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Fulham Solar Farm, Victoria

Risk Management Plan

Prepared for:	The Trustee for Fulham Solar Farm Trust Level 8, 627 Chapel St SOUTH YARRA, VIC, 3141
Prepared by:	RED Fire Engineers Pty Ltd
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Executive Summary

RED Fire Engineers Pty Ltd has been appointed by The Trustee for Fulham Solar Farm Trust to develop a risk management plan (RMP) of the proposed Fulham Solar farm located at the corner of Hopkins road and McLarens road, Fulham, VIC. Specifically, this report relates to the fire safety risks associated with the new Fulham solar farm.

This RMP has investigated the proposed design from the solar panels to the transmission point out of the site. Of significance are the facts that the solar panel meets at least Class C under UL 790 and that the GridSolv Quantum passed the 'unit' test under UL 9450A. Both of these outcomes indicate the potential for fire ignition associated with these items as well as fire spread from these items is limited / effectively managed. For the solar panels it means that combustion cannot be maintained without a significant fire source. Therefore, when the site is so wet that the dirt track may not support fire truck movement, it is implausible that the CFA would need to be responding to a fire related to the solar panel. As the solar panels do not introduce a site specific fire threat but are only a potential fuel load. The tracks, i.e., roads, associated with the Distribution Power Station (DPS) from the access gate near the site buildings are to be all-weather as the DPS are a site specific fire threat that is different from that of a farm or bushland environment.

Overall, the risk is seen as very low to low as long as the risk mitigation measures are appropriately implemented and sustained.

To achieve this very low to low fire risk there are many control measures to be applied such as local earth bunding around the DPS units to control the movement of fire water across and out of the site.

The site building is to be designed and constructed in accordance with the NCC 2022 Amendment 1 (ABCB, 2022). Similarly, the collector and switching stations are to be laid out in line with AS 2067:2016, (Standards Australia, 2016).

Across the site there are to be various detection and monitoring systems for fault and fire identification and notification. The notification of an issue / incident occurs both at the site and at the remote monitoring site (RMS).

The site is to be supplied with at least 288 kL of water for fire fighting operations. This water is to be stored in various tanks across the site. All DPS units are to be covered by a 45 kL fire water tank. These fire water tanks are to be at least 10 m away from a DPS unit and other structures, but may be within 2 m of solar panels. No wiring is to pass under or near a fire water tank, wiring associated with adjacent solar panel is to be directed away from the tank. Connection point for these tanks is to be on the opposite side of the solar panels. There is to be a hardstand for the fire trucks, located such that only a 4 m hose is required to connect the truck to the tank. There shall be a hardstand on each side of the tank where DPS units are located.

The switchboard room is to be fitted with Inergen fire suppression system as well as a fire detection and monitoring system.

CFA is to have access to the site via five gates that connect to the tracks which that loop and cross the site.

Access to battery energy storage systems (BESS), i.e., battery enclosures associated with the DPS, does require emergency responders to be within 20 m of the inverter. It is not confirmed at this stage if this position would be within the arc flash hazard demarcation zone for the inverters. An arc flash hazard management process is under development and will be shared with CFA once available.

The soil type at this site makes erosion an issue and therefore vegetation is proposed to be maintained across the entire site. This is to be managed to a maximum height of 100 mm. This includes the tracks across the site. There shall also be a landscape buffer along the boundary that is 5 m wide and is designed to generate a BAL of no greater than 19 at 15 m from the buffer.

To limit unauthorised access to the site a security fence is to surround the landscaping buffer. This fence is to also limit animals accessing the site.

This site is to be remotely managed from the RMS. Contractors and support staff are to access the site as required to maintain the equipment and respond to an incident. Therefore, the RMS is to provide the continuous operational monitoring and control of the site.

Systems and components at the site are to be maintained in accordance with Australian Standards, manufacturers guidance, and the guidance provided in Section 7.

Table of Contents

Executive Summary 4
Table of Contents 6
List of Figures7
1 Introduction 8
2 Scope of Report 14
3 Description of Facility 15
4 Risks Identified 24
5 Risk analysis and evaluation 25
6 Risk Treatment 39
7 Monitoring, reviewing, and reporting 66
8 Conclusions 68
9 References 70
Appendix A. Site Map 71
Appendix B. Risk Matrix 87

List of Figures

Figure 1: GridSolv Quantum System 17
Figure 2: Doors opened at the front of the GridSolv Quantum 18
Figure 3: Doors opened at the back of the GridSolv Quantum 18
Figure 4: Dry pipe sprinkler connection point 19
Figure 5: Unit level test configuration....21
Figure 6: Module post-test....21
Figure 7: Fire alarm panel on the GridSolv Quantum DC door....22
Figure 8: Google Map image of the proposed Fulham Solar Farm site © 2023 72
Figure 9: Contour and Boundary Plan....73
Figure 10: 1% AEP Max Depth of Flow 74
Figure 11: Proposed arrangements for the Fulham Solar farm....75
Figure 12: Legend to Figure 11 76
Figure 13: 66/33kV 80/100MVA Substation 77
Figure 14: 66kV Switching Station....78
Figure 15: Generic proposed DPS Arrangement, top view 79
Figure 16: Generic proposed DPS Arrangement, side view 80
Figure 17: Option 2 sound wall enclosing two DPS units 80
Figure 18: Option 3 sound wall enclosing two DPS units 81
Figure 19: Option 4 sound wall enclosing two DPS units 82
Figure 20: Security fence 83
Figure 21: Site landscaping arrangements 84
Figure 22: Planting Schedule....85

1 Introduction

1.1 Background

1.1.1 RED Fire Engineers Pty Ltd has been appointed by The Trustee for Fulham Solar Farm Trust to develop a risk management plan (RMP) of the proposed Fulham Solar farm located at the corner of Hopkins road and McLarens road, Fulham, VIC.

1.2 Report Applicability

1.2.1 This report reviews the fire and life safety risks associated with the proposed Fulham Solar farm and provides recommendations to manage the risks appropriately. The strategy behind the management of the fire and life safety risk is to limit the number and size of fires at this facility. The actions taken to achieve this management will also support property protection and business continuity, but the purpose of this RMP is not explicitly to achieve these outcomes.

1.2.2 The findings and opinions expressed within this report are based on the information provided by The Trustee for Fulham Solar Farm Trust and are applicable only to the detailed circumstances envisaged herein.

1.3 Applicable Legislation

1.3.1 The principal Victoria legislation associated with this Risk Management Plan are:

a) Country Fire Authority Act 1958,
b) Planning and Environmental Act 1987,
c) Building Act 1993,
d) Occupational Health and Safety Act 2004, and
e) Dangerous Goods Act 1985.

1.4 Risk Management Process

1.4.1 The risk management process that is proposed to be implemented within this RMP is in line with the framework set out in AS/ISO 31000:2018, Risk Management Guidelines, as well as following the CFA, 'Design Guidelines and Model Requirements – Renewable Energy Facilities, 2023', (Country Fire Authority (Vic), 2023). Specifically:

a) Risk Identification – On-site and off-site fire hazards,
b) Risk analysis and evaluation – Determine the potential of the fire hazard to occur and its consequences. With this the hierarchy of controls and industry good practices shall be adopted when proposing control measures,
c) Risk treatment – Selection of appropriate fire safety measures, and
d) Monitoring, review, and reporting – Sets out the actions to be taken to confirm the appropriateness of the fire safety measures and, if required, their modification.

1.5 Stakeholders and Documentation

1.5.1 The stakeholders associated with this project are listed in Table 1.

Table 1: Project stakeholders

Organisation	Role	Representative
Octopus Investments Australia	Client	Suzie Hunter Jaryd Revere
Darthmouth Consulting	Project Manager	Ben Corley
Country Fire Authority	Reporting Authority	Matthew Allen Jennifer Blyth
RED Fire Engineers Pty Ltd	Fire Engineering Consultant	Ian Raymond Sukhdeep Batra
	Fire Safety Engineer	MC Hui
		Blair Stratton

1.5.2 The relevant documents and drawings on which this report is based are listed in Table 2.

Table 2: Relevant documentation

Organisation	Title	Project number / ref	Date	Revision
Victoria Planning	Planning Permit	PA2101365	28/03/2022	-
Beon Energy Solutions	Octopus Investments, Fulham Solar farm, Site Equipment Layout	-	1/09/2023	D
	Fulham Solar Farm, 66/33kV, 80/100MVA Substation, General Arrangement Plan		29/8/2023	F
	Fulham Solar Farm, Proposed Conduit Arrangement, DC Conduits	-	13/7/2023	B
RPS AAP Consulting Pty Ltd	Contour and Boundary Plan, Fulham Solar farm	AU7064	29/06/2023	A
Kevin Hazell	Bushfire Planning Assessment, Solar energy facility, Lot 2/ LP204862 Hopkins Road, Fulham	-	9/09/2021	1.0
Wartsila	Appendix A2. Technical specification	PQ2022-00979A1R-	4/10/2022	-
	Compliance Chart for Wartsila GridSolv Quantum	-	14/04/2023	-
	UL 9540A Fire Protection Engineer Supplemental Report for Ground-Mounted Battery Energy Storage Systems	-	4/4/2023	0b

Organisation	Title	Project number/ ref	Date	Revision
	Wartsila GridSolv Quantum Project Battery Energy Storage Subsystem – Design Failure Mode Effect Analysis	-	24/2/2023	1
	Fire Safety Assessment for Outside Ground-Mounted Battery Energy Storage System	-	29/3/2023	1a
	Safety Sheet – GridSolv Quantum	-	2022	-
	Gridsolv Quantum Energy Storage System (ESS) (Presentation)	-	-	-
	Fire Protection Site Design Guide for Outside Ground-Mounted Battery Energy Storage Systems (Australia)	-	2023	2
Nextracker	NX Horizon	-	-	-
Suntech	Ultra V Pro	-	2023	-
SMA	MV Power Station	-	-	-
AusNet Services	Fulham 66kV Switching Station, 66kV Switchyard, General Arrangement	2584086-UP-SK002	6/12/2022	0.1
APAR	SDS – Transformer oil Poweroil to 1020 60 UX	-	1/10/2020	09
TUV Rheinland	Certificate: CU 7220221 02	Battery Rack	22/09/2022	-
	Certificate: CU 72192852 01	DC to DC Converter	20/8/2019	-
Cargill	SDS – Envirotemp FR3 Fluid	-	17/10/2019	-
	Dielectric Fluids – Envirotemp FR3 Fluid	-	2016	-
Douglas Partners	Geotechnical and Environmental Assessment	220821.00	20/07/2023	0
Southeast engineering and environmental	Fulham Solar Farm – Existing Conditions Hydrologic and Hydraulic Assessment	-	9/8/2023	-
Intertek	Test Report – ANSI/CAN/UL 9540A:2019, Test Method for Evaluating Runaway Fire Propagation in Battery Energy Storage Systems	105209563CRT-005	28/02/2023	-

Organisation	Title	Project number/ ref	Date	Revision
Midel	Natural Ester Dielectric Insulating Fluid Overview	-	Oct 2012	-
	SDS – MIDEL eN	-	Feb 2012	-
Davidson Design Studio	Landscape Plan – Layout	200802	20/07/2024	E
EnerSys Australia Pty Ltd	SDS – Sealed Lead Battery – Supersafe OPZV, GFM, T, T-FT, TMJ, TM, TE and TX; Datasafe NP, NPX and HX; GENSIS TD and TN; Teledata and Hawker Evolution Range of Batteries	Chemwatch: 5349-31	24/4/2019	3.1.1.1
Nexan – Olex	Technical Data Sheet	1499, 300400, 01, 7434	15/02/2021	-
		1499. 145010, 01, 7425		
		5468, 300300, 98, 9006		
Australia Pacific Electric Cables Pty Ltd	Product Description	IVM070E	-	-
		IVM025E		
Optimised Network Equipment	Harmonic filter for Sebastopol solar farm. AIS Option	977SOQ4-1	18/12/2020	-
Elsewedy Electric	Power Transformer 45 MVA 66/11kV – Installation, Operation, and Maintenace	7029102	22/05/2022	-
Beon	Schedule of Guaranteed Performed [Contract Version]	-	09/01/2022	-
ABB	SACE Tmax XT – Low voltage moulded case circuit-breakers	-	2021	-
	Gas-insulated ring main unit and as-insulated compact switchgear – SafeRing / SafePlus 12-24 kV		2019	
CFA	CFA Advice on Documentation for a Renewable Energy Facility – Fulham Solar Farm	PA2101365	4/4/2024	-
Darthmouth Consulting	E-mail from Ben Corley to RED fire engineers	Subject: Additional information – Fulham Solar farm	19/07/2024	-
RINA	Fulham Solar Farm – Proposed Solar Array Layout	FHSF-PRI-EL-DR-0004	02/08/2024	I
			31/07/2024	G
			07/06/2024	C

Organisation	Title	Project number/ ref	Date	Revision
	Fulham Solar Farm – Proposed BESS Equipment Arrangement Acoustic Wall Details	FHSF-PRI-EL-DR-0003	02/08/2024	E
	Fulham Solar Farm – 66/33 kV Collector Station General Arrangement Plan	FHSF-PRI-EL-DR-0001	24/07/2024	D
	Fulham Solar Farm – 66/33 kV Collector Station Elevation Plan	FHSF-PRI-EL-DR-0002	30/07/2024	D
	Fulham Solar Farm – General Building Arrangements Layouts and Elevations	FHSF-PRI-EL-DR-0005	02/08/2024	C
	Fulham Solar Farm – Switching Station General Arrangement Plan	FHSF-PRI-EL-DR-0006	31/07/2024	0

1.5.3 Citations and references used throughout this report are listed in section 9.

1.6 Assumptions and Limitations

1.6.1 Assumptions that are critical to this RMP are as follows:

a) All equipment at the Fulham Solar farm is suitably and properly maintained for occupant fire life safety and efficient operations.

b) No additional fuel loads at the Fulham Solar farm, outside that noted within this report.

1.6.2 This RMP has the following limitations:

a) The outcome of this assessment is based on the information referenced in this report.

b) This report excludes the analysis of multiple ignition sources or acts of terrorism.

1.6.3 Whilst RED Fire Engineers has used reasonable care and judgement in preparing the RMP, a fire with a severity exceeding the design inputs may still occur.

1.7 Glossary and Abbreviations

Table 3: Glossary and Abbreviations

Abbreviation	Meaning
AC	Alternating current
AEP	Annual Exceedance Probability
BAL	Bushfire Attack Level
BESS	Battery energy storage system
BMS	Battery Management System

CCTV	Close circuit television
CFA	Country Fire Authority
DC	Direct current
DPS	Distributed Power Station
EMS	Energy Management System
IRA	Initial Risk Assessment
Li-ion	Lithium ion
PRA	Proposed Risk Assessment
O&M	Operation and Maintenance
RMP	Risk Management Plan
RMS	Remote Monitoring Site
SQEP	Suitably Qualified and Experienced Person
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply

1.7.1 Definition: Suitably qualified and experienced person: is a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relating to the subject matter using the relevant protocols, standards, methods or literature.[1]

[1] https://www.lawinsider.com/dictionary/suitably-qualified-and-experienced-person#:~:text=suitably%20qualified%20and%20experienced%20person%20means%20a%20person%20who%20has,the%20relevant%20protocols%2C%20standards%2C%20methods

2 Scope of Report

2.1 Scope

2.1.1 The scope of this RMP is to review the potential fire hazards associated with the Fulham Solar farm. Specifically, this report considers fire and life safety risk to this facility that may originate within and outside of the site. This report evaluates these risks and propose treatments. With respect to these treatments, this RMP sets out the required monitoring, review, recording, and reporting requirements.

3 Description of Facility

3.1 Fulham Solar Farm

<u>Site</u>

3.1.1 The Fulham Solar Farm is to be located at the corner of Hopkins Road and McLarens Road, Fulham, VIC. Figure 8 presents a Google satellite image of this location. As can be seen from the figure, this site will share part of one boundary with the Fulham correctional centre. Further north of this site is the West Sale Airport. The region around the site is mainly farmland of mostly crops.

3.1.2 This solar farm is situated on a 160.3 Ha of land. Figure 9 presents the contours across the site. The southeast corner of the site is the lowest point / area of the site. As noted in the Southeast engineering and environmental (Southeast) report the average slope of the land is approximately 1%.

3.1.3 The Douglas Partner report notes that ground water was detected between 3.8 to 4.6 m below the ground level. The topsoil, up to 30 cm depth, at the site is a clayey silt or silty sand. This layer has high plasticity and is firm. Underneath it is a silty clay that is very stiff to becoming hard, as noted in the Douglas Partners report.

3.1.4 These clay soils have a moderate propensity for shrinking and swelling with fluctuations in soil moisture. As noted in the Douglas Partners report, this can result in seasonal cracking to a depth of 1.0 m. Additionally, these soils are highly susceptible to dispersive erosion. Therefore, the soil needs to be covered by vegetation as recommended by the Doulgas Partners report. Additionally, erosion control measures are recommended such as silt fencing as well as measures to limit the speed of water run-off such as swales.

3.1.5 The Southeast report notes that local land shaping has a significant influence of water flow across the site, see Figure 10. Note this figure relates to the expected flood level at 1% AEP. On this basis it can be expected that water released on site would pond to slowly move along one of the four paths presented in Figure 10.

<u>Boundary</u>

3.1.6 The site will be enclosed by a fence as presented in Figure 20. This security fence is expected to keep out wildlife, farm animals, and most trespassers. As presented in Figure 21, in from this security fence is the original 5 m wide landscape buffer arrangement, as noted in the Davidson Design Studio report. Figure 23, presents the proposed planting schedule for this buffer.

3.1.7 The distance from this landscape buffer to the solar pods and other site infrastructure/equipment is to be 15 m. Across this distance the vegetation shall only be grass with a height no greater than 100 mm.

Solar Pods

3.1.8 The solar panels that will be used in the solar pods come from Suntech; its brochure is noted in Table 2 of this report. These solar panels are described as having a maximum rated output of 605 W and meet Type C of UL 790 (Underwriters Laboratories, 2022). The junction box has an IP68 rating, whilst the operating module temperature range is -40°C to 85°C. If there is an electrical issue, this can be detected by the solar pod monitoring systems and notification sent to the remote monitoring site (RMS).

3.1.9 These solar panels are grouped into rows that are then fitted to a NX Horizon solar tracking system, or equivalent (alternative systems to be reviewed by the client and fire engineer). The NX Horizon system tilts a row of solar cells towards the Sun and in so doing improves efficiency of the system. This arrangement of a row of solar panel on a tracker is referred to as a solar pod.

3.1.10 Figure 11 shows the arrangement of the solar farm at this Fulham site.

Cables

3.1.11 It is proposed to use Nexan-Olex and Australia Pacific Electric Cables Pty Ltd cables at the Fulham Solar Farm. Data and products sheets for these cables are noted in Table 2 of this report. These cables are appropriate for the wiring required across the site, include having most of the cables buried.

Distribution Power Stations

3.1.12 All solar pods connect to one of 24 Distributed Power Stations (DPSs) across the site. The generic DPS arrangement is presents in Figures 15 and 16, the DPS are made up of an inverter and transformer, DC/DC converter, and battery enclosures. As can be noted from Figure 11, some DPSs are to be located next to each other. In these cases, adjacent Battery Enclosure, i.e., BESS, is to be 10 m apart. Some of these DPSs will have sound (absorption) wall associated with them. The arrangements of the sound walls are presented in Figures 17 to 23, which includes doors for fire fighting access.

3.1.13 Across these 24 DPSs there is a total 128 MWh of energy storage capacity.

3.1.14 The inverter and transformer unit are detailed in the SMA brochure noted in Table 2 of this report. This unit is open to the environment with an operating temperature range between -25°C to 45°C. These are oil-cooled units. All up 2,276 L of oil is within this unit. Required clearance distance from this unit to other transformers or non-combustible material is 1.5 m horizontal, whilst this distance increases to 7.5 m horizontal for combustible material as set out in AS 2067:2016, (Standards Australia, 2016). The inverter and transformer oils and liquids to be used are K2 class as defined in IEC 61039:2008, (International Electrotechnical Commission, 2008). The datasheets for the liquids, i.e., FR3 and Midel, to be used are noted in Table 2.

3.1.15 The DC/DC converter is a SMA DPS-500 DC-DC converter, as noted in the battery energy storage systems (BESS), i.e., battery enclosure, technical specification report. There will be six of these units between the inverter and transformer unit and the battery enclosures. This unit is forced air-cooled. This converter meets UL 1741:2010 R2.18, UL 62109-1:2014, and CSA C22.2 No. 107.1-16 based on the TUV Rheinland certificate.

3.1.16 The battery enclosure consists of one GridSolv Quantum DC, controller, and four GridSolv Quantum units, battery enclosures. Figure 1 shows one of each of these items; it should be noted that the options presented in Figure 1 are not included at this site. Each GridSolv Quantum consists of 4 Li-ion battery racks.

