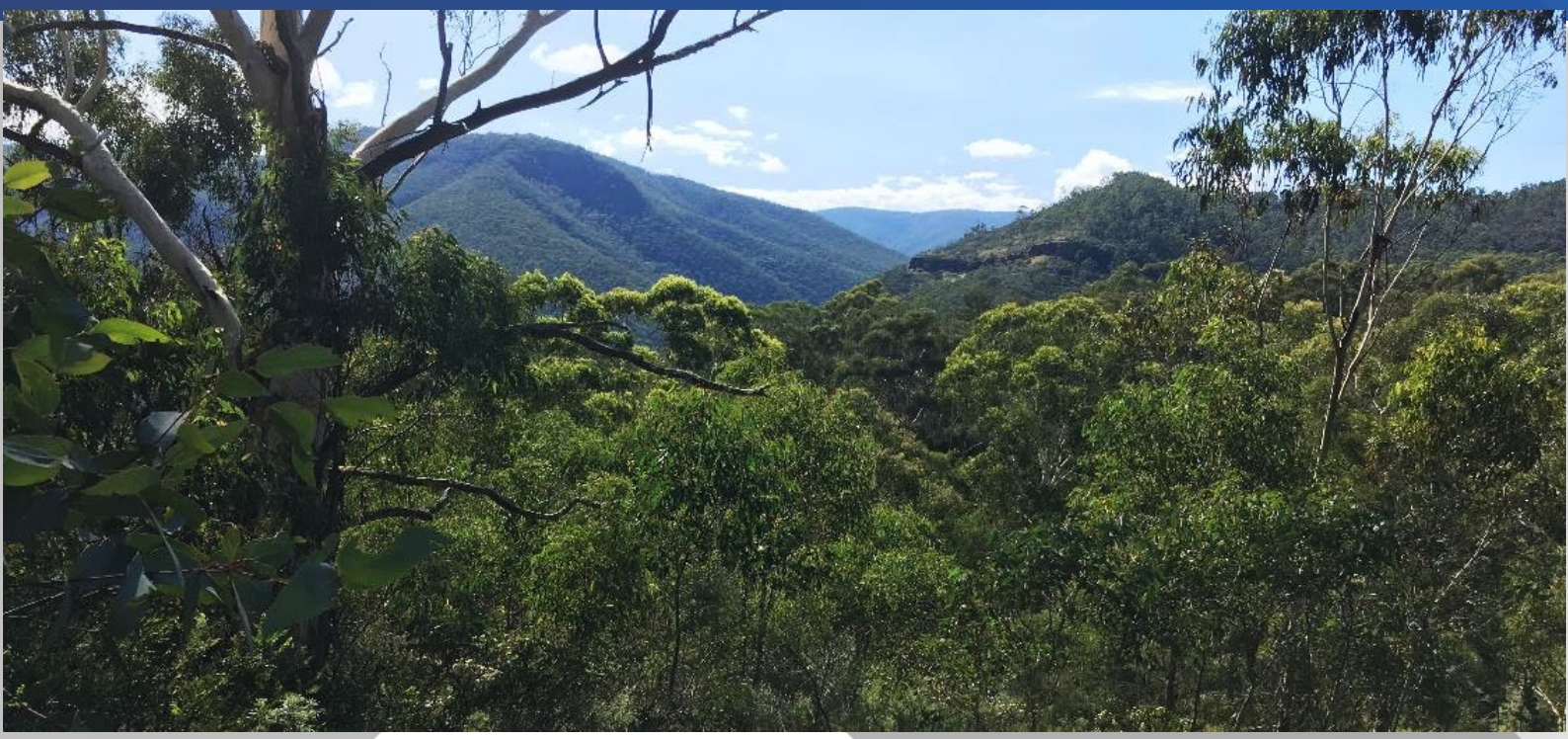
Appendix F Bushfire assessment

Snowy 2.0 Transmission Connection Project

Environmental Impact Assessment

(February 2021)



Snowy 2.0 Transmission Connection Project

Bushfire Assessment Report

Rev 05

December 2020

TransGrid

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Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to assess the bushfire risk of the Snowy 2.0 Transmission Connection Project (the project) and provide recommendations to manage that risk in accordance with the scope of services set out in the contract between Jacobs and TransGrid. That scope of services, as described in this report, was developed with TransGrid.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by TransGrid and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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Users of this Bushfire Assessment Report should note that bushfire behaviour, particularly under extreme fire weather and fuel hazard conditions, can be difficult to predict. As a result, even with appropriate risk controls in place, bushfires may pose extreme risks to personal safety, property and the environment. This Bushfire Assessment Report refers to Neighbourhood Safer Places, evacuation points or other forms of bushfire refuge. *Persons using these locations should be aware that they may still experience extreme conditions and that their safety cannot be absolutely guaranteed.*

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1. Introduction

TransGrid is the manager and operator of the major high-voltage electricity transmission network in New South Wales (NSW) and the Australian Capital Territory (ACT).

TransGrid is seeking approval under Part 5 Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of an overhead transmission connection and substation to enable the grid connection of the Snowy 2.0 pumped hydro generation project (Snowy 2.0).

The Snowy 2.0 Transmission Connection Project (the project) has been declared critical State Significant Infrastructure (SSI) under the *State Environmental Planning Policy (State and Regional Development) 2011*, and is subject to assessment and determination by the Minister for Planning and Public Spaces. This bushfire risk assessment has been developed in support of the Environmental Impact Statement (EIS) for the project.

1.1 Purpose of this technical report

This technical report has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the project on 1 November 2019 by the Planning Secretary of the NSW Department of Planning Industry and Environment (DPIE).

The SEARs relevant to this bushfire risk assessment are presented in **Table 1-1**, along with a reference to where these requirements are addressed in this report.

Table 1-1: Secretary's environmental assessment requirements - Bushfire Risk Assessment

SEARs		Section addressed
Bushfire Risk	An assessment of: any public safety risks, including bushfire and flooding risks;.	**Section 4.** Other public safety risks including flooding are addressed in Chapter 6 of the EIS

This report has been developed following guidance from the NSW Rural Fire Service (NSW RFS), particularly *Planning for Bush Fire Protection* (PBP) (RFS, 2019a), as well as bushfire safety guidance developed by and for NSW electricity network operators.

2. Project description

2.1 Project components

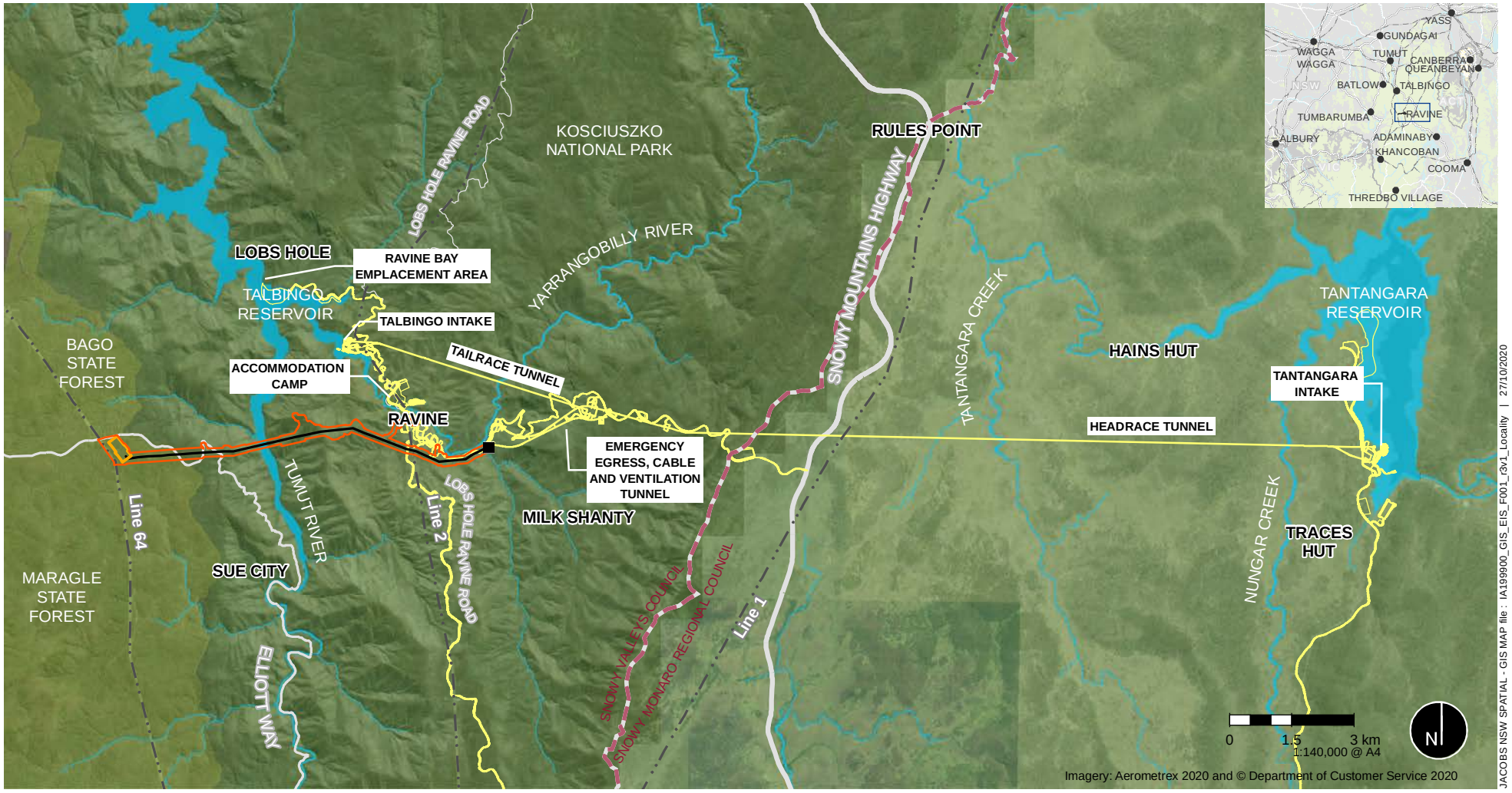
The project would involve the construction and operation of an overhead transmission connection and substation to connect Snowy 2.0 to the National Electricity Market.

The key elements of the project would include:

- A new 500/330 kilovolt (kV) substation located within Bago State Forest and adjacent to TransGrid's existing Line 64, which forms a 330 kV connection between Upper Tumut and Lower Tumut switching stations. The substation would occupy a footprint of approximately 300 metres (m) wide by 600 m long inclusive of an approximate 25 to 45 m wide cleared asset protection zone (APZ) surrounding the switchyard
- Upgrade and widening of an existing access road off Elliott Way to the new substation including the construction of a new driveway into the 330 kV and 500 kV switchyards
- Two new 330 kV overhead double-circuit transmission lines from the Snowy 2.0 cable yard to the new substation:
  - Total length of each line is approximately nine kilometres (km)
  - Located in a corridor ranging in width from approximately 120 m to 200 m
  - Each line would comprise approximately 21 steel lattice structures up to 75 m in height.
- Short overhead 330 kV transmission line connection (approximately 300 m in length) comprising both steel lattice structures and pole structures as required between the substation and Line 64
- Construction of approximately 10 km of new access tracks (Option A) or 8 km (Option B) to the transmission structures and upgrade to existing access tracks where required. Option A minimises disturbance within a mapped high risk naturally occurring asbestos (NOA) zone. The access tracks would remain following the completion of construction to service ongoing maintenance activities along the transmission lines
- Establishment of a helipad (approximately 30 m wide by 30 m long) to support the transmission line construction activities carried out at higher elevations and steep terrain along Sheep Station Ridge
- Ancillary activities, including the establishment of tensioning and pulling sites for conductor and earth wire stringing, crane pads, site compounds, and equipment laydown areas.

