24/03/2011

Summary Report

1003809 Vincentia Mall

Prepared by Cundall for:

Fabcot

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1 Introduction

In considering the viability of open malls versus enclosed malls at Vincentia we have compared the two options in three ways:

- the sustainability of the business through maintaining suitable comfort levels within the malls themselves in an open mall scenario
- the operational energy consumption of the two options
- the embodied carbon of the two options.

2 Maintaining suitable comfort conditions in the open mall scenario

In the enclosed mall option it is assumed that the mall will be designed to Australian best practice and find the balance between daylight, sunlight and thermal comfort whilst maximizing energy efficiency.

In assessing the ability to maintain comfort in the open mall option we have analysed local weather data to and compared that to the local weather data from recent and existing outdoor malls in New South Wales.

There are many climatic elements that need to be considered, however the three key climatic elements for assessing the suitability of external malls and open air spaces are:

- Wind Speed
- Air Temperature
- Rainfall

The following sections assess these three key elements for Richmond (Rouse Hill Town Centre), Sydney (Warringah Mall), Camden (Macarthur) and Vincentia.

2.1 Wind Speed

Air movement is beneficial in summer where it can provide a cooling effect in hot temperatures but detrimental in winter when the cooling effect of air movement is not desirable. Higher wind speeds can also cause wind driven rain in open malls.

9am wind speed [km/h]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Richmond	9.1	8.1	6.6	6.9	5.7	6.3	5.9	8.1	9.9	10.3	9.9	8.9
Vincentia	14.2	14.0	13.5	15.0	16.8	19.1	17.7	17.1	16.2	15.2	15.6	14.8
Sydney	8.6	8.2	7.9	8.8	10.5	11.9	13.1	13.3	12.4	12.2	11.0	9.8
Camden	6.5	5.5	6.0	6.3	5.4	5.9	5.8	7.9	9.0	9.3	8.0	7.9

3pm wind speed [km/h]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Richmond	16.6	15.6	14.7	14.4	12.6	13.5	14.3	17.7	19.4	19.1	19.0	17.7
Vincentia	20.5	19.3	18.3	17.9	17.9	19.1	19.4	20.5	21.3	21.2	22.5	21.9
Sydney	17.9	16.8	15.2	13.8	12.7	13.6	15.3	17.6	18.3	19.1	19.4	19.5
Camden	17.2	15.5	15.0	13.8	12.5	13.9	14.6	16.8	18.1	17.7	17.7	18.5

The average monthly wind speeds are typically 20-30% higher in the afternoon compared to the other locations and 50-100% higher in the mornings compared to Richmond and Camden. The result of this will be that the apparent temperature (wind chill) in the winter in Vincentia will be more pronounced than in Richmond and Camden and even Sydney.

The high average wind speeds will need to be carefully considered in both the open mall option and the enclosed mall option, particularly around the entrances.

2.2 Air Temperature

9am wind chill temperature [°C]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Richmond	23.1	22.3	19.9	17.4	13.1	9.4	8.2	10.6	15.1	18.5	19.6	21.7
Vincentia	21.0	21.3	20.1	17.2	13.7	10.6	9.4	10.5	13.2	15.9	17.7	19.9
Sydney	26.1	26.2	25.2	18.5	14.1	10.6	9.3	11.2	15.2	18.6	20.4	22.5
Camden	29.7	28.7	26.9	17.4	13.1	9.0	7.9	9.8	14.3	17.9	19.2	21.8

3pm wind chill temperature [°C]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Richmond	30.7	29.4	27.4	24.0	20.0	16.7	16.0	18.5	21.9	24.4	26.6	29.5
Vincentia	22.9	23.3	22.2	19.6	16.6	13.9	12.8	13.8	15.6	17.5	19.3	21.4
Sydney	26.1	26.2	25.2	22.8	19.7	16.5	15.8	17.0	19.1	20.9	22.7	24.8
Camden	29.7	28.7	26.9	23.4	19.5	16.0	15.3	17.3	20.5	23.1	25.5	28.6

The second key element is air temperature, as discussed above wind speed also impacts the comfort of a particular air temperature we have therefore used wind chill as a more accurate high level assessment of comfort.

In comparing the wind chill temperatures at 9am in Vincentia compared to the other locations it can be seen that the number of months with cold mornings (<19.5°C, shown in blue) is very similar across all locations. However, when comparing the cold afternoons it can be seen that on average Vincentia has more cold afternoons when compared to the other locations. These cold afternoons are being exemplified by the faster wind speeds in Vincentia compared to the other locations.

In comparing the summer conditions Vincentia is an ideal climate to open the mall up in the summer and autumn to capture and make use of the cooler conditions.

This early assessment would indicate that reasonable comfort conditions could not be maintained in the open malls in the winter. The combination of higher wind speeds and cool temperatures at Vincentia would indicate that for the majority of the winter months from May through to October, thermal comfort would be below acceptable conditions.

The detailed work in Appendix A further analyses the climate and supports this early finding. The outdoor climate in Vincentia, while comfortable for 76% of the time, is too cold for 24% of the operating time, mostly due to cold winter winds from the west and south.

2.3 Rainfall

The final key climatic element to consider is rainfall. Rain can dramatically impact the sustainability of a retail business in an open mall scenario.

No. of days with rain >1mm/hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Richmond	8	9	8	6	6	5	4	4	5	6	8	6
Vincentia	13	12	12	11	11	11	9	8	9	12	12	12
Sydney	13	13	13	11	11	11	9	8	8	11	12	13
Camden	4	4	4	4	3	3	3	3	3	4	4	4

Average monthly rainfall [mm]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Richmond	70	129	68	44	55	46	32	32	49	56	83	62
Vincentia	97	98	122	132	134	129	107	90	79	85	84	83
Sydney	101	119	129	126	121	131	97	81	69	78	83	78
Camden	75	103	85	66	59	58	39	43	39	67	76	55

It can be seen from the above data that the number of days with rain in Vincentia is on average double that at Rouse Hill and at Macarthur Square and very similar to Sydney. The average monthly rainfall in Vincentia is also considerably higher than Rouse Hill and Macarthur Square.

2.4 Summary

In assessing the ability of an open mall scenario in maintaining comfort conditions at Vincentia we would conclude that the high wind speeds and cold temperatures through the day in winter would mean that significant enclosure of the mall would be needed to maintain comfort. Further more that this enclosure would compromise the ability of the open mall to maintain thermal comfort in the summer where a more open mall is needed.

In addition, in analysing the wind and rain conditions significant cover would be needed to avoid and minimize wind driven rain into the public areas as well as the shops. This again would compromise the ability of the open mall to maintain comfort levels in the summer due to the increased enclosure for rain protection.

