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29 September 2016 | Final | Report No. s141588_FSS_05

Fire Safety Strategy

Australian Habitat and Taronga Wildlife Retreat

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Report Details

Project: Australian Habitat and Taronga Wildlife Retreat
Bradleys Head Road, Mosman NSW 2088
Document: Fire Safety Strategy
Report No.: s141588_FSS_05

Report Revision History

REV	DATE ISSUED	COMMENT	PREPARED BY	REVIEWED BY
01	01/12/15	Draft Issue for comment	**Tass Georgas** *B.Tech (Building Surveying)* *Grad.Dip (Fire Safety & Risk Engineering)* *M.Eng (Construction Management)* *Registered Building Practitioner (Vic): EF31029* *AffiIIEAust* *MAIB*	**Vicky Trajkovski** *BE (Architectural)* *Grad.Dip (Building Fire Safety & Risk Engineering)*
02	08/03/16	Final issue	**Vicky Trajkovski** *BE (Architectural)* *Grad.Dip (Building Fire Safety & Risk Engineering)*	**Sandro Razzi** *BE (Building), Grad. Dip. (Performance Based Building and Fire Codes),* *Accredited Fire Engineer BPB 0501,* *FIEAust,* *CPEng 2180287*
03	11/03/16	Final issue		
04	02/09/16	Draft Issue for Comment *Incorporates FRNSW Comments*	**Colin Thomson** *BEng (Chemical Engineering)*	
05	29/09/16	Final Issue		

DOCUMENT REVISION HISTORY

The following is a summary of the revisions and changes to this document.

Version 5 – 29th September 2016

Finalised Issue – Updated for Team Comments

This version incorporates numerous changes from v4:

1. Updated per Matthew Spooner's comments received 12 September 2016.
    a. Corrected rise in Storeys and updated Door Closer/Sliding Door discussion.
2. Updated per Mark Davey's comments received 13 September 2016.
    a. Clarified 60 minute FRLs to Pods A/B/C and 90 minutes to Pods D/E (Table 8-1).
    b. Pod corridors permitted to have 60 minute FRLs (Section 8.2).
    c. External stairs to be non-combustible but compliant in not requiring an FRL (Section 8.2).
    d. Egress distance markups removed for the time being, leaving just general travel distances as the non-compliance. As this FSS is a high level design document, further detail and design of the distances can be covered in more detail in the FEBQ/FER process.
    e. Clause D1.7 non-compliance regarding kitchen opening to stair removed.
    f. Other minor updates per comments.
3. Updates per Andrew Brohier's updated Fire Alternative Solutions Register:
    a. Inclusion of United Building/FRL Reduction and Bushfire non-compliances (Table 7-1).

Version 4 – 2nd September 2016

Revised Draft Issue – Updated for FRNSW Comments

This version incorporates numerous changes from v3:

1. Updated to reference BCA 2016, for the inclusion of CLT construction methods.
2. Inclusion of FRNSW Comments from 10 May 2016 Letter and associated recommendations. See APPENDIX A for details.
3. Inclusion of CORE Engineering Consultant Advice regarding the Bush Fire risk and the building. See APPENDIX B for details.
4. Update to Section 2 (Project Scope) for personnel, and to reference the FRNSW and NSW Rural Fire Service advisory letters.
5. Updates to Section 6 (Fire Hazards) to include discussion on the Bush Fire risk and scenario.
6. Updates to Section 8 (Fire Safety Strategy) with regards to Passive Fire Construction (Details of BCA2016 compliance using CLT) and BAL29/40 strategies, Egress provisions, Hydrant layout requirements, other minor edits.

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1 INTRODUCTION

1.1 OVERVIEW

This Fire Engineering Report has been undertaken to nominate a proposed Alternative Solution for assessing compliance with the nominated Performance Requirements of the Building Code of Australia 2016 (BCA) [1] in accordance with the methodologies defined in the International Fire Engineering Guideline IFEG [3].

In order to develop and assess the nominated non-compliances the following flowchart process is to be adopted.

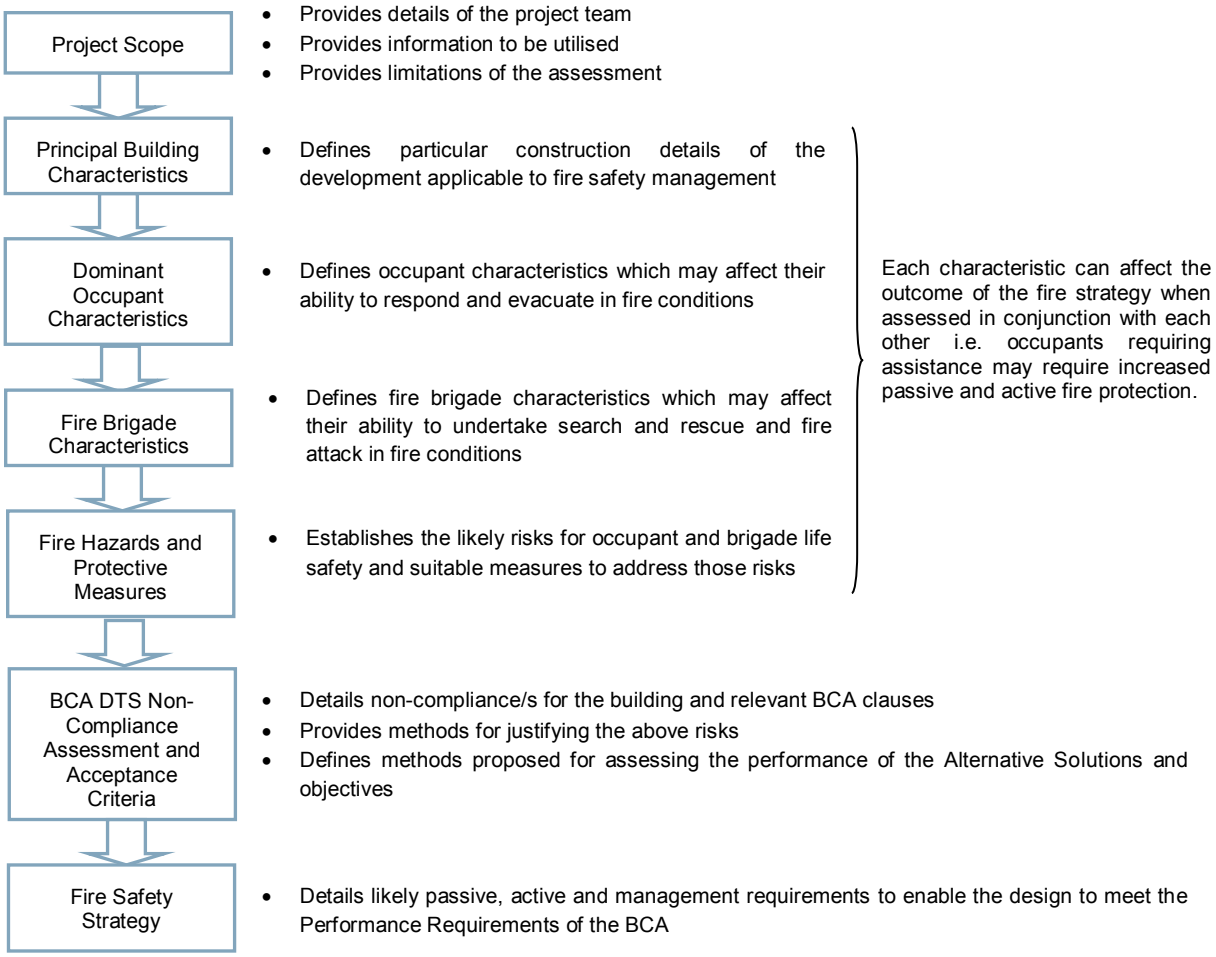


Figure 1-1: Fire Safety Strategy Process

The scope of the Fire Safety Strategy is to detail the nominated non-complying BCA Deemed-to-Satisfy (DTS) provisions with the performance requirements of the BCA and provide methodologies for establishing a workable and safe Fire Safety Strategy through a trial design.

1.2 FIRE SAFETY OBJECTIVES

The objective of this Fire Engineering Assessment is to develop a Fire Safety System, which satisfies the performance requirements of the BCA whilst maintaining an acceptable level of life safety, protection of adjacent property and adequate provisions for Fire Brigade intervention. At a community level, fire safety objectives are met if the relevant legislation and regulations are complied with. As stated in the BCA, "*A Building Solution will comply with the BCA if it satisfies the Performance Requirements*". In addition to this certain non-regulatory objectives exist as detailed below.

1.2.1 Building regulatory objectives

The following items are a summary of the fire and life safety objectives of the BCA:

- **Life safety of occupants -** the occupants must be able to leave the building (or remain in a safe refuge) without being subject to hazardous or untenable conditions. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would minimise the risk of exposing building occupants to hazardous or untenable conditions in an event of a fire.
- **Life safety of fire fighters -** fire fighters must be given a reasonable time to rescue any remaining occupants before hazardous conditions or building collapse occurs. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would facilitate fire brigade intervention and minimise the risk of exposing fire fighters to hazardous or untenable conditions in an event of a fire.
- **Protection of adjoining buildings** - structures must not collapse onto adjacent property and fire spread by radiation should not occur. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would minimise the risk of fire spreading from one building to another.

1.2.2 Fire Brigade objectives

The overall philosophical Fire Brigade objectives throughout Australia are to protect life, property and the environment from fire according to the Fire Brigade Intervention Model (FBIM) [6] as per the Fire Services State and Territory Acts and Regulations.

Over and above the requirements of the BCA, the Fire Brigade has functions with regard to property and environmental protection and considerations regarding occupational health and safety for its employees.

1.2.3 Non-prescribed objectives

Fire Engineering has an overarching benefit to many facets of the built environment where non-prescribed objectives can have an influence on the Fire Safety Strategy adopted. Although not assessed within, the following can be considered if requested.

- **Business continuity -** will the loss of a particular facility due to fire / smoke damage result in excessive financial impact on the client? For example, is the facility critical to business continuity?
- **Public perception -** should a fire occur within the facility is there likely to be questionable public perception about the safety and operation of the facility?
- **Environmental protection -** fires of excessive sizes can have significant effects on the environment which may require a detailed risk assessment to minimise such outcomes.
- **Heritage salvation -** buildings can have a heritage value for both cultural and educational purposes which can be destroyed by insufficient fire protection.
- **Risk mitigation / insurance limitations -** are there specific limitations on insurance with respect to risk mitigation and fire safety design? i.e. Does the relevant insurer have concerns with respect to open voids through the building?
- **Future proofing (isolation of systems) -** what flexibility is required in the overall design to allow for future development or changes in building layout?
- **Occupational Health and Safety (OHS) requirements -** buildings may have specific fire safety requirements pertaining to OHS requirements.

1.3 REGULATORY FRAMEWORK OF THE FIRE ENGINEERING ASSESSMENT

1.3.1 Building Code of Australia

One of the goals of the BCA is the achievement and maintenance of acceptable standards of safety from fire for the benefit of the community. This goal extends no further than is necessary in the public interest and is considered to be cost effective and not needlessly onerous in its application.

Section A0.5 of the BCA [1] outlines how compliance with the Performance Requirements can be achieved. These are as follows:

(a) complying with the Deemed-to-Satisfy Provisions; or

(b) formulating an Alternative Solution which –

(i) complies with the Performance Requirements; or

(ii) is shown to be at least equivalent to the Deemed-to-Satisfy Provisions or

(c) a combination of (a) and (b).

Section A0.9 of the BCA provides several different methods for assessing that an Alternate Solution complies with the Performance Requirements. These methods are summarised as follows:

(a) Evidence to support that the use of a material, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision.

(b) Verification Methods such as:

(i) the Verifications Methods in the BCA; or

(ii) such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements.

(c) Comparison with the Deemed-to-Satisfy Provisions.

(d) Expert Judgment.

Section A0.10 of the BCA provides methods for complying with provisions A1.5 (to comply with Sections A to J of the BCA inclusive). The following method must be used to determine the Performance Requirements relevant to the Alternative Solution: These methods are summarised as follows:

(a) Identify the relevant Deemed-to-Satisfy Provision of each Section or Part that is to be the subject of the Alternative Solution.

(b) Identify the Performance Requirements from the same Section or Part that are relevant to the identified Deemed-to-Satisfy Provisions.

(c) Identify Performance Requirements from the other Sections and Parts that are relevant to any aspects of the Alternative Solution proposed or that are affected by the application of the Deemed-to-Satisfy Provisions that are the subject of the Alternative Solution.

1.3.2 International Fire Engineering Guidelines 2005

The IFEG [3] document has been developed for use in fire safety design and assessment of buildings and reflects world's best practice. The document is intended to provide guidance for fire engineers as they work to develop and assess strategies that provide acceptable levels of safety.

The document is particularly useful in providing guidance in the design and assessment of Alternative Solutions against the Performance Requirements of the BCA. The prescribed methodology set out in the IFEG has been generally adopted in the Fire Engineering Report.

2 PROJECT SCOPE

2.1 OVERVIEW

CORE Engineering Group has been engaged to develop a Fire Safety Strategy for the construction of Taronga Wildlife Retreat at Bradleys Head Road, Mosman NSW. The purpose of this fire safety strategy is to outline the fire engineering principles that will be utilised in ensuring that the prescriptive Deemed-to-Satisfy (DTS) non-compliances noted in the Building Code of Australia (BCA) report are resolved in order to conform to the building regulations and permit development approval.

The complete fire engineered analysis will be included within the Fire Engineering Report, and as such is not documented herein. This document does however outline the construction and management requirements considered necessary to achieve an acceptable level of life safety within the building as a result of the Alternative Solution and to satisfy the Performance Requirements of the BCA.

2.2 RELEVANT STAKEHOLDERS

This Alternative Solution has been developed collaboratively with the relevant stakeholders as identified below:

Table 2-1: Relevant Stakeholders

ROLE	NAME	ORGANISATION
Client/Project Manager	Matthew Spooner	Taronga Conservation Society Australia
Development Manager	Paul McDonald	Compass Project Management
Principal Certifying Authority/BCA Consultant	Andrew Brohier Geoffrey Pearce	McKenzie Group
Architect	Mark Davey James Vine	Cox Richardson
Fire Safety Consultant	Colin Thomson	Core Engineering Group
Fire Safety Engineer	Sandro Razzi	

It should be noted that at times some parties may have a vested interest in the outcome of the Fire Engineering assessment. Such parties can include local fire brigades, insurers, Environmental Protection Authority (EPA), project control groups, end users and community representatives. Although not always a legislative requirement, the design team should give due consideration to their inclusion in the Fire Engineering process. Where not required by legislation it is the client's decision to involve such parties, especially local fire brigade, to ensure a transparent and adequate fire safety solution for all. Where we are not notified of the inclusion of such parties it is assumed the client / representative has given due consideration to the above.

2.3 SOURCES OF INFORMATION

The following sources of information have been provided by the design team:

- BCA Compliance report prepared by McKenzie Group. Project Ref. 067876 – 04BCA Revision D, 10.02.2016.
- Architectural plans provided by COX Architects, as indicated in Table 2-2.
- FRNSW Letter received 10 May 2016, reference BFS16/661 (10237).
- Rural Fire Services Letter received 10 August 2016, reference D16/2436.

Table 2-2: Drawings

DRAWING NO.	DESCRIPTION	REVISION	DATE
AR-DA-1001	LOCATION PLAN	03	10.03.16
AR-DA-2101	LEVEL A – RL51 PLAN	03	10.03.16

DRAWING NO.	DESCRIPTION	REVISION	DATE
AR-DA-2102	LEVEL B – RL54 PLAN	03	10.03.16
AR-DA-2103	LEVEL C – RL57 PLAN	03	10.03.16
AR-DA-2104	LEVEL D –RL60 PLAN	03	10.03.16
AR-DA-2105	LEVEL E - RL63 PLAN	03	10.03.16
AR-DA-2106	LEVEL 1 – RESTAURANT RL67 PLAN	03	10.03.16
AR-DA-2107	LEVEL 2 – TERRACE RL71 PLAN	03	10.03.16

2.4 FRNSW FEEDBACK

Fire and Rescue New South Wales provided a commentary advisory letter on 10 May, 2016, Ref BFS16/661 (10237), with regards to this development and project. The commentary included multiple recommendations to the design for consideration of the project from a fire safety perspective. These recommendations are addressed in APPENDIX A.

2.5 NSW RURAL FIRE SERVICE FEEDBACK

The NSW Rural Fire Service provided a commentary advisory letter on 10 August, 2016, Ref D16/2436, with regards to this development and project. The commentary in this regard dealt with the bush fire risk and emergency management planning for the site, and therefore shall be responded to by the Bush Fire Consultant and Taronga Conservation Society Australia personnel, and are not specifically addressed in this report.

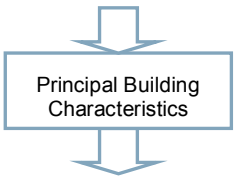
2.6 LIMITATIONS AND ASSUMPTIONS

In this instance the Fire Safety Strategy is developed based on applicable limitations and assumptions for the development which are listed as follows:

- The report is specifically limited to the project described in Section 3.
- The report is based on the information provided by the team as listed above in Section 2.3.
- Building and occupant characteristics are as per Section 3 and 4 respectively of this report. Variations to these assumptions may affect the Fire Engineering Strategy and therefore they should be reviewed by a suitably qualified Fire Engineer should they differ.
- As per any building design, DTS or otherwise, the report is limited to the fire hazards and fuel loads as prescribed in Section 6.5. The report does not provide guidance in respect of areas, which are used for Dangerous Good storage, processing of flammable liquids, explosive materials, multiple fire ignitions or sabotage of fire safety systems.
- The development complies with the fire safety DTS provisions of the BCA [1] with all aspects for fire and life safety unless otherwise stated in this report. Where not specifically mentioned, the design is expected to meet the BCA DTS requirements of all relevant codes and legislation at the time of construction and / or at the time of issue of this report.
- The assessment is limited to the objectives of the BCA and does not consider property damage such as building and contents damage caused by fire, potential increased insurance liability and loss of business continuity.
- Malicious acts or arson with respect to fire ignition and safety systems are limited in nature and are outside the objectives of the BCA. Such acts can potentially overwhelm fire safety systems and therefore further strategies such as security, housekeeping and management procedures may better mitigate such risks.
- This report is prepared in good faith and with due care for information purposes only, and should not be relied upon as providing any warranty or guarantee that ignition or a fire will not occur.
- The Fire Engineering Strategy is only applicable to the completed building. This report is not suitable, unless approved otherwise, to the building in a staged handover.
- Where parties nominated in Section 2.2 have not been consulted or legislatively are not required to be, this report does not take into account, nor warrant, that fire safety requirements specific to their needs have been complied with.