The project location and key components of the project are shown **Figure 2-1** and in **Figure 2-2** respectively.

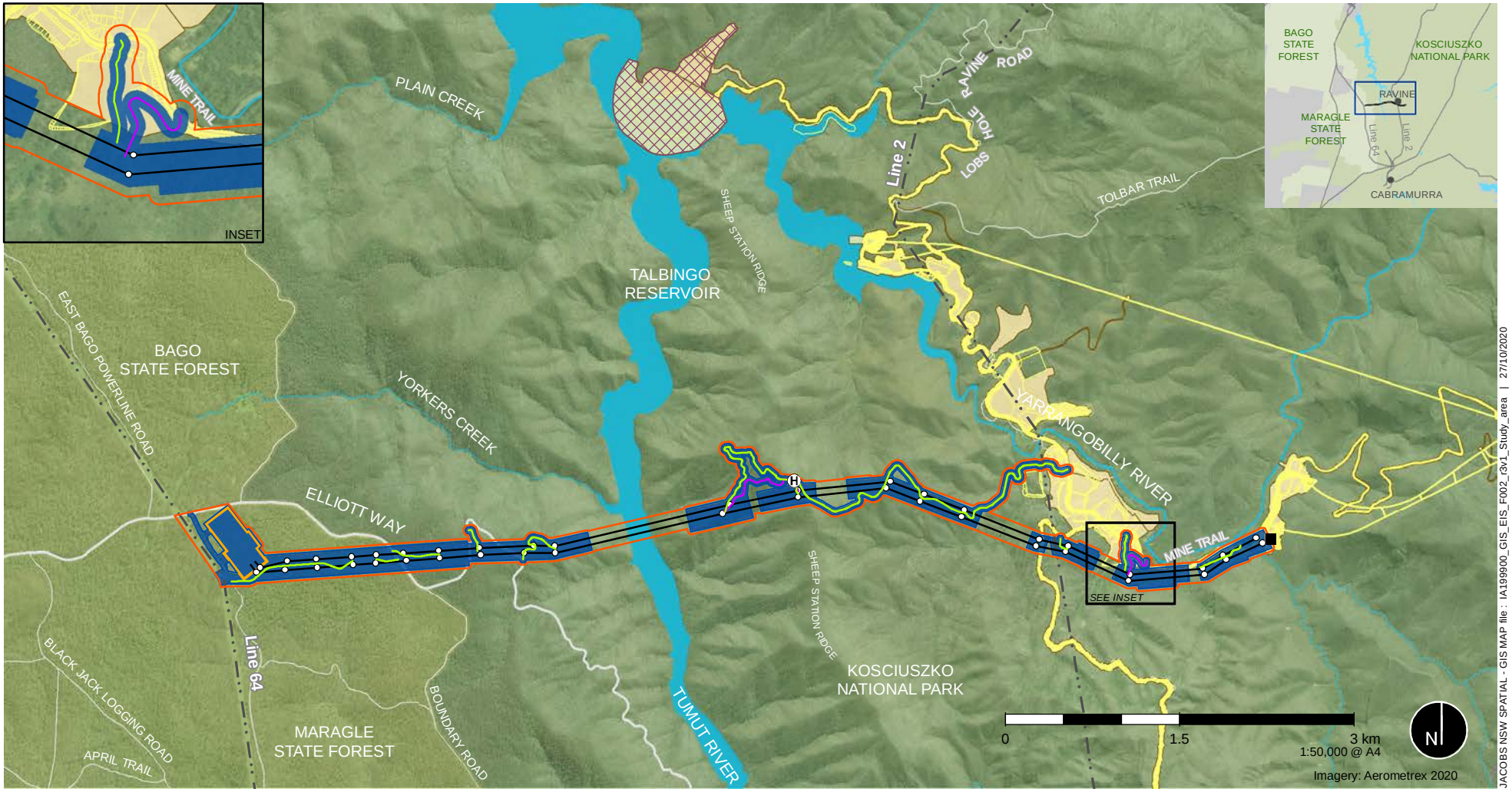
A complete project description which includes a consolidated summary and discussion of the construction and operation of the project is provided in Chapter 5 of the EIS.



Project area
Proposed transmission line
Proposed 500kV substation
Snowy 2.0 cable yard
Snowy 2.0 element
Electricity transmission line
Local Government boundary
Waterway
Water body
State forest
NPWS estate

Figure 2-1 | Project location

Data source:
Jacobs 2020, TransGrid, EMM 2020
© Department Finance, Services and Innovation 2018



- Project area
- Disturbance area
- Proposed 500kV substation
- Potential helipad location
- Proposed structure
- Proposed transmission line
- Proposed access track - Option A
- Proposed access track - Option B
- Snowy 2.0 cable yard
- Snowy 2.0 element
- Ravine Bay Emplacement Area
- Snowy 2.0 Disturbance footprint
- Electricity transmission line
- Waterway
- Water body
- State forest
- NPWS estate

Figure 2-2 | Project overview

Data source:
Jacobs 2020, TransGrid, EMM 2020,

2.2 Project location

The eastern extent of the project is defined by the location of the Snowy 2.0 cable yard at Lobs Hole in Kosciuszko National Park (KNP). The cable yard serves as the transition point between the underground cables carrying electricity generated by Snowy 2.0 to the overhead transmission connection. The cable yard forms part of Snowy 2.0.

From the cable yard, the transmission connection extends west through KNP and up Sheep Station Ridge which is characterised by steep, mountainous terrain before traversing Talbingo Reservoir. The transmission connection then continues west, passing over Elliott Way at three locations before entering Bago State Forest to the substation site. The location of the project is shown in **Figure 2-1**.

2.3 Project area

For the purposes of predicting environmental impacts of the project, a disturbance area has been defined. The disturbance area encompasses the extent of physical disturbance likely to be required to accommodate construction activities and infrastructure needed to build the overhead transmission line, the permanent substation and access roads and vegetation clearing along the transmission corridor.

A broader project area has also been defined. The project area represents the limits of where disturbance may occur during construction to allow for flexibility for the final siting of project infrastructure. Final siting of the infrastructure (i.e. the disturbance area) can move within the assessed project area subject to recommended environmental management measures and provided it does not exceed the limits defined by the project area.

The project traverses Talbingo Reservoir, which naturally splits the project area into two. When defining the area of works, the terms 'project area east' and 'project area west' have been used where required for the purpose of the EIS. These are defined as follows:

- **Project area east:** includes the project area and existing surrounding access roads in the area east of Talbingo Reservoir
- **Project area west:** includes the project area and existing surrounding access roads in the area west of Talbingo Reservoir.

The project area and disturbance area are shown in **Figure 2-2**.

2.4 Construction activities

The construction works would commence with the construction of the access tracks to the substation and transmission structure locations. Construction of the helipad is also expected to commence in the initial stages. Once suitable access has been established, construction of the substation and transmission line would commence and occur concurrently. A summary of the construction activities is provided in **Table 2-1**.

Table 2-1: Summary of construction activities

Construction activity	Description
Pre-construction, site establishment and vegetation clearance	▪ Site mobilisation once relevant approvals have been granted, property acquisitions have been finalised with Forestry Corporation of NSW (FCNSW) and National Parks and Wildlife Service (NPWS) and agreements with construction contractors has been achieved ▪ Surveying and marking out the approved disturbance area and any environmental avoidance areas ▪ Installation of appropriate stormwater and diversion drainage and erosion and sedimentation control works prior to ground disturbance and vegetation clearing ▪ Inform recreational users of KNP, Bago State Forest and Talbingo Reservoir of the construction activities, the extent of work areas and the locations of environmental exclusion areas with project notifications, including warning signs of construction activities and notifications of access restrictions ▪ Establishment of the construction compound and equipment laydown areas at the substation site and at Lobs Hole*.
Access tracks	▪ Vegetation clearing within the approved corridor. This is expected to be carried out both manually in the areas of steeper slopes and machine clearing where access can be safely achieved ▪ Grubbing and bulk earthworks (cut and fill) using an excavator ▪ Installation of suitable drainage structures and sediment retention basins where required ▪ Laying and compaction of a suitable rock aggregate/road base ▪ Grading and/or reshaping of existing tracks where required, within the existing access track width (no road widening) ▪ Minor excavations followed by laying and compaction of crushed rock or gravel, to improve the existing track surface and drainage.
Substation	▪ Vegetation clearing across the substation site and surrounding APZ. This would involve the stripping and stockpiling of topsoil for later use. Vegetation clearing is expected to be carried out utilising a bulldozer equipment with a tree pusher, however would be confirmed in consultation with FCNSW ▪ Establishment of a site compound and laydown area within the cleared APZ. The site compound would be in place throughout the construction period and is expected to contain a demountable office, meal room, and toilet/shower facilities, equipment laydown areas, vehicle and equipment storage, maintenance sheds, chemical/fuel stores and stockpile areas ▪ Minor earthworks to establish the site amenities; which would include cut and fill to establish a level area for the site facilities and temporary storage areas and establishment of the permanent site access road ▪ Earthworks: - Excavation works to remove excess material, provide a level surface, and create the required trenches for drainage, earthing, and electrical conduits. Some spoil from the excavation may be reused on site for filling and compaction (including benching areas of the site where required). Excavation works would be carried out using equipment such as excavators, dozers and crushing plant. Furthermore, depending on the underlying geology, blasting may be required to facilitate the break-up of rock, should it be present - Bulk earthworks to establish the level surface for the substation bench - Approximately 11,300 cubic metres of excess spoil would be generated from the levelling of the substation site and construction of the access road. Any soil which cannot be reused onsite as fill material, landscaping or other means would be disposed of off-site at a suitably licenced facility and/or at a location(s) as agreed with FCNSW - Where excavated spoil is not appropriate for reuse on site, additional spoil would be imported to site. ▪ Civil and building works: - Civil works involving the establishment of concrete footings for the high voltage equipment and buildings, construction of stormwater drainage and oil containment infrastructure and cable trenches and subsurface cables - Construction of onsite buildings (e.g. control room) and services installed including general lighting, power and ventilation.

Construction activity	Description
Transmission corridor	▪ Vegetation clearing within the approved transmission corridor where the overhead conductors would not meet safe clearance heights above the underlying vegetation ▪ Grading and/or reshaping of existing access tracks where required ▪ Vegetation clearing and bulk earthworks to establish the level helipad ▪ Establishment of the transmission structure work sites involving: - Clearing of an approximate 40 m by 60 m area around each transmission structure location to allow for the laydown of materials and equipment and facilitate access for vehicles, plant and machinery during structure construction - Bulk earthworks (cut and fill) to establish level construction benches within the worksite to allow for the safe operation of plant and equipment (namely elevated works platforms and cranes) during structure construction - Geotechnical investigation works using a mobile drill rig at each structure location to determine the most appropriate footing design - Bulk earthworks and excavations to establish the structure footings involving the installation of steel framework and backfilling with concrete or pile type footings involving boring four boreholes at each structure leg location and backfilling with concrete - Steel lattice structures would be transported to each structure location via heavy vehicle in parts and assembled on site using mobile cranes ▪ Stringing of conductor and overhead earth wire which would involve: - Establishment of level tensioning and pulling sites within the approximate 40 m by 60 m structure worksite or at suitable locations within the transmission corridor - Attachment of sheaves (or pulleys) to the top of the structures in readiness for stringing work using an elevated work platform - Pulling out a light weight draw wire across the section of line being strung using a drone or, vehicle/machine (such as dozer), followed by the placement of the draw wire through the sheaves - Attachment of the draw wire to the earth wire or conductor drum (depending on which is being strung) and pulling it through the sheaves under tension using specialised tensioning and pulling equipment - Termination of the conductor/earth wire at each end clipping it into position followed by the removal of the sheaves.
Commissioning	▪ Testing of all high voltage equipment at the substation and ensuring all protection, control and metering equipment is operating correctly ▪ Completion of all necessary cut-in works to Line 64 and relevant testing undertaken ▪ Placement of the new transmission lines and substation into standby in readiness for Snowy 2.0 to be completed ▪ Once Snowy 2.0 becomes operational, energisation of the high voltage equipment and the project placed into service.
Rehabilitation and demobilisation	▪ Removal of all non-permanent infrastructure and equipment from the work sites and site compounds ▪ Decommissioning and dismantling of the site compounds at the substation and Lobs Hole ▪ Site stabilisation and landscaping involving: - Stabilisation of exposed areas and slopes - Installation and maintenance of erosion and sediment controls at the work sites to manage impacts post-construction - Seeding soil slopes to assist stabilisation - Planting vegetation on any higher risk slopes - Mulching of stabilised and revegetated areas where required.

