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bushfire & ecology

bushfire protection assessment

Proposed Residential Subdivision
Lot 6 DP 593628 & Lot 3 DP 1103503,
46a & 46 -66 O'Connell Street, Caddens

Under Section 100B of the Rural Fires Act (1997)

January 2017
(REF: A16195B)

Bushfire Protection Assessment

Proposed Residential Subdivision
Lot 6 DP 593628 & Lot 3 DP 1103503
46a & 46-66 O'Connell Street, Caddens

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BPAD Bushfire Planning & Design Accredited Practitioner Level 3

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The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

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EXECUTIVE SUMMARY

A bushfire protection assessment has been undertaken for the proposed residential subdivision of Lot 6 DP 593628 & Lot 3 DP 1103503 46a & 46-66 O'Connell Street, Caddens.

The development is categorised by the NSW Rural Fire Service (RFS) as being a residential subdivision and this requires the RFS to issue a bushfire safety authority (BSA) in accordance with *Planning for Bush Fire Protection 2006 (PBP).*

PBP dictates that the subsequent extent of bushfire attack that can potentially impact a building envelope in a proposed allotment should exceed a radiant heat flux of 29kW/m^2 for residential subdivision development. This rating assists in determining the size of the asset protection zone (APZ), which provides the necessary defendable space between hazardous vegetation and a building.

The assessment found that bushfire can potentially affect the proposed development from the forest vegetation located to the west of the site, beyond O'Connell Street, and the bushland vegetation proposed to be retained and revegetated within the southern portion of the site resulting in the subdivision being exposed to potential radiant heat and ember attack.

The bushfire risk posed to the development can be mitigated as appropriate bushfire protection measures will be in place and managed in perpetuity.

The assessment has concluded that the proposed development can provide compliance with *PBP*.

GLOSSARY OF TERMS

AHIMS	Aboriginal Heritage Information System
APZ	Asset protection zone
AS1596	*Australian Standard – The storage and handling of LP Gas*
AS2419	*Australian Standard – Fire hydrant installations*
AS3745	*Australian Standard – Planning for emergencies in facilities*
AS3959	*Australian Standard – Construction of buildings in bushfire-prone areas 2009*
BAL	*Bushfire attack level*
BCA	*Building Code of Australia*
BSA	Bushfire safety authority
EP&A Act	*Environmental Planning & Assessment Act 1979*
FDI	Fire danger index
IPA	Inner protection area
LEP	Local Environmental Plan
OPA	Outer protection area
PBP	*Planning for Bush Fire Protection 2006*
RF Act	*Rural Fires Act 1997*
RFS	NSW Rural Fire Service
SFPP	Special fire protection purpose

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Introduction 1

A bushfire protection assessment has been undertaken for the proposed residential subdivision of Lot 6 DP 593628 & Lot 3 DP 1103503 46a & 46-66 O'Connell Street, Caddens.

The proposed subdivision is located on land mapped by Penrith City Council as being bushfire prone. This triggers a formal assessment by Council in respect of the NSW Rural Fire Service (RFS) policy against the provisions of *Planning for Bush Fire Protection 2006 (PBP).*

1.1 Aims of the assessment

The aims of the bushfire protection assessment are to:

- Review the bushfire threat to the landscape
- Undertake a bushfire attack assessment in accordance with *PBP*
- Provide advice on mitigation measures, including the provision of asset protection zones (APZs), construction standards and other specific fire management issues
- Review the potential to carry out hazard management over the landscape

1.2 Project synopsis

The proposal is to subdivide the site of approximately 12.18ha into 320 Multi-dwelling Housing Units and an undisclosed number of Apartment Units within ancillary infrastructure such as roads and services. The existing two residences and associated structures will be removed.

The proposal involves the conservation of threatened Cumberland Plain Woodland vegetation within the 'woodland park' located in the central southern portion of the site. A perimeter road network will be provided around the perimeter of the vegetation.

Schedule 1 shows the proposed subdivision and bushfire protection measures, including APZs.

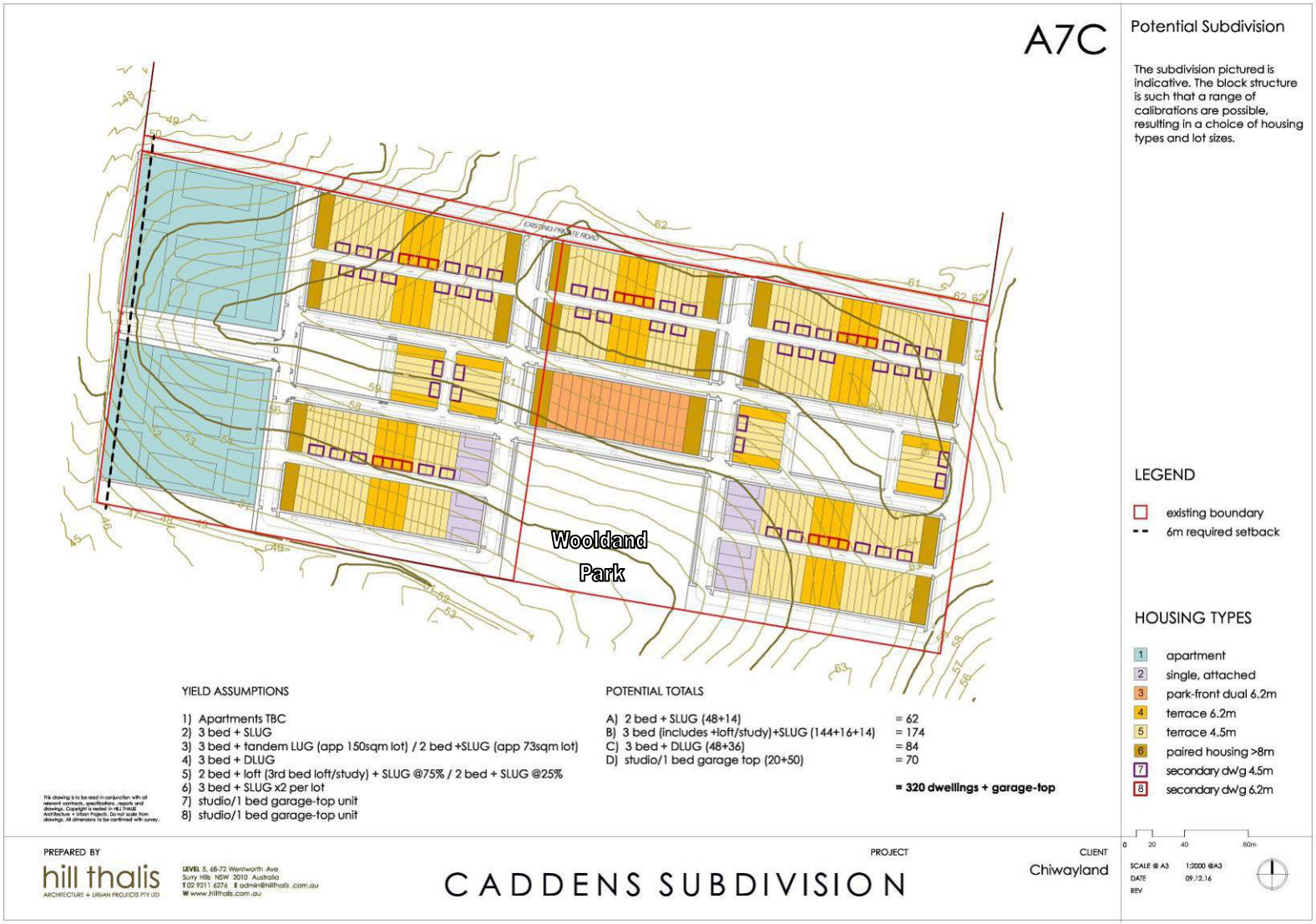


Figure 1.1 – Proposed subdivision

1.3 Information collation

To achieve the aims of this report, a review of the information relevant to the property was undertaken prior to the initiation of field surveys. Information sources reviewed include the following:

- Concepts plans prepared by *Hill Thalis 09.12.2016*
- Penrith Local Environmental Plan 2012
- *NearMap* aerial photography
- Topographical maps DLPI of NSW 1:25,000
- Australian Standard 3959 *Construction of buildings in bushfire-prone areas* (AS3959)
- *Planning for Bush Fire Protection (PBP)*

An inspection of the proposed development site and surrounds was undertaken by Nicole van Dorst on 28 January 2016 to assess the topography, slopes, aspect, drainage, vegetation and adjoining land use. The identification of existing bushfire measures and a visual appraisal of bushfire hazard and risk were also undertaken.

1.4 Site description

The site is located to the east of O'Connell Street, Caddens within the local government area (LGA) of Penrith.

The site is bound to the north by the Nepean Tafe College Kingswood Campus, to the east by the University of Western Sydney – Werringtons South Campus and managed lands (future Town Centre/ High Density Residential) to the south. The land beyond O'Connell Street to the west consists of a mixture of forest and forested wetland vegetation. The southern portion of the site currently supports Cumberland Plain Woodland vegetation within a 'woodland park' and will be retained as part of the development (refer Figure 1.2).