3 PRINCIPAL BUILDING CHARACTERISTICS

3.1 OVERVIEW



Building characteristics are assessed as part of the Fire Engineering Review due the following:

1. The location can affect the time for fire brigade intervention and potential external fire exposure issues.
2. The structure will impact on the ability to resist a developing fire and support condition to allow occupants to escape the building and the fire brigade to undertake fire fighting to the degree necessary.
3. The floor area determines the potential fire size and area required to be evacuated in the event of a fire.
4. BCA details such as Type of Construction, Class and Height will dictate passive and active fire safety systems.

3.2 SITE LOCATION

The development site is located on the shores of Sydney Harbour in the suburb of Mosman, approximately 8km north-east of Sydney's central business district.

Given the location of the Taronga Zoo accommodation buildings relatively close proximity to vegetation to the east of the site, the site is exposed to high bushfire risks.

The site is divided into eight zoogeographic regions across 21 hectares. The Taronga Wildlife Retreat is located to the east of the site along the Bradleys Head Road.

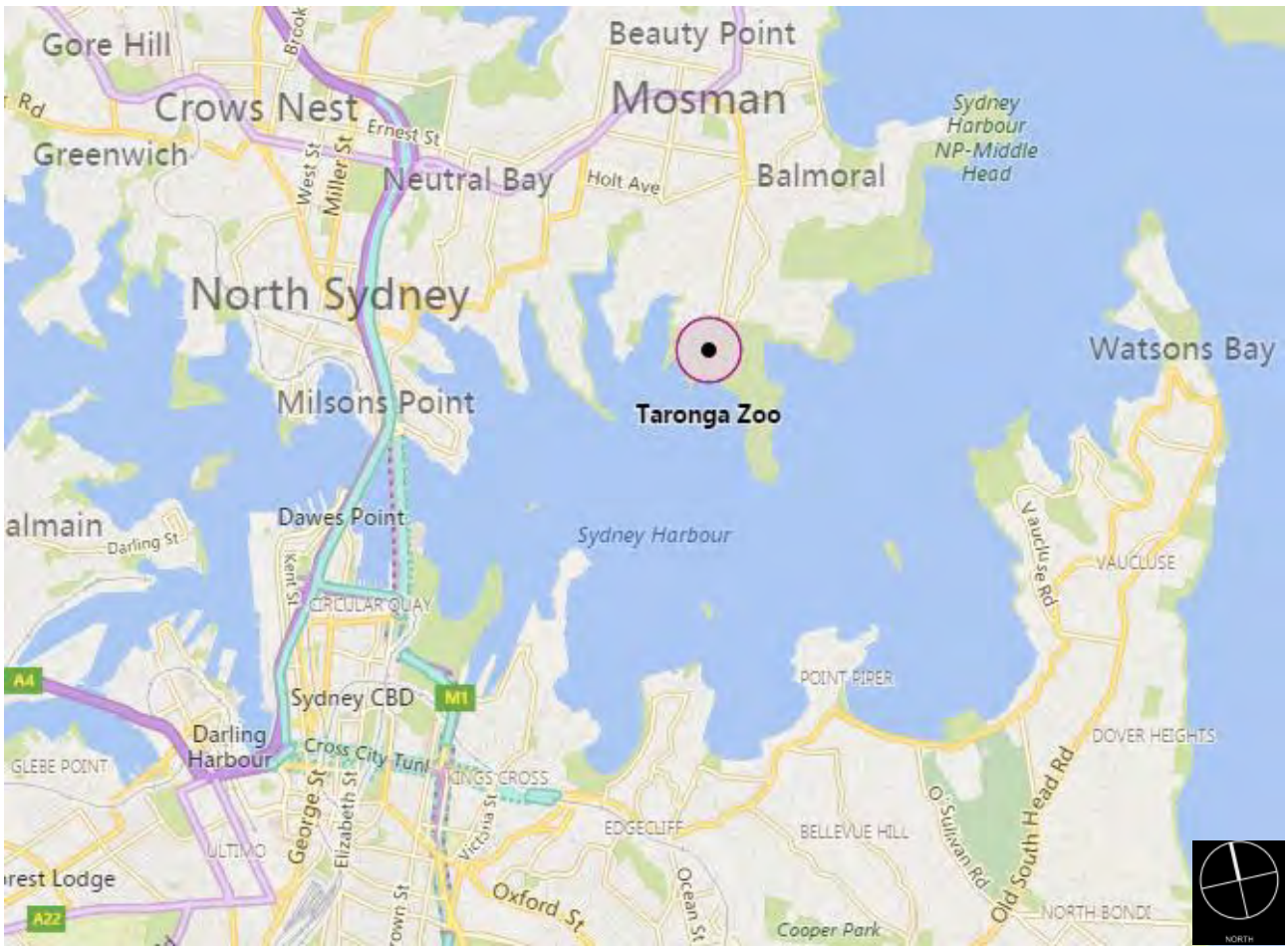


Figure 3-1: Site Location **Source: www.googlemaps.com.au**

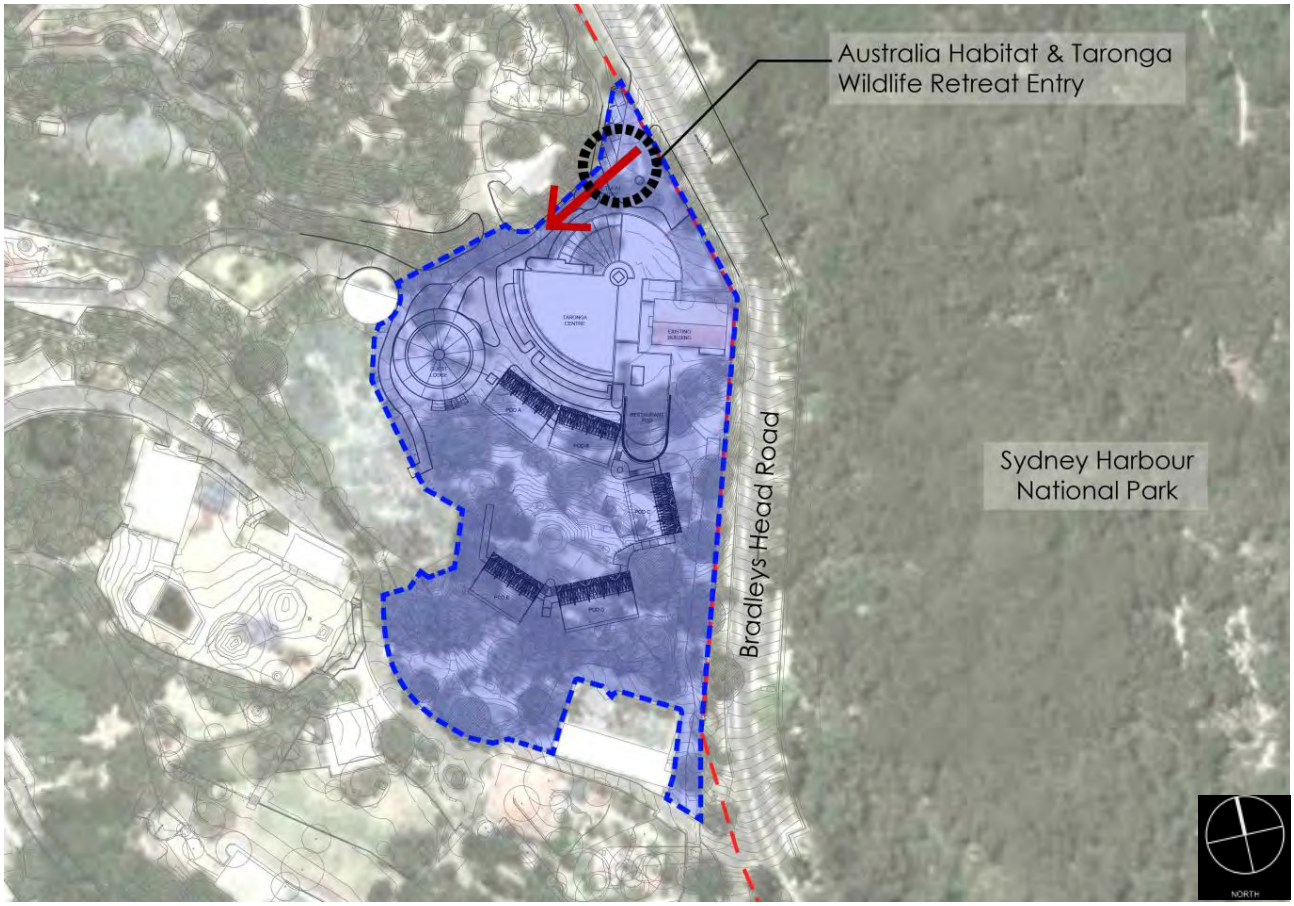


Figure 3-2: Plan

The building site influences the likely fire brigade intervention times, and given the close proximity to the nearest fire station is expected to facilitate a relatively convenient and expedient fire brigade response. Furthermore, being located in an inner suburb of a major city, the development is provided with the services and facilities expected in an urban setting. The two nearest fire brigade stations provided with permanent staff are Mosman and Neutral Bay approximately 2.0 km and 3.5 km from the site respectively when considering actual driving directions.

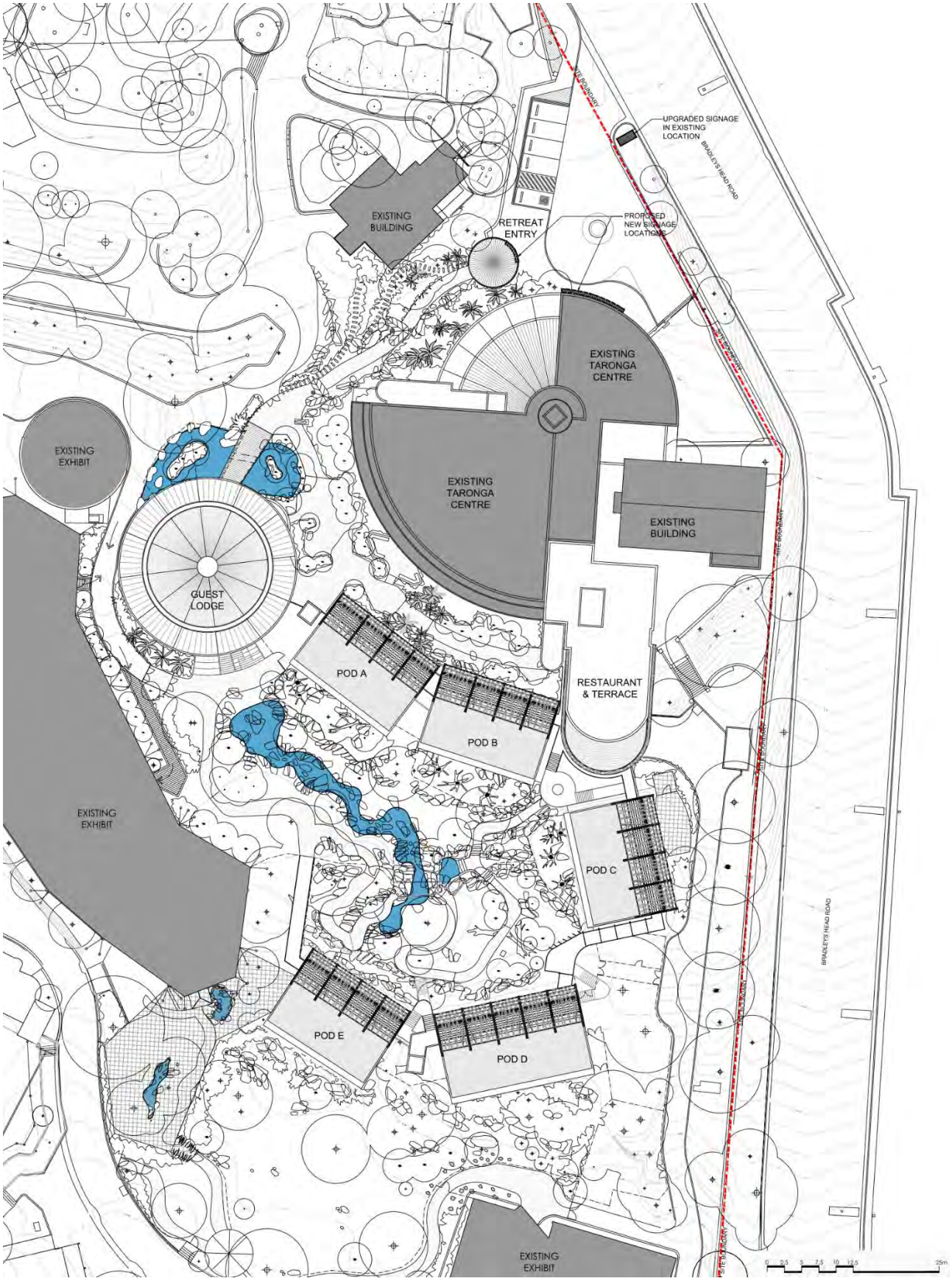


Figure 3-3: Proposed site plan

3.3 BUILDING DESCRIPTION

The subject development comprises of 5 residential buildings which are connected via external stairways and open passageways in order to form a single building. The passageways between buildings, although covered, are open and therefore provide well ventilated egress paths. The Class 3 portion of the building has a rise in storeys of 6, with a single Class 3 "building" located at the bottommost level and increasing the number of "buildings" at each level due to the steep sloping topography of the site. In addition to the Class 3 parts (Guest Lodge), a new restaurant and terrace have been proposed to the north-east end of the Class 3 parts. The restaurant will be located on Level 1, and associated kitchen will be located on Level E. The Class 6 parts will be connected to the Class 3 parts by open elevated passageways.

