Bushfire Protection Assessment

Ryde Hospital Redevelopment Concept Plan

for NSW Health Infrastructure

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DOCUMENT TRACKING

Project Name	**Bushfire Protection Assessment of Ryde Hospital Redevelopment Concept Plan**
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LIMITATIONS

The bushfire protection measures recommended in this report do not remove the risk to life and property, and they do not guarantee a development will not be adversely impacted by bushfire. Bushfire intensities beyond the design standards proposed are possible but are a lower probability than that considered in this report and upon current national and state bushfire design standards. Maintenance of the bushfire protection measures proposed in the report and the action of occupants and firefighters also affect building survivability.

DISCLAIMER

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Abbreviations

Abbreviation	Description
AS 3959	Australian Standard AS 3959-2018 *Construction of buildings in bushfire-prone areas*
APZ	Asset Protection Zone
BAL	Bushfire Attack Level
BFPL	Bush Fire Prone Land
BPM	Bushfire Protection Measures
CEEC	Critically Endangered Ecological Community
DA	Development Application
DtS	Deemed-to-Satisfy
EP&A Act	*Environmental Planning and Assessment Act 1979*
FFDI	Forest Fire Danger Index
FDR	Fire Danger Rating
IPA	Inner Protection Area
NCC	National Construction Code
OPA	Outer Protection Area
PBP	Planning for Bush fire Protection 2019
RF Act	*Rural Fires Act 1997*
RF Reg	*Rural Fires Regulation 2013*
RFS	NSW Rural Fire Service
RHF	Radiant Heat Flux
SEARs	Secretary's Environmental Assessment Requirements
SSD	State Significant Development

1. Property and Proposal

Table 1 identifies the subject property and outlines the type of development proposed.

Table 1: Site information and development type

Street address:	1 Denistone Road, Denistone
Postcode:	2122
Lot/DP no:	Lot 10 and 11 DP 1183279 + Lot A and Lot B DP 323458
Local Government Area:	Ryde
Fire Danger Index (FDI)	100
Type of development proposed:	Concept Plan for Special Fire Protection Purpose development

1.1 Description of Proposal

Ryde Hospital redevelopment will enable replacement of aging infrastructure and expansion of clinical services to support the growing population of Ryde Hospital catchment. This report accompanies a State Significant Development Application that seeks approval for the establishment of a maximum building envelope and gross floor area for the future new hospital buildings, and physical Stage 1 Early Works to prepare the Site for the future development. The proposed Concept Plan is provided in Appendix 1, more detailed plans can be provided on request.

1.2 Planning Provisions

A multi-stage State Significant Development (SSD) application under the NSW *Environmental Planning and Assessment Act 1979* is planned in order to seek planning approval for the proposed development. A Concept SSD application will be submitted seeking approval for a Concept Proposal and Stage 1 Early Works for environmental approvals of the Concept Plan and to commence Early Works. This will be followed by a Stage 2 SSD application seeking approval for detailed design and related matters.

The following provides further information on these stages:

Concept Proposal and Stage 1 Early Works SSD Application

The Concept Plan proposal seeks to facilitate the development of new hospital services, car-park and refurbishment works. It includes approval for:

- The establishment of a maximum building envelope; and
- Maximum gross floor area

The Stage 1 Preliminary Early Works SSD application will include the following matters:

- Establishing access to the Project site and general establishment;
- Site preparation including environmental clearing;
- Bulk earthworks, including, cut and fill associated with Stage 1 footprint and proposed Stage 1 internal roads;
- Shoring associated with bulk earthworks
- Establishment of construction access roads; and

- Relocation and upgrades of in-ground building services works and utility adjustments to facilitate bulk earthworks.

Stage 2 Detailed Design SSD Application

Stage 2 will be subject to a separate SSD application following the Stage 1 Concept Proposal and Stage 1 Early Works application, and will seek approval for:

- Detailed design, construction and operation of the new Hospital building;
- Connections to the existing Hospital;
- Public domain improvements;
- Refurbishment of existing hospital facilities; and
- Multi-deck and on-grade car-park.

1.2.1 Secretary's Environmental Assessment Requirements

The bushfire related Planning Secretary's Environmental Assessment Requirements (SEARs) applicable to the project are as follows:

No.21: Bush Fire Risk

• If the development is on bush fire prone land, provide a bush fire assessment that details proposed bush fire protection measures and demonstrates compliance with Planning for Bush Fire Protection.

1.2.2 Planning for Bushfire Protection 2019

The proposed development is located on land identified as Bush Fire Prone Land (BFPL) on the Bushfire Prone Land layer within the ePlanning Spatial Viewer[1]. This small parcel of BFPL is within an expansive urban setting, with a few, small and disconnected remnant patches of bushfire prone vegetation. Figure 1 shows the broader locality context and Figure 2 the site setting.

Planning for Bush Fire Protection (PBP) states that the Rural Fire Service is not a consent authority for SSD applications and that these are exempt from requiring a Bushfire Safety Authority. It also states:

"Given the scale of SSI and SSD projects, the requirements of this document should still be applied, and seeking advice from the NSW RFS is encouraged."

1.3 Assessment Process

The Stage 1 Concept Plan proposal is assessed herein in accordance with the SEARs, the *Environmental Planning and Assessment Act 1979*, the *Rural Fires Act 1997* and *Planning for Bush Fire Protection* (RFS 2019).

The following information was considered in the assessment:

- Background documentation provided by TSA Management and Health Infrastructure, including concept designs, background studies and other materials
- GIS data including online spatial resources (i.e. Google Earth, SIX Maps, Nearmap and the NSW Government Planning Portal);

[1] https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address

- Site inspection undertaken by Nathan Kearnes on 12/8/2021;
- Advice and documentation from ecological and vegetation management specialists;
- Various inputs from the Project Design team;
- Pre-DA information provided to the RFS dated 15/12/2021 (Stakeholder Briefing Note) and 25/1/2022 (Vegetation Management);
- Meeting with RFS on 12/1/2022 to discuss and confirm assessment specifics detailed in the pre-DA advice;
- RFS email response to pre-DA information dated 2/2/2022; and
- Various phone calls and emails between Rod Rose and the RFS to help progress specific bushfire assessment and protection matters.

1.3.1 Special Fire Protection Purpose

The proposed hospital redevelopment is a Special Fire Protection Purpose (SFPP) development under Section 100B of the *Rural Fires Act 1997*. This assessment reviews the proposed development against the Specific Objectives, Performance Criteria and Acceptable Solutions prescribed for SFPP development within PBP. As the redevelopment involves demolition of the majority of the existing hospital and is substantially a totally new building, it is assessed against that related to new development.

Notwithstanding this assessment approach, the PBP requirements for redevelopment of existing SFPP facilities are relevant. PBP states that:

> *"In circumstances where new building projects within existing SFPP developments are proposed, an appropriate combination of BPMs are required."*
>
> *"The intention for any building work occurring within an existing SFPP development is to achieve a better bush fire outcome than if the development did not proceed. Achieving this may require a combination of measures including improved construction standards, APZs and evacuation management."*
>
> *"Where practically achievable, full compliance should be provided before variations to the required BPMs are considered"*
>
> *"The objectives that apply to existing SFPP development are as follows:*
>
> - *provide an appropriate defendable space;*
> - *site the building in a location which ensures appropriate separation from the hazard to minimise potential for material ignition;*
> - *provide a better bush fire protection outcome for existing buildings;*
> - *new buildings should be located as far from the hazard as possible and should not be extended towards or situated closer to the hazard than the existing buildings (unless they can comply with section 6.8);*
> - *ensure there is no increase in bush fire management and maintenance responsibility on adjoining land owners without their written confirmation;*
> - *ensure building design and construction enhances the chances of occupant and building survival; and*
> - *provide for safe emergency evacuation procedures including capacity of existing infrastructure (such as roads)."*

1.3.2 Performance-based Solution

PBP allows for an Acceptable Solution approach or a Performance-based Solution approach that meets the Performance Criteria for each of the Bushfire Protection Measures required to achieve compliance. While Acceptable Solutions have been sought for every Bushfire Protection Measure for the proposal, significant site constraints have required that Performance Solutions be applied in order to achieve a viable redevelopment Concept Plan. Constraints include the bushfire hazard being classified a Critically Endangered Ecological Community and the retention of Cultural Heritage features and Heritage Buildings. The Bushfire Protection Measures proposed (and assessed) are therefore a combination of Acceptable and Performance-based Solutions. Table 2 identifies which of the proposed Bushfire Protection Measures are an Acceptable Solution or Performance-based Solution.

Table 2: Methods used for assessing proposed Bushfire Protection Measures

Bushfire Protection Measure	Acceptable Solution	Performance Solution	Report Section
Asset Protection Zones	☐	☑	3.1
Landscaping	☐	☑	3.2
Construction standard	☑	☐	3.3
Access	☐	☑	3.4
Water supply	☑	☐	3.5
Electrical services	☑	☐	3.6
Gas services	☑	☐	3.7
Emergency Management	☑	☐	3.8

1.3.3 Stakeholder Consultation

Many stakeholders have been consulted for the redevelopment proposal and the Concept Plan. The primary bushfire related consultation has occurred with the NSW Rural Fire Service (RFS) and Fire and Rescue NSW. As per the SEARs and the requirements for SSD within PBP, RFS advice has been obtained. In this instance the consultation with the RFS followed a Design Brief style approach, where Performance Solutions were explored through agreements on design and assessment methodology, analysis of the findings and agreements on appropriate Concept Plan refinements.

The consultation involved numerous ad-hoc email and phone communications, as well as a formal meeting (12/1/2022), document provision (15/12/2021 and 25/1/2022) and a formal RFS response (2/2/2022).

1.4 Significant Environmental Features

An assessment of significant environmental features, threatened species, populations or ecological communities under the NSW *Biodiversity Conservation Act 2016* or Commonwealth *Environmental Protection and Biodiversity Conservation Act* 1999 potentially affected by the proposed Bushfire Protection Measures is not part of this report. It is however, covered by other reports prepared for the SSDA.

Substantial consultation with the Project's ecological assessment consultants and the RFS has occurred to ensure the size of the APZ and the vegetation management within the APZ has minimised the impact

on the Critically Endangered Ecological Community of Blue Gum High Forest. This is demonstrated in the Design Fire Assessment (Section 2.1.5) and APZ landscaping design (Section 3.2).

1.5 Aboriginal Cultural Heritage

An assessment of any Aboriginal cultural heritage objects (within the meaning of the NSW *National Parks and Wildlife Act 1974*) that may potentially be affected by the proposed Bushfire Protection Measures is not part of this report. It is however, covered by other reports prepared for the SSDA.

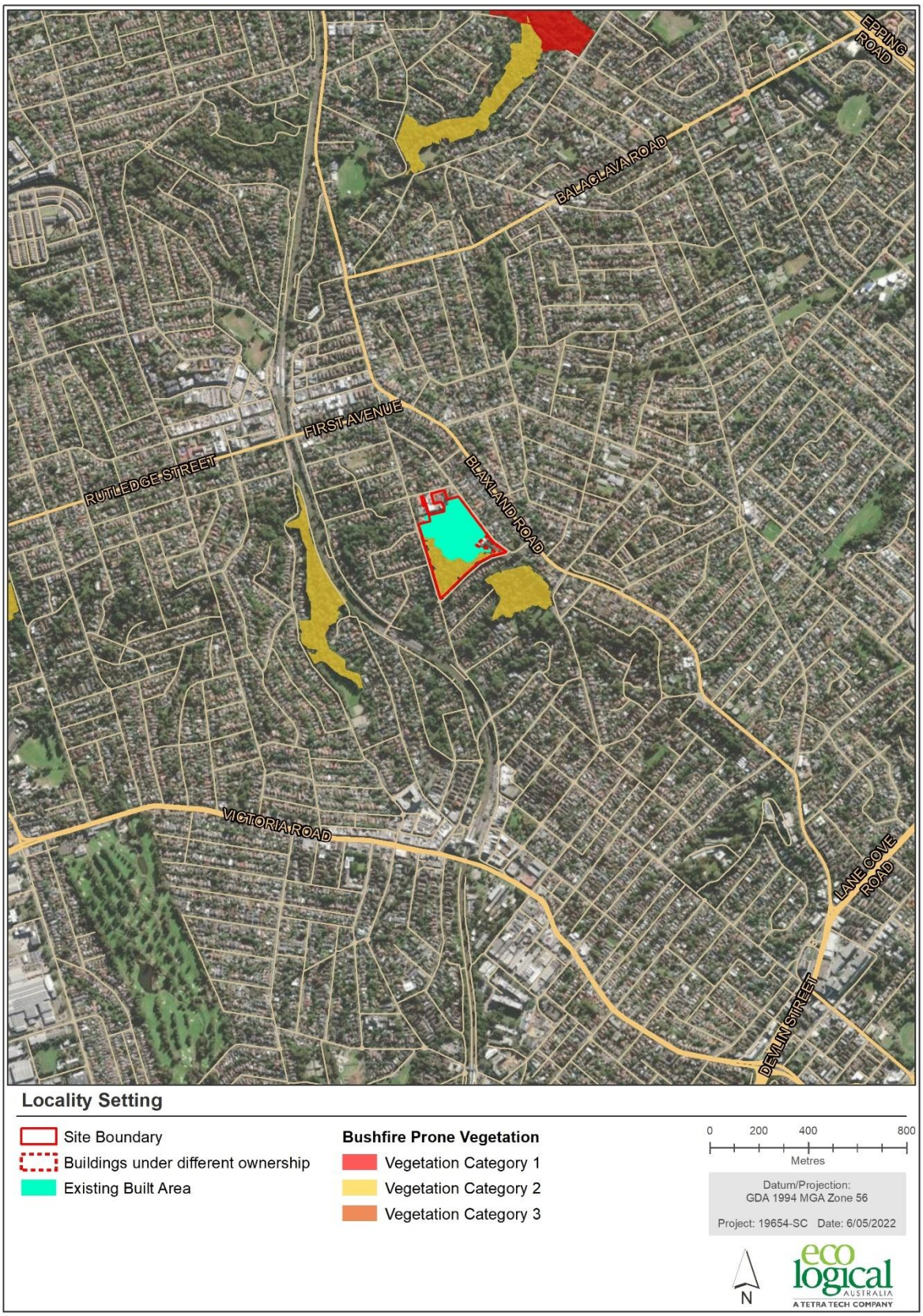

Figure 1: Bushfire Prone Vegetation

Figure 2: Site Context

2. Bushfire Risk Assessment

2.1 Hazard Assessment

The site assessment methodology from Appendix 1 of PBP has been followed and is described below. Figure 3 and Table 3 show the effective slope and predominant vegetation on various Transects representing the highest bushfire threat potentially posed to the proposed development from various directions. These Transect lines were agreed to with the RFS during the consultation process.

