PRELIMINARY HAZARD ANALYSIS FOR THE SOLAR FARM AND BATTERY ENERGY STORAGE SYSTEM IN COBBORA, NSW

Prepared for: Cobbora Solar Farm Pty Ltd in its capacity as trustee for the Cobbora Solar Farm Trust

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Preliminary Hazard Analysis for Cobbora Solar Farm Pty Ltd's Solar Farm and Battery Energy Storage System in Cobbora, NSW

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Rev	Date	Description	Prepared By	Checked By	Authorised By
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EXECUTIVE SUMMARY

Cobbora Solar Farm Pty Ltd, in its capacity as trustee for the Cobbora Solar Farm Trust (a wholly owned subsidiary of Pacific Partnerships Pty Ltd) is seeking development consent to construct, operate and decommission the Cobbora Solar Farm in the central west region of New South Wales (NSW).

The solar farm would be a large-scale solar photovoltaic generation facility with a battery energy storage system (BESS) and associated infrastructure for its management and connection to the national electricity market (the Project). The Project would be located near Cobbora, approximately 20 kilometres (km) south-west of the township of Dunedoo and 55 km east of Dubbo in Central West NSW (the Site).

The Project would connect to the Central West Orana (CWO) Renewable Energy Zone (REZ) grid infrastructure via up to four onsite grid substations which would connect to the Elong Elong Energy Hub.

Key features of the Project, assessed as part of this report, would include:

- Construction and operation of a 700 MW (AC) (875 MW (DC)) solar farm
- Installation of a 400 MW / 1,600 MWh BESS
- Installation of up to four substations, comprising:
    - One substation connecting the BESS to the Elong Elong Energy Hub
    - Up to three substations connecting the solar farm to the Elong Elong Energy Hub (four potential substation locations have been assessed in the PHA, which will be reduced during detailed design)
- Supporting facilities and infrastructure, including internal roads, upgrades to external access roads (if required), underground and overhead cabling, waterway crossings, staff office, meeting facilities, operations and control room, workshop, amenities, accommodation, car parking, storage facilities and fencing and landscaping.

The overall study objective is to address the Hazards component of the Secretary's Environmental Assessment Requirements (***SEARs***) for the Project, as listed below:

• *Dangerous goods* - preliminary risk screening completed in accordance with *State Environmental Planning Policy* (Resilience and Hazards);
• *Battery Energy Storage System* - a Preliminary Hazard Analysis (PHA) must be prepared in accordance with the Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis' and Multi-Level Risk Assessment (DoP, 2011). The PHA must consider all recent standards and codes and verify separation distances to on-site and off-site receptors to prevent fire propagation and compliance with Hazardous Industry Advisory Paper No. 4, 'Risk Criteria for Land Use Safety Planning (DoP, 2011); and
• *Health* - an assessment of potential hazards and risks including but not limited to bushfires, spontaneous ignition, electromagnetic fields or the proposed grid connection infrastructure against the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines for Limiting Exposure to Time-varying Electric, Magnetic and Electromagnetic Fields;
• *Bushfire* - a bush fire hazard assessment completed by a suitably qualified consultant and identifies potential hazards and risks associated with bushfires including the risks that a solar farm would cause bush fire and demonstrate compliance with Planning for Bush Fire Protection 2019;
• an assessment of the likely impacts associated with the high-pressure pipeline traversing the site in consultation with APA Group

The hazard analysis combines qualitative and quantitative methods to assess the adequacy of the proposed controls for the Project. The aim is to show that the Project can be developed with risks kept As Low As Reasonably Practicable (ALARP), and appropriate land use safety planning can be achieved in accordance with relevant land use criteria (as defined in Hazardous Industry Advisory Paper No. 4, HIPAP4).

This PHA focusses on potential high consequence - low likelihood incidents in construction, commissioning and operation of the Project that may affect the health and safety of people and the environment outside the Project Area, in accordance with the requirements in *Hazardous Industry Planning Advisory Paper No. 6 – Guideline for Hazard Analysis* (HIPAP6) and the *Multilevel Risk Assessment* guideline (MLRA). In addition, the risks inside the Project Area are also included in this PHA as there is potential for first responders from the public authorities (e.g. from Fire and Rescue NSW (FRNSW) or from the Rural Fire Service (RFS)) to access the site in an emergency.

The findings are as follows:

- The Project is not considered *potentially hazardous* in accordance with the Department of Planning, Housing and Infrastructure's (DPHI) definition, based on the intended storage and transport of hazardous material.
- Potential hazards from the Project are predominantly associated with the *other types of hazards* including with the risk of a fire associated with the Li-ion batteries, and of environmental pollution from a spill of oil used in the transformers, or other pollutant (depending on the

detailed design considerations, this may for example include coolant for use within the battery enclosure).

- Using a risk matrix which has been calibrated to the Department of Planning risk criteria (in their HIPAP4 document), the PHA found that the risk profile for the Project is consistently between *Moderate* and *Low* risk, with no *High* or *Very High* risks identified.

  - *Off-site risk:* The PHA found that the risk profile for land outside of the Site including outside the Project Area is *Acceptable*.

  - *On-site risk:* The PHA found that the risk profile for personnel working within the Site including within the Project Area is consistently *ALARP*.

The assessment found that the facilities associated with the Project can be managed in accordance with the established risk criteria and in accordance with ALARP principles, including the risk to the nearby residents.

Most hazards can be prevented or mitigated by employing a combination of standard measures, including following all applicable Australian/New Zealand Standards and Codes (AS/NZ Standards) and referring to international Standards where appropriate. Preventative measures include separation distances and setbacks, physical protection, and automatic control systems. Mitigation measures to reduce the severity of the hazards should they occur, include specific secondary containment, e.g. as integrated into the battery enclosure and transformers; and operational training.

Table E1 below provides an overview of the risk assessment results and ALARP conditions.

Table E1: Overview of risk assessment results and ALARP conditions

Project hazardous incident event	Finding	Risk result and ALARP evaluation
1. Fire at a battery enclosure within the BESS during operation or during construction (from the first energisation of batteries)	Codes and Standards provide clear guidance as to how to prevent and protect against a fault in a battery escalating into a fire at a battery enclosure. Key controls include continuous battery management system (BMS) with automatic shut-down batteries and battery racks are certified with respect to not posing a fire propagation risk in accordance with international methodologies (e.g. the UL 9540A destructive test) and establishment of minimum separation distances within the BESS between Project infrastructure and between the BESS and the external boundaries (Recommendations 1, 2 and 5). Fire water would be stored in strategic locations on-site for firefighting in the surrounding grassland as per the requirement in the bushfire assessment. The need for external firefighting is unlikely for electrical and other fires associated with BESS infrastructure but would need to be determined in the detailed design phase, in consultation with RFS, FRNSW and DPHI (Recommendation 4). On-site hazardous effects are possible in case of a battery fire, and the risk associated with generation of flammable gas and toxic combustion products would be minimised in design via safe evacuation routes and procedures from the facility should be established, and the toxicity of combustion gas should be considered in emergency response.	Off-site (outside of the Project Area and Site), external land use: *Acceptable risk* On-site (within the Project Area): ALARP risk Managed to ALARP principles provided the battery and the enclosures are designed such that a fire will not propagate and that the relevant requirements in Codes and Standards are adhered to and the minimum separation distances within the BESS between battery enclosures and an appropriate Asset Protection Zone (APZ) are established and maintained
2. Loss of containment of pollutant material from the Project infrastructure (e.g. oil from the transformers,	Environmental pollution may occur from a failure to contain pollutants, and the need for secondary containment of a spill would be considered in detailed design including at the transformers (Recommendation 5).	Off-site (outside of the Project Area and Site), external land use: *Acceptable risk* On-site (within the Project Area): ALARP risk

Project hazardous incident event	Finding	Risk result and ALARP evaluation
coolant from the HVAC system in the BESS and diesel from the generator)	The requirements under the Australian Standards (including AS 1940) are sufficient to ensure the risk associated with environmental pollution at the infrastructure associated with the Project is managed to ALARP principles.	Conforms to ALARP provided the applicable requirements in Codes and Standards are followed
3. Electrical fault or failure to control electrical energy at electrical equipment (inverters, step-up transformers, substations, transmission line and gantries) causing fire, arc flash, or exposure to EMF	The requirements under the Australian Standards (e.g. AS 2067) and typical management practices for Low, Medium and High Voltage systems are sufficient to ensure the risk associated with fire at the electrical infrastructure associated with the Project is managed to ALARP principles. The EMF impact assessment concluded that the EMF levels generated by the Project are compliant with the applicable Australian and international standards and guidelines, specifically the ICNIRP reference levels and therefore the risk from EMF is acceptable.	Off-site (outside of the Project Area and Site), external land use: *Acceptable risk* On-site (within the Project Area): *ALARP risk* On-site (outside of the Project Area and Site) (EMF): *Acceptable risk* Conforms to ALARP provided the applicable criteria are followed as per Codes and Standards
4. Fire in nearby area (bush / grass fire or fire at the APA Gas pipeline) causes damage and escalation to Project infrastructure or fire on-site leads to fire in nearby area	An incident in a neighbouring area may affect the Project. Key controls identified in the workshop with APA include fire management and emergency response (including a Bushfire and Emergency Management Operation Plan (BEMOP)) and the establishment and maintenance of an APZ as per the bushfire assessment (Recommendations 3 and 6). The Development Footprint is away from the APA pipeline, which mitigates the risk of the Project interacting with this pipeline. Therefore, the risk associated with the presence of the APA Group pipeline near the Project Area is very low. Additionally, natural hazards from wind, lightning, etc. would be managed using Codes and Standards.	Off-site (outside of the Project Area and Site), external land use: *Acceptable risk* On-site (within the Project Area): *ALARP risk* Conforms to ALARP provided the applicable criteria are followed in the bushfire assessment and in Codes and Standards

Project hazardous incident event	Finding	Risk result and ALARP evaluation
5. Incident during construction activity causes impact with infrastructure	The risk arises from typical construction activities and may include Initiation of hazardous incidents through crushing and impact and initiation of incident scenarios 1, 2 and 3; and injury from fall from height, impact with moving machinery etc.. Construction risks are well known and understood. Existing Codes and Standards are established within the industry to manage construction risk. For specific risk management for the APA Group pipeline, refer to Recommendation 7.	Off-site (outside of the Project Area and Site), external land use: *Acceptable risk*
		On-site (within the Project Area): ALARP risk
		Managed to ALARP principles provided general construction Codes and Standards are adhered to

The footprint for the Project would fit comfortably within the available land of 1,600 hectares including, for the BESS Site, within the 100 hectares allocated.

The assessment found that, provided the recommendations listed below are implemented, the Project can be managed in line with the HIPAP4 established risk criteria and ALARP principles, including any risk to the nearby residents and businesses.

This PHA has been developed based on the following understanding:

1. All relevant requirements in the Australian Standards are applied for the Project, and requirements in major BESS international Standards such as the US National Fire Protection Association Code NFPA855.

2. Procurement of a battery system that is certified under an internationally recognised test method such as the Underwriters Limited UL 9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*.

3. Emergency Management Plan and Procedures to be developed for Project construction and operation. This should include the establishment of a BEMOP for bushfire protection, and evacuation protocols for those not involved in any emergency response and any not wearing appropriate PPE. The possibility of gas and pressure release from a battery enclosure, including the risk associated with opening a door during a thermal (runaway) event should be considered and communicated to first responders with appropriate responses.

4. Preparation of a Fire Safety Study in consultation with FRNSW and DPHI during detailed design. The design and layout of the BESS, including separation distances between battery enclosures and rows of enclosures, should be developed following the requirements by the FRNSW specified in their Fire Safety Guideline, Technical Information entitled *Large-scale external lithium-ion battery energy storage systems / Fire safety study considerations* (current latest version is D22/107002).

5. Measures to prevent leaks from the BESS and all three types of oil transformers (i.e. MV, HV and PCU), and for containing spills if they occur, should be addressed in the detailed design phase.

6. The Asset Protection Zone (APZ) required in the bushfire assessment should be established and maintained throughout the life of the Project.

7. Adhere to the site-specific requirements for protection of the high pressure pipeline, which would be defined by APA Group as part of the project development. Considerations by APA Group communicated at the early design stage include the need for clearing of trees or other

work at the north-western corner of the Project Area; potential for the requirement of an APA's impact assessment report to assess risks to the pipeline from the electrical design; and any need for potholing. These considerations should be included in the relevant Project management plans, for agreement with APA Group.

Glossary and Abbreviations

AEGL	Acute Exposure Guideline Levels: Used by emergency planners and responders worldwide as guidance in dealing with rare, usually accidental, releases of chemicals into the air. AEGLS are expressed as specific concentrations of airborne chemicals at which health effects may occur. They are designed to protect the elderly and children, and other individuals who may be susceptible
AC	Alternating current
ADGC	Australian Dangerous Goods Code
ALARP	As Low As Reasonably Practicable – term used by the DPHI for a similar concept to the SFAIRP (So Far As Is Reasonably Practicable) concept in the WHS Regulation. Defined by DPHI (in HIPAP4) as *a principle that may be applied in relation to the degree of risk reduction that may be sought from a particular activity, and then later, referring to the definition by the UK Health and Safety Executive:* 'In weighing the costs of extra safety measures the principle of reasonable practicability (ALARP) applies in such a way that the higher or more unacceptable a risk is, the more, proportionately, an employer is expected to spend to reduce it'.
APA Group	Owners and operators of a high pressure natural gas pipeline which traverses the north western corner of the Project Area
APA Group pipeline	high pressure natural gas pipeline
APZ	Asset Protection Zone
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS	Australian Standard
Battery rack	Physical rack which is made up of several battery cells arranged within modules connected in series or parallel. Each enclosure houses several battery racks, and each battery rack houses several battery modules (numbers to be confirmed in detailed design)
BATSO	BESS Safety Organization
BCA	Building Code of Australia
BEMOP	Bush Fire Emergency Management and Operations Plan
BESS	Battery Energy Storage System, a form of energy storage system relying on electrochemical batteries to store energy. A BESS consists of battery enclosure(s), a power conversion system (PCS), and associated auxiliary equipment (AC switchgear, meters, relays, and telecommunications equipment)
BESS Area	The area on the BESS Site where the battery enclosures are located
BESS Site	Location of the BESS Area and the BESS substation within the security fencing. A laydown area has also been provided within the BESS Site to support construction of the substation.

BMS	Battery Management System, protects the battery from harmful operation and maximises its lifespan by constantly controlling and monitoring the battery's parameters such as voltage, current, temperature, state-of-charge and state-of health, and ensuring they are within operating specifications
BPL	bushfire prone land
CCTV	Closed Circuit Television
CO	carbon monoxide
CO_2	carbon dioxide
DC	Direct Current
deflagration	a fire in which the flame travels rapidly, but at subsonic speed, and produces potentially damaging pressures
Development Footprint	The indicative developable area whereby Project Infrastructure (including access tracks and temporary construction support areas) would occupy, covering approximately 1,600 hectares
DG	Dangerous Goods
DN	diametre nominal
DoP	Department of Planning, title in 2011 when the Hazardous Industry Planning Advisory Papers No's 4 and 6 were published
DPHI	Department of Planning, Housing and Infrastructure (NSW), formerly the Department of Planning (DoP)
EIS	Environmental Impact Statement
ELF	Extremely Low Frequency
EMF	Electric and Magnetic Fields
enclosure	A discrete energy-storage unit that includes batteries within battery racks, a cooling system, communication interface and other equipment and accessories necessary to maintain health and long-term operation in an outdoor environment. Enclosures are interconnected to form rows of enclosures. The enclosure is the fundamental building block of the ESS plant layout
ERP	Emergency Response Plan
ESD	Emergency Shut Down
ESS	Energy Storage System. ESS technologies can be classified into five categories based on the form in which energy is stored: Mechanical, Electrochemical (using batteries), Thermal, Electrical and Chemical. The proposed BESS is an electrochemical ESS
FACP	Fire Alarm Control Panel
FRNSW	Fire and Rescue NSW
ha	hectare
H_2	Hydrogen (gas)
HCl	hydrogen chloride (gaseous)

HCN	hydrogen cyanide (gas)
HCs	hydrocarbons (NOS)
HF	hydrogen fluoride (gas)
HIPAP	Hazardous Industry Planning Advisor Paper (guidelines by the Department of Planning)
HV	High Voltage
HVAC	Heating, Ventilating, and Air Conditioning
IBC	International Building Code
IEC	International Electricity Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
kg	kilogram
kL	kilolitre
km	kilometre
kV	kilovolts
LEL	Lower Explosive Limit
LFP	lithium iron phosphate
LGA	Local Government Area
Li-ion	Lithium-ion (battery)
LTI	Lost time injury
LV	low voltage
m	metre
mG	milligauss
MLRA	Multilevel Risk Assessment (guidelines by the Department of Planning)
MP	Megapack
MPa	megapascal
MV	medium voltage
MVA	Mega Volt Ampere
MW	Megawatt
MWh	Megawatt-hour
NEM	National Electricity Market
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSW	New South Wales
NSW RFS	NSW Rural Fire Service
NDT	Non-Destructive Testing
NOS	Not Otherwise Specified

PBP	Planning for Bushfire Protection
PCS	Power Conversion System, converts alternating current (AC) to direct current (DC), and vice versa, to allow power flow between the BESS and the grid
PG	Packaging Group
PHA	Preliminary Hazard Analysis
PIRMP	Pollution Incident Response Management Plan
PM	Preventative Maintenance
PPE	Personal Protective Equipment
ppm	parts per million
Project	Construction, operation and decommissioning of the Cobbora Solar Farm. The Cobbora Solar Farm would be a large-scale solar photovoltaic (PV) generation facility with associated infrastructure
Project Area	The total area of the Site, covering approximately 3,000 hectares
PTW	Permit To Work
REZ	Renewable Energy Zone
RFS	Rural Fire Service
PV	photovoltaic
row	A number of enclosures, connected to form a row.
runaway	Occurs when excessive heat is generated and accumulated within the battery, e.g. due to poor system design, installation or mishandling, leading to the build-up of heat and flammable (and possibly toxic) gas
SAT	Site Acceptance Test (or Testing)
SCADA	Supervisory Control and Data Acquisition
SDS	Safety Data Sheets
SEPP	State Environmental Planning Policy
Site	Covers approximately 3,000 hectares
SOC	State-of-Charge
SOP	standard operating procedure
SWMS	Safe Work Method Statement
thermal runaway	See “runaway”
UL	Underwriters Laboratories
UN	United Nations
V	Volt
VOC	volatile organic compound
WHS	Work Health & Safety

REPORT

1 INTRODUCTION

Cobbora Solar Farm Pty Ltd, in its capacity as trustee for the Cobbora Solar Farm Trust (a wholly owned subsidiary of Pacific Partnerships Pty Ltd) is seeking development consent to construct, operate and decommission the Cobbora Solar Farm in the central west region of New South Wales (NSW).

The solar farm would be a large-scale solar photovoltaic (PV) generation facility with a battery energy storage system (BESS) and associated infrastructure for its management and connection to the national electricity market (NEM) (the Project). The Project would be located near Cobbora, approximately 20 kilometres (km) south-west of the township of Dunedoo and 55 km east of Dubbo in Central West NSW (the Site).

Planager Pty Ltd (Planager) has been commissioned to undertake a Preliminary Hazard Analysis (PHA) for the Project. The PHA considers construction and operational impacts associated with the Project.

1.1 SURROUNDING LAND USE AND EASEMENTS

1.1.1 Dwellings

Figure 2-4 shows the locations of receivers within and outside of the Site.

Residential receivers located within the Site are referred to as *associated dwellings,* and residential receivers located outside of the Site are referred to as a *non-associated dwelling.*

- *Associated dwellings:* There are four abandoned and dilapidated dwellings in the northern portion of the Development Footprint and a house, large shed and cattle yards in the south of the Development Footprint. These will be demolished to allow for the placement of the proposed solar array
- *Non-associated dwelling:* There are 51 non-associated dwellings (private) located within 4 km with a line of sight of the Project.

There is no sensitive development in accordance with the definition used by the DPHI in their HIPAP4 and HIPAP6 guidelines (e.g. schools, hospitals, aged care facilities) within 1 km of the Project Area.

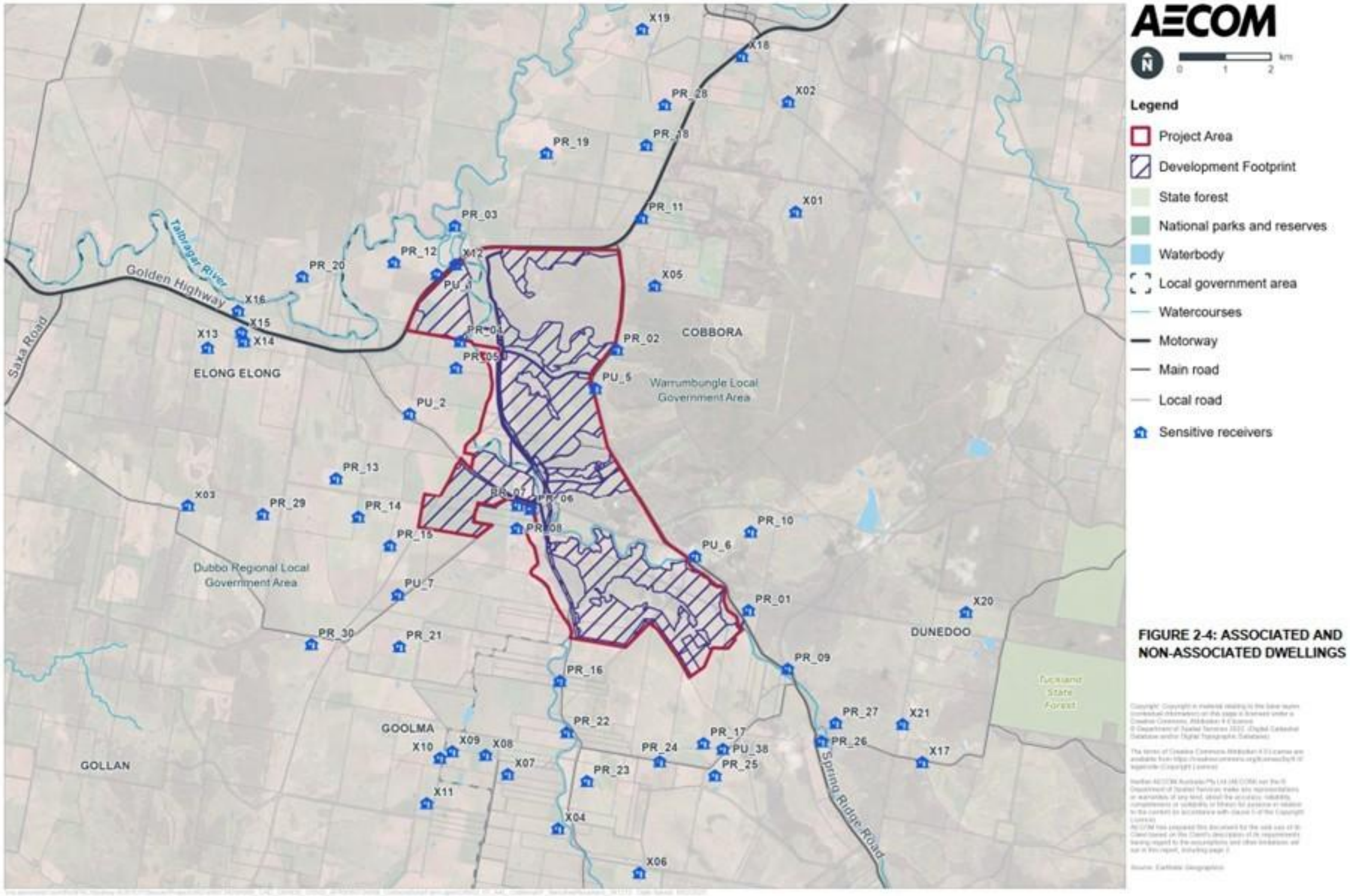


Figure 1-1: Associated and non-associated dwellings

1.1.2 Industrial land and infrastructure

There is no land zoned specifically as industrial within 10km of the Project Area.

1.1.3 Recreational and environmental land

There is no land zoned for recreational or environmental purposes within the Site. The nearest recreational zoned land is Talbragar River, approximately 16 km west of the Site. The Talbragar River is zoned as ‘W2 Recreational Waterway’ under the Dubbo Regional LEP.

The nearest environmental zoning is the Cobbora State Conservation Area, approximately 5.2 km north of the Site. This area is zoned as C1 National Parks and Nature Reserves under the Warrumbungle LEP.

The Project is not anticipated to affect recreational or environmental conservation land.

1.1.4 Agricultural land

The Project area is located within a region of land zoned as RU1 Primary Production under the Dubbo LEP and Warrumbungle LEP.

1.1.5 Easements

There is an APA Group pipeline which runs within an easement adjacent to the north western corner of the Site boundary and crosses the Site boundary slightly at one location. The APA Group pipeline easement is shown in Figure 2-5.

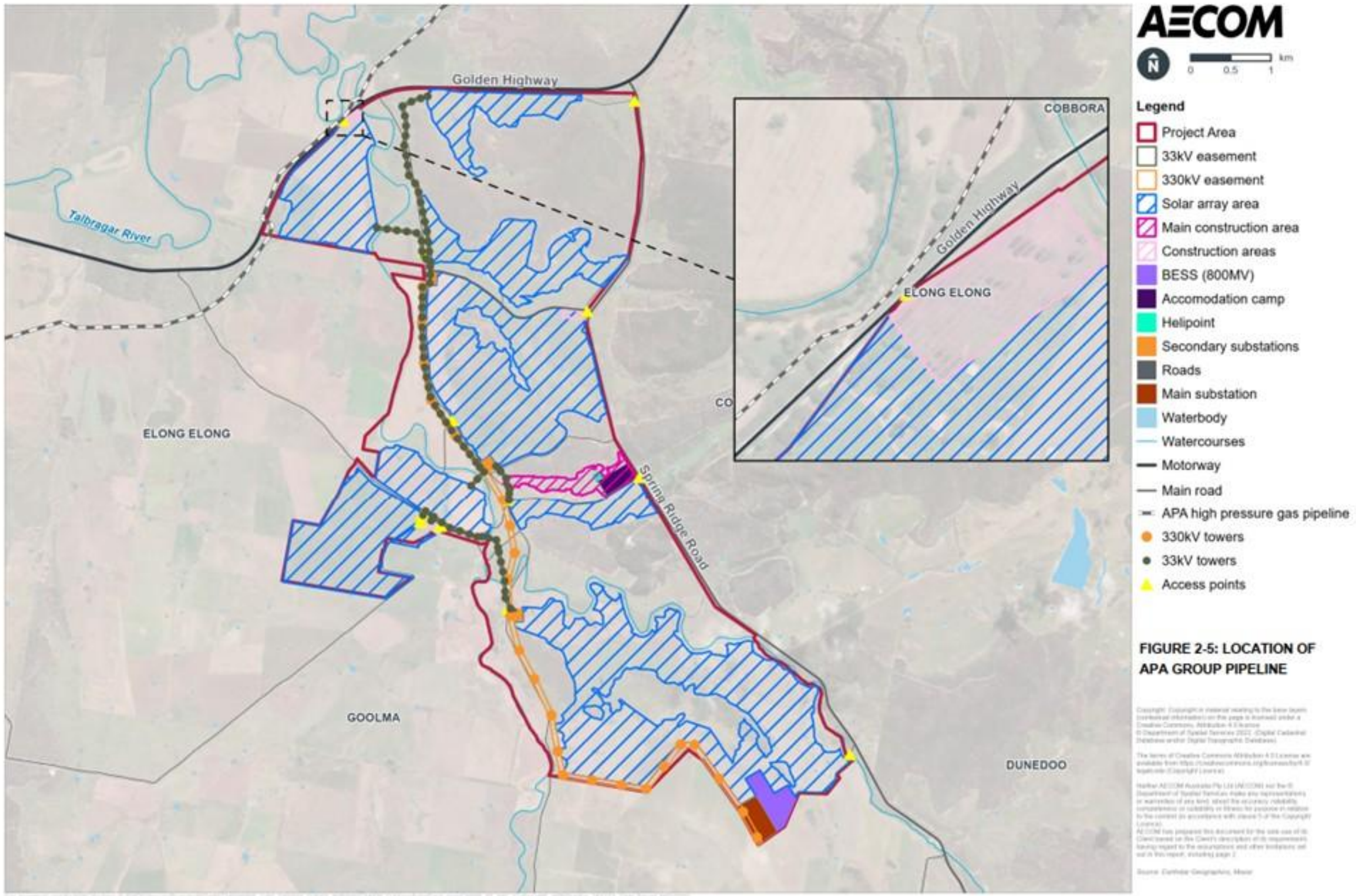


Figure 1-2: Project Area layout, with the APA Group pipeline easement in relation to the Project Area

No amendments or connection is required to the APA Group pipeline and the Project is designed to avoid this asset with the pipeline located outside of the Development Footprint but within the Project Area.

1.2 PROJECT OVERVIEW

The Project would connect to the Central West Orana (CWO) Renewable Energy Zone (REZ) grid infrastructure via up to four onsite grid substations which would connect to the Elong Elong Energy Hub.

Key features of the Project, and included in this study, would include:

- Construction and operation of a 700 MW (AC) (875 MW (DC)) solar farm
- Installation of a 400 MW / 1,600 MWh BESS
- Installation of up to four substations, comprising:
  - One substation connecting the BESS to the Elong Elong Energy Hub
  - Up to three substations connecting the solar farm to the Elong Elong Energy Hub
- Supporting facilities and infrastructure, including internal roads, upgrades to external access roads (if required), underground and overhead cabling, waterway crossings, staff office, meeting facilities, operations and control room, workshop, amenities, accommodation, car parking, storage facilities and fencing and landscaping.

1.3 SITE DESCRIPTION

The Site is approximately 3,000 hectares (ha) in size and spans two local government areas (LGAs): Warrumbungle Shire Council and Dubbo Regional Council.

Within these LGAs the Site also spans three suburbs: Dunedoo, Elong Elong and Cobbora, though is predominantly located within the suburb of Cobbora.

To the north the Site is bordered by the Golden Highway and to the east by Spring Ridge Road. The Site is zoned Primary Production (RU1) under both the Dubbo Regional Local Environmental Plan 2022 (Dubbo Regional LEP) and the Warrumbungle Local Environmental Plan 2013 (Warrumbungle LEP).

There is also a small area which is not zoned under either of the LEPs.

Land within the Site is characterised by undulating cleared land used primarily for sheep and cattle grazing or dry land cropping. The Site is largely clear of canopy vegetation, with some scattered trees and rows of trees along fence lines. Rural land surrounds the Site with residential premises located at varying distances.

1.4 Project area

The Project area covers approximately 3,000 hectares of land, of which 1,600 hectares would be occupied by the solar farm and associated infrastructure within the Site. This area was identified through eliminating land which is subject to environmental constraints (for example, areas with substantial native vegetation present, Aboriginal heritage sites or areas subject to flooding).

The key project components of relevance to the PHA are the BESS, the substations and the connecting underground and overhead cabling. Further details are provided in Section 2.4.