*The site compound at Lobs Hole would be located within the approved disturbance footprint of Snowy 2.0.

2.4.1 Construction staging and timing

Construction of the project is anticipated to commence in early 2022 and take approximately 39 months to complete. Estimated timing for the main construction activities is set out in **Table 2-2**. Further details on the estimated timing and staging of the main project activities is described in Section 5.3 of the EIS.

Table 2-2: Indicative timing for the construction of key project components

Construction works	**2022**				**2023**				**2024**				**2025**
Quarter	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**
Access tracks, roads and helipad													
330 kV Switchyard													
500 kV Substation													
Transmission connection													

2.4.2 Construction working hours

Given the isolated location and the construction of Snowy 2.0 occurring in parallel, construction works are expected to be carried out 12 hours per day, seven days per week between the hours of 6 am and 6 pm.

2.5 Operation and maintenance

The substation and transmission connection would be inspected by field staff on a regular basis. Key activities undertaken during operation would include:

- Regular inspection and maintenance of electrical equipment at the substation including structural integrity of all footings and support structures
- General inspection and maintenance of other components within the substation including the stormwater management system, fire detection system, onsite buildings and drainage infrastructure
- Regular inspection and maintenance of the transmission structures, footings, fittings, conductors and overhead earth wires
- Vegetation removal and trimming along the transmission corridor and APZ surrounding the substation to maintain appropriate clearances between ground vegetation and the overhead transmission lines and around the substation to manage bushfire risk
- Removal of trees which have the potential to strike the overhead conductors if they were to fall (referred to as hazard trees) as required.

It is expected that only light vehicles and small to medium plant would need to access the substation site and the transmission corridor for these activities. The substation would not accommodate full-time staff or contractors, and the regular collection of waste would not be required. Any waste generated during operation of the substation would be minimal and disposed of on an 'as need' basis.

2.6 Other relevant technical information

2.6.1 Substation

The substation is expected to occupy an area of about 300 m x 600 m inclusive of an APZ and laydown areas for materials and equipment during construction. Some laydown of equipment and materials may also occur within the disturbance area adjoining the substation/APZ boundary.

The substation switchyard would generally be orientated in a north-south direction and would be set back approximately 70 m from Elliott Way. The boundary of the APZ would extend to the road corridor of Elliott Way on the north east side.

The substation switchyard would comprise a level benched area on which all high voltage and ancillary substation equipment and buildings would be located. This would generally include (but not be limited to):

- Up to three 500/330 kV 3-phase or up to nine single-phase transformers to convert the voltage from 330 kV to 550 kV to support future 500 kV transmission line augmentations to TransGrid's network
- Approximately three ancillary transformers to provide low voltage supplies
- Two 500 kV reactors
- 330 kV and 500 kV switchbays
- Onsite buildings to house substation controls, secondary systems equipment and amenities
- Oil containment and stormwater system (including bunding and containment tank(s))
- Lightning masts
- Steel gantries
- Security fencing.

The indicative substation layout is shown in **Figure 2-3.**

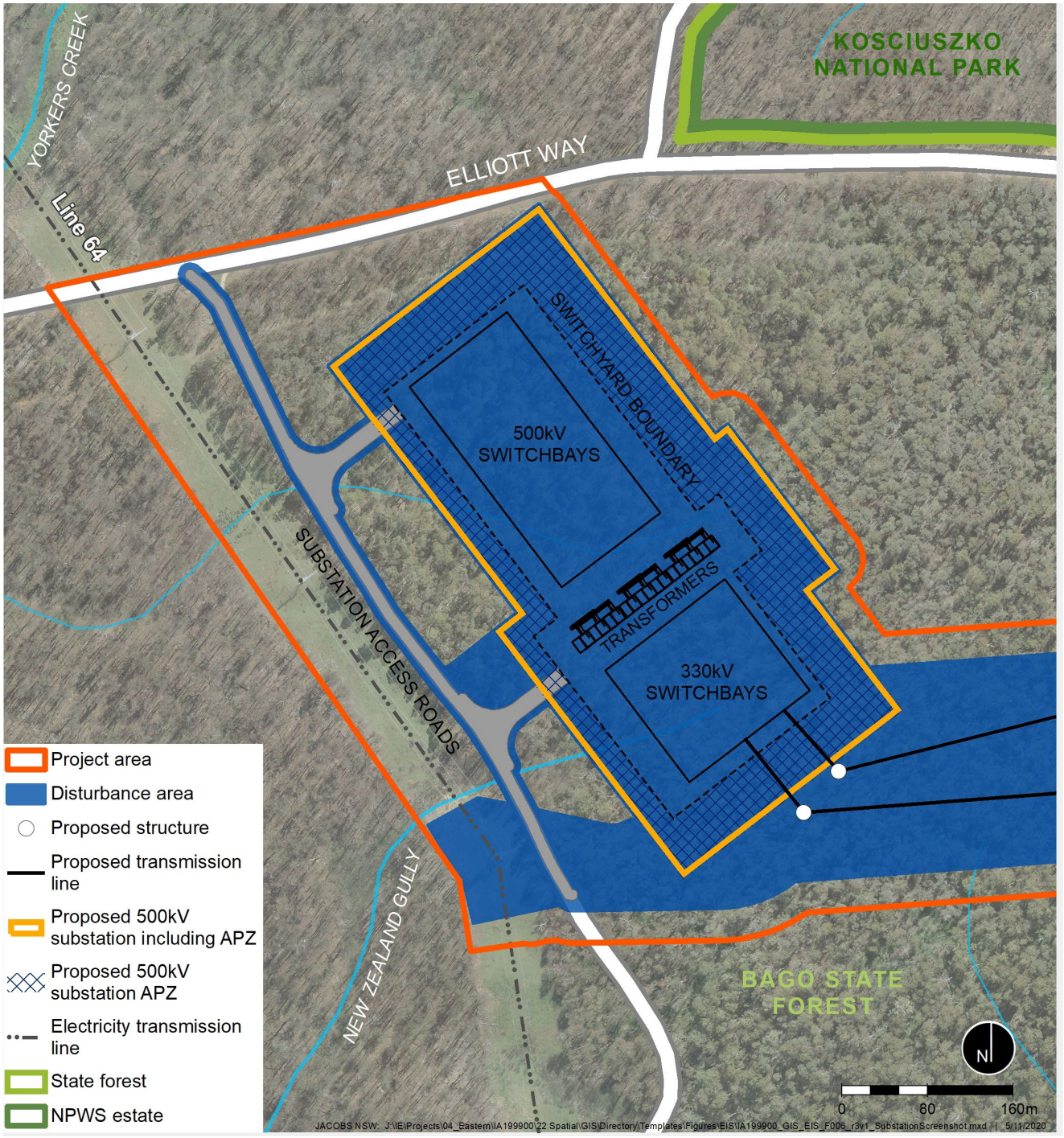


Figure 2-3: Indicative substation layout

2.6.2 Transmission line connection

2.6.2.1 Transmission line structures

Two 330 kV double-circuit transmission lines would be constructed from the Snowy 2.0 cable yard to the new substation and would be located side-by-side. The cable yard is the distribution and transition point from where electricity generated from the Snowy 2.0 underground power station complex would transition from underground to overhead.

Each transmission line would comprise approximately 21 steel lattice structures (approximately 42 in total). Each structure would be up to 75 m in height supporting two circuits comprising up to twelve conductors and a two overhead earth wires and/or optical ground wires (OPGW). The transmission structures supporting each double-circuit transmission line would generally be located adjacent to each other and supported at ground level on a combination of concrete pile, rock anchor and mass concrete style footings.

Geotechnical investigation works would be carried out at each structure to verify the type of footing that would be required. From the last structures at the western extent, the overhead conductors would enter the substation and connect to the substation gantry, which would then connect into the relevant 330 kV switchbays.

From the substation, an approximate 300 m long 330 kV double circuit overhead connection would be constructed to cut into Line 64. This short connection would comprise both steel lattice structures and concrete or steel pole structures as required. The existing overhead earth wire on Line 64 does not meet the required rating once the project becomes operational.

Due to the location of the transmission lines in an alpine area, the structures would be designed to handle ice and snow loads in addition to conventional structure loading requirements. The distance between structures would be designed to manage the sag and swing movement of suspended conductors.

To protect the transmission lines in the event of a lightning strike, adequate earthing controls would be installed as outlined in **Table 2-3**.

Table 2-3: Transmission line earthing

Earthing Component	Description
Earthing	Each structure would require earthing connections to 'ground' the structure in the event of a lightning strike. The fixtures would consist of earthing strips and earthing stakes consisting of galvanized steel or copper depending on the soil conditions. The earthing strips would be buried horizontally, just below the ground surface while earthing stakes would extend down vertically into the soil. Each structure would have one earthing fixture per leg (four in total).
Overhead earth wires	Each transmission line would have two earth wires strung along the top of each structure to provide protection to the conductors in the event of a lightning strike. The earth wires would consist of one standard ground wire and one OPGW. The OPGW would serve the dual purpose of protecting the line in the event of a lightning strike, whilst also providing a communications link between the Snowy 2.0 cable yard and the substation to aid in the monitoring and protection of the line. The earth wires would consist of an aluminium conductor steel reinforced line with a diameter of 16 to 18 mm.

2.6.2.2 Construction corridor and easement

The transmission lines would be located within an easement which would provide a right of access for TransGrid to construct, operate and maintain the transmission lines. The terms of the easements would be negotiated with NPWS and FCNSW as part of the property acquisition process. The final easement would be surveyed following the completion of construction.

Easements are sized to ensure standard safety clearances under high wind conditions, provide an area where vegetation heights can be controlled and provide ease of access for ongoing maintenance and repairs.

Vegetation with a potential mature height that could infringe upon the safe clearance distances below the height of the lowest conductor and vegetation within the blowout zone would need to be cleared. Any trees adjoining the transmission corridor which have the potential to strike the conductor in the event of failure (referred to as hazard trees), would also need to be cleared.

With consideration to the transmission connection concept design, Light Detection and Ranging (LIDAR) analysis was performed to determine the zones of vegetation clearance encompassing vegetation along the transmission corridor, vegetation within the conductor blowout zone and hazard trees. This determined a worst-case variable transmission corridor width ranging from approximately 120 m to 200 m. The vegetation clearing zones are captured in the project disturbance area as shown in **Figure 2-2**.

Further refinement of the transmission corridor including vegetation clearing areas is expected to occur during detailed design, which would further guide the permanent easement width along the extent of the transmission connection following the completion of construction.

Ensuring the clearances are achieved is critical in managing the risk of bushfire, ensuring public safety and maintaining system reliability.

3. Legislative and policy requirements

Legislation applicable to the bushfire management of this project is outlined in this section.