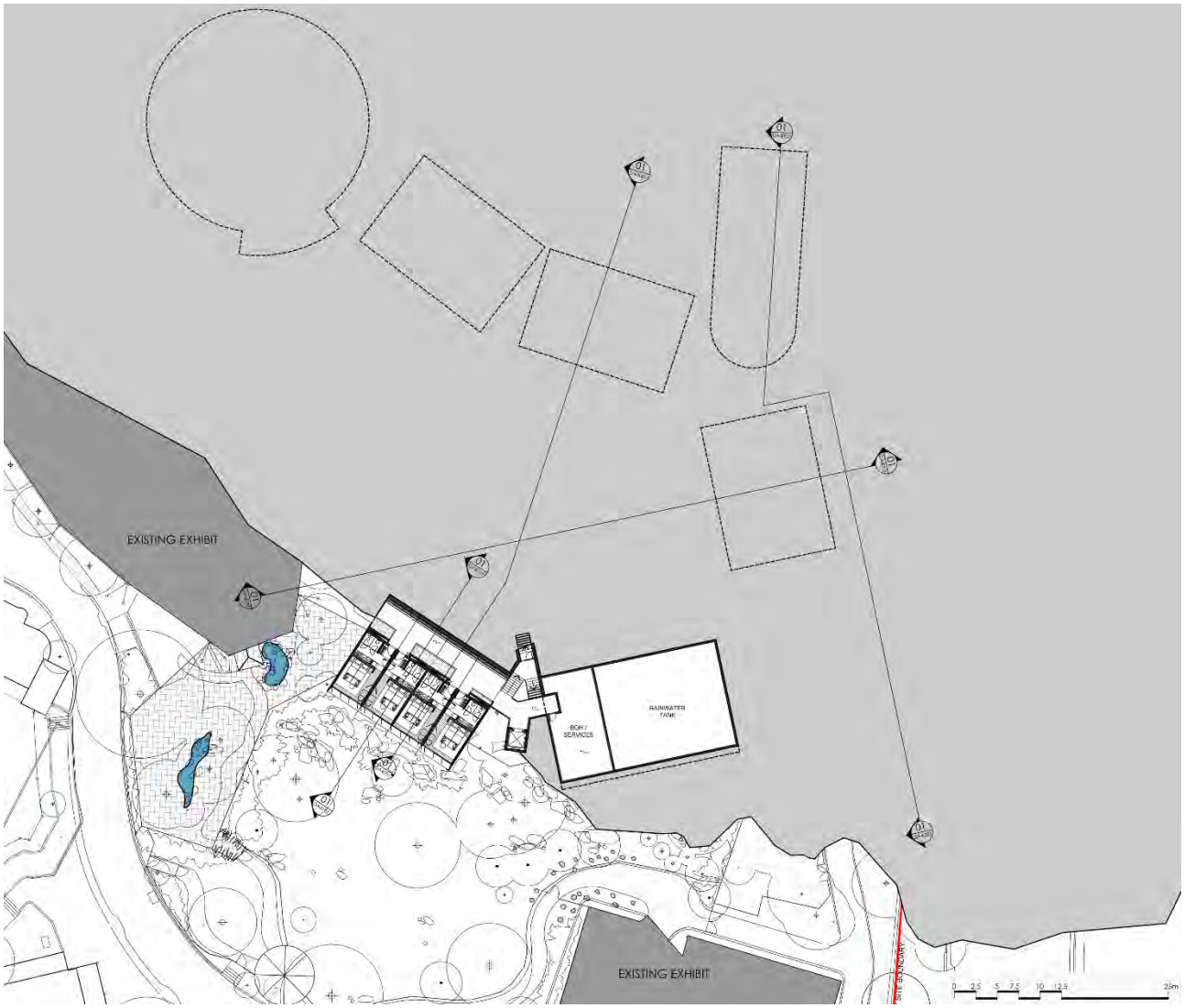


Figure 3-4: Level A

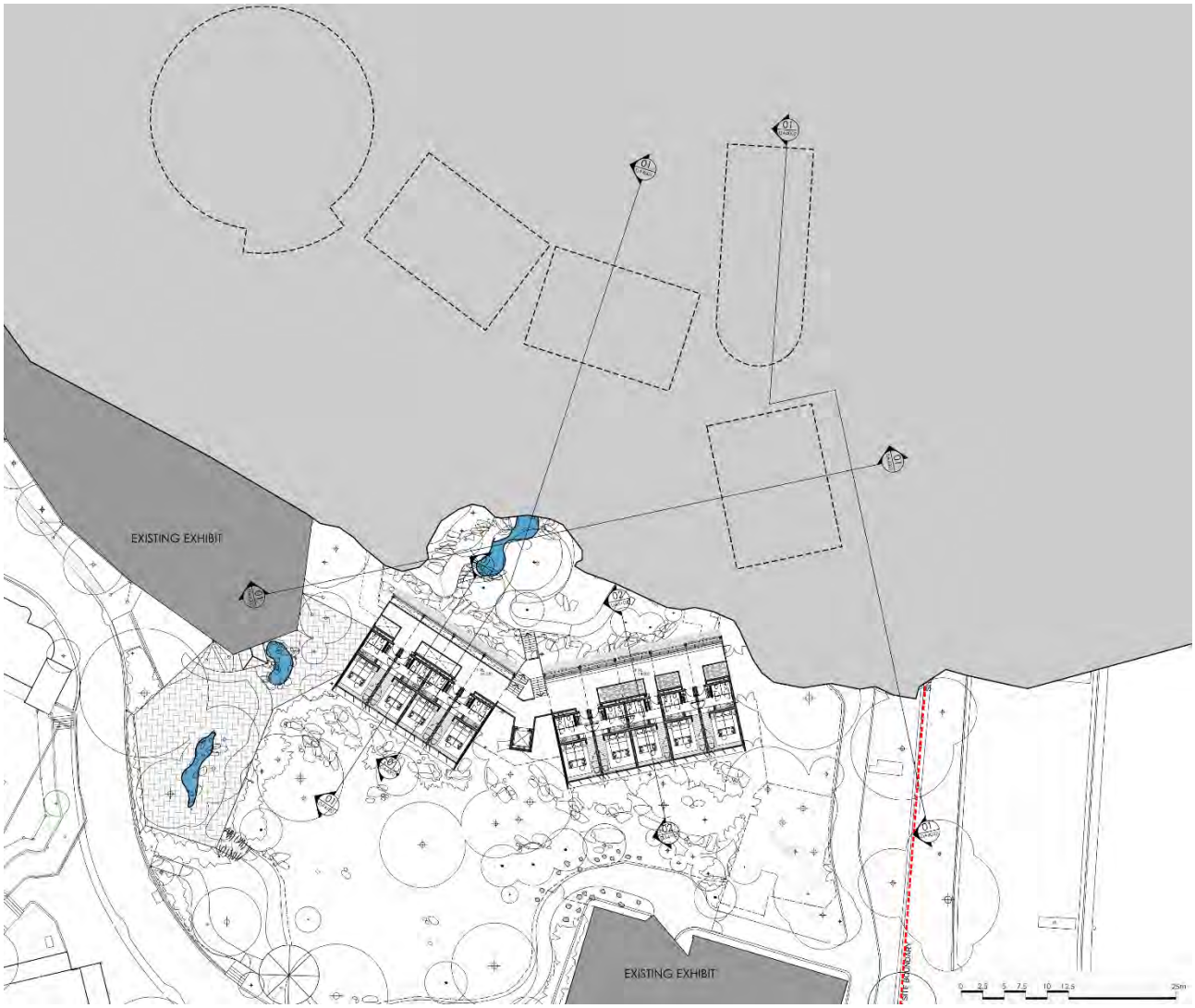


Figure 3-5: Level B

Figure 3-6: Level C

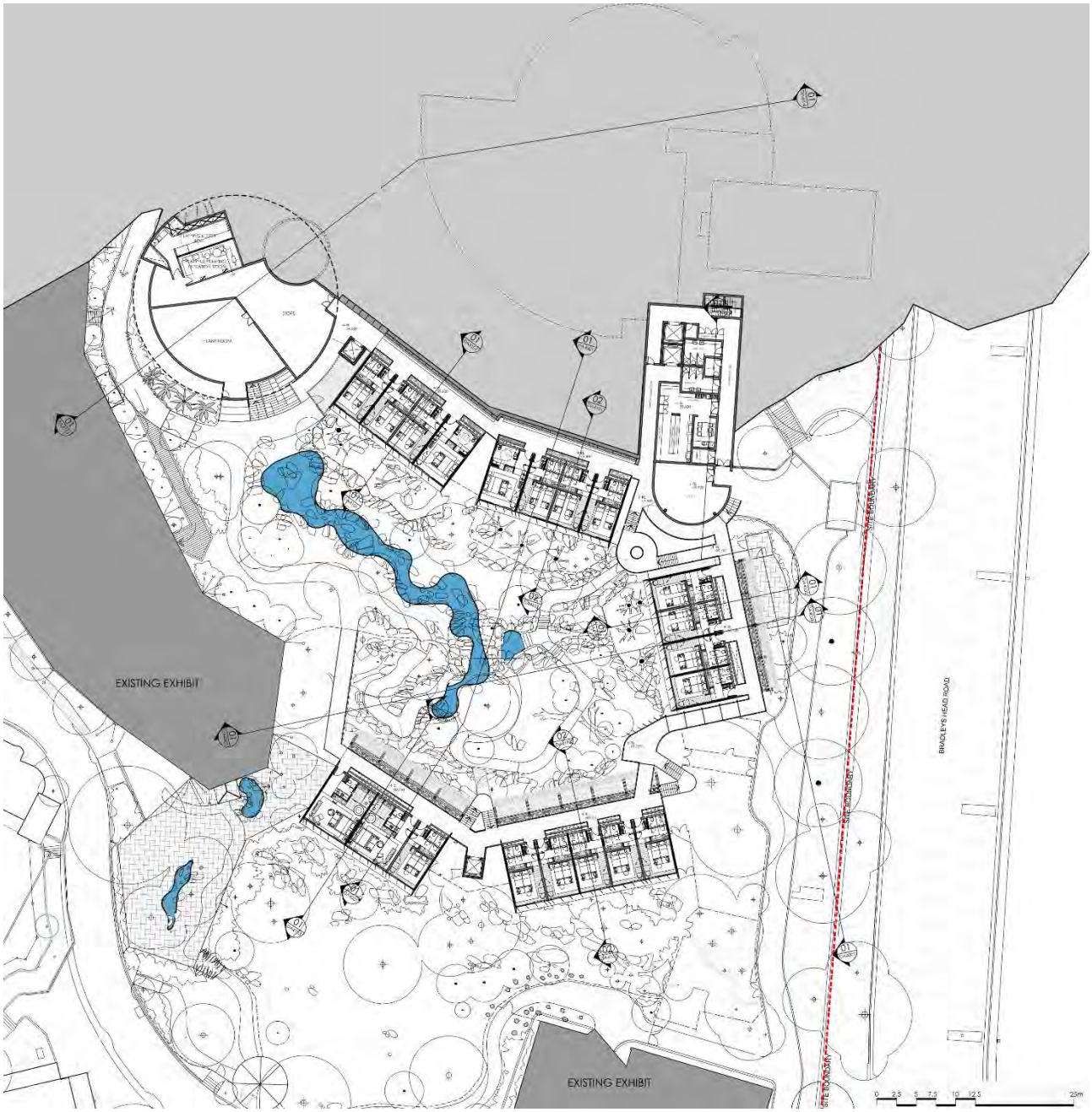


Figure 3-7: Level D

Figure 3-8: Level E

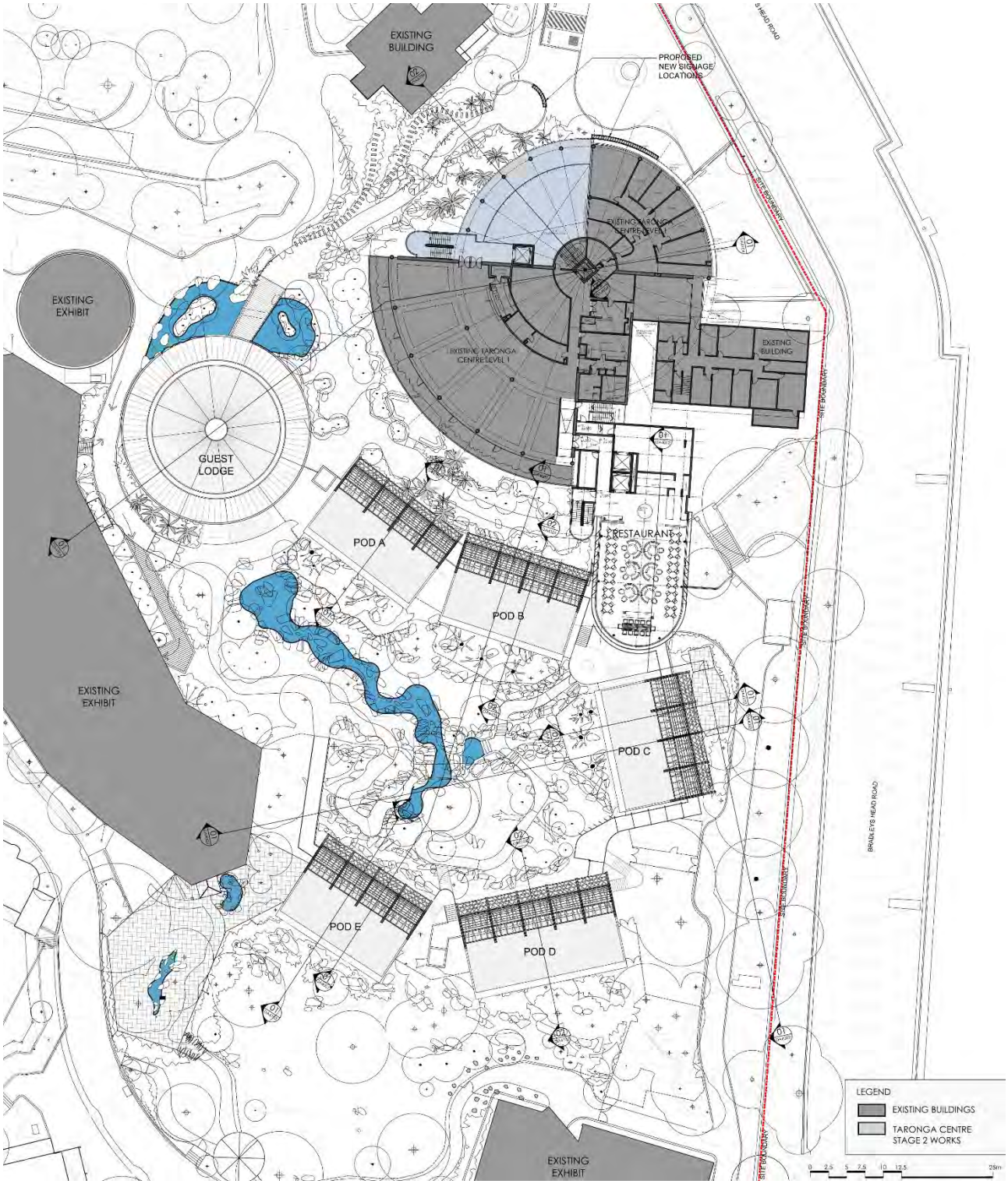


Figure 3-9: Level 1 – Restaurant

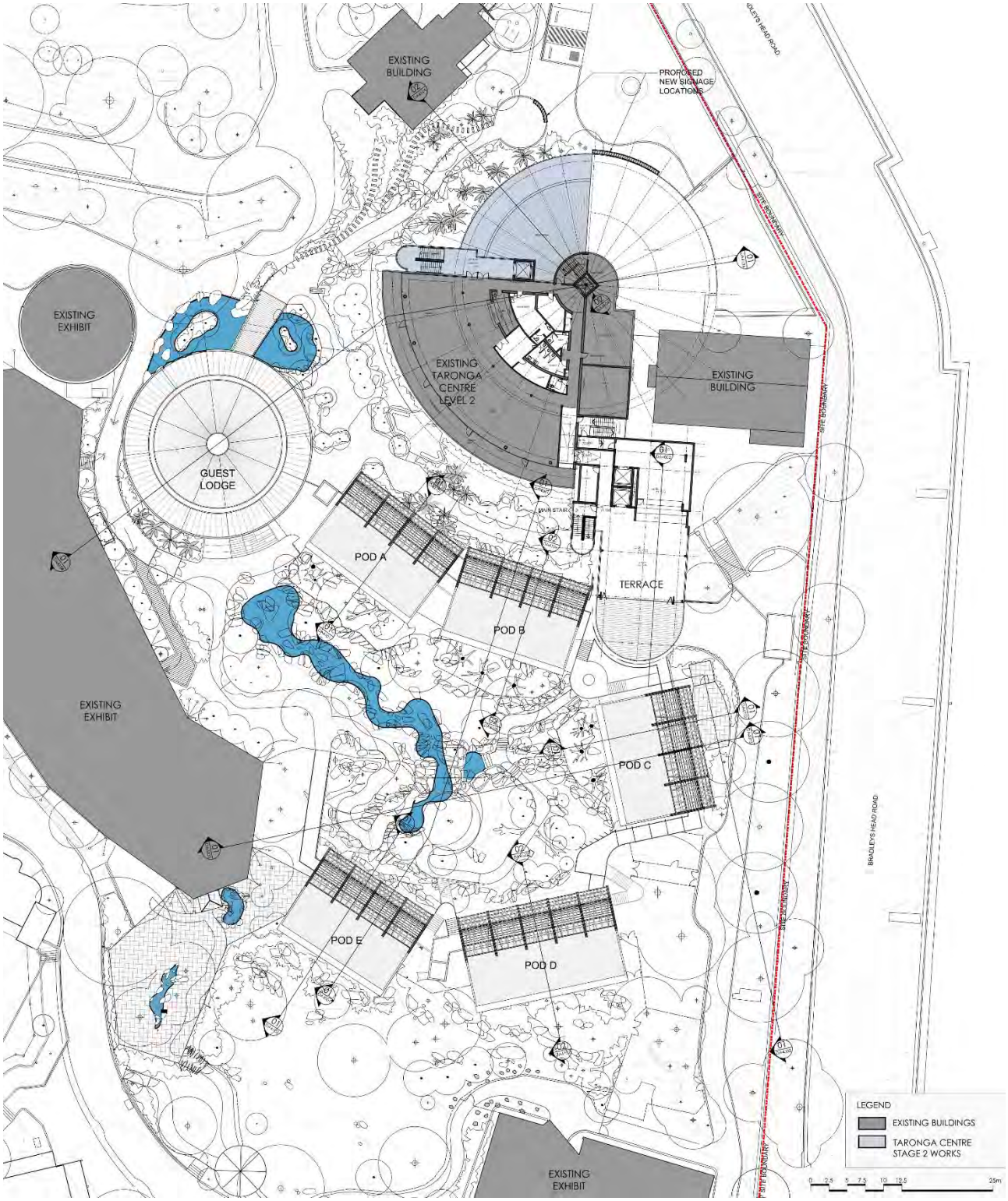


Figure 3-10: Level 2 – Terrace

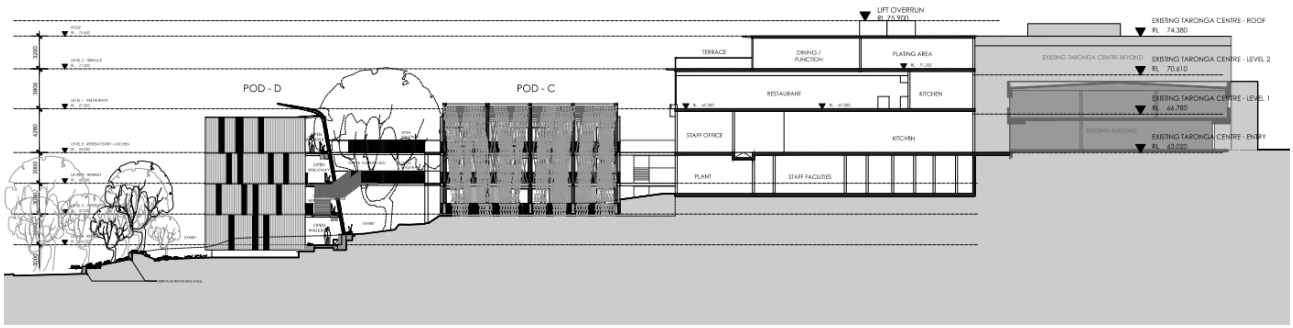


Figure 3-11: Site section

3.4 BCA ASSESSMENT SUMMARY

Table 3-1: BCA Building Characteristics (Overall)

CHARACTERISTIC	DESCRIPTION
Classification	3 – Residential Accommodation 6 – Restaurant and retail
Construction Type	A
Rise in Storeys	7 storeys
Effective Height	12 m
Floor Area	Approximately 1,100 m^2 for class 6 parts

The designation of a rise in storeys of 7 per the BCA is a bit misleading in this case, as the slope of the site shown in Figure 3-11 indicates that the overall rise per building is limited to 5 (Pod D being the only 5 storey). Each building is therefore quite low-rise compared to ground level, rather than the 7 storey designation would lead one to believe. Each accommodation pod and the restaurant is broken down in Table 3-2.

