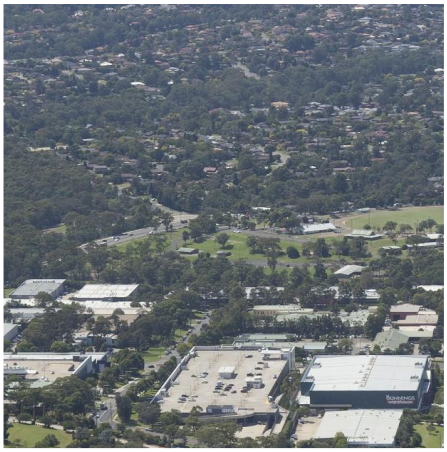
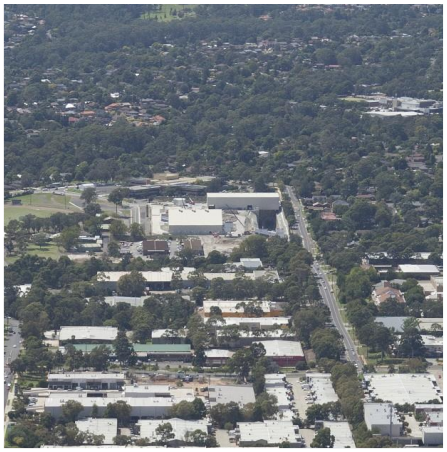
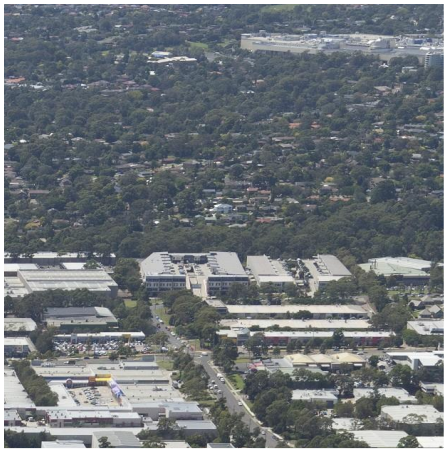

Transport for New South Wales

Norwest Station Subsurface Pedestrian Link and Northern Entry

Review of Environmental Factors

4 June 2015

PARSONS BRINCKERHOFF

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Abbreviations

ABS	Australian Bureau of Statistics
AHIP	Aboriginal heritage impact permit
AoS	Assessment of significance
AQMP	Air Quality Management Plan
AS	Australian standard
ASS	Acid sulphate soil
Breaking out	The method of clearing the top surface of an area, typically including the removal of hardstand and any other surface materials such as pavements, kerbs etc.
Canopy	The name given to the surface structure that would cover the circulation area and act as an entrance to the northern entry
Canopy tubes	A process where several holes are drilled around the perimeter of the excavation after which steel tubes are inserted into the ground to provide additional stabilisation
CCTV	Closed circuit television
CD	Candela
CEMP	Construction environmental management plan
CHAR	Cultural heritage application report
Circulation area	The name adopted in the proposal to describe where pedestrians would enter the pedestrian link via the lift or escalator
CMP	Contamination Management Plan
CNS	Construction Noise Strategy
CO_2-e	Carbon Dioxide Equivalent
CPTED	Crime prevention through environmental design
CTMP	Construction traffic management plan
DCCEE	Commonwealth Department of Climate Change and Energy Efficiency
DCP	*Development Control Plan*
DDA	Commonwealth *Disability Discrimination Act 1992*
DECCNSW	NSW Department of Environment and Climate Change now the Office of Environment and Heritage
DECNSW	NSW Department of Environment and Conservation now the Office of Environment and Heritage
DEFRA	UK Department of Environment Food and Rural Affairs
DMP	Dewatering Management Plan

DUAPNSW	NSW Department of Urban Affairs and Planning now the Department of Planning and Environment
EIS	Environmental impact statement
ENM	Excavated natural materials
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPIs	Environmental planning instruments
EPL	Environmental protection licences
ESD	Ecologically sustainable development
Eutrophic	A term given to a body of water rich in nutrients and so supporting a dense plant population, the decomposition of which kills animal life by depriving it of oxygen.
FM Act	*Fisheries Management Act 1994*
Formwork	The term given to either temporary or permanent moulds into which concrete or similar materials are poured
GMP	Groundwater monitoring plan
HCR	Heritage and conservation register
Heading and benching	A method for constructing tunnels where workers dig a smaller tunnel known as a heading. Once the top heading has advanced some distance into the rock, workers begin excavating immediately below the floor of the top heading; this is a bench
HVAC	Heating Ventilation and Air Conditioning
IBM	International Business Machines
ICNG	*Interim Construction Noise Guidelines*
IHO	Interim heritage order
INP	*Industrial Noise Policy*
ISEPP	*State Environmental Planning Policy Infrastructure 2007*
km/h	Kilometre per hour
LEP	*Local Environmental Plan*
LGA	Local government area
Mined tunnelling	The method of horizontally drilling in one direction
NCAs	Noise catchment areas
NEPM	*National Environmental Protection Measure*
NES	Matter of national environmental significance
NGA	*National Greenhouse Accounts*

NML	Noise management level
Northern entry	The name given to the proposed second entry to Norwest Station to the north of Norwest Boulevard
NPW Act	*National Parks & Wildlife Act 1974*
NRT	Northwest Rapid Transit
NSW	New South Wales
NSW OEH	NSW Office of Environment and Heritage
NWGC	North West Growth Centre
NWRL	North West Rail Link
OEH	Office of Environment and Heritage
OEMP	Operational Environmental Management Plan
Open cut	The drilling method used to construct the circulation area comprising working form the surface downwards
Overburden	The material (typically soil and vegetation) over bedrock
Pdfs	Portable document files
PEMP	Project environmental management plan
POEO Act	NSW *Protection of the Environment Operations Act 1997*
RAP	Remediation Action Plan
RBLs	Rating background noise levels
REF	Review of environmental factors
RNP	*Road Noise Policy*
ROL	Road occupancy licence
SEPP	State Environmental Planning Policy
SEPP	State Environmental Planning Policy
Shoring	A process of supporting an excavation to prevent it collapsing in on itself
Shotcrete	A form of concrete applied via a hose and projected at high velocity onto a surface
SHR	State heritage register
SIS	Species impact statement
Sound power level	A measure of sound energy per time unit. It is the power of the sound force on a surface of the medium of propagation of the sound wave. It is used to describe the maximum amount of noise that could theoretically be produced from noise-generating equipment
SSI	Separate state significant infrastructure
Station box	The name given to Norwest Station construction belowground
SWMP	Soil and Water Management Plan
TAGG	Transport Authorities Greenhouse Group

TfNSW	Transport for New South Wales
TI	Threshold increment
TMC	Roads and Maritime Traffic Management Centre
TPH	Total petroleum hydrocarbons
TSC Act	*Threatened Species Conservation Act 1995*
Vertical transportation	The collective name for the escalators and lifts in the circulation area
Visual catchment	The theoretical limit over which the construction site or proposal would be visible within the landscape
WRAPP	*Waste Reduction and Purchasing Policy*

Executive summary

The proposal

Transport for New South Wales (TfNSW), in conjunction with the Northwest Rapid Transit (NRT) consortium, is developing the eight stations that will form part of the Sydney Metro Northwest (formerly North West Rail Link (NWRL)), one of which is Norwest Station, which is currently under construction.

This station will be underground and located at the intersection of Norwest Boulevard and Brookhollow Avenue near the Norwest Business Park. Pedestrians will be required to exit Norwest Station on the southern side of Norwest Boulevard and, if required, cross to the northern side via a new signalised pedestrian crossing at the intersection.

Since it was granted approval to construct Norwest Station, the NSW Government has published its anticipated projections for job and population growth across the metropolitan region (*A Plan for Growing Sydney* (NSW Department of Planning and Environment, 2014)). In the Norwest Precinct it is anticipated that there will be about 15,000 jobs created by 2031. Having reviewed these projections TfNSW has concluded that the approved access arrangements would be substantially enhanced by providing an additional underground pedestrian link and second station entry ('the proposal') located on the northern side of Norwest Boulevard. TfNSW believe the proposal would:

- Reduce pedestrian travel times.
- Improve amenity and safety for rail and non-rail customers.
- Improve interchange between rail and bus services.
- Support urban renewal and anticipated future job growth.

The proposal would occupy about 400 m^2 aboveground and about 850 m^2 belowground. Its main features would include:

- A canopy-covered northern entry.
- An 11.5 metre deep vertical entrance shaft fitted with escalators and an elevator.
- A pedestrian tunnel extending from Norwest Station under Norwest Boulevard.

If approved, the proposal would be become operational at the same time Norwest Station opens.

Proposal objectives

TfNSW identified the following objectives for the second entry to Norwest Station:

- Providing a pedestrian link for rail and non-rail customers.
- Providing a dedicated link to service the northern side of Norwest Boulevard.
- Providing a station entry directly to the busiest part of the Norwest Precinct.
- Reducing pedestrian journey times by avoiding the need to wait to cross the road.
- Supporting planned future land use changes and urban growth and renewal in the area.
- Ensuring the link and entry designs are consistent with Norwest Station.

Sub-objectives

In addition to the above objectives TfNSW also set the following environmental and social objectives:

- Contributing to the environmental and social sustainability of the area as it continues to expand and develop.
- Minimising environmental, stakeholder and community impacts.
- Ensuring there are no significant combined impacts from constructing the link and entry at the same time as Norwest Station.

Options considered

Three alternatives were identified to deliver a proposal that would best achieve the above objectives, including:

- A bridge over Norwest Boulevard.
- A pedestrian tunnel under Norwest Boulevard.
- Both a bridge and tunnel respectively over and under Norwest Boulevard.

Each option was analysed to asses which one would provide the best outcome. It was concluded that a below ground (subsurface) pedestrian link tunnel would provide the most favourable solution as:

- There would not be sufficient pedestrian demand to warrant building both a bridge and subsurface pedestrian link close to the Norwest Boulevard and Century Circuit intersection.
- A subsurface pedestrian link would:
  - Provide a more direct access from Norwest Station into the core of the precinct.
  - Be used by an estimated two thirds of people travelling between Norwest Station and the north side of Norwest Boulevard compared to the bridge, which would only be used by about half of the people.
  - Provide a convenient connection for the majority of rail and non-rail customers.
  - Reduce time it would take to interchange between rail and bus services as well as the time taken to access the main part of the Norwest Precinct.

Key features of the proposal

The underground pedestrian link and northern entry would comprise the following key components.

Table E.1 Key components of the proposal

Design components	Design features
Northern entry (surface and subsurface)	■ An 11.5 metre deep vertical entry to the access Norwest Station via the pedestrian link. ■ Serviced by two escalators and one elevator. ■ Covered by a five-metre high glazed and/or metal clad entrance canopy. ■ Footpath and planting improvements around the entrance. ■ Fixtures and fittings that would be consistent with the design adopted in Norwest Station including closed circuit television (CCTV).

Design components	Design features
Pedestrian link (subsurface)	■ A 40 metre long 5-metre wide pedestrian tunnel. ■ Fixtures and fittings that would be consistent with the design adopted in Norwest Station including CCTV. ■ A breakout panel (false wall) at the northern end of the tunnel to safeguard for potential future connection between the pedestrian link and the Norwest Marketown shopping centre as part of future (private) development proposals.

The proposal would be mainly serviced by simply extending the infrastructure that will be installed in Norwest Station. This would remove the need to install separate generator, power, waste and waste water infrastructure and equipment.

Construction

If approved, construction would likely start in mid-2016 and it would take about eight months to complete, due to the need to integrate the proposal into Norwest Station's construction program. Surface and subsurface construction equipment would be used to complete each work stage. The surface work would take place during the day, while the subsurface work would take place during the day and at night.

Statutory and planning framework

The proposal would be delivered under the self-determination provisions of Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) (NSW Government, 1979). The proposal does not require development consent of the Hills Shire Council or the NSW Department of Planning and Environment.

Prior to determining whether to proceed, TfNSW is required to 'examine and take into account to the fullest extent possible all matters affecting, or likely to affect, the environment by reason of that activity'. This review of environmental factors (REF) reports the outcome of this process.

Community and stakeholder consultation

To provide the public and other stakeholders with an opportunity to understand the proposal and submit feedback, TfNSW will display this REF for two weeks in June/July 2015 before approving it. These comments will be considered and responded to in a report. As the proposal progresses TfNSW would also:

- Provide clear, factual and timely information about planned construction and operational work and its likely environmental and social impact on the local community.
- Provide a mechanism for prompt issues resolution.
- Provide adequate opportunities for community members and other stakeholders to provide feedback.
- Provide a detailed communication and engagement plan that supports the REF program.
- Ensure coordinated communications with other relevant agencies and stakeholders including Roads and Maritime, Hills Shire Council, Endeavour, Telstra, Optus and Jemena.

Environmental impacts

This section describes the proposal's likely potential adverse and beneficial impacts. Further detail is provided in Chapter 6. Table E.2 summarises the key construction impacts and Table E.3 summarises the key operational impacts.

Table E.2 Key construction impacts

Environmental aspect	Anticipated impact
Soils, geology and water	Hydrocarbons are likely to occur in the underlying soil and groundwater as a result of their migration onsite from the adjacent service station. Construction workers may be exposed to these contaminants/pollutants during construction; however the exact health risks are hard to determine without undertaking further investigations. There would also be the need to remove soil and groundwater (dewater) during construction. While this may have a short-term impact on the groundwater table, the extent, rate and duration of any drawdown would be unlikely to affect groundwater flow, surface settlement or lead to subsistence. There would however be a need to collect and dispose of the removed water and spoil. Technical studies have confirmed that the water and soil quality is too poor to allow it to be discharged or reused. This would become a management issue due to the need to temporarily store water and spoil onsite and the need to dispose of it offsite, potentially as special waste.
Traffic and transport	The aim is to construct the proposal in a timely and efficient manner; however there would still be a range of potential traffic, transport and access impacts experienced during construction, including: ■ Access to the proposal worksite may be signal controlled, either part time or full time. This would result in short-term delays for general road traffic. ■ Very occasionally, there may be the need to close Century Circuit for short periods adjacent to the construction site to take delivery of the main pieces of equipment and infrastructure. ■ There would also be a requirement to close two sections of footpath for up to eight months: ▸ The footpath adjacent to the eastbound lane to the north of Norwest Boulevard between Century Circuit and close to the service station. ▸ The footpath adjacent to the southbound lane to the east of Century Circuit between Norwest Boulevard and the intersection with Inglewood Place/Century Circuit. ■ There would also be a requirement to restrict access to about 60 car parking space for up to eight months.
Noise and vibration	The aim is to construct the proposal at the same time as Norwest Station. This would result in the following likely noise and vibration impacts: ■ Construction noise from the proposal site would be sufficient in its own right to affect local receivers including the Hillsong Church and a child care centre. ■ Surface daytime construction activities would not likely result in a perceptible increase noise levels if the proposal and station where constructed at the same time. ■ Subsurface night time construction activities would result a perceptible increase in noise levels affecting local receivers if the proposal was either constructed on its own or at the same time as Norwest Station, noting however that there would be no potential to cause sleep disturbance. While the belowground works would generate groundborne noise and vibration the nearest receivers are located too far away to be affected.
Landscape character and visual impacts	The local landscape and visual amenity would be slightly affected during construction. The most notable impacts would occur during major deliveries, while the crane would be in use, and while the canopy was being installed. As a result, the church congregation and potentially those local residents and others that regularly pass through the area may be affected by these activities.

Environmental aspect	Anticipated impact
Land use and property	There would be the need to close-off the area around the former KFC for about eight months to construct the proposal. This would prevent the use of about 60 peripheral car park spaces. These spaces are only typically used during busy periods and for the majority of the time there is sufficient capacity in the surrounding car parks for the temporary restriction not to have a notable affect.
Air quality	There would be no notable air quality issues during construction other than the need to manage the earthworks to prevent the spread of dust.
Waste and resource management	The main waste generated during construction would comprise: ■ About 9,000 m^3 of rock, overburden, vegetation and spoil. ■ Offcuts, containers, packaging and construction materials. While poor waste management practices can potentially cause a number of related pollution and contamination impacts, the likelihood of such an impact occurring would be negligible due to the proposed adoption of effective management and pollution prevention control measures.
Cumulative effects	The lack of any notable approved major development locally means that there would be no anticipated cumulative impacts beyond the combined impacts of constructing Norwest Station at the same time as the proposal.

Table E.3 Key operational impacts

Design features	Design principle
Soils, geology and water	While the in-ground structure would potentially act as a barrier to groundwater movement its small scale and size would be unlikely to impact regional groundwater flow, chemistry or quality, or affect the overburden.
Traffic and transport	About two thirds of all rail customers would use the pedestrian link compared to crossing Norwest Boulevard at the surface. This would be supplemented by the link's use by other non-rail customers. This would benefit pedestrian journey times. It would also provide a safer alternative. With fewer people crossing the road at the surface it may be possible to increase the length of 'green' time for road vehicles to improve traffic flows. This may benefit road user journey travel times.
Noise and vibration	There is not anticipated to be any notable operational noise impacts from the proposal.
Landscape character and visual impacts	The new entry canopy would be visible from a number of locations. It would be subjective as to whether the structure's visual impact would be beneficial or adverse; however by ensuring the canopy is designed to be consistent with Norwest Station, this would positively reinforce the character of the area.
Socioeconomic	The proposal on its own would be unlikely to generate any economic stimulus. However by improving pedestrian access into the Business Park this would support and strengthen the objective of bringing rapid transit to Sydney's North West, the economic benefit of which has been demonstrated at a strategic level.
Land use and property	By providing improved pedestrian access this would benefit future development and growth in the area. The only net loss would be about 20 peripheral car parking spaces close to the former fast food restaurant. This would represent about one per cent of the total number of available parking spaces in the area. As the spaces are only used when the main car park is full their loss is considered negligible.
Air quality	The proposal would not trigger any change in traffic conditions once operational. As such, there would be no change in air quality under the proposal.
Waste and resource management	The greatest resource use during operation would be the electricity needed to service the equipment and systems, including the lighting, the elevator and the escalation.
Cumulative effects	The proposal would supplement the Sydney Metro Northwest and the Norwest Station precinct by improving pedestrian access to and from the heart of the Norwest Precinct.

Overall, the predicted benefits of the proposal largely focus on providing positive socioeconomic outcomes in terms of pedestrian amenity and safety and providing wider opportunities for economic investment and attraction to the Norwest Precinct. The majority of the adverse impacts would be experienced during construction and would be temporary in nature.

Safeguards and management measures have been identified to avoid, reduce, address, manage and minimise the proposal's predicted adverse impacts. TfNSW would commit to these if the proposal is approved. They are summarised in Chapter 7. Providing these are implemented, there is anticipated to be no significant residual impact resulting from either the proposal's construction or operation or any cumulative impacts.

Justification and conclusions

The proposal's justification balances the long-term benefits against the temporary environmental and social impacts that would occur during construction and the effects if the proposal was not implemented.

The proposal would supplement the Sydney Metro Northwest and the Norwest Station precinct by improving pedestrian access to and from the heart of the Norwest Precinct. It is anticipated that the pedestrian link and northern entry would be used by about two thirds of rail customers. It would introduce an alternative solution than having pedestrians cross at the surface and it would provide better pedestrian amenity during wet weather. It would also provide a better-integrated transport solution than the current approved scheme as it provides a more direct interchange between rail and bus services. By not progressing with the pedestrian link the above benefits would not be realised.

As noted above, the construction work would generate noise, a small amount of construction traffic, a short-term visual impact and it would prevent the use of a number of overspill car park spaces. This would have a short-term temporary effect on the area's amenity and affect the local community.

The only permanent negative outcome would be would be the loss of about 20 car parking spaces and the canopy's visual impact.

In summary, the proposal is expected to achieve its objectives despite the identified impacts. As the identified impacts can be effectively safeguarded and managed, they are not likely to be significant and therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought for the proposal from the Minister for Planning and Environment under part 5.1 of the EP&A Act. The proposal is also unlikely to affect threatened species, populations or ecological communities or their habitats, within the meaning of the *Threatened Species Conservation Act 1995* (TSC Act) (NSW Government, 1995) or *Fisheries Management Act 1994* (FM Act) (NSW Government, 1994) and therefore a Species Impact Statement is not required. The proposal is also unlikely to affect Commonwealth land or have an impact on any matters of national environmental significance.

Display of the review of environmental factors

This review of environmental factors (REF) is on display for comment between for two weeks in June/July 2015. You can access the documents in the following ways:

Internet: The documents will be available as portable document files (pdfs) on the TfNSW website at northwestrail.com.au and feedback can be provided either via a link on the website, via a 24-hour community information line: 1800 019 989 or via an enquiry email address: info@northwestrail.com.au.

Display: The review documents can be viewed at the following locations:

- The Sydney Metro Northwest website: northwestrail.com.au.
- The Sydney Metro Northwest Community Information Centre, Shop 490, Castle Towers Shopping Centre (entry off Old Castle Hill Road) (Monday to Friday 9.00 am to 5.00 pm).
- The Hills Shire Council offices, 3 Columbia Court, Baulkham Hills (Monday to Friday 8.30 am to 4.30 pm).
- The Hills Library – Baulkham Hills Branch, Railway Street, Baulkham Hills (Monday 10.00 am to 8.00 pm, Tuesday to Friday 10.00 am to 5.20 pm, Saturday 10.00 am to 1.00 pm).
- TfNSW Information Centre, Ground Floor, 388 George Street (corner of King and George Streets) Sydney (Monday to Friday 9.00 am to 5.00 pm).

Compact discs: will be available free of charge at each display location.

How can I make a submission?

To make a submission on the proposal, please send your written comments to:

Sydney Metro Northwest – Norwest REF
PO Box 588
North Ryde BC NSW 1670

or

info@northwestrail.com.au

What happens next?

Following the submissions period TfNSW will collate submissions. Acknowledgement letters will be sent to each respondent. The details of submission authors will be retained and authors will be subsequently advised when project information is released. After considering community and stakeholder feedback TfNSW will determine whether the proposal should proceed as proposed, or whether any alterations to the proposal are necessary. The community will be kept informed about this. If the proposal goes ahead, TfNSW proceeds with final design and tenders will be called for construction.

1. Introduction

This Chapter introduces Transport for New South Wales' (TfNSW's) proposal and describes the purpose of this document.

1.1 Proposal identification

TfNSW, in conjunction with the Northwest Rapid Transport (NRT) consortium, are developing the eight stations that will form part of the Sydney Metro Northwest (formerly the North West Rail Link (NWRL)); itself an approved 23 kilometre twin-track passenger railway connecting Epping to Rouse Hill.

In November 2006, TfNSW submitted a staged development application to the State Government to approve the project's concept design. This application was determined and approved in May 2008. Subsequent to this, TfNSW prepared two separate state significant infrastructure (SSI) applications for the project, one to service the major civil construction work (environmental impact statement (EIS) (EIS 1)) (submitted in March 2012 and determined in September 2012) and the second to service Norwest Station's rail infrastructure and systems (EIS 2) (submitted in October 2012 and determined in May 2013). This was followed by a third development application to support the development of a rapid transit rail stabling and maintenance facility at Tallawong Road, Rouse Hill (submitted in July 2013 and determined in January 2014).

EIS 2 consented to the construction of eight new stations in support of the project. This included Norwest Station, which is currently under construction.

Norwest Station will be underground and located at the intersection of Norwest Boulevard and Brookhollow Avenue. It will service the Norwest Precinct. Norwest Station will comprise a street-edge pavilion that will be integrated into the scale and built form of the surrounding precinct development. Access to Norwest Station will be via this pavilion. It will require people wishing to access the main active part of the precinct to use a new signalised pedestrian crossing.

Since been granted approval to construct Norwest Station, the NSW Government has published its anticipated projections for job and population growth across the metropolitan region (*A Plan for Growing Sydney* (Department of Planning and Environment, 2014)). In the Norwest Precinct it is anticipated that there will be about 15,000 jobs created by 2031. Having reviewed these projections TfNSW has concluded that the approved access arrangements would substantially benefit from providing an additional underground pedestrian link and second station entry ('the proposal') located on the northern side of Norwest Boulevard.

1.1.1 Key features

The proposal is described in Chapter 3 and the concept design is shown on Figure 3.1. It would occupy about 400 m^2 aboveground and about 850 m^2 belowground. Its main features would include:

- A canopy-covered northern entry.
- An 11.5 metre deep vertical entrance shaft fitted with escalators and an elevator.
- A pedestrian tunnel extending from Norwest Station under Norwest Boulevard.

1.1.2 Regional and local context

Norwest Station will be located in an area that has experienced growth and produced significant employment and residential development opportunities (NSW Government, 2010)[1]. Norwest Station has been positioned to improve access to the core of the Norwest Precinct and it is recognised as having the 'potential to be a catalyst for future growth in the area' (TfNSW, 2013a)[2].

Norwest is a major employment area, characterised by large commercial development within a modern landscape setting. Norwest Station will service the existing business centre and will 'introduce a strong pedestrian-orientated environment serving future employment and residential catchments' (TfNSW, 2013a).

Norwest is well-connected with direct access to the M7 Motorway and other major arterial and regional roads including Windsor Road and Old Windsor Road both of which run perpendicular to Norwest Boulevard. As an established road, Norwest Boulevard will provide a good existing connectivity to and from Norwest Station. For this reason, Norwest Station's design does not provide any additional park and ride opportunities, but is primarily focussed on enabling integrated transport provisions between bus, pedestrian, cycling and kiss-and-ride connectivity all of which will be serviced by Norwest Boulevard.

1.1.3 Proponent and delivery

The proposal would be designed and constructed by the NRT consortium under an approval granted by TfNSW. The proposal, if approved, would be constructed at the same time as the Norwest Station. At completion Norwest Station and proposal will be operated by NRT on behalf of TfNSW.

1.1.4 Purpose of the report

Parsons Brinckerhoff has prepared this REF for TfNSW.

The REF describes the proposal (refer to Chapter 3), documents its likely environmental and social impacts (refer to Chapter 6) and details the protective measures that would be implemented to safeguard and manage against any adverse effects (refer to Chapter 7). The REF has been prepared to meet the environmental assessment requirements of Part 5 of the EP&A Act (refer to Section 4.3.1).

The description of the proposal and associated environmental impacts have been undertaken in the context of Clause 228(2) of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) (NSW Government, 2000a), the *TSC Act*, the *FM Act* and the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Commonwealth Government, 1999).

In doing so, the REF helps fulfil the requirements of Section 111 of the *EP&A Act*; namely that TfNSW 'examines and takes into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the [proposed] activity'.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the need for an EIS to be prepared and approval to be sought from the Minister for Planning and Environment under Part 5.1 of the *EP&A Act*.

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1 *A Plan for Growing Sydney* (NSW Department of Planning and Environment, 2014)

2 *Norwest Station's Rail Infrastructure and Systems (EIS 2)* (TfNSW, 2013a)

- The significance of any impact on threatened species, populations and communities as defined by the NSW *TSC Act* and/or NSW *FM Act*, in accordance with Section 5A of the *EP&A Act* and therefore the requirement to prepare a species impact statement (SIS).
- The potential for the proposal to significantly impact a matter of national environmental significance (NES) or Commonwealth land and the need to make a referral to the Commonwealth Department of the Environment for a decision by its Minister on whether assessment and approval is required under the *EPBC Act* (refer to Section 4.4.1).

1.2 Document structure and content

1.2.1 Structure and content

Table 1.1 describes the structure and content of this REF.

Table 1.1 REF structure and content

Chapter	Content
1: Introduction	The proposal's background and context, the purpose of this report and the report's structure.
2: Need and options	The proposal's strategic need, its objectives and the options and alternatives considered in developing the preferred option.
3: Proposal description	The concept design, its construction, operation and maintenance, as well as the associated ancillary facilities and need for any property acquisition.
4: Statutory and planning considerations	The statutory and planning framework governing the proposal's construction and operation, confirmation of the statutory position and the need for additional approvals, permits and licences.
5: Consultation	The process, involvement and outcome of community and stakeholder engagement to date and the consultation that is proposed in the future.
6: Environmental assessment	A description of the existing environment of the proposal footprint and locality, a description of the proposal's likely construction and operational impacts and the safeguards and management measures needed to mitigate any adverse effects.
7: Environmental management	The environmental management protocol that would be applied to service the proposal's construction and operation and the specific mitigation commitments that would be adopted should the proposal be approved.
8: Conclusions	Justification for the proposal and its conformance with planning and assessment objectives and the four key ecologically sustainable development principles described in the NSW *Environmental Planning and Assessment Regulation 2000* (NSW Government, 2000a).

Two technical papers have been prepared to support the REF:

- *Technical paper 1: Traffic and Access* (Parsons Brinckerhoff, 2015)
- *Technical paper 2: Noise and Vibration* (WSP, 2015).

1.2.2 Common terms used in this report

The following terms have been used routinely throughout this report:

- The ‘proposal’ refers to the work described as the Norwest Station Subsurface Pedestrian Link and Northern Entry as described in Chapter 3 of this REF. It also represents the ‘activity’ for the purposes of Part 5 of the *EP&A Act*.
- The ‘proposal footprint’ refers to any land impacted by the work (refer to Figure 3.1).
- The ‘study area’ covers the extent of the existing environment described under each environmental aspect heading in Chapter 6. It varies between each aspect and represents the area that may be indirectly impacted by the proposal.
- The ‘locality’ refers to a broader area. For some environmental aspects, reference data were collected across a broader area to support describing the existing environment of the study area.

2. Need and options

This chapter describes why the proposal is needed. It also describes and analyses the options TfNSW has considered during the development of the proposal. Finally, it describes the preferred option (the proposal) taken forward for approval by TfNSW.

2.1 Strategic need

The need for the proposal was identified and confirmed after consent to build Norwest Station was granted in 2013 (refer to Chapter 1). Following the recent publication of anticipated job creation data for the Norwest Precinct, TfNSW concluded that the approved access arrangements would substantially benefit from providing an additional underground pedestrian link and second station entry ('the proposal') located on the northern side of Norwest Boulevard. TfNSW believe the proposal would:

- Reduce pedestrian travel times.
- Improve amenity and safety for rail and non-rail customers.
- Improve interchange between rail and bus services.
- Support urban renewal and anticipated future job growth.

2.1.1 Supporting strategies and plans

As well as its strategic need, the proposal would support various strategic planning and development objectives outlined in:

- *NSW 2021: A Plan to Make NSW Number One* (NSW Department of Premier and Cabinet, 2011a)
- *NSW State Infrastructure Strategy* (NSW Department of Premier and Cabinet, 2012)
- *NSW Long Term Transport Master Plan* (TfNSW, 2012d)
- *A Plan for Growing Sydney* (NSW Department of Planning and Environment, 2014)
- North West Rail Link Structure Plans (NSW Department of Planning and Environment, 2013)
- *Norwest Precinct Traffic Master Plan* (TfNSW, 2012c).

NSW 2021: A Plan to Make NSW Number One

The above plan is the NSW Government's 10-year strategic business plan. It sets priorities for action and guides resource allocation to deliver economic growth and critical infrastructure throughout the State.
It emphasises delivering an efficient and effective transport system to relieve congestion, improve safety and expand road corridor capacity. While a number of goals are outlined in the plan the proposal would help to achieve:

- Goal 9: improve customer experience with transport services
- Goal 10: improve safety
- Goal 19: invest in critical infrastructure
- Goal 20: build liveable centres.

The proposal to provide direct (pedestrian) access to the Norwest Precinct from the Sydney Metro Northwest would assist in achieving these goals by improving the customer experience. It would also improve safety by avoiding the need for people to cross a busy road while providing more access into a developing 'liveable centre'. It also represents investment in a wider project that has been classified as critical state significant infrastructure.

NSW Long Term Transport Master Plan

The NSW *Long Term Transport Master Plan* (TfNSW, 2012d) provides the framework for delivering an integrated, modern transport system across NSW over the next 20 years. It identifies transport actions and investment priorities over the short, medium and long-term that have emerged in response to six identified transport challenges:

- Integrating transport services
- Getting Sydney moving again
- Sustaining growth in Greater Sydney
- Providing essential access to regional NSW
- Supporting efficient and productive freight
- Statewide actions.

The Master Plan responds to these challenges through three relevant identified types of action:

- Integrating transport services
- Modernising the transport system
- Growing the transport network to meet future demand, including the important task of corridor preservation.

The plan also recognises that 'completion of the Sydney Metro Northwest, and the introduction of rapid transit trains, will provide comfortable, frequent and high-capacity service. It will provide an additional rail service for to up to 300,000 residents in the North West and a convenient access to destinations across the Global Economic Corridor' (refer to Draft Metropolitan Strategy for Sydney to 2031 below).

The proposal would supplement this by 'providing [a] convenient access' to one of the eight Sydney Metro Northwest stations. It also reinforces the purpose of the Sydney Metro Northwest in sustaining the 'growth of Greater Sydney' by providing a direct access to the most active part of the Norwest Precinct to support the 'future demand' placed on Norwest Station.

NSW State Infrastructure Strategy

The NSW *State Infrastructure Strategy* (NSW Department of Premier and Cabinet, 2012) identifies and prioritises the delivery of critical public infrastructure over a 20-year period ending in 2032. The strategy links into other State infrastructure plans such as *A Plan for Growing Sydney* (NSW Department of Planning and Environment, 2014) (refer to the corresponding heading in this section). The strategy seeks to promote projects that bring economic benefit while also considering the Government's capacity to fund new projects. Notably, the proposal forms part of a committed project that has been classified as state significant infrastructure and will be developed for public benefit. The proposal would also support the economic development of the area by providing improved access to a reliable, frequent and rapid train service, which is a core objective of the strategy.

A Plan for Growing Sydney

A *Plan for Growing Sydney* (NSW Department of Planning and Environment, 2014) sets out the framework and planning foundation for housing and job growth across a number of defined sub-regions. It importantly recognises the role of the Sydney Metro Northwest in achieving these objectives.

The proposal is located within the 'central sub-region' of the Sydney metropolitan area, which is recognised under the plan as comprising a number of major development centres, transport links, urban areas, environmental assets and key corridors (termed city shapers). Specifically, Norwest Station is located in the 'Global Economic Corridor'. The Global Economic Corridor extends from Port Botany and Sydney (Kingsford Smith) Airport through the city centre (classified as 'Global Sydney') and to the city's North West. The 'Sydney Metro Northwest Corridor' links into the 'Global Economic Corridor'.

The plan acknowledges the need to:

- Strengthen connections within Global Sydney, and in turn, connections to the Global Economic Corridor and the Sydney Metro Northwest Corridor.
- Strengthen transit through the Global Economic Corridor; particularly around the city centre in line with the Long Term Transport Master Plan (TfNSW, 2012d) (refer to the corresponding heading in this section).
- Realise Global Sydney as a focal point and primary destination for high volume, high frequency rail and bus feeders.
- Realise Global Sydney as a focal point in the motorway network with links to key gateways via the Global Economic Corridor.
- Recognise the well-connected, highly accessible and walkable environments that contribute to the vitality of the suburbs.
- Expand the space and capacity for job growth and improve connectivity within the Global Economic Corridor to boost productivity.

The plan's success is measured by its ability to meet a number of objectives. The objectives that are relevant to the proposal are:

- Objective 2: strengthen and grow Sydney's centres (including the Global Economic Corridor)
- Objective 3: make Sydney connected by allowing a proportion of people to get into the city centre within 30 minutes by public transport
- Objective 7: deliver well-designed centres that attract investment and growth
- Objective 24: plan and deliver transportation and land uses that are integrated and promote sustainable choices by investing in (public) transport and reducing car travel
- Objective 25: improve access to major employment hubs and global gateways by investing in transport network capacity in central Sydney and the Global Economic Corridor
- Objective 28: protect corridors and sites for long-term transport needs.

The proposal would contribute to the above objectives by supporting the growing demand for access along the Global Economic Corridor and the Sydney Metro Northwest Corridor. It would do this by forming part of a project that will improve public transport network connectivity and integration over the coming years.
It therefore strengthens the strategic importance of the Global Economic Corridor in supporting the 'most significant concentration of economic activity in Australia'.

The plan makes specific reference to the Norwest (Specialised) Precinct as being the 'largest employment centre' in north-west Sydney, recognising that in 2011 it had generated about 17,000 jobs. The plan goes on to state that by 2031 there would be an additional anticipated 15,000 jobs created in the precinct, bring the total to about 31,000. This growth echoes the plan's initiative described above of extending the Global Economic Corridor to specifically include the Norwest Precinct.

The proposal, in forming part of the Sydney Metro Northwest, was developed to specifically support and service the growth of the Norwest Precinct over the coming years. Moreover, each station's location was selected to service the locations of concentrated job growth, employment and urban development, thus the chosen location of the Norwest Station. In providing a direct access beneath Norwest Boulevard this will improve connectivity to the most active part of the Norwest Precinct thus reinforcing the intent of *A Plan for Growing Sydney*.

North West Rail Link structure plans

Structure plans have been developed for all the Sydney Metro Northwest stations. The plans identify the anticipated long-term capacity within each catchment. This has been used to provide direction on the planning and design, layout and configuration of each station precinct, including its ancillary facilities and services.

The structure plan for the Norwest Station reiterates the job-creation predictions of *A Plan for Growing Sydney* (NSW Department of Planning and Environment, 2014), with the identified long-term creation for up to 46,000 jobs in the combined Norwest-Bella Vista employment centres, with around 26,000 of these potential jobs created within one kilometre of Norwest Station. The plan also identifies a higher employment density in the 'core' around Norwest Station, supported by business park uses, and a ring of higher density housing surrounding the core.

Source: North West Rail Link structure plans

Photo 2.1 Extent of the Norwest Station Structure Plan

Growth in the precinct is constrained by continued high private vehicle use (due to low public transport provisions), traffic congestion (resulting from the high private vehicle use) and a lack of pedestrian permeability (i.e. the ease with which pedestrians can get to and from places). Norwest Station's catchment plan recognises that these issues will be addressed through future masterplanning, changes to planning controls within the precinct, and other programs aimed at changing people's travel habits at the heart of which is to provide better public transport services (thus the approved Sydney Metro Northwest).

The proposal is part of this planned program. It also aims to avoid the existing challenges of navigating the busy Norwest Boulevard while providing a good alternative to improve pedestrian access.

2.2 Existing and planned rail and public transport infrastructure

The existing and approved road and public transport infrastructure within the locality of the proposal is described below.

2.2.1 Existing and planned rail infrastructure

Sydney's North West is undergoing transformation led by the initiatives and aspirations of the North West Growth Centre (NWGC). Comprising 16 development precincts, the NWGC will ultimately contain some 70,000 new dwellings, housing about 200,000 residents. While the proposal is not located in the NWGC an important function of the Sydney Metro Northwest is to service this area in the future by providing rapid transit into and out of Sydney.

The proposal will principally service the Norwest Business Park, established in 1983 during Sydney's housing boom. The Business Park contains a number of corporate headquarters (Hillsong Church, Woolworths), regional offices (Reserve Bank of Australia, ResMed, Wyeth, Optus Data Centre), retail premises and health care facilities.

The area is well-served by the M7 Motorway, opened in late 2005, with an exit at the western end of Norwest Boulevard. This gave the business park greater exposure to Sydney's south and west via the M5 Motorway and the M2 Motorway.

In 2007, the North West T-Way opened. Running between Parramatta and Rouse Hill, the T-Way comprises a dedicated bus lane operating along Old Windsor Road. The T-Way also services the Norwest Business Park. To date, this forms the only dedicated public transport link from the Norwest Precinct to the rail network via Blacktown and Parramatta train stations. In the wider area there are a number of bus routes that service the Norwest Precinct and Baulkham Hills as discussed further in Chapter 6.

There is also a network of on-road and off-road cycle routes in the area. They include:

- Century Circuit from its intersection with Inglewood Place to Norwest Lake.
- Around the Norwest Lake linking into Strangers Lake to the north and Fairmont Avenue to the south.
- Brookhollow Avenue to Old Windsor Road.
- Old Windsor Road.

The Business Park is also serviced by a dedicated cycleway that runs along Old Windsor Road, while all the roads in the area are serviced by footpaths generally running on both sides of the road.

2.2.2 Other transport provisions and improvements

Approved Norwest Station configuration

As discussed in Section 1.1, the approved Norwest Station forms part of the Sydney Metro Northwest, which will provide a much-needed method of rapid transit to access Sydney's North West. Serviced by its own station, the Norwest Precinct forms a key service and access point for the Sydney Metro Northwest, representative of its function as part of the 'Global Economic Corridor'. The Norwest Station will be underground and located at the intersection of Norwest Boulevard and Brookhollow Avenue. Table 2.1 outlines the design specification for the approved station.

Table 2.1 Norwest Station description

Feature	Description
Customers	Employment and residential
Location	■ The Norwest Station will be located within the 'Norwest Business Park', a major employment centre located about 30.5 kilometres north-west of Sydney city centre. ■ Norwest Station will be located adjacent to Norwest Boulevard within The Hills Shire. ■ A large area of recent residential development lies to the south of Norwest Station.
Platform depth	About 21 metres below street level.
Concourse depth	About eight to 13 metres below street level.
Station entrances	Off Norwest Boulevard at the corner of Norwest Boulevard and Brookhollow Avenue.
Design features	■ Way-finding signage and transport information. ■ Station utilities/services facilities. ■ Public space/plaza areas adjacent to station entry points. ■ Retail space. ■ Local bus interchange, comprising four bus stands, located on both sides of Norwest Boulevard. ■ Nine taxi spaces and nine kiss-and-ride spaces located on Brookhollow Avenue. ■ Bicycle parking and a storage facility for 35 bicycles. ■ Station entrance at the intersection of Norwest Boulevard and Brookhollow Avenue with an at-grade access via new signalised pedestrian crossing. ■ Two service buildings located south east of Norwest Boulevard along the eastern site boundary. ■ Two service access points adjacent to the service buildings, accessed via Norwest Boulevard and Brookhollow Avenue. ■ Provision of two rail-facility service roads accessed off: ▸ Brookhollow Avenue ▸ Norwest Boulevard. ■ Removal of roundabout and the provision of new signalised intersection at Norwest Boulevard and Brookhollow Avenue. ■ Pedestrian and bicycle upgrades as needed along Norwest Boulevard and Brookhollow Avenue. ■ Future development site. ■ New bus stops on Norwest Boulevard adjacent to Norwest Station.

2.3 Proposal objectives

In identifying the need to consider a pedestrian link, TfNSW then realised the need to identify a number of proposal objectives while also considering the wider Sydney Metro Northwest objectives. The aim would be to find a reasonable and feasible solution that would best meet these objectives.

The NRWL objectives are:

- Ensure customer needs are met through the provision of a safe, high quality, integrated and affordable transport service.
- Link existing communities and new growth areas in North West Sydney with jobs and services in the Global Economic Corridor between Macquarie Park via Chatswood and the city centre onto Sydney (Kingsford Smith) Airport.
- Deliver a transport service that has been informed by engagement with communities and stakeholders and represents value for money.
- Improve transport network reliability by facilitating a shift from road to rail for trips to and from the North West, to reduce bus and road congestion and improve amenity in Sydney city centre.
- Contribute to environmental and social sustainability by improving liveability and minimising impacts on the environment, stakeholders and the community.
- Support the Government's challenge to accommodate population growth in the North West by increasing the potential for a range of housing and employment opportunities.

The proposal's specific objectives are to:

- Provide a pedestrian link for rail and non-rail customers.
- Provide a dedicated link to service the northern side of Norwest Boulevard.
- Provide a station entry directly to the busiest part of the Norwest Precinct.
- Reduce pedestrian journey times by avoiding the need to wait to cross the road. Support planned future land use changes and urban growth and renewal in the area.
- Ensure the link and entry designs are consistent with Norwest Station.

In addition to the above objectives TfNSW also set the following environmental and social sub-objectives:

- Contribute to the environmental and social sustainability of the area as it continues to expand and develop.
- Minimise environmental, stakeholder and community impacts.
- Ensure there are no significant combined impacts from constructing the link and entry at the same time as Norwest Station.

2.4 Alternatives and options considered

A number of alternatives and options were identified and considered in developing the proposal and selecting the preferred option. These are summarised in this section.

2.4.1 Overview of the alternatives and options assessment

The proposal was first identified in preparing the concept design for the approved station in 2012. However, it was only safeguarded as an outline provision should its need be demonstrated at a later stage (refer to Section 2.1).

2.4.2 Strategic alternatives

Two strategic alternatives were considered in reviewing the need for the proposal as described below.

Do nothing

The Norwest Station would be developed as approved. Access to and from the Norwest Precinct would be via a signalised pedestrian crossing at the intersection of Norwest Boulevard and Century Circuit and then via the one surface access into Norwest Station.

The rationale for selecting this option would be from an urban design perspective where it is generally considered preferable to manage pedestrians at street level wherever possible because:

- Pedestrians contribute to the vibrancy and vitality of centres.
- Street level networks usually offer a higher level of connectivity to destinations in all directions.
- Lower order streets (local, collector roads with two traffic lanes) can usually be crossed with minimal wait times and with traffic calming measures installed to improve pedestrian safety.
- The additional vertical travel required to traverse a non-street level crossing may negate the time savings of avoiding the need to wait for road crossings.

While the first two of the above points provide compelling reasons not to progress with the proposal, it was concluded that the 'do nothing' options would not achieve the proposal's objectives of providing better, quicker and more-efficient access into the busiest part of the Norwest Precinct consistent with the aims of better-servicing the area's core as described in the North West Rail Link Structure Plans. Also, by not delivering the proposal, a number of design guidelines that justify the need to construct a non-street level (grade-separated) crossing would not be addressed (as discussed below).

Do something

In accordance with the proposal's objectives, this alternative would include for a grade-separated pedestrian crossing and new northern access to link the Norwest Station more directly to the Norwest Precinct. This option was considered appropriate given that grade-separated crossings are considered relevant where:

- There is the need to cross a major arterial road in the vicinity of public transport infrastructure stops, in particular where pedestrian signal wait times are long, the road crossing involves multiple 'legs' or there are vulnerable users such as children, the aged or disabled.
- Local topography or the built form means that a grade-separated connection would offer a faster/more direct route that improves accessibility for those with reduced mobility.
- There is a need to cross roads with high speed limits (typically greater than 70 kilometres per hour (km/h)).
- There is a history or perceived risk of pedestrian/vehicle accidents.

It was concluded that the crossing of Norwest Boulevard outside the Norwest Station warranted consideration of potential grade separation pedestrian solutions because of the need for people to otherwise cross a major arterial road in a location with a notably changing topography. This rationale was reinforced by the anticipated increase in Norwest Station's use over time, the forecasted growth of traffic on Norwest Boulevard (with an aspiration for the road to be widened in the longer term), and the potential for improved connectivity to enhance mode shift to public transport as the centre grows. Furthermore, this option would create an opportunity to provide a dedicated link to service the active part of the Norwest Precinct while decreasing journey times.

2.4.3 Proposal options

Once TfNSW confirmed the need for the proposal (i.e. the 'do-something' alternative) the next stage focussed on developing options for a grade-separated link. In total, three proposed options were developed as described below.

Option A: Bridge (refer to Figure 2.1 at the end of this section)

This option would principally comprise the construction of a bridge over Norwest Boulevard. The features of this option include:

- A pedestrian bridge:
  - Over Norwest Boulevard to connect Norwest Station to the entrance of the Norwest Precinct.
  - 'Angled' from Norwest Station to the east of the service station to take advantage of the falling level of Norwest Boulevard.
- Retention of the approved signalised pedestrian crossing on Norwest Boulevard.
- Retention of the approved 'soft wall' connection in the Norwest Station box for a future subsurface tunnel.

Option B: Tunnel (refer to Figure 2.2 at the end of this section)

This option would comprise a subsurface tunnel linking Norwest Station's concourse to a new entry point on the northern side of Norwest Boulevard. The features of this option include:

- A subsurface tunnel about 11 metres below the ground:
  - Passing under Norwest Boulevard to link into a new northern entry.
  - Allowing potential future extension directly to Century Circuit outside the Norwest Marketown shopping centre as part of future (private) development proposals.
- Retention of the approved signalised pedestrian crossing on Norwest Boulevard.

Option C: Bridge and tunnel (refer to Figure 2.3 at the end of this section)

This option would simply combine Option A and Option B. Its aim would be to maximise the opportunities to transform travel behaviour in favour of active and passive public transport use.

2.5 Options assessment

Table 2.3 present the analysis of the three considered options including their advantages and disadvantages compared against the proposal objectives described in Section 2.3 and a number of more specific environmentally and socially focussed evaluation criteria as set out in Table 2.2.

Table 2.2 Evaluation criteria and definitions

Criteria	Definition
Promotes connectivity throughout the precinct	Provides a direct and integrated access between Norwest Station precinct and other forms of sustainable transport including, public transport, walking and cycling.
Enhancement of the public domain	Promotes and enhances the public domain in line with the master plan provisions for the Norwest Precinct.
Required surface land take (footprint)	Minimises the surface land take and avoids or resolves any land use conflict.

The preferred option was selected as it would best meet the proposal objectives and the above evaluation criteria. Consideration was also given to the economic value for money and benefit-to-cost return for each proposal.

Table 2.3 Options analysis

Criteria	Assessment
Option A: Bridge	
Proposal objectives	
Provide a pedestrian link for rail and non-rail customers	The bridge would not be within the paid (ticketed) part of Norwest Station, allowing non- rail customers to also be able to use the link to cross Norwest Boulevard more safely. There is the risk however that the bridge's orientation would be offline of the main pedestrian flows from Norwest Station and the business park, which may simply result in people reverting to using the signalised crossing. As such, it is estimated that only about half of all rail customers would use a pedestrian bridge.
Provides a dedicated link to the northern site of Norwest Boulevard and the busiest part of the Norwest Precinct	While this option would provide an access to the most active part of the Norwest Precinct it would not be as central or direct as constructing a tunnelled pedestrian link, as it does not provide a convenient connection to the commercial and community amenity located to the north of Norwest Boulevard.
Reduced pedestrian journey times	This option would require people to walk further to the eastbound bus stop on Norwest Boulevard compared to the approved design. Equally, as the bridge would be located off the main pedestrian flows from Norwest Station, people may continue to use the signalised surface pedestrian crossing.
Supports future land use changes, urban growth and renewal	While the bridge on its own would be unlikely to stimulate or generate job growth in the area it would offer an incentive to prospective investors by having an improved direct link from the precinct to the rail line.
Design integration	While the form and fabric of the bridge could replicate that of Norwest Station, this may not provide the best aesthetic to minimise the bridge's visual impact. Consequently, and more than likely, the bridge would be both architecturally and visually separate from Norwest Station.
Proposal sub-objectives	
Contribution to the area's sustainability	This option would allow the area to be developed in accordance with the master plan supporting multimodal traffic integration and the implementation of sustainable forms of public transport, including walking and cycling. However, as this option would require a section of Century Circuit to be closed to accommodate the bridge landing, supported by the construction of an offline arrangement, this option would not provide as good a transport integration solution as a pedestrian link (tunnel).

Criteria	Assessment
Environmental, stakeholder and social impact minimisation	The main impact of such an option would be its associated surface footprint, its visual impact and its effects on existing traffic flows (through the need to close a traffic lane on Century Circuit combined with the likely retained use of the signalised pedestrianised crossing). These impacts would be permanent and they may have a greater social reaction than the alternative of a tunnelled solution that would likely to be less visually prominent other than the surface entrance.
Avoidance of cumulative impacts	The main cumulative impact of this option would be the visual impact resulting from the overall increased mass and scale of the aboveground station infrastructure.
Evaluation criteria	
Promotes connectivity throughout the precinct	This option would connect to regional cycle routes and supports a potential future 'active transport spine' connecting Norwest Station to the land uses around the Norwest Lake.
Enhancement of the public domain	This option would provide an opportunity to enhance the public domain on Century Circuit between the bridge and the Norwest Marketown shopping centre.
Required surface land take (footprint)	This option would require the closure of the northbound lane to the east of Century Circuit to accommodate the bridge landing, with a consequential impact on local traffic access.
Summary	There are clear pedestrian benefits from this option in the longer-term as it would serve intra-precinct demand. It would also be the cheapest option to construct. However, it does not address all the proposal's objectives and evaluation criteria, and most notably, this option neither provides a direct access nor reduces travel times for rail customers.
Option B: Tunnel	
Proposal objectives	
Provide a pedestrian link for rail and non-rail customers	This option would likely have a high patronage given that about two thirds of the passengers using Norwest Station would need to cross Norwest Boulevard. It would also cater for non- rail customers. The tunnel is also more directly orientated on the alignment of the main pedestrian flows in the area and would therefore be used due to it directly servicing facilities like the Norwest Marketown shopping centre and the Hillsong Church.
Provides a dedicated link to the northern site of Norwest Boulevard and the busiest part of the Norwest Precinct	This option would provide a station entry to the most active part of the Norwest Precinct, adjacent to the Norwest Marketown shopping centre.
Reduced pedestrian journey times	The option would create a direct link that would allow people to leave and enter the train station quickly would therefore reduce travel times compared to the need to cross at the surface or over a bridge. It would also avoid the need to wait at a signalised crossing, which indirectly would be a safer design solution, while reducing bus-train interchange times.
Supports future land use changes, urban growth and renewal	The tunnel would deliver the same broad benefit as the bridge insofar as offering an incentive to prospective investors by having an improved direct link from the precinct to the rail line. However this would be supplemented by offering better links and interchange with bus services.
Design integration	This option would allow the themes of Norwest Station to be replicated throughout the tunnel. The northern entry can be design to integrate with neighbouring development.
Proposal sub-objectives	
Contribution to the area's sustainability	This option would provide a solution that would better capture sustainable transport interchange between pedestrians, bus and train customers, and cyclists.
Environmental, stakeholder and social impact minimisation	This option would result in additional environmental impacts during construction compared to the base case due to the larger footprint of works. During the operational phase it would provide improved social and environmental outcomes by improving access to and from Norwest Station and encouraging people to travel by public and active (walk/cycle) transport.

Criteria	Assessment
Avoidance of cumulative impacts	The pedestrian link would form an extension of the existing station. While there would be additive cumulative impacts from extending the extent and footprint of the underground station, they would be largely mitigated by simply extending agreed safeguards and management measures that are being implemented for Norwest Station (i.e. groundwater management and protection, vibration management and control).
Evaluation criteria	
Promotes connectivity throughout the precinct	This option would connect directly into the areas of the Norwest Precinct that are identified for future development. This option would allow the pedestrian link to be more easily extended in the future to provide a direct underground connection between the Norwest Marketown shopping centre and Norwest Station.
Enhancement of the public domain	This option would provide a station entry to the most 'active' part of the Norwest Precinct, adjacent to the Norwest Marketown shopping centre. This would provide opportunity to improve place-making outcomes.
Required surface land take (footprint)	The required surface footprint needed for the entrance and canopy to the pedestrian link would be larger than that needed for the bridge footings; however the overall mass and scale of the surface components of this option would be less than an overpass pedestrian bridge.
Summary	This option delivers customer benefits by providing a direct connection into the active heart of the Norwest Precinct, and in doing so; it would reduce travel times for more potential users compared to the base case design or the construction of a bridge. Also, as about two thirds of all rail customers would use the link, this would remove the pressure on the signalised crossing. Economically, this option would be more costly than constructing a bridge however by constructing the tunnel at the same time as Norwest Station the costs could be minimised.
Option C: Bridge and tunnel	
Proposal objectives	
Provide a pedestrian link for rail and non-rail customers	This option would be used by the majority of the all rail customers as well as other non- rail customers. It would also service rail customers and others making intra-precinct trips. At the minute however there is not the demonstrated patronage to warrant construction of both a bridge and tunnel (i.e. there is not the demonstrated business case, benefit-to-cost returns or value for money outcomes).
Provides a dedicated link to the northern site of Norwest Boulevard and the busiest part of the Norwest Precinct	This option would provide the greatest choice. As such, it is estimated that the majority of all rail customers would use either the bridge or tunnel. However, while the construction of a bridge would improve access into the precinct it would not improve 'direct access' into the precinct. This makes this option comparable to the construction of a pedestrian link tunnel in this regard.
Reduced pedestrian journey times	The tunnel is the only solution that would reduce journey times over the approved project. The inclusion of a bridge would not have a cumulative benefit. This makes this option comparable to the construction of a pedestrian link tunnel in this regard.
Supports future land use changes, urban growth and renewal	As a combination of the above two options, it would provide an attraction for investors on account that the pedestrian link would provide integrated access to bus and rail services while the bridge would provide a second access farther east. That said, it is concluded that investors would only need the incentive of either a pedestrian link or bridge as there is not projected to be the volume of jobs in the area to warrant the construction of both.
Design integration	As a combination of the above two options, the pedestrian link component would provide strong and clear architectural continuity while the bridge component may detract from this.
Proposal sub-objectives	
Contribution to the area's sustainability	This option fully supports the master plan vision for the transformation of the Norwest Precinct to a pedestrian-orientated mixed-use centre with an active main street (primary axis) and a pedestrian/cycle 'green spine' (secondary axis).

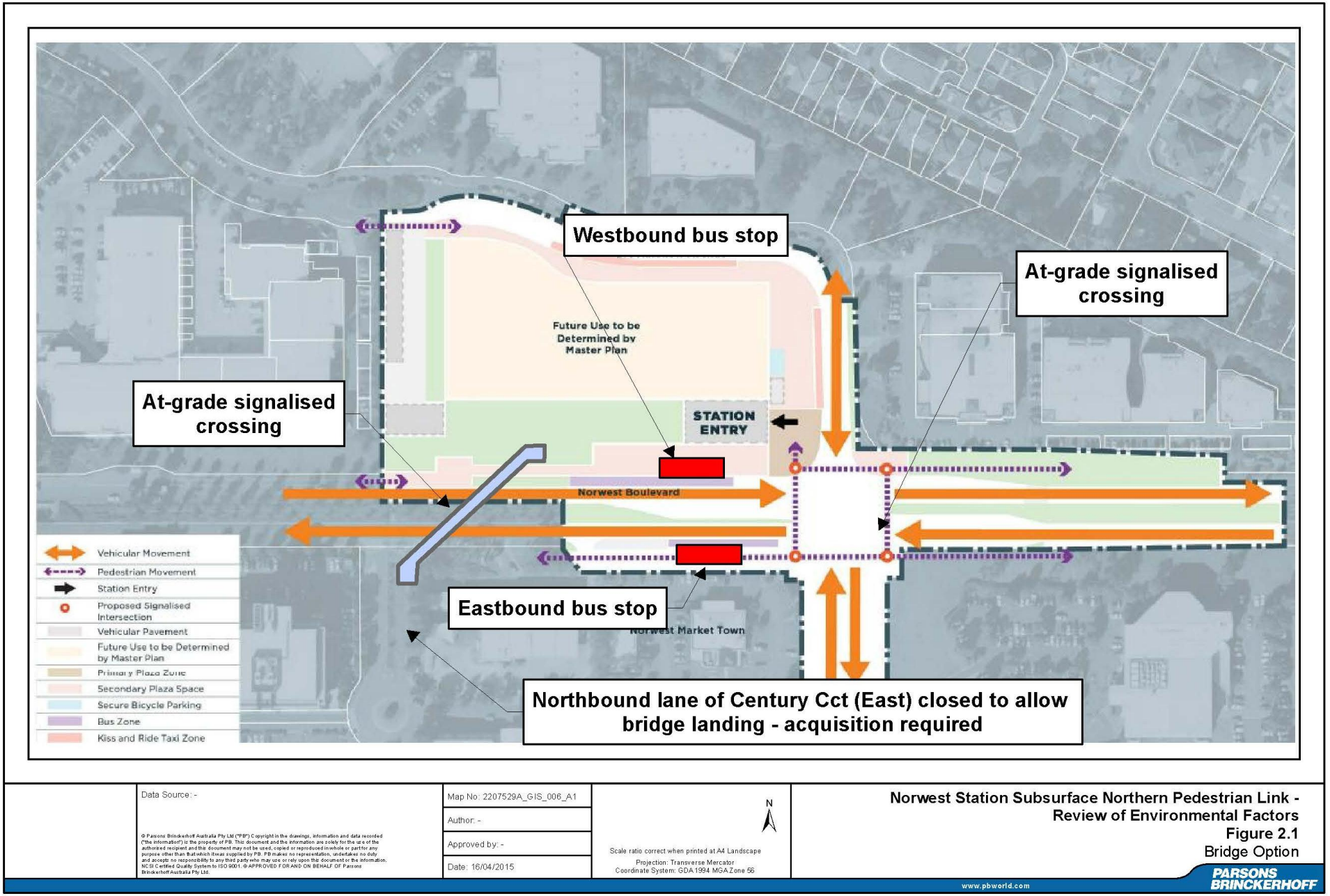
Criteria	Assessment
Environmental, stakeholder and social impact minimisation	This option would provide the same combined outcome as the other two options. Notably however, there would be more construction-related impacts due to the need to construct both a tunnel and a bridge. Operationally, it would provide the best social outcome in terms of flexibility and choice; however such a benefit would not be economical.
Avoidance of cumulative impacts	This option would have the greatest cumulative impact given the combined impacts of the tunnel, bridge and station.
Evaluation criteria	
Promotes connectivity throughout the precinct	This option provides multiple safe crossing options. This would maximise access opportunities across the entire northern catchment of the Norwest Precinct.
Enhancement of the public domain	This option would deliver the long-term vision of the master plan at the outset by providing two connections from Norwest Station to the north of Norwest Boulevard. It would therefore allow the public domain to be planned in a more coordinated manner compared to the alternative of constructing one link at this point in time and the second link at some point in the future.
Required surface land take (footprint)	This option would require the most land take. While this would be the case, the benefit would be avoiding any future land use conflict or the need to safeguard a footprint for development of the future option (refer to Section 2.6.1).
Summary	This option would offer the best provision of all three options. It would provide all the benefits of either of the above options, and in doing so, remove some of the dis-benefits. However, as there is not the demonstrated patronage or demand at this point to warrant constructing both elements this makes this option cost prohibitive as it would not deliver value for money due to it being the most expensive option. Also, it would be the most complex to construct, with the generation of more wide-scale cumulative construction impacts. It would also have the greatest cumulative visual impact once built due to the combined mass and scale of the aboveground structures.

2.6 Preferred option

By identifying, considering and assessing the various alternatives and options for the proposal, the preferred option was selected as being Option B (the tunnel). Overall, the proposed solution is considered most favourable in meeting the proposal's objectives and inherently addressing the evaluation criteria described in Table 2.2. Furthermore, this solution is considered feasible and suitable for construction and integration with the wider development of the Norwest Station for the following reasons:

- There is not the demonstrated patronage in the area to warrant the need to construct both a bridge and tunnel at this point in time, despite the fact that this solution would prevent nearly everyone from using the signalised pedestrianised crossing. As such, it would not deliver value for money, discounting Option C.
- A subsurface pedestrian link provides a better outcome than a bridge as it would provide a direct access into the heart of the Norwest Precinct. It would also take about two thirds of the pedestrian traffic away from the signalised pedestrian crossing. This diversion would only see about half of all rail customers using the bridge.
- A pedestrian link tunnel would reduce travel times between Norwest Station and the most active part of the Norwest Precinct.
- The main disadvantage of promoting pedestrian link tunnel is its cost compared to the construction of a bridge. However, costs would be greatly reduced by constructing the pedestrian link at the same time as Norwest Station instead of in the future.

On balance, despite the associated cost, the superior customer benefits of constructing a pedestrian link made it TfNSW's preferred option. A more detailed description of the preferred option is provided in the following Chapter.