3.1 NSW legislation

3.1.1 Electricity Supply Act 1995

The NSW *Electricity Supply Act 1995* (ESA) requires network operators to take *appropriate action* to ensure public safety. This includes infrastructure considered to be a potential cause of bushfire. 'Appropriate action' can include modifying the infrastructure, removing risky structures/items in proximity to the infrastructure, and trimming/removing vegetation. Bushfire prevention works on aerial consumer mains required under Section 53 of this Act supersede environmental planning instruments including approval or consent requirements under other Acts (including EP&A Act, *Biodiversity Conservation Act 2016*, *Local Land Services Act 2013* (Part 5A), *National Parks and Wildlife Act 1974* (NPW Act). However, this does not apply to vegetation in the vicinity transmission lines in protected areas, such as national parks (Section 48).

3.1.2 Electricity Supply (Safety and Network Management) Regulation 2014

The *Electricity Supply (Safety and Network Management) Regulation 2014* (ES(SNM) Regulation) requires a network operator to take all reasonable steps to ensure that all aspects of its network are safe. This includes preventing network assets from igniting bushfires. Bushfire risk management must be part of an operator's safety management system.

3.1.3 Environmental Planning and Assessment Act 1979

The EP&A Act requires that any development on bushfire-prone land (BPL) for any purpose complies with PBP (NSW RFS, 2019a; see **section 3.2**). State significant infrastructure is exempt from this requirement. Councils maintain and update maps of BPL in their region.

3.1.4 National Parks and Wildlife Act 1974

The NPW Act is in place to conserve natural and cultural values. Fire management is a mandated consideration for land protected under the Act. Certain protections at reserved sites (e.g. of Aboriginal cultural significance) are waived, if necessary, to respond to bushfires or undertake fuel hazard reduction, in line with the *Rural Fires Act 1997*.

3.1.5 Rural Fires Act 1997

The objectives of the *Rural Fires Act 1997* are to prevent bushfires and protect people, built assets and natural assets from fire damage. The Act provides for the designation of Neighbourhood Safer Places, where people may find shelter from a bushfire. It provides for the designation and maintenance of fire trails.

The Act states that it is the duty of public authorities, land owners and occupiers to take all notified and practical steps to prevent ignition and minimise spread on their land. Trees that are reasonably necessary for protection of threatened species may be retained in fire breaks. Permits are required to light fires for bushfire fuel hazard reduction or to clear fire breaks. The Act reiterates that certain instruments under the EP&A Act, NPW Act, *Local Government Act 1993, Biodiversity Conservation Act 2016* and the *Local Land Services Act 2013* do not apply when responding to fire emergencies.

The Act declares the bushfire danger period to run from October to March (inclusive), which can be modified by the NSW RFS. Total fire bans (TOBANs) may be issued by the Minister in the interests of public safety.

Under the Act, network operators are public authorities and therefore have the associated rights and responsibilities.

3.1.6 Work Health and Safety Act 2011

The Commonwealth *Work Health and Safety Act 2011* (and state-based legislation, the NSW *Work Health and Safety Act 2011*) provides a national framework for protection of the health and safety of people at work, and those who may be affected by such work. Under the Act, persons conducting a business or undertaking have the primary responsibility to ensure (so far as reasonably practicable) the safety of workers, and the general public, at a workplace. This includes ensuring, so far as reasonably practicable, the safety of workers and the general public during construction for the project and operation of the substation and transmission line.

3.2 NSW guidelines

3.2.1 Planning for Bush Fire Protection

As designated critical state significant infrastructure, the project is exempt from the requirement under the EP&A Act to comply with PBP. However, the level of bushfire risk to and from the project means PBP should inform the bushfire management of the project.

PBP (NSW RFS, 2019a) seeks to provide for human safety (including fire responders) during bushfire events and minimise the effects of bushfires on property; while considering development potential, site characteristics and environmental protection. It is underpinned by several principles:

- *Bushfire protection measures:* preparations which assist building survival during bushfires and contribute to the safety of fire responders and members of the public located within a development on BPL. They may include any combination of the following: APZs, construction, siting, design, access, water and other utilities, landscaping, and emergency planning
- *Risk:* protection measures are proportional to the threat or risk bushfires pose to a development. Note that regardless of any setbacks or protection measures, the safety of a development in a bushfire-prone area cannot be entirely guaranteed
- *Managing interfaces:* threats posed by bushfires are diminished by reducing the direct interface between developments and bushfire hazards
- *Good practice in planning and management:* planning for bushfire resilience though planning, building and operation of a development reduces risk and increases bushfire resilience of the development and its users.

Long-distance or high-voltage transmission lines are not specifically addressed in PBP. The document sets standards for electrical transmission for residential subdivision and special fire protection purpose developments, the intent of which is to reduce bushfire risk to nearby buildings or surrounding bush. However, the document also provides guidance for the consideration of bushfire risk for electrical infrastructure more broadly, which can apply to this project.

The main bushfire risk associated with transmission lines as identified by PBP is the risk of ignition associated with electrical conduction. For this risk, PBP refers to *ISSC3 - Guide for Management of Vegetation in the Vicinity of Electricity Assets* (ISSC, 2016). However, ISSC3 does not provide guidance for transmission lines. Commercial and industrial development with no residential component is held to the aims and objectives of PBP and requires that appropriate bushfire protection measures be put in place, however, no particular measures are mandated.

3.2.2 ISSC 20 – Guideline for the Management of Activities Within Electricity Easements and Close to Electricity Infrastructure

ISSC 20 - Guideline for the Management of Activities Within Electricity Easements and Close to Electricity Infrastructure (ISSC, 2012) was written to protect public safety and electricity assets and by offering guidance on the management of activities in electricity easements. Consideration of activities to occur in electricity easements must include impact on safety clearances (accounting for conductor sag and sway) and safety issues including bushfire. Clearances are calculated for typical spans to accommodate error margins for blowouts, so longer spans may require a greater distance.

Lighting of fires, including planned or prescribed burns, is a controlled activity under ISSC 20 and is subject to consultation and negotiation with the network operator.

3.2.3 Guide for Bush Fire Prone Land Mapping

The identification of bushfire prone land (BPL) in NSW is required under the EP&A Act. It is the responsibility of local government area-based Bush Fire Management Committees (BFMC). BPL mapping is typically published by the respective local government and the maps and metadata are developed according to guidance provided by NSW RFS (2015).

BPL assessments are based on allocation of the vegetation present into one of three broad categories, as follows:

- *Category 1:* which includes areas of forest, woodland, heath, forested wetland and timber plantation. Highest risk category
- *Category 2:* rainforests and "lower risk vegetation parcels" these parcels contain remnant vegetation, but it is limited in its connectivity to larger areas and contain land management practices and a bushfire plan that identifies the appropriate management of bushfire risk
- *Category 3:* which includes grasslands, freshwater wetlands, semi-arid woodlands, alpine complex and arid shrublands. Moderate risk category
- *Exclusion:* Areas of vegetation less than 1 hectare and greater than 100 m separation from category 1, 2 or 3 vegetation; small patches or strips of remnant vegetation; managed grasslands; agricultural cropland; gardens; and mangroves are not mapped as bushfire prone.

BPL is defined as land with category 1, 2 or 3 vegetation and land within 100 m of category 1 or within 30 m of category 2 or 3 vegetation.

4. Bushfire risk factors

4.1 Regional context

The western end of the project area is in Bago State Forest, with the remainder in KNP. The project crosses Talbingo Reservoir, the largest of the dams in the Snowy Mountains Scheme.

The state forest and national park are popular tourist destinations, with most visitation coinciding with the summer bushfire season. Areas around waterbodies and waterways are most popular.

There is strong evidence for historic Aboriginal presence and occupation throughout KNP, with cultural heritage assets including shield and scarred trees likely to be widespread (NSW NPWS, 2008). These values are susceptible to bushfire.

The project is mapped (NSW NPWS, 2008) as having a high (moderate-high-extreme mosaic) bushfire behaviour potential; due to:

- Hilly terrain
- North, west and south-west aspects
- Lower elevations
- Fuel groups that can support a high-intensity fire (woodland and dry forest).

4.2 Current bushfire management arrangements

The project area is currently managed as a Land Management Zone under the *KNP Fire Management Strategy* (NSW NPWS, 2008), as well as under the *Snowy Valleys Bush Fire Management Committee Bush Fire Risk Management Plan* (Snowy Valleys BFMC, 2018). Bushfire management in a Land Management Zone focuses on ecological and heritage objectives, by maintaining ecologically-appropriate burn regimes and reducing the likelihood of wildfire through managing fuel loads (Snowy Valleys BFMC, 2018).

The existing TransGrid Transmission Network is noted in the Snowy Valleys Bush Fire Risk Management Plan as a high-risk asset (impact of fire is rated as unlikely, but would have catastrophic consequence). The main bushfire hazard reduction tactic is the management of easement clearances, noted as TransGrid's responsibility (Snowy Valleys BFMC, 2018). Bushfire risk associated with existing public infrastructure in the region is influenced by (NSW NPWS, 2008):

- Single access roads
- Lack of available water for fire fighting
- Size and maintenance of APZ
- Remote locations, where protections would be difficult and/or dangerous for fire crews
- Proximity to areas with potential to support threatening fires.

In recognition of the high-risk status of its assets, TransGrid participates in the Snowy Valleys Bush Fire Management Committee and reports on its risk reduction strategies.

4.3 Bushfire weather

4.3.1 Historical bushfire weather

The region experiences a cool temperate climate with cool, wet winters and warm, drier summers, as shown in **Figure 4-1**. Average daily maximum temperatures range between 10.7°C in July and 29°C in January. Temperatures in excess of 35°C have been recorded in all months between November and March. The hottest day on record (since 1965) reached 40.8°C (January 2019). Average annual rainfall is 976 mm, with the driest year on record (1967, records since 1885) receiving less than half the average, at 421 mm. Approximately one third of the yearly rainfall falls during the warm season (November – April).

Climate records from Tumbarumba Post Office (BoM station 072043, elevation 645 m AHD, data from 1965 (temperature) / 1885 (rainfall)) have been used to characterise climate in this region. Data from the newer Cabramurra SMHEA AWS (BoM station 072161, elevation 1482 m AHD, data 1996-2019) indicates the differences in climate in the region, influenced by the topography. Cabramurra is, on average, 7°C cooler across the year and receives 200 millimetres (mm) less rain annually than Tumbarumba (BoM, 2019).

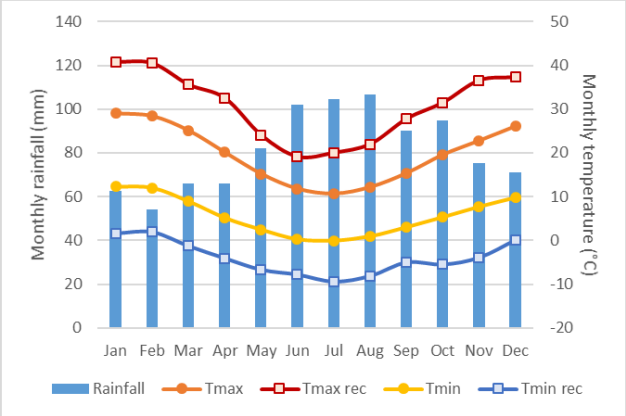


Figure 4-1: Average monthly rainfall, average daily maximum (Tmax) and minimum (Tmin) temperatures, maximum (Tmax rec) and minimum (Tmin rec) temperatures on record (BoM station 072043, Tumbarumba Post Office, data 1885 [rain] / 1965 [temperature] to 2019).