In conclusion, when considering thermal comfort in isolation we would recommend that the mall be enclosed. However, in recommending this we need to consider the impact on the operational energy consumption of the entire mall as well as the embodied carbon in the construction of the two options.

3 Operational energy consumption of the two options

The detailed analysis in Appendix B has shown that the open mall option (naturally ventilated) does reduce the demand on cooling and heating within the overall retail centre, by approx. 6%. However, when this is considered against the overall operational energy consumption of the entire retail centre it can be seen this reduction is less than 1%.

In consideration of the comparison of the impact that an open mall will have on the sustainability of the retail business in the winter against the operational energy consumption saving of less than 1% we do not believe that this level of energy saving warrants an open mall scenario.

4 Embodied carbon of the two options

To complete the analysis of the consideration of open mall versus enclosed mall we have gone to the next step at Vincentia when compared to other retail centres. For the first time we have considered the embodied carbon of the two options. We have compared the existing open mall design with the alternative enclosed mall design and have considered the differing treatments to the shop fronts as well as the entrance to the malls themselves. The detailed analysis is in Appendix C.

In summary the embodied carbon between the two options is very similar in total impact. This should therefore not be considered when deciding upon open versus enclosed mall.

5 Conclusion

In considering the three key aspects of open mall versus enclosed mall at Vincentia it can be seen that the operational energy consumption and embodied energy of the two options are close enough between the options for these two elements not to be deciding factors. However, the analysis of the ability to maintain comfort conditions in an open mall has shown that the higher wind speeds and cooler afternoon temperatures at Vincentia are likely to result in significant period of the winter where comfort can't be maintained. In addition, the extra cover needed to temper the winter conditions and keep rain out of the public spaces is likely to cause detrimental effects in the summer where the mall needs to be as open as possible.

In conclusion, on the grounds of maintaining comfort only we would recommend that the mall be enclosed and where possible be designed to have the ability to open up in the summer and mid-season to allow the air conditioning and heating to be turned off.

Appendix A

Detailed Climate Analysis

Climate and Comfort

1 Objective/Aim

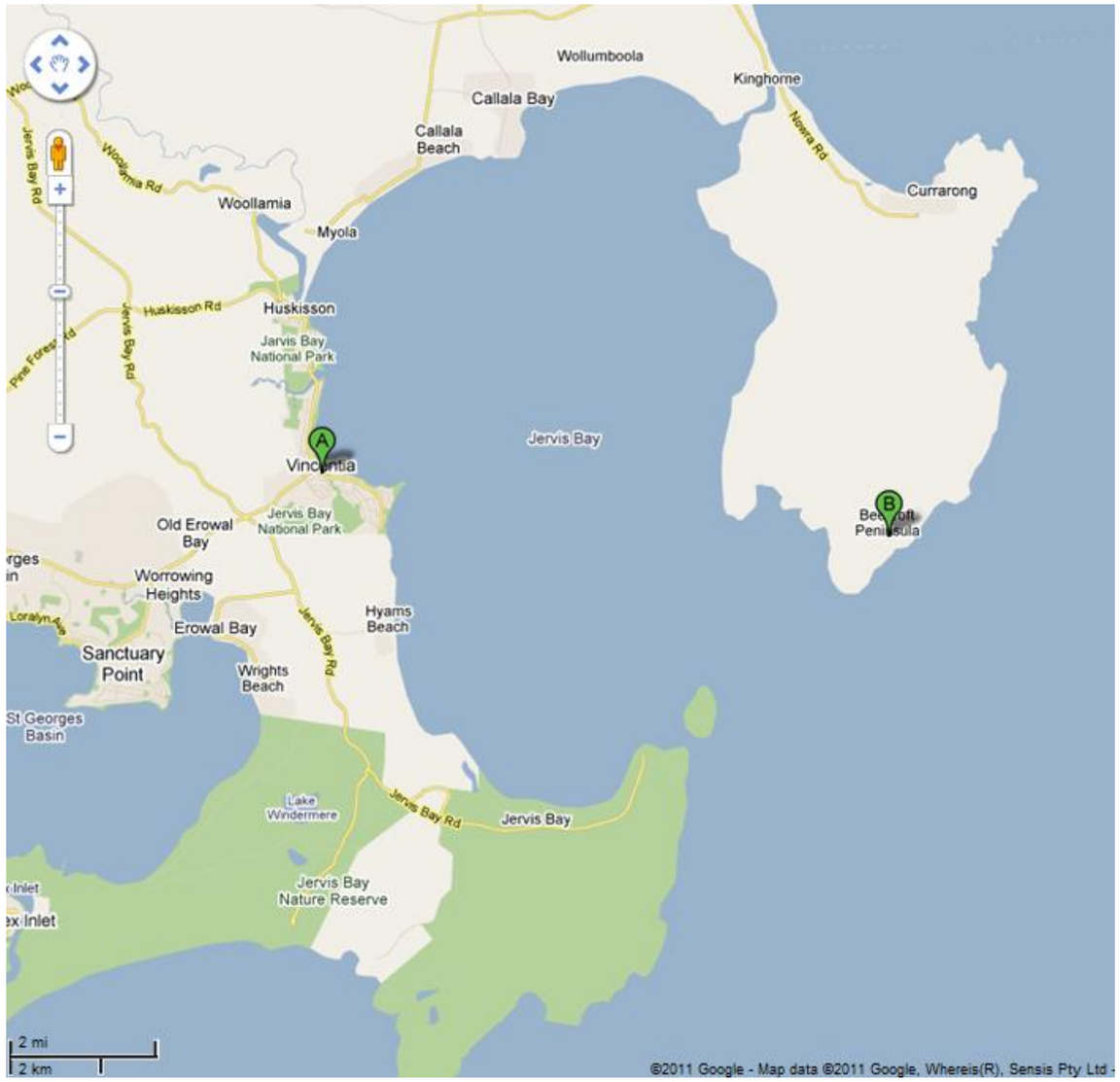
The objective of this information paper is to assess potential of the local climate to provide thermal comfort in an outdoor retail environment and to assess whether an open or closed mall is more suitable to the climate.

2 Methodology

The first step in gaining understanding of wind and thermal conditions is to obtain historic weather data from the Bureau of Meteorology. The bureau collects weather data from many sources around Australia, for Vincentia the closest station is in Jervis Bay at Point Perpendicular. Point Perpendicular is 12km from Vincentia and therefore gives us good representation of the climatic conditions that will be experienced at the development. The image to the right shows the proximity of Vincentia (A) to Point Perpendicular (B).

Jervis Bay has approximately 10 years of good historic data for temperatures but the station only started measuring wind speed and wind direction on an hourly basis in mid 2007. Weather data analysed is from 2008 to 2010.

We have then used our work on other outdoor retail spaces such as in Richmond, Newcastle and Sydney to assess the suitability of the climatic conditions of Vincentia in providing thermal comfort in outdoor retail areas.