2.1.1 Vegetation Assessment

The native vegetation of the Site is currently weed infested and a highly modified version of Blue Gum High Forest, a Critically Endangered Ecological Community (CEEC). As the vegetation is to be restored under a Vegetation Management Plan the current weedy condition has not been used in the Assessment. In general terms, this Assessment validated the vegetation mapping and the Project's ecological studies of the Site, which identified the vegetation as Blue Gum High Forest. The was also confirmed in a site inspection by Principal Bushfire Consultant Nathan Kearnes on the 12 August 2021.

As Short Fire Run models have been used for all Transects in this Assessment, vegetation is classified according to the Short Fire Run Fast Fact (RFS 2019) and the University of Wollongong published fuel loads within Appendix A of that Fast Fact. Using this methodology, the Blue Gum High Forest is classified as Wet Sclerophyll Forest (shrubby) and fuel loads applied based upon classification to the Keith Class (Keith 2004) of North Coast Wet Sclerophyll Forest (Shrubby).

2.1.2 Slope Assessment

More than 50 Transects were assessed to identify those that best represent the effective slope for the Site. The final twelve (12) Transects used (see Figure 3) were agreed to with the RFS during the consultation process. This number of Transects used over a small patch of vegetation provides an accurate and detailed assessment of the effective slope. This level of detail was applied to add robustness to the Performance-based Solution and to minimise the impact on the CEEC, whilst not exceeding radiant heat exposure of 10 kW/m^2 at the proposed building line.

Surveyor compiled 1 m contours covering the vegetated portion of the Site were used to determine the effective slope on each Transect (see Figure 3). The slope grade shown in Table 3 is the average slope on each Transect as the grades along each Transect were relatively consistent. Figure 3 includes a base layer of slope classes overlaid by the contours from which it was derived and displayed as a 1 m grid cell GIS dataset. The slope classes used in Figure 3 are in 5-degree increments.

Table 3: Design Fire Inputs for Bushfire Attack Assessment and Resultant RHF (kW/m²)

	Unmanaged vegetation			APZ				SFRM incl.	
Transect	Height (m)	Fire run length (m)	Effective slope (degrees)	Height (m)	Length (m)	Site slope (degrees)	Vegetation Class	RHF (kW/m²)	Comment
1	24	92	14.6	7.1	45	9	North Coast WSF (Shrubby)	13.0	Carpark shielding not included
1a	24	92	14.6	7.1	45	9	North Coast WSF (Shrubby)	3.4	Carpark shielding used (31.9 m high and 33.68 m wide).
2	9	51.4	9.9	11	48.2	12.9	North Coast WSF (Shrubby)	5.0	T2a APZ is used to plot APZ on T2
2a	18	90	11.3	14	62	12.7	North Coast WSF (Shrubby)	5.4	
3	13	72	10.2	13	54	13.5	North Coast WSF (Shrubby)	5.5	T3a APZ is used to plot APZ on T3
3a	19	112	9.6	15	63	13.4	North Coast WSF (Shrubby)	5.8	
4	11	83.6	7.5	23	85.3	15.1	North Coast WSF (Shrubby)	2.1	used to plot APZ
5	15.5	160.6	5.5	25.5	90.5	15.7	North Coast WSF (Shrubby)	3.1	used to plot APZ
6	8	87	5.3	19	77.3	13.8	North Coast WSF (Shrubby)	2.4	used to plot APZ
7	24	180	7.6	17	73.7	13	North Coast WSF (Shrubby)	5.8	used to plot APZ
7a	24	147	9.3	16	70	12.9	North Coast WSF (Shrubby)	5.9	
8	10	60	9.5	10	49.3	11.5	North Coast WSF (Shrubby)	5.5	T8a APZ is used to plot APZ on T8
8a	19	119	9.1	12	64	10.6	North Coast WSF (Shrubby)	5.9	

Figure 3: Bushfire Hazard Assessment

2.1.3 FFDI

The Site is located within the Ryde City Council area, which is assigned a Forest Fire Danger Index (FFDI) of 100 under the Acceptable Solutions within PBP. This Assessment has used FFDI 100 in all of its Design Fire modelling, however, as the primary bushfire attack on the proposed development is restricted to a predominantly southerly direction, the maximum FFDI is always much lower than 100.

In a recent study of a nearby area (ELA 2021) an analysis of FFDI from different attack directions was undertaken, using long-term historical weather records from the Lucas National Fire Weather Dataset (Lucas 2010). Analysis of this data using the Generalised Extreme Value (GEV) FFDI approach documented by Douglas *et al* (2014 and 2016) revealed that the GEV FFDI for wind directions from the south-east to south-west was 47. This is the bushfire attack direction that the proposed development could be affected by. This reduced FFDI is relevant to this Site as the only winds that can drive a bushfire toward the development on the Site (in the manner assumed under PBP) would typically be cooler, moister winds from the south under a lower FFDI.

This lower FFDI value (FFDI 47 is 53% lower than FFDI 100) is not used in the Design Fires within this Assessment but are identified here to demonstrate that the FFDI used in the Performance-based Solution is conservative and that the predicted 10kW/m^2 line from all Design Fires are conservative.

2.1.4 Assessment of Performance-based Solutions

The Performance-based Solutions within this Assessment are based on a Method 2 approach from AS 3959 (SA 2018). All Short Fire Run modelling has followed the requirements of A1.11.2 of PBP and the RFS Short Fire Run Fast Fact (May 2019). Use of the Short Fire Run model was agreed to by the RFS during consultation as the Site is a small remnant bushland in an expansive urban area. Ten (10) of the Transects used for the Design Fires have potential fire runs <150 m, the other two are 160 m and 180 m long.

Although the Site's bushfire hazard is small (3.6 ha), surrounded by urban development and within an expansive urban developed area, the Hospital occupants represent a higher risk cohort (SFPP development). The proposed hospital buildings therefore require an APZ that complies with the PBP Performance Criteria '*Radiant heat levels of greater than 10kW/m² (calculated at 1200K) will not be experienced on any part of the building*'.

The Performance-based Solution for the APZ design and vegetation management was used because the bushfire hazard is a Critically Endangered Ecological Community and has important Aboriginal Cultural values. The Acceptable Solution APZ was considered an unacceptable impact on these values by various stakeholders and the Performance-based Solutions offered the potential for a smaller impact on the CEEC and Cultural Heritage.

2.1.5 Design Fire Assessment

2.1.5.1 APZ footprint

Data from the twelve (12) Design Fire Transects (Figure 3) have been assessed. Many other Design Fires (Transects) were considered but were dismissed as they either resulted in a lower BAL (e.g. additional fire runs from the southern end of the Site) or represented an unrealistic bushfire risk (e.g. very short fire runs emanating from the upper eastern and western sides of the Site).

Each Design Fire (Transect) was assessed using the Short Fire Run feature within the Newcastle Bushfire Attack Assessment software and modelled in accord with the Developer's training and instructional notes.

The Design Fire inputs were FFDI 100, flame temperature 1200 K, North Coast Wet Sclerophyll Forest (Shrubby) and effective slope calculated from beyond the proposed APZ in Figure 3. The APZ from these Design Fires was plotted by moving the APZ line in various directions until the smallest APZ resulting in a Radiant Heat Flux (RHF) <10kW/m^2 was achieved. The process was undertaken iteratively by measuring and remeasuring the slopes, fire runs, APZ distances and the resultant RHF.

Although the APZ plotting process aimed to minimise the APZ footprint, a conservative APZ line was ultimately chosen. At the proposed Hospital building line the average RHF from the twelve (12) Transects was 4.8 kW/m^2 with the highest RHF being 5.9 kW/m^2. These predicted RHF values are well under the 10 kW/m^2 Performance Criteria prescribed by PBP.

Table 3 shows the Design Fire inputs for calculating the RHF on each Transect and the resultant Radiant Heat Flux. Bushfire Attack Assessment reports from this modelling are provided in Appendix 2. The Short Fire Run model was used on all Transects. In addition, Transect 1a used both shielding and the Short Fire Run models as detailed in Section 2.1.5.2.

2.1.5.2 Shielding assessment of the carpark

For Transect 1, the multi-storey carpark shields part of the Hospital building from radiant heat and flames. The proposed carpark is five stories high, accessed off Ryedale Road and extends into the Site for a distance of 68 m (Figure 4). The carpark is 24.9 m in height and sits on top of a near vertical masonry embankment, with the hazard vegetation located 7 m below, giving a combined height of 31.9 m.

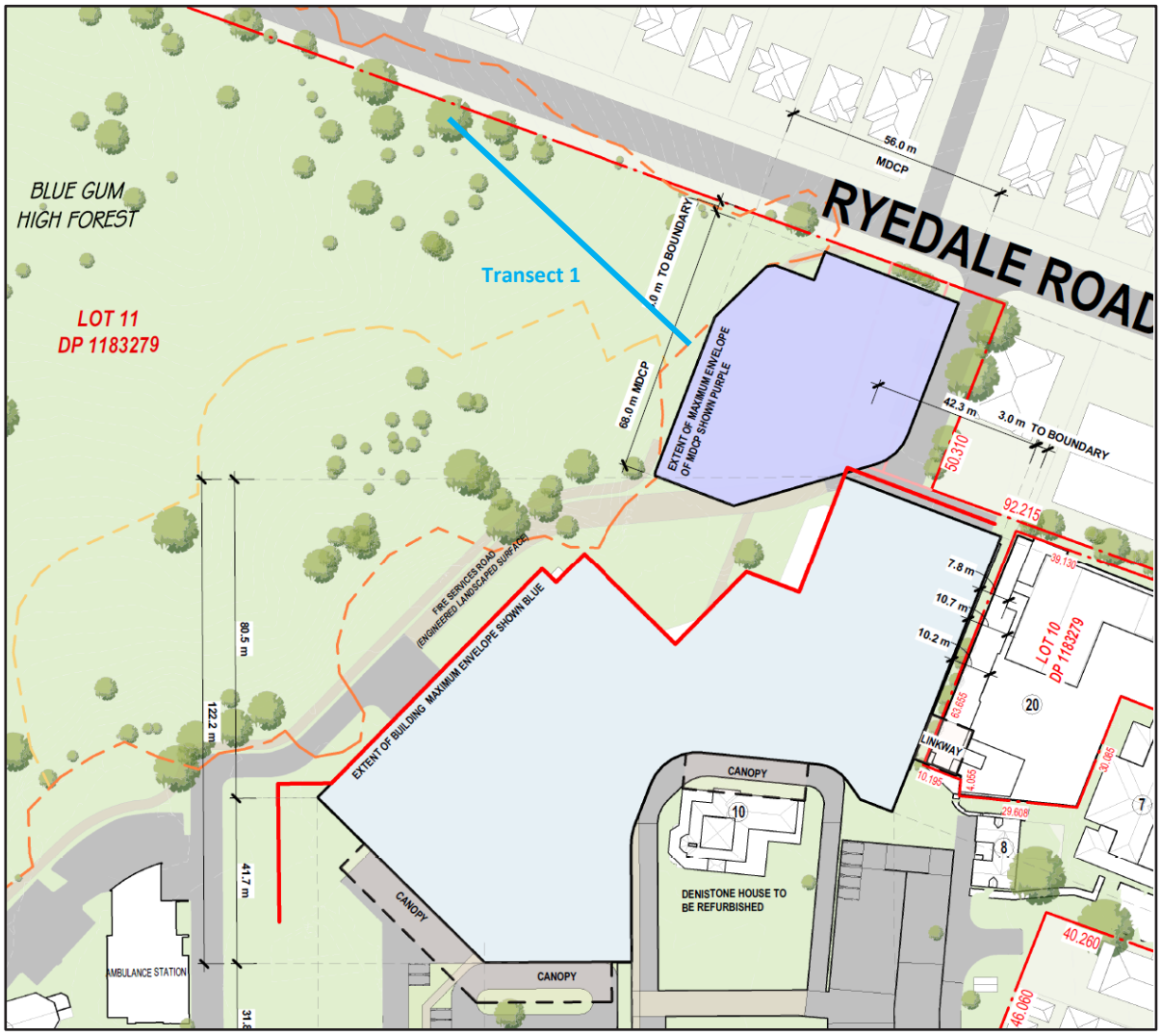

Figure 4: Location and orientation of carpark and proposed hospital building

The multi decked car park (MDCP) is proposed to be constructed of non-combustible materials with at least the southern façade having open metal screening that encloses all openings between concrete pillars, floors and barriers. The screening is not ember proof but in the Detailed Design stage the percentage radiant heat removed by the screening will be determined to work in conjunction with other internal and external features of the carpark to achieve a 100% shielding from radiant heat for the portion of the Hospital building located behind the carpark. This outcome is not difficult to achieve given the 30 m - 45 m depth of the carpark (northward from the hazard) and the internal carpark design options which can facilitate further shielding if required, and especially as Radiant Heat only travels in a straight line.

