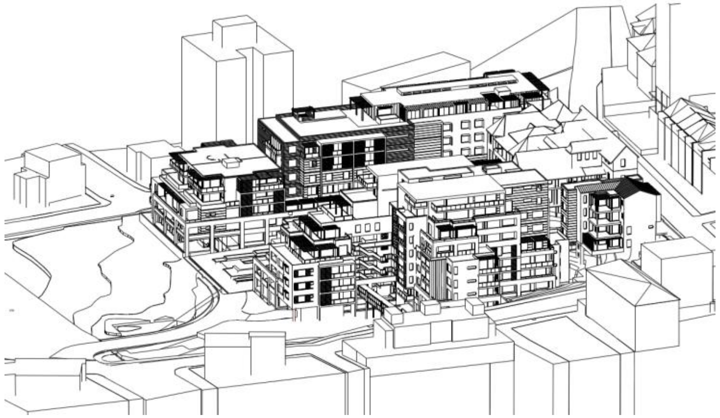
Analysis Report

SEPP65 ISSUES OF AMENITY

SOLAR ACCESS AND NATURAL VENTILATION



CONCEPT PLAN AND STAGE 1 PROJECT APPLICATION

Residential Development

at the former

Meadowbank Employment Area

15 November 2010

Signed,

S T E V E   K I N G

C O N S U L T A N T   A R C H I T E C T

1 1   C l o v e l l y   R o a d   R a n d w i c k   N S W   2 0 3 1   A u s t r a l i a

P H O N E   0 4 1 4 3 8 5 4 8 5

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0.0 SUMMARY

0.1 This report addresses issue of **solar access** and **natural ventilation** relating to the design of the **Concept Plan and Stage 1 Project Application for a Residential Development at the former Meadowbank Employment Area.** The Stage 1 project provides for 242 apartments and carparking.

0.2 **Concept Plan.** I comment on the general massing and site planning of the concept plan. My comments are directed at the likely impacts on designing for the two major amenity provisions, within the constraints of appropriate urban design principles applied to the given site.

I note that the site is steeply sloping towards the south and a dominant view over the harbour in the same direction. Together with a planning constraint which encourages the preservation and reinforcement of the existing street grid, this limits the potential to achieve midwinter solar access to a significant proportion of any likely mix of apartments, in building forms that can achieve appropriate densities.

I have given considerable thought to whether alternative massing strategies could achieve significantly different proportion of apartments that can be said to enjoy a higher level of solar access amenity. I have concluded that the concept plan adopts a layout and massing strategy that has the potential to achieve approximately the optimum balance between solar access for apartments, exposure to prevailing summer cooling breezes, the preservation of winter solar access for parts of the public domain during the relevant parts of the day, and competing urban design and amenity issues.

0.2 **Solar access**. I have independently reviewed in detail the design for solar access for the **Stage 1 Project** Application, and provide the relevant quantification. I note that the Residential Flat Design Code which gives effect to SEPP65 includes rules of thumb that recommend achieving 70% or greater proportion of apartments with a guaranteed minimum solar access to living areas. However, the RFDC provides for achieving compliance with the performance requirements for amenity in circumstances where the simple rules of thumb cannot be satisfied. In my quantification I paid due regard to the site and other constraints, and to the evidence of specific design strategies that have maximised the proportion of apartments which achieve effective midwinter sun access. In my considered opinion, both the concept plan and the Stage 1 Project application deal appropriately with the constraints, and therefore satisfy the applicable performance requirements of SEPP65.

0.3 **Natural ventilation.** In larger developments, the proportion of apartments that achieve cross ventilation by openings to two or more facades is limited by the typical double loaded planning. Notwithstanding the provision of multiple vertical circulation cause, that constraint applies to the Stage 1 Project application. However, the site planning and exposure to the prevailing summer cooling breezes are such as to favour consideration of suitably designed single sided apartments as satisfying the performance objectives of the Residential Flat Design Code. I have demonstrated in a number of previous projects, by reference to suitable wind engineering studies, that single aspect apartments with highly articulated facades and multiple openings can achieve ventilation rates comparable to cross ventilated apartments. See in particular *6.3 Enhanced single sided natural ventilation* for a more detailed discussion.

Taking a relatively conservative view of which single aspect apartments may be considered suitable for of such characterisation, I find that up to approximately 76% of the apartments may be deemed to be complying for satisfactory natural ventilation.

1.0 PRELIMINARIES

1.1 My qualifications and experience are summarized in **2.0 Credentials**.

1.2 The documents utilised to support the opinions contained in this report are detailed in **3.0 Documents and Information**. I have visited the site.

2.0 CREDENTIALS

2.1 I have been teaching architectural design, thermal comfort and building services at the Universities of Sydney, Canberra and New South Wales since 1971. From 1992, I was a Research Project Leader in SOLARCH, the National Solar Architecture Research Unit at the University of NSW. Until November 2006, I was the Associate Director, Centre for Sustainable Built Environments (SOLARCH), UNSW. My teaching, research and practice specialization is in the assessment of comfort and energy performance of buildings, in particular solar access and other environmental control parameters such as natural ventilation.

My research and consultancy includes work in solar access, energy simulation and assessment for houses and multi-dwelling developments, building assessments under the NSW SEDA Energy Smart Buildings program, appropriate design and alternative technologies for museums and other cultural institutions, and 'asthma and domestic building design'. SOLARCH/UNISEARCH under contract to SEDA NSW set up and administered the House Energy Rating Management Body (HMB), to accredit assessors under the Nationwide House Energy Rating Scheme, NSW. I was until early 2004 the technical supervisor of the HMB, with a broad overview of the dwelling thermal performance assessments carried out by assessors in NSW over the initial four and a half years. I carried out the Independent Expert Review of the comparison of NatHERS and DIY methods of compliance for Thermal Comfort under BASIX, for the NSW Department of Planning. I have delivered professional development courses on topics relating to energy efficient design both in Australia and internationally.

