Paling Yards Wind Farm

Electric and Magnetic Fields Assessment

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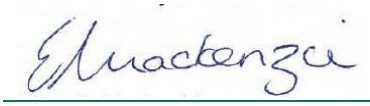
25 November 2022

Paling Yards Wind Farm

Electric and Magnetic Fields Assessment



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Acronyms and Abbreviations

ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
Commissioner	Australian Energy Infrastructure Commissioner
ELF	Extremely low frequency
EMF	Electric and magnetic fields
ERM	Environmental Resources Management Australia Pty Ltd
G	Gauss
GPG	Global Power Generation Australia
ha	Hectares
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICNIRP 2010	*Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz -100 kHz),* ICNIRP 2010
km	Kilometres
kV	Kilovolt
kV/m	Kilovolts per metre
m	Metres
mT	MilliT
MW	Megawatts
NHMCR	National Health and Medical Research Council
SEARs	Secretary's Environmental Assessment Requirements
T	Tesla
NSW	New South Wales
V	Volts
V/m	Volts per metre
WHO	World Health Organization
WTG	Wind turbines generators
µT	MicroT

1. INTRODUCTION

1.1 Project Overview

The Proponent Global Power Generation Australia (GPG) is seeking approval to construct and operate the Paling Yards Wind Farm, located approximately 60 kilometres (km) south of Oberon and 30 km north of Taralga in the Central Tablelands region of New South Wales (NSW) and within the Oberon Local Government Area (LGA) (the Project). A regional locality plan is provided in **Figure 1-1**. The Project would supply up to 287 megawatts (MW) of installed capacity renewable energy directly into the national electricity grid by connecting to the existing Mt Piper to Bannaby 500 kilovolt (kV) transmission line to the north east via a proposed 9 km overhead line of 132 kV with potential for a section of up to 500 kV capacity and switching station.

The proposed development involves the construction and operation of:

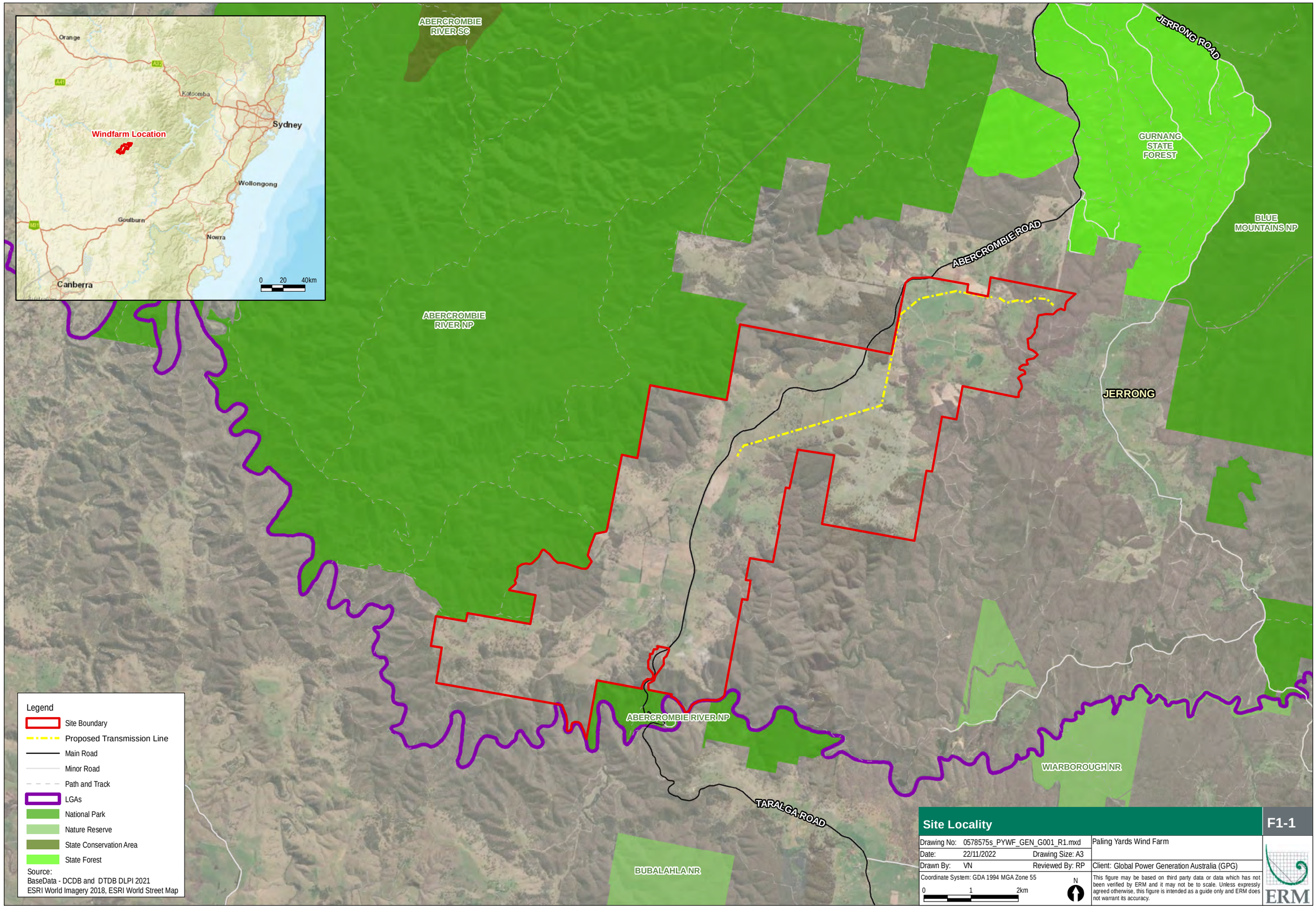
- 47 wind turbines generators (WTG) with maximum height of 240 metres (m) (to blade tip); and
- ancillary infrastructure including internal access tracks, road upgrades, internal electrical reticulation network (both overhead and underground), two on-site substations, three meteorological masts, and operation and maintenance buildings.