As the multi decked car park (MDCP) will be designed and constructed as a barrier to radiant heat and flames, its shielding properties have been calculated. Figure 5 shows the carpark provides limited shielding of the Hospital when viewed from the south along Transect 5 (see Figure 3). However, when viewed from along Transect 1 (Figure 4) the carpark is a significant barrier. The carpark shielding is only assessed for Transect 1 and is not considered in the RHF for the adjacent Transect 2 (Figure 3).

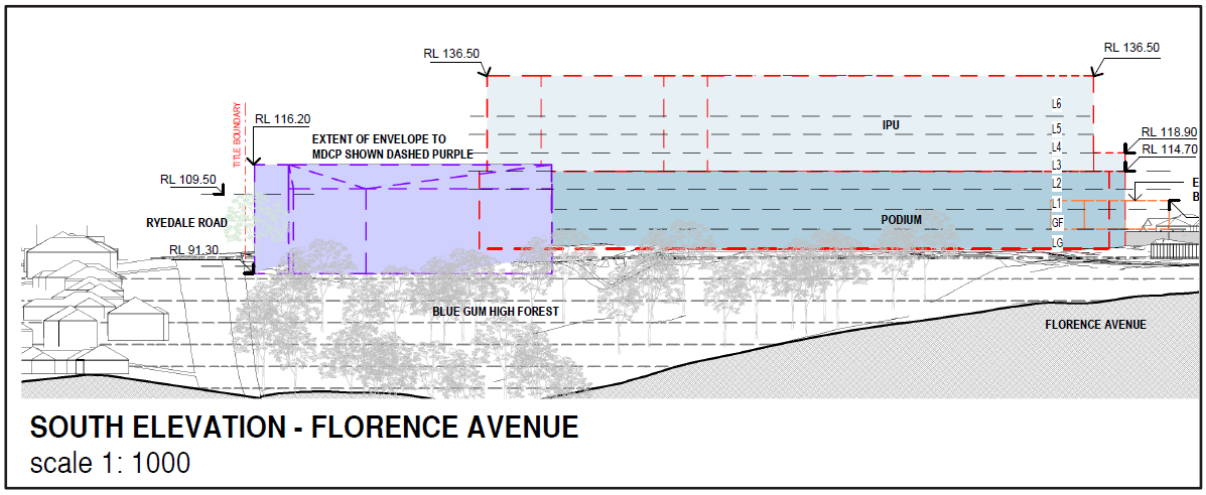

Figure 5: Position of MDCP relative to Hospital when viewed from the south (indicatively along Transect 5)

The shielding along Transect 1 provided by the MDCP was modelled using the Bushfire Attack Assessor (BFAA) software produced by Newcastle Bushfire Consulting. The methodology for modelling the shielding afforded by the carpark is described in Appendix 3. The key findings derived from the carpark shielding assessment include:

- Transect 1 identifies a 45 m separation of the hazard (APZ) from the multistorey hospital building. At this distance the RHF is <10 kW/m^2 from for all heights of 24 m and above on the hospital building. If the carpark shielding is considered, the RHF is reduced to 0.45 kW/m^2 at 39.5 m (top of building) and 1.85 kW/m^2 at 24 m.
- Carpark shielding is required below 24 m to ensure the RHF is <10 kW/m^2. The modelling shows that the carpark shielding reduces the RHF of the Hospital building at the 'peak elevation of receiver' (6.19 m) from 13 kW/m^2 to 3.44 kW/m^2.
- No additional APZ is required south of the carpark to achieve a RHF of <10 kW/m^2 on the shielded portion of the Hospital building.
- The carpark shields much more of the Hospital than that assessed in the Transect 1 Design Fire, but no other Transect/Design Fire relies on the carpark shielding.

2.1.5.3 APZ vegetation management

As the proposed APZ is within a Critically Endangered Ecological Community the vegetation management within the APZ is a primary consideration in the assessment of ecological impacts, and ultimately whether the SSDA will obtain the required approvals.

Information was provided to the RFS (ELA, 25/1/2022) on an Performance-based Solution under *Planning for Bushfire Protection* 2019 (PBP) for the vegetation management within the APZ and is provided as Appendix 4. A comparison of the performance of a PBP Acceptable Solution APZ with that of the proposed Performance-based Solution formed the basis of the assessment and consultation with the RFS. The information provided allowed the RFS to consider whether the proposed tree retention within the CEEC meets the Performance Criteria for an APZ prescribed within PBP.

The Performance-based vegetation management within the proposed APZ is as follows:

- retain all existing CEEC trees and allow for further recruitment

- retain up to 10% ground cover of CEEC shrubs within the Inner Protection Area (IPA) and 20% in the Outer Protection Area (OPA)
- retain up to 75% - 90% CEEC ground cover plants, but only those with lower above-ground biomass

The Performance Criteria for APZ vegetation management from PBP (p. 55) are:

- *APZ are managed and maintained to prevent the spread of fire to the building*
- *the APZ is to be provided in perpetuity,* and
- *APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is minimised*

Proposed vegetation management was analysed and assessed in a Design Brief manner (See Appendix 4) and discussed with the RFS. The RFS written response dated 2/2/2022 said

> *"… You have demonstrated the low risk of canopy fire and acknowledged that there is some residual risk given the proposed APZ does not meet the acceptable solutions for canopy management. Some additional measures would need to be proposed and agreed to at the pre-DA stage to offset the residual risk. Additional measures to consider could include some or all of the following:*
>
> - *New works constructed to BAL-29 and the existing buildings upgraded for ember protection.*
> - *Security patrols around the perimeter on total fire ban days.*
> - *Given the amount of leaf and branch litter likely generated from a full canopy, more frequent removal of surface fuels within the APZ.*

Each of the three requested additional measures to mitigate the risk associated with tree canopy retention are provided within Section 3 (Bushfire Protection Measures) and, in essence, these are:

- Plans to considerBAL-29 for new works and upgrading for ember protection of the existing buildings at the Detailed Design stage of the project.
- Security patrols around the perimeter on total fire ban days can be provided by the 24/7 security that will operate on site. This will also be included in the Bushfire Response and Evacuation Plan which will be prepared prior to occupation.
- The APZ will be maintained at the required standard by regular inspection and response under the Vegetation Management Plan for the Site.

In addition to these measures the APZ proposed provides a RHF at the building line about 50% of that required by the PBP Acceptable Solution of 10 kW/m^2. This lower RHF exposure is a significant compensation for the retained trees.

2.2 Other Bushfire Risk Considerations

Other bushfire risk considerations are relevant to the Assessment, these include:

- a very low likelihood of any bushfire, and particularly a moderate to higher intensity bushfire due to the isolated 3.4 ha remnant having no know bushfire history and being located within an expansive urban area

- a very low likelihood of an ignition on the Site developing into a fully developed bushfire, given the high visibility around all interfaces, nature of the fuel (mesic vegetation) and availability of suppression opportunities (brigades and local residents).

- a very low likelihood of the Bushfire Attack Levels (using the Acceptable Solution principles) occurring in remnant bushland as there is no bushfire encroachment from elsewhere and a very small 'bushfire catchment' of 3.4 ha.

3. Bushfire Protection Measures

3.1 Asset Protection Zones

The APZ footprint for the Site has been developed through extensive consultation with stakeholders. The RFS agreed with the use of the Short Fire Run models (in various 'pre-DA' discussions and in an email to Rod Rose from Alastair Patton dated 10.3.22) and the various Design Fire transects used to determine the APZ. The final APZ (see Figure 3) represents a footprint based upon the Performance Solutions discussed in Section 2 with two primary aims; firstly, to ensure no part of the proposed Hospital buildings would be exposed to >10 kW/m^2 and secondly, to ensure the impacts on the CEEC and heritage values were minimised.

The proposed APZ (Table 3 and Figure 2) has been assessed against the Performance Criteria within Table 6.8a of PBP with the findings summarised in Table 4.

Table 4: APZ requirements and design compliance (adapted from Table 6.8a of PBP)

Performance Criteria	Compliance Notes
Radiant heat levels of greater than 10kW/m^2 (calculated at 1200K) will not be experience on any part of the building	**Complies:** No part of the Hospital building is exposed to >5.9 kW/m^2 calculated using 1200K
APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is minimised.	**Complies:** Works to be undertaken by contractor, no trees removed, slopes >18^0 very small (see S. 2.1.2 in Appendix 4)
APZs are managed and maintained to prevent the spread of fire to the building.	**Complies:** See Appendix 4
The APZ is provided in perpetuity.	**Complies:** See Appendix 4

3.2 Landscaping

Table 5 identifies the proposed vegetation management within the APZ and compares it to the PBP Acceptable Solution APZ. Assessment of this Performance Solution design is provided Appendix 4**,** which was commented upon by the RFS (email dated 2/2/2022).

Table 5: Comparison of key APZ vegetation management for proposed Alternate Solution vs Acceptable Solution

Vegetation layer	Acceptable Solution for IPA and OPA (App. 4 of PBP or 'Standards for APZ')	Alternate Solution proposed for SSDA
Trees	• 15% canopy cover (IPA) • 30% canopy cover (OPA) • 2 – 5 m canopy separation • Tree height not considered, but forests are >10 m high (and uncommonly >30 m) • preference should be given to smooth barked and evergreen trees • lower limbs should be removed up to a height of 2m above the ground	• retain existing trees/allow recruitment • canopy cover variable across APZ from 15% - 70%, naturally thinner closer to buildings • variable vertical or horizontal separation, some connected canopies, estimated >2m canopy separation over 50% of site • trees generally >30 m in height • trees predominantly smoothed bark • lowest branches of mature *E. saligna* generally >15 m above ground
Shrubs	• 10% ground cover (IPA) • 20% ground cover (OPA)	• 10% ground cover (IPA) • 20% ground cover (OPA)

Vegetation layer	Acceptable Solution for IPA and OPA (App. 4 of PBP or 'Standards for APZ')	Alternate Solution proposed for SSDA
Ground cover	• Mown grass <100mm • 'Standards for APZ' (RFS undated) allows: ○ 75% - 90% ground cover for soil erosion prevention ○ A permanent ground cover (for example short grass). This will provide an area that is easy to maintain and prevent soil erosion.	• Grass mowing and Acceptable Solution compliant gardens around buildings as required • 75% ground cover of permanent plants with low above-ground biomass within the CEEC

Assessment of compliance of the proposed landscaping with Section 6.8.1 of PBP is provided in Table 6.

Table 6: Landscaping requirements and compliance (adopted from table 6.8a of PBP)

Performance Criteria	Compliance Notes
Landscaping is managed to minimise flame contact and radiant heat to buildings, and the potential for wind-driven embers to cause ignitions.	**Complies:** See Appendix 4. Table 1 in Appendix 4 shows the proposed vegetation management (Performance Solution). RFS email (dated 2/2/2022) responded to the Performance Solution and suggested additional protection measures be considered such as BAL 29 construction, security patrols and greater frequency of APZ maintenance. These will be considered in the Detailed Design stage of the Project. However, the primary additional measure proposed is an APZ that achieves RHF <6 kW/m^2 rather than the <10 kW/m^2 required by PBP. Figure 6 shows slopes >18^0 within the APZ. Compliance of the small areas of slopes >18^0 was assessed in S. 2.1 of Appendix 4 and accepted by RFS. The small area of slope >18^0 is predominantly on the upper embankment within 20 m of the carparks or within a narrow band 22 m wide within the most outer part of the APZ.

3.3 Construction Standards

The assessment of the Design Fire Transects (Figure 3) demonstrate that the proposed Hospital buildings are exposed to <6 kW/m^2 calculated using a 1200K flame temperature and under FFDI 100. The RFS response to the Appendix 4 analysis of the vegetation management suggested additional protection measures be considered, including *"… New works constructed to BAL-29 and the existing buildings upgraded for ember protection …"*. This matter will be considered in the Detailed Design stage; however, the proposed development can meet the minimum SFPP construction standard prescribed by PBP of BAL 12.5.