I am the principal author of SITE PLANNING IN AUSTRALIA: Strategies for energy efficient residential planning, funded by the then Department of Primary Industry and Energy, and published by AGPS, and of the RAIA Environment Design Guides on the same topic. Through UNSWGlobal and NEERG Seminars, I conduct training in solar access and overshadowing assessment for Local Councils.

Also of relevance, I teach the wind and ventilation components of environmental control in the course in architecture at UNSW, and am the author of refereed papers and internationally referenced, web accessed coursework materials on the subject.

I am a registered Architect and maintain a specialist architectural consultancy practice in Sydney and Canberra.

2.2 I regularly assist the Land and Environment Court as an expert witness in similar matters.

3.0 DOCUMENTS AND INFORMATION

3.1 I base my report on

- Preliminary DA architectural drawings issued to me electronically on 8 October 2010, by Robertson and Marks Architects.
    - A 117-C - SECTIONS C-D
    - A 116-C - SECTIONS A-B
    - A 115-C - HAMILTON CRESCENT & COMMERCIAL STREET ELEVATION
    - A 114-C - ROTHESAY AVENUE & BELMORE STREET ELEVATION
    - A 113-C - ROOF PLAN
    - A 112-C - LEVEL 8 PLAN
    - A 111-C - LEVEL 7 FLOORPLAN
    - A 110-C - LEVEL 6 FLOORPLAN
    - A 109-C - LEVEL 5 FLOORPLAN
    - A 108-C - LEVEL 4 FLOORPLAN
    - A 107-C - LEVEL 3 FLOORPLAN
    - A 106-C - LEVEL 2 FLOORPLAN
    - A 105-C - LEVEL 1 FLOORPLAN
    - A 104-D - GROUND FLOOR PLAN
    - A 103-D - LOWER GROUND FLOOR PLAN
    - A 102-C - UPPER BASEMENT PLAN
    - A 101-C - BASEMENT PLAN
    - A 100-B - COVER
    - A-118-B
    - A-119-B
    - A 121-B - SHADOW DIAGRAMS SHEET 2
    - A 120-B - SHADOW DIAGRAMS SHEET 1
- Half-hourly ‘views from the sun’ views of the digital model prepared by the architects to my instructions.
- Digital copy of Revit model file.

4.0 CONCEPT PLAN: GENERAL PLANNING AND MASSING

4.1 Topography and urban design considerations

The site is a former industrial area which is the amalgamation of a significant number of smaller properties. It has an existing street pattern which is retained and reinforced as part of the concept plan. My understanding is that this is an urban design requirement.

There is a significant slope generally towards the south, and towards the dominant harbour view. The part of the site for which the Stage 1 Project application is being made is the most steeply sloping. It is clear that the combination of adverse orientation and the desirability of high-quality views in the same direction is a significant constraint on the likely building layout and massing. It is readily inferred that there is an additional constraint to create and reinforce corridors generally north to south, in order to create connections and use through the site to the harbour, for areas of the suburb remote from the shoreline. This is further emphasised by the necessity to undertake significant remedial engineering works for overland stormwater flow along one or more of those connections.

4.2 Constraints: massing and solar access geometry

I have given considerable thought to what broad massing strategies could achieve optimum proportions of apartments with high levels of midwinter of solar access. Clearly, the option of high-rise point blocks, or widely spaced low rise medium density development is not appropriate in this location. Given the intent to achieve higher densities with limits on general height of the development, the likely proportion of apartments to achieve the recommended levels of midwinter solar access is inherently limited to approximately half of the dwelling is provided. This is an outcome of the combination of geometric factors; while the ratio of apartments with faces to the sunny quadrant (from north-east and north-west) may be improved by good design, a significant number of appropriately oriented apartments will nevertheless be subject of mutual overshadowing when building blocks are laid out with appropriate street widths and the internal courtyard separations.

4.3 The proposed concept plan layout

The concept plan adopts a layout that satisfies the urban design and stormwater management considerations described above, which results in elongated building blocks with a generally north-south axis. The proposed stage one project develops a U-shaped building massing, maximising the number of apartments on the north-easterly street facade, and with the internal courtyard open towards the south-west and the view. Another long street facade with a north-west orientation is able to provide for a significant number of apartments to enjoy winter afternoon sun. Southeast facing apartments generally do not receive sun at midwinter. Where possible, such apartments are adjusted in the planning and/or provided with raised roof portions with appropriately oriented highlights, to achieve the benefits of solar orientation. Some additional apartments which would otherwise be favourably oriented, are overshadowed for all or part of the day at midwinter across the internal courtyard.

4.4 Alternative layouts and massing considered

The question is therefore whether alternative massing strategies could achieve significantly different proportion of apartments that can be said to enjoy a higher level of solar access amenity?

The broad brush alternative of a building layout and massing with long axis in an east-west direction does not of itself increase the number of favourably oriented potential apartments. Applied to a site with a southerly slope, to derive any benefit from the author geometry the necessary building separations exceed any realistic dimensions. In any case, that alternative this counter indicated by the urban design considerations relating to connections with the harbour. In addition such a layout would tend to produce streets and courtyards shaded throughout the day in winter; in contrast, the proposed layout provides for winter sun to those spaces in the middle of the day. A further consideration is that east-west oriented streets with street-wall facade design of midrise buildings would tend to block both concentrations of prevailing summer cooling breezes, where the proposed design has the effect of effectively channelling these breezes through the site.

In developing a more detailed massing for the given layout, there is potential for adjusting the heights of various parts of the building mass to reduce the overall self shading. However, as exemplified by the stage one building configuration, reduction in the height of the northerly elements results in a loss of a greater number of favourably oriented apartments, than the number of apartments which achieve additional hours of solar access by the reduction of the overshadowing.

