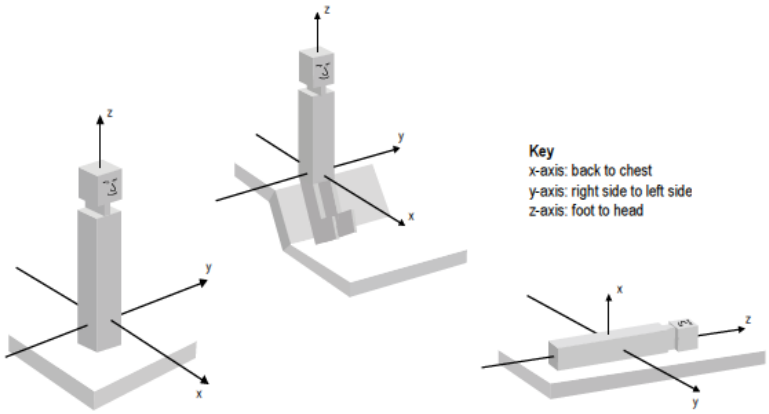
concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 6: Orthogonal axes for human exposure to vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 14.

Table 14: Preferred and maximum levels for human comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
2. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
3. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 15

Table 15: Acceptable vibration dose values for intermittent vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous of impulsive criteria for critical areas.
Source: BS 6472-1992

6.5.2 Building damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2 [9] and German Standard DIN4150-3 [10]. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

Within British Standard 7385 Part 1: 1990, different levels of structural damage are defined:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

The vibration limits in Table 1 of British Standard 7385 Part 2 [9] are for the protection against cosmetic damage, however guidance on limits for minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.

Within DIN4150-3 [10], damage is defined as "*any permanent effect of vibration that reduces the serviceability of a structure or one of its components*" (p.2). The Standard also outlines:

"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if

- *cracks form in plastered surfaces of walls;*
- *existing cracks in the building are enlarged;*
- *partitions become detached from loadbearing walls or floors.*

These effects are deemed 'minor damage. " (DIN4150.3, 1990, p.3)

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

6.5.2.1 British Standard

British Standard 7385: Part 2 '*Evaluation and measurement of vibration in buildings*', can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises 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. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.Table 16 sets out the BS7385 criteria for cosmetic, minor and major damage.

Regarding heritage buildings such as the Locomotive Shed, British Standard 7385 Part 2 (1993) notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*" (p.5).

Where the Locomotive Shed is not considered structurally unsound, the management of potential effects of vibration could consider general criteria rather than Category 3 requirements under DIN 4150-3.

Table 16: BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor*	100		
		Major*	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor*	30 to 40	40 to 100	100
		Major*	60 to 80	80 to 200	200

Notes: Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

* Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

6.5.2.2 German Standard

German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure*' (DIN 4150-3), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure. The vibration limits increase as the frequency content of the vibration increases. The criteria are presented in Table 17.

Table 17: DIN 4150-3 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at 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 value (eg buildings under a preservation order)*	3	3 to 8	8 to 10	8

Notes: * - Refer also to British Standard 7385 Part 2 (1993)

6.6 Construction noise and vibration assessment

6.6.1 Equipment list and source noise levels

Noise generated from the site will vary depending on the level and specific type of activity carried out, as well the number of items of plant equipment operating at any one time. Table 18 provides the Sound Power Levels (LW) of plant likely to be used during the excavation and construction phases.

Table 18: Construction plant source levels

Equipment Type	Indicative Size	Indicative Equipment		Sound Power Level, dB(A) Lw re: 1pW
		Earthworks	Construction	L_{Aeq}
Air Compressor - Silenced	8 kW	-	Y	109
Cherry Picker	6 t	-	Y	106
Concrete Pump	6 t	Y	Y	103
Concrete Saw	9 kg	Y	-	119
Concrete Vibrator	2 kW	-	Y	97
Crane - Mobile	55t	-	Y	98
Crane - Diesel	22 t	-	Y	104
D10 Dozer	-	Y	-	110
Dump truck	30 t	Y	-	109
Excavator	40 t	Y	-	107
Excavator	32 t	Y	-	105
Excavator	12 t	Y	-	102
Generator - Diesel	100 kVA	-	Y	94
Hoist - Twin cage high speed Alimak	0.5 t	-	Y	96
Piling - Rotary bored cast in-situ	110 t	Y	Y	111
Pneumatic Hand Tools (general)		Y	Y	111
Pneumatic Jack Hammer	20 kg	Y	-	121
Power Generator	28 kg	Y	Y	102
Roller - Vibratory (pad foot)	20 t	Y	Y	108
Truck - Cement Mixer	26 t	-	Y	104
Water Cart	10-12t	Y	Y	107
Water jet fans	DSU T700	Y	-	108
Welders - welding & cutting steel piles	-	Y	Y	101

Note: Source:- Renzo Tonin & Associates Construction Noise Database (QTD-06 (rev 5))
LA1 only noted for equipment potentially used during the night period (as noted in the Construction Program in Appendix C)

6.6.2 Predicted Noise Levels

Noise emissions were determined by modelling the noise sources, receiver locations, and operating activities, based on the information currently available. Table 19 following presents a summary of the

predicted L_{Aeq} noise levels for each stage. Noise predictions have been conservatively assessed on the basis of the following:

- All plant and equipment for each stage operating concurrently for each phase/activity
- No acoustic shielding has been assumed for future structures on site. As the site works progress, acoustic shielding will be provided by the constructed structures to some locations. The modelling conservatively assumes a clear unobstructed site.
- A 25dB(A) reduction from outside to inside for offices and commercial buildings assuming closed windows, and a 60dB(A) reduction for the studios at 6-8 Central Avenue.
- No consideration of site hoardings or other forms of shielding have been considered in the modelling

While various stages and phases of work will overlap across the site, resulting in various combinations of activity, assessment has been based on the concurrent earthworks and construction phases that will occur on site.

Table 19: Summary of predicted L_{Aeq} levels

Receiver	Predicted L_{Aeq} noise levels, dB(A)		Noise management level, dB(A)	
	Stage 1 and 2 Earthworks (excavation)	Stage 1 and 2 Construction (structures)	Noise affected	Highly noise affected
R1 - Henderson Rd - West of Mitchell Rd	69	66	56	75
R2 - Henderson Rd - East of Mitchell Rd	66	63	59	75
R3 - Garden St	65	62	59	75
R4 - Cornwallis St	70	67	59	75
E1 - Child care centre - internal	49	46	45	-
E1 - Child care centre - external	69	66	65	75
E2 - TOP Education - internal	50	47	45	-
C2a - 6-8 Central Avenue - Eastern offices	48	45	50	-
C2b - 6-8 Central Avenue - Southern offices	50	47	50	-
C2c - 6-8 Central Avenue - Studios	12	9	TBC	-
C3 - 13 Garden St	49	46	50	-

Notes: 1 - NML applies to external areas
2 - NML applies to internal areas

Based on the predicted noise levels from construction activities, in accordance with the EPAs INCG, consideration will need to be given to all reasonable and feasible mitigation and management measures. General recommendations for the site wide management of noise and vibration are provided in the following section.