The proposed carpark is located with BAL FZ, but has a non-combustible façade (steel and concrete) a non-habitable building and appropriate NCC fire safety construction requirements will be applied

Figure 6: Slopes > 18 degrees within APZ

3.4 Access

A Performance-based Solution has been assessed for access. Figure 7 shows the indicative access plan for the Site. Notable bushfire protection related considerations are as follows:

- Roads exist as a perimeter around the hazard. These are the public roads of Ryedale Road and Florence Avenue, and a private through road from Denistone Road to Ryedale Road.
- The through road on Site is a combination of access to public parking area (near ambulance station), access to the Multideck Staff Carpark (off Ryedale Road) and a linking fire services road
- The fire services road separates the Hospital Buildings from the hazard.
- The multideck staff carpark is non-combustible and is on the hazard side of the fire services road. It will be provided with fire fighter pedestrian access (to run out hoses) from suitable hard stand areas on Ryedale Road and at a suitable location along the fire services road at the eastern end of the multideck carpark.
- Public and ambulance access for the Redeveloped Hospital is entirely off Denistone Road and would not be exposed to a bushfire attack due to distance or shielding.
- There is low potential for traffic interaction between fire service vehicles along the linking road (between Ryedale Rod and Denistone Road) and the logistic vehicles, staff carpark use and ambulance station traffic.
- The linking portion of the fire services road will be engineered to comply with PBP.

The fire services road will be 4 m wide and designed to comply with the Performance Criteria for access within PBP. The design concepts have been agreed to in principle by the RFS during consultation.

A summary assessment of the proposed access compliance with PBP Performance Criteria for SFPP development (PBP Table 6.8b) is provided in Table 7**.**

Table 7: Assessment of access compliance with PBP Performance Criteria

Access type	Performance Criteria (from PBP Table 6.8b)	Compliance notes
General	firefighting vehicles are provided with safe, all-weather access to structures and hazard vegetation.	**Complies**: access to the full perimeter of hazard is provided. The Hospital is separated from the hazard by the Fire Services Road. Roads can be constructed to required standard.
	the capacity of access roads is adequate for firefighting vehicles.	**Complies:** fire services road can be engineered to comply. Proposed to be 4 m wide.
	there is appropriate access to water supply.	**Complies:** access to water supply to be provided within Detailed Design Plans.

Access type	Performance Criteria (from PBP Table 6.8b)	Compliance notes
Perimeter road	perimeter access roads are designed to allow safe access and egress for firefighting vehicles while occupants are evacuating as well as providing a safe operational environment for emergency service personnel during firefighting and emergency management on the interface.	**Complies:** Public Roads and Fire Services Road provide safe access for firefighting and emergency management. Evacuation of occupants will not occur (see S. 3.8). Limited or negligible interaction between fire service and other vehicles. Notably there is none on the Fire Services Road.
Non-perimeter road	non-perimeter access roads are designed to allow safe access and egress for firefighting vehicles while occupants are evacuating.	**Complies:** Public access is off Deniston Road. Staff access of both Denniston Road and Ryedale Road.

Figure 7: Indicative access plan

3.5 Water Supplies

A reticulated water supply system is proposed. Assessment of compliance of the proposed water supply with Section 6.8.3 of PBP is shown in Table 8.

Table 8: Water supply requirements (adapted from Table 6.8c of PBP)

Performance Criteria	Acceptable Solution	Compliance Notes
An adequate water supply for firefighting purposes is installed and maintained.	Reticulated water is to be provided to the development	**Complies**
Water supplies are located at regular intervals; and The water supply is accessible and reliable for firefighting operations.	Fire hydrant, spacing, design and sizing complies with the relevant clauses of Australian Standard AS 2419.1 (SA 2005); Hydrants are not located within any road carriageway; and Reticulated water supply to urban subdivisions uses a ring main system for areas with perimeter roads.	**Can comply:** to be addressed in Detailed Design. **Not applicable**
Flows and pressure are appropriate.	Fire hydrant flows and pressures comply with the relevant clauses of AS 2419.1 (SA 2005).	**Can comply:** to be addressed in Detailed Design.
The integrity of the water supply is maintained.	All above-ground water service pipes are metal, including and up to any taps; and Above-ground water storage tanks shall be of concrete or metal.	**Can comply:** to be addressed in Detailed Design. **Not applicable**

3.6 Electricity Services

The proposed electricity service is underground within the Site. The above ground service outside the Site is predominantly not located on Bush Fire Prone Land. The electricity supply compliance with PBP is assessed in Table 9.

Table 9: Assessment of requirements for the supply of electricity services (adapted from Table 6.8c of PBP)

Performance Criteria	Acceptable Solution	Compliance Notes
Location of electricity services limits the possibility of ignition of surrounding bush land or the fabric of buildings.	Where practicable, electrical transmission lines are underground; Where overhead, electrical transmission lines are proposed as follows: - Lines are installed with short pole spacing (30 m), 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 ISSC3 Guide for the Management of Vegetation in the Vicinity of Electricity Assets (ISSC3 2016).	**Complies**

3.7 Gas Services

The proposed supply of gas services (reticulated or bottle gas) will be provided within the Detailed Design stage; however the development has the potential to comply with PBP (Table 6.8c) as shown in Table 10.

Table 10: Assessment of requirements for the supply of gas services (adapted from Table 6.8c of PBP)

Performance Criteria	Acceptable Solution	Compliance Notes
Location and design of gas services will not lead to ignition of surrounding bushland or the fabric of buildings.	Reticulated or bottled gas is installed and maintained in accordance with AS/NZS 1596:2014 – The Storage and handling of LP gas, the requirements of relevant authorities, and metal piping is used. All fixed gas cylinders are kept clear of all flammable materials to a distance of 10 m and shielded on the hazard side. Connections to and from gas cylinders are metal. Polymer-sheathed flexible gas supply lines are not used; and Above-ground gas service pipes are metal, including and up to any outlets.	**Can comply:** to be addressed in Detailed Design.

3.8 Emergency Management

The proposed redevelopment will increase the occupancy numbers on the site, with actual numbers determined at Detailed Design stage. Assessment of compliance of the proposed emergency and evacuation planning with Section 6.8.4 of PBP is shown in Table 11.

Early off-site evacuation is recommended as the safest option by Australasian Fire. However, it is not possible, nor necessary, to incorporate off-site evacuation into the emergency planning for response to a bushfire within the small remnant bushland on the Site.

Under worst-likely bushfire attack, a fire would travel the full length of the bushland within a few minutes and given that evacuation of any part of the Hospital would take hours, it is inappropriate to consider off-site evacuation as a viable response to bushfire attack at this Site.

An on-site bushfire response and 'internal evacuation' plan will be prepared prior to occupation of the first stage of the Hospital redevelopment and bushfire risk concepts will be considered in the Detailed Design stage. Smoke and traffic management will be considered in the designs along with ignition risks within gardens and pedestrian thoroughfares.

Table 11: Assessment of emergency requirements (adopted from Table 6.8d of PBP)

Performance Criteria	Acceptable Solutions	Compliance Notes
A bushfire emergency and evacuation management plan is prepared	• Bush fire emergency management and evacuation plan is prepared consistent with the: ○ The NSW RFS document: A Guide to Developing a Bush Fire Emergency Management and Evacuation Plan; ○ Australian Standard AS 3745:2010 Planning for emergencies in facilities; and ○ Australian Standard AS 4083:2010 Planning for emergencies – Health care facilities.	**Can comply**

Performance Criteria	Acceptable Solutions	Compliance Notes
	• The bushfire emergency and evacuation management plan should include a mechanism for the early relocation of occupants. Note: A copy of the bush fire emergency management plan should be provided to the Local Emergency Management Committee for its information prior to occupation of the development.	**Can comply** (NB: off-site evacuation not appropriate)
Appropriate and adequate management arrangements are established for consultation and implementation of the bush fire emergency and evacuation management plan.	• An Emergency Planning Committee is established to consult with residents (and their families in the case of aged care accommodation and schools) and staff in developing and implementing an Emergency Procedures Manual; and • Detailed plans of all emergency assembly areas including 'on-site' and 'off-site' arrangements as stated in AS 3745:2010 are clearly displayed, and an annual (as a minimum) trial emergency evacuation is conducted.	**Can comply** **Can comply**

3.9 Fire Services Response

Unlike the Acceptable Solutions within PBP, a comprehensive Performance-based Solution (and a Design Brief process) considers fire service intervention and any associated reduction in risk. The Fire Brigade Intervention Model (FBIM) described within the Australian Fire Engineering Guidelines (ABCB 2021) has not been used, but could be if required, to compare the PBP Acceptable Solutions (e.g. based upon no fire service intervention) with this Site's Performance-based Solution where fire service intervention is highly likely to be rapid and effective. It is therefore a relevant and effective Bushfire Protection Measure redundancy within this Assessment.

Importantly, the elapsed time for fire service intervention should be the time from ignition and spread of fire through the remnant bushland, plus the time taken for this to cause ignition of buildings, plus the time for building ignition to spread a fire beyond a development design limit. Given the nearest Fire and Rescue NSW station is located at Ryde (216-218 Blaxland Road) is staffed 24 hours and is only 2.3 km away (an approximate 4-minute travel time), it is likely that the firefighter intervention will be highly effective. It is expected that consultation with Fire and Rescue NSW would demonstrate the performance would far exceed that underpinning the Acceptable Solutions within PBP.

As with most modern commercial building design and construction materials, it is likely the Hospital façade would comply with or meet a higher BAL than the Acceptable Solutions required BAL 12.5 and the APZ based upon a RHF of <10 kW/m^2. This extends the time for effective fire service intervention and the potential for their effectiveness. Fire and Rescue NSW also have good access to all sides of the Hospital and the remnant bushland from public roads and the proposed road between the hazard and the Hospital building. This access significantly increases the controllability of bushfire within the remnant bushland.

4. Staging

The redevelopment will occur in stages to allow the existing hospital to remain functional whilst the new buildings are under construction.

All new buildings within each stage of the development can comply with the 10 kW/m^2 threshold and provide access for fire vehicles between buildings and the hazard. Specific bushfire protection measures will be detailed for each stage of development once there is sufficient detail available from later stages of the design process.

5. Conclusion

The proposed Ryde Hospital redevelopment is a Special Fire Protection Purpose (SFPP) development and has been assessed against the relevant Performance Criteria and Acceptable Solutions within Planning for Bush Fire Protection (2019) using a Performance-based Solution. The NSW RFS and other stakeholders have been regularly engaged to help identify and assess critical components of the Performance-based Solution for the Proposal.

Section 2 of this Assessment Report documents the risk assessment. This was based on a very large number of Design Fires relative to the size of the bushland hazard and its location within an expansive urban area. The Assessment determined in Section 3 that the PBP required Bushfire Protection Measures proposed for the Concept Plan have all met the Performance Criteria for SFPP development. Notably, the Radiant Heat Flux of 10 kW/m^2 is not exceeded by any of the proposed footprint of Hospital Buildings, and public vehicular access is not directly exposed to the hazard, with fire services able to operate efficiently and safely around the perimeter of the hazard, and between the hazard and Hospital Building.

The Concept Plan will enable the subsequent Detailed Design to comply with PBP. It also provides a safer bushfire outcome than exists for the current Hospital buildings abutting the hazard, as these are all pre-2001 construction and non-compliant with *Australian Standard AS3959:2018 Construction of Buildings in Bushfire Prone Areas*. The Assessment also adopts a conservative approach and particularly with the primary Bushfire Protection Measure of the Radiant Heat Flux at the Hospital building line which the modelling predicts to achieve a maximum 5.9 kW/m^2, which is 40% lower than the PBP Performance Criteria of <10 kW/m^2.

As this Bushfire Assessment Report is for a Concept Plan, it focused on whether a future Detailed Design can comply with the Performance Criteria prescribed by PBP. It is concluded that the Concept Plan will enable future detailed design for the Ryde Hospital Redevelopment to comply with PBP 2019.

6. Recommendation

It is recommended that the Ryde Hospital Redevelopment Concept Plan be approved.