In my considered opinion, the proposed site layout optimises the balance between solar access for apartments, exposure to prevailing summer cooling breezes, the preservation of winter solar access for parts of the public domain during the relevant parts of the day, and competing urban design and amenity issues.

Finally, given that the proposed layout and massing is applied to that part of the site with the most adverse southerly slope, I expect that future stages will achieve equal or better ratios of solar access compliance for their apartment mix.

5.0 STAGE 1 PROJECT: SOLAR ACCESS

5.1 Relevant solar access standard

The Residential Flat Design Code gives the following quantified recommendations:

- Living rooms and private open spaces for at least 70 percent of apartments in a development should receive a minimum of three hours direct sunlight between 9am and 3pm in mid winter.
  In dense urban areas a minimum of two hours may be acceptable.
- Limit the number of single-aspect apartments with a southerly aspect (SW-SE) to a maximum of 10 percent of the total units proposed.
- Developments which seek to vary from the minimum standards must demonstrate how site constraints and orientation prohibit the achievement of these standards and how energy efficiency is addressed (see Orientation and Energy Efficiency).
  (Rules of Thumb: Daylight Access p. 84)

5.2 Predicted solar access: methodology

Because of the complexity of *demonstrating* in detail the quantification of solar access to glazing of various orientations — and taking into account the considerable mutual and self-shading and other potential obstructions by recessed balconies and other facade detailing — I undertook exhaustive detailed analysis by computer generated projections. The digital model was provided to me by the applicant from the Revit software used to prepare the design and application documents, and independently checked by me for sufficient accuracy. I independently verified the direction of True North by examining the cadastral grid north, which is, as expected, within 1° of the north on the model provided to me. That *possible* margin of error is not relevant in solar access analysis.

The views of the model were prepared by the architects on my instructions, using the heliodon routine of the Revit software package, and with the appropriate solar geometry data supplied by me. The projections used are known as *'View from the Sun'*, and were taken at half hourly intervals. A view from the sun shows all sunlit surfaces at a given time and date. It therefore allows a very precise count of sunlight hours on any glazing or horizontal surface, with little or no requirement for secondary calculations or interpolation. Figure 1 illustrates the technique. *Note that a 'view from the sun' by definition does not show any shadows.*

For the purpose of calculating the compliance with the control, I have examined sun patches on the relevant glazing line of each apartment. Given the design, the balconies will in most cases enjoy a more favourable sun exposure with an additional are or more of complying solar access. The limiting condition for solar access to the glazing is generally self-shading by the privacy walls and/or deeply recessed balconies. This is a common issue that comes about with the necessity to comply with minimum dimensions of private open space.

Figure 1: View from the sun, 2pm June 21

Because of its key importance in the determination of what is 'effective sunlight' for characterisation of compliance, for both glazing and private open space, I refer specifically to the application of the relevant *L+EC Planning Principle (The Benevolent Society v Waverley Council [2010] NSWLEC 1082).*

- I quantify as complying all sun patches of reasonable size. I ignore very large angles of incidence to the glazing surface, and unusably small areas of sunlit glazing.
- I have generally characterised as complying when sun access is over three hours total of partially and fully sunlit glazing between 9am and 3pm mid-winter. Given that the development is to achieve what elsewhere is characterised as a closely built-up urban setting, I add a proportion of those apartments which only achieve a 'two-hour standard'.

The following additional considerations are relevant to the manner in which I have considered whether an apartment achieves compliance with the overarching amenity objectives of the Residential Flat Design Code:

- I quantify all **effective sun** that is demonstrably available to a point of interest, including sun earlier than 9am, or later than 3pm.
- Where appropriate, I note extended periods of sun available to bedrooms, as contributing significantly to the amenity of any apartment that has an otherwise unfavourably oriented living area. I extended this principle to those apartments where it is clear that the designers have made the choice of orienting the living areas towards the dominant view. In each instance where I take this into consideration, I do so on the basis that the future occupants of the apartment will be in no less position to make reasoned choice in enjoying the achieved periods of winter sunlight – I take the view that it would be unreasonable to characterise such apartments as failing to comply with the performance objectives of the RFDC.

Both latter characterisations are consistent with the interpretation of *the BenSoc Principle (and its predecessor Parsonage Principle)* as previously accepted by the Land and Environment Court, and by various Councils.

5.3 Maximising solar access

I have assumed that there is limited potential for the designers to radically depart from an efficient floor layout, which necessarily implies double loaded planning of much of the building. A simplified massing study on this site would then suggest that without explicit design improvements, the potential for apartments to achieve complying solar access is limited to rather less than 50% of the total. As previously noted, this is because even the favourably oriented north-westerly facade facing into the open courtyard, will have its lower stories overshadowed in winter. Also as previously noted, if the element of the massing which contributes this self shading is reduced in height, more complying apartments are lost than are gained.

Prior to undertaking this assessment and quantification I advised the applicant on the necessity to demonstrate by good design, any possible improvements on the baseline. I note that the following specific design strategies have been employed to achieve a significant increase in the number of apartments receiving improved solar access:

- at each instance of the multiple vertical circulation cores, apartments have been laid out to achieve the maximum number of corner and ‘through’ apartments (and by corollary, to reduce the number of unfavourably oriented single sided apartments);
- at the southern end of each ‘wing’, generally apartments have been laid out such that part of the apartment would benefit from afternoon sun;
- on the top floors, unfavourably oriented apartments have been treated with a raised ceiling portion with suitably oriented vertical glazing – these apartments actually enjoy effective sun to living areas throughout the winter day.

