BUSHFIRE ASSESSMENT REPORT
ALTERNATE SOLUTION

PROPOSED MIXED USE DEVELOPMENT
AND RESIDENTIAL SUBDIVISION

Lot 4-10 SEC 6 DP 2505, Lot 101 DP 1110774 and Lot 100 DP 847314
118 Cary Street, Toronto

Date: **20/10/2021**

Prepared for: **Toronto Investments No.1 Pty Ltd**

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Document Status

Revision No.	Issue	Description	Reviewed	Approved by Director
1	07/08/2017	Final	M. Hamilton	P.Couch
2	20/10/2021	Rev A – updated report addressing current legislation, more conservative fire weather data and multi-storey development	E. Davis	P.Couch

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This report has assessed the proposed Mixed Use Development against the requirements of Section 100B of the Rural Fires Act 1997, AS3959 (2018) Construction of buildings in bushfire-prone areas and Planning for Bush Fire Protection (2019).

This report establishes that the development does not comply with the acceptable solutions of Planning for Bush Fire Protection 2019 and offers an alternate solution to more accurately measure the bushfire attack level.

TABLE 1 – PROPERTY DETAILS AND TYPE OF PROPOSAL

Applicant Name	Toronto Investments No.1 Pty Ltd		
Site Address	118 Cary Street, Toronto	**Lot/Sec/DP**	Lot 4-10 SEC 6 DP 2505, Lot 101 DP 1110774 and Lot 100 DP 847314
Local Government Area	Lake Macquarie	**FDI**	100
Bushfire Prone Land	Yes, mapped bushfire prone land		
Type of development	New Building	**Type of Area**	Commercial
Special Fire Protection Purpose	No	**Flame Temperature**	1090K
Application Complies with DTS Provisions	No. Alternate solution with detailed fire model	**Referral to RFS required**	Recommended

TABLE 2 – BUSHFIRE THREAT ASSESSMENT

	North	**East**	**South**	**West**
Vegetation Structure	Maintained Lands	Maintained Lands	Maintained Lands	Forest
Asset Protection Zone (APZ)	140 metres	140 metres	140 metres	33 metres
Accurate Slope Measure	N/A	N/A	N/A	1 degree downslope
Slope Range	N/A	N/A	N/A	1 to 5 degrees downslope
Planning for Bush Fire Protection (2019) Table A1.12.2 Minimum Setbacks	N/A	N/A	N/A	29 metres
AS3959 (2018) Bushfire Attack Level (BAL)	BAL-LOW	BAL-LOW	BAL-LOW	BAL-19

TABLE 3 – PLANNING FOR BUSH FIRE PROTECTION (2019) 5 COMPLIANCE

Performance Criteria	Proposed Development Determinations	Method of Assessment
Asset Protection Zone	Minimum setbacks comply with Planning for Bush Fire Protection (2019) Table A1.12.2 and are able to be achieved within the subject site and neighbouring road reserve considered equivalent to an Asset Protection Zone. Asset Protection Zones for construction have been derived in accordance with AS 3959-2018 Method 2 Detailed Procedure and Planning for Bush Fire Protection (2019). Refer to Appendix 2.0 for Detailed Fire Models	**Alternate Solution**
Landscaping	Landscaping to comply with Planning for Bush Fire Protection (2019) Appendix 4.	Acceptable Solution
Public Road Access	No new public roads are proposed for this development.	Acceptable Solution
Property Access	Property access offers compliance with Planning for Bush Fire Protection (2019) Section 5.	Acceptable Solution
Fire Trail Access	No new fire trails are proposed for this development.	Acceptable Solution
Water and Utility Services	Water, electricity and gas services offer compliance with Planning for Bush Fire Protection (2019) Section 5.	Acceptable Solution

2.0 INTRODUCTION

2.1 PURPOSE OF REPORT

The purpose of this report is to establish suitable bushfire mitigation measures for the proposed Mixed Use Development to be constructed at Lot 4-10 SEC 6 DP 2505, Lot 101 DP 1110774 and Lot 100 DP 847314, 118 Cary Street, Toronto. The assessment acknowledges the requirements of Section 100B of the Rural Fires Act 1997 and Planning for Bush Fire Protection (2019) to protect persons, property and the environment from dangers that may arise from a bushfire.

Under the provisions of Section 100B of the Rural Fires Act 1997 as amended, a Bushfire Safety Authority (BFSA) is required from the Commissioner of the NSW Rural Fire Service.

This report complies with Rural Fires Regulation 2008 Clause 44 Application for Bushfire Safety Authority. The assessment encompasses the subject site and neighbouring areas.

