APPENDIX

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DUNGOWAN DAM AND PIPELINE EIS

Bushfire Hazard Assessment

NSW GOVERNMENT | EMM creating opportunities

BLACKASH
BUSHFIRE CONSULTING

Bushfire Risk Assessment

Dungowan Dam and pipeline project

Prepared for

EMM Consulting Pty Ltd

BPAD Bushfire Planning & Design Accredited Practitioner Level 3

Version 4

28 September 2022

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Disclaimer

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The client may, at its discretion, use the report to inform regulators and the public.

Executive summary

Blackash Bushfire Consulting has been engaged by EMM Consulting Pty Ltd (EMM) to complete a Bushfire Risk Assessment Report for the Dungowan Dam and pipeline project (the project) This Bushfire Risk Assessment supports the EIS for the project. It documents the project's bushfire risk in accordance with *Planning for Bushfire Protection 2019* NSW Rural Fire Service (PBP 2019).

This assessment has been prepared by Lew Short, Principal Blackash Bushfire Consulting (Level 3 FPAA BPAD-A Certified Practitioner No. BPD-PA-16373) who is recognised by the NSW Rural Fire Service (RFS) as qualified in bushfire risk assessment and has been accredited by the Fire Protection Association of Australia as a suitably qualified consultant to undertake alternative solution proposals.

An inspection of the project site and surrounding area was completed on 20 October 2020.

Bushfire impact is a key consideration to ensure bushfire risk is understood and mitigation measures are implemented to reduce the consequences of any bushfire impacts during the construction and operational phase of the Dungowan Dam and pipeline project. The pipeline has been considered as part of the risk assessment, although, it is a low bushfire risk due to the pipeline being underground.

Bushfire protection measures should be commensurate with the bushfire risk and criticality of the infrastructure. Mitigation measures have been outlined in Section 8.

The construction phase of the project will require large numbers of workers to be in a relatively remote area that is susceptible to bushfire. Detailed emergency management planning should be completed prior to construction to ensure the safety of workers.

The operational phase of the project will have ongoing management requirements to reduce the bushfire attack level on key assets. The management of bushfire risk on an ongoing basis should be determined by the dam operator (WaterNSW) in accordance with required management plans and conditions of approval.

Contents

1. Introduction

1.1. The Project

The Peel River, part of the Namoi River catchment, provides water for irrigation as well as being the primary water supply for the city of Tamworth. Prompted by the millennium drought, investigations into the future water supply and demand for bulk water were undertaken for the regional city of Tamworth and the Peel Valley water users. The Dungowan Dam and pipeline project (the project) is a critical project to improving long-term water security for the region. The project includes a new dam at Dungowan (new Dungowan Dam) approximately 3.5 km downstream of the existing Dungowan Dam and a new section of pipeline about 32km long between the proposed Dam outlet and the tie in point to an existing pipeline from Dungowan Showground to the Calala Water Treatment Plant (WTP).

In September 2022, the Minister for Planning and Homes declared the project to be Critical State Significant Infrastructure (CSSI) as it is a development that is essential for the State for economic and social reasons. This requires Schedule 5 of the *State Environmental Planning Policy (Planning Systems) 2021* to be updated to reflect the CSSI status of the project. As CSSI, the project is subject to Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), which requires the preparation of an environmental impact statement (EIS) and the approval of the NSW Minister for Planning and Homes. The EIS has been prepared for the planning approval application for the project. This Bushfire Hazard Assessment has been prepared to support the EIS.

In addition to requiring approval from the NSW Minister for Planning and Homes, the project has been deemed a controlled action under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and requires approval from the Commonwealth Minister for the Environment and Water. The Minister for the Environment and Water has accredited the NSW planning process for the assessment of the project. Therefore, a single EIS has been prepared to address the requirements set out by the NSW Department of Planning and Environment (DPE) and the Commonwealth Department of Climate Change, Energy, the Environment and Water.

1.2. Project Location

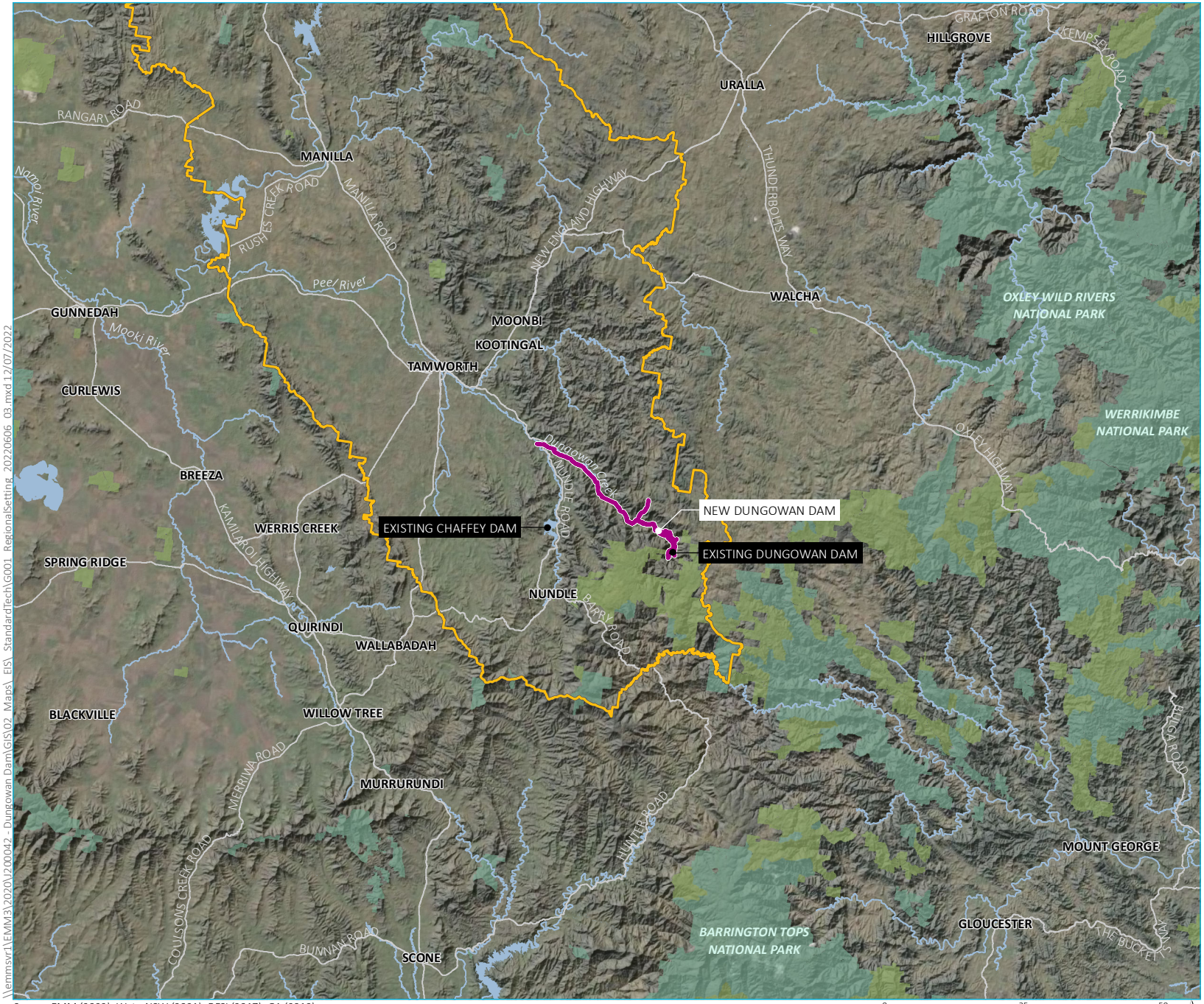
The project is located in the Tamworth Regional local government area (LGA), the New England Tablelands bioregion and part of the New England and North West region of NSW, west of the Great Dividing Range (DPE 2017). The New England and North West region is home to approximately 186,900 people and has a total area of around 99,100 km2 (ABS 2018).

The city of Tamworth is the nearest (and largest) town to the project with over 40,000 residents. Other nearby regional towns include Quirindi (70 km west), Manilla (90 km north-west), Gloucester (90 km

south-east), Armidale (100 km north) and Gunnedah (110 km west of the project). The existing Dungowan Dam is in the Namoi River catchment approximately 50 km south-east of Tamworth in NSW. The Namoi catchment covers 4,700 km2 and borders the Gwydir and Castlereagh catchments and is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north.

The existing Dungowan Dam is on Dungowan Creek, which is a tributary of the Peel River. Dungowan Creek is confined by the existing Dungowan Dam, while the Peel River system is regulated by Chaffey Dam, located in the upper catchment near the town of Woolomin, approximately 45 km from Tamworth.

The project's regional setting is shown in Figure 1.



\\emmsvr1\EMM3\2020\200042 - Dungowan Dam\GIS\02 Maps\ EIS\ StandardTech\G001 RegionalSetting 20220606 03.mxd 12/07/2022

Source: EMM (2022); WaterNSW (2021); DFSI (2017); GA (2013)

Regional setting

Dungowan Dam and pipeline project
Figure 1

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1.2.1. Project impact areas

In outlining the project, a project footprint has been defined to facilitate the assessment of direct impacts from the project:

- Project footprint: all areas where direct impacts may be experienced during construction and/or operation.

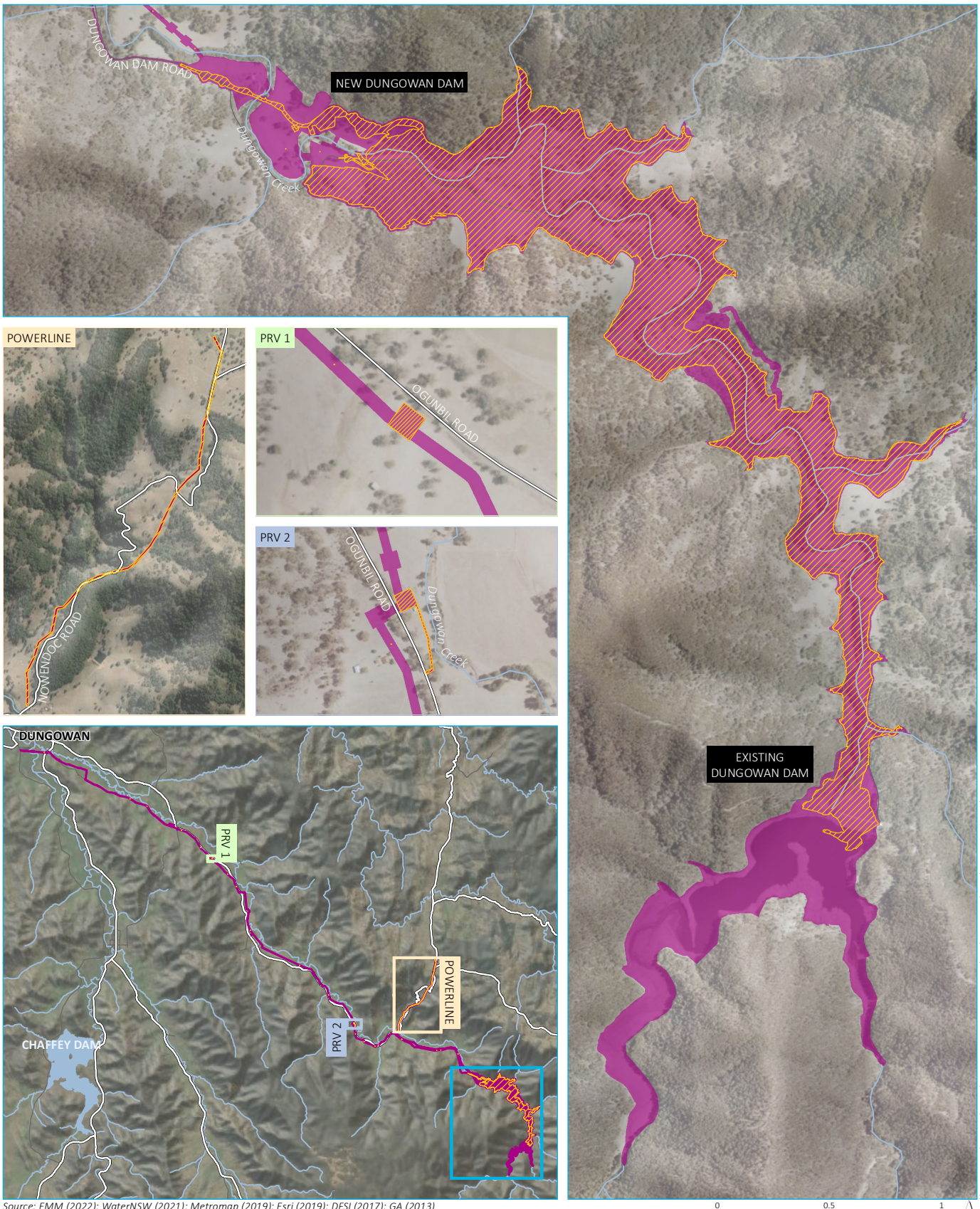
The project footprint has an area of 315 ha and is comprised of the construction and operational footprints, of which there is some overlap:

- Construction footprint: areas where vegetation clearing and/or ground disturbance is required for construction of the dam, pipeline and ancillary facilities, including the area needed to decommission and rehabilitate the existing dam.
- Operational footprint: areas where there will be permanent operational elements or easements, including infrastructure needed to operate the new Dungowan Dam and pipeline. The operation footprint includes the inundation area, being the area defined by the proposed full supply level (FSL) for the project.