Given that the site has an unfavourably oriented slope and significant conflict with conventional amenity values of the dominant view, the overall outcome can be said represent the necessary additional design effort, and to come close to the maximum potential of an otherwise effective building envelope.

5.4 Achieved solar access

I tabulate available effective sun in detail. Table 1 shows available sun for all apartments, with cells equal to 30 minutes showing acceptable area of sunlit glazing to Living rooms, and where appropriate effective sun to Bedrooms.

Level	Unit No.	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	Comment
UB	UB19																		
	UB20																		
	UB21																		
	UB22																		
	UB23												B	B	B	B	B*	B*	
	UB24																		
	UB25																		
	UB26										L	L	L	L	L	L	L*	L*	
	UB27								B	B	L	L	L	L	L	L	L*	L*	
	UB28								B	B	L	L	L	L	L	L	L*	L*	
LG	LG13																		
	LG14																		
	LG15																		
	LG16																		
	LG17																		
	LG18																		
	LG19																		
	LG20																		
	LG21																		
	LG22																		
	LG23												B	B	B	B	B*	B*	
	LG24																		
	LG25																		

Level	Unit No.	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	Comment
	LG26										L	L	L	L	L	L	L*	L*	
	LG27								B	B	L	L	L	L	L	L	L*	L*	
	LG28								B	B	L	L	L	L	L	L	L*	L*	
	LG29									B	B	B	B	B	B	B	B*	B*	
	LG30																		
	LG31																		
	LG32									B	B	B	B	B	B	B	B*	B*	
	LG33							B	B	L	L	L	L	L	L	L	L*	L*	
	LG34										L	L	L	L	L	L	L*	L*	
GF	GF01			L	L	L	L	L	L	L									
	GF02					L	L	L	L	L									
	GF03					B	B	B	B	B									
	GF04																		
	GF05									B	B	L	L	L	L	L	L*	L*	
	GF06	B*	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L*	L*	
	GF07	B*	B	B	B	B	B	B	B	B									
	GF08	L*	L	L	L	L	L	L	L	L									
	GF09	L*	L	L	L	L	L	L	L	L	L	L							
	GF10	B*	B	B	B	B	B	B	B	B									
	GF11																		
	GF12																		
	GF13																		
	GF14																		
	GF15																		
	GF16																		
	GF17																		
	GF18																		
	GF19																		
	GF20																		
	GF21																		
	GF22								B										
	GF23												B	B	B	B	B*	B*	
	GF24																		
	GF25																		
	GF26										L	L	L	L	L	L	L*	L*	
	GF27								B	B	L	L	L	L	L	L	L*	L*	
	GF28								B	B	L	L	L	L	L	L	L*	L*	
	GF29									B	B	B	B	B	B	B	B*	B*	
	GF30																		
	GF31																		
	GF32									B	B	B	B	B	B	B	B*	B*	
	GF33							B	B	L	L	L	L	L	L	L	L*	L*	
	GF34										L	L	L	L	L	L	L*	L*	
L	101	L*	L	L	L	L	L	L	L	L									
	102	L*	L	L	L	L	L	L	L	L									
	103	B*	B	B	B	B	B	B	B	B									
	104																		
	105									B	B	L	L	L	L	L	L*	L*	

Level	Unit No.	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	Comment
	106	B*	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L*	L*	
	107	B*	B	B	B	B	B	B	B	B									
	108	L*	L	L	L	L	L	L	L	L									
	109	L*	L	L	L	L	L	L	L	L	L	L							
	110	B*	B	B	B	B	B	B	B	B									
	111																		
	112																		
	113																		
	114																		
	115																		
	116																		
	117																		
	118								B	B									
	119																		
	120																		
	121									L	L								
	122								B	B	B								
	123												B	B	B	B	B*	B*	
	124																		
	125																		
	126										L	L	L	L	L	L	L*	L*	
	127								B	B	L	L	L	L	L	L	L*	L*	
	128								B	B	L	L	L	L	L	L	L*	L*	
	129									B	B	B	B	B	B	B	B*	B*	
	130																		
	131																		
	132									B	B	B	B	B	B	B	B*	B*	
	133							B	B	L	L	L	L	L	L	L	L*	L*	
	134										L	L	L	L	L	L	L*	L*	
2	201	L*	L	L	L	L	L	L	L	L									
	202	L*	L	L	L	L	L	L	L	L									
	203	B*	B	B	B	B	B	B	B	B									
	204																		
	205									B	B	L	L	L	L	L	L*	L*	
	206	B*	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L*	L*	
	207	B*	B	B	B	B	B	B	B	B									
	208	L*	L	L	L	L	L	L	L	L									
	209	L*	L	L	L	L	L	L	L	L	L	L							
	210	B*	B	B	B	B	B	B	B	B									
	211																		
	212																		
	213																		
	214																		
	215																		
	216																		
	217																		
	218								B	B	L	L	L						
	219																		

Level	Unit No.	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	Comment
	220																		
	221									L	L	L	L	L	L				
	222								B	B	B								
	223												B	B	B	B	B*	B*	
	224																		
	225																		
	226										L	L	L	L	L	L	L*	L*	
	227								B	B	L	L	L	L	L	L	L*	L*	
	228								B	B	L	L	L	L	L	L	L*	L*	
	229									B	B	B	B	B	B	B	B*	B*	
	230																		
	231																		
	232									B	B	B	B	B	B	B	B*	B*	
	233							B	B	L	L	L	L	L	L	L	L*	L*	
	234										L	L	L	L	L	L	L*	L*	
3	301	L*	L	L	L	L	L	L	L	L									
	302	L*	L	L	L	L	L	L	L	L									
	303	B*	B	B	B	B	B	B	B	B									
	304																		
	305									B	B	L	L	L	L	L	L*	L*	
	306	B*	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L*	L*	
	307	B*	B	B	B	B	B	B	B	B									
	308	L*	L	L	L	L	L	L	L	L									
	309	L*	L	L	L	L	L	L	L	L	L	L							
	310	B*	B	B	B	B	B	B	B	B									
	311																		
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	316																		
	317																		
	318							B	B	B	L	L	L	L					
	319																		
	320			L	L	L	L	L	L	L	L	L	L	L	L	L	L*		
	322							B	B	B	L	L	L	L	L				
	323												B	B	B	B	B*	B*	
	324																		
	325																		
	326										L	L	L	L	L	L	L*	L*	
	327								B	B	L	L	L	L	L	L	L*	L*	
	328								B	B	L	L	L	L	L	L	L*	L*	
	329									B	B	B	B	B	B	B	B*	B*	
	330																		
	331																		
	332									B	B	B	B	B	B	B	B*	B*	
	333							B	B	L	L	L	L	L	L	L	L*	L*	
	334										L	L	L	L	L	L	L*	L*	