The Project encompasses approximately 4,600 hectares (ha) (the 'Project Area'). A preliminary Project layout is provided in **Figure 1-2**.

1.2 Report Purpose

This report considers the potential for adverse impacts from electric and magnetic fields (EMFs) associated with the Project to people within close vicinity of the Project Area and the wider community. The SEARs require the Proponent to:

> *'Health – consider and document any health issues having regard to the latest advice of the National Health and Medical Research Council (NHMCR), and identify potential hazards and risks associated with electric and magnetic fields (EMF) and demonstrate the application of the principles of prudent avoidance'.*



Site Locality

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Coordinate System: GDA 1994 MGA Zone 55

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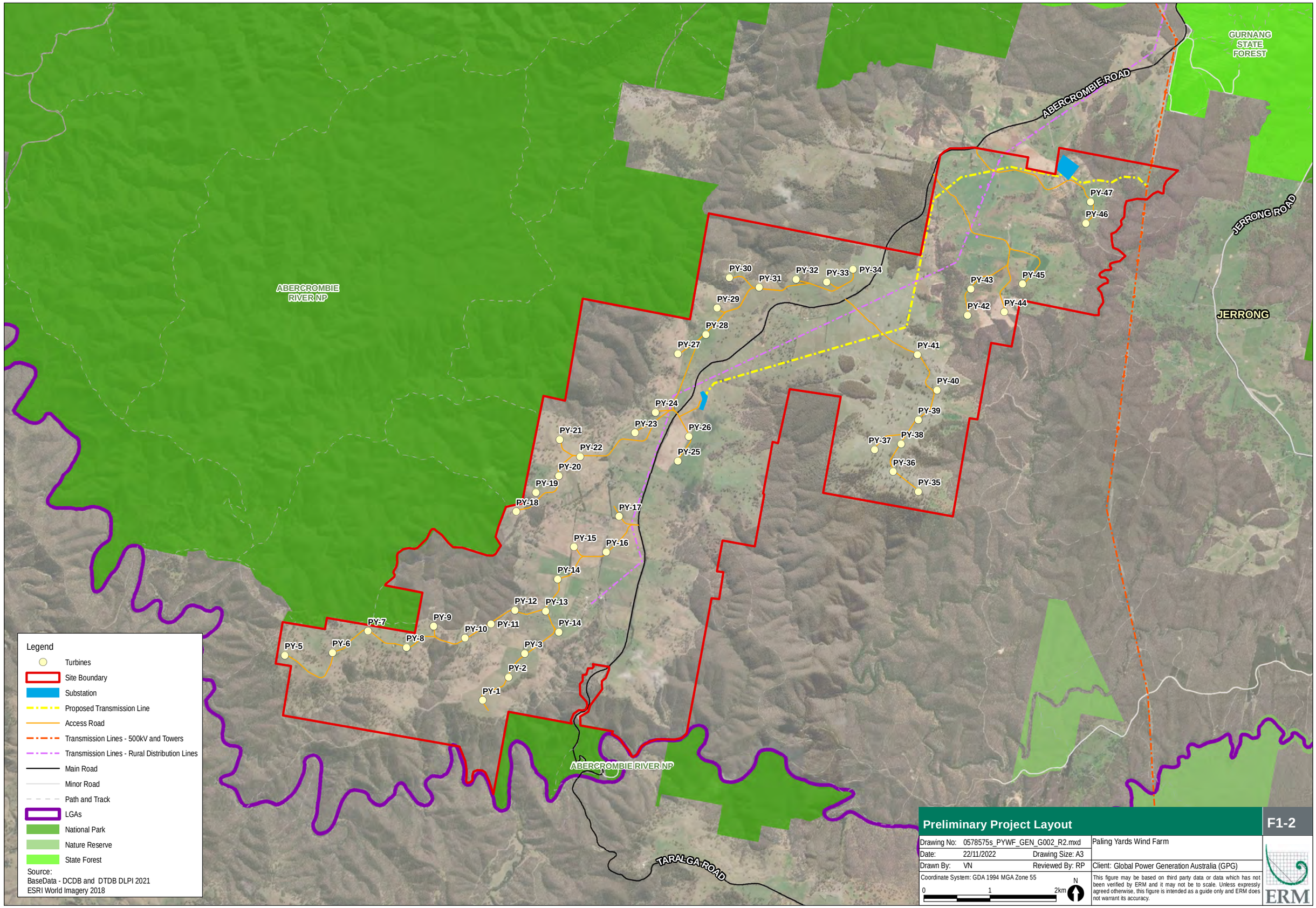
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Legend
Turbines
Site Boundary
Substation
Proposed Transmission Line
Access Road
Transmission Lines - 500kV and Towers
Transmission Lines - Rural Distribution Lines
Main Road
Minor Road
Path and Track
LGAs
National Park
Nature Reserve
State Forest
Source:
BaseData - DCDB and DTDB DLPI 2021
ESRI World Imagery 2018
Preliminary Project Layout
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Paling Yards Wind Farm
Date: 22/11/2022
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Drawn By: VN
Reviewed By: RP
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2. BACKGROUND

2.1 NHMRC Statement: Evidence on Wind Farms and Human Health

The *NHMRC Statement: Evidence on Wind Farms and Human Health* was released on 11 February 2015. The document provides advice to the community and to policy makers regarding the potential impact of wind farms to human health. While it is acknowledged that there are limitations to the existing evidence, NHMRC have concluded that there is currently no consistent evidence that wind farms cause adverse health effects in humans.

2.2 Commissioner's Observations and Recommendations on Health Matters

The Australian Energy Infrastructure Commissioner (Commissioner) is an independent role established in October 2015 by the Federal Minister for the Environment. The Commissioner's role is to facilitate the referral and resolution of complaints received from concerned residents about proposed or operating wind farms, solar plants, energy storage facilities, and transmission projects. Further, the Commissioner promotes best practices related to the planning, development and operation of renewable energy projects, including standards and compliance.

The *National Wind Farm Commissioner 2020 Annual Report* covers the Office's activities for the period of 1 January 2020 through to 31 December 2020.

The 2020 report cites that a number of complaints about wind farms received by the Commissioner's Office include reference to health impacts attributed to wind farm operations. The complainants generally state that such conditions are caused by audible noise and low frequency noise. In some cases, complainants have stated that some health conditions persist even when the turbines are not operating.