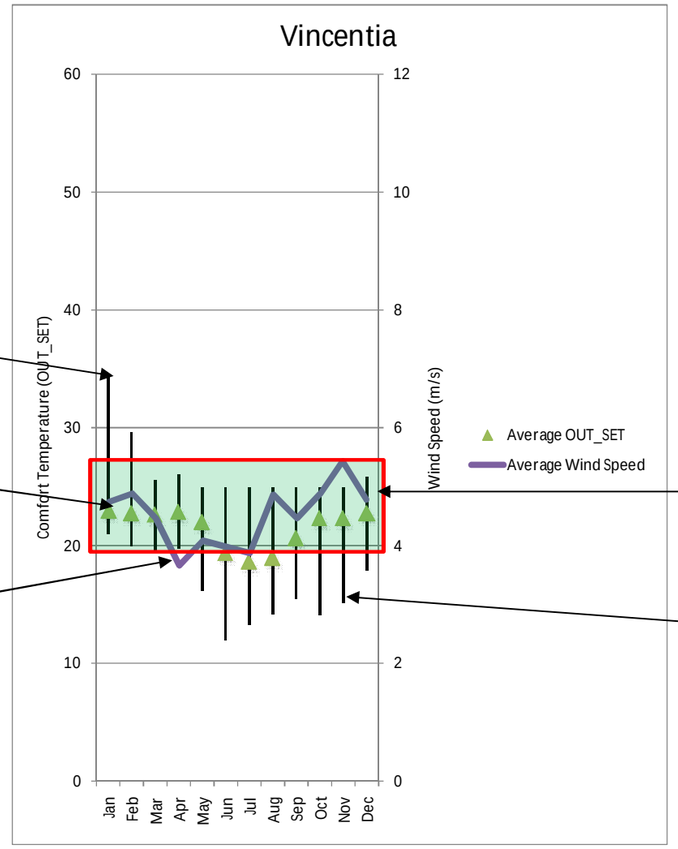
3 Results

The Jervis Bay (Vincentia) wind rose has been overlayed on top of the Vincentia District Centre site plan to help to gain a perspective of where the prevailing winds will come from on site. The wind rose represents the average of hourly wind data from 2008 – 2010.

The prevailing wind conditions for Vincentia are as follows:

- Still – approx. 0.7% of the time
- From South – approx. 28% of the time
- From North – approx. 28% of the time
- From West – approx. 12% of the time

In assessing thermal comfort in semi-outdoor and outdoor areas we use a comfort index know as OUT_SET. OUT_SET uses the measures of air temperature, surface temperatures, relative humidity, wind speed, clothing level and activity rate to calculate a single comfort temperature in degrees Celsius. From previous projects and from research at Macquarie University an OUT_SET of 19.5 to 27 °C provides sufficient comfort in semi-outdoor and outdoor environments. The graph below shows the results for Vincentia over a typical year.



Top of the black line indicates the maximum OUT_SET temperature for the month

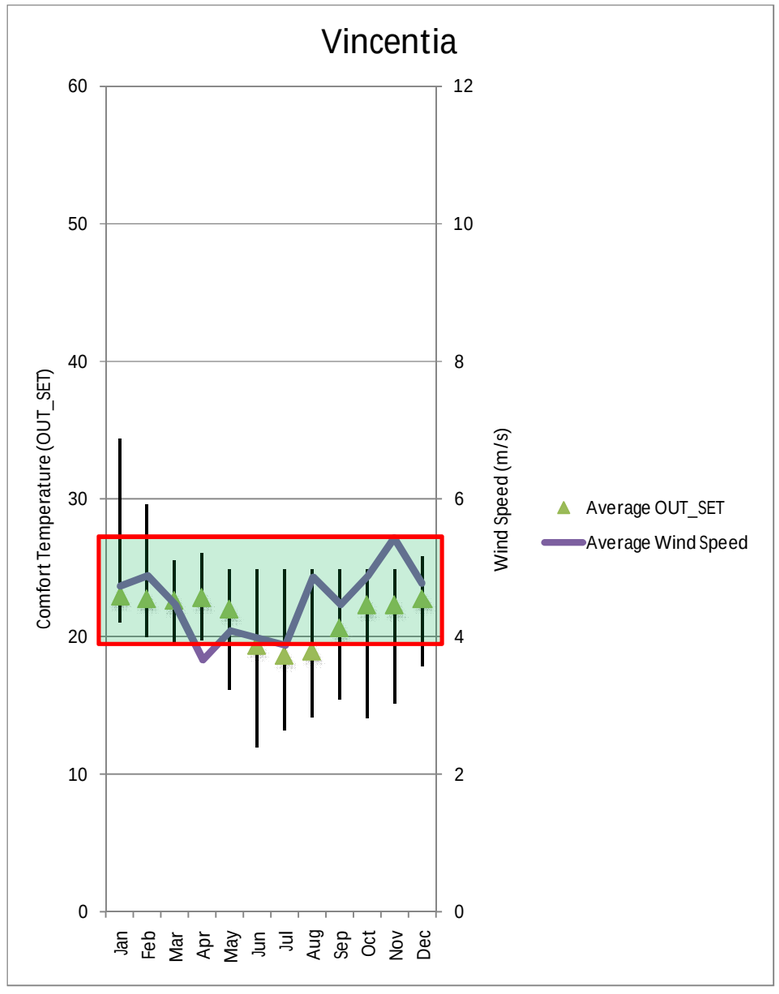
Green triangle shows the average OUT_SET temperature for the month