Level	Unit No.	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	Comment
4	401	L*	L	L	L	L	L	L	L	L									
	402	L*	L	L	L	L	L	L	L	L									
	403	B*	B	B	B	B	B	B	B	B									
	404																		
	405									B	B	L	L	L	L	L	L*	L*	
	406	B*	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L*	L*	
	407	B*	B	B	B	B	B	B	B	B									
	408	L*	L	L	L	L	L	L	L	L									
	409	L*	L	L	L	L	L	L	L	L	L	L							
	410	B*	B	B	B	B	B	B	B	B									
	411																		
	412																		
	413								B	L	L	B	B	L	L				
	415	L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L*		
	416	L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L*		
	418							B	B	B	L	L	L	L	L				
	423												B	B	B	B	B*	B*	
	424																		
	425																		
	426										L	L	L	L	L	L	L*	L*	
	427								B	B	L	L	L	L	L	L	L*	L*	
	428								B	B	L	L	L	L	L	L	L*	L*	
	429									B	B	B	B	B	B	B	B*	B*	
	430																		
	431																		
	432									B	B	B	B	B	B	B	B*	B*	
	433							B	B	L	L	L	L	L	L	L	L*	L*	
	434										L	L	L	L	L	L	L*	L*	
5	501	L	L	L	L	L	L	L	L	L									
	502	L	L	L	L	L	L	L	L	L									
	503	B	B	B	B	B	B	B	B	B									
	504																		
	505									B	B	L	L	L	L	L	L	L	
	506	B	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	
	507	B	B	B	B	B	B	B	B	B									
	508	L	L	L	L	L	L	L	L	L									
	509	B	B	B	B	B	B	B	B	B	B	B							
	512																		
	523								B	B	B	B	B	B					
	524	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	Rooflights
	528	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
	529									B	B	B	B	B	B	B	B	B	
	530																		
	531																		
	532									B	B	B	B	B	B	B	B	B	
	533							B	B	L	L	L	L	L	L	L	L	L	
	534										L	L	L	L	L	L	L	L	
6	601	L	L	L	L	L	L	L	L	L									

Level	Unit No.	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	Comment
	602	L	L	L	L	L	L	L	L	L									
	603	B	B	B	B	B	B	B	B	B									
	604																		
	605									B	B	L	L	L	L	L	L	L	
	606	B	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	
	607	B	B	B	B	B	B	B	B	B									
	608	L	L	L	L	L	L	L	L	L									
	609	B	B	B	B	B	B	B	B	B	B	B							
	612																		
	629									B	B	B	B	B	B	B	B	B	
	630																		
	631	L	L	L		L	L	L	L	L	L	L	L	L	L	L	L	L	rooflights
	632	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	rooflights
	633							B	B	L	L	L	L	L	L	L	L	L	
	634										L	L	L	L	L	L	L	L	
7	701	L	L	L	L	L	L	L	L	L									
	702	L	L	L	L	L	L	L	L	L									
	703	B	B	B	B	B	B	B	B	B									
	704																		
	705										L	L	L	L	L	L	L	L	
	706	B	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	
8	801	L	L	L	L	L	L	L	L	L									
	802	L	L	L	L	L	L	L	L	L									
	803	B	B	B	B	B	B	B	B	B									
	804	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	rooflights
	805										L	L	L	L	L	L	L	L	
	806	B	B	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	

Table 1: Effective sun

Note

- Table 1 records the presence of effective sun at the nominated time, and for the *subsequent* 30 minute period.
- In my summary quantification, I ignore all sun before 9am and after 3pm which is shown on the views from the sun for the lower six levels, as it is highly likely to be obstructed by future surrounding development of similar heights. These periods are shown by an asterix (*) in the table.
- In characterising compliance applied to some dwellings, I consider it appropriate to pay regard to sun to *two* bedrooms of larger apartments where a clear choice, to locate the living area on an unfavourable orientation, appeared appropriate. I am generally conservative with this characterisation, but consider it an important acknowledgement of the actual sun access for apartments.
- I consider it is appropriate to admit some dwellings as compliant under the RFDC '2 hour standard', if (as here) only a small proportion of apartments are projected to receive between two and three hours of effective sun in mid-winter.

Table 2 summarizes the projected solar access for the residential dwelling units in the development.