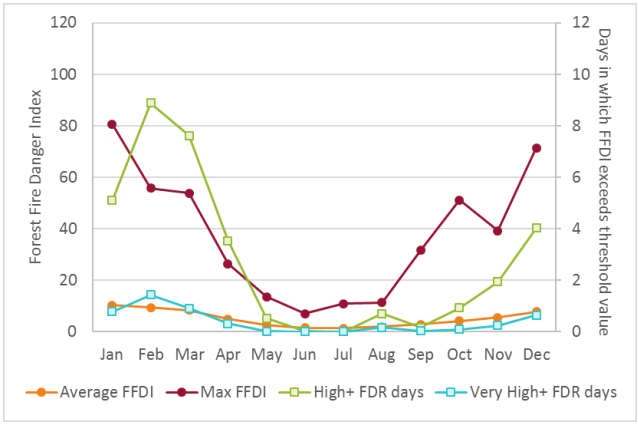


Figure 4-2: Monthly average and maximum FFDI, and average number of days per month High (FDI 12) and Very High (FDI 25) FDR and above (BoM station 072043, Tumbarumba Post Office, based on 3 pm observations for 1995-2014)

Average monthly fire danger ratings (FDR) are low to moderate (Forest Fire Danger Index [FFDI] <12) throughout the year (**Figure 4-2**). Days of Very High FDR or greater (FFDI ≥25) have occurred in all months of between September and April, but are most common between December and March. The highest FDR since 1994 occurred on 30 January 2003, when FDR reached Extreme. Indicative fire behaviour at each FDR and average number of days per year at each FDR is described in **Table 4-1**.

TOBANs are declared by the NSW RFS. During TOBANs, potential human sources of ignition are prohibited or restricted to reduce the risk of bushfires igniting during or (rarely) immediately preceding a period of dangerous fire weather. FDR on TOBAN days is typically Very High or higher.

Under AS3959:2018 – *Construction of buildings in bushfire-prone areas* (Standards Australia, 2018), a Forest Fire Danger Index (FFDI) of 50 applies to the NSW Alpine Areas for the purposes of design. Buildings constructed according to these standards (mostly residential buildings) should be resistant to fires occurring on days of Very High FDR, with the standards acknowledging the rarity of more extreme bushfire weather in the region.

The bushfire season generally runs between November and March (Snowy Valleys BFMC, 2018), however in some local government areas (particularly in the north-east of NSW) the start of the bushfire danger season can be declared in August or September (TransGrid, 2018a). TransGrid's standard approach is to plan for the bushfire danger period to start on 1 September (TransGrid, 2018b). Northerly or north-westerly winds are prevalent over this time (Snowy Valleys BFMC, 2018). Most of the fire spread in the recent past has been under the influence of west, north-west, and northerly winds (NSW NPWS, 2008). Dry lightning storms are a common occurrence during the bushfire season (Snowy Valleys BFMC, 2018). Historically, seasons with relatively high incidences of bad fire weather are likely to occur every 5-11 years, generally coinciding with El Niño events (NSW NPWS, 2008).

4.3.2 Climate change projections for bushfire

The project would remain in service for the operational life-span of Snowy 2.0, which is anticipated to exceed 50 years. The project should therefore be resilient to conditions in the 2070s and beyond. Climate projections indicate bushfire weather in the region is very likely to become harsher over the coming decades (Timbal *et al.*, 2015).

Climate projections for 2070 were generated for this project, based on the mean model results for all CMIP5[1] models with projections for wind speed, relative humidity, daily rainfall and maximum temperature for RCP8.5[2] (high emissions scenario); as made available through CSIRO and BoM's *Climate Futures Tool*[3]. Change factors to 2070 for each of these weather parameters were applied to the 1995-2014 data for BoM station 072043 (Tumbarumba Post Office), as data for the standard baseline (1986-2005) were not available for this location.

Climate models suggest that the main projected changes in climate for the region under the RCP8.5 scenario are for:

- **Increased temperature.** Temperatures are projected to increase throughout the year, with annual average maximum temperatures approximately 2.9°C hotter by 2070
- **Decreased average annual rainfall**. Some increases in summer rainfall may occur, but these are projected to be outweighed by reductions in winter rainfall, with annual average rainfall declining by four per cent
- **Decreased relative humidity**. Changes in relative humidity can be expected due to increased temperatures and reduced rainfall. Relative humidity is projected to decrease throughout the year, with the largest reduction occurring during spring
- **Little change to wind**. Average wind speeds are not projected to be materially affected by climate change.

Combined, these projections indicate that bushfire weather will become harsher over the coming decades. Average FDR is projected to increase from Low-Moderate (currently) to High during January. The number of days at Very High FDR or above are projected to approximately double (**Figure 4-3**). Extreme conditions (FFDI ≥ 75) are projected to occur once every 10 years, up from the current one-in-20-year occurrence (**Table 4-1**).

1 CMIP5: Coupled Model Intercomparison Project Phase 5. This refers to the collaborative framework resulting in a collection of models for climate change. They were used in the International Panel on Climate Change's (IPCC's) Fifth Assessment Report. CMIP5 is the most recent phase of the CMIP project at the time of writing.

2 Population and economic growth, technological change including reliance on fossil fuels, and political and social changes will all have substantial effects on greenhouse gas emissions and accumulation in the atmosphere. To account for this uncertainty, the Intergovernmental Panel on Climate Change (IPCC) developed four Representative Concentration Pathways (RCPs) to illustrate four different scenarios for global human activity and development over the coming century, and the resulting effect on global climate. The four RCPs are distillations of a large volume of future scenarios discussed in the scientific literature, chosen by a multi-disciplinary team of experts to form the basis of the Fifth Assessment Report (IPCC, 2014). RCP8.5 represents a scenario in which emissions continue to rise rapidly through most of the century. This is driven by continued population and economic growth, without a transition to low-carbon technologies (business as usual).

3 https://www.climatechangeinaustralia.gov.au/en/climate-projections/, results for the Murray Basin sub-cluster.

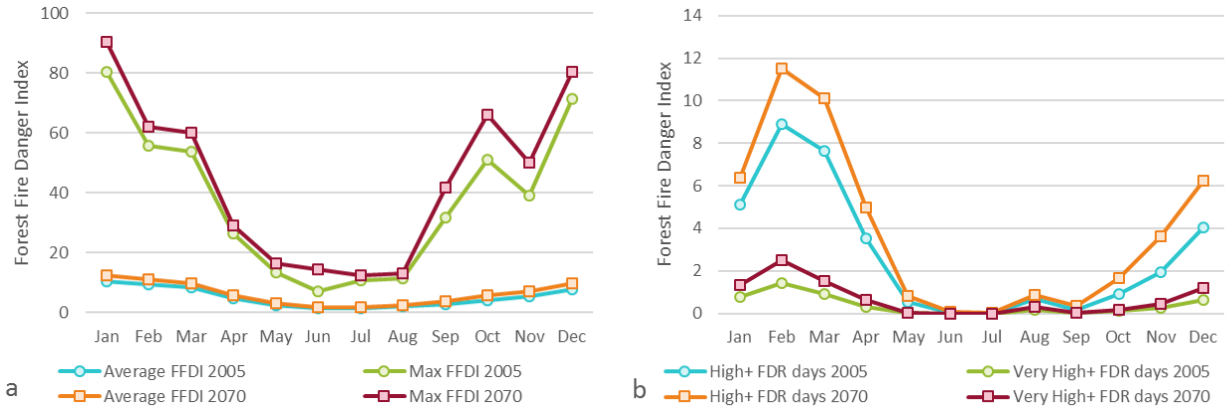


Figure 4-3: Comparison between: a) Average monthly and maximum FFDI and b) number of days per month at or exceeding High (FFDI 12+) and Very High (FFDI 25+); for 2005 (based on data for 1994-2015) and 2070 (2060-2079, derived from median model result for RCP 8.5).

Table 4-1: Fire danger index, indicative fire behaviour and average occurrence at the project area

FDR	Fire behaviour guidance	Average number of days per year	
		Current (1995-2014)	2070 (2060-2079)
Low-moderate FDI<12	There is some potential for fires and those that occur will normally stop (meteorological conditions allowing) at roads, tracks and watercourses. Fires that occur can generally be extinguished by the use of hand operated water sprays and fire beaters.	327 (90%)	312 (86%)
High FDI 12-24	Fires are capable of spreading rapidly, particularly in the absence of preventative measures and may require additional work effort to be extinguished.	33 (9%)	43 (12%)
Very high FDI 25-50	Fires are capable of spreading rapidly, with or without preventative measures. Fire containment may require significant effort and the use of earthmoving equipment and/or backburning.	5 (1%)	9 (2%)
Severe FDI 51-74	Fires are capable of being uncontrollable, unpredictable and extremely fast moving, and will NOT be contained without extensive effort on established fire lines with adequate personnel and equipment (this may include water bombing aircraft).	0.3 (0.07%)	0.6 (0.2%)
Extreme FDI 75-100		0.05 (0.01%)	0.1 (0.03%)
Catastrophic FDI>100	Fires are capable of being uncontrollable, unpredictable and extremely fast moving, and will NOT be contained without extensive effort on very large established fire trails with extensive personnel and equipment (this will include water bombing aircraft).	Not recorded	Not projected

4.4 Topography

Assets located on ridgelines are recognised as being at comparatively higher risk of fire (NSW NPWS, 2008). The new transmission corridor would traverses mountainous terrain. Elevation ranges from 547 m AHD (at the Talbingo Reservoir crossing) to 1198 m AHD near the western end of the alignment (**Figure 4-4**, right hand side of figure). The alignment contains two major slopes with easterly aspects, and one with a westerly aspect. Vegetation on west-facing slopes tends to be drier, and available as bushfire fuel for more of the year (NSW NPWS, 2008).

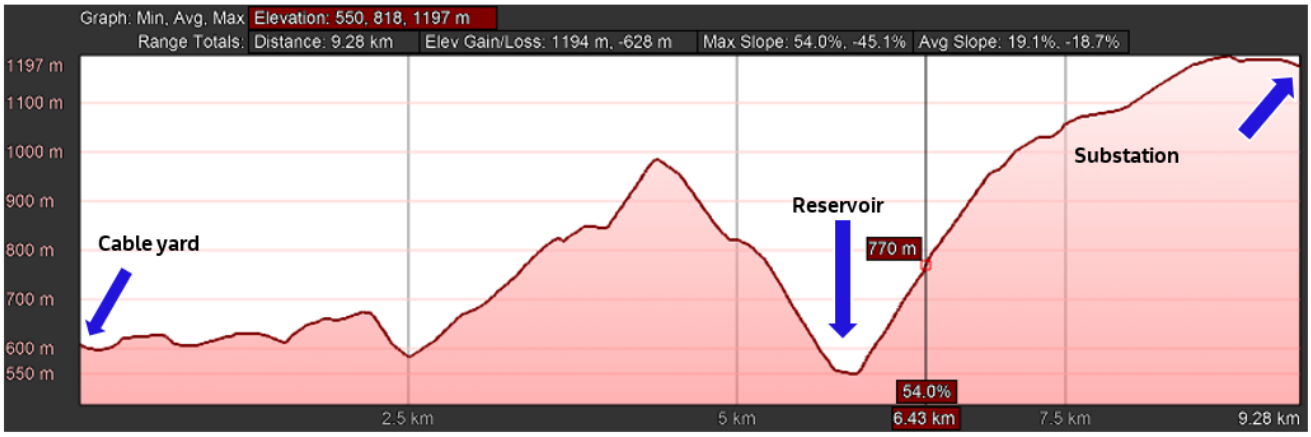


Figure 4-4: Elevation profile of the new transmission line, from cable yard (left - east) to substation (right - west) (source: Google Earth Pro)

4.5 Vegetation

The bushfire study area extends for 140 m around the permanent project infrastructure (transmission line, structures and substation), following guidance in PBP.