Additional areas outside the project footprint have also been considered where relevant to the assessment of project impacts and include:

- Upstream flood extent: An area above the FSL to the level of a probable maximum flood (PMF) event that would be inundated for relatively short periods during operation associated with extreme rainfall events.
- Project area: A 10 km buffer around the project footprint defined to allow for assessment of potential indirect impacts.
- Downstream impact area: the area where hydrological changes may occur due to the project. This area is discussed in detail in the Surface Water Assessment (EMM 2022) as well as other technical reports subject to changed flow regimes as a result of the new Dungowan Dam operation. The downstream impact area includes Dungowan Creek and also the Peel River downstream of Chaffey Dam.

The project construction and operational footprints are shown in Figure 2.



Source: EMM (2022); WaterNSW (2021); Metromap (2019); Esri (2019); DFSI (2017); GA (2013)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Construction footprint
- Operational footprint

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Project footprint

Dungowan Dam and pipeline project

Figure 2

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\\emmsvr1\EMM3\2020\200042 - Dungowan Dam\GIS\02_Maps_EIS_StandardTech\G002_ProjectAreas_20220602_06.mxd 12/07/2022

1.3. Purpose of this report

Blackash Bushfire Consulting has been engaged by EMM Consulting Pty Ltd (EMM) to complete a Bushfire Risk Assessment Report for the project. This Bushfire Risk Assessment supports the EIS for the project. It documents the project's bushfire risk in accordance with PBP 2019.

This assessment has been prepared by Lew Short, Principal Blackash Bushfire Consulting (Level 3 FPAA BPAD-A Certified Practitioner No. BPD-PA-16373) who is recognised by the NSW Rural Fire Service (RFS) as qualified in bushfire risk assessment and has been accredited by the Fire Protection Association of Australia as a suitably qualified consultant to undertake alternative solution proposals. An inspection of the project site and surrounding area was completed on 20 October 2020.

1.3.1. Assessment guidelines and requirements

This Bushfire Risk Assessment has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the Dungowan Dam and pipeline project, issued on 27 July 2020, as well as relevant government assessment requirements, guidelines and policies, and in consultation with the responsible government agencies.

The SEARs must be addressed in the EIS. This report addresses the following matters required by the SEARs.

> *51. An assessment of the likely risks of the project to public safety including flood risk, subsidence risks, bushfire risks and the handling and use of dangerous goods.*

To inform preparation of the SEARs, DPE invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs.

Relevant guidelines and requirements are:

> ***Planning for Bushfire Protection 2019*** NSW Rural Fire Service (PBP 2019)
> Contains specifications for planning and building on land identified as bushfire prone. The project is in a designated bushfire prone area. All new development on bushfire prone land must comply with the PBP 2019.
> ***Standards for Asset Protection Zones*** NSW Rural Fire Service
> Provides standards for the establishment and maintenance of asset protection zones.

2. Description of the Project

This chapter provides a summary of the Dungowan Dam and pipeline project. It outlines the permanent infrastructure required to operate the project, as well as the key construction elements and activities required to construct the project. A comprehensive and detailed description of the project is provided as Appendix B1 of the EIS, which has been relied upon for the basis of this technical assessment.

2.1. Project overview

Water Infrastructure NSW proposes to build a new dam at Dungowan (new Dungowan Dam) about 3.5 km downstream of the existing Dungowan Dam and an enlarged delivery pipeline from the new Dungowan Dam outlet to the tie in point to the existing pipeline from Dungowan Showground to the Calala WTP. The existing pipeline from Dungowan Showground to the Calala WTP is not part of the Dungowan Dam and pipeline project. A summary of project elements is provided in Table 2.1**Error! Reference source not found.**.

Table 2.1. Overview of the project

Project element	Summary of the project
New Dungowan Dam infrastructure	Earth and rockfill embankment dam with height of ~58 m and a dam crest length of ~270 m.
	Storage capacity of 22.5 GL at full supply level (FSL) of RL 660.2 m AHD.
	The new Dungowan Dam on Dungowan Creek has a catchment size of 175 km2 and is part of the Peel Valley and Namoi River catchment.
	Inundation extent (to FSL) of 130 ha (1.3 km^2)
	Spillway to the south of the dam wall including an approach channel, uncontrolled concrete ogee crest, chute and stilling basin. Free standing multiple-level intake tower connected with a bridge to the embankment, diversion tunnel with outlet conduit, valve house and associated pipework and valves.
	A permanent access road over the Dam crest to the valve house for operation and maintenance.
	Water diversion works including a diversion tunnel and temporary pipeline and upstream and downstream cofferdams to facilitate construction of the dam wall embankment.
Pipeline infrastructure	31.6 km of buried high density polyethylene (HDPE) pipe between 710 mm to 900 mm nominal diameter.
	Maximum 71 ML/day from the proposed dam to the junction with the pipeline from Chaffey Dam to the Calala Water Treatment Plant, to replace the existing 22 ML/day pipeline. The pipeline would connect to the valve house on the left abutment of the embankment. Valve infrastructure would include control valves installed in two above ground buildings along the pipeline.

Table 2.1. Overview of the project

Project element	Summary of the project
	10 m wide easement for the 31.6 km length of the pipeline. The replacement pipeline extends from the new Dungowan Dam to a connection point with the existing pipeline between Dungowan Showground and Calala WTP.
Ancillary infrastructure and works	Road works to improve existing roads to provide construction access, temporary establishment and use of a construction compound, an accommodation camp, two upstream quarries and four borrow areas within the inundation area.
	A new 4.2 km long 11 kV overhead powerline (including a new easement and access track) connecting to an existing overhead line approximately 6 km north west of the dam. The existing overhead line that extends approximately 13.2 km to the Niangala area would also require minor upgrades, including re-stringing of new overhead wiring and replacement of some poles.
Decommissioning of existing Dungowan Dam	Dewatering of existing dam, removal of existing Dungowan Dam infrastructure and full height breach of the existing Dungowan Dam wall. Rehabilitation of inundation area of the existing Dungowan Dam.
Disturbance	Areas of disturbance have been identified based on the direct impacts of the project. There is some overlap in the areas disturbed during construction and operation, with a resulting total disturbance area proposed for the project of 315 ha (project footprint).
	Disturbance would occur in a staged manner, with construction requiring disturbance of approximately 315 ha (construction footprint). Following construction and once rehabilitation is completed, there would be a permanent disturbance of approximately 158 ha comprising the inundation area and permanent infrastructure (operational footprint).
Construction	Construction duration of approximately 6 years.
	Construction workforce of approximately 125 workers at construction peak.
Operation	WaterNSW will be responsible for management, operation and general maintenance of the new dam. Tamworth Regional Council will be responsible for the management, operation and general maintenance of the pipeline. Public use and access to the dam would not be permitted and there would be no public facilities available during operation.
	One to two new full time workers plus part time work for existing WaterNSW operations team.
	Due to the new Dungowan Dam being prioritised over Chaffey Dam for Tamworth's future water supply, the water reserved for town water in Chaffey Dam would increase from 14.3 GL to 30 GL to ensure that water is set aside to meet Tamworth's town water supply water demand in years when rainfall is low.
Design life	100 years for zoned earthen embankment, structural concrete elements of the dam and the pipeline. 15 to 50 years for other non-structural project elements and pavements.
Assessment period (operational)	The assessment end point is when the water system performance reaches a level when an additional water supply option or change to the Water Sharing Plan is required. This has been estimated to be when the mean average annual water demand from Tamworth increases to 11 GL/year.

2.2. Construction ancillary infrastructure

Several ancillary facilities and activities are required to enable the construction of the permanent infrastructure described in the previous sections. This section provides a description of the temporary infrastructure and activities proposed to enable the construction of the project.

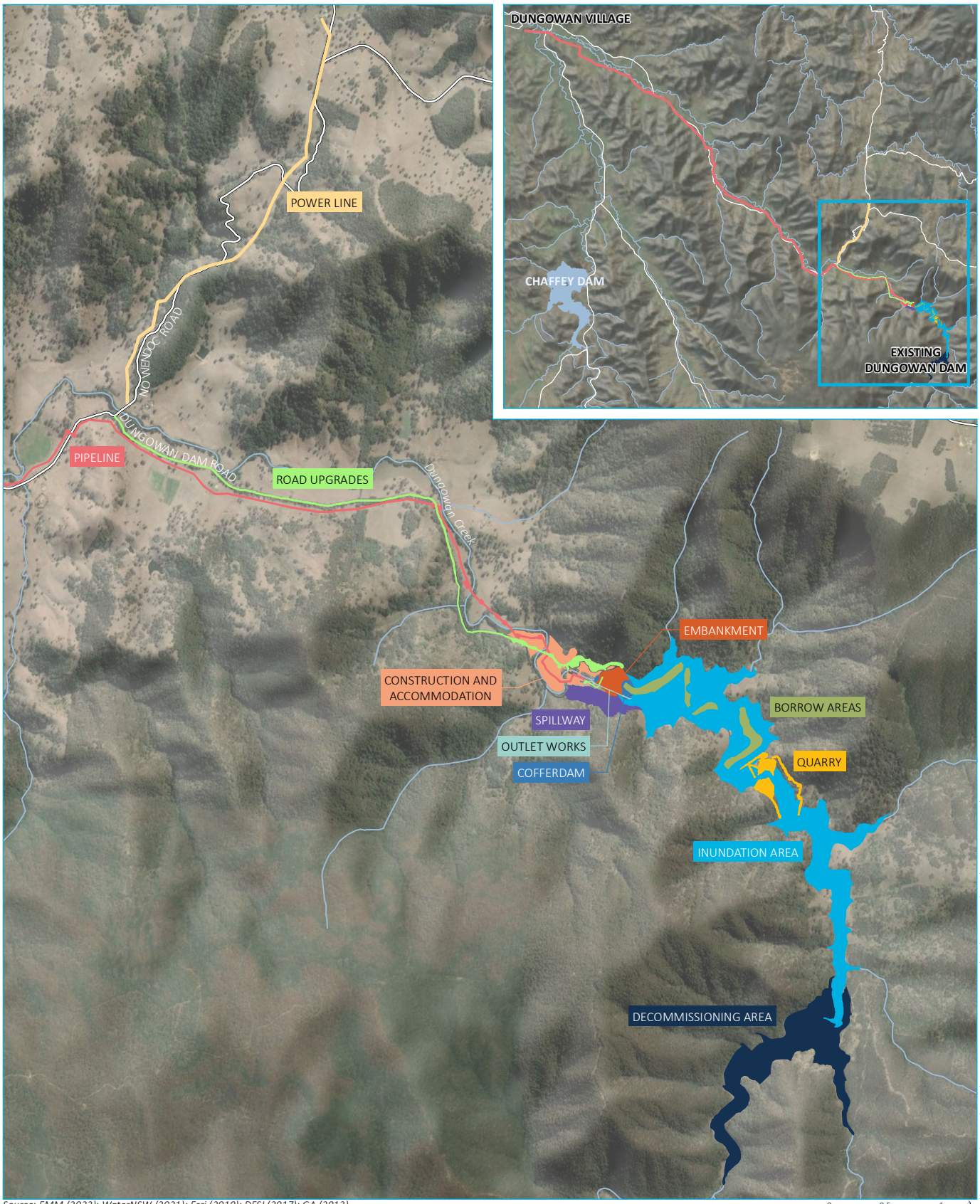
2.2.1. Accommodation camp

An accommodation camp is proposed to provide accommodation for about 140 workers. The accommodation camp would be adjacent to the dam construction compound, with both facilities having a combined footprint of about 12.5 ha. The accommodation camp would be operational throughout the project construction and would provide facilities for the overnight accommodation of workers including: 140 single story units, central facilities, stormwater detention/quality treatment, maintenance areas, bus and car parking. The accommodation camp area would be cleared of vegetation and earthworks would include cut and fill to ensure a level site area. Once the camp is no longer required for the project construction it would be de-commissioned and rehabilitated.

2.2.2. Construction compound

A construction compound would be located adjacent to the dam wall embankment to support the project's construction activities. The construction compound would provide construction support facilities, such as a concrete batching plant (CBP), laydown yard and site sheds. The CBP would produce up to about 90,000 m3 of concrete through the construction period. The dam construction compound area would be cleared of vegetation and earthworks would include cut and fill to ensure a level site area. Once the construction compound is no longer required for the project construction it would be de-commissioned and rehabilitated. The construction compound would be sited adjacent to the new Dungowan dam wall.

The accommodation camp and construction compound is shown in Figure 4.