Westbound bus stop
At-grade signalised crossing
Future Use to be Determined by Master Plan
At-grade signalised crossing
STATION ENTRY
Norwest Boulevard
Eastbound bus stop
Norwest Market Town
Northbound lane of Century Cct (East) closed to allow bridge landing - acquisition required
Vehicular Movement
Pedestrian Movement
Station Entry
Proposed Signalised Intersection
Vehicular Pavement
Future Use to be Determined by Master Plan
Primary Plaza Zone
Secondary Plaza Space
Secure Bicycle Parking
Bus Zone
Kiss and Ride Taxi Zone
Data Source: -
Map No: 2207529A_GIS_006_A1
Author: -
Approved by: -
Date: 16/04/2015
N
Scale ratio correct when printed at A4 Landscape
Projection: Transverse Mercator
Coordinate System: GDA 1994 MGA Zone 56
Norwest Station Subsurface Northern Pedestrian Link - Review of Environmental Factors
Figure 2.1
Bridge Option
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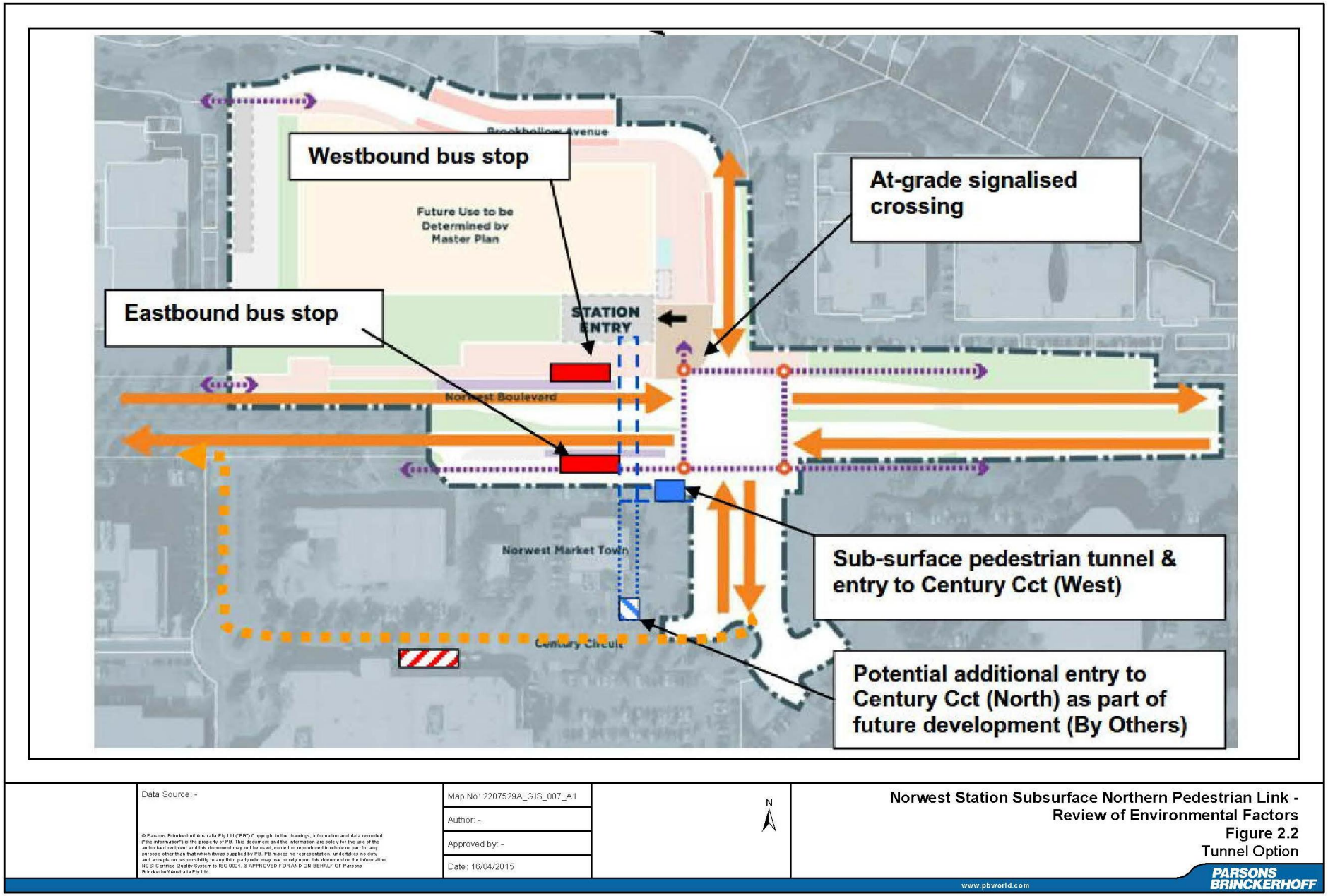
Westbound bus stop
At-grade signalised crossing
Future Use to be Determined by Master Plan
Eastbound bus stop
STATION ENTRY
Norwest Boulevard
Norwest Market Town
Century Circuit
Sub-surface pedestrian tunnel & entry to Century Cct (West)
Potential additional entry to Century Cct (North) as part of future development (By Others)
Data Source: -
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Map No: 2207529A_GIS_007_A1
Author: -
Approved by: -
Date: 16/04/2015
N
Norwest Station Subsurface Northern Pedestrian Link - Review of Environmental Factors
Figure 2.2
Tunnel Option
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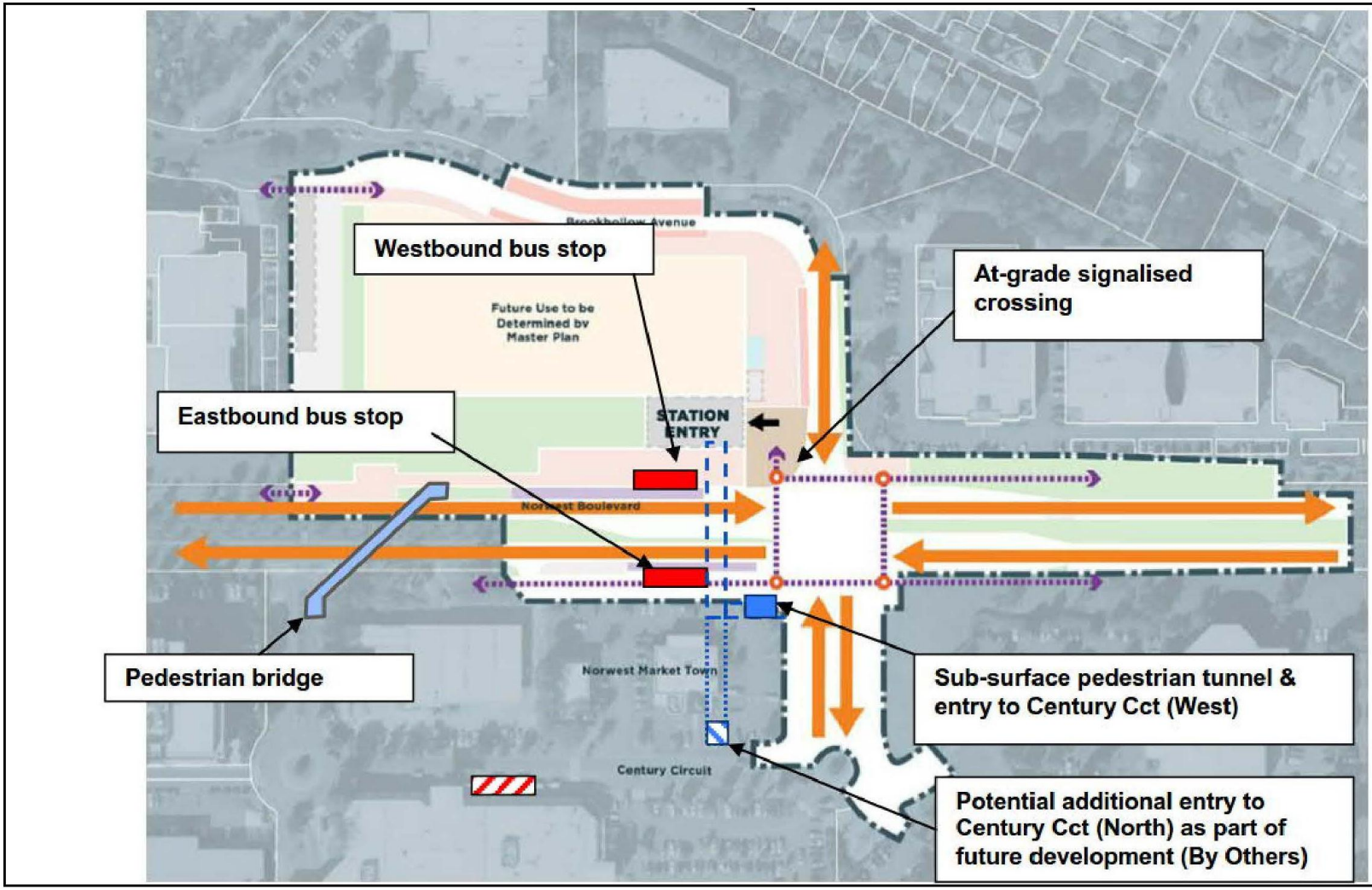
Westbound bus stop
At-grade signalised crossing
Future Use to be Determined by Master Plan
Eastbound bus stop
STATION ENTRY
Norwest Boulevard
Pedestrian bridge
Norwest Market Town
Sub-surface pedestrian tunnel & entry to Century Cct (West)
Century Circuit
Potential additional entry to Century Cct (North) as part of future development (By Others)
Data Source: -
Map No: 2207529A_GIS_008_A1
Author: -
Approved by: -
Date: 16/04/2015
N
Norwest Station Subsurface Northern Pedestrian Link - Review of Environmental Factors
Figure 2.3
Bridge and Tunnel Option
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3. Proposal description

The proposal is described in this chapter.

3.1 Proposal footprint

The proposal would include an aboveground (surface) component and a belowground (subsurface) component comprising:

- A surface entry portal covering a footprint of about 400 m^2.
- A 11.5 metre deep vertical entrance shaft covering a footprint of about 650 m^2.
- A 40 metres long subsurface pedestrian tunnel extending under Norwest Boulevard covering a footprint of about 200 m^2.

Figure 3.1a and Figure 3.1b show the proposal's footprint as divided into the surface and subsurface components. Figure 3.2a to Figure 3.2c show the proposal concept design.


Country Club
Bella Vista
CENTURY CIRCUIT
NORWEST BOULEVARD
BROOKHOLLOW AVENUE
Legend
Surface Footprint
Transport for NSW
Data Source: - Based on information provided by Transport NSW
Map No: 2207529A_GIS_001_A3
Author: - GoganovskiM
Approved by: -
Date: 4/05/2015
Scale ratio correct when printed at A4 Portrait
Projection: Transverse Mercator
Coordinate System: GDA 1994 MGA Zone 56
NRTH WEST RAIL LINK
Figure 3.1A
Surface Footprint
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Country Club
Bella Vista
CENTURY CIRCUIT
NORWEST BOULEVARD
BROOKHOLLOW AVENUE
Legend
Subsurface Footprint
Transport for NSW
Data Source: - Based on information provided by Transport NSW
Map No: 2207529A_GIS_002_A3
Author: - GoganovskiM
Approved by: -
Date: 4/05/2015
Scale ratio correct when printed at A4 Portrait
Projection: Transverse Mercator
Coordinate System: GDA 1994 MGA Zone 56
NRTH WEST RAIL LINK
Figure 3.1b
Subsurface Footprint
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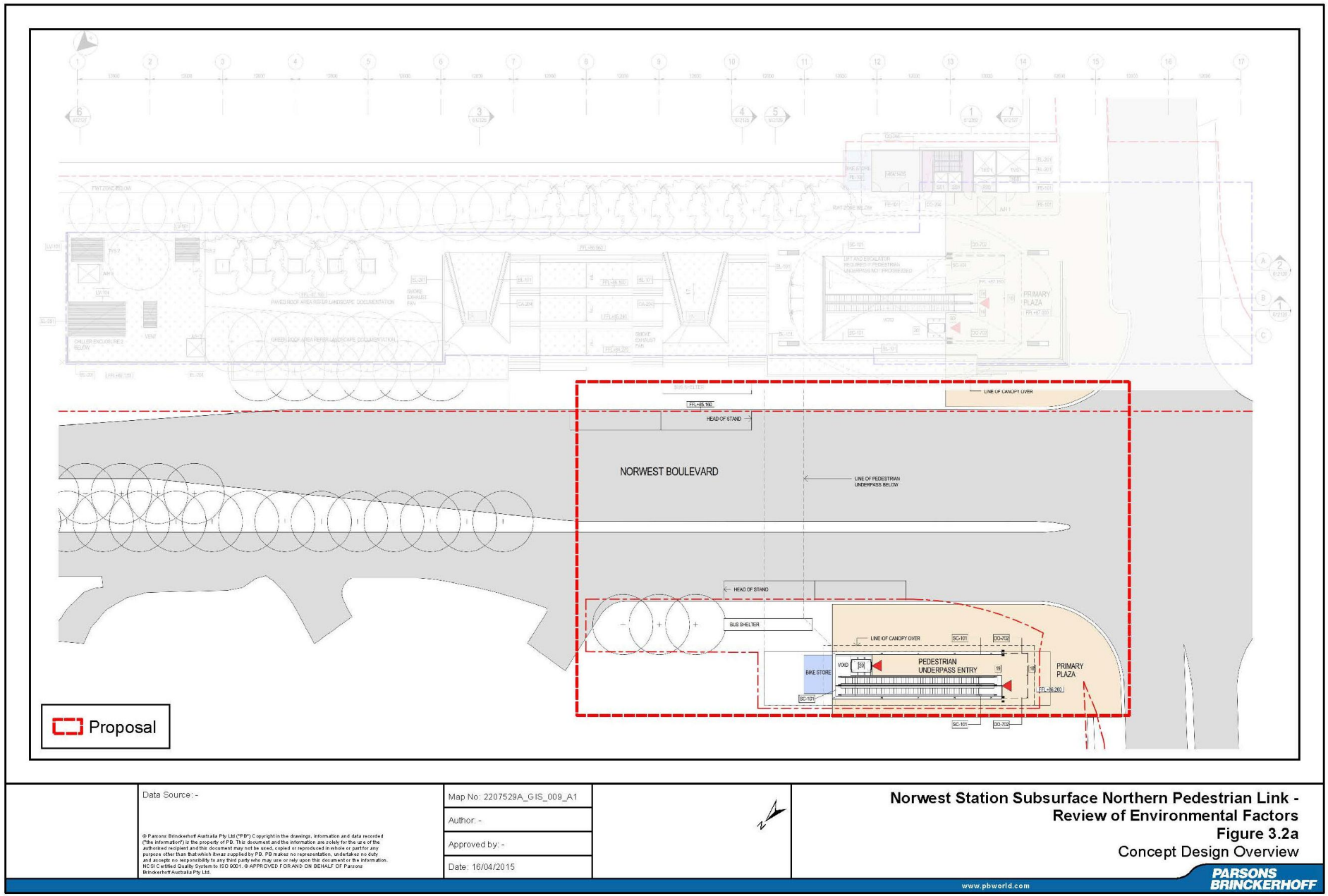

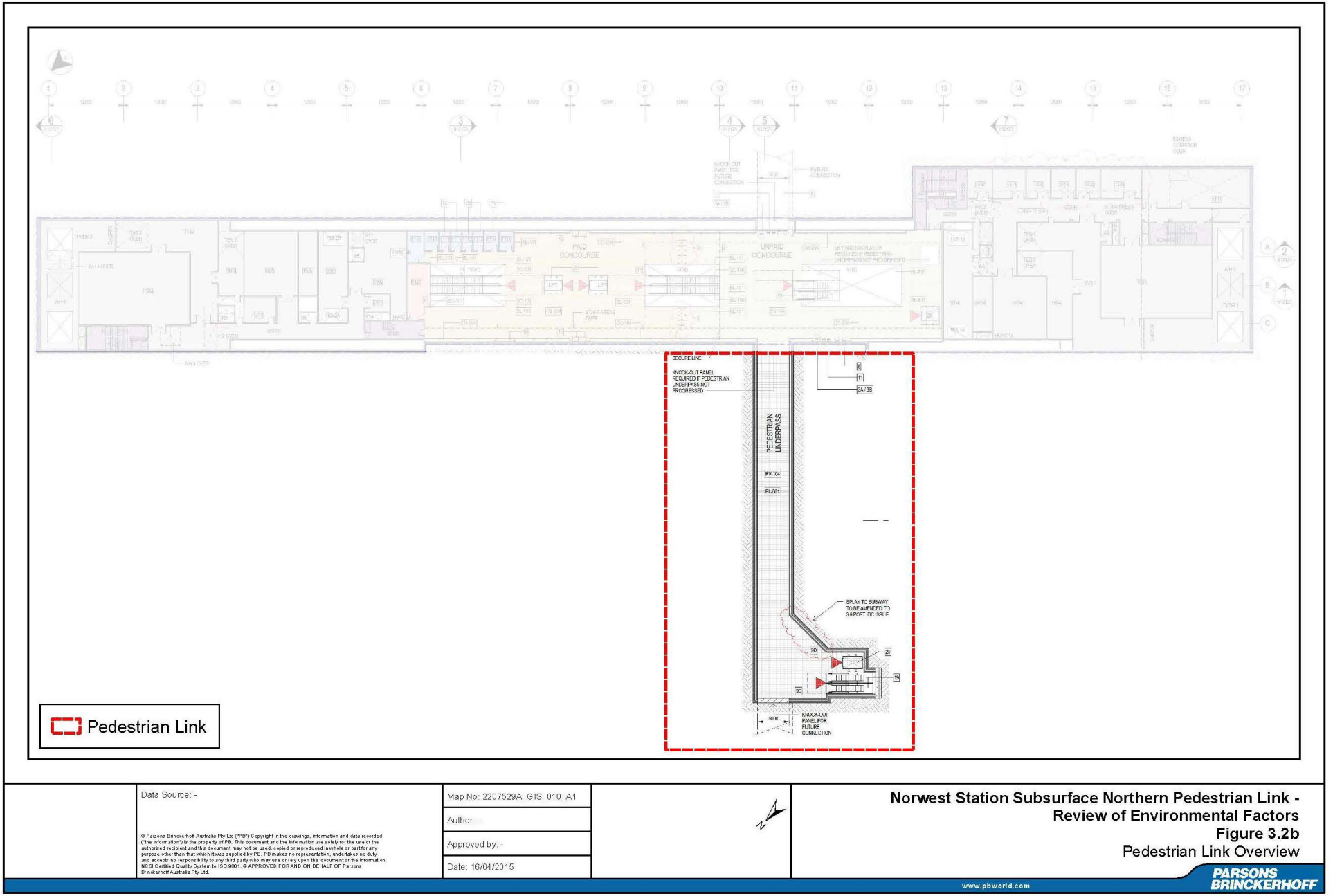

Data Source: -

Map No: 2207529A_GIS_010_A1

Author: -

Approved by: -

Date: 16/04/2015

Norwest Station Subsurface Northern Pedestrian Link - Review of Environmental Factors
Figure 3.2b
Pedestrian Link Overview

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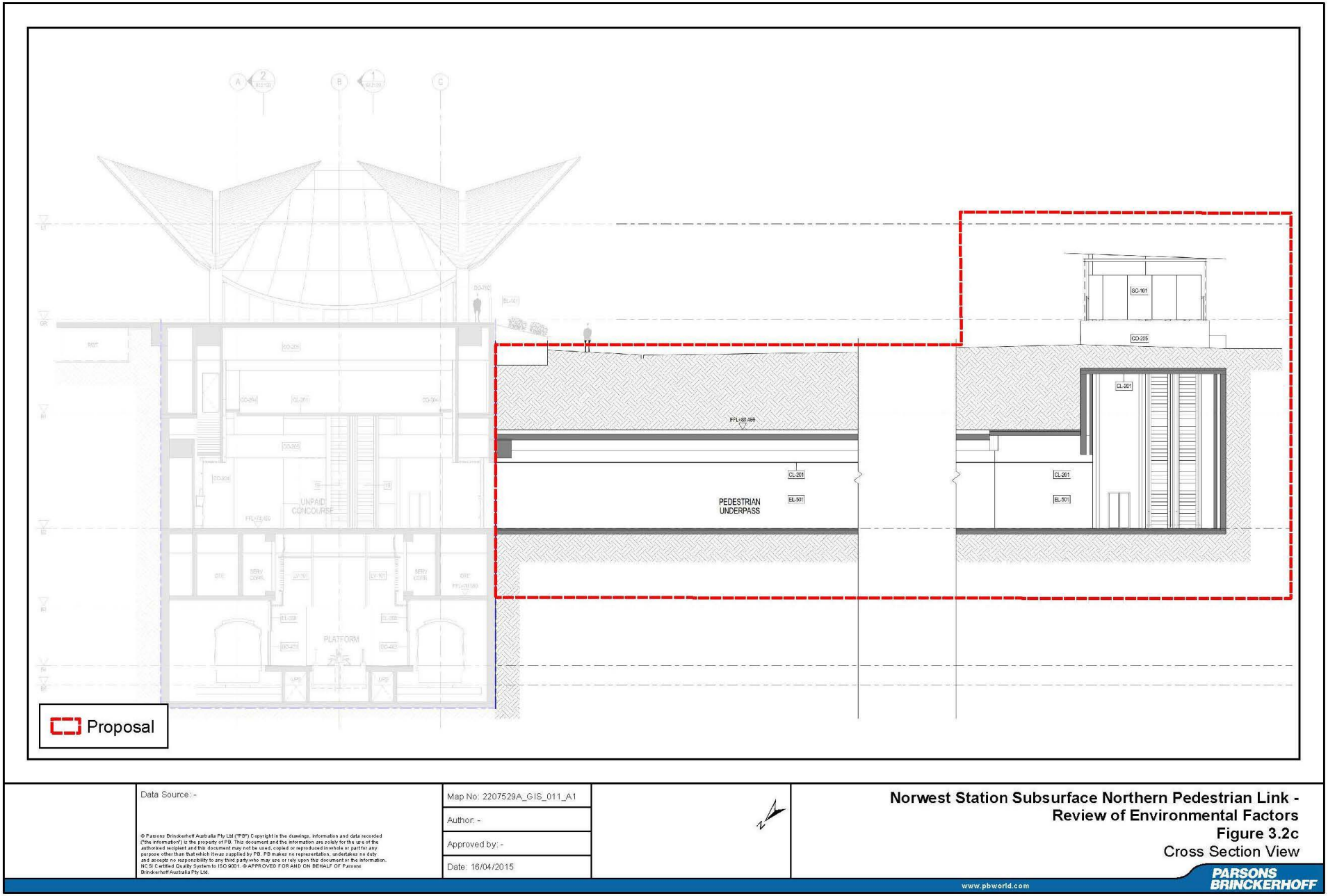
UNPAID CONCOURSE
PLATFORM
PEDESTRIAN UNDERPASS
CL-201
EL-501
SC-101
CO-205
Proposal
Data Source: -
Map No: 2207529A_GIS_011_A1
Author: -
Approved by: -
Date: 16/04/2015
Norwest Station Subsurface Northern Pedestrian Link - Review of Environmental Factors
Figure 3.2c
Cross Section View
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3.2 Proposal description

The approved Norwest Station design comprises a single southern entry to service all customers using the NRWL. People wishing to access the Norwest Business Park and other amenities on the northern side of Norwest Boulevard will need to use the southern entry and then cross the road via a new pedestrian crossing.

Under this proposal a second 'northern entry' would be created to specifically service what is the most active part of the Norwest Precinct. The northern entry would be located on the north-east corner of the intersection of Norwest Boulevard and Century Circuit. It would connect to Norwest Station via a subsurface pedestrian link. The core design concepts are described below:

The northern entry

- A 11.5 metre deep vertical entry to the access Norwest Station via the pedestrian link.
- Serviced by two escalators and one elevator.
- A glazed and/or metal clad entrance canopy/portal about five metres high.
- Improvements to the footpath and planting around the entrance.
- Fixtures and fittings that would be consistent with the design adopted in Norwest Station.
- A 'breakout' panel (false wall) at the northern end of the tunnel to safeguard for potential future connection between the pedestrian link and the Norwest Marketown shopping centre as part of future (private) development proposals.

The pedestrian link

- A 40 metres long five-metre wide pedestrian tunnel.
- Fixtures and fittings that would be consistent with the design adopted in Norwest Station.

Supporting infrastructure

The pedestrian link and circulation area would be founded on a concrete base slab laid on top of a waterproof membrane that in turn would be placed on top of a drainage layer. In combination, these would provide groundwater protection.

Services would be constructed behind the internal walls and ceiling (i.e. the architectural lining of the pedestrian link and circulation area). Discrete access panels would be provided within the lining to enable inspection, maintenance, replacement or installation of future services.

Connection into Norwest Station

The pedestrian link would connect into the mezzanine level of the Norwest Station box. Given the differential in ground level between Norwest Station and the northern entry, the pedestrian link would be constructed at a 1-in-33 gradient.

3.3 Design

The proposal's concept design is described in this section. The concept design includes sufficient information to:

- Identify the required permanent property acquisition needed for the proposal's footprint as well as the need to lease land during construction.
- Understand and assess the nature and extent of the proposal's likely impacts.
- Provide flexibility in developing the detailed design while having regard to reasonable and feasible safeguards and management measures to minimise environmental and social impacts.
- Facilitate community and key stakeholder feedback.

3.3.1 Overall design objectives and principles

The proposal has been designed to be consistent with the principles, standards and criteria adopted for all the Sydney Metro Northwest stations.

Objectives

Design objectives have been developed for the internal and external built form of all Sydney Metro Northwest stations, associated service buildings and facilities, namely:

- Create memorable vibrant new focal points for the community, places where customers feel safe, are protected from the weather, and places that offer enjoyable uplifting experiences.
- Offer opportunities for customers to easily transfer between different transport modes (including on foot) or readily access local facilities and services.
- Are informed by local character, including natural systems and the supporting built environment.
- Provide a positive lasting legacy for future generations.

3.3.2 Design principles

Table 3.1 lists the proposal's design principles. These are consistent with those adopted for the built form of Norwest Station's associated service buildings and facilities. These principles will guide the proposal's detailed design.

Table 3.1 Proposal design criteria

Design features	Design principle	Adoption and consideration
Effective use of space	Creation of good public spaces, by providing a high quality customer experience, including direct, equitable, safe and convenient connections between transport modes and integration with adjacent land uses.	Creation of a direct link from the Norwest Station to the most active part of the Norwest Precinct. Reduced journey times between Norwest Station and the northern side of Norwest Boulevard.
Value for money	Balance of contextual responsive architectural and urban design with a wider design that ensures value for money.	A design that is consistent with Norwest Station thus providing architectural and visual continuity.
Visual impact and amenity	Above ground structural designs that are minimal and visually unobtrusive as far as practical.	Use of glazing, metal work and a steel-framed canopy roof structure to reduce visual impacts. Optimised northern entry surface footprint to reduce visual impacts.
Design integration	Design integration of all components, while allowing for easy maintenance.	A design that is consistent with Norwest Station and uses low maintenance materials.

Design features	Design principle	Adoption and consideration
Active use spaces	Creation of 'active use' spaces through the urban design such as local retailing and services around stations, active and passive public spaces, good quality landscaping and sustainable car parking.	A design that uses continual design themes between Norwest Station and the proposal that replicates the urban design of the precinct.
Material selection	Material selection that provides robust and easily maintained finishes that protect against graffiti, dust, rain and heavy usage	A design that adopts the use of protective, durable and hard waring components to prevent against degradation, abuse and wear and tear.
Noise mitigation	The incorporation of reasonable and feasible noise mitigation.	A design that addresses operational noise issues as required and includes reasonable and feasible noise management during construction.
Sustainability in design	The incorporation of sustainable initiatives into the built form.	A design that includes the use of recycled materials, materials with a low embodied energy content, locally sourced materials and looks to minimise resource consumption and waste generation.
Safety in design	The adoption of 'safer by design' principles.	Refer to the following section.

Safety in design

Sydney Metro Northwest has been designed to ensure it is safe for customers, workers, rail customers, maintenance crews and anyone that would use the Norwest Station precinct, including the pedestrian link. The following key safe design features would be implemented under the proposal:

- The use of fire-retardant materials in the design.
- A lighting design that ensures all areas are lit.
- Clear directional signage to ensure rail customers move through the pedestrian link quickly and effectively and do not get distracted or lost.
- Outside lighting areas to provide a safe environment for waiting passengers.
- Provision of anti-slip surfaces for rail customers.
- Shelter and weather proofing.
- Closed circuit television (CCTV) to enhance security.
- Other emergency, fire, safety and address equipment.

The above provisions would be largely provided through installing a range of operations systems and building services as described below.

TfNSW is also committed to reducing crime prevention through environmental design (CPTED). In 2001, the Department of Planning and Environment released the NSW Government's guidelines as to how CPTED should be implemented under the NSW *EP&A Act.* The guidelines include a number of principles that have been adopted in the proposal's design to allay operational safety concerns. They include:

- For the pedestrian link to have end-to-end visibility.
- For natural observation to be maximised by providing lines-of-sight throughout the pedestrian link and its connection into Norwest Station, including the supporting furniture, while also minimising the use of narrow corridors and hidden corners and adopting the use of appropriate lighting.

- The use of natural access control through considered urban design that guides passengers to appropriate entries.
- The adoption of 'territorial reinforcement' through design that clearly delineates public areas from non-public areas.
- As noted above, the use of CCTV and appropriate maintenance, particularly regarding vandalised hardware and quick repair/removal of graffiti.
- The link and entrance being safe and attractive places to wait and travel through, supported by the use of appropriate lighting and be fitted with emergency calling infrastructure.

3.3.3 Systems and building services design

The proposal would need to include a number of operations systems and building services. In all cases, these would be extensions of what will be installed in Norwest Station. They are described below.

Operations systems

The following operations systems would be installed under the proposal:

- CCTV
- Internal and external lighting
- Public address/passenger information
- Emergency service communication (including help points)
- Fire and life safety
- Mobile phone and data services
- Environmental controls (heating, ventilation and air conditioning).

Central control systems

A central control system would be installed and configured to monitor and control the main electrically powered equipment, namely:

- The lift and escalators
- Environmental control equipment
- Lighting zones
- Electrical shutters
- Fire alarm system.

The Sydney Metro Northwest building management system would monitor the equipment while the power control system would supply and monitor power. There would be no separate power supply needed for the proposal.

Passenger information and emergency communication systems

As noted above, both the passenger information and emergency communication systems would be extended to service the proposal. The address system would be confined to the pedestrian link and the base of the circulation area. The emergency communication system would additionally cover the surface entrance and whole of the circulation area. Both systems would require a number of:

- Public address speakers, power amplifiers and associated loop amplifiers to make station passenger announcement.
- Help points equipped with video devices for passengers to communicate with Norwest Station's operational control centre for assistance.
- Passenger information display boards to provide useful information to passengers such as station operational messages, the time, weather information, and service information for trains and other transport connections.

Radio and mobile phone systems

Both the radio and mobile phone systems would be extended to service the proposal. This would be achieved by installing various amplifiers, antenna, cables, and accessories to relay radio and mobile phone signals in the pedestrian link.

Fire and life safety systems

The proposal would incorporate the Sydney Metro Northwest fire and life safety systems. The required infrastructure will be determined through evacuation and smoke modelling undertaken during the detailed design. The emergency sound and intercom system would also be extended to cover the proposal with coordination back to Norwest Station.

Power systems and supply systems

All control, communication and radio systems installed to service the proposal would be supplied with an uninterrupted power supply to the same specifications as installed in Norwest Station. The uninterrupted power supply would by charged from batteries installed in Norwest Station. No additional batteries or generator equipment would be installed under the proposal.

Equipment that uses low voltage power (which includes the lighting) would be supplied by extension from Norwest Station. No additional system capacity (i.e., transformers or switch supplies) would be required to service the proposal other than additional feeder circuit breakers and cabling required for low voltage distribution.

Environmental control systems

The existing heating, ventilation and air conditioning systems would be extended from Norwest Station to service the proposal. Outside air ducts would be provided throughout the length of the pedestrian link and circulation area. Air vents would be installed every five metres and a new outside air fan would be installed within the Norwest Station plant room.

Drainage and dewatering equipment

As noted in Section 3.2, the pedestrian link and circulation area would be founded on a concrete base slab laid on top of a waterproof membrane that in turn would be placed on top of a drainage layer. In combination these will form the proposal's 'groundwater collection system'.

Inflow groundwater would discharge to behind the northern walls of the Norwest Station box where it would be collected in the Norwest Station sumps. The groundwater collection system would be a closed to prevent any groundwater from being exposed to the air and thus prevent the risk of iron oxide sludge build up (refer to Section 6.1.3).

Lighting requirements

The circulation area and pedestrian link would be lit using wall and ceiling lighting. In addition, the surface entrance and canopy would also be externally lit using conventional street and building lighting.

3.3.4 Engineering constraints

The following table provides an overview of the three key structural design considerations and constraints associated with the proposal.

Table 3.2 Key structural design considerations

Design component	Consideration
Subsurface geology	The majority of the proposal would be constructed in bedrock. The exception would be at the top of the circulation area, which would be constructed in overburden. As such, bored piles would be used to minimise the potential for settlement in the circulation area and to support the loads imposed from the operating escalators.
Interface with Norwest Station's construction	Construction of Norwest Station and track would take place at the same time as the proposed construction of the pedestrian link. This would include temporary works. As such, the station and track temporary works would have to be removed to allow the pedestrian link to be constructed. This would affect the bored piles and ground anchors used to support construction of the southern face of the Norwest Station box.
Existing buried services	Refer to Section 3.9.

3.4 Construction

If approved, the proposal would be constructed as part of the Norwest Station. An indicative construction method, staging, plant and equipment requirements, approximate earthwork volumes, anticipated material requirements and traffic management controls are described below. An indicative construction plan is also provided. The actual construction plan and method may vary from the description provided in this section due to the identification of additional constraints pre-construction, ongoing detailed design refinements, community consultation feedback, and construction contractor requirements/limitations.

3.4.1 Work method

Work on the proposal would only take place within the areas specified and assessed in this REF. It would be completed in accordance with the safeguards and management measures included in Chapter 7 and any refinement to these during the approvals process.

Work method overview

The overall construction method would be to excavate the circulation area ventilation shaft followed by the pedestrian link, which would be constructed north to south.

As the proposal would be constructed at the same time as Norwest Station the work method and program would be reliant on a number of points in Norwest Station's construction program, namely:

- Obtaining site access.

- For the proposal's construction start date to link into the period when Norwest Station site is being established.
- For the proposal and the southern access to be constructed at the same time, in line with workforce availability and scheduling.
- For the proposal to be completed by the time that Norwest Station is being commissioned.

3.4.2 Construction method and activities

The proposal would be constructed in stages, broadly comprising:

- Stage 1: site establishment (including surface clearance and the demolition of existing structures)
- Stage 2: earthworks and excavation
- Stage 3: civil and building work
- Stage 4: fit out and furnishing
- Stage 5: pre-commissioning and commissioning
- Stage 6: post work tie-ins, treatments and vegetation planting
- Stage 7: demobilisation.

Stage 1: site establishment

The first stage would be to install security fencing around the surface proposal footprint shown in Figure 3.1a, while at the same time, providing diversion-signage for rail customers of the car park to direct them to alternative parking areas.

All underground services and buried utilities would then be marked out; while the area would be inspected for any unrecorded or unaccounted services.

Once the proposal footprint is secured, any roadside planted amenity vegetation would be removed. The existing kerbing and hard standing would then be broken out (removed) while belowground services and utilities would be diverted, removed and/or capped and sealed. Any other demolition would then be undertaken as necessary to create the required access space to construct and operate the northern entry and pedestrian link.

The site establishment work would take about four weeks to complete.

Stage 2: earthworks and excavation

The northern entry (East of Century Circuit and North of Norwest Boulevard)

The first step would be to excavate the circulation area (ventilation shaft) form the northern entry. Excavation would be progressive using open cut methods (i.e. it would be constructed from the surface working downwards). As the shaft is advanced the sides would be shored, a process of supporting the excavation to prevent it collapsing in on itself.

Depending on local ground conditions, the surface overburden may also need stabilising using canopy tubes, a process where several holes are drilled around the perimeter of the excavation after which steel tubes are inserted into the ground to provide additional stabilisation.

Through this process, overburden and rock would be progressively excavated and removed to the surface at which point it would be set down temporarily and either segregated, tested and/or classified prior to either being transported to the main construction compound/laydown area or directly offsite to a licenced waste handling facility (refer to Section 3.6.2).

Through this process about 6,500 m^3 of material (rock and overburden) would be excavated, not accounting for any surface materials (hard standing, vegetation, kerbing).

The pedestrian link

Once the circulation area was excavated, shored, and stabilised, the excavation and drilling equipment needed to form the pedestrian link tunnel would be lowered into the shaft.

This equipment would work under a 'mined tunnelling' method, which would see the drilling equipment work progressively and horizontally north to south.

The tunnel would be constructed using a heading and benching method. The tunnel's total area would be about six metres wide and three metres high. As such, the drilling equipment would work in stages to advance the tunnel. Firstly, a 'head' would be drilled, which would be about two-to three metres deep. The head would not cover the entire area of the face of the tunnel. This head would then be stabilised by installing rock bolts and using reinforced concrete (shotcrete). In drilling the 'head' a 'bench' would be formed in the tunnel. The bench (or benches) would then be drilled to advance the face of the tunnel, again ensuring the tunnel was stabilised. This process would occur until the Norwest Station box was reached.

The drilling method would crush and grind rock that would be progressively excavated via the created circulation area shaft. In creating the link about 720 m^3 of rock would be excavated, noting that the initial section of the tunnel would form part of the circulation area. As with the circulation area shaft, the material would be removed to the surface where it would be managed, tested, and stored before being transferred 'offsite'.

The excavation and earthworks work would take about eight weeks to complete.

Stage 3: civil and building work

Civil and building work would take place at the same time as the circulation area and pedestrian link are being excavated and stabilised.

The Norwest Station box would be anchored to secure it in the bedrock. These anchors would be under tension. As such, in order to allow the pedestrian link to connect into the Norwest Station box some of these anchors may need 'de-stressing' and in some instances they would need temporarily removing. Accordingly, the Norwest Station box would need to be temporarily strengthened to replace the lost tension provided by the anchors. This would then allow the pedestrian link tunnel to be advanced into the Norwest Station box.

The other main civil work would be the application of shotcrete layers on the circulation area shaft and in the pedestrian link tunnel. Shotcrete is liquid concrete that sets quickly. It would be applied to the all surfaces of the shaft and tunnel. It would be sprayed onto meshing to form reinforced concrete. It would also be applied over the canopy tubes, which as a result, would provide needed additional structural reinforcement to the shaft and tunnel.

At this point, the drainage, membrane and base slabs would be installed in both the circulation area and pedestrian link.

During this stabilisation process, the drilling and excavation equipment would be removed from the tunnel and shaft.

The civil and building work would take about 8 weeks to complete.

Stage 4: fit out and furnishing

Once stabilised, and the basic shaft and tunnel structures were complete, major equipment installation would take place. The escalators would be lifted into the shaft in sections and secured (bolted) to the walls of the shaft. At the same time, the main lift equipment would be installed from the surface. The required power equipment would also be supplied. Once preliminary testing of the 'vertical transportation' equipment was complete, the concrete roof would be lifted into place and secured in the bedrock.

The next step would be to install the glazed/metal clad canopy over Norwest Station. The steel formwork would be prefabricated offsite and transported onsite in sections on low loaders and oversize vehicles. It would be lifted into place and then assembled. The canopy would be founded onto securing bolts set in reinforced concrete.

The next stage would be installing the main equipment, systems and utilities as described in Section 3.3.3. This equipment would be attached to the ceiling and walls of the tunnel followed by the shaft.

This would be followed by installing the floor paving in the tunnel and then the shaft, after which architectural treatments and finishes would be applied to the ceilings and walls.

Once installed, the final equipment facings, fixtures and finishes for the systems and equipment would be installed.

It would take about 8 weeks to complete this stage of the work.

Stage 5: pre-commissioning and commissioning

The pre-commissioning phase would involve testing and commissioning the services described in Section 3.3.3 along with further testing of the 'vertical transportation' equipment. The testing and commissioning phase would last about 4 weeks.

Stage 6: post work tie-ins, treatments and vegetation planting

The final stage would be to finish and install the external surface treatments to the canopy (lighting, glazing and metal work) as well as external paving, planting and street furniture. It would take about 2 weeks to complete this stage of construction.

Stage 7: demobilisation requirements

Once the northern entry was complete and commissioned, the site would be cleaned and washed down, and all construction equipment would be demobilised and removed offsite. The security fencing would then be taken down and the car parking spaces reinstated when Norwest Station is ready to open.

3.4.3 Program

The proposal would be constructed as part of the Norwest Station. Construction is anticipated to start in mid-2016. If approved, the proposal would be constructed while Norwest Station was being built. It would therefore be integrated in Norwest Station's overall construction program meaning that it would take about 8 months to complete. The majority of the work would take place below ground. This would allow for the proposal's construction program to interface with the construction program for Norwest Station.

3.4.4 Staging

Construction staging would be ultimately determined during detailed design and pre-construction. It would depend on contractor requirements, occupancy, leasing and acquisition agreements, traffic management requirements, the overall program for Norwest Station construction, and other external factors that may restrict working times and hours. The overall objective would be to construct the proposal in a timely and efficient manner considering the need to:

- Maintain access into and out of the Norwest Business Park.
- Coincide with the construction of Norwest Station and the ability for the pedestrian link to tie into the Norwest Station box.
- Ensure this proposal does not conflict with the construction of the Sydney Metro Northwest and any associated surface impacts such as traffic management controls.

3.4.5 Hours and duration

The NSW *Interim Construction Noise Guidelines 2009* (NSW EPA, 2009) have identified 'recommended standard hours for construction work'. They have been established to preserve the local amenity of an area at certain times depending on the surrounding land use.

All surface work, with the exception of tunnel-generated spoil removal, would only take place during the recommended hours, namely:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm Saturday
- No work on Sundays or during public holidays.

The underground work would take place continuously, 6 day per week, with no work taking place on a Sunday or during a public holiday. As noted above, all surface traffic movements or work to support the underground work (i.e., waste and spoil removal) would also take place at night.

3.4.6 Plant and equipment

The proposal would be constructed using various plant and equipment (refer to Table 3.3). Some of this equipment would be in use to construct Norwest Station. Its use would be extended to construct the proposal. The table also shows the estimated amount of time the equipment would be in use under each stage of construction.

Table 3.3 Plant and equipment – indicative only

Activity	Plant and equipment		Surface/ belowground
Stage 1: Site establishment (including surface clearance and the demolition of existing structures)			
Security fence installation, 'breaking out' the surface, utility relocation	▪ Bobcat x 1- continuous ▪ Generator x 1 - continuous ▪ Hand tools – 75% ▪ Angle grinder x 1 – 10%	▪ Tipper trucks x 2 – 50% ▪ Trucks x 3 – 50% ▪ Concrete saw x 2 – 20% ▪ Jackhammer x 2 – 30%	Surface
Stage 2: Earthworks and excavation			
Circulation area shaft (piling and surface work)	▪ Piling rig (Bauer BG36) x 1 – 80% ▪ Crawler crane x 1 – 30%	▪ Bulldozer x 1 – 80% ▪ Truck and dog x 3 – 50% ▪ Rock hammer x 2 – 50%	Surface
Circulation area (excavation)	▪ 12 to 30 tonne excavator with bucket x 1 – continuous ▪ Rock saw x 1 – 75% ▪ Piling equipment – continuous ▪ Trucks and trailers x 1 – 50%	▪ Tipper trucks x 2 – 50% ▪ Shotcrete diesel rig x 1 – 50% ▪ Truck and dog x 3 – 50% ▪ Excavator (with bucket) x 1 – continuous ▪ Concrete truck x 2 – 50%	Surface and within excavation shaft
Pedestrian link tunnel (excavation)	▪ Micro tunnelling machine x 1 – continuous ▪ *12 to 30 tonne excavator with bucket x 1 – continuous ▪ Road header x 1 – continuous ▪ *Mobile/crawler crane x 1 – 30% ▪ *Trucks and trailers x 1 – 50% ▪ Hand tools – continuous	▪ *Tipper trucks x 2 – 50% ▪ Shotcrete diesel rig x 1 – 50% ▪ *Truck and dog x 3 – 50% ▪ Excavator (with bucket) x 1 – continuous ▪ Piling equipment – continuous ▪ Concrete truck (surface) x 2 – 50%	Belowground *This equipment may also operate at the surface
Stage 3: Civil and building work			
Structural work (shaft and tunnel)	▪ Concrete pump x 1 – 60% ▪ Concrete trucks x 3 – 60%	▪ Mobile crane x 1 – 60%	Surface and belowground
Stage 4: Fit out and furnishing			
Elevator, lift and equipment installation	▪ *Trucks x 3 – 50% ▪ *Low loaders x 1 – 15% ▪ Angle grinders – 10%	▪ Bobcat x 1 – 20% ▪ Hand tools - continuous ▪ *Mobile crane x 1 – 20%	Belowground *This equipment may/would also operate at the surface
Roof canopy	▪ Trucks x 3 – 40% ▪ Low loaders x 1 – 20% ▪ Angle grinders – 10%	▪ Bobcat x 1 - 20% ▪ Hand tools – continuous ▪ Mobile crane x 2 – 60%	Surface

Activity	Plant and equipment		Surface/ belowground
Stage 5: Pre-commissioning and commissioning			
Testing and pre-commissioning equipment	▪ Hand tools – continuous		Surface and belowground
Stage 6: Post work planting, tie-ins and treatments			
External and surface treatments and finishes	▪ Trucks x 3– 50% ▪ Angle grinders – 10% ▪ Bobcat x 2– 50% ▪ Hand tools – continuous ▪ Mobile crane x 1 – 25% ▪ Pavement machine x 1 – 40% ▪ Profiler x 1 – 60%	▪ Generator x 1 – continuous ▪ Road planer x 1 – continuous ▪ Roller x 2 – 70% ▪ Suction sweeper x 1 – 30% ▪ Line marking machine x 1 – 20% ▪ Compactor x 1 – 30% ▪ Paving machine x 1 – 60%	Surface
Stage 7: Demobilisation			
Fence removal, site wash down and clearing.	▪ Suction sweeper x 1 – 20% ▪ Hand tools – continuous	▪ Trucks x 2 – 40% ▪ Bobcat x 1 – 50%	Surface

3.5 Earthworks

The work would require the sequential excavation of spoil to first construct the vertical circulation area shaft and then the pedestrian link tunnel. Table 3.4 summarises the spoil volumes that would be generated under the proposal.

Table 3.4 Earthworks – indicative only

Proposal component	Approximate volume (m^3)
Circulation area shaft (rock and overburden)	6,500 m^3
Pedestrian link tunnel (rock)	700 m^3
Surface cleared materials (vegetation, spoil)	1,500 m^3
Total	**8,700 m^3**

This construction method would result in subsurface material (rock and overburden) `being generated continuously during working hours for an anticipated period of about eight weeks. It would be removed to the surface via the constructed entrance shaft. The spoil removed from the circulation area shaft would be temporarily set down in the surface proposal footprint area where it would be segregated, tested and/or classified. Reusable material would be either deployed elsewhere in the Norwest Station precinct or else it would be transported offsite either directly to another part of the Sydney Metro Northwest, another project site, a licenced waste handling or disposal facility, or to the main construction compound/laydown area. The overall aim would be to reuse the majority of the claimed spoil under a resource recovery exemption. Alternatively, the spoil would be treated to allow for its reuse, or failing that, it would be disposed offsite, most likely due to it containing hydrocarbons (refer to Section 6.1.3).

Mass balance

While this proposal would generate an excess of material, the overall Sydney Metro Northwest project would require the net import of material. This reason drives the objective to reuse as much of the rock and overburden as possible.

3.6 Resources and waste

3.6.1 Resources, materials and sourcing

The types and quantities of resources and materials needed to construct the proposal would be confirmed during the detailed design. Table 3.5 describes the provisional key material requirements. These materials would be obtained through established contractors.

Table 3.5 Material and resource requirements – indicative only

Activity	Requirement	
Stage 1: Site establishment (including surface clearance and the demolition of existing structures))		
Site establishment	▪ Block and mesh fencing ▪ Temporary traffic signage	▪ Traffic barriers
Stage 2: Earthworks and excavation		
All elements	▪ Shoring materials (metal) ▪ Canopy tubes (metal) ▪ Skips ▪ Geotextile fabric	▪ Water ▪ Sand ▪ Rock bolts (metal) ▪ Concrete (shotcrete)
Stage 3: Civil and building work		
Structural work (shaft and tunnel)	▪ Preformed concrete slabs ▪ Concrete (shotcrete) ▪ Waterproof membranes ▪ Drainage materials	▪ Pipes ▪ Ducting ▪ Electrical cabling ▪ Conduits
Stage 4: Fit out and furnishing		
Elevator, lift and equipment installation	▪ Prefabricated equipment ▪ Lift (and lift shaft) ▪ Escalator ▪ Motors and electrical equipment ▪ Lighting ▪ Electrical equipment	▪ Fire alarm system equipment ▪ Communication system equipment ▪ Power supply equipment ▪ Heating, ventilation and air conditioning equipment
Roof canopy	▪ Metal ▪ Glass	
Stage 6: Post work planting, tie-ins and treatments		
External and surface treatments and finishes	▪ Plants and trees ▪ Soil ▪ Sand ▪ Concrete	▪ Kerbs ▪ Paving slabs ▪ Light poles and street lamps ▪ Plastic piping

Activity	Requirement	
General construction		
General construction materials	■ Diesel, petrol, fuel and oil ■ Water	■ Lubricants and greases ■ Paper, cardboard and metal

Consistent with TfNSW's sustainable procurement requirements, the aim would be to procure the material locally and for the materials to contain a high recycled content and a low embodied energy where they are cost and performance competitive and comparable in environmental performance (refer to Section 6.9). Notably, these materials are widely available across the Sydney metropolitan area. They would be transported to the main construction compound/laydown via road after which they would be transferred to the proposal footprint on an 'as needed' basis.

3.6.2 Waste

While the main waste stream would be claimed spoil generated from constructing the entrance shaft and pedestrian tunnel, a number of other construction wastes would be generated under the proposal. Table 3.6 provides an indicative list of the potential waste volumes and streams.

All waste would be segregated at source either allowing its reuse elsewhere in the Norwest Station precinct or else it would be transported offsite either directly to another part of the Sydney Metro Northwest, to another project site (again for reuse), to a licenced waste handling or disposal facility, or to the main construction compound/laydown area.

Any required testing and classification would also take place in situ 'onsite'.

All waste would be appropriately stored within the proposal footprint prior to its transfer 'offsite'.

Table 3.6 Waste generation – indicative only

Waste (and waste stream)	Approximate volumes (m^3/tonnes)
General solid waste (non-putrescible)	
Virgin excavated natural material – residual spoil (overburden) and rock	5,500 m^3
Demolition concrete and bitumen	650 m^3
Building rubble and structural element demolition waste	125 tonnes
Waste metal	30 tonnes
Wood products	50 tonnes
Mixed spoil	175 tonnes
Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses and tyres	25 tonnes
General solid waste (non-putrescible) – resource recovery exemption	
Excavated natural material	1,000 m^3
General solid waste – (putrescible)	
Green waste – vegetation grubbing and clearing	10 tonnes
Food waste	40 tonnes

Waste (and waste stream)	Approximate volumes (m^3/tonnes)
Liquid waste	
Slurries, sludge, paint and solvent washout	10 tonnes
Wastewater from other sources including dust suppression and vehicle wash-down and sewage/grey water	10 tonnes
Special waste (potential)	
Contaminated spoil (including potential acid sulphate soils and actual acid sulphate soils)	Unknown

3.6.3 Traffic management, access, controls and signage

The following traffic management and access measures would be developed during the detailed design. They would be implemented under a construction traffic management plan (CTMP) (refer to Section 7.1).

Overall traffic management

The proposal would take place within the context of the traffic management controls that have been developed under Norwest Station. In constructing the proposal, the following activities would take place that have associated traffic management implications:

- Site establishment
- Car parking reallocation
- Service relocations
- Installation of erosion and sediment controls
- Temporary road pavement and access construction
- Pedestrian diversions
- Vegetation clearing, grubbing and planting
- Materials and equipment delivery (including low loaders and oversize vehicles)
- Shaft and tunnel construction
- Spoil haulage (associated with shaft and tunnel construction)
- Street furniture, fabrications and fittings
- Post work treatments and reinstatement
- Footpath and pavement reinstatement.

Road traffic, pedestrians and cyclists

During the eight month construction program there would be a requirement for trucks and heavy vehicles to access and leave the proposal footprint. Access would be off Century Circuit.

Access to the proposal footprint may be signal controlled by signals or people, either part time or full time. This would result in short-term delays for general road traffic. Very occasionally there may be the need to close the road to take receipt of the major infrastructure components that would be delivered on oversize vehicles and low loaders. This equipment would be escorted to site. Road closures would take place outside of peak periods and would only affect the local roads for a few hours during each delivery. In total about 10 to 15 trips would be needed to deliver this equipment and they would take place at routine intervals throughout the construction program. Only when delivering the main escalator and lift equipment could there be a period of a few consecutive days where one-or-two oversize vehicles would arrive at site each day.

There would also be routine construction material deliveries to, and the removal of waste from, the site. On average eight trucks would arrive and leave the site at regular intervals throughout a 24-hour period during peak construction. About 15 concrete pourers would also arrive and leave site during the day during peak construction. Construction workers would additionally travel to and from the wider station precinct during construction. They would park in the main construction car park and likely walk to the proposal footprint.

Business, community and residential access would be maintained throughout, except for the short few hours when a major delivery arrived at site where diversions would be set up to provide continued access to the core of the precinct (refer to Section 6.2.3).

In terms of pedestrians, there would be a requirement to implement a temporary diversion around the proposal footprint for the lost footpath along Norwest Boulevard. The diversions would be signposted, and where required, temporary signals would operate across the access and egress points to the proposal footprint.

Emergency vehicle access would be maintained at all times, with a management provision included to allow for this during a major delivery.

Controls and signage

The CTMP would detail traffic management controls required to maintain access, and traffic and pedestrian safety. The plan would also contain specific traffic and pedestrian control plans.

Temporary signage and traffic management controls would be implemented around the proposal footprint to supplement the controls put in place to service Norwest Station's construction. These signs would describe the changes in traffic and pedestrian conditions, highlight any expected delays and identify any diversion routes. The traffic management controls would likely include temporary traffic lights and stop-go controls.

Site access and haul routes

The proposal footprint would be accessed and exited via Century Circuit. As noted above, about eight trucks and 15 concrete pourers would need to enter and leave the proposal footprint at regular intervals across the day. The identified temporary traffic management controls would be implemented to allow these vehicles to safely enter and leave site.

Materials required to construct the proposal would be sourced from the metropolitan area. They would be transferred to the construction compound/laydown area by road, primarily along the adjacent motorway network and then Norwest Boulevard.

Equally, generated waste would be transferred 'offsite' using licenced contractors. The location to where the waste would be transferred for reuse, reprocessing or disposal would depend on its nature, type and classification (refer to Section 3.6.2). The waste would be hauled from the construction compound along Norwest Boulevard to the motorway network after which they would be transported to either an intermediary or end-use location. This would be determined and confirmed during the detailed design.

3.6.4 Workforce

This proposal would be serviced by the Sydney Metro Northwest workforce. During peak construction, there would be expected to be about 20 people working onsite on average. Consistent with the construction of Norwest Station, workers would be expected to use public transport or travel by car. Parking would be provided in the main site construction compound/laydown area.

3.7 Operation and maintenance

The proposal would be commissioned and it would operate as part of the Norwest Station. This would include its future maintenance. As noted above, finishes, fixtures and fittings would be consistent with those used across Norwest Station precinct. This would support the proposal's operation and maintenance. Similarly, the systems deployed in the proposal would be extensions of the systems that would operate in Norwest Station, again to facilitate ease of operation and maintenance.

3.7.1 Operation

The pedestrian link would operate between about 4.00 am and 2.30 am in line with the planned station-opening hours. These hours may be extended during special events. Peak use would be during the week between 7.30 am and 9.00 am and 5.00 pm and 6.30 pm. During this period it is anticipated that about two thirds of the rail customers would use the pedestrian link and northern entry. Proportionally, the percentage of rail customers using the link in the future would remain about the same, however about twice as many people would be expected to use the link by 2036.

During an accident or emergency, access to the pedestrian link would be restricted from the surface and from Norwest Station. The fire safety systems would direct people to evacuate the pedestrian link or circulation area via the nearest (lit) exit. If required, fire safety doors would be used to seal and isolate the pedestrian link from Norwest Station area and/or the circulation area.

3.7.2 Ongoing maintenance

The proposal would be placed on a routine cleaning, inspection and maintenance schedule. It would not be maintained in isolation but as part of the wider Norwest Station precinct. Mechanical and electrical components would be tested and inspected routinely as would fire and safety equipment. Maintenance access would be via the public entry points to the pedestrian link (i.e., Norwest Station or the circulation area). Maintenance and service vehicles would park in Norwest Station's service car park. Occasionally, vehicles may need to park adjacent to the northern entry, in which case, they would use one of the existing retained car parking spaces servicing the Norwest Marketown shopping centre.

3.8 Ancillary facilities

The only supporting ancillary facilities would be a small temporary construction compound and laydown area adjacent to the entry shaft. This would be used to temporarily store materials required for immediate use. It would also be used to temporarily store excavated spoil prior to its removal 'offsite'. The proposal would be mainly serviced by the main construction compound and laydown area established for Norwest Station located on the corner of Norwest Boulevard and Brookhollow Avenue (refer to Figure 3.3). There would be capacity in the main construction compound/laydown area to store additional materials and waste required and generated under this proposal.

3.8.1 Construction compound and laydown area

Both the main and ancillary construction compound and laydown areas would:

- Be contained on hard stand
- Include temporary (prefabricated) buildings (site offices)
- Include parking areas
- Allow for materials laydown, storage and transfer
- Allow for the storage of plant and equipment
- Allow for chemical and waste storage and segregation.

3.9 Public utility and drainage adjustment

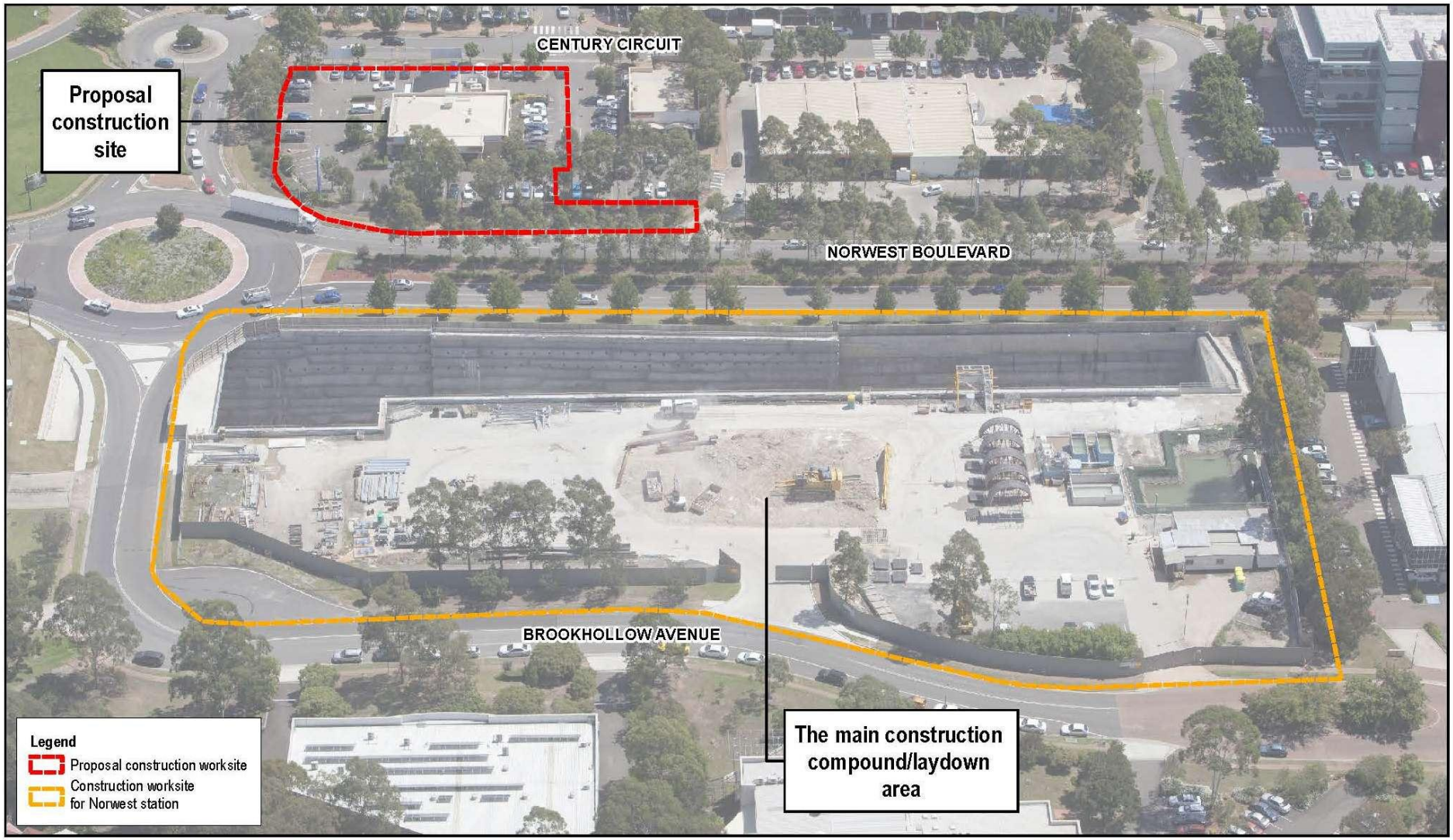
The proposal would be largely constructed in bedrock below the depth of any utilities and buried services. There are two exceptions however, which are deep and located close to the rock level. They include a stormwater drain line, which is located near the centre of Norwest Boulevard and a sewer line, which is located within the footpath area on the southern side of Norwest Boulevard. The proposal has also been designed to account for, tie into or avoid any services that would be installed to support the Norwest Station box and/or rail line.

Potentially affected public utility companies would be consulted as part of the detailed design to confirm the location, extent and depth of these two utilities and to confirm the presence of any other buried services. Additional survey work would take place to confirm the location of each utility before construction.

Table 3.7 shows the type and location of each known existing utility impacted under the proposal. The level of survey information collected at this stage does not confirm the exact location of each utility or its depth below ground.

Table 3.7 Public utility and drainage adjustment – indicative only

Utility	Location	Adjustment, relocation and/or instalment
Stormwater drainage line	Norwest Boulevard median	Survey and relocate if required
Sewage line	Southern footpath of Norwest Boulevard	Survey and relocate if required



Transport for NSW

Data Source: - Based on information provided by Transport NSW

Map No: 2207529A_GIS_005_A3
Author: - GoganovskiM
Approved by: -
Date: 4/05/2015

Scale ratio correct when printed at A4 Landscape
Projection: Transverse Mercator
Coordinate System: GDA 1994 MGA Zone 56

NRTH WEST RAIL LINK
Figure 3.3
Main and proposal construction compound and laydown areas

Client Name

PARSONS BRINCKERHOFF
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3.10 Property acquisition and leasing arrangements

A total of about 0.4 hectares of land would be needed to construct the proposal while the footprint of the final northern entrance and associated footpath and vegetation planting would be about 0.13 hectares. This would affect two landowners (Norwest City Pty Ltd and the State Government). During construction TfNSW would lease the land from Norwest City Pty Ltd, while the footpath along Norwest Boulevard (which is managed by Roads and Maritime) would be closed under an agreement arrangement. The only acquisition would be the permanent acquisition needed for the northern entrance and the surrounding area. This acquisition would result the loss of about 20 car parking spaces servicing the Norwest Marketown shopping centre and would represent a loss about one per cent of the available parking in the area. The leased areas would be handed back once the construction work was complete and the footpath would be reopened. Table 3.8 provides the property acquisition details.

Table 3.8 Leasing arrangements and property acquisition

Lot and DP	Current land use	Approximate area (m^2)	Temporary/permanent
Construction			
DP878258 (Norwest City Pty Ltd)	Car park (former fast-food establishment)	3000 m^2	Leased from Norwest City Pty Ltd covering an area that contains about 60 car parking spaces and the former fast-food restaurant.
Norwest Boulevard (Classified Road) (State owned managed by Roads and Maritime)	Road – dual carriageway	620 m^2	Temporary footpath closure under agreement with Roads and Maritime
Operation			
DP878258 (Norwest City Pty Ltd)	Car park (former fast-food establishment)	1300 m^2	Permanent acquisition from Norwest City Pty Ltd resulting in the loss of about 20 car parking spaces.

4. Statutory and planning considerations

This chapter describes the statutory and planning framework that would apply during the proposal's construction and operation by referencing relevant environmental planning instruments (EPIs) and other legislative provisions. The chapter also confirms the statutory position and identifies the approvals, licences and notices needed in order for the proposal to proceed.

4.1 Previous planning approvals

In 2008, concept plan approval for the Sydney Metro Northwest was granted under Part 3A of the NSW *EP&A Act*. This approval was later transitioned to a 'staged infrastructure' approval under part 5.1 of the EP&A Act following the repeal of Part 3A. Subsequently, two EISs were prepared, the first for the major civil construction work (determined in September 2012) and the second for Norwest Station's rail infrastructure and systems (determined in May 2013). This was followed by a third development application to support the development of a rapid transit rail stabling and maintenance facility at Tallawong Road, Rouse Hill (submitted in July 2013 and determined in January 2014).