Figure 1.2 – Aerial appraisal
(Source: Six Maps Vegetation, 2016)

1.5 Legislation and planning instruments

1.5.1 Environmental Planning and Assessment Act (EP&A Act)

The *EP&A Act* governs environmental and land use planning and assessment within New South Wales. It provides for the establishment of environmental planning instruments, development controls and the operation of construction controls through the *Building Code of Australia (BCA)*. The identification of bushfire prone land is required under Section 146 of the *EP&A Act*.

1.5.2 Bushfire prone land

Bushfire prone land maps provide a trigger for the development assessment provisions. The proposed development is located on land that is mapped by Penrith City Council as being bushfire prone.

The proposed development is an integrated development under Section 91 of the *EP&A Act 1979*. Consequently, the proposed residential development will require a bushfire safety authority (BSA) from the NSW Rural Fire Service (RFS). The Commissioner must be satisfied that the proposal complies with *PBP* before granting a BSA.

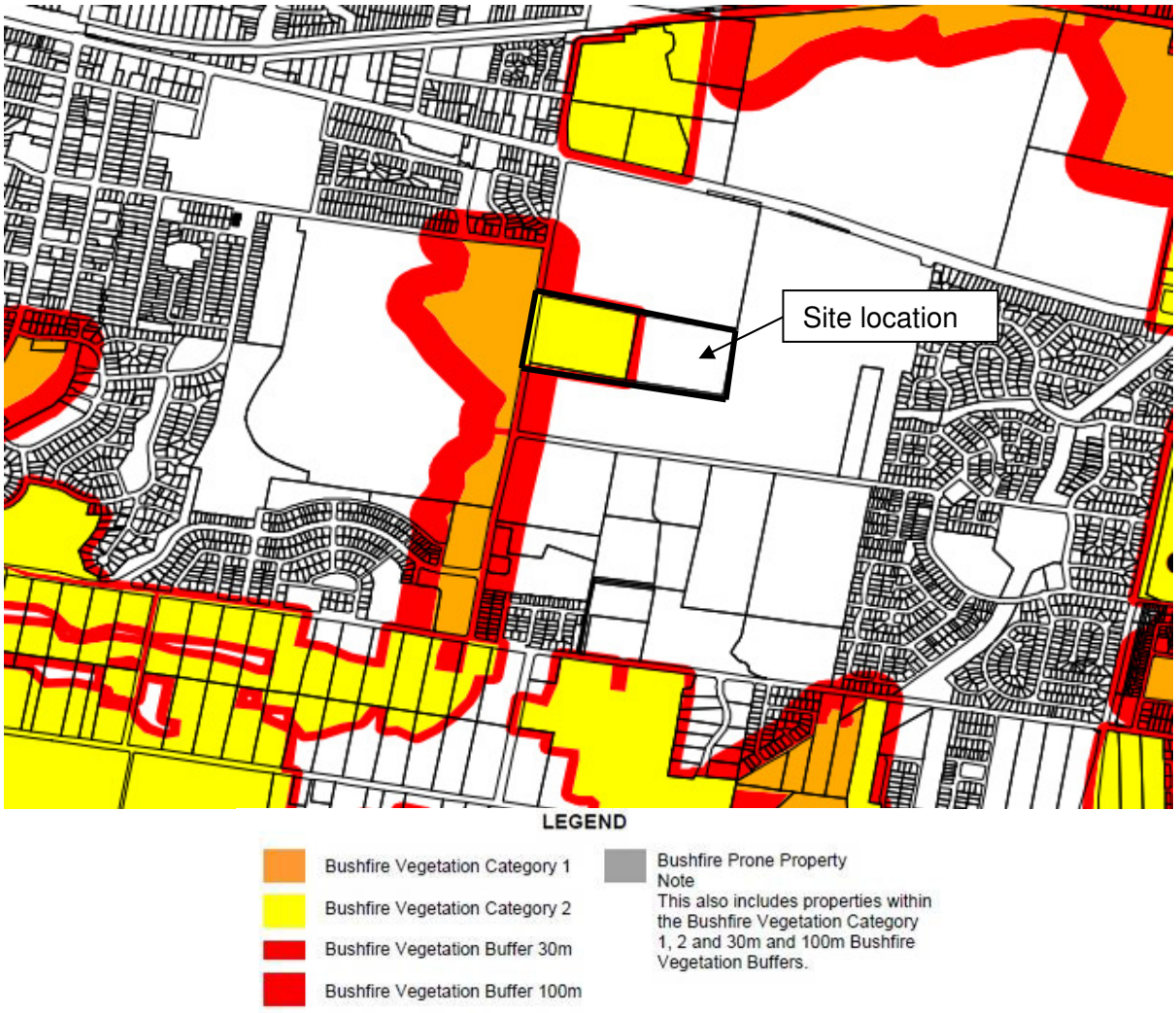


Figure 1.3 – Bushfire Prone Land Map
(source: Penrith City Council, 2015)

1.5.3 Rural Fires Act (RF Act)

This legislation is concerned with the prevention and control of bushfire, hazard reduction and administration. Section 100B of the *Rural Fires Act* states that the Commissioner may issue a BSA for a subdivision development on bushfire prone land.

1.5.4 Local environmental plan (LEP)

A LEP provides for a range of zonings which list development that is permissible, or not permissible, as well as the objectives for development within a zone.

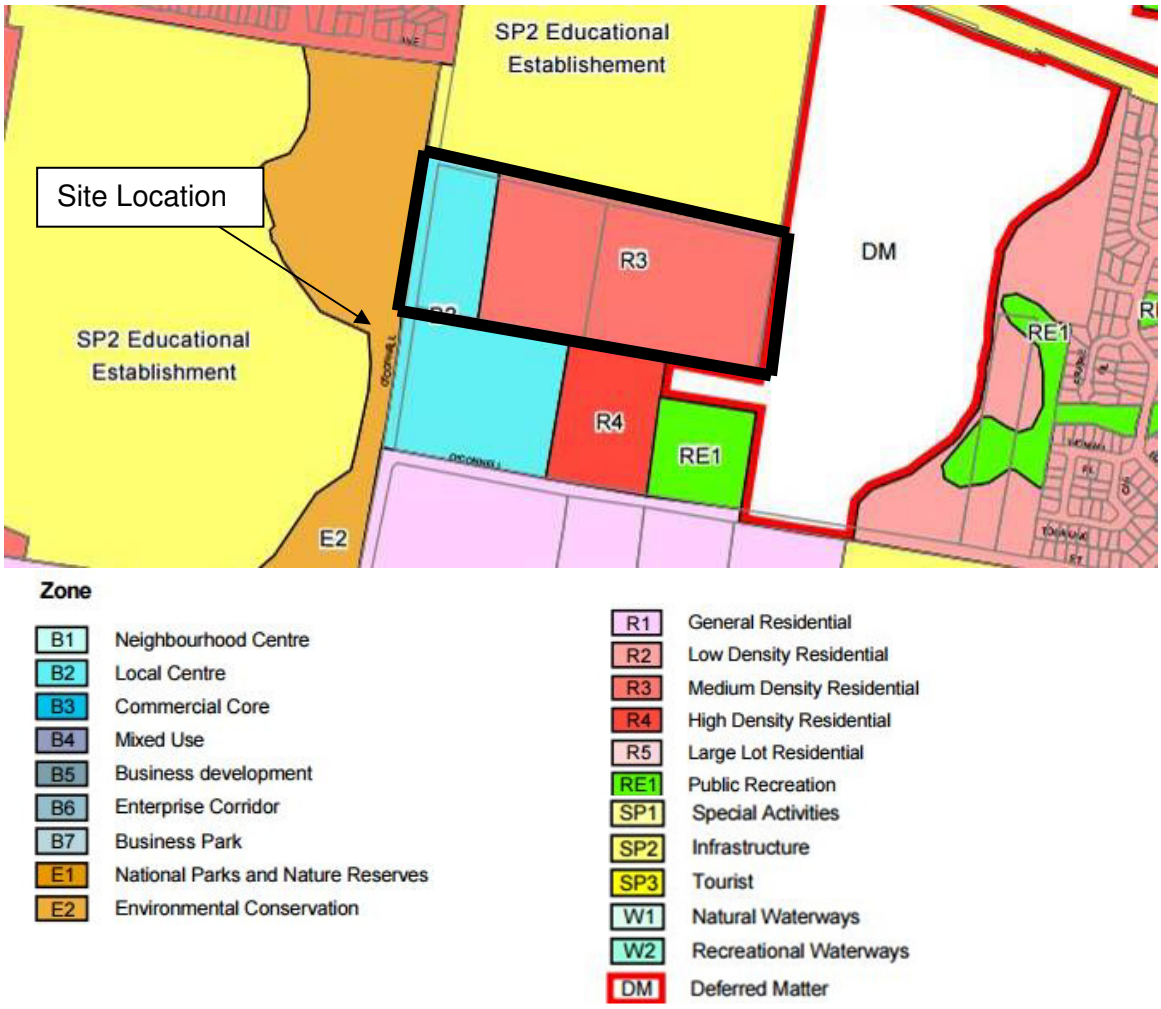


Figure 1.4 – Zoning map
(source: Penrith Local Environmental Plan (LEP), 2010)

The site is zoned under the Penrith LEP (2010) as R3 –Medium Density Residential and B2 – Local Centre.