The recommendations within this report address the aims and objectives of Planning for Bush Fire Protection (2019) to reduce the risk of ignition of the development in a bushfire event.

2.2 PROPOSED DEVELOPMENT

The land is zoned B2 Local Centre and is comprised of nine allotments totalling 5350 square metres in size. The proposed development includes the construction of a mixed used development including commercial and residential components which will be 5 stories in height above finished ground level.

2.3 SIGNIFICANT ENVIRONMENTAL FEATURES

The only known significant environmental feature is that the site is located within a mine subsidence area.

2.4 ENVIRONMENTAL ASSETS

There are no known environmental assets on the subject site.

2.5 ABORIGINAL HERITAGE

Searches of National Parks and Wildlife database identify no known aboriginal relics or aboriginal places as defined by National Parks and Wildlife Act 1974 to exist on the site.

PHOTOGRAPH 1 – SITE PHOTO

View of the subject site looking west from Arnott Avenue. Commerical development and roads surround the subject site.

PHOTOGRAPH 2 – WESTERN FORESTED WETLAND

View of the narrow arm of forested wetland located west of the subject site. The vegetation consists of thin strips of vegetation straddling a walkway. Casuarinas dominate the upper stratum with an understorey of native and exotic shrubs. The vegetation is narrow with a detailed fire model prepared to more accurately determine the bushfire attack level.

FIGURE 1 – SITE CONSTRAINTS MAP

3.0 BUSHFIRE ATTACK ASSESSMENT

3.1 VEGETATION CLASSIFICATION

Potential bushfire hazards were identified from Lake Macquarie Council bushfire prone mapping as occurring within the investigation area. Aerial mapping and inspection of the site reveals that the bushfire prone land map is reasonably accurate in respect to the current bushfire hazard.

The major vegetative threats have been determined using Keith (2004) to derive vegetation structures listed in Planning for Bush Fire Protection (2019).

Primary Vegetation Structures have been identified in Figure 1 – Site Constraints Map and separation distances shown in Table 2 – Bushfire Attack Assessment.

3.2 EFFECTIVE SLOPE

Effective slope was measured using 0.5 metre contour data obtained from Department of Lands and verified by a laser hypsometer on site. The laser hypsometer verified slope within the vegetation calculating effective fire run slope from 5 separate measurements in each dominant direction.

Effective Slopes have been identified in Figure 1 – Site Constraints Map and slope ranges are shown in Table 2 – Bushfire Threat Assessment.

3.3 MINIMUM SETBACKS AND ASSET PROTECTION ZONES

Minimum setbacks have been determined in accordance with Table A1.12.2 (Planning for Bush Fire Protection). The minimum Asset Protection Zone for subdivision has been demonstrated in Section 1 Executive Summary and Compliance Tables.

The required asset protection zone is available within the subject site and road reserve.

3.4 BUSHFIRE ATTACK LEVELS

Bushfire attack levels and relevant construction levels in accordance with AS3959 (2018) have been demonstrated in Section 1 Executive Summary and Compliance Tables, Table 2 Bushfire Threat Assessment.

A detailed fire model has been provided which more accurately measures the bushfire attack level to the proposed building works. Reasoning and results have been detailed in Section 8.0 Alternate Solution.

3.5 REVIEW OF MULTI-STOREY RESIDENTIAL DEVELOPMENT

The proposed mixed use building is five stories in height, incorporating a ground floor commercial area and four levels of residential accommodation.

The proposed development complies with Planning for Bush Fire Protection (2019) Section 8.2.2 Multi-storey residential development. The key issues have been examined below:

Issue	Specific Concern	Technical Consideration
Population	Impact on existing community and infrastructure.	What capacity does the existing infrastructure have to allow evacuation of existing and proposed residents in the event of a bush fire?
Design Compliance: A primary arterial road is located to the west of the site. Access to the proposed development is from Arnott Avenue to the east which is both significantly shielded from the bushfire and does not have a high density of neighbouring properties.		
Location of Building	Locating on ridge tops emphasises the risk of convective plume interaction and wind related impacts.	Can the building be located away from ridge tops to areas that have a reduced bush fire exposure? If unavoidable, what is the impact on the risk to the building? Is this risk appropriate for the building and occupant numbers?
Design Compliance: The building is not located on a ridgetop with relatively level topography. The bushland threat to the west is relatively low with the risk appropriate for the building size and occupant numbers.		
Design Fire	Different elements of the flame could have different impacts on different levels of the building; and The whole building could be impacted by ember attack and multiple floors could be alight simultaneously	What are the flame dimensions, including the flame angle? Where is the hottest part of the flame located? How would this impact on the proposed building? How would the warning and suppression systems in the building cope with this?
Design Compliance: The flame length is less than the asset protection zone with no chance of potential flame contact. The hottest part of the flame is located at the base with the peak radiant heat exposure occurring at 9.63 metres above finished ground level. The building will have non-combustible cladding and significant concrete with BAL-19 deemed a conservative level of construction to mitigate potential bushfire.		

