Mortlake Energy Hub - Fire Risk Assessment

Urbis

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	Mortlake Energy Hub – Fire Risk Assessment
Project Number	23MEL4927
Project Manager	Danielle Woodhams
Prepared by	Marcus Kratzat
Reviewed by	Nathan Kearnes – FPAA BPAD Certified Practitioner No. BPAD23575-L3
Approved by	Nathan Kearnes – FPAA BPAD Certified Practitioner No. BPAD23575-L3
Status	**Final**
Version Number	**V2**
Last saved on	**6 May 2024**

This report should be cited as 'Eco Logical Australia. 2024. Mortlake Energy Hub Fire Risk Assessment. Prepared for Urbis Pty Ltd.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Urbis Pty Ltd

Contents

List of Figures

List of Tables

Glossary of Terms

Term	Description
Assets	Anything valued by people which includes houses, crops, forests and, in many cases, the environment.
Bushfire	Unplanned vegetation fire. A generic term which includes grass fires, forest fires and scrub fires both with and without a suppression objective.
Fire break	A fire break is a gap in fuel (vegetation) that reduces the potential for fire to enter or leave an area. Fire breaks may be used for emergency vehicle access.
Fire behaviour index	The fire behaviour index (FBI) is a scale of potential fire severity, ranging from 0 to 100. It informs decisions about the Fire Danger Rating as well as preparedness and operational decisions.
Fire management	All activities associated with the management of fire prone land, including the use of fire to meet land management goals and objectives.
Fuel hazard	Fine fuels in bushland that burn in the continuous flaming zone at the fire's edge. These fuels contribute the most to the fire's rate of spread, flame height and intensity. Typically, they are dead plant material, such as leaves, grass, bark and twigs thinner than 6 mm thick, and live plant material thinner than 3 mm thick.
Head fire	The part of the fire where the rate of spread, flame height and intensity are greatest, usually when burning downwind or upslope.
Intensity	The rate of energy release per unit length of fire front usually expressed in kilowatts per metre (Kw/m).
Residence time	The time required for the flaming zone of a fire to pass a stationary point; the width of the flaming zone divided by the rate of spread of the fire.
Spotting	Behaviour of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire.

Most terms are taken from the Bushfire Glossary prepared by the Australasian Fire and Emergency Service Authorities Council Limited (AFAC).

Abbreviations

Abbreviation	Description
APZ	Asset Protection Zone
BAL	Bushfire Attack Level
BESS	Battery Energy Storage System
BMO	Bushfire Management Overlay
BPA	Bushfire Prone Area
CFA	Country Fire Authority
EMP	Emergency Management Plan
FDR	Fire Danger Rating
FBI	Fire Behaviour Index
FFDI	Forest Fire Danger Index
FMP	Fire Management Plan
FRA	Fire Risk Assessment
GFDI	Grassland Fire Danger Index
PCS	Power Conversion System
PE Act	*Planning and Environment Act 1987*
PV	Photovoltaic
RMU	Ring Main Unit

1. Introduction

1.1 Background

The proposed Mortlake Energy Hub (the project) is a renewable energy project that consists of a photovoltaic (PV) solar farm installation including solar panel arrays across 1060 hectares, substation, main control building, Battery Energy Storage System (BESS), transmission lines, and associated solar farm infrastructure. The project is located approximately 5-10 km north-west of Mortlake adjacent to the Hamilton Highway. The project site is approximately 1900 hectares and is situated entirely within the Moyne Shire (see Figure 1). The site is currently being used as farming land for livestock grazing.

Mortlake Energy Hub has been designed to minimise impacts to native vegetation, waterways, and aboriginal cultural heritage. As a result, solar panels are located primarily in the east and the west of the project area, with large parts of the site left undeveloped.

This Fire Risk Assessment (FRA) for the project has been prepared in accordance with the *Design Guidelines and Model Requirements, Renewable Energy Facilities* (CFA 2023) (herein referred to as the *CFA Design Guidelines*). It has been prepared in support of an application to obtain a Planning Permit approval from the Minister for Planning under the *Planning and Environment Act 1987*.

The proposal is for the construction, operation, and ultimately decommissioning of a commercial large-scale solar farm. The project will have an installed generating capacity of approximately 360 MW, and storage capacity in the BESS of approximately 600 MW. The proposed site layout for the project is shown in Figure 2 and Appendix A.

1.2 Legislative and Policy Framework

The primary legislative and policy context for the proposed renewable energy project is through the *Planning and Environment Act 1987* (PE Act) and Clause 13.02-1S of the Planning Policy Framework.

The PE Act establishes the bushfire assessment framework for a Planning Permit to be issued by the Minister for Planning. Fire management planning conditions contained within the Planning Permit are required to meet the requirements of the current CFA Design Guidelines. The CFA Design Guidelines also reference the need to comply with other appropriate Australian / New Zealand Standards and International Standards and to consider other relevant requirements, including building fire safety, dangerous goods and electricity safety.

Referral of planning applications to the CFA by the Department of Energy, Environment and Climate Action (DEECA) is not a requirement as part of the planning application process, however under Section 55 of the PE Act it is considered prudent for installations such as the proposed project.

Clause 13.02-1S of the Victorian Planning Policy Framework sets the objective '*To strengthen the resilience of settlements and communities to bushfire through risk-based planning that prioritises the protection of human life*'. It outlines strategies to achieve this objective, summarised as:

- Prioritise protection of human life through policy, siting and bushfire risk based decision making;
- Identify bushfire hazard, consider potential bushfire impacts and appropriately assess risk;
- Land use planning that seeks resilience by directing proposals to low risk locations, applies appropriate bushfire protection measures and results in no net increase or a reduction in risk.

This FRA aims to address these legislative and policy requirements to ensure that the facility complies in its design; is suitably situated; is appropriately supported by fire protection and risk mitigation measures; and does not contribute to an increased level of fire risk to life, property and the environment.

1.3 Aims and Objectives

This FRA has the following aims and objectives:

- To identify fire risks and mitigation actions in accordance with the CFA Design Guidelines, in order to:
  - Protect fire-fighters in the event of a fire within the site.
  - Reduce the likelihood of a bushfire impacting the site or spreading from the site.
  - Identify measures to prevent or mitigate fires igniting.
  - Identify work that should not be carried out during total fire bans.
  - Assess availability of fire-suppression equipment, access and water.
  - Recommend storage and maintenance of fuels and other flammable materials.
  - Guide notification of the local CFA for any works that have the potential to ignite surrounding vegetation, proposed to be carried out during a bush fire danger period to ensure weather conditions are appropriate.
  - Guide appropriate bush fire emergency management planning.

- Address all principles contained in the CFA Design Guidelines *(CFA 2023)*:
  - *Effective identification and management of hazards and risks specific to the landscape, infrastructure, layout, and operations at the facility.*
  - *Siting of renewable energy infrastructure so as to eliminate or reduce hazards to emergency responders.*
  - *Safe access for emergency responders in and around the facility, including to renewable energy and firefighting infrastructure.*
  - *Provision of adequate fire-fighting infrastructure for safe and effective emergency response.*
  - *Vegetation sited and managed so as to avoid increased bushfire and grassfire risk.*
  - *Prevention of fire ignition on-site and spreading to adjoining properties.*
  - *Prevention of fire spread between site infrastructure (solar panel banks, wind turbines, battery containers/enclosures).*
  - *Prevention of external fire impacting and igniting site infrastructure.*
  - *Provision of accurate and current information for emergency responders during emergencies.*
  - *Effective emergency planning and management, specific to the site, infrastructure, operations and hazards (including bushfire).*

- To inform:
  - Assessment of the proposed development and Planning Permit application.
  - Subsequent development of a Fire Management Plan.
  - Subsequent development of an Emergency Management Plan.

1.4 Project Overview

The key components of the project consist of:

- A 1900 ha development site.
- Photovoltaic (PV) modules (solar panels):
  - 795,762 modules with a maximum generation capacity of approximately 360 MW.
  - Ground mounted modules that use a single-axis, solar tracking technology.
  - Each module consisting of P type mono-crystalline cells with a 2.0 mm anti-reflection coated semi-tempered glass, set in an anodised aluminium alloy frame.
- 44 solar inverter skids.
- A Battery Energy Storage System (BESS) consisting of 950 40 ft containers and 78 BESS inverters, with 600 MW / 2400 MWh capacity.
- A substation and main control building.
- Infrastructure setback from hazards, property boundaries and to adjoining land uses.
- Roads and tracks:
  - All-weather access roads off Hamilton Highway and Connewarren Lane along with internal road and track network, suitable for heavy vehicle access.
  - Multiple access points (primary and alternate) to the three sections of the solar farm and BESS, facilitated by the proposed internal road network.
- Electrical infrastructure:
  - Underground 33 KV line connecting the solar array to the BESS.
  - 500 kV overhead line connecting the BESS to the existing Mortlake Terminal Station.
- Ancillary infrastructure:
  - Water tanks for firefighting, made of non-combustible material.
  - 2.3m high chain link security fencing installed around the solar farm asset, with existing stock fencing retained around the property boundary.
  - Closed circuit television cameras, mounted on 3m high poles around the perimeter, utilising infrared technology.

During the construction phase, construction materials will be temporarily stored in the laydown areas located at the BESS and along Hamilton Highway before installation.

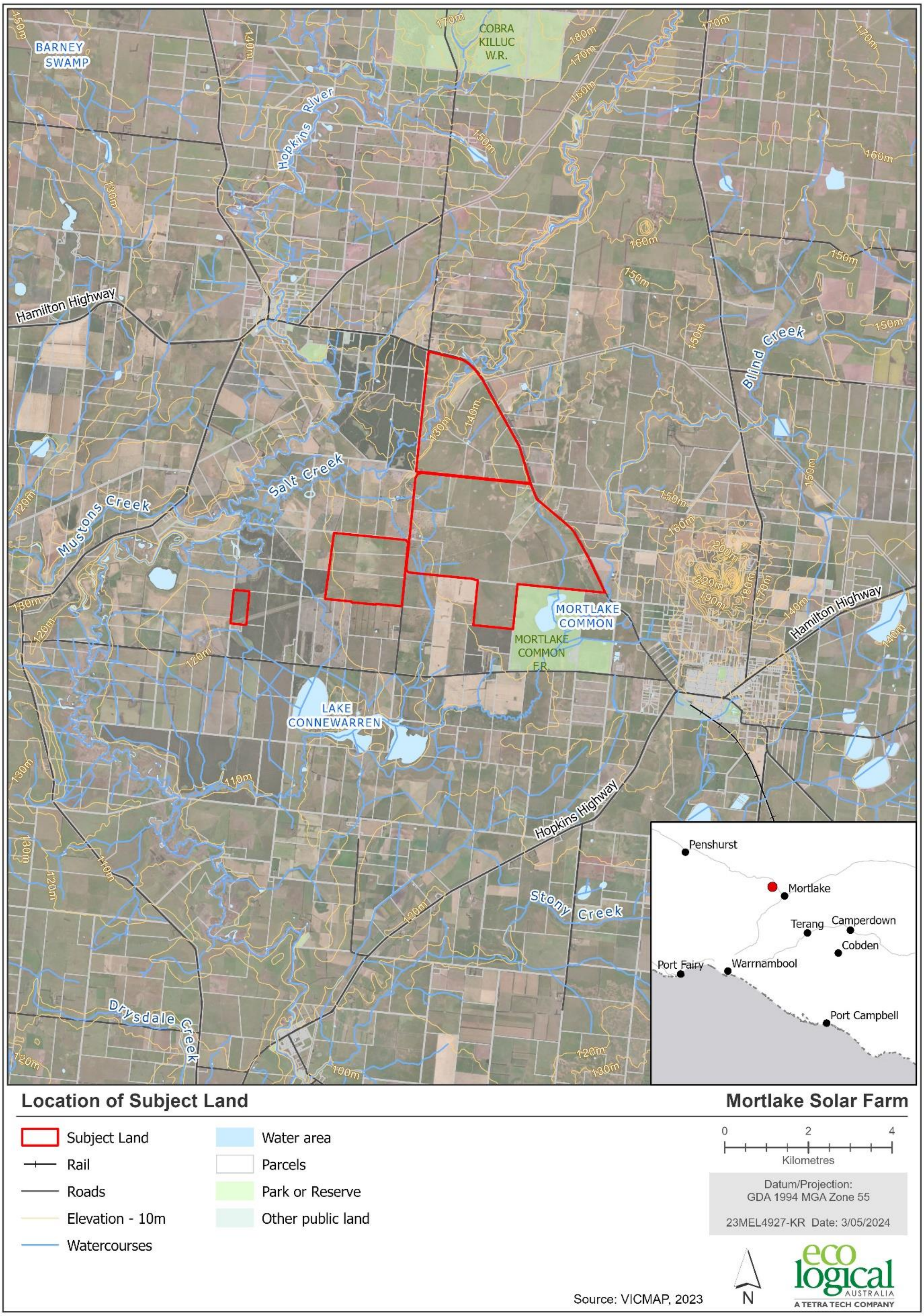


Figure 1: Project Site Locality

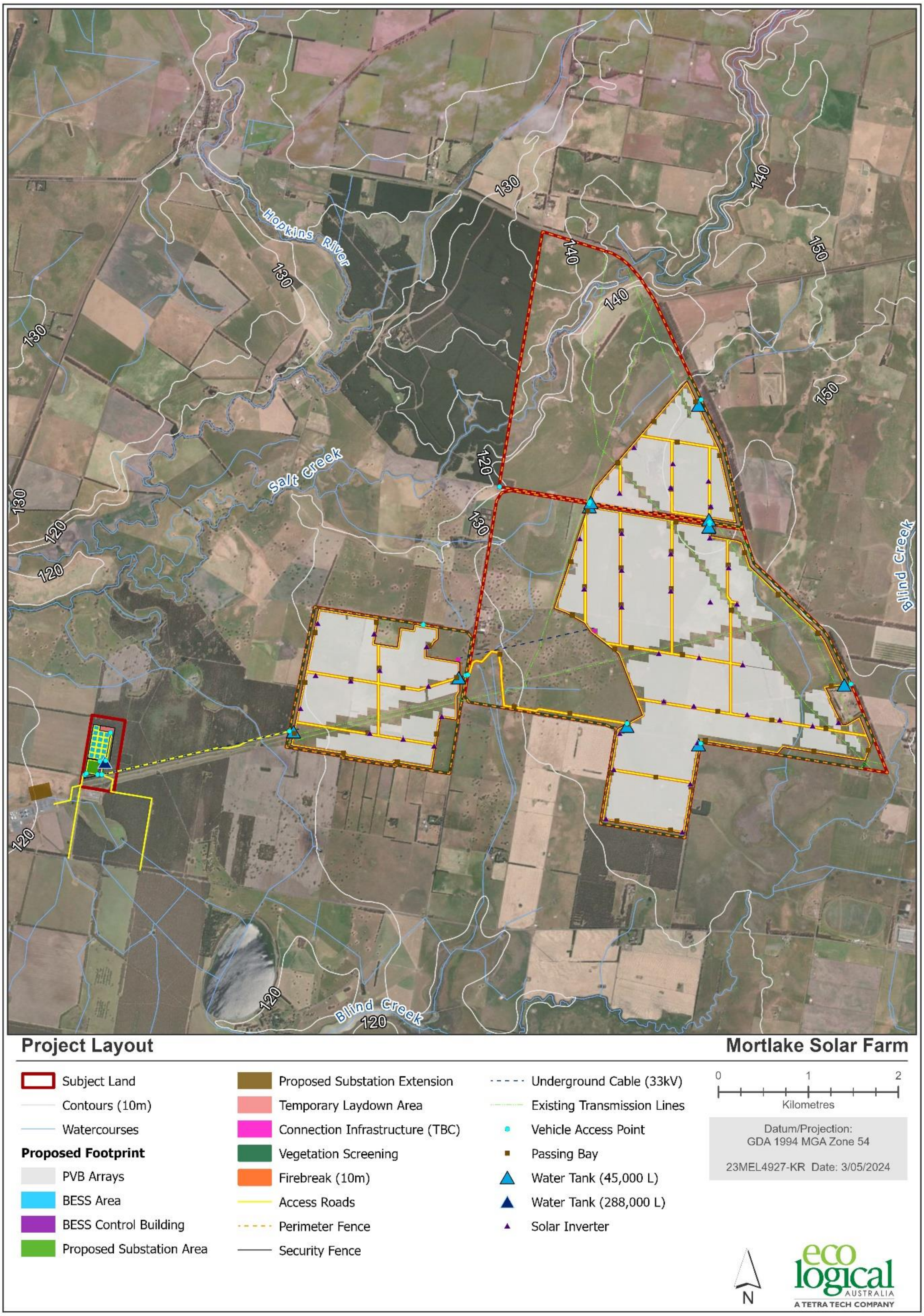


Figure 2: Proposed Project Layout

1.5 Facility Location

The level of risk exposure in the location proposed for the project is an important evaluation consideration. The CFA Design Guidelines promote locating renewable energy facilities on lower risk sites, however where in higher risk environments, the guidelines state '*strengthened or additional risk mitigation measures will be required*'. Site locations within the Bushfire Management Overlay (BMO) and Bushfire Prone Areas (BPA) are considered high-risk environments.

The entire site is situated within the BPA, and the location of the BESS is within the BMO. In addition, the south-western boundary of Site A and the southern boundary of Site C is adjacent to the BMO. Table 1 indicates the requirements (Section 4.1.1) for facilities located in high-risk environments.

Table 1: CFA model requirements for renewable energy facilities located in high-risk environments.

Model Requirements	Compliance Notes
Planning applications for all renewable energy facilities proposed in high-risk environments must address the following: a) An assessment against policy at *Clause 13.02-1S (Bushfire Planning)* where the facility is located in a Bushfire Prone Area (BPA). b) The impact of any ignitions arising from the infrastructure (solar panels, wind turbines, battery energy storage systems, electrical infrastructure) on nearby communities, infrastructure and assets. c) The impact of bushfire on the infrastructure (e.g. ember attack, radiant heat impact, flame contact). d) Assessment of whether the proposal will lead to an increase in risk to adjacent land and how the proposal will reduce risks at the site to an acceptable level.	**Complies** The PV part of the facility (Site A, B and C) is located within a low fuel hazard type (i.e. grassland) on existing agricultural grazing lands (Farming Zone) that is mapped as a BPA. The PV component adjoins high fuel hazard type (i.e. eucalypt plantation) that is mapped in the BMO, in two locations. However, it is afforded significant setbacks to this vegetation to the degree that the Bushfire Attack Level (BAL) is reduced to BAL-12.5, in accordance with AS 3959 (SA 2018). The BESS part of the facility is proposed to be located within the BMO. However, extensive vegetation clearing is proposed to surround the BESS, which will provide a significant setback to bushfire hazard. The setback proposed to vegetation mapped as BMO is 100 m, meaning that the BAL exposure will be reduced to BAL-Low from this hazard. In accordance with the CFA Design Guidelines, being located within a BMO or BPA is considered a high-risk environment. Thus, bushfire mitigation incorporated into the development design needs to respond to the landscape risk. The primary bushfire risk mitigation to be provided for the development includes: significant setbacks to high hazard vegetation to reduce the BAL exposure to appropriate levels; roads and tracks to facilitate ready access and egress; fire fighting water supply; and fire ignition mitigation measures including infrastructure control and safety systems, along with personnel / activity procedures. These matters are detailed further in Sections 2 and 3 of this report. Given the risk mitigation strategies inherent in the design and to be afforded to the facility, the proposed development is consistent with the objective of *Clause 13.02-1S (Bushfire Planning)*. Specifically, it responds to the four stated strategies: • The development design has considered and appropriately responded to the bushfire hazard, such that the bushfire risk is significantly reduced; • The development is to be sited in lower risk locations, including the BESS, which is to be afforded a significant setback to (BMO mapped) higher hazard vegetation, meaning its exposure will only be BAL-LOW; • The development will be afforded an appropriate combination of bushfire protection measures; • The risk mitigation strategies to be afforded to the development will reduce risks to an acceptable level. Potential impacts of fire ignition arising from the solar farm, and spread to nearby communities, infrastructure and assets can be mitigated to an acceptable level through the ignition management and other mitigation strategies detailed herein. Bushfire impact on the solar farm infrastructure (i.e. from ember attack, radiant heat, and flame contact) from fire spreading to the site is possible but can be mitigated through the various mitigation strategies detailed herein.

Model Requirements	Compliance Notes
	Overall, the proposal will not result in an increased level of fire risk that cannot be mitigated to an acceptable level given: • Provision of perimeter firebreaks around solar farm infrastructure along with setbacks to high hazard vegetation; • Management of onsite vegetation around electrical infrastructure to minimal fuel condition (i.e. slashing); • Ignition prevention measures and fire suppression systems; • Availability of water supply tanks dedicated for fire fighting; • Access roads and tracks for fire fighter access; • The development of a fire management plan for the facility to identify, manage and mitigate risks from fire ignition onsite or potential bushfire attack on the facility from offsite; and • The development of a fire emergency management plan for the facility, addressing fire preparedness and fire response measures.

2. Hazards and Risks

Section 2 of this FRA seeks to identify the fire hazards, assets that are at risk from various fire sources, and the factors that contribute to affecting the overall risk context.

Potential fire sources include bushfires (including bushfire attack on the facility and spread externally from the site) as well as fires associated with personnel activities, machinery, liquid fuel, structures, electrical and other facility associated infrastructure.

Factors that affect the level of risk exposure include the assets at risk as well as fire ignition factors and fire influences such as weather, fuel hazards, topography, fire behaviour and development potential.

2.1 Assets at Risk

The following assets are located on site or surrounding the proposed solar farm facility:

- Modified grazing pastures
- Livestock
- Boundary fences
- Eucalypt plantation
- Existing Mortlake power station and substation.
- Scattered rural residences and sheds in the surrounding farmland.
- The town of Mortlake, south-east of the study area.
- The locality of Hexham, north-west of the study area; and
- Mortlake Common Flora Reserve, containing biodiversity values.

Solar farm assets that are at risk include:

- PV panels and associated infrastructure;
- Battery Energy Storage System (BESS);
- Main Control Building;
- Substation;
- Electrical infrastructure (powerlines).

Temporary assets only onsite during the construction phase that could be placed at risk include:

- Construction material temporarily stored in a laydown area; and
- Construction workers, vehicles and equipment, however the fire management plan to be developed post consent will detail measures to avoid or mitigate this risk.

All these existing assets and the proposed components of the solar farm are at risk from fire that may propagate within the solar farm site, or from an external fire threat. In some scenarios, fire risk to life may arise, as outlined in Section 2.1.1.

2.1.1 Fire Fighter and Public Safety

The use of the general area surrounding the solar farm site is mostly limited to local landowners and rural workers, infrequent access by forestry plantation workers and for limited public recreation. Risk to life from fire spreading from the site is therefore limited but will be further mitigated by ignition prevention and fire suppression mechanisms. There will be no public access to the solar farm site and thus no direct public safety concern onsite.

The fire-fighters likely to respond to a bushfire in the area would be those from the Mortlake CFA station or the Hexham CFA station. Other CFA brigades that could respond to fire outbreaks in the area would include those from Ellerslie, The Sisters, Wooriwyrite, and Kolora fire stations. The normal risks to fire-fighter safety when attending a fire in grassland and forest fuels apply onsite.

