Fire Engineering Report

5 Tamworth Place
Allambie Heights NSW 2100

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Document Control

Document Control and Verification					
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		Comment:	Draft Issue		

Executive Summary

MCD Fire Engineering Pty Ltd has been appointed by Rick & Jenny Mirabito to carry out a fire engineering assessment for an existing residential development located at 5 Tamworth Place, Allambie Heights NSW 2100.

The intent of this Fire Engineering Report (FER) is to address the identified non-compliances with the Deemed-to-satisfy Provisions of the National Construction Code (NCC) Volume 1 (aka, the Building Code of Australia (BCA)) as identified by the BCA/PCA consultant with respect to the subject development and to present a proposed solution for each, to ensure compliance with the relevant BCA Performance Requirements. The following non-compliances with the Deemed-to-Satisfy (DtS) Provisions have been identified by the Principal Certifying Authority and are addressed in this report:

Table 1: Summary of Performance Solution

No	Description of non-compliance	DtS Clause	Performance Requirement (A0.7)	IFEG Sub-systems	Method of meeting Performance Requirements (A0.2)	Assessment Method (A0.5)
1	To review and permit a performance-based approach to the protection of openings located within 3 m of the boundaries.	C3.2, C3.4	CP2	A and C	A0.2(a) Refer Table 3	A0.5(b)(ii) Refer Table 3

It is outlined herein that the assessments undertaken in this report demonstrate that the above non-compliances with the Deemed-to-Satisfy (DtS) Provisions meet the relevant Performance Requirements of the BCA subject to the proposed fire safety measures as detailed in Table 2 which are required as part of the fire design. All other aspects of the development are understood to be in accordance with the DtS provisions of the BCA except those as modified in this report.

Table 2: Required Fire Safety Features

Fire Safety Measure	Description
Construction Requirements	**Fire Resistance, Stability and Hazard Properties** ▪ In accordance with Part C of the BCA, the building is required to be a Type A construction. All building elements is required to have a fire resistance level (FRL) as listed in Table 3 of Specification C1.1 of the BCA.
Protection of Openings	The proposed protection measures for the openings within 3 m of boundaries are as follows. Refer to Figure 5 - Figure 11 for the notation of the window/door numbers. ▪ The windows (W1, W2, W3, W5 & W6 on Ground floor, W11, W12 & W13 on Level 1, and W15 on Lower ground floor) that are **parallel to** and within 3 m of **eastern and western** boundary (shown in Figure 5 - Figure 9) shall be protected with fire attenuation screens. Refer to section 4.1.8.3 for detailed requirements for the fire attenuation screens. ▪ The door (D3) on Lower Ground floor that is **parallel to** and within 3 m of **western boundary** (shown in Figure 5 and Figure 8) shall be fitted with self-closing -/60/30 fire doors. ▪ The eastern garage (D1) on Ground floor that is **perpendicular to** and within 3 m of **eastern boundary** (shown in Figure 6 and Figure 10) shall be normally closed. ▪ The windows (W8) on Ground floor that is **perpendicular to** and within 3 m of **western boundary** (shown in Figure 6) shall be protected with fire attenuation screens or window to be fixed shut. Refer to section 4.1.8.3 for detailed requirements for the fire attenuation screens. ▪ The doors (D4 on Lower ground floor) that are **perpendicular** to and within 3 m of **western** and **eastern boundary** (shown in Figure 5, Figure 6 and Figure 11) shall be fitted with a self-closing device. ▪ The windows (W4 and W7 on Ground floor, W9, W10 and W14 on Level 1) that are **perpendicular to** and within 3 m of **western** and **eastern boundary** (shown in Figure 6 and Figure 7) **do not** require protection. ▪ The door (D2 on Ground floor) that are **perpendicular to** and within 3 m of **western boundary** (shown in Figure 6 and Figure 11) **do not** require protection.
Interconnected smoke/heat alarms	▪ The building shall be provided with interconnected smoke alarms in accordance with BCA E2.2a and AS 3786. ▪ The garage carparking area shall be provided with interconnected heat alarms in accordance with AS 1603.3 with spacing to generally be 7 m grids (3.5 m from walls). ▪ The above-mentioned smoke alarms and heat alarms shall be interconnected to each other.
Maintenance	A maintenance program shall be developed for the building with all essential safety measures (active, passive and management) maintained in accordance with AS 1851 and AS 2293.2, and is to incorporate system interface testing, where relevant.

Contents

1 Introduction

1.1 Appointment

MCD Fire Engineering Pty Ltd has been appointed by Rick & Jenny Mirabito to carry out a fire engineering assessment for an existing residential development located at 5 Tamworth Place, Allambie Heights NSW 2100.

1.2 Report Applicability

This report addresses only the identified Performance Solutions having regard to the scope of the proposed works to which the certification applies. All other aspects of the design with regard to fire and life safety are assumed to be compliant with the Deemed-to-Satisfy (DtS) Provisions of the Building Code of Australia (BCA).

This report is for the use of Rick & Jenny Mirabito and the design team appointed to this project. It should not be used in full or in part to support any other scheme and MCD Fire Engineering will not accept any responsibility for matters arising as a result of its misuse. Changes in the design of the building may invalidate the proposals of this scheme, and therefore the report will need to be updated if the scheme changes. The findings and opinions expressed within this report are based on the conditions encountered and / or the information reasonably available at the date of issue of this document, and shall be applicable only to the circumstances envisaged herein.

1.3 Applicable Legislation

The primary legislation applicable to the development is the National Construction Code (NCC), Volume One aka as the BCA 2016 (Amendment 1): Building Code of Australia.[1] The BCA provides a set of prescriptive requirements, *Deemed-to-Satisfy* (DtS) Provisions that if meet, are deemed an acceptable level of safety and achieve compliance with the Performance Requirements of the BCA. Deviations from the BCA DtS Provisions must be shown and be addressed as a Performance Solutions to demonstrate they comply with the BCA Performance Requirements.

The assessment of a Performance Solution can be undertaken using a variety of methods. These are defined in BCA Clause A0.5. One or more, or a combination of these methods are adopted to determine whether the proposed Performance Solution complies with the BCA Performance Requirements. The relevant BCA Performance Requirements are determined in accordance with BCA Clause A0.7. Compliance with BCA Performance Requirements is undertaken in accordance with BCA Clause A0.2. BCA Clause A0.2 and A0.5 are presented below in Table 3.

Table 3: Methods of Meeting the Performance Requirements and Assessment Method for Performance Solutions

BCA Clause A0.2	BCA Clause A0.5
The Performance Requirements can only be satisfied by a— (a) Performance Solution; or (b) Deemed-to-Satisfy Solution; or (c) a combination of (a) and (b)	The following Assessment Methods, or any combination of them, can be used to determine that a Performance Solution or a Deemed-to-Satisfy Solution complies with the Performance Requirements, as appropriate: (a) Evidence to support that the use of a material or product, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision as described in A2.2 of the BCA. (b) Verification methods such as— (i) the Verification Methods in the NCC; or (ii) such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements (c) Expert Judgement (d) Comparison with the Deemed-to-Satisfy Provisions

[1] See Appendix C for a list of references

The following New South Wales Legislation is applicable:

- NSW Environmental Planning and Assessment Act, 1979 and subsequent amendments
- NSW Environmental Planning and Assessment Regulation, 2000 and subsequent amendments

This document has been prepared by MCD Fire Engineering to support the application for a Construction Certificate (CC) in meeting the legislative requirements of the NSW Environmental Planning and Assessment Regulations 2000.

1.4 Fire Engineering Process

In accordance with the International Fire Engineering Guidelines (IFEG), a fire engineer should prepare a Fire Engineering Brief (FEB) that is subject to the Performance Solutions to the BCA for the project. The FEB should include the objectives, proposed trial designs, methods of analysis and acceptance criteria for any proposed Performance Solutions for the project. Depending on the complexity of the project, this process may be documented in an individual document, or in the case of simpler or well-established industry Performance Solutions, combined in the Fire Engineering Report.

Following acceptance of the FEB, the Fire Engineering Report (FER) is progressed and this contains all the relevant design calculations and justifications to demonstrate that the proposed Performance Solutions comply with the relevant BCA Performance Requirements. On agreement from stakeholder, submission to the PCA for their assessment and approval of compliance to the BCA Performance Requirements is then carried out.

The FEB process has not identified any Category 2 Fire Safety Provisions (as defined by the EP&A Regulation 2000), and so does not require a referral to the fire brigade under Clause 144 of the Regulation. Therefore, the Fire Authority is not a consent or referral agency.

1.5 Scope and Objectives

The objective of the Fire Engineering process is to recognise variations from the DtS Provisions and to present a way forward for resolution of each, and to demonstrate compliance with the relevant BCA Performance Requirements. All design solutions are subject to formal approval by the relevant regulatory authorities.

In order to provide a robust fire engineering design that meets the BCA Performance Requirements, it is important that all stakeholders agree to the fire engineering design principles before the analysis is carried out and the design is finalised. Key features of this report are to be reviewed and agreed to by the stakeholders, including the assumptions, design fires, occupant characteristics, proposed fire and egress modelling scenarios (where applicable), methods of analysis and the proposed overall design philosophy.

1.6 Stakeholders and Documentation

The relevant stakeholders in the design of this development are listed in Table 4.

Table 4: Relevant Stakeholders

Name	Organisation	Role
Rick & Jenny Mirabito	-	Client
TBA	Total Surveying Solutions	Surveyor
Graham Scheffers	GRS Building Reports Pty Ltd	Principal Certifying Authority
Mark McDaid, Lei Wang, Lin Li	MCD Fire Engineering Pty Ltd	Fire Engineering

The relevant documents and drawings assessed as part of this report are listed in Table 5. Refer to Appendix A for a full set of relevant drawings.

Table 5: Relevant design team documentation

Ref	Name	Organisation	Date	Revision
4521/ 5-A	Floor Plans	-	-	-
DA07	Plan Showing Detail & Levels Over Lot 18 IN DP 241941	Total Surveying Solutions	19/02/2019	-

1.7 Fire Safety Sub-Systems

Table 6: Fire Safety Sub-Systems [IFEG]

Symbol	Name	Description
	**Sub-system A:** Fire Initiation & Development & Control	Sub-system A (SS-A) is used to define design fires in the enclosure of fire origin as well as enclosures to which the fire has subsequently spread and how fire initiation and development might be controlled.
	**Sub-system B:** Smoke Development & Spread & Control	Sub-system B (SS-B) is used to analyse the development of smoke, its spread within the building, the properties of the smoke at locations of interest and how the development and spread might be controlled.
	**Sub-system C:** Fire Spread & Impact & Control	Sub-system C (SS-C) is used to analyse the spread of fire beyond an enclosure, the impact a fire might have on the structure and how the spread and impact might be controlled.
	**Sub-system D:** Fire Detection, Warning & Suppression	Sub-system D (SS-D) is used to analyse detection, warning and suppression for fires. This process enables estimates to be made of the effectiveness of suppression.
	**Sub-system E:** Occupant Evacuation & Control	Sub-system E (SS-E) is used to analyse the evacuation of the occupants of a building. This process enables estimates to be made of the times required for occupants to reach a place of safety.
	**Sub-system F:** Fire Services Intervention	Sub-system F (SS-F) is used to analyse the effects of the intervention activities of fire services on a fire including the effectiveness of suppression activities.