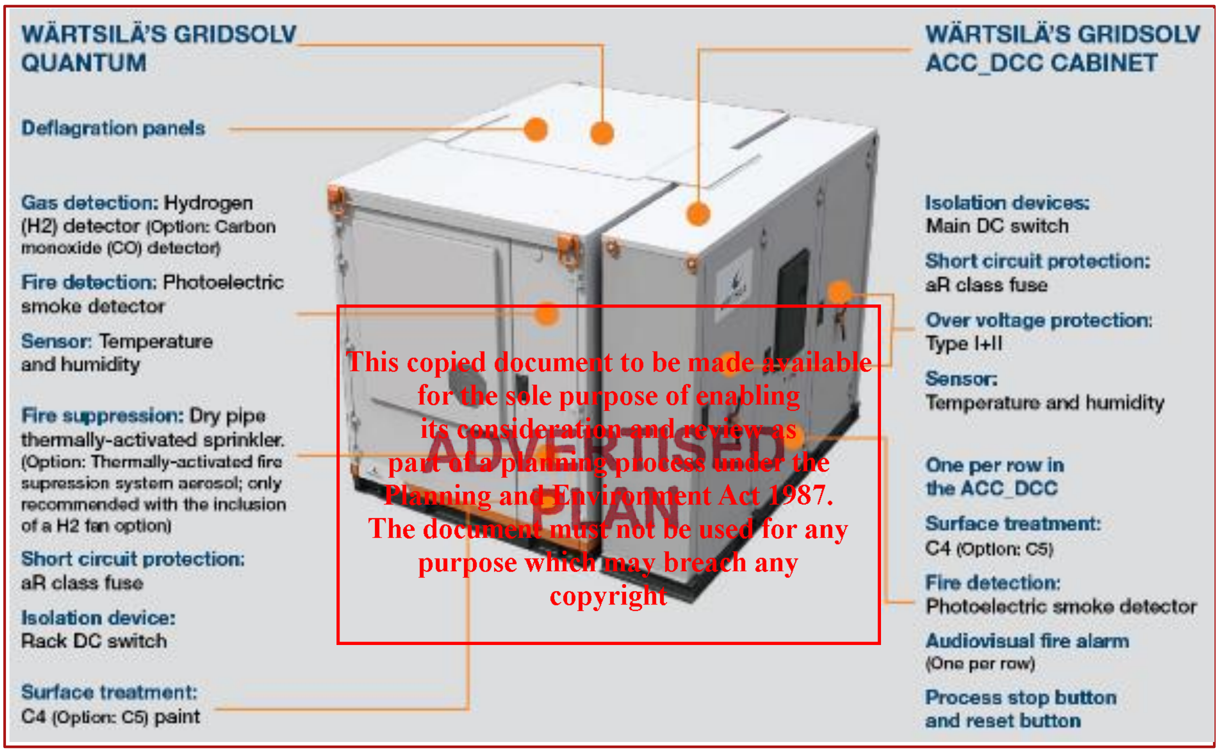

Figure 1: GridSolv Quantum System

3.1.17 Each Li-ion battery rack consists of 8 Li-ion battery modules as well as its own battery management system (BMS). The BMS interfaces between the Li-ion battery modules and the energy management system (EMS). The rack has a nominal energy capacity of 372.7 kWh and is water-cooled. This Li-ion battery rack meets the requirements set out in UL 1973:2018, presented in the TUV Rheinland certificate noted in Table 2 of this report.

3.1.18 Within each GridSolv Quantum there are four Li-ion racks and their associated support systems that can only be accessed via the external doors, see Figures 2 and 3. All four walls of the GridSolv Quantum have a fire resistance of 1-hour, that meets EN 13501-2:2016 and EN 1364-1:2015[2]. There are smoke and H_2 detectors fitted inside each of these units. Upon detection of smoke an alarm is sent to a central alarm panel, within the GridSolv Quantum DC, which shuts

[2] 1 hour fire resistance to these European standards is similar to a -/60/60 FRL to AS1530.4.

down[3] that particular GridSolv Quantum unit. On detection of H_2 within a GridSolv Quantum the unit will ventilate as well as central alarm activation and the unit shuts down. There is also a dry pipe sprinkler system, noted at Figure 3, with thermally activated nozzle, as noted in the Wartsila documents in Table 2 of this report. This sprinkler is supplied via a 1-inch pipe with a water discharge rate of 122 L/m @ 2.7 bar.

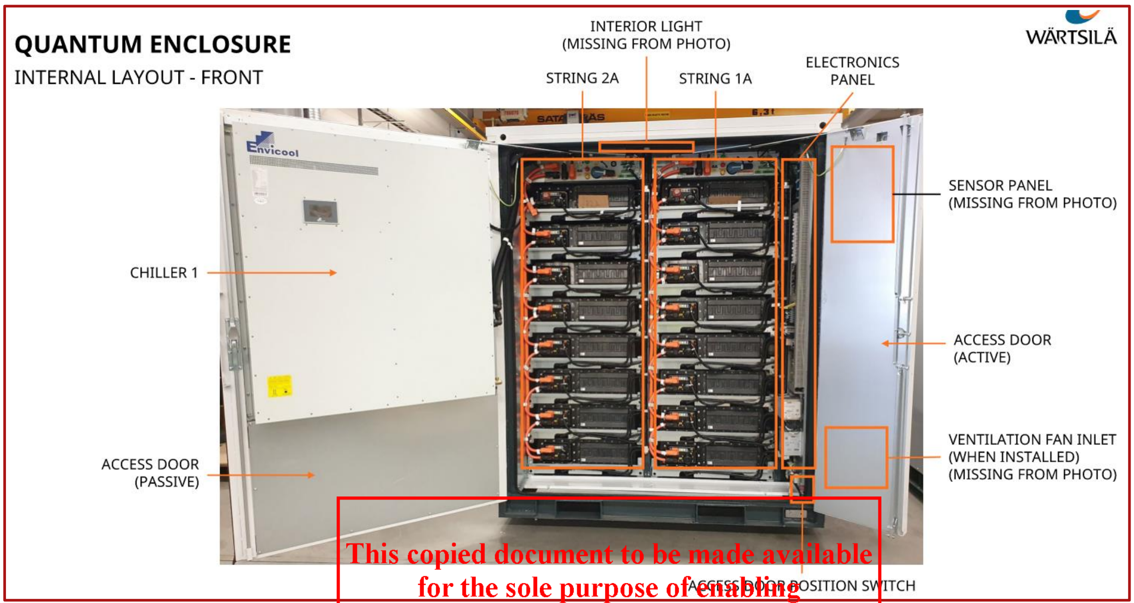

Figure 2: Doors opened at the front of the GridSolv Quantum

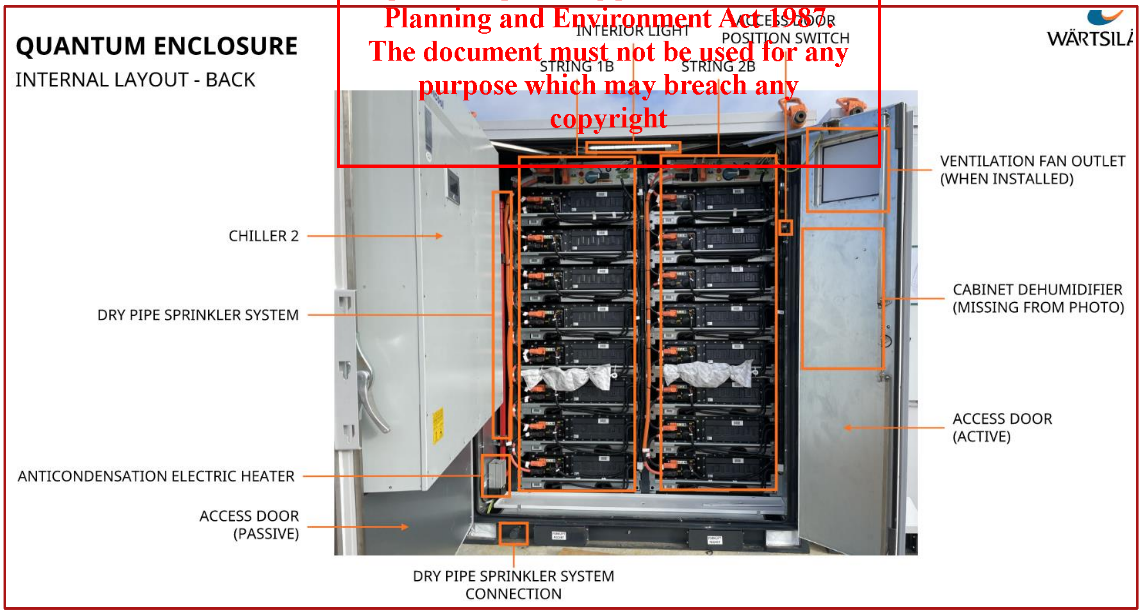

Figure 3: Doors opened at the back of the GridSolv Quantum

[3] Shut down of the GridSolv Quantum stops any further charging or discharging of from the system.

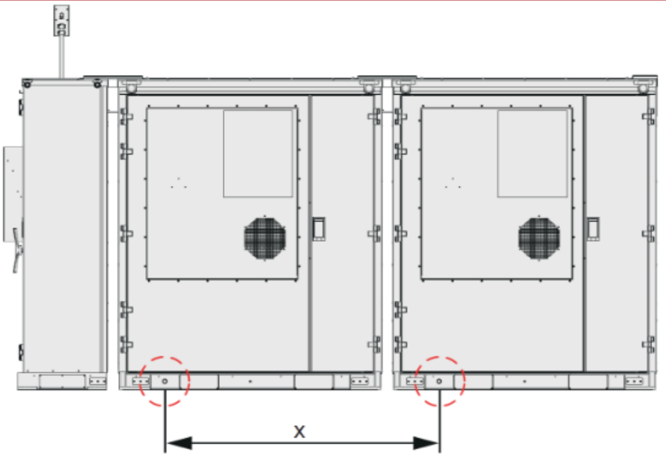

Figure 4: Dry pipe sprinkler connection point

3.1.19 A GridSolv Quantum management system is able to automatically shut down the unit if there is any fault or abnormal environmental condition, such as high/low temperature or high humidity. Finally, the unit can be manually shut down via the emergency stop button located on the GridSolv Quantum DC. Included with this in the GridSolv Quantum DC is a UPS that powers essential safety and control equipment in the unit.

Generic Li-ion battery fire dynamics

3.1.20 With regard to generic Li-ion battery thermal runaway and fire, (Hutchison, 2017) notes that this occurs due to one or a combination of the following:

a) Electrical failures: overcharging and over-discharge,
b) Mechanical failures: internal short-circuit, physical damage, and manufacturing defects,
c) Thermal failures: overheating, internal localised heating (60-80°C, where 80°C is the maximum acceptable temperature).

3.1.21 All of these failures generate heat and therefore could lead to thermal runaway. The risk of thermal runaway occurring in a Li-ion battery / cell increase with the age or number of cycles the battery has been through, (Hutchison, 2017).

3.1.22 As the temperature within a Li-ion battery / cell increases the rate of chemical reaction between the flammable organic electrolyte and the intercalated-lithium of the negative electrode also increases. The negative electrode breaks down, releasing various hydrocarbon gases and leading to pressure increase within the cell. The separator melts, which permits the electrodes to short circuit as well as the electrolyte to break down due to mixing. The reaction between the electrolyte and the cathode results in the cathode decomposing. Oxygen is released due to this cathode decomposing, which oxidises the flammable electrolyte. The temperature within the cell continues to rise, which results in the venting of hot flammable gases readily for ignition, if not already ignited. This sustained combustion can lead to thermal runaway spreading to adjacent Li-ion batteries / cells, (Hutchison, 2017).

3.1.23 As noted in (Hutchison, 2017), there can be three jet flames over the combustion lifecycle of a Li-ion battery / cell, if the state of charge is greater than 50%. These three jet flames related to the decomposition of the anode, separator, and cathode, with the cathode generally being the most violent due to the emission of oxygen.

3.1.24 Finally, (Hutchison, 2017) notes that approximately 0.33 L of flammable gas is released per Watt-Hour.

GridSolv Quantum System

3.1.25 As noted within various Wartsila documents presented in Table 2 of this report, the GridSolv Quantum system has undergone the UL 9540A:2019 test up to unit level. As set out within the UL 9540A, cell and module testing has also been undertaken. In all cases the Li-ion cell that was forced into thermal runaway was at 100% State of Charge.

3.1.26 From cell testing it was noted that thermal runaway was induced around 239°C, whilst cell venting of gases occurred at 168.2°C. This venting can produce flammable gas concentrations in excess of 25% of the lower flammability limit. Table 4 (below) presents the principal vented gas from a cell thermal runaway.

Table 4: Gas Composition Vented during Thermal Runaway during UL 9540A cell testing associated with GridSolv Quantum Battery

Gas Composition	Litres	Concentration (%)
CO	24.[illegible]	11.086
CO_2	73.671	33.290
H_2	79.000	35.698
Hydrocarbons	5.975	2.700
CH_4	22.296	10.075
C_2H_6	2.410	1.089
C_3H_6	1.264	0.571
C_3H_8	0.513	0.232
Total	221.3	94.741

3.1.27 For cell, module, and unit test no flaming combustion was detected. Similarly, there was no evidence of flying debris.

3.1.28 Figure 5 presents the test set up used for the unit test. During the unit test the thermocouple within the module next to the cell that was forced into thermal runaway reached a temperature of 1,200°C. Thermocouples within the GridSolv Quantum but outside the module did not record temperatures above 100°C and generally they were around 40°C. The temperature emitted by the module with the thermal runaway cell, including the hot gases existing the vent hole, was insufficient to spread thermal runaway to modules above or below. In front of the GridSolv Quantum unit with the cell forced into thermal runaway is a heat flux gauge at approximately 4 feet (1.2 m) away. During the test, this heat flux gauge did not reach 1.3 kW/m^2.

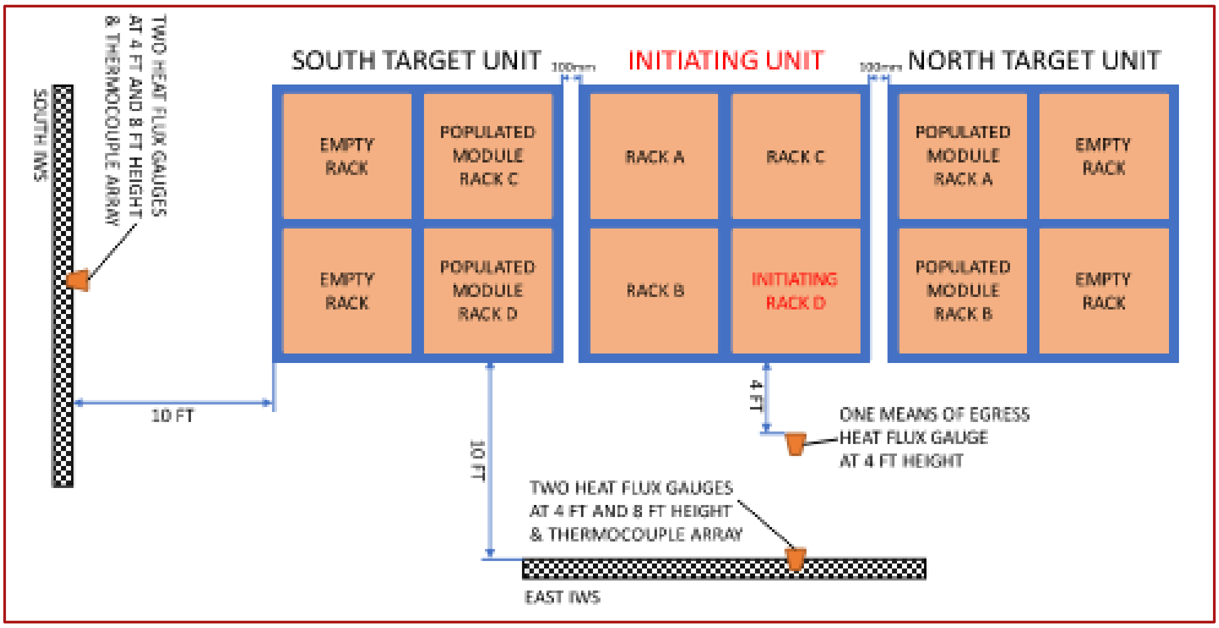

Figure 5: Unit level test configuration

3.1.29 All Li-ion modules within GridSolv Quantum have an aluminium alloy base and a plastic top that has a vent for off-gassing.

3.1.30 Cell-to-cell thermal runaway spread was shown to be limited to three cells; one initiating cell and two adjacent cells on each side, see Figure 6.

Figure 6: Module post-test

3.1.31 Finally, if thermal runaway involved many more cells or multiple modules and therefore could lead to deflagration or detonation within the unit, the GridSolv Quantum has a deflagration panel as part of its roof, which is in accordance with NFPA 68.

3.1.32 Additionally, Wartsila have conducted large-scale fire tests with the GridSolv unit, as reported in Table 2 of this report. After permitting the event to propagate for 4 hours the fire was extinguished by 760 L of water. The fire within one GridSolv did not affect the along side GridSolv Quantum units even though no cooling water was applied.

3.1.33 From a review of summary of building codes requirements that are provided within the Wartsila documents presented in Table 2 of this report, it is recommended that combustible vegetation and other combustible materials are kept 10 feet (3.1 m) away from these units. This is to restrict the spread of fire from Li-ion battery units to other items on site.

3.1.34 The GridSolv Quantum DC is the interface between the DC to DC converter and the GridSolv Quantum battery enclosure. This cabinet includes the fire alarm panel, see Figure 7, for the smoke detectors that are within this unit and the associated GridSolv Quantum battery enclosures. The control system provides access to current and historical alarm and fault situations that have occurred within the battery enclosures.

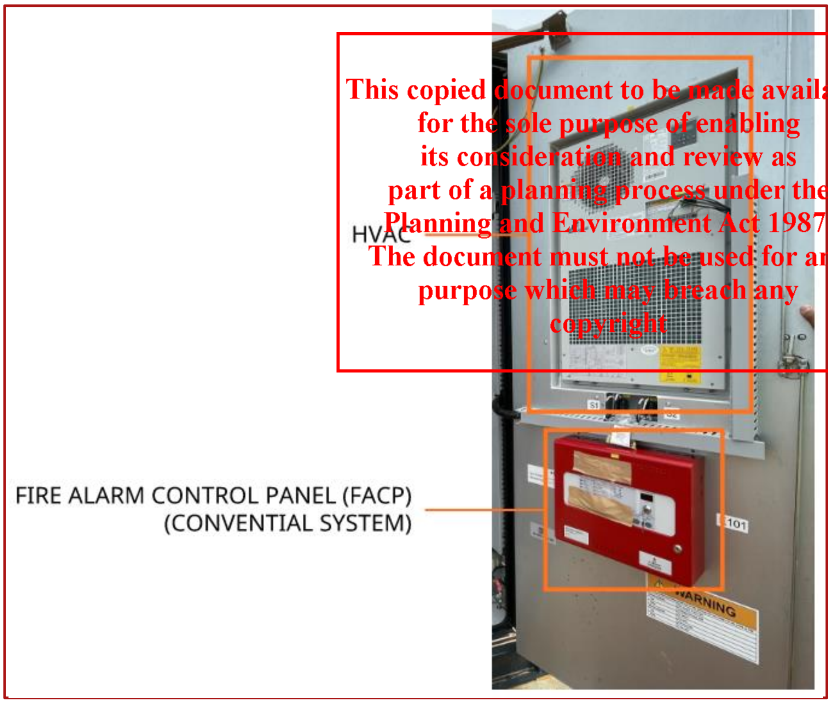

Figure 7: Fire alarm panel on the GridSolv Quantum DC door

3.1.35 The power flows from the DPS to the Collector station and the Switching station before going into the power grid.

Collector and Switching Station

3.1.36 The Collector station current arrangement is presented in Figure 13. As can be noted there is a control room and switchboard rooms. The transformer may hold up to 45 kL of oil. This oil is both a fire and environmental risk. The power transformer, harmonic filters, and oil / liquids documentation are stated within Table 2 within this report. Figure 13 shows that appropriate clearance distances, as required under AS 2067:2016, (Standards Australia, 2016), are met.

3.1.37 An indicative arrangement for the Switching Station is presented in Figure 14. As can be noted there is a control room and two battery rooms. These battery rooms hold the site's lead-acid batteries as back up power for the communication system to the RMS.

3.1.38 ABB systems are fitted within both control rooms, their relevant information is noted at Table 2 of this report.

Site Buildings

3.1.39 There will be an operation and maintenance building and shed, referred to as the site buildings, that will be located close to the laydown area. These buildings will be constructed in accordance with the National Construction Code 2022 Volume 1 (ABCB, 2022). It will be used to store equipment and items to support the solar farm operations. This site will not be permanently staffed, but a kitchen facility will be provided within the operation and maintenance building.

3.1.40 Within the site buildings, there will be the first responder panel which will provide an a single source of all information / alarms associated with the 24 GridSolv Quantum DC units fire alarm panels across the site.

Monitoring

3.1.41 CCTV monitoring will be provided across the entire site to support remote monitoring and management from the RMS. The RMS will also receive notification of system issues and fire alarm system faults and activations for the site. On receiving notification of an alarm, the CCTV system will be used to investigate the incident before appropriate actions are taken.

Site Fire Fighting Systems

3.1.42 Currently, it is proposed for the site to have five access gates, two of which are to be used for emergency and come off farmland. At the main gate there will be a single 50 kL fire water tank. Across the site and within 120 m of each DPS there is to be a 45 kL fire water tank. It is planned for four of these 45 kL tanks to be distributed across the site. It is this 45 kL of fire water which would be used to extinguish a fire at a DPS and cool adjacent items. Additionally, there will be a 100 kL tank near the O&M Building with at least 65 kL reserved for fire fighting. This provides over 288 kL of fire water across the site. This is presented in Figure 11.

4 Risks Identified

4.1 Internal Hazards

4.1.1 From a review of the Fulham Solar Farm the following fire safety related internal hazards exist:

a) Solar panel / pod fire – fire may occur due to wiring issue, loose wiring terminations, or similar. Fire may spread to adjacent modules and other infrastructure on site.

b) Direct current power cables to the DPS – fire may occur due to damage to these power cables from construction and operations, deterioration of insulating materials, and being soaked by rain or fire water. Outcome may be a fire or electrocution of staff / fire fighters from the cable or the module.

c) DPS – fire may occur due to mechanical damage, overheating, short-circuiting, arc faults, overcharging, mechanical damage, or being impacted by a fire in its vicinity. May lead to explosion and / or fire spread.

d) Alternating current power cables to the collection station – fire may occur due to damage to these power cables from construction and operations, deterioration of insulating materials, and being soaked by rain or fire water. Outcome may be a fire or electrocution of staff / fire fighters.

e) Collection and Switching stations – fire may occur due to mechanical damage, short circuiting, arc faults, or being impacted by a fire in its vicinity. May lead to explosion and / or fire spread.

f) Site buildings – various fire sources from cooking to electrical power systems. This may result is a fire that could spread to other infrastructure.

g) Vehicle fire – This may relate to roll over, collision, or overheating of engine. Results in a fire that could spread to adjacent infrastructure.

