BUSHFIRE THREAT ASSESSMENT

Warnervale Residential Subdivision

Prepared by:

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Approval for Issue

Name	Signature	Date
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Summary

Bushfire Planning Australia (BPA) has been engaged by ADW Johnson Pty Ltd, to undertake a Bushfire Threat Assessment (BTA) for the development of Hannan Land, Warnervale, NSW.

The assessment aims to consider and assess the bushfire hazard and associated potential threats relevant to such a proposal, and to outline the minimum mitigative measures which would be required in accordance with the provisions of the Planning for Bush Fire Protection 2006 (PBP 2006) that has been released and adopted through the Environmental Planning & Assessment Amendment (Planning for Bush Fire Protection) Regulation 2007 & the Rural Fires Amendment Regulation 2007.

In order to determine whether the proposed development is bushfire-prone, and if so, which setbacks and other relevant Bush Fire Protection Measures (BFPM) will be appropriate, this assessment adheres to the methodology and procedures outlined in PBP 2006 and is accordance with clause 44 of the Rural Fires Regulation 2000.

This BTA found the land surrounding the site to support vegetation consistent with *Forest* and *Forested Wetland* vegetation formation as described by PBP 2006.

In summary, the following key recommendations have been generated to enable the proposed development to comply with PBP 2006:

- Asset protection zones (APZs) shall be established in accordance with **Table 6**; ranging in distance between 16m and 23m;
- A 20m APZ shall be established on Lot 4 DP247082 directly to the south of proposed lot 1108. Suitable arrangements must be made to ensure the APZ will be maintained in perpetuity. Alternatively, a 20m APZ shall be established on the northern side of the boundary (lot 1108 and proposed laneway), with no habitable buildings permitted until such time as the bushfire hazard is removed to the south (Lot 4 DP247082);
- A temporary APZ up to 100m shall be established outside of each completed stage within the development footprint and only in land zoned R2;
- Future buildings used for accommodation within the site should have due regard to the specific considerations given in the BCA, which makes reference to the Australian Standard (AS3959 – 2009) *Construction of buildings in bushfire prone areas*;
- Roads are to be constructed in accordance with section 4.2.3 (1) PBP 2006 as outlined in section 3.3 of this report;
- Consideration should be given to landscaping and fuel loads on site to decrease potential fire hazards on site;
- The proposed development is to be linked to the existing mains pressure water supply and that suitable hydrants be clearly marked and provided for the purposes of bushfire protection. Fire hydrant spacing, sizing and pressure should comply with AS2419.1 – 2005.

This assessment has been made based on the bushfire hazards in and around the site at the time of inspection and production (May 2017).

In conclusion, should the recommendations above be duly considered and incorporated, the bushfire hazard present should be reduced to a level considered necessary to provide an adequate level of protection to life and property of the site, however will not prevent a bushfire from occurring offsite or radiating from the site.

Finally, the implementation of the adopted measures and recommendations forwarded within this report comply with PBP (2006) and will contribute to the amelioration of the potential impact of any bushfire upon the development estate, but they do not and cannot guarantee that the area will not be affected by bushfire at some time.

1.0 Introduction

Bushfire Planning Australia (BPA) has been engaged by ADW Johnson Pty Ltd, to undertake a Bushfire Threat Assessment (BTA) for the development of Hannan Land, Warnervale, NSW hereafter referred to as the 'site' (**Figure 1**). The site includes the following land parcels:

- Lot 1 DP385242;
- Lots 1-3 DP247082;
- Lots 73- 76 DP7091;
- Lots 1-3 DP1101086;
- Lot 102 DP588421; and
- Lot 2 DP10184444.

The assessment aims to consider and assess the bushfire hazard and associated potential threats relevant to such a proposal, and to outline the minimum mitigative measures which would be required in accordance with the provisions of the PBP 2006 that has been released and adopted through the Environmental Planning & Assessment Amendment (Planning for Bush Fire Protection) Regulation 2007 & the Rural Fires Amendment Regulation 2007.

In order to determine whether the proposed development is bushfire-prone, and if so, which setbacks and other relevant Bush Fire Protection Measures (BFPM) will be appropriate, this assessment adheres to the methodology and procedures outlined PBP 2006 and clause 44 of the Rural Fires Regulation 2013.

1.1 Site Particulars

Locality	Warnervale Road, Warnervale
LGA	Wyong Shire Council
Area	Approximately 49.55 ha.
Zoning	The land covers a range of land zoning areas (see **Figure 3**) including; E2 – Environmental Conservation, E3 – Environmental Management, B1 – Neighbourhood Centre, IN1 – General Industrial, RE1 – Public Recreation, RE2 – Private Recreation, R2 – Low Density Residential and RU6 – Transition.
Boundaries	The site is bordered by residential properties to the north and north east. Vegetated land borders the site to the east and west and industrial properties border the site to the south.
Current Land Use	The site is currently vacant land under adjustments. Exotic grassland, Melaeluca forests and open forests dominate the site (see **Figure 1**).
Topography	Topography underlying vegetation surrounding the site is relatively level at a low elevation, varying in slope between approximately 0.00° and 3.43°. The steepest gradient is located north of the site.
Climate / Fire History	The site lies within a geographical area with a Fire Danger Index (FDI) rating of 100. Extreme bushfire weather is therefore associated with long periods of drought, high temperatures, low humidity and gusty often north-westerly winds. The site is classified by Wyong Shire Council as vegetation category 1 & 2 (**Figure 2**).