The proposal, including the provision of APZs, is consistent with the objectives of the zoning.

1.5.5 Planning for Bush Fire Protection 2006 (PBP)

Bushfire protection planning requires the consideration of the RFS planning document entitled *PBP. PBP* provides planning controls for building in bushfire prone areas as well as

guidance on effective bushfire protection measures. The policy aims to provide for the protection of human life (including fire fighters) and to minimise impacts on property and the environment from the threat of bushfire, while having due regard to development potential, on site amenity and protection of the environment. *PBP* outlines the following general objectives that must be achieved for all development, as well as the specific objectives for subdivision development.

1. Afford occupants of any building adequate protection from exposure to a bushfire

2. Provide for a defendable space to be located around buildings

3. Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition

4. Ensure that safe operational access and egress for emergency service personnel and residents is available

5. Provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the APZ

6. Ensure that utility services are adequate to meet the needs of fire fighters (and others who may assist in bushfire fighting)

More specifically, the objectives for subdivision development are to:

7. Minimise the perimeters of the subdivision exposed to the bushfire hazard

8. Minimise bushland corridors that permit the passage of fire

9. Provide for the siting of future dwellings away from ridge tops and steep slope, particularly up slopes, within saddles and narrow ridge crests.

10. Ensure that separation distances (APZs) between the bushfire hazard and future dwellings enable conformity with the deemed to satisfy requirements of the *BCA.*

11. Provide and locate, where the scale of development permits, open space and public recreation areas as accessible public refuge areas or buffers (APZs)

12. Ensure the ongoing management of APZs

13. Provide clear and ready access from all properties to the public road system for residents and emergency services

14. Ensure the provision and adequate supply of water and other services to facilitate effective fire fighting

PBP outlines the bushfire protection measures required to be assessed for new development in bushfire prone areas. The proposal has been assessed in compliance with the following measures:

- Asset protection zones
- Building construction and design
- Access arrangements
- Water supply and utilities

- Landscaping, and
- Emergency management arrangements.

1.5.6 Building Code of Australia and the Australian Standards AS3959 - 2009

The *BCA* is given effect through the *EP&A Act* and forms part of the regulatory environment of construction standards and building controls. The *BCA* outlines objectives, functional statements, performance requirements and deemed-to-satisfy provisions. For residential dwellings these include Classes 1, 2 & 3 buildings. The construction manual for the deemed to satisfy requirements is AS3959.

1.6 Environmental & cultural constraints

Travers bushfire & ecology was also commissioned to provide an ecological assessment for the site. The report concluded that the development is not likely to further fragment or isolate local wildlife corridors or patches, provided that the Cumberland Plain Woodland vegetation within the subject site is retained, managed and improved under a Vegetation Management Plan (VMP).

A basic search was conducted on the Aboriginal Heritage Information System (AHIMS). The results show that there are no identified Aboriginal sites of significance within Lot 6 DP 593628 & Lot 3 DP 1103503 or within 50m of the site.

Bushfire Threat Assessment

2

To assess the bushfire threat and to determine the required width of an APZ for a development, a review of the elements that comprise the overall threat needs to be completed.

PBP provides a methodology to determine the size of any APZ that may be required to offset possible bushfire attack. These elements include the potential hazardous landscape that may affect the site and the effective slope within that hazardous vegetation.

2.1 Hazardous fuels

PBP guidelines require the identification of the predominant vegetation formation in accordance with David Keith (2004) to determine APZ distances for subdivision developments. The hazardous vegetation is calculated for a distance of at least 140m from a proposed building envelope.

The vegetation posing a bushfire threat to the site is a combination of Shale Plains Woodland and Alluvial Wetland (Cumberland vegetation, 2008 VISmap_3785) located within the bushland reserve to west of the site and the small pocket of Shale Plains Woodland located within the 'woodland park' in the central southern portion of the site (refer to Figure 2.1 & 2.2).

The remaining land, within 140m of the development, is not considered a bushfire threat as it consists of a managed landscape.

Figure 2.1 – Vegetation mapping
(source: Six vegetation - VISmap 3785)

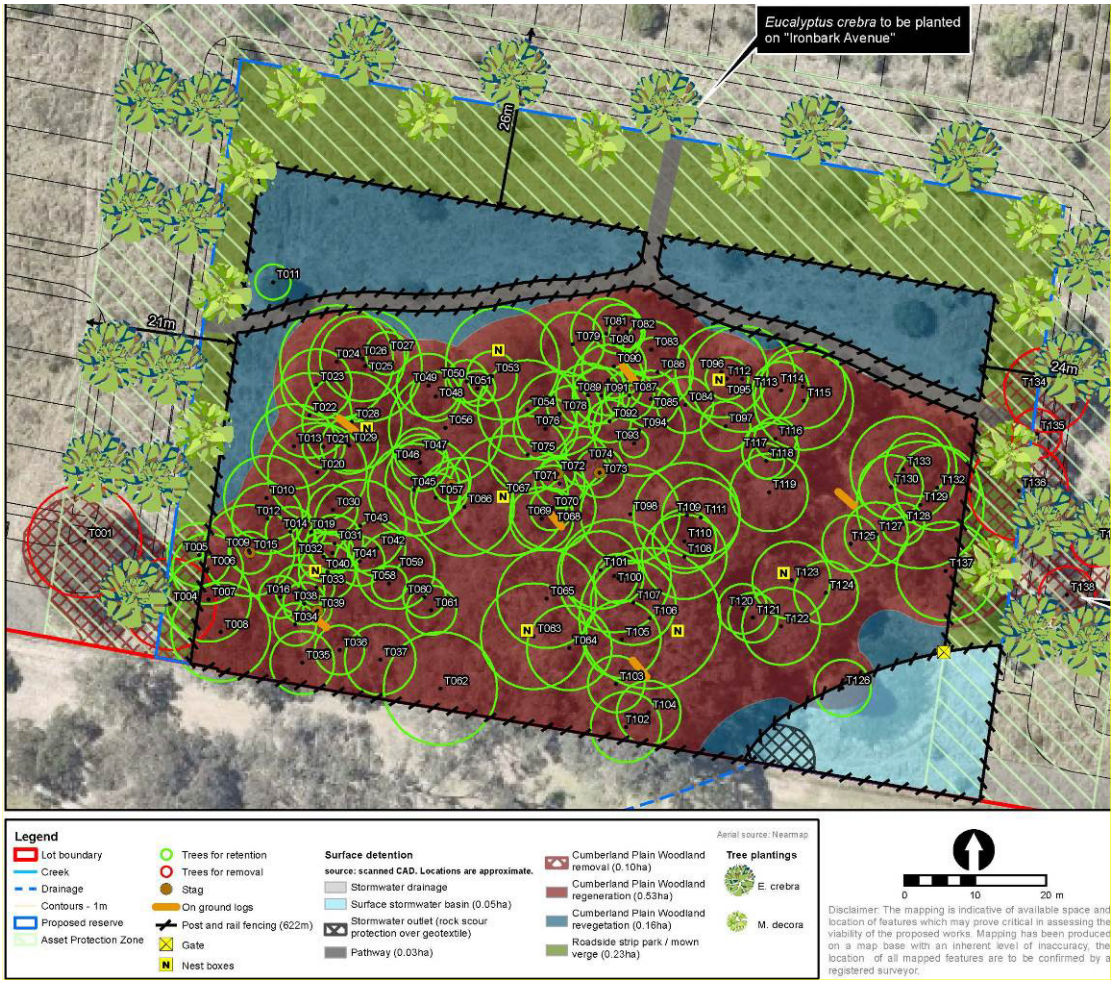


Figure 2.2 – Vegetation management works
(source: Vegetation Management Plan – Proposed Masterplan prepared by *Travers bushfire & ecology* December 2016)

Photo 1 – Forest vegetation to the west (beyond O'Connell Street)

Photo 2 & 3 – Managed land to the south

Photo 4 – Managed land to the east

2.2 Effective slope

The effective slope is assessed for a distance of up to 100m. Effective slope refers to that slope which provides the most effect upon likely fire behaviour. A mean average slope may not in all cases provide sufficient information such that an appropriate assessment can be determined.

The effective slope within the hazardous forest vegetation is summarised below:

- 4^0 downslope beyond O'Connel Street to the west; and
- Level, 4^0 and 5^0 downslope within the internal 'woodland park'.

2.3 Bushfire attack assessment

The following assessment has been undertaken using a deemed to satisfy and alternate solution approach which provides two (2) different results in terms of APZ and BAL level outcomes.

It is important that the developer understands these two methods to ensure that there is a clear understanding of the implications for future dwelling construction:

- ***Deemed to satisfy approach*** (DS) – The deemed to satisfy approach is undertaken in compliance with AS3959 and is used by future lots owners to obtain approval for a construction certificate under complying development.

  The assessment uses Method 1 Table 2.4.2 of AS3959. This will allow future purchasers of each allotment to submit their application for building construction in accordance with the Code's SEPP (i.e. complying development). This is a simplified process and results in a cheaper bushfire assessment at building construction stage (refer Column 6 of Table 2.1). However it is often not the cheapest approach as BAL levels can be higher.