1.5 Purpose of this report

The overarching objectives of this PHA are to:

- Address the Secretary's Environmental Assessment Requirements (SEARs) for *Hazards* (refer to Section 1.6)
- Provide a preliminary risk screening to determine the need for and the focus for the PHA
- Address the potential hazards and risks associated with the Project to people, property and the environment at adjacent land use, particularly from:
  - Reactions and fires associated with electrical infrastructure and flammable material, including from a battery runaway reaction
  - Spills of hazardous material
  - Threats from the surrounding bush and vegetated lands, making reference to the bushfire assessment
  - Exposure to electromagnetic fields
  - Threat to and from the APA Group pipeline traversing the Site.

1.5.1 Report structure

This report is structured as follows:

- Sections 1 and 2 introduce the Project in the context of the PHA
- Section 3 includes the risk screening to determine whether the Project is *potentially hazardous industry* as per the definition in use by the NSW Department of Planning, Housing and Infrastructure (DPHI)
- Section 4 includes the preliminary hazard and risk assessment including hazard identification, with Section 4.2 analysing the hazards and risks and the proposed risk treatments, and determines the risk profile for the Project
- Section 5 includes the conclusion of the study and lists the recommendations, including further study, to allow the Project to be established within the hazard and risk management framework set by the DPHI for land use planning
- Section 6 lists the key references and sources used for the PHA.

1.6 Secretary's Environmental Assessment Requirements

SEARs for the Project were issued on 11 November 2021. An extension to the SEARs was provided and issued on 7 November 2024. The SEARs presented in Table 1-1 have informed the preparation of this PHA:

Table 1-1: SEARs – Preliminary Hazard Analysis

Relevant SEARs Preliminary Hazard Analysis	Where addressed
Dangerous goods - preliminary risk screening completed in accordance with *State Environmental Planning Policy* (Resilience and Hazards) 2021;	Section 3
Battery Energy Storage System - a Preliminary Hazard Analysis (PHA) must be prepared in accordance with the Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis' and Multi-Level Risk Assessment (DoP, 2011). The PHA must consider all recent standards and codes and verify separation distances to on-site and off-site receptors to prevent fire propagation and compliance with Hazardous Industry Advisory Paper No. 4, 'Risk Criteria for Land Use Safety Planning (DoP, 2011); and	Section 4

Relevant SEARs Preliminary Hazard Analysis	Where addressed
Health - an assessment of potential hazards and risks including but not limited to bushfires, spontaneous ignition, electromagnetic fields or the proposed grid connection infrastructure against the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines for Limiting Exposure to Time-varying Electric, Magnetic and Electromagnetic Fields;	Section 4 with specific details as follows: Bushfire: Sections 2.3.1 (context) and Section 4.2.3 (analysis) Spontaneous ignition (thermal battery runaway): Sections 4.1 incl. 4.2.1 Electric, Magnetic and Electromagnetic Fields: Sections 4.1.3 and 4.2.2
Bushfire - a bush fire hazard assessment completed by a suitably qualified consultant and identifies potential hazards and risks associated with bushfires including the risks that a solar farm would cause bush fire and demonstrate compliance with Planning for Bush Fire Protection 2019;	Bushfire: Sections 2.3.1 (context) and Section 4.2.3 (analysis)
an assessment of the likely impacts associated with the high-pressure pipeline traversing the site in consultation with APA Group.	Section 4.2.4

Note: DoP (Department of Planning) are currently known as the Department of Planning, Housing and Infrastructure (DPHI)

AECOM, on behalf of Cobbora Solar Farm Pty Ltd, has appointed ***Planager*** to prepare this PHA.

In accordance with the SEARS, the PHA has been prepared in accordance with the methodology in the Hazardous Industry Planning Advisory Paper No. 6 *Hazard analysis* (***HIPAP6***, Ref 1) and *Multi-level risk assessment* (***MLRA***, Ref 2) and the risk is compared with the risk criteria in HIPAP No 4 *Risk criteria for land use planning* (***HIPAP4***, Ref 3).

1.7 Exclusions and Limitations

- The PHA is based on concept design, and the results depend on the implementation of the commitments made during the study and the recommendations made in the PHA
- The assessment of hazards and risks included in this PHA should be reviewed if there are any significant Project description changes as part of detailed Project development.

1.8 SAFETY MANAGEMENT SYSTEMS

This risk assessment assumes that the Project would be managed in accordance with an appropriate safety management system including control of work health and safety and asset integrity. Without such controls, the range and impact of potential hazards becomes unpredictable, and the likelihood at which incidents of any type may occur cannot be adequately estimated using historical data.

Safety management systems allow the risk from potentially hazardous installations to be managed through a combination of hardware, software and human factors. It is essential to ensure that the reliability of the hardware and software systems and management procedures allows for safe operation of the facility.

Typical workplace health and safety practices for management of potentially hazardous facilities are listed below. Policies and procedures to support the establishment and maintenance of a safe workplace will be established as part of Project development, typically including the following:

- Safe work system and procedures established
- Monitoring and control of operations associated with Project infrastructure including protective systems routinely inspected and tested
- Emergency management, including emergency procedure and procedure for pollution incident response
- Incident reporting and response systems developed, and first aid station(s) installed at suitable locations throughout the Site
- Staff (including contractor) competency for operation, maintenance, and support of the Project infrastructure
- Personal protective equipment (***PPE***)
- Site compliance with relevant Australian Codes and statutory requirements with respect to design and work conditions continued throughout the life of the Project.

2 DESCRIPTION OF THE PROJECT

2.1 OVERVIEW

A description of the Project location is provided in Table 2-1 below, with supporting information provided in the figures, as follows:

- Location of the Project Area within the broader regional context is provided in Figure 2-1

Project Area boundaries is provided in Figure 2-2: Project Area boundaries

-
- Dwellings at and near the Project Area are shown on the map in Figure 2-4
- Project Area Layout, including the APA Group pipeline easement, is shown in Figure 2-5.

Table 2-1: Locational details

Element	Description
LGA	Spans two Local Government Areas (LGAs): Warrumbungle Shire Council and Dubbo Regional Council
Address	1050 Spring Ridge Road, Cobbora, NSW
Location	The Project would be located near Cobbora, approximately 20 kilometres (km) south-west of the township of Dunedoo and 55 km east of Dubbo in Central West NSW
Zoning	*RU1 Primary Production* under the Dubbo Local Environmental Plan (LEP) and Warrumbungle LEP, refer to Figure 2-3. There is also a small area which is not zoned under either of the LEPs.
Project Area	The Project Area covers approximately 3,000 ha of land
Development Footprint	The Development Footprint covers approximately 1,600 ha of land, which would be occupied by the solar farm and associated infrastructure within the Project area (the developable area). The PV panels would occupy the majority of the Site. The BESS and the BESS substation (the Main substation) would be located within the Site in proximity to the Elong Elong Energy Hub to allow connection of the Project to the CWO REZ grid infrastructure and ultimately the NEM. There are also 4 smaller substations within the Development Footprint. The BESS substation and the BESS are expected to occupy approximately 30 ha. The solar farm substations are expected to occupy approximately 2 hectares each.

Element	Description
Site access	There would be four vehicle access points from Spring Ridge Road: • North - access off Spring Ridge Road, approximately 300 m south of the intersection with the Golden Highway • Central (north) – access off Spring Ridge Road, approximately 3 km south of the intersection with the Golden Highway • Central (south) – access off Spring Ridge Road, approximately 5 km south of the intersection with the Golden Highway • South – access off Spring Ridge Road, approximately 10 km south of the intersection with the Golden Highway. There would also be a vehicle access point off the Golden Highway into the northwestern corner of the Development Footprint.

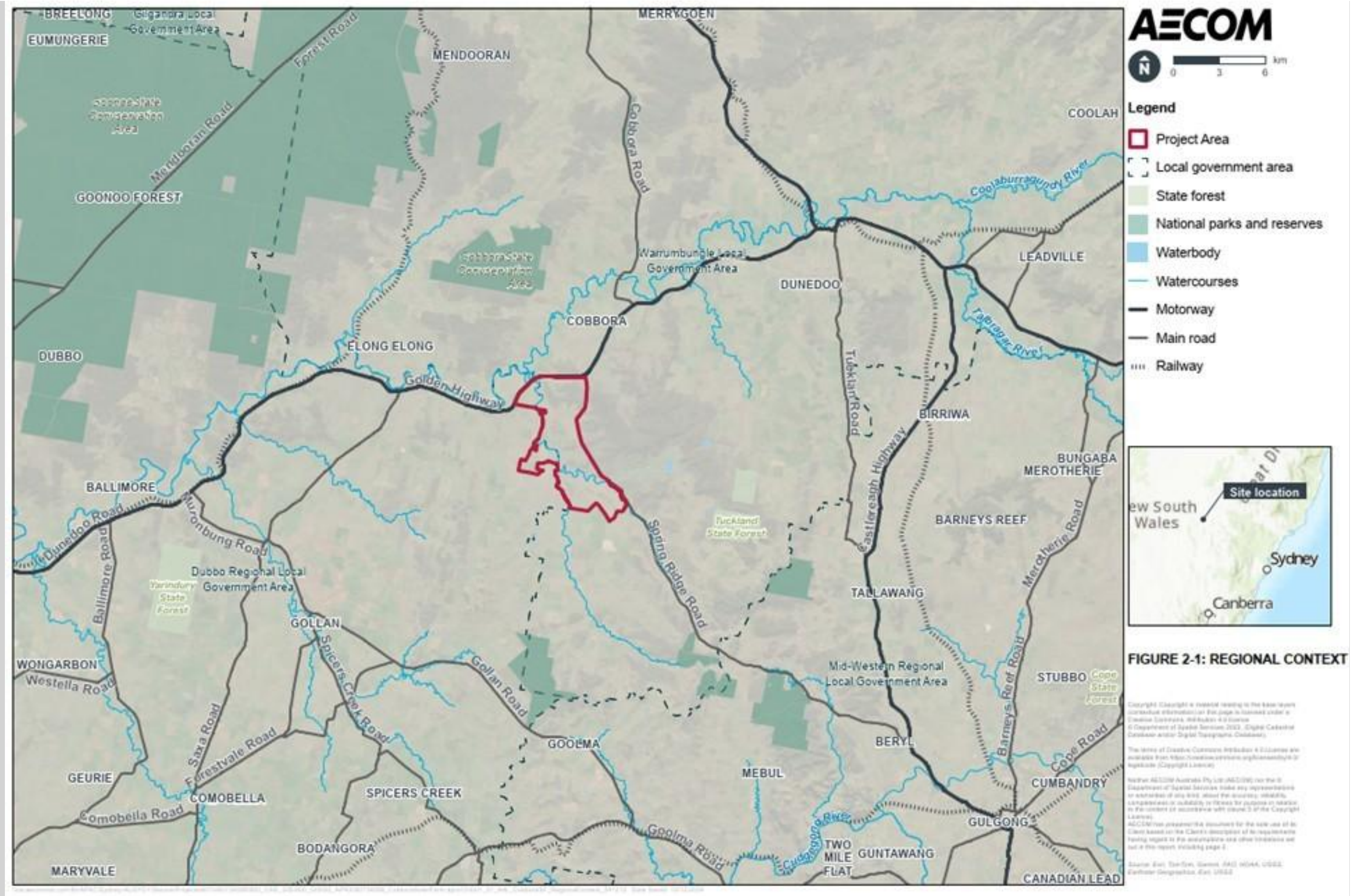


Figure 2-1: Locality map and regional context

Figure 2-2: Project Area boundaries

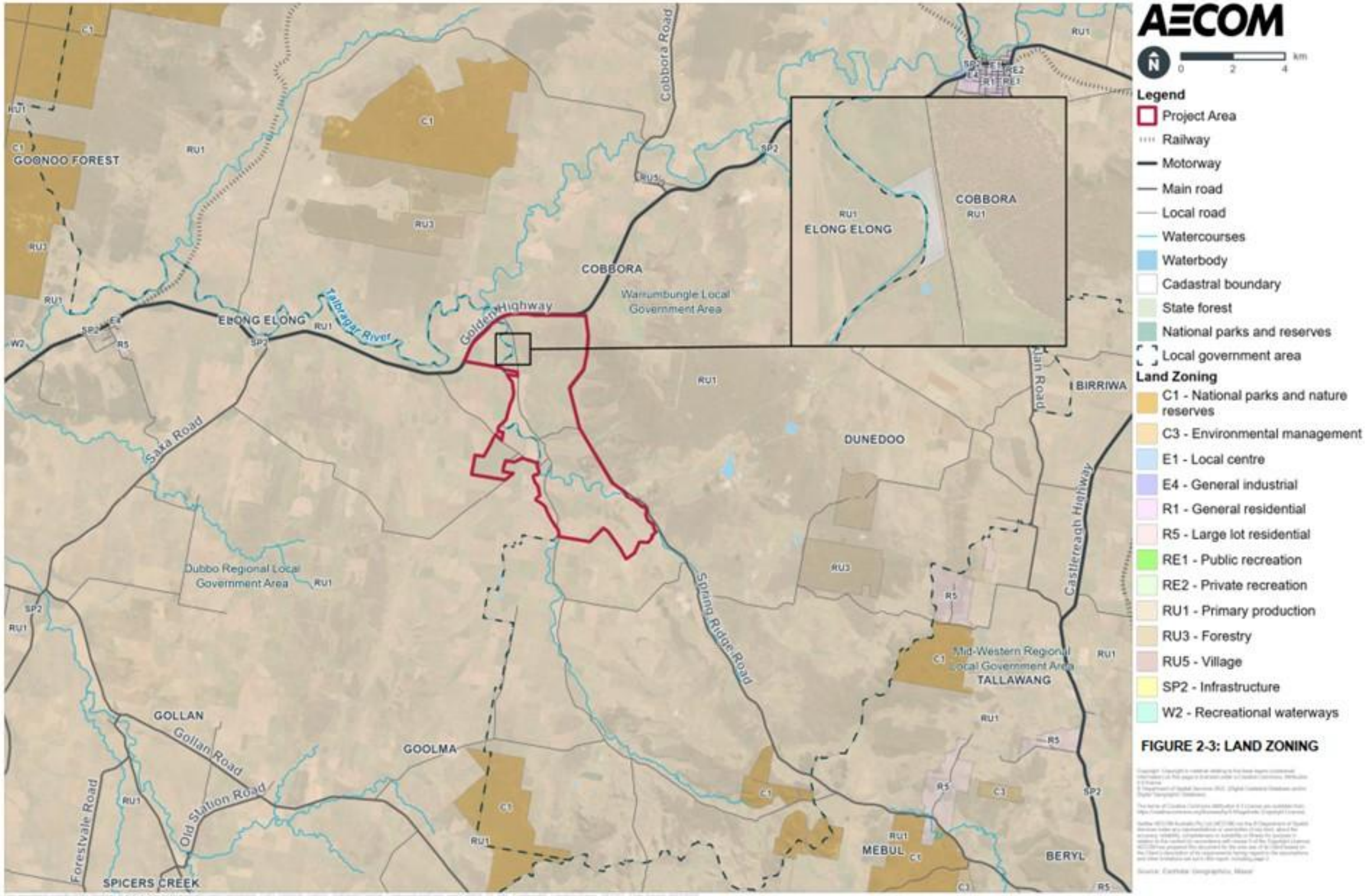


Figure 2-3: Land zoning map

2.2 SURROUNDING LAND USE AND EASEMENTS

2.2.1 Dwellings

Figure 2-4 shows the locations of receivers within and outside of the Site.

Residential receivers located within the Site are referred to as *associated dwellings,* and residential receivers located outside of the Site are referred to as a *non-associated dwelling.*

- *Associated dwellings:* There are four abandoned and dilapidated dwellings in the northern portion of the Development Footprint and a house, large shed and cattle yards in the south of the Development Footprint. These will be demolished to allow for the placement of the proposed solar array
- *Non-associated dwelling:* There are 51 non-associated dwellings (private) located within 4 km with a line of sight of the Project.

There is no sensitive development in accordance with the definition used by the DPHI in their HIPAP4 and HIPAP6 guidelines (e.g. schools, hospitals, aged care facilities) within 1 km of the Project Area.

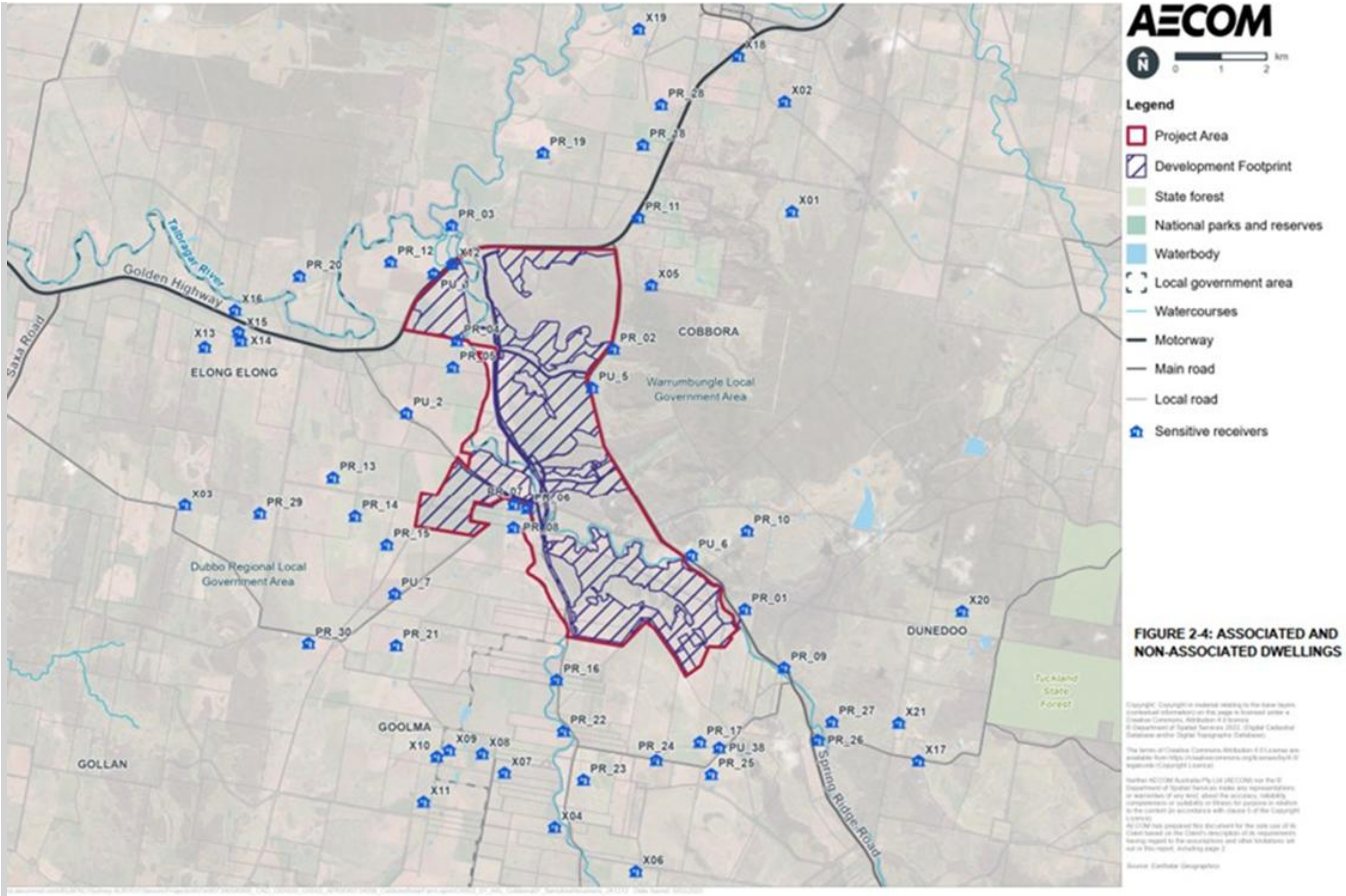


Figure 2-4: Associated and non-associated dwellings

2.2.2 Industrial land and infrastructure

There is no land zoned specifically as industrial within 10km of the Project Area.

2.2.3 Recreational and environmental land

There is no land zoned for recreational or environmental purposes within the Site. The nearest recreational zoned land is Talbragar River, approximately 16 km west of the Site. The Talbragar River is zoned as 'W2 Recreational Waterway' under the Dubbo Regional LEP.

The nearest environmental zoning is the Cobbora State Conservation Area, approximately 5.2 km north of the Site. This area is zoned as C1 National Parks and Nature Reserves under the Warrumbungle LEP.

The Project is not anticipated to affect recreational or environmental conservation land.

2.2.4 Agricultural land

The Project area is located within a region of land zoned as RU1 Primary Production under the Dubbo LEP and Warrumbungle LEP.

2.2.5 Easements

There is an APA Group pipeline which runs within an easement adjacent to the north western corner of the Site boundary and crosses the Site boundary slightly at one location. The APA Group pipeline easement is shown in Figure 2-5.

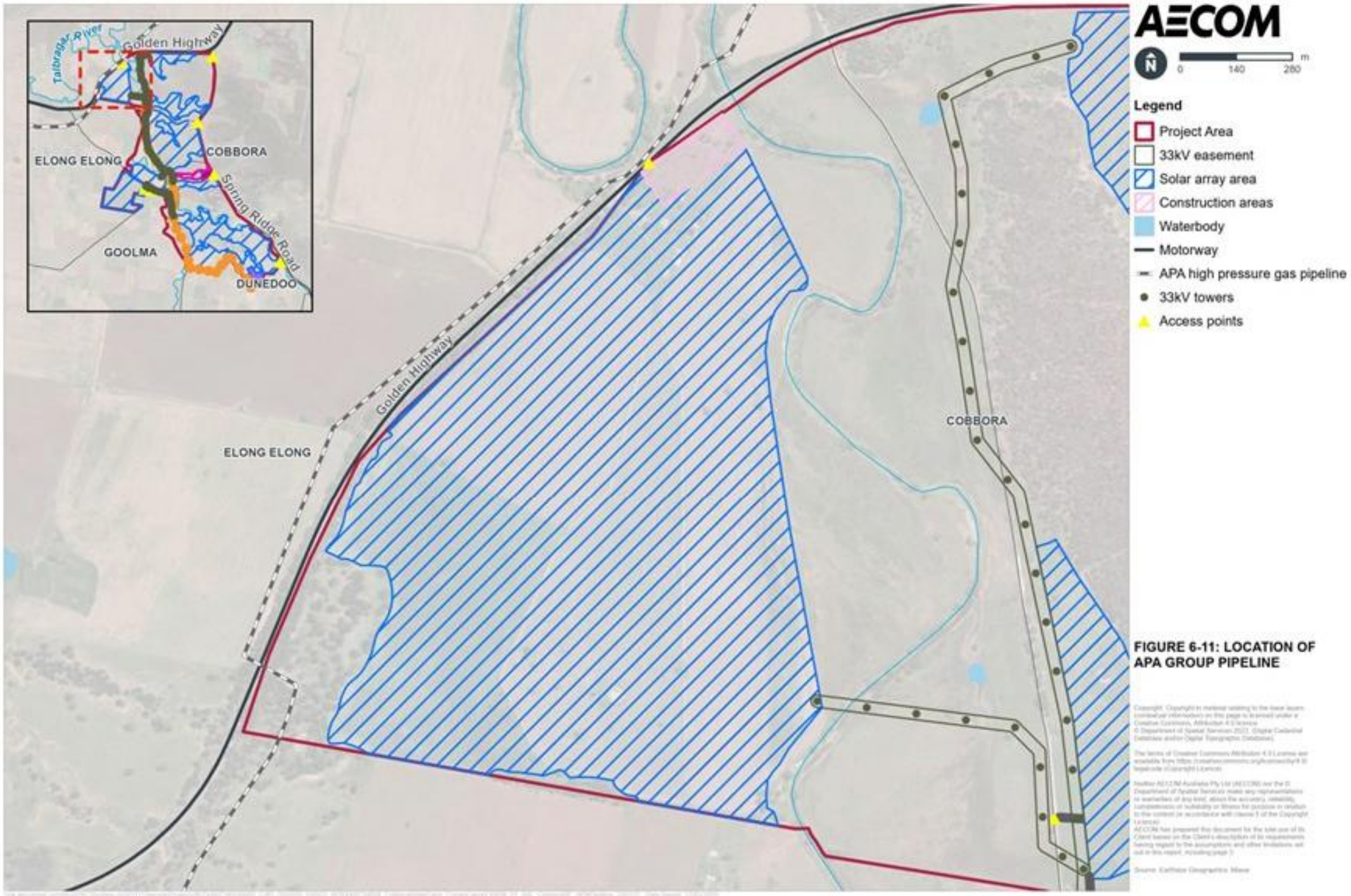


Figure 2-5: APA Group pipeline easement in relation to the Project Area

No amendments or connection is required to the APA Group pipeline and the Project is designed to avoid this asset.

2.3 ENVIRONMENTAL BASELINE

The Project area's potential for exposure to bushfire, flooding, earthquake, land subsidence events and for lightning strike is moderate to low, as detailed below.

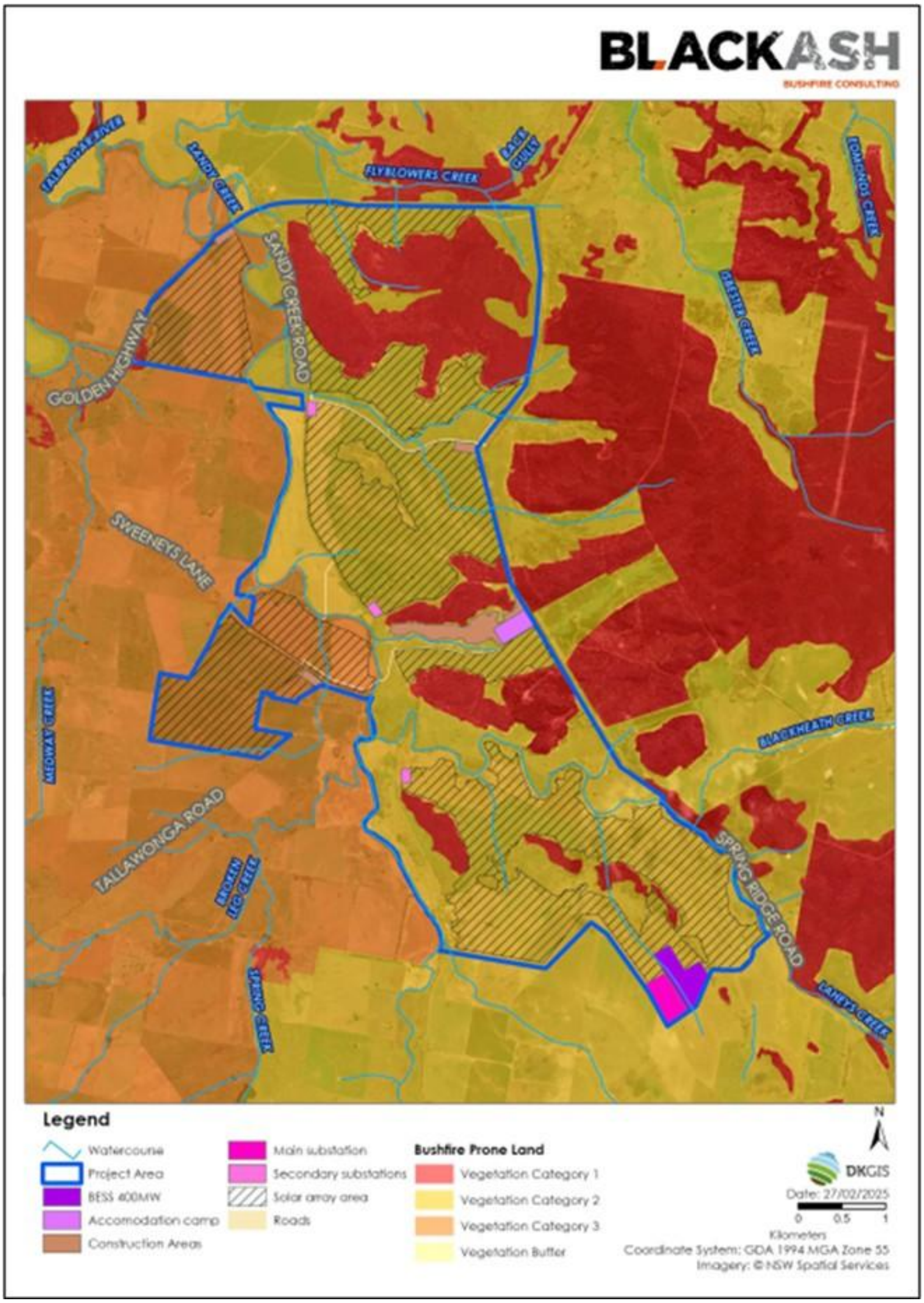
2.3.1 Bushfire

Should a bush or grass fire impact the Project Area during construction and/or operation of the Project it has the potential to result in damage to infrastructure, initiation of a thermal runaway reaction and fire at the batteries, and/or oil spill and fire at the transformers, and damage to overhead transmission infrastructure and equipment. Conversely, failure to manage hot work or other activities at the Project area may initiate a bush or grass fire.

Blackash Bushfire Consulting has undertaken the bushfire impact assessment for the Project (Ref 4, referred to here as *the bushfire assessment*). The bushfire assessment has been prepared in accordance with the requirements by DPHI in their SEARs (listed in Section 1.6), and accordance to the NSW Rural Fire Service (RFS) document *Planning for Bushfire Protection 2019* (PBP). A summary of the findings is provided below.

The bushfire assessment includes an analysis of the hazard, threat and subsequent bushfire risk to the Project and provides recommendations that satisfy the aims and objectives of PBP. It is based on mapping of vegetation formations and slope assessment; a detailed analysis of the Project, including aerial mapping and GIS analysis involving a landscape wide assessment of the bushfire risk; and a review of the Orana and Castlereagh Bush Fire Risk Management Plans.

The bushfire assessment has found that the Project Area is located on land that is identified as having the potential to support or be subject to bushfires (i.e. *bushfire prone lane*, or BPL), and that such land requires specific management strategies to reduce the risk of bushfire occurrence or spread, as shown in Figure 2-6.



Note 1: Figure extracted from the bushfire assessment (Ref 4)
Note 2: The Project Area sits within an area of Vegetation Category 2, with pockets of Category 1 BPL and extensive areas of Category 3 Grasslands to the west of the site

Figure 2-6: Bushfire prone land map

The bushfire assessment (Ref 4) defines a series of possible initiators (or threats) for fires and outlines control mechanisms to reduce the risk of a fire threatening Project infrastructure. The report also addresses the potential for the Project itself to initiate a fire.

The following risk mitigation measures apply for the Project (Ref 4):

Asset Protection Zone:

The Project design currently works on meeting and mapping BAL-29 standard Asset Protection Zones (APZ). The proponent understands that the bushfire risk assessment uses a Bushfire Attack Level of <29kW/m2 (BAL-29) as the basis of assessment for this Project. APZ will be finalised at detailed design stage, with consideration of bushfire risk to assets.

A BAL-29 APZ providing an acceptable level of risk mitigation to assets, minimising damage and impact on operations and business continuity. The BAL-29 APZ width provides a separation of between 11 and 25 metres between Project Components and the surrounding vegetation, increased to between 32 and 250 metres between the BESS and surrounding vegetation. This exceeds the basic requirement for APZ in the PBP for wind and solar farms (refer to Section 8.3.5, p. 77 in the PBP), of 10 metres.

This increased level APZ provides a high standard of protection to the surrounding vegetation in the unlikely event of an ignition occurring onsite. The APZ also reduce the chance of any ignition caused through electrical failure from spreading or developing into a bushfire. The APZ would contain in part the trails required to install, maintain and replace solar farm components and would meet and/or exceed the standards for fire tanker access required in PBP.