The risks to fire-fighter safety associated with a fire burning the solar panels, and associated equipment include:

- Electrocution – solar panels would be energised under any natural or artificial light conditions – isolation of DC current can only occur external to any solar array because there is no single point of disconnect internally (Backstrom and Dinni 2011); and
- Inhalation of potentially toxic fumes and smoke from any plastic or rubber components such as cables (although the main structure of the panels will be glass and aluminium) or other decomposed products of the panels (Allianz Risk Consulting 2012).

The majority of the solar farm by area is comprised of PV arrays (the panels and their supporting tracking system). The panels are considered to have a low level of combustibility given only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backing sheets (framed panels only), plastic junction boxes on the rear of panels, and the insulation on wiring. The majority of the panel is composed of non-flammable components, notably including one or two layers of protective glass and aluminium casing.

Provided that there is only a limited heat source under a PV panel, together with active vegetation management underneath, their low combustibility means that fires at a solar farm are not likely to be supported by fuels associated with the PV arrays themselves and therefore the PV infrastructure poses a low overall risk to fire fighter safety.

Potential risks to fire fighter safety associated with the supporting BESS infrastructure (Worksafe 2019) include:

- Electrocution - BESS have the potential to deliver a severe electrical shock when interconnected as battery banks, reaching hazardous voltage levels;
- Arc Flash/Fire & Explosion - this occurs where the battery short circuits or a fault occurs which can result in temperatures reaching 12,000 degrees Celsius with the capacity to melt metal and cause fires and explosions. They can also produce flammable gases if there is a fault. Fire and explosions can result from excessive temperatures, component failure, short circuit or loose connections; and
- Hazardous Chemicals - this occurs where battery casings rupture as a result of extreme temperatures occurring from chemical reactions, such as from over-changing. Where ruptured, the electrolyte contained internally within the battery can leak externally releasing toxic fumes and posing risk of burns or explosions.

The risk to fire fighter safety from a fire in the BESS can be mitigated by control and safety systems to reduce this risk, along with suppression systems, equipment and a layout/design that assists safe fire response.

In addition to the above, there are specific construction phase risks to fire fighter safety and personnel including fires in stored materials, vehicle or machinery fires, and grass fires. The risk of and from these fires can be managed through appropriate avoidance, mitigation and response procedures.

2.2 Fire Ignition

The main potential sources of fire ignition can occur from agricultural activities, forestry operations, machinery use, lightning strikes, escape from legal and illegal burning operations, and anthropogenic causes (i.e. cigarettes, arson, motor vehicle accidents, slashing machinery, earthmoving plant, angle grinders, and welders).

Farming activity and machinery are well known for starting bushfires under conditions of high temperature, low humidity and high wind.

Lightning strikes during dry storm activity can also be experienced in the summer months each year, resulting in ground strikes and fire ignitions when associated with little to no rainfall.

Construction and ongoing maintenance of the solar farm presents potential sources of ignitions during the bushfire season including:

- Fires as a result of electrical or mechanical faults;
- The use of or inappropriate storage of flammable fuels;
- Utilisation of machinery and equipment;
- Land management activities (e.g. fire break maintenance, vegetation management along access road or powerlines);
- Construction or maintenance activities (e.g. welding, grinding and other ignition generating works); and
- Other anthropogenic sources (e.g. from discarded cigarette butts, cooking fires, fire starts from vehicles or accidents, etc.).

2.3 Bushfires

2.3.1 Fire Weather

Fire weather strongly influences the likelihood of ignition and how often fires that are ignited will be uncontrollable. The bushfire season is declared annually by the CFA Chief Officer and generally commences on October 1 and concludes on March 31 the following year, however these dates can be modified depending on the season and conditions.

The fire weather relevant to the Mortlake Energy Hub site has been investigated using data from the Bureau of Meteorology (BOM, 2024) for the Morwell (Latrobe Valley Airport) weather station. The BOM data reveals that the hottest and driest weather occurs on average during the months of January, February and March (Figure 3). Elevated fire weather conditions would therefore generally correspond with this period, in addition to other periods in years of significantly below average rainfall combined with high temperature, as has occurred in the months of October, November, December and April (Figure 4). Days of elevated fire weather would generally follow periods of hot and dry weather, combined with strong winds from the north to west, or during a southerly change (Figure 5).

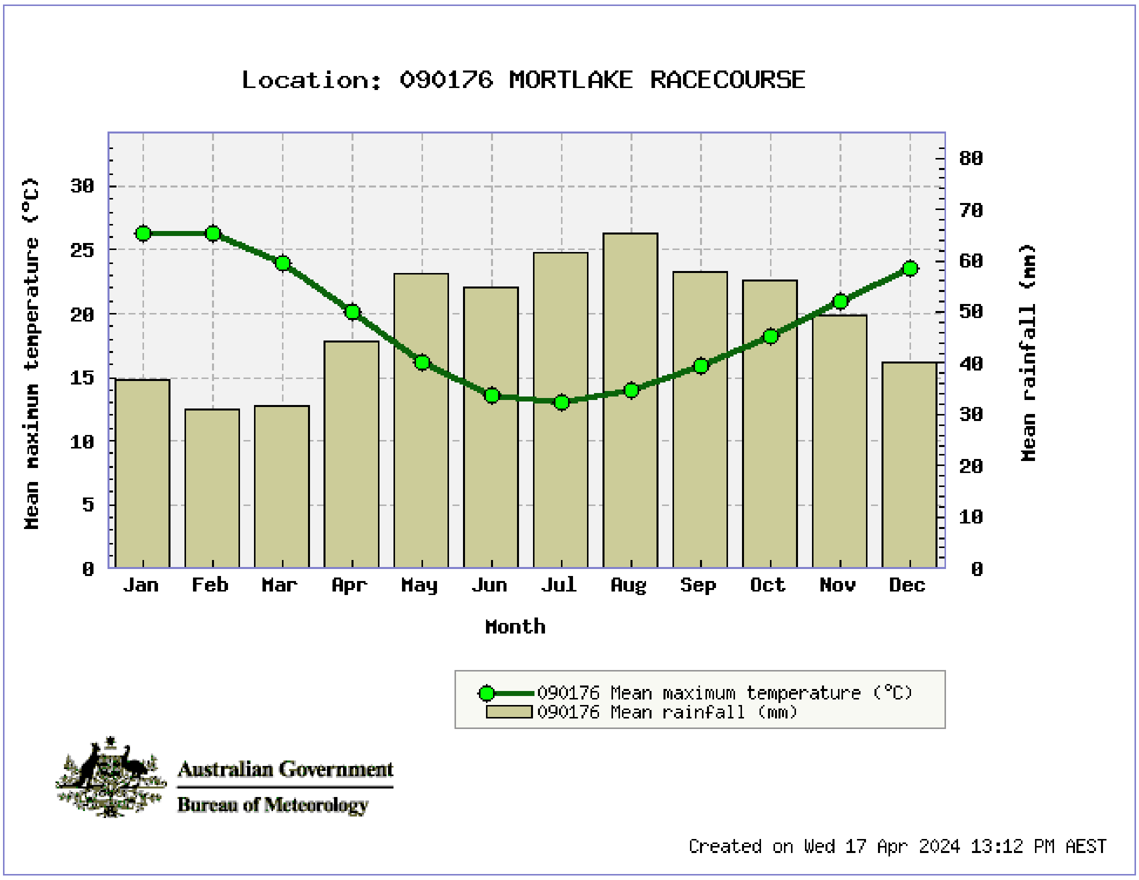


Figure 3: Weather averages (BOM 2024)

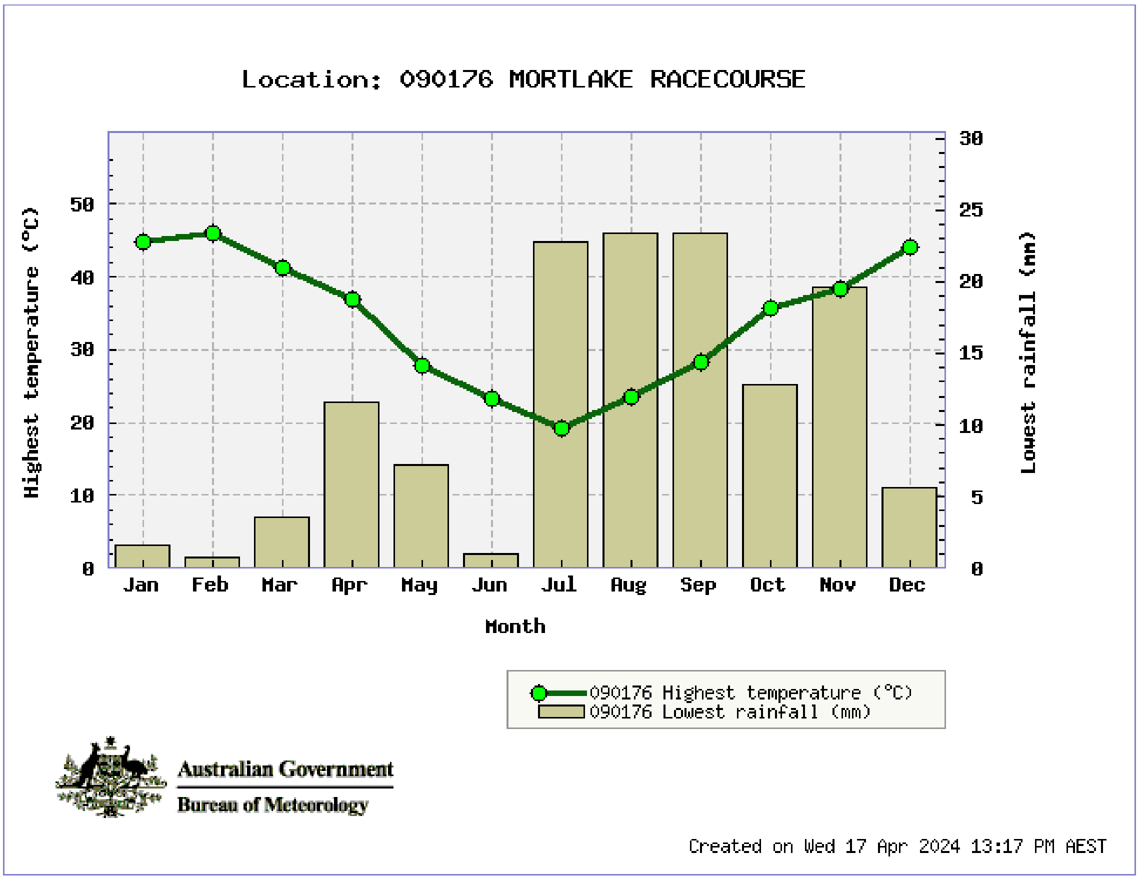


Figure 4: Weather Extremes (BOM 2024)

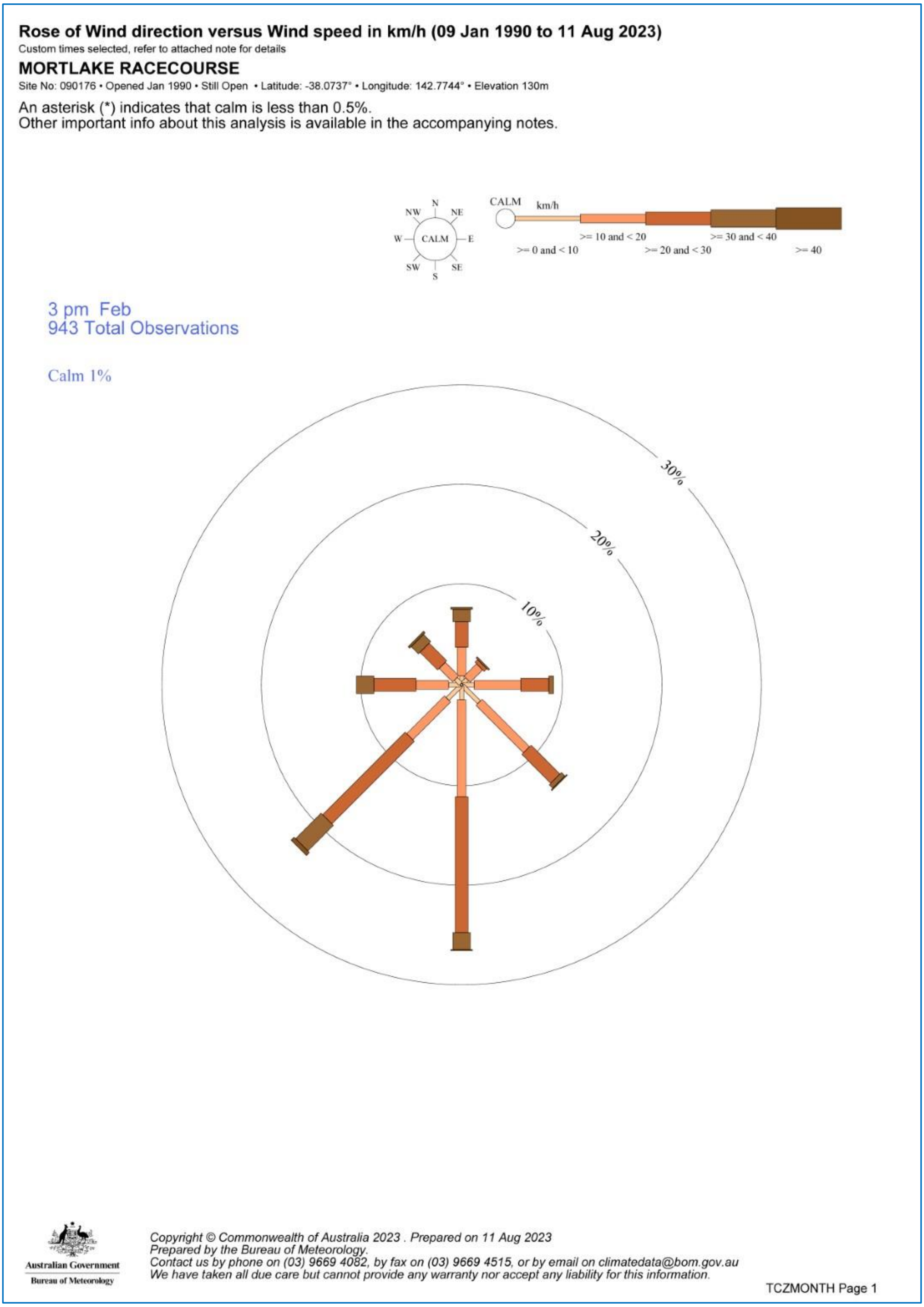


Figure 5: Wind Rose - Average 3pm Condition in February (BOM 2024)

2.3.2 Fuel Hazard

The land surrounding the site is largely used for mixed farming and grazing, as well as for eucalyptus plantation (Figure 6). The fuel hazard within and around the site therefore predominately classifies as grassland with a lesser extent of forest, in accordance with AS3959 (SA 2018) (Figure 7).

The forestry plantation in adjoining lands represents a temporally and spatially variable fuel hazard, depending on the state of forest growth / harvest. In a similar way, the grassland fuel hazard is temporally and spatially variable, depending on the pattern and intensity of grazing, along with grass growth and degree of curing. For much of the year, grass may not be cured and/or may be in an 'eaten out' state and therefore less likely to support fire development and spread.

Land uses and fuel hazards across the broader landscape are similar to those proximal to the site, albeit there is greater predominance of grassland hazard on generally flat terrain (Section 2.3.3). As such, the primary bushfire risk is grassfire, which whilst it burns hot and quick, is less likely to result in significant landscape scale spread, thus indicating the lower risk landscape where the site is located.

It is intended that the grassy fuels within the solar farm site be maintained in a low fuel state by mechanical, grazing and chemical methods prior to construction activities commencing and as part of ongoing maintenance activities for the duration of operation and decommissioning of the facility.

2.3.3 Topography

The subject site is located in a landscape of generally flat terrain. The topography of the land within and surrounding the site is predominately flat, with an elevation range across the site of between 120 m to 140 m above sea level (Figure 7). Slope assessment in accordance with AS3959 (SA 2018) indicates that adjoining bushfire hazards north and west of the development are generally flat or downslope 0-5° (predominately 1°) and hazards east and south are generally flat or upslope.

2.3.4 Fire Behaviour Potential

Within the study area, grassland is the predominant fuel type, along with discrete areas of Eucalypt plantation (i.e. forest hazard). These fuel hazard types along with the topography and fire weather contribute to the bushfire behaviour potential.

2.3.4.1 Grassland Areas

In relation to grassland fuels, there will be periods when these modified pastures and cropped lands will be non-flammable because they are either fallow, too green to burn or are recently planted. There will also be periods when the pastures and crops are cured and highly flammable.

In relation to grassland fuels, as the predominant agricultural activity in the area is livestock grazing, there will be periods when pasture has been grazed substantially enough to pose a very low fire risk. In contrast, there will also be periods when pasture is cured and highly flammable.

Within and surrounding the site, the grassland fuels are generally in a fuel reduced state i.e. 'eaten out' or 'cut/grazed'. This lessens the likelihood for an ignition source developing into a fire and can reduce the spread potential under mild conditions, along with the effectiveness of fuel breaks (e.g. roads, tracks and fire breaks).

Despite this, it should be assumed that under the most extreme fire weather, a fire would spread even in heavily grazed grass. The rate of spread and fire intensity values for 'eaten out pastures' are considerably lower compared to 'cut/grazed pastures', however significant fires can still develop (Cruz et al 2015). The residence time for flames in heavily grazed pasture are likely to be very short, probably less than five seconds (Cheney and Sullivan 2008), so the solar farm components will have a similarly short time of exposure to flame contact (if any) and high radiant heat.

Fire breaks can be effective at stopping grass fires, however, at wind speeds greater than 25 km/h even very wide fire breaks can fail (Cheney and Sullivan 2008). Under the worst weather conditions that could be expected, a fire break of even 40 m width may fail to stop a grass head fire (Cheney and Sullivan 2008). Therefore, fire breaks are utilised as one part of the bushfire mitigation and protection strategy.

2.3.4.2 Woodland and Forest Areas

The main wooded vegetation type in the locality is eucalypt plantation, which classifies as a 'forest' and could therefore present fire behaviour somewhat similar to a natural forest. However, the plantation fuel hazard is temporally and spatially variable, meaning that fire behaviour is dependent on the fuel hazard state.

Previous studies predicting bushfire behaviour potential for 'forest and woodland' vegetation (Nobel *et al.* 1980) found rate of spread and fire intensity values in woodland and forest vegetation can be fast and intense. Similar findings were found for bushfire behaviour potential in 'forest' vegetation structures under Project Vesta (Gould 2008). Given the bushfire behaviour potential for the 'forest and woodland' (i.e. potential for significant levels of intensity beyond controllability limits) direct attack on such fires will usually fail at elevated fire weather conditions (Table 2 from Cary, 2011).

Table 2: Suppression capabilities at increasing fire line intensities (Cary 2011)

Fireline Intensity (kW/m)	Suppression
<350	Head/flank attack using hand tools Hand constructed breaks should hold
350 - 2000	Too intense for hand attack Dozers and tankers with retardant effective on flanks and possibly head fire. Fires may jump dozer breaks
2000 - 5000	Fires represent serious control problem May be crowning and long-distance spotting Head fire attack will fail and will endanger lives of fire fighters
> 5000	Crowning, long distance spotting, whirlwinds and highly erratic fire behaviour Control efforts at the head of fire will fail Mass spotting and erratic fire behaviour can endanger fire fighters many kilometres ahead of the main fire front

2.3.5 Fire History

The wildfire history in the area is minor, with only two small grass fires mapped within 10 km of the project area, one in 2004 some distance to the south west and another in 2012 within Mortlake Common which adjoins part of the southern boundary of the site. In addition, there have been several small fuel reduction burns within parks or reserves within the region (Figure 8).

Whilst the compiled wildfire history mapping would not contain all bushfire occurrences, the collated fire history indicates an absence of large wildfires in the area surrounding the site. The compiled fire history dataset indicates a lower likelihood of bushfires impacting on the subject site, especially larger scale events burning under elevated bushfire weather conditions.