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Source: EMM (2022); WaterNSW (2021); Esri (2019); DFSI (2017); GA (2013)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Inundation area
- Borrow areas
- Construction and accommodation camp
- Outlet works
- Cofferdams
- Embankment
- Quarries
- Spillway
- Road upgrade
- Decommissioning area
- Power line footprint
- Pipeline construction footprint

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Project overview

Dungowan Dam and pipeline project

Figure 3

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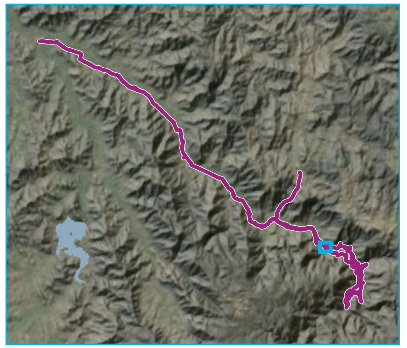

KEY

- Project footprint
- Construction compound and accommodation camp indicative layout
- Construction compound and accommodation camp

Existing environment

- Minor road
- Named watercourse
- Named waterbody

\\emmsvr1\EMM3\2020\J200042 - Dungowan Dam\GIS\02 Maps\ EIS\EIS007 ConstructionAccommodationCamp 20220510 12.mxd 10/05/2022

Source: EMM (2022); WaterNSW (2021); Metromap (2019); DFSI (2017); GA (2013)

0 100 200 m

GDA 1994 MGA Zone 56

N

Construction compound and accomodation camp

Dungowan Dam and pipeline project
Project description
Figure 4

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3. Legislative and policy framework

This section provides an overview of the relevant legislation, policy and guidelines as it relates to the bushfire risk assessment.

Environmental Planning and Assessment Act, 1979 (EP&A Act)

The designation of Bushfire Prone Land (BFPL) in NSW is required under the EP&A Act (s.10.3). BFPL Maps provide the trigger for the various development assessment provisions. The BFPL Map is a trigger for the consideration of bushfire matters for new development. It is not intended as a detailed measure of risk. The map does not form part of the site assessment process.

Rural Fires Act, 1997

The *Rural Fires Act 1997* (RF Act) establishes the NSW Rural Fire Service, defines its functions and makes provision for the prevention, mitigation and suppression of rural fires. Section 52 of the RF Act requires Bushfire Management Committees (BFMCs) to prepare Bushfire Risk Management Plans. The Bushfire Risk Management Plan provides a risk assessment across a fire district, which have been reviewed as part of this bushfire assessment. The project is within the Tamworth Bushfire Risk Management Plan area (refer to Section 4.2). Section 63 of the RF Act requires public authorities and owners and occupiers of land to prevent bushfires and to manage land they are responsible for:

> *s. 63 Duties of public authorities and owners and occupiers of land to prevent bushfires*
>
> *(1) It is the duty of a public authority to take the notified steps (if any) and any other practicable steps to prevent the occurrence of bushfires on, and to minimise the danger of the spread of a bushfire on or from:*
>
> *(a) any land vested in or under its control or management, or*
>
> *(b) any highway, road, street, land or thoroughfare, the maintenance of which is charged on the authority.*

Section 63 places on ongoing bushfire management requirement on the dam operator to mitigate the risk of bushfire within the project site.

4. Bushfire risk

With respect to property loss and fire impact, CSIRO studies have found that approximately 98% of all building loss has been found to occur on days when the Forest Fire Danger Index (FFDI) exceeded 45 (Blanchi & Lucas, 2010). The McArthur FFDI was developed in the 1960s by CSIRO scientist A. G. McArthur to measure the degree of danger of fire in Australian forests. The index combines a record of dryness, based on rainfall and evaporation, with meteorological variables for wind speed, temperature and humidity. The scale starts at 0 and tops out at an FFDI of 100. However, in recent years, FFDI above 100 have been calculated by the Bureau of Meteorology during catastrophic fire weather conditions.

The FFDI measures the degree of danger of fire in Australian vegetation. For the purposes of PBP 2019, the FFDI is required for development assessment purposes and is based on local government boundaries. PBP 2019 uses a design fire for bushfire risk assessment based on a 1:50 year fire weather scenario. Most of the state was determined as FFDI 80, however, a number of areas including the Greater Sydney, Greater Hunter, Illawarra, Far South Coast and Southern Ranges Fire Areas have higher FFDIs, which are set at 100 by PBP 2019 (see Section 5 for the assessment methodology).

In events where the FFDI exceeds 50 (which is the point where a total fire ban is declared), fire suppression at any part of a fire line is virtually impossible due to the intensity and unpredictable behaviour of a fire (Blanchi et al, 2012). Building design and construction, fuel management, and restriction of use of the sites during forecast bad fire weather are the only effective defence mechanisms available once the FFDI has exceeded 50 (Blanchi & Lucas, 2010; Leonard & Blanchi, 2012). These are provided by PBP 2019 and the construction requirements provided within the Australian Standard for Construction of Buildings in Bushfire Prone Areas (AS3959).

In considering risk to life, it is incumbent to examine historical bushfire-related life loss research. In 2012, the CSIRO in conjunction with the former Bushfire Corporative Research Centre undertook a comprehensive study into matters of both life and house loss utilising over 110 years (1901-2011) of data across 260 bushfire events (Blanchi et al. 2012). Over this period, a total of 825 known civilian and firefighter fatalities have occurred (Blanchi et al. 2012). Important findings of this seminal research are as follows:

- It is evident that fire weather and proximity to forest are very strong contextual drivers for defining the potential for fatalities to occur
- 85 per cent of fatalities occur within 100 m of bushland
- 50 per cent of all recorded facilities have occurred on days exceeding FFDI 100 (most fatalities occur as a result of infrequent but high magnitude events)

- Late evacuation is the most common activity persons were engaged in at time of death (30.3 per cent) followed by sheltering inside a structure (24.8 per cent) and defending a property outside (22.4 per cent)
- For those instances where sufficient data is available with respect to fatalities occurring during the act of evacuation, most were trapped on roads by either fallen trees or becoming bogged, the remainder having run off the road due to poor visibility as a result of smoke conditions
- In terms of location of fatal exposure, 50 per cent occurred out in the open (including persons found outside structures and outside vehicles), 28 per cent occurred inside structures and in events where FFDI exceeded 100, fatalities within structures represented over 75 per cent of life loss
- The percentage of fatalities within structures appears to be increasing over time, mostly attributed to the 2009 Victorian Bushfires where 118 of the 173 fatalities occurred inside a structure
- Most fatalities occur between the hours of 3pm and 9pm – when FFDI is at its peak (3pm) and when summer cool-change winds occur, with 90 per cent of fatalities occurring immediately after afternoon wind changes.

In considering the above findings, there remain two key contextual matters, which reflect the extent of fatalities in certain situations, including:

1. there is a direct relationship between fire intensity (as a function of FFDI) and both property and life loss, over distance from the bushland interface; and
2. the afternoon cool-wind change is likely a key phenomenon in situations where life loss occurs. These winds change the direction of the fire front, where the wide fire flank transitions to the head of the fire, creating a drastic spike in fire intensity and rate of spread over a wide distance and in a direction, which is not anticipated by the general community. These situations can lead to higher proportions of people taking passive shelter (i.e. the window to evacuate has passed) and attempting late evacuation, as can the 'wait and see' mindset. Topographic conditions can also result in the same effect, where residents may not be aware of an approaching fire until it reaches a nearby ridgeline.

4.1. Land use planning and bushfire risk

Australia has a history of high consequence bushfires, which have caused loss of life, damage and disruption. Risk based land use planning provides the tolerable bushfire risk levels through documents such as PBP 2019, legislation, policy and guidelines.

Risk based land use planning has consistently been identified as one of the key means to reduce natural disaster risks to assets and communities. Improved risk based land use planning in areas that are subject to natural hazard are fundamental to developing and enhancing resilient development, critical infrastructure and communities.

The objectives of PBP 2019 articulates the criteria to determine tolerable risk to assets and people associated with 'other' development.

4.2. Tamworth Bushfire Risk Management Plan

The Tamworth Zone BFMC *Bushfire Risk Management Plan 2011* (Risk Plan) includes the Local Government Area (LGA) of Tamworth Regional. The Risk Plan is a strategic document that identifies community assets at risk and sets out a five-year program of coordinated multi-agency (State and local) treatments to reduce the risk of bushfire to the assets.

The Risk Plan (p. 10) identifies the typical climate in the Tamworth BFMC area (in which the project is located) has an average summer maximum temperature of 31 degrees Celsius and an average winter maximum temperature of 16 degrees Celsius. The average low temperatures are 16 degrees Celsius in summer and 3 degrees Celsius in winter. Most of the rain is summer predominant with average annual rainfall of 650mm. The area experiences low relative humidity and has average elevations of 400 metres above sea level for Tamworth and to the west towards Manilla and Barraba. To the north and east the land rises to the Northern Tablelands and the Great Divide with elevations of up to 1400 meters. These areas generally experience a shorter fire season. The bush fire season generally runs from October to March for the majority of the Tamworth BFMC area.

Prevailing weather conditions associated with the bush fire season in the Tamworth BFMC area are usually north-westerly winds accompanied by high daytime temperatures and low relative humidity. There are also frequent dry lightning storms occurring throughout the area during the bush fire season.

The Tamworth BFMC area has on average 200 bush fires per year, of which 15 on average can be considered to be major fires. The main sources of ignition in the Tamworth BFMC area are:

- *Lightning Strikes*
- *Agricultural Burns/Practices*
- *Malicious Fires*
- *Escaped Pile Burns*

- *Machinery and Vehicles*
- *Welding/Grinding and associated construction activities*

The Risk Plan follows RFS guidelines for the assessment of bushfire risk. Identifying the level of bush fire risk firstly involved identifying important community assets considered to be at risk from bush fire in the Tamworth BFMC area, and then assessing the likelihood and consequence ratings. The Risk Planning process requires that for all asset types the likelihood of a bushfire occurring is assessed. This involves considering fire history, including ignition cause and patterns, known fire paths, access, containment potential and potential fire run (size of the vegetated area).

Figure 5 is the Bushfire Risk map for the project area. Once the risk ratings for each asset were identified by the BFMC, they were evaluated (Risk Plan p. 15) to:

a) confirm that risk levels identified in the risk analysis process are appropriate and

reflect the relative seriousness of the bush fire risk;

b) identify which assets require treatments; and

c) identify treatment priorities.

The Dungowan Dam and Catchment area is identified within the Risk Plan. The Risk Plan assessment is shown in Table 4.1.

Table 4.1 Risk Plan Assessment

Risk Plan Asset Register								
Map Reference Number	**Asset Type**	**Asset Name**	**Likelihood**	**Consequence**	**Risk**	**Priority**	**Treatment Number**	**Risk Plan Reference**
43	Economic	Dungowan Dam Catchment	Likely	Moderate	High	3A	26, 27	
0	Economic	Dungowan Dam and Infrastructure	Likely	Moderate	High	3A	17	
Risk Plan Treatment Register								
Treatment No	**Strategy**	**Priority**	**Action**	**Comment**	**Responsible Agency**	**Support Agency**	**Agency Scheduled Action Date**	**Asset Ref Nos**
17	Hazard Reduction	2A	Inspect and maintain APZ	Maintain APZ on western side of Kingswood Estate along Gazetted road reserve	LGA	RFS	1112;1213;1314 ;1415;1516	52
26	Hazard Reduction	3A	Inspect and maintain APZ	Monitor fuel loads and conduct hazard reduction as required.	LGA	RFS: DPI	1112;1213;1314 ;1415;1516	43
27	Preparedness	Inspect & maintain fire trails	Nil		LGA	RFS: DPI	1112;1213;1314 ;1415;1516	43