Further details below:

- PV panels: the single axis tracking frames for the solar arrays are of heavy duty steel construction and are likely to be highly resistant to bushfire attack, with typical industry standard panels designed for extended operation in the field, and key electrical cabling for the system will be provided underground. The only vegetation underneath the arrays and generally within the development footprint overall will be grassland that is maintained to the required APZ standard, effectively *managed land*.
- Substations: these will use well established setback distances (APZ) and are typically surrounded by gravel hardstand to aid construction and servicing.
- BESS: the BESS will similarly be surrounded by the substation to the west; the solar arrays to the west, north and east; and the Elong Elong Energy Hub to the east and south. This effectively provides setbacks of a minimum of 32 metres up to 250 metres that will be managed land maintained to APZ standards or higher. The nearest retained bushland to the BESS is 32 metres away from the edge of the BESS site (an isolated 3.9 hectares section of retained woodland).

- Transmission lines: the transmission lines extending from the substations to the high voltage grid connection point at the Elong Elong Energy will be maintained to APZ standards.

Building construction standards:

Buildings would be constructed to appropriate BAL levels in accordance with PBP and AS3959. This will be refined during the detailed design phase.

Fire suppression / firefighting:

Permanent firefighting water supplies in the form of a number of 20,000 litre tanks, strategically located around the Project Area. Tank(s) will be located nearby to critical infrastructure including the BESS and the substations. Other locations will be determined in the detailed design process. This will be reported to FRNSW and RFS in the Fire Safety Study for their consideration (refer to recommendation 4).

Fire water tanks shall be of non-combustible construction or suitably protected from bushfire attack, and accessible to heavy vehicle within 4.0m of the fittings) in accordance with PBP.

Water carts used onsite shall have fittings capable of efficient resupply to firefighting vehicles.

Use of any automatic fire detection and suppression systems will be determined in the detailed design and will comply to power generation industry standard as a minimum. This will be reported to FRNSW and RFS in the Fire Safety Study for their consideration (refer to recommendation 4).

Other equipment should be appropriate to the activities being conducted and the fire danger at the time of works, but as a minimum must include:

- Minimum 2 x Category 9 Light Tankers
- Extinguishers, knap sacks and hand tools (e.g. rake hoes).
- Radio communications suitable for both normal operations and communication with emergency services.

Emergency control:

- The presence of permanent trained staff and bushfire prevention protocols will significantly reduce the chance of any ignition spreading. The accommodation camp is surrounded by infrastructure, construction area and APZ as required.

- A Bush Fire Emergency Management and Operations Plan (BEMOP) will be prepared for the Project, that identifies all relevant risks and mitigation measures associated with the construction and operation of Project infrastructure.

For further details, refer to the bushfire assessment (Ref 4). The threat from a nearby bush or grass fire is carried forward to the safety and risk assessment and is discussed in Section 2.3.1 and 4.2.3.

2.3.2 Flooding

Should flooding occur during construction and/or operation of the Project it has the theoretical potential to result in the accidental spill or discharge of chemicals or hydrocarbons, such as fuels and oils in vehicles and/or equipment, with the potential to contaminate surface water and/or groundwater.

Risk of flooding is included as a stand-alone assessment in the EIS, and not considered further in this PHA.

2.3.3 Earthquake and landslide

The EIS (Chapter 6.5) indicates that the Project would not be located within a known mapped mine subsidence district, and that the risk of landslide is low.

Should earthquake occur during construction and/or operation of the Project, it has the theoretical potential to result in an initiation of a thermal runaway reaction and fire at the batteries, and an oil spill and fire at the transformers.

The Geoscience earthquake risk map (sourced from Ref 5), shown in Figure 2-7, indicates a low earthquake risk for the Project Area.

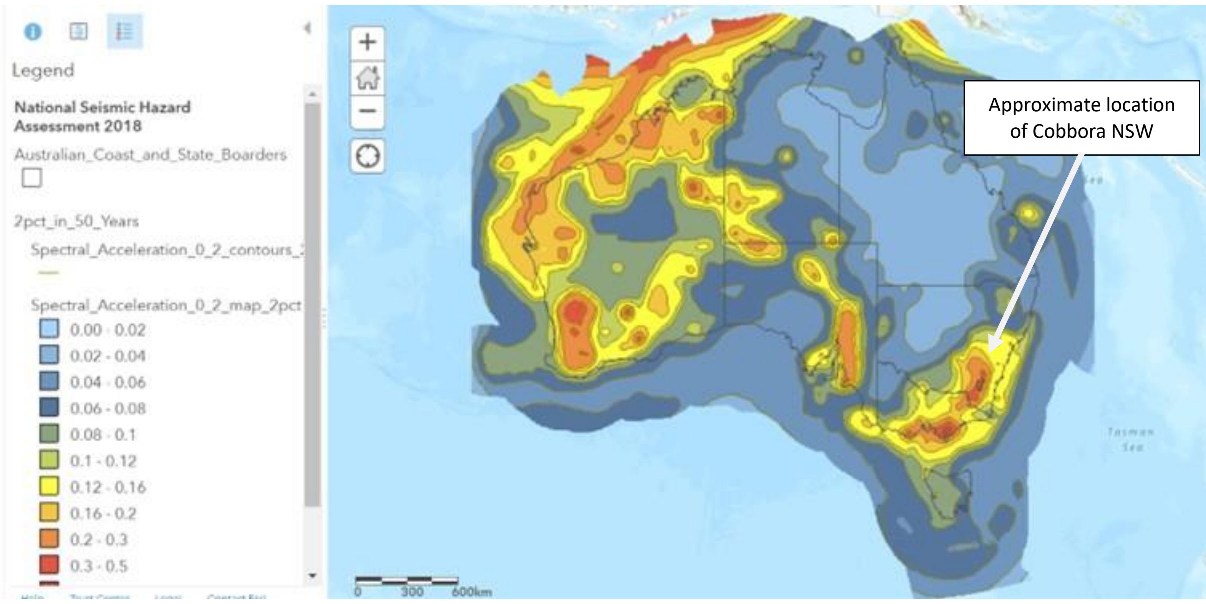


Figure 2-7: Extract from Geoscience earthquake risk map showing earthquake risk at the Project area (downloaded from Geoscience Australia website on 15 November 2024)

This risk would be adequately managed by implementing the requirements under the Australian Standard AS/NZ 1170 Part 4 *Earthquake actions in Australia.*

The risk associated with landside and earthquake is low and is not considered further in the PHA.

2.3.4 Lightning strike

Should a lightning strike occur during construction and/or operation of the Project, it has the theoretical potential to result in damage to Project infrastructure, the initiation of a thermal runaway reaction and fire at the batteries, and an oil spill and/or fire at the transformers. In addition, a lightning strike has the theoretical potential to result in damage to overhead transmission infrastructure and equipment if installed as part of the Project.

The Bureau of Meteorology annual average thunder days and lightning-ground flash density map for Australia (Ref 6), shown in Figure 2-8, indicates that the Project Area is located in a region that experiences 1 to 3 flashes per square kilometre per year (20 to 25 thunder events per day per square kilometre per year), which is similar to that for much of the East Coast in Australia, including Sydney.

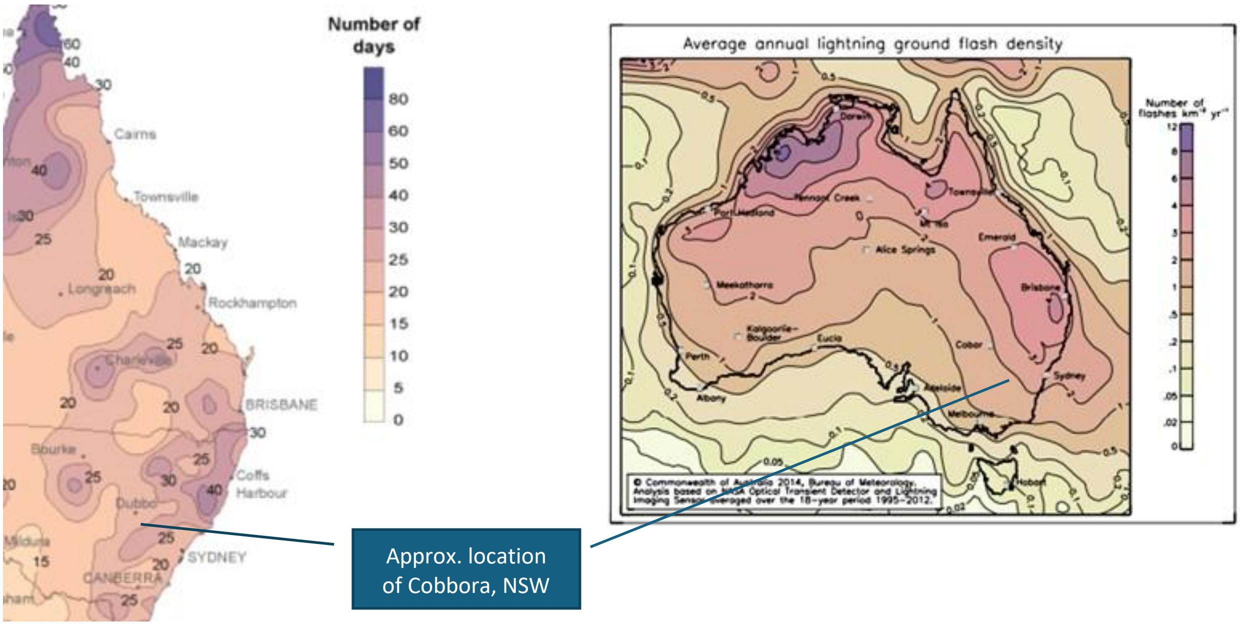


Figure 2-8: Extract from Bureau of Meteorology maps: LEFT - Annual average thunder days for the Project area; and RIGHT - Average annual lightning ground flash density (downloaded from BoM website 25 July 2022)

The likelihood of lightning strike is low to moderate and would be adequately managed by implementing the requirements under the Australian Standard AS/NZS 1768 *Lightning protection* in the design and installation of Project infrastructure, and the risk is not considered further in the PHA.

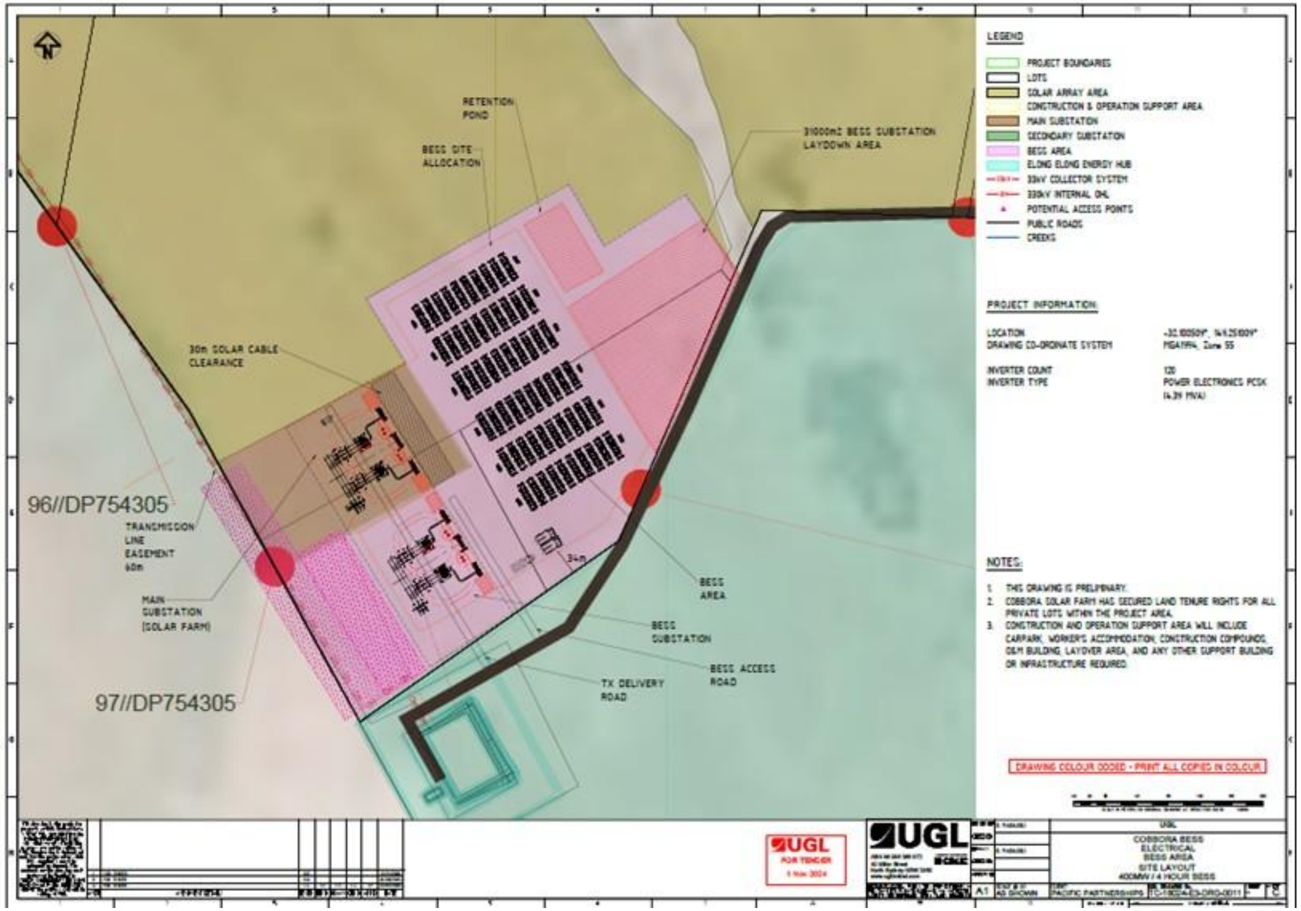
2.4 Project Area Layout and Infrastructure

An indicative Project Area layout is provided in Figure 2-5.

An indicative BESS Site layout is provided in Figure 2-9[1].

A summary of the typical major design parameters for the Project is presented in Table 2-2. These may change through the detailed design and procurement stages of the Project.

[1] The BESS Site layout has been developed for the battery technology associated with the largest footprint under evaluation (in this case, CATL). This is to ensure that the Project allocates enough space to allow for a 400MW/,1,600MWh. As noted previously, for the hazard assessment, the Tesla MP2XL, which represent the largest enclosure solution under consideration for the Project, is used as the “typical” representative enclosure, given it’s the more likely technology to be adopted.



Note: The BESS Site layout has been developed for the battery technology associated with the largest footprint under evaluation (in this case, CATL) to ensure that the Project allocates enough space for a 400MW/1,600MWh BESS

Figure 2-9: Indicative BESS site layout

Table 2-2: Summary of typical major design parameters

Project element	Description
Overall Project Area	1,600 hectares, including PV solar, BESS, transformer yard and substations, and switchyards and transmission line.
Solar array area 	PV site dimensions: 1,500 hectares. Solar panels mounted on tracking array structures to follow the position of the sun throughout the day. The configuration of the solar panels (i.e. one-in-portrait (1P) or 'two-in-portrait' (2P)) would be determined at detailed design. A 1P configuration comprises a single row of solar panels that are orientated vertically. In a typical 1P configuration at maximum tilt, the higher edge of the panel would be about 2.5 m from the ground and the lower edge would be about 0.5 m from the ground. In a 2P configuration, two vertical rows of solar panels are stacked on top of each other. At maximum tilt, the higher edge of the panel would be about 4.5 m from the ground and the lower edge would be about 0.5 m from the ground. The PV modules and trackers arranged in power blocks and connected to Power Conditioning Units (PCUs), inclusive of inverters, transformers and interconnected via a ring main. The PCUs convert the direct current (DC) electricity generated by the PV modules into alternating current (AC) and increase the voltage from low voltage to 33 kV (AC). Anticipated: around 198 PCUs; and each PCU is anticipated to be about 2.5 metres tall 6.0 metres long and 2.5 metres wide. PV generating capacity: 700 MW (the solar farm would generate electricity during daylight hours, seven days a week, 365 days per year. The PCU transformer would typically hold approximately 2.1 – 2.8 m^3 of oil.

Project element	Description
BESS battery, inverters, and inverter transformers 	BESS Site dimensions: 30 hectares. BESS storage and discharge capacity: 400MW / 1600MWh (4 hour battery). Battery technology: to be determined in detailed design. This PHA assumes lithium-ion (Li-ion) battery such as lithium iron phosphate (LFP). Battery module and enclosure model and manufacturers to be determined in detailed design. Battery modules arranged in racks within BESS enclosures. The BESS battery enclosure would either consist of a series of containers or smaller outdoor rated cabinets. The larger, containerised, enclosure represents the higher level of hazard. A typical “representative” containerised enclosure, the Tesla Megapack 2XL (Tesla MP2 XL), is used to inform the hazard analysis in this PHA. This containerised enclosure is approximately 2.8 metres tall and has a footprint of approximately 8.8 metres by 1.7 metres (Ref 7). BESS enclosures are connected to Power Conversion System (PCS) including inverters and transformers to increase the voltage from low (LV) to medium voltage (MV)). The PCS will either be integrated within the battery enclosures or separate, stand-alone cubicles (number to be defined in detailed design). The typical maximum height of the infrastructure (the enclosures and the PCS units) within the BESS would be 2.8 metres. The battery supplier will determine the number of battery enclosures and PCS, and the electrical connection layout. Nominally, for this PHA, approximately 448 containerised battery enclosures would be needed to meet a storage capacity. A typical BESS arrangement is shown in **Error! Reference source not found.**.

<table>
<tr><th>Project element</th><th>Description</th></tr>
<tr><td>Transformer yard and substations

</td><td> Substations dimensions: Up to 15 hectares for the Main Project substation, located within the BESS Site, and up to 6 hectares for the Secondary substations (2 hectares each substation, 3 Secondary substations).
Maximum height of the infrastructure (the lightning rods) within the substation: 21 metres. Maximum height of the HV transformers: approximately 10 metres.
Number substations: Up to four (4) substations, within separate areas, constructed on compacted gravelled hardstand and surrounded by security fence.
A switchyard, installed at each substation, would comprise of 2 bay(s) fully equipped with 132kV switching gear (subject to detailed design).
The HV transformers convert the generation voltage from MV to high voltage (HV).
MV electrical cabling: Connects the BESS to the nearest substation and connects the 3 secondary substations to the main substation.
Number HV transformers:
Main Project substation: Up to 2 HV transformers in the Main substation
Secondary substations (each): Up to 1 HV transformers in each substation.
Each transformer would typically contain about 67,100 litres of oil and would have an oil bund as part of each transformer foundation. </td></tr>
<tr><td>Transmission line

</td><td> The HV electrical connection would have a voltage of up to 330 kV and would be approximately 10 kilometres long.
The location of the new HV electrical connection is shown in the site layout in Error! Reference source not found.. It would be installed underground or above ground and would connect the project substations to the Elong Elong Energy hub.
Within the boundary of the Main Project substation, the new electrical HV connection would, if an underground option is selected, transition to an above ground arrangement to allow for connection. </td></tr>
<tr><td>Permanent ancillary infrastructure</td><td>Operations and maintenance building, control room with supervisory control and data acquisition (SCADA) facilities, switchroom(s)
Workshop area
Lightning protection</td></tr>
</table>

Project element	Description
	• Security fencing, CCTV • Internal roads, car park • Optional: Diesel generator, for use during construction activities, before establishment of electricity on the Site. inclusive of a 70,000 L diesel tank. • Storm water detention basin ((volume to be determined during the detailed design process and demonstrated as adequate as part of the Fire Safety Study, refer to Recommendation 4) • Water for combatting grass/bush fire or building fire to be determined in detailed design, see bushfire assessment Ref 4 • Security fencing, lighting, signage and lightning protection • APZ (Ref 4)
Construction laydown area	The Project would include a main construction support area in the central portion of the Site. This area would also include an accommodation camp and helipoint. Three other smaller construction support areas are also proposed across the Site. Construction support areas would be provided for: • Spoil handling and storage • Equipment storage • Onsite construction parking • Construction compounds with site offices and staff amenities.
Control and safety features	Control and safety features would include a fully integrated operating system for comprehensive control, asset management, and system visibility. The battery enclosures would be equipped with: • An integrated battery management system (BMS) to provide monitoring and safety functions, including detection and response to abnormal operation and emergency shutdown • A thermal management system, for example using liquid cooling, to maintain a suitable operating temperature within the enclosures • Fire and gas detection and shut down would be integrated within the BMS and/or as a separate function. • Physical safety functions such as overpressure/deflagration venting, locks, open door sensors etc.
Design environment of buildings and	Environmental conditions, to be considered/defined at the detailed design stage, typically include: • Maximum and minimum design temperatures

Project element	Description
battery enclosures on the site	• Ingress Protection (IP) rating such that the battery enclosures would be protected against dust and water ingress that could be harmful for the normal operation of the battery • Level of lightning protection required as per AS 1768-2021 *Lightning protection*

An example of the PV module layout is presented in **Error! Reference source not found.**.

Plate 1: PV module layout (source: Pacific Partnerships, 2025)

Each PCU is anticipated to be a containerised design comprising inverters, transformers, mounted on a concrete pad or piles, as presented in **Error! Reference source not found.**.

Plate 2: PCU at Glenrowan Solar Farm (source: Pacific Partnerships, 2025)

The BESS would either consist of a series of containers or smaller outdoor rated cabinets (referred to *battery enclosures* in this PHA). The larger containerised configuration represents the more likely solution for this Project and is also expected to be associated with a higher level of hazard due to its size. It is therefore assumed to be the *typical* (expected) battery enclosure in this PHA.

2.5 Security, Access and Egress

2.5.1 Security

A permanent security fence would be constructed around the perimeter of the BESS Site at the start of construction. The fence would remain in place throughout the operation of the Project. This permanent fence would be up to 1.8 metres in height and would be made of chain link with barbed wire attached to the top.

The Main Project substations would be separated from the BESS Area, e.g. bounded by security fencing to delineate the infrastructure.

Access to the fenced solar array blocks during operation would have its own access and would be restricted by locked security gates. Movement-triggered security lighting and security devices such as closed circuit television (CCTV) cameras would also be installed around the perimeter of the BESS Site, as well around other project infrastructure such as the project substations and the BESS.

Warning signs would be installed at the entry point to the BESS Site and at the various battery enclosures and substations in accordance with Codes and Standards, and will clearly communicate the presence of hazardous areas, the need for authorised access, and any specific safety protocols to be followed. The signage will include emergency contact information and directions for safe evacuation in case of an incident.

2.5.2 Access and egress

Access to the Site would be via Spring Ridge Road during both construction and operation. There would be four access points to the Site along this road, shown on **Error! Reference source not found.**, and described below:

- North - access off Spring Ridge Road, approximately 300 m south of the intersection with the Golden Highway
- Central (north) – access off Spring Ridge Road, approximately 3 km south of the intersection with the Golden Highway
- Central (south) – access off Spring Ridge Road, approximately 5 km south of the intersection with the Golden Highway
- South – access off Spring Ridge Road, approximately 10 km south of the intersection with the Golden Highway.

There would also be a vehicle access point off the Golden Highway into the northwestern corner of the Development Footprint.

There would be several secondary Site crossings along Sweeneys Lane and Sandy Creek Road which would provide access to sections of the solar farm which are not directly accessible via the Spring Ridge Road entry points. Please refer to the EIS Section 6.8 *Traffic and transport* for further details.

Internal access roads would be provided to enable vehicular access around the Site during both construction and operation, and these will be defined during the detailed design process.

2.6 Activities

2.6.1 Construction and commissioning phase

Construction and commissioning work that would be required for the Project is summarised in Table 2-3.

Table 2-3 Summary of construction and commissioning work

Aspect	Description
General activities	• Site establishment and enabling works, including establishment of site access; flooding, erosion and sediment controls; exclusion zones etc. and transport plant, equipment and materials to the Site • Construction of solar farm, BESS and project substations, including earthworks, slabbing and construction of hardstand to support project infrastructure; transport Project elements to their respective site location (including the battery enclosures, transformers, operations buildings and switch rooms); construct, install and connect above ground plant, equipment and structures. Connect to surrounding utilities (including HV electrical connection to Elong Elong Energy Hub). • Commissioning, including testing of Project elements to ensure its safe operation in accordance with relevant electrical standards and quality and environmental management systems and processes. • Demobilisation and rehabilitation works, including removal of construction equipment and temporary construction facilities and rehabilitation of disturbed areas (e.g. laydown areas).
Construction hours	Construction would be carried out during standard working hours, as defined by the NSW EPA's Draft Construction Noise Guideline (2020), being: • 7am to 6pm, Monday to Friday • 8am to 1pm, Saturdays • No work on Sundays or public holidays.
Workforce	Average total personnel across the construction program would be 390 full time equivalent (FTE) workers. The peak construction workforce would be up to 734 FTE workers for a period of up to 12 months.
Duration	36 months for construction of the infrastructure and an additional 7 to 11 months for commissioning
Vehicle movements	14 light, 88 heavy and 2 OSOM per day and 34 shuttle bus per week.
Dangerous Goods	Any potentially hazardous material and Dangerous Goods (DGs), such as diesel for the diesel generator, would be located on compacted areas and would have adequate bunding and spill controls installed in accordance with Australian Standards requirements. Such controls would be detailed in Construction Environment Management Plan (or other equivalent plan).

2.6.2 Operational phase

The details of the operational phase of the Project are summarised in Table 2-4.

Table 2-4 Summary of operational phase activities

Aspect	Description
Design life	35 years for the solar farm and 25 years for the BESS (this may be extended subject to replacement of components).
Operational hours	The BESS is designed for one full cycle per day but can also operate at reduced power and adopting several shallow cycles. The BESS would be operated remotely 24 hours per day, 7 days per week, depending on demand/supply. The solar farm would operate during daylight hours, 7 days a week.
Workforce	The BESS is expected to operate unmanned on a 24 hours per day, seven days per week basis, with regular maintenance undertaken during normal operating hours. Up to 20 FTE employees would be expected to regular undertake operational and maintenance activities. If necessary, reactive or emergency maintenance can be undertaken outside of standard operating hours, however this would be a rare occurrence. At this point the number of personnel on Site may increase to approximately 40 persons during major maintenance activities.
Typical operational activities	Typical operational activities are: • Remote monitoring and control of the BESS and substations • Maintenance and management of equipment, Site buildings and landscaping • General office activities • Receipt of goods • Waste removal.
Typical operation and maintenance procedures and/or management plans	Activities requiring procedures and/or management plans would typically include, but would not necessarily be limited to: • Routine inspections covering electrical, civil and environmental operational performance • Cleaning of PV panels (e.g. annual) • Pest control and vegetation management, including weed control and maintenance of buffer zones (including APZ) • Preventative maintenance and other activities as defined in the operation and maintenance management plans • Corrective maintenance activities including testing and replacing of faulty plant components such as modules, fuses and other corrective actions within operation and maintenance scope.
Deliveries	Ad hoc deliveries of replacement parts would be unlikely to exceed one delivery per day on average.

2.7 SIGNIFICANT GUIDELINES AND REGULATORY COMPLIANCE

An overview of the statutory framework that applies to ensuring the safety of Project infrastructure, and that forms the basis of this PHA, is listed below[2]. Only those that are directly related to the PHA are included – refer to Appendix 4 for a more complete listing.

Legislation and Regulation:

- NSW Work Health and Safety Act 2011 and Work Health and Safety Regulation 2017
- NSW Electricity Supply Act 1995, Electrical Supply (General) Regulation 2014 and Electricity Supply (Safety and Network Management) Regulation 2014
- *NSW Environmental Planning and Assessment Act 1979* and Environmental Planning and Assessment Regulation 2021.

Governmental policy and guideline documents:

- State Environmental Planning Policy (SEPP) *Resilience and Hazards*, 2021 (Ref 8), Chapter 3 *Hazardous and offensive development*
- *Applying SEPP 33*, 2011 (Ref 9)
- *HIPAP 6: Guideline for Hazard Analysis,* 2011 (Ref 1)
- *Multi-level Risk Assessment guideline*, 2011 (Ref 2)
- HIPAP 4: Risk criteria for land use planning, 2011 (Ref 3)
- HIPAP 10: *Land use safety planning* (Ref 10)
- *Planning for Bushfire Protection*: A guide for councils, planners, fire authorities and developers, 2019 (Ref 11).

Codes and Standards

While large-scale BESSs, such as the one proposed for the Project, are relatively new in Australia, there are numerous Australian Codes and Standards and protocols that apply. A number of those relevant to this PHA are listed in Appendix 4.

[2] The full list of Acts, Codes, Standards and guidelines would be identified by the Engineering Contractor selected for each element of this Project, with the Engineering Contractor ultimately responsible for nominating the applicable Codes and Standards.

In addition, it is common practice in BESS development to follow one or several international Codes and Standards, depending on the enclosure solution chosen, for example (US) National Fire Protection Association, refer to Recommendation 2. The international Codes and Standards listed below are listed below for reference only, and their applicability to the Project will be defined in the detailed design stage:

- (US) National Fire Protection Association (NFPA), e.g. NFPA-855, Ref 12
- (US) Underwriters Laboratories (UL)
- Institute of Electrical and Electronics Engineers (IEEE)
- National Electrical Manufacturers Association (NEMA)
- International Electrotechnical Commission (IEC)
- United Nations (UN)
- Battery Safety Organization (BATSO).

3 RISK SCREENING

3.1 INTRODUCTION

The objective of risk screening described in the MLRA guideline (Ref 2), is to determine whether a proposed development or facility is considered to be '*potentially hazardous industry'* as per the following definition by the DPHI:

> *'Potentially hazardous industry' means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:*
>
> *(a) to human health, life or property; or*
>
> *(b) to the biophysical environment, and:*
>
> *includes a hazardous industry and a hazardous storage establishment.*

Development that is deemed to be *potentially hazardous industry* must undergo a rigorous PHA as per the requirements set in the guidelines for hazard analysis in SEPP (*Resilience and Hazards*) 2021 (Ref 8) Chapter 3 and HIPAP6 (Ref 1), to determine the risk to people, property and the environment.

Additionally, and irrespective of the outcome of the risk screening process, DPHI can request that a PHA be developed for a proposal, based on other considerations.

3.2 RESULTS

The MLRA screening for the Project is presented in the following tables, depending on the quantities and activities associated with Dangerous Goods (DG):

- Table 3-1: *Storage of hazardous material* (on the Site)
- Table 3-2: *Transport of hazardous material* (to and from the Site)
- Table 3-3: *Other types of hazards*.