Units which achieve 3 hours or more sunlight to Living and POS 9am – 3pm as defined in the RFDC	**46**	**19%**
Units which achieve 2 hours or more sunlight to Living and POS 9am – 3pm as defined in the RFDC	**52**	**21%**

Units which achieve 3 hours or more sunlight to Living and POS (with effective sun available to upper levels)	**92**	**38%**
Units which achieve 2 hours or more sunlight to Living and POS (with effective sun available to upper levels)	**6**	**2%**
Units which achieve 3 hours or more *effective* sunlight *taking account of bedrooms where appropriate* (with effective sun available to upper levels)	**135**	**55.8%**
Units which achieve 2 hours or more *effective* sunlight *taking account of bedrooms where appropriate* (with effective sun available to upper levels)	**10**	**4.1%**
Total units	242	
Total deemed complying	**145**	**59.9%**

Table 2: Summary of solar access for units

6.0 NATURAL VENTILATION

6.1 Performance Objectives

The Residential Flat Design Code (RFDC) gives a quantified recommendation for interpreting SEPP 65 with respect to natural ventilation:

- Building depths, which support natural ventilation typically range from 10 to 18 metres.
- Sixty percent (60%) of residential units should be naturally cross ventilated.
- Twenty five percent (25%) of kitchens within a development should have access to natural ventilation.
- Developments, which seek to vary from the minimum standards, must demonstrate how natural ventilation can be satisfactorily achieved, particularly in relation to habitable rooms. *(*Rules of Thumb: *Natural Ventilation* p.87)

SEPP65 itself does not refer to prescribed quantitative standards, but may be regarded as a performance based regulatory instrument. Proper reading of the Residential Flat Design Code as it interprets SEPP65 similarly makes clear the performance based approach of the Code.

The control of energy efficiency and energy use for assuring thermal comfort is now vested exclusively in SEPP BASIX. Specific performance measures for buildings designed in compliance with SEPP65 are therefore scrutinized in light of an objective of *natural ventilation for general amenity*.

6.2 Natural ventilation/cross ventilation

So-called 'cross-ventilation' is a simplistic expedient for checking the likely contribution of natural ventilation to projected comfort conditions. 'Cross-ventilation' describes where a dwelling has operable openings to two or more distinctly different orientations, thus making likely that in any conditions of breeze, relative pressure differentials will assure some air movement through connected spaces in the dwelling. The *Rules of Thumb* in the Residential Flat Design Code give a quantified recommendation *with respect only to cross ventilation*, relating to the overall proportion of complying dwellings, but not to the expected performance for any one dwelling.

6.2.1 Cross ventilation by openings in adjacent or opposite facades

In the subject development, all such apartments are classified as cross-ventilated without further discussion here – the simple definition of cross ventilation is met by all 'corner' apartments in the complex.

6.2.2 Cross ventilation by roof openings

A number of apartments on the top floors of the building are characterised as cross ventilated by virtue of suitably designed raised monitors, with operable vertical glazed sashes in two or more faces. In a flat roof under all wind directions, such openings may be relied on to be in a region of reduced static pressure, and therefore to act as reliable outlet openings for cross ventilation.

6.3 Enhanced single sided natural ventilation

As a consequence of the double loaded planning, approximately 60% of the apartments in the proposed development are single sided, and don't have the benefit of conventional cross ventilation as described in *6.2.1 and 6.2.2* above.

I have previously demonstrated with respect to a number of other projects, that natural ventilation compliance under the RFDC is achievable by suitably designed *single sided apartments with reliable exposure to the prevalent summer cooling breezes* in Sydney. The fundamental attribute for achieving this condition is the degree of 'relief' in the dominant windward façade — by use of protruding elements and recessed balconies, as notably employed in this design.

Where apartments meet this and other design pre-requisites, and are suitably oriented, the ventilation regime of such single sided, multi-room frontage apartments is sufficiently comparable to cross ventilation to satisfy the performance objectives.

6.3.1 Cooling wind and breeze exposure

Figure 2 illustrates the relative distribution of frequency and velocity of summer winds for Sydney, based on the Reference Meteorological Year.

The chart shows relative frequencies for the whole day. It may be noted that the most frequent winds suitable for general cooling are the sea breezes from just east of north to south-east. Southerly 'busters' can achieve rapid cooling, often accompanied by rapid temperature drops and higher wind speeds. These also occur with useful frequency.

I would normally exclude apartments only facing north-west from consideration as benefiting from the summer cooling breezes. However, on this site, it can be fairly assumed that because of the location of the development on the harbour's edge, the orientation of the bounding streets, and the likely configuration of adjacent developments of similar scale, both sets of prevailing cooling breezes will be reliably channelled in the two directions at an acute angle to the long street facades. The northeast facade should have relatively unobstructed exposure, with any channelling also further enhancing the likely efficacy of the dominant northeasterly summer afternoon breezes. All upper level single aspect apartments that have a pronounced articulated design and multi room 'face' onto any of the street facades can therefore safely be assumed to benefit from such exposure.

6.3.2 Design attributes for enhancing single sided ventilation

The ventilation potential of single sided units is significantly enhanced by some design attributes:

- Detailing of façade elements that is likely to create and enhance local pressure differentials between adjacent rooms and/or openings to the same room. In this case the relevant apartments have notably pronounced local corner conditions for both living space and primary bedrooms;
- Internal layout that is relatively 'clean', i.e. minimizes obstructions to air movement;
- Internal openings of significant area provided to bedrooms, assuring least loss of momentum for the air stream where air movement between living and sleeping zones is envisaged;
- Appropriate window sizes and operable sash areas;
- Physical protection of principal openings to assure shelter in conditions of wind driven rain.

