use when approached by a member of the public.

## 9. REFERENCES

- TJH-GL-MPR-EN-006 Site Environmental Plan
- TJH-GL-MPR-EN-008 Water Quality Monitoring
- TJH-GL-MPR-EN-009 Air Quality Monitoring
- TJH-GL-MPR-EN-010 Vibration Management
- TJH-GL-MPR-EN-0011Noise Management
- TJH-GL-MPR-EN-014 Sediment Control Design and Management
- TJH-GL-MPR-EN-016 Weed Management
- TJH-GL-MPR-EN-017 Dewatering
- TJH-GL-MPR-EN-018 Tree Management – General
- TJH-GL-MPR-EN-019 Flora Management
- TJH-GL-MPR-EN-020 Fauna Management
- TJH-GL-MPR-EN-022 Approvals Management
- TJH-GL-MPR-EN-023 Cultural Heritage – Non-Indigenous
- TJH-GL-MPR-EN-024 Waste Management
- TJH-GL-PLN-CO-006 Project Traffic Management Plan
- TJH-GL-PLN-CO-008 Construction Traffic Management Plan (Rose St)
- Rose Street Community Engagement and Communication Plan

SAFETY

- TJH Occupational Health and Safety (OH&S) Management Plan.
- Occupational Health and Safety Act 2000
- Occupational Health and Safety Regulations 2001
- Work Cover Code of Practice – Excavation (March 2000)
- Work Cover Code of Practice – Moving Plant on Construction Sites (2004)
- TJH procedures for mobile plant on work sites, including operator certification.

QUALITY

*Quality Assurance will be carried out in accordance with the TJH Project Management Plan (PMP) and associated sub plans.*

*TJH-AM-ITP-CO-0003 Demolition and Clearing*

*TJH-AM-CKL-CO-0003 Demolition and Clearing*

DRAWING

*TJH-AM-SEP-EN-0001-A-01 – Rose Street Site Environmental Plan*

APPENDICES

*Proposed equipment specifications*

# Appendix A.3 – Air and Noise Quality Assessment – Rose Street Worksite

# TJHJV

# ROSE STREET - NOISE AND AIR QUALITY ASSESSMENT

**June 2009**

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| 03 | | | | | | |
| 04 | | | | | | |

# CONTENTS

# 1 INTRODUCTION

This report forms part of a Request for Change submission associated with the proposed Rose Street construction site. In order to assess potential environmental impacts and identify appropriate mitigation measures, acoustic and air dispersion modelling has been undertaken by Air Noise Environment.

The assessment specifically addresses potential air and noise impacts associated with various stages of the Rose Street project:

- construction of the proposed acoustic shed;
- excavation of the shaft (during construction of the acoustic shed);
- operational phase (post-construction of shed) during roadheader excavation;
- haul vehicles along the proposed haul routes.

The results of the predictive modelling have been compared with noise and air quality goals specified in the Coordinator General's Report for the Airport Link and Northern Busway (APLNB) Project. Where goals are not specified in the Coordinator General's report, referenced has made to goals from other relevant agencies.

# 2 ASSESSMENT GOALS

## 2.1 AIR QUALITY GOALS

Tables 2.1 and 2.2 presents a summary of the air quality goals considered for the purposes of the assessment. It is noted that the Coordinator General's report provides air qualities for dust fallout and $PM_{10}$ levels only. Where air quality goals associated with other pollutants are required, air qualities provided by the National Environmental Protection (Ambient Air Quality) Measure 2003 in the Environmental Protection (Air) Policy 2008.

**TABLE 2.1: APLNB COORDINATOR GENERAL'S REPORT - SUMMARY OF AIR QUALITY GOALS**

| **Existing Dust Fallout Level ($g/m^2$/month)** | **Maximum acceptable increase over existing background fallout levels ($g/m^2$/mth)** | |
|---|---|---|
| | Residential Area | Commercial Area |
| 2 | 2 | 2 |
| 3 | 1 | 2 |
| 4 | 0 | 1 |
| 5 | 0 | 0 |
| **Health-based goal for ambient air ($PM_{10}$)** | | |
| 24 hr average (exceedances no more than 5 times / year) | | 50 $\mu g/m^3$ |

**TABLE 2.2: SUMMARY OF AIR QUALITY GOALS**

| Pollutant | Goal | Averaging Period | Source |
|---|---|---|---|
| Carbon Monoxide | 11,000 | 8-hour | NEPM/EPP(Air) |
| Nitrogen Dioxide | 246<br>62 | 1-hour<br>Annual | NEPM |
| TSP | 90 | Annual | NEPM |
| Benzene | 10 | Annual | NEPM |

## 2.2 NOISE GOALS

### 2.2.1 APLNB Coordinator Generals Report

The APLNB CG's report places requirements on the management of noise emissions during the construction of the Airport Link project. In particular the CG's Report requires that:

'*7. General Construction*
*(a) Construct the Project in accordance with the Construction EMP and Construction*

*EMP Sub-Plans.*

*(b) Collection, unloading and haulage of spoil from construction sites may be undertaken at any time of the day or night between 6.30 am Mondays to 6:30 pm Saturdays, but with no haulage on Sundays or public holidays. Otherwise, construction activities for works on or above the surface and which generate excessive levels of noise, vibration, dust or construction traffic movements, must only be undertaken between 6.30 am to 6.30 pm Mondays to Saturdays and at no time on Sundays or public holidays, except for special circumstances where the above-the-surface works should be conducted outside these days and hours. Examples of such special circumstances include:*

*(I) works on arterial roads to avoid disruption to peak traffic flows (eg Inner City Bypass, Lutwyche Road, Gympie Road, East West Arterial);*
*(II) works in rail corridors; and*
*(III) works involving and transport of large pre-fabricated components (eg bridge works).*

*(c) Construction worksites along the tunnel alignment must be designed and constructed to provide for the management and mitigation of construction impacts by:*

*(I) incorporating acoustic screening, ventilation and dust filtration equipment to achieve the environmental objectives and performance criteria set out in the EIS Chapter 19 Draft Outline EMP (Construction) of these Conditions. In particular, spoil-handling facilities (being for stockpiling, handling and loading into haulage trucks) and tunnel shafts servicing underground works should be enclosed, ventilated and acoustically-lined;'*

In addition to a number of noise management measures the CG's Report makes reference to the noise goals presented in the Draft Environmental Management Plan (Draft EMP) provided in the Environmental Impact Statement (EIS) prepared for the project. These goals are summarised in the following section.

### 2.2.1 Draft EMP

The draft EMP presented in the EIS provides a number of goals for the assessment of the acoustic performance of the construction works. It is intended that these goals are considered in the development of the construction program and design of acoustic mitigation measures implemented as part of the construction works.

Tables 2.3 and 2.4 present a summary of the noise goals as provided in the Draft EMP from the EIS.

**TABLE 2.3: DAYTIME CONSTRUCTION INTERNAL NOISE GOALS**

| Type of Building Occupancy | Maximum Construction Internal Noise Target | |
|---|---|---|
| | Steady $L_{Aeq(15\ minute)}$ dB(A) | Non-steady $L_{A10(15\ minute)}$ dB(A) |
| Residential buildings<br>▪ Living areas<br>▪ Sleeping areas | 45 – near major roads<br>40 – near minor roads | 55 – near major roads<br>50 – near minor roads |

| Type of Building Occupancy | Maximum Construction Internal Noise Target | |
|---|---|---|
| | **Steady $L_{Aeq(15\ minute)}$ dB(A)** | **Non-steady $L_{A10(15\ minute)}$ dB(A)** |
| Place of Worship | 40 – with speech amplification | 50 – with speech amplification |
| Schools:<br>▪ Music rooms<br>▪ Teaching areas<br>▪ Libraries<br>▪ Gymnasia | <br>45<br>45<br>50<br>55 | <br>55<br>55<br>60<br>65 |
| Commercial buildings<br>▪ Office space<br>▪ Retail space | <br>45<br>50 | <br>55<br>60 |

**TABLE 2.4: INTERNAL NOISE GOALS TO AVOID SLEEP DISTURBANCE**

| Criterion | Hours | Goal |
|---|---|---|
| For intermittent construction noise | 6:30 pm – 6:30 am | ▪ For residences within R1 – R3 categories as described in NIAPSP – 45 dB(A) $L_{Amax}$<br>▪ For residences within R4 – R6 categories as described in NIAPSP – 50 dB(A) $L_{Amax}$ |
| For steady construction noise | 6:30 pm – 6:30 am | For residences within R1 – R3 categories as described in NIAPSP:<br>▪ 35 dB(A) $L_{Aeq\ adj\ (15mins)}$ for temporary noise<br>▪ 30 dB(A) $L_{Aeq\ adj\ (15mins)}$ for long term noise |
| | | For residences within R4 – R6 categories as described in NIAPSP:<br>▪ 45 dB(A) $L_{Aeq\ adj\ (15mins)}$ for temporary noise<br>▪ 35 dB(A) $L_{Aeq\ adj\ (15mins)}$ for long term noise |

These goals are considered in the assessment of potential impacts associated with construction activities for Rose Street.

### 2.2.1 BCC Noise Impact Assessment Planning Scheme Policy (NIAPSP)

The Brisbane City Council NIAPSP provides guidance (through reference to Australian Standard AS 1055.2) to average background noise levels for residential areas in Brisbane. These values represent an indication of the typical background noise levels expected in an area given its proximity to major and minor roads and commercial or industrial uses.

Table 2.5 presents a summary of the typical average background noise levels for each category of residential use within Australia. This information is used to identify the most appropriate noise goals for residential receptors near to the Rose Street site based on pre-commencement noise monitoring.

**TABLE 2.5: ESTIMATED AVERAGE BACKGROUND A-WEIGHTED SOUND PRESSURE LEVELS ($L_{A90,T}$) FOR DIFFERENT AREAS CONTAINING RESIDENCES IN AUSTRALIA**

| Noise area category | Description of Neighbourhood | Average background A-weighted sound pressure level, ($L_{A90,T}$) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Monday to Saturday | | | Sunday and public holidays | | |
| | | 0700 – 1800 | 1800 – 2200 | 2200 – 0700 | 0900 – 1800 | 1800 – 2200 | 2200 - 0900 |
| R1 | Areas with negligible transportation | 40 | 35 | 30 | 40 | 35 | 30 |
| R2 | Areas with low density transportation | 45 | 40 | 35 | 45 | 40 | 35 |
| R3 | Areas with medium density transportation or some commerce or industry | 50 | 45 | 40 | 50 | 45 | 40 |
| R4[a)] | Areas with dense transportation or with some commerce or industry | 55 | 50 | 45 | 55 | 50 | 45 |

[a)] *Categories R5 and R6 from the NIAPSP would be expected to have background noise levels equal to or greater than these*

### 2.2.2 Summary of Assessment Noise Goals

Table 2.6 presents a summary of the internal noise goals considered for the purposes of the assessment.

Noise monitoring completed at the Rose Street site indicates the area can be defined as an R3 Noise Category. The day and evening average $L_{A90}$ noise levels were measured at 52 dB(A) and 46 dB(A) respectively (night-time measurements have been considered invalid due to the heavy rainfall). These correspond to the designated day and evening R3 background noise levels of 50 dB(A) and 45 dB(A), respectively.

**TABLE 2.6: SUMMARY OF NOISE GOALS**

| Noise Goals | Day (Area Near Major Road) | | Night (R3 Noise Area) | |
|---|---|---|---|---|
| | Steady-state ($L_{Aeq,adj,15\text{-}min}$) | Non-steady state ($L_{A10,adj,15\text{-}min}$) | Steady-state ($L_{Aeq,adj,15\text{-}min}$) | Non-steady state ($L_{AMax}$) |
| **Residential Receptors** | | | | |
| Internal | 45 | 55 | 30 | 45 |
| External[1] | 55 | 65 | 40 | 55 |
| **Teaching Areas (Queensland Aerospace College)** | | | | |
| Internal | 45 | 55 | 45 | 55 |
| External[2] | 65 | 75 | 65 | 75 |

| Noise Goals | Day (Area Near Major Road) | | Night (R3 Noise Area) | |
|---|---|---|---|---|
| | **Steady-state ($L_{Aeq,adj,15\text{-}min}$)** | **Non-steady state ($L_{A10,adj,15\text{-}min}$)** | **Steady-state ($L_{Aeq,adj,15\text{-}min}$)** | **Non-steady state ($L_{AMax}$)** |
| **Commercial Receptors** | | | | |
| Internal | 45 | 55 | - | - |
| External[2] | 65 | 75 | - | - |

*[1] 10 dB attenuation assumed for construction materials*
*[2] 20 dB attenuation assumed for construction materials*

It is assumed that the noise level difference between the level outside a residential dwelling, and inside a habitable room is a nominal 10 dB(A) for older type dwellings that rely predominantly on natural ventilation through windows.

# 3 AIR QUALITY ASSESSMENT

## 3.1 INTRODUCTION

This section presents an assessment of potential air quality impacts associated with construction activities at the proposed Rose Street construction site. For the purposes of assessing compliance of the proposed works with the air quality goals, air dispersion modelling has been undertaken.

The Ausplume model (version 6.0) was used in this assessment. Ausplume is an approved Gaussian plume dispersion model for regulatory assessment in Queensland. The model accounts for meteorological data, building wake effects and terrain effects in the prediction of ground level concentrations of pollutants from stack, area or volume sources. Ausplume assumes steady state meteorology for the field of influence of the source being considered.

Steady state meteorology assumes that for any given time period of model calculation (usually 1 hour), the wind and other meteorological conditions are uniform over the entire area being modelled, and that a plume is assumed to travel instantaneously to the edge of the modelled area in a straight line. A number of additional parameters are considered in the modelling. Each of these parameters is considered in the following sections. The modelling was completed with impacts considered only for the proposed development site.

## 3.2 RECEPTORS

Terrain data for area surrounding the development was obtained using the NASA SRTM (Shuttle Radar Topography Mission) dataset (90 metre intervals). Terrain heights for an area of approximately 1 km x 1 km surrounding the proposed development was included in the dispersion model to account for ground height variability. The gridded receptors were spaced at 10 metre intervals.

## 3.3 METEOROLOGICAL DATA

For the dispersion modelling a prognostic meteorological dataset for Kedron based on meteorological modelling previously undertaken by Air Noise Environment was utilised. This datafile contains the range of typical meteorological conditions for the region.

## 3.4 BACKGROUND AIR QUALITY MONITORING

In order to predict cumulative ground level concentrations, consideration has been given to existing background levels based monitoring completed by the Queensland Environmental Protection Agency.

The Queensland EPA operate a number of monitoring stations within the Brisbane area. Table 3.1 presents a summary of the nearest monitoring station to the proposed site measuring each of the considered contaminants along with the measured averaging period. For CO and $PM_{10}$, background levels have been based on monitoring completed by Air Noise Environment in 2006 at Pinkenba.

**TABLE 3.1: BACKGROUND AIR QUALITY MONITORING**

| Contaminant | CO | $NO_2$ | Benzene | $PM_{10}$ | TSP |
|---|---|---|---|---|---|
| **Background Concentration ($\mu g/m^3$)** | 375 | 41 | 5.4 | 25 | 84 |
| **Averaging Period** | 1 hour | 1 hour | 24 hour | 24 hour | 24 hour |
| **Monitoring Site** | Pinkenba | Rocklea | Springwood | Pinkenba | Brisbane CBD |

## 3.5 MODELLING RESULTS

### 3.5.1 Scenario 1 – Shed Construction

#### *3.5.1.1 Introduction*

During the construction of the acoustic shed, various diesel powered equipment and machinery are expected to be utilised. Potential emissions sources associated with construction of the shed include haul trucks, cranes, piling rig and concrete-related equipment (concrete pump/vibrator). Construction activity is expected to occur between the hours of 6.30 am and 6.30 pm only.

#### *3.5.1.2 Emission Data*

Table 3.2 presents the modelled source and emission data considered for modelling of shed construction emissions. Emission factors have been sourced from the *US EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modelling – Compression Ignition.* The modelling has taken into consideration that construction and associated air emissions will occur during the daytime only.

**TABLE 3.2: SHED CONSTRUCTION - EMISSON DATA**

| Equipment | Power kW | Load Factor | Operating Time | Emission Rate (g/s) | | | |
|---|---|---|---|---|---|---|---|
| | | | | CO | NO | $PM_{10}$ | Benzene |
| Concrete Truck | 350 | 0.1 | 50% | 0.00549 | 0.01628 | 0.00098 | 0.00005 |
| Haul Truck | 350 | 0.1 | 50% | 0.00549 | 0.01628 | 0.00098 | 0.00005 |
| Piling Rig | 200 | 0.5 | 50% | 0.01402 | 0.04688 | 0.00281 | 0.00017 |
| Crane | 270 | 0.5 | 50% | 0.02118 | 0.06285 | 0.00377 | 0.00021 |
| Concrete Pump | 45 | 0.75 | 50% | 0.00958 | 0.02955 | 0.00125 | 0.00009 |
| Concrete Vibrator | 5 | 0.75 | 50% | 0.00287 | 0.00300 | 0.00020 | 0.00002 |

### *3.5.1.3 Predicted Results*

Predicted dispersion ground level concentrations for carbon monoxide, nitrogen dioxide, $PM_{10}$ and Benzene are presented in Figures 1 to 4.


**Figure 1: Predicted Cumulative Ground Level CO Concentrations (8-hour Average) (mg/m3),** Air Quality Goal – 10 mg/m3


**Figure 2: Predicted Cumulative Ground Level $NO_2$ Concentrations (1-hour Average) ($\mu g/m^3$), Air Quality Goal – 246 $\mu g/m^3$**

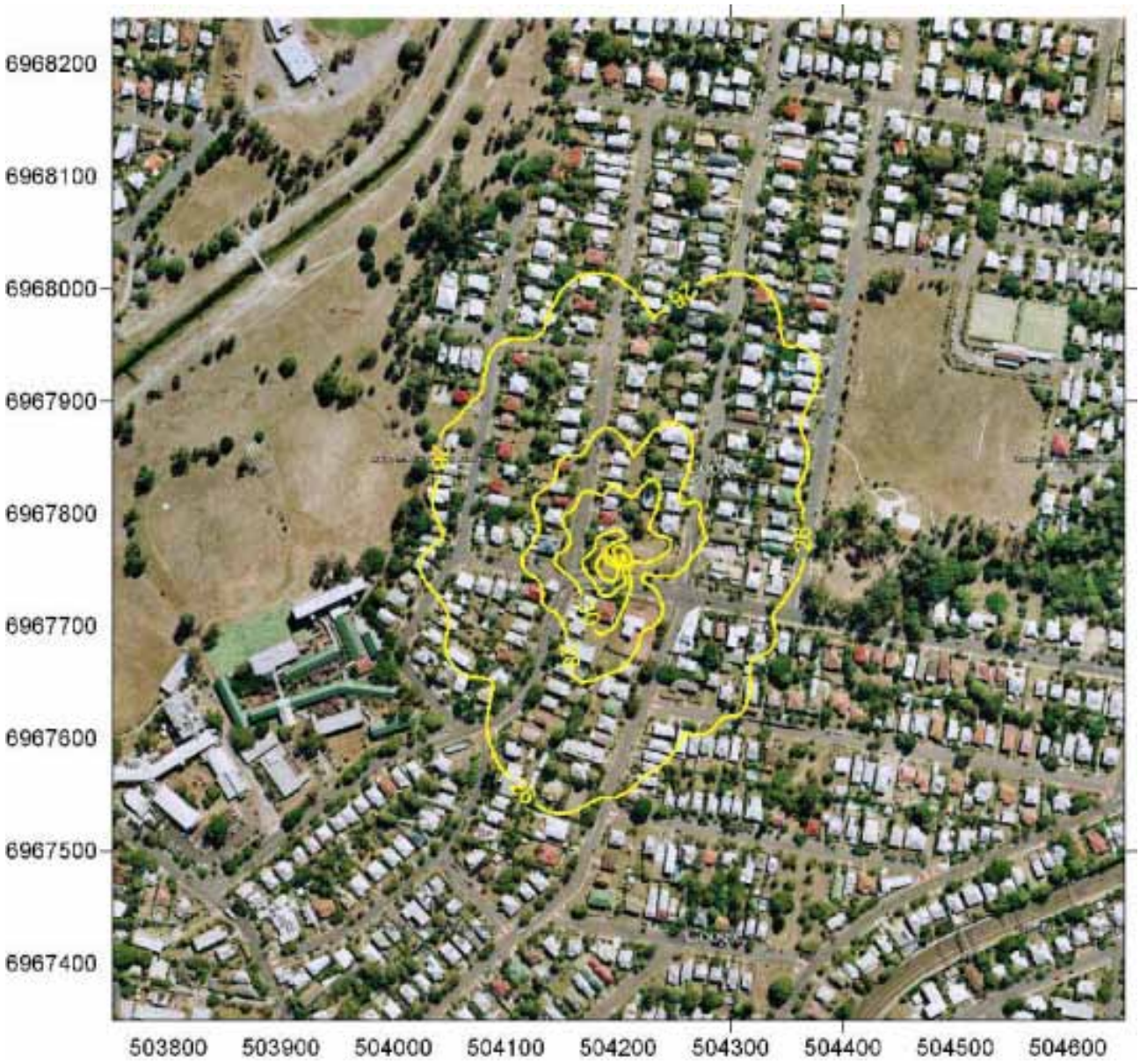


**Figure 3: Predicted Cumulative Ground Level $PM_{10}$ Concentrations (24-hour Average) (µg/m$^3$), Air Quality Goal – 50 µg/m$^3$**

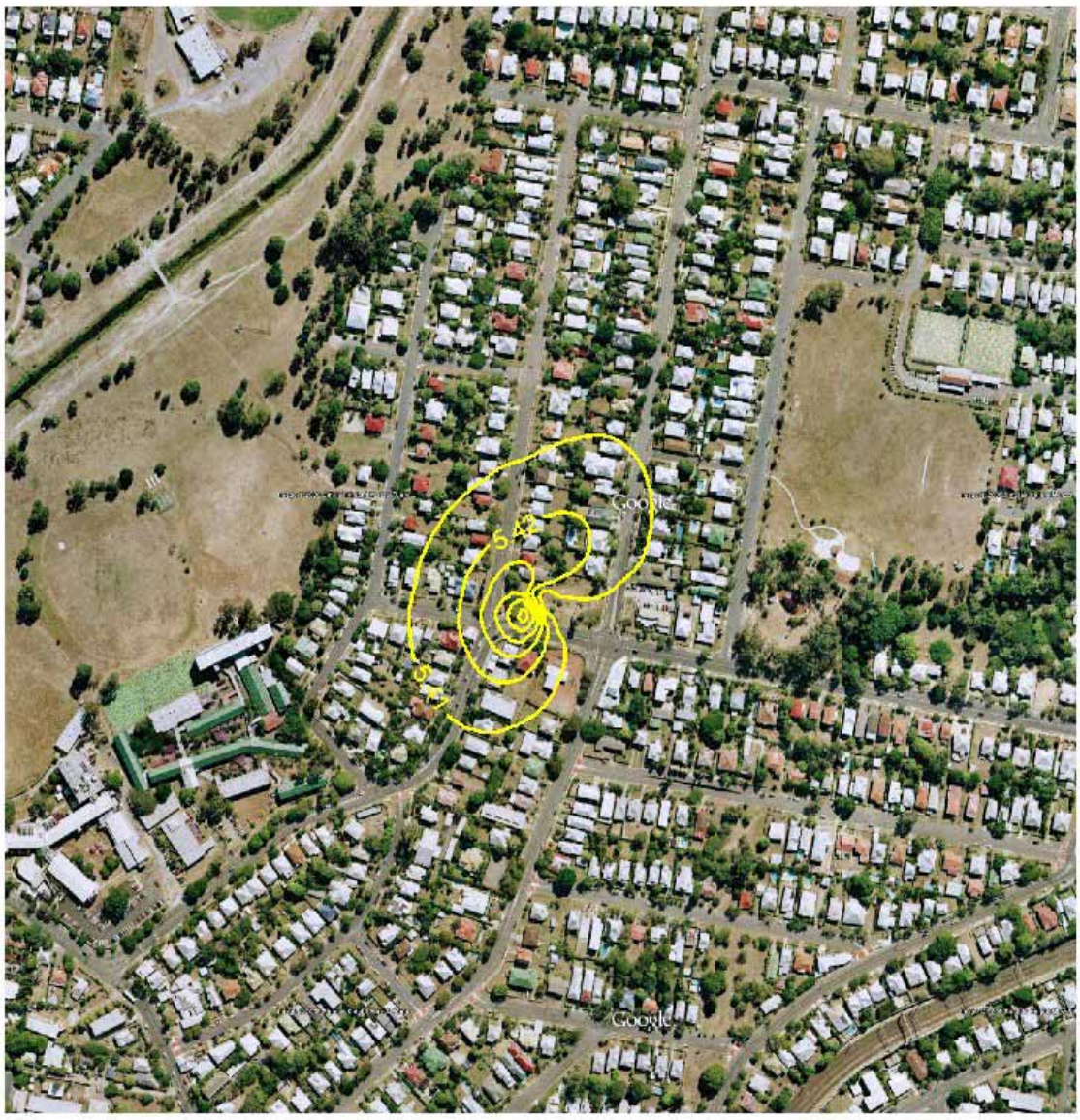


**Figure 4: Predicted Cumulative Ground Level Benzene Concentrations (Annual Average) (µg/m$^3$), Air Quality Goal – 10 µg/m$^3$**

### 3.5.2 Scenario 2 – In Operation

#### *3.5.2.1 Introduction*

Once the construction of the shed has been completed, the main sources of air emissions will be tunnel excavation construction activity (using roadheader machinery) and four proposed diesel generators. It is noted that the use of diesel generators on-site has not yet been confirmed however, as a worst-case scenario, generator emissions have been included in the assessment.