Table 3-1: Storage of hazardous materials

DG Class	Category	Hazardous material proposed	Proposed quantities	Threshold [3]	Exceeds threshold?
2.2	Non-flammable, non-toxic gas	Refrigerant compressed gas in the enclosures	Typical 0 to 5 kg per enclosure depending on the battery enclosure chosen. For the "typical" representative battery solution, with 3kg per enclosure (total of 1,344 kg, distributed in small quantities in discrete locations)	Excluded from screening process	No
3 PGI	Flammable liquids	Flammable liquids in small containers	Minor, in DG cabinet on-site (e.g. solvents for maintenance or during construction phase, not exceeding 20 L typical). Diesel for use in the diesel generator, would typically not exceed 5 tonnes	Flammable liquid Cat. 4, (no PG), excl. from screening process. Until SDS received, use 5 tonnes (DG3, PGIII)	No
3 PGII or PGIII or C1/ C2	Oil and other petroleum products (e.g. diesel)	Oil and other petroleum products for use in switchgear and in the transformers	Nominally, up to 700-800m^3 of transformer oil and diesel, distributed in discrete locations	Combustible liquid is excluded from screening process	No
6	Toxic and infectious substance	Weedicide / herbicide	Small amounts, held on-site in DG cabinets. Would not exceed 1 tonne	2.5 tonnes	No
8	Corrosive material	Corrosive liquids in small containers	Small amounts e.g. acids for use during maintenance cleaning, held on-site in DG cabinets. Would not exceed 5 tonnes	5t PG I 25t PG II 50t PG III	No

[3] Threshold incorporated within the SEPP *Resilience and Hazards*

DG Class	Category	Hazardous material proposed	Proposed quantities	Threshold [3]	Exceeds threshold?
9	Miscellaneous dangerous goods	Lithium ion (Li-ion) batteries held within the BESS Area	For the "typical" representative battery solution, nominal 448 battery enclosures, each enclosure can weigh up to 40 tonnes in total, with a proportion of this being Li-ion	Excluded from screening process	No
9	Miscellaneous dangerous goods	Coolant in each enclosure, e.g. mixture of ethylene and glycol	Typically, less than 2 m^3 per enclosure. For the "typical" representative battery solution, with nominally 2 m^3 per enclosure, less than of 900 m^3, distributed in small quantities in discrete locations	Excluded from screening process	No
Legend:		Not potentially hazardous (Ref 9)		Potentially hazardous (Ref 9) – none for this Project	

Table 3-2: Transport of hazardous materials

Hazardous material	DG Class and Packaging Group	Category	Vehicle movements applicable for the Project		Threshold (vehicles carrying DGs) [3]	Proposal exceeds threshold?
			Cumulative annual	Peak weekly		
Li-ion batteries (BESS)	DG Class 9	Miscellaneous dangerous goods	Ongoing operations: Zero During construction: Much less than the threshold of 1,000 vehicles annually	Ongoing operations: Zero During construction: Much less than the threshold of 60 vehicles weekly	>1,000 (annual) >60 (peak weekly)	No
Coolant	Not expected to be a DG	Not expected to be combustible or toxic	Ongoing operations: Zero During construction: Much less than the threshold of 1,000 vehicles annually	Ongoing operations: Zero During construction: Much less than the threshold of 60 vehicles weekly	>1,000 (annual) >60 (peak weekly)	No
Refrigerant compressed gas may be used in battery enclosures or racks (at the BESS)	Expected to be DG Class 2.2	Non-Flammable, Non-Toxic Gases	Ongoing operations: Zero During construction: Much less than the threshold of 1,000 vehicles annually	Ongoing operations: Zero During construction: Much less than the threshold of 60 vehicles weekly	>1,000 (annual) >60 (peak weekly)	No
Oil and other petroleum products (e.g. diesel)	Not DGs	Combustible liquid C1 Diesel can be 3 PGII or PGIII or C1/ C2 (AS 1940)	Ongoing operations: Zero During construction: Much less than the threshold of 1,000 vehicles annually	Ongoing operations: Zero During construction: Much less than the threshold of 60 vehicles weekly	>1,000 (annual) >60 (peak weekly)	No
	(green)	Not potentially hazardous (Ref 9)		(blue)	Potentially hazardous (Ref 9) – none for this Project	

Table 3-3: Other types of hazards to be assessed as part of SEPP33

Other Types of Hazards to be considered	Applicable (Yes or No)	Results of the screening	Proposal exceeds threshold?) [3]
Any incompatible materials (hazardous and non-hazardous materials)?	No	No incompatible materials identified for this Project	No
Any wastes that could be hazardous?	No	No significant hazardous wastes identified for the construction or operation of Project infrastructure	No
Types of activities the dangerous goods and otherwise hazardous materials are associated with (storage, processing, reaction) – if different to tables above?	No	No additional associated activities	No
Incompatible, reactive or unstable materials and process conditions that could lead to uncontrolled reaction or decomposition?	Potentially yes	Runaway reaction associated with Li-ion batteries has occurred in other similar projects in the past. Hydrogen release is possible under fault conditions – fire/explosion hazard. If toxic gas is released in a battery fire, then toxic exposure may occur.	YES, due to potential for runaway reaction within battery cells which may become a precursor for a battery fire
Storage or processing operations involving high (or extremely low) temperatures and/or pressures?	No	No conditions with high (or extremely low) temperatures and/or pressures identified as associated with Project infrastructure	No
Details of known past incidents (and near misses) involving hazardous materials and processes in similar industries?	Potentially yes	Runaway reaction associated with Li-ion batteries has occurred in other similar BESS facilities in the past. Damage to high pressure pipelines during construction activities has occurred in the past. The APA Group operates an underground high pressure natural gas pipeline, which is located within an easement at the northern tip of the Project Area (refer to Figure 2-5). Incidents have occurred in Australia and internationally where construction activities have damaged buried high pressure pipelines.	YES, due to past thermal runaway reaction (spontaneous ignition) incidents at similar BESSs and due to construction hazards near high pressure pipeline (APA Group)

Other Types of Hazards to be considered	Applicable (Yes or No)	Results of the screening	Proposal exceeds threshold?) [3]
Will the Project threaten the particular qualities of the environment (for example, the likely presence of rare or threatened species, watercourses)?	Potentially yes	Approximately 148.5 hectares (of the 1,600 hectares in the Development Footprint and of the 3,000 hectares of the Project Area) of the grassland and forest within the Project Area is threatened ecological community. Management is included in the Biodiversity Development Assessment Report which is discussed in Section 6.2 of the EIS.	YES, grassland and forest within the Project Area is threatened ecological community. Spill of pollutant is possible during construction, commissioning and operations phases
The nature of the hazards that the environment would be exposed to, and the likely response of the environment to such a hazard, and the reversibility of any hazardous impact	Potentially yes	Information available for the Project is such that environmental pollution cannot be ruled out at the concept design stage	YES, subject to selection of battery manufacturer and detailed design

Legend:	(green)	Not potentially hazardous (Ref 9)	(blue)	Potentially hazardous (Ref 9)

3.3 Conclusions of the Preliminary Risk Screening

The results of the preliminary risk screening show the following:

- The expected storage of hazardous materials associated with the Project would not exceed the relevant risk screening threshold
- The expected transport of hazardous materials associated with the Project would not exceed the relevant risk screening threshold.

On the basis of storage and transport alone, the development would not be considered *Potentially hazardous* under the definition within the MLRA guidelines, which correspond to that in Chapter 3 of SEPP (*Resilience and Hazards*) 2021. The application of Codes and Standards is sufficient to mitigate the risk, and no further assessment is required as part of this PHA.

However, DPHI requires *Other types of hazards* to be assessed in a PHA and the following potential hazards are associated with the Project:

- *Thermal runaway (including due to spontaneous ignition) and fire in a battery enclosure*, which has the potential to be harmful to people in the area and to lead to propagation to nearby infrastructure
- *Loss of containment of pollutant material from the Project infrastructure*, e.g. oil, cooling medium, or diesel. In particular, the environmentally constrained land within the Project Area is vulnerable to any degree of pollution and requires protection
- *Electrical fault or failure to control electrical energy (including EMF)* has the potential to be harmful to people in the area, and an arc flash can lead to propagation to nearby infrastructure
- *Fire in nearby area (bushfire, or APA Group pipeline)* may cause damage and escalation to Project infrastructure
- *Incident during construction activity causes impact with infrastructure*, e.g. damage to the APA Group pipeline or to a battery enclosure.

Based on *Other types of hazards,* and on DPHI's particular requirements for a PHA for the Project, a Hazard Analysis including a detailed Risk Analysis are included in the following sections of this report.

4 PRELIMINARY HAZARD AND RISK ASSESSMENT

4.1 HAZARD IDENTIFICATION

4.1.1 Introduction

A rigorous hazard identification process has been conducted for the Project to ensure the following are identified and defined, at the early design phase of the Project:

- All reasonably foreseeable hazards and associated events that may arise during the construction, commissioning and operation of the facilities, and
- The proposed management of these hazards.

The hazard identification is based on a desktop review undertaken by Planager, including review of the following factors and inputs:

- Project infrastructure, location, workforce, local environment, adjacent land use, and construction, commissioning, operation and maintenance activities and threats
- Type of equipment and other known significant incidents that have occurred in similar facilities, and recent developments in research and standards for BESS facilities
- Materials and their energies and properties
- External factors, including bushfire, flooding, earthquake and landslide, lightning strike, and the proximity of the APA Group pipeline on the north western corner of the Project Area.

Events with a potential to result in major consequence impacts to people (injury and/or fatality), the environment and to asset are identified. The study excludes hazards related with Occupational Health & Safety (OH&S), i.e. slips, trips and falls.

4.1.2 Material hazards and inventories

The inventories and potentially hazardous properties of materials typically stored and handled during the construction, commissioning and operations phases of the Project are detailed in Table 4-1.

Table 4-1: Materials inventory and hazardous properties associated with the Project

Material	Inventory	Description and potential hazards
Commissioning and operations phases		
Li-ion batteries	*Commissioning & operations:* For the "typical" representative battery solution: nominally 40 tonnes/unit, 448 units = total 17,920 tonnes, with a proportion of this being Li-ion *Construction:* none prior to delivery of enclosures to the BESS Site, then as above	Fire at a Li-ion battery may be caused through uncontrolled reaction (e.g. thermal runaway leading to spontaneous ignition), overcharge, short-circuit, damage or decomposition within a cell. Thermal runaway is triggered when battery cells reach a certain temperature (anticipated around 270°C for LFP batteries). The heat source can be internal (i.e. due to a fault at the battery cell or electrical connection) or external (e.g. from a bush or grass fire). The self-heating ignition occurs when the heat release rate from exothermic chemical reactions exceeds the environmental cooling rate. Because of the exothermic reactions involving the electrodes and electrolyte, the Li-ion battery can undergo self-heating in the absence of external impact. A fire event would generate heat and possible deflagration overpressure if flammable vapours were ignited. Depending on the design and manufacture of the Li-ion battery, projectiles may be generated and/or cell explosions may occur if off-gases are not vented effectively. Generation of toxic gases (including HCl, HF and HCN) may also be formed during a thermal runaway event and a fire event (several incl. Ref 13). It is possible for a Li-ion battery to re-ignite due to the exothermic reactions that continue to occur within the battery cell. If the burning battery cells are located close to combustible material within the enclosure, or close to other battery cells, or if the battery enclosure is located close to other infrastructure, there is a potential for propagation to other areas and escalation of the fire event. Detailed analysis, refer to Section 4.2.1.
Coolant (for the typical "representative" enclosure)	*Commissioning and operations*: For the "typical" representative battery solution: nominally 2 m^3 per unit, 448 units = total 896 m^3 *Construction*: none prior to delivery of enclosures to BESS Site, then as above	Some type of coolant may be used in the battery racks or enclosures, likely to be a non-DG material of low hazard. A typical battery coolant consists of a mixture of ethylene glycol and water. While pure ethylene glycol is a combustible liquid (Ref 14), when mixed with water it becomes non-combustible, but, if water is driven off in a fire it can participate in the combustion reaction. This is unlikely to significantly increase the heat radiation from a battery fire which would largely be defined by the combustible

Material	Inventory	Description and potential hazards
		material within the battery and enclosure. The effects from this potential hazard are likely to be confined to the Project Area or during transport to the Project Area.
Refrigerant	*Commissioning and operations*: For the "typical" representative battery enclosure solution, nominally 3 kg/unit, 448 units = total 1,344 kg, distributed in small quantities in discrete locations *Construction*: none prior to delivery of enclosures to BESS Site, then as above	The typical battery rack may include a refrigerant, probably composed of a single or mixture of non-flammable non-toxic compressed gases (DG Class 2.2) or solids. If refrigerant compressed gases are used, the chiller unit may explode if heated. Contact with compressed gases may cause frostbite. Exposure is likely to be harmful (all routes). The effects from this potential hazard are likely to be confined to the Project Area or during transport to the Project Area.
Oil, diesel and other petroleum products	*Commissioning and operations:* Typical quantities, up to around 700m^3 in separate discrete location around the Project Area: 1) MV transformers within the BESS: nominally 4 m^3/unit; 120 units = 480m^3 total 2) HV transformers (at the substations): nominally 100 m^3/unit, up to 6 units = 600 m^3 total 3) PCU transformer (at the PV solar site): Nominally 3 to 4 m^3/unit, up to 130 units = 520 m^3 total *Construction*: limited amounts incl. diesel for the generator (typically up to 5 m^3) and other materials typical for construction activities, prior to delivery of transformers etc. to Ste, then as above.	*Oil* is expected to be used and handled, e.g. as insulating oils and in the transformers. The main hazard associated with oil relates to environmental pollution in case of a loss of containment, and with toxicity in case of human exposure. Oil is combustible and, while difficult to ignite in atmospheric conditions, it can result in a pool fire and can pose a serious fire hazard if not contained. *Diesel* is flammable category 4 liquid, typically difficult to ignite in atmospheric conditions, but, if ignited, it can result in a pool fire and can pose a serious fire hazard if not contained. The main hazard associated with diesel relates to environmental pollution in case of a loss of containment, and with toxicity in case of human exposure. The effects from the potential hazards associated with oils and diesel are likely to be confined to the Project Area or during transport to the Project Area.

Material	Inventory	Description and potential hazards
Small amounts of flammable and/or combustible material, e.g. oil, diesel, acetone, and other solvents. Small amounts Corrosive liquids and aerosols. For use e.g. for cleaning during construction and maintenance activities	*Commissioning, construction and operations*: Limited amounts, typical for construction activities	Small amounts of flammable or combustible material (e.g. diesel, petrol, superglue, solvents, thinners and paints) and small amounts of corrosive and toxic liquids (e.g. small containers of hydrochloric acid and other corrosives for surface preparation, pesticide for ground clearing etc.) are expected to be stored and handled during the construction phase of the Project. The quantities of DGs and other potentially hazardous/pollutant material would be held well below the SEPP33 screening thresholds (Ref 2). Further, transportation of DGs would be well below the SEPP33 *Transportation Screening Thresholds* (Ref 2, Table 2). These are not considered *potentially hazardous* (Ref 2), and application of Codes and Standards cover this hazard. This is not discussed further in this PHA.

4.1.3 Potential hazards and their control

The outcome of the hazard identification review is formally detailed in the *Hazard identification word diagram* in Appendix 1, including:

- Hazardous incident / event
- Possible causes
- Worst-case credible consequences (assuming no active controls in place)
- Preventative and protective safeguards
- Potential for impact outside boundary.

A summary of the types of hazards associated with the Project is provided in Table 4-2.

Only those hazards that may give rise to a significant potential for harm, in accordance with HIPAP6 (Ref 1), are included.

Table 4-2: Overview of the types of hazards associated with the Project (HIPAP6 type hazards only)

Project element	Electrical hazards	Energy hazard incl. EMF	Fire hazard	Explosive hazard	Pollution hazard	Toxic hazard	Key Standard
PV solar farm including PCU	✓	Note 2	Note 3	-	Note 5	✓	AS 2067 / AS 1940
BESS	Note 1	Note 2	Note 3	Note 4	Note 5	Note 6	NFPA 855, UL9540, (AS 5139)
Switch room and HV transformers	✓	Note 2	Note 6	Note 2	Note 5	✓	AS 2067, AS 1940
Transmission connection	✓	Note 2	Note 6	✓	Note 5	✓	AS 2067, AS 1940
General fires in buildings	-	-	Note 3	-	-	✓	NCC, National Construction Code
External (natural events) or construction impact	Note 7	Note 7	Note 7	Note 7	Note 7	Note 7	Various see Appendix 4

Notes:

1. Electrical hazard remains when battery is isolated
2. Arc flash incident and exposure to EMF
3. Fire may be caused by internal or external threats
4. Depending on the battery solution selected, if the batteries release flammable gases such as hydrogen under fault conditions, it is regarded as an explosive gas hazard. Fire or heat exposure to the refrigerant unit may cause it to disintegrate releasing overheated compressed (non-flammable) gases with ejection of material
5. Failure to contain a spill e.g. of transformer oil or coolant, may cause pollution
6. Depending on the battery solution selected, toxic fumes may contain HCl, HF or HCN from battery fire; or oxides of sulphur (note – the UL 9540A *Cell Level Testing* for the Tesla MP battery, which is used as "typical" representative battery solution in this PHA, did not pick up any toxic gases venting from the cells. A fire involving plastics and other combustible construction material e.g. in electrical cabling or building material/contents may evolve toxic combustion material.
7. A. Bush/grass fire hazards; lightning strike; security breach event, construction activities.

   B. APA Group pipeline at the north western corner of the Project Area.

In addition (outside the scope of the PHA) mechanical hazards are associated with the Project infrastructure, e.g. weight, sharp edges and corners, moving parts, falling over, tripping, seismic, and lack of lifting or securing.

A total of 5 hazardous events have been identified, as follows:

1. *Thermal runaway (including due to spontaneous ignition) and fire in a battery enclosure* within the BESS, which has the potential to be harmful to people in the area and to lead to propagation to nearby infrastructure
2. *Loss of containment of pollutant material from the Project infrastructure*, if there is a spill from the battery enclosure, transformers, generator or landing gantries, e.g. oil, cooling medium, or diesel. In particular, the environmentally constrained land within the Project Area is vulnerable to any degree of pollution and requires protection
3. *Electrical fault or failure to control electrical energy (EMF; electrical interference)* at electrical equipment (inverters, transformers, substations, transmission line and gantries and electrical cabling) has the potential to be harmful to people in the area, and an arc flash can lead to propagation to nearby infrastructure
4. *Fire in nearby area (bushfire or APA Group pipeline)* may cause damage and escalation to Project infrastructure
5. *Incident during construction activity causes impact with infrastructure*, e.g. damage to the APA Group pipeline or to a battery enclosure.

4.1.4 Level of analysis

The MLRA guidelines (Ref 2) provide a decision tool that is to be used to determine the level of analysis in a PHA.

The tool is based on quantities of DGs and their distance to Site boundary and other considerations.

For this Project, where the Project infrastructure is located within the Project Area, the tool has been applied to assess the potential for harm within and outside the Project Area.

The level of analysis for each potential hazardous incident is shown in Figure 4-1 below. Further details are provided in Table 4-3.

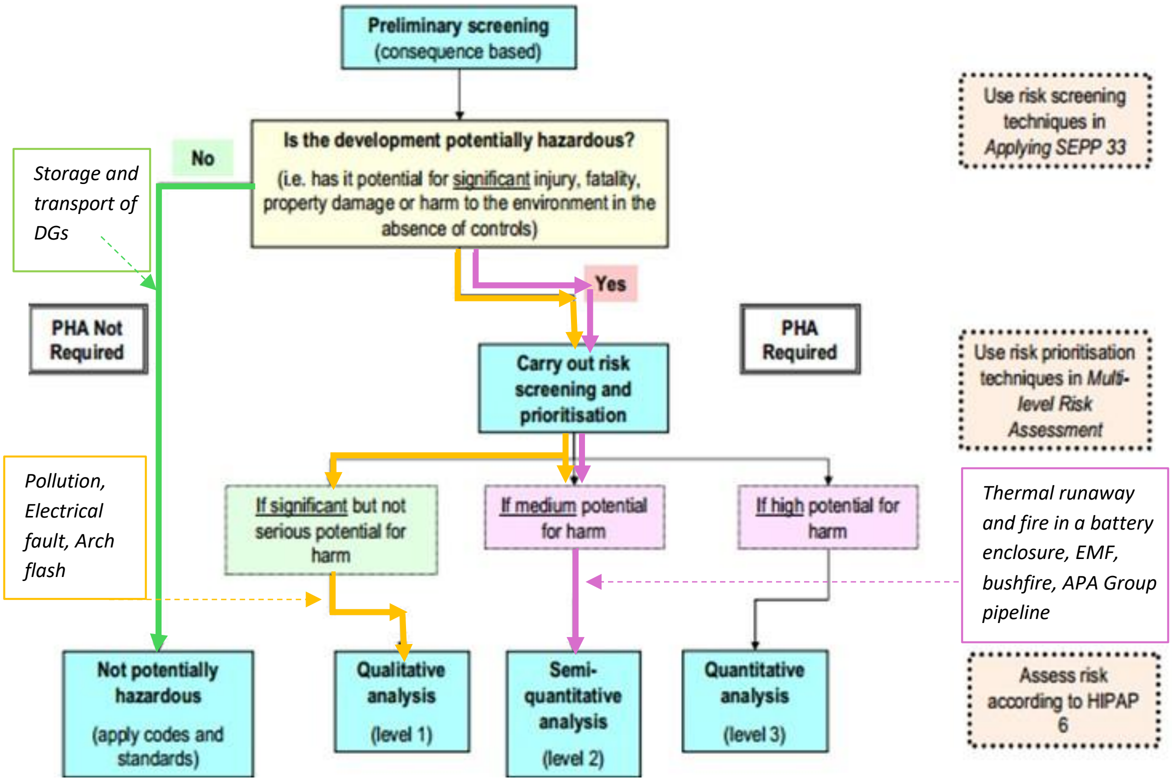


Figure 4-1: Level of analysis in the PHA (figure extracted from the per Multi-level Risk Assessment guidelines, Ref 2, with Project specific hazards superimposed)

Table 4-3: Level of risk analysis required, as determined using MLRA guideline methodology

Incident	Type effect	Qualitative	Semi-quantitative	Quantitative	Comment
1. Thermal runaway (including due to spontaneous ignition) and fire in a battery enclosure within the BESS leads to generation heat radiation, flammable vapours (deflagration / overpressure), and toxic gas	Heat radiation		✓		Purple arrow in Figure 4-1. Medium potential for harm outside of the Site including outside of the Project Area. If uncontrolled, heat radiation from a major fire technically has the potential to initiate an incident in adjacent environment and infrastructure, e.g. a bushfire, or escalate to further Project infrastructure. Assessment in Section 4.2.1.
	Deflagration / overpressure	✓			Orange arrow in Figure 4-1. Significant but not serious potential for effect outside of the Site including outside of the Project Area. While potentially significant within the Project Area, it is not expected to cause significant effects outside the boundary. Assessment in Appendix 2.
	Toxic gas	✓			Orange arrow in Figure 4-1. Significant but not serious potential for effect outside of the Sit including outside of the Project Area e. While potentially significant within the Project Area, it is not expected to cause significant effects outside the boundary. Assessment in Appendix 2.
2.Loss of containment of pollutant material (transformer oil, cooling water, diesel)	Environmental pollution	✓			Orange arrow in Figure 4-1. Significant but not serious potential for effect outside of the Site including outside of the Project Area. While potentially significant within the and outside of the Project Area, it is not expected to

Incident	Type effect	Qualitative	Semi-quantitative	Quantitative	Comment
					cause significant effects outside the boundary. Assessment in Appendix 2.
3. Electrical fault or failure to control electrical energy at electrical equipment (inverters, step-up transformers, substations, transmission line and gantries, electrical cabling across the APA Group pipeline) causing fire, arc flash, exposure to EMF, corrosion damage to the APA Group pipeline	Arc flash	✓			Orange arrow in Figure 4-1. Significant but not serious potential for effect outside of the Site including outside of the Project Area. While potentially significant within the Project Area, it is not expected to cause significant effects outside the Site or outside of the Project Area. Assessment in Appendix 2.
	Heat radiation transformer oil / cabling fire	✓			Orange arrow in Figure 4-1. Significant but not serious potential for effect outside of the Site including outside of the Project Area. While potentially significant within the Project Area, it is not expected to cause significant effects outside the Site or outside of the Project Area. Assessment in Appendix 2.
	Electromagnetic fields		✓		Purple arrow in Figure 4-1. If uncontrolled, electro, magnetic and electromagnetic fields technically have the potential to cause harm. Medium potential for harm outside of the Project Area. Assessment in Section 4.2.2.
	Electrical cabling across the APA Group pipeline	✓			Purple arrow in Figure 4-1. Electrical interference with the APA Group gas pipeline may cause damage, loss of containment and fire at the pipeline which has the potential to initiate an incident within and outside the Project Area.

Incident	Type effect	Qualitative	Semi-quantitative	Quantitative	Comment
					Medium potential for harm outside of the Site and the Project Area. Assessment in Section 4.2.4B.
4. Fire in nearby area (bush / grass fire) causes damage and escalation to Project infrastructure or fire on-site leads to fire in nearby area	Fire and damage propagation from bushfire		✓		Purple arrow in Figure 4-1. Bushfire, if impacting on Project infrastructure, has a medium potential for harm. It has a potential to initiate Scenario #1. Assessment in Section 4.2.3.
5. Incident during construction activity causes damage to infrastructure and potential initiation of Incident 1, 2 or 3	Impact with APA Group pipeline		✓		Purple arrow in Figure 4-1. Damage to the APA Group pipeline may cause damage, loss of containment and fire which may have the potential to initiate an incident within and outside the Project Area and needs to be assessed. Medium potential for harm outside of the Site including outside of the Project Area. Assessment included in Section 4.2.4A.
	Impact with battery enclosure		✓		Purple arrow in Figure 4-1. Impact on a battery enclosure may initiate a thermal runaway (scenario #1). Medium potential for harm outside of the Site including outside of the Project Area. Assessment included in Section 4.2.1.

Notes:

1. No high potential for harm outside of the Site including outside of the Project Area has been identified as part of this PHA
2. Threats from natural events other than bushfire are analysed in Section 2.2, covered using Australian Standards, and not discussed further in this PHA.

4.2 Risk analysis and risk treatment

A detailed evaluation of all potentially hazardous incident scenarios is provided in Appendix 2, with those scenarios that have been deemed to have the potential for impact outside of the Site including outside of the Project Area, detailed in the following sections below:

- Section 4.2.1 Thermal runaway (including due to spontaneous ignition) and fire in a battery enclosure
- Section 4.2.2 EMF
- Section 4.2.3 Bushfire assessment
- Section 4.2.4 APA Group pipeline.

4.2.1 Thermal runaway (including due to spontaneous ignition) and fire in a battery enclosure

A battery event may be initiated by a thermal runaway and spontaneous ignition within a battery cell which propagates to other parts (cells, modules, racks) within the enclosure. This may be caused by electrical system failures (damage to wiring, fuse or breaker failure) or by mechanical interference (mishandling, rodents, impact during construction activities).

While the following three possible outcomes are considered in Appendix 2, the first (generation of heat from a fire) is assessed to have the most significant consequences if not controlled, and is assessed further in the body of the report:

- Generation of heat from a fire
- Generation of toxic combustion gases from a fire
- Overpressure from a deflagration event.

Generation of heat from a fire:

A thermal runaway in a battery enclosure is possible despite all precautions taken during design, operation and maintenance. Provided the BESS (cells, modules, enclosures) is designed such that a fire does not propagate to other areas within the BESS, it is unlikely that the event will cause significant harm outside of the Project Area.

A design which demonstrates that a thermal runaway does not propagate, together with BESS layout and separation distances (enclosure to enclosure and to other potential receptors) are key controls to prevent on-site and off-site impact.

While the selection of a technology solution for the BESS would not occur until the detailed design stage, the Tesla MP2XL configuration (Figure 4-2, reproduced from Ref 15) has been used as a "typical" representative battery solution in the PHA to provide a guide to the internal arrangement of the battery enclosure. This configuration is expected to be associated with the most severe consequences should a battery enclosure fire occur, as more battery racks are fitted inside the enclosure compared with smaller cabinet-type enclosures.

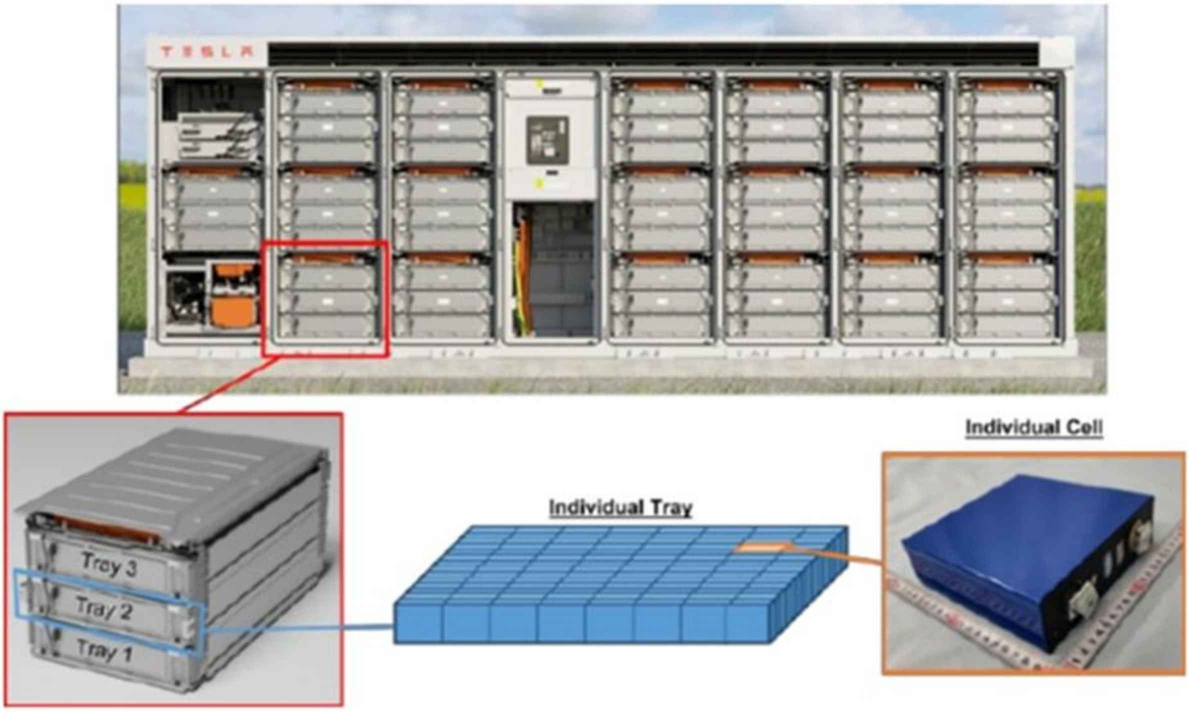


Figure 4-2: Configuration inside the typical containerised solution (Tesla MP2XL as a typical worst-case example; figure reproduced from Ref 15)

The heat flux model developed by Tesla (via Fisher Engineering, Ref 15) was used to determine the potential for propagation of a thermal event in one ("typical" representative) battery enclosure to adjacent enclosures. A summary of the results from the heat flux calculation model is presented in Table 4-4.

Table 4-4: Heat flux model summary results (Tesla MP, Ref 15, as "typical" representative enclosure)

Radiation emitting from	Wind weather condition	Target location & distance		Max predicted (calculated) heat flux (kW/m^2)
Cabinet (hot surface)	With or without wind	Back / side targets	0.152 m	5.12
			0.457 m	4.40
			0.914 m	3.65
			1.219 m	3.18
			2.438 m	2.90

Radiation emitting from	Wind weather condition	Target location & distance		Max predicted (calculated) heat flux (kW/m^2)
Flames: front of the MP2/2XL Cabinet	No wind (vertical flames)	Front target	2.438 m	8.50
	Worst-case wind (45° tilted flames)	Front target	2.438 m	11.77
Flames: top of the MP2/2XL Cabinet	Worst-case wind (45° tilted flames)	Back / side targets	0.152 m	12.83

Off-site impact: The closest enclosure is approximately 34 metres from the BESS Site boundary and any vegetation outside of the BESS area

With this clearance, the heat radiation level associated with a fire at the BESS facility is not likely to reach a heat radiation of 1 kW/m^2 at the BESS boundary (Ref 15), well below 3 kW/m^2 which is commonly defined as the heat radiation level which could cause discomfort[4].