Numerous invitations have been extended by the Commissioner to complainants to provide evidence of their medical conditions. Complaints regarding health concerns received by the Office have, in the main, provided only anecdotal evidence regarding stated health issues and perceived causality. The Commissioner therefore concludes:

> *'It has therefore been difficult to form an opinion on whether or not the stated health conditions reported by complainants are valid and, if valid, whether or not the health conditions are possibly a result of the wind farm's operations or from some other known cause'* (Commonwealth of Australia, 2021).

The Office has stated that it will continue to monitor relevant decisions that explore evidence about wind farms and health in consultation with the Independent Scientific Committee on Wind Turbines, such as the guidelines issued by the World Health Organization (WHO) in 2018, as well as hearing outcomes.

The full statement on health can be found via the following link: https://www.aeic.gov.au/observations-and-recommendations/health-matters.

2.2.1 Overview of Electric and Magnetic Fields

EMFs are associated with all electrical wiring and equipment. The electric field is caused by the voltage of the equipment and the magnetic field is caused by the current flowing (amperage). Electric fields and magnetic fields are essentially independent of one another and, in combination, cause energy to be transferred along electric wires.

Electric Fields

Electric fields are the result of an electric charge on an object. The strength of this force is related to the voltage, or pressure, which forces electricity along wires. Electric fields are strongest close to their source, and their strength diminishes rapidly with distance from the source, in much the same way as the warmth of a fire decreases with distance. Many common materials (such as brickwork or

metal) block electric fields, and, for all practical purposes, electric fields do not penetrate buildings. Electric fields are also shielded by human skin, such that the electric field inside a human body will be at least 100,000 times less than the external field. The units commonly used to describe electric field strength are volts per metre (V/m) or kilovolts (1,000 Volts) per metre (kV/m).

To demonstrate the range of electric fields that exist day-to-day, electric fields at normal user distance from appliances are generally of the order of tens of volts per metre. On the other hand, electric fields produced by electric blankets have been reported ranging from a few hundred to more than a thousand volts per metre.

Magnetic Fields

Magnetic fields result from the movement of electric charges, that is, an electric current. The strength of a magnetic field depends on the size of the current (measured in amps), and decreases with distance from the source. Because magnetic fields are related to the current rather than the voltage, high voltage equipment is not the only source of magnetic fields encountered in everyday life. In fact, modern life involves frequent contact with magnetic fields from a variety of sources such as appliances and electrical machinery. While electric fields are blocked by many common materials, this is not the case with magnetic fields. This is one reason why power lines may contribute to the overall magnetic fields in the environment and why burying power lines will not necessarily eliminate these fields.

Magnetic fields are often described in terms of their flux density which is commonly measured in units of Tesla (T) or the older unit of Gauss (G) where:

- 1 Tesla (T) = 1,000 milliT (mT) = 1,000,000 microT (μT);
- 1 μT = 10 mG; and
- 1 Gauss (G) = 1,000 milliG (mG).

Typical Values of Magnetic Fields

Dwellings usually have negligible background electric fields, while magnetic fields are usually in the order of 2 mG. Magnetic fields may reach into the tens of milligauss within dwellings, depending on the location of electrical wiring. The magnetic fields in the vicinity of a selection of appliances are indicated in **Table 2-1**.

Table 2-1 Typical Magnetic Fields of Household Appliances

Appliance	Typical Range at Normal User Distance	
	Microtesla (μT)	Miligauss (mG)
Electric Stove	0.2 - 3	2 - 30
Computer	0.2 - 2	2 - 20
Television	0.002 - 0.2	0.2 - 2
Electric Blanket	0.5 - 3	5 - 30
Hair Dryer	1 - 7	10 - 70
Refrigerator	0.2 - 0.5	2 - 5
Toaster	0.2 - 1	2 - 10
Electric Kettle	0.2 - 1	2 - 10
Pedestal Fan	0.002 - 0.2	0.2 - 2

Source: ARPANSA 2020c

Magnetic field measurements associated with overhead power lines and substations are shown in **Table 2-2**. The magnetic field from power lines will vary with configuration, phasing and load.