#### *3.5.2.2 Emission Data*

The following emission sources have been considered during operation of the shed:

- emissions from tunnel excavation works; and
- emissions from the proposed diesel generators (total of 4).

Emission rates for the proposed tunnel excavation works have been based on monitoring data provided by TJHJV associated with previous tunnel works in Australia. Emission rates for the proposed generators have been based on information provided by the equipment supplier (Aggreko).

Two scenarios have been considered for the purpose of assessing potential impacts:

- No Mitigation – tunnel excavation emissions vented via shed louvres along southern wall, no particulate or catalytic converters provided for the generators; and
- Mitigation:
    - all tunnel excavation emissions vented via stack with vertical dispersion. In order to direct all emissions via a stack, vehicle entry points would need to remain closed. This can be achieved through the use of entry curtains, which automatically open and close to allow vehicles to pass through; and
    - particulate filters (> 90% $PM_{10}$ reduction) and catalytic converter (> 90% $NO_x$ reduction) on generators.

Table 3.3 presents the estimated emission rates for the proposed operational works.

**TABLE 3.3: IN OPERATION - EMISSION DATA**

| | Emission Rate (g/s) | | | | |
|---|---|---|---|---|---|
| **Equipment/Activity** | **CO** | **$NO_x$** | **$PM_{10}$** | **TSP** | **Benzene** |
| *No Mitigation* | | | | | |
| Tunnel Excavation Works | 1.26 | 0.19 ($NO_2$) | 0.047 | 0.094[1] | 0.0003 |
| Generators | 0.833 | 4.962 | 0.069[2] | 0.069 | 0.0024 |
| *With Mitigation* | | | | | |
| Tunnel Excavation Works | 1.26 | 0.19 ($NO_2$) | 0.047 | 0.094[1] | 0.0003 |

| | Emission Rate (g/s) | | | | |
|---|---|---|---|---|---|
| **Equipment/Activity** | **CO** | **$NO_x$** | **$PM_{10}$** | **TSP** | **Benzene** |
| Generators | 0.833 | 0.4962 | 0.0069[2] | 0.0069 | 0.0024 |

[1] *Assumed to be 2 times the amount of $PM_{10}$ (based on NPI mining emission factors)*
[2] *All particulate matter emitted from the generators are assumed to be $PM_{10}$*

### *3.5.2.1 Predicted Results – No Mitigation*

Table 3.4 presents maximum predicted sensitive receptor concentrations with and without mitigation for each pollutant. Predicted dispersion ground level concentrations for pollutants are presented in the following figures.


**Figure 5: Predicted Cumulative Ground Level CO Concentrations (8-hour Average) (µg/m³), Air Quality Goal – 11,000 µg/m³**

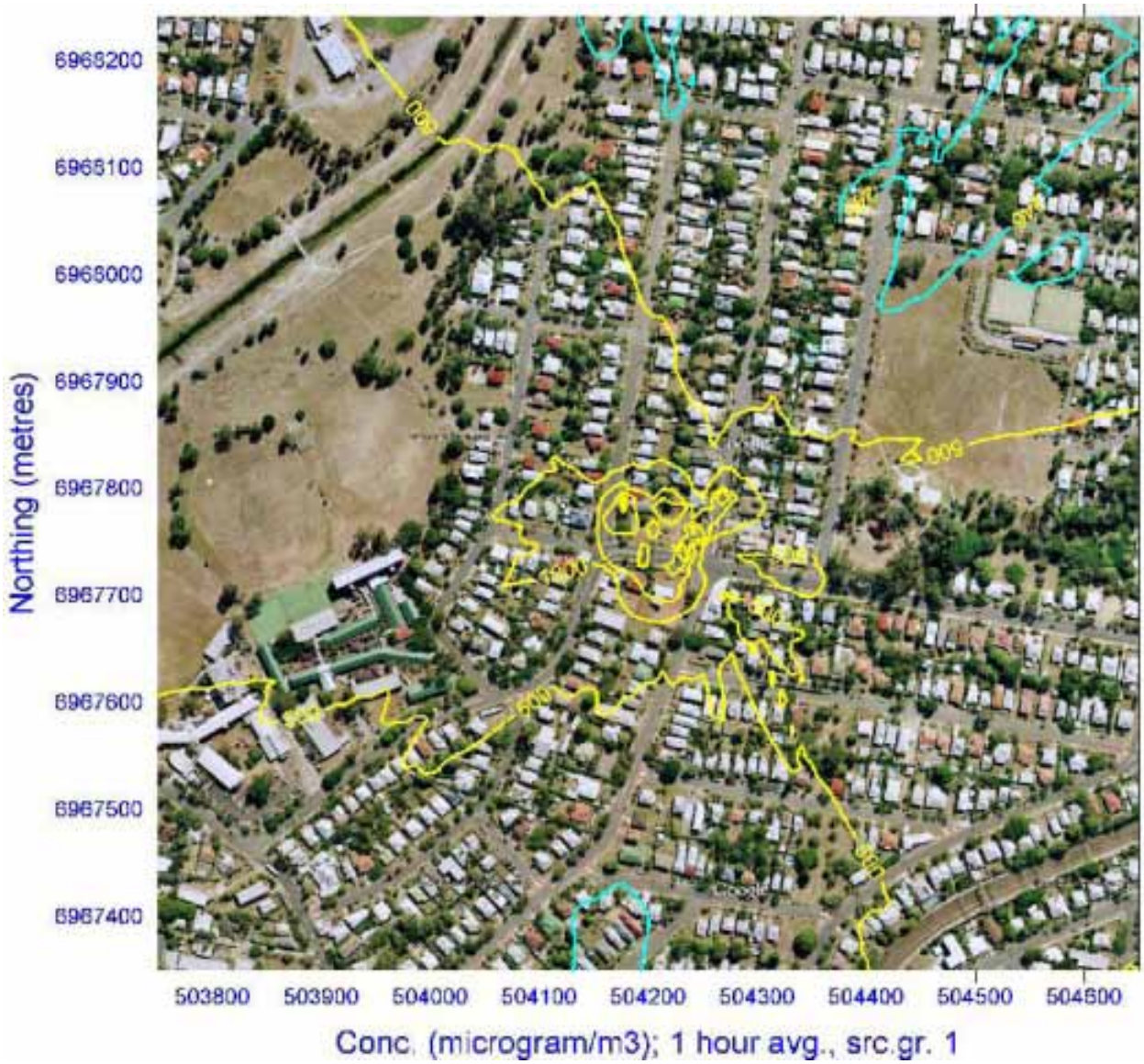


**Figure 6: Predicted Cumulative Ground Level $NO_2$ Concentrations (1-hour Average) ($\mu g/m^3$) Air Quality Goal – 246 $\mu g/m^3$**

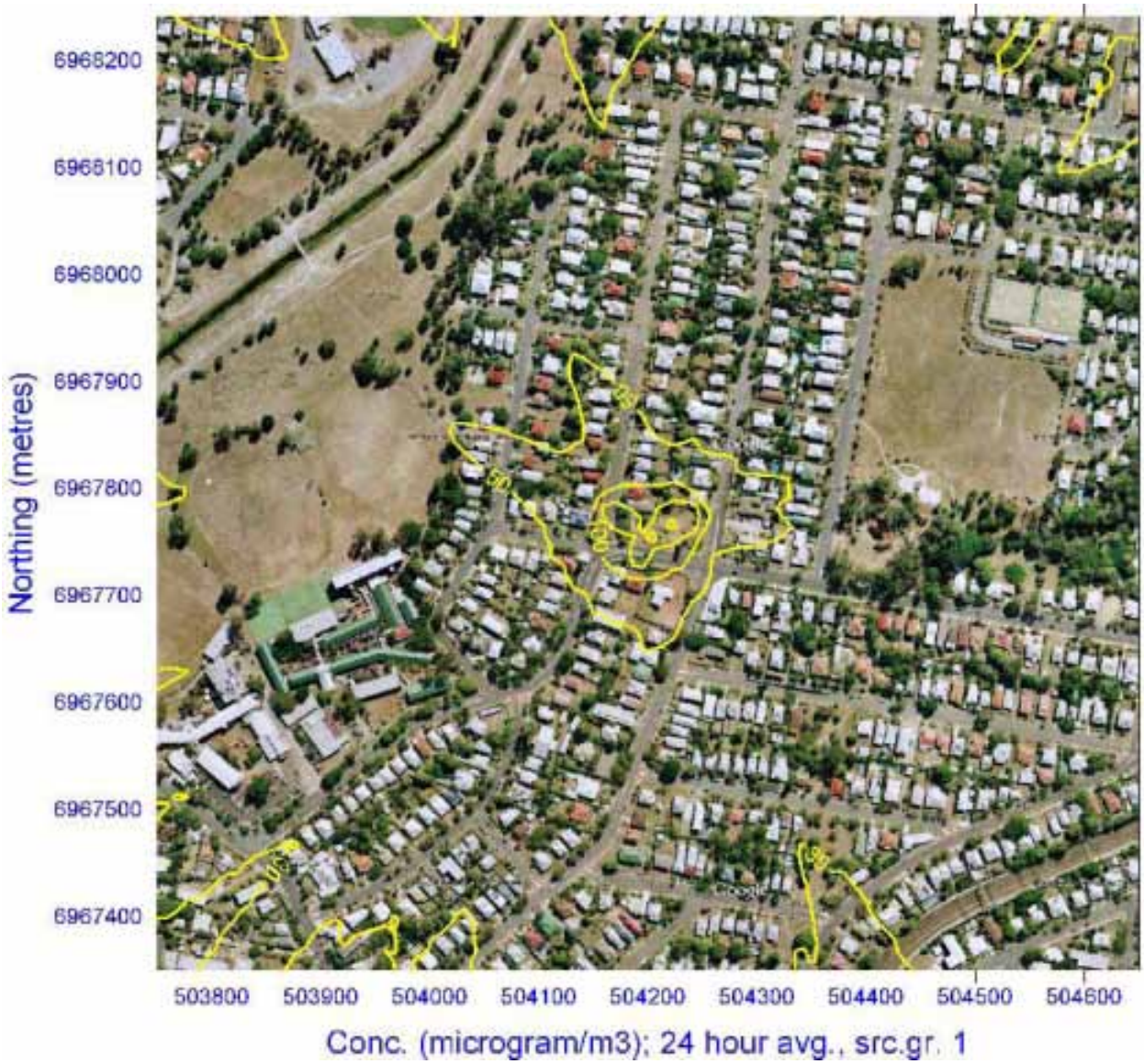


**Figure 7: Predicted Cumulative Ground Level $PM_{10}$ Concentrations (24-hour Average) ($\mu g/m^3$), Air Quality Goal – 50 $\mu g/m^3$**

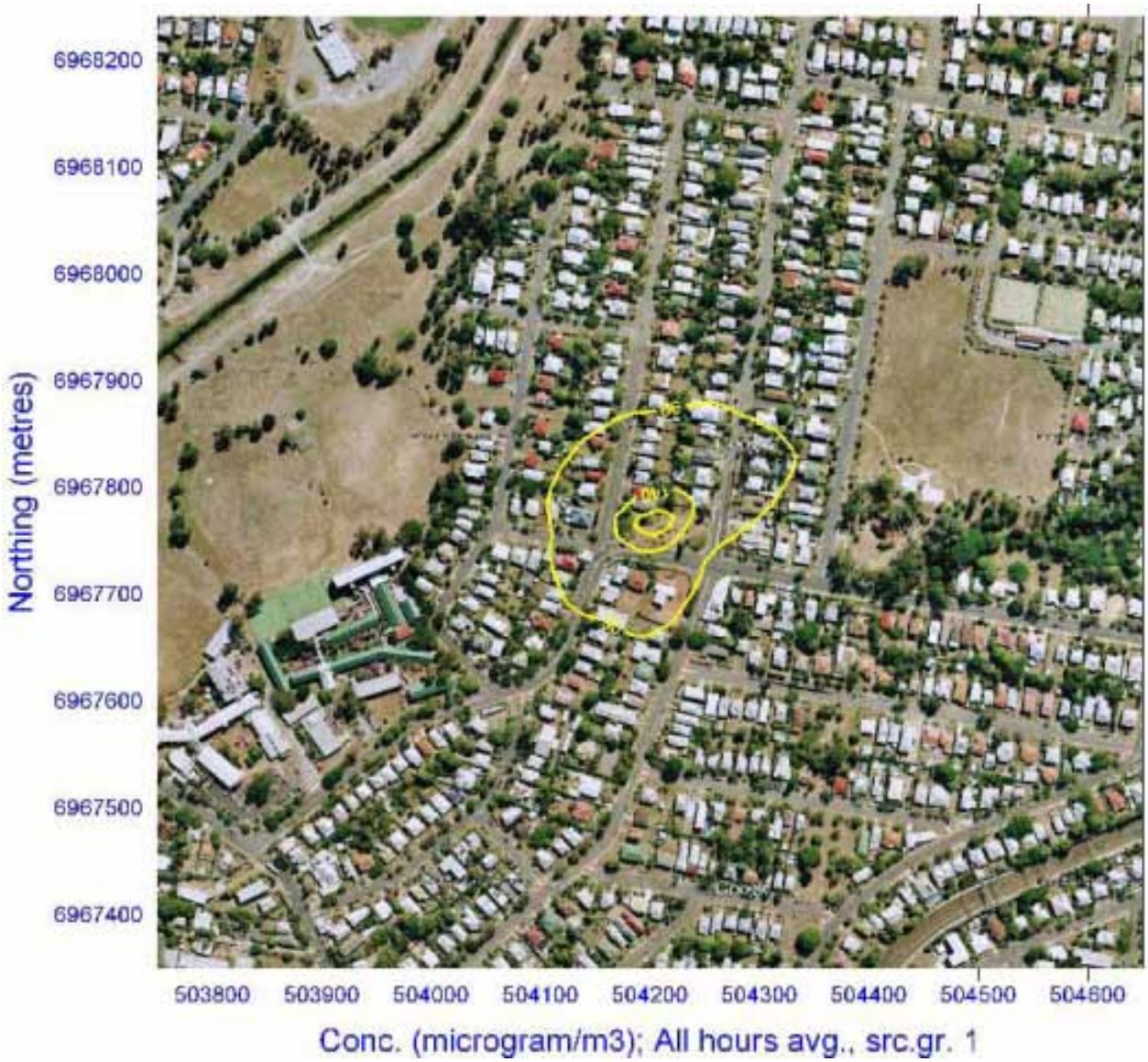


**Figure 8: Predicted Cumulative Ground Level TSP Concentrations (Annual Average) (μg/m$^3$), Air Quality Goal – 90 μg/m$^3$**

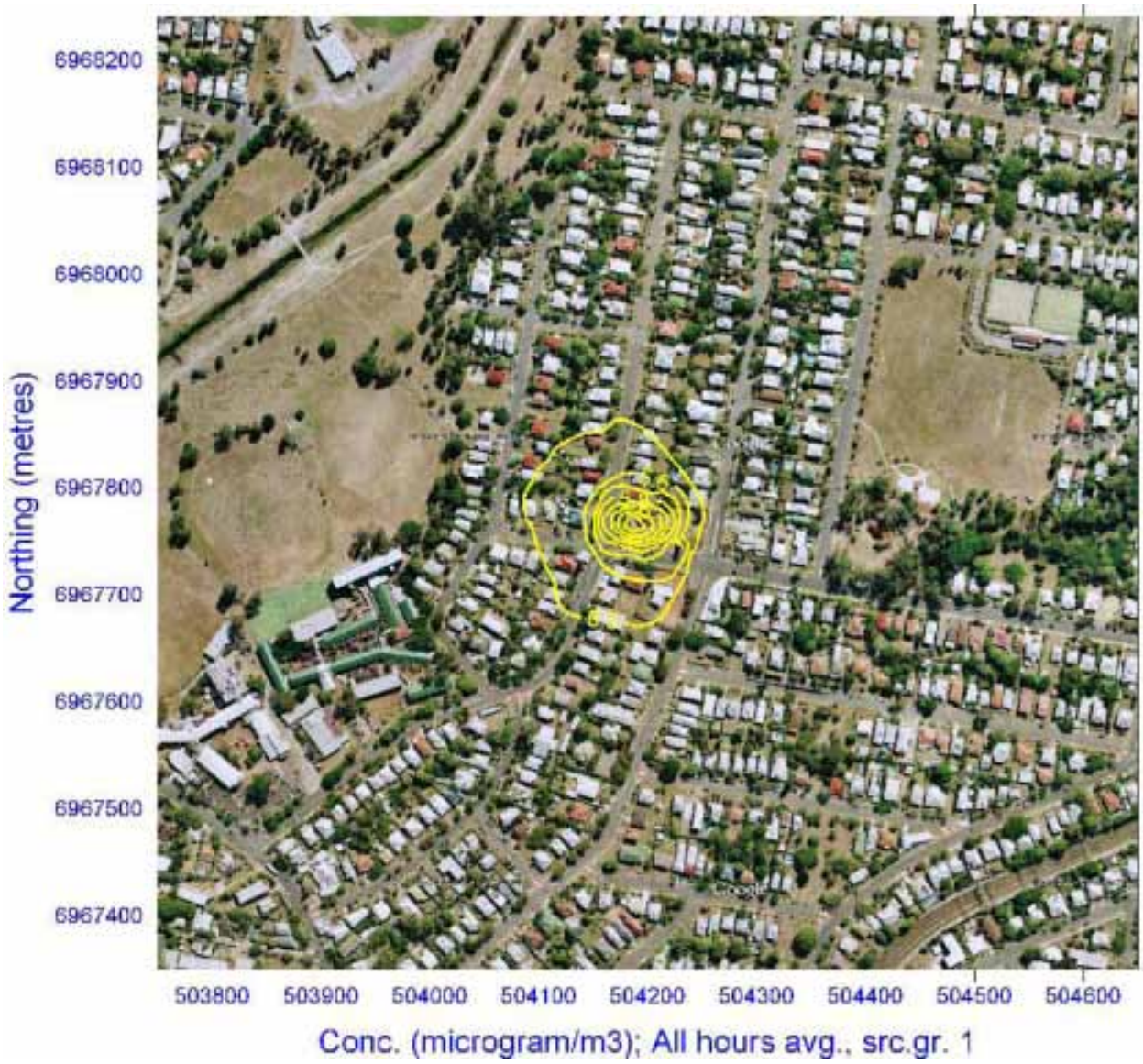


**Figure 9: Predicted Cumulative Ground Level Benzene Concentrations (Annual Average) (µg/m³), Air Quality Goal – 10 µg/m³**

According to the predicted results, non-compliance with the relevant air quality goals is predicted for $PM_{10}$, TSP and nitrogen dioxide concentrations. Nitrogen dioxide is predicted to exceed the air quality goal by a significant margin (with the generators contributing significantly to the overall concentrations from the site).

### *3.5.2.1 Predicted Results – Mitigation*

Figures 10 to 12 present predicted concentrations taking into the mitigation options presented in Section 3.4.2.1.