On-site impact: The National Fire Protection Association (***NFPA***) 855 is widely regarded as one of the world´s most comprehensive Code of Practice for BESS. NFPA 855 specifies that BESS may be installed with 3,048 metres between units but allows smaller separation distances if the enclosures meet with the stringent requirements set in the UL 9540 A *Test method for evaluation thermal runaway fire propagation in Battery Energy Storage Systems*, or equivalent standard. UL9540A testing examines the propagation potential of BESS systems at cell, module and unit level. Any BESS that has achieved certification to UL 9540A, such as the Tesla MP2XL, will present a low risk of on-site impact from this scenario.

4.2.2 EMF

Whenever electrical equipment is in service, it produces an electric field and a magnetic field. The electric field is associated with the voltage of the equipment and the magnetic field is associated with the current (amperage). In combination, these fields cause energy to be transferred along electric wires.

- *Electric fields*: Being related to voltage, the electric fields associated with high voltage equipment remain relatively constant over time, except where the operating voltage changes. The strength of the electric field depends on the voltage and is present in any live wire whether an electrical appliance is being used or not.

[4] This assessment does not include the potential for embers generated in the fire, starting a fire beyond the BESS Site boundary. There would be no significant impact on adjacent land users expected from this scenario.

- *Magnetic fields*: Being related to current, the magnetic field strength resulting from an electrical installation varies continually with time as the load on the equipment varies.

The electric and magnetic fields associated with electrical equipment, whilst interrelated, are not dependent on each other and as such can exist independently.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) states (in Ref 16) that there is no established scientific evidence that exposure to electric and magnetic fields (EMF) causes adverse health effects. However, there are some epidemiological (population) studies that have reported a possible association between prolonged exposure to extremely low frequency (ELF) magnetic fields at levels higher than typical and increased rates of childhood leukaemia.

Typical values of magnetic fields measured near powerlines and substations are listed in Table 4-5. The values can be compared with typical values of magnetic fields in household appliances in Table 4-6 (Ref 16).

Since late 2016, ARPANSA has adopted the international guideline published by ICNIRP in 2010. The *Reference Levels* set out in the guideline are derived from the levels at which interactions with the central nervous system are established, with a safety factor applied and a further adjustment to simplify compliance measurement. It should be noted that these criteria are independent of duration of exposure. The reference levels established by the ICNIRP and adopted by ARPANSA are provided in Table 4-7.

Table 4-5: Typical values of magnetic fields measured near powerlines and substations

Source	Location of measure	Range of measurement (milligauss (mG))	Reference
Project substations	At substation fence	1 – 8	Ref 16
High voltage connection (HV powerlines)	Directly underneath (if overhead)	10 – 200	Ref 16
High voltage connection (HV powerlines)	At edge of easement	2 - 50	Ref 16
33 kV above or belowground cable	Above ground option: - Directly underneath - At edge of easement Below ground option[5]: - 1m above ground - 20 m from source	 10 – 200 2 - 50 24 1	 Ref 16 Ref 16 Ref 17 Ref 17

[5] Values are for a 400 kV underground cable (stronger than proposed transmission line of 330 kV)

Source	Location of measure	Range of measurement (milligauss (mG))	Reference
The PCU – assuming the same levels as substations[6]	Outside PCU	1 – 8	Ref 16
The BESS – assuming the same levels as substation[6]	Outside battery enclosure	1 – 8	Ref 16

Table 4-6: Typical values of magnetic fields (ARPANSA)

Source	Location of measure	Range of measurement	(milligauss (mG))
Electric stove	at normal user distance	2 – 30	Ref 16
Refrigerator	at normal user distance	2 – 5	Ref 16
Electric kettle	at normal user distance	2 – 50	Ref 16
Hair dryer	at normal user distance	10 – 70	Ref 16)

Table 4-7:- ARPANSA limits – electric and magnetic fields, (2002, updated 2016)

Field type	Public limits		Occupational limits	
	Magnetic Field (µT rms)	Electric Field (volts per meter rms)	Magnetic Field (µT rms)	Electric Field (volts per meter rms)
Reference Levels for Time Varying Fields at 50 Hz (AC)	100	5,000	500	10,000
Guidance Levels for Static Fields (DC)	56,600	14,100	283,000	28,300

For comparison, ten milligauss (mG) equal one microTesla (µT).

Conclusions, exposure to EMF:

The magnitude of the EMF at a location is inversely proportional to the distance from the current carrying elements. As such, increasing the distance between the conductor and the receiver is a valid approach to managing EMF exposure.

[6] This is a conservative assumption. In reality, the magnetic fields at a Battery enclosure will much lower than for a substation as they operate at voltage <1kV

Closest distance to any receiver as follows:

- Closest residence from any substation: Approximately 700 metres
- Closest resident to the BESS: Over 1 kilometer

This separation exceeds that which is generally considered as safe (refer to Table 4-5).

A number of operational and maintenance buildings are also proposed at the Site. The precise location of these buildings would be confirmed at detailed design, however these buildings would not be permanently occupied and would only be used on an intermittent basis.

4.2.3 Bushfire assessment

The bushfire assessment (Ref 4, summarised in Section 2.3.1) sets a BAL-29 APZ, to be applied from the outer edge of all built Project infrastructure. This APZ provides a separation of between 11 and 25 metres between Project Components and the surrounding vegetation, increased to between 32 and 250 metres between the BESS and surrounding vegetation. This separation distance exceeds the basic requirement for APZ in the PBP for wind and solar farms (refer to Section 8.3.5, p. 77 in the PBP), of 10 metres.

The bushfire assessment demonstrates that the BAL-29 APZ provides an acceptable level of risk mitigation to assets and minimises damage and impact on operations and business continuity. In addition, recognising that radiant heat flux reduces sharply with distance, assets further away from the bushfire vegetation would receive higher levels of protection from failure. This means that the radiant heat that the BESS would be exposed to in a bush fire, at a minimum of 32 metres from the surrounding vegetation, would be much lower than the maximum allowable for that development.

The APZ also reduce the chance of any ignition caused through electrical failure from spreading or developing into a bushfire.

With the clearance provided by the APZ, the heat radiation level associated with a fire at the BESS facility is not likely to reach a heat radiation of 1 kW/m^2 at the BESS boundary (Ref 15), well below 3 kW/m^2 which is commonly defined as the heat radiation level which could cause discomfort[7].

To further reduce the risk of a bushfire impacting Project infrastructure, the bushfire assessment stipulates that a number of 20,000 litre tanks be strategically located around the Project Area including

[7] This assessment does not include the potential for embers generated in the fire, starting a fire beyond the BESS Site boundary. There would be no significant impact on adjacent land users expected from this scenario.

nearby to critical infrastructure including the BESS and the substations (other locations will be determined in the detailed design process and reported to FRNSW and RFS in the Fire Safety Study for their consideration, refer to recommendation 4).

A Bush Fire Emergency Management and Operations Plan (BEMOP) and evacuation panning will be developed.

The bushfire assessment report (Ref 4) demonstrates that the Project design approach has taken a substantially higher standard than is required with respect to the key considerations around BAL and provision of APZ. The Project meets and/or exceeds the NSW APZ requirements under PBP and has considered electricity transmission industry standards to demonstrate how impacts from bushfire can be mitigated, and conversely these measures provide very significant mitigation against any fire occurring onsite spreading to surrounding areas.

Further, the bushfire assessment repots concludes that appropriate measures can be developed to mitigate the bushfire risks from and to the Project Area; will be further refined during the detailed design phases to come; and that the Project Area is suitable for the development and operation of a solar farm and BESS.

4.2.4 APA Group pipeline

Golden Highway is between the solar farm and the APA Group pipeline for most of the northern boundary except for a short intersection at the north western corner of the Site, refer to Figure 2-5.

In Australia, high pressure gas pipelines are designed and operated in compliance with AS 2885 suite of standards.

AS2885.3 requires high pressure pipelines to be managed under a Pipeline Management Plan (PMP), including a Pipeline Integrity Management Plan (PIMP), and the implementation of the requirements under the PMP and the PIMP must be independently audited each year and the report submitted to the NSW Pipeline Regulator for approval.

AS2885.6:2018 defines a corridor width (or *measurement length*) on either side of the pipeline which is based on the proximity distance to populated areas determined according to the distance to potentially fatal and injurious heat radiation levels from an ignited loss of containment at a pipeline. The measurement lengths, in turn, depend on the operating pressure and the diameter of the pipeline.

A consultation meeting was held with the APA Group regarding the high pressure natural gas pipeline which traverses part of the Site (meeting held 4 August 2022 between APA Group, Marble Energy and Planager, Ref 18).

APA Group have provided the following information regarding their pipeline:

- Material transported: natural gas (a pressurised flammable gas)
- Design pressure of the pipeline is 10.2MPa
- Dimensions as follows: internal diameter 200 mm (DN200) with an outer diameter of 219.1 mm
- The measurement length for the pipeline as follows[8]:
    - 224 metres to heat radiation level of 4.7kW/m^2, i.e. the maximum distance from the pipeline where injury may occur in a worst case incident (AS2885.1 and HIPAP4, Ref 3)
    - 137 metres to heat radiation level of 12.6 kW/m^2, i.e. the maximum distance from the pipeline where fatality may occur in a worst case incident (AS2885.1 and HIPAP4, Ref 3).

Ignition of wood or oil (e.g. if oil was unprotected in the PCU transformers) is possible at a heat radiation level of 12.6 kW/m^2 (HIPAP4, Ref 3). Propagation to other nearby infrastructure at this heat level is unlikely, and oil inside steel containers (as unprotected steel) may occur at around 23 kW/m^2 (HIPAP4, Ref 3).

Two potential threats have been identified as needing investigation as part of this PHA:

- Incident unrelated to the Project leads to damage to the APA Group pipeline which threatens Project infrastructure
- Project activity causes damage to the APA Group pipeline – this threat has been mitigated with construction activity and no removal of trees, will occur in the area near the pipeline.

The damage at the pipeline may lead to loss of containment of flammable gas which, if ignited, would burn as a jet fire. The heat radiation may theoretically propagate to Project infrastructure by initiating a fire in the oil storage at a PCU.

[8] APA Group are reviewing Maximum Operating Pressure, MOP, and these distances may be changed as a result of this. However, it is not expected to change any of the outcomes of this PHA

A. Incident unrelated to the Project leads to damage to the APA Group pipeline which threatens Project infrastructure

Consequence assessment:

The measurement length (of 137 metres from the centreline of the pipeline) to a heat radiation level of 12.6 kW/m^2 can be used to inform the distance from a worst case pipeline incident where oil or other Project infrastructure may be affected (HIPAP4, Ref 3).

The distance indicates that a jet fire at the APA Group pipeline would not reach the BESS or either of the substations.

The solar array areas with the oil storage in the PCUs may be affected depending on the detailed layout, if located within 137 metres radially from the centreline of the pipeline. The consequences, should the oil ignite, would be a pool fire which would burn causing heat radiation and acrid, possibly toxic, combustion products. The heat from fire would cause the fumes to be lifted high into the air, and significant consequences are unlikely at the ground. It is likely that the hazardous consequences of the oil pool fire would be much lower than the consequences of the pipeline jet fire itself.

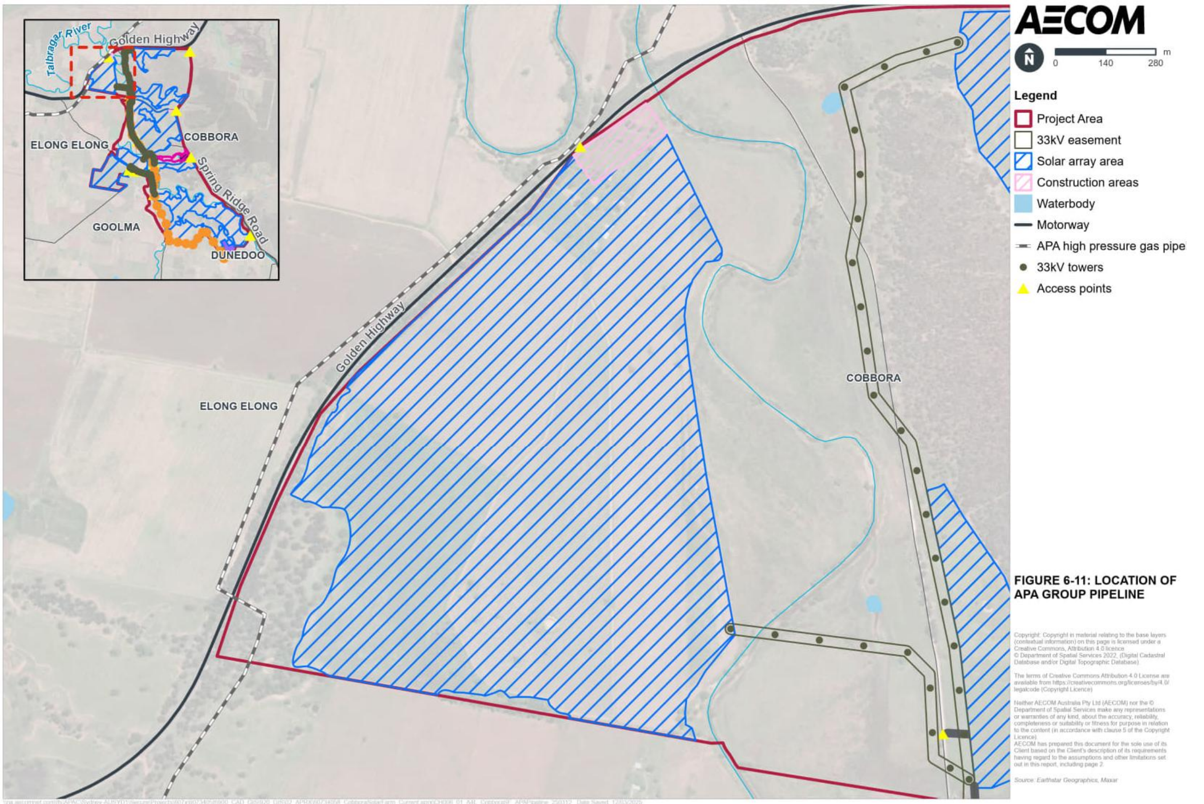


Figure 4-3: APA Group pipeline with the approximate distance to the measurement length shown on the Project Area map

The pipeline jet fire could cause a bushfire, and the APZ determined as part of the bushfire assessment (Ref 4) would ensure that a bushfire does not propagate to the Project Area infrastructure, including to the BESS Site or the Main Project substation.

To determine whether the pipeline poses a restriction on the Project it is necessary to assess the likelihood of the incident at the pipeline and compare with maximum criterion for propagation risk in use by DPHI (HIPAP4, Ref 3).

Likelihood assessment:

High pressure underground pipeline failures are fortunately rare in Australia and internationally in well managed pipelines. The likelihood of a failure of the pipeline can be estimated based on the statistically available data from similar pipeline industry. Historical data on pipeline failures and in some cases incidents of damage not leading to failure, is collected by several groups around the world.

The UK Health and Safety executive (UK HSE, Ref 19) has evaluated the European databases, covering 1,745 failure events over more than 6 million pipeline kilometres years. Failure rates for four categories of failure of pipelines: *pinhole*, *small hole*, *large hole* and *rupture* covering the four principal failure modes for a pipeline operated for some time were determined. Failure modes (or *causes*) are mechanical failures, ground movement and other events, corrosion and third party activity. The UK HSE is regarded as the most current and comprehensive database at the time of the present PHA and applies to pipelines in Australia which are managed well, in line with European pipelines.

Only ignited leaks have the potential to affect the Project Area. A conservative estimate is that 10% of pinhole, small and large leaks will ignite, and 40% of all rupture leaks will ignite (Refs 20, 21),

Table 4-8 details the set of data relevant for the APA Group pipeline in this location. Conservatively estimated, approximately 3 metres of pipeline travels in proximity to the Project Area[9]. Pinhole leaks are ignored as being too small to cause an impact on Project Infrastructure or threaten personnel on the Project Area.

Table 4-8: : Pipeline failure frequency and likelihood of pipeline fire

Pipeline diameter 200 mm	Leak Frequency (per km per year) all causes			Likelihood of a fire (per year) at the pipeline in proximity to the Project Area (defined by the measurement length to 4.7kW/m^2)
	Small hole	Large hole	Rupture	All causes
	4.9 x 10^{-6}	3.7 x 10^{-7}	2.5 x 10^{-6}	3.6 x 10^{-6} per year

[9] Distance is approximate only and includes the full length of the pipeline along the NW Site border plus the measurement length to 4.7kW/m^2 on each side, where impact to a pipeline incident may be felt

Conclusions, incident at the APA Group pipeline:

An incident at the APA Group pipeline would not directly affect the BESS or the substations as the measurement length for the pipeline, i.e. the distance measured radially from the pipeline where a propagation incident to oil and other combustible materials, may occur. The APZ applies for possible bushfire initiated by the pipeline, i.e., if the pipeline incident initiates a bush fire, the APZ would ensure the BESS and the substations are safe. Propagation to the BESS and the substations can be ruled out on consequence assessment alone.

An impact at the PCUs (e.g. the oil in the transformers) from an incident at the pipeline cannot be ruled out at this stage of the design, until the final layout of the solar array has been determined. The likelihood of a fire at the pipeline in proximity to the Project Area has been calculated to be 3.6 x 10^{-6} per year based on pipeline incident statistics. This is well below the criterion for maximum likelihood of propagation to an adjacent industrial facility, in use by the DPHI, of 50 x 10^{-6} per year (HIPAP4, Ref 3).

The presence of the APA Group pipeline on the north western border does not constrain the Project development.

B. Project activity causes damage to the APA Group pipeline

Two initiating causes have been identified whereby Project activity causes damage to the APA Group pipeline:

- Construction activity causes impact on the pipeline, or
- Failure to control electrical energy from cabling across the pipeline, which causes corrosion damage at the pipeline.

Provided the following controls remain, as per the consultation meeting with APA Group (Ref 18), the risk associated with damage to the APA Group pipeline is managed in accordance with APA Group requirements:

- Trees in north western corner of the Site would remain. Should this change, it is necessary to consult with APA Group.
- Cabling would need to be reviewed by APA Group at the detailed design stage. An APA's impact assessment report to assess risks to the pipeline from the electrical design may be required.
- Any need for potholing would be determined by APA Group at the detailed design stage.

4.3 Project risk profile

4.3.1 Introduction

The risk matrix approach provides a qualitative/semi-quantitative methodology for determining risk and, as such, is useful for risks requiring a Level 1 or 2 analysis (as defined in the MLRA guidelines). This approach determines the risk by combining the consequence and likelihood of each nominated incident scenario using a risk matrix which has been calibrated in accordance with the risk criteria for land use safety planning in place in NSW (HIPAP4).

As per HIPAP4, risk evaluation considers whether the level of risk meets (a) generally acceptable risk criteria and whether (b) it has been reduced ALARP. The risk evaluation has three possible outcomes:

- *Well below the acceptable criteria*: further risk reduction may be impractical
- *Sufficiently close to or above the acceptable criteria*: further risk reduction controls to be investigated in detail using ALARP principles
- *Well above the acceptable criteria*: further controls need to be found, or continued operation questioned.

Guidelines are provided in the HIPAP4 (Ref 3) to allow for a demonstration that a risk is eliminated or prevented, or where that is not possible, controlled to a level which can be regarded as ALARP.

4.3.2 Risk outside of the Project Area (off-site risk)

The Project risk profile for land use outside of the Project Area is shown in the risk matrix in Figure 4-4, where the Red zone represents an "Unacceptable" risk level; the Yellow zone a risk regarded as "ALARP", and the Green zone as "Acceptable" (refer to Appendix 2 for further details). Only the highest risk ranking for each scenario is shown.

With the Project Area being located within the Site, the risk outside the Site is necessarily the same or lower than the risk outside of the Project Area.

The risk profile outside of the Project Area (and outside the Site) is ranked as *Acceptable* with no notable effects.

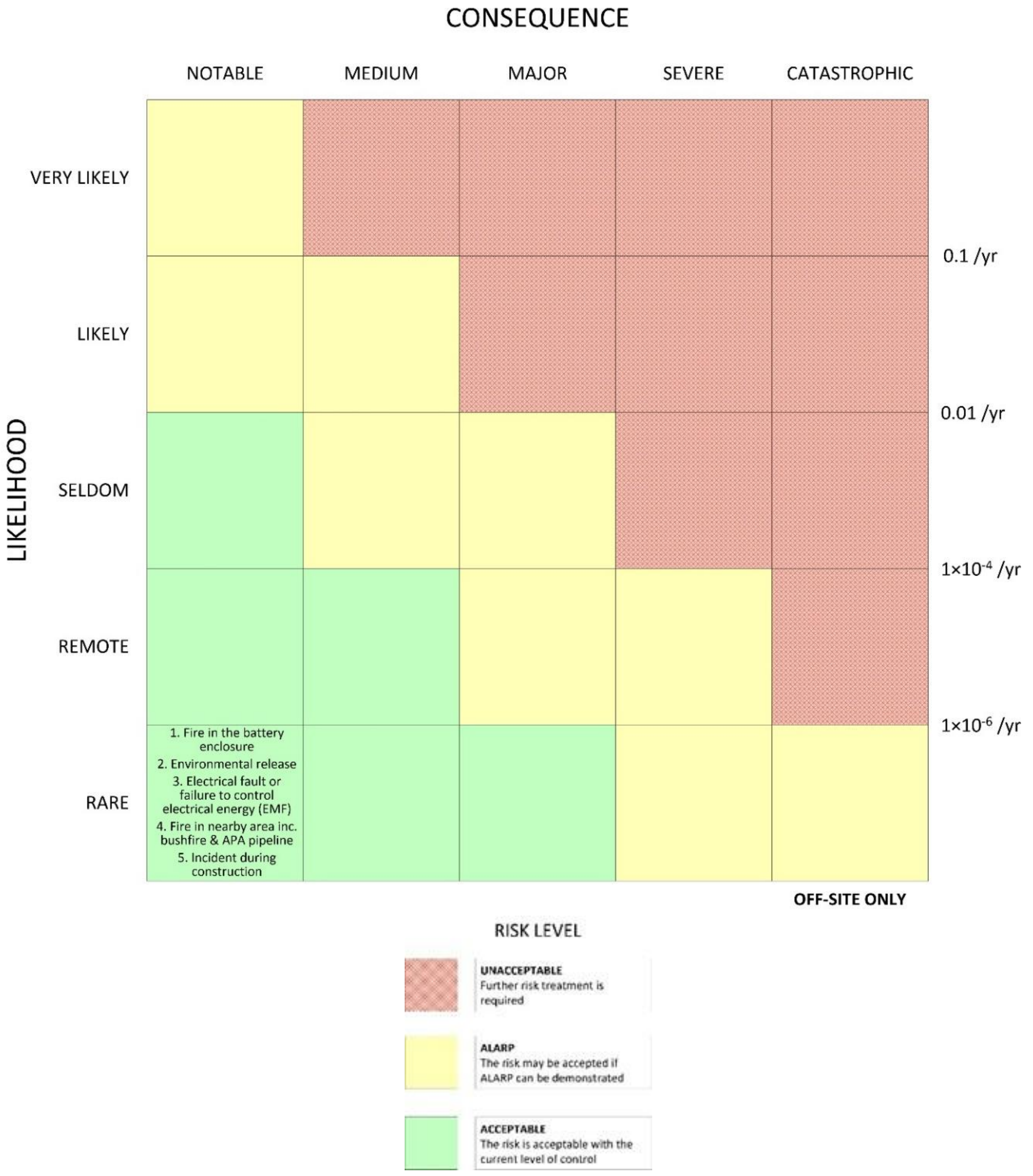


Figure 4-4: Risk profile - Outside of the Project Area

4.3.3 Risk within the Project Area (on-site risk)

The Project risk profile for land use within the Project Area is shown in the risk matrix in Figure 4-5. Only the highest risk ranking for each scenario is shown.

The risk inside the Project Area (i.e. on-site risk) is ranked consistently as *ALARP* except for exposure to EMF which is ranked as acceptable. Severe consequences are associated with the following scenarios:

- Fire in the battery enclosure
- Arc flash and electrocution associated with electrical equipment
- Incident during construction including work on high voltage equipment and the transmission line connection with risk of electrocution.

The scenarios are well known and understood and, provided that the requirements in Codes and Standards are implemented, the risk can be managed to ALARP requirements.

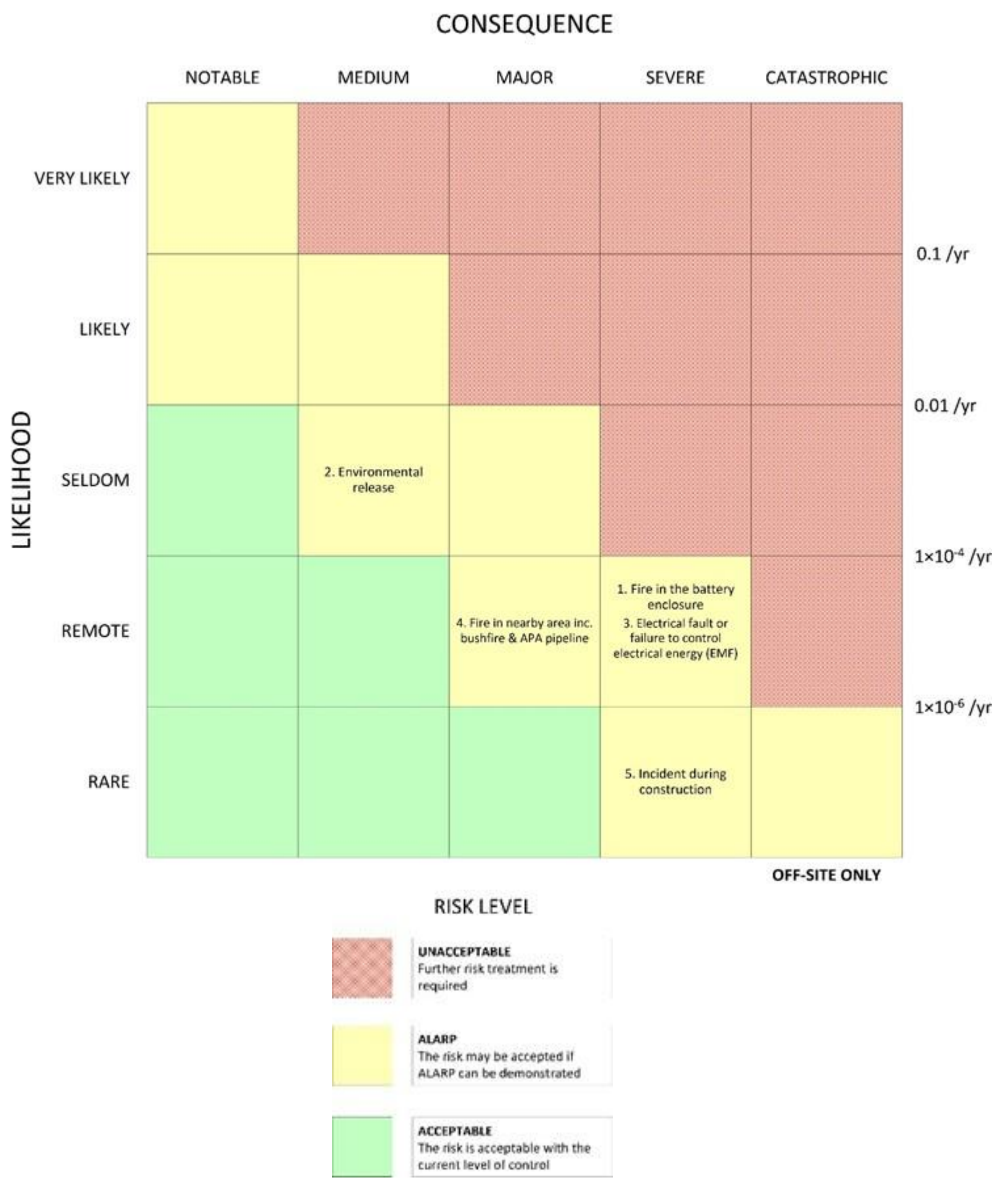


Figure 4-5: Risk profile - Inside the Project Area

4.4 BESS FOOTPRINT

Minimising the risk of a fully developed fire in one battery enclosure from escalating to directly adjacent enclosures in the same row or to those in a facing row represents one of the key requirements of a BESS design.

The worst-case consequences within the scope of the PHA, should an enclosure fire involving several battery modules occur, are consistent with those determined by Tesla (via Fisher Engineering, Ref 15) in Section 4.2.1, for the "typical" representative battery enclosure.

The controls required to minimise the risk of a fire incident associated with the BESS depends on the choice of battery enclosure solution. Essentially, the controls can be divided into *preventative* and *protective* controls, with preventative controls keeping the fire from happening, and protective controls protecting people, the environment or property from exposure to dangerous materials or situations should prevention fail, and the fire occurs.

Preventative and protective controls are discussed in Section 4.1.3 and listed in Appendix 1. The final list of controls would be determined in the detailed design stage, assessed in the Fire Safety Study (Recommendation 4, including using the FRNSW Technical Information), and critically reviewed by the DPHI and by the FRNSW before the development receives final approval for construction.

Protective controls are further discussed here, to assess the proposed separation distances between battery enclosures and the resulting BESS footprint, with key BESS controls as follows:

- The separation distance between the battery enclosures and between the enclosures and other BESS infrastructure must be sufficiently large to ensure that the strategy of allowing a battery enclosure to burn without firefighting is not compromised, and
- The BESS Site must be sufficiently large to allow it to be laid out such that sufficient separation between the BESS infrastructure and external boundaries can be achieved in order to minimise off-site risk, with reference to the detailed consequence analysis conducted in the PHA.

Tesla MP2XL specifies a minimum 2.44 metres separation distance between enclosure rows to ensure fire propagation is prevented. This separation distance has been determined based on the heat radiation for the worst-case scenario, as discussed in Section 4.2.1 and detailed in Appendices 2 and 3.

To provide flexibility in the battery selection process, and to ensure that the Project allocates enough space to allow for a 400MW/1600MWh, the BESS Site layout in Figure 2-9 has been developed for the battery technology associated with the largest footprint under evaluation (in this case, CATL). This layout allows for a 3.048 metres (10 feet) separation distance between enclosure rows, in line with the requirement for clearance to exposures in the (US) National Fire Protection Association NFPA 855

Standard for the Installation of Stationary Energy Storage Systems paragraph 4.4.3.3 (NFPA-855 allows this distance to be reduced to 0.914 metres based on compliant large-scale fire testing).

The BESS Site footprint will fit in within the 30 hectares allocated for the BESS Site.