Located entirely in Bago State Forest and KNP, the project area is covered by a combination of eucalypt woodlands and wet and dry sclerophyll eucalypt forests; part of a large area of contiguous vegetation. The plant community types (PCTs), associated Keith Vegetation Formation and Classifications are listed in **Table 4-2**. PBP provides indicative fuel loads based on Keith Vegetation Classifications. All formations in the project footprint can have an indicative surface and elevated fuel load of approximately 22 t/ha, and overall fuel load (including bark and canopy) of approximately 36 t/ha. Modelling by NPWS in 2008 indicated that the region in which the project area is located had a surface fuel load of 10-15 tonnes per hectare (t/ha), and that fuel accumulation for the vegetation types in the project area tends to stabilise about 15 years after a fire. Fuel loads are currently much reduced due the area being affected by wildfire in 2020.

All vegetation in the bushfire study area is classified as Vegetation Category 1 (according to the *Guide for Bush Fire Prone Land Mapping* (NSW RFS, 2015)). This category is considered to have the highest risk for bushfire, with the highest combustibility and greatest likelihood of forming large fires with embers.

Table 4-2: Plant community types and Keith vegetation classifications for the bushfire study area (NSW OEH, 2019)

PCT	PCT description	Keith vegetation formation
285	Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)
296	Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)
300	Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Wet Sclerophyll Forests (Grassy sub-formation)
302	Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)
729	Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)
999	Nortons Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)
1196	Snow Gum – Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Grassy Woodlands

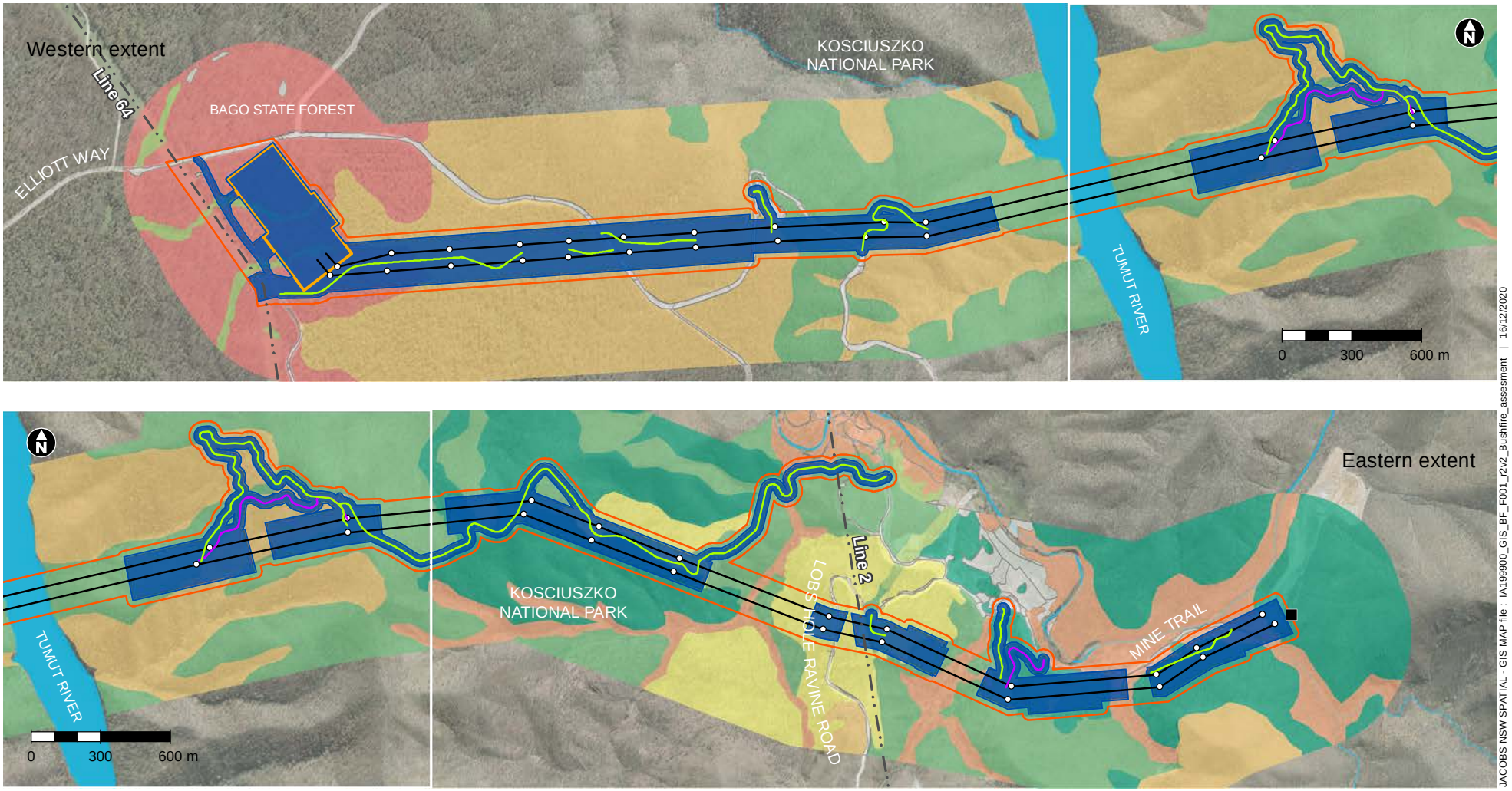


Figure 4-5 | Plant community types in the project area

4.6 Ignition sources

Sources of bushfire ignition have been reported by NPWS (2008) and Snowy Valleys BFMC (2018). In descending order of frequency, they include:

- Lightning strike – late spring and summer thunderstorms are common and are sometimes dry
- Arson – most common around townships, roads and trails; in grassy areas (which are more accessible than forests) and during school holidays
- Escaped campfires – tourists in State Forest and National Park, especially during the summer holiday period
- Escaped planned burns
- Smoking
- Motor vehicles
- Powerlines.

Powerlines caused two per cent (12 incidents) of unplanned fire ignitions in KNP during the period 1957-2007 (NSW NPWS, 2008)[4]. Unless carefully managed, installation of new transmission lines may increase the number of bushfire incidents in this region.

4.7 Fire history

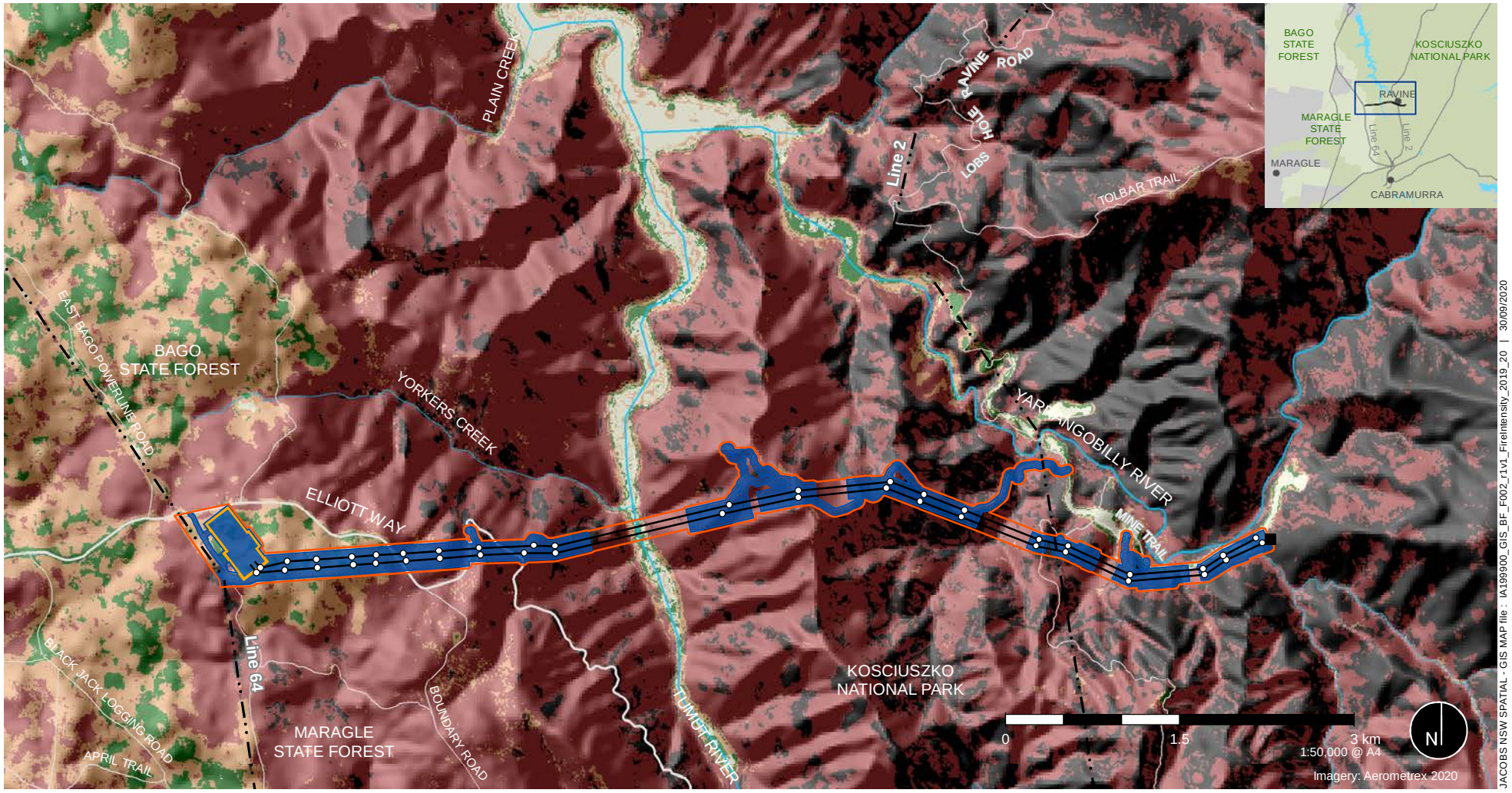
Between 10 and 30 (average of 13.4) unplanned fires ignite in KNP each year (NPWS, 2008). The project area was extensively affected by the 2019-20 Dunns Road bushfire. The severity of this fire across the project area is shown in **Figure 4-6**.

Prior to this, KNP was burnt in the 2003 Australian Alps fires. During this event, a reported 140 individual fires were ignited in the Alps by lightning on a single day (Worboys, 2003). It was also burnt by bushfire in 1980, 1964 and 1938. Various portions of the project area were also subject to prescribed burns between 1970 and 1980. **Table 4-3** provides a history of fires known to have impacted the project area. During the period 1986-2007 NPWS have completed an average of five prescribed burns in KNP per year (NPWS, 2008). These have generally been near the edges of the KNP, or in areas with higher ignition frequency.

Table 4-3: History of fires that have impacted the project area (source: NSW NPWS 2020)

Fire name	Start date	Area (Ha)	Type
Dunns Road	27/12/2019	333 980	Wildfire
Kosciuszko	1/02/2003	449 441	Wildfire
Block 136 (137 escape)		1854	Wildfire
Block 137	1/03/1981	4026	Prescribed Burn
Block 138	1/04/1980	4903	Prescribed Burn
Block 164	1/03/1977	3267	Prescribed Burn
Block 139	1/03/1974	7176	Prescribed Burn
Block 137	1/04/1972	2604	Prescribed Burn
Block 136	1/03/1971	1854	Prescribed Burn
Ravine (Tumut Valley)		76 957	Wildfire
Burnt 1938-39		3 465 373	Wildfire

[4] This report does not distinguish between distribution and transmission powerlines. Incidences of fire ignition associated with powerlines are more commonly associated with distribution powerlines than transmission powerlines.