- ***Alternate solution approach*** (AS) – The alternative solution approach in undertaken in compliance with PBP (Appendix 2) and is used to obtain subdivision approval and to maximise the developable area.

  This assessment uses AS3959 Appendix B Method 2 assessment methodology to obtain an accurate BAL rating using reduced fuel loads (i.e. forest vegetation (20/25t) and accurate slopes.

  This method also provides future lots owners with the best way to achieve cheaper building construction costs. However future purchasers (particularly for lots around the perimeter of the development / fronting the bushland) will be required to lodge their dwelling application under Section 79BA of the *EP&A Act,* which will require a further bushfire protection assessment report (i.e. increased cost for report) to support the lower BAL level. Approval is also required from the RFS.

Please note that the BAL levels depicted in Schedule 1 attached are based on an alternative solution approach (i.e. subdivision approval). The BAL setbacks identified in Column 6 (Table 2.1) have been provided to as a guide for the developer, to determine setbacks required for complying development.

Table 2.1 – Bushfire attack assessment

Lots Vegetation formation within 140m of development (refer Note 1)	Effective slope of land	Minimum APZ required (Alternative solution approach) (refer Note 2)	APZ provided	Building construction standards (Alternative solution approach) (refer Note 2)	Building construction standards (Deemed to satisfy approach) (refer Note 3)
Northern, southern and eastern aspect					
Managed / Grassland	N/A	N/A	>100m	N/A	N/A
Western Aspect					
Forest (AS - 20/25t) (DS - 25/35t for forest)	4° D	26 (includes O'Connell Street)	26	BAL 29 (26-<36) BAL 19 (37-<48) BAL 12.5 (48-<100)	BAL 40 (24-<32) BAL 29 (32-<43) BAL 19 (43 - <57) BAL 12.5 (57-<100)
Southern Aspect (internal woodland park) (refer Note 4)					
EAST Forest (AS - 20/25t) (DS - 25/35t for forest)	Level	21	21 (includes perimeter road & managed land in accordance with VMP)	BAL 29 (21-<29) BAL 19 (29-<49) BAL 12.5 (49-<100)	BAL 40 (19-<25) BAL 29 (25-<35) BAL 19 (35 - <48) BAL 12.5 (48-<100)
SOUTH Forest (AS - 20/25t) (DS - 25/35t for forest)	4° D	26	26	BAL 29 (26-<36) BAL 19 (36-<48) BAL 12.5 (48-<100)	BAL 40 (24-<32) BAL 29 (32-<43) BAL 19 (43 - <57) BAL 12.5 (57-<100)
WEST Forest (AS - 20/25t) (DS - 25/35t for forest)	3° D	24	24 (includes perimeter road & managed land in accordance with VMP)	BAL 29 (24-<34) BAL 19 (34-<48) BAL 12.5 (46-<100)	BAL 40 (24-<32) BAL 29 (32-<43) BAL 19 (43 - <57) BAL 12.5 (57-<100)

Note 1: Fuel loads utilised for each method is provided in brackets. AS – Alternate solution, DS – Deemed to satisfy.

Note 2: A performance based assessment using Appendix B of *AS3959* was undertaken to determine the minimum APZ and BAL levels based on forest vegetation (fuel load 20/25) as allowable under PBP on slopes provided in column 2. The results of the assessment, provided within Appendix 2, were prepared using the bushfire attack assessor (BFAA) developed by *Newcastle Bushfire Consulting.*

Note 3: Under clauses 3.36B and 3A.37 of the Codes SEPP the construction of dwellings on some bush fire prone land may be considered as complying development. For complying development to occur on future allotments, the land must be certified as being below a BAL 29 risk rating and be provided a minimum setback of <32m. A BAL Certificate must be obtained from the council or a person who is recognised by the RFS as a suitably qualified consultant in bush fire risk assessment prior to lodging an application for a CDC. Buildings assessed as BAL 40 or BAL FZ are not considered complying and must lodge their application under section 79BA and a full bushfire protection assessment must be prepared for submission to NSW RFS.

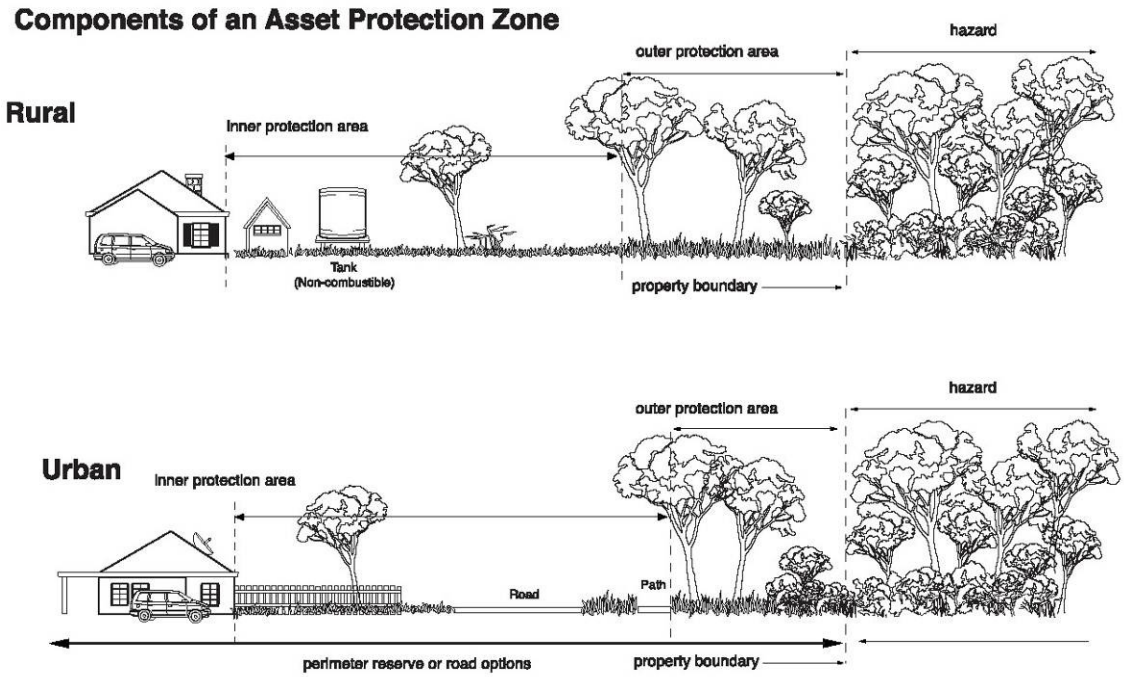
Note 4: The APZ includes the perimeter road widths as well as land extending within the woodland park. As outlined in the Vegetation Management Plan (prepared by this firm) the APZ portion of land will be implemented by the developer with ongoing maintenance being undertaken by either Council or under a community title agreement. The APZ area will be mown grass, scatter trees with picnic and a kick around areas (refer Figure 2.2).

Specific Protection Issues

3

3.1 Asset protection zones

APZs are areas of defendable space separating hazardous vegetation from buildings. The APZ generally consists of two subordinate areas, an inner protection area (IPA) and an outer protection area (OPA). The OPA is closest to the bush and the IPA is closest to the dwellings. The IPA cannot be used for habitable dwellings but can be used for all external non-habitable structures such as pools, sheds, detached garages, cabanas, etc. A typical APZ, and therefore defendable space, is graphically represented below:



APZs and progressive reduction in fuel loads (Source: RFS, 2006)

Note: Vegetation management as shown is for illustrative purposes only. Specific advice is to be sought in regard to vegetation removal and retention from a qualified and experienced expert to ensure APZs comply with the RFS performance criteria.

PBP dictates that the subsequent extent of bushfire attack that can potentially emanate from a bushfire must not exceed a radiant heat flux of $29kW/m^2$ for residential subdivision developments. This rating assists in determining the size of the APZ to provide the necessary defendable space between hazardous vegetation and a building.

Table 3.1 outlines the proposal's compliance with the performance criteria for APZs

Table 3.1 – Performance criteria for asset protection zones (*PBP* guidelines pg. 19)

Performance criteria	Acceptable solutions	Complies
Radiant heat levels at any point on a proposed building will not exceed 29kW/m^2	APZs are provided in accordance with Appendix 2 APZs are wholly within the boundary of the development site	Yes - A performance based assessment has been undertaken as identified in Section 2.3. The APZ extends within the woodland park and will be maintained by the developer, Council or under a community title agreement.
APZs are managed and maintained to prevent the spread of fire towards the building	In accordance with the requirements of *Standards for Asset Protection Zones* (RFS 2005)	Yes – can be made a condition of consent
APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is negated	The APZ is located on lands with a slope of less than 18^o	Yes. APZs are located on slopes less than 18^o

3.2 Building protection

The construction classification system is based on five (5) bushfire attack levels (BAL). These are BAL – Flame Zone (FZ), BAL 40, BAL 29, BAL 19 and BAL 12.5 (AS3959 (2009) – *Construction of buildings in bushfire-prone areas*). The lowest level, BAL 12.5, has the longest APZ distance while BAL – FZ has the shortest APZ distance.