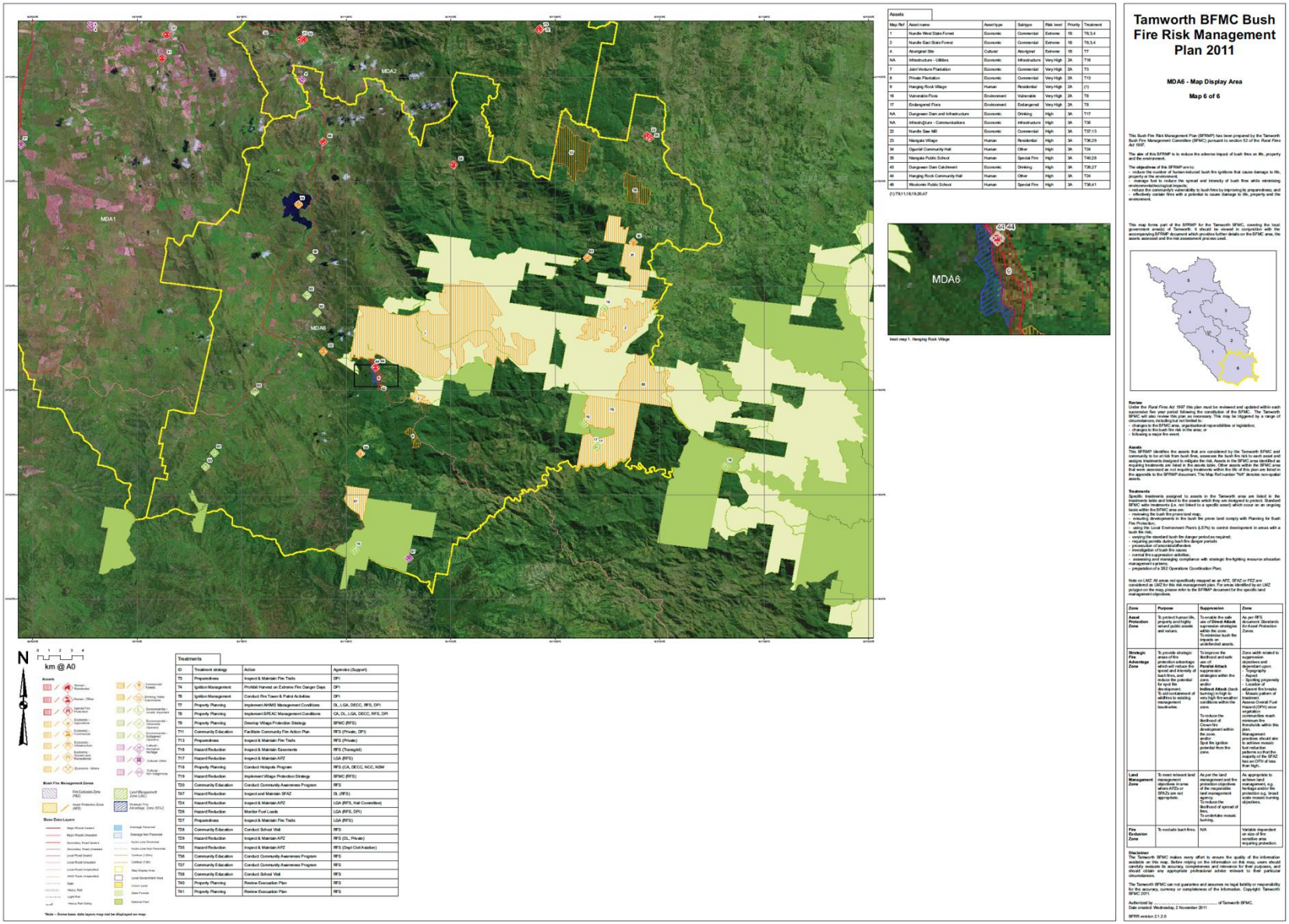

Figure 5 Extract from Tamworth Bushfire Risk Management Plan (p. 42)

4.3. Bushfire History

The project site and surrounds have a history of bushfires. Figure 6 shows the fire history in the vicinity of the site. Small fires (less than 350ha) were recorded within the vicinity of the site in 2002-2003, 2006 – 2007 and 2009 – 2010 bushfire seasons. The project area was impacted by a large bushfire (in the summer of 2019 – 2020. The Pearson Trail Complex fire south-east of Tamworth burnt through more than 22,000 hectares and surrounded the existing Dungowan Dam.

The Risk Plan has recognised the potential for fires within the catchment of the project. The management of fuel and impacts on dam infrastructure will need to be considered over the life of the dam. The 2019 – 2020 fires removed fuel in the vicinity of the existing Dungowan dam that has reduced the bushfire risk for the next couple of years. However, fuel will accumulate and will be at levels capable of carrying fire within 2 – 3 years of the last fire. Fires burning under extreme weather conditions have the potential to burn through recently burnt country.

The management of sediment and silt entering the dam will need to be considered into the future with a mosaic of burnt and unburnt areas recommended to reduce the risk of large fires burning through the entire catchment at one time.

Bushfires can impact the quality of waterways by increasing the amount of poor-quality runoff entering waterways during significant rain events. This runoff can have a range of impacts on water quality including depleted dissolved oxygen levels, increased sedimentation, algal blooms and fish kills. Most critical effects occur if there is heavy rain soon after fire, as loss of vegetation and altered soil structure can make fire-affected soils more erodible. Runoff can carry sediments and pollutants that affect aquatic environments, drinking water quality and agricultural industries.

The degree to which water quality is affected by fire depends on factors such as:

- geographical features and size of the catchment
- size and extent of the fire
- time period between the last fire and a significant rainfall event
- type of surrounding vegetation, soil and erosion.

High intensity fires can cause enormous damage to water catchments by destroying ground cover and changing hydrology, as well as altering the structure, behaviour and erosion of soil. The loss of riparian vegetation may result in high volumes of sediment (measured as turbidity) entering the stream and may also increase stream temperatures due to a lack of shade[1].

Chemical reactions triggered by fire can release nutrients, metals and other toxicants stored in

[1] https://www.waterquality.gov.au/issues/bushfires

vegetation and soil. Rainfall after a fire washes these contaminants into waterways and reservoirs, which can have substantial implications for agriculture, human safety and amenity.

Use of affected water may be unsafe for agriculture or human consumption without additional treatment or alternative water sources may have to be found.

Local food chain can also be affected by loss of riparian vegetation after a fire, which leads to:

- higher water temperatures
- increased light availability
- loss of habitat
- reduced protection from predators for instream biota.

Combined with increased contaminant loading, increased water temperature can trigger greater breakdown of organic matter by bacteria, which may deplete oxygen levels in the water.

Fish suffocation is a common result of this sudden depletion of dissolved oxygen.

Use of firefighting foam and chemical retardants should be restricted within the catchment area. However, the operational decisions for this will be undertaken independent of the project by the relevant responding authority.

BLACKASH
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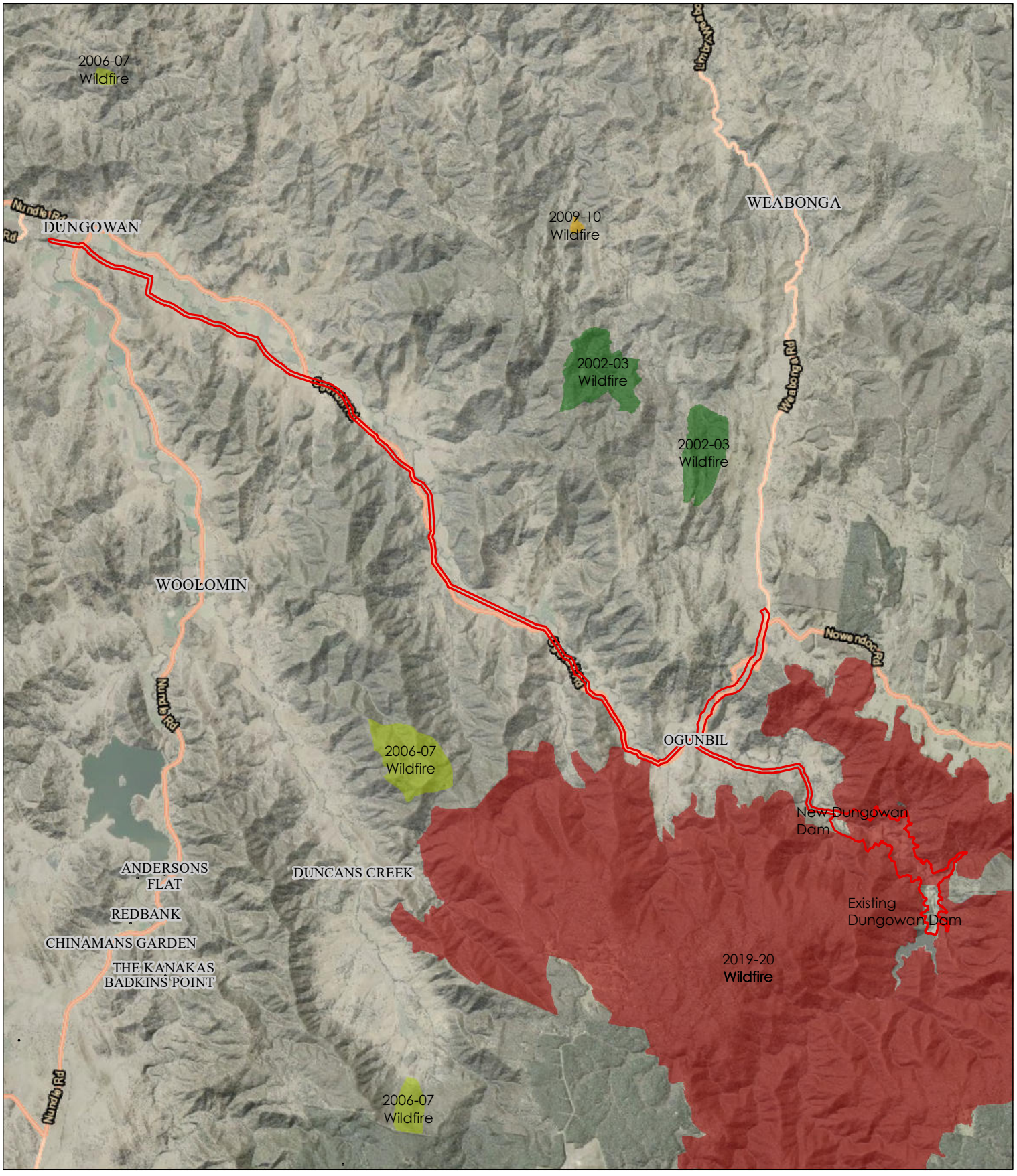


Legend

Subject Site

2002-03 Wildfire

Fire History

2019-20 Wildfire

2009-10 Wildfire

2006-07 Wildfire

Figure 6 - Bushfire History

N

DKGIS

Date: 5/11/2020

0 1 2 4 6

Kilometers

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Dept. Customer Service

5. Assessment framework

The project is classified as Critical State Significant Infrastructure (CSSI) and is subject to Part 5, Division 5.2 of the EP&A Act, which requires the preparation of an environmental impact statement (EIS) and the approval of the NSW Minister for Planning. An EIS has been prepared for the planning approval application for the project. This EIS has been prepared for the planning approval application for the project. Where an environmental assessment is completed, referral to obtain concurrence of agencies, such as the RFS is not required. On this basis, referral to the RFS is not required. However, the RFS has been consulted in the development of this assessment. A meeting was held with RFS, WINSW, Blackash and EMM on 19 May 2022 to provide a project briefing and discuss the bushfire risk assessment approach and findings.

All new development on bushfire prone land must comply with PBP 2019. The aim of PBP 2019 is to provide for the protection of human life and minimise impacts on property from the threat of bushfire, while having due regard to development potential, site characteristics and protection of the environment.

The objectives are to:

- *Afford buildings and their occupants protection from exposure to a bushfire*
- *Provide for a defendable space to be located around buildings*
- *Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent the likely fire spread to buildings*
- *Ensure that appropriate operational access and egress for emergency service personnel and occupants is available*
- *Provide for ongoing management and maintenance of bushfire protection measures (BPMs); and*
- *Ensure that utility services are adequate to meet the needs of firefighters.*

PBP 2019 articulates the regulatory framework for new development in NSW, along with the relevant bushfire protection measures to be contemplated in the delivery of bushfire-resilient development design. The document provides detailed provisions for various types of development, which is focussed at residential and Special Fire Protection Purpose development.

On 1 March 2020, PBP 2019 was given legislative effect and replaced *Planning for Bushfire Protection 2006* (PBP 2006). The *Environmental Planning and Assessment Amendment (Planning for Bush Fire Protection) Regulation 2020* under the EP&A Act came into effect on 1 March 2020.

The project is considered as 'other development' in PBP 2019. 'Other development' includes industrial and infrastructure development. PBP 2019 does not provide a framework for the project in a meaningful way as the document is focussed at residential development in Bushfire Prone Areas. However, 'other

development' must only satisfy the aim and objectives of PBP 2019. This assessment includes an analysis of the hazard, threat and subsequent bushfire risk to the project and provides recommendations that satisfy the aims and objectives of PBP 2019.

5.1. Bushfire prone land

The identification of BFPL in NSW is provided under S.10.3 of the EP&A Act. The project is on designated BFPL and the surrounding grassland area is not managed, which causes a bushfire risk. The BFPL Maps provide the trigger for the consideration of bushfire matters for new development.