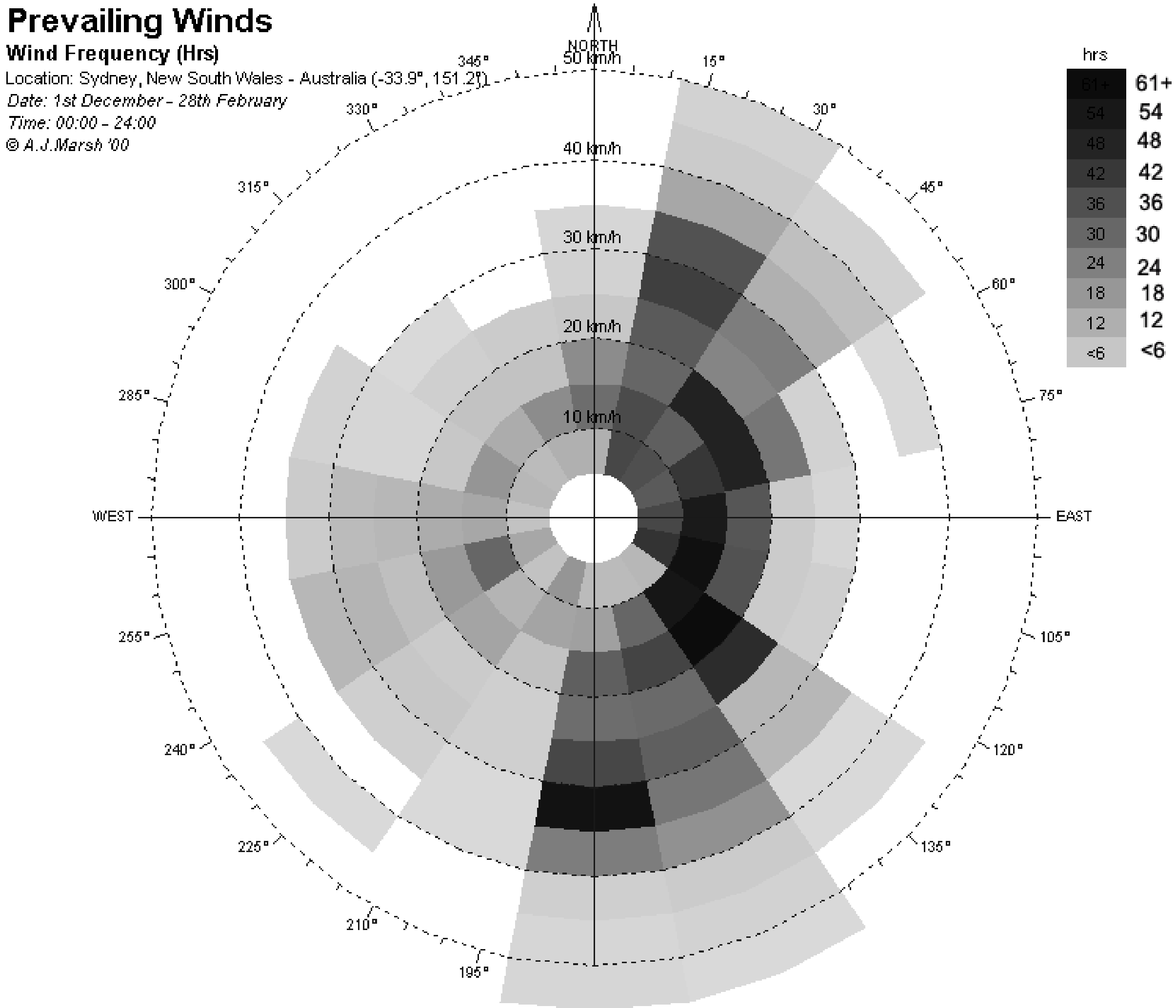

Figure 2: Summer wind velocities and frequencies, Sydney.

6.3.3 Validation studies

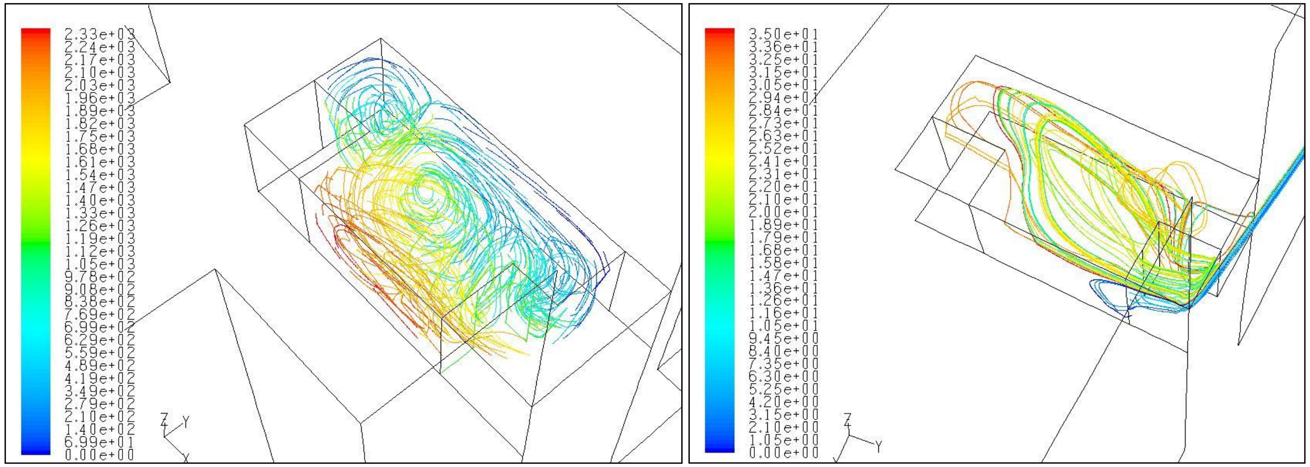

Figure 3: Simulated ventilation of typical single sided apartment
Left: Wind with moderate yaw from SE
Right: Wind channelled with large yaw from N
Source: VIPAC

I have the benefit of a number of simulation based validation studies for likely projected ventilation performance of single sided apartments that meet the above design attributes. Those studies have been carried out under my direction by Heggies Australia, Vipac Engineers and Scientists Ltd., and CPP Wind Engineering, on a number of apartment proposals where directly comparable conditions and apartment designs were under consideration.