This proposal is being progressed for approval as development without consent under *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) *(*NSW Government, 2007) as described below in Section 4.2.1. This follows TfNSW identifying that the proposal's scale and impact would not be sufficient to be considered state significant infrastructure (NSW Government, 2011)[3].

4.2 State environmental planning policy

The following state environmental planning policies (SEPPs) are relevant to the proposal.

4.2.1 State Environmental Planning Policy (Infrastructure) 2007

ISEPP (NSW Government, 2007) aims to facilitate the effective delivery of infrastructure across the State. Clause 79 of *ISEPP* permits a railway or railway infrastructure facilities to be developed by or on behalf of a public authority without consent.

As the proposal is for a defined rail infrastructure facility (and specifically a 'pedestrian and cycleway facility') and is to be carried out on behalf of TfNSW it can be assessed under Part 5 of the *EP&A Act*. Development consent from council or the Department of Planning and Environment is not required.

[3] Schedule 3(1) of *State Environmental Planning Policy (State and Regional Development) 2011* (NSW Government, 2011b) includes a provision allowing TfNSW to consider if any proposed road infrastructure needs to be approved under Part 5.1 of the *EP&A Act*. If this planning approval pathway is adopted by Transport for NSW, then an environmental impact statement (EIS) is prepared for approval by the NSW Department of Planning and Environment.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* (NSW Government, 1974) and does not affect land or development regulated by *State Environmental Planning Policy No. 14 – Coastal Wetlands* (NSW Government, 2010), *State Environmental Planning Policy No. 26 – Littoral Rainforests* (NSW Government, 2011a)*, State Environmental Planning Policy (State and Regional Development) 2011,* (NSW Government, 2011b) or *State Environmental Planning Policy (Transitional Major Projects) 2005* (NSW Government, 2005). For that reason other EPIs do not apply in preference to the provisions of the *ISEPP*.

Under the *ISEPP* there is also a requirement to notify key Government agencies about the proposal if it likely to affect various environmental assets. In this case TfNSW was required to notify the council as discussed further in Chapter 5.

4.2.2 State Environmental Planning Policy No. 55 – Remediation of Land

*State Environmental Planning Policy 55 on the Remediation of Land (SEPP 55) (*NSW Government, 1988) provides a State-wide approach to the remediation of contaminated land for the purpose of minimising the risk of harm to the human health and the environment. Typically development consent must not be provided on land unless:

- Consideration has been given as to whether the land is contaminated.
- If the land is contaminated, consideration has been given to ensure that the land is suitable in its contaminated state (or would be suitable, after remediation) for the purpose for which the development is proposed to be carried out.
- If the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, consideration has been given to ensure that the land would be remediated before the land is used for that purpose.

As the proposal is permissible without consent the provisions of SEPP 55 do not apply. However, section 6.1.3 of this REF contains an assessment of the potential contamination impacts associated with the proposal due to the proximity of an active service station. This has been prepared in general accordance with the provisions of *SEPP 55*.

4.3 Commonwealth and State legislation and regulation

The following legislative provisions would apply to the proposal during its construction and operation.

4.3.1 NSW Environmental Planning and Assessment Act 1979

As noted in Chapter 1, the proposal constitutes a development ‘activity’ for the purposes of Part 5 of the *EP&A Act* by reason of clause 79 of the *ISEPP* (NSW Government, 2007). Under this pathway, TfNSW is required to:

- Examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity, in accordance with Section 111 of the *EP&A Act*.
- Review the environmental factors described under Clause 228 of the EP&A Regulation to consider the likely impact of the proposed ‘activity’.
- Subsequently, determine whether or not the activity is likely to significantly affect the environment or is likely to significantly affect threatened species, populations and ecological communities.

Chapter 6 of this REF assesses the likely effect of the proposal on the environment including any threatened species, populations and ecological communities. Having regard to the provisions of sections 111 and 112 of the *EP&A Act*, no significant impact on the environment or threatened species is considered likely. As such, there is no recommendation to prepare either an EIS or a SIS for the purpose of approving this proposal.

Sustainability requirements under the EP&A Act

Schedule 2 of the *EP&A Regulation* and Section 6(2) of the NSW *Protection of the Environment Administration Act 1991* (NSW Government, 1991) outline the four key principles of ecologically sustainable development (ESD). TfNSW is committed to ensuring that its projects are implemented in a manner that is consistent with the four ESD principles, which are:

- The precautionary principle: if there are threats of serious or irreversible damage, a lack of full scientific uncertainty should not be used as a reason for postponing measures to prevent environmental degradation.
- Intergenerational equity: the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.
- Conservation of biological diversity and ecological integrity: the diversity of genes, species, populations and their communities, as well as the ecosystems and habitats they belong to, should be maintained or improved to ensure their survival.
- Improved valuation, pricing and incentive mechanisms: environmental factors should be included in the valuation of assets and services.

TfNSW has considered these principles and broader sustainability themes in developing this proposal. This is discussed in Section 8.3 of this REF.

4.3.2 (NSW) National Parks and Wildlife Act 1974

The *National Parks & Wildlife Act 1974* (NPW Act) (NSW Government, 1974) provides statutory protection for some aspects of Aboriginal heritage. This protection applies irrespective of the heritage's significance or issues of land tenure. However, areas are only gazetted as 'Aboriginal Places' if the Minister is satisfied that sufficient evidence exists to demonstrate that the location was and/or is, of special significance to Aboriginal culture.

The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (NSW DECC, 2010) was introduced in 2010 to assist individuals and organisations exercise due diligence when carrying out activities that may harm Aboriginal objects. Central to this is the need to apply for consent in the form of an Aboriginal heritage impact permit (AHIP) if the proposal is expected to impact of Aboriginal values.

The NWRL EIS determined that the area surrounding Norwest Station is highly disturbed. It concluded that (at best) there is a 'very low' potential for intact Aboriginal sites to be present. This conclusion extends to cover this proposal. This makes the above provisions largely irrelevant other than the need to include a default commitment to manage any unexpected finds as discussed in Section 6.10.

4.3.3 (NSW) Heritage Act 1977

The *Heritage Act 1977* (NSW Government, 1977) provides for the conservation of buildings, works, archaeological relics and places of heritage value. It principally achieves this by listing, and therefore protecting, heritage values, under a number of registers. This includes the State heritage register (SHR), the heritage and conservation register (HCR), LEP heritage schedules, public authority heritage and conservation registers (termed Section 170 registers) and interim heritage orders (IHOs).

The Act requires TfNSW to assess the proposal's impact on historic buildings, places, objects and archaeological sites to ensure their cultural heritage value is protected (refer to Section 6.11.3).

The Act requires developers to obtain permits and approvals in instances where there is an expected impact on non-Aboriginal heritage values in the area. Consistent with the above conclusions, the historic disturbance of the local area, including the proposal footprint, removes all but the remotest risk of encountering subsurface non-Aboriginal archaeology. Consequently, there is no supporting requirement to obtain approval from the NSW Heritage Branch prior to undertaking the work. There is however a requirement to include a default provision to manage any unexpected finds as discussed in Section 6.11.4.

4.3.4 (NSW) Noxious Weed Act 1993

The NSW *Noxious Weeds Act 1993* (NSW Government, 1993a) provides for the declaration of noxious weeds by the Minister for Primary Industries. Noxious weeds may be considered noxious on a national, state, regional or local scale. All private landowners, occupiers, public authorities and councils are required to control noxious weeds on their land under Part 3, Division 1 of the above Act.

A number of exotic species were recorded within the study area and several are declared noxious weeds within The Hills local government area (LGA). That said the proposal footprint is largely located on an area of hard-standing with the exception of a small area of roadside planted amenity vegetation. As such, while there is all but the remotest potential of encountering and needing to manage any noxious weeds, the work would need to be carried out to ensure any cleared areas were inspected and managed to prevent the spread of seed stock. This would include the appropriate management and disposal of suspected weed-containing materials. Further detail is provided in Section 6.10.4.

4.3.5 (NSW) Roads Act 1993

Under the *Roads Act 1993* (NSW Government, 1993b) the consent of the relevant road's authority is required to dig up, erect a structure or carry out work in, on or over a road (refer to Section 138 of the Act). For classified roads the relevant roads authority is Roads and Maritime Services and for unclassified roads it is the relevant local council. In the case of this proposal it would require work on Norwest Boulevard (a classified road) and Century Circuit (a private road that is neither managed by Roads and Maritime or the council).

Despite this, TfNSW does not need Roads and Maritime or landowner consent under the Act prior to starting work onsite. This is due to the exclusions set out under Clause 5(1), Schedule 2 of the Act. However TfNSW would be required to obtain a road occupancy licence (ROL) from the Roads and Maritime Traffic Management Centre (TMC) to work on Norwest Boulevard. It would also contact the landowner before starting work.

The ROL would allow the contractor to work within the classified road corridor and to implement agreed diversions, road closures and traffic management controls. Similar requirements may also be requested by the council before, during, and post-construction to ensure there is an integrated response to traffic management through the area over this period. This is discussed in Chapter 5.

4.3.6 (NSW) Fisheries Management Act 1994

The objectives of the *FM Act* are to conserve, develop and share the fishery resources for the benefit of present and future generations. Should the proposal result in any impact on a fishery resource then the provisions of this Act would apply. However, such a potential is considered exceptionally remote given the proposal's location away from any relevant surface water features.

One remaining risk would be the discharge of sediment into an existing stormwater drain or sewer during construction or operation, which would result in the blockage or siltation of a (remote) watercourse. If such an impact was to occur, then TfNSW would need to obtain a permit under the Act to clear the sediment.

4.3.7 (NSW) Threatened Species Conservation Act 1995

The *TSC Act* provides for the protection of threatened species, populations and ecological communities in NSW. If a threatened species, population or ecological community, or its habitat, is likely to occur in any area that may be affected by the proposal then an assessment of significance (AoS) must be prepared to determine whether the proposal would have a significant impact. If it is concluded that there would be a significant impact then TfNSW would be required to prepare a SIS for approval by the NSW Office of Environment and Heritage (NSW OEH). Given the highly urbanised and disturbed nature of the proposal footprint the provisions of this Act would not influence how the proposal would be approved. The Act has been considered for completeness in accordance with the requirements under part 5 of the *EP&A Act*.

4.3.8 (NSW) Protection of the Environment Operations Act 1997 (as amended)

Environmental protection in NSW is provisioned under the NSW *Protection of the Environment Operations Act 1997 (POEO Act)* (NSW Government, 1997b). The underlying objective of the Act is to reduce pollution and manage the storage, treatment and disposal of waste.

A key feature of the Act is the issuing of environmental protection licences (EPLs) for certain (scheduled) activities. NRT Consortium would work under an EPL due to the proposal being defined as a 'scheduled activity' under schedule 1(33) (5g) of the Act (i.e. ancillary works associated with railway systems activities (and specifically a tunnel)).

In addition, the Act would require NRT Consortium to manage the proposal to prevent and avoid its potential to cause water, noise and/or air pollution. TfNSW and its contractor would also be required to manage the proposal's waste streams.

This would be achieved through implementing the safeguards and management measures identified in Chapter 7 and the conditions and provisions of the EPL. TfNSW and its contractor would also be required to notify the NSW EPA (as the administrators of this Act) in instances where any pollution incident has the potential to 'cause or threaten material harm to the environment' (refer to Section 148 of the Act).

4.3.9 (NSW) Contaminated Land Management Act 1997

Part 3 of the NSW *Contaminated Land Management Act 1997* (NSW Government, 1997a) empowers the NSW EPA to regulate contaminated sites that pose a significant risk of harm to human health and/or the environment. While there are no registered contaminated sites local to the proposal footprint, it would be constructed within close proximity to an active service station. There is therefore an inherent contamination risk associated with such a land use.

Contamination management measures would be implemented to minimise any impacts of contamination and its removal. This Act would also require NRT Consortium to immediately notify the EPA if it suspected that the work has resulted in ground contamination or encountered/remobilised existing ground contamination. Section 6.1.3 discusses this further.

4.3.10 (Commonwealth) Environment Protection and Biodiversity Conservation Act 1999

Under the *EPBC Act* a referral is required to the Commonwealth Government for proposed 'actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land'. If the proposal is determined to be a 'controlled action' under the Act then approval from the Commonwealth Minister for the Environment would be required.

There are no matters of national environmental significance located within the general area of the proposal, as confirmed in Appendix A.

4.3.11 Disability Discrimination Act 1992

The Commonwealth Government *Disability Discrimination Act 1992 (the DDA)* (Commonwealth Government, 1992) aims to eliminate disability discrimination as far as reasonably practical. TfNSW promotes DDA compliance across all its proposals. As such, the proposal has been designed to provide pedestrian and public transport access for people with mobility issues.

4.4 Other relevant environmental planning instruments

4.4.1 Local environmental and development plans

The proposal is located within the Hills Shire Council LGA. Development control and land use zoning is managed under *The Hills Local Environmental Plan (LEP) 2012* (Hills Shire Council, 2012) and *The Hills Development Control Plan (DCP) 2012* (Hills Shire Council, 2012).

The Hills Local Environmental Plan 2012

While the policies and provisions of *The Hills LEP* do not apply to the proposal (refer to Section 4.1.2) they are relevant in identifying potential land use impacts and planning policy conflicts. The proposal footprint is located on land zoned for commercial uses:

- B2: Local Centre
- B7: Business Park.

Table 4.1 describes the land use objectives of each zone and the proposal's consistency, or otherwise, with these objectives.

Table 4.1 Consistency with The Hills LEP 2012 land use zoning objectives

Land use zone (location) and objectives	Proposal's consistency with the objectives
B2: Local Centre ■ To provide a range of retail, business, entertainment and community uses that serve the needs of people who live in, work in and visit the local area ■ To encourage employment opportunities in accessible locations ■ To maximise public transport patronage and encourage walking and cycling	The proposal forms part of an overall program to provide greater public transport and accessibility into the area through the creation of the Sydney Metro Northwest. The proposal would permit safe and efficient access to and from the Norwest Station. This would promote further employment opportunities by providing a dedicated direct access to the more active part of the Norwest Precinct.
B7: Business Park ■ To provide a range of office and light industrial uses ■ To encourage employment opportunities ■ To enable other land uses that provide facilities or services to meet the day to day needs of workers in the area ■ To make provision for high technology industries that use and develop advanced technologies, products and processes	The proposal would permit safe and efficient access to and from the Norwest Station. It would also serve as a dedicated quick access to and from the existing Norwest Business Park therefore meeting the 'day to day needs of workers in the area'. In combination with the construction of the Sydney Metro Northwest, this would improve access to the Norwest Business Park therefore indirectly encouraging employment opportunities.

The Hills Development Control Plan 2012

Development control plans (DCPs) are non-statutory documents. They support LEPs by providing more-detailed planning and design guidelines. Like *The Hills LEP 2012*, the policies and provisions of *The Hills DCP* do not apply to the proposal (refer to Section 4.1.2), however they are relevant in identifying potential land use impacts and planning policy conflicts.

The *Hills DCP 2012* seeks to provide development guidance and standards to ensure aesthetically pleasing and practical development that relates to adjoining and surrounding areas. The Norwest Station precinct and proposed pedestrian underpass are not located in any special character area; however they are located within 300 metres of the Norwest Town Centre Residential Precinct who amenity and values are protected under a number of development controls.

Table 4.2 describes the relevant DCP objectives development principles that are relevant to the proposal. The table also describes the proposal's consistency, or otherwise, with these objectives and principles.

Table 4.2 Consistency with The Hills DCP 2012 objectives and principles

Principles and objectives	Proposal's consistency with the objectives
Provide a comprehensive document that contains all the development controls, standards and provisions that apply to land in The Hills Shire, and that satisfies the legislative requirements with regards to the preparation and content of Development Control Plans.	Not applicable – objective is related to the development and maintenance of the DCP.
Clearly set out the processes, procedures and responsibilities for the involvement of the community and key stakeholders in the development of land.	Not applicable – objective is related to the development and maintenance of the DCP.
Encourage a high standard of aesthetically pleasing and functional development that sympathetically relate to adjoining and nearby developments.	The proposal would be tied in with the Norwest Station through similar architectural features. The overall design of the Norwest Station precinct will be sympathetic to the surrounding development types.

Principles and objectives	Proposal's consistency with the objectives
Ensure that development will not detrimentally affect the environment of any adjoining lands and ensure that satisfactory measures are incorporated to ameliorate any impacts arising from the proposed development.	The proposal would be primarily underground, excluding the entry portal on the northern side of Norwest Boulevard. This entry would be aesthetically designed to ensure they relate to the surrounding development, and would not detrimentally impact on adjoining properties.
Encourage innovative and imaginative design with particular emphasis on the integration of buildings and landscape areas that add to the character of neighbourhoods.	The proposal would be similar in style to that of the adjacent Norwest Station to ensure consistency in design and integration into the overall fabric of the area.
Provide safe and high quality environments for the residents, workers and visitors of the Shire.	The proposal would provide safe access for pedestrians across Norwest Boulevard, grade separated from road traffic.
Ensure that development incorporates the principles of ESD.	The proposal would seek to provide greater motivation for active movement by introducing safe and efficient pedestrian networks to and from the Norwest Station.

4.5 Planning approval pathway and statutory position

4.5.1 Planning approval pathway

Prior to determining whether to proceed with the activity as set out in the proposal, TfNSW is required under Part 5 of the *EP&A Act* to 'examine and take into account to the fullest extent possible all matters affecting, or likely to affect, the environment by reason of that activity'. This REF documents the required assessment of environmental impacts and describes measures proposed to mitigate any adverse impacts.

The REF concludes that the proposal is unlikely to have a significant environmental impact (refer to Chapter 8). In addition, it would not affect any matters of national environmental significance protected under the *EPBC Act*, or critical habitat, threatened species, populations, or communities listed under the *NSW TSC Act* or the *NSW FM Act*.

4.5.2 Additional approvals and notification requirements

In addition to the determination of this REF, TfNSW would be required to undertake the following actions prior to construction:

- Secure a ROL under Section 138 of the NSW *Roads Act 1993* (NSW Government, 1993b).
- Work under an EPL due to the proposal being listed under schedule 1(33) of the *POEO Act.*

While certain legislative provisions do not apply to this proposal, TfNSW has also committed to working closely with:

- The Hills Shire Council to ensure there would be an integrated response to traffic management around the immediate works area during construction.
- Utility and service providers to ensure all utilities would remain unaffected by the work.
- The Hills District Emergency Services to determine access requirements during construction.
- Roads and Maritime to ensure there would be an integrated response to traffic management and public transport integration during operation.

5. Stakeholder and community consultation

This chapter summarises the planned community and stakeholder engagement activities to be undertaken to support the REF display and construction phase. The REF display period will include targeted consultation to provide an opportunity for stakeholders and the community to provide feedback on the proposal.

5.1 Consultation objectives

The proposal would be delivered under a communications and consultation strategy that describes the key activities that would take place to inform and engage with the local community and key stakeholders across the proposal's lifecycle, including:

- Providing a communication and engagement plan that supports the REF program.
- Informing the community and other stakeholders by providing clear, factual and timely information about planned construction and operational work and its associated environmental and social impacts.
- Providing a mechanism for prompt issues resolution.
- Providing adequate opportunities for community members and other stakeholders to provide feedback.
- Ensuring coordinated communications with other relevant agencies and stakeholders including Roads and Maritime, The Hills Shire Council, Endeavour, Telstra, Optus and Jemena.

This REF will also be displayed. Through this process the community and stakeholders area will be invited to make submissions, raise issues, seek clarification or ask questions about any aspect of the proposal. All issues that are raised will be considered and responded to in a report. This process will constitute the main way in which TfNSW will advise the community about this proposal. Where required community updates will be provided online and posted to local residents.

5.2 ISEPP notification

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to commencing work that would affect various infrastructures. This includes the need to notify:

- The council where the proposal is likely to impact on stormwater infrastructure, likely to generate traffic, affect any sewerage infrastructure, involves the connection/use of a water supply, installing a structure in a public place or affects a council-maintained footpath, a local heritage item, or takes place within flood liable land.

There is also a requirement to notify other Government agencies that administer various environmental statutes.

The Hills Shire Council will be notified at the same time as the REF is publically displayed due to its likely impact on council-managed infrastructure. TfNSW will consider any comments provided by the council and will report this in the response to Submissions Report (refer to Section 5.5).

5.3 Consultation during REF display

5.3.1 Engagement activities and tools

Table 5.1 lists the key engagement activities and tools and how they will be used to engage with the community and stakeholders during the public display of the REF.

Table 5.1 Key community and stakeholder engagement tools and activities

Engagement tool	Activity
Project Website	northwestrail.com.au
Community Newsletter	A newsletter will be distributed to surrounding residential, community and commercial properties.
Stakeholder meetings/briefings	TfNSW will undertake a briefing session with The Hills Shire Council, and other stakeholders on the proposed works the subject of this REF.
Advertisements	Advertisements will be placed in The Hills Shire Times and the Hills News. The advertisements will notify the community about the proposal.
Doorknocking	Directly impacted residential, community and commercial properties will be doorknocked to notify stakeholders of the REF display.

5.3.2 Consultation with Government Agencies and key stakeholders

During the public display of the REF, TfNSW intends to brief The Hills Shire Council and other key stakeholders. Any feedback would be considered in the detailed design.

5.4 REF display

The REF will be likely displayed for two weeks in June/July 2015. During this period, written submissions will be accepted for consideration.

The REF will be displayed at the following locations:

- The Sydney Metro Northwest website: northwestrail.com.au.
- The Sydney Metro Northwest Community Information Centre, Shop 490, Castle Towers Shopping Centre (entry off Old Castle Hill Rd) (Monday to Friday 9.00 am to 5.00 pm).
- The Hills Shire Council offices, 3 Columbia Court, Baulkham Hills (Monday to Friday 9.00 am to 5.00 pm).
- The Hills Library – Baulkham Hills Branch, Railway Street, Baulkham Hills (Monday 10.00 am to 8.00 pm, Tuesday to Friday 10.00 am to 5.20 pm, Saturday 10.00 am to 1.00 pm).
- TfNSW Information Centre, Ground Floor, 388 George Street (corner of King and George Streets) Sydney (Monday to Friday 9.00 am to 5.00 pm).

Community members and stakeholders are invited to submit their feedback on the proposal to TfNSW by emailing info@northwestrail.com.au or writing to:

Sydney Metro Northwest – Norwest REF
PO Box 588
North Ryde BC NSW 1670

During the display period, community members and stakeholders can direct any enquiries to TfNSW:

- Enquiries phone line: 1800 019 989

  Email: info@northwestrail.com.au

5.5 Submissions report

As noted under Section 5.1 following the REF display, a report will be prepared by TfNSW. This report will:

- Summarise the issues raised in the submissions.
- Provide responses to each issue raised in the received submissions.
- Describe the proposed modifications and describes and assesses the environmental impact these changes.
- Identify any proposed new or revised environmental safeguards and management measures.

TfNSW will write to individuals and organisations that have made submissions advising them that their submission will be addressed in the submissions report. The submissions report will be published on the Sydney Metro Northwest website http://northwestrail.com.au.

5.6 Post-determination consultation activities

Subject to determination of the project, TfNSW would continue to engage with community and stakeholders in the lead up to, and during the proposal's construction.

Methods used for engaging and providing project information to the community and stakeholders include:

- Project updates on the Sydney Metro Northwest website: northwestrail.com.au.
- A 24-hour community information line: 1800 019 989.
- An enquiry email address: info@northwestrail.com.au.
- Notifying the local community of planned major work, major construction activities and any road diversions.
- Doorknocking directly impacted residents and businesses.
- Meetings and briefing for stakeholders, businesses and residents as required.
- Site signage.

6. Environmental assessment

This chapter identifies the likely environmental impacts that would occur during the proposal's construction and operation. Proposal-specific safeguards and management measures have been identified to mitigate likely impacts. These are reported at the end of each assessment section and summarised in Chapter 7. This chapter is structured to report the impacts in the order of their relevance to the proposal.

6.1 Soils, geology and water

This section assesses the proposal's impact on surface and groundwater, geology and soils.

6.1.1 Method

Study area

The study area accounted for the likely effects across the proposal footprint, within the local surface and groundwater catchment and to the underlying soil landscape and solid and drift geology. Regional characteristics were used to provide wider context and reference.

Method and assessment criteria

The assessment:

- Identified and described the soil landscape and solid and drift geology characteristics of the study area by referring to:
  - *1:100,000 Geological Series Sheet 9130: Sydney, 1983* (Herbert, C., 1983)
  - *1:100,000 Soil Landscape Series Sheet 9130: Sydney, 1989* (Chapman G.A. and Murphy C.L., 1989)
  - *The Hills LEP Acid Sulphate Soil mapping, 2012* (The Hills LEP, Hills Shire Council, 2012).
- Identified and described the surface and groundwater characteristics of the study area.
- Confirmed the current drainage arrangements and discharge pathways across the study area focussing on the proposal footprint.
- Confirmed the study area's contamination potential by referring to:
  - The EPA's contaminated land records
  - Pollution prosecutions and notices issued by the EPA
  - Historic mapping
  - Existing physiochemical testing of the soil and groundwater.
- Confirmed the flood risk potential across the proposal footprint.
- Identified key activities that could potentially affect surface or groundwater values.
- Determined the sensitivity of the subsurface to the changes that would occur as a result of introducing the proposal into the study area.
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Environmental assessment impact ratings

The impact assessment considered the likelihood for the proposal to impact on the local surface and groundwater catchment, the underlying soil landscape and/or solid and drift geology either directly or indirectly though migration pathways. Consequently, the assessment considered the value that these resources provide and any how these values would be likely affected by the proposal. Exposure, contamination, migration, flood risk and change in function/quality were aspects referred to in undertaking the assessment. This was used in defining the following the impact ratings:

- Negligible: where there is predicted to be no perceptible risk of contamination, pollution, flooding, exposure or change in asset functionality or impact on soil/water quality.
- Minor: where there is predicted to be a measurable change however no assessed risk of contamination, pollution, flooding, exposure or change in asset functionality or impact on soil/water quality.
- Moderate: where there is predicted to be a notable change that may result in a risk of contamination, pollution, flooding, exposure or change in asset functionality or impact on soil/water quality. Importantly the risk or impact could be effectively mitigated.
- Major: where there is predicted to be a notable change that may result in a risk of contamination, pollution, flooding, exposure or change in asset functionality or impact on soil/water quality. Importantly, the risk or impact would either be permanent and irreversible, semi-reversible however the values and existing environmental conditions could not be reinstated to an acceptable level, or it would be prohibitively expensive to reverse the impact. A major impact may also lead to the risk of prosecution, a fine or legal action.

Notably, the ratings are a combination of the likelihood of the impact occurring and the magnitude of the impact, were it to occur.

6.1.2 Existing environment

Soils and geology

Landform

The proposal is located in a regional landform shaped by the environments of the Cumberland Plain and The Hills. The main difference between the two environments regionally is their relative heights above sea level, which vary by up to 100 metres. The proposal footprint is located in the environment of The Hills, which comprises a lower gently undulating landform while the Cumberland Plain is located on a rising undulating plateau.

The landform has been locally influenced by a number of meandering lower-order creeks and watercourses, the closest of which is Strangers Creek located about 500 metres from the proposal footprint. Others include Elizabeth McArthur Creek, Caddies Creek and Second Ponds Creek.

Within the study area, the topography gives rise to a gentle south-east to north-west sloping topography across The Hills landform that varies from about 110 metres above sea level to about 60 metres above sea level over a distance of about three kilometres.

Regional geology (solid and drift)

The broadest geological classification in the area is that of the Sydney Basin, which covers a large expanse of the metropolitan area. The basin is characterised by the sequential layering of sediment. The quality and character of the layered sediment (sands) varies. It has been affected by how the sediments were deposited and how they were subsequently compacted (creating sandstone), weathered and exposed.

As a result, the main geological unit the region is Hawkesbury Sandstone overlain in locations by the Wianamatta Group (shales). This is true of the study area, which is immediately underlain by Ashfield Shale; a sub-set of the Wianamatta Group. These shales contain black mudstone with frequent iron-rich clay bands and are typically associated with overlying Blue Gum Forest and Sydney Turpentine-Ironbark Forest. Its mineral properties are limited and therefore the overlying soil is not typically fertile.

Soil landscape

The study area is located on the interface of the Blacktown and Luddenham soil landscapes.

- Blacktown soil landscape: The associated soils occur on the low undulating terrain of the Wianamatta Group shales. The soils are generally about one metre deep, red-brown, and podzolic (iron-rich). Typically, they are moderately reactive, highly plastic and poorly draining.
- Luddenham soil classification: These soils are sub-set of the Blacktown soil landscape. They are characterised by being highly erosive.

It was confirmed through geotechnical investigations (TfNSW, 2012b) that the proposal footprint is probably underlain by fill material, which is likely to have been placed when the wider business park area was developed in the 1980s.

Overall soil and geological profile

A geotechnical model was developed for the land beneath Norwest Station (TfNSW, 2012b). It confirmed the profile and sequence beneath footprint of Norwest Station and it is considered likely that this profile extends to beneath the proposal footprint.

Table 6.1 Geological sequence and depth

Material	Depth from surface (metres)	Description
Fill	From the surface to about 0.5 to 2.5 metres	Minor fill, typically associated with road construction and landscaping to approximately 0.5 metres found across much of the area, however extending to 2.5 metres to the west where this material is likely to be associated with a fill platform for the commercial developments of Brookhollow Avenue. The fill platform material comprises silty sand, likely to have been imported to the site.
Residual soil and shale	From about 0.5 to 2.5 metres to 2 to 5 metres	Residual soil generally one to two metres thick and typically described as very stiff to hard, high plasticity clay. The shale is generally observed as a thin layer, typically less than one metre below the residual soil and described as ‘shaley clay’.
Kellyville laminate	From about 3 metres to 6 to 7 metres	This material is encountered as a low-to-medium strength dark grey siltstone with orange brown staining and clay seams.
Rouse Hill siltstone	From about 6 to 7 metres to 8 to 15 metres	The less weathered shale is encountered as a medium-to-high strength fresh siltstone. Localised heavy jointing is observed within the Rouse Hill Siltstone, typically within the lower half of the formation close to the boundary with the Mittagong Formation.
Mittagong Formation	From about 11 metres to 16 metres	The material is encountered as a highly fractured, fresh interbedded siltstone and sandstone and typically about 2.5 metres thick. This is the interface point between the shale and sandstone.
Hawkesbury sandstone	Below about 16 metres	The base sandstone is characterised as fresh, fine-to-medium grained, indistinctly cross bedded with widely spaced defects.

Acid sulphate soils

Acid sulphate soil (ASS) is present across many areas of Sydney. It occurs in areas rich in iron sulphide, which generate sulphuric acid if exposed to the air (oxygen). The acid is an issue in its own right as well as causing the mobilisation of metals (e.g. aluminium, iron, manganese), which can also have a detrimental environmental impact. ASS can also decrease the amount of dissolved oxygen in surface waters, leading to eutrophic conditions.

According to regional mapping, there is no known risk of (potential) acid generating soils being present across the study area. However, the iron-rich bands that occur in Ashfield Shale can contain iron-sulphide material. As such, the risk of encountering ASS cannot be fully discounted.

Contaminated land

Development history

The area has been heavily developed since the 1980s. While this has been principally for commercial and residential development, there are two specific land issues that present a contamination risk. They include the surficial fill material (refer to the previous section), as its origin is unknown, and the Shell service station located about 30 metres east of the limit of the proposal footprint.

While investigations in 2012 did not note or raise concern about the quality of the fill under Norwest Station, the encountered groundwater was recorded as containing elevated hydrocarbon concentrations believed to be associated with the service station (TfNSW, 2012b) (refer to the following section).

With regards to the proposal footprint, the unknown condition, origin, and variability in underlying fill material means that it may still contain various contaminants. Also, for the groundwater to contain hydrocarbons likely means that there would be some impact on the soils close to the service station. The extent of any impact has not been confirmed however it would be reasonable to assume that it may have impacted the soils of the proposal footprint.

Contaminated land register

There are no registered contaminated sites in the study area as confirmed by reviewing the NSW Environment Protection Authority (EPA) contaminated land records. These are sites determined to be contaminated within the definition of the *NSW Contaminated Land Management Act 1997* (NSW Government, 1997a).

Surface and groundwater

Surface water

The nearest natural surface watercourse is Strangers Creek located about 500 metres to the west of the proposal footprint. It is classified as a lower-order creek and forms a tributary of Cattai Creek, which in turn drains into the Nepean River. The watercourse typically retains a permanent flow south to north. The riparian habitat of Strangers Creek has been improved under a joint Sydney Water/ Hills Shire Council landscape management plan, while there are future plans to further enhance the embankments for recreational use.

There are also a number of artificial waterbodies developed to improve the amenity of the area. The nearest is Norwest Lake, located about 200 metres north east of the limit of the proposal footprint.

The alignment of Strangers Creek was also modified and increased to create the lake area Hillsong Church, about 500 metres to the north of the limit of the proposal footprint.

Drainage

The proposal footprint is located on existing hardstand, with the exception of a small area of planted vegetation. Stormwater drains are used to capture runoff from both Norwest Boulevard and Norwest Marketown shopping centre car park. It is likely that these drains discharge to the trunk main sewer and then possibly the local creek; however this was not confirmed at the time of preparing this REF.

Flood risk

The study area is not classified as being at risk of major flooding; however localised flooding may occur adjacent to the creek lines following significant rainfall. As the proposal footprint is located a notable distance from any creek line it would therefore be exceptionally unlikely that it would be at risk of flooding.

Groundwater

General characteristics

The base regional groundwater unit is contained with the Hawkesbury Sandstone. Typically, groundwater levels and flows within the sandstone follow the area's topography. The mean water table depth can vary by up to 130 metres. The water table depth can also change by up to 10 metres due to the effects of inundation, drawdown and rainfall.

Depth

The groundwater under the study area is likely to be unconfined or occasionally perched. While the water table would vary due to natural fluctuations (as described above) the mean depth is likely to be consistent across the study area.

Within the context of the proposal footprint, nearby groundwater monitoring confirmed the presence of a perched water table within the shale at about 6 metres below the ground surface and a base flow in the sandstone at about 14 metres below the ground surface (TfNSW, 2012b). While the same conditions would be likely to occur under the proposal footprint they may vary due to the unpredictable characteristics of any underlying fill material (refer to Table 6.1).

Flow and direction

Geology also affects the rate and direction of groundwater flow. Regionally, it is determined that the underlying geology provides for flows of about one litre per second over every kilometre (reported as 1 l/s/km) (Golder Associates, 2008). Around the proposal footprint the rate of groundwater inundation (flow) is lower, calculated at about 0.3 to 0.4 litres per second (TfNSW, 2012b). The direction of groundwater flow is also likely to be from the south-east to the north-west towards Strangers Creek.

Chemistry

Monitoring undertaken in support of the Sydney Metro Northwest confirmed the groundwater to be moderately saline (however it can include areas of high salinity), slightly acidic-to-neutral, moderately conductive, and iron rich. Further chemistry testing on the regional groundwater confirmed the water to be:

- Too brackish (saline) for discharge to a creek
- Iron rich to the point of oxidising and precipitating out causing clogging and staining
- Too turbid to allow its discharge to surface waters
- Rich in iron, nickel, copper and zinc at concentrations that exceed drinking water standards.

Groundwater testing (TfNSW, 2012b) close to Norwest Station also confirmed the presence of hydrocarbons in the form of total petroleum hydrocarbons (TPH). The source of the hydrocarbons was attributed it to the service station.

The chemistry of the groundwater would make it unsuitable for drinking; however it could be potentially used for stock watering, industry or construction. The salinity of the water would also make it unsuitable for discharge via a standard stormwater system.

6.1.3 Potential impacts

Construction

Geology and soils

Accidental spillage

There is limited risk for the construction work detailed in Section 3.4 to result in major accidental chemical, oil and fuel spillage. More likely, would be the potential for minor spills to occur as a result of:

- General construction activity taking place at the main construction site.
- Accidents or poorly maintained vehicles along haulage routes.
- Poor materials handling, poor materials storage or poor equipment maintenance practices at the construction compounds/laydown area.

The corresponding activities taking place within the proposal footprint that would give rise to the greatest risk of causing an accidental spillage would include:

- Major ground excavation work
- Spoil excavation, transfer and management
- Spoil and waste removal offsite (i.e. haulage)
- Material delivery to site (i.e. haulage)
- Loading and unloading.

The effects of an accidental spillage would depend on where it would occur, the type and quantity of materials spilt, and the sensitivity surrounding land conditions. Under this proposal the two greatest risks would be:

- Surface spillages next to the stormwater drains that service both the car park and Norwest Boulevard.
- Subsurface spillages during ground excavation work when the soil and geology is exposed.

Major spills could potentially impact the quality and chemistry of the soil landscape or geology. They may also migrate offsite to affect adjacent creeks and/or the groundwater (refer to the following section).

While this is a potential concern, it would take a failure to implement basic site management controls for such an impact to occur. As such, the likelihood of a major spill incident occurring is assessed as negligible. More likely would be localised small spills occurring due to poor practices. As such, while the likelihood of such spills occurring would be minor-to-moderate their impacts would be less notable. As such, the overall impact is rated as minor adverse.

Sediment-laden runoff

The work would generate a notable quantity of spoil that has the potential to cause a water quality impact due to sediment-laden runoff. The subsurface work would also potentially affect groundwater turbidity due to the release of fine sediments during construction. The likelihood of either impact occurring within the surficial ground layers is increased due to the erosive nature of the soil landscape (refer to Section 6.1.2). The sediment has the potential to impact the quality of the adjacent creeks and/or groundwater (refer to the following section). The risk would be greatest during or immediately following heavy rainfall or as a result of sweeping the area as part of the general site maintenance.

The activities within the proposal footprint that would be at greater risk of causing sediment-laden runoff or the release of sediment into the groundwater include the ground excavation work, utility adjustments, drainage modifications, and when 'breaking-out' the surface.

Consistent with the risk of an accidental spill it would take a failure to implement basic site management controls for a major impact to occur, and therefore the impact is rated as negligible. Poor site management practices are more likely to lead to minor sediment releases above and belowground, the impact of which is rated as minor adverse.

Stockpile runoff

Temporary stockpiles would be created adjacent to the main circulation area excavation. These materials would only remain onsite for a short period of time prior to being transferred offsite, either to the main construction compound/laydown area (where they may be re-stockpiled) or sent for reuse, testing or disposal.

The main construction compound/laydown is an established site that will have existing management processes and controls in place to manage associated stockpile runoff. Similar provisions would be needed to manage runoff risks from material that would be continually stockpiled in the proposal footprint at a rate of about 190 m^3 per day over a period of about 8 weeks.

Stockpiled materials would be generated as a result of the planned ground excavation work, utility adjustments, drainage modifications, and when 'breaking-out' the surface.

Any major impact from stockpile runoff would only occur due to a failure to implement standard stockpile management measures and therefore the impact is rated as negligible. Conversely, and more likely, would be minor impacts that would occur due to poor management and maintenance. Such an impact is rated as minor adverse.

Saline soils

The underlying soils are moderately saline. This presents a risk during construction from the perspective of:

- Soil contamination and groundwater pollution due to saline leaching or groundwater level modification.
- Increased salinity in surface watercourses due to leaching and/or migration.

While saline conditions would be encountered during construction, for there to be an impact there would either need to be a notable change in groundwater chemistry, flows or conditions, or the creation of a migration pathway. The depth and location of proposed ground excavation work would not be sufficient to likely result in changes on a scale sufficient to cause any of the above impacts sufficient to rate the impact as negligible.

Acid sulphate soils

If acid sulphate soils were encountered during construction they may:

- Impact surface water quality, and in turn, aquatic environments if it is released during construction.
- Lead to the release of metals into the environment (e.g. aluminium, iron and manganese), which are recognised contaminants, pollutants and can have both human health and toxicological impacts.

While there is no recorded or mapped evidence of acid sulphate soil potential in the study area, the underlying shales are iron-rich and have been known to contain iron sulphides. Also, the nature of the underlying fill is unconfirmed. It too may contain materials rich in iron sulphides. For that reason, the risk cannot be fully discounted. Consequently, the likelihood of an impact occurring is negligible-to-low however the magnitude of the impact could be moderate-to-high. The overall impact is therefore rated as negligible-to-minor adverse.

Contaminated land

Causing contamination

The proposed work would require the use of various materials that can pollute and contaminate if discharged in sufficient quantities. However, the risk of causing contamination within the definition of the *Contaminated Land Management Act 1997* (NSW Government, 1997a) is considered negligible. More likely would be the spill or release of small quantities of contaminants and pollutants as described above under the previous heading. The risk of such an impact is rated minor adverse.

Encountering contaminants

There is a reasonable potential of encountering hydrocarbons in the underlying soils due to its migration from the service station adjacent to the proposal footprint. The associated concentrations would depend on a number of factors and without further assessment it is not possible to determine the exact risk. Any encountered contaminated materials would need to be managed, stored, treated and disposed of as a special waste, meaning it would need transferring offsite to a licenced facility (refer to Table 6.36). It would also present an exposure risk to workers during construction, principally through inhalation. The risk of such an impact is rated minor-to-moderate adverse.

Surface water

The surface water features and values in the study area would not be directly affected by the proposal. There is however a residual potential risk for chemical runoff and sediment to be discharged to stormwater drains which would drain to local creeks (refer to headings above). There is also the residual potential to disturb in situ contaminants and groundwater pollutants (notably hydrocarbons), which may migrate down gradient and affect adjacent surface waters. Overall however, the likelihood of such impacts occurring is assessed as negligible-to-low and correspondingly the impact is rated as negligible-to-minor adverse.

Groundwater

Causing pollution

The risk of causing groundwater pollution would be either as a result of an accidental spillage or due to sediment-laden runoff as discussed above under the corresponding headings.

Encountering pollution

The risk of discovering hydrocarbons in the groundwater under the proposal footprint is assessed as high given its recorded presence at elevated concentrations locally. This would present:

- At risk to construction workers via direct contact.
- A disposal management risk (as a result of needing to dewater the shaft and tunnel (refer to the following section)).
- A risk from its potential dispersion over a wider area than may be currently impacted.

While the likelihood of such impacts occurring is high, the magnitude of the impact would depend on the groundwater quality under the proposal footprint, which is unknown. It would be likely that the effects could be minor-to-moderate meaning that the overall impact is rated as moderate adverse.

Inundation

Groundwater is likely to be encountered during construction and therefore there would be a requirement to dewater. The dewatered groundwater is not of a quality that it could be discharged offsite either due to its natural properties or its potential hydrocarbon content. This would become a management issue due to the need to temporarily store water onsite and the need to dispose of it offsite, potentially as a special waste.

Depth, flow and chemistry

The excavation and management of inundated groundwater also has a potential to lead to the following impacts:

- Groundwater table drawdown or flow impedance through the excavation work leading to loss of supply at surface or in any adjacent wells.
- Flow diversions, which would affect groundwater chemistry and relationships.
- Regional effects at surface due to impacts on groundwater dependent ecosystems or more generally covering vegetation that relies on groundwater base flows.
- Changes in river chemistry and flows due to changes occurring in the groundwater table.
- Morphological changes in the subsurface geology due to changes in groundwater pressures, flows and patterns.
- Loss of groundwater pressure and its effects across the aquifer unit.
- Surface subsidence through loss of groundwater pressure.

The above impacts would only occur in locations of significant ground disturbance. The limited depth and extent of proposed ground excavation work means that any of the above impacts would be unlikely to occur, other than potentially a minor localised drawdown in the water table during construction. The proposal would also be unlikely lead to a cumulative impact in combination with the impacts of constructing Norwest Station.

As such, there are not expected to be any material groundwater impacts. This is supported by the fact that the rate of groundwater recharge is likely see the water table recover shortly after any dewatering activity stops. The impact is therefore assessed as negligible for all potential impacts other than the potential localised groundwater drawdown, which is rated as minor adverse.

Operation

Geology and soils

The proposal would be serviced from Norwest Station. As such, there would be no equipment within the proposal footprint that would present an operational maintenance risk in terms of leaks and spills.

The only operational risk would be an accidental spillage occurring from undertaking the few maintenance activities that require the use of potentially contaminating/polluting materials. Any materials would be used in exceptionally small quantities such that the associated impact is rated as negligible.

Surface water

Drainage changes

The proposal would not alter the impervious area. Consequently, runoff rates and stormwater discharge loading into the main trunk sewers would not be impacted. The stormwater drainage network would be unchanged following the work. There is also no proposal to alter the existing stormwater drainage infrastructure other than minor realignments to support kerb extension alterations. As such, the catchment of each drain would be unaffected and consequently there would be no operational impact. All drainage would continue to be managed under the current management and maintenance program. No new drainage devices or pollutant controls would be installed under the proposal.

Groundwater

Long term barrier and drawdown effects

The in-ground structure would have two potential operational effects, it would:

- Act as a barrier to groundwater movement.
- Drawdown on the groundwater table as a result of needing to dewater the circulation area and pedestrian link, which may affect surface settlement or lead to subsidence.

It was predicted that the entire Sydney Metro Northwest project would reduce the water table by one-to-two metres (TfNSW, 2012b). This proposal footprint would be insufficient in its size or scale to alter or supplement the overall predicted reduced groundwater depth. It may have a localised impact on the water table and groundwater flows. The scale of the changes would be unlikely to impede regional flows or the overall groundwater conditions. It would also be unlikely to cause any surface or morphological impacts. Therefore the likelihood of any localised changes is assessed as negligible-to-low, with the impacts conservatively rated as minor adverse.

Long-term inflow and discharge

It was predicted that the entire Sydney Metro Northwest project would generate inflows of about 0.5 mega litres per day, with Norwest Station generating inflows of about 0.026 to 0.035 mega litres per day, or about five-to-seven per cent of the project's total (TfNSW, 2012b). This proposal would supplement this. By volume, it may generate an additional inflow that is about one-fifth that of Norwest Station (0.0052 to 0.007 mega litres per day). This would therefore contribute about one per cent to the total inflow volumes, which is rated as a minor adverse impact.

Disposal

The inflow water captured across the entire Sydney Metro Northwest project will be managed at the Lady Game Drive water treatment plant. The water will be treated to correct its salinity, iron content, turbidity and bacteria content. It may also need treating for its hydrocarbon content. The inflow water captured under this proposal would be treated via the same process at the above water treatment plant.

6.1.4 Safeguards and management measures

Table 6.2 lists the soils, geology and water safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.1.3.

Table 6.2 Soil, geology and water safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Risk of encountering historic contamination or pollution during construction	Any contaminated areas directly affected by the project would be investigated and remediated prior to the construction work starting. All remediation works would be undertaken in accordance with the requirements of the *Contaminated Land Management Act 1997* (NSW Government, 1997a) and *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites* (NSW EPA, 1997). Given that groundwater in the vicinity of the adjacent service station is likely to be disturbed during construction, there is an exposure risk to construction workers. There is also a risk of waste management and disposal. This would need to be further assessed during the detailed construction planning stage. If required further delineation, remediation or management would need to take place before construction starts. Any investigations undertaken to confirm the contamination and pollution risk would be forwarded to TfNSW for approval along with any Site Auditor endorsed Remediation Action Plan (or similar). A Site Auditor would need to certify that any contaminated land or polluted groundwater had been remediated to a standard consistent with its proposed use.	TfNSW	Detailed design
Groundwater discharge and treatment	A specific process regarding groundwater discharge and treatment methods would be identified during detailed design. As part of this process the management of groundwater and surface water ingress into pedestrian link and northern entry, including the design of capture, monitoring, treatment and discharge methods shall be undertaken in consultation with the NSW Environment Protection Authority.	TfNSW	Detailed design

Impact	Safeguard/management measure	Responsibility	Timing
Stormwater pollution	Stormwater management controls would be implemented to: ■ Manage runoff volumes through the use of measures to promote stormwater infiltration ■ Minimise increases in peak flows through the use of detention and retention measures as appropriate. Treating stormwater through a range of at source and end point measures that are integrated with the urban landscape.	TfNSW	Detailed design
Groundwater reuse from operational inflows	All feasible and reasonable opportunities would be identified for the reuse of captured groundwater.	TfNSW	Detailed design
Water quality	Implement policy to preserve water quality as per Section 4.13 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design
Water efficiency	Implement water efficiency policy as per Section 4.9 and 4.15 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design
Pre-construction (construction)			
Accidental spillage and sediment-laden runoff	Procedures to quickly address any contaminant spill or accident would be developed and implemented during operation of Norwest Station sites.	Construction contractor	Pre-construction
Management and reuse of groundwater inflow	All feasible and reasonable opportunities for groundwater reuse for construction purposes or recycling nearby would be taken in the first instance. Should groundwater inflows and required treatment volumes outstrip the potential for reusing the water for construction purposes discharge options would be investigated.	Construction contractor	Pre-construction/ construction
Changes in groundwater level, flow, chemistry and quality during construction	A groundwater monitoring plan (GMP) would be prepared for implementation during construction. Parameters to be monitored would include groundwater levels and groundwater quality with field parameters, laboratory parameters and sample frequency to be developed prior to construction.	Construction contractor	Pre-construction/ construction
Changes in groundwater level, flow, chemistry and quality during construction	A network would be established to monitor groundwater levels and groundwater quality during construction. The groundwater monitoring network would contain monitoring wells that intersect the Ashfield Shale and Hawkesbury Sandstone.	Construction contractor	Pre-construction/ construction
Groundwater management	Groundwater sampling would be undertaken during construction to determine the most suitable treatment processes to meet the required water quality standards. Where the groundwater quality does not meet licence requirements it would be treated prior to discharge. Also the proposal would be designed and constructed to minimise its groundwater impact including capture and drawdown.	Construction contractor	Pre-construction/ construction

Impact	Safeguard/management measure	Responsibility	Timing
Groundwater inflows	All feasible and reasonable measures would be implemented during construction to limit groundwater inflows to no greater than 0.5ML/day. Any inflows would be collected and treated prior to reuse or discharge.	Construction contractor	Pre-construction/ construction
Groundwater supply during construction	Groundwater water supply from the Hawkesbury Sandstone for construction purposes would be used where feasible and reasonable. Negotiation with the NSW Office of Water would be undertaken regarding impacts and applicable licenses.	Construction contractor	Pre-construction/ construction
Sediment-laden runoff and associated water quality impacts	A Construction Soil and Water Management would be prepared to manage soil, surface water and ground water. The plan shall include, but not be limited to: ■ Details of construction activities and their locations that have the potential to impact on water courses, stormwater flows and groundwater. ■ Detail the proposed extraction, use and disposal of groundwater, and the measures to mitigate potential impacts on groundwater sources, incorporating monitoring, impact-trigger definitions, and response actions for all likely affected groundwater sources. ■ Surface water and groundwater impact criteria consistent with the principles of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1: The Guidelines* (Australian and New Zealand Environment and Conservation Council, 2000). ■ Management measures to be used to minimise surface and groundwater impacts, including the identification of water treatment measures and discharge points, details of how spoil and fill material will be sources, handled, stockpiled, reused and managed. Also included would be erosion and sediment control measures and salinity control measures. ■ A contingency plan consistent with the NSW *Acid Sulfate Soil Manual Assessment Guidelines* (NSW Acid Sulfate Soils Management Advisory Committee, 1998), to deal with the unexpected discovery of actual or potential acid sulphate soils, including procedures for the investigation, handling, treatment and management of such soils and water seepage. ■ A description of how the effectiveness of these actions and measures would be monitored during construction, clearly indicating how often monitoring would take place, how the monitoring results would be recorded and reported and if any exceedances are detected, how any non-compliance would be rectified. ■ Mechanisms for monitoring, reviewing and amending this plan.	Construction contractor	Pre-construction/ construction

Impact	Safeguard/management measure	Responsibility	Timing
	Additional water quality mitigation measures would be implemented in accordance with relevant requirements of: ■ *Managing Urban Stormwater – Soils and Construction Volumes 1 and 2* (Landcom and NSW Government, 2004 and 2006). ■ *Guidelines for Controlled Activities* (NSW Office of Water, 2000). ■ *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1: The Guidelines* (Australian and New Zealand Environment and Conservation Council, 2000) ■ NSW *Water Management Act 2000* (NSW Government, 2000b). ■ Applicable Environment Protection Licences. A holistic approach to water quality and stormwater management would be adopted that incorporates Water Sensitive Urban Design principles to minimise impacts on the existing hydrologic regime. Such measures would include: ■ Managing total runoff volumes through the use of rainwater tanks and measures that promote stormwater infiltration. ■ Minimising increases in peak flows through the use of detention and retention measures as appropriate. Appropriate erosion control measures would be installed such as sediment fencing, check dams, temporary ground stabilisation, diversion berms or site regrading. Inspection of water quality mitigation controls (e.g. sediment fences, sediment basins) would be carried out regularly and following significant rainfall to detect any breach in performance.		
Risk of encountering historic contamination or pollution during construction	Before starting on site, a summary of soil contamination would be prepared detailing the outcomes of any further contamination site investigations. The summary would detail, where relevant, whether or not the soil is suitable for the intended land use or can be made suitable for reuse through the application of a Remediation Action Plan (or similar). An accredited Site Auditor would endorse the documentation and any Remediation Action Plan or similar. In the event of encountering potentially contaminated materials during construction all work would cease in the vicinity of the discovery and it would not recommence until the extent of contamination has been assessed, and if necessary, a Remediation Action Plan or similar had been prepared and endorsed by an accredited Site Auditor. Soil and land remediation is to occur as soon as practicable following construction. This is	Construction contractor	Pre-construction/ construction

Impact	Safeguard/management measure	Responsibility	Timing
	to include remediation in stages as the construction process allows. Any investigations undertaken to confirm the contamination and pollution risk would be forwarded to TfNSW for approval along with any Site Auditor endorsed Remediation Action Plan (or similar). A Site Auditor would need to certify that any contaminated land or polluted groundwater had been remediated to a standard consistent with its proposed use. Where the investigations identify that the site is suitable for its intended use and that there is no need for a specific remediation strategy, measures to identify handle and manage potential contaminated spoil, materials and groundwater shall be incorporated into the construction environmental management plan (CEMP).		
Groundwater quality	Dissolved iron would typically be removed from discharge water by oxidising the Ferric ion (Fe^{3+}) to Ferrous (Fe^{2+}) that enables precipitation and physical removal. Water turbidity would typically be treated by settling/filters. Iron reducing bacteria in discharge water would be typically treated by biocide dosing. The management of groundwater and surface water ingress, including the design of capture, monitoring, treatment and discharge methods shall be undertaken in consultation with the NSW EPA.	Construction contractor	Pre-construction/ construction
Construction			
Accidental spillage and associated water quality impacts	Procedures to quickly address any contaminant spill or accident would be developed and implemented during the proposal's operation.	Construction contractor	Construction
Accidental spillage and associated water quality impacts	Storage of hazardous materials such as oils, chemicals and refuelling activities would occur in bunded areas.	Construction contractor	Construction
Operation			
Groundwater pollution or changes in groundwater chemistry caused by the operational proposal	Groundwater quality would be subject to testing. Where it does not meet licence requirements it would be treated prior to discharge.	NRT	Operation
Groundwater pollution or changes in groundwater chemistry caused by the operational proposal	Ensure the proposal is captured within the wider groundwater treatment processes implemented to service Sydney Metro Northwest, including the treatment of groundwater at the Lady Game Drive water treatment plant. Also groundwater would be managed under the NWRL Construction Soil and Water Management Plan	NRT	Operation

6.2 Traffic and transport

This section describes the proposal's likely impact on traffic movement, transport and access. Appendix B contains a traffic and transport review prepared by Parsons Brinckerhoff to support the REF, with relevant information provided or summarised below.

6.2.1 Method

Study area

The assessment study area considered the proposal's effect on traffic movement, transport and access on key roads and intersections in the Norwest Precinct as summarised below in Table 6.3.

Table 6.3 Traffic and transport study area

Key roads
Norwest Boulevard
Brookhollow Avenue
Century Circuit
Key intersections
Norwest Boulevard and Windsor Road
Norwest Boulevard, Columbia Street and Brookhollow Avenue (east)
Norwest Boulevard and Solent Crescent
Norwest Boulevard, Brookhollow Avenue (west) and Century Circuit
Norwest Boulevard, Reston Grange and Solent Circuit (west)
Norwest Boulevard and Old Windsor Road

Method and assessment criteria

The traffic, transport and assess review referred to the following documents:

- *Guide to Traffic Generating Development* (Roads and Maritime, 2002)
- *North West Rail Link, Environmental Assessment No.2 Technical Paper: Operational Traffic and Transport Management* (TfNSW, 2012b)
- *Traffic Modelling Guidelines* (Roads and Maritime, 2013b)
- *Guide to Traffic Management* (Austroads, 2014).

The assessment:

- Reviewed existing and future traffic, transport and access conditions within the Norwest Precinct accounting for the construction and operation of Norwest Station.
- Identified the proposal's construction and operation impact on traffic, transport and access across the study area.
- Assessed the intersection performance changes across the study area as a result of the proposal.
- Identified likely adverse impacts that would need safeguarding and managing under the proposal.

As there is the approval and commitment to construct the Sydney Metro Northwest, the assessment has taken into account the impacts that are likely to occur as a result of constructing both Norwest Station and the proposal at the same time (i.e. the cumulative impact). This is discussed in Section 3.4.2 and Section 3.4.3.

Traffic modelling, monitoring data and forecasting

Baseline data

In 2012, TfNSW obtained real-world data to confirm the traffic conditions across the study area. These data were used as the input to a traffic model that was prepared to describe the impacts of constructing and operating the approved Norwest Station. These data were also used as the basis for this assessment as no newer data were available. To make the data relevant for use in this REF, a growth factor was applied to predict how traffic conditions have changed since 2012. The adopted annual growth factor is two per cent. This was derived from survey data collected in December 2011.

Changes

The modelled predictions of how the proposal would affect traffic and transport were made using the road configuration and layout reported in 2012. The model did not account for the road configuration changes that have occurred since 2012 (refer to Section 6.2.2). The reason why this approach was adopted was to allow a comparison of the impact of the proposal against the impact of constructing and operating Norwest Station as assessed. As Norwest Station's impacts were assessed using a 2012 road layout this was used for the purpose of this assessment. This was deemed adequate as the changes would not have a material impact on the outcome of the traffic and transport review.

Assessment

The newly forecasted baseline data were used to assess the impacts on the study area's intersection performance due to the proposal by considering the following parameters:

- Degree of saturation: This is a percentage measure of available capacity at an intersection, where above about 85 per cent the intersection is broadly considered to be performing poorly.
- Delay: This is a measure of the time it takes for each vehicle to approach an intersection.
- Level of service: This is a graded measure of how well an intersection operates. The grades range for 'A' good intersection performance to 'F' unacceptable intersection performance.

Modelling outputs

Table 6.4 summarises the scenarios considered and modelled in the traffic and transport review.

Table 6.4 Traffic modelling scenarios and outputs

Modelling scenarios	Assessment scenarios	Modelled year	
Construction assessment	Assessment of the changes to traffic conditions and network performance during the construction of the Norwest Station and the proposal.	2015	
Do nothing	Assessment of the changes to traffic conditions and network performance between 2015 and 2026 due to the construction of the Norwest Station and other committed development in the area, but not the proposal.		2026
Do something	Assessment of the changes to traffic conditions and network performance between 2015 and 2026 due to the construction of the Norwest Station, the pedestrian link and other committed development in the area including the proposal.		2026

Environmental assessment impact ratings

Each impact has been assigned a rating. The rating considers the likelihood of the impact occurring and the magnitude of the impact on the receiving environment. The ratings are defined as:

- Negligible: where the predicted changes are not sufficient to affect access or intersection performance.
- Minor: where there is predicted to be no change in access other than short-term delays during construction, and the change in intersection performance would not affect the overall ‘capacity’, ‘degree of saturation’ or ‘level of service’.
- Moderate: where there is predicted to be either a permanent loss in access to one or two properties, a total access delay of no more than one week during construction, or a measurable permanent change in intersection performance.
- Major: where there is predicted to be either be a permanent loss in access to more than two properties, a total access delay of longer than one week during construction, or a measurable permanent change in intersection performance that, as a direct result of the proposal, would lead to the intersection ‘failing’.

6.2.2 Existing environment

Overview and setting

Existing regional characteristics

Norwest Boulevard is a major arterial road with direct access to and from the M7 Motorway and a number of other major arterial and regional roads including Windsor Road and Old Windsor Road, both of which run perpendicular to Norwest Boulevard.

Norwest Boulevard is currently the only main arterial road to, from, and through the Norwest Precinct. It receives most of its traffic during peak weekday periods, which coincides with the times when station patronage and resultant pedestrian activity will be at their highest.

Future regional characteristics

To combat the existing capacity constraints along Norwest Boulevard, Roads and Maritime has an aspiration to upgrade the road from a four-lane dual carriageway to a six-lane dual carriageway at some point in the future. However, while this remains an aspiration it has not be assessed or considered in the REF.

Road characteristics

Existing characteristics

The study area is centred on the intersection of the west-east running Norwest Boulevard and the north-south running Brookhollow Avenue and Century Circuit. Brookhollow Avenue is located to the south of the intersection and Century Circuit is located to the north of the intersection. Table 6.5 describes the general characteristics of each of the three roads.

Table 6.5 Existing characteristics of the main roads in the study area

Road	Details
Norwest Boulevard	■ Main arterial road providing east-west access between the Norwest Precinct and the M7 Motorway. ■ A 70 kilometre per hour (km/h) divided four lane arterial road that includes a wide landscaped central median. ■ It is used by about 26,000 vehicles each day of which about five per cent are heavy vehicles (trucks and buses). ■ The only arterial road providing access into the Norwest Precinct. ■ The road is characterised by high commuter flows during the morning and evening peak periods. ■ There is no on-street parking or stopping allowed.
Brookhollow Avenue	■ A local loop road providing access to the southern part of the Norwest Precinct. ■ A 50 km/h undivided two lane road with no central median. ■ It is used by about 3,000 vehicles each day. ■ The road is characterised by low traffic flows throughout the day and the provision of speed controls at points along the road in the form of a landscaped median and chicanes. ■ Parking and stopping is allowed on both sides of the road.
Century Circuit	■ A local loop road providing access to the Norwest Marketown shopping centre, the Hillsong Church, and health and recreational facilities and commercial properties principally surrounding the Norwest Lake. ■ A 50 km/h two lane road with no central median, with the exception of the exit from Norwest Boulevard up to a second roundabout about 70 metres to the north. ■ It is used by about 3,000 to 10,000 vehicles each day (the range accounting for a typical day and a busy event/shopping day). ■ The road is characterised by moderate traffic flows throughout the day, representing both commuters and users of the shopping centre. ■ There is no on-street parking or stopping allowed however the road is the primary access point to off-street parking provided by these developments.

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012b)

Future characteristics

The road characteristics, average speeds, flows and conditions are expected to change over time in line with more people working and living in the area. However, there are no committed or planned infrastructure changes on the road network at this point in time that would affect its characteristics.

Intersection characteristics

Existing characteristics

The study area comprises a number of signalised and un-signalised four-way intersections, unsignalised roundabouts and T-junctions. Norwest Boulevard is signal controlled at both its western end (Old Windsor Road) and its eastern end (Windsor Road). The main intersections along the boulevard comprise un-signalised roundabouts. Table 6.6 describes the characteristics of the main intersections in the study area.

Table 6.6 Existing characteristics of the main intersections in the study area

Intersection	Control method	Details
Norwest Boulevard/ Columbia Circuit/ Brookhollow Avenue (East)	Roundabout (Two-lanes)	■ Norwest Boulevard: ▸ two lanes on each approach ■ Columbia Circuit has: ▸ a single lane approach ■ Brookhollow Avenue: ▸ two lanes marked for a short distance on approach.
Norwest Boulevard/ Solent Circuit (East)	Priority (T-junction)	■ Norwest Boulevard: ▸ through movements have priority ▸ right turn bay provided for traffic turning from Norwest Boulevard into Solent Circuit. ▸ right turns not permitted out of Solent Circuit.
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	Roundabout (Two-lanes) Commitment to be signalised under the Sydney Metro Northwest	■ Norwest Boulevard: ▸ Two lanes on each approach marked as a shared left/through and shared through/right. ■ Century Circuit: ▸ Two lane approach with an exclusive right turn lane and a shared left/through/right lane. ■ Brookhollow Avenue: ▸ Single lane approach.
Norwest Boulevard/ Reston Grange/ Solent Circuit (West)	Roundabout (Two-lanes)	■ Norwest Boulevard: ▸ Two lanes on each approach marked as a shared left/through and shared through/right. ■ Solent Circuit: ▸ Two lane approach with an exclusive right turn lane and a shared left/through lane. ■ Reston Grange: ▸ Dual lane approach.
Norwest Boulevard/ Old Windsor Road	Signalised (Grade-separated)	■ Old Windsor Road: ▸ two lanes in each direction passing under the intersection ▸ traffic signals provided for the turning movements from Old Windsor Road and Norwest Boulevard ▸ off-ramps provide two right turn lanes and two left turn lanes for each of the approaches. ■ Norwest Boulevard: ▸ eastern approach provides a left turn slip lane, two through lanes and a right turn lane ▸ western approach provides a left turn slip lane, two through lanes and two right turn lanes.