2 Principal Building and Occupant Characteristics

2.1 Principal Building Characteristics

2.1.1 Occupancy

The existing building is a BCA Class 1a Dwelling that is proposed to change the lower ground floor level into a “granny flat” or secondary dwelling and thus the new proposed use is defined as BCA Class 2 Residential (Flat/Apartment) Building with associated Class 10a (Private Garage).

2.1.2 Location

The building is located at 5 Tamworth Place, Allambie Heights NSW 2100. The Fire Service can access the building from Tamworth Place as shown in Figure 1. The closest fire stations are listed in Table 7.

Figure 1: Map showing brigade access (© 2019 Sinclair Knight Merz, Map data ©2019 Google)

Table 7: Responding fire services

Station Location	Resources	Road Distance (Google Maps – ©2019 Google)
FORESTVILLE FIRE STATION 8 Cook Street Forestville NSW 2087	1 x Class 3 Pumper	5.8 km
MANLY FIRE STATION 128 Sydney Road Fairlight NSW 2094	1 x Class 3 Pumper 1 x Bronto F27 Ladder Platform	5.5 km

2.1.3 Size and shape

The existing building was a Class 1 a Dwelling house. It was modified to have a separate dwelling on the lower ground floor and thus the entire building has become a Class 2 building. There are 2 units: one on lower ground floor and the other on the upper two levels. The footprint of the building is approximately 200 m^2. Refer to Appendix A for relevant drawings.

2.2 Occupant Characteristics

Building occupants can generally be classified into separate distinctive groups: residents and visitors. All occupants are assumed to be representative of the general population with no specific or unusual distributions in respect to gender, age and physical or mental attributes. A detailed description is contained in Table 8 below:

Table 8: Occupancy Characteristics

Characteristic	Description
Familiarity	Residents: Residents are expected to be familiar with the layout of the building and the location of exits. visitors: visitors will generally be aware of the route they entered the building and are more likely to evacuate the building via this route even if other exits are closer. Most occupants, however, are expected to be mostly transient and it cannot be guaranteed that all occupants would be familiar with the building, its layout and the exit points.
Awareness	Residents and visitors may be under the influence of alcohol or other mild narcotics at some times.
Mobility	The occupants are considered to be representative of the general population including a limited proportion of mobility impaired occupants. These occupants may require crutches, a wheelchair or similar to evacuate on their own or need assistance from other occupants.
Training	It is assumed that occupants in the development will not have any emergency training.
Age	All occupants are considered to be representative of the general population with no specific or unusual distributions in respect to gender or age.
Culture / language	The occupants are considered to be representative of the general population with some members having varying cultural backgrounds and languages.
Occupancy Loading	Occupancy levels and distribution throughout the building is assumed to be in accordance with the occupancy loadings of Table D1.13 of the BCA.

3 Building Fire Safety

3.1 BCA Reference Characteristics

The Fire Engineering Brief process identified the building information listed in Table 9.

Table 9: Basic Building Information

BCA Clause		Description or Requirement
A1.1	Effective Height	Less than 12 m
A3.2	Occupancy Classification	BCA Class 2 - Residential Apartments BCA Class 10a – Private Garage
C1.1	Minimum Type of Construction	Type A
C1.2	Rise in Storeys	3
C2.2	Fire Compartment Floor Area and Volume	BCA Class 2, 10a – N/A

3.2 Summary of the Performance Solution

Table 10 lists variations to the BCA DtS Provisions that have been identified by the PCA and are addressed in this report.

Table 10: Summary of Performance Solution

No	Description of non-compliance	DtS Clause	Performance Requirement (A0.7)	IFEG Sub-systems	Method of meeting Performance Requirements (A0.2)	Assessment Method (A0.5)
1	To review and permit a performance-based approach to the protection of openings located within 3 m of the boundaries.	C3.2, C3.4	CP2	A and C	A0.2(a) Refer Table 3	A0.5(b)(ii) Refer Table 3

3.2.1 Means of escape

Each of the two units in the building has an exit directly to outside next to Tamworth Place. Figure 3, Figure 4 and Figure 2 show the location of the exits. Note that the exit signs are not required, but rather shown below only for visual indication of the entry/exit points to the units/dwelling.

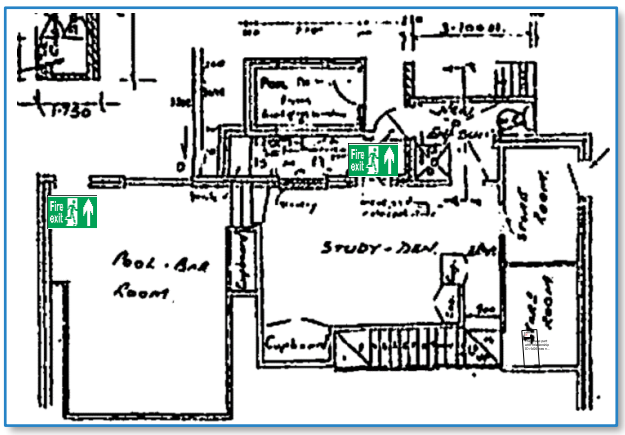


Figure 2: Egress points on Lower ground floor

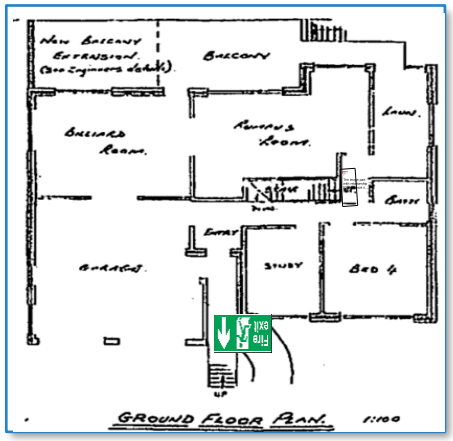


Figure 3: Egress points on ground floor

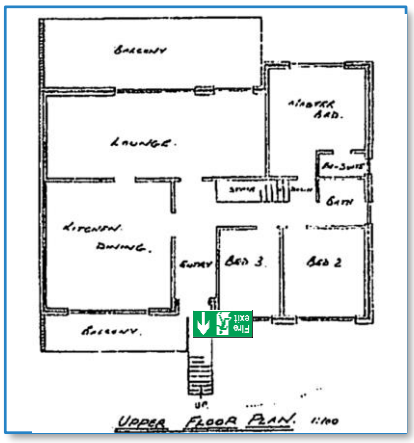


Figure 4: Egress points on Level 1

3.2.2 Passive Fire Resistance Levels and Construction type

The works in the building are required to be a Type A construction. All new/modified building elements shall have a fire resistance level (FRL) as listed in Table 3 of Specification C1.1 of the BCA. All penetrations in fire rated construction shall be fire stopped in accordance with the BCA DtS requirements, except where addressed in this Report as an Alternative Solution

4 Performance Solution

4.1 Solution 1: Unprotected openings within 3 m of boundary

4.1.1 Introduction

Table 11 provides a summary of this Solution, the relevant BCA DtS Provisions which are affected, and the relevant BCA Performance Requirements and IFEG sub-systems.

Table 11: Summary of Solution

No	Description of non-compliance	DtS Clause	Performance Requirement (A0.7)	IFEG Sub-systems	Method of meeting Performance Requirements (A0.2)	Assessment Method (A0.5)
1	To review and permit a performance-based approach to the protection of openings located within 3 m of the boundaries.	C3.2, C3.4	CP2	A and C	A0.2(a) Refer Table 3	A0.5(b)(ii) Refer Table 3

Figure 5 - Figure 11 show the unprotected openings and distance to eastern and western boundary. The distance for parallel openings is 1.2 m, and it varies between 1.545 m to 2.3 m for perpendicular openings.

There is a total of 15 windows (W1-W15) and 4 doors (D1-D4) that are assessed in the solution. The openings on each levels are as follows and also noted in Figure 5 - Figure 11.

- Ground floor: windows W1-W8, doors D1 & D2
- Level 1: windows W9-W14
- Lower Ground floor: window W15, doors D3 & D4

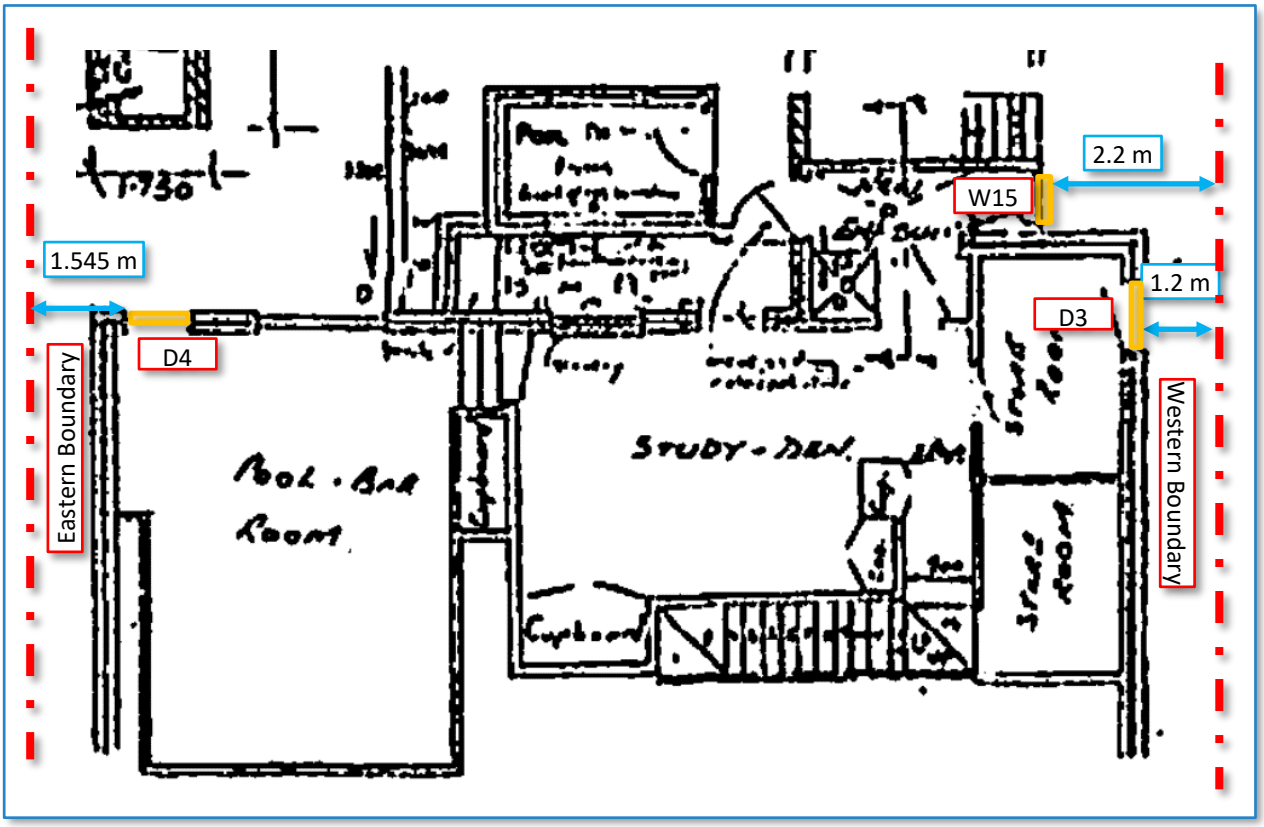


Figure 5: Lower Ground floor plan showing unprotected openings and distance to eastern and western boundary