4.5 Clearance to off-site receptors

4.5.1 Off-site receptors

The main source of hazard from with the Project is associated with the BESS. Clearance between the BESS and the closest off-site receptors is listed below:

- *Distance to sensitive receptors:*
    - *The* closest residence is at over 1 kilometre from the BESS. At this distance, the heat radiation in case of a battery enclosure fire would be well below any criteria in HIPAP4 (Ref 3).
    - The closest residence to any substation is at approximately 700 metres from any substation. At this distance, the EMF would be well below levels which would be considered safe (APANSA, Ref 16).
- The NFPA855 (para. 4.4.3.1) separation distance of 30.5 metres (100 feet) between the BESS infrastructure with no / limited fire-fighting and suppression capability and *buildings, lot lines that can be built upon, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure*, is adhered to, provided such design is allowed by the authority having jurisdiction (***AHJ***), which in this case would be the FRNSW in conjunction with the DPHI (detailed considerations would be included in the Fire Safety Study, see recommendation 3)

4.5.2 On-site receptors

Clearance between the BESS and on-site receptors (i.e. receptors inside the Project Area) is shown in **Error! Reference source not found.** below, as follows:

- *Battery enclosure to BESS Site boundary:* The clearance distance between the closest battery enclosure and the BESS Site boundary exceeds 32 metres. At this distance, the heat radiation in a worst-case credible enclosure fire is maximum 1 kW/m^2, as per the calculations in Section 4.2.1. This is well below any risk criteria specified in HIPAP4 (Ref 3)
- *Asset Protection Zone:* The bushfire assessment (Ref 4) specifies an APZ of between 11 and 25 metres to comply with BAL-29. **Error! Reference source not found.**The closest battery enclosure to the BESS Site boundary is approximately 32 metres . The clearance requirement in the bushfire assessment, between the BESS Site and any nearby vegetation, is met

- *BESS to Main Project substation and other 3 substations:* Clearance between the BESS Site and the nearest HV transformer is approximately 140 metres. At this distance, the heat radiation from a battery enclosure fire would be less than 1 kW/m^2, as per the calculations in Section 4.2.1, well below levels where propagation is likely to occur. This distance also exceeds all requirements in Table 6.1 *Clearance for outdoor transformers* in AS 2067-2017

- *Clearance for unimpeded access*: While it is noted that the grid scale BESS is outside the scope of AS/NZS 5139:2019 *Electrical installations - Safety of battery systems for use with power conversion equipment* scope[10], the minimum clearance requirements as per the Standard are depicted in Figure 4-6, for information only. The indicative BESS Site layout in Figure 2-9 uses 3.048 metres between enclosure rows, as per the requirements in NFPA 855, for an enclosure with no large-scale fire test, exceeding the recommended clearance of 2.44 metres by Tesla for their MP2XL enclosure[11],. This layout conforms with and AS/NZS5139 para 6.2.6.1 and para 6.2.5.4(a).

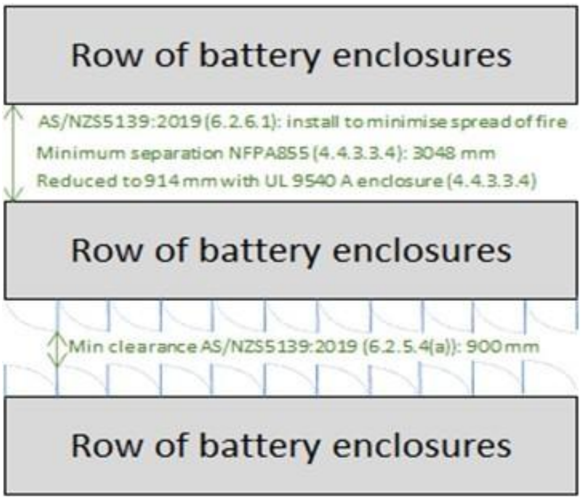


Figure 4-6: Code requirements (AS/NSZ 5139) minimum required clearances between rows of enclosures, with those from NFPA 855 also included for illustrative purposes

- The indicative BESS site layout in Figure 2-9 also meets with the (US) National Fire Protection Association (NFPA) 855:2020 *Standard for the Installation of Stationary Energy Storage Systems* para 4.4.3.3.4 for an enclosure which meets the requirement of UL 9540A.

[10] BESS comes under exclusion 1 pertaining to critical power requirements
[11] which is used as the ‘’typical’ representative enclosure in this PHA

5 CONCLUSION AND RECOMMENDATIONS

5.1 OVERVIEW OF RESULTS AND ALARP CONDITION

This PHA finds that the Project is not considered *Potentially hazardous* in accordance with the DPHI's definition, based on the intended storage and transport of hazardous material.

Potential hazards from the Project are predominantly associated with the *Other types of hazards* which are required to be assessed in a PHA (as per the *Applying SEPP 33* guideline, Ref 9) including the risk of a fire associated with the Li-ion batteries with the potential to cause a thermal runaway and fire in a battery enclosure.

Other hazards with potential worst-case consequences limited to within the Project Area include the potential for loss of containment of pollutant material, electrical fault or failure to control electrical energy, external hazards e.g. bushfire and lightning, and standard construction related hazards.

An overview of the findings including key controls is as follows:

- *Thermal runaway and fire in a battery enclosure:* The main potential impact from the Project to receptors outside of the Project Area is associated with a failure to manage propagation from a fire or explosion in a battery cell, module or rack or within a transformer. BESS and transformer fires technically have the potential to propagate and even to initiate a bushfire if the risk of propagation is not managed. Combustion products and smoke may be produced and could potentially affect nearby land use and/or emergency services personnel.

  Provided that the batteries and the battery enclosures are designed and tested to withstand a credible fire scenario, and that sufficient separation is established within the BESS and between the BESS and the transformers and the surrounding grassland (including through an APZ, Ref 4), the risk of propagation can be managed to a level that is ALARP.

  Further, emergency response protocols would be prepared, and provided these are implemented, including ensuring the risk to emergency personnel is minimised (measures to be determined during the development of the emergency response plan), the risk to firefighters can be managed to a level that is ALARP.

  If the fire was to spread to further parts of the BESS, including to general construction materials which generate toxic and acrid smoke, the knowledge gained by FRNSW and RFS from general building fires, including the rate of formation and dispersion of toxic combustion products from plastics, can be used (Ref 22). In such case, evacuation of people on the site who are not wearing appropriate PPE (e.g. self-contained breathing apparatus) would be prudent. This requirement would need to be integrated into the emergency response plan for the Project and communicated with emergency services. With such emergency response, the risk to on-site receptors can be managed to a level that is ALARP and the risk to off-site receptors can be managed to an Acceptable level.

Although the PHA found that the need for external firefighting is unlikely, these conclusions should be discussed in consultation with RFS, FRNSW and DPHI, in conjunction with the development of the Fire Safety Study.

- *Loss of containment of pollutant material from the Project infrastructure* to the Project area may occur, subject to detailed design, in the event of a failure to contain pollutants such as transformer oil, coolant in the battery enclosures or construction material. If a spill is not contained, there is a potential to affect Project and adjacent land. Measures to prevent a loss of containment from occurring, and for secondary containment, would be addressed in the detailed design phase for the Project.

  Implementing the requirements in Australian Standards and Codes would ensure that the risk to onsite receptors of environmental pollution during construction, commissioning and operational phases of the Project is managed to a level that is ALARP and the risk to off-site receptors can be managed to an Acceptable level.

- *Electrical fault or failure to control electrical energy at electrical equipment:* Stringent protocols for the control of electric and arc flash hazards would be integrated into the management of the site. Application of these protocols and Australian Codes and Standards are generally sufficient for this Project to ensure that the risk to on-site receptors associated with electrical equipment including from arc flash and EMF is managed to a level that is ALARP and the risk to off-site receptors can be managed to an Acceptable level.

  The EMF impact assessment (Section 4.2.2) concluded that the EMF levels generated by the Project are compliant with the applicable Australian and international standards and guidelines, specifically the ICNIRP reference levels.

- *Fire in nearby area (bushfire, or APA Group pipeline):* Application of Codes and Standards are generally sufficient for this Project to ensure that the risks of other hazards are managed to a level that is ALARP (see Section 2.3). In addition:

  - *Bushfire:* impact damage from a bushfire is prevented through implementation of internal protocols and practices, including training, permits, establishment of Fire Management and Emergency Response Plans and by establishing and maintaining an APZ, as determined in the Bushfire Assessment (Ref 4). The same APZ applies to prevent a fire in the neighbouring area should a fire arise within the Project Area.

  - *APA Group pipeline:* impact damage from an incident at the pipeline is highly unlikely and well within the risk criterion specified by the DPHI (HIPAP4, Ref 3) for maximum risk of propagation to neighbouring industrial land use.

- *Incident during construction activity causes impact with infrastructure*: Application of Codes and Standards are generally sufficient for this Project to ensure that the risks associated with construction activities are managed to a level that is ALARP. In addition, the risk to the APA Group pipeline from Project activities is mitigated by the Development Area avoiding the pipeline. Any additional specific risks to the APA Group pipeline from electrical cabling and any work near the pipeline to be defined as part of detailed design (Recommendation 7).

The analysis conducted as part of this PHA has found that the Project can be managed in accordance with the established risk criteria and in accordance with ALARP principles.

The available land for the BESS is sufficient to allow for the minimum required separation distance between battery enclosures while preventing fire escalation between enclosure rows.

Most hazards can be prevented by employing a combination of common measures, including following all applicable AS/NZ Standards, separation distances and setbacks, physical protection and control systems measures.

Mitigation measures are available, to reduce the severity of the hazards should they occur, including specific secondary containment, e.g. as integrated into the battery enclosure and transformers, and operational training.

Provided the recommendations in Section 5.2 of this PHA are adhered to, the risk profile assessed for the Project is as follows:

- Off-site risk: The PHA found that the risk profile for land outside of the Site, including outside the Project Area, is Acceptable.
- On-site risk: The PHA found that the risk profile for personnel working within the Site, including within the Project Area, is consistently ALARP, except for exposure to EMF which is Acceptable.

The BESS Site layout in Figure 2-9 has been developed for the battery technology associated with the largest footprint under evaluation (in this case, CATL), including with a separation distance of 3.048 metres between battery enclosure rows. This exceeds the separation distance recommended by Tesla for their MP2XL, and provides the Proponent flexibility in their battery selection process, and ensures that the Project allocates enough space to allow for a 400MW/1600MWh. The 30 hectares allocated for the BESS Site is sufficient for this footprint.

An overview of the risks associated with the Project is provided in Table 5-1. This table also includes a brief summary of the ALARP condition, with the details provided in Section 4.2 and Appendix 2.

Table 5-1: Overview of risks evaluation and ALARP conditions

Project hazardous incident event	Finding	Risk result and ALARP evaluation
1. Fire at a battery enclosure within the BESS during operation or during construction (from the first energisation of batteries)	Codes and Standards provide clear guidance as to how to prevent and protect against a fault in a battery escalating into a fire at a battery enclosure. Key controls include continuous battery management system (BMS) with automatic shut-down batteries and battery racks are certified with respect to not posing a fire propagation risk in accordance with international methodologies (e.g. the UL 9540A destructive test) and establishment of minimum separation distances within the BESS between Project infrastructure and between the BESS and the external boundaries (Recommendations 1, 2 and 5). Fire water would be stored in strategic locations on-site for firefighting in the surrounding grassland as per the requirement in the bushfire assessment. The need for external firefighting is unlikely for electrical and other fires associated with BESS infrastructure but would need to be determined in the detailed design phase, in consultation with RFS, FRNSW and DPHI (Recommendation 4). On-site hazardous effects are possible in case of a battery fire, and the risk associated with generation of flammable gas and toxic combustion products would be minimised in design via safe evacuation routes and procedures from the facility should be established, and the toxicity of combustion gas should be considered in emergency response.	Off-site (outside the Project area and Site), external land use: *Acceptable risk* On-site (within the Project Area): *ALARP risk* Managed to ALARP principles provided the battery and the enclosures are designed such that a fire will not propagate and that the relevant requirements in Codes and Standards are adhered to and the minimum separation distances within the BESS between battery enclosures and an appropriate APZ are established and maintained
2. Loss of containment of pollutant material from the Project infrastructure (e.g. oil from the transformers, cooling water from the HVAC system in the BESS and diesel from the generator)	Environmental pollution may occur from a failure to contain pollutants, and the need for secondary containment of a spill would be considered in detailed design including at the transformers (Recommendation 5). The requirements under the Australian Standards (including AS 1940) are sufficient to ensure the risk associated with environmental pollution at the electrical infrastructure associated the Project is be managed to ALARP principles.	Off-site (outside the Project area and Site), external land use: *Acceptable risk* On-site (within the Project Area): *ALARP risk* Conforms to ALARP provided the applicable requirements in Codes and Standards are followed

Project hazardous incident event	Finding	Risk result and ALARP evaluation
3. Electrical fault or failure to control electrical energy at electrical equipment (inverters, step-up transformers, substations, transmission line and gantries) causing fire, arc flash, or exposure to EMF	The requirements under the Australian Standards (e.g. AS 2067) and typical management practices for Low, Medium and High Voltage systems are sufficient to ensure the risk associated with fire at the electrical infrastructure associated the Project is be managed to ALARP principles. The EMF impact assessment concluded that the EMF levels generated by the Project are compliant with the applicable Australian and international standards and guidelines, specifically the ICNIRP reference levels and therefore the on-site risk from EMF is acceptable.	Off-site (outside the Project area and Site), external land use: *Acceptable risk* On-site (within the Project Area): *ALARP risk* On-site (EMF) (within the Project Area): *Acceptable risk* Conforms to ALARP provided the applicable criteria are followed as per Codes and Standards
4. Fire in nearby area (bush / grass fire or fire at the APA Group pipeline) causes damage and escalation to Project infrastructure or fire on-site leads to fire in nearby area	An incident in a neighbouring area may affect the Project area. Key controls include fire management and emergency response (including a Bushfire and Emergency Management Operation Plan (BEMOP)), the establishment and maintenance of an APZ at per the bushfire assessment (Recommendations 3 and 6). The risk associated with the presence of the APA Group pipeline near the Project Area is very low. Additionally, natural hazards from wind, lightning, etc. would be managed using Codes and Standards.	Off-site (outside the Project area and Site), external land use: *Acceptable risk* On-site (within the Project Area): *ALARP risk* Conforms to ALARP provided the applicable criteria are followed in the bushfire assessment and in Codes and Standards
5.Incident during construction activity causes impact with infrastructure	The risk arises from typical construction activities and may include Initiation of hazardous incidents through crushing and impact and initiation of incident scenarios 1, 2 and 3; and injury from fall from height, impact with moving machinery etc. Construction risks are well known and understood. Existing Codes and Standards are established within the industry to	Off-site (outside the Project area and Site), external land use: *Acceptable risk* On-site (within the Project Area): *ALARP risk*

Project hazardous incident event	Finding	Risk result and ALARP evaluation
	manage construction risk. Specific risk management for the APA Group pipeline, refer to Recommendation 7.	Managed to ALARP principles provided general construction Codes and Standards are adhered to

5.2 RECOMMENDATIONS

This PHA has been developed based on the following understanding:

1. All relevant requirements in the Australian Standards are applied for the Project, and requirements in major BESS international Standards such as the US National Fire Protection Association Code NFPA855.

2. Procurement of a battery system that is certified under an internationally recognised test method such as the Underwriters Limited UL 9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*.

3. Emergency Management Plan and Procedures to be developed for Project construction and operation, including establishment of a Bushfire Emergency Management Operation Plan (BEMOP) for bushfire protection and evacuation protocols for those not involved in any emergency response and any not wearing appropriate PPE. The possibility of gas and pressure release from a battery enclosure, including the risk associated with opening a door during a thermal (runaway) event should be considered and communicated to first responders with appropriate responses.

4. Preparation of a Fire Safety Study in consultation with FRNSW and DPHI during detailed design. The design and layout of the BESS, including separation distances between battery enclosures and rows of enclosures, should be developed following the requirements by the FRNSW specified in their Fire Safety Guideline, Technical Information entitled Large-scale external lithium-ion battery energy storage systems / Fire safety study considerations (current latest version is D22/107002).

5. Measures to prevent leaks from the BESS and transformers, and for containing spills if they occur, should be addressed in the detailed design phase.

6. The Asset Protection Zone required in the bushfire assessment should be established and maintained throughout the life of the Project.

7. Adhere to the site-specific requirements which would be defined by APA Group as part of the project development. Considerations by APA Group include the need for clearing of trees or other work at the NW corner of the Site; the potential for a requirement of an APA's impact assessment report to assess risks to the pipeline from the electrical design; and any need for potholing.

6 REFERENCES

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Appendix 1

Hazard identification and controls

Preliminary Hazard Analysis for the Solar Farm and Battery Energy Storage System in Cobbora, NSW

Appendix 1 - Hazard identification and controls

Table A1.1: Hazard identification word diagram

Hazardous incident / Event	Possible causes	Worst-case credible consequences (assumes no active controls in place)	Typical preventative and protective safeguards (subject to detailed design)	Potential for impact outside Project boundary
1) Thermal runaway in a BESS battery enclosure may lead to a fire and generation heat and toxic / flammable gases *i.e. generation of excessive heat inside or outside the cell which keeps on generating more and more heat. The chemical reactions inside the cell in turn generate additional heat until there are no reactive agents left in the cell*	Faulty battery causing electrical failure (faulty manufacture or design; short circuit, excessive current/voltage, imbalance charge) Elevated temperature (e.g. external fire from bush fire, failure of BMS / cooling system) Surrounding infrastructure failure (e.g. adjacent HV infrastructure) Mechanical failure (internal cell defect, damage, crush/ penetration/ puncture, impact, e.g. during construction and maintenance)	Fire in the battery cell and modules with generation of heat and potentially toxic / flammable gases. Possible escalation to adjacent cells and modules. Potential escalation to neighbouring enclosures, with further escalation to other areas within the BESS Site. Possible injury/fatality from heat generation and exposure to toxic combustion products and deflagration overpressure. Environmental pollution e.g. from firefighting medium (firefighting water) or from spill of pollutant material from the enclosure which is not contained.	<u>Prevention:</u> - BESS to be designed and operated to all relevant Australian Standards and to one or more of the major international BESS Codes, e.g. NFPA 855 (refer Recommendation 1) - Battery cells, modules and enclosures designed to prevent initiation of a thermal runaway and potential for propagation to other area (certified to UL 9540A, refer Recommendation 2) - Installation and maintenance by trained personnel, and induction of personnel prior to work. Work conducted in accordance with recognised major Codes of Practice, including procedures, using JSAs / SWMS, PTW and isolation, control of modifications, inspection and audit regimes - Warning signs (electrical hazards, arc flash, entry procedures) - Battery enclosures permanently connected to SCADA/BMS (and/or TMS) from their first energisation (unless under supervision). BMS (and/or TMS) likely to include over-temperature, loss of communication, over-voltage, and isolation, defined in design. Automatic isolation and shutdowns where required, also determined in detailed design - Preventative maintenance and condition monitoring ongoing through Project operations <u>Protection and limitation:</u> - Deflagration venting and venting of toxic or flammable gases, as required, as per Codes and Standards and OEM´s recommendations	Assessed in Section 4.2.1

Hazardous incident / Event	Possible causes	Worst-case credible consequences (assumes no active controls in place)	Typical preventative and protective safeguards (subject to detailed design)	Potential for impact outside Project boundary
			- Only restricted personnel allowed on the BESS Site and only certified person to open door and enter enclosures - Separation distance to other infrastructure including battery enclosures minimise risk of escalation in accordance with Codes and Standards and OEM recommendations (Refer to Recommendation 4) <u>Minimising generation of toxic and flammable gases</u> - Battery enclosure venting reduces build-up of toxic and flammable gases inside the enclosure. No entering or opening a battery enclosure during operation unless under direct supervision. Warning signs installed - Enclosures are located outside in an open area to minimise risk of accumulation / ingress of toxic combustion products. Toxic and flammable evacuated via natural dispersion allows escape <u>Emergency response</u> - Fire protection system outside and within the enclosure to Standard requirements determined in detailed design - Escape from BESS area in accordance with Code requirement - Emergency response, including activation of local and/or remote activated emergency shutdown (ESD), and initiation of Emergency Response Plan (Recommendation 3) - APZ established and maintained to prevent propagation to nearby vegetation in line with requirements defined in the bush fire assessment	
2) Loss of containment of pollutant material from the Project infrastructure (e.g. oil	Damage to infrastructure due to:	Release of pollutant material leading to environmental pollution if not contained.	<u>Prevention</u> - Equipment and systems designed and tested to comply with the relevant international standards and guidelines	NO

Hazardous incident / Event	Possible causes	Worst-case credible consequences (assumes no active controls in place)	Typical preventative and protective safeguards (subject to detailed design)	Potential for impact outside Project boundary
from the transformers, cooling water from the HVAC system in the BESS or diesel from the diesel generator)	- Mechanical failure or damage - Corrosion, wear and tear - Fire water applied (e.g. during bush/grass fire fighting)	Possible injury from exposure to irritant material (all routes)	- Equipment installed by reputable contractors following Contractor Work Health and Safety (WHS) Management Standard, permits, control of modifications etc. Installation and maintenance by trained personnel Installation would occur in accordance with the Principal Contractors safe systems of work using SWMS. Induction of all personnel prior to work - Preventative maintenance and condition monitoring as per maintenance schedule - Design of cooling water system prevents release of coolant - Low toxicity / irritation of coolant water system. <u>Protection</u> - Dedicated enclosure(s) i.e. only restricted personnel allowed - PPE and eye wash stations requirements to be determined in detailed design - Transformer oil bunding as per AS 2067 and AS 1940 requirements <u>Detection</u> - Smoke and/or heat detectors at substation and transformers. BMS at battery enclosures indicate fault condition - Oil level detection and surge protection at HV transformers (low level to protect against dry running and high level to prevent overfilling) <u>Emergency response</u> - Spill clean-up determined in detailed design - Activation of Pollution Incident Response Management Plan - Activation of shutdown (locally or remote activated)	

Hazardous incident / Event	Possible causes	Worst-case credible consequences (assumes no active controls in place)	Typical preventative and protective safeguards (subject to detailed design)	Potential for impact outside Project boundary
			- Emergency response to be determined in detailed design and may include spill clean-up using dry absorbent material and activation of Emergency Response Plan for major spills	
3) Electrical fault or failure to control electrical energy at electrical equipment (inverters, MV/HV transformers, substations, electrical connections (above and below ground) and gantries) causing fire, arc flash, or EMF	Electrical connection fault causes short circuit, due to (e.g.): - incorrect procedure used during installation/ maintenance - faulty equipment (e.g. corrosion on conductors) - equipment too close to each other or insulation damage Note: Thermal runaway in a battery enclosure due to impact from construction activities is included in scenario #1	Heat, possibly fire if combustible material is ignited by faulty electrical equipment Arc flash / blast may result in fires and pressure waves blasts and resulting heat Potential propagation to adjacent infrastructure (e.g. oil storages at transformers) and domino effects and further fire, release of toxic combustion products Exposure to intense light and noise cause injury Toxic combustion products Burns, injury and/or fatality Pollution (transformer oil) Exposure to voltage Exposure to EMF	<u>Prevention:</u> - Installation and maintenance by trained and inducted personnel and contractors using HSE Management Standards and policies including JSEAs / SWMSs, PTW and control of modifications - Equipment and systems designed and tested to comply with the relevant Australian and international Standards and guidelines - Prudent avoidance measures for exposure to EMF - Preventative maintenance and condition monitoring as per requirements by asset owner where relevant, and by OEM´s requirements <u>Detection and automatic shut-down:</u> - BMS at battery enclosures and Power Conversion System (PCS) with auto safety shut-off function in case of fault detection. Design of earthing schemes - Current limiting devices and shut-offs (trips) as per manufacturers recommendations - Electrical protection settings designed and commissioned for fault detection <u>Protection and limitation (including to prevent escalation):</u> - Where relevant, equipment housed in dedicated (key-controlled) enclosures; only restricted personnel allowed. No entering or opening a battery enclosure during operation unless under direct supervision. Warning signs installed - Separation distances between infrastructure to minimise risk of escalation as per Codes and Standards and OEM´s recommendations	NO in general EMF assessed in Section 4.2.2

Hazardous incident / Event	Possible causes	Worst-case credible consequences (assumes no active controls in place)	Typical preventative and protective safeguards (subject to detailed design)	Potential for impact outside Project boundary
			- Fire protection to minimise propagation as per Code requirements, e.g. AS 2067; NFPA855 or equivalent and, for battery enclosures, confirmed via UL 9540 A test (Recommendations 1 and 2) - Use of PPE, including to protect against arc flash, as per warning sign <u>Minimising generation of toxic combustion products</u> - Battery enclosure venting reduces build-up of toxic or flammable concentrations as per requirements in Codes and Standards - The BESS and other electrical plant located in an open area to minimise risk of accumulation of toxic combustion products <u>Emergency response</u> - Emergency response, incl. emergency shutdown (ESD); Emergency Response Plan (Recommendation 3) - APZ established and maintained	
4) Fire in nearby area (bush / grass fire) causes damage and escalation to Project infrastructure or fire on-site leads to fire in nearby area Other external hazards: lightning, earthquake, flood	Encroachment of off-site fire onto Project Area infrastructure Escalated event from a fire associated with plant and equipment on the Project area Ignition source may come from faults in electrical equipment; mechanical energy from hot work	Injury/fatality Asset damage Potential initiation of thermal runaway in the Battery enclosure (refer scenario #1)	<u>Prevention</u> - Bush fire threat assessment prepared and requirements for brush / bush firefighting to be defined in detailed design and in consultation with Fire Services - Lightning study to be completed at detailed design including determining whether lightning protection is required as per AS 1768 - Equipment housed in IP rated enclosures constructed in accordance with relevant Standards and above flood level - Infrastructure designed to earthquake requirements as per AS 1170.4 *Structural design actions – Earthquake actions in Australia*	Bushfire assessed in Section 4.2.3 Other hazards assessed in Appendix 2

Hazardous incident / Event	Possible causes	Worst-case credible consequences (assumes no active controls in place)	Typical preventative and protective safeguards (subject to detailed design)	Potential for impact outside Project boundary
	during operation or construction of Project; mechanical crashes, human (failure to follow procedures and requirements; arson/ sabotage; uncontrolled smoking) etc.		- Wind damage prevented through bracing, fixing and/or tie-downs for the conditions and design to AS1170.2 *Structural design actions - Wind actions* Protection - Fire water to be available to combat bush / grass fire in accordance with the requirements in the bushfire risk assessment - Additional fire protection measures (e.g. hydrants) to protect site infrastructure from a fire in a neighbouring area / facility to be determined in detailed design Emergency response - Emergency response plan to be developed including response to nearby fires (including bushfire emergency response) - APZ as per bushfire assessment - Vegetation management within the APZ to be scheduled as maintenance task	
5) Incident during construction activity causes impact with infrastructure	- Digging, trenching - Toppling of major lifting equipment - Dropping of equipment during heavy lift - Failure to manage heavy traffic - Hitting above / underground services	Impact on the APA Group pipeline Injury on-site Initiation of hazardous incidents through crushing, impact included in incident scenarios 1, 2 and 3	Prevention - Company and Contracting Company's Policies and Procedures require appropriate safety measures to prevent incidents and injury - Construction Management Plan incl. key controls - Risk management processes to ensure safe work - Induction, training & competency - Work plans to avoid conflicting tasks, provide adequate space prior to initiating plant manoeuvring and load/unload operations - Management Plans including Traffic, Scaffolding / Elevated Works Platform as / if required	NO

Hazardous incident / Event	Possible causes	Worst-case credible consequences (assumes no active controls in place)	Typical preventative and protective safeguards (subject to detailed design)	Potential for impact outside Project boundary
	- Failure to manage work at height, confined space, slip-trip-fall, site traffic, trench / pit collapse, bites (snakes, spiders, mosquitos), struck by, electrocution, high pressure equipment, hoses, pumps & rotating equipment, cutting, grinding		- Adherence to SafeWork NSW and other Codes of Practice Specific to the APA Group pipeline - The 2024 Scoping Report specifies no need to clear trees in area adjacent to the pipeline. - APA Group requirement is for the Project to consult with them should this requirement change, refer to Recommendation 7 - Review the cabling across the development, and potential for a requirement an EPR/LFI report to assess risks to the pipeline in detailed design, refer to Recommendation 7 Emergency response - Emergency Management Plan for construction activities	

Appendix 2

Risk assessment

Preliminary Hazard Analysis for the Solar Farm and Battery Energy Storage System in Cobbora, NSW

Appendix 2 –Risk assessment

A2.1 – Risk assessment tool

The Planager risk assessment tool, in the form of a risk matrix, is provided in Figure A2.1. The catastrophic consequence level relates to off-site effects only. With the Project Area being located within the large Site, the tool is conservatively applied to the Project Area. Any potential incident which is assessed as having catastrophic consequences should be analysed quantitatively (Level 3 as per MLRA Guideline, see Figure 4-1).