Table 2-2 Typical Values of Magnetic Fields Measured Near Overhead Power Lines and Substations

Source	Location of Measurement (1m above the ground)	Range of Measurements*	
		Microtesla (μT)	Milligauss (mG)
Distribution Line (street power lines)	Directly underneath	0.2 - 3	2 - 30
Distribution Line (street power lines)	10m away	0.05 - 1	0.5 - 10
Substation	At substation fence	0.1 - 0.8	1 - 8
Transmission Line (high voltage power lines)	Directly underneath	1 - 20	10 - 200
Transmission Line (high voltage power lines)	At edge of easement	0.2 - 5	2 - 50

Notes: Levels of magnetic fields may vary from the range of measurements shown.
Switching stations typically do not have power transformers and thus would have lower magnetic fields than substations.
Source: ARPANSA 2020c

Standards and Guidelines

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the Australian Government's primary authority on radiation protection and nuclear safety. ARPANSA regulates Commonwealth entities using radiation with the objective of protecting people and the environment from radiation. Established by the *Australian Radiation Protection and Nuclear Safety Act 1998*, ARPANSA commenced operation on 5 February 1999.

ARPANSA considers the publications produced by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), which is a body of independent scientific experts who provide information and advice on the potential health hazards from exposure to non-ionising radiation. ARPANSA is also a contributor to the work of ICNIRP.

ICNIRP has issued *Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz -100 kHz)* (2010) which are aimed at preventing the established health effects resulting from exposure to extremely low frequency (ELF) EMF. Exposure to high levels of ELF EMF is extremely rare and does not occur in people during their day-to-day living (ARPANSA, 2020a).

In Australia, EMFs associated with the use of electricity are generated at a frequency of 50 hertz (Hz). This frequency falls within the ELF range. **Table 2-3** below summarises reference levels for exposure to external magnetic fields and electric fields respectively at 50 Hz as contained in ICNIRP 2010.

Table 2-3 Reference Levels for Exposure to Magnetic Fields and Electric Fields Respectively at 50 Hz (ICNIRP, 2010)

	Magnetic Fields Reference Levels at 50 HZ	Electric Field Reference Levels at 50 HZ
General Public (general exposure)	200 μT	5 kV/m
Occupational (general exposure)	1,000 μT	10 kV/m

3. RISK ASSESSMENT

3.1 Extremely Low Frequency EMF

The process in which an electron is given enough energy to break away from an atom is called ionisation (ARPANSA, 2020b).

ELF EMF occupy the lower part of the electromagnetic spectrum and is non-ionising radiation, or in other terms, there is insufficient energy to cause ionisation and there is not enough energy to damage DNA (ARPANSA, 2020a).

Exposure to high levels of ELF EMF is extremely rare apart from medical exposures to patients and some specialised occupational exposures (ARPANSA, 2020a). Therefore, exposure to high levels of ELF EMF will not occur in people during their day-to-day living.

3.2 EMF and Human Health

Over the past 50 years, concerns have been expressed that the EMFs associated with electrical equipment might have adverse health effects. The issue has been the subject of extensive research throughout the world, which includes more than 2,900 studies at a cost of more than $490 million (Energy Networks Association, 2016). There are known health effects from very high levels of EMFs and health standards have been established to protect against these effects.

The WHO (2020) recognise that to date, no adverse health effects from ELF, long-term exposure to radiofrequency or power frequency fields have been confirmed.

While some researchers believe there is a need for further scientific research, the WHO considers the existing body of research on EMF to be extensive. This assessment however recognises that while adverse health effects from exposure to ELF EMFs have not been established, the possibility remains that such effects may exist.

3.3 EMF and Wind Farms

There has been some research conducted on wind turbine emissions of EMF from both the turbines themselves or from the power lines required for distribution of the generated electricity. Researchers (McCallum, et al., 2014) have associated fears about exposure to EMF from wind turbines to internet sources and misunderstanding of science, as opposed to actual measurements of EMF exposure surrounding existing wind turbines. The available evidence at large does not find EMF from wind turbines to be a likely causative agent for negative health effects in the community (Knopper, et al., 2014).

