innova services
Fire Safety Engineering
Building Services Engineering

Fire Engineering Report

North Eveleigh Affordable Housing
Wilson Street, Eveleigh

Prepared For:
City West Housing Pty Ltd

Project No. 13017-R01
Issue No. 3
Issue Date: 27 May 2014

QUALITY SYSTEM

Report Register

The following report register documents the development and issue of this Report as undertaken by this office.

Reference	Issue No.	Remarks	Date	Prepared By	Checked By
13017-R01	1	Issued for referral to Fire & Rescue NSW	31-10-2013	JDP	JDP
13017-R01	2	Alternative Solution 3 Added	04-04-2014	JDP	JDP
13017-R01	3	Amended following Comments from PCA	27-05-2014	JDP	JDP

Report Authorisation

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1.0 EXECUTIVE SUMMARY

Introduction

This Fire Engineering Report has been prepared by Innova Services Pty Ltd for City West Housing Pty Ltd, and relates to a proposed residential affordable housing development located at Wilson Street Eveleigh.

Innova Services Pty Ltd has been commissioned to conduct a Fire Engineering Analysis of proposed Alternative Solutions to the Deemed to Satisfy (DTS) provisions of the Building Code of Australia 2013 (BCA) relating to the subject development.

The subject development comprises the construction of a new residential building, comprising:

- Basement Level - car parking, plant and ancillary use areas
- Ground Floor - residential lobby, residential units, plant and ancillary use areas
- Levels 1 to 6 - residential units

Alternative Solutions

The design variations to the DTS provisions of the BCA and the related BCA Performance Requirements have been identified by the BCA Consultant, Group DLA, in their Building Code of Australia 2012 assessment report.

Table 1 below summarises the Variations to the BCA DTS Provisions, the relevant BCA Performance Requirements, the Assessment Methods, and the Methods of Analysis and Acceptance Criteria that has been used in the Fire Engineering Analysis.

Conclusions and Recommendations for Implementation

Based on the Fire Engineering Analysis presented in this report, it is the opinion of Innova Services Pty Ltd that the proposed Alternative Solutions to the BCA DTS provisions will comply with BCA Performance Requirements DP4, EP1.1 and EP2.2, subject to the implementation of the Fire Safety Requirements nominated in Section 2 (***Summary of Fire Safety Requirements***) of this report.

Table 1: Summary of Alternative Solutions

Alt Sol	BCA DTS Provisions	Variations to BCA DTS Provisions	Summary of Fire Safety Strategy	BCA Performance Requirements	BCA Compliance and Assessment Method
1	**Clause D1.4** Exit travel distances	To have an exit travel distance from a residential unit to a point of choice from which travel in different directions to 2 exits is available on residential levels 1 to 5 of up to 11m, in lieu of 6m. To have an exit travel distance from a residential unit to a single exit on level 6 of up to 9m, in lieu of 6m.	The fire safety strategy is based on: ▪ The provision of an AS 1670.1-2004 automatic smoke detection and alarm system throughout the internal public corridors of the building. ▪ The provision of an additional heat detector within each residential unit located immediately adjacent the unit entry door (i.e. within 1.5m), and connected back to the AS 1670.1 smoke detection system. ▪ The provision of high temperature smoke seals to all fire rated unit entry doors. ▪ The provision of illuminated exit signs in lieu light reflecting signs. ▪ The characteristics and use of the public corridors.	**DP4, EP2.2**	**A0.5(b)(ii),** and **A0.9(c)** Comparative Assessment Qualitative Analysis
2	**Clause D1.4** Exit travel distances	To have an exit travel distance to a point of choice from which travel in different directions to 2 exits is available within the basement level of up to 32m, in lieu of 20m.	The fire safety strategy is based on: ▪ The provision of an AS 1670.1-2004 heat detection system throughout the basement level. ▪ The provision of an enhanced building occupant warning system. ▪ The characteristics and use of the basement level.	**DP4, EP2.2**	**A0.5(b)(ii),** and **A0.9(c)** Comparative Assessment Qualitative Analysis
3	**Clause E1.4** Fire hose reels	To not install fire hose reels on the residential levels of the building.	The fire safety strategy is based on: ▪ The provision of portable fire extinguishers on the residential levels in lieu of fire hose reels to enable occupants to undertake an initial attack on a fire. ▪ The characteristics of the residential levels. ▪ The DTS provisions of BCA 2014.	**EP1.1**	**A0.5(b)(i) & (ii),** and **A0.9(b)(ii) & (c)** Absolute and Comparative Assessment Qualitative Analysis

2.0 SUMMARY OF FIRE SAFETY REQUIREMENTS

2.1 FIRE RESISTANCE

The subject development shall fully comply with the DTS provisions of Section C of the BCA (Parts C1, C2 & C3), including the following specific requirements:

Specific Requirements

- The fire rated unit entry doors that open into the enclosed foyer areas of the building shall be fitted with high temperature smoke seals.

  The high-temperature smoke seals shall comply with a tested system in accordance with AS1530.4-2005 and achieve an FRL of not less than -/60/30. The smoke seals shall be fitted to all sides of the doors, including the bottom of each door leaf.

2.2 ACCESS AND EGRESS

The subject development shall fully comply with the DTS provisions of Section D of the BCA (Parts D1, D2 & D3), except for the following permitted variations.

Permitted Variations

- The exit travel distance from a residential unit to a point of choice from which travel in different directions to 2 exits is available on residential levels 1 to 5 can be extended to up to 11m, in lieu of 6m. Refer also Figure 1 below.

- The exit travel distance from a residential unit to a single exit on level 6 can be extended to up to 9m, in lieu of 6m. Refer also Figure 2 below.

- The exit travel distance to a point of choice from which travel in different directions to 2 exits is available within the basement level can be extended to up to 32m, in lieu of 20m. Refer also Figure 3 below.

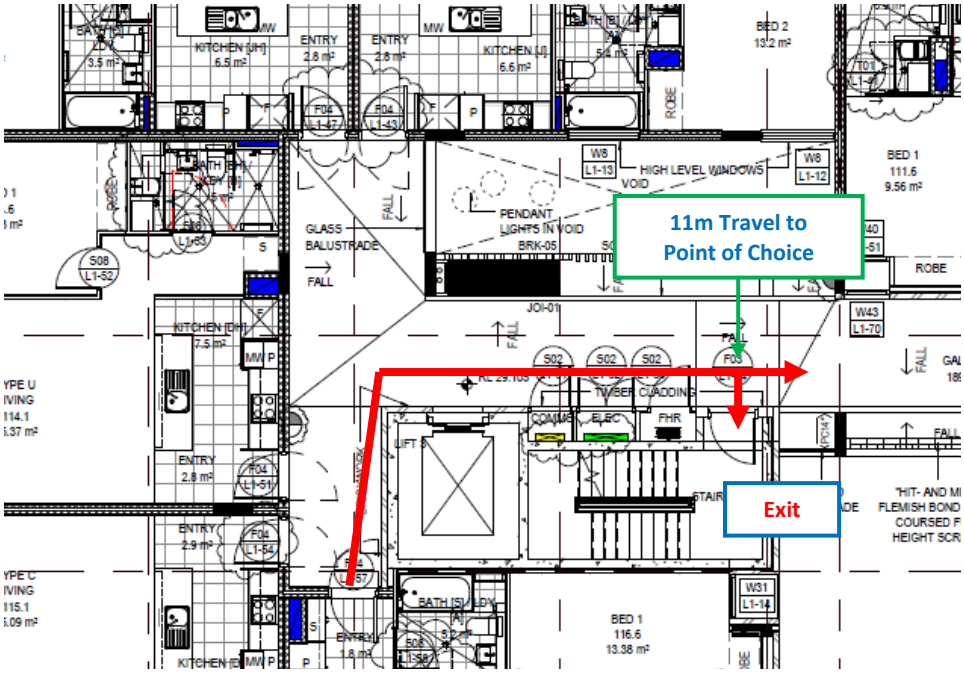

Figure 1: Part Level 1 Plan (Similar for Levels 2 to 5)

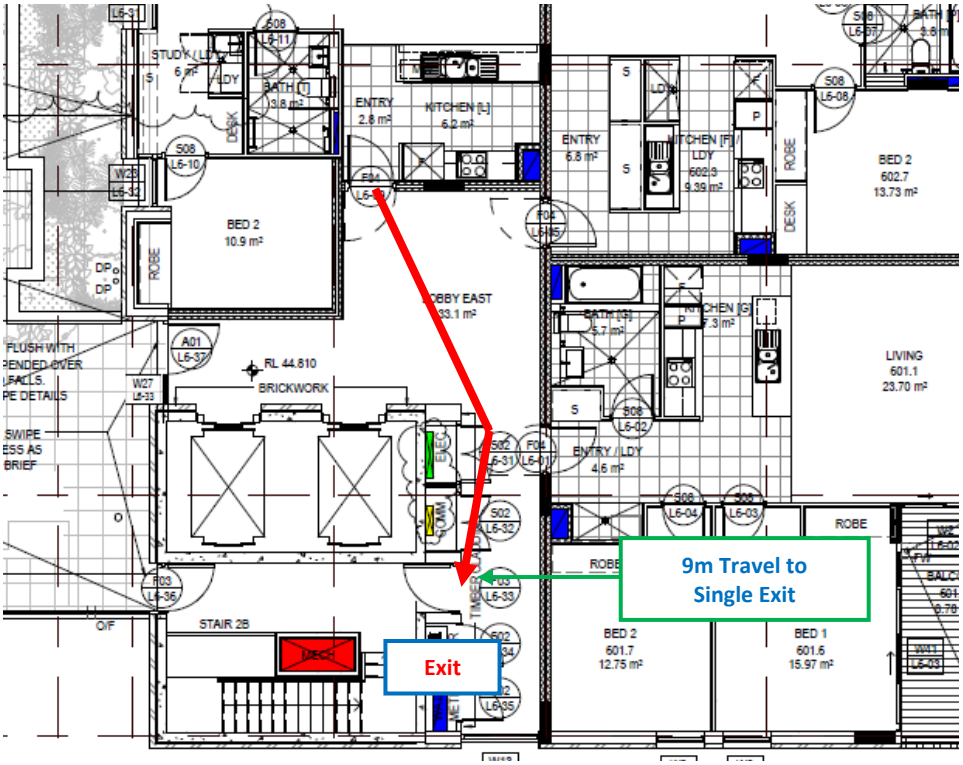

Figure 2: Part Level 6 Plan

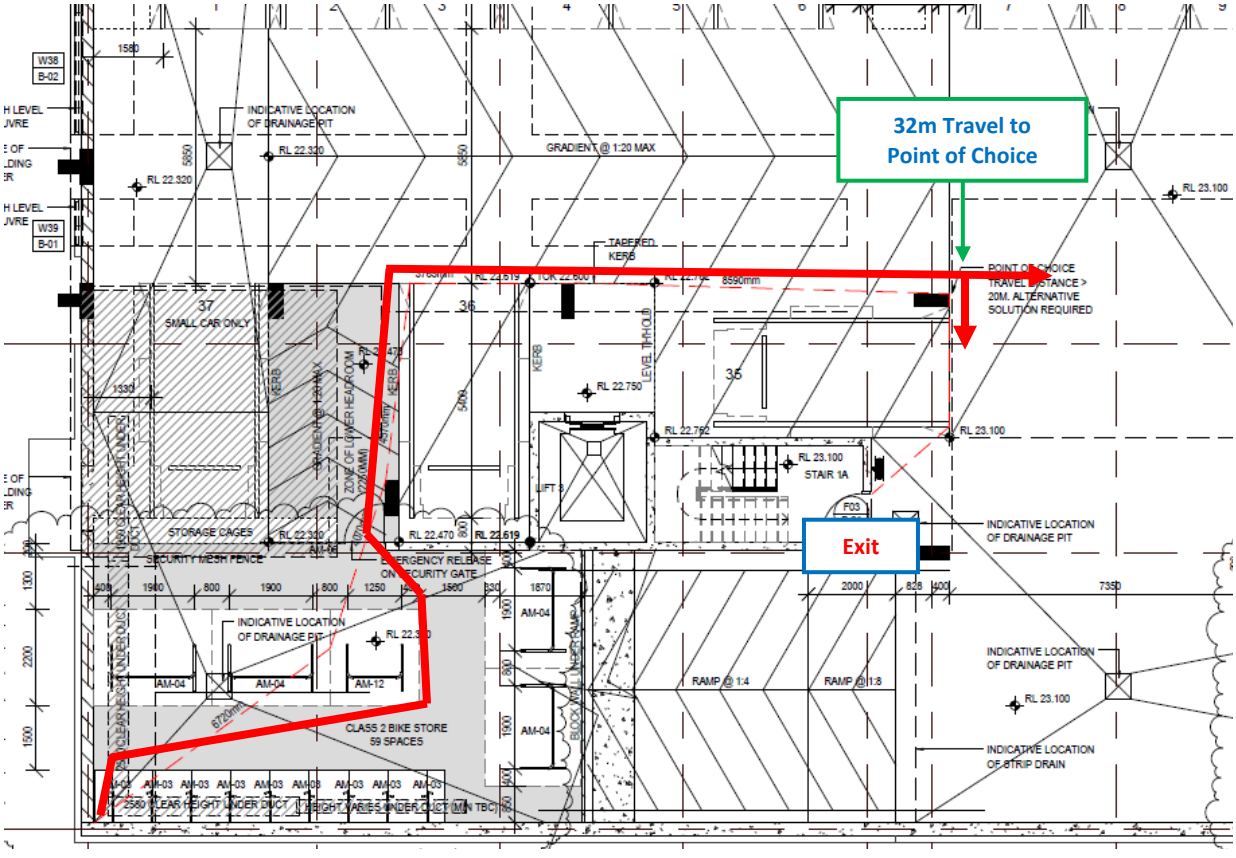

Figure 3: Part Basement Level Plan

2.3 SERVICES AND EQUIPMENT

The subject development shall fully comply with the DTS provisions of Section E of the BCA (Parts E1, E2, E3 & E4), except for the following permitted variations.