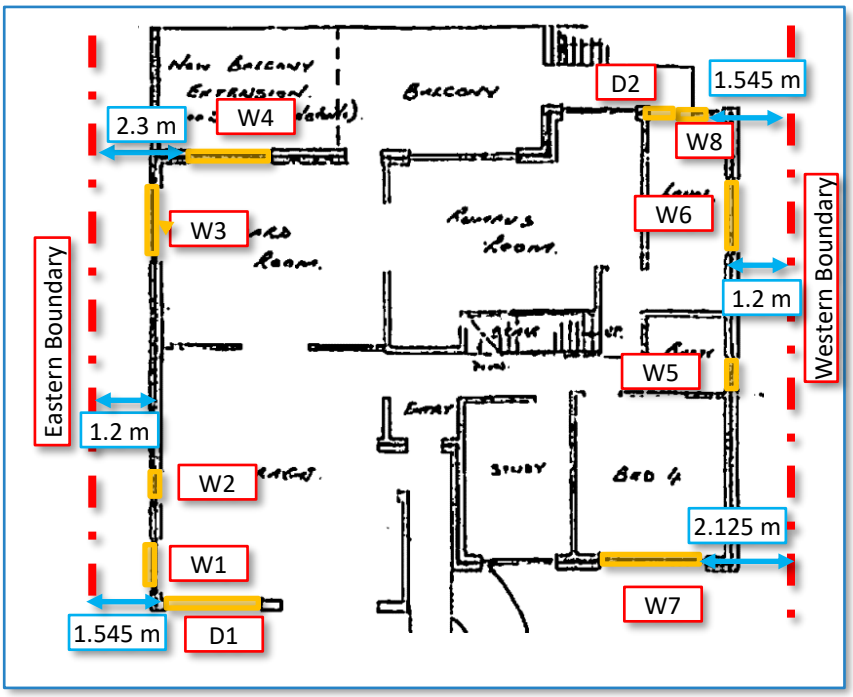


Figure 6: Ground floor plan showing unprotected openings and distance to eastern and western boundary

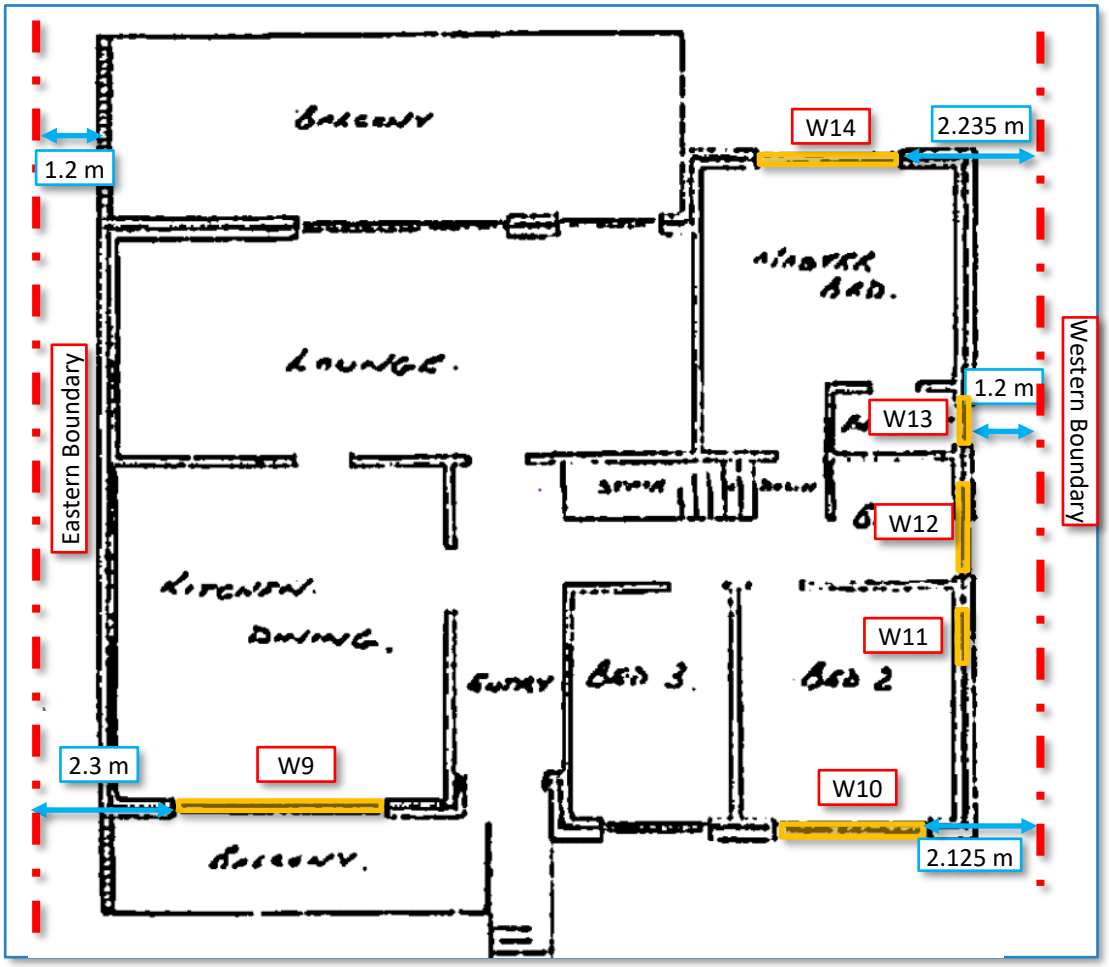


Figure 7: Level 1 floor plan showing unprotected openings and distance to eastern and western boundary