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012b)

Future characteristics

The Norwest Boulevard and Brookhollow Avenue/Century Circuit roundabout will be removed to create a signalised intersection as part of the construction of the Norwest Station.

Public transport infrastructure

Existing provisions

Buses are the only form of public transport servicing the Norwest Precinct:

- Six routes operate along Norwest Boulevard
- Two routes terminate on the edge of the Norwest Business Park in Reston Grange
- Additional routes operate along Old Windsor Road and Windsor Road.

There are two bus stops on Norwest Boulevard close to the proposal footprint:

- One to the east near the pedestrian underpass toward the Solent Circuit (east) intersection
- One to the west near the Reston Grange intersection.

Future provisions

Under the Norwest Precinct Master Plan there is a commitment to expand the bus services to and from the Norwest Business Park. There is also a commitment by Roads and Maritime to provide two additional bus stops adjacent to Norwest Station. These will become operational to coincide with Norwest Station opening.

Footpath infrastructure

Existing provisions

Footpaths run along both sides of most of the roads in the study area including Norwest Boulevard, Brookhollow Avenue and Century Circuit. The other key pedestrian infrastructure in the area are two pedestrian underpasses located on Norwest Boulevard; one located about 320 metres to the east of the proposal footprint and one about one kilometre to the west of the proposal footprint.

There are no signalised crossing provisions at Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection; however, paved sections with drop kerbs are provided on the islands that form the approaches to the intersection. These act as pedestrian refuges.

With regards to pedestrian numbers, the Norwest Precinct generates a significant number of pedestrians. They comprise a base flow of people using the amenities in the area and they are supplemented by a weekday spike of workers accessing the business park and other commercial facilities. Peak pedestrian movement occurs during the morning and evening peak periods as well as during the weekday lunchtime.

Future provisions

Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection will be signalised as part of the Norwest Station development and provided with pedestrian crossings on all arms to improve access to and from Norwest Station.

Cycle path infrastructure

Existing provisions

Solent Circuit from its intersection with Inglewood Place to Norwest Lake is marked as a cycle route. There is an off road cycle route around the Norwest Lake that links into the Strangers Lake to the north and Fairmont Avenue to the south. There is also a cycle route south of Brookhollow Avenue that links into Old Windsor Road. Old Windsor Road includes a dedicated shared use path setback from the southbound eastern carriageway.

Future provisions

There are preliminary plans and aspirations to provide a future cycleway link around the area. This plan is being developed by Roads and Maritime in consultation with TfNSW and the Council.

Intersection performance

Intersection performance is a measure of how well traffic moves through an intersection. Broadly, it appraises how much available capacity there is at a given intersection. By assessing intersection performance it is possible to infer the level of congestion at each intersection and therefore the time it takes (or would take) for traffic to travel through the intersection.

It was appropriate in this circumstance to assess the cumulative impact of constructing and operating the proposal and station at the same time. Therefore, the existing environment referred to in this assessment accounted for the changes that will occur due to the construction of Norwest Station in 2016 and its operation in 2026. The real-world conditions observed in 2012 are also summarised below to provide reference, context and setting.

Observed performance

In 2012 it was observed that during the weekday morning peak period (8.00 am to 9.00 am):

- The Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection operated with spare capacity, it was not congested, and there were no delays on travelling through the intersection.
- The Norwest Boulevard/Windsor Road intersection operated at capacity and therefore it was congested resulting in delays and the build-up of traffic queues. This led to the intersection's upgrade.
- The remaining intersections on Norwest Boulevard in the study area operated with spare capacity and therefore they were not congested.

Existing environment

The following section describes the predicted changes in intersection performance in 2015 and 2026 accounting for Norwest Station's construction and the signalisation of the intersection.

Table 6.7 Key intersection performance during the morning peak period/hour in 2015 and 2026

Intersection	Traffic volume	Degree of Saturation (%)	Average delay (seconds)	Level of Service (A–F)	95 % back of queue	
					Queue length (m)	Approach
2015 Morning peak period (8.00 am to 9.00 am) – Norwest Station under construction						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,535	71	9	A	60	Norwest Blvd (W)
2026 Morning peak period (8.00 am to 9.00 am) – Norwest Station under operation						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,905	88	43.0	D	310	Norwest Blvd (W)
2015 Afternoon peak period (4.30 pm to 5.30 pm) – Norwest Station under construction						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,580	67	7.4	A	50	Norwest Blvd (W)
2026 Afternoon peak period (4.30 pm to 5.30 pm) – Norwest Station under operation						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,430	92	51.0	D	370	Norwest Blvd (W)

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012b)

The above table shows that there is anticipated to be little difference in the performance of each intersection between the morning and afternoon peak periods in both 2015 and 2026. The difference comes in comparing the anticipated performance of Norwest Boulevard/Brookhollow Avenue/ Century Circuit intersection in 2015 compared to 2026 due to an additional 600 vehicles using the intersection each hour in the morning peak period and an additional 160 vehicles using the intersection each hour in the afternoon peak period. As a result, it is predicted that:

- The degree of saturation would exceed the 85 per cent threshold described in Section 6.1.1
- The delay would be about four or five times worse on the approach to the intersection
- The intersection's level of service would decrease from 'good' (A) to 'at-capacity' (D).

These changes account for the likely impact of the construction and operation of Norwest Station as well as other predicted regional traffic growth factors that would occur as more people live and work in the Norwest Precinct.

6.2.3 Potential impacts

Construction impacts

As described in Chapter 3, the aim is to construct the proposal in a timely and efficient manner, considering the need to:

- Maintain access for all travel modes through the precinct
- Minimise the impacts to the performance of the road network particularly during peak periods.

Consequently, the objective is to work for extended hours and interface the program with the construction of Norwest Station to reduce travel delays during times of heaviest traffic demand (i.e. the peak periods), and to limit the overall impact on the performance of the road network during construction. Notwithstanding this approach, there would still be a range of potential traffic, transport and access impacts experienced during the proposal's construction as described below.

Road infrastructure

The proposal would be constructed to the north of Norwest Boulevard. A construction site would be created on the footprint of part of the existing Norwest Marketown shopping centre car park (refer to Figure 3.3).

Access to the proposal footprint construction site may be signal controlled, either part time or full time. This would result in short-term delays for general road traffic. Very occasionally there may be the need to close Century Circuit adjacent to the construction site for short periods to take receipt of the major infrastructure components that would be delivered on oversize vehicles and low loaders (refer to Section 3.4). This equipment would be escorted to site. Road closures would take place outside of peak periods and would only affect the local roads for a few hours or less during each delivery.

Business, community and residential traffic access would be maintained during road closures, with traffic diverted to alternative routes. Anytime that Century Circuit would be closed, alternative access would be provided by the second point of access to Century Circuit from Norwest Boulevard east of Norwest Boulevard/Century Circuit/Brookhollow Avenue intersection, or via Solent Circuit. The residual impact of any diversions would be an increased travel distance of around one kilometre, which would be the equivalent of about two-minute increase in travel time. This is rated as a minor adverse impact.

Emergency vehicle access would be maintained at all times, with a management provision included to allow for this during a major delivery.

Public transport infrastructure

Construction of the proposal would not directly impact on the bus stop on Norwest Boulevard east of Century Circuit. All bus movements through the area would be managed during construction to maintain service provisions and schedules.

Footpath infrastructure

There would be a requirement to close two sections of footpath during construction:

- The footpath adjacent to the eastbound lane to the north of Norwest Boulevard between Century Circuit and close to the service station.
- The footpath adjacent to the southbound lane to the east of Century Circuit between Norwest Boulevard and the intersection with Inglewood Place/Century Circuit.

The closures may be in place for up to eight months, coinciding with the proposal's anticipated overall construction program (refer to Section 3.4). During this time, the few pedestrians would be diverted to use the footpath provisions on the opposite side of each road. Pedestrian travel times would increase slightly due to the delay in crossing each road. The additional distances pedestrians would need to walk would be marginal. As such, the impact is rated as minor adverse and temporary.

These footpaths would be resurfaced and reinstated following the proposal's construction.

Cycle path infrastructure

There would be no cycle infrastructure impacts or diversions during construction.

Parking

Access to about 60 parking spaces within the construction footprint (refer to Figure 3.3) would be restricted for about eight months. These parking spaces were initially provided to service the former fast-food restaurant. While they are still available for use they are located at the farthest point from either the shopping centre and/or Hillsong Church meaning that they only provide an 'overspill' function during peak shopping periods or when there is a major event held at the church. In total they represent about one per cent of the available space across the area and therefore restricting their use is rated as a minor adverse impact.

Demand management (construction traffic)

As described in Section 3.4, there would be about eight trucks and 15 concrete pourers arriving at the construction site each day during peak construction. These would be supplemented by about 10 to 15 oversize vehicles/low loaders that would arrive at site periodically over the eight month construction period to deliver large prefabricated infrastructure. The trucks would either bring construction materials to site or remove spoil and other waste offsite.

The origin and designation of the construction traffic would depend on construction requirements, the program, and the requirement to transfer of materials and waste between the construction site and Norwest Station construction compound/laydown area (refer to Section 3.4). Construction traffic may also arrive and leave site directly from Norwest Boulevard and the wider motorway network.

In addition, there would be up to 20 workers servicing the proposal during construction; however they would be resourced from the wider Sydney Metro Northwest workforce.

Therefore, during peak construction it could be assumed that there would be no more than one or two vehicles arriving and leaving site every hour during the day and one vehicle at night. This traffic would supplement the anticipated peak traffic generated in constructing Norwest Station, as summarised in Table 6.8.

Table 6.8 Anticipated construction traffic generation during peak construction

Movements (i.e. trips to and from site)	Norwest Station (approved)	Proposal (additional)
	Traffic numbers (per day)	
Construction vehicles	240	46
Oversize vehicles	Not reported	Periodic
Workforce (day time shift)	20	0
	Traffic numbers (per hour during working hours)	
Construction vehicles	22	4
Oversize vehicles	Not reported	Periodic
Workforce (day time shift)	*20	0
Total	44	4

* This assumes that the workforce would arrive at site within the peak period.

As reported in Table 6.5 about 3,000 vehicles would use Norwest Boulevard/Brookhollow Avenue/ Century Circuit intersection during the morning peak period during Norwest Station's construction. This proposal would add about four vehicle movements to this total (two vehicles arriving and leaving site during this period). This proposal would therefore contribute about 0.1 per cent to the overall traffic flows, a negligible impact. This equates to about a 10 per cent increase in traffic generated from constructing Norwest Station, rated as a minor adverse impact.

Intersection performance

Traffic modelling was used to assess the impact on the performance of Norwest Boulevard/ Brookhollow Avenue/Century Circuit intersection as a result of the proposal being constructed at the same time as Norwest Station. Table 6.9 summarises the results. By including the data from Table 6.7 it is possible to compare the impacts proposal.

Table 6.9 Key intersection performance during the peak period during construction (2015)

Norwest Boulevard/ Brookhollow Avenue (West)/Century Circuit	Traffic volume	Degree of Saturation (%)	Average delay (seconds)	Level of Service (A–F)	95 % back of queue	
					Queue length (m)	Approach
2015 Morning peak period (8.00 am to 9.00 am)						
Existing environment (Norwest Station under construction)	3,535	71	9	A	60	Norwest Blvd (W)
Proposal's impact (Norwest Station and the proposal construction)	3,575	75	9.4	A	65	Norwest Blvd (W)
Difference	+40	+5	+0.4	-	+5	N/A

Norwest Boulevard/ Brookhollow Avenue (West)/Century Circuit	Traffic volume	Degree of Saturation (%)	Average delay (seconds)	Level of Service (A–F)	95 % back of queue	
					Queue length (m)	Approach
2015 Afternoon peak period (4.30 pm to 5.30 pm)						
Existing environment (Norwest Station under construction)	3,580	67	7.4	A	50	Norwest Blvd (W)
Proposal's impact (Norwest Station and the proposal construction)	3,615	68	7.6	A	50	Norwest Blvd (W)
Difference	+35	+1	+0.2	-	-	N/A

The modelled predictions confirm that the anticipated changes under the proposal would be marginal having no meaningful impact on the intersection's performance. The impact would be negligible.

Operational impacts

Norwest Station's operation would have two effects on the existing area:

- The number of pedestrians would dramatically increase.
- The Norwest Boulevard/Century Circuit/Brookhollow Avenue intersection would be signalised and upgraded to include pedestrian crossing facilities on all approaches.

These changes would affect the intersection and pedestrian flows in the area at the point of this proposal becoming operational.

Road infrastructure

There would be no change to the road layout and configuration under this proposal.

Public transport infrastructure

There would be no change to existing or new bus infrastructure under this proposal.

Footpath infrastructure

The pedestrian link is anticipated to be used by about two thirds of the people that would use Norwest Station, plus additional non- rail customers wishing to cross Norwest Boulevard. These pedestrians would therefore not need to use the surface crossings installed as part of the approved station work. As a result:

- Pedestrians would not be required to wait at the surface traffic signals before crossing Norwest Boulevard. This would reduce pedestrian delays when compared to conditions without the proposal.
- Pedestrians would not cross the road at the surface. This would reduce movement conflicts and the accident risk of potential collisions between vehicles and pedestrians.

Also by not having to wait at the pedestrian crossing this would reduce the time it would take for people to cross between Norwest Station and the north of Norwest Boulevard.

Cycle path infrastructure

There would be no change to any cycle paths or the installation of cycle infrastructure under the proposal.

Parking

The northern entry and the associated footpath and landscaping would result in the loss of about 20 parking spaces. As noted above they are only used during peak shopping periods or when there is a major event held at the Hillsong Church. Their loss is therefore not considered important to the function or amenity of either the shopping centre or church. In total it represents less than one per cent of the available parking space in the area. Therefore, their loss is rated is a minor adverse impact.

Intersection performance

Traffic modelling was used to assess the impact on performance of Norwest Boulevard/Brookhollow Avenue/ Century Circuit intersection as a result of the proposal operating at the same time as Norwest Station. Table 6.10 summarises the results. By including the data from Table 6.7 it is possible to compare the impacts proposal.

Table 6.10 Key intersection performance during the peak period during operation (2026)

Norwest Boulevard/ Brookhollow Avenue (West)/Century Circuit	Traffic volume	Degree of Saturation (%)	Average delay (seconds)	Level of Service (A–F)	95 % back of queue	
					Queue length (m)	Approach
2026 Morning peak period (8.00 am to 9.00 am)						
Future existing environment (Norwest Station operation)	3,905	88	43	D	310	Norwest Blvd (W)
Proposal's impact (Norwest Station under and proposal operational)	3,905	88	43	D	310	Norwest Blvd (W)
Difference	-	-	-	-	-	N/A
2026 Afternoon peak period (4.30 pm to 5.30 pm)						
Future existing environment (Norwest Station operation)	3,430	92	51	D	370	Norwest Blvd (W)
Proposal's impact (Norwest Station under and proposal operational)	3,430	92	56	D	370	Norwest Blvd (W)
Difference	-	-	-	-	-	N/A

As per the above table, there would be no predicted operational changes to the performance of the intersection despite about two thirds of the rail customers and other non-rail customers using the pedestrian link and northern entry (refer to Section 2.1). The reason for this is that the signals would still need to operate under the same timing and phasing sequence regardless of whether one or multiple people cross the intersection. However what is not shown in the above table are the effects of potentially being able to extend the period of time before the lights turn red (termed the lighting phasing). This may be possible due to the reduced use of the crossing. This would therefore provide a benefit to operational traffic flows and would be something that would be considered during the detailed design. Should this measure be implemented there would be no reduction in the amount of time provided for people to cross the road. This would be maintained to standards set to ensure pedestrian safety.

6.2.4 Safeguards and management measures

Table 6.11 lists the traffic, transport and access safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.2.3.

Table 6.11 Traffic and transport safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Pre-construction (construction)			
Construction traffic management	Implement a construction traffic management plan in consultation with and to meet the reasonable requirements of the relevant road authority and transport operator(s). The plan shall include by not be limited to: ■ a routine traffic management plan ■ a parking management plan ■ a site traffic and access management plan ■ an incident response plan ■ mechanisms for monitoring, reviewing and amending this plan. Develop, assess, and implement appropriate management measures in consultation with the relevant road authority, transport operator(s), and emergency services, and adjoining major land holders. This shall include: ■ Construction site access, including the efficient and safe egress and ingress of vehicles, consistent relevant Austroads, Australian Standards and Roads and Maritime requirements. ■ Parking management, including on and off street and remote parking and access. ■ Heavy vehicle management, the restriction (unless otherwise approved) of heavy vehicles on certain routes (for example T-Ways and past education facilities) and the minimisation of heavy vehicle traffic in peak traffic periods. ■ Bus rerouting and access to bus stops. ■ Full and partial road closures and associated restrictions, detours and the like. ■ Special event management. ■ The retention and reinstatement of emergency and property access. ■ The retention of user and passenger safety, including pedestrians, cyclists, public transport users, including at stops and related facilities. ■ Incident response planning.	Construction contractor	Pre-construction

Impact	Safeguard/management measure	Responsibility	Timing
Temporary access restrictions during construction across the proposal footprint	Without limiting the outcomes of the Construction Traffic Management Plan, construction traffic shall be scheduled, where feasible and reasonable, to outside of morning and afternoon peak periods and also during special events. Methods used to limit construction traffic outside of peak traffic periods shall be incorporated into the Construction Traffic Management Plan. Access to property shall be maintained during construction unless otherwise agreed with the owner in advance. A landowner's access that is physically affected by the proposal shall be reinstated to at least an equivalent standard in consultation with the property owner. Safe pedestrian and cyclist access through or around worksites shall be maintained during construction. In circumstances where pedestrian and cyclist access is restricted due to construction activities, a feasible and reasonable alternate route shall be provided and signposted.	Construction contractor	Pre-construction
Pedestrian diversions during construction	Directional signage and line-marking would be used to direct and guide drivers, cyclists and pedestrians past construction sites and on the surrounding network. This would be supplemented by permanent and portable Variable Message Signs, where reasonable and feasible to advise drivers of any potential delays, traffic diversions, speed restrictions, or alternative routes. The public would be notified of proposed traffic changes by newspaper, radio, project web site and other forms of community liaison.	Construction contractor	Pre-construction/ construction
Construction			
Haul routes and access	Construction vehicles (including staff vehicles) shall be managed to: ■ Minimise parking or queuing on public roads and non-associated sites ■ Minimise the use of local roads (through residential streets and town centres) to gain access to construction sites and compounds; ■ Minimise traffic past schools and child care centres, particularly during opening and closing periods. Adhere to the nominated heavy vehicle routes identified in the Construction Traffic Management Plan.	Construction contractor	Construction
Night time traffic movements	Restrict night time traffic to the removal of spoil from site, unless there is an accident or emergency during construction. This will be managed by Contractor's CEMP, by the EPL, by a Road Occupancy Licence, by a Construction Noise Impact Statement and by an Out of Hours Work Permit.	Construction contractor	Construction

6.3 Noise and vibration

This section describes the likely noise and vibration impacts from constructing and operating the proposal. Appendix C contains a noise and vibration assessment prepared by WSP to support the REF, with relevant information provided or summarised below.

6.3.1 Method

Study area

The assessment study area considered the people and other sensitive receivers and buildings that would be potentially affected within 500 metres of noise and vibration generated during the proposal's construction and operation.

Method and assessment criteria

The noise and vibration assessment referred to:

- *British Standard BS 7385-2:1993 Evaluation and Measurement for Vibration in Buildings. Guide to Damage Levels from Groundborne Vibration* (British Standards Institution, 1993).
- *DIN Standard 4150-2 Part 2: Human Exposure to Vibration in Buildings* (DIN Deutsches Institut für Normung, 1999).
- *Industrial Noise Policy (INP*) (EPA, 2000).
- *Accessing Vibration: A Technical Guideline* (Department of Environmental and Conservation, 2006).
- *Environmental Noise Management, Assessing Vibration: A Technical Guideline* (DECC, 2006).
- *Australian Standard AS 2187.2-2006 Explosives – Storage and Use – Part 2: Use of Explosives* (Standards Australia, 2006).
- *Interim Construction Noise Guidelines (ICNG)* (DECC, 2009).
- *Road Noise Policy (RNP)* (Roads and Maritime, 2011).
- *Construction Noise Strategy* (TfNSW, 2012a).

The assessment:

- Identified noise and vibration sensitive receivers within the study area.
- Determined the background noise levels within the study area (refer to Figure 6.1).
- Predicted how construction work and traffic would impact on the identified noise and vibration-sensitive receivers accounting for the concurrent construction of Norwest Station.
- Predicted how operational traffic noise would impact on the identified noise sensitive receivers accounting for the concurrent operation of Norwest Station.
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Given the approval and commitment to construct the Norwest Station, the assessment effectively considered the cumulative impact of the proposal and Norwest Station being constructed and operating at the same time. This is discussed in Section 3.4.2 and Section 3.4.3. However, the assessment also realises the potential for construction work to only be taking place on the proposal for the reasons described below in this section.


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NW-02
NW-03
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NWO_03
NWO_04
NWO_05
NWO_06
NWO_07
NWO_08
NWO_10
NWO_11
NWO_12
SPURWAY DRIVE
WINDSOR ROAD
SOLENT CIRCUIT
COLUMBIA WAY
COLUMBIA COURT
CENTRAL PARK AVENUE
FARWAY DRIVE
HIGHRANGE TERRACE
DE VILLIERS RISE
BRIGHTON DRIVE
BRONZEWING TERRACE
THE POINTE
ASHBURN CLOSE
BURBANK PLACE
NORWEST BOULEVARD
BROOKHOLLOW AVENUE
CENTURY CIRCUIT
MONTPELLIER RISE
CHAMONIX PLACE
ROWANBRAE CRESCENT
MOUNT BANK RISE
GLENVIEW CLOSE
OSPREY TERRACE
PIPERSBROOK CRESCENT
MIDDLEBROOK RISE
INGLEWOOD PLACE
FAIRMONT AVENUE
HILLSBOROUGH WAY
MACKILLOP DRIVE
NORTHRIDGE AVENUE
EDGEWATER DRIVE
WATERFALL CRESCENT
RIDGEHAVEN PLACE
VALADON PLACE
COORUMBENE COURT
BARINA DOWNS ROAD
IBIS PLACE
WESTWOOD WAY
LINDEN WAY
LONGREACH PLACE
WHITEMAN AVENUE
SALAMANDER GROVE
N
Legend
Noise Source
Receiver
Commercial Building
Project Boundary
Construction Boundary EIS1
Construction Boundary EIS2
Concept Alignment: EIS2Sub
Noise Catchment Area (NCA)
Site Boundary
WSP | PARSONS BRINCKERHOFF
A 19/02/15 NF Issue for submission AC
REV DATE BY DESCRIPTION AC
DRAWING STATUS: ISSUE FOR CNVIS
CLIENT: Transport for NSW
DESIGN DRAWN: NF
DATE: February 2015
PROJECT: Norwest Station Subsurface Northern Pedestrian Link
SCALE: 1:5,116 @ A3
0 20 40 80 120 160 200 Meters
TITLE: Noise catchment areas
DRAWING No: APPENDIX A
REV: A
Document Path: \\au.wspgroup.com\dfs\Data\Sydney\Buildings\WSP\projects\ACG1501400\2 - Calculations\ArcMap\Norwest Site Map.mxd

Noise monitoring

Noise monitoring data obtained in support of the EIS prepared to assess the impact of Norwest Station were used to characterise the study area's existing background noise environment and to establish the noise management levels that the contractor would need to adhere to when undertaking the work.

The monitoring data were collected before construction work started on Norwest Station. As no new noise sources (other than Norwest Station's construction) or operational changes to existing noise sources have taken place since the data were collected they are considered sufficiently representative of the background noise environment in 2015. Also, any new monitoring would capture Norwest Station's construction noise. This is only a temporary noise source and is therefore not representative of the real background, further supporting the decision to use the existing data.

Figure 6.1 shows the monitoring locations that were used for the assessment prepared to support this REF.

Equipment and traffic

Equipment and traffic (including changes in traffic) have the potential to generate noise and vibration either during construction or operation. To assess the proposal's likely impacts, the assessment has relied upon:

- The construction equipment schedules and timings presented in Table 3.3.
- The anticipated amount of construction generated traffic discussed in Section 3.4.
- The predicted changes in the performance of the main road intersections during construction and operation discussed in Table 6.9 and Table 6.10.

By understanding the above factors it was then possible to use a combination published data and equipment rating data gathered to support the Sydney Metro Northwest to determine the level of noise and vibration generated during construction and operation. Appendix C describes this in more detail.

Noise averaging periods

Noise can be measured over a range of 'averaging periods'. The following averaging periods were used to describe and assess different conditions and impacts due to the proposal:

- L_{Aeq} describes the average noise levels across a period of time (either day, evening or night, or over a 15-minute period).
- L_{A90} describes the average noise levels that occur for 90 per cent of the time so as to remove any outlying high noise levels. L_{A90} is used to describe the rating background noise level (see below).
- L_{A1} describes the average noise levels that occur for one per cent of the time, therefore describing the nosiest periods.
- L_{Amax} describes the average maximum noise level recorded at any point in time.
- Rating background (noise) levels (RBLs) describe the ambient noise levels during the day, evening and at night. They represent the overall single-figure background noise level determined based on measured L_{A90} in each relevant assessment period as described in detail in the INP (EPA 2000).

Assessment criteria

Noise and vibration impacts were assessed by referring to a number of assessment criteria.

Construction noise assessment criteria

The *ICNG* establishes construction noise management levels (NMLs) for a number of sensitive receiver-types. Reasonable and feasible safeguards and management measures should be implemented where NMLs are exceeded either during or outside of recommended standard hours for construction work.

The recommended standard hours for construction work are: Monday to Friday from 7.00 am to 6.00 pm and Saturday from 8.00 am to 1.00 pm. They represent the times of the day when receivers are likely to be less sensitive to noise impacts. Consequently, during the recommended standard hours for construction work the NMLs for residential receivers are less stringent (i.e. higher). For all other receiver-types the NMLs only apply to when the receiver is being used.

Residential receivers

For residential receivers, two NMLs are established under the *ICNG*. The first represents noise limits above which the receiver is considered likely to be affected by noise impacts (termed 'noise affected'). This is derived from the determined RBL plus an additional permissible level of construction noise. The second more stringent NML is an absolute limit above which there is anticipated to be notable affects (termed 'highly noise affected'). Table 6.12 shows the construction NMLs for residential receivers and how they have been applied to the proposal during standard and non-standard construction hours (termed 'out of hours' work). Calculations were then undertaken to assess a potentially worst-case impact.

Table 6.12 Construction noise management levels for residential receivers and working hours

Time of day	NML $L_{Aeq(15minute)}$ [1,2]	NML application
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise: ■ Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ■ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: ■ Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences). ■ If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2: The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (NSW EPA, 2000).

Table C.3 of Appendix C describes how the residential NMLs were derived and adopted under the assessment. They range from:

- 52 to 72 dB(A) during the day
- 50 dB(A) during the evening
- 43 dB(A) at night.

Non-residential receivers

For other relevant land uses within the study area the following NMLs *ICNG* and were applied to the assessment:

- Places of worship: internal 45 dB(A) $L_{Aeq(15minute)}$
- Classrooms/educational facilities, hospitals: internal 45 dB(A) $L_{Aeq(15minute)}$
- Office and retail uses: external 70 dB(A) $L_{Aeq(15minute)}$
- Industrial uses: external 75 dB(A) $L_{Aeq(15minute)}$
- Passive recreational areas: external 60 dB(A) $L_{Aeq(15minute)}$.

Construction noise (sleep disturbance) assessment criteria

The *Application Note of the INP* (NSW EPA, 2000) describes a maximum night-time noise level (L_{Amax}) as being the RBL + 15 dB above which sleep disturbance may occur. Based on the NMLs developed for the proposal (refer to Appendix C) sleep disturbance has the potential to occur above be 65 dB(A) measured using the $L_{Aeq1\text{-}min}$.

Construction vibration assessment criteria

Construction vibration can have two potential impacts, for which limits have been set under different guidance:

- Cosmetic damage
- Loss of amenity due to human comfort impacts.

Importantly, cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building's structural integrity. If there is no significant risk of cosmetic damage then there is no requirement to assess the risk of structural building damage.

The German *DIN Standard 4150-2 Part 2: Human Exposure to Vibration in Buildings* (DIN Deutsches Institut für Normung, 1999) describes the point at which vibration measured as peak particle velocity (mm/s) becomes perceptible to people that are inside of buildings. This limit is 0.2 mm/s.

The propagation of vibration emitted from a source is site-specific and depends on the vibration energy generated by the source, the vibration frequency, the localised ground conditions and the interaction of structures and features which can dampen vibration. However, by considering a range of conservative assumption TfNSW has developed a set of recommended safe working distances for construction plant (*Construction Noise Strategy*, TfNSW, 2012a). Table 6.13 lists the limits for the equipment that would be used during the construction of this proposal.

Consistent with *British Standard BS 7385-2:1993 Evaluation and Measurement for Vibration in Buildings. Guide to Damage Levels from Groundborne Vibration* (British Standards Institution, 1993) and the *Accessing Vibration: A Technical Guideline* (Department of Environmental and Conservation, 2006), the recommendations are for the practical management of potential vibration to minimise the likelihood of cosmetic damage to buildings and disturbance or annoyance in humans. Additional caution has been

adopted in developing the working distances needed to prevent a human response, where it assumes that the vibration would be from a continuous source and its impact would be on an a typical residential building.

Table 6.13 Recommended safe working distances for vibration intensive plant

Plant item	Rating/description	Minimum working distance, m	
		Cosmetic damage	Human response (complaints)
Vibratory roller	< 50 kN (typically 1–2 tonnes)	5	15 to 20
	< 100 kN (typically 2–4 tonnes)	6	20
	< 200 kN (typically 4–6 tonnes)	12	40
	< 300 kN (typically 7–13 tonnes)	15	100
	< 300 kN (typically 13–18 tonnes)	20	100
	> 300 kN (typically > 18 tonnes)	25	100
Hydraulic hammer	300 kg (5–12 tonne excavator)	2	7
	900 kg (12–18 tonne excavator)	7	23
	1600 kg (18–34 tonne excavator)	22	73
Vibratory pile driver	Sheet piles	2 to 20	20
Pile boring	≤ 800 mm*	2 (nominal)	-
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure
Note 1: Referenced from British Standard BS 7385:2-1993 Evaluation and measurement for vibration in buildings Part 2 Note 2: Referenced from DEC's Assessing Vibration: a technical guideline			

Groundborne noise

Groundborne noise is caused by vibration transferring through the ground and causing surrounding structures to vibrate. In turn, this causes noise to be reradiated within the buildings. Typically, groundborne noise is only a problem where airborne noise has been reduced through insulating certain buildings such as television and recording studios. While this reduces surface noise from entering these insulated spaces, they can be still affected by groundborne noise. The *ICNG* describes the noise management levels for groundborne noise.

Table 6.14 Noise management levels for groundborne noise

Time of day	Ground-borne noise management level
Daytime (7.00 am–6.00 pm)	N/A (vibration criteria only apply)
Evening (6.00 pm–10.00 pm)	40 dB $L_{Aeq,15min}$
Night-time (10.00 pm–7.00 am)	35 dB $L_{Aeq,15min}$
Note 1 These criteria only apply at surrounding residential noise sensitive receivers. However, NWO 01 (Hillsong Convention Centre) has been identified as particular noise sensitive commercial receiver due to the presence of recording facilities contained within. As a result, the recommended noise management levels at NWO 01 is 30 dB $L_{Aeq,15min}$.	

Operation noise (road traffic) assessment criteria

The *RNP* states that 'for residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option''. This criterion was adopted to assess the predicted operational noise impacts.

Modelling and assessment

A noise model was developed to assess a reasonable and typical worst case scenario where the nosiest equipment (or a combination of equipment) would operate at its maximum output and at the minimum distance between the limit of proposal footprint and the representative noise-sensitive receiver(s) listed in Table 6.16 and Table 6.17. Section C5 of Appendix C provides further details.

Vibration calculations were undertaken to predict a typical worst case scenario adopting a number of conservatively adopted criteria.

Assessment scenarios

Surface and subsurface construction would take place during the day, while subsurface construction would only take place at night. While both scenarios would generate noise and vibration they would have a different influence on adjacent receivers:

- The noise generated by any subsurface drilling activity undertaken during the day would have no material influence on adjacent receivers as the surface noise emissions would dominate.
- Conversely, the vibration generated by any surface activity undertaken during the day would have no material influence on adjacent receivers as the subsurface vibration emissions would dominate.

The influence of the above factors has resulted in how the impacts have been modelled and assessed.

At the proposal site, there could be surface and subsurface work taking place at the same time during the day. The same would be true of Norwest Station site. This would represent the worst case noise and vibration scenario. Even if surface work is just taking place at both sites this would still represent a worst case noise assessment scenario due to the lack of influence from the subsurface. Conversely, subsurface work taking place at both sites would represent the worst case vibration scenario, as surface vibration has no material influence. Finally, there is the scenario where construction work would only take place at the proposal site. Collectively, this describes the assessment scenarios that have been considered in this assessment, as summarised in the following table.

Table 6.15 Modelling assessment scenarios

Assessment	Proposal site	Station site	Timing
Worst case isolated noise scenario	Surface work	-	Day only
Worst case isolated vibration scenario	Subsurface	-	Day and night
Worst case combined noise scenario	Surface work	Surface work	Day only
Worst case combined vibration scenario	Subsurface work	Subsurface work	Day and night

While the above table shows the worst case modelling scenarios, the night time subsurface work would still generate noise impacts at the surface. As there would be no surface noise generated at night, the noise impacts from the subsurface work would also need considering. Equally, when there is no subsurface work taking place during the day, there would still be some vibration risks associated with the surface work. As such, this scenario has been considered.

Input data

The assessment was based on the equipment schedule provided in Table 3.3 and sound power levels were obtained from published information. Sound power levels represent the maximum noise that is expected to be generated from a piece of equipment as corrected in certain circumstances where the generated noise could be easily distinguished (termed as 'tonal' or 'impulsive' noise). Table C.8 and Table C.9 in Appendix C list the sound power levels used as input to the model. The traffic component of the assessment used the information reported in Table 6.8 as representing the anticipated number of construction vehicles that would arrive and leave site over the course of a day during peak construction.

Environmental assessment impact ratings

Each impact has been assigned a rating. The rating considers the likelihood of the impact occurring and the magnitude of the impact on the receiving environment. The ratings are defined where one or more of the following conditions are satisfied:

- Negligible: where the predicted changes are not sufficient to affect ambient noise or vibration levels beyond natural variations.
- Minor: where there is predicted to be some level of generated noise and vibration or there is a perceptible change that would occur for less than three weeks during construction.
- Moderate: where there is predicted to be a perceptible change in noise and vibration lasting more than three weeks, an exceedance of the 'noise affected' noise management levels the potential for sleep disturbance to occur at some point during construction, the potential for groundborne vibration to cause cosmetic damage or to result in 'annoyance' at some point during construction, or a change in operational traffic movement is sufficient to alter noise levels by more than 2 dB.
- Major: where there is predicted to be a notable change in noise and vibration lasting more than three weeks, an exceedance of the 'highly noise affected' noise management levels the risk of long term sleep disturbance during construction, an accepted certainty that groundborne vibration would have an impact on people or buildings, or a change in operational traffic movement that is sufficient to alter noise levels by more than 4 dB.

6.3.2 Existing environment

Background noise levels

Background noise is influenced by its urban context and setting. Major existing noise sources include road traffic (which remains the dominant source), pedestrians, business operations, building air conditioning plant and commercial operations. Noise levels during the day and evening are higher than at night. This reflects how the area is used across the day.

While the noise monitoring data were captured to describe the background noise conditions close to the Norwest Station site, they can be applied to the proposal study area. The data were collected at locations representative of the identified noise-sensitive receivers (see below) that would have the greatest exposure to noise due to the proposal's construction and operation.

The recorded average background conditions across the study area (measured as the dB(A) $L_{Aeq\ 90\text{-}minute}$ average and expressed as the RBL were:

- 47 dB(A) during the day (7.00 am to 6.00 pm)
- 45 dB(A) during the evening (6.00 pm to 10.00 pm)
- 38 dB(A) at night (10.00 pm to 7.00 am).

Noise-sensitive receivers

The study area includes a number of residential, community and commercial land uses that contain noise-sensitive receivers that could be affected by the proposal. The number of potentially affected receivers would vary. Certain receivers may be affected by the noise generated from site work activities plus traffic-generated noise. These receivers would be local to the construction site. However, other receivers may only be affected by traffic-generated noise. These receivers would be located in the wider study area adjacent to the key haul routes. However, the latter scenario has not been assessed as the amount of construction traffic generated by the proposal or as a combination of this proposal and Norwest Station would have a marginal effect on the existing traffic flows on the surrounding network (refer to Section 6.2.3). Certainly, it would have no measurable noise impact on adjacent receivers.

Residential receivers

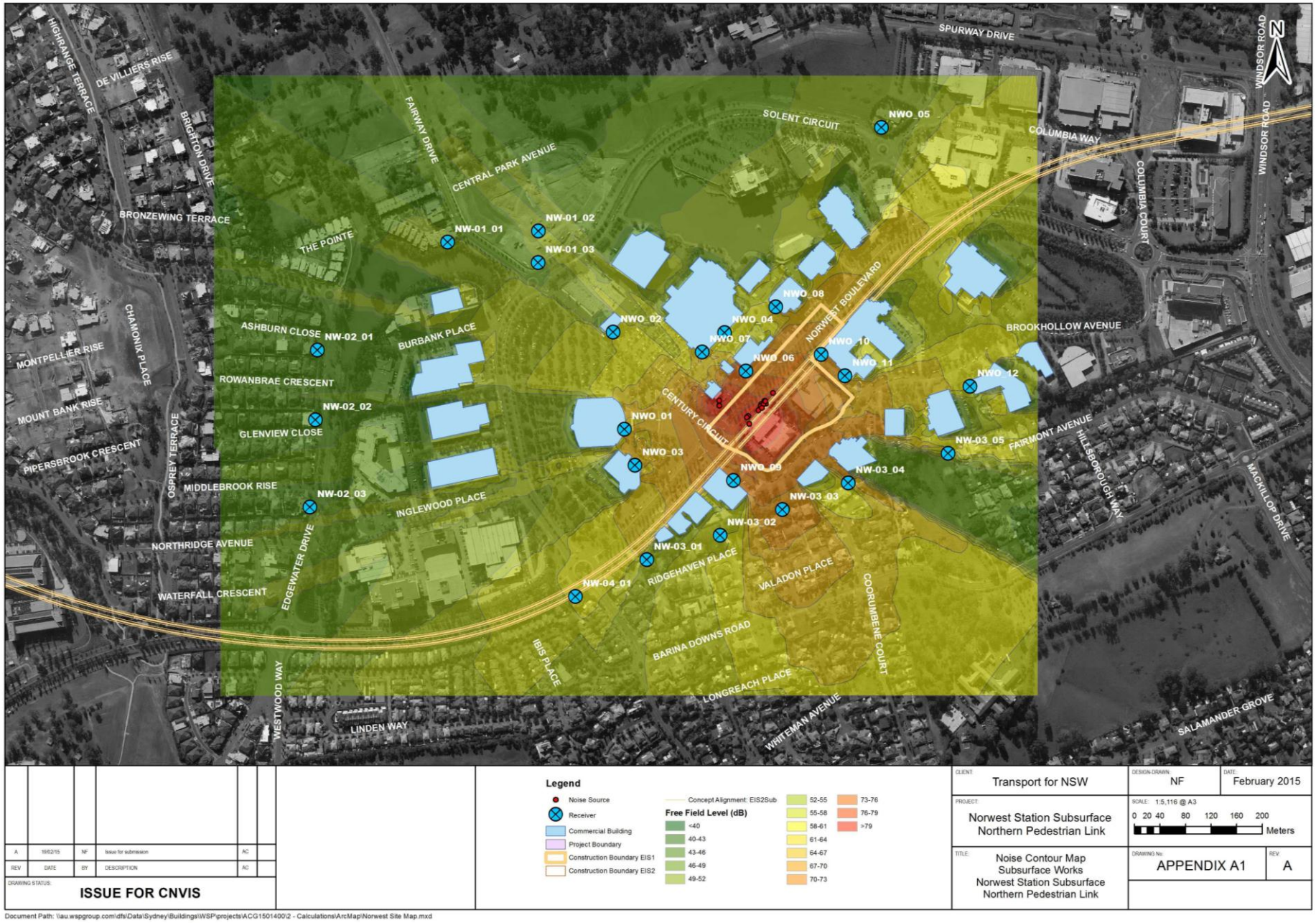
While it is possible to assess the noise impacts at each potentially affected sensitive receiver the guidance allows receivers to be grouped to create noise catchment areas (NCAs). This approach can be reliably used where the receiver type (i.e. residential, commercial, industrial) in the defined NCA is likely to be exposed to a similar level of noise.

There are about 450 noise-sensitive residential receivers in the study area that can be reasonably grouped into four NCAs. Table 6.16 summarises the character of the four NCAs. It also shows the location of the nearest noise-sensitive receiver in each NCA. This is the receiver that would have the greatest noise 'exposure' (impact) due to the proposal.

Table 6.16 Residential noise catchment areas, number of residential receivers in the catchment area and closest residential receivers to the proposal footprint in each catchment area

NCA	Total number of residential receivers	Location of the nearest 'most exposed' residential receivers		
		ID	Address	Minimum separation distance to the limit of the proposal footprint (metres)
NCA01	90	01	4 Peninsula Way, Baulkham Hills	490
		02	92 Central Park Ave, Baulkham Hills	360
		03	29 Central Park Ave, Baulkham Hills	490
NCA 02	85	01	2 Ashburn Cl, Bella Vista	635
		02	1 Glenview Cl, Bella Vista	625
		03	2 Middlebrook Rd, Bella Vista	650
NCA 03	170	01	38A Ridgehaven Pl, Bella Vista	235
		02	54 Ridgehaven Pl, Baulkham Hills	160
		03	19-21 Jacqui Cct, Baulkham Hills	140
		04	16 Evesham Ct, Baulkham Hills	190
		05	32 Fairmont Ave, Baulkham Hills	330
NCA 04	100	01	7–9 Plover Glen, Baulkham Hills	360

Figure 6.2 shows the location and extent of the NCAs in relation to the proposal footprint.


HIGHRANGE TERRACE
DE VILLIERS RISE
BRIGHTON DRIVE
BRONZEWING TERRACE
THE POINTE
FAIRWAY DRIVE
CENTRAL PARK AVENUE
SPURWAY DRIVE
SOLENT CIRCUIT
COLUMBIA WAY
COLUMBIA COURT
WINDSOR ROAD
NW-01_01
NW-01_02
NW-01_03
NWO_05
NWO_08
NWO_02
NWO_04
NWO_07
NWO_10
NWO_11
NWO_06
NWO_12
NORWEST BOULEVARD
BROOKHOLLOW AVENUE
ASHBURN CLOSE
NW-02_01
BURBANK PLACE
MONTPELLIER RISE
CHAMONIX PLACE
ROWANBRAE CRESCENT
NW-02_02
GLENVIEW CLOSE
MOUNT BANK RISE
PIPERSBROOK CRESCENT
OSPREY TERRACE
CENTURY CIRCUIT
NWO_01
NWO_03
NWO_09
NW-03_05
FAIRMONT AVENUE
HILLSBOROUGH WAY
MACHILLOP DRIVE
NW-03_04
NW-03_03
NW-03_02
NW-03_01
MIDDLEBROOK RISE
NW-02_03
INGLEWOOD PLACE
NORTHRIDGE AVENUE
EDGEWATER DRIVE
WATERFALL CRESCENT
NW-04_01
RIDGEHAVEN PLACE
VALADON PLACE
COORUMBENE COURT
BARINA DOWNS ROAD
IBIS PLACE
LONGREACH PLACE
WESTWOOD WAY
LINDEN WAY
WHITEMAN AVENUE
SALAMANDER GROVE
N
Legend
Noise Source
Receiver
Commercial Building
Project Boundary
Construction Boundary EIS1
Construction Boundary EIS2
Concept Alignment: EIS2Sub
Free Field Level (dB)
<40
40-43
43-46
46-49
49-52
52-55
55-58
58-61
61-64
64-67
67-70
70-73
73-76
76-79
>79
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DESIGN DRAWN: NF
DATE: February 2015
PROJECT: Norwest Station Subsurface Northern Pedestrian Link
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Non-residential receivers

The study area also contains a number of non-residential noise-sensitive receivers. These have not been grouped due to their fewer numbers and separated locations. Table 6.17 provides a list of the receivers, their location and their 'land use' as described in the *ICNG.*

Table 6.17 Non-residential noise sensitive receivers, location and distance from the proposal

Land use	Location of the nearest 'most exposed' non-residential receivers		
	ID	Address	Minimum separation distance to the limit of the proposal footprint (metres)
Place of worship (incl. TV and recording studio)	NWO 01	Hillsong Convention Centre, 1–9 Solent Circuit Baulkham Hills	140
	NWO 02	Hillsong Chapel, 1–9 Solent Circuit, Baulkham Hills	205
Education	NWO 03	Hillsong International Leadership College	150
	NWO 04	Parkview Childcare Centre, 4 Century Circuit, Baulkham Hills	140
	NWO 05	Norwest Childcare Centre, 2 Maitland Place, Baulkham Hills	525
Commercial (office and retail)	NWO 06	Shell Service Station, 4 Century Circuit, Baulkham Hills	70
	NWO 07	Norwest Market Town shopping centre	95
	NWO 08	2 Century Circuit, Baulkham Hills	140
	NWO 09	Block A, Capital Business Centre, 38 Norwest Boulevard, Baulkham Hills	60
	NWO 10	19 Brookhollow Avenue, Baulkham Hills	150
	NWO 11	21 Brookhollow Avenue, Baulkham Hills	165
	NWO 12	Adina Apartments Hotel, 22 Brookhollow Avenue, Baulkham Hills	350

Vibration-sensitive receivers

Structural building damage can occur up to 15 metres from a vibration source while amenity effects (human comfort) can be experienced up to 100 metres from a vibration source. Construction vibration impacts could therefore affect any noise-sensitive receivers and buildings that are located this distance from the proposal footprint.

6.3.3 Potential impacts

Construction noise

The aim is for this proposal to be constructed at the same time as Norwest Station. This gives rise to the possible scenarios discussed in Section 6.3.1.

In-isolation impacts

Table 6.18 shows the predicted noise impacts that could occur should construction work be taking place on the proposal while there would be no construction work taking place at Norwest Station site. The table shows the predicted noise levels at each residential NCA and at each non-residential noise sensitive receiver that would occur during the day (due to surface activities) and at night (due to subsurface activities).

The following shading enhancements have been used in the table:

- Grey shading shows where there is an exceedance of the corresponding NML.

Table 6.18 Predicted noise levels from constructing the proposal

Receiver ID	Daytime NML	Highest predicted noise level (dB(A) L_{Aeq})	Night time NML	Highest predicted noise level (dB(A) L_{Aeq})
	Day time surface work		Night time subsurface work	
Residential noise-sensitive receivers (NCAs)				
NCA 01	52	51	43	49
NCA 02		44		42
NCA 03		62		66
NCA 04		54		55
Non-residential noise-sensitive receivers				
NWO 01	55	60	55	62
NWO 02		59		56
NWO 03		62		62
NWO 04		58		60
NWO 05		48		47
NWO 06	75	68	75	69
NWO 07	70	61	70	61
NWO 08		59		56
NWO 09		67		70
NWO 10		67		65
NWO 11		66		65
NWO 12	60	59	60	54

The table confirms that construction of the proposal is sufficient to affect residents, the church and a child care centre. Whether the non-residential receivers would be impacted at night would depend on their operational hours. The impact is rated as moderate adverse.

Combined noise impacts

Table 6.19 shows the relative increase in noise due to constructing the proposal at the same time as Norwest Station. The table shows the predicted noise levels that could be conceivably experienced in each residential NCA and at each non-residential noise-sensitive receiver. It then shows the relative increase in noise levels at each receiver due to the contribution made by the proposal. The assessment is notably conservative as it assesses the worst case noise emissions from both sites, which in reality would be exceptionally unlikely to occur. The predictions consider the noise impacts due to surface work taking place at both sites during the day and subsurface work taking place at both sites at night.

The following shading and text enhancements have been used in the table:

- *NML Exceedance:* Grey shading shows where there is an exceedance of the corresponding NML.
- *Relative increase:* Red text shows where the change would exceed 3 dB which is taken as the point where the impact becomes perceptible.

Table 6.19 Predicted noise levels from constructing the proposal and Norwest Station at the same time

Receiver ID	Day time noise levels dB(A) L_{Aeq}				Night time noise levels dB(A) L_{Aeq}			
	NML	Station	Station + proposal	Relative increase	NML	Station	Station + proposal	Relative increase
	Day time surface work				Night time subsurface work			
Residential noise-sensitive receivers (NCAs)								
NCA 01	52	60	61	1	43	32	49	**17**
NCA 02		52	53	1		30	42	**12**
NCA 03		72	72	-		45	66	**21**
NCA 04		58	60	2		32	55	**23**
Non-residential noise-sensitive receivers								
NWO 01	55	70	70	-	55	37	62	**25**
NWO 02		66	67	1		33	56	**23**
NWO 03		70	71	1		38	62	**24**
NWO 04		57	61	4		30	60	**30**
NWO 05		57	58	1		30	47	**17**
NWO 06	75	80	80	-	75	40	69	**29**
NWO 07	70	74	74	-	70	39	61	**22**
NWO 08		77	77	-		42	56	**14**
NWO 09		79	79	-		49	70	**21**
NWO 10		82	82	-		47	65	**18**
NWO 11		72	73	1		42	65	**23**
NWO 12	60	62	64	2	60	31	54	**23**

The following conclusions can be drawn from the table:

- Surface daytime construction activities would not likely result in a perceptible increase noise levels if the proposal and station where constructed at the same time.
- Subsurface night time construction activities would result a perceptible increase in noise levels at all the receivers if the proposal was constructed at the same time as Norwest Station.
- The proposal would likely result in eight additional NML exceedances at night across three of the NCAs and at six of the non-residential noise-sensitive receivers.

The overall impact is rated as moderate adverse.

Sleep disturbance

Sleep disturbance is assessed by considering the maximum noise levels ($L_{AM\ 1\text{-}min}$) that could occur. Unlike the above assessment it considers the average noise level that could occur over a 15-minute period ($L_{Aeq\ (15\ minutes)}$). The two measurements therefore differ slightly. As above, there are two possible construction scenarios where sleep disturbance may potentially occur, as considered below.

Table 6.20 Potential sleep disturbance risk

ID	Limit dB(A) $L_{A1,1min}$	Maximum predicted level, $L_{A\ 1\ min}$	
		In-isolation impacts (i.e. the proposal)	Combined impacts (i.e. the proposal and Norwest Station)
Residential noise-sensitive receivers (NCAs)			
NCA 01	65	48	48
NCA 02		42	42
NCA 03		64	64
NCA 04		35	35
Adina Apartments Hotel, 22 Brookhollow Avenue, Baulkham Hills			
NWO 12	65	35	35

It can be concluded that the proposed night work would not lead to sleep disturbance issues. While the noise level at NCA 03 is close to the sleep disturbance limit it can be considered a worst-case prediction.

The same noise levels are predicted under both scenarios. This is because the predicted noise generated from constructing Norwest Station at night would have a negligible influence on the overall night time noise levels, which are dominated by constructing the proposal.

Groundborne noise

As discussed above, groundborne noise occurs when insulation has been provided to reduce airborne noise. The only location where this would be an issue for this proposal would be at the Hillsong Church, which is located about 140 metres from the limit of the proposal footprint.

As the noisiest activity in construction would from using the road header and rock breaker it would be reasonable to assess their groundborne noise impacts on the Hillsong Church. As reported in Appendix C, at 140 metres from the source, groundborne noise would be about 25 dB $L_{Aeq\ 15\text{-}minutes}$. This is below both the daytime and night time limits described in Table 6.14. The predicted noise level at the church was based on the use of a number of worst-case assumptions, which therefore validate the conclusion. Such an impact is therefore rated as negligible. However, it is recommended that additional detailed calculations are undertaken during the detailed design in order to confirm compliance with established criteria and to assess

whether there would be any additional influence or impact from undertaking subsurface work on Norwest Station at the same time.

Construction vibration

As noted in Section 6.3.1, the vibration generated from any subsurface work would dominate, with surface vibration impacts having no impact on the outcome of the assessment. However, unlike the noise assessment, there would be periods during construction when surface work would only be taking place as considered below, thus consideration of surface vibration impacts is below.

Surface work

The use of a vibratory roller, hydraulic hammer, pile driver, pile bore and jackhammer all have the potential to result in either cosmetic damage and/or amenity (human comfort) impacts during construction.

Table 6.11 shows that of the range of vibration-generating equipment that would be used to service the proposal's construction, the use of a large vibratory roller within 25 metres of a building could cause cosmetic damage and that amenity (human comfort) impacts could occur for up to 100 metres.

There are three buildings within 100 metres of the limit of the proposal footprint; the nearest being 60 metres away (NWO 09 – Block A – Capital Business Centre). While there would be no cosmetic damage to any building the building occupants may complain of vibration impacts. This could be prevented by using a smaller vibratory roller (less than six tonnes) and hydraulic hammer (less than 18 tonnes).

While there could be the feasible scenario of surface work taking place at both sites at the same time, the combined vibration impacts have not been assessed as the same safe working distances would still apply from any piece of machinery.

Subsurface vibration

The construction of the shaft and tunnel would generate groundborne vibration in using the road header and rock breaker (drilling equipment). Table 6.21 shows the distances it would take from the subsurface work to achieve set vibration levels (peak particle velocities) based on based on published data and measured limits for similar equipment (refer to Appendix C).

Table 6.21 Subsurface vibration impacts

Equipment	Vibration level (peak particle velocity) (mm/s) at distance (metres)					
	1 mm/s	0.8 mm/s	0.6 mm/s	0.4 mm/s	0.2 mm/s	0.1 mm/s
Road header	15–20	20–25	20–25	25–30	30–35	40–45
Rock breaker (35 t carrier)	35	40	45	55	70	100

As noted above, there are three buildings within 100 metres of the location where the vibration would be generated, the nearest of which is about 60 metres from the limit of the proposal footprint.

At 60 metres, the peak particle velocity would be just above 0.2 mm/s. There would be an additional loss as the vibration transfers from the ground to the building meaning that in reality the peak particle velocity would be lower than the limit of human perception described in DIN 4150-2 part 2 (refer to Section 6.3.1), and as a result it is not expected that any adverse impacts will be experienced. The impact is therefore rated as negligible.

There is also the potential for groundborne vibration to be caused while both Norwest Station and proposal are under construction. However, there would be negligible influence from the subsurface work taking place at Norwest Station (as inferred from Table 6.19). As such, the above conclusions would be true for this scenario.

Operational noise

Road traffic noise

The proposal would have no impact on operational traffic movements (refer to Section 6.1.3). As a result, there would be no change in operational traffic-generated noise impacts.

Equipment generated noise

The proposal would require the installation of noise-generating equipment:

- A ventilation fan that would service the proposal.
- An emergency public address system.

The fan would be located in the same location as the ventilation fans installed as part of Norwest Station. It is not anticipated that the fan's operational noise would notably affect the cumulative output from Norwest Station. This would be ensured by designing its output to meet Industrial Noise Policy requirements.

The emergency equipment would only be used occasionally. Its impacts would therefore not form part of the normal operating conditions. While the noise may affect local receivers, given the purpose of the equipment it is likely that it would be accepted by the community. Equipment testing would also need to take place. This would only last for a short-period of time and it would likely take place with prior notice being issued to the local community.

6.3.4 Safeguards and management measures

Table 6.22 lists the noise and vibration safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.3.3.

Table 6.22 Noise and vibration safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Noise and vibration impacts during construction	Identify and consult with potentially-affected community, religious, educational institutions and vibration-sensitive businesses and critical working areas, and where feasible and reasonable, ensure that noise generating construction works in the vicinity of the receivers are not timetabled during sensitive periods, unless appropriate other arrangements are made. The proposal shall be designed and operated with the objective of not exceeding the vibration goals for human exposure for existing sensitive receivers, as presented in *Assessing Vibration: a Technical Guideline* (DECC, 2006).	TfNSW	Detailed design
Noise and Vibration Pollution during construction and operation	Implement noise pollution policy as per Section 4.13 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed Design
Pre-construction (construction)			
Surface equipment vibration	Wherever feasible and reasonable vibration-generating activities shall be undertaken using quieter alternative methods.	Construction constrictor	Pre-construction

Impact	Safeguard/management measure	Responsibility	Timing
Surface noise impacts during construction	Three metre high noise barriers (site hoardings) would be constructed around the perimeter of construction sites.	Construction contractor	Pre-construction/construction
Construction			
Surface noise impacts	Undertake noise monitoring at representative noise-affected receivers and representative locations in each noise catchment area while work is taking place to validate the modelling predictions. Implement additional feasible and reasonable safeguards if the observed monitoring results in higher than predicted noise levels.	Construction contractor	Construction
Noise and vibration impacts during construction	Prepare a Construction Noise and Vibration Plan to detail how construction noise and vibration impacts will be minimised and managed. The Plan shall be consistent with the guidelines contained in the *Interim Construction Noise Guidelines* (DECC, 2009) and *Assessing Vibration: A Technical Guide* (DEC, 2006). The plan shall include, but not be limited to: ■ Identification of work areas, site compounds and access points. ■ Identification of sensitive receivers and relevant construction noise and vibration goals applicable to the SSI stipulated in this approval. ■ Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to generate noise and/or vibration impacts on surrounding sensitive receivers, particularly residential areas. ■ Identification of feasible and reasonable measures proposed to be implemented to minimise and manage construction noise impacts (including construction traffic noise impacts), including, but not limited to, acoustic enclosures, erection of noise walls (hoardings), respite periods and the limiting of truck movements during night periods. ■ Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including a suitable blast program, applicable buffer distances for vibration intensive works, use of low-vibration generating equipment/ vibration dampeners or alternative construction methodology, and pre- and post- construction dilapidation surveys of sensitive structures where blasting and/or vibration is likely to result in damage to buildings and structures (including	Construction contractor	Construction

Impact	Safeguard/management measure	Responsibility	Timing
	surveys being undertaken immediately following a monitored exceedance of the criteria). ■ Where the use of vibration-intensive activities take place an assessment of the potential noise and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program. ■ A description of how the effectiveness of mitigation and management measures would be monitored during the proposed works, clearly indicating how often this monitoring would be conducted, the locations where monitoring would take place, how the results of this monitoring would be recorded and reported, and, if any exceedance is detected, how any noncompliance would be rectified. ■ Mechanisms for the monitoring, review and amendment of this plan.		

6.4 Landscape character and visual impacts

This section identifies and assesses the proposal's impact on landscape character and sensitive visual receivers. The assessment accounts for the changes to the existing environment that will occur as a result of the ongoing construction and eventual operation of the Norwest Station.

6.4.1 Method

Study area

The assessment considered the predicted changes in landscape character and visual amenity across the proposal footprint and its immediate environs comprising locations where it would be possible to see the construction site and eventually the new pedestrian link surface canopy. Regional landscape characteristics were also used to describe the existing environment.

Method and assessment criteria

The landscape character and visual impact assessment was undertaken in accordance with:

- *The Guidelines for Landscape Character and Visual Impact Assessment (EIA-N04)* (Roads and Maritime, 2013a)
- *Australian Standard (AS) 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting* (Australian Standards, 1997).

The assessment:

- Characterised the existing regional and local landscape character.
- Determined regional visual characteristics and the study area's local visual context and setting.
- Defined the visual envelope, which represents the theoretical limit from where the proposal would be visible.

- Determined the sensitivity of landscape character and visual environment to the changes that would occur as a result of constructing and introducing the proposal into the study area.
- Considered the lighting impacts on adjacent receivers during construction and operation.
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Environmental assessment impact ratings

Landscape character quality or the quality of a view determines how sensitive either would be to change. Nature, scale, loss, duration, intensity and extent are the parameters used to determine impact magnitude. These factors combine to produce the overall landscape character and visual impact ratings that were adopted in the assessment (refer to Table 6.23).

Table 6.23 Landscape character and visual impact rating matrix

		Magnitude of change			
		High	**Moderate**	**Low**	**Negligible**
Sensitivity	**High**	High	High-Moderate	Moderate	Negligible
	Moderate	High-Moderate	Moderate	Moderate-low	
	Low	Moderate	Moderate-low	Low	
	Negligible	Negligible			

Assessing lighting impacts

The adverse impacts of light spill from outdoor lighting are influenced by:

- The height of the light source relative to the receive, where light is considered more obtrusive where the light source is higher than the receiver.
- Surrounding landforms and topography, which can shield the light source from the receiver.
- Ambient existing light levels and the type of light.
- Surrounding land uses; for instance residential receivers are considered more sensitive than commercial and industrial land uses.

Table 6.24 is taken from *Australian Standard (AS) 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting* (Australian Standards, 1997). This standard provides recommended maximum light levels that should be achieved at the boundary of a receiver. The table also shows the corresponding recommended maximum light levels at night in residential areas (shaded blue).

Table 6.24 Recommended maximum light levels

Parameter	Time of day	Commercial areas	Residential areas
Illuminance (in the vertical plane) (lux)	Evening	25 lux	10 lux
	Night	4 lux	2 lux
Luminous intensity emitted by luminaries (I) (candela (CD))	Evening	7,500 CD	100,000 CD
	Night	2,500 CD	1,000 CD
Threshold increment (TI) (per cent CD per square metres)	Any time	20 per cent based on adaption luminance of 10 CD/m^2	

6.4.2 Existing environment

Landscape character is a function of the composition of physical, natural and human features and activities across the study area. The assessment of the proposal's impact on landscape character considered how the composition of these elements would change as a result of constructing the proposal and once it was operational. Visual impacts were assessed by considering how susceptible people in the study areas would be to changes in landscape character. This study area's landscape character can be defined at two levels:

- The regional landscape character across north-west Sydney.
- The local landscape character across the study area and within the immediate environs of the proposal footprint.

Regional landscape character

Regionally, the proposal is located at the transition of the Cumberland Plain, an expanse of broad undulating hills spanning form Parramatta in the east to the Hawkesbury-Nepean basin in the west, and The Hills, characterised by a flatter open expanse of lowland undulations that have been cleared and developed.

East of the transition point, the regional characteristic of The Hills is dominated by heavily-forested ridges, valleys and nature reserves that have become remnant and fractured as the area has being developed. Its regional character is defined more by the built environment instead of the natural environment. The landform has been modified and levelled to allow for the area's development resulting in the creation of a number of residential hubs, conurbations and modern out-of-town self-contained commercial and business park developments. This is in contrast to the Cumberland Plain, which retains a dominant semi-rural character comprising larger development plots, remanent woodland, farmed land, and cleared open areas.

The transition point between the two environments occurs just to the west of the proposal footprint, broadly along the orientation of Old Windsor Road marked by the Caddies Creek flood plain. The proposal is therefore located within the landscape of The Hills environment.

Local landscape character

The development of the study area has led to a number of distinct landscape character zones. Table 6.25 describes the character of study area's landscapes as well as their perceived sensitivity to change. As there is a commitment to construct the Norwest Station, this is considered in describing the study areas landscape.

Table 6.25 Local landscape character zones

Landscape character zone	Character	Quality and sensitivity to change
North Baulkham Hills residential area	Framed by Norwest Boulevard and a retained planted tree line, the area is characterised by a compact network of detached housing wide urban streets and a managed urban landscape. There is little distinction across the character area and few reference or focal points, in place of a uniform pattern of residential development interspersed by occasional small reserve areas. The area is self-contained due to the flat topography, which results in there being little reference to its relationship and context to the wider area. As such, the area can be described as being of ordinary quality however having a negligible sensitivity to change in the context of this proposal.	Ordinary quality and negligible sensitivity to change.