Figure 3 illustrates streamline patterns for an apartment (of similar design and orientation of the smaller north-east facing apartments in the proposed building) exposed to the two dominant summer cooling wind regimes (Source: Vipac). The examples are from the Ashfield RSL project, which was determined for approval by former Senior Commissioner Roseth in s34 Conference in the Land and Environment Court.

The results of such CFD simulations confirm that the single sided ventilation effects are sufficiently reliable under the influence of Sydney's prevailing wind regime. It is therefore confidently predicted that ventilation for *mass heat flow* (ie. removal of excess heat from the air volume and building fabric at appropriate times) will be sufficient to ensure adequate cooling performance.

So-called *comfort ventilation*, which relies on adequate *air velocities*, can also be expected to be adequate for all units in the development which are exposed to the nominated cooling breeze directions, at most times. Given the detailed design of the single aspect apartments under consideration, I am confident that such usable air velocities occur in relevant parts of the living spaces of those apartments.

6.4 Quantification of ventilation compliance

Table 3 summarises the apartment types with their ventilation status as assessed against the criteria described, and reports the compliance deemed to be achieved. Apartments identified as having *'enhanced single sided ventilation'* potential are included as deemed complying with the RFDC performance objectives. I apply my opinion only to specific apartments in the proposed design. A characterisation of compliance as *'enhanced single sided ventilation'* is limited to those single sided apartments that have been qualified by the necessary design attributes, and *directly comparable to previous simulation based investigation.* In brief, these are apartments exposed to the north-east and/or south to south-east cooling winds, as they are expected to be channelled by the streets running down to the harbour.

In Appendix B, I attach a full table of the individual apartments, identifying the basis of classification of natural ventilation performance for each one.

Cross ventilated	**95**	**39%**
Enhanced single sided ventilation	**89**	**37%**
Single sided	**58**	**24%**
Total	**242**	
Total deemed complying	**184**	**76%**

Table 3: Ventilation compliance

I specifically *exclude* apartments which may be otherwise similar, but where I consider the likely level of exposure to prevailing summer cooling breezes to be insufficient. Apartments fall into this category where they are:

- within the inner courtyard of the U-shaped building form (except those close to the southerly corner of each wing),
- too close to ground level, or
- deeply recessed with a narrow veranda unlikely to develop the necessary pressure gradient across multiple openings.

I believe my characterization of compliance is therefore conservative. For a full discussion of the basis of my characterisation of compliance refer to *6.5 Discussion.*

7.0 CONCLUSION

7.1 Concept Plan: Layout for solar access and natural ventilation

I have considered the topographic and urban planning constraints to which the proposed master planning of the overall site responds. The general orientation of the site, with a marked southerly slope towards the dominant harbour view, severely constrains the possibility of achieving high levels of compliance for winter solar access. I have been advised that he preservation and reinforcement of the existing street grid has been a strong urban design constraint, as is the desirable outcome of preserving view and access corridor from the suburb towards the harbour shoreline.

In my considered opinion, the proposed site layout optimises the balance between solar access for apartments, exposure to prevailing summer cooling breezes, the preservation of winter solar access for parts of the public domain during relevant parts of the day, and competing urban design and amenity issues.

In the stage 1 project, the proposed layout and massing is applied to that part of the site with the most adverse southerly slope. I expect that future stages will achieve equal or better ratios of solar access compliance for their apartment mix.

7.2 Stage 1 project: Solar access

The development achieves 40% of apartments with complying periods of effective sun, applying the relevant Rule of Thumb of the RFDC with no regard to the actual effective sun. This proportion of apartments is derived by counting 46 apartments (19%) at the *minimum 3 hours of effective sun access to living area glazing and private open space between 9am* *and 3pm on June 21, together with a further 52 apartments (21%) at greater than 2 hours. However, the majority of the apartments thus characterized as complying actually enjoy mid-winter sun well in excess of the nominated '3 hour standard'.*

The application of the relevant Planning Principle of the Land and Environment Court in my view requires that one takes account of effective sun before 9am and after 3pm, where is demonstrated to be unlikely to be alienated by adjacent development. Similarly, I consider it appropriate to characterize as complying those apartments with extended periods of sun to bedrooms, the more especially where the total sunlit space is greater than if the planning of such apartments were distorted by unreasonably ignoring considerations such as the dominant view to the South. When I apply these considerations, 135 out of 242, being 55.8% of the apartments are projected to comply at the minimum 3 hour standard. A further 10 apartments are projected to receive a minimum 2 hours effective sun at mid-winter. I consider it legitimate under the broad intents of the RFDC to add these apartments to those complying by strict interpretation of the *Rule of Thumb*.

The total proportion of apartments that may then be characterized as complying with the performance requirements of the RFDC is 59.9%. The recommended minimum percentage in the Rule of Thumb is 70%, but I note that the RFDC makes explicit provision for the consideration of contextual and other factors that may justify a lower proportion. In my considered opinion, the proportion achieved here is a very reasonable standard, given the nature of the siting constraints, and should not be an impediment to approval.

7.3 Stage 1 project: Natural ventilation

The number of cross ventilated apartments is 95 out of a total of 242, being 39%.

The detailed disposition of apartments, and in particular the method of articulation of the façade, is critical in achieving a reliable regime of natural ventilation for single aspect units. Quantitative analysis of the likely single sided ventilation undertaken for comparably designed apartments under identical wind exposure conditions suggests that the numerical majority of apartments in the Stage 1 project proposal may be safely characterised as complying with the performance requirements of the RFDC. Single sided apartments that may be safely classified as having satisfactory ventilation patterns and that may be deemed as complying for natural ventilation is 89 (37%).

A relatively conservative characterisation therefore allows approximately 76% of apartments to be described as complying with the performance objectives for natural ventilation. In my considered opinion, on that basis the development may be considered fully compliant for natural ventilation under the Residential Flat Design Code.