With regard to the Channel 7 studios located at 6-8 Central Ave, the noise intrusion from airborne noise is expected to be sufficiently reduced so as not to affect the use. However, on-site testing should be

carried out to confirm outcomes due to the sensitivity of the use. It is expected that structure borne noise generated by any vibration intensive works would be most critical with regard to impacts upon the studios and all endeavours should be made to reduce vibration intensive work in proximity to the studios, or in contact with the carpark structure below the plaza area.

6.7 Noise and vibration control measures

The following at-source control and management measures should be considered for the management of noise from construction works to reduce potential noise impacts. The management measures are focused on minimising unnecessary noise generation from the site and the extent and duration of peak noise levels.

Table 20: Construction noise management measures

Measure	Detail
Source controls	
Noise barriers	Where possible, stage development so that structures provide acoustic shielding to sensitive receiver locations. Construct any solid site hoarding as soon as practical. Where possible, stationary equipment or loading areas should be located to make most use of the solid hoarding. Barriers or enclosures around stationary plant should also be considered where it is required to be located in close proximity to sensitive receivers.
Location equipment	Loading/unloading zones and stationary plant such as generators should where practicable be located away from the most sensitive receivers.
Equipment selection	Use the quietest and least vibration emitting construction methods where feasible and reasonable.
Limit equipment in use	Only the equipment necessary for the construction works will be used at any time. Avoid any unnecessary noise when carrying out manual operations and when operating plant
Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off whilst being unloaded.
Reversing alarms	Alternative reverse alarm, such as non-tonal 'quackers' should be installed where feasible and reasonable.
Management measures	
Implement community consultation measures	Inform community of construction activity and potential impacts
Develop good relations	Good relations with building occupants should be established at the beginning of the works and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the building occupants should be adequately trained and experienced in such matters.
Work staging	Where practical, stage works so that intrusive works are carried out at least noise sensitive periods.

Measure	Detail
Site inductions	All employees, contractors and subcontractors are to receive a Project induction. The environmental component may be covered in toolboxes and must include: • all relevant project specific and standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries), and • environmental incident procedures
Complaints management procedure	A management procedure would need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.
Noise monitoring	Noise and vibration monitoring should be carried out for any identified sensitive works, where monitoring could be used to proactively identify noisy works that may be otherwise managed and mitigated.

Regarding vibration, Table 21 below presents the recommended minimum working distances for high vibration generating plant.

Table 21: Recommended minimum working distances for vibration intensive plant

Plant item	Rating / description	Min. working distance, m	
		Cosmetic damage[2]	Human response[3]
Bobcat	Travelling	1 (nominal)	Avoid contact with structure
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure
Excavator	<=30 Tonne (travelling/ digging)	5	15
Truck Movements[1]	Travelling loaded	5	10

Notes:
3. Renzo Tonin & Associates project files, databases & library
4. Based on DIN4150.3 Group 1 Buildings
5. For residential receivers

Site specific buffer distances shall be determined where vibration significant plant items, in particular jackhammers, operate within cosmetic damage minimum working distances detailed in Table 21 above. Where this occurs, minimum buffer distances to affected receivers shall be determined by site measurements prior to the commencement of the regular use of the vibration significant plant on site. The site specific minimum working distance shall be maintained in order to comply with relevant vibration limits.

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers:

- At the commencement of operation for each plant or activity on site (once only, not every day), which has the potential to generate significant vibration levels, attended vibration

monitoring should be undertaken so to refine the recommended minimum working distances set out in Table 21 and provide a site-specific table of minimum working distances

- Where vibration is found to be excessive, management measures shall be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller rock breakers, using alternative processes or establishment of larger minimum working distances.
- Carry out additional vibration monitoring when construction activities are at the nearest point to the nearby sensitive structures. This monitoring may signal to the contractor by way of a buzzer or flashing light, when levels approach/exceed the recommended limits.
- Before, during and after the demolition and construction stages we recommend preparation of a dilapidation report on the state of the existing buildings sharing the property boundary with the site.
- It is further recommended that a vibration complaints management system be established prior to the commencement of these works.

7 Conclusion

Renzo Tonin & Associates has completed an assessment of noise and vibration in regard to the operation and construction phases of proposed Australian Technology Park (ATP) redevelopment. While the Secretary's Environmental Assessment Requirements (SEARs) referred only to SEPP (Infrastructure) 2007, the assessment has been carried out in accordance with standard NSW policies and guidelines. Where relevant the report has presented recommended mitigation and management measures for the control of noise and vibration for both the construction and operational phases of the development. The report has also identified where additional detailed assessment may be required during the design development phase of the project.

References

[1] NSW Government, "State Environmental Planning Policy (Infrastructure)," Sydney, 2007.

[2] NSW Department of Planning, "Development in Rail Corridors and Busy Roads – Interim Guideline," NSW Department of Planning, Sydney, 2008.

[3] NSW EPA, NSW Industrial Noise Policy, Sydney: NSW EPA, 2000.

[4] Department of Environment and Climate Change NSW, "Interim Construction Noise Guideline," Department of Environment and Climate Change NSW, Sydney, 2009.

[5] Department of Environment and Conservation (NSW), "Assessing Vibration: A technical guideline," Department of Environment and Conservation (NSW), Sydney, 2006.

[6] NSW EPA, NSW Road Noise Policy, Sydney: NSW EPA, 2012.

[7] GTA Consultants, "Australian Technology Park, Eveleigh Redevelopment - Transport Impact Assessment 15S1478000 A-Dr2," GTA Consultants, Sydney, 2015.

[8] Bristish Standards Institution, "BS 6472-1992 Evaluation of human exposure to vibration in buildings (1-80Hz)," Bristish Standards Institution, London, 1992.

[9] Bristish Standard Institution, "BS 7385-2: 1993 Evaluation and measurement for vibration n buildings - Pt 2: Guide to damage levels from groundborne vibration," Bristish Standard Institution, London, 1993.