Permitted Variations

- Fire hose reels are not required to be installed on the residential levels of the subject development.

2.4 REQUIRED FIRE SAFETY SYSTEMS

The following fire safety systems shall be installed throughout the subject development, including additional provisions where noted that exceed the minimum DTS provisions of the BCA.

Fire Hydrants

- A fire hydrant system shall be installed throughout the subject development in accordance with Clause E1.3 of the BCA, and the relevant provisions of AS 2419.1-2005.

- The fire hydrant booster assembly connections and all fire hydrant valves shall be fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with Clauses 7.1 and 8.5.11.1 of AS 2419.1-2005. All hydrant valves shall posses a forging symbol and manufacturers mark, and shall comply with Fire & Rescue NSW Guide Sheet No. 4.

Fire Hose Reels

- A fire hose reel system shall be installed throughout the non-residential use areas of the subject development in accordance with Clause E1.4 of the BCA and the relevant provisions of AS 2441-2005.

- Fire hose reels are NOT required to be installed on the residential levels of the building.

Portable Fire Extinguishers

- Portable fire extinguishers shall be provided throughout the subject development in accordance with Clause E1.6 of the BCA, and the relevant provisions of AS 2444-2001.

- 2.5 kg dry chemical powder AB(E) type portable fire extinguishers shall be provided within the public corridors on each residential level of the subject development. The extinguishers shall be distributed within the public corridors such that the travel distance from the entrance doorway of any sole-occupancy unit to the nearest extinguisher is not more than 10m.

Automatic Smoke Detection and Alarm System

- An automatic smoke detection and alarm system shall be installed throughout the public corridors on the residential levels of the subject development in accordance with BCA Specification E2.2a (Clause 4) and AS 1670.1-2004.

- Heat detectors shall also be installed throughout the basement level in accordance with the relevant provisions of AS 1670.1-2004.

- A heat detector shall be installed within each residential unit located immediately adjacent the unit entry door (i.e. within 1.5m). These heat detectors shall be connected back to the AS 1670.1 smoke detection system serving the public corridor areas.

Building Occupant Warning System

- A building occupant warning system shall be installed throughout the subject development in accordance with Specification E2.2a of the BCA (Clause 6), and the relevant provisions of AS 1670.1-2004.

- The building occupant warning system shall be enhanced to incorporate a verbal directive, which instructs occupants to evacuate in the event of fire. The verbal directive shall be in clear and concise English that announces the following in the event of a fire alarm:

"This is an Emergency - Evacuate the Building Immediately"

- The building occupant warning system shall automatically activate upon operation of the automatic smoke detection and alarm system serving the public corridors, including the heat detectors within the basement level, and the additional heat detector installed within each residential unit.

Smoke Alarms

- A 240V smoke alarm shall be installed within each residential unit of the subject development in accordance with BCA Specification E2.2a (Clause 3).

- All smoke alarms shall comply with the relevant provisions of AS 3786-1993, and shall be powered from the consumer mains source.

Car Park Ventilation System

- The mechanical ventilation systems serving the car parking areas shall be designed to comply with Clause 5.5 of AS/NZS1668.1-1998.

- Fan override controls for the car park ventilation fans shall be located on an FIP, in accordance with Clause 5.5 of AS/NZS1668.1-1998.

Emergency Lighting and Exit Signs

- Emergency lighting and exit signs shall be installed throughout the subject development in accordance with Clauses E4.2, E4.4, E4.5, E4.6 and E4.8 of the BCA, and the relevant provisions of AS 2293.1-2005.

- All exit and directional exit signs shall be of the illuminated type. That is, the concession given by Clause E4.7 of the BCA, which allows the use of non-illuminated exit signs, shall not be adopted for the development.

2.5 MANAGEMENT IN USE

General

The Body Corporate or Managing Entity of the subject development shall implement a Management in Use type system for the building that incorporates the following measures as a minimum:

- A no smoking policy within public / common areas.
- Routine maintenance of all plant and equipment.
- Routine maintenance of all fire safety systems and measures.
- Regular emptying of rubbish bins.
- Ensuring paths of travel to exits are kept free of anything that may obstruct or impede the free passage of persons.
- Ensuring all exit doors are functional and all statutory signage is in place.

Maintenance and Servicing

All fire safety measures installed throughout the subject development shall be maintained and serviced in accordance with the relevant Australian Standards and manufacturers guidelines, and shall be certified annually as part of an Annual Fire Safety Statement (AFSS).

Certification of Fire Engineering Design

This Fire Engineering Report shall form part of the Fire Safety Schedule for the subject development, and shall be certified annually as part of the AFSS.

3.0 INTRODUCTION

3.1 PURPOSE OF REPORT

Innova Services Pty Ltd has been commissioned to conduct a Fire Engineering Analysis of proposed Alternative Solutions to the Deemed to Satisfy (DTS) provisions of the Building Code of Australia 2013 (BCA) relating to a proposed residential affordable housing development located at Wilson Street, Eveleigh.

The subject development comprises the construction of a new residential building, comprising:

- Basement Level - car parking, plant and ancillary use areas
- Ground Floor - residential lobby, residential units, plant and ancillary use areas
- Levels 1 to 6 - residential units

The purpose of this Fire Engineering Report is to document the Fire Engineering Analysis that demonstrates that the Alternative Solutions achieve compliance with the relevant Performance Requirements of the BCA.

3.2 SCOPE OF REPORT

Group DLA is the BCA Consultant for the subject development. In assessing the subject development the matters summarised in Table 1 of this report were proposed by the Client and identified by the BCA Consultant as variations to the DTS provisions of the BCA. These matters relate to the following:

- Exit travel distances (residential levels).
- Exit travel distances (basement level).
- Fire hose reels (residential levels).

3.3 BASIS OF REPORT

The content of this report is based on the following Legislation:

- The Building Code of Australia 2013 (BCA).
- NSW Environmental Planning & Assessment Act 1979.
- NSW Environmental Planning & Assessment Regulation 2000.

The content of this report is based on the following texts and references:

- International Fire Engineering Guidelines, 2005 Edition.
- Guide to the BCA, ABCB 2013.

The content of this report is based on the following documentation:

- Building Code of Australia 2012 Assessment Report prepared by Group DLA (Ref: 130058, Revision 4, dated 29 July 2013).
- BCA Assessment Report prepared by Steve Watson & Partners (Ref: 2013/0104, Revision R1.0, dated 5 May 2014).
- Architectural drawings for the subject development prepared by Architectus (refer Appendix A for list of referenced drawings).

3.4 EXCLUSIONS AND LIMITATIONS

This report does NOT cover the following:

- A detailed BCA assessment of the subject development.
- Access for people with disabilities (Part D3 of the BCA).
- System or engineering design of any part of the subject development.
- Operational checks of fire safety equipment, verification of construction techniques, fire resistance levels or the witnessing of fire drills.
- Arson (other than as a source of initial ignition), multiple ignition sources, acts of terrorism.
- Protection of property (other than adjoining property).
- Business interruption or losses or personal or moral obligations of the owner/occupier.
- Occupational Health and Safety.

This report is limited to an assessment of the subject development against the proposed variations to Clauses D1.4 and E1.4 of the BCA only, as summarised in Table 1 of this report.

This report is consistent with the objectives and limitations of the BCA. Therefore, effects of arson (i.e. arson resulting in multiple fire starts), terrorism, explosive devices, use of accelerants, and sabotage of fire safety systems are considered outside the scope of this report.

'Absolute' or '100%' safety is not attainable, and there will always be a finite risk of injury, death or property loss. Also, fire and its effects on people and property are complex and variable. Thus, all stakeholders should understand that a fire safety system may not effectively cope with all possible scenarios.

3.5 ASSUMPTIONS

It is assumed that apart from the design variations summarised in Table 1 of this report, all other fire safety aspects of the subject development will comply with the relevant DTS provisions of the BCA.

3.6 REGULATORY FRAMEWORK

A Building Solution will comply with the BCA if it satisfies the Performance Requirements of the BCA. Clause A0.5 of the BCA states that compliance with the Performance Requirements can only be achieved by:

(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;

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

Clause A0.9 of the BCA states that the following Assessment Methods, or any combination of them, can be used to determine that a Building Solution complies with the Performance Requirements:

(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 as described in A2.2.

(b) Verification methods such as -

(i) the Verification 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

3.7 PROJECT STAKEHOLDERS

The relevant project stakeholders for the subject development are listed within Table 2 below.

Table 2: Project Stakeholders

Name	Company	Role
Sam Galvin Steven De Pasquale	City West Housing Pty Ltd	Client
Tommy Ford Paul Jenkins	Architectus	Architect
Ben Dedman Simon Jeffs	WSP Buildings Pty Ltd	Building Services
Brian Healy Jens Knappe	Enstruct	Structural Engineer
Justin Jones-Gardiner	Group DLA	BCA Consultant
Steve Watson & Partners	Steve Watson & Partners Pty Ltd	Principal Certifying Authority
Team Leader, Building Fire Safety Unit	Fire & Rescue NSW	Advisory Agency
Jason Powell	Innova Services Pty Ltd	Fire Safety Engineer

3.8 FIRE ENGINEERING BRIEF PROCESS

The purpose of a Fire Engineering Brief (FEB) process is to document the assumptions and parameters to be used in the Fire Engineering Analysis, so that an "in-principle" agreement can be reached between the relevant stakeholders.

For the subject development, the FEB process was conducted in the following way:

- Receipt of advice from the BCA Consultant in regards to the identified variations to the DTS provisions of the BCA.
- Internal review at Innova Services Pty Ltd of the referenced Architectural Plans in relation to the identified variations to the DTS provisions of the BCA.
- Development of a Trial Design and Fire Safety Strategy (i.e. Alternative Solutions) for the identified variations to the DTS provisions of the BCA, which were proposed to satisfy the relevant Performance Requirements of the BCA.
- Liaison with the Client, BCA Consultant and Architect in regards to the proposed Alternative Solutions.
- In house discussions at Innova Services Pty Ltd in regards to the Assessment Methods, Methods of Analysis and Acceptance Criteria proposed to be adopted to demonstrate that the Alternative Solutions will satisfy the relevant Performance Requirements of the BCA.

- Finalisation of the Trial Design following further discussions and liaison with the Client, BCA Consultant and Architect.

- Completion of a Fire Engineering Brief Consultation Questionnaire for the subject development, for submission to Fire & Rescue NSW (FRNSW).

  The questionnaire provided a brief description of the subject development, summarized the extent of the proposed Alternative Solutions, and provided details of the proposed Design Fire Scenarios, Design Fires, Assessment Methods and Acceptance Criteria that is proposed to be adopted in the Fire Engineering Analysis to demonstrate compliance with the relevant Performance Requirements of the BCA.

  The questionnaire was initially prepared in Draft format for the review and comment by the Client, BCA Consultant and Architect.

- Finalisation of the Fire Engineering Brief Consultation Questionnaire following the receipt of comments from the Client, BCA Consultant and Architect.

- Submission of the completed Fire Engineering Brief Consultation Questionnaire to FRNSW on 10 July 2013. Submission was made by email, and FRNSW confirmed receipt of the questionnaire by return email.

  NOTE: *As of the date of this report, FRNSW has not provided any feedback or comment on the submitted Fire Engineering Brief Consultation Questionnaire.*

4.0 DEVELOPMENT DESCRIPTION

4.1 GENERAL LAYOUT AND CONSTRUCTION

General

The subject development comprises the construction of a new residential affordable housing development, comprising:

- Basement Levels - car parking, plant and ancillary use areas (≈ 1,528m^2)
- Ground Floor - residential lobby, residential units, plant and ancillary use areas (≈ 880m^2)
- Levels 1 to 5 - residential units (≈ 955 m^2 to 1,051m^2 per level)
- Levels 1 to 6 - residential units (≈ 520m^2)

The development is located on Site D4 within the Eveleigh Rail Yards, Redfern. There will be a total of 88 residential units, made up of a mixture of 1, 2 and 3 bedrooms, some of which will be adaptable for disabled users.