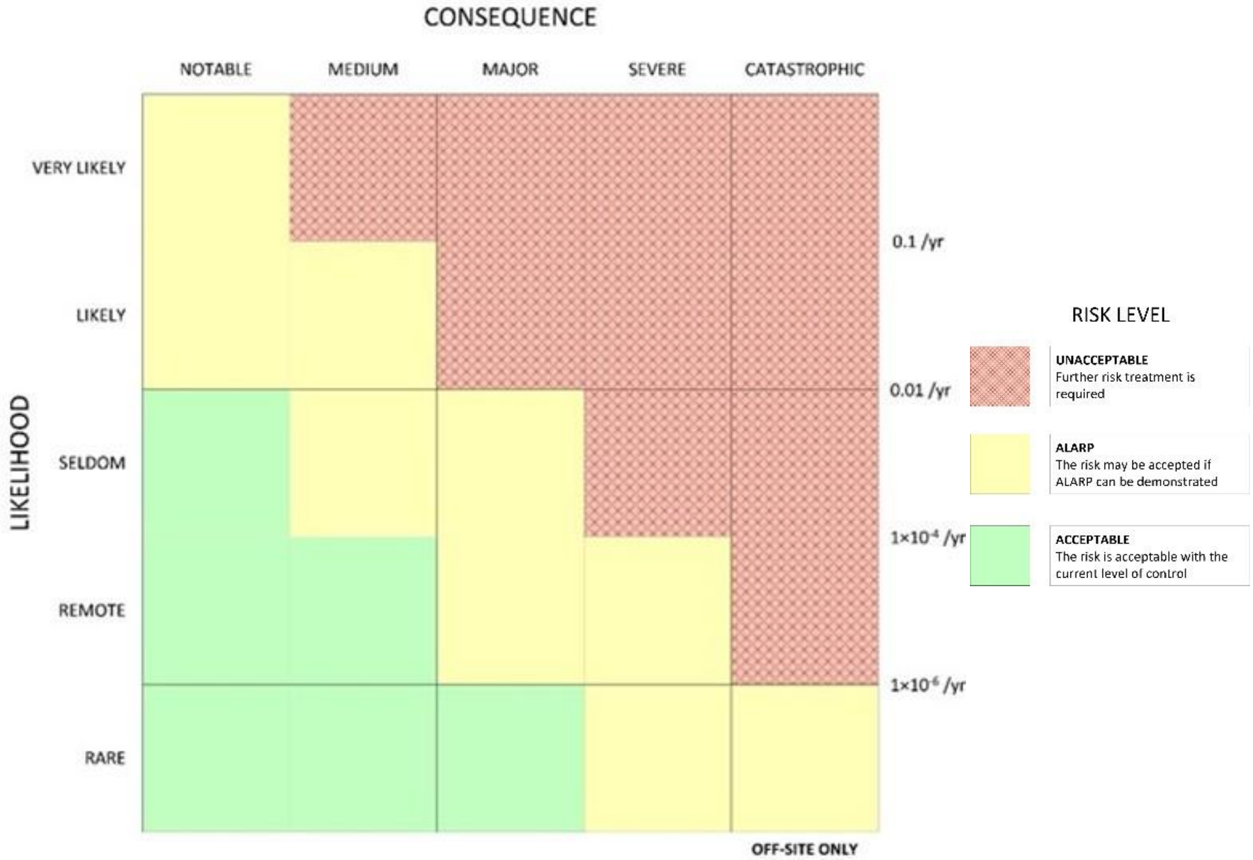

Figure A2.1: Risk Matrix

Table A2.1: Consequence and likelihood ratings

Rating	Description
CONSEQUENCE - HEALTH AND SAFETY:	
Catastrophic	Off-site fatality (conservatively applied outside the Project Area as well as the Site)
Severe	On-site fatality On- or off-site life-threatening injuries (WHS Act 2011 S36, e.g. AEGL3) (applied to injuries within the Site and within the Project Area incl. the BESS Site)
Major	Serious injuries with long lasting effects (ego AEGL2)

Rating	Description
Medium	Harm causing notable discomfort, irritation etc. Not disabling and transient/reversible effects (e.g. AEGL1)
Notable	Injury or illness which may require medical treatment or first aid. No lost time
CONSEQUENCE - ENVIRONMENTAL:	
Catastrophic	Severe long-term environmental damage or sustained, widespread community complaints. Any damage to protected environment
Severe	Off-site environmental damage requiring major remediation effort, widespread local community complaint
Major	Reportable environmental damage, local, short-term community complaint
Medium	Environmental clean-up required
Notable	Negligible and short term environmental impact.
LIKELIHOOD:	
Very likely	Happens regularly within the industry. Knowledge/evidence suggests there is a greater than 1 in 10 chance of the event occurring.
Likely	Happens on an irregular basis but frequently enough to be more than a remote possibility. Knowledge/evidence suggests there is a between a 1 in 10 and 1 in 100 chance of the event occurring
Seldom	Has happened on an irregular basis but frequently enough to be more than a remote possibility. Knowledge/evidence suggests there is a between a 1 in 100 and 1 in 10000 chance of the event occurring.
Remote	Has happened very occasionally but only in unusual circumstances. Knowledge/evidence suggests there is between a 1 and 100 chance in a million of the event occurring
Rare	Has not happened but there is a non-zero chance that it could in extremely unusual circumstances. Knowledge/evidence suggests there is a less than 1 chance in a million of the event occurring

A2.2 Risk assessment

The most serious potential impacts are associated with a thermal event in the battery enclosure. which leads to a battery enclosure fire. The event may be initiated by a by electrical system failures (damage to wiring, fuse or breaker failure) or by mechanical interference (mishandling, rodents).

Three possible outcomes are considered:

- Generation of heat from a fire, detailed in Section 4.2.1 with further discussion in Section A2.2.1.
- Generation of toxic combustion gases from a fire, discussed in Section A2.2.2
- Overpressure from a deflagration event, discussed in Section A2.2.3.

Other hazardous events are discussed in Sections A2.2.4 to A2.2.9.

A2.2.1 Thermal runaway (including due to spontaneous ignition) and fire in a battery enclosure

HAZARDOUS EVENT
The event focuses on the conditions under which a fully involved fire event within a battery enclosure could occur. The scenario assumes all protective functions and controls have failed and consists of a fully developed fire or explosion in one battery enclosure caused, for example, by an extreme battery failure event. Such a scenario is considered the worst-case-credible fire. While the selection of a technology solution for the BESS would not occur until the detailed design stage, the Tesla MP2XL configuration (Figure A2.2, reproduced from Ref 15) has been used as a guide to the internal arrangement of the battery enclosure. This configuration has been used in the PHA as it is expected to be associated with the most severe consequences should a battery enclosure fire occur, as more battery racks are fitted inside the enclosure compared with smaller cabinet-type enclosures.

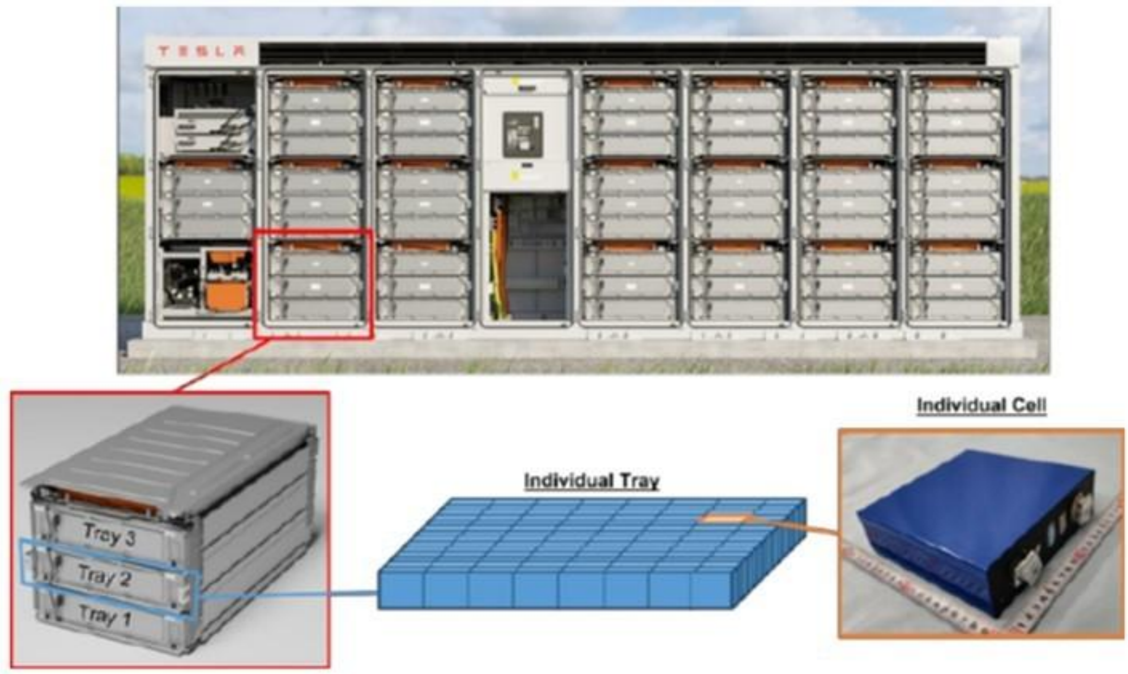

Figure A2.2: Configuration inside the typical containerised solution (Tesla MP2XL as a typical worst-case example)

The fire scenario considered consists of a fully developed fire, e.g. due to a breached enclosure. Tesla Energy, in their fire protection engineering analysis by Fisher Engineering (Ref 15), have modelled the fire scenario of the Tesla MP2XL, which represent the largest enclosure solution under consideration for the Project and is used as the "typical" representative enclosure in this PHA.

The fire model was developed based on the results from the destructible fire test which was initiated by simultaneously heating 48 cells within a battery tray to thermal runaway. During the fire test, fire spread within the battery bays with flames principally exiting through the front door and front grill of the thermal roof for over six hours, with maximum observable flame heights of 3.5 m (ground to top of flame), reaching 0.75 m above the top of the unit and having a base width of 1 m during peak flame intensity.

Fire propagation potential was investigated by modelling heat flux as follows (Ref 15):

Heat flux model: The heat flux model was used to estimate the heat flux that surrounding receptors (enclosures) would be exposed to during an enclosure fire under both calm (no wind) and windy weather conditions. Two dominant modes of heat transfer were included, namely heat radiation from the external flames and from the hot surface of the fire-involved enclosure, as shown in Figure A2.3.

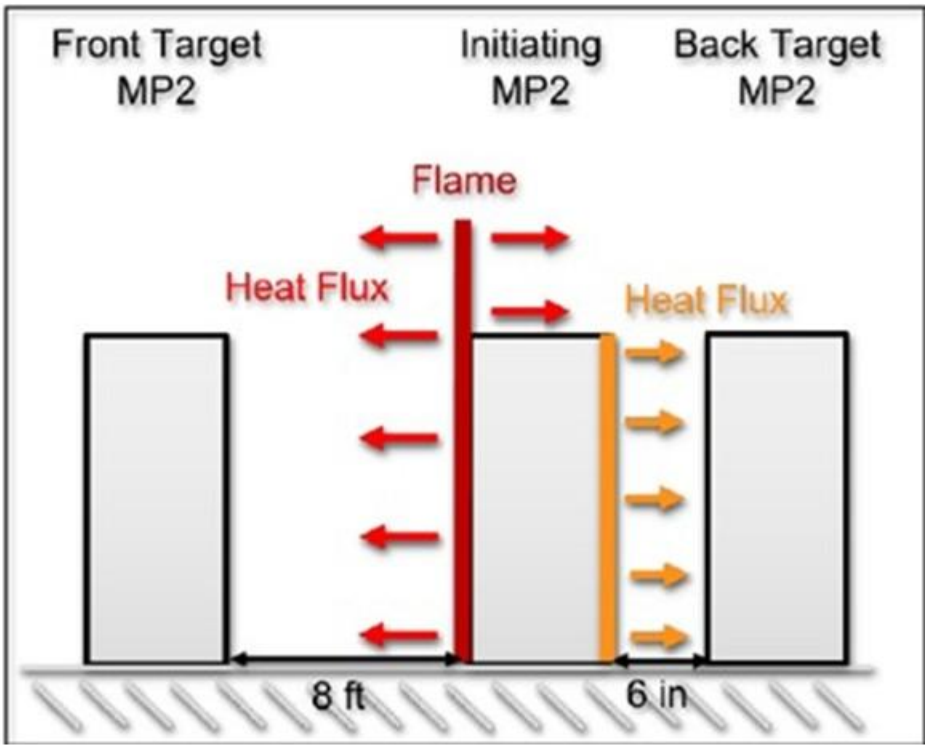

Figure A2.3: Heat flux model conditions: calm weather (Ref 15)

Heat fluxes were calculated using a combination of formulae for solid flame radiation and for high temperature surface radiation between two parallel rectangular plates. Required inputs include flame height, width and temperature for the flame radiation part of model and the external surface temperature of the enclosure for the high temperature surface radiation part. Estimates of flame dimensions and surface temperature were obtained from the results of the destructive unit level test, and a flame temperature of 927°C (1200 K) was used as a typical flame temperature assumption for this type of fire. The model predictions were within 20% of the experimental findings.

To predict the maximum heat flux imposed on target enclosures resulting from flame tilt caused by wind, rather than consider specific wind speeds, a worst case flame tilt angle of 45° (see Figure A2.4) was assumed by the Tesla fire engineers, based on the work of Howell[12].

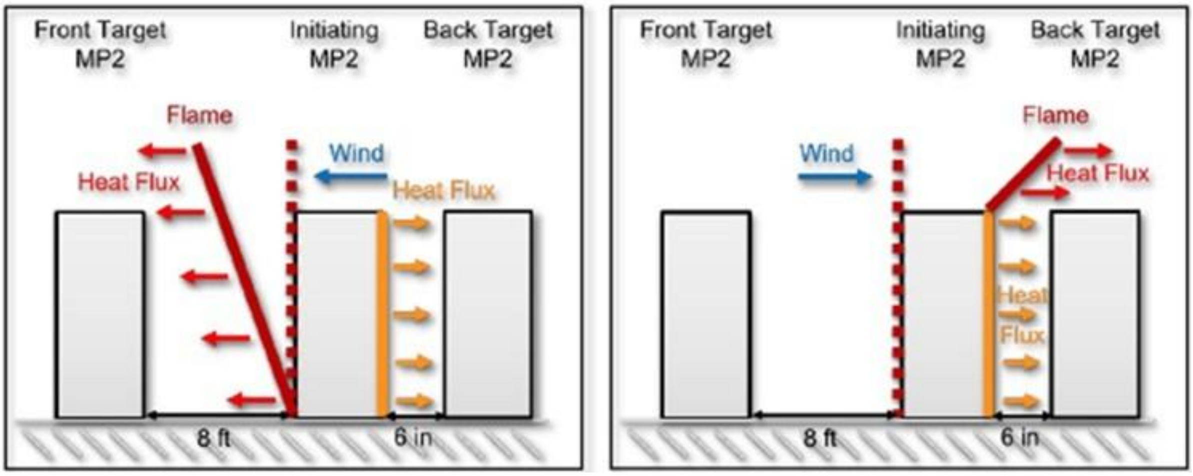

Figure A2.4: Heat flux model conditions: with wind blowing towards the front target and with wind blowing towards the back target with flames exiting the top of the initiating enclosure (Ref 15)

Consequences (immediate and ultimate)

The results of the heat radiation calculations using the fire model are presented in Figure A2.5 (heat radiation from the hot surface of the fire-involved enclosure) and Figure A2.6 (heat radiation from the external flames of the fire-involved enclosure) below.

[12] Howell, J.R. (2010). *A catalog of radiation heat transfer configuration factors,* cited in Ref 15.

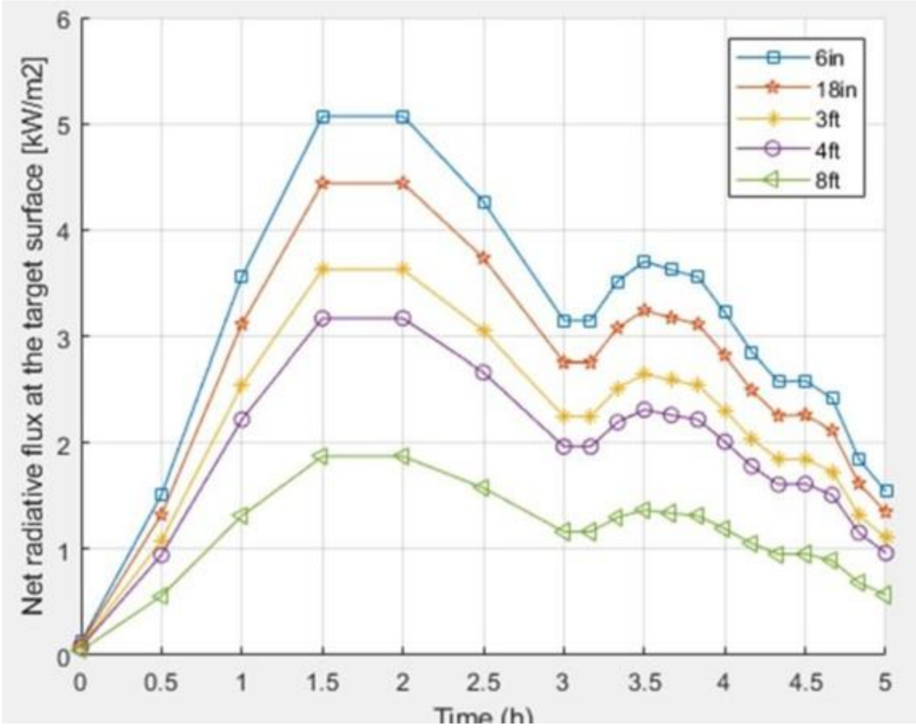

Figure A2.5: Heat radiation from the hot surface of the fire-involved enclosure (based on model for Tesla MP2XL, Ref 15)

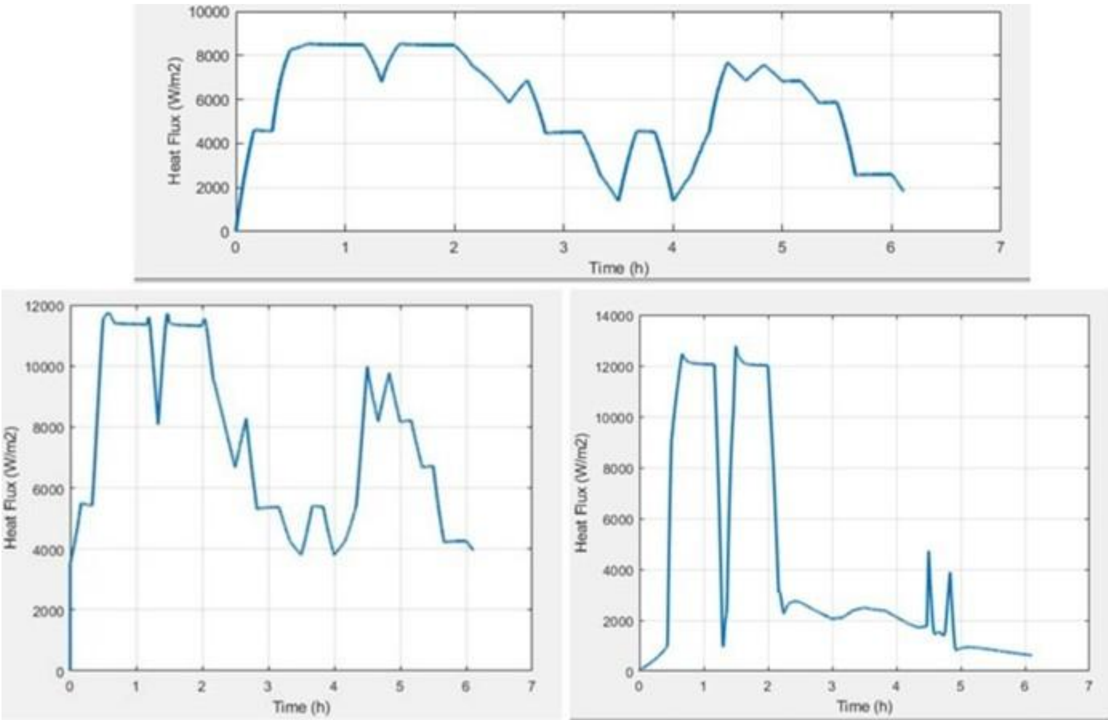

Figure A2.6: Heat radiation from the external flames of the fire-involved enclosure, no wind condition at 8 feet (top); wind blowing towards the front target at 8 feet (bottom left); and wind blowing towards the back target at 6 inches (bottom right), (based on model for Tesla MP2XL, Ref 15)

A summary of the results from the heat flux calculation model is presented in Table

Table A2.2: Heat flux model summary results (based on model for Tesla MP2XL, Ref 15)

Radiation emitting from	Wind weather condition	Target location & distance		Max predicted (modelled) heat flux (kW/m^2)
Cabinet (hot surface)	With or without wind	Back / side targets	0.152 m	5.12
			0.457 m	4.40
			0.914 m	3.65
			1.219 m	3.18
			2.438 m	2.90
Flames: front of the MP2/2XL Cabinet	No wind (vertical flames)	Front target	2.438 m	8.50
	Worst-case wind (45° tilted flames)	Front target	2.438 m	11.77
Flames: top of the MP2/2XL Cabinet	Worst-case wind (45° tilted flames)	Back / side targets	0.152 m	12.83

The closest enclosures are at least 25 metres from the vegetation outside of the BESS Site boundary (separated from the external bushland by the APZ, the internal access road, etc.). With this clearance, the heat radiation level associated with a fire at the BESS facility is not likely to exceed 1 kW/m^2 at the boundary (Ref 15), below 3 kW/m^2 which is commonly defined as the heat radiation level which could cause discomfort. This assessment does not include the potential for embers generated in the fire, starting a fire beyond the BESS Site.

There would be no significant impact on adjacent land users expected from this scenario.

The consequence for the worst-case credible scenario is rated as per the consequence scoring table in paragraph A2.1, set as *Major - Permanent disability*, based on the potential for workplace safety leading to a potentially serious injury (environmental consequences are set as *Serious*). The worst-case credible consequence scoring outside of the BESS Site is set as a Level 1, *Negligible*.

Consequence ranking	On-site (within the Project Area): *Major* – Serious injuries with long term effects (Medium - Environmental damage) Off-site (outside the Project Area): *Notable event* – Negligible physical injury and/or environmental consequences

Likelihood and key risk controls

An overview of the fire safety strategy for this Project is provided in the Hazard Identification Word Diagram in Appendix 1.

The likelihood of the worst-case credible scenario is rated, using the likelihood scoring table in paragraph A2.1, as *Remote*, based on the likelihood for workplace safety leading to a serious injury. The likelihood of off-site injury from this scenario is rated as *Rare*.

Likelihood ranking	On-site (within the BESS site): *Remote* Off-site (outside the BESS Site): *Rare*

Risk evaluation	
The risk associated with generation of heat radiation from a battery enclosure fire can be determined by combining the consequences of the fire with the likelihood of the event with reference to the risk matrix in paragraph A2.1. The risk to on-site personnel including first responders is assessed as *ALARP* (a combination of a *Major* safety consequence with a *Remote* likelihood). The environmental risk is assessed as *Acceptable* (a combination of a *Medium* environmental consequence with a *Remote* likelihood). The risk to off-site land uses is assessed as *Acceptable* (a combination of a *Notable event* consequence with a *Rare* likelihood).	
Risk ranking – Project Area Site personnel including first responders	ALARP
Risk ranking – On-site (within the Project Area): environmental	ACCEPTABLE
Risk ranking – Off-site (outside the Project Area and Site): public safety and environment	ACCEPTABLE
ALARP evaluation	
Minimum separation distances within the BESS and between the BESS and external boundaries prevents propagation and escalation scenarios, as determined during detailed design and in agreement with the battery enclosure manufacturer, the DPIH and FRNSW, and in accordance with the requirements in Codes and Standards.	
ALARP justification:	
ALARP justified provided requirements in Codes and Standards are adhered to, including at least one international Standard (e.g. NFPA 855) the battery system (cells, modules, racks and enclosure) designed and constructed to prevent fire propagation, as demonstrated with UL 9540 certification and / or other test and the minimum separation distances between Battery infrastructure and APZ are established and maintained. Residual on-site risk can be managed via emergency response procedures and protocols.	Justified

A2.2.2 Toxic combustion products

HAZARDOUS EVENT
The incident initiation and controls are discussed in paragraph A2.2. The event discussed here focuses on the conditions under which a fire event within a battery enclosure results in the generation of toxic combustion products. The scenario assumes all protective functions and passive controls have failed resulting in a major fire within a battery enclosure, with generation of a toxic fume from burning plastic cabling and other combustible material inside the enclosure. Such a scenario is considered the worst-case-credible fire. The toxic fume may be emitted from vents or failed door seals, open door or from the top of the enclosure if the deflagration vent has opened.

Consequences (immediate and ultimate)
The approach used in this PHA to evaluate toxic gas generation and dispersion in a major BESS fire is to develop a qualitative understanding of the release of toxic combustion products during a Li-ion battery enclosure fire, based on current research and experience from actual fires, including: • The atmospheric monitoring reported at the EPA AirWatch data at the Moorabool Sites during and after the Victorian Big Battery fire incident at Geelong (which occurred on 31/7/2021) did not identify air quality issues outside the site limits. This indicates that, at least on a windy day, there was only limited toxicity in the fire plume emitted from the fire. While a toxic smoke warning was initially issued to people downwind of the fire by the Fire Rescue Victoria (***FRV***), there appears to have been no real threat to the community from the toxic gases in the smoke, as confirmed by atmospheric monitoring. This provides a general understanding of the nature of the toxic combustion products and may be used, with caution, to provide guidance on appropriate locations for evacuation areas. • Depending on battery manufacture, vent gases may include volatile organic compounds (***VOCs***), hydrogen gas, carbon dioxide, carbon monoxide, soot, and particulates containing oxides of nickel, aluminium, lithium, copper, and cobalt, hydrogen fluoride (***HF***), hydrogen chloride (***HCl***), and hydrogen cyanide (***HCN***)[13]. Gases may irritate the eyes, skin, and throat. • Of the various hazardous gases released from a Li-ion fire to atmosphere, HF and HCN are of the highest concern due to their very low toxic endpoint values, particularly their AEGL3 value). • DNV research[14] concluded as follows: The average emissions rate[15] of a battery during a fire condition is lower per kilogram of material than a plastics fire. However, the peak emissions rate (during thermal runaway of a Li-ion battery, for example) is higher per kilogram of material than a plastics fire. This illustrates that a smouldering Li-ion battery on a per kilogram basis can be treated with the same precautions as something like a sofa, mattress, or office fire in terms of toxicity, but during the most intense moments of the fire (during the 2-3 minutes that cells are igniting exothermically) precautions for toxicity and ventilation should be taken. The DNV research further goes on to say that: The randomized failure rate limits the toxicity and heat release rate of the fire. Given the findings in the aforementioned research and actual BESS fire, fumes and smoke may be generated in a major BESS fire, some of which may be toxic.

[13] The UL 9540A Cell Level Testing for the Tesla battery, which is used as representative battery solution in this PHA, did not pick up any significant concentration of toxic gases venting from the cells during the test

[14] Hill D, Warner N, Kovacs W*, Considerations for ESS Fire Safety, Consolidated Edison and NYSERDA New York, NY*, DCN: OAPUS301WIKO(PP151894), Det Norske Veritas (USA) Inc. (DNV GL), Rev. 4, 9 February 2017

[15] Emissions concentration in ppm averaged over total minutes of burn time

The fumes may be released from the opening of deflagration panels (if included), failure of door and other seals, through vents or if the door was open. The smoke plume generated by the fire would be at a temperature that is significantly higher than ambient, typically exceeding 600°C. With the limited confinement in the open BESS layout, most of the combustion products are likely to be carried up to an altitude where they would be dispersed to below hazardous levels, without harm to people in the vicinity. Long term environmental damage is likely to be insignificant. In line with the findings in the DNV research, the fire plume is predicted to be similar to that generated from a fire involving a sofa, mattress, or office fire in terms of toxicity, but during the most intense moments of the fire precautions for toxicity and ventilation should be taken (DNV cites that this is confined to the 2-3 minutes that cells are igniting exothermically – however, such ignition is likely to be random and staggered in case of a large battery fire and needs to be expected to occur at any time). *It is therefore deduced in this PHA that in an open air, outdoor BESS, the concentrations of toxic gas generated may pose a hazard in the near field and would need to be included in emergency response guidelines.* *Outside the Project Area and Site:* It is unlikely that harmful concentrations of toxic combustion products would be experienced outside of the Project area (as detailed in Section A2.2). It then follows that concentrations that may cause significant harm would not be experienced in areas beyond the Project area. In the event of a major fire at the BESS, evacuation of the local community would be at the discretion of the emergency services and would be based on real-time atmospheric monitoring undertaken by the fire service's HAZMAT team or NSW EPA. *Inside the BESS Site:* Higher concentrations, e.g. AEGL3 and above, may be experienced very close to the fire within the BESS compound. The risk of exposure to toxic combustion products by first responders should be communicated as part of the emergency services information pack (***ESIP***) and included in emergency response procedures. Further, people who are not directly required for emergency response should be removed from the BESS Site in the event of a major fire at the BESS. The consequence for the worst-case credible scenario is rated as per the consequence scoring table in Section A2.1, with the worst-case on-site scoring set as *Severe – on-site fatality or life-threatening injuries*, based on the potential for workplace safety leading to a potentially serious injury. The worst-case credible off-site consequence scoring is set as *Notable – short term discomfort/injury*.	
Consequence ranking	On-site (within the Project Area): *Severe* –on-site fatality or life-threatening injuries Off-site (outside the Project Area): *Notable event* – short term discomfort/injury
Likelihood and key risk controls	
The risk controls for this scenario are largely identical to those for the fire scenario above (*Generation of heat from a fire and potential for fire escalation*). The initiating event is a battery fire and hence the initiating likelihood is the same as that determined for the fire scenario, *generation of heat from a fire and potential for fire escalation*.	
Likelihood ranking	On-site (within the Project Area): *Remote*

	Off-site (outside the Project Area): *Rare*

Risk evaluation	
The risk associated with toxic combustion products generated in the battery enclosure fire can be determined by combining the consequences if exposed to credible concentrations of combustion products with the likelihood of the event with reference to the risk matrix in paragraph A2.1. The risk to on-site personnel including first responders is assessed as *ALARP* (a combination of a *Severe* safety consequence with a *Remote* likelihood). The risk to off-site land uses is assessed as *Acceptable* (a combination of a *Notable* consequence with a *Rare* likelihood).	
Risk ranking – Project Area Site personnel including first responders	ALARP
Risk ranking – Off-site outside the Project Area and Site: public safety	ACCEPTABLE
ALARP evaluation	
The ALARP evaluation is the same as for the fire scenario, *generation of heat from a fire and potential for fire escalation*.	
ALARP justification:	
ALARP justified provided requirements in Codes and Standards are adhered to, including at least one international Standard (e.g. NFPA 855) the battery system (cells, modules, racks and enclosure) designed and constructed to prevent fire propagation, as demonstrated with UL 9540 certification and / or other test the minimum separation distances between Battery infrastructure and APZ are established and maintained, and the location of the BESS out in the open. Residual on-site risk can be managed via emergency response procedures and protocols.	Justified

A2.2.3 Deflagration overpressure

HAZARDOUS EVENT
A thermal runaway event in a battery enclosure causes the rapid evolution of hydrogen and other flammable gases. Since one of the major evolved gases is hydrogen, which has a very low ignition energy, ignition of these gases is likely and may result in a fire (discussed above as *generation of heat from a fire and potential for fire escalation*), or if their concentrations are within the explosive region (defined as between the lower and upper explosive limits), in a deflagration. If the thermal runaway is of sufficient size, that is, has propagated beyond the initiating battery module/rack within the battery enclosure, the overpressure associated with the deflagration may not be contained within the enclosure. If the thermal runaway results in a fully developed fire scenario, rather than deflagration, or if the fire is caused by some other event, the accumulation of gases within the explosive range required for deflagration is unlikely to occur. However, if the fire does not fully develop due to a lack of oxygen within a sealed enclosure, the resulting fuel-rich, smouldering fire will generate carbon monoxide, which may react explosively if exposed to an ingress of fresh air (e.g. if the enclosure sides/roof are breached or the door is opened).