[10] DIN, "DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures," DIN Deutsches Institut fur Normung, Berlin, 1999.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

Appendix D:
Traffic Management Plan (TMP)

Prepared by: GTA Consultants

Australian Technology Park, Eveleigh
Proposed Mixed Use Development
Construction Traffic Management Plan

Client //	Mirvac Projects Pty Ltd
Office //	NSW
Reference //	15S1478000
Date //	16/12/15

Australian Technology Park, Eveleigh

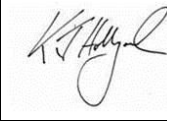
Proposed Mixed Use Development

Construction Traffic Management Plan

Issue: B 16/12/15

Client: Mirvac Projects Pty Ltd
Reference: 15S1478000
GTA Consultants Office: NSW

Quality Record

Issue	Date	Description	Prepared By	Checked By	Approved By	Signed
A	10/12/15	Final – For Test of Adequacy	Oasika Faiz/ Michael Lee	Michael Lee	Ken Hollyoak	Ken Hollyoak
B	16/12/15	Final – For SSDA Submission	Oasika Faiz/ Michael Lee	Michael Lee	Ken Hollyoak	

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Tables

1. Introduction

1.1 Background

This construction traffic and pedestrian management plan (CTPMP) accompanies a State Significant Development (SSD) application relating to three separate parcels of land within the Australian Technology Park (ATP). The SSD application seeks approval for three separate mixed used buildings. Mirvac has commissioned GTA Consultants to prepare the CTPMP to examine the impacts of the construction works on the surrounding road network and to detail the proposed construction traffic and pedestrian management measures.

This CTPMP has been prepared in accordance with the City of Sydney Standard Requirements for Construction Traffic Management Plans and Mirvac proposes to undertake all works in accordance with this CTPMP. The requirements are attached in Appendix A.

The overall principles of traffic management during the construction activity include:

- provide an appropriate and convenient environment for pedestrians
- minimise the impact on pedestrian movements
- minimise the impact on cyclist movements
- maintain appropriate capacity for pedestrians at all times on footpaths around the site
- maintain appropriate public transport access
- minimise the loss of parking wherever possible
- maintain access to/from adjacent buildings
- restrict construction vehicle movements to designated routes to/from the site
- manage and control construction vehicle activity in the vicinity of the site, and
- carry out construction activity in accordance with City of Sydney's approved hours of works.

1.2 Purpose of this Report

This report addresses the traffic and transport impacts during the construction phase of the development to satisfy Condition 6 of the Secretary's Environmental Assessment Requirements (SEARs).

The objectives of this report are:

- to provide a detailed description of the project and construction activities
- to examine and consider the proposal's likely impact to traffic on the surrounding road network
- to provide mitigating measures to address any traffic and transport impacts.

This report has been prepared and checked by engineers who hold the RMS Select/Modify Traffic Control Plans (Red Card) certification.

1.3 References

In preparing this report, reference has been made to the following:

- an inspection of the site and its surroundings
- Procedures for use in the Preparation of a Traffic Management Plan (TMP), Roads and Maritime Services (RMS), December 2001 (Version 2.0)

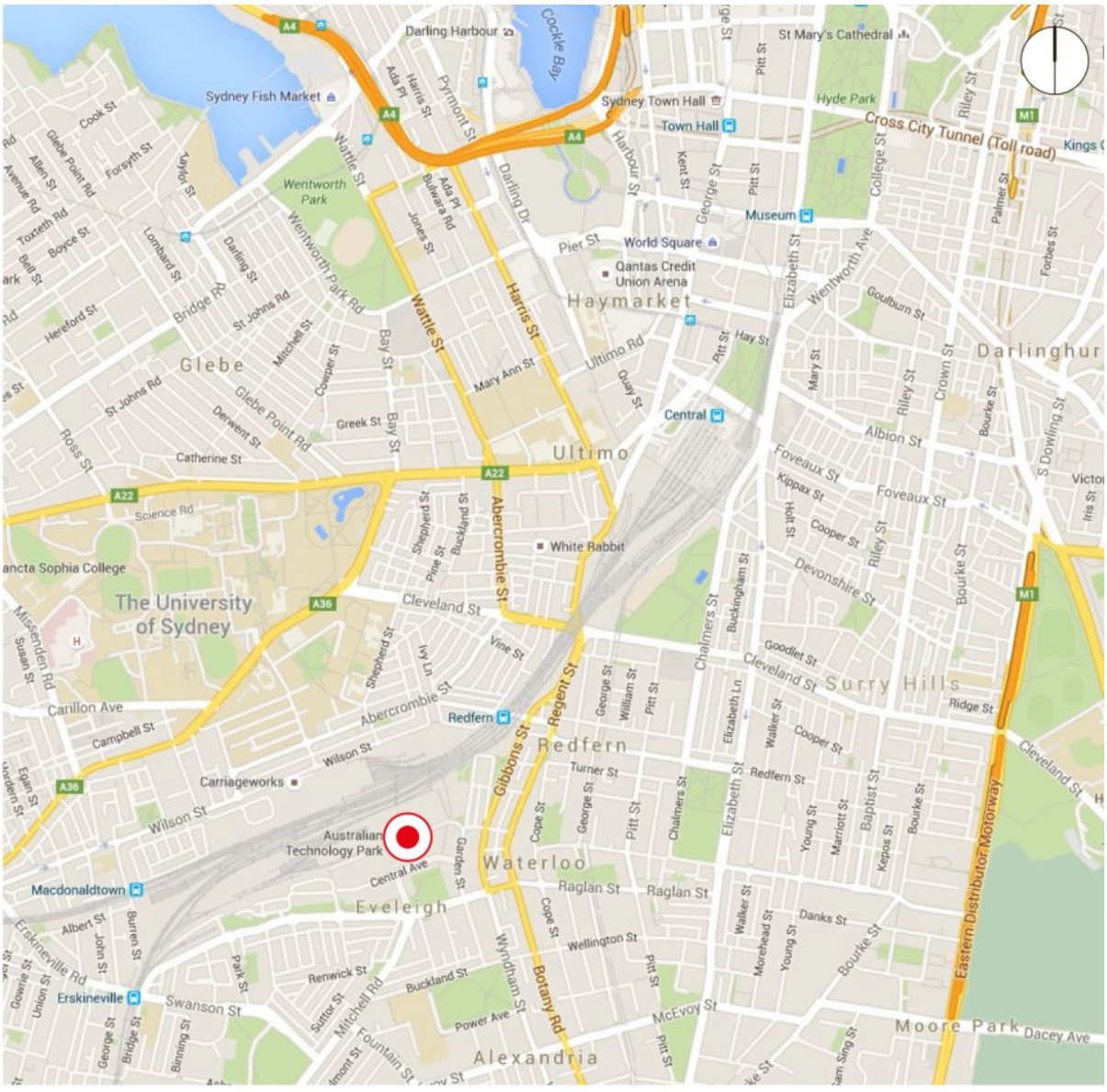
- Traffic Control at Work Sites manual, RMS, June 2010
- Australian Standard AS1742.3 – 2009 'Manual of Uniform Traffic Control Devices – Part 3: Traffic control for works on roads'.