Figure 7 shows the Bushfire Prone Land Map for the project area. The site for the new Dungowan Dam is within Vegetation Category 1 bushfire prone land. The RFS Guide for bush fire prone land mapping (RFS, 2015) describes Vegetation Category 1 land as:

Vegetation Category 1

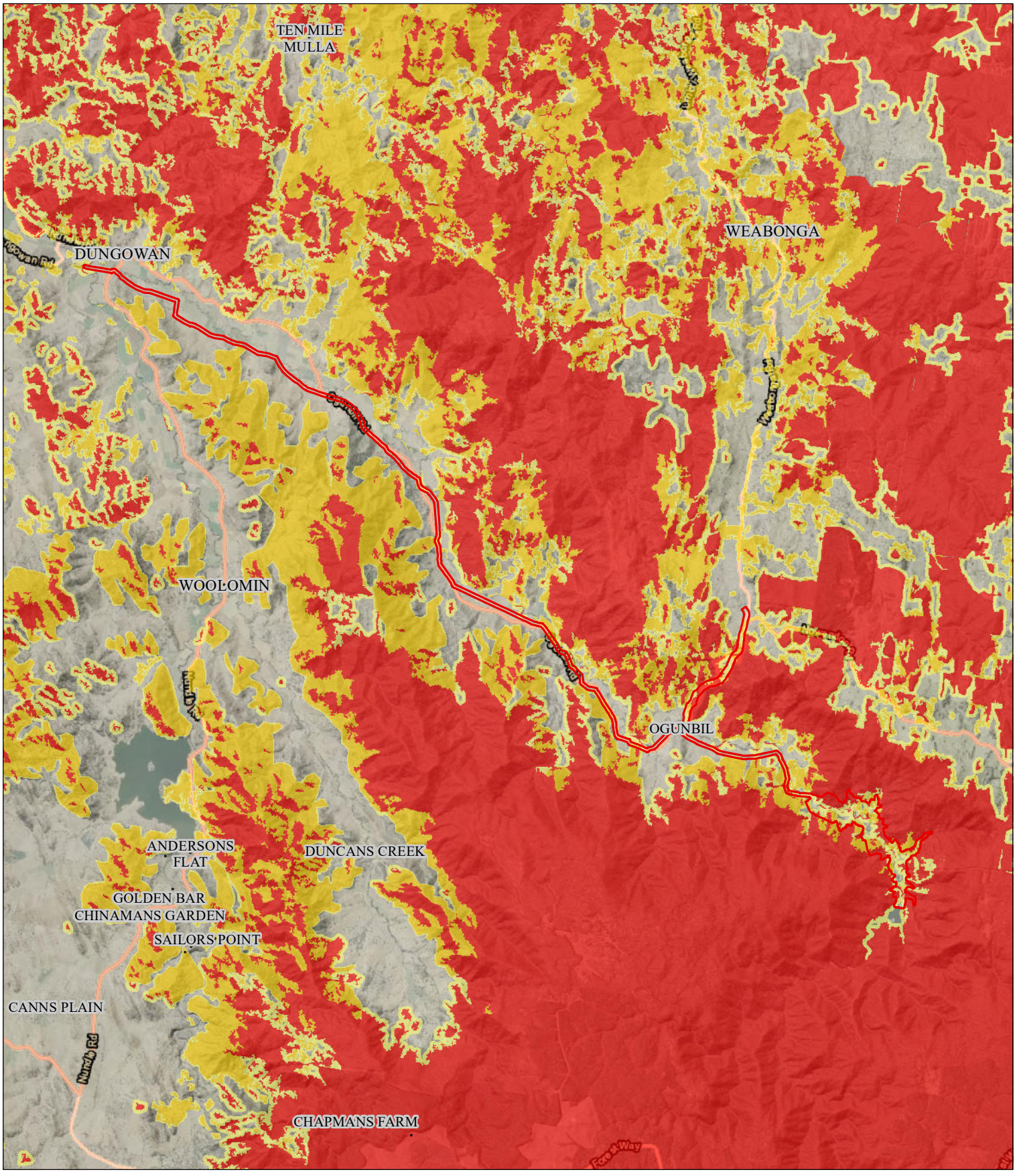
Vegetation Category 1 is considered to be the highest risk for bush fire. It is represented as red on the bush fire prone land map and will be given a 100 m buffer. This vegetation category has the highest combustibility and likelihood of forming fully developed fires including heavy ember production.

Vegetation Category 1 consists of:

- *Areas of forest, woodlands, heaths (tall and short), forested wetlands and timber plantations.*

PBP 2019 (p. 111) notes that grass, whether exotic or native, which is regularly maintained at or below 10 centimetres in height (includes maintained lawns, golf courses, maintained public reserves, parklands, nature strips and commercial nurseries) is regarded as managed land. Managed land is land that has vegetation removed or maintained to limit the spread and impact of bushfire. It may include existing developed land (i.e. residential, commercial or industrial), roads, golf course fairways, playgrounds or sports fields, vineyards, orchards, cultivated ornamental gardens and commercial nurseries. Most common would be gardens and lawns within curtilage of buildings. Areas in the vicinity of relevant structures within the project footprint would be managed to meet the Asset Protection Zone (APZ) requirements outlined in section 7.3.

While the grassland surrounding the project footprint is not designated as being bushfire prone on the BFPL map, it is able to carry a bushfire. As such, the unmanaged grassland areas have been treated within this Bushfire Hazard Assessment as a hazard.



Legend

- Subject Site

Bushfire Prone Land

- Vegetation Buffer
- Vegetation Category 1
- Vegetation Category 2

Figure 7 - Bushfire Prone Land (source NSW RFS)

N

DKGIS

Date: 5/11/2020

0 1 2 4 6

Kilometers

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Dept. Customer Service

6. Assessment methodology

PBP 2019 identifies the methodology to determine Bushfire Attack Levels (BAL) based on calculated radiant heat levels at a site. This assessment is based on mapping of vegetation formations and slope assessment in accordance with PBP 2019. This assessment is based on a site inspection and detailed GIS analysis of the site with accessible public data layers utilising the following resources:

- *Planning for Bushfire Protection* (RFS, 2019)
- Aerial mapping
- Detailed GIS analysis.

Bushfire risk as influenced by fire history (see Figure 6) and future mitigation strategies (e.g. hazard reduction burning) has no bearing on the determination of bushfire protection strategies for future development at sites. This is due to PBP 2019 identifying the assessment of bushfire threat based on vegetation and slope (i.e. hazard and not risk), making the assumption that a fire may occur at a near worst-case scenario and with maximum fuel loads.

In undertaking the assessment, Blackash has followed the methodology outlined in accordance with PBP 2019. The following methodology is from PBP 2019 (p. 80), which has been used to determine the BAL at the site. The process to determine BAL is outlined below:

To Determine Bushfire Attack Level

Step 1: *Determine vegetation formation in all directions around the building to a distance of 140 metres*

Step 2: *Determine the effective slope of the land from the building for a distance of 100 metres*

Step 3: *Determine the relevant FFDI for the council area in which the development is to be undertaken*

Step 4: *Determine the separation distance by measuring from the edge of the unmanaged vegetation to the closest external wall of an asset*

Step 5: *Match the relevant FFDI, appropriate vegetation, distance and effective slope to determine the appropriate BAL using the relevant tables in PBP 2019.*

The vegetation formations (bushfire fuels) and the topography (effective slope) combine to create the bushfire threat that may affect bushfire behaviour at the project site, and which determine the planning and building response of PBP 2019.

6.1. Fire weather

The fire weather is dictated by PBP 2019 and assumes a credible worst-case scenario and an absence of any other mitigating factors relating to aspect or prevailing winds. The FFDI measures the degree of danger of fire in Australian vegetation.

For the purposes of PBP 2019, the FFDI required to be used for development assessment purposes is based on local government boundaries. The project site has a FFDI of 80 as required by the RFS and PBP 2019[2].

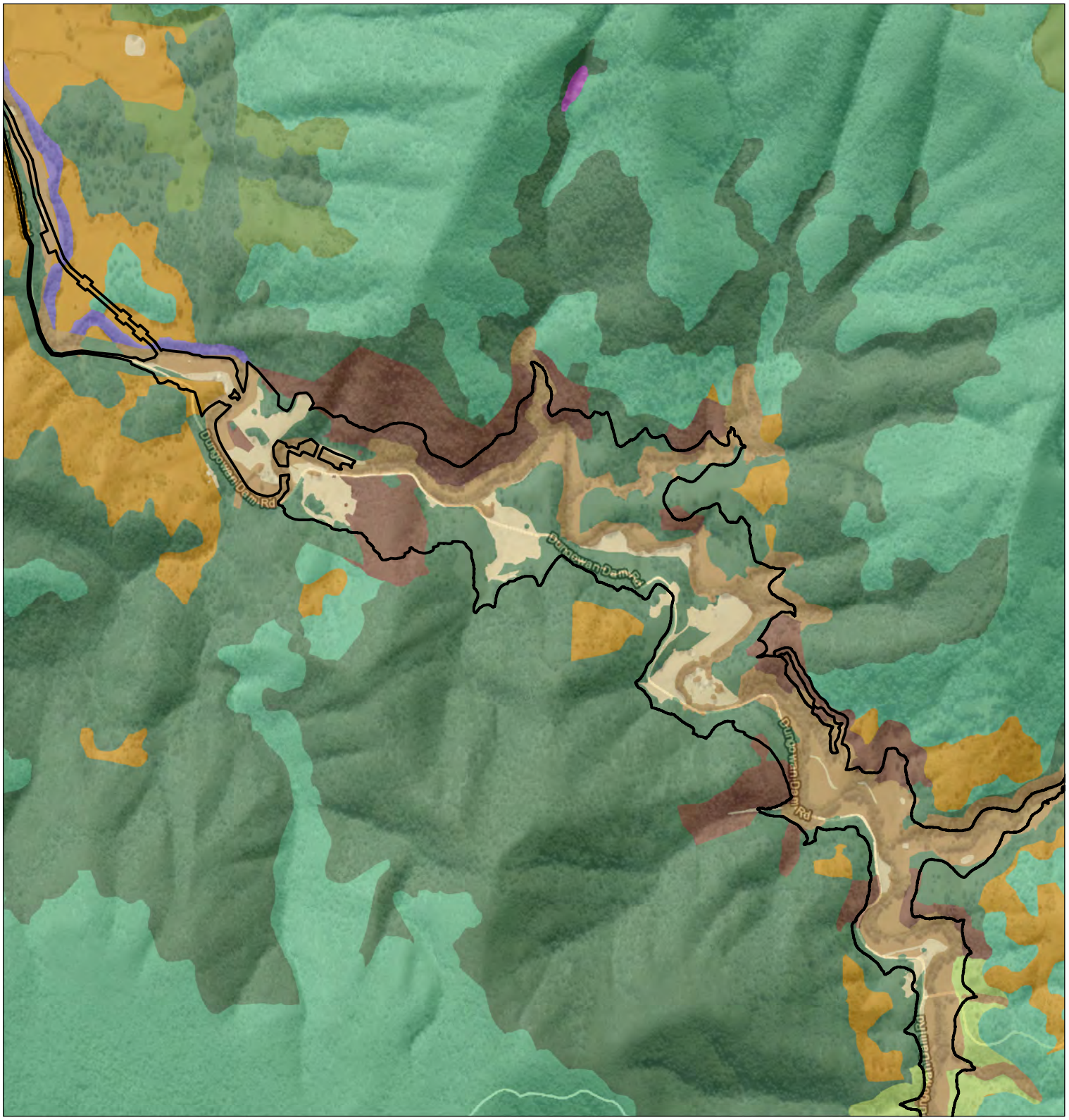
It may be possible that days of higher FFDI may be experienced at the project site. This may result in fire situations where conditions challenge survivability of buildings and their occupants. The framework provided for by PBP 2019 has been used in this assessment.

6.2. Vegetation

Predominant vegetation is classified by structure or formation using the system adopted by David Keith (2004) and by the general description using PBP 2019. Vegetation types give rise to radiant heat and fire behaviour characteristics. The predominant vegetation has been determined for the project over a distance of at least 140 metres in all directions from the project site boundary or key assets on the project site. Where a mix of vegetation types exist, the type providing the greater hazard is said to predominate.

The land to the west of the new Dungowan Dam site (consisting of dam infrastructure, including the temporary camp) is identified as bushfire prone land (see Figure 7) and is made up of a mix of vegetation with the most significant being dry sclerophyll forest, woodland and grassland vegetation (Figure 8). The pipeline runs through developed farmland that has a mixture of grazing and intensive agricultural cropping. Areas for the pipeline are not designated as being BFP land (Figure 7).

[2] https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0007/55285/Local-government-areas-and-FDI.pdf



Legend

- Construction Footprint

Vegetation Formation

- Grassland
- Dry Rainforests
- Dry Sclerophyll Forest (Shrub/grass sub-formation)
- Eastern Riverine Forests
- Forested Wetland
- Grassy Woodlands
- New England Dry Sclerophyll Forests
- North-west Slopes Dry Sclerophyll Woodlands
- Temperate Montane Grasslands
- Western Slopes Grasslands

Figure 8 - Vegetation

N

DKGIS

Date: 27/04/2022

0 125 250 500 750

Meters

Coordinate System: GDA 1994 MGA Zone 56

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6.3. Slope assessment

The slope assessment (Figure 9) for the project has been undertaken in the GIS analysis and is a component of determining the BAL rating.