4.2 External Hazards

4.2.1 From a review of the Fulham Solar Farm the following fire safety related external Hazards exist:

a) Bushfire / grassfire – a local bushfire / grassfire could spread to the solar farm as well as the potential for a grassfire to spread across and out of the site.

b) Animal/pest management – native animals, livestock or rodents could enter the farm and damage various systems leading to a fire.

c) Trespassing – trespasser, including vehicles or prisoners, within the solar farm could start a fire.

d) Lightning strike – lightning strike could start a fire within the farm.

e) Boundary fire – A vehicle on a boundary road could have an accident and catch fire. A structural fire could also occur on an adjacent site. Worst case would be assumed to be a fuel tanker transporting aviation fuel to the West Sale Airport.

f) Aviation crash – It is possible that a light aircraft crashes at the solar farm.

5 Risk analysis and evaluation

5.1 Introduction

5.1.1 In this section the Hazards noted in Section 4, are investigated. Specifically, this investigation is around causes of an incident, initial risk assessment based around no control measures being applied, and then finally, all the control measures that have been considered.

5.1.2 In Section 6, the selected control measures are presented, and the risk assessment is updated based on these control measures being applied.

5.2 Internal Risks

5.2.1 Solar panel / pod fire.

a) Identification of incident – Solar panels are recognised as being one of the lowest fire risk electrical items in use. Most of the recorded fires associated with solar panels relate to installation quality and the invertor. At this site the inverters are separated from the solar panel. The common causes of solar panel fires are:

i) Damaged wiring within the panel or at the outputs from the panel / pod. This can generate an arc that can ignite flammable / combustible material within the solar panel. The damage may occur during construction or installation, as well as over its service life due to deterioration, weather conditions, animals, or vehicles.
ii) Improper wiring terminations.
iii) Poor installation which can cause damage to the solar panel.
iv) Hot spot(s) within the solar panel that leads to overheating and then a fire.
v) Water ingress into the solar panel / pod.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of a solar panel catching fire is considered to be probable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel as they could be slightly injured due to the fire. It is expected that staff members will move away from any fire. The facility consequence is moderate as the fire is likely to spread. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be medium for occupant life safety and facility and low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of a solar panel / pod fire and minimise fire occurrence.

i) Select solar panel / pod that come from a reputable, recognised, and reliable supplier and has undergone the UL 790 (Underwriters Laboratories, 2022) test to meet at least Class C rating. Additionally, the solar panels are to at least be enclosed front and back by glass and have non-combustible side frame, preferably of metal. This will permit a review of the solar panel to confirm that their fire risk is low due to appropriate quality control in the manufacturing process.

ii) Have the solar panels professionally designed and installed, including the wiring to the DPS and cable terminations. This is to limit potential degradation/performance issues from environmental and other factors and minimise damage to the solar panels due to incorrect wiring installation from these panels.

iii) Regular maintenance to be undertaken by professional maintenance personnel following appropriate procedures, who will repair or replace components before a fire is expected to occur.

iv) Keeping vegetation away from the solar panels by regular clearing / treatments / maintenance. This is to limit the risk of interactions of vegetation to power systems leading to a fire.

v) Keeping animals away from the solar panel / pod by perimeter fences and limiting vegetation. This is to reduce the risk of mechanical damage to the solar panels.

vi) Keeping rodents away from the solar panel / pod by cleaning up trash, and other food and water sources in the field that can draw rats and the like when required. This is to reduce the risk of damage to the solar panel.

vii) Separation distance between adjacent solar panels as well as to DPS.

viii) Visually inspect (including with thermal imaging camera) the solar panels regularly, especially after extreme weather events and take appropriate actions. This will permit damage to be responded to as soon as possible.

ix) Appropriate procedure and system to extinguish solar panel fire and manage contaminated water.

x) Procedure and systems to call out the local fire brigade to extinguish the fire.

5.2.2 Direct current power cables to the DPS.

a) Identification of incident – Direct current cable coming from a solar pod to one of the DPSs can cause a fire or electrocution of staff / fire fighters. The common causes of this are:

i) Inappropriate cable for the environment, i.e., not designed for the outdoor environment or the power level. The cable would quickly degrade and therefore become a fire and electrocution hazard.

ii) Poor installation of the cables can lead to water infiltration or arcing that can generate a fire.

iii) Damage or deterioration over its service life of the cables can lead to water infiltration or arcing that can generate a fire.

iv) Water ingress at connection / joints within the cable can lead to fire or electrocution.
v) Heat builds up due to multiple cables in close proximity that are in use.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of a cable fire is considered to be probable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be critical for personnel as it could result in electrocution. The facility consequence is moderate as the fire is likely to spread and the loss of at least one cable run. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be high for occupant life safety, medium for the facility and low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of the direct current cable(s) catching fire and to extinguish such fire if it has occurred.

i) Select cables that are appropriate for the environment and power requirements. This would reduce the risk of degradation of the cables.
ii) Transit the cable below ground in a conduit that has appropriate rodent-proofing.
iii) Cabling system installed and maintained by a professional service provider.
iv) Keeping vegetation away from the cables by regular treatments / maintenance. This is to limit the risk of interactions of vegetation to power systems leading to a fire.
v) Keeping animals away from the cables by perimeter fences and limiting vegetation. This is to restrict the risk of mechanical damage to the cables.
vi) Keeping rodents away from the cables by cleaning up trash, and other food and water sources in the field that can draw rats and the like when required. This is to reduce the risk of damage to the cables.
vii) Visually inspect the cables regularly, especially after extreme weather events and take appropriate actions. This will permit damage to be responded to as soon as possible.
xi) Appropriate procedure and system to extinguish cable fire and manage contaminated water.
viii) Procedure and systems to call out the local fire brigade to extinguish the fire.

5.2.3 DPS

a) Identification of incident – The DPS consists of an inverter and transformer unit, DC/DC converter, and the GridSolv Quantum battery system. Therefore, there exists fire risks associated with industrial electrical systems such as transformers and Li-ion battery racks and containers. If conditions for fire were to develop within a GridSolv Quantum this would be related to a buildup in concentration of hydrogen / methane gases. This mechanism could also lead to an explosion. However, from the UL 9540A:2019, (Underwriter Laboratories, 2019), test results it is unlikely to lead to flaming combustion or an explosion due to thermal runaway of a Li-ion cell. The common causes of a fire in this environment are:

i) Poor quality components and installation across the DPS. This could lead to component failure more regularly.
ii) Inappropriate installation on site. This could result in mechanical damage to the system or inappropriate power flow into or out of the DPS.
iii) Mechanical and other damage during transport or whilst in use. This could result in damage to the Li-ion batteries resulting in thermal runaway conditions.
iv) Heat build-up during operation of the Li-ion batteries or other components of the DPS. This could lead to system degradation and therefore fire conditions.
v) Water ingress into electrical components, which could lead to an arc fault fire.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of a DPS catching fire is considered to be probable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be critical for personnel as there could be significant injuries associated with this fire. The facility consequence is major as the fire is likely to spread and the impact of losing a DPS on operations. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be high for occupant life safety and facility and low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of a DPS system catching fire and to extinguish such fire if it has occurred.

i) Select a DPS system that comes from a reputable, recognised, and reliable supplier. This will permit a review of DPS component to confirm that its fire risk is low due to appropriate quality control in the manufacturing process. Particularly, the Li-ion battery enclosure should have passed the UL 9540A:2019, (Underwriter Laboratories, 2019), unit test.
ii) DPS system installed and maintained by a professional service provider. This is to limit the risk of damage during installation or degradation over time being overlooked.
iii) Keeping vegetation away from the DPS by regular treatments / maintenance. This is to limit the risk of interactions of vegetation to

power systems leading to a fire, as well as limiting vegetation fire spreading to the DPS.

iv) Keeping animals away from the DPS system by perimeter fences and limiting vegetation. This is to restrict the risk of mechanical damage to the container.

v) Keeping rodents away from the DPS system by cleaning up trash and food in the vicinity. Any openings in the walls/roof for ventilation or viewing purposes shall be protected with rodent-proof meshes. This is to reduce the risk of damage to the cables.

vi) Separation between DPS and solar pod.

vii) Reduction in impact forces from a vehicle collision, so that the Li-ion batteries and other electrical components are not likely to be damaged in such an event. This would be achieved by site speed limit and restricted access. Armco barriers, bollard, and like have been considered for the DPS, but as these units will be housed within a local earth bund mound, these other measures become impractical as well as do not provide significant benefits.

viii) Visually inspect the DPS system regularly, especially after extreme weather events and take appropriate actions.

ix) Environmental conditions monitoring within the GridSolv Quantum permits damage to be responded to as soon as possible.

x) Smoke and gas monitoring, especially for hydrogen, within the GridSolv Quantum to detect the formation of fire conditions.

xi) Appropriate procedure and system to extinguish a DPS fire and manage contaminated water. This would likely include the use of water. The selection of the on-site fighting capabilities is covered within Section 6 of this document.

xii) Procedure and systems to call out the local fire brigade to extinguish the fire.

5.2.4 Alternating current power cables to the collection station.

a) Identification of incident – This alternating current cable comes from each DPS to the collection station. A fault along this cable could result in a fire or electrocution of staff / fire fighters. The common causes of this are:

i) Inappropriate cable for the environment, i.e., not designed for the outdoor environment or the power level. The cable would quickly degrade and therefore become a fire and electrocution hazard.

ii) Poor installation of the cables can lead to water infiltration or arcing that can generate a fire.

iii) Damage over its service life of the cables can lead to water infiltration or arcing that can generate a fire.

iv) Water ingress at connection / joints within the cable can lead to fire or electrocution.

v) Heat build-up due to multiple cables in close proximity that are in use.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

   i) Likelihood of a cable fire is considered to be probable as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be critical for personnel as it could result in electrocution. The facility consequence is major as the fire is likely to spread and the loss of at least one cable run and DPS supply. Environmental consequence would be minor.
   iii) The risk level is determined, through Table 9, to be high for occupant life safety and the facility and low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of the alternating circuit cable(s) catching fire and to extinguish such fire if it has occurred.

   i) Select cables that are appropriate for the environment and power requirements. This would limit the risk of degradation of the cables.
   ii) Transit the cable below ground in a conduit that has appropriate rodent-proofing.
   iii) Cabling system installed and maintained by a professional service provider.
   iv) Keeping vegetation away from the cables by regular treatments / maintenance. This is to limit the risk of interactions of vegetation to power systems leading to a fire.
   v) Keeping animals away from the cables by perimeter fences and limiting vegetation. This is to reduce the risk of mechanical damage to the cables.
   vi) Keeping rodents away from the cables by cleaning up trash and food in the vicinity of the cables. This is to reduce the risk of damage to the cables.
   vii) Visually inspect the cables regularly, especially after extreme weather events and take appropriate actions. This will permit damage to be responded to as soon as possible.
   viii) Appropriate procedure and system to extinguish cable fire and manage contaminated water. This would likely include the use water. The selection of the on-site fighting capabilities is covered within Section 6 of this Plan.
   ix) Procedure and systems to call out the local fire brigade to extinguish to the fire.

5.2.5 Collection and switching stations

a) Identification of incident – These stations consist of various industrial electrical transmission units as well as control rooms, switchboard room, and battery rooms. Within the industrial electrical units are oils that have a fire and environmental risk. The battery rooms contain lead-acid batteries and their associated fire and environmental risks[4]. The control rooms and switchboard rooms have various fire risks and are expected to be provided with at least fire detection systems if not fire suppression systems as well. The common causes of fires are:

i) Poor quality components and installation within the stations of the electrical units and structures. This could lead to component failure and frequent fires.
ii) Mechanical and other damage during transport or whilst in use. This could result in damage resulting in fire conditions.
iii) Heat build-up during operations of the various systems. This could lead to system degradation and therefore fire conditions within a system.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of a fire at one of these stations is considered to be occasional as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be catastrophic for personnel as it could result in electrocution and fire. The fire is likely to be significant and potentially could be spread, in so doing placing staff and fire fighters at risk. The facility consequence is critical as the fire is likely to spread. Environmental consequence would be moderate.
iii) The risk level is determined, through Table 9, to be high for occupant life safety and the facility, and low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the fire risk associated with these two stations.

i) Select industrial electrical transmission system and associated components from a reputable, recognised, and reliable supplier. By itself this will permit a revision of the fire risk to low due to appropriate quality control in the manufacturing process.
ii) Industrial electrical transmission system and associated components installed and maintained by a professional service provider. This is to limit the risk of damage during installation or degradation being missed overtime.
iii) Reduction in impact forces from a vehicle collision. This would be achieved by site speed limit and restricted access to the unit for a vehicle.
iv) Separation between these stations and combustible items.
v) Keeping rodents away from these stations by cleaning up trash and food in the vicinity of the station fence lines and associated internal structures. Any openings in the walls/roof of the associated internal structures for ventilation or viewing purposes shall be protected with rodent-proof meshes.

[4] The principal fire risk relates to the off gassing of hydrogen, whilst the environmental risk relates to loss of containment of contaminated fire water containing lead.

vi) Visually inspect the systems within the stations regularly, especially after extreme weather events and take appropriate actions.
vii) Control rooms, switchboard room, and battery rooms to have fire detection and suppression systems to effectively manage fire conditions within these structures.
viii) Water containment around each station to limit environmental impact.
ix) Appropriate procedure and system to extinguish a fire at one of these stations. The selection of the on-site fighting capabilities is covered within Section 6 of this Plan.
x) Procedure and systems to call out the local fire brigade to extinguish the fire.

5.2.6 Site buildings

a) Identification of incident – The site buildings are vulnerable to the standard fire hazards, such as electrical fault, cooking fires, and maintenance incidents, as well as the less common hazards relating to the storage of chemicals and supplies. The common causes of site building fires are:

i) Inappropriate design and/or construction of the building to be able to safely undertake its role. In this situation fires could occur due to operations, such as refuelling and maintaining site vehicles, being undertaken within or near a building.
ii) Lack of procedure and training related to site building safety, such as the use of unsafe electrical equipment, unattended cooking, and the overuse of extension boards, could lead to fires.
iii) Inappropriate storage of chemicals and fuels in the site buildings. This situation could rapidly lead to a fire.

iv) Poor electrical wiring installation and maintenance could lead to fire ignition.
v) Deterioration of the cable insulation due to ageing or rodent attack.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of a building fire is considered to be occasional as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be catastrophic for personnel as there may be within the building. The facility consequence is moderate. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be high for occupant life safety, Low for the facility, and very Low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of the site building catching fire and to extinguish such fire if it occurred.

i) The site buildings are to be designed and built to comply with the National Construction Code 2022 Volume 1 (ABCB, 2022).

ii) Storage of chemicals and fuels in accordance with the Code of Practice for Dangerous Goods, (WorkSafe Victoria, 2013).

iii) Keeping rodents away from the site buildings by cleaning up trash and food in the vicinity of the buildings. Any openings in the walls/roof of the building for ventilation or viewing purposes shall be protected with rodent-proof meshes. This is to reduce the risk of damage to the buildings.

iv) The electrical power supply and lighting system for the site building shall fully comply with AS/NZS 3000:2018.

v) Appropriate fire detection systems fitted across the buildings to monitor fire conditions.

vi) Appropriate procedure and system to extinguish a building fire. This would likely include the use of water and portable fire extinguishers. The selection of the on-site fighting capabilities is covered within Section 6 of this Plan.

vii) Procedure and systems to call out the local fire brigade to extinguish the fire.

5.2.7 Vehicle fire

a) Identification of incident – Vehicle fires can occur due to collision, mechanical failure, overheating of the engine, or a delayed ignition of a faulty or damaged Li-ion battery in an electric vehicle. The common causes of vehicle fires are:

i) Inappropriate operations of the vehicle. This could lead to fire due to collision or similar incident.

ii) Lack of maintenance of the vehicle.

iii) Electric vehicle battery thermal runaway leading to a fire.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of a vehicle fire is considered to be probable as set out in Table 7.

ii) The consequences, as set out in Table 8, are seen to be catastrophic for personnel within the vehicle. The facility consequence is major as the fire is likely to spread. Environmental consequence would be moderate.

iii) The risk level is determined, through Table 9, to be very high for occupant life safety, high for the facility, and medium for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of the vehicle fire and to extinguish such fire if it has occurred.

i) Speed limit across the site to be 20 km/hr. This will limit the impact speed of any collision.

ii) On site roads to be maintained and inspected at least once a year and after extreme weather.
iii) All vehicles to be maintained by professional maintainers, in accordance with manufacturer's scheduled servicing.
iv) Regular checking and heeding any mandatory / voluntary recalls.
v) Appropriate procedure and system to extinguish a vehicle fire. This would likely be the use of the on-board portable fire extinguishers. The selection of the on-site fighting capabilities is covered within Section 6 of this Plan.
vi) Procedure and systems to call out the local fire brigade to extinguish the fire.

5.3 External Risks

5.3.1 Bushfire / grassfire.

a) Identification of incident – Bushfire risk relates to the vegetation around and within the site. The common causes of bushfires are:

i) Natural bushland and the terrain near the site. The bushfire report, referenced in Table 2 of this report, notes the risk is low due to the surrounding vegetation.
ii) Vegetation level within the solar farm. Overgrown vegetation can be a fuel source for a travelling grassfire.
iii) Solar farm components being an ignition point for a grassfire, including the vehicle(s).
iv) Lack of security can lead to arson at the site, resulting in a grassfire.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of an external bushfire / grassfire impacting the site is considered to be improbable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel as there are expected to have evacuated the site earlier. The facility consequence is catastrophic as the fire could destroy or significantly damage the site. Environmental consequence would be moderate with respect to the site's impact on the environment.
iii) The risk level is determined, through Table 9, to be very low for occupant life safety, high for the facility, and very low for the environment.

c) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of an internal grassfire impacting the site is considered to be occasional as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel. The facility consequence is catastrophic as the fire could

destroy the site. Environmental consequence would be moderate with respect to the site's impact on the environment.

iii) The risk level is determined, through Table 9, to be low for occupant life safety, high for the facility, and low for the environment.

d) Control options – The following provides the various controls that could be applied to mitigate the risk of a bushfire/grassfire within and without the site.

i) Maintaining the vegetation on site to less than 100 mm in height except for the landscape buffer. This will limit the fuel load and therefore the ability to support fire spread across the site.
ii) Perimeter fence around the entire site with signage stating, 'NO TRESPASSING'.
iii) Appropriate procedures and monitoring components on site to reduce the probability of failure / fire.
iv) Procedure and systems to call out the local fire brigade to respond to a bushfire.

5.3.2 Animal management.

a) Identification of incident – Native animals or livestock within the Fulham Solar Farm could damage cables and the like. This could lead to a fire on site.
b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

i) Likelihood of animals impacting the site is considered to be almost certain as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel. The facility consequence is major as a cable could be damaged or broken or similar for other systems. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be medium for occupant life safety, high for the facility, and low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of animals and livestock entering the site.

i) Appropriate perimeter fence and gate arrangement to keep native animals and livestock out of the site.
ii) Reduce the vegetation level within the solar farm. If low, vegetation is less likely to encourage native animals and livestock to enter as well as making it easier to observe them.
iii) Procedure and systems to deal with pest/stray animals.

5.3.3 Pest management.

a) Identification of incident – Pests, especially rodents, could enter the Fulham Solar farm and damage various systems across the site. This damage could result in fire(s) and other incidents.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

   i) Likelihood of animals impacting the site is considered to be almost certain as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be moderate for personnel. The facility consequence is major as a cable could be damaged or broken or similar for other systems. Environmental consequence would be minor.
   iii) The risk level is determined, through Table 9, to be medium for occupant life safety, high for the facility, and low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of animals and livestock entering the site.

   i) Manage of food and rubbish across the Fulham Solar farm.
   ii) Bait across the site, when required.
   iv) Rodent proof mesh to protect openings within containers and the site buildings.
   v) Reduce the vegetation level within the solar farm. If low less likely to encourage pests to enter as well as making it easier to observe them.
   vi) Procedures and systems to deal with pests.

5.3.4 Trespassing

a) Identification of incident – The Fulham Correctional Centre adjoins the northern allotment boundary. Therefore, there is a risk of escaping prisoner entering the site. As with any such facility, trespassing by people or vehicles are a risk. All of these threats could result in an arson incident at the site.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

   i) Likelihood of a trespasser on the site that does damage causing fire is considered to be occasional as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be critical for personnel as the damage may lead to a large fire, explosive risk, or physical harm. The facility consequence is critical. Environmental consequence would be major.
   iii) The risk level is determined, through Table 9, to be high for occupant life safety, high for the facility, and medium for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of arson.

   i) Perimeter fence around the entire site with signage stating, 'NO TRESPASSING'.

ii) Procedure and systems to deal with trespassing.

5.3.5 Lightning strike

a) Identification of incident – Lightning strike that impacted a DPS or other systems on site could lead to a fire.
b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

   i) Likelihood of a lightning strike impacting the site is considered to be occasional as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be critical for personnel as the fire may spread and include explosion risk, depending on what was hit by the lightning. The facility consequence is critical. Environmental consequence would be minor.
   iii) The risk level is determined, through Table 9, to be high for occupant life safety, high for the facility, and very low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of lightning strike effects the site.

   i) Site design and certified as being lightning and surge protected.

5.3.6 Boundary fire

a) Identification of incident – There are roads on two sides of the Fulham Solar Farm. A vehicle fire could occur along one of these roads. This fire could impact this facility. Worst credible case fire would be a large fuel tanker delivering fuel to the local airport.
b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

   i) Likelihood of a boundary fire adjacent to the site is considered to be improbable as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be critical for personnel as the fire may spread and include explosion risk. The facility consequence is critical. Environmental consequence would be minor with respect to the sites impact on the environment.
   iii) The risk level is determined, through Table 9, to be medium for occupant life safety, medium for the facility, and very low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of boundary fire.

   i) Appropriate perimeter fence and gate arrangement.
   ii) Vegetation level within the solar farm is to be low (less than 100 mm outside of the landscape buffer).
   iii) Procedure and systems to call out the local fire brigade to extinguish the fire.