Egress	Elevations exposed to bush fire risk.	How does the emergency evacuation procedure take account of the location of bush fire prone vegetation?
Design Compliance: The architect has identified that no emergency management plan or evacuation procedure has been prepared for the development application and that this will be considered later. A recommendation for condition of consent is to have the building manager prepare an emergency management plan in accordance with NSW RFS guidelines. Bushfire risk should be considered within the evacuation plan and bushfire response with residents recommended to close windows and doors in the event of bushfire and move any flammable outside furnishings into the building.		
Building Construction	Performance of the building façade in a bush fire scenario. Balconies may contain external features which could ignite and contribute to building ignition and fuel loads.	What wall and cladding materials are proposed and what is proposed for the openings/penetrations (i.e. windows and doors)? How does the proposed building construction deal with fire spread from the vegetation to the inside of the building? Is compliance with AS 3959 sufficient to ensure that the bush fire risk is mitigated? Is this appropriate for the design fire scenario? Are there balconies proposed? What may be stored on the balconies? Can there be restrictions on what is stored on the balconies due to fire risk?
Design Compliance: Wall materials will be non-combustible for NCC compliance of Class 2 Building. Exact material not decided yet as the building system not decided yet. BAL-19 is deemed appropriate construction to reduce the chance of building ignition from bushfire. Balconies are proposed and will be sprinklered as part of BCA compliance for Class 2, Building Type A. There is no restriction of what may be stored on the balconies.		

Car Parking	Lower storey car park could be subject to ember attack and high radiant heat loads.	Is the warning and suppression system designed to take account of bush fire impact? Where are exits located? Are they guiding occupants away from the car park?
Design Compliance: The warning and fire suppression system is expected to be designed in the construction certificate phase. The exits are located away from the bushland with significant shielding of the building bulk. Residents will be able to evacuate away from the bushfire directly towards Lake Macquarie.		
Other Considerations	Access for fire fighters may be restricted or challenging; and Risk implications of floor to floor fire spread.	What would this mean for fire suppression? How would warning and suppression systems take account of this? What would this mean for evacuation?
Design Compliance: A BCA review has been completed. The review has identified required FRLs and NCC compliance factors, which are to be addressed as part of construction certificate documentation. This may include fire engineering solutions for evacuation routes within the building. There are multiple stairwells and lifts providing redundancy in building evacuation and access for firefighters.		