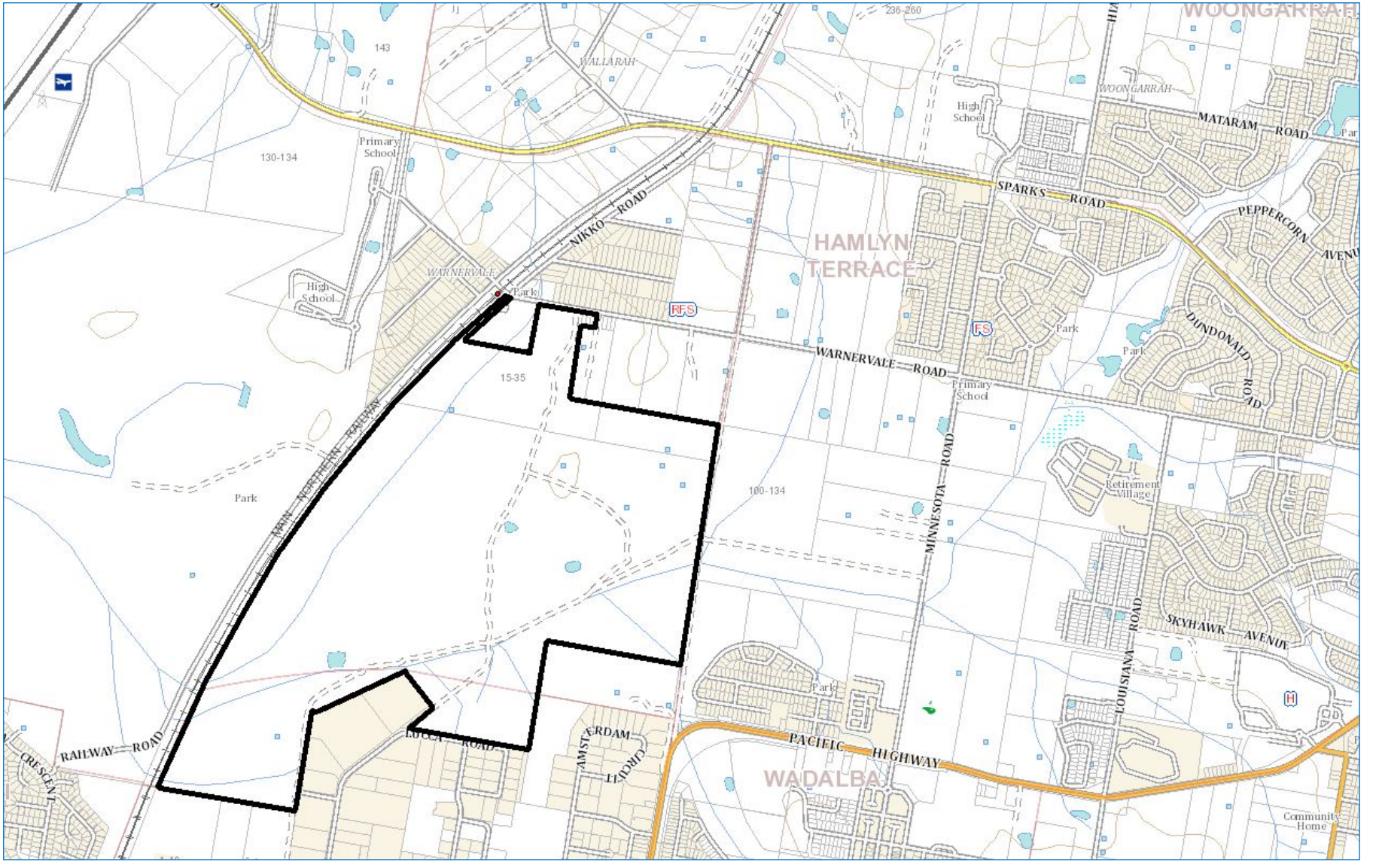


Figure 1: Site Location

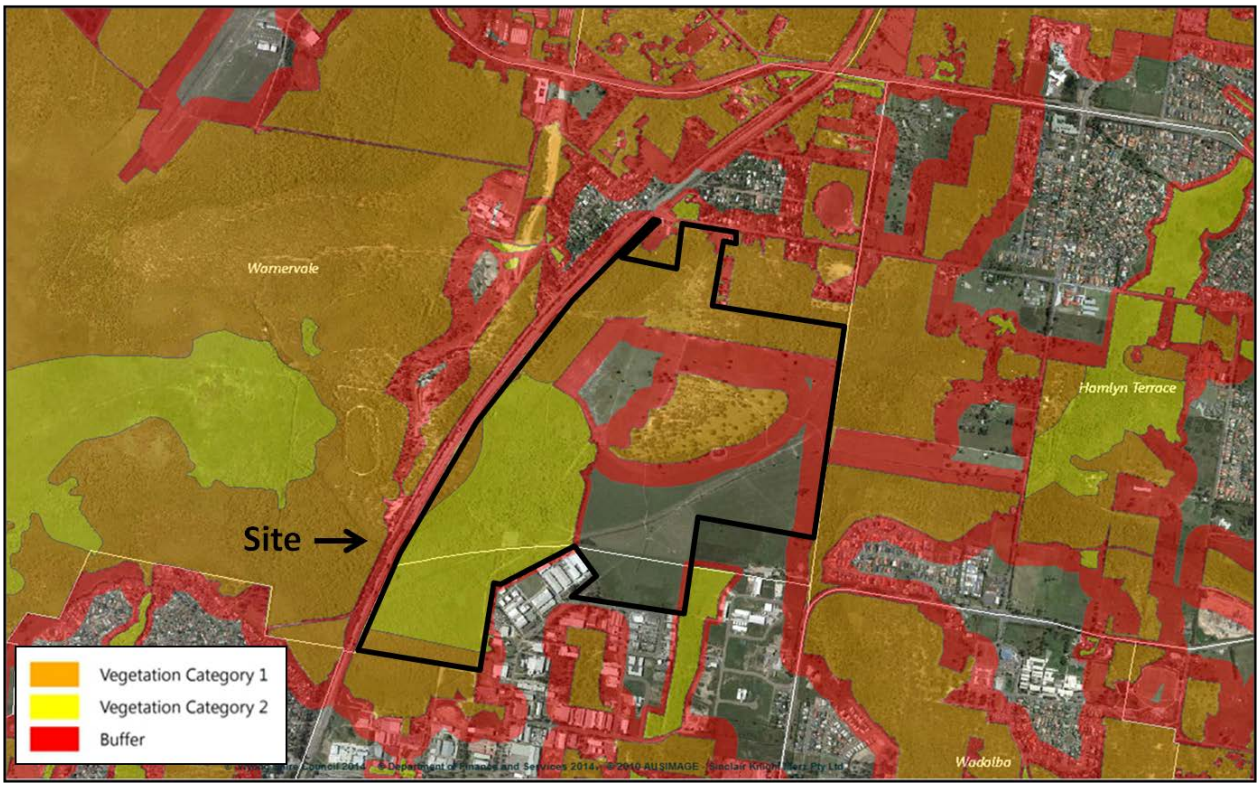


Figure 2: Bushfire Prone Land Map (Wyong Shire Council LEP 2013)

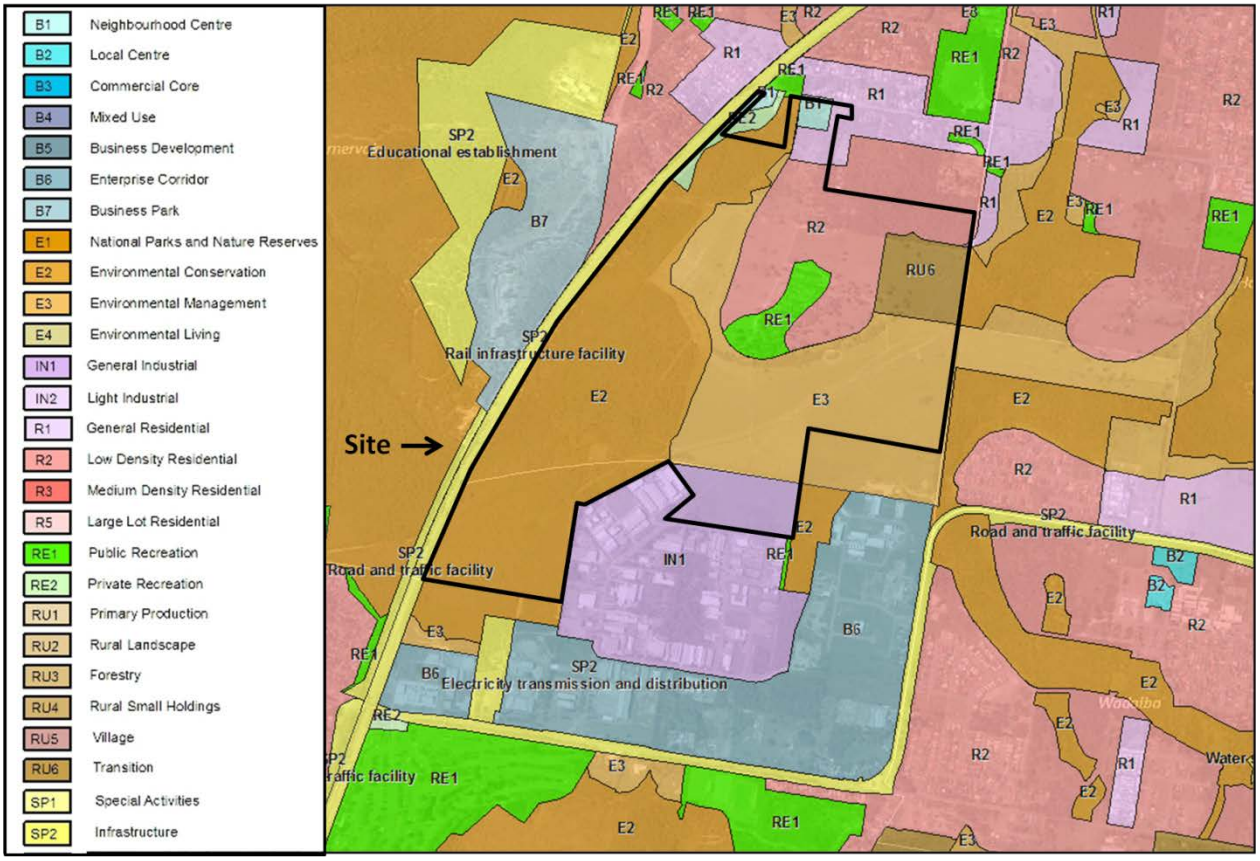


Figure 3: Land Zoning (Wyong Shire Council LEP 2013)

1.2 Description of Proposal

The proposed development is for construction of a residential community consisting of 578 lots and public recreational areas. Included in the development will be the construction of roads, clearing, earthworks, stormwater and landscaping as well as servicing provisions for sewer, water supply, power and communications. For detail on the proposed development, refer to the Master Plan attached in **Appendix 1**.

1.3 Objectives of Assessment

This assessment has been undertaken in accordance with clause 44 of the RF Regulation 2013. This BTA also addresses the six key Bush Fire Protection Measures (BFPM) in a development assessment context being:

1. The provision of clear separation of buildings and bushfire hazards, in the form of fuel-reduced Asset Protection Zones (and their components being Inner Protection Areas and Outer Protection Areas);
2. Construction standards and design (Bushfire Attack Levels);
3. Appropriate access standards for residents, fire-fighters, emergency workers and those involved in evacuation;
4. Adequate water supply and pressure;
5. Emergency management arrangements for fire protection and/ or evacuation; and
6. Suitable landscaping to limit fire spreading to a building.

2.0 Bushfire Hazard Assessment

2.1 Vegetation Assessment

2.1.1 Methodology

Vegetation classification over the site has been carried out as follows:

- Aerial photograph interpretation to map the vegetation classification and extent;
- Onsite vegetation assessment (23rd March 2016);
- Reference to regional vegetation community mapping.

In accordance with PBP 2006, an assessment of the vegetation over a distance of 140 m in all directions from the site was undertaken. Vegetation that may be considered a bushfire hazard was identified and classified in accordance with Appendix 2 of PBP 2006 and Table 2.3 of AS3959-2009.

2.1.2 Predominant Vegetation Formations

Refer to **Table 1** and **Figure 4** for vegetation classifications. Plates 1-7 display the vegetation surrounding the site.

