ACOUSTIC REPORT

FOR

PORTSIDE EAST – BUILDING 16A AND 16B
HAMILTON

EMF GRIFFITHS

Consulting Engineers

BROOKFIELD RESIDENTIAL PROPERTIES ON BEHALF OF
MULTIPLEX PORTSIDE EAST PTY LTD
Client

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SECTION 1.0 SITE DESCRIPTION

1.1 INTRODUCTION

EMF Griffiths have been engaged by Multiplex Portside East Pty Ltd to provide acoustic consultancy for the architectural and building services of the proposed mixed use development at Lot 16A and 16B Port side East, Hamilton.

The development proposal comprises two buildings that rise from a retail plaza. The site comprises:-

Tower 16A:	20 storey residential tower
Tower 16B:	20 storey residential tower
Ground Level:	Retail tenancies

Car parking is provided in a two level basement and level 1 with spaces for residents, retail tenants and visitors.

The proposed mix is as follows:-

Tower 16A	
1 bed apartments:	70
2 bed apartments:	46
3 bed apartments:	47
Penthouses	6
Tower 16B	
1 bed apartments:	74
2 bed apartments:	46
3 bed apartments:	47
Penthouses	6
Total apartments:	342 units
Ground Level	1966 m² NLA.

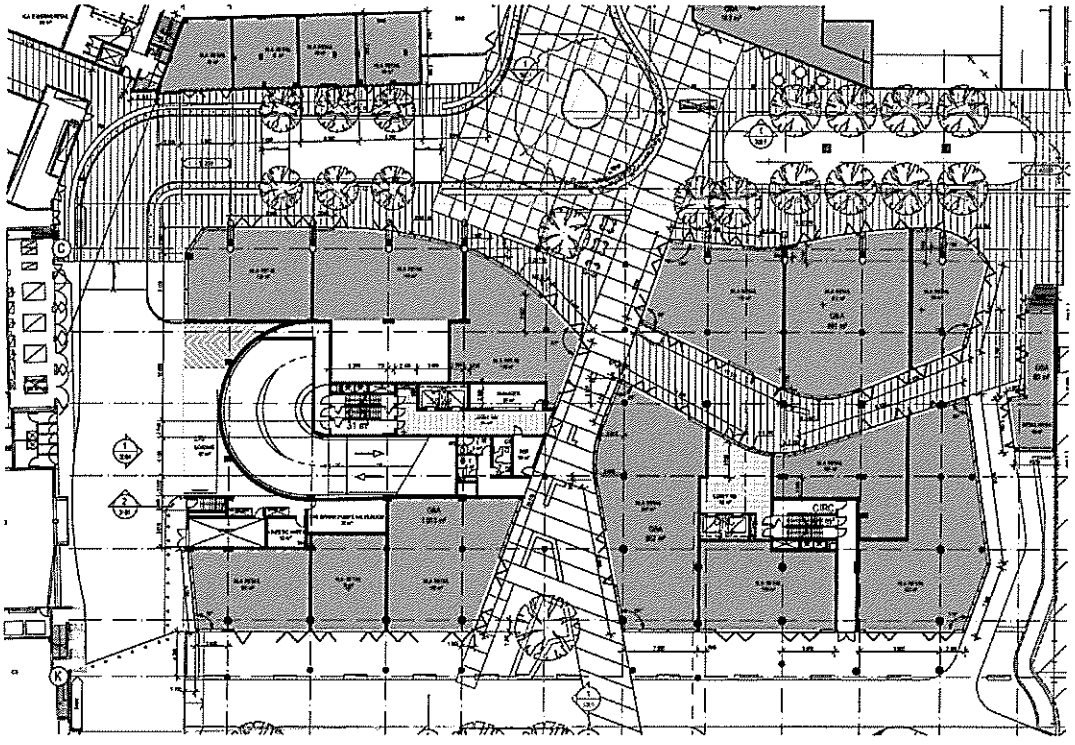


Figure 1: Site Plan

1.2 BACKGROUND

An acoustic assessment for noise intrusion to maintain appropriate levels of amenity for the building residents and users is required along with assessment of impact on adjacent noise sensitive receivers.

The assessment reviews building layout drawings, mechanical services, architectural schedules and proposes acoustic design recommendation with respect to the acoustic requirements of :-

- Local and State Regulations propose acoustic design recommendations including requirements of Brisbane City Council (BCC) Noise Impact Assessment Planning Scheme Policy (NIAPSP) and the State Environmental Protection (Noise) Policy 2008.
- The BCA 2014 section F5.
- Australian Standard AS 2107-1987 Acoustics - Recommended design sound levels and reverberation times for building interiors.
- Australian Standard AS 2021-2000 Acoustics- Aircraft noise intrusion- Building siting and construction.

1.3 OBJECTIVES

Acoustic study as follows:-

- Identification of target internal noise levels.
- Identification of noise emissions targets.
- Characterisation of noise emissions associated with the external mechanical plant (including pumps, fans and chiller noise) and activities (e.g. waste and on site vehicle movements, outdoor space noise emissions from site occupants) associated with the development.
- Characterisation of noise from external sounds such as nearby roads, aircraft noise and industrial sources.
- Acoustic Modelling, calculations and recommendations for appropriate noise amelioration measures to mitigate noise impact for the building residents and building users.
- Acoustic design in accordance with requirements of the Building Code of Australia.
- Acoustic Design of Noise Control Measures for Mechanical Ventilation. The noise emanating from the mechanical ventilation system shall be in accordance with the requirements of Appendix B of the Australia Standard AS 1055.2-1984 (Description and Measurement of Environmental Noise).
- Acoustic design based on measured environmental noise statistical noise characterisation parameters, as defined in AS1055.1-3 1997 accounting for:-
  - Tonality.
  - Frequency weighting.
  - Impulsive characteristics.
  - Fluctuations and temporal content.
  - Recommended maximum planning noise levels.

1.4 SUBJECT SITE - LOCATION AND DESCRIPTION

The site is located in Hamilton, Queensland. The site and location are shown in the PDonline satellite image in Figure 2.

Figure 2: Aerial View of Subject Site

The site is located in the Portside EDQ Precinct which is a residential/ mixed use area of Hamilton as shown in the zoning map below.

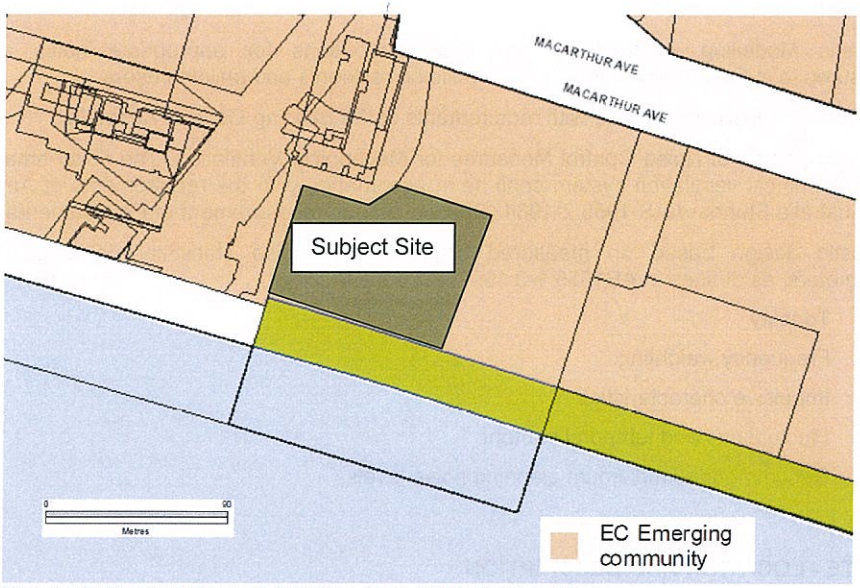


Figure 3: Extract From BCC City Plan 2014 Zoning Map

Figure 5 shows an extract from the site plan indicating the proposed configuration of the re-developed site. The site is located outside the designated transport corridor for Kingsford Smith Drive (Refer Appendix C – extract in Figure 4) and there is significant shielding from the intervening buildings. However some of the upper levels are exposed to this road. The site is outside the ANEF 20 boundary as shown in the airport overlay (including impacts from the second runway) in Appendix E. However, based on the Brisbane Airport N70 map there are significant (approx. 30) over aircraft noise events over 70dB(A) and hence the development is to include design elements to mitigate the impact within the units.