Table 3-2: BCA Building Characteristics (Per Building)

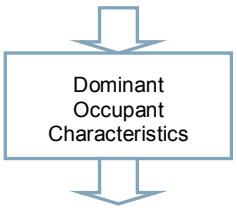
CHARACTERISTIC	POD A	POD B	POD C	POD D	POD E	RESTAURANT
Classification	3 – Residential Accommodation					6 – Restaurant and retail
Rise in Storeys	2	2	3	5	4	4

3.5 EXISTING EMERGENCY PROCEDURES

The existing Taronga Conservation Society Australia (TCSA) facility is subject to a range of emergency procedures owing to the secure nature of the facility. The zoo is monitored on a 24-hour basis by security staff and an emergency control organisation (ECO) exists to manage identified emergencies. In relation to bushfire threats from the immediate zoo surrounds, it is also understood that TCSA has developed specific emergency procedures to manage and mitigate the risk to the zoo's visitors, zoo property, staff and animals.

4 DOMINANT OCCUPANT CHARACTERISTICS

4.1 OVERVIEW



Occupant characteristics are considered in the fire engineering process for the following reasons:

1. Population numbers can dictate the time required to evacuate the building and the required life safety systems to be provided due to evacuation times.
2. Physical and mental attributes affects the occupants capacity to respond to various fire cues and react accordingly.
3. Familiarity of occupants can affect the time taken to evacuate the building and subsequent active / passive requirements.

4.2 OCCUPANT NUMBERS AND DISTRIBUTION

The population to be used for the purposes of this fire engineering assessment will be based on:

- BCA DTS Table D1.13 for the Class 6 areas, which equates to 1m^2 person;
- Residential accommodation units: 3 occupants per room; and
- Larger residential accommodation units on Level D: 3 occupants per room.

Where relevant subordinate NSW legislation prescribes an alternative floor area to occupant ratio in respect of the use of dormitories, boarding houses and similar shared accommodation buildings, the ratios specified within the relevant NSW legislation will be used to determine the design population for the residential accommodation areas.

4.3 OCCUPANT ATTRIBUTES

Occupants throughout the building will vary from alert and able bodied, to occupants who are asleep, affected by medication and or alcohol and people with disabilities.

The occupant group generally represents the broader population, i.e. all age groups, levels of mobility and disability are likely to be present. At times, a portion may be affected by alcohol, medication or other drugs that could inhibit their response time and actions/reactions in a fire emergency.

- ***Taronga Conservation Society Australia Staff and Security*** are expected to be mobile with normal hearing and visual abilities, and occupants in this group are considered to take and implement decisions independently, and require minimal assistance during evacuation in a fire emergency. This occupant group is expected to be awake and fully conscious at all times when inside the building; and
- ***Short-term Guests*** are unlikely to be familiar with the building's layout. Further knowledge of the egress provisions cannot be depended upon as they will most likely rely upon the exit and emergency evacuation signage available in the event of a fire emergency; and
- ***Visitors*** to the zoo's facilities are expected to be mobile with normal hearing and visual abilities, this occupant group are expected to be capable of making and implementing decisions independently however may require assistance in locating the nearest and safest egress path in an emergency; and
- ***External Maintenance Contractors*** are expected to be mobile with normal hearing and visual abilities and occupants in this group are considered to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. The contractors are expected to be awake and aware of their surroundings at all times when inside the building; and
- ***FRNSW*** are expected to be equipped with safety equipment and will be educated in fire fighting activities and the dangers associated with fire incidents. This occupant group would be expected to be in a position to assist other occupants requiring assistance to evacuate. It is not expected that this occupant group would be present in the building at the time of fire ignition; however, they are expected to enter the building at a later stage to assist with the evacuation of occupants, if required, and to undertake fire suppression activities.

4.4 OCCUPANT FAMILIARITY

- ***Taronga Conservation Society Australia Staff and Security*** can be expected to have a good familiarity with the building and the fire safety systems provided and may be trained in emergency procedures; and
- ***Visitors and Short-term Residents*** may or may not be familiar with the layout of the building and may require assistance in locating the exits; and
- ***External Maintenance Contractors*** are expected to have a reasonable familiarity with the building as they would have to undergo site specific induction prior to commencement of work on site; and
- ***FRNSW*** are not expected to have any familiarity of the building layout, however are assumed to obtain the required information from the site block plans and tactical fire plans available prior to entering the building. Notwithstanding this they will be equipped with breathing apparatus and specialist equipment to prevent them from being adversely affected by fire hazards.

4.5 EMERGENCY TRAINING

Occupants themselves are not expected to have any evacuation training or knowledge. TCSA staff, who are trained as fire wardens, shall ensure that all residential guests are promptly evacuated and should be familiar with escape procedures through fire drills under Workplace Health and Safety legislation (AS 3745:2010). Clear escape routes should be maintained with doors unlocked, and no obstructions or rubbish to hinder evacuation.

Visitors are not expected to have fire suppression training and such training is not relied upon for this building; however, are expected to possibly attempt to extinguish a fire or limit fire spread by removing objects in the vicinity of the fire in order to defend their belongings.

5 FIRE BRIGADE CHARACTERISTICS

5.1 OVERVIEW

The fire brigade characteristics are assessed within the Fire Engineering Report due to the fact that Fire Brigade characteristics can dictate the time required for fire brigade intervention including search and rescue and fire attack.

5.2 FIRE BRIGADE ACCESS

Taronga Zoo is located within the Fire and Rescue New South Wales (FRNSW) jurisdictional turnout area. The closest two fire stations to the site that are provided with permanent staff are located in Neutral Bay and Mosman, which are located approximately 3.5km and 2.0km away from Taronga Zoo and shown in Figures 5-1 and 5-2 below.

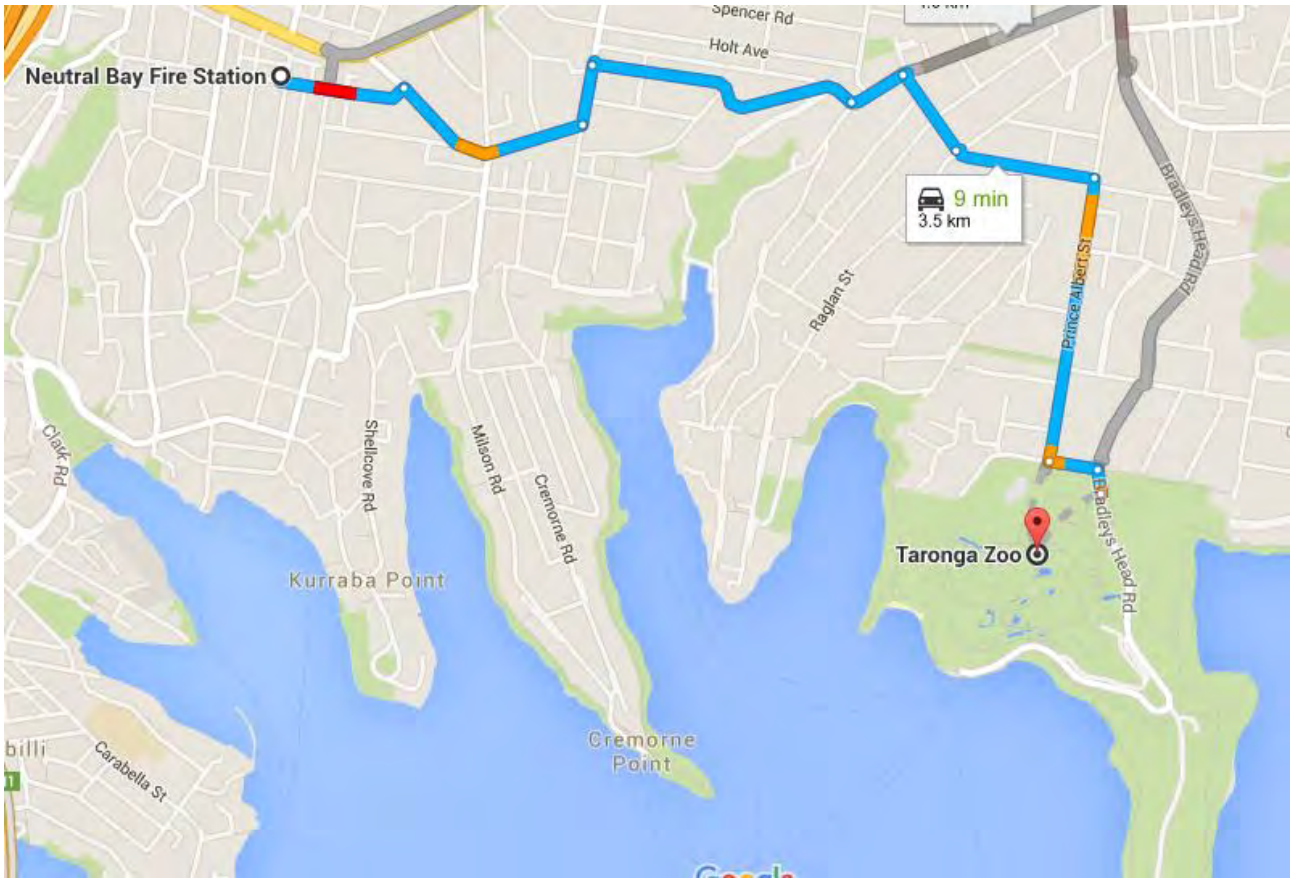


Figure 5-1: Neutral Bay Fire Station Location **Source: www.googlemaps.com.au**

On the basis of the site's major use being that of a zoological facility, it is anticipated that any fire, rescue or emergency medical related response to Taronga Zoo will be based on a predetermine plan, which FRNSW fire fighters from Mosman and Neutral Bay are considered to be reasonably familiar with.

Figure 5-2: Mosman Fire Station Location **Source: www.googlemaps.com.au**

5.3 FIRE FIGHTING EQUIPMENT

The fire fighting equipment that is to be provided to facilitate a FRNSW response at the site includes:-

- External and internal fire hydrants and booster connections;
- Sprinkler system booster connections;
- Monitored sprinkler system and fire alarm system;
- Fire indicator panel; and
- SSISEP panel that is provided with red manual call points.

6 FIRE HAZARDS AND PROTECTIVE MEASURES

6.4 OVERVIEW

The fire hazard analysis forms the basis for the review of non-compliances within the building. In assessing expected and statistically validated hazards, preventative and protective measures are developed commensurate with those expected risks. The following section reviews applicable hazards and recommends possible measures to address those risks. Furthermore, hazards identified can form a justified basis for selected scenarios.

6.5 FIRE STATISTICS

In order to assess the most likely fire hazards within the building, and subsequently the risk presented by these hazards it is necessary to develop an understanding of the factors that have an influence on the fire safety of building occupants. The best method in doing so is to review existing statistical data.

Existing data is an invaluable tool in providing an overview of the situations in which occupant deaths have, and are likely to occur, and factors that contribute to more severe fires. This aids in understanding, and helps evaluate the effectiveness of, and the need for various fire safety systems. Reference is made to the American database as it is significantly larger than Australian data sets, but is generally considered to be representative of the Australian situation.

Table 6-1: Fire Statistics in all Building Types [5]

STRUCTURE USE	FIRES PER YEAR	CIVILIAN FATALITIES PER YEAR	CIVILIAN FATALITIES PER 1000 FIRES
Hospitals	1,288	0	0
Schools	4,060	0	0
Public assembly	14,650	5	0.34
Retail/Department Store	1,150	1	0.87
Eating and Drinking Establishments	**7,480**	**3**	**0.40**
Business offices	2,890	3	1.04
Manufacturing	5,303	7	1.32
Vehicle Storage/Garage	6,200	10	1.61
24-hour nursing homes	2,749	5	1.82
Hotels or motels	**3,610**	**11**	**3.05**
Warehouse	1,270	4	3.15
Apartments	106,380	410	3.85
Homes	260,180	2165	8.32

From the NFPA 'Structure Fires by Occupancy 2007-2011' Report [5], The civilian fatality rates from 2007 to 2011 highlighted in Table 6-1 show that hotels and motels have a medium risk to life compared to other property types with 3.05 civilian deaths per 1000 fires on average. Fires in Eating and Drinking Establishments represent a lower risk to life compared to other property type, with 0.40 civilian deaths per 1000 fires. Hotel and motels fires indicates a much greater risk per fire than other non-residential occupancies; however, this is balanced by the relatively low number of fires that occur.

6.5.1 Hotel facility fire statistics

As can be seen in Table 6-1, hotel and motel buildings present a significant threat to life compared to other occupancy types. This is in large part because, unlike in many other buildings, people are regularly asleep and not able to immediately respond to fire threats.

Statistics taken from the NFPA report "U.S. Hotel and Motel Structure Fires" by Evarts [10] allow an analysis of the peak times that fires occur, death rates, the cause of fires and their area of origin and the extent of fire spread, based on data from 2006-2010.

During 2006-2010 an estimated annual average of 3,700 structure fires were reported at hotel and motel properties. These fires caused an average annual of 12 civilian fatalities and 143 civilian injuries.

Alarm time:

Figure 6-1 presents the percentage of fires by time of alarm. Fires in hotel and motel structures are more common during the evening hours between 18:00 and 21:00 due to the prevalence of confined cooking fires.

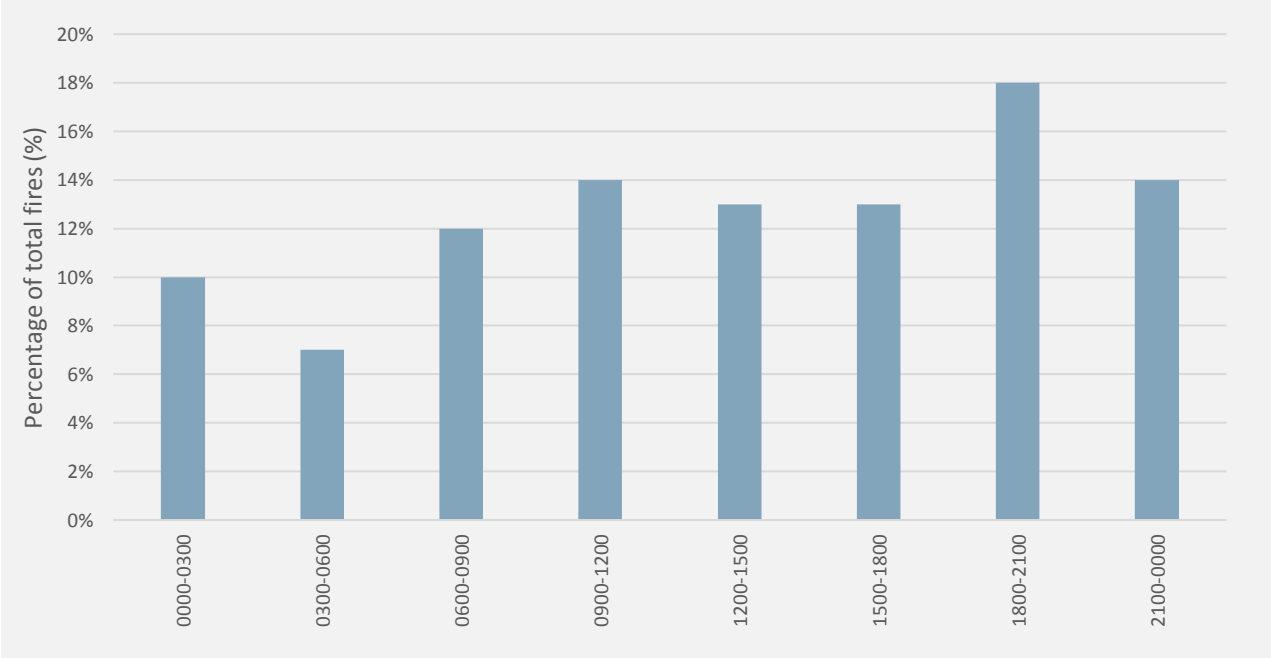


Figure 6-1: Fires by alarm time for hotels and motels [10]

Causes of fires:

Figure 6-2 presents the leading cause of fire in hotels and motels and illustrates that cooking equipment (45% of fires) is the most probable cause of fires in these properties as it leads to significantly more fires than other causes. Relatively few fires started by cooking equipment lead to fatalities, most likely due to their function; occupants are generally awake and reasonably alert to fire when cooking. Smoking materials (causing 10% of fires) lead to a disproportionately large number of deaths, most likely because of the very slow initial growth rate of fires started by cigarette butts. This allows the fire to grow for a significant amount of time before detection would occur, often when people are asleep, further delaying response to a fire incident.