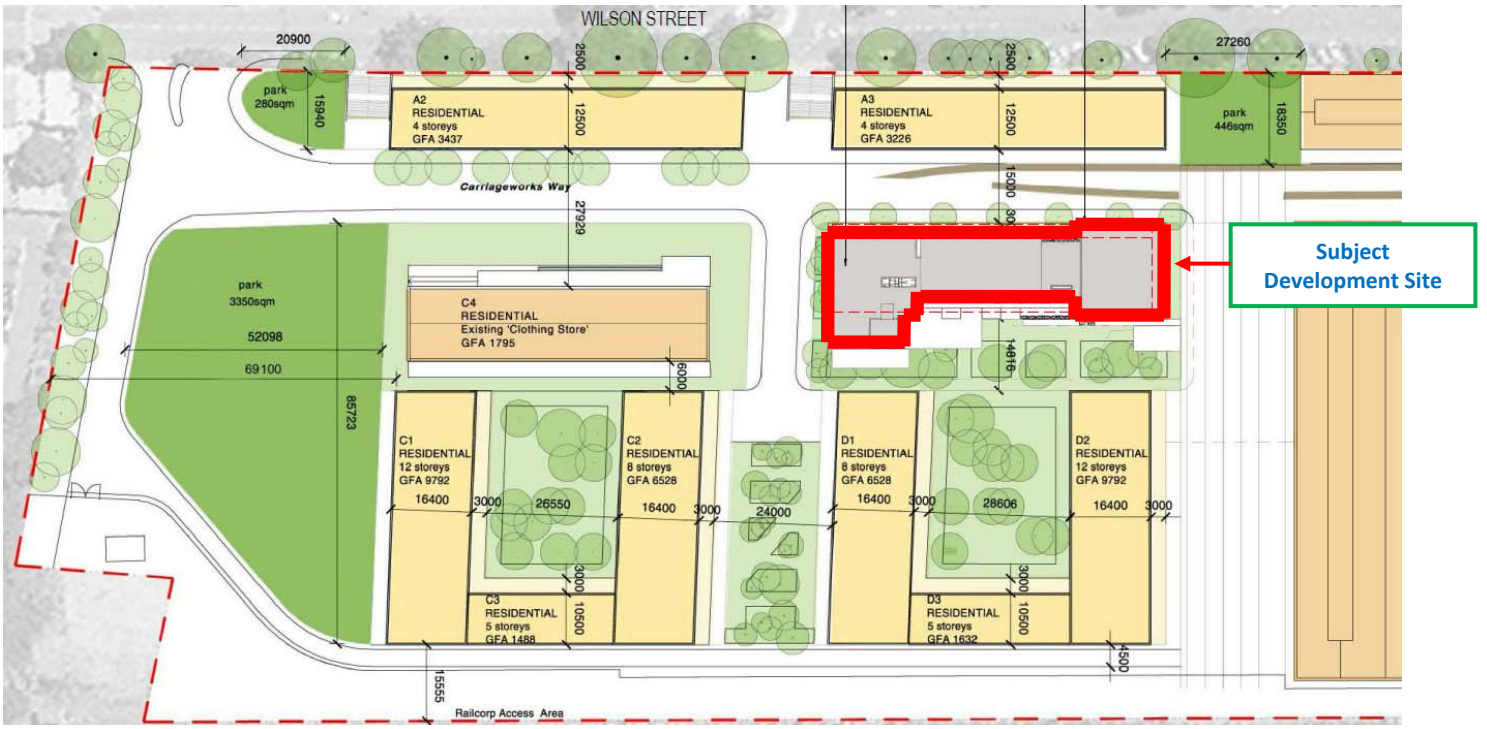

Figure 4: Site Plan

Egress Provisions

The provisions of egress for the subject development are summarised as follows:

- Egress from basement level is via 2 separate fire-isolated stairs, which discharge directly to an open space.
- Egress from the above ground residential levels is via 2 separate fire-isolated stairs, which discharge directly to an open space. Access to the fire-isolated stairs is via enclosed public corridors and open access balconies.

Access throughout the building is via 3 separate passenger lifts, which provide access to all levels of the building, including the basement.

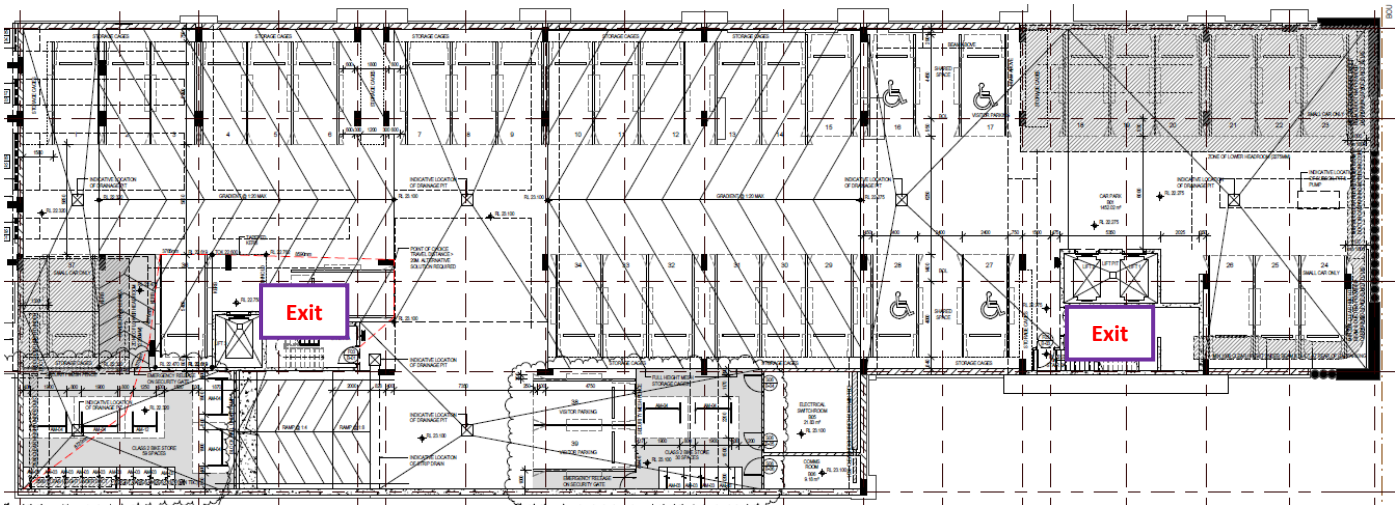

Figure 5: Basement Level Plan

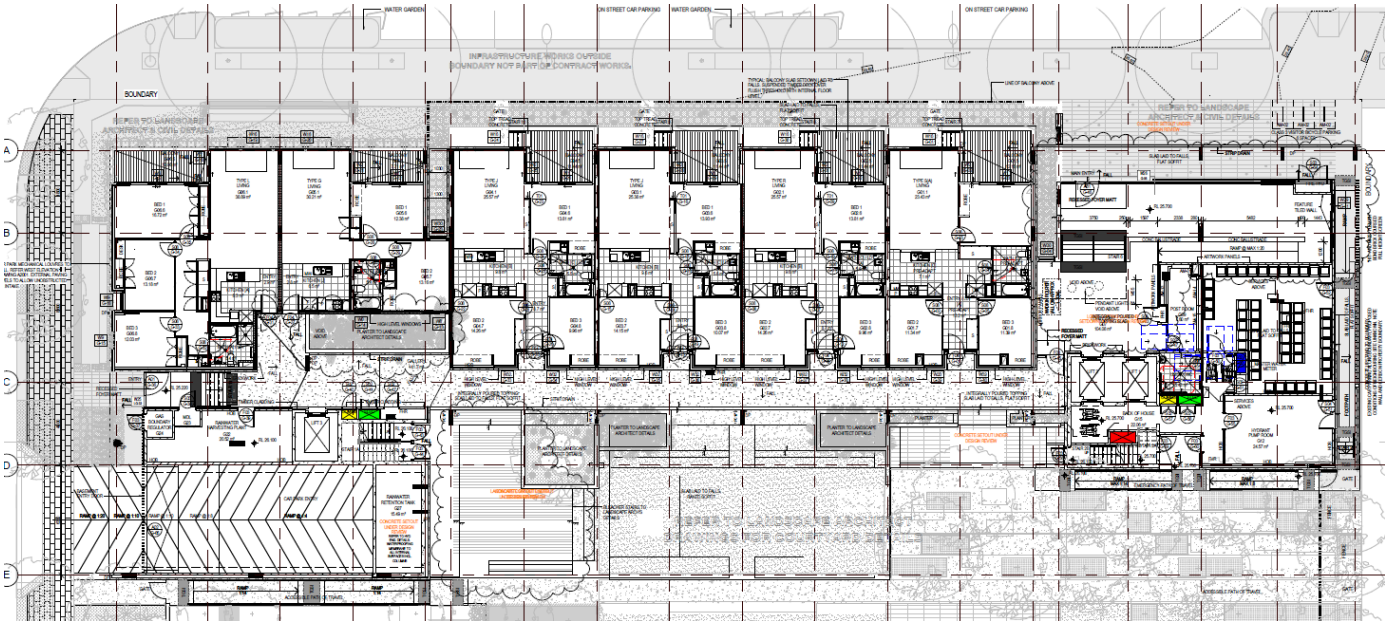

Figure 6: Ground Level Plan

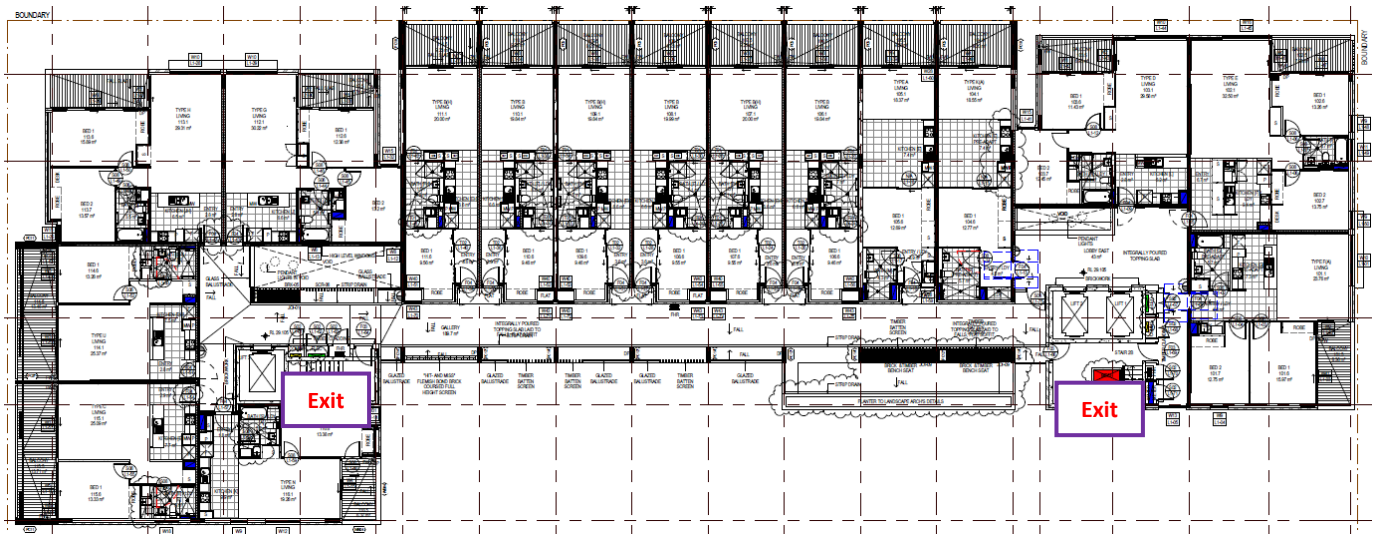

Figure 7: Level 1 Plan (similar for Levels 2 to 5)

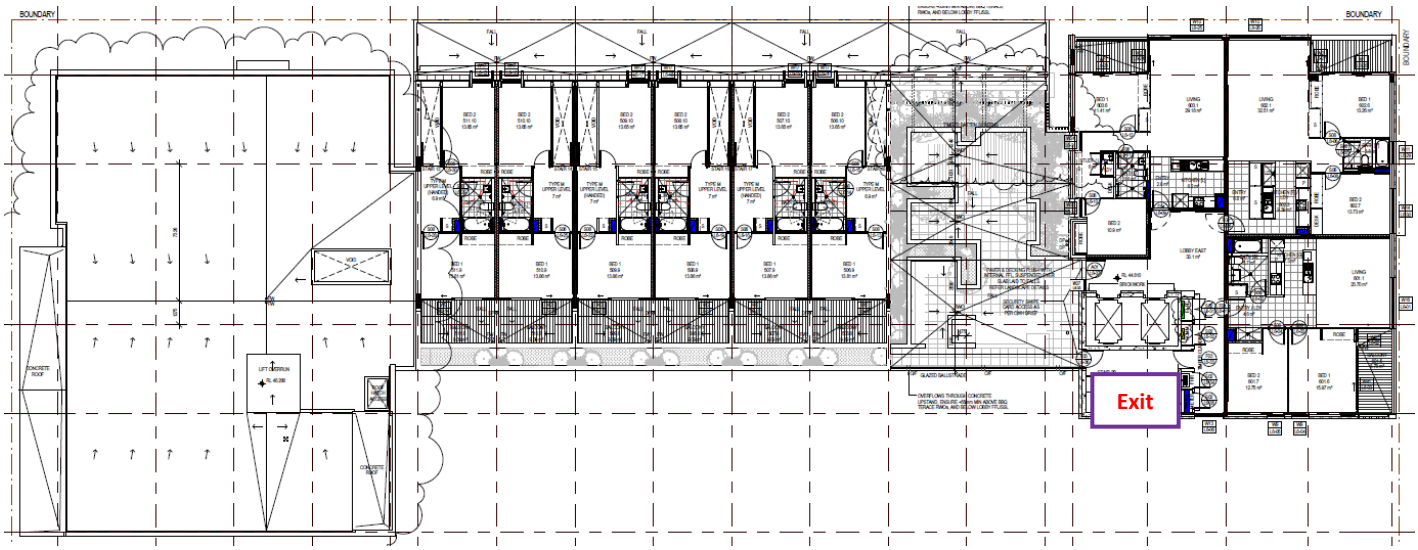

Figure 8: Level 6 Plan

Figure 9: North Elevation (Front View)

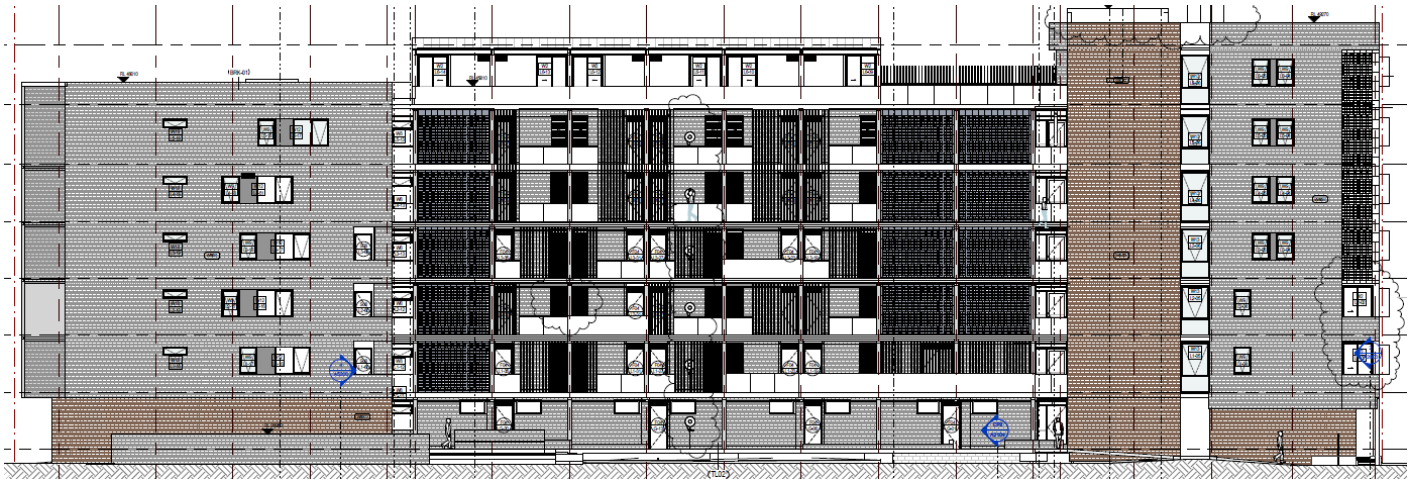

Figure 10: South Elevation (Rear View)

4.2 Relevant BCA References

The relevant BCA References for the subject development are summarised in Table 3 below.