Table 1 Vegetation Classification

Transect	Direction of vegetation	Vegetation Description	Vegetation Community	Classification of vegetation formations (PBP 2006)	Overall Fuel Load (t/ha) (PBP 2006)
T1	West	Narrow road with dense vegetation on the western side and scattered vegetation and grassland on the eastern side.	Alluvial Melaleuca Sedge Forest and Narrabeen Buttonderry Footslopes Forest (C)	Forested Wetland	20
T2	West	Narrow road with vegetation both sides and a small gully/ stream alongside the road.	Alluvial Melaleuca Sedge Forest	Forested Wetland	20
T3	East	Vegetated residential land with a driveway and powerline easement.	Narrabeen Buttonderry Footslopes Forest (C)	Forest	25
T4	North	Vegetated land with a dirt access trail.	Narrabeen Buttonderry Footslopes Forest	Forest	25
T5	North	Vegetated land with a dirt access trail.	Narrabeen Buttonderry Footslopes Forest	Forest	25
T6	North	Vegetated land with a dirt access trail.	Narrabeen Buttonderry Footslopes Forest	Forest	25
T7	North	Vegetated land with a dirt access trail.	Narrabeen Buttonderry Footslopes Forest	Forest	25
T8	East	Virginia Road, powerline easement and dense vegetation.	Alluvial Melaleuca Sedge Forest	Forested Wetland	20
T9	East	Virginia Road, powerline easement and dense vegetation.	Alluvial Melaleuca Sedge Forest	Forested Wetland	20
T10	East	Grassland, dirt trails and scattered vegetation.	Narrabeen Buttonderry Footslopes Forest-Cleared Understory	Forested Wetland	20
T11	South	Grassland, gully to man-made dam and scattered vegetation.	Narrabeen Buttonderry Footslopes Forest-Cleared Understory	Forested Wetland	20

Transect	Direction of vegetation	Vegetation Description	Vegetation Community	Classification of vegetation formations (PBP 2006)	Overall Fuel Load (t/ha) (PBP 2006)
T12	West	Grassland and road reserve.	Narrabeen Buttonderry Footslopes Forest (C)	Forested Wetland	20
Stage 1B	West	Development site	n/a	Non-vegetated areas	0
Stage 1B	North	Warnervale Road, managed land/dwellings	n/a	Non-vegetated areas	0
Stage 1B	East	Driveway, dwellings, managed land	n/a	Reduced vegetation	0
Stage 1B	South	<1ha patch of forest	Narrabeen Buttonderry Footslopes Forest (C)	Forest	25

Plate 1 Vegetation hazard and Powerline easement east of the site

Plate 2 Forest Vegetation North of the site

Plate 3 Vegetation hazard along the north western boundary

Plate 4 Vegetation Hazard South of the site

Plate 5 Vegetation hazard south east of the site

Plate 6 Vegetation and powerline easement south east of the site

Plate 7 Vegetation east of the site

Figure 4: Slope and Vegetation Assessment

2.2 Effective Slope Assessment

2.2.1 Methodology

Slope assessment has been undertaken as follows:

- Aerial photography;
- LiDAR derived contours; and
- Site inspection (23rd March 2016)

In accordance with PBP 2006, an assessment of the slope affecting the bushfire behaviour was undertaken for a distance of 100m from the edge of the site boundary in the direction of the bushfire hazard.

The slopes leading away from the site in the direction of the identified bushfire threat have been evaluated to identify both the average slope and the maximum slope present. These values help determine the level of gradient which will most significantly influence the fire behaviour of the site.

2.2.2 Effective Slope

The slope of the bushfire hazard is documented in **Table 2** below:

Table 2 Slope Assessment

Transect	Direction of Vegetation	Vegetation Type (PBP 2006)	Slope
T1	West	Forested Wetland	0.56° Downslope
T2	West	Forested Wetland	0.00° Level
T3	East	Forest	3.43° Upslope
T4	North	Forest	1.72° Downslope
T5	North	Forest	0.44° Upslope
T6	North	Forest	1.72° Upslope
T7	North	Forest	2.70° Upslope
T8	East	Forested Wetland	1.15° Downslope
T9	East	Forested Wetland	0.57° Downslope
T10	East	Forested Wetland	0.57° Downslope
T11	South	Forested Wetland	1.15° Downslope
T12	West	Forested Wetland	1.15° Downslope
Stage 1B	West	Low-threat vegetation	Downslope
Stage 1B	North	Reduced vegetation	Upslope
Stage 1B	East	Low-threat vegetation	Upslope
Stage 1B	South	Forest (<1ha)	Level/Upslope

2.3 Significant Environmental Features

The existing cleared and grazed nature of the site reduces the potential presence of any significant environmental features. SEPP 14 Wetlands are located within the site boundary, however not within the development area. No significant features were identified during the site inspection.

2.4 Significant Threatened Species

A search of the NSW Atlas Database was undertaken on February 13th 2017 to review any previous records of threatened species occurring on site. The atlas includes records of threatened species listed under both the NSW Threatened Species Act 1995 and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. No threatened species have been recorded on site.

2.5 Cultural Significance

According to the Office of Environment and Heritage AHIMS web service, 12 Aboriginal Heritage Items may be located on or near the site. Refer to the AHIMS report attached in **Appendix 2**.

2.6 Bushfire Risk Management Plan

The *Rural Fires Act 1997* (RF Act) requires each bushfire management committee to prepare a bushfire risk management plan for a nominated area; commonly defined by local government area boundaries. The Wyong Bush Fire Management Committee developed the Wyong Bush Fire Risk Management Plan (BFRMP) which was endorsed in March 2011 and approved in July 2011. The BFRMP investigated the community assets in the Wyong Shire Government Area and ranked them according to the assessed bushfire risk and the likely consequence of a bushfire attack.

BFRMP's are often not site specific, and individual sites or developments do not have a statutory obligation to prepare a BFRMP, however it is often recommended as part of preparedness a BFRMP is prepared.

Wyong Bushfire Risk Management Plan indicates no assets are located within or surrounding the site, nor is the site located in a Bushfire Management zone. **Figure 5** indicates the approximate location of the site within the Bushfire Management Plan map.

A description of the different bushfire management zones are described in **Table 3** below.

Table 3 Bushfire Management Zones

Zone	Purpose	Suppression Objective(s)	Zone Characteristics
Asset Protection Zone (APZ)	To protection human life, property and highly valued public assets and values.	To enable the safe use of Direct Attack suppression strategies within the zone.	As per RFS document *Standards for Asset Protection Zones.*
Strategic Fire Advantage Zone (SFAZ)	To provide strategic areas of fire protection advantage which will reduce the speed and intensity of bushfires and reduce the potential for spot fire development; To aid containment of wildfires to existing management boundaries.	To improve the likelihood and safe use of: **Parallel Attack** suppression strategies with the zone. and/or **Indirect Attack** (back burning) in high to very high fire weather conditions within the zone. To reduce the likelihood of: Crown fire development within the zone; and/or Spot fire ignition potential from the zone.	Zone width related to suppression objectives and dependant: Topography; Aspect; Spotting propensity; Location of adjacent firebreaks; Mosaic pattern of treatment; Assess Overall Fuel Hazard (OFH) once vegetation communities reach minimum fire thresholds within this plan. Management practises should aim to achieve mosaic fuel reduction patterns so that the majority of the SFAZ has an OFH of less than high.

Zone	Purpose	Suppression Objective(s)	Zone Characteristics
Land Management Zone (LMZ)	To meet relevant land management objectives in areas where APZ's or SFAZ's are not appropriate.	As per the land management and fire objectives of the responsible land management agency. To reduce the likelihood and spread of fires. To undertake mosaic burning.	As appropriate to achieve land management eg. heritage and/or fire protection eg. broad scale mosaic burning objectives.
Fire Exclusion Zone (FEZ)	To exclude bushfires.	N/A	Variable dependant on size of fire sensitive area requiring protection.

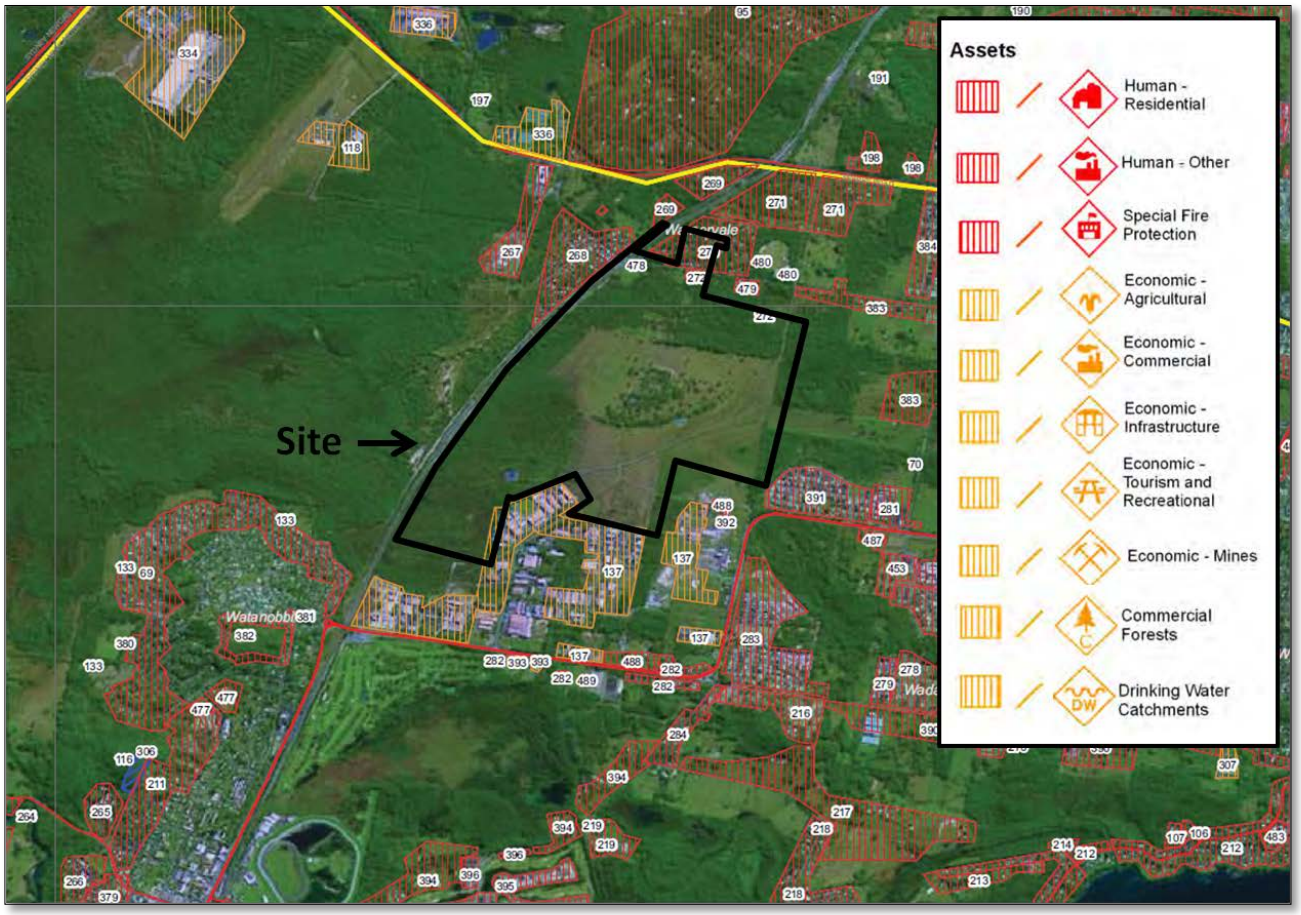


Figure 5: Wyong Bushfire Risk Management Plan

The Wyong BFRMC includes a series of treatment actions available for implementation at any particular site exposed to a bushfire threat. **Table 4** describes the available treatment actions.