2. Existing Conditions

2.1 Site Description

The ATP site is strategically located approximately 5km south of the Sydney CBD, 8km north of Sydney airport and within 200m of Redfern Railway Station. The site, with an overall area of some 13.2 hectares, is located within the City of Sydney local government area (LGA). Refer to Figure 2.1 below for a graphic representation of the site location and context.

Figure 2.1: Site Location



Three key sites remain undeveloped within the ATP site and are presently used for at-grade worker and special event car parking. These sites are:

- Lot 8 in DP 1136859 – site area circa 1,937m^2
- Lot 9 in DP 1136859 – site area circa 8,299m^2
- Lot 12 in DP 1136859 – site area circa 11,850m^2.

In addition, the site contains the Locomotive Workshops which is a large heritage listed masonry and steel former railway building, which has undergone adaptive re-use in recent years for commercial purposes. This building comprises of PT 4000 in DP 1194309. Figure 2.2 provides an aerial image of the ATP site along with identifying the three development sites and the Locomotive Workshop.

Figure 2.2: Existing Site Layout

2.2 Road Network

The subject site is generally bounded by local streets with Garden Street and Cornwallis Street located to its east and Henderson Road located to its south. On the site's northern boundary runs the railway line. The ATP site is accessed by two internal roads, namely at Central Avenue from Garden Street and Davy Road from Henderson Road. A description of the roads in the immediate vicinity of the site is summarised below.

Henderson Road is a two-way road aligned in an east-west direction. Henderson Road is a four-lane road to the east of Davy Road and a two-lane road to the west of Davy Road. Henderson Road is a regional road which is owned by Roads and Maritime Services (RMS), but maintained by Council with funding from the State Government. At intersections, Henderson Road includes auxiliary turning lanes. Kerbside parking lanes are also available on both sides of the road. It contains a carriageway width of 14 to 17 metres within an approximately 25 metre road reserve.

Garden Street is a two-way, two-lane local road aligned in the north-south direction. It has a 12 metre wide carriageway with kerbside parking within a 25 metre wide road reserve. North of Central Avenue the carriageway widens to allow 90 degree parking on the western side of the road. Garden Street bends to the east at its intersection with Cornwallis Street and continues in an east-west alignment to the Gibbons Street intersection with Wyndham Street.

Cornwallis Street continues in a north-south alignment from Garden Street to Redfern Station. Cornwallis Street is a one-way local road in the southbound direction configured with a 6 metre carriageway within a 12 metre wide road reserve. Kerbside parking is permitted on the eastern side of the road.

Central Avenue is an internal two-way road configured with two lanes separated by a central median, on a 20 metre wide carriageway and 30 metre wide road reserve.

Davy Road is an internal two-way road configured with four lanes separated by a central median on a 15 metre carriageway and a 25 metre wide road reserve. At the intersection with Henderson Road, Davy Road includes an additional southbound, right turn lane.

Both Central Avenue and Davy Road are private roads.

2.3 Public Transport

2.3.1 Train Services

Redfern Railway Station is located approximately 300m north-east of the ATP site and is within a 4 minute walk. The station is a major stop in the Sydney Trains network, with frequent services on four rail lines, namely T1 North Sore, Northern & Western Line, T2 Airport, Inner West & South Line, T3 Bankstown Line, T4 Eastern Suburbs & Illawarra Line. The services are shown in Table 2.1.

Table 2.1: Rail Service Provision

Lines	Frequency Peak Period	Frequency Off Peak
T1 North Sore, Northern & Western Line	3 minutes	4 minutes
T2 Airport, Inner West & South Line	5 minutes	5-15 minutes
T3 Bankstown Line	10-15 minutes	10-15 minutes
T4 Eastern Suburbs & Illawarra Line	4 minutes	10 minutes

Data Source: www.transportnsw.info (accessed 05 November 2015)

2.3.2 Bus Services

Regular scheduled bus services also service the area. Bus stops are located within 2 minute walking distance from the site including on Henderson Road and Wyndham Street.

The available bus services are summarised in Table 2.2.

Table 2.2: Bus Service Provision

Service	Route	Route Description	Location of Stop	Distance to Nearest Stop	Frequency On/Off Peak
Bus	305	Mascot (Stamford Hotel) to Railway Square	Wyndham St near Boundary Street	120m	30 minutes between 3pm and 6.30pm
Bus	308	Marrickville Metro to City	Wyndham St near Boundary Street	120m	15 minutes peak/ 30 minutes off peak
Bus	309	Port Botany to Railway Square	Wyndham St near Boundary Street	120m	5-15minutes peak/ 20 minutes off peak
Bus	310	Eastgardens to Railway Square	Wyndham St near Boundary Street	300m	15 minutes peak/ 30 minutes off peak

Data Source: www.transportnsw.info (accessed 05 November 2015)

As can be seen from the above, the site is located in easily walking distance to existing public transport services with regular and high frequency services.

2.4 Pedestrian Infrastructure

Pedestrian footpaths are located on both sides of all streets, surrounding and internal to the site. Public roads include footpath widths of 1.5-2 metres along Henderson Road, and 2.5 metres along Garden Street. The site's internal roads, Central Avenue and Davy Road contain footpaths of 3 to 4 metres in width which are connected to pedestrian only spaces within the site.