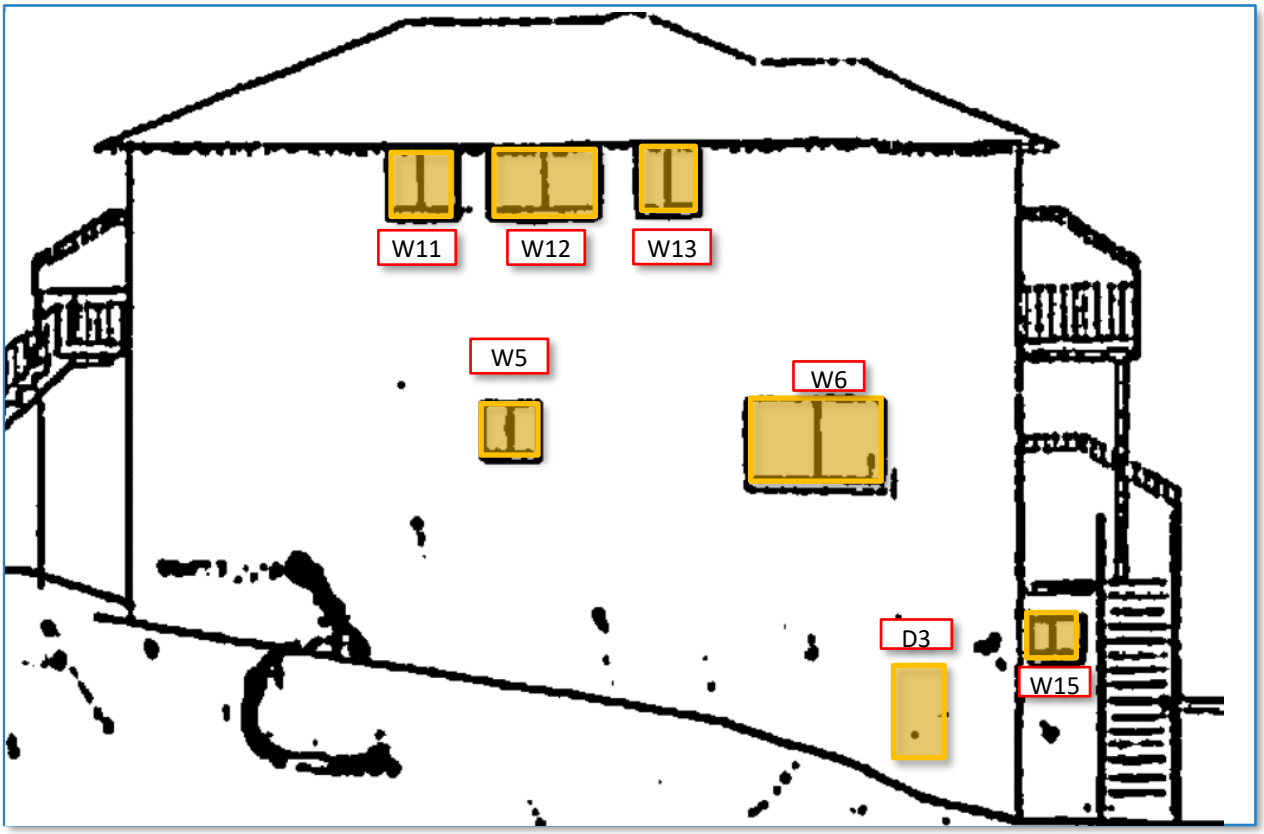


Figure 8: Western Elevation plan

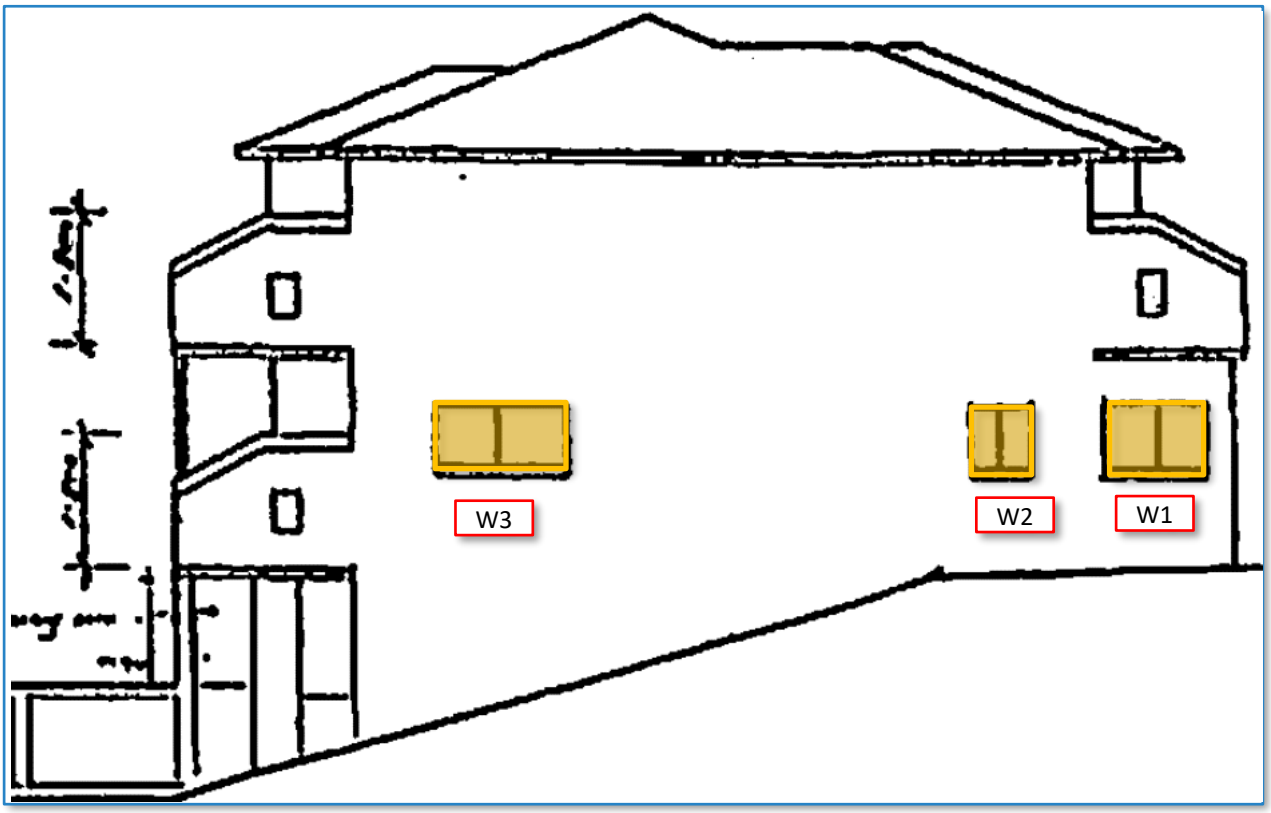


Figure 9: Eastern Elevation plan

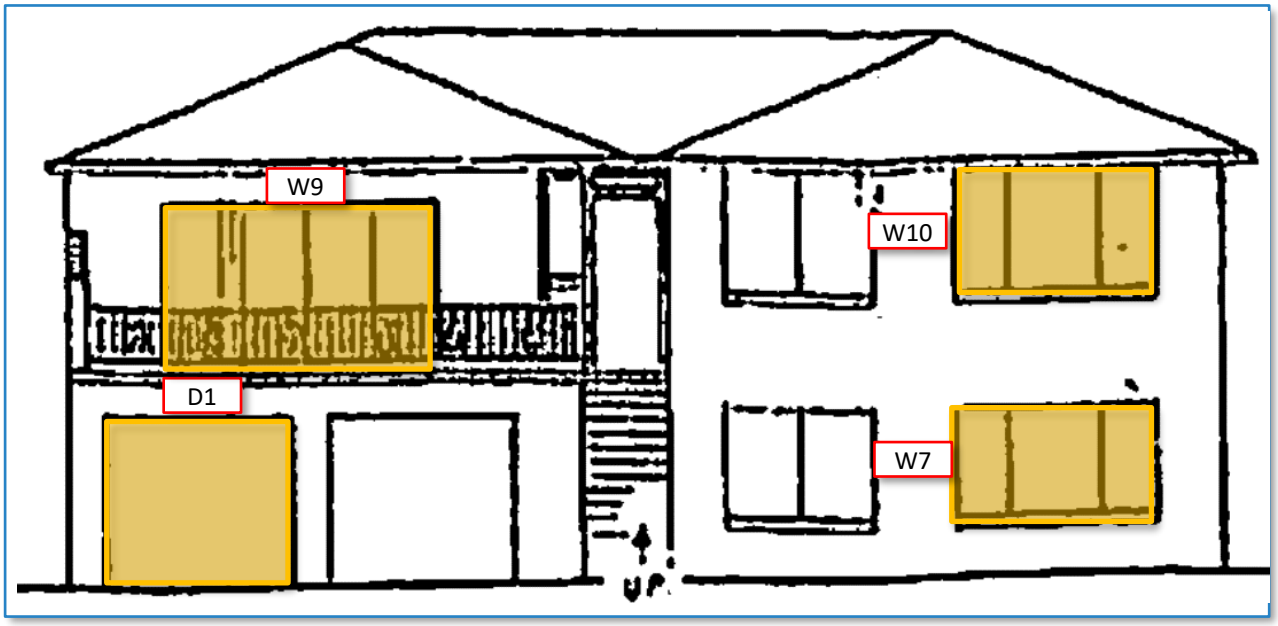


Figure 10: Northern Elevation plan

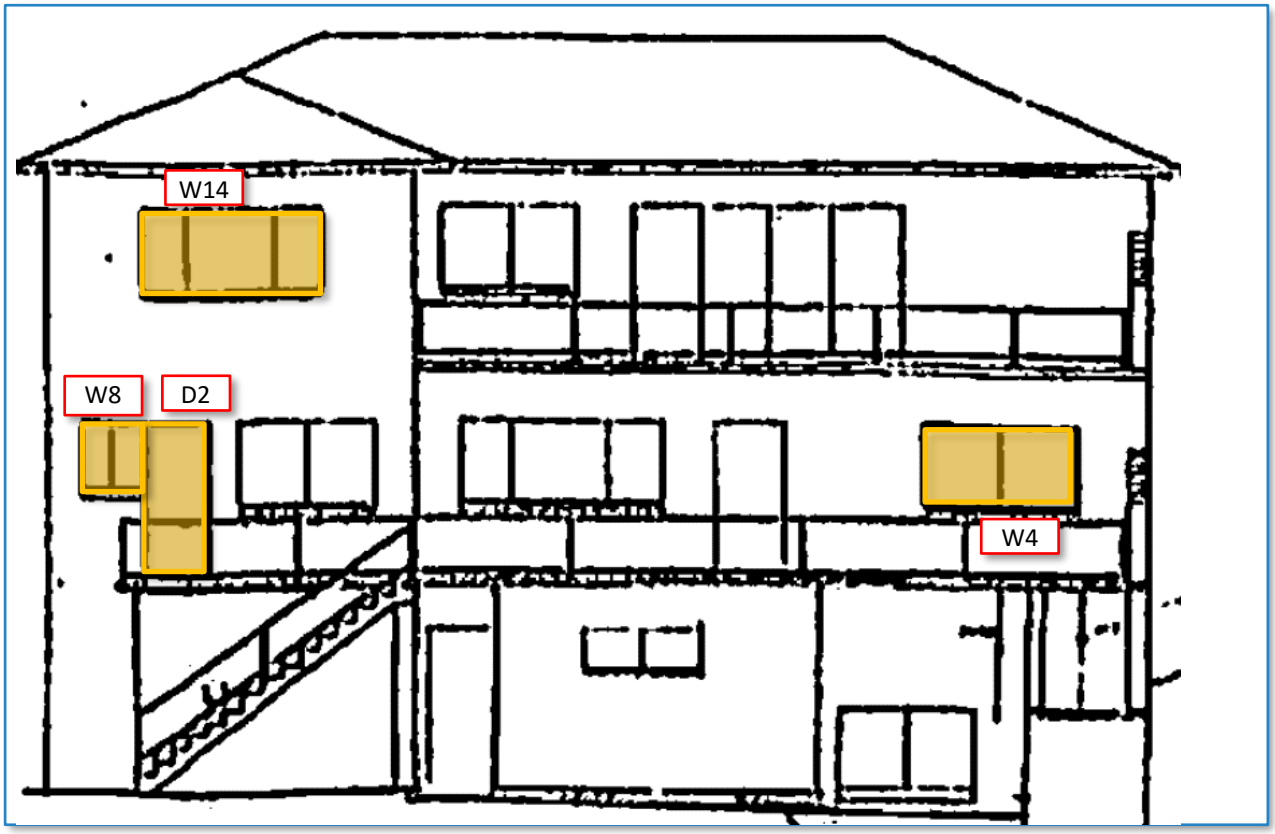


Figure 11: Southern Elevation plan

4.1.2 Intent of BCA

4.1.2.1 BCA Clause C3.2

BCA Clause C3.2 concerns protection of openings in external walls and states that;

Openings in an external wall that is required to have an FRL must—

(a) if the distance between the opening and the fire-source feature to which it is exposed is less than—

(i) 3 m from a side or rear boundary of the allotment; or

(ii) 6 m from the far boundary of a road, river, lake or the like adjoining the allotment, if not located in a storey at or near ground level; or

(iii) 6 m from another building on the allotment that is not Class 10, be protected in accordance with C3.4 and if wall-wetting sprinklers are used, they are located externally; and

(b) if required to be protected under (a), not occupy more than 1/3 of the area of the external wall of the storey in which it is located unless they are in a Class 9b building used as an open spectator stand.

As per the BCA Guide the intent of BCA Clause C3.2 of the BCA is to require any opening in external walls to be protected, only where the wall is required to have an FRL, to prevent the spread of fire from the boundary of an adjoining allotment, or one building to another building on the same allotment.

4.1.2.2 BCA Clause C3.4

BCA Clause C3.4 details the acceptable methods of protection under the BCA

(a) Where protection is required, doorways, windows and other openings must be protected as follows:

(i) Doorways—

(A) internal or external wall-wetting sprinklers as appropriate used with doors that are self-closing or automatic closing; or

(B) –/60/30 fire doors that are self-closing or automatic closing.