Table 3: Relevant BCA References

BCA Reference	BCA Assessment
Classification and Use	Class 2 (residential) Class 7a (car parking)
Rise in Storeys	7
Levels Contained	8
Minimum Type of Construction Required	Type A
Effective Height	Less than 25m (≈ 18.71m)
Maximum Size of Fire Compartments	Complies

4.3 Proximity to Other Hazards

The surrounding buildings adjacent to the development are residential, with carriageworks to the east.

The subject development is not located adjacent to sites that present any significant or special hazard.

4.4 Other Relevant Site and Building Attributes

The subject development is predominantly used for residential purposes, with typical residential fire loadings.

The subject development is not heritage listed. There are no unusual features associated with the subject development.

The subject development does not contain any atriums. Shafts and ducts will be provided throughout the development for services and ventilation as required.

There are no hidden voids within the subject development. The basement car parking level will be mechanically ventilated. Ventilation will be provided throughout the development to satisfy BCA requirements.

4.5 Fire Brigade Intervention

Fire Station Locations

The two nearest fire stations to the subject development are:

- Darlington Fire Station - 0.47km (radial distance).
- Newtown Fire Station - 1.15km (radial distance).

Emergency Services Access

The principal entry to the building is proposed to be located at the north east corner of the development, with secondary entrance to the western elevation.

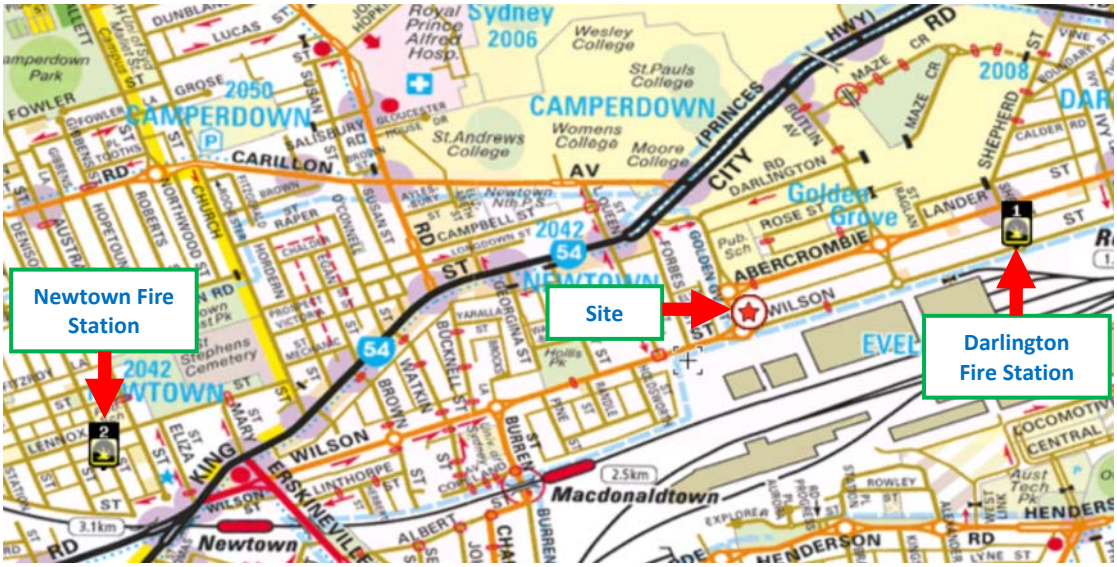

Figure 11: Fire Station Locations

Fire Brigade Booster Assembly

The fire brigade booster assembly will be located adjacent to, and within view of, the main entry to the building. The location of the fire brigade booster assembly will comply with the relevant provisions of AS 2419.1.

Fire Hydrant Pump Room

The fire hydrant pump room will be located within a dedicated enclosure, fire separated from the remainder of the building, and accessed directly from an open space.

Fire Indicator Panel

The Fire Indicator Panel (FIP) will be located within the main entry foyer / lobby of the building.

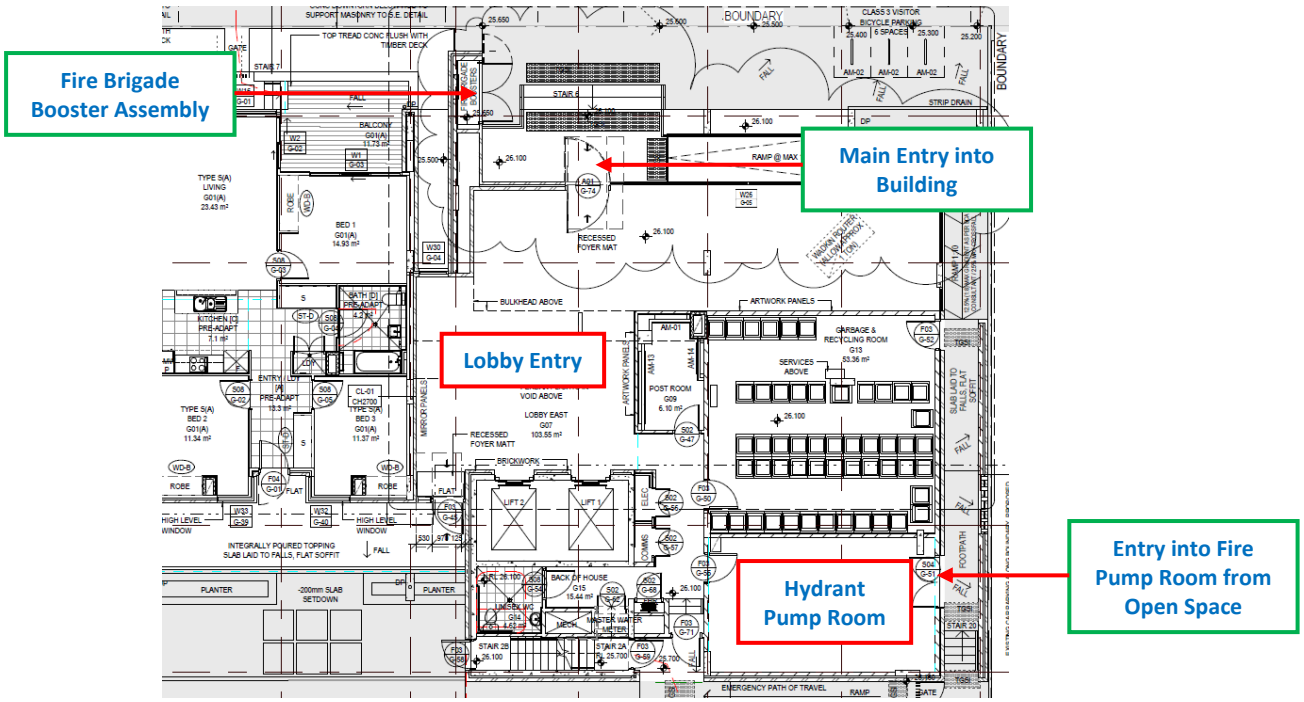

Figure 12: Part Ground Floor Plan

5.0 DOMINANT OCCUPANT CHARACTERISTICS

5.1 POPULATION AND DISTRIBUTION

The building occupants will comprise of residents and visitors to the residential parts of the building, and associated basement level car park.

Residential Levels

Population densities are not specified under Table D1.13 of the BCA for residential occupancies. However population numbers will be taken to be 2 occupants per bedroom.

Car Park Level

The population level associated with the basement level car park is assumed to be based on the population densities given in Table D1.13 of the BCA (i.e. 30m^2 per person).

5.2 STATE, PHYSICAL AND MENTAL ATTRIBUTES

Residential Levels

Residents of the building could comprise of persons of all ages and backgrounds that could potentially respond differently to various fire cues. During the day, residents are typically mobile and their response time to a possible fire scenario is likely to be minimal. However at night, residents are typically sleeping and their response time to a possible fire scenario are expected to be delayed.

Car Park Level

The car parking level is expected to be dedicated to building residents, with similar attributes as described above. The car parking level may also be occasionally occupied by technicians and / or maintenance personnel etc for ancillary purposes. The basement car parking level is not accessible to the general public.

5.3 FAMILIARITY WITH THE BUILDING

Residential Levels

Occupants of the residential units are considered to be long-term residents, and are expected to be familiar with the building layout and the location of exits.

Car Park Level

The car parking level is expected to be dedicated to building residents, with similar attributes as described above. Occupants within the car park are expected to be familiar with the building layout and the location of exits.

5.4 LEVEL OF ASSISTANCE AND EMERGENCY TRAINING

Residential Levels

Residents of the building are considered to be generally mobile, not requiring assistance to evacuate the building in an emergency, as per the relevant DTS provisions of the BCA. Disabled residents are considered to be assisted by able-bodied carers, family or friends.

Car Park Level

The car parking level is expected to be dedicated to building residents, with similar attributes as described above. Occupants within the car park are not expected to be trained in early fire fighting and emergency response.

5.5 DISABLED OCCUPANTS

People with disabilities are considered to be assisted by able-bodied carers, family / friends, or other staff members.

Managing the evacuation of people with disabilities relies on the individual building management systems, procedures and training, which are outside the scope of the BCA, but can substantially contribute to the overall evacuation efficiency of the subject building.

Therefore disabled access and egress should be addressed in an emergency evacuation plan and management procedures for people with disabilities, which is to be specifically developed and applied for the subject building.

6.0 HAZARDS & PREVENTATIVE AND PROTECTIVE MEASURES

6.1 HAZARD IDENTIFICATION

In identifying potential fire hazards, the following factors are considered:

- General building layout and construction.
- Building activities.
- Potential ignition sources.
- Combustible contents.

General Building Layout and Construction

Refer to Section 4 of this Report for a description of the subject development. The subject development will comply with the relevant provisions for Type A construction.

Building Activities

The subject development will be predominantly used for residential purposes, with associated amenities and car parking. Given the end use of the subject development, it is unlikely that the installed fire safety systems within the building will be isolated for short periods of time for building and / or fitout works.

Potential Ignition Sources and Areas of Fire Origin

Fire & Rescue NSW Statistics for the years 2004/2005 and 2006/2007 nominate the following ignition factors within residential properties:

- Unattended heat sources (approximately 23%).
- Undetermined, non reported and not applicable (approximately 16%).
- Incendiary and suspicious (approximately 10%).
- Short circuits or electrical failures (approximately 8%).

It was reported that between 45.7 - 49.0% of fires originated in a kitchen or cooking area, between 10.5 - 13.0% of fires originated in a sleeping area, between 8.6 - 9.0% of fires originated in a lounge area, and approximately 3.1% of fires originated in a garage or vehicle storage area.

Combustible Contents

The following items are considered highly combustible within this type of occupancy, and these material forms are the most likely to be ignited first, and / or contribute to the development and spread of fire:

- Motor vehicles within the basement car parking level.
- Storage areas within the basement car parking level, housing combustible materials.
- Curtains and window blinds.
- Bedding and clothing.
- Cooking materials.
- Residential furniture, furnishings and surface finishes.
- Electrical equipment, electrical wiring, and cable insulation.

- Storage of paper, cardboard, stationary, and other combustible materials / goods.
- Rubbish, trash and waste.

6.2 PREVENTATIVE AND PROTECTIVE MEASURES

Preventative Measures

Preventative measures are typically 'Management in Use' methods as described in Section 2 of this Report, and include required measures and procedures to minimise the likelihood of fire initiation, fire development and spread.

Protective Measures

The fire safety systems / measures nominated in Section 2 of this Report are to be installed throughout the subject development.

7.0 DESIGN OBJECTIVES

7.1 REGULATORY OBJECTIVES

The main objectives of the Building Code of Australia (BCA) include:

- Life safety of occupants.
- Facilitation of fire brigade operations.
- Protection of adjacent buildings.

The objectives of the BCA are met when the relevant Performance Requirements of the BCA are satisfied. Thus, an Alternative Solution will comply with the BCA if it satisfies the relevant Performance Requirements of the BCA.

7.2 RELEVANT PERFORMANCE REQUIREMENTS

The relevant BCA Performance Requirements (*DP4, EP1.1 and EP2.2*) associated with the proposed Alternative Solutions are presented below. The Alternative Solutions in Table 1 must comply with these Performance Requirements.

DP4 *Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to -*

(a) the travel distance; and

(b) the number, mobility and other characteristics of occupants; and

(c) the function or use of the building; and

(d) the height of the building; and

(e) whether the exit is from above or below ground level.

EP2.2 *(a) In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that -*

(i) the temperature will not endanger human life; and

(ii) the level of visibility will enable the evacuation route to be determined; and

(iii) the level of toxicity will not endanger human life.

(b) The period of time occupants take to evacuate referred to in (a) must be appropriate to -

(i) the nuer, mobility and other characteristics of the occupants; and

(ii) the function or use of the building; and

(iii) the travel distance and other characteristics of the building; and

(iv) the fire load; and

(v) the potential fire intensity; and

(vi) the fire hazard; and

(vii) any active fire safety systems installed in the building; and

(viii) fire brigade intervention.