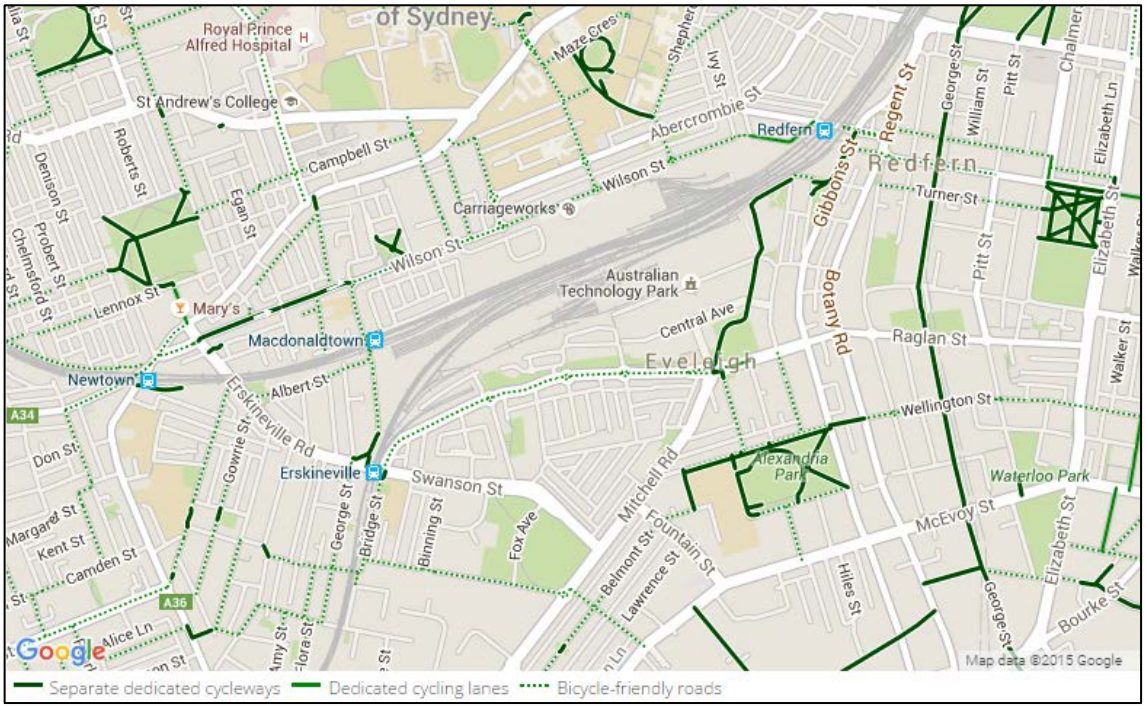
Marked foot crossings are provided at all signalised intersections within the area including along Henderson Road, and on the western and southern legs of the Wyndham and Garden Street intersection, which is located on the way to Redfern Railway Station from the site.

2.5 Cycle Infrastructure

The ATP site is well situated within Sydney's cycle network with cycle routes surrounding the site and an off-road cycle route passing the site itself. A shared path between Henderson Road and Cornwallis Road runs through the site via the Vice Chancellors Oval and Mitchell Way (internal road).

The bicycle network surrounding the site is shown in Figure 2.3.

Figure 2.3: Cycle Network



Source: http://www.sydneycycleways.net/map/ (accessed 05 November 2015)

2.6 Existing Car Parking Supply

The ATP site currently contains a total of 1,159 car parking spaces spread across the site as follow:

- Spaces accessible from Davy Road, Central Avenue and Locomotive Street:
  - Channel 7 Building Visitor Parking – 363 spaces
  - Channel 7 Building Staff Parking – 339 spaces
  - Open air car park (Lot 12) (adjacent to Locomotive Workshop) – 280 spaces
  - Biomedical Building Staff Parking – 33 spaces
  - open air car park adjacent to Biomedical Building (Lot 8) – 53 spaces
  - Locomotive Workshop – 4 spaces
  - Sub-Total – 1,072 spaces
- Spaces not accessible from Davy Road, Central Avenue and Locomotive Street:
  - Nicta Building – 66 spaces
  - NIC Building – 4 spaces
  - IBC Building – 17 spaces
  - Sub-total – 87 spaces
- total – 1,159 spaces

In addition to the above, another 272 car parking spaces are located in an open air car park in front of the Channel 7 Building (Lot 9). However this car park is currently closed and not utilised. As such, for the purposes of the parking assessment in this report, the car parking provision of the ATP site is assumed to exclude this car park.

3. Overview of Construction Activities

3.1 Description of Construction Activities

The following works are to be undertaken under this project:

- site preparation works, including demolition and clearance of the existing car parking areas/ancillary facilities and excavation
- construction and use of a 9 storey building within Lot 9 (Building 1), comprising of parking, retail, commercial and childcare uses
- construction and use of a 7 storey building within Lot 12 (Building 2) comprising of parking, retail and commercial uses
- construction and use of a 4 storey community building within Lot 8 (Community Building) comprising of gym, retail, community, commercial and childcare uses
- extensive landscaping and public domain improvements throughout the precinct
- extension and augmentation of physical infrastructure/utilities as required.

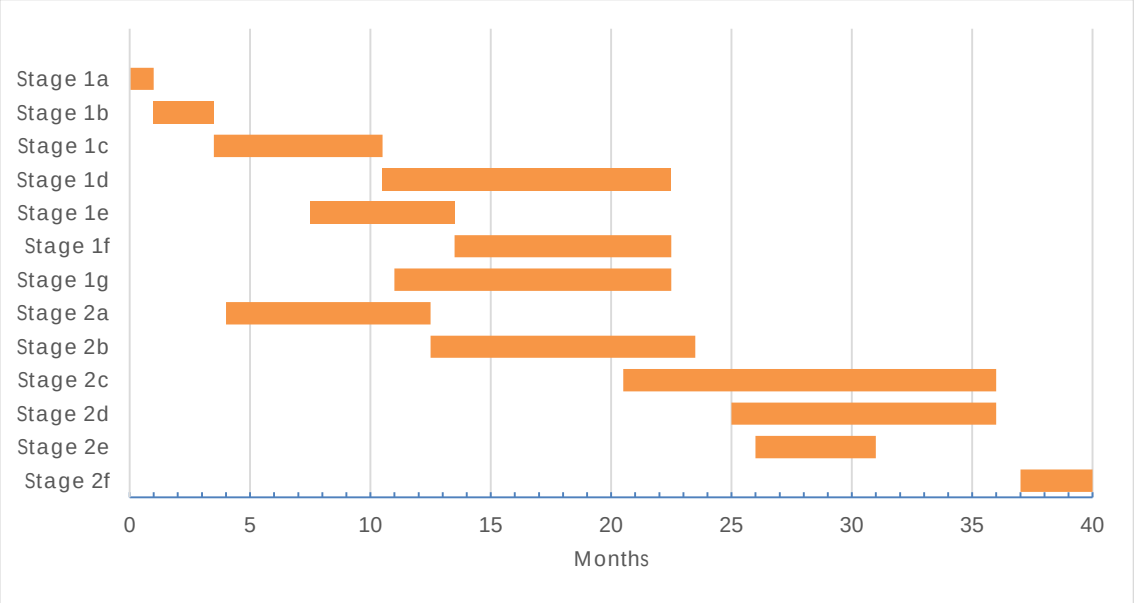
The project is scheduled to be carried out in stages with works to commence in late 2016/ early 2017 and to be completed by mid 2020. Construction of the three buildings would overlap, with Building 2 works to commence after Building 1, and the community centre works to commence after Building 1. The staged construction schedule is detailed in Table 3.1 and shown figuratively in Figure 3.1.