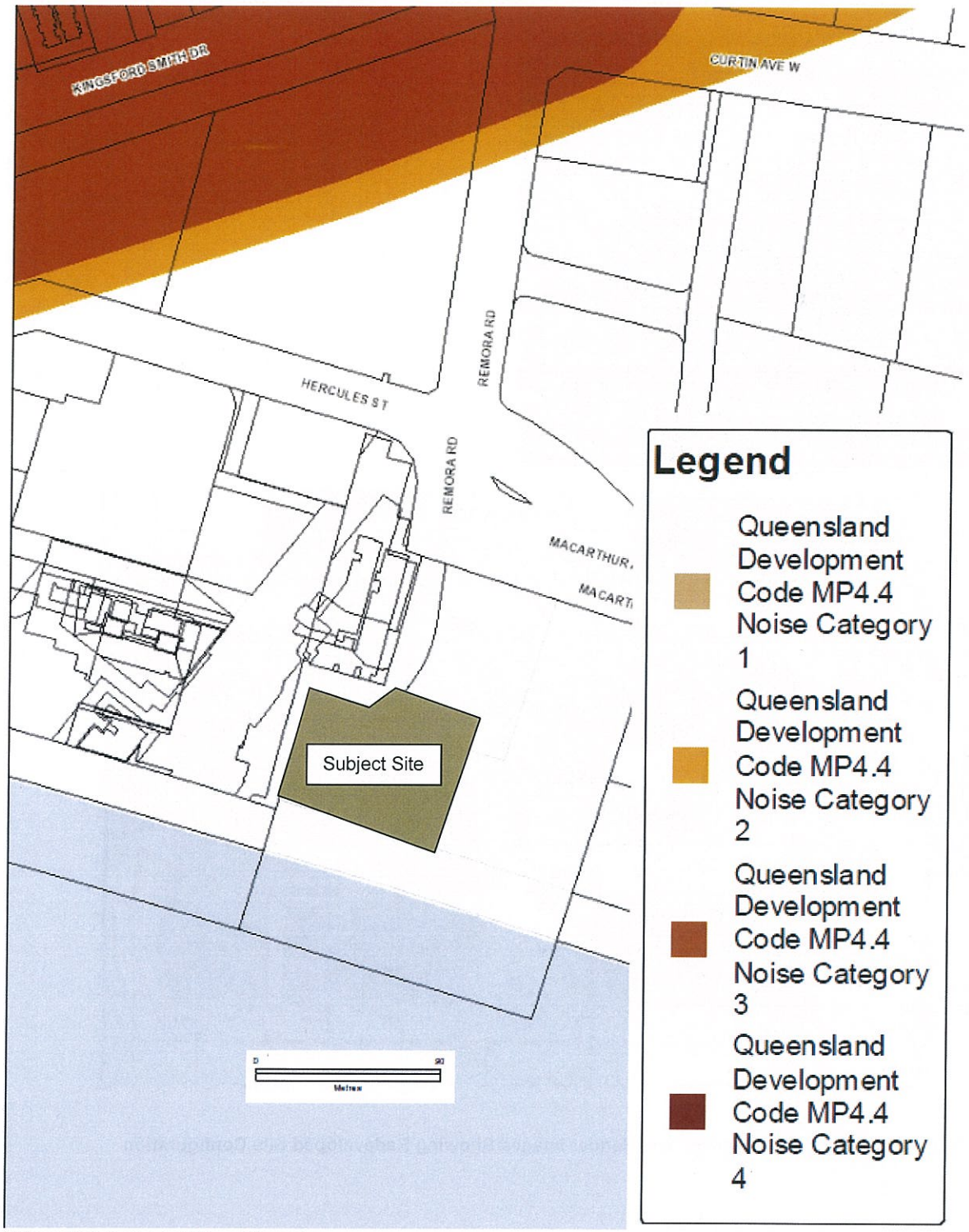


Figure 4: Location of Road Corridor

Figure 5: Extract from Drawings and Render Images Showing Redeveloped Site Configuration

1.5 NEAREST NOISE SENSITIVE RECEIVERS

The nearest noise sensitive receivers to proposed development are the adjacent mixed use, residential and commercial developments listed below. There is also a common open space area to the North West.

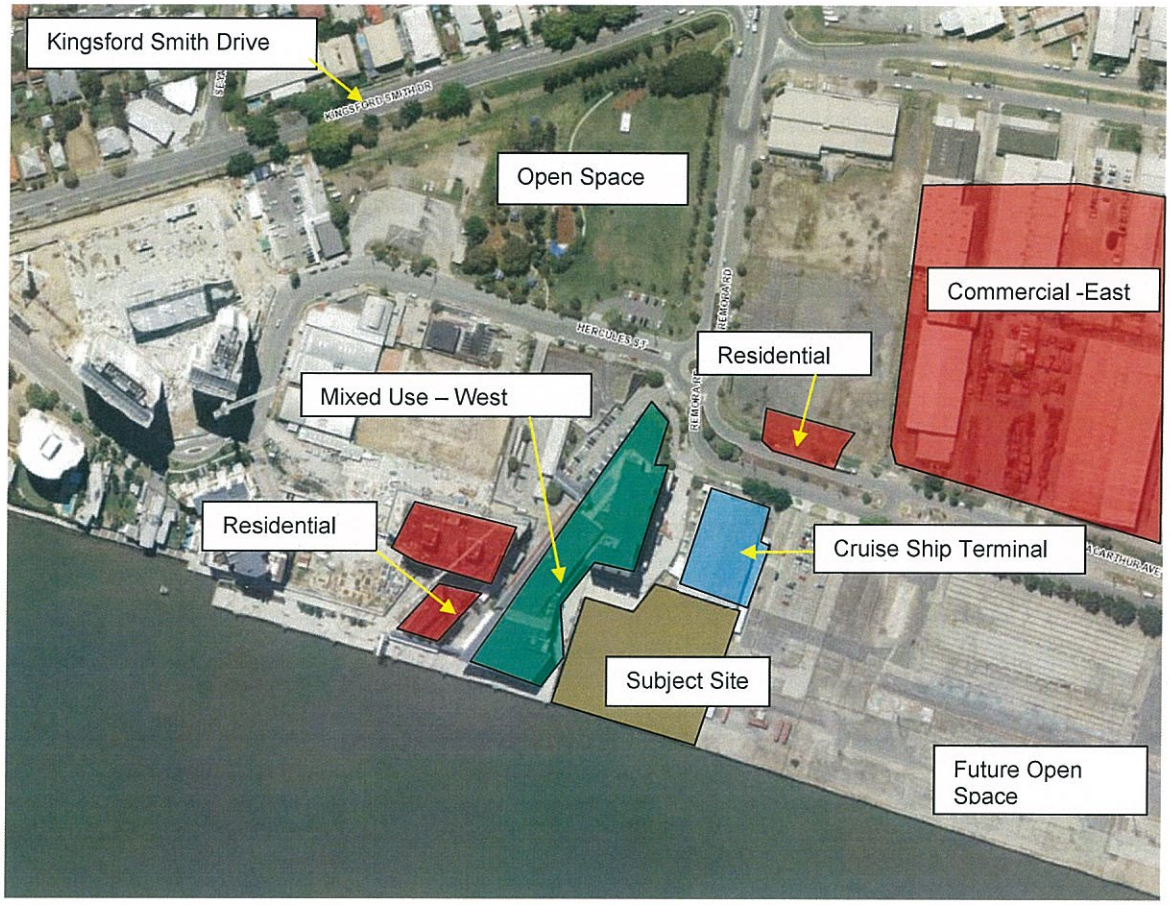


Figure 6: Extract from Drawings Showing Redeveloped Site Configuration

Noise source propagation modelling has been used to assess the impact of noise sources from the proposed development on these existing adjacent noise sensitive receivers.

SECTION 2.0 GENERAL AMENITY ISSUES

2.1 EXISTING NOISE AMENITY

Typical Noise Levels at the subject site (see Figure below) are shown in the table below. Noise sources at the subject site are:-

- Traffic Noise from adjacent roads, Kingsford Smith Drive, Remora Road and Hercules Street.
- Vehicle noise from passenger and commercial vehicles entering and leaving the area.
- Noise from planes flying overhead.
- Noise from users of the adjacent sites and commercial properties including
- Nose from waste trucks and waste management activities at the adjacent mixed use development
- Noise from vehicles using the loading docks at the adjacent mixed use development to the west.
- Building services noise (loading dock exhaust, cooling towers, kitchen exhaust, ventilation units) at adjacent development to the west as well as the cruise ship terminal.

The L_{A90} Rating Background Noise Levels (RBL) typical of the area are summarised below:-

Period	Time	Noise Level dB(A)		
		$L_{Aeq\text{-}1hour}$	$L_{A90\text{-}1hour}$	$L_{A10\text{-}1hour}$
Day	0700-1800	55	52	58
Evening	1800-2200	51	48	54
Night	2200-0700	49	46	52

Table 3: Typical Noise Data for Area

$L_{10\text{-}1hr\ max}$ 7am-6pm	$L_{10\ 1hr\ max}$ 6pm-10pm	$L_{10\ 1hr\ max}$ 10pm-7am
63	62	52

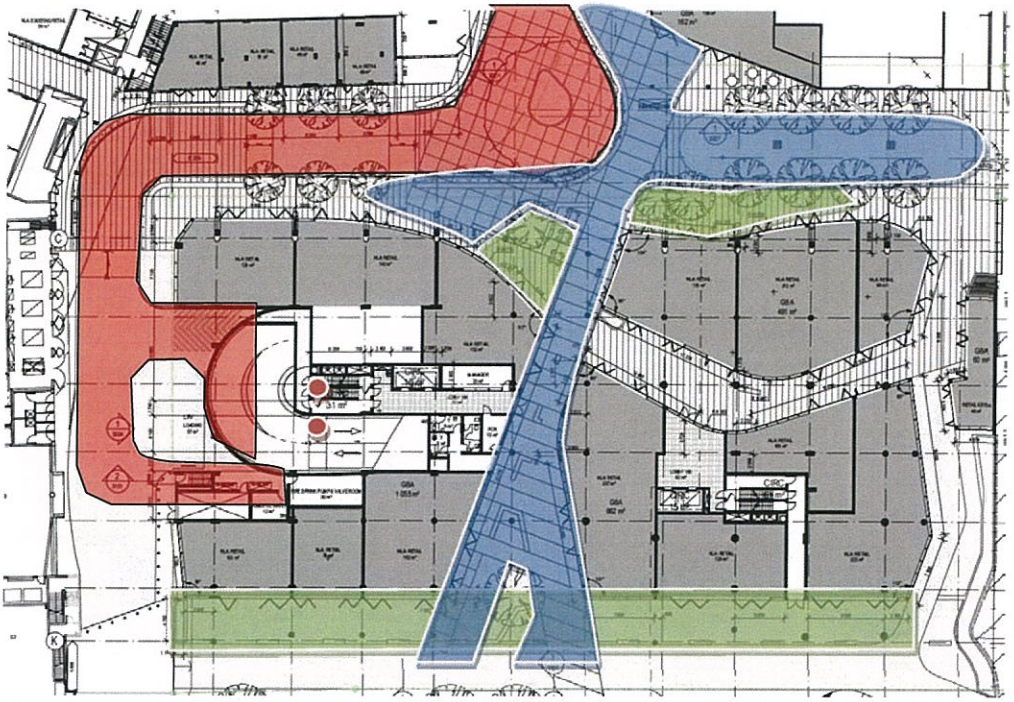
Table 4: Noise Survey Results

2.2 NOISE SOURCES

There are a variety of noise sources at the proposed development including:-

- Mechanical Plant Noise from car park fan exhausts at the ground level.
- Noise from operation of mechanical services.
- Noise from operation of kitchen exhausts from retail area where retail areas require a kitchen. These are to be discharged horizontally at the roof level of the retail tenancy.
- Noise transmitted by internal building services and pipework.
- Noise from waste vehicles and loading vehicles at ground level.
- Noise from passenger vehicles entering and leaving the car park at ground level and on level 1.
- Noise from users of the retail precinct, outdoor dining areas, common areas and private outdoor areas.