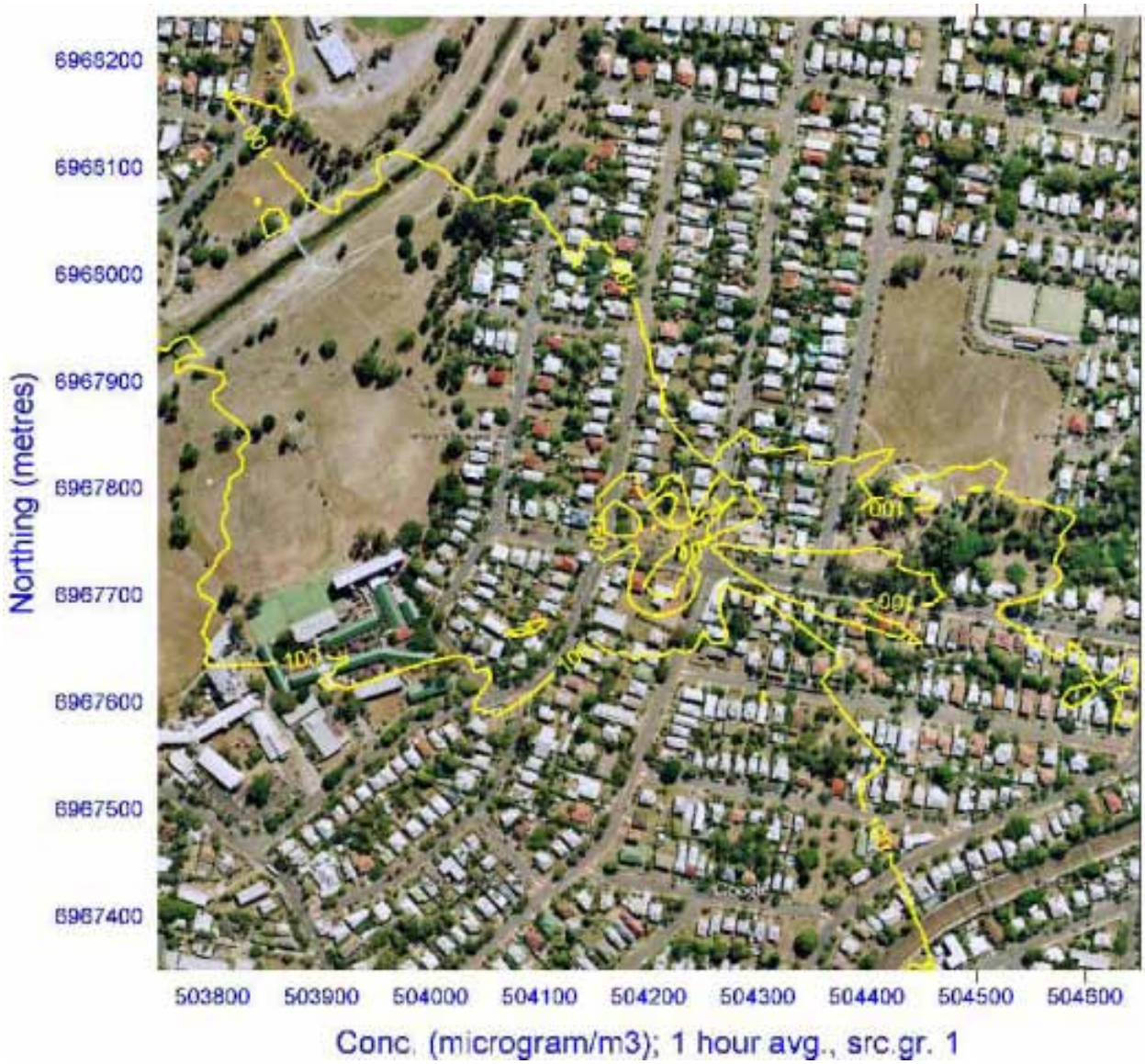


**Figure 10: Mitigation - Predicted Cumulative Ground Level $NO_2$ Concentrations (1-hour Average) ($\mu g/m^3$), Air Quality Goal – 246 $\mu g/m^3$**

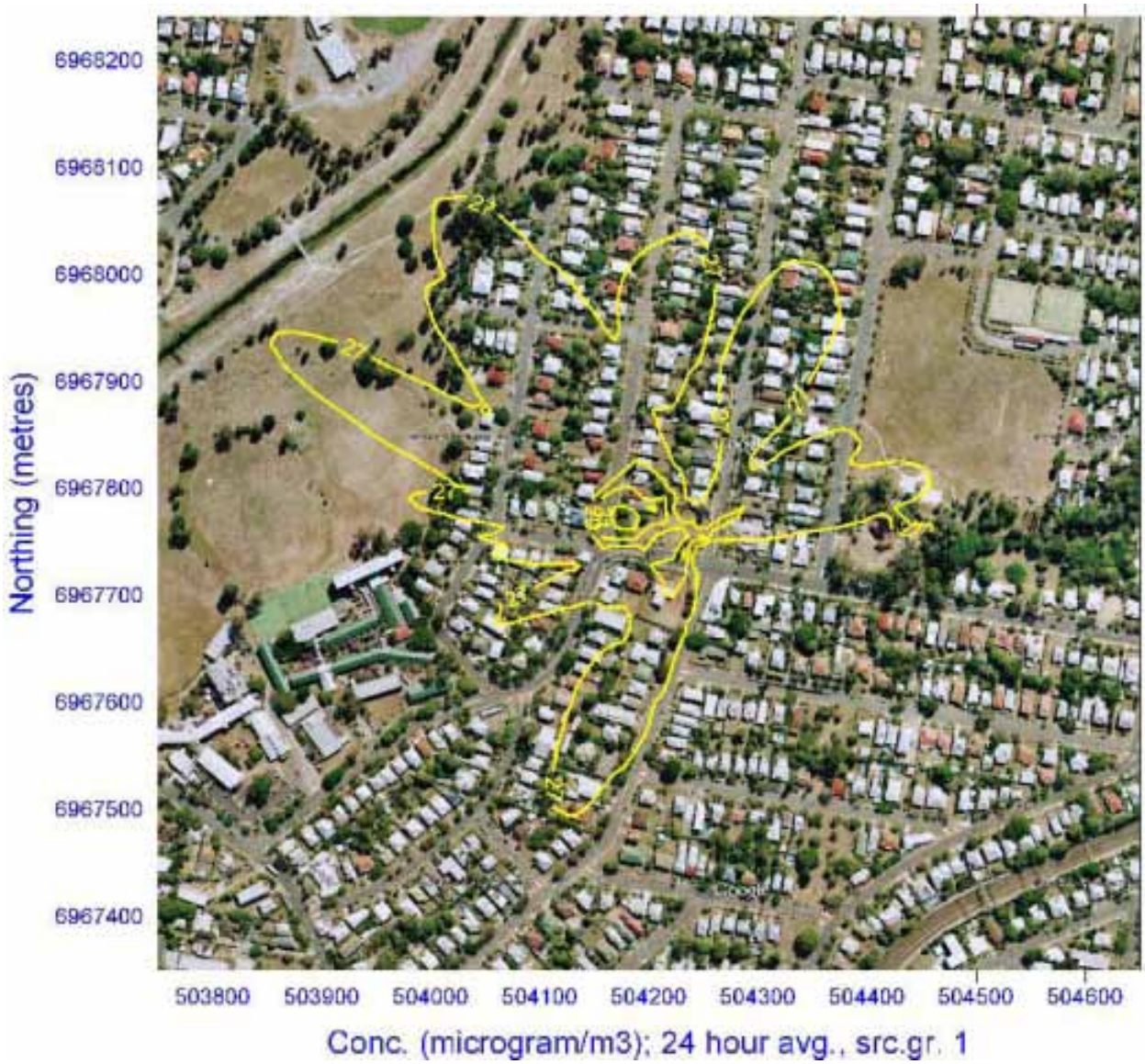


**Figure 11: Mitigation - Predicted Cumulative Ground Level $PM_{10}$ Concentrations (24-hour Average) ($\mu g/m^3$),Air Quality Goal – 50 $\mu g/m^3$**

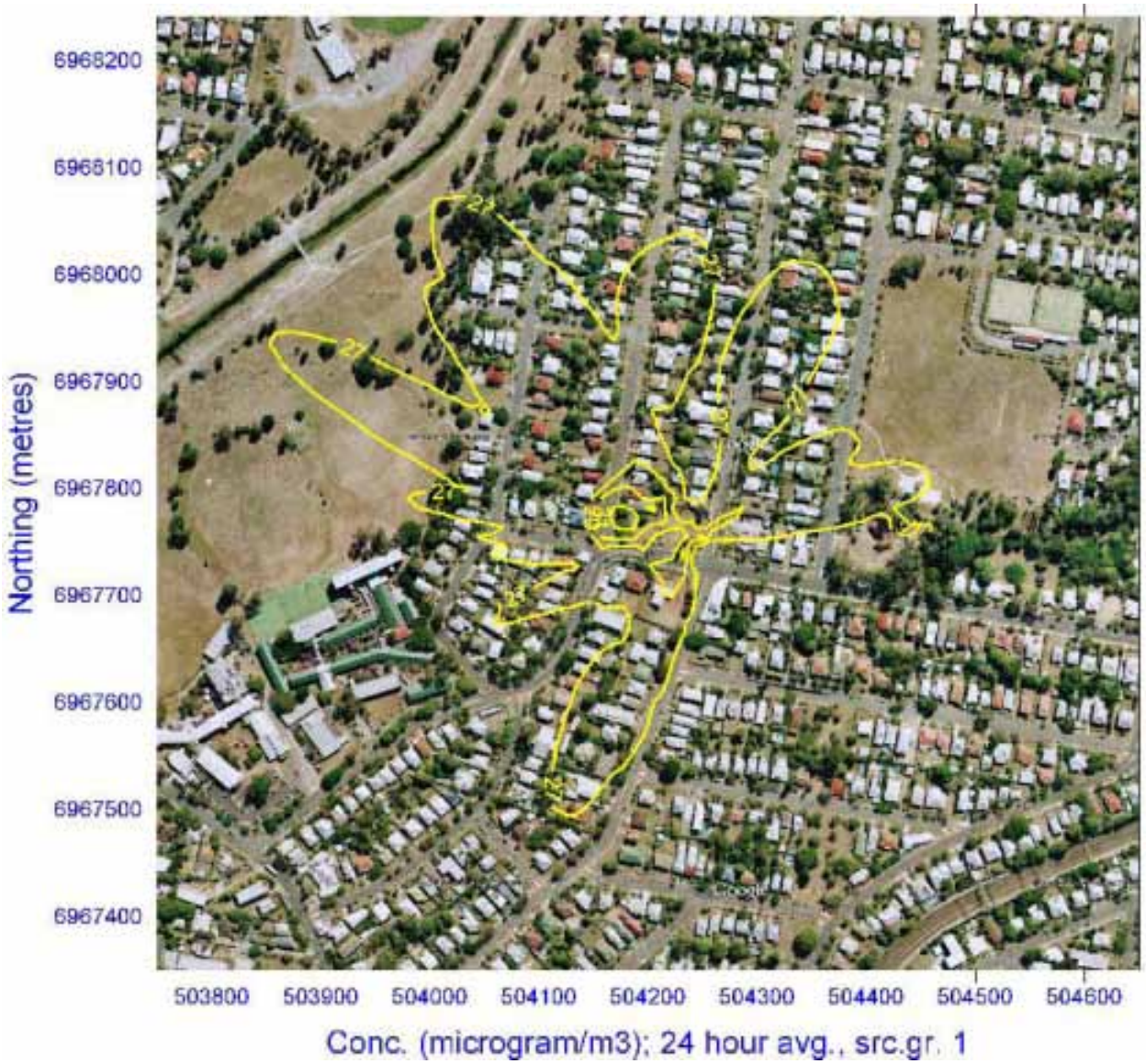


**Figure 12: Mitigation - Predicted Cumulative Ground Level TSP Concentrations (Annual Average) (μg/m$^3$), Air Quality Goal – 90 μg/m$^3$**

According predicted results, provided that the appropriate mitigation measures are installed, pollutant concentrations are predicted to comply with the relevant air quality goals.

### 3.5.3 Scenario 3 – Haul Routes

*3.5.3.1 Introduction*

During roadheader excavation, up to 10 haul truck movements are proposed per hour. Haul trucks are to be directed along Gympie Road, Park Road, Rose Street, Junction Road, Rode Road and Sandgate Road.

Dispersion modelling was completed for maximum hourly traffic movements on the proposed haul route. For the purpose of assessing potential impacts, haul truck emissions along Park Road, Rose Street and Junction Road have been considered.

*3.5.3.2 Emission Data*

In order to model existing traffic emissions, vehicle fleet emission rates were provided by BCC in the form of an emissions factoring spreadsheet for the Brisbane vehicle fleet of 2000. Tables 3.4 and 3.5 presents the modelled emission factors.

**TABLE 3.4: TRAFFIC DATA**

| Pollutant | Existing Traffic | | Proposed Construction Traffic |
|---|---|---|---|
| | Park Road Traffic (g/km/veh) | Rose Street Traffic (g/km/veh) | Articulated Diesel Vehicle (g/km/veh) |
| Max Hourly Count | 1083 | 922 | 10 |
| HV% | 6.3 | 5.3 | 100 |

**TABLE 3.5: EMISSION FACTORS**

| Pollutant | Park Road Traffic (g/km/veh) | Rose Street Traffic (g/km/veh) | Articulated Diesel Vehicle (g/km/veh) |
|---|---|---|---|
| $NO_x$ | 2.705 | 2.843 | 34.314 |
| CO | 12.947 | 12.852 | 6.940 |
| TOC | 0.759 | 0.758 | 0.664 |
| Benzene[1] | 0.038 | 0.038 | 0.033 |
| $PM_{10}$ | 0.106 | 0.115 | 1.001 |

*[1]. Estimated as 5 % of total organic compounds (TOC)*

### *3.5.3.3 Emission Data*

Figures 13 to 16 present predicted contour plots for various vehicular emission compounds. Contour plots for both existing traffic and the contribution from haul vehicles are presented. As indicated on these figures, 10 haul vehicles are not predicted to contribute significantly to the surrounding.

**Figure 13a: Existing Traffic - Predicted Ground Level $PM_{10}$ Concentrations (24-hour Average) ($\mu g/m^3$)**

**Figure 13b: Contribution from Haul Vehicles - Predicted Ground Level $PM_{10}$ Concentrations (24-hour Average) ($\mu g/m^3$)**

**Figure 14a: Existing Traffic - Predicted Ground Level $NO_2$ Concentrations (1-hour Average) ($\mu g/m^3$)**

**Figure 14b: Contribution from Haul Vehicles - Predicted Ground Level $NO_2$ Concentrations (1-hour Average) ($\mu g/m^3$)**


**Figure 15a: Existing Traffic - Predicted Ground Level Benzene Concentrations (Annual Average) (µg/m$^3$)**


**Figure 15b: Contribution from Haul Vehicles - Predicted Cumulative Ground Level Benzene Concentrations (Annual Average) (µg/m$^3$)**

**Figure 16a: Existing Traffic - Predicted Cumulative Ground Level CO Concentrations (8-hour Average) (µg/m$^3$)**

**Figure 16b: Contribution from Haul Vehicles - Predicted Cumulative Ground Level CO Concentrations (8-hour Average) (µg/m$^3$)**

# 4 CONSTRUCTION NOISE ASSESSMENT

## 4.1 INTRODUCTION

Environmental noise modelling has been completed using the computational software Cadna/A (Version 3.7) developed by DataKustik. The model has been utilised to predict the impacts associated with airborne noise emissions from the plant noise sources anticipated to operate during the Airport Link and Busway construction activities identified in this report on nearby sensitive receptors.

Cadna/A is a recognised modelling package designed to account for the influences of three dimensional terrain, ground type and air absorption in addition to source characteristics, shielding and/or reflections from buildings and barriers and distance attenuation to predict noise impacts at receptor locations.

Modelling scenarios for the various stages of construction and operations have been considered in the following sections. Modelling considers the no mitigation and mitigation scenarios for comparison for each of the stages of the construction works. The adopted sound power level of plant and equipment are considered based on available data for the equipment proposed to be utilised.

The results of the acoustic modelling presented in this report are provided as:

- maximum noise levels predicted at individual sensitive receptor buildings;
- tabulated results of the number of sensitive receptor buildings/properties predicted to exceed the criteria for each scenario.

It should be noted that where multiple residences are contained within a single building (e.g. residential units) these are considered as a single building/property in the assessment presented in this report.

## 4.1 GENERAL ASSUMPTIONS

In order to compare predicted maximum noise levels with the project construction noise goals, the following assumptions have been adopted:

- as a worst case assessment approach, $L_{Amax}$ predictions are compared to $L_{A10}$ noise goals (for non-steady state daytime operations);
- to predict $L_{Aeq}$ noise levels, the percentage of time equipment are expected to be in operation has been included in the noise model;
- noise predictions are calculated on all façades of potentially affected buildings to identify the worst affected façade for all floor levels identified during site visits; and
- meteorological effects have not been considered due to the close proximity of the worst affected receptors to the noise sources.

## 4.1 SENSITIVE RECEPTORS

The area surrounding the proposed construction site is predominantly residential. Some small commercial businesses are located to the south at the corner of Rose Street and Kent Street. The majority of residential housing is either raised or two-storey. The nearest sensitive receptors are located adjacent to the northern boundary of the proposed site.

Figure 17 identifies the sensitive receptors considered in the predictive noise modelling. A total of 98 residential houses have been modelled to determine potential impacts.


***Figure 17: Noise Modelling Receptor Locations***

## 4.2 PROPOSED CONSTRUCTION ACTIVITIES

For the purpose of assessing potential impacts, the following noise scenarios have been considered:

- Scenario 1 – construction of shed foundations (including construction of concrete foundations and piling);
- Scenario 2 – shaft excavation beyond depth of 20 metres with hydraulic hammer (prior to construction of the shed)
- Scenario 3 – in operation (commencement of roadheader excavation).

Scenarios 1 and 2 are expected to occur during the daytime period only (6.30 am to 6.30 pm). Scenario 3 is expected occur during both the day and nighttime periods. Table 4.1 summarises the noise sources considered Scenarios 1 to 3.

**TABLE 4.1: POTENTIAL CONSTRUCTION SCENARIOS**

| Activity | Noise Source | Number Required | Sound Power Level (dB(A)) | Acoustical Usage Factor (%) [1] |
|---|---|---|---|---|
| Shed Construction | Concrete Truck | 1 per hour | 111 | 1 @ 40% |
| | Concrete Pump | 1 | 107 | 50 |
| | Concrete Vibrator | 1 | 108 | 20 |
| | General Tool Noise | 1 | 109 | 50 |
| | Piling Rig | 1 | 118 | 20 |
| | Crane | 1 | 105 | 17 |
| | Haul Truck | 1 | 103 | 40 |
| | Warning Horns / Reversing Beepers | All vehicles | 115 | 5 |
| Shaft Excavation (during shed construction) | Excavator with Hydraulic Hammer | 1 | 115 | 20 |
| | Crane | 2 | 105 | 17 |
| | General Tool Noise | 1 | 109 | 50 |
| | Boom/Scissor Lifts | 2 | 107 | 17 |
| In Operation | Haul Truck (daytime) | 6 per hour | 103 | 40 |
| | Front End Loader | 1 | 111 | 40 |
| | Gantry Crane | 1 | 105 | 17 |
| | General Tool Noise | 1 | 109 | 50 |
| | Generators (external to shed)[2] | 4 | 81 | 100 |
| | Compressors (external to shed)[2] | 1 | 83 | 100 |
| | Pump[2] | 1 | 76 | 100 |

[1.] *Acoustical usage factors based on information provided by the United States Department of Transportation Federal Highway Administration (http://www.fhwa.dot.gov/environment/noise/handbook/09.htm)*
[2.] *Total sound power level considers an acoustic enclosure around external plant*

During operation of the shed, it is assumed that the majority of noise from the shed is caused by the front end loader, gantry crane and workshop tool noise at surface level. Contribution from noise associated with equipment within the tunnel has been assumed to be minimal.

## 4.1 PROPOSED MITIGATION

### 4.1.1 Scenarios 1 and 2

The following mitigation scenarios have been considered for the construction of the shed:

- no mitigation;
- 2.4 m perimeter barrier; and
- 5.0 m perimeter barrier.

Figure 18 presents the proposed barrier locations during construction of the shed.


***Figure 18: Site Perimeter Barriers***

### 4.1.1 Scenario 3

For the operation of the proposed shed, the following mitigation scenarios have been considered:

- Option 1 low performance shed material (typical Colorbond-type steel with no insulation);
- Option 2 proposed shed materials ($R_w$ 50); and
- Option 2 proposed shed materials ($R_w$ 50) with 2.4 m perimeter barrier.

The proposed shed construction material comprises of an external 50 mm Ortech Easiboard, internal 0.6 mm steel and cavity filled with 50 mm thick fibre glass insulation (14-18 kg/m$^3$). The roller doors are located along the western wall (4.5 m x 5.0 m) and eastern wall (7.5 m x 5.0 m).

In addition to the above, acoustic enclosures around external fixed plant (with an $R_w$ of 20 dB) have been considered.

Table 4.2 presents the construction material specifications considered in the noise modelling.

**TABLE 4.2: ACOUSTIC SPECIFICATIONS OF CONSTRUCTION MATERIALS**

| Material Option | Construction Material | Octave Band Frequencies (Hz) | | | | | | | | $R_w$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | |
| **Sound Reductions** | | | | | | | | | | |
| 1 | Low Performance Steel | 3 | 8 | 14 | 20 | 23 | 26 | 27 | 35 | 23 |
| 1 | Roller Doors | 3 | 8 | 14 | 20 | 23 | 26 | 27 | 35 | 23 |
| 2 | Proposed Ortech Wall/Ceiling System | 16 | 24 | 40 | 50 | 56 | 61 | 71 | - | 50 |
| 2 | Roller Doors | 3 | 8 | 14 | 20 | 23 | 26 | 27 | 35 | 23 |
| **Absorption** | | | | | | | | | | |
| 2 | Proposed 50 mm fibre glass (14-18 kg/m$^3$) | - | 0.17 | 0.45 | 0.8 | 0.89 | 0.97 | 0.94 | - | - |

# 4.1 MODELLING RESULTS

## 4.1.1 Scenario 1 – Shed Construction

Table 4.3 presents predicted external noise levels during the construction of the shed. Construction noise is proposed to occur only during the daytime. Table 4.4 presents the total number of properties predicted to exceed the relevant noise goals.

**TABLE 4.3: SHED CONSTRUCTION - PREDICTED EXTERNAL NOISE LEVELS**

| Receptor Group | Maximum Predicted External $L_{Aeq}$ Noise Levels dB(A) | | | Daytime Noise Goals | Maximum Predicted External $L_{A10}$ Noise Levels | | | Daytime Noise Goals |
|---|---|---|---|---|---|---|---|---|
| | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | |
| Residential | 80 | 73 | 68 | 55 | 87 | 81 | 75 | 65 |
| Educational | 68 | 63 | 61 | 65 | 74 | 69 | 69 | 75 |
| Commercial | 67 | 62 | 57 | 65 | 74 | 69 | 64 | 75 |

**TABLE 4.4: SHED CONSTRUCTION – TOTAL PROPERTIES EXCEEDING NOISE GOALS**

| Receptor Group | No. of Properties Exceeding Daytime $L_{Aeq}$ Noise Goal | | | No. of Properties Exceeding Daytime $L_{A10}$ Noise Goal | | | Total No. of Properties |
|---|---|---|---|---|---|---|---|
| | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | |
| Residential | 66 | 54 | 38 | 48 | 34 | 24 | 98 |
| Educational | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Commercial | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

During the construction phase, significant exceedances are predicted without any form of acoustic mitigation. The $L_{Aeq}$ and $L_{A10}$ noise goals are exceeded by up to 25 dB and 22 dB respectively.

Provision of acoustic barriers at the site perimeter are predicted to significantly reduce potential noise levels and the total number of properties with potential to exceed the noise goals. With a 5.0 m acoustic barrier, an exceedance of the $L_{Aeq}$ and $L_{A10}$ noise goals of up to 13 dB and 10 dB respectively is predicted. It is noted that the total number of properties predicted to exceed the noise goals is significantly reduced through the provision of 5.0 m acoustic barriers.