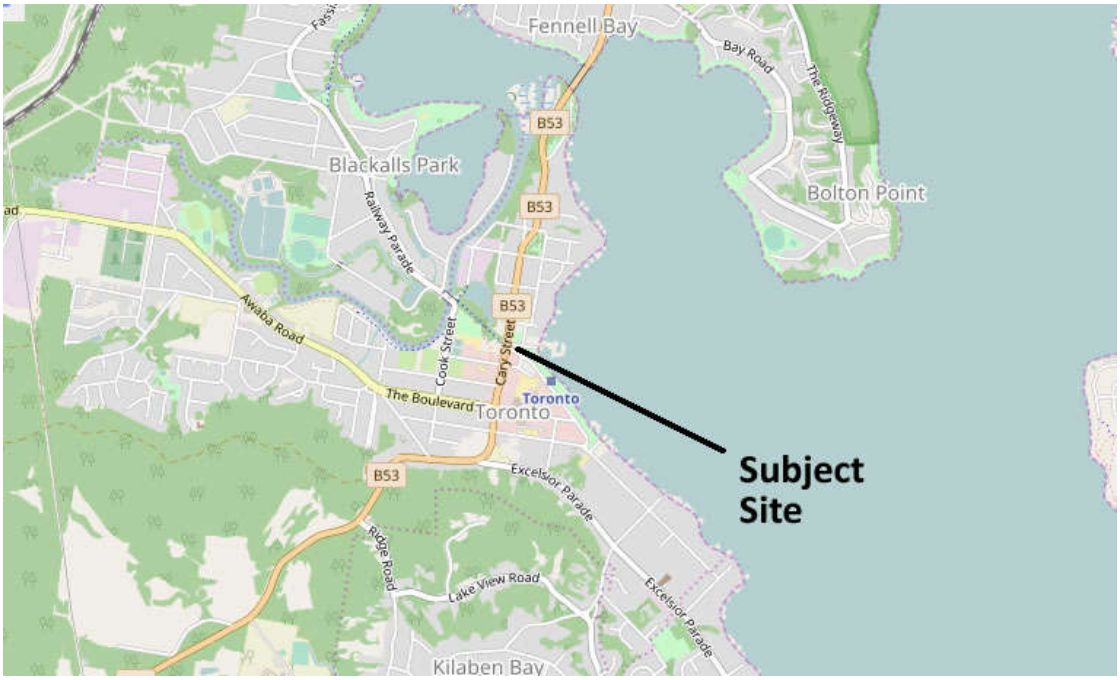

FIGURE 2 – LOCALITY MAP
Courtesy of OpenStreetMap

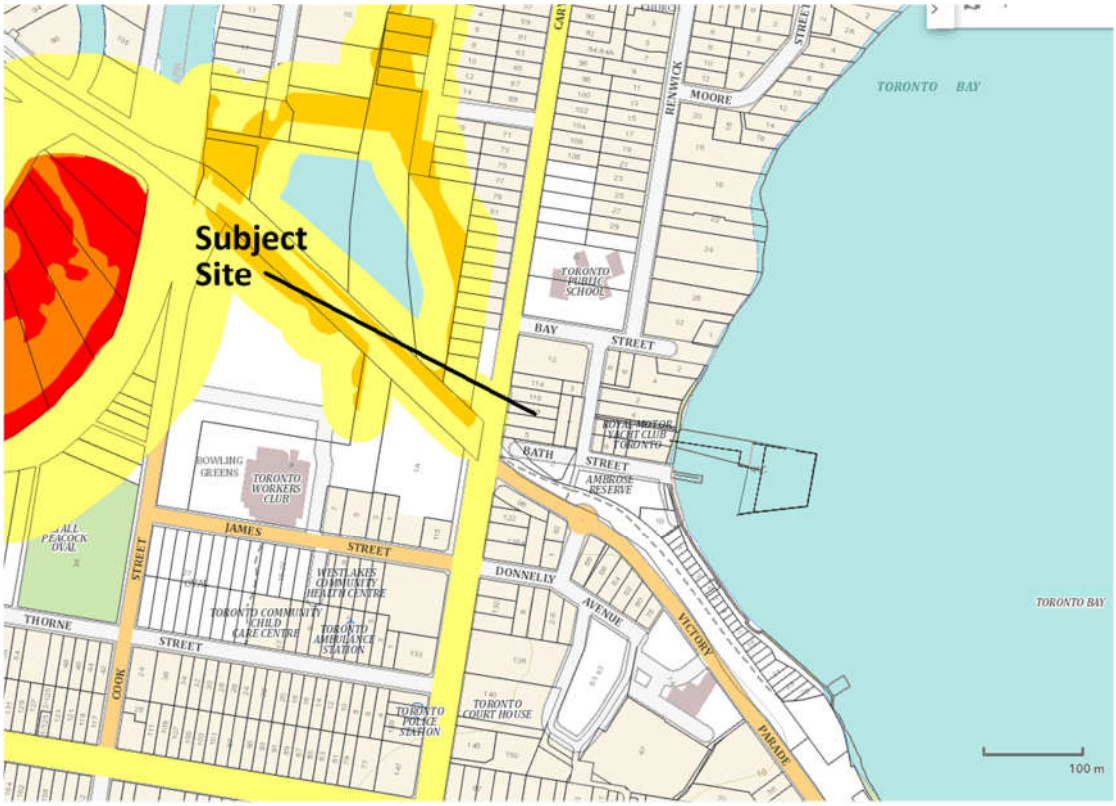

FIGURE 3 – COUNCIL'S BUSHFIRE PRONE LAND MAP

4.0 UTILITY SERVICES AND INFRASTRUCTURE

4.1 WATER SERVICES

A reticulated water supply and street hydrant access is available. The proposed building footprint is within 70 metres of a hydrant with internal attack hydrants expected to be designed and installed in accordance with AS2419.1. It is noted that hydrant pressures have not been tested as part of this report.

4.2 ELECTRICITY SERVICES

The existing electrical supply to the local area is via overhead electrical transmission lines. Landscaping onsite should be managed so that no part of a tree is closer to a power line than the distance set out in accordance with the specifications in 'Vegetation Safety Clearances' issued by Energy Australia (NS179, April 2002).