Indicative building construction standards have been depicted within Schedule 1 so future purchasers have an idea regarding which construction level they can build to.

Please note that the BAL levels depicted are based on an alternative solution approach and therefore if using these BAL levels a further bushfire report will be required under Section 79BA of the *EP&A Act.* Alternatively a future occupant may wish to proceed in accordance with the Code's SEPP (i.e. complying development). If proceeding as complying development a higher BAL level may be applicable.

3.3 Hazard management

Should the development be approved, the owner or occupier of each lot will be required to manage the APZ in accordance with RFS guidelines *Standards for Asset Protection Zones* (RFS, 2005), with landscaping to comply with Appendix 5 of *PBP*.

In terms of implementing and / or maintaining APZs, there is no physical reason that would constrain hazard management from being successfully carried out by normal means (e.g. mowing / slashing).

A summary of the guidelines for managing APZs is attached as Appendix 1 to this report.

3.4 Access for fire fighting operations

Proposed public access to the site is provided via a two (2) access points from O'Connell Street in the west. An internal perimeter road network is also proposed with future linkages to a concept Town Centre towards the south.

This public access and its compliance with *PBP* is detailed within Table 3.2.

Table 3.2 – Performance criteria for public roads (*PBP* guidelines pg. 20)

Performance criteria	Acceptable solutions	Complies
Fire fighters are provided with safe all weather access to structures (thus allowing more efficient use of fire fighting resources).	Public roads are two-wheel drive, all weather roads.	Yes
Public road widths and design that allow safe access for fire fighters while residents are evacuating an area.	Urban perimeter roads are two way, that is, at least two traffic lane widths (carriageway 8m minimum kerb to kerb) allowing traffic to pass in opposite directions. Non perimeter roads comply with Table 3.3.	O'Connell Street and the roads surrounding the internal pocket park are perimeter roads. To comply with the acceptable solutions they should be upgraded to provide a minimum carriageway width of 8m. All other internal roads require a width of 6.5m to comply with the acceptable solutions
	Perimeter road is linked with the internal road system at an interval of no greater than 500m in urban areas.	Yes
	Traffic management devices are constructed to facilitate access by emergency services.	Yes – can be a condition of consent
	Public roads have a cross fall not exceeding 3°.	Yes
	All roads are through roads. If unavoidable, dead end roads are not more than 200m in length, incorporate a minimum 12m outer radius turning circle, sign posted dead end and direct traffic away from the hazard.	Yes – all roads are through roads
	Curves of roads (other than perimeter) have a minimum inner radius of 6m and are minimal in number to allow for rapid access and egress.	Yes
	The minimum distance between inner and outer curves is 6m.	Yes
	Maximum grades for sealed roads do not exceed 15° and an average grade of not more than 10°.	Yes
	Minimum vertical clearance of 4m above the road at all times.	

Performance criteria	Acceptable solutions	Complies
The capacity of road surfaces and bridges is sufficient to carry fully loaded fire fighting vehicles.	The capacity of road surfaces and bridges is sufficient to carry fully loaded fire fighting vehicles (15 tonnes for reticulated water and 28 tonnes for all other areas). Bridges clearly indicate load rating.	Yes
Roads that are clearly sign posed (with easily distinguishable names) and buildings / properties that are clearly numbered.	Public roads >6.5m wide to locate hydrants outside of parking reserves to ensure accessibility to reticulated water. Public roads 6.5 - 8m wide are No Parking on one side with the hydrant located on this side to ensure accessibility to reticulated water. Public roads <6.5m wide provide parking within parking bays and locate services outside of parking bays to ensure accessibility to reticulated water. One way only public access are no less than 3.5m wide and provide parking within parking bays and locate services outside of parking bays to ensure accessibility to reticulated water.	Yes – Can be made a condition of consent.
There is clear access to reticulated water supply. Parking does not obstruct the minimum paved width	Parking bays are a minimum of 2.6m wide from kerb edge to road pavement. No services or hydrants are located within parking bays. Public roads directly interfacing the bushfire hazard are to provide roll top kerbing to the hazard side of the road.	Yes – can be a condition of consent

Table 3.3 – Minimum widths for public roads that are not perimeter roads (*PBP* guidelines pg. 20)

Curve radius (inside edge) (metres)	Swept Path (metres width)	Single lane (metres width)	Two way (metres width)
<40	3.5	4.5	8.0
40-69	3.0	3.9	7.5
70-100	2.7	3.6	6.9
>100	2.5	3.5	6.5

3.5 Water supplies

Town reticulated water supply is available to the proposed subdivision. This will provide adequate water supply for fire fighting services.

Table 3.4 outlines the proposal's compliance with the performance criteria for reticulated water supply.

Table 3.4 – Performance criteria for reticulated water supplies (PBP guidelines pg. 27)

Performance criteria	Acceptable solutions	Complies
Water supplies are easily accessible and located at regular intervals.	Reticulated water supply to urban subdivisions uses a ring main system for areas with perimeter roads. Fire hydrant spacing, sizing and pressures comply with AS2419.1 - 2005. Where this cannot be met, the RFS will require a test report of the water pressures anticipated by the relevant water supply authority, once development has been completed. In such cases, the location, number and sizing of hydrants shall be determined using fire engineering principles. Hydrants are not located within any road carriageway All above ground water and gas service pipes external to the building are metal, including and up to any taps. The provisions of public roads are met.	Complies - can be made a condition of consent.

3.6 Gas

Table 3.8 outlines the required performance criteria for gas supply.

Table 3.5 – Performance criteria for gas supplies (*PBP* guidelines pg. 27)

Performance criteria	Acceptable solutions	Complies
Location of gas services will not lead to the ignition of surrounding bushland land or the fabric of buildings.	Reticulated or bottled gas bottles are to be installed and maintained in accordance with AS1596 – 2002 and the requirements of relevant authorities. Metal piping is to be used. All fixed gas cylinders are to be kept clear of flammable materials to a distance of 10m and shielded on the hazard side of the installation. If gas cylinders are to be kept close to the building the release valves must be directed away from the building and at least 2m away from any combustible material, so that they do not act as a catalyst to combustion. Connections to and from gas cylinders are metal. Polymer sheathed flexible gas supply lines to gas meters adjacent to buildings are not to be used.	Yes – any future gas supply is to comply with this acceptable solution.

3.7 Electricity

Table 3.6 outlines the required performance criteria for the subdivision's electricity supply.

Table 3.6 – Performance criteria for electricity services (*PBP* guidelines pg. 27)

Performance criteria	Acceptable Solutions	Complies
Location of electricity services limit the possibility of ignition of surrounding bushland or the fabric of buildings Regular inspection of lines in undertaken to ensure they are not fouled by branches.	Where practicable, electrical transmission lines are underground Where overhead electrical transmission lines are proposed: • Lines are installed with short pole spacing (30m), unless crossing gullies, gorges or riparian areas: and • No part of a tree is closer to a power line than the distance set out in accordance with the specification in *Vegetation Safety Clearances* issued by *Energy Australia* (NS179, April 2002)	Can be made a condition of consent.

Conclusion & Recommendations

4

4.1 Conclusion

A bushfire protection assessment has been undertaken for the proposed residential subdivision of Lot 6 DP 593628 & Lot 3 DP 1103503 46a & 46-66 O'Connell Street, Caddens.

The assessment found that bushfire can potentially affect the proposed development from the forest vegetation located to the west of the site, beyond O'Connell Street, and the bushland vegetation being retained within the southern portion of the site resulting in the subdivision being exposed to potential radiant heat and ember attack.

The assessment has concluded that the proposed development can provide compliance with *PBP*.

4.2 Recommendations

Recommendation 1 - The subdivision is as generally indicated on the attached Schedule 1 – Plan of Bushfire Protection Measures.

Recommendation 2 – Minimum APZ's are to be provided to the development as outlined is Schedule 1 attached. Fuel management within the APZs is to be maintained by regular maintenance of the landscaped areas, mowing of lawns in accordance with the guidelines provided in Appendix 1, and / or as generally advised by the RFS in their publications.

Notwithstanding specialist advice in those guidelines, the following general advice for maintaining an APZ is to be followed:

- *Mowing or grazing of grass*: Grass needs to be kept short (approximately 5cm in height) and green where adequate water supplies are available.

- *Raking or manual removal of fine fuels*: Ground fuels such as fallen leaves, twigs (less than 6 mm in diameter) and bark should be removed on a regular basis. Fine fuels can be removed by hand or with tools such as rakes, hoes and shovels.

- *Removal or pruning of trees, shrubs and understorey*: The control of existing vegetation involves both selective fuel reduction (removal, thinning and pruning) and the retention of vegetation. Prune or remove trees so that you do not have a continuous tree canopy leading from the hazard to the asset. Separate tree crowns by 2-5m. A canopy is not to overhang a dwelling unless specifically approved by the RFS. Native trees and shrubs should be retained as clumps in landscape beds and should not exceed a covering of more than 20% of the IPA.