Landscape character zone	Character	Quality and sensitivity to change
Norwest Business Park	Characteristic of a modern planned developed comprising a well-spaced network of commercial multi-story low-rise buildings separated by managed vegetation and framed within the context of a network of planned non-linear tree-lined connecting roads to provide good access. The Hillsong Church, Norwest Marketown shopping centre and Norwest Central provide distinctive reference points in the landscape that reinforce the area's overall character. The existing road network forms a dominant component within the landscape, with Norwest Boulevard being purposefully designed as a 'boulevard' to provide setting and context to the commercial buildings that run along each side. The landscape is undergoing transformation with the construction of the Norwest Station. Its built form will reinforce the area's character becoming another distinct reference point in the landscape.	Ordinary quality and low sensitivity to change.
Strangers Creek and Castle Hill Country Club	Framed by the Solent Circuit to the south, the area is characterised by an expanse of managed open land containing both planted and remnant vegetation. Occasional houses on larger plots separated by planted trees are in marked contrast to the dense residential character to the south. The two key reference points across the zone are the Country Club golf course, comprising a large expanse of managed land and the retained character of the Strangers Creek riparian corridor. Again the landscape is contained due to the area's topography preventing views into or out of the area. As such, while of good quality it would have a negligible sensitivity to change in the context of this proposal.	Good quality negligible sensitivity to change

Visual context

When considering the visual context of the study area there is an important distinction between the views offered when travelling through an area, which are transient, versus the zone of visual influence (referred to as the 'visual catchment') exerted by the landscape character of the proposal footprint. The visual context of the area can be described in terms of its sensitivity and its catchment.

Visual sensitivity

The proposal footprint is contained on the periphery of the Norwest Business Park landscape character zone and just north of the North Baulkham Hills landscape character zone. These two zones provide two distinct visual characteristics. While the amenity of the business park has been improved though urban design, this can be easily recreated. As such, the visual amenity of the proposal footprint is not particularly important. This is reinforced by the area's occupation by high numbers of transient visitors or workers that are less sensitive to their environs than other land uses. Conversely, the residents in North Baulkham Hills and the Hillsong Church congregation are considered to be more visually sensitive given that they have a greater connection with the landscape and higher concern about change in the landscape.

Visual catchment

The proposal footprint is visually contained within the context of the wider business park. Views do not extend beyond the fringes of the surrounding roads. This means the footprint is only visible from the immediately adjacent commercial buildings and by road users. The visual relationship in all directions is partially interrupted by planted vegetation and occasional mature well-spaced trees that line the surrounding roads or that have been used as amenity planting in front of buildings. This contains the footprint to the south and partially to the east; however there are open near views to and from the service station. There are also open near views from the Norwest Marketown shopping centre and its associated car park, with part of the car park forming the proposal footprint. There are also middle-to-distant views to and from the Hillsong Church separated by a wide grassed verge in front of the church. Overall the visual environment is considered or ordinary quality and low sensitivity to change.

Visual receivers

Visual receivers are those people who would be affected by landscape impacts. They are assessed in terms of identifying places where people regularly congregate and include residential property, public buildings, public spaces, heritage items and key businesses. With reference to the proposal the visual receivers include:

- Shoppers and workers associated with the Norwest Marketown shopping centre and the adjacent service station.
- Passengers, drivers and other road users travelling along Norwest Boulevard and Century Circuit.
- The Hillsong Church congregation.

The sensitivity of each receiver to the change in the landscape introduced under the proposal would be affected by a combination of whether:

- They would be permanently or temporarily affected (e.g. people that work and live in the area versus people that occasionally use the shopping centre).
- The function and use of each receiver (e.g. a residential property versus a public open space).
- Their location relative to the proposal footprint.

In the case of the proposal, there would be no residents that would be permanently impacted by the visual change in landscape character resulting from the proposal. The landscape changes would also not affect views to and from any commercial buildings sufficient to affect any workers or regular occupants. The changes would therefore only affect visual receivers that either routinely or occasionally visit the area. While their visual environment would be affected by the proposal they are considered as having a low sensitivity to change, or occasionally, being moderately sensitive to change as could be potentially claimed for the Hillsong church congregation and local residents that routinely travel through the area.

Views at night

Existing road and building lighting is provided throughout the study area. It influences ambient conditions introducing light spill and upwards light glare. While no ambient measurements are available, it is considered that the existing lighting infrastructure was designed to confirm to *Australian Standard (AS) 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting* (Australian Standards, 1997). However, it is also reasonable to assume that the aggregated light levels across the study area are close to the limits set out in Table 6.24.

6.4.3 Potential impacts

The assessment considers the additive impacts of constructing and operating the proposal at the same time as Norwest Station.

Construction impacts

Landscape character

The proposal's impact during construction would depend on the type of construction activity taking place and the duration of the work, as described in Section 3.4. The impacts would also be limited to any surface work taking place to either service the excavation of the circulation area or pedestrian link or to construct the entrance and canopy. The impacts would therefore be generated as a result of:

- Security fencing and noise wall installation
- Ground excavation work

- Spoil management, temporary storage and removal
- Equipment transfer, loading and unloading
- Roof canopy construction and the installation of external finishes, fitting and landscape planting.

The landscape character would therefore be affected by the general construction activities associated with this work including dust generation, amenity affects (including noise and vibration impacts), loading and unloading activities, the presence of construction equipment and the erection of fencing and hoardings. The most notable impacts would occur during major deliveries, while the crane is in use, and while the canopy in being installed.

The above work, activities and impacts would all take place while Norwest Station is under construction, which would also generate similar impacts on the receiving environment. In effect, the proposal would add to the overall extent of these impacts.

It was assessed that Norwest Station's construction would have a limited effect on the area's landscape character even over a two-year construction program (TfNSW, 2013a). By constructing the proposal for eight months within this program it is assessed that the impacts would be more notable, principally as there would be a construction site located on both side of Norwest Boulevard. However, this would still not have a marked effect on the wider landscape and no material impact on the character of a self-contained zone that has a low sensitivity to change.

Table 6.26 summarises the construction impacts on each landscape character zone.

Table 6.26 Construction landscape character (cumulative) impacts

Zone	Sensitivity	Magnitude of change	Impact rating
North Baulkham Hills residential area	Negligible	Negligible	Negligible
Norwest Business Park	Low	Low	Low
Strangers Creek and Castle Hill Country Club	Negligible	Negligible	Negligible

Visual impacts

The activities described above that would affect the landscape character would also affect the area's visual amenity during construction. By providing boundary fencing and hoardings around the proposal footprint this would screen the site from view. This would reduce its zone of visual influence and any ground level visual impacts would be mitigated. However, there would still be a residual visual impact as a result of construction traffic accessing and leaving site, the use of cranes during the movement and installation of major structural components, and once the canopy is under construction as it would extend above the fence height. The scale of the proposal's construction activities would not appreciably increase the overall mass or scale of construction in the precinct in combination with the construction work needed to support Norwest Station. As such, the impact is rated as being low or negligible other than for the church congregation and potentially those local residents and others that regularly pass through the area, where the impact is rated as moderate-low.

Table 6.27 Construction visual (cumulative) impacts

Receiver	Sensitivity	Magnitude of change	Impact rating
Shoppers and workers	Low	Low	Low
Road users (occasional)	Negligible	Low	Negligible
Road users (regular)	Moderate	Low	Moderate-low
Hillsong Church congregation	Moderate	Low	Moderate-low

Night time works and light spill impacts

There would be limited night work taking place during construction (refer to Section 3.4). It can be inferred that the excavation area within the proposal footprint would need lighting for at least eight weeks to service the removal of spoil (refer to Section 3.4). It is also assumed that security lighting would be used onsite throughout construction. The introduction of this light would potentially create additive light-spill impacts. The nature of the impact would depend on the height, strength, type and direction of the lighting and its location relative to any receiver. It would also depend on whether the surrounding buildings were in use at night.

Operational impacts

Landscape character

The proposal would modify an existing car park, extend the paved area, introduce a 5 metre high canopy structure, and relocate or introduce street furniture and landscape planting. The mass and scale of the changes alone would not be sufficient to have a marked influence on the area's landscape character. They would however have a cumulative influence in combination with the operational changes introduced at Norwest Station site. A consistent design has been selected across the two developments to reinforce the urban character of the Norwest Business Park. This would be achieved by replicating design elements and selecting themes and materials that reinforce and replicate the urban design of the area.

On this basis it can be concluded that the proposal and Norwest Station would combine to enhance the area's character. This would be seen as a beneficial outcome on the local landscape character. These benefits would not extend beyond the immediate zone as it is self-contained as described above. Table 6.28 summarises the potential impacts.

Table 6.28 Operational landscape character (cumulative) impacts

Zone	Sensitivity	Magnitude of change	Impact rating
North Baulkham Hills residential area	Negligible	Negligible	Negligible
Norwest Business Park	Low	Beneficial	Beneficial
Strangers Creek and Castle Hill Country Club	Negligible	Negligible	Negligible

Visual impacts

It was assessed that the operational station would have a negligible visual impact due to it neither improving nor reducing the area's visual amenity (TfNSW, 2013a). The one described exception was an alteration to the amenity of the views from the Hillsong Church, an impact that was assessed as being minor adverse.

By including this proposal into the landscape it would be unlikely that the Norwest Station canopy would substantially increase the overall mass or scale of station infrastructure despite being visible from different vantage points. The only receivers that would be able to see both components (i.e. the proposal and Norwest Station) would be the congregation of the Hillsong Church and road users as they drive through the area. It would be subjective whether this would be a beneficial or adverse impact. By having infrastructure that replicates and reinforces the area's urban design this may be perceived as a benefit by improving the visual amenity of the urban environment. Equally, there may be others that perceive the additional canopy as additional visual 'clutter' in the environment. This reaction would be perceived as a negative impact, albeit the rating is assessed as being no greater than moderate-to-low.

Finally, the canopy would also introduce a new component in the views of those that look over the site, which is limited to the users of the shopping centre. Their low sensitivity to change means that the impacts are only rated as low.

Table 6.29 Operational visual (cumulative) impacts

Receiver	Sensitivity	Magnitude of change	Impact rating
Shoppers and workers	Low	Negligible/beneficial	Low/beneficial
Road users (occasional)	Negligible	Negligible	Negligible
Road users (regular)	Moderate	Low/beneficial	Moderate-low/ beneficial
Hillsong Church congregation	Moderate	Low/beneficial	Moderate-low/ beneficial

Light spill impacts

The canopy entrance would be lit. While this would introduce more lighting, it would be unlikely to contribute anything of significance to the ambient light or increase the light pollution in the area. This conclusion is supported by the fact that the adopted lighting design promotes the use of direction modern lighting that prevents light scatter, backscatter and upward glare.

6.4.4 Safeguards and management measures

Table 6.30 lists the landscape character and visual impact safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.3.3.

Table 6.30 Landscape character and visual impacts safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Operational visual and landscape impacts across the proposal footprint	High quality landscape and urban treatments would be used in and around the proposal. Prepare and implement an Urban Design and Corridor Landscape Plan for the proposal. The Plan shall be prepared by appropriately qualified person and detail the design initiatives used to integrate the proposal into their proposed settings, and the landscaping measures to minimise, mitigate and/or offset the proposal's visual amenity impacts and effects on local vistas. The Plan shall include, but not necessarily be limited to: ■ Identification of design objectives and standards based on local environmental values, strategic and statutory planning, future land release form and function, sustainable design and maintenance, transport and land use integration, passenger and community safety and security, community amenity and privacy, and relevant design standards and guidelines. ■ Specific plans for station precincts to provide high quality sustainable infrastructure that enhance the public domain and provide for active uses, ensure intermodal integration and equitable and safe access, including connectivity to surrounding precinct.	TfNSW	Detailed design

Impact	Safeguard/management measure	Responsibility	Timing
Operational light spill impacts on adjacent properties due to the use of external lighting	Cut–off and directed lighting would be used to ensure glare and light spill on surrounding existing and future residents are minimised.	TfNSW	Detailed design
Construction			
Management of the construction work to minimise its visual impacts and localised effect on landscape character	Hoardings would be designed to be considered and appropriate with their surroundings. This may include project related artworks or project information. These would be installed as early as feasible and reasonable in the construction process. Regular maintenance of site hoarding and perimeter site areas would be undertaken, including the prompt removal of graffiti.	Construction contractor	Construction
Light spill impacts during construction across the proposal footprint	Cut-off and directed lighting would be used to ensure glare and light trespass are minimised.	Construction contractor	Construction
Visual impacts during construction at sensitive locations	Where feasible and reasonable the elements within construction sites would be located to minimise visual impact (e.g. setting particular equipment/structures back from the site boundaries to minimise their visual impact). The proposal shall be constructed in a manner that minimises visual impacts resulting from construction sites, including retaining, where feasible and reasonable, existing vegetation around the perimeter, providing temporary landscaping where appropriate to soften views of the construction sites, minimising light spillage, and incorporating architectural treatment and finishes within key elements of temporary structures that reflect the context within which the construction sites are located.	Construction contractor	Construction

6.5 Socioeconomic

This section presents an assessment of the proposal's potential socioeconomic impacts and benefits. This section is limited to a consideration of business and economic impacts and benefits. Section 6.6 (land use and property) describes the proposal's social (community) impacts and benefits.

6.5.1 Method

Study area

The socioeconomic study area considered the economic characteristics of north-west Sydney and The Hills LGA by referring to Census and statistical data.

Method and assessment criteria

The assessment:

- Identified the existing socioeconomic characteristics of the study area through desktop research, reviewing secondary-source quantitative data, undertaking limited primary research, and in particular referring to:
  - ABS Census data (as collected in 2011)
  - Information on local community structure and patterns
  - Business and economic data.
- Determined the study area's business characteristics.
- Assessed how the proposal's construction and operation would hinder or stimulate business.
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Environmental assessment impact ratings

In the context of this proposal, economic impacts and benefits were assessed in terms of the likely loss of generation of business in the area where the following impact ratings were applied:

- Negligible: where there is predicted to be no effect on business activity, growth, reduction, loss or stimulation.
- Minor: where there is predicted to be either some minor short-term loss or increase in revenue during the proposal's construction or operation however it would be hard to externally quantify.
- Moderate: where there is predicted to be demonstrated business growth or loss locally (i.e., new employment, expansion, closures, competition, investment) either during the proposal's construction or operation.
- Major: where there is predicted to be demonstrated business growth or loss regionally through the transformation of an area or an economic uplift or downturn extending beyond business but also affecting the wider community.

6.5.2 Existing environment

Regional socioeconomic characteristics

The Hills Shire LGA is predominantly residential and semi-rural with minor commercial and industrial uses. As of 2011 about 180,000 people lived in the shire, representing about four per cent of Sydney's metropolitan population. Over the preceding five years, the area's residential population had steadily grown by about two per cent year-on-year.

Regional economic characteristics

The study area is characterised by the commerce and business that takes place in the Norwest Precinct. Central to this is the Norwest Business Park that houses a number of corporate headquarters. Across the shire however the majority of businesses (about 94 per cent) are defined by the ABS as 'small businesses'. These businesses typically employ few people however they can generate what the ABS describe as 'medium turnovers'. Table 6.31 summarises the area's business characteristics.

Table 6.31 The Hills LGA business characteristics

Scale	%	Top industry (size)	%	Top industry (turnover)
Small	94	Construction	47	Construction
Medium	7	Retail trade, professional, scientific and technical services, administrative and support	39	Construction
Large	-	-	14	Construction

Local economic characteristics

As referenced above, the proposal footprint is located within the Norwest Business Park. The Business Park contains a number of corporate headquarters (Hillsong Church, Woolworths), regional offices (Reserve Bank of Australia, ResMed, Wyeth, Optus Data Centre), retail premises and health care facilities. It also contains support businesses and community facilities that have established in the area including childcare, hotels, restaurants, and gyms. The Hillsong Church also includes a tertiary college, television centre and music recording studio which, along with the church, are registered businesses.

Potential impacts

Construction

Business impacts

The following economic impacts are anticipated during the proposal's construction:

- Short-term access delays during construction along Century Circuit (refer to Section 6.1.3) that may delay or inconvenience customers or suppliers, notwithstanding the ability to effectively implement diversions under the proposal. Rated as a minor adverse impact.
- The temporary loss of about 60 car park spaces, noting however that this is assessed not to have a material impact on the businesses in the area due to their peripheral location and their low use (refer to Section 6.6.3). As such, the impact is rated as a minor adverse impact.
- Minor economic stimulus in the construction sector (which is the main business type in the area) and a follow-on increase in trade from local material purchases, worker day-to-day purchases (i.e., cafés, restaurants), increased incomes and increased employment. Such benefits are only likely to be short-term and minor in nature, with there being a low probability of businesses seeing measureable growth in construction as a result. As such, the impact is rated as minor beneficial.
- Amenity impacts due to the visibility of the construction site, noise and vibration, dust, and construction traffic. However as the proposal footprint is remote from the core of the Norwest Business Park and located away from any sensitive operational businesses the impact is rated minor adverse at worst.

The location of the proposal footprint does not front any active businesses. It would therefore be unlikely to reduce the viability of any businesses in the area.

Operation

Business impacts

The proposal on its own would be unlikely to generate any economic stimulus or cause any economic impacts. However by improving access into the Business Park it would support and strengthen the objective of bringing rapid transit rail to Sydney's North West. The economic benefit of this has been demonstrated by supporting the introduction of new business and investment, competition and economic stimulation and increased accessibility and connectivity. The proposal would therefore contribute to this outcome.

Specific benefits and impacts associated with the Norwest Station (and therefore the proposal) would include:

- Retail, café and food businesses would operate around the Norwest Station precinct introducing competition in the area.
- Adversely, existing businesses in the area may experience rent increases as the area becomes more attractive economically.

Overall, the proposal on its own is rated as having a negligible impact or benefit; however as part of the wider station and Sydney Metro Northwest it is rated as having a moderate or even major beneficial impact despite the potential increase in rents in the area.

6.5.3 Safeguards and management measures

Table 6.32 lists the socioeconomic safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.5.3.

Table 6.32 Socioeconomic safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Business impacts over the life of the proposal	Prepare and implement a Business Management Plan to minimise impacts on adjacent business. The plan shall include measures to minimise business related impacts, maintain where feasible and reasonable vehicular and pedestrian access during business hours, and the maintenance of visibility of the business appropriate to its reliance on such.	TfNSW/construction contractor/NRT	Detailed design through to operation
Business impacts during construction and during the initial phase of operation	Employ specialist Place Managers to act as a single, identifiable and direct point of contact for local residents, business people and community groups with the project during construction. Place Managers would work closely with all affected local businesses to help ensure timely responses to queries. A toll free number and website would be in place for the duration of the construction works to enable business owners and/or operators to receive prompt responses to their concerns, access information and view assistance measures in place during construction related works.	TfNSW/construction contractor/NRT	Detailed design through to operation

Impact	Safeguard/management measure	Responsibility	Timing
Enhance Community benefits and experience	Implement policy to enhance community benefits and customer benefits as per Section 4.6 and 4.7 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design
Pre-construction (construction)			
Business impacts during construction	A business consultation group would be formed to monitor, consider and provide business specific advice to manage the impacts during construction. Members of the consultation group may include representatives from local councils, and the NSW Chamber of Commerce and industry.	TfNSW	Pre-construction

6.6 Land use and property

This section identifies and assesses the proposal's potential impacts on land use and property.

6.6.1 Method

Study area

The assessment study area considered the land and property within and adjacent to the proposal footprint. State and local planning policy was also used to describe the existing environment.

Method and assessment criteria

The assessment:

- Considered the land use development control provisions described in State and local legislation and planning policy with reference to the information reported in Chapter 4.
- Identified existing land uses, trends and characteristics across the study area.
- Identified current and future land uses within and adjacent to the proposal footprint.
- Identified the current and future property characteristics of the proposal footprint.
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Environmental assessment impact ratings

Impact ratings were determined by considering the sensitivity of the study area's land use and property characteristics to the changes introduced under the proposal, and the likelihood for any assets, resources or values being impacted during construction and/or operation:

- Negligible: where there is predicted to be no land use or property conflicts or any required property acquisition.
- Minor: where the proposal is permissible under land use zoning however there some potential land use or property conflict would occur due to temporary property acquisition.
- Moderate: where the proposal is permissible under land use zoning however there would be some potential land use or property conflict resulting in either temporary or permanent property acquisition that may require compensation or remuneration.

- Major: where the proposal is not permissible under land use zoning or there would be major land or property conflict in terms of the loss of an important land use or permanent property acquisition requiring compensation or remuneration.

6.6.2 Existing environment

Land use zoning

The proposal footprint is located on and under land whose local development control is provisioned under *The Hills LEP*. As mentioned in Section 4.1, the approval pathway means that the proposal is not subject to the development controls contained in the LEP, however the LEP zoning is relevant in identifying land use conflict. Figure 6.3 shows the land use zones associated with the proposal footprint and its environs. Table 4.1 describes the character and controls of each zone and the proposal's consistency with these controls.

In summary, the surface and subsurface components of the proposal footprint are located on land zoned as a local centre; an area where mixed use development is promoted to encourage employment opportunities and public transport links. The proposal is also not located in any area that contains active subsurface mineral, mining or petroleum rights.

General land use characteristics

The main land uses in the study area comprise:

- The Norwest Marketown shopping centre located about 150 metres to the north on the opposite side of Century Circuit.
- Hillsong Church, located about 140 metres to the west on the opposite side of Century Circuit.
- Business and commercial premises associated with the Norwest Business Park centred around Norwest Lake.
- The construction footprint of the Norwest Station.
- Dense residential development to the south.
- The Norwest Lake, an amenity passive recreation space and 'green corridor'.
- Recreation and amenity areas and low density residential to the north.

The area's housing density reflects the principal land use characteristics described above. Immediately south of Norwest Boulevard the housing density is more than 40 people per hectare, while within the business park is negligible at about one person per hectare.

The development footprint forms part of a release area (Balmoral Road) that will cater for future employment and housing growth. The area is also in the initial stages of residential development and will house a substantial number of people over the next two decades.

The Norwest Business Park was first developed in 1980s, with the objective of creating a major employment opportunity area based on a campus design. The aim was to create a range of three-to-five story commercial buildings within a modern landscape and urban setting. This has been achieved and supplemented by the development of characteristically wide 'boulevard' roads, setbacks and the use of planting that comprises a mixture of remnant native vegetation and new amenity planting. As a result, it creates an informal urban theme in the area supported by amenity features such as the Norwest Lake. Footpaths and shared use paths provide interconnectivity and allow quick movement from one area to another. As such, the area has been designed to promote sustainable living as well as to encourage walking and cycling.

Over time, many corporation headquarters have established in the area including Woolworths, ResMed Inc., B. Braun, International Business Machines (IBM), Schneider and Capital Finance. The precinct continues to grow and attract investment. As a result, support businesses and community facilities have also established in the area including childcare, hotels, restaurants, and gyms (refer to Section 6.5.2).

The proposal footprint also contains a number of community facilities incorporating the Hillsong Church, The Hillsong Performing Arts Centre, and the Sydney Ice Arena. The wider area contains a number of local centres including Bella Vista Village Centre, Bella Vista Farm Park and the Crestwood Community Centre.

The Hillsong Church additionally contains a tertiary college, television centre and music recording studio. It provides an important role in the community attracting a large number of people from across the Sydney metropolitan area. There are also three educational facilities about 1.5 kilometres form the proposal footprint; Crestwood High School, Crestwood Public School and St. Michael's School.

Proposal footprint land uses

The surface component of the proposal footprint (and construction site) would be located on a car park that services the Norwest Marketown shopping centre. It also includes the eastern footpath on the link section of Century Circuit off Norwest Boulevard, and the northern footpath along a section of Norwest Boulevard from its intersection with Century Circuit up to a point close to the access to the adjacent service station. It also includes areas of amenity planting, a former fast food restaurant (unoccupied), and footpath infrastructure and furniture (e.g. street lighting and kerbs and gutters).

Property

The proposal footprint is located across two lots (DP878258 and DP285227). The main property owner is Norwest City Pty Ltd. The footprint is also located on State-owned land managed by Roads and Maritime (Norwest Boulevard) and Hills Council (Century Circuit). Figure 6.3 shows the lots and the land ownership. The other notable property owner is the Hillsong Church that owns the land to the west of Century Circuit up to Solent Crescent.

Development applications

At the time of publication, there are no approved development applications that would affect the proposal's construction or operation. However TfNSW is aware of the aspiration to lodge a development application in the near future for a multistorey residential tower and commercial development on the land that will be used for the construction compound (refer to Figure 3.3). The developer is aware of this proposal. It would be unlikely that the development application would be lodged and determined before this REF is reviewed. This application would need to consider the cumulative impacts of the operational northern entry and any approved adjacent residential and commercial development. The construction licence would remove there being any risk of this aspirational development being constructed at the same time as the proposal.


Coles
Century Circuit
Coles Express
Norwest Boulevard
Norwest Boulevard
Norwest Boulevard
Norwest
Castle Hill Country Club
Bella Vista
DP878258
DP848605
DP285227
DP285227
DP285227
DP285227
DP285227
DP1129197
DP1180966
DP270106
SP54644
DP270106
DP270106
DP828992
DP828992
Brookhollow
Legend
Construction Footprint
Cadastre
© OpenStreetMap (and) contributors, CC-BY-SA
Data Source: - Based on information provided by Transport NSW
Map No: 2207529A_GIS_004_A1
Author: - GoganovskiM
Approved by: -
Date: 24/02/2015
1:1,200
Scale ratio correct when printed at A4 Portrait
Projection: Transverse Mercator
Coordinate System: GDA 1994 MGA Zone 56
NRTH WEST RAIL LINK
Figure 6.3
Land Use
www.pbworld.com
PARSONS BRINCKERHOFF

6.6.3 Potential impacts

Construction

Land use zoning

The proposal would not impact on the objectives or development controls set for each coinciding land use zone or precinct (refer to Section 4.2). Therefore there would be no land use zoning impact.

Land use and development

The proposal would not inhibit, conflict with, or affect land use development. Its only impact would be indirect, relating to the potential for short-term minor traffic delays and access restrictions during construction (refer to Section 6.1.3). The work would be staged and programmed to reduce travel delays during times of heaviest traffic demand, which would include any required access to the Business Park and Hillsong Church. There would be no land use or development impacts during construction.

Property acquisition and leasing requirements

The proposal's construction footprint would require the leasing of an area that contains about 60 car parking spaces. It would also prevent access to the unoccupied former fast food restaurant and the closure of two lengths of footpath as described above. These restrictions would be in place for about eight months. This impact is rated as minor-to-moderate adverse depending on the patronage and use of the car parking spaces.

Operation

Land use zoning

The proposal would not impact on the objectives or development controls set for each coinciding land use zone or precinct. However, by providing an additional access to a public transport link this would support the development of the local area, as provisioned under the LEP. This is therefore seen as a benefit of the proposal.

Land use and development

As above, by providing improved pedestrian access and capacity into the heart of the Norwest Precinct the proposal would benefit future development and growth in the area, reinforcing the proposal's objective and the objectives of the wider Sydney Metro Northwest. In terms of the future residential and commercial development of the adjacent land this would need to consider the objectives of this proposal in its application as it is likely to be determined after this REF is considered and assessed.

Property acquisition and leasing arrangements

The operational footprint would result in the permanent loss of about 20 car parking spaces. They are some of the most distant spaces form the shopping centre and would only be typically used on exceptionally busy days when the car parks were near capacity. The car park is also occasionally provides an 'overspill' function for special events held at the Hillsong Church. The remaining 40 car parking spaces would be reinstated once the proposal is operational. This impact is rated as minor-to-moderate adverse depending on the patronage and use of the car parking spaces.

All other land would be returned to its existing use once the proposal was operational notwithstanding the proposed enhancement of the urban environment around the pedestrian link entrance.

6.6.4 Safeguards and management measures

Table 6.33 lists the land use and property safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.6.3.

Table 6.33 Land use and property safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Leasing	Opportunities to minimise temporary loss of land should be investigated through detailed construction planning and site layout.	TfNSW/construction contractor	Detailed design/ pre-construction
Indirect land use (access) impacts during construction	Consider staging construction, particularly at busy locations, to complement traffic management measures and assist in minimising disruption to key land uses and vehicle and pedestrian movements.	TfNSW/construction contractor	Detailed design/ pre-construction
Land use	Implement land use policy as per Section 4.5 and 4.8 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design
Pre-construction (construction)			
Planning control integration	Liaise with statutory organisations, and the Hill Shire Council to ensure the proposal is integrated with local and regional land use planning, and that environmental planning instruments reflect the planning, construction and operation of the Project, and include integrated planning provisions to enhance potential future development.	TfNSW	Pre-construction
Impacts on the Hillsong Church	Consultation with Hillsong Church would be undertaken prior to construction to identify specific mitigation measures to reduce operational and amenity impacts.	Construction contractor	Pre-construction

6.7 Air quality

This section assesses the proposal's impact on air quality.

6.7.1 Method

Study area

The air quality assessment study area considered people within 200 metres of the proposal footprint focussing on residential properties and locations where significant numbers of people and more vulnerable members of the public regularly congregate[4].

[4] This distance is specified in Volume 11, Section 3, Part 1 of the UK Design Manual for Roads and Bridges, 2007 (UK Highways Agency, 2007).

Method and assessment criteria

The air quality assessment was undertaken by referring to the:

- *National Environmental Protection Measure for Ambient Air Quality (Air NEPM)* (National Environment Protection Council, 1998)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005).

The assessment considered the potential for dust generation as well as emissions generated through changes in traffic flows and the use of equipment. It was concluded that as the volume of construction traffic would be negligible in air quality impact terms (refer to Chapter 3) this factor was not considered in this assessment.

The construction assessment:

- Identified sensitive receivers within the study area.
- Identified key construction activities that would potentially generate dust.
- Identified the locations where these activities would take place within 200 metres of any identified receivers[4].
- Confirmed the effect of the prevailing wind and meteorological conditions on dust dispersion
- Described any potential for nuisance[5].
- Described any impacts due to travel delays on the approach to and throughout the proposal footprint during construction.
- Set out the safeguards to manage dust emissions and traffic impacts.

The operational assessment:

- Established the existing local ambient air quality in the study area.
- Identified any operational activities that would generate air quality emissions.
- Identified specific sensitive receivers that could be affected by the proposed traffic changes introduced under the proposal.
- Evaluated the impacts against the Air NEPM to determine the significance of any changes.

Environmental assessment impact ratings

The following impact ratings were adopted for the purpose of the air quality assessment:

- Negligible: where there is perceived to be no risk of dust deposition leading to statutory nuisance or complaints, and the changes are not sufficient to 'affect' the receiving environment
- Minor: in instances where there is the potential for dust deposition and some potential for statutory nuisance or complaints. The proposal would also have a measurable contribution to the area's local air quality
- Moderate: in instances where there is expected statutory nuisance and complaints due to persistent dust deposition or there would be either a short-term exceedance of the air quality objectives or a long-term measurable effect on the local air quality

[5] Environmental nuisance is defined as unreasonable interference (or likely interference) with an environmental value caused by air quality and dust emissions (amongst other emissions).

- Major: in instances where there is expected to be health problems due to dust deposition or other environmental and human health issues or there would be a long-term exceedance of the air quality objectives.

6.7.2 Existing environment

Ambient meteorological conditions

Sydney's temperate subtropical climate is generally characterised by very warm summers and mild, warm winters. Average daily temperatures generally range between 18 degrees Celsius (°C) and 26°C during summer and between 9°C and 18°C during winter. Uniform rainfall is experienced throughout the year with an average of about 1,300 millimetres received per annum. Autumn is typically the wettest period, while spring is generally the driest.

The meteorological conditions would affect dust dispersion during the work. Generally, the urban environment provides greater shelter; however, the wind can be channelled along streets, with other wind effects occurring around buildings. This only becomes a problem with high-rise development, where the corridor effects can be significant. The ambient average wind speed varies. In the morning during summer months it is lower (8 to10 metres per second (ms^{-1})) compared to winter months (10 to 13 ms^{-1}). However, in the afternoon (due to differences in the land/sea temperature) the wind increases. It is generally lower in the autumn (13 to 15 ms^{-1}) compared to the rest of the year (15 to 20 ms^{-1}).

Due to the variability in local meteorological conditions and soil characteristics there is no absolute limit above which wind-blown dust becomes a problem. However, guidance documents quote that above 7.5 ms^{-1} dust may become an issue and above 8 ms^{-1} dust-suppression controls should be put in place, as dust would mobilise, and above 15 ms^{-1}, works should stop temporarily, as described by the United States Environment Protection Authority and UK Department of Environment, Food and Rural Affairs (DEFRA). In the case of the proposal, the ambient average conditions in the afternoon are sufficient to warrant dust control and suppression measures.

Ambient air quality

The air quality local to the proposal footprint is representative and typical of a suburban environment. It is largely governed by regional factors such as seasonal variations, wind and temperature effects, varying pollutant sources, such as changing traffic volumes and industrial output, and natural sources such as bushfires.

The primary air pollutants in the area are traffic generated, as supplemented by key commercial activities such as service stations and garages. It is also affected to some degree by domestic activities (e.g. backyard burning).

By reviewing ambient conditions across the Sydney Basin it is concluded that of the key pollutant sources attributed to the above activities (sulphur dioxide, nitrogen dioxide, carbon monoxide, ozone and particulate matter) then there are very few recorded exceedances. They are restricted to ozone and particulate matter and largely attributed to natural causes such as the exceedances in 2009 and 2013 that were caused due to bushfires. In summary, the NSW EPA, who is responsible for monitoring and assessing regional air quality, describe the air quality of the study area as generally being good with the exceptions noted above.

Sensitive receivers

It would be reasonable to assume that the noise-sensitive receivers identified in Section 6.3.2 would be also susceptible to air quality impacts with the exception of the impacts being limited to 200 metres of the proposal footprint, the most sensitive of which would be the one child care facility in the business park and the Hillsong Church and its associated tertiary college.

6.7.3 Potential impacts

Construction

Dust dispersion

Ground excavation work has the greatest risk and potential for generating dust due to the storage, loading, transfer and transportation of spoil. This would occur as a result of the planned excavation of the shaft and tunnel, which would generate about 9,000 m^3 of spoil (refer to Table 3.4). These materials would be generated over a period of about 2 months. This would mean that about 190 m^3 of spoil would be brought to surface each day on average. These materials would be temporarily stockpiled before being transported offsite. If the material is then transferred to the main construction compound/laydown area it would also contribute to the overall stockpiled materials in this location.

The risk of dust mobilisation increases where spoil is stockpiled and exposed for notable periods. While the material would only be stockpiled onsite for a short period, it would be constantly generated for about 2 months. The risk is increased due to the prevailing weather conditions, which are sufficient to cause the dispersion of dust (refer to Section 6.7.2), and the fact that the surface soils, including the fill, are likely to be erosive in character (refer to Section 6.1.2).

Stockpile management measures are being implemented at the main construction compound/laydown area. Any materials transferred for stockpiling in this location would be managed under these procedures. As such, the remaining issues would be dust management onsite in the proposal footprint and the risk of dust propagation along haul routes.

While long-term dust exposure can lead to human health impacts, including asthma, such impacts from this proposal would be unlikely. More likely, would be the potential for localised nuisance in the form of minor and temporary dust deposition on building frontages, domestic laundry, windows and parked cars. This impact rated as minor adverse.

Concrete would not be batched onsite, therefore removing this as a dust generation source.

Equipment emissions (surface)

Emissions-generating construction equipment (refer to Section 3.4) would need to operate within the restricted space of the proposal footprint over a period of several months. This machinery would idle, which in turn would reduce engine performance, leading to localised air quality emissions. That said, while the scale of the proposal would likely have some measurable effect on local air quality, the amount of machinery and the location of the proposal footprint, would mean that it would neither cause an exceedance of the air quality goals nor present a risk to the receivers in the area. As such, the impact is rated as minor adverse.

Equipment emissions (tunnels)

Emissions-generating equipment would also be used subsurface (refer to Table 3.3). This equipment would be used in a confined space sufficient to present a risk to workers. Tunnel construction works are stringently governed by the need to include adequate controls to maintain the air quality either by controlling vehicle emission or including forced ventilation. If these controls were not implemented, the human health asphyxiation risk would be significant. However, by needing to work within stringent controls the impact is rated as negligible.

The indirect impact of using forced ventilation in the excavation is the associated concentrated surface emissions at the tunnel excavation ventilation exit point. Consequently, the ventilation exit point would need locating to ensure it is not close to a sensitive receiver and provides sufficient dilution and dispersion at the surface. As such, this impact is rated as minor adverse.

Emissions associated traffic delays during construction

Section 6.2.3 discusses the consequential minor traffic delays that would occur across the proposal footprint caused as a result of implementing traffic management controls during construction. While the construction program and staging would be used to ensure there would be no effect on the performance of the road network overall, there would be a temporary minor effect on air quality within the immediacy of the affected road corridor due to increased idling traffic. However, as ambient conditions are significantly below the air quality goals this impact would have no human health impact despite it potentially being perceptible. As such, the impact is rated as minor adverse.

Operation

Traffic related emissions

The proposal would not trigger any change in traffic conditions once operational (refer to Section 6.2.3). As such, there would be no change in air quality under the proposal. Arguably, the proposal, in forming part of the Sydney Metro Northwest, would support the transfer of people onto public transport, which would have a regional benefit in air quality terms due to a reduction in private vehicle use.

Equipment emissions (tunnels)

The operational link will be fitted with an air filtration system. Fresh air would replace stale air, which would be emitted via a fan located within the footprint of Norwest Station. It would form part of Norwest Station's overall ventilation system. While the ventilation servicing Norwest Station would include train-generated emissions, the proposal would not supplement this. The only effect would be the emission of slightly warm air. The only exception would be during a fire when smoke (particulate matter) would be actively pumped from underground.

6.7.4 Safeguards and management measures

Table 6.34 lists the air quality safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.7.3.

Table 6.34 Air quality safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Air quality ventilation exit points	Location and design of air ventilation to consider avoidance of air quality impacts on sensitive receivers.	TfNSW	Detailed design
Air quality during construction and operation	Implement air quality policy as per Section 4.13 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design
Construction			
Air quality emissions and dust propagation across the proposal footprint	Prepare a Construction Air Quality Management Plan to minimised and managed impacts. The plan shall include, but not necessarily be limited to: ■ The identification of potential sources of air pollutants of concern, in particular dust. ■ Air quality management objectives. ■ Mitigation measures to be implemented, including measures during adverse weather conditions (such as strong	Construction contractor	Construction

Impact	Safeguard/management measure	Responsibility	Timing
	winds in dry weather). ■ A monitoring program to assess compliance with the identified objectives. ■ Mechanisms for the monitoring, review and amendment of this plan. ■ The requirement that engines of onsite vehicles and plant would be switched off rather than left idling for extended periods of time.		
Air quality emissions and dust propagation across the proposal footprint	All vehicles carrying loose or potentially dusty material to and/or from the site would be covered. Waste or any other material would not be burnt on construction sites. Dust generating activities would be assessed during periods of strong winds and rescheduled, where required. Wind breaks, which may include site hoardings, would be constructed, where construction works are in close proximity to sensitive receptors and where feasible and reasonable. Re-vegetating or stabilising disturbed areas would occur as soon as feasible. The proposal shall be constructed in a manner that minimises dust emissions from the site, including wind-blown and traffic-generated dust and tracking of material onto public roads. All activities on the site shall be undertaken with the objective of minimising visible emissions of dust from the site. Should such visible dust emissions occur at any time, all feasible and reasonable dust mitigation measures shall be identified and implemented including cessation of relevant works, as appropriate, such that emissions of visible dust cease.	Construction contractor	Construction
Dust generation (general)	Working face and areas of open excavation would be kept to a minimum, where feasible and reasonable.	Construction contractor	Construction
Dust generation (general)	Water suppression would be used for active earthwork areas, stockpiles and loads of soil being transported to reduce wind-blown dust emissions.	Construction contractor	Construction
Dust generation (general)	Wind breaks, which may include site hoardings, would be constructed, where construction works are in close proximity to sensitive receptors and where feasible and reasonable	Construction contractor	Construction
Dust generation (haul routes)	Appropriate site speed limits would be imposed and signed within and on entry and exit from the proposal footprint to minimise dust propagation.	Construction contractor	Construction

Impact	Safeguard/management measure	Responsibility	Timing
Dust generation (haul routes)	Wheel-wash facilities or rumble grids would be provided and used near site exit points and a street-cleaning regime would be implemented to remove any dirt tracked onto roads.	Construction contractor	Construction
Vehicle emissions (general)	Engines of onsite vehicles and plant would be switched off rather than left idling for extended periods of time. Low emission vehicles and plant fitted with catalysts, diesel particulate filters or similar devices would be used, where feasible and reasonable. Plant would be well maintained and serviced in accordance with manufacturers' recommendations.	Construction contractor	Construction
Operation			
Operational air quality management	Develop an operational environmental management plan (OEMP) including an Air Quality section.	NRT	Operation

6.8 Greenhouse gas and climate change

This section assesses the proposal's potential greenhouse gas impacts and response to climate change through adaptation.

6.8.1 Method

Study area

The greenhouse gas and climate change assessment study area considered the proposal's contribution to NSW's greenhouse gas emissions and the wider effects of climate change on the scheme design.

Method and assessment criteria

The greenhouse gas and climate change assessment was undertaken by referring to:

- *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, revised edition* (World Council for Sustainable Business Development and World Resources Institute, 2004).
- *Greenhouse Gas Assessment Workbook for Road Projects* (Transport Authorities Greenhouse Group (TAGG), 2011) (TAGG Workbook).
- *National Greenhouse Accounts (NGA) Factors* (DCCEE, 2012).
- *Draft Australian and New Zealand standard AS/NZS DR AS 5334 Climate Change Adaptation for Settlements and Infrastructure* (Standards Australia, 2013)
- *Climate Change Impacts and Risk Management: A Guide for Business and Government* (Department of the Environment and Heritage, Australian Greenhouse Office, 2006).

The assessment considered two aspects, the proposal's:

- Greenhouse gas emission contribution.
- Response to climate change adaptation through the concept design.

The assessment:

- Reviewed the Australian and NSW Government's policies towards greenhouse gas emissions and climate change.
- Confirmed Australia's current greenhouse gas contribution.
- Assessed the proposal's contribution to greenhouse gas emissions.
- Determined how the proposal should be designed to respond to climate change.
- Determined any impacts that would occur as a result of the proposal.

Greenhouse gas policy

The *NSW Greenhouse Gas Plan* (NSW Government, 2005) recognises the 15 per cent contribution transportation makes to the State's emissions of which, 47 per cent is due to cars, 25 per cent is due to commercial vehicles, 18 per cent is due to aviation, four per cent due to rail, four per cent is due to shipping, and two per cent is due to other road transport modes (NSW Government, 2005). The consequential policy response is to:

- Adopt urban design principles to reduce reliance on the car (as taken forward in Section 3.2.4).
- Improve and promote public transport.
- Facilitate cycling and walking.
- Integrate public transport.

Climate change policy

The *NSW Climate Change Policy (NSW 2021: A Plan to Make NSW Number One* (NSW Department of Premier and Cabinet, 2011b)) focusses on building resilience to extreme climatic events and hazards by 'helping understand and minimise the impacts of climate change'. The policy contains climate change targets focussing on increasing renewable energy use, reducing energy consumption, increasing public transport use, promoting walking and cycling and encouraging the development of sustainable communities.

6.8.2 Existing environment

Greenhouse gas

The Australian Department of Climate Change and Energy Efficiency estimates that NSW produced 157 million tonnes of carbon dioxide equivalent (tCO_2-e) in 2010, 22 million tCO_2-e (14 per cent) of which was from the transport sector.

Climate change in NSW

Global climate change predictions vary across the scientific community. There is however broad consensus that 'extreme events' will become more frequent[6] over time, leading to more prolonged dry periods, heavier more-intense rainfall, higher winds, and more extreme (hot and cold) temperatures. In addition, a general warming in global temperatures is predicted, which could see temperatures increase locally by 0.2 to1.6 degrees Celsius (°C) on average by 2030.

TfNSW's climate change adaptation plan is to build climate change resilience into the road infrastructure to prevent flooding, improve runoff and drainage, improve asphalt durability against temperature extremes, ensure wind-damage protection and provide pedestrian shading.

[6] Hennessey et al, 2004a and Hennessey et al, 2004b

6.8.3 Potential impacts

Construction

Greenhouse gas emissions

Greenhouse gas emissions would result from the following activities:

- Construction traffic and equipment emissions.
- Emissions generated in producing construction materials (termed embodied energy).
- Electricity-generated emissions in response to the power requirements to service the proposal.
- Upstream and downstream lifecycle emissions (e.g. fuel extraction, processing, production, transport, disposal) including emissions at the construction compounds/laydown areas.
- Emissions resulting from the breakdown of cleared vegetation.

The proposal is of a scale that would only generate minor greenhouse gas emissions from the above sources over its construction period. Consequently, the emissions have not been quantified suffice to note that the proposal would have negligible contribution to the State's annual greenhouse gas emissions.

The greatest contribution, which would be likely to be over half of the total emissions, would come from the embodied energy associated with the energy-intensive production of the concrete, asphalt and other construction materials needed for the proposal, as concluded by referring to the quantified assessments undertaken for similar projects.

This percentage and the overall emissions generated by the proposal may decrease by using a higher proportion of recycled materials as proposed under Section 6.9.3.

Climate change

Extreme weather events could affect the construction work. The most notable impact would be during adverse weather events (e.g. extreme heat, heavy rainfall, wind storms) and its potential occupational health and safety risk to construction workers.

Operation

Greenhouse gas emissions

As noted in Section 6.2.3 there would be no net change in traffic flows or traffic numbers due to this proposal and therefore no additional greenhouse gas emission as a result of this proposal forming an additional component of the Sydney Metro Northwest.

The operational proposal would generate a greenhouse gas output that would reflect the scale of the development and its power and energy requirements. While the operational maintenance of the asset would also use materials, require operational staff to travel to and from the site and involve the use of powered equipment, the scale of the greenhouse gas emissions would be negligible compared to the emissions generated by the whole of the Sydney Metro Northwest.

In terms of electricity and power requirements, the EIS that was prepared to assess the impacts of operating the Norwest Station (and the other stations that form the Sydney Metro Northwest) identified that 86 per cent of the total annual greenhouse gas emissions would be generated from the project's operational electricity demands. It is anticipated that the broadly the same percentage would be attributed to the operation of the proposal, however the overall cumulative greenhouse gas emissions would represent a negligible increase on the operational estimates reported in the EIS.

Climate change

The proposal would be affected by any extreme weather events that would occur over its operational life; the duration, frequency and intensity of which may increase as described above. During detailed design, consideration would be given to ensuring that:

- Passengers' thermal comfort would be maintained during extreme hot and cold events.
- An extreme rainfall event would not cause flooding either from the surface or through increased groundwater inundation.
- An extreme rainfall event would not cause changes in ground stability affecting the either the circulation area or pedestrian link.
- Extreme solar radiation leading to material degradation.

6.8.4 Safeguards and management measures

Table 6.35 lists the greenhouse gas and climate change safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.8.3.

Table 6.35 Greenhouse gas and climate change safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Refrigerant use	GHG emissions arising from use of refrigerants, electricity and materials would be minimised though design initiatives incorporated into the proposal and its infrastructure. Example initiatives include, but are not limited to natural ventilation, daylighting, energy efficient Heating, Ventilation and Air Conditioning (HVAC) and selection of material with low embodied materials.	TfNSW	Detailed design
Operational electricity consumption	The proposal would minimise GHG emissions through energy reduction and avoidance, energy efficiency and onsite and offsite renewable or low carbon energy in accordance with the NWRL Environment and Sustainability *Policy* (TfNSW, 2013b)	TfNSW	Detailed design
Climate adaptation and operational electricity consumption	Implement climate change policy as per Section 4.2, 4.3, 4.4 and 4.15 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design

6.9 Waste management and resource use

This section assesses the proposal's potential waste management and resource use impacts.

6.9.1 Method

Study area

The study area considered the generation of waste across the proposal footprint, its temporary storage onsite and its disposal offsite. It also considered the availability and ability to obtain construction materials locally.

Method and assessment criteria

The waste management and resource use assessment was undertaken with reference to the:

- *Waste Reduction and Purchasing Policy (WRAPP)* (NSW Government, 1997c).
- *Protection of the Environment Operations Act 1997* (NSW Government, 1997b).
- *Waste Classification Guidelines Part 1: Classifying Waste* (NSW EPA, 2014).
- *Waste Avoidance and Resource Recovery Act 2001* (NSW Government, 2001).
- *Storing and Handling Liquids, Environmental Protection* (DECC, 2007).

The assessment:

- Identified the likely types and volumes of generated construction waste.
- Identified the likely types and volumes of required construction materials.
- Determined the waste management strategy that would be implemented during construction, including the potential for waste reduction.
- Determined the material procurement strategy that would be implemented during construction, including the potential for reducing resource consumption.
- Identified the waste management and resource use issues that would need safeguarding and managing under the proposal.

Policy setting

NSW waste management legislation and planning policy governs waste generation and management, materials reuse and recycling, transportation and disposal and establishes a waste minimisation hierarchy that prioritises waste solutions according to how successfully they conserve natural resources. The hierarchy advocates:

- Avoidance, in preference to
- Recovery, including reuse, recycling, reprocessing and energy recovery, in preference to
- Responsible disposal.

The *WRAPP* sets objectives to minimise government-sector waste by employing the above hierarchy as well as providing waste segregation at source and the purchase of recycled materials or materials with a high recycled content.

Where disposal remains the only option, the *Waste Classification Guidelines Part 1: Classifying Waste* (NSW EPA, 2014). provide for classifying six types of waste in NSW: special, liquid, hazardous, restricted solid waste, general solid (putrescible) and general solid (non-putrescible). The classifications define how the materials are to be stored, transported, managed and disposed of.

The above documents also provide for the preferential reuse of available excavated natural materials (ENM) over their disposal, providing they satisfy a number of requisite criteria, including engineering suitability, classification and/or condition. TfNSW is exempt from the normal permitting requirements needed to reuse claimed ENM and road material, including asphalt pavement and aggregate.

Environmental assessment impact ratings

The following impact ratings have been adopted in this assessment:

- Negligible: where there predicted to be no waste generated or resources used either during construction or operation.
- Minor: where the predicted waste and resource use is typical of the scale of the proposal, can be managed and sourced locally (with the exception of specialist technologies/equipment) and does not present either a risk to the environment, does not place pressure on waste management facilities and/or does not represent a depletion in a finite resource.
- Moderate: where the predicted waste and resource use is atypical of the scale of the proposal, major cannot be managed or sourced locally, would present some environmental risk as it could not be effectively managed, would place some pressure on waste management facilities and/or it would deplete a finite resource.
- Major: where the proposal places an exception demand on resources (and in particular finite resources), would likely cause environmental harm as it cannot be managed effectively, the materials are in exceptional short supply or would need important from overseas, and/or the waste could not be managed and treated effectively.

6.9.2 Existing environment

Sydney is well-placed to manage waste and to source materials due to its population, its construction industry and its commerce. The major materials required to construct the proposal are likely available or manufactured within the metropolitan area, with the potential exception of either some of the major infrastructure components and potentially specialist electrical and IT equipment.

Equally, there is ample provision within the metropolitan area to reuse and recycle materials, and if required, dispose of restricted and controlled waste.

6.9.3 Potential impacts

Construction

Materials generation and management

Table 3.4 lists the likely materials that would be generated during construction. They would principally comprise:

- About 9,000 m^3 of rock, overburden, vegetation and spoil.
- Offcuts, containers, packaging and construction materials.

Table 6.36 describes how the above materials would be generated, classified and managed.

Table 6.36 Waste generation – indicative only

Waste (and waste stream)	Principal generating activity	Approximate volumes (m^3/tonnes)	Preferred management
General solid waste (non-putrescible)			
Virgin excavated natural material - residual spoil (overburden) and rock	Stage 2: Earthworks and excavation	5,500 m^3	Recovery under exemption for reuse offsite
Demolition concrete and bitumen	Stage 1: Site establishment	650 m^3	Recovery under exemption for reuse offsite
Building rubble and structural element demolition waste	Stage 1: Site establishment	125 tonnes	Recovery under exemption for reuse offsite
Waste metal	Stage 3: Civil and building work and Stage 4: Fit out and furnishing	30 tonnes	Recovery and reuse onsite/ offsite
Wood products		50 tonnes	Recovery and reuse onsite/ offsite
Mixed spoil		175 tonnes	Recovery and reuse onsite/ offsite
Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses and tyres		25 tonnes	Disposal to a licenced facility offsite
General solid waste (non-putrescible) – resource recovery exemption			
Excavated natural material	Stage 1: Site establishment Stage 2: Earthworks and excavation	1,000 m^3	Recovery under exemption for reuse offsite
General solid waste – (putrescible)			
Green waste – vegetation grubbing and clearing	Stage 1: Site establishment	10 tonnes	Recovery and reuse onsite/ offsite (mulch or composting)
Food waste	All stages	40 tonnes	Recovery and reuse onsite/ offsite (mulch or composting)
Liquid waste			
Slurries, sludge, paint and solvent washout	Stage 1: Site establishment to Stage 4: Fit out and furnishing	10 tonnes	Disposal to a licenced facility offsite
Wastewater from other sources including dust suppression and vehicle wash-down and sewage/grey water	All stages	10 tonnes	Disposal to a licenced facility offsite
Special waste (potential)			
Contaminated spoil (including potential acid sulphate soils and actual acid sulphate soils)	Stage 1: Site establishment and Stage 2: Earthworks and excavation	Unknown	Disposal to a licenced facility offsite

Generated waste has the potential to affect the local environment if it is not managed appropriately. Potential impacts include:

- Runoff resulting from:
  - Accidental spillages
  - Stockpile mismanagement and runoff

  - Waste transfer
  - Poor waste storage
  - Sedimentation and erosion.
- Ground contamination resulting from:
  - Untreated excavated contaminated material leaching into the surrounding environment
  - Accidental spillages
  - Incorrect disposal of contaminated materials
  - Stockpile mismanagement and runoff.
- Amenity impacts through littering.
- Potential waste misclassification.
- Excessive waste being diverted to landfill.
- Vermin risk due to the poor storage of putrescible waste.

While the impact magnitude would potentially be high the likelihood of an impact occurring would be negligible due to the proposed adoption of standard waste management and pollution prevention control measures. Consequently, the impact is rated as minor adverse.

Resource consumption and management

Section 3.6 describes the indicative resources and materials required to construct the proposal. Material and resource types and quantities would be confirmed during the proposal's detailed design. The provisional list demonstrates that the proposal could be largely constructed from recycled materials. This is consistent with TfNSW's requirement for its contractors to propose the use of recycled materials where they are cost and performance competitive and comparable in environmental performance.

In addition, the contractor(s) would be able to propose the use of low embodied-energy alternatives (e.g. materials that require less energy to produce) for items such as concrete and paint where they are cost and performance competitive and comparable in environmental performance.

The required construction materials are commonly used and can be supplied locally. Again, the contractor would be able to propose obtaining locally-sourced and manufactured/recycled materials to reduce associated transportation impacts.

As a result, the resource consumption and demand impacts are rated as minor adverse as they would be typical of what is expected for developments that are similar in nature and size.

Operation

Materials generation and resource consumption

The operational proposal would be managed and maintained as part of the wider station and Sydney Metro Northwest. It would require ongoing cleaning and maintenance, which in turn would generate small volumes of waste and require small amount of resources. This impact is rated as negligible.

By and far the greatest resource use during operation would be electricity to service the equipment and systems, including the lighting, the elevator and the escalation. This is rated as minor adverse as the quantities would be typical of similar infrastructure development.

6.9.4 Safeguards and management measures

Table 6.37 lists the waste and resource safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.37.

Table 6.37 Waste and resource safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Waste generation and resource use during construction	Where feasible and reasonable local materials would be preferentially used. Where feasible and reasonable fully offset carbon emissions generated by the proposal's operation.	TfNSW	Detailed design
Construction and operational waste and resource management	Design innovation during the detailed design stage would provide opportunities to reduce the amount of resources required for operation.	TfNSW	Detailed design
Construction and operational waste and resource management	Implement waste and material policy as per Section 4.10 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design
Pre-construction (construction)			
Waste generation during construction	Adopt the wider Sydney Metro Northwest waste management targets for the proposal, that include: ■ 100 per cent beneficial reuse of usable spoil ■ 95 per cent beneficial reuse of construction and demolition waste.	Construction contractor	Pre-construction/ construction
Waste generation during construction	Deliver the proposal in accordance with TfNSW waste-management policies. Adopt the waste and resource management hierarchy in all work method statements.	Construction contractor	Pre-construction/ construction
Construction			
Littering and site tidiness during construction across the proposal footprint	Report and audit waste volumes and disposal destinations. Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	Construction contractor	Construction
Waste generation during construction	All waste would be assessed, classified, managed and disposed of in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (NSW EPA, 2014).	Construction contractor/NRT	Construction/ operation
Waste and resource management during construction and operation	Prepare a waste and resource management plan (WRMP) as a sub-plan of the CEMP. As a minimum describe the measures for handling, storing and classifying waste when 'onsite' and its subsequent disposal offsite to the relevant licenced facility.	Construction contractor/NRT	Construction/ operation

Impact	Safeguard/management measure	Responsibility	Timing
Resource recovery during construction and operation	Excavated material and spoil would be beneficially reused on the project site or other sites, where feasible and reasonable, in accordance with the waste hierarchy. Recyclable wastes, including paper at site offices, would be stored separately from other wastes. Storage facilities would be secure and recyclables collected on a regular basis	Construction contractor/NRT	Construction/ operation
Waste reporting and management and operation	Initial and ongoing education would be provided to staff and sub-contractors regarding the importance of appropriately managing waste.	Construction contractor/NRT	Construction/ operation
Operation			
Operational waste and resource management	Develop an Operational Waste and Resource Recovery Management plan. This would detail opportunities for avoiding waste generation and responsible disposal methods for different waste streams.	NRT	Operation

6.10 Biodiversity

This section identifies and assesses the proposal's potential impacts on biodiversity.

6.10.1 Method

Study area

The biodiversity study area considered the ecological values of the proposal footprint and across a wider locality covering up to 10 kilometres.

Method and assessment criteria

The assessment:

- Identified and described the biodiversity values of the study area by referring to:
  - NSW National Parks and Wildlife Services wildlife atlas database covering NSW *TSC Act* listings.
  - Commonwealth Government's protected matters search tool covering Commonwealth *EPBC Act* listings.
  - The PlantNet database covering sensitive and rare plant species.
  - The noxious weed database covering species controls under the NSW *Noxious Weed Act 1993* (NSW Government, 1993a).
- Identified the proposal's impacts on biodiversity values.
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Environmental assessment impact ratings

Impact ratings were determined by referring to:

- *Threatened Species Assessment Guidelines: The Assessment of Significance* (NSW DECC, 2007)

- *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* (Commonwealth Department of Environment, 2013)

The above guidelines do not include impact ratings in place of the assessor using professional judgement to assess the significance of an impact by considering a number of factors. As such, the following impact ratings have been developed with reference to the above guidelines and in context of this proposal:

- Negligible: where there predicted to be no impact on threatened biota and there is limited potential ecological value associated with the area.
- Minor: where there is predicted to be some ecological value or habitat, however there would be no impact on threatened biota. Any impact would be to common species and the impact could be easily mitigated.
- Moderate: where there is predicted to be an impact on ecological values, habitat and/or threatened biota however there is the potential to limit the impact through mitigation to allow partial or full recovery.
- Major: where there is predicted to be an impact on ecological values, habitat and/or threatened biota (including a significant species, population or community), however there is limited potential to mitigate the impact.

6.10.2 Existing environment

With regards to the proposal footprint it contains planted amenity vegetation that is maintained and managed. It comprises native and non-native species dominated by an immature canopy of mixed-origin eucalypts with an understory of grevillea and lomandra. In ecological value terms the area is highly-disturbed, urbanised and fragmented. Its value is therefore low to negligible.

No threatened flora or fauna species were recorded onsite in 2012, a conclusion that stands in 2015 given the absence of suitable habitat in the area. The only potential item of interest, the eucalypts, are too immature to contain any tree hollows; an ecological feature that is taken to indicate the possible presence of important ecological species. The only other residual interest is the winter flowering of the eucalypts, as this may provide a limited foraging resource for nectar-feeding migratory birds and potentially the grey-headed flying fox; a species that is reasonably well distributed over the Sydney metropolitan area, yet listed as vulnerable under the *TSC Act*. There are no records of noxious weeds in the area.

6.10.3 Potential impacts

Construction

Flora, vegetation and habitat loss

All vegetation affected by the proposal is introduced. It is neither endemic nor native to the area and therefore the biodiversity conservation provisions of the *TSC Act* and *EPBC Act* do not apply. As noted above, the eucalypts would only provide a foraging resource for native fauna that can survive in a highly-modified urban environment. The impact rating of the loss is therefore assessed negligible to minor adverse.

Fauna

Any mobile species (e.g. birds and bats) affected by the proposal would be able to temporarily move out of the area. This would not be the case for less mobile species. Consequently, the species most at risk of injury or death would be any small terrestrial and arboreal mammals, microchiropteran bats or reptiles; none of which are likely to be threatened, endangered or vulnerable in line with the discussions above. Such an impact is rated as minor adverse.

With regards to the local presence of grey-headed flying fox, this species is unlikely to roost or breed in the immediate area. The one remaining residual risk would be the low potential for echolocating bats (including the grey-headed flying fox) to become disorientated immediately following the vegetation removal. However, bat species are generally adaptive and find alternative routes. This would be assisted by the widespread presence of alternative structures to echolocate off. As such, the impact is assessed as negligible.

Statutorily protected biodiversity

As noted above, while the grey-headed flying fox may intermittently forage over the proposal footprint it is improbable that it depends on any of the affected vegetation for its survival. Consequently, as the proposal is unlikely to have a significant effect on this species no assessment of significance under the *Threatened Species Assessment Guidelines: The Assessment of Significance* (NSW DECC, 2007) is required.

Noxious weeds

There are no records of noxious weeds in the proposal area.

Operation

The proposal would have no operational biodiversity impact. The amenity vegetation would be reinstated following construction. This would likely provide the same limited ecological value as the vegetation removed during construction.

6.10.4 Safeguards and management measures

Table 6.38 lists the biodiversity safeguards and management measures that would be implemented to mitigate the predicted impacts identified above in Section 6.10.3.

Table 6.38 Biodiversity safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Biodiversity conservation	Implement biodiversity conservation policy as per Section 4.12 and 4.15 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design
Construction			
Impacts on non-listed species across the entire proposal footprint	As a precautionary measure, ensure a qualified ecologist would be on call during the removal of the amenity vegetation to identify any manage wildlife that may be disturbed and/or injured. The ecologist would assess the species and then release them to the nearest suitable habitat if uninjured.	Construction contractor	Construction
Remote risk of encountering noxious weeds	Noxious and environmental weeds would be controlled within the operational site boundary. To prevent establishment or spread of weeds: ■ Machinery would be cleaned before entering the works site. ■ Cleared weed material would be disposed of at a site licenced to receive green waste.	Construction contractor	Construction

6.11 Non-Aboriginal heritage

This section confirms the heritage value of the local area and the proposal's likely impact on non-Aboriginal heritage items and subsurface archaeology.

6.11.1 Method

Study area

The non-Aboriginal heritage assessment considered the proposal's impact on all heritage-listed items and potential subsurface archaeology within the proposal footprint and its immediate environs. The European settlement history of the locality was used to describe the existing environment.

Method and assessment criteria

The non-Aboriginal heritage assessment was undertaken by referring to:

- *NSW Heritage Act 1977* (NSW Government, 1997)
- *NSW Heritage Manual* (NSW DUAP, 1996)
- *Assessing Heritage Significance* (NSW Heritage Office, 2001)
- *Statements of Heritage Impact* (NSW Heritage Office and DUAP, 1996 (revised 2002)

The assessment:

- Identified the existing non-Aboriginal heritage characteristics of the study area.
- Assessed the study area's heritage value and significance.
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Environmental assessment impact ratings

Heritage value and significance were determined by referring to the assessment criteria included in *Assessing Heritage Significance* (NSW Heritage Office, 2001). The assessment considered impacts on identified heritage values in terms of loss, partial destruction, impingement, setting, value, amenity and context.

The study area's archaeological potential was determined though a preliminary review of relevant documentation.