Figure 19 presents predicted external $L_{Aeq}$ noise levels for ground floor and first floor levels.

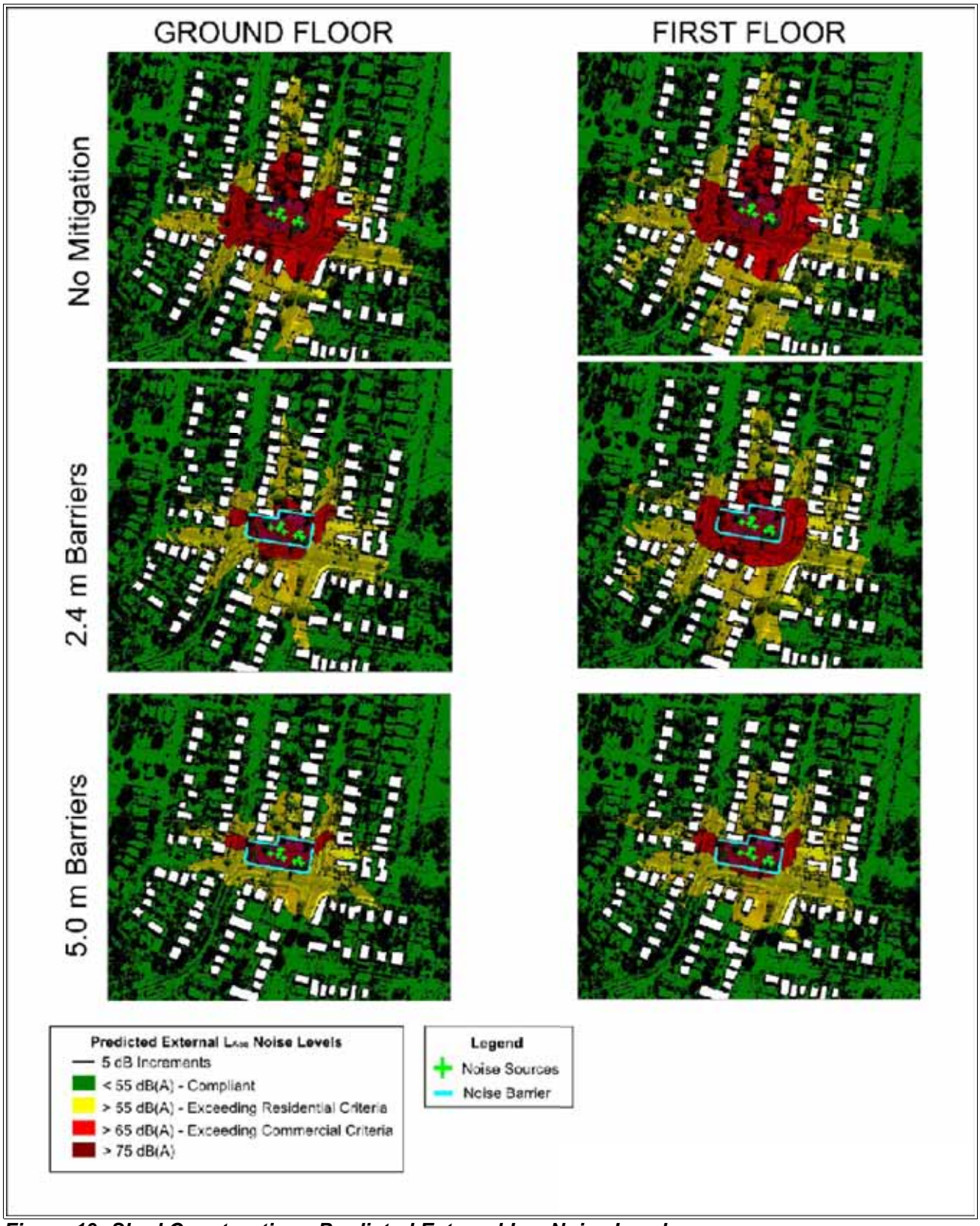


***Figure 19: Shed Construction - Predicted External $L_{Aeq}$ Noise Levels***

### 4.1.1 Scenario 2 – Shaft Excavation

Tables 4.5 presents predicted external noise levels during shaft excavation. Construction noise is proposed to occur only during the daytime. Table 4.6 presents the total number of properties predicted to exceed the relevant noise goals.

**TABLE 4.5: SHAFT EXCAVATION - PREDICTED EXTERNAL NOISE LEVELS**

| Receptor Group | Maximum Predicted External $L_{Aeq}$ Noise Levels dB(A) | | | Daytime Noise Goals | Maximum Predicted External $L_{A10}$ Noise Levels | | | Daytime Noise Goals |
|---|---|---|---|---|---|---|---|---|
| | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | |
| Residential | 75 | 70 | 62 | 55 | 85 | 80 | 72 | 65 |
| Educational | 61 | 57 | 58 | 65 | 68 | 64 | 66 | 75 |
| Commercial | 63 | 58 | 56 | 65 | 71 | 67 | 64 | 75 |

**TABLE 4.6: SHAFT EXCAVATION – TOTAL PROPERTIES EXCEEDING NOISE GOALS**

| Receptor Group | No. of Properties Exceeding Daytime $L_{Aeq}$ Noise Goal | | | No. of Properties Exceeding Daytime $L_{A10}$ Noise Goal | | | Total No. of Properties |
|---|---|---|---|---|---|---|---|
| | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | No Mitigation | 2.4 m Barrier | 5.0 m Barrier | |
| Residential | 39 | 24 | 18 | 30 | 16 | 12 | 98 |
| Educational | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Commercial | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

Where the hydraulic hammer is used, both the $L_{Aeq}$ and $L_{A10}$ noise goals for the project are predicted to be exceeded by up to 20 dB.

Provision of acoustic barriers at the site perimeter are predicted to significantly reduce potential noise levels and the total number of properties exceeding the noise goals. With a 5.0 m acoustic barrier, an exceedance of the $L_{Aeq}$ and $L_{A10}$ noise goals of up to 7 dB is predicted. It is noted that the total number of properties predicted to exceed the noise goals is reduced by up to 15 and 21 properties through the provision of 2.4 m and 5.0 m acoustic barriers, respectively.

Figure 20 presents predicted external $L_{Aeq}$ noise levels for ground and first floor levels.

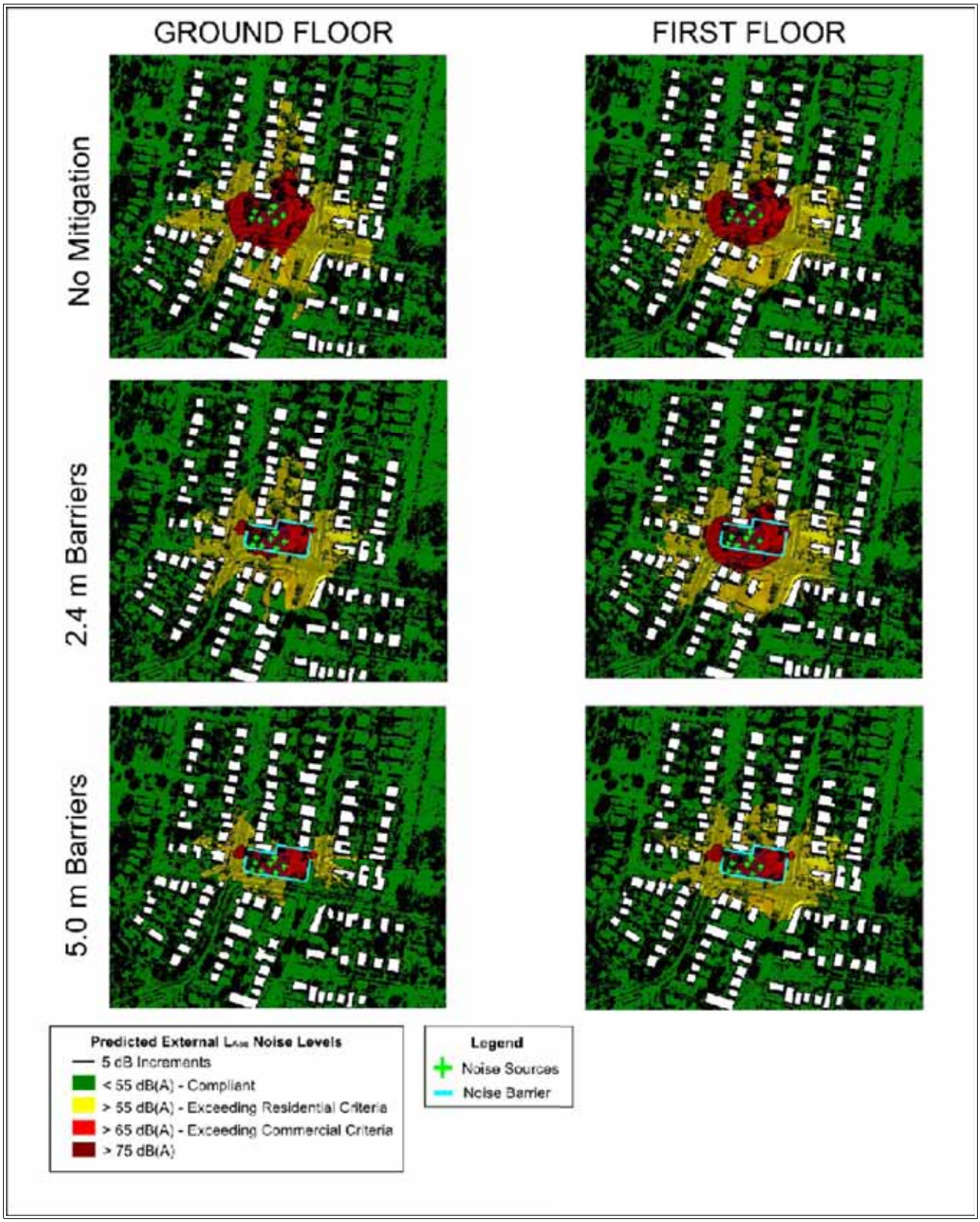


***Figure 20: Shaft Excavation - Predicted External $L_{Aeq}$ Noise Levels***

### 4.1.2 Scenario 3 – Operational Phase

Tables 4.7 presents predicted external noise levels operation of the shed. Roadhoader excavation is expected occur during the daytime and nighttime. It is assumed that the roller doors to the shed remain closed during the nighttime period only. Table 4.8 presents the total number of properties predicted to exceed the relevant noise goals.

**TABLE 4.7: OPERATIONAL PHASE - PREDICTED EXTERNAL NOISE LEVELS**

| Receptor Group | Predicted External $L_{Aeq}$ Noise Levels dB(A) | | | Noise Goals | Predicted External $L_{A10}$ Noise Levels dB(A) | | | Noise Goals |
|---|---|---|---|---|---|---|---|---|
| | Low Performance Materials | Proposed Material | Proposed Material with 2.4 m Barrier | | Low Performance Materials | Proposed Material | Proposed Material with 2.4 m Barrier | |
| *Daytime* | | | | | | | | |
| Residential | 83 | 66 | 66 | 55 | 86 | 69 | 69 | 65 |
| Educational | 73 | 55 | 53 | 65 | 75 | 58 | 56 | 75 |
| Commercial | 72 | 54 | 54 | 65 | 74 | 57 | 57 | 75 |
| *Nighttime* | | | | | | | | |
| Residential | 77 | 51 | 50 | 40 | 82 | 57 | 54 | 55 |
| Educational | 65 | 45 | 40 | 50 | 67 | 47 | 43 | 65 |
| Commercial | 65 | 44 | 42 | 50 | 69 | 47 | 46 | 65 |

**TABLE 4.8: OPERATIONAL PHASE – TOTAL PROPERTIES EXCEEDING NOISE GOALS**

| Receptor Group | No. of Properties Exceeding $L_{Aeq}$ Noise Goal | | | No. of Properties Exceeding $L_{A10}$ Noise Goal | | | Total No. of Properties |
|---|---|---|---|---|---|---|---|
| | Low Performance Materials | Proposed Material | Proposed Material with 2.4 m Barrier | Low Performance Materials | Proposed Material | Proposed Material with 2.4 m Barrier | |
| *Daytime* | | | | | | | |
| Residential | 98 | 8 | 6 | 58 | 1 | 1 | 98 |
| Educational | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Commercial | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| *Nighttime* | | | | | | | |
| Residential | 98 | 17 | 10 | 98 | 1 | 0 | 98 |
| Educational | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Commercial | 3 | 0 | 0 | 3 | 0 | 0 | 3 |

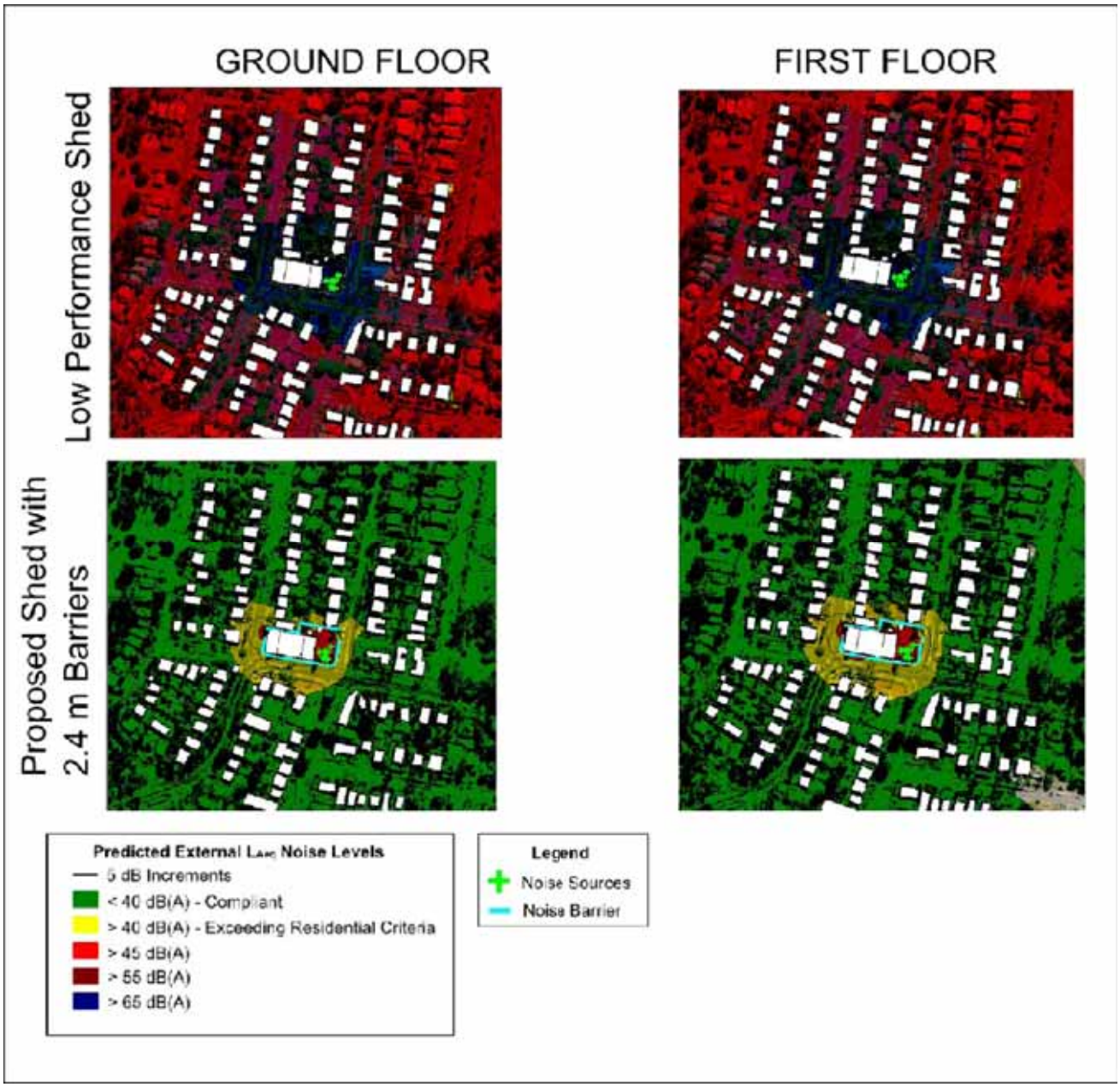


***Figure 21: Nighttime Shed Operation - Predicted External $L_{Aeq}$ Noise Levels***

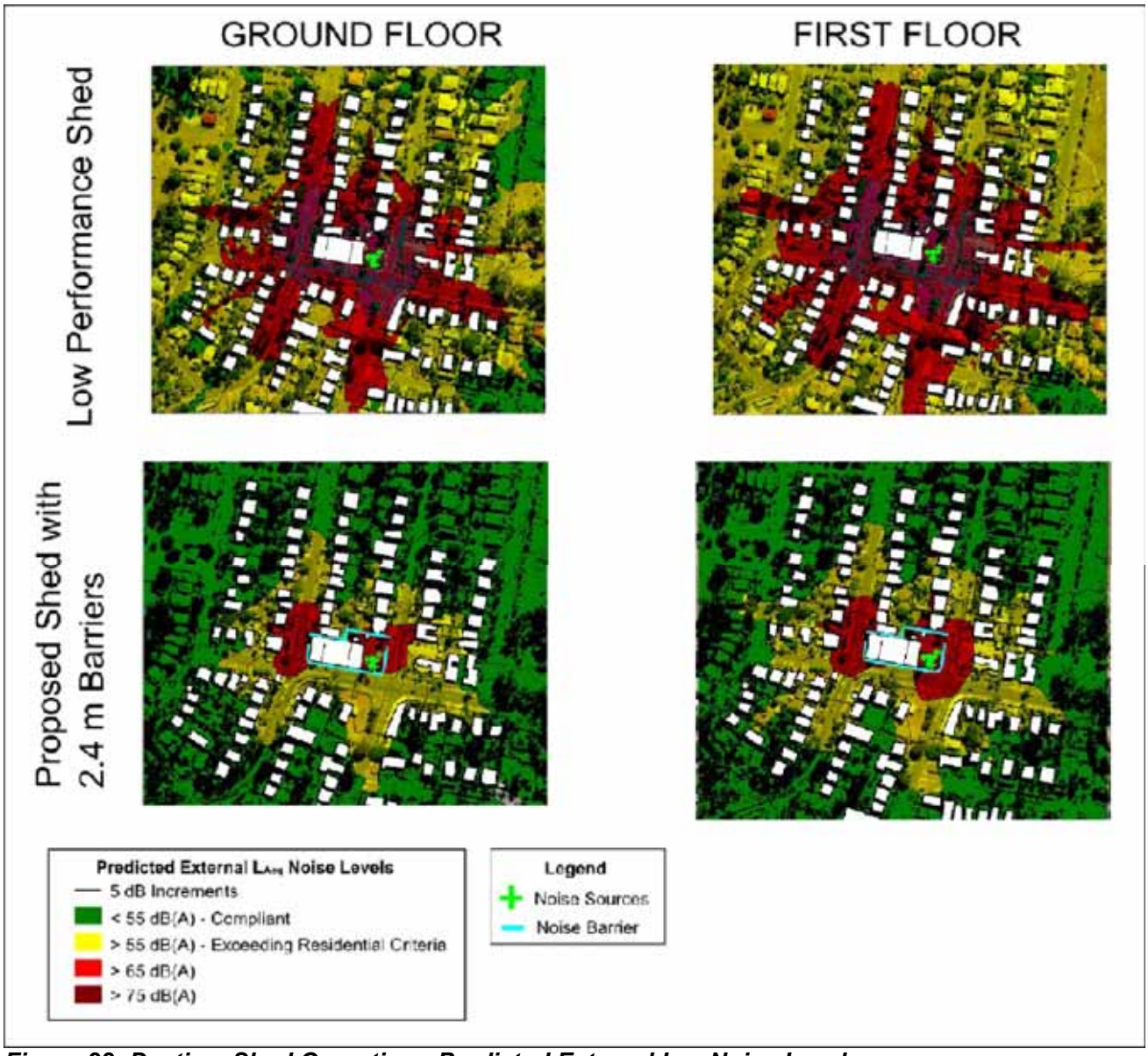


***Figure 22: Daytime Shed Operation - Predicted External $L_{Aeq}$ Noise Level***

During the daytime operation of the shed, exceedance of the noise goals is predicted for each of the mitigation scenarios. For proposed materials with a 2.4 m acoustic barrier, the $L_{Aeq}$ and $L_{A10}$ daytime noise goals are predicted to be exceeded by up to 11 dB(A) and 4 dB(A), respectively. Exceedances of $L_{Aeq}$ and $L_{A10}$ nighttime noise goals are predicted at 6 properties and 1 property, respectively. Compliance is predicted at the Queensland Aerospace College and the nearest commercial receptors using the proposed shed construction materials.

During the nighttime operation of the shed, exceedance of the $L_{Aeq}$ noise goals is predicted for each of the mitigation scenarios. For proposed materials with a 2.4 m acoustic barrier, the $L_{Aeq}$ nighttime noise goal is predicted to be exceeded by up to 10 dB(A). The provision of a 2.4 m acoustic barrier is predicted to reduce maximum $L_{Aeq}$ noise levels by up to 3 dB. In addition, the number of properties exceeding the noise goals are reduced by 7 properties (10 properties compared to 17 properties exceeding).

Overall, significant reductions in noise levels are predicted for the acoustic shed using the proposed

shed construction materials ($R_w$ 50 with 50 mm thick fibre glass insulation, 14-18 kg/m3). It is also noted that there is a potential for 1 or 2 concrete trucks to arrive before 10 pm. In order to reduce noise breakout from the shed and minimise potential impacts, acoustic curtains at the vehicle entry/ exit doors should be provided.

# 5 HAUL VEHICLE NOISE ASSESSMENT

## 5.1 APPROACH

Increases in noise emissions from roadways as a result of the addition of construction-related truck traffic has been assessed by predicting how the additional truck traffic would alter the $L_{A10\ (1\text{-hour})}$ level of noise emission from roadways using the CoRTN prediction method and CadnaA noise abatement software.

As a worst case the minimum 1 hour of traffic has between attained for each section of road during the proposed haulage hours, Monday to Saturday, 6:30 am and 6:30 pm. For the assessment of worst case, the peak hourly spoil truck frequencies have been adopted.

The calculations have been predicted to attain the potential increase in relative noise levels from each travelled road section. The addition of haul vehicles will increase both the traffic volumes and percentage heavy vehicles, as described in Table 4.1.

## 5.2 PROPOSED HAULAGE ROUTES

Figures 23 and 24 identify the two haulage scenarios that have been considered. All sections of route have been assessed where existing traffic data is unavailable for these sections.