Table 3.1: Construction Description and Duration

Stage	Phase	Description	Duration
Stage 1	**1a.** Building 1 Piling Works	Foundation piling	1 month
	1b. Building 1 Excavation	Bulk excavation and detailed excavation Below Ground Services	2.5 months
	1c. Building 1 Structure Construction	Construction of 12 Storey structure	7 months
	1d. Building 1 Fit out	Fit out works for commercial, retail and childcare uses	12 months
	1e. Community Centre Construction	Construction of 4 storey timber framed structure	6 months
	1f. Community Centre Fitout	Fit out works for commercial, retail and childcare uses	9 months
	1g. Public Domain Works – Building 1/ Community Centre and Oval	Public Domain works surrounding Building 1 including Central Avenue. Public Domain works surrounding the Community Centre and the Oval.	11.5 months
Stage 2	**2a.** Building 2 Excavation and Piling	Retention wall piling Bulk excavation Bulk and Detailed excavation Foundation piling Below ground services	8.5 months

Stage	Phase	Description	Duration
	2b. Building 2 Structure Construction	○ Construction of 7 storey structure.	11 months
	2c. Building 2 Fit out	○ Fit out works for commercial and retail uses	15.5 months
	2d. Public Domain Works – Building 2	○ Public Domain works surrounding Building 2 including roads.	11 months
	2e. Public Domain Works – Leisure Courts	○ Public Domain works to Leisure Courts	5 months
	2f. Public Domain Works – Vice Chancellor's Oval	○ Public Domain works to Oval	3 months

Figure 3.1: Indicative Construction Staging and Duration



Note: Schedule subject to change based on final planning

3.2 Work Hours

The permitted hours of work will be conditioned in the development approval. However, construction work hours for construction sites within the City of Sydney would typically be as follows:

- Monday to Friday 7:00am – 6:00pm
- Saturday 7:00am – 5:00pm
- No work will be carried out on Sundays and Public Holidays without prior approval by the relevant authorities.

Works outside of the approved hours will be subject to agreement and approval by City of Sydney Council and/or the relevant approving authority.

3.3 Contact Details

Mirvac representatives will be on-site during all construction works. The roles and contact details of key Mirvac personnel are detailed in Table 3.2.

Table 3.2: Contact details

Organisation	Project Role	Contact Name	Contact Number
Mirvac	Construction Manager	Dominic Callanan	0403 601 330
Mirvac	Site Manager	TBC	TBC
Emergency			000
NSW Police (Sydney City LAC)			02 8303 5199
NSW Fire and Rescue (Redfern Fire Station)			02 9698 1161

3.4 Site Access

The project includes the construction of three buildings on three separate sites within ATP. To reduce the likelihood of congestion from the cumulative traffic generated by the three construction sites, separate entry and egress routes through ATP have been provided for each site with one-way circulation.

To support this objective, a temporary egress road is to be constructed between Central Avenue and Henderson Road. The temporary egress will be located west of the Building 1 site and would allow the Building 1 construction traffic to exit the site by left turn only onto Henderson Road, without interacting with Building 2 or the Community Building construction traffic. This temporary access will be managed by a traffic controller during all truck movements.

Construction traffic will also utilise Locomotive Street for access to Building 2 and public domain construction works. In this regard, construction vehicles would undertake a u-turn prior to the Channel 7 loading docks to exit the site. Swept path analysis has been conducted and the relevant swept path diagrams are provided in Appendix B.

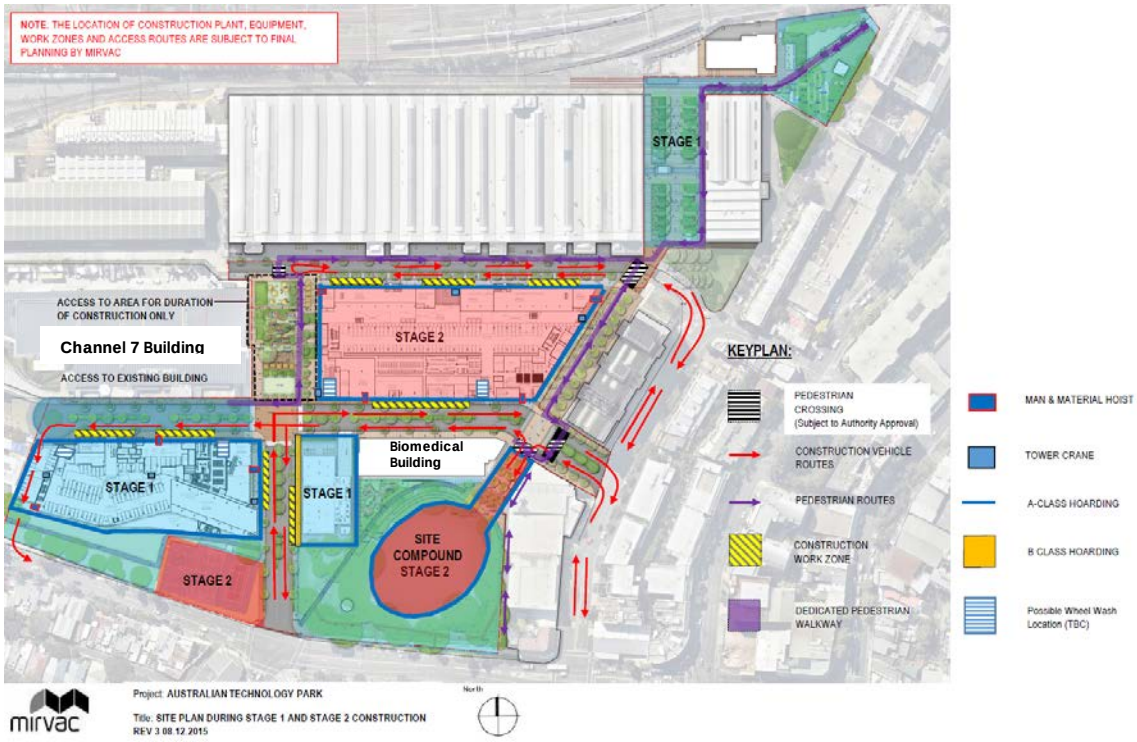
The access routes through the site for each building site are as follows:

- Building 1 – entry from Henderson Road via the Davy Road access, exit from Central Avenue to the temporary egress road to Henderson Road
- Building 2 - entry from Henderson Road via the Davy Road access, exit from Central Avenue to Garden Street and also entry/exit from Locomotive Street
- Community Centre - entry from Garden Street via the Central Avenue access, exit from Davy Road to Henderson Road.