Impact ratings were used to assess the degree of potential impact. They include:

- Negligible: where there is perceived to be limits risk of potential for any impact on a heritage item or archaeology independence of its value or potential.
- Minor: in instances where there is a potential indirect impact on a heritage item of local or state significance or an archaeological item of low potential.
- Moderate: in instances where there is a potential direct impact on a heritage item of local or state significance, an indirect impact on a heritage item of national or world heritage significance or a direct impact on an archaeological item of low or moderate potential.
- Major: in instances where there is a potential direct impact on a heritage item of national or world significance or an archaeological item of moderate or major potential.

6.11.2 Existing environment

Early European settlement in the study area was shaped by the construction of the Windsor and Old Windsor Roads connecting farms in Parramatta with those in Hawkesbury. This allowed clusters of farms to be developed along these roads from as early as the 1790s (TfNSW, 2013a).

With regards to the proposal footprint and its immediate environs it remained largely farmed or undeveloped until the 1960s at which point it was developed as part of the rapid post-war expansion of Sydney's outer suburbs. This expansion and development continued until the 1980s at which point the business park was established. Over the intervening 35 years, the area has continued to develop. As a consequence, the study area contains no historic heritage values as can be by the absence of recorded heritage items or archaeological potential.

6.11.3 Potential impacts

There are no anticipated non-Aboriginal heritage impacts that would result from the proposal's construction or operation. Also, the potential for encountering any archaeology during construction is assessed as negligible.

6.11.4 Safeguards and management measures

Despite there being all by the remotest potential for any impacts, the following safeguards and management measures would be adopted as a precautionary measure.

Table 6.39 Non-Aboriginal safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Heritage Conservation	Implement heritage policy as per Section 4.11 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design
Construction			
Exceptionally remote potential for encountering unrecorded archaeology and/or heritage items during construction	Immediately cease all works within 10 metres of discovering an unexpected find (e.g. archaeological remains, heritage item, potential relic). Subsequently implement the following actions: ■ Inform the TfNSW Heritage Officer/Environment Officer ■ TfNSW to subsequently notifying Heritage Division of NSW OEH in accordance with Section 146 of the *Heritage Act 1977* (NSW Government, 1977) ■ For an archaeologist to record the location and context of any historic heritage and implement controls to avoid, record, excavate and store materials ■ Manage any significant finds to allow for their long-term storage.	Construction contractor	Construction

6.12 Aboriginal heritage

This section assesses the proposal's potential impact on Aboriginal heritage.

6.12.1 Method

Study area

The Aboriginal heritage assessment study area considered any remanet artefacts, sites or items within the proposal footprint and its immediate environs. Regional pre-European settlement history was also used to describe the existing environment.

Method and assessment criteria

The Aboriginal assessment referred to the following legislation and guidance:

- *National Parks and Wildlife Act 1974* (NSW Government, 1974)
- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW, 2010* (NSW DECC, 2010).

Environmental assessment impact ratings

Impact ratings were used to assess the degree of potential impact. They include:

- Negligible: where there is perceived to be limits risk of potential for any impact on a heritage item or site independence of its value or potential.
- Minor: in instances where there is a potential indirect impact on an Aboriginal object of low potential.
- Moderate: in instances where there is a potential direct impact on an Aboriginal object of moderate potential or an Aboriginal place of low value.
- Major: in instances where there is a potential direct impact on an important Aboriginal place.

6.12.2 Existing environment

The proposal footprint is located in the territory of the Darung/Dharung Aboriginal community and more specifically the Bidjigal/Bediagal clan (wood tribes). The Darung subsisted on fishing, possums and yams supplemented by various native plants and animals. They therefore assumed an extensive hunter-gatherer existence, making tools using the lithic materials (pieces of rock) found on the Cumberland Plain. They were attracted to places where there was an abundance of resources (both physical and spiritual) including:

- Fresh water (including associated plants and animals)
- Hinterland resources (e.g. tall open forest, woodland and sheltered gullies)
- Woodland where there were the available resources needed for fuel, shelter and material culture
- Overhanging sandstone, which provided shelter or were used to create art
- Sandstone platforms used for axe grinding
- Exposed areas of stone (lithic areas) to make tools.

None of these features are associated with the environment of the study area. Moreover, the area has been heavily disturbed and worked, as further supported by the likely presence of fill material below the proposal footprint (refer to Table 6.1). Consequently, there is considered to be no potential for Aboriginal heritage to occur across the study area.

6.12.3 Potential impacts

There are no anticipated Aboriginal heritage impacts that would result from the proposal's construction or operation. Also, the potential for encountering any unforseen subsurface archaeology during construction is assessed as negligible.

6.12.4 Safeguards and management measures

Despite there being all by the remotest potential for any impacts, the following safeguards and management measures would be adopted as a precautionary measure.

Table 6.40 Aboriginal safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Detailed design			
Heritage Conservation	Implement heritage policy as per Section 4.11 of the *NWRL Sustainability Plan* (TfNSW, 2013c)	TfNSW	Detailed design
Construction			
Exceptionally remote potential of discovering unexpected Aboriginal heritage	Stop all work within 10 metres of an unexpected find discovery and: ■ Inform the TfNSW Heritage Officer/Environment Officer. ■ For an archaeologist to record the location and context of any historic heritage and implement controls to avoid, record, excavate and store materials. ■ Manage any significant finds to allow for their long-term storage.	Construction contractor	Construction
Determined impact on Aboriginal heritage	An AHIP would be obtained prior to restarting works in the event of discovering an unexpected find: ■ Have a qualified heritage specialist prepare a cultural heritage application report (CHAR) that would support an application for the permit. ■ Consult with the local Aboriginal land council in preparing the CHAR. ■ Obtain the permit from the Heritage Council of NSW. This application would be accompanied by a prepared by a heritage specialist.	TfNSW	Construction

6.13 Cumulative effects

Clause 228 of the EP&A Regulation requires that for the purposes of Part 5 of the *EP&A Act* any cumulative environmental effect of the proposal with other existing or likely future activities must be taken into account when consideration is being given to the likely impact of an activity on the environment. This section assesses the potential cumulative effects of constructing and operating the proposal in combination with other, as yet unbuilt, projects.

6.13.1 Method

Study area

The cumulative effects study area considered the geographical location (spatial) and timing (temporal) extent of any potential impacts identified in Section 6.1 to Section 6.12.

Method and assessment criteria

The assessment:

- Identified the proposal's impacts.
- Identified committed projects that are likely to be under construction and/or operation in the area at the same time as the proposal, by referring to:
  - The NSW Department of Planning and Environment major projects assessments register
  - The Australian Government Department of Environment public notices and the invitation to comment register
  - Public agency websites that are progressing development under Part 5 of the *EP&A Act*, with a particular focus on TfNSW and Roads and Maritime websites.
- Identified the potential impacts of the above projects where known.
- Assessed if the proposal's impacts would combine with the impacts of these projects to create a cumulative effect.
- Assessed if the safeguards and management measures considered in this REF would be affected sufficient to need modifying or supplementing.

The Norwest Station

Where required, the rest of the REF has considered the additive and cumulative impacts of constructing and operating the proposal and Norwest Station at the same time. This section considers the cumulative impacts from constructing and operating the proposal, Norwest Station and any other development at the same time.

Environmental assessment impact ratings

Unlike the other environmental aspects considered in this section, cumulative impacts consider the combination of impacts from two or more projects. The focus of the assessment is to determine if the cumulative impacts would combine to either alter the rating of any impact described above, whether it would result in new impacts or whether it would affect the effectiveness of any mitigation measures.

6.13.2 Existing environment

Having reviewed the above databases it can be confirmed that across the study area:

- There are no active Roads and Maritime upgrades.
- There are no active major projects being proposed.
- There are no large development applications lodged with Hills Shire Council.

There are numerous small development applications lodged with Council that would not have an effect upon or be affected by the outcome of this proposal (i.e. residential extensions, awning installation). As noted in Section 6.6.2 there is an aspiration of for the adjacent land to be developed for residential and commercial purposes. However at the time of completing the REF, no application for this development has been lodged with The Hill Shire Council. It is also likely that this application would be determined after this REF is reviewed. Consequently, this application would need to assess the cumulative impacts of this proposal any residential and commercial development.

As noted in Section 6.2.2 there is an aspiration to widen Norwest Boulevard to three lanes in each direction. As such, its impacts are not defined to the point of being considered in this assessment. This is also true of any future aspiration to include a pedestrian overpass to connect to the Norwest Station precinct as described as an outcome in Chapter 2.

Finally, the ancillary infrastructure that would be installed as part of the Norwest Station including the bus stops and the signalisation of the intersection is considered in the preceding sections of this Chapter of the REF.

6.13.3 Potential impacts

The lack of any notable major development in the study area means that there would be no anticipated cumulative impacts beyond the combined impacts of constructing and operating Norwest Station at the same time as the proposal.

The only other issue would be at a more strategic level, in terms of this proposal's contribution to the cumulative impact of the entire Sydney Metro Northwest (i.e. extending beyond the cumulative impacts that would occur between the Norwest Station and the proposal). The EIS prepared to assess the impacts of construction and operating the Sydney Metro Northwest stations identified a range of potential project-wide cumulative impacts that may occur as a result of constructing and operating the rail link. While this proposal would contribute to this cumulative impact the effects would be negligible and likely imperceptible due to its comparative size and scale.

6.13.4 Safeguards and management measures

While there are no anticipated cumulative effects, table 6.41 lists two precautionary cumulative impact safeguards and management measures that would be adopted.

Table 6.41 Cumulative effect safeguards and management measures

Impact	Safeguard/management measure	Responsibility	Timing
Pre-construction (construction)			
Cumulative impacts	During construction, proponents of other major construction works in the vicinity of the proposal shall be consulted and reasonable steps taken to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.	TfNSW Construction contractor	Pre-construction/ Construction
Cumulative impacts	Review environmental impacts during the construction phase. Any new impacts identified during construction would be addressed appropriately to reduce the cumulative effects and reported.	TfNSW Construction contractor	Pre-construction/ Construction

7. Environmental management

7.1 Environmental management plans

This chapter describes how the proposal would be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A summary of site-specific environmental safeguards is provided as detailed in Chapter 6 and the licence and/or approval requirements required prior to construction are also listed.

A number of safeguards and management measures have been identified in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

The proposal would be delivered under a project environmental management plan (PEMP) and contractors CEMP. These plans would describe safeguards and management measures identified. They would provide a framework for establishing how these measures would be implemented and who would be responsible for their implementation.

The plans would be prepared prior to construction of the proposal. The CEMP would be a working document, subject to ongoing change and updated as necessary to respond to specific requirements.

7.2 Summary of safeguards and management measures

Environmental safeguards outlined in this document would be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards would minimise any potential adverse impacts arising from the proposal on the surrounding environment. The safeguards and management measures are summarised in Table 7.1.

Table 7.1 Summary of site specific environmental safeguards

No.	Impact	Environmental safeguards	Responsibility	Timing
General provisions				
Pre-construction (construction)				
1	General	All environmental safeguards would be incorporated within the following documents: ■ Design Management Plan ■ Contractor's Environmental Management Plan.	Project Manager	Pre-construction
2	General	All businesses and residences likely to be affected by the proposal would be notified at least five working days prior to the commencement of the proposed activities.	Project Manager	Pre-construction
3	General	Environmental awareness training would be provided, to all field personnel and subcontractors.	Contractor	Pre-construction and during construction as required.
Soils, geology and water				
Detailed design				
4	Risk of encountering historic contamination or pollution during construction	Any contaminated areas directly affected by the project would be investigated and remediated prior to the construction work starting. All remediation works would be undertaken in accordance with the requirements of the *Contaminated Land Management Act 1997* (NSW Government, 1997a) and *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites* (NSW EPA, 1997). Given that groundwater in the vicinity of the adjacent service station is likely to be disturbed during construction, there is an exposure risk to construction workers. There is also a risk of waste management and disposal. This would need to be further assessed during the detailed construction planning stage. If required further delineation, remediation or management would need to take place before construction starts. Any investigations undertaken to confirm the contamination and pollution risk would be forwarded to TfNSW for approval along with any Site Auditor endorsed Remediation Action Plan (or similar). A Site Auditor would need to certify that any contaminated land or polluted groundwater had been remediated to a standard consistent with its proposed use.	TfNSW	Detailed design
5	Groundwater discharge and treatment	A specific process regarding groundwater discharge and treatment methods would be identified during detailed design. As part of this process the management of groundwater and surface water ingress into pedestrian link and northern entry, including the design of capture, monitoring, treatment and discharge methods shall be undertaken in consultation with the NSW Environment Protection Authority.	TfNSW	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
6	Stormwater pollution	Stormwater management controls would be implemented to: ■ Manage runoff volumes through the use of measures to promote stormwater infiltration. ■ Minimise increases in peak flows through the use of detention and retention measures as appropriate. Treating stormwater through a range of at source and end point measures that are integrated with the urban landscape.	TfNSW	Detailed design
7	Groundwater reuse from operational inflows	All feasible and reasonable opportunities would be identified for the reuse of captured groundwater.	TfNSW	Detailed design
8	Water quality	Implement policy to preserve water quality as per Section 4.13 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design
9	Water efficiency	Implement water efficiency policy as per Section 4.9 and 4.15 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design
Pre-construction (construction)				
10	Accidental spillage and sediment-laden runoff	Procedures to quickly address any contaminant spill or accident would be developed and implemented during operation of Norwest Station sites.	Construction contractor	Pre-construction
11	Management and reuse of groundwater inflow	All feasible and reasonable opportunities for groundwater reuse for construction purposes or recycling nearby would be taken in the first instance. Should groundwater inflows and required treatment volumes outstrip the potential for reusing the water for construction purposes discharge options would be investigated.	Construction contractor	Pre-construction/ construction
12	Changes in groundwater level, flow, chemistry and quality during construction	A groundwater monitoring plan (GMP) would be prepared for implementation during construction. Parameters to be monitored would include groundwater levels and groundwater quality with field parameters, laboratory parameters and sample frequency to be developed prior to construction.	Construction contractor	Pre-construction/ construction
13	Changes in groundwater level, flow, chemistry and quality during construction	A network would be established to monitor groundwater levels and groundwater quality during construction. The groundwater monitoring network would contain monitoring wells that intersect the Ashfield Shale and Hawkesbury Sandstone.	Construction contractor	Pre-construction/ construction

No.	Impact	Environmental safeguards	Responsibility	Timing
14	Groundwater management	Groundwater sampling would be undertaken during construction to determine the most suitable treatment processes to meet the required water quality standards. Where the groundwater quality does not meet licence requirements it would be treated prior to discharge. Also the proposal would be designed and constructed to minimise its groundwater impact including capture and drawdown.	Construction contractor	Pre-construction/ construction
16	Groundwater inflows	All feasible and reasonable measures would be implemented during construction to limit groundwater inflows to no greater than 0.5 ML/day. Any inflows would be collected and treated prior to reuse or discharge.	Construction contractor	Pre-construction/ construction
15	Groundwater supply during construction	Groundwater water supply from the Hawkesbury Sandstone for construction purposes would be used where feasible and reasonable. Negotiation with the NSW Office of Water would be undertaken regarding impacts and applicable licenses.	Construction contractor	Pre-construction/ construction
16	Sediment-laden runoff and associated water quality impacts	A Construction Soil and Water Management would be prepared to manage soil, surface water and ground water. The plan shall include, but not be limited to: ■ Details of construction activities and their locations that have the potential to impact on water courses, stormwater flows and groundwater. ■ Detail the proposed extraction, use and disposal of groundwater, and the measures to mitigate potential impacts on groundwater sources, incorporating monitoring, impact-trigger definitions, and response actions for all likely affected groundwater sources. ■ Surface water and groundwater impact criteria consistent with the principles of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1: The Guidelines* (Australian and New Zealand Environment and Conservation Council, 2000). ■ Management measures to be used to minimise surface and groundwater impacts, including the identification of water treatment measures and discharge points, details of how spoil and fill material will be sources, handled, stockpiled, reused and managed. Also included would be erosion and sediment control measures and salinity control measures. ■ A contingency plan consistent with the NSW *Acid Sulphate Soil Manual Assessment Guidelines* (NSW Acid Sulfate Soils Management Advisory Committee, 1998), to deal with the unexpected discovery of actual or potential acid sulphate soils, including procedures for the investigation, handling, treatment and management of such soils and water seepage. ■ A description of how the effectiveness of these actions and measures would be monitored during construction, clearly indicating how often monitoring would take place, how the monitoring results would be recorded and reported and if any exceedances are detected, how any non-compliance would be rectified. ■ Mechanisms for monitoring, reviewing and amending this plan.	Construction contractor	Pre-construction/ construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		Additional water quality mitigation measures would be implemented in accordance with relevant requirements of: ■ *Managing Urban Stormwater – Soils and Construction Volumes 1 and 2* (Landcom and NSW Government, 2004 and 2006). ■ *Guidelines for Controlled Activities* (NSW Office of Water, 2000). ■ *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1: The Guidelines* (Australian and New Zealand Environment and Conservation Council, 2000). ■ NSW *Water Management Act 2000* (NSW Government, 2000b). ■ Applicable Environment Protection Licences. A holistic approach to water quality and stormwater management would be adopted that incorporates Water Sensitive Urban Design principles to minimise impacts on the existing hydrologic regime. Such measures would include: ■ Managing total runoff volumes through the use of rainwater tanks and measures that promote stormwater infiltration. ■ Minimising increases in peak flows through the use of detention and retention measures as appropriate. Appropriate erosion control measures would be installed such as sediment fencing, check dams, temporary ground stabilisation, diversion berms or site regrading. Inspection of water quality mitigation controls (e.g. sediment fences, sediment basins) would be carried out regularly and following significant rainfall to detect any breach in performance.		
17	Risk of encountering historic contamination or pollution during construction	Before starting on site, a summary of soil contamination would be prepared detailing the outcomes of any further contamination site investigations. The summary would detail, where relevant, whether or not the soil is suitable for the intended land use or can be made suitable for reuse through the application of a Remediation Action Plan (or similar). An accredited Site Auditor would endorse the documentation and any Remediation Action Plan or similar. In the event of encountering potentially contaminated materials during construction all work would cease in the vicinity of the discovery and it would not recommence until the extent of contamination has been assessed, and if necessary, a Remediation Action Plan or similar had been prepared and endorsed by an accredited Site Auditor. Soil and land remediation is to occur as soon as practicable following construction. This is to include remediation in stages as the construction process allows. Any investigations undertaken to confirm the contamination and pollution risk would be forwarded to TfNSW for approval along with any Site Auditor endorsed Remediation Action Plan (or similar). A Site Auditor would need to certify that any contaminated land or polluted groundwater had been	Construction contractor	Pre-construction/ construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		remediated to a standard consistent with its proposed use. Where the investigations identify that the site is suitable for its intended use and that there is no need for a specific remediation strategy, measures to identify handle and manage potential contaminated spoil, materials and groundwater shall be incorporated into the CEMP.		
18	Groundwater quality	Dissolved iron would typically be removed from discharge water by oxidising the Ferric ion (Fe3+) to Ferrous (Fe2+) which enables precipitation and physical removal. Water turbidity would typically be treated by settling/filters. Iron reducing bacteria in discharge water would be typically treated by biocide dosing. The management of groundwater and surface water ingress, including the design of capture, monitoring, treatment and discharge methods shall be undertaken in consultation with the NSW EPA.	Construction contractor	Pre-construction/ construction
Construction				
19	Accidental spillage and associated water quality impacts	Procedures to quickly address any contaminant spill or accident would be developed and implemented during the proposal's operation.	Construction contractor	Construction
20	Accidental spillage and associated water quality impacts	Storage of hazardous materials such as oils, chemicals and refuelling activities would occur in bunded areas.	Construction contractor	Construction
Operational				
21	Groundwater pollution or changes in groundwater chemistry caused by the operational proposal	Groundwater quality would be subject to testing. Where it does not meet licence requirements it would be treated prior to discharge.	NRT	Operation
22	Groundwater pollution or changes in groundwater chemistry caused by the operational proposal	Ensure the proposal is captured within the wider groundwater treatment processes implemented to service Sydney Metro Northwest, including the treatment of groundwater at the Lady Game Drive water treatment plant. Also groundwater would be managed under the NWRL Construction Soil and Water Management Plan.	NRT	Operation
Traffic and transport				
Pre-construction (construction)				
23	Construction traffic management	Implement a construction traffic management plan in consultation with and to meet the reasonable requirements of the relevant road authority and transport operator(s). The plan shall include by not be limited to:	Construction contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		■ A routine traffic management plan ■ A parking management plan ■ A site traffic and access management plan ■ An incident response plan ■ Mechanisms for monitoring, reviewing and amending this plan. Develop, assess, and implement appropriate management measures in consultation with the relevant road authority, transport operator(s), and emergency services, and adjoining major land holders. This shall include: ■ Construction site access, including the efficient and safe egress and ingress of vehicles, consistent relevant Austroads, Australian Standards and Roads and Maritime requirements. ■ Parking management, including on and off street and remote parking and access. ■ Heavy vehicle management, the restriction (unless otherwise approved) of heavy vehicles on certain routes (for example T-Ways and past education facilities) and the minimisation of heavy vehicle traffic in peak traffic periods. ■ Bus rerouting and access to bus stops. ■ Full and partial road closures and associated restrictions, detours and the like. ■ Special event management. ■ The retention and reinstatement of emergency and property access. ■ The retention of user and passenger safety, including pedestrians, cyclists, public transport users, including at stops and related facilities. ■ Incident response planning.		
24	Temporary access restrictions during construction across the proposal footprint	Without limiting the outcomes of the Construction Traffic Management Plan, construction traffic shall be scheduled, where feasible and reasonable, to outside of morning and afternoon peak periods and also during special events. Methods used to limit construction traffic outside of peak traffic periods shall be incorporated into the Construction Traffic Management Plan. Access to property shall be maintained during construction unless otherwise agreed with the owner in advance. A landowner's access that is physically affected by the proposal shall be reinstated to at least an equivalent standard in consultation with the property owner. Safe pedestrian and cyclist access through or around worksites shall be maintained during construction. In circumstances where pedestrian and cyclist access is restricted due to construction activities, a feasible and reasonable alternate route shall be provided and signposted.	Construction contractor	Pre-construction
25	Pedestrian diversions	Directional signage and line-marking would be used to direct and guide drivers, cyclists and	Construction	Pre-construction/

No.	Impact	Environmental safeguards	Responsibility	Timing
	during construction	pedestrians past construction sites and on the surrounding network. This would be supplemented by permanent and portable Variable Message Signs, where reasonable and feasible to advise drivers of any potential delays, traffic diversions, speed restrictions, or alternative routes. The public would be notified of proposed traffic changes by newspaper, radio, project web site and other forms of community liaison.	contractor	construction
Construction				
26	Haul routes and access	Construction vehicles (including staff vehicles) shall be managed to: ■ Minimise parking or queuing on public roads and non-associated sites. ■ Minimise the use of local roads (through residential streets and town centres) to gain access to construction sites and compounds. ■ Minimise traffic past schools and child care centres, particularly during opening and closing periods. Adhere to the nominated heavy vehicle routes identified in the Construction Traffic Management Plan.	Construction contractor	Construction
27	Night time traffic movements	Restrict night time traffic to the removal of spoil from site, unless there is an accident or emergency during construction. This will be managed by Contractor's CEMP, by the EPL, by a Road Occupancy Licence, by a Construction Noise Impact Statement and by an Out of Hours Work Permit.	Construction contractor	Construction
Noise and vibration				
Detailed design				
28	Noise and vibration impacts during construction	Identify and consult with potentially-affected community, religious, educational institutions and vibration-sensitive businesses and critical working areas, and where feasible and reasonable, ensure that noise generating construction works in the vicinity of the receivers are not timetabled during sensitive periods, unless appropriate other arrangements are made. The proposal shall be designed and operated with the objective of not exceeding the vibration goals for human exposure for existing sensitive receivers, as presented in Assessing Vibration: a Technical Guideline (DECC, 2006).	TfNSW	Detailed design
29	Noise and Vibration Pollution during construction and operation	Implement noise pollution policy as per Section 4.13 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
Pre-construction (construction)				
30	Surface equipment vibration	Wherever feasible and reasonable vibration-generating activities shall be undertaken using quieter alternative methods.	Construction constrictor	Pre-construction
31	Surface noise impacts during construction	Three metre high noise barriers (site hoardings) would be constructed around the perimeter of construction sites.	Construction contractor	Pre-construction/ construction
Construction				
32	Surface noise impacts	Undertake noise monitoring at representative noise-affected receivers and representative locations in each noise catchment area while work is taking place to validate the modelling predictions. Implement additional feasible and reasonable safeguards if the observed monitoring results in higher than predicted noise levels.	Construction contractor	Construction
33	Noise and vibration impacts during construction	Prepare a Construction Noise and Vibration Plan to detail how construction noise and vibration impacts will be minimised and managed. The Plan shall be consistent with the guidelines contained in the Interim Construction Noise Guidelines (DECC, 2009) and Assessing Vibration: a technical guide (DEC, 2006). The plan shall include, but not be limited to: ■ Identification of work areas, site compounds and access points. ■ Identification of sensitive receivers and relevant construction noise and vibration goals applicable to the SSI stipulated in this approval. ■ Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to generate noise and/or vibration impacts on surrounding sensitive receivers, particularly residential areas. ■ Identification of feasible and reasonable measures proposed to be implemented to minimise and manage construction noise impacts (including construction traffic noise impacts), including, but not limited to, acoustic enclosures, erection of noise walls (hoardings), respite periods and the limiting of truck movements during night periods. ■ Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including a suitable blast program, applicable buffer distances for vibration intensive works, use of low-vibration generating equipment/ vibration dampeners or alternative construction methodology, and pre- and post- construction dilapidation surveys of sensitive structures where blasting and/or vibration is likely to result in damage to buildings and structures (including surveys being undertaken immediately following a monitored exceedance of the criteria). ■ Where the use of vibration-intensive activities take place an assessment of the potential	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		noise and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program. ■ A description of how the effectiveness of mitigation and management measures would be monitored during the proposed works, clearly indicating how often this monitoring would be conducted, the locations where monitoring would take place, how the results of this monitoring would be recorded and reported, and, if any exceedance is detected, how any noncompliance would be rectified. ■ Mechanisms for the monitoring, review and amendment of this plan.		
Landscape character and visual impacts				
Detailed design				
34	Operational visual and landscape impacts across the proposal footprint	High quality landscape and urban treatments would be used in and around the proposal. Prepare and implement an Urban Design and Corridor Landscape Plan for the proposal. The Plan shall be prepared by appropriately qualified person and detail the design initiatives used to integrate the proposal into their proposed settings, and the landscaping measures to minimise, mitigate and/or offset the proposal's visual amenity impacts and effects on local vistas. The Plan shall include, but not necessarily be limited to: ■ Identification of design objectives and standards based on local environmental values, strategic and statutory planning, future land release form and function, sustainable design and maintenance, transport and land use integration, passenger and community safety and security, community amenity and privacy, and relevant design standards and guidelines. ■ Specific plans for station precincts to provide high quality sustainable infrastructure that enhance the public domain and provide for active uses, ensure intermodal integration and equitable and safe access, including connectivity to surrounding precinct.	TfNSW	Detailed design
35	Operational light spill impacts on adjacent properties due to the use of external lighting	Cut–off and directed lighting would be used to ensure glare and light spill on surrounding existing and future residents are minimised.	TfNSW	Detailed design
Construction				
36	Management of the construction work to minimise its visual impacts and localised effect on landscape character	Hoardings would be designed to be considered and appropriate with their surroundings. This may include project related artworks or project information. These would be installed as early as feasible and reasonable in the construction process. Regular maintenance of site hoarding and perimeter site areas would be undertaken, including the prompt removal of graffiti.	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
37	Light spill impacts during construction across the proposal footprint	Cut-off and directed lighting would be used to ensure glare and light trespass are minimised.	Construction contractor	Construction
38	Visual impacts during construction at sensitive locations	Where feasible and reasonable the elements within construction sites would be located to minimise visual impact (e.g. setting particular equipment/structures back from the site boundaries to minimise their visual impact). The proposal shall be constructed in a manner that minimises visual impacts resulting from construction sites, including retaining, where feasible and reasonable, existing vegetation around the perimeter, providing temporary landscaping where appropriate to soften views of the construction sites, minimising light spillage, and incorporating architectural treatment and finishes within key elements of temporary structures that reflect the context within which the construction sites are located.	Construction contractor	Construction
Socioeconomic				
Detailed design				
39	Business impacts over the life of the proposal	Prepare and implement a Business Management Plan to minimise impacts on adjacent business. The plan shall include measures to minimise business related impacts, maintain where feasible and reasonable vehicular and pedestrian access during business hours, and the maintenance of visibility of the business appropriate to its reliance on such.	TfNSW/construction contractor/NRT	Detailed design through to operation
40	Business impacts during construction and during the initial phase of operation	Employ specialist Place Managers to act as a single, identifiable and direct point of contact for local residents, business people and community groups with the project during construction. Place Managers would work closely with all affected local businesses to help ensure timely responses to queries. A toll free number and website would be in place for the duration of the construction works to enable business owners and/or operators to receive prompt responses to their concerns, access information and view assistance measures in place during construction related works.	TfNSW/construction contractor/NRT	Detailed design through to operation
41	Enhance Community benefits and experience	Implement policy to enhance community benefits and customer benefits as per Section 4.6 and 4.7 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design
Pre-construction (construction)				
42	Business impacts during construction	A business consultation group would be formed to monitor, consider and provide business specific advice to manage the impacts during construction. Members of the consultation group may include representatives from local councils, and the NSW Chamber of Commerce and industry.	TfNSW	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
Land use and property				
Detailed design				
43	Leasing	Opportunities to minimise temporary loss of land should be investigated through detailed construction planning and site layout.	TfNSW/construction contractor	Detailed design/ pre-construction
44	Indirect land use (access) impacts during construction	Consider staging construction, particularly at busy locations, to complement traffic management measures and assist in minimising disruption to key land uses and vehicle and pedestrian movements.	TfNSW/construction contractor	Detailed design/pre-construction
45	Land use	Implement land use policy as per Section 4.5 and 4.8 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design
Pre-construction (construction)				
46	Planning control integration	Liaise with statutory organisations, and the Hill Shire Council to ensure the proposal is integrated with local and regional land use planning, and that environmental planning instruments reflect the planning, construction and operation of the Project, and include integrated planning provisions to enhance potential future development.	TfNSW	Pre-construction
47	Impacts on the Hillsong Church	Consultation with Hillsong Church would be undertaken prior to construction to identify specific mitigation measures to reduce operational and amenity impacts.	Construction contractor	Pre-construction
Air quality				
Detailed design				
48	Air quality ventilation exit points	Location and design of air ventilation to consider avoidance of air quality impacts on sensitive receivers.	TfNSW	Detailed design
49	Air quality during construction and operation	Implement air quality policy as per Section 4.13 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
Construction				
50	Air quality emissions and dust propagation across the proposal footprint	Prepare a Construction Air Quality Management Plan to minimised and managed impacts. The plan shall include, but not necessarily be limited to: ■ The identification of potential sources of air pollutants of concern, in particular dust. ■ Air quality management objectives. ■ Mitigation measures to be implemented, including measures during adverse weather conditions (such as strong winds in dry weather). ■ A monitoring program to assess compliance with the identified objectives. ■ Mechanisms for the monitoring, review and amendment of this plan. ■ The requirement that engines of onsite vehicles and plant would be switched off rather than left idling for extended periods of time.	Construction contractor	Construction
51	Air quality emissions and dust propagation across the proposal footprint	All vehicles carrying loose or potentially dusty material to and/or from the site would be covered. Waste or any other material would not be burnt on construction sites. Dust generating activities would be assessed during periods of strong winds and rescheduled, where required. Wind breaks, which may include site hoardings, would be constructed, where construction works are in close proximity to sensitive receptors and where feasible and reasonable. Re-vegetating or stabilising disturbed areas would occur as soon as feasible. The proposal shall be constructed in a manner that minimises dust emissions from the site, including wind-blown and traffic-generated dust and tracking of material onto public roads. All activities on the site shall be undertaken with the objective of minimising visible emissions of dust from the site. Should such visible dust emissions occur at any time, all feasible and reasonable dust mitigation measures shall be identified and implemented including cessation of relevant works, as appropriate, such that emissions of visible dust cease.	Construction contractor	Construction
52	Dust generation (general)	Working face and areas of open excavation would be kept to a minimum, where feasible and reasonable.	Construction contractor	Construction
53	Dust generation (general)	Water suppression would be used for active earthwork areas, stockpiles and loads of soil being transported to reduce wind-blown dust emissions.	Construction contractor	Construction
54	Dust generation (general)	Wind breaks, which may include site hoardings, would be constructed, where construction works are in close proximity to sensitive receptors and where feasible and reasonable.	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
55	Dust generation (haul routes)	Appropriate site speed limits would be imposed and signed within and on entry and exit from the proposal footprint to minimise dust propagation.	Construction contractor	Construction
56	Dust generation (haul routes)	Wheel-wash facilities or rumble grids would be provided and used near site exit points and a street-cleaning regime would be implemented to remove any dirt tracked onto roads.	Construction contractor	Construction
57	Vehicle emissions (general)	Engines of onsite vehicles and plant would be switched off rather than left idling for extended periods of time. Low emission vehicles and plant fitted with catalysts, diesel particulate filters or similar devices would be used, where feasible and reasonable. Plant would be well maintained and serviced in accordance with manufacturers' recommendations.	Construction contractor	Construction
Operation				
58	Operational air quality management	Develop an OEMP including an Air Quality section.	NRT	Operation
Greenhouse gas and climate change				
Detailed design				
59	Refrigerant use	GHG emissions arising from use of refrigerants, electricity and materials would be minimised though design initiatives incorporated into the proposal and its infrastructure. Example initiatives include, but are not limited to natural ventilation, daylighting, energy efficient Heating, Ventilation and Air Conditioning (HVAC) and selection of material with low embodied materials.	TfNSW	Detailed design
60	Operational electricity consumption	The proposal would minimise GHG emissions through energy reduction and avoidance, energy efficiency and onsite and offsite renewable or low carbon energy in accordance with the NWRL *Environment and Sustainability Policy* (TfNSW, 2013b).	TfNSW	Detailed design
61	Climate adaptation and operational electricity consumption	Implement climate change policy as per Section 4.2, 4.3, 4.4 and 4.15 of the *NWRL Sustainability Plan* (TfNSW, 2013c).	TfNSW	Detailed design
Waste management and resource use				
Detailed design				
62	Waste generation and resource use during construction	Where feasible and reasonable local materials would be preferentially used. Where feasible and reasonable fully offset carbon emissions generated by the proposal's operation.	TfNSW	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
63	Construction and operational waste and resource management	Design innovation during the detailed design stage would provide opportunities to reduce the amount of resources required for operation.	TfNSW	Detailed design
64	Construction and operational waste and resource management	Implement waste and material policy as per Section 4.10 of the *NWRL Sustainability Policy* (TfNSW, 2013b).	TfNSW	Detailed design
Pre-construction (construction)				
65	Waste generation during construction	Adopt the wider Sydney Metro Northwest waste management targets for the proposal, that include: ■ 100 per cent beneficial reuse of usable spoil ■ 95 per cent beneficial reuse of construction and demolition waste.	Construction contractor	Pre-construction/ construction
66	Waste generation during construction	Deliver the proposal in accordance with TfNSW waste-management policies. Adopt the waste and resource management hierarchy in all work method statements.	Construction contractor	Pre-construction/ construction
Construction				
67	Littering and site tidiness during construction across the proposal footprint	Report and audit waste volumes and disposal destinations. Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	Construction contractor	Construction
68	Waste generation during construction	All waste would be assessed, classified, managed and disposed of in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (NSW EPA, 2014).	Construction contractor/NRT	Construction/operation
69	Waste and resource management during construction and operation	Prepare a waste and resource management plan (WRMP) as a sub-plan of the CEMP. As a minimum describe the measures for handling, storing and classifying waste when 'onsite' and its subsequent disposal offsite to the relevant licenced facility.	Construction contractor/NRT	Construction/operation
70	Resource recovery during construction and operation	Excavated material and spoil would be beneficially reused on the project site or other sites, where feasible and reasonable, in accordance with the waste hierarchy. Recyclable wastes, including paper at site offices, would be stored separately from other wastes. Storage facilities would be secure and recyclables collected on a regular basis.	Construction contractor/NRT	Construction/operation
71	Waste reporting and management and operation	Initial and ongoing education would be provided to staff and sub-contractors regarding the importance of appropriately managing waste.	Construction contractor/NRT	Construction/operation

No.	Impact	Environmental safeguards	Responsibility	Timing
Operation				
72	Operational waste and resource management	Develop an Operational Waste and Resource Recovery Management plan. This would detail opportunities for avoiding waste generation and responsible disposal methods for different waste streams.	NRT	Operation
Biodiversity				
Detailed design				
73	Biodiversity conservation	Implement biodiversity conservation policy as per Section 4.12 and 4.15 of the *NWRL Sustainability Policy* (TfNSW, 2013b).	TfNSW	Detailed design
Construction				
74	Impacts on non-listed species across the entire proposal footprint	As a precautionary measure, ensure a qualified ecologist would be on call during the removal of the amenity vegetation to identify any manage wildlife that may be disturbed and/or injured. The ecologist would assess the species and then release them to the nearest suitable habitat if uninjured.	Construction contractor	Construction
75	Remote risk of encountering noxious weeds	Noxious and environmental weeds would be controlled within the operational site boundary. To prevent establishment or spread of weeds: ■ Machinery would be cleaned before entering the works site. ■ Cleared weed material would be disposed of at a site licenced to receive green waste.	Construction contractor	Construction
Non-Aboriginal heritage				
Detailed design				
76	Heritage Conservation	Implement heritage policy as per Section 4.11 of the *NWRL Sustainability Policy* (TfNSW, 2013b).	TfNSW	Detailed design
Construction				
77	Exceptionally remote potential for encountering unrecorded archaeology and/or heritage items during construction	Immediately cease all works within 10 metres of discovering an unexpected find (e.g. archaeological remains, heritage item, potential relic). Subsequently implement the following actions: ■ Inform the TfNSW Heritage Officer/Environment Officer. ■ TfNSW to subsequently notifying Heritage Division of NSW OEH in accordance with Section 146 of the *Heritage Act 1977* (NSW Government, 1977). ■ For an archaeologist to record the location and context of any historic heritage and implement controls to avoid, record, excavate and store materials.	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		■ Manage any significant finds to allow for their long-term storage.		
Aboriginal Heritage				
Detailed design				
78	Heritage Conservation	Implement heritage policy as per Section 4.11 of the *NWRL Sustainability Policy* (TfNSW, 2013b).	TfNSW	Detailed design
Construction				
79	Exceptionally remote potential of discovering unexpected Aboriginal heritage	Stop all work within 10 metres of an unexpected find discovery and: ■ Inform the TfNSW Heritage Officer/Environment Officer. ■ For an archaeologist to record the location and context of any historic heritage and implement controls to avoid, record, excavate and store materials. ■ Manage any significant finds to allow for their long-term storage.	Construction contractor	Construction
80	Determined impact on Aboriginal heritage	An Aboriginal heritage impact permit (AHIP) would be obtained prior to restarting works in the event of discovering an unexpected find: ■ Have a qualified heritage specialist prepare a cultural heritage application report (CHAR) that would support an application for the permit. ■ Consult with the local Aboriginal land council in preparing the CHAR. ■ Obtain the permit from the Heritage Council of NSW. This application would be accompanied by a prepared by a heritage specialist.	TfNSW	Construction
Cumulative effects				
Pre-construction (construction)				
81	Cumulative impacts	During construction, proponents of other major construction works in the vicinity of the proposal shall be consulted and reasonable steps taken to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.	TfNSW Construction contractor	Pre-construction/ construction
82	Cumulative impacts	Review environmental impacts during the construction phase. Any new impacts identified during construction would be addressed appropriately to reduce the cumulative effects and reported.	TfNSW Construction contractor	Pre-construction/ construction

Other licences, permits and approvals

TfNSW would be required to:

- Secure a ROL under Section 138 of the NSW *Roads Act 1993* (NSW Government, 1993b).
- Work under an EPL due to the proposal being listed under schedule 1(33) of the *Protection of the Environment Operations Act 1997* (NSW Government, 1997b).

8. Conclusions

This chapter provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the NSW *EP&A Act*, including the principles of ecologically sustainable development (ESD) as defined in Schedule 2 of the NSW *EP&A Regulation*.

8.1 Justification

The proposal's justification balances the long-term benefits against the temporary environmental and social impacts that would occur during construction and the effects if the proposal was not implemented.

The proposal would supplement the Sydney Metro Northwest and the Norwest Station precinct by improving pedestrian access to and from the active core of the Norwest Precinct. It is anticipated that the pedestrian link would be used by about two thirds of rail customers and other non-rail customers now and in the future as it would reduce the time taken to walk to and from Norwest Station. It would also introduce an alternative solution than having pedestrians cross at the surface and it would provide better pedestrian amenity during wet weather.

By not progressing with the pedestrian link the above benefits would not be realised. Also, there is more opportunity under the proposal to optimise the signal timing and phasing on Norwest Boulevard as fewer people would cross at the surface. This may achieve benefits in terms of reducing travel-time delays for road traffic through the intersection. Even if this was not done as part of this proposal, in constructing the pedestrian link it provides an opportunity for such improvements to be made in the future.

8.1.1 Short-term construction impacts

As discussed in Chapter 6, the majority of the impacts would occur during the eight-month construction period. While many of the anticipated impacts are rated as minor adverse the construction work is expected to cause moderately adverse noise and visual impacts. The other main risk would be encountering, managing and dealing with potential hydrocarbon contamination and pollution in the soil and groundwater. The construction work would also result in minor traffic, transport and access disruption off Century Circuit, prevent shoppers from being able to use up to 60 car parking spaces, and result in the excavation of a notable volume of spoil that would need careful management.

Such impacts are consistent with infrastructure development projects in urban areas and would be safeguarded and managed by implementing measures that have are known to mitigate impacts to an acceptable level consistent with best practice guidelines and statute. As such, the measures would be effective in reducing the magnitude, extent, duration and scope of the proposal's construction impacts. Central to this would be managing the work to minimise disruption as far as reasonably and feasibly possible for road users, adjacent businesses, the local community and other affected stakeholders.

While the proposal would be constructed at the same time as Norwest Station its cumulative impacts would be limited due to the size and scale of the work. There would be about a 10 per cent increase in construction traffic on the local roads while Norwest Station and this proposal are being constructed. Noise would be the only aspect where there would be a notable cumulative impact from the proposal generating night time noise impacts, which currently would not occur as a result of only constructing Norwest Station.

8.1.2 Long-term operational impacts and benefits

Chapter 6 identifies that there would be few anticipated long-term impacts and a number of wider benefits to the precinct over the coming years.

The impacts would include the loss of about 20 car parking spaces to the surface footprint of the Norwest Station canopy and the introduction of a new eight metre high structure to the north of Norwest Boulevard closer to the Hillsong Church and the shopping centre.

Conversely, the proposal would introduce a number of socioeconomic benefits in reducing travel times, improving pedestrian safety, and enhancing public transport access and connectivity between the Norwest Precinct and Norwest Station, which would encourage development and investment in the area. Also, the investment in the area's urban landscape would also further reinforce and enhance the character of the area.

8.1.3 Summary

The proposal offers a mechanism to help connect the Norwest Precinct to the Norwest Station precinct by making it safer and quicker for pedestrians to get to and from the core of the precinct to the station platforms.

The proposal is expected to achieve its objectives, but would result in certain short-term temporary environmental and social impacts during construction that can be effectively safeguarded and managed. Over the long-term, the proposal's predicted impacts would be limited to the loss of about 20 car parking spaces and changes in the visual environment due to the installation of the surface canopy. However, the scale of these impacts would not outweigh the anticipated socioeconomic benefits of the proposal and the broader introduction of Sydney Metro Northwest that would be enhanced by this proposal.

8.2 Planning and assessment objectives

Part 1(5) of the *EP&A Act* describes a number of 'objects' (objectives). They encourage eight outcomes as described in the Table 8.1. The table also comments on the proposal's consistency with these objects.

Table 8.1 Cumulative effect safeguards and management measures

Object	Comment
5(a)(i) To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.	This object describes how environmental and social resources and values can be best used and preserved for the community now and in the future. In the case of the proposal, it would achieve this objective by supporting the North West Rail Link Structure Plans (NSW Department of Planning and Environment, 2013) and the Norwest Precinct Traffic Master Plan (TfNSW, 2012c), which focus on promoting, managing and developing the area's transport infrastructure in a sustainable and integrated manner. The Norwest Precinct has been strategically identified and released for development to 'promote social and economic welfare for the north west communities'. Its focus is on creating accessible and liveable centres based on the principals of self-containment, good access, good amenity and good transport links. The proposal is part of delivering the above outcomes. The proposal would only impact on an existing developed area and it would therefore have no impact on either natural or artificial resources. The design and construction of the proposal is committed to implementing a number of resource management and conservation measures that focus on material reduction, reuse and recycling. The proposal would have no impact on agricultural land, natural areas, forests or minerals. Its water quality impacts have been assessed and rated as minor adverse as they would not material impact on regional groundwater conditions, patters or quality.

Object	Comment
5(a)(ii) To encourage the promotion and coordination of the orderly economic use and development of land.	The proposal would develop land that is already in use as a car park. The required permanent loss of car parking would be from peripheral areas, which are not well used. Improving connectivity and access between Norwest Station and the main core of the Norwest Precinct, is something that is recognised as a tangible economic benefit (refer to Section 6.5) as it would support the growth and development of the area. While the Norwest Station would still introduce economic benefit to the area, it is assessed that this would not be as marked as it could be on including the proposal in Norwest Station design.
5(a)(iii) To encourage the protection, provision and coordination of communication and utility services.	The proposal would impact on few utilities and services (refer to Section 3.9). TfNSW would work with the utility and service providers to identify any conflicts in maintenance and upgrade schedules as well as any emergency access requirements. This would ensure that all services were identified and protected. The temporary access restrictions would have no impact on aboveground public amenities and utilities during construction other than a few street lighting posts. Again, TfNSW would ensure that they could be accessed to be serviced or repaired during construction.
5(a)(iv) To encourage the provision of land for public purposes.	The proposal would service the local community and others wishing to access the amenity and services in the Norwest Precinct. The proposal is therefore provisioned for use by the public.
5(a)(v) To encourage the provision and coordination of community services and facilities.	During construction there would be some short-term community impacts, however there would be unlikely to be any material impact on the key community features in the area and notably the Hillsong Church. The most notable effects would be the noise and visual impacts during construction. Once operational, the proposal would provide improved pedestrian access from Norwest Station to the Norwest Precinct and its community services and facilities. The proposal is therefore provisioned for providing improved access to community services and facilities.
5(a)(vi) To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The REF has 'examined and taken into account to the fullest extent possible all matters affecting, or likely to affect, the environment by reason of that activity'. In doing so it has identified a number of safeguards and management measures to protect the environment. Principal to these are pollution prevention controls, waste management controls, resource conservation and the protection of environmental and social values and resources. These measures are deemed sufficient to avoid the potential for any significant residual impacts to occur as a result of the proposal's construction or operation. This consequently means that the environment would be adequately protected. The environment of the proposal footprint does not contain any important biological value or sensitive habitats.
5(a)(vii) To encourage ecologically sustainable development (ESD).	ESD is considered in sections 8.2.1–8.2.4 below.
5(a)(viii) To encourage the provision and maintenance of affordable housing.	This objective is not relevant to the proposal.
5(b)(viii) To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Sharing the responsibility of environmental planning is interpreted under two principal planning approval pathways in the *EP&A Act*. The Act also describes who is responsible for managing and coordinating these pathways. Part 5 of the Act describes the responsibilities for public agencies undertaking development without consent. These provisions are supported by the provisions of State Environmental Planning Policy (Infrastructure) 2007 (NSW Government, 2007). Collectively they describe the sharing responsibilities across all levels of Government in delivering public infrastructure. In delivering the proposal under the above pathway TfNSW has fulfilled its obligations in this regard under the *EP&A Act.*
5(c)(viii) To provide increased opportunity for public involvement and participation in environmental planning and assessment.	The REF commits TfNSW to ongoing consultation as the detailed detail is developed, as the pre-construction work takes place, while the proposal is being constructed, and once construction is complete. As such, the public would be involved at all stages of the proposal's lifecycle. The display of the REF and the submissions response process will provide an opportunity for the public to raise concerns and comments about the proposal. TfNSW will respond to these query submissions and undertake additional environmental assessment or design refinements if and where required.

8.3 Ecologically sustainable development

This section describes how four of the ESD principles have been incorporated into the proposal's concept design and environmental assessment.

8.4 The precautionary principle

Principle 15 of the United Nations Conference on Environment and Development 1992 (the Rio Summit) defined the precautionary principle. 'Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'. In 2000, a European Union communication further refined the definition to account for action where scientific evidence is 'insufficient, inconclusive or uncertain'. Also realised was the responsibility placed on the developer to prove their actions as being safe and act in instances where there is uncertainty.

In all cases impact assessment is a subjective process. It relies on professional judgement and interpretation. This includes quantified traffic and noise modelling undertaken to support this REF, as this has relied on the subjective manipulation of input data.

Consequently, in all instances precaution has been built into the assessment undertaken and reported in this REF. This includes adopting a number of worst-case assumptions, such as all noise-generating equipment operating at its maximum output at the same in the same location, or the assumption of a worst-case impact occurring as a result of working at the minimum distance between the source and receptor. It also assumes a worst-case interaction between projects to assess interactive and cumulative effects. While the likelihood of such eventualities occurring is remote, precaution is employed to remove subjective uncertainty.

There has also been a responsibility on TfNSW to employ 'reasonable and feasible' measures to protect the environment and to do this where there is uncertainty. In the case of the proposal, there are certain impacts that have very low likelihood of occurring, such as there being a major spill onsite. However, TfNSW has still committed to implement measures to safeguard against these risks.

Conversely, there are certain proposed work activities, which when assessed under a worst-case scenario, clearly show there is likely to be an impact. A good example is construction noise and its exceedance of the corresponding noise management levels. Again in reality there would be an exceptionally low likelihood of the conditions modelled in the REF actually transpiring onsite. Nonetheless, TfNSW is committed to controlling noise to a worst-case level. This again, demonstrates the adoption of precaution where there is uncertainty.

Finally, the concept design will be developed and refined into a detailed design. At this stage there are many aspects of the design that are not detailed (e.g. final finishes, the final ancillary facility requirements). TfNSW has committed to confirming that the impacts reported in this REF are still relevant, accurate and consistent and reflect the proposal's detailed design. Additional environmental assessment would be undertaken where there is an identified inconsistency. This again would ensure that uncertainty is identified, addressed and resolved throughout the proposal's design lifecycle.

8.5 Intergenerational equity

Establishing intergenerational equity allows for the needs of today to be met without affecting the ability of future generations to meet their own needs, as termed by the World Commission on Environment and Development in 1993 when defining sustainable development. In instances where environmental resources and values are preserved for use by future generations to create 'wealth' this is termed 'weak sustainable development'. Where there is recognition that humans cannot replace a degrading environmental resource or value for future generations to benefit from, this is termed 'strong sustainable development'.

At a fundamental level, the proposal would enhance the built environment for use by future generations. It would have little impact on environmental resources and values other than the required use of a limited amount of natural resources to construct the proposal. TfNSW is also committed to its Climate Change Plan and the NSW Greenhouse Gas Plan (refer to Section 6.8). Both include priorities to ensure that TfNSW reduces its demands on natural resources by conserving energy, reducing the carbon footprint of all its development activities, and accommodating climate change into its designs. TfNSW has committed to these measures in designing this proposal.

In addition, the proposal's core function is to improve pedestrian safety, amenity and travel times between Norwest Station and the core of the Norwest Precinct. It would therefore support the following Sydney Metro Northwest initiatives:

- Link existing communities and new growth areas.
- Deliver a transport service that has been informed by engagement with communities and stakeholders and represents value for money.
- Improve transport network reliability by facilitating a shift from road to rail for trips to and from the North West, to reduce bus and road congestion and improve amenity in the Sydney city centre.
- Contribute to environmental and social sustainability by improving liveability and minimising impacts on the environment, stakeholders and the community.
- Support the Government's challenge to accommodate population growth in the North West by increasing the potential for a range of housing and employment opportunities.

These measures encourage reduced reliance on private vehicle use (refer to Section 6.8.4). The proposal therefore supports sustainable transport initiatives and forms part of a wider agenda for sustainable development. Overall, therefore, the proposal commits to intergenerational equity and sustainable development.

8.6 Conservation of biological diversity and ecological integrity

Preserving biological diversity and ecological integrity requires that ecosystems, species, and biological diversity are maintained. As concluded in the biodiversity assessment (refer to Section 6.10), the proposal would not impact on threatened, endangered or vulnerable species, communities, populations or their associated habitat. Therefore biological diversity and ecological integrity would not be affected by the proposal.

8.7 Improved valuation, pricing and incentive mechanisms

The pricing of environmental resources involves placing a monetary value on natural assets and services. The principle suggests that TfNSW should:

- Bear reasonable costs to avoid pollution risks and implement controls to contain or abate pollution should it occur.
- Consider the lifecycle environmental, social and economic costs of building, operating and maintaining the proposal.
- Implement the proposal's environmental goals by enabling specialists to identify the most cost-effective safeguards and management measures to respond to its predicted environmental impacts.

TfNSW has committed to safeguards that would reduce the likelihood of routine pollution occurring during the proposal's construction and operation to negligible levels. It has also committed to adopting safe working methods to reduce the likelihood of an accidental spillage or pollution event, while including further precaution by implementing management measures to contain or abate pollution in the exceptionally unlikely event that it should occur. The assessment also realises the need to identify and manage any existing hydrocarbon contamination and pollution from the adjacent service station in accordance with relevant best practices and if necessary consulting with Shell to discuss any required remediation action. Consequently, the proposal has adopted the polluter-pays principle.

TfNSW has also committed to the purchase of recycled materials and materials with low-embodied energies where reasonable and feasible (refer to Section 6.9.3). These provisions serve to consider the lifecycle demand on natural resources and their conservation. It has also committed to sourcing the materials from local markets, including primary materials wherever possible. Finally, all materials, construction staff and equipment, and waste would be obtained and disposed of as close to the proposal footprint as possible (termed the 'proximity principle'). This would reduce the proposal's wider secondary, indirect and lifecycle impacts.

Finally, TfNSW has developed environmental assessment guidance to allow external parties to prepare its environmental assessment documentation. These external parties comprise specialists who are competent in environmental impact assessment and are experienced in identifying cost-effective safeguards based on a hierarchy of avoidance over mitigation. In addition, TfNSW has its own in-house team of environmental specialists who review all environmental assessments to ensure the safeguards are cost-effective and achieve the proposal's environmental goals and TfNSW 's organisational environmental goals.

8.8 Conclusion

The proposal is subject to assessment under part 5 of the *EP&A Act*. The REF has examined and taken into account to the 'fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity'.

A number of potential environmental impacts have been avoided or reduced during the options assessment and the development of the concept design. The proposal, as described in the REF, best meets the project objectives, but would still results in moderate adverse short-term noise and visual impacts during construction along with a number of minor adverse impacts. Safeguards and management measures, as detailed in Chapter 7, would mitigate or minimise these anticipated impacts.

The proposal would benefit pedestrian access, safety and travel times to and from Norwest Station and the core of the Norwest Precinct compared to the approved project. It would also provide a long-term benefit by investing in the region and supporting the identified need to develop Sydney's North West. Collectively, these benefits are recognised as being an effective response to linking existing communities in new growth areas and contributing to social sustainability by improving liveability and providing better connectivity and access. On balance the proposal is considered justified.

The environmental impacts of the proposal are not likely to be significant and therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought for the proposal from the Minister for Planning and Environment under Part 5.1 of the *EP&A Act*. The proposal is unlikely to affect threatened species, populations or ecological communities or their habitats, within the meaning of the NSW *TSC Act* or NSW *FM Act* and therefore a SIS is not required. The proposal is also unlikely to affect Commonwealth Government land or have an impact on any matters of national environmental significance.

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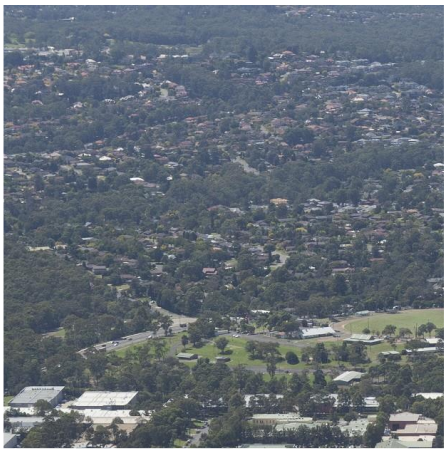
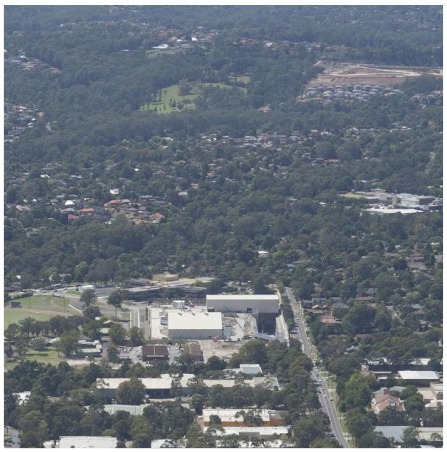
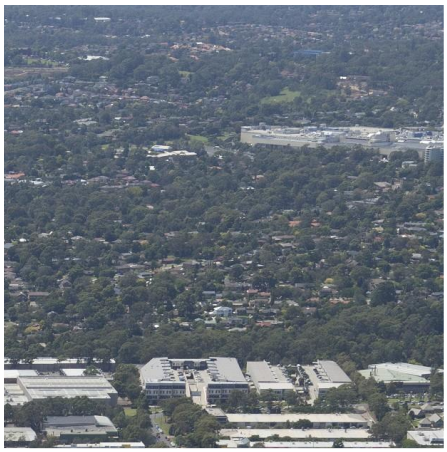




Appendix A

Consideration of environmental factors and matters

A1. Consideration of clause 228(2) factors and matters of national environmental significance

Clause 228(2) Checklist

In addition to the requirements of the Is an EIS required? guideline as detailed in the REF, the following factors, listed in Cause 228(2) of the EP&A Regulation have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Table A.2 Review of clause 228(2) environmental factors

Factor	Impact
a. Any environmental impact on a community?	
Construction: Some short-term moderate adverse noise and visual impacts would affect the community during construction including the Hillsong Church and adjacent businesses. The construction work would also have amenity impacts that would affect the community, including traffic management, access delays, the loss of 60 parking spaces, and dust generation. However, there is a commitment to implement effective construction staging and programming to limit these impacts and minimise disruption particularly during times of peak demand.	Short-term minor adverse reversible impacts to the local community safeguarded through the controls listed in Chapter 7.
Operation: The net impact of implementing the proposal would be the minor-to-moderate impact of losing about 20 peripheral car parking spaces and the minor-to-moderate visual impact generated from the canopy structure. These impacts would affect the community however the lost car park spaces are not regularly used and the proposal to design the canopy structure to be consistent with the urban design themes in the area is considered a beneficial outcome as it would reinforce and enhance the urban character. Also the proposal would benefit the community by improving pedestrian access and connectivity between Norwest Station and the core of the Norwest Precinct.	Permanent minor-to-moderate adverse impacts due to the acquisition and loss of about 20 car parking spaces and the visual impact of introducing a new structure. Permanent benefit to community by improving pedestrian access and connectivity between Norwest Station and the core of the Norwest Precinct.
b. Any transformation of a locality?	
Construction: There would be a moderate short-term visual impact due to the creation of an additional construction work site (supplementing the Norwest Station site) within a more central part of the Norwest Precinct. This would have a minor-to-moderate effect on the amenity and landscape character of the area. It would therefore transform the locality of the area around the proposal footprint for up to eight months. Altered travel patterns, diversions, delays and access changes would be minor in nature having a limited impact on the transformation of the area. These impacts would be safeguarded through effective community consultation, and the promoted staging and programming of the work to avoid peak demand periods.	Short-term reversible minor-to-moderate adverse impacts local to the proposal footprint appropriately safeguarded through the controls listed in Chapter 7.
Operation: The locality of the proposal footprint would be altered following the installation canopy structure. While this would introduce a new visual component in the landscape (deemed a minor-to-moderate adverse impact) the canopy's design would reinforce the urban design themes of the Norwest Precinct. This would be reinforced by improving the urban landscape in and around the canopy through new paved areas and the establishment of amenity planting.	Permanent benefit to the area due to reinforcement of the urban landscape character and reinforcement of the themes that run throughout the Norwest Precinct.
c. Any environmental impact on the ecosystems of the locality?	
There would be some limited amenity vegetation loss that provides a foraging resource for native fauna that can survive in a highly-modified urban environment. The vegetation is amenity-planted and does not form part of an ecosystem. It may provide foraging habitat for a number of mobile species; however they do not contribute to a valuable or important ecosystem in the locality.	Negligible adverse impact restricted to the proposal footprint.

Factor	Impact
d. Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?	
Construction: There would be short-term construction disruption impacts that would affect the visual amenity and aesthetics of the area as discussed above. The local environmental quality would also be affected in the short-term due to construction noise, visual impacts, dust generation and general construction activities. The key receivers in the area (the Hillsong Church or adjacent businesses) would be impacted by construction noise or vibration as well as being affected by the visual impact of the proposal footprint and general construction activity taking place in the area. There are no other recreational, scientific or environmental qualities in the area that would be impacted during construction. Again, the promoted staging and programming of the work to avoid peak demand periods would be used to manage these impacts.	Short-term reversible minor-to-moderate adverse impacts affecting local values safeguarded through the controls listed in Chapter 7.
Operation: Once the proposal is operational, while having a visual impact it would enhance the area's urban locality. In combination with Norwest Station this should improve the amenity of the area overall, This would be reinforced by the proposal's urban design and the sensitive use of materials and amenity-planting. There would be no anticipated reduction in aesthetic, recreational, scientific or other environmental quality values in the area once the proposal was operational.	Permanent benefit to the area due to embracing urban design themes and investing in positive material and amenity-planting outcomes.
e. Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?	
Construction: As described above, there would be minor-to-moderate adverse impacts on the receivers in the area during construction. This would include the Hillsong Church, which is regarded as the only receiver of social significance and special value. There are no other locations in the area that have aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific value.	Short-term reversible minor-to-moderate adverse impacts within the proposal footprint appropriately safeguarded through the controls listed in Chapter 7.
Operation: While the visual impact of the new canopy structure would have a minor-to-moderate adverse impact on the Hillsong Church this would be subjective. By replicating design themes in the canopy structure that are consistent with the wider precinct this will reinforce overall landscape character of the Norwest Precinct. Therefore while visible, the proposal's impact on landscape character is assessed as beneficial.	Permanent adverse visual impact however a beneficial improvement to the area's landscape character.
f. Any impact on the habitat of protected fauna (within the meaning of the *National Parks and Wildlife Act 1974*)?	
The proposal would have no impact on habitat or fauna protected under the *National Parks and Wildlife Act 1974.*	Nil
g. Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?	
The proposal would have no impact on endangered, threatened or vulnerable species, communities or their supporting habitat within the meaning of the TSC Act, FM Act and EPBC Act.	Nil
h. Any long-term environment effects?	
Chapter 8 describes the long-term/permanent impacts and benefits of the proposal. In summary, the proposal's main permanent impacts would be the loss of about 20 peripheral car parking spaces and the visual impact from introducing a new structural component in the landscape. Other permanent, yet minor adverse, impacts would include the need to manage groundwater inflows and drawdowns around the main subsurface structures and the ongoing electricity demand needed to operate the proposal. However, these would be offset by the long-term benefits of improving pedestrian connectivity and access between Norwest Station and the core of the Norwest Precinct.	Permanent minor-to-moderate adverse impacts affecting the proposal footprint and the locality. Permanent benefit to the area due to improved pedestrian connectivity and access.