3.4 EMF and Transmission Lines, Substations and Switching Stations

Energy Networks Association (2016) note that large substations such as zone and transmission substations vary greatly in size, configuration and loading. Key sources of magnetic fields within the substation include the transformer secondary terminations, cable runs to the switch room, capacitors, reactors, busbars, and incoming and outgoing feeders. Energy Networks Association (2016) continue that in most cases the highest magnetic fields at the boundary come from the incoming and outgoing transmission lines, and the magnetic field decrease to background levels within a few metres of the substation. For this reason, Energy Networks Association (2016) conclude that distribution substations are not a significant source of exposure. Switching stations contain fewer sources of magnetic fields than substations (such as power transformers) and thus would likely be an even lower source of exposure than substations.

Table 2-2 presents data showing that the typical magnetic field of a transmission line at the edge of an easement and a substation at the substation fence measures 0.2 - 5 µT (or 2 - 50mG) and 0.1 - 0.8 µT (or 1 - 8mG), respectively (ARPANSA, 2020c).

Table 2-3 provides reference levels for exposure to magnetic fields at 50 Hz, which is the frequency at which electricity is generated in Australia**.** Based on this data, the reference level for magnetic field exposure to the general public and occupational exposure is 200 μT and 1,000 μT respectively (ICNIRP, 2010).

Based on the available data, the EMF from transmission lines and substations, based on likely exposure scenarios, are well within acceptable levels. Furthermore, the locations of Project infrastructure (e.g. substations, switching station, transmission line) are generally a significant distance from dwellings or publicly-accessible locations, indicating that potential EMF exposure from project infrastructure will be negligible.

4. MANAGEMENT AND MITIGATION

The Project has been designed to implement prudent avoidance by ensuring appropriate setbacks consistent with setbacks as detailed below.

4.1 Prudent Avoidance

While compliance with standards and guidelines is important, because they are based on established effects only, such compliance does not imply absolute safety. Therefore, it is generally considered that the prudent avoidance approach is the most appropriate response in these circumstances. Under this approach, power utilities should design their facilities to reduce the intensity of the fields they generate, and locate them to minimise the fields that people encounter over prolonged periods. Provision of setbacks and easements are discussed below.

The practice of 'prudent avoidance' has been adopted by the Energy Networks Association and most Australian power utilities. The Energy Networks Association is the national industry body representing Australia's electricity transmission and distribution and gas distribution network.

The WHO (WHO, 2007) also advocates this response while addressing prudent avoidance in these terms:

> *'…it is not recommended that the limit values in exposure guidelines be reduced to some arbitrary level in the name of precaution. Such practice undermines the scientific foundation on which the limits are based and is likely to be an expensive and not necessarily effective way of providing protection;*
>
> *Electric power brings obvious health, social and economic benefits, and precautionary approaches should not compromise these benefits; and*
>
> *Provided that the health, social and economic benefits of electric power are not compromised, implementing very low-cost precautionary procedures to reduce exposure is reasonable and warranted.'*

4.2 Provision of Setbacks and Easements

In line with the above approach of prudent avoidance, the Project incorporates significant setbacks between residential dwellings and Project components which will generate ELF EMF.

The current setbacks based on the indicative Project layout are outlined in **Table 4-1** and provide further assurance for the community in relation to all ELF EMF generated from the Project:

Table 4-1 Distance Between Dwellings and Project Components

Project Component	Approximate Distance to Nearest Dwelling (m)	Approximate Distance to O&M Building (m)
Substation Option 1	1,151	6,368
Collector Substation	1,300	0
Transmission Line	359	0

5. CONCLUSION

It has not been established that EMFs have any adverse effects on the community. The broadly accepted guideline in both Australia and overseas is to implement a prudent avoidance approach which has been adopted in the Project design through the provision of setbacks and easements. The Project has also been designed in accordance with relevant standards and guidelines as outlined in this document in order to minimise overall risks to EMFs.

Due to the low exposure likely to be generated from the proposed activity and the findings of the scientific community, no adverse impacts are expected due to EMFs from the Project.

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