EP1.1 *A fire hose reel system must be installed to the degree necessary to allow occupants to safely undertake initial attack on a fire appropriate to -*

(a) the size of the fire compartment; and

(b) the function or use of the building; and

(c) any other fire safety systems installed in the building; and

(d) the fire hazard.

7.3 FIRE BRIGADE OBJECTIVES

Each fire agency throughout Australia, including Fire & Rescue NSW, has a fundamental set of legal obligations, which are defined under the Fire Agency Act for each State or Territory.

The objectives of the fire brigades involve the protection of life, property and the environment. The BCA outlines DTS provisions for buildings in relation to fire resistance, egress, and services and equipment (such as fire hydrants) to enable the objectives of the fire brigades to be fulfilled during fire brigade intervention activities.

To satisfy the performance requirements of the BCA, fire fighters must have reasonable time to enter and exit a building to undertake fire brigade intervention activities before untenable conditions occur and prior to building collapse. The proposed Alternative Solutions will be assessed against the objectives of the fire brigades during fire brigade intervention activities. Where the relevant Performance Requirements of the BCA refer to Fire Brigade Intervention, the objectives of the fire brigades will be considered.

8.0 APPROACHES AND METHODS OF ANALYSIS

8.1 APPROACHES

The Fire Engineering Analysis will utilise a Comparative Approach and / or an Absolute Approach to assess the Alternative Solutions.

- A Comparative Approach is where the Alternative Solution is shown to be at least equivalent to the DTS provisions of the BCA, as permitted under Clauses A0.5(b)(ii) and A0.9(c) of the BCA.

- An Absolute Approach is where the Alternative Solution is assessed against the relevant Performance Requirements of the BCA, as permitted under Clauses A0.5(b)(i) and A0.9(b)(ii) of the BCA.

8.2 METHODS OF ANALYSIS

The Fire Engineering Analysis contained within this report will comprise of Qualitative methods to assess the Alternative Solutions.

Table 1 in the Executive Summary details the Approaches and Assessment Methods to be adopted for each Alternative Solution.

9.0 ACCEPTANCE CRITERIA

Table 4 below summarises the Acceptance Criteria for each Alternative Solution.

Table 4: Acceptance Criteria for Alternative Solutions

Alt Sol	Summary of Variations to BCA DTS Provisions	Acceptance Criteria
1	Clause D1.4 To have an exit travel distance from a residential unit to a point of choice from which travel in different directions to 2 exits is available on residential levels 1 to 5 of up to 11m, in lieu of 6m. To have an exit travel distance from a residential unit to a single exit on level 6 of up to 9m, in lieu of 6m.	The Alternative Solution is to comply with BCA Performance Requirements DP4 & EP2.2 in terms of: ▪ Ensuring occupants on levels 1 to 6 can evacuate safely at least equivalent to the DTS provisions of the BCA. ▪ Maintaining conditions in the evacuation routes on levels 1 to 6 to allow occupants to evacuate safely at least equivalent to the DTS provisions of the BCA. Consideration will be given to: ▪ The travel distance. ▪ The fire hazard. ▪ The installed fire safety systems. ▪ The characteristics and use of the public corridors.
2	Clause D1.4 To have an exit travel distance to a point of choice from which travel in different directions to 2 exits is available within the basement level of up to 32m, in lieu of 20m.	The Alternative Solution is to comply with BCA Performance Requirements DP4 & EP2.2 in terms of: ▪ Ensuring occupants within the basement level can evacuate safely at least equivalent to the DTS provisions of the BCA. ▪ Maintaining conditions in the evacuation routes within the basement level to allow occupants to evacuate safely at least equivalent to the DTS provisions of the BCA. Consideration will be given to: ▪ The travel distance. ▪ The fire hazard. ▪ The installed fire safety systems. ▪ The characteristics and use of the basement level.
3	Clause E1.4 To not install fire hose reels on the residential levels of the building.	The Alternative Solution is to comply with BCA Performance Requirement EP1.1 in terms of: ▪ Allowing occupants to safely undertake an initial attack on a fire on the residential levels of the building. Consideration will be given to: ▪ The fire hazard. ▪ The installed fire safety systems.

10.0 DESIGN FIRE SCENARIOS

General

In consideration of the hazard assessment contained in Section 6, the most likely cause of ignition will be unattended heat sources within a residential unit.

For the basement car parking level, statistics by Denda[1] have shown that a fire within a car park rarely involves more than 2 cars. It was found that of the 404 car par fires surveyed, 93% were limited to a single car and a further 5% where limited to 2 cars.

Such scenarios will result in fire and the production of smoke and toxic products that will affect building occupants during evacuation and fire fighters during fire brigade intervention activities.

Non Sprinkler Controlled Design Fires

Considering that fire sprinklers will not be installed within the subject development, a fire can be expected to grow to flashover conditions involving a majority of the combustible items within the area of fire origin.

Summary of Fire Scenarios

The following fire scenarios have been considered to appropriately assess the proposed Alternative Solutions:

1. A non-sprinkler controlled fire within a typical residential unit, located adjacent to those units in which the travel distance to a point of choice, or to a single exit, exceeds 6m. Such a fire could grow to flashover conditions within the unit of fire origin.

2. A non-sprinkler controlled fire within the basement car parking level.

NOTE: Quantitative design fires will not be considered as the Fire Engineering Analysis for each Alternative Solution will focus on a qualitative assessment.

[1] Parking Garage Fire. A Statistical Analysis of Parking Garage Fires in the United States: 1986-1988, 1992. Denda, D.F. Parking Market Research Company, Virginia USA.

11.0 FIRE ENGINEERING ANALYSIS (ALTERNATIVE SOLUTION 1)

11.1 GENERAL

This Fire Engineering Analysis will assess whether the proposed Alternative Solution will achieve compliance with Performance Requirements DP4 and EP2.2 of the BCA.

11.2 RELEVANT BCA DTS PROVISIONS

Clause D1.4 of the BCA states, in part, that the entrance doorway of any sole-occupancy unit must be not more than 6m from an exit or a point from which travel in different directions to 2 exits is available.

11.3 BASIS OF BCA DTS PROVISIONS

The Guide to the BCA states that the intent of Clause D1.4 of the BCA is ***"To maximise the safety of occupants by enabling them to be close enough to an exit to safely evacuate"***.

The maximum exit travel distances given within the BCA are notional figures, and do not consider the layout of the building and / or the active fire safety systems installed.

11.4 VARIATION TO BCA DTS PROVISIONS

As outlined in Table 1 of the Executive Summary:

- It is proposed to have an exit travel distance from a residential unit to a point of choice from which travel in different directions to 2 exits is available on residential levels 1 to 5 of up to 11m, in lieu of 6m.
- It is proposed to have an exit travel distance from a residential unit to a single exit on level 6 of up to 9m, in lieu of 6m.

11.5 ASSESSMENT OF ALTERNATIVE SOLUTION

Qualitative Assessment

Introduction

It is considered that the DTS requirements for travel distances of 6m to an exit, or 6m to a point of choice, within residential buildings relates to the potential that an occupant may be exposed to a fire from a unit whilst evacuating. Therefore increasing the travel distance to an exit or point of choice may increase the risk that the path of travel to an exit becomes blocked or obstructed as a result of fire within a residential unit.

When occupants evacuate from a fire affected unit, there is a potential for a large amount of smoke to enter into the adjacent public corridor area, which serves as the path of travel to the required exits.

The following is an assessment / discussion of the fire safety systems and measures that will be implemented within the subject development that will ensure occupants can evacuate from the residential levels in conditions at least equivalent to that of a design that complies with the minimum DTS provisions of the BCA.

Smoke Seals to Unit Entry Doors

The fire rated unit entry doors that open into the enclosed foyer areas of the building will be fitted with high temperature smoke seals. The provision of smoke seals significantly reduces the available gap around the perimeter of the doors, through which smoke can flow from the unit of fire origin into the egress path.

The required high temperature smoke seals will comply with a tested system in accordance with AS1530.4-2005 and will achieve an FRL of not less than -/60/30. Therefore the high temperature smoke seals are expected to be capable of mitigating smoke spread into the public corridors in the event of fire flashover fire, where temperatures exceed 600^0C.

In consideration of the above, the temperature, visibility and toxicity within the public corridor areas of the development, experienced by occupants evacuating in the event of fire, is considered to be improved when compared to a design that complies with the minimum DTS provisions of the BCA where smoke seals are not required.

Enhanced Smoke / Fire Detection System

An automatic smoke detection and alarm system will be installed throughout the public corridor areas of the building to BCA Specification E2.2a (Clause 4), and the relevant provisions of AS 1670.1-2004.

As part of the AS 1670.1 system, a heat detector will be installed within all residential units located immediately adjacent the unit entry doors (i.e. within 1.5m). These heat detectors will be connected back to the AS 1670.1 smoke detection system within the public corridors. Therefore in the event of fire within a residential unit, building occupants within the non fire affected units will be provided with an automatic fire cue prior to the affects of fire spreading to the public corridors.

For a DTS Compliant Design, building occupants within the non fire affected units will not be provided with an automatic fire cue until a smoke detector within the public corridor has activated. For this to occur, smoke needs to spread from the unit of fire origin into the public corridor. The time at which this occurs would depend on when the entry door into the fire affected unit is opened, or when smoke spreads through the perimeter gaps around the unit entry door.

Therefore in the event of fire within a residential unit of the subject development, occupants within the non fire affected units will be provided with an earlier fire cue when compared to a design that complies with the minimum DTS provisions of the BCA as described above. This will enable evacuation to begin much earlier, and prior to the affects of fire reaching the public corridors, unlike a DTS Compliant Design.

Characteristics of Public Corridors

The public corridors on the residential levels of the development are purely circulation areas and will contain no combustible items, and comprises of fire rated bounding construction. It is therefore considered unlikely that a fire will initiate in the public corridor areas that will block the path of travel to the point of choice or to a single exit.

On levels 1 to 5, where the travel distance to the point of choice exceeds 6m (being 11m), part of the public corridor is open to a full height void that is open at roof level. This void will provide natural ventilation to the public corridors and also aid in the natural ventilation of smoke should smoke from a fire within a residential unit spread to within the public corridors. Further a large portion of the public corridors on levels 1 to 5 are actually considered to be open access balconies, where smoke from a fire affected residential unit could dissipate directly to atmosphere.

In consideration of the above, the temperature, visibility and toxicity within the public corridor areas, experienced by occupants evacuating in the event of fire, is considered to be improved when

compared to a design that complies with the minimum DTS provisions of the BCA where the public corridors are fully enclosed with no provisions for natural ventilation.

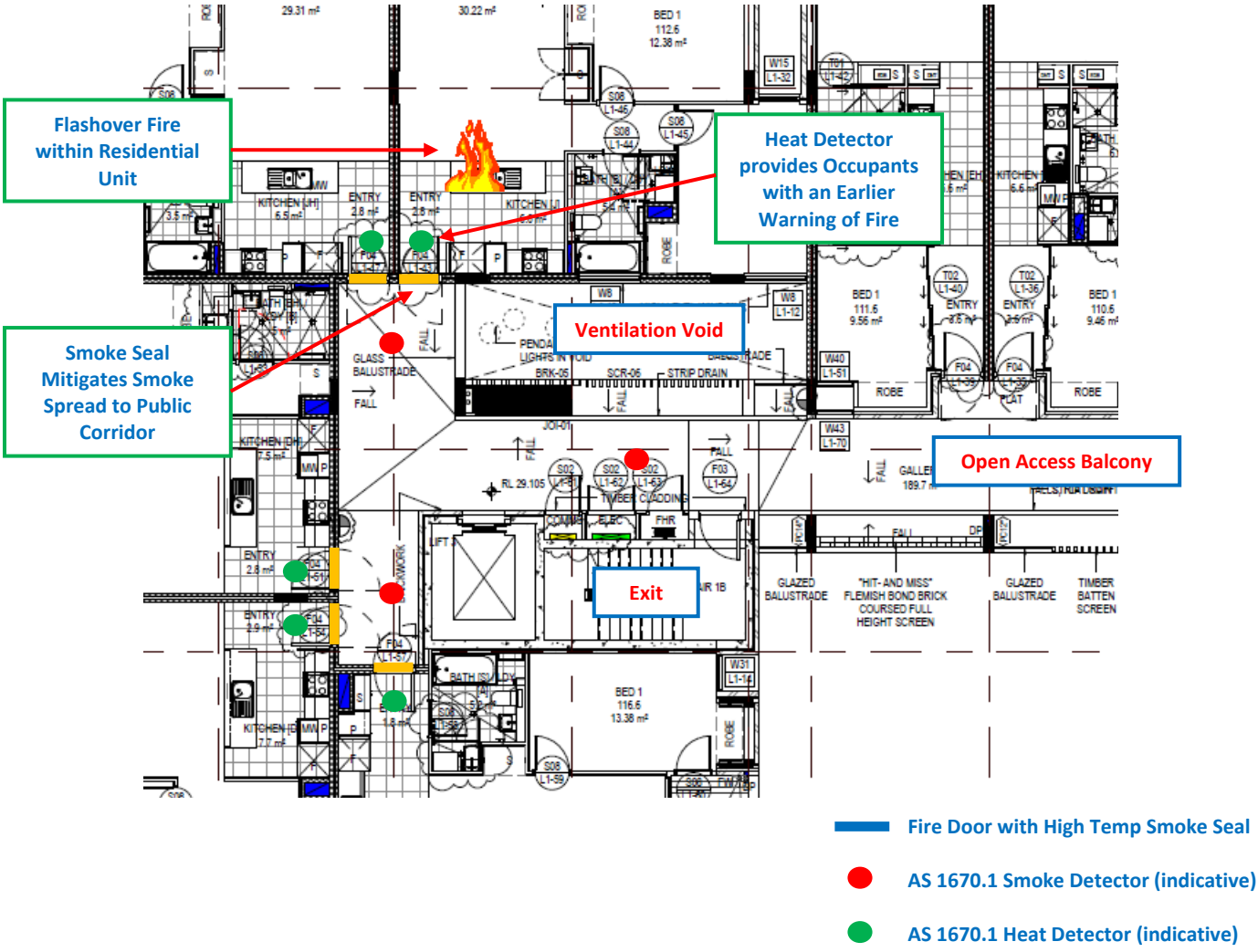

Figure 13: Part Level 1 Plan (Similar for Levels 2 to 5)

Characteristic of Occupants

As detailed in Section 5, the occupants within the residential units are considered to be long-term residents, and are expected to be familiar with the building layout and the location of the available exits.