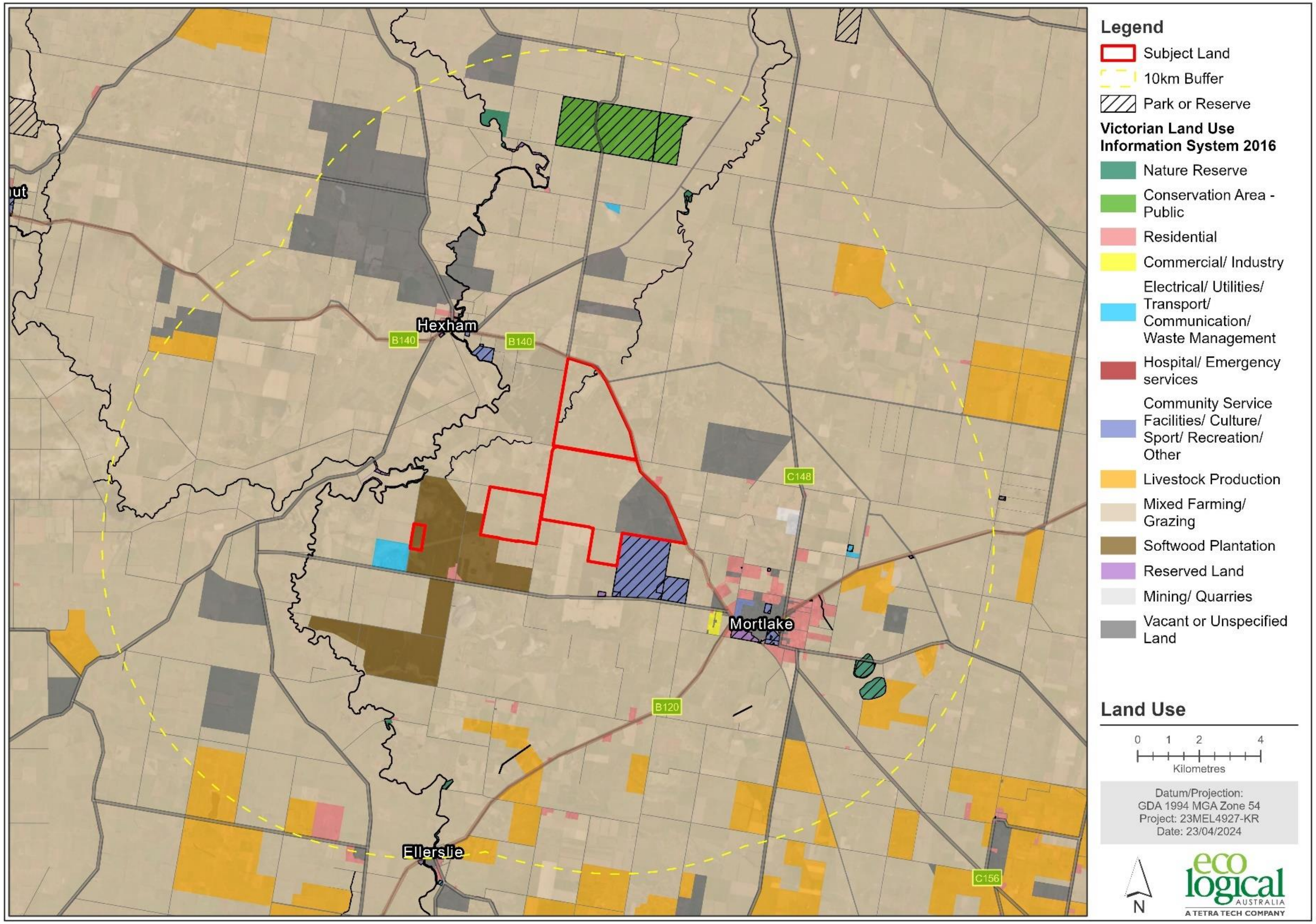


Figure 6: Land Use

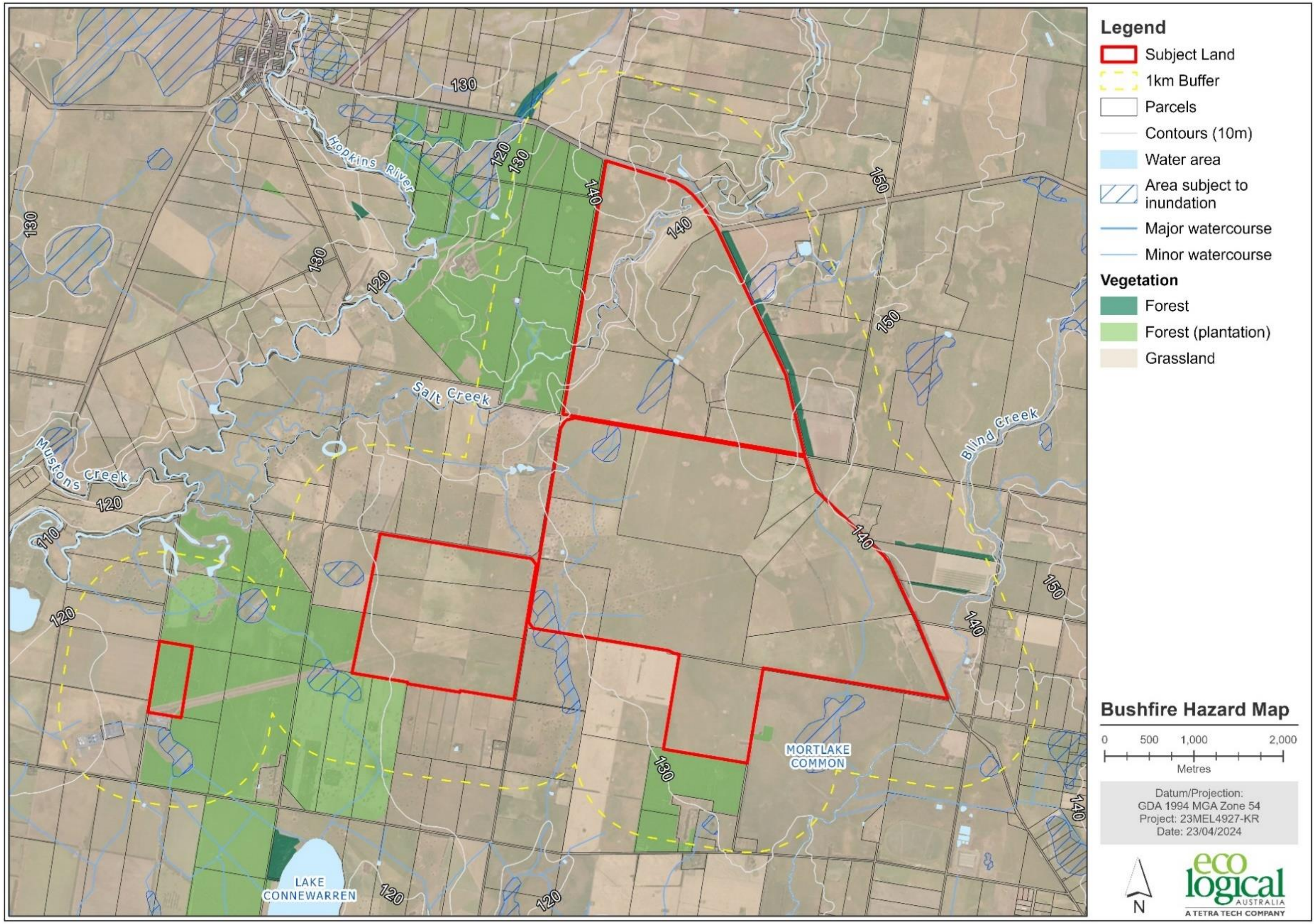


Figure 7: Bushfire Hazard Assessment

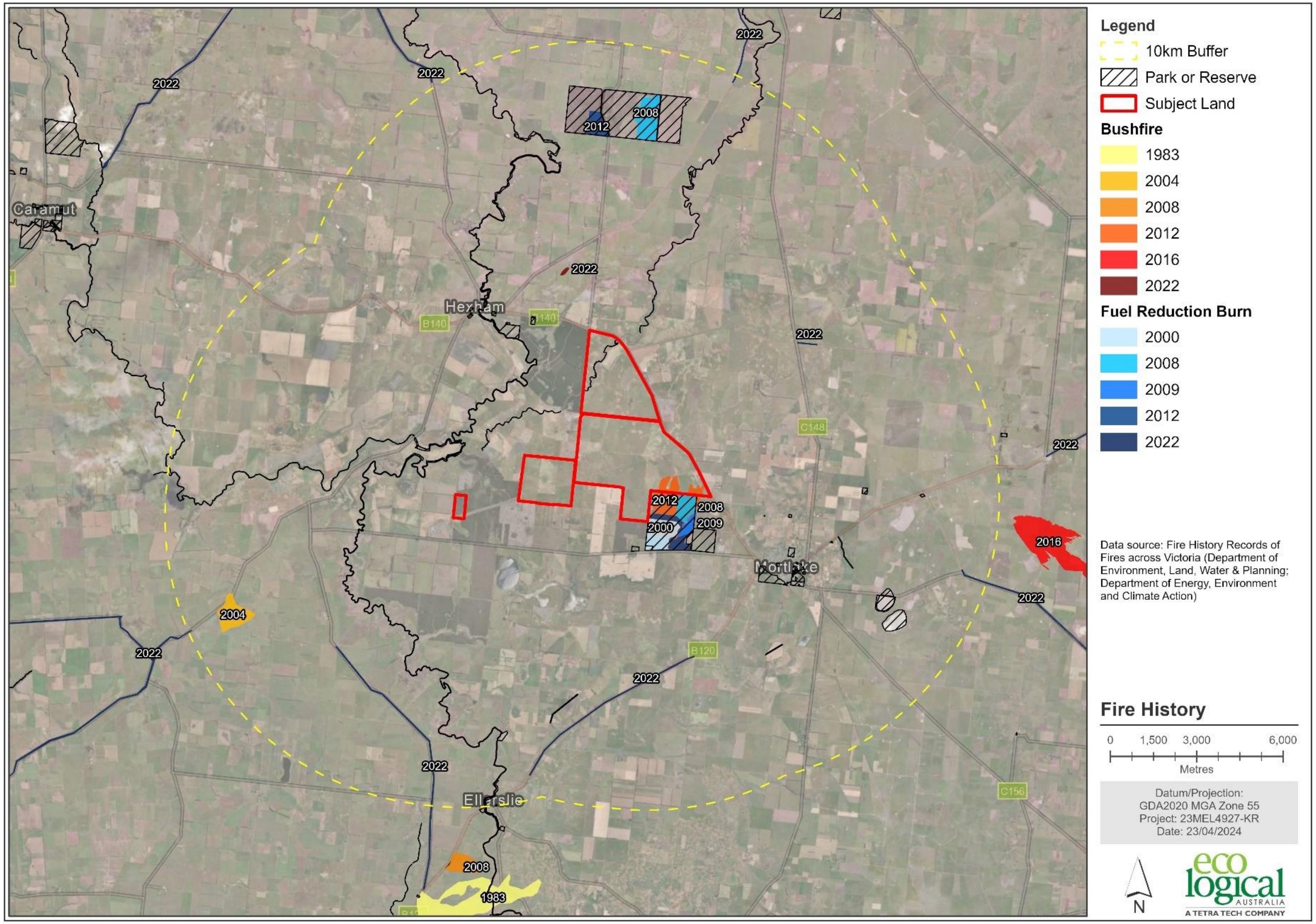


Figure 8: Fire History (DEECA 2024)

2.3.6 Bushfire Scenarios

The perceived worst case bushfire scenarios have been considered for the purpose of understanding the level of bushfire risk exposure based on the fire weather, fuels, terrain, fire behaviour potential and fire history. They assume bushfire risk mitigation strategies have been implemented for the development.

Solar Panel Array

1. A large landscape scale bushfire starts outside of the project site, near Hexham to the northwest on a day with an FBI of 50 or higher. Winds are from the west to northwest, with fully grown eucalypt plantation bordering the western boundary of the Site A PV field, and dense fully cured grassland in non-forested areas adjoining other site boundaries. The fire progresses east and southeast, reaching the PV field boundary, with ember attack and radiant heat on the facility. The likelihood of such a large-scale fire occurrence is low, given the typically 'eaten out' state of the grassland vegetation during the peak of the fire season, and interruptions to fuel continuity from roads, tracks, waterbodies etc, which would lessen the chance of fire spread. The risk of fire encroachment onto the facility is lowered by the perimeter firebreak, the managed state of grassland within the facility, and the non-flammability of the infrastructure.
2. An electrical fault ignites managed grass (less than 100mm in height) under a solar panel array on a day with FBI of 50 or greater, with a west to northwest wind direction and at a time when grassland fuels within the site as well as grazing land adjacent to the facility are fully cured. The fire spreads to the east and southeast where it could impact Mortlake Common Flora Reserve, rural properties or assets, and potentially commercial property and residences on the outskirts of Mortlake. As for the first scenario, the likelihood of such a fire igniting within the facility is low, given the electrical system management and ignition prevention strategies to be employed. In addition, regular vegetation management undertaken across the site, as part of the operational maintenance program, the perimeter firebreak, and fuel discontinuity in the surrounding landscape will all serve to facilitate reduced ignition and fire progression potential. Furthermore, suppression resources and opportunities both on and off site will limit the chance of fire development and spread of this magnitude.

BESS Facility

1. A large landscape scale bushfire starts outside of the project site, in farmland to the northwest of the BESS facility, on a day with an FBI of 50 or higher, with winds from the west to northwest. The fire spreads eastward through pasture grass that exists in an un-grazed and fully cured state, interspersed with planted windbreaks. The majority of the fire front reaches the perimeter fence and firebreak surrounding the BESS. However, given the large setback afforded to the BESS from the site boundary, sized to achieved BAL-12.5 or less, fire attack through adjoining grassland is not expected to be significant.
2. A fire spreads to or starts within the Eucalypt plantation and spreads towards the BESS. The largest potential fire runs to the BESS are from the north-east through to south-east. Whilst a large fire could reach the BESS, it is of lower likelihood and would likely be of reduced severity given the generally lesser fire weather conditions experienced during winds from these directions. In addition, a 100m setback to forest vegetation is proposed, resulting in BAL-Low exposure. Therefore, the only bushfire attack mechanism of note would be ember attack. Within the BESS, the risk of a fire being ignited by ember attack is very low, as the infrastructure is of non-

flammable construction and well protected. Fire suppression resources and opportunities within the facility also limit the chance of fire development.

3. An electrical fault within one of the BESS containers causes an explosion, on a day with an FBI of 50 or higher with winds from the west. Flaming debris is thrown into the air and ignites surrounding vegetation which then spreads into the surrounding plantation. The wind carries this fire front to the east, igniting the bulk of the plantation and further increasing the intensity of the fire and spreading embers into the surrounding farmland, igniting spot fires, threatening farm infrastructure and residences, and posing a risk to the solar panel arrays, approximately 2km east of the BESS. While this scenario is possible, it is highly unlikely as the BESS containers are protected with monitoring, control, explosion prevention and fire suppression systems. Further the BESS is serviced by other fire suppression resources including dedicated fire water and access.

The risk of a major fire spreading to or from the solar farm is low, based on the low likelihood of ignition, good suppression opportunities, impedances to fire development and spread (i.e. roads, fuel breaks and fuel reduced areas). Despite the low likelihood, the risk still warrants mitigation.

In contrast to major fires, the risk of less severe or smaller fires spreading to or from the solar farm is higher, albeit still relatively low. This includes bushfires burning under more moderate conditions, fire escapes from neighbouring lands including prescribed burns, and on-site ignitions. Given that fire weather conditions are more moderate in this scenario, fire spread to the solar farm is more likely to be impeded or suppressed, before reaching the site, and any fire that does reach the site will be less severe and pose less risk of impact during attack on the facility. Similarly, any fire starting on the site, is less likely to present significant spread and risk to life and property off-site.

2.4 Other Fire Types

2.4.1 Machinery or Vehicle

Machinery or vehicle fires pose a hazard in that toxic gases are released and other hazardous substances along with flying debris and explosions are a serious danger to staff, site visitors, and fire fighters. A dangerous byproduct of these fires is potentially lethal quantities of carbon monoxide.

2.4.2 Structural

A main control room building is proposed, located adjacent to the proposed BESS and substation locations. Therefore, there exists the potential for a structural fire to occur within the proposed solar farm facility.

2.4.3 Electrical

Electrical fires within the solar facility can occur as a result of PV panel and inverter related electrical faults as well as DC electricity being retained within the solar panel post shut-down or isolation of the units. Other sources of electrical fires include the powerline connection and the BESS units as a result of a thermal runaway event triggered from events such as battery faults, internal short circuits, overcharging, and lighting strikes.

2.4.4 Flammable Liquids

There is no flammable liquid storage contemplated for the facility. However, diesel or petrol fuel may be brought to site in containers for some construction or maintenance tasks. Therefore, liquid fuel fires within the facility are a possible fire source. Diesel has a flashpoint of between 52^{o}C and 96^{o}C, whereas petrol has a flashpoint of -43ºC (STOREMASTA 2023) and can catch fire very easily when exposed to an ignition source, and thus must be stored/handled carefully.

2.4.5 Other Fires Risk Summary

The risk of fire development from other fires types covered in Section 2.4.1 to 2.4.4 and propagating outside of the facility is considered to be very low in combination with a number of risk mitigation factors covered in Section 3.

These risk mitigation factors include appropriate solar design practices; ignition management practices; fire response resources (fire breaks, water supply, and access), fire awareness training, compliance with the appropriate Australian Standard (AS 1940-2017), remote site monitoring, isolation, suppression systems and regular inspection and maintenance schedules of solar infrastructure; and emergency awareness and preparedness.

3. Risk Mitigation Strategies

3.1 Overview

Mitigation strategies are guided by knowledge of the factors that contribute to the risk:

- Fuels, fire weather, topography, potential bushfire behaviour;
- Spatial patterns and frequency of unplanned ignitions;
- Plausible worst case bushfire spread and attack scenarios;
- Suppression capability including resources (air and ground), access (roads, tracks) and fire fighting water supply; and
- Values and assets at risk and the degree or consequence of impact: people, buildings, commerce, industry, services, heritage and the natural environment.

Mitigation strategies are also guided by evidence of the efficacy of available treatment options, likelihood of risk reduction, implementation practicalities and cost-benefit. Mitigation must be a combination of complementary strategies, all of which are required to provide the most appropriate risk mitigation outcome for the facility and the community. The CFA Model Design Guidelines are considered in the development of an appropriate suite of mitigation measures.

3.2 Facility Design

The intent of this Section is to ensure that the facility is designed to eliminate or reduce the overall risk of fire occurring within the site or offsite fire impacting the facility and its consequences. Design measures used to mitigate the risk include compliance with separation between solar farm components including PV panels, BESS, and other onsite infrastructure. Other compliance requirements relating to the BESS include provision of fire breaks, the safety of emergency responders, suitable siting, fire detection and suppression systems, ember protection, and access.

Table 3 indicates the model requirements for facility design under Section 4.2.6 of the CFA Design Guidelines for large-scale solar farms. Table 4 indicates the model requirements for BESS facility design under Section 4.2.6 of the CFA Design Guidelines for BESS facilities.

Table 3: CFA model requirements for design of renewable energy facilities

Model Requirements	Compliance Notes
Facility Design - Solar Energy Facilities	
Solar energy facilities are to have a minimum six (6) metre separation between solar panel banks.	**Complies** As per the design plans, solar panels banks will have a minimum separation distance of 7.25 metres.

Table 4: CFA model requirements for design of renewable energy facilities with BESS

Model Requirements	Compliance Notes
Facility Design - BESS	
1) The design of the facility must incorporate: **a)** A separation distance that prevents fire spread between battery containers/enclosures and: • Other battery containers / enclosures • On-site buildings • Substations	**1) To Comply** **a)** A Fire Engineering Design Brief, Fire Safety Study (as per NSW Planning's Hazardous Industry Planning Advisory Paper 2: Fire Safety Study Guidelines (2011)) or an equivalent assessment, should be undertaken for the project to ensure adequate separation distances between the BESS units and appropriate safety systems to prevent fire spread between enclosures and other built and natural

Model Requirements	Compliance Notes

• The site boundary
• Any other site buildings
• Vegetation
Separation must be at least the distance where the radiant heat flux (output) from a battery energy storage system container/enclosure fully involved in fire does not create the potential for ignition of these site elements.
 	
b) A fire break around the battery energy storage system and related infrastructure, of a width of no less than 10m, or greater where determined in the Risk Management Plan.
Fire breaks must be non-combustible, constructed of concrete, mineral earth or non-combustible mulch such as crushed rock.
The width must be calculated based on the ignition source being radiant heat of surrounding vegetation, including landscaping.
 	
c) A layout of site infrastructure that:
i. Considers the safety of emergency responders.
ii. Minimises the potential for grassfire and/or bushfire to impact the battery energy storage system.
iii. Minimises the potential for fires in battery containers/enclosures to impact on-site and off- site infrastructure.
	assets.
	b) A fire break is provided by the BESS facility perimeter road of 6 m wide with further setbacks of 3 m between the road and BESS units and 2 m between the road and the security fence, providing a total of 11 m. . In addition, a 100 m Asset Protection Zone (APZ) is afforded to the north, east and south of the BESS (i.e. the directions where forest vegetation is located), which reduces potential fire exposure from these directions to BAL-Low. To the west of the BESS, an APZ to the property boundary of 33 m is provided. Beyond the property boundary there is the lesser fuel hazard type of grassland vegetation, so the APZ results in an appropriate BAL-12.5 exposure from this direction. These APZ areas will be cleared of forest vegetation and maintained in a minimal fuel state.
	c) To enhance the safety of emergency responders, the BESS layout (Appendix A) contains:
	• Significant APZs provided on all elevations greatly lessening the BAL exposure from any fire on adjoining lands as outlined above.
	• Three access/egress routes:
	  ○ One access/egress point in the south eastern corner of the BESS site providing a route south to and from Connewarren Lane.
	  ○ Another access/egress point in the south western corner of the BESS site providing an alternate route south to Connewarren Lane as well as west to an existing electrical substation and Mortlake Power Station.
	  ○ An emergency access track along the powerline route, which connects the above access points with the solar panel fields to the east and other public road access/egress options.
	• Six (6) metre wide roads around and within the facility to provide suitable access to BESS and fire service infrastructure.
	• A static water supply of a minimum 288,000L capacity dedicated for fire fighting located immediately adjoining the entrance road.
	• A fire hydrant network distributed within the BESS site; and
	• Onsite safety and advisory signage.
	The impact of bushfire spread to the BESS units is minimised (beyond any intervention by emergency services) through the provision of a significant APZ (as outlined above) and a perimeter fire break, along with the robust non-combustible construction of the BESS units.
	Monitoring, safety and fire suppression systems are proposed for incorporation into the BESS containers, so as to mitigate the risk of fire start and impact on adjoining infrastructure, vegetation or persons.

2) Battery energy storage systems must be: **a)** Located to be reasonably adjacent to a site vehicle entrance (suitable for emergency vehicles). **b)** Located so that the site entrance and any fire water tanks are not aligned to the prevailing wind direction (therefore least likely to be impacted by	**To Comply** **a)** The proposed BESS compound is accessed from the existing public road network by three access/egress routes, suitable for emergency vehicles. **b)** The fire water supply is conveniently located close to the primary vehicle access road, however there is opportunity

Model Requirements	Compliance Notes
smoke in the event of fire at the battery energy storage system.) **c)** Provided with in-built fire and gas detection systems. Where these systems are not provided, measures to effectively detect fires within containers must be detailed within the Risk Management Plan. **d)** Provided with explosion prevention via sensing and venting, or explosion mitigation through deflagration panels. **e)** Provided with suitable ember protection to prevent embers from penetrating battery containers/enclosures. **f)** Provided with suitable access roads for emergency services vehicles, to and within the site, including to battery energy storage system(s) and fire service infrastructure. **g)**Installed on a non-combustible surface such as concrete. **h)** Provided with suitable ventilation. **i)** Provided with impact protection to at least the equivalent of a W guardrail-type barrier, to prevent mechanical damage to battery containers/enclosures. **j)** Provided with enclosed wiring and buried cabling, except where required to be above-ground for grid connection. **k)** Provided with spill containment that includes provision for management of fire water runoff.	for layout adjustments during detailed design, if sought by the CFA. **c)** All BESS units are to be fitted with fire and smoke detection, gas sensors, ventilation, and sprinkler suppression systems (Appendix C). **d)** The BESS units are afforded explosion prevention provided by monitoring and detection systems, fire protection systems, internal design and venting. The ventilation system has been independently tested and assessed as compliant with NFPA69-2019: *Deflagration Prevention by Combustible Concentration Reduction* (Appendix C). **e)** It is recommended that all BESS units are to have openable doors affixed with rubber protection strips or other equivalent device that seal in a closed position against ember entry. All ventilation openings should be screened with metal mesh with aperture size no greater than 2mm to prevent ember entry. Ember protection to be in accordance with Australian Standard AS 3959:2018 *Construction of buildings in bushfire prone areas* (AS 2018). **f)** The BESS facility will be serviced by three access routes (as above) along with a perimeter and internal road network. The onsite road network provides access to the static fire water supply as well as the hydrant network. **g)** The BESS units will be installed on concrete foundations. **h)** The ventilation system has been independently tested and assessed as compliant with NFPA69-2019: *Deflagration Prevention by Combustible Concentration Reduction* (Appendix C). **i)** The BESS compound must be provided with barrier impact protection, such as concrete bollards or a metal guard rail to prevent vehicle impact damage. **j)** All cabling between the BESS containers and the inverter / switchgear must be enclosed underground. All communication and I/O circuit cables will be buried in HDPE conduit. **k)** Spill containment for the BESS units must be designed with a concrete bund or a retaining wall retention basin, or a combination of both. The bunded area should incorporate a manual shut-off valve installed to the graded sump pit, such that under standard operation the valve remains open to enable rainwater to drain away. In the event of an emergency and a fire within the BESS, emergency personnel will manually close the valve to isolate the spill. The sump capacity is to meet the required fire water supply capacity for the solar farm facility.

3.3 Ignition Management

3.3.1 Australian Fire Danger Rating System

The Fire Danger Rating (FDR) under the Australian Fire Danger Rating System forecasts and reports fire danger using up-to-date fuel state data, spatial and satellite data, weather data, science, and technology. It uses decades of research incorporated into eight fire behaviour models. The Fire Behaviour Index (FBI) which adopts values between 0 to 100 is used to review in finer detail and assist in better decision making within the four Fire Danger Ratings. The higher the FBI the more dangerous the fire behaviour and therefore fire danger risk. The four FDR categories are displayed in Figure 9.

Figure 9: Fire Danger Ratings

During both the solar farm construction and ongoing operational phase, consideration should be given to cease or modify potential ignition generating activities on elevated fire danger days. These are discussed in further detail in Section 3.3.2 and Section 3.3.3 below and should be detailed in the Fire Management Plan for the project.

Daily forecast FDR and declared Total Fire Bans (as determined by the Bureau of Meteorology and the Country Fire Authority respectively) can be viewed at www.cfa.vic.gov.au/warnings-restrictions/total-fire-bans-and-ratings.