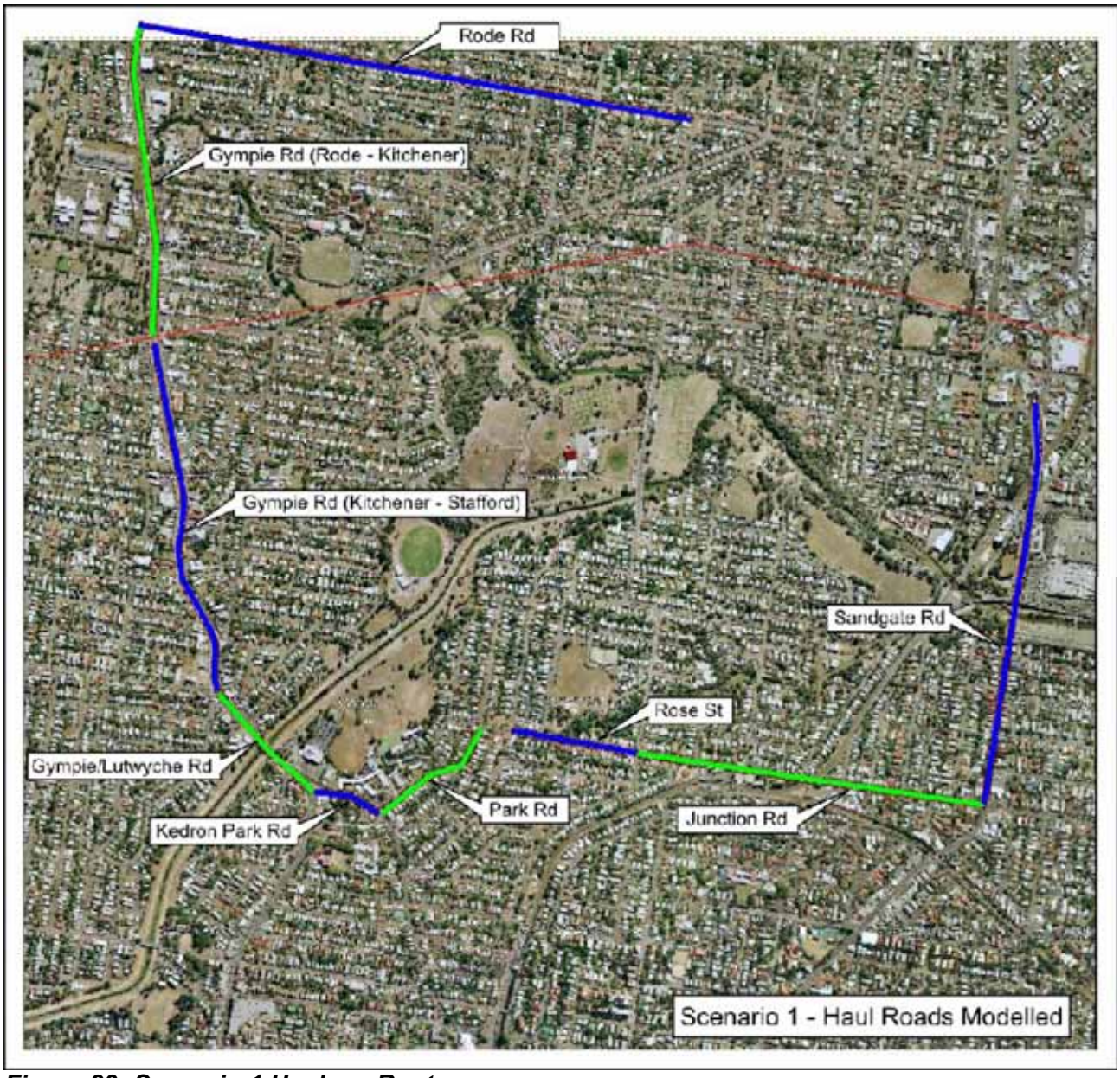


***Figure 23: Scenario 1 Haulage Route***

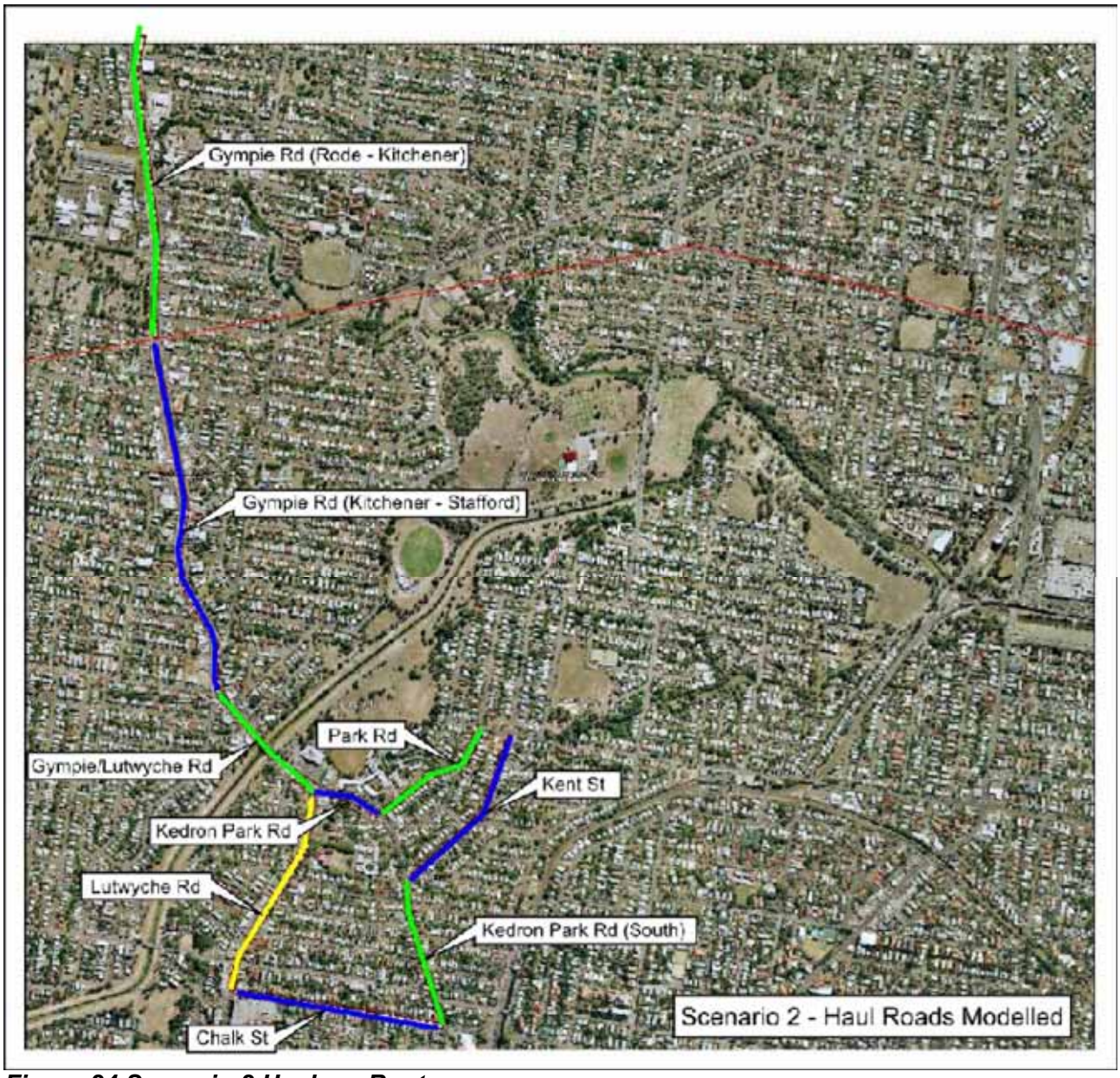


***Figure 24 Scenario 2 Haulage Route***
*note: no traffic data has been available for Chalk Street at this time*

## 5.3 TRAFFIC DATA

Discussions with TJHJV have indicated that a total of 85 Haulage vehicle movements to and from the Rose Street tunnelling operation are likely to occur per day. With an estimated maximum of 10 vehicle movements in a single hour being possible.

Table 1 presents the traffic flows along each sections of road considered based on 2006 and 2008 traffic counts performed by the Department of Main Roads. The minimum traffic occurring during any 1-hour period from 6:30 am – 6:30 pm Monday to Saturday has been extracted from the DMR data. Table 5.1 also presents the relative increase in %CV (commercial vehicles) predicted as a

result of a maximum hourly increase of 10 vehicles. It should also be noted that traffic for Saturday as well as weekday periods has been considered for Kent Street, to provide an indication of the impacts for the quieter Saturday period (traffic data for Saturday was unavailable for other road sections).

**TABLE 5.1: DMR TRAFFIC COUNTS 2008**

| Road Section | Minimum 1 hour Count (6:30am – 6:30pm) | %CV | Count CV | Additional Haulage Vehicles | %CV with Haulage |
|---|---|---|---|---|---|
| ***Scenario 1*** | | | | | |
| Gympie Rd (Rode – Kitchener) (2006 data) | 3526 | 5.6 | 199 | 10 | 5.9 |
| Gympie Rd (Kitchener - Stafford) | 3400 | 6.4 | 219 | 10 | 6.7 |
| Gympie/Lutwyche Rd | 3942 | 6.5 | 256 | 10 | 6.7 |
| Kedron Park Rd | 985 | 4.6 | 45 | 10 | 5.5 |
| Park Rd | 625 | 6.3 | 39 | 10 | 7.8 |
| Rose St | 810 | 5.3 | 43 | 10 | 6.5 |
| Junction Rd | 1011 | 2.8 | 28 | 10 | 3.8 |
| Sandgate Rd (Junction – East West Arterial) | 2480 | 6.9 | 172 | 10 | 7.3 |
| Sandgate Rd (East West Arterial – Nundah Tunnel) | 1086 | 7.5 | 81 | 10 | 8.3 |
| Rode Rd (2006 data) | 1077 | 4.4 | 47 | 10 | 5.3 |
| ***Scenario 2*** | | | | | |
| Gympie Rd (Rode – Kitchener) (2006 data) | 3526 | 5.6 | 199 | 20 | 6.2 |
| Gympie Rd (Kitchener - Stafford) | 3400 | 6.4 | 219 | 20 | 7.0 |
| Gympie/Lutwyche Rd | 3942 | 6.5 | 256 | 20 | 7.0 |
| Kedron Park Rd | 985 | 4.6 | 45 | 10 | 5.5 |
| Park Rd | 625 | 6.3 | 39 | 10 | 7.8 |
| Kent Road (Weekdays) | 99 | 2.0[a] | 2 | 10 | 11 |

| Road Section | Minimum 1 hour Count (6:30am – 6:30pm) | %CV | Count CV | Additional Haulage Vehicles | %CV with Haulage |
|---|---|---|---|---|---|
| Kent Road (Saturdays) | 55 | 2.0[a] | 1 | 10 | 17.1 |
| Kedron Park Road (South) | 985 | 4.6 | 45 | 10 | 5.5 |
| Chalk St | Counts not available | - | - | - | - |
| Lutwyche Rd (Chalk – Kedron Park) | 2583 | 3.2 | 83 | 10 | 3.6 |

[a] *Commercial vehicles counts were not available for Kent Street, therefore typical %CV data has been used based on the road type.*

The change in traffic volumes and %CV is most significant where existing volumes of traffic are low. This is because the addition of a small number of commercial (or heavy) vehicles greatly increases the number of commercial vehicles and proportionately increases the %CV for this section of road. Kent Street is the most prominent, going from an assumed 2% existing heavy vehicle content to a significant 17.1% or 11.0% depending on the day of the week considered.

## 5.4 NOISE PREDICTIONS

Table 5.2 presents a summary of the predicted increase in 1-hour $L_{Aeq}$ traffic noise levels for each section of road considered.

**TABLE 5.2: PREDICTED CHANGE TO 1-HOUR $L_{AEQ}$ NOISE LEVELS**

| Road Way | Road Section | Change to 1-Hour $L_{AEQ}$ Predictions (dB(A) |
|---|---|---|
| ***Scenario 1*** | | |
| Gympie Road | Rode Rd – Kitchener Street | + 0.1 |
| Gympie Road | Kitchener Street – Stafford Road | + 0.1 |
| Gympie/Lutwyche Roads | Stafford Road – Kedron Park Road | + 0.1 |
| Kedron Park Road | Lutwyche Road – Park Road | + 0.3 |
| Park Road | Kedron Park Road – Rose Street | + 0.4 |
| Rose Street | Park Road to Dawson Street | + 0.3 |
| Junction Road | Dawson Street – Sandgate Road | + 0.3 |
| Sandgate Road | Junction Road – East West Arterial | + 0.1 |

| Road Way | Road Section | Change to 1-Hour $L_{AEQ}$ Predictions (dB(A) |
|---|---|---|
| Sandgate Road | East West Arterial – Nundah Tunnel | + 0.2 |
| Rode Road | Shaw Road – Gympie Road | + 0.3 |
| ***Scenario 2*** | | |
| Gympie Road | Rode Rd – Kitchener Street | + 0.1 |
| Gympie Road | Kitchener Street – Stafford Road | + 0.2 |
| Gympie/Lutwyche Roads | Stafford Road – Kedron Park Road | + 0.1 |
| Kedron Park Road | Lutwyche Road – Park Road | + 0.3 |
| Park Road | Kedron Park Road – Rose Street | + 0.4 |
| Kent Road (Weekdays) | Rose Street – Kedron Park Road | + 2.8 |
| Kent Road (Saturdays) | Rose Street – Kedron Park Road | + 3.6 |
| Kedron Park Road | Kent Street – Chalk Street | + 0.3 |
| Chalk Street | Kedron Park Road – Lutwyche Road | Data unavailable |
| Lutwyche Road | Chalk Street – Kedron Park Road | + 0.1 |

The results presented in Table 4.2 predict that spoil traffic would generally not increase average traffic noise levels for scenario 1, however would significantly impact on predicted noise from traffic along Kent Street in scenario 2. Changes in noise levels of 3 dB(A) or less are usually considered undetectable to the human ear and such changes are therefore usually considered to represent negligible additional impact.

Review of the results for Kent Street indicates that for the Saturday traffic, having lower initial volumes than weekday traffic, the increase in both traffic volume and the relative percentage of heavy vehicles is significant. There is the potential for all road sections to have elevated predictions where traffic flows are reduced on Saturdays.

## 5.5 MITIGATION

Recommended mitigation measures include:

- Best practice management over engine noise emissions by procurement and maintenance of a fleet that conforms to Australian Design Rule 28/01 for engine noise emissions, tested in accordance with the National Road Transport Commission document Stationary Exhaust Noise Test Procedures for In-Service Motor Vehicles.

- Adoption of airbag suspension throughout the fleet to minimise noise associated with empty trucks travelling over road irregularities.
- Satellite tracking and management of the position of the truck fleet to ensure that waiting queues are appropriate to space constraints, minimising noise from idling trucks.
- Negotiation with residents to discuss noise mitigation measures available such as property treatments (eg window and/or door upgrades and ventilation/air-conditioning) if determined to be required during detailed.
- Keeping roads sections well maintained will reduce the noise impacts (trailers banging across pot holes, etc.). Achieving this will require notification of authorities to ensure proper maintenance of road sections.
- inform residences along haul route sections located in residential areas.

# 1 CONCLUSIONS

## 1.1 AIR QUALITY ASSESSMENT

Air dispersion modelling has been completed for the Rose Street construction site to assess potential air quality impacts. The modelling results can be summarised as follows:

- compliance with the air quality goals for emissions associated with the construction of the site;
- non-compliance with the air quality goals for emissions associated with tunnel excavation and site diesel generators;
- pollutant concentrations associated with additional haul route vehicles are predicted to be minimal.

Based on the predictive air dispersion modelling, the following recommendations should be implemented at the proposed Rose Street site:

- provision of emission reduction technology (ie.particulate filters and catalytic converters) on the proposed generators. A minimum reduction of 90% is required for $PM_{10}$ and $NO_x$ emissions from the generators;
- direct all tunnel air emissions externally via a rooftop stack (instead of the proposed ventilation louvres). In order to achieve this, vehicle entry doors should remain closed to provide a negative pressure, forcing all emissions up the stack. As up to 7 haul vehicles per hour enter and leave the site during the daytime period, it would be necessary to provide entry curtains at the vehicle entry/exit points. It should be noted that the provision of entry curtains will help minimise potential noise impacts; and
- shakedown areas for haul trucks leaving the proposed shed enclosure; and
- provision of covers over haul material leaving and entering the construction site.

In addition to the above, completion of dust fall out and $PM_{10}$ monitoring should be completed in order to monitor particulate concentrations at the nearest sensitive receptors. Permanent dust fall out gauges should be installed at the nearest sensitive receptors and monitoring should be completed for one month periods for comparison with the Coordinator General air quality goals. It is recommended that $PM_{10}$ monitoring be completed monthly and during the beginning of new construction phases.

## 1.1 NOISE ASSESSMENT

Based on the predictive noise modelling, the following recommendations should be implemented at the proposed Rose Street site:

- construct a 5.0 m acoustic barrier at the site perimeter (as presented on Figure 2). The acoustic barrier should be construction of a material with a minimum mass density of 10 $kg/m^2$ and be continuous with no air gaps;
- for the proposed shed:

- construct the acoustic shed using the proposed wall/ceiling system - external 50 mm Ortech Easiboard, internal 0.6 mm steel and cavity filled with 50 mm thick fibre glass insulation (14-18 kg/$m^3$);
- provision of acoustic enclosure around external fixed plant (20 dB attenuation);
- provision of acoustic curtains at the vehicle entry/exit points; and
- provision of an acoustic barrier (at least 2.4 m high) at the site perimeter (as presented on Figure 2). The acoustic barrier should be construction of a material with a minimum mass density of 10 kg/$m^2$ and be continuous with no air gaps.

Exceedances of the adopted noise goals are predicted even with the above noise control measures. However, it should be noted that the frequency of exceedances will depend on the intensity of the use of noisy equipment during construction. The modelling represents a conservative approach and takes into account noisy equipment operating during the busiest construction periods.

In addition to the above acoustic mitigation measures, noise monitoring during operation of the site should be completed to determine whether the appropriate noise goals are achieved. Background monitoring should be completed internally at the nearest sensitive receptors during known periods of construction. The results of the modelling should also be compared with pre-construction noise measurements to identify changes associated with construction activity. In order to identify $L_{AMax}$ noise levels associated with construction noise, it is recommended that attended measurements are completed during particularly noisy activities (e.g. rock hammering, piling).

# APPENDIX A

# ACOUSTIC GLOSSARY

# APPENDIX A: GLOSSARY OF ACOUSTIC TERMINOLOGY

| | |
|---|---|
| **A-Weighting** | A response provided by an electronic circuit which modifies sound in such a way that the resulting level is similar to that perceived by the human ear. |
| **dB (decibel)** | This is the scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure ($0.00002 N/m^2$). |
| **dB(A)** | This is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies. |
| **Facade Noise Level** | Refers to a sound pressure level determined at a point close to an acoustically reflective surface (in addition to the ground). Typically a distance of 1 metre is used. |
| **Free Field** | Refers to a sound pressure level determined at a point away from reflective surfaces other than the ground with no significant contribution due to sound from other reflective surfaces; generally as measured outside and away from buildings. |
| **Hertz (Hz)** | A measure of the frequency of sound. It measures the number of pressure peaks per second passing a point when a pure tone is present. |
| $L_{Aeq}$ **Equivalent Continuous Sound Level** | This is the equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over the given period. For a steady sound with small fluctuations, its value is close to the average sound pressure level. |
| $L_{A90,T}$ | This is the dB(A) level exceeded 90% of the time, T. |
| $L_{A10,T}$ | This is the dB(A) level exceeded 10% of the time, T. |
| $L_{A50,T}$ | This is the dB(A) level exceeded 50% of the time, T. |
| $L_{WA}$ | The A-weighted sound power level in dB. |

# Appendix A.4 – Geotechnical Site Investigation


# GEOTECHNICAL SITE INVESTIGATION BOREHOLE DRAFT LOG

## AREA: ROSE STREET, KEDRON

## BOREHOLE NO: DT17A

## DATED DRILLED: 6 May 2009

**Transmittal Date: 14 May 2009**
**J Anders**


**General Location Plan. Refer to as-built co-ordinates for exact bore location.**

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# ABBREVIATIONS USED IN DISCONTINUITIES COLUMN OF BORE REPORT SHEETS

| Abbreviation | Meaning |
|---|---|
| D | Drill Break |
| S | Shear |
| P | Parting |
| J | Joint |
| B | Bedding |
| F | Fault |
| pl | planar |
| sm | smooth |
| rgh/ro | rough |
| cf | clay fill |
| cr | crushed |
| fol | foliation |
| lim | limonite |
| fz | fractured zone |
| un | undulating |
| nf | no fill |
| frg | fragmented |
| st | stepped |
| sl | slickensided |
| Fe | ironstained |
| hor/horz | horizontal |
| v | vertical |
| sh | sub-horizontal |
| sv | sub-vertical |
| sil | silicified |
| disc | discontinuities |
| conj | conjugate |
| ag | again |
| irr | irregular |
| inf | infill |
| h | healed |
| ti | tight |
| qtz | quartz |
| cs lam | carbonaceous siltstone lamination |
| cc | clay coating |
| ir ox st | iron oxide staining |
| di | drilling induced |
| cal | calcite |
| clsm | coal seam |
| lin | lineation |
| vnr | veneer |

**Examples:**

1. at 15.65m, P, 30°, un, st, ro, cs lam
   (at 15.65m, Parting, 30°, undulating, stepped, rough, on carbonaceous siltstone lamination)

2. At 24.95m, fr, 70°, pl, ro, st, frg
   (at 24.95m, fracture, 70°, planar, rough, stepped, fragmented)

# DESCRIPTION AND CLASSIFICATION OF ROCKS FOR ENGINEERING PURPOSES

## DEGREE OF WEATHERING

| Term | Symbol | Definition |
|---|---|---|
| Extremely Weathered | EW | Rock substance affected by weathering to the extent that the rock exhibits soil properties - ie. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident. |
| Highly Weathered | HW | Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable. |
| Moderately Weathered | MW | Rock substance affected by weathering to the extent that staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is no longer recognisable. |
| Slightly Weathered | SW | Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable. |
| Fresh | Fs | Rock substance unaffected by weathering; limonite staining along joints. |
| Fresh | Fr | Rock substance unaffected by weathering. |

## ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index ($I_{s(50)}$) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described in Australian Standard AS4133.4.1 1993.

| Term | Symbol | Field Guide* | Point Load Index ($I_{s(50)}$) MPa | Approx Unconfined Compressive Strength ($q_u$) MPa** |
|---|---|---|---|---|
| Extremely Low | EL | Easily remoulded by hand to a material with soil properties. | <0.03 | <0.6 |
| Very Low | VL | Material crumbles under firm blows with sharp end of geological pick; can be peeled with a knife; too hard to cut a triaxial sample by hand. SPT will refuse. Pieces up to 30mm thick can be broken by finger pressure. | 0.03 - 0.1 | 0.6 - 2 |
| Low | L | Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the geological pick point; has dull sound under hammer. A piece of core 150mm long by 40mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling. | 0.1 - 0.3 | 2 - 6 |
| Medium | M | Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty. | 0.3 - 1 | 6 - 20 |
| High | H | A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken with geological pick with a single firm blow; rock rings under hammer. | 1 - 3 | 20 - 60 |
| Very High | VH | Hand specimen breaks with geological pick after more than one blow; rock rings under hammer. | 3 - 10 | 60 - 200 |
| Extremely High | EH | Specimen requires many blows with geological pick to break through intact material; rock rings under hammer. | >10 | >200 |

Note that these terms refer to strength of rock and not to the strength of the rock mass, which may be considerably weaker due to rock defects.