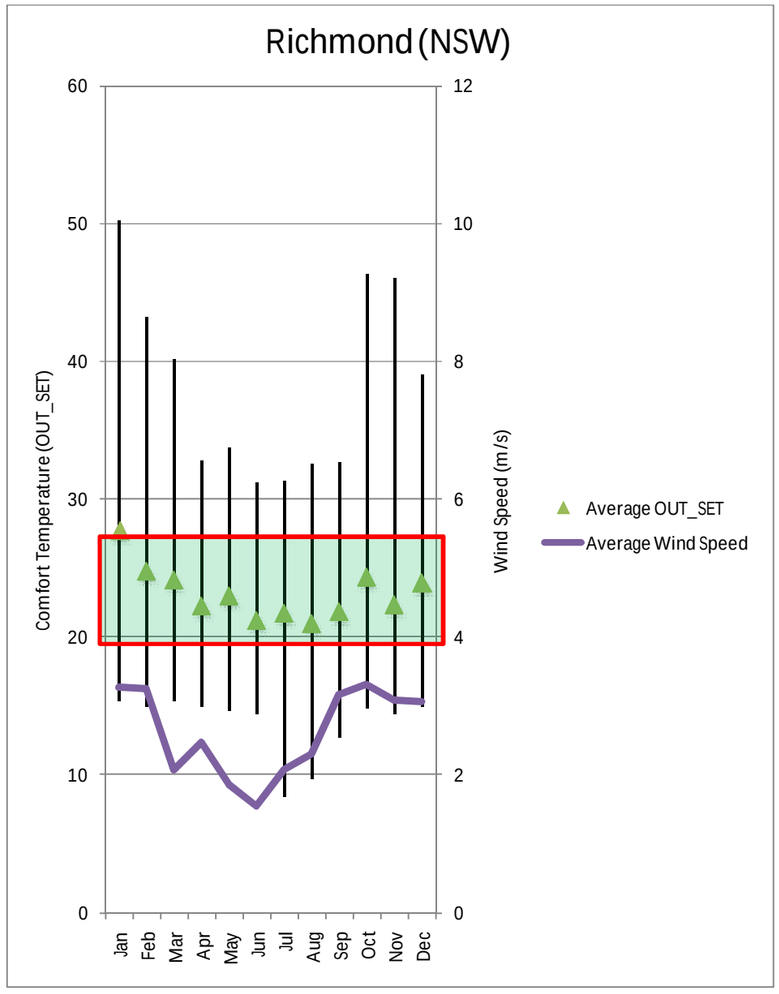
Purple line shows the average Monthly Wind Speed to be read from the right hand axis of the chart

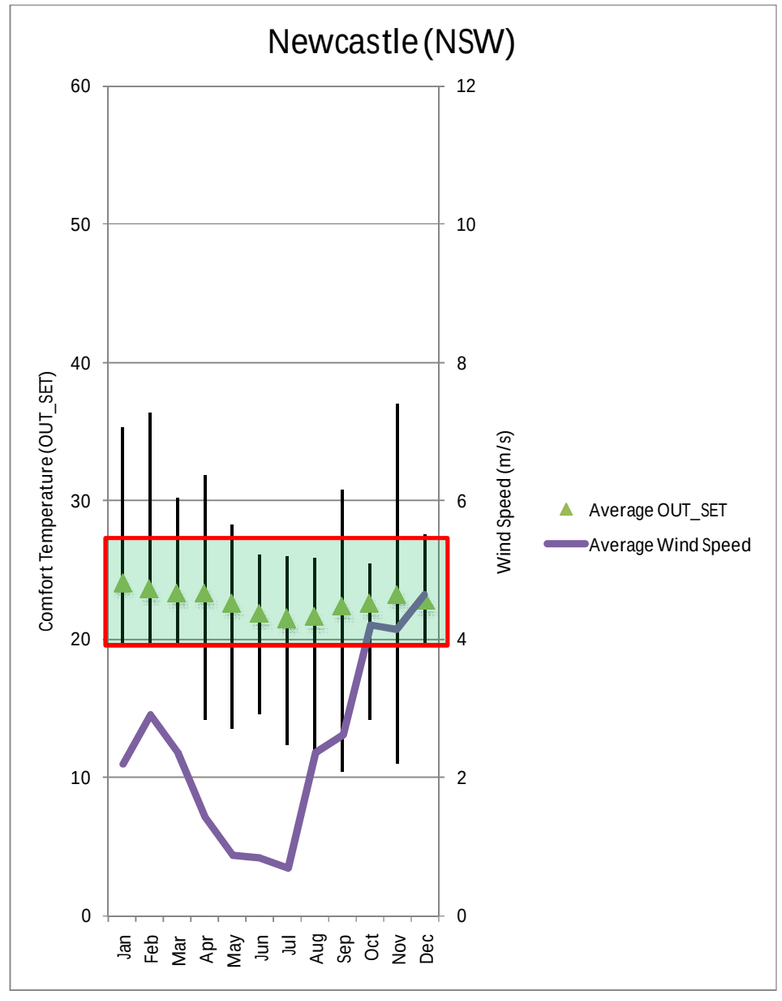
Red box shows the acceptable comfort conditions for semi-outdoor and outdoor

Bottom of the black line indicates the minimum OUT_SET temperature for the month

The following results show a comparison of Vincentia to Richmond and Newcastle weather conditions, these results are not what was achieved at each retail centre they are ideal situations – ie what could be achieved in an ideal situation.







In comparing the Vincentia results to Richmond and Newcastle the following can be noted:

- Higher average wind speeds in Vincentia (4m/s) during the winter reduce comfort levels considerably compared to Richmond (1-2m/s)
- Winter average comfort levels fall outside of acceptable comfort levels in Vincentia but not in Richmond
- Winter max comfort levels are well below Richmond indicating that Vincentia suffers from cold winds that Richmond isn't exposed to
- Average summer comfort levels at Vincentia are much lower than Richmond, with much lower maximums as well.

The following shows the average number of hours of too hot, too cold and comfortable taken over a typical year.

	Vincentia	Newcastle	Richmond	Greensborough		London	Hong Kong
Too Hot	0%	2%	9%	4%		0%	8%
Comfortable	76%	92%	89%	69%		54%	88%
Too Cold	24%	6%	2%	27%		46%	4%

In comparing the percentage of too hot and too cold hours between Vincentia, Richmond, Newcastle and Greensborough it can be seen that Vincentia has less comfortable hours than Richmond and Newcastle but better than Greensborough (VIC). In comparison to overseas climates, London would be uncomfortable for 46% of the time and Hong Kong for 12% of the time.

In assessing the percentage of the time that a climate is uncomfortable it is important to assess when the hours of discomfort occur, for example if the 25% of discomfort at Vincentia was for the first 1.5 hours of trading and the last 1.5 hours of trading every day then this maybe seen as an acceptable compromise of comfort. However, if the number of hours of discomfort occurred every day and every hour for 3 months then this may not be acceptable. To asses this we have taken a typical year of Jervis Bay data to assess the times and occurrences of discomfort. The calendar on the next page highlights the occurrences.

JERVIS BAY DATA – TYPICAL YEAR HOT AND COLD CALENDAR

HOT OCCURENCES

Full Hot Day Half Hot Day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Number of Half and Full Hot Days

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	2	0	0	0	0	0	0	0	0	0	1
10%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%

Number of Full Hot Days

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	0	0	0	0	0	0	0	0
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

COLD OCCURENCES

Full Cold Day Half Cold Day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1												
2												
3												
4												
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Number of Half and Full Cold Days

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	13	29	30	30	22	7	5	2
3%	0%	0%	0%	42%	97%	97%	100%	73%	23%	17%	6%

Number of Full Cold Days

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	4	20	29	26	19	4	2	0
0%	0%	0%	0%	13%	67%	94%	87%	63%	13%	7%	0%

The calendar above highlights the impacts of the cold occurrences. In June, July and August approx. 90% of the days have more than 2 hours where it is too cold. From a business perspective this is too high. The calendar on the following page shows the comparison to the Richmond typical year where the highest percentage of hot or cold days is 60% of the time and 40% of the time in Newcastle.