- Trees or tall shrubs may require pruning upon dwelling completion in line with *PBP.* Notwithstanding this, the presence of shrubs and trees close to a dwelling in a

bushfire prone landscape requires specific attention to day-to-day management and owners and / or occupiers should be made aware that whilst landscaping can contribute to a way of life and environmental amenity, the accumulated fuels must be regularly removed.

- Trees may remain within close proximity of a building where it can be demonstrated that the tree is not able to produce a build-up of fuel on the roof of a dwelling due to:

    1. A roof pitch which self sheds leaf litter
    2. Ongoing roof maintenance by staff or contractors
    3. Adequate ember protection has been installed

- Trees that are likely to be structurally unstable such that they could cause a limb to fall would require removal for the RFS to agree to a dwelling in proximity to the trees.

In addition, the following general APZ planning advice is to be followed:

- Ensure that vegetation does not provide a continuous ignition path to the house

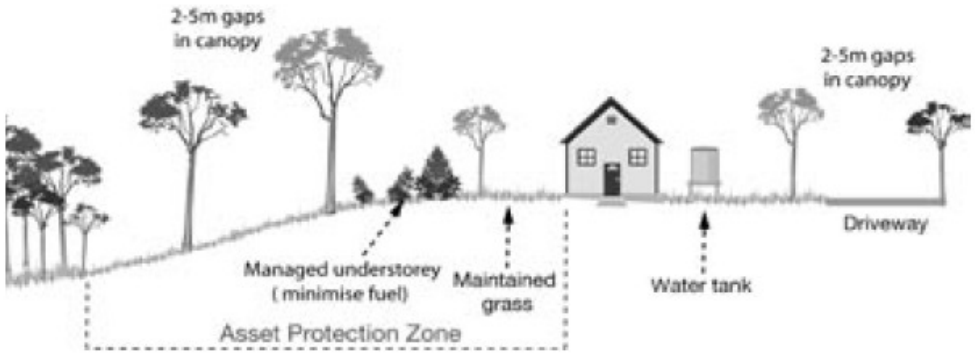
- Plant or clear vegetation into clumps rather than continuous rows

- Prune low branches 2m from the ground to prevent a ground fire from spreading into trees

- Locate vegetation far enough away from the proposed dwellings so that plants will not ignite the dwelling by direct flame contact or radiant heat emission

- Ensure that shrubs and other plants do not directly abut the dwelling. Where this does occur, gardens should contain low-flammability plants and non-flammable ground cover such as pebbles and crushed tiles

- The following RFS diagram depicts one version of an ideal situation. Divergence from this ideal should not be undertaken without expert advice



Recommendation 3 – Building construction standards for the proposed future dwellings are to be applied in accordance with *AS3959 Construction of buildings in bushfire prone areas (2009)* with additional construction requirements as listed within Section A3.7 of Addendum Appendix 3 *PBP*.

Recommendation 4 - Access is to comply with Table 3.2 of this report. Perimeter roads are to have a carriageway width of 8m. All other internal roads are to have a width of 6.5m to comply with the acceptable solutions.

Recommendation 5 - Water, electricity and gas supply is to comply with Section 4.1.3 of *PBP.*

Recommendation 6 - The landowner / manager is to be made aware of their liability to manage the development lands for the ongoing protection of themselves and their neighbours (refer Section 63(2) *Rural Fires Act*)

Recommendation 7 - Landowners living in bushfire prone areas should familiarise themselves with publications published by the NSW Rural Fire Service. These are located on the RFS web site www.rfs.nsw.gov.au under 'Publications'.

REFERENCES

Australian Building Codes Board (2010) – *Building Code of Australia*, Class 1 and Class 10 Buildings Housing Provisions Volume 2.

Chan, K.W. (2001) – *The suitability of the use of various treated timbers for building constructions in bushfire prone areas*. Warrington Fire Research.

Councils of Standards Australia AS3959 (2009) – *Australian Standard Construction of buildings in bush fire-prone areas.*

Keith, David (2004) – *Ocean Shores to Desert Dunes – The Native Vegetation of New South Wales and the ACT*. The Department of Environment and Climate Change.

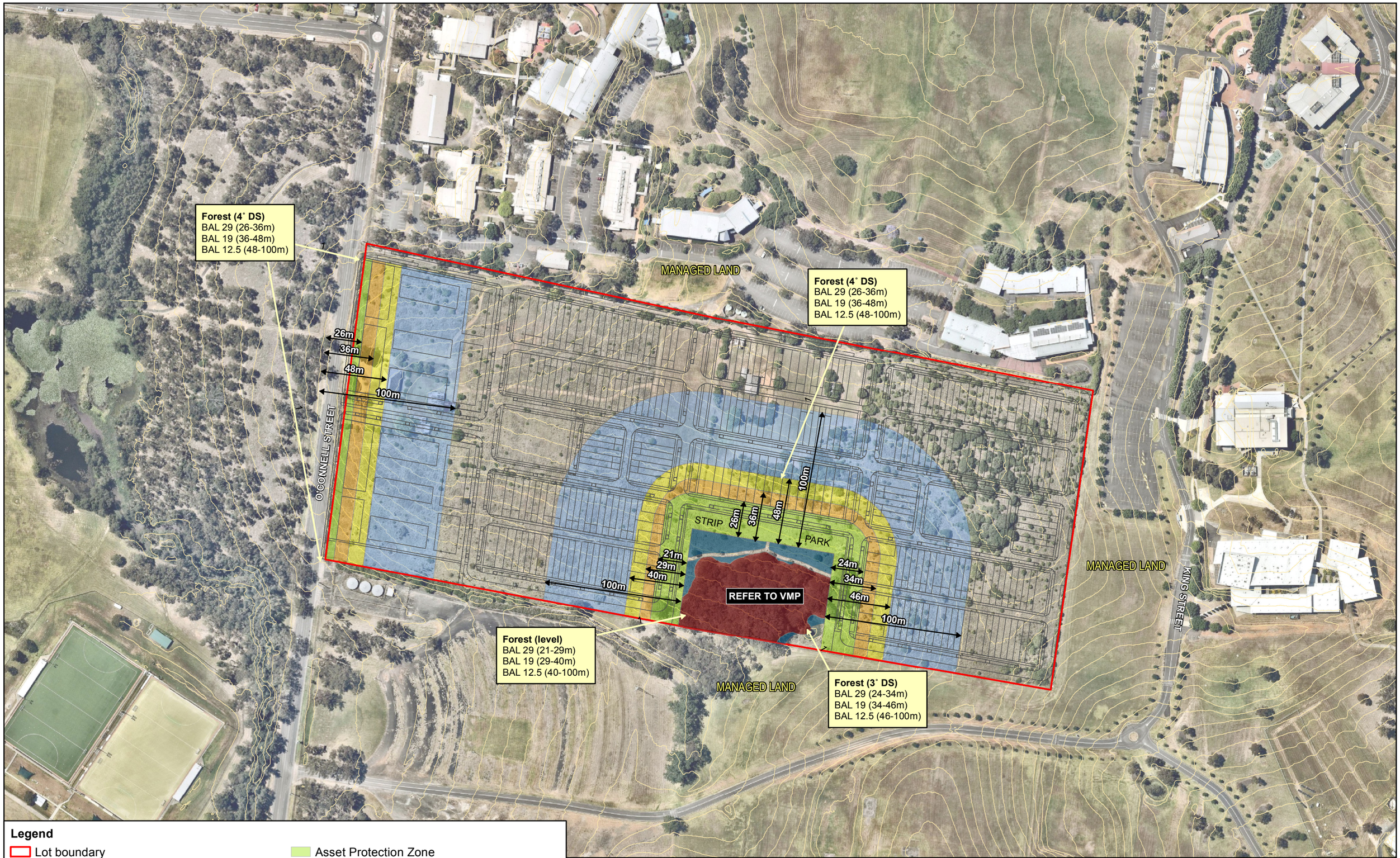
Rural Fire Service (2006) - *Planning for bushfire protection – a guide for councils, planners, fire authorities and developers*. NSW Rural Fire Service.

Rural Fire Service (2006) - Bushfire Attack Software on RFS Web site.

Tan, B., Midgley, S., Douglas, G. and Short (2004) - *A methodology for assessing bushfire attack.* RFS Development Control Service.

Plan of Bushfire Protection Measures

S1



Legend

- Lot boundary
- Contours - 1m (source: LiDAR)

Vegetation management works (refer to VMP)

- Cumberland Plain Woodland regeneration (0.53ha)
- Cumberland Plain Woodland revegetation (0.16ha)
- Asset Protection Zone

Bushfire Construction Standards (AS3959) (2009)*

- BAL 12.5
- BAL 19
- BAL 29

* Please refer to additional construction requirements for BAL levels which are contained in Addendum Appendix 3 of *'Planning for Bushfire Protection'* (2006).

Aerial source: Nearmap

0 50 100 m

Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

PROJECT & MXD REFERENCE	DATE & ISSUE NUMBER	SCALE & COORDINATE SYSTEM
46A & 46-66 O'Connell Street, Caddens A16195_BF001	22/12/2016 Issue 1	1:2,500 @A3 GDA 1994 MGA Zone 56

TITLE

Schedule 1 - Bushfire Protection Measures

Document Path: N:\GIS STORAGE\N Drive\A16004_O'Connell_St_Caddens\MXDs\A16195_BF001.mxd

Management of Asset Protection Zones

A1

The RFS advises that when living in a bushfire prone environment APZs are required to be provided between hazardous fuels and a dwelling.