5.3.7 Aviation crash

a) Identification of incident – The Fulham Solar Farm is close to the West Sale Airport and its controlled airspace. Although rare it is conceivable for a light aircraft to crash onto the site.

b) Initial risk assessment (IRA) – The IRA is based on no special controls having been implemented.

   i) Likelihood of an aviation crash impacting the site is considered to be rare as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be catastrophic for personnel as the fire may spread and include explosion risk. The facility consequence is critical. Environmental consequence would be minor.
   iii) The risk level is determined, through Table 9, to be medium for occupant life safety, low for the facility, and very low for the environment.

c) Control options – The following provides the various controls that could be applied to mitigate the risk of an aviation crash at the site.

   i) Procedure and systems to call out the local fire brigade to extinguish the fire.

6 Risk Treatment

6.1 Fire Prevention Strategy

6.1.1 The fire prevention strategy for the Fulham Solar Farm is based on the appropriate installation of inherently safe systems plus separation distances that limit the spread of a fire.

6.2 Internal Risks

6.2.1 Solar panel / pod fire – Selected controls

a) The solar panel proposed to be used is the SunTech Ultra Vpro, STPXXXS-C72/Nsh+. These panels meet Class C under UL 790:2022 (Underwriters Laboratories, 2022), as well as having been tested against extended wind and snow loading. Additionally, these solar panels, front and backs are to be covered by 2 mm semi-tempered glass and has an anodised aluminium alloy frame.

b) These solar panels are to be fitted onto a NX Horizon tracking system to form a solar pod. Where NX Horizon tracking system is substituted for an alternative tracking system it shall meet or exceed the fire safety characteristics of this system, to the satisfaction of a fire safety engineer.

c) The installation and maintenance of the solar panel, including the tracking system and cable connections, is to be carried out by suitably qualified and experienced person (SQEP).

d) Vegetation under and around solar pods is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This will restrict fire spread across the site as well as from and to the solar pods.

e) The security fence around the Fulham solar farm shall be appropriate to keep out native animals and livestock.

f) The separation between adjacent solar pods shall be at least 3.6 m, whilst between banks of solar panels the distance shall be 6.0 m, as presented in Figure 11. Class C rating for UL 790:2018 (Underwriters Laboratories, 2022) demonstrates that the solar panels will only propagate fire for a short distance before extinguishment. Therefore, if one solar panel did combust, it's not expected to spread to adjacent panels or panels in another solar pod.

g) Separation of solar pods to the DPS will not be less than 6 m. This is to be managed by the limited fuel load in between these systems. It is noted that from the UL 9540A test results for the GridSolv Quantum system that during the unit fire test at 1.2 m from the side with the fire / thermal runaway Li-ion battery that the radiant heat was less than 1.3 kW/m^2. The solar panels are required to meet Class C of UL 790, (Underwriters Laboratories, 2022). A class C UL 790 test has a gas flame applied to the bottom of the solar panel within the rig for 4 minutes. Until the flaming combustion on the solar panel has ceased the flame spread up the panel has to be less than 3.9 m, whilst sidewards spread has to be less than 0.3 m. The radiant impact from a gas flame is more than a magnitude larger than that expected from the

GridSolv Quantum based on the UL 9540A testing. Therefore, fire spread to the solar panels from the GridSolve Quantum system is not plausible. Additionally, each DPS is to be enclosed by a local soil bund to manage contaminated fire water. This bund is to have a nominal height of 0.5 m. This would further decrease any radiant heat transfer from a DPS fire to solar panels. Furthermore, some DPSs will have sound (absorbing) walls fitted, which are to have a height around 5 m and a fire resistant level of 60/60/60.

Additionally, the radiant heat emitted from the GridSolv Quantum is not expected to lead to a large vegetation fire. This is because the vegetation around the DPS and solar pods is to be no higher than 100 mm. Additionally, (Khan, 2021) highlights that grass of this height will not support spread beyond 15 m.

Finally, as the solar panels meet UL 790 Class C the panel themselves can not support combustion. Therefore, the solar panels can not generate radiant heat which could result in fire spread to a DPS or the grass. It is plausible that an electrical short associated with a solar panel could start a grass fire, if the grass is dry. But noting (Khan, 2021) and that the grass will be kept to no higher than 100 mm then grass fire spread is not expected. Therefore, it does not seem plausible that combustion at a solar panel could impact the DPS due to the separation distance and the low heat release rate associated with these types of fire.

h) The landscape buffer is 15 m away from the solar pods / panels. The landscape buffer has been designed to meet BAL-19 in this arrangement, which relates to at most 19 kW/m² radiant flux imposing onto the solar panel. From studies it is noted that the critical heat flux for a solar panel to ignite is at least 26 kW/m² from (Yang, 2015), whilst (Backstrom, 2012) examining different solar panels found a critical heat flux range of 31 to 34 kW/m². Further to this the solar panel meets Class C for UL 790:2022 (Underwriters Laboratories, 2022), and therefore it is considered implausible for the landscape buffer, when on fire, to ignite a solar panel. The vegetation between the landscape buffer and the solar panels is to be no higher than 100 mm high grass and therefore could not transfer the fire across it as noted in (Khan, 2021).

i) Site-wide CCTV to be provided support to the RMS.

j) Solar pods electrical system to be monitored for faults and issues. Where an issue occurs, notification is to be sent to the RMS.

k) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.

l) Earth bunding mounds are to be provided around each DPS or group of DPS to contain / restrict the flow of contaminated water across the site and off it after a fire. This is covered in Section 6.4.

m) Procedures and training are to be developed to cover the use and maintenance of the solar panels / pods used on site. Additionally, visual inspection of the solar modules after extreme weather events is to be carried out. In addition, there shall be procedures in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.

n) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

   i) Likelihood of a solar module catching fire is considered to be improbable as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be moderate for personnel as there could be slightly injured due to the fire. It is expected that staff members will move away from any fire. The facility consequence is minor as the fire is not likely to spread. Environmental consequence would be minor.
   iii) The risk level is determined, through Table 9, to be very low for occupant life safety, facility, and the environment.

6.2.2 Direct current power cables to the DPS – Selected controls

a) The cables are to transit from the solar pod to DPS are underground.
b) The installation and maintenance of the cables is to be carried out by an SQEP.
c) Vegetation around the cables is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This will restrict fire spread across the site as well as from and to the cables.
d) The security fence around the Fulham solar farm shall be appropriate to keep out native animals and livestock.
e) Site-wide CCTV to be provided support to the RMS.

f) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.
g) Procedures and training are to be developed to cover the use and maintenance of the cables used on site. Additionally, visual inspection of the cables after extreme weather events are to be carried out. In addition, there shall be procedure in the case of a fire, including to call the fire brigade when fire is detected and confirmed.
h) Proposed risk assessment (PRA) – The PRA is based on no special controls having been implemented.

   i) Likelihood of a cable fire is considered to be improbable as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be moderate for personnel as the risk to electrocution has practically been removed. A fire could result in burns and the like. The facility consequence is minor

as the fire is not likely to spread, although at least one cable run would be lost. Environmental consequence would be minor.

iii) The risk level is determined, through Table 9, to be very low for occupant life safety, for the facility, and for the environment.

6.2.3 DPS – Selected controls

a) Fire or fault with the inverter and transformer would be detected by the GridSolv Quantum DC due to lack of supply. This is similar for the DC to DC converter.

b) The GridSolve Quantum and GridSolv Quantum DC will have various fire detection systems. The Wartsila GridSolv Quantum systems are to shut down on fault or fire detection and send notification to remote monitoring. The GridSolv Quantum walls to have an equivalent fire resistant level of 1-hour.

c) Within the GridSolv Quantum there is to be a dry pipe deluge sprinkler system fitted to the container. This dry pipe system is to be used by the local fire brigade to extinguish a fire within the container, if required. The coupling for the dry pipe sprinkler system shall be situated on the other side of the DPS from the inverter and transformer. A second connection shall be on the other side of the road across from the DPS. The use of this system and potential fire fighting scheme is set out in in Section 6.4.

d) The installation and maintenance of the DPS, including the cable connections, are to be carried out by an SQEP.

e) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site as well as from and to the DPS.

f) The security fence around the Fulham solar farm shall be appropriate to keep out native animals and livestock.

g) Separation of solar pods to the DPS will not be less than 6 m. The remaining side will be managed by the limited fuel load in between these systems. It is noted that from the UL 9540A test results for the GridSolv Quantum system, during the unit fire test at 1.2 m from the side with the fire / thermal runaway Li-ion battery the radiant heat was less than 1.3 kW/m^2. The solar panels are required to meet Class C of UL 790, (Underwriters Laboratories, 2022). A Class C UL 790 test has a gas flame applied to the bottom of the solar panel within the rig for 4 minutes. Until the flaming combustion on the solar panel has ceased the flame spread up the panel has to be less than 3.9 m, whilst sidewards spread has to be less than 0.3 m. The radiant impact from a gas flame is more than a magnitude larger than that expected from the GridSolv Quantum based on the UL 9540A testing. Therefore, fire spread to the solar panels from the GridSolve Quantum system is not plausible.
Additionally, each DPS is to be enclosed by a local soil bund to manage contaminated fire water. This bund is to have a nominal height of 0.5 m. This would further decrease any radiant heat transfer from a DPS fire to solar panels. Furthermore, some DPS will have sound (absorbing) walls

fitted, which are to have a height around 5 m and a fire resistant level of 60/60/60.
Additionally, the radiant heat emitted from the GridSolv Quantum is not expected to lead to a large vegetation fire. This is because the vegetation around the DPS and solar pods is to be no higher than 100 mm. Additionally, (Khan, 2021) highlights that grass of this height will not support spread beyond 15 m.
Finally, as the solar panels meet UL 790 Class C the panel themselves can not support combustion. Therefore, the solar panels can not generate radiant heat which could result in fire spread to a DPS or the grass. It is plausible that an electrical short associated with a solar panel could start a grass fire, if the grass is dry. But noting (Khan, 2021) and that the grass is to be kept to no higher than 100 mm then grass fire spread is not expected. Therefore, it does not seem plausible that combustion at a solar panels could impact the DPS due to the separation distance and the low heat release rate associated with these types of fires.

h) As noted in section 6.2.1, the solar panel is not expected to sustain combustion and therefore could not generate sufficient radiant flux to lead to a fire in the DPS.

i) All of the DPS units have been moved into the centre of the site, so can not be impacted by the landscape buffer.

j) As the DPS units are surrounded by a containment bund, this is expected to limit vehicle access and remove the potential for front on collision. Therefore, impact protection devices such as bollards are not recommended to be fitted.

k) Site-wide CCTV to be provided support to the RMS.

l) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.

m) Earth bunding mounds are to be provided around each DPS or group of DPSs to contain / restrict the flow of contaminated water across the site and off it after a fire. This is covered in Section 6.4.

n) Procedures and training are to be developed to cover the use and maintenance of the DPS and the systems used on site. Additionally, visual inspection of the inverter container system after extreme weather events is to be carried out. In addition, there shall be procedure in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.

o) Proposed risk assessment (PRA) – The PRA is based on no special controls having been implemented.

    i) Likelihood of an inverter catching fire is considered to be improbable as set out in Table 7.

    ii) The consequences, as set out in Table 8, are seen to be major for personnel as there could be injuries associated with this fire. The facility consequence is moderate as the fire will impact an inverter. Environmental consequence would be minor.

iii) The risk level is determined, through Table 9, to be low for occupant life safety, very low for the facility, and very low for the environment.

6.2.4 Alternating current power cables to the collection station – Selected controls

a) The cables are to transit from a DPS to collection station are off the ground.
b) The installation and maintenance of the cables is to be carried out by an SQEP.
c) Vegetation around the cables is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site as well as from and to the cable.
d) The security fence around the Fulham solar farm shall be appropriate to keep out native animals and livestock.
e) Site-wide CCTV to be provided support to the RMS.
f) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.
g) Procedures and training are to be developed to cover the use and maintenance of the cables used on site. Additionally, visual inspection of the cables after extreme weather events are to be carried out. In addition, there shall be procedure in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.

h) Proposed risk assessment (PRA) – The PRA is based on no special controls having been implemented.

i) Likelihood of a cable fire is considered to be improbable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel as the risk to electrocution has practically been removed. A fire could result in burns and the like. The facility consequence is minor as the fire is not likely to spread, although at least one cable run would be lost. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be very low for occupant life safety, for the facility, and for the environment.

6.2.5 Collection and switching stations – Selected controls

a) The installation and maintenance of the industrial electrical transmission systems and associated structures are to be carried out by an SQEP.
b) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire

spread across the site as well as from and to the collection and switching stations.

c) The security fence around the Fulham solar farm and the stations shall be appropriate to keep out native animals and livestock. The security fencing around the stations shall support appropriate combustible material separation from electrical systems. Additionally, the security fence limits the potential for a vehicle collision.
d) Site-wide CCTV to be provided support to the RMS.
e) Industrial electrical systems to be monitored for faults and fire which would lead to notification of the remote controller.
f) Control rooms, switchboard room, and battery rooms to have the following fire detection and suppression system:

   i) Each control room and switchboard room shall be fitted with an aspirating smoke detector. This is to be connected to the site's fire indicator panel (FIP),
   ii) The battery rooms shall be monitored by a hydrogen sensor. If a hydrogen sensor is not possible then a point type smoke detector is to be fitted,
   iii) The switchboard room shall be protected with an Inergen gaseous fire suppression system, which meets the requirements set out in AS 4214:2019, (Standards Australia, 2019 (Amend 1)),
   iv) There shall be mechanical ventilation for the battery rooms to support continuous air movement from the floor region out of the roof. On the exhaust side the ventilation system shall be intrinsically safe. If a hydrogen sensor is fitted, then at 20% of lower flammability limit it shall set off local and remote notification. Additionally, the mechanical ventilation system air flow rate is to increase to at least 0.3 m^3 per square metre of floor area per minute, and
   v) Portable fire extinguishers shall be fitted across the control rooms, switchboard room, and the battery rooms in accordance with AS 2444:2001, (Standards Australia, 2001).

g) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.
h) Procedures and training are to be developed to cover the use and maintenance of the systems within Collector and Switching stations. Additionally, visual inspection of these stations after extreme weather events is to be carried out. In addition, there shall be procedure in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.
i) Proposed risk assessment (PRA) – The PRA is based on no special controls having been implemented.

i) Likelihood of a fire at one of these stations is considered improbable as set out in Table 7.

ii) The consequences, as set out in Table 8, are seen to be major for personnel as there could be injuries associated with this fire. The facility consequence is moderate as the fire will impact at least one Li-ion battery container. Environmental consequence would be minor.

iii) The risk level is determined, through Table 9, to be low for occupant life safety, very low for the facility, and very low for the environment.

6.2.6 Site buildings – Selected Controls

a) The buildings are to be fitted with an AS 1670.1:2018 (Standards Australia, 2018) fire detection and alarm system. This will be generally smoke detectors, at locations where false alarms are likely then heat detectors are to be used. Within this building there shall be portable fire extinguishers that meet AS 2444:2001 (Standards Australia, 2001). No fire hose reels are required; if needed this can be justified under a fire engineering report. The building to be of Type C construction and sprinklers are not considered necessary; if necessary the absence of sprinklers can be justified under a fire engineering report.

b) Workspaces and storage arrangements shall be designed to limit the risk of fire and other hazards.

c) The installation and maintenance of the building to be done by an SQEP.

d) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site as well as from and to the site buildings.

e) The security fence around the Fulham solar farm and the stations shall be appropriate to keep out native animals and livestock.

f) The separation distance between the site buildings and the stations and solar pods is to be at least 10 m.

g) Site-wide CCTV to be provided support to the RMS.

h) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.

i) Spill kits shall be located near any and all chemical / dangerous goods stores.

j) Procedures and training to be developed to cover the use and maintenance of the building and the systems being used on site. In addition, there shall be emergency procedures in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.

k) Proposed risk assessment (PRA) – The PRA is based on no special controls having been implemented.

i) Likelihood of an O&M building fire is considered to be improbable as set out in Table 7.

ii) The consequences, as set out in Table 8, are seen to be major for personnel as there could be injuries associated with this fire. The facility consequence is moderate as the fire will impact the building. Environmental consequence would be minor.

iii) The risk level is determined, through Table 9, to be low for occupant life safety, very low for the facility, and very low for the environment.

6.2.7 Vehicle fire – Selected Controls

a) The tracks, including the perimeter road, at the Fulham Solar farm will be covered by vegetation up to 100 mm in high. This is in accordance with the recommendation provided in the Douglas Partner report. The tracks are to be at least 4 m wide. There shall be rigid truck turn around points at least every 1 km. These tracks shall meet the conditions set out in the CFA guide 2022 (Country Fire Authority (Vic), 2023). These tracks shall be rolled/graded every 2 to 6 years depending on their condition.

b) The perimeter road[5] is to also makes up part of the firebreak. This firebreak shall be at least 15 m wide, including the perimeter road. The firebreak area which is not part of the perimeter road is to also have vegetation with a height of up to 100 mm.

c) Vehicles used at the Fulham Solar farm shall be road worthy and appropriate for the role undertaken and load being carried.

d) The installation and maintenance of the roads and site vehicles is to be carried out by an SOEP.

e) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site.

f) The security fence around the Fulham solar farm shall be appropriate to keep out native animals and livestock.

g) Site-wide CCTV to be provided support to the RMS.

h) All site vehicles shall have at least one water portable fire extinguisher (3A rating or higher) to respond to vegetation fire plus another portable fire extinguisher for vehicle fire response.

i) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.

[5] CFA access to the site is assumed to be based on responding to a fire. CFA successfully responds to grass fire in this region on dirt tracks /roads as these events occur in summer, i.e., when the environment is dry. As previously noted, the solar panels meet Class C of UL 790 and therefore will not support flaming combustion without a significant fire input. Therefore, in a wet environment where the dirt track may not support fire truck movement, it is implausible that the solar panel would in themselves generate a fire event requiring the deployment of the CFA to the perimeter roads.

j) Procedures and training are to be developed to cover the use and maintenance of the vehicles on site. This shall include safe driving practices, which is to set a speed limit of 20 km/hr at the site. In addition, there shall be procedures in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.

k) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

   i) Likelihood of a vehicle fire is considered to be rare as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be critical for personnel as a death could still occur. The facility consequence is minor as the fire is not likely to spread. Environmental consequence would be minor.
   iii) The risk level is determined, through Table 9, to be low for occupant life safety and very low for the facility and the environment.

6.3 External Risks

6.3.1 Bushfire / grassfire – Selected controls

a) The surrounding area to the Fulham Solar farm is farmland and a correctional facility. This limits the potential for a bushfire to occur, but a grass fire could still reach the site.

b) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site. This is supported by FM Global 7-106:2023 (FM Global, 2023) that vegetation less than 150 mm would not be a sustained fire hazard. Additionally, (Khan, 2021) presents numerical findings that it is unlikely that a grass fire would spread 15 m where the grass height is no more than 1 m with wind speed of up to 45 km/h.

c) Site-wide CCTV will be provided support to the RMS.

d) The security fence around the Fulham solar farm shall be appropriate to keep out trespassers.

e) Appropriate traces across the site to support fire fighting operations, that meet the CFA design guide 2023 (Country Fire Authority (Vic), 2023).

f) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.

g) Procedures and training are to be developed to cover bushfire incidents, which are to be based on early evacuation and shut-down of the site. In addition, there shall be procedures in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.

h) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

i) Likelihood of an external bushfire / grassfire impacting the site is considered to be improbable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel. The facility consequence is critical as the fire will be slower to spread. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be very low for occupant life safety, medium for the facility, and very low for the environment.

i) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

i) Likelihood of an internal grassfire impacting the site is considered to be improbable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel. The facility consequence is critical as the fire will be slower to spread. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be very low for occupant life safety, medium for the facility, and very low for the environment.

6.3.2 Animal management – Selected controls

a) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site.
b) The security fence around the Fulham solar farm shall be appropriate to keep out native animals and livestock.
c) The installation and maintenance of the fence is to be carried out by an SQEP.
d) Procedures and training are to be developed to cover animal management on site. Additionally, visual inspection of the fences after extreme weather events is to be carried out.
e) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

i) Likelihood of animals impacting the site is considered to be improbable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel. The facility consequence is major as cables and the like could still be damaged, just in smaller numbers compared to the IRA. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be very low for occupant life safety, low for the facility, and very low for the environment.

6.3.3 Pest management – Selected controls

a) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site.
b) Regularly clean up and tidy the site of rubbish and food matter.
c) Set bait/traps across the site, as required.
d) Rodent proof mesh covering openings associated with structures on the sites.
e) Procedures and training are to be developed to cover pest management on site.
f) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

i) Likelihood of pests having a significant fire impact across the site is considered to be improbable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel. The facility consequence is major as cables and the like could still be damaged, just in smaller numbers compared to the IRA. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be very low for occupant life safety, low for the facility, and very low for the environment.

6.3.4 Trespassing – Selected controls

a) The security fence around the Fulham solar farm shall be appropriate to keep out trespassers.
b) Site-wide CCTV will be provided support to RMS.
c) There shall be sign on the perimeter fence stating, 'NO TRESPASSING'. These signs shall be fade and corrosion resistant, made from metal and mechanically fixed to the fence. The letters shall be at least 50 mm in height and the letter colour black and the background white.
d) The installation and maintenance of the fence and monitoring system is to be carried out by an SQEP.
e) Procedures and training are to be developed to cover trespassers on site. This is to include calling the Police.
f) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

i) Likelihood of trespassers impacting the site is considered to be improbable as set out in Table 7.
ii) The consequences, as set out in Table 8, are seen to be moderate for personnel as there quickly move to a place of safety. The facility consequence is major as arson or the similar could be undertaken. Environmental consequence would be minor.
iii) The risk level is determined, through Table 9, to be very low for occupant life safety, low for the facility, and very low for the environment.

6.3.5 Lightning strike – Selected controls

a) The separation distance between adjacent systems to limit the potential for fire spread.
b) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site.
c) Site-wide CCTV to be provided support to RMS.
d) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.
e) The solar farm to be designed and certified to meeting lightning protection and surge protection requirements.
f) Procedures and training are to be developed to cover the response to a lightning strike. In addition, there shall be procedure in the case of a fire, including to call the fire brigade upon detection and confirmation of fire.
g) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

   i) Likelihood of lightning impacting the site and course damage is considered to be improbable as set out in Table 7.
   ii) The consequences, as set out in Table 8, are seen to be major for personnel as there could be injuries. The facility consequence is moderate as an item could still be lost. Environmental consequence would be minor.
   iii) The risk level is determined, through Table 9, to be low for occupant life safety, very low for the facility, and very low for the environment.