Factor	Impact
i. Any degradation of the quality of the environment?	
Construction: There would be a short-term environmental degradation due to the noise, visual and amenity impacts during construction. The greatest risk however would be encountering and mobilising existing hydrocarbon contaminants and pollutants when undertaking the earthworks that would have migrated from the adjacent service station site. TfNSW has committed to a number of safeguards to investigate, manage and remediate the site prior to construction as required.	Short-term reversible moderate adverse impacts affecting the proposal footprint and wider area appropriately safeguarded through the controls listed in Chapter 7.
Operation: There is not anticipated to be any overall change to the area's environmental quality.	Nil
j. Any risk to the safety of the environment?	
Construction: As above, there is a likelihood of encountering hydrocarbons during construction, which has been safeguarded through a number of commitments. There is also a residual risk of pollution occurring during construction through unforseen, unplanned or accidental emissions and discharges. The likelihood of such impacts would be reduced through careful management and additional controls that would be implemented to handle and manage any incidents. Finally, there is also a requirement to work and use equipment within a confined space during construction. This would present a risk of asphyxiation for the work force was it not for the construction contractor needing to adopt stringent controls. Pedestrian, cyclist and road user safety issues are also a consideration during construction due to the proposal's location. Again, the likelihood of the impact would be greatly reduced through careful management.	Pollution management is assessed as a moderate adverse impact affecting the proposal footprint and wider environment if not appropriately managed using the controls listed in Chapter 7. The other impacts would constitute short-term reversible negligible impacts affecting the proposal footprint appropriately safeguarded through the controls listed in Chapter 7.
Operation: The proposal has been designed under approved standards to ensure operational environmental and community safety in design.	Nil.
k. Any reduction in the range of beneficial uses of the environment?	
Construction: The construction site would occupy the footprint of a former fast food restaurant and peripheral car parking used by the shopping centre and very-occasionally the Hillsong Church. The loss of access to the footprint in terms of its use is assessed as minor adverse. There would also be the loss in being able to use two sections of footpath adjacent to the construction site. However, there are alternatives available locally, with the only affect being a slight increase in pedestrian travel times during construction.	Short-term reversible minor adverse impacts affecting the proposal footprint appropriately safeguarded through the controls listed in Chapter 7.
Operation: The only reduction in use of the existing environment would be the loss of about 20 car parking spaces. These spaces are peripheral to the main car parking areas, with the impact assessed as minor adverse.	Long-term irreversible minor adverse residual impact affecting the proposal footprint.
l. Any pollution of the environment?	
Construction: The proposal would result in both noise pollution and dust generation during construction. Both impacts would be managed; however there would be residual construction noise impacts. There would also be cumulative noise effects across the city centre. There is also a risk of encountering hydrocarbon pollution arising from the adjacent service station site affecting the groundwater.	Pollution management is assessed as a moderate adverse impact affecting the proposal footprint and wider environment if not appropriately managed using the controls listed in Chapter 7. The other impacts would constitute short-term reversible negligible impacts affecting the proposal footprint appropriately safeguarded through the controls listed in Chapter 7.
Operation: There would be no long-term pollution.	Nil.

Factor	Impact
m. Any environmental problems associated with the disposal of waste?	
Construction: The proposal would take place in areas that have an associated contamination potential and a hydrocarbon risk. This could generate spoil and dewatered groundwater that would be classified as special waste. All waste would be classified, handled and stored in accordance with the NSW Waste Classification Guidelines 2009: Part 1 Classifying Waste (DECCW) and Storing and Handling liquids, Environmental Protection (DECC, 2007). It would therefore be appropriately segregated, transported and disposed of to a relevant licenced facility in the metropolitan area.	While there would be a risk of needing to manage and dispose of special waste there would be no associated environmental problems due to the adoption of the safeguards described in Chapter 7.
Operation: There would be negligible waste generated once the proposal was operational. The only key waste stream, the removed groundwater inflow, would be managed using infrastructure and methods being installed as part of Norwest Station project. As such there would be no perceived operational waste disposal issues.	Nil.
n. Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?	
Construction: The provisional resource requirements demonstrate that the proposal could be largely constructed from recycled materials. This is consistent with TfNSW's requirement for its contractors to propose the use of recycled materials where they are cost and performance competitive and comparable in environmental performance. In addition, the contractor(s) would be able to propose the use of low embodied-energy alternatives (e.g. materials that require less energy to produce) for items such as concrete and paint, where they are cost and performance competitive and comparable in environmental performance. The required construction materials are commonly used and can be supplied locally.	Nil.
Operation: There would be minor resource requirements to operate the proposal. The key operational resource requirement would be power and electricity. TfNSW would investigate design outcomes that reduce the amount of power needed to operate the proposal while also investigating opportunities to include resource recovery measures. While potentially produced from a finite resource there is no power supply shortage likely to affect the proposal's operation.	Nil.
o. Any cumulative environmental effect with other existing or likely future activities?	
Construction: The proposal would be constructed at the same time as Norwest Station. This would introduce a number of cumulative impacts including additive and cumulative noise and vibration impacts, cumulative groundwater impacts and cumulative visual, landscape and amenity impacts. Through assessment (refer to Chapter 6) it was concluded that the cumulative construction impacts would not be notable. Existing activities have been captured in appraising the existing environmental conditions discussed in Chapter 6.	Minor adverse impacts affecting the local area. The impacts would be managed across wider strategy safeguards and management measures described in Chapter 7.
Operation: There would be a number of cumulative benefits including increased economic investment in the area, greater accessibility to the Norwest Precinct and reinforcement of the urban design themes across the area. These would be offset against the cumulative groundwater drawdown and inflow impacts that would occur across the area and the additional cumulative waste and requirements. Notably, there are a number of aspects that are not assessed as being cumulatively impacted by the combined operation of Norwest Station and the proposal, notably relating to air quality, noise, amenity and traffic impacts.	Cumulative benefits delivered without any major or notable cumulative impacts from operating Norwest Station and proposal at the same time.

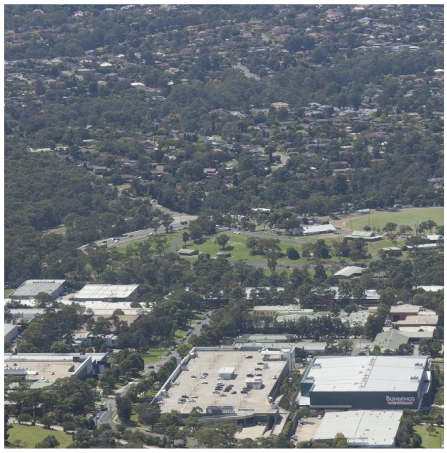
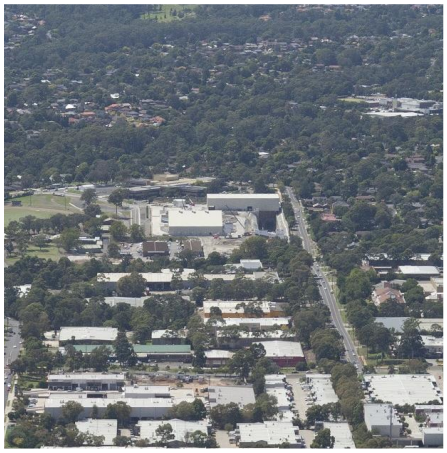
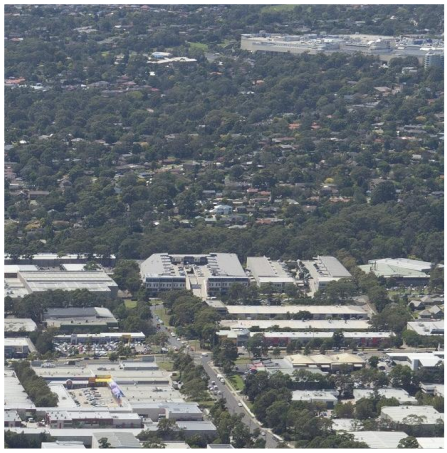
Factor	Impact
p. Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?	
The proposal would have no impact on coastal hazards. It would however be designed to account for climate change forecast projections relating to increased flooding, increased temperatures and increased solar gain.	Nil

Matters of National Environmental Significance

Under the environmental assessment provisions of the EPBC Act, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government's Department of Environment.

Table A.3 Review of Commonwealth Matters of National Environmental Significance

Factor	Impact
a. Any impact on a World Heritage property?	
The proposal would have no impact on world heritage properties.	Nil
b. Any impact on a National Heritage place?	
The proposal would have no impact on a National Heritage place.	Nil
c. Any impact on a wetland of international importance?	
The proposal would have no impact on a wetland of international importance.	Nil
d. Any impact on a listed threatened species or communities?	
The proposal would have no impact on a listed threatened species or community.	Nil
e. Any impacts on listed migratory species?	
The proposal would have no impact on a listed migratory species.	Nil
d. Any impact on a Commonwealth marine area?	
The proposal would have no impact on a Commonwealth marine area.	Nil
g. Does the proposal involve a nuclear action (including uranium mining)?	
The proposal does not involve a nuclear action.	Nil
h. Any impact (direct or indirect) on Commonwealth land?	
The proposal would have no impact on a Commonwealth land.	Nil

Appendix B

Norwest Station Subsurface Northern Pedestrian Link Traffic and Transport Review

Document information
Client: Transport for NSW Title: Appendix B – Norwest Station Subsurface Northern Pedestrian Link Traffic and Transport Review Document No: 2207529A-ITP-RPT-001 Date: 17 February 2015

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Executive summary

Introduction

Norwest Station will be located at the intersection of Norwest Boulevard and Brookhollow Avenue to service local residents and the Norwest Business Park. Transport for New South Wales (TfNSW) has reviewed the access provisions to the approved station and has proposed they could be improved by providing a separate pedestrian access to the north of the Norwest Boulevard and a link under the road ('the proposal'). The proposal would allow pedestrians travelling to and from Norwest Station to avoid the need to cross Norwest Boulevard to cross at the surface. It is anticipated that about two thirds of rail users would use the pedestrian link and northern entry, plus a number of additional non-rail users. The remaining third are anticipated to cross at the surface via the signalised pedestrian crossing provided as part of the approved station development.

Existing conditions

Norwest Boulevard is currently the only main arterial to, from, and through the area. Norwest Business Park creates high volumes of commuter traffic on Norwest Boulevard and the wider road network during the morning and afternoon peak periods, which coincides with the times when station patronage and resultant pedestrian activity will be at its highest. Intersection modelling of peak period conditions undertaken by the *NWRL Environmental Assessment* (TfNSW, 2013) indicated:

- The Norwest Boulevard/Brookhollow Avenue/Century Circuit roundabout adjacent to the proposal site was operating at Level of Service (LoS) A with spare traffic capacity.
- Intersections on Norwest Boulevard between Brookhollow Avenue/Century Circuit and Windsor Road were generally operating with spare traffic capacity.
- The Norwest Boulevard/Windsor Road intersection was operating at capacity, but has been upgraded since the time of assessment.

Construction impact assessment

The proposal would create a second construction worksite to the north of the main worksite for Norwest Station. Traffic management measures would be developed during the detailed design to manage construction work. The proposal would take place within the context of the traffic management controls that have been developed for the construction of Norwest Station. The proposed pedestrian tunnel is a bored tunnel meaning Norwest Boulevard would remain operational throughout construction. The main impacts of construction would comprise:

- Short delays for road traffic during typical construction activities.
- Minor traffic diversions resulting in additional travel times and distances during possible infrequent road closures.
- Pedestrian diversions resulting in additional travel times and distances during possible footpath closures.

Intersection modelling has been undertaken to assess performance impacts on the Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection as a result of simultaneous construction of Norwest Station and the proposal. The results illustrate that:

- Traffic generated by construction would increase volumes at the intersection by around 1% during peak periods.
- Construction traffic would have no meaningful impact on intersection operations or performance.

Operational impact assessment

Following the construction of Norwest Station (and the increased development around the station), there would be two major changes to traffic and transport conditions in the proposal area:

- Significantly increased pedestrian activity to, from, and within the area.
- The intersection of Norwest Boulevard/Brookhollow Avenue/Century Circuit would be upgraded to a signalised intersection, including pedestrian crossing facilities across all approaches.

The introduction of traffic signals would result in the Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection operating at LoS D during peak periods. However, as a result of the proposal the following changes to the utilisation of the north-south pedestrian crossings of Norwest Boulevard would reduce the impact of pedestrian movements and consequently improve overall intersection performance.

- Reduced demand and utilisation of the north-south pedestrian crossings could reduce the average delay to traffic which they create. If these crossings were not called every cycle, this would reduce the average pedestrian phase time required over a number of cycles.
- Reduced pedestrian demand would also decrease the conflict between pedestrian movements and vehicle movements where they occur during the same phase.

The above changes would increase effective intersection traffic capacity and improve performance based on forecast 2026 demand. These benefits would also potentially delay or negate the need for further capacity upgrades to the intersection should demand continue to grow.

In addition to increasing effective traffic capacity, the proposal would also benefit pedestrians. The provision of a pedestrian subsurface tunnel would allow pedestrians travelling to and from Norwest Station to avoid the need to cross Norwest Boulevard to cross at the surface. As a result:

- Sydney Metro Northwest pedestrians would not be required to wait at traffic signals before crossing Norwest Boulevard, reducing pedestrian delays when compared to conditions without the proposal.
- Sydney Metro Northwest pedestrians would not need to cross the road at surface, reducing movement conflicts and the risk of potential collisions between vehicles and pedestrians.

The proposal would not remove the need for the surface pedestrian crossing. The crossing will still be used by other pedestrians using the Norwest Precinct, cyclists, and Norwest Station customers that would prefer to cross at the surface; and some bus customers.

Mitigation measures and strategies

The construction traffic management approach would be consistent with the overarching approach for the North West Rail Link project. Key mitigation measures and strategies are categorised as follows:

- Contractors' responsibilities.
- Agency and community liaison.
- General mitigation measures.

1. Introduction

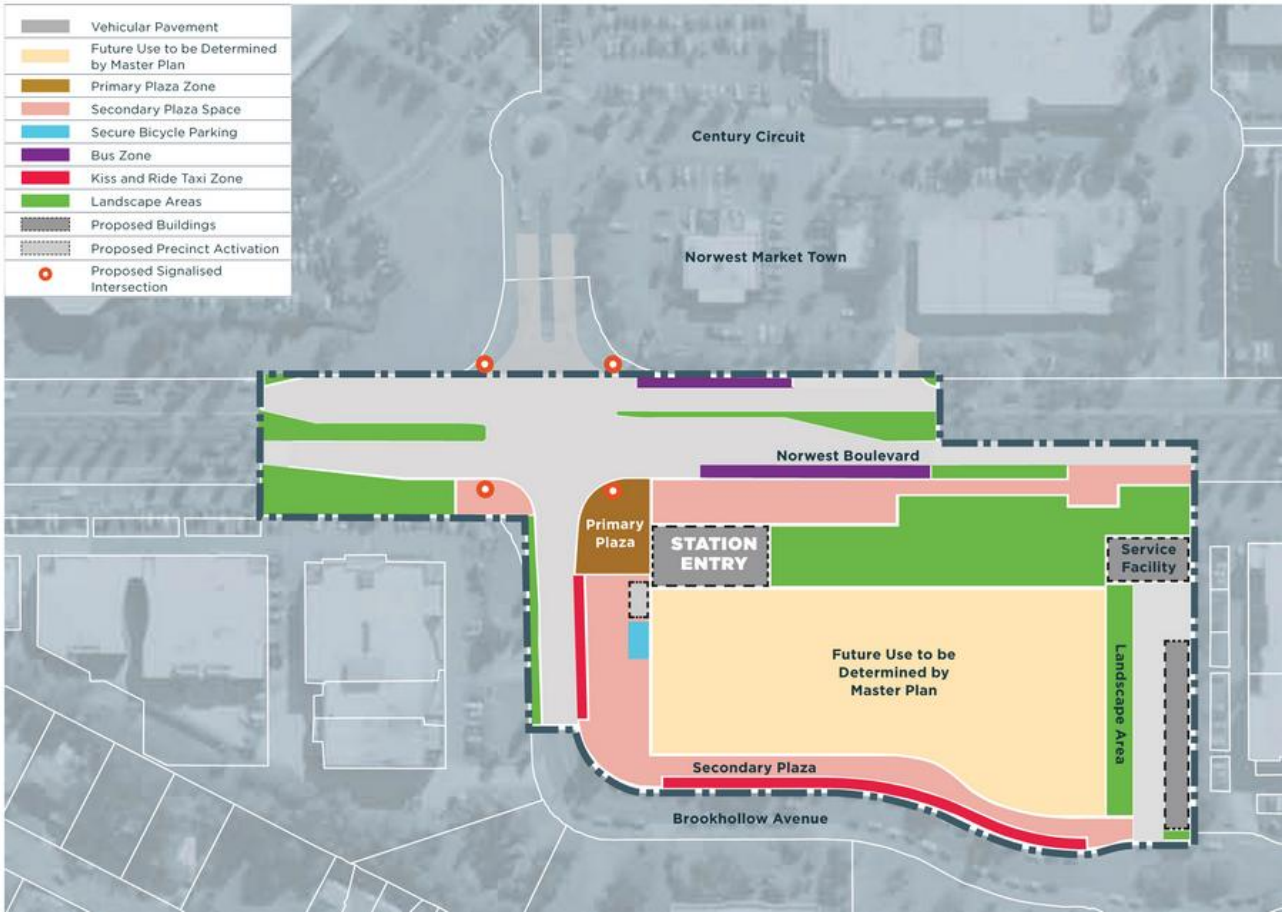
1.1 The proposal

Transport for NSW (TfNSW), in conjunction with the Northwest Rapid Transport (NRT) consortium, is developing the 8 stations that will form part of the Sydney Metro Northwest (formerly North West Rail Link (NWRL)); itself an approved 23 kilometre twin-track passenger railway linking Chatswood to Rouse Hill.

In 2008 TfNSW applied to develop the project's concept design. Subsequent to this, it prepared two separate state significant infrastructure applications for the project, one to service the major civil construction work and the second to service Norwest Station's, rail infrastructure and systems.

The latter application, determined and approved in 2013, consented to the construction of eight new stations in support of the project. This included Norwest Station.

Norwest Station will be underground and located at the intersection of Norwest Boulevard and Brookhollow Avenue to service local residents and the Norwest Business Park. The station will comprise a street-edge pavilion that will be integrated into the scale and built form of the surrounding business park development. Access to Norwest Station will be via this pavilion. It will require people from the business park to cross Norwest Boulevard via a new pedestrian crossing. An overview of the approved station location and features is shown in Figure 1.1.



Source: Sydney Metro Northwest website (http://nwrail.transport.nsw.gov.au/The-Project/Stations/Norwest#2) (TfNSW, extracted February 2015)

Figure 1.1 Norwest Station approved layout and access features

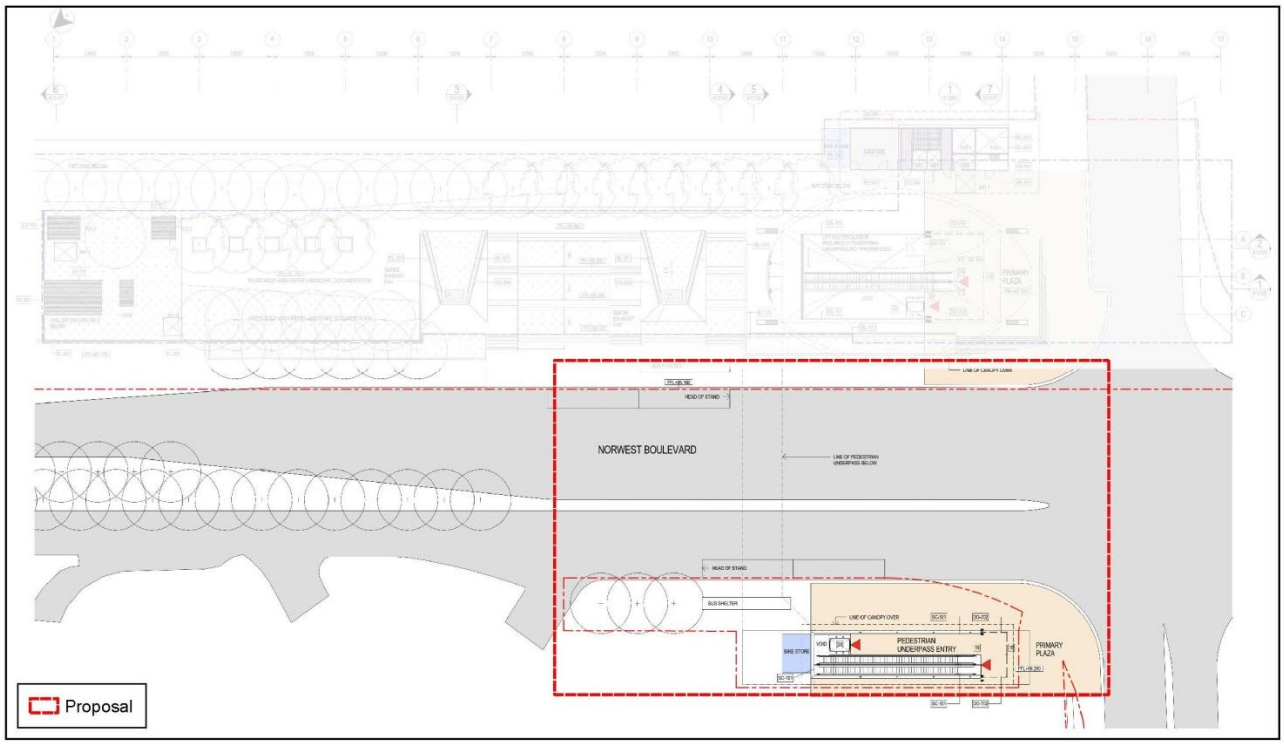
Transport access features and facilities associated with Norwest Station are described in Section 8.4.2 of the *NWRL Environmental Assessment No. 2 Technical Paper: Operational Traffic and Transport Management* (TfNSW, 2012), which states that the approved station would provide the following transport facilities for commuters to cater for forecast demand:

- Nine kiss-and-ride spaces in Brookhollow Avenue.
- 30 bicycle parking spaces.
- Nine taxi spaces in Brookhollow Avenue.
- Two bus bays eastbound and two bus bays westbound on Norwest Boulevard.

Since being granted approval to construct Norwest Station, the NSW Government has published its anticipated projections for job and population growth across the metropolitan region (A Plan for Growing Sydney, 2014). Locally, it is anticipated that there will be about 15,000 jobs created by 2031. Having reviewed these projections TfNSW has concluded that the approved access arrangements would substantially benefit from providing an additional underground pedestrian link and second station entry ('the proposal') located on the northern side of Norwest Boulevard. TfNSW believe the proposal would:

- Reduce pedestrian travel times.
- Improve amenity and safety for rail and non-rail customers.
- Improve interchange between rail and bus services.
- Support urban renewal and anticipated future job growth.

Access to and from the proposed subsurface pedestrian link is located on Norwest Boulevard, north-east of the Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection, as illustrated in Figure 1.2.



Source: Norwest Station – Potential Grade Separated Pedestrian Crossing: Customer Analysis and Options Assessment (TfNSW, January 2014)

Figure 1.2 Indicative location of subsurface pedestrian link and access point

The proposal would allow pedestrians travelling to and from Norwest Station to avoid the need to cross Norwest Boulevard to cross at the surface. This underground connection was 'safeguarded' in the original design, however it was never approved nor its design developed.

The proposal would occupy about 400 m^2 aboveground and about 850 m^2 belowground. Its main features would include:

- A canopy-covered northern entry.
- An 11.5 metre deep vertical entrance shaft fitted with escalators and an elevator.
- A pedestrian tunnel extending from Norwest Station under Norwest Boulevard.

1.2 Construction working hours

The proposed works would generally be undertaken during the standard NSW Environment Protection Authority (EPA) construction hours, which are as follows:

- 7.00 am to 6.00 pm Monday to Friday.
- 8.00 am to 1.00 pm Saturdays.
- No work on Sundays or public holidays.

All surface traffic movements or work to support underground work (i.e. waste and spoil removal) would only take place during the recommended standard hours for construction.

1.3 Purpose of the report

The main purpose of this report is to:

- Identify and assess the key traffic and transport impacts and benefits of the construction and operation of the proposed subsurface pedestrian link.
- Recommend mitigation measures and strategies to ameliorate potential traffic and transport impacts.

1.4 Structure of this report

This report has the following structure:

- Section 2 describes existing conditions.
- Section 3 provides an assessment of construction impacts.
- Section 4 provides an assessment of operational impacts.
- Section 5 discusses impact mitigation measures and strategies.

2. Existing conditions

2.1 Road network

2.1.1 Overview

Norwest is well-connected with direct access to the M7 Motorway and other major arterial and regional roads including Windsor Road and Old Windsor Road, both of which run perpendicular to Norwest Boulevard.

Norwest Boulevard is currently the only main arterial to, from, and through the area. Norwest Business Park creates high volumes of commuter traffic on Norwest Boulevard and the wider road network during the morning and afternoon peak periods, which coincides with the times when station patronage and resultant pedestrian activity will be at its highest. Roads and Maritime Services (RMS) has identified the upgrade of Norwest Boulevard from its current four lane configuration to a six lane configuration in the future. The proposal is located on Norwest Boulevard, north east of the Norwest Boulevard/Brookhollow Avenue/ Century Circuit intersection. A summary of the key features of these roads is provided in Table 2.1.

Table 2.1 Details of roads adjacent to the proposal

Road	Details
Norwest Boulevard	■ Main arterial road providing east-west access between the Norwest Precinct and the M7 Motorway. ■ A 70 kilometre per hour (km/h) divided four lane arterial road that includes a wide landscaped central median. ■ It is used by about 26,000 vehicles each day of which about 5 percent are heavy vehicles (trucks and buses). ■ The only arterial road providing access into the Norwest Precinct. ■ The road is characterised by high commuter flows during the morning and evening peak periods. ■ There is no on-street parking or stopping allowed.
Brookhollow Avenue	■ A local loop road providing access to the southern part of the Norwest Precinct. ■ A 50 km/h undivided two lane road with no central median. ■ It is used by about 3,000 vehicles each day. ■ The road is characterised by low traffic flows throughout the day and the provision of speed controls at points along the road in the form of a landscaped median and chicanes ■ Parking and stopping is allowed on both sides of the road.
Century Circuit	■ A local loop road providing access to the Norwest Marketown shopping centre, the Hillsong Church, and health and recreational facilities and commercial properties principally surrounding the Norwest Lake. ■ A 50 km/h two lane road with no central median, with the exception of the exit from Norwest Boulevard up to a second roundabout about 70 metres to the north. ■ It is used by about 3,000 to 10,000 vehicles each day (the range accounting for a typical day and a busy event/shopping day). ■ The road is characterised by moderate traffic flows throughout the day, representing both commuters and users of the shopping centre. ■ There is no on-street parking or stopping allowed however the road is the primary access point to off-street parking provided by these developments.

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012)

2.1.2 Key intersections

In the proposal area the Norwest Boulevard corridor is controlled by signalised intersections at its western end (Old Windsor Road) and eastern end (Windsor Road). Roundabouts are generally employed at major intersections along the corridor. The details of key intersections are provided in Table 2.2.

Table 2.2 Intersection details on Norwest Boulevard

Intersection	Control method	Details
Norwest Boulevard/ Columbia Circuit/ Brookhollow Avenue (East)	Roundabout (Two-lanes)	▪ Norwest Boulevard: ▸ two lanes on each approach ▪ Columbia Circuit has: ▸ a single lane approach ▪ Brookhollow Avenue: ▸ two lanes marked for a short distance on approach.
Norwest Boulevard/ Solent Circuit (East)	Priority (T-junction)	▪ Norwest Boulevard: ▸ through movements have priority ▸ right turn bay provided for traffic turning from Norwest Boulevard into Solent Circuit ▸ right turns not permitted out of Solent Circuit.
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	Roundabout (Two-lanes) Commitment to be signalised under the Sydney Metro Northwest	▪ Norwest Boulevard: ▸ two lanes on each approach marked as a shared left/through and shared through/right ▪ Century Circuit: ▸ two lane approach with an exclusive right turn lane and a shared left/through/right lane ▪ Brookhollow Avenue: ▸ single lane approach.
Norwest Boulevard/ Reston Grange/ Solent Circuit (West)	Roundabout (Two-lanes)	▪ Norwest Boulevard: ▸ two lanes on each approach marked as a shared left/through and shared through/right ▪ Solent Circuit: ▸ two lane approach with an exclusive right turn lane and a shared left/through lane ▪ Reston Grange: ▸ dual lane approach.
Norwest Boulevard/ Old Windsor Road	Signalised (Grade-separated)	▪ Old Windsor Road: ▸ two lanes in each direction passing under the intersection. ▸ traffic signals provided for the turning movements from Old Windsor Road and Norwest Boulevard ▸ off-ramps provide two right turn lanes and two left turn lanes for each of the approaches ▪ Norwest Boulevard: ▸ eastern approach provides a left turn slip lane, two through lanes and a right turn lane ▸ western approach provides a left turn slip lane, two through lanes and two right turn lanes.

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012)

The recent upgrades to the Norwest Boulevard/Windsor Road intersection highlighted in Table 2.2 occurred after the completion of the *Sydney Metro Northwest* (*NWRL) Environmental Assessment* (TfNSW, 2012). Consequently, the analysis it presents is indicative of conditions prior to the upgrade of this intersection. Outputs relating to this intersection and other intersections presented in the *Sydney Metro Northwest (NWRL) Environmental Assessment* (TfNSW, 2012) have been adopted and analysed as a worst-case scenario. The performance of this intersection, and potentially intersection approach roads including Norwest Boulevard, would have been improved by the upgrades based on consistent traffic volumes and patterns.

2.2 Land use

Surrounding land uses in the proposal area are described in Section 8.4.2 of the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012). Surrounding land are generally commercial and industrial developments. On the northern side of Norwest Boulevard is Norwest Business Park, a local shopping centre, Norwest Marketown, which provides a supermarket, cafes, restaurants and other retail shops. The Hillsong Church and its associated facilities are located immediately to the west of the proposed station site.

2.3 Public and active transport

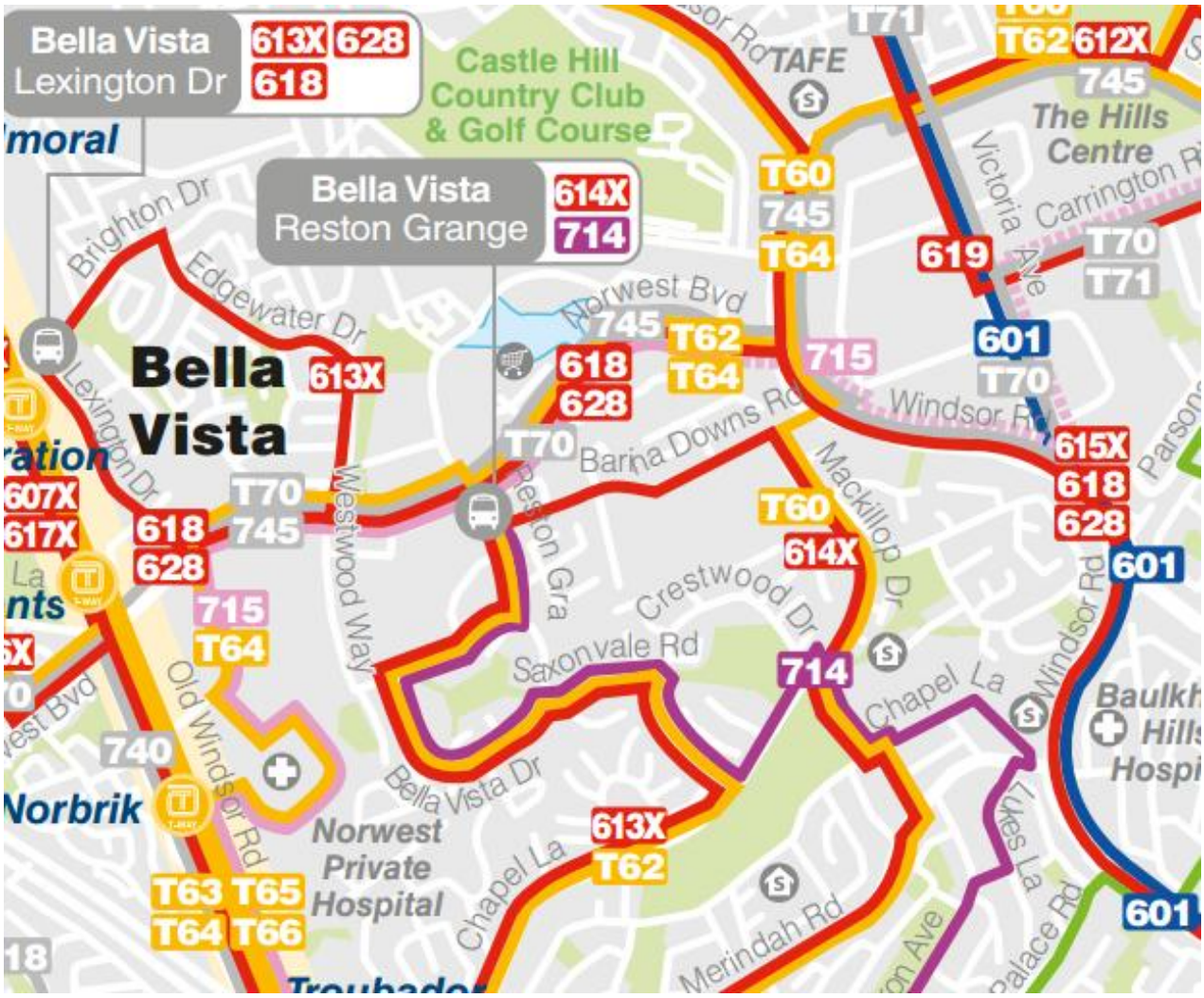
2.3.1 Buses

Existing bus routes in the proposal area are illustrated in Figure 2.1 and described in Section 8.4.2 of the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012). In summary:

- Bus services to Norwest Business Park in the vicinity of the proposal are currently operated along Norwest Boulevard by Hillsbus and Busways.
- Six routes travel along Norwest Boulevard passing the proposal site.
- Two routes terminate on the edge of the Business Park in Reston Grange.
- Numerous additional routes travel along Old Windsor Road and/or Norwest Boulevard west of Old Windsor Road, and along Windsor Road.

Existing bus stops are located on Norwest Boulevard in the proximity of the proposal:

- To the east near the pedestrian underpass toward the Solent Circuit (East) intersection.
- To the west near the intersection with Reston Grange.



Source: Hills District Bus Guide (Hillsbus, January 2015)

Figure 2.1 Existing bus routes

2.3.2 Walking

Existing pedestrian conditions and facilities in the proposal area are described in Section 8.4.2 of the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012). In summary:

- With regards to pedestrian numbers, the Norwest Precinct generates a significant number of pedestrians. They comprise a base flow of people using the amenities in the area and they are supplemented by a weekday spike of workers accessing the business park and other commercial facilities. Peak pedestrian movements occur during the morning and evening peak periods as well as during the weekday lunchtime.
- Footpaths are provided on both sides of Norwest Boulevard, Brookhollow Avenue and Century Circuit in the vicinity of the proposal.
- Two pedestrian underpasses of Norwest Boulevard are provided located approximately 320 m east and around 1 km west of the proposal site.
- No specific pedestrian facilities are provided at the roundabout at Norwest Boulevard/ Brookhollow Avenue/Century Circuit; paved sections with drop kerbs are provided on the islands at the intersection to act as pedestrian refuges.

2.3.3 Cycling

Century Circuit from its intersection with Inglewood Place to Norwest Lake is marked as a cycle route. There is an off road cycle route around the Norwest Lake that links into the Strangers Lake to the north and Fairmont Avenue to the south. There is also a mixed off road and on road cycle route south of Brookhollow Avenue that links into Old Windsor Road, which includes a dedicated shared use path setback from the southbound eastern carriageway facilitating access to and from surrounding areas.

2.4 Intersection performance

LINSIG modelling software was previously used to assess intersection performance in the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012). Key outputs used to assess intersection performance based on 2012 traffic volumes and intersection configurations are summarised in Table 2.3. The results of the modelling undertaken are provided in Table 2.4 and Table 2.5. In summary, the peak period modelling indicated that:

- The Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection adjacent to the proposal site is currently operating at Level of Service (LoS) A with spare traffic capacity.
- Intersections on Norwest Boulevard between Brookhollow Avenue/Century Circuit and Windsor Road were generally operating with spare traffic capacity.
- The Norwest Boulevard/Windsor Road intersection was operating at capacity at the time of the assessment, although intersection capacity has been increased since the assessment was undertaken (refer to Table 2.2 for details of recent upgrades).

With the exception of the Norwest Boulevard/Windsor Road intersection upgrades noted in Section 2.1.2, it is understood that the configuration of Norwest Boulevard has not been meaningfully changed since the completion of the *NWRL Environmental Assessment* (TfNSW, 2012). In addition, the *NWRL Environmental Assessment No. 2 Technical Paper: Operational Traffic and Transport Management* (TfNSW, 2012) found that “Little increase in traffic on Norwest Boulevard” is expected.

Considering the above factors, the assessment of 2012 conditions undertaken for the *NWRL Environmental Assessment* (TfNSW, 2012) has been adopted as it is still believed to provide an accurate representation of current (2015) traffic conditions.

Although it is acknowledged that recent upgrades to the Norwest Boulevard/Windsor Road intersection would have increased capacity and potentially improved its performance, this intersection would not be impacted by heavy vehicles created by construction of the proposal, and would not be impacted during operation of the proposal.

Table 2.3 Key intersection performance statistics

Performance statistic	Description			
Degree of Saturation (DoS)	The proportion of available intersection capacity occupied by traffic: ▪ DoS = 0: No demand; all capacity available. ▪ DoS = 1: All available capacity occupied by traffic.			
Average delay (seconds)	The average delay per vehicle for all vehicles approaching the intersection.			
Level of Service (LoS)	Overall performance indicator based on average delay:			
	LoS	Average delay (seconds)	Traffic signals and roundabouts	Priority control (Give way and stop signs)
	A	<14	Good operation.	Good operation.
	B	15–28	Good with acceptable delays and spare capacity.	Acceptable delays and spare capacity.
	C	29–42	Satisfactory operation.	Satisfactory, but accident study required.
	D	43–56	Operating near capacity.	Near capacity and accident study required.
	E	57–70	At capacity. At signals incidents will cause excessive delays. Roundabouts require other control mode.	At capacity; requires other control mode.
	F	>71	Unsatisfactory with excessive queuing.	Unsatisfactory with excessive queuing; requires other control mode.
Queue length (95th percentile, m)	Length of vehicle queues on approach to the intersection. The 95th percentile queue length indicates the maximum length which 95% of all queues occurring will be contained within.			

Source: Parsons Brinckerhoff, based on *Guide to Traffic Generating Developments* (Roads and Traffic Authority, 2002)

Table 2.4 Key intersection performance (AM peak hour, 2012)

Intersection	Traffic volume (AM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Norwest Boulevard/ Columbia Circuit/ Brookhollow Avenue (East)(1)	3,545	0.78	6.2	A	85	Norwest Boulevard (E)
Norwest Boulevard/ Solent Circuit (East)	2,670	0.43	1.7	A	5	Norwest Boulevard (E)
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,050	0.71	6.6	A	10	Norwest Boulevard (E)

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012)

(1) Results for Norwest Boulevard/Columbia Circuit/Brookhollow Avenue (East) intersection provided in the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012) appear to be incorrect. Results for this intersection have been produced using SIDRA models provided by TfNSW and re-processed by Parsons Brinckerhoff using SIDRA 6.0 software.

Table 2.5 Key intersection performance (PM peak hour, 2012)

Intersection	Traffic volume (PM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Norwest Boulevard/ Columbia Circuit/ Brookhollow Avenue (East)(1)	3,825	0.93	16.0	B	140	Norwest Boulevard (W)
Norwest Boulevard/ Solent Circuit (East)	2,420	0.50	8.1	A	5	Norwest Boulevard (W)
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,020	0.60	8.9	A	5	Norwest Boulevard (W)

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012)

(1) Results for Norwest Boulevard/Columbia Circuit/Brookhollow Avenue (East) intersection provided in the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012) appear to be incorrect. Results for this intersection have been produced using SIDRA models provided by TfNSW and re-processed by Parsons Brinckerhoff using SIDRA 6.0 software.

2.5 Crash analysis

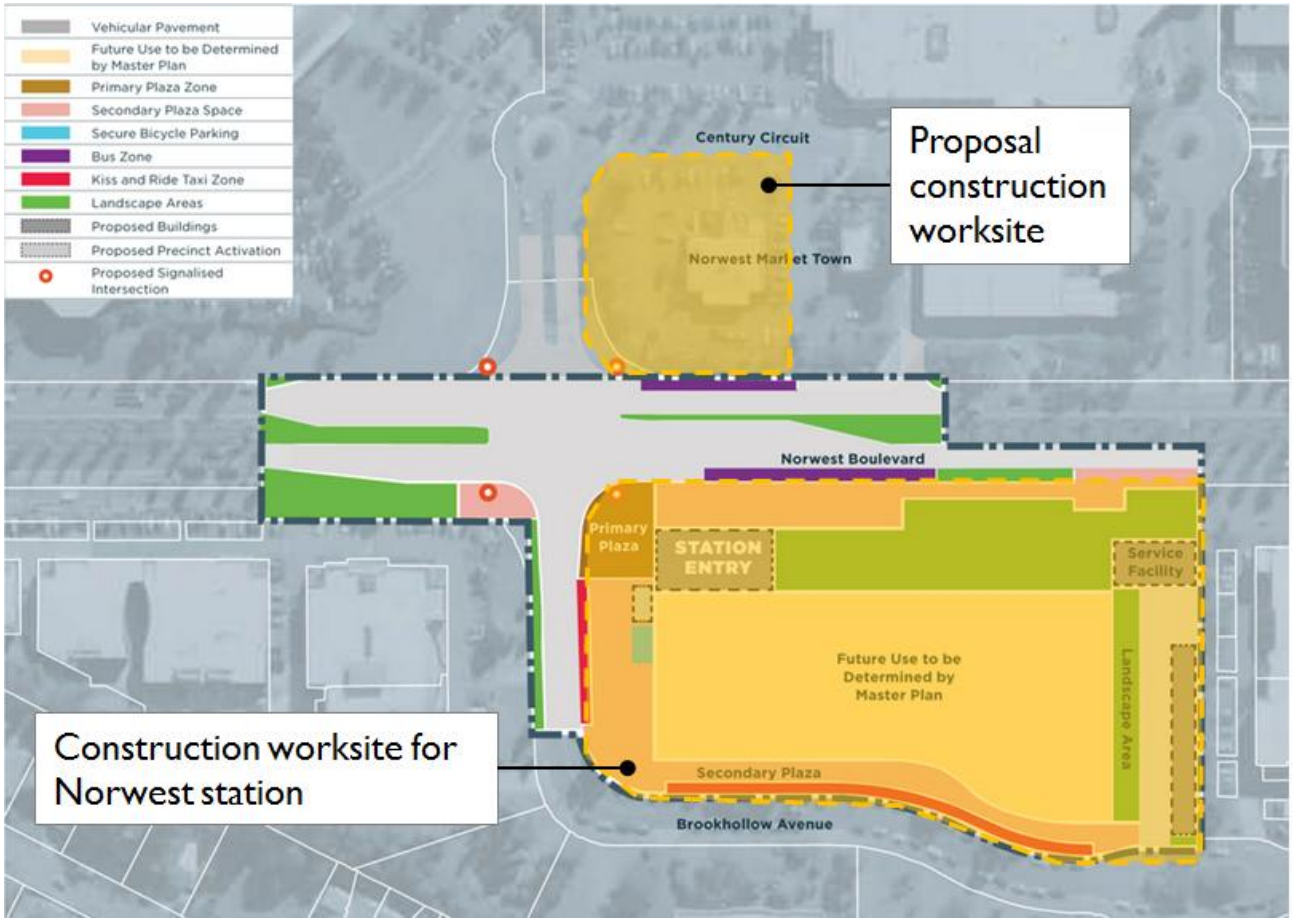
An analysis of crashes which occurred within a 400m radius of Norwest Station is provided in Section 8.4.2 of the N*WRL Environmental Assessment No. 2 Technical Paper: Operational Traffic and Transport Management* (TfNSW, 2012). In summary, between January 2006 and December 2010:

- There were a total of 29 crashes, with 15 occurring on Norwest Boulevard.
- Nine crashes occurred at the Norwest Boulevard/Century Circuit/Brookhollow Avenue intersection. The majority (six) of these crashes were rear-end crashes.
- Three crashes occurred on Century Circuit, including one involving a pedestrian and two crashes related to driveway incidents.

3. Construction impact assessment

3.1 Construction worksite location

The proposal would create a second construction worksite to the north of the main worksite for Norwest Station. The proposal construction worksite would be located to the north of Norwest Boulevard and to the east of Century Circuit, as illustrated in Figure 3.1.



Source: (Adapted from) *Sydney Metro Northwest* website (http://nwrail.transport.nsw.gov.au/The-Project/Stations/Norwest#2) (TfNSW, extracted February 2015)

Figure 3.1 Construction worksite locations

3.2 Traffic management

3.2.1 Traffic management measures

Traffic management measures would be developed during the detailed design to manage construction work. They would be implemented under a construction traffic management plan (CTMP) (as described in Section 6.2 of the main REF document). The CTMP would detail traffic management controls required to maintain and control traffic and pedestrian safety and access.

The proposal would take place within the context of the traffic management controls that have been developed under the Norwest Station. Temporary signage and traffic management controls would be implemented around the proposal footprint to supplement the controls put in place to service the Norwest Station's construction. These signs would describe the changes in traffic and pedestrian conditions, highlight any expected delays and identify any diversion routes. The traffic management controls would likely include temporary traffic lights and stop-go controls.

In constructing the proposal, the following activities would take place that have associated traffic management implications:

- Site establishment.
- Car parking reallocation.
- Service relocations.
- Installation of erosion and sediment controls.
- Temporary road pavement and access construction.
- Pedestrian diversions.
- Vegetation clearing, grubbing and planting.
- Material and equipment delivery (including low loaders and oversize vehicles).
- Shaft and tunnel construction.
- Spoil haulage (associated with shaft and tunnel construction).
- Street furniture, fabrications and fittings.
- Post work treatments and reinstatement.
- Footpath and pavement reinstatement.

3.2.2 Traffic management impacts

Access to the proposal worksite may be signal controlled, either part time or full time. This would result in short-term delays for general road traffic. Very occasionally there may be the need to close Century Circuit adjacent to the worksite for short periods to take receipt of the major infrastructure components that would be delivered on oversize vehicles and low loaders. This equipment would be escorted to site. Road closures would take place outside of peak periods and would only affect the local roads for a few hours or less during each delivery.

Business, community and residential traffic access would be maintained during road closures, with traffic diverted to alternative routes. During any time that Century Circuit would be closed, alternative access to surrounding developments would be provided by the second point of access to Century Circuit from Norwest Boulevard east of the Norwest Boulevard/Century Circuit/Brookhollow Avenue intersection, or via Solent Circuit. The maximum residual impact of any diversions would be an increased travel distance of around 1 km, or around 2 minutes.

Emergency vehicle access would also be maintained at all times, with a management provision included to allow for this during a major delivery.

Impacts to public and active transport modes would be similar to those anticipated by the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012). These impacts are summarised in Table 3.1, in addition to further impacts as a result of the construction of the proposal.

Table 3.1 Construction impacts to public and active transport

Feature	Construction impacts
Bus operations	■ Identified features/impacts of construction of Norwest Station: ▸ Access to and from the westbound bus stop in Norwest Boulevard east of Century Circuit would be maintained. Provision for buses to pull up safely at will be investigated as part of the Construction Traffic Management and Control Plans for the site. ▸ Eastbound bus bay and stop can be retained. ▸ Assumed that the RMS proposal to widen and install bus lanes will occur after Sydney Metro Northwest is operational. ■ Additional impacts resulting from construction of the proposal: ▸ None, assuming proposed eastbound bus bay on Norwest Boulevard is constructed after construction of the proposal is complete.
Pedestrian and cyclist movements	■ Identified features/impacts of construction of Norwest Station: ▸ Access to the indented westbound bus stop in Norwest Boulevard will be maintained to and from the east. ▸ Southern footpath along the frontage to the construction site will be closed. ▸ A pedestrian underpass under Norwest Boulevard is provided to the east of the site. Barricades may need to be erected as part of the site works to direct pedestrians to use this underpass to access the northern and southern pathway. ▸ The western and southern footpath along the Brookhollow Avenue frontage of the construction site will be closed throughout the duration of construction. ▸ Pedestrian access will be possible via the footpath on the other side of Brookhollow Avenue with the exception of that section of the western footpath between the intersection with Norwest Boulevard and a point about 50 metres back along Brookhollow Avenue which will be closed for some period during station box excavation works, albeit primarily as part of the EIS 1 works. ■ Additional impacts resulting from construction of the proposal: ▸ Northern footpath along Norwest Boulevard may be realigned or access denied during construction. ▸ Eastern footpath along Century Circuit may be realigned or access denied during construction. ▸ In the event of footpath closure, pedestrians would be diverted via signposting to alternative routes, resulting in increased travel times and distances. ▸ Where required, temporary sign and/or signal control would operate across access and egress points to the proposal footprint, resulting in minor delays.

Feature	Construction impacts
Parking	■ Identified features/impacts of construction of Norwest Station: ▸ It will be necessary to displace kerbside parking along one side of Brookhollow Avenue during the Norwest Station site works. ▸ There will be no on-street restrictions along Norwest Boulevard as a result of construction activities; on-street parking is not permitted along Norwest Boulevard. ▸ Off-street parking would be lost within the commercial land uses to be acquired by the project on the northern side of Norwest Boulevard. ■ Additional impacts resulting from construction of the proposal: ▸ Although the loss of on-street and off street parking was identified as an impact of the construction of Norwest Station, in a worst-case scenario it is assumed that this loss of parking would be created by the construction of the proposal only. Consequently, the proposal would result in the temporary loss of: – Kerbside parking along one side of Brookhollow Avenue for around 150 m (estimated as up to approximately 30 car parking spaces). – Off-street parking within the commercial land uses to be acquired by the project on the northern side of Norwest Boulevard (estimated as up to approximately 60 car parking spaces)

Source: (Adapted from) NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012)

3.3 Construction traffic

3.3.1 Construction traffic generation

During the eight month construction program there would be a requirement for trucks and heavy vehicles to access and leave the proposal footprint. The proposal worksite would be accessed via Century Circuit. The identified temporary traffic management controls would be implemented to allow vehicles to safely access the site.

This proposal would be serviced by the Sydney Metro Northwest workforce. During peak construction, there would be expected to be about 20 people working onsite. Consistent with the construction of Norwest Station, workers would be expected to use public transport or travel by car. Parking would be provided in the main site construction compound/laydown area. Construction workers for the proposal would park in the main construction car park and walk to the proposal worksite.

There would be regular construction material deliveries and the removal of waste and excavated materials from the site. On average 8 trucks and 15 concrete pourers would arrive and leave the site at regular intervals across the day to facilitate these activities. In total only around about 10 to 15 trips would be needed to deliver large items of equipment, occurring at regular intervals throughout the 8 month construction program. When delivering the main escalator and lift equipment there could be a period of a few consecutive days where one-or-two oversize vehicles would arrive at site each day.

Materials and equipment would be transferred to the construction compound/laydown area by road. Materials and equipment required to construct the proposal would be sourced from the metropolitan area. Heavy delivery vehicles would likely arrive and leave via the M7 motorway and Norwest Boulevard from the west of the proposal.

Generated waste would be transferred ‘offsite’ using licenced contractors. The location to where the waste would be transferred for reuse, reprocessing or disposal would depend on its nature, type and classification (refer to Section 3.6.2 of the main REF document). Waste would be hauled from the construction compound along Norwest Boulevard west to the M7 Motorway and on to an intermediary or end-use location. The final destinations of any waste generated would be determined and confirmed during the detailed design.

Details and assumptions relating to construction traffic generation are provided in Table 3.2. A summary of construction traffic generation during an average weekday is provided in Table 3.3. Assumptions relating to the distribution of this traffic are summarised in Table 3.4.

Table 3.2 Construction traffic generation details and assumptions (Average weekday)

	Norwest Station (Approved project traffic generation)	Proposal (Additional traffic generation)
Light vehicle movements – workforce commuting		
Employees	20	0
Vehicle occupancy (employees/vehicle)	1(1)	-
Movements per vehicle per day	2	0
Total light vehicle movements per day	40	0
Peak hour movements (% total)	25%(1)	-
Peak hour movements (Vehicles/hr)	10	0
Light vehicle movements – construction-related movements		
Total vehicle movements per day	180(1)	0
Peak hour movements (% total)	9%	-
Peak hour movements (Vehicles/hr)	16	0
Off-peak movements (% total, per hour)	9%	-
Off-peak movements (Vehicles/hr)	17	0
Heavy vehicle movements (Material /equipment deliveries & waste and spoil removal)		
Total heavy vehicles per week	150(1)	115
Construction days/week	5	5
Total heavy vehicles per day	30	23
Movements per vehicle per day	2	2
Total heavy vehicle movements per day	60	46
Peak hour movements (% total)	9%	9%
Peak hour movements (Vehicles/hr)	5	4
Off-peak movements (% total, per hour)	10%	10%
Off-peak movements (Vehicles/hr)	6	5

(1) Assumptions provided in NWRL – TSC Works Construction Traffic Management Plan (Thiess, June 2014)

Table 3.3 Construction traffic generation summary (Average weekday)

Hour beginning	<6.00 am	6.00 am	7.00 am	8.00 am–3.00 pm	4.00 pm	5.00 pm	6.00 pm	7.00 pm<	Total
Light vehicle movements									
Workforce commuting	0	10	10	0	5	10	5	0	40
Construction-related movements	0	0	16	131	17	16	0	0	180
Total	**0**	**10**	**26**	**131**	**22**	**26**	**5**	**0**	**220**
Heavy vehicle movements									
Norwest Station construction	0	0	5	40	5	5	0	0	55
Proposal construction	0	0	4	34	4	4	0	0	46
Total	**0**	**0**	**9**	**74**	**9**	**9**	**0**	**0**	**101**

Table 3.4 Construction traffic distribution summary (Peak hour)

Movement type	Origin-destination	Inbound/outbound	Routing
Light vehicle movements			
Workforce commuting	▪ Norwest Station worksite	▪ AM peak: 100% inbound ▪ PM peak: 100% outbound	▪ Norwest Boulevard W: 50% ▪ Norwest Boulevard E: 50%
Construction-related movements	▪ Norwest Station worksite: 50% ▪ Proposal worksite: 50%	▪ 50% inbound/50% outbound	▪ Norwest Boulevard W: 50% ▪ Norwest Boulevard E: 50%
Heavy vehicle movements			
Norwest Station construction	▪ Norwest Station worksite	▪ 50% inbound/50% outbound	▪ Norwest Boulevard W(1)
Proposal construction	▪ Proposal worksite	▪ 50% inbound/50% outbound	▪ Norwest Boulevard W(1)

(1) Assumptions provided in *Sydney Metro Northwest (NWRL)* – TSC Works Construction Traffic Management Plan (Thiess, June 2014)

3.3.2 Intersection performance impacts

Traffic generated by the simultaneous construction of Norwest Station and the proposal would impact the operation of intersections on Norwest Boulevard in the proposal area. An assessment of the anticipated impacts to performance as a result of the construction of Norwest Station (only) was undertaken in the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012). Anticipated intersection performance is presented in Table 3.5 and Table 3.6. In summary, when compared to pre-construction conditions (summarised in Table 2.4 and Table 2.5):

- No meaningful increase to intersection delay or LoS as a result of construction traffic was expected.
- Intersections on Norwest Boulevard between Brookhollow Avenue/Century Circuit and Windsor Road were expected to continue to operate with spare capacity and minimal traffic delays.

- The Norwest Boulevard/Windsor Road intersection was expected to continue to operate at capacity at the time of the assessment, although intersection capacity has been increased since the assessment was undertaken (refer to Table 2.2 for details of recent upgrades).

Table 3.5 Key intersection performance (AM peak hour, Norwest Station construction)

Intersection	Traffic volume (AM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Norwest Boulevard/ Columbia Circuit/ Brookhollow Avenue (East) (1)	3,555	0.78	6.2	A	90	Norwest Boulevard (E)
Norwest Boulevard/ Solent Circuit (East)	2,705	0.44	1.7	A	5	Norwest Boulevard (E)
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,125	0.72	7.6	A	10	Norwest Boulevard (E)

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012)

(1) Results for Norwest Boulevard/Columbia Circuit/Brookhollow Avenue (East) intersection provided in the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012) appear to be incorrect. Results for this intersection have been produced using SIDRA models provided by TfNSW and re-processed by Parsons Brinckerhoff using SIDRA 6.0 software.

Table 3.6 Key intersection performance (PM peak hour, Norwest Station construction)

Intersection	Traffic volume (PM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Norwest Boulevard/ Columbia Circuit/ Brookhollow Avenue (East) (1)	3,840	0.94	16.9	B	150	Norwest Boulevard (W)
Norwest Boulevard/ Solent Circuit (East)	2,460	0.42	6.0	A	5	Solent Circuit (N)
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,095	0.61	9.5	A	5	Brookhollow Avenue (S)

Source: NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management (TfNSW, 2012)

(1) Results for Norwest Boulevard/Columbia Circuit/Brookhollow Avenue (East) intersection provided in the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012) appear to be incorrect. Results for this intersection have been produced using SIDRA models provided by TfNSW and re-processed by Parsons Brinckerhoff using SIDRA 6.0 software.

The proposal would generate additional heavy vehicle traffic on Norwest Boulevard at and west of the intersection with Brookhollow Avenue/Century Circuit when compared to the construction of Norwest Station (only). As the point of access for heavy vehicles entering and leaving the proposal construction worksite, this intersection would be most heavily impacted by this additional traffic.

SIDRA (V6.0) intersection modelling has been undertaken to assess the performance impacts on the Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection as a result of simultaneous construction of Norwest Station and the proposal.

The modelling undertaken has assumed traffic growth of approximately 2% per annum on all approaches from the date the survey data was collected (December 2011) to estimate worst-case background traffic volumes at the time of construction (2015). It is noted that the *NWRL Environmental Assessment No. 2 Technical Paper: Operational Traffic and Transport Management* found that 'Little increase in traffic on Norwest Boulevard' is expected. Consequently, the application of 2% per annum growth rates is believed to be a reasonable worst-case assumption. Anticipated traffic volumes generated by construction of both Norwest Station and the proposal have been added to forecast 2015 background traffic volumes to demonstrate the impact of construction traffic on intersection performance. The results, summarised in Table 3.7 and Table 3.8[1], illustrate that:

- Combined traffic generated by the construction of both Norwest Station and the proposal would increase volumes at the intersection by around 35–40 vehicles per hour (around 1%) during peak periods.
- This increase in traffic would have no meaningful impact on intersection operations or performance.

Table 3.7 Key intersection performance (AM peak hour, 2015)

Intersection	Traffic volume (AM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Existing conditions (No construction)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,535	0.71	9.0	A	60	Norwest Boulevard (W)
Construction conditions (Including Norwest Station and proposal construction traffic)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,575	0.73	10.4	A	65	Norwest Boulevard (W)

Source: Parsons Brinckerhoff, using SIDRA models provided by TfNSW

Table 3.8 Key intersection performance (PM peak hour, 2015)

Intersection	Traffic volume (PM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Existing conditions (No construction)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,580	0.67	7.4	A	50	Norwest Boulevard (W)
Construction conditions (Including Norwest Station and proposal construction traffic)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,615	0.68	8.5	A	50	Norwest Boulevard (W)

Source: Parsons Brinckerhoff, using SIDRA models provided by TfNSW

[1] Table 3.7 and Table 3.8 present average performance for all approaches to provide a consistent approach with other tables within this report. Intersection performance at priority-controlled intersections is generally defined by the worst-performing approach. For the results presented in Table 3.7 and Table 3.8, this is LoS B or better for all scenarios, with a maximum individual approach delay of 16 seconds.

4. Operational impact assessment

4.1 Future conditions

Norwest Station is currently under construction. Once operational this would result in the following changes to the existing environment:

- A marked increase in the number of pedestrians in the area.
- The removal of the Norwest Boulevard and Brookhollow Avenue/Century Circuit roundabout and its conversion to a signalised intersection.

4.2 Intersection performance benefits

An assessment of future intersection performance during the operation of Norwest Station was undertaken in the *Sydney Metro Northwest* (*NWRL) Operational Precinct Traffic Analysis* (TfNSW, 2013). A summary of this analysis is presented in Table 4.1 and Table 4.2, which indicates that in 2026 during both AM and PM peak periods the signalised intersection was anticipated to operate at LoS C.

Table 4.1 Key intersection performance (AM peak hour, 2026 – With Norwest Station)

Intersection	Traffic volume (AM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,710	0.88	33.2	C	245	Norwest Boulevard (W)

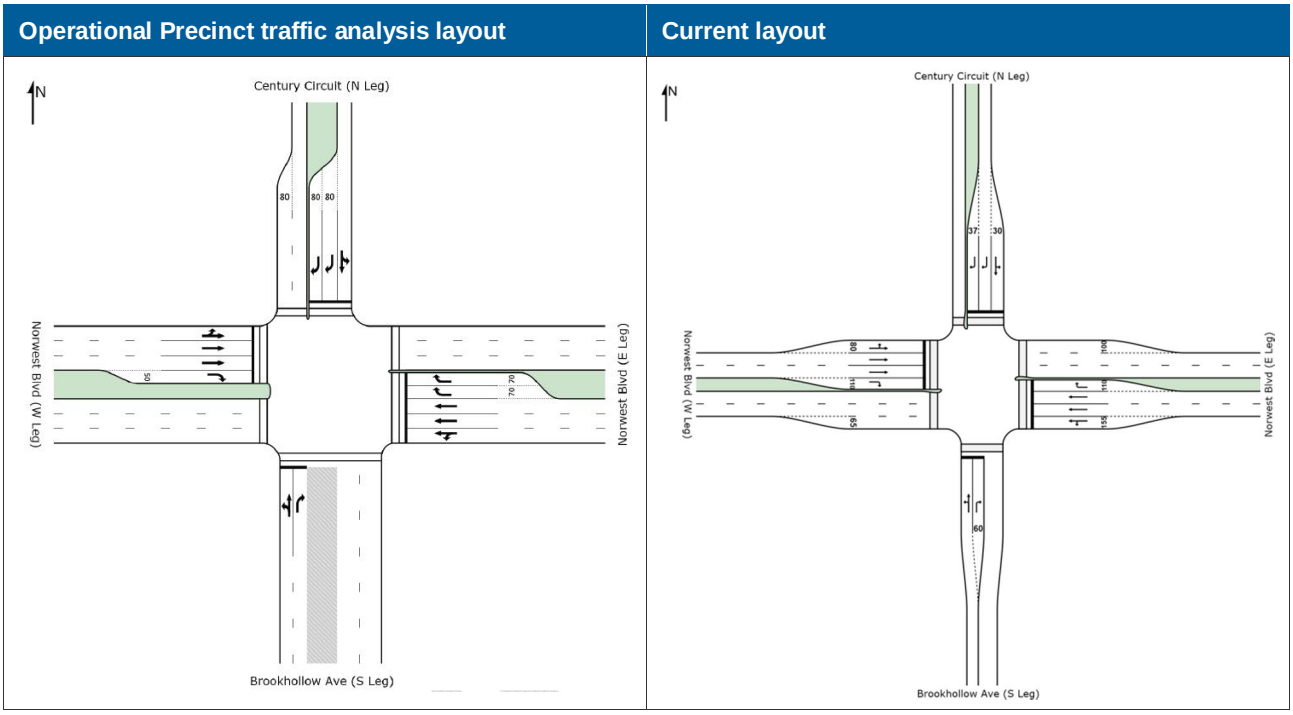
Source: NWRL Operational Precinct Traffic Analysis (TfNSW, 2013)

Table 4.2 Key intersection performance (PM peak hour, 2026 – With Norwest Station)

Intersection	Traffic volume (PM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,255	0.93	39.5	C	335	Norwest Boulevard (W)

Source: NWRL Operational Precinct Traffic Analysis (TfNSW, 2013)

It is noted that the proposed layout of the intersection has been adjusted since the completion of the *NWRL Operational Precinct Traffic Analysis* (TfNSW, 2013). The differences between the previous and currently proposed layout are illustrated in Figure 4.1.



Source: Parsons Brinckerhoff, based on SIDRA models provided by TfNSW

Figure 4.1 Norwest Boulevard/Brookhollow Avenue/Century Circuit intersection layouts

Updated SIDRA intersection modelling based on the currently proposed intersection layout and latest demand forecasts has been undertaken to assess the performance of the Norwest Boulevard/ Brookhollow Avenue/Century Circuit intersection both with and without the proposal. The results summarised in Table 4.3 and Table 4.4 indicate that:

- The currently proposed intersection layout would operate at LoS D or better during AM and PM peak periods.
- Future intersection performance, assuming the same intersection configuration and signal operations both with and without the proposal, would be similar in terms of LoS and delay.