The following section identifies the location and levels of the significant noise sources which have been considered in the assessment. The figures below show the location of the noise sources associated with the development. Note precise locations of mechanical plant are to be determined and the locations shown are indicative only.


Key
Vehicle Noise
Pedestrian Noise
Restaurant Noise

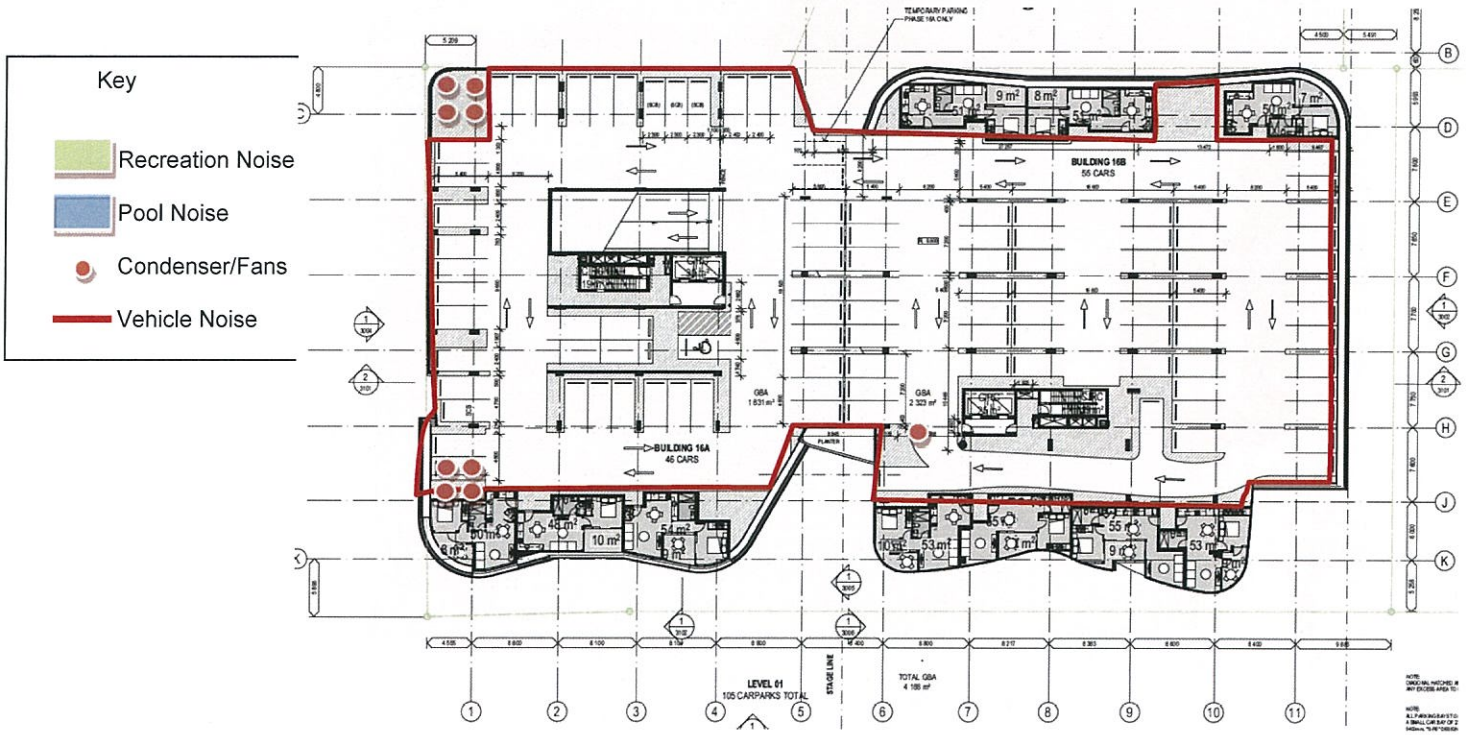


Figure 9: Level 1

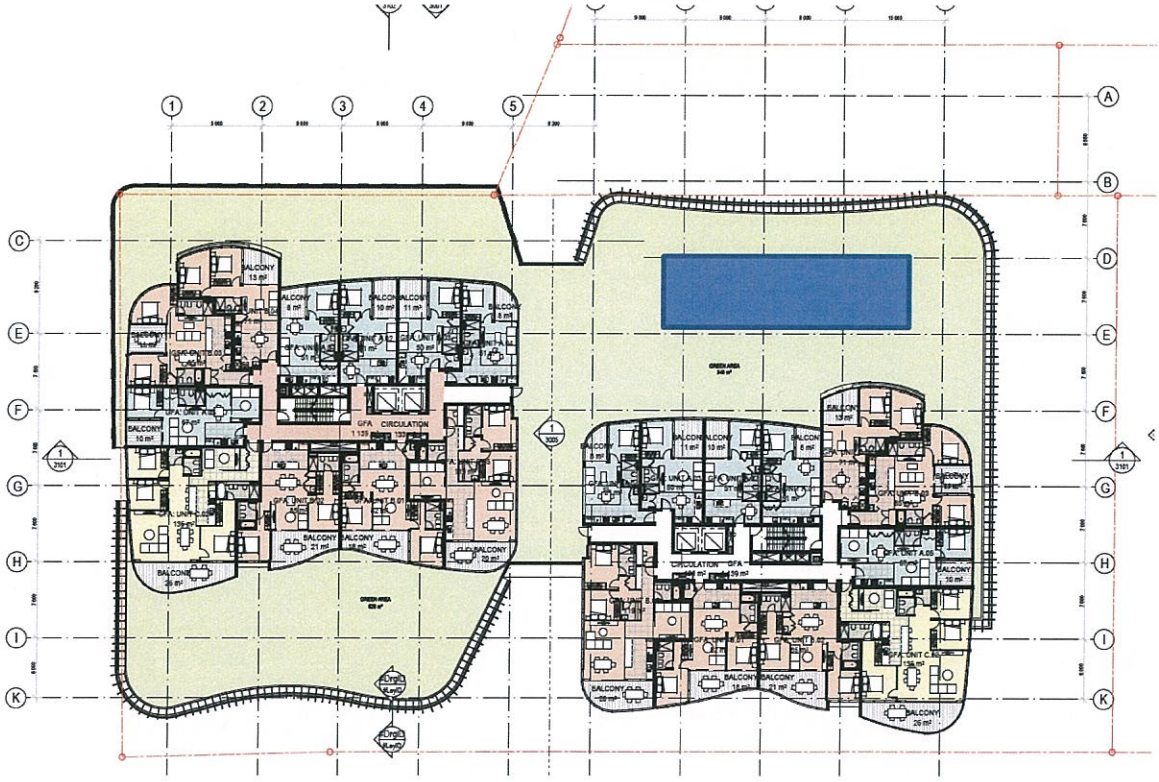


Figure 10: Level 2

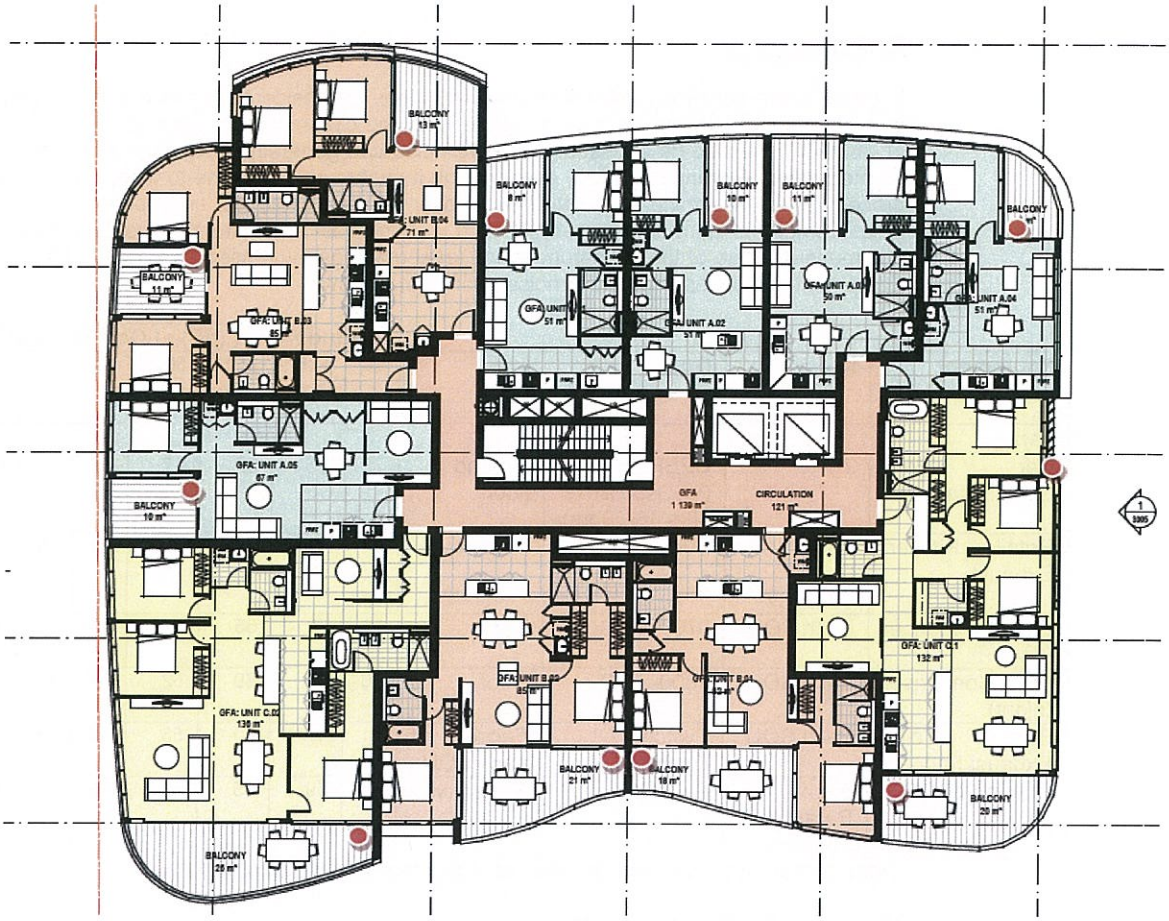


Figure 11. Typical Unit level

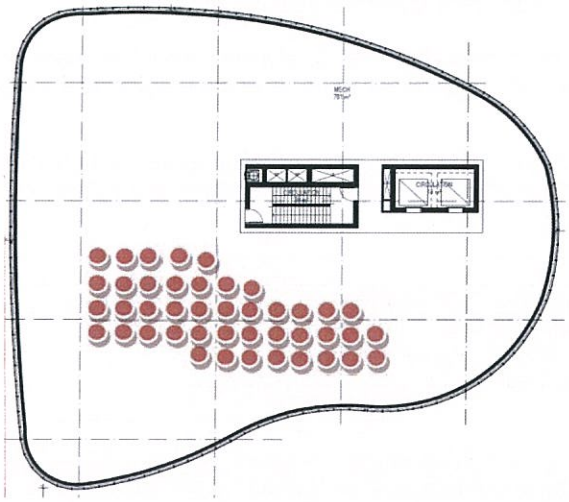


Figure 12: Roof

2.2.1 Mechanical Plant

External Noise Intrusion, generally from plant noise, is considered in this report. In most cases the transmission path will be via airborne noise. In some circumstances, regenerated noise as a result of vibration may also be an issue. Intrusive noise can generally be classified as either continuous or intermittent. Continuous noise, even though it might vary from time to time, is measured using a procedure to determine its equivalence over a representative time period. The continuous measurement is normally expressed as L_{Aeq} whereas intermittent noise is measured as the arithmetic average of the maximum sound level readings expressed as $L_{Amax,avg}$. Mechanical Plant Equipment comprises continuous noise sources as follows:-

				Sound Power (dB) at Octave Band (Hz)								
Equipment	**No.**	**Oper.**	**Loc.**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**SPL dB(A) @3m**
Fans												
Car Park Exhaust fan	2	CPEF-2 (VSDs50%6-8hrs,18-20hrs)	Ground floor	76	86	92	87	80	72	65	60	6
Retail Kitchen Exhaust	Each Retail Tenancy	Bus. Hrs	Retail Lvl.	89	89	84	78	78	75	75	72	63
SOU Condenser (day)	Each SOU	0700-1800	Roof	51	59	65	67	65	62	52	54	57
SOU Condenser (night)	Each SOU	1800-0700	Roof	36	44	50	52	50	47	37	39	42
SOU Toilet Exhaust Fan	Each SOU	Switch Operated	Façade of each SOU	51	47	50	53	48	43	36	31	33
Commercial AC	Each Retail Tenancy	Bus. Hrs	Mezz. Lvl.	51	59	65	67	65	62	52	54	57

Table 5: Sound Power and Number of Major Items of Mechanical Plant

2.2.2 Waste and Car Park Vehicle Movements

The car parks are located in the basement car park and level 1. Waste collection is by an 8.5m medium rigid rear loading waste truck at the existing waste storage area on ground level.

The collection of recycling and general waste (domestic) would be up to twice per week. Bins from the basement are to be moved daily and loaded into the compactor. Plastic bins and trailer are to be used to reduce the noise this part of the waste management process.

The commercial impacts from the current additional development would be relatively minimal: the current weekly service may increase to twice per week as all the development elements come on line.

The noise due to entrance and exiting of the vehicles (reversing alarms, vehicles accelerating and starting) has been modelled. These noise sources are intermittent and typical sound levels from these events are shown below:-

Description	**L_{Amax}**
Waste Vehicle Movement* for ¼ hour between 7am and 8am	100dB(A)
Internal Car Movement (entering/leaving)*** For the generation of site – based upon 0.4vph/ unit, the site is expected to generate 125 vehicles during peak hours, and 1250 vehicles daily.	94dB(A)

* Truck and loading noise on operating ground of cargo centres, delivery warehouses and haulage contractors, Hessische Landesanstalt für Umwelt, 16.05.1995 Heft 192

** Forum Schall – emissions data catalogue

*** 2000-04-23/JKI, DELTA Acoustics and Vibration, Danish Acoustical Institute, DK-2800 Lyngby

Table 6: Sound Levels of Waste and Internal Car Park Movements

2.2.3 **Common Area Use and Private Outdoor Spaces**

The associated intermittent noise sources from use of the common areas and commercial outdoor areas and private outdoor spaces associated with each unit are detailed in the table below:-

Description	L_{Aeq}
People talking (loud conversation)*	70dB(A)

* Technischer Überwachungs-Verein Norddeutschland e.V., 1987

Table 7: Sound Levels of Common Area noise Sources

2.2.4 **Traffic Noise**