6.3.6 Boundary fire – Selected controls

a) Landscaping along the Fulham solar farm is presented at Figure 21, whilst Figure 23 sets out the proposed planting schedule. This landscaping shall include a 15 m wide firebreak. This firebreak shall consist of vegetation that will be no higher than 100 mm.
b) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site. Site-wide CCTV to be provided support to RMS.
c) Site-wide CCTV to be provided support to RMS.
d) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are

distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.

e) Procedures and training is to be developed to cover the response to an incident along the boundary of the site. This is to include when to call the fire brigade.

f) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

   i) Likelihood of a boundary fire to the site is considered to be improbable as set out in Table 7.

   ii) The consequences, as set out in Table 8, are seen to be moderate for personnel as there could be slightly injured due to the fire. The facility consequence is moderate as the fire is not likely to spread. Environmental consequence would be minor.

   iii) The risk level is determined, through Table 9, to be very low for occupant life safety, facility, and the environment.

6.3.7 Aviation crash

a) Vegetation across the site is to be kept to 100 mm height via mowing and spraying herbicide undertaken via appropriate procedures and wearing correct personnel protective equipment. This is expected to restrict fire spread across the site. Site-wide CCTV to be provided support to RMS.

b) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply. More details are provided in Section 6.4.

c) Site-wide CCTV to be provided support to RMS.

d) Procedures and training are to be developed to unexpected incidences that impact the site. This is to include when to call the fire brigade.

e) Proposed risk assessment (PRA) – The PRA is based on the above being implemented.

   i) Likelihood of an aviation incident impacting the site is considered to be rare as set out in Table 7.

   ii) The consequences, as set out in Table 8, are seen to be major for personnel as there could be nearby. It is not expected that staff would be directly impacted by this incident. The facility consequence is major as the fire is not likely to spread but the initial event likely to affect multiple parts of the site. Environmental consequence would be minor.

   iii) The risk level is determined, through Table 9, to be very low for occupant life safety, facility, and the environment.

6.4 Details on Control Measures

6.4.1 Figure 11 presents the proposed arrangement for the site to provide appropriate control measures, including water tank for fire fighting and local earth bunding to limit contaminated water run off. Specifically, this figure presents:

a) Additional emergency access gate at the south-west corner,
b) There are firefighting water tanks around the site to support local fire brigade operations. The water tanks arrangement provides 288 kL of water across the site in tanks that the CFA can access. As noted in CFA design guide 2023 (Country Fire Authority (Vic), 2023), these fire water tanks are distributed around the site, so no DPS is more than 120 m from a water supply, and
c) Earth bunding mounds are to be provided around each DPS or group of DPS to contain / restrict the flow of contaminated water across the site and off it after a fire. Figures 16 to 20 present the arrangements of the earth bunding mounds. .

6.4.2 All personnel associated with the site shall receive basic training that covers:

a) Site and operational risk and hazards,
b) Emergency management roles, responsibilities, and procedures that includes the how to understand what incident is occurring,
c) How to operator systems associated with emergency response, including the fitting of personnel protective equipment,
d) Safe and appropriate storage of chemicals and dangerous goods,
e) Location of first aid kits and other emergency response equipment, and
f) Meaning of bushfire risk levels.

6.4.3 All personnel are to annually demonstrate the above knowledge as well as the site undergo a fully exercise. Involvement of the local fire brigade should be considered.

6.4.4 Proposed fire fighting scheme for the DPS is as follows:

a) If the fire only involves the inverter and transformer and / or the DC to DC converter then standard fire fighting procedure for industrial electrical systems should be applied, including shut down of the DPS and cooling of the GridSolv Quantum components.
b) If the fire only involves the GridSolv Quantum DC this is to be confirmed by checking for hot spots with the forward looking infrared (FLIR) camera. The DPS is to be shut down and all its components to be cooled down. The standard fire fighting procedure for industrial electrical systems should be applied.
c) If the fire involves a GridSolv Quantum but there are no signs of combustion on the outside, then shut down the DPS, confirm the internal temperature from the GridSolv Quantum DC or from the RMS, and the external temperature via the FLIR. If all of the temperatures are below 68°C then do not use the internal dry pipe sprinkler. Instead, apply continuous cooling to

the GridSolv Quantum units and review the temperatures every 10 mins. Once temperature is below 30°C stop cooling.

d) If the fire involves a GridSolv Quantum and the internal temperature is above 68°C, and there may be signs of combustion on the outside, then shut down the DPS, connect to the correct dry pipe coupling and discharge sprinklers for approximately 10 mins whilst continuously cooling the GridSolv Quantum units. Review the temperatures and continue to apply sprinkler and cooling in 10 mins intervals until the internal temperature is below 30°C.

e) If the fire involves a GridSolv Quantum and the deflagration panel has blown out, then shut down the DPS. Apply cooling water continuously across the GridSolv Quantum units and consider protection of adjacent equipment, buildings and infrastructure. Review the temperature via the FLIR every 10 mins and continue until temperature is below 30°C.

6.5 Revised Fire Safety Permit Details

6.5.1 Table 5 providers all the fire safety related permit requirements and the comments on them related to this RMP.

Table 5: Permit Detail Review

Initial Permit Details	Comments based on this RMP
32. Any high value or electrical infrastructure should be installed at or above 600 millimetres above the existing ground surface level.	This has been modified to 300 mm and confirmed by AusNet.
38. Before development plans are endorsed under condition 1, a risk management plan (RMP), incorporating a risk assessment, must be prepared in conjunction with the relevant fire authority. The RMP must:	RMP has been developed.
a. Be prepared with consideration to CFA's Guidelines for Renewable Energy Facilities (the current version at the time of preparing the RMP).	It is believed that this RMP has been prepared in line with that guideline, as well as being updated to the current guideline.
b. Specify an appropriate fire break width around the facility perimeter, between any landscape buffer/screening vegetation and solar panels, battery energy storage systems (and related infrastructure). The width of the perimeter fire break must be a minimum of 10m, and at least the distance where radiant heat flux (output) from the vegetation does not create the potential for ignition of on-site infrastructure.	The fire break is 15 m wide and due to the soil type it will be covered by vegetation with a height no greater than 100 mm. As mentioned above and with consideration of (Khan, 2021) this arrangement is not expected to support fire spread. The perimeter road is part of this fire break. The landscape buffer shall have a BAL of 19 as set out in the simple method in AS 3959. Therefore, the maximum radiant flux which would impact the solar panel and other structures is 19 kW/m^2. Although it may be possible for the landscaping buffer to generate a radiant flux of 19 kW/m^2 at these items, as this buffer will only have a depth of 5 m it would have a shorter duration than that AS 3959 is based on. The solar panels will at least meet class C of UL 790. Under this standard test gas flame is applied to the solar panel to see if ignition as

	well as fire spread occurs. The flame temperature is 704°C, which is a significantly greater thermal input than could be expected from any fuel load at this site. Additionally, solar panels have generally been found to have a critical flux of at least 26 kW/m^2. Therefore, for solar panels it is foreseen that if the landscape buffer was combusting that this would not result in the panel igniting or supporting fire spread through into the site. Similar other structures / materials generally have a critical heat flux higher than 20 kW/m^2, therefore the chance of fire spread is unlikely.
c. Specify appropriate fire break widths between battery energy storage systems (and related infrastructure) and solar panels. The width of the fire breaks must be at least the distance where radiant heat flux (output) from the battery energy storage system fully involved in fire does not create the potential for ignition of adjacent infrastructure (including other battery energy storage systems) and vegetation.	The GridSolv Quantum unit has been tested to UL 9540A up to and including unit testing. This testing demonstrated that thermal runaway of a single Li-ion cell did not lead to propagation across its module, rack, or single unit. During the unit test heat flux was measured at 1.2 m from the unit with the thermal runaway. Due to the equivalent 1-hour fire rating of the walls, the heat flux never meets 1.3 kW/m^2. Due to this fire spread due to radiant heat is not expected.
d. Identify and assess controls for the management of onsite and offsite risks at the facility, including but not limited to: i. Battery chemistry and technology risks including thermal runaway, off-gassing, toxic smoke. ii. Electrical equipment faults. iii. Fire spread between battery containers. iv. Grassfire/bushfire to and from the battery containers. v. Ember attack to the battery containers. vi. Radiant heat and flame contact to the battery containers. vii. Physical/mechanical damage to battery containers. viii. Radiant heat from battery containers fully involved in fire as an ignition source (to other battery containers, site infrastructure, on-site buildings, site boundary and vegetation). ix. Related dangerous goods storage and handling including transformer oil/diesel spills/leaks, refrigerant gas releases. 	This RMP considers onsite and offsite fire risks and demonstrates that there are manageable. To the specific points the following are provided: i. As noted from the UL 9450A test results the off gassing is principal volatile and flammable gases. All gases will be vented from the unit. ii. System monitoring will permit the detection of electrical equipment faults and notification at the RMS. iii. The UL 9450A test demonstrated this did not occur. Both walls of adjacent GridSolv Quantum have an equivalent fire resistant level of 1-hour. iv. Bushfire is unlikely at the site, although a grassfire is possible. The GridSolv Quantum fire resistant walls represents a higher level of fire protection than required for building within a BAL-19 area. Equally the fire resistant walls lower the potential for a fire within the GridSolv Quantum to spread to the surrounding vegetation. v. The GridSolv Quantum is a metal box that will have appropriate metal mesh as such, ember attack is not able to affect. vi. The walls of the GridSolv Quantum have equivalent fire resistant level of 1-hour. Therefore, for radiant heat and flame to be an issue the thermal load and its duration would need to be greater than that in the test. In this situation the fire brigade would have been called out to

 	respond to this external fire event as well as shutting down the DPS. vii. The GridSolv Quantum will be protected by it being seated on concrete pads and that on most sides there is limited access to due to the local earth bund which remove the potential fort a front one collision. Plus, the site's speed limit is restricted to 20 km/hr. viii. From the UL 9450A unit test this is deemed improbable event. If a larger fire / thermal runaway propagation event was to occur there is an internal dry pipe sprinkler system that can be used to thermal manage the conditions within the unit as well as potential knock down the fire within it. If the fire did break out of the unit this would be at the deflagration panel on the roof. The closest item to these units is the solar panel. As the solar panels are positioned below the roof of the unit and meet Class C of UL 790 it is unlikely that combustion would occur. The fire brigade would have the ability to lob water into the unit via the opening due to the blown out deflagration panel. ix. The dangerous goods on site relate to transformer oil and diesel. Significant quantities of these combustible liquids are not located near the GridSolv Quantum. Standard procedures for managing these items shall be applied.
e. Provide an evidence-based determination of the effectiveness of the risk controls against the identified hazards/risks.	The main evidence is that the solar panel meets Class C UL 709 and the GridSolv Quantum passed UL 9450A unit test. The parameters presented from these tests have been used to justify the lack of fire spread risk.
f. Identify battery safety and protective systems including battery management systems, monitoring systems, overcharge detection, off-gas detection, pressure relief systems, thermal detection, smoke detection, gaseous or extinguishing agent (suppression) systems, refrigeration/cooling systems, visual and audible warning systems.	These are covered throughout the RMP.
g. Be developed or peer-reviewed by a suitably qualified, independent third party.	This RMP has been developed by RED Fire Engineers who are suitably qualified and an independent party from the developer.
40. Solar facilities are to have a minimum 6 metre separation between solar panel banks. A bank of solar panels may be that connected to a single power conversion unit/inverter.	The separation distance between solar pods is 3.6 m, whilst for solar banks is 6.0 m or greater. This is shown in Figure 11.
41. The area under solar arrays must consist of non-combustible material such as mineral earth, crushed rock, or vegetation managed to no more than 100 millimetres. Managed vegetation may include localised crops of root vegetables or other plants with low	This is met and noted in the RMP.

flammability, planted to ensure that no part of the plant extrudes from underneath panel banks.	
Siting and Design for Battery Energy Storage Systems Note: CFA acknowledges that the proposed battery installation includes a 20-container AC coupled battery installation in the south-east of the subject site, and 69 DC coupled batteries (in groups of three) located in the separation areas between solar pods/zones.	This arrangement is no longer being applied.
42. Facilities with battery energy storage systems must be designed to separate battery containers/enclosures to a distance that prevents radiant heat exposure from igniting:	This is covered within the RMP.
a. Other battery containers/enclosures (battery to battery ignition).	Demonstrated by the UL 9540A unit test.
b. Related system infrastructure (power conversion equipment, substations, etc.).	Not expected to impact the DC to DC converters based on the UL 9540A unit test.
c. Buildings and structures.	No building or structures near the GridSolv Quantum units.
d. Vegetation, both on-site and off-site, including screening vegetation. The potential for radiant heat impact from surrounding vegetation must be reduced to a level that prevents ignition of battery infrastructure.	Already covered above.
43. The AC coupled battery energy storage systems must be:	No longer in the design
a. Located so as to be reasonably adjacent to a site vehicle entrance (suitable for emergency vehicles).	Not Applicable
b. Located so that the site entrance and any fire water tanks are not aligned to the prevailing wind direction (therefore least likely to be impacted by smoke in the event of fire at the battery energy storage system).	Not Applicable, but fire water tanks spread across the site.
44. All BESS facilities must be:	-
a. Provided with an in-built fire detection and suppression system in each battery container/enclosure. Where these systems are not provided, additional measures to effectively detect and/or suppress fires within containers must be detailed within the Risk Management Plan.	As noted in the RMP the GridSolv Quantum have smoke and hydrogen detectors and a dry pipe sprinkler system.
b. Provided with suitable ember protection to prevent embers from penetrating battery containers/enclosures.	Openings in the GridSolv Quantum are to have appropriate protection against ember attack.
c. Provided with a suitable access road for emergency services vehicles to and within the site, including to battery energy storage system(s) and fire service infrastructure.	There are tracks across the entire site that connect with each DPS and the collector and switching stations.
d. Installed on a non-combustible surface such as concrete.	The GridSolv Quantum will be located on a concrete pad.
e. Provided with adequate ventilation as per the manufacturer's requirements/the Safety Data	The GridSolv Quantum will be implemented in accordance with the manufacturer's

Sheet(s) for the BESS and/or any relevant national or international standards.	requirements. This includes the ventilation and the water chiller system.
f. Provided with underground (buried) cabling and enclosed wiring, except where required to be above-ground for grid connection.	Cabling within the DPS and across the site will be enclosed / buried.
g. Provided with impact protection to at least the equivalent of the W guardrail-type barrier, installed in accordance with the manufacturer's instructions.	The GridSolv Quantum are protected from collision by the concrete pad and that they are surrounded by earth mounds. This removes front on collision risk and with site speed limits significantly reduces sideswipe collision force.
h. Provided with appropriate spill containment (bunding or otherwise) that includes provision for management of fire water runoff.	Each DPS is to be surrounded by an earth mound bunding arrangement.
45. Landscaping/vegetation (buffers, screening or otherwise), to be planted under a requirement of any permit, with a width of greater than 15 metres must be designed in consultation with CFA.	The landscape buffer is to have a width of approx. 5 m.
46. For BESS facilities at unmanned sites, appropriate monitoring and intervention measures must be provided to ensure that any shorts, faults, off-gassing, temperature increases above normal parameters and equipment failures with the potential to ignite or propagate fire are rapidly identified and controlled, and any off-gassing, smoke or fire is notified to 000 immediately.	Each GridSolve Quantum DC has a fire panel for the GridSolv Quantum connected to it. On detection of fire conditions, as well as faults and abnormal conditions within the unit, notification will be sent to RMS. This will lead to appropriate response to the specific issue, including calling 000, where appropriate.
47. The provision for direct alarm monitoring to the fire brigade for BESS automatic detection systems must be considered.	This was considered, however as the site is monitored and controlled by RMS, the operators will investigate the cause of alarms and determine whether a fire has occurred before calling 000. As this is a Country Fire Authority area, review by the RMS team is considered important to limit false call outs.
48. A fire protection system suitable for the risks and hazards at the facility must be provided.	The facility is to be provided with at least 288 kL of fire water for operations. There are monitoring and detection systems associated with the solar panels, DPS, collector and switching stations and the site building. The site is also to be covered by CCTV cameras. Finally, the switchboard room are to be covered by an Inergen system.
49. For the AC coupled battery installation, the fire protection system must be designed in line with the requirements of AS 2419.1-2005: Fire hydrant installations, Section 3.3: Open Yard Protection. For the purposes of determining system requirements, the 'area' referenced within AS 2419.1-2005 may be considered that of the battery installation, including the fire break around the battery infrastructure, rather than the entire area of the yard or site.	AC coupled batteries are no longer within the design.
50. The fire protection system for the AC coupled battery installation must include at a minimum, a fire water supply in static storage tanks of a quantity no less than 144,000L or as per the provisions for Open	AC coupled batteries are no longer within the design.

Yard Protection of AS 2419.1-2005, flowing for a period of no less than four hours, whichever is the greater.	
a. The quantity of static fire water storage is to be calculated from the number of hydrants required to flow from AS 2419.1-2005, Table 3.3. (E.g., For battery installations with an aggregate area of over 27,000 square metres, 4 hydrant outlets are required to operate at 10 litres per second for four hours, which equates to a minimum static water supply of 576 kilolitres.)	AC coupled batteries are no longer within the design.
b. The fire water supply must be located so as to be reasonably adjacent to the AC coupled battery energy storage system and shall be accessible without undue danger in an emergency (e.g., fire water tanks are to be located closer to the site entrance that the battery energy storage system).	AC coupled batteries are no longer within the design.
c. The fire water supply must comply with AS 2419.1-2005, Section 5: Water Storage.	AC coupled batteries are no longer within the design.
51. In addition to the fire water provided for the AC coupled battery installation, the fire protection system for the DC coupled battery installations must include at a minimum, a fire water supply in static storage tanks of an aggregate quantity no less than 144,000 litres.	This has been met.
52. This quantity must be provided across a minimum of three static water tanks that comply with AS 2419.1-2005, Section 5: Water storage, located at strategic locations within the facility. These locations are to include the primary and secondary entrances to the facility, and elsewhere in consultation with CFA.	Please note the distribution of fire water tanks across the site as set out in Figure 11.
53. Static fire water tanks are to be positioned at least 10 metres from any infrastructure (electrical substations, power conversion equipment, battery energy storage systems, etc.).	All fire water tanks are located 10 m from the DPS and the collector station. These fire water tanks may be as close as 2 m from solar panels. All wiring from the solar panel / pods are to be directed away from the fire water tank. The fire water tanks manifold / discharge connection shall be on the opposite side of the tank from the solar panels.
54. Fire water access points must be clearly identifiable and unobstructed to ensure efficient access.	It is intended that the fire water signs and arrangements called up in (Country Fire Authority (Vic), 2023) shall be applied.
55. Any static fire water storage tank(s) must be:	-
a. Above ground water tank(s) constructed of concrete or steel.	The tanks are to be concrete or steel.
b. Capable of being completely refilled automatically or manually within 24 hours.	Refilling is to be done manually, and it is intended that this will be achieved within 24 hours.
c. Provided with a hard-suction point, with a 150 millimetres full bore isolation valve, equipped with a Storz connection, sized to comply with the required suction hydraulic performance. (Adapters that may be required to match the	Each fire water tank is to meet these requirements. The fire water tank and vehicle hardstand may be on a common crushed rock base. There is to be a vehicle hard stand within 4 m of the tank discharge point and in

connection are 125 millimetres, 100 millimetres, 90 millimetres, 75 millimetres, 65 millimetres Storz tree adapters with a matching blank end cap provided.) The hard-suction point must be: i. Positioned within 4 metres to a hardstand area and provide a clear access for emergency services personnel. ii. Protected from mechanical damage (e.g., bollards) where necessary.	the direction of the DPS units that are protected by that tank.
d. An all-weather road access and hardstand must be provided to the hard-suction point. The hardstand must be maintained to a minimum of 15 tonne GVM, 8 metres long and 6 metres wide or to the satisfaction of the relevant fire authority.	The hardstand is planned to be crushed rock of the sized set out. The access tracks are intended to be covered in vegetation.
e. The road access and hardstand must be kept clear at all times.	This shall be achieved.
f. Where the access road has one entrance, a 10 metre radius turning circle must be provided at the tank.	The site has a loop / interconnected road system.
g. An external water level indicator must be provided to the tank and be visible from the hardstand area.	This shall be provided.
h. Signage indicating 'FIRE WATER' and the tank capacity must be fixed to each tank.	This shall be provided.
i. Signage must be provided at the front entrance to the facility, indicating the direction to static water tank(s).	A site map shall be provided at each access gate.
56. Construction of a perimeter road with a width of no less than 4 metres within the perimeter fire break.	This is provided.
57. Roads including on-site access tracks, are to:	-
a. Be of all-weather construction and capable of accommodating a vehicle of 15 tonnes.	The tracks are to be covered in vegetation with a height up to 100 mm and rolled/graded every 2-6 years.
b. Where roads are constructed roads, they are to be a minimum of 4 metres in trafficable width with a 4 metre vertical clearance for the width of the formed road surface.	Roads are not being constructed.
c. Be of average grade no more than 1 in 7 (14.4% or 8.1°) with a maximum of no more than 1 in 5 (20% or 11.3°) for no more than 50 metres.	This shall be met.
d. Where there are dips in the road, they are to be no more than a 1 in 8 (12.5% or 7.1°) entry and exit angle.	This shall be met.
e. Roads must incorporate passing bays at least every 600 metres, which must be at least 20 metres long and have a minimum trafficable width of 6 metres. Where roads are less than 600 metres long, at least one passing bay must be incorporated.	This shall be met.
f. The provision of at least two but preferably more access points to the facility, to ensure	Five access point are to be provided.

safe and efficient access to and egress from areas that may be impacted or involved in fire. The number of access points must be informed through a risk management process.	
g. Where a single point of access is proposed, a suitable turning arrangement at the end of the internal access road must be provided, such as a turning circle of 10 metre radius or T-turn arrangement.	The tracks on site makes a loop and interconnect each other. Where dead ends are formed then a turning circle arrangement is to be included.
58. Road networks must enable responding emergency services to access all areas of the facility.	They do.
59. BESS facilities are to be inspected regularly for any signs of mechanical damage to the external containers/enclosures and any accumulation of materials (including leaf litter) in or within 10 metres of the system. Any identified issues must be immediately remedied.	This is included within the RMP.
60. BESS facilities are to be regularly serviced as per the manufacturer's specifications to ensure that all safety and protective systems are in effective working order.	This shall be implemented.
61. Fire breaks of a width specified in the Risk Management Plan, must be maintained around:	This shall be implemented.
a. The perimeter of the facility.	This shall be implemented.
b. Containers and infrastructure for BESS facilities.	This shall be implemented.
62. Fire break(s) must:	
a. At the perimeter, commence from the boundary of the facility or from the vegetation screening (landscape buffer) inside the property boundary.	This shall be implemented.
b. Be constructed using either mineral earth or non-combustible mulch such as crushed rock.	This is not appropriate for the soil type and would lead to erosion issues. Therefore, the firebreak is expected to be 15 m wide and covered by vegetation of no more than 100 mm in height.
c. Be free of vegetation, including grass, at all times.	This is not appropriate for the soil type and would lead to erosion issues. Therefore, the firebreak is expected to be covered by vegetation of no more than 100 mm in height.
d. Be free of all combustible and extraneous materials at all times (e.g., this area must not be used for the storage of materials or the placement of infrastructure of any kind).	This shall be implemented.
63. Grass within the facility must be maintained at below 100 millimetres in height during the declared Fire Danger Period.	This shall be implemented.
64. All plant and heavy equipment must carry at least a 9 litre water stored-pressure fire extinguisher with a minimum rating of 3A, or firefighting equipment as a minimum when on-site during the Fire Danger Period.	This shall be met.