Table 4 Asset specific treatments used in the Wyong BFRMC area

Strategy	Targeted Treatments
Ignition Management	Manage access to potential ignition areas. Patrol on Extreme & Catastrophic FDI days.

Strategy	Targeted Treatments
Hazard Reduction	Implement burning program in mapped SFAZ Review adequacy of Asset Protection Zones and inspect and maintain. Investigate creation of Asset Protection Zone. Investigate implementation of burning within LMZ.
Community Engagement	Undertake community engagement activity.
Property Planning	Investigate the possibility of Community Fire Unit (NSW Fire Brigade area). Investigate building upgrades and maintenance (Council buildings). Investigate power supply protection (infrastructure assets).
Preparedness	Prepare and update Pre-Incident Plan for urban interface (NSWFB). Prepare Pre-Incident Plan (RFS). Develop Emergency Management Plans Inspect and maintain fire trails program – the BFMC Fuel Management & Fire Trail Sub-committee to produce an annual inspection and maintenance plan. Develop guidelines for Incident Management Teams – BFMC to develop environmental and cultural heritage protection guidelines for Incident Management Teams.
Other	Identify actions to protect heritage values.

3.0 Bushfire Protection Measures

3.1 Asset Protection Zones

An APZ is an area surrounding a development that is managed to reduce the bushfire hazard to an acceptable level to mitigate the risk to life and property (refer to **Figure 6**). The required width of the APZ varies with slope and the type of hazard. An APZ may consist of both an Inner Protection Area (IPA) and an Outer Protection Area (OPA). The respective IPA and OPA widths for the required APZs are as detailed in **Table 6**. An APZ can include the following:

- lawns;
- discontinuous gardens;
- swimming pools;
- driveways;
- unattached non-combustible garages with suitable separation from the dwelling;
- open space / parkland; and
- car parking.

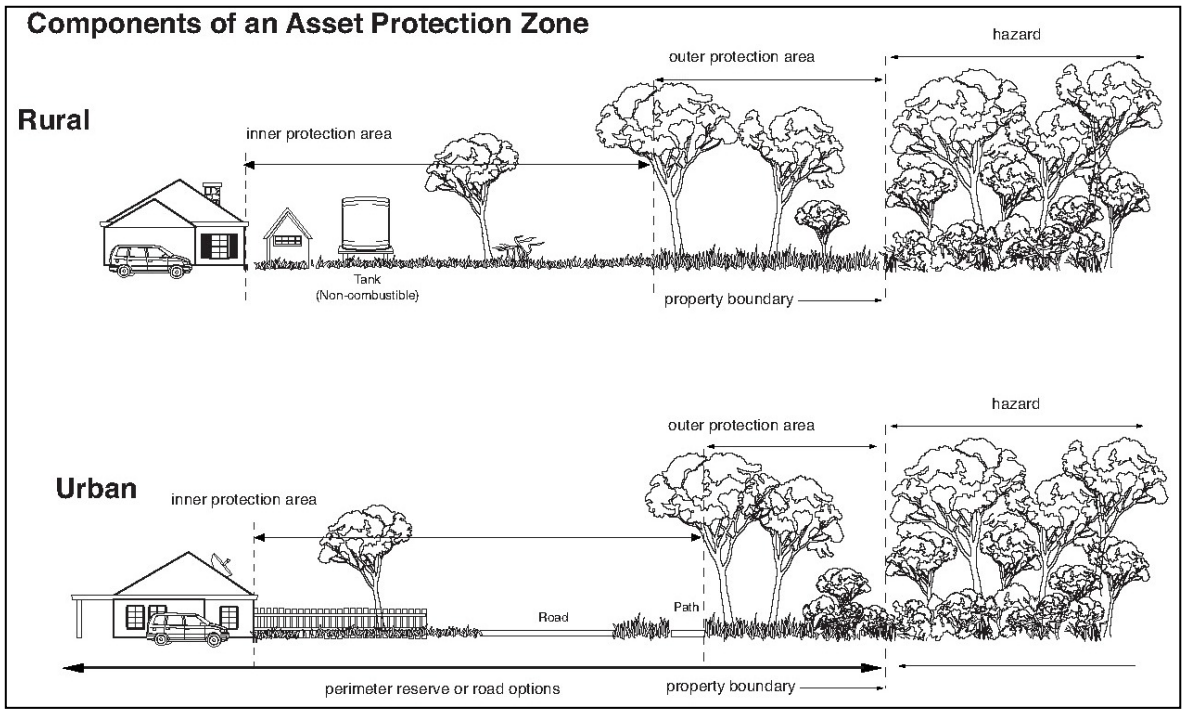


Figure 6: Components of an APZ

3.1.1 Inner Protection Area

The IPA ensures that the presence of fuels are minimised close to a development, thereby minimising the impact of direct flame contact and radiant heat. The performance of the IPA must be such that:

- There is minimal fine fuel at ground level which could be set alight by a bushfire;
- Any vegetation in the IPA does not provide a path for the transfer of fire to the development – that is, the fuels are discontinuous.

The presence of a few shrubs or trees in the IPA is acceptable provided that they:

- Do not touch or overhang any buildings;
- Are well spread out and do not form a continuous canopy;
- Are not species that retain dead material or deposit excessive quantities of ground fuel in a short period or in a danger period; and
- Are located far enough away from any dwelling so that they will not ignite the dwelling by direct flame contact or radiant heat emission.
- Woodpiles, wooden sheds, combustible material storage areas, large areas / quantities of garden mulch, stacked flammable building materials etc. should not be permitted in the IPA, although the IPA can include lawns, discontinuous gardens, fire-trails, perimeter roads, access roads, car parking facilities and driveways.

3.1.2 OPA (Outer Protection Area)

The OPA is located adjacent to the hazard. Within the OPA any trees and shrubs should be maintained in a manner such that the vegetation is not continuous. Fine fuel loadings should be kept to a level where the fire intensity expected will not impact on adjacent developments.

3.1.3 Determining the Appropriate Setbacks

The site lies within the Wyong Shire LGA and therefore is assessed under a FDI rating of 100. In accordance with Table A2.4 and Table A2.7 within PBP 2006, the appropriate width setbacks have been calculated based on the topography and the vegetation around the development site. Refer to **Table 5** for the minimum specifications for APZs in accordance with Appendix 2 of PBP 2006. The required APZs for the proposed development are shown in **Table 6**; equvialent to BAL-29.

Table 5 APZ (Appendix 2 PBP 2006)

Transect	Direction of Hazard	Vegetation Classification (PBP 2006)	Slope	Required APZ (m) (PBP 2006)
T1	West	Forested Wetland	0.56° Downslope	20
T2	West	Forested Wetland	0.00° Level	20
T3	East	Forest	3.43° Upslope	20
T4	North	Forest	1.72° Downslope	20
T5	North	Forest	0.44° Upslope	20
T6	North	Forest	1.72° Upslope	20
T7	North	Forest	2.70° Upslope	20
T8	East	Forested Wetland	1.15° Downslope	0
T9	East	Forested Wetland	0.57° Downslope	15
T10	East	Forested Wetland	0.57° Downslope	15
T11	South	Forested Wetland	1.15° Downslope	20
T12	West	Forested Wetland	1.15° Downslope	15
Stage 1B	West	Low-threat vegetation	Downslope	0
Stage 1B	North	Reduced vegetation	Upslope	0
Stage 1B	East	Low-threat vegetation	Upslope	0

Transect	Direction of Hazard	Vegetation Classification (PBP 2006)	Slope	Required APZ (m) (PBP 2006)
Stage 1B	South	Forest (<1ha)	Level/Upslope	20

3.1.4 Temporary APZs

It is expected the development will be constructed in stages and not all of bushfire hazard within the approved development footprint will be removed. Accordinlgy, it is possible that lots in the earlier stages maybe exposed to a bushfire hazard that will utilamtely be removed. In order to avoid unduly burdening future landowners of lots in these areas, temporary APZs of 100m wide are required at the hazard side of each stage. The temporary APZs must be within the approved development footprint and suitably zoned land (R2). Appropriate erosion controls must be implemented.