(ii) Windows—

(A) Internal or external wall-wetting sprinklers as appropriate used with windows that are automatic closing or permanently fixed in the closed position; or

(B) –/60/– fire windows that are automatic closing or permanently fixed in the closed position; or

(C) –/60/– automatic closing fire shutters.

(iii) Other openings—

(A) excluding voids — internal or external wall-wetting sprinklers, as appropriate; or

(B) construction having an FRL not less than –/60/–.

(b) Fire doors, fire windows and fire shutters must comply with Specification C3.4.

As per the BCA Guide, the intent of BCA Clause C3.4 is to set out acceptable methods of protection required for different types of openings in a building.

4.1.2.3 BCA Performance Requirement CP2

BCA Performance Requirement CP2 is described in Appendix A of this report.

The BCA Guide sets out that the intent of BCA Performance Requirements CP2 is to avoid spread of fire between fire compartments and buildings. CP2 does not reference a fire-resistance level (FRL). FRLs are only included as part of the Deemed-to-Satisfy Provisions. The BCA Guide also states that it may be determined by a building proponent using a Performance solution that applying FRLs to building element is not necessary because other methods, such as the use of active systems, can satisfy the Performance Requirements.

The Guide to the BCA outlines that the following with respect to the term “to the degree necessary”

> “to the degree necessary” is used to “show that provisions can differ according to various elements which appropriate authorities may take into consideration when assessing building applications.

The Guide further expands and elaborates the intention of this phrase by stating that

this expression provides flexibility by allowing appropriate authorities to determine the degree of compliance necessary in a particular case. For example, an appropriate authority might judge that an item need not be installed, or a particular level of performance be achieved" and that:

… the BCA recognises that different building elements require differing degrees of structural stability during a fire…Any decision made in this context can extend to not requiring an item to be installed or a particular level of performance to be achieved, if that is the appropriate action to be taken

The BCA [Guide] states that:

"CP2 deals with the spread of fire both within the building and between buildings, and which does not only result from the structural failure of a building element.

CP2 does not make any reference to a fire-resistance level (FRL). FRLs are only included as part of the Deemed-to-Satisfy Provisions. However, proponents of a Performance solution should note, if they so wish. See CF2.

CP2(a)(iii) aims to minimise the risk of fire spreading from one building to another that could endanger the occupants of both buildings and impede the actions of the fire brigade. See CV1 and CV2 for two means of verifying, under certain circumstances, whether or not the requirements of CP2(a)(iii) will be achieved. Other assessment methods for determining compliance with the Performance Requirements are in A0.9."

4.1.3 Approach and assessment method

The approach is approach is quantitative, deterministic and absolute using the assessment methods as shown in Table 3 and Table 11.

4.1.4 Fire safety design

The fire safety measures listed in Table 2 form the holistic fire safety design for the building. Specific measures to this solution include the following with respect to openings within 3 m of the boundary:

- The windows (W1, W2, W3, W5 & W6 on Ground floor, W11, W12 & W13 on Level 1, and W15 on Lower ground floor) that are **parallel to** and within 3 m of **eastern and western** boundary (shown in Figure 5 - Figure 9) shall be protected with fire attenuation screens. Refer to section 4.1.8.3 for detailed requirements for the fire attenuation screens.
- The door (D3) on Lower Ground floor that is **parallel to** and within 3 m of **western boundary** (shown in Figure 5 and Figure 8) shall be fitted with self-closing -/60/30 fire doors.
- The eastern garage (D1) on Ground floor that is **perpendicular to** and within 3 m of **eastern boundary** (shown in Figure 6 and Figure 10) shall be normally closed.
- The windows (W8) on Ground floor that is **perpendicular to** and within 3 m of **western boundary** (shown in Figure 6) shall be protected with fire attenuation screens or window to be fixed shut. Refer to section 4.1.8.3 for detailed requirements for the fire attenuation screens.
- The doors (D4 on Lower ground floor) that are **perpendicular** to and within 3 m of **western** and **eastern boundary** (shown in Figure 5, Figure 6 and Figure 11) shall be fitted with a self-closing device.
- The windows (W4 and W7 on Ground floor, W9, W10 and W14 on Level 1) that are **perpendicular to** and within 3 m of **western** and **eastern boundary** (shown in Figure 6 and Figure 7) **do not** require protection.
- The door (D2 on Ground floor) that are **perpendicular to** and within 3 m of **western boundary** (shown in Figure 6 and Figure 11) **do not** require protection.

4.1.5 Acceptance criteria

The acceptance criteria for this particular non-compliance are:

- The proposed Performance Solution will comply with BCA Verification Method CV1 for emitting radiant heat flux from the unprotected openings.

- The received radiation on the unprotected opening from the boundary shall not be greater than the ignition criteria. As per Table A3 of AS 1530.4, ignition is assumed to occur at 25 kW/m^2 for unpiloted ignition and 13 kW/m^2 for piloted ignition (which correspond to the normal ignition range of materials).

TABLE A3

TYPICAL RADIANT HEAT INTENSITIES FOR VARIOUS PHENOMENA

Phenomena	kW/m^2
Maximum for indefinite exposure for humans	
Pain after 10 s to 20 s	4
Pain after 3 s	10
Piloted ignition of cotton fabric after a long time	13
Piloted ignition of timber after a long time	13
Non-piloted ignition of cotton fabric after a long time	25
Non-piloted ignition of timber after a long time	25
Non-piloted ignition of gaberdine fabric after a long time	27
Non-piloted ignition of black drill fabric after a long time	38
Non-piloted ignition of cotton fabric after 5 s	42
Non-piloted ignition of timber in 20 s	45
Non-piloted ignition of timber in 10 s	55

Figure 12: Typical Radiant Heat Intensities for Various Phenomena (AS 1530.4)

4.1.6 Hazards

The key hazard specific to having openings located within 3 m of the property boundary is that in the event of a flashover fire within the building, the unprotected openings are likely to break and the fire would then emit a radiant heat flux towards the boundary. As the openings are located closer to the boundary without DtS protection measures, the risk of fire spread to an adjoining building is increased.

4.1.7 Method of analysis

A quantitative, deterministic and absolute analysis is undertaken to determine the radiant heat flux emitted from the unprotected openings towards the boundary and the radiant heat flux received by the unprotected openings from a notional building on the adjoining allotment using interpolated values of CV1 (for receiving).

The radiation heat flux emitted is normally taken as 84 kW/m^2 (as per guidance documents [BRE 187], [BBR 2012] and [WAG-15] for residential, office or assembly type building. This is based on previous studies in residential buildings having temperatures in the order of 830 °C and an emissivity of 1.0.

For a sensitivity study and more robustness, the emitting temperature in the subject calculation is taken as 1,000 °C. This corresponds to a radiation heat flux of 150 kW/m^2 and an emissivity of 1.0.

4.1.8 Analysis

4.1.8.1 Emitting Radiant Heat Flux

The radiant heat flux calculations are based on the location and size of the openings in the architectural drawings. All the subject openings on the same levels are considered together as they are from the same SOU. The emitting radiant heat flux calculated from the unprotected area is summarised in Table 12 and an example is detailed in Appendix B.

Table 12: Radiant heat flux emitting

Opening	Distance to boundary (m)	Maximum Radiant Heat Flux Allowed (Table CV1, BCA) (kW/m²)				Acceptability based on emitted radiant heat flux
		0 m from boundary	1 m from boundary	3 m from boundary	6 m from boundary	
		80	40	20	10	
Lower Ground floor parallel to western boundary openings (**window W5 + door D3**)	1.2-2.2	38.4	15.2	0.7	1	**Acceptable**
Lower Ground floor perpendicular to eastern boundary openings (**door D4**)	1.545	25	10.7	0.5	0.8	**Acceptable**
Ground floor parallel and perpendicular to western boundary openings (**windows W5-W8 and door D2**)	1.2-2.125	5.5	4.5	2.6	1.2	**Acceptable**
Ground floor parallel and perpendicular to eastern boundary openings (**windows W1-W4 and door D1**)	1.545-2.3	44.8	19.8	3.1	1.8	**Acceptable**
Level 1 floor parallel and perpendicular to western boundary openings (**windows W10-W14**)	1.2-2.235	41.9	20.1	4.3	1.7	**Acceptable**
Level 1 floor perpendicular to eastern boundary opening (**window W9**)	2.3	6.6	4.1	1.1	0.5	**Acceptable**

As shown in Table 12, the results for the radiant heat flux emitted from the unprotected openings is less than the maximum heat flux allowed by BCA Table CV1. Whilst it is noted to be a result of the conservative consideration as above mentioned, the protection of the openings is proposed in the following sections.

4.1.8.2 Receiving Radiation from adjoining allotment

This section assesses the received radiation at the openings of the building from adjoining allotment. An interpolation of CV1 figures will be used based on the distances from the boundary. The received radiant heat flux calculated from adjoining allotment and corresponding protection requirement is summarised in Table 13.

Table 13: Radiant heat flux received and protection requirement

Unprotected opening	Radiant Heat Flux Received (kW/m^2)	Protection Required?	Type of Protection Required?
Openings along each side (parallel to boundary)			
All Levels - Openings (W1, W2, W3, W5 & W6 on Ground floor, W11, W12 & W13 on Level 1) **parallel** to **western or eastern** boundary (1.2 m)	36.6	YES	▪ Windows fitted externally with fire attenuation screens. ▪ Doors fitted with -/60/30 fire door.
Lower Ground Floor			
Lower Ground floor Opening (D4) **perpendicular** to **eastern** boundary – **Rear door** (1.545 m)	Up to 15.9	YES	▪ Door to be provided with a self-closing device
Lower Ground floor Opening (W15) **parallel** to **western** boundary – **Rear toilet/Landry window** (2.2 m)	Up to 25.4	YES	▪ Windows fitted externally with fire attenuation screens.
Ground Floor			
Ground floor Opening **perpendicular** to eastern boundary – **Garage doors** (D1)(1.545 m)	Up to 15.9	YES	Eastern garage door (metal) shall be normally closed.[2]
Ground floor Opening (W8) perpendicular to western boundary – Rear (1.545 m)	Up to 15.9	YES	▪ Windows fitted externally with fire attenuation screens. OR ▪ Windows to be fixed shut.
Ground floor Opening (W7) perpendicular to **western** boundary – **Front** (2.125 m)	Up to 12.9	NO	▪ N/A
Ground floor Opening (D2) perpendicular to **western** boundary – **rear** (2.35 m)	Up to 12.1	NO	▪ N/A
Ground floor Opening (W4) perpendicular to **eastern** boundary – **rear** (2.3 m)	Up to 12.3	NO	▪ N/A
Level 1 Floor			
Level 1 floor Opening (W10) **perpendicular** to **western** boundary – **Front** (2.125 m)	Up to 13.0	NO	▪ N/A
Level 1 floor Opening (W14) **perpendicular** to **western** boundary – **Rear** (2.235 m)	Up to 12.7	NO	▪ N/A
Level 1 floor Opening (W9) **perpendicular** to **eastern** boundary – **Front** (2.3 m)	Up to 12.3	NO	▪ N/A

To reduce the received the radiation, it is proposed to have attenuation screens. The reduced radiation after the attenuation by the attenuation screens is shown in Figure 13.