PHOTOGRAPH 3 – WESTERN ARTERIAL ROAD

View of Cary Street being a primary arterial road through Toronto which offers a significant asset protection zone. The public road network will support parallel and direct firefighting efforts for any low-intensity fires that may occur in the bushland.

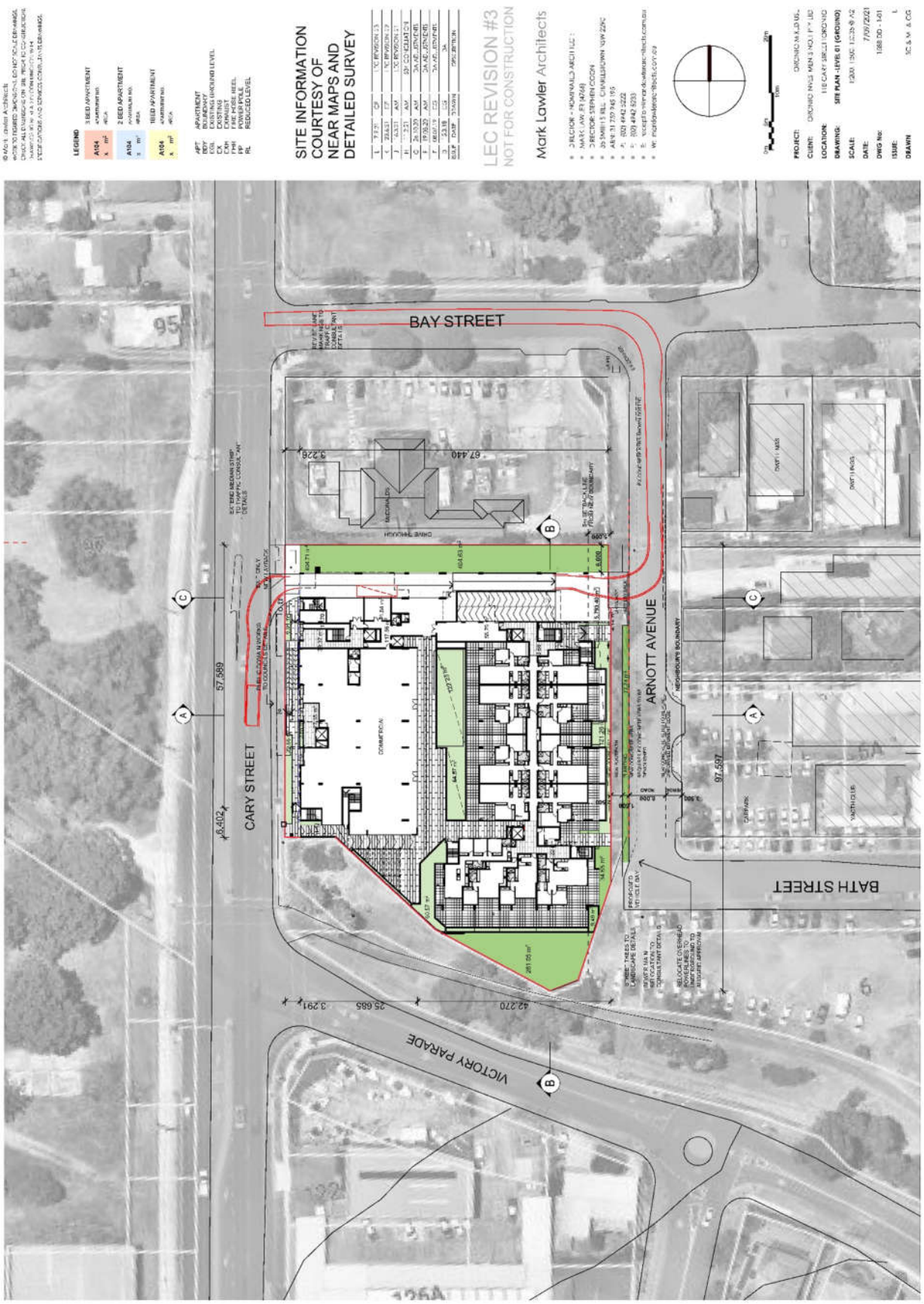

FIGURE 4 – SITE PLAN

4.3 GAS SERVICES

- Reticulated or bottled gas installed and maintained in accordance with AS 1596 -2002 and the requirements of the relevant authorities. Metal piping is to be used.
- Fixed gas cylinders to be kept clear of flammable material by a distance of 10m and shielded on the hazard side of the installation.
- Gas cylinders close to the dwelling are to have the release valves directed away from the building and at least 2m from flammable material with connections to and from the gas cylinder being of metal.
- Polymer sheathed flexible gas supply lines to gas meters adjacent to the buildings are not to be used.