The RFS provides basic advice in respect of managing APZs in several documents namely, *Planning for Bush Fire Protection 2006 (PBP)* and *Standards for Asset Protection Zones* (undated but circa 2006).

APZs provide a level of defendable space between the hazard and a habitable dwelling or similar structure. These zones are usually shown on plans adjacent to either cultural or natural assets (e.g. dwelling). They act to significantly lessen the impact of intense fire. The major mitigating factor that limits the effects of wildfire is the amount of fuel available to burn. By reducing the amount of fuel there will be a reduction in the intensity of the fire.

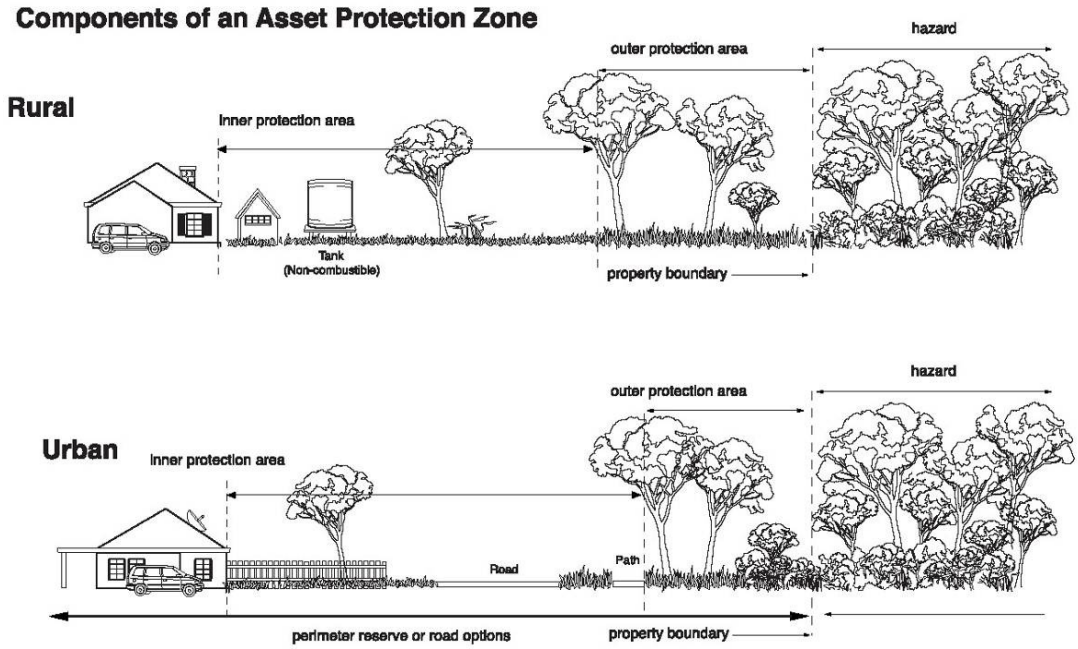
When considering bushfire fuel it is important to understand that it occurs in our native bushland in three vertical layers – see Table 1.

Table 1 – Fuel layers

Fuel layer name	Location of layer in vertical column	Type of fuel
Ground fuels	Below ground level	Peatmoss (always below the surface)
Surface fuels	0-200mm	Litter layer (leaves & twigs)
Aerial fuels	200 – 3000mm	Shrubs and grasses
Canopy fuels	> 3000mm	Tree canopy

The APZ can be further classified into two sub-zones with each having a specific role. These sub-zone areas are called the inner protection area (IPA) and the outer protection area (OPA) – see figure below.

The IPA is managed as a fuel free zone while the OPA is managed as a fuel reduced zone. This means that the fuel free zone has little fuel available to be consumed in the event of a fire whilst the fuel reduced zones has less than normal fuel levels that could be consumed in the event of a fire.



APZs and progressive reduction in fuel loads (Source: RFS, 2006)

Inner protection area (IPA)

This area is almost free of all fuels and usually takes the form of grassy areas, car parks, roads, concrete areas, tracks or trails. It does not imply or require the wholesale removal of every tree and / or shrub.

This zone is intended to stop the transmission of flame and reduce the transmission of radiant heat by the elimination of available fuel. This area also allows airborne embers to fall safely without igniting further outbreaks.

This zone also provides a safe fire fighting position and is operationally important for implementation of clear fire control lines.

Grasses may occur within an IPA if they are generally no higher than 50-75mm. Above this height, fuel weights tend to increase exponentially and consequentially cause greater flame heights and therefore fire intensity.

Shrubs may occur within an IPA in the form of clumping amidst open grassy areas. The design of the clumping will be dependent on species selection and spatial density. For example, the larger the shrubs the less clumping may occur in a given area.

As a general rule, trees are allowed within an IPA but only where those trees are at least 5m away from a dwelling.

A recommended performance standard for the fuel load of an IPA is between 0-4 t/ha. Shrubs may occur within an IPA commensurate with a spatial distribution of 15-20%. For example, an area of 100m2 (10mx10m) can have up to 20% of this area composed of shrubs.

If a shrub layer is present the following table shows the additional fuel weights that should be added to the calculated surface fuels.

Shrub cover	Fuel weight
10-30%	2.5 tonnes / ha
35-50%	5.0 tonnes / ha
55-75%	7.5 tonnes / ha

Presence of trees within an inner protection area

A tree may occur within an IPA if the canopy does not form a link with shrubs. The reason is to reduce any chance for vegetation linking and the capability for fire to extend into the canopy.
It is a basic premise in fire behaviour understanding that fire cannot occur in the canopy unless surface fuels such as grasses or shrubs are burning. This merging creates opportunity for fire to link with the canopy and therefore increase fire intensity by some significant amount.

Trees that have a canopy beginning near the ground (such as Forest Oaks *Allocasuarina*) form a continuous link with the tree canopy and shrubs. A forest canopy cannot therefore burn without fuel to feed that fire. In a tall open forest, where the trees are generally above 20m in height, the canopy is separated from the land surface by some distance. In an open woodland the low canopy height (usually < 5m) merges with the shrubland layer.

Knowing the relationship between the shrub layer and the tree canopy allows fire managers to design safer areas in the APZs. It is for this reason that vegetation such as Forest Oaks are usually excluded from an IPA.

Similarly in open forests the height of the forest is sufficiently removed from the shrub layer. As a general rule, trees are allowed within an IPA where the density of those trees is commensurate with Table 2 below and located on slopes up to 20% with a westerly aspect.

In respect of trees that can be located in an IPA Table 2 provides guidelines.

Table 2 – Tree density in inner protection area

Distance from dwelling wall	Trees permitted on the exposed side of a dwelling	Trees permitted on the non exposed side of a dwelling
Within 5m	No trees	No trees
Between 5-10m	One tree per 100m^2	2 trees per 100m^2
Between 10-20m	<10 tree per 400m^2	<10 trees per 400m^2

Outer protection area (OPA)

This zone is designed to stop the development of intense fires and the transmission of severe radiated heat.

The OPA assumes all trees will remain but with either a modified shrub / grass layer or regular removal of the litter layer. In some sparse vegetation communities the shrub layer may not require modification.

The fire fighting advantage will manifest in reduced fire intensity. It achieves this by denying fire a significant proportion of the fuel to feed upon. Fuels containing small (or fine) leaves such as Forest Oaks (or similar) are targeted for removal due to the capacity to burn quickly and therefore feed fire up into adjacent trees.

In most cases, the removal of 85% of the litter layer will achieve a satisfactory OPA. A recommended performance standard for the fuel load of an OPA is between 4-6 t/ha.

Managing the APZ

Fuel management within the APZs should be maintained by regular maintenance such as:

- Mowing grasses regularly - grass needs to be kept short and, where possible, green.
- Raking or manual removal of fine fuels - ground fuels such as fallen leaves, twigs (less than 6mm in diameter) and bark should be removed on a regular basis. This is fuel that burns

quickly and increases the intensity of a fire. Fine fuels can be removed by hand or with tools such as rakes, hoes and shovels.

- Removal or pruning of trees, shrubs and understorey - the control of existing vegetation involves both selective fuel reduction (removal, thinning and pruning) and the retention of vegetation. Prune or remove trees so that you do not have a continuous tree canopy leading from the hazard to the asset. Separate tree crowns by 2-5m. A canopy should not overhang within 2-5m of a dwelling. Native trees and shrubs should be retained as clumps or islands and should maintain a covering of no more than 20% of the area.

- Trees or tall shrubs may require pruning upon dwelling completion in line with *PBP*. Notwithstanding this, the presence of shrubs and trees close to a dwelling in a bushfire prone landscape requires specific attention to day to day management and owners and / or occupiers should be made aware that whilst landscaping can contribute to a way of life and environmental amenity the accumulated.

In addition, the following general APZ planning advice should be followed:

- Ensure that vegetation does not provide a continuous path to the house.