It is shown that that for openings parallel to the boundary with a distance of 1.2 m (worst-case scenario), after the attenuation with the fire attenuation screens presented in Table 13, the received radiation is down to 18.3 kW/m^2, which is lower than the non-piloted ignition criteria. As the openings are fitted with attenuation screens, it is unlikely

[2] Whilst not full height, the boundary wall provides partial protection to garage doors.

to have amber or spark passing through therefore the non-piloted ignition criteria, i.e., 25 kW/m^2 can be used for the assessment.

Distance from boundary (m)	Received radiation (kW/m2)		Single Barrier / Layer of Protection			
			Attenuated by toughened glass Only		Attenuated by Fire Attenuation Screen Only	
Orienation of opening to boundary	parallel	perpendicular	parallel	perpendicular	parallel	perpendicular
1.200	36.6	18.3	22.0	11.0	22.0	11.0
1.545	31.9	15.9	19.2	9.6	19.1	9.6
2.100	26.2	13.1	15.8	7.9	15.7	7.9
2.125	26.0	13.0	15.6	7.8	15.6	7.8
2.235	25.1	12.5	15.1	7.5	15.1	7.5
2.300	24.6	12.3	14.8	7.4	14.8	7.4

Figure 13: Reduced radiation after the attenuation by the toughened glass or fire attenuation screens

4.1.8.3 Crimsafe or Amplimesh Screens

Crimsafe 304 grade, 0.9 mm Tensile-Tuff ® Stainless Steel Security Mesh (or equivalent product with equal or better approved performance) which is to be fixed closed in front of the window as illustrated in Figure 14. This product (when tested to The Fire Attenuation Test - FSZ0688 in furnace temperature of 850 ^{o}C), achieved a rating for attenuation of radiant heat flux of 45 % which means that almost half of the heat from a fire source on the other side of the screen is blocked. For the subject openings as calculated above, this would reduce the received radiation down to less than 25 kW/m^2, lower than the non-piloted ignition criteria.

Amplimesh SupaScreen® Stainless Steel Security is a high-tensile 316 marine grade stainless steel and has a similar level of performance to the Crimsafe noted above, with a slightly lower attenuation of 41% in the proposed building, this would also reduce the received radiation down to less than 25 kW/m^2.

The proposed screens would remain in place to block the direct radiant heat from a fire on the adjoining allotment with the screen acting as a shield from radiation being emitted from the property boundary. It is noted that the Australian Standard AS3959 requires screening of openings to be made of corrosion resistant steel, with an aperture size that will not allow a circular probe of 2 mm diameter to pass through. Crimsafe 304 grade, 0.9 mm Tensile-Tuff ® Stainless Steel Security Mesh has an aperture size of 1.5 mm x 1.5 mm and therefore complies with the standard. The Amplimesh SupaScreen® Stainless Steel Security (high-tensile 316 marine grade stainless steel) is also understood to satisfy this requirement.

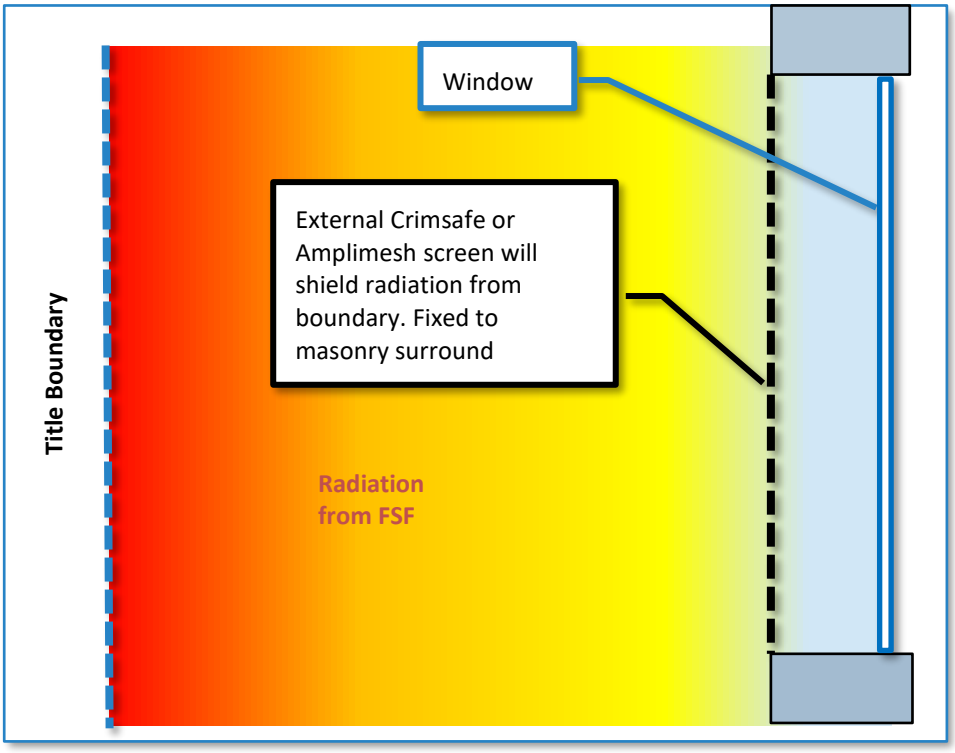


Figure 14: Sectional view illustrating louvered window behind Crimsafe or Amplimesh screen

A fixed tag is required to be placed on the inside of the screen stating “Fire Protection Screen. Refer to Construction Certificate when replacing the window”.

4.1.9 Conclusion

This analysis demonstrates that the proposed fire safety measures forming part of this performance solution manage the deviations from the relevant BCA DtS provisions and demonstrate that the relevant BCA Performance Requirement CP2 is met.

5 Assumptions and Limitations

- This report is consistent with the fire safety provisions, objectives and limitations of the Building Code of Australia (BCA):
    - We have been informed that building features not part of a Performance solution will comply with the Deemed to Satisfy provisions of the BCA.
    - This report excludes the analysis and design of fires including incendiary ones involving accelerants, explosives and/or multiple ignition sources, or acts of terrorism.
    - The concepts outlined in this report assume a complete and operational building, and do not address protection of the building during construction, renovation or demolition.
    - Egress and fire safety provisions for persons with disabilities including compliance with the Disability Discrimination Act (DDA) were considered to the same degree as the BCA.
    - Unless stated otherwise, protection of property (other than adjoining property), business interruption or losses, personal or moral obligations of the owner/occupier, reputation, environmental impacts, broader community issues, amenity or non-fire related matters in the building such as health, security, energy efficiency, and occupational health & safety or the re-installation and costs associated with any damages from fire are specifically excluded from this analysis.
    - All essential equipment services and strategies will be maintained, to the operational capacity to which they were designed, installed, commissioned and certified, in accordance with the manufacturer's instructions. Therefore, all essential equipment services and strategies discussed within this report are assumed to function correctly during a fire situation.
- This report is not a compliance or conformance audit for any fire safety system. For example, operational checks of fire safety equipment, verification of construction techniques, fire resistance levels or the witnessing of fire drills or exercises are specifically excluded from the scope of this report.
- The recommendations in this report are based on information provided by others as listed in Section 1.6. MCD Fire Engineering has not verified the accuracy and/or completeness of this information.
- The recommendations, data and methodology apply to the subject building and must not be utilised for any other purpose. Any modifications or changes to the building, fire safety management system, or building usage from that described in this report may invalidate the findings, necessitating a re-assessment.

Appendix A BCA Performance Requirements

A.1 BCA Performance Requirement CP2

BCA Performance Requirement CP2 stipulates;

> (a) A building must have elements which will, to the degree necessary, avoid the spread of fire—
> (i) to exits; and
> (ii) to sole-occupancy units and public corridors; and
> (iii) between buildings; and
> (iv) in a building.
> (b) Avoidance of the spread of fire referred to in (a) must be appropriate to—
> (i) the function or use of the building; and
> (ii) the fire load; and
> (iii) the potential fire intensity; and
> (iv) the fire hazard; and
> (v) the number of storeys in the building; and
> (vi) its proximity to other property; and
> (vii) any active fire safety systems installed in the building; and
> (viii) the size of any fire compartment; and
> (ix) fire brigade intervention; and
> (x) other elements they support; and
> (xi) the evacuation time."

The BCA Guide sets out that the intent of BCA Performance Requirements CP1 and CP2 is to set structural stability requirements for building elements during fire and avoid spread of fire between fire compartments and buildings. CP1 and CP2 do not reference a fire-resistance level (FRL). FRLs are only included as part of the Deemed-to-Satisfy Provisions. The BCA Guide also states that it may be determined by a building proponent using a Performance Solution that applying FRLs to building element is not necessary because other methods, such as the use of active systems, can satisfy the Performance Requirements.