3.3.2 Solar Farm Construction

Should construction of the solar farm take place during a period of elevated bushfire risk, which based on the bushfire danger period would generally be expected to be between 1 October and 31 March on most years, the following mitigation measures are recommended to control the risk of fire ignitions during construction:

- Fire breaks, APZ and site access routes to be constructed and maintained for the facility prior to infrastructure installation and any other construction works.
- All plant, vehicles and earth moving machinery to be kept clean of any accumulated flammable material (e.g. soil and vegetation).
- All operations involving earth moving equipment, vehicles, slashers, hot works (e.g. grinders, welders) and any other works with potential to generate ignitions, to cease while the FDR is forecast to be Extreme or greater and / or a Total Fire Ban is declared, unless they are undertaken in an area free of combustible materials.
- Controls are put in place to avoid or minimise the risk of other anthropogenic ignition sources such as from cigarettes, cooking fires, vehicles.
- All vehicles should contain a fire extinguisher and all activities with ignition risk potential should have a fire extinguisher readily available nearby and someone trained in how to use it.
- The handling and storage of flammable goods is undertaken in accordance with AS1940-2017.

- Promote awareness amongst employees, contactors and other site visitors to prevent all potential fire ignitions within the subject site and especially on days of elevated fire danger (i.e. High FDR or above).
- All construction activities to cease and no persons to be onsite on days of Catastrophic FDR.

3.3.3 Solar Farm Ongoing Operations

To minimise the risk of fire ignitions, all operations involving earth moving equipment, vehicles, slashers, hot works (e.g. grinders, welders) and any other works with potential to generate ignitions, should cease while the FDR is forecast to be Extreme or greater and / or a Total Fire Ban is declared, unless they are undertaken in an area free of combustible materials.

A Fire Management Plan should be developed and document these ignition management measures along with any other adjustments to operational activities to respond to elevated fire weather conditions.

3.4 Fuel Management

It is assumed that there is potential for a fire to start and spread within the footprint of the solar farm. Fire ignitions could include lightning strikes, human error, electrical faults or arson. For this reason, it is recommended that vegetative fuels throughout the solar farm site be maintained in a minimal condition by grazing, slashing, mowing or herbicide treatment. This will minimise the ignition and fire development probability along with the radiant heat exposure to solar farm components from any fire and reduce the risk of a fire spreading beyond the solar farm site should an onsite fire occur. Where fuel management is not possible under the PV panels, other lower risk ground cover should be considered e.g. mineral earth, gravel or non-curing ground cover vegetation.

It is recommended that a Fire Management Plan (FMP) be developed for the facility that includes a schedule of works implementation to establish and maintain fire breaks around both the site perimeter and associated infrastructure, to reduce the risk of fire impacting on the site or from escaping the site.

3.4.1 Fire Breaks

Table 5 shows the model requirements for fire breaks from Section 4.2.5 of the CFA Design Guidelines that are required to be addressed at the facility. Table 6 shows the model requirements for fire breaks in BESS facilities from Section 4.2.5 of the CFA Design Guidelines.

Table 5: Model requirements for fire breaks for Solar Farm Facilities

Model Requirements	Compliance Notes
Fire Breaks – All Facilities	
A fire break must be established and maintained around: • The perimeter of the facility, commencing from the boundary of the facility or from the vegetation screening inside the property boundary. • The perimeter of control rooms, electricity compounds, substations and all other buildings on-site. *The width of fire breaks must be a minimum of 10m, and at least the distance where radiant heat flux (output) from the vegetation does not create the*	**Complies** A perimeter fire break of a minimum 10m wide (comprised of mineral earth or non-combustible mulch such as crushed rock) will be created and maintained around the site boundary. Herbicides to be used to control vegetation regrowth within the fire break. In addition to the perimeter fire break, a variety of APZ setbacks have been provided around the solar farm PV fields. APZ setbacks are as follows:

Model Requirements	Compliance Notes
potential for ignition of on-site infrastructure.	• Site A: all boundaries have setbacks ranging between 33 to 212 m. Boundaries adjoining forest vegetation have minimum setbacks of 57m to the west and 62m to the south. Additional setback (>20m) is also available offsite to the west, provided by a forestry access track which runs along the boundary. • Site B: all boundaries adjoin grazed grassland hazard and setbacks up to 85 m proposed. • Site C: all boundaries have setbacks up to 162 m. A minimum setback of 57m is afforded the southern boundary which adjoins Eucalypt plantation forest hazard. Fire breaks are also proposed to be created and maintained around on-site infrastructure, including the substation and main control room. Fire breaks and APZ setbacks can be reviewed and rationalised at detailed design stage if required.

Table 6: Model requirements for fire breaks for BESS facilities

Model Requirements	Compliance Notes
Fire Breaks - BESS	
• A fire break must be established and maintained around battery energy storage systems and related infrastructure.	**Complies** A perimeter fire break is provided around the BESS compound. In addition, a significant APZ setback of a minimum of 100m to the north, east and south of the BESS facility will be implemented to separate the facility from the surrounding Eucalypt plantation. To the west of the BESS, an APZ to the property boundary of 33 m is provided. Beyond the property boundary there is the lesser fuel hazard type of grassland vegetation. Implementation of the APZ provides the BESS facility with a BAL-12.5 exposure to grassland in the west and BAL-Low to forest vegetation in all other directions. After clearing of the plantation vegetation within the APZ, mechanical methods will be used to routinely manage the buffer zone and maintain it in a state of minimal fuel load.

A fire break is typically designed to separate a vulnerable asset from the bushfire hazard (vegetation/fuel). The CFA Design Guidelines recommend that fire breaks are mineral earth, crushed rock or other fuel free land / non-combustible surface. Fire breaks do not eliminate the fire risk but may lower it to an extent where fire control is more feasible or damage to the asset is reduced or eliminated, and where fire spread may be impeded, slowed or stopped. They are supported by additional APZ setbacks where fuel loads are maintained in a minimal state. APZ can limit or lessen the spread of bushfire and severity of attack.

Understanding the value and limitations of a fire break and/or APZ is important, as is the understanding that bushfires attack built assets by either flame contact, radiant heat or burning debris (i.e. embers). A fire break and/or APZ can be used to lower or eliminate the bushfire attack from flame contact and radiant heat around the perimeter of the solar farm facilities, but under winds of >25 kph burning debris can result in a fire breaching a fire break to ignite grassy fuel within other parts of the site. A fire emanating from the proposed development may also jump a fire break by burning debris triggering a spot fire downwind.

Despite the limitations of any firebreak, they provide one of the most valuable bushfire protection and mitigation strategies. A fire break teamed with an APZ will significantly reduce the likelihood of a bushfire spreading to the proposed infrastructure (particularly with regard to flame contact and excessive radiant heat) but will also significantly mitigate the risk of fire spread from an on-site ignition.

Where vegetation management around overhead powerline infrastructure is required to be undertaken, it should be in accordance with the ISSC3 guidelines (ISSC 2016).

3.4.2 Landscape Screening

Table 7 shows the model requirements for landscape screening from Section 4.2.4 of the CFA Design Guidelines that are required to be addressed at the facility.

Table 7: Model requirements for landscape screening for Solar Farm Facilities

Model Requirements	Compliance Notes
Landscape Screening and On-Site Vegetation - Solar Farms	
• Where landscape screening is required, for example, to screen visual impacts or to prevent visual glare from a solar energy facility, the design must consider any potential increase in fire risk due to the type (species), density, height, location and overall width of the screening. • Where practicable, low-flammability vegetation (such as root vegetables) may be planted under solar panels, provided foliage does not extend beyond the panel footprint. • Substations should be surfaced to eliminate all vegetation including grasses	**To Comply** Any proposed planting of screening vegetation including trees and hedges to be low flammability vegetation, planted in narrow rows and discontinuous in nature, that does not increase fire risk. Any vegetation planted under solar panels to be low flammability. The grounds of the Substation, Control Room and BESS compounds to be maintained in a fuel free state (i.e. mineral earth or non-combustible mulch).

3.5 Dangerous Goods Management

The planning, design, construction, handling and storage of dangerous goods on the site is to be undertaken in accordance with the Victorian *Dangerous Goods (Storage and Handling) Regulations* 2022 and relevant Australian Standards such as AS1940-2017 *The storage and handling of flammable and combustible liquids*.

3.6 Infrastructure Risk Management

To identify an appropriate approach for the detailed design, installation, equipment operation, monitoring systems, alarm systems, and fire suppression systems associated with fire protection of the proposed solar farm infrastructure, a Fire Safety Study (as per NSW Planning's Hazardous Industry

Planning Advisory Paper 2: Fire Safety Study Guidelines (2011)) or equivalent assessment, is recommended to be undertaken for the project. The purpose is for the mitigation of hazards to persons as well as the risk of fire start and spread or infrastructure damage.

Electrical infrastructure must be designed, installed and maintained to mitigate the risks associated with arc flash hazards to both persons and ignitable materials, in accordance with the *Arc Flash Hazard Management Guideline* (Energy safe Victoria 2022).

Monitoring systems for the electrical infrastructure of the facility will be required, to ensure that any shorts, faults or equipment failure that could present a hazard or an ignition risk are rapidly identified and controlled. In addition to the other electrical infrastructure, Section 4.3 of the CFA Design Guidelines outlines the design considerations for safety and protective systems for BESS. These include:

- Battery management/monitoring systems;
- Detection systems for smoke, heat and gas;
- Systems to prevent heat/fire spread;
- Systems to prevent explosion;
- Systems to prevent water ingress; and
- Warning and alarm systems.

The details of the proposed BESS are provided in Appendix C.

An inspection and maintenance schedule should also be developed under a Fire Management Plan as per Section 6 of the CFA Design Guidelines for all solar infrastructure including PV panels, BESS and other electrical components to mitigate the level of risk and incidence of electrical infrastructure fires occurring.

Further to the above, Section 4.2.3 of the CFA Design Guidelines prescribe the Model Requirements for Fire Detection and Suppression, which are shown in Table 8.

Table 8: Model requirements for Fire Detection and Suppression Equipment

Model Requirements	Compliance Notes
Suitable fire detection and suppression equipment must be provided: **a)** For on-site buildings and structures, according to the requirements of the National Construction Code. **b)** For storages of dangerous goods, according to the requirements of any Australian Standards for storing and handling of dangerous goods. **c)** For electrical installations, a minimum of two (2) suitable fire extinguishers must be provided within 3m-20m of each PCU. **d)** In all vehicles and heavy equipment, each vehicle must carry at least a nine (9)-litre water stored-pressure fire extinguisher with a minimum rating of 3A, or other firefighting equipment as a minimum when on-site during the Fire Danger Period.	**To Comply** **a)** The main control building for the BESS facility will need to be fitted with fire detection and suppression equipment as per the requirements of the National Construction Code. **b)** Dangerous goods will need to be stored and handled in accordance with relevant Australian Standards and other requirements, as per Section 3.5. **c)** An appropriate suite of fire detection and suppression equipment is required for all electrical infrastructure in accordance with relevant Australian Standards, regulations and other requirements. **d)** All work vehicles, equipment and work sites are to be provided with appropriate fire suppression equipment (i.e. fire extinguishers, fire blankets) and persons trained in their use.

3.7 Emergency Response Resources

3.7.1 Emergency Vehicle Access

Table 9 shows the model requirements for emergency vehicle access from Section 4.2.1 of the CFA Design Guidelines. Table 10 and Table 11 show the model requirements for emergency vehicle access to Solar Farm and BESS facilities respectively, as per Section 4.2.1 of the CFA Design Guidelines.

Table 9: Model requirements for emergency vehicle access for Solar Farm Facilities

Model Requirements	Compliance Notes
Emergency Vehicle (Fire Truck) Access-All Facilities	
a) Construction of a four (4) metre perimeter road within the perimeter fire break.	**Complies** The project layout (Figure 2 and Appendix A) provides for the construction of a 4m wide perimeter road within the perimeter fire break around the entire perimeter of the facility.
b) Roads must be of all-weather construction and capable of accommodating a vehicle of fifteen (15) tonnes (e.g. no compacted earth).	**Can Comply** Roads to be of all-weather construction and engineered to accommodate a vehicle of 15 tonnes. To be addressed in detailed design.
c) Constructed roads should be a minimum of four (4) metres in trafficable width with a four (4) metre vertical clearance for the width of the formed road surface. Ensure any fencing along access routes allows for width of fire vehicles.	**Complies** Constructed roads will have a minimum 4m trafficable width. All roads to have no vegetation obstructions within 4m vertical clearance of the formed road surface.
d) The average grade should be no more than 1 in 7 (14.4% or 8.1°) with a maximum of no more than 1 in 5 (20% or 11.3°) for no more than fifty (50) metres.	**Can Comply** To be addressed in detailed design.
e) Dips in the road should have no more than a 1 in 8 (12.5% or 7.1°) entry and exit angle.	**Can Comply** To be addressed in detailed design stage.
f) Roads must incorporate passing bays at least every 600 metres, which must be at least twenty (20) metres long and have a minimum trafficable width of six (6) metres. At least one passing bay must be incorporated where roads are less than 600 metres long.	**Can Comply** The perimeter and internal road network for the facility incorporates passing bays as per the model design.
g) Road networks must enable responding emergency services to access all areas of the facility, including fire service infrastructure, buildings, and	**Complies** The perimeter and internal road network provides access to all parts of the facility, including the fire service infrastructure (i.e. water tanks and hydrants), substation, control room, BESS, PV panels, grid connection areas and other infrastructure.

Model Requirements	Compliance Notes
battery energy storage systems and related infrastructure, substations and grid connection areas.	
h) Provision of at least two (2) but preferably more access points to each part of the facility. The number of access points must be informed through a risk management process, in consultation with CFA.	**Complies** Each part of the facility is afforded a minimum of two access points as follows: • BESS ○ One access/egress point in the south eastern corner of the BESS site providing a route south to and from Connewarren Lane. ○ Another access/egress point in the south western corner of the BESS site providing an alternate route south to Connewarren Lane as well as west to an existing electrical substation and Mortlake Power Station. ○ An emergency access track along the powerline route, which connects the above access points with the Site A solar panel field to the east and other public road access/egress options. • Site A ○ Primary access point to Boonerah Estate Road providing access and egress north then east to Hamilton Hwy, south to Connewarren Lane, and east to Site C via overland connection. ○ Emergency access point to Hardys Lane in the north. ○ Alternate emergency access route west along transmission line towards BESS and other access tracks. • Site B ○ Two access points to Boonerah Estate Road (one in the east and one in the west) providing access and egress east to Hamilton Hwy and west then south to Connewarren Lane. These access points facilitate access both north and south of Boonerah Estate Road. ○ Access south through the facility to Site C and respective access and egress points provided for Site C. ○ Emergency access is provided in the north-east of Site B, off Hamilton Highway. • Site C ○ Primary site access point at the intersection of Booths Lane and Thulborns Lane ○ Access north through the facility to Site B and respective access and egress points provided for Site B. ○ Overland access connection to Boonerah Estate Road in the west, providing access to Site A, the BESS and Connewarren Lane. ○ Emergency access is provided in the east, off Hamilton Highway. All site access points are displayed graphically on Figure 2 and in Appendix B.

Table 10: Model requirements for emergency vehicle access for Solar Energy facilites

Model Requirements	Compliance Notes
Emergency Vehicle Access - Solar Energy facilites	
Where solar energy facilities are designed over several land parcels separated by private or public roads, overhead powerlines, and/or water courses, vehicle entrances are to be provided into each section. The number and location of vehicle access points must be determined in consultation with CFA.	**Complies** Multiple vehicle access options are provided into each section of the solar farm facility as detailed above. This includes primary access and secondary access points, along with alternative emergency access to/from and between different parts of the facility, in addition to the perimeter and internal road network.

Table 11: Model requirements for emergency vehicle access for BESS facilites

Model Requirements	Compliance Notes
Emergency Vehicle Access – BESS facilites	
At least two access points are to be provided into each section where battery energy storage systems are located. The number and location of vehicle access points must be determined in consultation with CFA.	**Complies** Three access routes are available to the BESS facility providing access to Connewarren Lane in the south and Boonerah Estate Road in the east.

3.7.2 Fire Fighting Water Supply

Given the proposed development is located on bushfire prone land and without a reticulated water supply, provision of a non-reticulated fire water supply is critical to support firefighting efforts undertaken by emergency services, should a fire incident occur on or adjoining the subject site. For all types of renewable energy facilities, firefighting infrastructure must be designed to provide effective emergency response to risks and hazards at the facility. General water supply requirements for renewable energy facilities are provided below:

- Water access points to be clearly signed posted to indicate availability of static water supply on site. Access to the static water supply to be kept clear of any obstructions at all times.
- Static water storage tank installation to comply with *AS 2419.1-2021 – Fire hydrant installations – System design, installation and commissioning*.
- The proposed static water storage tanks to be constructed of concrete or steel and located above ground on a hardstand area.
- Tank water level to be maintained at full capacity during facility operation.
- Water tanks located at vehicle access points and at least 10m or more away from any infrastructure.
- Hard suction points to be installed with Storz adaptor(s) within 4 m of the hardstand area and readily accessible by emergency service personnel.
- All-weather access road and hardstand to be provided to all suction points, kept clear of obstructions at all times. The installed hardstand area to be a minimum of 8m by 6m and support a minimum of 15 tonne GVM.

- Bollards or equivalent barrier system to be constructed to protect the hard-suction points, where necessary.
- Provision of an 8 m radius turning area adjoining the static water supply tank, where necessary.
- Tanks to be fitted with an external water level indicator, and clearly sign posted as "FIRE WATER" and displaying tank capacity.

Table 12 shows the specific model requirements for fire fighting water supply from Section 4.2.2 of the CFA Design Guidelines that are required to be addressed at the solar farm facility. Table 13 shows the specific model requirements for fire fighting water supply from Section 4.2.2 of the CFA Guidelines for BESS facilities.

Table 12: Model requirements for fire fighting water supply for Solar Farm Facilities

Model Requirements	Compliance Notes
Firefighting Water Supply – Solar Energy Facilities	
a) The fire protection system for solar energy facilities must incorporate at least one (1) x 45,000L static water tank at the primary vehicle entrance to each the part of the facility. **b)** Additional static fire water tanks of at least 45,000L effective capacity must also be incorporated for every 100ha.	**Complies** **a)** Each PV field within the facility will be afforded at least one 45,000L static water tank located adjacent to the primary access point and at least 10m from proposed solar farm infrastructure. **b)** An additional 45,000L tank for every 100ha of each PV field is proposed, as follows. • Site A (233 ha) two 45,000L tanks provided. • Site B (426 ha) five 45,000L tanks provided. • Site C (367 ha) three 45,000L tanks provided.

Table 13: Model requirements for fire fighting water supply for BESS facilities

Model Requirements	Compliance Notes
Fire Fighting Water Supply – BESS (Centralised)	
For facilities with centralised battery energy storage systems, the fire protection system must include at a minimum: • Where reticulated water is available, a fire hydrant system that meets the requirements of *AS 2419.1-2021: Fire hydrant installations*, Section 3.9: Open Yard Protection, and Table 2.2.5(D): Number of Fire Hydrant Outlets Required to Flow Simultaneously - Open Yards. *Except, that fire hydrants must be provided and located so that every part of the battery energy storage system is within reach of a 10m hose stream issuing from a nozzle at the end of a 60m length of hose connected to a fire hydrant outlet.*	**Not applicable – reticulated water not available**
OR • Where no reticulated water is available, a fire water supply in static storage tanks, where: ○ The fire water supply must be of a quantity no less than 288,000L or as per the provisions of *AS 2419.1-2021:*	**To Comply** To meet water supply requirements a static storage tank with dedicated fire water capacity of 288,000L is proposed to be provided. The fire water tank is proposed to be located in close proximity to the site entrance, 10m off the entrance road

Model Requirements	Compliance Notes
Fire hydrant installations, Table 2.2.5(D) for open yards flowing for a period of no less than four hours at 20L/s, whichever is the greater. o The quantity of static fire water storage is to be calculated from the number of hydrants required to flow from *AS 2419.1-2021: Fire hydrant installations*, Table 2.2.5(D) *(E.g., For battery installations with an aggregate area of over 27,000m², 4 (four) hydrant outlets are required to operate at 10L/s for four hours, which equates to a minimum static water supply of 576kL).* o Fire hydrants must be provided and located so that every part of the battery energy storage system is within reach of a 10m hose stream issuing from a nozzle at the end of a 60m length of hose connected to a fire hydrant outlet. o The fire water supply must be located at vehicle entrances to the facility, at least 10m from any infrastructure (electrical substations, inverters, battery energy storage systems, buildings). o The fire water supply must be reasonably adjacent to the battery energy storage system and shall be accessible without undue danger in an emergency. (E.g. Fire water tanks are to be located closer to the site entrance than the battery energy storage system). The fire water supply must comply with AS *2419.1-2021: Fire hydrant installations*, Section 5: Water storage tanks.	and reasonably adjacent to the BESS. A compliant design addressing storage quantity, tank location, fire hydrants and the requirements of AS 2419:2021 is to be confirmed during detailed design.

3.7.3 Fire Response Equipment

An Emergency Management Plan (EMP) is to be developed under Section 7 and Section 8 of the CFA Design Guidelines, which will provide a list of equipment that needs to be provided. This equipment must be regularly checked and maintained in order to be available during a fire emergency.

The range of fire equipment for inclusion in the plan would include, but not be limited to the following:

- Torch / light bar;
- Reflective vest;
- Logbook and pen;
- Mobile phone (with up to date emergency contacts);
- UHF radio;
- Fire extinguishers;
- Water supply;
- Emergency information;
- Signage;
- Fire blankets;
- Personal Protection Clothing and Personal Protective Equipment;
- Whistle;
- Handheld public address speaker; and
- First Aid Kit.

Documentation should also be included in the EMP detailing the operational response procedures for fire incidents involving BESS, PCS, PV panels or other electrical infrastructure, so as to monitor, isolate, and restore facility operations.

3.7.4 Training

An EMP is to be developed under Section 7 and Section 8 of the CFA Design Guidelines which identifies the need for new staff or contractors to undertake Fire Awareness training, covering both bushfire and other fires. The training would be focused on their role pre, during and post an emergency.

Training would need to cover:

- Fire weather and fire behaviour;
- Emergency prevention, preparedness, and response;
- Use of fire fighting equipment;
- Emergency response drill exercises; and
- Safe resumption of normal operations.

3.8 Protection of Life (Emergency Management)

To protect human life during an emergency event at the facility, an EMP is to be prepared in accordance with Section 7 and Section 8 of the CFA Design Guidelines and enacted prior to construction commencing at the site and maintained for the life of facility operation.

The EMP is to detail the emergency procedures (including communications, roles and responsibilities) that are necessary to conduct both onsite refuge and off site evacuation (where safe to do so) to prioritise the protection of life.

4. Conclusion

Overall, the potential risk of fire impacting on the proposed solar farm is considered to be relatively low, given the background hazard context, landscape risk profile (hazard characteristics, bushfire history and land uses), its siting, construction, design and mitigation strategies. In addition, the solar farm is not expected to result in a significant increase in fire risk in the locality and to downwind assets and values.

This FRA demonstrates compliance is achievable with Section 4 of the CFA Design Guidelines (CFA 2023) and also the overall aims and objectives covered in Section 1.3. Although the proposed facility is situated within a BPA and a higher risk BMO, the overall facility layout is considered to be appropriate to the risk (once all required compliances with the CFA Design Guidelines and detailed design matters are addressed) and results in a low residual fire risk outcome. This is supported further through additional mitigation strategies as covered in Section 3.