65. Long grass and/or deep leaf litter must not be present in areas where plant and heavy equipment will be working.	This is expected to be appropriately managed.
69. Prior to the commissioning of the facility, an Emergency Information Container must be installed at each road entry to the site. The container must:	This shall be done.
a. Be painted red and marked 'EMERGENCY INFORMATION' in white contrasting lettering not less than 25 millimetres high.	This shall be done.
b. Be installed at a height of 1.2 metres to 1.5 metres above ground level.	This shall be done.
c. Be unobstructed and accessible with a fire brigade standard 003 key.	The local CFA unit is expected to be provided with a key specific for this site.
d. Be maintained to ensure that the information within is current and accurate, and that the container remains accessible (e.g., clear of vegetation and infestations, and clearly identifiable).	This shall be done.
e. Contain emergency information for the facility, including:	-
General Information: i. A description of the facility, its infrastructure and operations. ii. Site plans that include the layout of the entire site, including any buildings, internal roads, infrastructure, fire detection and protection systems and equipment, dangerous goods storage areas (including BESS facilities and inverters), substations, grid connections, bunds, drains and isolation valves, site neighbours and the direction of north. iii. Details of smoke and fire detection, fire suppression (including the quantity of any on-site fire water supply and related infrastructure) warning and alarm systems at the facility. iv. Contact details for site personnel and/or facility operators, regulatory authorities and site neighbours. v. Procedures for management of emergencies, including evacuation, containment of spills and leaks, and fire procedures (including bushfire/grassfire). vi. A manifest of dangerous goods (if required) as per Schedule 3 of the Dangerous Goods (Storage and Handling) Regulations 2012. vii. Safety Data Sheets (SDS) for any dangerous goods stored on-site, including batteries.	This is to be created and maintained over the lifecycle of the site.
Solar Facilities: i. Specifications for safe operating conditions for temperature and the safety issues related to electricity generation, including isolation and shut-down procedures if solar panels and related infrastructure are involved in fire.	This is to be created and maintained over the lifecycle of the site.
Battery Energy Storage Systems:	This is to be created and maintained over the lifecycle of the site.

i. Specifications for safe operating conditions for temperature. ii. Schematics and technical data for BESS containers. iii. Details of the hazards for the BESS, including thermal runaway, electrical safety hazards, explosion hazards, dangerous goods hazards (including off-gassing), and the effects of fire on the BESS. iv. Details of battery monitoring systems and safety systems, including battery smoke and fire detection systems, fire suppression systems, thermal detection, gas detection and pressure relief systems, cooling systems, and warning and alarm systems at the facility. v. The shut down and/or isolation procedures if the batteries are involved in fire.	

6.6 CFA response to Risk Management Plan

6.6.1 Version D2 of the Risk Management Plan was submitted to CFA on 14 March 2024. On 4 April 2024, CFA provided their response. Table 6 presents the outstanding issues CFA have with the RMP and associated discussions and response.

Table 6: Response to CFA issues

CFA Issues	Discussion and Response
1. The Risk Management Plan (and the supporting documents) provide technical specifications of the proposed battery energy storage system. CFA's expectation is that: a) The anticipated (aggregate) capacity of the BESS across the facility is detailed within the RMP.	Section 3 has been updated to note that the aggregate capacity of 128 MWh.
2. The Risk Management Plan details a fire water supply of maximum 220kL for the facility, incorporating a wholly decentralised BESS arrangement. CFA's expectation is that: a) A minimum of (aggregate) 288kL dedicated fire water supply is provided across the facility.	In discussions with CFA, the need for this requirement was better understood. The available water supply has been modified so that an aggregate of at least 288 kL is supported.
b) The fire water supply consists of tanks of no less than 45kL effective capacity.	Figure 11, demonstrates that this is achieved.
c) Fire water tanks are located: i. At the main vehicle entrance to the site and at least one other entrance; and ii. Within 120m of each battery energy storage system in accordance with CFA's Design Guidelines and Model Requirements for Renewable Energy Facilities v4 2023, Section 4.2.2: Facility Design – Firefighting Water Supply, Battery Energy Storage Systems	The arrangement of fire water tank, fire truck location, and associated distances were discussed with CFA. This permitted a better understanding of this requirement, including that a fire water tank could cover more than one DPS unit. The updated arrangement of the site meets this requirement.

(Decentralised) and/or to the satisfaction of CFA.	
The Risk Management Plan (and support documents) indicate that connection(s) to dry pipe sprinkler/deluge system(s) are provided with the BESS units. CFA's expectation is that: d) The means of providing water (water supply) to the dry pipe system are detailed within the RMP.	This has been discussed and will be provided within the Fire Safety Study. The sprinkler (input) hydrant is to be at least 10 m away from the closest BESS units, which means that it will be on the other side of the earth bund.
3. The Risk Management Plan outlines the Distributed Power Station arrangements. CFA's expectation is that the safety of emergency responders is considered in relation to access to battery energy storage systems, by: a) Providing separation of at least 10m between BESS units and solar panel infrastructure. This minimum 10m area must be non-combustible (e.g., no vegetation).	From discussion with the CFA, it has been agreed that the separation distance could be reduce to 6 m, if supported by a radiant heat assessment. This has been demonstrated within this RMP. The requirement of local bunding around the DPS and sound wall in some cases is expected to limit the width of the area around the DPS unit.
b) Ensuring that access to BESS units does not require emergency responders to enter the 20m arc flash hazard demarcation zone for inverters (or greater where determined through the arc flash hazard management process required by Energy Safe Victoria).	An arc flash hazard management process is being developed. Once available it will be shared with the CFA.
4. The Risk Management Plan indicates that separation between solar panel pods is 3.6m (p. 36) and that a 6m separation will be maintained between solar panel banks (p. 54). CFA's expectation is that the RMP: a) Specifies the correct separation between solar panel pods/banks.	These separation distances have been confirmed and noted within the RMP.
b) Includes a marked-up site plan indicating the six-metre separation locations.	Figure 11 shows separation spacing and can be used to determine the solar banks.
5. The Risk Management Plan shows access roads within the facility, but not around the facility perimeter. a) CFA's expectation is that an all-weather access road is provided around the site perimeter, or to the satisfaction of CFA.	The site has been re-arranged so that no DPS are located on the edge of the site. Therefore, only solar panels fire would be related to the use of the perimeter track. As the solar panels meet or exceed Class C of UL 790, these items will not combust without significant fire / thermal input. Therefore, a fire requiring the use of the perimeter track is dependent on a grass fire occurring. This is implausible if the site is wet and therefore, all-weather track for the perimeter is not recommended. Please note the track (roads) associated with the DPS and from the access gate near the site buildings is to be all-weather track.
6. The Risk Management Plan indicates that fire water containment is to be provided via strategically placed mounds across the existing clay soil. a) CFA's expectation is that fire water retention consists of impermeable barriers	This has been changed to local earth bunding around each DPS unit. The bund is to meet the impermeable requirements set out in publication 1698.

as per EPA's Liquid Storage and Handling Guidelines, publication 1698 dated June 2018.	
7. The Risk Management Plan outlines potential emergency response scenarios that include firefighter actions to connect to the dry pipe sprinkler/deluge system(s) of the BESS units, and the direct application of cooling water to BESS units. CFA advises that these approaches will be considered by emergency responders only where it is safe to do so.	Noted.

7 Monitoring, reviewing, and reporting

7.1 Monitoring

7.1.1 At the Fulham Solar farm active monitoring is to be undertaken. This monitoring shall first and foremost cover any incidence and near misses at the site in addition to the condition of system and components at the site.

7.1.2 Incidents and near misses shall be examined to determine the root causes and what actions to be undertaken to limit them occurring again.

7.1.3 Monitoring of systems and components shall be undertaken regularly in line with appropriate standards and manufacturer's guidance.

7.1.4 Where components fail unexpectedly, there shall be examined, and the maintenance program appropriately adjusted.

7.1.5 Beyond inspections called for under standards and guidelines the following are to be inspected monthly:

a) Vegetation height,
b) Fuel loads, and
c) Signs of rodents and other pests.

7.1.6 Similarly, the following are to be inspected across the site quarterly:

a) Perimeter security fence,
b) Landscape buffer,
c) Firebreak,
d) Fire water tanks,
e) CCTV,
f) Chemical and dangerous goods stores,
g) Batteries for backup power for the communication system,
h) Erosion across the site,
i) Cabling across the site, and
j) Solar panels.

7.2 Reviewing

7.2.1 Reviews of site procedures and control measure systems are to be carried out at least once every 5 years or after an incident that has a consequence of major or greater as noted in Table 8.

7.2.2 All incident data are to be reviewed so as to reduce or eliminate the potential for that incident to occur again at the Fulham solar farm. If the hazard cannot be eliminated, then the potential consequence is to be investigated to see if it can be reduced.

7.3 Reporting

7.3.1 Findings from all of these reviews are to be documented and reported to management, the staff, and the relevant authorities as required under the OHS Act: 2004 (VIC OHS Act, 2004) and Planning and Environmental Act 1987, (VIC P&E Act, 1987).

7.3.2 Where the outcome of the review leads to modification to the site, system(s), and / or procedures for these shall be appropriately reported to management, the staff, and relevant authorities.

8 Conclusions

8.1.1 RED Fire Engineers Pty Ltd has been appointed by The Trustee for Fulham Solar Farm Trust to develop a risk management plan (RMP) of the proposed Fulham Solar farm located at the corner of Hopkins road and McLarens road, Fulham, VIC.

8.1.2 This RMP has investigated the proposed design from the solar panel to the transmission point out of the site. Of significance are the facts that the solar panels meet at least Class C under UL 790 and the GridSolv Quantum passed the unit test under UL 9450A. Both of these outcomes indicate the potential for fire ignition associated with these items as well as fire spread from these items is limited / effectively managed. Overall, the risk is seen as very low to low as long as the risk mitigation measures are appropriately implemented and sustained.

8.1.3 To achieve this very low to low fire risk there are many other control measures applied such as vegetation management across the site and local earth bunding around the DPS units to control the movement of fire water across and out of the site. The use of sound walls at some DPS is expected to improve the water and fire spread management at the site.

8.1.4 The site buildings are to be designed and constructed in accordance with the NCC 2022, (ABCB, 2022). Similarly, the collector and switching stations are to be laid out in line with AS 2067: 2016 (Standards Australia, 2016).

8.1.5 Across the site there are to be various detection and monitoring system for fault and fire identification and notification. The notification of an issue / incident occurs both at the site and at the remote management site.

8.1.6 The site is to be supplied with at least 288 kL of water for fire fighting operations. This water is to be stored in various tanks across the site. Additionally, the switchboard room are to be fitted with Inergen fire suppression system.

8.1.7 CFA is to have access to the site via five gates that connects to the tracks which loop and cross the site.

8.1.8 The soil type at this site makes erosion an issue and therefore vegetation is to be maintained across the entire site, but only to a height of 100 mm. This includes the tracks across the site. There shall also be a landscape buffer along the boundary that is 5 m wide and designed to meet BAL-19 at 15 m.

8.1.9 To limit unauthorised access to the site a security fence surrounds the landscaping buffer. This fence is to also limit animals accessing the site.

8.1.10 This site is to be remotely managed from the RMS. Contractors and support staff are to access the site as required to maintain the equipment and respond to an incident. Therefore, the RMS is to provide the continuous operational monitoring and control of the site.

8.1.11 Systems and components at the site are to be maintained in accordance with Australian Standards, manufacturers guidance, and the guidance provided in Section 7.

9 References

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Appendix A. Site Map

A.1. Fulham Solar Farm

A.1.1. Figure 8 provides a Google aerial view of the location for the proposed solar farm. This image also presents many of the local features. The layout of the site is shown in Figure 9. The arrangement of the solar farm is shown in Figure 11, whilst Figure 12 provides the legend.

A.1.2. The DPS arrangement including sound wall options are shown in Figures 15 to 23. Figure 20 presents the security fence arrangement, whilst the initial landscaping arrangement is shown at Figure 21. The proposed seal roads presented in Figure 21 is incorrect, Figure 23 presents the all-weather road coverage at the site. Figure 22 prese Planting schedule for the proposed landscaping buffer.