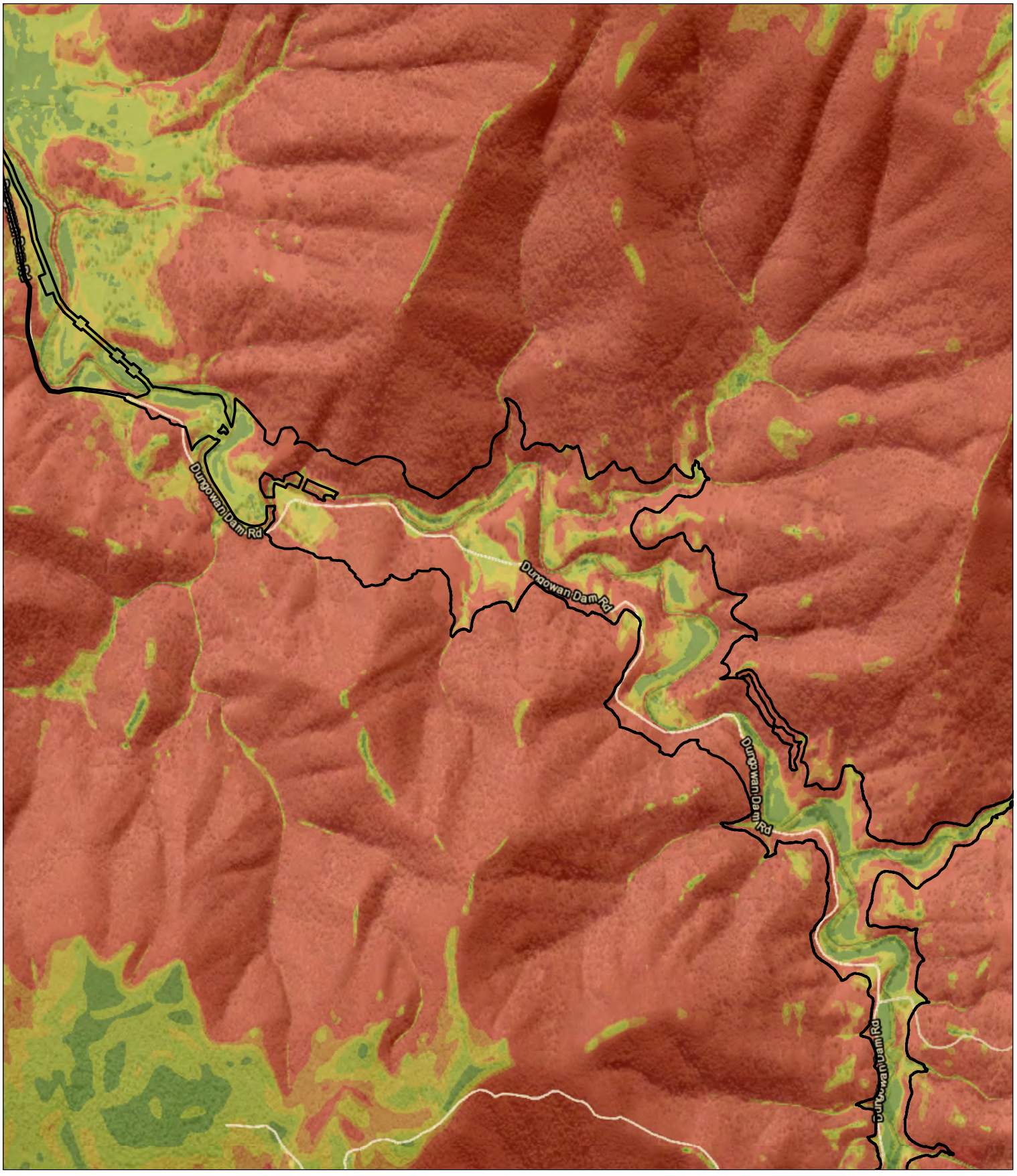
The slope is to be categorised into one of following classes (as required by PBP 2019), relative to the location of the hazard:

- all upslope vegetation (considered 0 degrees)
- >0 to 5 degrees downslope vegetation
- >5 degrees to 10 degrees downslope vegetation
- >10 degrees to 15 degrees downslope vegetation; and
- >15 degrees to 20 degrees downslope vegetation.

The slope of the land under the classified vegetation has a direct influence on the rate of fire spread, the intensity of the fire and the ultimate level of radiant heat flux. The effective slope is the slope of the ground under the hazard (vegetation). It is not the slope between the vegetation and the building (slope located between the asset and vegetation is the site slope).

In identifying the effective slope, it may be found that there are a variety of slopes covering different distances within the vegetation. The effective slope is considered to be the slope under the vegetation, which will most significantly influence the bushfire behaviour for each aspect. This is usually the steepest slope, which has been used in this assessment.

As the project includes new dam infrastructure, which is in the valley floor, the slopes predominantly affecting the site are upslope. The detailed slope is at Figure 9. The pipeline runs along the valley floor and is within flat land.



Legend

- Construction Footprint

Slope

- Flat
- 0-5°
- 5-10°
- 10-15°
- 15-20°
- 20°

Figure 9 - Slope Assessment

N

DKGIS

Date: 27/04/2022

0 125 250 500 750

Meters

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Dept. Customer Service

7. Impact assessment

7.1. Bushfire attack levels

The predominant (direct) threat to the project is from grassfire being driven by north westerly or westerly winds into the project site. The risk posed by grass fires is different to that of fires in other vegetation types. Grass fires burn at a higher intensity and spread more rapidly with a shorter residence time. Embers produced by grass fires are smaller and fewer in number.

The Bushfire Attack Levels (BAL) for the project site have been determined in accordance with PBP 2019 and the Australian Standards for Construction of Buildings in Bushfire Prone Areas (AS3959).

The BAL is a means of measuring the severity of potential exposure to ember attack, radiant heat and direct flame contact (see Table 7.1). The BAL has been assessed (Figure 11) for the new Dungowan dam infrastructure, including the temporary camp for construction. In the Building Code of Australia through AS3959, the BAL is used as the basis for establishing the requirements for construction to improve protection of building elements and to understand the radiant heat exposures for people in the open.

Importantly, for the project, the BAL map (Figure 11) gives an indication of the radiant heat levels likely to affect assets associated with the new Dungowan dam. From this information, the asset owner can make informed decisions about the level of radiant heat and bushfire attack likely to impact on key assets. This bushfire assessment has not undertaken a risk assessment of the assets associated with the construction and operation of the dam.

The BAL levels, the associated radiant heat flux and the predicted bushfire attack mechanisms from AS3959 are shown in Table 7.1. Figure 11 shows the bushfire attack level.

Table 7.1 Bushfire Attack Levels (source AS3959 p. 34)

Bushfire Attack Level	Radiant Heat Flux exposure	Description of predicted bushfire attack and levels of exposure
BAL - Low	NA	There is insufficient risk to warrant specific construction requirements
BAL – 12.5	<12.5kWm^2	Ember attack
BAL – 19	>12.5kWm^2 - <19kWm^2	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing radiant heat flux
BAL – 29	>19kWm^2 - <29kWm^2	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing radiant heat flux

BAL – 40	>29kWm^2 - <40kWm^2	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing radiant heat flux with the increased likelihood of exposure to flames
BAL – Flame Zone	>40kWm^2	Direct exposure to flames from the fire front in addition to radiant heat flux and ember attack.

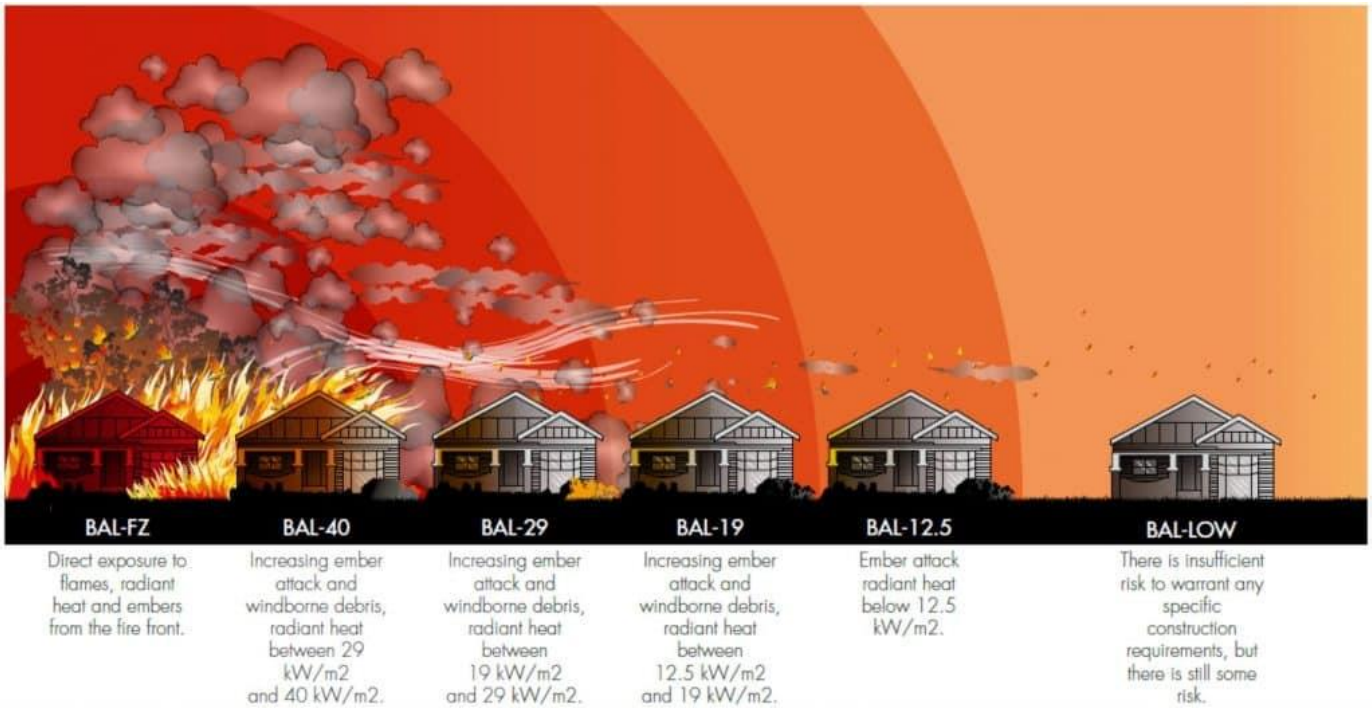
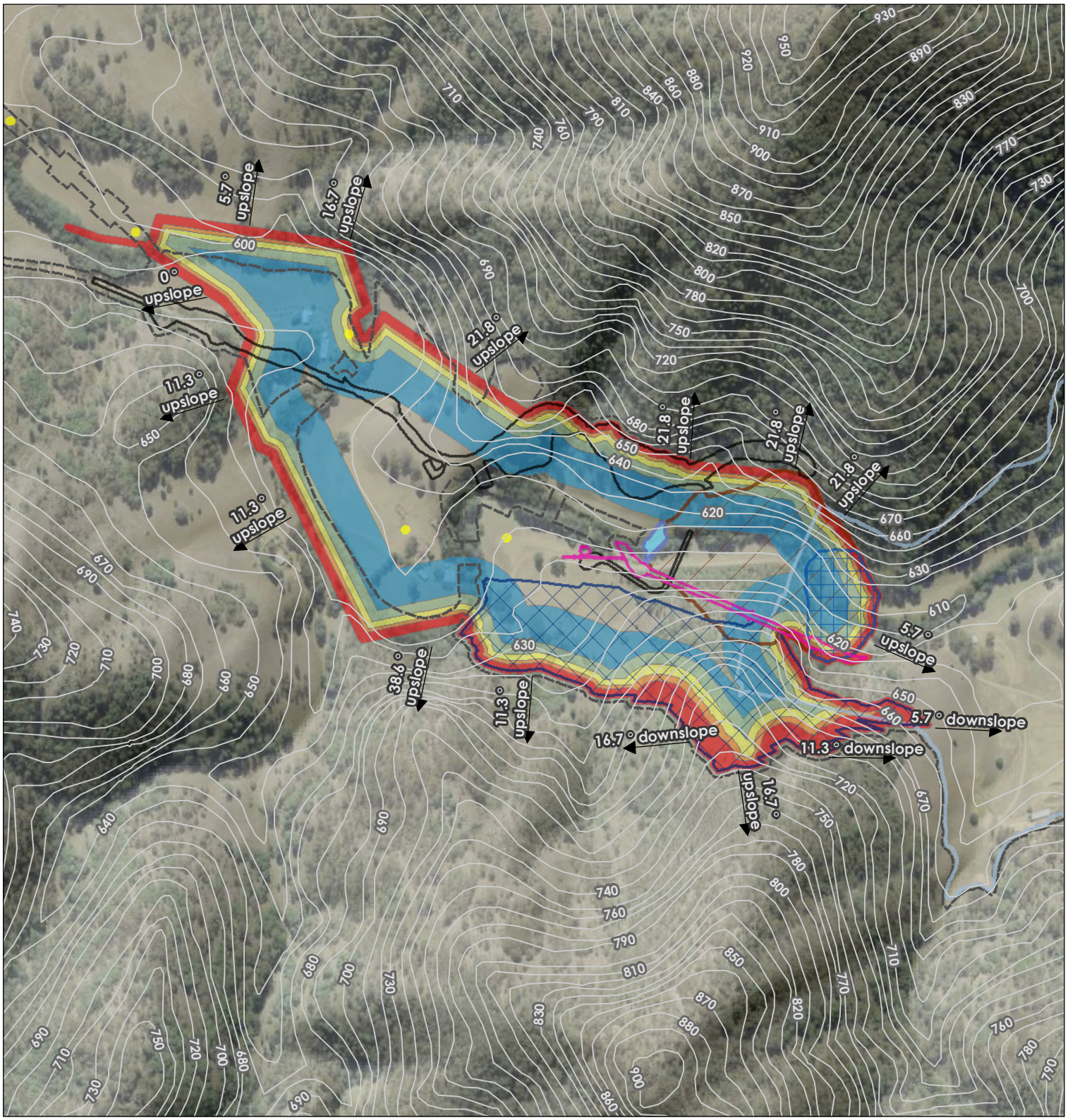


Figure 10 Forms of Bushfire Attack (source cfa.vic.gov.au)

The BAL assessment (Figure 10) has been completed based on the project footprint for the operational parts of the new Dungowan Dam, including the temporary construction camp and likely managed areas of vegetation. The BAL assessment has only been completed for the constructed assets and does not include inundation areas.