Rod Rose
Senior Principal - Bushfire
FPAA BPAD Accredited Practitioner No. BPAD1940-L3

7. References

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Appendix 1: Development Concept Plan

Concept Proposal - Proposed Site Layout Plan

RYDE HOSPITAL REDEVELOPMENT

ISSUED FOR INFORMATION

Appendix 2: Method 2 Bushfire Attack Assessment Models

NBC Bushfire Attack Assessment Report V4.1

AS3959 (2018) Appendix B - Detailed Method 2

Print Date: 10-Mar-22 **Assessment Date:** 10-Mar-22

Site Street Address:	Ryde Hospital, Eastwood		
Assessor:	Nathan Kearnes; Eco Logical Australia		
Local Government Area:	Ryde	**Alpine Area:**	No

Equations Used

Transmissivity: Fuss and Hammins, 2002
Flame Length: RFS PBP, 2001/Vesta/Catchpole
Rate of Fire Spread: Noble et al., 1980
Radiant Heat: Drysdale, 1985; Sullivan et al., 2003; Tan et al., 2005
Peak Elevation of Receiver: Tan et al., 2005
Peak Flame Angle: Tan et al., 2005
Short Fire Run - Methodology for Assessing Bush Fire Risk for Low Risk Vegetation May 2019 NSW RFS

Run Description: 1

Vegetation Information

Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	45

Fire Inputs

Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200

Radiant Heat Shielding Inputs

Shield Height(m):	0	**Shield Width(m):**	0

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

Level of Construction:	BAL 19	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	13	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	66
Shielded View Factor:	0	**Maximum View Factor:**	0.146
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.796	**Outer Protection Area(m):**	0

Short Fire Run Calculations

Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Run Description:	1a		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	6.19	**APZ/Separation(m):**	45
Fire Inputs			
Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	31.9	**Shield Width(m):**	33.68
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	3.44	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	66
Shielded View Factor:	0.108	**Maximum View Factor:**	0.039
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.796	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Run Description:	2		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	9.9 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	12.9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	48.2
Fire Inputs			
Veg./Flame Width(m):	18.67	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0.19
Radiant Heat(kW/m2):	5.01	**Fire Intensity(kW/m):**	97172
Flame Length(m):	23.07	**Flame Angle (degrees):**	77
Shielded View Factor:	0	**Maximum View Factor:**	0.057
Rate Of Spread (km/h):	5.23	**Inner Protection Area(m):**	48
Transmissivity:	0.785	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	51	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	175.09	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.59	**Total Ellipse Length(m):**	52.71
ROS and H/B Ratio:	90.04		

Run Description:	2a		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	11.3 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	12.7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	62
Fire Inputs			
Veg./Flame Width(m):	32.94	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	5.44	**Fire Intensity(kW/m):**	107027
Flame Length(m):	24.74	**Flame Angle (degrees):**	82
Shielded View Factor:	0	**Maximum View Factor:**	0.064
Rate Of Spread (km/h):	5.76	**Inner Protection Area(m):**	62
Transmissivity:	0.766	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	90	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	192.85	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.94	**Total Ellipse Length(m):**	93.01
ROS and H/B Ratio:	99.17		

Run Description:	3		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	10.2 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	13.5 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	54
Fire Inputs			
Veg./Flame Width(m):	26.35	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	5.53	**Fire Intensity(kW/m):**	99205
Flame Length(m):	23.42	**Flame Angle (degrees):**	80
Shielded View Factor:	0	**Maximum View Factor:**	0.064
Rate Of Spread (km/h):	5.34	**Inner Protection Area(m):**	54
Transmissivity:	0.775	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	72	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	178.75	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.81	**Total Ellipse Length(m):**	74.41
ROS and H/B Ratio:	91.92		

Run Description:	3a		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	9.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	13.4 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	63
Fire Inputs			
Veg./Flame Width(m):	41	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	5.83	**Fire Intensity(kW/m):**	95181
Flame Length(m):	22.72	**Flame Angle (degrees):**	84
Shielded View Factor:	0	**Maximum View Factor:**	0.068
Rate Of Spread (km/h):	5.12	**Inner Protection Area(m):**	63
Transmissivity:	0.764	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	112	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	171.5	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	1.31	**Total Ellipse Length(m):**	115.75
ROS and H/B Ratio:	88.19		

Run Description:	4		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	7.5 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	15.1 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	85.3
Fire Inputs			
Veg./Flame Width(m):	30.75	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	2.13	**Fire Intensity(kW/m):**	82342
Flame Length(m):	20.46	**Flame Angle (degrees):**	92
Shielded View Factor:	0	**Maximum View Factor:**	0.026
Rate Of Spread (km/h):	4.43	**Inner Protection Area(m):**	85
Transmissivity:	0.743	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	84	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	148.37	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	1.14	**Total Ellipse Length(m):**	86.81
ROS and H/B Ratio:	76.3		

Run Description:	5		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	5.5 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	15.7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	90.5
Fire Inputs			
Veg./Flame Width(m):	58.93	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	3.08	**Fire Intensity(kW/m):**	71728
Flame Length(m):	18.52	**Flame Angle (degrees):**	96
Shielded View Factor:	0	**Maximum View Factor:**	0.037
Rate Of Spread (km/h):	3.86	**Inner Protection Area(m):**	90
Transmissivity:	0.74	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	161	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	129.24	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	2.5	**Total Ellipse Length(m):**	166.39
ROS and H/B Ratio:	66.46		

Run Description:	6		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	5.3 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	13.8 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	77.3
Fire Inputs			
Veg./Flame Width(m):	31.85	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	2.44	**Fire Intensity(kW/m):**	70745
Flame Length(m):	18.34	**Flame Angle (degrees):**	91
Shielded View Factor:	0	**Maximum View Factor:**	0.029
Rate Of Spread (km/h):	3.81	**Inner Protection Area(m):**	77
Transmissivity:	0.75	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	87	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	127.47	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	1.37	**Total Ellipse Length(m):**	89.91
ROS and H/B Ratio:	65.55		

Run Description:	7		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	7.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	13 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	73.7
Fire Inputs			
Veg./Flame Width(m):	65.89	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	5.76	**Fire Intensity(kW/m):**	82912
Flame Length(m):	20.57	**Flame Angle (degrees):**	89
Shielded View Factor:	0	**Maximum View Factor:**	0.069
Rate Of Spread (km/h):	4.46	**Inner Protection Area(m):**	74
Transmissivity:	0.753	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	180	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	149.4	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	2.42	**Total Ellipse Length(m):**	186.03
ROS and H/B Ratio:	76.83		

Run Description:	7a		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	9.3 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	12.9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	70
Fire Inputs			
Veg./Flame Width(m):	53.81	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	5.9	**Fire Intensity(kW/m):**	93231
Flame Length(m):	22.39	**Flame Angle (degrees):**	87
Shielded View Factor:	0	**Maximum View Factor:**	0.07
Rate Of Spread (km/h):	5.02	**Inner Protection Area(m):**	70
Transmissivity:	0.756	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	147	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	167.99	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	1.76	**Total Ellipse Length(m):**	151.92
ROS and H/B Ratio:	86.39		

Run Description:	8		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	9.5 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	11.5 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	49.3
Fire Inputs			
Veg./Flame Width(m):	21.96	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0.96
Radiant Heat(kW/m2):	5.49	**Fire Intensity(kW/m):**	94527
Flame Length(m):	22.61	**Flame Angle (degrees):**	76
Shielded View Factor:	0	**Maximum View Factor:**	0.063
Rate Of Spread (km/h):	5.08	**Inner Protection Area(m):**	49
Transmissivity:	0.783	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	60	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	170.32	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.71	**Total Ellipse Length(m):**	62.01
ROS and H/B Ratio:	87.59		

Run Description:	8a		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	9.1 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	10.6 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	64
Fire Inputs			
Veg./Flame Width(m):	43.56	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	0
Radiant Heat(kW/m2):	5.89	**Fire Intensity(kW/m):**	91954
Flame Length(m):	22.16	**Flame Angle (degrees):**	83
Shielded View Factor:	0	**Maximum View Factor:**	0.069
Rate Of Spread (km/h):	4.95	**Inner Protection Area(m):**	64
Transmissivity:	0.763	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	119	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	165.69	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	1.44	**Total Ellipse Length(m):**	122.99
ROS and H/B Ratio:	85.2		

Appendix 3: Carpark shielding calculations

The methodology for calculating the RHF shielding provided by the carpark is provided below (the modelling reports are provided in Appendix 2.

Steps:

i. Model the baseline radiant heat exposure of the hospital from Transect 1, prior to incorporation of the radiation heat shield. This revealed the unshielded RHF at the hospital building of 13kW/m^2 at the peak elevation of receiver of 6.19m.
ii. Model the unshielded RHF at the top of the hospital building (39.5m), which identified an exposure of 5.86kW/m^2.
iii. Model the unshielded RHF at the lowest point on the main hospital building that is still <10kW/m^2. This resulted in 9.93kW/m^2 at 24m height.
iv. Incorporate the shielding provided by the carpark and model the RHF at the peak elevation of receiver of 6.19m identified in model run 1. This identified a significant reduction in RHF from 13kW/m^2 (model run 1) to 3.44kW/m^2. The radiant heat shield metrics utilised were 31.9m height (24.9m carpark + 7m embankment) and 33.68m width (reduced from the 68m carpark width to the SFR calculated flame width).
v. Model the shielded RHF at the highest point on the main hospital building (39.5m).
vi. Model the shielded RHF on the main hospital building at 24m height.

The base inputs used for modelling are:

- RFS Comprehensive fuel loads: North Coast Wet Sclerophyll Forest (Shrubby sub-formation)
- Separation distance: 45m (calculated from the Concept Plan)
- Vegetation slope: 14.6° downslope (calculated from 1m survey contours)
- Site slope: 9° downslope (estimated from Concept Design using base of embankment to base of main building)
- Flame temperature: 1200K
- FDI: 100
- Short Fire Run parameters for Transect 1:
    - Run distance: 92m
    - Model: Vesta

The BFAA modelling reports for the radiant heat shielding provided by the carpark are below. The key findings derived from the modelling results include:

- At 45m separation, the top of the main hospital building and down to a height of 24m is exposed to a RFH of <10kW/m^2 without any need for a radiant heat shield.
- The carpark is predicted to reduce the radiant heat at the 'peak elevation of receiver' from 13kW/m^2 to 3.44kW/m^2 (well below the PBP Performance Criteria of 10kW/m^2).
- Although carpark shielding is not required for a RHF <10kW/m^2 for the portions of the Hospital building higher than 24 m above ground level, the carpark reduces the RHF to 0.45kW/m^2 at 39.5m (top of building) and 1.85kW/m^2 at 24m.
- No additional APZ is required south of the carpark to achieve a RHF of <10kW/m^2 on the shielded portion of the Hospital building.
- While the carpark shields much more of the Hospital than that assessed in the Transect 1 Design Fire, no other Transect/Design Fire incorporates the benefits of the carpark shielding.

NBC Bushfire Attack Assessment Report V4.1

AS3959 (2018) Appendix B - Detailed Method 2

Print Date: 22-Apr-22 **Assessment Date:** 22-Apr-22

Site Street Address:	Ryde Hospital Carpark, Eastwood
Assessor:	Nathan Kearnes; Eco Logical Australia
Local Government Area:	Ryde
Alpine Area:	No

Equations Used

Transmissivity: Fuss and Hammins, 2002
Flame Length: RFS PBP, 2001/Vesta/Catchpole
Rate of Fire Spread: Noble et al., 1980
Radiant Heat: Drysdale, 1985; Sullivan et al., 2003; Tan et al., 2005
Peak Elevation of Receiver: Tan et al., 2005
Peak Flame Angle: Tan et al., 2005
Short Fire Run - Methodology for Assessing Bush Fire Risk for Low Risk Vegetation May 2019 NSW RFS

Run Description: Carpark 1: Base SFR

Vegetation Information

Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	45

Fire Inputs

Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200

Radiant Heat Shielding Inputs

Shield Height(m):	0	**Shield Width(m):**	0

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

Level of Construction:	BAL 19	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	13	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	66
Shielded View Factor:	0	**Maximum View Factor:**	0.146
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.796	**Outer Protection Area(m):**	0

Short Fire Run Calculations

Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Run Description:	Carpark 2: SFR at 39.5m EoR		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	39.5	**APZ/Separation(m):**	45
Fire Inputs			
Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	5.86	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	88
Shielded View Factor:	0	**Maximum View Factor:**	0.067
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.786	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Run Description:	Carpark 3: SFR at 24m EoR		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	24	**APZ/Separation(m):**	45
Fire Inputs			
Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	0	**Shield Width(m):**	0
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	9.93	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	78
Shielded View Factor:	0	**Maximum View Factor:**	0.112
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.791	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Run Description:	Carpark 4: SFR + RHS at peak EoR		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	6.19	**APZ/Separation(m):**	45
Fire Inputs			
Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	31.9	**Shield Width(m):**	33.68
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	3.44	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	66
Shielded View Factor:	0.108	**Maximum View Factor:**	0.039
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.796	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Run Description:	Carpark 5: SFR + RHS at 39.5m EoR		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	39.5	**APZ/Separation(m):**	45
Fire Inputs			
Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	31.9	**Shield Width(m):**	33.68
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	0.45	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	88
Shielded View Factor:	0.062	**Maximum View Factor:**	0.005
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.786	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Run Description:	Carpark 6: SFR + RHS at 24 EoR		
Vegetation Information			
Vegetation Type:	North Coast WSF (Shrubby)		
Vegetation Group:	Wet Sclerophyll Forests (Shrubby)		
Vegetation Slope:	14.6 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	22	**Overall Fuel Load(t/ha):**	35.98
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	9 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	24	**APZ/Separation(m):**	45
Fire Inputs			
Veg./Flame Width(m):	33.68	**Flame Temp(K):**	1200
Radiant Heat Shielding Inputs			
Shield Height(m):	31.9	**Shield Width(m):**	33.68
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			
Level of Construction:	BAL 12.5	**Peak Elevation of Receiver(m):**	6.19
Radiant Heat(kW/m2):	1.85	**Fire Intensity(kW/m):**	134395
Flame Length(m):	29.16	**Flame Angle (degrees):**	78
Shielded View Factor:	0.091	**Maximum View Factor:**	0.021
Rate Of Spread (km/h):	7.23	**Inner Protection Area(m):**	45
Transmissivity:	0.791	**Outer Protection Area(m):**	0
Short Fire Run Calculations			
Fire Run(m):	92	**Length to Breadth Ratio:**	2.82
Full Ellipse Length(m):	242.16	**Headfire Backfire Ratio:**	29.85
Travel Duration (mins):	0.76	**Total Ellipse Length(m):**	95.08
ROS and H/B Ratio:	124.53		

Appendix 4: Alternate Solution Vegetation Management for APZ

Proposed Alternate Solution Vegetation Management for APZ
Ryde Hospital State Significant Development Application

25th January 2022

1. Background

The RFS has verbally indicated a willingness to support (in a meeting with Alastair Patton 12/1/2022) the approach proposed for finalising the APZ footprint for the subject development based upon Performance Solutions. Refinement of the APZ footprint on the eastern and western side of the site is currently underway to address discussion points at the last meeting. Finalisation of the APZ footprint is independent of the proposed vegetation management within the APZ, at least to the extent being considered in this memo, as they require compliance with different Performance Criteria.