The traffic noise levels, within an ultimate planning horizon of 20 years from the establishment of the proposed development (year 2016), were predicted using the noise prediction model SoundPLAN. Calculations are based on the procedures developed by the U.K. Department of Transport, Welsh Office, issued as *"Calculation of Road Traffic Noise"* in 1988 (CoRTN'88). The dominant traffic noise source is Kingsford Smith Drive. Current typical week day traffic volumes on Kingsford Smith Drive are approximately 60,000 vehicles per day and approximately 15 per cent of this is commercial vehicles.

Brisbane City Council's traffic modelling predicts that typical week day traffic volumes will increase to approximately 75,000 vehicles per day by 2031. The traffic model takes into account known proposed upgrades to the traffic network and proposed developments in the area the data is summarised in the table below:-

Year	Traffic Flow AADT	Traffic Speed (kph)	Heavy Vehicles (%)
2000	57,000	60	15%
2031	71,250	60	15%

The predicted traffic flows were scaled down by a factor of 0.95, to represent the 95-percentile traffic flow in an 18-hour period between 6:00 a.m. and 12:00 midnight.

Table 8: Traffic Flows

2.2.5 **Aircraft Noise**

The site is outside the ANEF 20 boundary as shown in the airport overlay (including impacts from the second runway) in Appendix C. However, based on the Brisbane Airport N70 (see Appendix D) map there are a significant number of aircraft noise events (over 30 between 0600hrs and 1800hrs) over 70dB(A) and hence the development is to include design elements to mitigate the impact within the units. The reference noise level for large passenger aircraft landing/ascending at is L_{Amax} 84dB(A):-

SECTION 3 ACOUSTIC DESIGN CRITERIA

3.1 NOISE LEVELS AND REVERBERATION TARGETS

Under performance criteria of the BCC city plan high density design code the development is required to comply with the requirements of the noise impact assessment planning scheme policy (NIAPSP) the NIAPSP criteria are summarised in the table below:-

Methodology	Applicable Noise Level and Criteria
Comparisons of like parameters	Waste collection vehicles, Noise from development not exceed the L_{A10} parameter describing the ambient noise by more than 3dB(A).
Application of AS2107	Refer Tables 8 and 9 for applicable levels for steady state noise such as from air A/C condensers and continuous road noise.
Sleep Awakening	Sound Exposure Level L_{AE} to be less than 65dB(A) at Bedroom facades from noise from other residents.
Background Creep	Not to exceed existing L_{A90} level at site.

Table 9: NIAPSP and Methodologies

The site is outside the zones requiring specific treatment required by MP4.4 buildings in a Transport Noise Corridor – Refer map in Appendix C. Noise intrusion criteria applicable to the residential areas of the development as required by the EPP (2008) have been summarised in Table 10 below.

Authority	Item	Applicable Area	Descriptor	Noise Goal,dB(A)
The Environmental Protection (Noise) Policy 2008	Acoustic Quality Objective in private outdoor space	Outdoor Space of Dwelling	$L_{Aeq,adj,1hr}$ $L_{A10,adj,1hr}$ $L_{A1,adj,1hr}$	50 55 65
	Acoustic Quality Objective in dwelling during daytime (0700-1800) and evening (1800-2200)	Indoor	$L_{Aeq,adj,1hr}$ $L_{A10,adj,1hr}$ $L_{A1,adj,1hr}$	35 40 45
	Acoustic Quality Objective in dwelling during night (2200-0700)	Indoor	$L_{Aeq,adj,1hr}$ $L_{A10,adj,1hr}$ $L_{A1,adj,1hr}$	30 35 40

Table 10: Noise Intrusion Criteria

In addition, the Australian Standard AS/NZS 2107:2000 recommends the following interior noise level targets for residential areas:-

Authority		Applicable Area	Descriptor	Noise Goal,dB(A)
AS/NZS 2107:2000	Acoustic Quality Objective in dwelling during day	Living Areas	L_{Aeq}	45
	Acoustic Quality Objective in dwelling during night (2200-0700)	Sleeping areas	$L_{Aeq\ (1\text{-}hour\ max)}$	40

Table 11: Additional Noise Intrusion Criteria

The Australian Standard AS/NZS 2107:2000 recommends the following interior noise level and reverberation targets for the common areas:-

Authority	Sensitive Use Area	Descriptor	Noise Goal,dB(A)
AS/NZS 2107:2000	Foyers	$L_{Aeq\ (8\text{-}hour)}$	45-55
	Enclosed Car Parks	$L_{Aeq\ (8\text{-}hour)}$	40-45
	Apartment Common Areas	$L_{Aeq\ (8\text{-}hour)}$	45-50
	Retail Areas (incl/ restaurants)	L_{Aeq}	45-50