The hot occurrences are more spread out over the summer months with the largest percentage being 10%, however as with all weather data this is based on past occurrences and does not guarantee future performance.

RICHMOND DATA – TYPICAL YEAR HOT AND COLD CALENDAR

HOT OCCURENCES

Full Hot Day Half Hot Day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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2												
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Number of Half and Full Hot Days

17	11	11	4	1	0	0	0	0	11	4	10
55%	39%	35%	13%	3%	0%	0%	0%	0%	35%	13%	32%

Number of Full Hot Days

12	9	5	0	0	0	0	0	0	8	3	4
39%	32%	16%	0%	0%	0%	0%	0%	0%	26%	10%	13%

COLD OCCURENCES

Full Cold Day Half Cold Day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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2												
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Number of Half and Full Cold Days

0	0	0	2	0	18	17	16	8	0	2	0
0%	0%	0%	7%	0%	60%	55%	53%	27%	0%	7%	0%

Number of Full Cold Days

0	0	0	2	0	2	5	8	3	0	1	0
0%	0%	0%	7%	0%	7%	16%	27%	10%	0%	3%	0%

NEWCASTLE DATA – TYPICAL YEAR HOT AND COLD CALENDAR

HOT OCCURENCES

Full Hot Day Half Hot Day

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

Full Cold Day Half Cold Day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Number of Half and Full Hot Days

9	5	2	3	1	0	0	0	2	0	2	0
29%	18%	6%	10%	3%	0%	0%	0%	7%	0%	7%	0%

Number of Full Hot Days

3	1	0	1	0	0	0	0	1	0	2	0
10%	4%	0%	3%	0%	0%	0%	0%	3%	0%	7%	0%

Number of Half and Full Cold Days

0	0	0	1	3	12	10	12	9	4	1	0
0%	0%	0%	3%	10%	40%	32%	40%	30%	13%	3%	0%

Number of Full Cold Days

0	0	0	0	1	1	2	6	1	2	0	0
0%	0%	0%	0%	3%	3%	6%	20%	3%	6%	0%	0%

4 Recommendation

In consideration of the above results we would recommend that most of the mall should be enclosed, that completely outdoor areas are minimised and that semi-outdoor or mixed mode areas are preferred over completely outdoor areas. We recommend that entries to the mall are positioned facing away from the prevailing cold west and south winds in the winter and that the shading of these spaces is minimised.

Outdoor seating areas are recommended as being sheltered from westerly and southerly winds and unshaded for winter sun with shading for summer sun. An orientation to the north north east is ideal for any proposed outdoor eating areas.

Appendix B

Detailed Energy Analysis

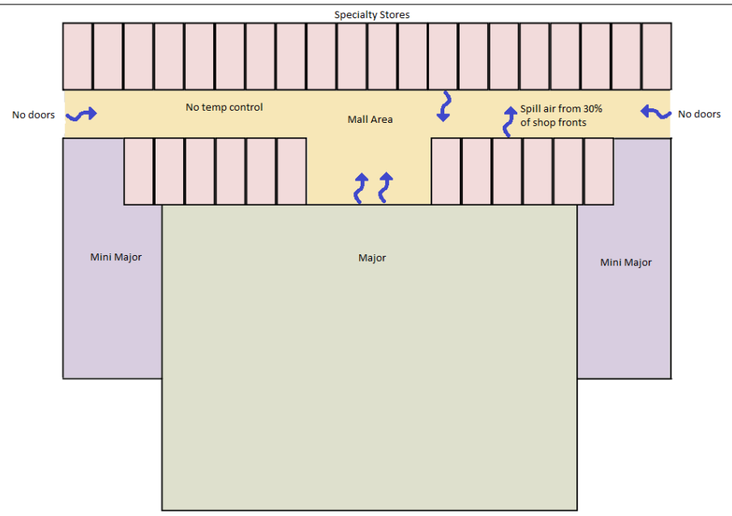
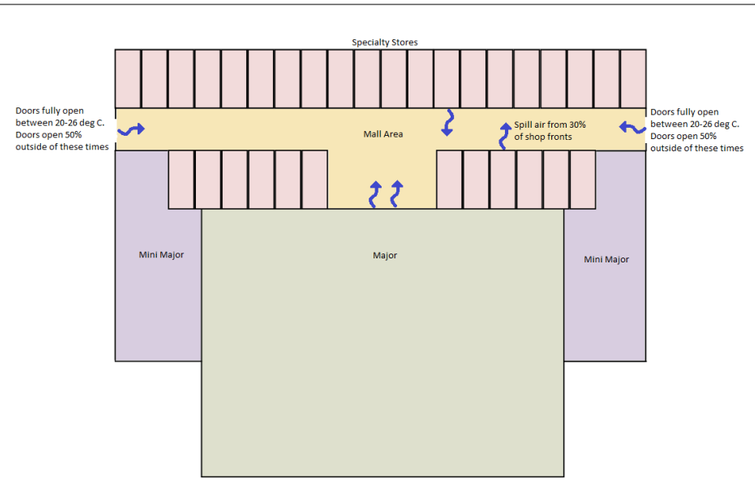
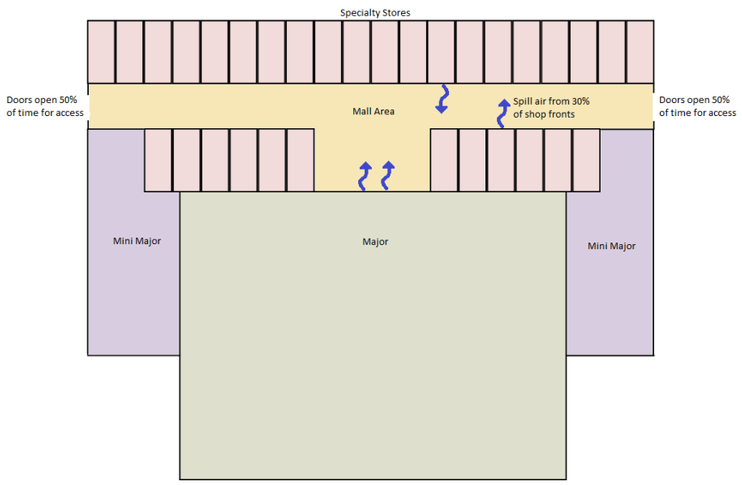
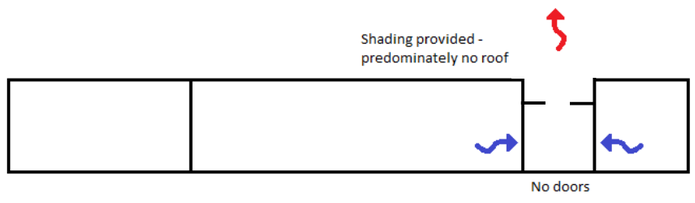
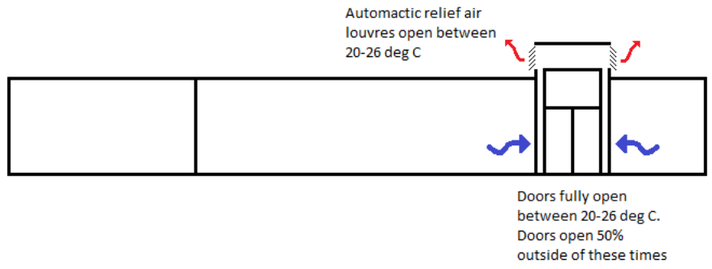
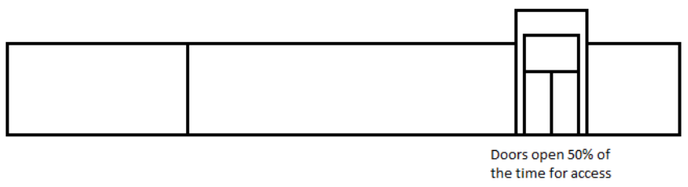
Mall Air Conditioning Options