3.2 Design and Construction

Building design and the materials used for construction of buildings containing sleeping quarters should be chosen based on the information contained within AS3959-2009. The development plans should be checked by an architect to confirm they meet the relevant Bushfire Attack Level (BAL) as detailed in AS3959-2009.

The The determinations of the appropriate BAL are based upon parameters such as weather modelling, fire-line intensity, flame length calculations, as well as vegetation and fuel load analysis. The determination of the construction level is derived by assessing the:

Relevant FDI = 100;

Flame Temperature = 1090 K;

Slope = variable;

Vegetation Classification = variable; and

Building Location = variable.

To provide a greater level of protection to occupants on site, building requirements under AS3959-2009 should be considered for the hangar and engineering building as they are attached, either directly or indirectly, to the main office and sleeping quarters. Consideration of the requirements of BAL – 29 would suffice.

3.2.1 Bushfire Attack Level for the Proposed Development

The NBC Bushfire Attack Assessor V2.1 was used to calculate the radiant heat exposure based on the methodology detailed under Method 2 by AS 3959-2009. The results are attached in **Appendix 3**. Twelve transects were selected based on the slope and vegetation that would have greatest influence of fire behaviour. Although many of the fire runs do not expose the site to the entire width of the fire front, the calculations assume the site is exposed to a 100m flame width with the fire run approaching perpendicular to the site.

Refer to **Table 7** and **Figure 7** for the BALs calculated for the site.

Table 6 Required Bushfire Attack levels

Transect	Direction of Hazard	Vegetation Classification	Slope	APZ	Separation Distance (m)	BAL
T1	West	Forested Wetland	0.56° Downslope	17m	0 - < 15	BAL - FZ
					15 - < 17	BAL – 40
					17 - < 24	**BAL – 29**
					24 - < 34	BAL – 19

Transect	Direction of Hazard	Vegetation Classification	Slope	APZ	Separation Distance (m)	BAL
					34 - < 100	BAL – 12.5
T2	West	Forested Wetland	0.00° Level	16m	0 - < 15	BAL - FZ
					15 - < 16	BAL – 40
					16 - < 23	**BAL – 29**
					23 - < 33	BAL – 19
					33 - < 100	BAL – 12.5
T3	East	Forest	3.43° Upslope	17m	0 - < 16	BAL - FZ
					16 - < 17	BAL – 40
					17 - < 25	**BAL – 29**
					25 - < 35	BAL – 19
					35 - < 100	BAL – 12.5
T4	North	Forest	1.72° Downslope	23m	0 - < 21	BAL - FZ
					21 - < 23	BAL – 40
					23 - < 32	**BAL – 29**
					32 - < 44	BAL – 19
					44 - < 100	BAL – 12.5
T5	North	Forest	0.44° Upslope	20m	0 - < 19	BAL - FZ
					19 - < 20	BAL – 40
					20 - < 29	**BAL – 29**
					29 - < 39	BAL – 19
					39 - < 100	BAL – 12.5
T6	North	Forest	1.72° Upslope	20m	0 - < 19	BAL - FZ
					19 - < 20	BAL – 40
					20 - < 29	**BAL – 29**
					29 - < 39	BAL – 19
					39 - < 100	BAL – 12.5
T7	North	Forest	2.70° Upslope	17m	0 - < 16	BAL - FZ
					16 - < 18	BAL – 40
					18 - < 26	**BAL – 29**
					26 - < 36	BAL – 19
					36 - < 100	BAL – 12.5
T8	East	Forested Wetland	1.15° Downslope	17m	0 - < 15	BAL - FZ
					15 - < 17	BAL – 40
					17 - < 24	**BAL – 29**
					24 - < 34	BAL – 19
					34 - < 100	BAL – 12.5
T9	East		0.57° Downslope	17m	0 - < 15	BAL - FZ

Transect	Direction of Hazard	Vegetation Classification	Slope	APZ	Separation Distance (m)	BAL
		Forested Wetland			15 - < 17	BAL – 40
					17 - < 24	**BAL – 29**
					24 - < 34	BAL – 19
					34 - < 100	BAL – 12.5
T10	East	Forested Wetland	0.57° Downslope	17m	0 - < 15	BAL - FZ
					15 - < 17	BAL – 40
					17 - < 24	**BAL – 29**
					24 - < 34	BAL – 19
					34 - < 100	BAL – 12.5
T11	South	Forested Wetland	1.15° Downslope	17m	0 - < 15	BAL - FZ
					15 - < 17	BAL – 40
					17 - < 24	**BAL – 29**
					24 - < 34	BAL – 19
					34 - < 100	BAL – 12.5
T12	West	Forested Wetland	1.15° Downslope	17m	0 - < 15	BAL - FZ
					15 - < 17	BAL – 40
					17 - < 24	**BAL – 29**
					24 - < 34	BAL – 19
					34 - < 100	BAL – 12.5
Stage 1B	South	Forest	Level	20m	0 - < 19	BAL - FZ
					19 - < 20	BAL – 40
					20 - < 29	**BAL – 29**
					29 - < 39	BAL – 19
					39 - < 100	BAL – 12.5

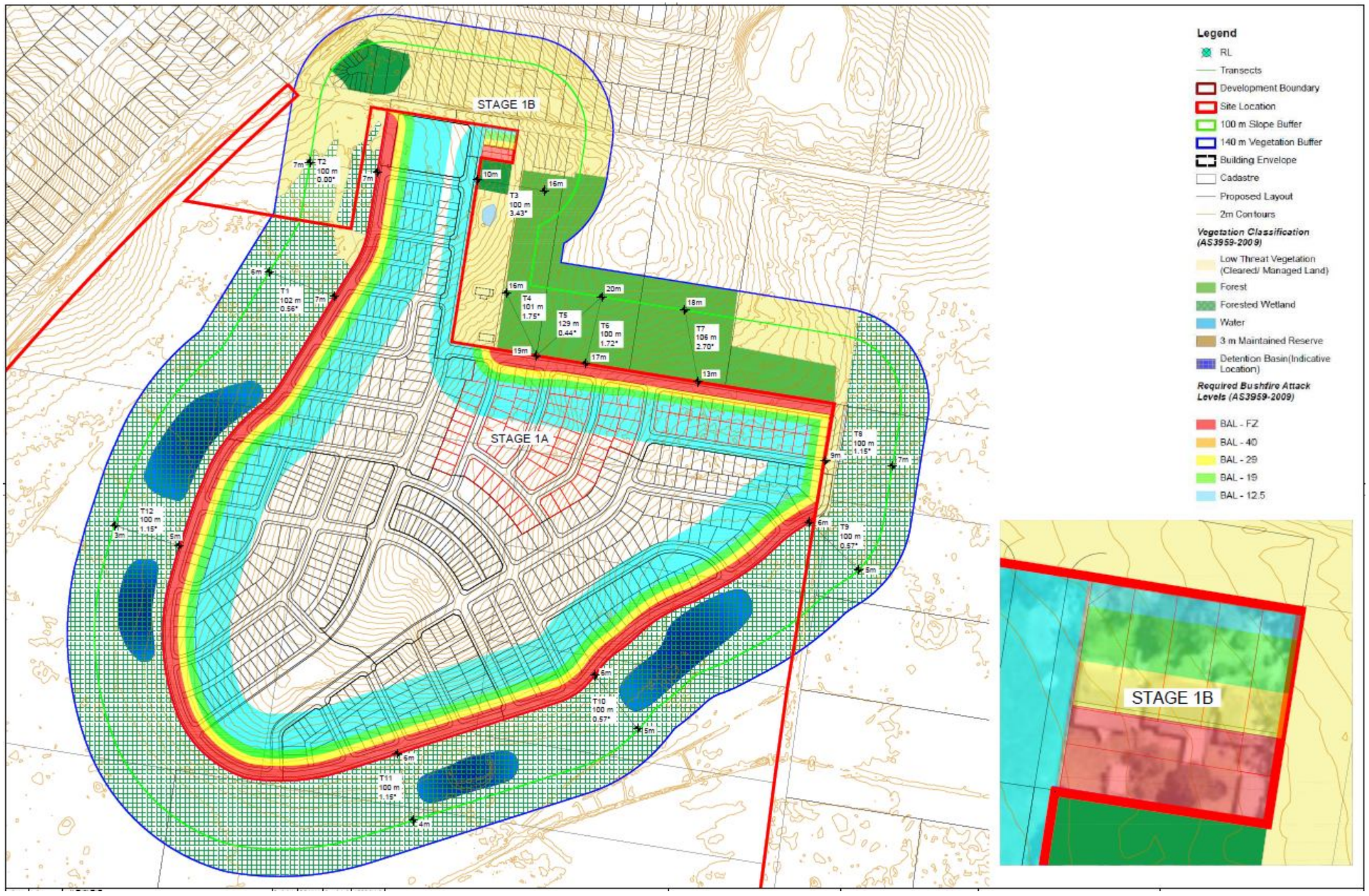


Figure 7: Required Bushfire Attack Levels (AS3959-2009)

3.3 Access

The following road specifications are considered as acceptable solutions as detailed within section 4.1.3 of PBP 2006. Deviations from these solutions for access may be considered (depending on the situation) through a performance-based assessment.

In the event of a serious bushfire threat to the proposed development, it will be essential to ensure that adequate evacuation routes are provided and that access to all areas of retained adjacent vegetation (both on-site and adjacent) is feasible and remains unobstructed.