5.0 PROPERTY ACCESS

Public Road Access
The subject site is located on Arnott Avenue being a two lane road interconnecting into the local road network. Resident evacuation will be away from the bushland threat. Emergency Services are expected to have good access to the area at most times.

A traffic study has been completed for this development.

Fire Trails
Fire trails do not intersect the vegetation in the local area. No new fire trails are proposed for this development.

Property Access
Property access is provided by way of Cary Street providing access from the public road system directly to the private land giving fire fighters access to the building.

Property access roads shall comply with section 5 of Planning for Bush Fire Protection 2019.

Planning for Bush Fire Protection (2019) requires no specific access requirements in an urban area where a 70 metres unobstructed path can be demonstrated between the most distant external part of the proposed dwelling and the nearest part of the public access road (where the road speed limit is not greater than 70kph) that supports the operational use of emergency firefighting vehicles (i.e. a hydrant or water supply). There are no formal requirements for property access.

6.0 LANDSCAPING MAINTENANCE

It is recommended that landscaping is undertaken in accordance with Appendix 5 of Planning for Bush Fire Protection 2019 and maintained for the life of the development.

Trees should be located greater than 2 metres from any part of the roofline of a building. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres from an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground.

The landscaped area should be maintained free of leaf litter and debris. The gutter and roof should be maintained free of leaf litter and debris.

Landscaping should be managed so that flammable vegetation is not located directly under windows.

Ground fuels such as fallen leaves, twigs (less than 6mm in diameter) and branches should be removed on a regular basis, and grass needs to be kept closely mown and where possible green.

7.0 EMERGENCY AND MAINTENANCE PLANS

7.1 BUSHFIRE MAINTENANCE PLANS

There is no known Bushfire Maintenance Plan for the site. A condition of development is to maintain the entire site as an Inner Protection Area which should be monitored by the building owner.

7.2 FIRE EMERGENCY PROCEDURES

The building manager is recommended to prepare an Emergency /Evacuation Plan consistent with the NSW Rural Fire Service document Guidelines for the Preparation of Emergency/Evacuation Plan.

8.0 ALTERNATE SOLUTION

At the request of the client I have been asked to provide an unbiased safety model for the proposed development. The proposed alternate solution offers compliance with National Construction Code 2019 performance measure of reducing the chance of ignition to the building from the firefront and the objectives of Planning for Bush Fire Protection (2019).

Proposed Performance Based Solution

The proposed performance based solution determines the Bushfire Attack Level (BAL) using an AS3959 (2018) Method 2 Detailed Fire Model. There is a narrow arm of forested wetland located west of the site with a reduced potential fire head width. This will significantly reduce the rate of spread, flame length and intensity of the fire. The AS3959 (2018) and Planning for Bush Fire Protection (2019) simplified design fire models are for a 100 metre wide fire front which is deemed inaccurate.

Investigations into the forecast fire behaviour have been considered in accordance with a 1 in 50 year event (Douglas et al., 2014).

Methodology of Assessment

The building works need to comply with the performance requirement of P2.3.4 of the Building Code of Australia (BCA). Part 1.0.5 of the Housing Provisions identifies how to satisfy the performance requirements as follows:

> **1.0.5 Meeting the Performance Requirements**
> 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; or
> (c) a combination of (a) and (b).

This bushfire assessment achieves compliance by meeting the performance requirements of Section 1.0.5(c) of the Housing Provisions of the BCA.

The assessment method for the Performance Based Solution is identified in Part 1.0.9 – Assessment Methods in the Housing Provisions of the BCA. The assessment has been prepared in accordance with Part 1.0.9(b)(ii) by using a qualitative and quantitative analysis consistent with Planning for Bush Fire Protection (2019).

Quantitative Analysis

Vegetation Structure Assessment

Planning for Bush Fire Protection (2019) general fuel loads for forest have been accepted as a conservative measure Forest fuel loads utilised in the design fire are:

- Surface Fuel Load: 22 tonnes per hectare
- Overall Fuel Load: 36.1 tonnes per hectare

Design Fire Parameters

Douglas et al. (2014) defines forest fire dangers using Extreme Value Analysis in Determining Annual Probability of Exceedance for Bushfire Protection Design. The FFDI for a 1 in 50 year event based upon Williamtown weather station is FFDI 106, with this having been used in all fire models.