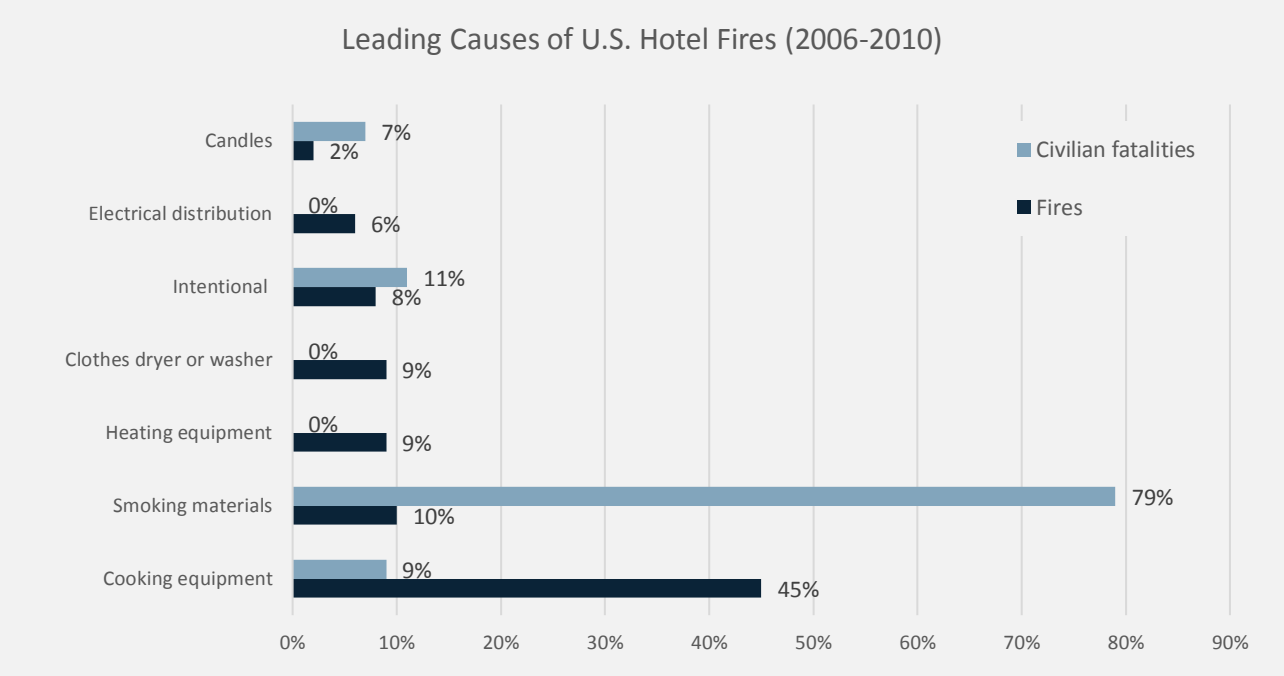


Figure 6-2: Leading causes of hotel and motel fires and their associated fatality rates [10]

Areas of fire origin:

Figure 6-3 presents the area of origin of fires in hotels and motels, and confirms the data concerning leading causes. The most probable area of origin for these properties is a kitchen or cooking area (36%). A significant number of fires begin in the kitchen, as would be expected with the rate of fires caused by cooking equipment; however, the high death rates from smoking materials can also be seen in the high death rates from fires originating in bedrooms (72%) since this is an area where hotel and motel occupants will spend significantly more time, and hence are more likely smoke in. Bedroom fires can also present a significant threat to life because an occupant will be asleep, and can be overcome by conditions without ever waking up.

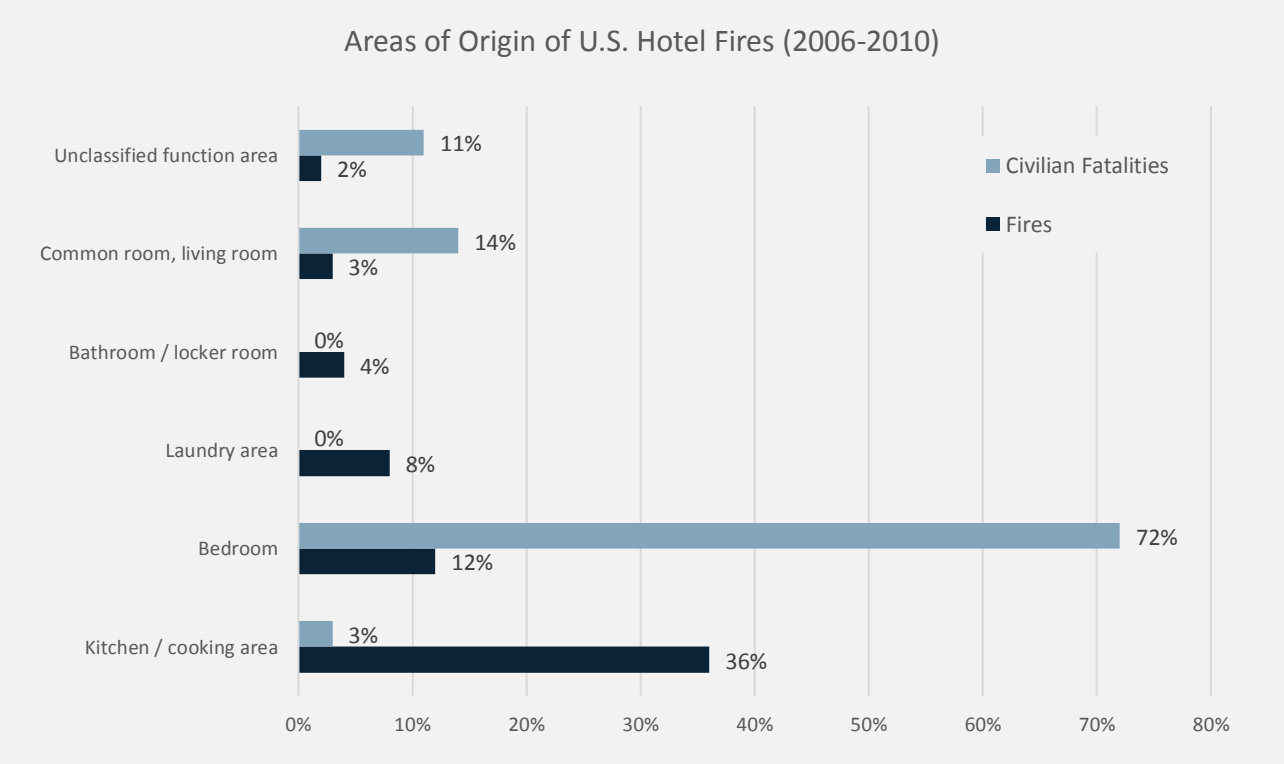


Figure 6-3: Areas of origin of hotel and motel fires and their associated fatality rates [10]

Extent of fire spread:

Figure 6-4 presents data on the extent of fire spread for hotels and motels. Nearly three-quarters (73%) of hotel and motel fires were confined to the object of origin, and 91% were confined to the room of origin.

It should be noted that the probability of whether a fire spreads beyond the room of origin is considered approximately equivalent to the occurrence of that fire reaching flashover [10]. This is based upon the reasonable assumption that if automatic or human/manual fire suppression was to occur to control fire growth, that this is likely to only be effective if it is carried out prior to a fire spreading beyond the room of origin - due to high risk to life safety in the room of origin and the fact that if a fire has spread from a room, it has most likely fully involved the room of origin.

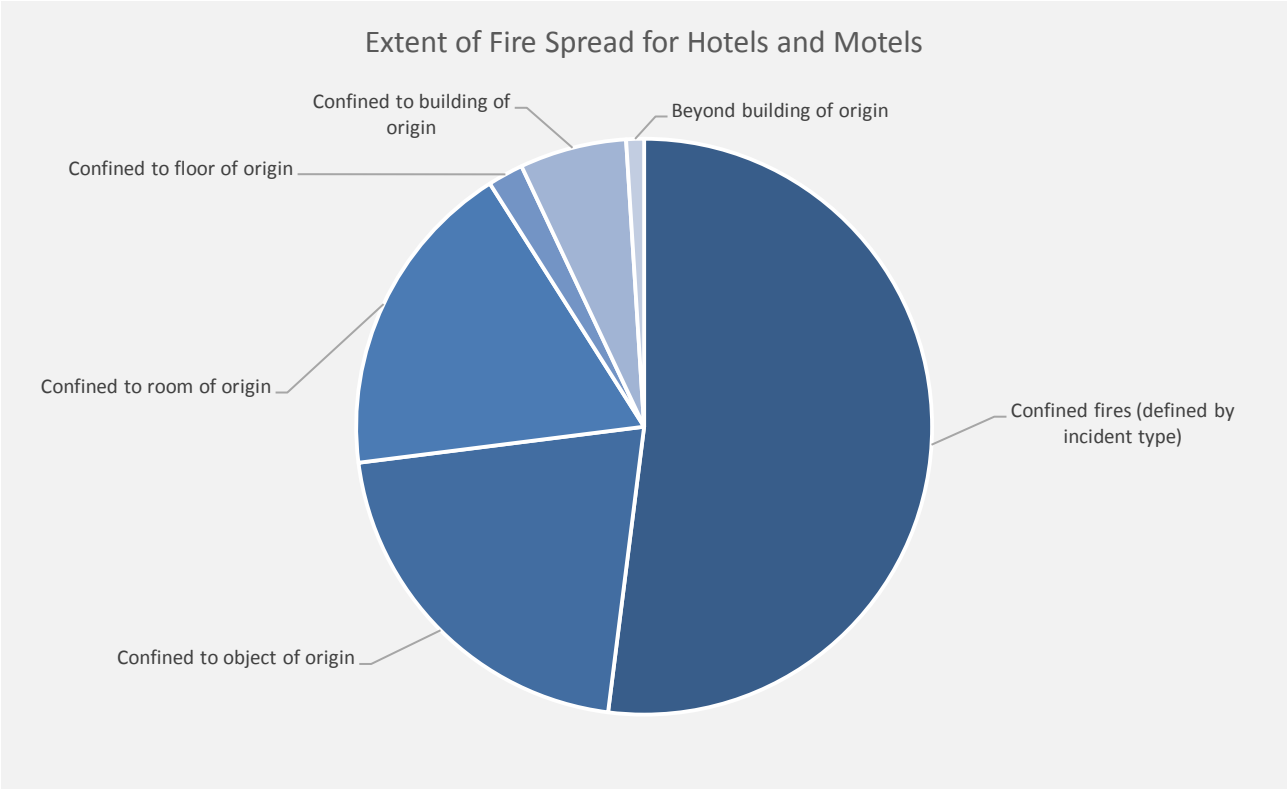


Figure 6-4: Extent of fire spread for hotels and motels [10]

6.5.2 Eating Establishment fire statistics

As shown in the Table 6-1, during 2007-2011 the estimated annual average of structure fires in eating and drinking establishments were reported to be 7,480. These fires caused average annual losses of 3 civilian fatalities.

Statistics taken from the NFPA report “Structure Fires in Eating and Drinking Establishments” by Evarts [12] allow an analysis of the peak times that fires occur, death rates, the cause of fires and their area of origin and the extent of fire spread, based on data from 2006-2010.

Fires by time of day:

Figure 6-5 presents the percentage of fires that occur at various intervals in a 24-hour period. The figure illustrates that fires are less common during the overnight hours between 00:00 and 06:00 but are relatively common throughout the day.

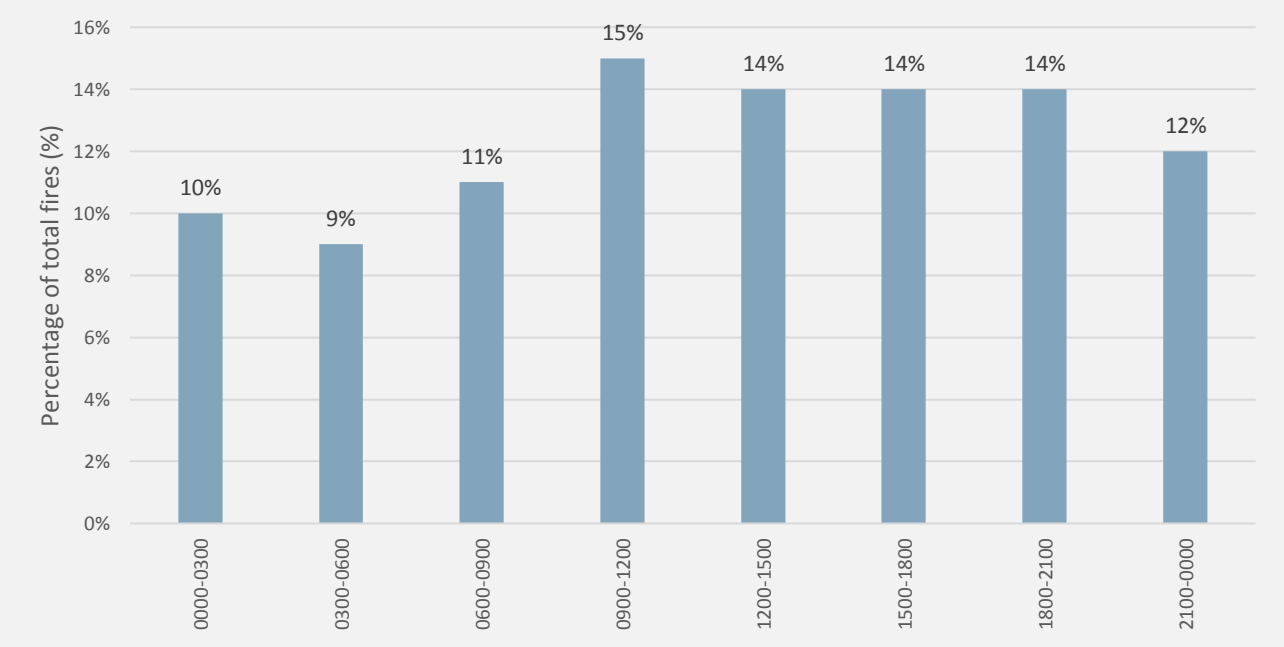


Figure 6-5: Fires by time of day for eating establishments [12]

Causes of fires:

As Figure 6-6 presents the leading cause of fires in eating and drinking establishments. The figure clearly illustrates that the most probable cause of fire is cooking equipment, accounting for 57% of fires. Heating equipment is the second most probable cause, accounting for 10% of fires.

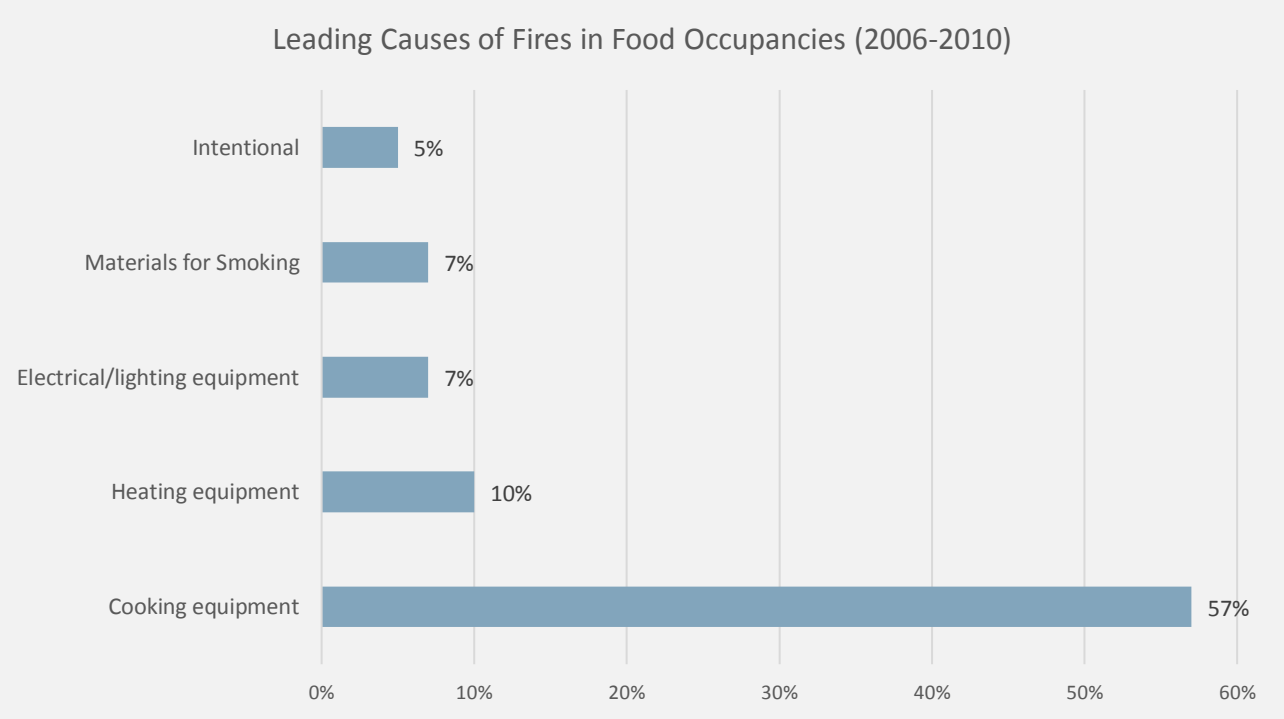


Figure 6-6: Leading causes of fires in eating establishments [12]

Areas of fire origin:

Figure 6-7 presents data on the area of origin of fires in eating and drinking establishments. The most probable area of origin is a kitchen or cooking area (56%). This is unsurprising given the prevalence of cooking fires in these properties.

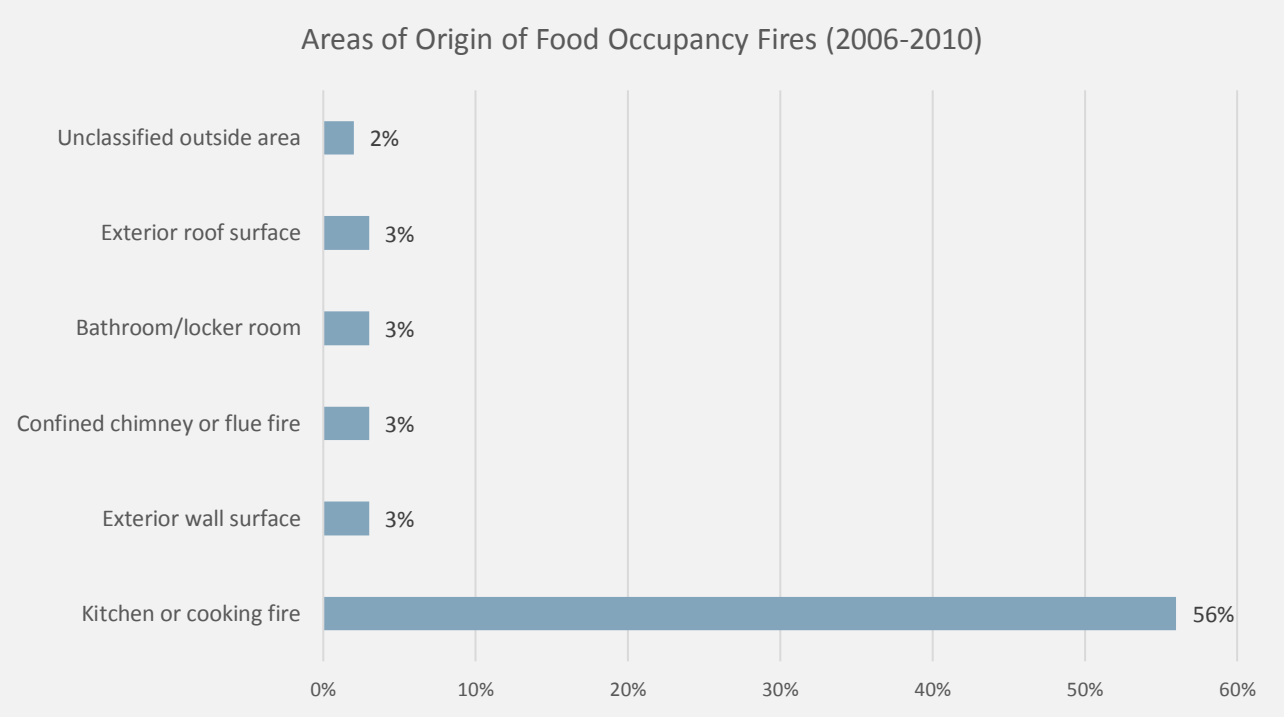


Figure 6-7: Leading areas of origin for fires in eating establishments [12]

Extent of fire spread:

Figure 6-8 presents data on the extent of fire spread for eating and drinking establishments. Seven out of ten (71%) of fires in these properties stay relatively small, and do not spread beyond the object of origin.