According to PBP 2006, the design specifications for Public Access Roads require:

- Urban perimeter roads are two-way, that is, at least two traffic lane widths (carriageway eight metres minimum kerb to kerb);
- Public roads are two-wheel drive, all weather roads;
- The perimeter road is linked to the internal road system at an interval of no greater than 500 metres in urban areas;
- Public roads have a cross-fall not exceeding 3^{o};
- All roads are through roads. Where dead end roads are unavoidable, dead ends are not more than 200 metres in length and incorporate a minimum 12 metre outer radius turning circle and are clearly signposted as a dead end;
- Curves of roads (other than perimeter roads) are a minimum inner radius of six metres;
- Maximum grades for sealed roads do not exceed 15^{o} and an average grade of not more than 10^{o};
- There is a minimum vertical clearance to a height of four metres above the road at all times;
- The capacity of road surfaces and bridges is sufficient to carry fully loaded fire fighting vehicles (15 tonnes for areas with reticulated water, 28 tonnes for all other areas);
- Public roads greater than six and a half metres wide to locate hydrants outside of parking reserves;
- Public roads between six and a half metres and eight metres wide are to have No Parking on one side with the hydrants located on this side;
- Parking bays are a minimum of 2.6 metres wide from kerb edge to road pavement; and
- Public roads directly interfacing the bush fire hazard vegetation provide roll top kerbing to the hazard side of the road.

Egress and ingress to the site will remain consistent with the existing entry points from Warnervale Road and Virginia Road.

Access for the development is displayed on the development plans in **Appendix 1**. The proposed road network is considered acceptable and will provide safe operational access for firefightrers whilst residents are evacuating.

3.4 Water

Associated with any kind of development upon the land, it is expected that water mains will be extended into the site. Provision of access to this supply should be provided for fire-crews in the form of readily accessible and easily located fire hydrants. Fire hydrant spacing, sizing and pressure should comply with AS 2419.1 – 2005. Hydrants are not to be 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.

3.5 Gas

Any reticulated or bottled gas should be installed and maintained according to the requirements of the relevant authorities and AS 1596 – 2002. It is expected that the location of gas services will not lead to ignition of surrounding bushland or the fabric of buildings.

3.6 Fire Fighting Capability

Hamlyn Terrace Fire Brigade is located approximately 1.6 km north east of the site on Minnesota Road.

To facilitate quick and efficient action by the Fire Brigade / Rural Fire Service upon arrival, it is recommended that all necessary connections / pumps etc. on the property be clearly marked and visible, and in good working order.

3.7 Landscaping

Landscaping should be designed and managed to minimise flame contact and radiant heat to buildings and the potential for wind driven embers to cause ignitions.

In choosing plants for landscaping consideration should be given to plants that possess properties, which help to protect buildings. If the plants themselves can be prevented from ignition, they can improve the defence of buildings by:

- filtering out wind-driven burning debris and embers;
- acting as a barrier against radiation and flame; and
- reducing wind forces.
- Consequently, landscaping of the site should consider the following:
- meet the specifications of an IPA detailed in PBP 2006;
- priority given to retaining or planting species which have a low flammability and high moisture content;
- priority given to retaining or planting species which do not drop much litter in the bushfire season and which do not drop litter that persists as ground fuel in the bush fire season; and
- create discontinuous or gaps in the vegetation to slow down or break the progress of fire towards the dwellings.

3.8 Vegetation Fuel Management

Consideration should be given to vegetation fuel loads present on site with particular attention to APZs.

Careful thought must be given to the type and physical location of any proposed site landscaping. Inappropriately selected and positioned vegetation has the potential to ‘replace’ any previously removed fuel load.

Bearing in mind the desired aesthetic and environment sought by site landscaping, some basic principles have been recommended to help minimise the chance of such works contributing to the potential hazard on site.

Whilst it is recognised that fire-retardant plant species are not always the most aesthetically pleasing choice for site landscaping, the need for adequate protection of life and property requires that a suitable balance between visual and safety concerns be considered.

It is reiterated again that it is essential that any landscaped areas and surrounds are subject to ongoing fuel management and reduction to ensure that fine fuels do not build up.

4.0 Conclusion and Recommendations

It is clear from this investigation and assessment that the site constitutes Bushfire Prone Land. In accordance with the provisions of PBP 2006, the recommendations outlined within this assessment will substitute as appropriate actions to reduce the risk of damage and/or harm in the event of a bushfire event.

This BTA found the land surrounding the site to support vegetation consistent with *Forest* and *Forested Wetland* as described by PBP 2006.

In summary, the following key recommendations have been generated to enable the proposed development to comply with PBP 2006:

- Asset protection zones (APZs) shall be established in accordfance with **Table 6**; ranging in distance between 16m and 23m;
- A 20m APZ shall be established on Lot 4 DP247082 directly to the south of proposed lot 1108. Suitable arrangements must be made to ensure the APZ will be maintained in perpetuity. Alternatively, a 20m APZ shall be established on the northern side of the boundary (lot 1108 and proposed laneway), with no habitable buildings permitted until such time as the bushfire hazard is removed to the south (Lot 4 DP247082);
- A temporary APZ up to 100m shall be established outside of each completed stage within the development footprint and only in land zoned R2;
- Future buildings used for accommodation within the site should have due regard to the specific considerations given in the BCA, which makes reference to the Australian Standard (AS3959 – 2009) *Construction of buildings in bushfire prone areas*;
- Roads are to be constructed in accordance with section 4.2.3 (1) PBP 2006 as outlined in section 3.3 of this report;
- Consideration should be given to landscaping and fuel loads on site to decrease potential fire hazards on site;
- The proposed development is to be linked to the existing mains pressure water supply and that suitable hydrants be clearly marked and provided for the purposes of bushfire protection. Fire hydrant spacing, sizing and pressure should comply with AS2419.1 – 2005.

A review of the site and proposed development layout indicates that compliance with the above recommendations can be achieved or practically implemented without substantial change to the proposed layout or construction methodology.

Finally, the implementation of the adopted measures and recommendations forwarded within this report comply with PBP 2006 and will contribute to the amelioration of the potential impact of any bushfire upon the development, but they do not and cannot guarantee that the area will not be affected by bushfire at some time.

5.0 References

BFRMP (2011) Wyong Bush Fire Management Committee - Bush Fire Risk Management Plan. Available online at: http://www.rfs.nsw.gov.au/__data/assets/pdf_file/0015/2526/Wyong-BFRMP.pdf.

NSW Rural Fire Service (2006). *Planning for Bushfire Protection – A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners.*

NSW Rural Fire Service (2005). Standards for Asset Protection Zones. NSW Rural Fire Service.

Rural Fires and Environmental Assessment Legislation Amendment Act 2002.

Standards Australia (2009). *AS 3959 – 2009: Construction of Buildings in Bushfire-prone Areas..*

Wyong Shire Council (2011) Bush Fire Prone Land Map. Available online at: http://mapping.wyong.nsw.gov.au/WSCMapping/mapping.html#.

6.0 Acronyms and Units

AHIMS	Aboriginal Heritage Information Management Systems
AS2419 -2005	Australian Standard – Fire Hydrant Installations
AS3959-2009	Australian Standard – Construction of Buildings in Bush Fire Prone Areas
BCA	Building Code of Australia
BFRMP	Bush Fire Risk Management Plan
BTA	Bushfire Threat Assessment
BPA	Bushfire Planning Australia
EPA Act	*NSW Environmental Planning and Assessment Act 1979*
FDI	Fire Danger Index
FMP	Fuel Management Plan
ha	hectare
IPA	Inner Protection Area
LEP	Local Environment Plan
LGA	Local Government Area
OPA	Outer Protection Area
PBP 2006	Planning in Bushfire Prone areas 2006
PBP 2006	Planning for Bushfire Protection 2006
RF Act	*Rural Fires Act 1997*
RF Regulation	Rural Fires Regulation
SEPP 14	State Environmental Planning Policy No. 14

Appendix 1

Master Plan

Master Plan

LEGEND

1. Neighbourhood Centre
2. Medium Density Residential
3. Low Density Residential
4. Park
5. Shared path connection
6. Perimeter path and increased verge for APZ
7. SEPP14 Wetland
8. Water quality basin (indicative only)
9. Regional water storage
10. Flood Plain
11. Existing Alluvial Melaleuca Sedge Forest vegetation retained

Appendix 2

AHIMS

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 190251P

Client Service ID : 276382

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders						Permits		

There are no sites found for given search criteria.

Report generated by AHIMS Web Service on 12/04/2017 for Brooke Whalley for the following area at Lot : 1, DP:DP247082 with a Buffer of 50 meters. Additional Info : Due Diligence Assessment. Number of Aboriginal sites and Aboriginal objects found is 0

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 190251P

Client Service ID : 276386

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders						Permits		

There are no sites found for given search criteria.