Appendix B Radiation Calculations

B.1 Radiation Methodology

The radiation assessment is based on the following equations:

$$\dot{q}_r^{"} = F_{1-2} q^{"} \qquad \textbf{Equation 1}$$

Where:

$\dot{q}_r^{"}$ is the radiant heat flux received by the receiver [kW/m²]
F_{1-2} is the configuration factor [-]
$q^{"}$ is the radiant heat flux emitted by the opening

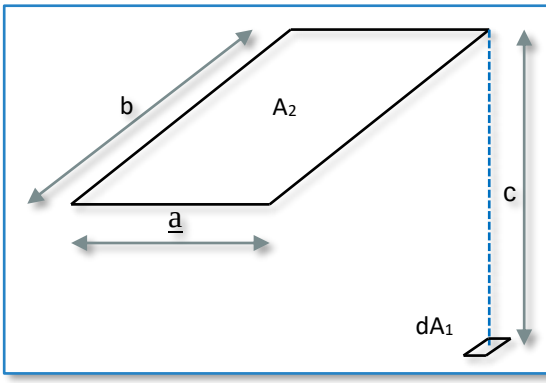
$$q^{"} = \varepsilon \sigma T^4 \qquad \textbf{Equation 2}$$

Where,

ε = emissivity, conservatively assumed to be 1.0
σ = Stefan-Boltzmann constant (5.67E-11 kW/m²/K)
T = Absolute Temperature of emitter [K]

B.2 Configuration factor for Parallel and Perpendicular Openings

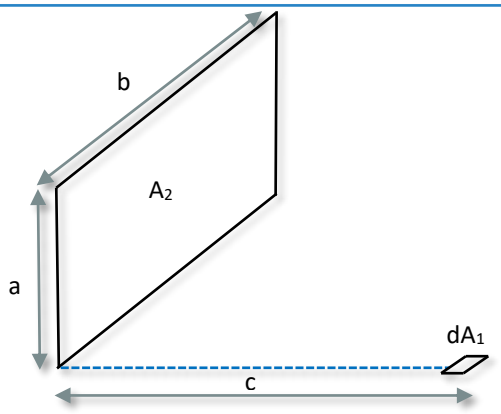
The configuration factor for parallel emitting and receiving surfaces from [Tien] is:



For A=a/c: B=b/c

$$F_{d1\text{-}2} = \frac{1}{2\rho}\left\{\frac{A}{\left(1+A^2\right)^{1/2}}\tan^{-1}\left[\frac{B}{\left(1+A^2\right)^{1/2}}\right] + \frac{B}{\left(1+B^2\right)^{1/2}}\tan^{-1}\left[\frac{A}{\left(1+B^2\right)^{1/2}}\right]\right\}$$

The configuration factor for perpendicular emitting and receiving surfaces from [Tien] is:



$$F_{d1-2} = \frac{1}{2\pi}\left(\tan^{-1}\left(\frac{1}{Y}\right) - AY\tan^{-1}A\right)$$

Where:

$$A = \frac{1}{\sqrt{(X^2+Y^2)}}$$

And:

$$X = \frac{a}{b}, \text{ and, } Y = \frac{c}{b}$$

Where:

a = half the width of area A_2 (area of emitter)
b = half the height of area A_2 (area of emitter)
c = the distance from the emitter to the receiver

B.3 Radiation Results – emitting radiation to eastern boundary from Ground floor opening

Radiation Assessment - Emitting

$$\dot{q}''_e = \varepsilon \sigma T^4_{emitter}$$

Where:

	Input Values	
ε is the emissivity,	1.00	
σ is Stefan-Boltzmann constant	5.67E-11	$kW/m^2/K^4$
Absolute Temperature of emitter,	1000	°C

And:	Output Values	
$\dot{q}''_e$ is the radiant heat flux emitted,	148.9	kW/m^2
the distance from boundary is	0.00	m
with nearest openings offset on the X-axis by a distance of	0.00	m (if applicable)
resulting in a max radiant heat flux emitted at target ref	44.8	kW/m^2

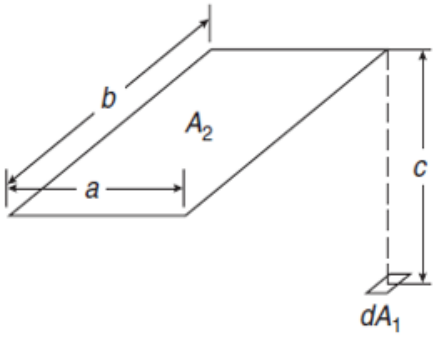
Unprotected Opening Dimensions - Parallel

Opening ID	W1	W2	W3			
Width, m	1.300	0.800	1.700			
Height, m	1.000	1.000	1.000			
Distance to target ref, (c1), m	1.20	1.20	1.20			
Distance from X-axis, (xl,b), m	0.30	2.50	8.50			
Distance from y-axis, (yl,b), m	1.100	1.100	1.100			

Unprotected Opening Dimensions - Perpendicular

Opening ID	D1	W4				
Width, m	2.400	2.000				
Height, m	2.100	1.000				
Distance to target ref, (c1), m	1.55	2.30				
Distance from X-axis, (xl,b), m	0.00	11.00				
Distance from y-axis, (yl,b), m	0.000	0.900				

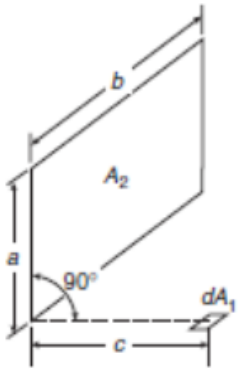
Parallel Configuration



$$X = a/c \qquad Y = b/c$$

$$F_{d1-2} = \frac{1}{2\pi}\left[\frac{X}{\sqrt{1+X^2}}\tan^{-1}\left(\frac{Y}{\sqrt{1+X^2}}\right) + \frac{Y}{\sqrt{1+Y^2}}\tan^{-1}\left(\frac{X}{\sqrt{1+Y^2}}\right)\right]$$

Perpendicular Configuration



$$X = a/b \qquad Y = c/b \qquad A = 1/\sqrt{X^2 + Y^2}$$

$$F_{d1-2} = \frac{1}{2\pi}[\tan^{-1}(1/Y) - AY\tan^{-1}A]$$

	Unprotected Openings	Distance to boundary (m)	Maximum Radiant Heat Flux Allowed (Table CV1, BCA) (kW/m^2)				Comments
			0 m from boundary	1 m from boundary	3 m from boundary	6 m from boundary	
			80	40	20	10	
Overall Results	W1+W2+W3+D1+W4	1.2 - 2.3	44.8	19.8	3.1	1.8	Acceptable

Appendix C References

Abbreviation in square brackets is how item is referred to throughout this report.

C.1 Australian Legislation and Referenced Documents

[BCA]	*National Construction Code Series Volume 1: Class 2 to 9 buildings – Building Code of Australia 2016 (Amendment 1), Australian Building Codes Board. National Construction Code Series Volume 1 Appendices: Variations and Additions – Building Code of Australia 2016 (Amendment 1), Australian Building Codes Board.*
[EP&A Act]	*NSW Environmental Planning and Assessment Act 1979*.
[EP&A Regs]	*NSW Environmental Planning and Assessment Regulation 2000* and subsequent amendments.

C.2 Texts and Guidance Documents

[BCA Guide]	*Guide to the Building Code of Australia, Australian Building Codes Board, 2016 (Amendment 1).*
[IFEG]	International Fire Engineering Guidelines, Australian Building Code Board, 2005.
[FBIM]	Fire Brigade Intervention Model. Australasian Fire and Emergency Services Authorities Council August 2008
[IFEG]	International Fire Engineering Guidelines, 2005, Australian Building Code Board, Canberra, Australia.

C.3 Australian Standards

[AS 1851]	AS 1851, 2012, Routine Service of Fire Protection Systems and Equipment.
[AS 2293.1]	AS 2293 Part 1, 2005, Emergency escape lighting and exit signs for buildings – System design, installation and operation.
[AS 2293.2]	AS 2293 Part 2, 2005, Emergency escape lighting and exit signs for buildings – Inspection and maintenance.
[AS 2419.1]	AS 2419 Part 1, 2005, Fire hydrant installations – System design, installation and commissioning.
[AS 2444]	AS 2444, 2001, Portable fire extinguishers and fire blankets – Selection and location.
[AS 3786]	AS 3786, 2014, Smoke alarms using scattered light, transmitted light or ionization.

Appendix D Referenced Drawings

NOTE:

THIS DETAIL SURVEY IS NOT A "LAND SURVEY" AS DEFINED BY THE SURVEYING AND SPATIAL INFORMATION ACT, 2002. IF ANY CONSTRUCTION OR DESIGN WORK, WHICH RELIES ON CRITICAL SETBACKS FROM THE STREET OR BOUNDARIES IS PLANNED, IT WOULD BE IMPERATIVE TO CARRY OUT FURTHER SURVEY WORK TO DETERMINE THE BOUNDARY DIMENSIONS.

PRIOR TO ANY CONSTRUCTION WORK, SURVEY MARKS SHOULD BE PLACE TO DEFINE THE PROPERTY BOUNDARIES.

SERVICES SHOWN ARE INDICATIVE ONLY. POSITIONS ARE BASED ON SURFACE INDICATOR(S) LOCATED DURING FIELD SURVEY. CONFIRMATION OF THE EXACT POSITION SHOULD BE MADE PRIOR TO ANY EXCAVATION WORK. OTHER SERVICES MAY EXIST WHICH ARE NOT SHOWN.

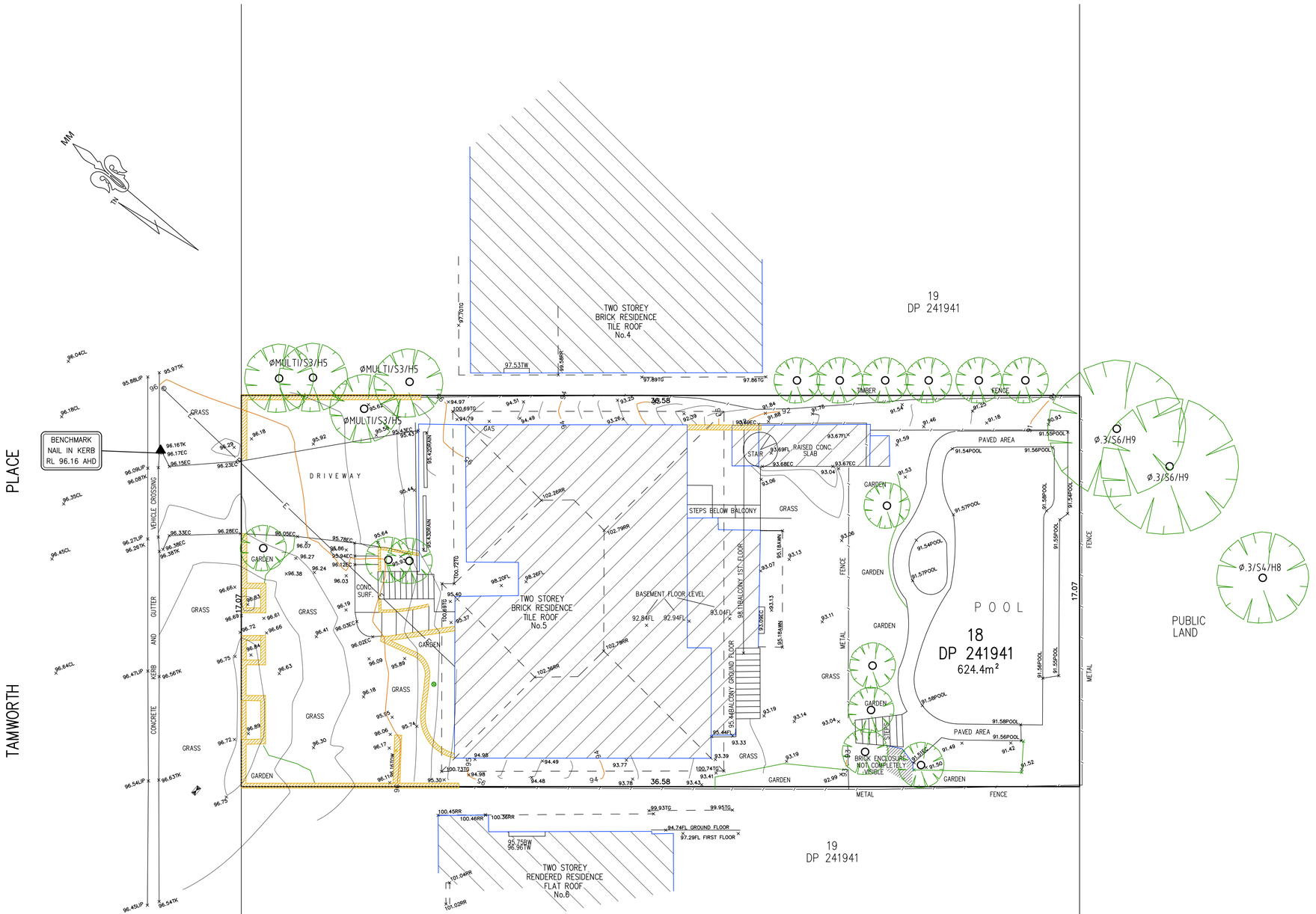
LEVELS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD) USING SSM 11976 WITH RL 96.49 (AHD).