Project area
Disturbance area
Proposed 500kV substation
Proposed structure
Proposed transmission line

Snowy 2.0 cable yard
Snowy 2.0 element

2019-20 Fire severity
Not mapped
Low - burnt understory with unburnt canopy
Medium -partial canopy scorch
High- full canopy scorch/partial consumption
Extreme - full canopy consumption

Electricity transmission line
Waterway

Figure 4-6 | Fire severity across the Project area during the 2019-20 fire season

Data source:
Jacobs 2020, TransGrid, EMM 2020, DPIE 2020,

4.8 Electrical equipment failure modes

Operating powerlines and related infrastructure are a known cause of bushfire ignition. Failures and other incidents that can lead to ignition include (TransGrid, 2017):

- Transmission line structure failure
- Transmission line conductor drop
- Contact with vegetation, e.g. due to vegetation growing into the transmission corridor
- Explosive failure of substation equipment
- Electrically induced fire (earthing system fault causes transfer of current or voltage to nearby metallic objects).

Under the ES(SNM) Regulation, TransGrid is required to eliminate risks associated with these failure modes, so far as reasonably practicable (SFARP) or if elimination is not reasonably practicable, to reduce them as low as reasonably practicable (ALARP).

4.9 Key bushfire risk scenarios

The key bushfire scenarios that may affect the project are:

- A fire igniting in Bago State Forest or north-western areas of KNP on a day of elevated fire danger burns under the influence of north-westerly winds towards/through the project area. Embers are carried across Talbingo Reservoir to ignite the westerly slopes and burn through the project area east
- Electrical equipment failure, explosive equipment failure (most likely a transformer), contact (or flashover) between conductor and vegetation, or hot works cause ignition at the project area. Fire spreads from the project area into Bago State Forest or KNP.

The project area is located within a remote, rugged and generally undisturbed landscape. Any fire that was unable to be contained quickly could result in significant areas of the landscape being affected by fire due to limited vehicle access in the area. The consequences of a fire in the region could include:

- Direct threat to the safety of the project, visitors to the KNP and State Forest, or others working in the area (e.g. Snowy 2.0 and NPWS personnel)
- Destruction of public and private property
- Destruction of Aboriginal and Non-Aboriginal heritage features
- Ecological degradation, if fire intensity or time between burns exceeds ecosystem fire tolerances, post-fire climate is unsuitable for regeneration or heavy rain causes erosion of soil from areas whose vegetation cover has been removed by fire
- Ash and sediment being washed into waterways and Talbingo Reservoir in rainfall events following a widespread fire.

A fire ignited by project works (construction or operation) that results in a threat to human life or destruction of public or private property may affect TransGrid's reputation and breach its transmission licence requirements.

5. Bushfire protection measures

Bushfire protection measures have been developed for construction and operational phases of the transmission line and substation, based on guidance from the NSW RFS (especially PBP), electrical network industry sources and TransGrid's standard bushfire risk mitigation procedures (TransGrid, 2018a). Adoption of the measures described here is expected to reduce, to an acceptable level, both the risk of bushfire ignition by construction and/or operation of the assets and the risk that bushfires in the landscape pose to the assets.

TransGrid will liaise and cooperate with NPWS and FCNSW on bushfire protection measures to minimise the risk of bushfire ignition from the transmission lines in KNP and Bago State Forest. Measures will include slashing of woody vegetation regeneration in easements (NPWS, 2008), maintenance of safe clearance zones between vegetation and conductors and removal of hazard trees. The project will need to be incorporated in the relevant bushfire management plans by NPWS and Snowy Valleys BFMC, as both an asset to be protected from bushfire and a potential source of ignition. NPWS, NSW RFS and FCNSW have provided review and input into this bushfire assessment report.

In rare cases, powerline easements (including for 330 kV transmission lines) may be used by emergency services as control lines for bushfires and backburning. Powerlines may need to be deactivated prior to sending emergency services personnel to the easement during a bushfire incident, due to the danger of electricity arcing (NPWS, 2008).

The project will benefit from bushfire prevention and suppression strategies and measures in KNP and Bago State Forest, such as:

- NPWS, FCNSW and NSW RFS fire response capability
- Fire trail network
- Identified control lines (natural and man-made)
- Nearby water source and other water points
- Fire detection structures
- Airbases and helipads
- Planned burning program.

The project notes the request from NSW RFS for suitably qualified personnel to be released from normal duties and tasked with fire-fighting duties during periods of operational need, should the project be impacted by a fire or a fire being in close proximity to the transmission corridor.

5.1 Permanent bushfire protection measures

The vegetation removal for the project includes:

- Removal of trees and woody vegetation within the 120-200 m wide transmission corridor as required to provide safe clearance distance to the overhead conductors (but only to the extent that this is required to maintain safe clearances)
- Removal of vegetation for the construction of the substation, and the substation's APZ
- Ongoing management of 'hazard trees' on a risk basis, according to TransGrid's *Maintenance Plan (Easements and Access Tracks)* (2018b)
- Removal of vegetation as part of the access track construction.

The management and disposal of timber and vegetation debris would be developed in consultation with NPWS and FCNSW to avoid local concentrations of bushfire fuels. It is expected to include a combination of:

- Processing timber through a timber chipper followed by distributing the chips across exposed areas of the transmission corridor to assist in the prevention of erosion
- Relocation of felled timber containing hollows that could provide fauna habitat into the adjoining forested areas
- Removal of timber off-site and stockpiling at a suitable location for potential re-use as building material or firewood.

5.1.1 Transmission corridor

The main bushfire protection measure for the project is the removal of vegetation from the transmission corridor. Vegetation clearances must prevent conductors coming into contact with vegetation under all conditions, considering conductor sag due to temperature, and conductor and insulator sway due to wind. Additionally, vegetation which has the potential to grow within the safe clearance zones beneath the conductors must also be required to be cleared, as must identified hazard trees. All these factors would be considered as part of the detailed design process.

Where the vertical distance between conductors and nearby vegetation exceeds the minimum requirement (allowing for regrowth), the transmission corridor may not need to be cleared. In this case, the transmission corridor may not provide a fire break or potential fire control line.

5.1.2 Substation APZ

An APZ will be defined around the substation, with the inner edge at the security fence. The APZ will be maintained free of woody vegetation as a bushfire buffer zone (according to *Maintenance Plan – Network Property;* TransGrid, 2019), with buffer width as specified in this section.

It is recommended that any grass present within the APZ will be kept to a maximum height of approximately 10 cm when cured and approximately 20 cm at all other times. Periodic mowing/slashing to the frequency stated in TransGrid's maintenance plans (TransGrid, 2019) is expected to be sufficient to maintain this standard. Regular maintenance is only likely to be required from the onset of the spring growth flush to the curing of the grass in late spring-early summer (depending on the season).

The heat sensitivity of key substation components is shown in **Table 5-1**. Ideally, the APZ would be wide enough to reduce radiant heat flux from any bushfire burning in nearby vegetation to less than that which may be tolerated by the most sensitive component (polymeric bushing/insulators; maximum allowable radiant heat flux of 11 kW/m^2). This would require a separation (of the more sensitive components) from bushfire-prone vegetation of ~100 m to the north, east and south of the substation and ~80 m to the west (calculated using AS5339-2018 *Construction of buildings in bushfire prone areas*).

While the actual location of heat-sensitive components within the disturbance areas will not be confirmed until detailed design, the APZ is unlikely to be large enough to allow placement of the substation so that radiant heat exposure is any lower than 19 W/m^2 (and most likely higher in some areas). This reflects a trade-off between protection of the sub-station from bushfire damage and minimising the area of clearance of native vegetation.

Table 5-1: Radiant heat exposure limits for substation materials (from Ausgrid, 2017)

Item	Maximum allowable radiant heat flux (kW/m^2)	Comment
Cable	12.5	Cables begin to distort and may ignite. Cables may also sustain damage at lower radiant heat levels.
Steel support structure	15.0	To 60% of yield strength.
Porcelain bushing/Insulators	12.5	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure.
Polymeric bushing/insulators	11	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure.
Aluminium busbar	12.5	Busbars may undergo significant distortion and impose significant stresses on rigid insulators.
Copper busbar	12.5	Busbars may undergo significant distortion and impose significant stresses on rigid insulators.
Transformer tank	25 (Top) 17 (Side)	Transformers always have some more vulnerable components such as bushings and cables etc.
Conservator	20	Limited by maximum oil temperature
Combustibles	<12.5 typical	Piloted ignition may occur on timber

5.1.3 Maintenance

Ongoing vegetation management will be in accordance with TransGrid's operational vegetation monitoring and management procedures. Routine inspections of the transmission corridor and substation APZ will be conducted, at a time of year allowing the remediation of any defects prior to the start of the bushfire season (inspection expected to be in June, with defects rectified by 1 September[5]). Ongoing management will fall under TransGrid's existing inspection and maintenance program, which includes identification, recording, prioritisation and rectification of defects. These vegetation management standards are essential to maintain the safe and effective functioning of the transmission connection, and to minimise the risk of fire ignition from vegetation coming into close proximity to conductors. They also help to minimise the risk of ignition in case of failure of structures, conductors, and/or structure assemblies.

Hot work (activities involving high temperatures) and fire risk work (activities involving heat or with the potential to generate sparks) from maintenance activities may cause fire ignition. These works will be managed under TransGrid's *Hot Work and Fire Risk Work procedure* (TransGrid, 2020), with measures including suspension of activities on days of elevated fire danger. Certain maintenance activities, including hot works, are prohibited by law on any day declared to be a TOBAN. Essential work during operations may be completed by TransGrid on a TOBAN providing it complies with the *Hot Work and Fire Risk Work procedure* and TransGrid's standing exemption from the NSW RFS.

It is not practical to prohibit network personnel being present on site on days of elevated fire danger, given the remote nature of the project area. However, because of the remote location of the project area and limited evacuation routes in case of a fire, it is recommended that non-essential works be postponed on days with FDR of Severe or greater. This should help to reduce the risk to personnel by an externally caused fire.

FDR for the project area can be obtained from https://www.rfs.nsw.gov.au/fire-information/fdr-and-tobans (Southern Slopes Fire Area 16).

[5] Noting that grass growth (where grass is present in the sub-station APZ) will primarily occur during spring and early summer and will need to be maintained during that period. Once cured, the grass is unlikely to regrow until significant rainfall has been received.

5.1.4 Other permanent measures

Access tracks constructed for the project would be approximately 5 m wide. While mainly used for vegetation management and infrastructure maintenance, the tracks may also provide access for bushfire response activities[6]. TransGrid's maintenance standards for access tracks (TransGrid, 2018b) require consideration of use by third parties, including as fire trails. As such, they it is recommended meet the standards for a Category 9 fire trail (NSW RFS, 2019b, see Appendix A). Access tracks are not intended to provide defendable space in case of fire.

Lightning protection measures for the project are as follows:

- Each structure will be equipped with earthing fixtures
- Each transmission line will have two earthing lines at the top of each structure to provide protection to the conductors from lightning strike
- Lightning masts will be installed at the substation

Lightning protection measures will be inspected and maintained following TransGrid's standard practices.

5.2 Bushfire protection measures during construction

Construction activities pose additional risks for on-site ignitions which may result in a fire escaping to the surrounding state forest and national park. These mainly arise from hot work, fire risk work, vegetation clearing and management and use of vehicles on site. Contractors should incorporate suitable bushfire protection measures into safe work procedures to ensure these risks are appropriately managed. It is recommended that all works be suspended and personnel not attend site on days with forecast FDR of Severe or greater[7], to minimise the risk to personnel by an internally or externally caused fire.

Accommodation for workers during construction will be at Snowy Hydro facilities at Lob's Hole and existing facilities within the townships of Tumbarumba and Tumut. This is outside the scope of the current assessment, but it is expected that accommodation at Lob's Hole will be compliant with AS3959 (EMM, 2017).

Two main compound areas will be set up at each end of the project. The eastern compound at Lob's Hole will be established to support construction activities in project area east, and is expected to use a cleared area provided by Snowy Hydro. The second compound to support construction activities is within project area west, and will be set up within the disturbance area that will established for the substation. A minimum of 40 metre clearance is required between fuel/chemical storage points and woody vegetation. Compound buildings should have at least 20 m vegetation clearance.