Report generated by AHIMS Web Service on 12/04/2017 for Brooke Whalley for the following area at Lot : 1, DP:DP385242 with a Buffer of 0 meters. Additional Info : Due Diligence Assessment. Number of Aboriginal sites and Aboriginal objects found is 0

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 190215P

Client Service ID : 276387

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-3-3406	Bitova ISO 3	GDA	56	355830	6319481	Open site	Valid	Artefact : 1		101823
	Contact	**Recorders**	Mr.John Appleton					**Permits**		
45-3-3407	Bitova OS 4	GDA	56	355761	6319510	Open site	Valid	Artefact : 40		101823
	Contact	**Recorders**	Mr.John Appleton					**Permits**		
45-3-3410	Bitova OS 7	GDA	56	355509	6319327	Open site	Valid	Artefact : 11		101823
	Contact	**Recorders**	Mr.John Appleton					**Permits**		
45-3-3411	Bitova ISO 8	GDA	56	355687	6319543	Open site	Valid	Artefact : 1		101823
	Contact	**Recorders**	Mr.John Appleton					**Permits**		
45-3-3412	Bitova OS 9	GDA	56	355745	6319429	Open site	Valid	Artefact : 4		101823
	Contact	**Recorders**	Mr.John Appleton					**Permits**		
45-3-3413	Bitova OS 10	GDA	56	355767	6319460	Open site	Valid	Artefact : 18		101823
	Contact	**Recorders**	Mr.John Appleton					**Permits**		

Report generated by AHIMS Web Service on 12/04/2017 for Brooke Whalley for the following area at Lot : 2, DP:DP1101086 with a Buffer of 0 meters. Additional Info : Due Diligence Assessment. Number of Aboriginal sites and Aboriginal objects found is 6

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 190251P

Client Service ID : 276394

Brooke Whalley

5 Pioneer Avenue PO Box 3717
Tuggerah New South Wales 2259

Attention: Brooke Whalley

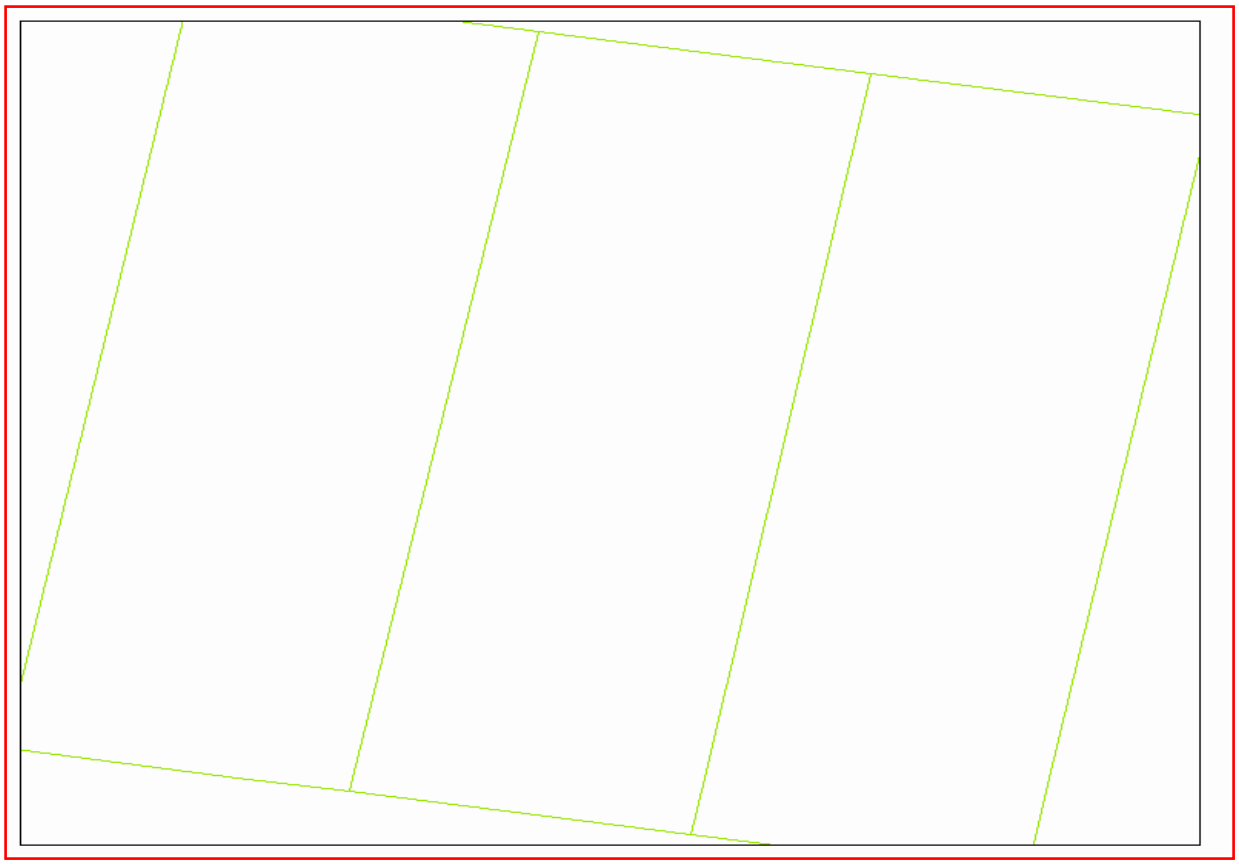
Email: brookew@adwjohnson.com.au

Date: 12 April 2017

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 2, DP:DP247082 with a Buffer of 0 meters, conducted by Brooke Whalley on 12 April 2017.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

3 Marist Place, Parramatta NSW 2150
Locked Bag 5020 Parramatta NSW 2220
Tel: (02) 9585 6380 Fax: (02) 9873 8599

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 190251P

Client Service ID : 276397

Brooke Whalley

5 Pioneer Avenue PO Box 3717
Tuggerah New South Wales 2259

Attention: Brooke Whalley

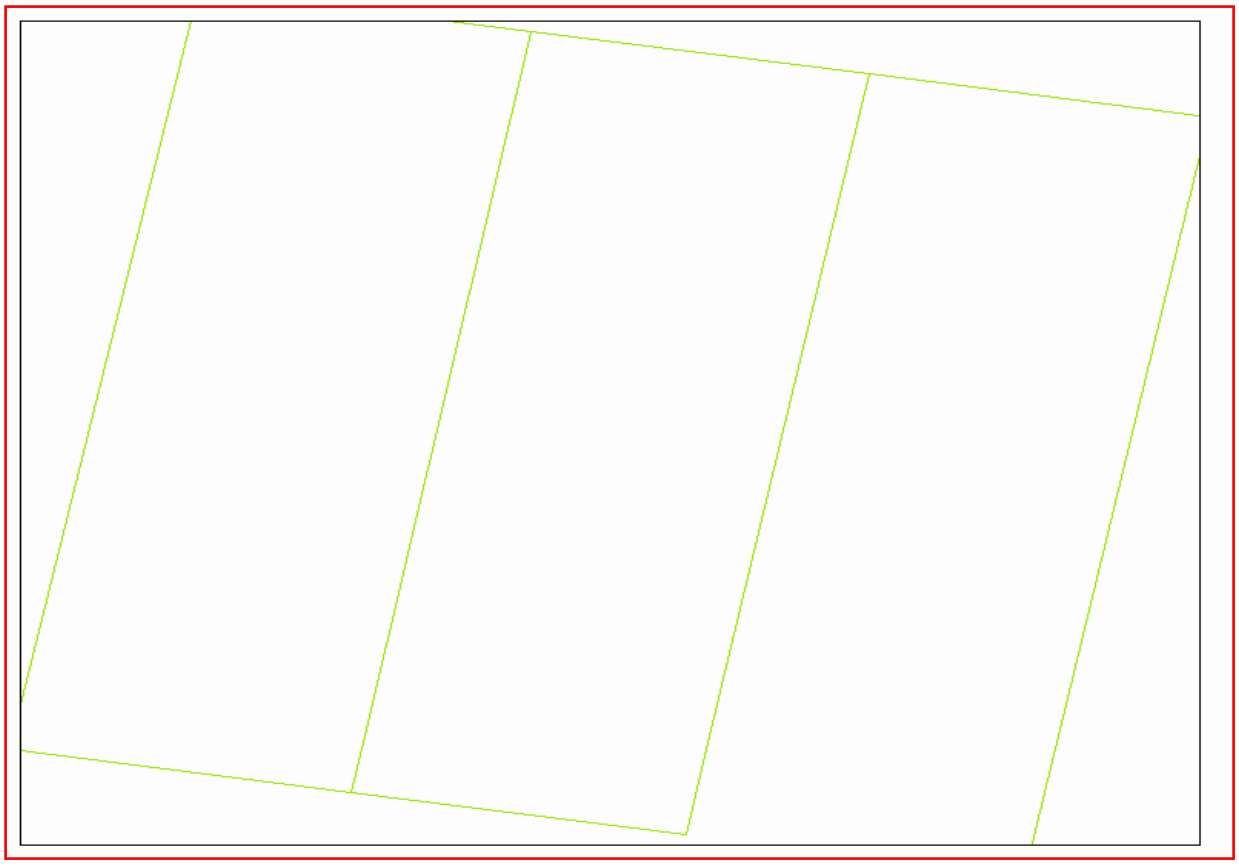
Email: brookew@adwjohnson.com.au

Date: 12 April 2017

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 3, DP:DP247082 with a Buffer of 0 meters, conducted by Brooke Whalley on 12 April 2017.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



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If your search shows Aboriginal sites or places what should you do?