The scenario requires an accumulation of gases, something which is not likely to occur during a fully developed fire scenario where the flammable gases are more likely to be consumed by the fire as they are generated. In this scenario, the gases must be allowed to evolve in one area of the enclosure before they encounter an ignition source (or before the door opens allowing oxygen back in).	
Consequences (immediate and ultimate)	
Should a deflagration event occur, and in the event of available deflagration protection failing to provide pressure relief, the resulting overpressure may cause loss of integrity of the battery enclosure and ejection of material which in turn could cause injury to persons present within the BESS, as well as further damage, including potential damage to nearby enclosures. The damage at a nearby enclosure could in turn initiate a fire, with the worst-case consequences described in the fire scenario, *generation of heat from a fire and potential for fire escalation* above. A subsequent deflagration in a nearby enclosure, damaged by the initial event, is however not considered as a credible consequence. There is also the possibility of an instantaneous release of toxic gases relieved to ground level, which is described in the scenario *toxic combustion products*, above. Only part of the enclosure would be empty space, i.e. not occupied by battery modules, fans, ducting and electrical cabling, limiting the volume of flammable gas that can participate in the deflagration. While injury or damage to people and infrastructure within the BESS Site is possible, it is unlikely that the deflagration overpressures would cause any significant effect outside of the BESS Site boundary. The deflagration overpressure experienced in any other occupied locations, as detailed in Section 2.2 of this PHA, is likely to be insignificant (though the noise may be heard), including at the nearest residential and recreational areas. The consequence for the worst-case credible scenario is rated as per the consequence scoring table in Section A2.1, with the worst-case on-site scoring set as *Severe – on-site fatality or life-threatening injuries*, based on the potential for workplace safety leading to a potentially serious injury. The worst-case credible off-site consequence scoring is set as *Notable – short term discomfort/injury.* In the destructive test conducted for the Tesla MP enclosures, the enclosure doors remained shut and no hazardous pressure waves, debris, shrapnel, or pieces of the cabinet were ejected. The destructive unit level test demonstrated that the MP2/2XL cabinets are likely to be capable of safely failing in the extreme case of a catastrophic failure with one of its battery modules.	
Consequence ranking	On-site (within the Project Area): *Severe* – on-site fatality or life-threatening injuries Off-site (outside the Project Area): *Notable event* – short term discomfort/injury
Likelihood and key risk controls	
The key preventative controls for this scenario are largely identical to those listed for the battery enclosure fire scenario, *generation of heat from a fire and potential for fire escalation*. Protective control to minimise the effects in case of a deflagration in an enclosure should be considered in the battery enclosure design selection process (Recommendation 2), and the risk associated with a battery deflagration should be	

minimised to level as that are ALARP (e.g. through fitting of deflagration panels on the roof of the battery solution). The likelihood of the initiating event (battery fire) is the same as that determined for the fire scenario. The likelihood of causing an on-site injury is set as *Remote*. The likelihood of an off-site injury is set as *Rare*.		
Likelihood ranking	On-site (within the Project Area): *Remote* Off-site (outside the Project Area): *Rare*	
Risk evaluation		
The risk associated with deflagration overpressure generated at the battery enclosure can be determined by combining the consequences of exposure to credible levels of overpressure with the likelihood of the event, with reference to the risk matrix in paragraph A2.1. The risk to on-site personnel including first responders is assessed as *ALARP* (a combination of a *Severe* safety consequence with a *Remote* likelihood). The risk to off-site land uses is assessed as *Acceptable* (a combination of a *Notable* event consequence with a *Rare* likelihood).		
Risk ranking – Project Area Site personnel including first responders		ALARP
Risk ranking – Off-site (outside the Project Area and Site): public safety		ACCEPTABLE
ALARP evaluation		
The ALARP evaluation is the same as for the fire scenario, *generation of heat from a fire and potential for fire escalation*, together with the design of an appropriate mitigation system such as emergency ventilation and/or venting system (subject to detailed design).		
ALARP justification:		
ALARP justified provided requirements in Codes and Standards are adhered to, including at least one international Standard (e.g. NFPA 855) the battery system (cells, modules, racks and enclosure) designed and constructed to prevent fire propagation, as demonstrated with UL 9540 certification and / or other test the minimum separation distances between Battery infrastructure and APZ are established and maintained and design of the deflagration panel to protect against the deflagration event.		Justified

A2.2.4 Loss of containment of pollutant material from the Project infrastructure

HAZARDOUS EVENT
Potential pollutant materials associated with this Project include: • Cooling water from the battery enclosures • Oil in the transformers • Materials used during construction phase and during maintenance activities at the operating Site. • Firewater if used during a fire on the Site.

Consequences (immediate and ultimate)	
A loss of containment of pollutants may lead to ground and groundwater contamination and pollution of local surface waters, if not contained. There is also the potential for personal injury arising from exposure to irritant material. WHS and environmental consequences are likely to be limited so long as relevant Codes and Standards are applied and personnel are provided with appropriate PPE and training.	
Consequence ranking	On-site (within the Project Area): *Medium* – Environmental clean-up (short term) Off-site (outside the Project Area and Site): *Notable event* – No environmental consequences
Likelihood and key risk controls	
Preventative and protective strategies are included in Appendix 1.	
Likelihood ranking	On-site (within the Project Area): *Seldom* Off-site (outside the Project Area and Site): *Rare*
Risk evaluation	
The risk associated with loss of containment and environmental pollution can be determined by combining the consequences should a loss of containment occur with the likelihood of the event with reference to the risk matrix in paragraph A2.1. The risk to the on-site environment is assessed as *ALARP* (a combination of a *Medium* environmental consequence with a *Seldom* likelihood). The risk to the off-site environment is assessed as *Acceptable* (a combination of a *Notable* event environmental consequence with a *Rare* likelihood).	
Risk ranking – On-site (within the Project Area): environmental	ALARP
Risk ranking – Off-site (outside the Project Area and Site): environmental	ACCEPTABLE
ALARP evaluation	
Australian Standards are considered as sufficient to specify the safeguards required for the management of pollutants associated with this Project (refer to the risk classification and prioritisation in Section 3). In addition to Australian Standards, the BESS would comply with the requirements in at least one international standard, e.g. NFPA 855.	
ALARP justification:	
ALARP is justified provided the requirements in Australian Standards, including AS 5139 and international standards, e.g. US NFPA 855 (for the BESS), AS 2067 (for transformers), and AS 1940 (for combustible liquids) and AS 3780 (for corrosive liquids), and management practices are adhered to and that the maximum credible spill at the batteries and transformers can be captured.	Justified

A2.2.5 Electrical fault or failure to control electrical energy at electrical equipment leads to fire, arch flash or exposure to EMF

HAZARDOUS EVENT
The electrical equipment associated with the Project would have sufficient energy to cause an arc flash in the case of a short circuit or fault. Arc flashes can be dangerous since they can cause serious burns and electrocution. Arc flash temperatures can exceed 12,000°C (or even more) and are therefore capable of melting metal or causing fires and explosions. The massive energy released in the fault rapidly vaporises the metal conductors involved, blasting molten metal and expanding plasma outward with extraordinary force. All equipment that is powered by electricity produce EMFs. The Project will introduce sources of EMF into the Project area including BESS enclosures, substations, connection infrastructure and overhead power lines that would connect the Project to the existing transmission line. EMFs can have harmful effects to human health.
Consequences (immediate and ultimate)
Consequences from an arc flash include generation of heat and pressure waves which may lead to burns, injury and/or fatality as well as exposure to intense light and noise which may cause injury. Noxious vapours from combustion of metal can also cause injury and/or fatality. There is also a potential for propagation to adjacent infrastructure and domino effects and further fire, release of toxic combustion products. The intensity and the resultant potential for harm to people is dependent on various factors including voltage, arcing current, arcing time, the amount of energy available, the distance from the arc, the location of the arc and any barriers in place that may direct the arc in a particular direction[16]. Arcing faults may cause catastrophic failure within the electrical equipment unless the fault conditions are quickly removed, e.g. through automated shutdowns and trips. High Voltage electrical equipment has a higher risk of severe arc flash than lower voltage equipment. Arc flash at a transmission line may be caused by operating error, e.g. due to an erroneous grounding attempt, an arc across a broken or contaminated insulator or a phase-to-phase flashover. Given the distance between the transmission line connection and members of the public (should they be present in the vicinity at the time of a flashover) no significant off-site hazard associated with an arc flash is expected from the 132 kV transmission line connection[17]. *On-site risk*: An arc flash can be fatal to people within the Project Area especially to people close to the electrical equipment. This risk is well known and understood by people working with electrical equipment, and Codes and Standards have been developed to ensure that the risk of arc flash is managed to within ALARP levels.

[16] *Best practice guide, Battery storage equipment - Electrical safety requirements*, Australian Industry Group et. al, 6 July 2018

[17] See for example, *Khan J and Armstrong M, Arc-flash Assessment for High Voltage Transmission Lines–A BC Hydro Perspective*, BC Hydro

The EMF modelling undertaken in the impact assessment identified that the maximum electric and magnetic field levels (on-site exposure) associated with the Project infrastructure and the existing environment are smaller than 2.5 kV/m and 19 microtesla (µT) respectively. These levels are well below the applied International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines reference limits of 5 kV/m and 200 µT. Further, the closest property boundary is located more than 100 m east from the Project area. At this distance from the Project infrastructure, EMF would be much lower than the indicated levels. *Off-site risk*: The closest distance between the electrical equipment on the Project Area and any location occupied by the public is well outside locations of harm from either electrical equipment or EMF. No significant impact is expected, though people may well see the flash of light, especially during the night. There would be no hazardous consequences at any residential or sensitive locations from this incident.

Consequence ranking	On-site electrical (inside the Project Area): *Severe* – fatality/life-threatening injuries Off-site (outside the Project Area and Site): *Notable event* – no physical injury
Likelihood and key risk controls	
Key risk controls are listed in Appendix 1. Hence, the likelihood of injury or fatality from an arc flash on the site is considered to be *Remote* taking into account the risk management practices and protocols that will be established. Off-site likelihood is *Rare*.	
Likelihood ranking	On-site (inside the Project Area): *Remote* Off-site (outside the Project Area and Site): *Rare*
Risk evaluation	
The risk associated with a failure to manage energy from electrical energy, including arc flash can be determined by combining the consequences with the likelihood of the event with reference to the risk matrix in Section A2.1. The risk to people on the BESS site in the vicinity of electrical equipment is assessed as *ALARP* (a combination of a *Severe* consequence with a *Rare* likelihood). The risk to people at other locations on-site is assessed as *Acceptable* (a combination of a *Medium* consequence with a *Remote* likelihood) The risk to people off-site is assessed as *Acceptable* (a combination of a *Notable event* safety consequence with a *Rare* likelihood). The EMF exposure risk level is based on the assessment in the EMF impact assessment rather than a separate determination of consequence and likelihood using the matrix in Section 2.1. As per the analysis and discussion in the EMF report, the risk level for this hazard on- and off-site is assessed as acceptable.	
Risk ranking - Site personnel in vicinity of electrical equipment (inside the Project Area)	ALARP
Risk ranking – On-site EMF (inside the Project Area)	ACCEPTABLE
Risk ranking – Off-site: public safety (outside the Project Area and Site)	ACCEPTABLE

ALARP evaluation	
Requirements under the Australian Standards (including AS 2067) and standard management practices in place as per Codes of Practice, the risk associated with an arc flash at the Low Voltage, Medium Voltage and High Voltage infrastructure is managed in accordance with ALARP principles. Provided the APZ is established and maintained, as determined through the bushfire assessment (Ref 4), it is unlikely that an arc flash would affect land uses outside of the Project Area, and the risk is managed in accordance with ALARP principles.	
ALARP justification:	
ALARP justified provided requirements in Codes and Standards are adhered to, including AS 2067, and APZ in place as per bushfire assessment (Ref 4).	Justified

A2.2.7 Fire involving transformer oil or electrical cable insulation (included in the risk assessment as " on-site fire affects nearby area")

HAZARDOUS EVENT
Other than a battery fire and an arc flash, the following potential fires may be associated with this Project: • Transformer oil fire • Electrical cable insulation fire, e.g. in the control and switch room building • General building fire (outside of the scope of this PHA).
Consequences (immediate and ultimate)
A pool fire may occur as a result of loss of containment of combustible oil at the transformer, with subsequent ignition. A pool fire is only applicable for the Low Voltage, Medium Voltage and High Voltage transformer areas. The size of the fire depends on the amount of product spilt and the secondary containment in the location of the spill (i.e. the transformer bund's capacity to contain the spilled volume of liquid). There are generally two types of pool fires which may occur, with the *Late ignition* model applicable for the transformer pool fire: • Early ignition, where the released product is ignited early during the release. In this scenario the pool will grow in size until the burn off rate of the fuel, expressed in kg/m^{2}s, over the area of the pool, is equal to the release rate. Where secondary containment is provided this equilibrium pool size will not be reached if it is larger than the secondary containment area, rather the depth of the pool formed by the unburnt material will increase. Where there is no secondary containment is assumed that the spill will extend to the full equilibrium size. • Late ignition, where the ignition does not occur until after the release has stopped. For a fixed volume release, such as a transformer, this quantity is the full volume of the oil storage. Where the release may be stopped through intervention, such as a safety system relay, this volume is the rate of release for the expected time for an automated response (e.g. Buchholz Relay). This may be contained within secondary containment, or if there is no secondary containment its spread will be uncontrolled. Where there is uncontrolled spread, the pool fire size for a late ignition is generally larger than for an early ignition, as no material has been consumed by fire as the pool forms.

A pool fire would burn until either the fuel is exhausted, or a foam blanket is applied to extinguish the fire (where appropriate). Pool fires generate heat which could cause injury or escalation resulting in damage to adjacent assets. Transformer oil burns to mostly carbon dioxide (CO_2) if sufficient air is present, but smoke is also expected to be generated. Generation of toxic and flammable carbon monoxide (CO) is possible if the air supply is restricted. Other toxic and corrosive gases may also be released, such as nitrogen and sulphur oxides - from burning of cable insulation. Cable insulation may cause fire, e.g. in the control and switch room. Fire in a switch room may cause escalation to other areas if not properly managed. Smoke from both transformer oil and from cable insulation fires consists of very fine solid particles and condensed water vapour. In many cases smoke reaches harmful levels before the temperature does. This is especially so when the fire occurs indoors or in confined areas. Smoke particles can cause damage to the respiratory system and may impair vision if they lodge in eyes, with the potential to impair the ability to escape the fire. Heat, smoke and fumes may cause local injury and asset damage. No significant consequences are expected to reach areas outside of the Project Area or Site boundary from this incident scenario provided the APZ is established and maintained. Smoke, other combustion products and/or fire damage may result in *Medium* level consequence to on-site personnel and the local environment.

Consequence ranking	On-site (within the Project Area): *Medium* – Harm causing notable, transient discomfort/irritation (health and safety) and/or environmental clean-up required. Off-site (outside the Project Area and Site): *Notable event* – no physical injury nor environmental impact.
Likelihood and key risk controls	
Key risk controls are listed in Appendix 1. The likelihood of an on-site injury is set as *Seldom*. The likelihood of an off-site impact is set as *Rare*.	
Likelihood ranking	On-site (within the Project Area): *Seldom* Off-site (outside the Project Area and Site): *Rare*
Risk evaluation	
The risk associated with a transformer fire or fire in electrical cable insulation can be determined by combining the consequences should a fire occur with the likelihood of the event, with reference to the risk matrix in Section A2.1. The risk to people on-site and the environment within the Project Area is assessed as *ALARP* (a combination of a *Medium* – potential for medical treated injury or environmental clean-up – consequence with an *Unlikely* likelihood). The risk to people and the environment off-site is assessed as *Acceptable* (a combination of a *Notable event* consequence with a *Rare* likelihood).	
Risk ranking – On-site (within the Project Area): safety and environmental	ALARP

Risk ranking – Off-site (outside the Project Area and Site): safety and environmental	ACCEPTABLE
ALARP evaluation	
Provided the requirements under the Australian Standards (including AS 2067) and management practices in place by the Operator are adhered to, the risk associated with fire at the transformers and electrical cabling including the control and switch room building is managed ALARP. Provided an adequate APZ is established and maintained the risk associated with this type of fire is managed in accordance with ALARP principles.	
ALARP justification:	
ALARP justified provided requirements in Codes and Standards are adhered to, including AS 2067.	Justified

A2.2.8 Fire in nearby area (bush / grass fire or fire at the APA Group pipeline) causes damage and escalation to Project infrastructure

HAZARDOUS EVENT	
Incidents such as a fire in a nearby area including a bush or grass fire, or fire at the APA Group pipeline have the potential to cause damage and escalation to Project infrastructure.	
Consequences (immediate and ultimate)	
There is a theoretical possibility of encroachment of an off-site fire (e.g. a bushfire, APA Group pipeline flammable gas fire) onto Project Area infrastructure leading to injury of site personnel, asset damage and potentially initiation of a thermal runaway in the BESS, including heat radiation, toxic combustion products, and explosion overpressure (events A.2.2.1, A2.2.2 and A2.2.3, respectively). The consequences of a propagation incident from an off-site fire would be the same as that assessed for the battery enclosure scenario (*generation of heat from a fire and potential for fire escalation*), and is rated, in accordance with the risk matrix in Section A2.1, as *Major* for on-site effects and *Notable event* for off-site effects.	
Consequence ranking	On-site (within the Project Area): *Major* - Serious injuries with long term effects (Medium - Environmental damage) Off-site (outside the Project Area and Site): *Notable event* – Negligible physical injury and/or environmental consequences
Likelihood and key risk controls	
Measures established to minimise damage potential in case of an incident at a nearby area (excluding any preventative measures) are listed in Appendix 1. Likelihood of an on-site injury is set as *Remote*. Likelihood of an off-site impact exceeding the initiating event is set as *Rare*.	
Likelihood ranking	On-site (within the Project Area):: *Remote* Off-site (outside the Project Area and Site):: *Rare*

Risk evaluation	
The risk associated with an impact from the neighbouring area can be determined by combining the consequences should a fire or explosion occur with the likelihood of the event, with reference to the risk matrix in Section A2.1. The risk to people on-site is assessed as *ALARP* (a combination of a *Major* consequence with a *Remote* likelihood). The risk to people off-site from knock-on effects emanating from the Project Area, as a result of an incident at a neighbouring area, is assessed as *Acceptable* (a combination of a *Notable event* consequence with a *Rare* likelihood).	
Risk ranking – On-site (within the Project Area):: safety	ALARP
Risk ranking – Off-site (outside the Project Area and Site):: safety	ACCEPTABLE
Note: The risk relates to the consequences of the propagation incident, not the initiating event which is outside of the scope of this PHA	
ALARP evaluation	
Provided an adequate APZ is established and maintained the risk associated with these types of incidents is managed in accordance with ALARP principles.	
ALARP justification:	
ALARP justified provided requirements the APZ is established and maintained	Justified

A2.2.9: Incident during construction activity causes impact with infrastructure

HAZARDOUS EVENT	
Construction activities may damage nearby infrastructure; cause injury to site personnel	
Consequences (immediate and ultimate)	
Consequences should an event occur have the potential to cause initiation of incidents A2.2.1 to A2.2.7, with consequence detailed above. Damage to the APA Group pipeline is theoretically possible and could result in a fire. The separation distance to the BESS, and the presence of the APZ, are such that a propagation incident is not likely.	
Consequence ranking	On-site (construction crew, within the Project Area): *Severe* – fatality/life-threatening injuries Off-site (general public, outside the Project Area and Site): *Notable event* – no physical injury
Likelihood and key risk controls	
Key risk controls are listed in Appendix 1. Damage to the APA pipeline, while theoretically possible, is managed by ensuring that no Project activity is to occur at or near the pipeline.	

Likelihood ranking	On-site (within the Project Area): *Rare* Off-site (general public , outside the Project Area and Site): *Rare*
Risk evaluation	
An incident involving below ground high pressure pipelines are well known and understood and the required controls are specified in Codes and Standards with site specific details to be determined in conjunction with the APA Group. Requirements for the management of risk of damage to site infrastructure such as transformers and battery enclosures are also well known and understood and are detailed in Codes of Practice. The risk can be determined by combining the consequences with the likelihood of the event, with reference to the risk matrix in Section A2.1. The risk to people on- and off-site is assessed as *Acceptable* (a combination of a *Notable event* consequence with a *Rare* likelihood).	
Risk ranking – On-site (within the Project Area):: safety	ACCEPTABLE
Risk ranking – Off-site (outside the Project Area and Site): safety	ACCEPTABLE
ALARP evaluation	
Provided that Codes and Standards are adhered to and that the requirements by APA Group for control during construction activities and management are followed, the risk can be managed to ALARP principles.	
ALARP justification:	
ALARP justified provided Project conforms to the requirements in Codes and Standards for high voltage equipment and to APA Group requirements.	Justified

Appendix 3

Minimal footprint of the BESS Area

Preliminary Hazard Analysis for the Solar Farm and Battery Energy Storage System in Cobbora, NSW

Appendix 3 - Minimal footprint of the BESS Area.

The BESS Area would consist of large outdoor enclosures installed in rows. Each enclosure would be connected to a power conversion system (PCS) complete with inverter and step-up transformer. The PCS would either be housed within the enclosure or separate as a standalone cubicle. Inverter transformers (33 kV) and switchgear would either be housed on a common skid with the PCS or as a standalone skid.

The battery enclosures provide the building blocks for the BESS, repeated until the desired BESS capacity is reached. An indicative BESS Site layout is shown in Figure 2-9 in the body of the report, with an extract of the total BESS layout shown in Figure A3.1 below.

The battery supplier would determine the number of battery enclosures, inverter stations and the electrical connection layout. For the purpose of developing the BESS Area footprint (i.e. the area on the BESS Site where the battery enclosures are located), the largest footprint under evaluation[18] has been used, incorporating a separation distance of 3.048 metres between battery enclosure rows[19], as shown in Figure A3.1 (extracted from Figure 2-9).

Figure A3.1 - Generic layout for the BESS, repeated for the desired output (largest BESS Area footprint under evaluation)

[18] in this case, CATL

[19] This exceeds the separation distance recommended by Tesla for their MP2XL, and provides the Proponent flexibility in their battery selection process, and ensures that the Project allocates enough space to allow for a 400MW/1,600MWh.

The separation distances within the BESS, including between battery enclosure rows, form a key control in ensuring that a thermal event in one enclosure does not propagate to adjacent enclosures. The final separation distances within the BESS, and the associated BESS Site footprint, would be determined during detailed design.

The BESS Area footprint developed for this PHA uses the largest separation requirements between rows (i.e. CATL) believed to be the most conservative. This confirms that the separation distances proposed in the preliminary BESS Site layout (Figure 2-9) are likely to be sufficient to prevent a fire in one enclosure from propagating to adjacent enclosure rows, as based on the following:

- The Project would select a battery enclosure confirming no propagation in accordance with a destructive UL9540 A test or equivalent[20] (Recommendation 2).
- With no propagation confirmed via the destructive test (Recommendation 2), the separation distances in the indicative Project layout area (Figure 2-9) comply with and exceed the stringent requirements for separation distances between battery enclosures specified in the National Fire Protection Association (NFPA) 855 *Standard for the Installation of Stationary Energy Storage Systems*, which is widely viewed as one of the most comprehensive Codes of Practice in the industry[21].
- Modelling of the heat radiation from external flames, which was conducted by the manufacturer for the example enclosure (Ref 15), demonstrates that in the even under worst-case wind weather conditions, the fire would not propagate from one battery enclosure to adjacent enclosures.
- The distance between the BESS Area[22] to the nearest off-site residence is over 1 kilometre. At this separation distance, no significant off-site impact to offsite receptors is expected from a potential BESS fire.
- The distance between the any substation and the nearest off-site residence is approximately 700 metres. At this separation distance, no significant off-site impact to offsite receptors is expected from EMF.

[20] The UL 9540A testing is a destructive test method used for evaluating the thermal runaway impacts in a BESS and gathering data to assist in assessing or developing mitigation measures for the failure event, propagation of the failure, or consequences of an event, such as an explosion or fire.

[21] NFPA 855 para's 4.6.2 to 4.6.4 sets the minimum default separation distances to 3,048 mm (for maximum allowable energy storage unit at 50 kWh and 600 kWh for the overall BESS installation), with smaller separation allowed if the destructive large-scale fire testing (UL 9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems* or equivalent test standard) confirms no propagation, and as approved by the AHJ (in NSW, the FRNSW and the DPHI).

[22] Even further between the residential dwelling and the closest BESS enclosure

- The closest enclosure are 32 metres from the BESS area boundary and surrounding vegetation, as separated from the external bushland by the APZ, the internal access road, etc. This minimises off-site impact from a fire or toxic gas generation, and the heat radiation level associated with a fire at the BESS facility is not likely to exceed 1 kW/m^2 at the boundary (Ref 15), below 3 kW/m^2 which is commonly defined as the heat radiation level which could cause discomfort (refer to Appendix 3). The effects from a BESS enclosure fire are not expected to extend beyond the BESS Site.

- The minimum distance between a BESS enclosure the nearest HV transformer is 140 metres. In the unlikely event of a battery enclosure fire, the heat radiation level is not likely to exceed 1 kW/m^2 at the closest transformer (Ref 15), below 3 kW/m^2 which is commonly defined as the heat radiation level which could cause discomfort. The effects from a BESS enclosure fire are not expected to cause propagation to supporting HV infrastructure.

The 30 hectares allocated for the BESS Site is sufficient, to ensure that the Project allocates enough space to allow for a 400MW / 1,600MWh BESS.

Appendix 4

List of Codes and Standards relevant to the PHA

Preliminary Hazard Analysis for the Solar Farm and Battery Energy Storage System in Cobbora, NSW

Appendix 4 – List of Codes and Standards relevant to the PHA

The following listings provide a summary of codes and standards that have a particular relevance to the PHA. A complete listing of codes and standards would be made available as part of the detailed design package.

BESS – LIST OF CODES AND STANDARDS WITH PARTICULAR RELEVANCE TO THE PHA

- General:
  - IEC 60364 Low-voltage electrical installations
  - IEC 60529 Degrees of protection provided by enclosures (IP Code)
  - IEC 61000 Electromagnetic compatibility (EMC)
  - ISO 14001 Environmental Management Systems
  - IEC 61936-1 Power installations exceeding 1 kV a.c. – Part 1: Common rules
  - IEC 60071 Insulation co-ordination – Part 1: Definitions, principles and rules
  - IEC 60068 Environmental testing. Part 1: General and guidance
- Electrical works and equipment:
  - EN 50178 Electronic equipment for use in power installations
  - IEC 61000 Electromagnetic compatibility
  - IEC 60050 Earthing and protection against electric Shock
  - IEC 62305 Protection against lightning
  - IEEE 80 Guide for Safety in AC Substation Grounding
  - AS 2067:2016 Substations and high voltage installations exceeding 1 kV a.c.
  - AS 3000:2018 Electrical installations
  - the ENA Substation Earthing Guide
- Overhead Lines:
  - AS 2344 Limits of Electromagnetic Interference from Overhead a.c. Powerlines and High Voltage Equipment Installations in the Frequency Range 0.15 to 1000MHz
  - AS/NZS 7000 Overhead line design and AS / NZS 7000:2016 Overhead Line Design – Detailed Procedures
- Cables & Joints:
  - IEC 60038 IEC standard Voltage
  - EN 50618 Electric cables for photovoltaic system
  - IEC 60085 Electrical insulation
  - IEC 60189 Low-frequency cables and wires with PVC insulation and PVC sheath
  - VDE 0100 Part 430: Protection of cables against overcurrent – Part 410: Protective measures and protection against electric shock

- Inverters:
  - IEC 60146 Semiconductor converters
  - IEC 62109-1 and 2 Safety of Power Converters for Use in Photovoltaic Power Systems
  - EN 50530 Overall Efficiency of Photovoltaic Inverters
  - UL 1741SA: Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
- Transformers:
  - IEC 60076 Power transformers
  - IEC 60606 Application Guide for Power Transformers
  - IEC 61558 Safety of power transformers, power supplies, reactors and similar products
  - IEC 62041 EMC requirements for power transformers, power supplies, reactors and similar products
- Civil works:
  - EN 752 Drain and Sewer System Outside Buildings
  - BS 1722 Fencing
  - Australian Building Codes
- Fire Protection:
  - National Fire Protection Association applicable standards and notably NFPA 850 (Recommended Practice for Fire Protection for Electric Generating Plants)
  - UL 1642: UL Standard for Safety Lithium Batteries
  - IEC 62619: Safety requirements for secondary lithium cells and batteries, for use in industrial applications
  - UL 1973: UL Standard for Safety Batteries for Use in Stationary and Motive Auxiliary Power Application
  - UL 9540: Standard for Energy Storage Systems and Equipment
  - UL 9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy.
  - IEEE 1547: Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
  - UL 1741SA Standards for Renewable Energy Inverters
  - AS1603 – Automatic Fire Detection and Alarm Systems
  - AS1670 – Automatic fire detection and alarm systems System design, installation and commissioning
  - AS1670.4 – Fire detection, warning control and intercom systems- System design, installation and commissioning- Sound systems and intercom systems for emergency purposes
  - AS1851 – Maintenance of Fire Protection systems and Equipment
  - AS1940 – The storage and handling of flammable and combustible liquids
  - AS2067 – Substation and high voltage installations exceeding 1kV AC

- AS2444 – Portable fire extinguishers and fire blankets Selection and location
- AS4428 – Fire detection, warning, control and intercom systems Control and indicating equipment
- AS4487 – Condensed aerosol fire extinguishing systems - Requirements for system design, installation and commissioning and test methods for components (as applicable)
- AS/ISO14520 – Gaseous Fire extinguishing Systems (as applicable)
- NFPA850 – Recommended Practice for Fire Protection for Electrical Generating Plants and High Voltage Direct Current Stations 2010 Edition
- NFPA 855 – Standard for the Installation of Energy Storage Systems
- FM Global 5-33 Data Sheet

- Lightning protection AS 1768
- Stormwater design and construction AS/NZS 3500:3:2015 (Part 3)

Reference Standard Solar Farm

ELECTRICAL – LIST OF STANDARDS WITH PARTICULAR RELEVANCE TO THE PHA

Standards	Descriptions
AS-2067	Substations and high voltage installations exceeding 1 kV AC
AS-3000	Wiring Rules
AS-5033	Installations and safety requirements of photovoltaic arrays
AS-4777	Grid connection of energy systems via inverters (all applicable sections)
AS-60076	Power transformers
AS-62271	High-voltage alternating current circuit-breakers (all applicable sections)
AS 1939	Classification of Degrees of Protection Provided by Enclosures for Electrical Equipment
AS 2184-1985	Low voltage switchgear and control gear - moulded-case circuit- breakers for rated voltages up to and including 600 V a.c. and 250 V DC
AS 3010:2005	Electrical Installations- Generating Sets
AS/NZS 3439.1:2002	Low-voltage switchgear and control gear assemblies - type-tested and partially type-tested assemblies
AS/NZS 3439.2:2002	Low-voltage switchgear and control gear assemblies - particular requirements for busbar trunking systems (busways)
AS/NZS 3947.3:2001	Low-voltage switchgear and control gear - switches, disconnectors, switch - disconnectors and fuse-combination units
AS/NZS 5000.1:2005	Electric cables - polymeric insulated - for working voltages up to and including 0.6/1 (1.2) kV
AS/NZS 1768:2007	Lightning protection

Standards	Descriptions
AS 60947.8-2005	Low-voltage switchgear and control gear - circuit-breakers
AS/NZS 60079	Series explosive atmospheres
AS 1768	Lightning protection
AS 3808	Insulating and sheathing materials for electric cables
AS 4853	Electrical hazards on metallic pipelines
IEEE 1547	IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
IEEE C62.45	IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
IEEE 62.41.2	IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEC 60228	Conductors of insulated cables
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 61215	Terrestrial photovoltaic (PV) modules - Design qualification and type approval
EN 50521	Connectors for photovoltaic systems - Safety requirements and tests
IEEE-80	Guide for Safety in AC Substation Grounding
IEEE 1584	IEEE Guide for Performing Arc Flash Hazard Calculations
NER	National Electricity Rules, Australia

CIVIL – LIST OF STANDARDS WITH PARTICULAR RELEVANCE TO THE PHA

Standards	Descriptions
AS/NZS 1170.2	Wind actions.
AS/NZS 1170.4	Earthquake Actions in Australia.
National Construction Code (NCC) / International Building Code, wherever required.	

SCADA – LIST OF STANDARDS WITH PARTICULAR RELEVANCE TO THE PHA

Standards	Descriptions
AS/NZS 61000.6.2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments

Standards	Descriptions
AS/NZS 61000.6.4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
IEC 61724-1	Photovoltaic (PV) system – Performance monitoring – Guidelines for measurement, data exchange and analysis
ISO 9060	Solar energy - Specification and classification of instruments for measuring hemispherical solar and direct solar radiation