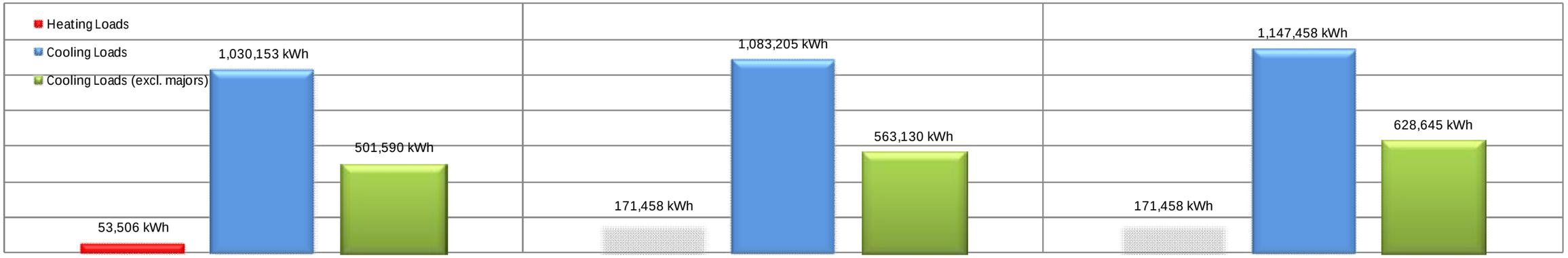
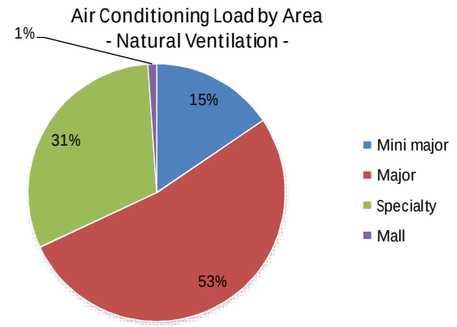
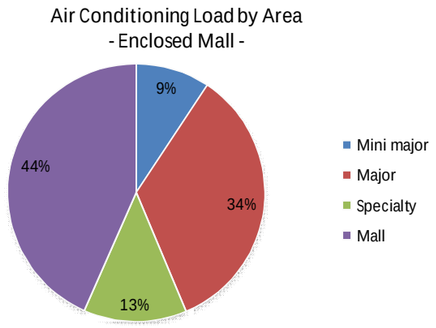
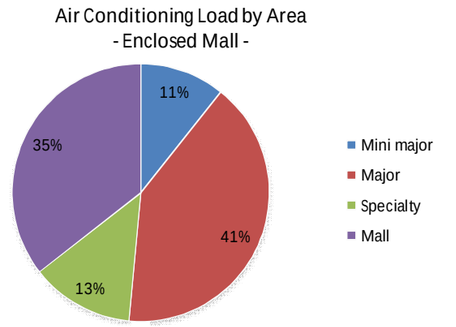
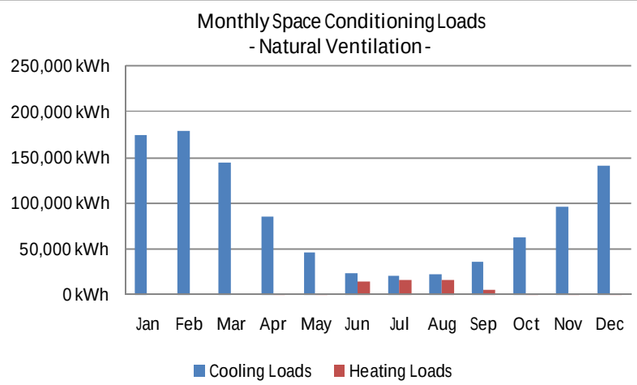
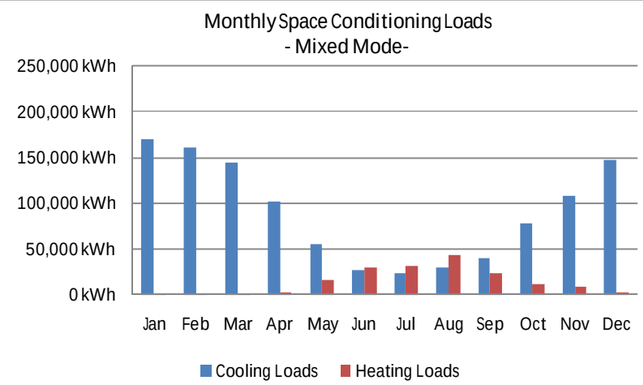
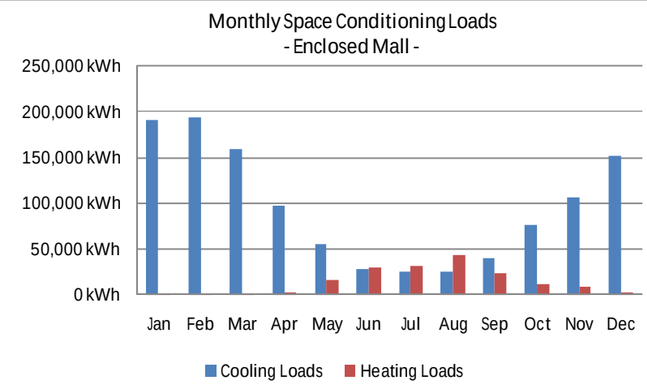
1 Objective/Aim

The objective of this information paper is to identify the high level impacts of different air conditioning strategies for the mall areas of the Vincentia district centre. The air conditioning strategies investigated will be natural ventilation, mixed mode enclosed mall and a fully air conditioned enclosed mall.