The mitigation strategies for the proposed development not only provide an appropriate level of risk reduction for the solar farm, but also a significantly lower risk of impact from fire originating from the facility to life, property, agricultural, commercial and environmental assets off-site. Key mitigation measures include ignition prevention; the provision of fire breaks, APZ and onsite vegetation maintenance; bulk static water supply; emergency access provision to, within and around the site; design and systems for the prevention, monitoring and suppression of operational hazards; and sound emergency management arrangements.

4.1 Summary of Recommended Mitigation Strategies

A suite of fire risk mitigation strategies are outlined in this report, which are summarised in Table 14.

Table 14: Summary of key recommended mitigation strategies and actions

Matter	Report Section	Recommended Mitigation Strategy
Model Design	3.2	A Fire Engineering Design Brief, Fire Safety Study or equivalent assessment to be undertaken for the project to ensure adequate separation distance between the BESS units and other built and natural assets. An additional APZ setback is afforded the BESS to reduce the BAL exposure. The APZ is to be 100m to the north, east and south, and to the site boundary to the west. This APZ is to be cleared of forest vegetation and maintained in a minimal fuel state for the life of the project. To enhance the safety of emergency responders, the BESS layout provides: • Three vehicle access routes; • 6m wide perimeter roads around the BESS compound, substation, control room, and the entire solar farm facility; • Non-combustible static water supply tank, dedicated to firefighting; and • Onsite safety and advisory signage. BESS units housed within fully enclosed non-combustible shipping container modules, and to include monitoring, safety and fire suppression systems. BESS units to have ventilation systems and explosion prevention measures integrated. BESS units to have all openable doors affixed with rubber protection strips or other equivalent device to seal in a closed position against ember entry. All ventilation openings to be screened with metal mesh with aperture size no greater than 2mm to

Matter	Report Section	Recommended Mitigation Strategy
		prevent ember entry. BESS units installed on concrete foundations with barrier impact protection. All cabling enclosed or buried. Spill containment for the BESS of an adequate size to manage fire water runoff.
Ignition Management (Solar Farm Construction)	3.3.2	If construction occurs during the bushfire danger period, the use of cutting and slashing machinery together with any hotworks is to be suspended on days of elevated fire danger ratings (i.e. Extreme FDR or above) and / or when a Total Fire Ban is declared. All construction activities to cease and no persons to be onsite on days of Catastrophic FDR. Appropriate ignition prevention measures are to be implemented and documented in an FMP.
Ignition Management (Solar Farm Operations).	3.3.3	With the exception of emergencies, suspend site maintenance operations and modify activities or system operation that pose an increased ignition potential on days of elevated fire danger ratings where the FDR is Extreme or above and / or a Total Fire Ban is declared. Document ignition prevention measures in an FMP.
Fuel Management	3.4	An FMP is recommended to be developed for the facility that includes a schedule of works implementation to establish and maintain fire breaks and APZs around both the site perimeter and facility infrastructure to reduce the risk of fire impacting on the site or escaping the site to impact on assets within the broader community.
Fire Breaks	3.4.1	**Solar Farm** A perimeter fire break of 10m wide (comprised of mineral earth or non-combustible mulch such as crushed rock) is to be created and maintained around the site boundary. Herbicides to be used to control vegetation regrowth within the fire break. In addition to the perimeter fire break, a variety of APZ setbacks have been provided around the solar farm PV fields, and are to be maintained in a fuel reduced state. **BESS** A perimeter fire break of 11m wide (comprised of mineral earth or non-combustible mulch such as crushed rock) is to be created and maintained around the BESS. An APZ setback of 100m to the north, east and south of the BESS facility will be implemented to separate the facility from the surrounding eucalypt forest plantation. An APZ setback of 33m to the site boundary in the west will be implemented. After clearing of the plantation vegetation within the APZ, it will be routinely managed to maintain it in a state of minimal fuel load.
Landscape Screening	3.4.2	Any proposed planting of screening vegetation including trees and hedges to be low flammability vegetation, planted in narrow rows and discontinuous in nature, that does not increase fire risk. Any vegetation planted under solar panels to be low flammability. The grounds of the Substation, Control Room and BESS compounds to be maintained in a fuel free state (i.e. mineral earth or non-combustible mulch).
Dangerous Goods Management	3.5	The planning, design, construction, handling and storage of any dangerous goods on the site is undertaken in accordance with the Victorian *Dangerous Goods (Storage and Handling) Regulations* 2022 and AS1940-2017.
Infrastructure Risk Management	3.6	A Fire Safety Study or similar be undertaken for the project to identify best practices for the detailed design, installation, equipment operation, monitoring systems, alarm systems, and fire suppression systems associated with fire protection of the proposed

Matter	Report Section	Recommended Mitigation Strategy
		solar farm infrastructure. Arc flash hazards be appropriately mitigated. Monitoring and response/suppression systems for all electrical infrastructure are integrated into design and the operation. All work vehicles, equipment and work sites are to be provided with appropriate fire suppression equipment and persons trained in their use. An inspection and maintenance schedule for all infrastructure and systems should be developed and documented in the FMP.
Emergency Vehicle Access	3.7.1	The model requirements for emergency vehicle (fire truck access) detailed within Table 9 are to be afforded and confirmed at detailed design stage. Each part of the facility is afforded a minimum of two access points as detailed in Table 9. This includes primary access and secondary access points, along with alternative emergency access to/from and between different parts of the facility, in addition to the perimeter and internal road network.
Fire Fighting Water Supply	3.7.2	**General** Water access points to be clearly signed posted to indicate availability of static water supply on site. Access to the static water supply to be kept clear of any obstructions at all times. Static water storage tank installation to comply with AS 2419.1-2021. The proposed static water storage tanks to be constructed of concrete or steel and located above ground on a hardstand area. The water level to be maintained at full capacity during facility operation. Water tanks located at vehicle access points and at least 10m or more away from any infrastructure. Hard suction points to be installed with Storz adaptor(s) within 4 m of the hardstand area and readily accessible by emergency service personnel. An all-weather access road and hardstand to be provided to all suction points, kept clear of obstructions at all times. The installed hardstand area to be a minimum of 8m by 6m and support a minimum of 15 tonne GVM. Bollards or equivalent barrier system to be constructed to protect the hard-suction points, where necessary. Provision of an 8 m radius turning area adjoining the static water supply tank, where necessary. Tanks to be fitted with an external water level indicator, and clearly sign posted as “FIRE WATER” and displaying tank capacity. **Solar Farm** Each PV field within the facility to be afforded at least one 45,000L static water tank located adjacent to the primary access point and at least 10m from proposed solar farm infrastructure. Additional 45,000L tanks to be provided for every 100ha of the PV fields. Site A, two tanks. Site B, five tanks. Site C, three tanks. **BESS** To meet water supply requirements a static storage tank with dedicated fire water capacity of 288,000L is proposed to be provided. The fire water tank must be located in close proximity to the site entrance, 10m off the entrance road and reasonably adjacent to the BESS. A compliant design addressing storage quantity, tank location, fire hydrants and the

Matter	Report Section	Recommended Mitigation Strategy
		requirements of AS 2419:2021 is to be confirmed during detailed design
Fire Response Equipment	3.7.3	Develop and maintain an EMP which provides a list of equipment that needs to be checked and maintained. The EMP to also detail the operational fire response procedures for electrical infrastructure so as to monitor, isolate, and restore facility operations.
Training	3.7.4	Develop and maintain an EMP which identifies the need for new staff or contractors to undertake Fire Awareness training.
Protection of Life (Emergency Management)	3.8	An EMP is prepared in accordance with the CFA Design Guidelines and enacted prior to construction commencing at the site and maintained for the life of facility operation.

5. References

Backstrom R. and Dinni D.A. 2011. *Firefighter Safety and Photovoltaic Installations Research Project.* Underwriters Laboratories Inc., Northbrook, USA.

Bureau of Meteorology (BOM). 2024. *Climate Data Online*. Climate Data Online - Map search (bom.gov.au).

Cary, G. (2011) ENVS6204 Lecture 3.2 Fire Regime, Australian National University.

Cheney N.P., Gould J.S. Catchpole W.R. 1998. Prediction of Fire Spread in Grasslands. *International Journal of Wildland Fire* 8, 1-13.

Cheney N.P., Sullivan, A.L. 2008. *Grassfires: Fuel weather and fire behaviour*. CSIRO Publishing 2nd Edition, Collingwood, Vic.

Country Fire Authority (CFA). 2023. *Design Guidelines and Model Requirements: Renewable Energy Facilities,* Version 4, August 2023. CFA Specialist Risk and Fire Safety Unit.

Cruz, M.G., Gould, J.S., Alexander, M.E., Sullivan, A.L., McCaw, W.L. and Matthews, S. 2015. *A Guide to Rate of Fire Spread Models for Australian Vegetation*. CSIRO Land and Water, Canberra ACT and AFAC, Melbourne, Vic, 125 pp.

Department of Environment, Land, Water & Planning (DELWP). 2023. *Fire history overlay of most recent fires - Dataset - Victorian Government Data Directory.*

Department of Environment, Land, Water & Planning (DELWP). 2018. *Native Vegetation - Modelled 2005 Ecological Vegetation Classes (with Bioregional Conservation Status).*

Energy safe Victoria 2022. *Arc Flash Hazard Management Guideline*.

Gould, J.S 2008. *Project Vesta: Fire in Dry Eucalypt Forest: Fuel Structure, Fuel Dynamics and Fire Behaviour.*

Safe Work Australia (SWA). 2009. *Managing risks of storing chemical in the workplace.*

Standards Australia (SA). 2018. AS 3959:2018- *Construction of buildings in bushfire prone areas.*

Standards Australia (SA). 2017. *AS 1940:2017 – The storage and handling of flammable and combustible liquids.*

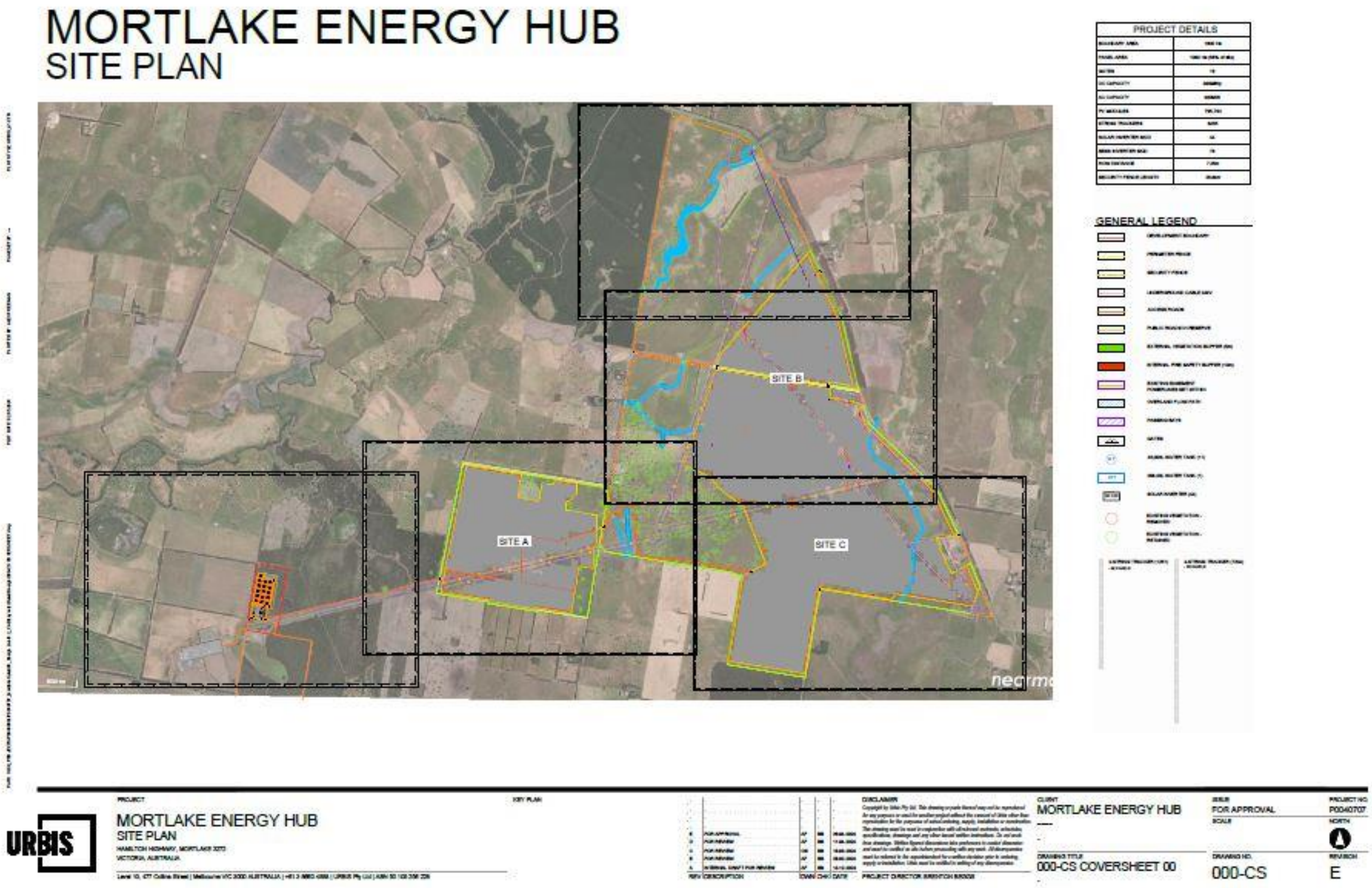
Standards Australia (SA). 2021. *AS 2419.1-2021 – Fire hydrant installations – System design, installation and commissioning.*

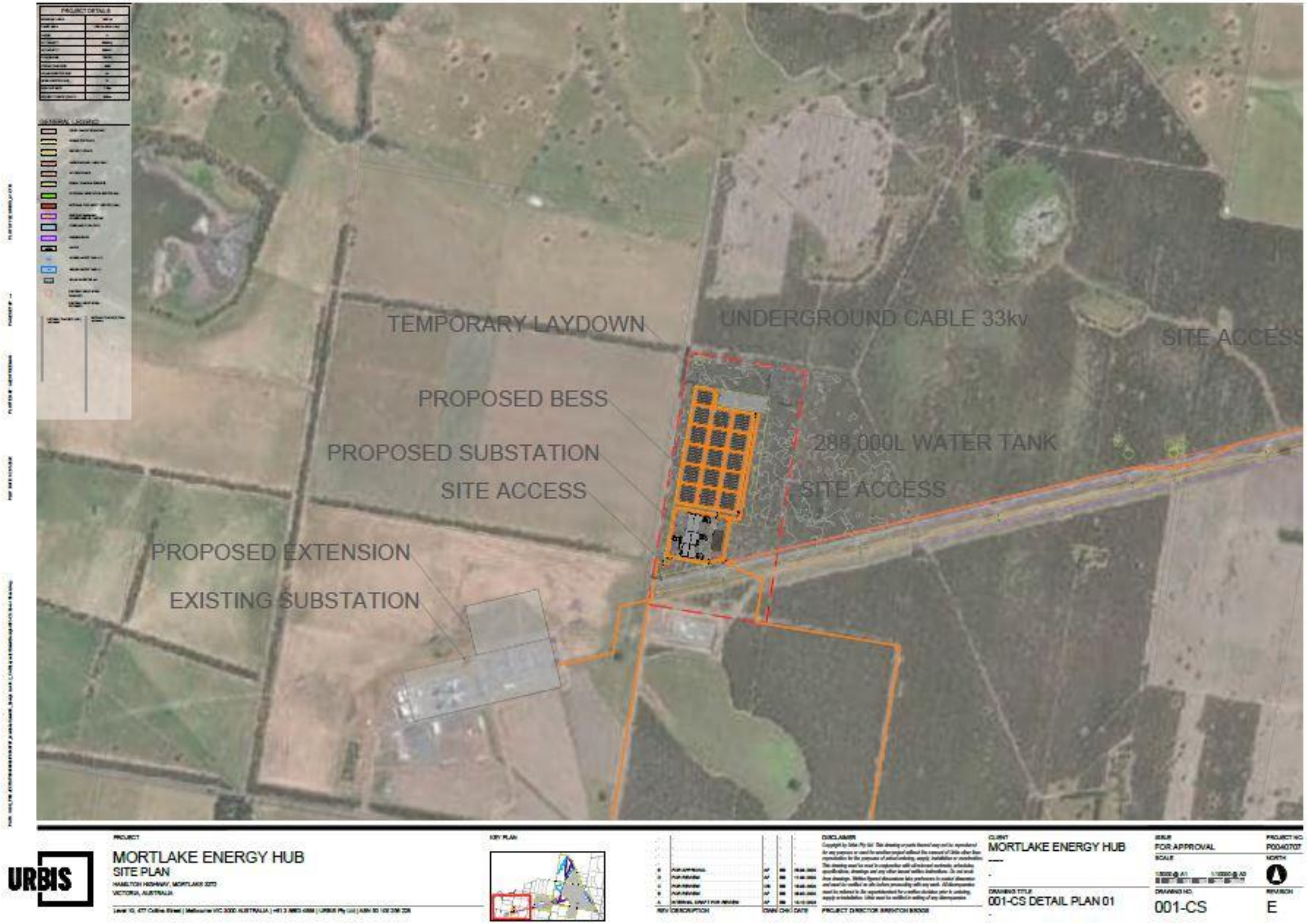
State of New South Wales Department of Planning. 2011. *Hazardous Industry Planning Advisory Paper No 2 Fire Safety Study Guidelines.*

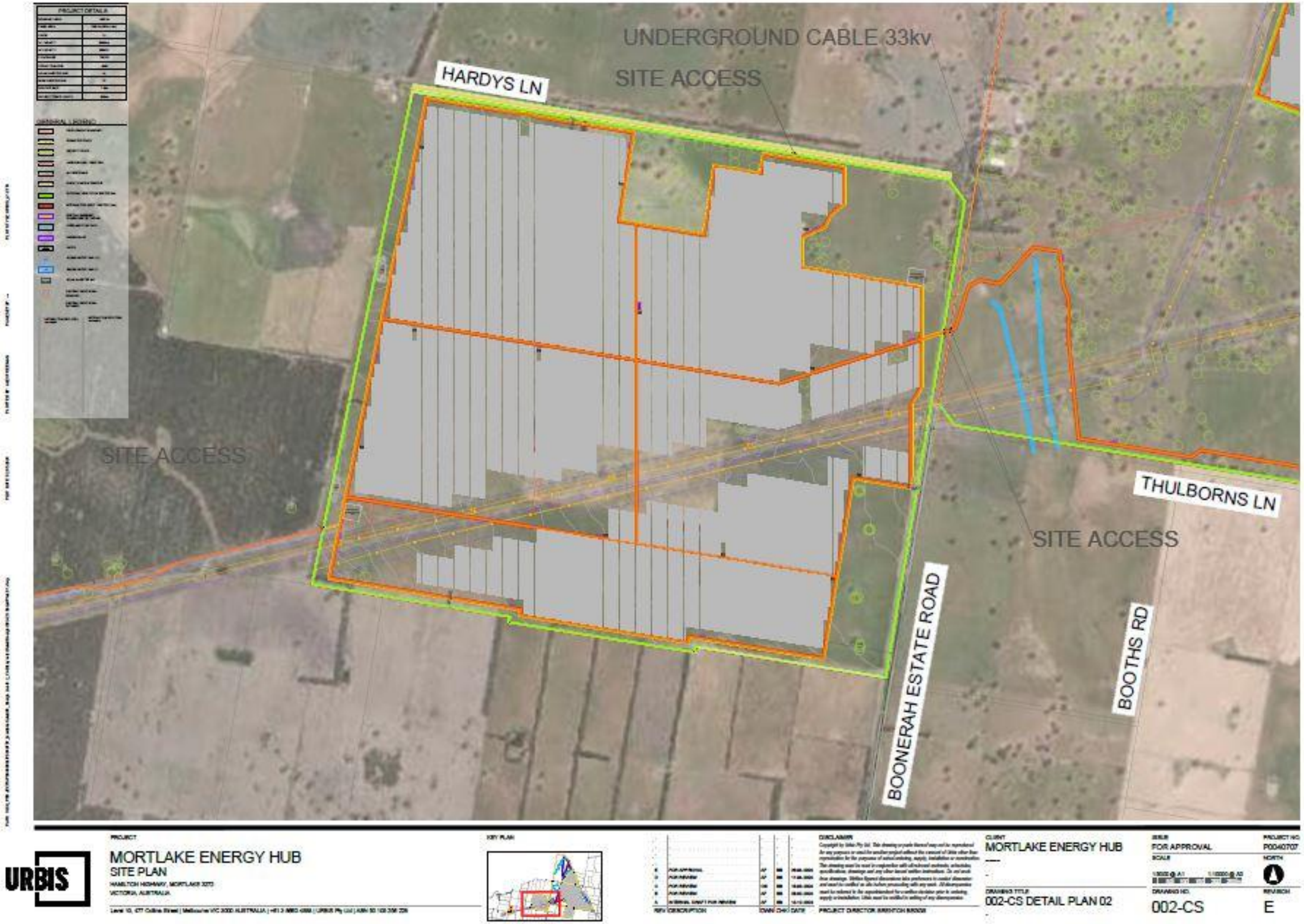
STOREMASTA. 2023. *Examples Of Flammable Liquids And Their Flash Points*. Examples Of Flammable Liquids And Their Flash Points (storemasta.com.au)

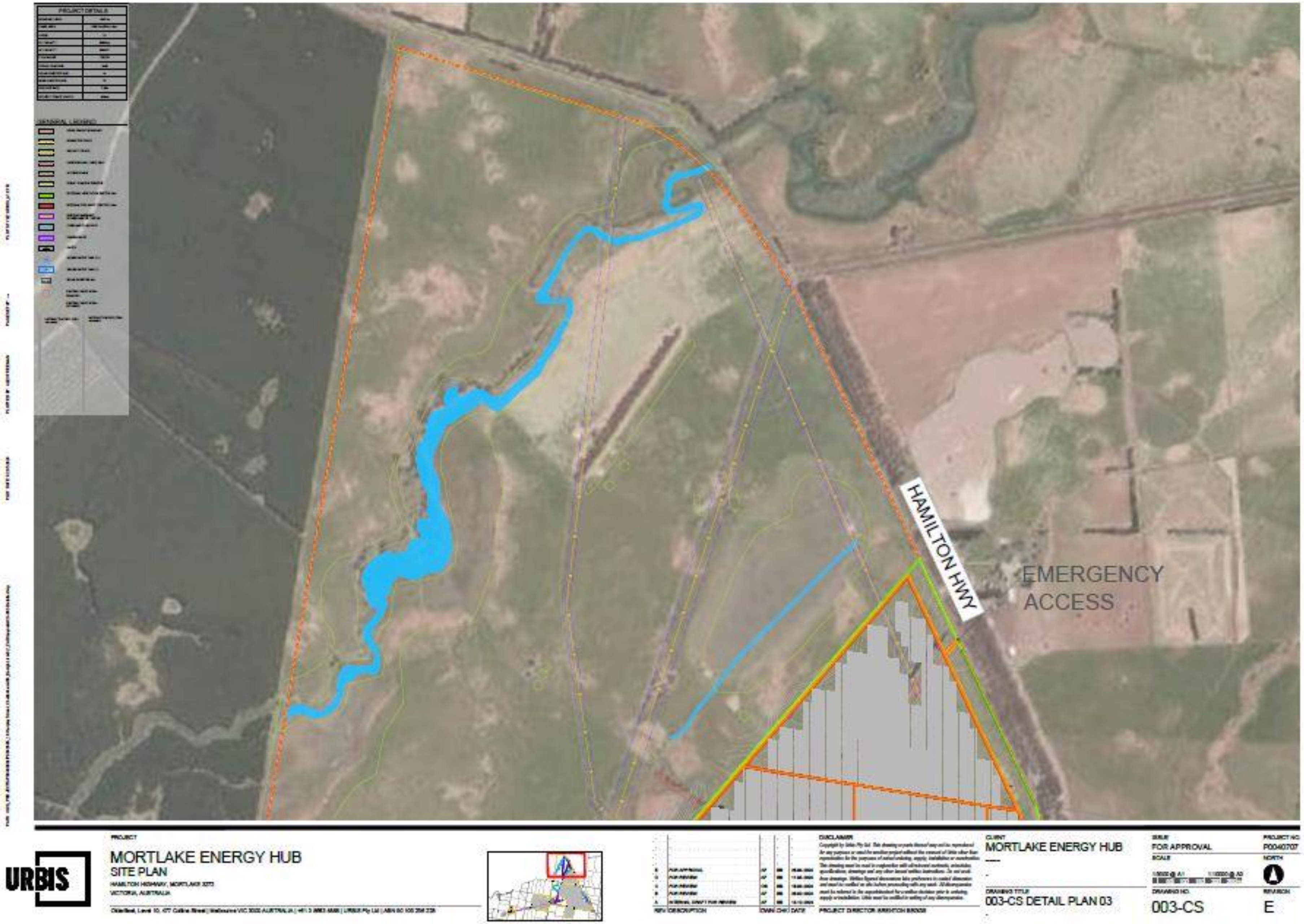
The Industry Safety Steering Committee (ISSC). 2016. *Guide for the Management of Vegetation in the Vicinity of Electricity Assets.*