The project area will also include minor site facilities and storage, including laydown areas at the location of each structure. Location of any facilities within the transmission corridor, with a minimum of 20 m clearance to the adjacent forest, will not require any additional bushfire protection measures.

[6] This would only occur if fire crews assess their condition to be suitable at the time. It is noted that access tracks are not necessarily regularly maintained by TransGrid. Track condition is assessed as part of routine easement inspections (TransGrid 2018b), with any maintenance based on condition and the relative cost-benefit of the activities.

7 Such days will almost certainly be TOBAN days.

Firefighting equipment will be maintained at and/or accessible to all active construction sites during the declared bushfire danger season, and site personnel trained in its use. Equipment should be appropriate to the activities being conducted and the fire danger at the time of works, but as a minimum must include (EMM, 2017):

- 4WD Striker with slip-on water unit, equipped with diesel pump and hoses[8],
- Extinguishers
- Knap sacks
- Hand tools (e.g. fire rakes).

Construction will also be occurring for the Snowy 2.0 Project at the nearby Lob's Hole. These works will have similar requirements for bushfire safety during construction and may be able to share resources with project area east.

5.3 Additional bushfire protection measures

In addition to vegetation management, other considerations apply to the operation of electricity assets to effectively manage bushfire risk, such as design standards for infrastructure and network de-energisation. These risk mitigation measures are outside the scope of this document but are applied as part of TransGrid's *Electricity Network Safety Management System* (see TransGrid, 2017a).

5.4 Potential environmental impacts of proposed bushfire protection measures

Potential environmental impacts of the proposed bushfire protection measures are largely confined to the clearing of native vegetation in Bago State Forest and KNP, and the potential for erosion and sedimentation associated with this and construction of the access tracks. Vegetation clearance is incorporated into the initial planning of the project and no additional clearing is proposed as part of this bushfire assessment. Removal and management of hazard trees should be undertaken in a way that minimises environmental impact while ensuring risk is mitigated, as per TransGrid's *Maintenance Plan - Easement and Access Tracks* (TransGrid, 2018b). As described in **Section 5.1**, any vegetation cleared as part of these works will be removed from site (as much as reasonably practicable), or otherwise processed to avoid excessive bushfire fuel accumulation, as agreed with FCNSW and NPWS.

Construction of access tracks will involve extensive earthworks creating local soil disturbance along their routes and potentially considerable disruption to overland flow paths. Vegetation removal and access track design, construction and maintenance should employ specific measures to minimise erosion and the generation and transportation of sediments. This will include the construction of appropriate drainage structures and the dispersal of drainage from access tracks into nearby vegetation.

[8] As a minimum, one unit each should be available for any works sites in project areas east and west during the prescribed fire danger period.

6. Emergency management during construction

This section outlines the emergency management arrangements for the construction phase of the project. Once the assets are commissioned, emergency management arrangements will follow those applying to other parts of TransGrid's network.

NSW RFS is the primary emergency response agency for any incident affecting the project area. NPWS and FCNSW are also fire-fighting agencies for bushfires occurring in KNP and Bago State Forest, respectively.

In case of a fire igniting in/around the project area:

- Personnel who are present should attempt to extinguish the fire *if safe to do so*
- Others present on site should be alerted to the presence of the fire
- Contact emergency services on 000
- Evacuate personnel to a safe location.

A Prepare-Act-Survive bushfire response plan would be prepared for the project. This plan would be aligned with the Snowy 2.0 Bushfire Emergency Management Plan.

6.1 National bushfire warning system

Advice of bushfires igniting in the landscape surrounding the project area may be provided through the National Bushfire Warning System (NBWS) alerts. The NSW RFS uses NBWS alerts to provide information to affected areas on locations and current status of nearby bushfires, to allow people to evacuate or otherwise prepare (**Figure 6-1**). Information is provided through:

- Radio: alerts broadcast on the local emergency services radio station (ABC Riverina: 89.9 FM, 97.9 FM, 675 AM, 549 AM; ABC South East NSW: 1602 AM)
- Internet: NSW RFS website (www.rfs.nsw.gov.au), 'Fire Near Me' app
- Telephone: Bushfire information line 1800 NSW RFS (1800 679 737)
- Television, newspapers.

Note that some fires ignite and spread too quickly for a warning to be issued. The remote location of the project may mean telephone or internet coverage is intermittent or not available. All site personnel should be on the watch for smoke during the bushfire danger period.

6.2 Prepare-Act-Survive

Sufficient measures should be in place such that project personnel are not on site in the event of a bushfire. However, the project must have contingency plans in place to support survival if personnel are caught in a bushfire.

Figure 6-1: National Bushfire Warning System advice levels

Prepare-Act-Survive bushfire response plan should be prepared by contractors according to NSW RFS guidelines and the Snowy 2.0 Construction Bushfire and Emergency Management Plan. They should include:

- Evacuation triggers
- Evacuation routes
- Mustering points
- Neighbourhood Safer Places and Refuges of Last Resort
- Instructions for sheltering in-vehicle if there are no other options.

Neighbourhood Safer Places are locations designated by fire authorities as having a higher likelihood of supporting human survival, should evacuation no longer be an option. ***It must be emphasised that anyone sheltering in a Neighbourhood Safer Place during a bushfire event may still experience extreme conditions and their safety is not guaranteed.***

Designated neighbourhood safer places in the vicinity of the project are:

- Tumbarumba Sportsground Oval, Lauder Street, Tumbarumba (30 min drive from the project area west)
- 1488 Bistro and Canteen, Town Complex, Murralin Road, Cabramurra (45 min drive from the project area east)
- Miles Franklin Park, Corner of Murray Jackson Drive and Bridle Street, Talbingo (1 hr 20 min drive from the project).

7. Conclusions and recommendations

7.1 Bushfire hazard assessment

The project commences in Bago State Forest and continues into KNP, crossing Talbingo Reservoir. The project is located within a large area of contiguous forest in mountainous terrain. All vegetation within and surrounding the project area is classified as bushfire prone.

Vegetation removal for the project includes:

- Removal of trees and other woody vegetation within the 120-200 m wide transmission corridor to enable installation of the new transmission lines and maintain appropriate safety clearances allowing for sag and sway in the conductors. Note that woody vegetation may be retained within the transmission corridor, as long as safety clearances can be maintained
- Removal of hazard trees which have the potential to fall onto or otherwise come into contact with the transmission line
- Removal of trees and other non-grassy vegetation to enable construction of the substation within an APZ
- Removal of vegetation for the construction of access tracks.

7.2 Bushfire risk scenarios

The bushfire season in the Snowy Mountains generally runs from October to March, although commencement has been declared as early as August. Days of elevated fire danger are relatively infrequent, but mostly occur during December to March. This coincides with peak time for tourism in the area. Dry electrical storms and north-westerly winds are common during the fire season.

Two main bushfire risk scenarios facing the project have been identified as part of this assessment:

- A fire igniting in Bago State Forest or north-western areas of KNP on a day of elevated fire risk burns under the influence of north-westerly winds towards/through project area west. Embers are carried across Talbingo Reservoir to ignite the western aspect slopes and burn through project area east
- Electrical failure, contact (or flashover) between a conductor and vegetation, or hot works during construction or operation cause ignition at the project area. Fire spreads from the project area into Bago State Forest or KNP.

Substantial bushfires can and do occur in the area. Powerlines (particularly distribution powerlines) are a recognised source of bushfire ignition in the region, as well as a critical asset at risk from bushfire. Appropriate measures must be in place to mitigate the bushfire risks from and to the project.

7.3 Bushfire protection measures

The main bushfire protection measure will be maintaining vegetation clearances between the assets and surrounding vegetation:

- A 120-200 m wide transmission corridor. The transmission corridor will be maintained in accordance with TransGrid (2018b) to manage vegetation grow-in and fall-in hazard
- An APZ providing clearance between the substation and the surrounding vegetation to reduce Bushfire Attack Level (BAL) and associated heat flux at sensitive components.

Access tracks are maintained periodically to facilitate access along the transmission corridor for maintenance. When it occurs, maintenance is recommended to be to the standards of a Category 9 fire trail (NSW RFS, 2019b) to allow fire response in the area.

A Prepare-Act-Survive bushfire response plan will be prepared by contractors according to NSW RFS guidelines and the Snowy 2.0 Construction Bushfire Emergency Management Plan. This should include:

- Evacuation triggers
- Evacuation routes
- Mustering points
- Neighbourhood Safer Places and Refuges of Last Resort
- Instructions for sheltering in-vehicle if there are no other options.

Vegetation removal to construct the project and on-going implementation of bushfire protection measures are expected to reduce bushfire risk to an acceptable level. This includes ignition by construction and/or operation of the assets and the risk that bushfires in the landscape pose to them. However, with electrical infrastructure in the highly bushfire-prone landscape in which the project is to be constructed and operated, those risks cannot be entirely eliminated.

7.4 Potential environmental impacts of bushfire protection measures

Potential environmental impacts of the proposed bushfire protection measures are largely confined to the clearing of native vegetation and the potential for erosion and sedimentation associated with this and the access tracks. Vegetation clearance is incorporated into the initial planning of the project and no additional clearing is proposed as part of this bushfire assessment. Vegetation removal and management of hazard trees should be undertaken with consideration of minimising environmental impact while ensuring risk is mitigated to a level consistent with TransGrid's objectives. Vegetation removal and access track design, construction and maintenance should minimise erosion and the generation and transportation of sediments.

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Appendix A. Category 9 fire trail standards

These standards are drawn from *NSW RFS Fire Trail Standards* (2019).

Requirement	Performance criteria	Acceptable solutions
Width	The width of the trail provides for safe, reliable and unobstructed passage by a Category 9 firefighting vehicle within acceptable operational limits.	The trafficable surface has a width of 3 m except for short constrictions to 2.5 m for no more than 30 m in length where an obstruction cannot be reasonably avoided or removed. Curves have a minimum inner radius of 5 m. The minimum distance between inner and outer curves is 5 m.
Capacity	The construction and formation of the trail is trafficable under all weather conditions (other than due to flood, storm surge or snowfall) for a Category 9 firefighting vehicle	Trail surfaces and crossing structures are capable of carrying vehicles with a gross vehicle mass of 4 t and an axle load of 2 t.
Grade and crossfall	The vertical profile of the trail provides for traction and safe working angle within the physical operational capability of a Category 9 firefighting vehicle. *Note: This includes design that does not impede the undercarriage of a vehicle.*	The maximum grade of a trail is not more than 15°. The crossfall of the trail surface is not more than 6°. Drainage structures, feature crossings, or other significant changes in the grade of the trail shall be in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manual*.
Clearance	A cleared corridor is provided around the trail which permits the unobstructed passage of a Category 9 firefighting vehicle and for a working corridor either side of the vehicle to enable firefighters to exit from, and access equipment in, the vehicle.	A minimum vertical clearance of 3 m is provided above the surface of the trafficable surface clear of obstructions.
Passing	The trail provides for two Category 9 firefighting vehicles to pass at appropriate intervals so as to avoid unacceptable delays in operations.	Capacity for passing bays are provided every 250 m comprising: ▪ A widened trafficable surface of at least 5 m for a length of at least 15 m; or, ▪ A 5.5 m wide and 6 m long area clear of the trafficable surface with a minimum inner curve radius of 5 m and minimum outer radius of 10 m.
Turnarounds	The trail provides for a turning manoeuvre for a Category 9 firefighting vehicle to return in the direction from which it came at appropriate intervals and at the termination of a trail.	A turning area is provided at the termination of a trail and every 500 m and is achieved by: ▪ An area clear of the trafficable surface 5.5 m wide and 6 m deep, with a minimum inner curve radius of 5 m and outer minimum radius of 10 m; or ▪ Turning circle of minimum 16 m diameter.


TransGrid