Design Fire Outputs

Western Forest
Flame Length: 23.82 m
Radiant Heat Flux: 15.72 kw/m2 (BAL-19)

Qualitative Analysis - Evaluation of Performance Based Solutions

AS3959 (2018) Construction of buildings in bushfire-prone areas and Planning for Bush Fire Protection (2019) detail the calculations required for detailed fire modelling and Newcastle Bushfire Consulting's proprietary modelling tool uses these. The detailed fire models have been provided in Appendix 2.0 of this report.

Section 3.5 of this report has examined multi-storey development in bushfire prone areas and found the development to provide safe egress to residents and a defendable development.

A fire yielding BAL-19 is deemed to be a conservative design fire from the west where the bushland is closest. All future buildings will be built in a location that will be exposed to BAL-29 or lower and multi-storey development has been examined.

Compliance with National Construction Code 2019

The combination of building recommendations, fire resistant design, maintenance of landscaping/asset protection zones and acknowledgment of risk achieves the performance requirements of the National Construction Code 2019.

National Construction Code 2019 P2.3.4 Bushfire areas

A Class 1 building or a Class 10a building or deck associated with a Class 1 building that is constructed in a designated bushfire prone area must, to the degree necessary, be designed and constructed to reduce the risk of ignition from a bushfire, appropriate to the—

a. potential for ignition caused by burning embers, radiant heat or flame generated by a bushfire; and
b. intensity of the bushfire attack on the building.

9.0 RECOMMENDATIONS

Based upon an assessment of the plans and information received for the proposal, it is recommended that development consent be granted subject to the following conditions:

1. The proposed building works for the residential component of the building excepting the eastern elevation shall comply with BAL-19 in accordance with AS3959 (2018) Construction of buildings in bushfire-prone areas or National Association of Steel-Framed Housing (NASH) Standard (1.7.14 updated) for Steel Framed Construction in Bushfire Areas as appropriate and the additional construction requirements of Planning for Bush Fire Protection (2019) Section 7.5.2.
2. The eastern elevation of the residential units shall comply with BAL-12.5 in accordance with AS3959 (2018) Construction of buildings in bushfire-prone areas or National Association of Steel-Framed Housing (NASH) Standard (1.7.14 updated) for Steel Framed Construction in Bushfire Areas as

appropriate and the additional construction requirements of Planning for Bush Fire Protection (2019) Section 7.5.2.

3. The proposed building works for the commercial component of the building shall comply with Building Code Australia 2019 Structural Fire Safety requirements.
4. At the commencement of building works and in perpetuity, the entire property shall be managed as an inner protection area (IPA) as outlined within Appendix 4 of Planning for Bush Fire Protection 2019 and the NSW Rural Fire Service's document Standards for Asset Protection Zones.
5. Water, electricity and gas are to comply with Planning for Bush Fire Protection (2019) Section 7.
6. Landscaping is to be undertaken in accordance with Planning for Bush Fire Protection (2019) Appendix 4 and managed and maintained in perpetuity.
7. The building manager is recommended to prepare an Emergency /Evacuation Plan consistent with the NSW Rural Fire Service document Guidelines for the Preparation of Emergency/Evacuation Plan.

10.0 CONCLUSION

The final recommendation is that there is buildable area onsite for the development with appropriate services and asset protection zones available. The proposed development can comply with the requirements of Planning for Bush Fire Protection 2019 guidelines as required under section 100b of the Rural Fires Act 1997. This report should be referred to NSW Rural Fire Service for the issue of a Bushfire Safety Authority.

11.0 APPENDIX 1.0 – ASSET PROTECTION ZONES SUMMARY

Below is a summary of Asset Protection Zones outlined in Planning for Bush Fire Protection (2019) Appendix 4 and the NSW RFS's Standards for Asset Protection Zones. The property owner(s) should obtain these two documents and familiarise themselves with their content.

Generally

Asset Protection Zones (APZ) refers to the area between the bushfire threat and the asset (i.e. building). The APZ may contain two areas; the Inner Protection Area (IPA) and the Outer Protection Area (OPA). Some areas should be managed entirely as an Inner Protection Area (IPA). Refer to the plans for locations of APZ and distances from Assets.

Inner Protection Area (IPA)

The inner protection area is located adjacent to the asset and is identified as a fuel free zone.