All accesses into the ATP site used by construction vehicles will be managed by a traffic controller during all truck movements. Traffic controllers would ensure there is no conflict between construction vehicles, general and pedestrians.

The proposed construction access routes are shown in Figure 3.2.

Figure 3.2: Site Access Routes



Source: Mirvac

3.5 Works Zone

Construction activities will involve the delivery to site of new facade panels, construction materials and the removal of excavation and building waste. An on-street works zone will be required for each site for the delivery of these materials. The proposed location of the works zones are as follows:

- Building 1 – northern (Central Avenue) and eastern (Davy Road) boundary of site
- Building 2 – northern (Locomotive Street) and southern (Central Avenue) boundary of site
- Community Centre – western (Davy Road) boundary of the site.

The location of the each proposed works zone is shown in Figure 3.2.

It is noted that all internal roads within the ATP site are private roads.

Davy Road would be reduced from a four lane road to a two-lane road to allow a works zone adjacent to both Building 1 and the Community Building. To maintain pedestrian walking routes through the site, pedestrian footpaths on at least one side of the road would be maintained. As such it is proposed to maintain pedestrian access through the eastern footpath of Davy Road, at the frontage of the Community Building construction site.

The craning of material from the works zone over an unprotected footpath is not permitted. As such, Class B hoarding would be constructed between the works zone and the western property boundary of the Community Centre to ensure safe passage of pedestrians.

It is proposed to close the pedestrian footpaths along the boundaries of Building 1 and Building 2 where pedestrian access is not critical and is able to be redirected to the opposite side of the

road. Pedestrian access into existing buildings would be maintained with no works zones proposed at the frontage of existing buildings.

The proposed works zones would be installed so as not to interrupt traffic flow along the roads.

All works zones are proposed along the internal roads of the ATP site. No works zones are proposed along public roads or footpaths.

3.6 Plant and Equipment

The materials and equipment required for the subject construction works are generally as follows:

- rigid truck (up to 12.5m) and up to 19m semi-trailer for the exportation of excavated material off site
- concrete trucks for delivery of ready mix concrete
- mobile cranes, of various sizes, for erection of site amenities, tower cranes and miscellaneous lifting
- rigid trucks (up to 12.5m) and 19m semi-trailer for delivery of materials
- medium rigid vehicles, small rigid vehicles, vans and couriers to deliver smaller materials
- for Building 1, tower cranes erected during the detailed excavation phase and Alimak twin man/material hoists to be erected during the tower structure works
- for Building 2, tower cranes erected during the detailed excavation phase and Alimak twin man/material hoists to be erected during the tower structure works.

From the above, the largest truck would be a 19m semi-trailer. Use of any larger vehicles will require approval from the City of Sydney in a separate application.

3.7 Construction Workers

The number of construction workers at the site would vary throughout each stage of the project as shown in Figure 3.3. It is anticipated that the peak number of personnel on site would occur around late 2018, where cumulative works from all three sites would see over 900 workers coming to the ATP site in a day. The arrival and departure patterns of workers during this peak month are shown in Figure 3.4.

Figure 3.3: Number of Site Personnel per Month

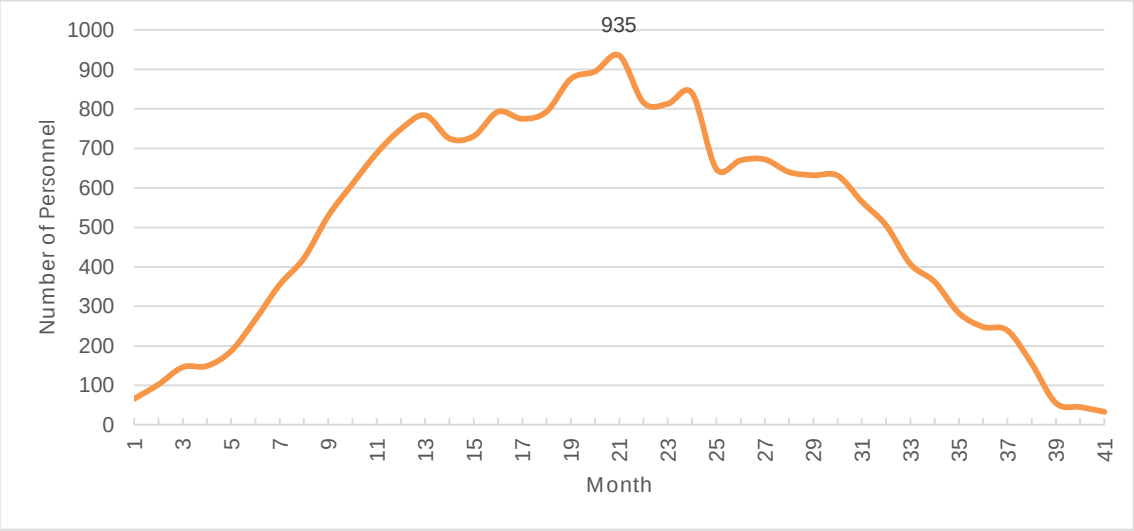
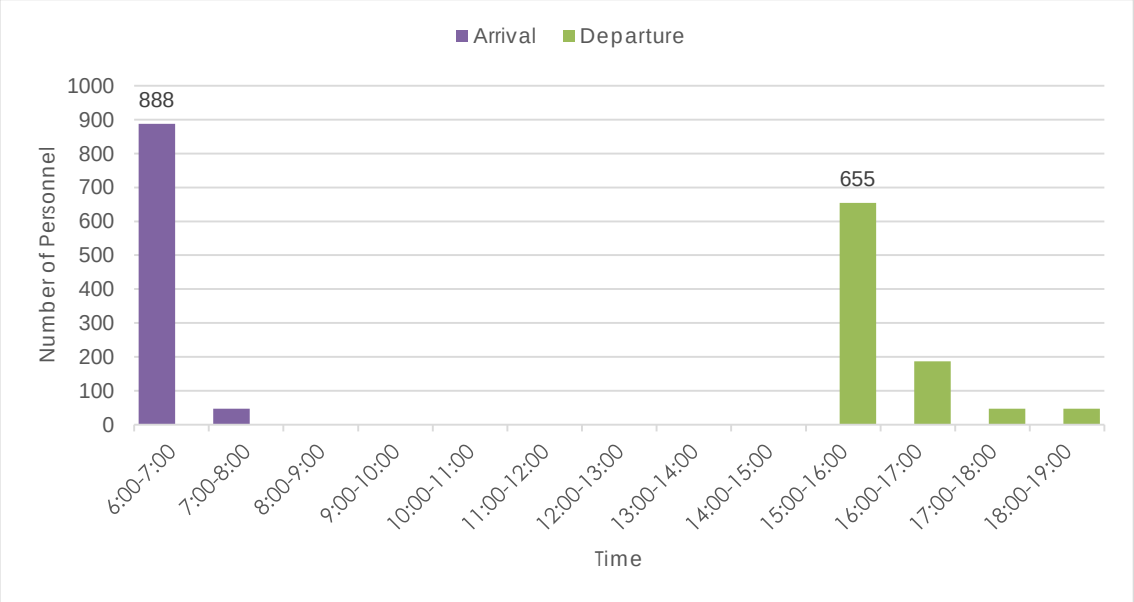