The proposed APZ is located in Blue Gum High Forest, a Critically Endangered Ecological Community (CEEC) under State and Commonwealth legislation. The vegetation management within the APZ is a primary consideration in the assessment of ecological impacts, and ultimately whether the State Significant Development Application will obtain the required approvals.

RFS requested additional information related to the plan to use an Alternate Solution under *Planning for Bushfire Protection* 2019 (PBP) for the vegetation management within the APZ. This memo discusses the proposed Performance-based Solution vegetation management, and the PBP accepted approaches to assessing Performance-based Solutions. A comparison of the performance of an Acceptable Solution APZ and the proposed Alternate Solution vegetation management is explored by identifying how these matters may be explored in a Bush Fire Design Brief (herein called Design Brief).

A Design Brief is currently not proposed as stakeholder agreement on APZ vegetation management on a low-risk site is likely to be sufficiently informed by the information provided herein. The memo allows the RFS to consider, from an expert judgment perspective, whether the proposed tree retention within the EEC meets the Performance Criteria for an APZ prescribed within PBP. A consideration that should be based upon the potential full range of bushfire Performance-based Solution risks typically explored in a Design Brief, and not the proposed tree retention as an individual and isolated risk.

2. Proposed Alternate Solution Vegetation Management and reason it is required

2.1. Proposed Alternate Solution Vegetation Management

The current proposal for vegetation management within the proposed APZ is as follows:

- retain all existing CEEC trees and allow for further recruitment
- retain up to 10% ground cover of CEEC shrubs within the Inner Protection Area (IPA) and 20% in the Outer Protection Area (OPA)

- retain up to 75% - 90% CEEC ground cover plants, but only those with lower above-ground biomass.

An Alternate Solution for APZ vegetation management needs to meet the Performance Criteria for APZ (PBP p. 55) listed below and discussed in Sections 2.1.1 – 2.1.3:

- *APZ are managed and maintained to prevent the spread of fire to the building*
- *the APZ is to be provided in perpetuity,* and
- *APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is minimised*

2.1.1. APZ vegetation management

Appendix 4 of PBP provides vegetation management details for the Acceptable Solution, but Appendix 4 is not specially mentioned, or called up by the Performance Criteria (see above). The Acceptable Solution APZ are nevertheless one way of achieving the Performance Criteria. They may also provide a useful guide to the type of vegetation management required in a Performance-based solution APZ, or a means of demonstrating compliance with the Performance Criteria by comparing the Performance-based Solution with the Acceptable Solution.

Table 1 compares the proposed Alternate Solution vegetation management with the Acceptable Solution vegetation management prescribed within Appendix 4 of PBP. As parts of the proposed APZ includes slopes of >18 degrees it does not comply with the Acceptable Solutions, and the three elements of the Performance Criteria related to steeper slope APZs needs to be assessed i.e. maintenance, soil stability and the potential for crown fires. These are discussed in Sections 2.1.2 and 2.1.3.

Table 1: Comparison of key APZ vegetation management for proposed Alternate Solution vs Acceptable Solution

Vegetation layer	Acceptable Solution for IPA and OPA (App. 4 of PBP or 'Standards for APZ')	Alternate Solution proposed for SSDA
Trees	• 15% canopy cover (IPA) • 30% canopy cover (OPA) • 2 – 5 m canopy separation • Tree height not considered, but forests are >10 m high (and uncommonly >30 m) • preference should be given to smooth barked and evergreen trees • lower limbs should be removed up to a height of 2m above the ground	• retain existing trees/allow recruitment • canopy cover variable across APZ from 15% - 70%, naturally thinner closer to buildings • variable vertical or horizontal separation, some connected canopies, estimated >2m canopy separation over 50% of site • trees generally >30 m in height • trees predominantly smoothed bark • lowest branches of mature *E. saligna* generally >15 m above ground
Shrubs	• 10% ground cover (IPA) • 20% ground cover (OPA)	• 10% ground cover (IPA) • 20% ground cover (OPA)
Ground cover	• Mown grass <100mm • 'Standards for APZ' (RFS undated) allows: ○ 75% - 90% ground cover for soil erosion prevention	• Grass mowing and Acceptable Solution compliant gardens around buildings as required • 75% ground cover of perennial plants with low above-ground biomass within the CEEC

Vegetation layer	Acceptable Solution for IPA and OPA (App. 4 of PBP or 'Standards for APZ')	Alternate Solution proposed for SSDA
	○ A permanent ground cover ... will provide an area that is easy to maintain and prevent soil erosion.	

2.1.2. APZ maintenance and soil stability on slopes >18^0

As the proposed APZ is expected to be a little over 1 ha the APZ maintenance can be undertaken by contractors engaged to complete the works. The APZ establishment and maintenance costs for approximately 1 ha is well within the budget of the redevelopment project and future hospital maintenance programs. Professional APZ maintenance crews and bush regeneration crews routinely deal with similar size areas (and much larger) on similar slopes in the Sydney Basin. The APZ maintenance on the steeper slopes is therefore practical.

Erosion resulting from the APZ is not expected as no trees are proposed to be removed, a 10% (IPA) - 20% (OPA) shrub layer is retained along with up to 75% 'light' ground covers. Any potential for erosion can therefore be managed by bush regeneration crews as part of the APZ maintenance program.

2.1.3. Potential for crown fires is minimised on slopes >18^0

Under the Acceptable Solutions within PBP the potential for crown fire exists in every APZ in forests, apart from those located at the foot of long steep downhill slopes (see Section 3.2). Figure 1 shows the slopes >18^0 within the APZ are patchy with most located within a 10 m -15 m wide 'constructed embankment' at the top of the slope. It is also likely this 'constructed embankment' is <10 m wide as the contours in these areas are extrapolated rather than surveyed. The 'constructed embankment' is considered too narrow and positionally ineffective to contribute to crown fire development within the site's vegetation and has fewer trees because of the nature of the embankment.

The patch of APZ with slope >18^0 of most interest is on Transect 4 (see Figure 1) and is only 0.14 ha in size. The potential uphill fire run in this small patch is 22 m along Transect 4, within an APZ compliant understorey, within an overall 3.4 ha patch of remnant bushland, located within an expanse of urban development. The potential for crown fires is intrinsically minimised by this combination of lower risk factors and represents a risk less than that of Acceptable Solution APZ located in non-remnant patches of vegetation (see Section 3.2).

APZ design- Ryde Hospital redevelopment

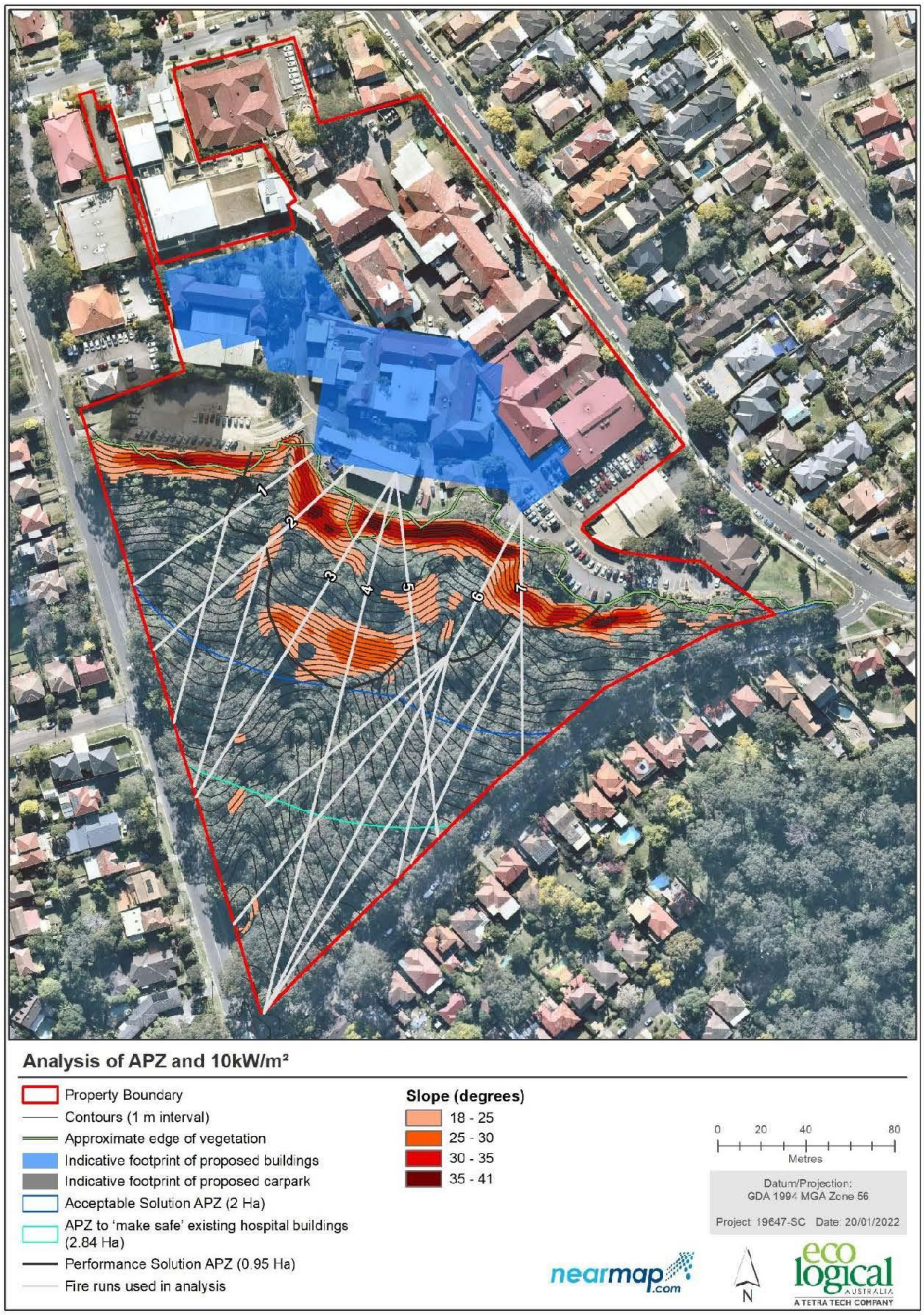

Figure 1: Slopes >18⁰ within the APZ

2.2. Dr Meredith Henderson (ecologist) statement of APZ impacts on CEEC

The primary reason for the proposed Alternate Solution vegetation management in the APZ is the impact on the CEEC. ELA Principal Ecologist Dr Meredith Henderson provided the following statement on the 17th January 2022 regarding the significance of the CEEC and the APZ impact.

> *"The vegetation present within the lower portion of the site is Blue Gum High Forest, which is listed as critically endangered under the* Environment Protection and Biodiversity Conservation Act 1999 *(EPBC Act) and the* Biodiversity Conservation Act 2016 *(BC Act). Only about 4.5% of its extent remained in 2000, which is about 200 ha. Most remnants are small, with the largest being about 20 ha. The remnant at Ryde Hospital is about 3.94 ha, with a relatively intact canopy of Eucalyptus saligna (Sydney Blue Gum), Angophora costata (Smooth-barked Apple) and Syncarpia glomulifera (Turpentine). The understorey has been heavily invaded by woody weeds and exotic climbers. However, given the size of the patch, it is relatively large compared with many of the remaining patches of the community. Only five remnants are larger than 5 ha.*
>
> *The Community has been identified as an entity at risk of Serious and Irreversible Impacts under the BC Act, and was listed as critically endangered under the EPBC Act for, among others, the criterion 'reduction in community integrity'. The remaining fragments are generally isolated and small, with a high edge-to-area ratio. They are particularly susceptible to edge effects, including the invasion by exotic plant species.*
>
> *A consequence of thinning the canopy for APZ purposes and potentially compromising understorey regeneration would be to exacerbate the key threatening processes of clearing and reduction in integrity. Loss of canopy would also potentially affect the foraging or breeding habitat of the Powerful Owl, which has been recorded in the remnant. Over time, if canopy is to remain thinned, the APZ may not meet the EPBC Act definition of the community, which would be a significant impact.*
>
> *The consequence of a significant impact under EPBC Act is that it becomes a controlled action further complicating approval and timeline. A controlled action decision is likely to lengthen the approval process, and potentially result in significant additional cost to the program. It also is inconsistent with the recovery of the community, which aims to allow all structural layers to persist and be enhanced. A controlled action, and potential future management, could mean that the area subject to the APZ would no longer meet the definition of the community under the EPBC Act, thus further reducing its extent, area of occupancy and ability to withstand stochastic effects. The Commonwealth would likely wish to see significant management plans put in place, along with a desire to permanently protect the remaining vegetation. This is not in the scope the project."*

Dr Henderson has also advised that the APZ vegetation management proposed in Table 1 could be undertaken in a manner consistent with the CEEC management objectives.