2 Methodology

A typical mall area was considered and modelled using a dynamic thermal analysis software package. The built form of the mall and associated specialty, mini majors and a major were modelled using typical retail construction and based on BCA minimum compliance. Operating time schedules and internal heat loads (occupancy rates, equipment and lighting) have been based on BCA JV specifications and were applied to develop a total load for the space. A total cooling and heating load for each strategy was then calculated, prior to any mechanical treatment of the air.

Natural Ventilation (Open Mall)	Mixed Mode Enclosed Mall	Fully Air Conditioned Enclosed Mall
The mall areas are open without any air conditioning provided. There is no roof in space, shading is provided. There are no doors to the mall. Spill air from the stores assists in the mall conditioning but is uncontrolled. Higher/lower temperatures in the mall indirectly impact the retail A/C. The forecourt to the major is tempered.	The mall is enclosed and treated with mechanical air conditioning. When the ambient temperature is between 20°C-26°C the high level louvres and entry doors are open. Outside of this temperature range the doors are open 50% of the time for access and the louvres are closed. As per the natural ventilation case the spill air from the stores assists in the mall conditioning.	The mall is enclosed and treated with mechanical air conditioning at all times. Spill air from the stores assists in the mall conditioning.
		
		

Natural Ventilation (Open Mall)	Mixed Mode Enclosed Mall	Fully Air Conditioned Enclosed Mall
		
Recommended A/C System: FCU/shop	Recommended A/C System: VAV or CAV for groups of shops	Recommended A/C System: VAV or CAV for groups of shops
		
		

3 Conclusion

The preliminary results indicate that the fabric and internal air conditioning loads can be reduced by 6% when applying a mixed mode strategy to the enclosed mall area in comparison to a fully enclosed mall. This equates to a 10% decrease if the air conditioning of the majors is excluded. However based on the total retail energy consumption this equates to less than 1% energy saving on a 2.5 star NABERS Energy rated retail centre, or 1.5% on a 5 star NABERS Energy rated retail centre. The natural ventilation strategy could use up to 10% less cooling energy equating to a 1.5% energy saving on a 2.5 star NABERS Energy rated retail centre, or 3% on a 5 star NABERS Energy rated retail centre. This is a minimal improvement over an enclosed mall and does not justify either natural ventilation or mixed mode operation.

Appendix C

Detailed Embodied Carbon Analysis

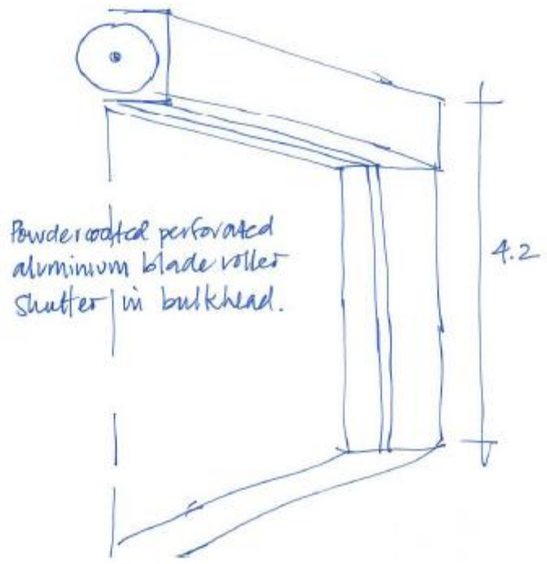
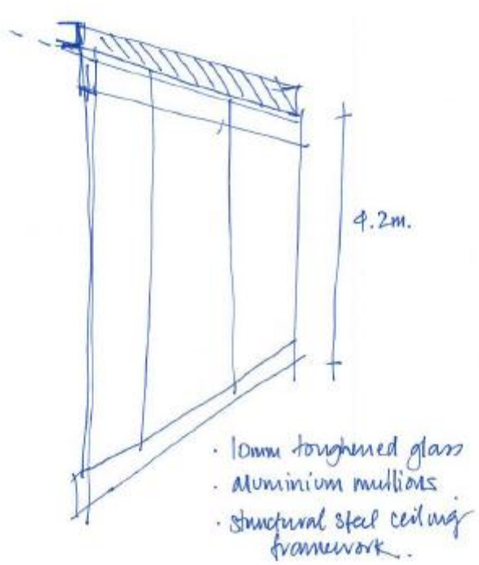
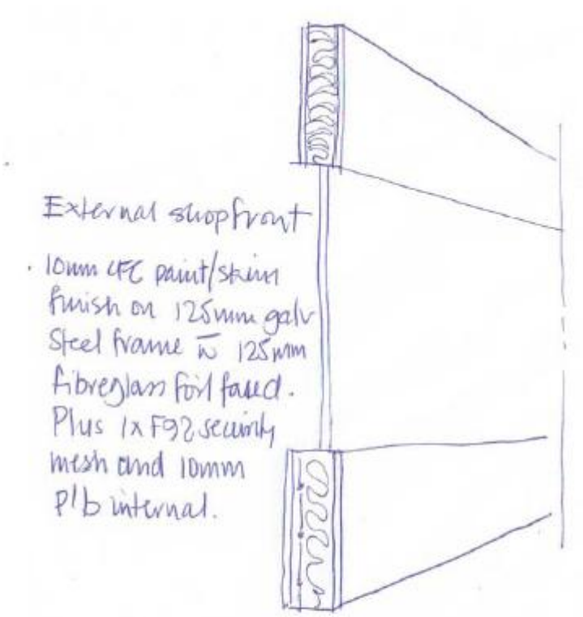
Embodied Carbon Comparison

1 Objective/Aim

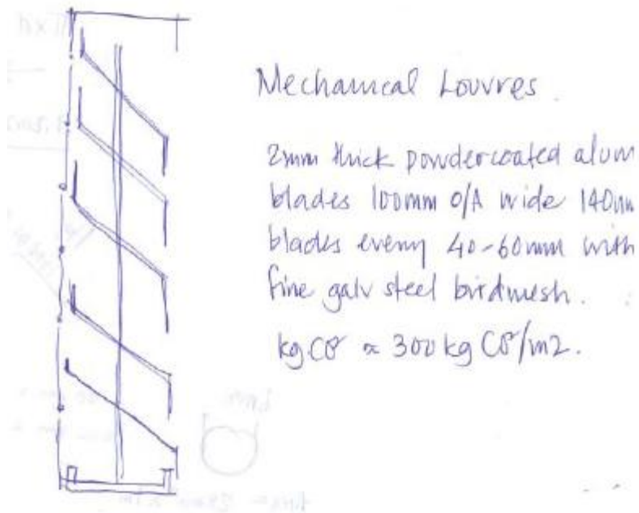
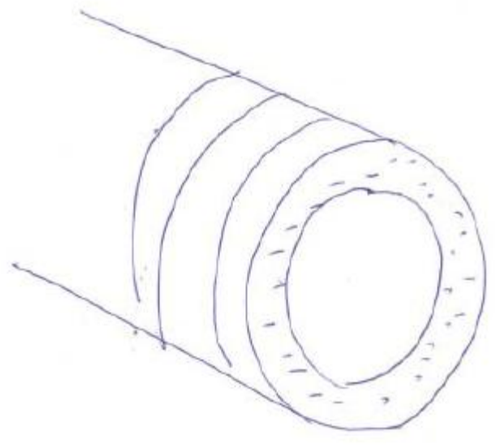
The objective of this information paper is to compare the embodied carbon of an open mall to an enclosed mall.