Table 12: Recommended Internal Noise Levels

The Australian Standard AS/NZS 2021:2000 recommends the following interior noise level due to aircraft noise

Authority	Sensitive Use Area	Descriptor	Noise Goal,dB(A)
AS/NZS 2021:2000	Residential - sleeping areas	L_{Max}	50
	Residential – other habitable spaces	L_{Max}	55
	Retail Areas (incl/ restaurants)	L_{Max}	75

Table 13: Recommended Internal Noise Levels due to Aircraft Noise

3.2 ACOUSTIC SEPARATION TARGETS

The design criteria for the apartments are governed by the provisions of the acoustic requirements of BCA 2014 section F5.1 to F5.6 for a Class 2 building. The deemed to satisfy provisions for parts F5.3 to F5.5 are detailed below:-

BCA Clause	Item	Criteria
F5.3	Determination of impact sound insulation rating for walls.	A wall in a building required to have an impact sound insulation rating must be discontinuous construction. Discontinuous construction means a wall having a minimum 20mm cavity between 2 separate leaves, and (i) For masonry, where wall tiles are required to connect leaves, the ties are of the resilient type; and (ii) For other than masonry, there is no mechanical linkage between leaves except at the periphery.
F5.4 (a) (i)	Sound insulation of floors between units.	A floor separating sole occupancy units must have an $R_W + C_{tr}$ (airborne) of not less than 50 and a $L_{n,w} + C_I$ (impact) of not more than 62.
F5.4 (a) (ii)	Sound insulation of floors between units and stairways, public corridors, public lobbies or the like.	A floor separating sole occupancy units from stairways, public corridors, public lobbies, lift shaft or the like must have an $R_W + C_{tr}$ (airborne) of not less than 50 and a $L_{n,w+CI}$ (impact) of not more than 62.
F5.5 (a) (i) & (ii)	Sound Insulation of walls between units	A wall must have an $R_W + C_{tr}$ (airborne) of not less than 50 if it separates sole occupancy units; A wall must have an R_W (airborne) of not less than 50 if it separates a sole occupancy unit from a plant room, lift shaft, stairway, public corridor, hallway or the like.
F5.5 (a) (iii)	Sound insulation of walls between a bathroom, sanitary compartment, laundry or kitchen and a bedroom or habitable room in adjoining room of SOU from a plant room or lift shaft	Walls must be of discontinuous construction (e.g. 20mm unconnected cavity, no linkage between leaves other than at periphery)
F5.5 (b)	Doors to apartments from public corridors and public lobbies.	Doors to the apartments are to achieve an Rw of not less than 30.
F5.5 (e)	Sound insulation of walls with floors above	Wall to continue to the underside of the floor above or to have a ceiling that provides the sound insulation required for the wall.
F5.5 (f)	Sound insulation of walls with roofs above	Wall to continue to the underside of the roof above or to have a ceiling that provides the sound insulation required for the wall.
F5.6	Sound Insulation Rating of Services	If a duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with an $R_w + C_{tr}$ (airborne) not less than – (i) 40 if the adjacent room is a habitable room (other than a kitchen); or (ii) 25 of the adjacent room is a kitchen or non-

BCA Clause	Item	Criteria
		habitable room. (b) If a storm water pipe passes through a sole-occupancy unit it must be separated in accordance with (i) and (ii).
F5.7	Sound Isolation of Pumps	Flexible couplings to be used at the point of connection between the service pipes in the build and any circulating or other pump.

Table 14: BCA 2014 Acoustic Design Criteria

All forms of construction detailed in table 12 must be installed as follows:-

(a) Masonry – Units must be laid with all joints filled solid, including those between the masonry and any adjoining construction.

(b) Concrete slabs – Joints between concrete slabs or panels and any adjoining construction must be filled solid.

(c) Sheeting materials:-

(i) If one layer is required on both sides of a wall, it must be fastened to the studs with joints staggered on opposite sides.

(ii) If two layers are required the second layer must be fastened over the first layer so that the joints do not coincide with those of the first layer.

(iii) Joints between sheets or between sheets and any adjoining construction must be taped and filled solid.

(d) Timber or steel-framed construction – perimeter framing members must be securely fixed to the adjoining structure and:-

(i) Bedded in resilient compound.

(ii) The joints must be caulked so that there are no voids between the framing members and the adjoining structure.

(e) Services:-

(i) Services must not be chased into concrete or masonry elements.

(ii) A door or panel required to have a certain $R_w + C_{tr}$ that provides access to a duct, pipe or other services must:-

- Not open into any habitable room (other than a kitchen); and
- Be firmly fixed so as to overlap the frame or rebate of the frame by not let than 10mm, be fitted with a sealing gasket along all edges and be constructed of:-
  - Wood, particleboard or blockboard not less than 33mm thick; or
  - Compressed fibre reinforced cement sheeting not less than 9mm thick; or
  - Other suitable material with a mass per unit area not less than 24.2 kg/m^2.

(f) A water supply pipe must –

- Only be installed in the cavity of discontinuous construction; and
- In the case of pipe that serves only one sole-occupancy unit, not be fixed to the wall leaf on the side adjoining any other sole-occupancy unit and have a clearance not less than 10mm to the other wall leaf.

(g) Electrical outlets must be offset from each other –

- In masonry walling, not less than 100mm; and
- In timber or steel framed walling, not less than 300mm.

3.3 SERVICES ACOUSTIC TARGETS

Hydraulic and Mechanical Services Risers to be acoustically treated give $L_{Amax,avg}$ 50.

NR levels are as below for noise levels due to operation of building services:-

Use Area	Noise Goal, NR
Reception Foyer	45
Bedrooms	35
Living Rooms/ Lounges	45
Kitchen /Dining Rooms	45
Bathroom	45
Retail Areas	40

Table 15: Recommended Service Acoustic Targets

Recommended maximum noise level within plant rooms is L_{Amax} 75dB(A) to minimise airborne transmission through the building fabric. Bounding fabric to common areas to be R_w 45 minimum.

SECTION 4 NOISE INTRUSION ASSESSMENT (FACADE CALCULATION)

4.1 NOISE CALCULATION METHODOLOGY

4.1.1 Computer Modelling Method

A three dimensional model was created using SoundPLAN noise propagation software. The noise sources identified in section 2 were added to the model in the appropriate locations. A three dimensional noise map of the noise levels due to the sources was calculated. In addition, noise levels were calculated at designated locations the building facades, common areas and private outdoor spaces.

4.1.2 Sound Power Levels of the Main Noise Sources

Sound Power Levels of the main sources, as detailed in Section 2.2 were input into the model at the proposed locations.

4.1.3 Tonality and Impulsiveness Adjustment

Where tonal components are significant, 5dB has been added to the calculated noise level to account for the increased intrusiveness of tonal noise levels.

4.2 NOISE CALCULATION RESULTS

Methodology	Applicable Noise Level and Criteria
Application of AS2107	Applicable levels for steady state noise such as from air A/C condensers and continuous road noise.
Background Creep	Noise associated with development not to exceed existing L_{A90} level at site.
Comparisons of like parameters	Waste collection vehicles, Noise from development not to exceed the L_{A10} parameter describing the ambient noise by more than 3dB(A).

Table 16: Methodology and application

4.2.1 Noise Intrusion Calculations - Application of AS2107

Based on all noise sources identified in Section 2.2 of this report, the noise intrusion calculation results at on site noise sensitive receivers are shown in the table below:-

Facade	Day (0700-1800hrs)	Evening (1800-2200hrs)	Night (2200-0700hrs)
	LAeq dB(A)		
North	65	63	63
East	65	63	63
South	53	51	51
West	65	63	63

Table 17: Noise Intrusion Levels for all noise sources

Noise levels due to all general noise emissions are unlikely to be intrusive over typical background noise levels provided the recommended facade attenuation measures (refer Section 5 of this report) are integrated into the design.

4.2.2 **Noise Intrusion Calculations – Traffic Noise Application of CTRN**

Based on all noise sources identified in Section 2.2 of this report, the noise intrusion calculation results at on site noise sensitive receivers are shown in the table below:-

Facade	Noise Level dB(A)
	L10 -1hr
North	60
East	58
South	44
West	58

Table 18: Traffic Noise Intrusion Levels for all noise sources

Noise levels due to traffic noise are unlikely to be intrusive over typical background noise levels provided the recommended facade attenuation measures (refer Section 5 of this report) are integrated into the design.

4.2.3 **Noise Emissions Calculations - Application of AS2107**

Based on all development related noise sources identified in Section 2.2 of this report, the noise intrusion calculation results at adjacent noise sensitive receivers due to noise sources associated with the site development are shown in the table below. Correction for internal calculation has used a minimum 10dB(A) correction :-

Location	Maximum Design Levels		Pass/Fail
	dB(A)	Result	
Commercial East	50 dB(A)	<50dB(A)	Pass
Open Space			Pass
Commercial East			Pass
Multi Use West			Pass
Residential West			Pass
Residential North			Pass

Table 19: Noise Intrusion Levels for all noise sources

Noise levels due to all general noise emissions from the site are unlikely to be intrusive at the nearest noise sensitive receivers.

4.2.4 **Noise Emissions Calculations – Background Creep**

Based on all development related noise sources identified in Section 2.2 of this report, the noise intrusion calculation results at adjacent noise sensitive receivers are shown in the table below:-

Location	dB(A) day		dB(A) evening		dB(A) night	
	L_{Aeq} Maximum Design Level	Result	L_{Aeq} Maximum Design Level	Result	L_{Aeq} Maximum Design Level	Result
Commercial East	52	<52	48	<48	46	<46
Open Space						
Commercial East						
Multi Use West						
Residential West						
Residential North						

Table 20: Noise Intrusion Levels for all noise sources

4.2.5 **Noise Emissions Calculations – Comparison of like parameters**

A comparison of like parameters at adjacent noise sensitive receivers has been used to assess the impact of waste noise during the morning period.