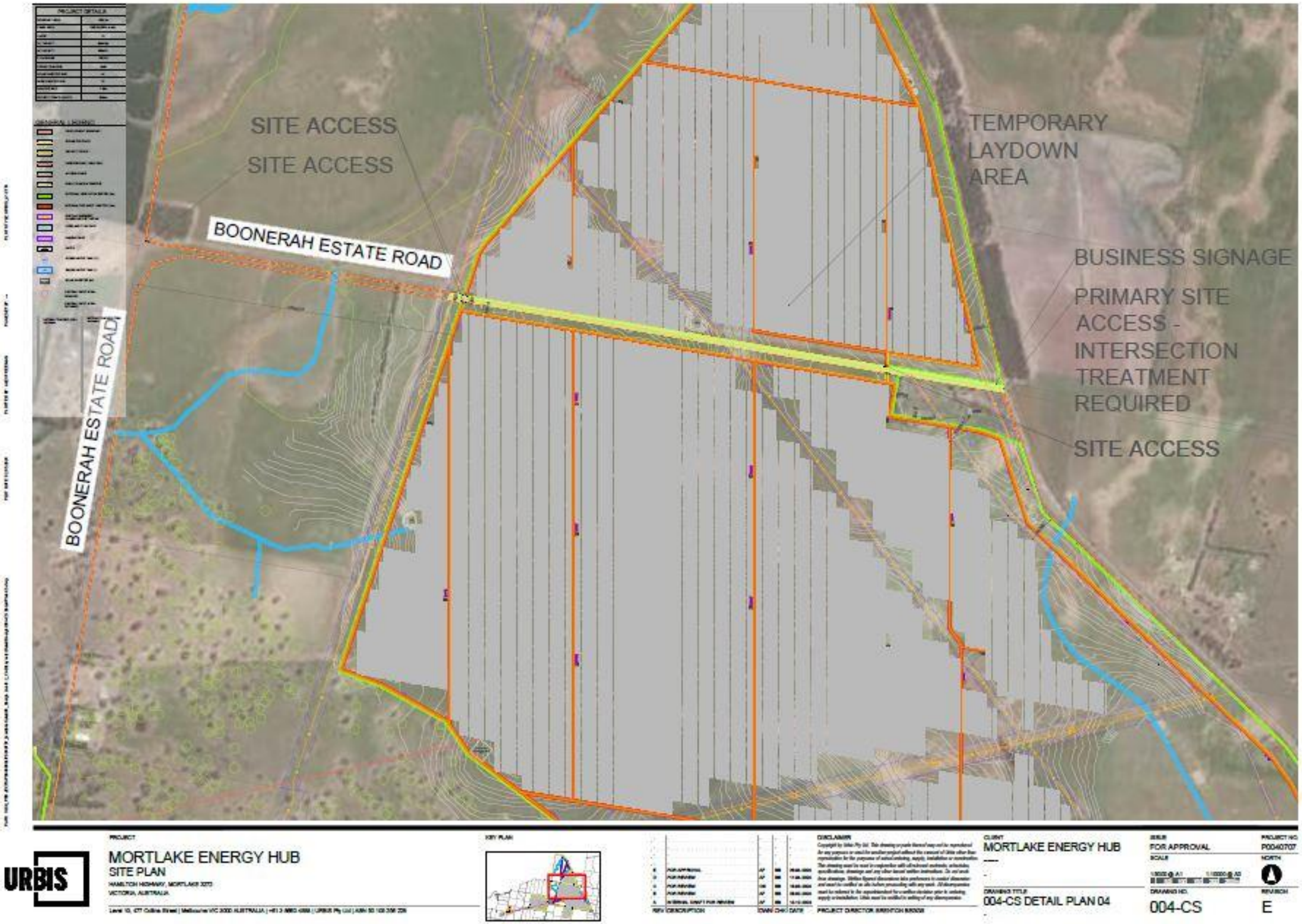
Appendix A : Project Layout

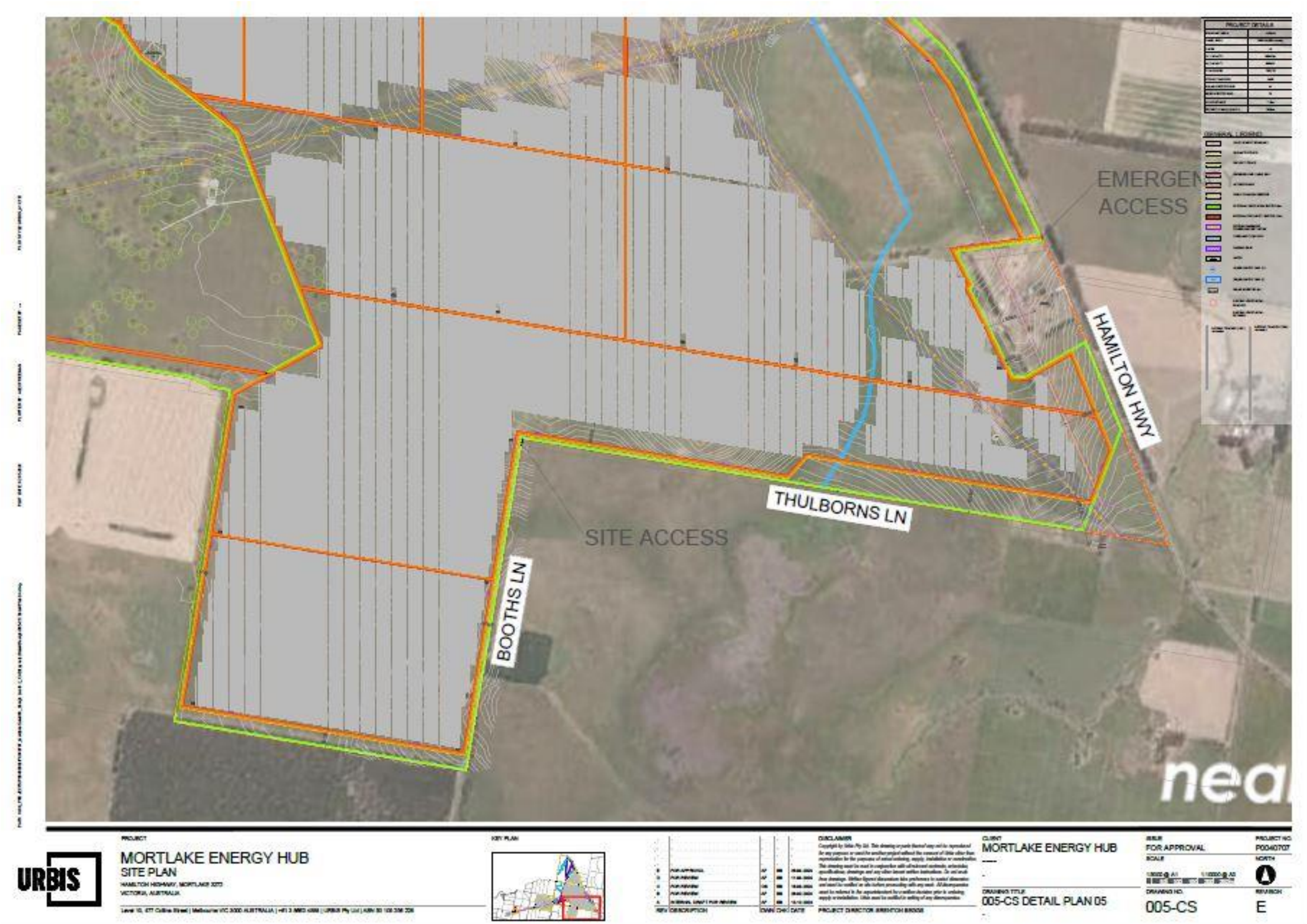

MORTLAKE ENERGY HUB
SITE PLAN
PROJECT DETAILS
GENERAL LEGEND
SITE A
SITE B
SITE C
MORTLAKE ENERGY HUB
SITE PLAN
FOR APPROVAL
000-CS COVERSHEET 00
000-CS
E


TEMPORARY LAYDOWN
UNDERGROUND CABLE 33kv
SITE ACCESS
PROPOSED BESS
288,000L WATER TANK
PROPOSED SUBSTATION
SITE ACCESS
SITE ACCESS
PROPOSED EXTENSION
EXISTING SUBSTATION
URBIS
MORTLAKE ENERGY HUB
SITE PLAN
MORTLAKE ENERGY HUB
FOR APPROVAL
001-CS DETAIL PLAN 01
001-CS
E

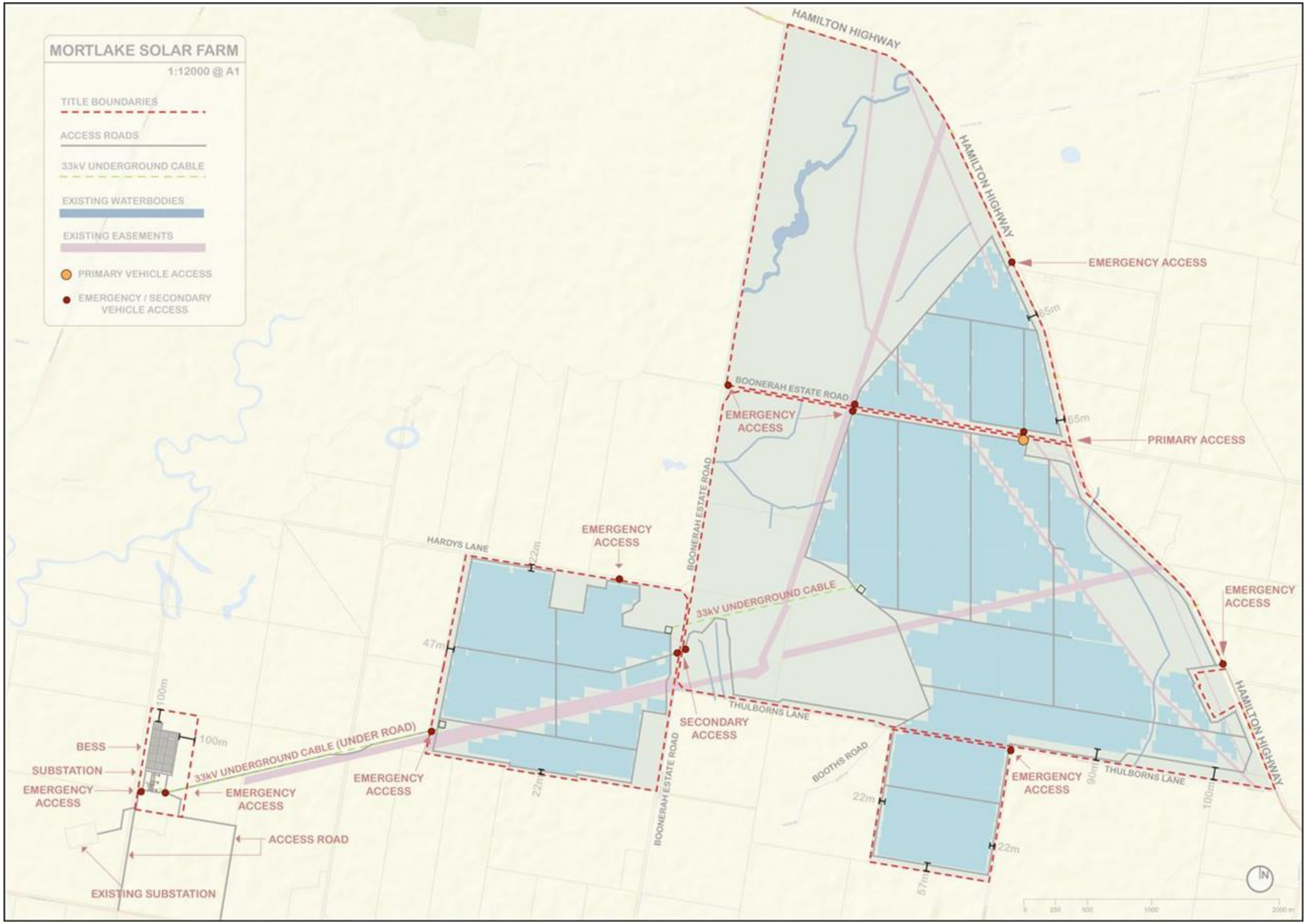

UNDERGROUND CABLE 33kv
SITE ACCESS
HARDYS LN
SITE ACCESS
SITE ACCESS
THULBORNS LN
BOONERAH ESTATE ROAD
BOOTHS RD
URBIS
MORTLAKE ENERGY HUB
SITE PLAN
MORTLAKE ENERGY HUB
FOR APPROVAL
P0040707
002-CS DETAIL PLAN 02
002-CS
E


HAMILTON HWY
EMERGENCY ACCESS
URBIS
MORTLAKE ENERGY HUB
SITE PLAN
MORTLAKE ENERGY HUB
003-CS DETAIL PLAN 03
FOR APPROVAL
003-CS
E


SITE ACCESS
SITE ACCESS
BOONERAH ESTATE ROAD
BOONERAH ESTATE ROAD
TEMPORARY LAYDOWN AREA
BUSINESS SIGNAGE
PRIMARY SITE ACCESS - INTERSECTION TREATMENT REQUIRED
SITE ACCESS
URBIS
MORTLAKE ENERGY HUB
SITE PLAN
MORTLAKE ENERGY HUB
FOR APPROVAL
004-CS DETAIL PLAN 04
004-CS
E

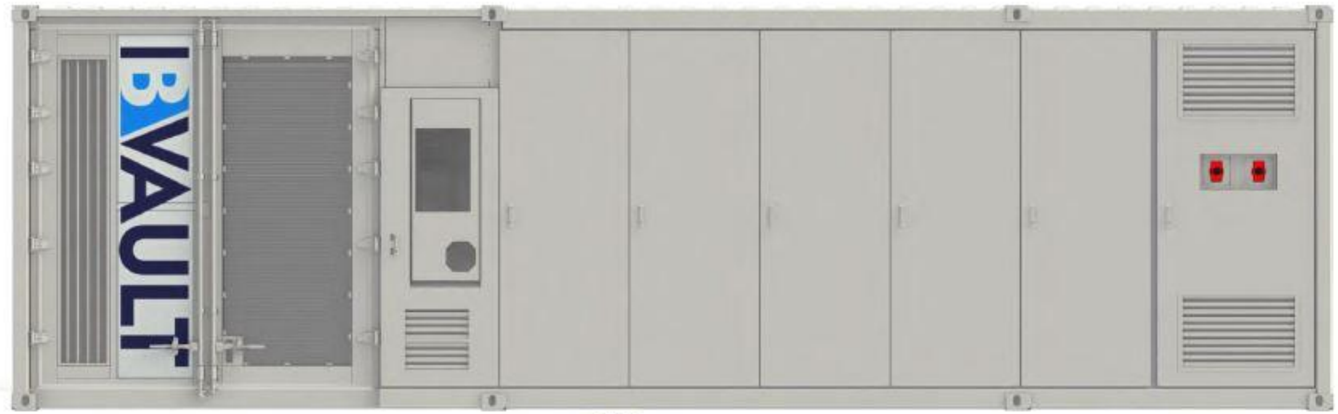

EMERGENCY ACCESS
HAMILTON HWY
THULBORNS LN
SITE ACCESS
BOOTHS LN
URBIS
PROJECT
MORTLAKE ENERGY HUB
SITE PLAN
KEY PLAN
DISCLAIMER
CLIENT
MORTLAKE ENERGY HUB
DRAWING TITLE
005-CS DETAIL PLAN 05
ISSUE
FOR APPROVAL
SCALE
DRAWING NO.
005-CS
PROJECT NO.
P0040707
NORTH
REVISION
E

Appendix B : Site Access Plan


MORTLAKE SOLAR FARM
1:12000 @ A1
TITLE BOUNDARIES
ACCESS ROADS
33kV UNDERGROUND CABLE
EXISTING WATERBODIES
EXISTING EASEMENTS
PRIMARY VEHICLE ACCESS
EMERGENCY / SECONDARY VEHICLE ACCESS
HAMILTON HIGHWAY
EMERGENCY ACCESS
BOONERAH ESTATE ROAD
PRIMARY ACCESS
HARDYS LANE
33kV UNDERGROUND CABLE
SECONDARY ACCESS
THULBORNS LANE
BOOTHS ROAD
BESS
SUBSTATION
33kV UNDERGROUND CABLE (UNDER ROAD)
ACCESS ROAD
EXISTING SUBSTATION

Appendix C : Indicative BESS Specifications

ENERGY VAULT®
Enabling a Renewable World



BVAULT™ PRODUCT INTRODUCTION

B-VAULT™: Modular and Scalable BESS Solution

CUSTOMIZED SOLUTION

B-VAULT™ can be customized for electrical output (DC, AC), battery chemistry (LFP, NMC), and major equipment OEM to address each p oj c 's uniqu qui m n s.

FUTURE PROOF DESIGN

The flexible architecture of B-VAULT™ provides freedom to choose battery and inverter technologies and augmentation strategies over the asset lifetime.

ENGINEERED SOFTWARE

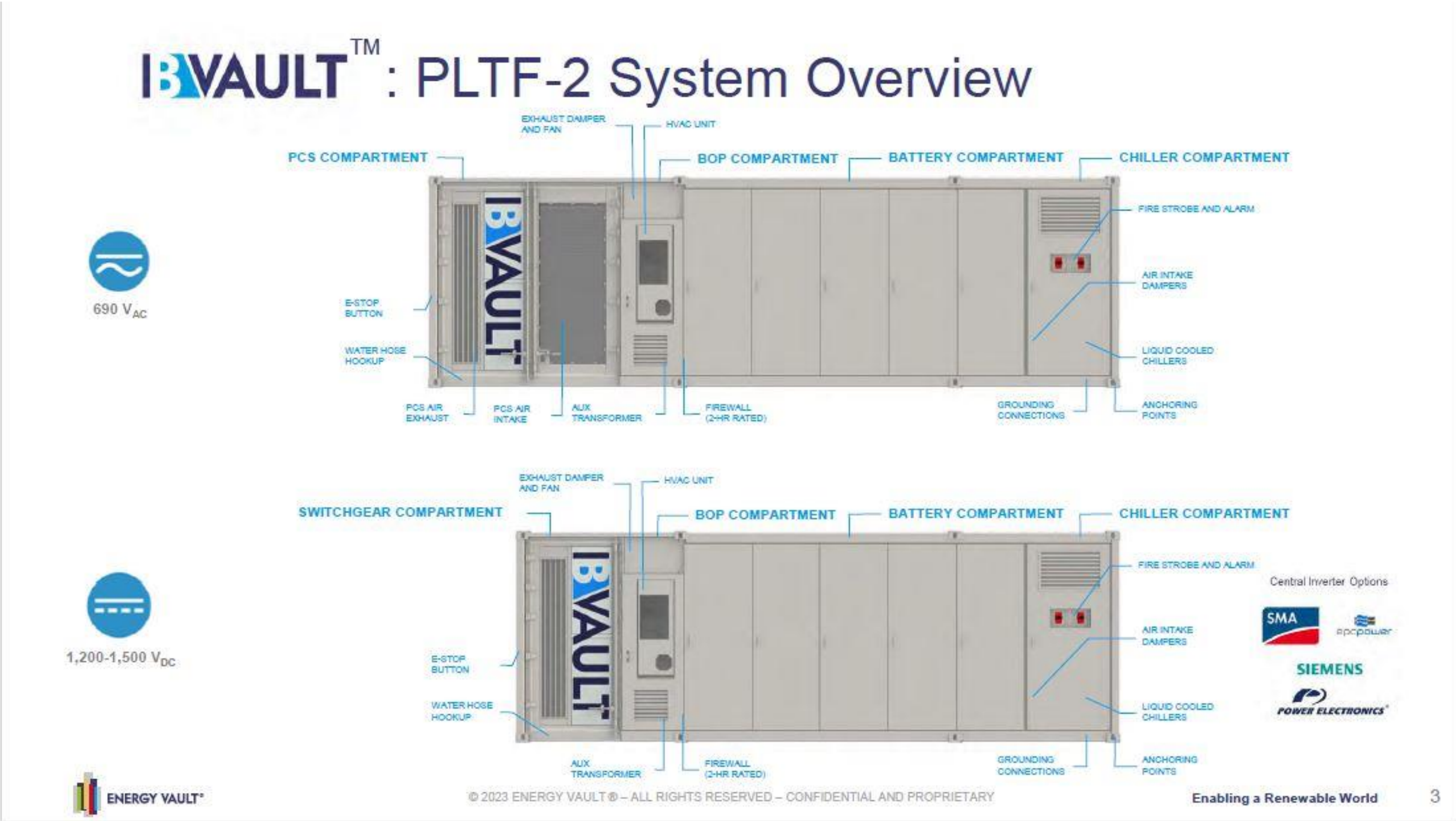
VAULT-OS™ features a cloud-based plant controller, operating modes, market participation algorithms, an analytics platform, and asset management.