A. Shrubs (consisting of plants that are not considered to be trees)

1. Shrubs must be located away from a buildings glazing and vent openings.
2. Avoid planting around entry ways if the vegetation is flammable.
3. A maximum 30% of the Inner Protection Area may contain shrubs.
4. A minimum 1.5 metre separation of shrubby vegetation from the building shall be maintained.
5. Shrubs must not have a connection with the tree canopy layer; remove/trim shrubs or underprune trees.
6. Ensure turf is suitably mown and/or grasslands are continually slashed to restrict to max 100mm high.

B. Trees: Maintain a minimum 2-5 metre canopy separation.

1. Trees are allowed in the inner protection area however they should not touch or overhang buildings. No tree should be within 2 metres of the roofline.
2. Underprune branches between the shrub layer and the canopy layer.
3. Ensure branches do not overhang buildings.
4. Ensure all trees in the IPA within 3 metres of buildings do not provide a serious fire threat.
5. Trees should have lower limbs removed up to a height of 2 metres above the ground.

Outer Protection Area (OPA)

The Outer Protection Area (OPA) is located adjoining vegetation threat. The OPA should be maintained as a fuel reduced area. This assumes trees may remain but with a significantly reduced shrub, grass, and leaf litter layer. In many situations leaf litter and the shrub layer may not require maintenance at all.

A. Shrubs:

1. Reduce or trim large stands of shrubs

B. Trees:

1. Existing trees can be retained.
2. Ensure a separation is available between shrubs and tree canopy.
3. Reduce tree canopy so there is no interlocking canopy.

12.0 APPENDIX 2.0 – AS3959 METHOD 2 DETAILED FIRE MODEL

NBC Bushfire Attack Assessment Report V4.1

AS3959 (2018) Appendix B - Detailed Method 2

Print Date: 20/10/2021 **Assessment Date:** 20/10/2021

Site Street Address: 118 Cary Street, Toronto

Assessor: Phillip Couch; Newcastle Bushfire Consulting

Local Government Area: Lake Macquarie **Alpine Area:** No

Equations Used

Transmissivity: Fuss and Hammins, 2002
Flame Length: RFS PBP, 2001/Vesta/Catchpole
Rate of Fire Spread: Noble et al., 1980
Radiant Heat: Drysdale, 1985; Sullivan et al., 2003; Tan et al., 2005
Peak Elevation of Receiver: Tan et al., 2005
Peak Flame Angle: Tan et al., 2005

Run Description: Western Forested Wetland

Vegetation Information

Vegetation Type:	Forest (including Coastal Swamp Forest)		
Vegetation Group:	Forest and Woodland		
Vegetation Slope:	1 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	36.1
Vegetation Height(m):	2	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	1 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	33

Fire Inputs

Veg./Flame Width(m):	42	**Flame Temp(K):**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg)	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	106

Program Outputs

Level of Construction:	BAL 19	**Peak Elevation of Receiver(m):**	9.63
Radiant Heat(kW/m2):	15.72	**Flame Angle (degrees):**	59
Flame Length(m):	23.82	**Maximum View Factor:**	0.254
Rate Of Spread (km/h):	3	**Inner Protection Area(m):**	20
Transmissivity:	0.812	**Outer Protection Area(m):**	13
Fire Intensity(kW/m):	55923		

13.0 REFERENCES AND DISCLAIMER

References

Standards Australia (2018) AS3959 Construction of buildings in bushfire-prone areas

Douglas G. He Y. Yang X. and Morris E.C. (2014) Use of Extreme Value Analysis in Determining Annual Probability of Exceedance for Bushfire Protection Design. Proceedings of the 11th International Association of Fire Science, Christchurch, New Zealand.

Keith D. (2004) "Ocean Shores to Desert Dunes," Department of Environment and Conservation, Sydney.

Environmental Planning and Assessment Act (1979)

New South Wales Rural Fire Service (2019) Planning for Bush Fire Protection

Watson, P. (2012) Fuel Load Dynamics in NSW Vegetation

Disclaimer

Despite the recommendations in this report, it is impossible to remove the risk of fire damage to the building entirely. This report assesses and provides recommendations to reduce that risk to a manageable level. It is of paramount importance that the recommendations are adhered to for the life of the structure and that all maintenance is performed to ensure a level of protection is provided to the building, occupants and firefighters.

Planning for Bush Fire Protection (2019) states that notwithstanding the precautions adopted, it should always be remembered that bushfires burn under a wide range of conditions and an element of risk, no matter how small, always remains.

AS3959 (2018) Building in bushfire-prone areas states that the standard is designed to lessen the risk of damage to buildings occurring in the event of the onslaught of bushfire. There can be no guarantee, because of the variable nature of bushfires, that any one building will withstand bushfire attack on every occasion.