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Web: www.environment.nsw.gov.au

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 190251P

Client Service ID : 276398

Brooke Whalley

5 Pioneer Avenue PO Box 3717
Tuggerah New South Wales 2259

Attention: Brooke Whalley

Email: brookew@adwjohnson.com.au

Date: 12 April 2017

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 73, DP:DP7091 with a Buffer of 0 meters, conducted by Brooke Whalley on 12 April 2017.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

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AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 190251P

Client Service ID : 276399

Brooke Whalley

5 Pioneer Avenue PO Box 3717
Tuggerah New South Wales 2259

Attention: Brooke Whalley

Email: brookew@adwjohnson.com.au

Date: 12 April 2017

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 74, DP:DP7091 with a Buffer of 0 meters, conducted by Brooke Whalley on 12 April 2017.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

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Web: www.environment.nsw.gov.au

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 190251P

Client Service ID : 276400

Brooke Whalley

5 Pioneer Avenue PO Box 3717
Tuggerah New South Wales 2259

Attention: Brooke Whalley

Email: brookew@adwjohnson.com.au

Date: 12 April 2017

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 75, DP:DP7091 with a Buffer of 0 meters, conducted by Brooke Whalley on 12 April 2017.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

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Web: www.environment.nsw.gov.au

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 190251P

Client Service ID : 276401

Brooke Whalley

5 Pioneer Avenue PO Box 3717
Tuggerah New South Wales 2259

Attention: Brooke Whalley

Email: brookew@adwjohnson.com.au

Date: 12 April 2017

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 76, DP:DP7091 with a Buffer of 0 meters, conducted by Brooke Whalley on 12 April 2017.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

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0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

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- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

3 Marist Place, Parramatta NSW 2150
Locked Bag 5020 Parramatta NSW 2220
Tel: (02) 9585 6380 Fax: (02) 9873 8599

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

LEGEND

- LIMIT OF BULK EARTHWORKS
- STAGE BOUNDARY
- PROPOSED LOT BOUNDARY
- EXISTING LOT BOUNDARY
- FUTURE LOT BOUNDARY
- MAJOR CONTOURS
- MINOR CONTOURS
- PROPOSED KERB
- EXISTING KERB
- EXTENTS OF BATTER
- PROPOSED RETAINING WALL
- AHIMS SITE

CONTOUR INTERVAL = 1.0m

LEGEND (+ FILL - CUT) Lower_value		Upper_value		Colour
5	to	3	m	
3	to	2	m	
2	to	1.5	m	
1.5	to	1	m	
1	to	0.75	m	
0.75	to	0.5	m	
0.5	to	0.25	m	
0.25	to	0.05	m	
0.05	to	0	m	
0	to	-0.05	m	
-0.05	to	-0.25	m	
-0.25	to	-0.5	m	
-0.5	to	-0.75	m	
-0.75	to	-1	m	
-1	to	-1.5	m	
-1.5	to	-2	m	
-2	to	-3	m	
-3	to	-5	m	

NOTE:

1. CUT/FILL COLOURS RELATE TO EARTHWORKS FROM STRIPPED SURFACE TO SUBGRADE SURFACE

ver.	date	comment	drawn	pm	level information	scale (A1 original size)	notes
A	13.04.17	INITIAL ISSUE	PB	PJ	DATUM: N/A CONTOUR INTERVAL: N/A	0 50 100m SCALE: 1:2000 (FULL)	

drawing title:

SKETCH SHOWING AHIMS SITES

location: 15-41 WARNERVALE RD, WARNERVALE

council: CENTRAL COAST

dwg ref: 190251-PSK-015

client:

adw johnson
central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100
www.adwjohnson.com.au

working beyond expectations

Appendix 3

BAL Method 2 Assessment Report

NBC Bushfire Attack Assessment Report V2.1

AS3959 (2009) Appendix B - Detailed Method 2

Printed: 05-May-17 **Assessment Date:** 05-May-17

Site Street Address: PR1709 - Warnervale, Warnervale

Assessor: Stuart Greville; Bushfire Planning Australia

Local Government Area: Wyong **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: Stage 1B - south

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:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	20

Fire Inputs

Veg./Flame Width(m):	50	**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):**	7.8
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	31000
Radiant Heat(kW/m2):	27.76	**Flame Angle (degrees):**	57
Flame Length(m):	18.6	**Maximum View Factor:**	0.431
Rate Of Spread (km/h):	2.4	**Inner Protection Area(m):**	20
Transmissivity:	0.847	**Outer Protection Area(m):**	0

Run Description: T1 (forested wetland)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	0.56 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	15	**Overall Fuel Load(t/ha):**	20

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	17

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):**	6.54
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	19333
Radiant Heat(kW/m2):	27.45	**Flame Angle (degrees):**	64
Flame Length(m):	14.56	**Maximum View Factor:**	0.424
Rate Of Spread (km/h):	1.87	**Inner Protection Area(m):**	17
Transmissivity:	0.851	**Outer Protection Area(m):**	0

Run Description: T10 (forested wetland)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	0.57 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	15	**Overall Fuel Load(t/ha):**	20

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	17

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):**	6.55
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	19346
Radiant Heat(kW/m2):	27.46	**Flame Angle (degrees):**	64
Flame Length(m):	14.57	**Maximum View Factor:**	0.425
Rate Of Spread (km/h):	1.87	**Inner Protection Area(m):**	17
Transmissivity:	0.851	**Outer Protection Area(m):**	0

Run Description: T11 (forested wetland)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	1.15 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	15	**Overall Fuel Load(t/ha):**	20

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	17

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):**	6.71
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	20136
Radiant Heat(kW/m2):	28.43	**Flame Angle (degrees):**	63
Flame Length(m):	15.07	**Maximum View Factor:**	0.439
Rate Of Spread (km/h):	1.95	**Inner Protection Area(m):**	17
Transmissivity:	0.851	**Outer Protection Area(m):**	0

Run Description: T12 (forested wetland)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	1.15 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	15	**Overall Fuel Load(t/ha):**	20

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	17

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):**	6.71
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	20136
Radiant Heat(kW/m2):	28.43	**Flame Angle (degrees):**	63
Flame Length(m):	15.07	**Maximum View Factor:**	0.439
Rate Of Spread (km/h):	1.95	**Inner Protection Area(m):**	17
Transmissivity:	0.851	**Outer Protection Area(m):**	0

Run Description: T2 (forested wetland)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	0 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	15	**Overall Fuel Load(t/ha):**	20

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	16

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):**	6.28
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	18600
Radiant Heat(kW/m2):	28.4	**Flame Angle (degrees):**	63
Flame Length(m):	14.1	**Maximum View Factor:**	0.437
Rate Of Spread (km/h):	1.8	**Inner Protection Area(m):**	16
Transmissivity:	0.854	**Outer Protection Area(m):**	0

Run Description: T3 (forest)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	3.43 Degrees	**Vegetation Slope Type:**	Upslope
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):**	17

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):**	6.82
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	24467
Radiant Heat(kW/m2):	28.91	**Flame Angle (degrees):**	63
Flame Length(m):	15.31	**Maximum View Factor:**	0.446
Rate Of Spread (km/h):	1.89	**Inner Protection Area(m):**	17
Transmissivity:	0.852	**Outer Protection Area(m):**	0

Run Description: T4 (forest)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	1.72 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):**	23

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):**	9.08
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	34906
Radiant Heat(kW/m2):	27.88	**Flame Angle (degrees):**	62
Flame Length(m):	20.57	**Maximum View Factor:**	0.438
Rate Of Spread (km/h):	2.7	**Inner Protection Area(m):**	23
Transmissivity:	0.837	**Outer Protection Area(m):**	0

Run Description: T5 (forest)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	0.44 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25

Site Information

Site Slope:	2 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	20

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):**	7.45
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	30073
Radiant Heat(kW/m2):	28.27	**Flame Angle (degrees):**	64
Flame Length(m):	18.13	**Maximum View Factor:**	0.441
Rate Of Spread (km/h):	2.33	**Inner Protection Area(m):**	20
Transmissivity:	0.843	**Outer Protection Area(m):**	0

Run Description: T6 (forest)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	1.72 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25

Site Information

Site Slope:	2 Degrees	**Site Slope Type:**	Upslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	20

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):**	8.14
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	27531
Radiant Heat(kW/m2):	27.01	**Flame Angle (degrees):**	62
Flame Length(m):	16.85	**Maximum View Factor:**	0.421
Rate Of Spread (km/h):	2.13	**Inner Protection Area(m):**	20
Transmissivity:	0.843	**Outer Protection Area(m):**	0

Run Description: T7 (forest)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	2.7 Degrees	**Vegetation Slope Type:**	Upslope
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):**	18

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):**	7.11
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	25731
Radiant Heat(kW/m2):	28.29	**Flame Angle (degrees):**	63
Flame Length(m):	15.95	**Maximum View Factor:**	0.438
Rate Of Spread (km/h):	1.99	**Inner Protection Area(m):**	18
Transmissivity:	0.849	**Outer Protection Area(m):**	0

Run Description: T8 (forested wetland)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	1.15 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	15	**Overall Fuel Load(t/ha):**	20

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	17

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):**	6.71
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	20136
Radiant Heat(kW/m2):	28.43	**Flame Angle (degrees):**	63
Flame Length(m):	15.07	**Maximum View Factor:**	0.439
Rate Of Spread (km/h):	1.95	**Inner Protection Area(m):**	17
Transmissivity:	0.851	**Outer Protection Area(m):**	0

Run Description: T9 (forested wetland)

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	0.57 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):**	17

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:	FLAME ZONE	**Peak Elevation of Receiver(m):**	7.87
Level of Construction:	BAL FZ	**Fire Intensity(kW/m):**	32244
Radiant Heat(kW/m2):	36.7	**Flame Angle (degrees):**	55
Flame Length(m):	19.23	**Maximum View Factor:**	0.562
Rate Of Spread (km/h):	2.5	**Inner Protection Area(m):**	17
Transmissivity:	0.859	**Outer Protection Area(m):**	0