The assessed BAL level for the new Dungowan Dam should be used to determine the vulnerability of assets and mitigation strategies that can be utilised to reduce the bushfire threat. The objectives of PBP 2019 (P.10) requires that an appropriate separation between a hazard and buildings which, in combination with other measures, prevent the likely fire spread to buildings. By virtue of the site layout, the broader site is considered a low risk.



Legend

- Contour - 10m
- Air valve
- Diversion works
- Downstream cofferdam
- Embankment
- FSL - 660.2 mAHD
- Road upgrades
- Spillway
- Upstream cofferdam
- Construction Footprint

Bushfire Attack Level (BAL)

- BAL - Flame Zone
- BAL - 40
- BAL - 29
- BAL - 19
- BAL - 12.5

Figure 11 - Bushfire Attack Levels

N

DKGIS

Date: 27/04/2022

0 50 100 200 300

Meters

Coordinate System: GDA 1994 MGA Zone 56

7.2. Overview of bushfire attack mechanisms

Bushfires have long remained a fundamental characteristic of the Australian bush landscape, and likewise Australians have long retained a strong affinity with bush environments. There remain a number of common factors, which are associated with bushfire hazard and events and these include the incidence of fire weather, availability of fuel along with its type, structure and continuity or fragmentation, and the context of development at the bushland interface.

Bushfire attack refers to the various methods (see section 7.1) in which bushfire may impact upon life and property and principally encompass:

- Direct flame contact
- Ember attack
- Radiant heat flux
- Fire-driven wind
- Smoke.

In the progression of a bushfire event, these methods interact either exclusively or in concert and are explained in the following section.

7.2.1. Direct flame contact

Direct flame attack refers to flame contact from the main fire front, where the flame which engulfs burning vegetation is one and the same as that which assumes contact with the building. It is the highest level of bushfire attack as a consequence of direct flame contact from the fire front in addition to heat flux and ember attack.

7.2.2. Ember attack

The convective forces of bushfire raise burning embers into the atmosphere on prevailing winds and deposit them to the ground ahead of the fire front. Typically, ember attack occurs approximately 30 minutes prior to the arrival of the fire front and continues during the impact of the fire front and for several hours afterwards, thus it is the longest lasting impact of bushfire attack.

Ember attack is attack by smoldering or flaming windborne debris that is capable of entering or accumulating around a building, and that may ignite the building or other combustible materials and debris.

In essence, building loss via ember attack relates largely to the vulnerabilities and peculiarities of each building, its distance from hazardous vegetation and whether an occupant (or the like) is present to actively defend it. It is estimated by the CSIRO that approximately 80 to 90 per cent of buildings lost by bushfire are lost as a result of ember attack either in isolation or in combination with radiant heat impact.

7.2.3. Radiant heat flux

Exposure to radiant heat remains one of the leading causes of fatalities associated with bushfire events. Measured in kilowatts per square metre (kWm^2), radiant heat is the heat energy released from the fire front which radiates to the surrounding environment, deteriorating rapidly over distance.

In terms of impact on buildings, radiant heat can pre-heat materials making them more susceptible to ignition, or can cause non-piloted ignition of certain materials if the energy transmitted reaches a threshold level. Radiant heat can also damage building materials such as window glazing, allowing openings into a building through which embers may enter. Radiant heat impact is an especially important factor in building-to-building ignition.

In terms of radiant heat exposure for humans, it can cause pain to unprotected skin in milder situations or life threatening and fatal injury in higher exposure thresholds. The effects of radiant heat are shown in Table 7.2.

Table 7.2 The effects of radiant heat (NSWRFS 2006; Drysdale, 1999; CFA, 2012)

Radiant Heat Flux kW/m^2	Observed Effect
1	Maximum for indefinite skin exposure
3	Hazardous conditions, fire fighters expected to operate for a short period (10 minutes)
4.7	Extreme conditions, fire fighters in protective clothing will feel pain after 60 seconds exposure
6.4	Pain after 8 seconds of skin exposure
7	Likely to be fatal to unprotected person after exposure for several minutes
10	Critical conditions, fire fighters not expected to operate in these conditions although they may be encountered. Considered to be life threatening in less than 60 seconds in protective equipment. Fabrics inside a building could ignite spontaneously with long exposure
12.5 (BAL 12.5)	Volatiles from wood may be ignited by pilot after prolonged exposure. Standard float glass could fail during the passage of a bushfire
16	Blistering of skin after 5 seconds
19 (BAL 19)	Screened float glass could fail during the passage of a bushfire
29 (BAL 29)	Ignition of most timbers without piloted ignition (3 minutes exposure) during the passage of a bushfire. Toughened glass could fail.
40+	Flame zone – exposure to direct flame contact from fire front

7.2.4. Fire driven wind

The convective forces of bushfire typically result in strong to gale force fire-driven winds, which in itself can lead to building damage. The typical effects of fire driven wind include the conveyance of embers, damage from branches and debris hitting the building, as well as direct damage to vulnerable building components such as lifting roofs or roof materials and the damage / breakage of windows.

7.2.5. Smoke

Smoke emission remains a secondary effect of bushfire and is one which is typically not addressed by bushfire assessments. Irrespective, it is important to note the potentially severe impact of smoke emission on the human respiratory system. It can lead to difficulties in breathing, severe coughing, blurred or otherwise compromised vision, and can prove fatal. It is also important to note that toxic smoke can occur during bushfire, particularly where buildings or materials are ignited. With regard to evacuation, it can reduce visibility and create difficulties for particularly vulnerable persons.

7.3. Asset protection zones

An APZ is a buffer zone between a bushfire hazard and an asset. The APZ is managed progressively to minimise fuel loads and reduce potential radiant heat levels, flame, smoke and ember attack. The appropriate APZ distance is based on vegetation type, slope and the nature of the project. The APZ can include roads or land managed to be consistent with APZ standards set out in RFS document Standards for Asset Protection Zones (Standards for APZs).

The APZ provides a fuel-reduced, physical separation between buildings and bushfire hazards, which are a key element in the suite of bushfire measures and dictates the type of construction necessary to mitigate bushfire attack.

It is recommended that the new Dungowan Dam site and temporary construction camp is managed as an APZ. Access roads, carparks, hardstand areas and the dam wall infrastructure are all non-combustible and meet the requirements of an APZ.

Permanent buildings would need to meet the requirements of Australian Standard for Construction of Buildings in Bushfire Prone Areas (AS3959).

The Standards for APZs require extensive modification of vegetation such that an area will not support a bushfire. An APZ is a fuel reduced area surrounding a built asset or structure. An APZ provides:

- a buffer zone between a bushfire hazard and an asset;
- an area of reduced bushfire fuel that allows suppression of fire;

- an area from which backburning by fire fighters may be conducted; and
- an area which allows emergency services access and provides a relatively safe area for firefighters to defend property.

The requirement for an APZ allows for vegetation and planting. However, bushfire fuels are minimised within an APZ. This is so the vegetation within the planned zone does not provide a path for the transfer of fire to the asset either from the ground level or through the tree canopy or ground vegetation. It is noted that vegetation stockpiling should occur entirely within designated construction areas and should not occur within the APZ area.

The *Standards for APZ* requirements include:

- *raking or manual removal of fine fuels. Ground fuels such as fallen leaves, twigs (less than 6 mm in diameter) and bark should be removed on a regular basis*
- *mowing or grazing of grass. Grass needs to be kept short and, where possible, green.*
- *removal or pruning of trees, shrubs and understorey. The control of existing vegetation involves both selective fuel reduction (removal, thinning and pruning) and the retention of vegetation*
- *prune or remove trees so that you do not have a continuous tree canopy leading from the hazard to the asset*
- *separate tree crowns by two to five metres*
- *a canopy should not overhang within two to five metres of a dwelling*
- *native trees and shrubs should be retained as clumps or islands and should maintain a covering of no more than 20% of the area.*

Above ground points not requiring APZs would also need to consider vulnerability to radiant heat and consequence of loss or damage to the asset. The control valves will be located in two above ground buildings along the pipeline to reduce pressure. Control valves would be housed in approximately 8.1 m x 6.4 m x 3.5 m high Colourbond sheds surrounded by security fencing. Areas within the fencing would need to be managed and non-combustible. Radiant heat testing and size of the compounds to reduce radiant heat to tolerable levels will need to be refined when building locations are firmed up and during detailed design work.

7.4. Access

PBP 2019 requires that the location and design of access roads enables safe access and egress for people attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations. All roads within the project site should be a minimum of 5.5 m wide.

A network of existing public roads service the site and surrounds. Dungowan Dam Road is an existing

road servicing the operational Dungowan Dam. This road is gravel and variable width. The following recommendations are provided consistent with PBP 2019 (p. 44) for design specifications for access roads within the dam construction site:

- *Access roads are two-wheel drive, all-weather roads*
- *Minimum 5.5 m carriageway width kerb to kerb*
- *Maximum grades for sealed roads do not exceed 15 degrees and an average grade of not more than 10 degrees or other gradient specified by road design standards, whichever is the lesser gradient*
- *Curves of roads have a minimum inner radius of 6 m*
- *Dead end roads incorporate a minimum 12 m outer radius turning circle, and are clearly sign posted as a dead end*
- *A minimum vertical clearance of 4 m to any overhanging obstructions, including tree branches, is provided.*

7.5. Water Supply

PBP 2019 (p. 47) requires that adequate services of water for the protection of buildings during and after the passage of a bushfire, and to locate gas and electricity so as not to contribute to the risk of fire to a building. The water requirements apply to the construction and operational phase of the project.

The following recommendations regarding water are provided for both the construction and operational phase of the project:

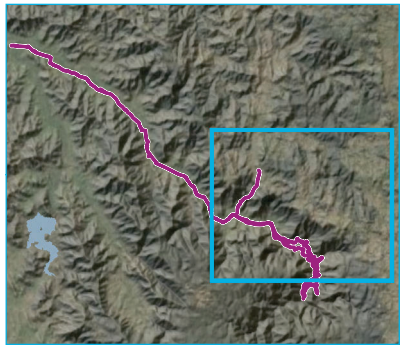
- A minimum static water supply of 20,000 litres should be provided at the project site for firefighting purposes. The firefighting water can be available in single tank or a number of tanks around the site
- A hardened ground surface for truck access is to be supplied up to and within 4 metres of the water source
- A 65 millimetres (mm) metal Storz outlet with a gate or ball valve shall be provided as an outlet on each of the tanks
- The water tank, if located above ground, shall be of a non-combustible material
- Underground tanks shall have an access hole of 200 mm to allow tankers to refill direct from the tank. A hardened ground surface for truck access is to be supplied within 4 metres of the access hole
- All associated above ground fittings to the tank shall be non-combustible.

7.6. Power Utilities

The indicative service provision and relocation for power is shown in Figure 12. PBP 2019 (p. 68) requires that:

> *no part of a tree is closer to a power line than the distance set out in accordance with the specifications in ISSC3 Guideline for Managing Vegetation Near Power Lines.*

The *Guide for the Management of Vegetation in the Vicinity of Electricity Supply Infrastructure*, has been written for the purposes of assisting Network Operators achieve the safety requirements specified in the NSW *Electricity Supply (Safety and Network Management) Regulation 2014* and Australian Standard (AS) *5577 Electricity Network Safety Management Systems* 2013 (AS 5577).