Figure 8: Google Map image of the proposed Fulham Solar Farm site © 2023

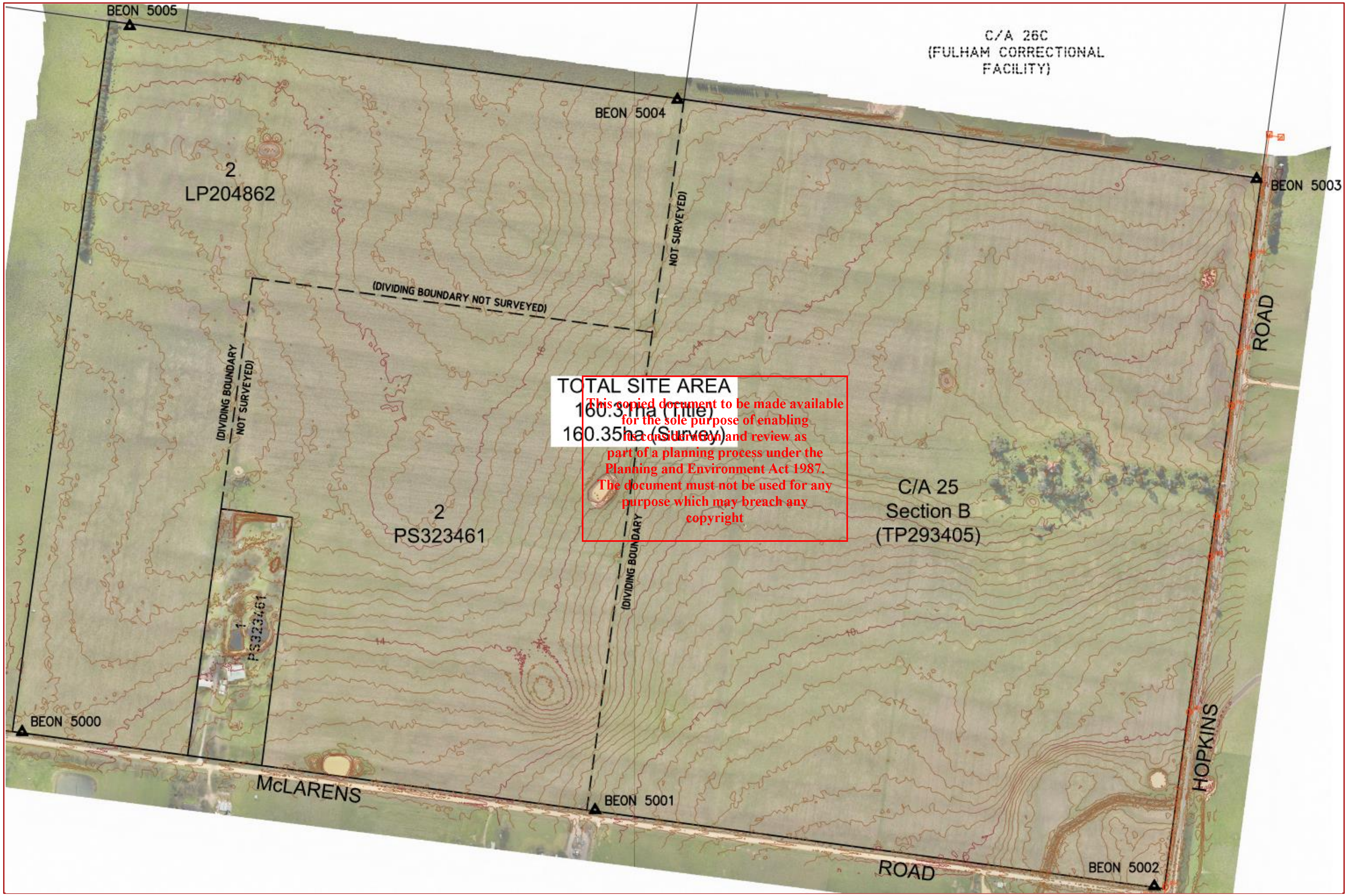

Figure 9: Contour and Boundary Plan

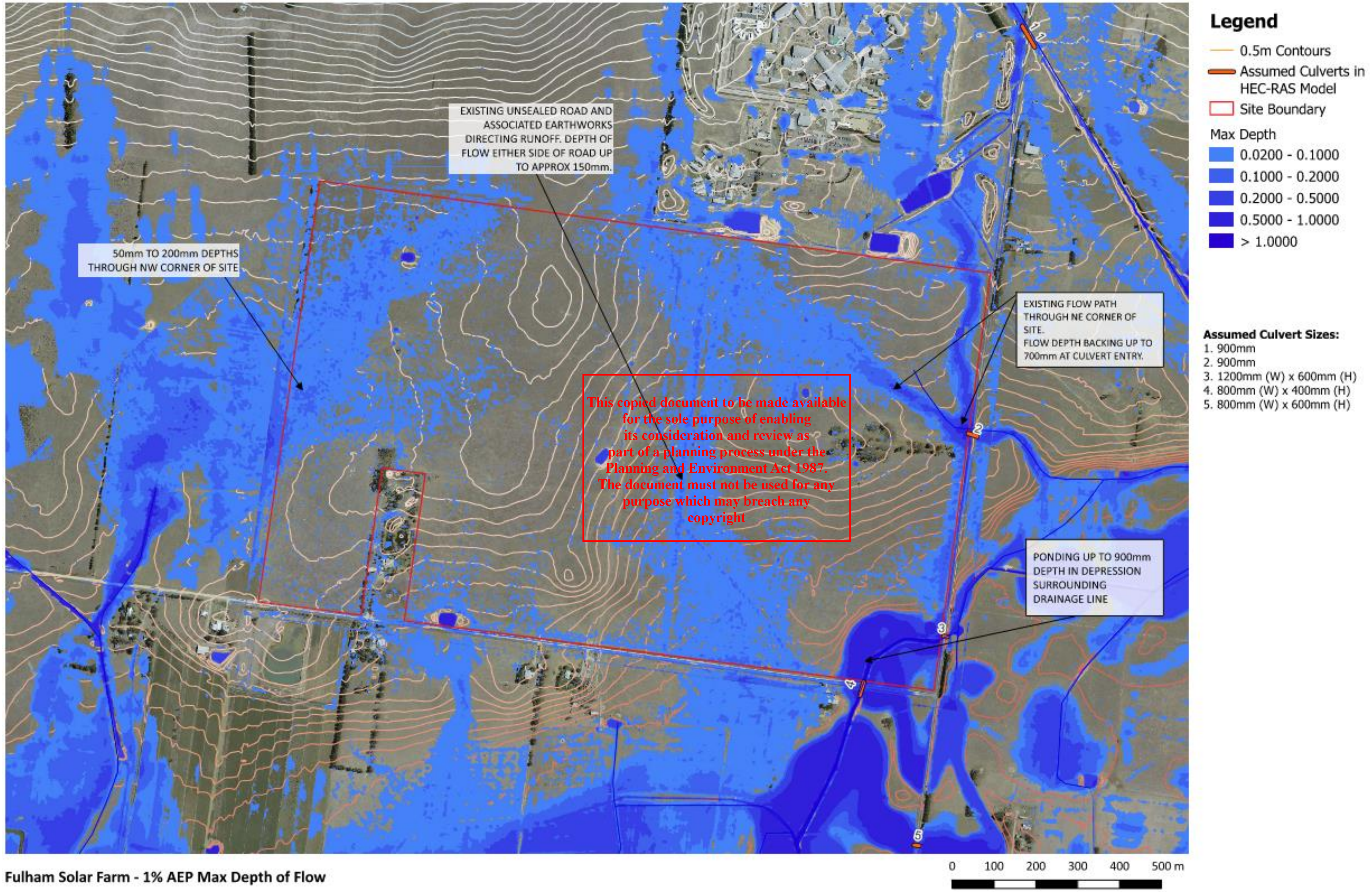

Figure 10: 1% AEP Max Depth of Flow

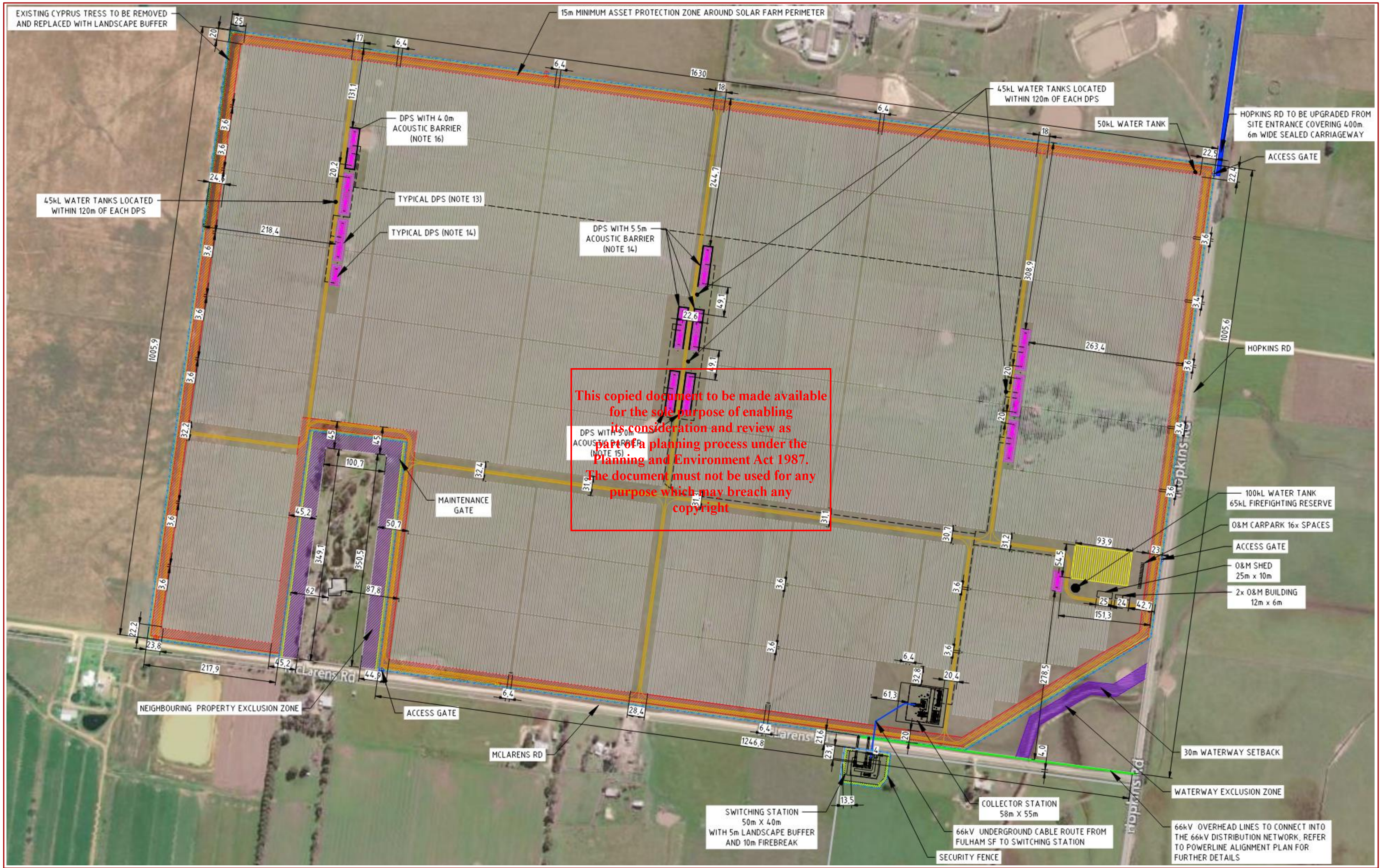

Figure 11: Proposed arrangements for the Fulham Solar farm

TABLE 1 - LEGEND			
LOT BOUNDARY		15m ASSET PROTECTION ZONE	
PERIMETER FENCE		ACCESS GATE	
PROPOSED LAYDOWN AREA		EXISTING VEGETATION	
PV TRACKERS		5m VEGETATION SCREENING	
DISTRIBUTED POWER STATION (DPS)		ACCESS TRACK	
UNDERGROUND 33kV CABLE ROUTE		EXTERNAL ROADS	
EMERGENCY ACCESS GATE		WATER TANKS	
EXCLUSION ZONE		WATERWAY SETBACK	