Location	dB(A)1hr $L_{A10-1hr}$		
	Maximum Design Levels	**Result**	**Pass/Fail**
Commercial East	63 daytime/evening 52 night-time time	<63 daytime evening <52 night-time	Pass
Open Space			Pass
Commercial East			Pass
Multi Use West			Pass
Residential West			Pass
Residential North			Pass

Table 21: Noise Intrusion Levels for all noise sources

Noise levels due to all general noise emissions are unlikely to be intrusive at the nearest noise sensitive receivers over current noise levels provided the recommended attenuation measures (refer Section 5 of this report) are integrated into the design.

SECTION 5 RECOMMENDATIONS

5.1 FACADE TREATMENTS

Glazing treatments have been recommended based on the noise calculated at each facade and the noise target within the spaces affected by facade performance. Please refer to mark up plan drawings in Appendices for the glazing and wall performance requirements

The following minimum construction elements or equivalent are recommended:-

Construction Element	R_w
Wall	
Wall – 150mm Concrete blockwork (245 kg/m^2)	≥50
Wall – 200mm Precast (245 kg/m^2)	≥50
Windows / Glazed Doors	
6.38mm laminated glass with acoustic seals	32
Glazed Doors	
10.38mm laminated glass with acoustic seals	35
Roof	
Concrete Roof 200mm with suspended pb ceiling and 75mm glass wool insulation above	50

Table 22: Weighted Sound Reduction Index of Recommended Building Elements

5.2 ACOUSTIC SEPARATION TREATMENTS

Based on space types identified in the layouts the following constructions or equivalent are recommended for adequate acoustic separation for elements within the building:-

Clause	Item	Proposed Construction
F5.4	Sound Insulation of floors between units	200 mm thick concrete slab with carpet on underlay or 200mm thick concrete slab (ideally floating floor construction) with ceramic floor tiles on high performance resilient layer (5mm thick impactamat or equivalent) to insulated plasterboard ceiling on underside.
F5.5 (a) (i) & (ii)	Sound Insulation of walls between units and between units and plant rooms, stairways, public corridors, hallways or the like.	At core: 1 x 13mm Plasterboard daub fixed wall lining at 500mm centres. Single 150mm min. thickness pre-cast/ In-situ concrete panel. 28mm furring channels at 600mm centres Impact clips/ isolation mounts Polyester insulation in cavity. 1 x 13mm Plasterboard screw fixed over 16mm Plasterboard Sheet Lightweight walls: 2 x 13mm firerated plasterboard on both xxx mounted at 600mm centres (max.) to 92mm Rondo quiet stud or equivalent with 50mm/111kg/m^3 glass wool insulation in cavity
F5.5 (a) (iii)	Walls between a bathroom, sanitary compartment, laundry or kitchen and a bedroom or habitable room in adjoining room or SOU from a plant room or lift shaft	At core: Discontinuous 150mm min. thickness pre-cast/ In-situ concrete panel with: (a) a row of 64mm steel studs at 600mm centres spaced 20mm from the masonry wall; and (b) 50mm thick mineral insulation or glass wool insulation with a density of 11kg/m^3 positioned between studs; and (c) One layer of 6mm fibre cement sheet fixed to outside face of studs (d) Lightweight walls: 2 rows of steel studs (discontinuous) at 600mm centres (max), 2 x 13 fire rated plasterboard, each face with 25mm shaftliner panel or equivalent, between studs. 14kg/m^3 glasswool batts in cavity.
F5.5 (b)	Doors to apartments from public corridors and public lobbies.	Single leaf door with acoustic perimeter seal and tread seal to R_w 30 rating for public lobbies/ corridors. Not required for private lobbies.
F5.5 (e)	Sound Insulation of walls with floors above	Wall to continue to the underside of the floor above or to have a ceiling that provides the sound of insulation required for the wall. Or Between bathrooms and habitable room in sole occupancy units and between bedrooms and public areas:- (a) concrete slab soffit with 200mm minimum cavity depth. (b) 30mm plasterboard barrier with 50mm Glasswool seal. (c) One layer of 13mm fibre-protective grade plasterboard. (d) Wall with required sound rating, to underside of ceiling

Clause	Item	Proposed Construction
F5.5 (f)	Sound Insulation of walls with roofs above	Wall between units to continue to the underside of the roof. Wall between units and public corridors to continue to the underside of the roof above or to have a ceiling that provides the sound insulation required for the wall.
F5.6	Sound Insulation Rating of Services	Generally recommend duct, soil, waste or water supply pipes located in SOU's are lagged (e.g. CSR Acoustilag 45 or equivalent.) Services in Ceiling/Floor/Wall Cavities, Kitchens and Non Habitable Areas. Where duct, soil, waste or water supply pipes are located in the ceiling space and pass through more than on sole occupancy unit - Acoustically sealed ceiling penetrations with surface mounted fittings at to be used or acoustically treated recessed light fittings - Ceiling to comprise minimum single layer of 13mm plasterboard. - Risers to comprise minimum layer of 13mm plasterboard. - Where lagged stormwater pipes pass through ceiling cavities of sole occupancy units ceilings to comprise minimum single layer of 13mm plasterboard. - Unlagged pipes in risers to comprise minimum outer layer of 13mm plasterboard with 75mm thick, 11kg/m3 glass wool insulation in riser cavity. Habitable Areas: Where duct, soil, waste or water supply pipes are located in the ceiling space and pass through more than one sole occupancy unit - Acoustic sealed ceiling penetrations with surface mounted fittings are to be used or acoustically treated recessed light fittings. - Ceilings to comprise minimum layer of 13mm plasterboard with 90mm thick, 10.5kg/m3 glass- wool insulation blanket. - Where stormwater pipes pass through sole occupancy units ceiling cavities, ceilings to comprise minimum layer of 13mm plasterboard with minimum 90mm thick, 10.5kg/m3 glass wool insulation blanket. - risers containing unlagged pipes to comprise minimum outer layer of 13mm plasterboard with 75mm thick, 11 kg/m3 glass wool insulation blanket in wall cavity and 13mm plasterboard inner layer and 50mm, 11 kg/m3 glass wood insulation in riser cavity.
F5.7	Sound Isolation of Pumps	Flexible couplings to be used at the point of connection between the service pipes in a building and any circulating or other pump.

Table 23: Recommended Acoustic Separation Construction Performance

5.3 SERVICES TREATMENTS

All mechanical and hydraulic services installations shall comply with the following requirements to ensure that noise and vibration from the plant installed under this Contract is reduced to a minimum:

(a) All rotary machinery shall be accurately balanced both statically and dynamically. Motor impeller rotors shall be balanced to International Standard ISO 1940 -"Balance Quality of Rotating Rigid Bodies" and shall be free from vibration at all operating speeds and during starting and stopping.

(b) Centrifugal and reciprocating rotating equipment shall be mounted on vibration absorbing mountings.

(c) All connections to rotating machinery, or assemblies containing machinery shall be rendered flexible by vibration hangers supporting ducting and piping systems, flexible connections between ductwork and fans, and in critical installations with flexible hose between pipes and pumps. If flexible hose is not installed, adequate provision shall be made to take up vibration in bends and pipe runs.

(d) Acoustic lining and/or attenuators shall be applied to critical sections of ducts and air handling units unless otherwise specified. Attenuators shall be selected to ensure not more than 35pa resistance is imposed to any system (exhausts & AHU's).

(e) Acoustic seals shall be provided where all pipes, ducts and conduits penetrate plantrooms or acoustic walls.

(f) All static equipment in major plant areas shall be mounted on 18mm Mason Super W isolation pads, loaded to between 250kPa and 400kPa.

(g) Duct connections to vibrating mechanical plant shall be isolated by flexible PVC connections not less than 100mm long when fully stretched out.

Element	Requirement	Typical Construction
Treatment of Condenser Units	NR40	Resilient mounts. Flexible couplings to be used at the point of connection between the service pipes.
Treatment of mechanical services ductwork	NR35 in bedrooms NR 45 in all other areas	Internally lined ductwork and attenuators as detailed in mechanical specification.
Risers	$L_{Amax, avg}$ < 50dB(A)	Un-lagged pipes in risers to comprise minimum outer layer of 13mm plasterboard with 75mm thick, 11 kg/m^3 glass wool insulation blanket in wall cavity and 13mm plasterboard inner layer and 50mm, 11 kg/m^3 glass wool insulation in riser cavity.
Pumps	Flexible couplings to be used at the point of connection between the service pipes in a building and any circulating or other pump.	Install flexible coupling

Table 24: Recommended Services Performance

5.4 LIFT CORE TREATMENTS

Recommend noise control measures for minimising lift core noise is:

1. Maximise stiffness of lift cores to minimum vibration levels. Minimum 150mm thick in-situ concrete or 190mm thick core filled wall.
2. Locate lift rail mounts on stiffest part of lift core structure: i.e. where shaft wall and floor slabs meet Fixings to be located on the centre line of the floor slab.
3. Discontinuous floor, wall and ceiling construction Typical Construction types are detailed below:

Item	Typical Construction
Floor	200mm thick concrete slab (floating floor construction) with tiles on resilient layer to minimise transmission of noise from operation of lift and car park lift roller shutters.
Ceiling	Isolation mounted with insulated (75mm acoustic insulation) and suspended plasterboard. Downlights to be acoustically treated.
Wall	Two layers of 13mm fire rated plasterboard on 76mm steel studs with 40mm gap to shaft wall. 75mm insulation in cavity.