Further the layout of the public corridors on the residential levels is relatively simplistic, which will minimise the potential for occupants becoming confused or directionless during evacuation.

Provision of Illuminated Exit Signs

Illuminated exit signs will be provided throughout the residential levels of the building. That is, the concession given by Clause E4.7 of the BCA, which allows the use of non-illuminated exit signs, will not be adopted for the development.

Illuminated exits signs can be seen much further through smoky conditions, when compared to light reflecting signs. Thus the provision of illuminated exit signs will assist in occupants identifying the location of the exit should smoke enter the public corridors in the event of fire.

Failure of Unit Entry Door

If the entry door to the fire affected unit is held or chocked open, or held slightly ajar (e.g. due to an occupant laying a fire hose through the door prior to evacuation), then large volumes of smoke could spread into the public corridor. This could lead to deteriorated conditions in the egress paths to the fire-isolated exits. In the event of a flashover fire within the unit of fire origin, the tenability limits within the egress paths are likely to be exceeded.

The above scenarios could render the egress paths to the fire-isolated exits untenable, and occupants may need to remain within their respective units and wait for fire brigade intervention. This is referred to as 'protect in place'.

However such scenarios could also occur for a DTS Compliant Design. That is, the risk that a unit entry door will fail, as described above, for the Alternative Solution is considered at least equivalent to that of a DTS Compliant Design.

Risk of Obstruction

There is a risk that those occupants located more than 6m from the point of choice, or 6m to a single exit, may need to pass directly by the entry door of another sole-occupancy unit, which is on fire, to reach an exit. Thus there is a risk that the path of travel to the point of choice, or to the single exit, may become obstructed.

The configuration of the residential levels is such that occupants located more than 6m from the point of choice, or to a single exit, are potentially exposed to the same number of openings that could be expected in a DTS compliant design. Further the travel distance past the last unit entry door to reach a point of choice, or a single exit, does not exceed 6m. Refer also Figures 14 and 15 below.

As outlined above, the public corridor areas of the building are purely circulation areas and will contain no combustible items, and will comprise of fire rated bounding construction. It is therefore considered unlikely that a fire will initiate in the public corridor areas that will block the path of travel to an exit. Therefore the increased travel distance to the point of choice, or to the single exit, on the residential levels will not result in an increased risk of the path of travel to the exits being obstructed.

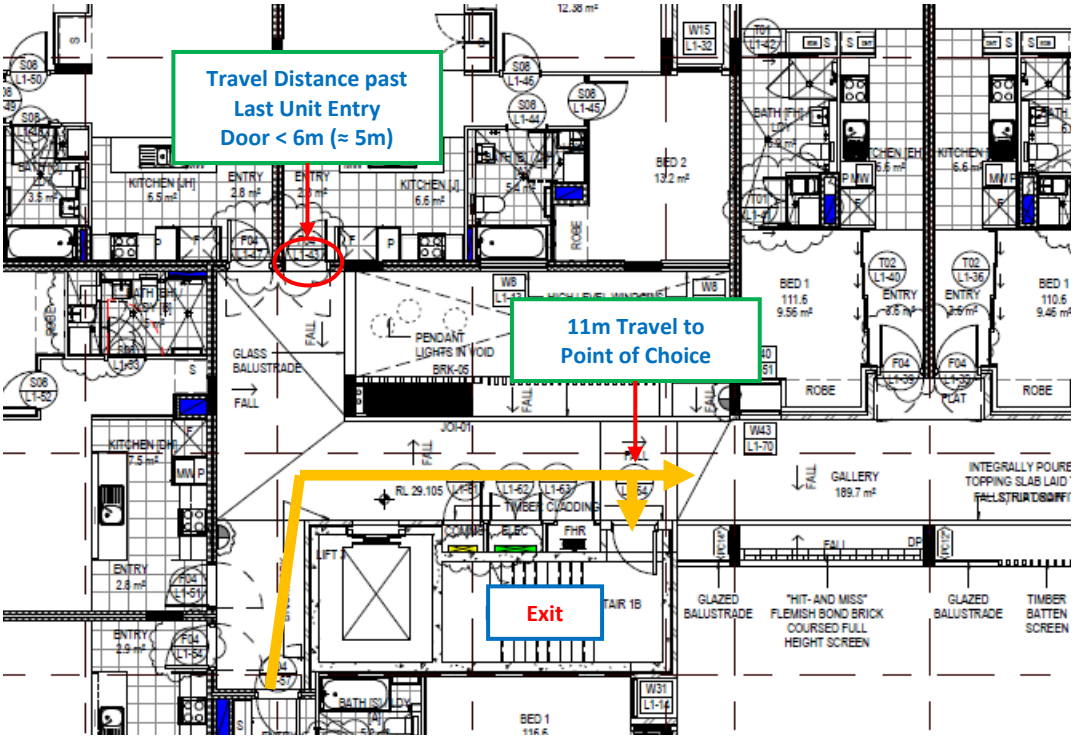

Figure 14: Part Level 1 Plan (Similar for Levels 2 to 5)

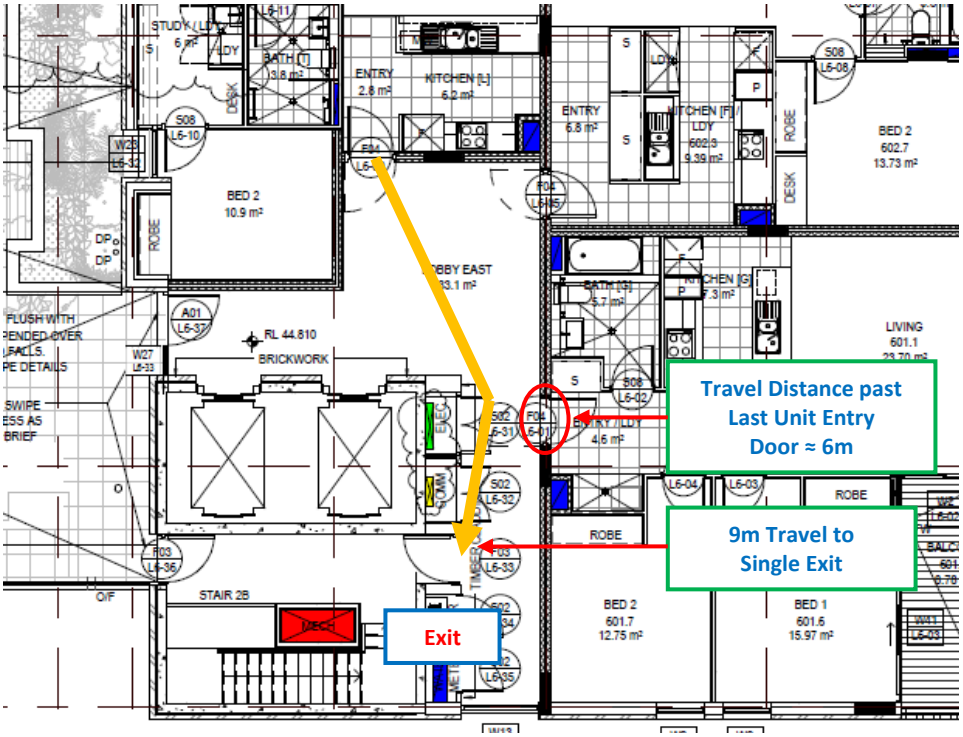

Figure 15: Part Level 6 Plan

Fire Brigade Intervention

As shown in Figure 16 below, there are 2 fire stations located within a 1.5km radial distance of the subject development. These include:

- Darlington Fire Station - 0.47 km (radial distance).
- Newtown Fire Station - 1.15 km (radial distance).

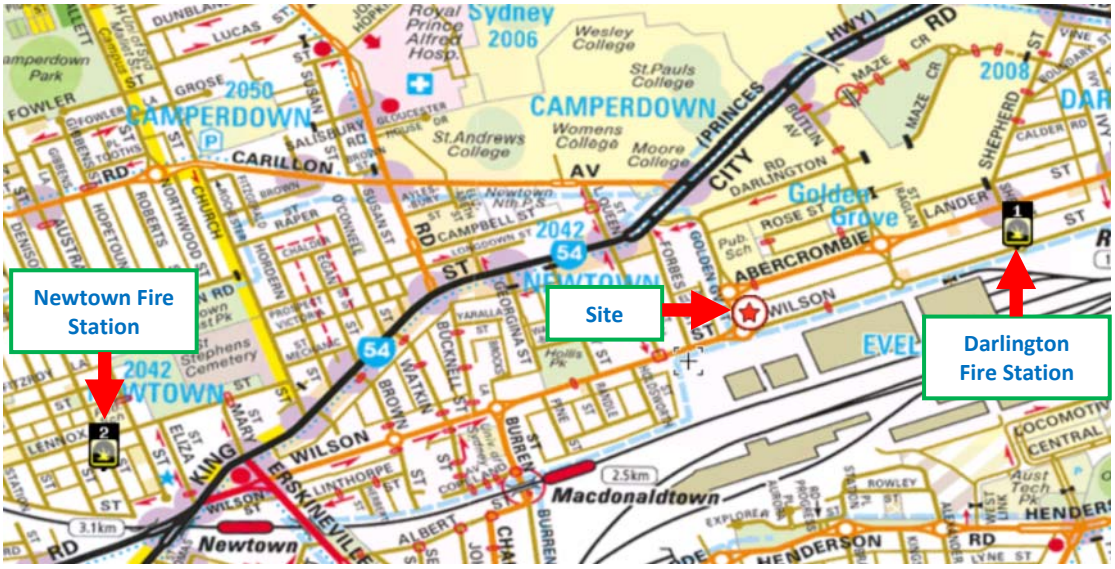

Figure 16: Fire Station Locations

Fire & Rescue NSW (FRNSW) response time for structural fires for the years 03/04, 04/05 and 05/06 was in the range of 7 minutes (50th percentile) and 12 minutes (90th percentile). Therefore in the event of fire within the subject development, it is likely that fire crews from 1 or more of the abovementioned fire stations would arrive on site and begin fire fighting activities within 12 minutes.

It is generally considered that the intensity and extent of a fire will be controlled once fire crews begin fire fighting activities.

A fire hydrant system will be installed throughout the subject development in accordance with AS 2419.1-2005, and will comprise of internal fire hydrants located within the fire-isolated exits. The fire brigade booster assembly will be located adjacent to the main entrance to the building, and will be protected from radiant heat as per the relevant provisions of AS 2419.1.

The attending fire brigades can access the residential levels of the development via the fire-isolated exits. Access and egress from the fire-isolated exits will comply with the relevant DTS provisions of the BCA.

In consideration of the above, the provisions for fire brigade intervention will facilitate the needs of the fire brigades at least equivalent to that of the DTS provisions of the BCA.

Conclusion

In consideration of the layout of the residential levels, and of the required fire safety systems and measures discussed above, it is demonstrated that occupants can evacuate from the residential levels of the building safely and under tenable conditions, at least equivalent to that of a design that complies with the minimum DTS provisions of the BCA.

Therefore the proposed Alternative Solution is demonstrated to achieve compliance with BCA Performance Requirements DP4 and EP2.2.

11.6 SATISFYING BCA PERFORMANCE REQUIREMENTS

The proposed Alternative Solution has been shown to achieve compliance with BCA Performance Requirements DP4 and EP2.2, as summarised in Tables 5 and 6 below.

Table 5: Assessment of Compliance with the BCA Performance Requirement DP4

Performance Requirement DP4	Discussion
Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to -	
(a) the travel distance; and	As discussed in Section 11.5. In consideration of the installed fire safety systems and measures, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(b) the number, mobility and other characteristics of occupants; and	As discussed in Sections 5 and 11.5. Considered comparable to a similar building that complies with the DTS provisions of the BCA.
(c) the function or use of the building; and	As discussed in Section 11.5. In consideration of the installed fire safety systems and measures, and the characteristics of the residential levels, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.

Table 5: Cont'd

Performance Requirement DP4	Discussion
(d) the height of the building; and	N/A Considered comparable to the DTS provisions of the BCA.
(e) whether the exit is from above or below ground level.	N/A Considered comparable to the DTS provisions of the BCA.

Table 6: Assessment of Compliance with the BCA Performance Requirement EP2.2

Performance Requirement EP2.2	Discussion
(a) In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that -	
(i) the temperature will not endanger human life; and	As discussed in Section 11.5. In consideration of the installed fire safety systems and measures, and the characteristics of the public corridors, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(ii) the level of visibility will enable the evacuation route to be determined; and	As discussed in Section 11.5. In consideration of the installed fire safety systems and measures, and the characteristics of the public corridors, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(iii) the level of toxicity will not endanger human life.	As discussed in Section 11.5. In consideration of the installed fire safety systems and measures, and the characteristics of the public corridors, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(b) The period of time occupants take to evacuate referred to in (a) must be appropriate to -	
(i) the number, mobility and other characteristics of the occupants; and	As discussed in Sections 5 and 11.5. Considered comparable to a similar building that complies with the DTS provisions of the BCA.
(ii) the function or use of the building; and	As discussed in Section 11.5. In consideration of the installed fire safety systems and measures, and the characteristics of the residential levels, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(iii) the travel distance and other characteristics of the building; and	As discussed in Section 11.5. In consideration of the installed fire safety systems and measures, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.