* The field guide visual assessment of rock strength may be used for preliminary assessment or when point load testing is not able to be done.

** The approximate unconfined compressive strength ($q_u$) shown in the table is based on an assumed ratio to the point load index of 20:1. This ratio may vary widely.

# DESCRIPTION AND CLASSIFICATION OF ROCKS FOR ENGINEERING PURPOSES

## STRATIFICATION SPACING

| Term | Separation of Stratification Planes |
|---|---|
| Thinly laminated | <6mm |
| Laminated | 6mm to 20mm |
| Very thinly bedded | 20mm to 60mm |
| Thinly bedded | 60mm to 0.2m |
| Medium bedded | 0.2m to 0.6m |
| Thickly bedded | 0.6m to 2m |
| Very thickly bedded | >2m |

## DEGREE OF FRACTURING

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks. The orientation of rock defects is measured as an angle relative to a plan perpendicular to the core axis.

Note the recording of actual spacing and range of spacing is preferred in place of the terms below.

| Term | Description |
|---|---|
| Fragmented | The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter. |
| Highly fractured | Core lengths are generally less than 20mm to 40mm with occasional fragments. |
| Fractured | Core lengths are mainly 30mm to 100mm with occasional shorter and longer sections. |
| Slightly fractured | Core lengths are generally 300mm to 1000mm with occasional longer sections and occasional sections of 100mm to 300mm. |
| Unbroken | The core does not contain any fracture. |

## ROCK QUALITY DESIGNATION (RQD)

This is defined as the ratio of sound (ie. low strength or better) core in lengths of greater than 100mm to the total length of the core, expressed in percent. If the core is broken by handling or by the drilling process (ie. the fracture surfaces are fresh, irregular breaks rather than joint surfaces), the fresh broken pieces are fitted together and counted as one piece.

## REFERENCE

International Society of Rock Mechanics, Suggested Method for Determining the Point Load Strength, 1985.

# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 1 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FILLING - brown gravelly clayey sand, fine to coarse sand fraction, fine to medium gravel fraction, dry to moist | | | | | | | | | | |
| | 0.7 | SILTY CLAY - hard grey and orange-brown high plasticity silty clay with some fine sand, moist (alluvial) | | | | | | | | | | |
| | 1.4 | SANDY SILTY CLAY - hard brown-orange medium plasticity sandy silty clay, fine to medium sand fraction, moist (alluvial) | | | | | | | S | | | 25/70mm |
| | 2.3 | CLAYEY SAND - medium dense orange-brown clayey sand, fine to medium sand fraction, moist (alluvial) | | | | | | | | | | |
| | 3.0 | SANDY SILTY CLAY - very stiff grey-brown high plasticity sandy silty clay, fine to medium sand fraction (alluvial) | | | | | | | S | | | 6,9,7 N = 16 |
| | 3.35 | - with some fine to medium sub-angular gravel | | | | | | | | | | |
| | | SILTY CLAY - very stiff brown-grey medium to high plasticity silty clay (alluvial) | | | | | | | | | | |
| | 4.0 | CLAYEY SAND - medium dense grey clayey sand, fine to medium sand fraction (alluvial) | | | | | | | | | | |
| | 4.3 | SILTY SANDY CLAY - very stiff grey medium plasticity silty sandy clay (alluvial) | | | | | | | S | | | 7,12,15 N = 27 |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m, HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

| CHECKED |
|---|
| Initials: |
| Date: |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 2 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5.0 | SILTY SANDY CLAY - (as before) | | | | | | | | | | |
| | 6 | | | | | | | | S | | | 3,8,7<br>N = 15 |
| | 6.4 | SILTY CLAY - very stiff grey high plasticity silty clay (alluvial) | | | | | | | | | | |
| | 6.9 | SILTY SANDY CLAY - very stiff grey and brown medium to high plasticity silty sandy clay, with trace fine to medium sub-angular to sub-rounded gravel (alluvial) | | | | | | | | | | |
| | 7 | | | | | | | | S | | | 7,9,12<br>N = 21 |
| | 8 | | | | | | | | | | | |
| | 9 | | | | | | | | $U_{50}$ | | | |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m, HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

| CHECKED |
|---|
| Initials: |
| Date: |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 3 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10.0 | SILTY SANDY CLAY - (as before) | | | | | | | | | | |
| | 10.2 | CLAYEY SAND - medium dense grey clayey sand, medium to coarse sand fraction (alluvial) | | | | | | | S | | | 4,5,7<br>N = 12 |
| | 11 | | | | | | | | | | | |
| | 12 12.0 | SILTY SANDY CLAY - soft to firm grey medium plasticity silty sandy clay, fine to medium sand fraction (alluvial) | | | | | | | S | | | 4,4,4<br>N = 8 |
| | 13 | | | | | | | | | | | |
| | 13.2 | SANDY GRAVEL - loose grey and brown sandy gravel, fine to medium sub-angular to sub-rounded gravel fraction, medium to coarse sand fraction (alluvial) | | | | | | | S | | | 3,3,3<br>N = 6 |
| | 14 | | | | | | | | | | | |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m, HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

| CHECKED |
|---|
| Initials: |
| Date: |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 4 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15.0 | SILTY CLAY - very soft brown and grey high plasticity silty clay with some fine sand (alluvial) | | | | | | | S | | | 1,0,0<br>N = 0 |
| | | - becoming soft to firm | | | | | | | $U_{50}$ | | | pp = 40-50kPa |
| | 16 | | | | | | | | | | | |
| | | | | | | | | | ($U_{50}$) | | | |
| | 17 | | | | | | | | | | | |
| | | - becoming stiff | | | | | | | | | | |
| | 18 | | | | | | | | | | | |
| | 18.2 | CLAYEY SAND - medium dense grey and brown clayey sand, medium to coarse sand fraction | | | | | | | $U_{50}$ | | | pp = 100-120kPa |
| | 18.57 | SILTY CLAY - hard grey high plasticity silty clay, trace rock structure visible (residual) | | | | | | Refer to abbreviation of discontinuities sheet attached | | | | |
| | 19 | | | | | | | | S | | | 8,14,25/60mm |
| | 19.2 | SANDSTONE - extremely low to very low strength fresh dark grey poorly lithified fine to medium sandstone, with siltstone interbeds and significant clay content | | | | | | Natural fracturing mostly undeveloped to 20.25m | | | | |
| | 19.6 | SILTSTONE - extremely low strength fresh dark grey-dark brown poorly lithified siltstone, with fine to medium sandstone interbeds and significnat clay content | | | | | | | C | 100 | 0 | |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 5 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20.0 | - 100mm clay band | | | | | | | | | | |
| | | - 100m very low strength fine sandstone band<br>- becoming very low to low strength fresh stained fractured dark brown thinly laminated siltstone<br>- becoming low strength | | | | | | 20.17m: J: 10°, pl, ro, cc, on B, ag 20.20m<br>20.33m: J: sh, pl, sm, cc, on B, ag 20.37m<br>20.44m: J: sv, un, ro, cf 1mm, to 20.51m<br>20.51m: J: sh, pl, sm, cc, ag 20.52m<br>20.6m: J: 10°, pl, ro, on B<br>20.65m: J: 10°, pl, sm, cc, on B<br>20.67m: J: 80°, plsm, to 20.77m<br>20.71m: J: 15°, pl, sm | | | | |
| | 21 | - 80mm fine sandstone band<br>- increasing proportion of fine sandstone interbeds at 0-5°<br>- becoming dark grey | | | | | | 20.78m: J: sh, pl, sm, cc, on B<br>20.83m: J: 10°, pl, sm, cc, fe, on B, ag 20.87, 20.90, 20.96, 21.05, 21.13m<br>21.23m: D: ag 21.80, 21.95, 22.00, 22.37, 22.50, 22.60, 22.69, 22.93, 23.12, 23.35, 23.42, 23.82m | C | 100 | 34 | PL(A) = 0.06MPa*<br>PL(D) = 0.05MPa* |
| | 22 | - becoming medium strength fresh slightly carbonaceous siltstone, bedding sub-horizontal<br>- 5mm fine sandstone interbed<br>- increasing proportion of fine sandstone interbeds | | | | | | 21.31m: J: sh, pl, ro, cc, on B, ag 21.37m<br>21.52m: J: sh, pl ,sm, on B, ag 21.62, 21.70, 21.85m<br>21.65m: J: 70°, pl, ro, fe<br>21.85m: J: 70°, pl, ro, to 22.07m<br>22.07m: J: sh, pl, ro, fe, on B, ag 22.08m<br>22.44m: J: 60°, un, ro<br>22.6m: J: 65°, pl, ro | | | | |
| | 23 | - becoming low to medium strength<br>- with rare coal laminae to 1mm | | | | | | 23.1m: J: 65°, pl, ro, c vnr<br>23.67m: J: 5°, pl, sm, c vnr, ag 22.86m | C | 100 | 65 | PL(A) = 0.41MPa*<br>PL(D) = 0.41MPa* |
| | 24 | - 50mm extremely low strength clayey band<br>- becoming low strength dark grey thinly laminated carbonaceous siltstone, with thin non-carbonaceous laminae | | | | | | 23.95m: J: 30°, pl, sm, cc<br>24.03m: J: 30°, pl, ro, cc<br>24.11m: J: 5°, pl, sm, on B, ag 24.18, 24.33, 24.44, 24.59, 24.63, 24.95m<br>24.45m: J: sv, pl, sm, to 24.62m<br>24.63m: J: sv, pl, ro, to 25.05m<br>24.74m: J: sh, pl, sm, cc, on B | | | | PL(A) = 0.57MPa<br>PL(D) = 0.09MPa* |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m, HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 6 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25.0 | - becoming medium strength | | | | | | | | | | |
| | 25.16 | CLAY | | | | | | 25.1m: J: 40°, un, sm, cf 20mm | C | 100 | 65 | |
| | 25.55 | SILTSTONE - low strength fresh fractured dark grey thinly laminated siltstone with fine sandstone interbeds | | | | | | 25.63m: J: 65°, pl, sm, cc<br>25.72m: J: 50°, un, ro<br>25.75m: J: sv, pl, ro, to 25.92m<br>25.83m: J: 20°, pl, ro<br>25.97m: J: 70°, pl, ro<br>26m: J: 70°, pl, ro, to 26.16m, ag 26.05m, to 26.37m | | | | |
| | | - becoming fragmented due to steeply dipping fractures to 25.84m | | | | | | | | | | |
| 26 | | - increasing proportion of fine sandstone interbeds | | | | | | | | | | |
| | | - becoming medium strength | | | | | | | | | | |
| | 26.35 | SANDSTONE - medium strength fresh fractured dark grey fine sandstone with interbedded siltstone | | | | | | 26.31m: J: 50°, pl, ro, cf 10mm<br>26.35m: J: 40°, pl, ro, conj 26.35m<br>26.43m: J: 50°, un, ro, cc, ag 26.62m<br>26.45m: J: sv, pl, ro, cf 3mm, to 26.64m<br>26.7m: J: 35°, pl, ro, cf 3mm, ag 26.76m<br>26.72m: J: sv, un, ro | C | 100 | 45 | PL(A) = 0.32MPa<br>PL(D) = 0.71MPa |
| 27 | | - becoming fine to medium grained | | | | | | 27.15m: D<br>27.16m: J: 60°, un, ro, cc<br>27.22m: frg to 27.32m<br>27.32m: D: ag 27.39m<br>27.42m: frg to 27.52m<br>27.55m: J: 60°, un, ro<br>27.6m: J: 70°, pl, ro, cf 2mm, to 27.85m, conj 27.55m | | | | |
| | | - becoming fragmented around siltstone interbed from 27.42 to 27.52m | | | | | | | | | | |
| | | - becoming increasingly coarser grained | | | | | | | | | | |
| 28 | 28.0 | - becoming coarse grained | | | | | | 28.07m: J: 70°, pl, ro<br>28.08m: J: 5°, pl, ro, on contact<br>28.21m: J: sh, pl, ro, cf 40mm, on B<br>28.4m: frg to 28.44m<br>28.48m: J: 5°, pl, sm, on B, ag 28.53m | C | 88 | 30 | PL(D) = 0.46MPa |
| | | - 50mm fine sandstone band | | | | | | | | | | |
| | 28.25 | - 40mm clay band | | | | | | | | | | |
| | | SILTSTONE - medium strength fresh fractured dark grey thinly laminated carbonaceous siltstone, bedding 0-10° with fine sandstone interbeds | | | | | | | | | | |
| | | - becoming extremely low strength, significant clay content | | | | | | | | | | |
| | | - 15mm clay band | | | | | | | | | | |
| | | - becoming low strength fragmented | | | | | | 28.91m: frg to 29.00m | | | | |
| 29 | 29.0 | CORE LOSS | | | | | | 29m: CORE LOSS: 300mm | | | | |
| | 29.3 | - becoming extremely low strength fragmented, with clay | | | | | | 29.33m: J: 5°, pl, sm, on B<br>29.35m: frg to 29.50m | | | | |
| | 29.5 | CLAY | | | | | | | C | 96 | 85 | |
| | 29.72 | SILTSTONE - medium strength fresh fractured grey thinly laminated siltstone, sub-horizontal bedding with fine sandstone interbeds | | | | | | 29.72m: D: ag 29.87, 29.97m | | | | |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
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| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 7 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30.0 | SILTSTONE - (as before) | | | | | | 30.03m: J: sv, un, ro, to 30.20m<br>30.12m: D: ag 30.32, 30.52, 30.94m | | | | PL(A) = 0.33MPa<br>PL(D) = 0.29MPa |
| | 30.64 | SANDSTONE - medium strength fresh slightly fractured grey fine sandstone, with interbedded siltstone | | | | | | | | | | |
| 31 | 31.0 | - contact sharp | | | | | | | | | | |
| | 31.18 | CONGLOMERATE - medium to high strength fresh unbroken grey clast supported coarse conglomerate, dominant clasts phyllite, tuff and quartz in coarse sand matrix | | | | | | 31.18m: D: ag 31.30, 31.55, 31.64, 31.75, 32.00, 32.33, 32.58, 32.82m | C | 96 | 85 | |
| | | - contact sharp | | | | | | | | | | |
| | 31.65 | SANDSTONE - medium to high strength fresh slightly fractureed grey fine sandstone, with interbedded siltstone | | | | | | | | | | |
| | | - 20mm extremely low strength band | | | | | | | | | | |
| 32 | | - contact slightly gradational | | | | | | | | | | PL(A) = 6.95MPa<br>PL(D) = 4.15MPa |
| | | CONGLOMERATE - high strength fresh unbroken grey clast supported coarse conglomerate, dominant clasts phyllite, tuff and quartz in coarse sand matrix | | | | | | | | | | |
| | | - becoming coarser | | | | | | | | | | |
| | | **DRAFT** | | | | | | | | | | |
| 33 | | | | | | | | >33.03m: D: ag 33.12, 33.47, 33.80, 33.88, 33.95, 34.08, 34.65, 34.75, 34.87, 39.00m | C | 100 | 100 | |
| 34 | | | | | | | | | | | | PL(A) = 0.59MPa* PL(D) = 0.34MPa* |
| | 34.4 | - coarse sandstone band with conglomerate clasts from 34.40 to 34.60m | | | | | | | | | | |
| | 34.6 | | | | | | | | C | 100 | 93 | |

**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
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| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 8 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35.0 | CONGLOMERATE - (as before) | | | | | | 35.06m: D: ag 35.22, 35.64, 35.83, 36.00m | | | | |
| | 36 | | | | | | | | | | | |
| | 36.06 | - contact sharp on carbonaceous siltstone laminae | | | | | | 36.05m: J: sh, pl, sm, cc, cs lam, on B | | | | |
| | 36.14 | CLAY | | | | | | 36.15m: J: sh, pl, sm, cc, on B, ag 36.16, 36.19m | C | 100 | 93 | |
| | | SILTSTONE - medium strength fresh fractured dark grey thinly laminated siltstone, sub-horizontal bedding with interbedded fine sandstone | | | | | | 36.2m: J: sh, pl, ro, cc, on B | | | | |
| | | - 25mm clay band | | | | | | 36.4m: J: 10°, pl, sm, on B | | | | PL(A) = 2.07MPa PL(D) = 0.43MPa |
| | | - becoming medium to high strength slightly fractured, with rare carbonaceous siltstone laminae | | | | | | 36.41m: J: sv, pl, ro, to 36.56m | | | | |
| | 37 37.0 | - 120mm fine sandstone interbed grading fine to coarse with depth | | | | | | 36.56m: J: sh, pl, sm, cf 2mm, on B | | | | |
| | | - 5mm light brown non-carbonaceous interbed | | | | | | 36.84m: D: ag 37.00, 37.23, 37.38m | | | | |
| | | - contact sharp | | | | | | | | | | |
| | | SANDSTONE - medium to high strength fresh slightly fractured dark grey fine sandstone with interbedded siltstone | | | | | | 37.72m: J: 80°, pl, ro, to 38.14m | | | | |
| | 38 | | | | | | | | | | | |
| | 38.11 | contact sharp, sub-horizontal | | | | | | | | | | |
| | | TUFF - extremely low strength fresh green-grey kaolinitised Brisbane tuff | | | | | | 38.51m: J: sv, un, ro, cc, to 38.62m | | | | |
| | | - sub-horizontal lineation becoming more apparent | | | | | | 38.62m: J: sh, pl, ro, cf 5mm, on lin | | | | PL(A) = 0.53MPa PL(D) = 0.07MPa* |
| | | - becoming low strength slightly fractured | | | | | | 38.77m: J: 5°, pl, ro, on lin | C | 100 | 84 | |
| | | - becoming medium strength, dominant clasts sub-angular phyllite lithics to 8mm, flattened partially kaolinitised tuff lithics to 10mm | | | | | | 39m: D | | | | |
| | 39 | | | | | | | 39.04m: J: 45°, irr, ro, cc | | | | |
| | | | | | | | | 39.11m: J: 60°, un, ro, cc | | | | |
| | | | | | | | | 39.2m: J: sv, irr, ro | | | | |
| | | | | | | | | 39.3m: J: 5°, un, sm, cf 3mm, on lin | | | | |
| | | | | | | | | 39.35m: J: 60°, irr, ro, cc | | | | |
| | | - 3mm thick kaolinitised flattened tuff lithic | | | | | | 39.7m: D: ag 39.93, 40.00, 40.15, 40.36, 40.77, 40.90m | | | | |
| | | - pale grey-pale green in colour | | | | | | | | | | |
| | | - becoming high strength | | | | | | | | | | |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

| CHECKED |
|---|
| Initials: |
| Date: |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 9 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding J - Joint S - Shear D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40.0 | TUFF - (as before) | | | | | | | | | | PL(A) = 1.82MPa<br>PL(D) = 0.89MPa |
| | | **DRAFT** | | | | | | | C | 100 | 84 | |
| | | - chloritic alteration becoming less apparent | | | | | | | | | | |
| | 41 | | | | | | | 40.92m: J: sv, un, ro, to 41.02m<br>41.03m: D: ag 41.30, 41.69, 42.00m | | | | |
| | | - 20mm angular phyllite lithic | | | | | | | | | | |
| | 42 | - becoming fresh stained | | | | | | | | | | PL(A) = 2.69MPa<br>PL(D) = 2.27MPa |
| | | - zone of concentric iron-oxide alteration around lithics from 42.32 to 42.75m<br>- tight sub-vertical fracture with hard dark infill 6mm, to 42.66m | | | | | | 42.3m: D: ag 42.96, 43.00, 43.24, 43.30, 43.55, 43.90, 43.96, 44.00m | C | 100 | 100 | |
| | | - becoming grey, wavy lineation more developed at 0-10° | | | | | | 42.77m: J: 80°, un, ro, to 42.88m | | | | |
| | 43 | | | | | | | | | | | |
| | | | | | | | | 43.77m: J: 10°, un, ro, on lin | | | | |
| | 44 | - 70mm tuff lithic<br>- 40mm tuff lithic | | | | | | | | | | PL(A) = 2.73MPa<br>PL(D) = 2.63MPa |
| | | | | | | | | 44.15m: D: ag 44.36, 44.41, 45.13m<br>44.3m: J: 65°, pl, ro, cf 1mm, ti from 44.35m | C | 100 | 93 | |
| | | | | | | | | 44.6m: J: 10°, un, ro, on lin | | | | |
| | | | | | | | | 44.85m: J: 35°, un, ro, ag 44.94m | | | | |

**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

| CHECKED |
|---|
| Initials: |
| Date: |

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# BOREHOLE LOG

**CLIENT:** Thiess John Holland
**PROJECT:** Airport Link - Driven Tunnels
**LOCATION:** Rose Street, Kedron

**SURFACE LEVEL:** --
**EASTING:**
**NORTHING:**
**DIP/AZIMUTH:** 90°/--

**BORE No:** DT17A
**PROJECT No:** 47225.06
**DATE:** 06/05/2009
**SHEET** 10 OF 10

| RL | Depth (m) | Description of Strata | Degree of Weathering (EW HW MW SW FS FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break) | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45.0 | - lineation becoming more intensely developed - possibly representing base of flow | | | | | | | C | 100 | 93 | *Broke on existing defect |
| | 45.2 | Bore discontinued at 45.2m | | | | | | | | | | |
| | | This log represents field descriptions only, and does not include results of laboratory testing | | | | | | | | | | |
| | 46 | | | | | | | | | | | |
| | 47 | | | | | | | | | | | |
| | 48 | | | | | | | | | | | |
| | 49 | | | | | | | | | | | |



**RIG:** MD300 **DRILLER:** Taberner **LOGGED:** JB **CASING:** HWT to 3.00m, HQ to 20.50m

**TYPE OF BORING:** Auger 0.00-3.00m, Washbore 3.00-19.20m, NMLC Core 19.20-45.20m

**WATER OBSERVATIONS:** None during augering

**REMARKS:** Awaiting co-ords from client

**SAMPLING & IN SITU TESTING LEGEND**

| | | | |
|---|---|---|---|
| A | Auger sample | pp | Pocket penetrometer (kPa) |
| D | Disturbed sample | PID | Photo ionisation detector |
| B | Bulk sample | S | Standard penetration test |
| $U_x$ | Tube sample (x mm dia.) | PL | Point load strength Is(50) MPa |
| W | Water sample | V | Shear Vane (kPa) |
| C | Core drilling | ▷ | Water seep ▼ Water level |

| CHECKED |
|---|
| Initials: |
| Date: |

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| | | | |
|---|---|---|---|
| **AIRPORT LINK – DRIVEN TUNNELS** | **BORE DT17A** | **Project 47225.06** | Douglas Partners Geotechnics - Environment - Groundwater |


| AIRPORT LINK – DRIVEN TUNNELS | BORE DT17A | Project 47225.06 | Douglas Partners Geotechnics - Environment - Groundwater |
|---|---|---|---|


| AIRPORT LINK – DRIVEN TUNNELS | BORE DT17A | Project 47225.06 | Douglas Partners Geotechnics - Environment - Groundwater |
|---|---|---|---|


| AIRPORT LINK – DRIVEN TUNNELS | BORE DT17A | Project 47225.06 | Douglas Partners Geotechnics - Environment - Groundwater |
|---|---|---|---|


| | | | |
|---|---|---|---|
| **AIRPORT LINK – DRIVEN TUNNELS** | **BORE DT17A** | **Project 47225.06** | Douglas Partners Geotechnics - Environment - Groundwater |

# Appendix A.5 – Lighting Design

Zumtobel Lighting

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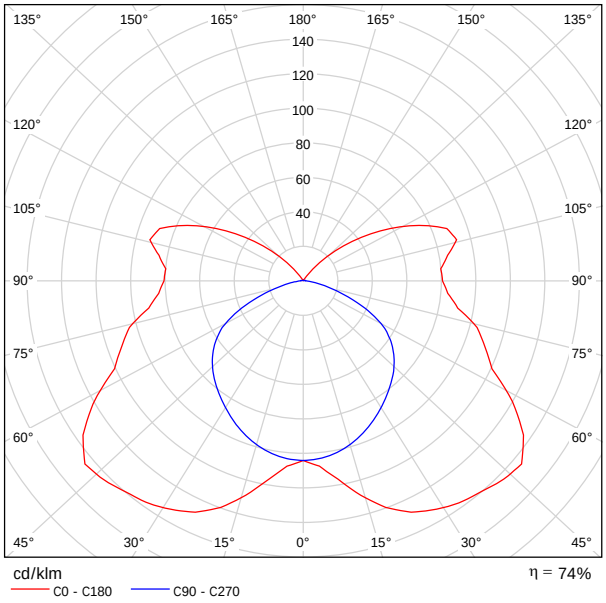
# Zumtobel 32 159 730 SCUBA PC 1/36W T26 VVG C V2A [STD] / Luminaire Data Sheet

## Luminaire classification according to CIE: 79
## CIE flux code: 33 64 86 79 74

Moisture-proof diffuser luminaire 1/36W; capacitive circuit, for T26, with low-loss conventional ballast; housing made of fibreglass reinforced polyester, halogen-free in light grey; one-piece, injection-moulded PC (polycarbonate) diffuser with internal prisms structure, installed using V2A standard spring clips on ceiling, wall or trunking; reflector made of galvanised steel sheet, white painted. Through-wiring: if fitted with low-loss ballast, exclusively use heat-resistant separate cables (see accessories to be ordered separately); if fitted with electronic ballast, use standard separate cables (NYM), or alternatively use single-end IN-OUT wiring; 5-pole connector terminal, protection type: IP65, protection class: SC1, V2, 850°C glow-wire tested; dimensions: 1295 x 110 x 113 mm; weight: 2.2 kg.