It should be noted that the probability of whether a fire spreads beyond the room of origin is considered approximately equivalent to the occurrence of that fire reaching flashover [11]. This is based upon the reasonable assumption that if automatic or human/manual fire suppression was to occur to control fire growth, that this is likely to only be effective if it is carried out prior to a fire spreading beyond the room of origin - due to high risk to life safety in the room of origin and the fact that if a fire has spread from a room, it has most likely fully involved the room of origin.

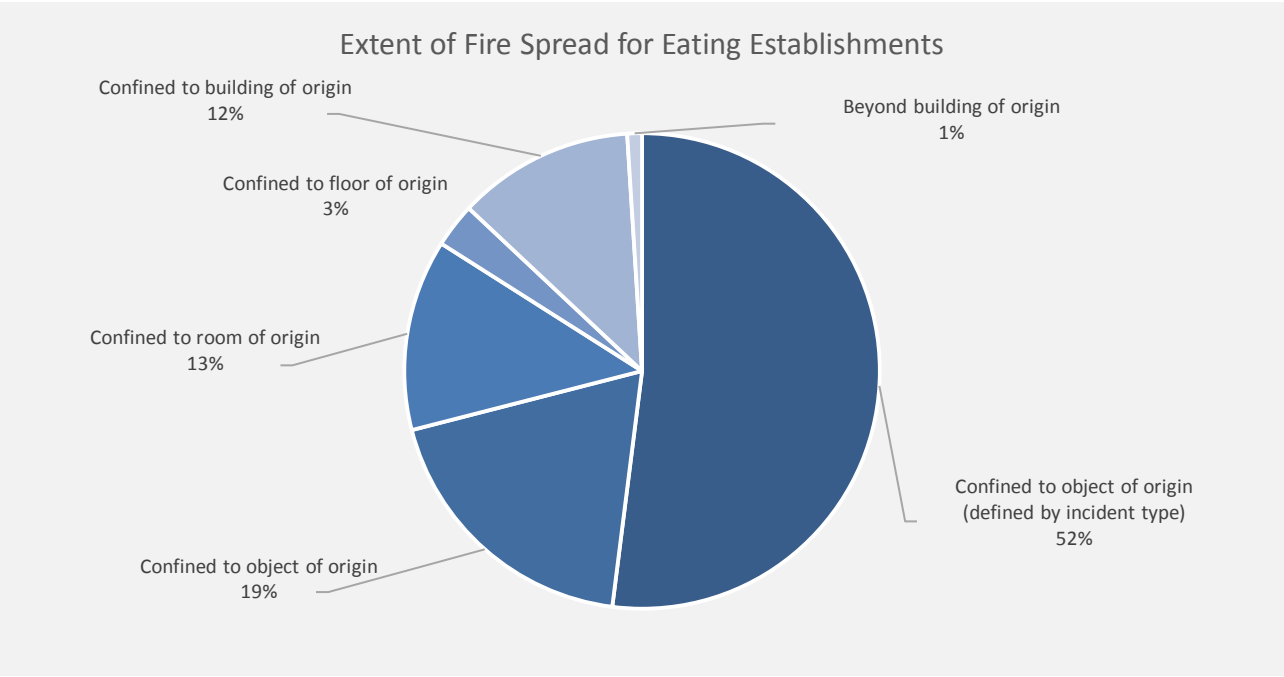


Figure 6-8: Extent of fire spread for eating establishments [12]

6.6 SPRINKLER EFFECTIVENESS & RELIABILITY

The effectiveness of automatic fire sprinklers in general in limiting fire spread and growth is supported by statistics and studies undertaken into the effects of automatic fire sprinklers within buildings. These studies show that fire sprinkler systems operate and control fires in 81% to 99.5% of fire occurrences [3]. The lower reliability estimates of 81.3% [7] as well as some of the higher values of 87.6% [8] appear to reflect significant bias in data in terms of the small number of fire incidents and the lack of differentiation between fire sprinklers and other fire suppression systems. A number of the lower figures are results of dated studies.

It must be noted that the higher reliability of fire sprinklers reported by Marryatt [9] of 99.5% reflect fire sprinkler systems where inspections, testing and maintenance exceeded normal expectations and applies to installations specifically in Australia and New Zealand. The statistical data indicate that sprinklers with appropriate maintenance are highly effective in reducing the loss of life and limiting fire spread.

FM Global Data Sheet 2-0 states, *"loss history over the past twenty years indicates approximately 25% of the time, the operation of a single sprinkler will control or suppress a fire if the sprinkler system has been properly designed and installed."* This percentage increases to approximately 50% of the time with the operation of 3 or fewer sprinklers, and 75% of the time with the operation of nine or fewer sprinklers.

In addition, analysis of the likelihood of sprinkler failure shows that most sprinkler system failures are due to impaired water supplies such as closed valves, blocked pipes, impaired sources, etc., which tend to affect sections of or the entire system [8]. As such, system reliability can be increased by active monitoring of water supplies and controls. The general consensus within the fire protection industry is that problems with individual sprinkler heads are rare. This information combined with sprinkler reliability data is favourable when compared with the reliability of fire compartmentation [3].

Moinuddin and Thomas [8] have found that masonry fire rated construction had a reliability of 81-95%, and gypsum 69-95%, with the upper level in both instances having been reported within the IFEG [3]. Both reported ranges are considered to be less than that offered by automatic sprinkler systems. Table 6-2 lists the effectiveness of sprinkler systems in the event of a fire growing to a size that facilitates sprinkler head activation [8].

Table 6-2: Effectiveness of Sprinkler systems

PROPERTY TYPE	EFFECTIVENESS OF SPRINKLERS IN EVENTS WHERE SPRINKLERS OPERATE
Public Assembly	90%
Educational	93%
Health care / Correctional Centre	95%
Residential (average)	**97%**
Office / Retail	91%
Manufacturing	93%
Storage	86%
Cold Storage	89%

6.7 FIRE LOAD

The fire load within a room or compartment will influence the duration and severity of a fire and resultant hazard to occupants. The effective fire load for the building has been estimated by consideration of the typical spaces within the building.

The following fire loads have been extracted from Chapter 3.4 of the International Fire Engineering Guidelines [3] and are listed in Table 6-3. This data is derived from Switzerland, however is also deemed applicable to buildings in Australia of similar use.

Table 6-3: Fire Load Densities

OCCUPANCY	MEAN	PERCENT FRACTILE		
		80	90	95
Hotel bedroom	310 MJ/m^2	400 MJ/m^2	460 MJ/m^2	510 MJ/m^2
Retail	600 MJ/m^2	900 MJ/m^2	1100 MJ/m^2	1300 MJ/m^2

6.8 FIRE GROWTH RATE AND INTENSITY

As the fire increases in size, the rate of fire growth accelerates. The growth rate of a fire can result in various hazards for occupants due to the following:

- Protective and preventative measures may not be adequate.
- Occupants may have insufficient time to evacuate.
- Occupants may perceive a reduced threat from slow growing fires.

The rate of fire growth is generally expressed in terms of an energy release rate. The most commonly used relationship is what is commonly referred to as a quadratic time-squared fire. The basis of the time squared fire arises from the fact that the growth during the flaming stage can be approximated by a smooth curve that can be expressed mathematically. The rate of heat release is given by the expression:

$$Q = (t/k)^2$$

Where: t = time from after ignition of the fire (seconds)

K = the growth time (seconds)

Q = a heat release output of 1.055 MW.

Studies of actual fires have led to the adoption of five (5) standard fire growth rates covering a wide range of potential fire scenarios and fuel loads. It should be noted, the times of fire incubation are not included in the time-squared growth fire models. National Fire Protection Association Standard NFPA 92B [8] provides information on the relevance of time-squared approximation to real fire as depicted in the figure below.

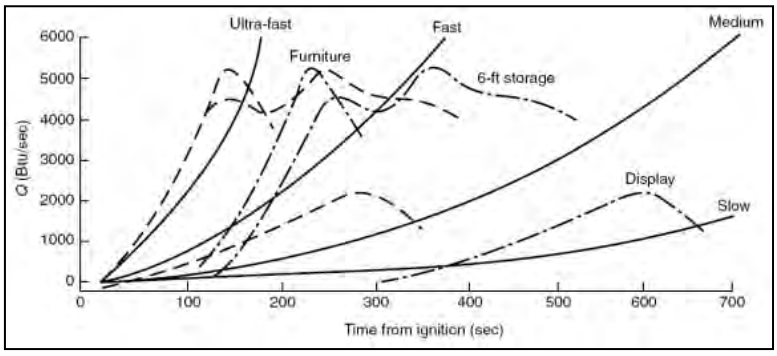


Figure 6-9: NFPA 92B: T-squared fire, rates of energy release

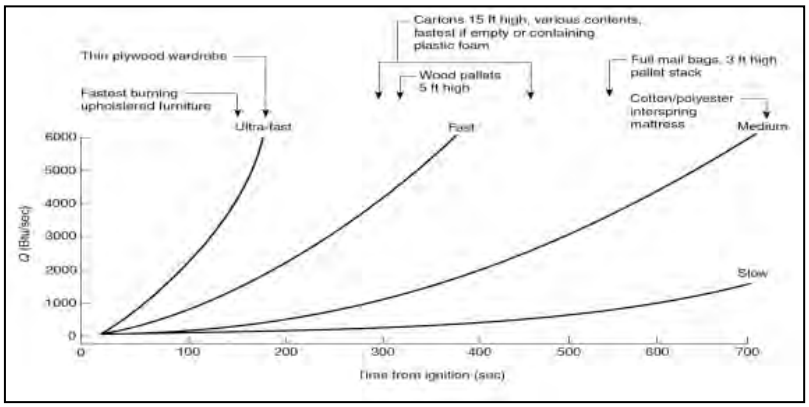


Figure 6-10: NFPA 92B: Relation of t-squared fires to some fire tests

The rate of fire growth can also be estimated from data published in British Standard (BS) 9999:2008 [4] as shown below in Table 6-4.

Table 6-4: Summary of Fire Growth Rates per Building Type

BUILDING AREA PROVIDING FUEL	GROWTH RATE	BUILDING AREA PROVIDING FUEL	GROWTH RATE
Shop	Fast	Hotel room	Medium

From the above tables it is concluded that the likely fire scenarios may be approximated by a medium standard time-squared fire growth rate curve.

6.9 FIRE HAZARDS

Subsequent to a review of the relevant fire statistics and hazards presented in Section 6.5, the fire hazards are specific to this building are summarised below.

6.9.1 General Layout

The building comprises of five accommodation pods, where pods are connected to each other and the existing parts of the building and proposed restaurant by an open passageway. Each pod is provided with an external stair, whereby access to a road and open space is provided at the topmost level due to the topography of the site.

6.9.2 Activities

It is not expected that regular hot work processes, use of highly flammable materials, manufacturing processes or operation of high friction or high temperature machinery will be performed within the building. However, there are restaurants and other kitchen areas within the building which will have cooking equipment and other ignition sources.

6.9.3 Ignition Sources

Based on the statistical review contained in Section 6.5 ignition sources relevant to this site, in order of occurrence:

Hotel:

- Cooking equipment (45%)
- Smoking materials (10%)
- Heating equipment (9%)
- Clothes dryer or washer (9%)
- Intentional (8%)
- Electrical distribution (6%)

Retail:

- Cooking equipment (19%)
- Electrical / lighting equipment (12%)
- Heating equipment (11%)
- Intentional (11%)
- Clothes dryer or washer (9%)
- Smoking materials (9%)
- Exposure to other fire (5%)

6.9.4 Fuel Sources

Quantity of Materials

- Hotel bedroom – Mean fuel load of 310MJ/m^2. 90% fractile fuel load 460MJ/m^2.
- Retail - Mean fuel load of 600MJ/m^2. 90% fractile fuel load 1100MJ/m^2.

Fire Behaviour

Fire growth rates will vary with fuel type and conditions of ventilation and compartmentation. The most likely outcome of any fire outbreak within the building is a sprinkler controlled fire. This would be expected to grow

at a medium time-squared fire growth rate until sprinkler activation in the hotel areas, at which point the sprinklers are expected to suppress or control the fire. A fast t^2 fire growth rate is expected in the retail areas.

6.9.5 Bush Fire

A bush fire hazard report has been prepared for the site (Australian Bushfire Assessment Consultants, Project #15006), as the new development is within a Bushfire zone. The impact below shows that BAL ratings are required to all of the accommodation pods, taken from the abovementioned bush fire hazard report.

Figure 6-11: Bush Fire Hazard Report Assessment of Accommodation Pods

The primary risk is a bush fire moving from the East to the West across the site. As a result of this report, increased fire safety in design is required for many of the accommodation pods to consider and address the BAL ratings. Please see the Consultant Advice Notice in APPENDIX B. The primary take-away from the Consultant Advice Notice is that the provisions of a CCTV system, with 24-hour staff monitoring, can be utilised as an early-warning system to alert staff, and therefore occupants, to the potential of a bushfire scenario. Further to this, emergency management planning specific to bush fires shall be incorporated into the management of the site.

6.10 PREVENTATIVE AND PROTECTIVE MEASURES

6.10.1 Fire Initiation and Development and Control (Sub-System A)

To minimise the risk of fires initiating and growing to a size which may impact on building occupants, fire safety systems are provided within the building as listed in the following sections.

6.10.2 Smoke Development and Spread and Control (Sub-System B)

It is recognised that smoke is one of the most serious threats to life safety in the event of a fire, in this instance, the passageways are open and smoke may dissipate to the atmosphere.

6.10.3 Fire Spread and Impact and Control (Sub-System C)

To limit the extent and impact of fire spread through the buildings, the following are implemented in the building.

- Type A construction throughout.
- Combination of lightweight and Cross Laminated Timber (CLT) construction to the accommodation pods, built in a compliant manner with BCA 2016 provisions.
- Sprinkler systems documented in Sub System D.
- The use of building materials, wall cladding, roofing and glazing systems that comply with the AS3959 construction requirements for BAL 29. Where BAL40 exposures exist, external sprinklers shall be provided to the exposed façade, specifically along any occupant walkways.

6.10.4Fire Detection, Warning and Suppression (Sub-System D)

The following active systems provided within the buildings to facilitate occupant warning and suppress a potential fire.

- Smoke detection and alarms within the residential accommodation units
- Sound System and Intercom Systems for Emergency Purposes.
- Sprinkler system
- Fire Hose Reels
- Fire Extinguishers

6.10.5Occupant Evacuation and Control (Sub-System E)

The building is provided with the following systems to assist in the evacuation of occupants:

- Emergency Lighting
- Exit Signage
- Sound System and Intercom Systems for Emergency Purposes.

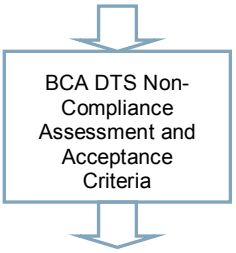
6.10.6Fire Services Intervention (Sub-System F)

The building is provided with the following systems to assist in fire brigade intervention:

- Fire Hydrants
- Fire hose reels
- Automatic fire sprinkler system
- Automatic link to Fire Brigade

7 BCA DTS NON-COMPLIANCE ASSESSMENT

7.1 OVERVIEW



In this instance the BCA DTS non-compliances have been formulated based on the regulatory review as provided by the principal certifying authority. Where not listed herein the building is required to achieve compliance with relevant DTS provisions or if existing, comply with relevant codes, reports and / or Standards approved at the time of consideration.

The following table lists the departures from the DTS provisions of the BCA for the proposed building and the analysis methodology proposed for the Fire Engineering assessment, which is to be generally in accordance with the IFEG [3].