2 Methodology

The embodied carbon of a typical large retail mall (enclosed) was compared with modifications required to make the shopfronts BCA 2011 compliant with respect to energy efficiency. In this case, the approved open mall already has a roof and the proposed enclosed mall has similar materials and finishes as the open mall so the shopfronts are the major difference.

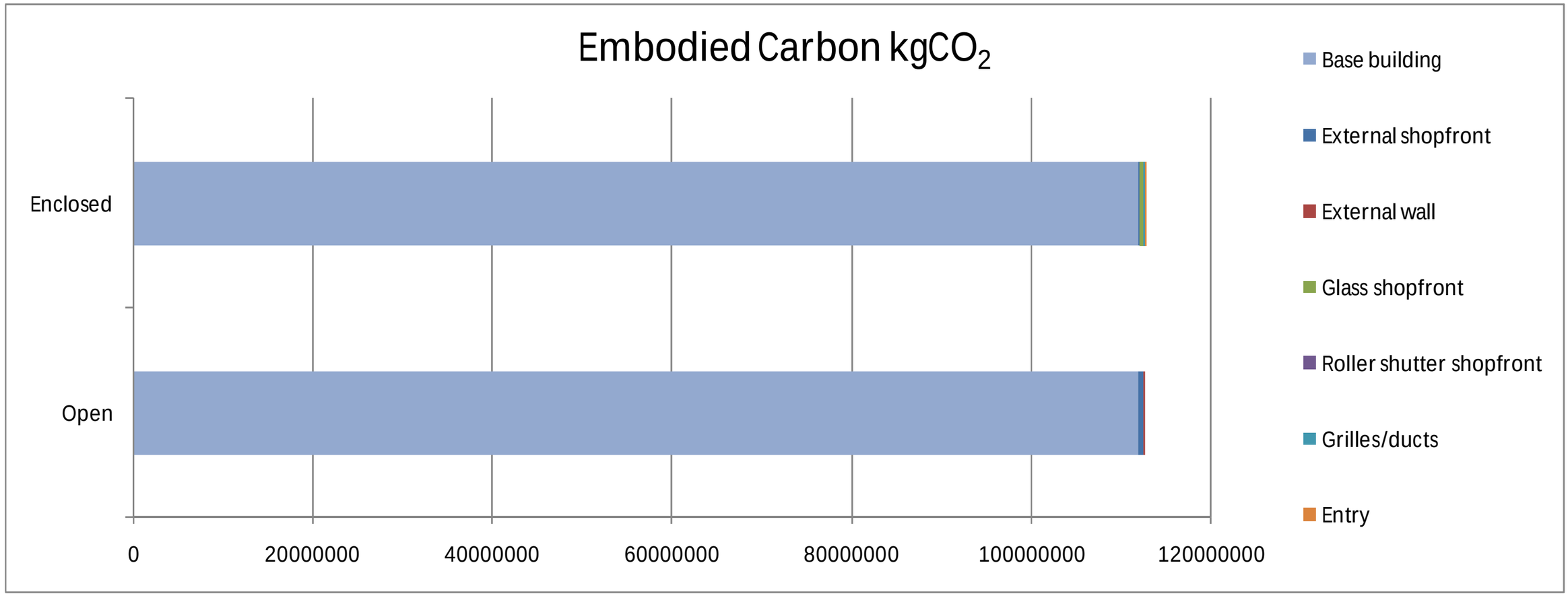
Roller Shutter – Enclosed Mall	Glass Shopfront – Enclosed Mall	BCA 2011 Shopfront – Open Mall
 **Roller Shutter – Internal Mall** 286 kg CO2 / m2 finished in place	 **100% Glass – Internal Mall** 218 kg CO2 / m2 finished in place	 **50% Fenestration – External Mall** 203 kg CO2 / m2 BCA Sec J compliant finished in place

In addition to the shopfronts, there is additional ductwork and grilles above the shopfronts required for the enclosed mall to supply air conditioning to this area. The air conditioning plant has already been sized for this scenario and it is unlikely that the number of rooftop air conditioning units would change for an open mall, although they may be slightly smaller in size.

Aluminium Grille	Flexible Duct
	
Louvers – Internal Mall 300 kg CO2 / m2 finished in place	**Flex Duct – Internal Mall** 19 kg CO2 / lm 350mm Dia finished in place

3 Results

The embodied carbon difference between the approved open mall and the proposed enclosed mall is shown below. The overall embodied carbon of the base building component of a retail mall ranges from 5,000-6,500kgCO_2/m² GLA. For this assessment we have assumed 5,000kgCO_2/m² GLA. The chart below highlights the very small component of this that makes up the shopfronts.



While the enclosed mall shopfronts and services for air conditioning the mall have a higher embodied carbon, overall it is a very slight increase of less than 1%.

Based on the energy assessment of a typical mall arrangement carried out in IP-02, the energy reduction for going from an enclosed mall to an open mall is 127,055kWh thermal energy. Assuming a medium efficiency for a rooftop packaged unit of COP=3.5, the actual electricity reduction could be 36,301kWh, equating to 38,843kgCO_2 emissions saved each year.

For a similar typical mall arrangement, the additional embodied carbon of the shopfronts for the enclosed mall and the addition of air conditioning grilles and flexible duct serving the mall, results in and additional embodied carbon of 37,456kgCO_2 required. If the tenancies have a changeover of 5 years then the shopfronts may need replacing and this would equate to 3,528kgCO_2 additional embodied carbon. Overall in operation this could be an additional 3.4kgCO_2/m²GLA/year.

4 Conclusion

The preliminary results indicate that the difference in embodied carbon of the open mall in comparison to a fully enclosed mall is minimal at less than 1%. The combined operational energy and carbon impact is expected to be in the range of 3.4kgCO_2/m²GLA each year. To put it in perspective, in comparison to a 2.5 star NABERS rated retail centre this is 3-4%, however it can not be directly compared because NABERS does not actually consider the embodied carbon component.