## Luminous emittance 1:




## Luminous emittance 1:

**Glare Evaluation According to UGR**

| ρ Ceiling | | 70 | 70 | 50 | 50 | 30 | 70 | 70 | 50 | 50 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ρ Walls | | 50 | 30 | 50 | 30 | 30 | 50 | 30 | 50 | 30 | 30 |
| ρ Floor | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Room Size X | Y | Viewing direction at right angles to lamp axis | | | | | Viewing direction parallel to lamp axis | | | | |
| 2H | 2H | 17.1 | 18.3 | 17.7 | 18.9 | 19.6 | 13.2 | 14.4 | 13.8 | 15.0 | 15.7 |
| | 3H | 19.3 | 20.4 | 19.9 | 21.0 | 21.7 | 14.3 | 15.4 | 14.9 | 16.0 | 16.7 |
| | 4H | 20.3 | 21.4 | 21.0 | 22.0 | 22.7 | 14.6 | 15.7 | 15.3 | 16.3 | 17.0 |
| | 6H | 21.4 | 22.3 | 22.0 | 23.0 | 23.7 | 14.8 | 15.8 | 15.5 | 16.5 | 17.2 |
| | 8H | 21.8 | 22.8 | 22.5 | 23.4 | 24.2 | 14.9 | 15.8 | 15.5 | 16.5 | 17.2 |
| | 12H | 22.3 | 23.2 | 23.0 | 23.9 | 24.6 | 14.9 | 15.8 | 15.6 | 16.5 | 17.2 |
| 4H | 2H | 17.3 | 18.3 | 17.9 | 19.0 | 19.7 | 14.3 | 15.4 | 15.0 | 16.0 | 16.7 |
| | 3H | 19.8 | 20.7 | 20.5 | 21.4 | 22.2 | 15.8 | 16.7 | 16.5 | 17.4 | 18.2 |
| | 4H | 21.2 | 22.0 | 21.9 | 22.7 | 23.5 | 16.4 | 17.2 | 17.1 | 17.9 | 18.7 |
| | 6H | 22.4 | 23.1 | 23.1 | 23.8 | 24.7 | 16.7 | 17.4 | 17.4 | 18.2 | 19.0 |
| | 8H | 23.0 | 23.7 | 23.7 | 24.4 | 25.2 | 16.8 | 17.5 | 17.5 | 18.2 | 19.0 |
| | 12H | 23.6 | 24.2 | 24.3 | 25.0 | 25.8 | 16.9 | 17.5 | 17.6 | 18.2 | 19.1 |
| 8H | 4H | 21.4 | 22.1 | 22.1 | 22.8 | 23.6 | 17.7 | 18.3 | 18.4 | 19.0 | 19.9 |
| | 6H | 22.9 | 23.5 | 23.7 | 24.3 | 25.1 | 18.4 | 18.9 | 19.1 | 19.7 | 20.6 |
| | 8H | 23.7 | 24.2 | 24.5 | 25.0 | 25.9 | 18.6 | 19.1 | 19.4 | 19.9 | 20.8 |
| | 12H | 24.5 | 24.9 | 25.3 | 25.7 | 26.6 | 18.7 | 19.2 | 19.5 | 20.0 | 20.9 |
| 12H | 4H | 21.4 | 22.0 | 22.1 | 22.8 | 23.6 | 18.0 | 18.6 | 18.7 | 19.3 | 20.2 |
| | 6H | 23.0 | 23.5 | 23.8 | 24.3 | 25.2 | 18.9 | 19.4 | 19.7 | 20.2 | 21.1 |
| | 8H | 23.9 | 24.3 | 24.7 | 25.1 | 26.0 | 19.3 | 19.8 | 20.1 | 20.6 | 21.5 |

Variation of the observer position for the luminaire distances S

| | | |
|---|---|---|
| S = 1.0H | +0.1 / -0.1 | +0.1 / -0.1 |
| S = 1.5H | +0.2 / -0.2 | +0.3 / -0.3 |
| S = 2.0H | +0.3 / -0.4 | +0.6 / -0.6 |
| Standard table | BK10 | BK13 |
| Correction Summand | 3.2 | -1.9 |

Corrected Glare Indices referring to 3350lm Total Luminous Flux

Zumtobel Lighting

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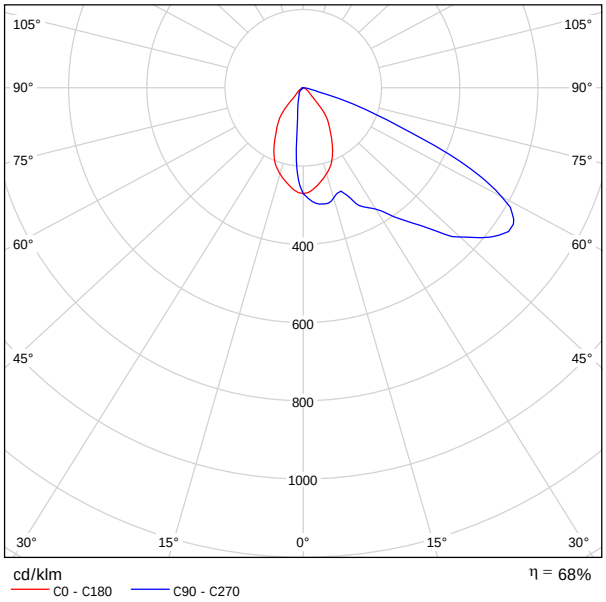
# BEGA 8141 1 HIT-DE 70W / Luminaire Data Sheet

Luminous emittance 1:




Luminaire classification according to CIE: 100
CIE flux code: 39 77 99 100 69

Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

BEGA-8141 Surface washer
Single pole-top luminaire for
1 discharge lamp HIT-DE 70 W · 5000 lumen
1 discharge lamp HST-DE 70 W · 7000 lumen
with asymmetrical light distribution
Protection class IP 65
Aluminium alloy, aluminium and stainless steel
Safety glass · Reflector of pure anodized
aluminium · Adjustable slope angle
The luminaire is designed for pole heights
4000 - 5000 mm
Pole top ø 76 mm · Insert depth 100 mm
Colour: graphite - article number
silver - article number + A

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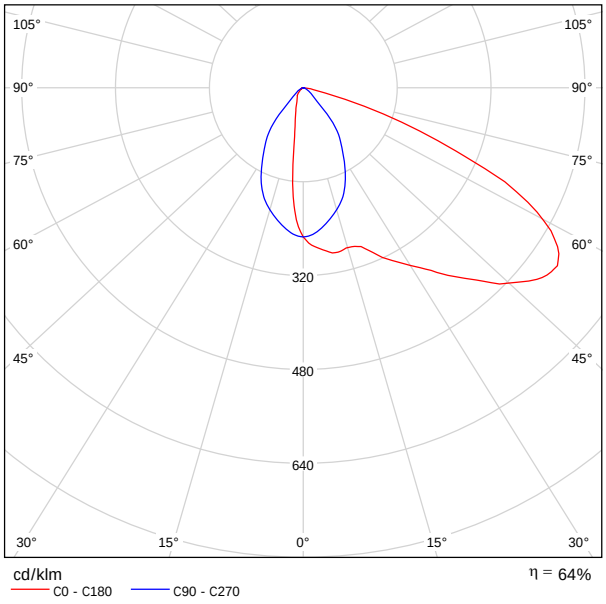
# BEGA 7476 1 HIT-DE 150W / Luminaire Data Sheet

Luminous emittance 1:




Luminaire classification according to CIE: 100
CIE flux code: 40 77 98 100 64

Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

BEGA-7476 Surface washer with asymmetrical light distribution for
1 discharge lamp HIT-DE 150 W - 11000 Lumen
1 discharge lamp HST-DE 150 W - 15000 Lumen
Protection class IP 65
Aluminium alloy, aluminium and
Stainless steel · Safety glass
Reflector of pure anodized aluminium
Adjustable joint
The luminaire can be installed with the light opening facing upwards or downwards.
With wallplate. Diameter 130 mm
Colour: graphite - article number
white - article number + W
silver - article number + A

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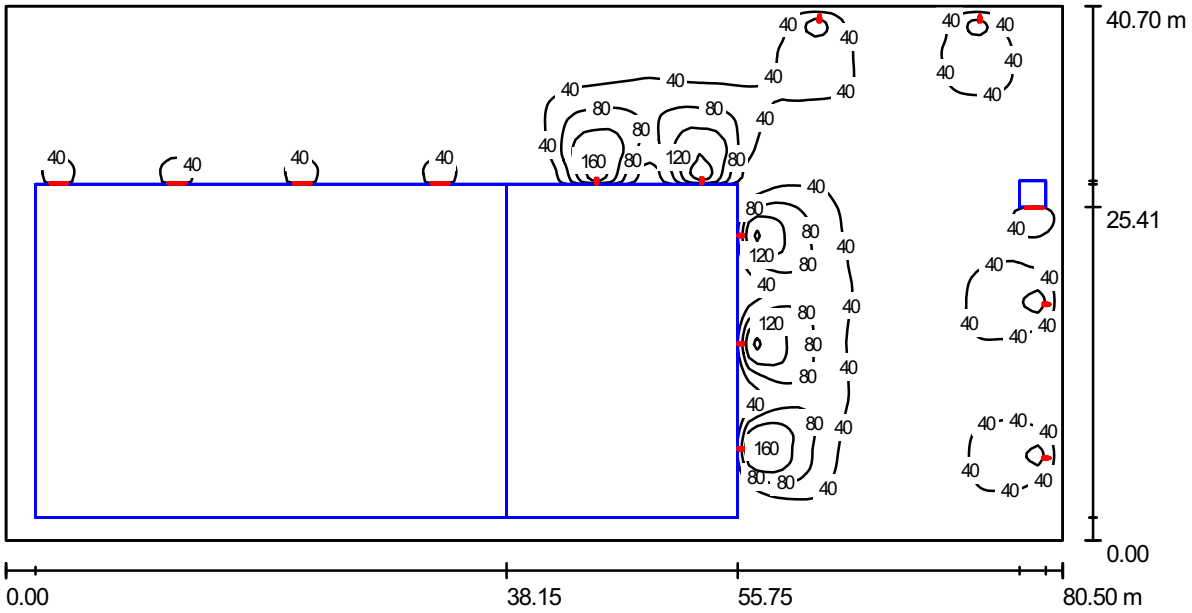
## Airportlink / Summary




Height of Room: 17.000 m, Maintenance factor: 0.80 Values in Lux, Scale 1:576

| Surface | ρ [%] | $E_{av}$ [lx] | $E_{min}$ [lx] | $E_{max}$ [lx] | u0 |
|---|---|---|---|---|---|
| Workplane | / | 26 | 0.00 | 187 | 0.000 |
| Floor | 25 | 15 | 0.00 | 187 | 0.000 |
| Ceiling | 2 | 1.99 | 0.03 | 5.37 | 0.017 |
| Walls (4) | 5 | 2.22 | 0.02 | 34 | / |

**Workplane:**

Height: 0.000 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.084, Ceiling / Working Plane: 0.075.

**Luminaire Parts List**

| No. | Pieces | Designation (Correction Factor) | Φ [lm] | P [W] |
|---|---|---|---|---|
| 1 | 5 | BEGA 7476 1 HIT-DE 150W (1.000) | 13250 | 170.0 |
| 2 | 4 | BEGA 8141 1 HIT-DE 70W (1.000) | 6600 | 88.0 |
| 3 | 5 | Zumtobel 32 159 730 SCUBA PC 1/36W T26 VVG C V2A [STD] (1.000) | 3350 | 43.0 |
| | | Total: | 109400 | 1417.0 |

Specific connected load: 0.43 W/m² = 1.64 W/m²/100 lx (Ground area: 3276.35 m²)

Zumtobel Lighting

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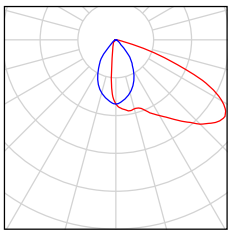
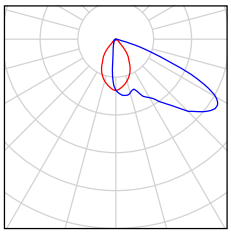
## Airportlink / Luminaire parts list

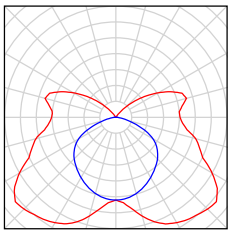
5 Pieces BEGA 7476 1 HIT-DE 150W
Article No.: 7476
Luminaire Luminous Flux: 13250 lm
Luminaire Wattage: 170.0 W
Luminaire classification according to CIE: 100
CIE flux code: 40 77 98 100 64
Fitting: 1 x HIT-DE-CE 150W (Correction Factor 1.000).



4 Pieces BEGA 8141 1 HIT-DE 70W
Article No.: 8141
Luminaire Luminous Flux: 6600 lm
Luminaire Wattage: 88.0 W
Luminaire classification according to CIE: 100
CIE flux code: 39 77 99 100 69
Fitting: 1 x HIT-DE-CE (Correction Factor 1.000).



5 Pieces Zumtobel 32 159 730 SCUBA PC 1/36W T26 VVG C V2A [STD]
Article No.: 32 159 730
Luminaire Luminous Flux: 3350 lm
Luminaire Wattage: 43.0 W
Luminaire classification according to CIE: 79
CIE flux code: 33 64 86 79 74
Fitting: 1 x T26 (Correction Factor 1.000).



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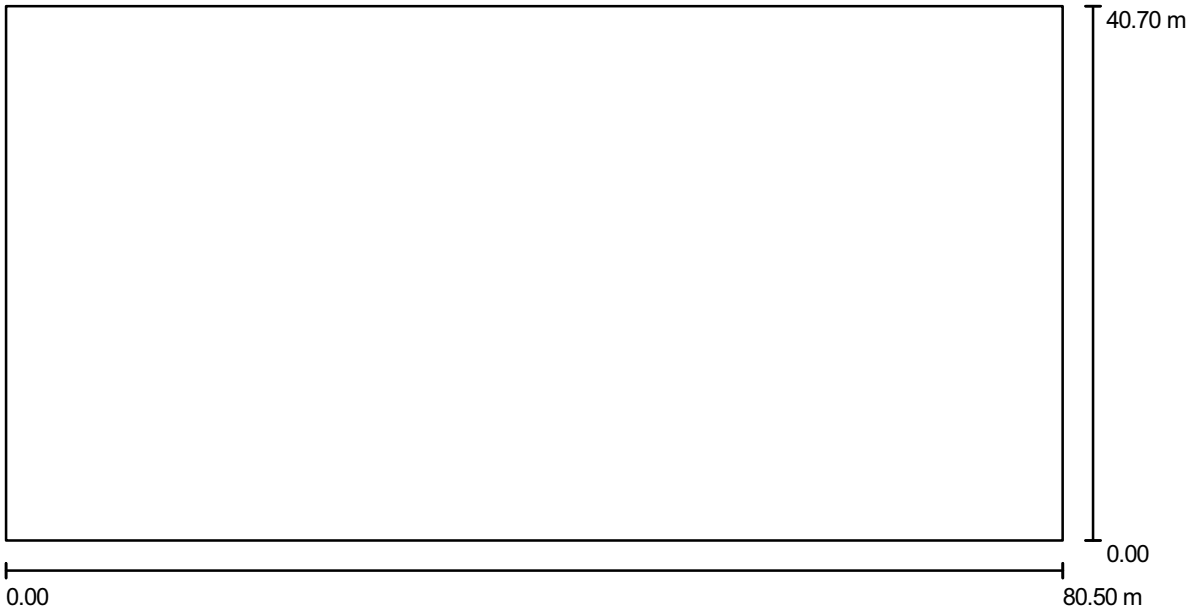
## Airportlink / Floor plan




Scale 1 : 576

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## Airportlink / Photometric Results

Total Luminous Flux: 109400 lm
Total Load: 1417.0 W
Maintenance factor: 0.80
Boundary Zone: 0.000 m

| Surface | Average illuminances [lx] | | | Reflection factor [%] | Average luminance [cd/m²] |
|---|---|---|---|---|---|
| | direct | indirect | total | | |
| Workplane | 25 | 1.01 | 26 | / | / |
| Floor | 15 | 0.60 | 15 | 25 | 1.22 |
| Ceiling | 0.02 | 1.97 | 1.99 | 2 | 0.01 |
| Wall 1 | 0.22 | 0.95 | 1.16 | 5 | 0.02 |
| Wall 2 | 0.72 | 2.84 | 3.56 | 5 | 0.06 |
| Wall 3 | 0.96 | 2.40 | 3.36 | 5 | 0.05 |
| Wall 4 | 0.24 | 0.49 | 0.73 | 5 | 0.01 |

Uniformity on the working plane
u0: 0.000
$E_{min}$ / $E_{max}$: 0.000

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.084, Ceiling / Working Plane: 0.075.