7.2 BCA DTS NON-COMPLIANCE ASSESSMENT

Table 7-1: Summary of Alternative Solutions

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
BCA DTS Provisions Specification C1.1 ***Performance Requirement(s)*** CP1 and CP2	***BCA DTS Provision*** Clause C1.1 requires the Class 3 parts to be of Type A construction. Whereby Type A construction requires building elements to be constructed of non-combustible and concrete masonry construction. Specification C1.1 requires that the floors to the Class 3 parts to have an FRL of 90/90/90. ***DTS Non-conformance*** The Accommodation Pods (Class 3 parts) are proposed to comprise of a combination of lightweight and CLT construction in lieu of non-combustible and concrete masonry construction. This construction shall be in compliance with BCA 2016. As the pods are considered a united building, the provisions allowing for the reduction of FRLs to Class 2/3 buildings (Specification C1.1, Clause 3.10), cannot apply due to the total rise in stories of 7. However, Pods A/B/C, when considered in isolation, would have the concession applied to reduce the FRLs to 60 minutes. Further, the corridor adjacent the accommodation pods are to be constructed of non-combustible and concrete masonry construction, supported in two ways. The steel 'rib' elements vertically supporting the concrete walkways are proposed to be exposed, however further support for the walkways shall be via a cantilevered design under the walkways themselves, providing a structurally compliant level of support to the egress pathways during a fire load scenario. The prescriptive fire ratings of these corridors are to meet 60 minute FRL requirements, in lieu of 90 minutes. ***Alternative Solution*** The Alternative Solution will rely upon the provision of the sprinkler system in accordance with AS 2118.1-1999 throughout the building and the open and separate nature of the pods in determining that allowance to reduce FRLs to Pods A/B/C and the corridors adjacent to all 5 pods. ***Assessment Methodology*** The assessment methodology will adhere to Clauses A0.5(b)(i) and A0.9(b)(ii) of the BCA. The analysis will be absolute and utilise a combination of qualitative and quantitative methods, which will be measured directly against the agreed acceptance criteria.

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
BCA DTS Provisions Clause D1.3 ***Performance Requirement(s)*** DP5 and EP2.2	***BCA DTS Provision*** Clause D1.3 requires stairs that connect more than three (3) storeys in a sprinkler protected Class 3 building to be fire isolated. ***DTS Non-conformance*** The Southern Stair is not fire isolated and it connects up to 5 storeys. ***Alternative Solution*** The Alternative Solution will rely upon the use of relatively open egress routes to demonstrate that occupants will not be exposed to untenable conditions resulting from a fire occurring within an adjoining accommodation room (SOU). ***Assessment Methodology*** The assessment methodology will adhere to Clauses A0.5(b)(i) and A0.9(b)(ii) of the BCA. The analysis will be absolute and utilise a combination of qualitative and quantitative methods, which will be measured directly against the agreed acceptance criteria.
BCA DTS Provisions Clause D1.4: Distance to the nearest exit. Clause D1.5: Distance between alternative exits. ***Performance Requirement(s)*** DP4 and EP2.2	***BCA DTS Provision*** Clause D1.4 travel distance to a single exit must not exceed 6 metres from the SOU doorway; Clause D1.4 travel distance to a single exit must not exceed 20 metres from areas not within an SOU; and Clause D1.4 the distance between alternative exits must not exceed 45m. ***DTS Non-conformances*** The following areas exceed the maximum allowable travel distance:- Accommodation: ■ Level A – Travel distance from entrance doorway of SOU is up to 15m in lieu of 6m to a single exit ■ Levels B, C, D – Travel distance from entrance doorway of SOU is up to 14m in lieu of 6m to a single exit . Commercial: ■ Level D, E – Distance between alternative exits is up to 70m in lieu of 45m. ***Alternative Solution*** The Alternative Solution will rely upon the use of relatively open egress routes to demonstrate that occupants will not be exposed to untenable conditions resulting from a fire within an accommodation room (SOU). ***Assessment Methodology*** The assessment methodology will adhere to Clauses A0.5(b)(i) and A0.9(b)(ii) of the BCA. The analysis will be absolute and utilise a combination of qualitative and quantitative methods, which will be measured directly against the agreed acceptance criteria.

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
BCA DTS Provisions Clause D1.8 (c): Protection of openings – Taronga Centre ***Performance Requirement(s)*** CP2 and DP5	***BCA DTS Provision*** Clause D1.8 (c) requires openings within 6m of an external stair to be protected Clause C3.4 of the BCA. ***DTS Non-conformance*** Existing openings within the wall of the Taronga Centre are within 4m of the stair serving Level E – Level 2 in the Wildlife Retreat. ***Alternative Solution*** The acceptance of the above non-conformances is based on the following fire safety systems/measures provided. ■ The specification and use of construction materials and methods that are able to withstand radiation heat fluxes of 29 kW/m^2. This level of radiation heat flux is also consistent with the BAL rating requirements that the building is required to comply with for the purpose of complying with Part G5 of the BCA; ■ The window openings of the subject residential accommodation building will not cause heat flux in excess of 29 kW/m^2; and ■ The provision of on-site external fire hydrants that have both feed and attack performance and a sealed accessible footpath, which fire fighters can utilise to protect exposures between the proposed building (Wildlife Retreat) and the existing building (Taronga Centre). ***Assessment Methodology*** The assessment methodology follows Clauses A0.5(b)(i) and A0.9(b)(ii) of the BCA. The risk of fire spread to the stair, from the nearest adjoining residential accommodation unit (SOU) will be examined using a quantitative and qualitative approach to demonstrate that occupant and fire fighter tenability criteria are not breached.
BCA DTS Provisions Clause D2.4: Separation of rising and descending stairs ***Performance Requirement(s)*** DP4	***BCA DTS Provision*** Clause D2.4: If a stairway serving as an exit is required to be fire-isolated, there must be no direct connection between a flight rising from a storey below the lowest level of access to a road or open space and a flight descending from a storey above that level. ***DTS Non-conformance*** Access to a road and open space is achieved from level E, being the top most level. Being a significantly sloping site, the occupants will be required to travel in an upward direction in order to evacuate the building. ***Alternative Solution*** The acceptance of the above non-conformances is based on the following fire safety systems/measures provided. ■ Illuminated exit signage and additional evacuation information and signage within the stair at each level. ■ Open stairway. ***Assessment Methodology*** The assessment methodology follows Clauses A0.5(b)(i), A0.9(b)(ii) and A0.10 of the BCA. A qualitative assessment shall be conducted including discussions on the provided signage within the stair indicating the level of discharge, the occupant characteristics and level indicators on each level. In addition, the signage, the stairway will be open, allowing for smoke ventilation, therefore occupants will not travel in the direction of smoke.

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
BCA DTS Provisions Clause G5: Bushfire Prone Areas ***Performance Requirement(s)*** GP5.1	***BCA DTS Provision*** Clause G5.2: Buildings in a Bushfire prone area must comply with AS3959. ***DTS Non-conformance*** Areas of the site requiring BAL40 protection are not prescriptively provided with all the provisions required by BAL40, including operable sliding doors and cladding only achieving BAL29. ***Alternative Solution*** ■ For areas required to achieve a BAL40 rating, external sprinklers shall be provided to the external combustible timber façade, specifically along the external walkways. ■ The existing Taronga Centre's evacuation plan shall be modified to encompass the new restaurant facility that will adjoin it. Further to this, a 24-hour CCTV monitoring is recommended with a view to the national park, in order to assess and identify any potential bushfire scenarios approaching the development. ***Assessment Methodology*** The assessment methodology follows Clauses A0.5(b)(i), A0.9(b)(ii) and A0.10 of the BCA. A qualitative assessment shall be conducted including discussions of the bushfire risk, and the additional measures that have been provided to compensate.

8 PROPOSED FIRE SAFETY STRATEGY

8.1 OVERVIEW

The fire safety strategy outlined below has been proposed to satisfy the fire and life safety objectives specified for this project by the relevant stakeholders. In addition, the fire safety strategy is required to adequately address the specific fire and life safety hazards identified for the proposed development, and as such have been generally derived from the preventative and protective measures outlined within the BCA, and fire engineering literature and research. Where items of non-compliance have not been identified by the design team in the concept design it is considered that those items are expected to be deemed-to-satisfy solutions.

This Section provides guidance for the design and application of fire safety measures. It highlights specific design considerations for a range of fire safety measures that will undergo analysis as part of the Fire Engineering Report to ascertain whether the relevant Performance Requirements of the BCA are satisfied. Design guidance (general informative details and specific requirements) for a range of specific fire safety measures is provided. This list is not exhaustive and the use of other fire safety measures including new technologies will require additional review.

8.2 PASSIVE FIRE PROTECTION

8.2.1 Type of Construction Required

The building shall be built in accordance with the BCA DTS provisions for Type A fire-resisting construction. This includes the construction of the Class 3 accommodation pods, which are proposed to be constructed of a combination of lightweight and CLT materials in lieu of concrete masonry construction. This method of construction is to be compliant with BCA 2016 allowances for Fire-Protected Timber and Massive Timber in Specification A1.1.

Specification C1.1 dictates the level of Fire Resistance applied to building types, including Type A construction. Due to the connected walkway all 5 Pods and the Restaurant are considered a united building, hence the Rise in Storeys of 7. In this case, Class 3, Type A construction dictates 90 minutes FRL to most elements. However, Clause 3.10 of Specification C1.1 allows for a reduction of many of these FRLs to 60 minutes in lieu of 90, so long as certain criteria are met, including a maximum of 3 storeys. A performance solution shall be provided which details why Pod A/B/C meet the intent of the 3 storey requirement, despite being classed as 7 storeys per the united building, and therefore can utilise the 60 minute FRLs.

To this effect, the following Fire Resistance Levels per Pod are therefore planned as:

Table 8-1: Pod Fire Resistance

	Pod A	Pod B	Pod C	Pod D	Pod E
# Storeys	2	2	3	5	4
Can meet Spec C1.1, C3.10?	Yes	Yes	Yes	No	No
Floor/Loadbearing FRL (minutes)	60	60	60	90	90

For Pods A/B/C for Specification C1.1, Clause 3.10 to apply, please note the following prescriptive requirements from the BCA:

(v) any insulation installed in the cavity of a wall required to have an FRL is non-combustible; and

(vi) the building is fitted with an automatic smoke alarm system complying with Specification E2.2a.

Finally, the reduction of FRLs to Pods A/B/C is to be applied per the BCA:

For any floor and any loadbearing wall, may be reduced to 60, except any FRL criterion of 90 for an external wall must be maintained when tested from the outside;

The SOUs of Pods D and E are to meet the prescribed FRL requirements of the BCA.

The restaurant and Guest Lodge are to meet the prescribed FRL requirements of the BCA.

The corridors outside the accommodation pods shall comprise of compliant Type A construction, with the exception of FRL. The steel 'rib' elements vertically supporting the concrete walkways are proposed to be exposed, however further support for the walkways shall be via a cantilevered design under the walkways themselves, providing a structurally compliant level of support to the egress pathways during a fire load scenario. A performance solution shall be provided to allow these walkways to meet a prescribed FRL of 60 minutes in lieu of 90 minutes for all Pods, inclusive of Pods D and E.

The walkways between Pods, if structurally independent from the pods, may have no FRL per PCA advice.

The exit stairs are permitted to be considered external stairs and therefore not require a prescriptive FRL per PCA advice.

The specification and use of building materials, wall cladding, roofing and glazing systems must comply with AS3959 construction requirements for BAL29 and BAL40 exposures, unless detailed otherwise.

With specific regards to the BAL29 and BAL40 exposures:

- Innowood cladding or hardwood, compliant with BAL29 requirements, shall be applied to areas required to achieve a maximum of BAL29.
- For areas required to achieve a BAL40 rating, external sprinklers shall be provided to the external combustible timber façade, specifically along the external walkways.

8.2.2 Openings in Class 3 Accommodation Pods

For operable louvers/windows/ventilation, this is to be provided with BAL compliant stainless steel radiant heat mesh, fixed in place.

For openable doors, this is handled in two aspects as both a compliant issue and operational issue to be included as part of the check-in information for occupants. The primary SOU entry doors are on automatic door closing operation, which is compliant operation. The sliding glazed doors that provide an external opening from the SOU are manual operation only. The likelihood of occupants keeping the sliding doors open is low due to the 'enclosed' nature of a hotel room, and the lack of screen to prevent the ingress of insects, birds, or the like. It is therefore expected that the sliding doors shall normally be in the closed position, and predominantly open when the room is occupied with awake occupants, reducing the risk to occupants significantly.

8.3 EGRESS PROVISIONS

8.3.1 Evacuation Strategy – Residential Accommodation Buildings

The activation of any sprinkler heads and smoke detection in the residential accommodation buildings shall initiate the operation of the occupant warning system and therefore the evacuation of all residential accommodation buildings. TCSA staff, who are trained as fire wardens, shall ensure that all residential guests are promptly evacuated.

The facility's emergency management plan shall consider the specific needs of disabled occupants and that appropriate evacuation management measures are implemented to ensure that all occupants can be safely evacuated. These considerations shall be built into the overall emergency management plan for the site. Further to this, as part of the overall design strategy, the accessible rooms have been specifically located in the northern accommodation pods (A&B) to provide further separation from the eastern side of the site and relative adjacency to staffed areas of the site.

8.3.2 Evacuation Strategy – Restaurant Building

The activation of any sprinkler heads and smoke detection within the restaurant building shall initiate the operation of the occupant warning system and therefore the evacuation of all guests and staff within this area. Restaurant staff, who have undertaken emergency evacuation training, shall ensure that commercial kitchen and dining areas of the restaurant have been evacuated.

8.3.3 Door Hardware, Operation and Mechanisms

All exit doors and doors in a path of travel to an exit are required to be DTS compliant throughout the building. This includes the swing of doors, the applied latching and locking mechanisms and the force required on mechanism used to open sliding doors.

8.3.4 Signage and Lighting

Emergency lighting is to be provided throughout the building in accordance with DTS Provisions E4.2 and E4.4 of the BCA 2016 and AS2293.1:2005.

Exit signage is to be provided throughout the building in accordance with the DTS Provisions E4.5, E4.6, E4.8 of the BCA 2016 and AS2293.1:2005.

Additional informative signage and level indicators shall be provided at each level in a visually prominent position from within the stair and on route to the stair.
The signage shall state:

- "**EXIT AT LEVEL E**" on Levels A, B, C and D;
- "**EXIT AT THIS LEVEL**" on Level E.

The text shall be in capitals, no less than 20mm high and in a colour contrasting to the background.

Level indicators shall be provided at each level, the text shall be no less than 50mm high, in a colour contrasting to the background.

8.4 ACTIVE FIRE PROTECTION SYSTEMS

8.4.1 Smoke Detection System

An Automatic Smoke Detection and Alarm System shall be provided throughout the building in accordance with BCA Specification E2.2a and AS 1670.1:2015.

8.4.2 Fire Sprinkler System

Sprinkler protection shall be provided throughout the building in accordance with AS 2118.1:1999. The building occupant warning system shall be activated on fire detection in accordance with Specification E1.5 of the BCA. Sprinklers shall be included along occupant egress pathways and specifically applied to apply water to external facades along these walkways that must achieve a BAL40 bushfire rating.

8.4.3 Sound System and Intercom System for Emergency Purposes (SSISEP)

A Sound System and Intercom System for Emergency Purposes (SSISEP) shall be provided throughout all parts of the building, including the accommodation pods. The system shall be in accordance with the prescriptive requirements of Specification E4.9 of the BCA 2016. The specific use of the system shall allow communication by fire wardens to residents to alert them to unique fire scenarios such as bush fires, as well as directing occupants away from dangerous areas and to areas of safe refuge. The system shall achieve a minimum 75dB at the bedhead in each residential SOU.

8.5 FIRST AID FIRE FIGHTING

8.5.1 Fire Hose Reels

Fire hose reel shall be provided in accordance with Clause E1.4 of the BCA and AS2441:2005.

Locations should be signposted and readily accessible to occupants. Use of facilities should be monitored for abuse, mistreatment and servicing. The fire hose reels shall be located within 4m of an exit and provide coverage to all areas of the building based on a 36m hose length with a 4m water stream (i.e. maximum 40m coverage from the hose location).

8.5.2 Portable Fire Fighting Equipment

Portable fire extinguishers are to be provided throughout in accordance with Table E1.6 of the BCA and selected, located, and distributed in accordance with AS2444:2001.

8.6 FIRE BRIGADE INTERVENTION

8.6.1 Fire Indicator Panels

The residential accommodation buildings shall be served by a Sub-Fire Indicator Panel (FIP) that is interfaced to operate with the Taronga Zoo's main fire indicator panel. The specific location of the Sub-FIP shall be determined in consultation with NSWFR.

The Sub-FIP must be installed in accordance with BCA Specification E2.2a and AS1670.1:2015 and have the following capabilities.

- The Sub-FIP panel must be capable of isolating, resetting, and determining the fire location within the residential accommodation buildings.

- A red strobe shall be installed at the highest level of approach to every residential accommodation building to provide a visual indication of the origin of alarm (sprinkler activation).

The sprinkler system serving the Class 6 restaurant shall be interfaced to the Sub-FIP or main FIP that serves the Taronga Centre building.

8.6.2 Fire Hydrants

The fire hydrant system shall be provided in accordance with BCA Clause E1.3 and AS2419.1:2005. Compliant coverage is to be provided to all areas of new works, including all external facades that may be exposed to radiant heat or ember attack during a bush fire.

8.7 BUILDING MANAGEMENT PROCEDURES

The ongoing management of the building is as important in maintaining a high level of life safety as the provisions recommended during the design phase of the building.

8.7.1 Maintenance of Fire Safety Equipment

The fire detection systems, fire sprinkler systems, emergency warning systems, fire hydrants, hose reels, portable fire extinguishers, emergency lighting and any other fire safety equipment shall be tested and maintained in accordance with Australian Standard AS1851 or other relevant testing regulatory.

8.7.2 Evacuation Plan

A specific evacuation plan should be developed for the site in accordance with AS3745:2010 that takes into consideration fire risks associated with a fire originating within the residential accommodation units. The emergency management plan shall consider the specific needs of disabled occupants and that appropriate evacuation management measures are implemented to ensure that all occupants can be safely evacuated.

The existing Taronga Centre's evacuation plan shall be modified to encompass the new restaurant facility that will adjoin it. Further to this, a 24-hour CCTV monitoring is recommended with a view to the national park, in order to assess and identify any potential bushfire scenarios approaching the development. Please see APPENDIX B for further discussion on such a system.

The provision of fire orders that are consistent with the requirements of Clause G4.9 of the BCA are to be displayed next to entry door to every residential accommodation unit.