2.3. Assessment of Performance Criteria for the proposed Alternate Solution

The Performance Criteria for the APZ vegetation management for Special Fire Protection Purpose (SFPP) developments within PBP are general in nature. The criteria *"the APZ is to be provided in perpetuity"* can

be provided by the proposed Vegetation Management Plan (VMP) for the site and the 'in-perpetuity' management regime of the hospital, and the issues associated with APZ located on slopes >18^0 are addressed in Section 2.1.2.

The assessment process for the more general Performance Criteria *"APZ are managed and maintained to prevent the spread of fire to the building"* is less clear, but can be explored under the Performance-based Solution assessment methodologies of the Australian Fire Engineering Guidelines (ABCB 2021) e.g. using comparative or absolute analysis (qualitative or quantitative methodologies). In this regard, the only aspect of the vegetation management within the proposed APZ NOT compliant with Appendix 4 in PBP is the tree canopy density (see Table 1) and this is therefore the focus of the compliance assessment.

Whilst this memo does consider objective parameters and evaluation criteria in the consultative and systematic manner of a Design Brief, it provides some APZ vegetation management information potentially suitable for analysis in a Design Brief and its subsequent assessment of bushfire risk. The information provided is also potentially adequate for expert judgment agreement between the RFS and the applicants experts if it is apparent the Design Brief analysis would likely conclude compliance with the PBP Performance Criteria.

3. Design Fire and Design Brief considerations

There are different ways to assess whether the proposed Alternate Solution meets the performance criteria of *"APZ are managed and maintained to prevent the spread of fire to the building"*. Whilst a Design Brief is currently not proposed, the specific risk factors that could be explored within a Design Brief and the anticipated findings of such a process are explored for the purposes of considering the proposed Alternate Solution for vegetation management. Considerations of appropriate Design Fire inputs relevant to the site characteristics include:

- The likelihood of a bushfire in an expansive urban area within an isolated 3.4 ha remnant of bushfire with no know bushfire history.
- The likelihood of an ignition developing into a fully developed bushfire given the high visibility around all interfaces, nature of the fuel (mesic vegetation) and availability of suppression opportunities (brigades and local residents).
- The likelihood of the Bushfire Attack Levels using the Acceptable Solution methodology occurring in remnant bushland with no fire encroachment from elsewhere and a maximum 'bushfire catchment' of 3.4 ha, but a practical bushfire catchment much less than this given the shape and orientation of the remnant.
- Whether a lower FFDI should be applied given the sites isolation and the primary direction of bushfire attack is from the south (Note: other ELA Generalised Extreme Value studies of directional FFDI in the Sydney region have shown that FFDI from the south as much lower than FFDI 100 used under the Acceptable Solutions. At the request of RFS one of these studies was

peer reviewed and validated by Dr Grahame Douglas (ELA 2019) and details can be provided if required).

- The appropriateness of applying a Flame Temperature of 1200K to facilitate fire service intervention and evacuation, when evacuation and fire service intervention is not possible within the 3 minutes travel time of a bushfire from the southern-most point of the bushland remnant (i.e. under the Acceptable Solution required model inputs).

  The PBP Intent of Measures for Special Fire Protection Purpose (SFPP) APZ and Emergency Management Planning are respectively:

  - *"to provide suitable building design, construction and sufficient space to ensure that radiant heat levels do not exceed critical limits for firefighters and other emergency services personnel undertaking operations, including supporting or evacuating occupants."* (PBP Table 6.8a), and
  - *"to provide suitable emergency and evacuation arrangements for occupants of SFPP developments."* (PBP Table 6.8d)

  The appropriateness of assuming fire service invention will be located between the hazard and the buildings when in this instance the site offers safer and potentially more effective operations from the adjoining Ryedale Road and Florence Avenue where the radiant heat exposure will be significantly less than that assumed by a head fire.

- The appropriateness of assuming the worst-case slope associated with 45 degree variation in the direction of fire run and the likelihood of this variation in wind or fire direction over a 3 minute fire run.

Notwithstanding the above factors that suggest a potential for lower inputs to any Design Fire and therefore lower bushfire intensity outputs compared to the Acceptable Solutions; one Design Fire (Transect 4, Figure 1) has been considered from the transects confirmed with the RFS during the meeting on 12/1/22 and is outlined below. It is also noteworthy that about 30% of the transects agreed to with the RFS result in a RHF <5kW/m^2 including those with the longest fire runs i.e. Transects 3, 4 and 5.

3.1. Flame length versus tree height

Although tree heights have not been measured across the site (due to the density of weeds restricting access) the mature height of the predominant tree within the Blue Gum High Forest, *Eucalyptus saligna* (Blue Gum) have the potential at maturity to reach heights ranging from 25 m – 50 m. Tree height and bark is an important when considering the likelihood of crown fire, and *E. saligna* is a very tall tree with smooth bark and many meters to the first branch; these features suggest it may be less prone to crown fire.

The predicted flame heights using the Acceptable Solution inputs into the Short Fire Run model for Transect 4 which is the longest fire run directly toward the proposed development (and therefore most likely to develop crown fire) is 29.41 m. The model inputs are shown in Table 2.

Table 3: Data used to model predicted Flame Height for Transect 4

	Unmanaged vegetation			APZ					
Transect	height (m)	length fire run (m)	effective slope (degrees)	height (m)	length separation (m)	site slope (degrees)	PBP vegetation	RHF (kW/m²)	Flame Height @ start of APZ
4	15.5	160.6	5.5	25.5	90.5	15.7	forest	5.0	29.41 m

The flame heights required for a crown fire in 25 m – 50 m high *E. saligna* are not known and using the RFS Short Fire Run model predictions of 29.41 m flame heights the potential for crown fire cannot be ruled out. However, as discussed earlier a Design Brief would likely agree on lower Design Fire inputs than considered in Table 2, and as a result the likelihood of canopy fire associated with flame heights reduced further.

All Acceptable Solution APZ in forests (apart from at the foot of long downhill slopes) are prone to crown fire due to the flame lengths produced at the outer edge of APZ being much greater than the spacing between tree canopies. If crown fire enters an APZ, then crown to crown fire transfer has the potential to spread through the full width of an APZ under any tree density.

3.2. Crown fire development period and likelihood

A comparison between the tree density in an APZ that meets the Acceptable Solutions for a SFPP development (forest and FFDI 100) with that proposed for the subject site is shown in Table 2. The Acceptable Solution examples have an apparent higher crown fire risk because they are exposed to the potential 'full development period' of a bushfire, unlike the lower risks associated with the subject site.

Table 2 also demonstrates that the potential for crown fire exists at least into the outer portion of every APZ approved under the Acceptable Solutions in PBP. As crown fires typically run with significant momentum (e.g. wind driven) and have long flame lengths, the 2 – 5 m crown separation under an Acceptable Solution APZ will have a negligible effect on the crown fire spread. Table 2 shows that the flame lengths in the examples vary from 21.5 m to 52.64 m and tree heights in forests under the Acceptable Solutions may be as low as 10 m and commonly in the 10 m – 30 m height range.

The PBP Acceptable Solution APZ tree density for forests undoubtedly will carry crown fire under an FFDI 100 and there is no known scientific evidence that this would continue to carry through even the widest Acceptable Solution compliant APZ under an FFDI 100. Furthermore, the data in Table 2 and the likelihood risk suggest crown fire spread in an Acceptable Solution APZ tree spacing is more likely than on the subject site because it is a remnant where fire does not fully develop, trees are predominantly smooth barked and very high and the likelihood of the worst likely scenario is much lower.

Tree canopy spacing under the longer flames lengths in forests under an FFDI 100 and is NOT a significant mitigator of crown fire spread unless the tree canopy density is much wider than the Acceptable Solution spacing. Plenty of anecdotal evidence exists for the canopy of a single tree burning in a very open area e.g. 60 m wide APZ, when high intensity fire impacts the edge of the clearing/APZ.

Lower crown fire risk is likely to be more strongly correlated to the potential fire intensity at the edge of the APZ rather than the APZ tree density, and the proposed site has a much lower likely of higher fire intensity at the APZ edge than those under the PBP Acceptable Solutions.

It is apparent from this type of comparison that the proposed APZ with no tree removal meets, and probably exceeds, the performance achieved by the 2 m – 5m tree gaps of the PBP Acceptable Solutions. A similar examination is expected to show that the 15% and 30% canopy cover criteria for the Acceptable Solutions also will not reduce crown fire lower than the risk in a remnant forest such as on the subject site.

Table 2: Comparison of flame height and fire intensity entering an SFPP Acceptable Solution APZ and the proposal*

Example	slope	Flame length	Fire Intensity (kW/m)	SFPP APZ	RHF
1	level	21.5	49,240	67 m	9.9
2	5^0 down	28.6	69,527	80 m	9.89
3	10^0 down	38.54	98,171	95 m	9.99
4	15^0 down	52.64	138,617	114 m	9.9
Subject-site T4	**5.5**	**29.41**	**71,967**	**90.5 m**	**5.4**

* Table data has been compiled from the NBC Bushfire Attack Assessor app . T4 has been chosen as it is the longest fire run on the subject site.

A limitation of the APZ criteria in the PBP Acceptable Solutions is that there is no consideration of the site-specific risks of likelihood, fire catchment and direction of fire spread. These factors considered within a Design Brief for the proposal are expected to find lower model inputs are appropriate for Design Fires.

Preliminary fire history analysis indicates no recorded bushfires within the site. Bushfire history for similar sized remnant bushland patches surrounded by similar expanses of urban development are expected to also show very low to no fire history. There is also no apparent reason for the fire ignition risk to change, and the site is highly visible by local residents and therefore unattractive for deliberate ignition. A Design Brief would likely find the fire ignition risk much lower than that assumed under the Acceptable Solutions in PBP.

In the unlikely scenario of a fire starting, and this occurring at the southern end of the site, a bushfire would not spread consistently from 'start to finish' at the rate assumed by the Bushfire Attack Assessment models. The influence of a bushfire development period could be explored further but is likely to show a lower risk of crown fire than that assumed under Acceptable Solutions.

A 'perfect storm' of weather, fuel, wind direction would likely need to align with a 'perfectly timed' ignition and also align with no fire service intervention, in order for a real crown fire risk to emerge within the proposed APZ. These 'alignments' would have a likelihood much lower than that underpinning the Acceptable Solutions within PBP. If required this type of Performance-based and Acceptable Solution comparisons could be explored further to demonstrate compliance with the Performance Criteria, but it is not considered necessary.

3.3. Potential for crown fire to carry through the APZ

Transect 4, the transect with the greatest potential for crown fire development, has a 90 m wide APZ. Given the likelihood of crown fire on the subject site is likely to be lower than the Acceptable Solutions, the risk of crown fire also having sufficient momentum to carry nearly 90 m through the APZ is likely to be lower risk than that resulting from the Acceptable Solutions APZ.

The slopes within the APZ of the subject site are relatively steep (but short) and crown fire is more likely to be sustained in such situations if the wind is also blowing directly upslope. However, on this site a crown fire must develop within the unmanaged fuel on more gentle slopes to have any potential to enter the tree crowns within the APZ. The likelihood of a 'perfect storm' required for crown fire within the site's APZ, compared to the likelihood of crown fire in the APZ of the Acceptable Solutions, is considered much lower when all risk factors are considered.

For example, there is no evidence that the 2 m – 5 m crown spacing or the 15% or 30% canopy cover (IPA and OPA respectively) within the Acceptable Solutions APZ prevent crown fire, and it can be demonstrated with RFS accepted methodology that the potential for crown fire exists in all APZs that meet the Acceptable Solutions i.e. based upon predicted flame lengths. The only exception would be where fires spread downhill over long distances prior to entering a compliant APZ and flame heights are much lower. The Acceptance Criteria within a Design Brief related to APZ tree density is therefore highly unlikely to be valid or applicable if it seeks to exclude tree density options on the basis that crown fire may occur.

Even if it is assumed that all the 'perfect storms' aligned, a Design Brief may find little difference in the probability of crown fire within an Acceptable Solution APZ compared to the Alternate Solution APZ proposed on this specific site because of its low likelihood risk and the effectiveness of fire service intervention (see below).