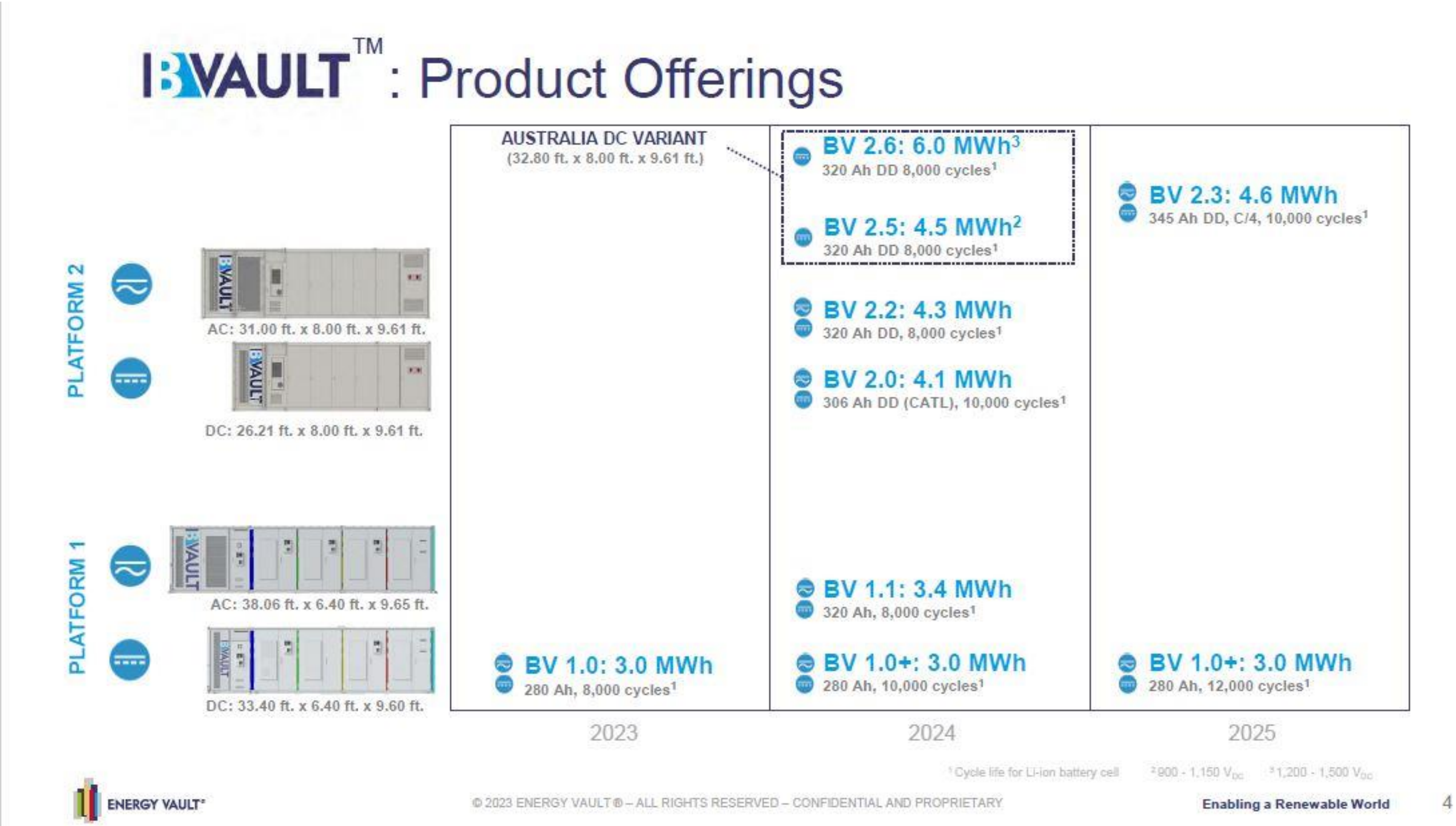
LIFETIME SAVINGS

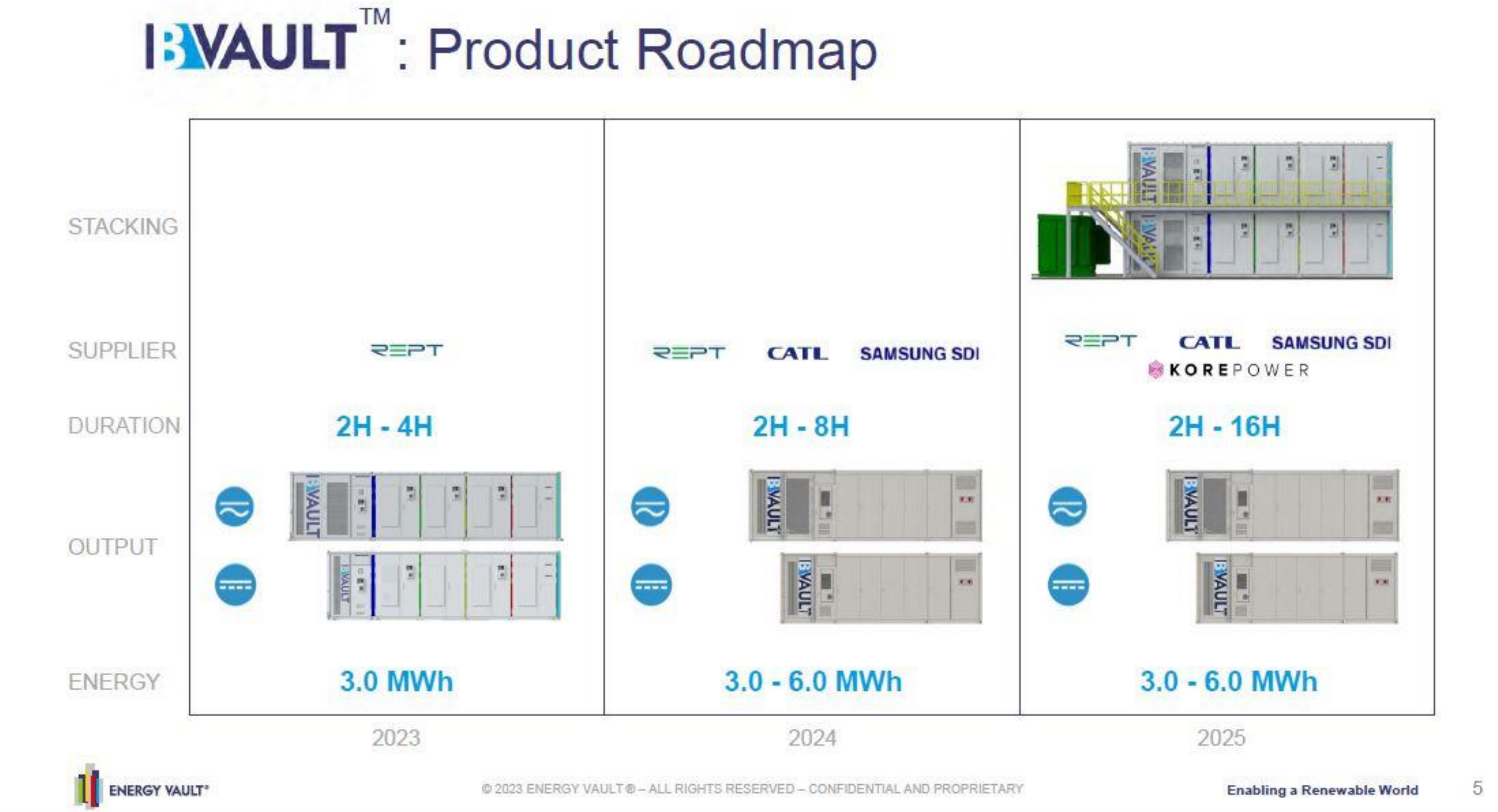
Customers are empowered with tailored solutions and services to best meet their needs – from equipment sale, turn-key EPC, long-term service agreement, to asset management.

ENERGY VAULT®

Enabling a Renewable World 2


B VAULT™: PLTF-2 System Overview
690 V AC
PCS COMPARTMENT
EXHAUST DAMPER AND FAN
HVAC UNIT
BOP COMPARTMENT
BATTERY COMPARTMENT
CHILLER COMPARTMENT
FIRE STROBE AND ALARM
AIR INTAKE DAMPERS
LIQUID COOLED CHILLERS
E-STOP BUTTON
WATER HOSE HOOKUP
PCS AIR EXHAUST
PCS AIR INTAKE
AUX TRANSFORMER
FIREWALL (2-HR RATED)
GROUNDING CONNECTIONS
ANCHORING POINTS
1,200-1,500 V DC
SWITCHGEAR COMPARTMENT
EXHAUST DAMPER AND FAN
HVAC UNIT
BOP COMPARTMENT
BATTERY COMPARTMENT
CHILLER COMPARTMENT
FIRE STROBE AND ALARM
AIR INTAKE DAMPERS
LIQUID COOLED CHILLERS
E-STOP BUTTON
WATER HOSE HOOKUP
AUX TRANSFORMER
FIREWALL (2-HR RATED)
GROUNDING CONNECTIONS
ANCHORING POINTS
Central Inverter Options
SMA
epcpower
SIEMENS
POWER ELECTRONICS
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
3


B VAULT™: Product Offerings
PLATFORM 2
AC: 31.00 ft. x 8.00 ft. x 9.61 ft.
DC: 26.21 ft. x 8.00 ft. x 9.61 ft.
PLATFORM 1
AC: 38.06 ft. x 6.40 ft. x 9.65 ft.
DC: 33.40 ft. x 6.40 ft. x 9.60 ft.
AUSTRALIA DC VARIANT
(32.80 ft. x 8.00 ft. x 9.61 ft.)
BV 1.0: 3.0 MWh
280 Ah, 8,000 cycles¹
BV 2.6: 6.0 MWh³
320 Ah DD 8,000 cycles¹
BV 2.5: 4.5 MWh²
320 Ah DD 8,000 cycles¹
BV 2.2: 4.3 MWh
320 Ah DD, 8,000 cycles¹
BV 2.0: 4.1 MWh
306 Ah DD (CATL), 10,000 cycles¹
BV 1.1: 3.4 MWh
320 Ah, 8,000 cycles¹
BV 1.0+: 3.0 MWh
280 Ah, 10,000 cycles¹
BV 2.3: 4.6 MWh
345 Ah DD, C/4, 10,000 cycles¹
BV 1.0+: 3.0 MWh
280 Ah, 12,000 cycles¹
2023
2024
2025
¹ Cycle life for Li-ion battery cell
² 900 - 1,150 VDC
³ 1,200 - 1,500 VDC
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
4


B-VAULT™: Product Roadmap
STACKING
SUPPLIER
DURATION
OUTPUT
ENERGY
REPT
2H - 4H
3.0 MWh
2023
REPT
CATL
SAMSUNG SDI
2H - 8H
3.0 - 6.0 MWh
2024
REPT
CATL
SAMSUNG SDI
KOREPOWER
2H - 16H
3.0 - 6.0 MWh
2025
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
5

B-VAULT™: DNV Bankability Report

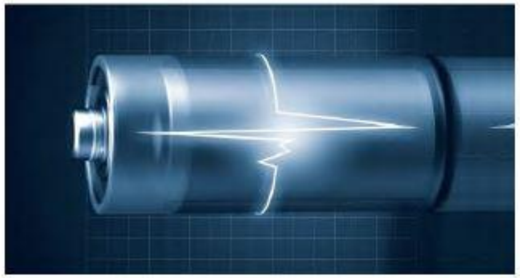
DNV

B-VAULT BATTERY ENERGY STORAGE SYSTEM

Technology Review Report

Energy Vault, Inc.

Document No.: 10443804-HOU-R-01
Issue: D, Status: FINAL
Date: 9 November 2023



Report Highlights

INTEGRATION AND FLEXIBILITY

"DNV cogniz d scop nd f xib ins ion c p ci y of En gy V u 's B-VAULT solution can address the site-specific requirements of a wide range of customers. The report ig ig s En gy V u 's p oc ss of d iv ing u n-key systems that are factory built, tested, and shipped to a project site ready for simple and economical installation process and commissioning. En gy V u 's B-VAULT solution is designed to meet a wide range of diverse customer needs and has the capability to incorporate battery cells with multiple different chemistries, various cell capacities, and from multiple suppliers. Energy Vault is proud to note that DNV recognized the uniqueness of B-VAULT's D (x n inv) nd AC (inside of the enclosure modular-inv) off ings wi in indus y."

THERMAL MANAGEMENT

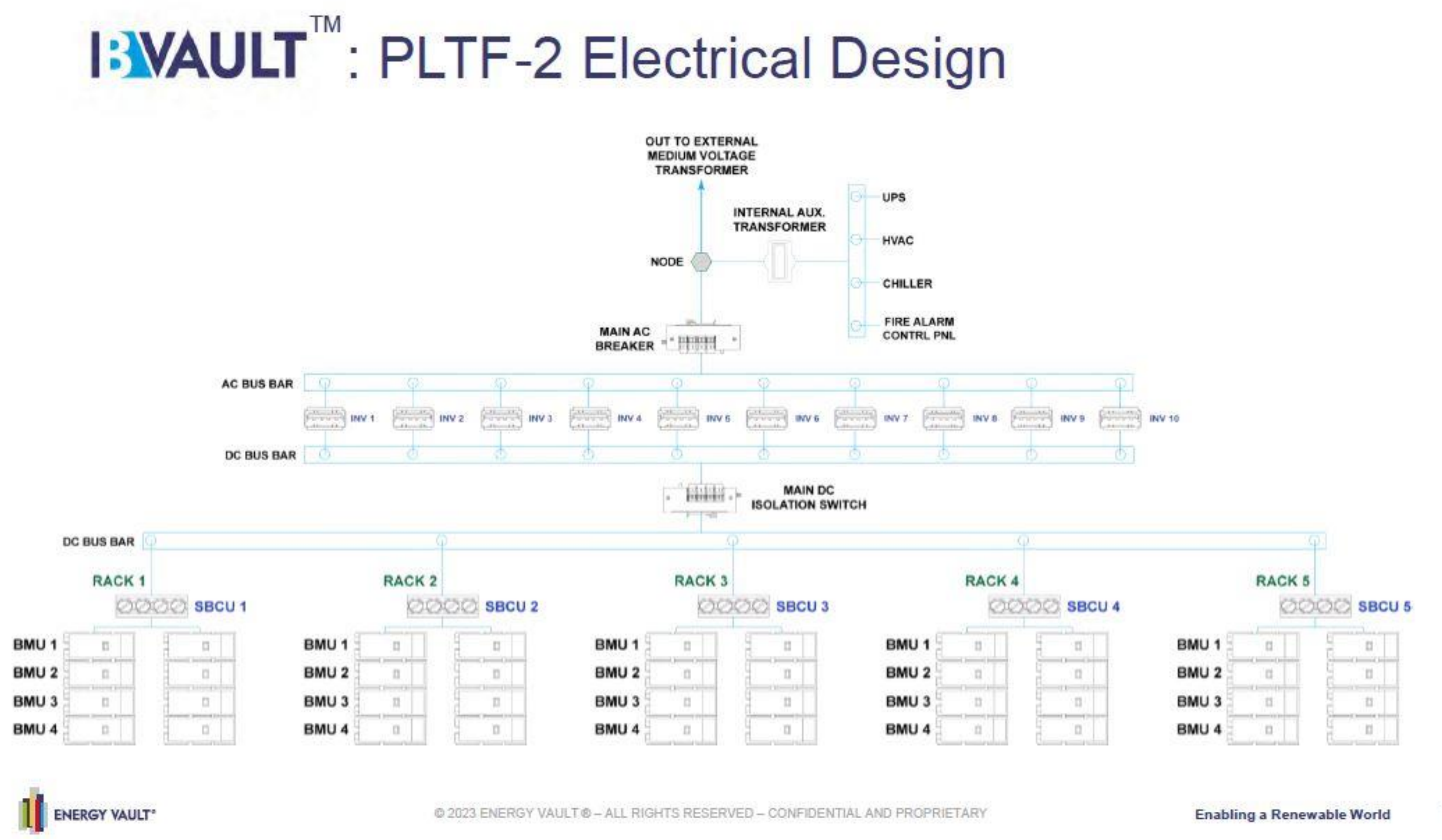
"DNV cknow dg s s ng s of B-VAULT's m m n g m n sys m, w ic combines liquid-cooling and air-cooling for components within the enclosure. The combination of liquid-cooling for battery racks and air-conditioning for general enclosure mp u con o nd d umidific ion nsu s op im sys m p fo m nc ."

SAFETY

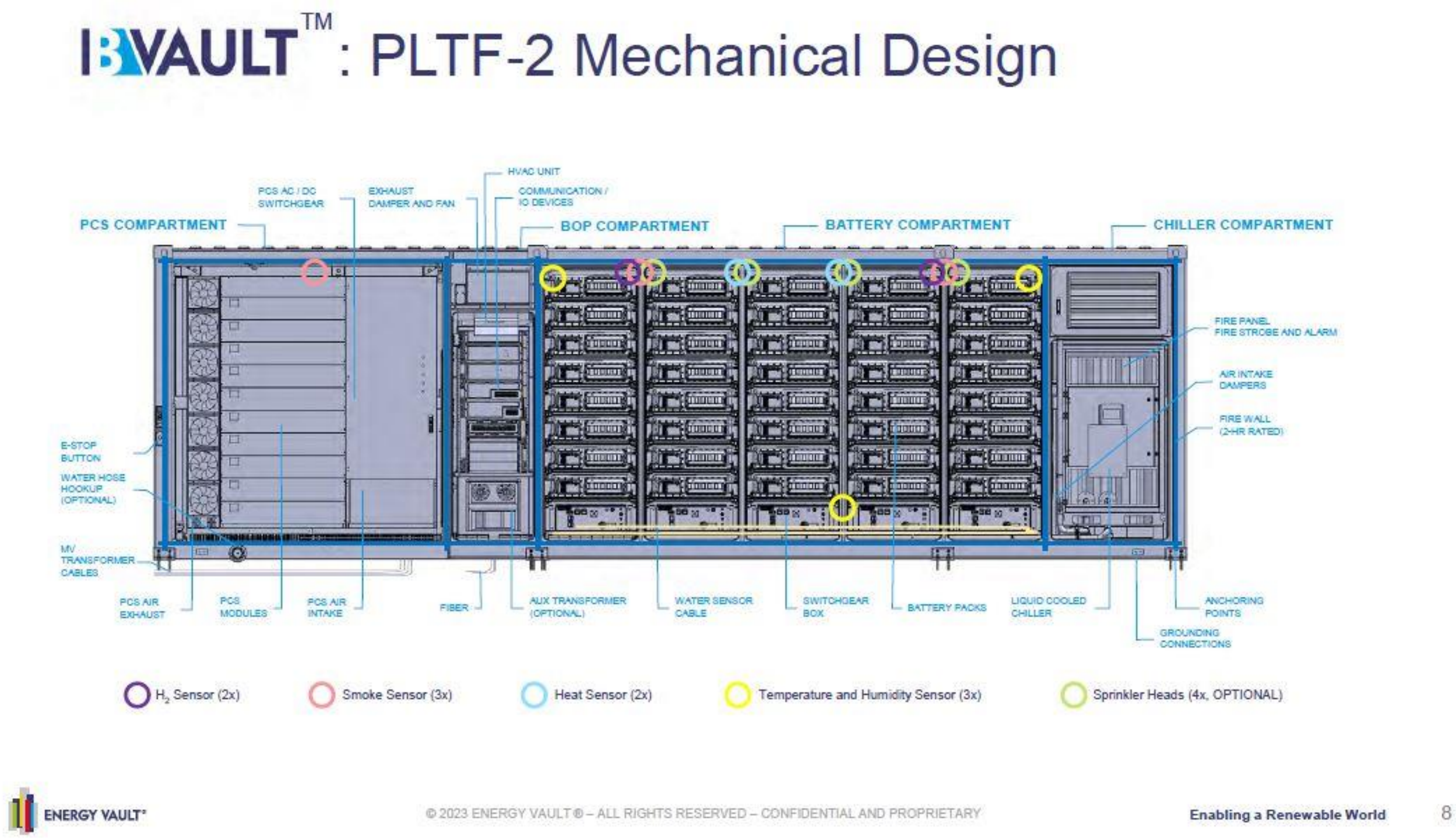
"DNV's o oug v u ion cogniz d En gy V u fo inc uding p o c ion sys ms fo fi and other hazards into the B-VAULT solution that comply with regulatory standards and are aligned with industry best practices. B-VAULT fire and emergency protection systems, which include fire and smoke detection, gas sensors, and ventilation, are designed to manage the system in a timely manner in order to reduce the risk of fire or explosion by imin ing sing poin of f iu ."

ENERGY VAULT®

Enabling a Renewable World 6

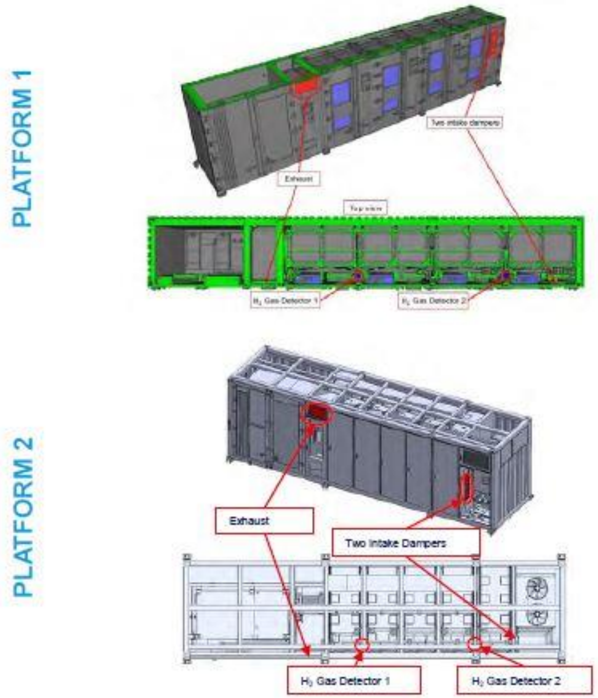


B VAULT™ : PLTF-2 Electrical Design
OUT TO EXTERNAL MEDIUM VOLTAGE TRANSFORMER
INTERNAL AUX. TRANSFORMER
NODE
UPS
HVAC
CHILLER
FIRE ALARM CONTRL PNL
MAIN AC BREAKER
AC BUS BAR
INV 1
INV 2
INV 3
INV 4
INV 5
INV 6
INV 7
INV 8
INV 9
INV 10
DC BUS BAR
MAIN DC ISOLATION SWITCH
DC BUS BAR
RACK 1
SBCU 1
RACK 2
SBCU 2
RACK 3
SBCU 3
RACK 4
SBCU 4
RACK 5
SBCU 5
BMU 1
BMU 2
BMU 3
BMU 4
ENERGY VAULT
© 2023 ENERGY VAULT® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
7



B-VAULT™ : PLTF-2 Mechanical Design
PCS COMPARTMENT
PCS AC / DC SWITCHGEAR
EXHAUST DAMPER AND FAN
HVAC UNIT
COMMUNICATION / IO DEVICES
BOP COMPARTMENT
BATTERY COMPARTMENT
CHILLER COMPARTMENT
FIRE PANEL FIRE STROBE AND ALARM
AIR INTAKE DAMPERS
FIRE WALL (2-HR RATED)
E-STOP BUTTON
WATER HOSE HOOKUP (OPTIONAL)
MV TRANSFORMER CABLES
PCS AIR EXHAUST
PCS MODULES
PCS AIR INTAKE
FIBER
AUX TRANSFORMER (OPTIONAL)
WATER SENSOR CABLE
SWITCHGEAR BOX
BATTERY PACKS
LIQUID COOLED CHILLER
ANCHORING POINTS
GROUNDING CONNECTIONS
H2 Sensor (2x)
Smoke Sensor (3x)
Heat Sensor (2x)
Temperature and Humidity Sensor (3x)
Sprinkler Heads (4x, OPTIONAL)
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
8