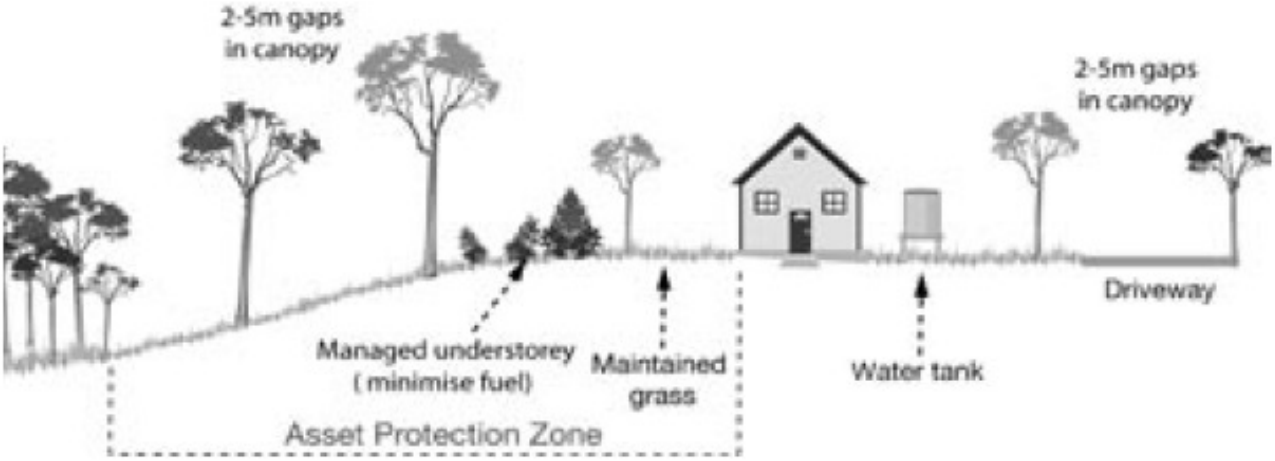
- Plant or clear vegetation into clumps rather than continuous rows.

- Prune low branches 2m from the ground to prevent a ground fire from spreading into trees.

- Locate vegetation far enough away from the asset so that plants will not ignite the asset by direct flame contact or radiant heat emission.

- Ensure that shrubs and other plants do not directly abut the dwelling. Where this does occur, gardens should contain low flammability plants and non flammable ground cover such as pebbles and crushed tile; and

- The following RFS illustrative diagram depicts one version of an ideal situation. Specific advice is to be sought from qualified experts to ensure that the implemented APZs meet the performance criteria of APZs.



Figures courtesy of NSW RFS 2006

Performance based assessment

A2

NBC Bushfire Attack Assessment Report V2.1

AS3959 (2009) Appendix B - Detailed Method 2

Printed: 22/12/2016 **Assessment Date:** 21/12/2016

Site Street Address:	46-66 O'Connell Street, Caddens		
Assessor:	Mr Admin; admin		
Local Government Area:	Penrith	**Alpine Area:**	No

Equations Used

Transmissivity: Fuss and Hammins, 2002
Flame Length: RFS PBP, 2001
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: A West (BAL 29)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	4 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25

Site Information

Site Slope	0 Degrees	**Site Slope Type:**	Level
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	26

Fire Inputs

Veg./Flame Width(m):	100	**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:**	100

Program Outputs

Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	10.3
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	40853
Radiant Heat(kW/m2):	27.83	**Flame Angle (degrees):**	61
Flame Length(m):	23.56	**Maximum View Factor:**	0.441
Rate Of Spread (km/h):	3.16	**Inner Protection Area(m):**	26
Transmissivity:	0.83	**Outer Protection Area(m):**	0

Run Description:	B West (BAL 19)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	4 Degrees	Vegetation Slope Type:	Downslope
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Level
Elevation of Receiver(m)	Default	APZ/Separation(m):	36
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	MODERATE	Peak Elevation of Receiver(m):	10.84
Level of Construction:	BAL 19	Fire Intensity(kW/m):	40853
Radiant Heat(kW/m2):	18.44	Flame Angle (degrees):	67
Flame Length(m):	23.56	Maximum View Factor:	0.302
Rate Of Spread (km/h):	3.16	Inner Protection Area(m):	36
Transmissivity:	0.802	Outer Protection Area(m):	0

Run Description:	C West (BAL 12.5)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	4 Degrees	Vegetation Slope Type:	Downslope
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Level
Elevation of Receiver(m)	Default	APZ/Separation(m):	48
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	LOW	Peak Elevation of Receiver(m):	11.14
Level of Construction:	BAL 12.5	Fire Intensity(kW/m):	40853
Radiant Heat(kW/m2):	12.31	Flame Angle (degrees):	71
Flame Length(m):	23.56	Maximum View Factor:	0.208
Rate Of Spread (km/h):	3.16	Inner Protection Area(m):	48
Transmissivity:	0.777	Outer Protection Area(m):	0

Run Description:	D Internal Forest Pocket (south -BAL 19)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	0 Degrees	Vegetation Slope Type:	Level
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Level
Elevation of Receiver(m)	Default	APZ/Separation(m):	29
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	MODERATE	Peak Elevation of Receiver(m):	8.68
Level of Construction:	BAL 19	Fire Intensity(kW/m):	31000
Radiant Heat(kW/m2):	18.97	Flame Angle (degrees):	69
Flame Length(m):	18.6	Maximum View Factor:	0.306
Rate Of Spread (km/h):	2.4	Inner Protection Area(m):	29
Transmissivity:	0.815	Outer Protection Area(m):	0

Run Description:	D Internal Forest Pocket (south -BAL 29)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	0 Degrees	Vegetation Slope Type:	Level
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Level
Elevation of Receiver(m)	Default	APZ/Separation(m):	21
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	HIGH	Peak Elevation of Receiver(m):	8.29
Level of Construction:	BAL 29	Fire Intensity(kW/m):	31000
Radiant Heat(kW/m2):	27.87	Flame Angle (degrees):	63
Flame Length(m):	18.6	Maximum View Factor:	0.436
Rate Of Spread (km/h):	2.4	Inner Protection Area(m):	21
Transmissivity:	0.841	Outer Protection Area(m):	0

Run Description:	E Internal Forest Pocket (south BAL 12.5)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	0 Degrees	Vegetation Slope Type:	Level
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Level
Elevation of Receiver(m)	Default	APZ/Separation(m):	40
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	LOW	Peak Elevation of Receiver(m):	8.89
Level of Construction:	BAL 12.5	Fire Intensity(kW/m):	31000
Radiant Heat(kW/m2):	12.47	Flame Angle (degrees):	73
Flame Length(m):	18.6	Maximum View Factor:	0.208
Rate Of Spread (km/h):	2.4	Inner Protection Area(m):	40
Transmissivity:	0.789	Outer Protection Area(m):	0

Run Description:	F Internal Forest Pocket (West BAL 29)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	3 Degrees	Vegetation Slope Type:	Downslope
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Downslope
Elevation of Receiver(m)	Default	APZ/Separation(m):	24
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	HIGH	Peak Elevation of Receiver(m):	9.7
Level of Construction:	BAL 29	Fire Intensity(kW/m):	38129
Radiant Heat(kW/m2):	28.73	Flame Angle (degrees):	61
Flame Length(m):	22.19	Maximum View Factor:	0.452
Rate Of Spread (km/h):	2.95	Inner Protection Area(m):	24
Transmissivity:	0.835	Outer Protection Area(m):	0

Run Description:	G Internal Forest Pocket (West BAL 19)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	3 Degrees	Vegetation Slope Type:	Downslope
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Downslope
Elevation of Receiver(m)	Default	APZ/Separation(m):	34
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	MODERATE	Peak Elevation of Receiver(m):	10.29
Level of Construction:	BAL 19	Fire Intensity(kW/m):	38129
Radiant Heat(kW/m2):	18.65	Flame Angle (degrees):	68
Flame Length(m):	22.19	Maximum View Factor:	0.305
Rate Of Spread (km/h):	2.95	Inner Protection Area(m):	34
Transmissivity:	0.805	Outer Protection Area(m):	0

Run Description:	H Internal Forest Pocket (West BAL 12.5)		
Vegetation Information			
Vegetation Type:	Forest	Vegetation Group:	Forest and Woodland
Vegetation Slope:	3 Degrees	Vegetation Slope Type:	Downslope
Surface Fuel Load(t/ha):	20	Overall Fuel Load(t/ha):	25
Site Information			
Site Slope	0 Degrees	Site Slope Type:	Level
Elevation of Receiver(m)	Default	APZ/Separation(m):	46
Fire Inputs			
Veg./Flame Width(m):	100	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:	100
Program Outputs			
Category of Attack:	LOW	Peak Elevation of Receiver(m):	10.55
Level of Construction:	BAL 12.5	Fire Intensity(kW/m):	38129
Radiant Heat(kW/m2):	12.3	Flame Angle (degrees):	72
Flame Length(m):	22.19	Maximum View Factor:	0.208
Rate Of Spread (km/h):	2.95	Inner Protection Area(m):	46
Transmissivity:	0.78	Outer Protection Area(m):	0