Quantifiable data is also available to demonstrate that the wind speed driving a ground fire is significantly reduced by tree cover, as is recognised in the fire risk associated with higher tree canopy cover in rainforests. A Design Brief may also lead to a finding that the mature 30 m – 55 m high *E. saligna* on the subject site are likely to reduce the wind speed at ground level even more so than those lower height forests within an Acceptable Solution APZ.

3.4. Fire services intervention

Unlike the Acceptable Solutions within PBP, a comprehensive Alternate Solution and a Design Brief process considers fire service intervention and any associated reduction in risk. The Fire Brigade Intervention Model (FBIM) described within the Australian Fire Engineering Guidelines (ABCB 2021) could be used to further compare Acceptable Solutions (presumably based upon no fire service intervention) with this site's Alternate Solution where fire service intervention is highly likely to be rapid and effective.

Importantly, the elapsed time for fire service intervention (a key component of FDIM) will be the time from ignition and spread of fire through the remnant bushland, plus the time taken for this to cause ignition of buildings, plus the time for building ignition to spread beyond a design limit. Given the NSW Fire and Rescue at Ryde (216-218 Blaxland Road) is staffed 24 hours and is 2.3 km away and is estimated in google maps as a 4-minute travel time, it is likely that the firefighter intervention will be highly

effective. It is expected that consultation with NSW Fire and Rescue would demonstrate the performance would far exceed that underpinning the Acceptable Solutions in PBP.

As with most modern infrastructure design and construction materials it is likely the hospital façade would comply with BAL 29 and therefore be much higher than the Acceptable Solutions required BAL 12.5 and the APZ based upon a RHF of <10 kW/m^2. This extends the time for effective fire service intervention and the potential for their effectiveness. NSW Fire and Rescue could also make comment on the significance or otherwise of a <10 kW/m^2 RHF using Flame Temperatures of 1200 K on this specific site, given the sites unusual accessibility from public roads not exposed to the fire front.

4. APZ proposal compared with PBP Acceptable Solution

Expert judgement is a fundamental part of comparing the performance of the tree density within the proposed APZ with that of an Acceptable Solution APZ. It is therefore useful to comment on the potential outcomes of some components of a Design Brief and its resultant analysis related to tree density. The memo therefore highlights some of the lower risk attributes of the site and how these affect tree density related risks and the authors opinion on how further investigations of these matters may unfold.

In some instances, such as fire service intervention and likelihood of fire, and specifically crown fire, it is evident that the performance achieved under the PBP Acceptable Solutions can be significantly exceeded by the Performance-based Solutions (Alternate Solutions) of the proposed APZ. Tree density in the APZ of this site, with its unique risk attributes, is not the primary driver of the Performance compliance of the proposal.

It is apparent from the preliminary investigations of two very experienced BPAD L3 practitioners (Rod Rose and Nathan Kearnes) that the retention of trees within the APZ of this low bushfire risk site is an insignificant risk, and this risk when compared to the residual risks accepted by the PBP Acceptable Solution APZ would be lower. Comparison of Performance-based solutions with Acceptable Solutions (or deemed to satisfy solutions) is a recognised approach for evaluation of Performance-based solutions under the Australian Fire Engineering Guidelines (ACBC 2021) which supersedes the International Fire Engineering Guidelines (2005) referred to in PBP Section A2.5 Bush Fire Design Brief.

5. Better bushfire outcome

While the proposal to date has not relied on the PBP guidelines for 'existing SFPP developments', a Performance-based solution would include consideration of PBP Section 6.4 Development of Existing SFPP facilities. A relevant component of Section 6.4 is achieving a better bushfire outcome than currently exists and a detailed assessment of a better bushfire outcome would likely conclude the proposed development provides a higher standard of bushfire protection than the existing buildings which are not compliant with AS3959 and do not have a compliant APZ.

Importantly, the ignition risk of the proposed buildings will be much lower than that within the Acceptable Solutions in PBP. This bushfire protection measure is more important that usually considered in a Performance-based Solution as off-site evacuation is not possible on this site within the time it would take a bushfire to burn from the bottom of the site to the top (under adverse conditions). It is therefore critical the buildings abutting the hazard are able to withstand the initial bushfire attack until fire service intervention occurs. The proposed buildings will achieve this with the modern infrastructure construction materials and design which typically complies with a BAL-29 construction, whereas the existing hospital does not.

In situations where evacuation is not possible, the increase in occupancy levels is less of a concern than the building survival. Not only is the proposed redevelopment resilient to the predicted bushfire attack but it provides a significant shield for the existing vulnerable portion of the hospital and its occupants. A better bushfire outcome associated with the required on-site evacuation is extremely important for the existing hospital not proposed for redevelopment and the hospital precinct overall.

The retention of trees in the APZ does not compromise the better bushfire outcome required by PBP for existing SFPP facilities and the proposal improves the vegetation management and bushfire risk on the site by weed removal (reduction in total fuel load) and the maintenance of a performance-based APZ design.

6. Conclusion

Given the likely support by the RFS on the soon to be finalised APZ footprint, the primary outstanding issue is the tree density proposed within the APZ, which contains the Critically Endangered Ecological Community (Blue Gum High Forest). This memo concludes that the retention of the CEEC trees meets the Performance Criteria for APZ within PBP.

This conclusion has been reached by comparing the crown fire risk of an SFPP APZ that meets the Acceptable Solutions with the crown fire risk of the more dense but predominantly very tall, smooth bark *Eucalyptus saligna* of the proposed APZ. Both the Acceptable Solution and the Performance-based Solution have crown fire risks, however the much lower risk associated with a remnant, 3.4 ha patch of bushland within an expansive urban setting is considered a lower crown fire risk.

It is also considered that a detailed analysis of each of the fire safety systems of a Design Brief, especially likelihood, fire service intervention and building construction, would conclude compliance with the PBP Performance Criteria and not significantly deviate from the information included within this memo.

Fundamentally, the site is a low bushfire risk. Compared to the residual bushfire risk from an Acceptable Solution APZ, the SSDA would have a lower residual bushfire risk than an SFPP development not located abutting a small, isolated remnant forest within an expansive urban area.

It is therefore not considered necessary to undertake a comprehensive Design Brief process prior to reaching agreement among stakeholders on the proposed tree retention within the APZ, but if this is required agreement on Acceptance Criteria and methodology would be required within the next week to meet government timeline expectations, and assessment of impacts on the EEC.

Rod Rose
Senior Principal - Bushfire
BPAD Level 3 Accredited Practitioner

Nathan Kearnes
Principal - Bushfire
BPAD Level 3 Accredited Practitioner

References

ABCB 2021. *Australian Fire Engineering Guidelines*, Australia Building Codes Board

ELA, 2019. *Integrated Development Application 21/1208672, 12A Shirley Road, Wollstonecraft*, letter to RFS

RFS, 2019. *Planning for Bushfire Protection, A guideline for councils, planners, fire authorities and developers*, NSW Rural Fire Service

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Appendix 5: Staging Plans

STAGING LEGEND

- TO BE DEMOLISHED
- NEW CONSTRUCTION
- NEW CONSTRUCTION (PREVIOUS STAGE)
- CURRENT STAGE BUILDING SITE
- NEW ROAD
- DECANT STRATEGY
- PUBLIC EMERGENCY
- MAIN ENTRY
- AMBULANCE
- LOGISTICS
- EEC LINE
- APZ EXTENT

Decant 1

- Install temporary prefabricated structre adjacent to The Stables building;
- Community Aged-care and Rehabilitation Service (CAReS) (Building 17) relocated to existing Graythwaite Rehabilitation Centre (GRC);
- Staff amentities (Chattery, Building 18) temporarily relocated to temporary structure;
- Cleaner's facility (Building 11) relocated to Engineering Department (Building 16).

Enabling Works

- Site clearance;
- Demolition B11, B17 and B18;
- Partial demolition of internal road and demolition of carpark P5;
- Decommissioning and diversions of minor services to facilitate earthworks;
- Site preparation earthworks to Stage 1 footprint;
- Lantana and weed clearing to Asset Protection Zone (APZ). (Approved under DPIE Part 2 Scientific Licence issued by EES).

Stage 1 Building Extent Temporary Decant Structure

Decant and Early Works

RYDE HOSPITAL REDEVELOPMENT

ISSUED FOR INFORMATION

STAGING LEGEND

- TO BE DEMOLISHED
- NEW CONSTRUCTION
- NEW CONSTRUCTION (PREVIOUS STAGE)
- CURRENT STAGE BUILDING SITE
- NEW ROAD
- TEMPORARY GENERATOR
- PROPOSED NATURAL GAS LINE
- FIRE HYDRANT & PIPEWORK
- PUBLIC EMERGENCY
- MAIN ENTRY
- AMBULANCE
- LOGISTICS
- EEC LINE
- APZ EXTENT
- DECANT STRATEGY
- BULK OXYGEN

Notes:

Main Works, Stage 1

- Stage 1 Acute Services Building (ASB) incl. eastern BoH lift core and Loading Dock & BoH services;
- Driveway access and new crossover to Ryedale Rd;
- New link to GRC;
- Temporary link to Denistone House;
- Services work including:
  - Temporary generator supporting existing Switchroom 2;
  - Upgrade of fire hydrant booster and new pipework;
  - New site wide gas meter & diversion of existing pipework;
  - Diversion of existing sewer & installation of new water main;
  - New bulk oxygen tank and pipework.

Multi-Deck Car Park

Decant 2

The following services are relocated in to the stage 1 ASB:

- Engineering Services;
- Mortuary;
- Stores, Food Services, BoH and Loading Dock;
- Physiotherapy;
- Wards 2 and 3;
- Administration

ICU/HDU & CCU to temporarily decant in Stage 1 IPU.

Stage 1 Works

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STAGING LEGEND
TO BE DEMOLISHED
NEW CONSTRUCTION
NEW CONSTRUCTION (PREVIOUS STAGE)
CURRENT STAGE BUILDING SITE
NEW ROAD
TEMPORARY GENERATOR
STAGE 2 DEVELOPMENT ZONE
LOGISTICS TRAVEL PATH
EMERGENCY PATIENT TRAVEL PATH
PUBLIC EMERGENCY
MAIN ENTRY
AMBULANCE
LOGISTICS
EEC LINE
APZ EXTENT
LOGISTICS TRAVEL PATH
Blue Gum High Forest
RYEDALE ROAD
MDCP
PRP RADIOLOGY
THE RYDE MEDICAL CENTRE
MEDICAL CENTRE
STAGE 1
AMBULANCE STATION
FLORENCE AVENUE
FOURTH AVENUE
DENISTONE ROAD
Temporary Generator Location
Existing Oxygen Compound Expanded in Place
Stage 1 Works - Flow Paths
RYDE HOSPITAL REDEVELOPMENT
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Health Infrastructure
Health Northern Sydney Local Health District
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STAGING LEGEND

- TO BE DEMOLISHED
- NEW CONSTRUCTION
- NEW CONSTRUCTION (PREVIOUS STAGE)
- CURRENT STAGE BUILDING SITE
- NEW ROAD
- DECANT STRATEGY
- TEMPORARY GENERATOR
- PUBLIC EMERGENCY
- MAIN ENTRY
- AMBULANCE
- LOGISTICS
- EEC LINE
- APZ EXTENT
- EXISTING SEWER LINE

Notes:

Main Works, Stage 2

- Demolition of B12, B13, B14, B15, B16;
- Partial demolition of B3;
- Site clearance and site preparation to Stage 2 footprint;
- Construction of Stage 2 ASB including central shared zone and lift cores;
- Fire trail access and landscaping;
- Temporary ambulance access;
- Temporary public drop-off.

Stage 2 Works

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STAGING LEGEND

- TO BE DEMOLISHED
- NEW CONSTRUCTION
- NEW CONSTRUCTION (PREVIOUS STAGE)
- CURRENT STAGE BUILDING SITE
- NEW ROAD
- DECANT STRATEGY
- PUBLIC EMERGENCY
- MAIN ENTRY
- AMBULANCE
- LOGISTICS
- EEC LINE
- APZ EXTENT

Decant 3

Decant 03a:

- Critical Care services relocated from temporary Stage 1 location to permenant stage 2.

Decant 03b:

The following services are relocated to the stage 2 ASB:

- Periop and day surgery;
- Critical Care;
- Emergency;
- Medical Imaging;
- Outpatient clinic;
- Remaining IPUs;
- Pharmacy, Pathology, SSD;

Temporary location for Education and Training (location TBC).

Final Works - Decant/Demolish

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STAGING LEGEND

- TO BE DEMOLISHED
- NEW CONSTRUCTION
- NEW CONSTRUCTION (PREVIOUS STAGE)
- CURRENT STAGE BUILDING SITE
- NEW ROAD
- DECANT STRATEGY
- PUBLIC EMERGENCY
- MAIN ENTRY
- AMBULANCE
- LOGISTICS
- EEC LINE
- APZ EXTENT

Notes:

Final Works - A

- Demolition of remaining B3, B4, B5, B6, B9;
- Demolition of existing main entry drop-off and crossovers;
- Refurbishment works to Denistone House;
- Front entry drop off, Forecourt and landscaping;
- Final ambulance and public emergency drop-off;
- New public at-grade parking.

Decant 3

The following services are relocated to Denistone House:

- Education, Training and Research.

Final Works - Completion

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