Figure 12: Legend to Figure 11

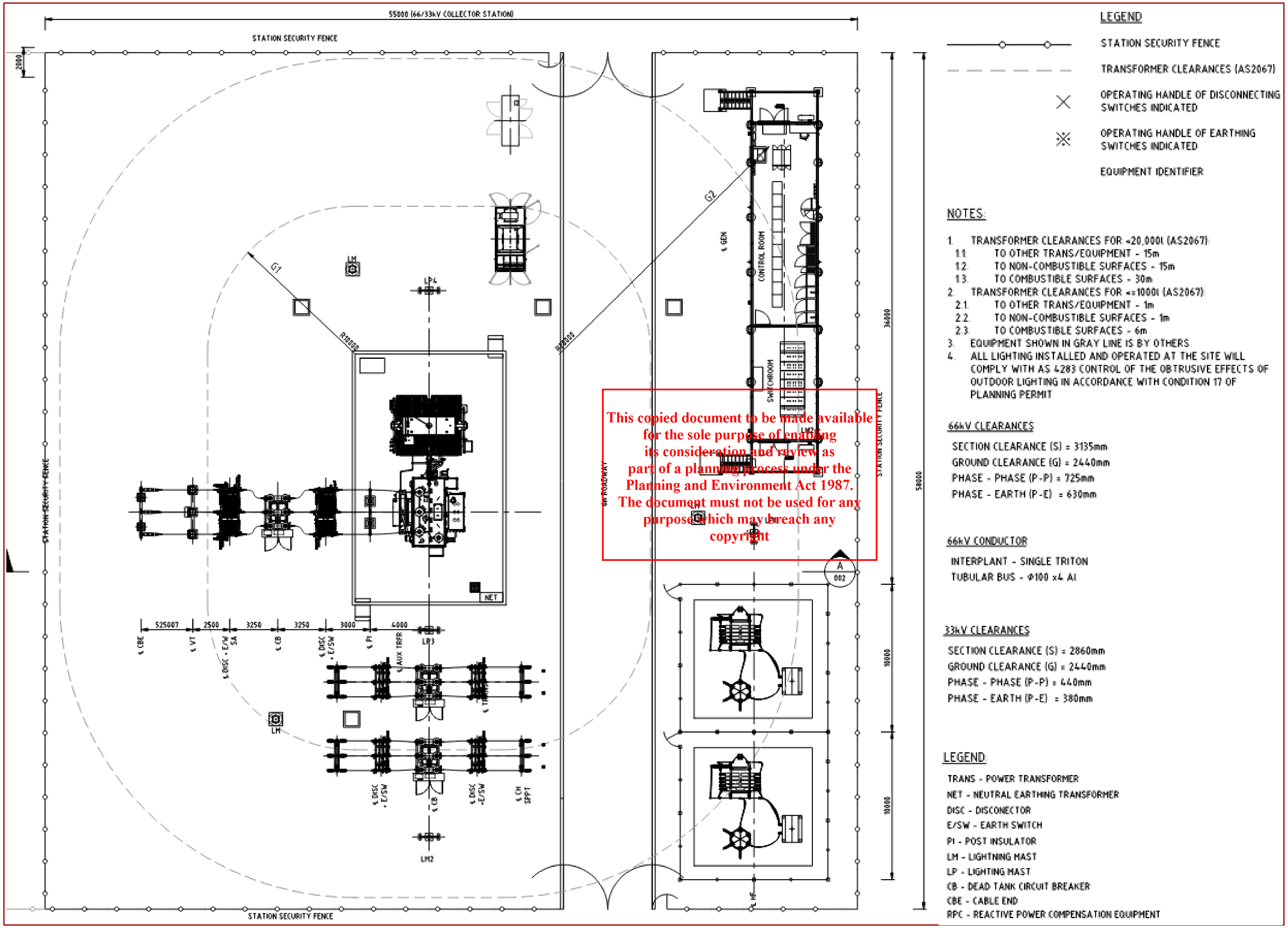

Figure 13: 66/33kV Substation

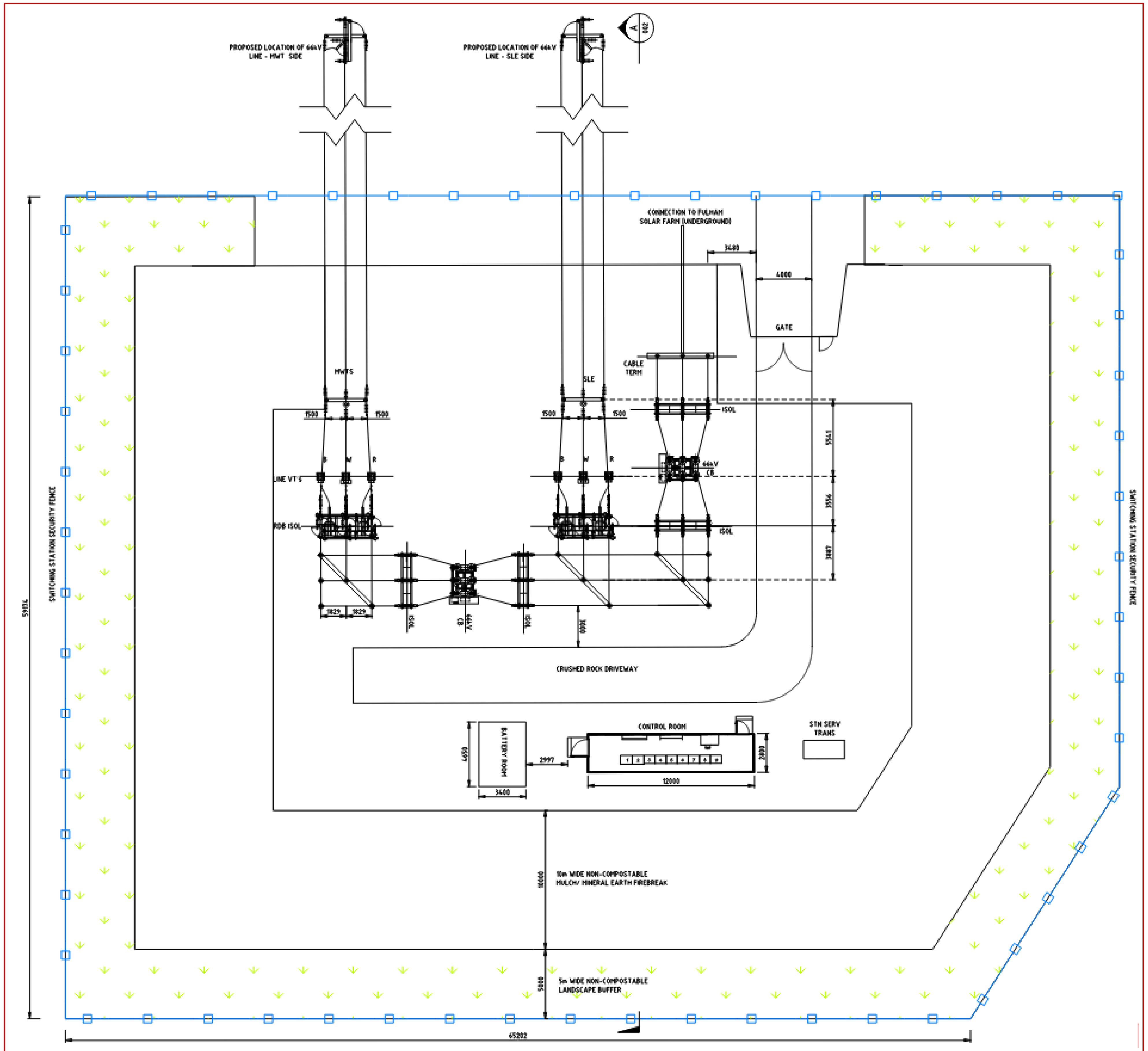

Figure 14: 66kV Switching Station

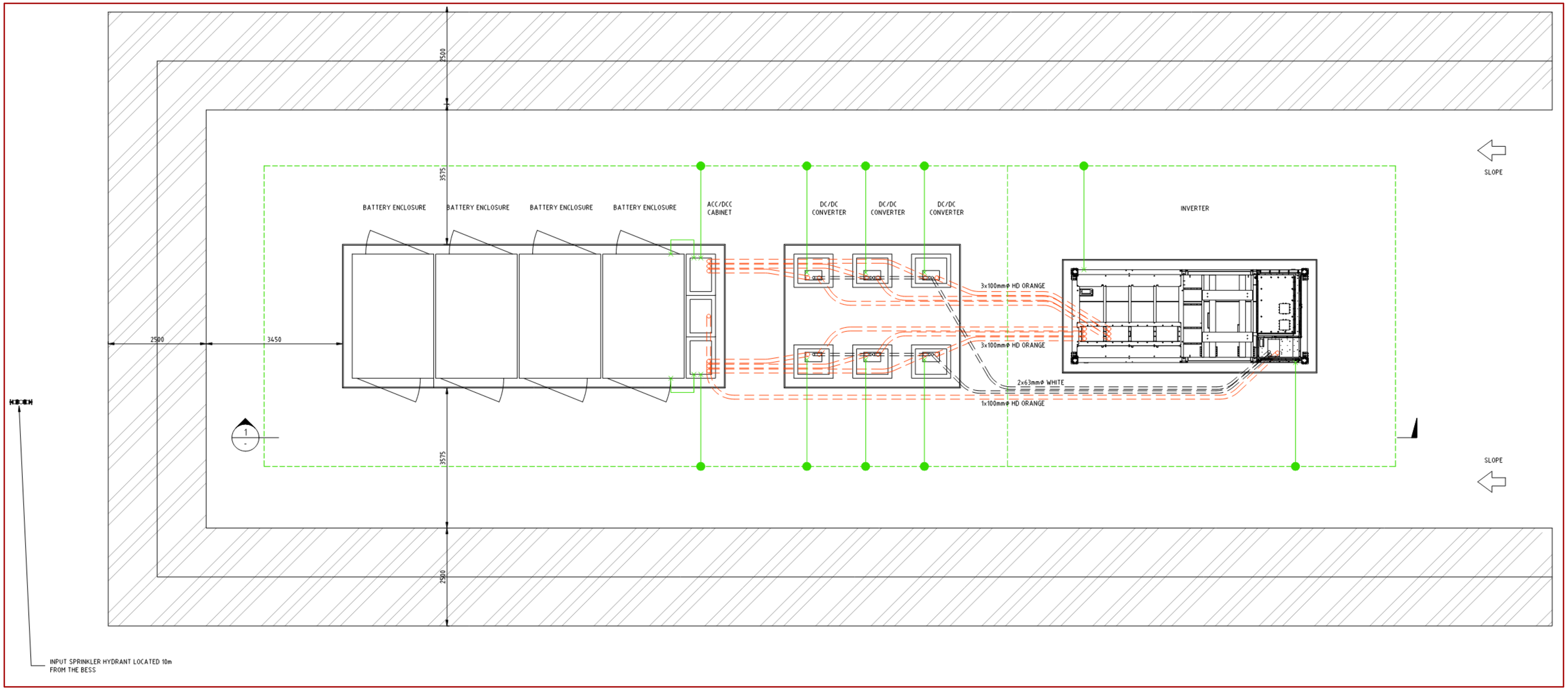

Figure 15: Generic proposed DPS Arrangement, top view

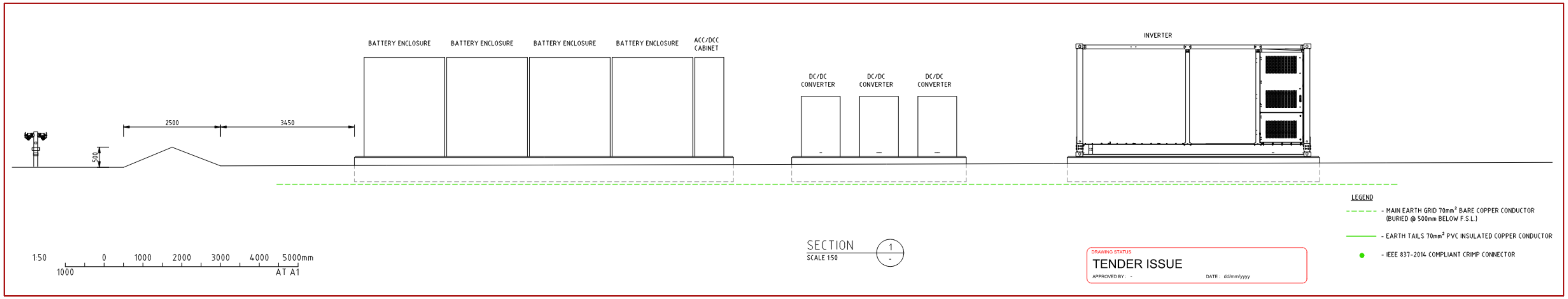

Figure 16: Generic proposed DPS Arrangement, side view

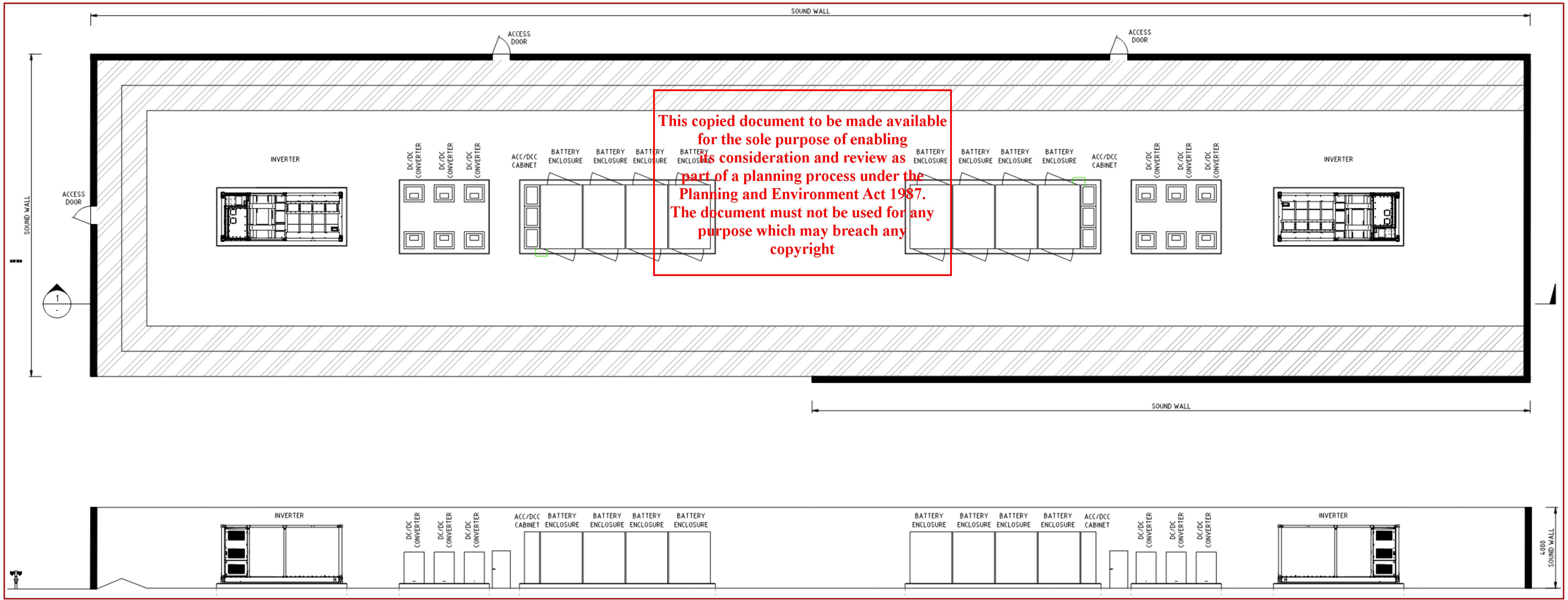

Figure 17: Option 2 sound wall enclosing two DPS units

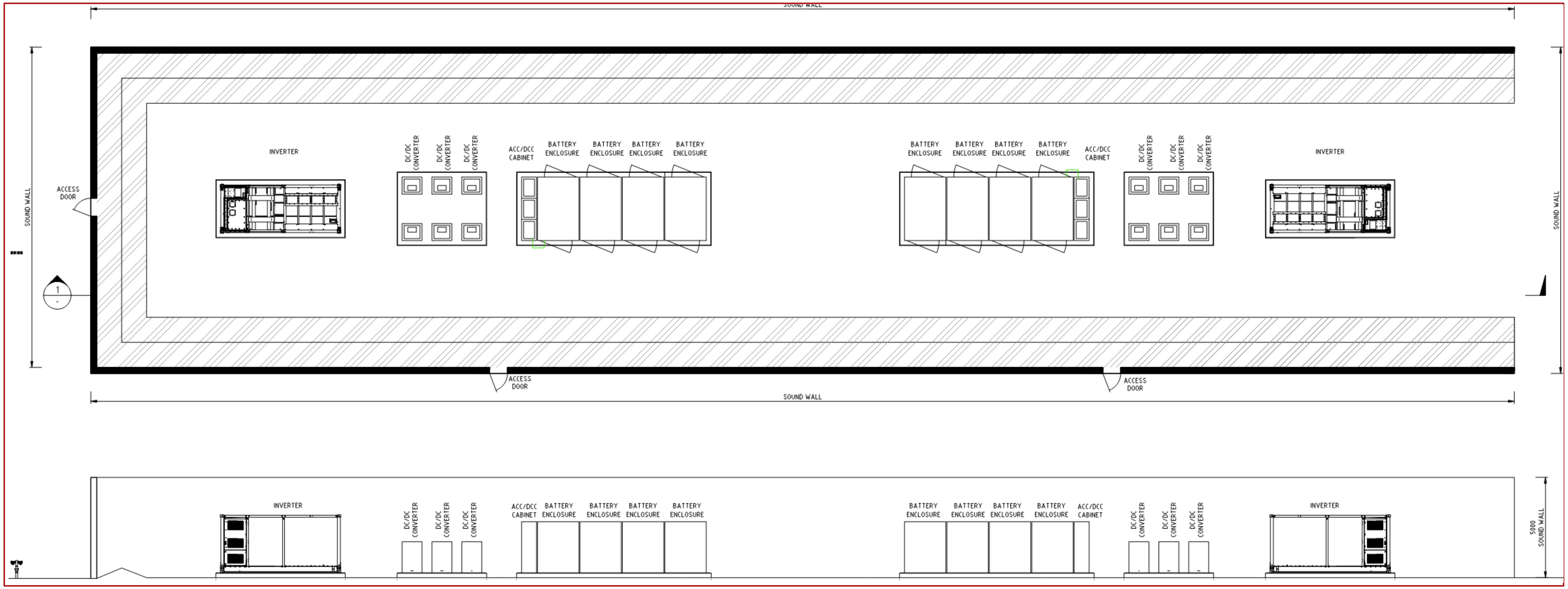

Figure 18: Option 3 sound wall enclosing two DPS units

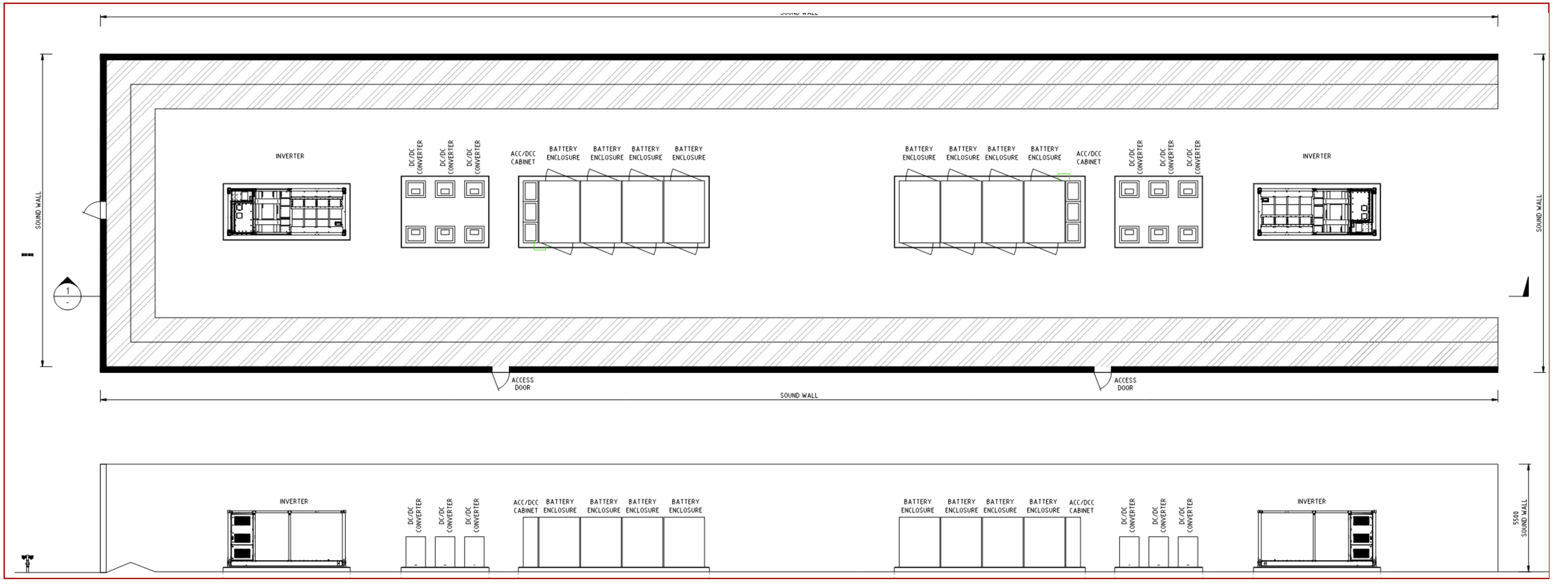

Figure 19: Option 4 sound wall enclosing two DPS units

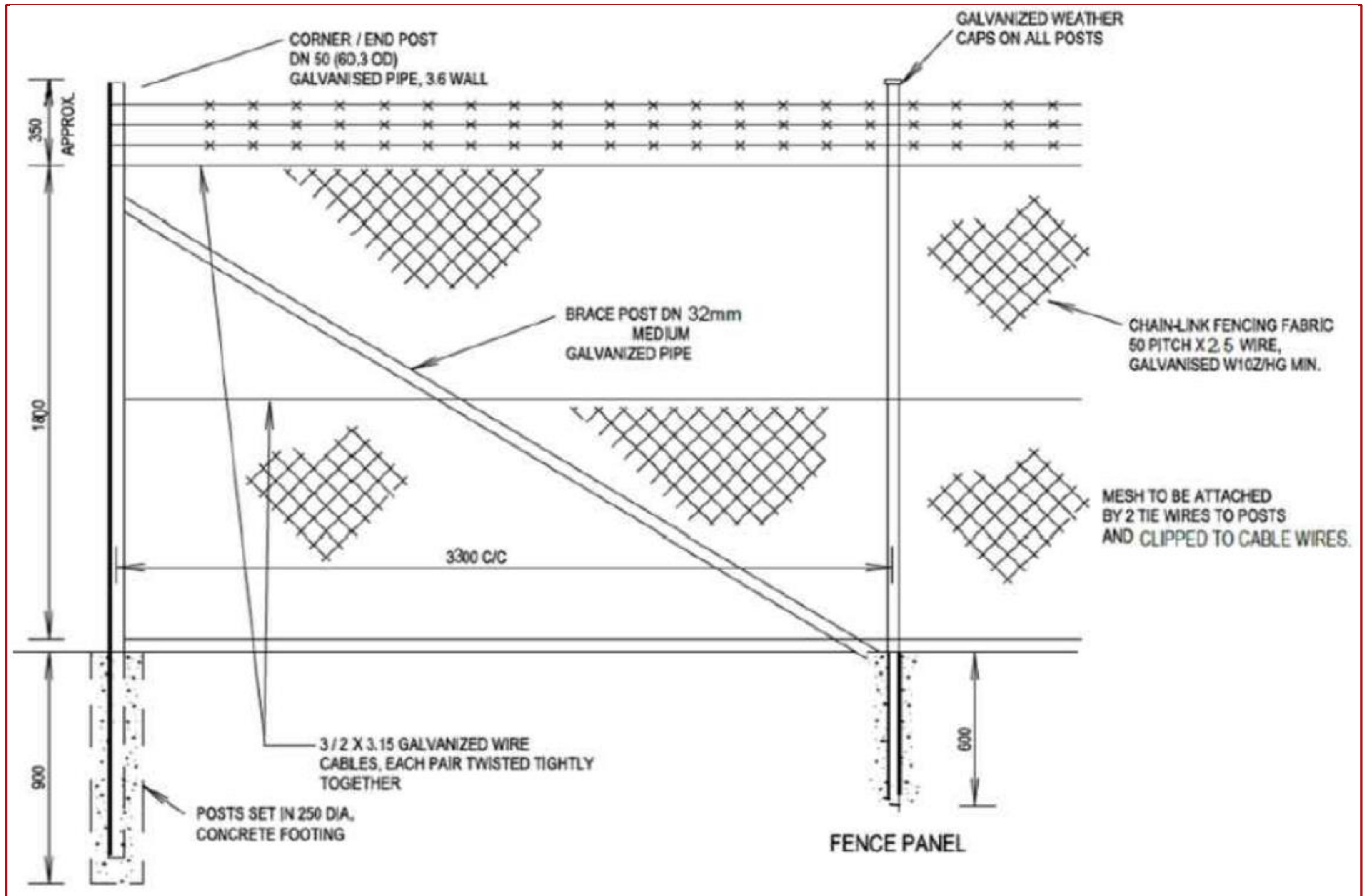

Figure 20: Security fence

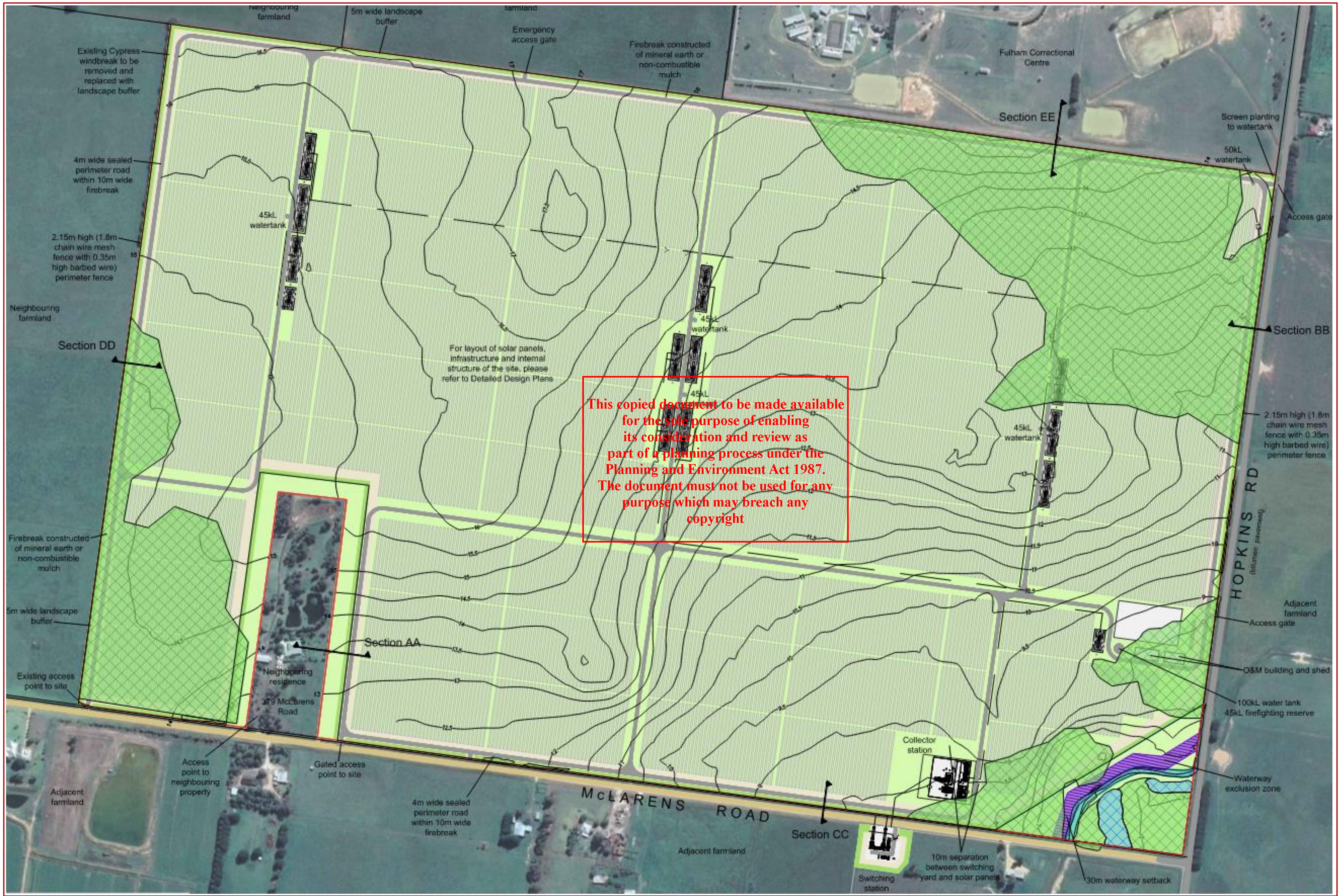

Figure 21: Site landscaping arrangements

Planting Schedule

GIPPSLAND PLAIN BIOREGION
SPECIES FROM PLAINS GRASSY WOODLAND (EVC 55), PLAINS GRASSY WETLAND (EVC 125) & SWAMP SCRUB (EVC 53)
BUFFER ZONE AREA: 28,849m²

CODE	BOTANIC NAME	COMMON NAME	SIZE (MATURITY)	RECOMMEND POT SIZE	% COVER	PLANTING DENSITY	QUANTITY
TREES					N/A		
	Acacia pycnantha	Golden Wattle	5-8 x 3.5	150mm	50%	n/a	290
	Eucalyptus kitsoniana	Gippsland Mallee	5-8 x 5	150mm	50%	n/a	290
SHRUBS					15% (4,327m²)		
	*Kunzea ericoides**	Burgan	2 x 2*	Tubestock	50%	0.25 per 1m²	540
	*Leptospermum continentale**	Prickly Tea-tree	2 x 2*	Tubestock	50%	0.25 per 1m²	540
GRASSES					75% (21,637m²)		
	Lomandra filiformis	Wattle Mat-rush	1 x 1	Tubestock	33%	1 per 1m²	7,212
	Poa labillardieri	Common Tussock-grass	1 x 1	Tubestock	33%	1 per 1m²	7,212
	Themeda triandra	Kangaroo Grass	1 x 1	Tubestock	33%	1 per 1m²	7,212
GROUNDCOVERS					10% (2,885m²)		
	Dichondra repens	Kidney Weed	prostrate	Tubestock	50%	4 per 1m²	5,770
	Microlaena stipoides var. stipoides	Weeping Grass	0.1 x prostrate	Tubestock	50%	4 per 1m²	5,770

* Shrubs exceeding 2 metres growth will be pruned accordingly

Typical Buffer Planting Layout - 20 x 5m Segment

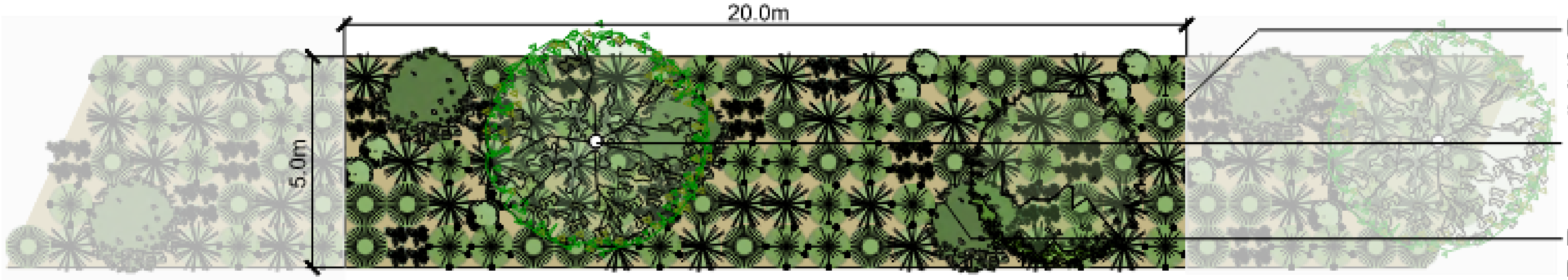

Figure 22: Planting Schedule

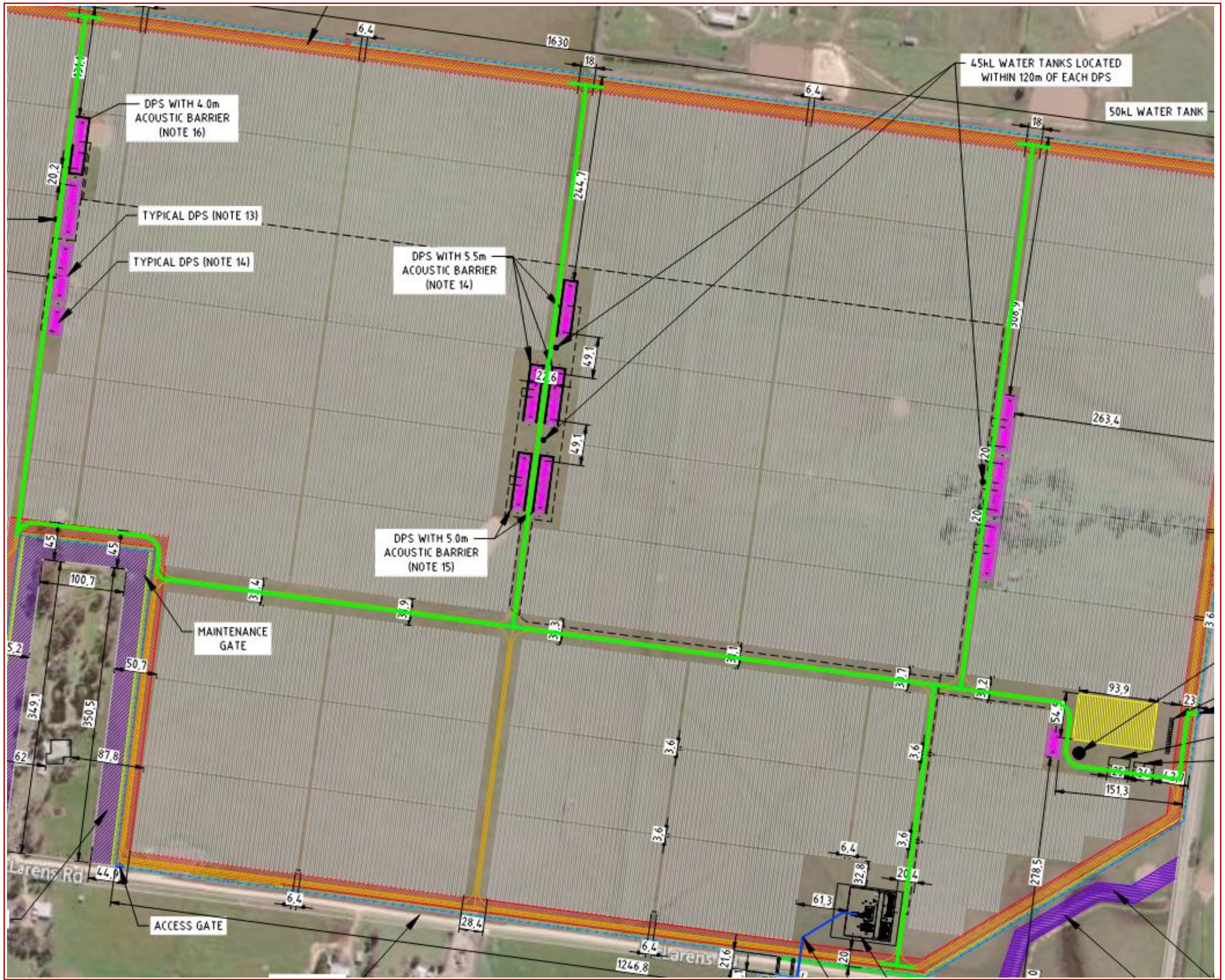

Figure 23: Fire Truck access tracks across the site, in green is all-weather access

Appendix B. Risk Matrix

B.1. Risk Matrix

B.1.1. The risk matrix presented in Table 9 is dependent on the likelihoods defined in Table 7 and the consequences defined in Table 8.

B.1.2. The risk levels presented in Table 9 are defined inn Table 10. Table 10 also sets out the actions to be taken on each of these risk levels.

Table 7: Likelihood Levels

Name	Description	Average recurrence interval / Historical data
Almost Certain	Expected to occur several times a year under normal circumstances.	Less than 1 year / Has occurred 3 or more times in the last year or at least each year over the last 5 years.
Probable	Expected to occur one or more times per 5 year period or numerous times in the system life cycle, nominally taken as 50 years.	Less than 2.5 year / Has occurred twice in the last 5 years.
Occasional	Expected to occur approximately once each 5 year period or several times during system life cycle, nominally taken as 50 years.	Less than 5 years / Has occurred twice in the last ten years.
Improbable	Expected to occur infrequency, but possible to experience one or several times during the system life cycle, nominally taken as 50 years.	Less than 20 years / May occur and has occurred once in the last 20 years.
Rare	Only expected to occur in rare or exceptional circumstances or no more than once during the system life cycle, nominally taken as 50 years.	Less than 50 years / Has occurred only once in the last 50 years or more.
Eliminated	Incapable of occurrence. This level is only used when potential hazards are identified and later eliminated.	Beyond the service life of the facility in this arrangement.

Table 8: Consequence Levels

Rating	Safety (Workers and the Public)	Facility	Environment
Minor	Minor injury or illness that is treatable in the workplace (first aid) or by a registered health practitioner, with no follow up treatment required.	Minimal damage resulting in negligible down time.	Impacts are localised or short term effects on habitat species or environment media.
Moderate	Injury or illness causing no permanent disability, which requires non-emergency medical attention by a registered health practitioner or at least ten minor outcomes.	Limited asset loss across the facility with short downtime.	Impacts habitat species or environmental media within a localised area over a long term or over a widespread area, i.e., no greater than 5,000m^2, for a short period.
Major	Serious injury or illness requiring immediate admission to hospital as an inpatient and / or permanent partial disability or at least ten moderate outcomes.	Serious asset loss and damage to the facility. Noticeable downtime.	Localised area irreversible habitat loss or persistent impact over a widespread area. The effect is not transmitted and / or accumulative.
Critical	Single fatality and / or permanent total disability or at least ten major outcomes.	Severe asset loss and damage, with significant downtime.	Impacts such as persistent reduction in ecosystem function on a large scale, i.e., around 50 km^2, or significant disruption of a sensitive species. The effect may be transmitted and accumulative.
Catastrophic	Multiple fatalities or at least ten critical outcomes.	Total destruction or damage to the facility. Potential for permanent loss of production.	Loss of a significant portion of a valued species or loss of effective ecosystem function on a landscape scale, i.e., around or greater than 100 km^2. The effect is transmitted and accumulative.

Table 9: Risk Matrix

Likelihood	Consequence				
	Minor	Moderate	Major	Critical	Catastrophic
Almost Certain	Low	Medium	High	Very High	Very High
Probable	Low	Medium	High	High	Very High
Occasional	Very Low	Low	Medium	High	High
Improbable	Very Low	Very Low	Low	Medium	High
Rare	Very Low	Very Low	Very Low	Low	Medium
Eliminated	Eliminated				

Table 10: Description of Risk Levels

Risk Level	Description	Action
Very High	Totally unacceptable level of risk.	Stop work and undertake action immediately.
High	Unacceptable level of risk.	Action plan immediately required to put controls in place to reduce risk level.
Medium	Can be tolerable if controls are in place.	Specific monitoring to be undertaken and attempt to reduce risk level. Regular review to be undertaken.
Low	Tolerable level of risk.	Attempt to lower or eliminate risk but higher risk items take priority. Periodic review to be undertaken.
Very Low	Lowest risk level whilst hazard still exists.	Attempt to eliminate risk but higher risk items take priority.
Eliminated	Hazard no longer exists.	No action.