KEY

- Project footprint
- Existing power line to be decommissioned
- Potential upgrade to existing overhead powerline
- Power line footprint

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody
- State forest

Source: EMM (2022); WaterNSW (2021); Esri (2019); DFSI (2017); GA (2013)

0 1 2 km

GDA 1994 MGA Zone 56

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Indicative service provision and relocation

Dungowan Dam and pipeline project
Figure 12

EMM
creating opportunities

The project powerline must meet the requirements of these standards and will be assessed prior to works by the energy provider to ensure compliance with the Network Operator's obligations[3] pertaining to:

- *The safety of the public, and persons near or working on the network including the maintenance of electrical safety clearances*
- *The protection of property and Electricity Assets*
- *Protection of the environment, including protection from ignition of fires; and*
- *Continuity of electricity supply.*

Network Operators must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network are safe. Safety management is a key requirement in all vegetation management activities. AS 5577 states that "the Network Operator cannot delegate its accountability for the safety and integrity of the electricity network" including for vegetation management to any other individual or party[4].

7.7. Evacuation and emergency management

A comprehensive Bushfire Emergency Management and Evacuation Plan should be completed for the construction and operational phase of the project. The bushfire evacuation procedures should be completed in accordance with NSW Rural Fire Service Guide to Developing A Bushfire Emergency Management Plan and meet the requirements of Australian Standard AS 3745-2010 – Planning for Emergencies in facilities. On-site and off-site evacuation procedures should be included.

Procedures should be put in place within the management plan for the project to ensure this risk is highlighted as part of the induction of people on the site and for timely notification of emergency services of fires within the vicinity of the site.

The focus of the Bushfire Emergency Management and Evacuation Plan should be to put in place strategies that do not expose the workers during the construction phase to the effects of bushfire attack and focus on eliminating exposure to bushfire threat. The management team will be able to determine the safest options regarding forecast bushfire risk and providing for early evacuation from the project site if there are fires in the vicinity.

[3] ISSC3 Guide for the Management of Vegetation in the Vicinity of Electricity Assets
[4] P. 11 ISSC3 Guide for the Management of Vegetation in the Vicinity of Electricity Assets

7.8. Defining acceptable risk

In order to understand the nature of bushfire risks posed to the assets, people working within the project site and people using the access road to and from the site, it is critical to contemplate the elements of bushfire risk, which may be relevant.

The tolerable level risk has not been determined by Blackash in this report for the sites. Tolerable risk is the readiness to bear the risk after risk treatment to achieve the overall objectives. To determine the tolerable risk, the proponent should work through the bushfire risk (BAL and corresponding level of radiant heat) currently facing each of the assets within the project site with a discussion about the vulnerability of assets (i.e. tolerable level of radiant heat).

The radiant heat and forms of bushfire attack can be reduced at the sites by increasing the size of the asset protection zone. This may have other knock on effects such as impacts on ecological integrity of adjoining land.

Considering the bushfire risk to the project site, a key risk management activity would be to not expose people to unreasonable risk. The most effective way to reduce loss of life risk is to not occupy the project site on above established thresholds for FFDI and fires within the surrounding landscape. This would need to occur with an understanding of the evacuation time from the sites and potential for fire to burn through the evacuation roads. Planning for bushfire evacuation is an immensely difficult task. Unlike flood and other events, bushfire events are not a 'known quantity'. There is no surety in when or where an ignition may occur, the direction it may spread, the extent of possible ember attack, etc. The impact of smoke and limited visibility in emergency situations, coupled with wind impact, may also lead to issues on the tracks and roads as workers attempt to evacuate.

The evacuation planning for the construction and operational phase would be a crucial mitigation measure. A Bushfire Emergency Management and Evacuation Plan would be prepared in accordance with RFS guidelines.

8. Mitigation and management measures

During the construction and operational phase of the project, measures must be put into place to manage ignition potential on or from the project site and to reduce the risk of fire impacting the site.

The following mitigation and management measures are recommended:

No.	Impact	Management and mitigation measures
BF1	**Bushfire**	The areas within the temporary construction site (see Figure 4) and the operational part of the dam infrastructure would be managed as an APZ. At the commencement of building works for each of the sites, a minimum separation of 24m is provided to unmanaged vegetation. It is recommended that the temporary construction site and the operational part of the dam infrastructure be managed as an APZ as outlined within Appendix 4 of 'Planning for Bushfire Protection 2019' and the NSW Rural Fire Service's document 'Standards for asset protection zones'. It is noted vegetation stockpiles should not form part of an APZ.
BF2	**Bushfire**	Vulnerable buildings and/or critical assets would be constructed to appropriate BAL levels in accordance with the Australian Standard for the *Construction of Buildings in Bushfire Prone Areas* (AS3959). A minimum APZ of 24 metres based on 29Kw of radiant heat should be provided based on the tolerable risk and vulnerability of the asset as determined by Water NSW. APZ are to be in accordance with RFS Standards for Asset Protection Zones.
BF3	**Bushfire**	Access roads within the construction and operational site would be in accordance with *Planning for Bushfire Protection 2019* Table 5.3b where practical including: 1. *Access roads are two-wheel drive, all-weather roads* 2. *Minimum 5.5 m carriageway width kerb to kerb* 3. *Maximum grades for sealed roads do not exceed 15 degrees and an average grade of not more than 10 degrees or other gradient specified by road design standards, whichever is the lesser gradient* 4. *Curves of roads have a minimum inner radius of 6 m* 5. *Dead end roads incorporate a minimum 12 m outer radius turning circle, and are clearly sign posted as a dead end* 6. *A minimum vertical clearance of 4 m to any overhanging obstructions, including tree branches, is provided.*

No.	Impact	Management and mitigation measures
BF4	**Bushfire**	The following water supply and utilities would be installed during construction and maintained during operation of the project in accordance with Planning for Bushfire Protection 2019 Table 5.3c including: • A minimum static water supply of 20,000 litres should be provided at the project site for firefighting purposes. The firefighting water can be available in single tank or a number of tanks around the site • A hardened ground surface for truck access is to be supplied up to and within 4 metres of the water source • A 65 millimetres (mm) metal Storz outlet with a gate or ball valve shall be provided as an outlet on each of the tanks • The water tank, if located above ground, shall be of a non-combustible material • Underground tanks shall have an access hole of 200 mm to allow tankers to refill direct from the tank. A hardened ground surface for truck access is to be supplied within 4 metres of the access hole • All associated above ground fittings to the tank shall be non-combustible.
BF5	**Bushfire**	The Contractor will prepare and implement a Bushfire Management Plan that addresses bushfire risk during construction in accordance with NSW Rural Fire Service Guide to Developing A Bushfire Emergency Management Plan and meet the requirements of Australian Standard AS 3745-2010 – Planning for Emergencies in facilities. At a minimum, the Bushfire Management Plan should specify: The staging of development and the likely bushfire risks at each stage; • An area of land between the development edge and hazardous vegetation consistent with the separation distances specified in AS3959-2009, managed as low threat; • The measures to be undertaken during construction to reduce the likelihood of an ignition or spread of fire due to work associated with the project; and • How access and egress will be provided for construction workers and emergency vehicles. The Bushfire Management Plan must be developed prior to construction and in consultation with the Rural Fire Service

No.	Impact	Management and mitigation measures
BF6	**Bushfire**	All site hot works, earthmoving or hole boring operations generating sparks and use of explosives is prohibited on all days of Severe, Extreme and Catastrophic Fire Danger.
BF7	**Bushfire**	Use of firefighting foam and chemical retardants should be restricted within the catchment area.
BF8	**Bushfire**	No smoking on project site except in designated smoking areas at the construction office site or laydown areas.
BF9	**Bushfire**	Where vegetation waste disposal is required, the residual waste would be pushed into a stockpile within 50 m to 100 m of the clearing area depending on topography. Controlled burning of the stockpiles would then be undertaken. Any pile burn would be provided a hazard reduction certificate by the NSW Rural Fire Service. The pile would be attended at all times by staff for control purposes and conducted in accordance with any specific requirements of the HRC.

9. Conclusion

This Bushfire Risk Assessment has been completed for the Dungowan dam and pipeline project. Bushfire impact is a key consideration to ensure bushfire risk is understood and mitigation measures are implemented to reduce the consequences of any bushfire impacts during the construction and operational phase of the dam. The pipeline has been considered as part of the risk assessment, although, it is a low bushfire risk due to the pipeline being underground.

Above ground points would need to consider vulnerability to radiant heat and consequence of loss or damage to the asset. The control valves will be located in two above ground buildings along the pipeline to reduce pressure. Control valves would be housed in approximately 8.1 m x 6.4 m x 3.5 m high Colourbond sheds surrounded by security fencing. Areas within the fencing would need to be managed and non-combustible. Radiant heat testing and size of the compounds to reduce radiant heat to tolerable levels will need to be refined when building locations are firmed up and during detailed design work.

Critical infrastructure associated with the new Dungowan Dam should be designed in such a way as to minimise the impact of bushfires and ensure that water infrastructure capabilities are not compromised during bushfire emergencies or after the impact of fires within the catchments for the dam. Water quality is a key issue to be managed through effective fuel management within the catchment boundaries.

Bushfire protection measures should be commensurate with the bushfire risk and criticality of the infrastructure. Mitigation measures have been outlined in Section 8. However, detailed risk assessment and vulnerability assessment has not been completed for assets as part of this bushfire risk assessment. The tolerable level of risk needs to be determined in accordance with required management plans and conditions of approval and measures put in place reflecting the level of acceptable bushfire attack on key assets.

The construction phase of the project will require large numbers of workers to be in a relatively remote area that is susceptible to bushfire. Detailed emergency management planning should be completed prior to construction to ensure the safety of workers. The operational phase of the project will have ongoing management requirements to be identified within environmental management plans to reduce the bushfire attack level on key assets. Key aspects for these plans include ensuring water quality in the event that areas of the dam catchment are burnt, or hazard reduced.

This Report is a Bushfire Risk Assessment that addresses the SEARS by assessing the potential impacts associated with bushfire risk and provides the required information for the construction and operation of the project.

Glossary

This section defines those core terms and concepts which are adopted throughout the body of this report.

Term	Definition
Asset Protection Zone (APZ)	A fuel-reduced area surrounding a built asset or structure which provides a buffer zone between a bushfire hazard and an asset. The APZ includes a defendable space within which firefighting operations can be carried out. The size of the required APZ varies with slope, vegetation and FFDI.
Bushfire	A general term used to describe fire in vegetation, includes grass fire.
Bushfire attack mechanisms	The various ways in which a bushfire can impact upon people and property and cause loss or damage. These mechanisms include flame contact, radiant heat exposure, ember attack, fire wind and smoke.
Bushfire Attack Level (BAL)	A means of measuring the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact. The BAL is used as the basis for establishing the requirements for construction to improve protection of building elements and to articulate bushfire risk.
Bushfire Management Committee (BFMC)	A Bushfire Management Committee provides a forum for cooperative and coordinated bushfire management in a local area. The BFMC is responsible for preparing, coordinating, reviewing and monitoring the Bush Fire Risk Management Plan for the Local Government Area. The BFMC consists of a range of stakeholders such as land managers, fire authorities and community organisations.
Bushfire prone land (BFPL)	An area of land that can support a bushfire or is likely to be subject to bushfire attack, as designated on a bushfire prone land map.
Bushfire Hazard	Any vegetation that has the potential to threaten lives, property or the environment.
Bushfire Threat	Potential bushfire exposure of an asset due to the proximity and type of a hazard and the slope on which the hazard is situated.
Forest Fire Danger Index (FFDI)	Measures the degree of danger of fire in Australian forests. The index combines a record of dryness, based on rainfall and evaporation, with meteorological variables for wind speed, temperature and humidity.

Risk	The degree of risk presented by that interaction will depend on the likelihood and consequence of the bushfire occurring. Risk may be defined as the chance of something happening, in a specified period of time that will have an impact on objectives. It is measured in terms of consequences and likelihood.
Risk assessment	A systematic process of evaluating the potential risks that may be involved in a projected activity or undertaking, having regard to factors of likelihood, consequence, vulnerability and tolerability.
Risk-based land use planning	The strategic consideration of natural hazard risk and mitigation in informing strategic land use planning activities.
Hazard	A hazard is any source of potential harm or a situation with a potential to cause loss. A hazard is therefore the source of risk.
Likelihood	The chance of an event occurring. Likelihood may be represented as a statistical probability (such as an Annual exceedance probability), or where this is not possible, it can be represented qualitatively using measures such as 'likely', 'possible' and 'rare'.
Managed land	Land that has vegetation removed or maintained to a level that limits the spread and impact of bushfire. This may include developed land (residential, commercial or industrial), roads, golf course fairways, playgrounds, sports fields, vineyards, orchards, cultivated ornamental gardens and commercial nurseries. Most common will be gardens and lawns within curtilage of buildings. These areas are managed to meet the requirements of an APZ.
Mitigation	The lessening or minimizing of the adverse impacts of a bushfire event. The adverse impacts of bushfire cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures include engineering techniques, retrofitting and hazard-resistant construction as well as on ground works to manage fuel and separate assets from bushland.
Planning for Bushfire Protection 2019 (PBP 2019)	NSW Rural Fire Service publication effective from 1 March 2020 which is applicable to all new development on bushfire prone land in NSW.
Tolerable risk	Organisation's readiness to bear the risk after risk treatment to achieve its objectives.

Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. The degree of susceptibility and resilience of the community and environment to hazards.

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