Table 4.3 Key intersection performance (AM peak hour, 2026)

Intersection	Traffic volume (AM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Future conditions (With Norwest Station – excluding the proposal)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,905	0.94	46.7	D	340	Norwest Boulevard (W)
Future conditions (With Norwest Station – including the proposal)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,905	0.94	47.0	D	340	Norwest Boulevard (W)

Source: Parsons Brinckerhoff, using SIDRA models provided by TfNSW

Table 4.4 Key intersection performance (PM peak hour, 2026)

Intersection	Traffic volume (PM peak hour, All vehicles)	Degree of Saturation (DoS, Most saturated movement)	Average delay (seconds)	Level of Service (LoS)	95% back of queue	
					Queue length (m)	Approach
Future conditions (With Norwest Station – excluding the proposal)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,430	0.97	55.0	D	410	Norwest Boulevard (W)
Future conditions (With Norwest Station – including the proposal)						
Norwest Boulevard/ Brookhollow Avenue (West)/ Century Circuit	3,430	0.97	55.0	D	410	Norwest Boulevard (W)

Source: Parsons Brinckerhoff, using SIDRA models provided by TfNSW

The SIDRA modelling results indicate that the introduction of traffic signals would result in the intersection operating at LoS D during peak periods. Future conditions both with and without the proposal would result in the average delay and degree of saturation remaining approximately constant. This is due to the reduction in pedestrian demand having no effect on signal phases or phase times within the SIDRA modelling undertaken, which assumes that at least one north-south pedestrian movement of Norwest Boulevard would be called and accommodated during every cycle.

Under the proposal the pedestrian crossings that would be constructed part of the approved design for the Norwest Station would be retained as:

- There would be other non-rail user pedestrians that would have a need to cross Norwest Boulevard at the surface.
- About 25 percent of the rail users would prefer to cross at the surface, for instance late at night.
- There would be the need to provide the ability to safely cross Norwest Boulevard at the surface if the pedestrian link or northern entry was closed for maintenance or any other reason.

When retaining the north-south pedestrian crossings of Norwest Boulevard, the phase time which these pedestrian movements are included within are constrained by the time required to enable a pedestrian to cross seven traffic lanes. Based on the currently proposed configuration and operation, this requires a minimum total phase time of around 30 seconds. However, the following changes to the utilisation of the north-south pedestrian crossings of Norwest Boulevard would reduce the impact of this current constraint, and consequently improve overall intersection performance during both peak periods:

- Reduced demand and utilisation of the north-south pedestrian crossings, a likely benefit of the proposal, could reduce the average delay to traffic which they create. If the north-south pedestrian crossings were not called every cycle, this would reduce the average phase time required to accommodate the pedestrian movement from 30 seconds over a number of cycles.
- Reduced pedestrian demand on the north-south pedestrian crossings during each phase would also decrease the conflict between pedestrian movements and vehicle movements where they occur during the same phase. This could effectively reduce the opposition to left turning traffic movements, improving effective intersection traffic capacity and performance.

The results presented in Table 4.4 indicate that the signalised intersection would be operating at an overall LoS D during PM peak periods in 2026, with an average delay of around 55 seconds. As shown in Table 2.3 (Section 2.4), intersection performance would drop to an unacceptable LoS E if average delay exceeded 56 seconds.

Lower than anticipated pedestrian demand for the north-south pedestrian crossings would increase effective intersection traffic capacity and improve traffic performance based on forecast 2026 demand. Lower utilisation of the signalised crossings than the assumed 25% of rail users would also potentially delay or negate the need for further traffic capacity upgrades to the intersection should traffic demand continue to grow and resulting performance decline.

4.3 Pedestrian benefits

In addition to increasing effective traffic capacity, the proposal would also benefit pedestrians. The provision of a pedestrian subsurface tunnel would allow pedestrians travelling to and from Norwest Station to avoid the need to cross Norwest Boulevard to cross at the surface. As a result:

- Pedestrians accessing Norwest Station would not be required to wait at traffic signals before crossing Norwest Boulevard, reducing pedestrian delays when compared to conditions without the proposal.
- Most rail users would not cross the road at surface, eliminating movement conflicts and the risk of potential collisions between vehicles and pedestrians.

5. Mitigation measures and strategies

The construction traffic management approach would be consistent with the overarching approach for the NWRL, which is described in Section 3 of the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012). Key features of this approach are summarised in the following sections.

5.1 Contractors responsibilities

The respective contractors for each of the packages of work would be responsible for the management of traffic around each of the construction sites and would be required to manage the construction traffic impacts through the development of traffic management and traffic control plans. The framework of procedures and techniques identified would be applied across all stages of construction with the following objectives:

- Adopt appropriate measures to protect pedestrians and cyclists and to maintain public transport networks.
- Manage traffic flows within, and surrounding, each construction site and associated construction materials and spoil haulage routes to minimise potential impacts on the local and regional road network.
- Minimise potential construction impacts on local residents, businesses and the local community while maximising worker and public safety.

The following key traffic management measures would be defined and documented in a Construction Traffic Management Plan (CTMP) and Construction Traffic Control Plan (CTCP):

- Directional signage and line-marking, supplemented by temporary Variable Message Signs (VMS), where possible.
- Public notification of proposed traffic changes.
- Co-ordination with Roads and Maritime Transport Management Centre's (TMC).
- Management of pedestrian and vehicular access to and past construction sites to ensure safe entry and exit procedures.
- Maintenance of access to existing properties and buildings.

5.2 Agency and community liaison

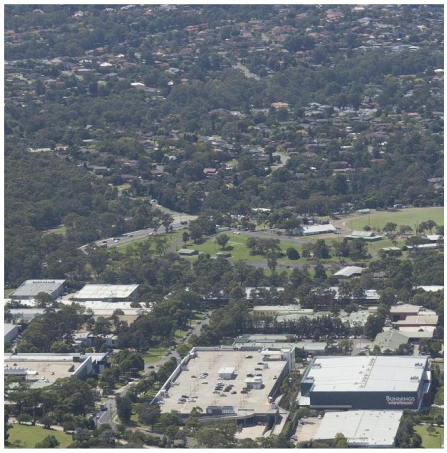
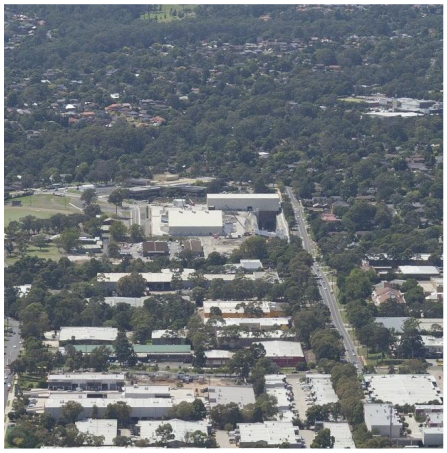
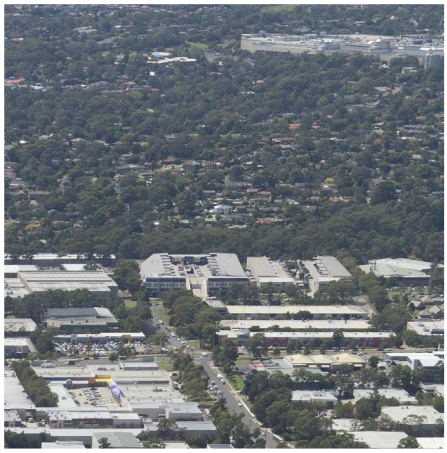
It is critical that the Sydney Metro Northwest construction works are coordinated with other developments and that stakeholders that would be most affected by the project are aware of the scheduling of works and related transport and road network implications. In this regard, the establishment of a Traffic and Transport Liaison Group for each Local Government Authority (LGA) and a strategic level Central Project Coordination Committee would assist in the effective and coordinated delivery of the Sydney Metro Northwest.

Consultation activities would include provision of information relating to traffic and transport changes sufficiently in advance of the changes occurring. The Construction Stakeholder and Community Involvement Plan to be prepared with input from the Central Project Coordination Committee would identify the various communication needs, including the requirement for notification associated with traffic and transport changes, and how they would be implemented.

5.3 General mitigation measures

The following relevant general mitigation measures are detailed in Section 3 of the *NWRL Environmental Assessment No. 2 Technical Paper: Construction Traffic and Transport Management* (TfNSW, 2012) to minimise impacts:

- Truck movements:
  - Minimise impacts on local streets and maximise use of arterial roads.
  - Traffic controllers would be available to manage heavy vehicle movements at construction sites.
  - All trucks would enter and exit construction sites in a forward direction.
- Pedestrians and cyclists:
  - Advance directional signage to direct pedestrians to alternative pedestrian routes.
  - Traffic controllers would be available to monitor and regulate pedestrian movements.
  - Ongoing review of traffic controls during construction period focussing on the appropriate management of traffic, pedestrian and cycle movements.

Appendix C

Norwest Station Subsurface Northern Pedestrian Link Noise and Vibration Impact Assessment

Quality Management

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Draft for Comment	Revised from internal review	Revised following TfNSW Review	
Date	2015-02-17	2015-02-20	2015-04-17	
Prepared by	C Grainger	C Grainger	C Grainger	
Signature				
Checked by	A Campbell	A Campbell	A Campbell	
Signature				
Authorised by	A Campbell	A Campbell	A Campbell	
Signature				
Project number	ACG1501400	ACG1501400	ACG1501400	
Report number				
File reference				

Norwest Station Subsurface Northern Pedestrian Link
Appendix C- Noise and Vibration Impact Assessment

2015-04-17

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1 Introduction

This technical report has been prepared to assess the noise and vibration impacts from constructing and operating the Norwest Station Pedestrian Link. The assessment is based on the proposal as described in Chapter 3 of the REF and the traffic modelling data presented in Appendix B of the REF.

WSP Parsons Brinkerhoff has been appointed to assess the noise and vibration impacts from constructing and operating the Norwest Station Pedestrian Link ('the proposal'). The proposal forms part of the approved Sydney Metro Northwest (formerly North West Rail Link (NWRL)) and has been based on detailed assessments prepared to support the development of an overall Construction Noise and Vibration Management Plan (CNVMP).

2 Noise sensitive receivers

The study area for the noise assessment contains approximately 450 noise sensitive receivers. The study area and surrounding noise sensitive receivers are the same as those that were assessed as part of the construction noise and vibration impact statement undertaken for the main Norwest Station works (*TF602-06.02F03 (rev 9) NW CNIS* dated 4 August 2014). As there is sufficient consistency in the footprint of the Norwest Station and the footprint of this proposal – the same noise sensitive receptors and Noise Catchment Areas (NCAs) are applicable. The receivers are given in Table 1 and Table 2 for this assessment.

The surrounding noise sensitive receptors and NCAs identified as part of the 2014 works are considered appropriate for re-use as has been no significant changes in the study area (such as new residential or commercial developments)

Table 1 – Nearest residential sensitive receivers

NCA	Approximate number of receivers in NCA	ID_	Representative receiver address	Approximate distance to worksite, m
NW-01	90	NW-01_01	4 Peninsula Way, Baulkham Hills	490
		NW-01_02	92 Central Park Ave, Baulkham Hills	360
		NW-01_03	29 Central Park Ave, Baulkham Hills	490
NW-02	85	NW-02_01	2 Ashburn Cl, Bella Vista	635
		NW-02_02	1 Glenview Cl, Bella Vista	625
		NW-02_03	2 Middlebrook Rs, Bella Vista	650
NW-03	170	NW-03_01	38A Ridgehaven Pl, Bella Vista	235
		NW-03_02	54 Ridgehaven Pl, Baulkham Hills	160
		NW-03_03	19-21 Jacqui Cct, Baulkham Hills	140
		NW-03_04	16 Evesham Ct, Baulkham Hills	190
		NW-03_05	32 Fairmont Ave, Baulkham Hills	330
NW-04	100	NW-04_01	7-9 Plover Glen, Baulkham Hills	360

Table 2 – Nearest non-residential sensitive receivers

Land use	ID	Receiver address	Approximate distance to worksite
Place of worship (incl. TV and recording studio)	NWO_01	Hillsong Convention Centre, 1-9 Solent Cct, Baulkham Hills	140
	NWO_02	Hillsong Chapel, 1-9 Solent Cct, Baulkham Hills	205
Education	NWO_03	Hillsong International Leadership College	150
	NWO_04	Parkview Childcare Centre, 4 Century Cct, Baulkham Hills	140
	NWO_05	Norwest Childcare Centre, 2 Maitland Pl, Baulkham Hills	525

Land use	ID	Receiver address	Approximate distance to worksite
Commercial	NWO_06	Shell Service Station, 4 Century Cct, Baulkham Hills	70
	NWO_07	Norwest Market Town Shopping Centre	95
	NWO_08	2 Century Cct, Baulkham Hills	140
	NWO_09	Block A, Capital Business Centre, 38 Norwest Bld, Baulkham Hills	60
	NWO_10	19 Brookhollow Ave, Baulkham Hills	150
	NWO_11	21 Brookhollow Ave, Baulkham Hills	165
	NWO_12	Adina Apartments Hotel, 22 Brookhollow Ave, Baulkham Hills[1]	350

This has been labelled as a Commercial receptor in order to maintain consistency with the main Norwest Station CNIS. However, for the purposes of this assessment it will be treated as a Residential receptor in all assessments. Labelling to remain as NWO_12 in order to consistency with main station CNIS.

The final construction methods and schedules would be confirmed during the detailed design stage. Therefore to account for the uncertainty in the methods and schedules, the assessment considers a worst-case scenario. It assumed that for each described phase of the project (refer to section 3 of the main REF) all the activities would be taking place simultaneously at locations in the proposal footprint that provide the minimum separation distance between the noise and vibration source and the most-exposed receivers. The assessment also assessed the impact assuming that construction equipment and machinery to be operating at its maximum output rating when in use.

3 Noise and vibration objectives

The noise and vibration objectives developed for the assessment of the construction of the main station works (*TF602-06.02F03 (rev 9) NW CNIS dated 4 August 2014*) have been adopted in order to be able to address the cumulative impact of the proposal and the ongoing station works.

3.1 Construction noise

Construction noise management levels (NMLs) were previously determined in the Construction Noise Impact Statement prepared for the general Norwest Station works. This was carried out using the *NSW Interim Construction Noise Guideline* (ICNG) DECC 2009), in accordance with Minister of Planning's Conditions of Approval No.18 and environmental protection licence (EPL) condition E1.1. Table 3 presents the adopted NMLs for the nearest noise sensitive receivers.

Table 3 – Construction noise management levels

NCA	NML[1] $L_{Aeq,15min}$ dBA			Sleep NML[1,2] $L_{A1,1min}$ dBA
	Day	Evening	Night	
NW-01	57 (52)[3]	50	43	65
NW-02	57 (52)[3]	50	43	65
NW-03	57 (52)[3]	50	43	65
NW-04	57 (52)[3]	50	43	65
NWO_01	55[4]	-	-	-
NWO_02	55[4]	-	-	-
NWO_03	55[4]	-	-	-
NWO_04	55[4]	-	-	-
NWO_05	55[4]	-	-	-
NWO_06	75[4]	-	-	-
NWO_07	70[4]	-	-	-
NWO_08	70[4]	-	-	-
NWO_09	70[4]	-	-	-
NWO_10	70[4]	-	-	-
NWO_11	70[4]	-	-	-
NWO_12	57 (52)[3]	50	43	65

Notes: [1] Applies 1.5 metres above ground level at the most affected property boundary for residential receivers (or within 30 metres of residence if a large plot).
[2] Applies during the night period.
[3] Bracketed numbers apply to daytime periods outside of standard hours (i.e. Saturdays 1pm – 6pm, Sundays, and public holidays).
[4] Applies when the facility is in use.

A highly affected noise objective of $L_{Aeq,15min}$ 75 dBA applies at all receivers during standard construction hours.

3.1.1 Background noise levels

The NMLs for the residential areas are based on the background noise monitoring reported in Section 6.1 of the Construction Noise and Vibration Management Plan (CNVMP) – *NWR-TJHDJV-MANU-PRW-00029*. The recorded background noise levels are presented in Table 4.

This location was used as it accurately represents the background noise level at the surrounding noise sensitive receptors, and is consistent with the assessment undertaken for the main station works.

Table 4 – Residential background noise levels

RBL location	RBL L_{A90} dBA		
	Day	Evening	Night
33 Jacqui Circuit, Baulkham Hills	47	45	38

3.2 Construction road traffic

As stated in the NSW *Road Noise Policy* (Roads and Maritime, 2011), a change in road noise level of up to 2 dB "*represents a minor impact that is considered barely perceptible to the average person".* As a result, construction traffic should not cause an increase in road traffic noise levels of 2 dB above existing $L_{Aeq,15hour}$ daytime or $L_{Aeq,9hour}$ night time road traffic noise levels on the surrounding network.

3.3 Construction vibration – building damage

To assess structural damage to buildings from vibrational energy, reference is made to:

- *British Standard BS 7385-2:1993 Evaluation and Measurement for Vibration in Buildings. Guide to Damage Levels from Groundborne Vibration* (British Standards Institution, 1993), which is referenced in the Sydney Metro Northwest (NWRL) EIS
- *DIN Standard 4150-2 Part 2 and Part 3: Human Exposure to Vibration in Buildings* (DIN Deutsches Institut für Normung, 1999)

There is not currently an Australian Standard that provides guidance for structural damage due to vibration.

3.3.1 Building damage: British Standard BS 7385

The assessment of potential building damage from ground vibration has been guided by BS 7385-2 "evaluation and measurement of vibration in buildings". This standard categorises damage in terms of 'cosmetic', 'minor', or 'major', providing limits for each. The levels provided in the standard are shown in Table 5.

Table 5 - BS 7385 Cosmetic damage criteria

Group	Type of structure	Peak component particle velocity, mm/s *		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial or heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial buildings	15 to 20**	20 to 50	50

Note: *Values referred to are at the base of the building, on the side of the building facing the source of vibration (where feasible).
**At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

These peak vibration limits are set so that the risk of 'cosmetic' damage is minimal. For 'minor' or 'major' vibrational damage to occur, the standard states that vibration magnitudes two times and four times (respectively) the values shown in Table 5 are necessary. It is noted that these levels are 'safe limits' which relate to transient vibrations. They have been set at the lowest level above which damage has been credibly demonstrated. 'Cosmetic' damage is described as minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks, and separation of partitions or intermediate walls from load bearing walls. Periods of continuous vibration may require reductions in these limits by up to half. The standard outlines the sources of vibration it has considered as including; blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

3.3.2 German Standard DIN 4150

German Standard DIN 4150 has also been used to set vibration limits for structural damage. DIN 4150 provides a recommendation for maximum allowable vibration levels to reduce the risk of structure damage. The minimum 'safe limits' listed have been presented in Table 6 and are generally recognised as being conservative.

Table 6 - DIN 4150-3 Structural damage criteria

Group	Type of structure	Vibration velocity, mm/s			
		At foundation frequency of			Plane of floor uppermost storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz*	All frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic values (e.g. buildings under a preservation order).	3	3 to 8	8 to 10	8

Note: *At frequencies above 100 Hz, the values given in this column may be used as minimum values.

3.4 Construction vibration – human response

To limit disturbance to human occupants of buildings, the vibration limits outlined in Table 7 have been adopted based on the guidance document Assessing Vibration: A Technical Guideline (Department of Environmental and Conservation, 2006),

Table 7 – Vibration limits (human exposure)

Location	Assessment period	VDV $m/s^{1.75}$	
		Preferred values	Maximum values
Critical areas	Day or night time	0.10	0.20
Residences	Daytime	0.20	0.40
	Night time	0.13	0.26
Offices, schools, educational institutions, and places of worship	Day or night time	0.40	0.80
Workshops	Day or night time	0.80	1.60

3.5 Groundborne noise

Groundborne noise relates to vibration from construction activities transferring through the ground and causing surrounding structures to vibrate (at vibration levels below those which would be tactile) and cause re-radiated noise within the surrounding buildings. Groundbourne noise is quantified by the average noise level radiated internally within the surrounding noise sensitive receivers. In accordance with the *ICNG*, the following ground-borne noise management levels apply.

Table 8 - Groundbourne NMLs for residential receivers

Time of day	Ground-borne noise management level
Daytime (7am-6pm)	N/A (vibration criteria only apply)
Evening (6pm-10pm)	40 dB $L_{Aeq,15min}$
Night-time (10pm-7am)	35 dB $L_{Aeq,15min}$

In accordance with the *ICNG*, these criteria only apply at surrounding residential noise sensitive receivers. However, NWO_01 (Hillsong Convention Centre) has been identified as particular noise sensitive commercial receiver due to the presence of recording facilities contained within. As a result, the recommended GBNML at NWO_01 is 30 dB $L_{Aeq,15min}$.

4 Construction noise assessment

A construction noise model was created using SoundPLAN modelling software to reflect the noise generated at each phase during construction. A three dimensional representation of the physical environment within the project area was simulated. Modelling inputs for each scenario included ground contours, road and traffic data, locations of sensitive receivers, noise-generating equipment as well as any other inputs which have an effect on the noise environment, such as the buildings surrounding the proposed site. All predicted noise levels are façade corrected (+2.5dB) at the receiver locations.

Two separate scenarios have been considered in this assessment; one to assess noise emissions from proposed surface works, and one to assess noise emissions from the proposed underground works. During periods when there is combined surface and underground works, the surface works will dominate noise emissions and hence the surface works can be considered representative of these times. The assessment has been informed that the vast majority of surface works are to be limited to standard construction hours (as defined in the ICNG), whilst the underground works will continue throughout the night time periods. The only surface works which will occur during the night period is spoil removal from tunnelling activities.

Detailed noise emission contour maps are included in Appendix B

4.1 Modelled equipment

This section identifies all sound power levels for equipment and plant used in the assessment. These levels are referenced to the following documents:

- *Construction Noise Strategy* (CNS) (Transport for NSW, 2012)
- *Directive 2000/14/EC Noise emissions for outdoor equipment – Database (European Commission, 2000)*
- Australian Standard *AS2436: 2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites (Standards Australia, 2010)*
- *Noise Database for Construction Sites* (UK Department for Environment, Food and Rural Affairs (DEFRA), various)
- *BS5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites (British Standards Institute, 2009)*
- *US Centers for Disease Control and Prevention (CDC) database* (Centers for Disease Control and Prevention, various)

4.1.1 Surface works

The equipment listed presented in Table 8 lists the main equipment expected to be used for the surface work and the associated sound power levels as referenced above.

To accord with the *ICNG*, a 5 dB ‘penalty’ has been included for activities identified as generating impulsive or tonal noise.

Table 8 – Typical sound power levels of required equipment for surface works

Equipment	Sound power level, L_{Aeq} dBA	Duration of noise per 15 minute period (worst-case)
Excavator (35T)	103	100%
Bulldozer	113	100%
Shotcrete rig (diesel)	104	100%
Truck and dog (spoil haulage)	108	100%
Jack hammer	110	100%
Concrete saw	115	100%
Road saw	115	100%
Drilling machine	110 + 5dB penalty	100%
Compressor	102	100%
Concrete pump	99	100%
Concrete truck	111	100%
Grinder	96	100%
Generator	94	100%
Crane (55T)	98	100%
Road truck (deliveries)	108	100%

The equipment listed in Table 8 is scheduled for use within the recommended hours for construction work described in the *ICNG*.

4.1.2 Underground works

The equipment listed in Table 9 presents the main equipment expected to be used for the underground works and the associated sound power levels as referenced above. To accord with the *ICNG*, a 5 dB 'penalty' has been included for activities identified as generating impulsive or tonal noise.

Table 9 – Typical sound power levels of required equipment for underground works

Equipment [1]	Sound power level, dBA	Duration of noise per 15 minute period (worst-case)
Shotcrete rig (diesel)	104	100%
Excavator with header	112	100%
Rock breaker	125 + 5dB penalty	100%
Drilling machine	110 + 5dB penalty	100%
Bulldozer	113	100%
Concrete pump	99	100%
Concrete truck	111	100%
Truck and dog (spoil haulage)[2]	108	100%

Note: [1] Note that a micro-tunneller machine (diameter <400mm) will also be used underground. Whilst accurate noise and vibration data is not available for this, based on previous experience it is fully expected that this will generate lower levels of noise and vibration than the Rock Breaker and Excavator.

[2] This equipment is required to operate at the surface. Spoil removal for the tunnelling is the only surface works that will be conducted during the night time period.

The modelled scenario considered night-time noise impacts due to the continual use of the above equipment during peak construction. As the ambient noise levels are lower at night this scenario assesses the worst-case impact.

4.2 Traffic noise

The anticipated construction traffic has been reviewed. This includes details relating to traffic access and expected movements to and from the construction site. The main truck/heavy vehicle movements would be due to equipment deliveries, construction material deliveries, and spoil removal. Table 10 lists the expected number of trucks/heavy vehicles during peak construction.

Table 10 – Expected construction vehicle movements

Type of movement	Expected frequency
Equipment delivery	10 – 15 in total across the construction program
Construction material delivery / waste removal	8 /average day
Concrete pour	15 /day of pour

Most construction traffic would arrive and leave site during the recommended standard hours for construction work. Trucks would occasionally remove spoil form site at night during the eight week period while the pedestrian link was being constructed.

4.3 In-isolation predicted noise levels

This section considers noise from the proposal alone, without consideration to the noise that will be generated by the main Norwest Station construction works. The predicted noise levels at noise sensitive receivers surrounding the work site are presented in the following sections. These noise levels are from noise generated from construction of the proposal only, not including any contribution from the main station works.

The results represent the 'worst-case' scenario where all noise-generating equipment is in operation simultaneously across a 15 minute period. In practice, actual noise levels emitted by construction activities will vary throughout the construction program and are generally expected to be lower than those shown in this assessment.

4.3.1 Surface works

The predicted noise emissions from surface construction work is summarised in Table 11. Such work will be constrained to daytime periods only

Table 11 – Predicted surface works noise levels

NCA	RBL L_{A90} dBA	NML $L_{Aeq,15min}$ dBA	Highest predicted level, L_{Aeq}	Predicted noise relative to NML
NW-01	47	57 (52)	51	-1[1]
NW-02	47	57 (52)	44	-8[1]
NW-03	47	57 (52)	62	10[1]
NW-04	47	57 (52)	54	2[1]

NCA	RBL L_{A90} dBA	NML $L_{Aeq,15min}$ dBA	Highest predicted level, L_{Aeq}	Predicted noise relative to NML
I_01	47	55	60	5
NWO_02	47	55	59	4
NWO_03	47	55	62	7
NWO_04	47	55	58	3
NWO_05	47	55	48	-7
NWO_06	47	75	68	-7
NWO_07	47	70	61	-9
NWO_08	47	70	59	-11
NWO_09	47	70	67	-3
NWO_10	47	70	67	-3
NWO_11	47	70	66	-4
NWO_12	47	57 (52)	59	7[1]

[1] Based on worst case daytime NML (Saturday 1pm-6pm and Sunday)

NML's in Table 11 are based on:

- RBL +10dB for Residential receptors (or RBL +5 dB for Saturday 1pm-6pm and Sunday periods)
- The appropriate classification for commercial receivers as given in Table 3 of the ICNG.

The results displayed in Table 11 indicate that noise emissions from surface works are expected to exceed the NML's by up to 10dB at NW_03. The equipment generating the highest noise levels have been identified as being:

- Drilling machine
- Bulldozer
- Road/concrete saws.

4.3.2 Underground works

The predicted noise emissions from evening and night time operations is summarised in Table 12.

Table 12 – Predicted underground levels

NCA	NML $L_{Aeq,15min}$ dBA			Highest predicted level, L_{Aeq}	Predicted noise relative to NML		
	Day	Evening	Night		Day	Evening	Night
NW-01	57 (52)[2]	50	43	49	-3[3]	-1	6
NW-02	57 (52)[2]	50	43	42	-10[3]	-8	-1

NCA	NML $L_{Aeq,15min}$ dBA			Highest predicted level, L_{Aeq}	Predicted noise relative to NML		
	Day	Evening	Night		Day	Evening	Night
NW-03	57 (52)[2]	50	43	66	14[3]	16	23
NW-04	57 (52)[2]	50	43	55	3[3]	5	12
NWO_01	55[1]			62	7		
NWO_02	55[1]			56	1		
NWO_03	55[1]			62	7		
NWO_04	55[1]			60	5		
NWO_05	55[1]			47	-8		
NWO_06	75[1]			69	-6		
NWO_07	70[1]			61	-9		
NWO_08	70[1]			56	-14		
NWO_09	70[1]			70	0		
NWO_10	70[1]			65	-5		
NWO_11	70[1]			65	-5		
NWO_12	57 (52)[2]	50	43	54	2[3]	4	11

Notes: [1] Applies when the facility is in use.
[2] Bracketed numbers apply to daytime periods outside of standard hours (i.e. Saturdays 1pm – 6pm, Sundays, and public holidays).
[3] Based on worst case daytime daytime NML (Saturday 1pm-6pm and Sunday)

The results displayed in Table 12 indicate that night time noise emissions may exceed the NMLs at some sensitive receptors (the worst case exposed receptors in NW-03) by up to 23 dB during the night periods, and 14 dB during the worst case daytime periods (Saturday 1pm-6pm and Sunday).

4.3.3 Sleep disturbance

Sleep disturbance is assessed by considering the maximum noise levels (LA1,1min) that could occur. This is unlike the above assessment that considered the average noise level that could occur over a 15-minute period ($L_{Aeq\ (15\ minutes)}$). The two measurements therefore differ slightly.

For the residential areas and the nearby hoteINWO_12), sleep disturbance has been assessed. As the majority of work conducted at night will be underground, the most likely source of sleep disturbance will be from the closing of vehicle doors and the spoil removal activities. The results have been summarised in

Table 13.

Table 13 – Predicted sleep disturbance noise levels

NCA	Sleep NML $L_{A1,1min}$ dBA	Maximum predicted level, $L_{A1,1min}$
NW-01	65	48
NW-02	65	42
NW-03	65	64
NW-04	65	35
NWO_12	65	35

4.4 Cumulative impacts

As the construction schedule for the pedestrian link is planned to coincide with the main Norwest Station works, the cumulative levels have been checked as part of this assessment. Table 14 addresses the predicted daytime noise emissions.

Table 14 – Cumulative daytime noise levels

NCA	NML $L_{Aeq,15min}$ dBA	Highest predicted level (pedestrian link works), dB L_{Aeq}	Highest predicted level (general station works), dB L_{Aeq}	Sum of highest predicted noise emissions	Increase due to pedestrian link works (dB)
NW-01	57 (52)	51	60	61	1
NW-02	57 (52)	44	52	53	1
NW-03	57 (52)	62	72	72	-
NW-04	57 (52)	54	58	60	2
NWO_01	55	60	70	70	-
NWO_02	55	59	66	67	1
NWO_03	55	62	70	71	1
NWO_04	55	58	57	61	4
NWO_05	55	48	57	58	1
NWO_06	75	68	80	80	-
NWO_07	70	61	74	74	-
NWO_08	70	59	77	77	-
NWO_09	70	67	79	79	-
NWO_10	70	67	82	82	-
NWO_11	70	66	72	73	1
NWO_12	57 (52)	59	62	64	2

The results show that during the daytime periods, overall noise emissions from the concurrent construction of both sites will be dominated by the main station works. The noise emissions associated with the proposal increase the cumulative noise by less than 2 dB at all receivers with the exception of NWO_04 (4 dB)

Table 15 addresses the predicted night time average noise emission levels, with Table 16 addressing cumulative sleep disturbance impacts.

Table 15 – Cumulative night time noise levels

NCA	NML $L_{Aeq,15min}$ dBA	Highest predicted level (pedestrian link works), dB L_{Aeq}	Highest predicted level (general station works), dB L_{Aeq}	Sum of highest predicted noise emissions	Increase due to pedestrian link works (dB)
NW-01	43	49	32	49	17
NW-02	43	42	< 30	42	12
NW-03	43	66	45	66	21
NW-04	43	55	32	55	23
NWO_01	55	62	37	62	25
NWO_02	55	56	33	56	23
NWO_03	55	62	38	62	24
NWO_04	55	60	< 30	60	30
NWO_05	55	47	< 30	47	17
NWO_06	75	69	40	69	29
NWO_07	70	61	39	61	22
NWO_08	70	56	42	56	14
NWO_09	70	70	49	70	21
NWO_10	70	65	47	65	18
NWO_11	70	65	42	65	23
NWO_12	43	54	31	54	23

Table 16 – Predicted sleep disturbance noise levels

NCA	Sleep NML dB $L_{A1,1min}$	Maximum predicted level (pedestrian link works), dB $L_{A1,1min}$	Maximum predicted level (main station works), dB $L_{A1,1min}$	Increase due to pedestrian link works (dB)
NW-01	65	48	48	0
NW-02	65	42	42	0
NW-03	65	64	64	0
NW-04	65	35	35	0
NWO_12	65	35	32	0

Table 15 shows a significant increase in the night time noise emissions due to the construction of the proposed pedestrian link in comparison to the main station works. The reason for this is that the main station works include very limited activity during the night time periods.

Table 16 shows that the predicted sleep disturbance levels for the main station and the pedestrian link are the same (rounded to the nearest dB). The reason for this is that the predicted sleep disturbance levels are based on the worst case single noise event that may occur at night. For both construction sites, this worst cast single event is the same, i.e, a truck movement on the site in closest point to the nearest noise sensitive receptor. .

4.5 Construction traffic noise impacts

To increase road traffic noise by 2dBA (as per the established criteria in line with the RNP) through an increase in traffic volume alone, the traffic volume needs to increase by nearly 60%. The construction traffic is using the existing road network, with no changes to the network and no new construction roads are proposed. The construction traffic movements will be significantly lower than 60% of the existing road traffic flows on the surrounding network, and as a result the increase in noise due to construction traffic will be negligible.

5 Construction vibration and ground-borne assessment

Table 17 is taken from TfNSW Construction Noise Strategy (CNS). This is based on a worst case assumptions regarding the equipment use and ground types. This table includes the worst case construction equipment that will be used for Surface works.

Table 17 – Vibration safe working distances

Plant item	Rating / description	Minimum working distance, m	
		Cosmetic damage	Human response (complaints)
Vibratory roller	< 50 kN (typically 1-2 tonnes)	5	15 to 20
	< 100 kN (typically 2-4 tonnes)	6	20
	< 200 kN (typically 4-6 tonnes)	12	40
	< 300 kN (typically 7-13 tonnes)	15	100
	< 300 kN (typically 13-18 tonnes)	20	100
	> 300 kN (typically > 18 tonnes)	25	100
Hydraulic hammer	300 kg (5-12 tonne excavator)	2	7
	900 kg (12-18 tonne excavator)	7	23
	1600 kg (18-34 tonne excavator)	22	73
Vibratory pile driver	Sheet piles	2 to 20	20
Pile boring	≤ 800 mm*	2 (nominal)	-
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure

In addition to the above equipment, a road header and rock breaker is proposed for tunnelling (subsurface) works. Based on published data and WSP measured vibration levels from similar equipment, the following vibration levels may be expected from the road header equipment and the following distance from the equipment:

Table 18 – Estimated vibration levels at distance

Equipment	Vibration level (mm/s) @ Distance (m)					
	1mm/s	0.8mm/s	0.6mm/s	0.4mm/s	0.2mm/s	0.1mm/s
Road Header	15-20m	20m	20-25m	25-30m	30-35m	40-45m
Rock breaker (35t carrier	35m	40m	45m	55m	70m	100m

These levels vary greatly with different ground types, however the above is based on a worst case assumption of hard ground with little damping between source and receiver.

5.1 Cosmetic damage

5.1.1 Surface works

To avoid cosmetic damage, the maximum set-back distance for all equipment listed in Table 17 is 25 metres. As the pedestrian link construction equipment is not expected to come within 60 metres of the closest receiver, it is not expected that cosmetic damage will occur under any circumstances.

5.1.2 Subsurface works

Based on the criteria in Section 3.3, a peak particle velocity of 5 mm/s should not be exceeded at surrounding sensitive buildings to avoid cosmetic damage (a conservative estimate). To exceed this level the most vibration generating equipment (rock breaker) would need to be within 20m of a structure, based on a solid rock ground type between source and receiver. This will not occur at any point during construction.

As such, it is deemed that there is no risk of cosmetic damage to surrounding buildings from the proposal.

5.2 Human comfort

5.2.1 Surface works

In relation to human comfort, vibrations may be detected up to 100 metres from some equipment. No residential receivers are within 100 metres from the proposed pedestrian link work site. Three commercial receivers (NWO_06, NOW_07 and NWO_09) are within 100 metres, however it is understood that the equipment for the actual works will not contain equipment of the maximum size noted in Table 17.

As such. it is not expected that vibration from construction equipment will have an adverse impact on the nearby noise sensitive receivers.

To minimise human discomfort caused by vibration, it is proposed that in the unlikely event that occupants of surrounding buildings have complaints regarding the works, it is recommended that a static roll (operating without the vibrating component) be adopted, or using a smaller vibratory roller (less than six tonnes) and hydraulic hammer (less than 18 tonnes).

5.2.2 Subsurface works

At a distance of 60m, the most highly vibration generating activity (Rock Breaker) will have a PPV of 0.2mm/s – not accounting for any losses that will occur in the vibration transferring from the ground in to the building. This is in on the limit of human perceptibility (reference: DIN 4150 part 2), and as a result it is not expected that any adverse impacts will be experienced.

5.3 Ground-borne noise

The subsurface works rock breaking is the activity which will have the highest potential to generate background noise levels at the surrounding noise sensitive locations.

The nearest ground-borne noise sensitive locations to the works are the residential NCA NW-03 and the Hillsong Convention Centre (NWO_01). Both of these are 140m from the closest point to the site.

At a distance of 140m, the predicted ground-borne noise from rock breaking activity is approximately 25 dB $L_{Aeq,15min}$. This is below the established criteria (Section 3.5), and as such is it not expected that adverse ground-borne noise impacts will be experienced from the proposed works. However, it should also be noted that this predicted level is based on several (believed worst-case) assumptions. It is recommended that additional detailed calculations are undertaken as part of the detailed design works for the proposal in order to confirm compliance with established criteria.

6 Operational noise impacts

There are two possible sources of increased operational noise associated with the proposal:

- New building services within the station serving the pedestrian link
- Any possible changes in road traffic on surrounding network.

6.1 Additional station noise generating elements

There are two potential noise generating elements proposed within the station due to the proposal:

Ventilation (fan based) system serving he underground pedestrian link.

The fan for this system will be located within the main station plant space. The fan and associated ductwork will be designed to achieve the external noise emission criteria developed in accordance with NSW Industrial Noise Policy (INP), 2000.

As such, no adverse impacts are expected due to this noise source

Emergency public address system

This will only generate noise in periods of emergency evacuation of the station. As a result, noise impacts form this system are not considered as the normal operating procedure for the facility and hence not considered in this assessment. Any testing of this system will be coordinated with the management operational policy of the main station.

6.2 Traffic noise impacts

As the proposals to not alter surface road traffic, there are no expected operational impacts from this associated with the proposal.

7 Summary of environmental impacts

Each impact has been assigned a rating. The rating considers the likelihood of the impact occurring and the magnitude of the impact on the receiving environment. The ratings are defined where one or more of the following conditions are satisfied:

- Negligible: where the predicted changes are not sufficient to affect ambient noise or vibration levels beyond natural variations
- Minor: where there is predicted to be some level of generated noise and vibration or there is a perceptible change that would occur for less than three weeks during construction
- Moderate: where there is predicted to be a perceptible change in noise and vibration lasting more than three weeks, an exceedance of the 'noise affected' noise management levels, the potential for sleep disturbance to occur at some point during construction, the potential for groundborne vibration to cause cosmetic damage or to result in 'annoyance' at some point during construction, or a change in operational traffic movement that is sufficient to cause more than a 2 dB change
- Major: where there is predicted to be a notable change in noise and vibration lasting more than three weeks, an exceedance of the 'highly noise affected' noise management levels, the risk of long term sleep disturbance during construction, an accepted certainty that groundborune vibration would have an impact on people or buildings, a change in operational traffic movement that is sufficient to cause more than a 4 dB change.

Table 20 – Noise impact assessment

Source	Assessed impact	Comments
Construction Noise: Daytime	In-isolation: Minor Cumulative (with station): Negligible	See section 8.1 for recommended mitigation
Construction Noise: Night-time	In-isolation: Moderate Cumulative (with station): Moderate	See section 8.1.2 for recommended mitigation
Construction Vibration: Building damage	Negligible	
Construction Vibration: Human perception	Negligible *	
Construction Vibration: Ground-borne noise	Negligible *	See section 8.2
Operational Noise	Negligible	

* Predicted impact is negligible, however, due to the preliminary nature of this assessment – this has been based on several (believed worst-case) assumptions. It is recommended that additional detailed calculations are undertaken as part of the detailed design works for the proposal in order to confirm compliance with established criteria.

8 Mitigation

This section sets out the recommended noise and vibration safeguards and management measures to be implemented during the proposal's construction and operation.

8.1 Noise

8.1.1 Surface works

Necessary mitigation measures to reduce noise emissions include:

- Install 3 metre high shrouding around both excavation sites
- Limit drilling machine emissions (e.g. through use of a silencer kit / localised shrouding)

The results presented in this report represent the 'worst-case' scenario where all noise-generating equipment is in operation simultaneously across a 15 minute period. In practice, actual noise levels emitted by construction activities will vary throughout the construction program and are generally expected to be lower than those shown in this assessment.

As the general site works are predicted to dominate the overall construction noise emissions, it is expected that these mitigation measures will be sufficient for the daytime surface works.

8.1.2 Subsurface night works

Based on TfNSW's Construction Noise Strategy 2012 (CNS:2012), the following mitigation of noise for out-of-hours works (OOHW) are recommended. These are based on predicted noise levels that exceed the measured rating background levels (RBLs). Table 21 below has been reproduced from the TfNSW CNS:2012. Note that all OOHW are subject to TfNSW approval procedure is this is to be followed by the managing contractor.

Table 21– Night time noise mitigation measures

Time period		$L_{Aeq\ (15min)}$ noise level above background (RBL) qualitative assessment of noise levels*			
		0 to 10 dB(A) Noticeable	10 to 20 dB(A) Clearly audible	20 to 30 dB(A) Moderately intrusive	> 30 dB(A)
Standard	Mon-Fri (7am-6pm) Sat (8am-1pm) Sun/Pub (Nil)	-	-	LB, M	LB, M
OOHW Period 1	Mon-Fri (6pm-10pm) Sat (1pm-10pm) Sun/Pub (8am-6pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN
OOHW Period 2	Mon-Fri (10pm-7am) Sat (10pm-8am) Sun/Pub (6pm-7am)	LB	M, LB	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN

Note: *The following abbreviations have been used –

- AA: Alternative accommodation
- M: Monitoring
- IB: Individual briefings
- LB: Letterbox drops
- RO: Proposal specific respite offer
- PC: Phone calls
- SN: Specific notifications.

The mitigation measures that apply to the underground works are outlined in Table 22. It is noted that the non-residential sensitive receivers may not be in use during the night time period. This should be verified prior to the implementation of any mitigation measures, as they are only applicable if the building is occupied.

Table 22 – Recommended mitigation measures (OOHW Periods 1 and 2)

NCA	Amount exceeding RBL (for worst case maximum noise emissions)	Required mitigation
NW-01	11	M, LB
NW-02	4	LB
NW-03	28	M, IB, LB, PC, SN
NW-04	17	M, LB
NWO_01	24	M, IB, LB, PC, SN
NWO_02	18	M, LB
NWO_03	24	M, IB, LB, PC, SN
NWO_04	22	M, IB, LB, PC, SN
NWO_05	9	LB
NWO_06	31	AA, M, IB, LB, PC, SN
NWO_07	23	M, IB, LB, PC, SN
NWO_08	18	M, LB
NWO_09	32	AA, M, IB, LB, PC, SN
NWO_10	27	M, IB, LB, PC, SN
NWO_11	27	M, IB, LB, PC, SN

NCA	Amount exceeding RBL (for worst case maximum noise emissions)	Required mitigation
NWO_12	21	M, IB, LB, PC, SN

Note that it is considered that the majority of non-residential receivers in Table 22 will not be in operation in OOHW Period 2 and likely in OOHW Period 1 (refer Table 21 for timing). As such, these receivers will not be considered for any mitigation during these periods should they not be operational. It is recommend that investigations are held as to the operational times of the non-residential noise sensitive receivers (NOW_01 to NOW_11) prior to any mitigation being considered or employed.

Noise monitoring

Where noted necessary in Table 22, undertake noise monitoring at the most impacted receiver in each noise catchment area shall be undertaken when loudest works are being carried out. This should be undertaken within 1 week of the work commencing.

This may take the form of an unattended noise monitoring system that would send an alert notification (such as SMS text message) to standby officer if noise levels exceed the limits identified in this assessment. If an exceedance alert was triggered, attended noise monitoring will be undertaken manually to confirm / justify the measured level. The procedure outlined in the CNVMP will be followed in the event of any measured exceedances.

8.2 Vibration and ground-borne noise

As discussed in Section 5, no cosmetic damage, human discomfort nor ground-borne noise adverse impacts are expected to occur at the surrounding sensitive receivers.

However, it should be noted that in particular NWO_01 (Hillsong Convention Centre) has been identified as a potentially highly sensitive commercial receiver due to the presence of recording facilities contained within. Any potential ground-borne noise issues for this receiver will depend on many factors, including the location of the recording studios within the building. As such, it is recommended that detailed investigations and calculations are undertaken as part of the detailed design works in order to ensure compliance with the criteria, and/or suitable management and monitoring mitigation measures developed.

Appendix A Site map

REV	DATE	BY	DESCRIPTION	AC
A	19/02/15	NF	Issue for submission	AC

DRAWING STATUS:

ISSUE FOR CNVIS

WSP | PARSONS BRINCKERHOFF

Legend

- Noise Source
- Receiver
- Commercial Building
- Project Boundary
- Construction Boundary EIS1
- Construction Boundary EIS2
- Concept Alignment: EIS2Sub
- Noise Catchment Area (NCA)
- Site Boundary

CLIENT: Transport for NSW

DESIGN-DRAWN: NF

DATE: February 2015

PROJECT: Norwest Station Subsurface Northern Pedestrian Link

SCALE: 1:5,116 @ A3

0 20 40 80 120 160 200 Meters

TITLE: Site Map Norwest Station Subsurface Northern Pedestrian Link

DRAWING No: APPENDIX A

REV: A

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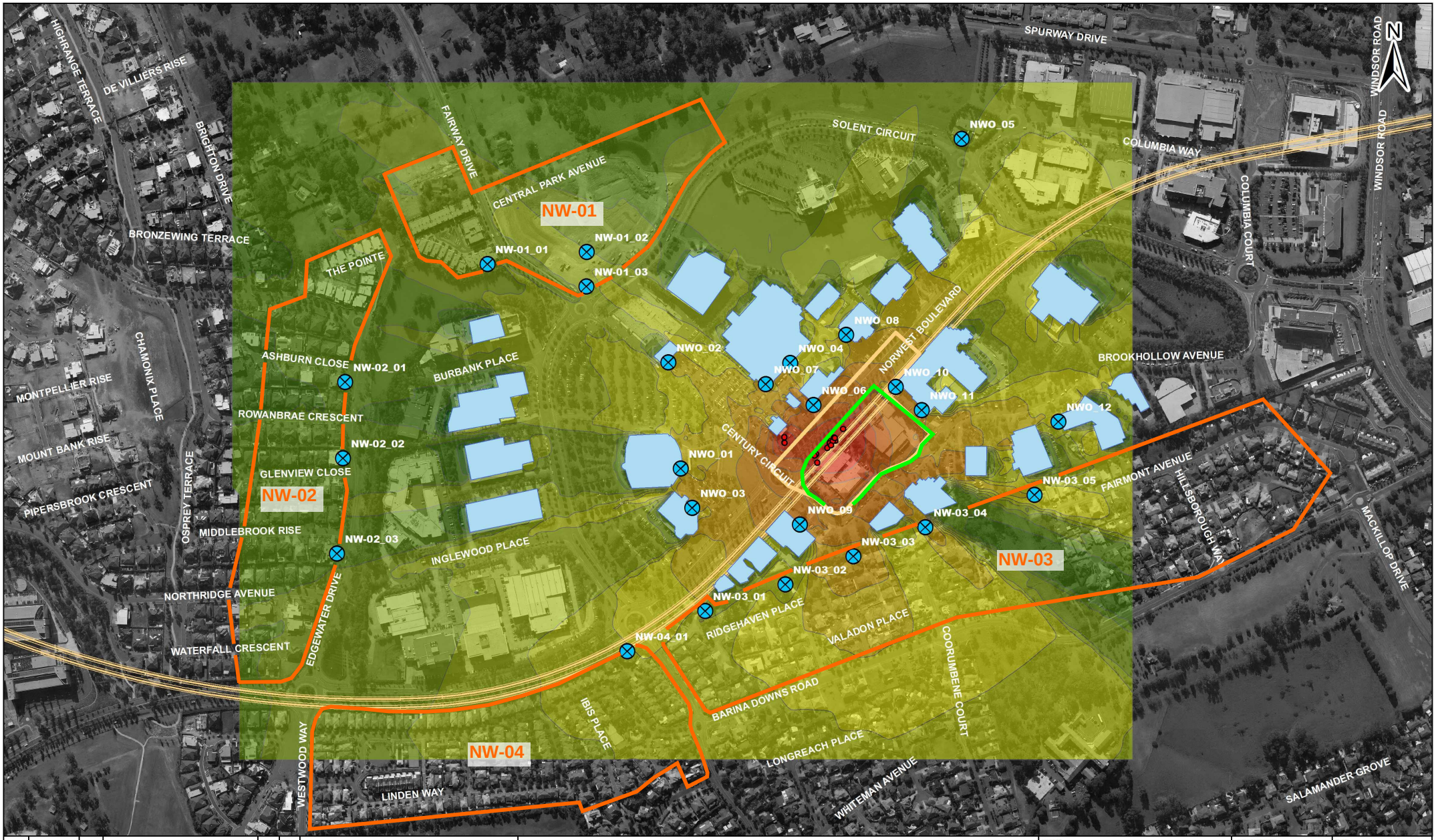
Appendix B Noise prediction results



REV	DATE	BY	DESCRIPTION	AC
A	19/02/15	NF	Issue for submission	AC

DRAWING STATUS:

ISSUE FOR CNVIS

WSP | PARSONS BRINCKERHOFF

Legend

- Noise Source
- Receiver
- Commercial Building
- Project Boundary
- Construction Boundary EIS1
- Construction Boundary EIS2
- Noise Catchment Area (NCA)
- Site Boundary
- Concept Alignment: EIS2Sub

Free Field Level (dB)

- <40
- 40-43
- 43-46
- 46-49
- 49-52
- 52-55
- 55-58
- 58-61
- 61-64
- 64-67
- 67-70
- 70-73
- 73-76
- 76-79
- >79

CLIENT: Transport for NSW

DESIGN-DRAWN: NF

DATE: February 2015

PROJECT: Norwest Station Subsurface Northern Pedestrian Link

SCALE: 1:5,116 @ A3

0 20 40 80 120 160 200 Meters

TITLE: Noise Contour Map Surface Works Norwest Station Subsurface Northern Pedestrian Link

DRAWING No: APPENDIX A2

REV: A

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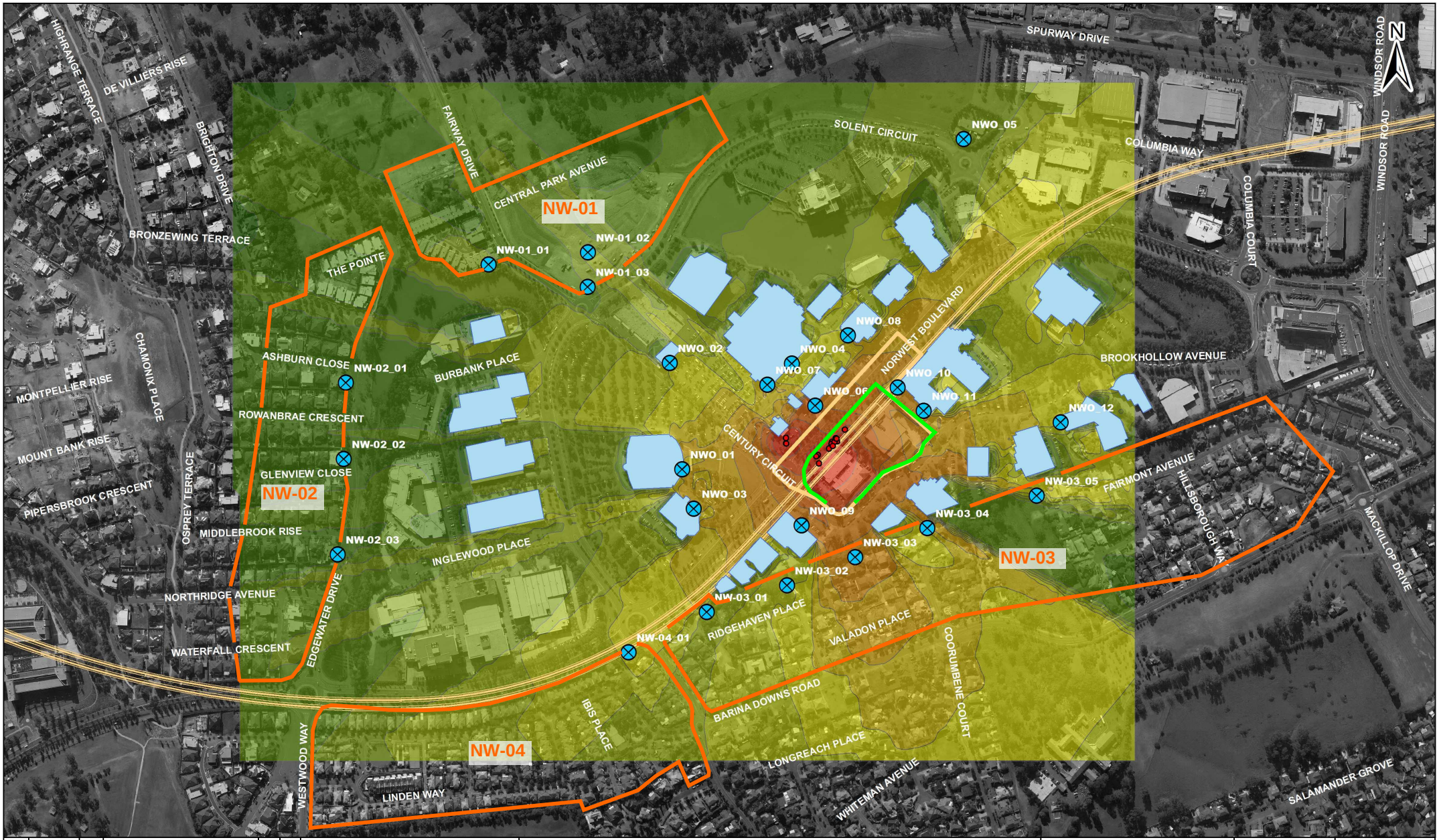

REV	DATE	BY	DESCRIPTION	AC
A	19/02/15	NF	Issue for submission	AC

DRAWING STATUS:

ISSUE FOR CNVIS

WSP | PARSONS BRINCKERHOFF

Legend

- Noise Source
- Receiver
- Commercial Building
- Project Boundary
- Construction Boundary EIS1
- Construction Boundary EIS2
- Noise Catchment Area (NCA)
- Site Boundary
- Concept Alignment: EIS2Sub

Free Field Level (dB)

- <40
- 40-43
- 43-46
- 46-49
- 49-52
- 52-55
- 55-58
- 58-61
- 61-64
- 64-67
- 67-70
- 70-73
- 73-76
- 76-79
- >79

CLIENT: Transport for NSW

DESIGN-DRAWN: NF

DATE: February 2015

PROJECT: Norwest Station Subsurface Northern Pedestrian Link

SCALE: 1:5,116 @ A3

0 20 40 80 120 160 200 Meters

TITLE: Noise Contour Map Subsurface Works Norwest Station Subsurface Northern Pedestrian Link

DRAWING No: APPENDIX A1

REV: A

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Appendix C Glossary

‘A’ Frequency Weighting

The ‘A’ frequency weighting roughly approximates to the Fletcher-Munson 40 phon equal loudness contour. The human loudness perception at various frequencies and sound pressure levels is equated to the level of 40 dB at 1 kHz. The human ear is less sensitive to low frequency sound and very high frequency sound than midrange frequency sound (i.e. 500 Hz to 6 kHz). Humans are most sensitive to midrange frequency sounds, such as a child’s scream. Sound level meters have inbuilt frequency weighting networks that very roughly approximates the human loudness response at low sound levels. It should be noted that the human loudness response is not the same as the human annoyance response to sound. Here low frequency sounds can be more annoying than midrange frequency sounds even at very low loudness levels. The ‘A’ weighting is the most commonly used frequency weighting for occupational and environmental noise assessments.

Ambient Noise

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. Ambient Noise is usually assessed as an energy average over a set time period ‘T’ (LAeq, T).

Attenuation

The reduction of sound energy as a function of distance travelled.

Audible

Audible refers to a sound that can be heard. There are a range of audibility grades, varying from “barely audible”, “just audible” to “clearly audible” and “prominent”.

Background Noise Level

Total silence does not exist in the natural or built-environments, only varying degrees of noise. The Background Noise Level is the minimum repeatable level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc.. It is quantified by the noise level that is exceeded for 90 % of the measurement period ‘T’ (LA90, T). Background Noise Levels are often determined for the day, evening and night time periods where relevant. This is done by statistically analysing the range of time period (typically 15 minute) measurements over multiple days (often 7 days). For a 15 minute measurement period the Background Noise Level is set at the quietest level that occurs at 1.5 minutes.

‘C’ Frequency Weighting

The ‘C’ frequency weighting approximates the 100 phon equal loudness contour. The human ear frequency response is more linear at high sound levels and the 100 phon equal loudness contour attempts to represent this at various frequencies at sound levels of approximately 100 dB.

Decibel

The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0 dB to 120 dB. The decibel is ten times the logarithm of the ratio of any two quantities that relate to the flow of energy (i.e. power). When used in acoustics it is the ratio of square of the sound pressure level to a reference sound pressure level, the ratio of the sound power level to a reference sound power level, or the ratio of the sound intensity level to a reference sound intensity level. See also Sound Pressure Level and Sound Power Level. Noise levels in decibels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dB, and another similar machine is placed beside it, the level will increase to 53 dB (from 10 log10 (10(50/10) + 10(50/10)) and not 100 dB. In theory, ten similar machines placed side by side will increase the sound level by 10 dB, and one hundred machines

increase the sound level by 20 dB. The human ear has a vast sound-sensitivity range of over a thousand billion to one so the logarithmic decibel scale is useful for acoustical assessments.

dBA – See 'A' frequency weighting

dBC – See 'C' frequency weighting

Directivity

The directivity of a sound source is a measure of the variation in its sound radiation with direction. Directivity is usually stated as a function of angular position around the acoustical centre of the source and also as a function of frequency. Some sources radiate sound energy uniformly in all directions. These are called non-directional sources. Most practical sources are somewhat directional; that is, they radiate more sound in some directions than in others. Directivity factor is the ratio of the increased level to the averaged value

Equivalent Continuous Sound Level, LAeq

Many sounds, such as road traffic noise or construction noise, vary repeatedly in level over a period of time. More sophisticated sound level meters have an integrating/averaging electronic device inbuilt, which will display the energy time-average (equivalent continuous sound level - LAeq) of the 'A' frequency weighted sound pressure level. Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the LAeq level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the LAeq noise level than any other descriptor.

'F'(Fast) Time Weighting

Sound level meter design-goal time constant which is 0.125 seconds.

Free Field

In acoustics a free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall or inside an anechoic chamber.

Frequency

The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.

Hertz (Hz):

The unit used to measure frequency of sound expressed by cycles per second.

Human Response to Noise Level Changes

- Less than 3dBA = No perceivable difference
- 3dBA = Barely perceptible difference
- 5dBA = Readily perceptible difference
- 10dBA = 'Doubling' (or 'halving') of performance

[Reference; Cowan, J.P., 1994 "Handbook of Environmental Acoustics" & Bell, L.H. and D.H. Bell. 1994. "Industrial Noise Control Fundamentals and Applications"]

'I' (Impulse) Time Weighting

Sound level meter time constant now not in general use. The 'I' (impulse) time weighting is not suitable for rating impulsive sounds with respect to their loudness. It is also not suitable for assessing the risk of hearing impairment or for determining the 'impulsiveness' of a sound.

Maximum Noise Level, LAFmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'F' (Fast) time weighting. Often used for noise assessments other than aircraft.

Maximum Noise Level, LASmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'S' (Slow) time weighting. Often used for aircraft noise assessments.

Noise

Noise is unwanted, harmful or inharmonious (discordant) sound. Sound is wave motion within matter, be it gaseous, liquid or solid. Noise usually includes vibration as well as sound.

Offensive Noise

Reference: Dictionary of the NSW Protection of the Environment Operations Act 1997).

"Offensive Noise means noise:

(a) That, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."

Pink Noise

Pink noise is a broadband noise with an equal amount of energy in each octave or third octave band width. Because of this, Pink Noise has more energy at the lower frequencies than White Noise and is used widely for Sound Transmission Loss testing.

'S' (Slow) Time Weighting

Sound level meter design-goal time constant which is 1 second.

Sound Attenuation

A reduction of sound due to distance, enclosure or some other devise. If an enclosure is placed around a machine, or an attenuator (muffler or silencer) is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 20 dB reduces the sound energy by one hundred times.

Sound Exposure Level (LAE)

Integration (summation) rather than an average of the sound energy over a set time period. Used to assess single noise events such as truck or train pass by or aircraft flyovers. The sound exposure level is related to the energy average (LA_{eq}, T) by the formula LA_{eq}, T = LAE – 10 log10 T. The abbreviation (SEL) is sometimes inconsistently used in place of the symbol (LAE).

Sound Intensity (*I*)

Sound intensity refers to the quantity of sound energy that flows through a unit area in a unit time, and is measured as the sound power (watts) per unit area (m^2). Intensity is the product of the sound pressure and the particle velocity.

Sound Pressure

The rms sound pressure measured in pascals (Pa). A pascal is a unit equivalent to a newton per square metre (N/m^2).

Sound Pressure Level (L_p)

The level of sound measured on a sound level meter and expressed in decibels (dB). Where LP = 10 log10 (Pa/Po)2 dB (or 20 log10 (Pa/ Po) dB) where Pa is the rms sound pressure in Pascal and Po is a reference sound pressure conventionally chosen is 20 µPa (20 x 10-6 Pa) for airborne sound. Lp varies with distance from a noise source.

Sound Power

The rms sound power measured in watts (W). The watt is a unit defined as one joule per second. A measures the rate of energy flow, conversion or transfer.

Sound Power Level, (SPL) Lw

The sound power level of a noise source is the inherent noise of the device. Therefore sound power level does not vary with distance from the noise source or with a different acoustic environment. Lw = Lp + 10 log10 'a' dB, re: 1pW, (10-12 watts) where 'a' is the measurement noise-emission area (m2) in a free field.

Statistical Noise Levels, Ln.

Noise which varies in level over a specific period of time 'T' (standard measurement times are 15 minute periods) may be quantified in terms of various statistical descriptors fro example:-

- The noise level, in decibels, exceeded for 1 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as LAF1, T. This may be used for describing short-term noise levels such as could cause sleep arousal during the night.
- The noise level, in decibels, exceeded for 10 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as LAF10, T. In most countries the LAF10, T is measured over periods of 15 minutes, and is used to describe the average maximum noise level.
- The noise level, in decibels, exceeded for 90 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as LAF90, T. In most countries the LAF90, T is measured over periods of 15 minutes, and is used to describe the average minim um or background noise level.

Steady Noise

Noise, which varies in level by 6 dB or less, over the period of interest with the time-weighting set to "Fast", is considered to be "steady". (Refer AS 1055.1 1997).

White Noise

White noise is broadband random noise whose spectral density is constant across its entire frequency range. The sound power is the same for equal bandwidths from low to high frequencies. Because the higher frequency octave bands cover a wider spectrum, white noise has more energy at the higher frequencies and sounds like a hiss.

'Z' Frequency Weighting

The 'Z' (Zero) frequency weighting is 0 dB within the nominal 1/3 octave band frequency range centred on 10 Hz to 20 kHz. This is within the tolerance limits given in AS IEC 61672.1-2004: 'Electroacoustics - Sound level meters – Specifications'.

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