Table 6: Cont'd

Performance Requirement EP2.2	Discussion
(iv) the fire load; and	Considered comparable to a similar building that complies with the DTS provisions of the BCA.
(v) the potential fire intensity; and	As discussed in Section 11.5. The potential fire intensity is considered at least comparable to a similar building that complies with the DTS provisions of the BCA.
(vi) the fire hazard; and	As discussed in Section 11.5. The fire hazard is considered at least comparable to a similar building that complies with the DTS provisions of the BCA.
(vii) any active fire safety systems installed in the building; and	As discussed in Section 11.5. An automatic smoke detection and alarm system will be installed throughout the public corridors to AS 1670.1. An additional heat detector will also be installed within each residential unit, connected to the AS 1670.1 smoke detection system, to provide building occupants with an earlier warning of fire when compared to the DTS provisions of the BCA.
(viii) fire brigade intervention.	As discussed in Section 11.5. A fire hydrant system will be installed throughout the subject development in accordance with the relevant DTS provisions of the BCA and AS 2419.1-2005. The provisions available for fire brigade intervention are considered at least equivalent to the DTS provisions of the BCA.

12.0 FIRE ENGINEERING ANALYSIS (ALTERNATIVE SOLUTION 2)

12.1 GENERAL

This Fire Engineering Analysis will assess whether the proposed Alternative Solution will achieve compliance with Performance Requirements DP4 and EP2.2 of the BCA.

12.2 RELEVANT BCA DTS PROVISIONS

Clause D1.4 of the BCA states, in part, that no point on a floor must be more than 20m from an exit, or a point from which travel in different directions to 2 exits is available, in which case the maximum distance to one of those exits must not exceed 40m.

12.3 BASIS OF BCA DTS PROVISIONS

The Guide to the BCA states that the intent of Clause D1.4 of the BCA is ***"To maximise the safety of occupants by enabling them to be close enough to an exit to safely evacuate"***.

The maximum exit travel distances given within the BCA are notional figures, and do not consider the layout of the building and / or the active fire safety systems installed.

12.4 VARIATION TO BCA DTS PROVISIONS

As outlined in Table 1 of the Executive Summary, it is proposed to have an exit travel distance to a point of choice from which travel in different directions to 2 exits is available within the basement level of up to 32m, in lieu of 20m. This occurs within the Bike Store, as shown in Figure 17 below.

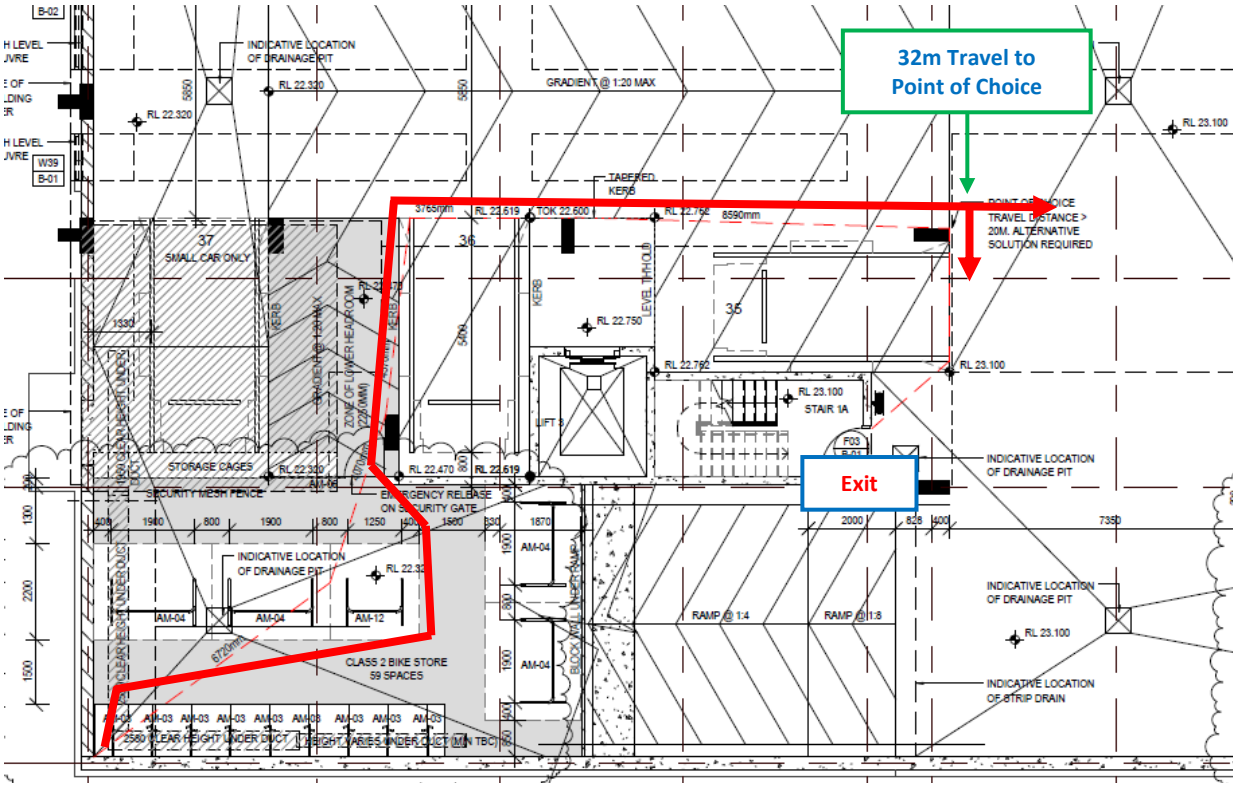

Figure 17: Part Basement Level Plan

12.5 ASSESSMENT OF ALTERNATIVE SOLUTION

Qualitative Assessment

Introduction

It is considered that the DTS requirements for a travel distance of 20m to a single exit, or 20m to a point of choice, relates to the potential that an occupant may be exposed to a fire whilst evacuating. Therefore increasing the travel distance to an exit or point of choice may increase the risk that the path of travel to an exit becomes blocked or obstructed as a result of fire.

The following is an assessment / discussion of the fire safety systems and measures that will be implemented within the subject development that will ensure occupants can evacuate from the basement level in conditions at least equivalent to that of a design that complies with the minimum DTS provisions of the BCA.

Fire Detection System

A system of heat detectors will be installed throughout all areas of the basement level in accordance with AS 1670.1, and will form part of the smoke detection system serving the residential levels of the building.

The heat detectors within the basement level will also be arranged to activate a building occupant warning system throughout all levels of the building. Thus occupants within the basement level will be provided with an automatic warning in the event of fire within the basement level.

As there are dedicated fire-isolated exits serving the basement level (i.e. not combined with the residential levels above), Table E2.2a of the BCA does not require a smoke and / or heat detection system to be installed throughout the basement level. Therefore the provision of heat detectors throughout the basement level, which will be arranged to activate a building occupant warning system, is considered to exceed the minimum DTS provisions of the BCA where such a system is not required.

For a DTS Compliant Design, where an automatic fire detection and alarm system is not installed, the time at which building occupants will receive a fire cue would be based on:

- Cues associated with the initiation and development of fire, which stimulate the senses of an occupant (i.e. visual, sound, smell).

  This type of cue could involve occupants having direct contact with a fire (i.e. sight), or receiving unexpected or unfamiliar signals as a result of fire (sound and/or smell). Unexpected sounds may include breaking glass or falling objects etc, and unfamiliar smells may include the products of combustion (smoke).

- Warning from others

  This type of cue involves the direct contact of occupants from other occupants who may have already received a fire cue as outlined above.

  Therefore if a fire initiated in the basement level, occupants are unlikely to receive a fire cue until the affects of fire or products of combustion have reached them, or through the warning from others. Therefore unless occupants are located directly adjacent to the fire or within the direct line of site of the fire, this will significantly delay the initiation of occupant movement towards the exits, especially for those occupants that are located remote from the fire.

Therefore the improved warning provided by the heat detectors within the basement level will correspond to a lower cue time, when compared to the DTS Compliant Design as described above.

The additional 12m of exit travel distance to reach the point of choice within the basement level could equate to an additional 12 seconds of occupant movement time to reach the point of choice (based on a conservative occupant movement speed of 1m/s). The improved occupant cue time provided by the required fire detection system is considered to offset the additional 12 seconds of movement time to reach the point of choice.

NOTE: The evacuation flow speed of a group of people is a function of the population density. Proulx[2] indicates that traditionally it has been calculated that if the population density is less than about 0.5 persons / m², people are able to move along walkways at about 1.25m/s, which is an average unrestricted walking speed. At this speed occupants are moving at their own pace, and independent of the speed of others.

The population density within the basement level is less than 0.5 persons / m², where an average walking speed of 1.25m/s could be considered. However for added redundancy, an average occupant travel speed of 1m/s has been considered. This is a widely accepted travel speed on level ground for fire engineering analysis.

Enhanced Building Occupant Warning System

As part of the overall fire safety strategy for the subject development, the building occupant warning system will be enhanced to include a pre-recorded message. The pre-recorded message will state in clear and concise English:

"This is an Emergency - Evacuate the Building Immediately"

The provision of an enhanced building occupant warning system exceeds the minimum DTS provisions of the BCA, and is expected to improve occupant pre-movement times in the event of fire, thus improving the overall evacuation efficiency from the basement level.

There is limited research in the area of occupant pre-movement times. However Table 21 of DD240 Part1[3], suggests some pre-movement times for different occupancies based on the type of building occupancy, the characteristics of the occupants, and the warning systems available, as presented in Figure 18 below.

Occupancy Type	W1 (min)	W2 (min)	W3 (min)
Offices, commercial and Industrial buildings, schools, colleges and universities (Occupants awake and familiar with the building, the alarm system, and evacuation procedure.)	< 1	3	> 4
Shops, museums, leisure-sport centers, and other assembly buildings (Occupants awake but may be unfamiliar with building, alarm system, and evacuation procedure.)	< 2	3	> 6
Dormitories, residential mid-rise and high-rise (Occupants may be asleep but are predominantly familiar with the building, alarm system, and evacuation procedure.)	< 2	4	> 5
Hotels and boarding houses (Occupants may be asleep and unfamiliar with the building, alarm system, and evacuation procedure.)	< 2	4	> 6
Hospitals, nursing homes, and other institutional establishment (A significant number of occupants may require assistance.)	< 3	5	> 8

W1: live directives using a voice communication system from a control room with closed-circuit television facility, or live directives in conjunction with well-trained, uniformed staff that can be seen and heard by all occupants in the space
W2: nondirective voice messages (prerecorded) and/or informative warning visual display with trained staff
W3: warning system using fire alarm signal and staff with no relevant training

Figure 18: Table 21 of DD240 Part1

[2] Proulx, "Evacuation Time", Section 3, Chapter 12, SFPE Handbook of Fire Protection Engineering, 4th Edition, 2008.
[3] Fire Safety Engineering in Building, Part 1: "Guide to the Application of Fire Safety Engineering Principles", Table 21, BSI, DD240, London, 1997

Based on the above table, the estimated delay time to start evacuation (pre-movement time) for the Alternative Solution and a DTS Compliant Design can be compared as follows:

- Alternative Solution - 4 mins (240 seconds), based on a pre-recorded voice message.
- DTS Compliant Design - >5 mins (> 300 seconds), fire alarms only with no voice message.

The above table suggests that the provision of an enhanced building occupant warning system could reduce the delay time of occupants to start evacuation by up to 60 seconds.

In consideration of the above, the provision of an enhanced building occupant warning system is expected to improve the overall evacuation efficiency from the building in the event of fire, and further assist in offsetting the additional 12m of travel distance to reach the point of choice within the basement level.

Characteristic of Occupants

As detailed in Section 5, the occupants within the subject building are considered to be long-term residents, and are expected to be familiar with the building layout and the location of the available exits.

Further the design and layout of the basement level is relatively simplistic, being of single storey and predominantly rectangular in shape. The basement level provides occupants with a simple layout with good visual access, and the travel distances to reach an exit, and between alternative exits, comply with the relevant DTS provisions of the BCA. Therefore the travel time for occupants to reach an exit, or to travel to an alternative exit, will comply with the DTS provisions of the BCA.

Risk of Obstruction

As outlined above, the design of the basement level car park reflects a typical open plan layout. In those areas where the travel distance to a point of choice extends to up to 32m, building occupants will have a clear line of sight to an exit.

The worst case fire scenario within the basement level will involve a non-sprinkler controlled car fire, where occupants may need to travel past a burning vehicle to reach the point of choice. If the design of the basement level was altered so that the travel distance to the point of choice was not greater than 20m (as per a DTS Compliant Design), occupants may still be required to pass by a burning vehicle.

As indicated in the discussions above, the provision of a heat detection system throughout the basement level will improve occupant cue times when compared to the DTS provisions of the BCA. Further, the provision of an enhanced building occupants warning system is expected to improve occupant pre-movement times. Further, much of the path of travel to the point of choice comprises of driveway areas, which are considered to be relatively fuel free and predominantly used for vehicle movement. In consideration of the above, the increase in travel distance to the point of choice will not result in an increased risk of occupants being exposed to a burning vehicle or an increased risk of the path of travel to the point of choice being obstructed.

Characteristics of Basement Level

Pursuant to Clause F3.1(f) of the BCA, the ceiling heights within a car park must not be less than 2.1m. The ceiling heights associated with the subject basement level will vary between approximately 2.7m and 3.6m, which will exceed the minimum DTS provisions of the BCA.

A typical compartment fire generates an upper hot smoke layer, and a relatively cool lower layer comprising of less smoke and predominantly ambient air. Occupants would evacuate through this lower layer where tenability conditions are maintained 2m above the floor.

The higher ceiling within the basement level would provide a larger reservoir for smoke to accumulate at ceiling level, delaying the descent of the hot smoke layer to below 2m from the floor level. As such, the Alternative Solution would render a longer period in which occupants can evacuate under tenable conditions (*where the average ceiling height varies between 2.7m and 3.6m*) when compared to a design that complies with the minimum DTS provisions of the BCA (*where the ceiling height is 2.1m*).