9 REFERENCES

1. ABCB, “Building Code of Australia, Volume One”, CanPrint Communications, Canberra 2016.
2. ABCB, “Guide to the BCA 2016”, CanPrint Communications, Canberra 2016.
3. ABCB, “International Fire Engineering Guidelines”, ABCB, Canberra, 2005.
4. BS 9999: Code of practice for fire safety in the design, management and use of buildings, October 2008.
5. Campbell, R., “Structure Fires in U.S. Warehouses”, National Fire Protection Association, Quincy MA, June 2013.
6. “Fire Brigade Intervention Model V2.2”, Australasian Fire Authorities Council, October 2004.
7. McGrattan, Kevin. “Sprinkler, Smoke & Heat Vent, Draft Curtain Interaction – Large Scale Experiments and Model Development” NISTIR 6196-1, National Institute of Standards and Technology, United States Department of Commerce, Gaithersburg Maryland, September 1998.
8. Technical Standard, “NFPA 92B: Standard for Smoke Management Systems in Malls, Atria and Large Spaces”, National Fire Protection Association (NFPA), 2009.
9. Marryatt, H.W., “Fire: A Century of Automatic Sprinkler Protection in Australia and New Zealand 1886-1986”, Australian Fire Protection Association, Melbourne, Australia, 1988.
10. Evarts. B., “U.S. Hotel and Motel Structure Fires”, National Fire Protection Association, Quincy MA, July 2012
11. England, J., “Guide for the design of fire resistance barriers and structures”, Building Control Commission, Australia, 2000.
12. Evarts, B., “Structure Fires in Eating and Drinking Establishments”, National Fire Protection Association, Quincy MA, November 2012.

APPENDIX A FRNSW FEEDBACK AND UPDATES

The following table has been prepared to address the issues raised by Fire & Rescue NSW (FRNSW) through their letter dated 10 May 2016, reference BFS16/661 (10237). The advice listed herein itemises the recommendations raised in the above mentioned document and provides additional information and confirmation of design with regards to the FRNSW feedback.

#	FRNSW COMMENT	CORE COMMENT
1	That the external combustible timber facades of the accommodation buildings are adequately protected for a sufficient period of time (e.g. by wall wetting sprinklers) to afford first responders with an opportunity to save fire impacted property immediately after a bushfire front passes (i.e. implement a fall back offensive strategy).	The following has been added to Section 8.2 of this FSS. *With specific regards to the BAL29 and BAL40 exposures:* ■ *Innowood cladding, compliant with BAL29 certification requirements, shall be applied to areas required to achieve a maximum of BAL29.* ■ *For areas required to achieve a BAL40 rating, external sprinklers shall be provided to the external timber façade*.
2	That openings used to achieve natural cross ventilation in the accommodation buildings are reconfigured to close automatically during a bush fire incident and that they are suitably protected (e.g. by wall wetting sprinklers) to minimise the likelihood of fire spread into the sole occupant units.	The following has been added to Section 8.2.2 of this FSS. *For operable louvers/windows, these are to be provided with BAL compliant stainless steel radiant heat mesh, fixed in place.* *For operable doors, this is an operational issue to be included as part of the check-in information for occupants. The likelihood of occupants keeping a door open is low due to the 'enclosed' nature of a hotel room, and the lack of screen to prevent the ingress of insects, birds, or the like. It is therefore expected that the sliding doors shall normally be in the closed position, and predominantly open when the room is occupied.*
3	That the fire hydrant system is designed to include appropriately located above ground external attack fire hydrants to ensure that hose lay coverage can be achieved (i.e. in accordance with the requirements of Australia Standard [AS] 2419.1 – 20050 to all external facades that may be exposed to radiant heat and ember attack during a bush fire.	The fire hydrant system throughout shall provide for AS2419.1 compliance, including reaching all external façade areas as requested by FRNSW.
4	That appropriate pedestrian pathways are installed from the site's roadways to the fire hydrants detailed in point 3 above and that all pathways to fire hydrants are interconnected to facilitate unhindered first responder access to all hydrants as necessary during a bushfire incident.	The provision of direct access via the site roadway isn't possible in this instance due to a heritage-listed fence along the site boundary at the road, as well as zoo animal management and security requirements. Access to the site is via the existing primary pedestrian pathway. This is consistent with the existing agreement between Taronga Zoo and the local fire brigade for intervention purposes.
5	That the facility's emergency plan considers the specific needs of disabled occupants and that appropriate evacuation management measures are implemented to ensure that all occupants can be safely evacuated.	Section 8.3.1 of this FSS has been updated to include the FRNSW comment as well as the following: *These considerations shall be built into the overall emergency management plan for the site. Further to this, as part of the overall design strategy, the accessible rooms have been specifically located in the northern accommodation pods (A&B) to provide ground emergency level access and provide further separation from the eastern side of the site.*

APPENDIX B CORE BUSHFIRE CONSULTANTS ADVICE

Core Engineering Group • Fire • Risk • Emergency Management

CONSULTANTS ADVICE

Project:	Taronga Zoo Eco Retreat Accommodation	**Ref No.:**	S141588
From:	Sandro Razzi	**Date:**	30th September 2015
		Issue:	Rev A

	Attention	**Company**	**Email/Fax**
To:	Paul McDonald	Compass Project Management	paul.mcdonald@compassprojects.net

RE: Bushfire Assessment – Egress Management Proposal

INTRODUCTION

This Consultant Advice has been prepared to provide comment on the proposed egress arrangement as a result of the issues identified by the Rural Fire Service (RFS) post review of the current bushfire report prepared by Australian Bushfire Assessment Consultants (ABAC) Draft_3 dated June 2015, the following items of concern have been reported:

a. The exposure of entry doors and walkways along the eastern elevation of the accommodation building nearest to Bradleys Head Road (BH Rd). Their concern is radiant heat exposure to people evacuating the units in the event of a bushfire in vegetation to the eastern side of BH Rd.

b. The option to relocate entry/egress from, in particular, the easternmost building, to the western side of that building as a means to mitigate issues associated with (a).

c. The safety of people evacuating from the accommodation facility in the event of a bushfire and the potential for conflict between these people wanting to reach the refuge vs people evacuating the zoo overall.

OBJECTIVES

The objective of this Consultant Advice Notice is to provide input into the concerns raised and make recommendations of how they can be addressed.

In relation to:

- a) RFSs view is that some form of radiant heat shielding should be in place along the eastern side of the building. An option for sprinklers/sprayers to be applied to the walkway areas was also flagged.
- b) This has been deemed not possible due to the western side of the buildings would be occupied by animal exhibits.
- c) Evacuation procedures for the TWR would need to be established to alleviate any conflict.

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ASSESSMENT

The bushfire assessment undertaken by ABAC has been summarised below:

The extent to which the development is to provide for setbacks including Asset Protection Zones

The proposed development incorporates the construction of the Taronga Wildlife Retreat, an eco-tourist facility within the confines of the Taronga Zoo site. The site is located within the Mosman local government area. According to Table A2.3 of Planning for Bush Fire Protection 2006, the site is located in the Greater Sydney fire weather area and is subject to a fire danger index rating of 100.

The classification of vegetation and assessment of effective slope have been based on the following assumptions:

- *The predominant vegetation classification(s) within a distance of 140 metres of the subject sites is classified as open forest.*
- *The effective slope of land under vegetation is:*
  - *>15-18° downslope (Transect 2)*
  - *> 5-10° downslope (Transect 3).*

According to Table A2.6 of Planning for Bush Fire Protection 2006, the Asset Protection Zones (APZs) that are required for the accommodation buildings for the TWR are:

- *North-east (transect 2) 100 metres; and*
- *East/south-east (transect 3) 85 metres.*

The location of the TWR in relation to the eastern boundary of the Zoo site and the vegetation hazard to the east of Bradleys Head Road is such that APZs cannot be contained within the eastern boundary of the Zoo site.

As the TWR is proposed as an eco-tourism development, the key issue then becomes the provision of a suitable refuge building that will be subject to a radiant heat flux of not greater than 10kW/m2 on any part of the building.

In the event of a bushfire in vegetation to the east of the TWR, within that part of Sydney Harbour National Park between the eastern side of Bradleys Head Road and Taylors Bay, guests of the eco-tourist facility will be evacuated into the Zoo site to an emergency refuge building (and not towards Bradleys Head Road). The emergency refuge building(s) identified for guests of the TWR is the Lecture Theatre building or the Centenary Theatre (in construction and scheduled for completion in late 2016, prior to construction and occupation of the TWR project). The emergency refuge building(s) is located well in excess of 100 metres from any vegetation/hazard to the east of the TWR and will not experience a radiant heat level greater than 10kW/m2 on any part of the building.

The report also makes the following observations:

The Adequacy of bushfire maintenance plans and fire emergency procedures for the development site.

Given the location of the TWR accommodation buildings in relatively close proximity to vegetation to the east of the site, evacuation procedures will be a critical component of the overall bushfire protection package for the site.

The Taronga Zoo site is subject to a range of emergency procedures. These procedures will be amended to incorporate the TWR project. RFS Factsheet 1/14 'Ecotourism' provides that emergency management planning shall be provided which complies with Section 4.2.7 of PBP and shall address use/closure of the facility on extreme and catastrophic fire rating days. The closure of the site is not

practical in relation to the Taronga Zoo site. The site is highly managed, subject to 24 hour security presence and provides a range of areas and buildings within the Zoo site that could potentially be utilised as alternative refuge points for guests of the TWR in the event that the designated emergency refuge building was unsuitable for whatever

DISCUSSION

As can be seen from the following images, the issue relates to a bushfire in vegetation to the east of the TWR within that part of Sydney Harbour National Park between the eastern side of Bradleys Head Road and Taylors Bay (see figure 2), guests of the eco-tourist facility will be evacuated into the Zoo site to an emergency refuge building (and not towards Bradleys Head Road). In terms of the likely BALs for the TWR accommodation buildings, it was noted in Section 7 of the ABAC report that the determination of BAL for the:

- Northern and easternmost accommodation buildings will be based on the maximum slope measured for Transect 2; and
- the BAL for the southernmost accommodation buildings will be based on the maximum slope measured for Transect 3.

For the purposes of identifying the BALs for the respective accommodation buildings, the buildings have been numbered as follows along with the highest assessed BAL for the respective buildings.

Building	BAL
A: North-western building	29
B: Central northern building	40
C: Eastern building	40
D: South-eastern building	29
E: South-western building	19

Table 1: Buildings and corresponding BAL ratings

The emergency refuge building(s) for guests of the TWR is the Lecture Theatre building or the Centenary Theatre (see figure 3). The emergency refuge building(s) are located well in excess of 100 metres from any vegetation/hazard to the east of the TWR. The refuge building is not expected to experience a radiant heat flux level greater than 10kW/m2 on any part of the building according to the ABAC report.

Therefore based on the above the priority will be for occupants to evacuate safely prior to the onset of untenable conditions. The BAL levels and proposed construction methodology does not warrant occupants remaining in place; as such an earlier means of warning should be provided to afford potentially sleeping occupants as much time as necessary to reach the refuge area or similar in the event of a bushfire. Given the lack of fire detection that is appropriate for bushfire type incidents, in this instance Taronga Zoo has the benefit of having 24hour on site security and management that deal will various types of emergencies. A bushfire potentially affecting the TWR would be an extension to the already comprehensive emergency procedures that exist. In order for any potential situation to be detected as early possible it would be feasible to recommend some form of CCTV Cameras that are positioned at the high point of the function centre that would overlook the National Park and alert staff of a potential bushfire threat. This earlier notification coupled with an updated comprehensive emergency management plan will far exceed the benefit of upgrading the

Taronga Wildlife Retreat – Egress CAN_01_Rev A 30/9/2015

construction methodology or installing external suppression systems which may assist in protecting the buildings but will certainly have less effect than a system that alerts occupants to a fire threat before the onset of untenable conditions.

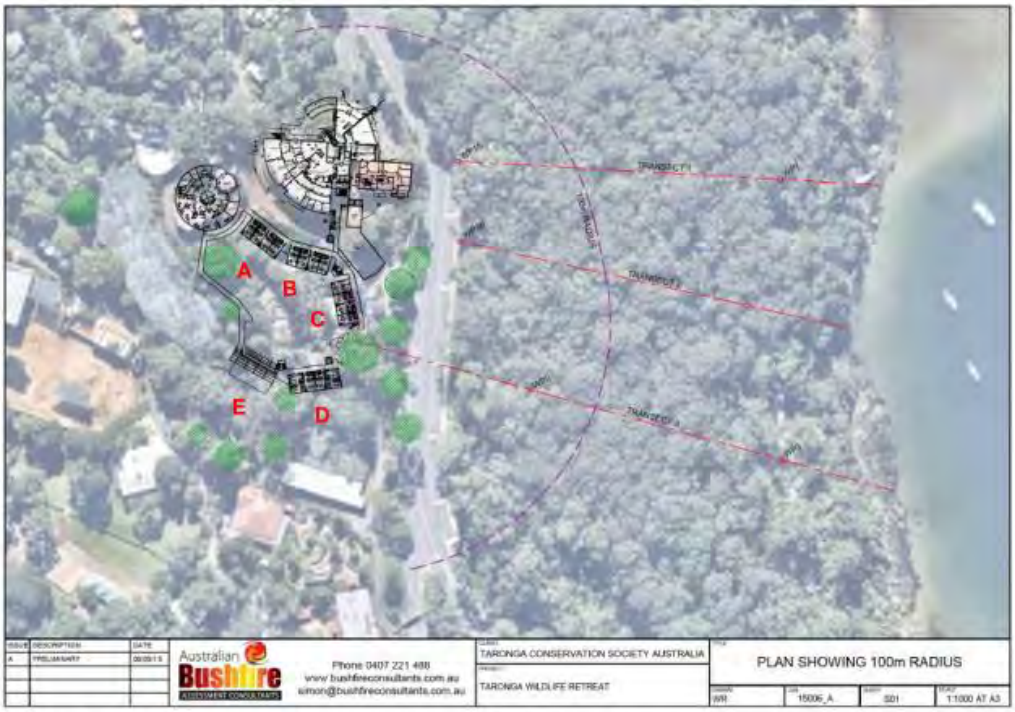

Figure 2: Aerial photos with Function Centre and TWR overlay

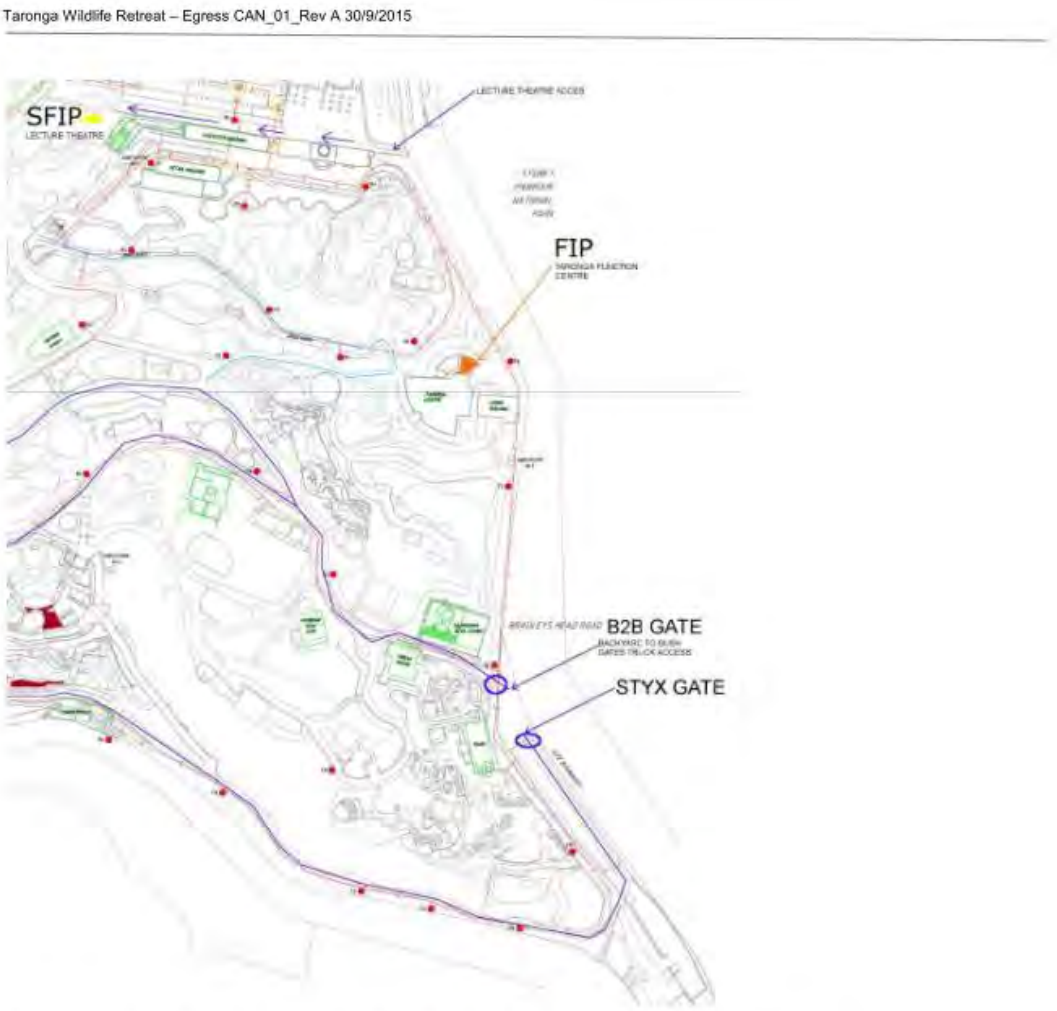

Figure 3: extract from Taronga Zoo Fire Panels, Routes and Hazards drawing

Going forward we recommend that the next steps will be to gain RFS and Taronga Zoo management support for the proposal and engage with the required stakeholders in drafting the necessary scope of work required to achieve the requirements noted herein.

For and on behalf of CORE Engineering Group Pty Ltd

Sandro Razzi
Managing Director
CORE Engineering Group