B-VAULT™: Safety Design



Design Highlights

- Jensen Hughes conducted a thorough safety analysis of B-VAULT and finds it to comply with NFPA 855, NFPA 69, and NFPA 72 requirements including HMA
- NFPA 69 compliant explosion prevention design uses a forced ventilation system, which is automatically actuated by H_2 detection, ensuring gas concentration < 25% LFL
- B-VAULT compartments are lined with 2-hour firewalls on each side, roof, and floor
- Each container has an E-stop button and fire strobe/ alarm on the outside
- Battery cells, packs, and racks have undergone UL9540A fire test and do not show fire propagation
- An optional water sprinkler system compliant with NFPA 13 can be included with B-VAULT

ENERGY VAULT®

Enabling a Renewable World

9

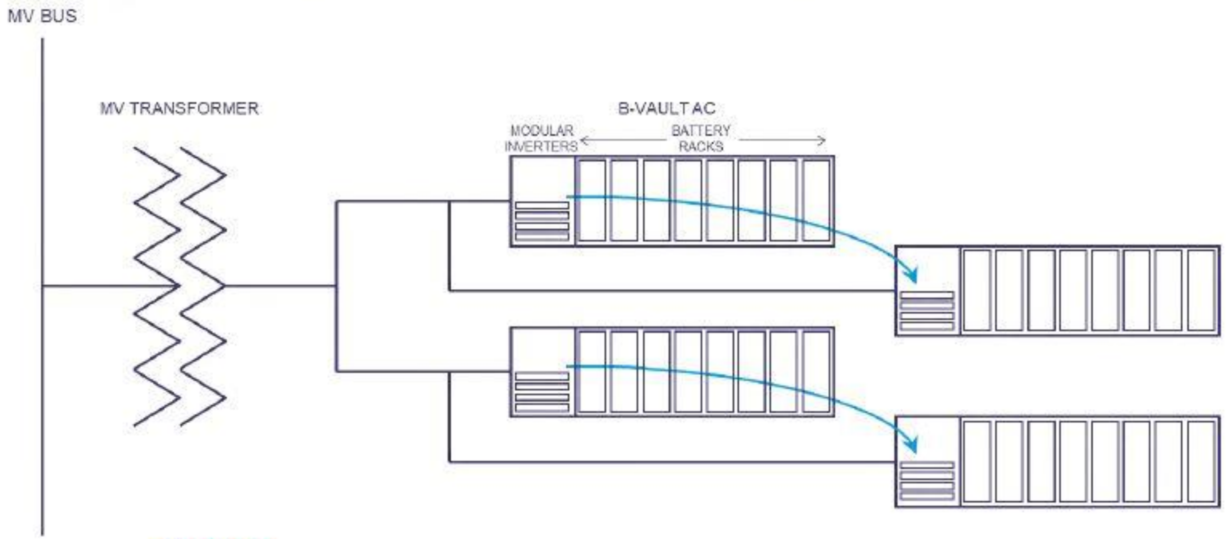
B-VAULT™: Transport and EPC Considerations

Design Highlights

- B-VAULT designed to reduce transport and EPC cost and to improve speed of implementation
- B-VAULT can be transported on 40 ft. flat-rack container from the factory to the project site
- B-VAULT can be laid side-by-side and back-to-back in cluster of four, improving project energy density
- Foundation can be bored/ driven piles or concrete pads, giving flexibility in site preparation
- Low-voltage AC and fiber cables can be penetrated under the base of the B-VAULT
- B-VAULT AC avoids cost of on-site DC-cabling

ENERGY VAULT®

B-VAULT™ : Augmentation Design



STEPS

1. Add new B-VAULT AC with no inverters
2. Move some modular inverters from old to new B-VAULT AC
3. Run low-voltage AC cable
4. Old and new battery modules are on separate DC buses. DC/DC converters are not required
5. Commission the project with augmented capacity

ENERGY VAULT®

Enabling a Renewable World 11

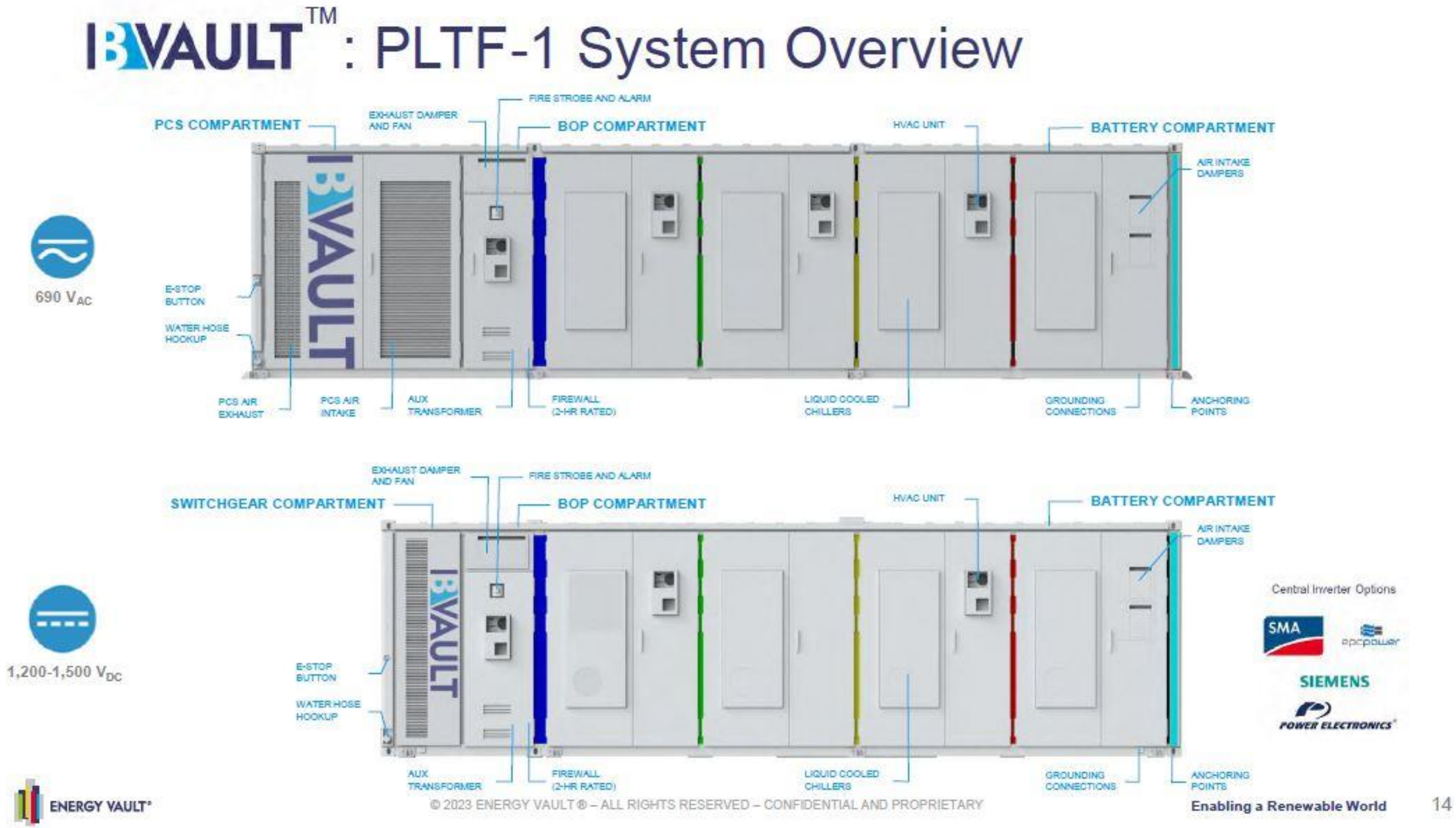

VAULTOS™ : Plant Controller
EMS ON-SITE
+
EMS CLOUD
MASTER PPC, HYBRID PPC
SYSTEM SECURITY
FAST RESPONSE TIME
SYSTEM UPTIME
SAFETY & THERMAL MANAGEMENT
BIDDER, SCADA MODULES
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
12

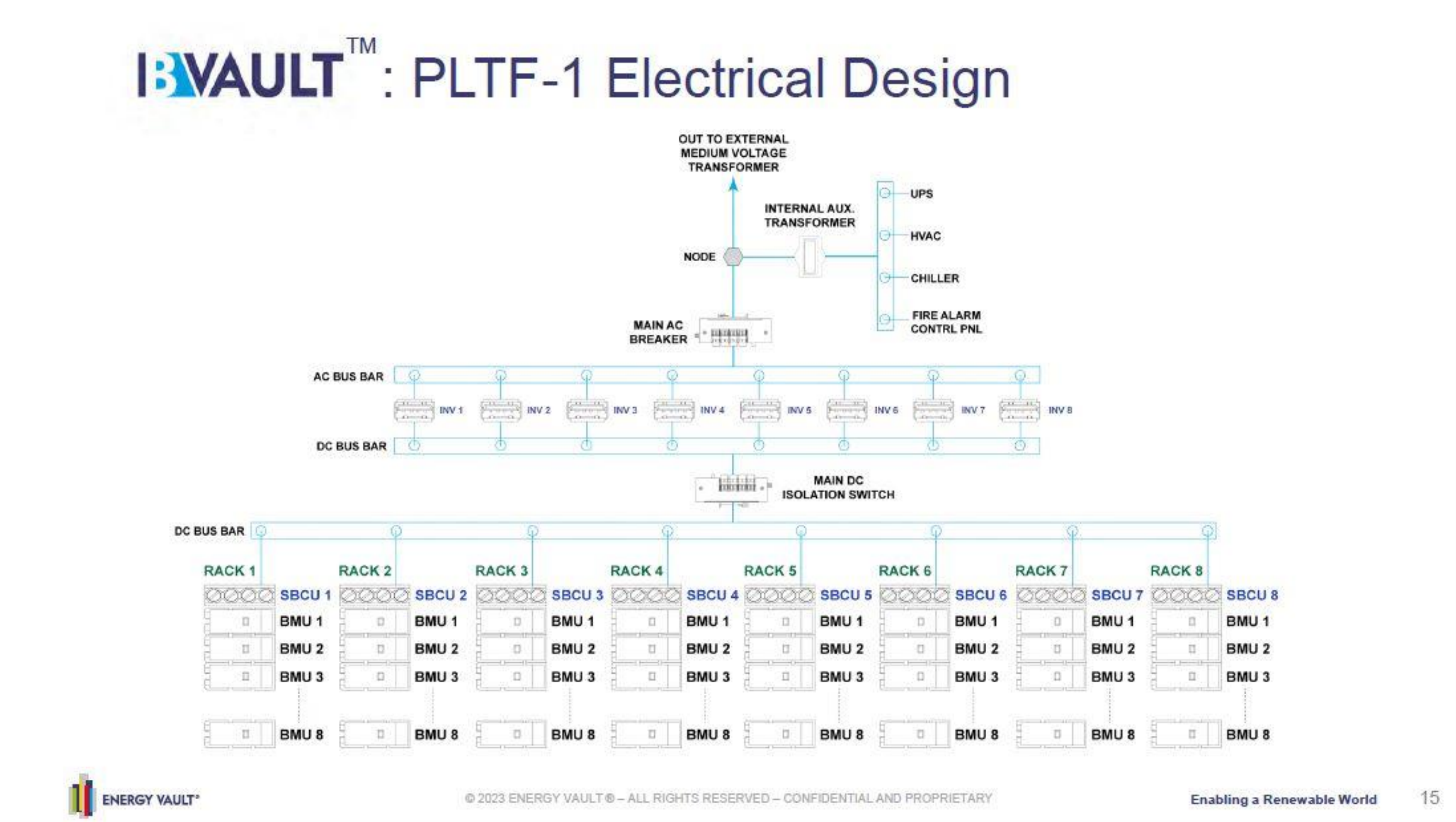
B-VAULT™: Certifications

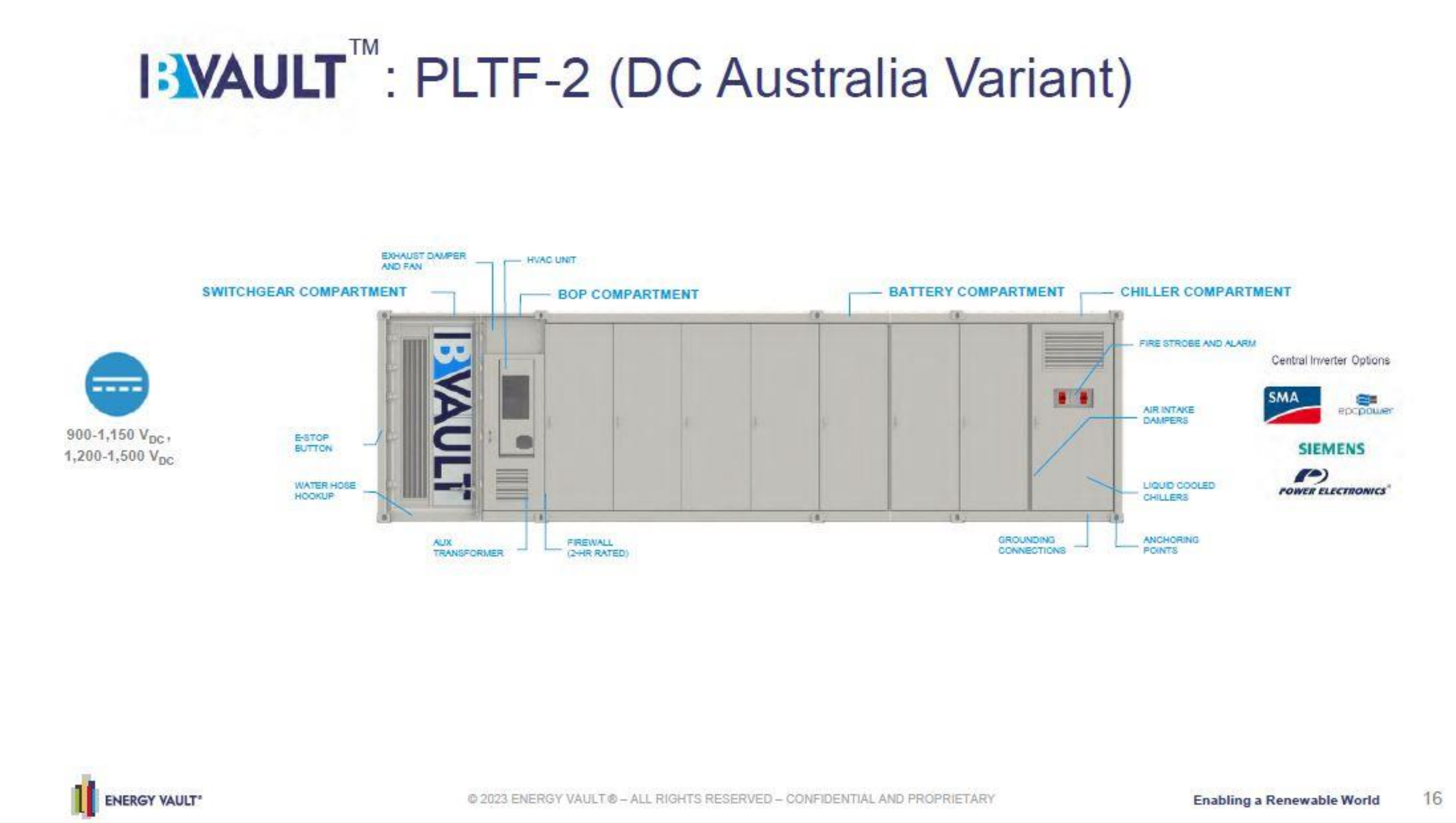
Certification	Description
UL 9540	B-VAULT AC – Standard for Energy Storage Systems & Equipment
UL 9540A	Battery Cell – Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
UL 9540A	Battery Pack – Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
UL 9540A	Battery Rack/String – Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
UL 1973	Battery Cell – Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
UL 1973	Battery Rack/String – Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and LER Applications
IEC 62619 & EN 62619	Battery Cell – Safety Requirements for Secondary Lithium Cells and Batteries, for Use in Industrial Applications
IEC 62619 & IEC 63056	Battery Rack/String – Safety Requirements for Secondary Lithium Cells and Batteries for Use in Electrical Energy Storage
UL 1741	Inverter – Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With DERs
IEEE 1547.1	Inverter – Standard Conformance Test Procedures for Equipment Interconnecting DERs with Electric Power Systems
G99	Inverter – Great Britain Requirements for the Connection of Generation Equipment in Parallel with Public Distribution Networks
CSC	B-VAULT AC – Container Certificates
CSC	B-VAULT AC – Certificate of Container Design
UN 38.3	Battery Cell (306 Ah) – Transportation Testing for Li-ion Batteries
UN 38.3	Battery Pack – Transportation Testing for Li-ion Batteries
UN 38.3	B-VAULT AC – Transportation Testing for Li-ion Batteries
UN 3536	B-VAULT AC – Lithium Batteries Installed in Cargo Transport Unit
ISO 3744	B-VAULT – Determination of sound power levels and sound energy levels of noise sources using sound pressure
AS 3000	B-VAULT DC – AUS/ NZ Electrical Installations (known as the Electrical Wiring Rules)

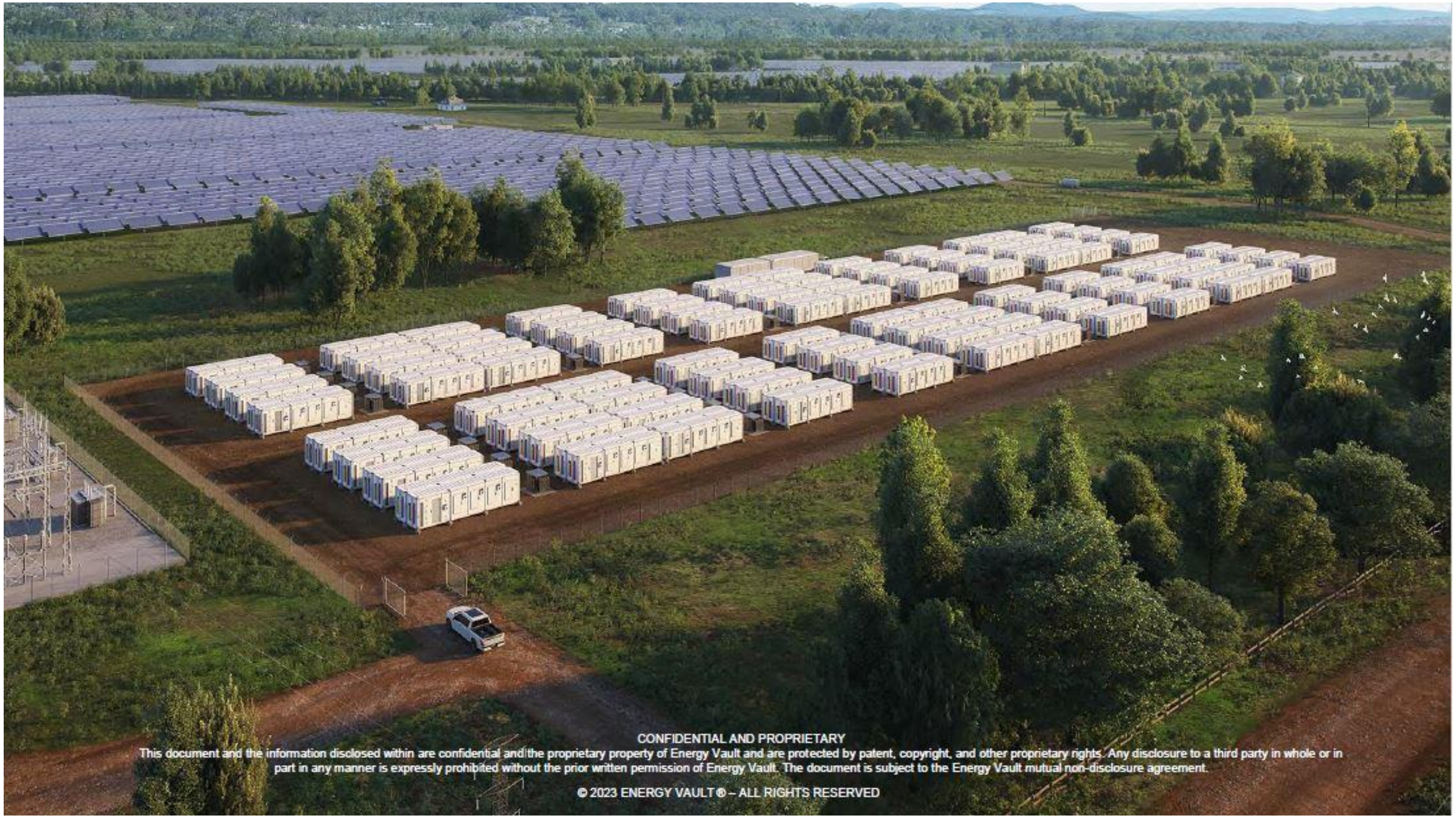
ENERGY VAULT®

Enabling a Renewable World 13


B-VAULT™: PLTF-1 System Overview
PCS COMPARTMENT
EXHAUST DAMPER AND FAN
FIRE STROBE AND ALARM
BOP COMPARTMENT
HVAC UNIT
BATTERY COMPARTMENT
AIR INTAKE DAMPERS
690 VAC
E-STOP BUTTON
WATER HOSE HOOKUP
PCS AIR EXHAUST
PCS AIR INTAKE
AUX TRANSFORMER
FIREWALL (2-HR RATED)
LIQUID COOLED CHILLERS
GROUNDING CONNECTIONS
ANCHORING POINTS
SWITCHGEAR COMPARTMENT
1,200-1,500 VDC
Central Inverter Options
SMA
epcpower
SIEMENS
POWER ELECTRONICS
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
14


B-VAULT™ : PLTF-1 Electrical Design
OUT TO EXTERNAL MEDIUM VOLTAGE TRANSFORMER
INTERNAL AUX. TRANSFORMER
UPS
HVAC
CHILLER
FIRE ALARM CONTRL PNL
NODE
MAIN AC BREAKER
AC BUS BAR
INV 1
INV 2
INV 3
INV 4
INV 5
INV 6
INV 7
INV 8
DC BUS BAR
MAIN DC ISOLATION SWITCH
DC BUS BAR
RACK 1
RACK 2
RACK 3
RACK 4
RACK 5
RACK 6
RACK 7
RACK 8
SBCU 1
SBCU 2
SBCU 3
SBCU 4
SBCU 5
SBCU 6
SBCU 7
SBCU 8
BMU 1
BMU 2
BMU 3
BMU 8
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
15


B-VAULT™: PLTF-2 (DC Australia Variant)
900-1,150 VDC, 1,200-1,500 VDC
SWITCHGEAR COMPARTMENT
EXHAUST DAMPER AND FAN
HVAC UNIT
BOP COMPARTMENT
BATTERY COMPARTMENT
CHILLER COMPARTMENT
FIRE STROBE AND ALARM
AIR INTAKE DAMPERS
LIQUID COOLED CHILLERS
E-STOP BUTTON
WATER HOSE HOOKUP
AUX TRANSFORMER
FIREWALL (2-HR RATED)
GROUNDING CONNECTIONS
ANCHORING POINTS
Central Inverter Options
SMA
epcpower
SIEMENS
POWER ELECTRONICS
ENERGY VAULT
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED – CONFIDENTIAL AND PROPRIETARY
Enabling a Renewable World
16


CONFIDENTIAL AND PROPRIETARY
This document and the information disclosed within are confidential and the proprietary property of Energy Vault and are protected by patent, copyright, and other proprietary rights. Any disclosure to a third party in whole or in part in any manner is expressly prohibited without the prior written permission of Energy Vault. The document is subject to the Energy Vault mutual non-disclosure agreement.
© 2023 ENERGY VAULT ® – ALL RIGHTS RESERVED

eco
logical
AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au