Figure 3.4: Arrival and Departure Volumes of Site Personnel – Peak Month



4. Construction Traffic Assessment

4.1 Construction Traffic Volumes

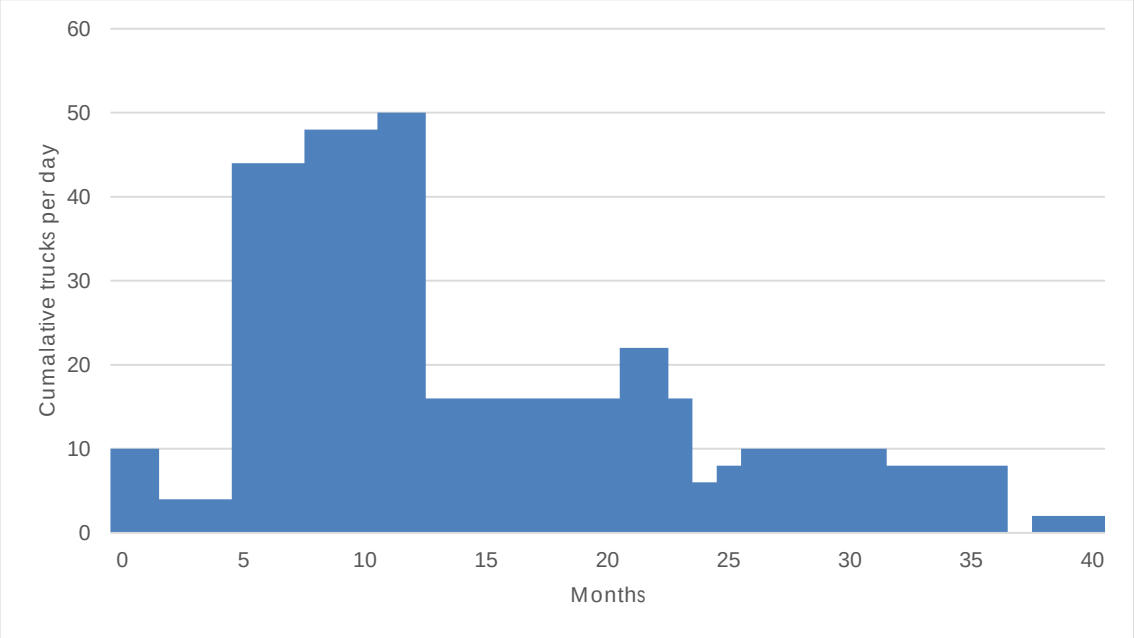
The estimated number of (two-way) construction vehicle movements per day and type of vehicle is detailed in Table 4.1 for each construction stage.

Table 4.1: Indicative Construction Traffic Volumes

Construction Stage	Average No. of Trucks Per Day	Average No. of Truck Movements Per Day	Cumulative Truck Movements per Day [1]	Cumulative Truck Movements per Hour [1]	Vehicle Type/ Size
1a. Building 1 Piling Works	10	20	20	2	8.8m Medium Rigid 12.5m Large Rigid 18.1m Truck & Dog/ 19m Semi-Trailer
1b. Building 1 Excavation	4	8	8	1	8.8m Medium Rigid 12.5m Large Rigid 18.1m Truck & Dog/ 19m Semi-Trailer
1c. Building 1 Structure Construction	4	8	100	9	8.8m Medium Rigid 12.5m Large Rigid
1d. Building 1 Fit out	4	8	96	9	8.8m Medium Rigid
1e. Community Centre Construction	4	8	96	9	8.8m Medium Rigid
1f. Community Centre Fitout	4	8	32	3	8.8m Medium Rigid
1g. Public Domain Works – Building 1/ Community Centre and Oval	2	4	100	9	8.8m Medium Rigid
2a. Building 2 Excavation and Piling	40	80	88	8	8.8m Medium Rigid 12.5m Large Rigid 18.1m Truck & Dog/ 19m Semi-Trailer
2b. Building 2 Structure Construction	6	12	32	9	8.8m Medium Rigid 12.5m Large Rigid
2c. Building 2 Fit out	6	12	44	4	8.8m Medium Rigid
2d. Public Domain Works – Building 2	2	4	16	2	8.8m Medium Rigid
2e. Public Domain Works – Leisure Courts	2	4	20	2	8.8m Medium Rigid
2f. Public Domain Works – Vice Chancellor's Oval	2	4	4	1	8.8m Medium Rigid

[1] These volumes indicate the cumulative truck movements per day/ hour at the commencement of each stage.

Figure 4.1: Daily Cumulative Truck Volumes



Based on Table 4.1, on average, the maximum vehicle volumes per day would be 40 vehicles per day (or 80 two-way movements per day). Taking cumulative works into consideration as shown in Figure 4.1, the average peak vehicle volumes would be 50 vehicles per day (100 two-way movements per day). It is not expected that this low level of daily traffic movements would create any adverse impact on the surrounding road network.

4.2 Staff Traffic

All staff will be encouraged to utilise public transport to access the site. The following measures will be in place to encourage staff to use public transport:

- during the induction and regular management meetings, staff will be informed of restricted parking conditions on site and the surrounding streets
- during the induction and regular management meetings, staff will be instructed to use public transport to access the site and public transport timetable information will be made available and displayed at prominent locations
- the above measures will be included in contract documents between Mirvac and its subcontractors.

As such, it is not expected there would be any staff generated traffic during the construction stage.

4.3 Construction Vehicle Routes

Generally, construction vehicles will have origins and destinations from a wide variety of locations throughout Sydney. However, all construction vehicles will be restricted to the State and Regional Road network, where possible.

As such, dedicated construction vehicle routes have been developed with the aim of providing the shortest distances to/from the arterial road network whilst minimising the impact of construction traffic on streets within the vicinity of the site.