Fire Brigade Intervention

As outlined in Section 11.5, a fire hydrant system will be installed throughout the subject development in accordance with AS 2419.1-2005, and will comprise of internal fire hydrants located within the fire-isolated exits. The fire brigade booster assembly will be located adjacent to the main entrance to the building, and will be protected from radiant heat as per the relevant provisions of AS 2419.1.

The attending fire brigades can access the basement level via the fire-isolated exits and / or via the vehicle entry ramp. Access and egress from the fire-isolated exits will comply with the relevant DTS provisions of the BCA.

In consideration of the above, the provisions for fire brigade intervention will facilitate the needs of the fire brigades at least equivalent to that of the DTS provisions of the BCA.

Conclusion

In consideration of the layout of the basement level, and of the required fire safety systems and measures discussed above, it is demonstrated that occupants can evacuate from the basement level safely and under tenable conditions, at least equivalent to that of a design that complies with the minimum DTS provisions of the BCA.

Therefore the proposed Alternative Solution is demonstrated to achieve compliance with BCA Performance Requirements DP4 and EP2.2.

12.6 SATISFYING BCA PERFORMANCE REQUIREMENTS

The proposed Alternative Solution has been shown to achieve compliance with BCA Performance Requirements DP4 and EP2.2, as summarised in Tables 7 and 8 below.

Table 7: Assessment of Compliance with the BCA Performance Requirement DP4

Performance Requirement DP4	Discussion
Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to -	
(a) the travel distance; and	As discussed in Section 12.5. In consideration of the installed fire safety systems and measures, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(b) the number, mobility and other characteristics of occupants; and	As discussed in Sections 5 and 12.5. Considered comparable to a similar building that complies with the DTS provisions of the BCA.

Table 7: Cont'd

Performance Requirement DP4	Discussion
(c) the function or use of the building; and	As discussed in Section 12.5. In consideration of the installed fire safety systems and measures, and the characteristics of the basement level, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(d) the height of the building; and	N/A Considered comparable to the DTS provisions of the BCA.
(e) whether the exit is from above or below ground level.	N/A Considered comparable to the DTS provisions of the BCA.

Table 8: Assessment of Compliance with the BCA Performance Requirement EP2.2

Performance Requirement EP2.2	Discussion
(a) In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that -	
(i) the temperature will not endanger human life; and	As discussed in Section 12.5. In consideration of the installed fire safety systems and measures, and the characteristics of the basement level, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(ii) the level of visibility will enable the evacuation route to be determined; and	As discussed in Section 12.5. In consideration of the installed fire safety systems and measures, and the characteristics of the basement level, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(iii) the level of toxicity will not endanger human life.	As discussed in Section 12.5. In consideration of the installed fire safety systems and measures, and the characteristics of the basement level, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(b) The period of time occupants take to evacuate referred to in (a) must be appropriate to -	
(i) the number, mobility and other characteristics of the occupants; and	As discussed in Sections 5 and 12.5. Considered comparable to a similar building that complies with the DTS provisions of the BCA.
(ii) the function or use of the building; and	As discussed in Section 12.5. In consideration of the installed fire safety systems and measures, and the characteristics of the basement level, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.

Table 8: Cont'd

Performance Requirement EP2.2	Discussion
(iii) the travel distance and other characteristics of the building; and	As discussed in Section 12.5. In consideration of the installed fire safety systems and measures, it has been demonstrated that occupants can evacuate safely and under tenable conditions, at least equivalent to the DTS provisions of the BCA.
(iv) the fire load; and	Considered comparable to a similar building that complies with the DTS provisions of the BCA.
(v) the potential fire intensity; and	The potential fire intensity is considered at least comparable to a similar building that complies with the DTS provisions of the BCA.
(vi) the fire hazard; and	. The fire hazard is considered at least comparable to a similar building that complies with the DTS provisions of the BCA.
(vii) any active fire safety systems installed in the building; and	Heat detectors and occupant warning will be installed throughout the basement level to provide occupants with an early warning in the event of fire.
(viii) fire brigade intervention.	As discussed in Section 12.5. A fire hydrant system will be installed throughout the subject development in accordance with the relevant DTS provisions of the BCA and AS 2419.1-2005. The provisions available for fire brigade intervention are considered at least equivalent to the DTS provisions of the BCA.

13.0 FIRE ENGINEERING ANALYSIS (ALTERNATIVE SOLUTION 3)

13.1 GENERAL

This Fire Engineering Analysis will assess whether the proposed Alternative Solution will achieve compliance with BCA Performance Requirement EP1.1.

13.2 RELEVANT BCA DTS PROVISIONS

Clause E1.4 of the BCA states, in part, that a fire hose reel system must be provided to serve the whole building where one or more internal fire hydrants are installed.

13.3 BASIS OF BCA DTS PROVISIONS

The Guide to the BCA states that the intent of Clause E1.4 of the BCA is ***"To require the installation of suitable fire hose reel systems to enable, where appropriate, a building's occupants to undertake initial attack on a fire"***.

13.4 VARIATION TO BCA DTS PROVISIONS

As outlined in Table 1 of the Executive Summary, it is not proposed to install fire hose reels on the residential levels of the building.

13.5 ASSESSMENT OF ALTERNATIVE SOLUTION

Introduction

The main issue to be addressed is to enable occupants to undertake an initial attack on a fire on the residential levels of the building where fire hose reels are proposed to be omitted.

The following is a discussion / assessment of the fire safety systems and measures that will be implemented for the building that will enable building occupants to undertake an initial attack on a fire.

Building Characteristics

For the purposes of BCA Clause E1.4, a residential unit in a Class 2 building is considered to be a fire compartment, fire separated from the remainder of the building. Thus a fire will be confined to the residential unit of fire origin, and will not spread to other parts of the building provided the passive fire systems (fire separation) are properly installed in accordance with the DTS provisions of the BCA.

Further the individual residential units will have floor areas of less than 500m^2, being the maximum permissible fire compartment floor area where fire hose reels are not required under BCA Clause E1.4 (and where internal fire hydrants are also not installed).

Therefore the fire hazard associated with the size of the residential units justifies the use of portable fire extinguishers, in lieu of fire hose reels.

Hazards associated with Fire Hose Reels

The purpose of a fire hose reel is to allow occupants to suppress / extinguish a fire in its infancy, if safe to do so. However, using a fire hose reel involves laying hose through an open unit entry door that can obstruct the path of egress from the unit, and can also contribute to smoke spread from the unit into the public corridors. This would inevitably impact on tenability conditions for occupants within the public corridors during evacuation. The use of fire hose reels could also increase the likelihood of injury in case of fire, due to the occupant fighting the fire in lieu of evacuating.

In addition to the increased risk of fire and smoke spreading into the public corridors, a laid out fire hose within the public corridor could present a trip hazard to other evacuating occupants.

Use of Portable Fire Extinguishers

In contrast to fire hose reels, a portable fire extinguisher can be employed in a residential unit while the unit entry door remains closed, restricting smoke spread into the public corridor.

Fire extinguishers also have a limited capacity of continuous use, which means that occupants can evacuate if the fire was unable to be extinguished. This reduces the risk of an occupant continuing to fight a fire (such as with a hose reel), which could become too large to contain.

The Guide to the BCA states that if an Alternative Solution is used, compliance with Clause E1.4 is not compulsory if alternative means can be found to satisfy the appropriate authority that the Performance Requirements will be achieved. The Guide to the BCA further states that fire extinguishers in buildings allow occupants to fight fires, and that extinguishment may complete all the functions listed in Performance Requirement EP1.1 (which relates to fire hose reels).

As part of the overall fire safety strategy for the subject development, 2.5 kg dry chemical powder AB(E) type portable fire extinguishers will be provided within the public corridors on each residential level of the subject development. The extinguishers will be distributed within the public corridors such that the travel distance from the entrance doorway of any sole-occupancy unit to the nearest extinguisher is not more than 10m.

As outlined above, the fire hazard associated with the size and characteristics of the residential units justifies the use of portable fire extinguishers, in lieu of fire hose reels. Further the use of portable fire extinguishers will reduce the risks associated with the spread of smoke from a fire affected unit into the pubic corridors, and the risks associated with impeding and / or delaying occupant evacuation as discussed above.

BCA 2014 Requirements

Whilst the applicable version of the BCA that applies to the subject development is BCA 2013, Clause E1.4 of BCA 2014 states that fire hose reels are not required to be installed within Class 2 parts of a building. Under the current provisions of BCA 2014, portable fire extinguishers are to be provided in lieu of fire hose reels within Class 2 parts of a building.

The provision of 2.5 kg dry chemical powder AB(E) type portable fire extinguishers within the public corridors of the subject development, where the travel distance from the entrance doorway of any sole-occupancy unit to the nearest extinguisher is not more than 10m, is consistent with the requirements of Clause E1.6 of the BCA 2014.

Conclusion

In consideration of the above, it is demonstrated that the provision of portable fire extinguishers on the residential levels of the building, in lieu of fire hose reels, will allow occupants to safety undertake an initial attack on a fire. Therefore the proposed Alternative Solution is demonstrated to achieve compliance with BCA Performance Requirement EP1.1.

13.6 SATISFYING BCA PERFORMANCE REQUIREMENTS

The proposed Alternative Solution has been shown to achieve compliance with BCA Performance Requirement EP1.1, as summarised in Table 9 below.

Table 9: Assessment of Compliance with the BCA Performance Requirement EP1.1

Performance Requirement EP1.1	Discussion
A fire hose reel system must be installed to the degree necessary to allow occupants to safely undertake initial attack on a fire appropriate to -	
(a) the size of the fire compartment; and	As discussed in Section 13.5. Considered comparable to a similar building that complies with the DTS provisions of the BCA, and where fire hose reels are not required.
(b) the function or use of the building; and	As discussed in Section 13.5. It has been demonstrated that the provision of portable fire extinguishers on the residential levels, in lieu of fire hose reels, will allow occupants to safety undertake an initial attack on a fire.
(c) any other fire safety systems installed in the building; and	As discussed in Section 13.5. Considered comparable to a similar building that complies with the DTS provisions of the BCA.
(d) the fire hazard.	As discussed in Section 13.5. The characteristics of the building and the installed fire safety systems will present a hazard that justifies the use of portable fire extinguishers, in lieu of fire hose reels.

14.0 STANDARDS OF CONSTRUCTION, COMMISSIONING & MAINTENANCE

14.1 GENERAL

The required fire safety systems for the subject development shall be designed and installed in accordance with relevant Australian Standards, and shall be fully commissioned and certified prior to the issue of an Occupation Certificate.

14.2 REQUIRED INSPECTIONS

The building works associated with the subject development shall be progressively inspected during construction to ensure compliance with the relevant provisions of the BCA, relevant Australian Standards, and the requirements and recommendations of this Fire Engineering Report.

The relevant parties required to undertake inspections include, but is not limited to, the following:

- Principle Certifying Authority (PCA).
- Fire Engineer.
- Design Engineer(s).
- Architect.
- Builder.
- Installation Contractor(s).

14.3 CERTIFICATION OF FIRE ENGINEERING DESIGN

This Fire Engineering Report shall form part of the Fire Safety Schedule for the subject development, and shall be certified annually as part of the Annual Fire Safety Statement (AFSS).

All recommendations and requirements outlined within this Fire Engineering Report shall be checked and certified annually as part of the AFSS.

14.4 MAINTENANCE AND SERVICING

All fire safety measures installed throughout the subject development shall be maintained and serviced in accordance with the relevant Australian Standards and manufacturers guidelines, and shall be included in an AFSS.

14.5 BUILDING CHANGES AND MODIFICATIONS

Should the subject development undergo a change in use or classification, or be modified, the Alternative Solutions for the development shall be re-evaluated by a suitably qualified fire safety engineer.

15.0 CONCLUSION

A Fire Engineering Analysis of Alternative Solutions to the DTS provisions of the BCA has been undertaken for a proposed residential affordable housing development located at Wilson Street Eveleigh. The Alternative Solutions relate to the following variations to the DTS provisions of the BCA:

- To have an exit travel distance from a residential unit to a point of choice from which travel in different directions to 2 exits is available on residential levels 1 to 5 of up to 11m, in lieu of 6m.
- To have an exit travel distance from a residential unit to a single exit on level 6 of up to 9m, in lieu of 6m.
- To have an exit travel distance to a point of choice from which travel in different directions to 2 exits is available within the basement level of up to 32m in lieu of 20m.
- To not install fire hose reels on the residential levels of the building.

Based on the Fire Engineering Analysis presented in this report, it is the opinion of Innova Services Pty Ltd that the proposed Alternative Solutions will satisfy BCA Performance Requirements DP4, EP1.1 and EP2.2, subject to the implementation of the Fire Safety Requirements nominated in Section 2 (***Summary of Fire Safety Requirements***) of this report.

APPENDIX A - REFERENCED DRAWINGS

Table 10: List of Referenced Architectural Plans

Drawing No.	Issue	Title	Date
A1000	22	Basement Level General Arrangement Plan	04-04-2014
A1001	36	Ground Level General Arrangement Plan	09-05-2014
A1002	23	Level 1 General Arrangement Plan	02-05-2014
A1003	23	Level 2 General Arrangement Plan	04-04-2014
A1004	22	Level 3 General Arrangement Plan	04-04-2014
A1005	22	Level 4 General Arrangement Plan	04-04-2014
A1006	23	Level 5 General Arrangement Plan	04-04-2014
A1007	22	Level 6 General Arrangement Plan	04-04-2014
A1008	20	Roof Level General Arrangement Plan	04-04-2014
A2000	16	North Elevation	24-04-2014
A2001	16	West Elevation	24-04-2014
A2002	17	South Elevation	24-04-2014
A2003	19	East Elevation & Section M-M	24-04-2014
A2100	15	Section A-A	04-04-2014
A2101	16	Section B-B & C-C & L-L	04-04-2014
A2102	15	Section D-D & E-E	04-04-2014
A2103	14	Section F-F	04-04-2014
A2104	14	Section G-G & H-H	04-04-2014
A2105	14	Section J-J & K-K	04-04-2014