Table 25: Proposed Construction for Apartments adjacent to/above lift cores

5.5 SWIMMING POOL TREATMENTS

	Requirement	Typical Construction
Spa Pump	55dB(A) max @ 1m	Spa shell to be mounted on resilient pads. Flexible couplings to be used at the point of connection between the service pipes and pump. Pump to be mounted on resilient pads/ anti-vibration mount Preferably use a dedicated one-speed pump to drive the jets and a smaller circulation pump to heat and filter to reduce noise during heating and filtering modes.
Spa Operation (noise due blower operation)	55dB(A) max @ 1m	Flexible couplings to be used at the point of connection between the service pipes and pump.
Pool Pumps	55dB(A) max @ 1m	Flexible couplings to be used at the point of connection between the service pipes and pump.
Pool Room Extraction fan	55dB(A) max @ 1m	Flexible couplings to be used at the point of connection between the service pipes in a building and pump.

Element	Requirement if located above residential apartment	Typical Construction
Swimming Pool Base	Shell to be supported on resilient mounts.	Elastomeric mounts to underside of swimming pool base. • Resilient rubber base. • Free standing vertically restrained and laterally stable without any housing • Capable of up to 16mm static deflection •
Swimming Pool Sides	Shell sides to be isolated from structure	17mm cross ribbed elastomeric pad bonded to corrosion resistant surface between pool shell and main building structure.

Table 26: Recommended Services Performance

SECTION 6 RECOMMENDATIONS

The noise levels due to the noise sources associated with the development within the apartments, at the private open spaces and at the adjacent noise sensitive receivers are acceptable provided the building design incorporates the attenuation measures as specified in this report or equivalent. Key Recommendations are summarised below:-

- Façade glazing to be minimum Rw 32. Façade areas which are extensively glazed to the north and east to to give Rw35 minimum to control exposure to aircraft noise,
- All low level fans to be attenuated to 75dB(A) measured at 1m from exit grille/louvre.
- Noise Management Plan to be developed to ensure noise from operations of commercial/retail areas do not affect residences above – including provision to limit noise sources after 10pm to 7am.
- Mechanical plant to be contained within plant room closures with Rw 50 nominal construction and louvres to give 75dB(A) measured at 1m from exit grille/louvre.

SECTION 7 CONCLUSION

The noise levels due to the noise sources associated with the development within the apartments, within the commercial areas, at the private open spaces and at the adjacent noise sensitive receivers are acceptable provided the building design incorporates the attenuation measures as specified in this report or equivalent.

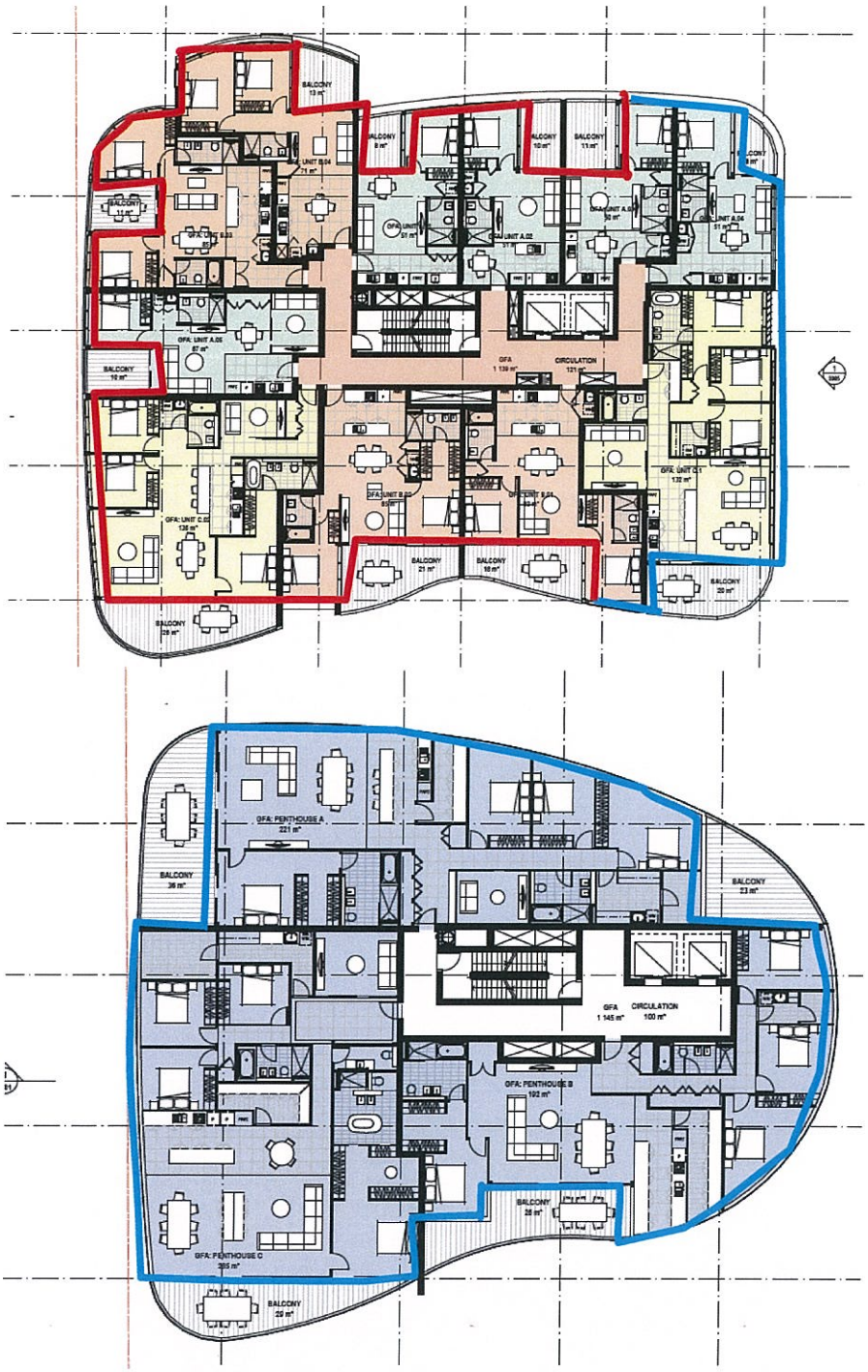
APPENDIX A

FACADE TYPES
(TYPICAL LEVEL)