Specific connected load: 0.43 W/m² = 1.64 W/m²/100 lx (Ground area: 3276.35 m²)

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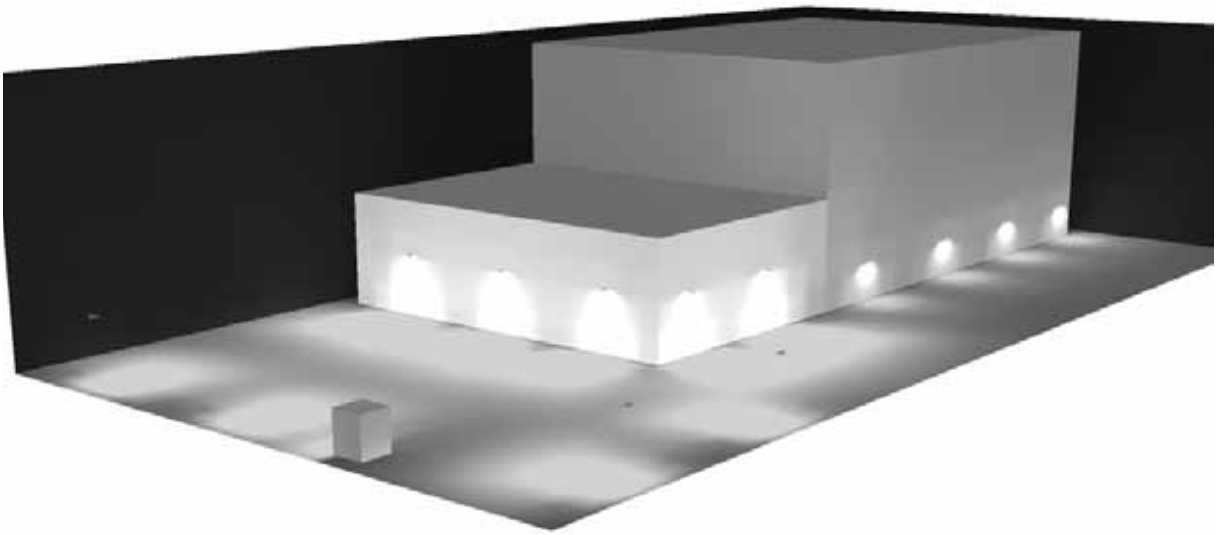
## Airportlink / 3D Rendering



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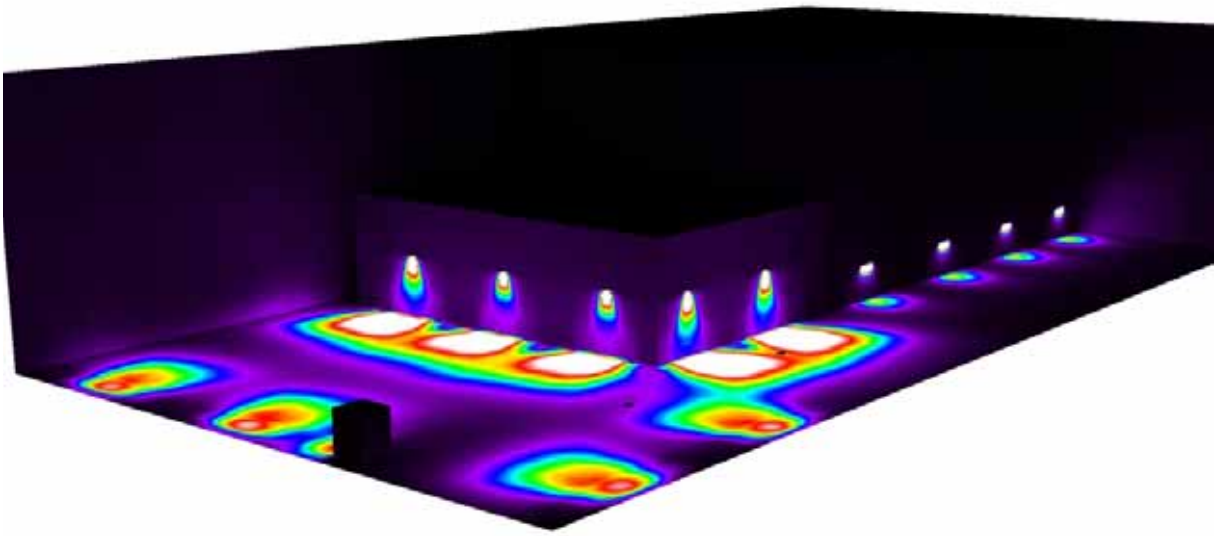
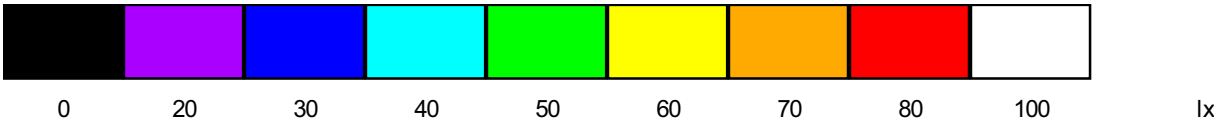
## Airportlink / False Colour Rendering





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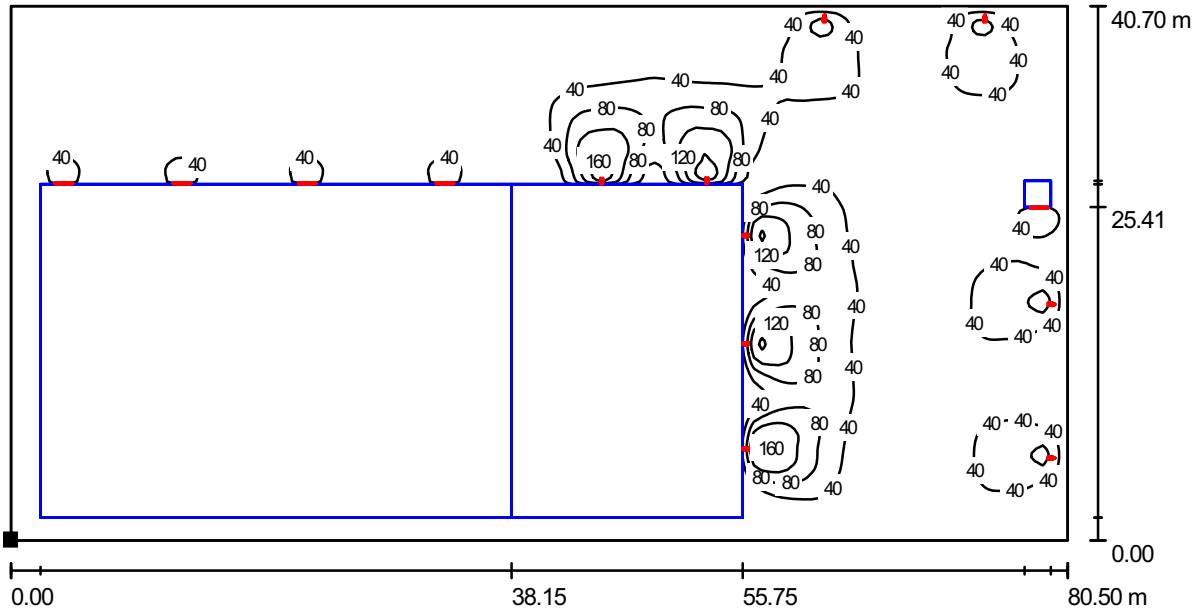
## Airportlink / Workplane / Isolines (E)




Values in Lux, Scale 1 : 576

Position of surface in room:
Marked point:
(0.000 m, 0.000 m, 0.000 m)

Grid: 128 x 128 Points

| $E_{av}$ [lx] | $E_{min}$ [lx] | $E_{max}$ [lx] | u0 | $E_{min}$ / $E_{max}$ |
|---|---|---|---|---|
| 26 | 0.00 | 187 | 0.000 | 0.000 |

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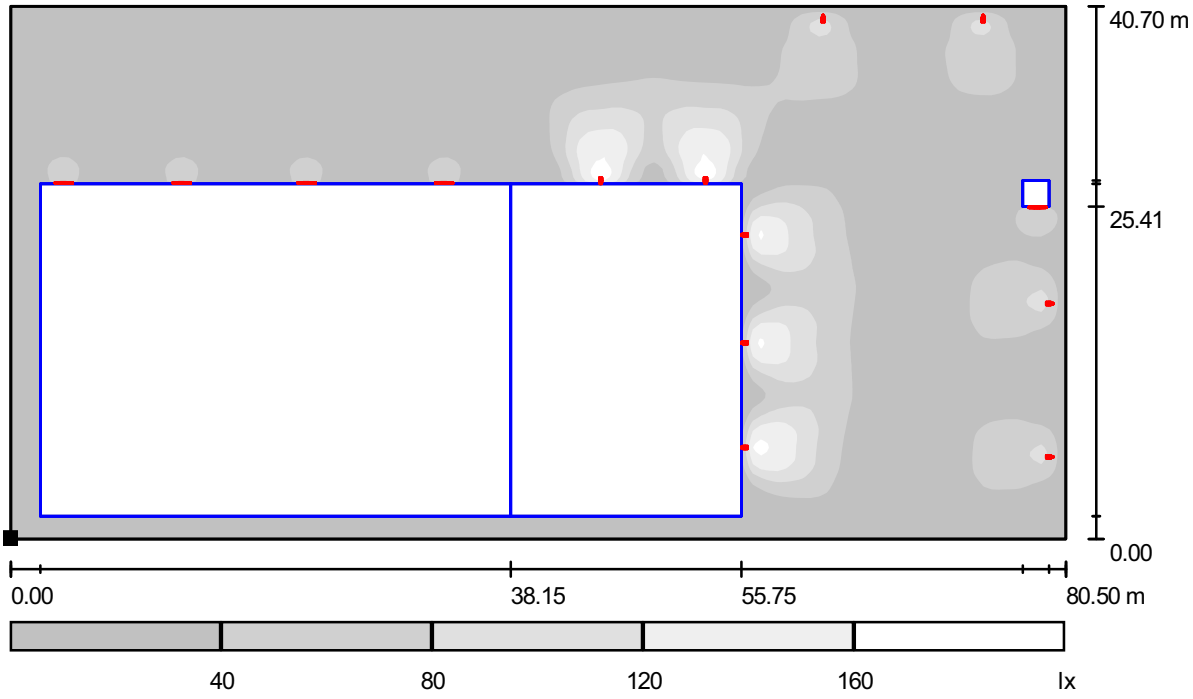
## Airportlink / Workplane / Greyscale (E)




Scale 1 : 576

Position of surface in room:
Marked point:
(0.000 m, 0.000 m, 0.000 m)

Grid: 128 x 128 Points

| $E_{av}$ [lx] | $E_{min}$ [lx] | $E_{max}$ [lx] | u0 | $E_{min}$ / $E_{max}$ |
|---|---|---|---|---|
| 26 | 0.00 | 187 | 0.000 | 0.000 |

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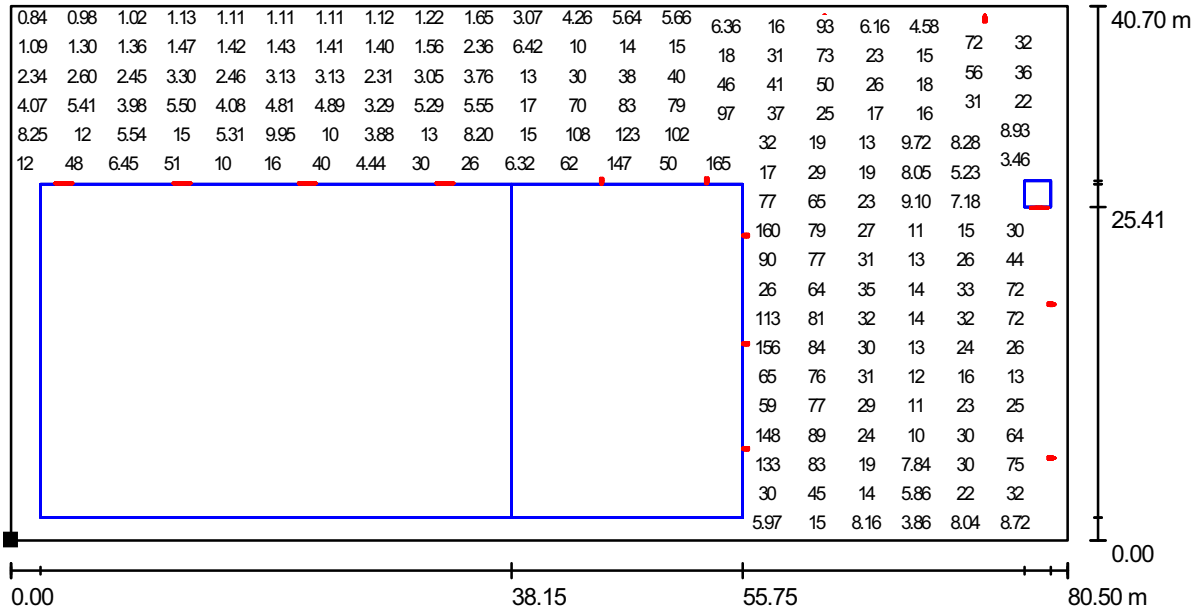
## Airportlink / Workplane / Value Chart (E)




Values in Lux, Scale 1 : 576

Not all calculated values could be displayed.

Position of surface in room:
Marked point:
(0.000 m, 0.000 m, 0.000 m)

Grid: 128 x 128 Points

| $E_{av}$ [lx] | $E_{min}$ [lx] | $E_{max}$ [lx] | u0 | $E_{min}$ / $E_{max}$ |
|---|---|---|---|---|
| 26 | 0.00 | 187 | 0.000 | 0.000 |

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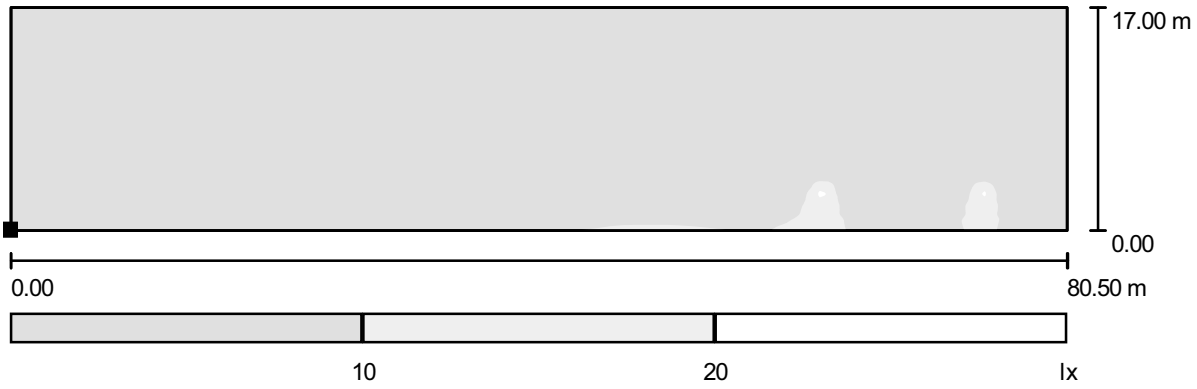
## Airportlink / Wall 3 / Greyscale (E)

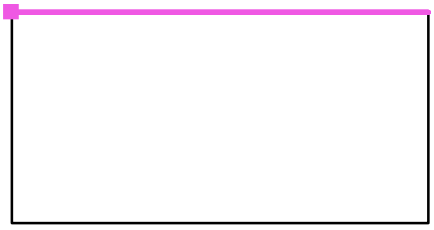






Scale 1 : 576

Position of surface in room:
Marked point:
(0.000 m, 40.700 m, 0.000 m)



Grid: 128 x 128 Points

| $E_{av}$ [lx] | $E_{min}$ [lx] | $E_{max}$ [lx] | u0 | $E_{min}$ / $E_{max}$ |
|---|---|---|---|---|
| 3.36 | 1.17 | 26 | 0.347 | 0.044 |

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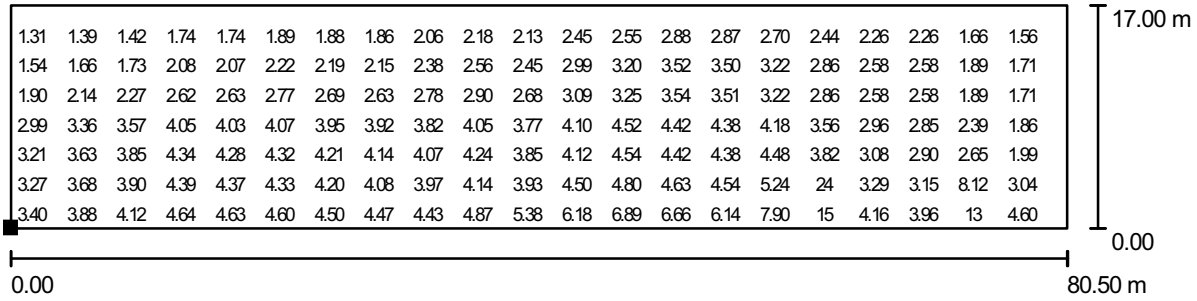
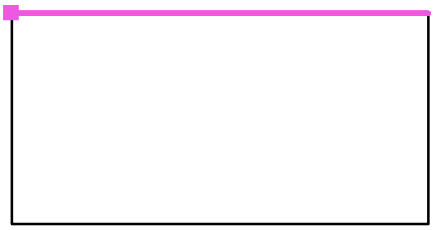
## Airportlink / Wall 3 / Value Chart (E)




Values in Lux, Scale 1 : 576

Not all calculated values could be displayed.

Position of surface in room:
Marked point:
(0.000 m, 40.700 m, 0.000 m)



Grid: 128 x 128 Points

| $E_{av}$ [lx] | $E_{min}$ [lx] | $E_{max}$ [lx] | u0 | $E_{min}$ / $E_{max}$ |
|---|---|---|---|---|
| 3.36 | 1.17 | 26 | 0.347 | 0.044 |

# Appendix A.6 – Groundwater Monitoring Summary

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**Table 2 - Kent Rd, Rose St Groundwater Monitoring Results Summary**
**Airport Link - Thiess John Holland**

| | | | Physical Parameters | | | | | | | BTEX ug/L | | | | | | Petroleum Hydrocarbons (TPH) | | | | | PAH | | | Metals | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Identification | Lab Batch Number | Sampling Date | Depth to Water (mbgl) | Height of Well (mAHD) | Height of Water Column (mAHD) | pH - Field | Electrical Conductivity - Field | Dissolved Oxygen | Turbidity | Benzene | Toluene | Ethylbenzene | meta--&para--Xylene | ortho--Xylene | Total Xylene | C6 -- C9 Fraction | C10 -- C14 Fraction | C15 -- C28 Fraction | C29 -- C36 Fraction | Sum TPH C10 -- C36 | Benzo(a) pyrene | Naphalene | Sum of reported PAHs | Arsenic | Cadmium | Chromium | Copper | Lead | Mercury | Nickel | Zinc |
| **Assessment Criteria A - ANZECC 2000 Freshwater 90%** | | | - | - | - | - | - | - | - | 1300 | NC | NC | NC | 470 | NC | NC | NC | NC | NC | 500 | NC | 37 | NC | 0.094 | 0.0004 | NC | 0.0018 | 0.0056 | 0.0019 | 0.013 | 0.015 |
| **Groundwater** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **LOR** | | | - | - | - | - | - | - | - | <1 | <2 | <2 | <2 | <2 | - | <20 | <50 | <100 | <50 | - | <1 | <1 | - | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.0001 | 0.001 | 0.005 |
| **Units** | | | m | | | pH | µS/cm | mg/l | NTU | µg/L | | | | | | µg/L | | | | | µg/L | | | mg/L | | | | | | | |
| TACL14 | EB0902198010 | 11.02.09 | 10.63 | 12.90 | 2.27 | 3.32 | 265 | 7.07 | - | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | **0.004** | **0.051** |

ND - Non Detect (Equal to or below LOR)
NC - No Criteria

# Appendix A.7 – Glossary

| Term | Description |
|---|---|
| **µg/m$^3$** | Micrograms per cubic metre |
| **AADT** | Average Annual Daily Traffic |
| **Acid Sulphate Soil** | The Queensland State Government defines Acid Sulphate Soil as:<br>*Soil or sediment containing highly acidic soil horizons or layers affected by the oxidation of iron sulphides (actual acid sulphate soils) and/or soil or sediment containing iron sulphides or other sulphidic material that has not been exposed to air and oxidised (potential acid sulphate soils).*<br>*Note: The term acid sulphate soil generally includes both actual and potential acid sulphate soils. Actual and potential acid sulphate soils are often found in the same soil profile, with actual acid sulphate soils generally overlying potential acid sulphate soil horizons.* |
| **Acoustic barrier** | A barrier designed to reduce the noise impacts of an activity on nearby sensitive areas. |
| **Adit** | Horizontal access passage |
| **AEP** | Area Environmental Plan |
| **AHD** | Australian Height Datum |
| **Ambient** | The background level at a specified location, being a composite of all sources. Examples include noise and pollution. |
| **Amenity** | A feature that increases attractiveness or value, especially of a piece of real estate or a geographic location. |
| **ASS** | Acid Sulphate Soils |
| **A-Weighting** | A response provided by an electronic circuit which modifies sound in such a way that the resulting level is similar to that perceived by the human ear. |
| **BC** | BrisConnections |
| **BCC** | Brisbane City Council |
| **bcm** | Bank cubic meter |
| **BGL** | Below Ground Level |
| **dB (decibel)** | This is the scale on which sound pressure level is expressed. It is define as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure (0.00002N/m$^2$). |
| **dB(A)** | This is the measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. 'A' Weighting) to compensate for the varying sensitivity to the human ear to sound at different frequencies. |
| **CCMP** | Community Consultation Management Plan |
| **CLC** | Community Liaison Coordinator |
| **CLG** | Community Liaison Groups |
| **CLR** | Contaminated Land Register |
| **Coordinator-General** | The corporation sole constituted under the *State Development and Public Works Organisation Act 1938* and preserved, continued in existence and constituted under the *State Development and Public Works Organisation Act 1971.* |

| | |
|---|---|
| **CSM** | Cutter Soil Mix |
| **Cumulative Impacts** | The combined impact on the environment from successive effects of a number of different projects or activities. |
| **CU** | Community Use |
| **Cut and Cover** | A method of tunnelling. Construction is from ground surface down forming a trench. The trench is 'lidded' after construction. |
| **CV** | Commercial Vehicle |
| **CPTED** | Crime Prevention through Environmental Design |
| **D&C** | Design and Construction |
| **Dangerous Goods** | Goods defined under the Australian Dangerous Goods Code as either dangerous goods or too dangerous to be transported. |
| **DERM** | Department of Environment and Resource Management (formerly Queensland Environmental Protection Agency - EPA) |
| **Drawdown** | A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by interference with groundwater. |
| **DES** | Queensland Department of Emergency Services |
| **EIS** | Environmental Impact Statement |
| **EMP** | Environmental Management Plan |
| **EMR** | Environmental Management Register |
| **EPA** | Environmental Protection Agency |
| **EPB** | Earth Pressure Balance |
| **EPBC Act** | Environment Protection and Biodiversity Conservation Act |
| **EPP** | Environmental Protection Policy |
| **ER** | Evaluation Report |
| **Hertz (Hz)** | A measure of the frequency of sound. It measures the number of pressure peaks per second passing a point when a pure tone is present. |
| **Heavy Vehicle** | A truck, transport or other vehicle with a gross vehicle weight above a specified level (for example, over 8 tonnes). |
| **kg/m$^2$** | Kilograms per square metre |
| **kph** | Kilometres per hour |
| **KR&C** | Kedron Ramps and Caverns |
| **$L_{Aeq}$** | This is the equivalent steady sound level dB(A) containing the same acoustic energy as the actual fluctuating sound level over a given period. For a steady sound with small fluctuations, its value is close to the average sound pressure level. |
| **$L_{A10}$** | Noise level exceeded for 10% of the measurement period. This represents the upper intrusive noise level, in particular traffic noise levels. |
| **$L_{AMAX}$** | The maximum instantaneous noise level during a measured period. |
| **Lux** | Unit of illuminance and luminous emittance. |
| **m$^3$** | Cubic metres |
| **mg/m$^2$** | Milligrams per square metre |
| **mg/m$^3$** | Milligrams per cubic metre |
| **mm/sec** | Millimetres per second |

| | |
|---|---|
| **NALL** | Natural Assets Local Law |
| **NEPM** | National Environmental Protection Measure |
| **NIAPSP** | Noise Impact Assessment Planning Scheme Policy |
| **$NO_2$** | Nitrogen Dioxide |
| **NOx** | Nitrogen oxides or oxides of nitrogen |
| **QTMR** | Queensland Department of Transport and Main Roads |
| **PCF** | Penetrative Cone Fracture |
| **$PM_{2.5}$** | Particulate matter with equivalent aerodynamic diameter less than 2.5 µm |
| **$PM_{10}$** | Particulate matter with equivalent aerodynamic diameter less than 10 µm |
| **Roadheader** | Type of tunnelling machine |
| **Rw** | Weighted Sound Reduction Index |
| **SDPWO Act** | State Development and Public Works Organisation Act, 1971 |
| **SEP** | Site Environmental Plan |
| **Spoil** | Soil or rock removed from the construction works |
| **Stakeholders** | Groups, companies or individuals who may be potentially affected, or have a particular interest in a proposal. Stakeholders may include local residents, government agencies, Aboriginal groups/ Land Councils/ Council of Elders, local businesses, relevant business and industry groups, community groups, potential competitors, and politicians/ elected representatives. |
| **Steady-state Noise** | A noise having negligibly small fluctuations of sound pressure level within the period of observation. |
| **STREAMS** | STREAMS is a synchronised system developed by Queensland Transport and Main Roads for managing the operation of signalised intersections on selected routes in Brisbane's road network. |
| **SWMP** | Soil and Water management Plan |
| **t** | Ton |
| **TBM** | Tunnel Boring Machine |
| **TJH** | Thiess John Holland Joint Venture |
| **TOC** | Total Organic Compounds |
| **TSP** | Total Suspended Particulates – the concentration of filterable particulates in water (retained no a 0.45αm filter) and reported by volume (mg/L). |
| **vpd** | Vehicles Per Day |
| **WQO** | Water Quality Objective |