RIDGE & GUTTER HEIGHTS HAVE BEEN OBTAINED BY INDIRECT METHOD AND ARE ACCURATE TO ± 0.05m.

CONTOURS SHOWN DEPICT THE TOPOGRAPHY. EXCEPT AT SPOT LEVELS SHOWN THEY DO NOT REPRESENT THE EXACT LEVEL AT ANY PARTICULAR POINT. THE SPOT LEVELS ARE TRUE FOR THEIR POSITION, AND ARE INTENDED TO BE USEFUL TO REPRESENT THE GENERAL TERRAIN. CARE SHOULD BE TAKEN IF EXTRAPOLATING.

LAND EXCLUDES MINERALS AND IS SUBJECT TO RESERVATIONS AND CONDITIONS IN FAVOUR OF THE CROWN
EXCEPTING THE LAND BELOW A DEPHT FROM THE SURFACE OF 15.24 METRES BY CROWN GRANT

BOUNDARIES HAVE NOT BEEN LOCATED BY SURVEY. THE BOUNDARIES SHOWN ON THIS PLAN HAVE BEEN TAKEN FROM THE TITLE DEPOSITED PLAN AND ARE APPROXIMATE RELATIVE TO THE DETAIL SURVEY.



LEGEND

BENCH MARK	▲
TELSTRA PIT	TEL
ELECTRIC LIGHT POLE	LP
POWER POLE	PP
SIGN POST	SP
SEWER INSPECTION PIT	SIP
SEWER VENT	SEWER
MANHOLE	MH
SEWER MANHOLE	SMH
STOP VALVE	SV
WATER HYDRANT	HYD
WATER METER	WM
GAS METER	
STATE SURVEY MARK	SSM

TSS TOTAL SURVEYING SOLUTIONS
ARTARMON | CAMDEN | MANLY VALE

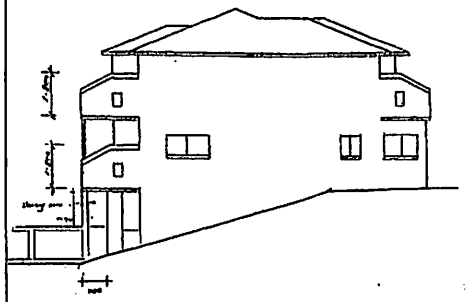
REVISION No.	REVISION DATE:	COMMENT:

LEGEND:
EC - EDGE OF CONCRETE
TK- TOP OF KERB
TW - TOP OF WINDOW
BW - BOTTOM OF WINDOW
TG - TOP OF GUTTER
RR - ROOF RIDGE
FL - FLOOR LEVEL
INV - INVERT LEVEL
Ø.4/S10/H16 - DIAMETER/SPREAD/HEIGHT

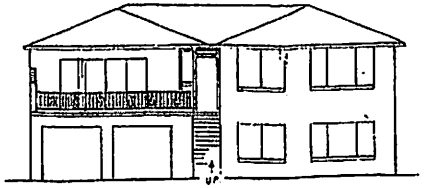
0 1 2 3 4 5 10m
BAR SCALE
PLOTTED SCALE 1:100 (A1 SIZE SHEET)

PLAN SHOWING DETAIL & LEVELS
OVER LOT 18 IN DP 241941

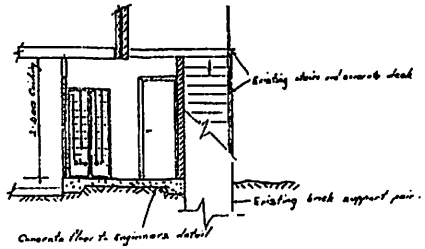
CLIENT:	MR AND MRS MIRABITO	JOB No.: 190328	LGA: NORTHERN BEACHES
PROJECT:	ALLAMBIE HEIGHTS	PLAN No.: 190328_A	DATUM: AHD
ADDRESS:	5 TAMWORTH PLACE, ALLAMBIE HEIGHTS	DATE: 19/02/2019	SCALE: 1:100@A1
		DRAWN: FS	CONT. INTERVAL: 0.25m
		CHK: GS	SHEET 1 OF 1



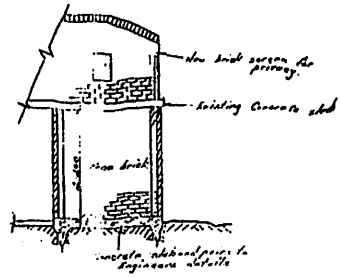
EASTERN ELEVATION 1:100



NORTHERN ELEVATION. 1:100



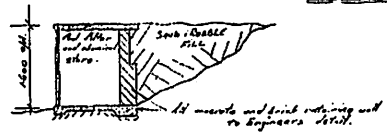
SECTION 'A-A' 1:50



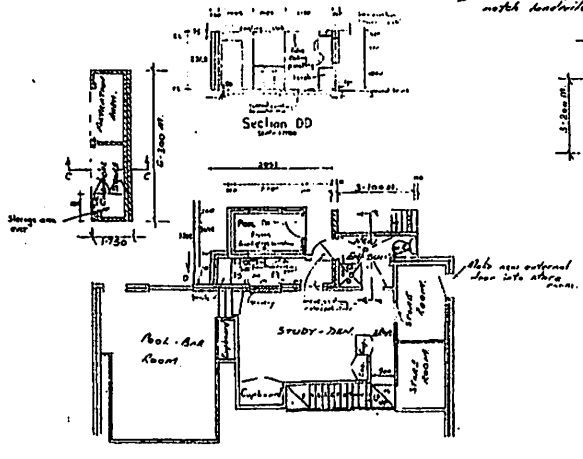
SECTION 'B-B' 1:50

NOTES

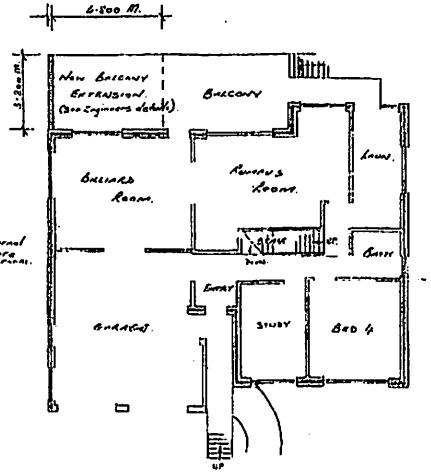
1. Lower ground floor slab and walls are existing except New En-suite, Verandah, Toilet, Shed and Pool Filter & Chemical Storage area.
2. Engineers details will be provided for all Concrete and Steel requirements on wall as brick retaining wall forming part of Pool Filtration Store.
3. All walls not Face brickwork in Study-Den and Pool-Bar Room to be cement rendered as required. Ceilings to be sprayed w plaster set.
4. All new brick privacy screens to match existing brickwork with feature panel to match brickwork.



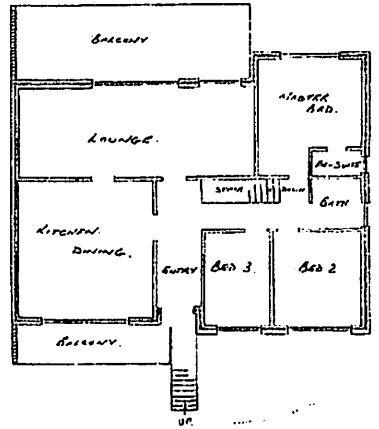
SECTION 'C-C' 1:50



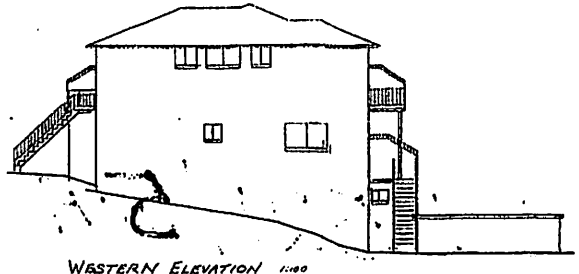
PROPOSED NEW LOWER GROUND FLOOR PLAN. 1:100



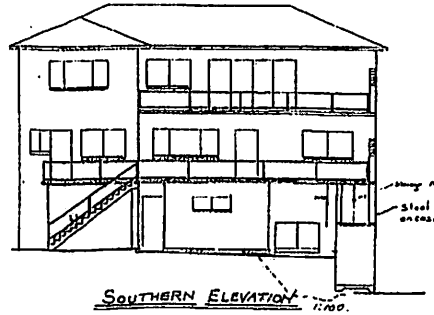
GROUND FLOOR PLAN. 1:100



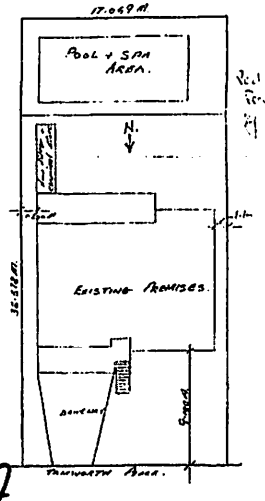
UPPER FLOOR PLAN. 1:100



WESTERN ELEVATION 1:100



SOUTHERN ELEVATION 1:100.



SITE PLAN

4521/5-A
1158188

DATE	REVISION	BY

PROPOSED ALTERATIONS AND ADDITIONS TO PREMISES OF:-

MR/MRS. R & J. MIRABITO
5 TAMWORTH PLACE,
ALLAMBIE HEIGHTS.

DRAWN	CHECKED	SCALE	DRAWING No.
		AS INDICATED.	46/87.

A1

DAVRON DIAZO PRODUCTS TEL 979 1022

1 2 3 4 MICROBOX 4 3 2 1