Minimum Acoustic Requirements

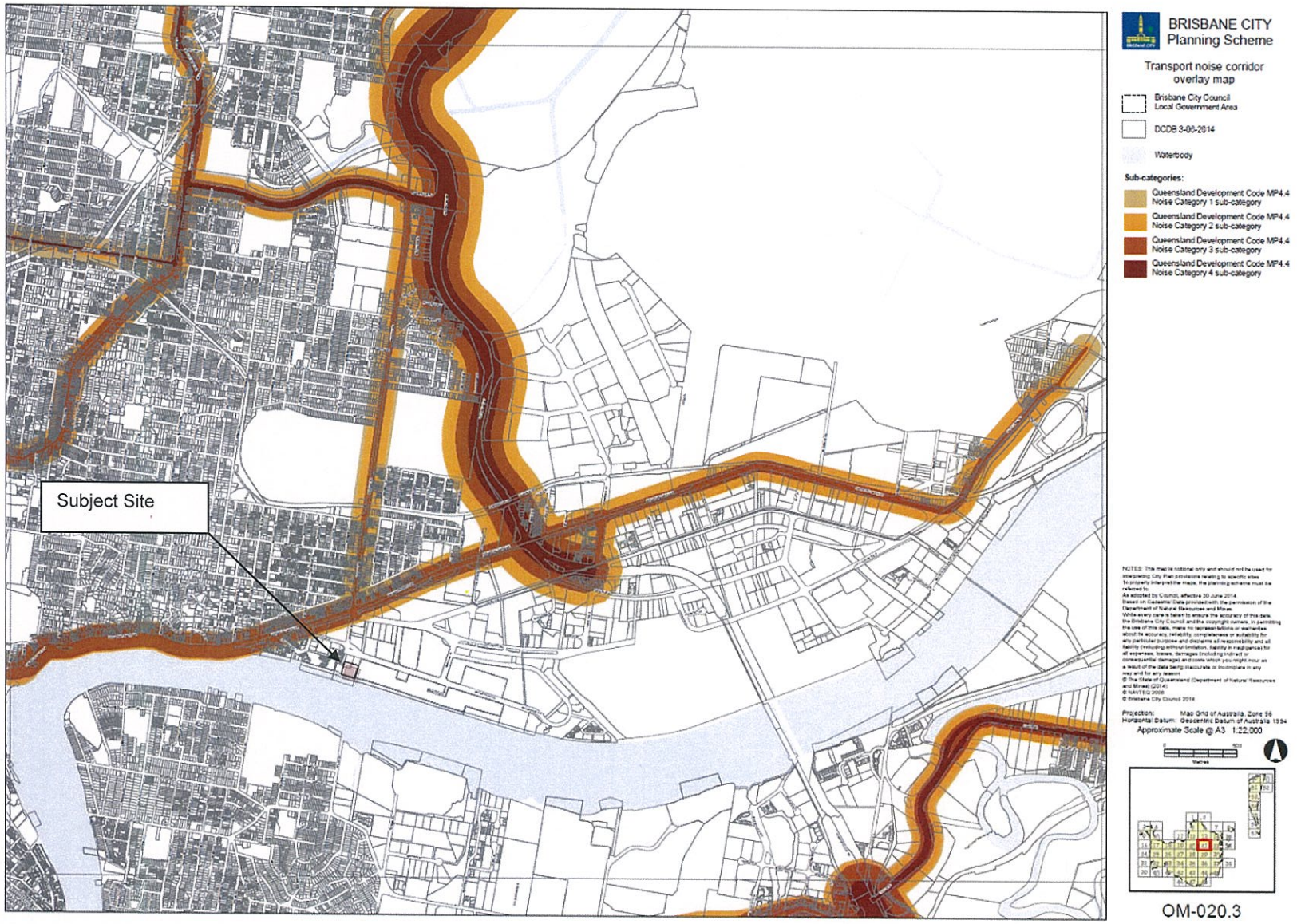
Glazing

Rw 32
Rw 35



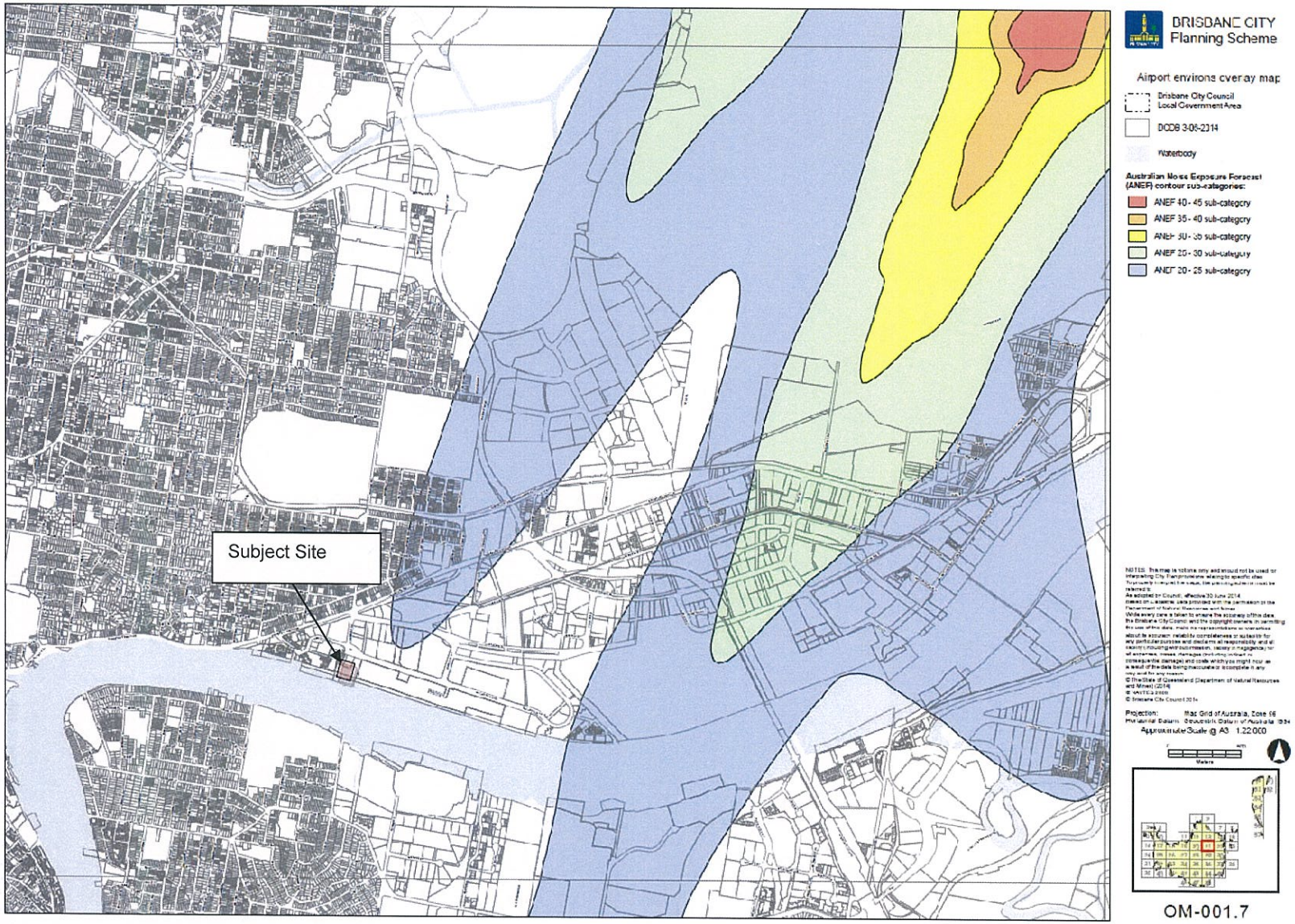
APPENDIX B

NOISE CORRDOR MAP


Subject Site
BRISBANE CITY
Planning Scheme
Transport noise corridor
overlay map
Brisbane City Council
Local Government Area
DCDB 3-06-2014
Waterbody
Sub-categories:
Queensland Development Code MP4.4
Noise Category 1 sub-category
Queensland Development Code MP4.4
Noise Category 2 sub-category
Queensland Development Code MP4.4
Noise Category 3 sub-category
Queensland Development Code MP4.4
Noise Category 4 sub-category
Projection: Map Grid of Australia Zone 56
Horizontal Datum: Geocentric Datum of Australia 1994
Approximate Scale @ A3 1:22,000
OM-020.3

APPENDIX C

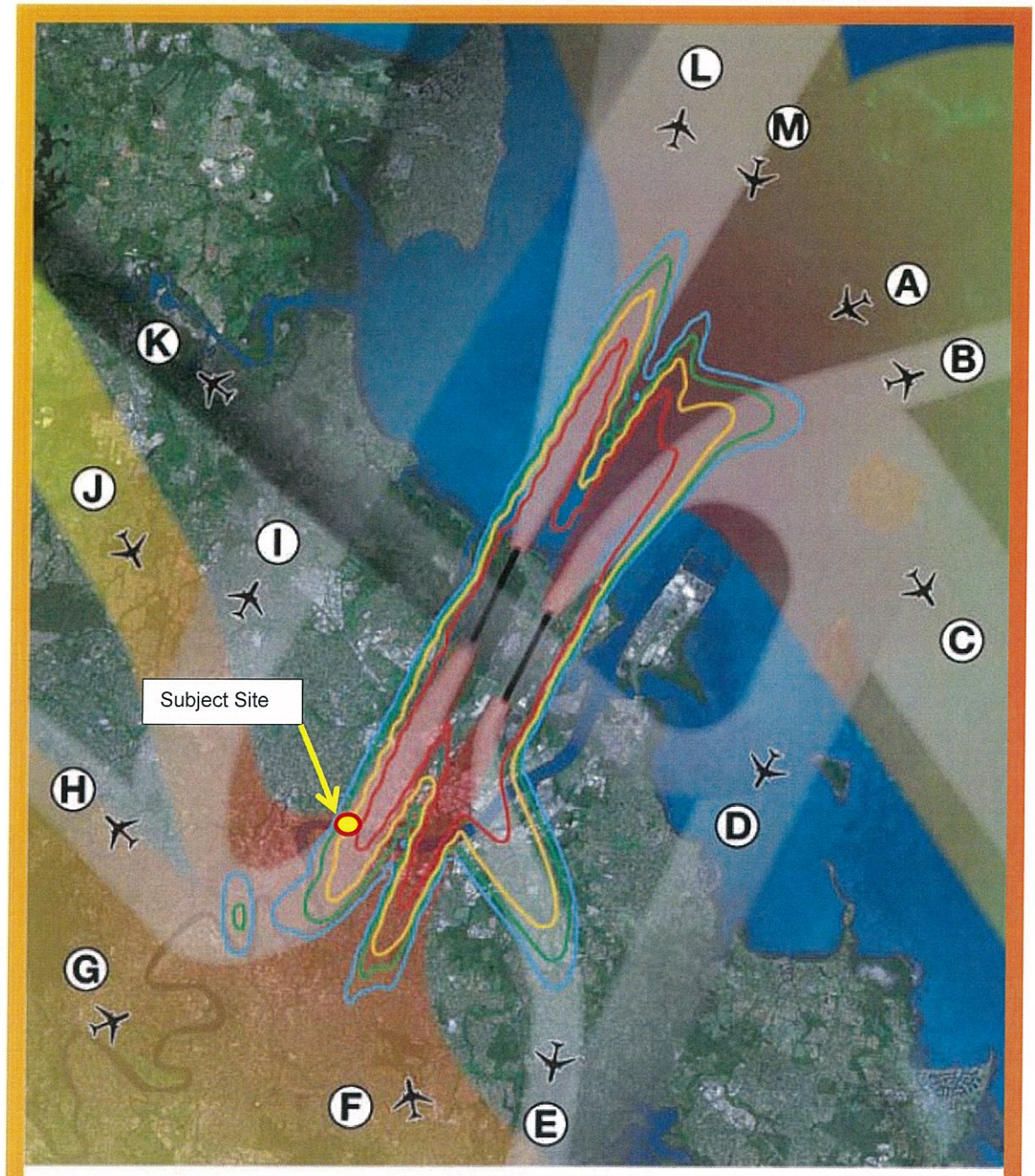
ANEF OVERLAY


Subject Site
BRISBANE CITY
Planning Scheme
Airport environs overlay map
Brisbane City Council
Local Government Area
DCDB 3-06-2014
Waterbody
Australian Noise Exposure Forecast
(ANEF) contour sub-categories:
ANEF 40 - 45 sub-category
ANEF 35 - 40 sub-category
ANEF 30 - 35 sub-category
ANEF 25 - 30 sub-category
ANEF 20 - 25 sub-category
Projection:
Map Grid of Australia, Zone 56
Approximate Scale @ A3 1:22 000
Metres
OM-001.7

APPENDIX D

N70 MAP

FIGURE 11.4 N70 CONTOUR WITH NPR FOR SUMMER WEEKDAY DAY (MONDAY TO FRIDAY - 6AM TO 6PM).



Flight Path	Flight path type	Average number of flights on flight path	Expected minimum and maximum numbers of flights on path	Percentage of Brisbane Airport's total flights on path	Percentage of days with no flights on path
A	Arrival	107	0 - 215	18%	19%
B	Departure	8	0 - 16	1%	25%
C	Departure	6	0 - 13	1%	29%
D	Departure	88	0 - 184	15%	25%
E	Departure	104	0 - 199	17%	19%
F	Arrival	91	0 - 196	15%	26%
G	Arrival	13	0 - 133	2%	26%
H	Departure	14	0 - 29	2%	20%
I	Departure	38	0 - 76	6%	20%
J	Arrival	36	0 - 95	6%	31%
K	Departure	10	0 - 18	2%	27%
L	Departure	37	0 - 74	6%	26%